Topocad 21

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Topocad help system

Get Started

Use this manual as a reference to help you use our software. In the program you will find question marks to lead you back here to the related Topic.

On the top left of the topics you can find where the command is found inside Topocad.

What is Topocad?

Topocad is a CAD application for survey, calculation, design and mapping. It is used in a 3D or 2D graphic mode while working on drawings or in other graphic windows. Some documents are in text mode, e.g. roadline, road profile, camber diagram etc.

Use the survey data document to import survey data from instruments and to calculate coordinates in the drawing.

Create terrain models from the drawing and calculate them from contour lines. Import road lines in civil planning and calculate sections and offset to these. The complete CAD makes it possible to edit polylines, rotate, scale, move and copy these.

Topocad is module based and the other modules are, for example, net adjustment, volume and tunnel calculation, sectioning, profile forms, drawing template, database adapters (ISM, ArcGIS and FDO), railway module etc.

There are different menus in Topocad depending on which type of document that is active. When you start Topocad and has an internet connection, a website with news from the Topocad team will be shown.

Recommended Hardware and installation

The minimum specs will run the program but will not be a very smooth experience when using commands that require more processing power.

The recommended will be a decent performance for most use cases. But for very heavy users as good of a CPU and GPU as possible will ensure the best performance.

Minimum required

OS: Microsoft Windows 7 (32 & 64 bit), Windows 8.1 (32 & 64 bit) or Windows 10 (64 bit)
.NET framework version 4.5 or higher.

CPU: 32 bit: 1.2 GHz (x86) processor or 64 bit: 1.2 GHz (X64) processor
GPU: Compatible with DirectX 11 alternatively OpenGL. 1 GB GPU memory
RAM: 4 GB
Network: Licence server and clients will use TCP/IP protocol
Graphics resolution: 1360 x 768

Recommended

OS: Windows 10 (64 bit) ***CPU:*** 64 bit: 2 GHz (X64) multicore processor
GPU: Compatible with DirectX 11 alternatively OpenGL. 2 GB GPU memory
RAM:16 GB
Graphics resolution: 1920 x 1080

Power user

CPU: 4 GHz (X64) multicore processor
GPU: Compatible with DirectX 11 alternatively OpenGL. 4 GB GPU memory
RAM: 32 GB

Installation of Topocad

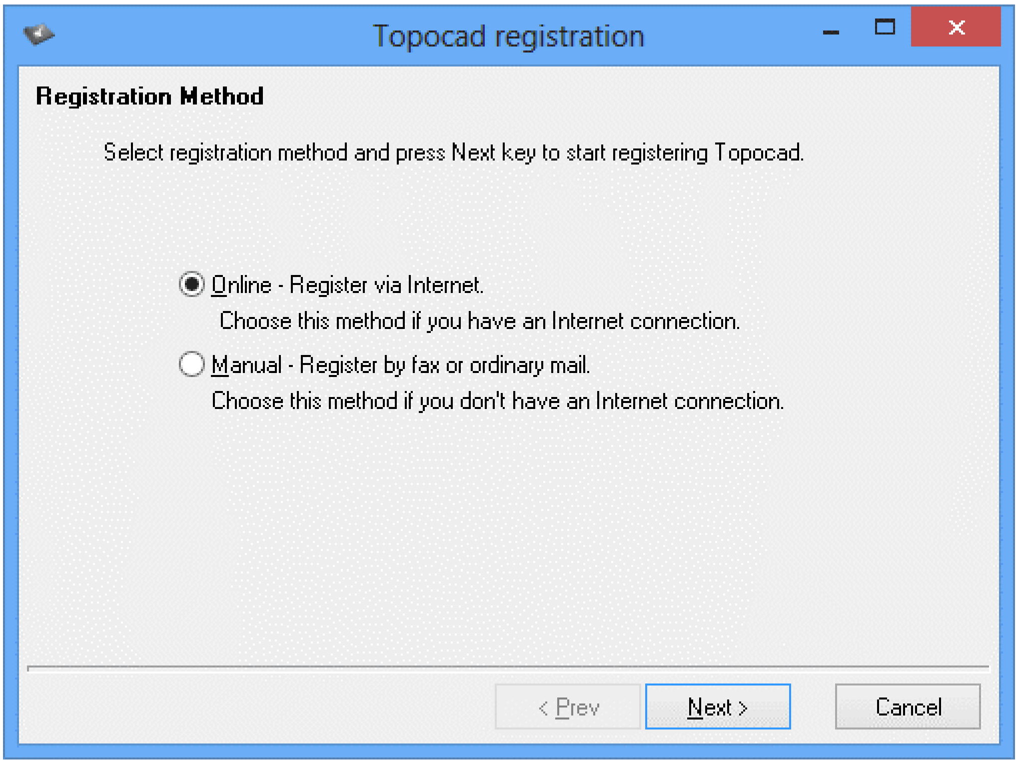
1. Download Topocad from adtollo.se
2. Run the .exe file.
3. After the installation you get asked to register. Use your registrations key to register online. If you have no internet access you can register manually by filling in the registrations form and send it to Adtollo.

Registration

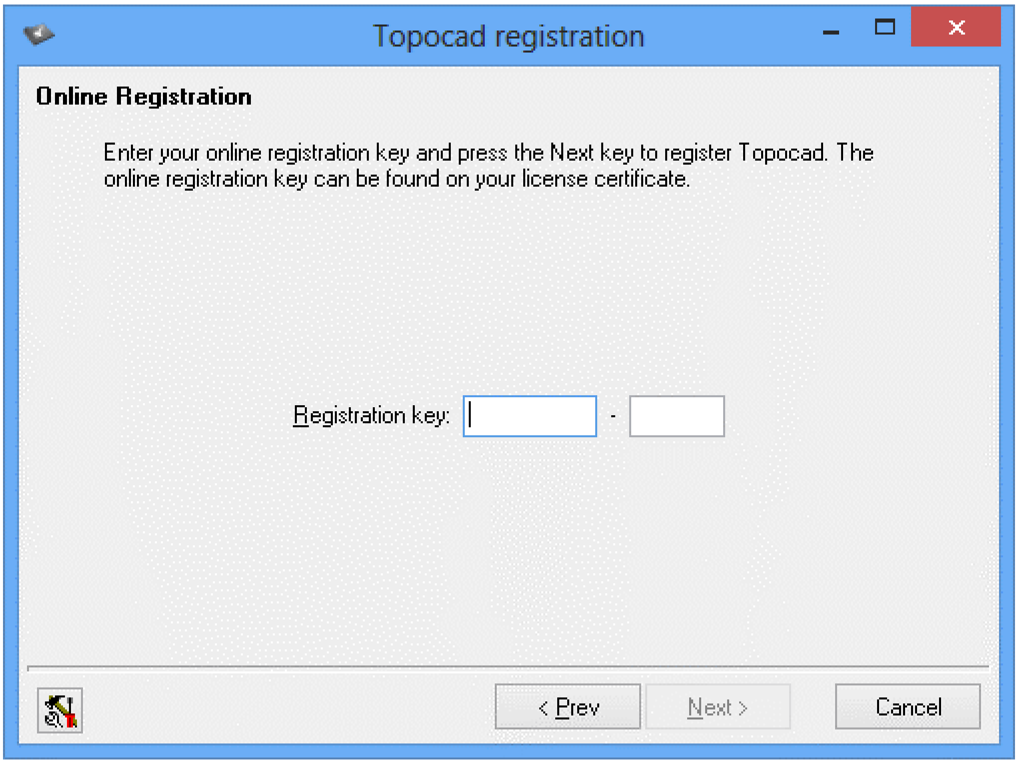
File|Registration

The first time you run Topocad you will be asked to register. Click Yes. There are two ways to register: online or by fax.

Online registration

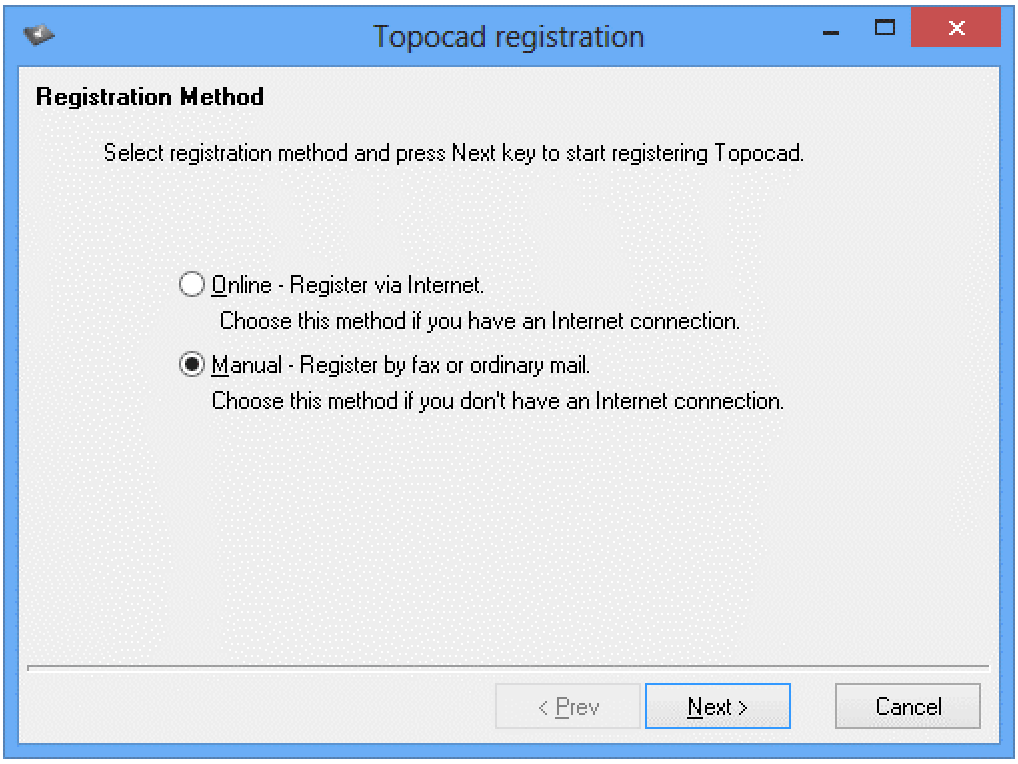


Select Online registration if you have an Internet connection.

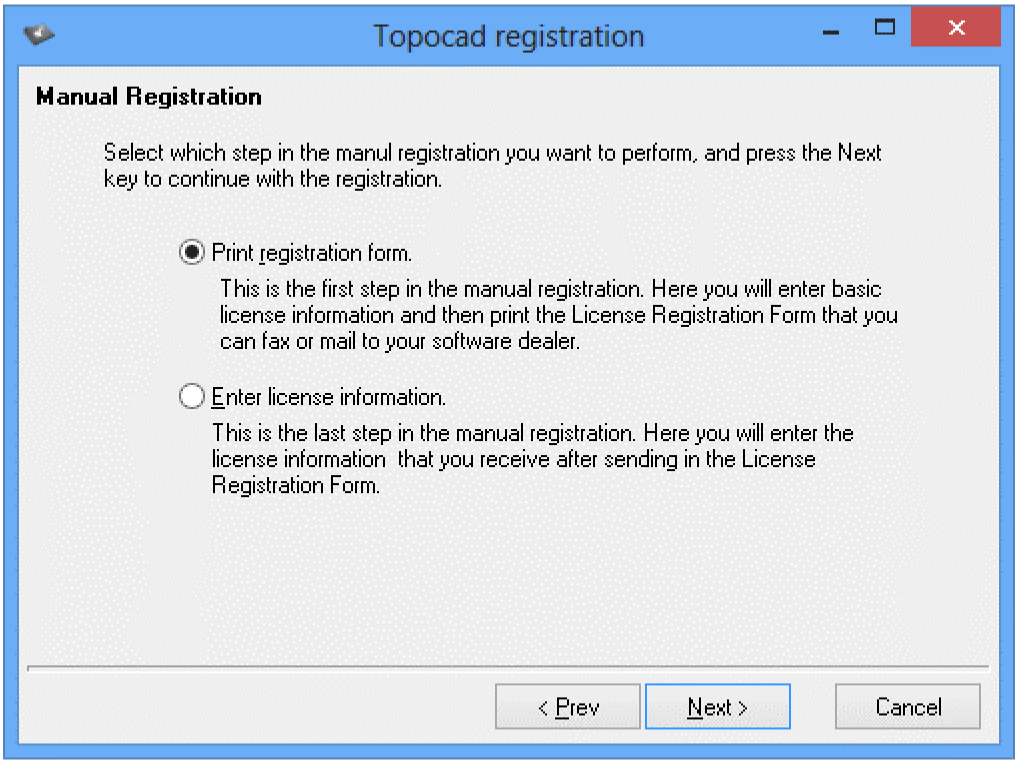


Type in your registration key. You will find this in your license agreement. Your registration is then complete.

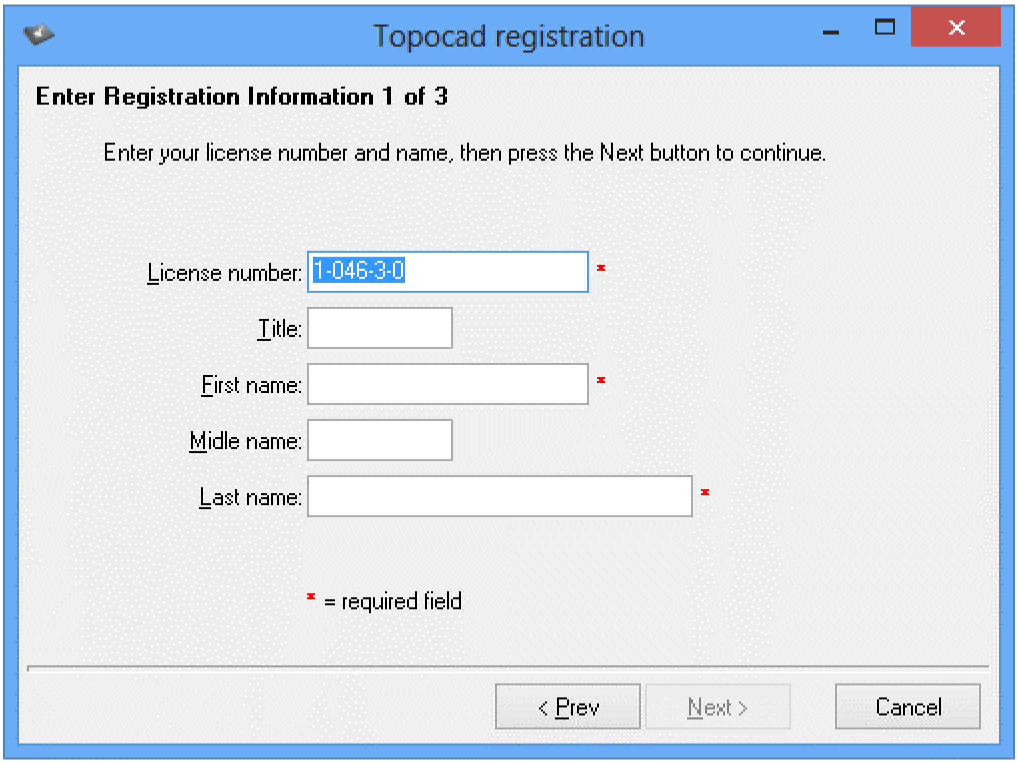
Manual registration - Fax



Select Manual if you don't have an Internet connection.

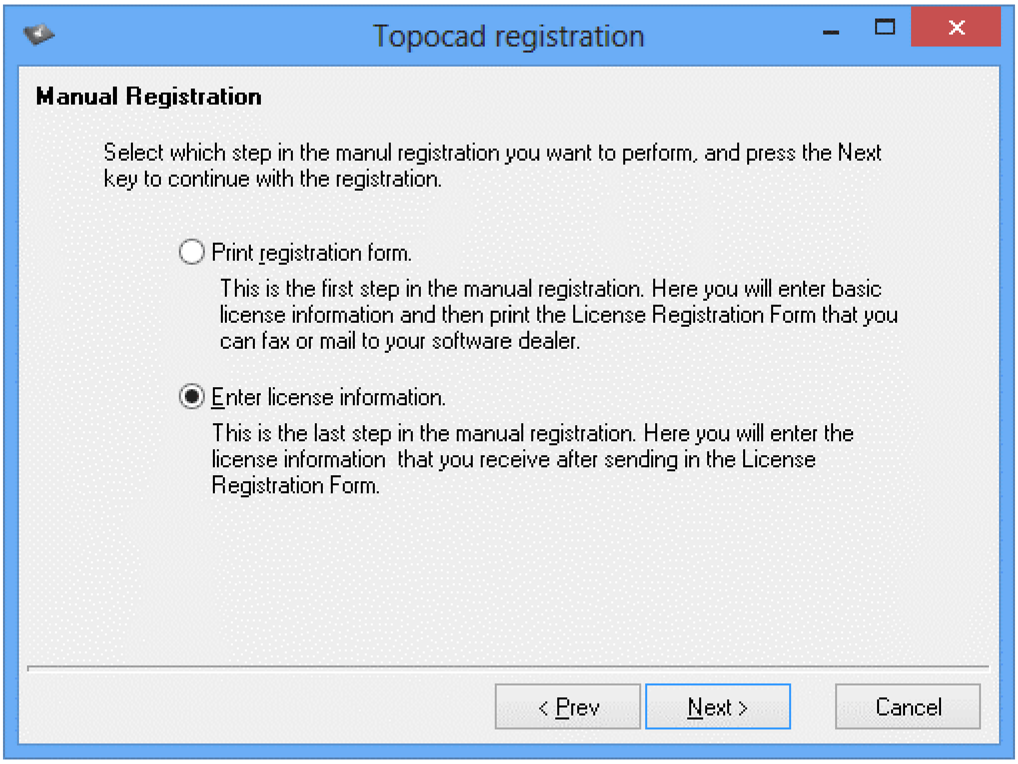


Select Print registration form.



Enter your license number and name. It is especially important to provide your contact details. Your lock code appears.

Print out the completed form and send it to us. You will receive a fax from us with your authorisation code.



When you have the authorisation code, return to the registration to enter the license information. Select Enter license information to fill in the authorisation code.

Your registration is complete!

License number
Your license number has the format A-BBB-C-XXXX
where:

A = Type of license, 1 for standard
B = Country code
C = Type of lock
X = Number

Control code
The control code is entered during online registration.

Add-on modules

Volume Section	01
Geometry	02
Volume Model	03
Net adjustment	04
Tunnel (included in Volume Section)	05
Reader PLUS	06
Engineer	07
Base	08
Earthworks	09

Field (included in Base)	10
ISM database adapter	14
Railway (included in Geometry)	15
Civil planning	16
ArcGIS database adapter	17
FDO database adapter	18
Macro (included in Base)	20
Point clouds	21
and more...	

Packages

Field Engineer package	07, 11
Design package	01, 02, 03, 08
Design package+	01, 02, 03, 08, 21
Volume package	03, 08
Earthworks package	02, 03, 08, 09
Package Base + Arc adapter	08, 17
Package Base + ISM adapter	08, 14
Package Base + FDO adapter	08, 18

Borrow licence

Borrow licence is used to borrow/check out a licence from a common licence server. The function is active only for network licences. The user chooses end date for borrowing the licence in the dialogue box and clicks OK. Maximum time for borrowing a licence is 30 days. The borrowed licence will expire at midnight. If choosing today's date as end date the licence can be borrowed until midnight. When the end date has passed the licence will return automatically to the licence pool.

Return licence is used to return a borrowed licence earlier than the end date. It is only the person borrowing the licence who is able to return it.

How to get going

The easiest way to start is to attend a Topocad training course. It is also possible to purchase training materials.

More info:

http://adtollo.se/en/systems/surveying-mapping/courses/

General commands

To get you started in Topocad there are a few things that are useful to know.

Right mouse button

A right click can be used at all times. This is an intelligent feature and it knows whether or not you have selected objects, whether you are currently executing a command etc and will always try to provide the most appropriate commands for the situation.

If there are no objects selected and you make a right click you will see: Repeat (the latest used command), Select, Zoom, Pan, Drag, Redraw, Regen (regenerate), and the most common construct commands; Polyline, Point, Circle, Arc, Text and Cancel, which cancels current command and also clears all selected objects.

When you have selected an object and click on the right mouse button a different menu appears. Commands connected to the screen are still here; Zoom, Drag, Redraw and Regen, but also the most common Modify commands like Copy, Move, Rotate, Scale and Erase.

When selecting a command we will see a further menu when clicking the right mouse button. First and foremost the Snap function appeared here and also as an icon in the menu to the left. The snap function follows by the most common screen commands and after that the most common commands of the Modify command you selected.

Some general function commands

Start point
In most of the modify commands you need a start point. This is what the command will relate to.

Select object
There are several ways to select an object and it can be done before or during the command.

Escape, release
You can quit the operation with the Escape button. You can quit the selection with the Escape button.

Toolbox/Dialogue box
You can close the toolbox but still continue working with the command.

See

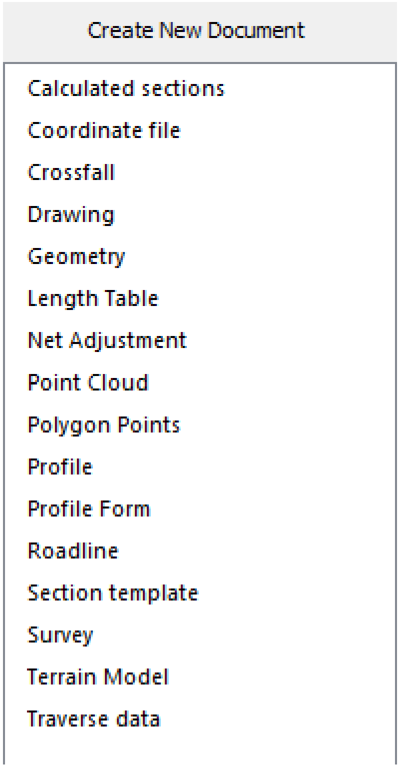
Shortcut keys

Select object

Snap

New document

Quick access toolbar|New



Short key Ctrl+N

Function to create a new document in a new window. The following types of document can be created:

Calculated sections (.tcs)
The calculated sections are saved as this file type.

Coordinate file (.pxy)
This is a window for entering co-ordinate files in .pxy format. It is possible to import .pxy files into .top format, and export .top file to .pxy format, but other than this the two file types are not compatible.

Crossfall - Camber diagram (.tcf)
The camber settings can be saved in a file for use in the profile form etc.

Drawing (.top)
Creates a new drawing - this is the most important component of Topocad. It is a graphic view of the map and drawing. You can change to the text edit view from the graphic view. See also Default drawing

Length Table (.trll)
Length table used in railroad lines.

Net Adjustment (.tna)
The net adjustment is stored in a special file format.

Point Cloud (.tpc)
Point clouds is a document type for managing laser scanning data or other large amounts of points. Data can be imported from coordinate files (*.pxy, *.niv, *.tsd, *.tun), LAS files or by general import. Point clouds can be used instead of terrain models (*.DTM), in calculated sections and in the command *Volume calculation between models.*

Polygon Points - PP files (.pp)
This is a special kind of document in which polygon points can be entered. This file can be imported to and exported from the Topocad drawing format .top.

Profile (.trp)
Contains section and height data for road profiles.

Profile Form (.tpf)
The form for longitudinal sections and terrain longitudinal sections.

Roadlines (.trl)
Topocad Roadlines is the format for roadlines and they are created in this format. It is also possible to import the .trl format into Topocad drawings.

Section Templates (.tst)
This is used to build up road sections etc. to be used for volume calculations.

Survey (.sur)
A survey data document contains all of the survey data. This file type can be used to import files from different overall stations and to edit new survey data. When calculating survey data for co-ordinates, a drawing document will be needed and this can be created from the survey document.

Terrain Model - Digital terrain model (.dtm)
Created digital terrain models.

Traverse data (.trv)
The traverse document contains all values relating to the traverse. The traverse can automatically load data from the Survey data file (.sur) or the data can be entered manually.

Tunnel section (.ttu)
Tunnel section template to be used in tunnel calculated cross sections.

Calculated Tunnel Sections (.ttc)
Calculated tunnel sections are saved as this file type. They are made from roadline, profile, tunnel DTM and a Tunnel section.

Tunnel Terrain Models (.tdtm)
Tunnel terrain model created inside and out at the tunnel walls.

Open

Application button - Open/Close/Save/Save as

Shortcut key Ctrl + O

Open your document. A path list appears on the left. Select the file format you want to open - see New document for a table of file formats.
You can also select All supported files, to open different document types at the same time.

Close

Shortcut key Ctrl + F4

Closes the current document. Asks whether you want to save it.

Save

Shortcut key Ctrl + S

Saves the current document. See also Windows - close all.

Save as...

Shortcut key Ctrl + Shift + S

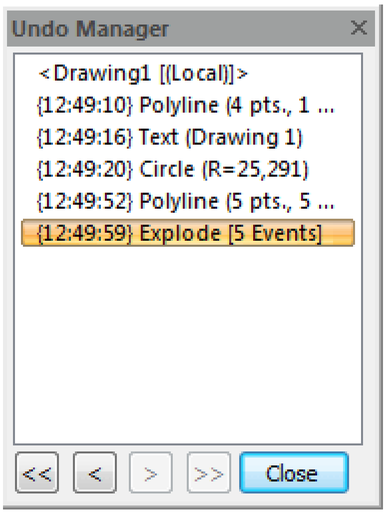
Allows you to save the file in a different name and/or to a new location.

You can also save the file in an older version.

Undo manager

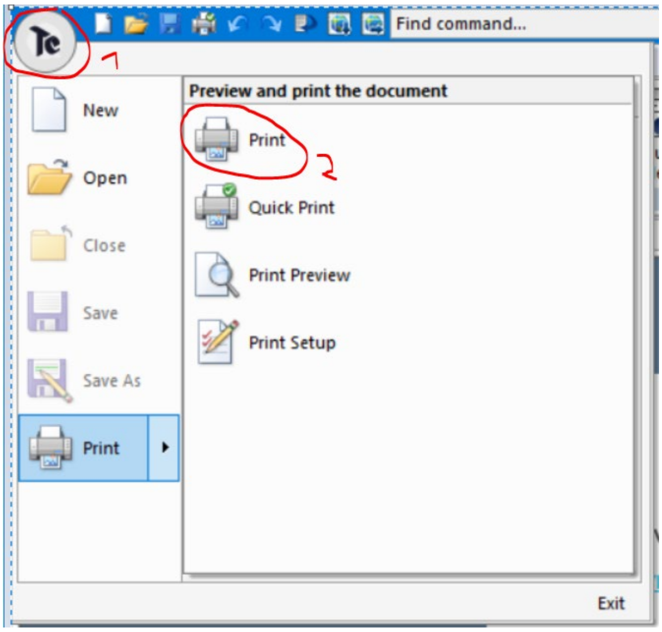
Quick access toolbar|Undo manager

View all events. Click on each line to view and/or undo the events.



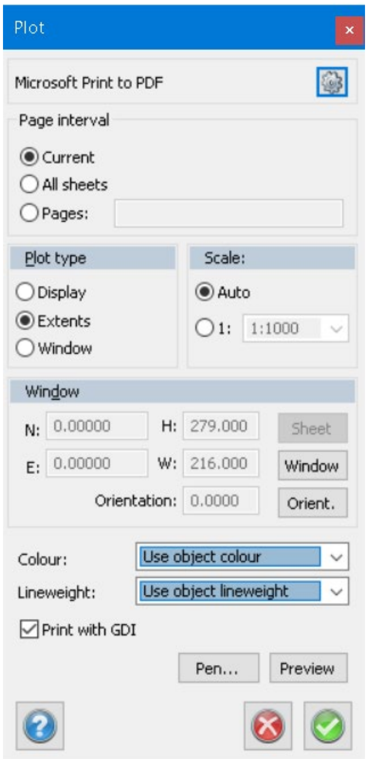
Print

Drawing|Export-Layer PDFApplication button|Print



Print from application button

Select print, quick print, print preview or print settings.



Select
To set up and select the printer. See Printer settings. In the setup you select the paper orientation and paper size. You may also be able to specify paper cartridges etc.

Plot type

Display
Plots everything that is currently displayed on screen. (The active zoom command.)

Extents
Plots everything you have in the document. This is the same end result as if you had zoomed to Extents.

Window
Select with the mouse or enter the window you want to plot. If you want to select the window with the mouse, click on Window or Orientation. You can select the window with the mouse first and adjust the values in the dialogue box afterwards if necessary. It is also possible to select the size by right clicking.

Scale
Select Auto scale if you want the plotted area to fit into the plot. You can also select a scale. If a scale is selected the printer will start with the selected lower left corner and plot/print the area that the paper format will cover with the set scale. The default scale is the one set in *Drawing|Drawing scale.*

If you plot a drawing sheet the scale should be 01:01.

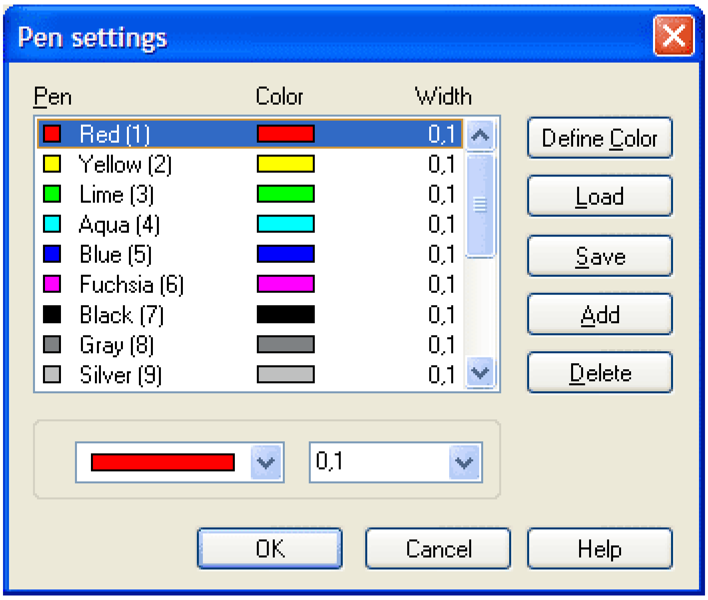
Colour
Choose between Use pen map and Use object colour. Pen settings gets the information from project or system settings under Drawing|Default pen map, or from Pen settings (the dialogue below). Object settings takes information from the drawing, in other words the objects' colours in the drawing.

Lineweight
The same values are valid as for colour (see text above). Notice that it is possible to select different settings for colour and for line width.

Print with GDI

Printing with GDI is printing with vectorized graphics, this means it can scale better in a digital format, for example you can zoom closer in a PDF. However GDI does not support transparency, and you do not have control over filesize of a PDF.

Printing without GDI means you print a pixel-graphic that you can set your resolution for from the system > screen > raster resolution. The higher resolution the sharper the print, and this will also increase filesize if you print to a PDF file.



Pen
For a better quality printout you should select a pen. Pen settings can be saved and opened/loaded. If you want to use specific pen settings or colours above 18 you will need to define them in Pen settings.

See also

Print Layer PDF

Drawing sheet.

Print setup

Application button|Print setup

You can select printers and plotters here and also edit the printer settings.

The procedure is as follows:

1. Go to *Application button|Print Setup*. You can also click on Select in the print dialogue box.
2. Select printer.
3. Select the paper format and orientation - portrait or landscape. Note that the default value for printers is portrait and the default value for plotters is landscape.
4. Click OK.

Note that there are different device drivers for different printers and plotters.

Exit

Application button|Exit

Shortcut key Alt + F4

Exit Topocad.

If you try to exit without saving a document you will be asked whether you want to save the file before closing it.

Home contents

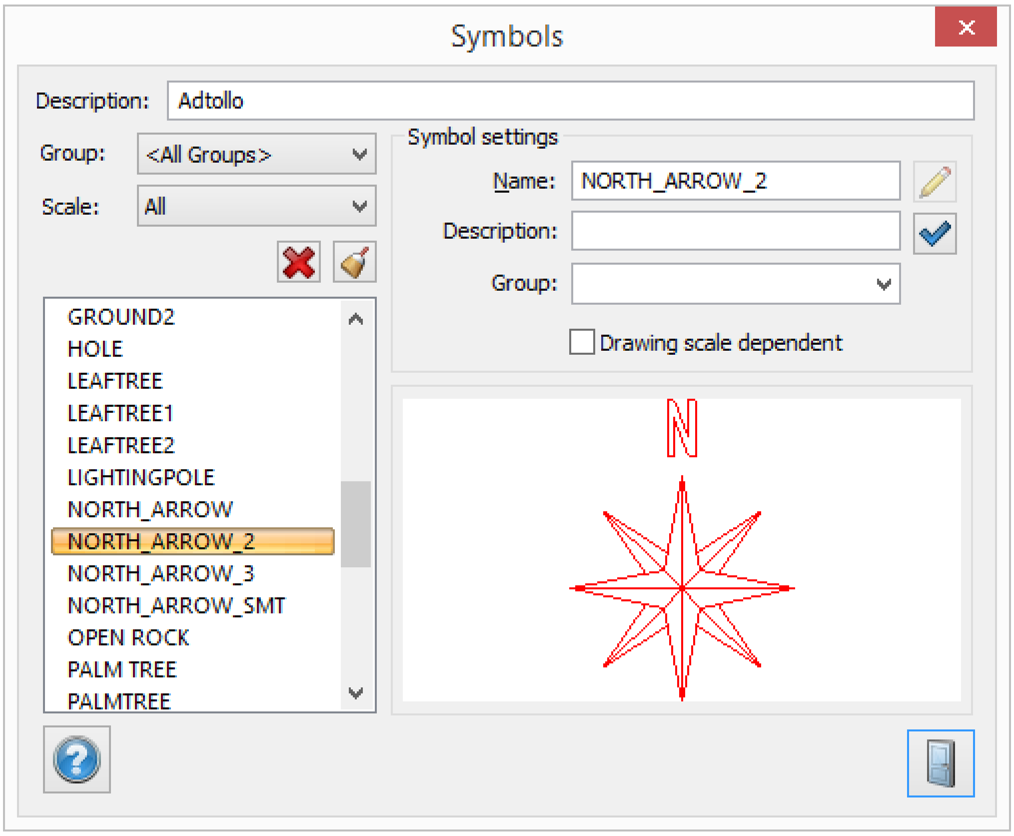
Drawing|Home

Function	Description
Settings	System settings, Project settings, Select Project
Symbols	Edit the symbol list.
Linetypes	
Attributes	Add and edit attributes
Code table	Code table definition and editing
Control codes	Control code editing
Dimension Style Manager	Settings for dimensions
Civil Properties	Add, delete and edit your civil properties
Register license	

Symbols

Drawing|Home|Symbols

The symbol manager can be used to rename and delete symbols from the symbol list. A preview function is built-in, allowing all symbols to be displayed.



Symbols that are connected to an existing point in the drawing, or to an attribute or code list, cannot be renamed or deleted.

In the Symbol/Line type manager you can also select whether you want to store your local symbols or line types in the global table or load a symbol from the global list (selected in *Settings|System files*) to the drawing. All symbols that you have imported, created or entered will also appear in the drawing.

Description
Add a description to a system file for symbols. The description shows under the settings for system files (system settings and project settings) if the mentioned system file is loaded (used).

Symbols that you have imported and/or created directly in the drawing must be exported to the global symbol table if you want to use them in this table.

Symbols that have been inserted from the current symbol table into the drawing will be displayed and stored in the local drawing. You can store any other symbol locally in the drawing if you want to export the symbol with the drawing.

Use Clear button to remove all not referenced symbols from system files.
>> and << buttons copies all the content from Local to Global and vice versa.

Find out more about attributes and symbols:

Drawing|Symbols
Created symbols are stored in the local drawing. You can add them to the global table here.

System|Symbol
All the symbols in the global table are displayed here. You can delete symbols from this dialogue box.

System|Attribute
Create the attribute itself and all associated data.

Define attribute
Defines the attribute with the symbol when creating a symbol.

Create symbol
How to create symbols and associate attributes with them.

Attributes for point codes

How to associate attributes with point codes.

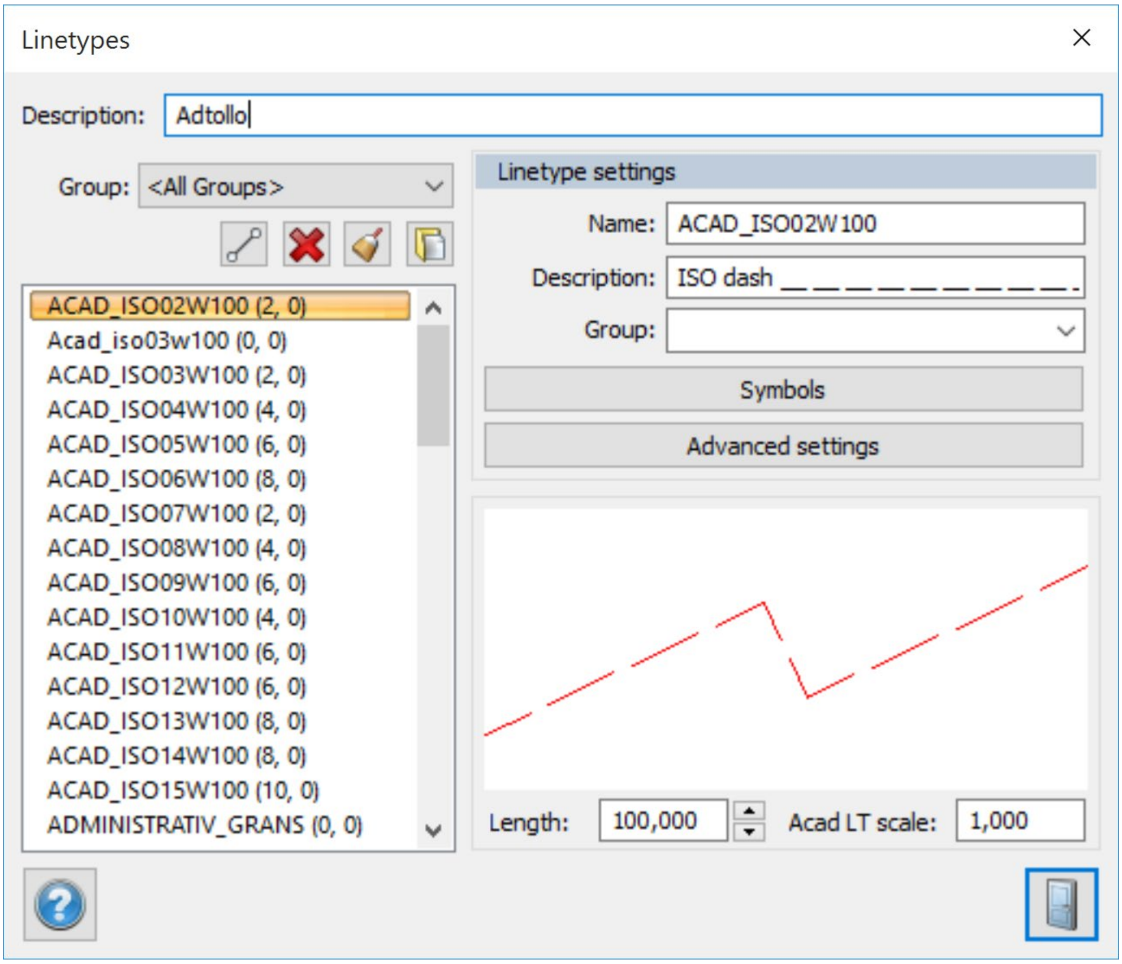
Edit attribute
How to edit an attribute in the drawing, whether it is connected to a point code, a symbol or both.

Settings|System files
The global file for symbols is selected under Settings and system files. The system files have a .tsy extension for symbols and .tat for attributes.

Linetypes

Drawing|Home|Linetypes

Function for line type settings and visualization of global line types.

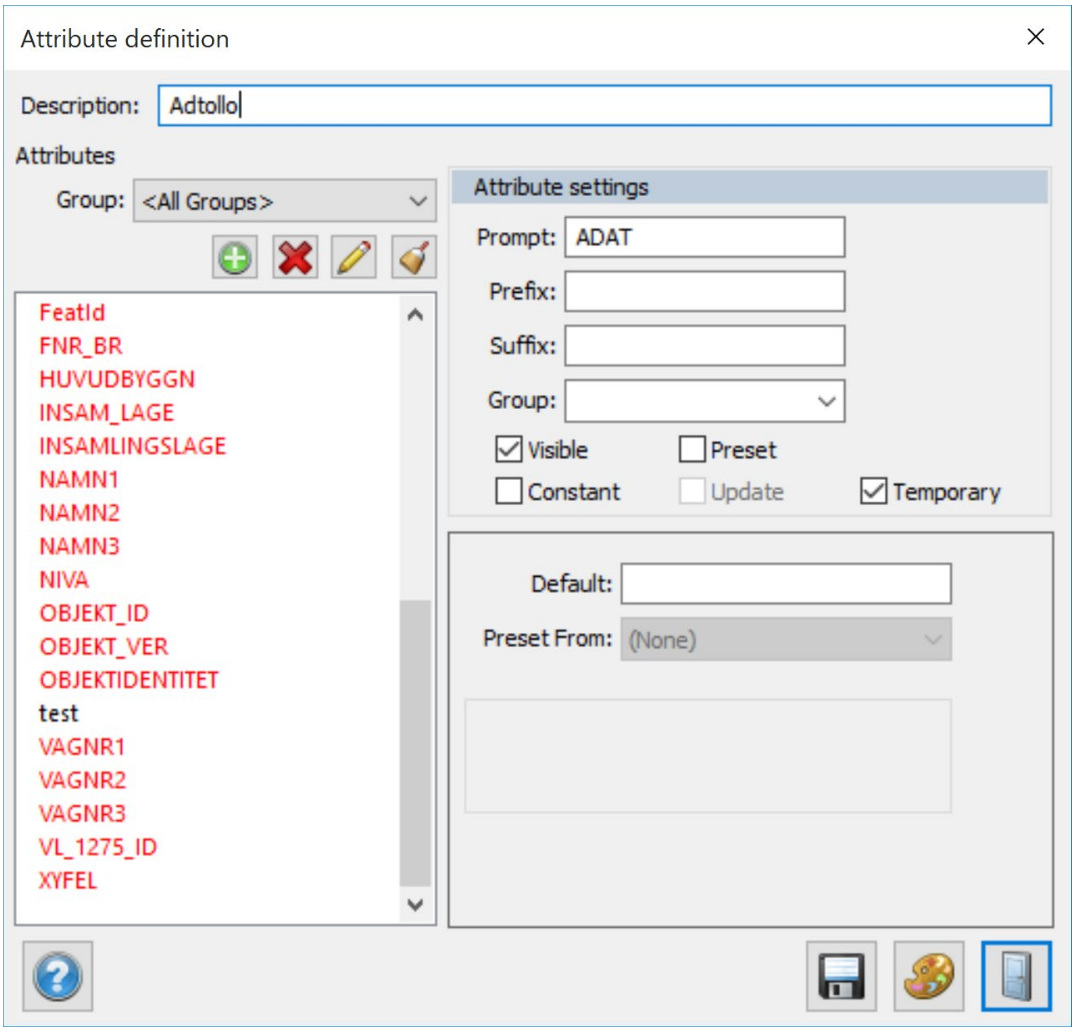


Attributes

Drawing|Home|Attributes

This is where you find all the defined or created attributes in Topocad. A so-called "attribute-library". Attributes are value added information on the points. These may include, for example, diameters of wells, currents in electrical cabinets, information about traverse points, and so on. The attributes are already in the field are fed into and remain in the points all the way to the drawing. During Attribute create attributes and give them the properties you wish to have on them.

Attributes can also be linked to the metadata. In that case, the metadata that is created. You can also create and edit directly in the dialog box. If the attribute is used and also updated if the attribute is changed in an external application.



You create attributes and assign the required characteristics to them under Project attributes.

Use Clear button to remove all not referenced attributes from system files.

Description
Add a description to a system file for the attribute. The description is shown under settings for system files (system and project settings) if the mentioned system file is loaded (used).

Group

Attributes can be divided into groups to be found easier and to shorten the search listings.

New attribute

In order to create a new attribute, tap *New* at the bottom left of the dialogue. Then select whether the attribute should be linked to the metadata, if there is to be a text attributes directly in the drawing, or Safe List.

Delete

Click Delete at the bottom left of the dialog to delete all attributes, which are not referenced from the system files. Save all Removes temporary flags from all attributes so that they are saved to attribute table.

Attribute settings

Prompt:
If you want the attribute to have another name when plotted, enter the alias name here.

Visible:
Tick this box if you want to the attribute to be visible on the drawing. The default value is visible. If you want to use an attribute but do not want to show it on the drawing leave this box unchecked.

Preset:
If you want the attribute to have a preset value enter it here.

Constant:

A value that has been assigned to a constant attribute cannot be changed or edited.

Update:
If the attribute is connected to another value, e.g. a height or point code, the value will be updated if this box is ticked.

Values:
Select the attribute type Value list when creating a new attribute. Add the different values by clicking on +. Possibilities to check "Allow values from list only" and "Allow null values".

Meta data:
Meta data can be selected if you create a new attribute and select the type of meta data (not text).

If you want the attribute value to be entered in the meta data file (X.md where X is the same name as the drawing) then select which meta data field you want to store this information in. For example you can choose to enter the scale in the SCALE field in the meta data file. If you have several attributes with the same meta data Topocad will use the most recent.

Prefix:
This is used if you want to enter a prefix for the attribute. e.g. D= Owner:

Suffix:
This is used if you want to enter a suffix for the attribute. e.g. mm, m, km, feet, MPa.

Default:
If you want the attribute to have a default value enter it here.

Preset from:
If you want the attribute value to be taken from another field, enter the relevant field here. Select between Point ID, North, East, Height, Point code, User name, Today's date, Today's date and time, Prism Const, Prism height or Instrument.

Upper/Ignore
State whether you only want upper case to be used for the attribute or whether it should be exactly as you entered it.

Temporary
By checking off Temporary flag or other change of the attribute, the attribute will not be temporary - it will be saved in the attribute table. Notice that attributes not created or changed manually by the user, are only temporary and are not saved in the attribute table. Temporary attributes displays with red text in the attribute dialogue.

Save all
Removes temporary flags from all attributes so they all will be saved in the attribute table.

See also

Define attribute.

Text styles

Text styles

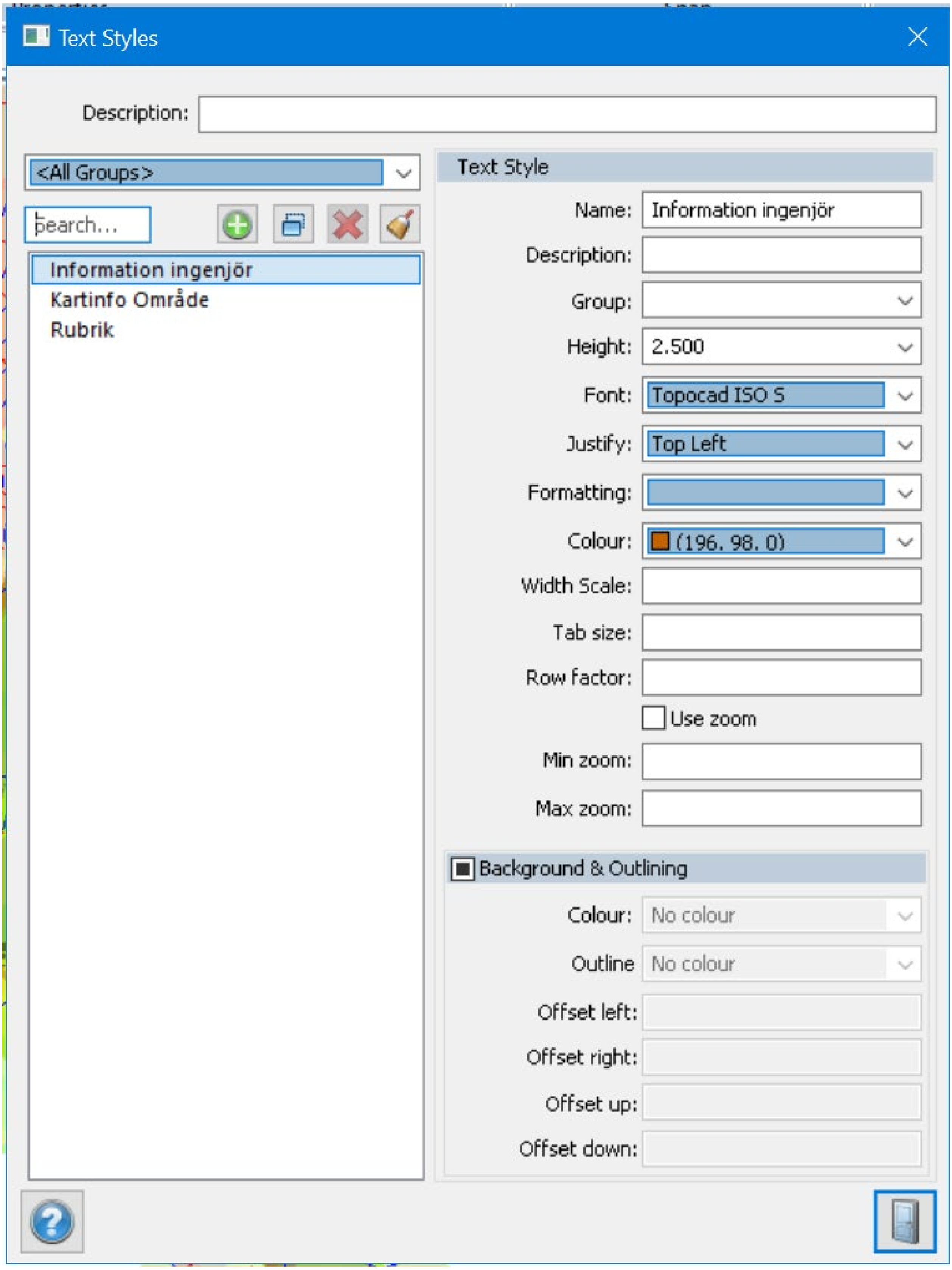
Drawing|Home|Text styles

Text styles is a text appearance that you can save and put on texts. You can use all the usual text parameters plus some extra functionality with the zoom feature.

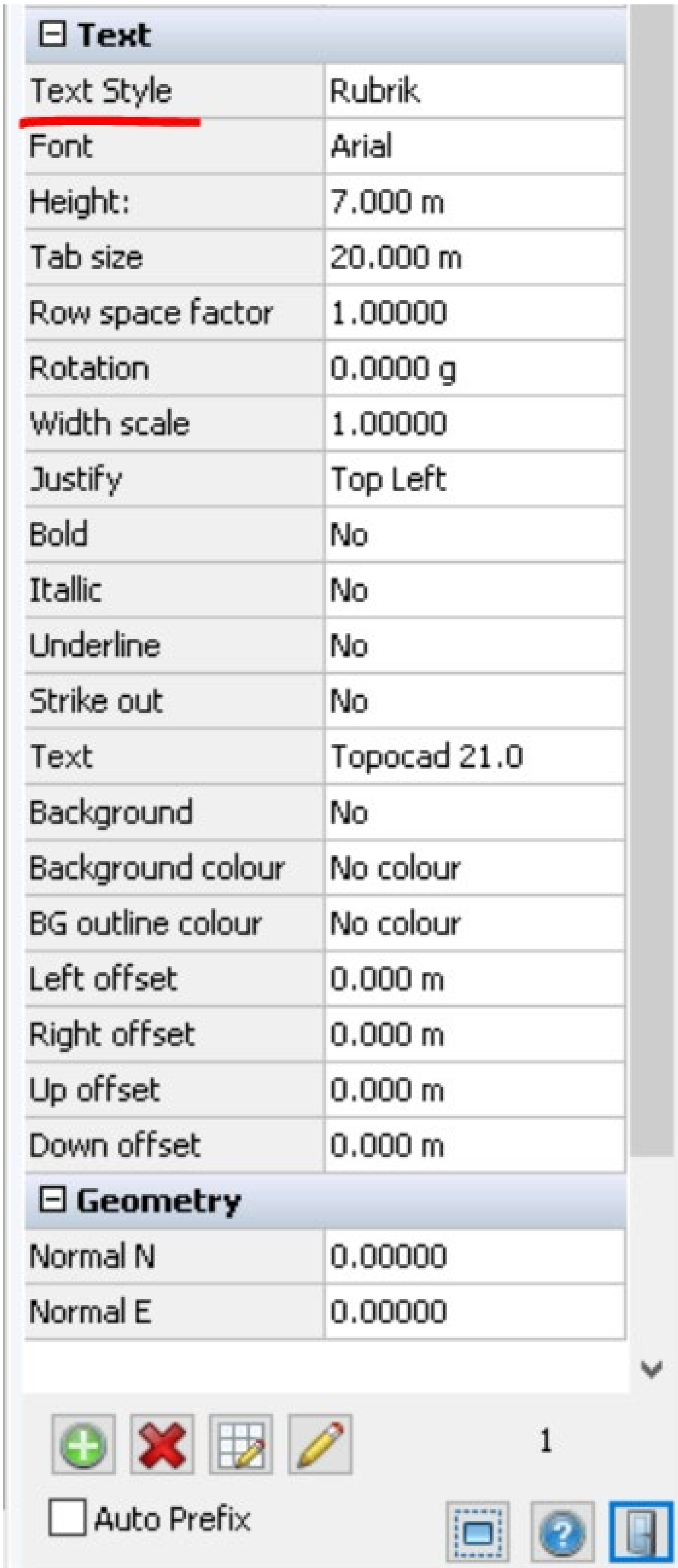
The global list is found under Home > System > Text styles
the local Text style list (the drawings list) is found under Misc > Drawing > Text Styles
The function for moving between the lists is found under Misc > Drawing > Edit Text Styles

Using zoom

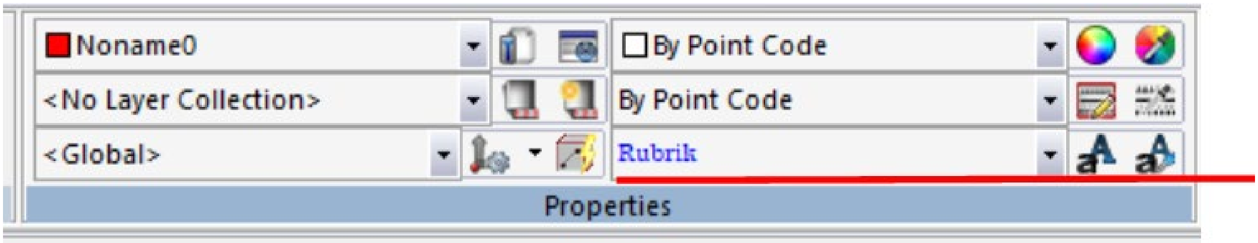
This is a feature you can use to set a zoom interval where you show your texts, this can be used for drawings with a lot of information to reduce clutter. The zoom level works in the Ortho-view (2D) and is viewed on the scale ruler.



Text style is a property on text objects which you can edit from the property panel. This will override the other text properties.



You can set a Text Style as active from the Drawing > Properties tools. This will make the texts you draw with Create Text inherit the text style.



Keywords: Text style, text, property, edit, system

Edit code table

Drawing|Home|Code table

Function, command	Description
General	General for all point codes
Linetype	Select line type
Symbol	Select which symbol (if any) the point code will have.
Attributes	Link an attribute directly to a point code, a symbol or both.
Import/Export	Change the point code when importing from, and exporting to a file.
Survey	
Import trimble	
Control codes	
Calculation function	

All codes which are used at any point in any open file will also appear in the code table. As soon as you open a file or import field data into a survey data file (.sur) all new codes will be inserted into the code table. You may of course have existing codes in the code table even when they are not being used in any open document or drawing. It is not possible to delete an existing code if it has been used in any open document. This is indicated by the delete button being greyed out. It is possible to use different code tables. They can be selected using *Home*|*Settings*.

To input a point code:

1. Open Edit code table.
2. Click New.
3. Add the new point code.

In the code table there are up to six different tabs with information and functions used in the survey and to import and export data. The last tab depends what function the code has.

The tabs are:

- Line
  Contains information about the type of line, colour and line type scale.
- Symbol
  Contains information about the type, colour, scale and orientation of the symbol.
- Attribute
  The attributes of the point code are entered on this tab.
- Survey
  Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.
- Import/Export
  Contains the transfer code, layer and export code.

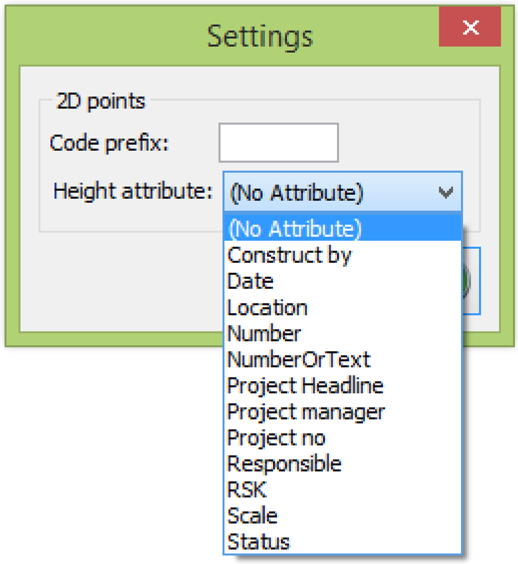
Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
- Rectangle 3
  Calculation function for three point rectangles.
- Circle 2
  Calculation function for two point circles.
- Circle 3
  Calculation function for three point circles.
- Arc 2
  Calculation function for two point arcs.
- Arc 3
  Calculation function for three point arcs.
- Parallel line
  Calculation function for parallel lines.
- Closed line
  Calculation function for measurement of closed polylines or polygons.

General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

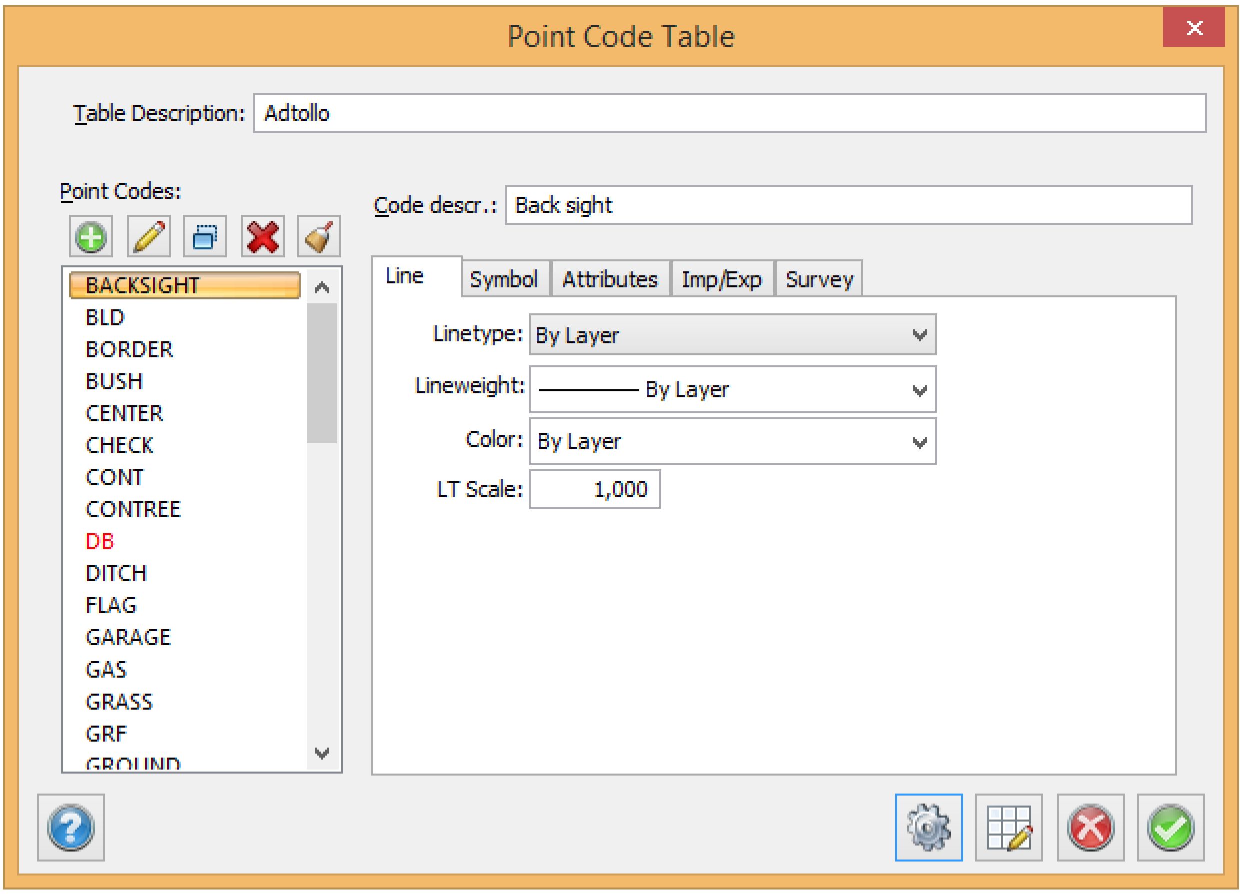
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line

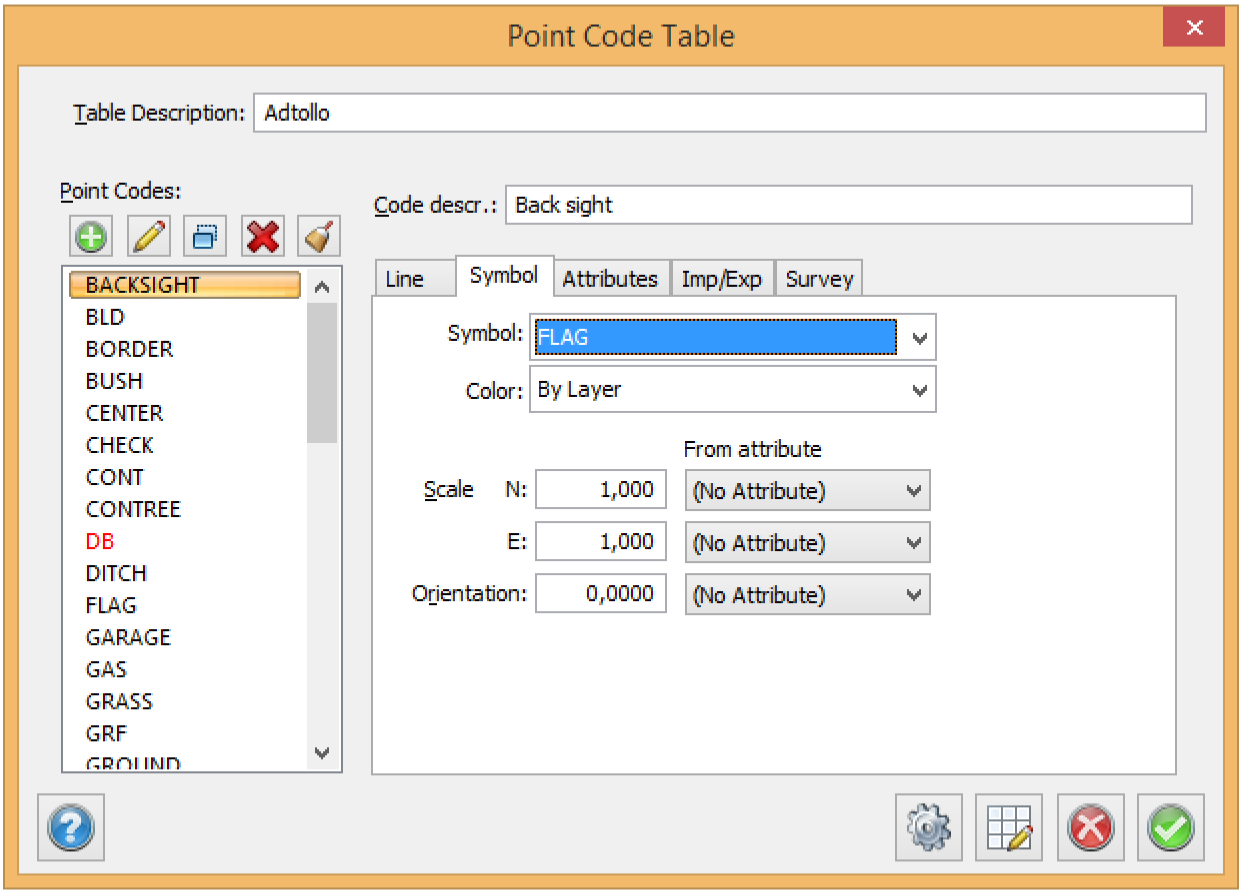


There are several different types of lines to select. It is also possible to select the line type in the Layer manager. This allows you to select the line type in several places, but any line type entered in the code table is given a higher priority than one entered in the layer manager. In the code table it is possible to select the line type by layer.

- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
- Use Clear button to remove all not referenced line types from system files.
- >> and << buttons copies all the content from Local to Global and vice versa.

Symbol

Home|Code table - Symbol

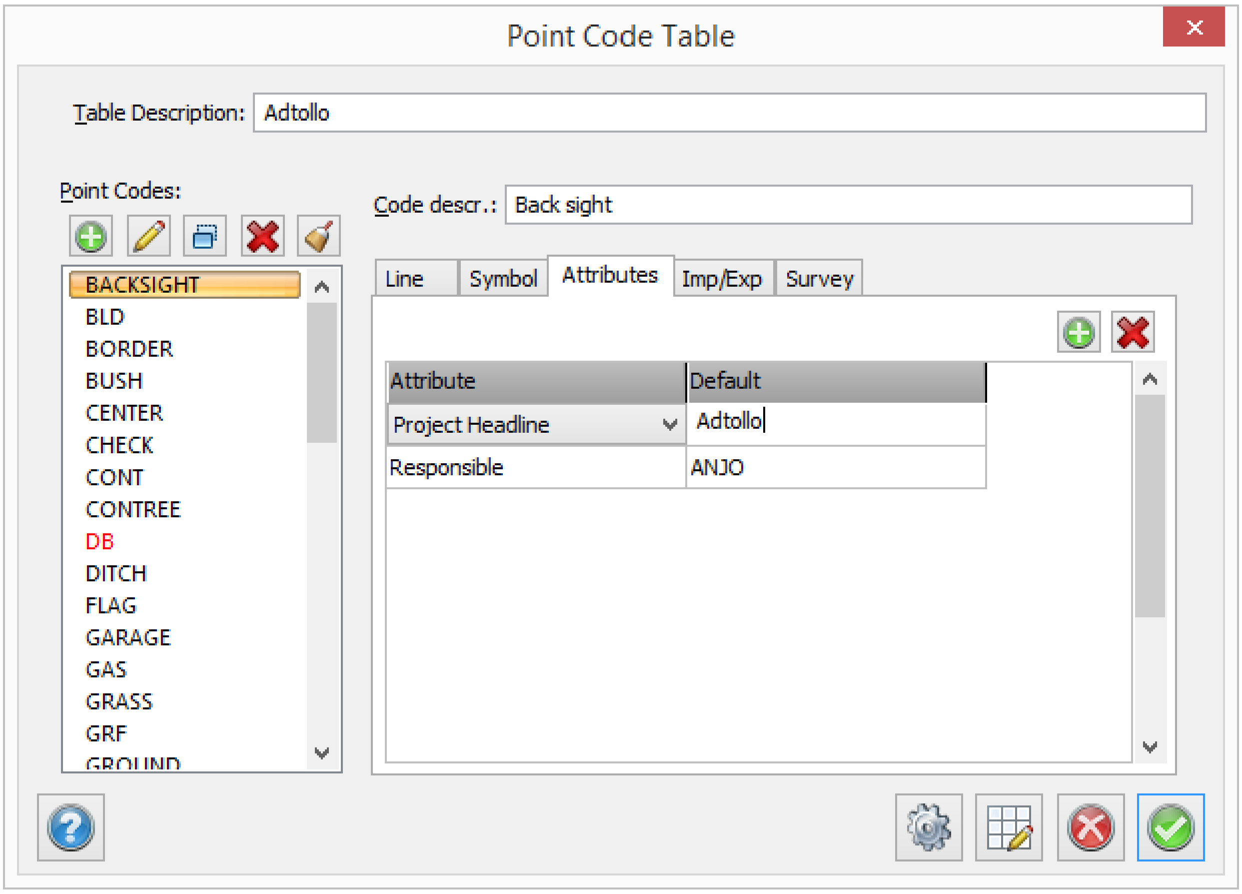


- **Symbol**
  Select which symbol (if any) the point code will have. Select from the drop-down list.
- **Colour:**
  Select the colour for the point code. It is also possible to select by layer.
- **X-scale, Y-scale**
  The symbol is always saved with a scale of 1:1000. The default drawing scale is also 1:1000. It is possible to select a different drawing scale in Settings|Drawing scale. For example, if you want to the symbol to appear at twice its original size (1:1000) you should enter the scale 2.0 in this field.

- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



An attribute is a type of added value for the point. An attribute can be linked directly to a point code, a symbol or both. The attribute can be entered in the field survey, the survey data document (.sur) or in the drawing - Go to Modify|Edit attribute. If you link an attribute to a point code you can give every point with this point code an attribute value. If you have used a symbol for the point code and want the attribute to be displayed as well, you will need to create the symbol with a linked attribute. To add an attribute to the symbol see Define attribute

There are no limits to number of attributes that a point can have.

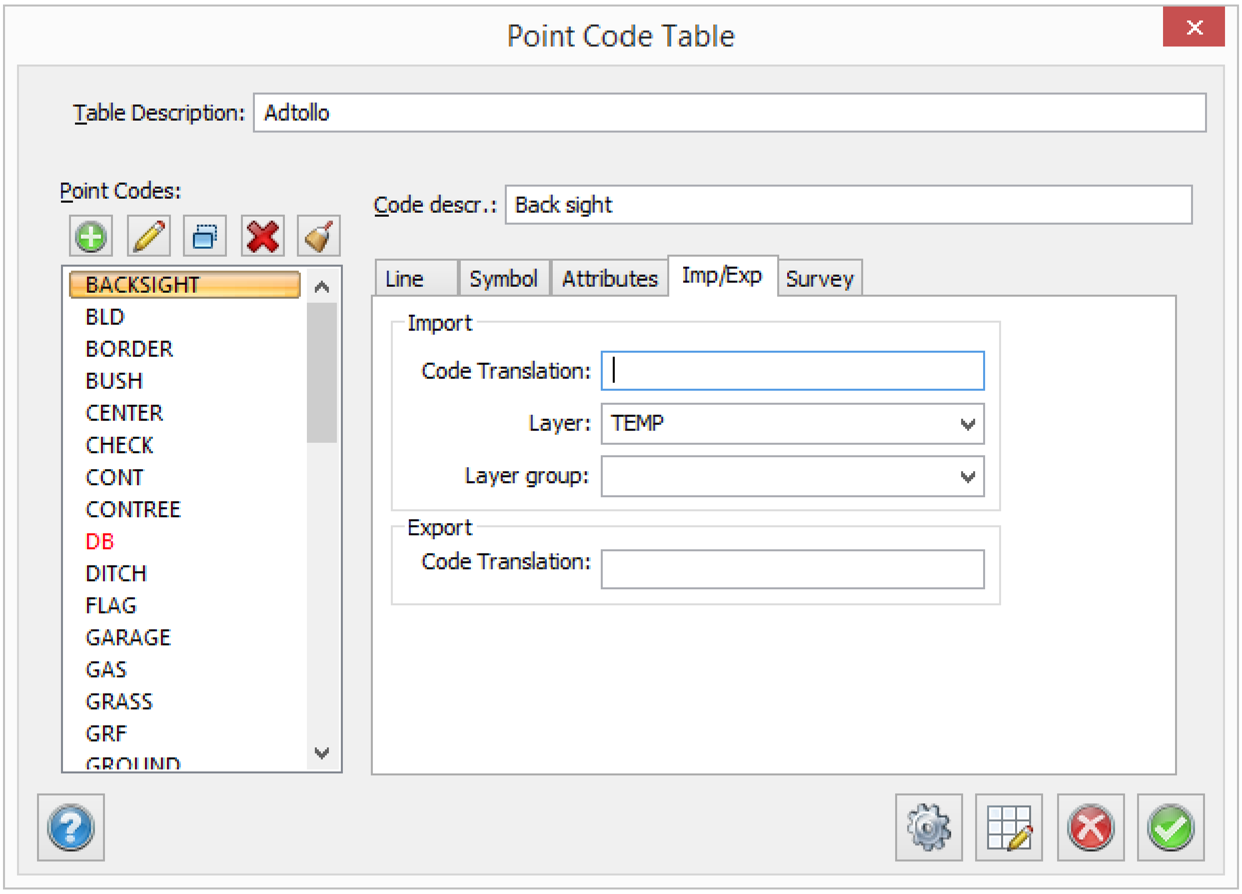
The value of the attribute belongs to the point but the type of attribute belongs to the point code.

Add
Click Add if you want to add an attribute to the point code. The attribute list appears and you can select from the list. To create an attribute go to Home|Attribute

Delete
Press delete if you want to delete a link to the specified attribute. Note that you only delete the link to the attribute and not the attribute itself.

Import/Export

Home|Code table - Import/Export



The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

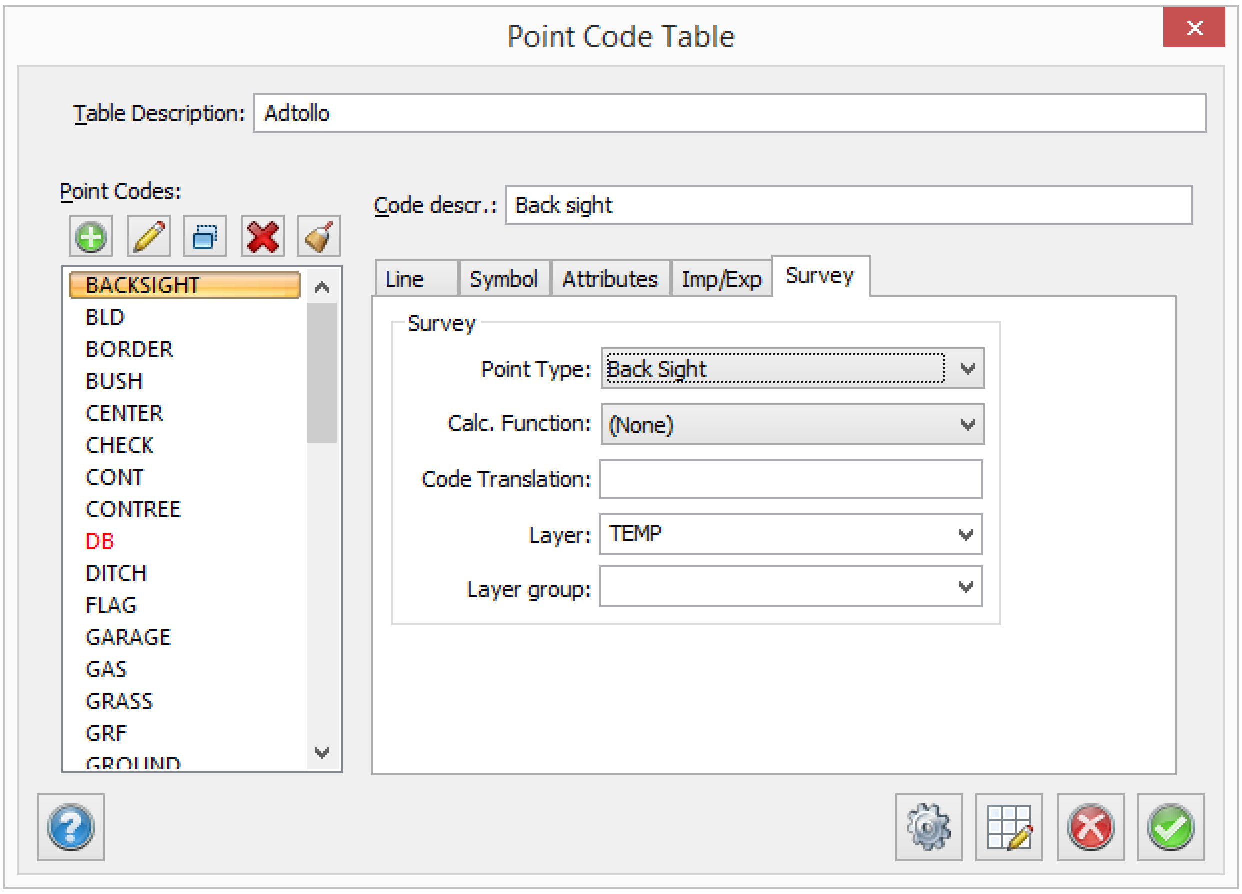
Import - Transfer point code:
Interpolates the point code (point in file) to another point code. For example, you can use the numeric point code 10 in the field which is translated to pp in the drawing. A similar function exists for points that are imported from a file. See previous page - Survey.

Layer:
This function allows a point code belonging to a point in a file to be moved to a specific layer. It is possible to use a layer name for all kinds of trees and then put all tree point codes in that layer. It is also possible to create a specific layer for every point code if required. Similar functions exist for points which are imported from files, see previous page - Survey.

Export - Transfer point code:
You can also specify that the point code used in the drawing should be interpolated to another point code when it is exported to a file.

Survey

Home|Code table - Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
The code can end up with a different code in the drawing. Enter the name here.

Layer
Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

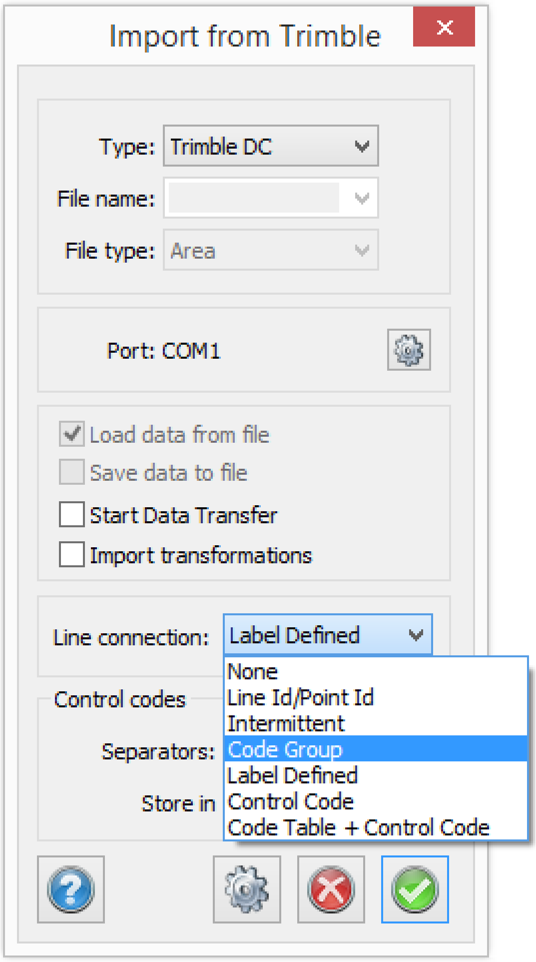
Point types:
None

Polygon point
The point will be calculated and added to the pp file.

Check point
Used for check towards known point.

Temporary point
The co-ordinates are temporarily saved and the point can be used as a back sight or station in later stations in the same survey file.

Back sight
Function used to code back sights in the survey.



Control codes

Code table + Control table
Point with codes using these point types will have the following control codes:

- Point
- Line: Starts in first point
- Construction point: control point. Will not be included for calculation. Can be used for breaking line and start over with the same code.

Line connection "Code table + Control Code" is also used for general import. Possibility to filter point codes on point type in all controls for selection of point code.

Calculation function

The calculation functions are:

Two prism measurement

The extra two prism measurement function is used when measuring a two prism object. An example is the measurement to the ABC pole which has two prisms at the same pole. You decide from which prism you measure the length to the end of the pole and also which of the two prisms you measure first.

See also

Control codes

Edit code table

Drawing|Home|Code table

Function, command	Description
General	General for all point codes
Linetype	Select line type
Symbol	Select which symbol (if any) the point code will have.
Attributes	Link an attribute directly to a point code, a symbol or both.
Import/Export	Change the point code when importing from, and exporting to a file.
Survey	
Import trimble	
Control codes	
Calculation function	

All codes which are used at any point in any open file will also appear in the code table. As soon as you open a file or import field data into a survey data file (.sur) all new codes will be inserted into the code table. You may of course have existing codes in the code table even when they are not being used in any open document or drawing. It is not possible to delete an existing code if it has been used in any open document. This is indicated by the delete button being greyed out. It is possible to use different code tables. They can be selected using *Home*|*Settings*.

To input a point code:

1. Open Edit code table.
2. Click New.
3. Add the new point code.

In the code table there are up to six different tabs with information and functions used in the survey and to import and export data. The last tab depends what function the code has.

The tabs are:

- Line
  Contains information about the type of line, colour and line type scale.
- Symbol
  Contains information about the type, colour, scale and orientation of the symbol.
- Attribute
  The attributes of the point code are entered on this tab.
- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

- Import/Export
  Contains the transfer code, layer and export code.

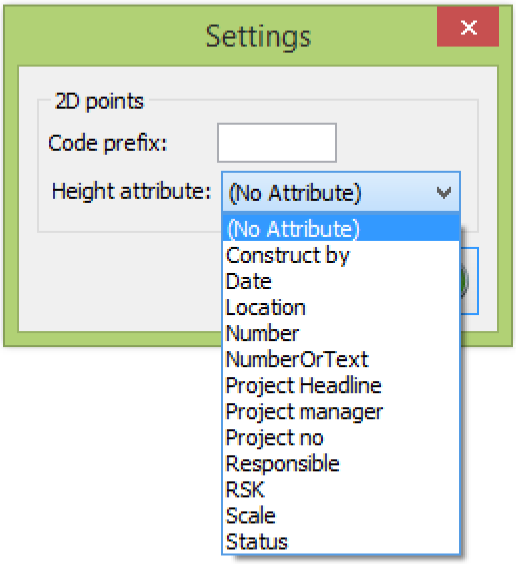
Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
- Rectangle 3
  Calculation function for three point rectangles.
- Circle 2
  Calculation function for two point circles.
- Circle 3
  Calculation function for three point circles.
- Arc 2
  Calculation function for two point arcs.
- Arc 3
  Calculation function for three point arcs.
- Parallel line
  Calculation function for parallel lines.
- Closed line
  Calculation function for measurement of closed polylines or polygons.

General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

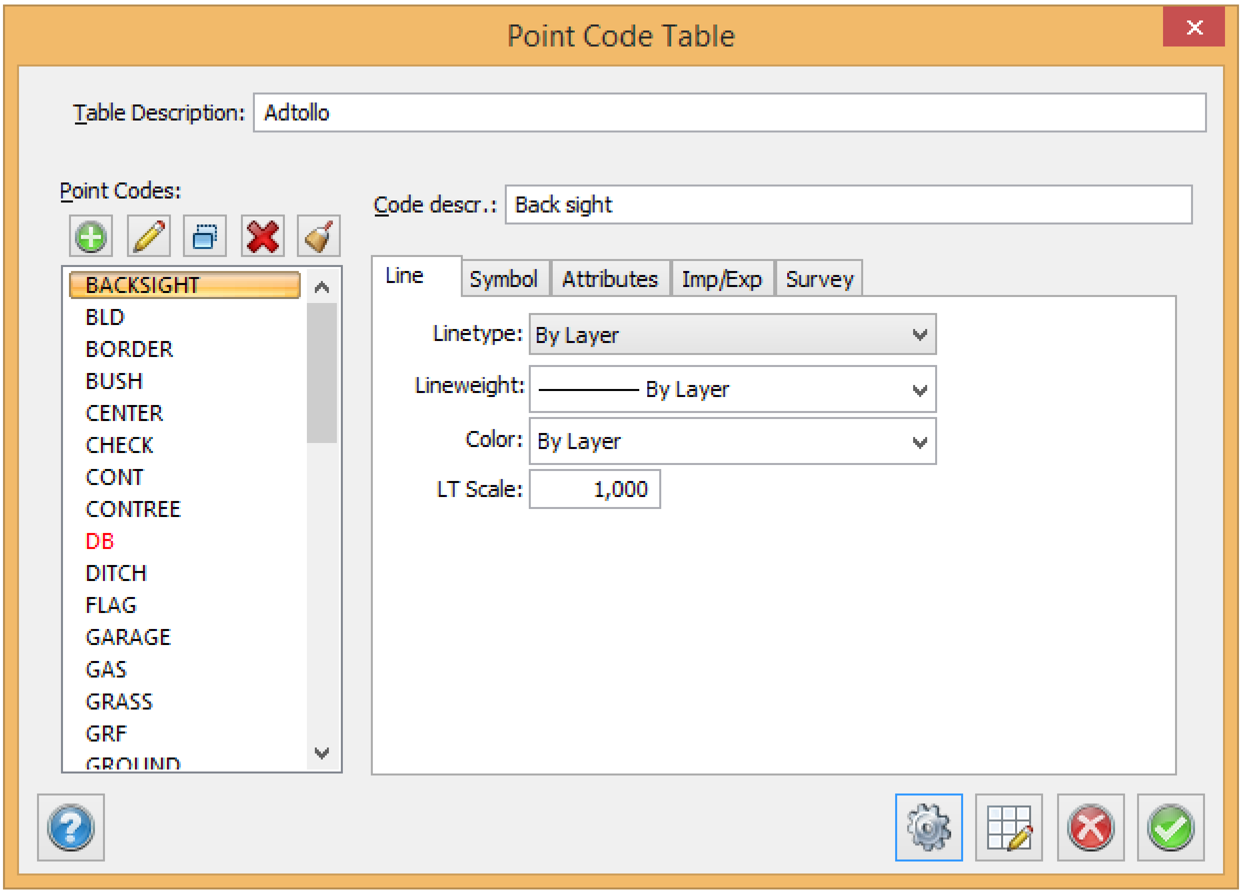
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line



There are several different types of lines to select. It is also possible to select the line type in the Layer manager. This allows you to select the line type in several places, but any line type entered in the code table is given a higher priority than one entered in the layer manager. In the code table it is possible to select the line type by layer.

- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
- Use Clear button to remove all not referenced line types from system files.
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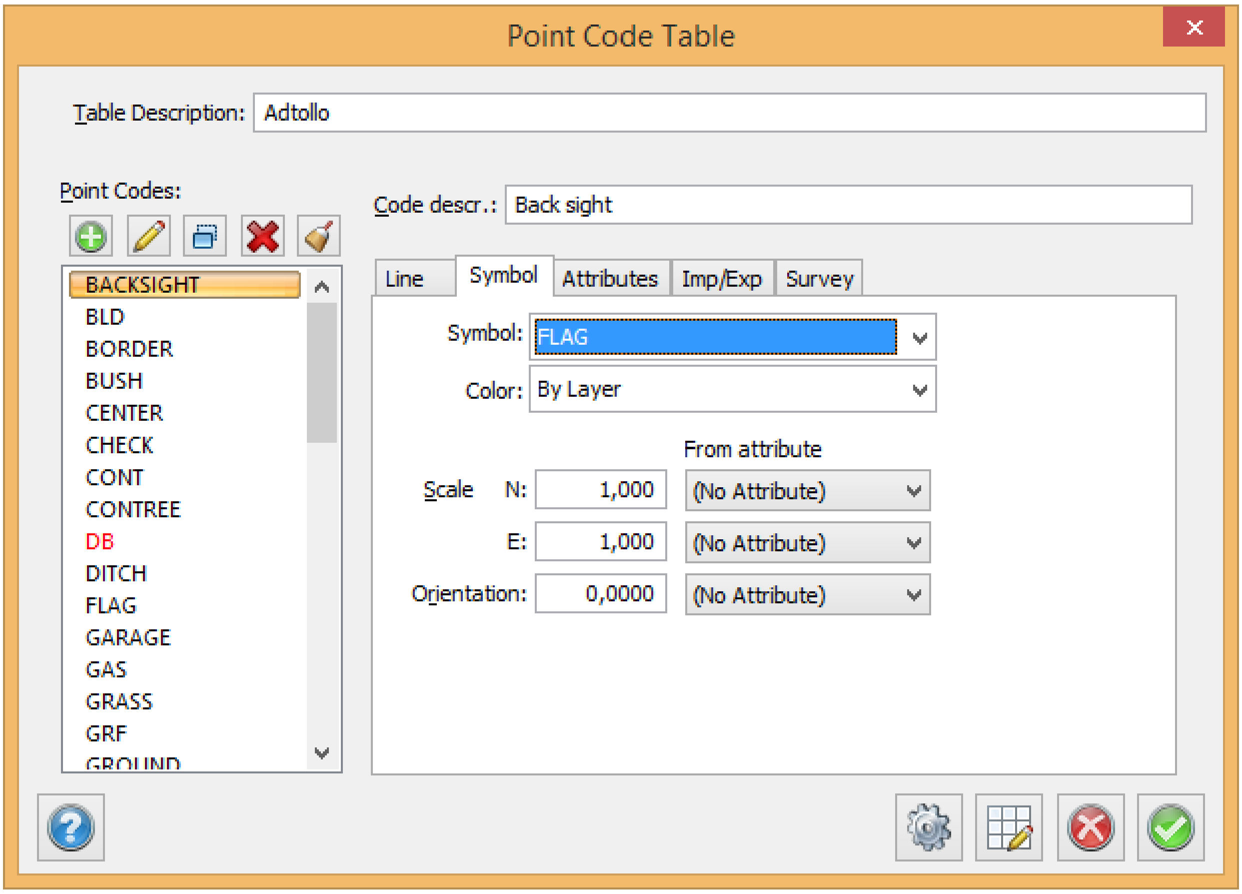
Symbol

Home|Code table - Symbol



- **Symbol**
  Select which symbol (if any) the point code will have. Select from the drop-down list.
- **Colour:**
  Select the colour for the point code. It is also possible to select by layer.
- **X-scale, Y-scale**
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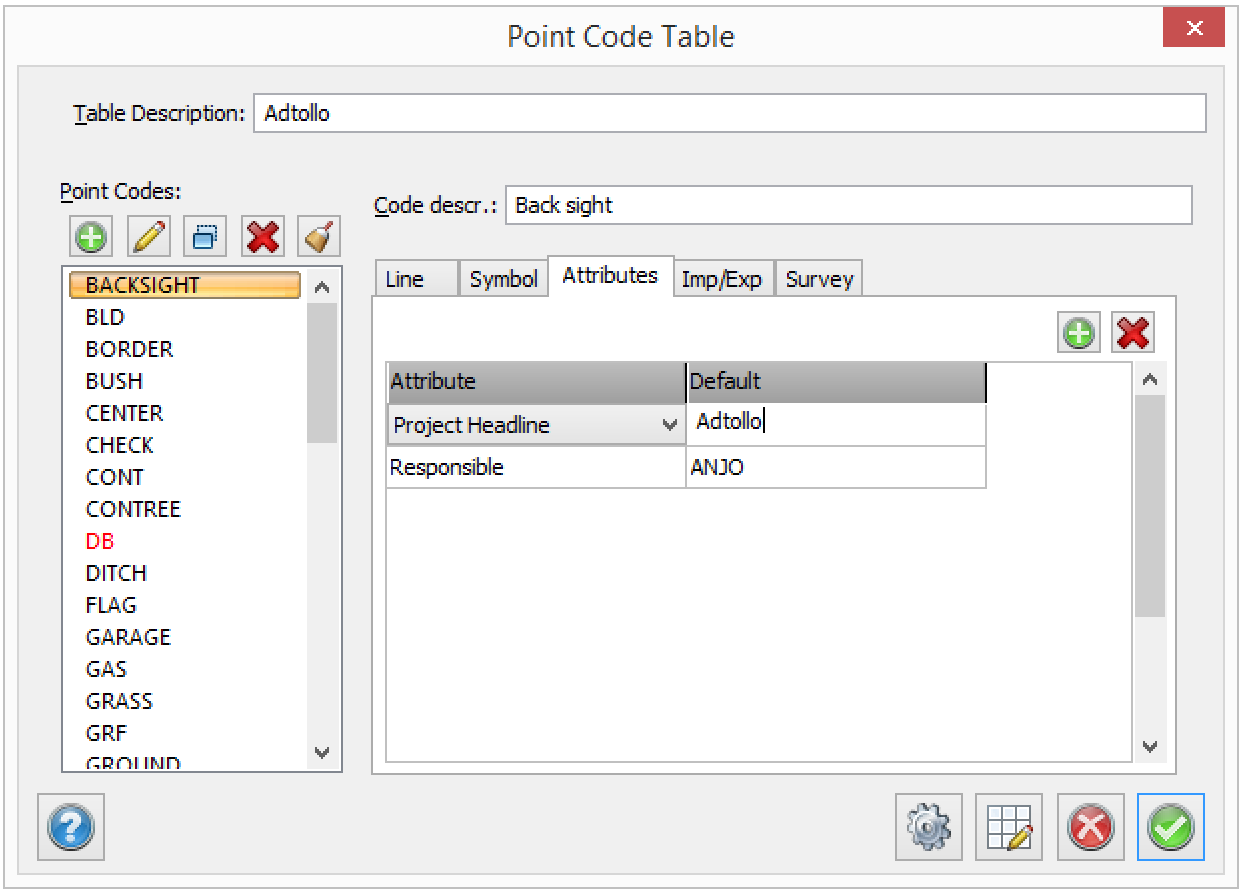
- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



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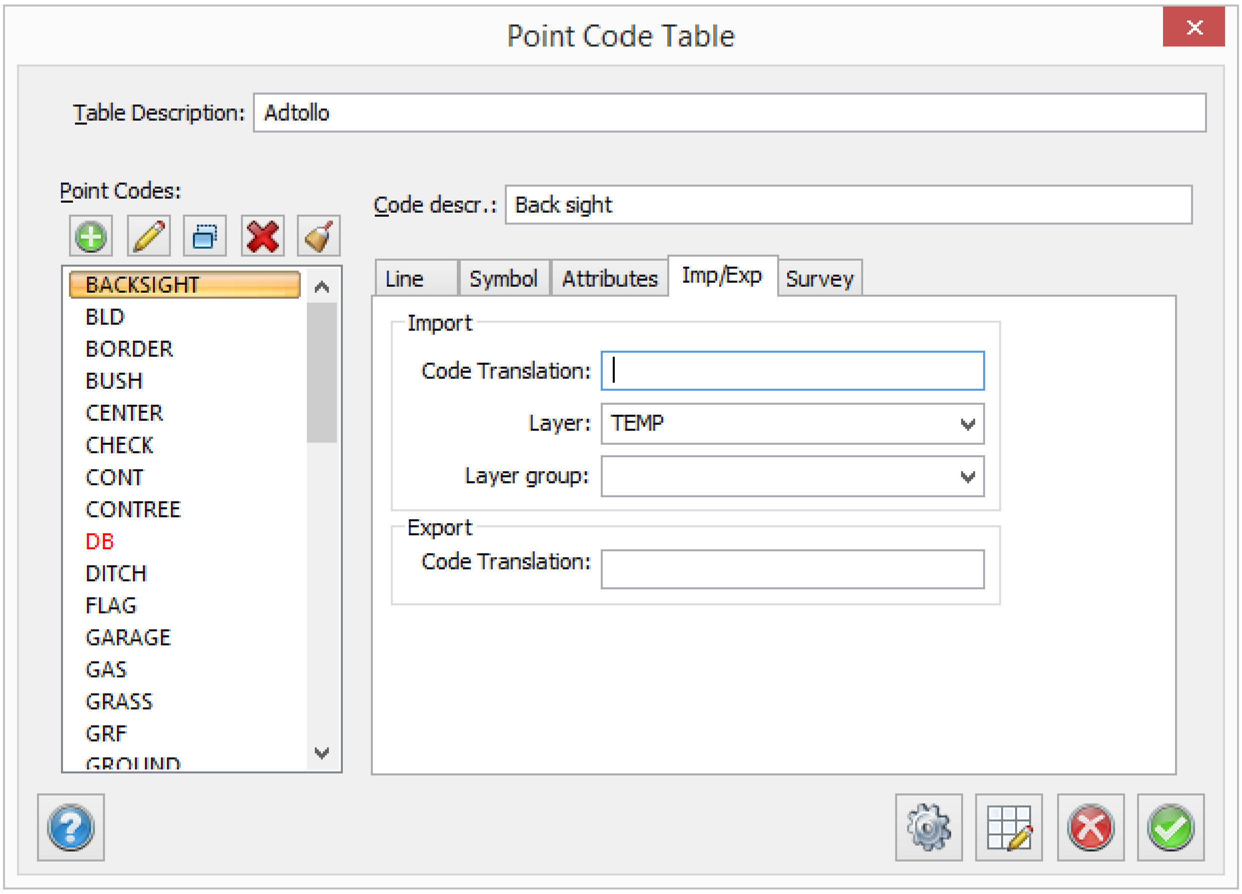
Import/Export

Home|Code table - Import/Export



The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

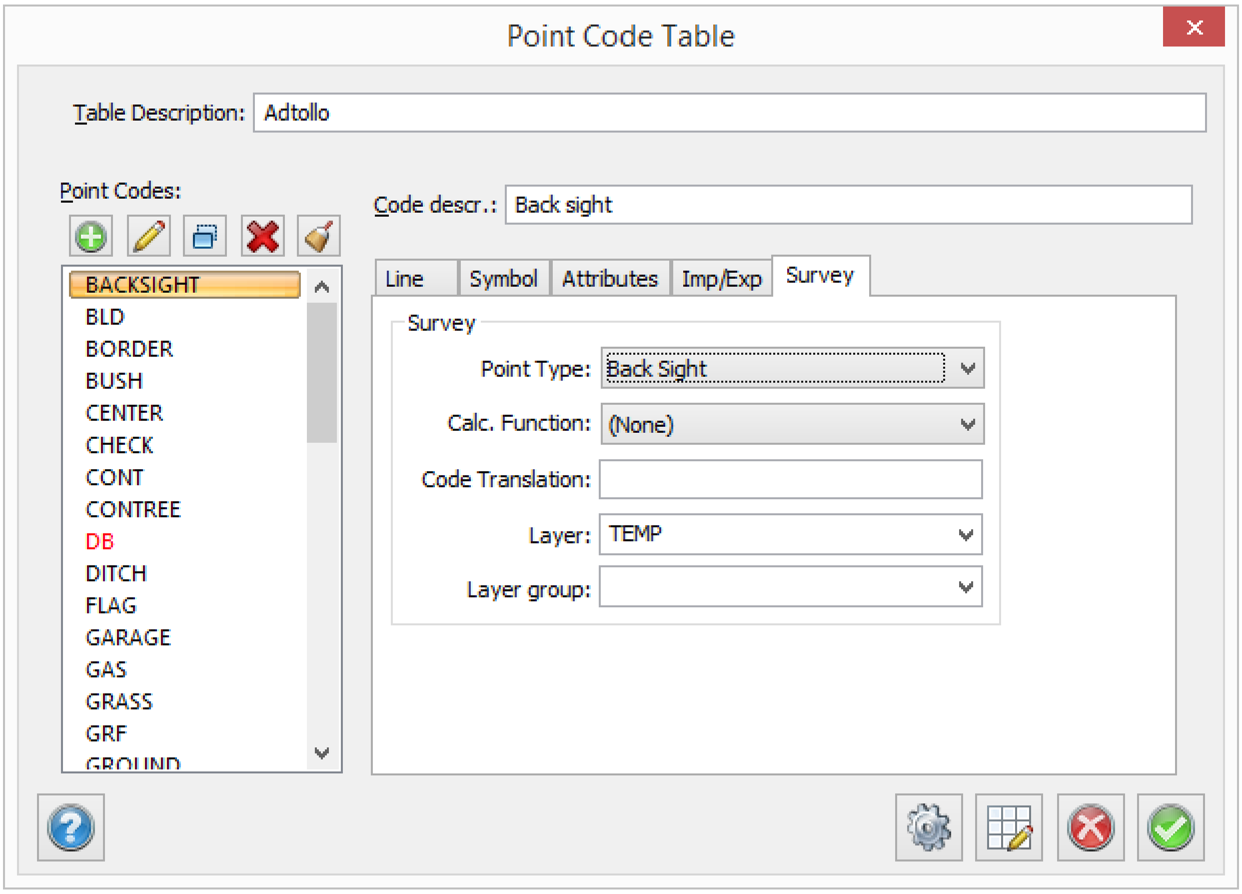
Import - Transfer point code:
Interpolates the point code (point in file) to another point code. For example, you can use the numeric point code 10 in the field which is translated to pp in the drawing. A similar function exists for points that are imported from a file. See previous page - Survey.

Layer:
This function allows a point code belonging to a point in a file to be moved to a specific layer. It is possible to use a layer name for all kinds of trees and then put all tree point codes in that layer. It is also possible to create a specific layer for every point code if required. Similar functions exist for points which are imported from files, see previous page - Survey.

Export - Transfer point code:
You can also specify that the point code used in the drawing should be interpolated to another point code when it is exported to a file.

Survey

Home|Code table - Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
The code can end up with a different code in the drawing. Enter the name here.

Layer
Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

Point types:
None

Polygon point
The point will be calculated and added to the pp file.

Check point
Used for check towards known point.

Temporary point
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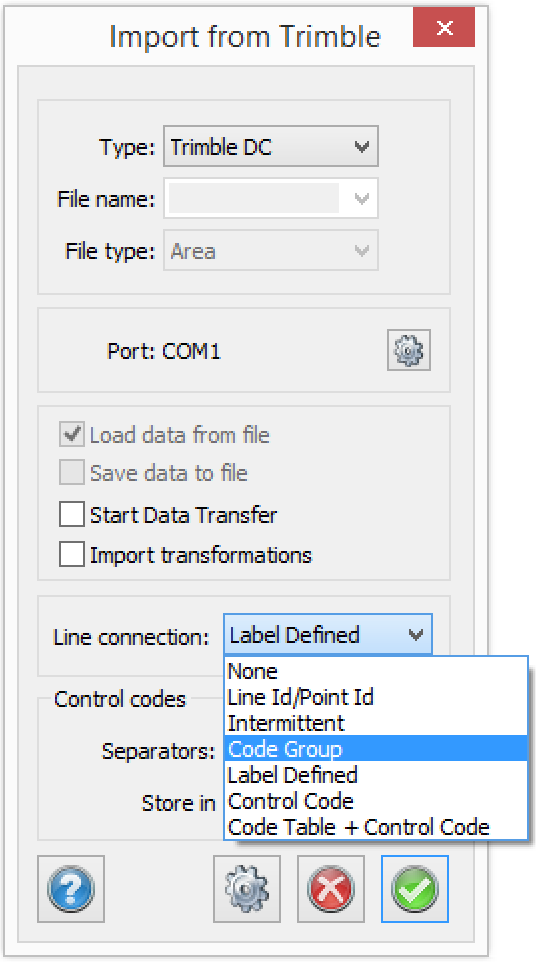
Function used to code back sights in the survey.



Control codes

Code table + Control table
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Calculation function

The calculation functions are:

Two prism measurement

The extra two prism measurement function is used when measuring a two prism object. An example is the measurement to the ABC pole which has two prisms at the same pole. You decide from which prism you measure the length to the end of the pole and also which of the two prisms you measure first.

See also

Control codes

Edit code table

Drawing|Home|Code table

Function, command	Description
General	General for all point codes
Linetype	Select line type
Symbol	Select which symbol (if any) the point code will have.
Attributes	Link an attribute directly to a point code, a symbol or both.
Import/Export	Change the point code when importing from, and exporting to a file.
Survey	
Import trimble	
Control codes	
Calculation function	

All codes which are used at any point in any open file will also appear in the code table. As soon as you open a file or import field data into a survey data file (.sur) all new codes will be inserted into the code table. You may of course have existing codes in the code table even when they are not being used in any open document or drawing. It is not possible to delete an existing code if it has been used in any open document. This is indicated by the delete button being greyed out. It is possible to use different code tables. They can be selected using *Home*|*Settings*.

To input a point code:

1. Open Edit code table.
2. Click New.
3. Add the new point code.

In the code table there are up to six different tabs with information and functions used in the survey and to import and export data. The last tab depends what function the code has.

The tabs are:

- Line
  Contains information about the type of line, colour and line type scale.
- Symbol
  Contains information about the type, colour, scale and orientation of the symbol.
- Attribute
  The attributes of the point code are entered on this tab.
- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

- Import/Export
  Contains the transfer code, layer and export code.

Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
- Rectangle 3
  Calculation function for three point rectangles.
- Circle 2
  Calculation function for two point circles.
- Circle 3
  Calculation function for three point circles.
- Arc 2
  Calculation function for two point arcs.
- Arc 3
  Calculation function for three point arcs.
- Parallel line
  Calculation function for parallel lines.
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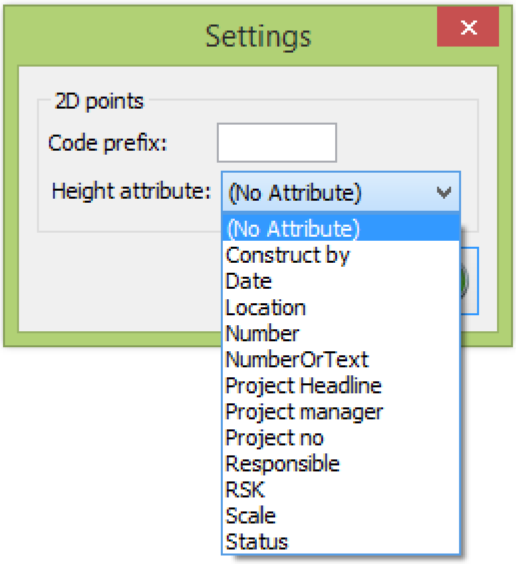
  Calculation function for measurement of closed polylines or polygons.

General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

New
Button for creating a new point code.

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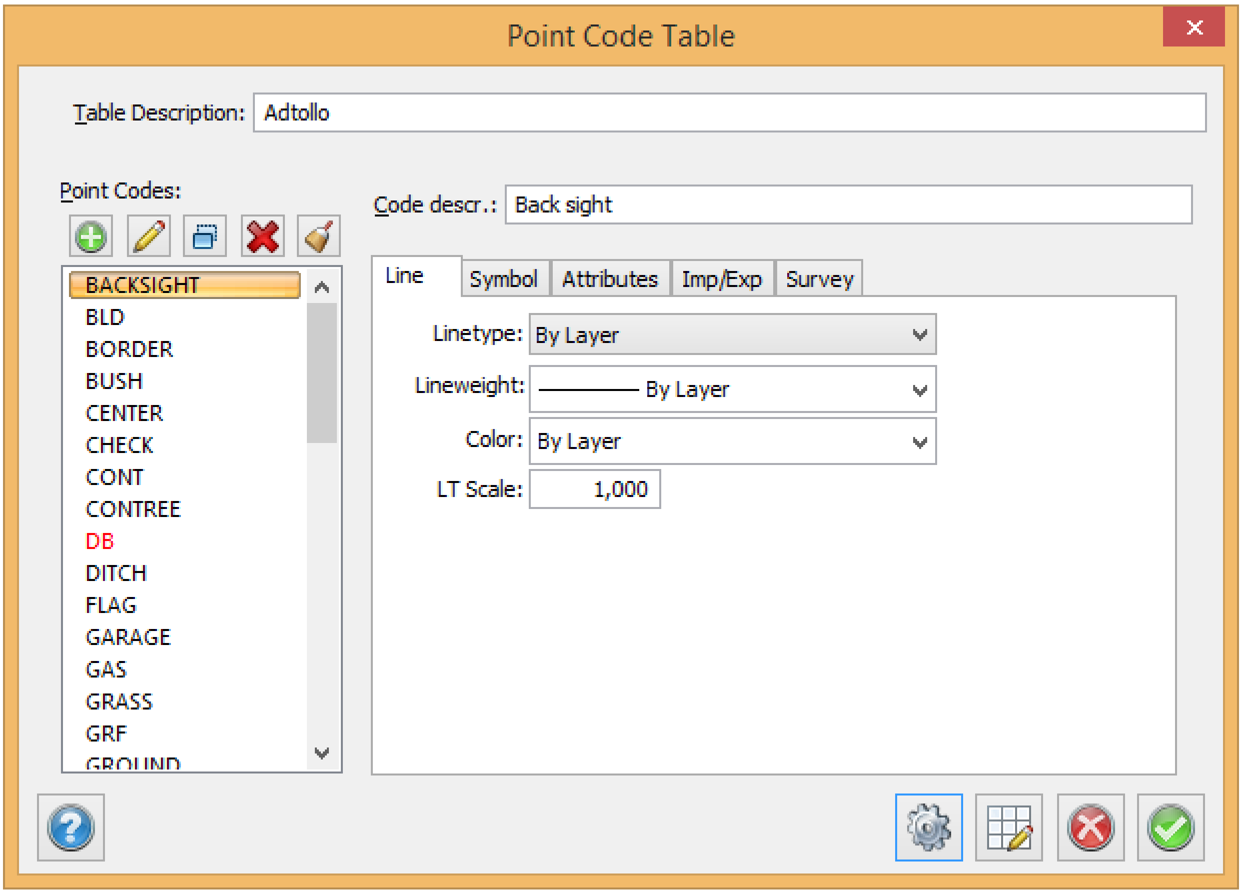
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line



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- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
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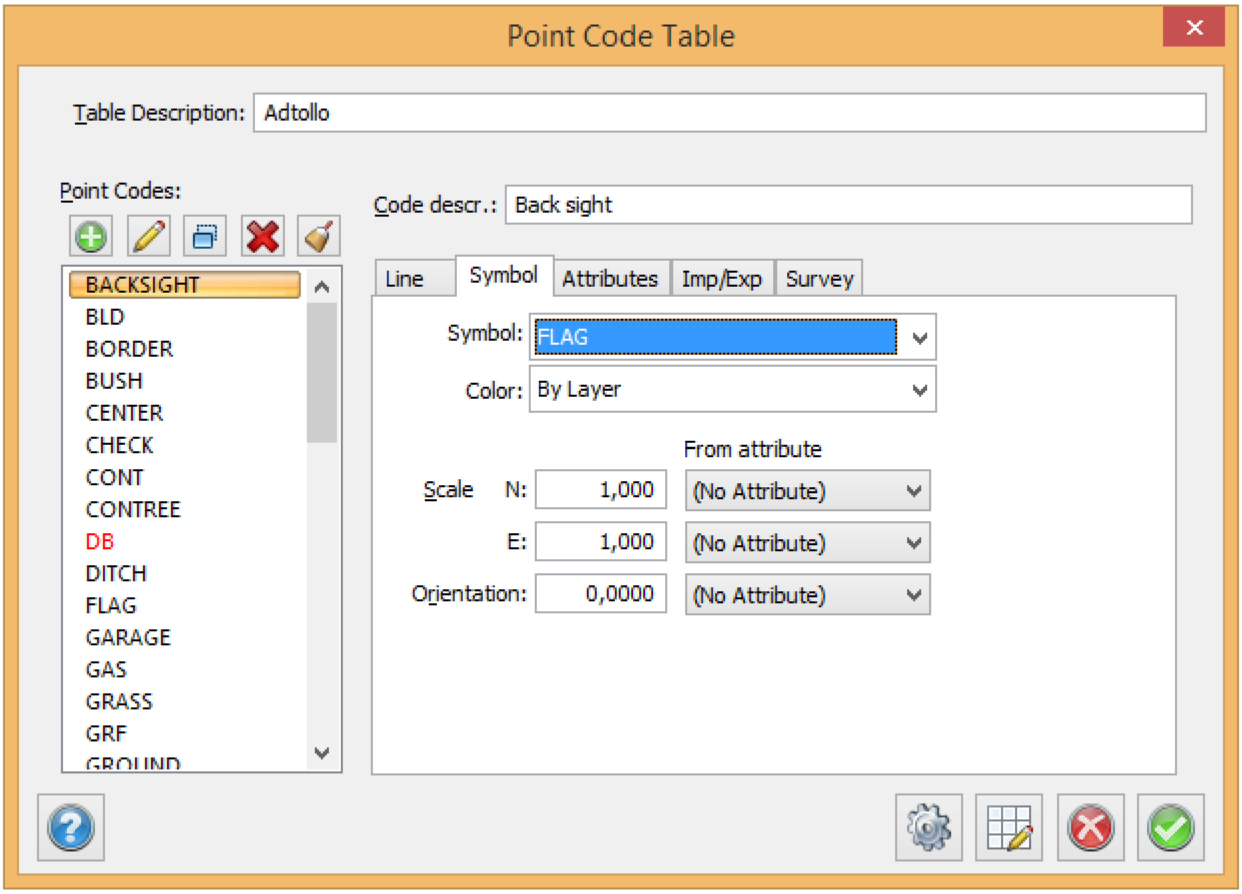

- **Symbol**
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- **Colour:**
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- **Rotation**
  Determines the rotation for the symbol.

Attributes

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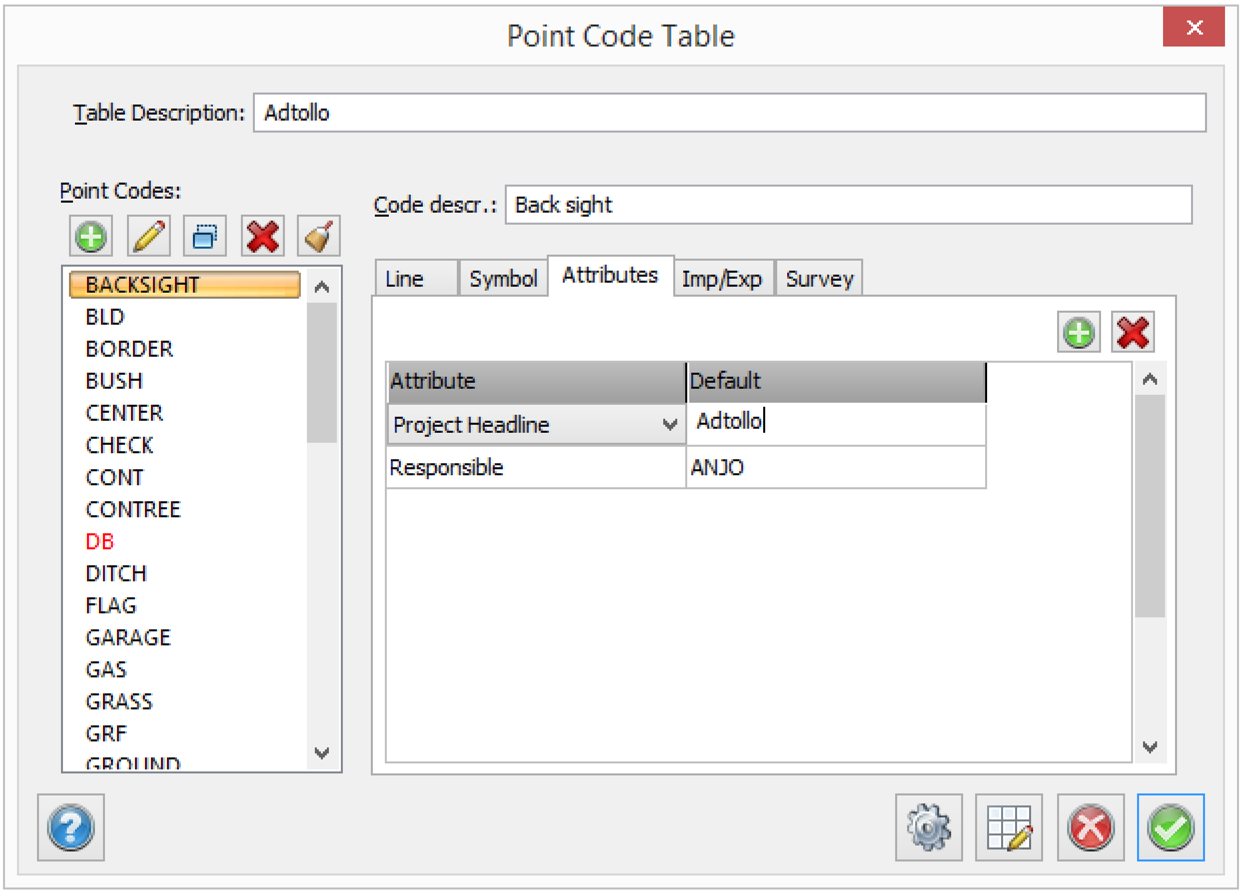

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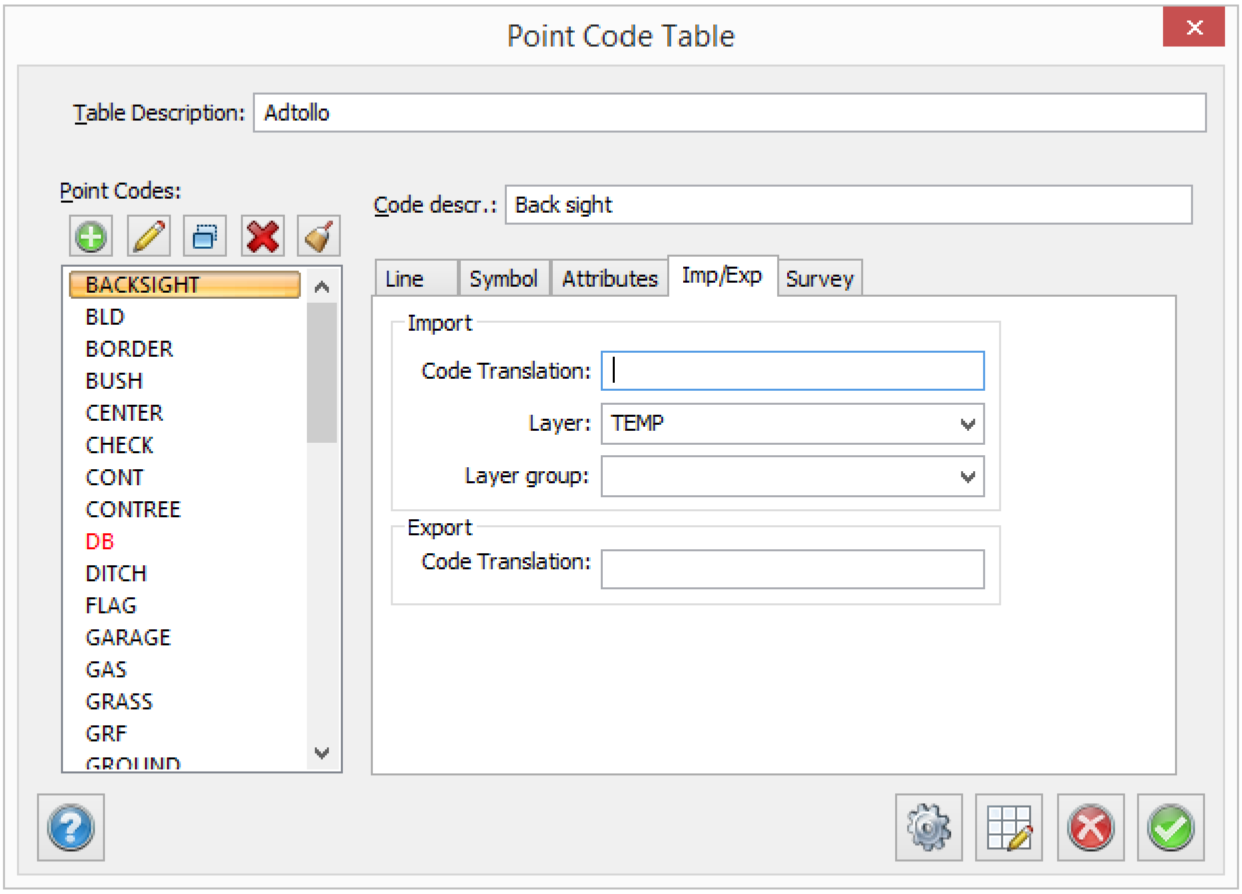
Import/Export

Home|Code table - Import/Export



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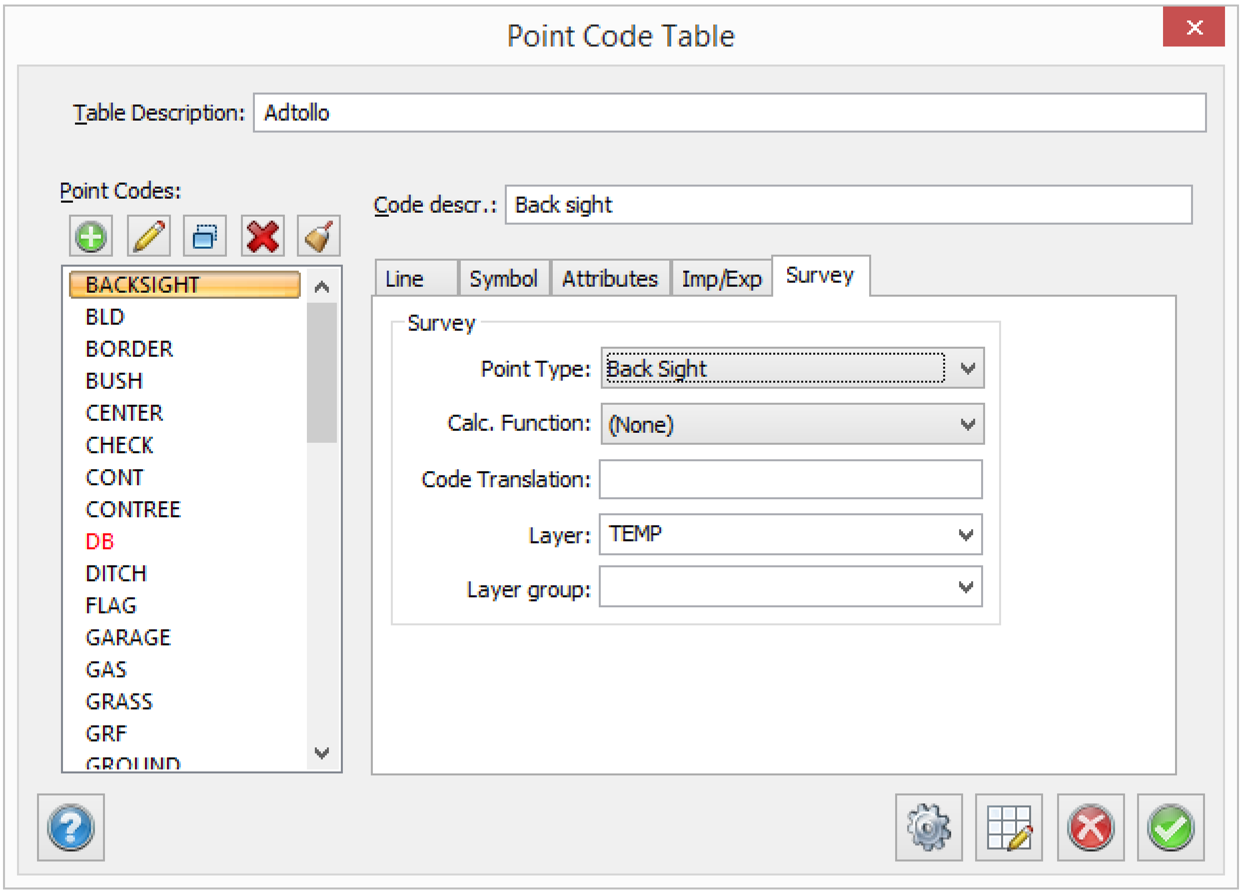
Survey

Home|Code table - Survey



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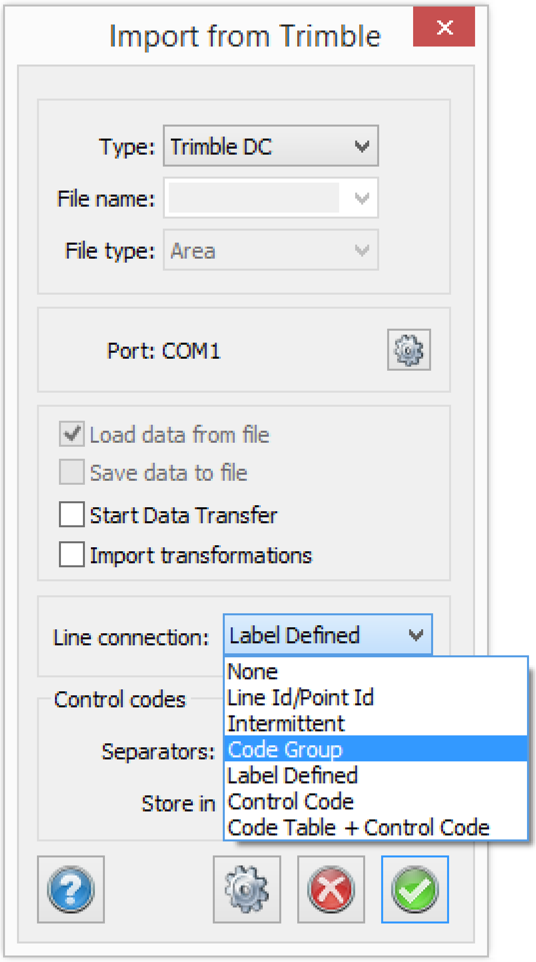

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Drawing|Home|Code table

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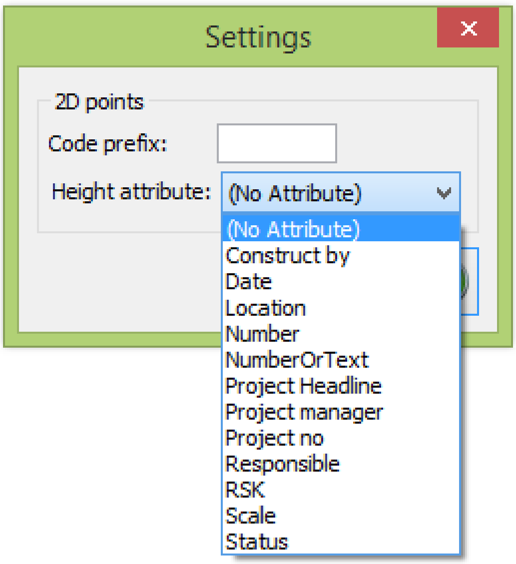

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Button for creating a new point code.

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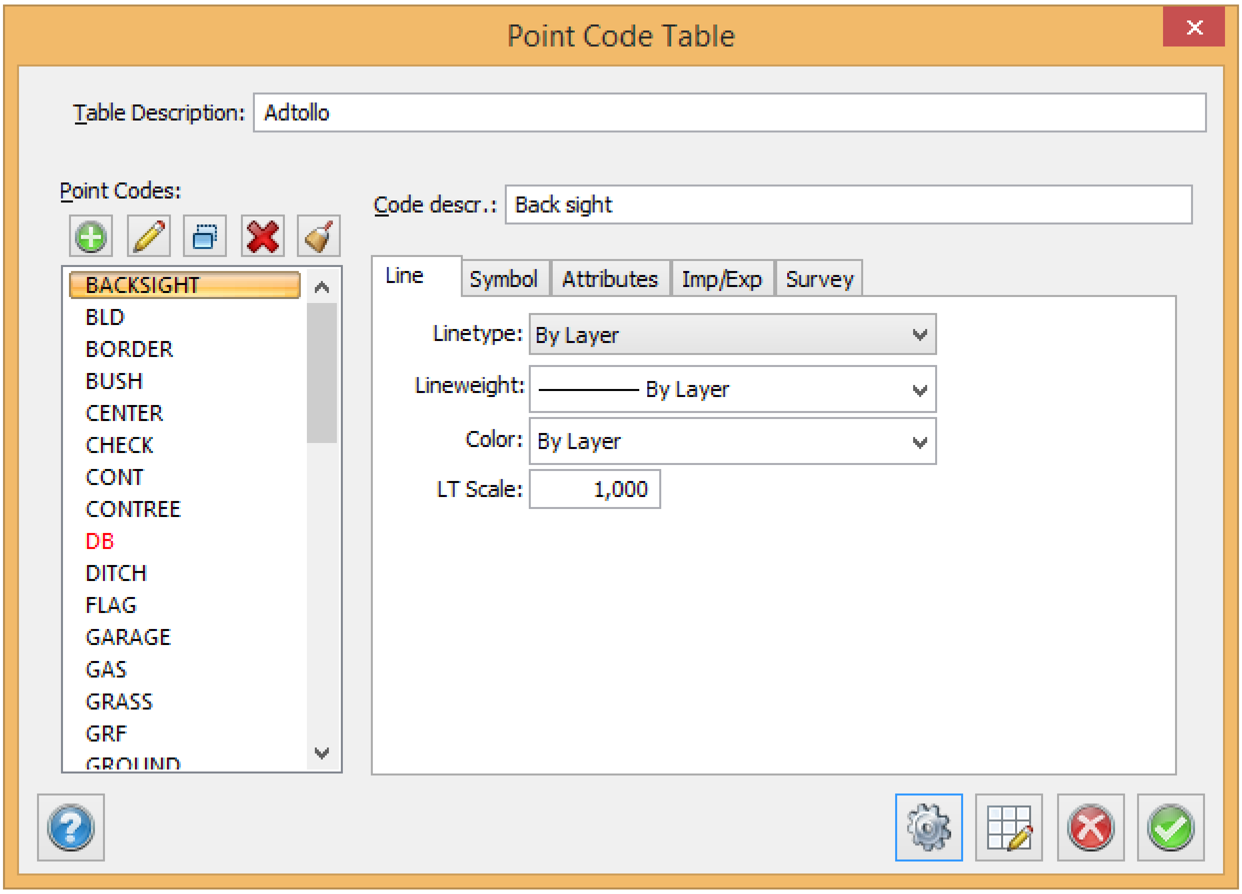
Linetype

Home|Code table - Line

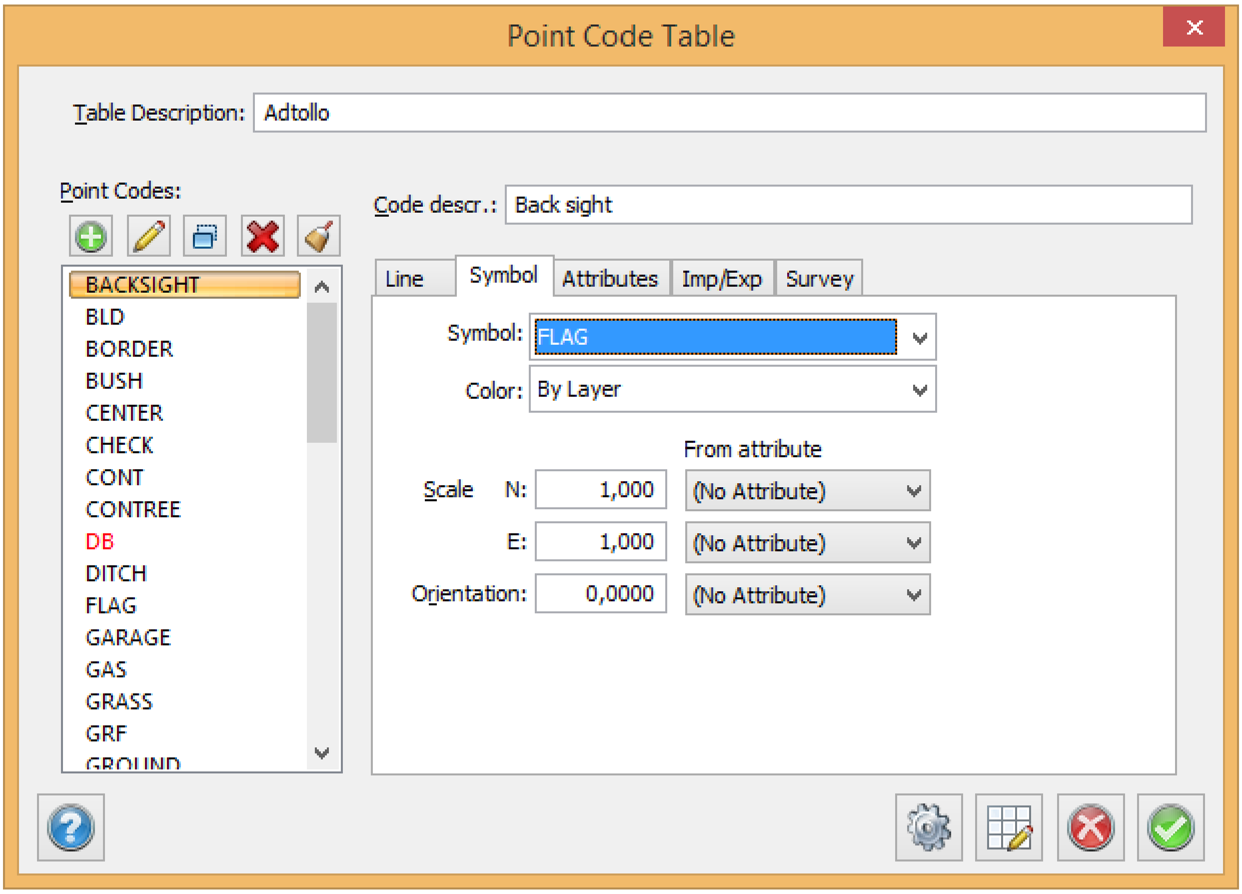


There are several different types of lines to select. It is also possible to select the line type in the Layer manager. This allows you to select the line type in several places, but any line type entered in the code table is given a higher priority than one entered in the layer manager. In the code table it is possible to select the line type by layer.

- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
- Use Clear button to remove all not referenced line types from system files.
- >> and << buttons copies all the content from Local to Global and vice versa.

Symbol

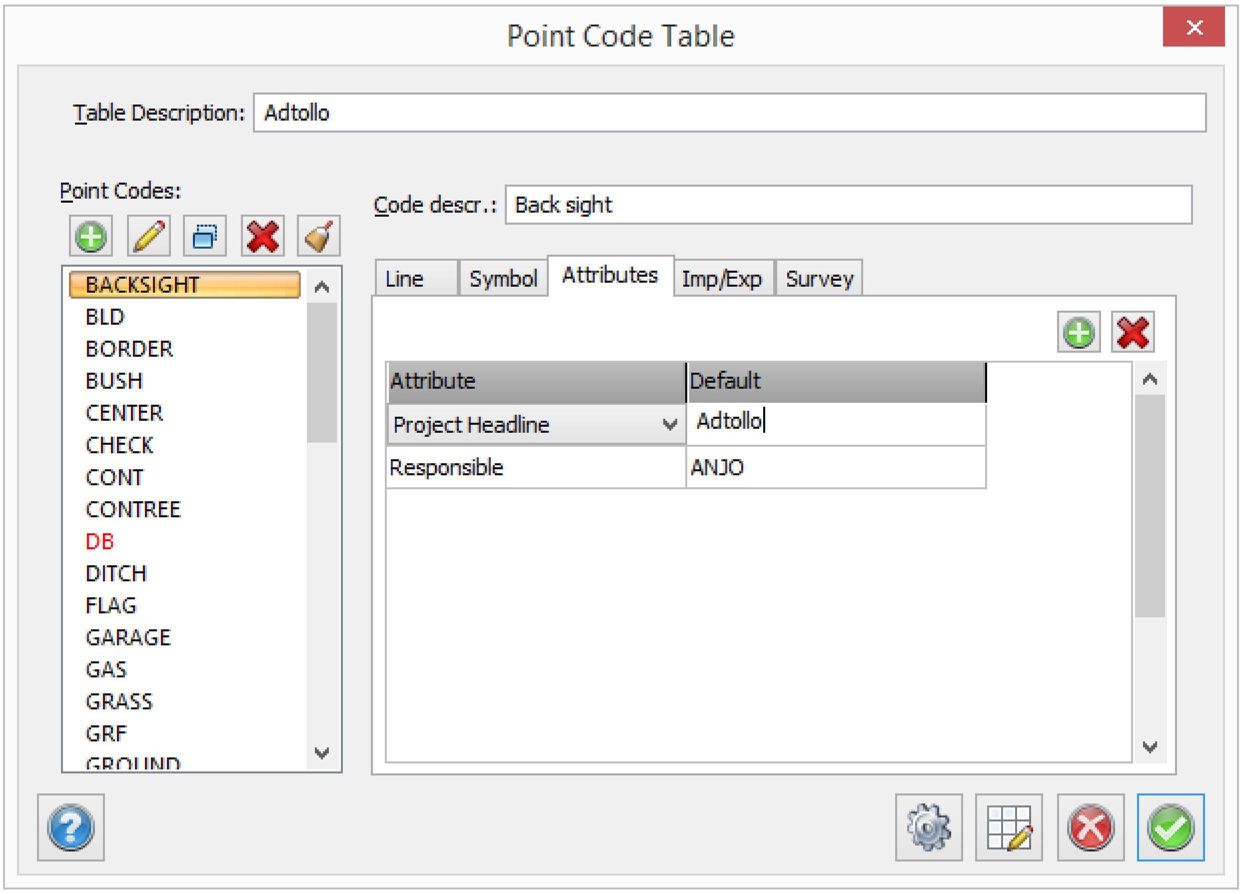
Home|Code table - Symbol



- **Symbol**
  Select which symbol (if any) the point code will have. Select from the drop-down list.
- **Colour:**
  Select the colour for the point code. It is also possible to select by layer.
- **X-scale, Y-scale**
  The symbol is always saved with a scale of 1:1000. The default drawing scale is also 1:1000. It is possible to select a different drawing scale in Settings|Drawing scale. For example, if you want to the symbol to appear at twice its original size (1:1000) you should enter the scale 2.0 in this field.
- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



An attribute is a type of added value for the point. An attribute can be linked directly to a point code, a symbol or both. The attribute can be entered in the field survey, the survey data document (.sur) or in the drawing - Go to Modify|Edit attribute. If you link an attribute to a point code you can give every point with this point code an attribute value. If you have used a symbol for the point code and want the attribute to be displayed as well, you will need to create the symbol with a linked attribute. To add an attribute to the symbol see Define attribute

There are no limits to number of attributes that a point can have.

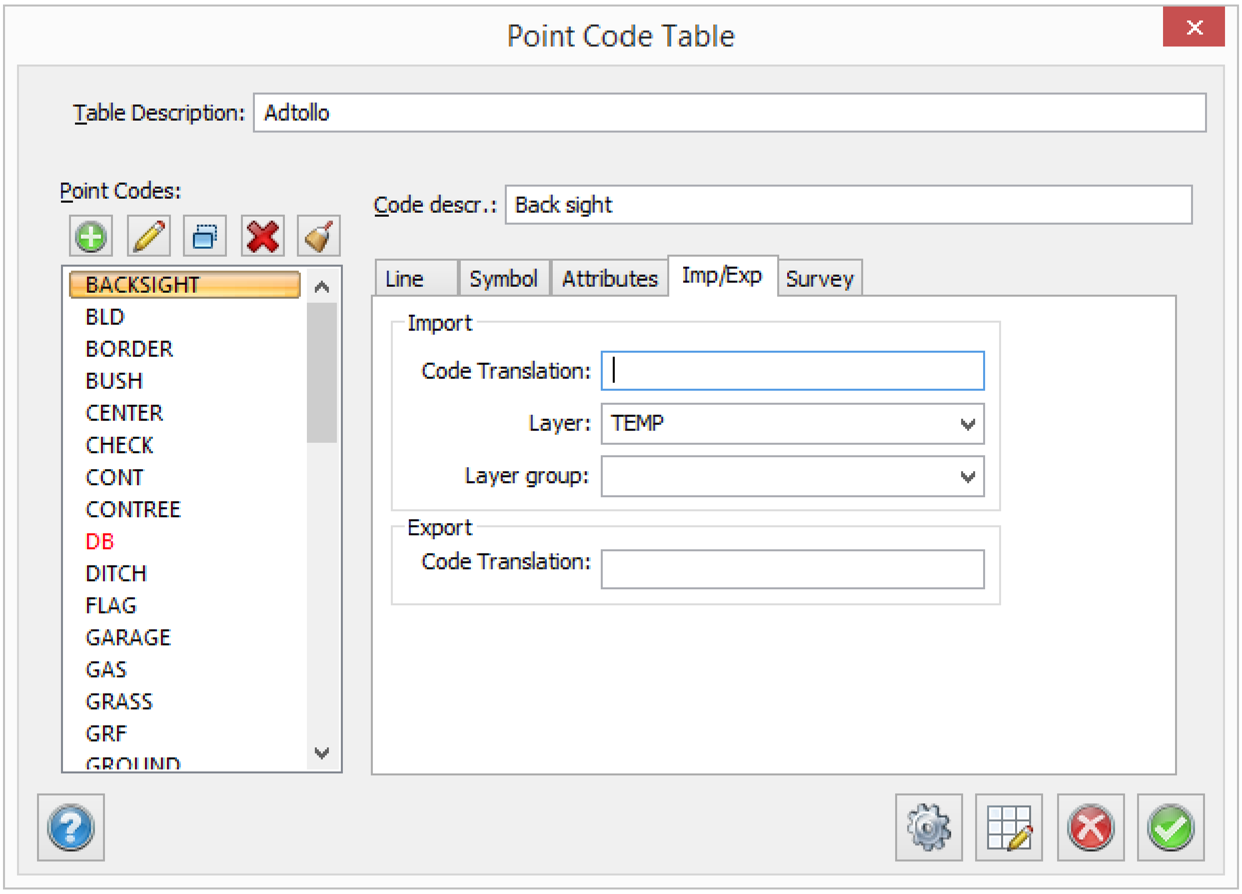
The value of the attribute belongs to the point but the type of attribute belongs to the point code.

Add
Click Add if you want to add an attribute to the point code. The attribute list appears and you can select from the list. To create an attribute go to Home|Attribute

Delete
Press delete if you want to delete a link to the specified attribute. Note that you only delete the link to the attribute and not the attribute itself.

Import/Export

Home|Code table - Import/Export



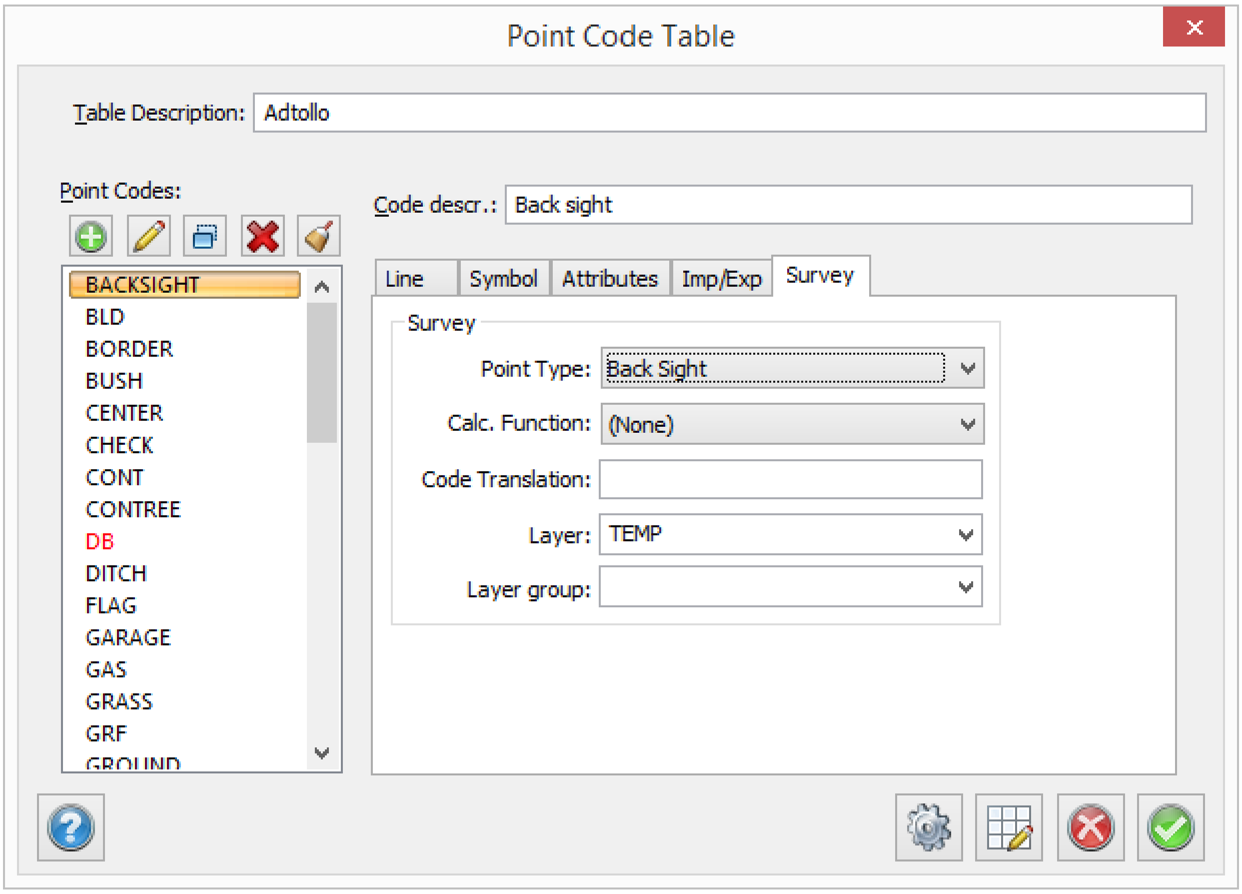
The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

Import - Transfer point code:
Interpolates the point code (point in file) to another point code. For example, you can use the numeric point code 10 in the field which is translated to pp in the drawing. A similar function exists for points that are imported from a file. See previous page - Survey.

Layer:
This function allows a point code belonging to a point in a file to be moved to a specific layer. It is possible to use a layer name for all kinds of trees and then put all tree point codes in that layer. It is also possible to create a specific layer for every point code if required. Similar functions exist for points which are imported from files, see previous page - Survey.

Export - Transfer point code:
You can also specify that the point code used in the drawing should be interpolated to another point code when it is exported to a file.

Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
The code can end up with a different code in the drawing. Enter the name here.

Layer
Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

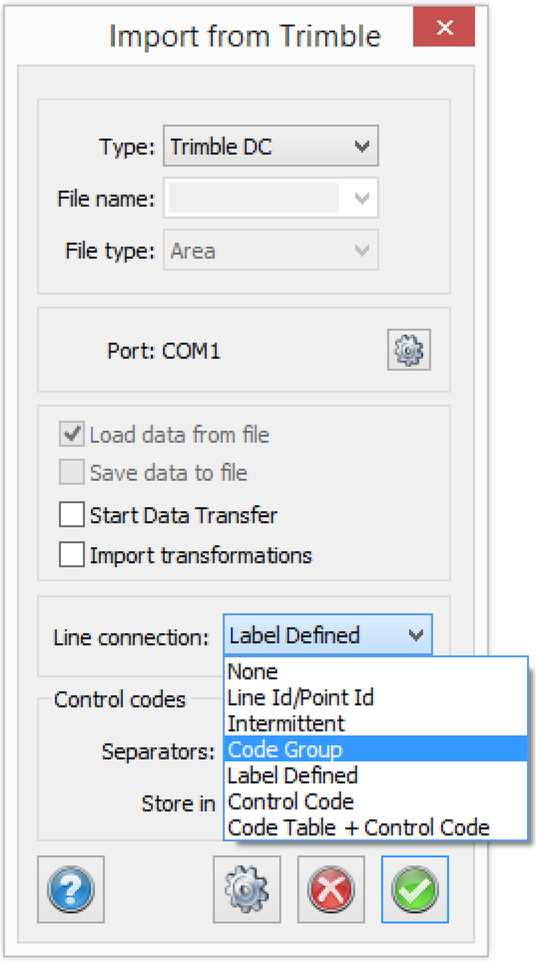
Point types:
None

Polygon point
The point will be calculated and added to the pp file.

Check point
Used for check towards known point.

Temporary point
The co-ordinates are temporarily saved and the point can be used as a back sight or station in later stations in the same survey file.

Back sight
Function used to code back sights in the survey.



Control codes

Code table + Control table
Point with codes using these point types will have the following control codes:

- Point
- Line: Starts in first point
- Construction point: control point. Will not be included for calculation. Can be used for breaking line and start over with the same code.

Line connection "Code table + Control Code" is also used for general import. Possibility to filter point codes on point type in all controls for selection of point code.

Calculation function

The calculation functions are:

Two prism measurement

The extra two prism measurement function is used when measuring a two prism object. An example is the measurement to the ABC pole which has two prisms at the same pole. You decide from which prism you measure the length to the end of the pole and also which of the two prisms you measure first.

See also

Control codes

Edit code table

Drawing|Home|Code table

Function, command	Description
General	General for all point codes
Linetype	Select line type
Symbol	Select which symbol (if any) the point code will have.
Attributes	Link an attribute directly to a point code, a symbol or both.
Import/Export	Change the point code when importing from, and exporting to a file.
Survey	
Import trimble	
Control codes	
Calculation function	

All codes which are used at any point in any open file will also appear in the code table. As soon as you open a file or import field data into a survey data file (.sur) all new codes will be inserted into the code table. You may of course have existing codes in the code table even when they are not being used in any open document or drawing. It is not possible to delete an existing code if it has been used in any open document. This is indicated by the delete button being greyed out. It is possible to use different code tables. They can be selected using *Home*|*Settings*.

To input a point code:

1. Open Edit code table.
2. Click New.
3. Add the new point code.

In the code table there are up to six different tabs with information and functions used in the survey and to import and export data. The last tab depends what function the code has.

The tabs are:

- Line
  Contains information about the type of line, colour and line type scale.
- Symbol
  Contains information about the type, colour, scale and orientation of the symbol.
- Attribute
  The attributes of the point code are entered on this tab.
- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

- Import/Export
  Contains the transfer code, layer and export code.

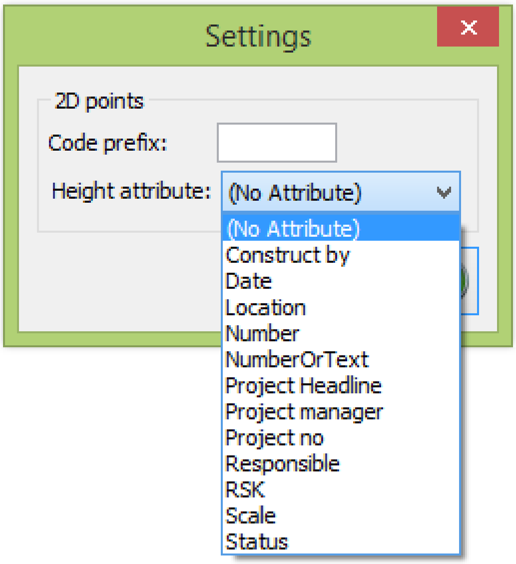
Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
- Rectangle 3
  Calculation function for three point rectangles.
- Circle 2
  Calculation function for two point circles.
- Circle 3
  Calculation function for three point circles.
- Arc 2
  Calculation function for two point arcs.
- Arc 3
  Calculation function for three point arcs.
- Parallel line
  Calculation function for parallel lines.
- Closed line
  Calculation function for measurement of closed polylines or polygons.

General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

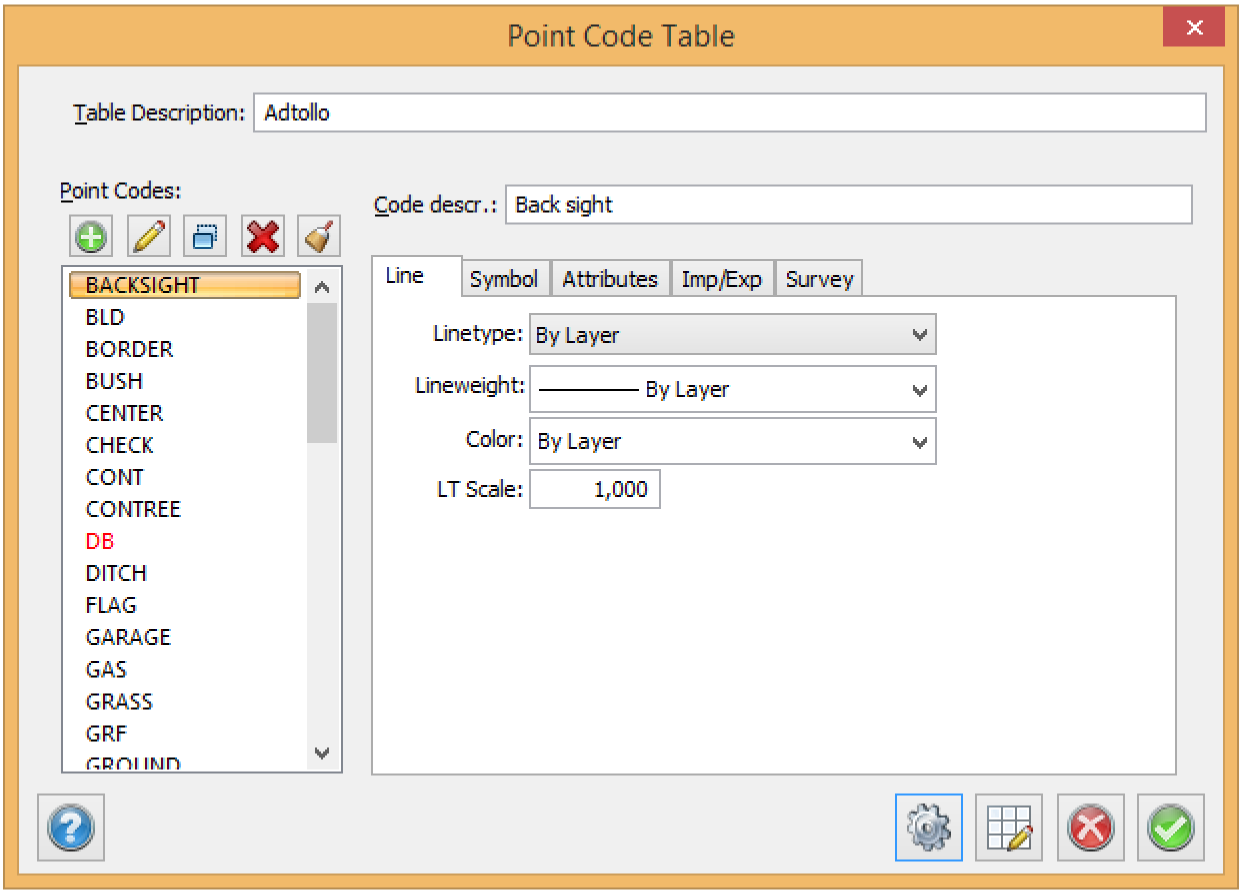
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line



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- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
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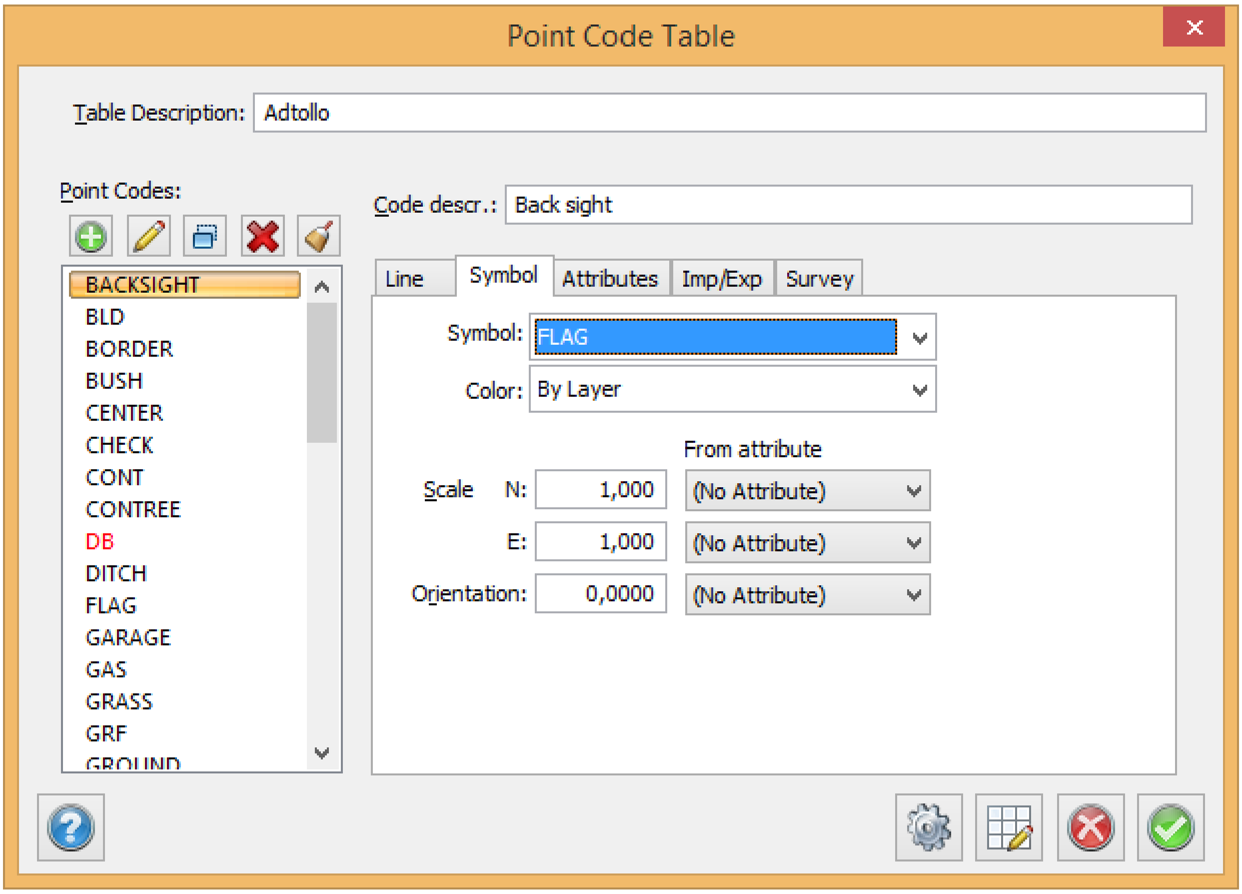
Symbol

Home|Code table - Symbol



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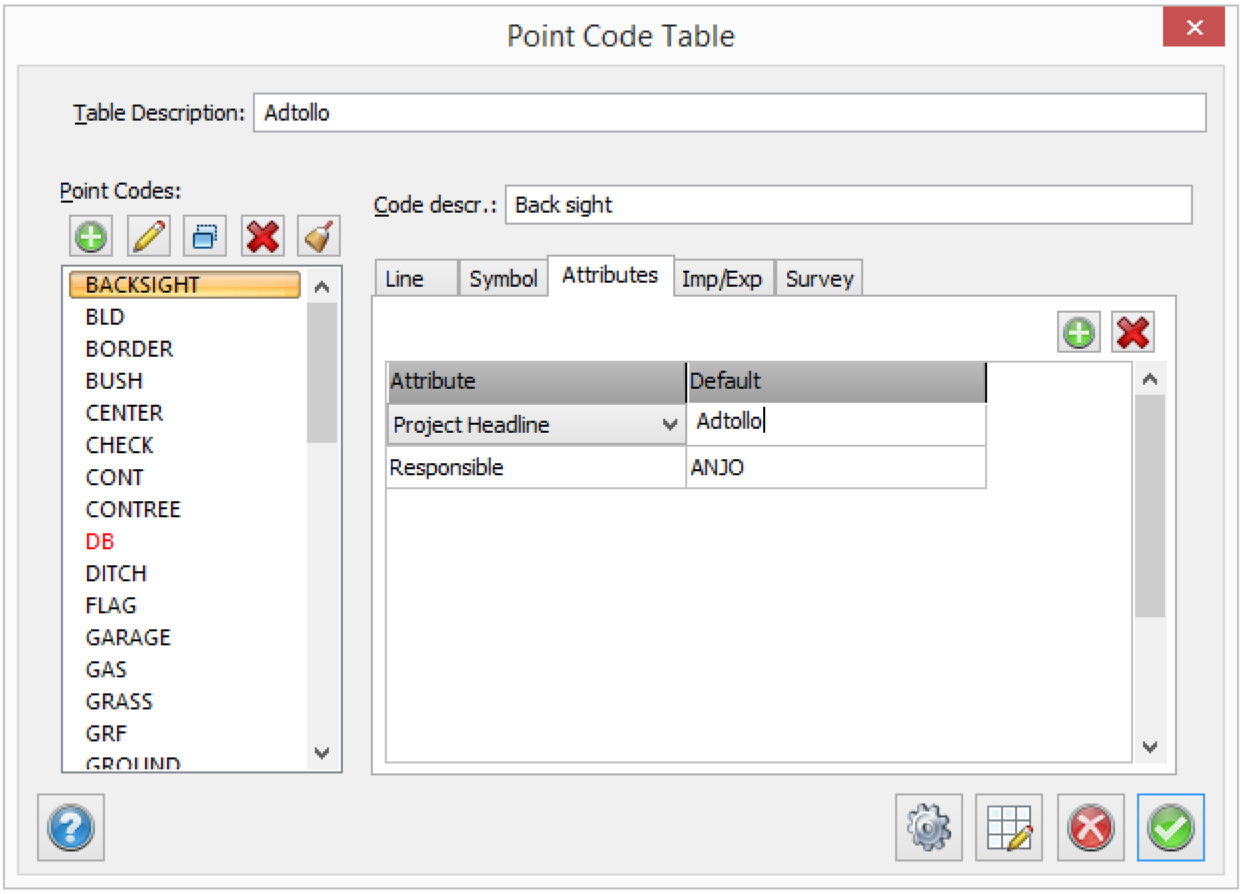
- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



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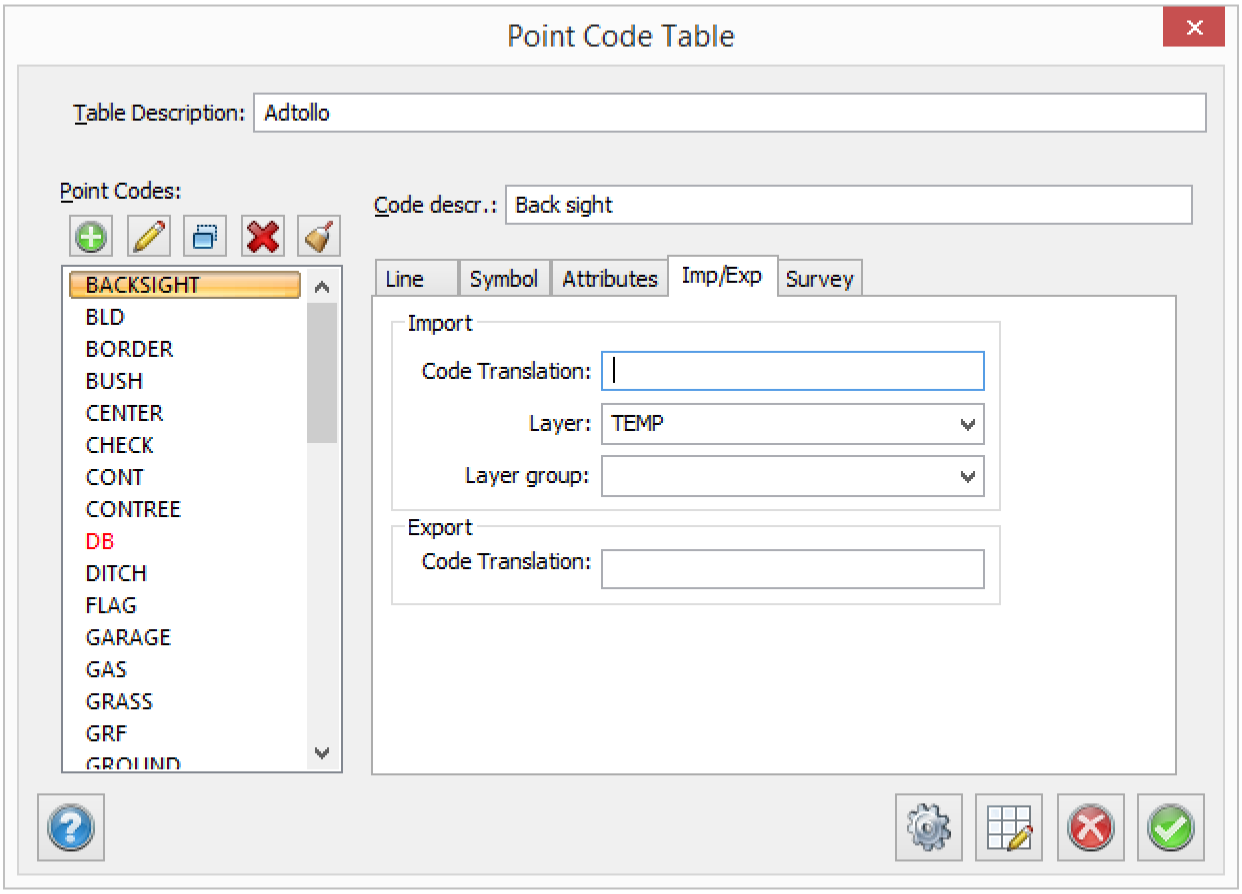
Import/Export

Home|Code table - Import/Export



The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

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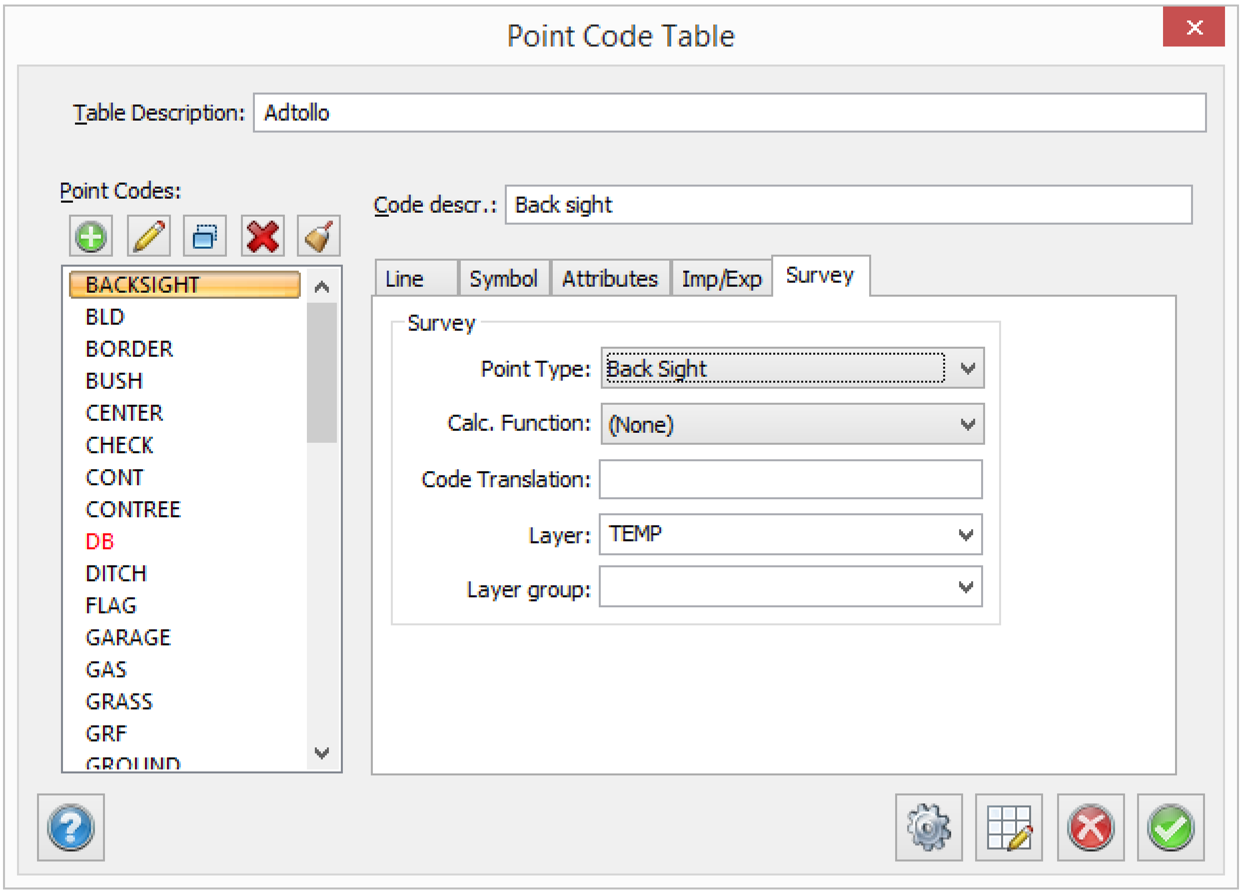
Survey

Home|Code table - Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
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Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

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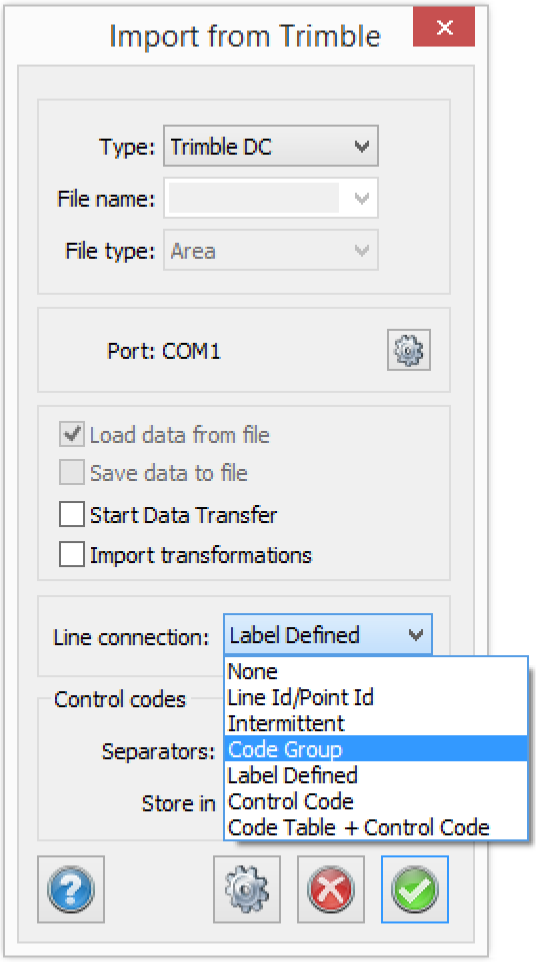

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Control codes

Edit code table

Drawing|Home|Code table

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Survey	
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Control codes	
Calculation function	

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- Attribute
  The attributes of the point code are entered on this tab.
- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

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  Contains the transfer code, layer and export code.

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  Calculation function for extrapolation.
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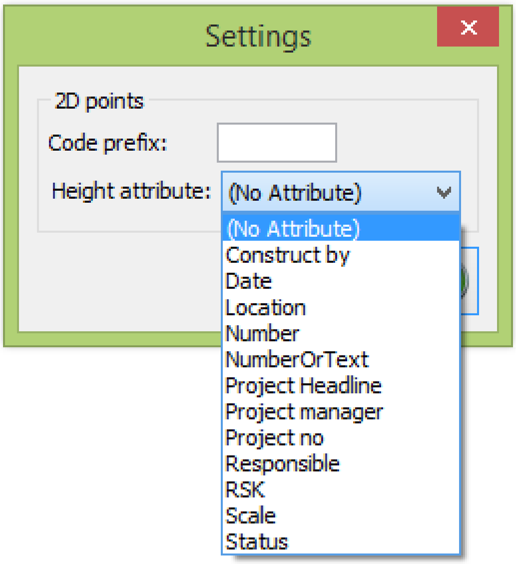
General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.



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Description
Description of the point code. This is not essential for the point code to function.

New
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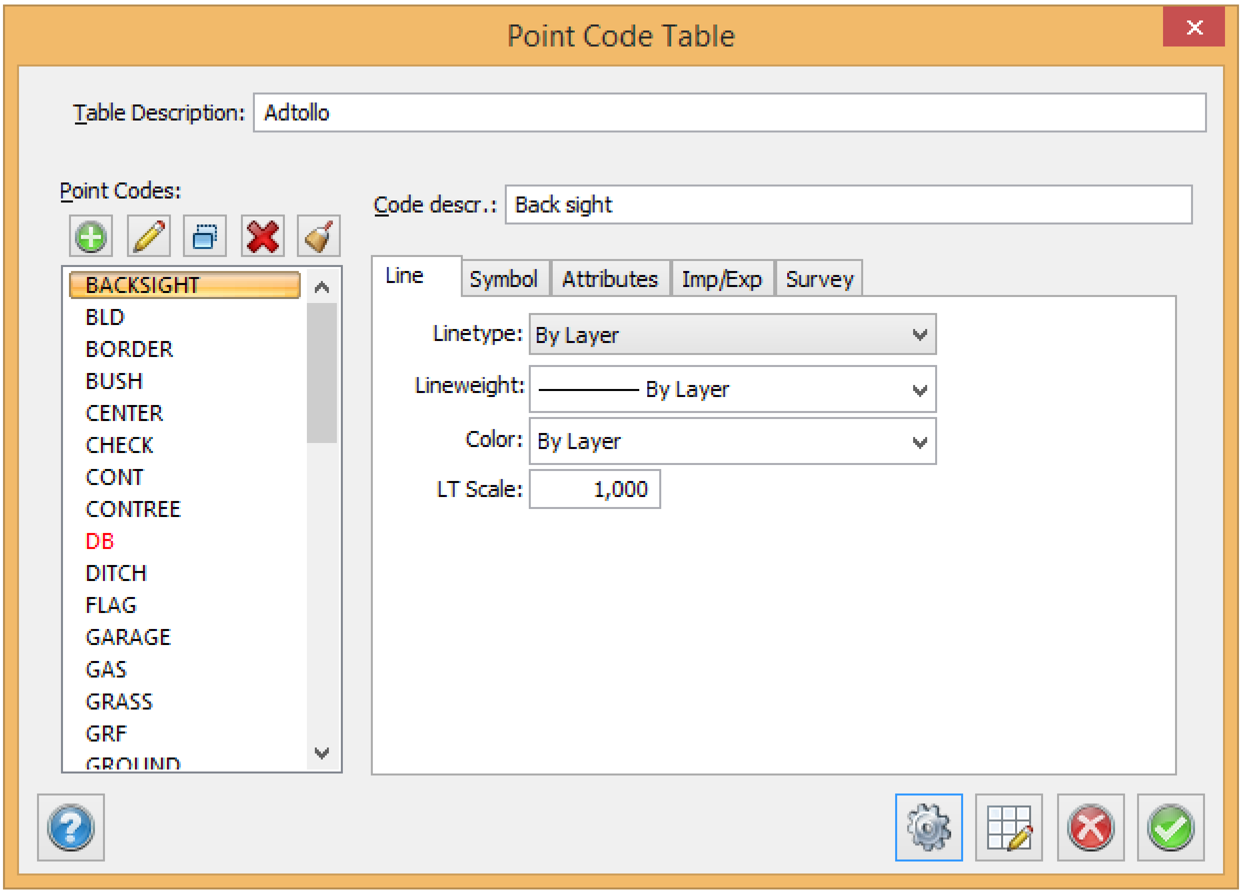
Linetype

Home|Code table - Line



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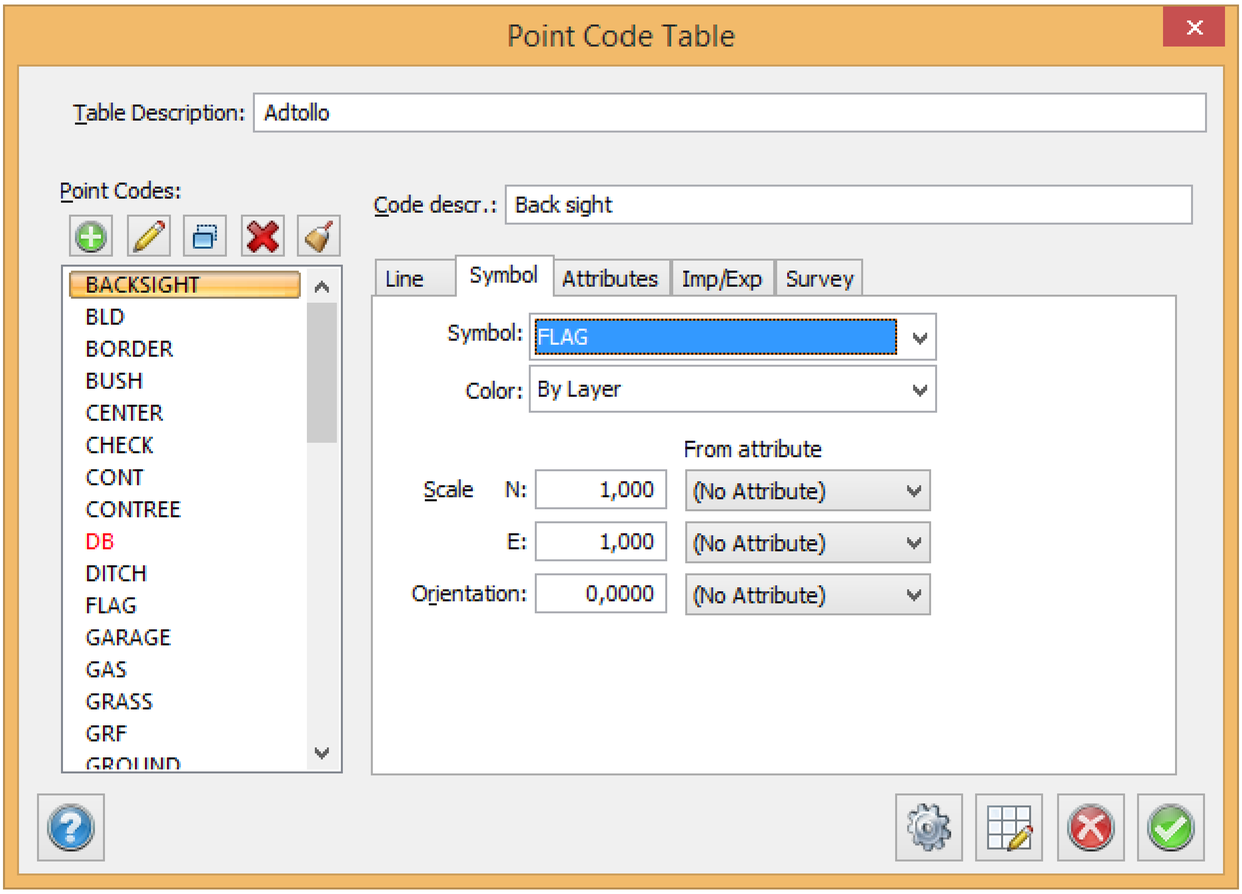

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Attributes

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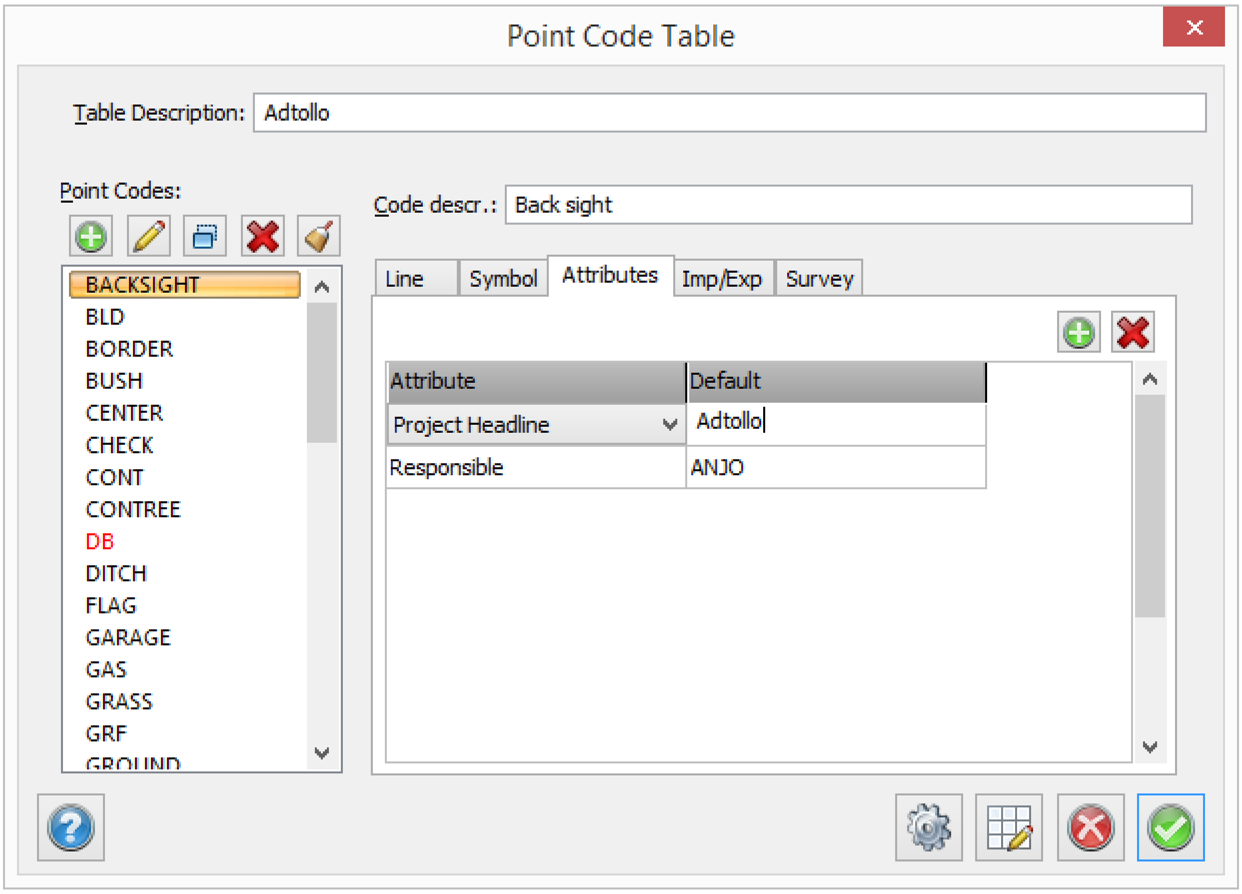

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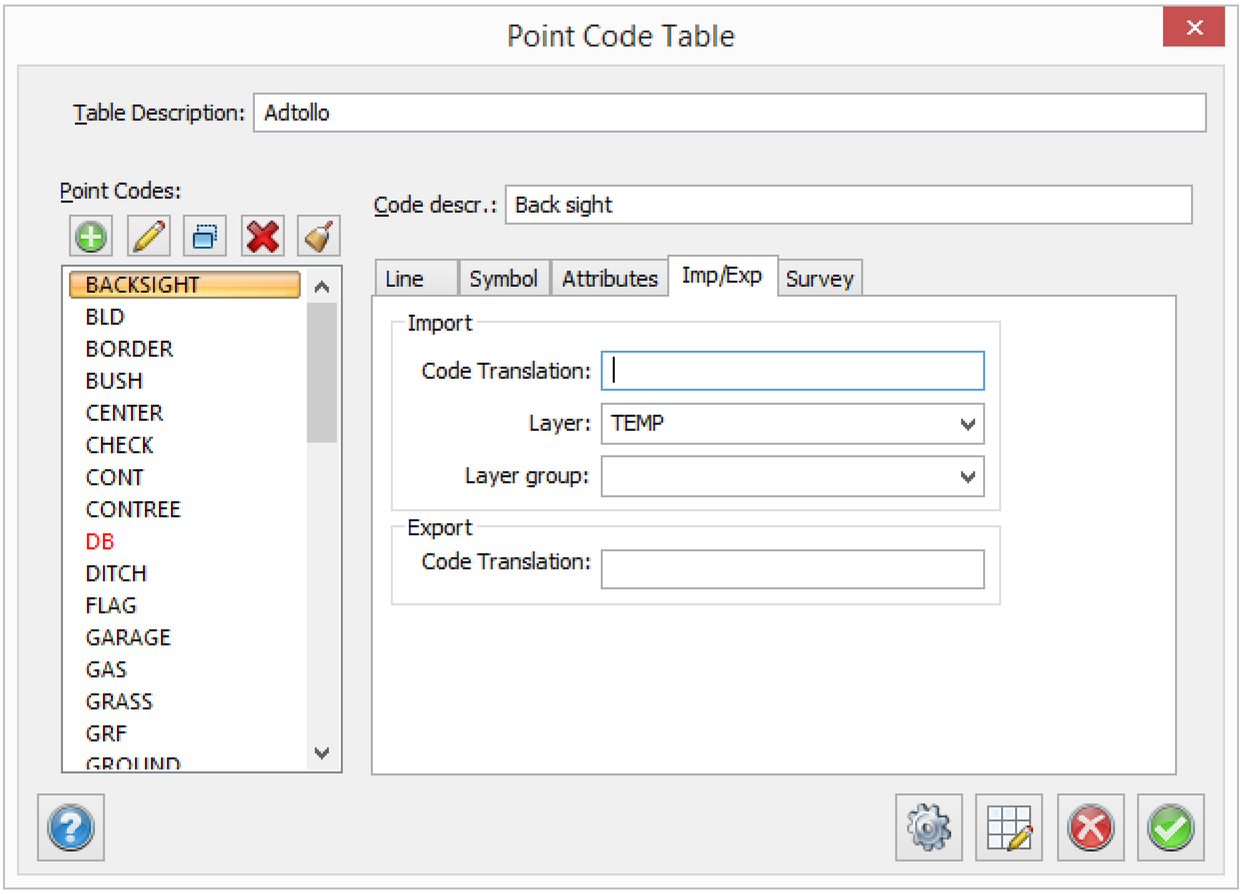

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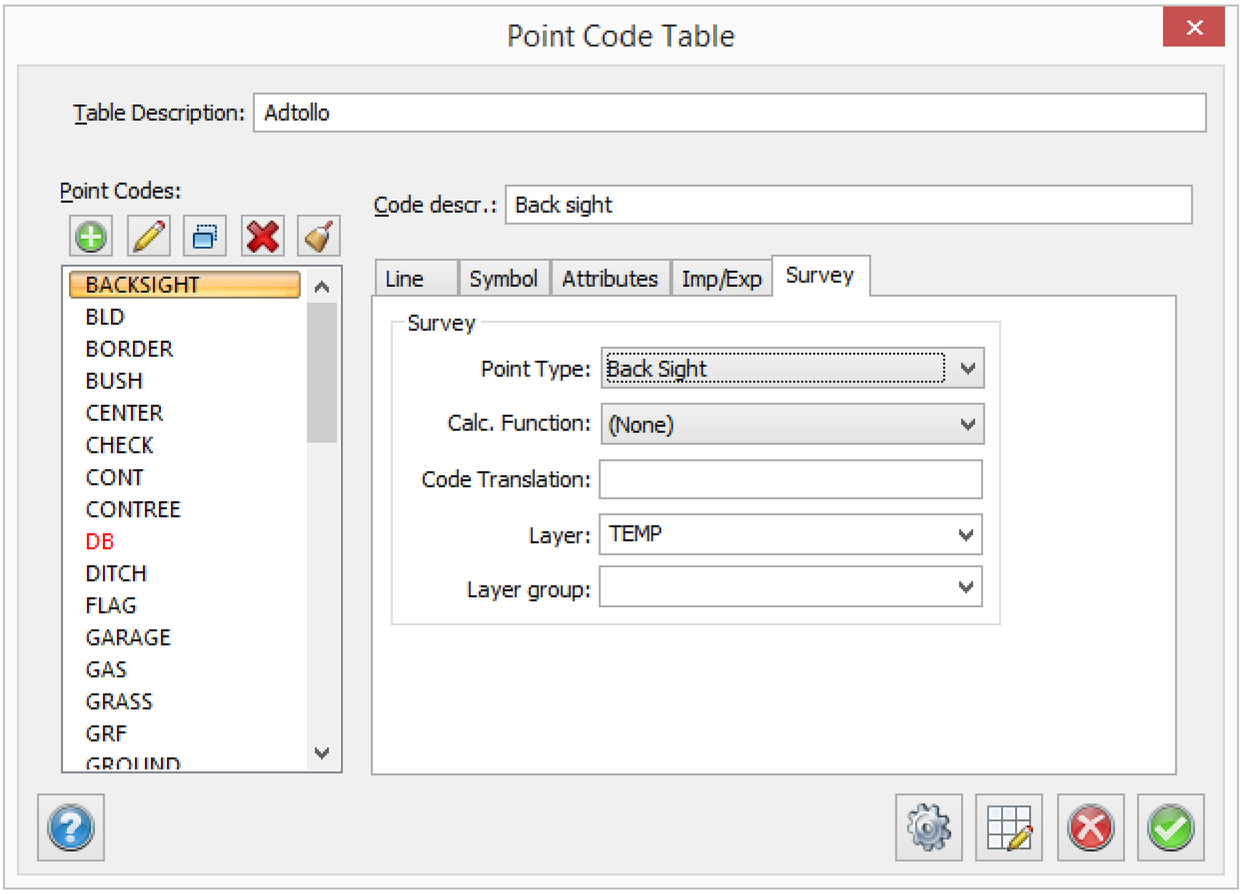

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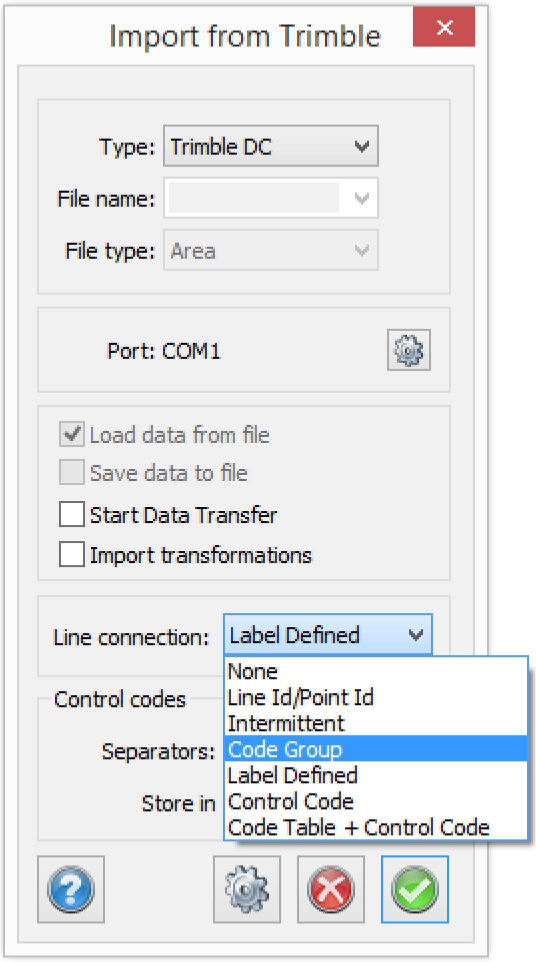

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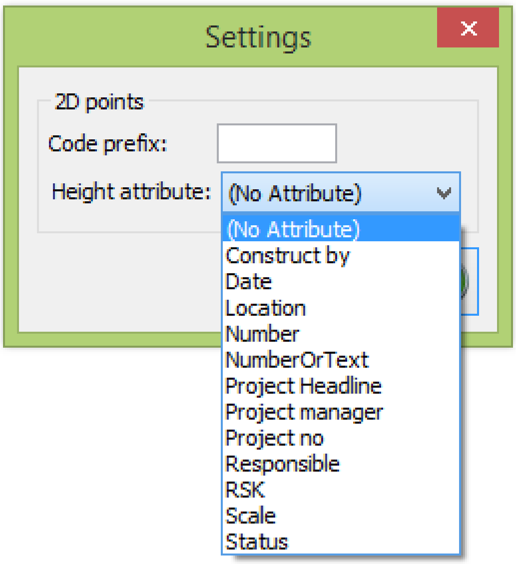
General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.



Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.

Description
Description of the point code. This is not essential for the point code to function.

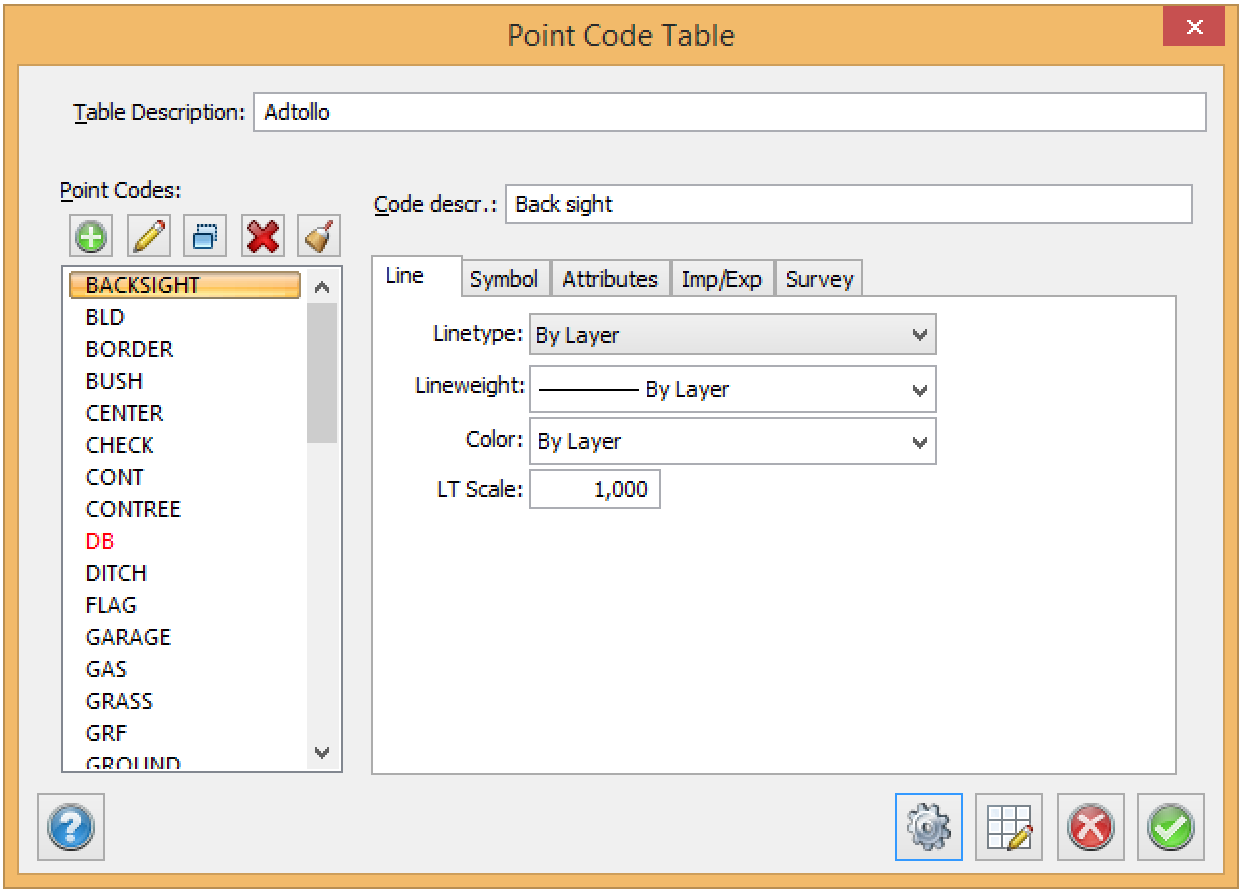
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line

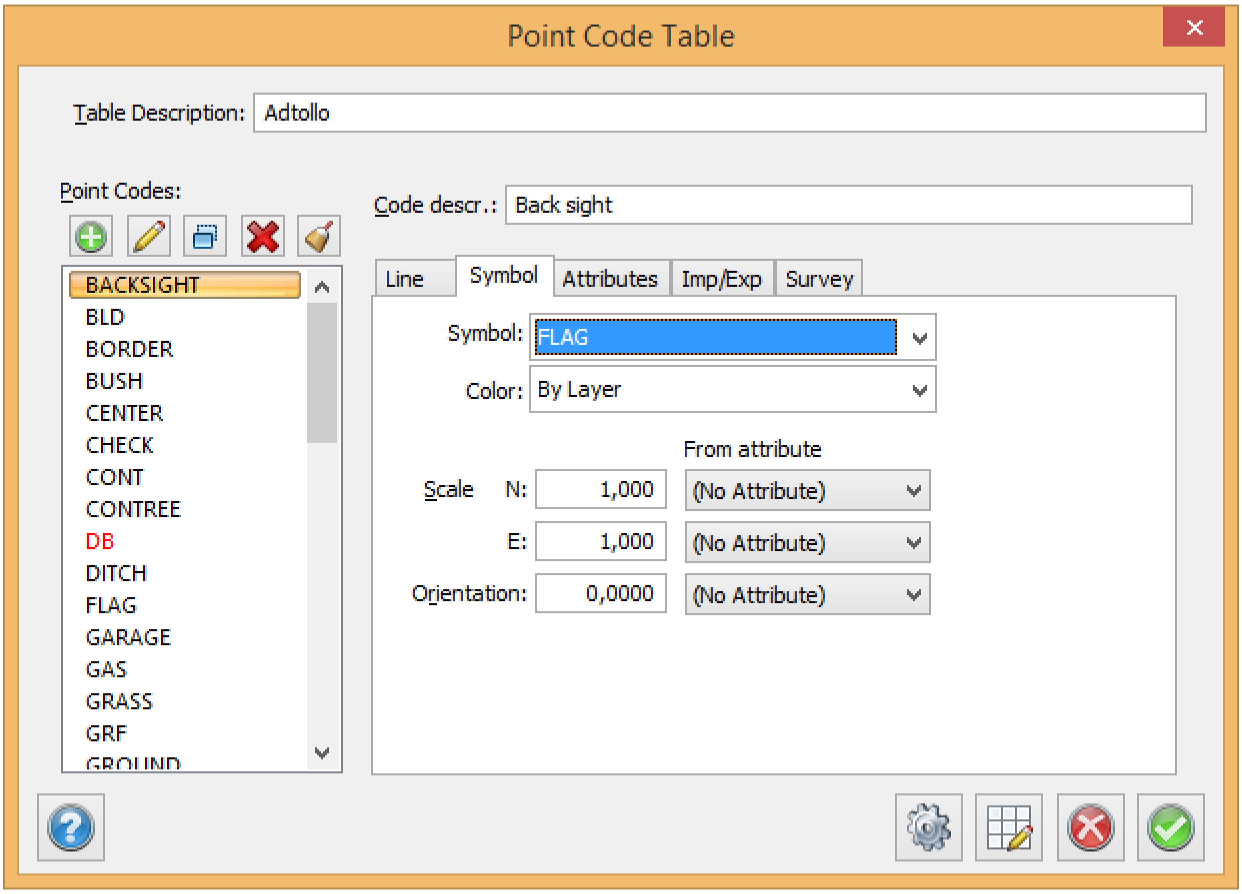


There are several different types of lines to select. It is also possible to select the line type in the Layer manager. This allows you to select the line type in several places, but any line type entered in the code table is given a higher priority than one entered in the layer manager. In the code table it is possible to select the line type by layer.

- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
- Use Clear button to remove all not referenced line types from system files.
- >> and << buttons copies all the content from Local to Global and vice versa.

Symbol

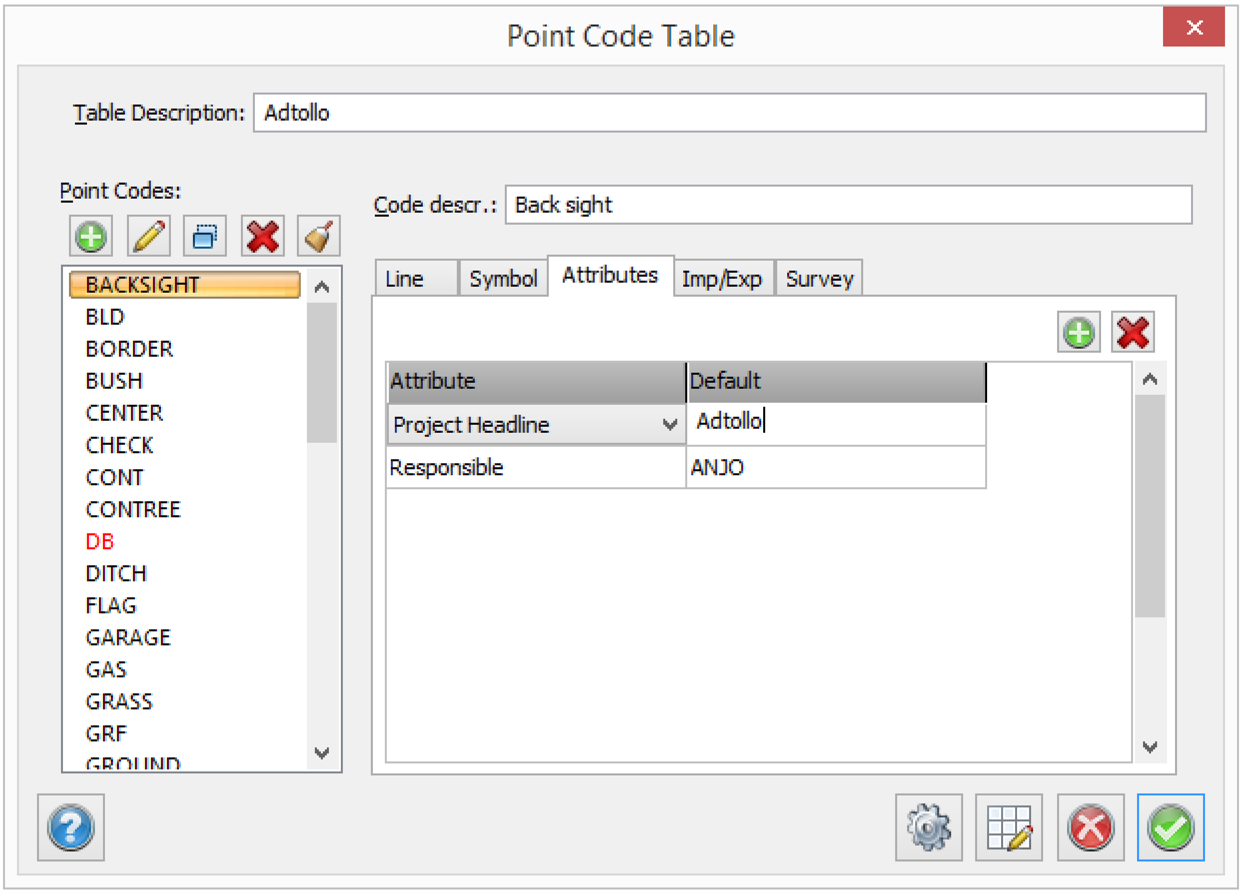
Home|Code table - Symbol



- **Symbol**
  Select which symbol (if any) the point code will have. Select from the drop-down list.
- **Colour:**
  Select the colour for the point code. It is also possible to select by layer.
- **X-scale, Y-scale**
  The symbol is always saved with a scale of 1:1000. The default drawing scale is also 1:1000. It is possible to select a different drawing scale in Settings|Drawing scale. For example, if you want to the symbol to appear at twice its original size (1:1000) you should enter the scale 2.0 in this field.
- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



An attribute is a type of added value for the point. An attribute can be linked directly to a point code, a symbol or both. The attribute can be entered in the field survey, the survey data document (.sur) or in the drawing - Go to Modify|Edit attribute. If you link an attribute to a point code you can give every point with this point code an attribute value. If you have used a symbol for the point code and want the attribute to be displayed as well, you will need to create the symbol with a linked attribute. To add an attribute to the symbol see Define attribute

There are no limits to number of attributes that a point can have.

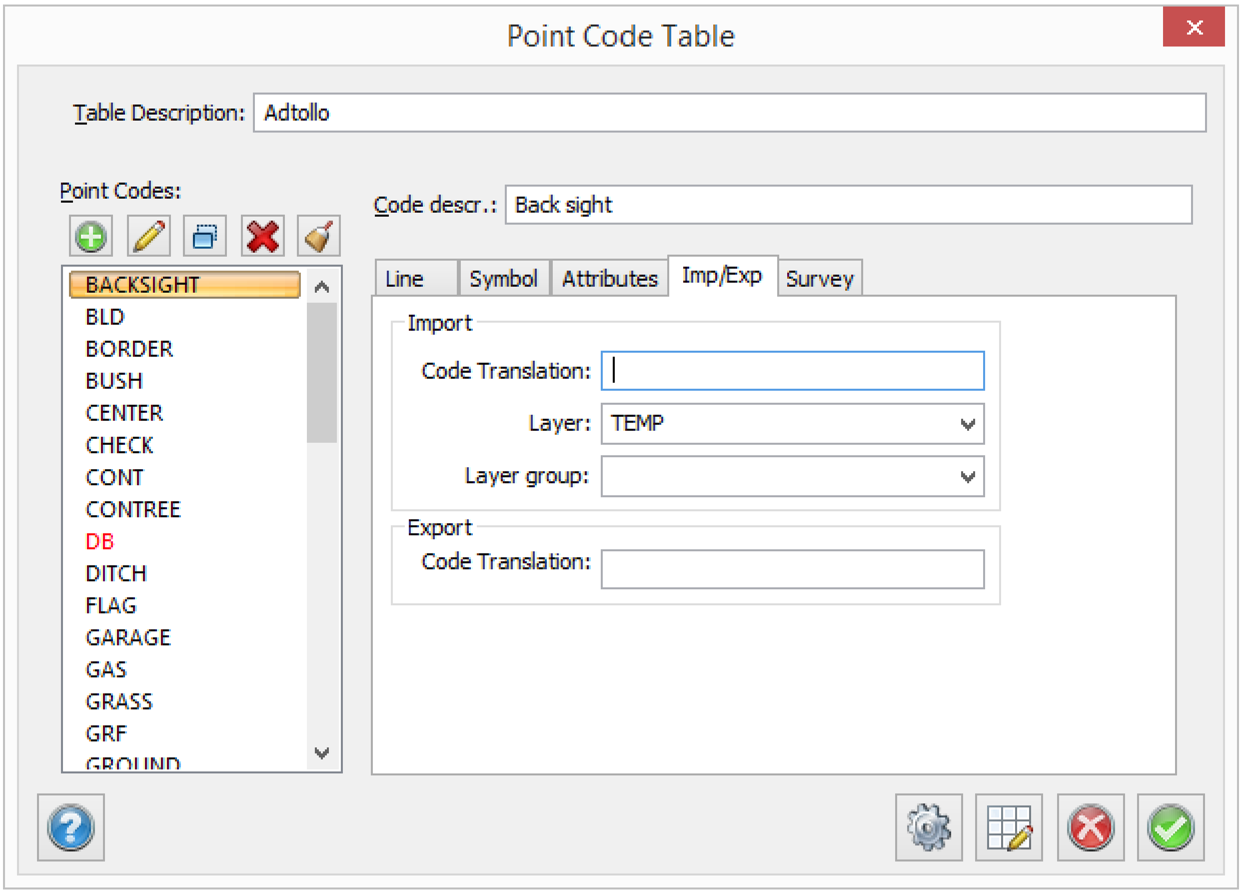
The value of the attribute belongs to the point but the type of attribute belongs to the point code.

Add
Click Add if you want to add an attribute to the point code. The attribute list appears and you can select from the list. To create an attribute go to Home|Attribute

Delete
Press delete if you want to delete a link to the specified attribute. Note that you only delete the link to the attribute and not the attribute itself.

Import/Export

Home|Code table - Import/Export



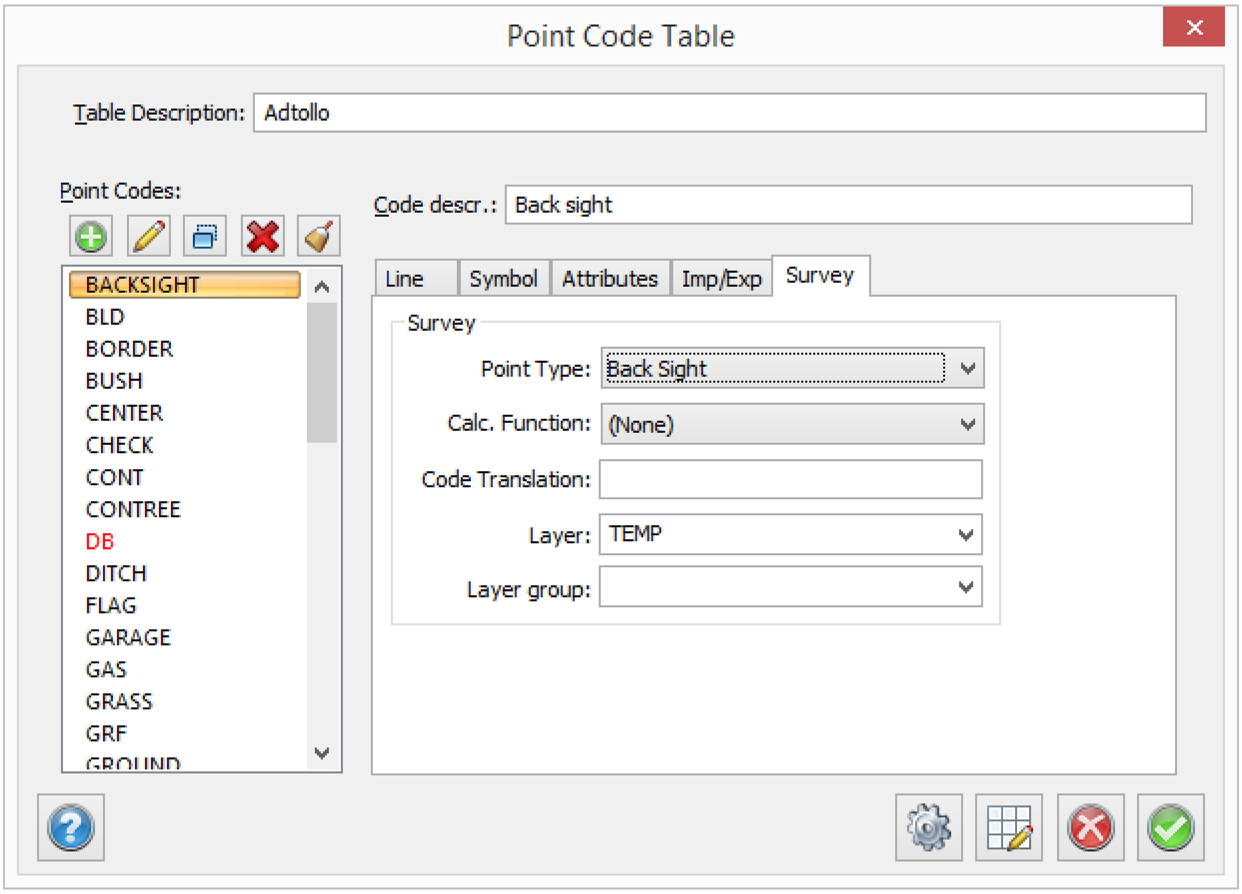
The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

Import - Transfer point code:
Interpolates the point code (point in file) to another point code. For example, you can use the numeric point code 10 in the field which is translated to pp in the drawing. A similar function exists for points that are imported from a file. See previous page - Survey.

Layer:
This function allows a point code belonging to a point in a file to be moved to a specific layer. It is possible to use a layer name for all kinds of trees and then put all tree point codes in that layer. It is also possible to create a specific layer for every point code if required. Similar functions exist for points which are imported from files, see previous page - Survey.

Export - Transfer point code:
You can also specify that the point code used in the drawing should be interpolated to another point code when it is exported to a file.

Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
The code can end up with a different code in the drawing. Enter the name here.

Layer
Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

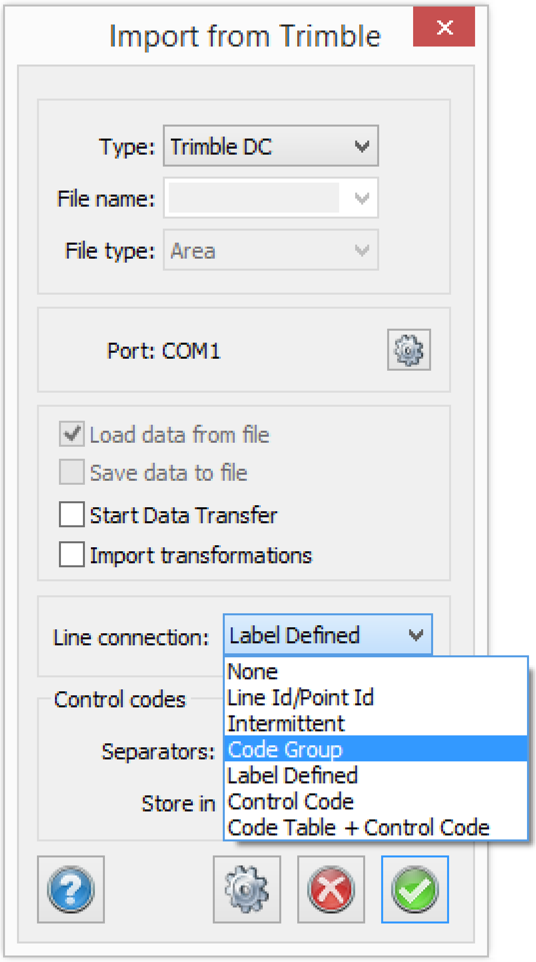
Point types:
None

Polygon point
The point will be calculated and added to the pp file.

Check point
Used for check towards known point.

Temporary point
The co-ordinates are temporarily saved and the point can be used as a back sight or station in later stations in the same survey file.

Back sight
Function used to code back sights in the survey.



Control codes

Code table + Control table
Point with codes using these point types will have the following control codes:

- Point
- Line: Starts in first point
- Construction point: control point. Will not be included for calculation. Can be used for breaking line and start over with the same code.

Line connection "Code table + Control Code" is also used for general import. Possibility to filter point codes on point type in all controls for selection of point code.

Calculation function

The calculation functions are:

Two prism measurement

The extra two prism measurement function is used when measuring a two prism object. An example is the measurement to the ABC pole which has two prisms at the same pole. You decide from which prism you measure the length to the end of the pole and also which of the two prisms you measure first.

See also

Control codes

Edit code table

Drawing|Home|Code table

Function, command	Description
General	General for all point codes
Linetype	Select line type
Symbol	Select which symbol (if any) the point code will have.
Attributes	Link an attribute directly to a point code, a symbol or both.
Import/Export	Change the point code when importing from, and exporting to a file.
Survey	
Import trimble	
Control codes	
Calculation function	

All codes which are used at any point in any open file will also appear in the code table. As soon as you open a file or import field data into a survey data file (.sur) all new codes will be inserted into the code table. You may of course have existing codes in the code table even when they are not being used in any open document or drawing. It is not possible to delete an existing code if it has been used in any open document. This is indicated by the delete button being greyed out. It is possible to use different code tables. They can be selected using *Home*|*Settings*.

To input a point code:

1. Open Edit code table.
2. Click New.
3. Add the new point code.

In the code table there are up to six different tabs with information and functions used in the survey and to import and export data. The last tab depends what function the code has.

The tabs are:

- Line
  Contains information about the type of line, colour and line type scale.
- Symbol
  Contains information about the type, colour, scale and orientation of the symbol.
- Attribute
  The attributes of the point code are entered on this tab.
- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

- Import/Export
  Contains the transfer code, layer and export code.

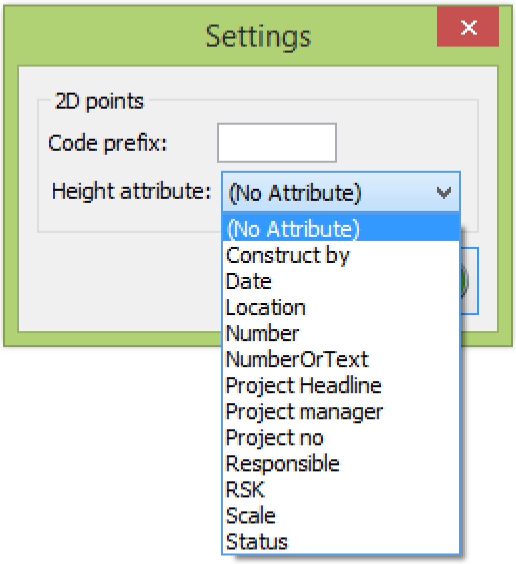
Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
- Rectangle 3
  Calculation function for three point rectangles.
- Circle 2
  Calculation function for two point circles.
- Circle 3
  Calculation function for three point circles.
- Arc 2
  Calculation function for two point arcs.
- Arc 3
  Calculation function for three point arcs.
- Parallel line
  Calculation function for parallel lines.
- Closed line
  Calculation function for measurement of closed polylines or polygons.

General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

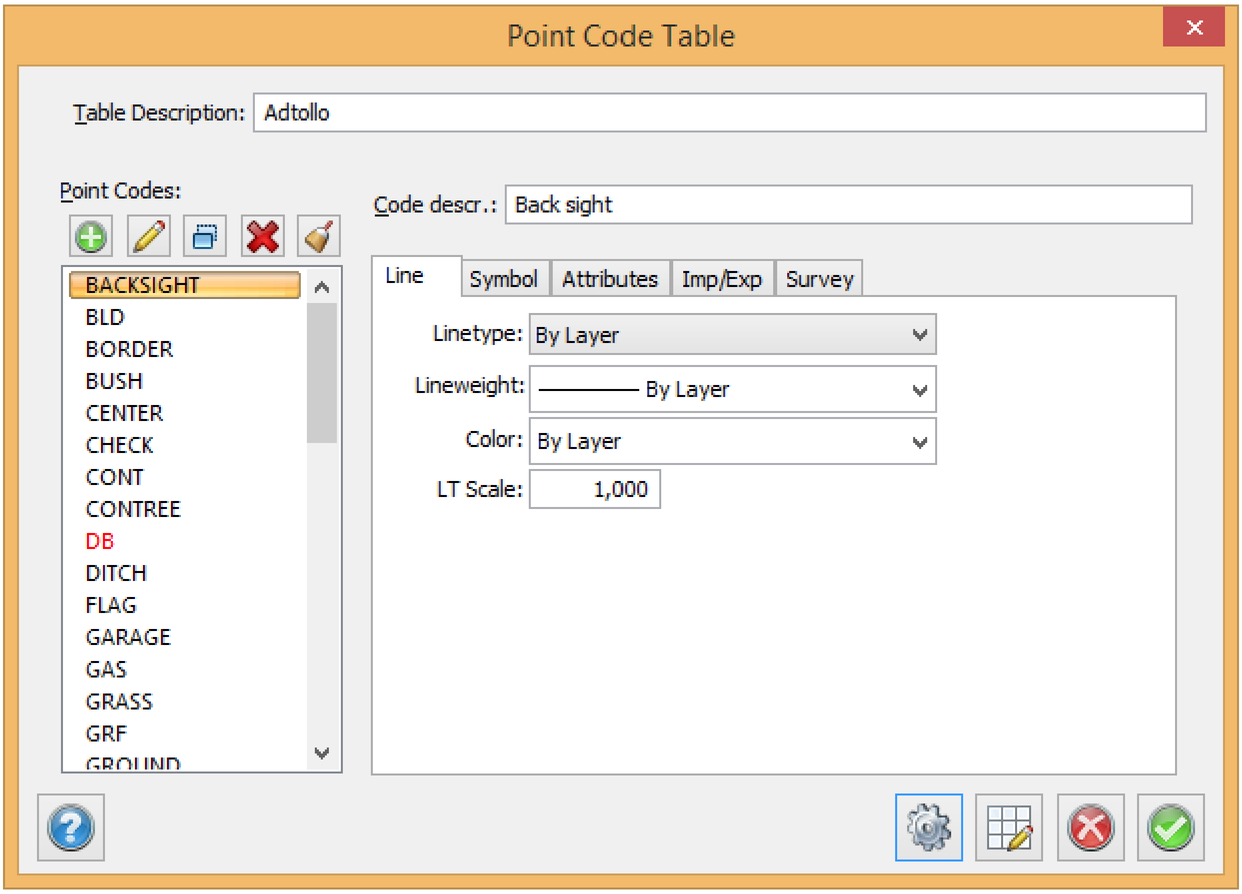
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line



There are several different types of lines to select. It is also possible to select the line type in the Layer manager. This allows you to select the line type in several places, but any line type entered in the code table is given a higher priority than one entered in the layer manager. In the code table it is possible to select the line type by layer.

- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
- Use Clear button to remove all not referenced line types from system files.
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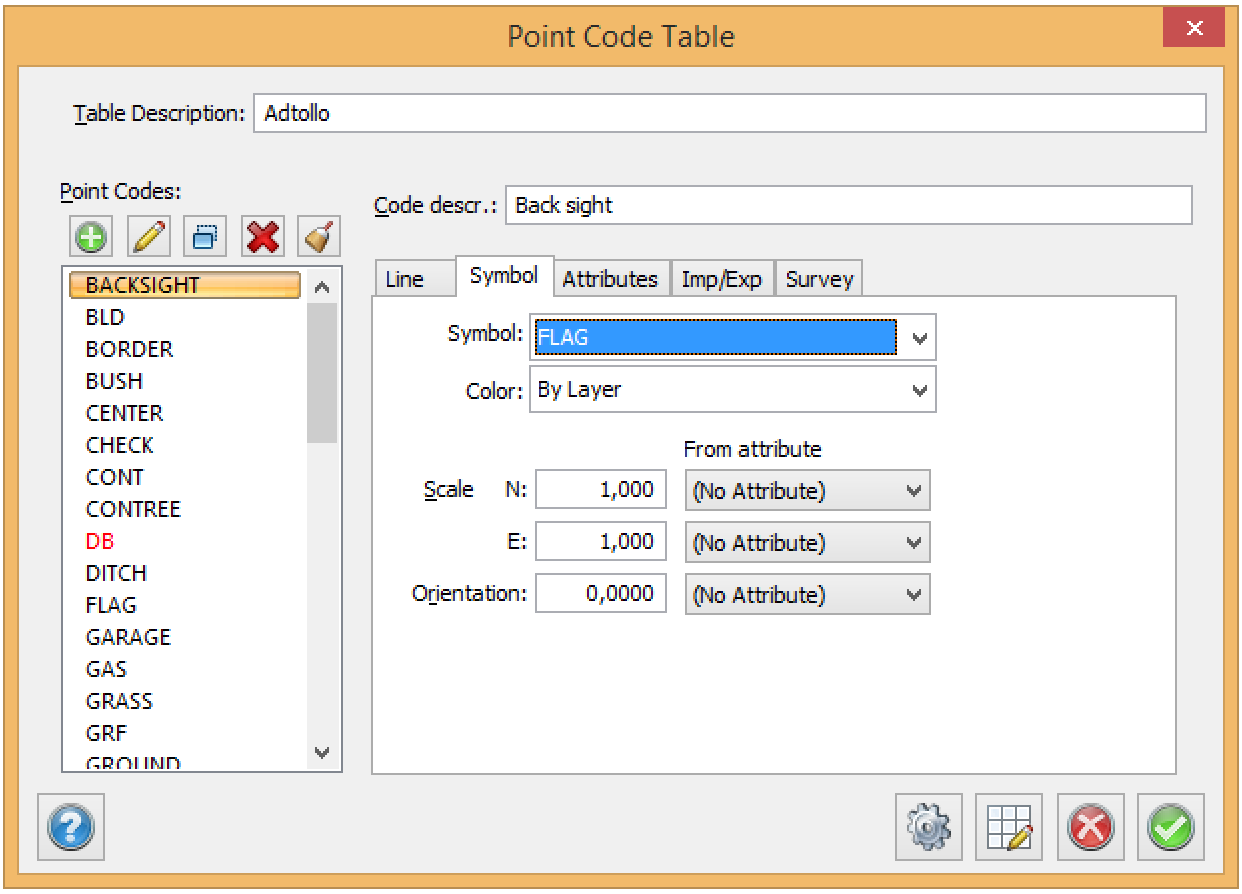
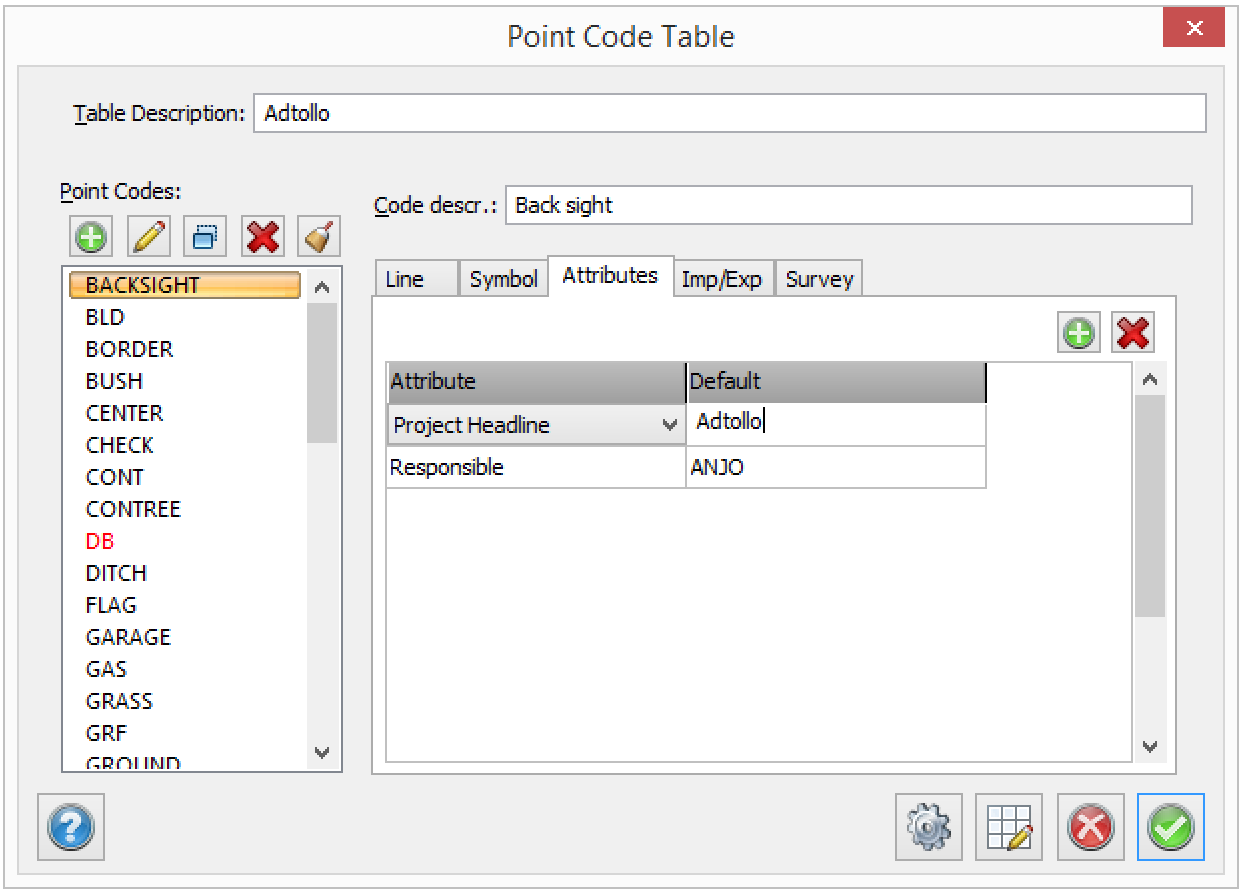
Symbol



- **Symbol**
  Select which symbol (if any) the point code will have. Select from the drop-down list.
- **Colour:**
  Select the colour for the point code. It is also possible to select by layer.
- **X-scale, Y-scale**
  The symbol is always saved with a scale of 1:1000. The default drawing scale is also 1:1000. It is possible to select a different drawing scale in Settings|Drawing scale. For example, if you want to the symbol to appear at twice its original size (1:1000) you should enter the scale 2.0 in this field.
- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



An attribute is a type of added value for the point. An attribute can be linked directly to a point code, a symbol or both. The attribute can be entered in the field survey, the survey data document (.sur) or in the drawing - Go to Modify|Edit attribute. If you link an attribute to a point code you can give every point with this point code an attribute value. If you have used a symbol for the point code and want the attribute to be displayed as well, you will need to create the symbol with a linked attribute. To add an attribute to the symbol see Define attribute

There are no limits to number of attributes that a point can have.

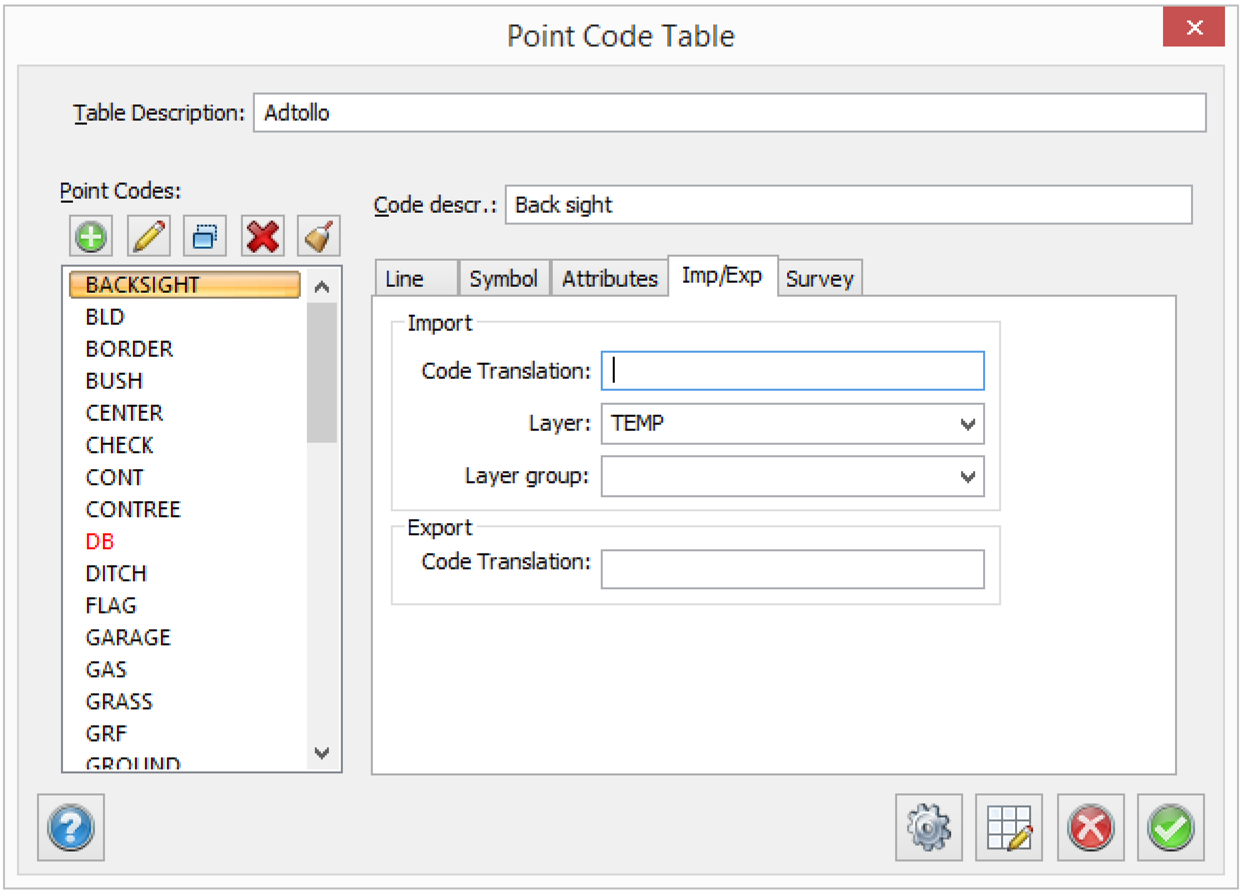
The value of the attribute belongs to the point but the type of attribute belongs to the point code.

Add
Click Add if you want to add an attribute to the point code. The attribute list appears and you can select from the list. To create an attribute go to Home|Attribute

Delete
Press delete if you want to delete a link to the specified attribute. Note that you only delete the link to the attribute and not the attribute itself.

Import/Export

Home|Code table - Import/Export



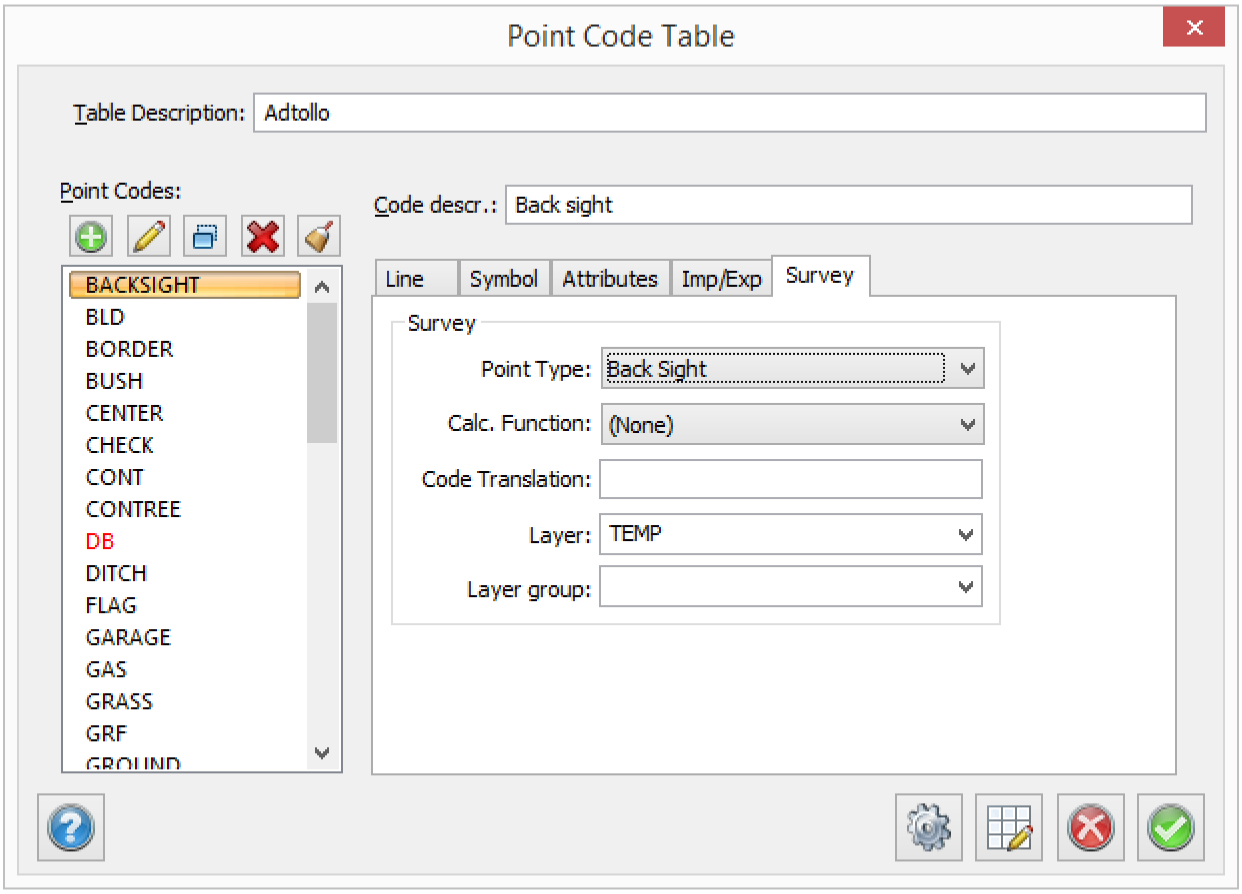
The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

Import - Transfer point code:
Interpolates the point code (point in file) to another point code. For example, you can use the numeric point code 10 in the field which is translated to pp in the drawing. A similar function exists for points that are imported from a file. See previous page - Survey.

Layer:
This function allows a point code belonging to a point in a file to be moved to a specific layer. It is possible to use a layer name for all kinds of trees and then put all tree point codes in that layer. It is also possible to create a specific layer for every point code if required. Similar functions exist for points which are imported from files, see previous page - Survey.

Export - Transfer point code:
You can also specify that the point code used in the drawing should be interpolated to another point code when it is exported to a file.

Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
The code can end up with a different code in the drawing. Enter the name here.

Layer
Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

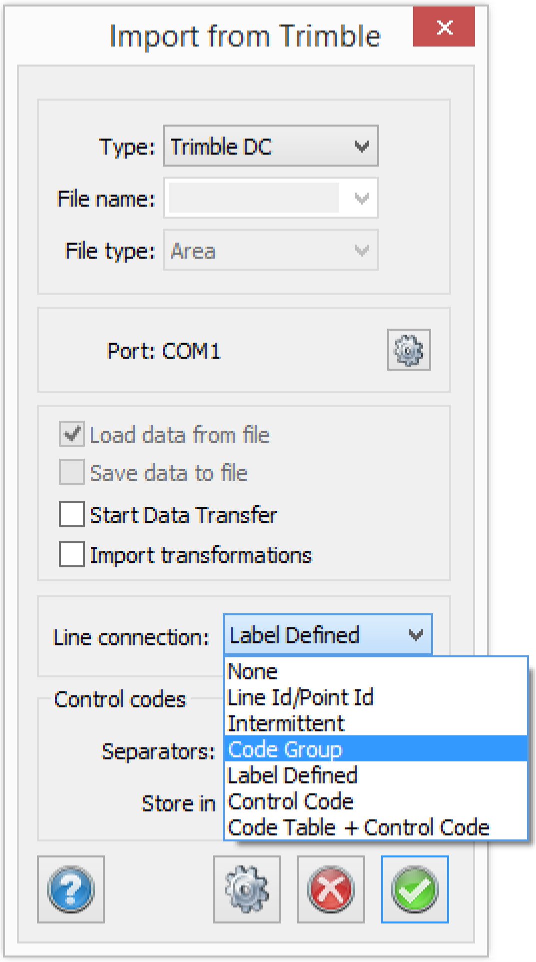
Point types:
None

Polygon point
The point will be calculated and added to the pp file.

Check point
Used for check towards known point.

Temporary point
The co-ordinates are temporarily saved and the point can be used as a back sight or station in later stations in the same survey file.

Back sight
Function used to code back sights in the survey.



Control codes

Code table + Control table
Point with codes using these point types will have the following control codes:

- Point
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Calculation function

The calculation functions are:

Two prism measurement

The extra two prism measurement function is used when measuring a two prism object. An example is the measurement to the ABC pole which has two prisms at the same pole. You decide from which prism you measure the length to the end of the pole and also which of the two prisms you measure first.

See also

Control codes

Edit code table

Drawing|Home|Code table

Function, command	Description
General	General for all point codes
Linetype	Select line type
Symbol	Select which symbol (if any) the point code will have.
Attributes	Link an attribute directly to a point code, a symbol or both.
Import/Export	Change the point code when importing from, and exporting to a file.
Survey	
Import trimble	
Control codes	
Calculation function	

All codes which are used at any point in any open file will also appear in the code table. As soon as you open a file or import field data into a survey data file (.sur) all new codes will be inserted into the code table. You may of course have existing codes in the code table even when they are not being used in any open document or drawing. It is not possible to delete an existing code if it has been used in any open document. This is indicated by the delete button being greyed out. It is possible to use different code tables. They can be selected using *Home*|*Settings*.

To input a point code:

1. Open Edit code table.
2. Click New.
3. Add the new point code.

In the code table there are up to six different tabs with information and functions used in the survey and to import and export data. The last tab depends what function the code has.

The tabs are:

- Line
  Contains information about the type of line, colour and line type scale.
- Symbol
  Contains information about the type, colour, scale and orientation of the symbol.
- Attribute
  The attributes of the point code are entered on this tab.
- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

- Import/Export
  Contains the transfer code, layer and export code.

Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
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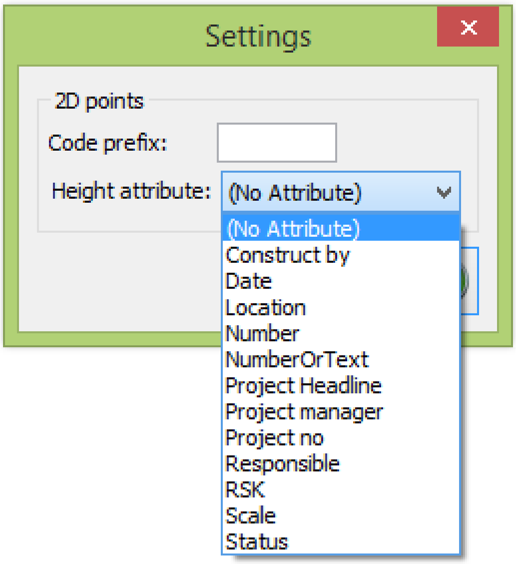
General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

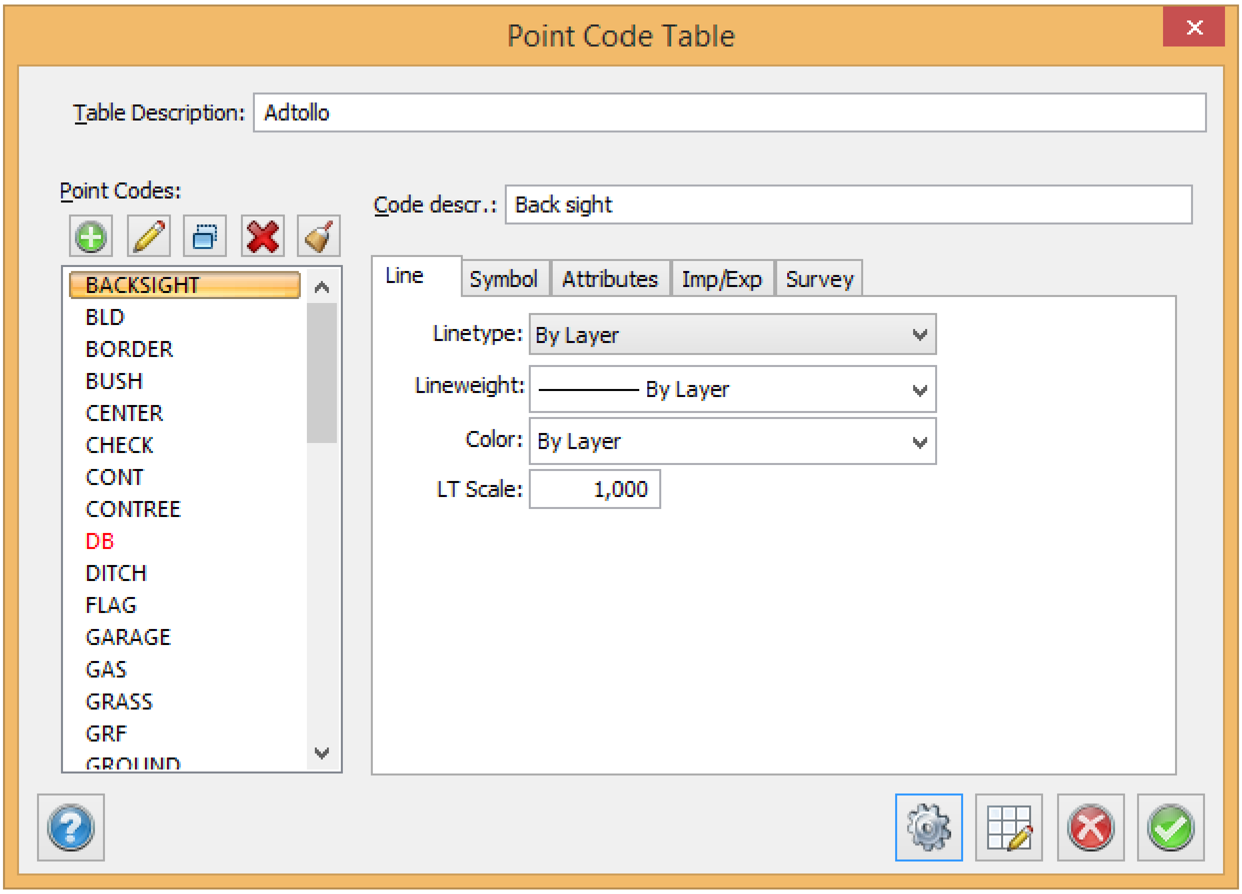
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line



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- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
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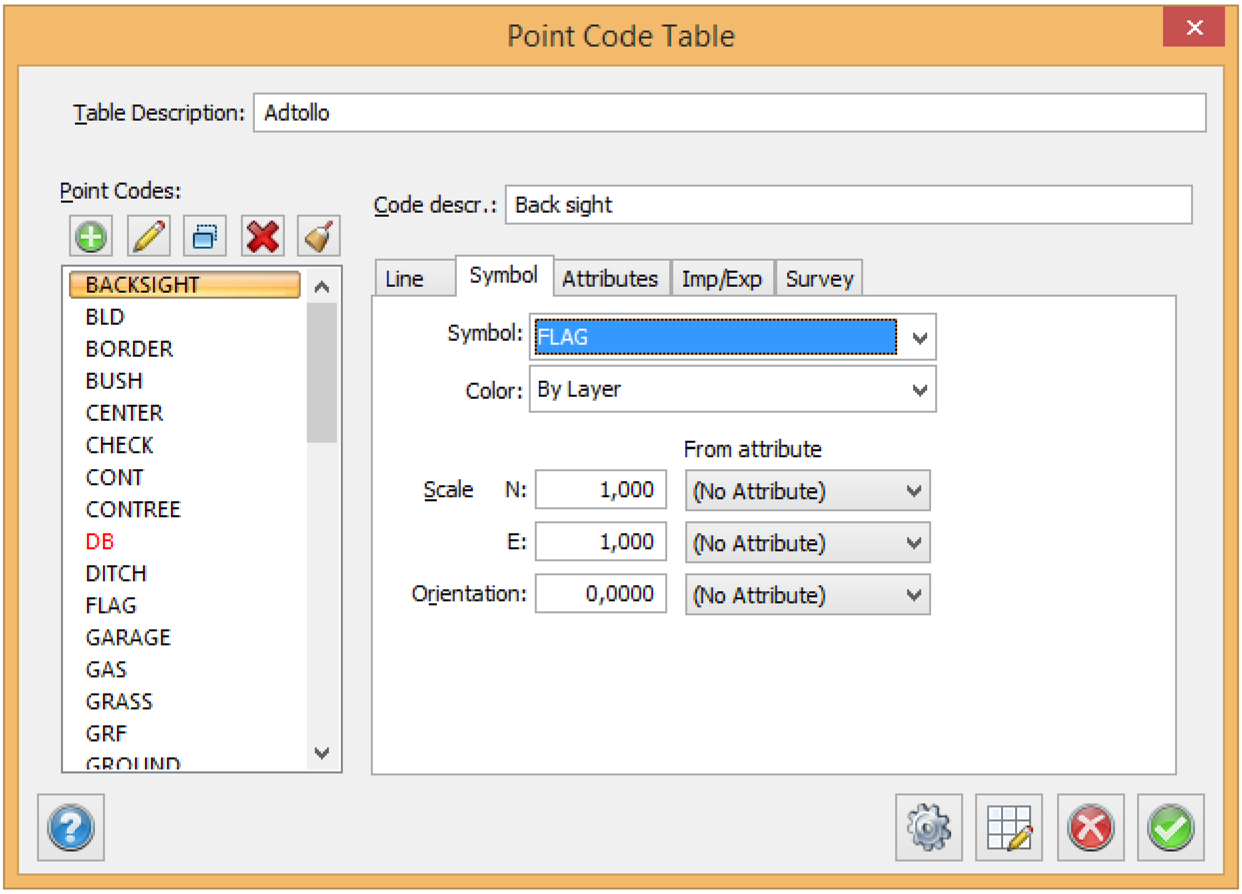
Home|Code table - Symbol



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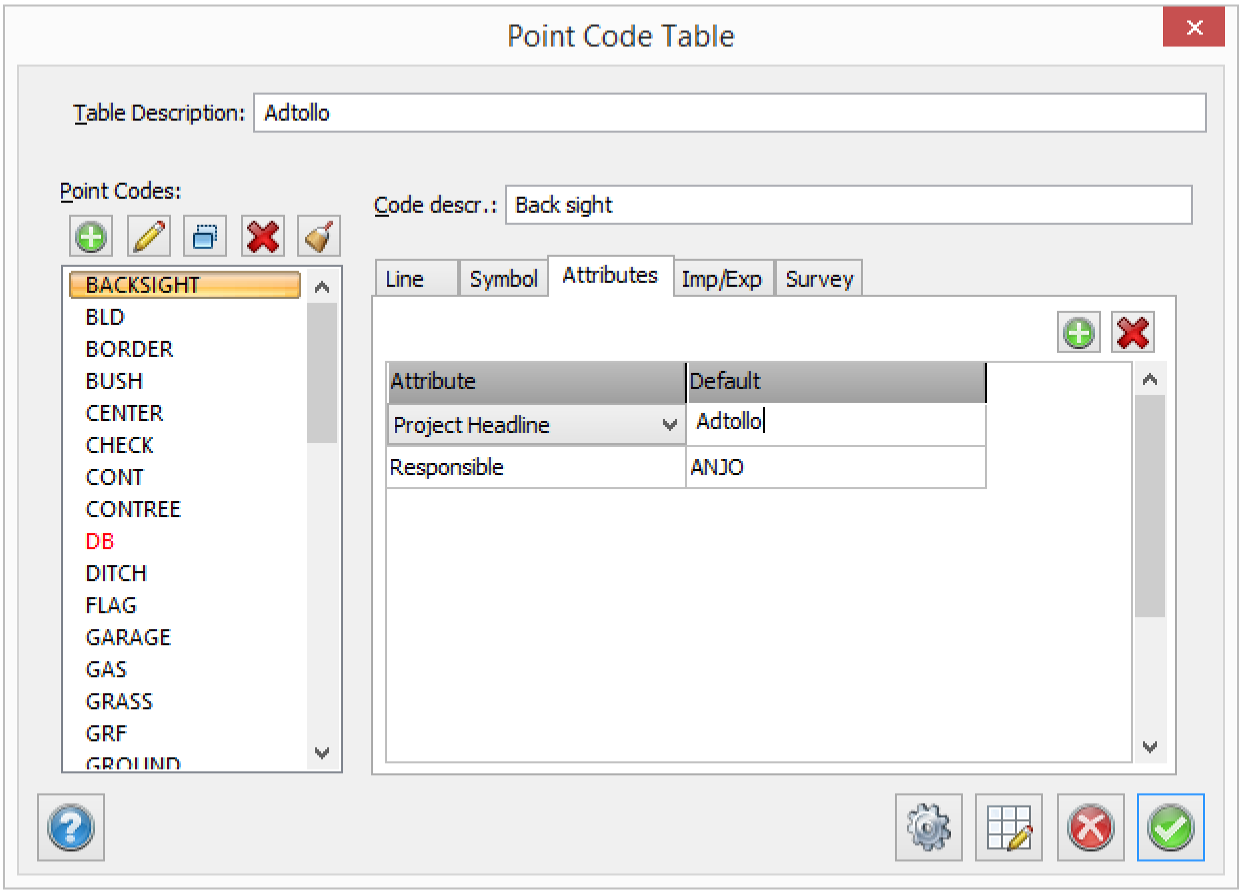
Attributes

Home|Code table - Attributes



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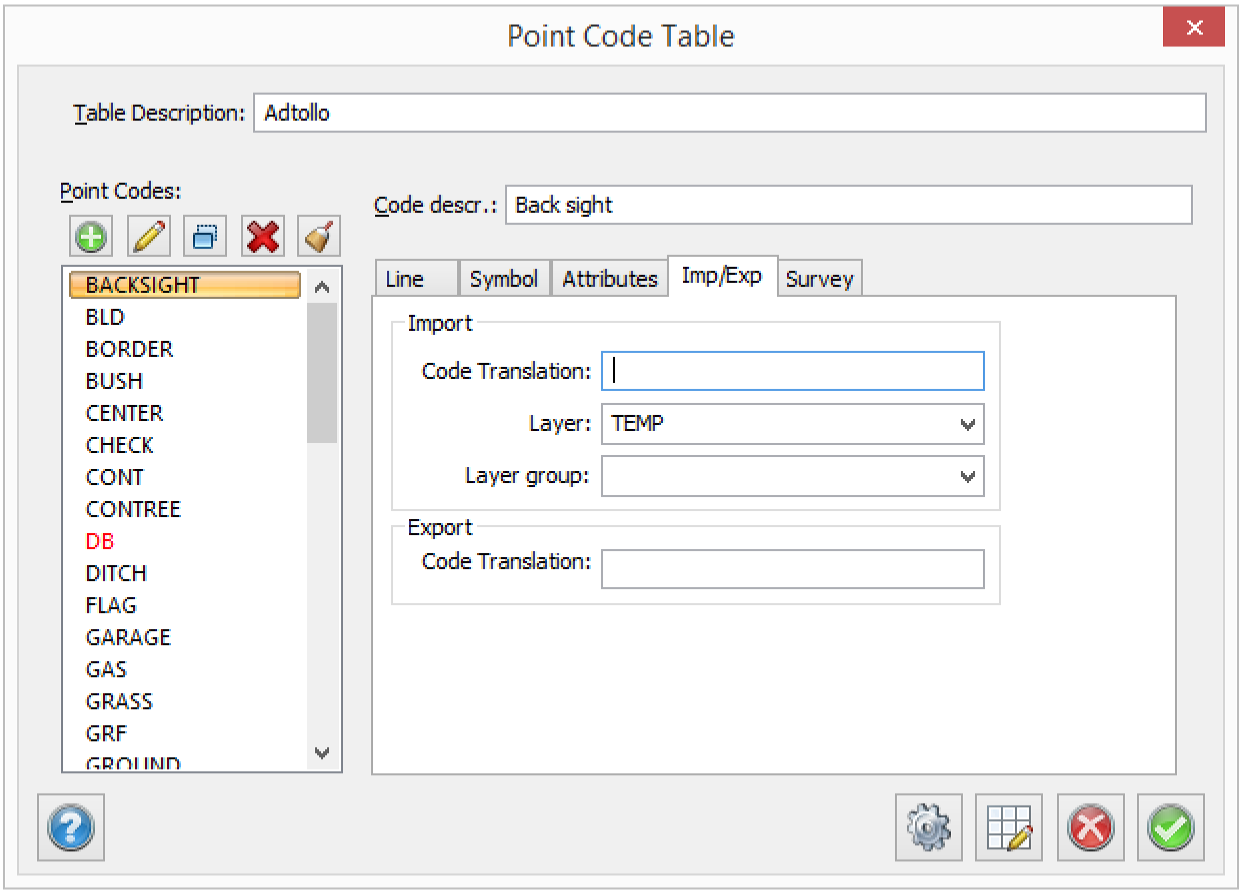

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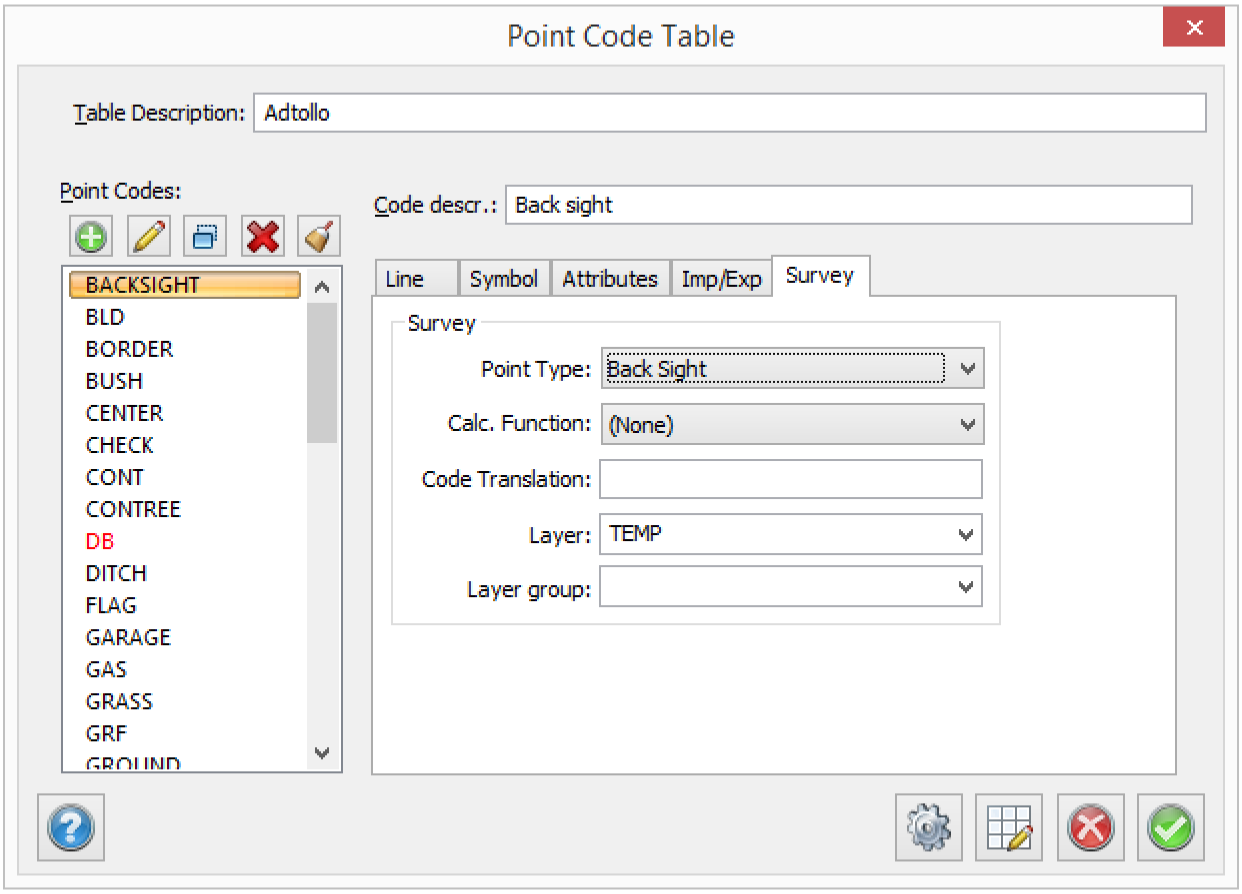
Survey



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Calculation function
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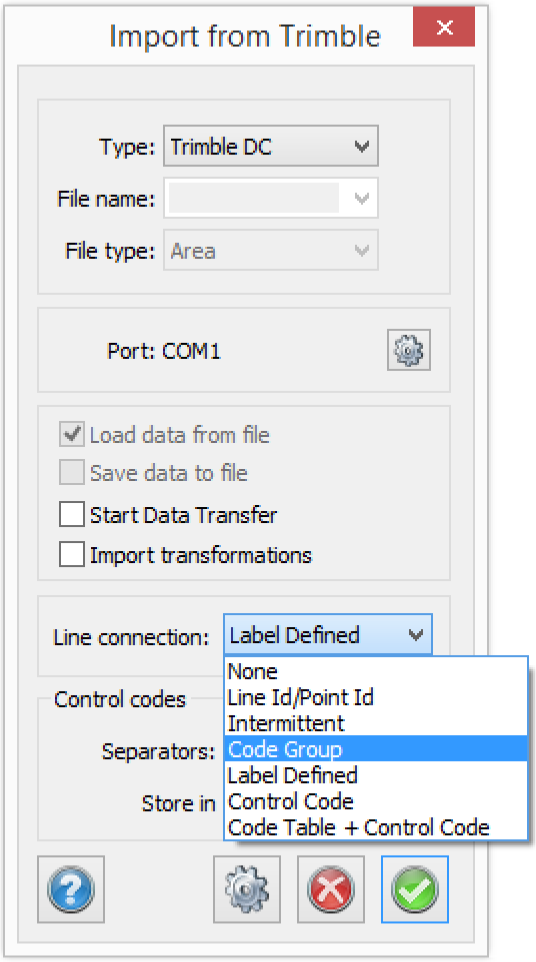

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See also

Control codes

Edit code table

Drawing|Home|Code table

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Survey	
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Calculation function	

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  Contains information about the type of line, colour and line type scale.
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- Survey

Information about the type of point, calculation functions, transfer code and in which layer the point code will appear.

- Import/Export
  Contains the transfer code, layer and export code.

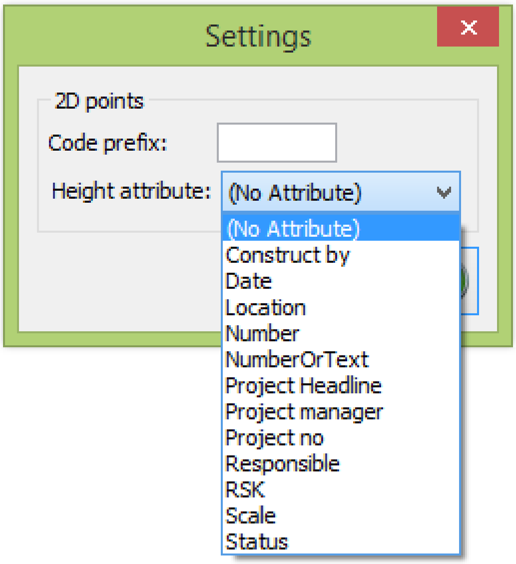
Calculation functions:

- Extrapolate
  Calculation function for extrapolation.
- Rectangle 2
  Calculation function for two point rectangles.
- Rectangle 3
  Calculation function for three point rectangles.
- Circle 2
  Calculation function for two point circles.
- Circle 3
  Calculation function for three point circles.
- Arc 2
  Calculation function for two point arcs.
- Arc 3
  Calculation function for three point arcs.
- Parallel line
  Calculation function for parallel lines.
- Closed line
  Calculation function for measurement of closed polylines or polygons.

General for all point codes

Grid
Function to edit the code table by a grid. Click the Grid button.

Settings
Function to indicates that the point shall not have a height, by entering a *code prefix*. For example - (minus sign). The height should be moved to the height attribute. This function works for import to SUR, survey data, drawing and coordinate files.



Description
Description of the point code. This is not essential for the point code to function.

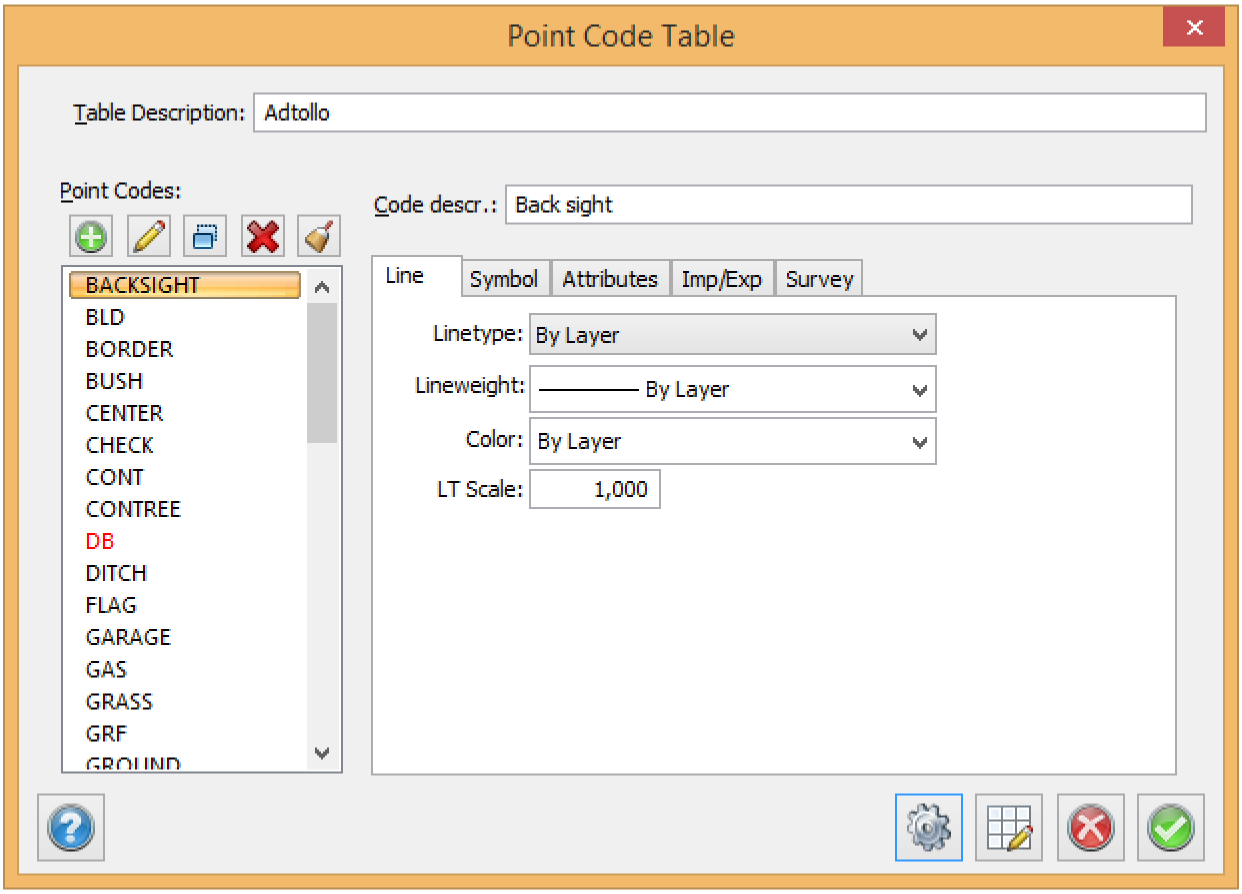
New
Button for creating a new point code.

Delete
Deletes an existing point code. If the point code exists in any open document this button is greyed out because the point code cannot be deleted.

Use Clear button to remove all not referenced point codes from system files.

Linetype

Home|Code table - Line

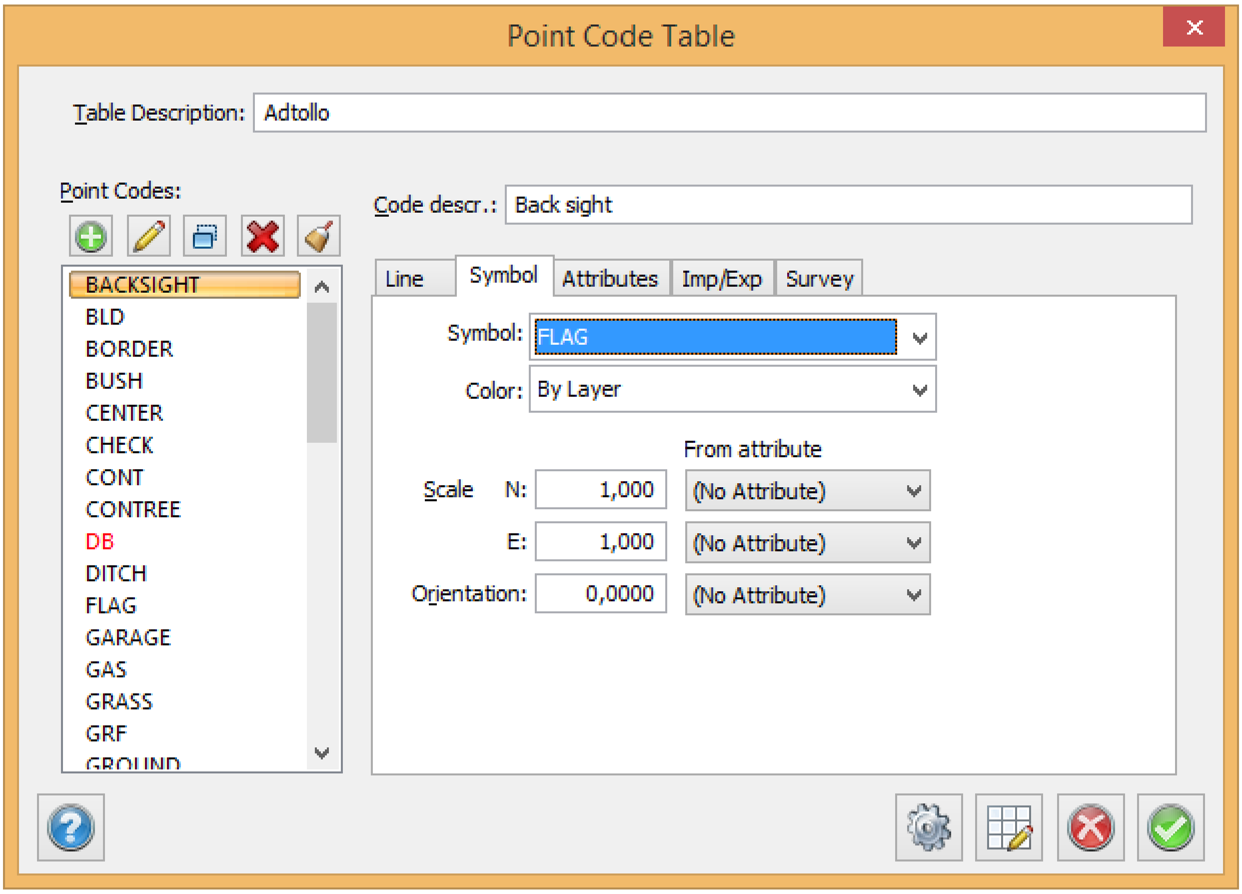


There are several different types of lines to select. It is also possible to select the line type in the Layer manager. This allows you to select the line type in several places, but any line type entered in the code table is given a higher priority than one entered in the layer manager. In the code table it is possible to select the line type by layer.

- Linetype
  Select the line type from the list or use the default choice by layer.
- Colour
  Select the colour of the line type.
- Linetype scale
  It is possible to select a scale for the line type. This means that you can decide the continuity for different line types.
- Use Clear button to remove all not referenced line types from system files.
- >> and << buttons copies all the content from Local to Global and vice versa.

Symbol

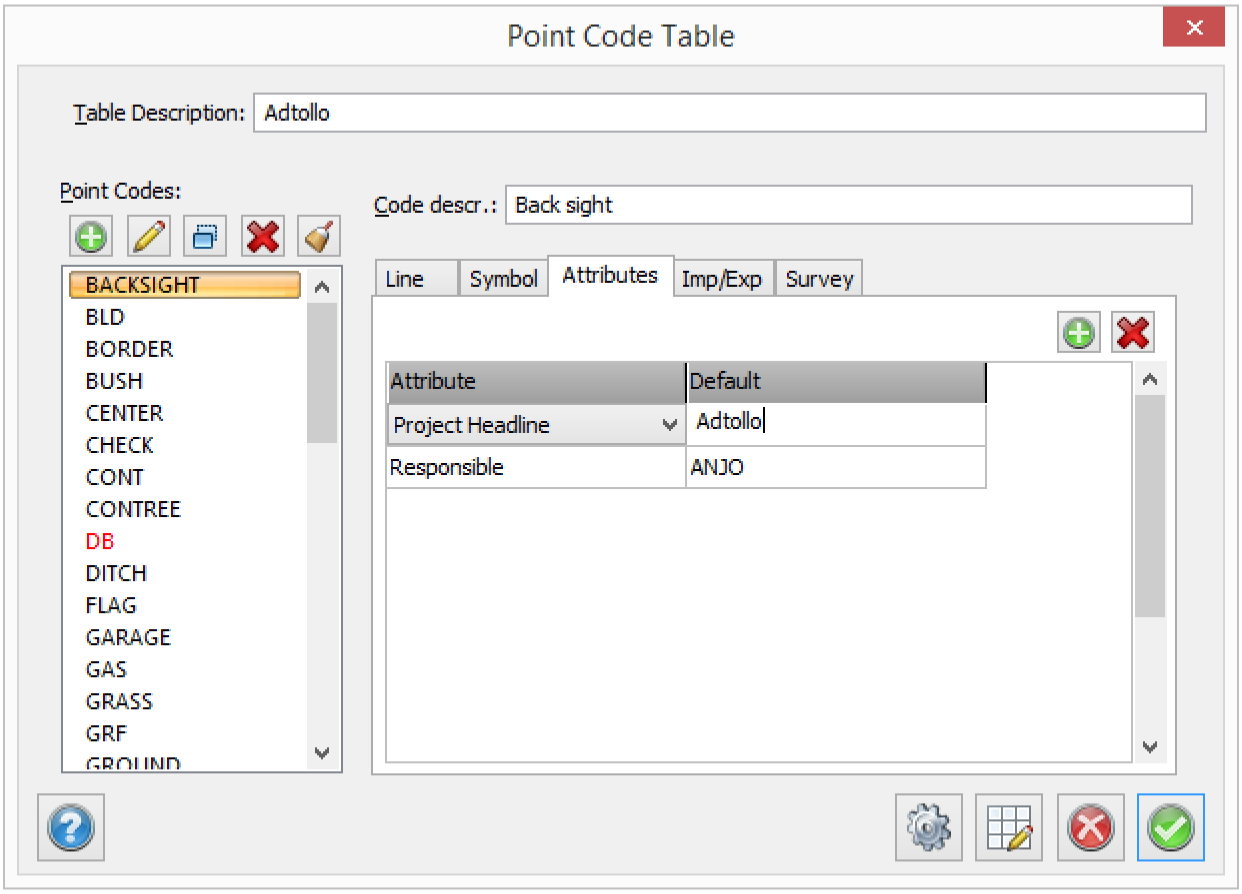
Home|Code table - Symbol



- **Symbol**
  Select which symbol (if any) the point code will have. Select from the drop-down list.
- **Colour:**
  Select the colour for the point code. It is also possible to select by layer.
- **X-scale, Y-scale**
  The symbol is always saved with a scale of 1:1000. The default drawing scale is also 1:1000. It is possible to select a different drawing scale in Settings|Drawing scale. For example, if you want to the symbol to appear at twice its original size (1:1000) you should enter the scale 2.0 in this field.
- **Rotation**
  Determines the rotation for the symbol.

Attributes

Home|Code table - Attributes



An attribute is a type of added value for the point. An attribute can be linked directly to a point code, a symbol or both. The attribute can be entered in the field survey, the survey data document (.sur) or in the drawing - Go to Modify|Edit attribute. If you link an attribute to a point code you can give every point with this point code an attribute value. If you have used a symbol for the point code and want the attribute to be displayed as well, you will need to create the symbol with a linked attribute. To add an attribute to the symbol see Define attribute

There are no limits to number of attributes that a point can have.

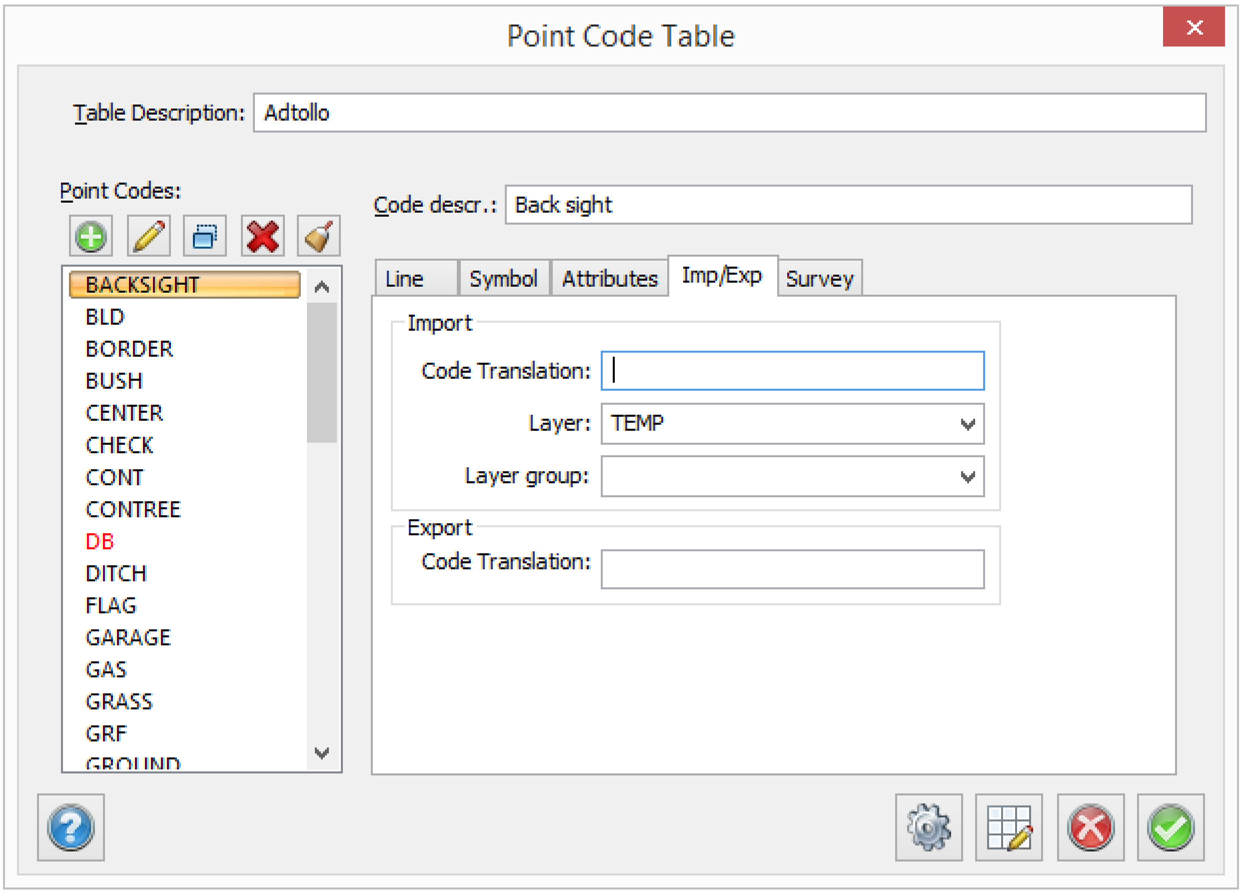
The value of the attribute belongs to the point but the type of attribute belongs to the point code.

Add
Click Add if you want to add an attribute to the point code. The attribute list appears and you can select from the list. To create an attribute go to Home|Attribute

Delete
Press delete if you want to delete a link to the specified attribute. Note that you only delete the link to the attribute and not the attribute itself.

Import/Export

Home|Code table - Import/Export



The Import and Export function allows you to change the point code when importing from and exporting to a file. It is also possible to sort the point code into different layers. You will find a similar function for survey data on the previous page - Survey.

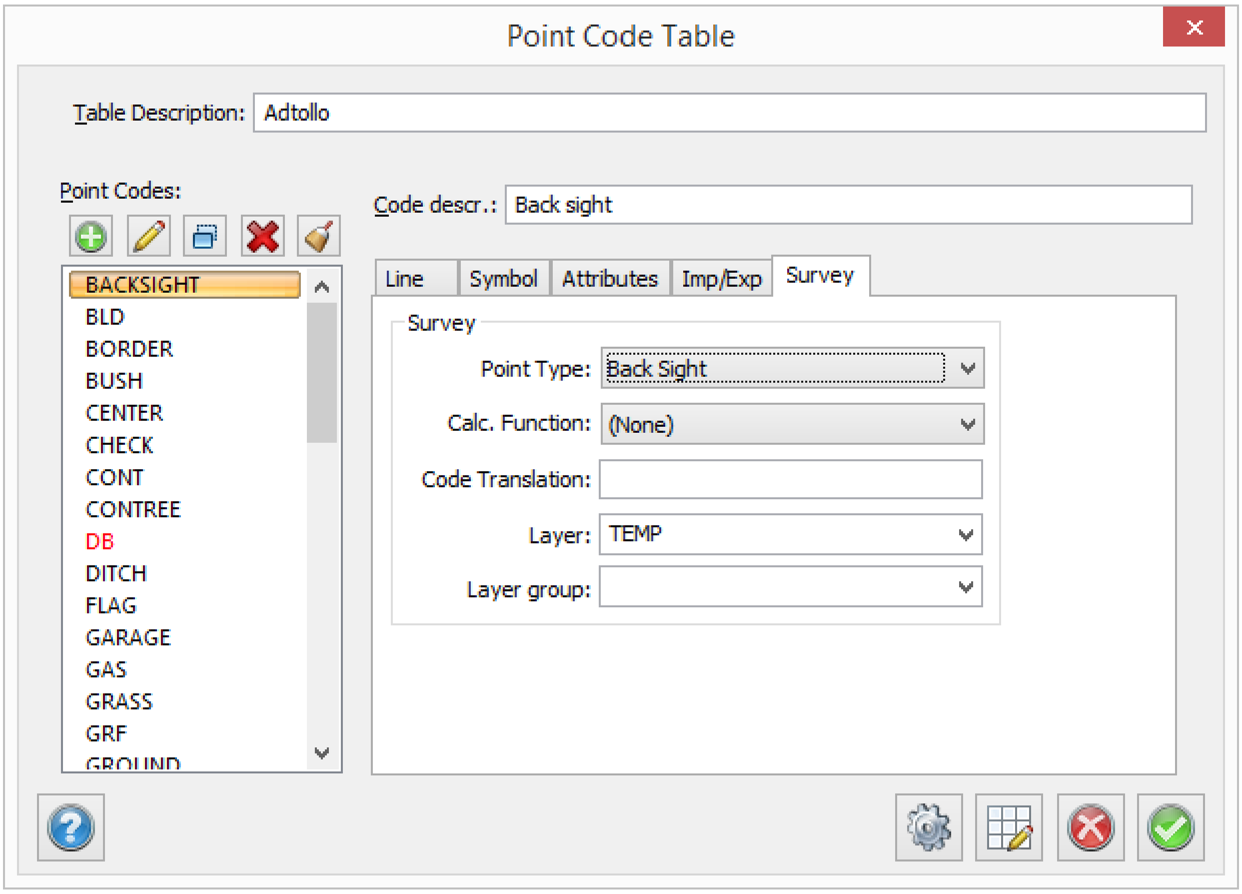
Import - Transfer point code:
Interpolates the point code (point in file) to another point code. For example, you can use the numeric point code 10 in the field which is translated to pp in the drawing. A similar function exists for points that are imported from a file. See previous page - Survey.

Layer:
This function allows a point code belonging to a point in a file to be moved to a specific layer. It is possible to use a layer name for all kinds of trees and then put all tree point codes in that layer. It is also possible to create a specific layer for every point code if required. Similar functions exist for points which are imported from files, see previous page - Survey.

Export - Transfer point code:
You can also specify that the point code used in the drawing should be interpolated to another point code when it is exported to a file.

Survey

Home|Code table - Survey



Point type
If the point is to be used as a back sight or control point, save it as a station.
Select "point" or "type" if the a point code shall be used specifically for points or lines.

Calculation function
Different types of calculation functions-.

Translation code:
The code can end up with a different code in the drawing. Enter the name here.

Layer
Which layer is the target layer in the drawing for this code? Enter the name here. The layer will be created if it does not exist.

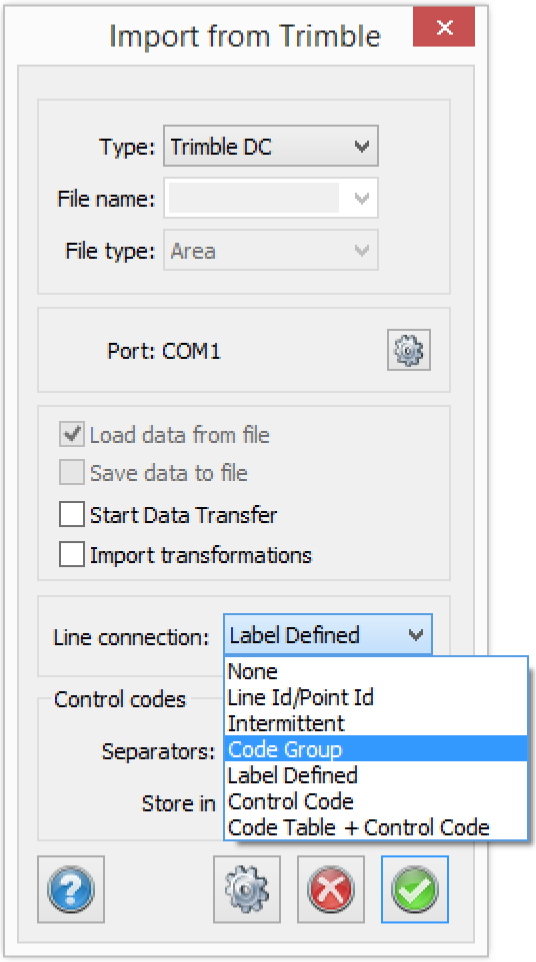
Point types:
None

Polygon point
The point will be calculated and added to the pp file.

Check point
Used for check towards known point.

Temporary point
The co-ordinates are temporarily saved and the point can be used as a back sight or station in later stations in the same survey file.

Back sight
Function used to code back sights in the survey.



Control codes

Code table + Control table
Point with codes using these point types will have the following control codes:

- Point
- Line: Starts in first point
- Construction point: control point. Will not be included for calculation. Can be used for breaking line and start over with the same code.

Line connection "Code table + Control Code" is also used for general import. Possibility to filter point codes on point type in all controls for selection of point code.

Calculation function

The calculation functions are:

Two prism measurement

The extra two prism measurement function is used when measuring a two prism object. An example is the measurement to the ABC pole which has two prisms at the same pole. You decide from which prism you measure the length to the end of the pole and also which of the two prisms you measure first.

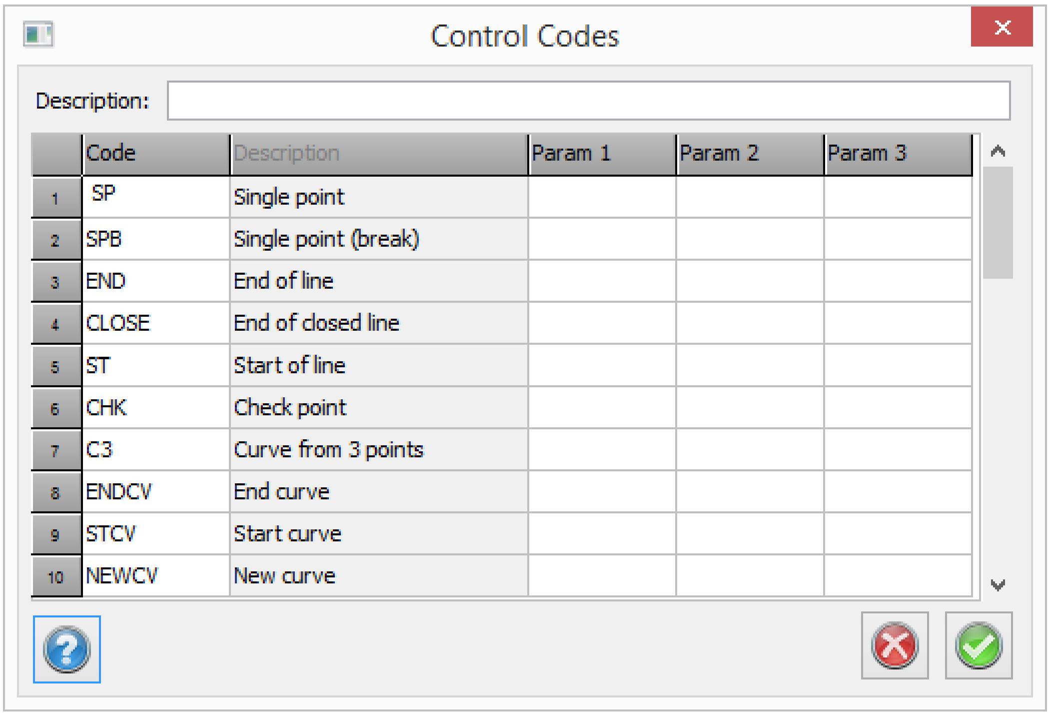
See also

Control codes

Control codes

Drawing|Home|Control codes

Control codes are used to create geometry directly from the field survey. You enter the control code in the field survey and it can provide you with a great deal of information when it is imported into the drawing.



The control codes are as follows:

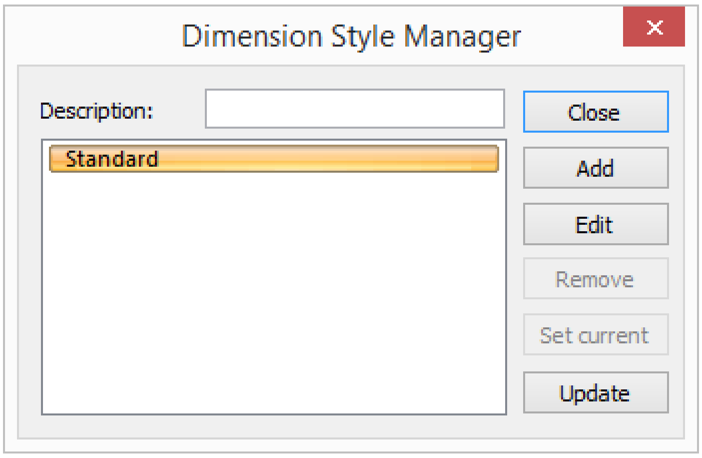
Code	**Description**	**Function**
SP	Single point	Survey of single point
SPB	Single point break	Survey of single point that breaks former line.
END	Line end	Line end
CLOSE	Closed line, end	Finishes a line and closes it.
ST	Line start	Start at line
CHK	Check point	Measurement of check point.
C3	Radius from 3 points	Creates a radius from three measured points.
ENDCV	Radius end	End of radius
STCV	Radius start	Start a line with a number of radii.
NEWCV	New radius	New radius
ENDONCV	End of radius	End of radius

CLSRECT	Closed rectangle.	
DIAM	Diameter	The diameter is stored in the attribute value (Diameter in this case).
STL	Size	
WID	Width	
POC	Point in curve	Measurement of curve through several points.
STIPC	Start of line, ignore point code	
SPAR	Start parallel	
EPAR	End parallel	
Ext	Extend	
Dist	Co-ordinate by distance	
DISTADJ	Co-ordinate by distance and adjust	
NOZ	No height	
CDOFF	Co-ordinate by distance and offset	
JC	Join to closest	
JN	Join to next	
JP	Join to previous	
RECT	Rectangle	
CIR2	Circle 2 points	
CIR3	Circle 3 points	
MOVETO	Move to point	Enter Point ID at attribute
CP	Construction point	
STSPL	Start spline curve	
ENDSPL	End spline curve	
RL	Return to line	

Dimension Style Manager

Drawing|Home|Dimension Style Manager

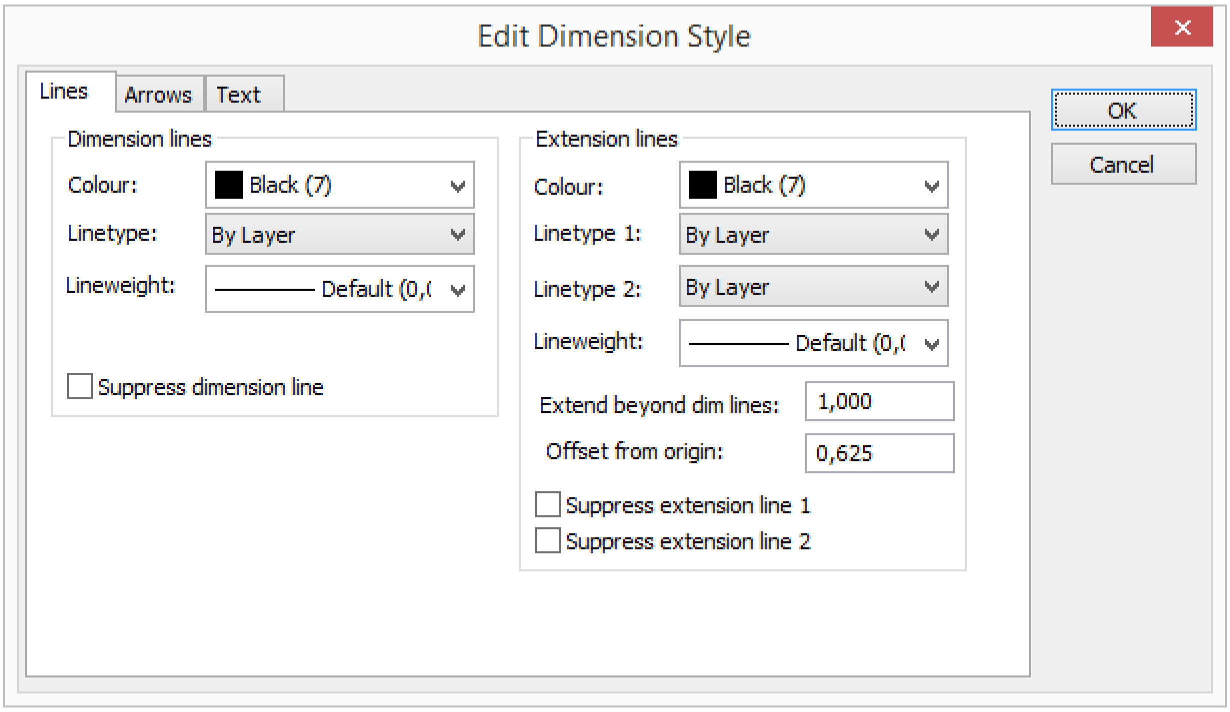
Configure different dimensions and select which style that will be current.
Dimension Style Library is found at System settings|System|Dimension Styles.



Edit
Edit lines, arrows and text.

Update
Update all dimension styles in current drawing to current style.

Lines



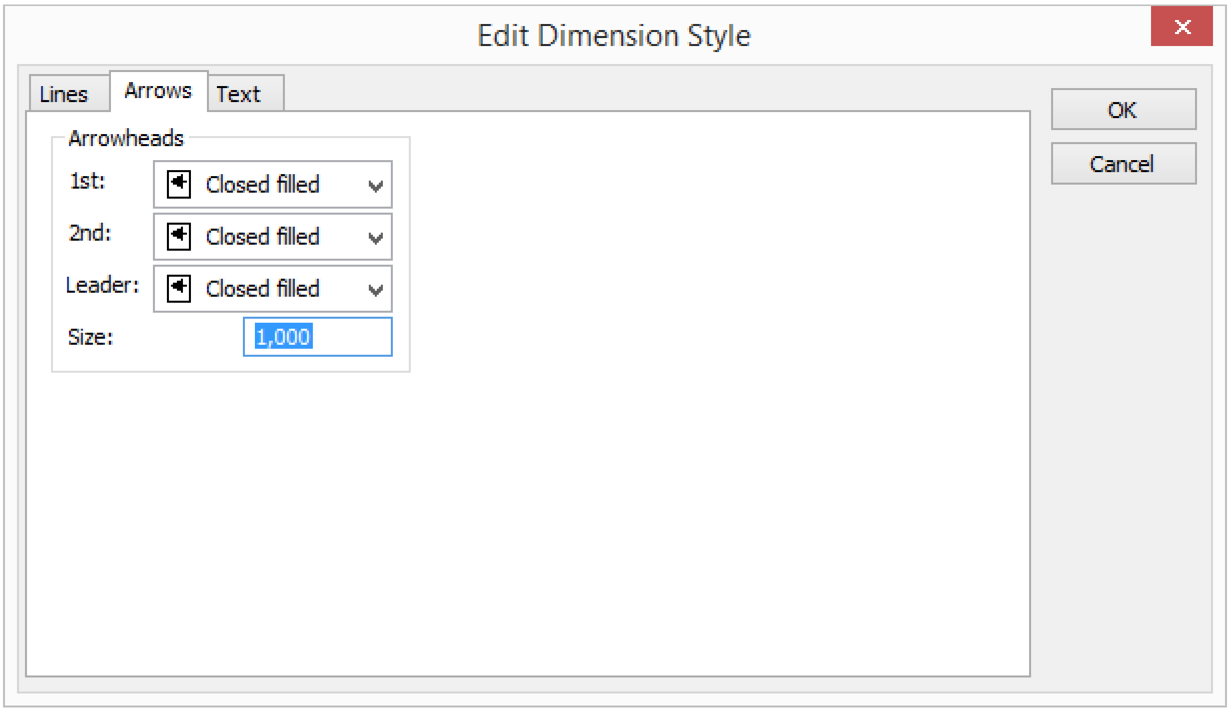
Dimension lines

Select the colour, layer and line type for the dimension lines.

Extension lines

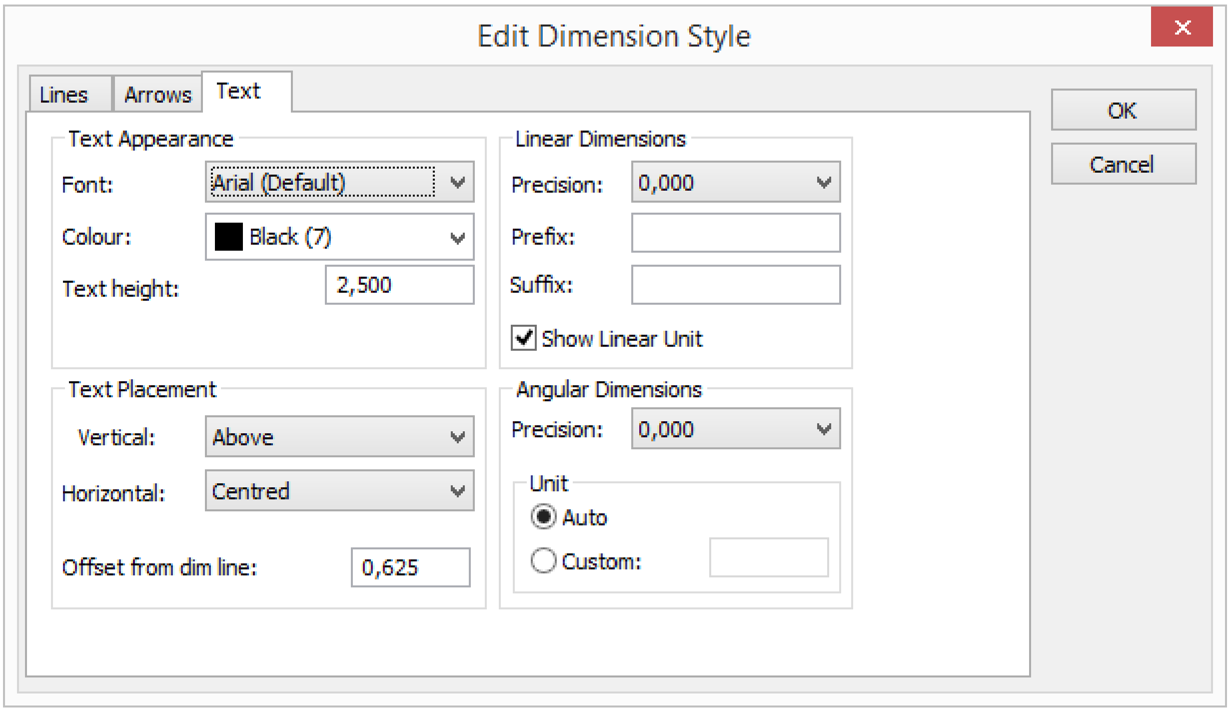
Select the length for the extension lines. This is used when the text is beyond the arrows and there is no space in between.

Arrows



Select different types and sizes of arrows.

Text



Select the font, colour and height

Text placement

Select the distance of the text from the line.

Linear dimensions, Angle dimension and Unit

Enter the accuracy, prefix and suffix.

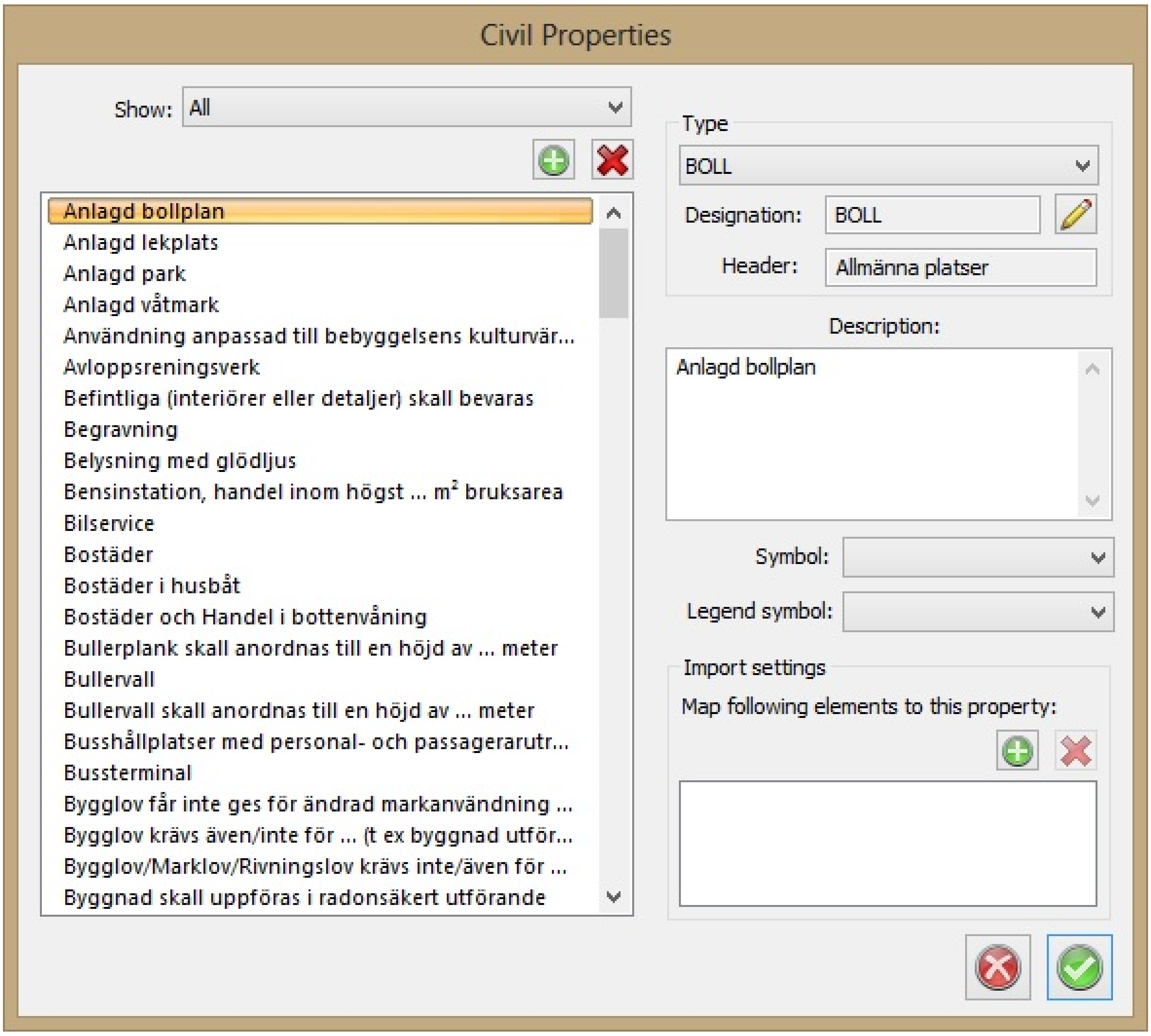
Civil properties

Drawing|Home|Civil properties

Here you can add, delete and edit your civil properties that are defined in your CVP file that you refer to in the system settings.

For each plan property, you can connect *Type, Designation, Description, Symbol, Legend symbol.*

These are also linked to your surfaces and objects in the drawing and the legend.



Settings

Home|Settings

Menu for Select project, System settings and Project settings.

Function	Project settings	Description
Select project		Select current project

CAD		
- Display		Settings for how objects are viewed on the screen/display
- Import/Export		Settings for import and export
- Point info		Settings for how the point info will be displayed in the drawing
- Snap		Snap settings
Database		
- FDO		
- ArcSDE		
- General database	Yes	Database settings
- Map		Map sheet settings
Drawing		
- Civil plan		Only for Swedish users. Contact Adtollo for further information.
- Drawing	Yes	Settings for default drawing
- Field		
- Macro		
- Plot		Appearance for points and radius etc when plotting
- WMS		Web map services
General		
- Axes	Yes	Settings for axis names, edit order.
- Angle	Yes	Settings for angles, clockwise, anticlockwise etc.
- Coordinate System	Yes	Coordinate system settings.
- Decimals	Yes	Settings for number of decimal places to display.
- Directories		Settings for the folders to be used for drawing sheet templates.
- Geometry		
- Keychain		Key chain for automatically login to database connections
- Language		Language settings

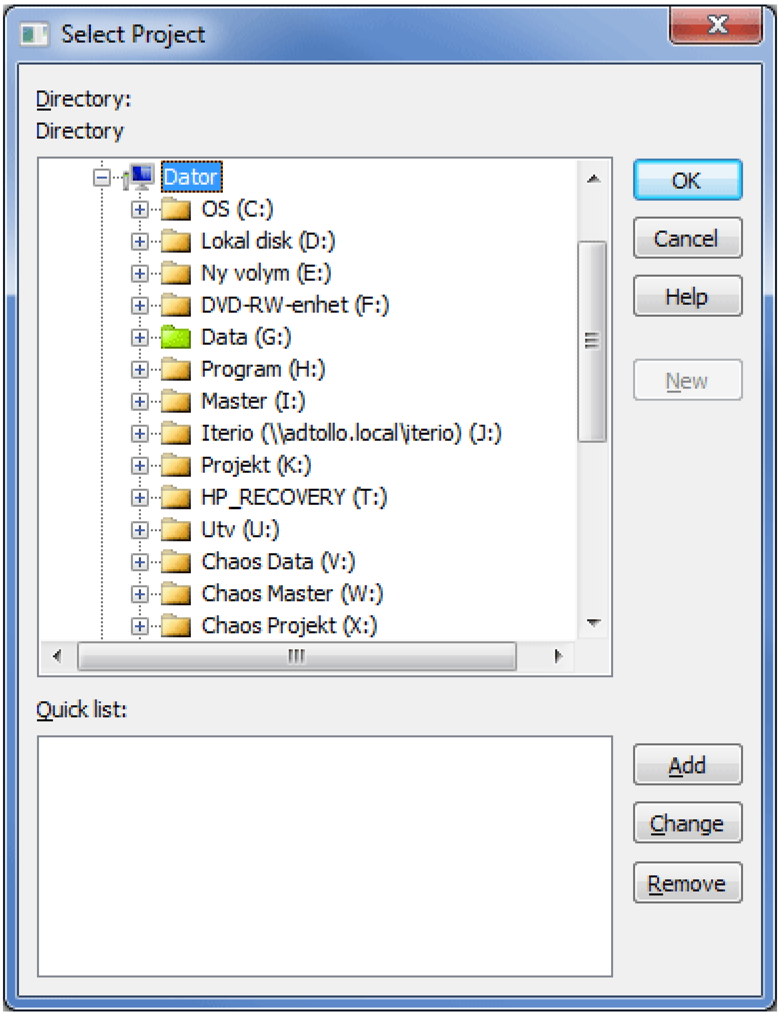
- Metadata		Metadata in Survey data window
- System Files	Yes	System files are entered here, including those for high priority projects
- Threshold	Yes	Settings for tolerance /threshold values
Survey		
- Instrument	Yes	Instrument settings
- Known points		Select if you want to get your known points from a database or PP file.
- Survey		Select name and location for the polygon point file.

Select project

Home|Select project

It is possible to save files and drawings anywhere but we recommend that you save all files in the project to the same folder.

The current folder can easily be specified in Select project.



Quick list: It is possible to select different hard drives or units from the Quick list.

Why work with a defined project?

This action means that:

- The default folder for open files will be the project folder.
- The default folder for saving new files will be the project folder.
- You can use the project folder as the default for files containing known points. See Settings for more information. This makes it possible to use the same name for every file containing known points.
- You can define your specific project settings, and they will be stored in the project.

To select a project:

1. In the list of directories on the left, **select** the **directory** you want to use for your project by clicking on it.
2. Click **Add** to create a new Quick list entry. In this dialogue box the directory is shown at the top, with the name of the quick list below. Enter a name for your project. Click **OK**.
3. Click on the project in the quick list. You have now selected this directory as the directory for the project. Click OK. You only need to select another project in this dialogue box if you start work on a different project. The selection is saved when you quit Topocad.

Explanations of the dialogue box

New directory
To create a new directory, click on New on the right-hand side.

Quick list
The Quick list works as a pointer for the project and helps you to find your project more easily. You can use any name in the quick list.

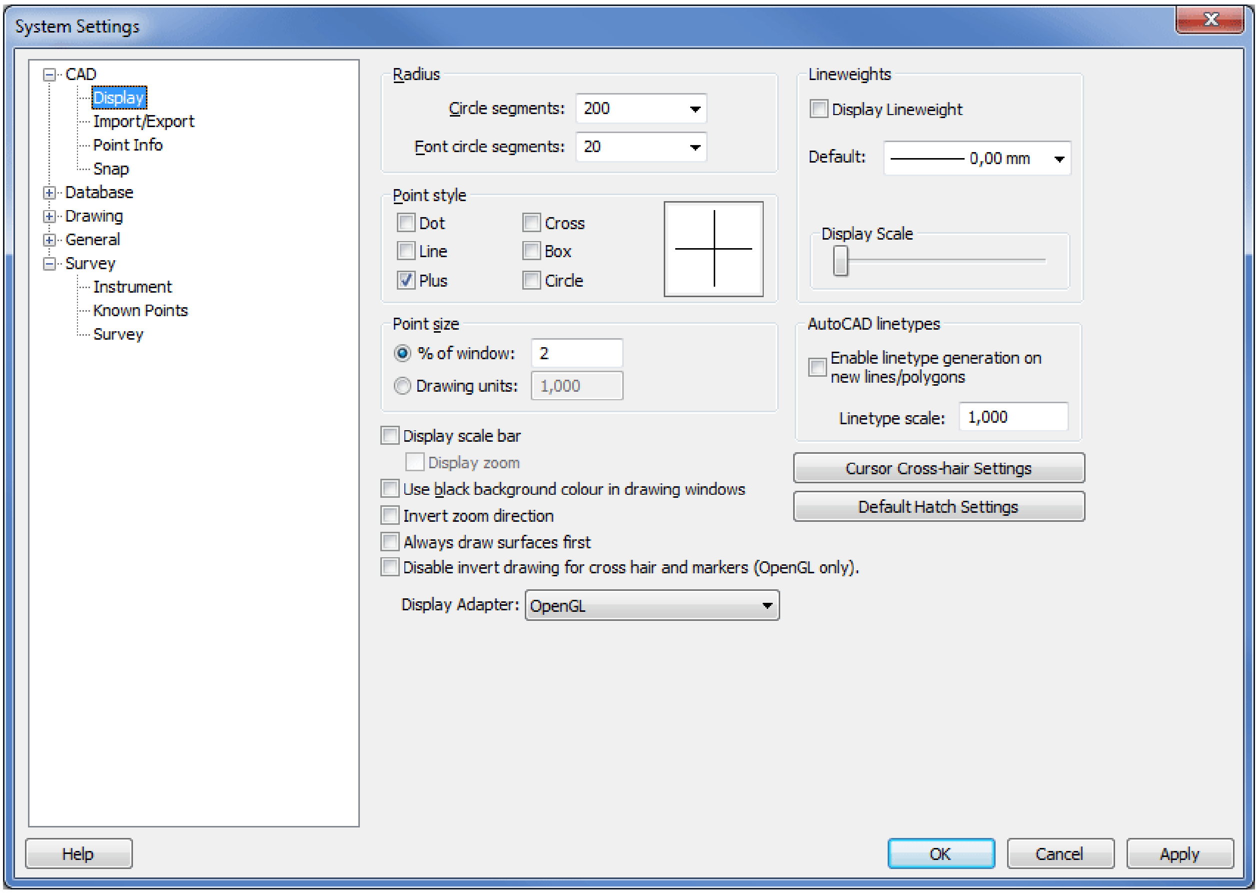
Add to Quick list
Adds a Quick list name - see above.

Delete project in Quick list
Click here to delete a Quick list name. Note that this does not delete the directory - only the quick list entry.

Display

Home|System settings

This is where you select how many radius segments are used and how points are displayed.



Radius
Circle segment
Enter a value for the number of segments you want to use for a lap. The default setting is 200 but a lower value such as 40 or 50 is recommended. The lower the value entered here, the faster the drawing will be plotted in the display.
Font segments
As above but for fonts. This will only apply to Topocad ISO and Topocad ISO-F fonts. TrueType fonts are displayed in their own way.

Point style

You can select how you want points to be plotted on the drawing (screen) by clicking in the different boxes. You can choose from point, line, plus, cross, box and circle or a combination of these.

Point size
You can select the size for points as a percentage of the screen or as a value in meters (or feet). The default value is 2% but 1% is recommended.

Display scale bar
In drawings, in terrain models and in the viewer of survey data, a scale bar is viewable at the right bottom of the window.

Use black background
Click the checkbox if you want black background in drawing windows. Default is white background. Entire white colours will be black and vice versa.

Invert zoom direction
Configuration for which direction the zoom on the mouse wheel shall respond to. Default for the software system (unchecked box) zooms in by rolling the mouse wheel towards yourself.

Always draw surfaces first
Click the checkbox to prevent line types/line widths to be hidden under overlaying surface.

Disable invert drawing for cross hair and markers
Cross hair is plotted in a color instead of the inverted color.

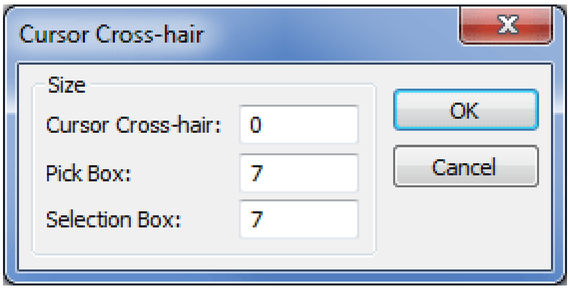
Display adapter
Select OpenGL for faster graphic and to be able to use 3D.

Line weight
The line width is useful for graphic representation of different objects and information. It works for polylines, points, circles, spirals, and road lines in the drawing. Objects has the line width "According to point code" as default while layers have "Default". The value of Default sets under System Settings|Display.

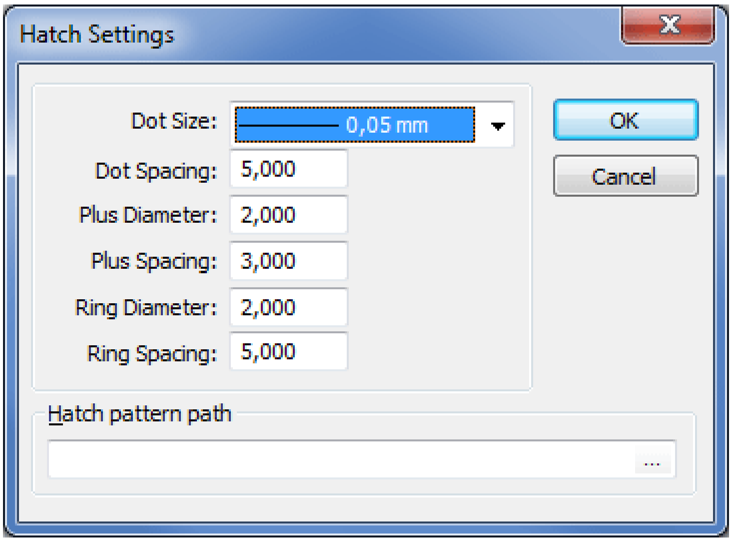
Display line width - Display line width or not. Displaying line width affects time and drawing in a negative way.
Default - Select which value the default line width shall be.
Display scale - The scale of the line width in the drawing.

AutoCAD linetypes
Ability to use AutoCAD line types. They can have the function to be generated so it does not become gaps on the nodes.

Cursor Cross-hair settings
Set size for Cross hair, pick box and selection box. Default is 0,7,7.



Default Hatch Settings
There are four different fill types except Windows standard. They are dotted ground, plus, empty circles and a mix of empty/filled circles. Here is where you do the settings for them.
The dot size is depending on a line width.
Settings for a specific drawing can be made from Drawing|Hatch settings.



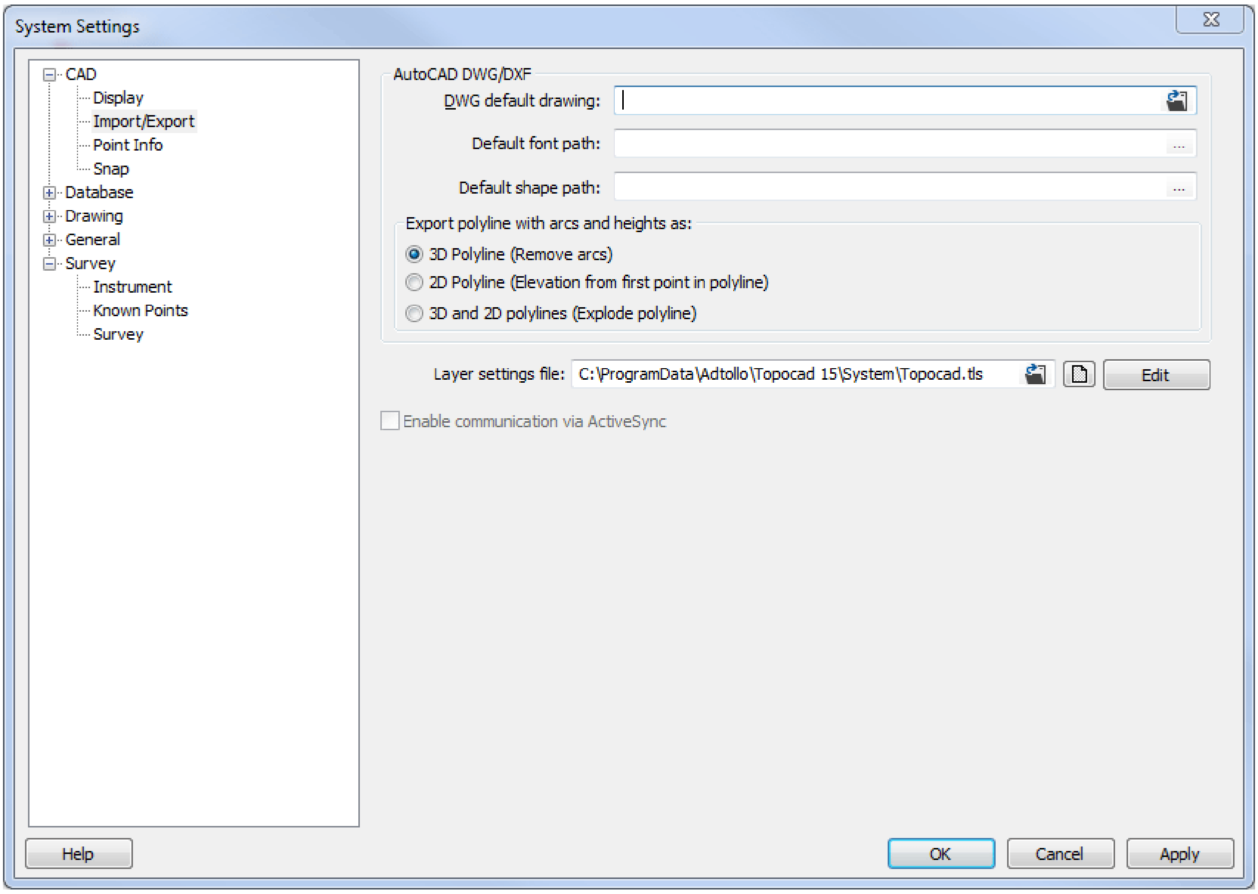
See also

Settings menu.

Import/Export

Home|System settings

This setting aids the conversion of DXF and DWG format to and from the Topocad drawing format.



AutoCAD DWG/DXF

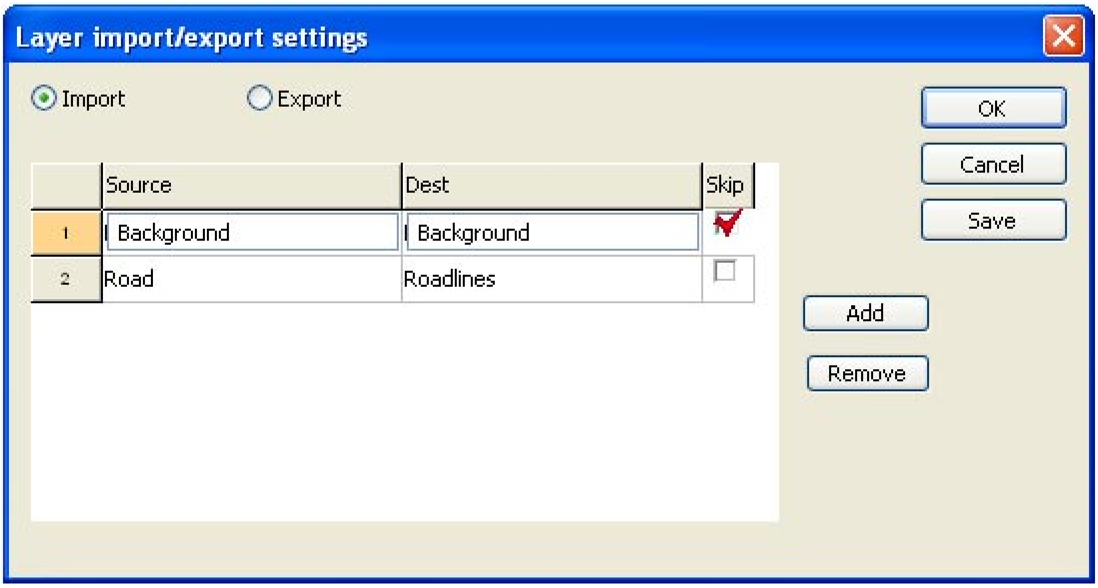
DWG Default drawing:
The default drawing Topocad.dwg makes sure that the scale and orientation remain correct. It is possible to

select another default drawing. This file version will also set the version for exporting DWG files. If this is a R14 file the export will be R14.

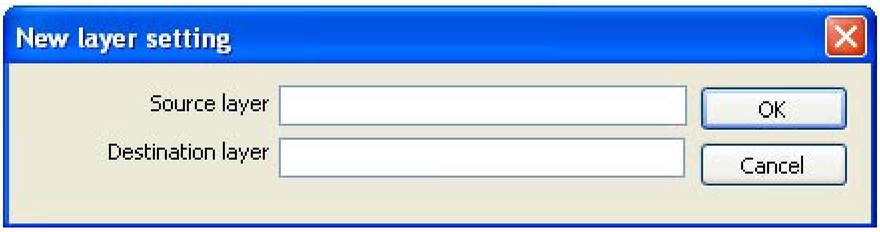
Export polyline with arcs and heights as

3D polyline (Remove arcs): Tick this box if you want to use the heights in the destination system. If so, polylines will be 3D.
2D polyline (Elevation from first point in polyline): Uses the height from the point.
2D and 3D polyline (Explode polyline): Explodes the object into its component parts. Sometimes it is necessary to do this is to edit the object. For example, a symbol needs to be exploded to be able to create a new symbol, text from the point info must be exploded if one is to modify the text individually.

Layer settings file
A translation table is used to set the layers right when importing/exporting Topocad drawings. The table is used between Topocad drawings and also between DWG/DXF and Topocad drawings.
Edit button opens following dialogue:



Select how the layer name shall be translated at import/export.
If ***Skip*** is checked, the selected layer won't be imported/exported.
Save: Settings are saved when clicking the button. If no file is selected you are not able to save. If you click OK without saving first, the settings will be used for this import/export, but not saved for the next time.
Add: The Add button adds an extra row and opens following dialogue:



Enable communication via ActiveSync
Open and save files directly to mobile units (for example Trimble ACU) via Active Sync. Demands installation of ActiveSync in Windows Xp or Windows Mobile Device Center in Windows Vista or Windows 7.

If a mobile unit is connected during open/save/import/export of file, a new dialogue is will open and you can open or save files directly on the unit.

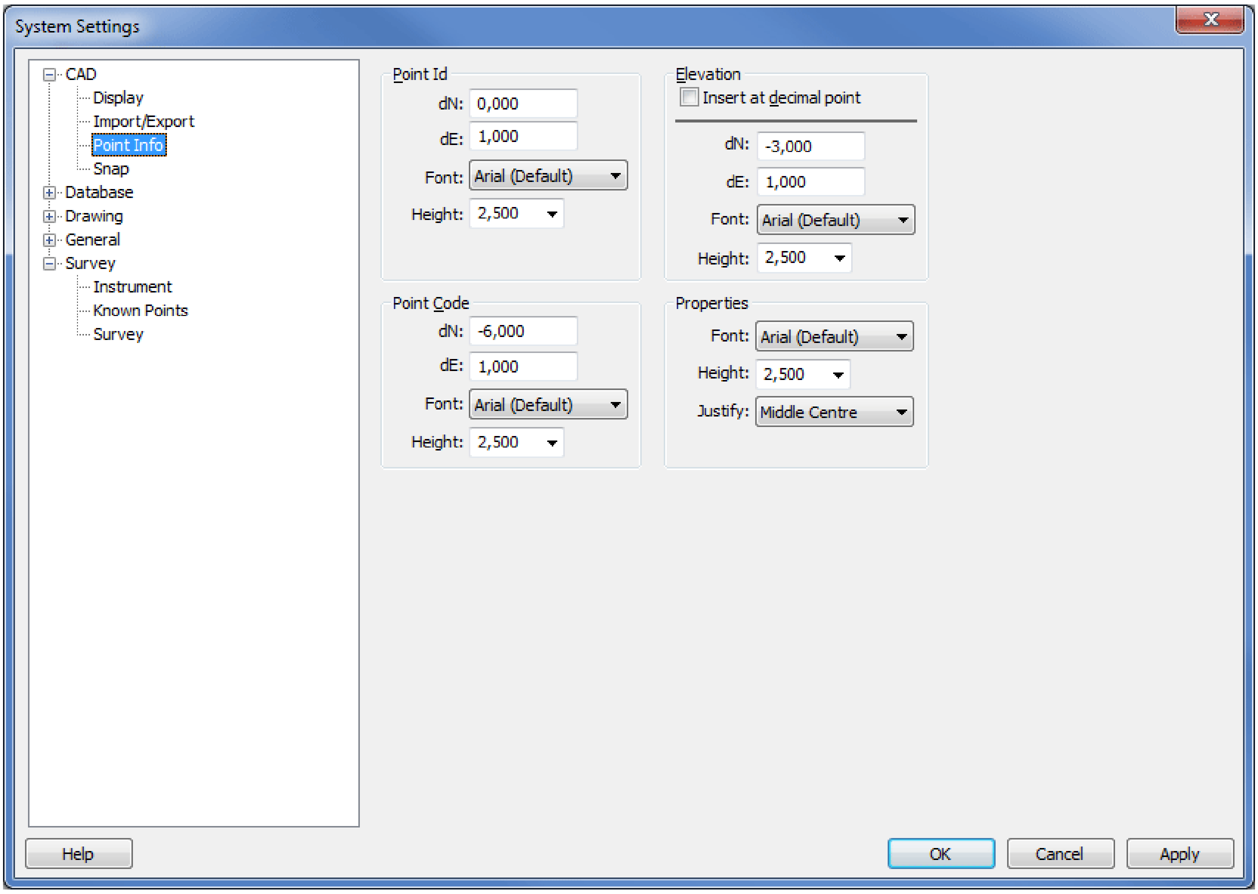
See also

Settings menu.

Point info

Home|System settings

You can display point info for standard points and points in polylines in Topocad. The point info that can be displayed automatically is the point ID, height and point code. System settings is a general setting for all the points that use point info. If you are displaying points with point info and you make changes to the settings you will have to regenerate the drawing for the changes to take effect.



The procedure is as follows:

1. Go to *System settings|Point info.*
2. Select the dX and dY distances from the point where you want the information (point Id, height and/or point code) to be displayed. Note that these distances are either in metres or whatever unit is used in the drawing.
3. Select whether or not the decimal separator will be the start point. (This only applies to the height). If this is selected you will probably also set dX and dY to 0.0.
4. Select font. Note that only True Type fonts can be used.

See also

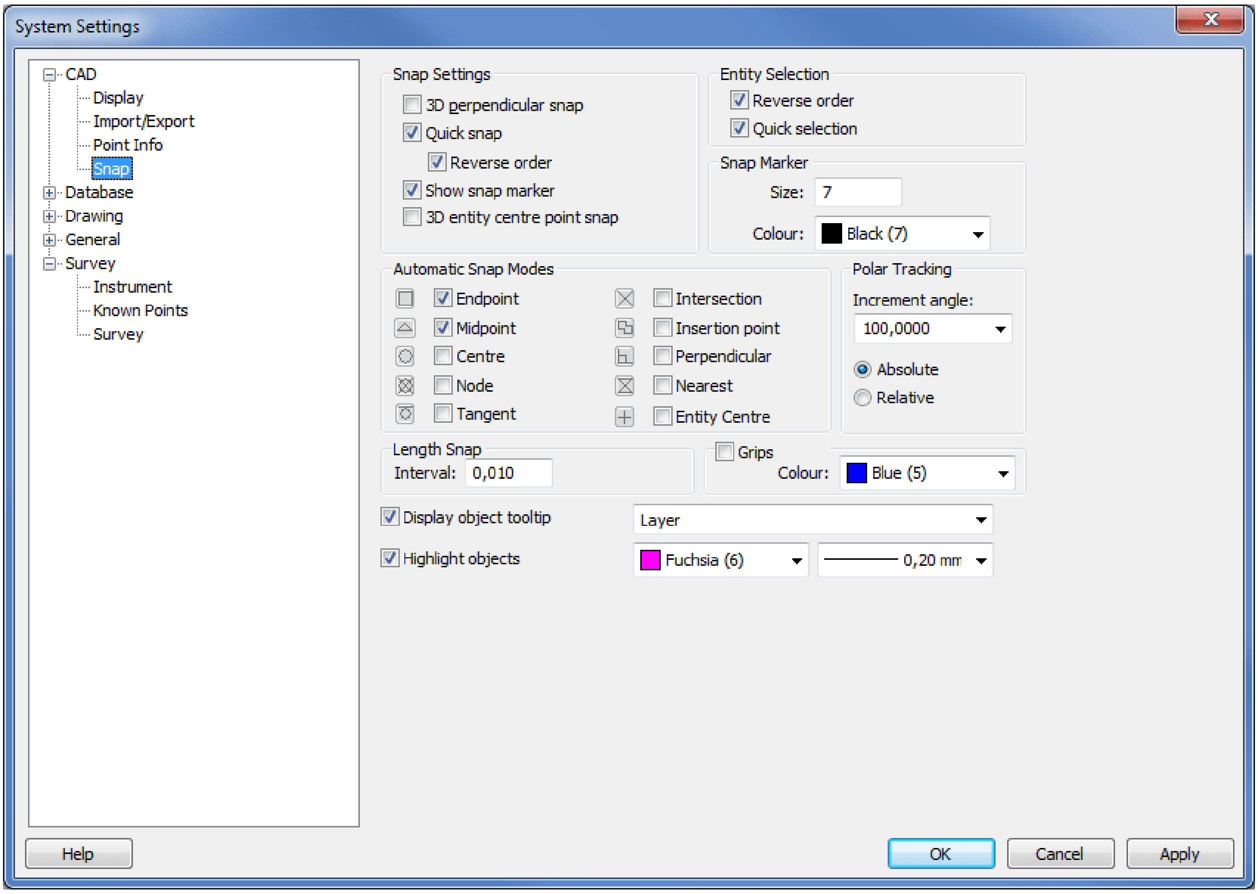
View - point info

Settings menu.

Snap

Home|System settings

The snap settings can be accessed directly from the snap menu.



Snap settings

3D perpendicular snap
To snap in three dimensions using perpendicular snap.

Quick snap
Auto snap

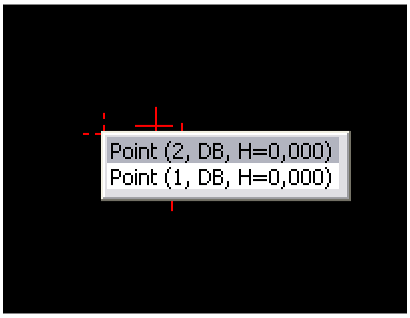
Reverse order
Snaps on objects starting from the bottom of the drawing order.

Show snap marker
Shows the snap with different symbols.

3D entity center point snap
Snaps on entities in three dimensions.

Reverse order
Selects the objects from below and up from the drawing order.

Quick selection
Always selects the object on top. A list of all objects on that point is shown.



Quick selection decides how the selection is made when selecting objects. If Quick selection is checked, the first found object will be marked. All the objects in the drawing will be searched through if Quick selection is unchecked. All objects that matches the selection are listed. Quick selection can take a little longer time since it has to control all objects in the drawing.

Snap Marker
Indicates which snap that is active. Select size and colour on the snap marker.

Automatic snap
Settings for the automatic snap, some combinations are not possible.

- Endpoint: Snaps on all endpoints in the line.
- Midpoint: Snaps in the middle of all part lines.
- Centre: Snaps on the centre of a radius or a circle.
- Node: Snaps on a point.
- Tangent: Snaps on the tangent point of a circle or a radius.
- Intersection: Snaps on the intersection between two objects.
- Insertion point: Snaps on the insertion point on a text or symbol.
- Perpendicular: Snaps 90 degrees towards a line.
- Nearest: Always snaps on a line, anywhere on the line.
- Entity Center: Snaps on the centre of gravity of an object.

Polar snap/tracking
For polar construction of lines, select the increment angle.

Length snap
Set the interval here if you want to use the length snap.

Grips
Select if you want markings on the objects in the drawing and which colours they shall have.

Display object tooltip
Select if you want to show tooltip.

Highlight objects
Select if you want to show a mouse-over highlight on your objects, and which colour.

FDO settings

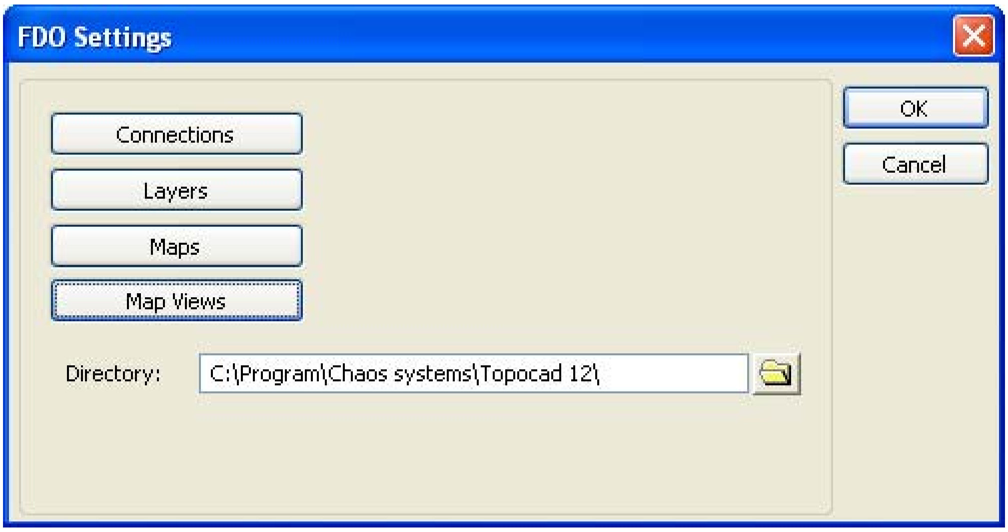
FDO|Settings

Command	Description
Providers	FDO uses a provider based model where each provider supports a certain format or data source.
Settings	Settings for database.
Connections	Configuration for connections to data sources.
Manage layers	Configuration of connections between layers in Topocad and tables in the data source.
Points	Style settings for points.
Lines/Polygons	Style settings for lines and polygons.
Attributes	Configuration of the attributes that will be added to each object in the layer.
Manage maps	Configuration of the layers that will be added in a map, in which order they will be imported and map views concerning only this map.
Manage map views	Configuration of global map views which can be used to open all maps in.

Following providers are available

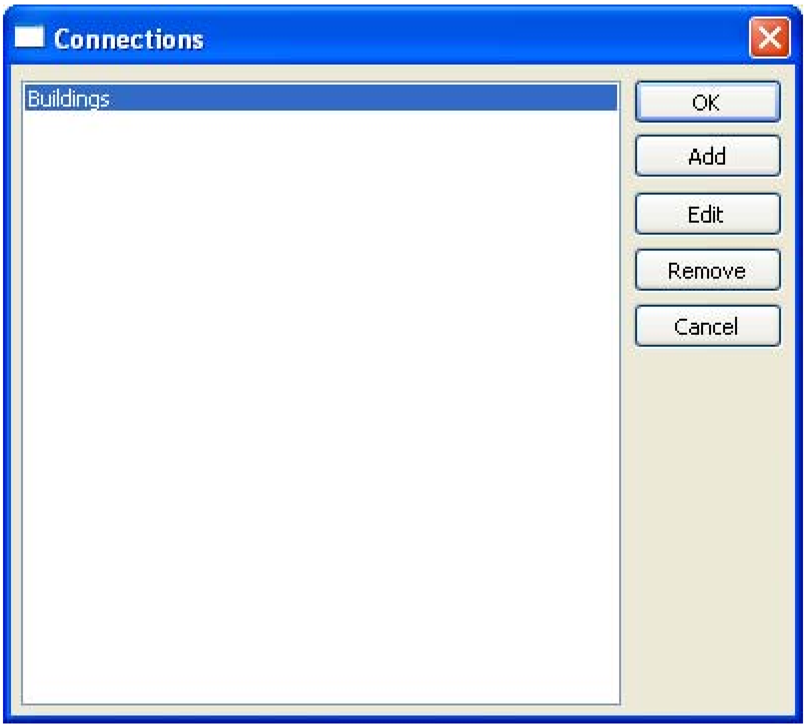
• ESRI ArcSDE
• MySQL
• SDF (Autodesk)
• ESRI SHP
• ODBC
• WFS
• WMS
• GDAL (Geospatial Data Abstraction Library) (Raster)
• OGR (Vector format: shp, gml, dgn, kml, mapinfo etc.)
• Oracle (Oracle 10g, express, and 9i)
• MS SQL Server Spatial
• SQLite
• PostGIS

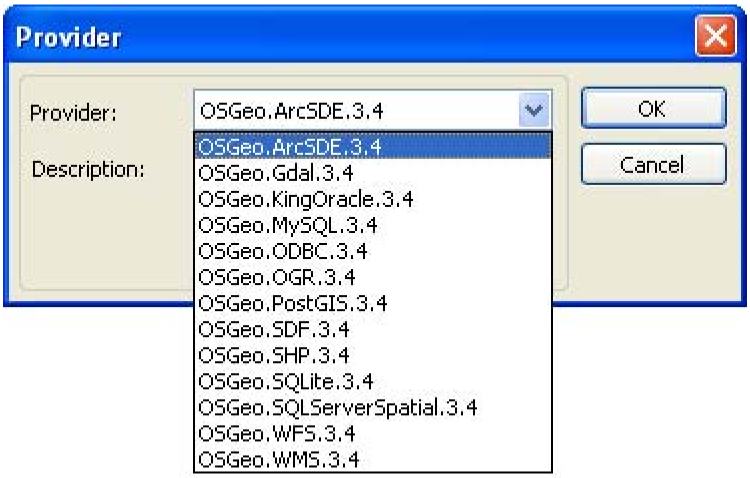
Settings



Connections

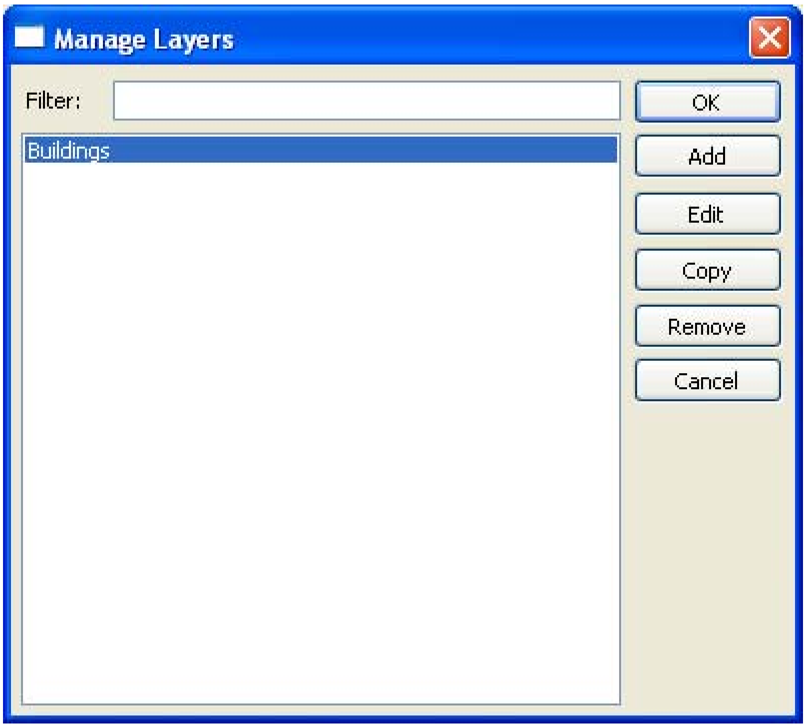
Configuration for connections to data sources.





Manage layers

Configuration of connection between layers in Topocad and tables in the data source. Select properties for each layer in the drawing, properties for object in layer and which attribute object the layer shall have. The attributes can also be used for style settings of object.



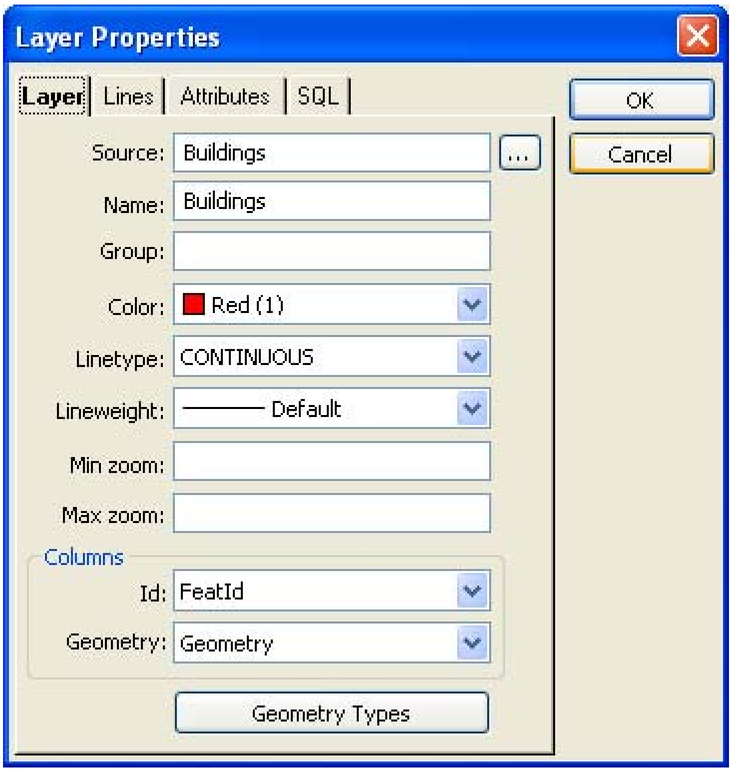
Layer

Style settings for layers in Topocad.

Source

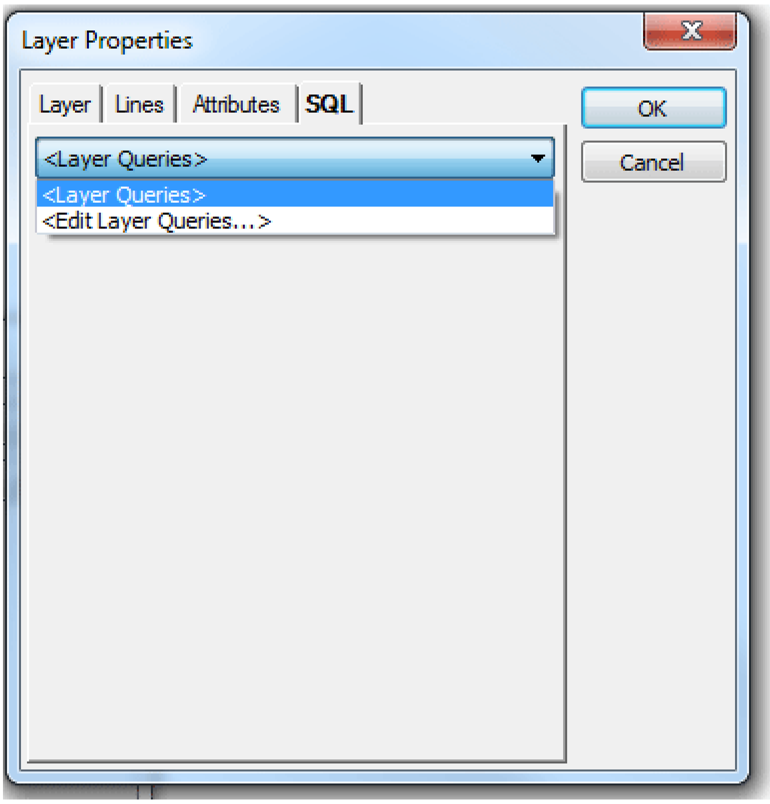
Select which table to write/read to.

For each layer you have to select which attribute that is used as a unique id (to be able to update correctly to the database) and which attribute that represent the geometry.

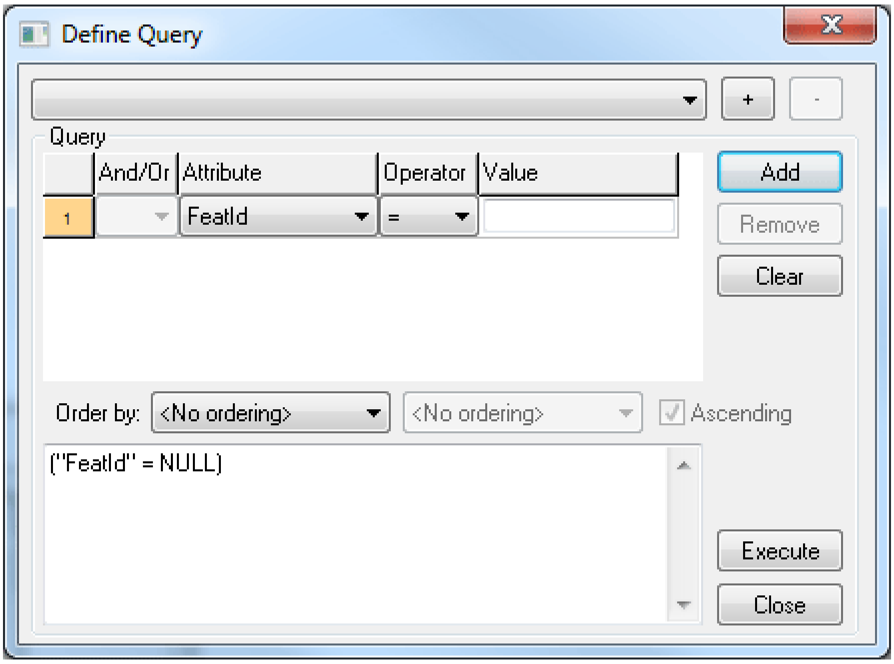


SQL

For each layer you can also select a SQL query to for example filtrate on a certain attribute. WHERE OBJECT_ID='1'



Select *Edit Layer Queries...* in the drop-down menu. The *Define query* dialogue will appear.



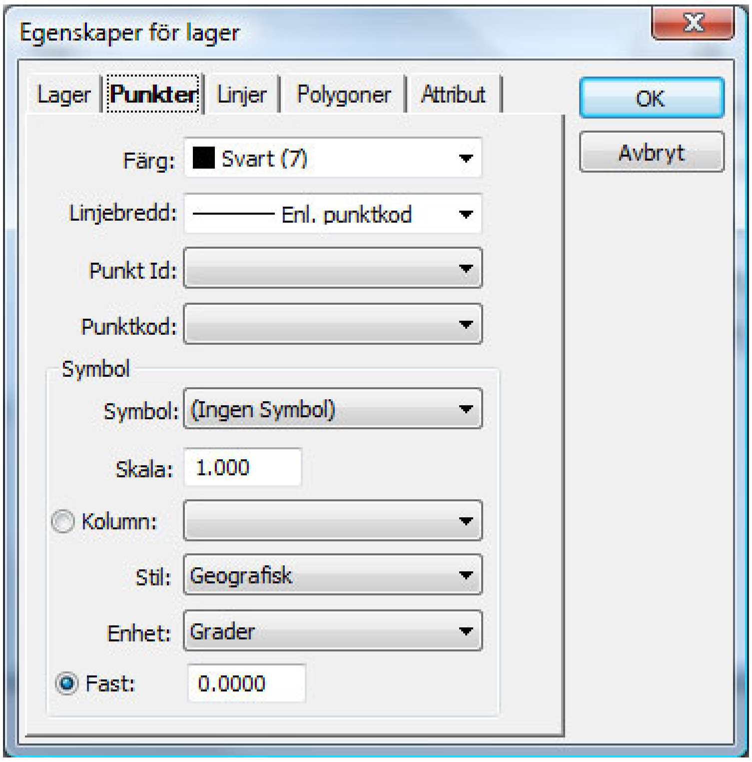
Click the Add button to Add a layer. The *Define Query* dialogue can also be reach from *FDO|Add layer* and the button *Search*.

Points

Style settings for points. Note that all points imports as symbols to display attribute styles correctly.

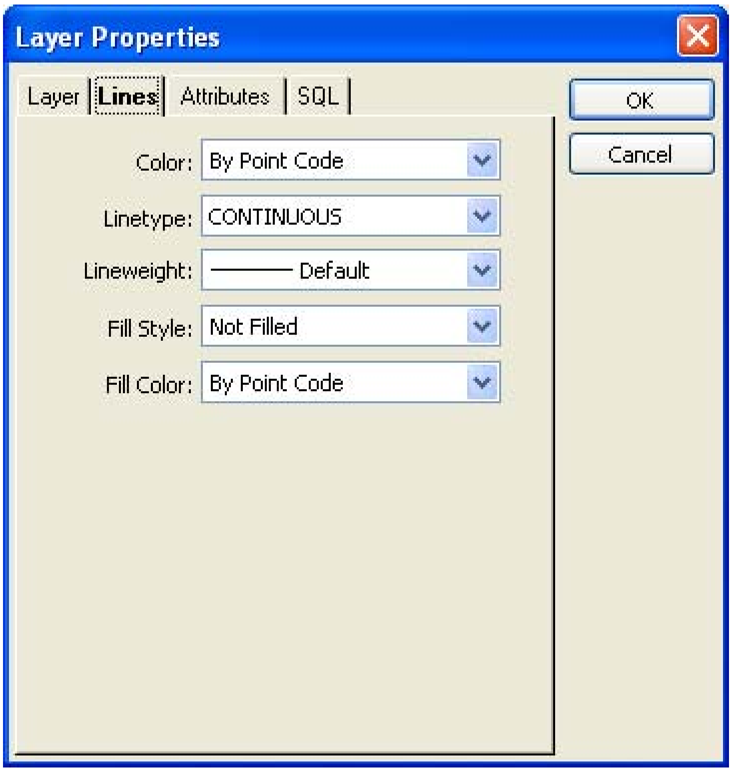
Point id and point code refer to the connection between attributes and the points' properties, id and code.

A symbol can rotate after optional attribute or with fixed rotation.



Line / polygon

Style settings for lines and polygons.

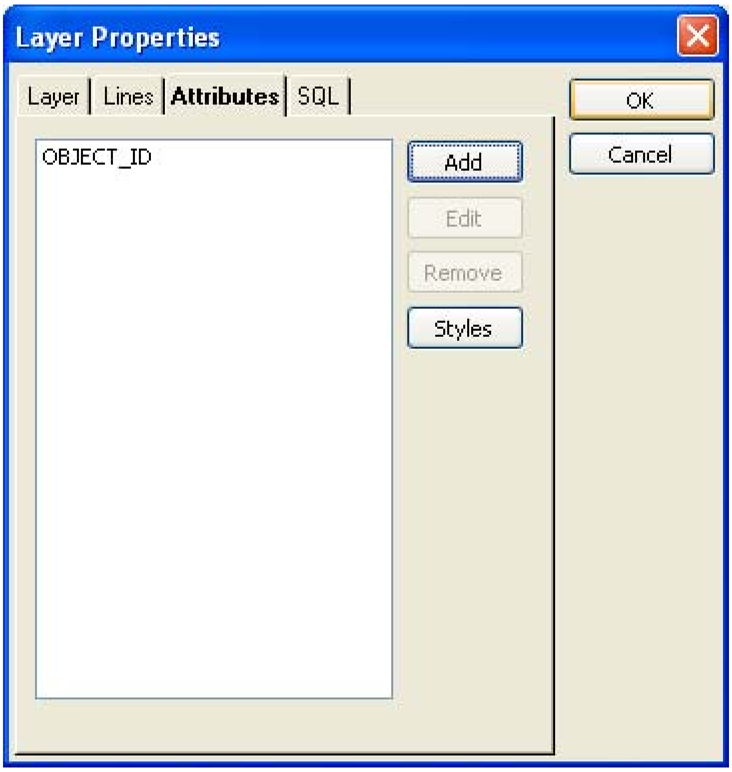


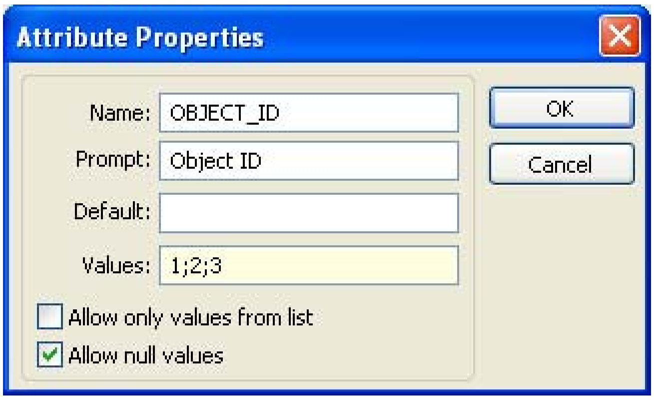
Attribute

Configuration of which attributes that shall be added to each object in the layer.

For each attribute you can add an alias, name, standard value and a value list.

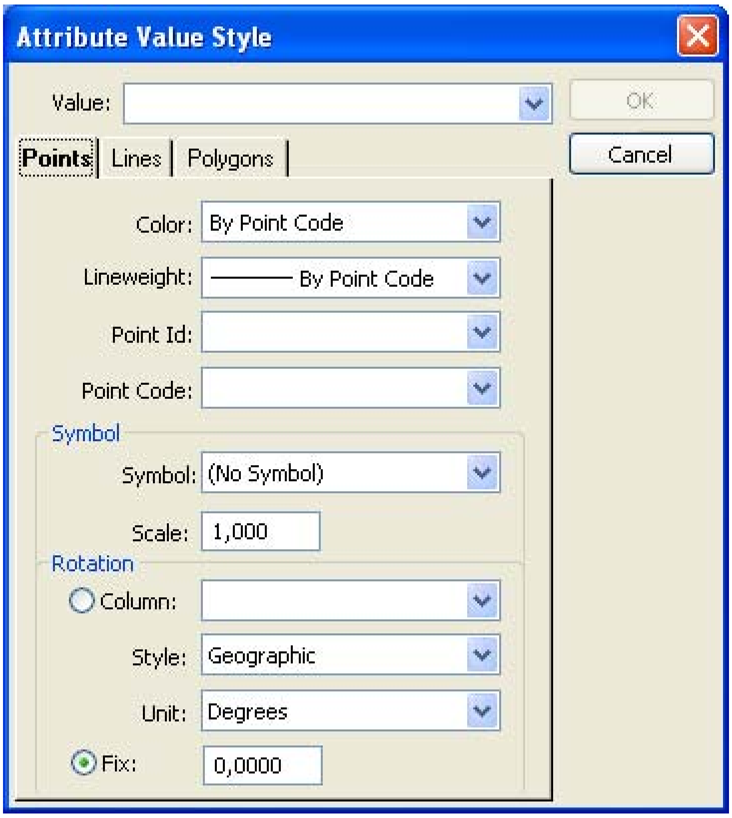
A value list is build by semicolon separated attribute values.





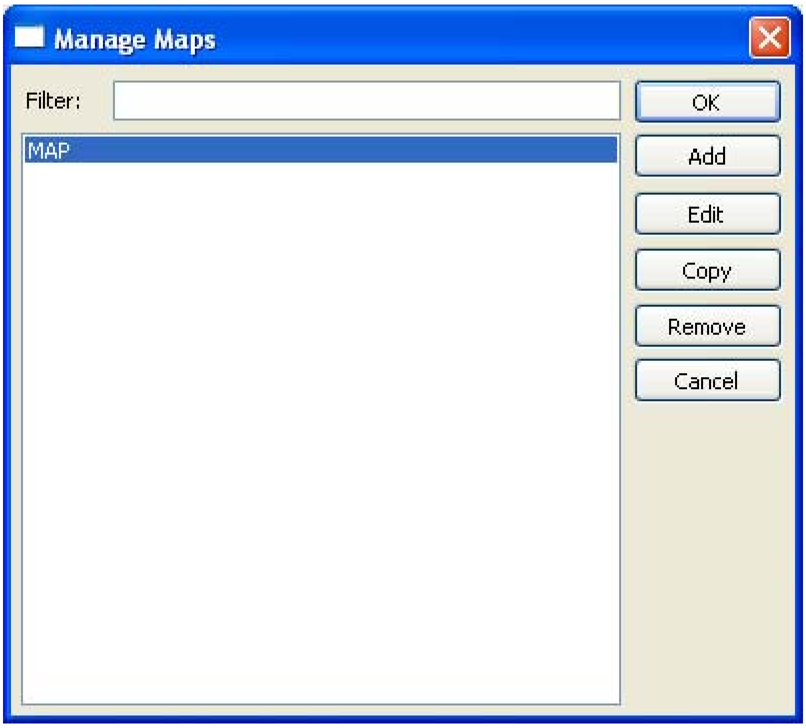
Styles via attribute values

Style setting can be connected to an attribute and then the layout of the object is depending on the value of the attribute.



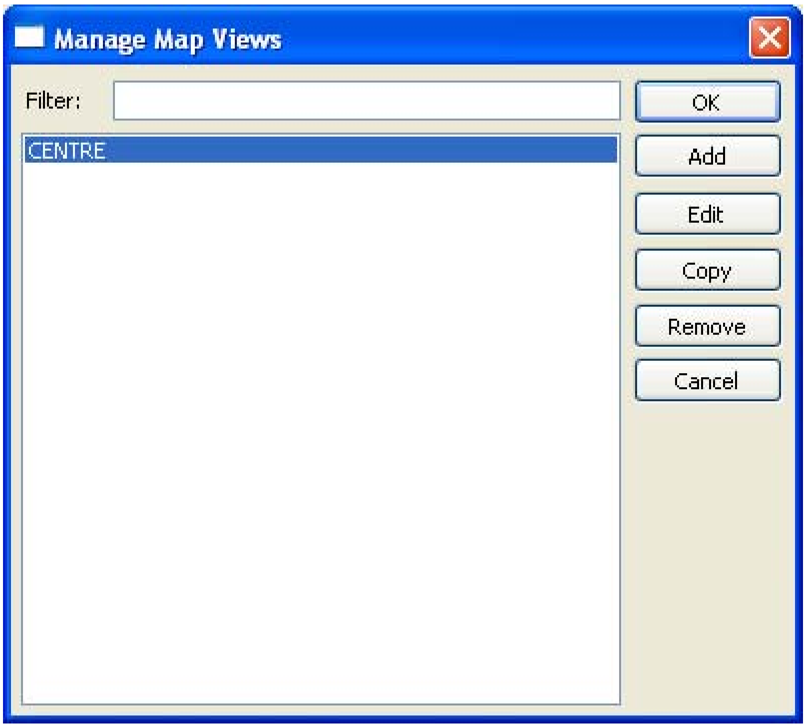
Manage maps

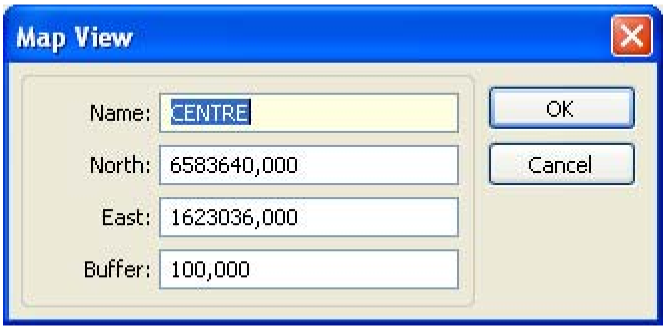
Configuration of which layers that will be included in a map, in which order they shall be read in and also map views valid for the map.



Manage map views

Configuration of global map views in which is used to open all maps. A map view contains of a centre point with a buffer which state height and width.





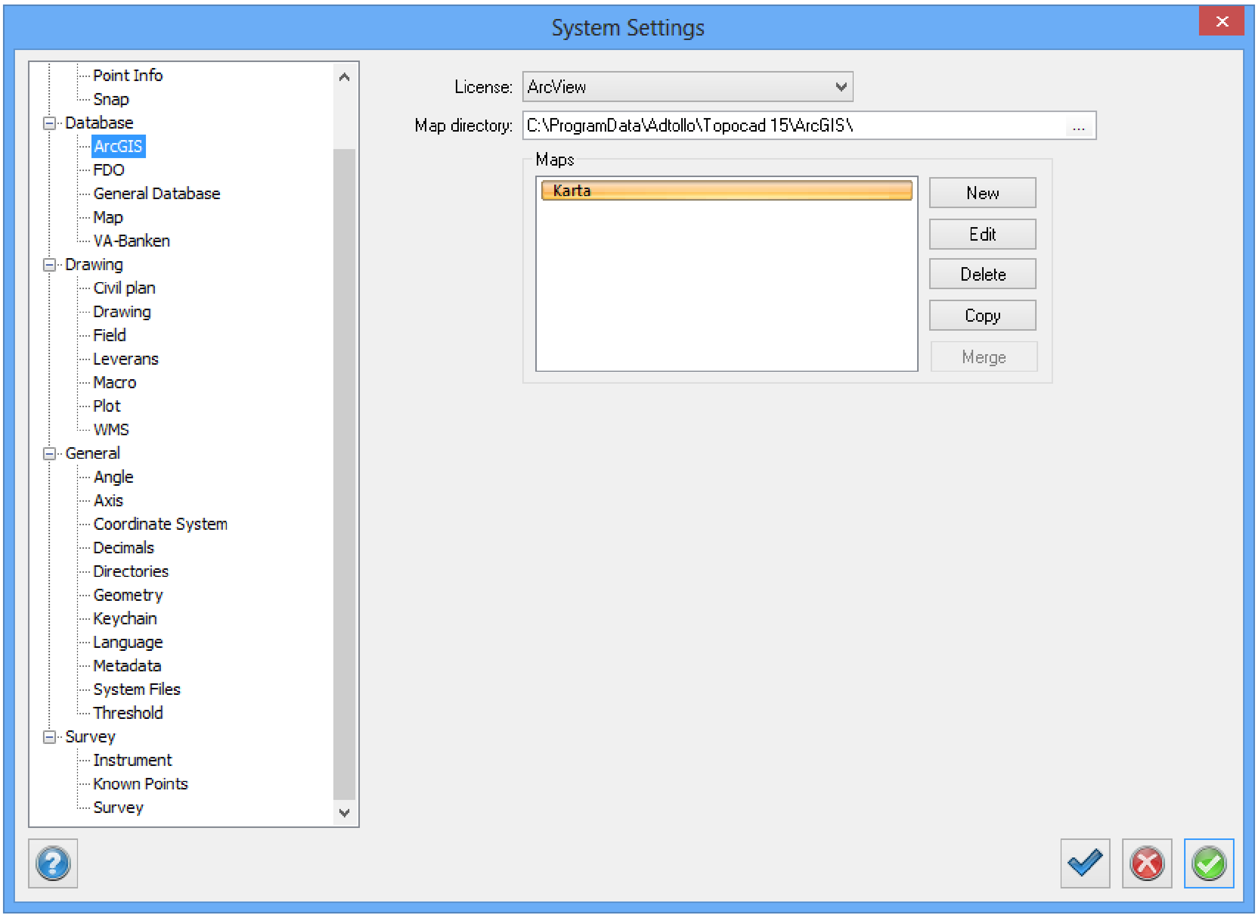
See more

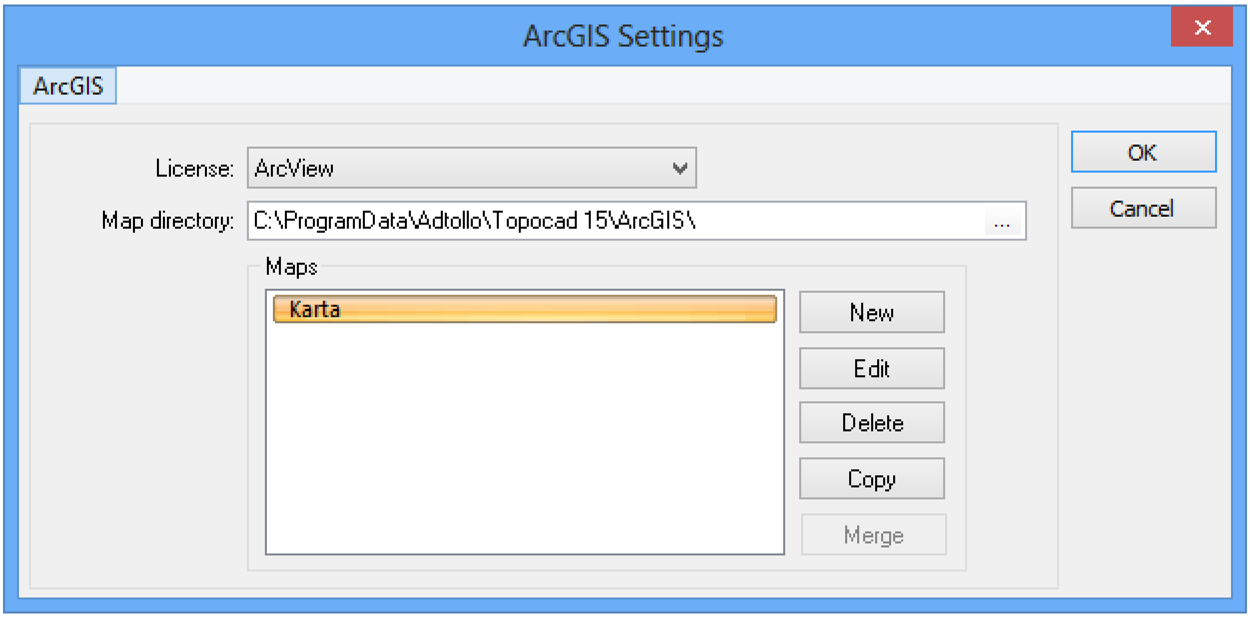
FDO database adapter content

ArcGIS settings

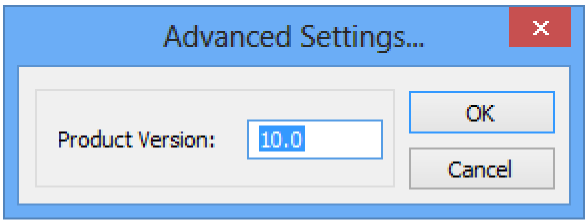
Home|System settings - ArcGIS
ArcGIS|Settings

Connection to ArcSDE is an add-on module for storage and for loading from the ArcGIS database. Data can be stored either in the ArcSDE database or in a personal geo data base. Settings created here are for the database and creation of maps.





Note!
Click on ArcGIS in the upper left corner of the dialog, to access Advanced system settings: (Only available from the ArcGIS menu, not in System settings.

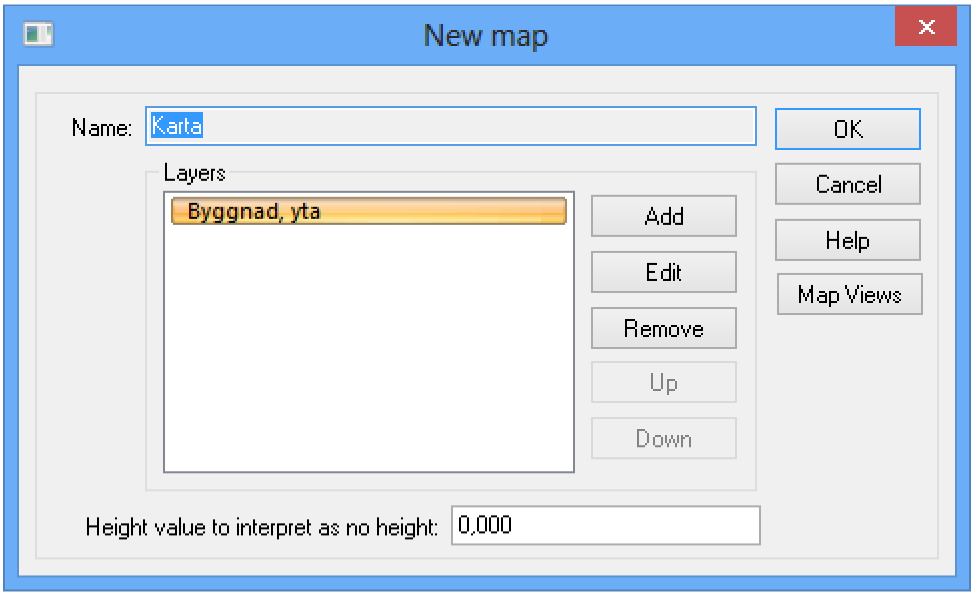


Map directory
Enter the folder in which the ArcSDE database is located.

Maps
The maps are listed here.

Copy/Merge
Copy or merge map(s)

New/Edit
Click New or Edit to open the following dialogue box:

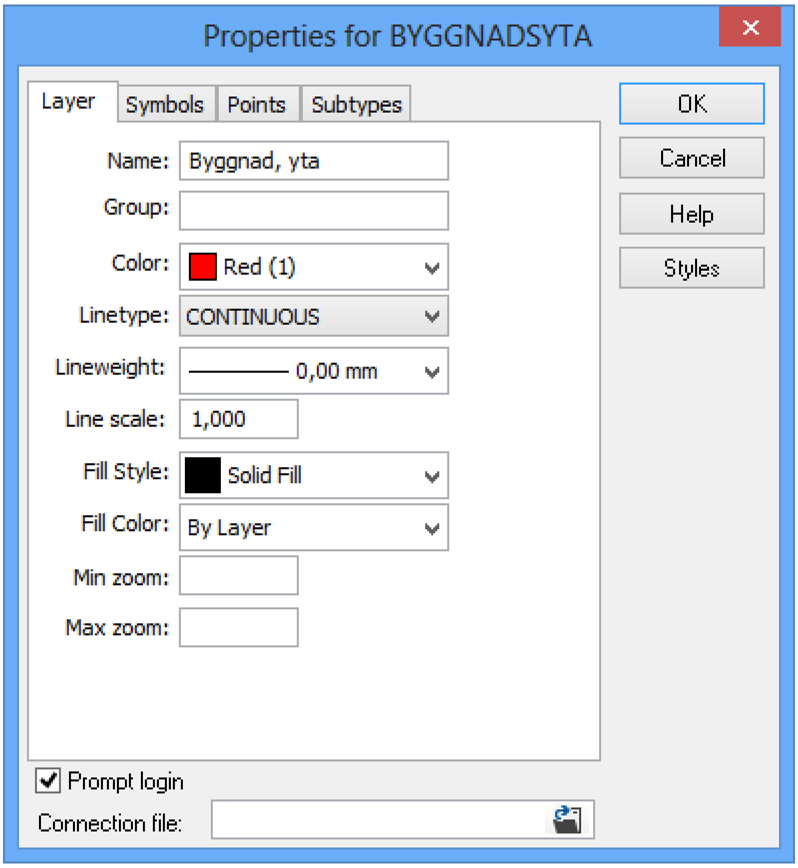


The layer for this map and the order of the layers are selected. This order is the same as the drawing order. Layers above will be drawn later and will therefore appear on top.

Map Views
Click the Map Views button to manage map views.

Adding or editing a layer opens the following dialogue box:

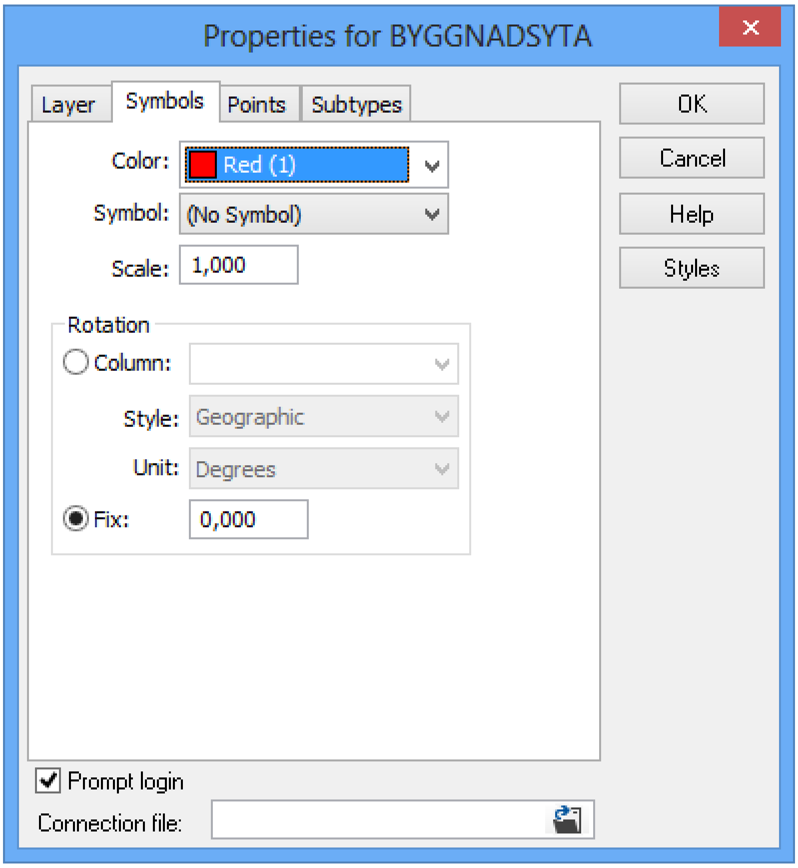
Layer



This allows you to determine how every layer in the map, including sub-types, will be displayed in Topocad. Select the colour, line type and line scale for each layer. Symbols connected to the layer are selected from the symbol file. Sub-types can have their own settings.

If objects in the layer have a valid point ID and point code the attribute table should be entered here.

Symbols



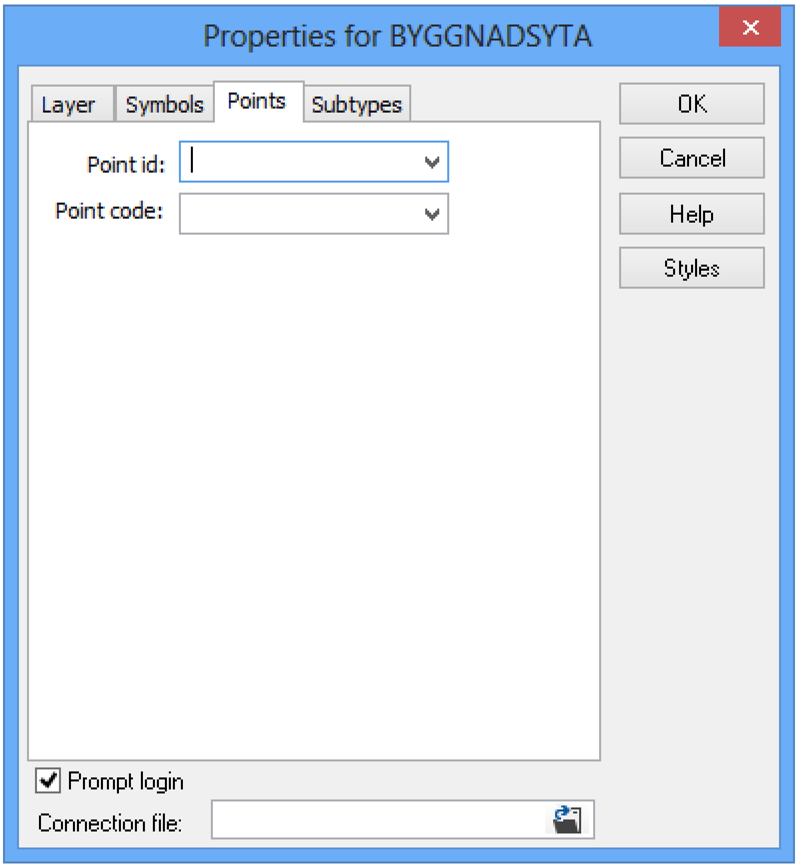
Rotation

Here you are able to set the rotation direction on symbols via an attribute.

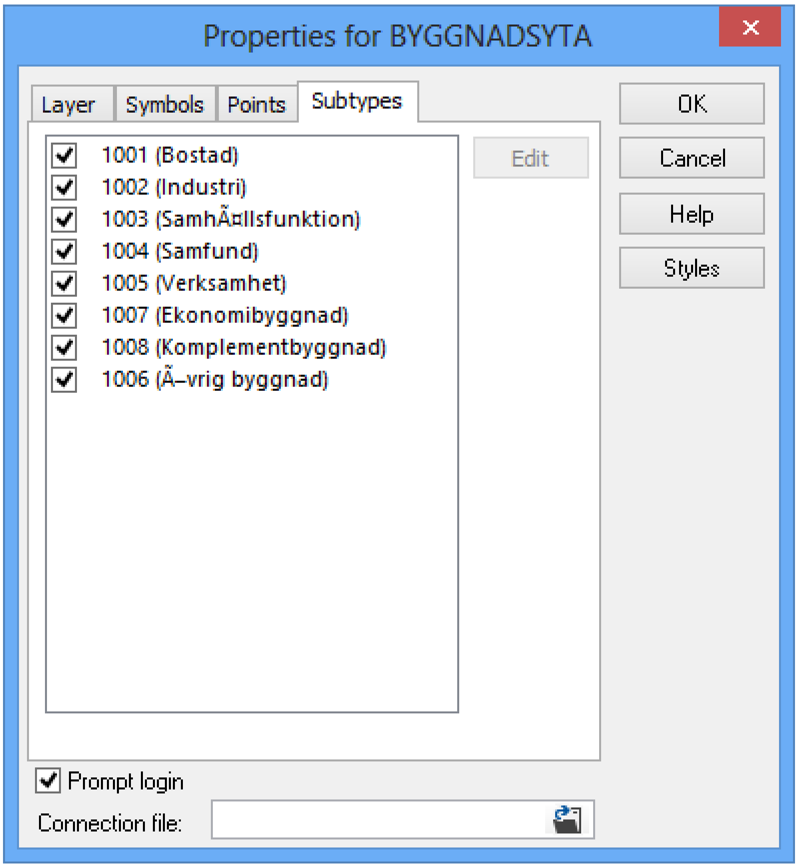
Column: The attribute column which rotation shall be picked from.
Style: The style which the rotation is stated in. (arithmetic or geographical)
Unit: The unit which the rotation is stated in (degrees, gon or radians)
Fix: The rotation can also be stated as a fixed angle which goes for all symbols.

The rotation attribute of the symbol updates when rotating the symbol in drawing.

Points



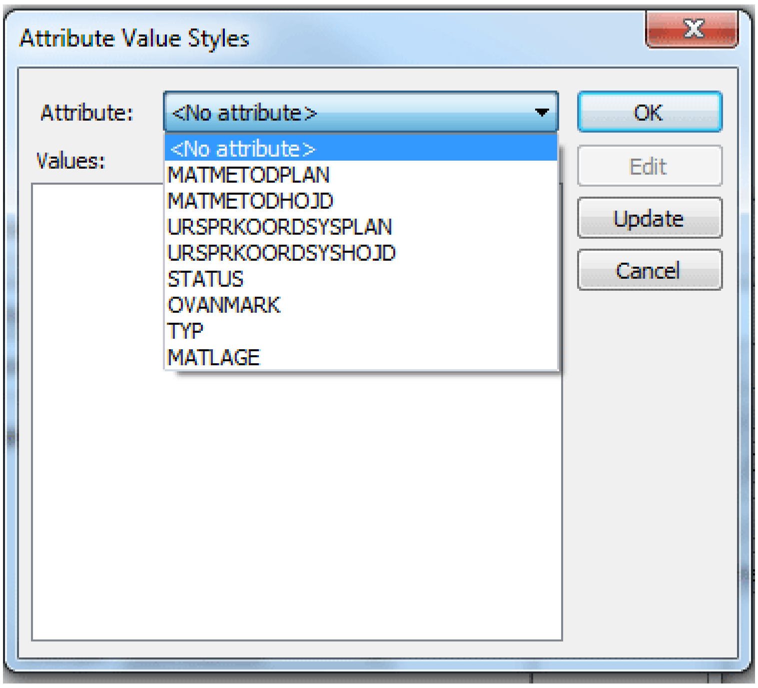
Sub types



Possibilities to exclude objects with certain sub types when opening map.

Styles

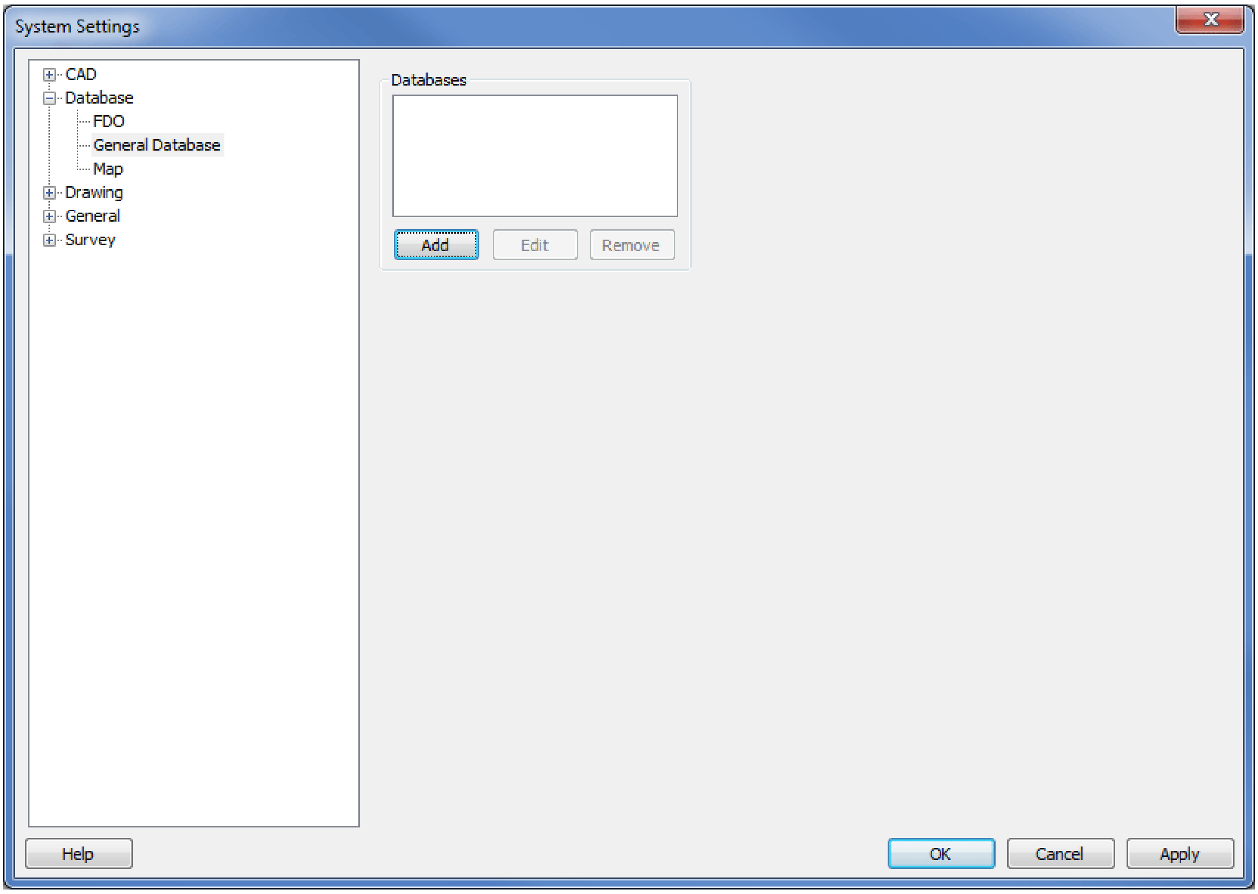
Click the Styles button to open following dialogue. Add your styles. Style selections go before subtype selections.



General database

Home|System settings

Information about the database to be connected to Topocad. This database connection is only for specific or known points. Almost all types of databases can be connected, including MS Excel and SQL databases. To connect and collect all the maps stored in a database you can use any of our other database connections, e.g. ISM adapter.

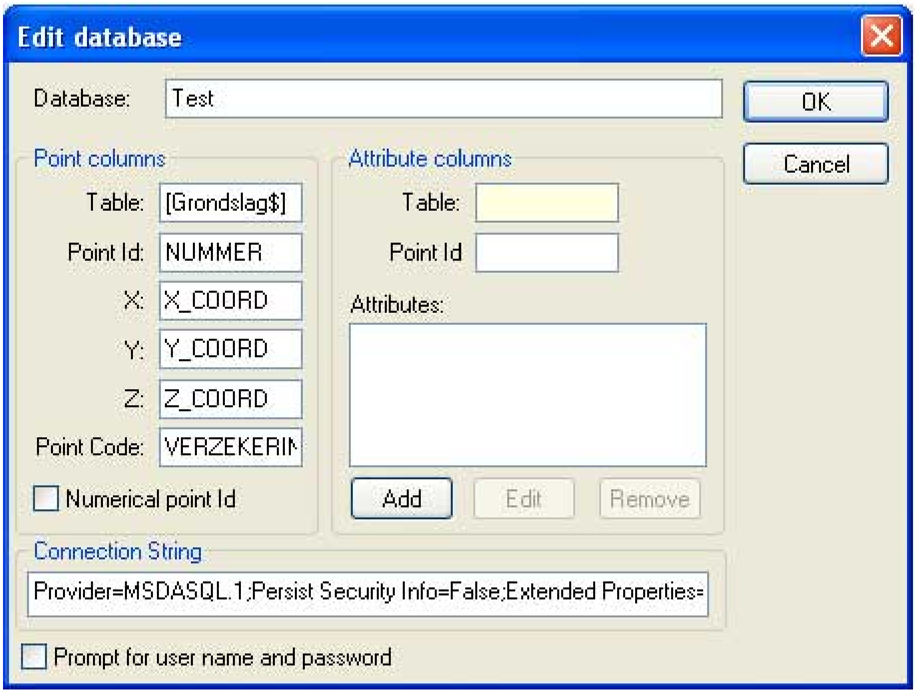


Databases
Add, edit or delete your database connections.

Search criteria

You can select whether you want to use the known point file (pp file), the database or both.

Editing



Database

Enter the name of the database.

Point columns

Enter the names of columns in the database for the point information.

Attribute columns

Table

Enter the names of columns in the database for the attribute information.

Attribute

Enter the names of columns in the database for the point information.

Connection string
To find the right database.

This is a sample of a Connection string for Excel sheet: Provider=MSDASQL.1;Persist Security Info=False;Extended Properties="DSN=Excel files;DBQ=C:\Chaos\database.xls;DefaultDir=C:\Chaos;DriverId=790;MaxBufferSize=2048;PageTimeout=5;";Initial Catalog=C:\Chaos

Where C:\Chaos\database.xls is the database in excel file.

Connection string for Microsoft access:

Provider=Microsoft.ACE.OLEDB.12.0;Password=XXXX;User ID=XXXX;Data Source=filnamn;Persist Security Info=True

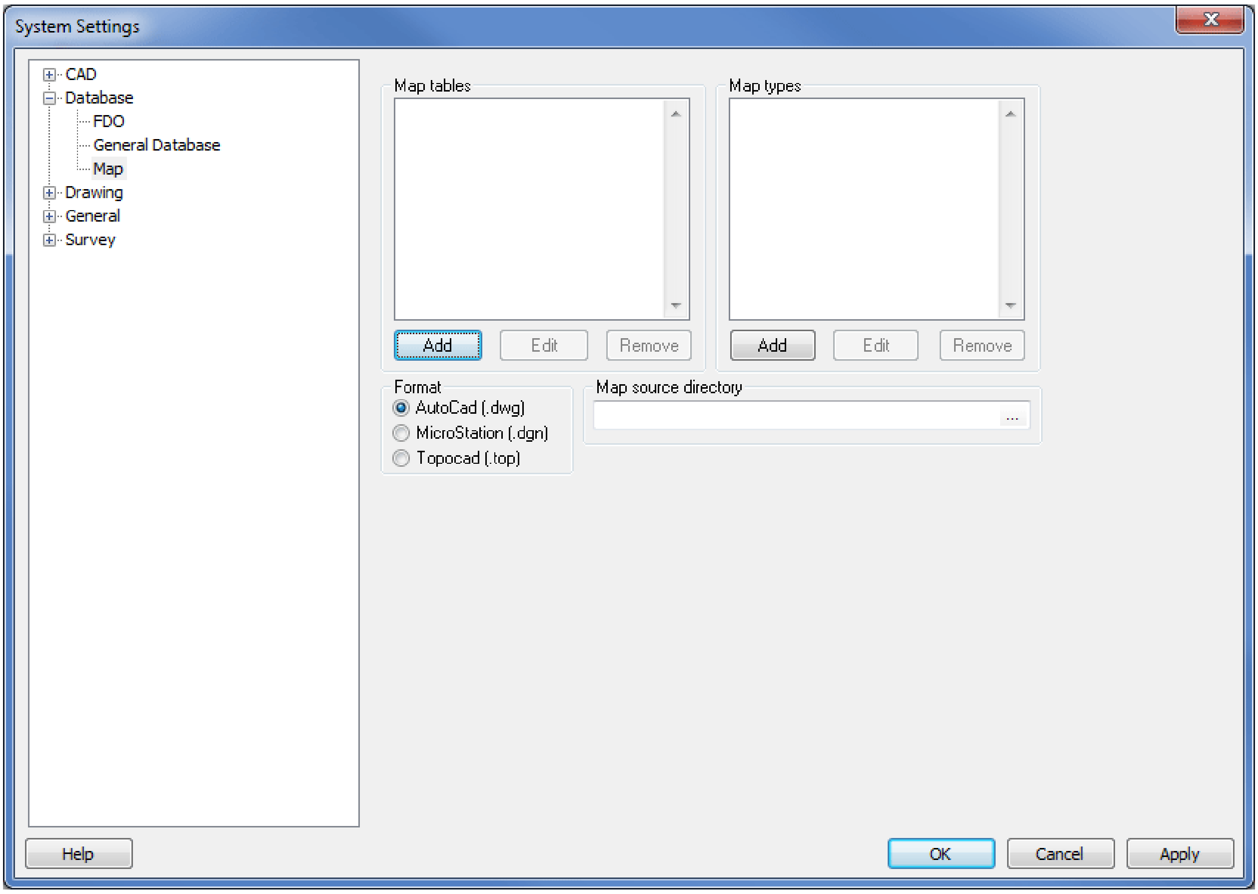
Request the user name and password

A separate login can be created.

Map

Home|System settings

These are the settings for the map sheet add-on module.



Map tables

Information about the map tables used is entered in a separate file. The file contains information about which coordinates the map charts start from (lower left corner) and the size in North and East directions. See more information below.

Map types

The map can be divided into several different types of information and these will be displayed as tables when the map sheet is imported. Different types can be separated with a prefix or suffix (extension). For example: if the map type is CADASTRE, all map sheets containing Cadastre information will be given the prefix CADAST_, e.g. CADAST_BF45 where CADAST stands for Cadastre information and BF45 relates to a specific map sheet.

Format

Map sheets can be in AutoCAD DWG format or Microstation DGN format. Topocad TOPX format will follow.

Map directory

Select the directory in which you have stored the map sheets. Subfolders can be entered in the map table file.

An example of a map table

The format, saved as a csv (comma separated format) file that can be created in MS Excel, is as follows:

Map sheet name,Sub folder,X,Y,height,width

Example:

AC035;AC;55600;97600;400;600

AC036;AC;55600;98000;400;600

AD036;AD;56000;98000;400;600

A subfolder can be empty but requires an extra , (comma).

Drawing

Home|System settings

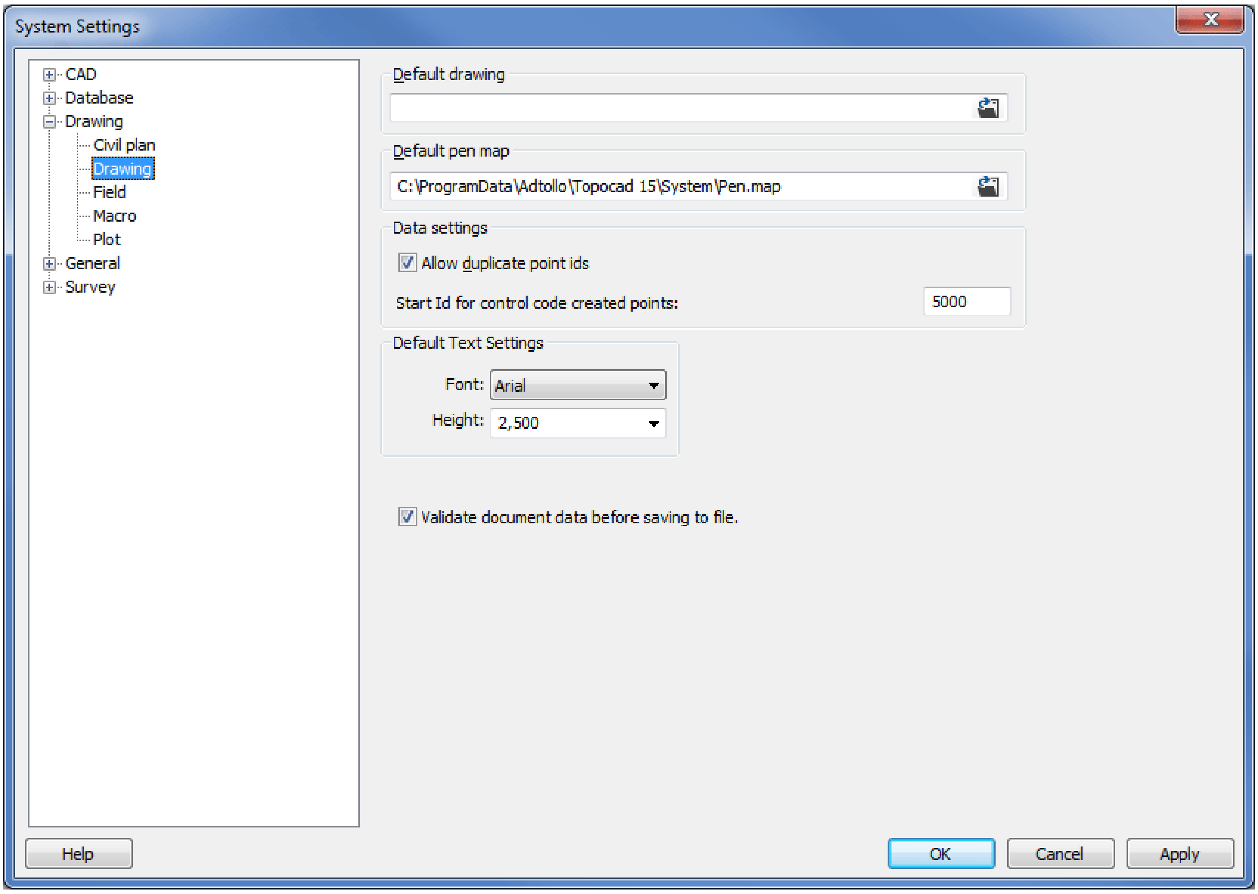
Default drawing
This is where the settings for default drawings are made.

Default pen map
Select default pen map.

Data settings
Allow duplicate point id:s: Select whether or not you want the system to allow duplicate point IDs.
Start ID for control code created points: If you have decided not to allow duplicate Point IDs it is best to use a number here that cannot be duplicated by mistake.

Default Text Settings
Select default font and height. Affects all the commands in the drawing.

Validate document data before saving to file
The document opens in the background to see if the document is okay to be saved.



See also

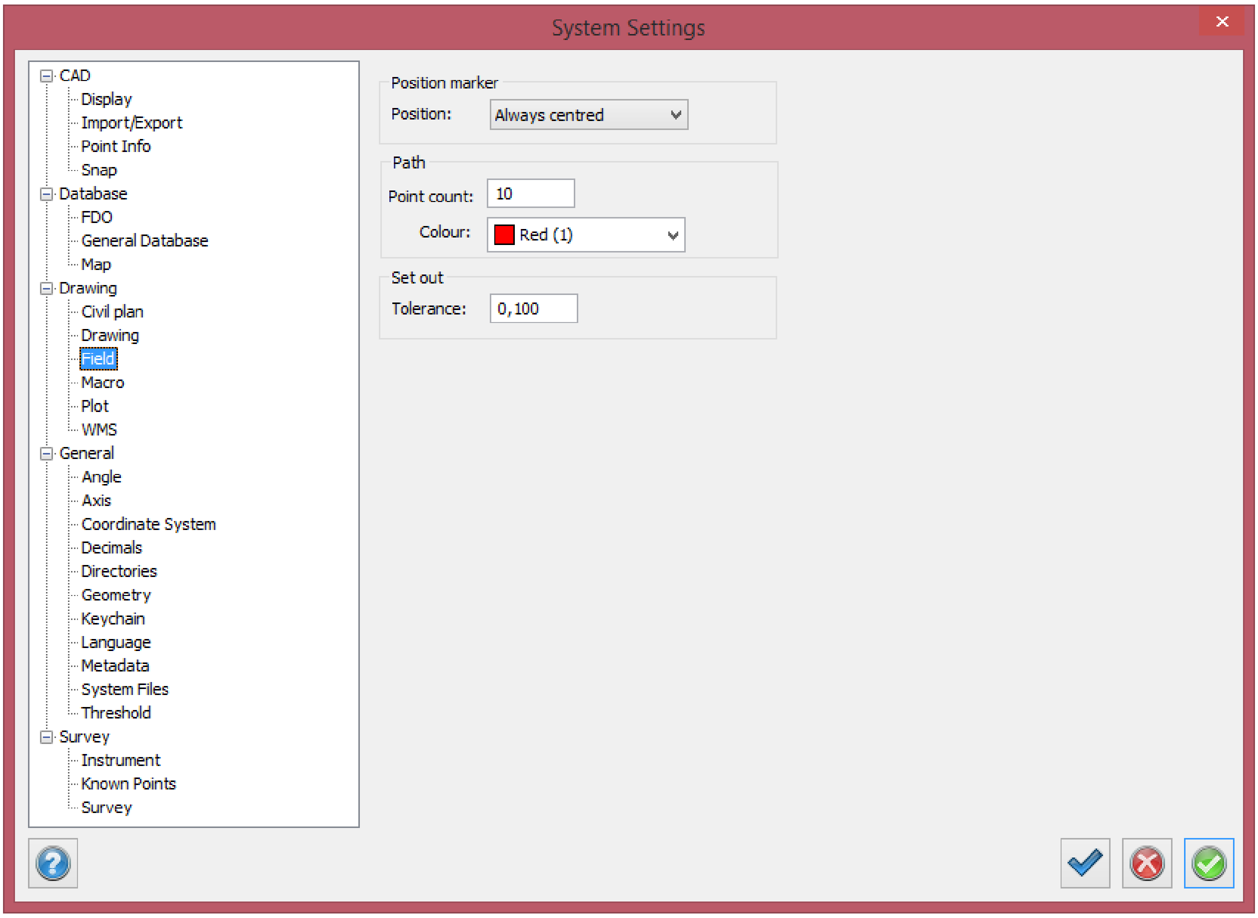
Settings menu.

Field

Home|Settings - Field

Settings for position marker, path and set out.

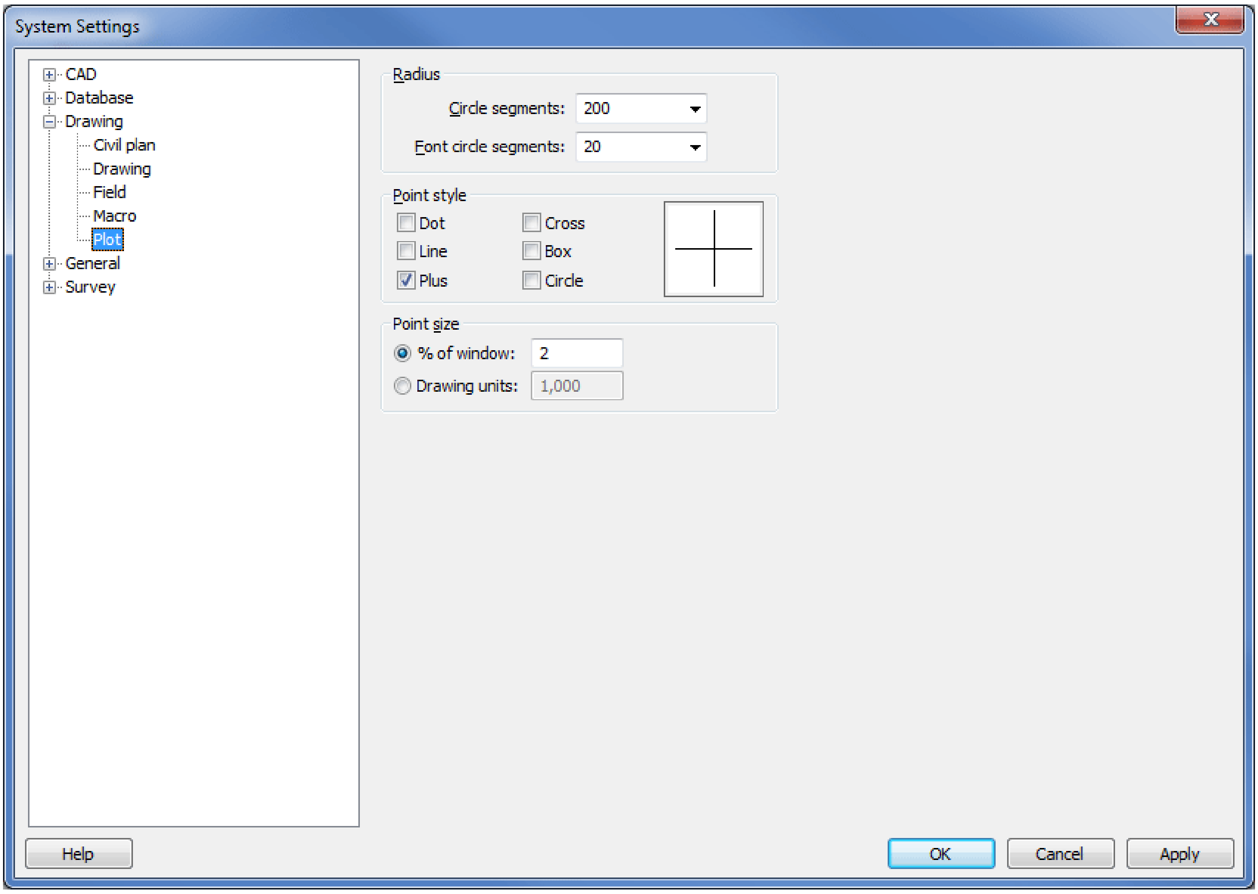
See also: Working with Field



Plot

Home|System settings

Appearance for points and radius when plotting is controlled here.



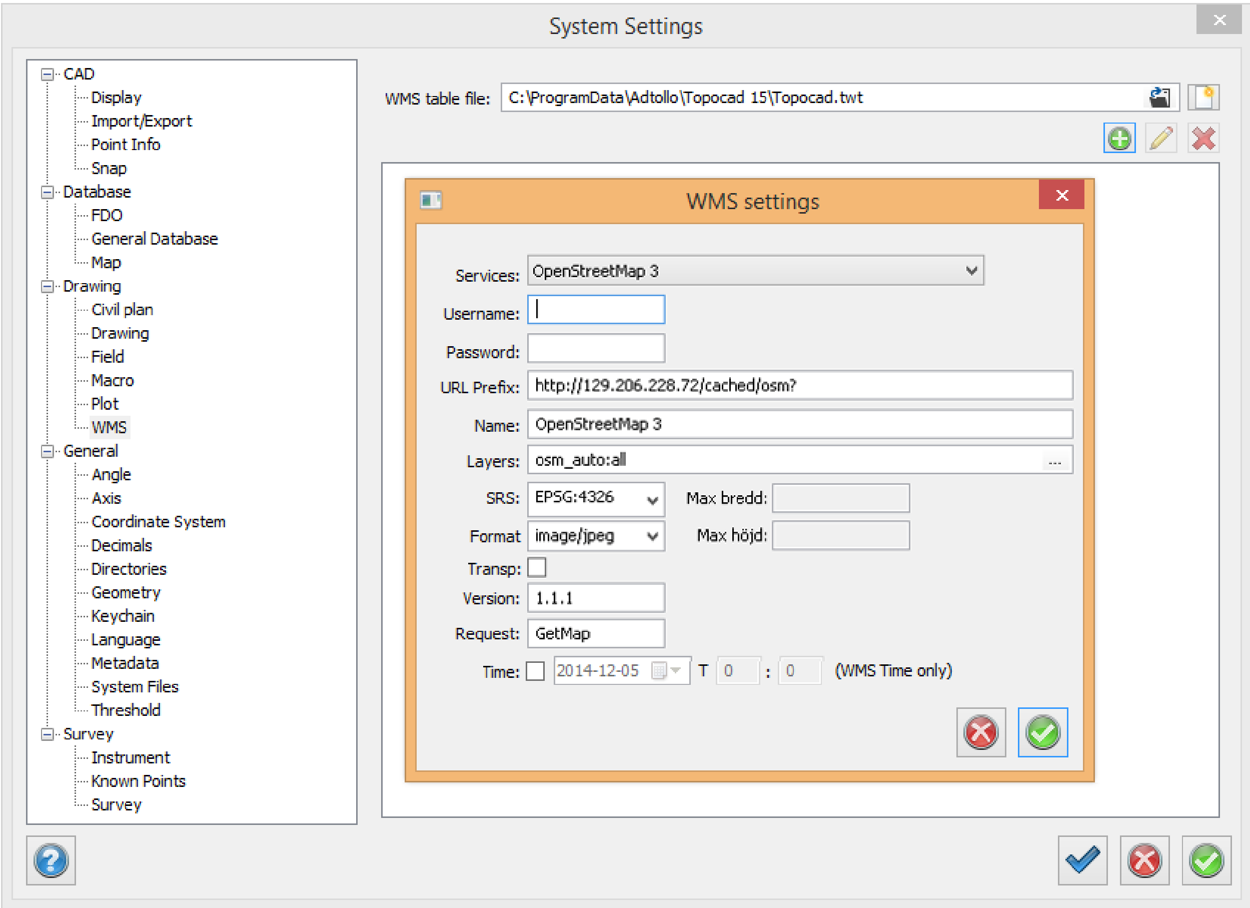
See also

Settings menu.

WMS

Home|System settings|WMS

Add your web map services in System settings.



Add or edit web map services

Services: When adding a new service, you can select an old service and make your changes.

Username and password
Add username and password if the service demands it.

URL
The URL to the service. It can sometimes be found intern on the web server.

Name
Your name on the service.

Layer
Select which layers you want to download from the service. Click Browse to see available layers.

SRS

Select coordinate system/reference system.

Format

Jpeg, Png, Tiff are the available formats. Select Png and transparent for transparent layers.

Version

Version 1.1.1 is default. Selects the version of the service.

Request

GetMap is default.

Time

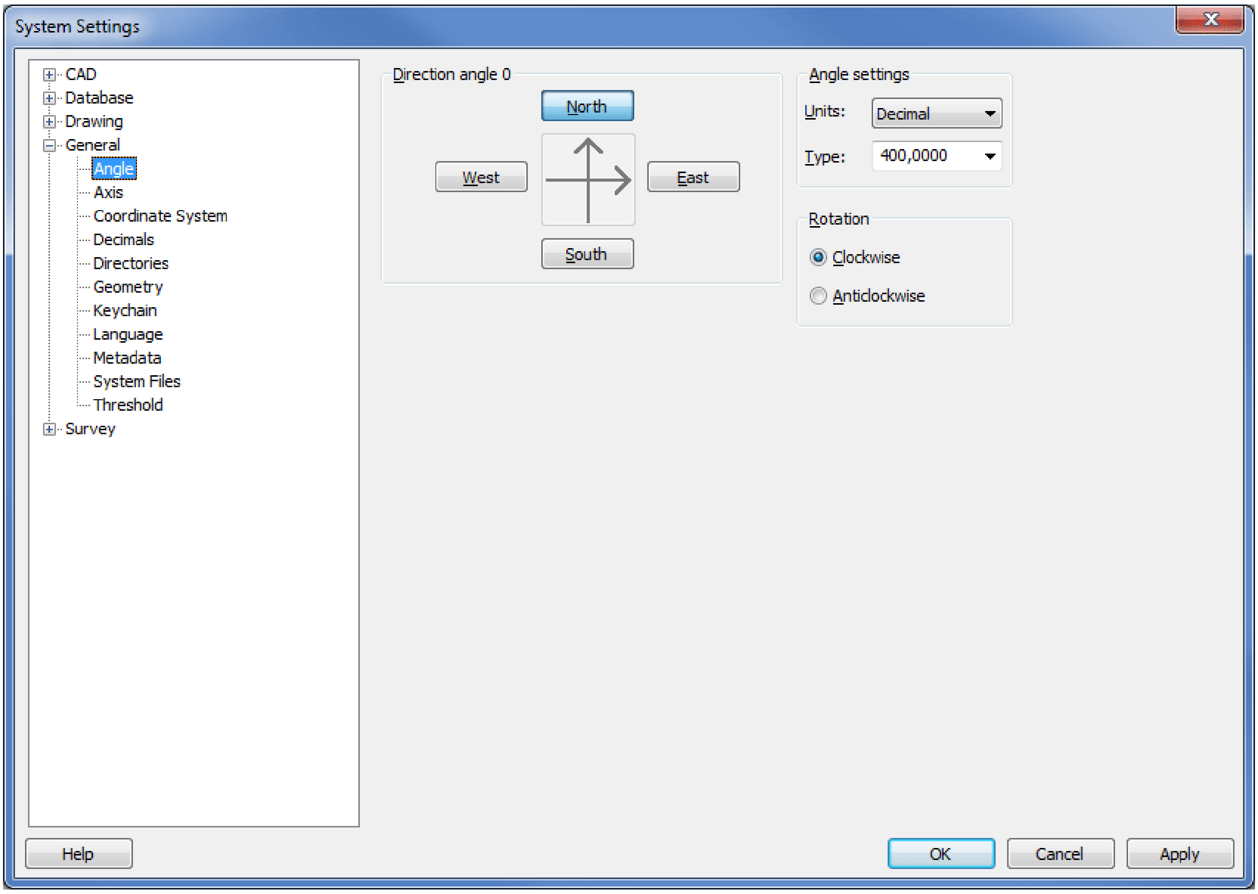
Only available WMS-T. Look at the map at a certain time, for example a weather forecast.

Angles

Home|System settings

It is possible to use any kind of angle system in Topocad. Select 360 degrees, 400 GONS or 6.28 mills. Select which angle you want to identify as 0 and the direction of rotation that will increase the angle values.

Settings for angles



Direction angle
Select the direction you want to set as 0 using the mouse or on the relevant tab.

Angle settings
Select 400 GON, 6.28 Mills (radians) or 360 degrees.

Rotation
Select whether it should be clockwise or anticlockwise.

These settings do not affect stored data.

See also

Settings menu

Axis

Home|System settings

Enter the names of the axis you want to use.

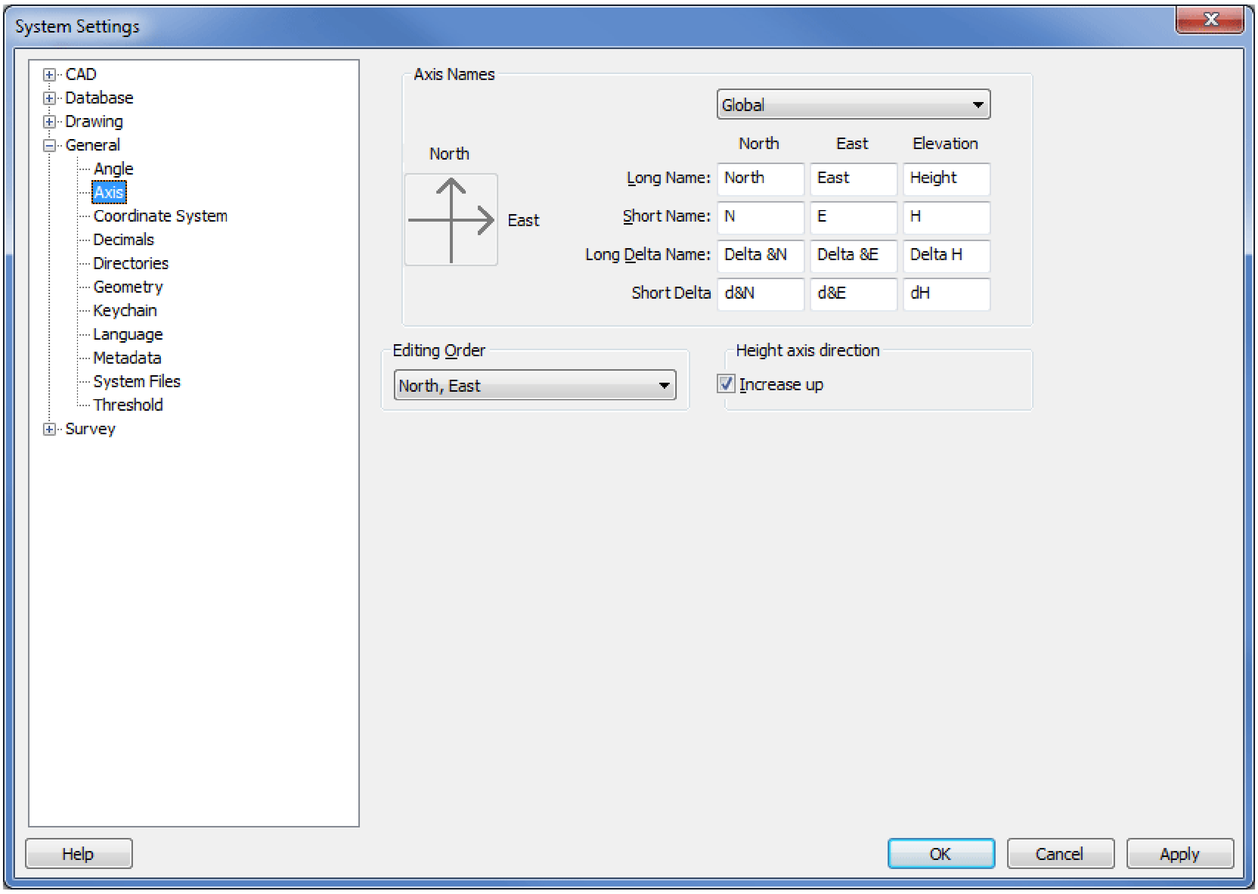
Axis Names

Select Global or UCS.

Long name/Short name
Different words will appear in the application and print settings. Enter the names you want to use as the long and short names respectively.

Editing order
Select the order for editing. This can be changed whenever required.

Height axis direction
Select whether you want to increase the height upwards or downwards. The height will increase downwards in mines and when measuring seas and lakes.



See also

Settings menu.

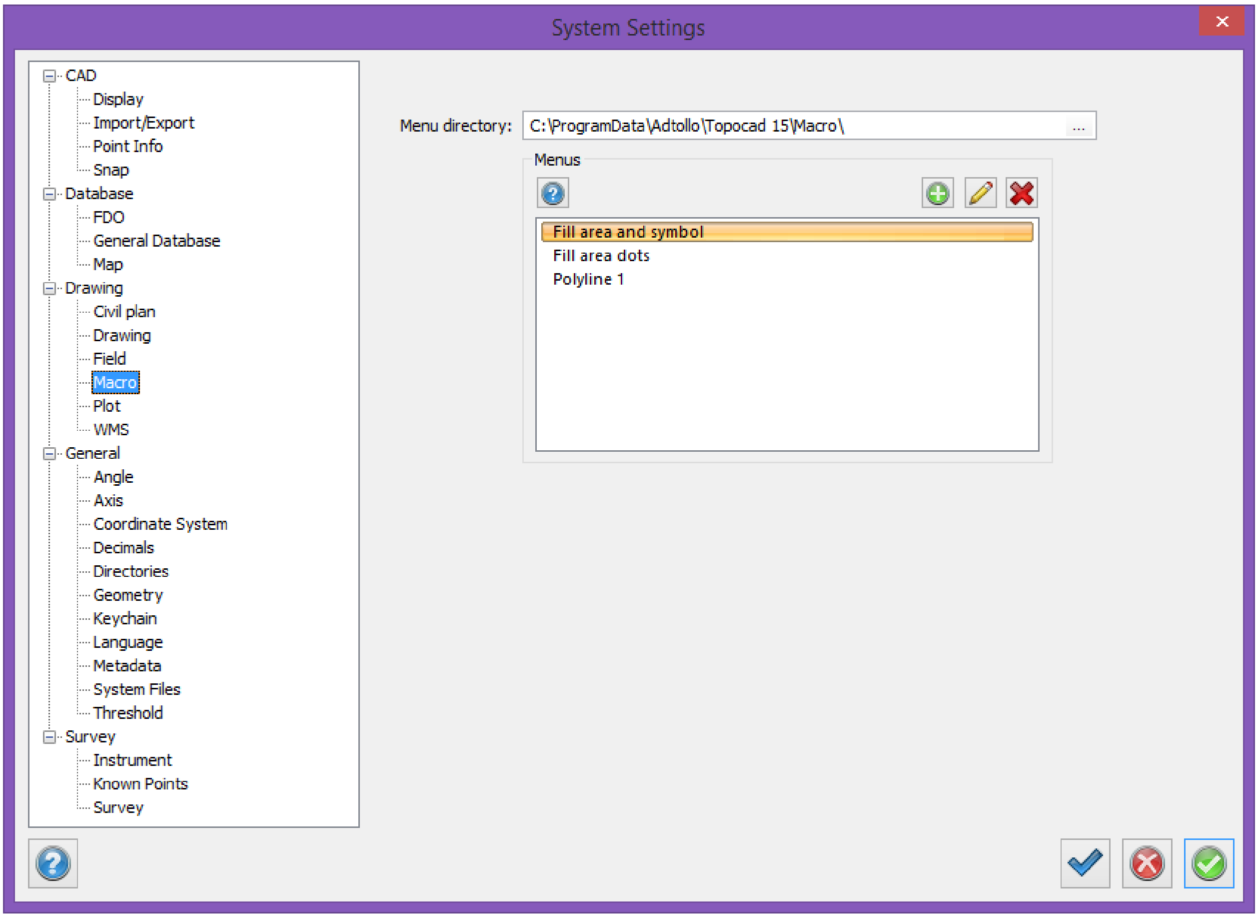
Macros

Home|System settings - Macros

Create/Edit macros

With the macro module you easily build own macro functions from some of Topocads commands. The available commands/macro types in the marco module are create point, polyline, symbol and text as well as change and copy properties. There is also a separator to add.

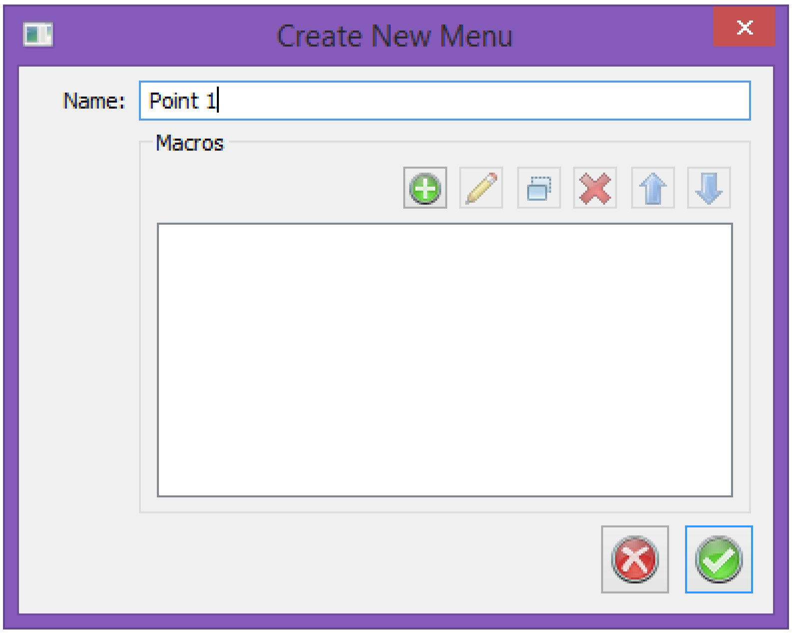
The macro helps to give the object and/or the layer the right properties and attributes.



Menu directory
Select the path for the folder where the XML files are or will be created.
Menus
Names of the menus (XML files) found in the map. Several manus can be created and it is possible to switch between them directly in the toolbox for macros.
The macros are saved in an XML file that can be shared by others by adding it on a network with access from other users. You can also copy and send the file to others. The macro module demands Topocad Engineer or Topocad base module.

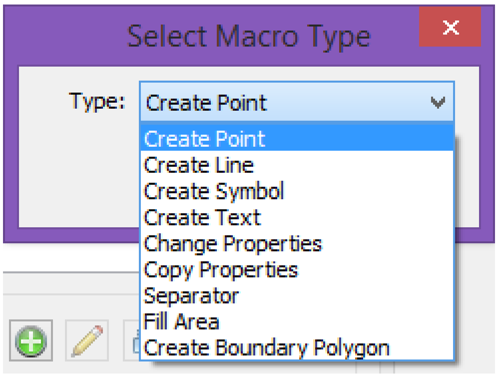
Create a new menu

Select New to create a new menu.



Add a name for the menu. If you click OK, the XML file will be created, but it is also possible to add the macros now in this menu and then click OK.

To create a macro in the menu click Add.



Select the type of macro you want to create. Available types are Point, Line, Symbol, Text, Change properties, Copy properties, Separator, Fill area and Boundary Polygon.

Create Point

Select name of macro, for example Create border point. This macro will use the command Create Point.

Layer: Settings for the layer. If the layer name already exist in the drawing, the layer of the drawing will be applied.

Object: Settings for the color, line type and line width of the object.

Line: Settings for point id, point code and if the line shall be closed. If it is a Closed line select fill style and fill color.

Attribute: Settings to define which attributes the object will have.

Hide command dialog: If checked, the command dialog will not be displayed when the macro runs. The dialogue can be activated in the macro by shortcut Q.

Create Line

Create Symbol

Settings for name of macro, for example Create Border Point, Symbol. This macro uses the command

Insert symbol.

Layer: Settings for the layer when it is created, if the layer name is already in the drawing, the layer of the drawing will be applied.

Object: Settings for the preferences of the object, such as color, line type and line width.

Symbol: Select which symbol that shall be used and rotation and scale. It is also possible to add settings for point id and point code for symbols.

Note! If you have selected a point code that has a symbol connected, it wont be displayed since the object is already a symbol and thereby have higher priority.

Attribute: Define which attributes the object will have.

Hide command dialog. If checked, the command dialog will not be displayed when the macro runs. The dialogue can be activated in the macro by shortcut Q.

Create Text

Settings for name of macro, for example Create Text. This macro is using Insert Text.

Layer: Settings for the layer when it is created, if the layer name is already in the drawing, the layer of the drawing will be applied.

Object: Settings for the preferences of the object, such as color, line type and line width.

Text: Settings for height, width scale, font and justify.

Attribute: Attribute: Define which attributes the object will have.

Hide command dialog. Not optional for this macro.

Change Properties

Settings for which name the macro shall have, for example Change to property border. This macro uses the command Modify Move.

Layer: Settings for the layer when it is created, if the layer name is already in the drawing, the layer of the drawing will be applied.

Object: Settings for the preferences of the object, such as color, line type and line width.

Hide command dialog. If checked, the command dialog will not be displayed when the macro runs. The dialogue can be activated in the macro by shortcut Q.

Copy Properties

Settings for which name the macro shall have, for example Copy to property border. This macro uses the command Create Copy.

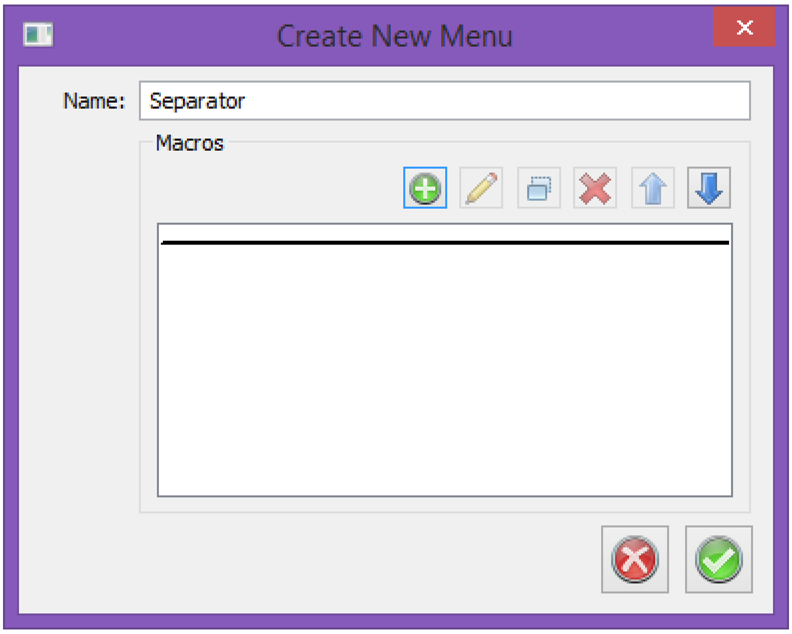
Layer: Settings for the layer when it is created, if the layer name is already in the drawing, the layer of the drawing will be applied.

Object: Settings for the preferences of the object, such as color, line type and line width.

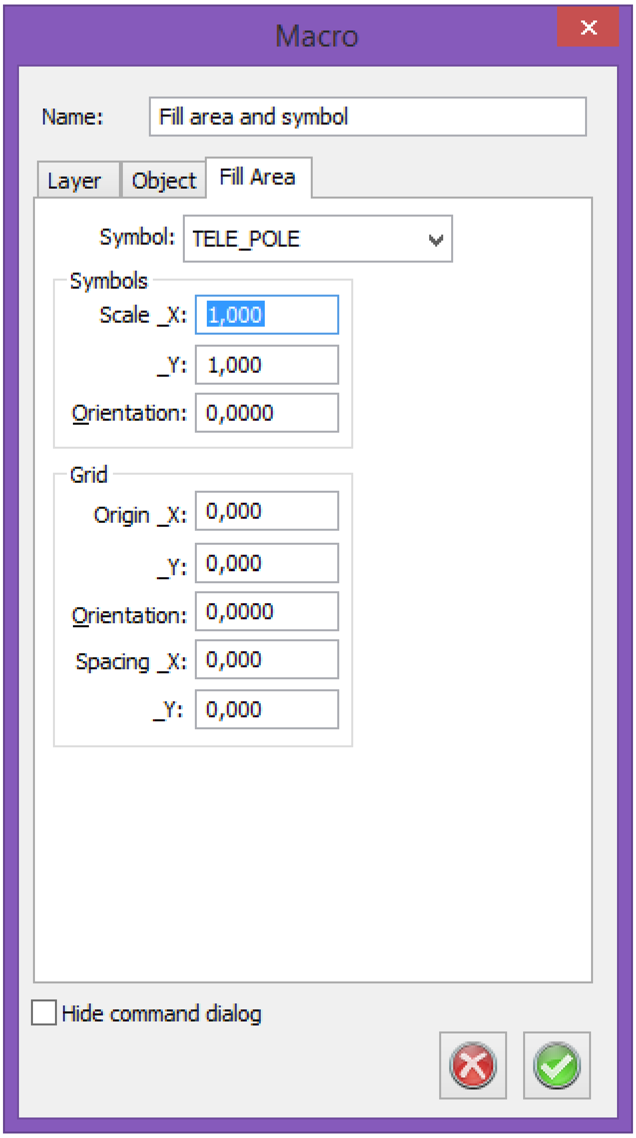
Hide command dialog. If checked, the command dialog will not be displayed when the macro runs. The dialogue can be activated in the macro by shortcut Q.

Separator

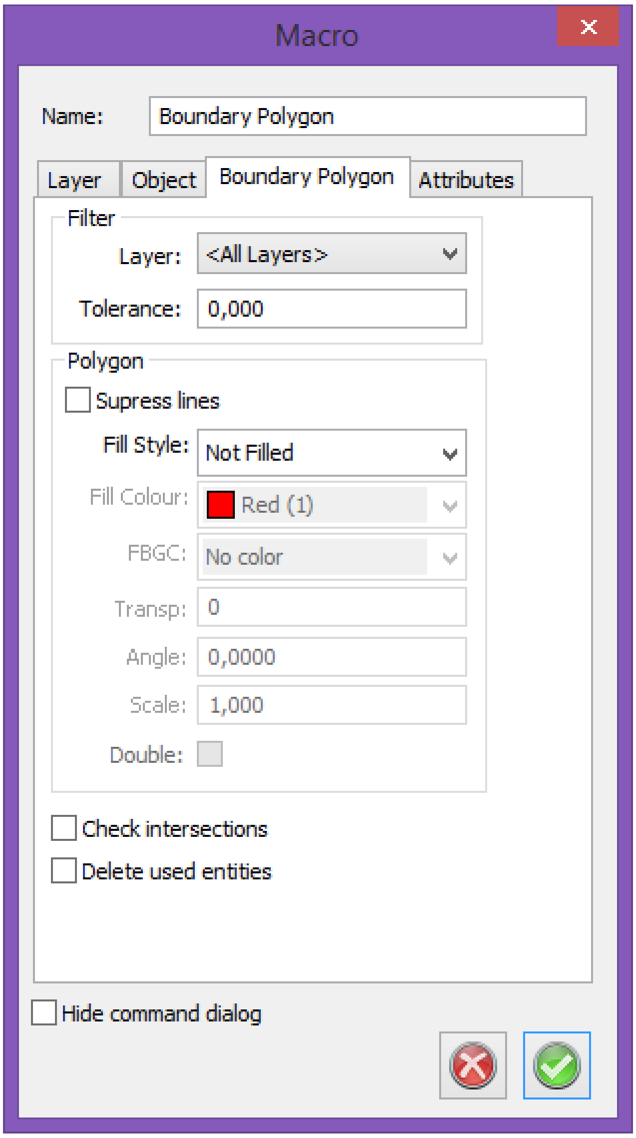
This macro type creates a broken line, a separator, in the menu.


Create New Menu
Name:
Separator
Macros

Fill area


Macro
Name:
Fill area and symbol
Layer
Object
Fill Area
Symbol:
TELE_POLE
Symbols
Scale _X:
1,000
_Y:
1,000
Orientation:
0,0000
Grid
Origin _X:
0,000
_Y:
0,000
Orientation:
0,0000
Spacing _X:
0,000
_Y:
0,000
Hide command dialog

Create Boundary Polygon



Read more

Use macros

Coordinate System

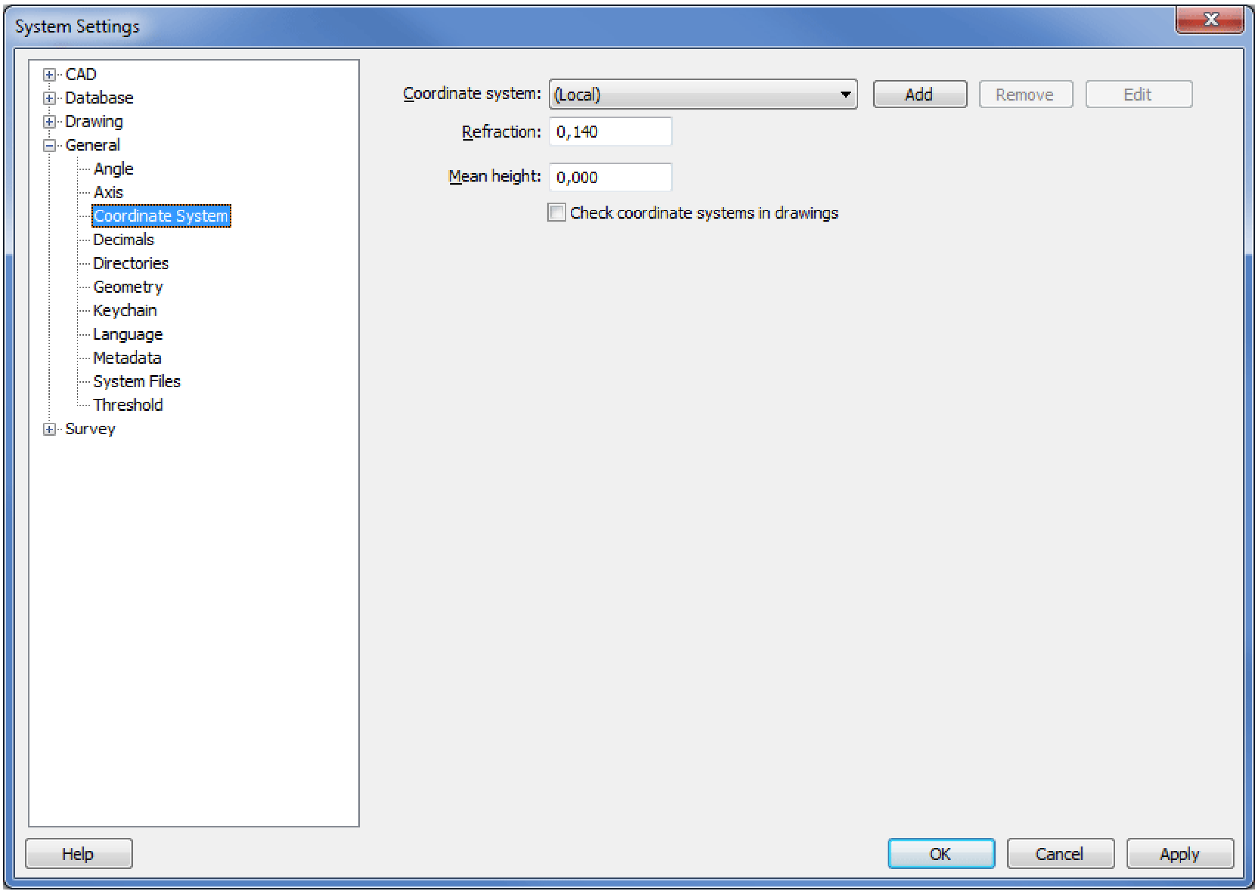
Home|System settings

Settings for the coordinate system to be used in this project. Refraction and mean height.

You can use the mean height if you want to compensate for heights but do not know the actual height. Entering a height here will cause Topocad to compensate for this height in length calculations.

Ellipsoid correction can be used if selected.

Coordinate systems can be added. Enter a name, origin for X and Y (North and East), ellipsoid type and average meridian.



See also

Settings menu.

Decimals & Units

Home|System settings|Decimals & Units

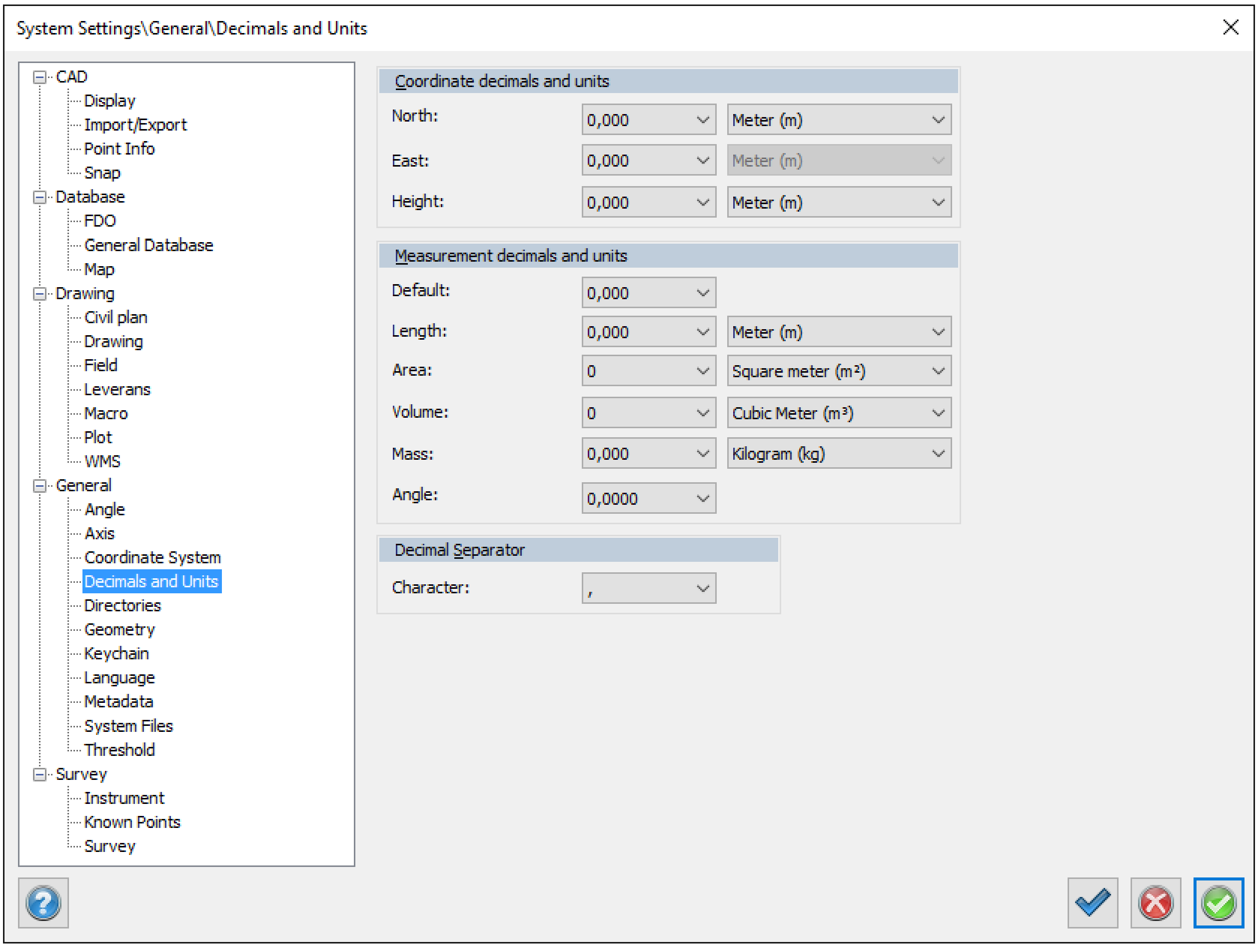
This is where you select the number of decimal places for co-ordinates, heights, lengths and angles. It is also possible to select which character you want to use as the decimal separator.

Coordinate decimals
Select how many decimal places you want to use for coordinates. This has no effect on the accuracy of the calculations. Topocad always calculates using 18 units. Note that X and Y (North and East) follow each other.

Measurement decimals
Select how many decimal places you want to use for lengths and angles. This has no effect on the accuracy of the calculations. Topocad always calculates using 18 units.

Decimal Separator
Select whether you want to use . (point) or , (comma) as the decimal separator. This is important when transferring data to some field collectors or instruments. Check which character is used in your field collector or instrument.

Units
Select which unit you want to use. Standard unit measurement is Mete. You can also select unit for areas (square meter) and volume (cubic meter). Topocad lets you choose the amount; choose between kilogram, tons or pounds.



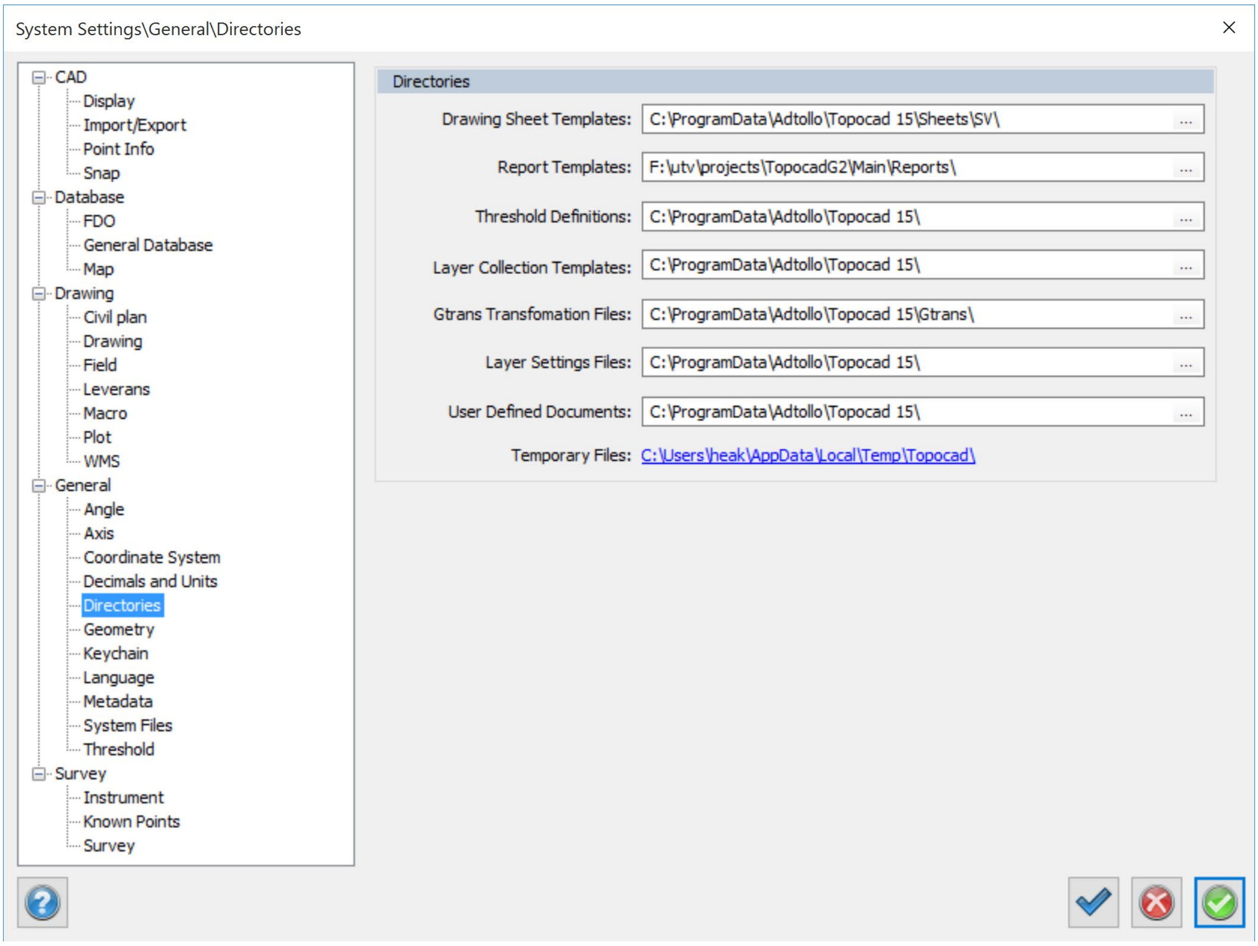
See also

Settings menu.

Directories

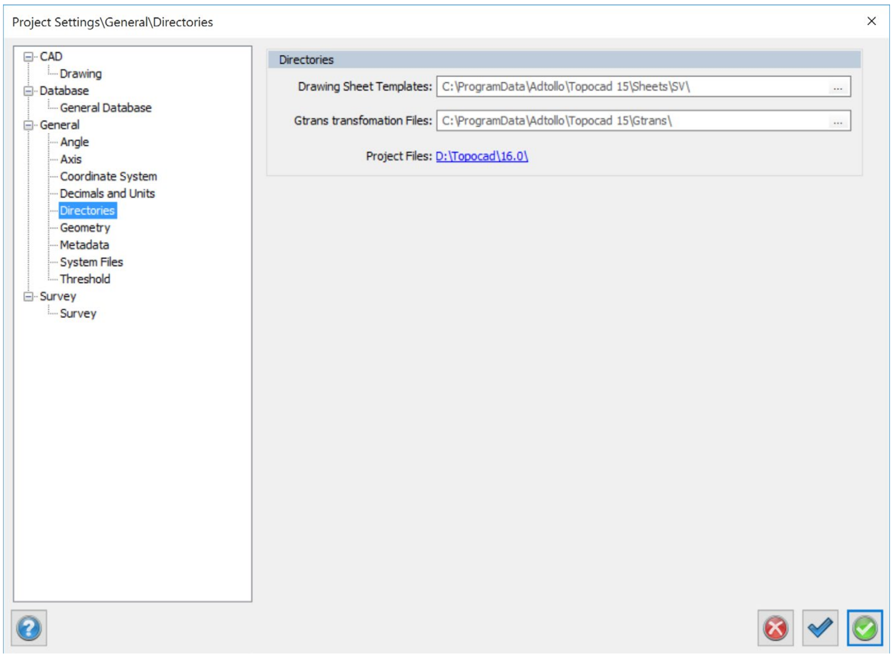
Home|System settings

This is where you select the folder to use for the drawing sheet templates. The templates should be created for a paper size of A1 (841 x 594mm) only.



Drawing Sheet Templates

Select the directory where



you have templates for different drawing sizes, frames.
Default is C: \ WINDOWS \ Adtollo \ Topocad X.0 \ Templates \ Sheets
These templates are the TOP files.

Report Templates
Specify the folder where your templates for reports. These files are RPT files.

Threshold Definitions
Specify the folder where the files for threshold definitions (tolerances) are available. The files have the

extension TTH.

Layer Collection Template
Directory for storage of exported layer collections is added here.
See also Layer collections

Gtrans Transformation files
Select directory for transformation files. The setting is also available in Project settings.

Layer Settings Files
Select directory for layer setting files.

User Defined Documents
Select directory for user defines documents.

Temporary files
Save the files temporary in your system

See also

Insert drawing sheet.

This is where report templates folders are set. The default folder is "C:\Program\Adtollo\Topocad\Reports\"

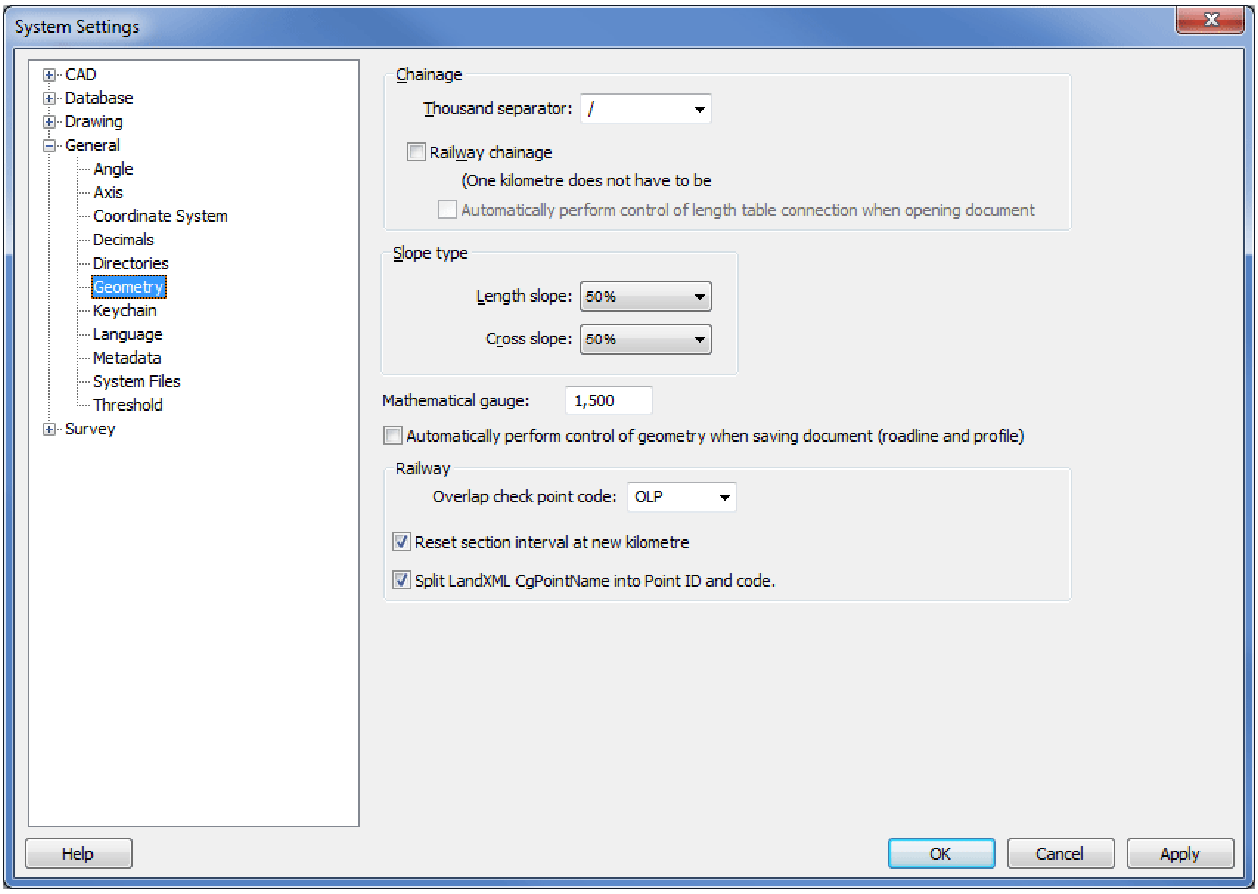
The settings for the folder containing the tolerance files are also made here.

See also

Settings menu.

Geometry

Home|System Settings



Chainage

Thousand separator: Enter the characters you wish to use kilometers as separators. / , , : Or ;

Railway chainage: Mark if you use railway chainage. One kilometer is not always 1000 meters, it can be shorter or longer.

Automatically perform length...: Settings is also available for Control of length table is to be connected to the geometries (roadlines and profile).

Slope type

Length slope: Enter the character you wish to use for the profile slope.

Cross slope: Enter the character you wish to use for cross slope . % Percent or parts per thousand.

Select Mathematical gauge.

Automatic perform control...
Checking the geometry of alignments and road profiles when saving the document.

Railway

Overlap check point code: Enter the code that defines the overlap check point code.

Reset section interval at new kilometre

If the railway sections are used, ie when one kilometer doesn't need to be 1000 meters, you can specify to reset the section interval at each new kilometer.
This gives the effect that, for example, profile form, sectional divisions in the plane calculation, section calculations etc, will get even numbers on the sections. However, the last section for each mile can be shorter than the specified interval.

Example:

We will print out sections along the line for each 50 m interval. The first section is 994 m in length according to the length of the table. If we do NOT check this box, the range to always be 50 m and we then get a line on section 1006. If we mark this box, will the last interval before new miles be 44 m instead of 50 m, but line ports on section 1,000.

Split LandXML..

When exporting LandXML to InDesign or Microstation we need this mark .

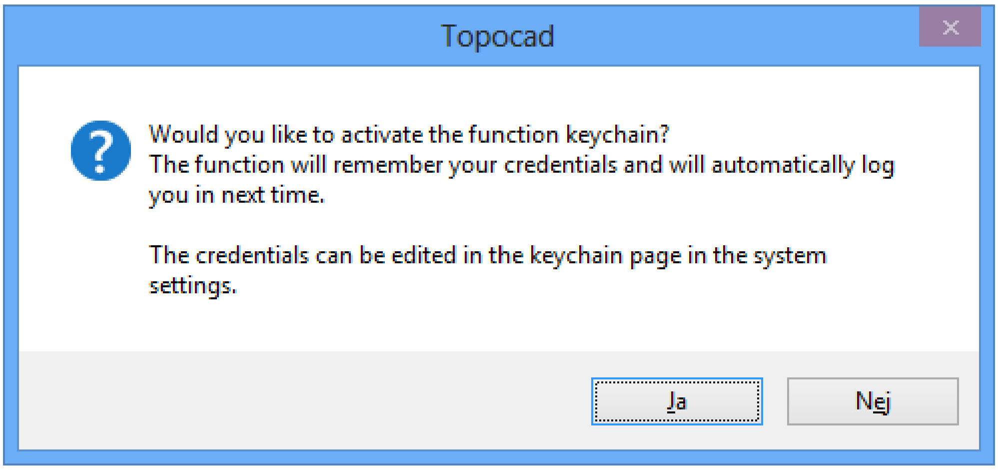
Keychain

Home|System settings

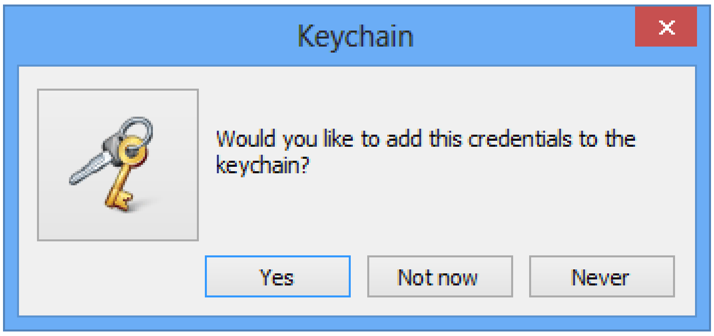
Function to automatic logon to database connections, such TC5D, FDO, ISM.

Select for example open map and a dialogue will appear to enter the login details.

Once you've done and click OK, the following dialog appears:



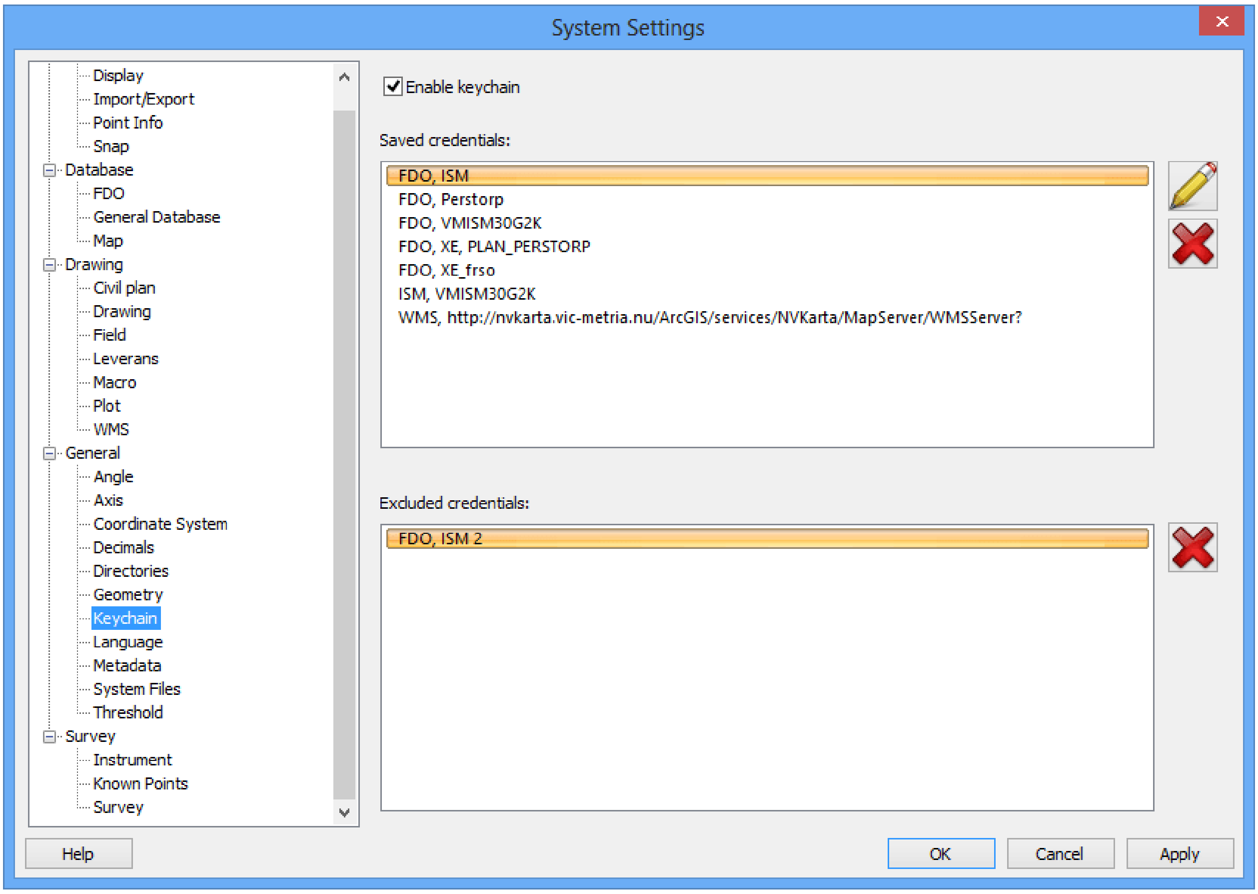
You are asked if you want to activate the keychain. If you select Yes, this login will be automatically in the future.



Click Yes to activate the keychain.

Answer *Not now*, and you will be asked again the next time you login.

If you answer *Never* you will not be asked again, but the settings can be edited in System Settings - Keyring and Saved credentials.



In system settings, you can edit the keychain.

Saved credentials
Mark the connection you want to edit and then click the pen icon. Click on the X icon to delete.

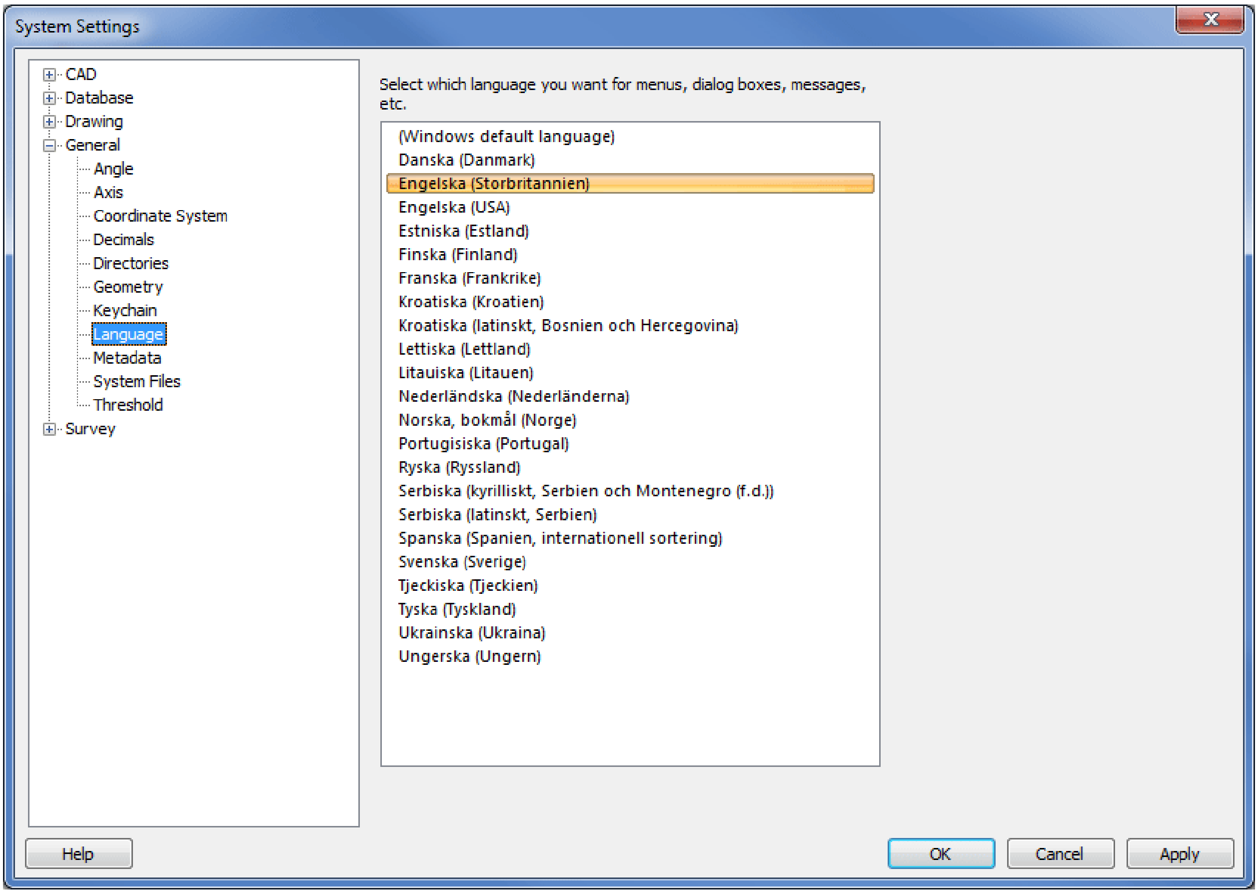
Excluded Credentials
Here are the connections where you have chosen to never use the keychain.
If you delete them, the question for start using the keychain will appear again at login.

Double-click or click the pen to change the data of your login.
It may look a little different depending on database connection.

Language

Home|System settings

The language is set by default based on your settings in Windows. You can change the language here. You will need to restart Topocad after changing this setting for it to take effect.



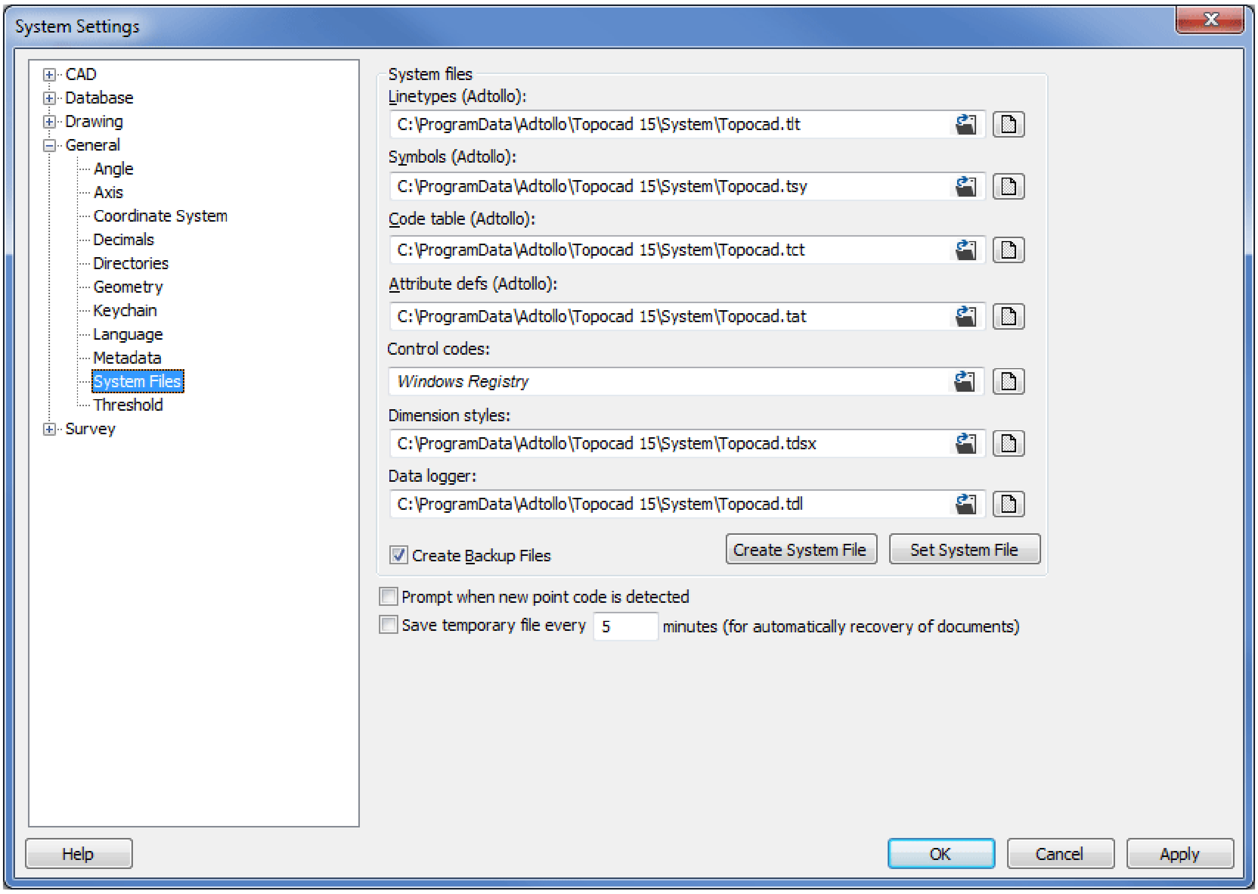
See also

Settings menu.

System files

Home|System settings - System

This is where you can select different symbol files, attribute files, code tables and line type files. Select a different file for each one of the file types.



Control codes
There is a system file which is used for names of control codes. If no system file for control codes is set, the information of control codes be saved in the configuration file of Topocad, called Topocadx.ini.

Dimension Styles
Specifies dimensions style library. You can configure different dimensioning styles and set the style to be current.

Read more in: System|Dimension Style manager.

Data logger
Ability to identify a file for the instrument configuration. The configuration can be done when importing data from Leica and Trimble.
See Leica - configuration and Trimble - Configuration.

Prompt when new point codes is detected
Check box if Topocad shall prompt when new point codes is detected.

Save temporary file
Select if the auto save shall be activated, and how often the file shall be saved.

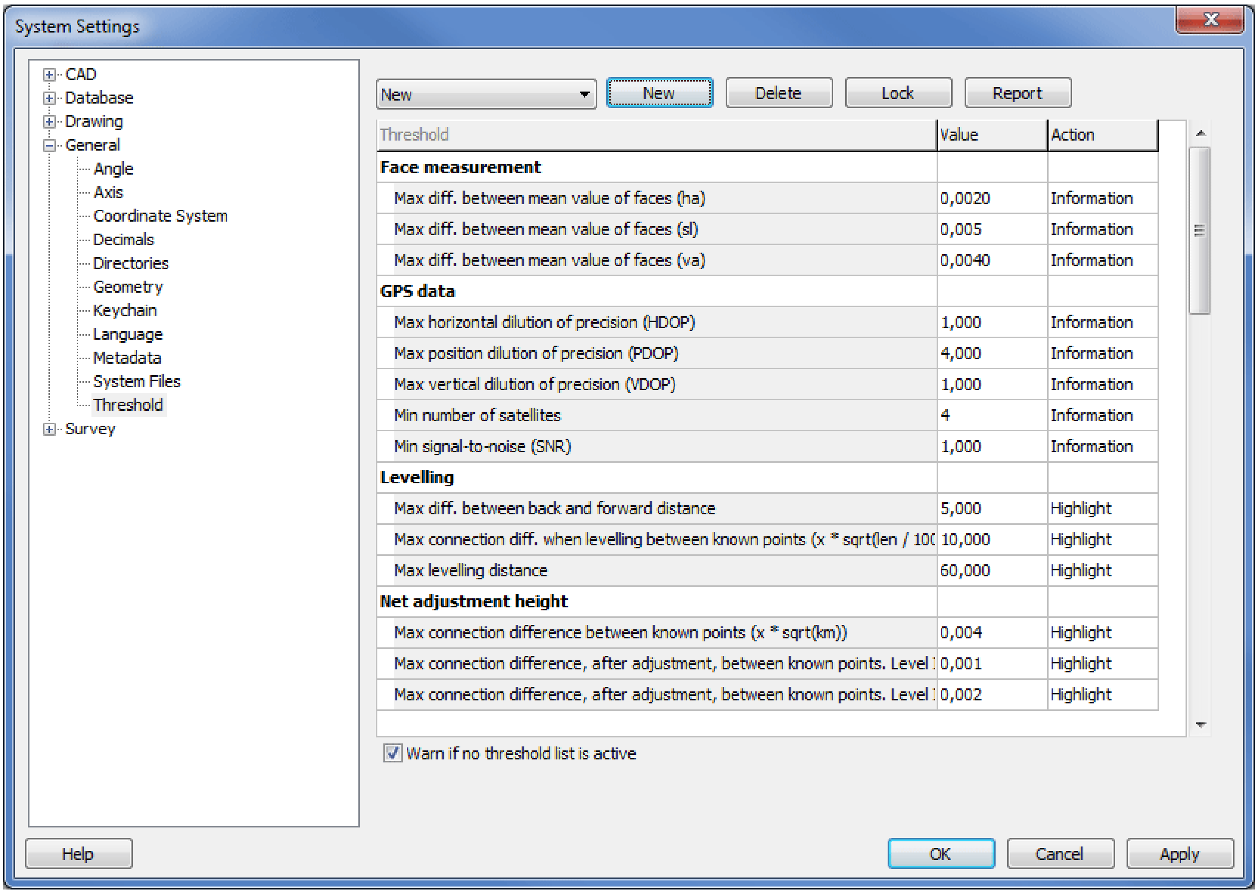
See also:

- Drawing|Symbol
- Drawing|Line type

Threshold

Home|System settings

Different threshold settings can be saved and used. Many different threshold can be set. The threshold files are stored in the settings for folders.



Five different settings can be used for different actions

- No action taken
- **Information** - Shows whether the tolerance or limit value has been exceeded.
- **Mark** - The value is entered in the report, usually in bold.
- **Warning** - Warning note, the calculation will continue
- **Error** - Error message, the calculation has been interrupted

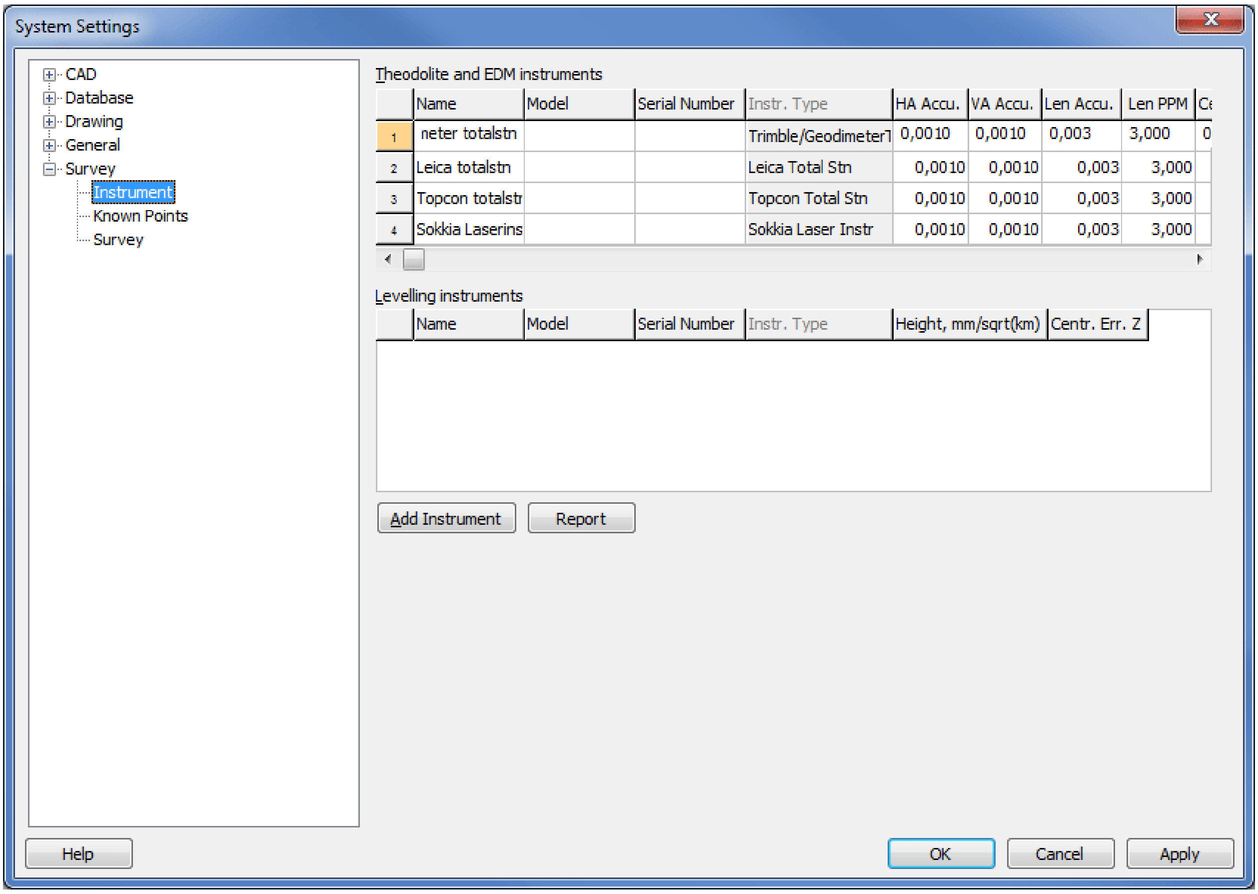
Instrument

Home|System settings

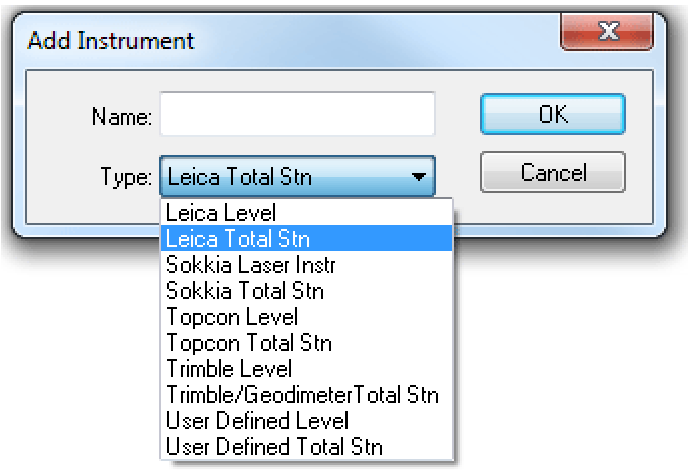
Type in the instrument(s) you are using and the accuracy they have. The settings will be used in survey data calculations and in the Net adjustment.

Corrections

Possible to set default values for the corrections to the survey data for the selected instruments. This is true for Length, Projection, Ellipsoid, Prism constant. If you enter the correct serial number on the instrument, settings will automatically be on your instrument.



Add instrument. Select between several types of instruments from list.



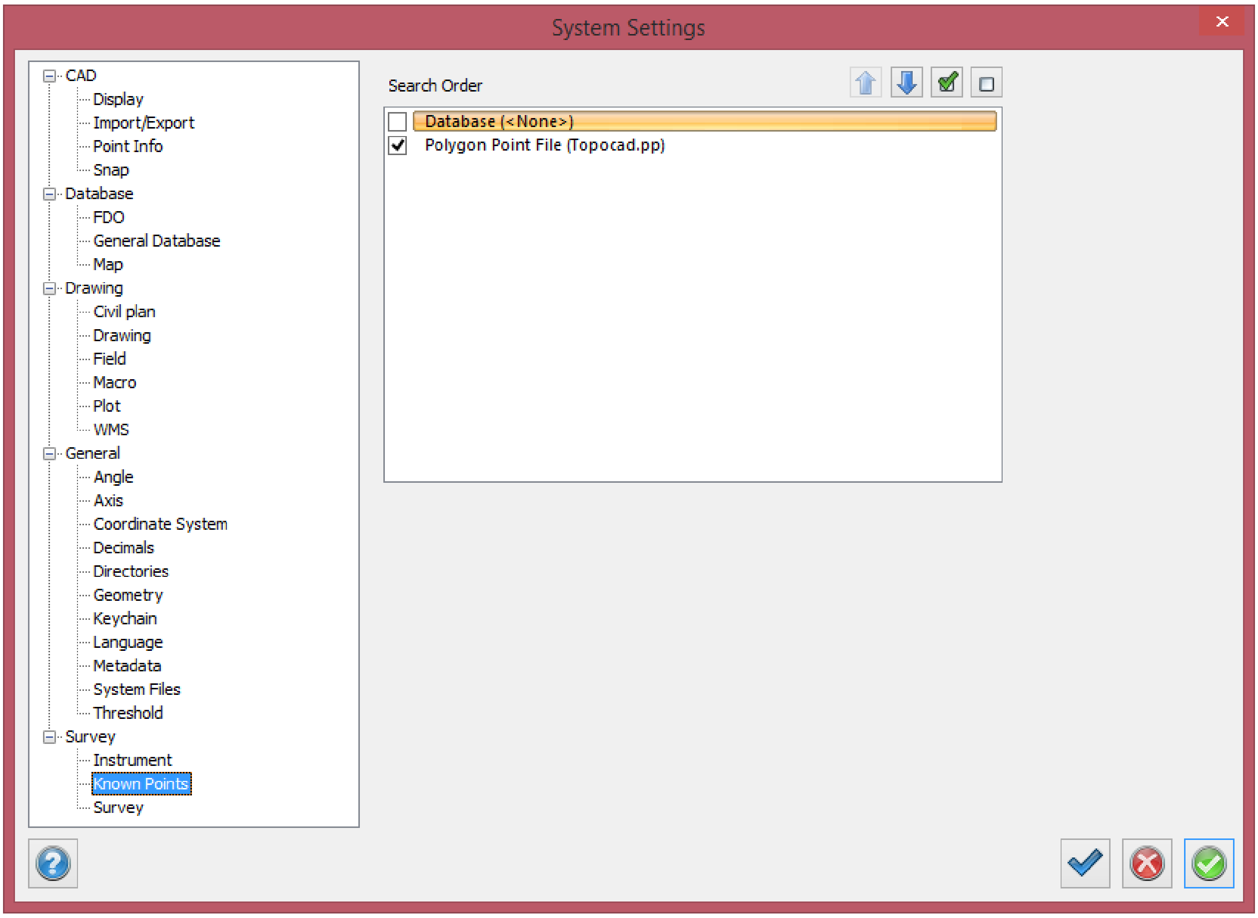
Known points

System settings|Known points

Settings for which file or database known points shall be collected from.

Add/change PP-file at System settings-Survey-Survey (Polygon points).

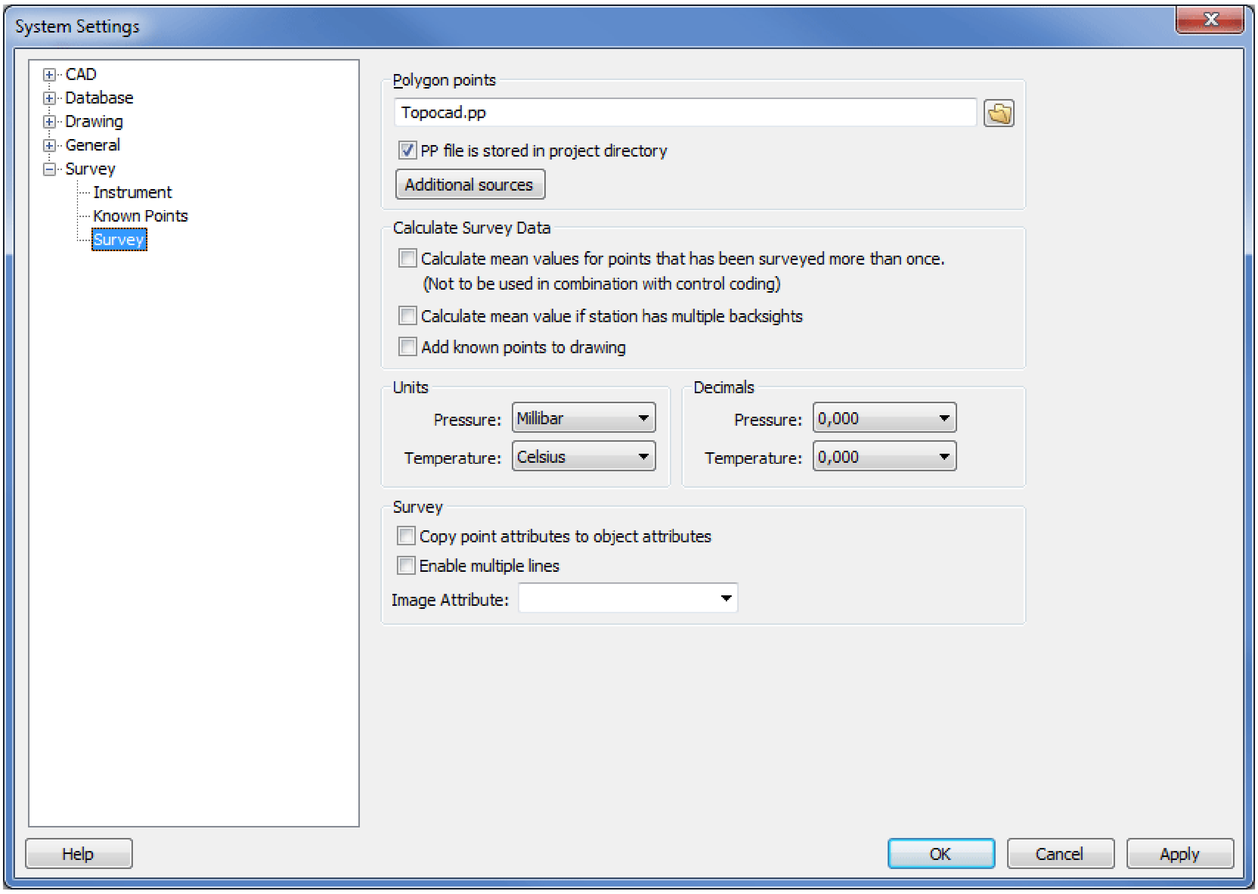
Read more: Collect known points.



Survey

Home|System settings

You can select the name and location for the polygon point file in Survey preferences.



For example, you can use a common polygon point file (.PP) and store it in the Topocad library. However, it is more common to have unique polygon point files for each project. It is important that the existing polygon point file actually has the name that is selected here. If not, the system will be unable to find it and will not be able to calculate a survey data file.

Tip! Make sure that the selected polygon point file name is the one you have used in your survey and that the correct project is selected when you calculate the survey data.

Polygon points
Enter the name of the file in which polygon points (known points) are stored. The default name is **Topocad.PP**.

The PP file should be saved in the project directory:
If it is, select this box. In this case you can give the pp file the same name in every project.

Calculate survey data
Calculate mean values for points measured more than once.
Select this option if required.

Calculate the mean value if there are several backsights on the station
if the station has several backsights a mean value can be calculated.

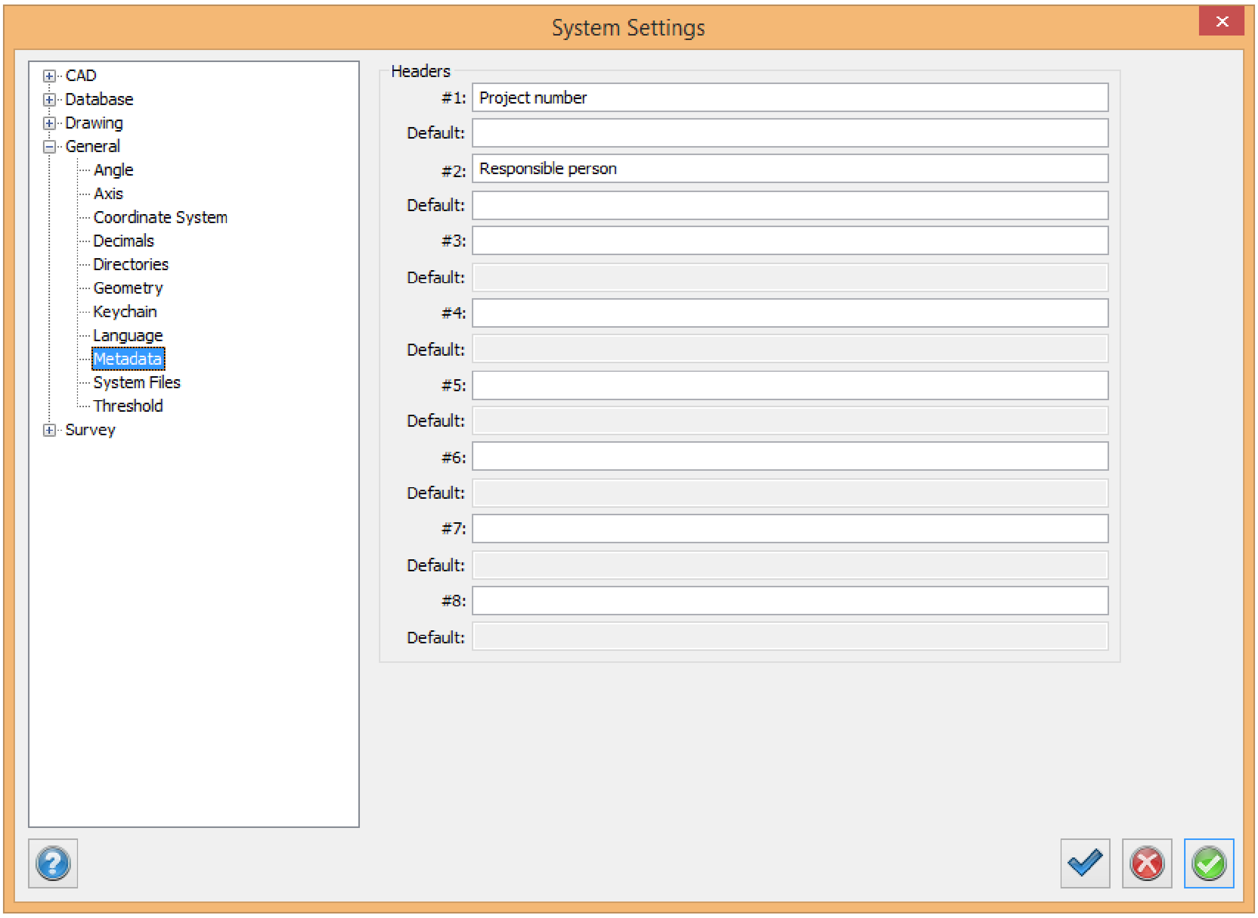
Refer to Select project for more information about the selected project.

Metadata

Home|System settings

Add metadata information for your survey data file.

See also: Metadata in Survey data window.



Survey contents

Survey data
Traverse

Function	Description
Survey data window	Description of the survey data window, the sur file
Survey data calculation	How to calculate survey data
Traverse	Create traverse

Survey data window

Survey data window

Tab	Description
Metadata	Metadata for the survey

Known Coords/Points	Point identified as known points
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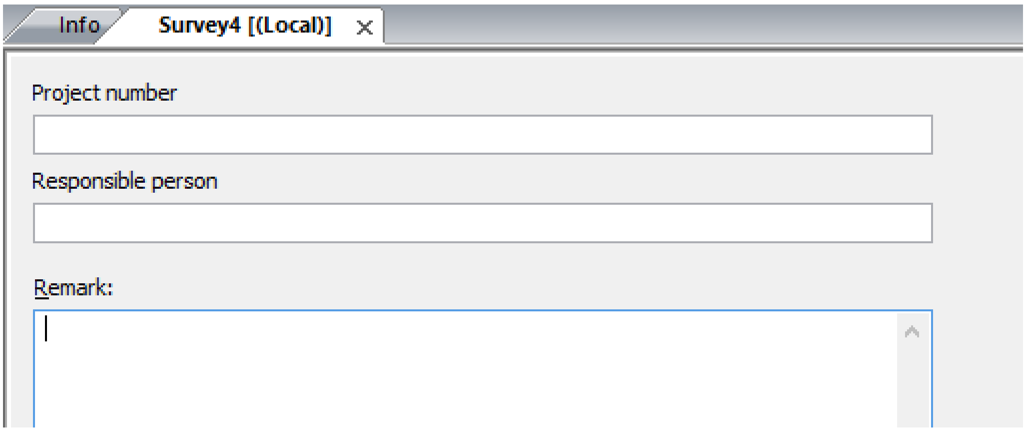
Co-ordinates	Co-ordinate data imported from total stations
Levelling data	Data from levellers
GPS data/observations	Observation data from GPS
GPS co-ordinates	Co-ordinates from GPS
Preview	Preview of data

Metadata

Contains metadata such as administrative data, environmental data and instrument data.

To add headers, go to system settings - metadata.



Known points

Contains points that the software identifies as known points and shall be used as known in the calculation.

Collect
Collect known points from instrument, database or PP file. See also: Settings for Known points.

You can see the origin of all known points and select which ones you want to use.

Survey data

For more information refer to Survey data

Co-ordinates

Co-ordinates can be saved in the field and will be displayed here. These can be used for importing into the drawing.

If you have both survey data and co-ordinates you can select them.
Find out more about point codes and control codes.

Levelling data

Data from levellers is recorded here and can be exported to co-ordinate files (pxy) or known point files (pp).

Field

Start height: The start height that will be used when calculating. When selecting no start height the software system looks among the known points that have been selected during calculation.

End height: The height where the train ends. If the train starts and ends in the same point the start height is used irrespective of the user selected to use the start height.

Columns

Observation type:
Move point - Reads backward and forward.
Detail - Reads only forward, points that are not included in the train.
Distance - Distance to pole.
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Calculation

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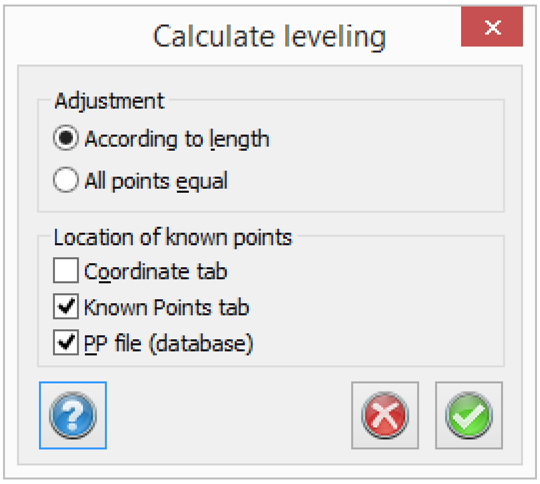
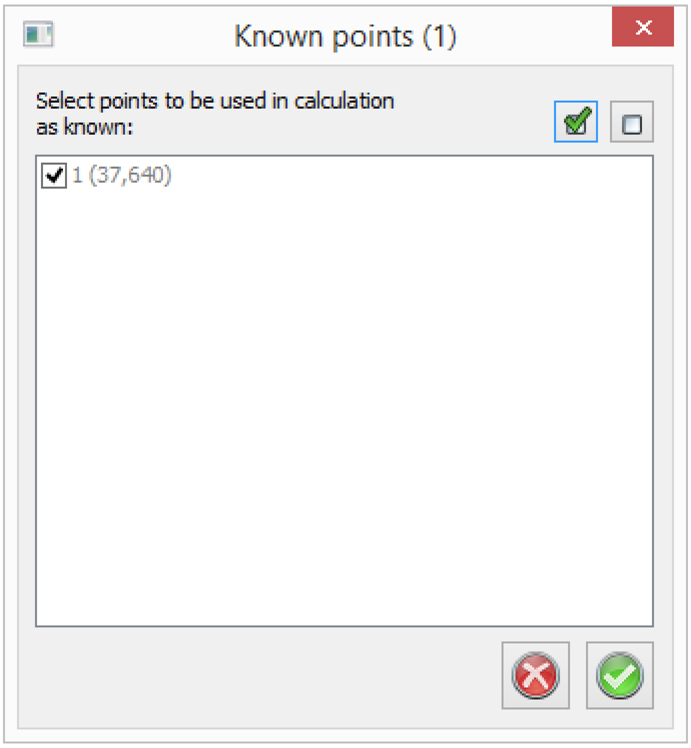
Calculation alternatives



Adjustment can be made with or without weighting and where the software system shall look for known points can be decided. The priority order is coordinate tab and then PP file (also database).

Known points



Known points that was found. The user can select which points that shall be used in calculation.

Calculation result

Under Survey data/Save adjustment result the user get a possibility to save the result to an existing file. Existing points can be updated in height and also new points can be saved.

Possibility to export the result you will find under File/Export/File...

Tip!

When importing twice weighed data the user can select if only the first reading shall be imported, if a mean value calculation shall be made or if a new train shall be created containing the measured data.

GPS data/observations

A survey with a GPS station often stores a base station co-ordinate and delta co-ordinates from the station to measure detailed points. It also stores various attributes that provide more information about the measurement. All attributes are stored. When a calculation is carried out, a transformation is made from the current co-ordinate system to the final co-ordinate system.

GPS co-ordinates

A GPS survey can also save co-ordinates directly. The data saved is the point ID, latitude, longitude, height and point code.

Preview

Allows you to preview the measurements. The preview can use data from various observations. The menu is accessed by right clicking. You can activate or deactivate it for different observations and use the F8 button for recalculations.

Survey data window

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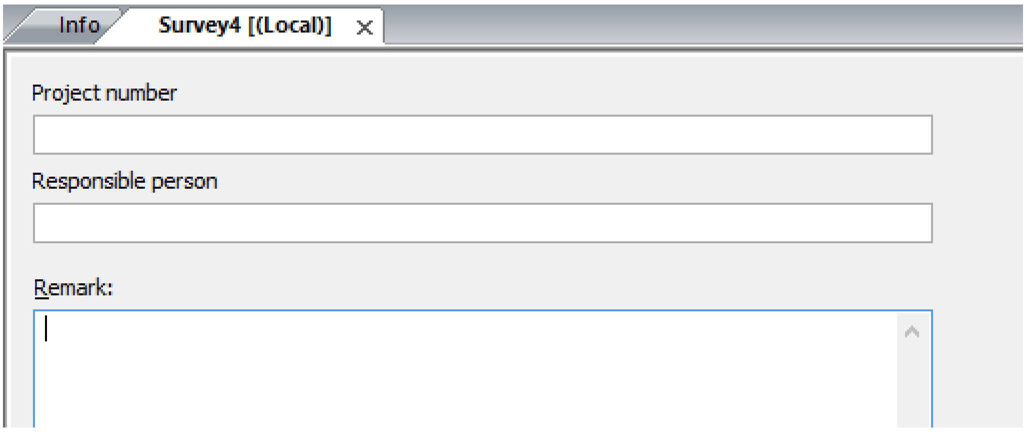

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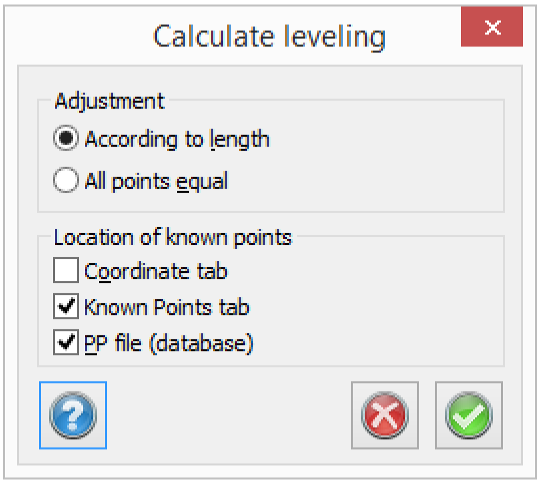

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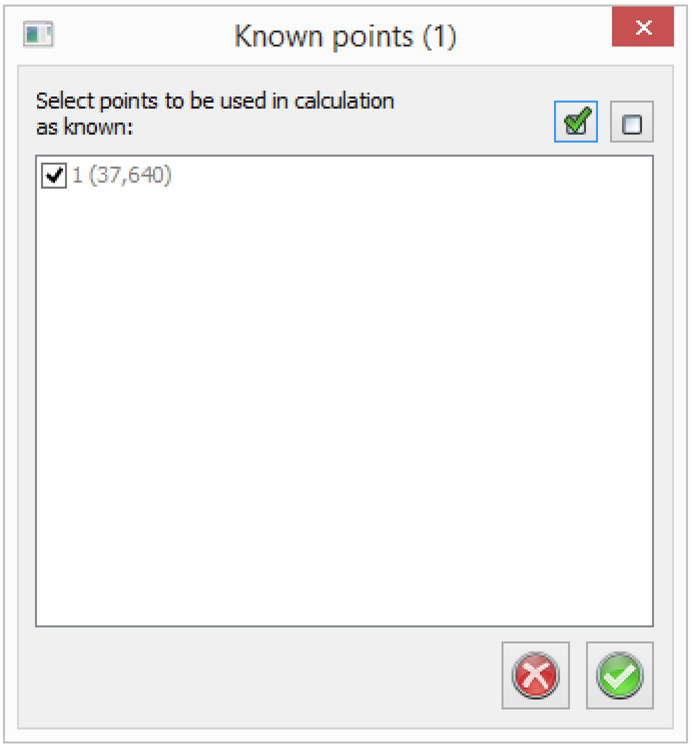

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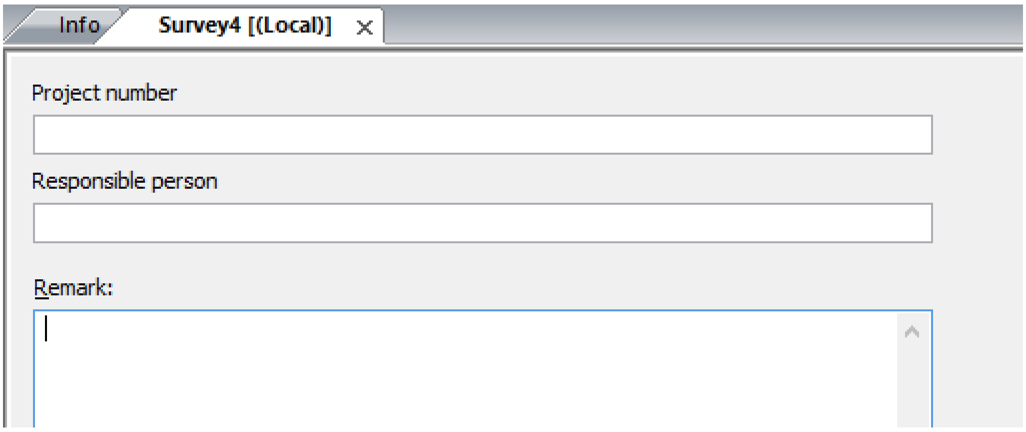

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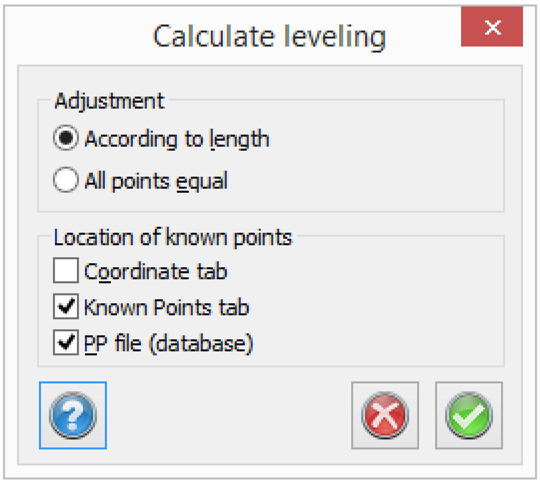

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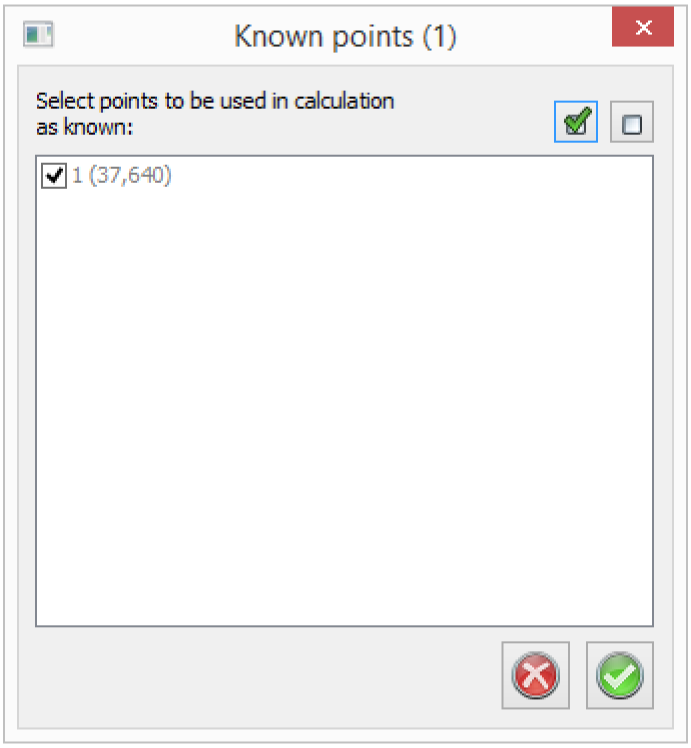

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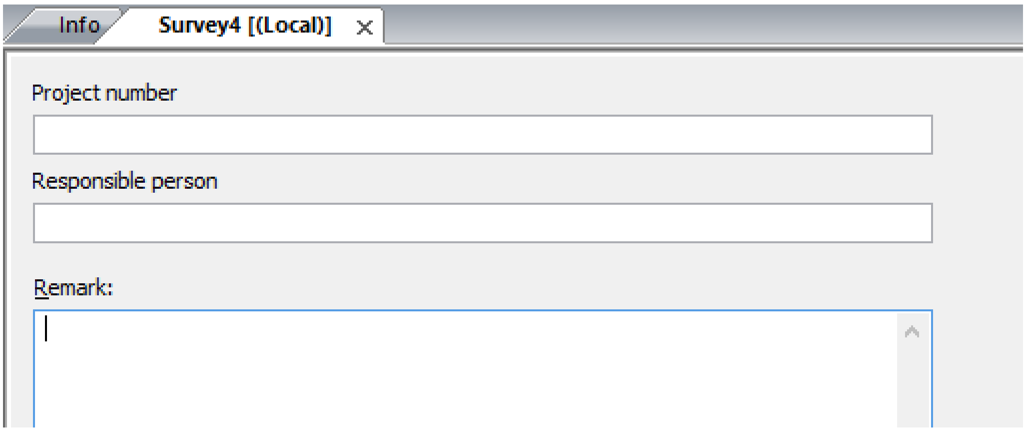

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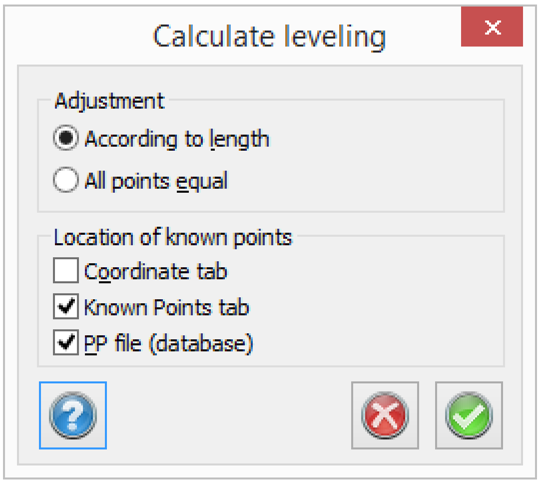

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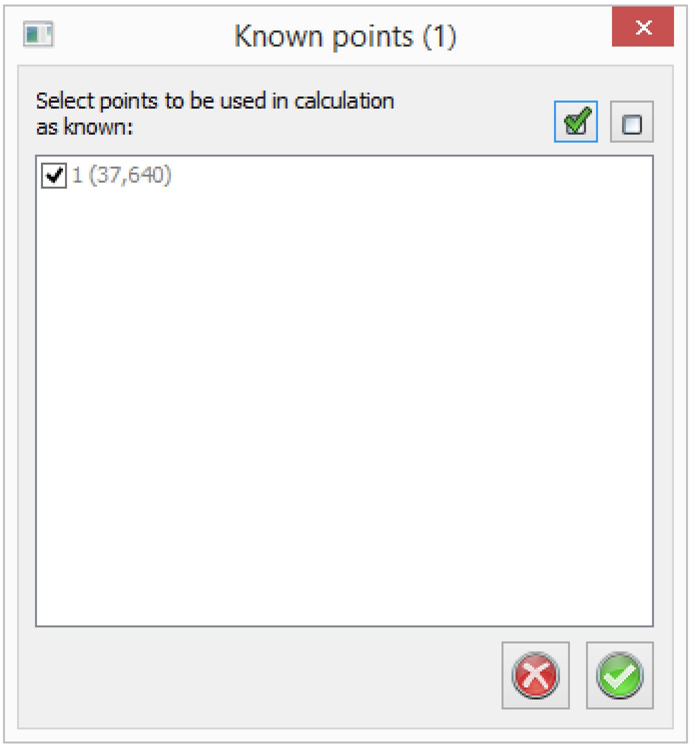

Known points that was found. The user can select which points that shall be used in calculation.

Calculation result

Under Survey data/Save adjustment result the user get a possibility to save the result to an existing file. Existing points can be updated in height and also new points can be saved.

Possibility to export the result you will find under File/Export/File...

Tip!

When importing twice weighed data the user can select if only the first reading shall be imported, if a mean value calculation shall be made or if a new train shall be created containing the measured data.

GPS data/observations

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GPS co-ordinates

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Preview

Allows you to preview the measurements. The preview can use data from various observations. The menu is accessed by right clicking. You can activate or deactivate it for different observations and use the F8 button for recalculations.

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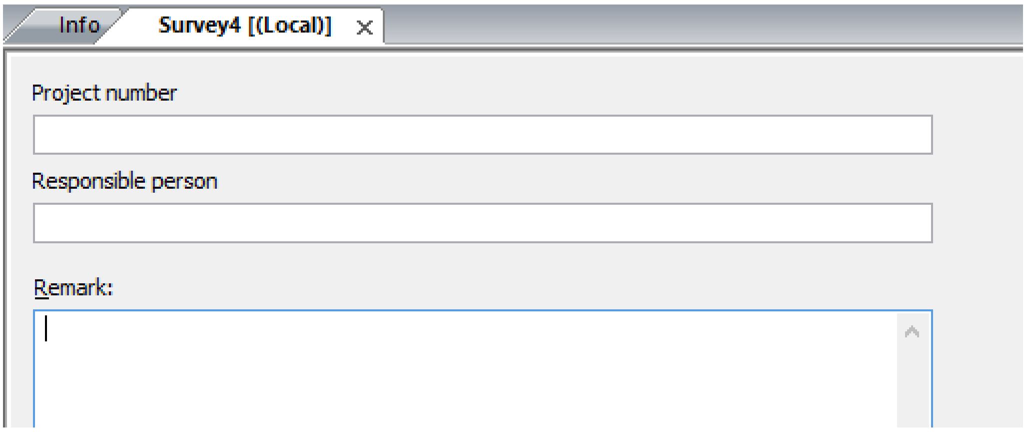

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Survey data

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Columns

Observation type:
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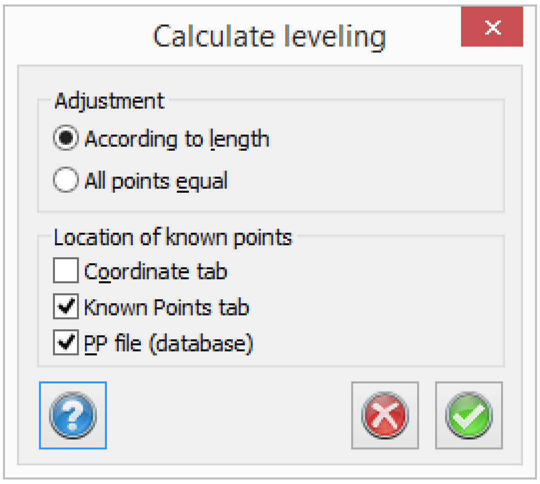

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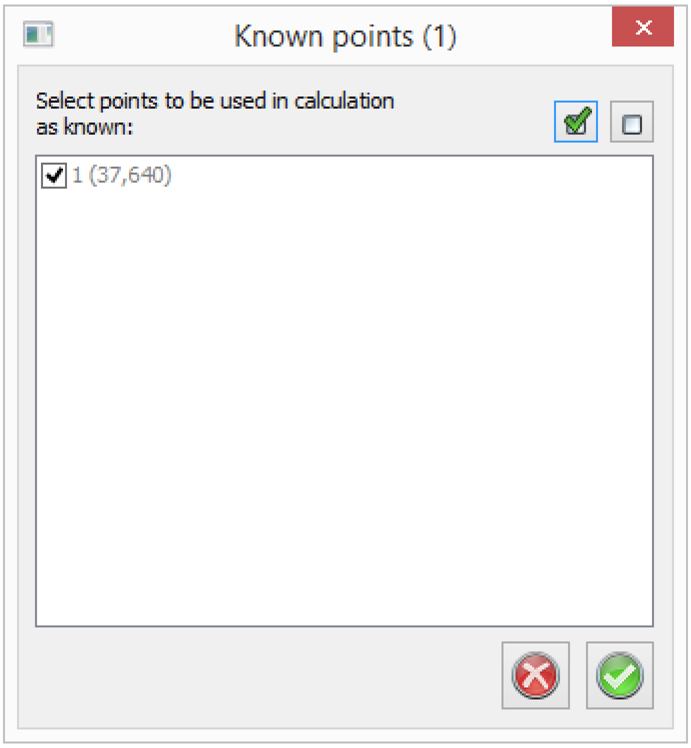

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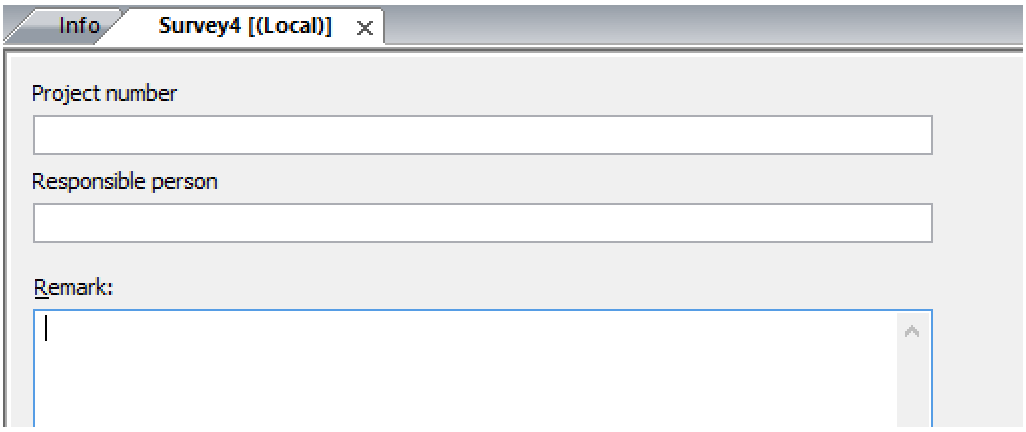

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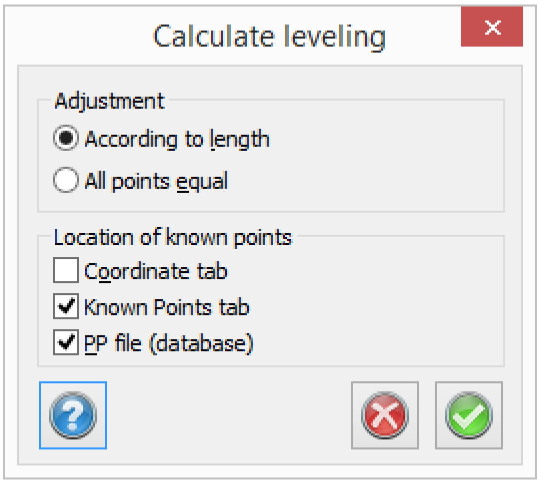

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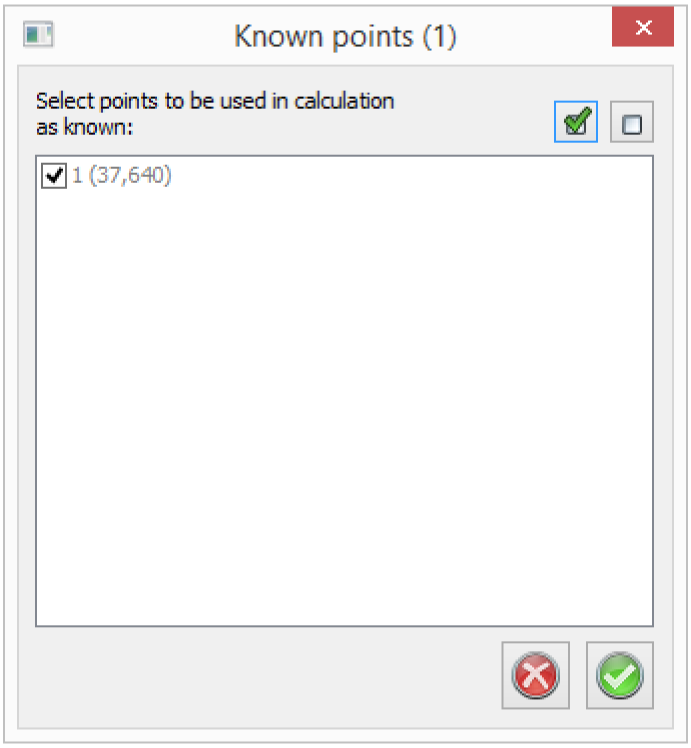

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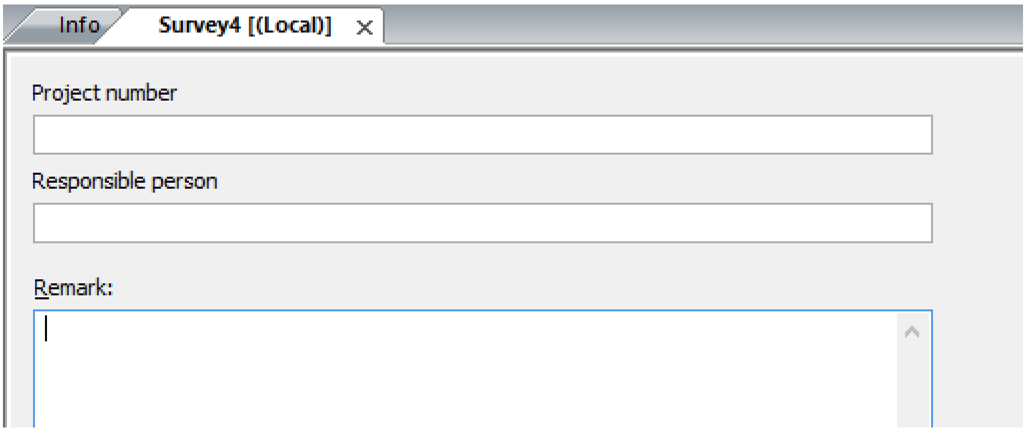

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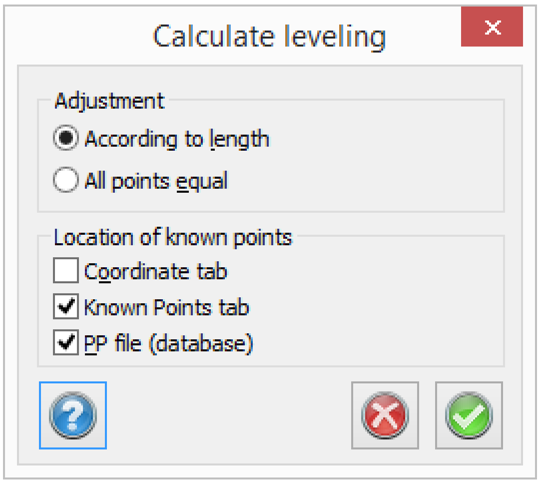

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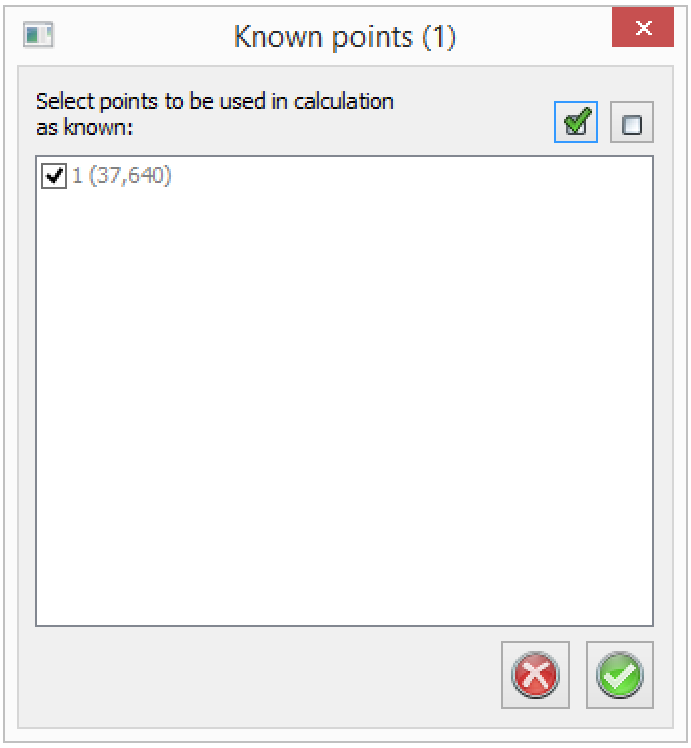

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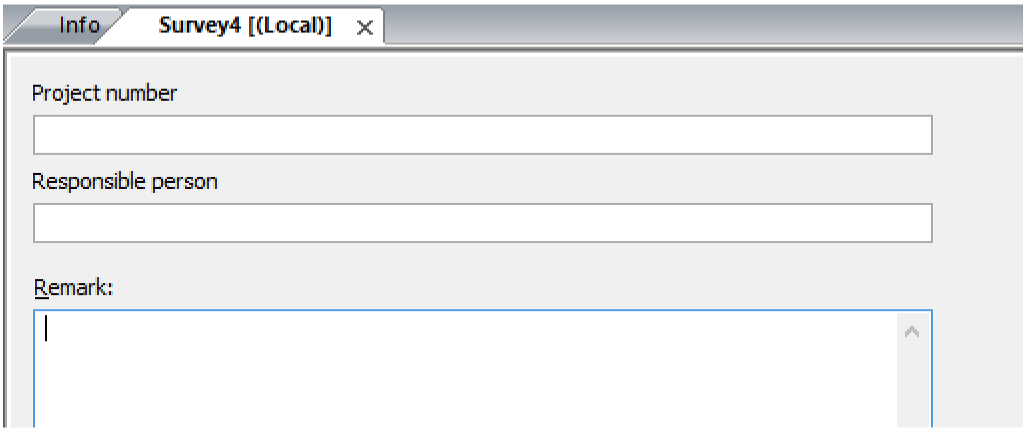

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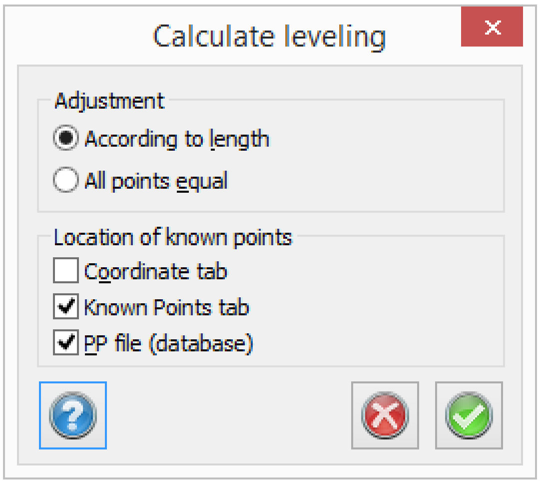

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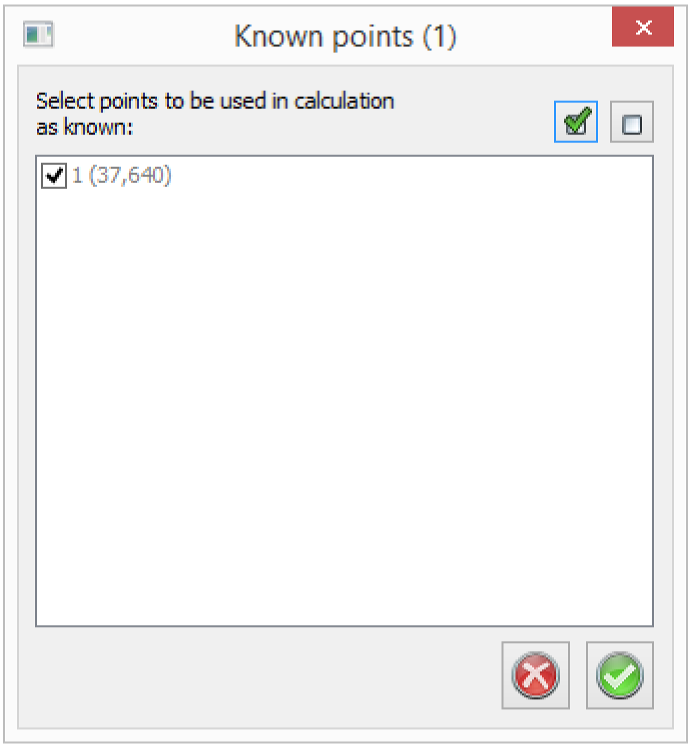

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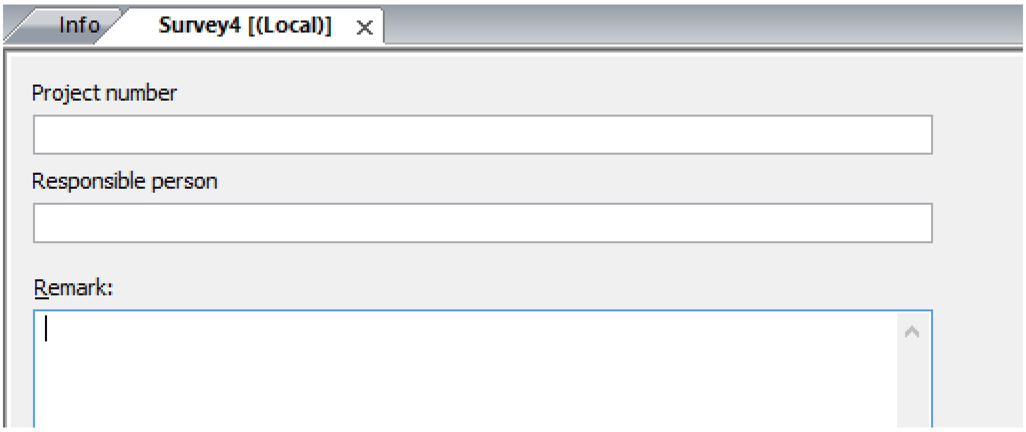

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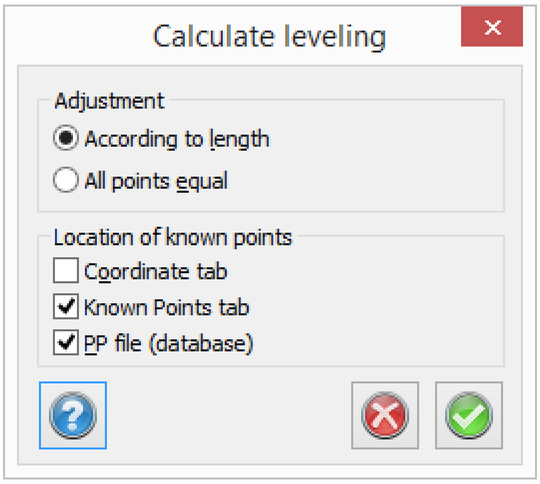

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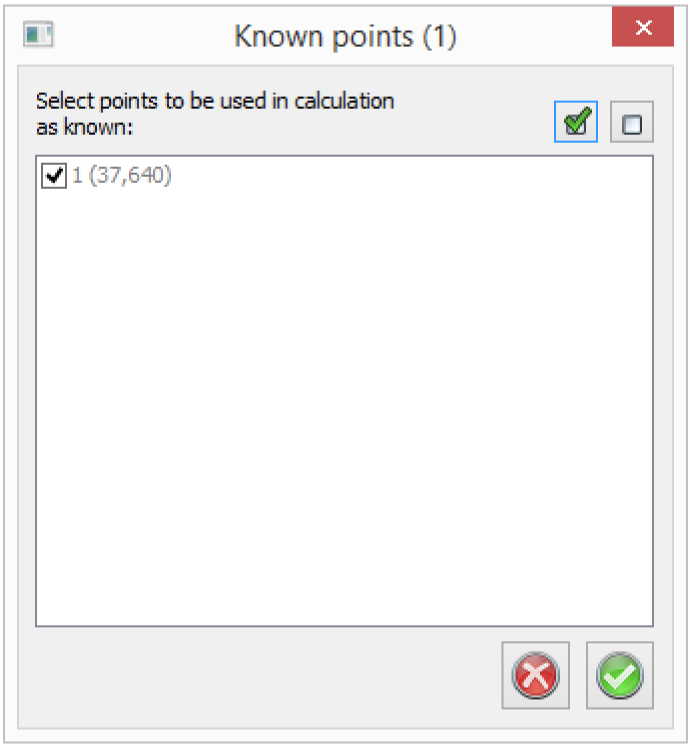

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Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	
Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***

- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined

in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
Specified accuracy for measurement data.

Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

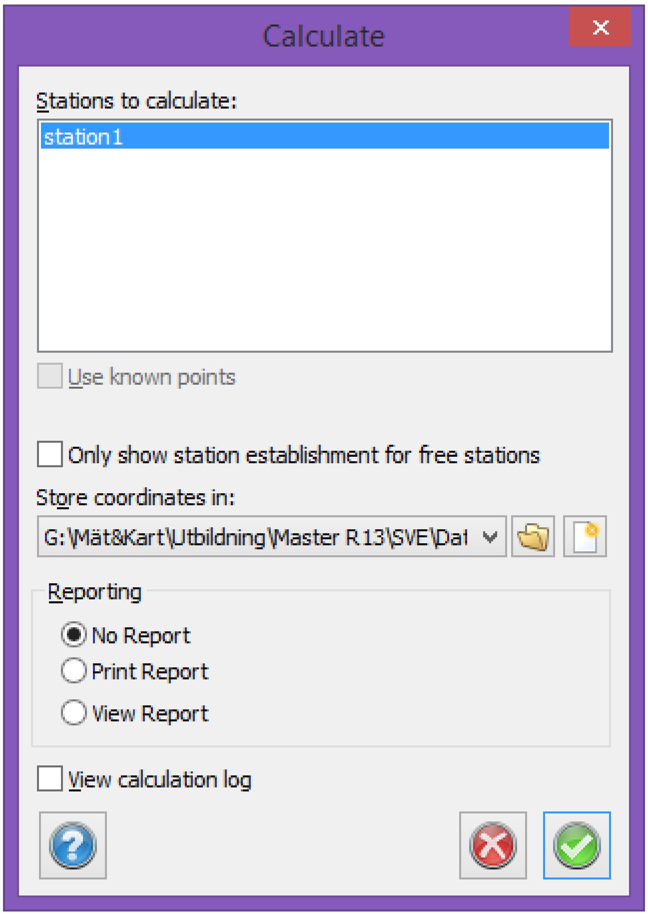
Use this to calculate the survey when you have one or more stations with survey data.

Columns

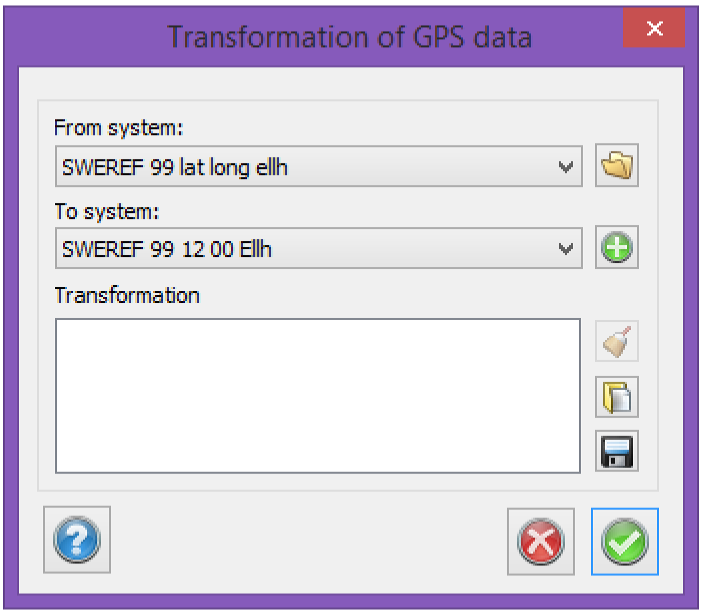
Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
Measured height: Height were calculated by summing the height differences.
Residual: Indicates the improvement added to the measured height after calculation.
Calculated height: Adjusted height.
Pt. Status: Indicates whether the point (forward or reverse) is used as fix at the calculation.
Connection error: Connection error between known points.
Height diff: Differences between read forward and backward.
Length diff: The difference between the lengths forwards and backwards.
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

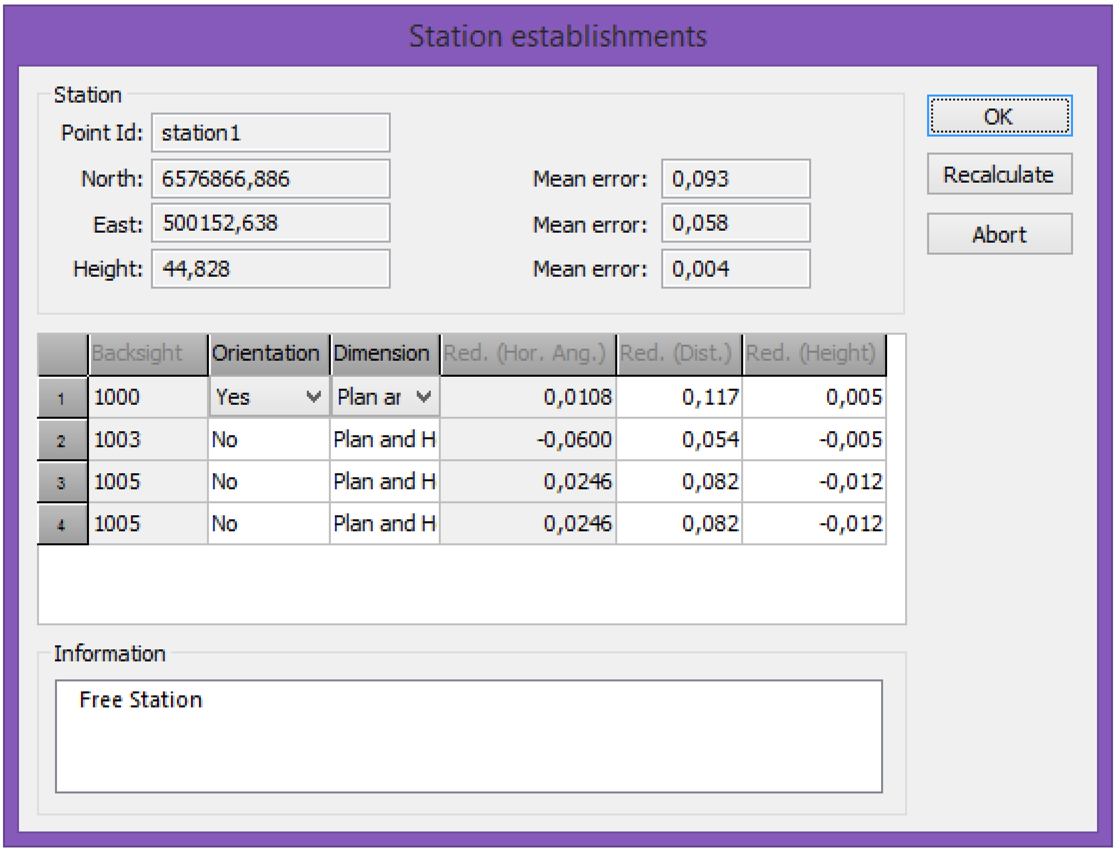
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
6. Station establishment: Alternative for skipping station establishment for free stations. Checked box means the window for station establishment only will be viewed for free stations.
7. Click Continue.





8. The stations, including free stations, will appear one by one. See Free station for more information about free station calculation.
9. If you clicked in the View box the calculation window will appear on the screen. Click Continue when you have finished, or Cancel if there are any errors.
10. The co-ordinates will be placed in the drawing.

TIP! The calculation requires known points. These can be stored in the known points file (see Settings), on the co-ordinates tab in the survey document or as station co-ordinates on the Survey tab (this is where you are now).

Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

projections and co-ordinate systems to get to the right one.

An integrated third party application called Gtrans is used. Topocad is compatible with many different co-ordinate systems. If your co-ordinate system is not listed, please contact your dealer for assistance.

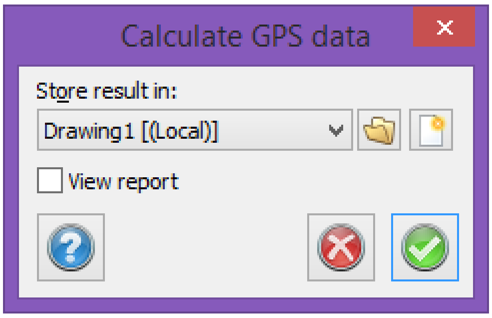
Go to *Survey|Calculate GPS Observations*

Process GPS co-ordinates

Survey|Process co-ordinates

If GPS data is stored in co-ordinates they can also be transformed using Gtrans as above.

Go to *Survey|Process GPS coordinates*.



Free station

Free station uses the Least Squares method for calculation. To force the calculation to use only known stations for plane or height data you can use the "Dimensions" column.

New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
[Calculate GPS observations]()	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
Specified accuracy for measurement data.

Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

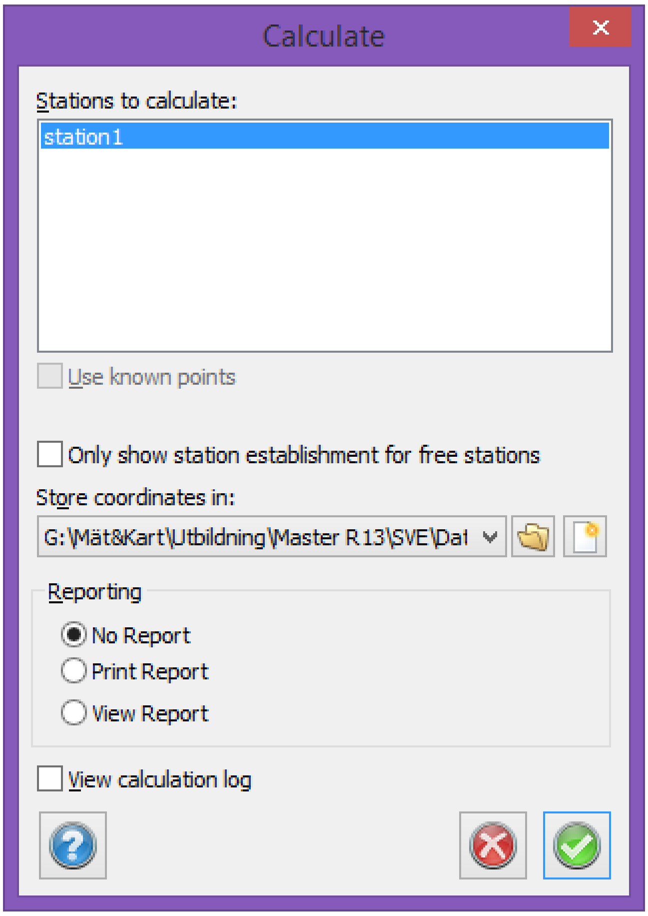
Use this to calculate the survey when you have one or more stations with survey data.

Columns

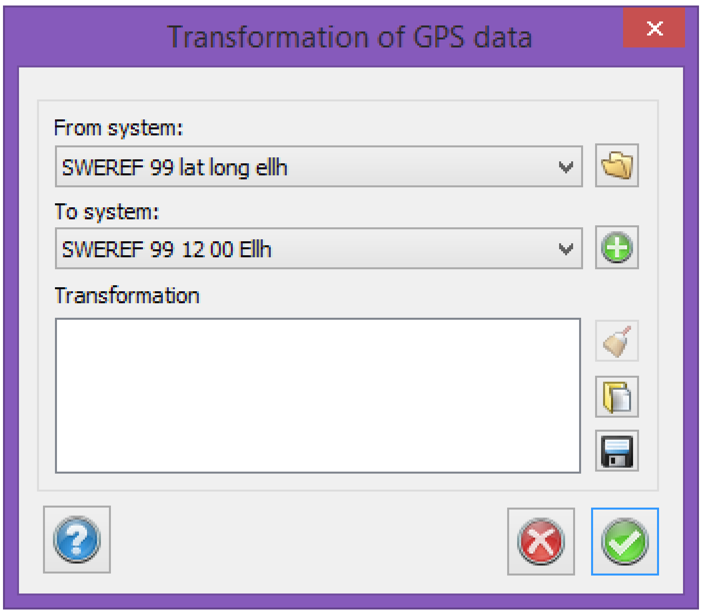
Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
Measured height: Height were calculated by summing the height differences.
Residual: Indicates the improvement added to the measured height after calculation.
Calculated height: Adjusted height.
Pt. Status: Indicates whether the point (forward or reverse) is used as fix at the calculation.
Connection error: Connection error between known points.
Height diff: Differences between read forward and backward.
Length diff: The difference between the lengths forwards and backwards.
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

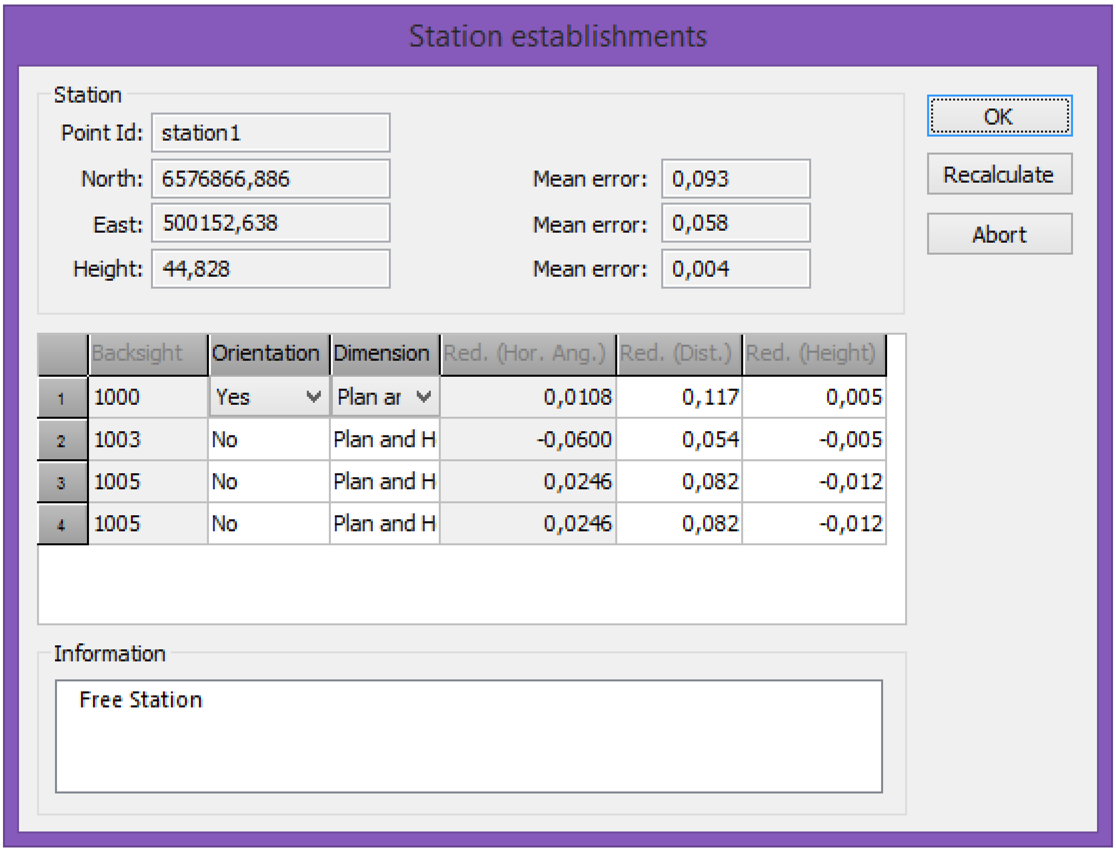
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
6. Station establishment: Alternative for skipping station establishment for free stations. Checked box means the window for station establishment only will be viewed for free stations.
7. Click Continue.





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9. If you clicked in the View box the calculation window will appear on the screen. Click Continue when you have finished, or Cancel if there are any errors.
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TIP! The calculation requires known points. These can be stored in the known points file (see Settings), on the co-ordinates tab in the survey document or as station co-ordinates on the Survey tab (this is where you are now).

Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

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An integrated third party application called Gtrans is used. Topocad is compatible with many different co-ordinate systems. If your co-ordinate system is not listed, please contact your dealer for assistance.

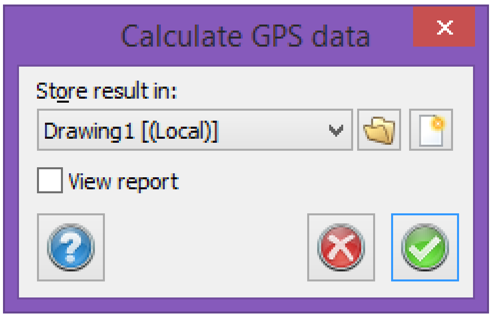
Go to *Survey|Calculate GPS Observations*

Process GPS co-ordinates

Survey|Process co-ordinates

If GPS data is stored in co-ordinates they can also be transformed using Gtrans as above.

Go to *Survey|Process GPS coordinates*.



Free station

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New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
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Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

Use this to calculate the survey when you have one or more stations with survey data.

Columns

Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
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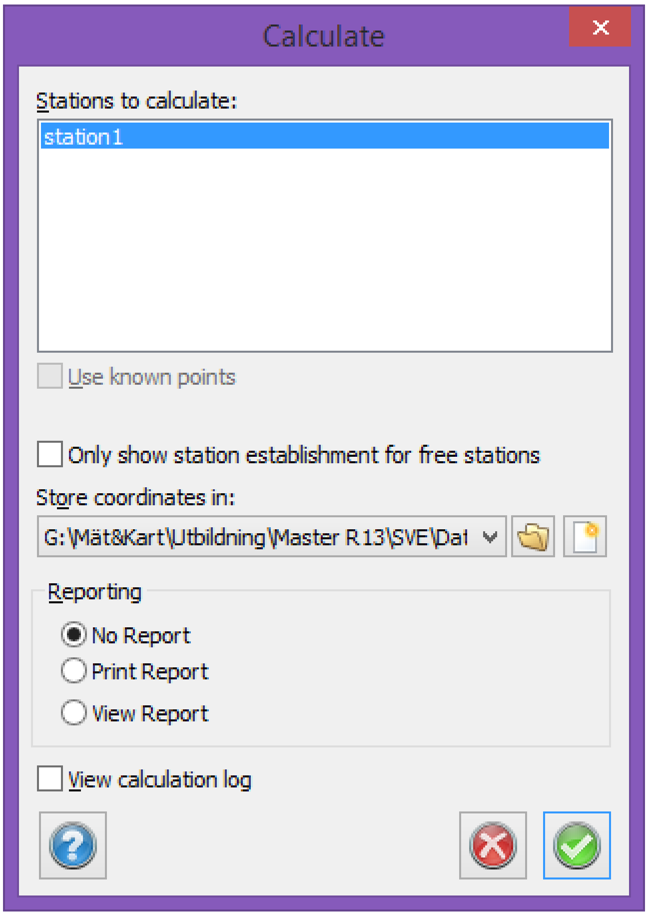
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
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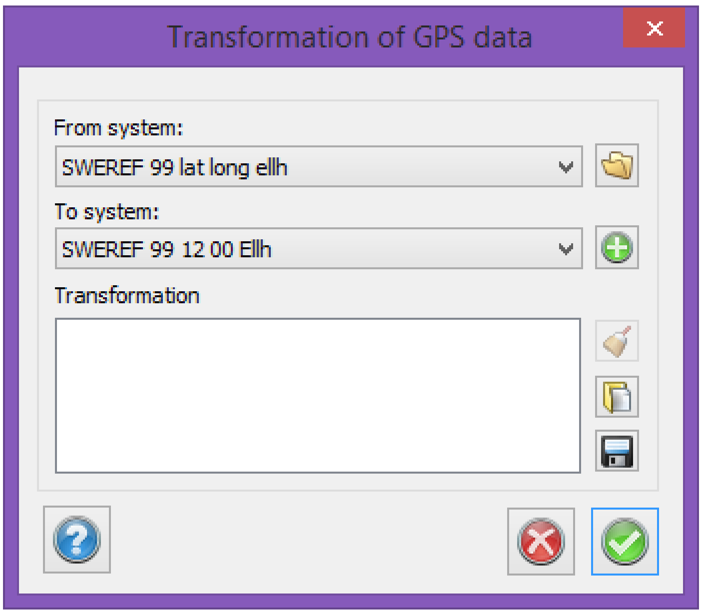

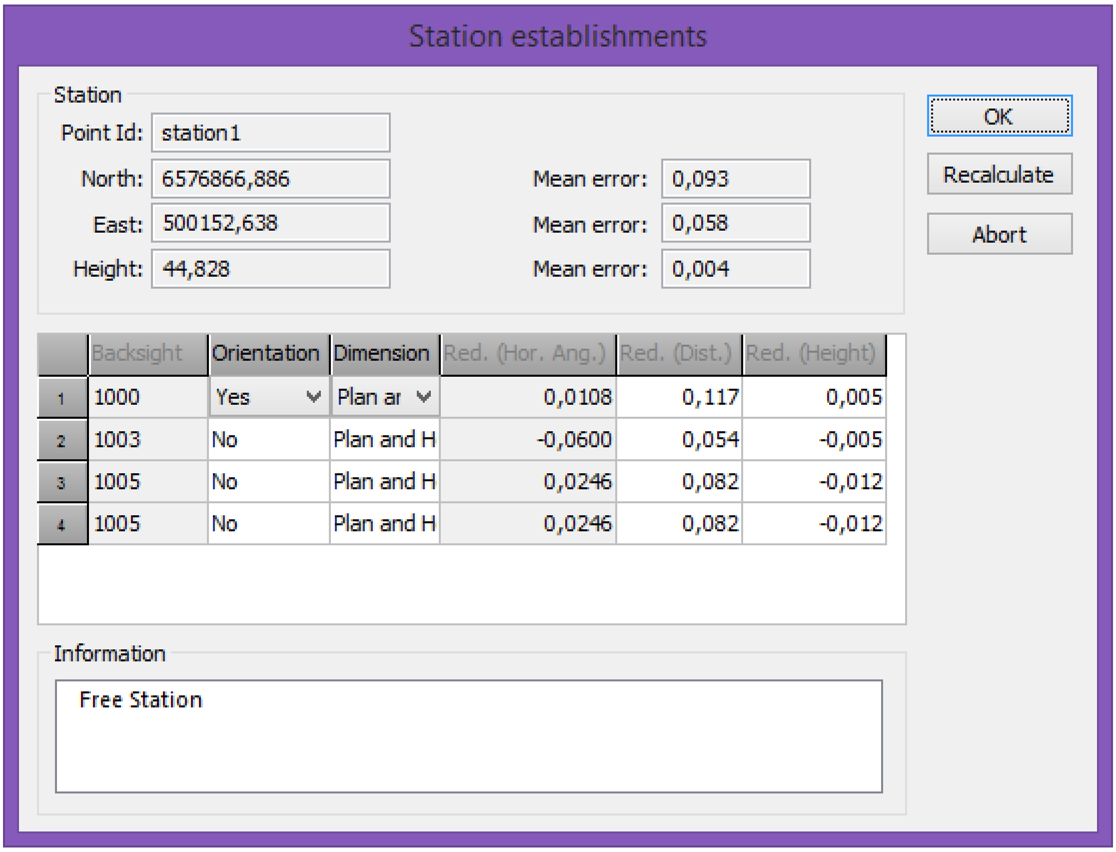

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Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

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Process GPS co-ordinates

Survey|Process co-ordinates

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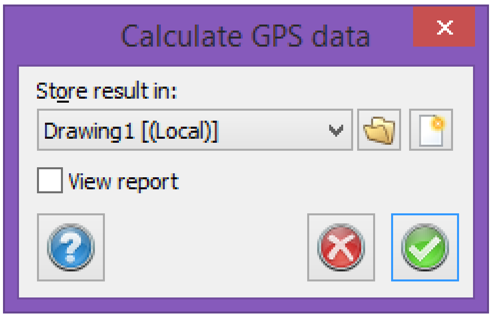

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Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

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Orientation
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External point identity
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Measurement type
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To calculate co-ordinates:

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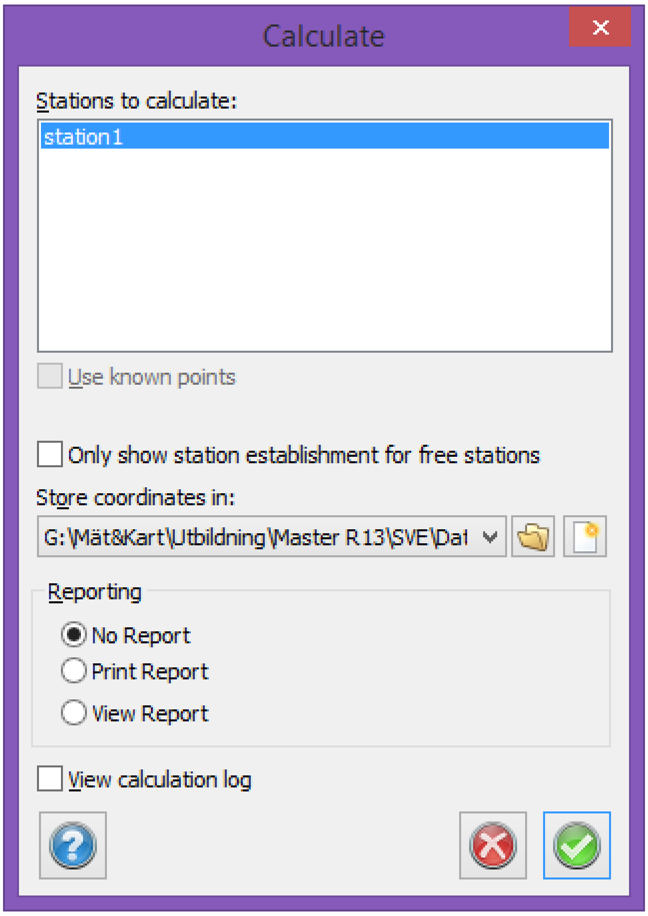
2. Select Survey|Calculate from the menu.



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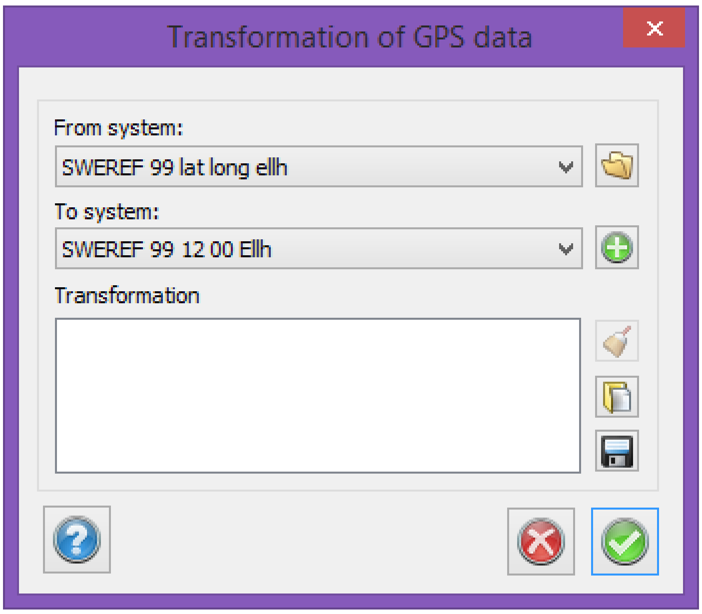

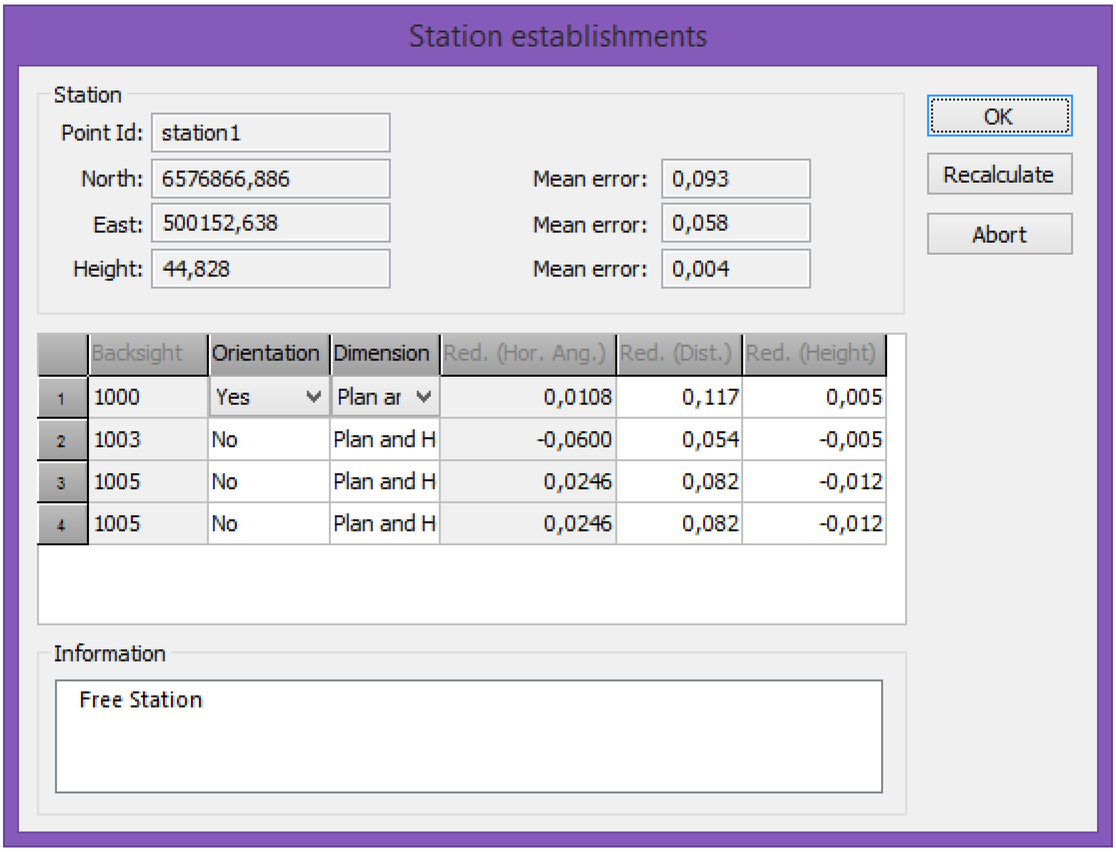

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1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
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Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

projections and co-ordinate systems to get to the right one.

An integrated third party application called Gtrans is used. Topocad is compatible with many different co-ordinate systems. If your co-ordinate system is not listed, please contact your dealer for assistance.

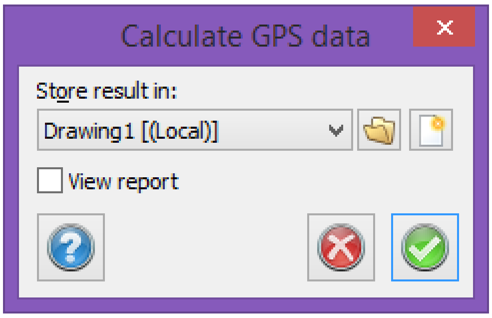
Go to *Survey|Calculate GPS Observations*

Process GPS co-ordinates

Survey|Process co-ordinates

If GPS data is stored in co-ordinates they can also be transformed using Gtrans as above.

Go to *Survey|Process GPS coordinates*.



Free station

Free station uses the Least Squares method for calculation. To force the calculation to use only known stations for plane or height data you can use the "Dimensions" column.

New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
Specified accuracy for measurement data.

Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

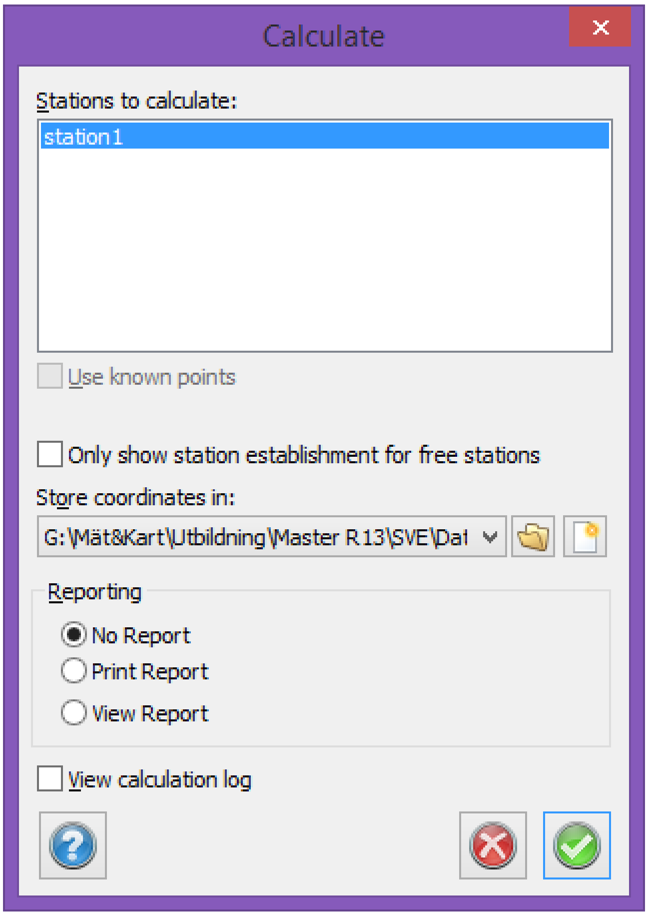
Use this to calculate the survey when you have one or more stations with survey data.

Columns

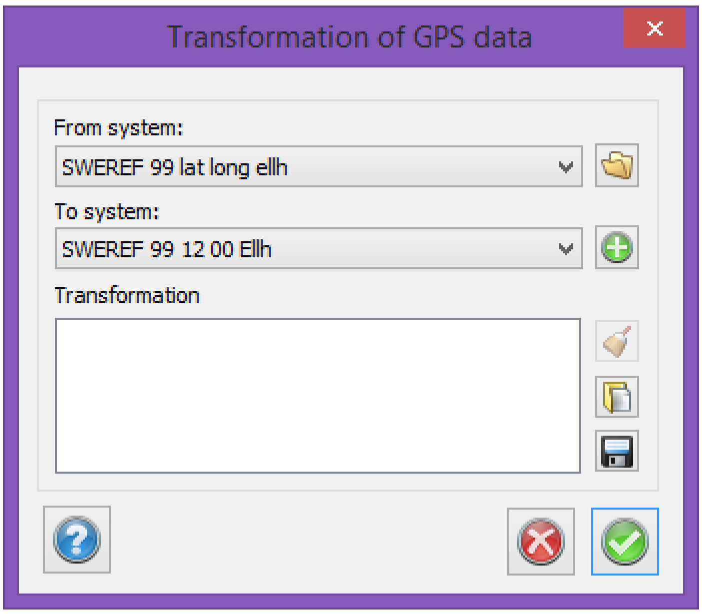
Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
Measured height: Height were calculated by summing the height differences.
Residual: Indicates the improvement added to the measured height after calculation.
Calculated height: Adjusted height.
Pt. Status: Indicates whether the point (forward or reverse) is used as fix at the calculation.
Connection error: Connection error between known points.
Height diff: Differences between read forward and backward.
Length diff: The difference between the lengths forwards and backwards.
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

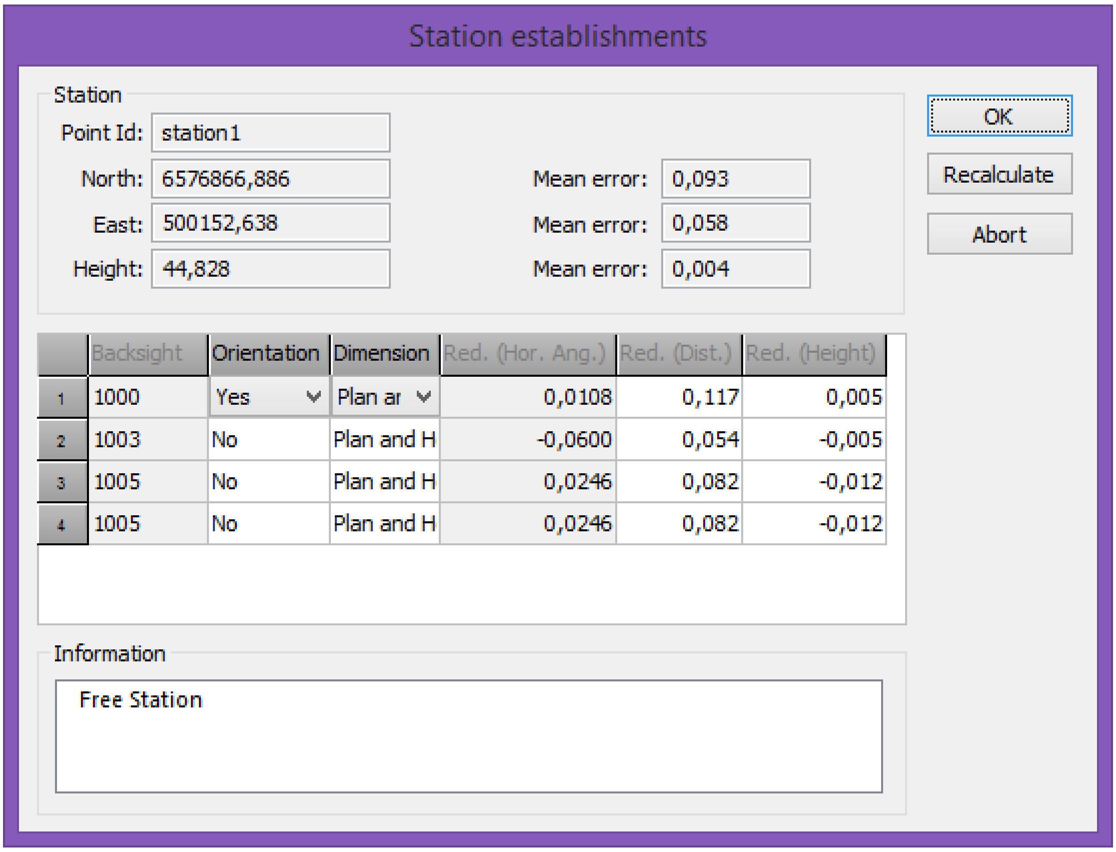
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
6. Station establishment: Alternative for skipping station establishment for free stations. Checked box means the window for station establishment only will be viewed for free stations.
7. Click Continue.





8. The stations, including free stations, will appear one by one. See Free station for more information about free station calculation.
9. If you clicked in the View box the calculation window will appear on the screen. Click Continue when you have finished, or Cancel if there are any errors.
10. The co-ordinates will be placed in the drawing.

TIP! The calculation requires known points. These can be stored in the known points file (see Settings), on the co-ordinates tab in the survey document or as station co-ordinates on the Survey tab (this is where you are now).

Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

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Process GPS co-ordinates

Survey|Process co-ordinates

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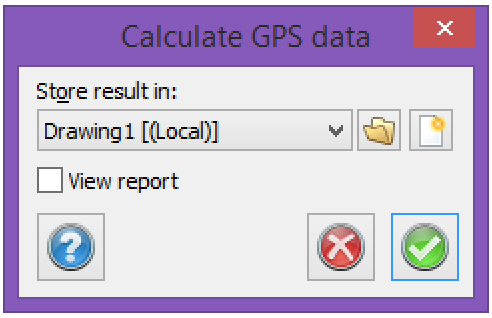

Free station

Free station uses the Least Squares method for calculation. To force the calculation to use only known stations for plane or height data you can use the "Dimensions" column.

New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
Specified accuracy for measurement data.

Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

Use this to calculate the survey when you have one or more stations with survey data.

Columns

Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
Measured height: Height were calculated by summing the height differences.
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Pt. Status: Indicates whether the point (forward or reverse) is used as fix at the calculation.
Connection error: Connection error between known points.
Height diff: Differences between read forward and backward.
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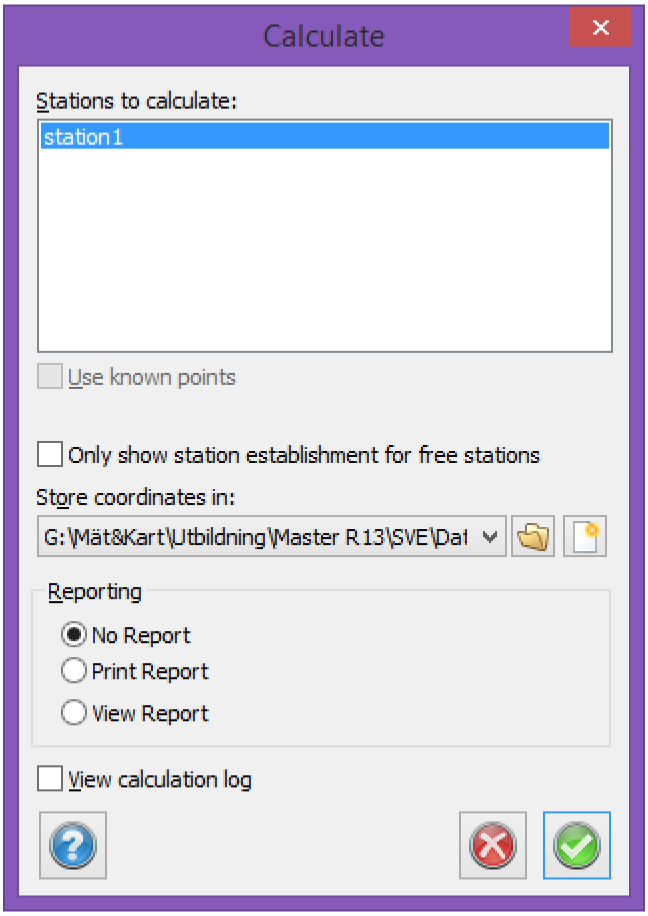
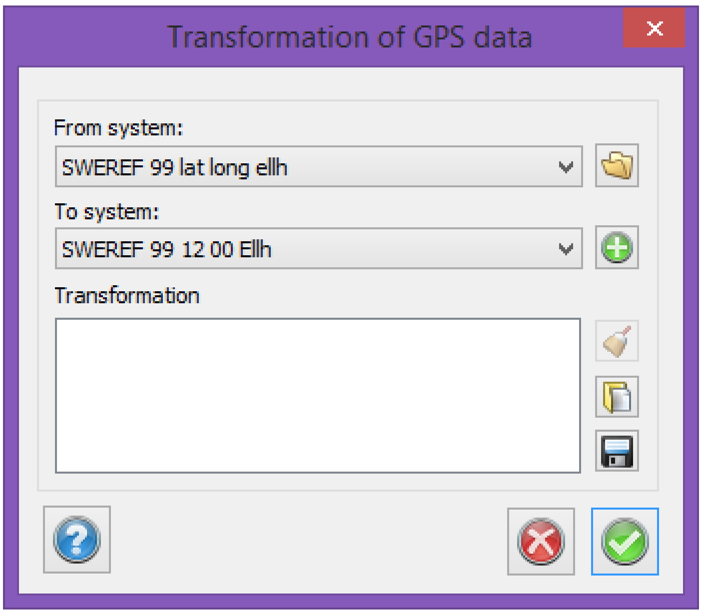
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

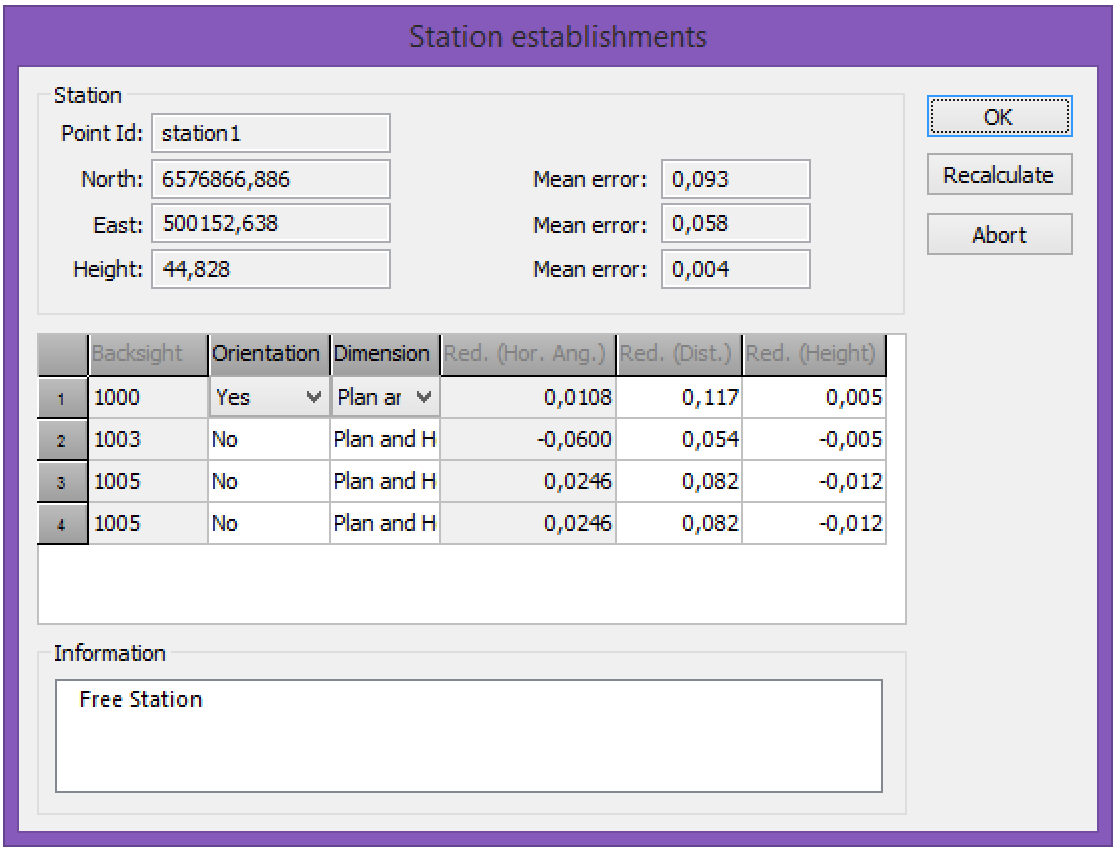
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
6. Station establishment: Alternative for skipping station establishment for free stations. Checked box means the window for station establishment only will be viewed for free stations.
7. Click Continue.





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9. If you clicked in the View box the calculation window will appear on the screen. Click Continue when you have finished, or Cancel if there are any errors.
10. The co-ordinates will be placed in the drawing.

TIP! The calculation requires known points. These can be stored in the known points file (see Settings), on the co-ordinates tab in the survey document or as station co-ordinates on the Survey tab (this is where you are now).

Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

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Process GPS co-ordinates

Survey|Process co-ordinates

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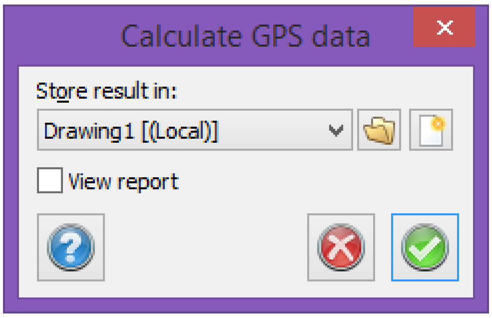

Free station

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New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

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Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
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Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
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Part of measurement
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Calculate survey data

Survey|Calculate

Use this to calculate the survey when you have one or more stations with survey data.

Columns

Observation type: Transfer Point reading backwards and forwards
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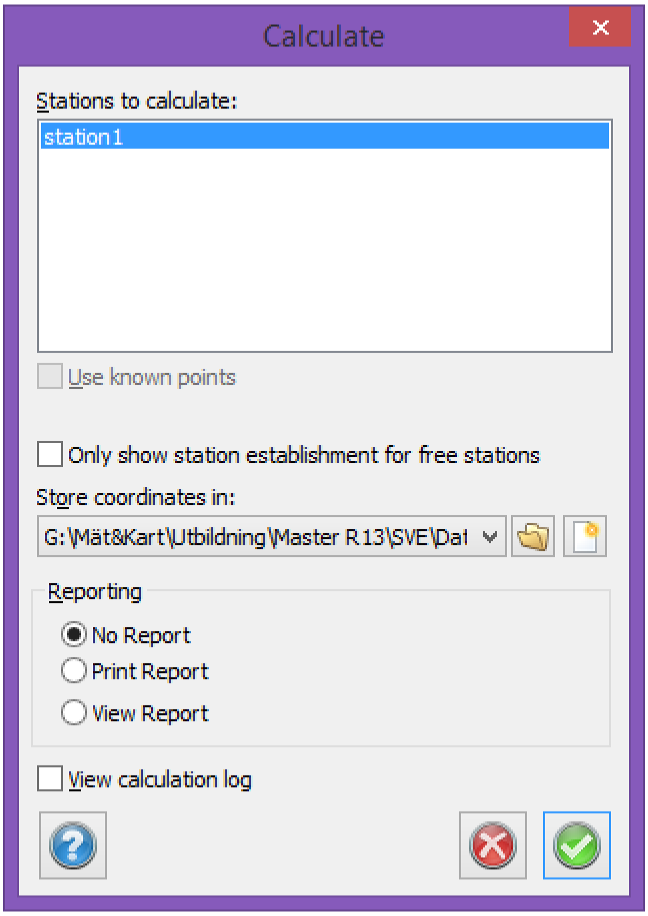
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



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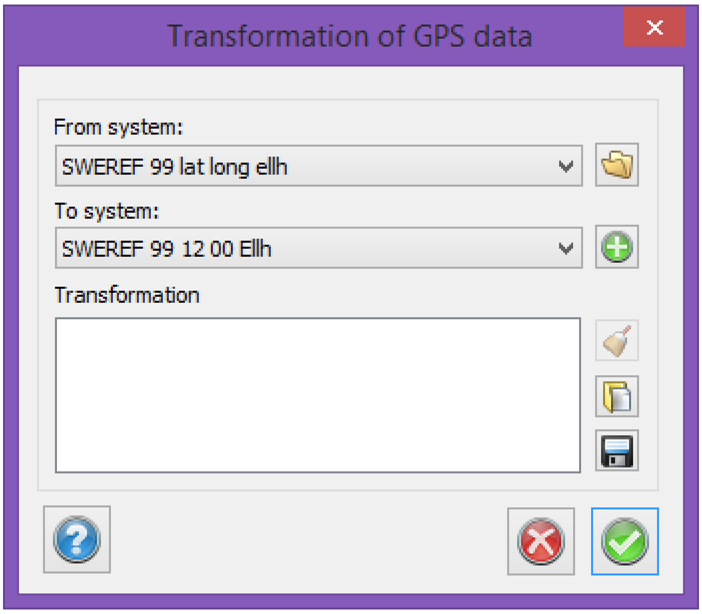

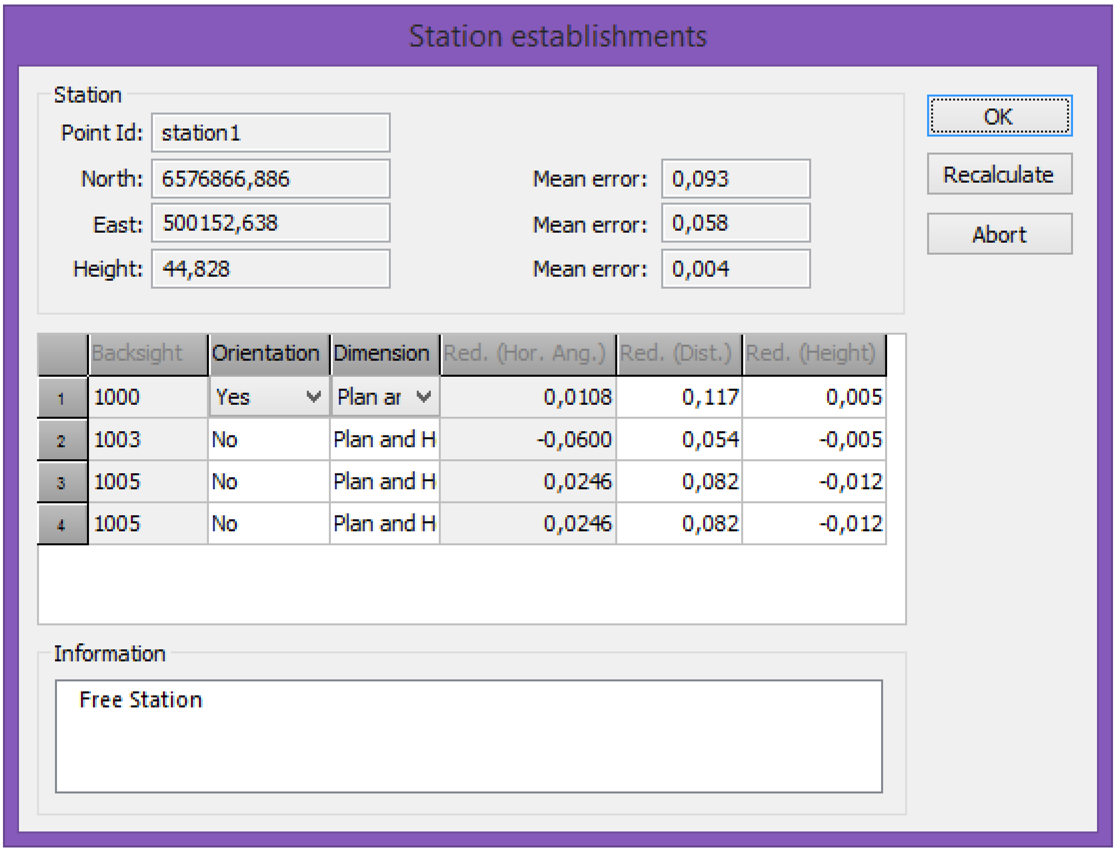

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1. Import the co-ordinates from your instrument.
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Process GPS co-ordinates

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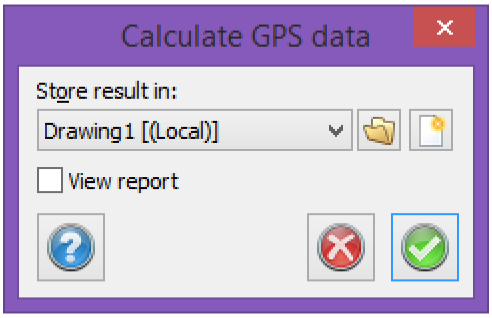

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The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
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- ***Temperature***
  Temperature at survey by this station.
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  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
Specified accuracy for measurement data.

Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

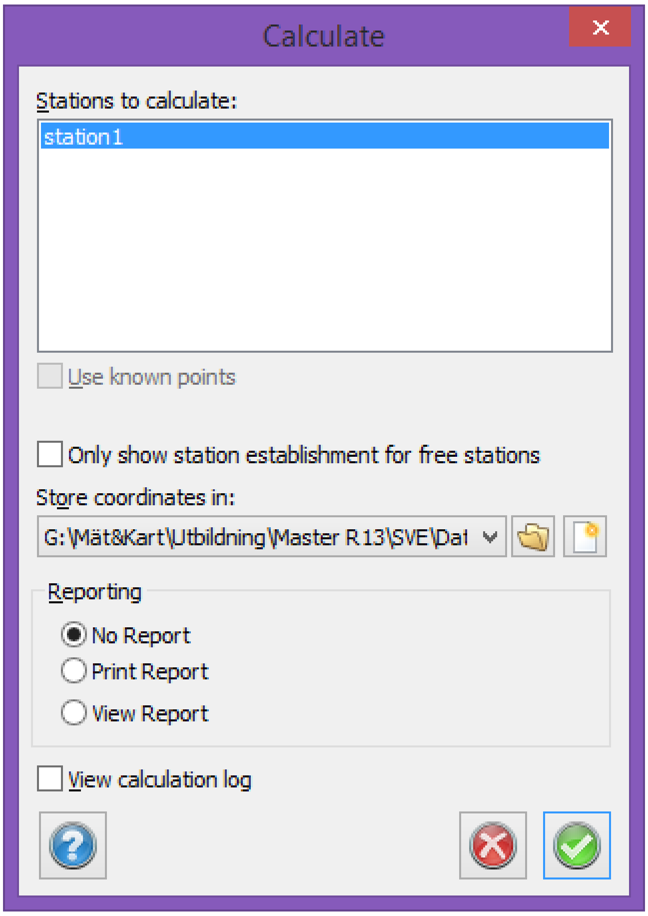
Use this to calculate the survey when you have one or more stations with survey data.

Columns

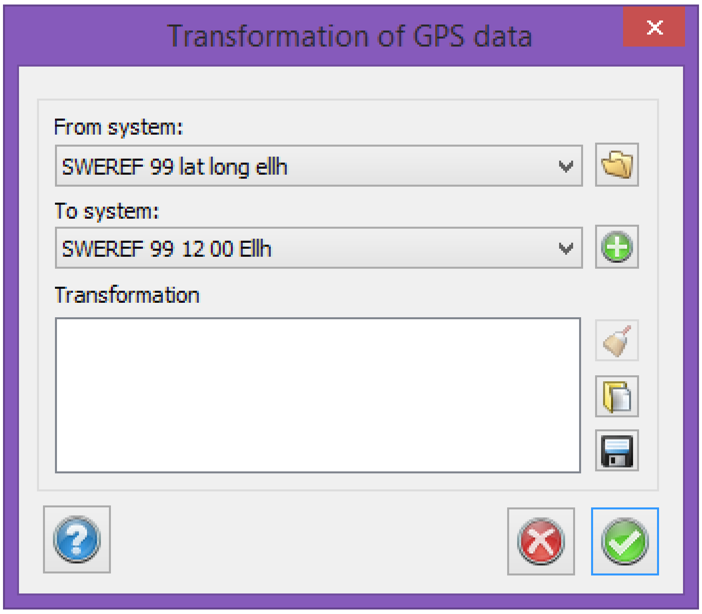
Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
Measured height: Height were calculated by summing the height differences.
Residual: Indicates the improvement added to the measured height after calculation.
Calculated height: Adjusted height.
Pt. Status: Indicates whether the point (forward or reverse) is used as fix at the calculation.
Connection error: Connection error between known points.
Height diff: Differences between read forward and backward.
Length diff: The difference between the lengths forwards and backwards.
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

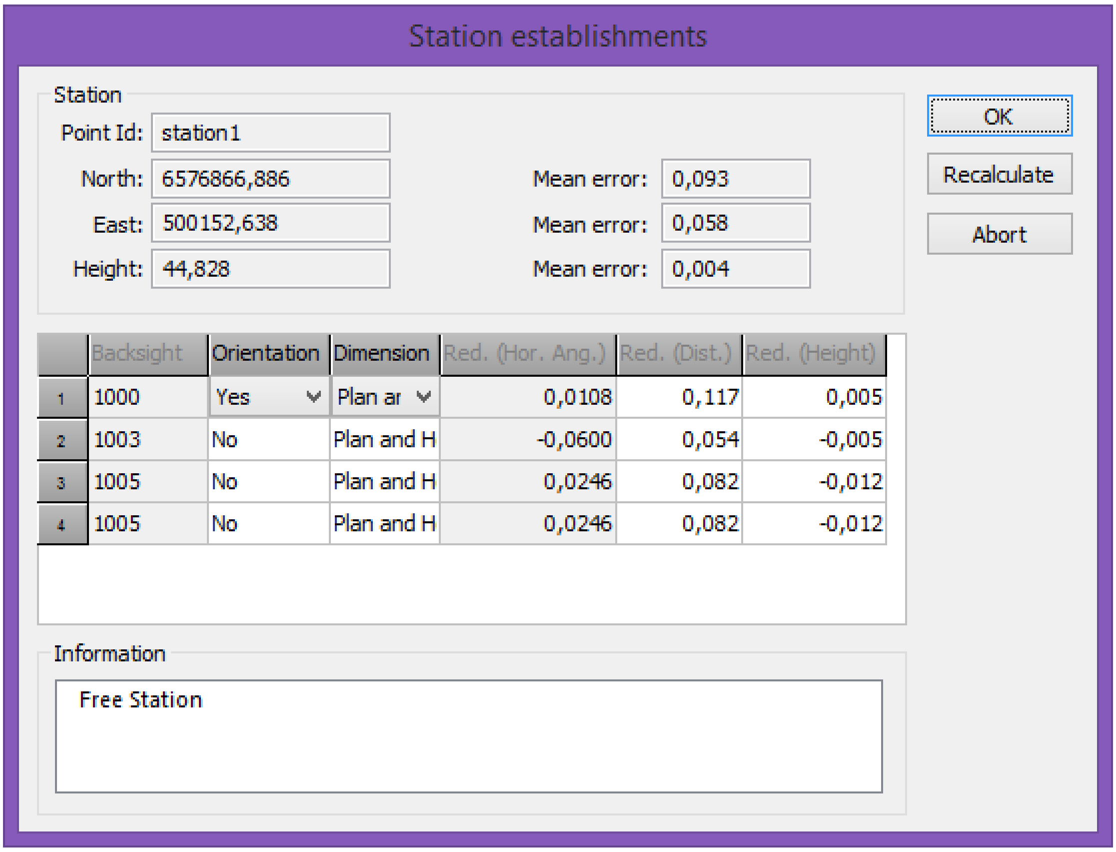
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
6. Station establishment: Alternative for skipping station establishment for free stations. Checked box means the window for station establishment only will be viewed for free stations.
7. Click Continue.





8. The stations, including free stations, will appear one by one. See Free station for more information about free station calculation.
9. If you clicked in the View box the calculation window will appear on the screen. Click Continue when you have finished, or Cancel if there are any errors.
10. The co-ordinates will be placed in the drawing.

TIP! The calculation requires known points. These can be stored in the known points file (see Settings), on the co-ordinates tab in the survey document or as station co-ordinates on the Survey tab (this is where you are now).

Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

projections and co-ordinate systems to get to the right one.

An integrated third party application called Gtrans is used. Topocad is compatible with many different co-ordinate systems. If your co-ordinate system is not listed, please contact your dealer for assistance.

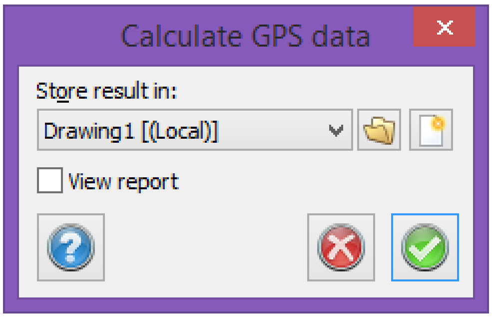
Go to *Survey|Calculate GPS Observations*

Process GPS co-ordinates

Survey|Process co-ordinates

If GPS data is stored in co-ordinates they can also be transformed using Gtrans as above.

Go to *Survey|Process GPS coordinates*.



Free station

Free station uses the Least Squares method for calculation. To force the calculation to use only known stations for plane or height data you can use the "Dimensions" column.

New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

The document format is always the same and this editing only affects how the survey data will appear on screen and when printing.

You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
This is the identification for the point and can consist of up to 24 alphanumeric characters. When points are manually entered in Topocad they are automatically numbered. If you start with number 1 the next point will have the point ID 2. If you enter 1,001 the next number will be 1,002

Remark
Remark field.

External point identity
This has no function in the message.

Object type
Description of classification of object.

Time
Time in local time. Time is given as hours 00-23, minutes 00-59 and seconds 00-59 (hhmmss), and if necessary with fractions of a second (hhmmss.ddd).

Error distance in plane
Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

Control
If the point is used as a control point, select Yes here. The default value is No.

Part of measurement
This is used when several measurements of the same object are required to define its co-ordinates.

Resection order
These are used in resections and describe which of two alternatives will be used if the point is not defined in any other way.

Space vector
This is used for the measurement of two prisms or if you want to measure a distance between a point and a prism. The value given here is the distance from the closest prism.

Accuracy
Specified accuracy for measurement data.

Eccentric cross angle
Horizontal cross angle at the centre point.

Eccentric vertical angle
Vertical cross angle at the centre point.

Eccentric distance
Slope distance to the centre point.

Calculate survey data

Survey|Calculate

Use this to calculate the survey when you have one or more stations with survey data.

Columns

Observation type: Transfer Point reading backwards and forwards
Detail: Read only forward, point not included in the train.
Distance: Distance to bar.
Reading: Read height on bar.
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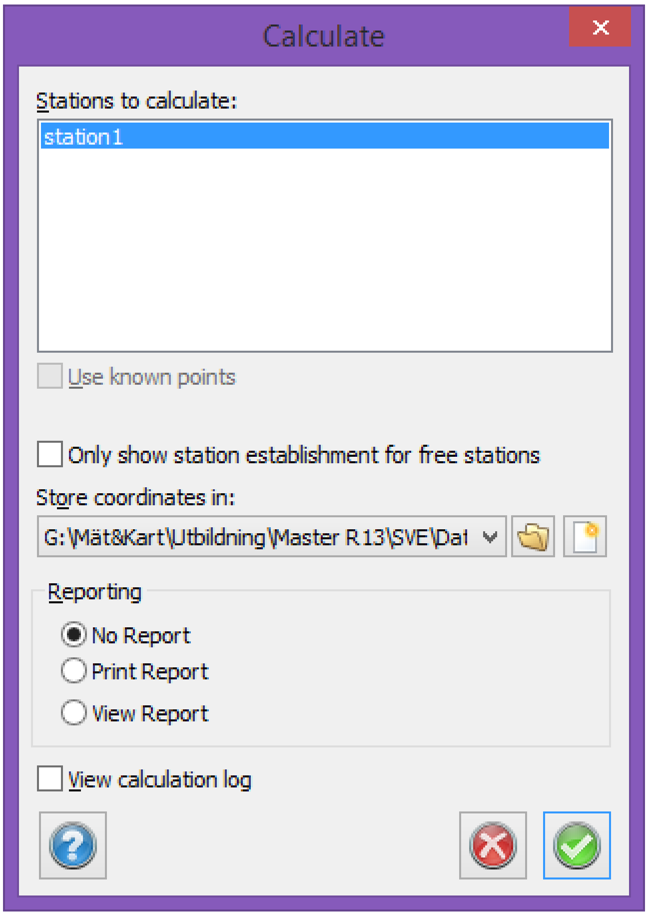
Length: The sum of the lengths forward and backward.
Origin: Name of the file that you imported from.

To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



3. The dialogue box that opens indicates how many stations there are in the survey. All of them are selected. If you want to exclude one or more of the stations from the calculation, select the ones that should be calculated. Use Ctrl to select one at a time or Shift to select several stations at once.
4. If you want to study the station calculations click in the box in bottom left corner.
5. Select the drawing in which you want the survey to be placed. You can select an open drawing, a previously saved drawing or a new drawing. If you select a new drawing it will be the default drawing that is selected (if there is one).
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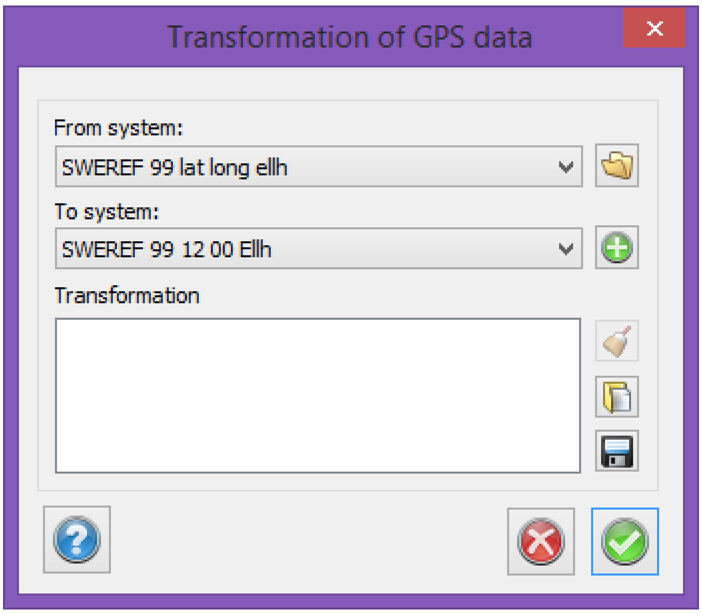
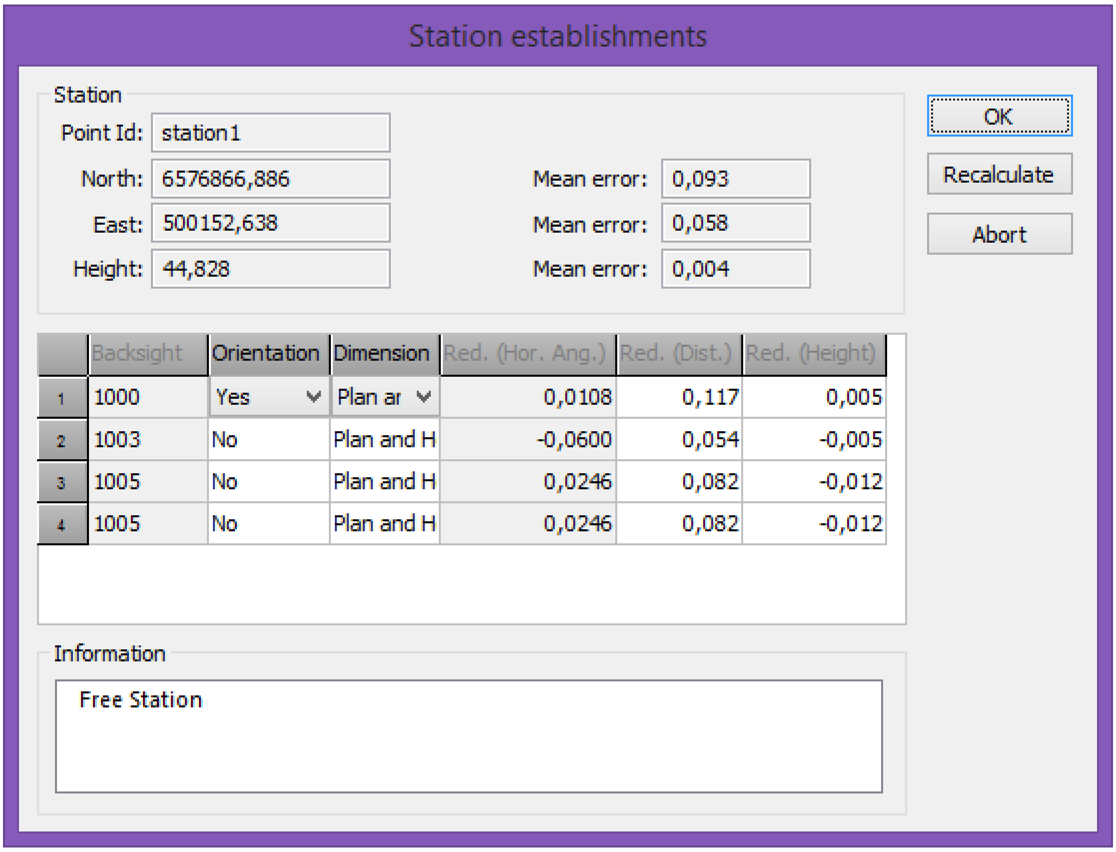




8. The stations, including free stations, will appear one by one. See Free station for more information about free station calculation.
9. If you clicked in the View box the calculation window will appear on the screen. Click Continue when you have finished, or Cancel if there are any errors.
10. The co-ordinates will be placed in the drawing.

TIP! The calculation requires known points. These can be stored in the known points file (see Settings), on the co-ordinates tab in the survey document or as station co-ordinates on the Survey tab (this is where you are now).

Process co-ordinates

Survey|Process

To calculate co-ordinates from the field you have two options. You can use this document (the sur file) or the drawing. If you use the survey document you have the chance to edit the co-ordinates before they are entered into the drawing.

1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

projections and co-ordinate systems to get to the right one.

An integrated third party application called Gtrans is used. Topocad is compatible with many different co-ordinate systems. If your co-ordinate system is not listed, please contact your dealer for assistance.

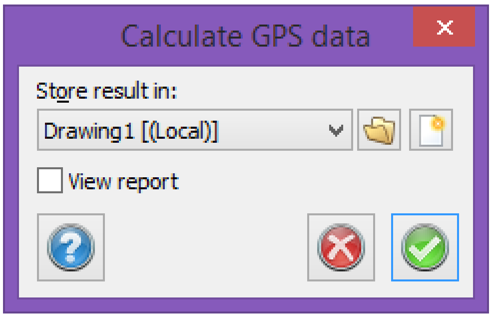
Go to *Survey|Calculate GPS Observations*

Process GPS co-ordinates

Survey|Process co-ordinates

If GPS data is stored in co-ordinates they can also be transformed using Gtrans as above.

Go to *Survey|Process GPS coordinates*.



Free station

Free station uses the Least Squares method for calculation. To force the calculation to use only known stations for plane or height data you can use the "Dimensions" column.

New station

You can create your own survey data and/or a new station with an existing survey data document.

The procedure is as follows:

1. From the menu, select New station.
2. Enter your survey data into the new station. If any other stations already exist in the survey data document the new station will appear last in the list.

Survey data - Settings, calculation

Function, command	Description
Station	
Edit settings	
Calculate survey data	

Free station	
Process coordinates	
Calculate GPS observations	
Process GPS coordinates	
Free station	
New station	

Station

The station contains information about:

- ***Point ID:***
  The point ID is specified if it exists.
- ***Instrument height***
- ***Temperature***
  Temperature at survey by this station.
- ***Pressure***
- ***Station type***
  Known station
  Free station
  Traverse
  Sets the calculation for the station and imports to the net adjustment form.
- ***Calculate heights***
  Select whether or not you want to calculate heights.
- ***Search co-ordinates for known points***
  The software system searches for known points in the co-ordinate list when calculating the survey data. If the box is checked, the software will search for known points in the co-ordinate list even if "process co-ordinates" has not been selected in calculation.
- ***Project:***
  The information is loaded from the field memory/station.
- ***User***
- ***Date***
- ***Code***
- ***Station co-ordinates***
  Loaded from instrument or entered here.
- ***Use oriented direction (no backsight)***
- ***Observation angle***
- ***Azimuth***
  Direction relative to north.

Edit settings

It is possible to edit the survey data form. Select Edit settings in the Survey column or right click and select Column settings. See also General grid editing. Selecting a type of observation allows you to add it or remove it from your list. You can place the observation wherever you want by using the up or down arrows. It is also possible to Remove all or Add all.

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You can also save the standard design.

Orientation
Determines whether or not Topocad will use the point for backsight. It is also possible to select the option ”r;If possible”r; and Topocad then checks if it finds the point number as a backsight.

Survey type
The survey types you can select if the values are Backsight, Point, Other, Backsight if possible, Round mean value or Station mean value.

Point ID
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Remark
Remark field.

External point identity
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Object type
Description of classification of object.

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Error distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Error distance in height
Error height distance entered or calculated - used to describe the accuracy of the points in the plane. The value is the radial point error distance.

Measurement type
Describes type of point. e.g. station, point, net. It is used in the free station when you know at the beginning which points to use for the calculation. If you use the backsight or polygon point code type, the setting will be changed automatically.

Dimensions
Describes how many dimensions will be calculated at the specific point. The alternatives are: no dimension, one dimension, two dimensions and three dimensions. The setting is also used prior to the calculation in the free station when describing the points that will be used for the plane and height respectively.

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This is used when several measurements of the same object are required to define its co-ordinates.

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Survey|Calculate

Use this to calculate the survey when you have one or more stations with survey data.

Columns

Observation type: Transfer Point reading backwards and forwards
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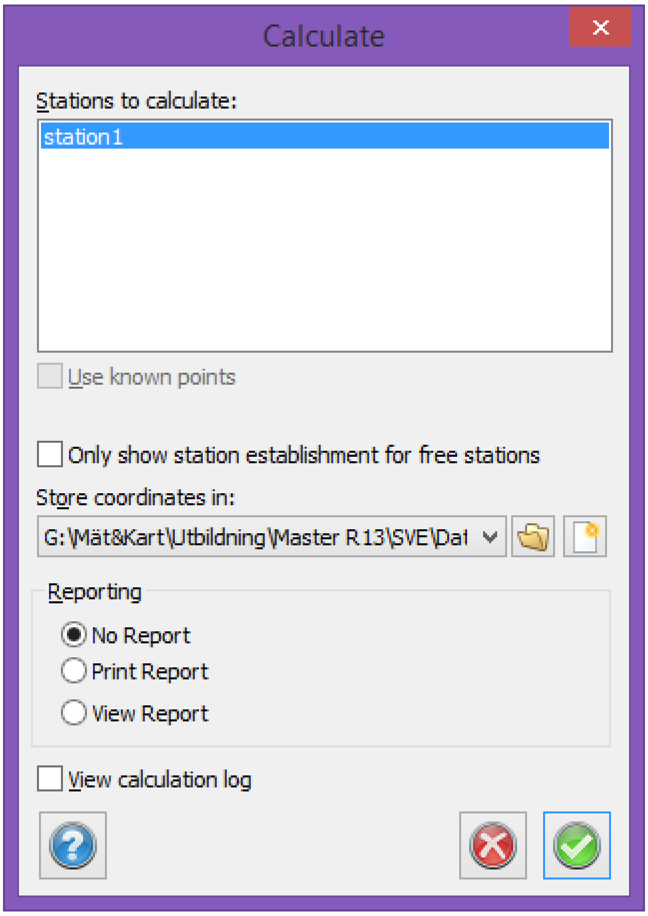
To calculate co-ordinates:

1. Open the survey document with the data you want to use to calculate co-ordinates.
2. Select Survey|Calculate from the menu.



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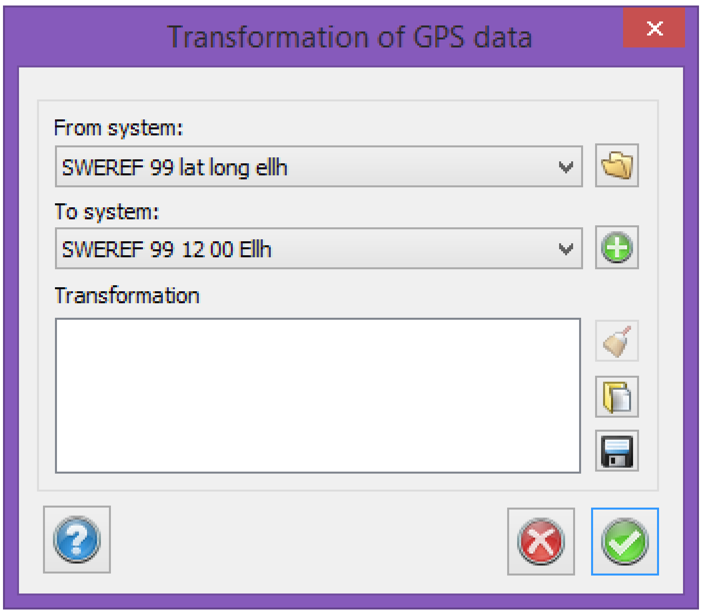

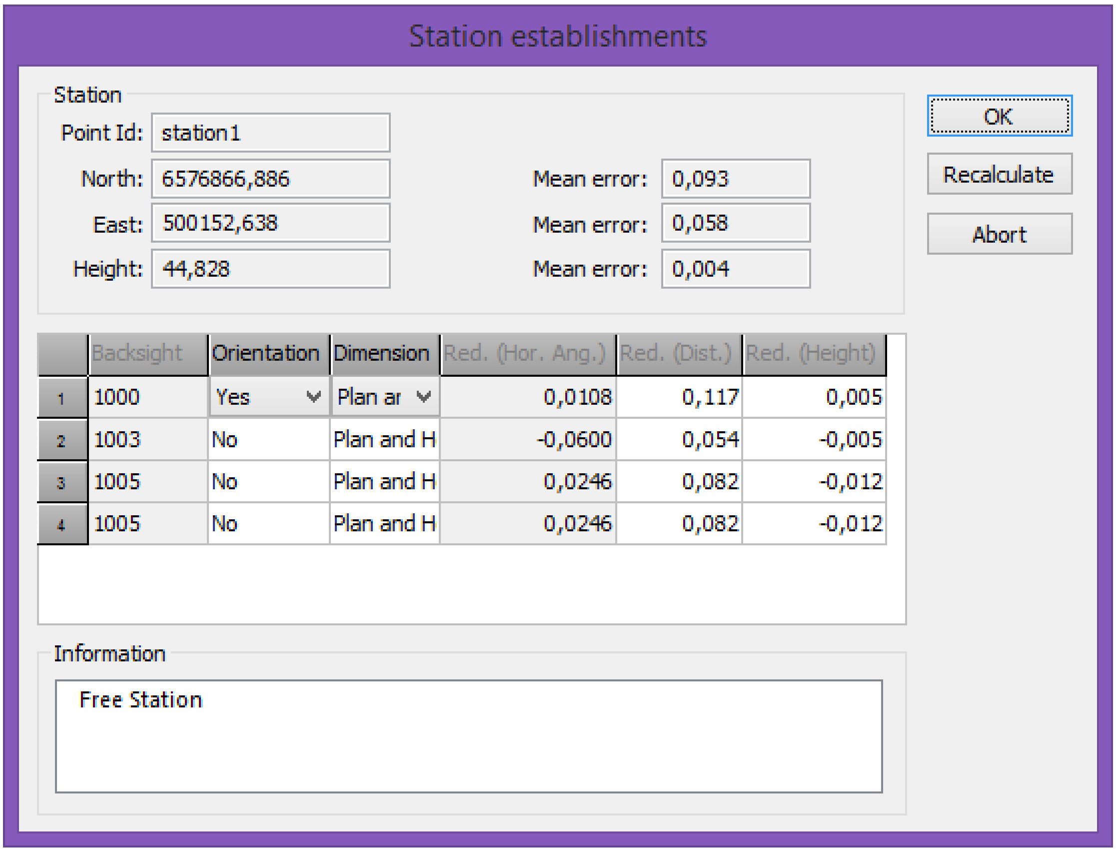

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Process co-ordinates

Survey|Process

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1. Import the co-ordinates from your instrument.
2. Go to *Survey|Process.*
3. Decide which drawing to place them in.
4. Click OK.

Calculate GPS observations

Survey|Calculate GPS observations

GPS observations are usually made from a base station and delta co-ordinates from this base station. In Topocad you can calculate and transform the co-ordinates from the current co-ordinate system (normally WGS84) to the existing co-ordinate system. This transformation can be made through several different

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Process GPS co-ordinates

Survey|Process co-ordinates

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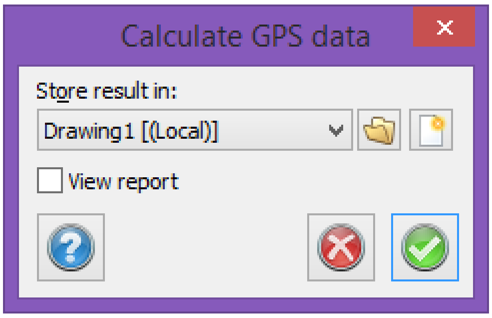
Go to *Survey|Process GPS coordinates*.



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Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Traverse

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

Traverse

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Traverse

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

Traverse

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Traverse

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

Traverse

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Traverse

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

Traverse

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

Last station
Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
Horizontal angle back, Vertical angle back, Slope distance back, Horizontal angle forward, Vertical angle forward and Slope distance forward. 3D

Vertical and horizontal distance
Horizontal angle back, Vertical angle back, Horizontal distance back, Horizontal angle forward, Vertical angle forward, Horizontal distance forward. 3D

Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

Dialogue box data:

Group number:
Used to select whether you want to see the station summary or only one round ahead.

Group:
Specifies the horizontal angle and the maximum and standard differences for the angle in the selected group/round.

Back/Forward
Shows whether the measurement has been taken towards the backsight or the forward sight.

Vertical angle:
The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
The sum of the slope distance and its maximum difference and standard deviation.

Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

You can calculate a traverse from the traverse document (.trv). When you are satisfied with the editing and entries, go to the menu and click Calculate traverse. A dialogue box appears. Topocad tries to find the connection type. This can be changed if it is not correct.

The following connection types exist:

- Not connected
  Traverse is not connected. It is connected to two points at the start of the traverse and is not connected to any points at the end of the traverse.
- Not connected inverse
  Traverse not connected. Starts with unknown points and ends at two known points.
- Co-ordinate connected
  The traverse is connected to two points at the start of the traverse and ends at one known point at the end of the traverse.
- Co-ordinate connected inverse
  The traverse has one known point at the start of the traverse and ends at two known points at the end of the traverse.
- End point connected
  The first and last points in the traverse are known points. All other points are unknown.
- Completely connected The traverse has two known points at both the start and end. This type of traverse is of course the most accurate and Topocad can also calculate more deviations and corrections from it.

Correction methods:

- No correction
  No correction at all
- Linear
  Linear correction from the first station.
- Length
  Complete correction

Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
Top left corner: first backsight
Top right corner: first point
Bottom left corner: last point
Bottom right corner: last forward sight

A maximum of all four of them can be known and displayed (as for completely connected) and at least two must be known and displayed.

Tick this box if you want to calculate a 3D traverse. Click OK when you want to continue with the calculation of the traverse.

Result in traverse

The results that are displayed in the dialogue boxes can also be printed. As soon as the calculation is done go to File|Print to send the complete report and results to the printer. See Traverse settings for more information about detailed and short lists.

The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

Point ID:
The point ID of the station. You can select from the list. You can also edit the point ID of the station by going to Traverse|Edit station ID.

Distance diff.:
Calculated the maximum difference at a measured distance between two points. The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

Traverse statistics

This dialogue box shows information about how many points there were in the traverse, the number of calculated new points (unknown), the number of measured angles, the rounds of angles and distances as well as the verifiability of the traverse and which corrections have been calculated for the traverse.

Number of points:
Total number of points in the traverse.

Number of unknown points:
Total number of points that where not known from the beginning and which have now been calculated.

Number of measured directions:
Total number of measured directions in the traverse from all points.

Number of measured distances:
Total number of measured distances between points in the traverse.

Number of direction sets:
Number of measured direction sets: This is the same as the number of stations that the direction measurements have been calculated from. Usually this is the number of points minus two (backsight and forward sight).

Verifiability:
The verifiability of a traverse is calculated using the following formula:

Number of measured directions + Number of measured distances - 2 x Number of unknown points - Number of direction sets divided by Number of measured directions + Number of measured distances

The verifiability value should be as high as possible. For a traverse a value of 0.5 would be a satisfactory result.

Correction angle:
In completely connected traverses you can calculate the angle difference and this difference can be distributed to the observations at the various points. This distribution is an average distribution using the same angle difference at all observations. The displayed difference is the adjusted angle created from every angle.

Co-ordinates:
In completely connected, co-ordinate connected and end point connected traverses you can calculate a co-ordinate difference. The displayed difference is the resulting co-ordinate calculation for every point.

Traverse

Survey|Traverse

Command, function	Description
Create traverse	How to create a traverse, either from a sur file or manually
Traverse document	Explanations about the document

Traverse settings	Settings
Information about stations in traverse	Information
Calculate traverse	How to calculate
Traverse statistics	Statitics
Result of traverse calculation	Result

The traverse can either be entered manually or you can load data from the survey data file (.sur). To use the survey data file, select the traverse in the station header and then to Survey|Construct traverse. You will then have a suggested station order. In the document all rounds of measurement data will automatically be calculated and it is possible to calculate the traverse.

The traverse can be calculated in the following ways:

- Not connected
- Inverted not connected (known points at the other end of the traverse)
- Co-ordinate connected
- Inverted co-ordinate connected
- End point connected
- Complete

Note: As well as the actual traverse calculation in the traverse document, this also relates to rounds of measurement.

Create traverse

Survey|Traverse

Create traverse from survey data:

The traverse can either be entered manually or you can load data from the survey data file (.sur).

To construct traverse from survey data file:

1. From the survey data document (.sur) go to Survey|Construct traverse.

1. The traverse document is opened in the background. A dialogue box appears which suggests a station order. This dialogue box has three columns. The first column lists the first station, used as the backsight, where the traverse begins. The second column lists all stations in the traverse in an order suggested by Topocad. You can remove stations from this field. The third column suggests the last station, used as the forward sight. There may be two stations in this column. If so you will need to click on the one to be used as the forward sight.

1. Topocad may not select the correct traverse order. In this case remove incorrectly placed stations by selecting them and clicking Remove. These stations will then appear in the third column. Add stations in the correct order by selecting the appropriate station from the third column and clicking Add. If you want to add stations that were not measured in the survey data document, this can be done afterwards. See further down - Manual entry.

1. You have now a traverse. It is possible to scroll between stations using the arrows. For more information about the document see Traverse document

Construct traverse by manual entry:

Traverse

Go to *File*|*New* and select Traverse (.trv)

The traverse document appears on the screen. Go to Traverse|Add station to enter the stations in the traverse. In the dialogue box you can add a backsight, station and forward sight. Next time you want to add a station, the backsight (back point ID) and the station point ID are already defined. You can only enter the next forward sight. (This will be the next station if you continue the traverse). Note that it is possible to select three types of observation data: - Vertical angle with slope distance, Vertical and horizontal distance and Horizontal distance only. See Traverse settings for more information.

It is possible to enter any number of observations and stations in the document.

Traverse document

Traverse

The Traverse document has its own menu with a unique column for the document named Traverse. The document itself shows the backsight, station and forward sight for every station. They all show the point ID and prism height/station height. The observations are as follows:

Use
Select Yes or No to indicate whether or not the observation should be used in the calculation.

No.
Number of rounds of measurement for this station.

Other observations are explained in the traverse settings.

The following commands are in the menu:

Previous station
Takes you to the previous station in the traverse. The same function can also be performed using the left arrow in the document.

Next station
Takes you to the next station in the traverse. The same function can also be performed using the right arrow in the document.

First station
Takes you straight to the first station in the traverse.

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Takes you straight to the last station in the traverse.

New station
Adds a new station. A dialogue box appears. For the first entry you can add the backsight, station and forward sight (next station). For subsequent entries you can only add the forward sight (next station). It is not possible to break the traverse without deleting all stations that are ahead of the required insertion point.

Remove
Removes an existing station from the traverse. It is only possible to remove stations at end points.

Edit station ID
Change the name of a station in the traverse.

Settings
Find out more about these in Traverse settings.

Traverse information
Find out more about these in Traverse station information.

Calculate traverse
Find out more about these in Calculate traverse.

Traverse settings

The observations in the traverse can be entered with three types of data. The data and observation types are as follows:

Vertical angle with slope distance
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Vertical and horizontal distance
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Horizontal distance only
Horizontal angle back, Horizontal distance back, Horizontal angle forward, Horizontal distance forward. 2D

The first option, Vertical angle with slope distance, is the format that is always saved. Other values are calculated using this format. You can always enter data in any of the above three formats. The selected observation type has a significant influence on the information and statistics displayed for the traverse.

Tolerance
Enter the tolerance for your traverse in metres. If the tolerance is exceeded during the calculation you will see an error message telling you that the tolerance has been exceeded and that the calculation has stopped.

Print format
Select detailed or short list.

View
You can choose to view the traverse after the calculation has been made.

Information about stations in traverse

You will find this command in the menu. It gives you all possible information about the current station. You will see a summary of all observations and partial observations for the station. Different data will appear in the dialogue box depending on which type of observation format has been selected.

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Shows whether the measurement has been taken towards the backsight or the forward sight.

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The sum of the vertical angle and its maximum difference and standard deviation.

Slope distance:
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Horizontal distance:
The sum of the calculated horizontal distance.

Vertical distance:
The sum of the calculated horizontal distance.

Calculate traverse

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Other data in the calculate traverse dialogue box is: known points, point ID and co-ordinates.

The dialogue box shows:
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Result in traverse

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The results display the adjusted station co-ordinates and the distance/height deviation from the points. You can select whether or not you want to add the station point ID to the current polygon point file (.pp).

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Distance diff.:
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Height difference:
Calculated maximum difference at a measured height between two points. (Backsight and forward sight). The displayed difference is a comparison between the average value of distances measured from one direction and the maximum distance measured from the other direction.

Previous/Next
Click on these arrows to go to the previous or next station in the traverse. A greyed-out arrows means that you are at the end of the traverse.

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Total number of points in the traverse.

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Total number of points that where not known from the beginning and which have now been calculated.

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Total number of measured directions in the traverse from all points.

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Correction angle:
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Co-ordinates:
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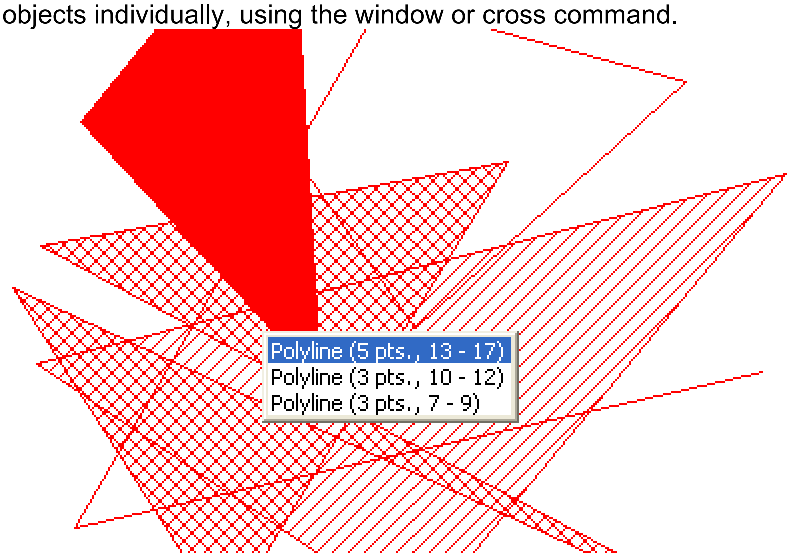
Drawing contents

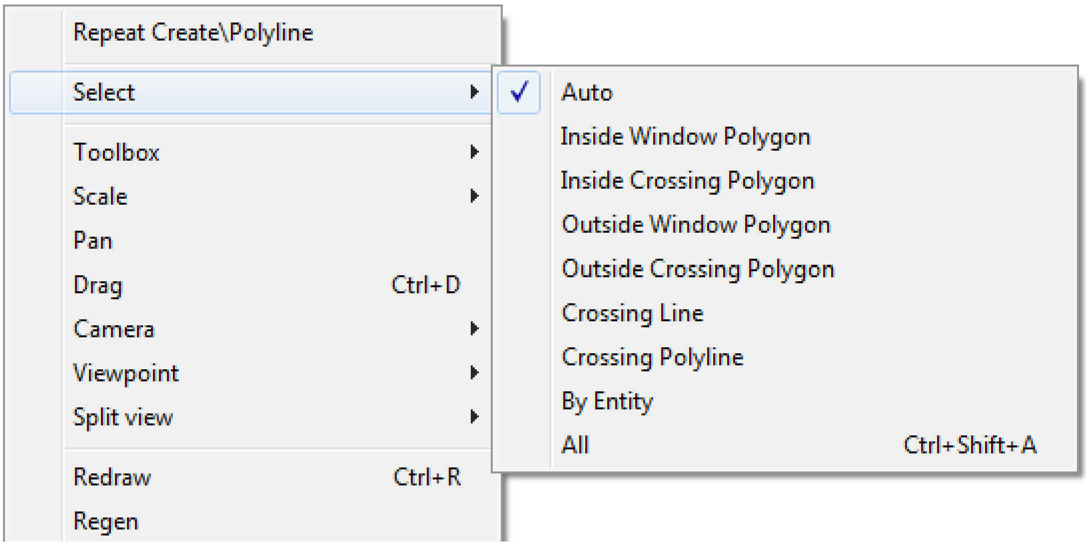
Select object

There are several ways to select objects.
You can select them one at a time by clicking on each one individually. To select all the objects that are completely inside an area, click to the left of them and drag the mouse to the right.
Click again. All the objects that were completely inside the rectangle are now selected.
To select all objects that are partly inside the rectangle, click on the right-hand side first and drag the rectangle to the left. All the objects that were partly inside the rectangle are now selected.
Objects can be deselected by pressing the Ctrl key when selecting one or more objects. You can deselect objects individually, using the window or cross command.

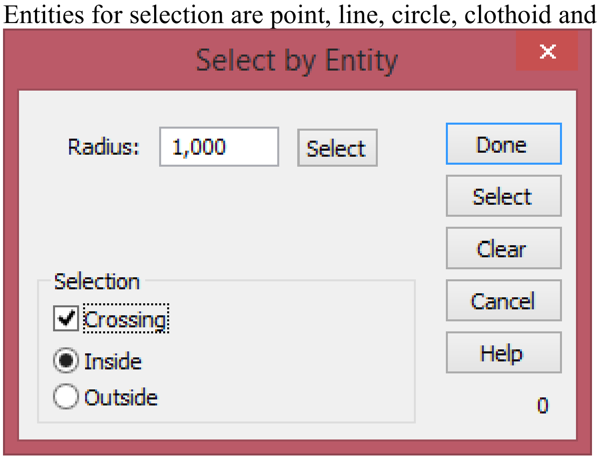


Selection possibilities

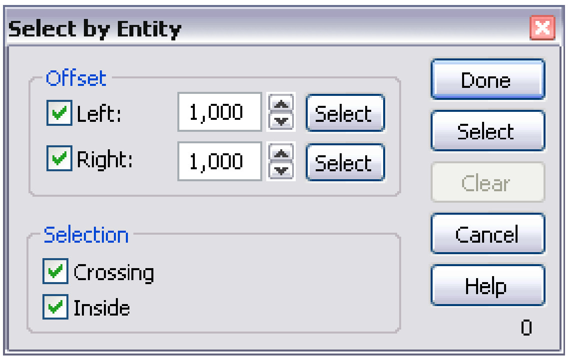
Point at a surface to select it. If there are several surfaces or point (points on polyline) a list will appear where you can select the correct object.

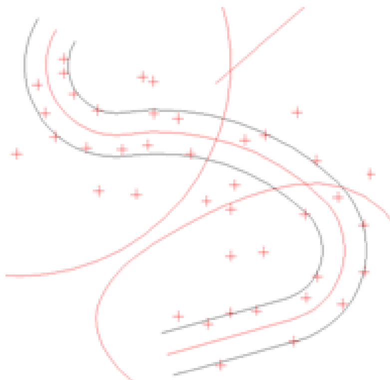


Select by polygon
You can select objects inside, partly inside (crossing), outside or partly outside a polygon. This is done by right clicking.
Select by entity
Entities for selection are point, line, circle, clothoid and roadline.



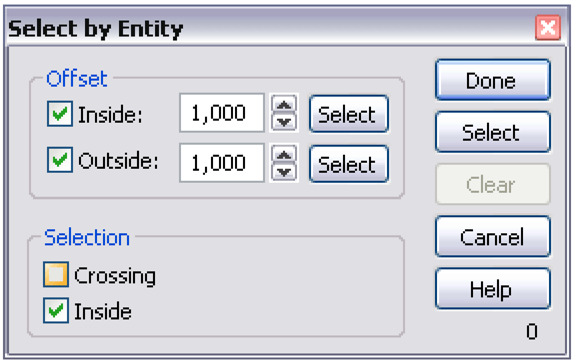
Selection
Crossing: Objects that are crossing selected area will be selected.
Inside: Objects that are inside the selected area will be selected.
Outside: Objects that are outside the selected area will be selected.
Line, roadline and clotoide

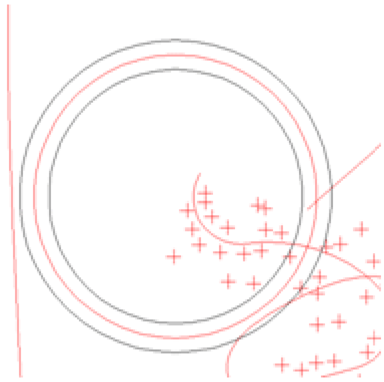




Offset left sets distance to the left of the line.
Offset right sets distance to the right of the line.

Arc





Inside sets the distance from the arc towards the middle.
Outside sets the distance from the arc and outwards.

See also

Toolbox - Selected objects.

Shortcut keys

Download and print! Shortcut keys list at http://adtollo.se/download/Topocad-short-keys.pdf

The following shortcut keys are used in Topocad:

Arc Ctrl + A

Auto snap F3

Baseline Shift + B

Boundary polygon Ctrl + 5

Break Ctrl + B

Cancel Escape

Circle Ctrl + U

Contour lines Shift + Z

Convert points to symbols Shift + 5

Convert symbols to points Shift + 6

Copy Ctrl + C

Copy objects to clipboard Ctrl + Shift + C

Create DTM Ctrl + F6

Create Polyline Ctrl + L

Divide Ctrl + D

Done F2

Done selecting, repeat command Enter

Done selecting, repeat command Space

Edit as text Shift + Q

Edit civil properties Shift + 7

Edit object attributes Shift + 8

Edit point attributes Shift + 9

Edit polygon Ctrl + 8

Edit polyline Shift + L

Edit text Shift + T

Erase DEL

Exit Ctrl + F4

Explode Ctrl + 0

Export file Shift + E

Extend to Shift + O

Extents Home

File new Ctrl + N

Fill area Shift + F6

Fillet Ctrl + Q

Filter Shift + F

Free flight 4

Group Ctrl + G

Gtransform Ctrl + F9

Import file Shift + I

Insert drawing sheet Shift + W

Insert drawing view Shift + V

Insert symbol Shift + S

Insert text Ctrl + T

Join Ctrl + J

Layer Ctrl + 1

Lengthen Ctrl + V

Mean points Ctrl + E

Measurement Shift + M

Mirror Ctrl + 3

Modify group Ctrl + 9

Modify raster Shift + R

Move Ctrl + M

Offset Ctrl + 2

Open file Ctrl + O

Orbit 3

Ortho 2

Paste objects from clipboard Ctrl + Shift + V

Pile differences Ctrl + F3

Point Ctrl + P

Point differences Ctrl + F

Point info Shift + F2

Polygon Ctrl + 4

Polyline nodes Shift + N

Fetch entity properties Shift + P

Proj4 transform Ctrl + F8

Properties Shift + F7 & Double click

Raster image Ctrl + R

Redo Ctrl + Y

Redraw F5

Regen Ctrl + F5

Rotate Ctrl + 6

Save Ctrl + S

Save as Ctrl + Shift + S

Scale Ctrl + 7

Select all Ctrl + Shift + A

Set civil properties Shift + C

Slope hatching Ctrl + H

Snap settings Ctrl + F11

Spiral Ctrl + K

Stretch Ctrl + F10

Text on contour lines Shift + Y

Transform Ctrl + F7

Trim Ctrl + X

Undo Ctrl + Z

View Area (Measure area) Shift + A

Window Ctrl + W

Zoom 0,25 x Ctrl + Page Down

Zoom 0,5x Page Down

Zoom 2x Page Up

Zoom 4x Ctrl + Page Up

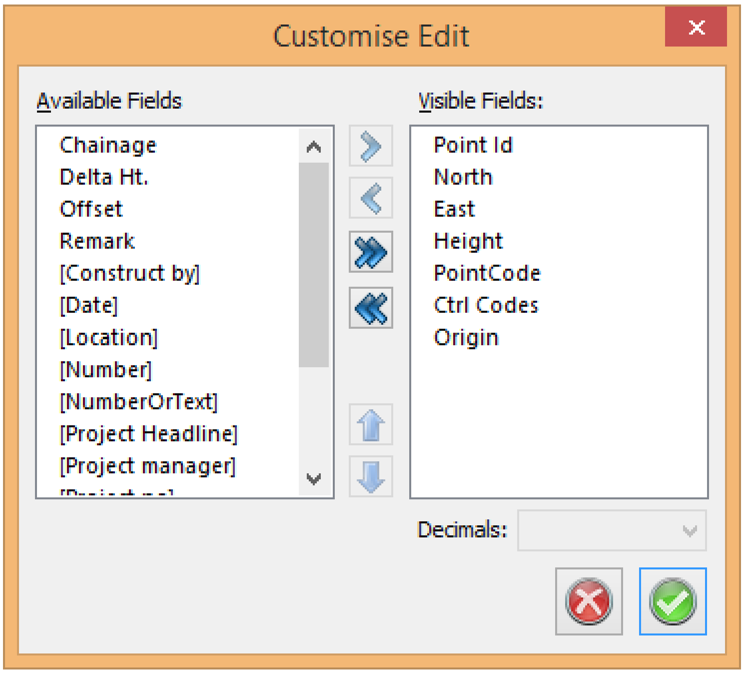
Column settings on grid

Right click on grid|Column settings

Grid, or tables, can be adapted in different ways in Topocad.

The data will only change visually when you customize your fields.

Right-click on the grid and select *Column settings* to edit your fields.
Select the fields you want to be visible, and how many decimal you want in each field.

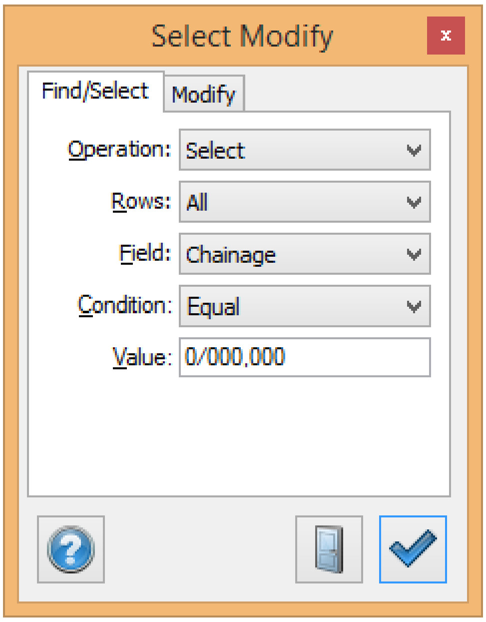


Search and Modify

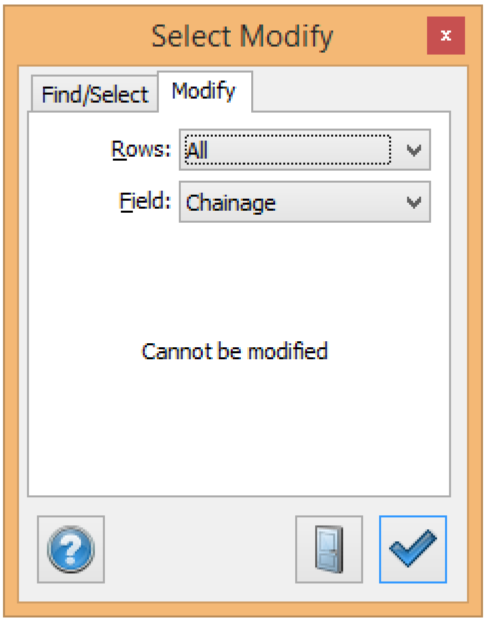
Right click on grid|Search and Modify

Right click on a grid/table and select *Search and Modify* to make advanced searches by

- Operation: Search next, Search first
- Rows: Selected, not selected etc
- Fields: Point Id for example
- Condition: Equal, Less, Greater etc



Modifications can be made during the search, for example Add, Multiply, Divide, change sign etc.

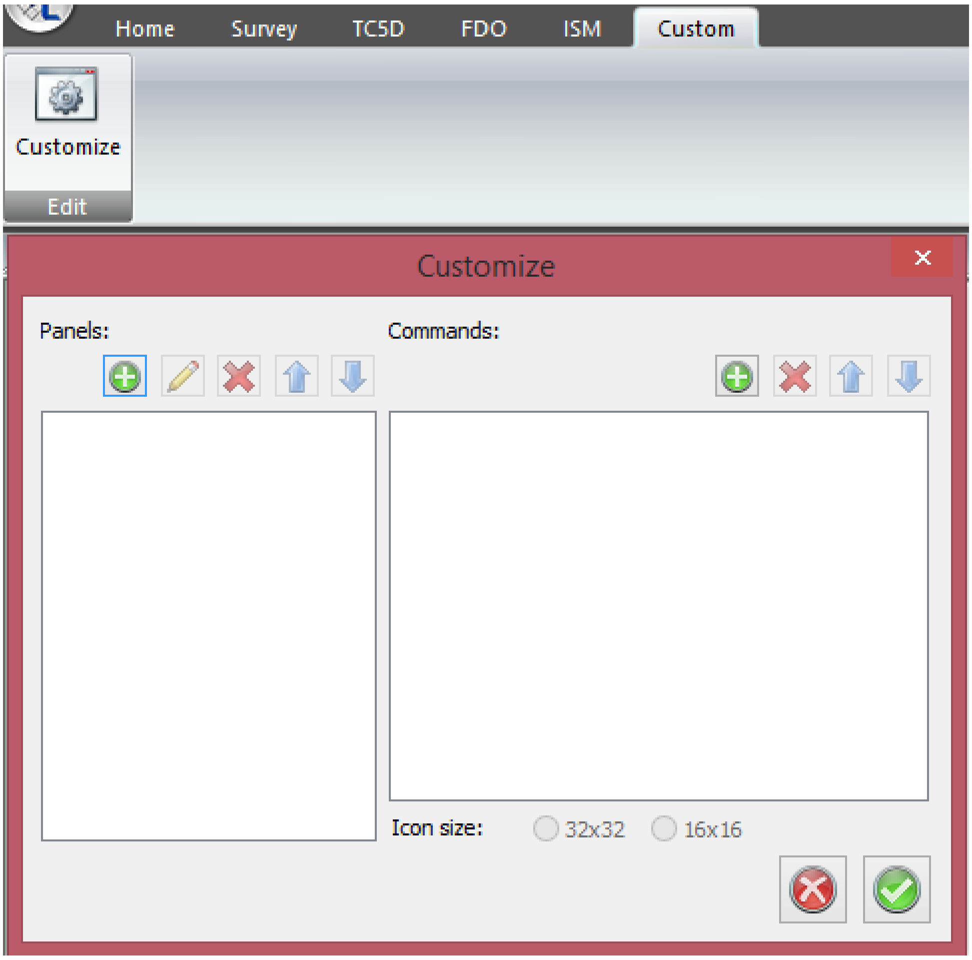


Customize toolbars

Drawing|Custom
Survey|Custom

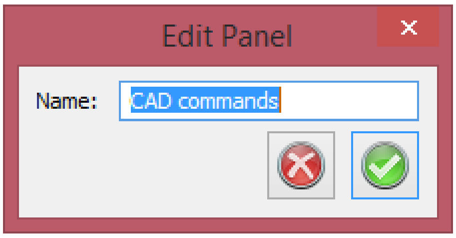
Function to create you own toolbar.

Open a drawing or survey document and go to Custom|Customize.

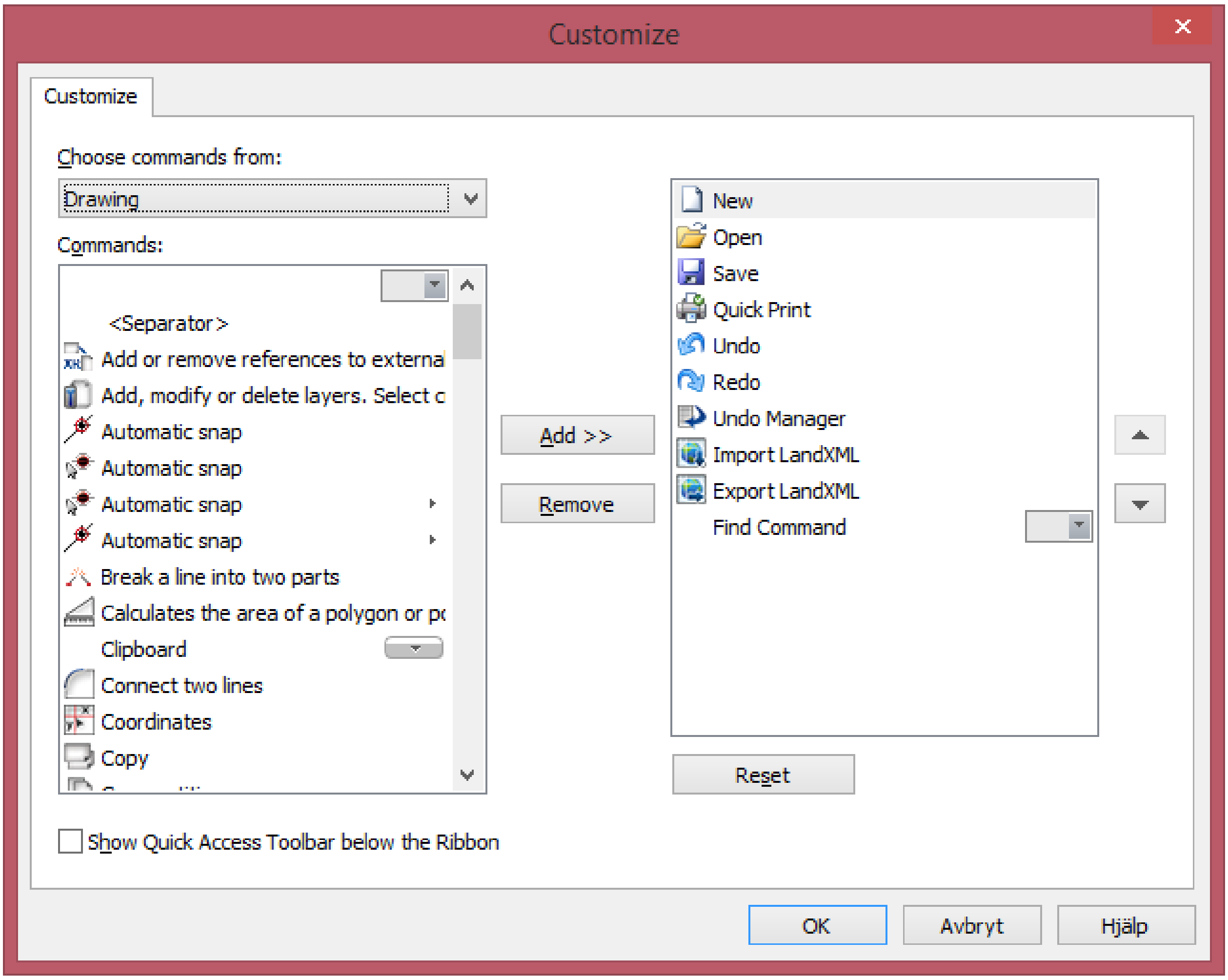


Add panles by clicking the Add button.

Name your panel.



Right-click your panel and select Customize Quick Access Toolbar.



Select your commands.

Drawing commands

Import/Export

Polyline
Polygon
Text
Point
Circle
Arc
Copy
Insert symbol

Dimension (Aligned)
Fillet
Group
Raster
Raster from WMS

Layer manager
Layer collections
User defined Coordinate systems

Snap settings

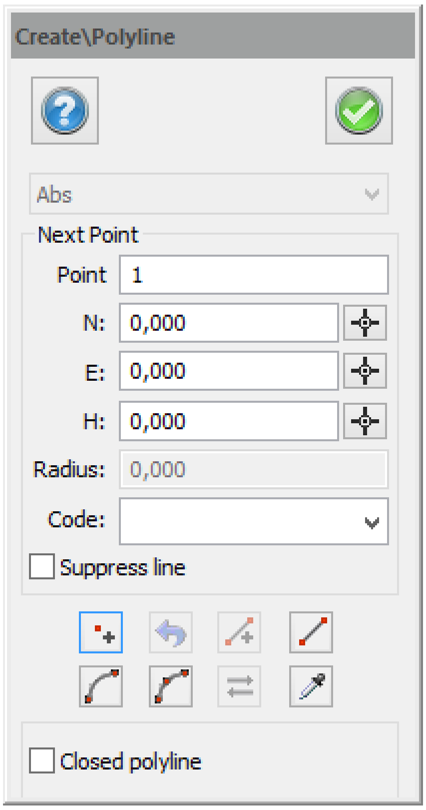
Move
Explode
Rotate
Stretch
Join
Extend
Polyline
Transform

Edit as text
Properties
External references
Point info
Distance
Area
XYZ
Filter
Nodes

Snap

Create polyline

Drawing|Polyline



Shortcut key Ctrl + L

Create Polyline

Enter the co-ordinates either in the dialogue box or directly on screen. If you are using the dialogue box click OK to continue to the next point. When the polyline is finished click Done.

Drawing with slope

You can draw a line with a slope by entering a slope like 1% or 1:100 into the height window. The first point in your polyline cannot have slope as it is a starting point of the line.

Dialogue explanations:

Add
When you type in co-ordinates click *Add* after each point. If you click OK twice for the same co-ordinates you will get two points at the same spot.

Finish
When the line is completed click Finish. This will terminate the command. You can also press the F2 button.

Undo
Undoes the last point

Arc
Arc which continues on the last element.

3 Pt. Arc
Arc with three points.

Reverse
Changes direction of line.

Get Style
Copies the style of any other object in the drawing. The style can be the layer name, colour or line type.

Suppress line
Check this box to suppress line or part of line. Double click on node (Shortcut N) to get to the Properties dialogue, to uncheck Suppress line.

Closed Polyline
If you want the line to be closed, i.e. a polygon, check this box.

Construction line
A construction line is not visible in the drawing.

Spline
A spline will create splines of the line (with a rounded shape)

Polygon
Polygon will create a polygon of the polyline.

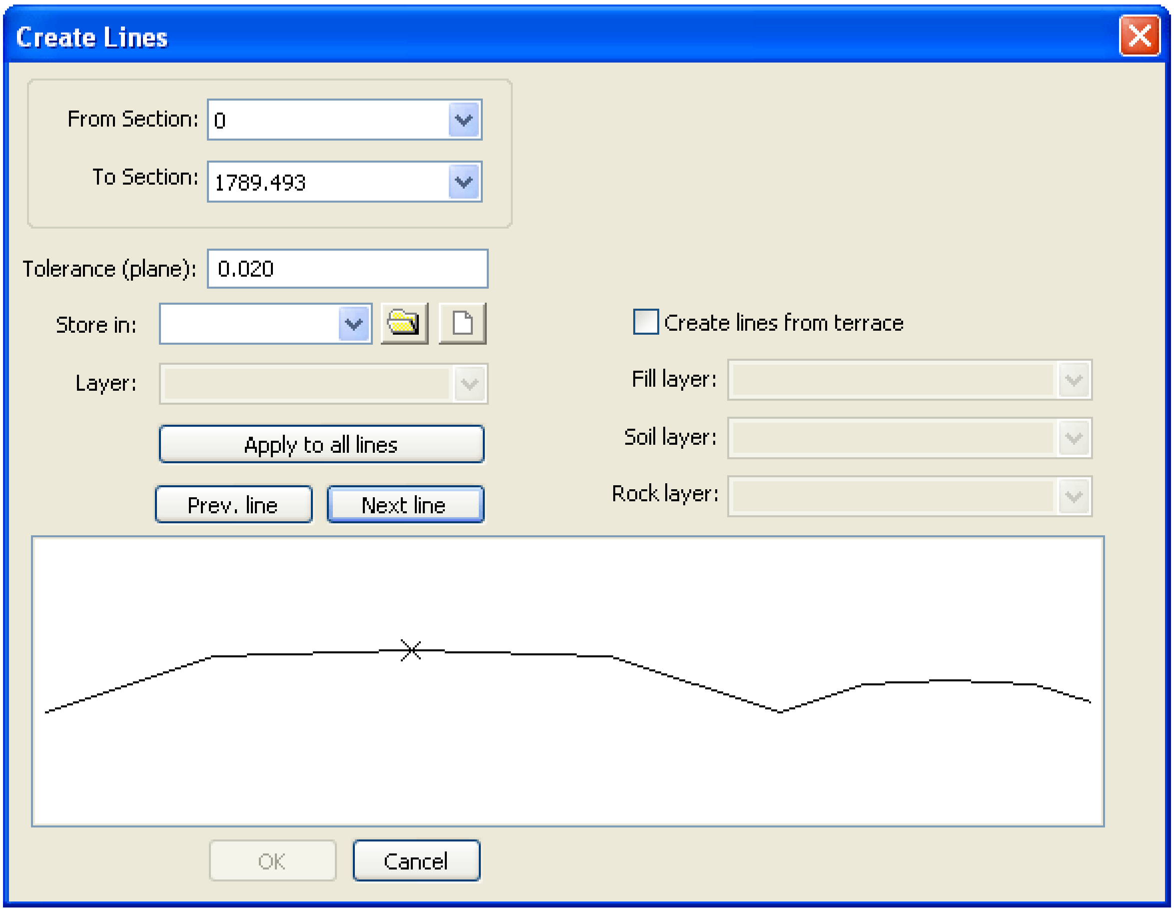
Filled
If you want this line to be filled with the same colour as the line itself, click in this box.

To draw a polyline with a baseline:

1. Select the baseline
2. Select the co-ordinates toolbox in *Tool box|Co-ordinates.*
3. Select Draw polyline.
4. Enter the co-ordinates directly into the toolbox rather than clicking on every co-ordinate. You can opt to enter true co-ordinates directly into the Draw polyline box. Enter the co-ordinates for the baseline function by entering them in the co-ordinates box. Enter delta co-ordinates from the last point in the baseline and the distance and bearing from the last point, by selecting the relevant set in the co-ordinates box. After each point press Enter while you are still in the box. You can then select another type of input data for the next point.
5. When the polyline is completed, click Done in the Polyline dialogue box.

The point number will increase one step at a time. If you enter 100 for the first point in the polyline, the next point ID will be 101. If you enter 100.01 the next number will be 100.02.

Create lines in drawing from several elements in calculated section

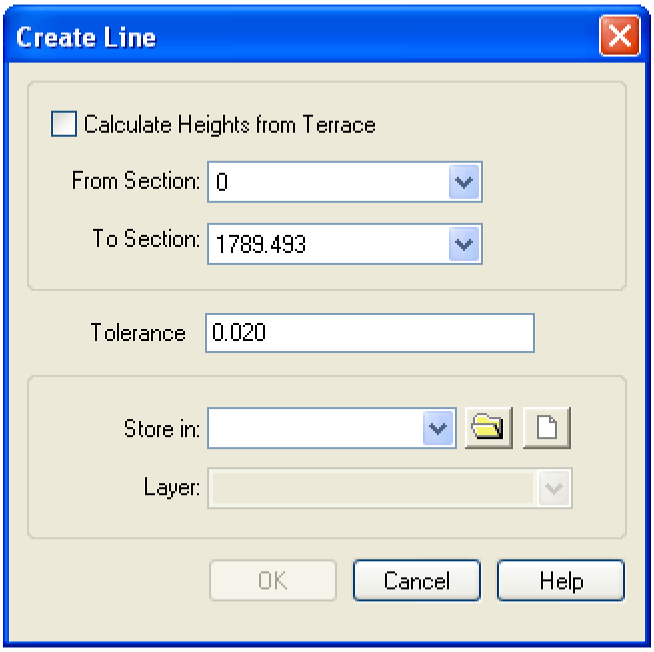


The command is available when you work with a calculated section and activates in the menu under Create | Create multiple lines in drawing.

The command works as Create polyline in drawing in the same menu, the difference is that multiple lines can be created at the same time. You must decide which layer to use for each created line. If no layer name is selected, the line will not be created. Select line by clicking "Prev. line" and "Next line". "Apply all lines" applies all lines in selected layer.

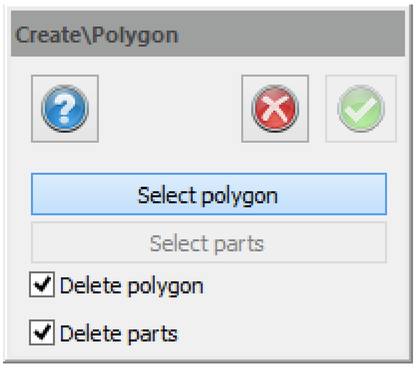
Create line with radius

From Create | Create line in drawing and Create | Create multiple lines in drawing you are able to set a tolerance. The tolerance decides how much the created lines can differ from a perfect line. A perfect line is in this case a line which is calculated with an infinite small interval. For example, if the tolerance is set to 0.02, no part of the created line can be created longer than 2 centimetre from the perfect line. The tolerance only refers to deviations in plane. The heights for the point in the created line are interpolated between the calculated sections. The tolerance is not used when lines are created from the terrace.



Polygon

Drawing|Polygon



Function to create a polygon i drawing.

Handle of holes in surfaces (polygon)

The polygon handles holes (polygons inside polygons) and islands (polygons outside polygons). Polygons are supported by import/export via the ISM connection, the ArcGIS connection and via ESRI Shap files.

Delete holes in surfaces (polygon)

Function to edit an existing polygon by deleting parts in the polygon and also to add another surface outside the "basic surface".

Select polygon
Select main polygon. Only polygons of polylines and arcs are supported at the moment.

Select Parts
Select parts (hole or islands). They cannot cut the main polygon or each other, neither be passing through each other.

Delete polygon
Delete selected objects used as main polygon or created of the polygon.

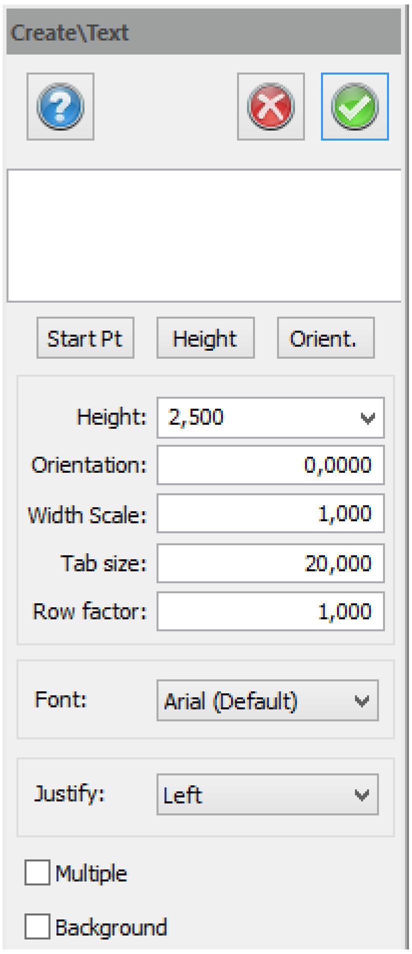
Delete parts
Delete objects that was selected as parts of the polygon.

Text

Drawing|Text

Shortcut key Ctrl + T

You can enter text directly into the drawing. It is also possible to select the height, rotation and width for the text.



To enter text:

1. Select the Text command or use the shortcut key (Ctrl + T).
2. Enter the text in the dialogue box. You can also copy and paste the text from another word processor.
3. Select the height, scale width, rotation and font style for the text. Enter the values manually or select from the drop-down list. It is also possible to select the height and rotation directly in the drawing.
4. Click on Height in the dialogue box. Select the height you want for the text. Next you will need to set the orientation. It is possible to select the orientation in the drawing by using snap commands or you can enter it manually. To exit the orientation selection, click on another step, such as Insertion point in the dialogue box.
5. Click on Insertion point in the dialogue box. Select the start point in the drawing.

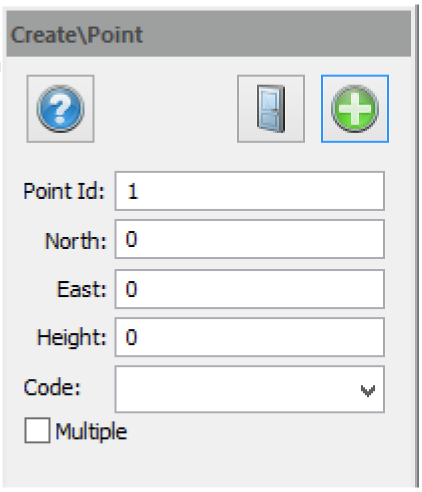
TIP! The insertion point for the text is the first letter of the first row in the bottom left-hand corner.

TIP! For this and the other commands you can close the dialogue box and use the context menu instead (right click).

TIP! Repeat the command by pressing the spacebar or Enter key.

Point

Drawing|Point



Function for drawing point. Enter the co-ordinates in the dialogue box or click on the screen with the mouse.

It is also possible to enter the point codes for points. You can either enter them manually or select an existing code from the drop-down list.

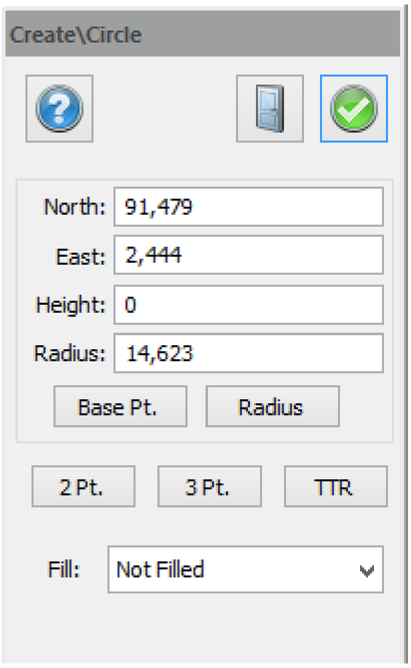
If you want to enter points with a baseline (A and B distances) you can create the baseline under *Settings*|*Baseline* and then select Toolbox|Co-ordinates to enter the local co-ordinates in the toolbox. For more information, refer to the section on Draw line

The point number will increase by one step at a time. If you enter 100 for the first point, the next Point ID will be 101. If you enter 100.01 the next number will be 100.02

Circle

Drawing|Circle

A constructed circle is made up of a centre point and a radius. There are several ways to input this data:



- Centre Point + Radius. The circle is created from the centre point with the given radius.
- 2 points (the diameter). The circle is created between the two points.
- 3 points. The circle is created from three points. The centre point and the radius are calculated.
- Tangent-tangent-radius. The circle is created from two tangents and a given radius. The centre point is calculated.

To draw a circle with the help of a centre point and a radius:

1. Select *Create* | *Circle*.
2. You can now either enter the co-ordinates for the centre point or click in the drawing with the mouse. Snap commands can be used. The co-ordinates toolbox can be used.
3. Enter the radius. You can either enter the value manually in meters or use the mouse.
4. If you entered the values manually you will need to click Done when you have finished. If you use the mouse the command will finish as soon as you have entered both the co-ordinates and the radius.

To draw a circle using two points:

1. Select *Create* | *Circle.*
2. Click 2 pt.
3. Click on one end of the diameter. Snap commands can be used. The co-ordinates toolbox can be used.
4. Click on the other side of the diameter. Snap commands can be used. The co-ordinates toolbox can be used.
5. Done.

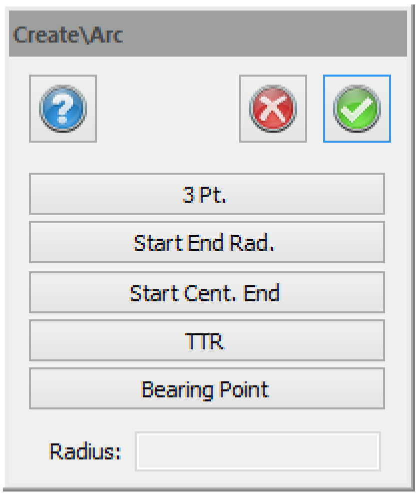
To draw a circle with using three points:

1. Select *Create* | *Circle.*
2. Click 3 pt.
3. Click on two of the points of the circle. Snap commands can be used. The co-ordinates toolbox can be used.
4. Click on the third point. You will see the shape of the circle before you input the last point. Snap commands can be used. The co-ordinates toolbox can be used.
5. Done.

To draw a circle using tangent-tangent-radius

1. Select *Create* | *Circle*.
2. Click the TTR button.
3. Click on the first tangent - polyline, circle or arc - you want to use. Snap commands can be used.
4. Click on the second tangent - polyline, circle or arc - you want to use. Snap commands can be used.
5. Click on the radius or input it manually. If you entered it manually you will need to press Done. If you click on two points in the drawings the length of the radius is given.

Arc



A constructed arc is made up of a centre point, a radius and a length for the arc. There are several ways to input data:

- **3 points** The arc is created from three points. The centre point and the radius are calculated.
- **Start-End-Radius** The arc is created from the endpoints and a given radius
- **Start-Cent. End** The arc is created between the two endpoints and a given centre point between them.
- **Tangent-tangent-radius** The arc is created from two tangents and a given radius. The centre point is calculated.
- **Bearing-Point** Select one end of the line. The radius will run from this end with no bearing difference to any other point of your choice.

To draw an arc using three points:

1. Select *Drawing|Arc*.
2. Press the **3 Pt.** button.
3. Point with your mouse or use the co-ordinates toolbox to input three points. Snap commands can be used.
4. If you are entering the values manually, click Done when you have finished. If you used the mouse the command will finish as soon as you have entered both the co-ordinates and the radius.

To draw an arc using endpoint-endpoint-radius:

1. Select *Drawing|Arc*.
2. Press the **Start-End-Radius** button.
3. Click each end of the arc or enter the values manually. Snap commands can be used. The co-ordinates toolbox can be used.
4. Select the radius. You can either use your mouse or enter the radius manually. Snap commands can be used. The co-ordinates toolbox can be used.
5. If you entered the values manually, click Done when you have finished. If you used the mouse the command will finish as soon as you have entered both the co-ordinates and the radius.
6. Done.

To draw an arc using endpoint-centre-endpoint:

1. Select *Drawing|Arc*.
2. Press the **Start-Cent. End** button.
3. Click on the first point of the arc. Snap commands can be used. The co-ordinates toolbox can be used.
4. Click on the centre point. This gives the length of the radius. Snap commands can be used.
5. Click on the other endpoint. You will see that the arc shapes when you use your mouse. You can either use the snap commands or input the co-ordinates manually by using the co-ordinates toolbox.
6. Done.

To draw an arc using tangent-tangent-radius:

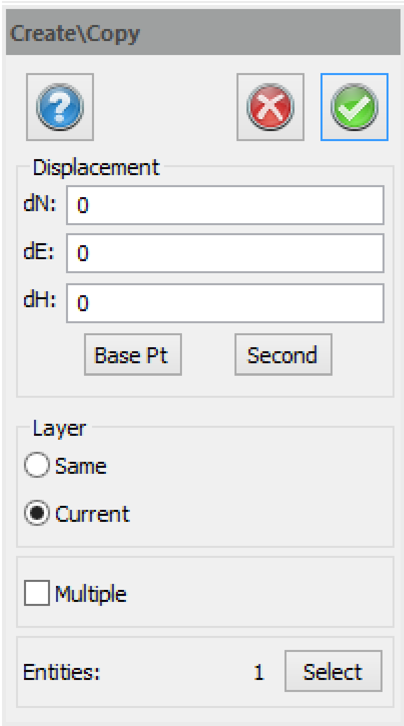
1. Select *Drawing|Arc*.
2. Press the **TTR** button.

3. Click on the first tangent - polyline, circle or arc - you want to use. Snap commands can be used.
4. Click on the second tangent - polyline, circle or arc - you want to use. Snap commands can be used.
5. Click on the radius or enter the value manually. If you entered it manually you need to press Done. If you click on two points in the drawing the length of the radius is given.

Copy

Drawing|Copy

Shortcut key Ctrl + C



It is possible to copy an object at the same time as rotating it.

The procedure is as follows:

1. Select Copy.
2. Click on Select (in the bottom right-hand corner of the dialogue box) and select which objects you want to copy. (Note: the Select command is automatically activated when the Copy command has been activated.) The Select command can also be activated both before activating Copy and after selecting the base and insertion points.
3. Select the base point to copy. This point should be somewhere in the copied object.
4. Select Next point. The selected objects will be copied.
5. If you want to copy the object in dX, dY or dZ you do not need to select the base point. Enter the value(s) and click OK.

Layer

Same
Places the copied objects in the same layer as the original.

Current
Places the copy in the current layer.

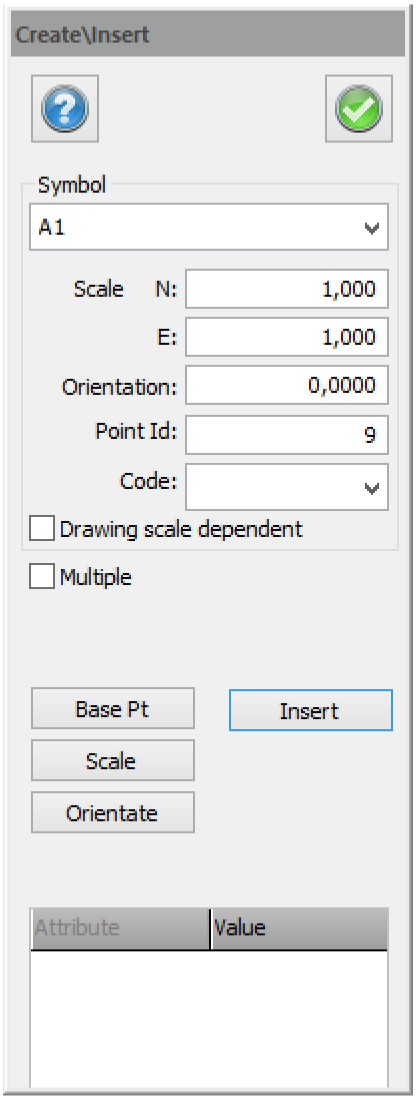
Multiple
Copies the object to multiple locations. This is only possible when you select Next point directly in the drawing. If you enter values manually you can only copy the object once.

Insert symbol

Drawing|Insert

Shortcut key Shift + S

It is easy to insert a symbol from the symbol list whenever required. Symbols are handled as points and an also have a point code.



To insert a symbol:

1. Select Insert symbol.
2. Select the symbol from the drop-down list.
3. Enter the values for Orientation and Scale if required. The scale is connected to the scale of the selected drawing (Drawing|Scale). For example: if the drawing scale has been set to 1:500, the scale here will automatically be set to 0.5 because the default drawing scale is 1:1000.
4. Select insertion point. Click with the mouse where you want it the symbol to appear. Snap commands can be used. When you have selected the insertion point you will be asked for the orientation. If you select the orientation here you will also be asked for the scale. When you have selected the insertion point you can click Done to use the settings in the dialogue box.

Sample: Insert the drawing frame:

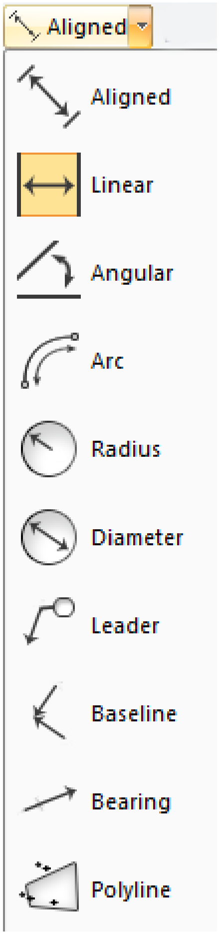
1. Select *Symbols and Attributes* | *Insert symbol*.
2. Select the drawing frame you want to use from the drop-down list. Symbols are selected under Preferences – System files.
3. Select the start point from the dialogue box. Go to the drawing to see whether the frame will fit or whether it is too big.
4. Select an appropriate scale. To re-scale the drawing frame A1S1000 to a 1:500 scale select the scale 0.5 for both X and Y-axes. Note that the scale is connected to the scale of the selected drawing (*Drawing|Scale*). For example: if the drawing scale has been set to 1:500, the scale here will automatically be set to 0.5 because the default drawing scale is 1:1000.
5. If you have not yet done so, click the point at which you want to place the drawing frame insertion point in the drawing. The insertion point for frames is in the lower left-hand corner.
6. Select orientation. You can either type in the orientation or indicate it in the drawing. When you are satisfied click Done in the dialogue box.

Select symbol - Select symbol by clicking on the symbol.
Delete symbol - Select Edit|Delete|Create|Delete Point or the Delete button, to delete selected symbols.
Modify - Select Create|Modify and a dialogue will open to edit selected symbol.

Dimension

Drawing|Aligned
Design|Aligned

Select dimension from the drop-down list called Aligned in the menu.



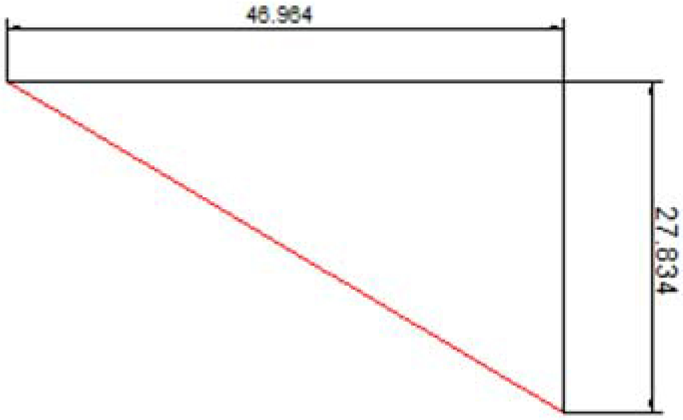
Dimension can be made in different ways with different settings.
Associative dimensioning is a connected dimensioning which is updated automatically when you edit the object that is connected to the dimensioning.

For settings, visit System|Dimension Style Manager

Different types of dimensioning

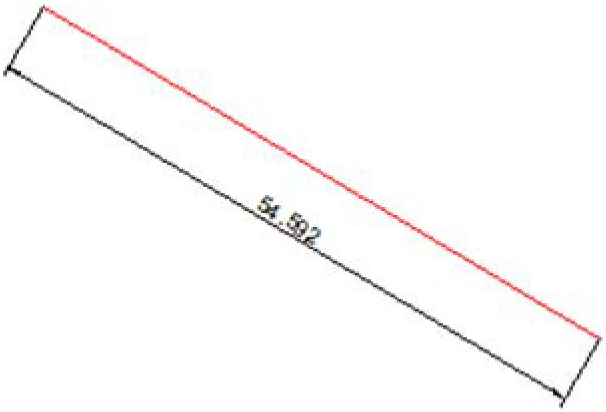
Linear

Linear dimensioning is always vertical or horizontal.



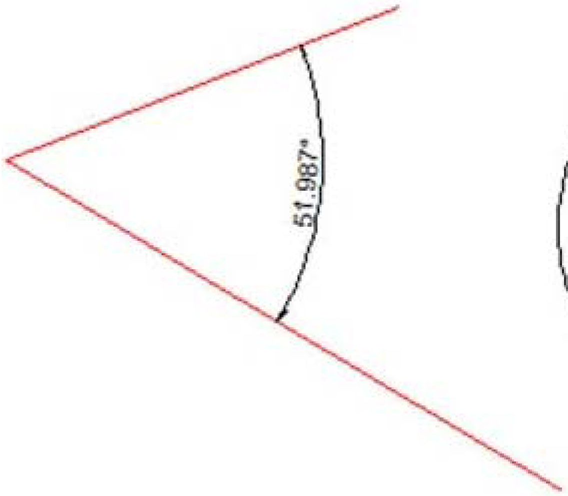
Aligned

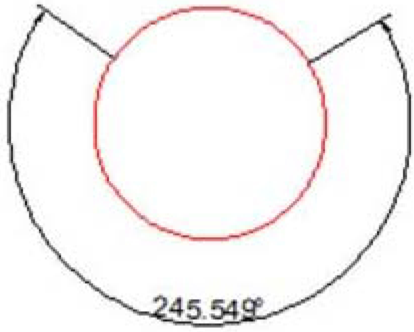
Aligned dimensioning is parallel to the measured object.



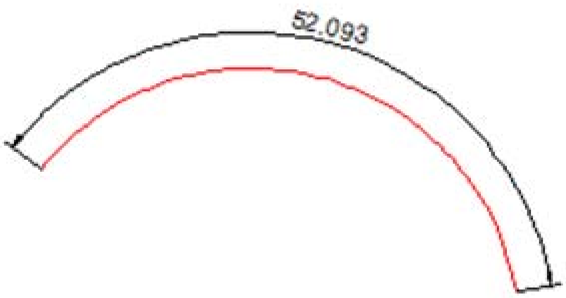
Angle

Inserts the angle between two lines.



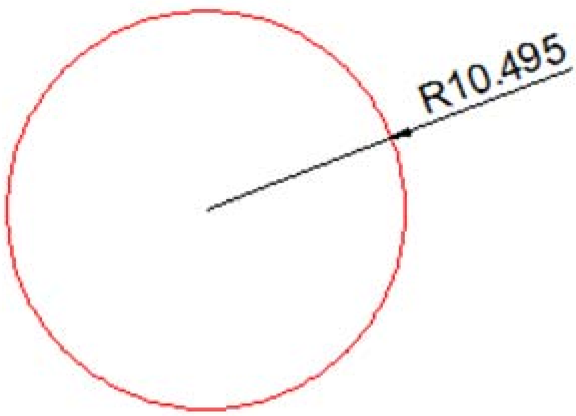


Arc Length



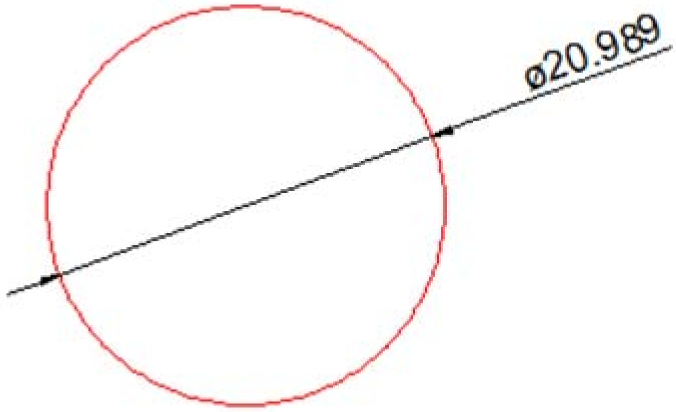
Radius

Measures the radius of circles and arcs.



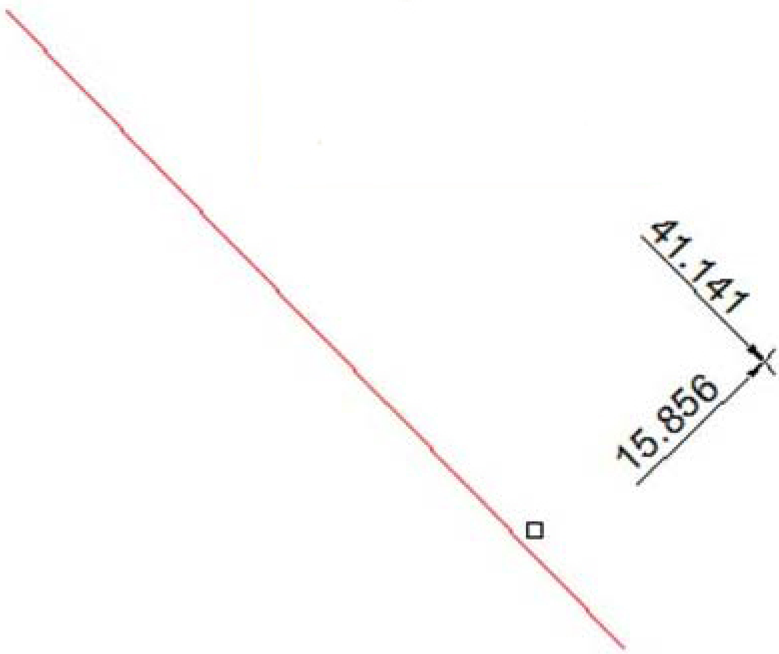
Diameter

Measures the diameter of circles and arcs.



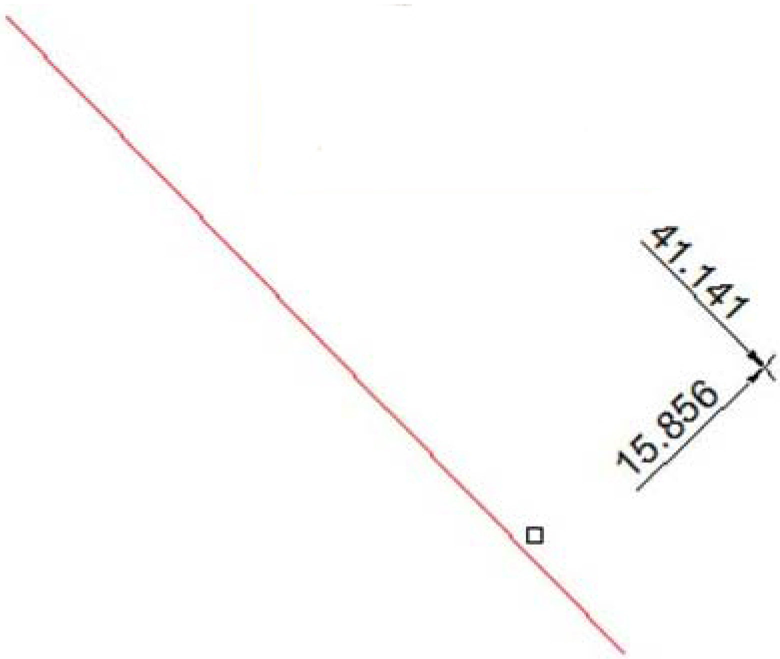
Leader

Inserts a line for an explanatory text.

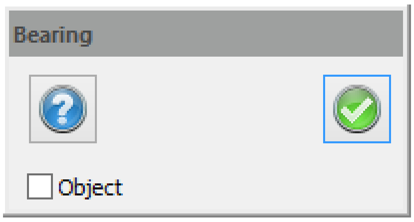


Baseline

Inserts the distances after each line.



Bearing

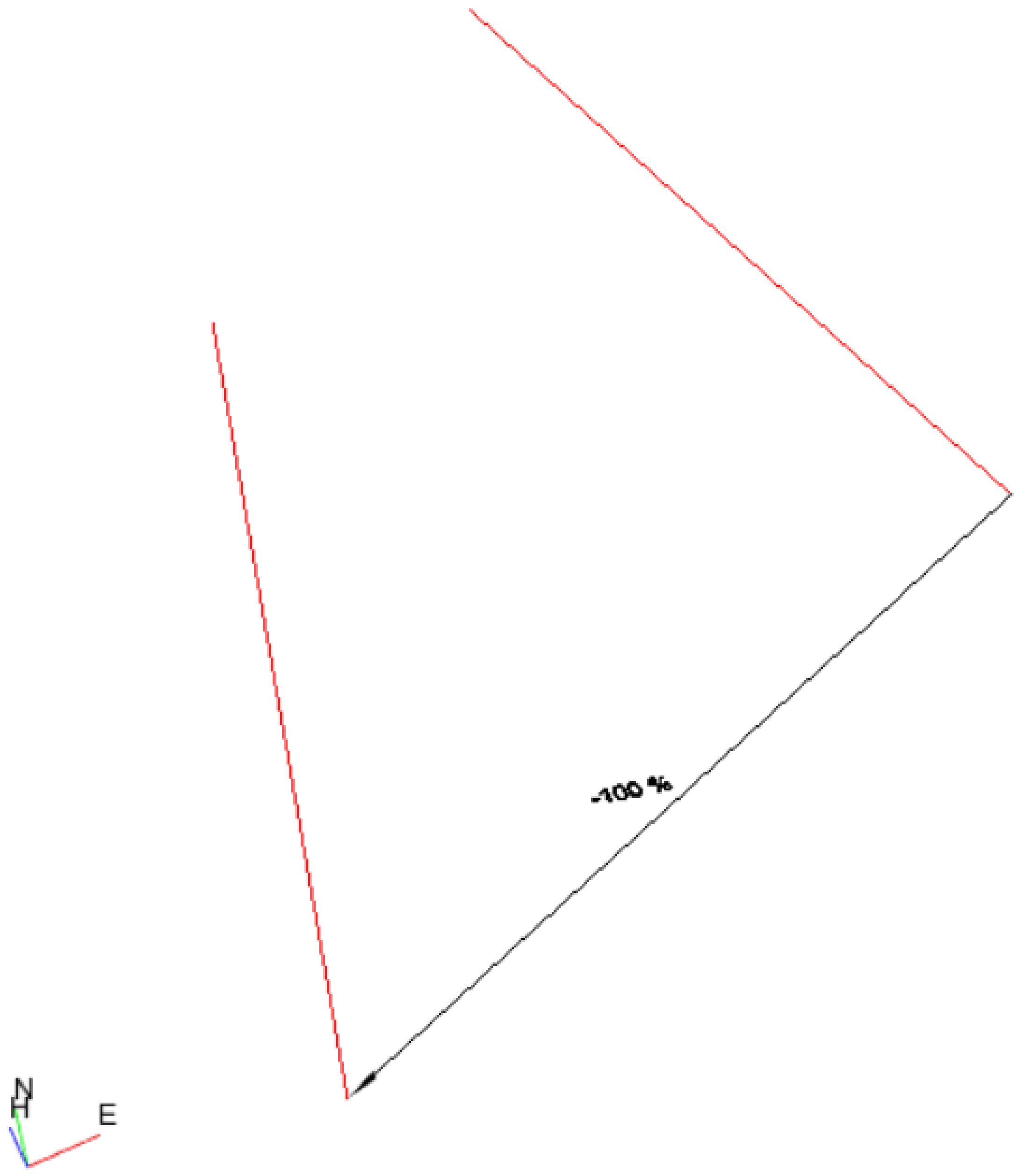


Polyline

Polyline dimensions adds distances for all sides in a polyline and is putting the distances in a box places manually.

Slope

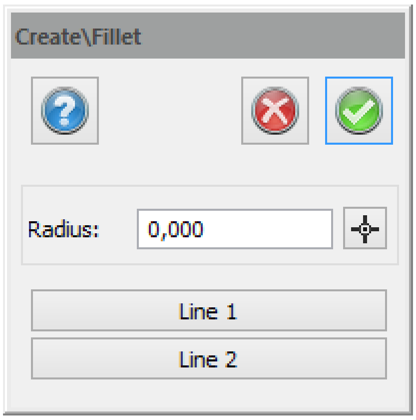
Adds the slope with a direction arrow.



Fillet

Drawing|Fillet

Shortcut key Ctrl + Q



Fillet is a command that connects two polylines to one another. It is also possible to use the radius in this command. In this case the two lines will be connected (but not joined) with a radius. There are three ways to do this:

- For two polylines which do not pass each other. These two polylines are extended until they meet.
- For two polylines which do pass each other. These polylines are shortened until they meet.
- For two polylines where one does not reach the other. One of the polylines is extended until it meets the other; the second one is shortened to the same point.

To use the Fillet function without a radius:

1. Select *Create|Fillet*
2. Select the two polylines that you want to join. If one or both polylines pass the other, click on the end of the line that you want to retain
3. You can continue with the command or click Done.

To use the Fillet function with a radius:

1. Select *Create|Fillet*
2. Select the radius that you want to use between the two lines. You can either input the radius manually or select it in the drawing.
3. Select the two polylines that you want to join.

Group

Drawing|Group

Shortcut key Ctrl + G

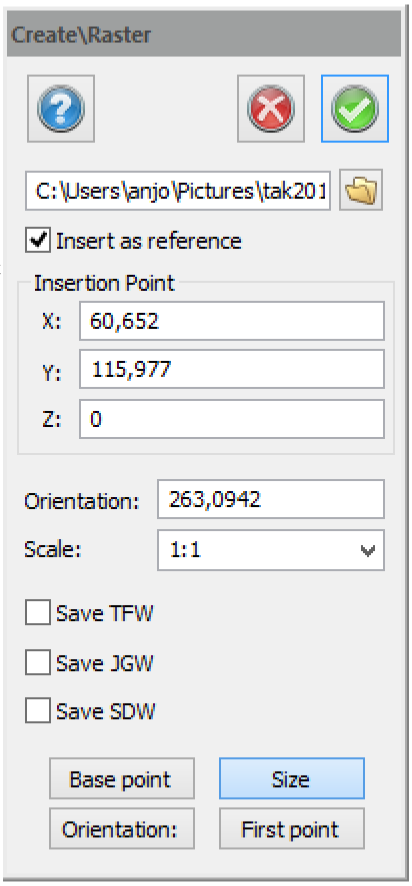
Objects can be grouped together. These objects do not have to be in the same layer or have other similar properties. If an object is grouped the complete group will be selected when the any one of the objects is selected.

This function is used when you want several objects to be treated in the same way, for example if you want to rotate multiple objects.

Insert raster image

Drawing|Raster image

The command "Raster" adds a raster image to the drawing. The image can be inserted directly into the drawing or as a reference with a link to the image.

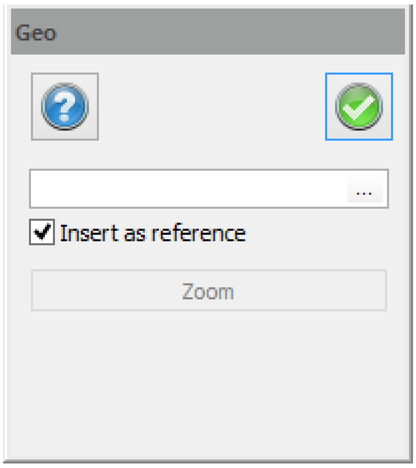


Settings that can be used are insertion coordinates in three dimensions; X, Y and Z, the direction of the image and the scale. If there is a Geo reference in the file or as an attached file, it will be read in the dialogue and applied.

Save TFW, JGW, SDW
Check boxes to save the geo ref. data in TFW, JGW and SDW files. The geo ref. data is saved the same time as the drawing is saved and has the same file name, except the file extension. If the geo ref. data is saved for a certain raster image, the raster image will get the same position if it is inserted into another drawing.

Click on selected point in drawing
If you click on the drawing and have a library of geo ref raster images, the software will automatically select the image covering the point you clicked on.

These images can be inserted in the drawing by clicking outside the frame of an image. When the cursor is placed inside of the frame, the frame will be drawn.



The *Zoom button* zooms the drawing so all of the images of the catalogue are covered.

If *Insert as reference* is checked, only the file name of the raster image will be stored in the drawing. If it is not checked, the whole image will be stored and the drawing file will be larger.

See also

Edit raster.

Raster - Insert raster image from WMS

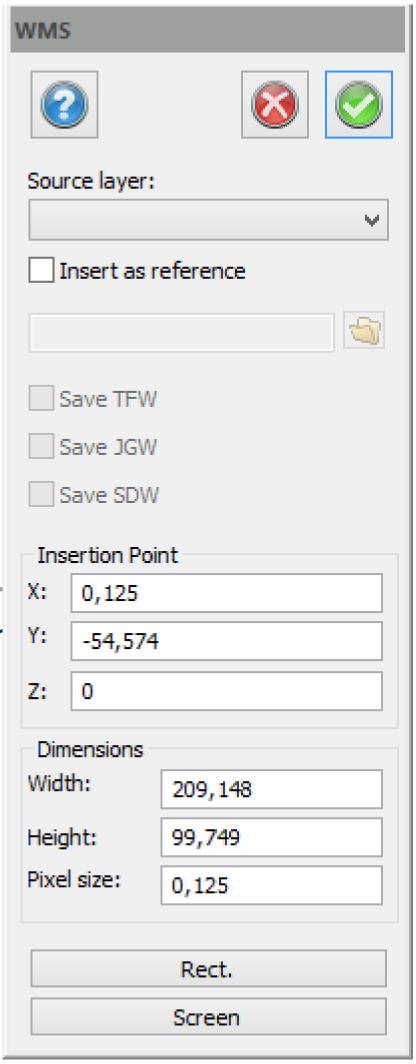
Create|Raster image from WMS

The command inserts an image from a WMS (Web Map Services) as a raster object in the drawing. The command requires at least one layer with WMS settings in the drawing. If the default settings are used, an image will be inserted to current view. It is also possible to select a rectangle from which the image shall be inserted.

If the image is inserted as reference, the image will be saved as a JPEG. You can also create a JGW-file which describes how the JPEG is georeffered. (It will automatically be saved in the right place if it is inserted in another drawing whith tje same co-ordinate system). The JGW file is saved at the same time as the drawing files is saved. If the image is not inserted as a reference, it will be a part of the drawing.

See also

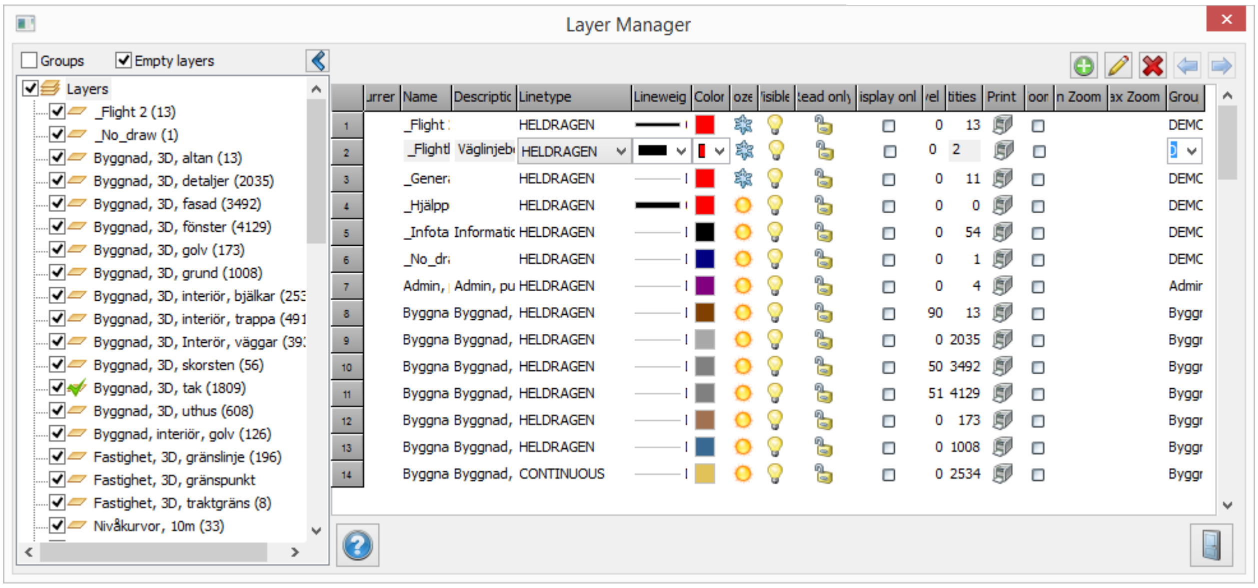
Layer manager WMS



Layer Manager

Drawing|Layer manager

Short key: Ctrl + 1



Layers are one of the many ways to distinguish between different types of data in Topocad. A layer can consist of buildings, pipes, cables, polygon points, survey 1 etc. Using layer control is an effective way to handle different types of data. The layer manager is a toolbox, in other words it can be open while you work with the drawing.

The Layer Manager is one of several ways to separate different types of data in Topocad. A layer may for example consist of buildings, roads or trees or may also have completely different classifications. The benefits of sorting different types of data in different layers are many. For example is it possible to turn on and off the type with a single command. Also, you can arrange the different codes (wall, middle of the road, curb, etc.) into different layers and you can in your drawing ignite or extinguish everything related to the code about to do. It is possible to select multiple layers simultaneously, for example, mark them as frozen simultaneously.

Working seamlessly with Layer Manager

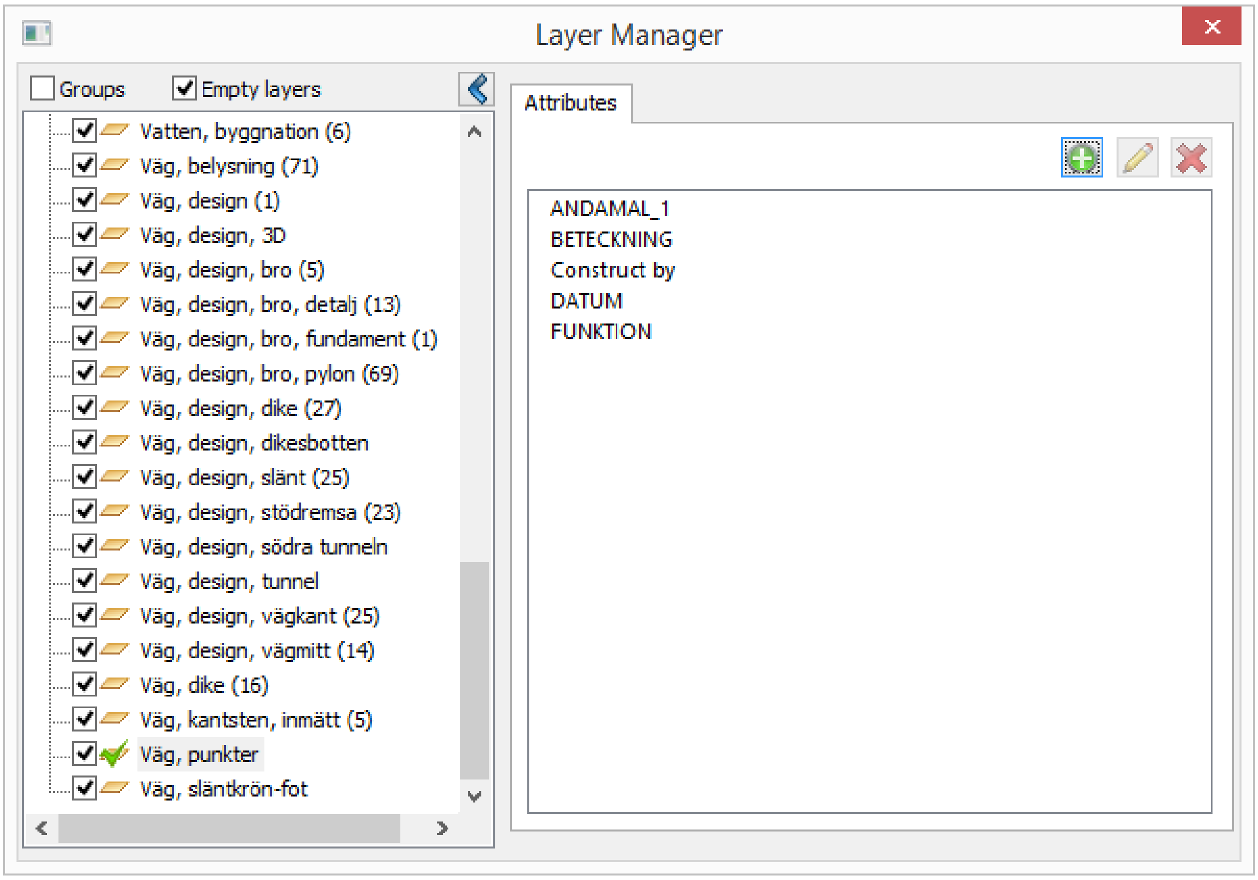
Layer Manager is a toolbox, that is, you can leave it out while working in the drawing. If you want to change the size of the dialog, you can click the button marked << above the layer list.

See also

Layer collections: create a list of the layers you want visible at the moment. A very quick way to turn layers on/off.

Attributes and Properties of the Layer Manager

Double-click a layer to display the layer's attributes and properties. In the Properties tab are sub-types, styles and objects.



It is possible to work with layers in several ways. These will be explained here.

To create a new layer:

1. **Activate** layer control.
2. Click on the button **Create** down to your left. Enter the name and description. The layer can have any name. Note that other CAD programs may not allow spaces or accented characters such ad Å, Ä, Ö.

Settings

Current

Select which layer will be the current layer. This can also be done in the menu. A quick way to select a current layer is to double click the layer name in the list to the left of the layer control window. The current layer will be displayed with an arrow to the left of it in the status list.

Name
Choose any name to the layer, but remember that it may change when exporting to other drawing files.

Description
The layer can have a description.

Line type
Select which line type you want to use for the layer. Note that the point code may have a different line type. If this is the case, the line type of the point code will be the active one.

Line weight
Select line weight for layer.

Color
Select which color you want the layer to have. If you have already made settings e.g. in. the code table you do not have to do so again.

Frozen
Yellow mark means not frozen and snowflake means frozen layer. A frozen layer is not visible and cannot be regenerated. The good thing about working with frozen layers is that it is much faster, compared to hidden layers. This is because they are not included when regenerating the drawing.
Function to easily freeze layer: Activates by clicking the button or from right click menu. If the command is activated, all the layers the user clicks on will be frozen. The command terminates when clicking Escape or Return or by activating another command.

Visible
The visible layer is marked with a yellow lamp when it is visible and a grey lamp when it is hidden. A hidden layer is not visible but will regenerate when the drawing is regenerated.

Read only
Read only is marked with a lock which can be locked or unlocked depending on its status. A read only layer is visible but although you can snap on it you will not be able to change anything in the layer.

Display only
Display only is marked with a cross in the square. The layer is visible but you cannot work in it.

Layer level
The layers can be stated in different levels where the higher the level shows higher in drawing. In a similar way as order but on a layer level. The layer level has a higher priority then what the object order has.

Zoom alternatives
A layer is visible only within certain zoom limits (zoom= the drawing width in meters).

- On: the layer displays only within certain zoom limits.
- Off: The layer is displays only if it is selected as Visible in the layer manager.
- Min zoom: the minimum zoom where the layer is visible.
- Max zoom: The maximum zoom where the layer is visible.

Blank values on Min zoom and Max zoom are not valued as limits.
Current zoom in drawing is displayed at the scaler if settings has been made under Settings|System settings|Screen|Display zoom and if the scalor is visible.

Object
The number of objects in this layer.

Print
Select which layers you would like to print.

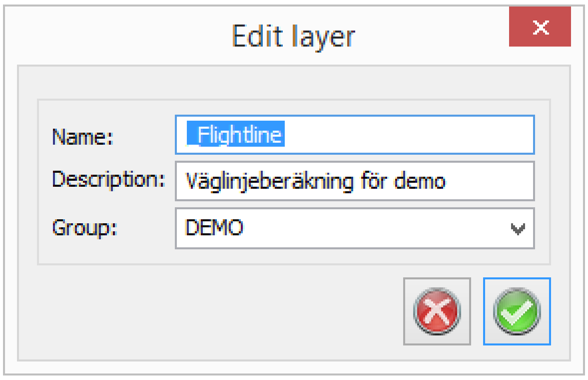
Group
Layer groups gives possibilities to set a group name on a layer. In the layer manager you can choose if layer groups shall be displayed and if all groups shall be displayed or just one group.
The title row of the group includes the group name, if the group is expanded or not, numbers of layers and number of objects i all the layers of the group. Click on the title to expand/close the group.
Layer preferences as frozen, visible, read only and display only can be changed for an expanded group by clicking in the respective column in the title row of the group.

There is also a possibility to select a group for layer for import/survey in the code table.

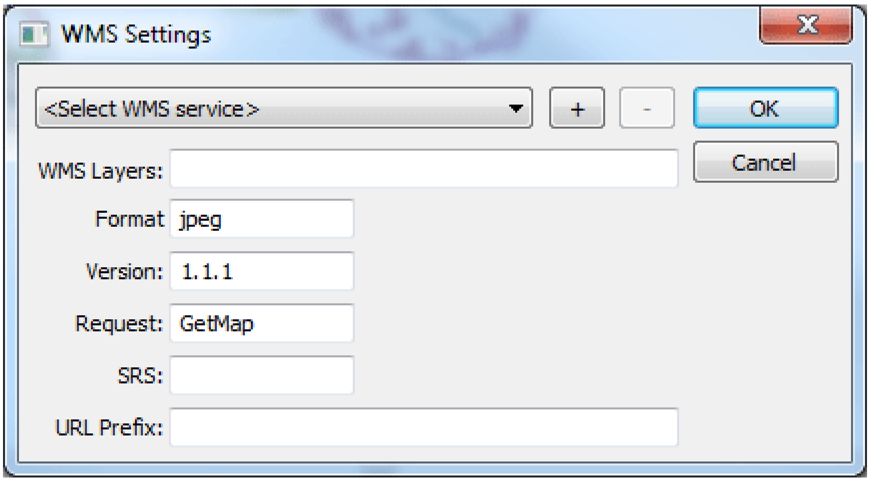
Commands

Create
Creates a new layer and a description can be made.

Edit
Gives you a possibility to edit the name of the layer and description.



WMS
WMS (Web Map Services) are maps on different servers. These can be used in Topocad by entering the search path, storage, format, version, request, SRS (coordinate system) and image formats.



Delete
Deletes a layer. If the layer contains an object you will be warned.

Previous/Next
Displays previous and next made layer setting.

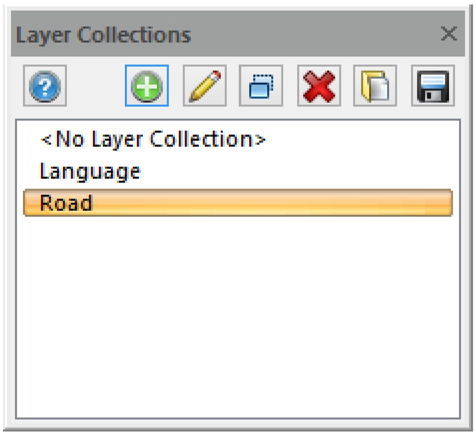
See also:

Object properties
Change Properties

Layer collections

Drawing|Layer collections

Function to define different layer collections that shall be visible in a drawing, in the drawing view and in the drawing sheet. Layer collection for drawing view is found under settings for drawing view.



Add
Add a new layer collection

Edit
Edit layer collection

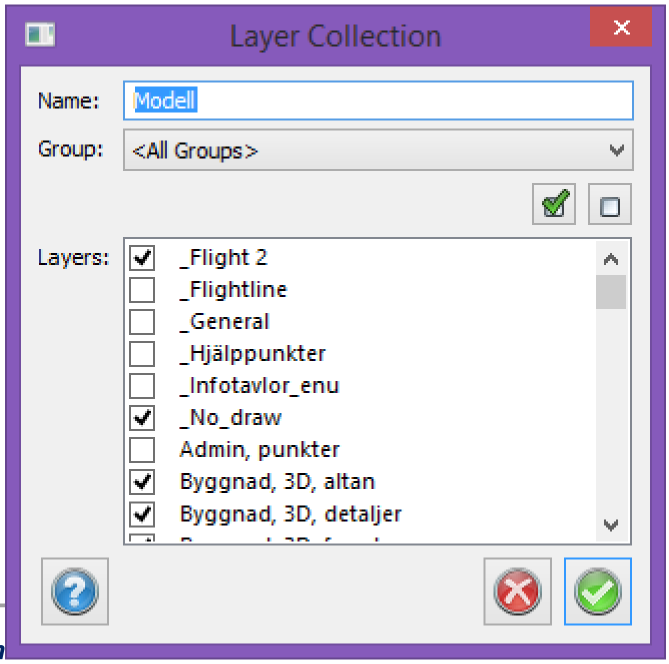
Remove
Remove layer collection

Import
Import layer collection from file (*.tlc).

Export
Export layer collection to file (*-tlc).

Catalogue for storage of exported layer collections is added under System settings/Directiories.

Add/Edit layer collection



Name
Name of layer collection

Group
Select layer group

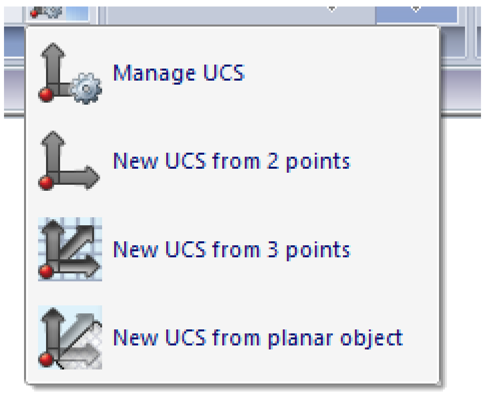
Layer
Select layers that shall be added to the layer collection

User Defined Coordinate system

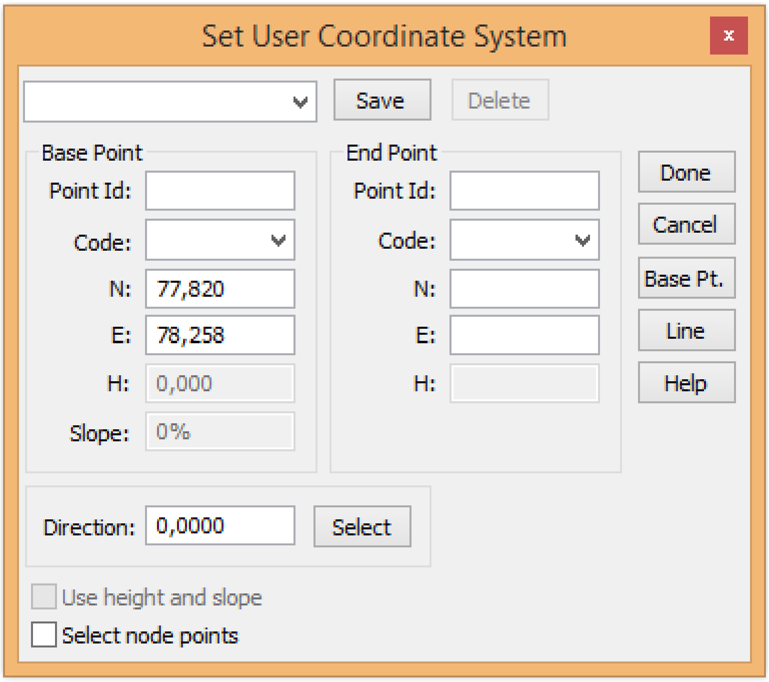
Drawing|User Defined Coordinate system

Shift + B

A baseline is an effective way to interpret different objects. To create a baseline you have to select the origin and the direction for the baseline. There are four different types of UCS - Local coordinate system can be specified.



To activate the baseline:



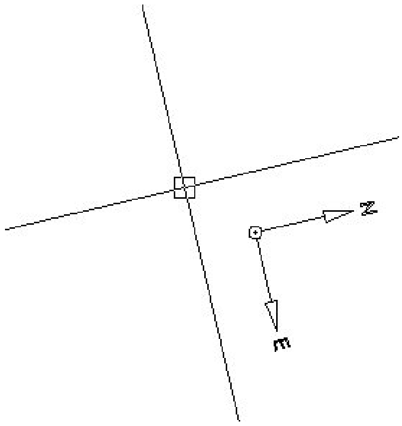
1. **Select** *Drawing|User defined Coordinate system*
2. You can now **select** a previously saved baseline by selecting the name from this list. To **create** the baseline:
3. Select the point for the new **origin**. You can use snap commands or enter the value manually.
4. Select the **direction** for the X (north) axis.
5. Save the baseline by entering a name in the upper box.

To activate the baseline, tick Activate. You will notice that as soon as you have selected the origin and direction the dialogue disappears. However, if you forget to activate the baseline you will not lose the settings.

The baseline will be displayed with the crosshairs, which will have the same direction as the baseline.

The baseline can also be used in *Misc|Co-ordinate toolbox* and for point difference.

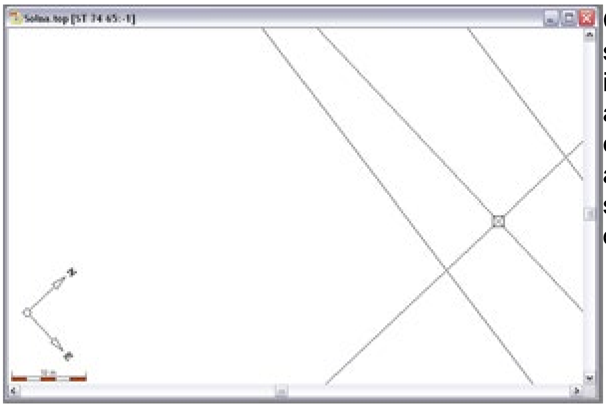
Selected co-ordinate system is also shown as co-ordinate axis in the systems origin or in the windows lower left part, if the origin not is visible.



To deactivate the baseline:

1. Select Baseline
2. Select Global from the list.
3. Click OK.

TIP! If you enter local co-ordinates from the baseline, enter them in the Co-ordinates toolbox (View|Toolbox|Co-ordinates)



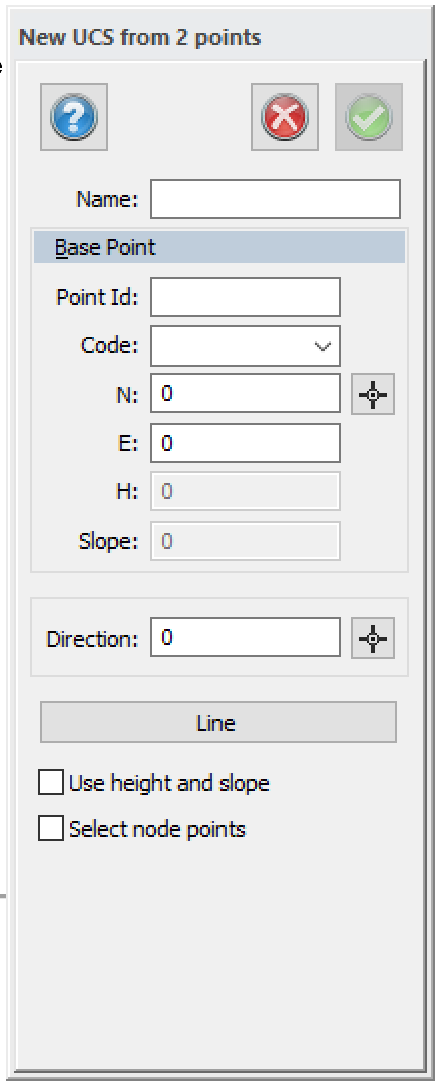
Current coordinate system is shown as a separate toolbar. Coordinate input in designing line, dot, circle, edit line properties (point and circle) and edit as the text is done in the current coordinate system. Name of the local coordinate axes are under System Settings | Axles Current coordinate system is also shown with coordinate axes in the system origin or the lower left part of the origin is not visible.

Create new UCS 2D

Drawing|User Defined Coordinate

system

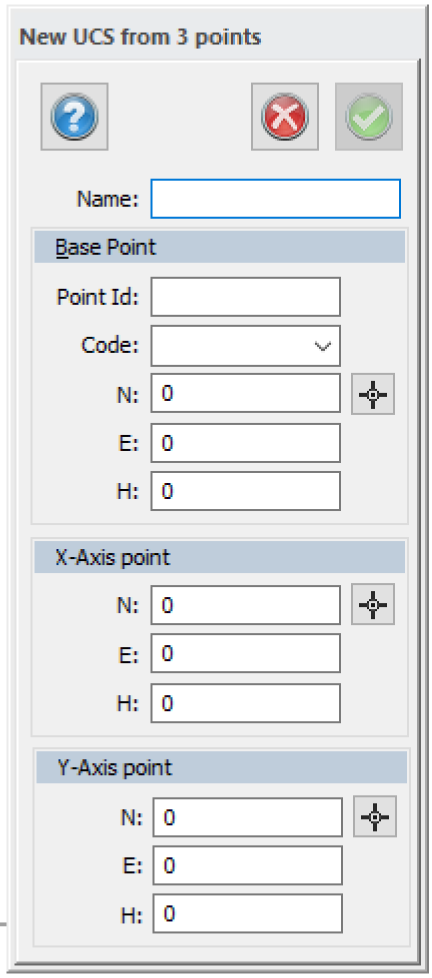
Enter the base point of the coordinate system and the direction of base point axis, it shows the extent to which the direction of the x-axis is. This is the same as the baseline command Topocad 15 except that you can not remove baselines (UCS) here.



Create new UCS 3D

Drawing|User Defined Coordinate system

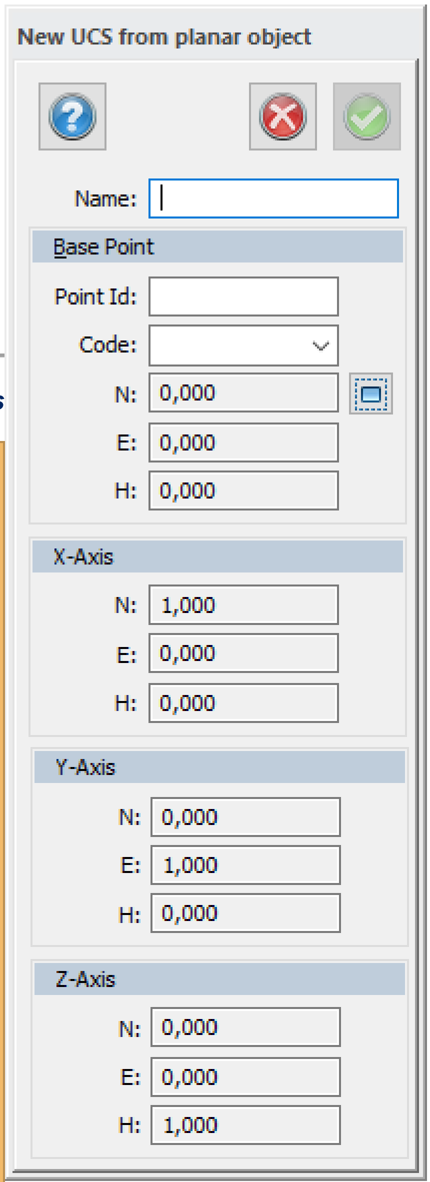
Specify the x and y-axis to create 3D plane. The difference between UCS 2D- and 3D is that you specify the Y-axis to view the item in 3D format. This provides an opportunity to draw the coordinate system entirely in 3D. Create a UCS in 3D by first pointing out the origo, then the extent of the X-axis and Y-axis.



Drawing|User Defined Coordinate system

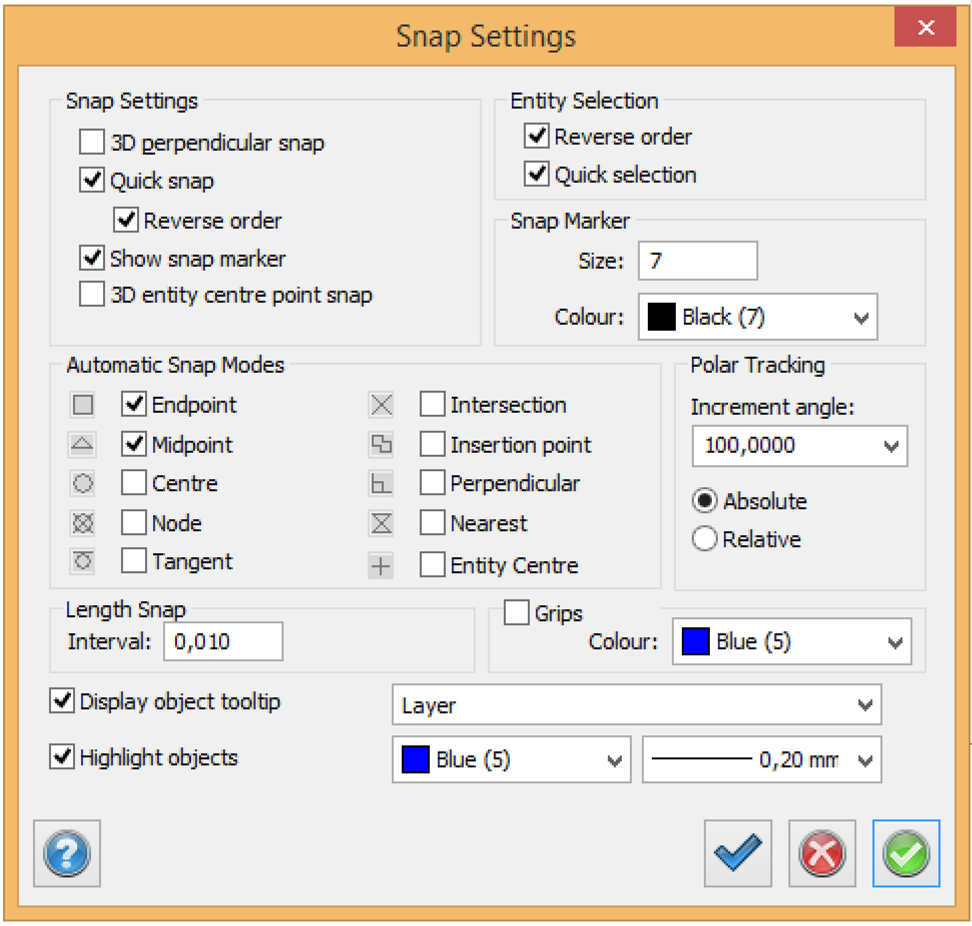
Create UCS from plane objects

A plane object/ plane entities can be lines, polygons, circles, text and symbolic references. For this feature you may use direction of extension of the entity. The point selection replaces the x-axis. The X-axis indicates which direction the nearest point is and that the X-axis will assumes. It also chooses which point and entity it concerns.



Snap settings

Drawing|Snap settings



3D perpendicular snap
To snap in three dimensions using perpendicular snap.

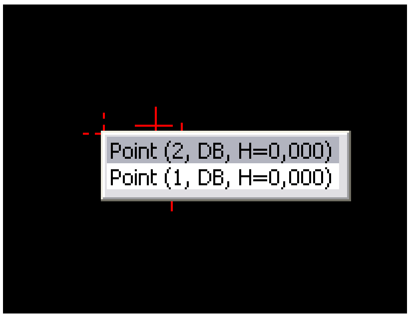
Quick snap
Auto snap

Reverse order
Snaps on objects starting from the bottom of the drawing order.

Show snap marker
Shows the snap with different symbols.

3D entity center point snap
Snaps on entities in three dimensions.

Quick selection
Function for selecting objects placed close to each other or on top of each other.



Quick selection decides how the selection is made when selecting objects. If Quick selection is checked, the first found object will be marked. All the objects in the drawing will be searched through if Quick selection is unchecked. All objects that matches the selection are listed. Quick selection can take a little longer time since it has to control all objects in the drawing.

Reverse order
Selects the objects from below and up from the drawing order.

Quick selection
Always selects the object on top. A list of all objects on that point is shown.

Snap Marker
Indicates which snap that is active. Select size and colour on the snap marker.

Automatic snap
Settings for the automatic snap, some combinations are not possible.

- Endpoint: Snaps on all endpoints in the line.
- Midpoint: Snaps in the middle of all part lines.
- Centre: Snaps on the centre of a radius or a circle.
- Node: Snaps on a point.
- Tangent: Snaps on the tangent point of a circle or a radius.
- Intersection: Snaps on the intersection between two objects.
- Insertion point: Snaps on the insertion point on a text or symbol.
- Perpendicular: Snaps 90 degrees towards a line.
- Nearest: Always snaps on a line, anywhere on the line.
- Entity Center: Snaps on the centre of gravity of an object.

Polar snap/tracking
For polar construction of lines, select the increment angle.

Length snap
Set the interval here if you want to use the length snap.

Grips
Select if you want markings on the objects in the drawing and which colours they shall have.

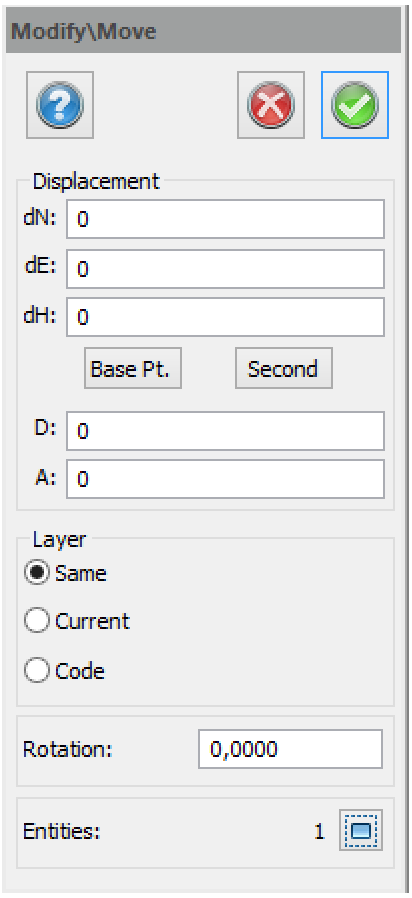
Display object tooltip
Select if you want to show tooltip.

Highlight objects
Select if you want to show a mouse-over highlight on your objects, and which colour.

Move object

Drawing|Move

Shortcut key Ctrl + M



This moves the selected objects in the direction you select. You can move objects in the drawing with the mouse or enter the values manually. In this case you can enter either the angle and distance or in dX, dY and dZ format. (dN, dE, dH)

You can select objects before or after you have activated the command and even add more objects afterwards.

The object to be moved can be placed in the same layer as the selected object or in the current layer.

To move an object:

1. **Select** *Drawing|Move*.
2. **Select objects** to move.
3. Select **Base point.** It is possible to snap on objects.
4. Select **Insertion point** (next point). You can select with the mouse, enter values for dX, dY, dZ or enter the angle and distance. If you click on the insertion point the command is completed if you have selected objects. If you type in the values you will need to click OK to finish.
5. Note that points 2, 3 and 4 may be entered in any order. However it is important that a base point is selected before the next point is selected in the drawing. The default value for the base point is the origin.
6. To move objects with a rotation, fill in the Rotation parameter and the object will rotate, depending on the lap you have selected in System settings - Angle, Angle Settings.

TIP! You can move an object in height (Z) only. Just enter the Z change and click OK.

TIP! For this and the other modify commands you can close the dialogue box and use the context menu instead.

Note: It is important to select a base point. If no base point is selected Topocad will calculate the movement from the base point with co-ordinates 0,0 (origin).

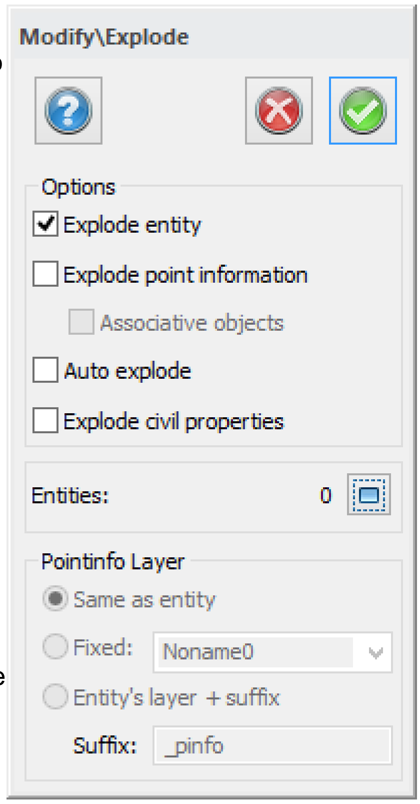
See also

Copy object.

Explode

Drawing|Explode

Shortcut key Ctrl + O



Explode is used to split symbols into their components and polylines into lines. If you want to change a symbol, or create a new symbol from an existing one you will need to use Explode. It can be used to separate point info from the point so that the point information can be moved individually. It can also be used to split a symbol linked to a point by a point code so that the symbol becomes separate from the point.

It is possible to explode a road line to its origin, i.e. lines, radius and spirals.

It is also possbile to explode civil properties.

The procedure is as follows:

1. Go to Drawing|Explode.
2. Select the object you want to explode.
3. Decide how you want to explode the object:
4. Explode object - Explodes a polyline into lines or a symbol into its components.
5. Explode point info - Separates the point info from the object.
6. Explode automatically - Separates the symbol from the point code (point).
7. Click OK when you have finished.

Pointinfo layer

Select explode point info to decide which layers they shall be moved to.

The existing alternatives are:

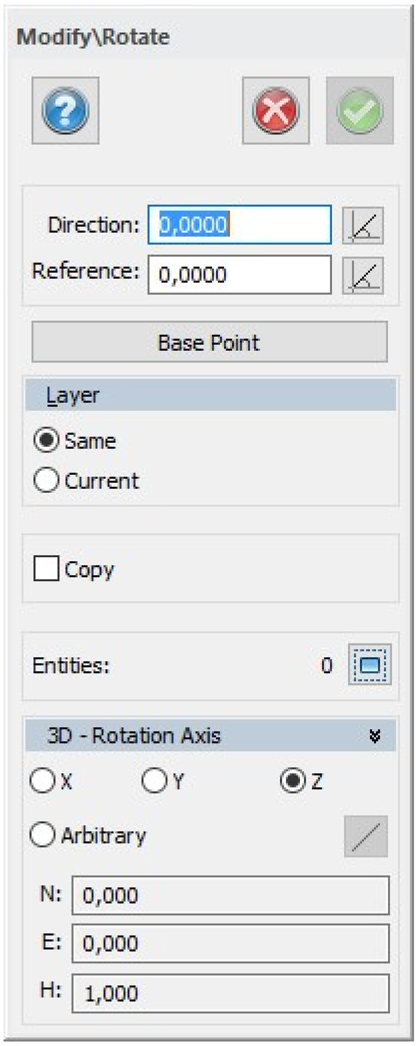
- Same as entity
- Fixed, select a layer for the text
- Same as entity + suffix of layer name

TIP! It is possible to repeat the command by pressing the spacebar or Enter key!

Rotate object

Drawing|Rotate

Shortcut key Ctrl + 6



This rotates the selected objects from the selected base point by whatever rotation angle you select. You can rotate objects in the drawing by using the mouse or by entering the values manually. In this case it is possible to enter the rotation and the reference point. It is also possible to select the rotation and the reference point with the mouse.

You can select objects before or after you have activated the command and even add more objects later.

The object to be moved can be placed in the same layer as the selected object or in the current layer.

To rotate an object:

1. Go to *Drawing|Rotate*.
2. Choose the command Rotate object
3. Select the objects to rotate.
4. Select the base point. It is possible to snap on objects. Right click to get a popup snap menu.
5. Select the orientation. It is possible to select with the mouse or manually enter the value for the direction (in GON, degrees or mills). If you selected the insertion point with the mouse the command is done if you have selected objects. If you entered the values manually you have to click OK to finish.
6. Note that points 2, 3 and 4 may be entered in any of order. However it is important that a base point is selected. The default value for the base point is the origin.

The rotating object can be placed in the same or current layer. You can also choose to copy the object.

Explanation of dialogue box

Reference angle:
This is used if you want to rotate an object relative to a selected reference angle instead of the default reference angle (that is 0 North). Click on Ref. and then select the first and second points of the reference angle. The angle will be displayed in the dialogue box. To rotate an object relative to this angle you can either use your mouse to select the rotation or enter the angle in the orientation box. This method is the best.

Copy
Tick this box to copy the rotated objects.

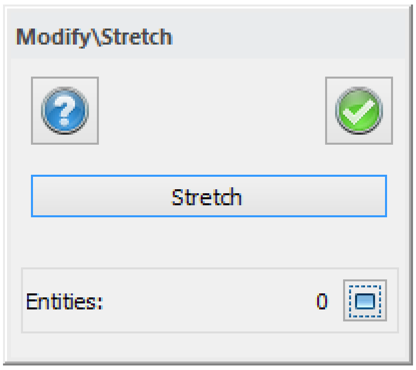
Note: It is important to select a base point. If no base point is selected Topocad will calculate the rotation from a base point with co-ordinates X=0, Y=0.

TIP! For this and the other commands you can close the dialogue box and use the context menu instead.

Stretch

Drawing|Stretch

Shortcut key: Ctrl + F10

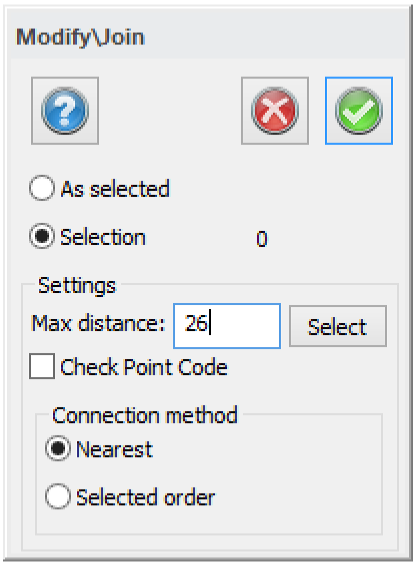


The command Stretch extend or pull together selected points in a line or a polygon.

Mark one or several points in one or several lines. Activate the command Modify|Stretch - click on "Stretch" and then you can move and stretch the chosen points. To add or delete points from your choice, just click the Choose button and then choose points (alternative Ctrl - choose) and then click the Stretch button.

Join

Drawing|Join



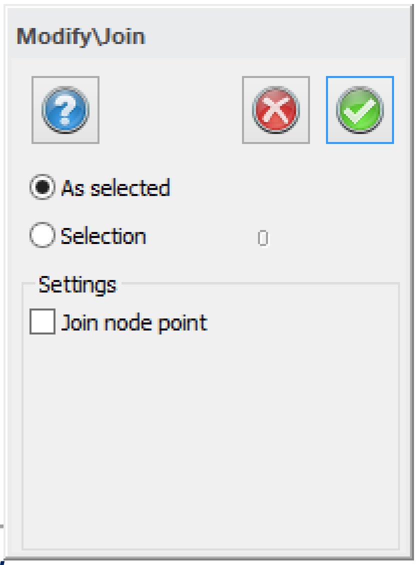
Shortcut key Ctrl + J

Join polyline is used to link two polylines or points together. You can also join all selected objects by choosing the point code and connection method.

The join command usually join two objects (lines or points) where the two objects have the shortest distance between another. This irrespective of where you do the mark. Avoid this by marking "Join node point" where you are able to select on which node you want to join to. Join node point join to the exact point and inherit its height.

The procedure is as follows:

1. **Select** *Drawing|Join*.
2. Select the two objects that you want to link together. It does not matter whereabouts on the objects you click because they will always be linked together at their closest end points.
3. You can now select more objects to link to this object.
4. When you have finished press F2 or Enter or right click and then and click Done.



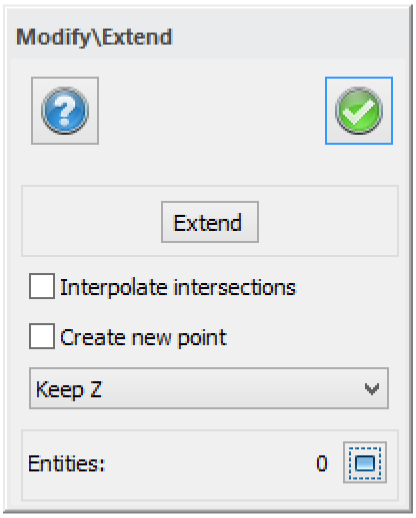
TIP! You can repeat this command by pressing the spacebar or Enter.

There is also a function for selecting with Selection; here you can choose how the selections shall function.

You can select a Max distance for how far a join shall be. Check point code makes the same point code for the both points involved in the selection can be joined, not others.

Extend

Drawing|Extend



Shortcut key Shift + E

Extend is a command that extends a polyline to other polylines, circles or arcs.

The procedure is as follows:

1. Go to Drawing|Extend.
2. Select the point on the polyline, circle or arc that you want to extend to. It is possible to select several polylines, circles or arcs.
3. Click on Polyline in the dialogue box. Select the polyline you want to extend. If there are several objects one after the other in the direction you want to extend the polyline you can extend to all of them by clicking on the polyline again. You can also select objects by clicking Select with right click, and then select either crossing line or crossing polyline.
4. You can immediately select another polyline to extend if required.
5. To end the command click Done or press F2 or Enter.

It is possible to extend in several steps. If there are several lines to extend on the extension of the line, you shall extend them in the order they are placed towards the line. You extend the end that is as far-off from the marking point, if it is possible to extend a line to both directions.

It is possible to extend lines to interpolated lines by clicking on the relevant button.

The extend command has the alternatives ”Keep Z, ”Extrapolate Z”, and ”Interpolate other Z”.

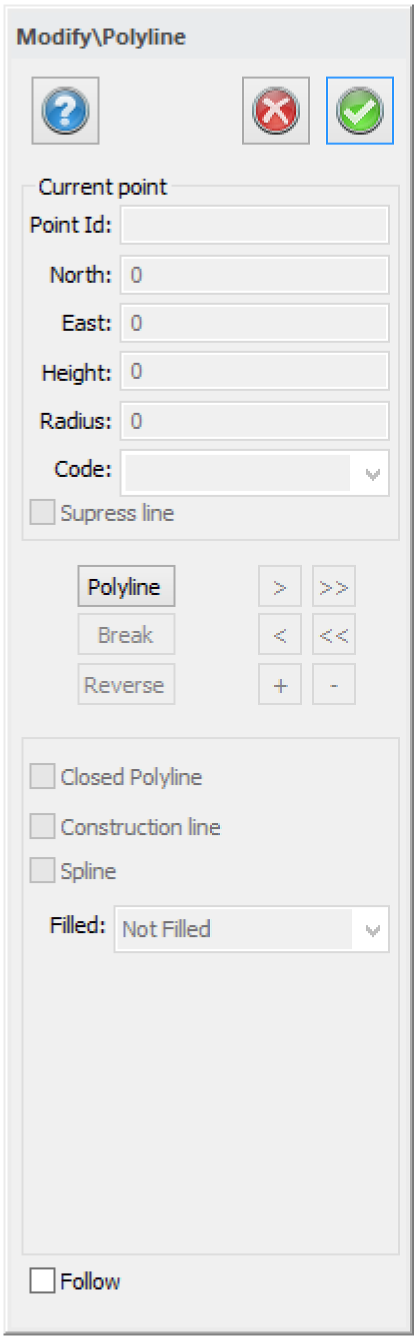
Keep Z means the Z coordinate is not effected.
Extrapolate Z means the Z coordinates is calculated at the intersection by extrapolate the extended object.
Interpolate other Z means the Z coordinate interpolates from the intersection line.

Polyline

Drawing|Polyline

Shortcut key Shift + L

The polyline can be edited in the Edit polyline dialogue box by editing the text or graphically using the mouse. A third way to edit polylines is to go to View|Edit as text



The procedure is as follows:

1. Go to Drawing|Polyline.
2. Select the polyline you want to edit.
3. Either move it with the mouse or enter new values in the dialogue box. You can change the co-ordinates, point ID, radius and point code. The point code can be selected from the drop-down list or you can enter another one. The new point code will automatically be stored in the current code table (default name is Topocad.TCT). To ensure that the changed information will be applied go to Next or Previous point before clicking Done.
4. To go to Next or Previous point: click on the appropriate button. You will see a small cross at the current point. When you reach the end of the polyline either the Next or Previous key will become greyed out.
5. To select a new polyline to edit, click Polyline and then select the desired polyline.
6. When you have finished editing the polylines click Done.

Explanations of the dialogue box

Add
Adds a point after the current point. The default position is halfway between the current and next point.

Remove
Deletes current point.

Break
Breaks the line into two polylines and creates a double point.

Reverse
Reverses the direction of the polyline.

Polyline
You can select another polyline by clicking here.

Supress line
Check this box to supress line or part of line. Double click on node (Shortcut N) to get to the Properties dialogue, to uncheck Surpress line.

Closed polyline
This will join the first and last points together. It will not create an extra point.

Construction line
A construction line will be displayed on the display or drawing but not on the printout.

Spline
Select whether or not the polyline should be a spline.

Filled polyline
Creates a filled area with the same colour as the line. You can also select a pattern for the line here.

You can close the dialogue box by clicking in the top left corner and then edit the polyline with the mouse. Right click functions can easily be used to make all changes.

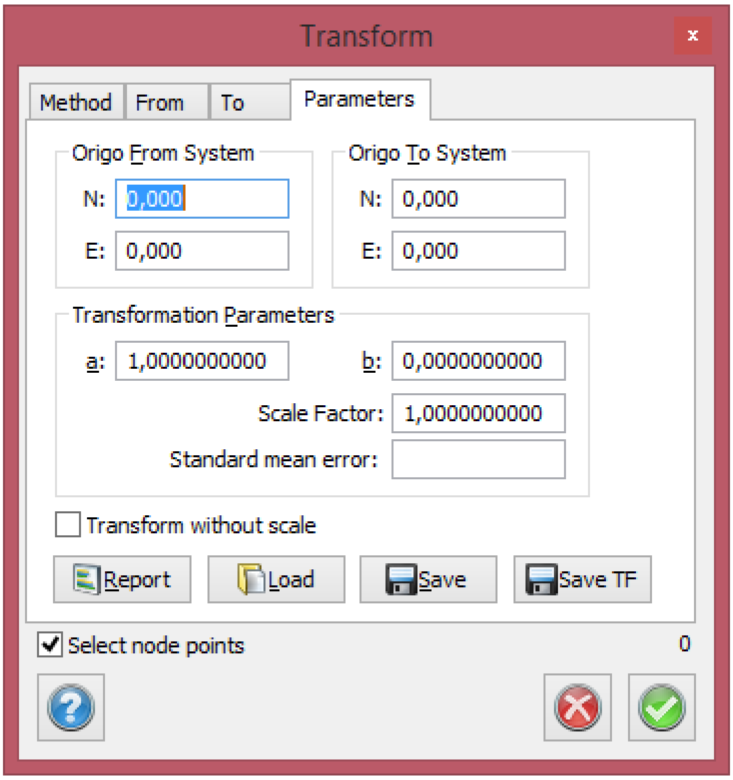
Select the co-ordinates toolbox or open the dialogue box.

Note: If you enter a new radius you will not be able to see it until you exit the polyline. (Done)

Transform

Drawing|Transform

Shortcut key: Ctrl + F7

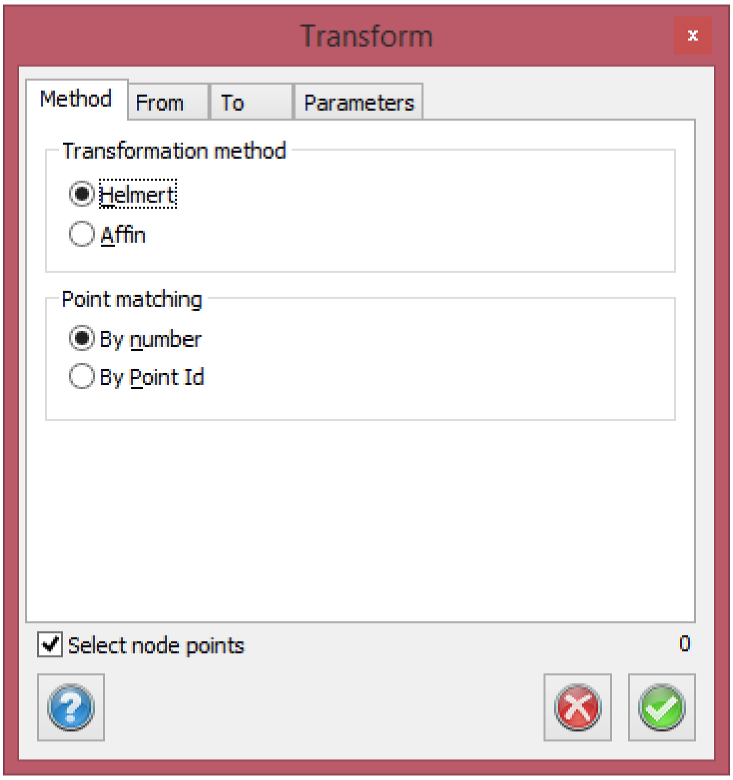


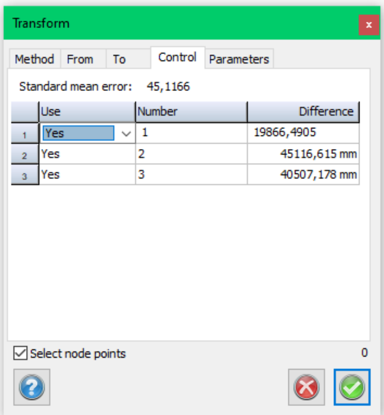
The transform function changes, scales, moves and rotates the objects at the same time. You can use either Helmert or Affin transformation and you can use any number of points (with a minimum of three) to calculate the transformation parameters. You can click on the points or enter them manually.

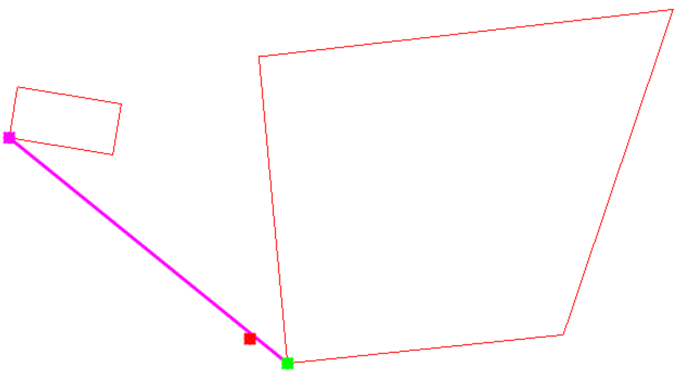
The procedure is as follows:

1. Check that you can select at least two points in both the to and from systems. You can either select them in the drawing with the mouse or enter the co-ordinates manually. You can also load previously stored parameters.
2. Select the objects you want to transform.
3. Select Transform.
4. Select the type of transformation system - Helmert or Affin.
5. Select the From tab and click on or enter co-ordinates for at least three points. The points do not have to be in the selected objects.
6. Select the To tab and click on or enter co-ordinates for the same amount of points. Note that they must be the added in the same order as in the From tab.
7. Select the Control tab and see if there are some bad points in the transformation that you do not want to be using. The red dot shows where the point would end up when taking all the transformation connections into account.
8. Select the Parameters tab to see the result of the transformation calculation. You can also save the parameters to another transformation.
9. Click Done. (If you have not selected any objects you can do so now before you click Done). You can select or deselect more objects by holding down the Ctrl key while making your selections.

Load/Save
It is possible to save and reload the transformation parameters.





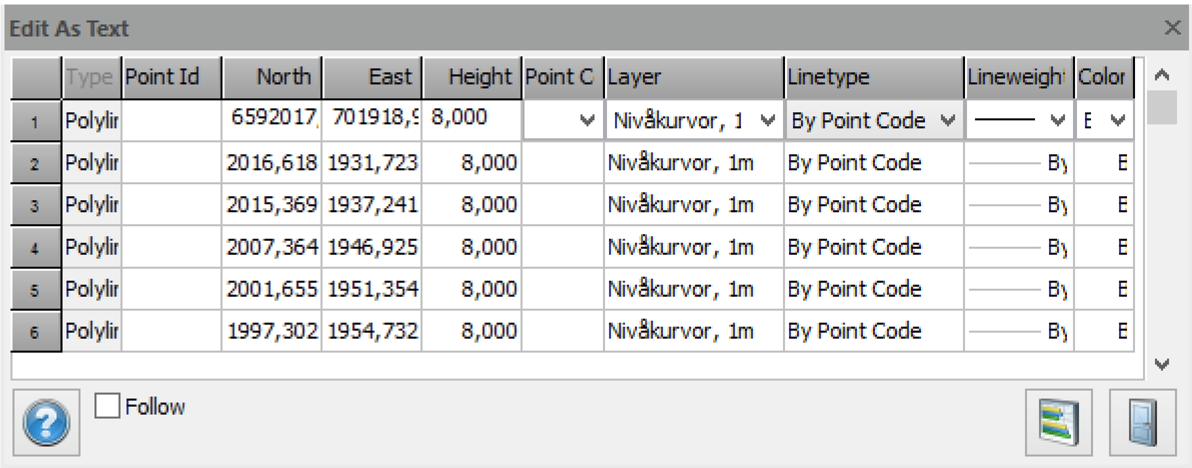


Edit as text

Drawing|Edit as text

Shortcut key Shift + Q

It is possible to view points and points in lines in Edit as text mode. They will be displayed in a grid and all ordinary edit functions for the grid can be used. The Copy command can also be used.

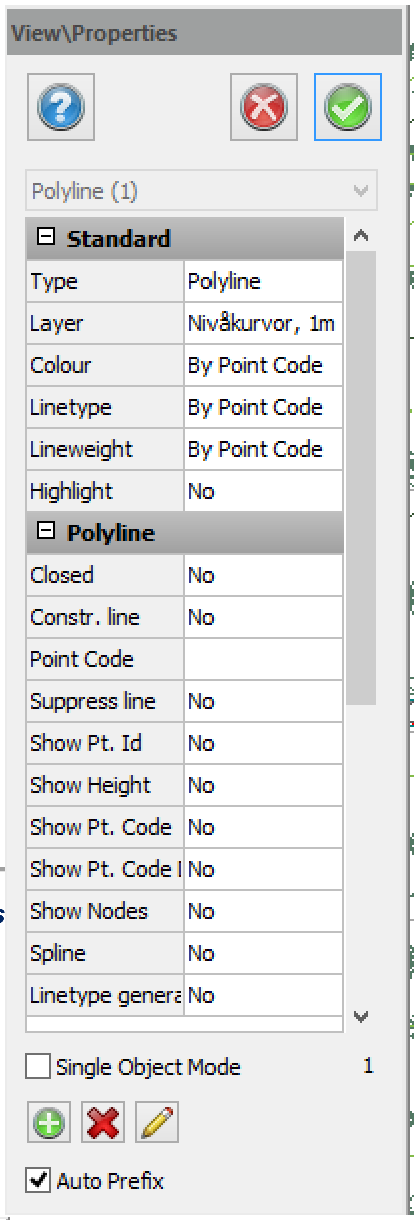


Properties

Drawing|Properties

Right click (when objects are selected).
Double click on the object

By selecting one or more objects and activating the Change properties command (also available in context menu) you can change almost anything regarding these objects - layer, colour, co-ordinates, closed polyline, radius etc. If you have selected different types of objects, for example a line and a text, you can edit the information they have in common, like layer or colour.



If several objects with a length are selected, the sum of these lengths will be displayed. If several objects with areas are selected will the sum of the areas be displayed. Neither the sum of the length or area are editable.

Show Pt. Code Description
The description of point code is viewable for points and lines in drawing. The description uses the same printing settings as the code.

Database information
Information regarding provider, connection, data source, dimensions and SQL.

See also:

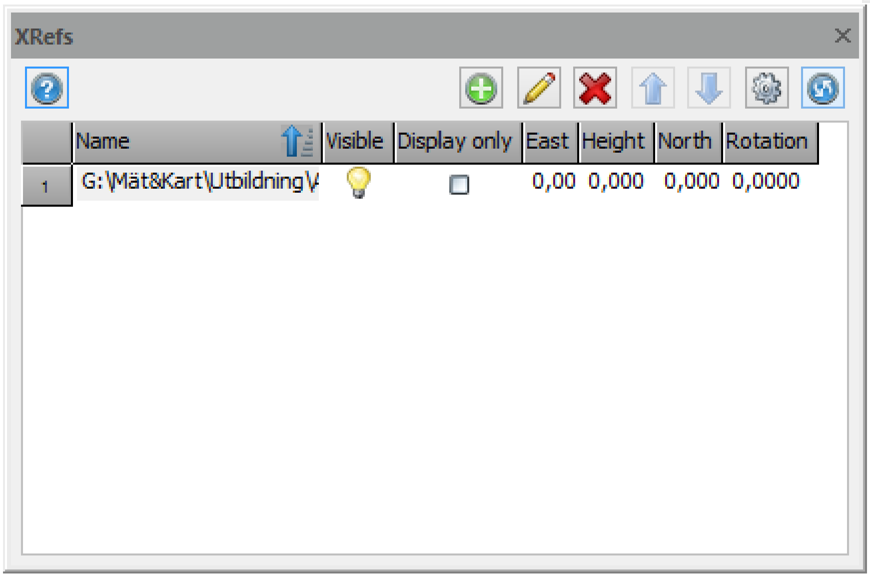
Change layer, line type, colour

Show point info

External references

Drawing|XRefs

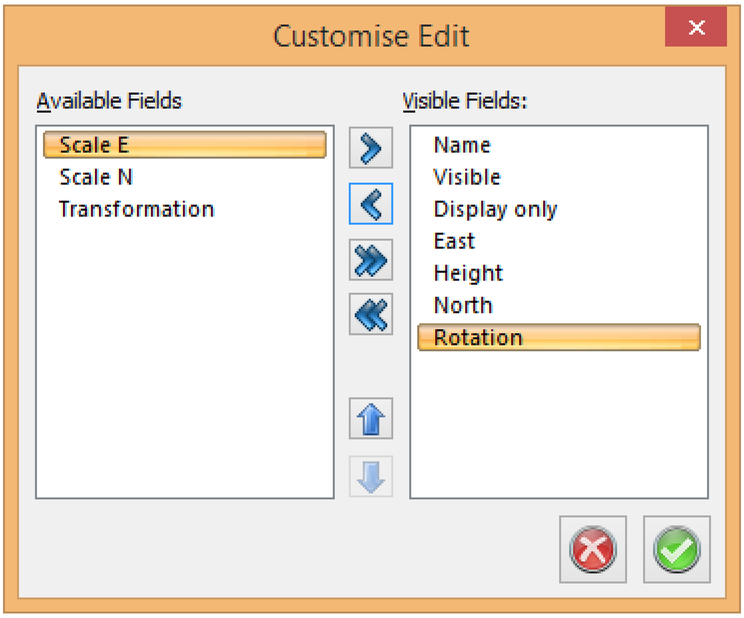
External references are used to link other drawings to the current drawing in the background. This is useful if you need to use other drawings for reference only. It can also be used to minimise the size of the individual drawings.



The documents that are able to link to is for example DWG/DXFm roadlines, coordinate lines and of course top files.

The procedure is as follows:

1. Select the *Drawing|XRefs*
2. To see more columns, right click in the dialogue and select Column settings. In the dialogue Customize Edit, select OK to return.



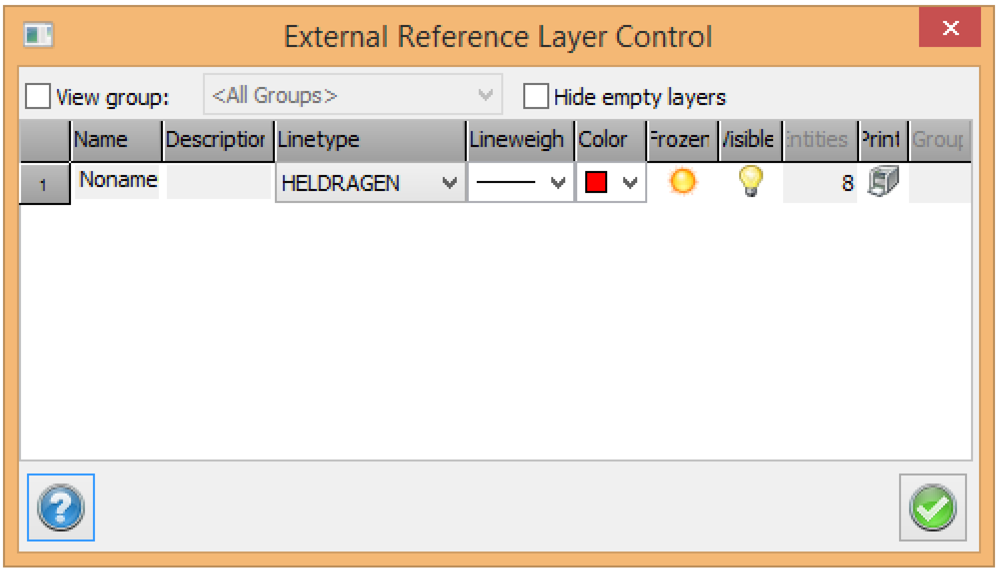
3. Click Add and load/open the drawing you want to link to for example your drawing in the background. Topocad supports a large number of file formats, see list over file formats here.
4. Continue until you have added all the drawings (models) you want to use in your drawing.
5. You can select an internal order for them.
6. You can also delete the external references and edit the drawing by clicking Modify.

You can choose if you want the external references toolbox to be visible or not, and also if it shall be active. To snap the toolbox needs to be active.

This can be useful when you need to create drawings to plot. Inserting the drawings you want to use as external references and then creating a drawing sheet to use for the plot is an effective method when you are using both models (real co-ordinates) and paper (paper co-ordinates).

Layer
Select which layers that shall be visible.

Edit appearance in external reference editor
Click on Layer to edit appearance in external references in the External references editor. You can also show/hide layer. Reads .lx- and .lr-files and writes .lx-files.



See also

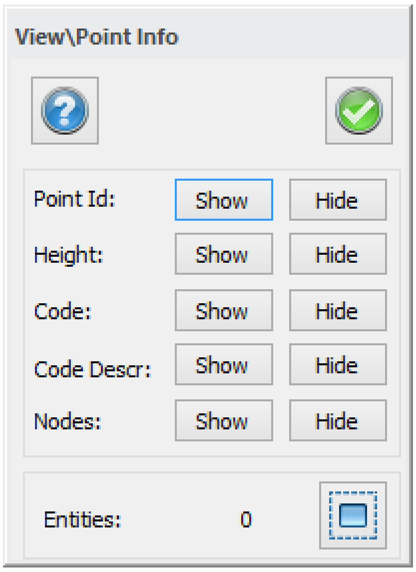
Drawing sheet

Point info

Drawing|Point info

Shortcut key Shift + F2

View point info is a quick way to view the point ID, heights, point codes or point nodes for different objects in the drawing. The settings for these are made in File|Preferences.



To view point information:

1. Select Drawing|Point info.
2. Select the objects you want to view the information for. Click on Select and then either click on each object individually or select using the window or crossing methods.
3. Click on View for the point ID, height and/or the point code. The information will be displayed directly on screen.
4. Click OK when you have finished.

To hide the information do the same but click Hide instead.

Code Description
Description of point code is viewable for points and lines in drawing. The description uses the same printing settings as the code.

TIP! It is possible to separate the point information from the object by selecting Explode.

See also:

- System settings - Point info

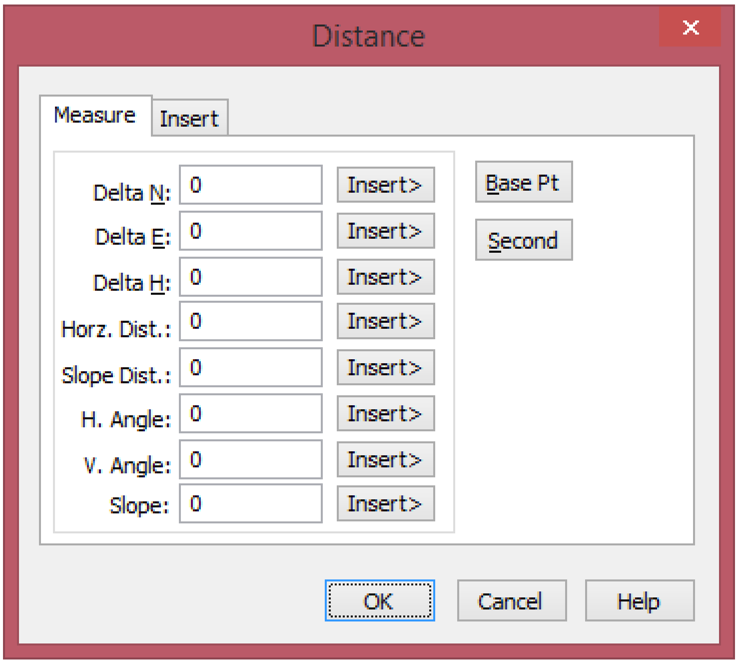
Distance

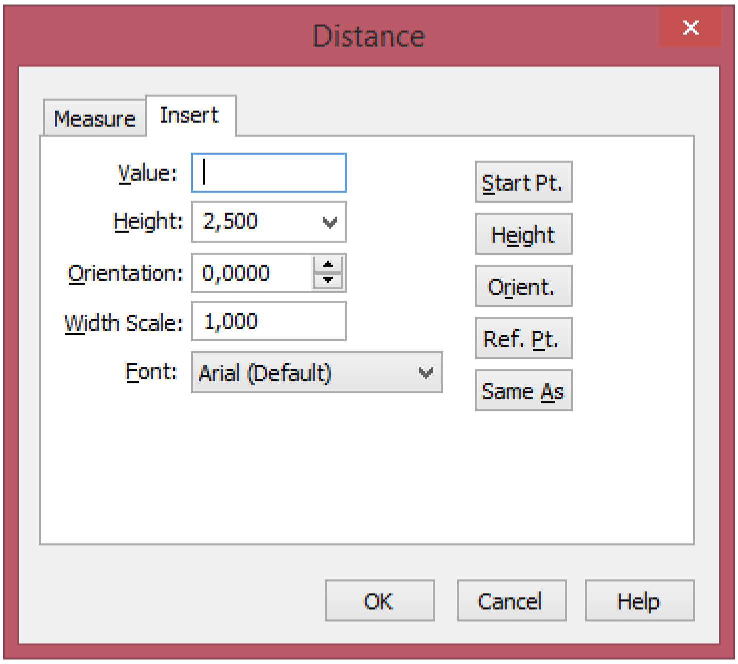
Drawing|Distance

Shortcut key: Shift + M

The procedure is as follows:

1. There are two steps - one for measuring and the other for inserting the value into the drawing.
2. Measure the distance. The result will be displayed with the distance, slope distance, dX, dY, dZ and bearing. Select the value you want to insert and click Add. Go to the Insert tab. Select the text height, font etc. The orientation is the one you have just measured. You can change the direction either by clicking on the arrows or by manually entering another value.
3. Insert the start point for the text.





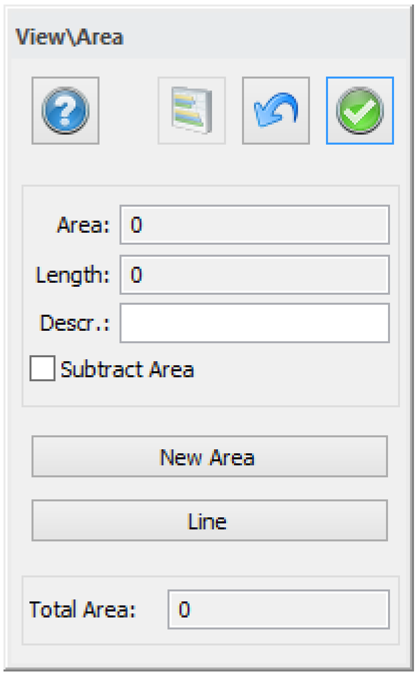
See also:

- Dimension

Area

Drawing|Area

Shortcut key: Shift + A



The Area command is used to measure the area of an object. The measured area is the sum of the area between the selected points. It is also possible to select another area and either subtract or add it to the first area.

To measure an area:

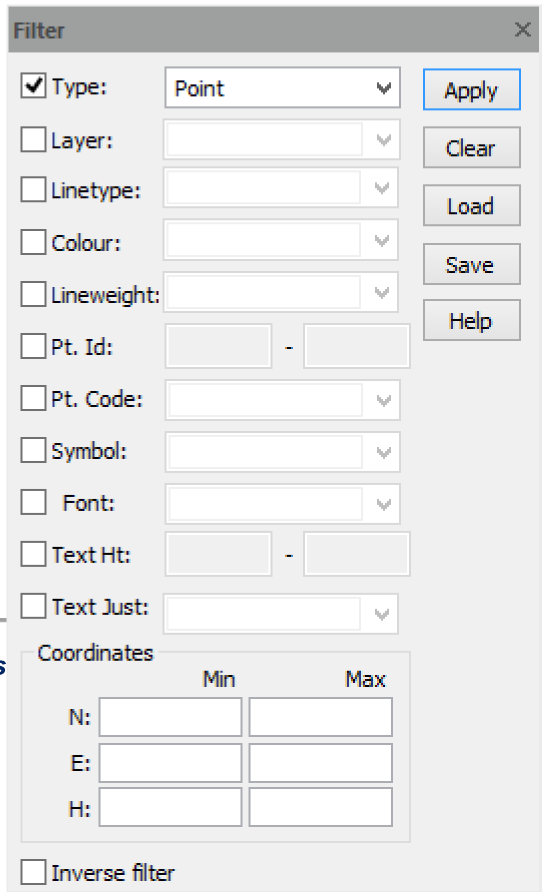
1. Go to *Drawing|Area*.
2. Use the mouse to click on the points that you want to measure. You can also select points to be excluded. Use the snap command if required. The distance can also be viewed.

The area and its co-ordinates can be logged and presented as a report. You can name the report.

Filter

Drawing|Filter

Shortcut key Skift + F



The filter toolbox is used to select different layers, types of objects, line types, colors or coordinates.

You select the box for the type, layer, linetype, color, lineweight, ponit id, point code, symbol, font, textheight and text just. Also, you can select max/min coordinates.

Only the objects which match your specifications in the filter box will be selected.

It is possible to select several layers at the same time.

The filter settings can be saved.

Nodes

Drawing|Nodes

Shortcut key: Shift + N

The Toggle nodes command displays nodes (points) on polylines. The opposite command is hide nodes. The command shows all nodes in the drawing.

The command does not have a dialog.

See also:

- Object properties

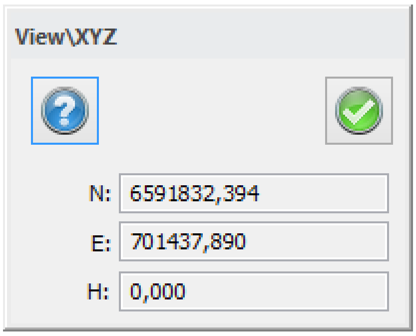
XYZ

Drawing|XYZ

XYZ is a function that allows you to see the exact co-ordinates for a point. This command is different from *Toolbox|Co-ordinates* in that it operates with snap commands only. There is no input function.

To view the co-ordinates for a point:

1. Go to View|XYZ.
2. Snap on the points you want to see the co-ordinates for.



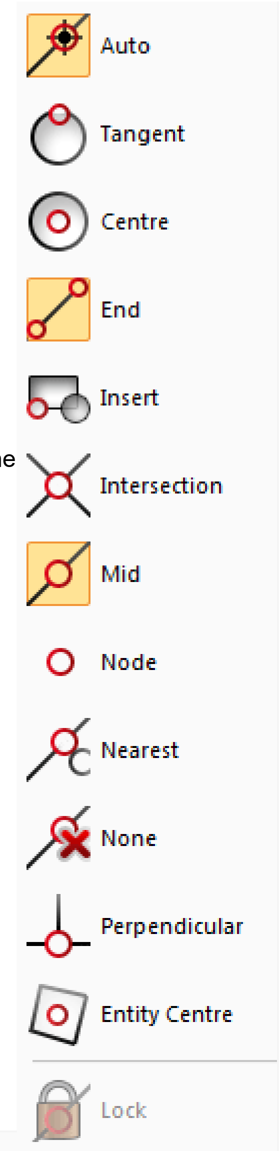
Snap

Snap

If the command you are using supports snap mode you can access the snap menu by right clicking, e.g. all construction and modifying commands. There are also icons for snap commands in the toolbar at the bottom right for easy access.

Auto

Shortcut key F3



Auto
Automatic snap.

Tangent
Snap to tangent.

Centre
Snaps to the centre point in a circle or radius.

End
Snaps to the end point of a polyline or radius.

Insert
Snaps to the insertion point in a text, attribute or symbol.

Intersection
Snaps to the intersection point of two polylines or radii.

Mid
Snaps to the mid point of a polyline or radius. Note that mid point between two points is not the complete polyline.

Node
Snaps to the node point in a polyline, point or radius.

Nearest
Snaps to the nearest point.

None
No snap at all.

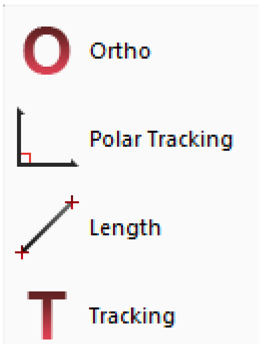
Perpendicular
Snaps to a perpendicular angle to a line at the last point you clicked it.

Entity Centre
Snaps to the centre of the entity.

Lock
Locks the snap until another snap command is selected. Be aware that the snap feature may be locked for some commands where snap commands are not available. For example if you are using the Offset command and need to click on one side.

Ortho

Shortcut key F8



Ortho
Snap using orthogonal settings. See Settings and Baseline for more details.

Polar tracking
Locks the snap to any angle.

Length
Snap by length. The settings are created in Settings (for example you can set the length snap to every 0.1m).

Tracking
Display length and angle.

Settings

Snap settings
Click Settings to access the snap settings.

Snap in profile form
In the profile form you are able to snap on the terrain models, and on inserted profiles. Implemented snap functions are snap nearest, snap endpoint, snap midpoint, snap length and polar tracking. You find the functions in the toolbar.

View content

Drawing|View

Function	Description
Zoom	Zoom command
Zoom and save view	
Pan	Pan command in zoom
Realtime Pan	Drag command in zoom
Regen	Regenerates the drawing and updates it, including any layers marked "hidden".
Redraw	Redraws the drawing but does not update it.
Camera: Orhto, Free Flight, Orbit	View data in 2D or 3D
Top - View Point	View data from top, bottom or directions.
Split view (No Split in menu)	View data in different views at the same time.

Zoom

View|Zoom

Function, command	Description
Zoom view - Save current view	Saves the current view.
Pan	Moves the drawing in current window.
Realtime Pan	Click and drag to pan the screen
Regen	Regenerates the drawing
Redraw	Redraws the screen

The menu will appear on screen when it is activated by right clicking.

Window Shortcut key Ctrl + W
Left click and drag to the second corner. You will zoom in on the area inside the rectangle.

Previous Shortcut key Ctrl + P
Returns to the last view.

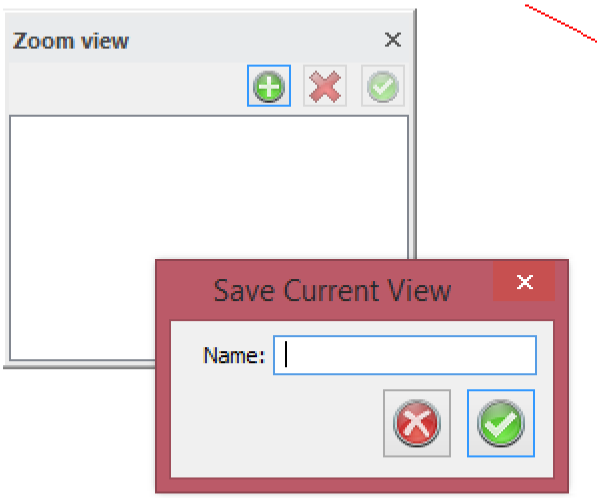
Next Shortcut key Ctrl + N
Zooms to the ”r;next”r; view if there are any previous views.

Max. Shortcut key Ctrl + A
Zooms to the max. limit for the current zoom.

Zoom view - Save current view

Drawing|View|Zoom view

Zoom view - Save Current view is a command that enables you to save the current zoom. You can then toggle between different views while working in the drawing.



Scale

Zooms to the selected scale. This is the only way to zoom to a larger area than the area of the objects in the document.

0.25x
Shortcut key Ctrl + Page Down

0.5x
Shortcut key Page Down

0.8x

2x
Shortcut key Page Up

4x
Shortcut key Ctrl + Page Up

All
Shortcut key Home

Zooms to the full area of the objects in the drawing.

Pan

Drawing|View|Pan

Pan is used to pan the drawing on the screen in the selected direction. Click on a point at the drawing. Pan the mouse in the direction you want the drawing to appear. Click again.

Realtime Pan

Drawing|View|Realtime Pan

Shortcut key Ctrl + D

Realtime Pan is a fast command to place the drawing in the position you want it.

Activate the command. Left click and hold down. Drag the drawing to the position you want. Note that you can watch the movement of the drawing during the operation.

The "hand" will be displayed until you click Escape or use any other zoom command.

Regen

Drawing|View|Regen

Shortcut key: Ctrl + F5

Regen is used to update and regenerate the drawing. It is a more comprehensive function than redraw. Regen sometimes has to be used for modifications regarding colours and line types to take effect.

Layers that are frozen are not included when regenerating a drawing.

Redraw

Drawing|View|Redraw

Redraws the screen and helps to get rid of small points, frozen crosshairs etc. that have occurred while working in the drawing.

Zoom

View|Zoom

Function, command	Description
Zoom view - Save current view	Saves the current view.
Pan	Moves the drawing in current window.
Realtime Pan	Click and drag to pan the screen
Regen	Regenerates the drawing
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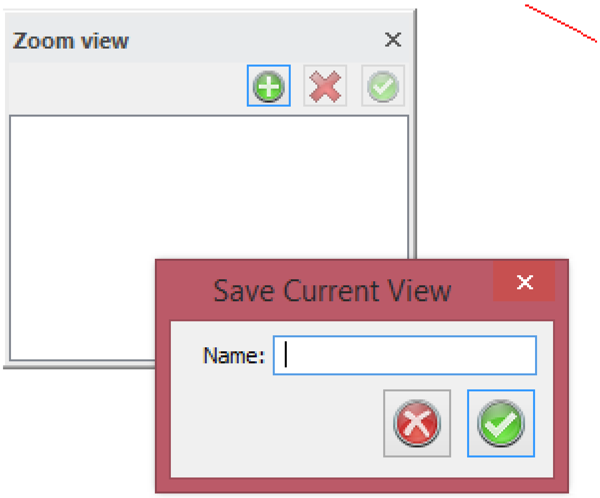
Zoom view - Save current view

Drawing|View|Zoom view

Zoom view - Save Current view is a command that enables you to save the current zoom. You can then toggle between different views while working in the drawing.



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0.25x
Shortcut key Ctrl + Page Down

0.5x
Shortcut key Page Down

0.8x

2x
Shortcut key Page Up

4x
Shortcut key Ctrl + Page Up

All
Shortcut key Home

Zooms to the full area of the objects in the drawing.

Pan

Drawing|View|Pan

Pan is used to pan the drawing on the screen in the selected direction. Click on a point at the drawing. Pan the mouse in the direction you want the drawing to appear. Click again.

Realtime Pan

Drawing|View|Realtime Pan

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Zoom view - Save current view	Saves the current view.
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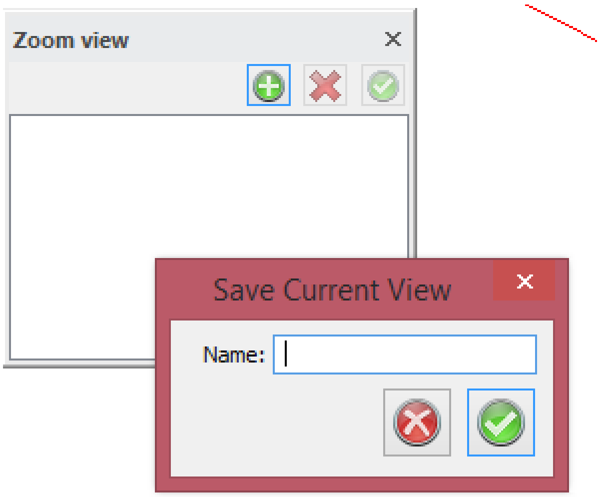
Zoom view - Save current view

Drawing|View|Zoom view

Zoom view - Save Current view is a command that enables you to save the current zoom. You can then toggle between different views while working in the drawing.



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0.25x
Shortcut key Ctrl + Page Down

0.5x
Shortcut key Page Down

0.8x

2x
Shortcut key Page Up

4x
Shortcut key Ctrl + Page Up

All
Shortcut key Home

Zooms to the full area of the objects in the drawing.

Pan

Drawing|View|Pan

Pan is used to pan the drawing on the screen in the selected direction. Click on a point at the drawing. Pan the mouse in the direction you want the drawing to appear. Click again.

Realtime Pan

Drawing|View|Realtime Pan

Shortcut key Ctrl + D

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Regen

Drawing|View|Regen

Shortcut key: Ctrl + F5

Regen is used to update and regenerate the drawing. It is a more comprehensive function than redraw. Regen sometimes has to be used for modifications regarding colours and line types to take effect.

Layers that are frozen are not included when regenerating a drawing.

Redraw

Drawing|View|Redraw

Redraws the screen and helps to get rid of small points, frozen crosshairs etc. that have occurred while working in the drawing.

Zoom

View|Zoom

Function, command	Description

Zoom view - Save current view	Saves the current view.
Pan	Moves the drawing in current window.
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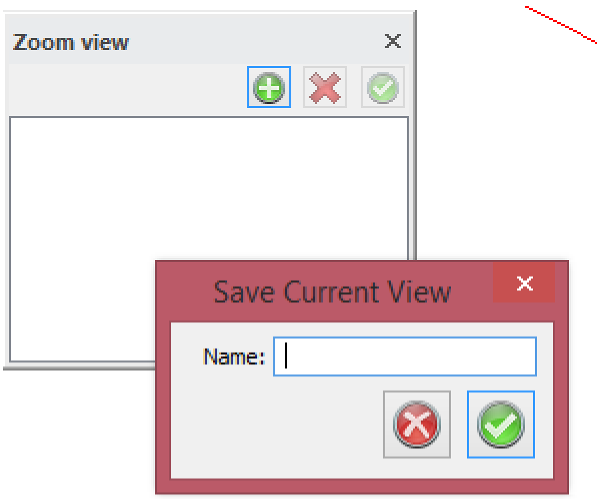
Zoom view - Save current view

Drawing|View|Zoom view

Zoom view - Save Current view is a command that enables you to save the current zoom. You can then toggle between different views while working in the drawing.



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0.25x
Shortcut key Ctrl + Page Down

0.5x
Shortcut key Page Down

0.8x

2x
Shortcut key Page Up

4x
Shortcut key Ctrl + Page Up

All
Shortcut key Home

Zooms to the full area of the objects in the drawing.

Pan

Drawing|View|Pan

Pan is used to pan the drawing on the screen in the selected direction. Click on a point at the drawing. Pan the mouse in the direction you want the drawing to appear. Click again.

Realtime Pan

Drawing|View|Realtime Pan

Shortcut key Ctrl + D

Realtime Pan is a fast command to place the drawing in the position you want it.

Activate the command. Left click and hold down. Drag the drawing to the position you want. Note that you can watch the movement of the drawing during the operation.

The "hand" will be displayed until you click Escape or use any other zoom command.

Regen

Drawing|View|Regen

Shortcut key: Ctrl + F5

Regen is used to update and regenerate the drawing. It is a more comprehensive function than redraw. Regen sometimes has to be used for modifications regarding colours and line types to take effect.

Layers that are frozen are not included when regenerating a drawing.

Redraw

Drawing|View|Redraw

Redraws the screen and helps to get rid of small points, frozen crosshairs etc. that have occurred while working in the drawing.

Zoom

View|Zoom

Function, command	Description
Zoom view - Save current view	Saves the current view.
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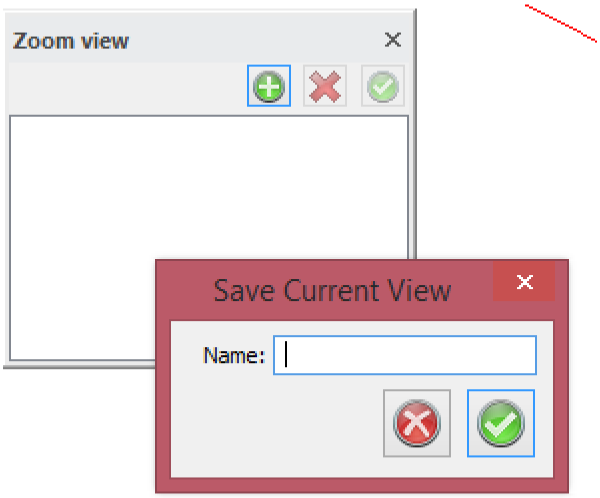
Zoom view - Save current view

Drawing|View|Zoom view

Zoom view - Save Current view is a command that enables you to save the current zoom. You can then toggle between different views while working in the drawing.



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0.25x
Shortcut key Ctrl + Page Down

0.5x
Shortcut key Page Down

0.8x

2x
Shortcut key Page Up

4x
Shortcut key Ctrl + Page Up

All
Shortcut key Home

Zooms to the full area of the objects in the drawing.

Pan

Drawing|View|Pan

Pan is used to pan the drawing on the screen in the selected direction. Click on a point at the drawing. Pan the mouse in the direction you want the drawing to appear. Click again.

Realtime Pan

Drawing|View|Realtime Pan

Shortcut key Ctrl + D

Realtime Pan is a fast command to place the drawing in the position you want it.

Activate the command. Left click and hold down. Drag the drawing to the position you want. Note that you can watch the movement of the drawing during the operation.

The "hand" will be displayed until you click Escape or use any other zoom command.

Regen

Drawing|View|Regen

Shortcut key: Ctrl + F5

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Layers that are frozen are not included when regenerating a drawing.

Redraw

Drawing|View|Redraw

Redraws the screen and helps to get rid of small points, frozen crosshairs etc. that have occurred while working in the drawing.

Zoom

View|Zoom

Function, command	Description
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Zoom view - Save current view

Drawing|View|Zoom view

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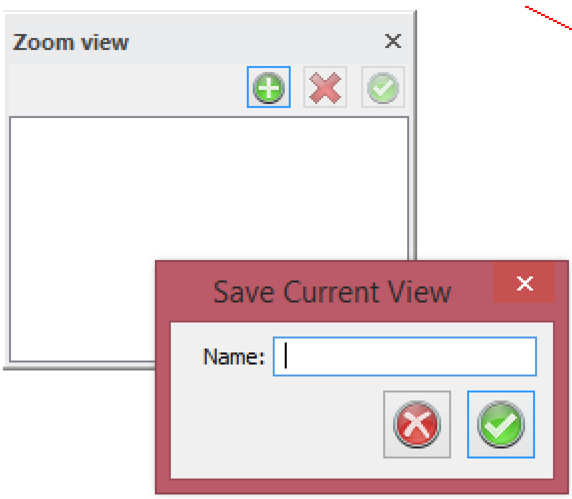

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0.25x
Shortcut key Ctrl + Page Down

0.5x
Shortcut key Page Down

0.8x

2x
Shortcut key Page Up

4x
Shortcut key Ctrl + Page Up

All
Shortcut key Home

Zooms to the full area of the objects in the drawing.

Pan

Drawing|View|Pan

Pan is used to pan the drawing on the screen in the selected direction. Click on a point at the drawing. Pan the mouse in the direction you want the drawing to appear. Click again.

Realtime Pan

Drawing|View|Realtime Pan

Shortcut key Ctrl + D

Realtime Pan is a fast command to place the drawing in the position you want it.

Activate the command. Left click and hold down. Drag the drawing to the position you want. Note that you can watch the movement of the drawing during the operation.

The "hand" will be displayed until you click Escape or use any other zoom command.

Regen

Drawing|View|Regen

Shortcut key: Ctrl + F5

Regen is used to update and regenerate the drawing. It is a more comprehensive function than redraw. Regen sometimes has to be used for modifications regarding colours and line types to take effect.

Layers that are frozen are not included when regenerating a drawing.

Redraw

Drawing|View|Redraw

Redraws the screen and helps to get rid of small points, frozen crosshairs etc. that have occurred while working in the drawing.

View (camera)

View|Ortho
View|Orbit
View|Free Flight

There are three ways to control the camera in Topocad: ortho, free flight and orbit.

Ortho

Pan by holding down the middle mouse button and moving the mouse. Zoom with mouse wheel.

Free flight

Pan by holding down the middle mouse button and moving the mouse. Rotate the camera around its axis by moving the mouse with your right mouse button. Move the camera by using the arrow keys. Change the camera's speed with mouse wheel.

Orbit

Pan by holding down the middle mouse button and moving the mouse. Rotate the camera around the center of the view by moving the mouse with your right mouse button. Move camera with the arrow keys. Zoom with mouse wheel.

Top: View point

Drawing|View|Top

This command allows you to quickly see which way you look at your data.

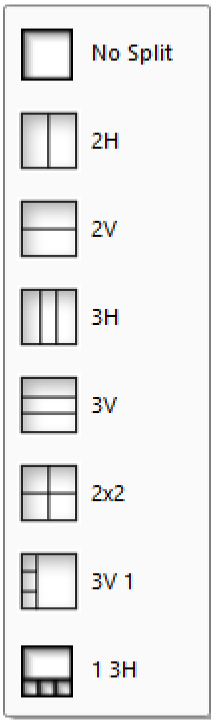
Choose to display the map from:

- Top
- Bottom
- North
- East
- South
- West

Split view

Drawing|View|Split view

This command displays your data in different views. There are eight different options, such as two views horizontally or vertically. If editing the map in one view, changes are made in all views.



XRef

XRefs

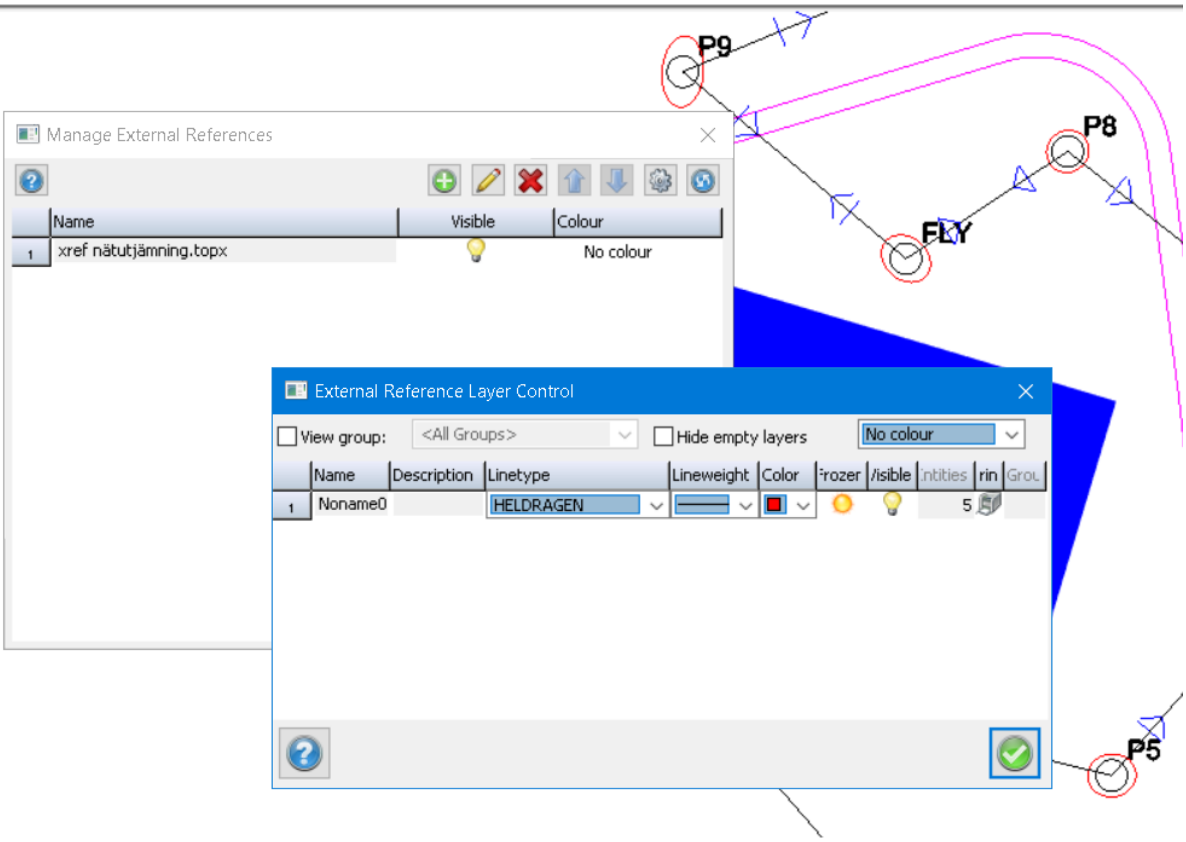
Drawing|View|XRefs

Terrain|View|XRefs

Point cloud|XRefs

Network adjustment |View|XRefs

XRefs are external data, viewed as a reference inside your document. You can add, edit and remove your External References with the Manage External References window.
You can set them as visible and go into the pen tool to manage individual layers in the reference.



Design contents

Drawing|Design

Design commands in Drawing

Spiral
Rectangel
BPolygon: Create Boundary Polygon
Offset
Divide line
Fetch Entity Properties
Find Entity
Freeze layer
Symbol - Define new symbol
Define linetype

Trace Line

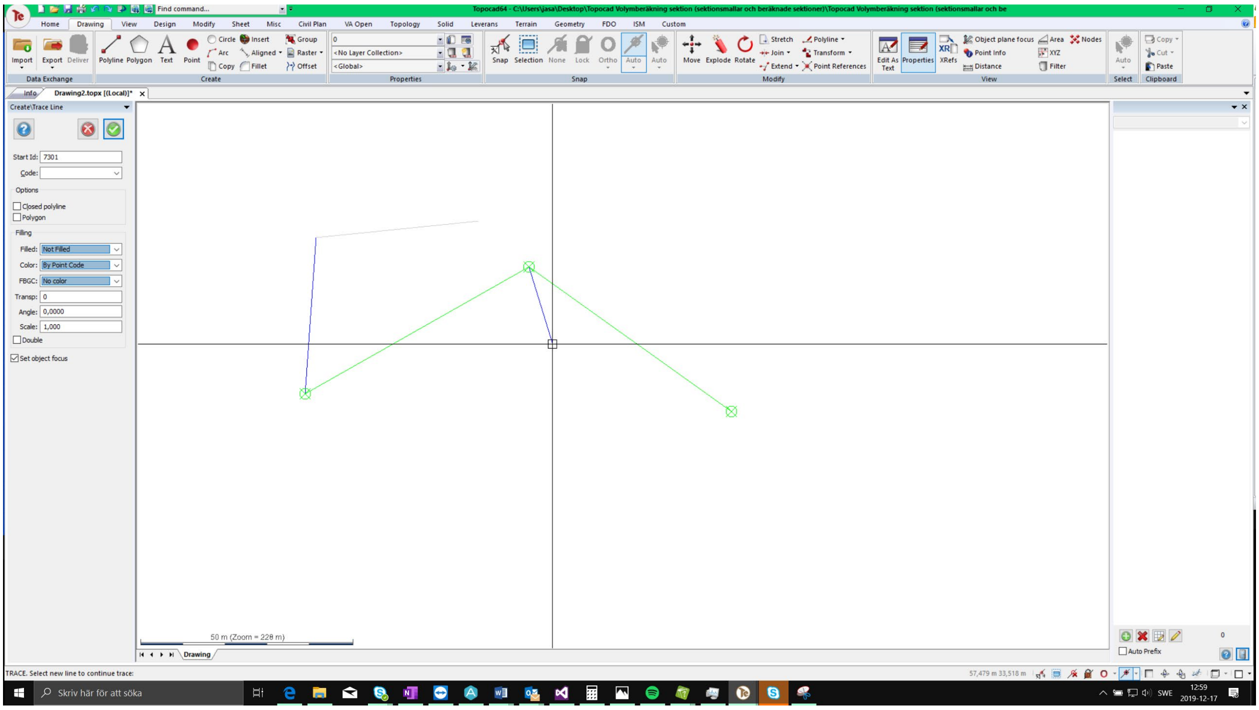
Drawing|Design|Trace Line

Function for tracing lines, making a new line over existing nodes from lines.

To start the function click the first line you want to trace, then hover over the nodes on the line you want to follow.
To folow another line, click on it.

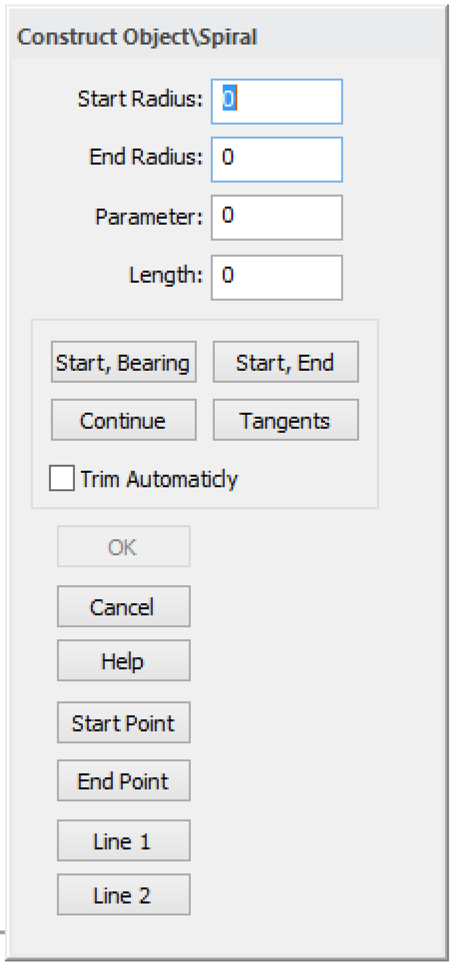
Press enter or the green checkmark to confirm the line.

You can fill in Start Id, Code, Closed polyline or Polygon as you can in the Polyline command.



Spiral

Drawing|Design|Spiral



The ability to interpret clothoids and spirals is a valuable tool when creating roadline and railroad line geometry.

There are different ways to interpret clothoids in Topocad. You can do it between a straight line and a radius or between two radii.

Certain data has to be entered to interpret clothoids.

Start, Bearing:
The start point for the clothoid is selected. Enter the end or start radius, or both, and then enter either the length or parameters. Finally, select the end point for the start bearing.

Start, End:
The start point for the clothoid is selected. Enter the end or start radius, or both, and then enter either the length or parameters. Finally, select the end point for the start bearing.

Continue:
When an end point on a straight line or arc has been selected, the clothoid will continue from this point. If a straight line is used, the end radius also has to be specified. If a radius is used, the end radius should be 0 but an alternative value can be entered.

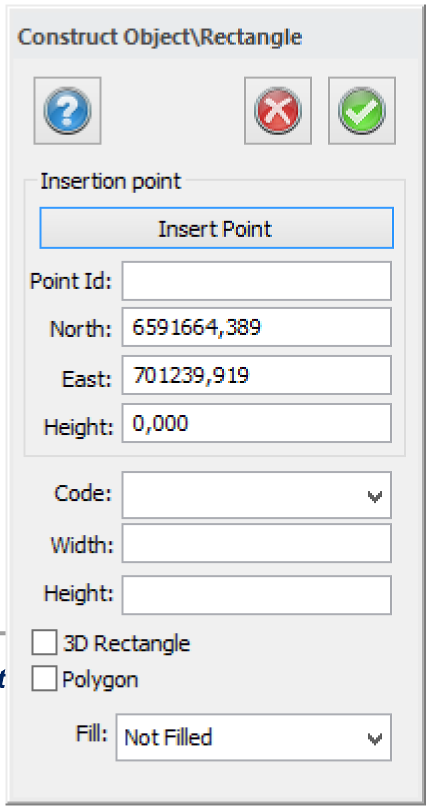
Tangents:
For this function you need only two elements for a straight line or radius. Because the distance between them and the start and end radius is known the parameter be calculated.

The clothoid cannot cover large gaps.

Use the trim function when using the tangent-tangent option.

Rectangle

Drawing|Design|Rectangle



Function to create rectangles in 2D and 3D.

Click on the point from where you want to start. The first two points determines the direction of the rectangle.

When you draw the third point: Click Shift to maintain the length from the base.

3D rectangle

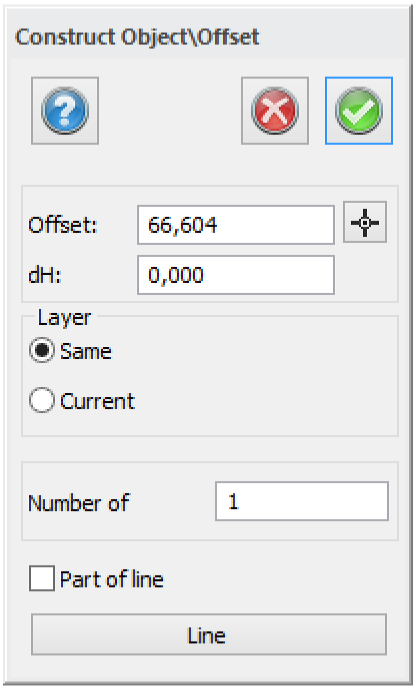
Tick to create a triangle in 3D.

Offset

Drawing|Design|Offset

Shortcut key: Ctrl + 2

Parallel polylines with a selected offset are constructed using the Offset command.



To construct an offset:

1. Select the command *Offset*.
2. Select the offset you want to use. You can select it either by clicking in the drawing or entering the value manually.
3. Click on Polyline in the dialogue box and select the line from which you want to make the offset.
4. Click on the side where you want the new line to appear.

TIP! It is possible to select a new polyline and a new side without closing the command!

1 TIP! Make sure that you do not have the snap lock function activated when you select the side for the offset.

2 TIP! Do not enter a negative value for the offset. You select the side by indicating the right side!

Divide line

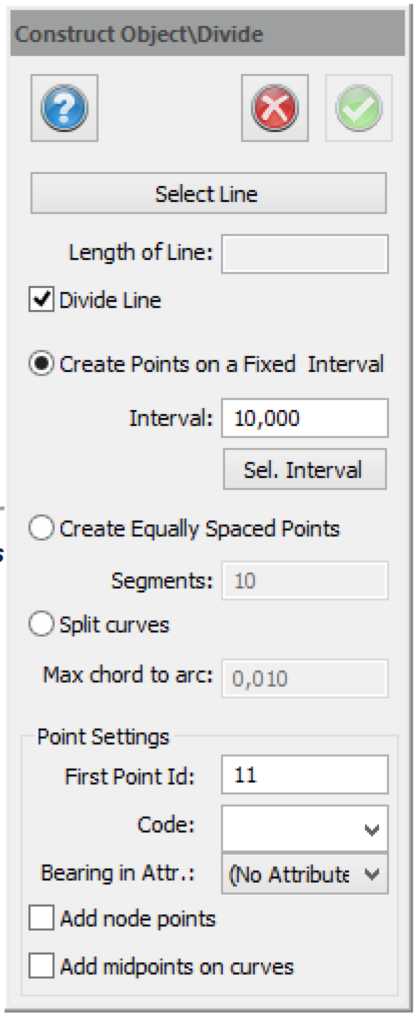
Drawing|Design|Divide

The Divide line command is used to divide a line into several segments and creates points on the line or to divide the line (click on the Divide line button in the lower right of the window) into smaller segments.

You can choose between a specified number of points along the line or a specified distance between the points.

For more information about attributes:

- Attributes
- Define attribute
- Create symbol



Fetch entity properties

Drawing|Design|Fetch Entity Properties

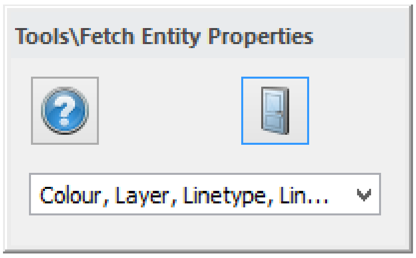
The command can be used to copy properties from an entity to another.

The procedure is as follows:

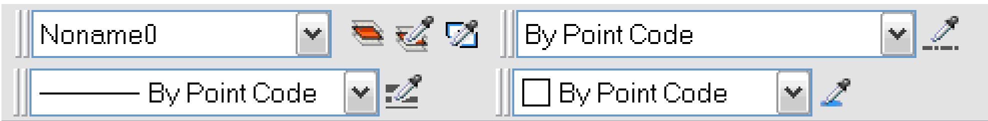
1. Select the properties that shall be copied. (Layer, line type, colour, line weight)

2. Select the entity that shall be changed.

3. Select the entity that selected properties shall be copied from.



The command can also be done from the toolbar:



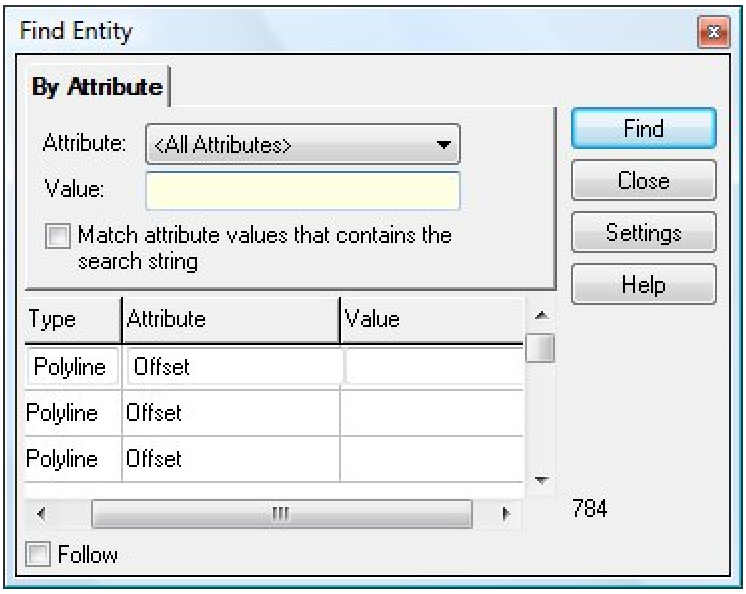
 ***Make entity layer current***
Click on the icon and thereafter on wanted entity in drawing.

 ***Make entity properties current***
Toolbox for current layer, line type, colour and line weight have a button for adding style of the properties from entity.

Find entity

Drawing|Find Entity

Find Entity locates the entities by their points, lines and object attributes and highlight them in any colour.



Attribute
Defines which attribute to search in. It can be all attributes or a single attribute.

Value
The value is the string to search for.

The search is not case sensitive and the user can choose to search for attributes with equal value or values that contain the search string.

The result is displayed in a grid as type (entity type), attribute (attribute name) and value (attribute value). The number of matches is located at the right bottom of the grid.

By selecting a row, the entity connected to it is highlighted.

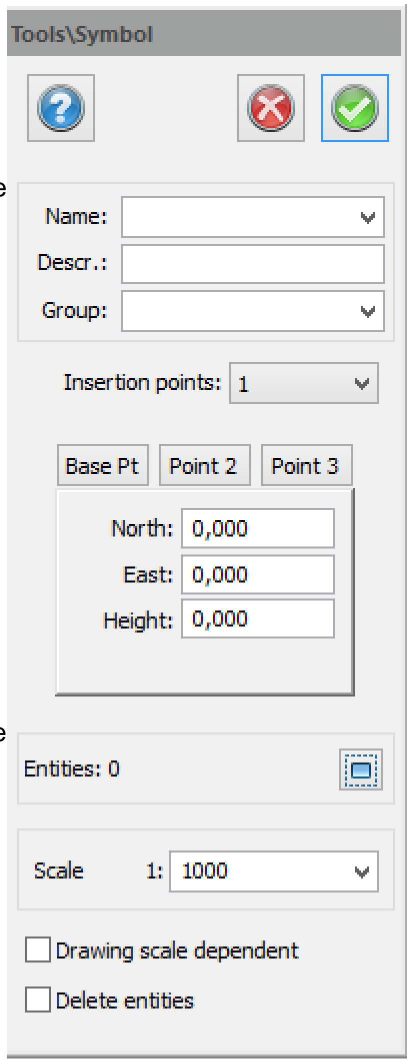
Entity can be selected/unselected in drawing by right clicking in the grid and selecting **Select Entity|Unselect Entity.**

Follow
Follow pans the screen to highlighted entity.

Settings
From Settings, the user can select which colour to use for highlighting.

Define new symbol

Drawing|Design|Define new symbol



Define a new symbol or change definition of an existing symbol.

Symbols can be created directly in the drawing whenever required. You can use points, polylines, texts, circles, arcs and attributes in your symbol. If you want to add a symbol to the constructed one, or if you want to change an existing symbol, you must explode the symbol before you create the new one. Symbols are handled as points and an also have a point code. The symbol can also contain text.

Draw the symbol you want to use with the commands Draw polyline, Draw point, Draw circle, Draw arc and Draw text. You can draw the symbol at any position in the drawing. Under *Create|Define attributes* enter the attributes that you want to assign to the symbol.

To create a symbol:

1. Select Symbols and Attributes|Create symbol.
2. Enter the new symbol name. (If you want to change the symbol name enter the new name here).
3. Click on Select (in the bottom right-hand corner of the dialogue box). Choose the objects you want to include in the symbol. If you have entered any attributes for the symbol it is best to select them in the order you want them to appear in the Edit attributes dialogue box.
4. Select the base point. This is the point at which the symbol will placed relative to the co-ordinates. Snap commands can be used.
5. If you have entered an existing symbol name you will be asked if you want to replace the old symbol.

Name
Select an existing name if you want to change a symbol or enter a new symbol name.

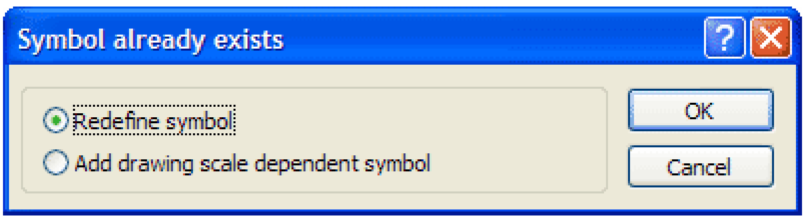
Delete Entities
If you want to delete the objects used to create your symbol, tick this box.

Change an existing symbol
If you want to change an existing symbol or make a new symbol out of an existing one, this is possible but you have to Explode (*Modify|Explode*) the previous symbol before creating a new one.

TIP! The created symbol can only be used in this drawing. If you want the symbol to be available for use in other drawings, go to the Symbol manager (Drawing|Symbol) and add the symbol to the global symbol file.

Symbol for different scales

The appearance of a symbol can be defined by the current drawing scale. When creating a symbol that already exists you get a question if the symbol shall be redefined or if the symbol shall be added to dependent symbol. If the symbol shall be added to dependent symbol, a dialogue with the symbol is displayed and also which drawing scale the symbol shall be displayed in.

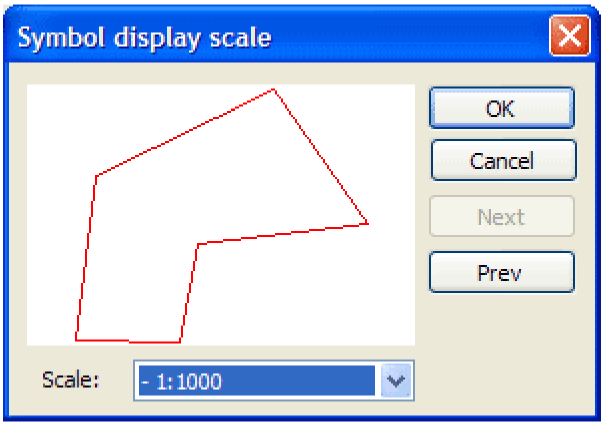


Add drawing scale dependent symbol

Choose between these drawing scales (all drawing scales are locked by the software.)

- All: The symbol is displayed in all scales
- 1:100: The symbol is displayed in all scales that are bigger and the same as 1:100.
- 1:1000: The symbol is displayed in all scales that are bigger and the same as 1:1000.
- 1:10000: The symbol is displayed in all scales that are bigger and the same as 1:10000.
- < 1:10000: The symbol is displayed in all scales that are smaller than 1:10000.

Note! Symbols in the drawing depends on the scale in the view.



For more information about attributes and symbols:

Drawing|Symbols
Created symbols are stored in the local drawing. You can add them to the global table here.

System|Symbol
All symbols in the global table are displayed here. You can delete symbols from this dialogue box.

System|Attributes
Create the attribute itself and all the associated data.

Define attribute
Defines the attributes for the symbol when creating a symbol.

Create symbol
How to create symbols and associate attributes with them.

Attributes at point codes
How to connect attributes to point codes.

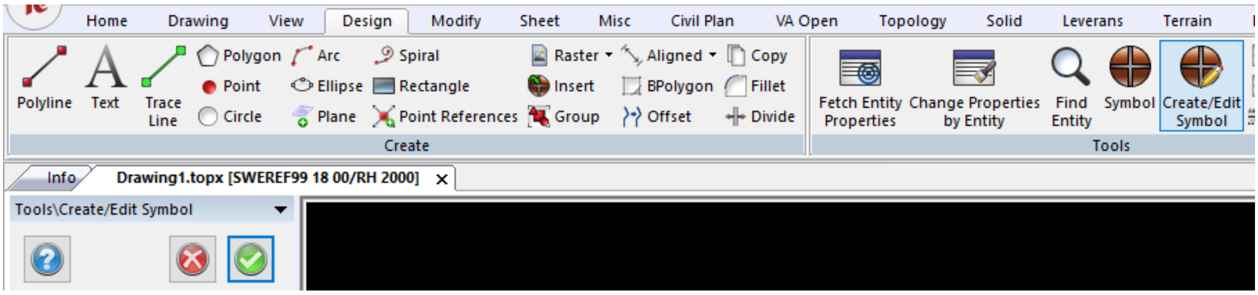
Edit attribute
How to edit an attribute in the drawing whether it is connected to a point code, a symbol or both.

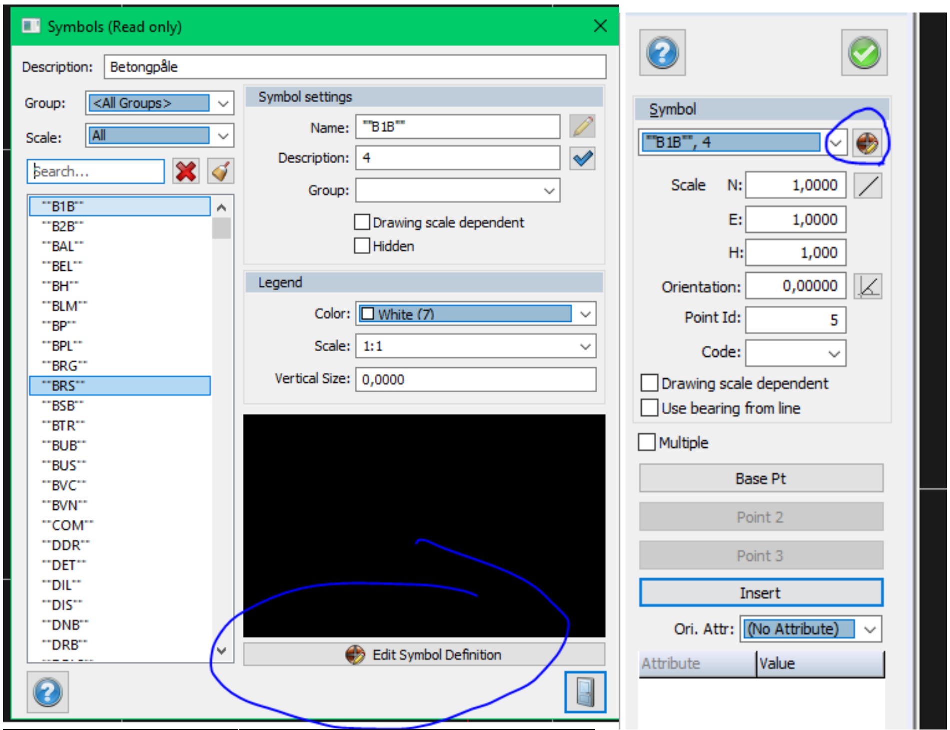
Settings|System files
The global file for symbols is selected in the settings and system files. The system files for symbols have the extension .tsy and the system file for attributes the extension .tat

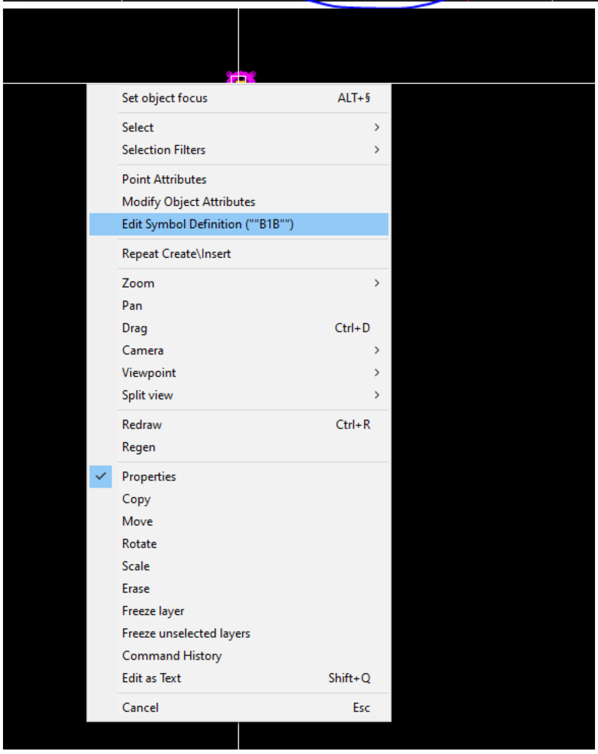
Symboleditor

Drawing|Design|Create/Edit Symbol

The symboleditor can be used to build a new symbol or edit an existing one. With the button from the designtoolbox you can select a symbol to edit straight from a drawing. You can also find your way to the symboledtior on most other places you handle symbols, such as in you symbol list from the home panel, insert symbol or if you rightclick in a drawing with a symbol selected.

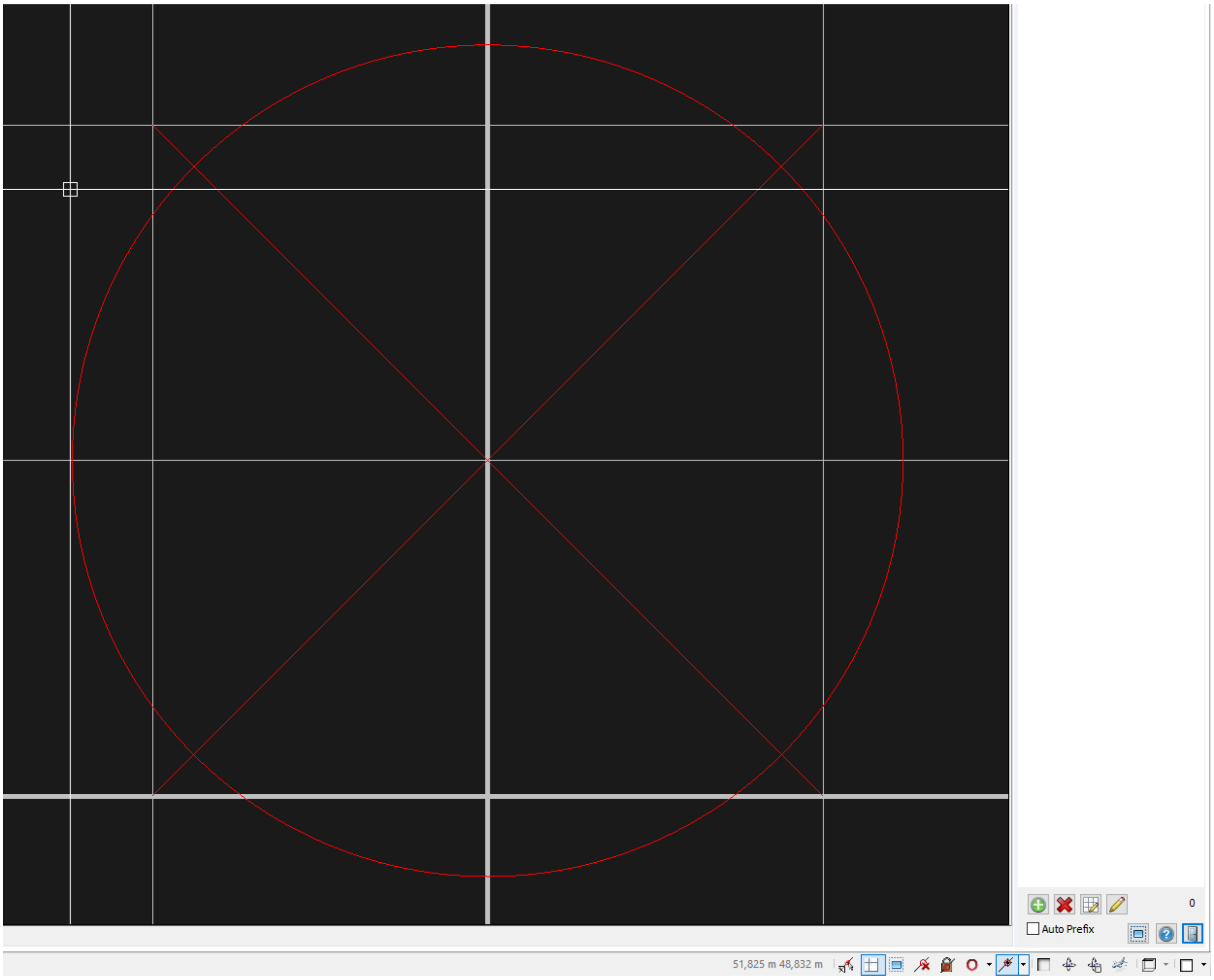




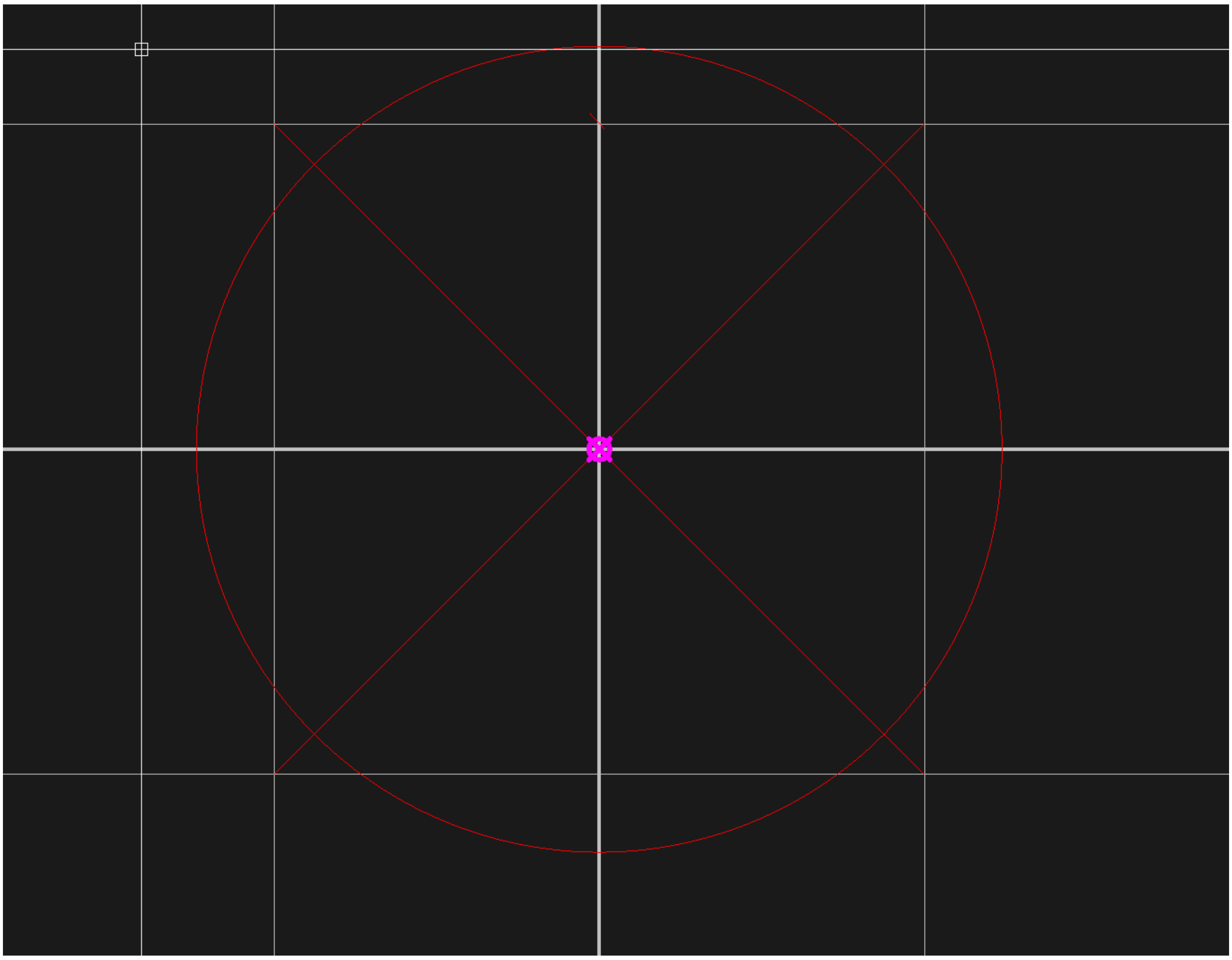


The symbol document is very similar to a drawing document but with less functions for a more focused workflow. You can see the symbols name in the head of the document.

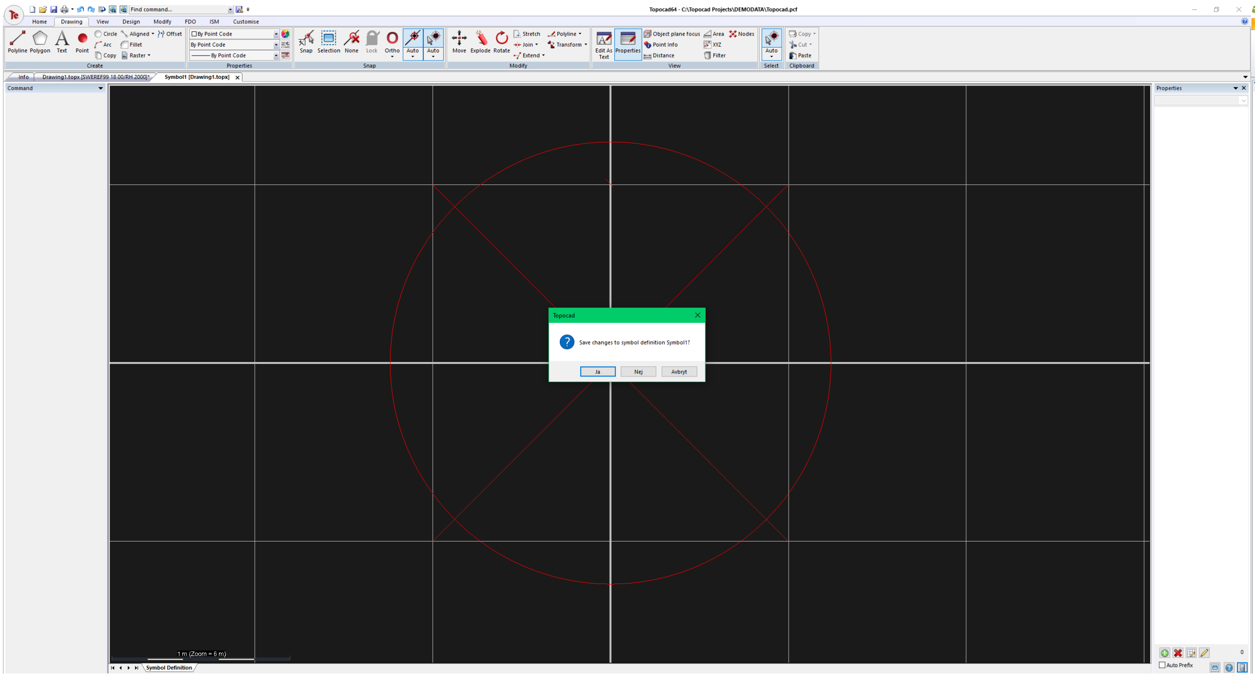
Grid: the grid is active when you enter the symboleditor, this can be turnt off with the F7 key and the button us located in the bottom toolspanel to the right of the snap settings.
The grid is also available from a drawing document.

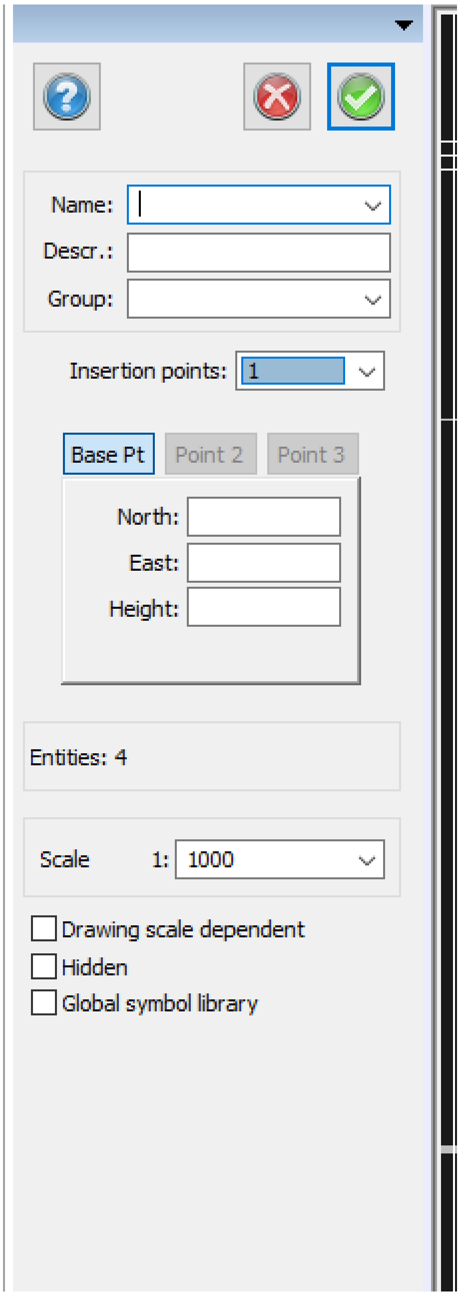


Insertion point: the purple point in the symbol editor is the insertion point of the symbol and is origo of the drawing, meaning it has coordinates 0,0.



Save: To save the symbol you can use the normal save button with a diskicon or if you close the editor down you will be asked if you would like to save.
You will then finalize the symbol from the <u>Define new symbol function.</u>

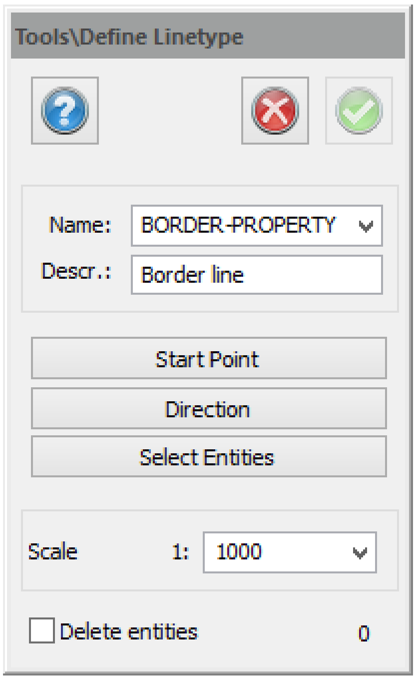




Keywords: Symbolediting, edit symbol, grid, snap on grid, create symbol, insertion point

Define linetype

Drawing|Design|Define line type



Creating a line type is similar to creating a symbol except that you also have to define a direction. The line type may consist of lines with no radius.

The line type is stored in the local drawing unless you copy it to the global line type file (TLT - see settings - system files) in the *Drawing|Line type* command.

Name
Enter a name for the line type.

Start point
Enter a start point for the line type. If you want to start with a space you will need to enter a start point before the line itself.

Direction
Select (by clicking) the direction for the line. This will also be the end point. The line will start from that point.

Select object
Select the objects that you want to include in the line. Only select lines without a radius.

Scale
Select a scale if different from the current drawing.

See also:

Drawing|Line types
The line types used locally and line types available in the global system file are listed here. You can copy them from either side.

Settings|System files
The line type files are selected under Settings - System files.

3D solids

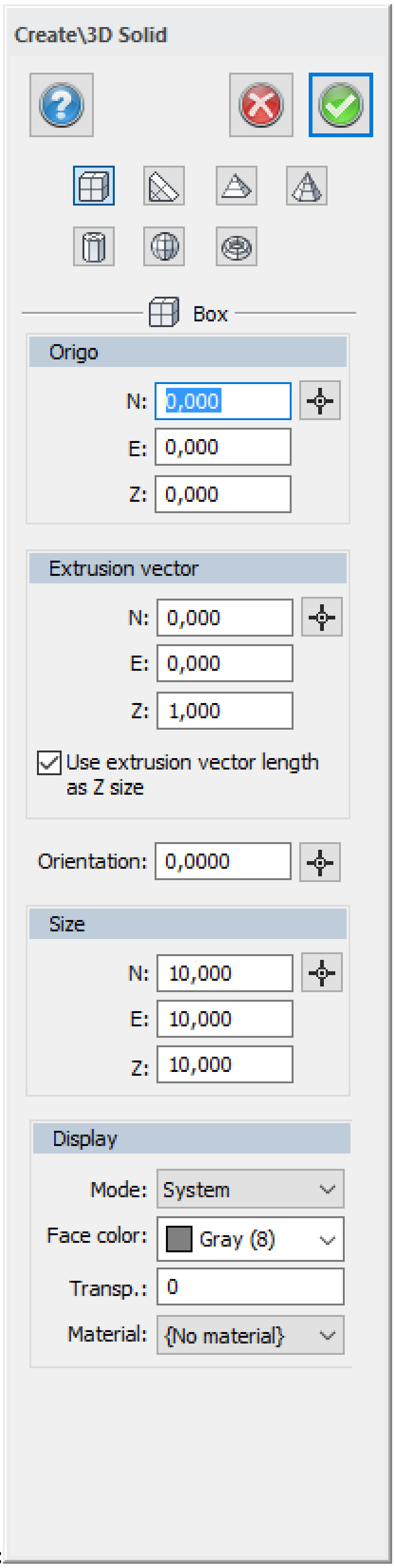
Design|.
Modify|Boolean ope

Solid menu

Create solid objects
Loft
Sweep
Revolve
Extrude
Boolean operations

Create solid objects

You can create wedges, pyramids and many other object that allows you to enter coordinates, appearance, size, origo, direction of ext of an object.
You can also specify the extension length of the height. Display indicates how the object will appear on screen which consists of prop that are adjustable, i.e. you may change the look of appearance.



7 different types of shapes:

- Box
- Wedge
- Pyramid
- Cone
- Cylinder
- Sphere
- Torus

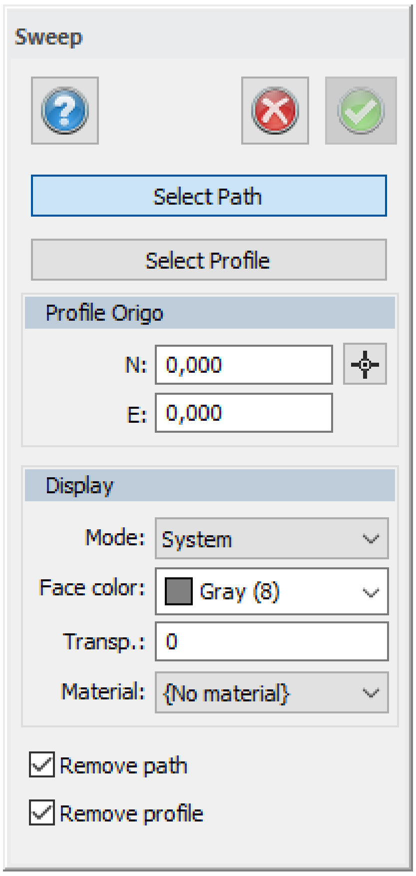
Choose insertion point, angle of the object and its size. You may also choose how the object shall be viewed, see info below, and the c
of the object. Also, you may choose material from the material list and if the color should match the chosen material.

Display modes:

- System
- Thread model
- Hard surface
- Soft surface
- Thread model plus hard surface
- Thread model plus soft surface

Sweep

Design|3D soli



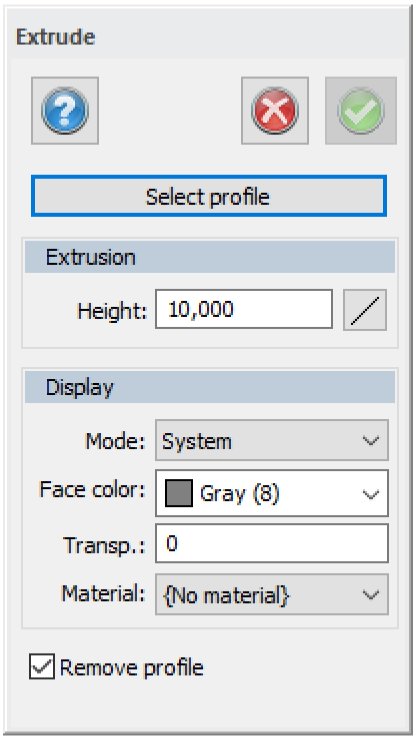
Uses a 2D profile to sweep after a line. A 2D profile can be a circle, polygon or an ellipse. First, you choose a line (it has to be a poly without point differences in the breaking points), then, a cross section profile (has to be a closed polyline that doesn't have any insofa direction). If the profile is a polygone which contains a hole, a solid profile with hole will be created.

You choose how the solid object will be displayed, according to the standard display of the solid objects.

Choose original data - if the lines and cross-sectional profile should be deleted or not.

Extrude object

Design|3D solid|

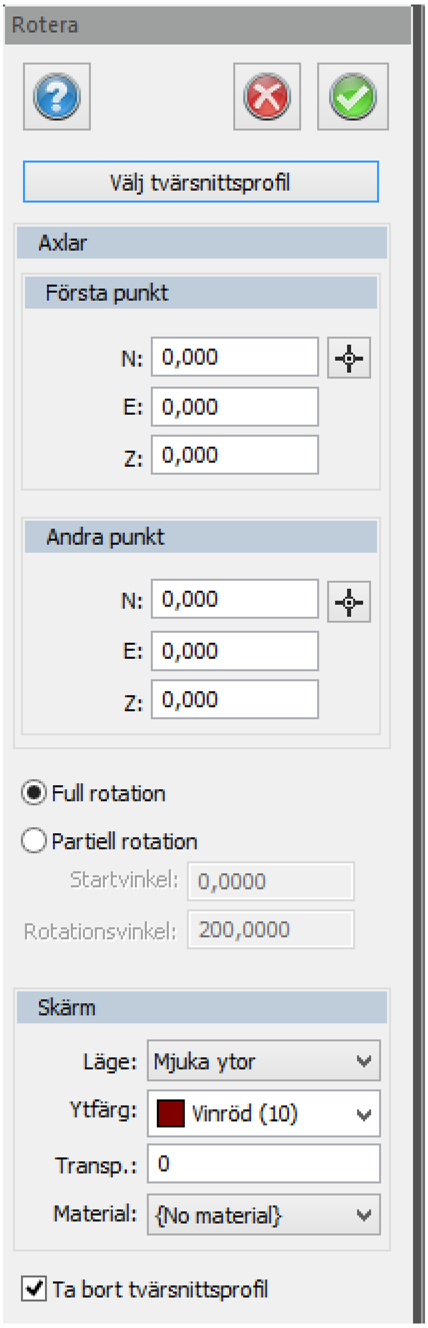


Pinpoint a height of a solid object and select the height of the object. You choose the profile and the length of an object. This will crea
Objects out of 2D objects.

You choose how the 3D solid object should be displayed according to the standard set for 3D solid objects.

Revolve

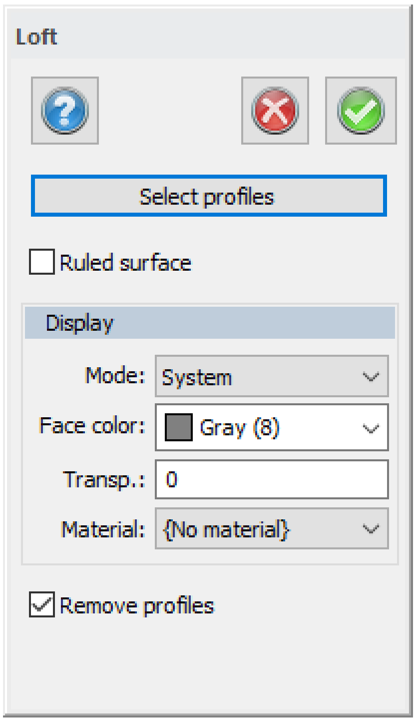
Design|3D solid|



Create revolving objects around an axis. Select profile (closed polyline or polygon) and axis to revolve. It is possible to revolve one fu
or parts of a lap.

Loft

Design|3D so

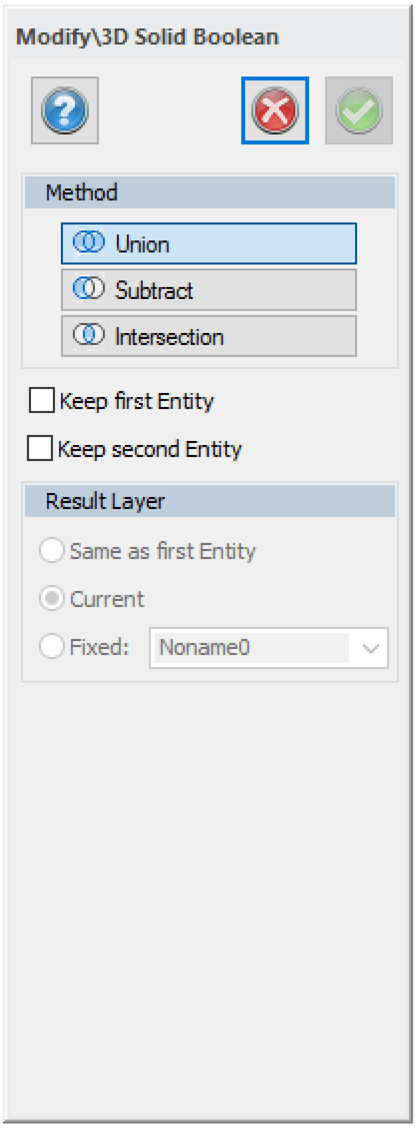


Create 3D solids that goes through cross sections/profiles. Choose cross section in order to create solid objects. Curved surfaces are cr if you choose more than two profiles to loft and the box ’Ruled surface’ isn't enabled. ’Ruled surface’ is enabled, straight surfaces wil created.

The profiles need to be closed areas.

Boolean Operations

Modify|3D solid|Boolean Op



There are three different methods in order to create boolean operations:

- Unite: Choose two 3D solid objects that are assembled to one 3D solid object.
- Subtract: Choose what you'd like to subtract from, this method is also used as a cutting-tool were you remove one object from another.
- Cutting: Choose to sort out to the joint surface between two solid objects, i.e. how they cut into each other.

The command can work on many solids in the same operation.

Keep the first and the second entities: You may choose to save the entities. This is useful when you want to save the original object bu
create a new result of the object. in other cases, the entity is removed.

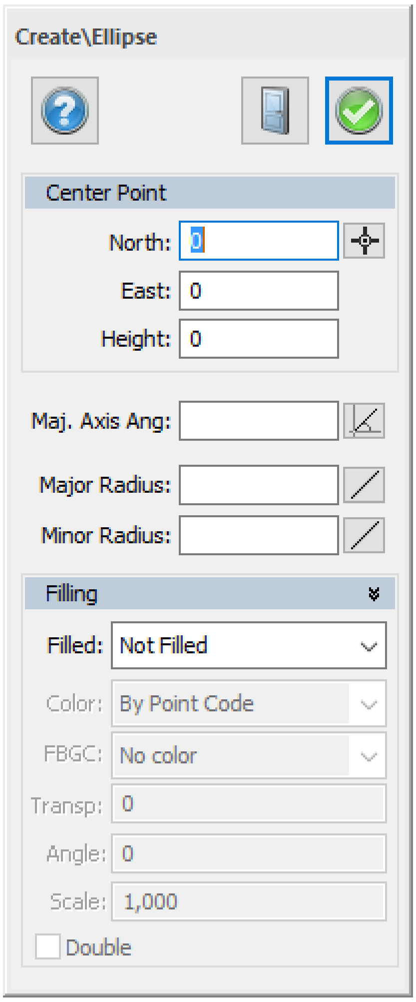
Result layer: You may also move the result to desired layer. Choose which layer; the same layer as the first item your first selected entity, the current layer, or a default layer. If any of the selected entities
to be saved is activated selecting stocks for the resulting entity.

The alternatives are:

1. Same as first chosen entity
2. Current layer
3. Chosen layer (choose in the drop down list)

Create Ellipse

Drawing



Create ellipse. The center point is to be stated, by stating the center point you point out the direction in which the largest and the sma rotary axes the ellipse has. These two factors indicate the appearance of the ellipse, i.e. if the ellipse axis of rotation has the same radi largest and smallest radius in order to create a circle.

Modify content

Drawing|Modify

Modify

Move
Join
Explode
Trim
Erase
Rotate
Scale
Break
Extend
Lengthen
Stretch
Cut

Mirror

Edit

Text
Polyline
Polygon
Check attributes
Point attributes
Object attributes
Raster
Group
Order

Tools

Edit as text
Filter

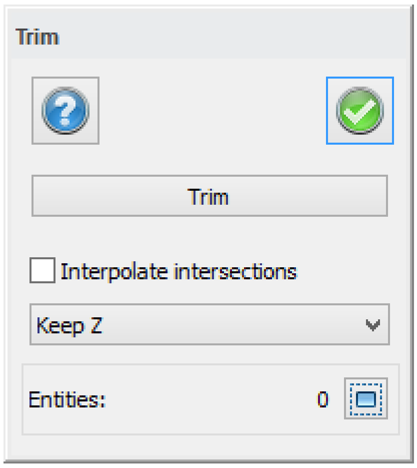
Transform

Transform
Gtransform
Proj4 transform

Trim

Drawing|Modify|Trim

Shortcut key Ctrl + X



This command cuts polylines, circles or arcs when they reach another object. You can trim the objects at either ends or in the middle.

To trim a polyline, circle or arc:

1. Go to *Trim*.
2. Select the polylines or other objects you want to trim to. You must select at least one polyline, circle or arc but you can select several. To trim to a symbol you need to explode it first. See Explode
3. Click Trim in the dialogue box.
4. Select the polyline, circle and/or arc that you wish to trim. The part of the polyline that you selected is trimmed (deleted). It is even possible to trim objects that you have trimmed to. It is possible to select several lines with the select command (for example windows or crossing) and you can also select a line or a polyline. Select with a right click and the Select button.
5. Click Done or press F2 or Enter when you have finished.

It is possible to trim to interpolated objects. The trim command, as well as the extend command, can trim towards the other lines extension. In other words the lines do not have to attach to be trimmed.

The alternatives of the trim command are ”Keep Z”, ”Interpolate Z” and ”Interpolate other Z”.

Keep Z means the Z coordinate is not affected.
Interpolate Z means the Z coordinate is calculated at the intersection, by interpolating the trimmed object.
Interpolate other Z means the Z coordinate interpolates from the intersection.

Note: It is not possible to trim a symbol that is connected to a point code. This is treated as a point or polyline and not as a symbol.
TIP! You do not have to close the command if you want to trim other objects. Just click Select again and select more objects to trim to.

Erase object

Drawing|Modify|Erase

Shortcut key Delete

This function deletes objects from the drawing.

You can either select the object and then go to *Modify|Erase* or right click and then select Delete. If you activate the Delete command first you have to select the objects for deletion and then select Done by right clicking or pressing F2.

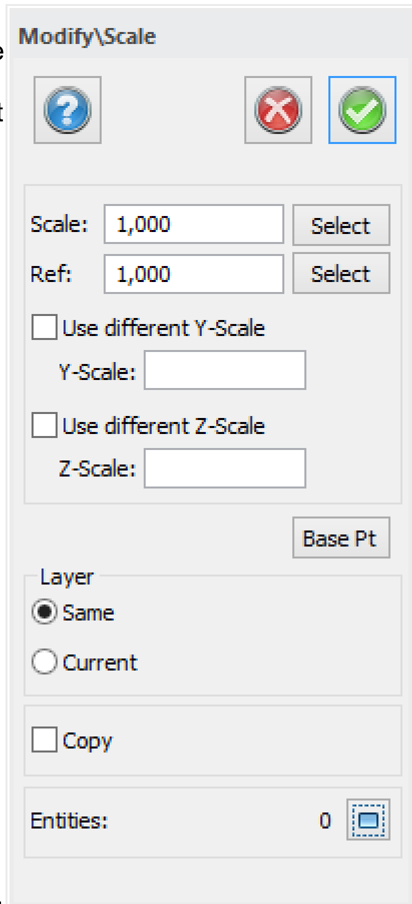
TIP! It is easier to select objects before activating the command. In this case you do not have to finish the command with another command.

Scale

Drawing|Modify|Scale

Shortcut key: Ctrl + 7

This scales the selected objects from the selected base point to whatever scale is required. You can scale objects in the drawing with the mouse or by entering the values manually. In this case it is possible to enter the scale factor and the reference point. It is also possible to select the scale factor and reference point with the mouse.



You can select objects before or after you have activated the command and even add more objects later.

The object to be scaled can be placed in the same layer as the selected object or in the current layer.

To scale an object:

1. **Select** *Modify|Scale*.
2. **Select objects** to scale.
3. **Select base point**. It is possible to snap on objects.
4. **Select Next point**. It is possible to select with the mouse or enter the values for scale manually. If you click on the insertion point the command is finished if you have selected objects. If you enter the values manually you have to click OK to finish.
5. Note that points 2, 3 and 4 may be entered in any order. However, it is important that a base point is selected before the next point is selected in the drawing. The default value for the base point is the origin.

Reference:
You can select a reference from which your new scale will be calculated. This is often easier to use than the default scale.

The modified object can be placed in the same or selected layer. You can also select copy object.

Note: It is important to select a base point. If no base point is selected Topocad will calculate the scale from a base point with co-ordinates 0,0.

TIP! For and the other modify commands you can close the dialogue box and use the context menu instead.

Break

Drawing|Modify|Break

Shortcut key Ctrl + B

The Break command is used to split a polyline.

The procedure is as follows:

1. **Select** *Modify|Break.*
2. **Click** on the first point at which you wish to break the polyline. If you do not wish to break the polyline again press Enter or click Done in the context menu. (You can also click again at the same point.) If you want to break the polyline at another point, click on the point.

See also

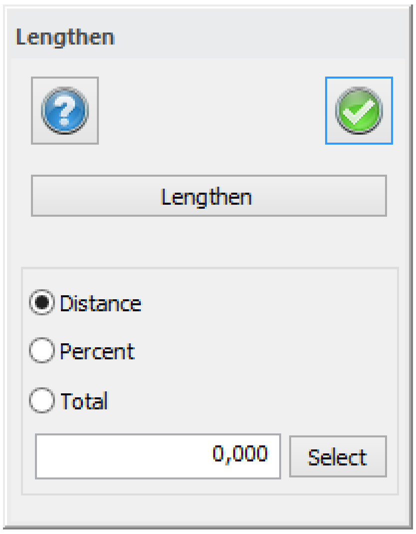
Trim command
Explode
Fillet

TIP! It is possible to repeat a command by pressing the spacebar or enter key!

Lengthen

Drawing|Modify|Lengthen

Shortcut key: Ctrl + V



Lengthen a polyline by a specified distance, a specified percentage of the line length or to the total length of the line. Click on the side of the line that needs to be lengthened. This command can also be used to shorten polylines by entering a length that is shorter then the original one.

The procedure is as follows:

1. Select the polyline.
2. Select if you want to lengthen the polyline with a fixed length, a percentage length or a total length.
3. Click on the part of the polyline that you want to lengthen.

You can select a negative value if you want to shorten the polyline.

Cut

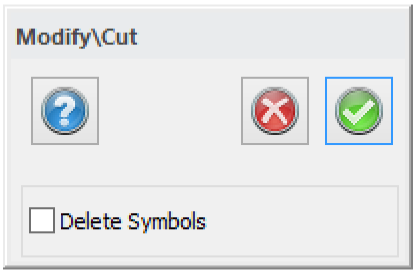
Drawing|Modify|Cut

Function to cut in a drawing.

Draw a rectangle. The function will cut away everything outside the rectangle.

Delete symbols

Tick box to also cut the symbols. If the box is not ticked, the entire symbol will be intact.



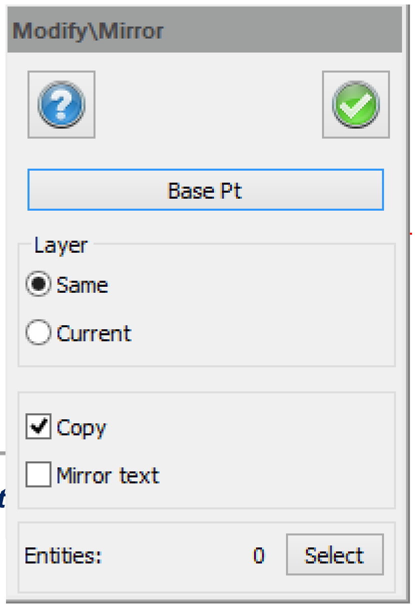
Mirror

Drawing|Modify|Mirror

The mirror command copies selected objects reversed, around selected base line.

Select object, activate the command, and choose if the mirrored object shall be in the same layer or in selected layer. Select Base point (Base Pt) and line to mirror around.

You can also select to copy the object (standard) and how you want to mirror text.

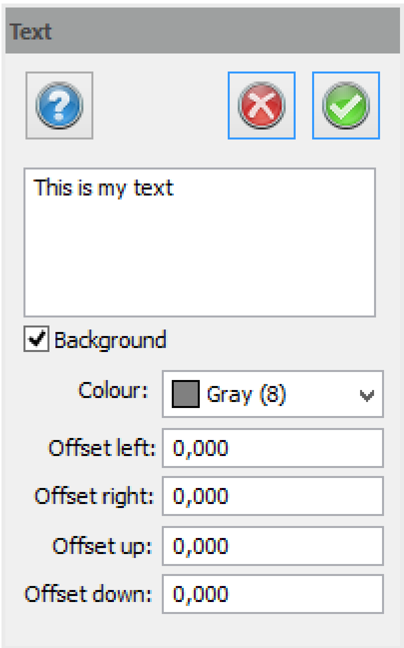


Modify text

Drawing|Modify|Text

Shortcut key Shift + T

The Edit text command can only be used to edit the content of the text, not to move or rotate it etc. If you want to move, scale or rotate text you need to select the appropriate commands such as Modify|Move, Modify|Scale and Modify|Rotate. It is also possible to edit text by going to Modify|Change properties



To edit text:

1. Select Modify|Text.
2. Click on the text to be edited.
3. Enter the correct text. You can also copy and paste (shortcut key Ctrl + V) text into the dialogue box from another text editor.
4. To edit another item of text, click on it in the drawing.
5. When you have finished click Done.

You can also edit text using the View Info command.

Another way to edit text is command Modify|Change|Properties (shortcut key Ctrl + E). In this command you can edit size, scale, position, colour, and also the content of the text. However it is easier to edit the content in this command.

Add background mask to text

Select Background Mask when creating text. Select Fill color to choose a color, and offset values to decide background mask size in relation to the text. The settings can be edited afterwards by changing settings for the text or by the command edit text.

See also:

Change properties

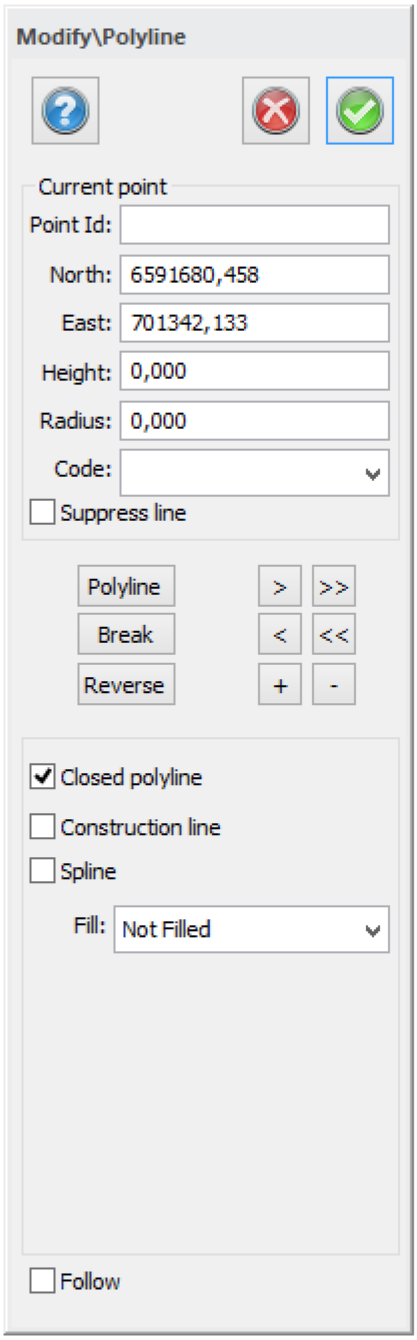
TIP! It is possible to repeat the command by pressing the spacebar or Enter key.

Modify polyline

Drawing|Modify|Polyline

Shortcut key: Shift + L

The polyline can be edited in the Edit polyline dialogue box by editing the text or graphically using the mouse. A third way to edit polylines is to go to View|Edit as text



The procedure is as follows:

1. Go to Polyline.
2. Select the polyline you want to edit.
3. Either move it with the mouse or enter new values in the dialogue box. You can change the co-ordinates, point ID, radius and point code. The point code can be selected from the drop-down list or you can enter another one. The new point code will automatically be stored in the current code table (default name is Topocad.TCT). To ensure that the changed information will be applied go to Next or Previous point before clicking Done.
4. To go to Next or Previous point: click on the appropriate button. You will see a small cross at the current point. When you reach the end of the polyline either the Next or Previous key will become greyed out.
5. To select a new polyline to edit, click Polyline and then select the desired polyline.
6. When you have finished editing the polylines click Done.

Explanations of the dialogue box

Add
Adds a point after the current point. The default position is halfway between the current and next point.

Remove
Deletes current point.

Break
Breaks the line into two polylines and creates a double point.

Reverse
Reverses the direction of the polyline.

Polyline
You can select another polyline by clicking here.

Supress line
Check this box to supress line or part of line. Double click on node (Shortcut N) to get to the Properties dialogue, to uncheck Surpress line.

Closed polyline
This will join the first and last points together. It will not create an extra point.

Construction line
A construction line will be displayed on the display or drawing but not on the printout.

Spline
Select whether or not the polyline should be a spline.

Filled polyline
Creates a filled area with the same colour as the line. You can also select a pattern for the line here.

You can close the dialogue box by clicking in the top left corner and then edit the polyline with the mouse. Right click functions can easily be used to make all changes.

Select the co-ordinates toolbox or open the dialogue box.

Note: If you enter a new radius you will not be able to see it until you exit the polyline. (Done)

Edit object attributes

Drawing|Modify|Object attributes

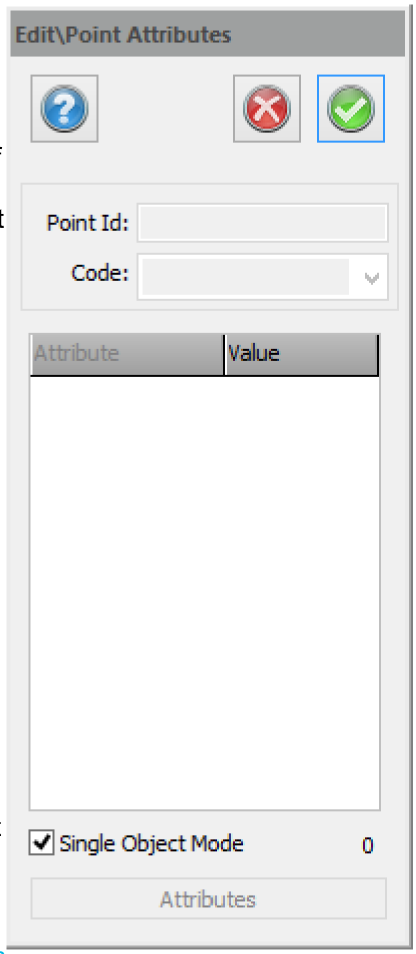
Edit object attribute
This command lets the user edit/ add/ delete object attributes, on objects without data base information. The command shows the attributes of an object, or the common attribute of several objects.

Attributes
Add or remove attributes via the attribute button.

Edit point attributes

Drawing|Modify |Edit point attributes

Shortcut key Shift + A



Edit attribute allows you to change the value (name etc.) of the attribute for a point. You can also use this command to change a point code or the point ID for a point. The order of the displayed attributes is the same as the order in which they were defined when the symbol was created. If more than four attributes are associated with the symbol you will notice a drop-down list to the right. You can also change a point code and point ID by going to View Info.

The procedure is as follows:

1. Select Edit attributes.
2. Click on the point for which you want to edit the attribute, point ID or point code.
3. Edit the point (point ID point code or any attribute data). Some attribute data cannot be edited because the attribute cannot be updated.
4. You can select the next point by double clicking on it.
5. Click Done.

See also

Edit Object Attributes

Add and delete attributes via the attribute button.

Note: It is not possible to edit the point ID or point code for a symbol that has attributes!

Note: The attributes are associated with the point code. If you select another code for the point the type of attributes will change. The data will be attached to the point but cannot be displayed or edited. If you want the attribute to appear on the drawing you will need to create or modify a symbol with that attribute.

Point attributes (with link from point code) can also be edited via Edit as text; View|Tool box|Edit as text. (Shortcut key Ctrl + U) This is a useful command if you want to edit several attributes at the same time.

See also:

Attribute definition

Attributes

Raster

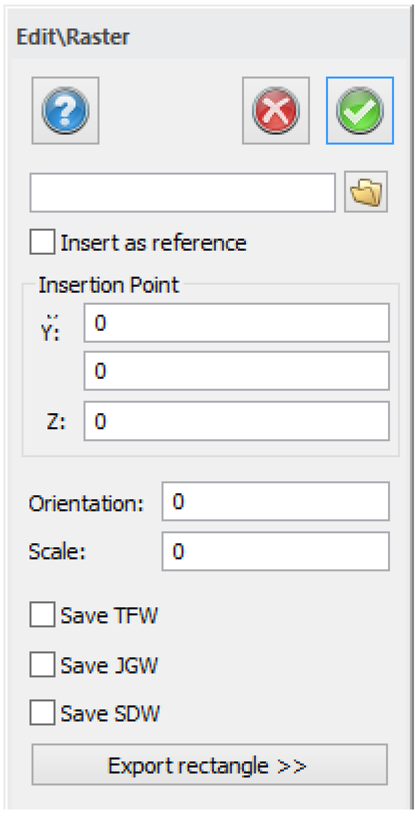
Drawing|Modify|Raster

The command changes the settings for inserted raster images.

Save TFW, JGW, SDW

Check boxes to save the geo ref. data in TFW, JGW and SDW files. The geo ref. data is saved the same time as the drawing is saved and has the same file name, except the file extension. If the geo ref. data is saved for a certain raster image, the raster image will get the same position if it is inserted into another drawing.

You can edit any image and its search path, if the image shall be referred or placed directly in the drawing, and its insertion points, direction and scale. This information can also be edited with the command "Edit preferences".



Group

Drawing|Modify|Group

Short key: Ctrl + 9

Function to edit group.

A group is a number of objects that are linked to one another. Some groups are connected automatically - such as contour lines, dimensions, slope hatches. Other groups can be created manually.

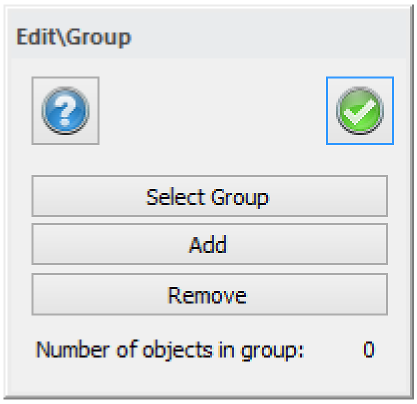
A group can be selected all at once. All modify commands will then apply to the whole group.
A group can contain subgroups.

To create a group go to the Group command.

To modify a group:

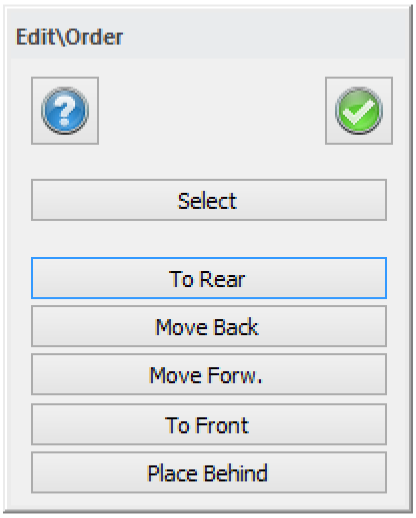
Add
Adds an object to the selected group.

Remove
Removes an object from the selected group.



Order

Drawing|Modify|Order



This command is used to change the order of objects in a drawing.

The command is used for filled and patterned areas so that you can move a filled area forwards, backwards, to the front or to the back in the drawing.

The procedure is as follows:

1. Go to *Modify|Order*
2. Select the object you want to move.
3. You can decide to place it at the front or back, behind another selected object, or move it forwards or backwards one step at the time.
4. Done!

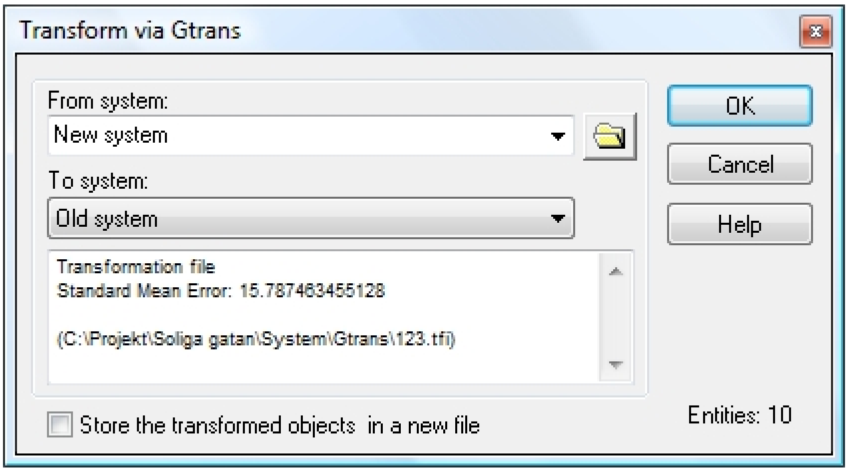
In a drawing there are often many objects. Therefore, when using commands like Move back and Move forward it may seems like nothing happens, but in fact it depends on the number of objects in the drawing, and it can take some time before you see the change in the drawing. It is then faster to use some of the other commands.

Compare this with the layer setting function where you can give the objects in a layer a priority - the higher the number the higher the object appears in the drawing list.

Gtransform

Modify|Gtransform

Gtrans is a third party software package that can be implemented into Topocad and used to transform known parameters between some systems. Systems can be set up.



New transformation relations (.tf and .tfi transformation information files) adds to the selected relation catalogue. The dialogue also shows a description of selected relation.

The procedure is as follows:

1. Select the objects you want to transform.
2. Go to *Modify|Gtransform*.
3. Select the system you want to start from.
4. Select the system you want to go to.
5. Select whether you want the transformation to create a new file (recommended).

A .tf file looks like this:

```
TFFIL               Lantmäteriverket         1996-09-02
 Transformation från geocentriska koordinater i WGS 84
 till geografiska koordinater i WGS 84 med höjder över ellipsoiden.
/
TSYSTEM WGS 84 lat long ellh/
LATLONG DEG/
HTYP ELLIPSOID METER/
FSYSTEM WGS 84 cart/
CART METER/
ELLIPSOID WGS 84/
CARTGEO/
STOP/
```

Geoid model

To use a grid file for your geoid you need to define this grid file in the geoid.def file that should be placed in the same directory as the transformation files. (tf- och tfi-files.)

Example:

```
GEOID        SWEN 01L grid
Geoidhöjdsmodell för SWEREF 99,
bilinjär interpolation i grid swen01l.grd, geografiska lat long
Gridstorlek: 601x301
lat-min: 55°       long-min: 10°
lat-max: 70°       long-max: 25°
dlat:      0°.025   dlong:      0°.05/
ELLIPSOID        GRS 1980/
GRIDSYSTEM       SWEREF 99 lat long/
HSYSTEM          RH 70/
GRIDFIL          swen01l.grd/
GEOID        SWEN05_RH2000 grid
Geoidhöjdsmodell för SWEREF 99,
bilinjär interpolation i SWEN05_RH2000.grd, geografiska lat long
Gridstorlek: 601x301
lat-min: 55°       long-min: 10°
lat-max: 70°       long-max: 25°
dlat:      0°.025   dlong:      0°.05/
ELLIPSOID        GRS 1980/
GRIDSYSTEM       SWEREF 99 lat long/
HSYSTEM          RH 2000/
GRIDFIL          SWEN05_RH2000.grd/
GEOID       RN 92 grid
Geoidhöjdsmodell för RR 92, RT 90 och RH 70,
bilinjär interpolation i grid RN92.GRD
xmin: 6100000      ymin: 1200000
xmax: 7700000      ymax: 1900000
dx:       5000     dy:       5000/
ELLIPSOID   BESSEL/
GRIDSYSTEM RT 90 2.5 gon V 0:-15/
HSYSTEM     RH 70/
GRIDFIL     rn92.grd/
GEOID       RN 92 polynom
Geoidhöjdsmodell för RR 92, RT 90 och RH 70,
POLYNOM gradtal 3/
ELLIPSOID   BESSEL/
GRIDSYSTEM RT 90 2.5 gon V 0:-15/
HSYSTEM     RH 70/
POLYNOM     3               1000000
        6881500.000      1535000.000
             -1.495            13.971
            -35.508            17.798
              1.161             5.807
            -11.195            38.700
             -7.616             2.246/
```

See also

Transformation.

Edit Reference Point

Modify|Design|Reference Point

Reference point is used when multiple line items are placed on the same coordinate. Instead of using several multiple points, a reference point is created and used to connect to the same reference. The point of reference is linked to two or more lines and are edited as one point. The reference point is used as a border point or in road nodes.

Bullets in a line that includes the reference point and cannot be edited individually.

Edit Reference Point

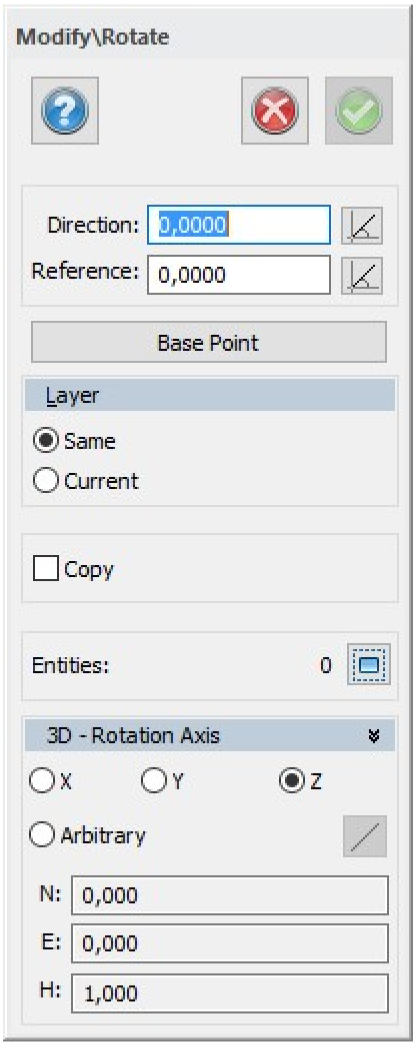
Modify|Edit|Reference Point

Add or change information and references. You can add lines and polygons as reference points. Add new reference by clicking on a point you want to add a reference to by clicking on the + icon. Remove reference done by selecting a reference point, and click on the red cross.

Rotate object

Drawing|Rotate

Shortcut key Ctrl + 6



This rotates the selected objects from the selected base point by whatever rotation angle you select. You can rotate objects in the drawing by using the mouse or by entering the values manually. In this case it is possible to enter the rotation and the reference point. It is also possible to select the rotation and the reference point with the mouse.

You can select objects before or after you have activated the command and even add more objects later.

The object to be moved can be placed in the same layer as the selected object or in the current layer.

To rotate an object:

1. Go to *Drawing|Rotate*.
2. Choose the command Rotate object
3. Select the objects to rotate.
4. Select the base point. It is possible to snap on objects. Right click to get a popup snap menu.
5. Select the orientation. It is possible to select with the mouse or manually enter the value for the direction (in GON, degrees or mills). If you selected the insertion point with the mouse the command is done if you have selected objects. If you entered the values manually you have to click OK to finish.
6. Note that points 2, 3 and 4 may be entered in any of order. However it is important that a base point is selected. The default value for the base point is the origin.

The rotating object can be placed in the same or current layer. You can also choose to copy the object.

Explanation of dialogue box

Reference angle:
This is used if you want to rotate an object relative to a selected reference angle instead of the default reference angle (that is 0 North). Click on Ref. and then select the first and second points of the reference angle. The angle will be displayed in the dialogue box. To rotate an object relative to this angle you can either use your mouse to select the rotation or enter the angle in the orientation box. This method is the best.

Copy
Tick this box to copy the rotated objects.

Note: It is important to select a base point. If no base point is selected Topocad will calculate the rotation from a base point with co-ordinates X=0, Y=0.

TIP! For this and the other commands you can close the dialogue box and use the context menu instead.

Sheet contents

Drawing|Sheet

Drawing sheet
Create drawing view
Legend
Add to legend

Coordinates grid
Polar stakeout
Profile form
Insert sections

Drawing sheet

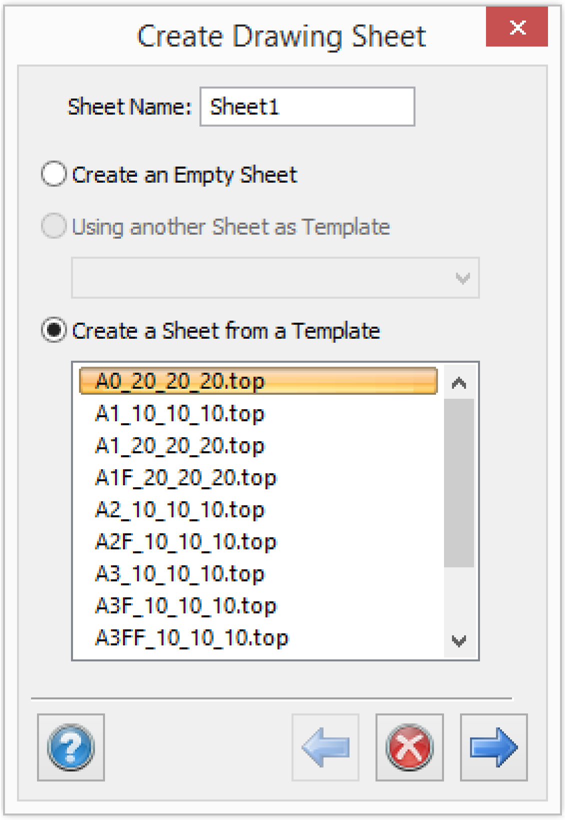
Drawing|Sheet|Drawing Sheet

When creating a drawing you start by creating one or more drawing sheets. Each drawing sheet can have one or more drawing views for viewing the object.

The drawing sheets can be blank, but it is better to create the actual drawing sheets with the frame, stamp and legend.The drawing sheets are selected using *Settings|Drawing*. They can also be copied from previous drawing sheets.

When you create a drawing sheet with one or more drawing views, these should be noted in the model. You can select the scale, direction and start point.

When creating your own templates for the drawing sheet you must create them using absolute values, scale 01:01. For example: an A1 drawing will be 841 x 594 mm



Tip: If you don't want to change scale and direction when by hand in the drawing, set these parameters beforehand and click enter after you clicked out your insertion point in the drawing.

See also

Drawing view.

Create multiple sheets

Multiple sheets

Drawing|Sheet|Create Multiple sheets

Create multiple sheets from points, area or roadline.

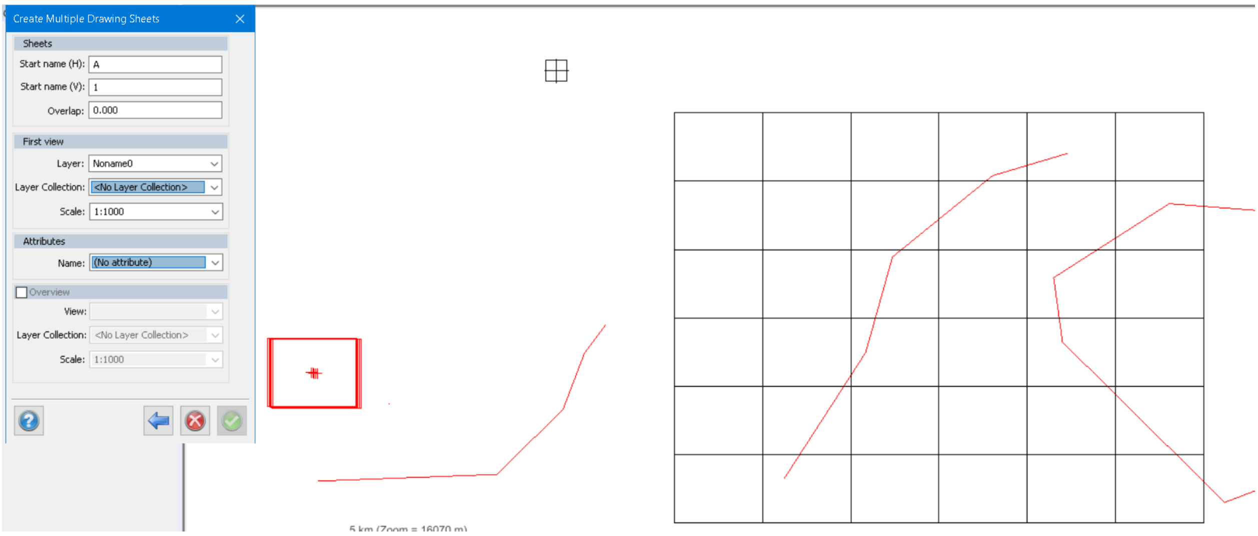
Points: Create multiple sheets from points, every point will be the centre of a new sheet

Roadline: Sheets will be created to show the whole roadline

Area: You cover an area with sheets next to eachother, you also have an option to handle overlap

Each drawing sheet can have one or more drawing views for viewing the object.

When creating your own templates for the drawing sheet you must create them using absolute values, scale 01:01. For example: an A1 drawing will be 841 x 594 mm



See also

Drawing view.

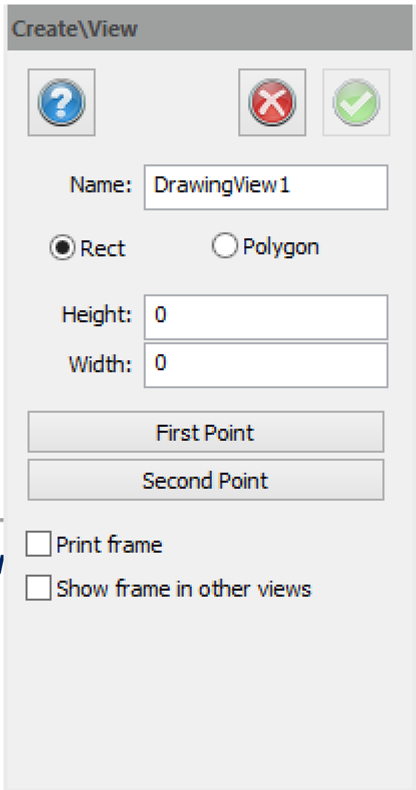
Create drawing view

Drawing|Sheet|View

When creating a view in a drawing sheet you should first select its size in the drawing. The default scale is 1:1000 but this can be changed easily.

A view is automatically inserted into the lower left-hand corner in the model view. If there are any objects outside your drawing area, the new view may be a long way away. Check this.

If the drawing view is inserted into the drawing sheet at the beginning you will have the option to insert the drawing view into the model view.



See also

Drawing sheet.

Legend

Drawing|Sheet|Legend

The function creates a Legend in a drawing sheet. The function is only available in the drawing view.

Placement and size of the explanation types in at the upper left in the dialogue. To the left you find a list over detailed components. At first the list is empty, use the buttons to the right to add/ delete/ move components.

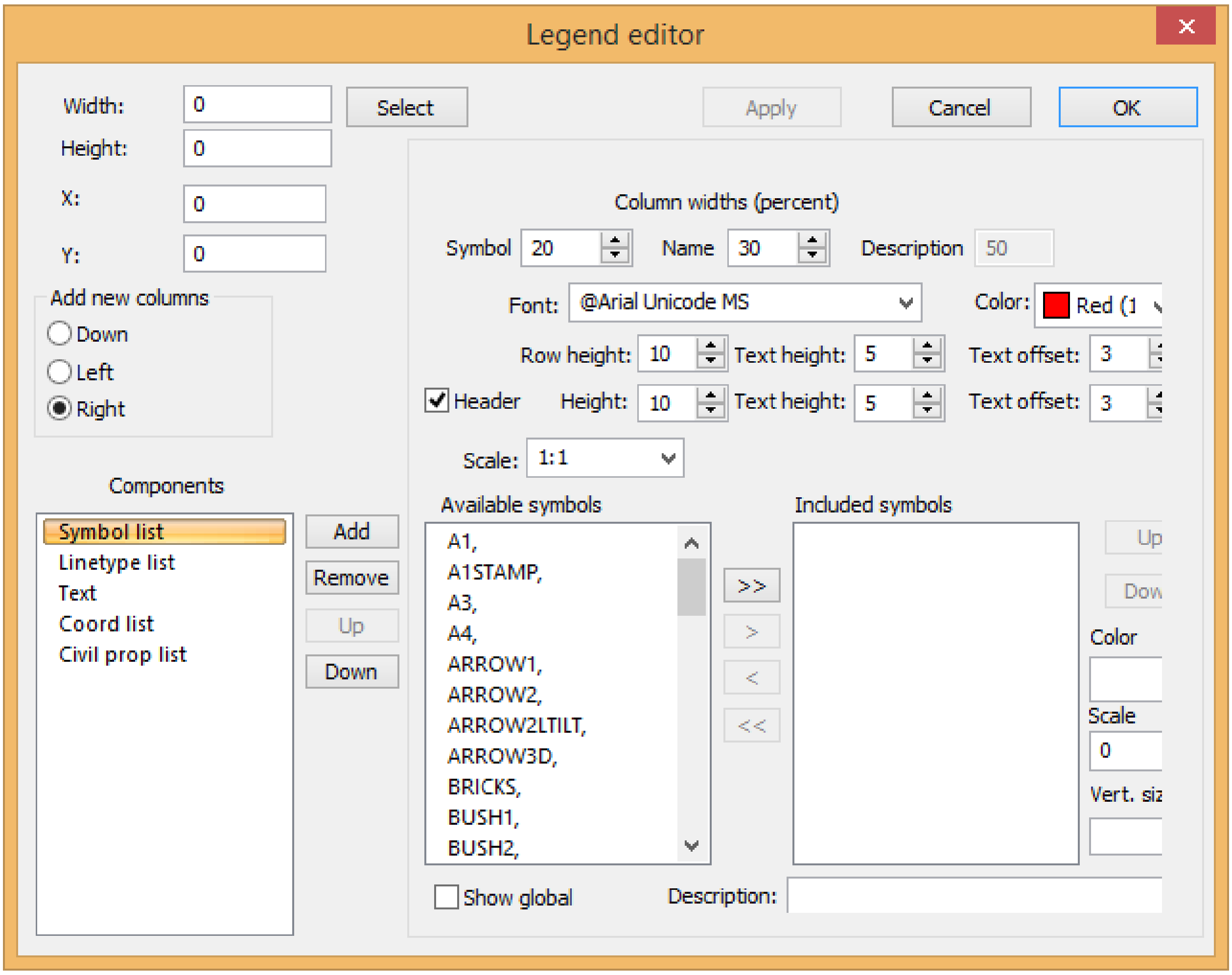
There are five types of components:

- Symbol list
- Line type list
- Text
- Coordinate list

- Civil Properties list

Select a component, to the right you see different commands for different components.

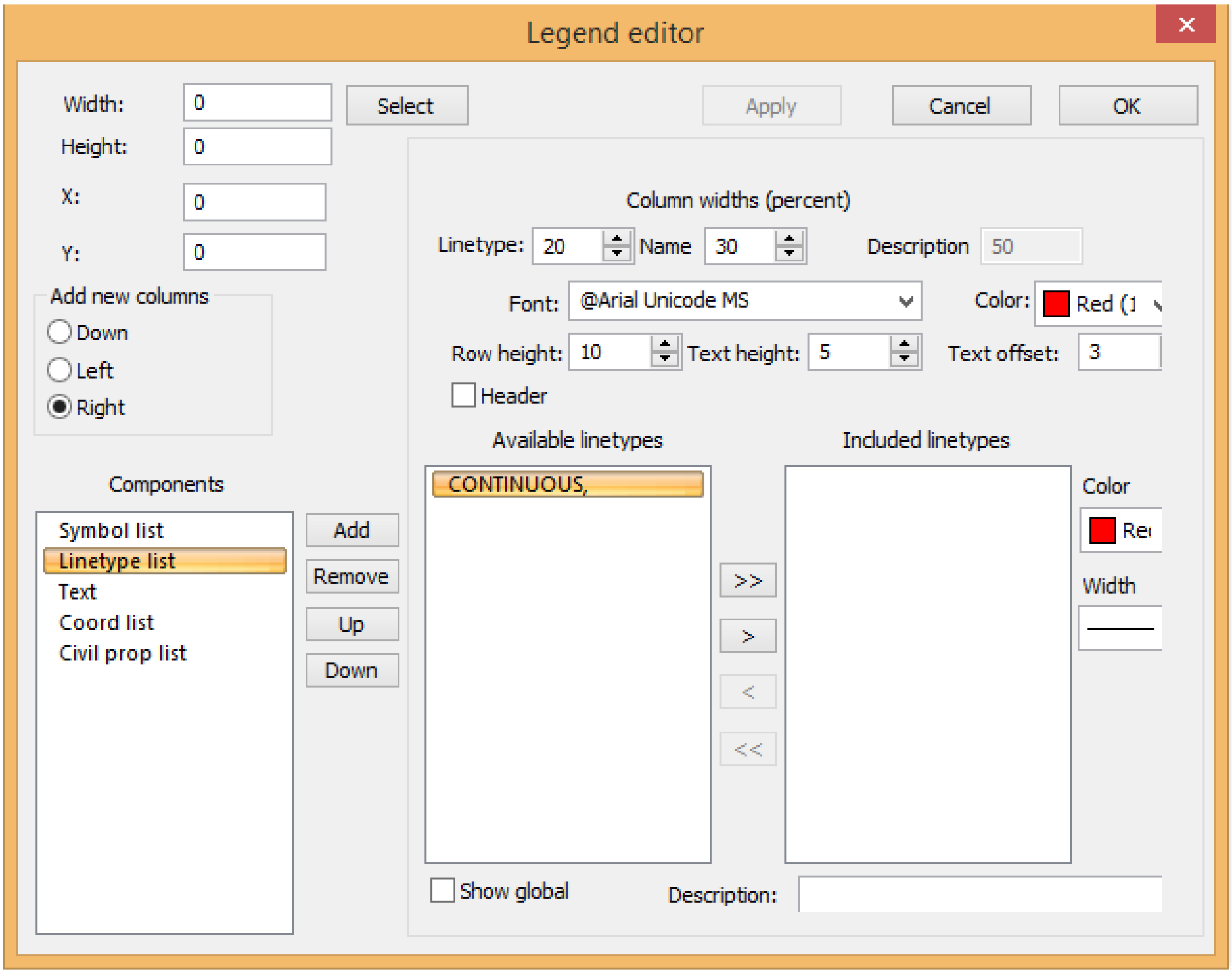
Symbol list



Select the symbols you want to see and add them to the right (Included symbols). In the description field the description for the symbol is displayed but you may edit the text here. Edit column width, font, scale and text height.

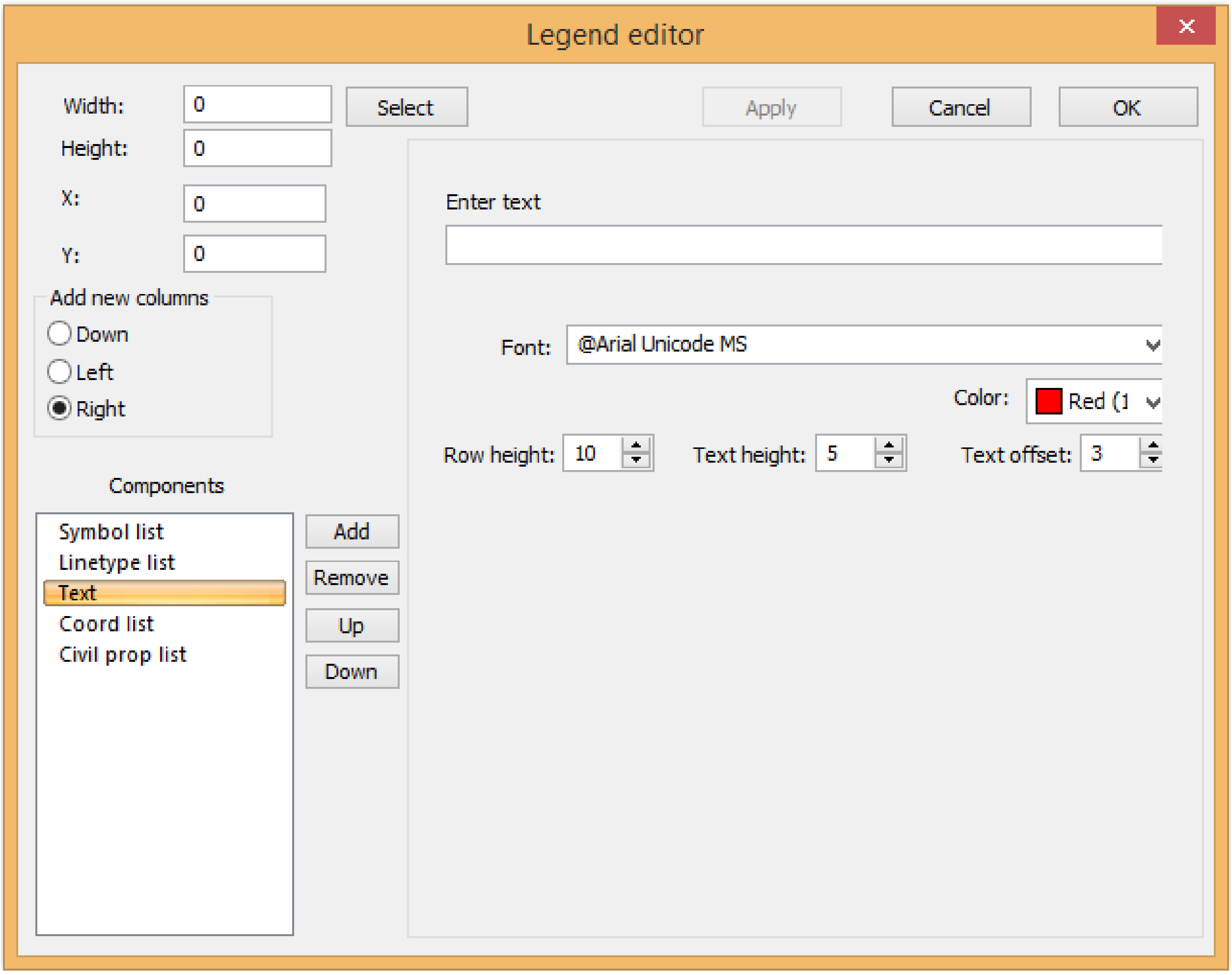
Scale: If the symbol is scale dependent, a scale can be selected. If the symbol is not scale dependent, the scale will not change.

Linetype list



Select the line types you want to see and add them to the right (Included line types). In the description field the description for the line type is displayed but you may edit the text here. Edit column width, font, scale and text height.

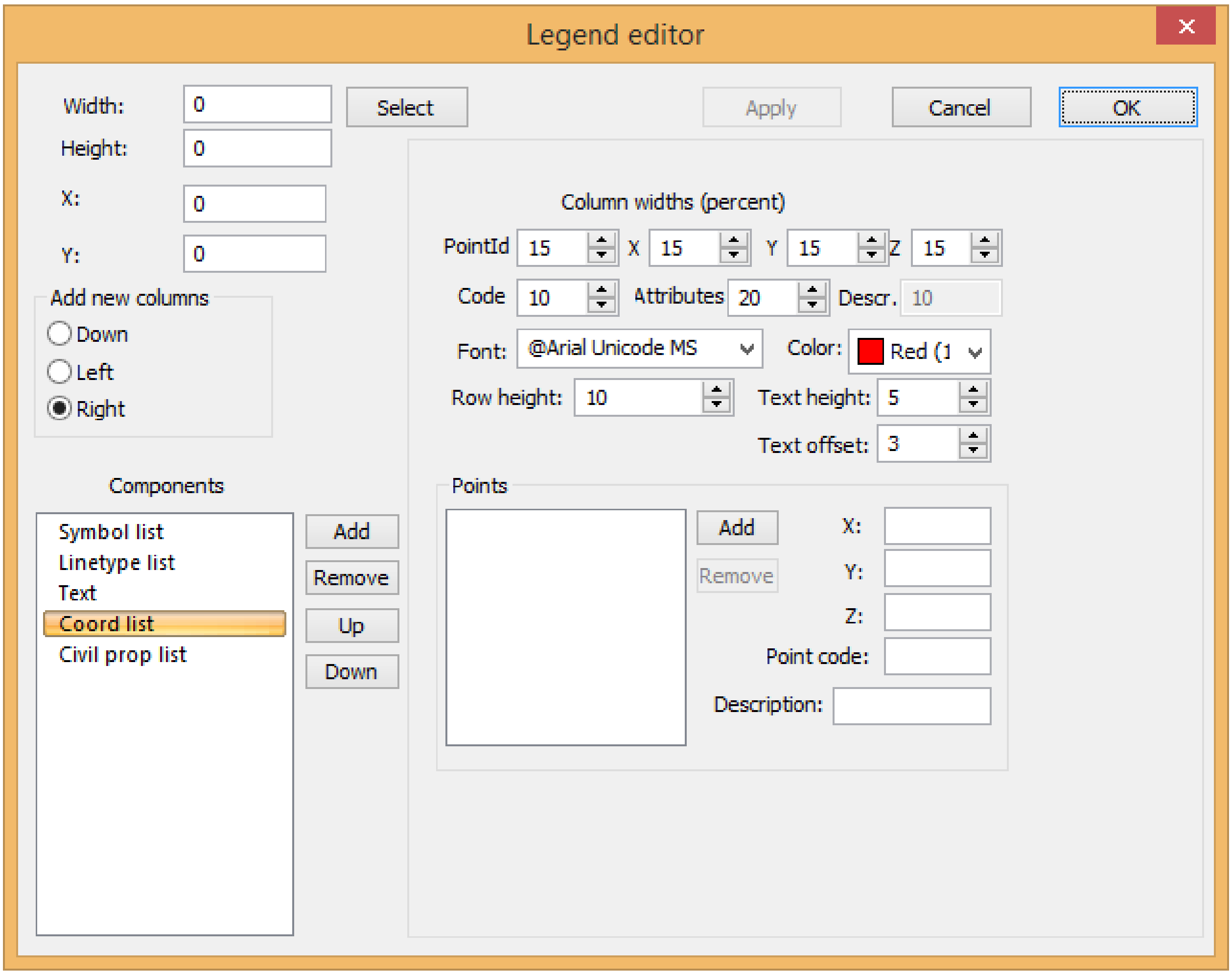
Text



Write the text you want to have in your legend. Select font and text height.

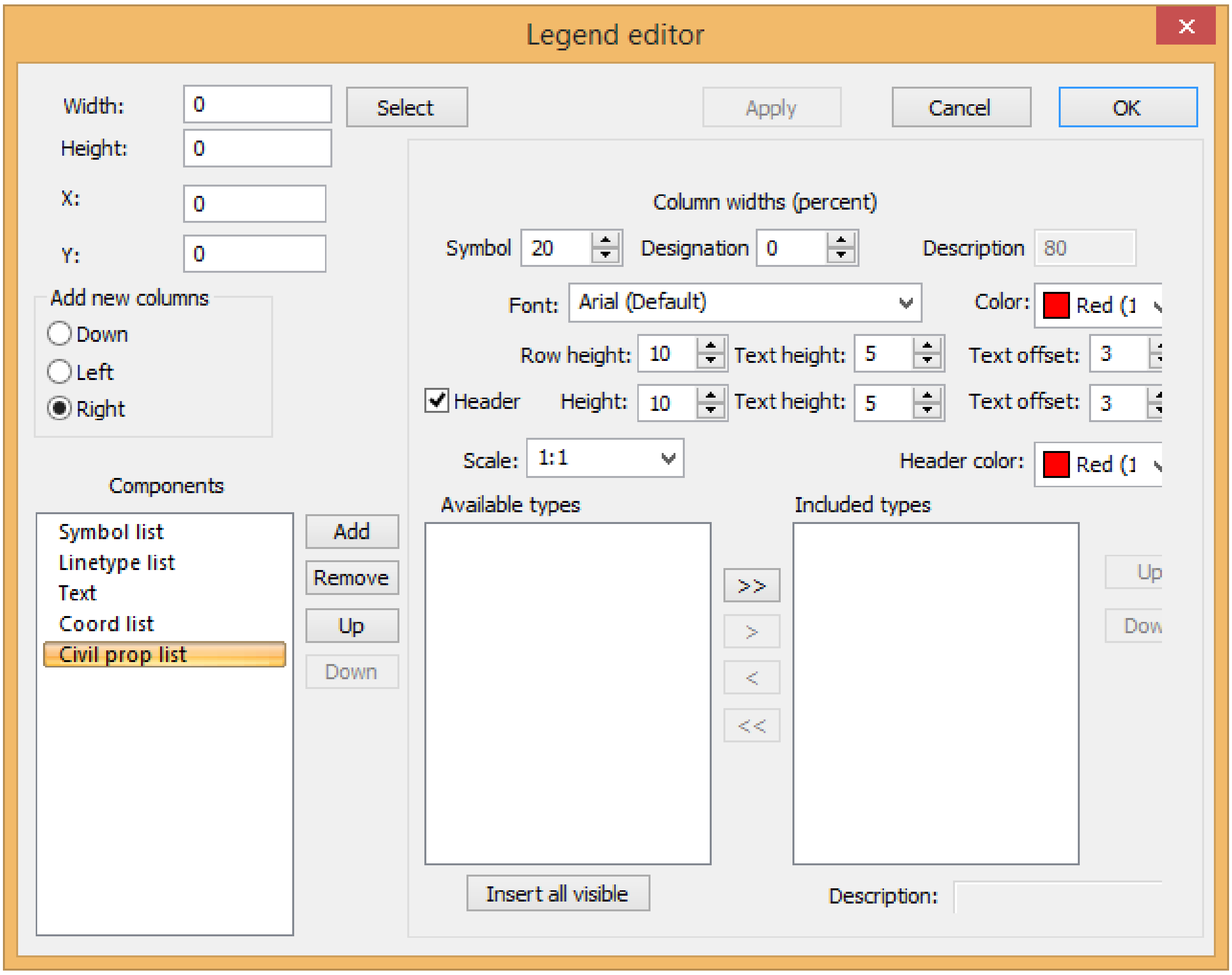
A component can be edited by selecting the component in the list to the left. When a component is selected in the list it becomes editable in the right part of the window.

Coordinate list



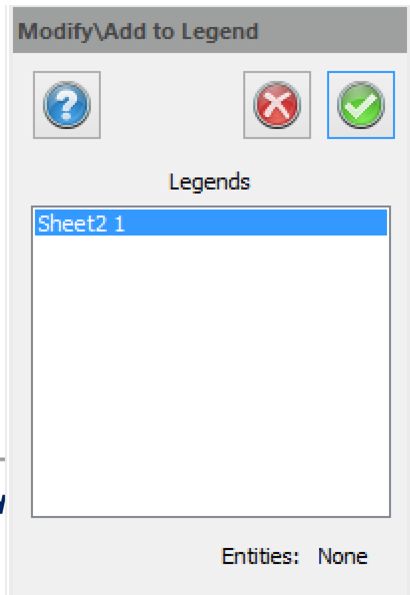
Add coordinates manually or use the command Add to legend.

Civil Properties list



Add to legend

Drawing|Sheet|Add to legend



Function to add coordinate data to the legend. The legend must have a coordinate list.

Select your points in the drawing, go to the Sheet menu and select Add to legend.

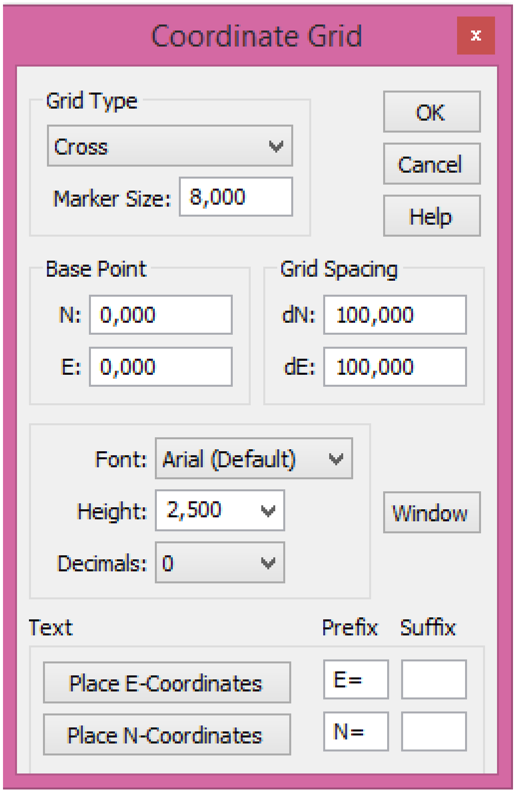
Selection of which drawing sheet and which legend is given.

Co-ordinate grid

Drawing|Sheet|Coordinate grid

The co-ordinates grid is created in the drawing or drawing sheet. The co-ordinates grid can be placed in the same layer as the drawing frame and drawing stamp.

The co-ordinates grid can be inserted in a drawing sheet. You will then need to select which drawing view to work in. The co-ordinates grid will adopt the scale and create a co-ordinates grid of the right size.



To create a co-ordinates grid:

1. Select or create the layer for the co-ordinates grid.
2. Select *Create|Coordinate grid.*
3. Select which type of co-ordinates grid you want to use. You can select from three different types - cross, net and frame.
4. Select size for the cross (this is not necessary when selecting net). Note that these distances are in metres.). The command identifies the set drawing scale and will suggest sizes relative to the drawing scale. If you want the size of the cross to be 8 mm on the drawing you will need to select the following heights for the different scales:
5. Drawing scale: Cross in mm on the plot. Size in metres:

- 1:100 8 0.8
- 1:400 8 3.2
- 1:500 8 4.0
- 1:1000 8 8.0
- 1:2000 8 16.0
- 1:10000 8 80.0

1. Select the base point. The base point is the point from which the numbering of the grid is to be calculated. The default value is X=0, Y=0.
2. Select the distance you want to have between the cross, net or marks in the frame.). The command identifies the set drawing scale and will suggest sizes relative to the drawing scale.
3. Select the font you want to use.
4. Select the height of the text. Note that the height is in metres.
5. Select where you want the text to be printed and also any prefixes or suffixes required.
6. Click on the window and select which area you want to create the co-ordinates grid to appear in.
7. Click OK. The grid will be plotted in the drawing.

See also

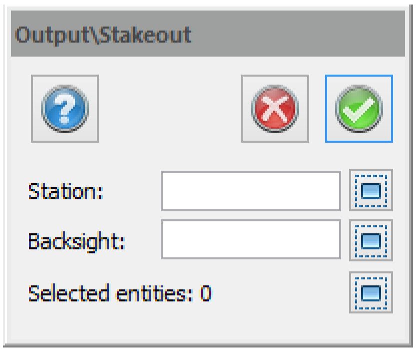
Insert drawing sheet

Insert drawing view

Polar stakeout

Drawing|Sheet|Stakeout

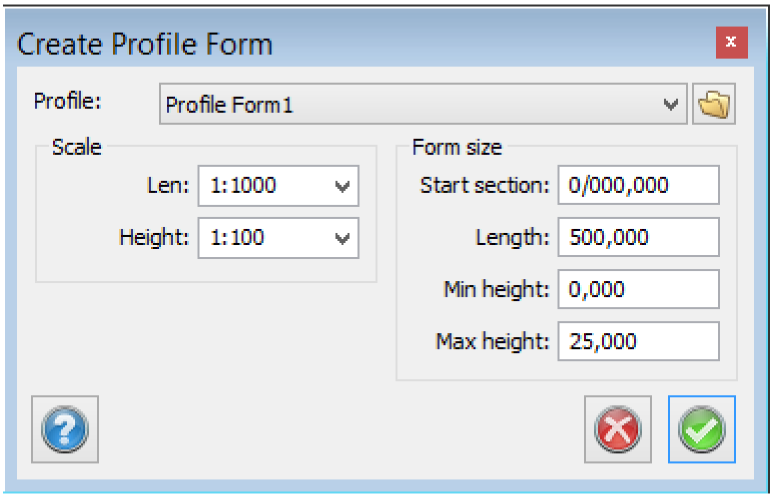
The stakeout creates a printout of horizontal distances and angles from selected stations and backsights.



The printout is added to a stake out log.s

Draw profile form

Drawing|Sheet|Profile form



The profile form cannot be printed from its original file type (.tpf). It must be inserted into a drawing. This will also make it easier to define the scale, size of plot, etc.

The procedure is as follows:

1. Start a new drawing.
2. Go to *Sheet|Profile form*.
3. Select the profile form you want to print.
4. Select an insertion point for the profile form. Select the length and scale of the form. If the profile form is too long to print out it can be split into two or more forms and each will still have the correct toolbox.
5. Done

You can divide a profile form into several sheets or drawings. For example: if you enter 0 as the start section, and a length of 300, and then a start section of 300 and length of 300, the headers will be repeated and the profile form will be displayed correctly.

Tip! You can use the Co-ordinates toolbox to insert the profile form at the origin. This makes it is easier to create the length and height in the profile form.

Tip! If you start with a drawing sheet with a drawing view inserted and zoom in on this, it is easier to insert the profile form and check that it has the correct size and scale.

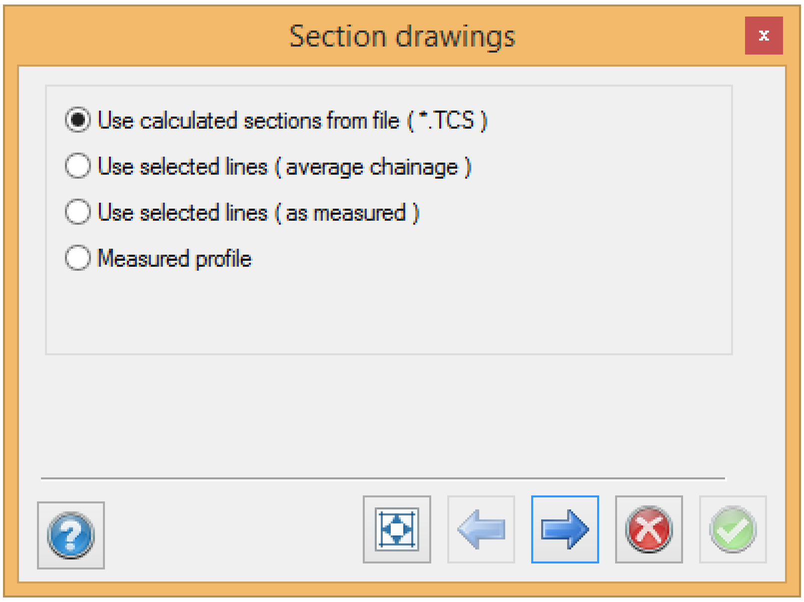
See also

Profile form

Insert sections

Drawing|Sheet|Insert sections

Command	Description
Enter calculated sections	
Sections from selected lines	
Sections from selected lines as measured	
Measured profile	Longitudinal section entry.
Drawing size and scale	How to get the size and scale right.
Print on drawing methods	General settings for inserting into the drawing

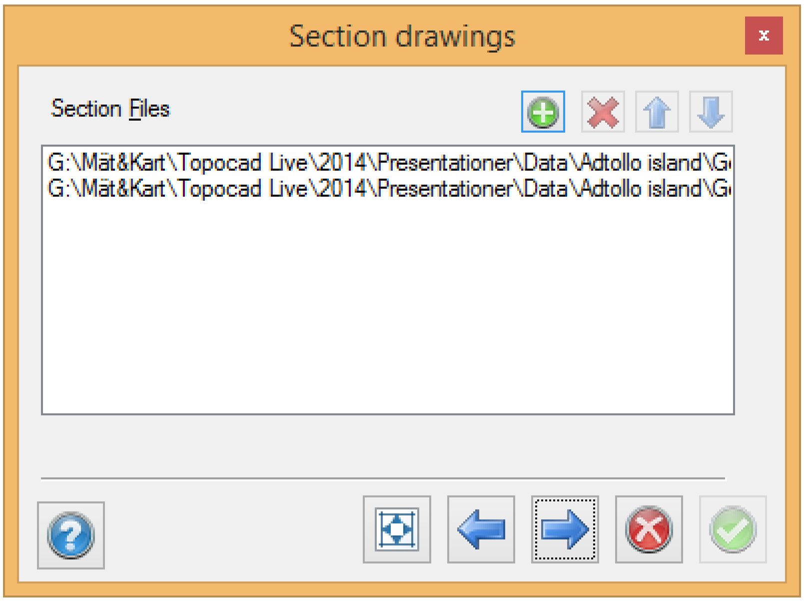


There are four ways to create and insert section drawings:

- Inserting created cross sections
- Creating sections from lines in the drawing
- Using measured sections
- Using measured profiles

Inserting calculated sections

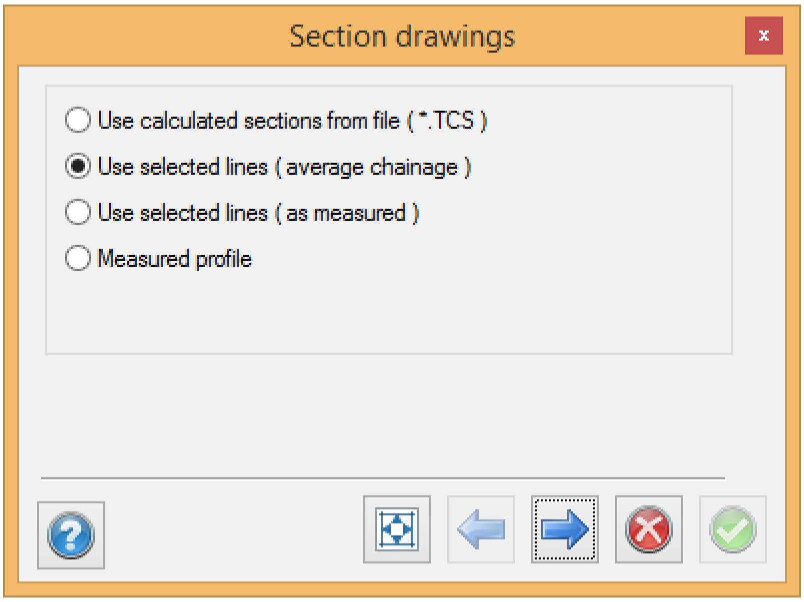
For insertion of created sections (TCS files)

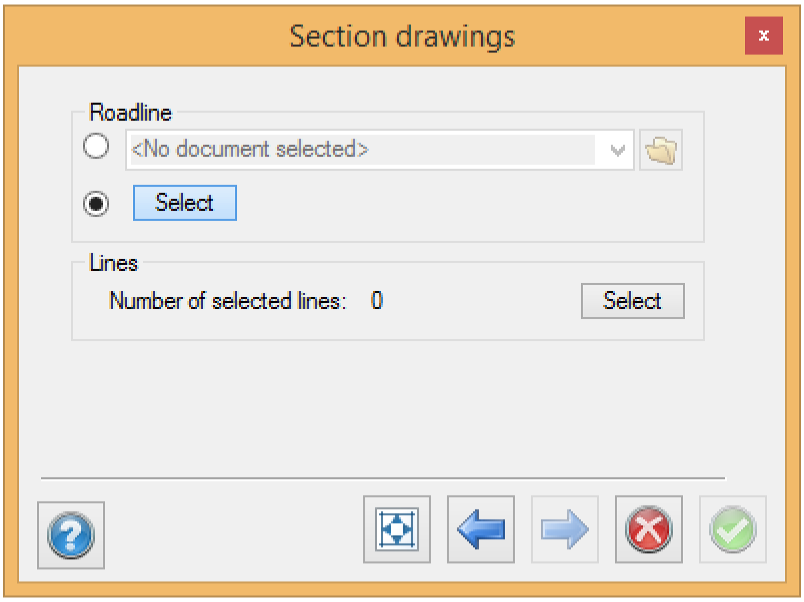


In this dialogue box, you select the section files you want to place in the drawing. You can use one or more created sections at the same time, but they will use the same section. If they are created along the same road line this is fine but if not they will show two different sections for the same section in the drawing. Use the up and down arrows to select the order. If you intend to insert two or more cross section files at the same time, they will need to have the same created section and section interval.

See the image above for details of how to enter information in the drawing.

Section from lines in drawing

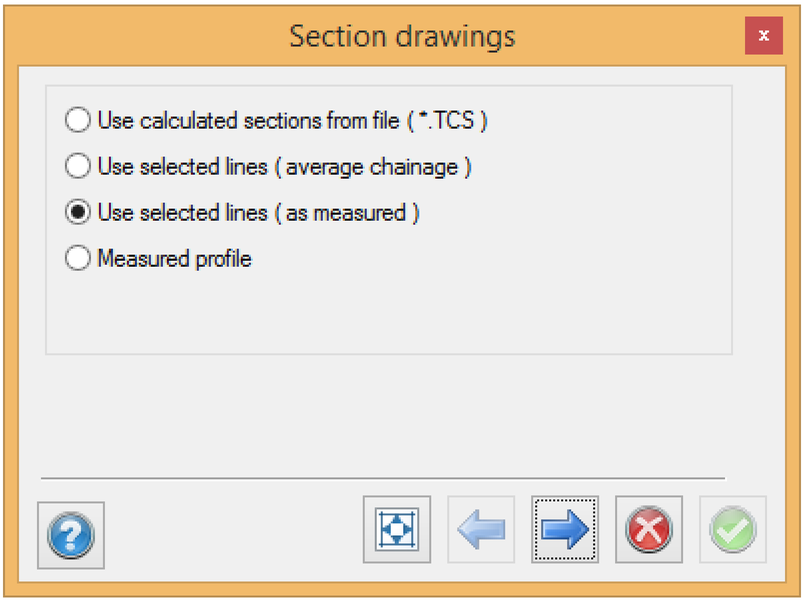




The procedure is as follows:

1. Enter the roadline or select it in the drawing.
2. Select the sections crossing this road line, click Next. Refer to DRAWING.

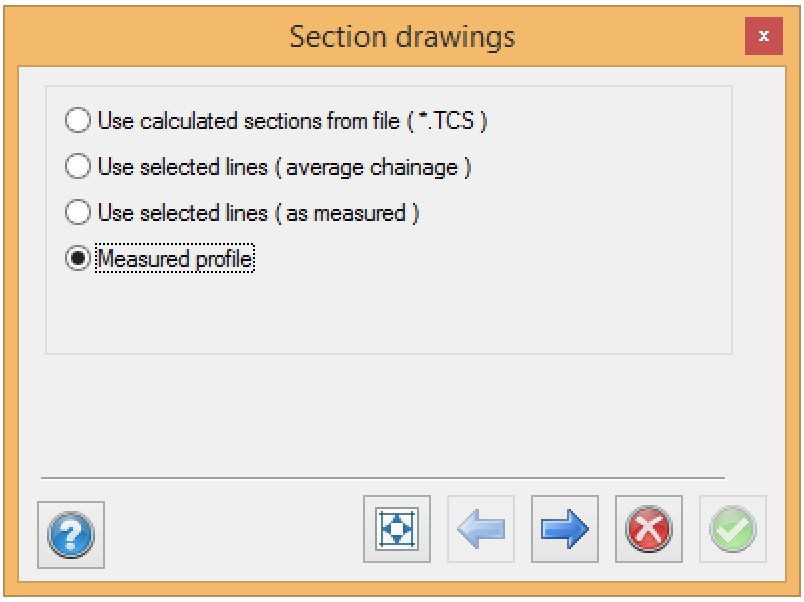
Calculate and set out the measured sections



The procedure is as follows:

1. Use the selected lines as measured option (see screenshot)
2. Enter the roadline or select it in the drawing.
3. Select the sections crossing this road line, click Next. Refer to DRAWING.

Calculate and show measured profile



The procedure is as follows:

1. Use the measured profile option (see screenshot)
2. Select the measured profile.
3. Select the insertion method. Refer to DRAWING.

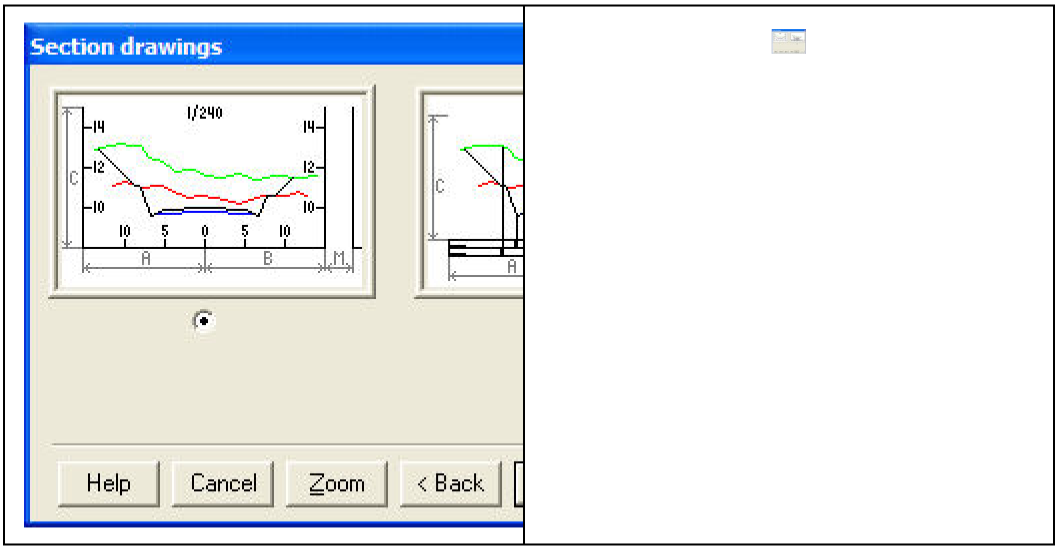
Drawing scale and size

Use a drawing sheet and views:

1. Use a new blank drawing.
2. Insert a drawing sheet with the scale and size you want in the drawing (if there are no drawing views, continue from 3-4)
3. Place a new drawing view in this drawing sheet.
4. Select the scale for it.
5. If you know that you will need more drawings, repeat these steps and place the drawing views next to one another.
6. Continue with the next step.

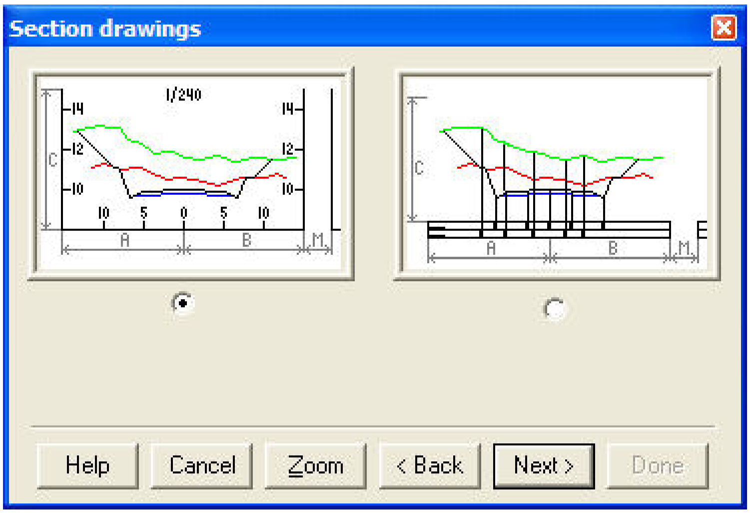
Insert in the drawing

There are two main methods, which mainly differ in terms of the layout. We call them the bucket and the form.



Method: The bucket	Method: The form	Description
Method selection	Method selection	Select method and type of view
Layout	Layout	It is possible to select the section size and the margin between them.
Text	Text	Text information, size etc
Layers	Layers	Select layers and information
	Forms	Select which objects are to be displayed
Sections, interval	Sections, interval	What sections, number, start section, intervals, sections per column etc.

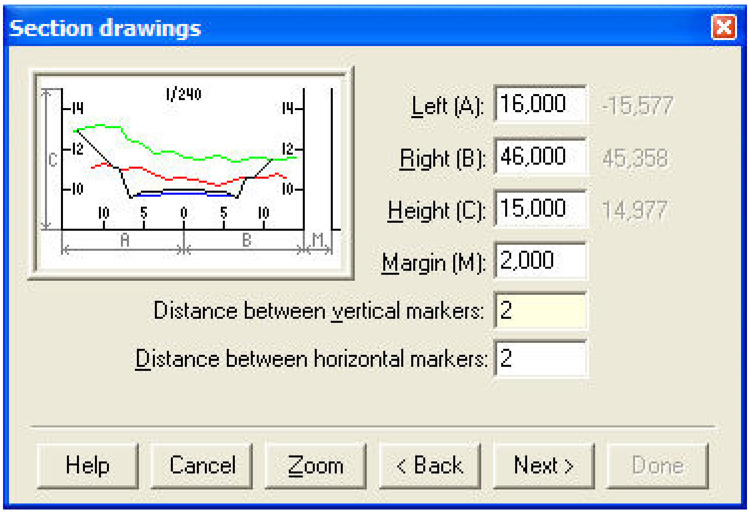
Method selection



Select the method you want to use to insert your sections:

Bucket method (left)	Form method (right)

Layout



Enter the values for different distances for the section. You will find the maximum value of any of the sections made/created in grey to the right.

Left (A)
Left-hand side of cross section from the centre point.

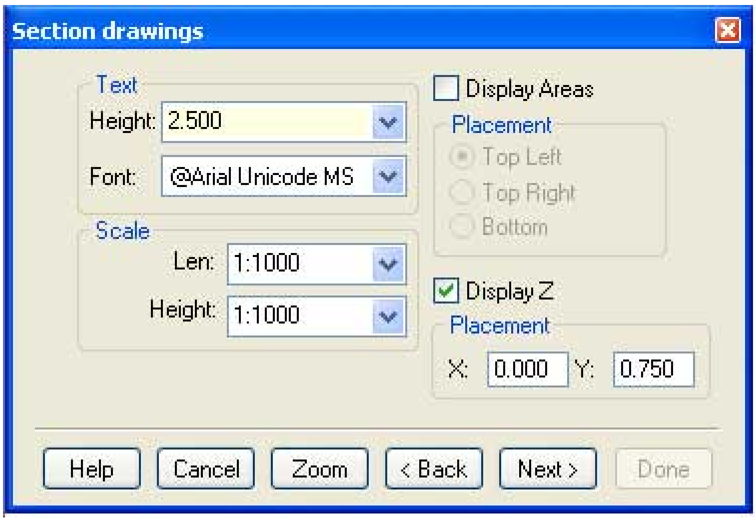
Right (B)
Right-hand side of cross section from the centre point.

Height (C)
The maximum height for any section.

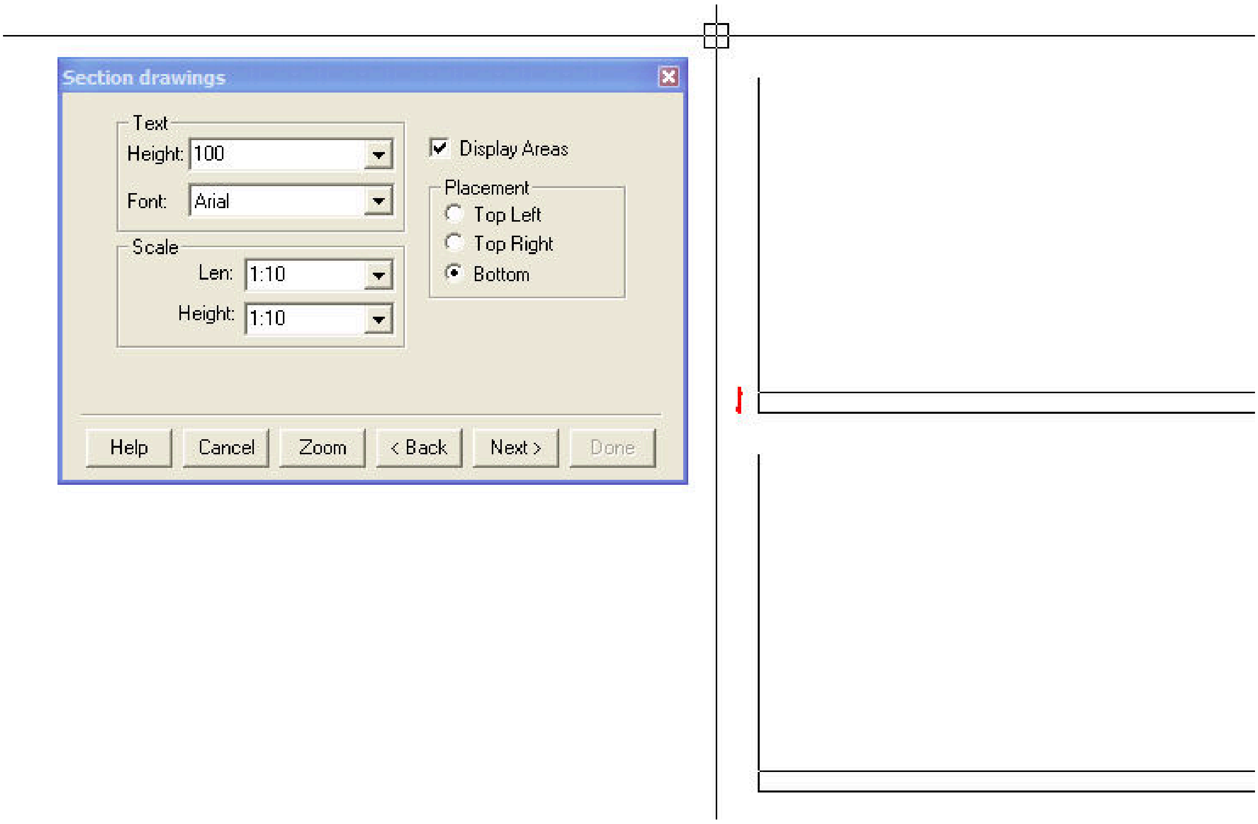
Margin (M)
The margin between the cross sections in the drawing.

Distance between markers
The distance between the markers for the vertical and horizontal side.

Text



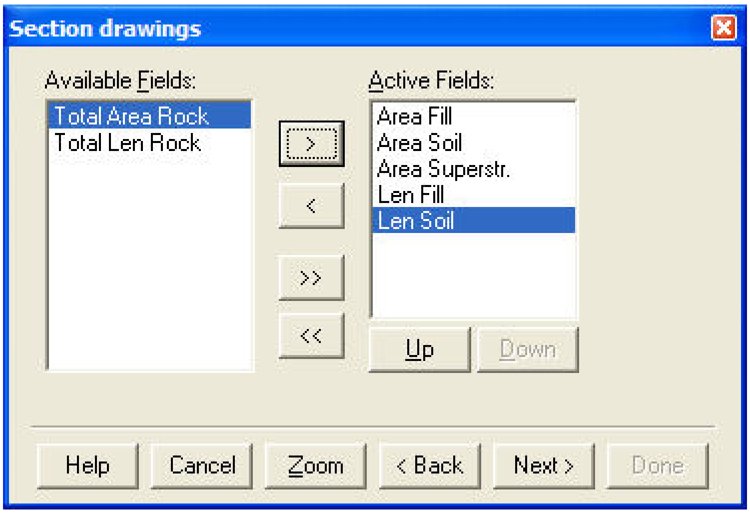
Select the text height and font. It will sometimes be difficult to identify the correct size. Try clicking once in the drawing to obtain an idea of the size. If you have selected "Display areas" and "Bottom" as shown, you will see in the drawing how high the bottom line is. This is shown by the red dot in the screenshot below.
Display Z: The coordinate refers to the middle point on the theoretical layer in the first document that has been indicated in the command. The placement of X and Y shall be between 0 and 1.
0.0 corresponds to the upper left margin and 1.0 corresponds to the lower right margin.



Scale
The scale is used for different scales in the sections.

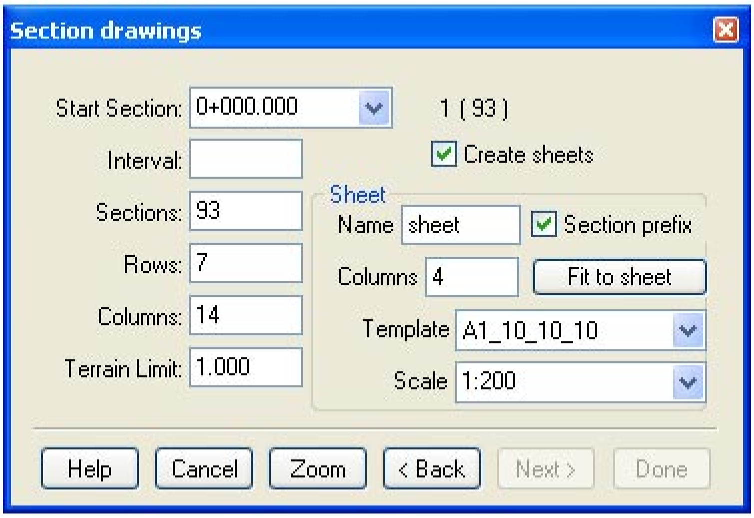
Placement
Where the area text is to be placed.

Field



This window is only used if you are using areas. All areas used in the cross sections will be available, including those fields you created yourself.

Sections



Select how many and which sections you want for each drawing. You can see their size by clicking once in the drawing. You need to fit them into the drawing view you have placed in the drawing.

Sections
Total number of sections for each drawing

Rows
How many rows you want to use in your drawing.

Columns
For your information only, shows how many columns there will be depending on the total number and how many rows you are using.

Terrain limit
The terrain limit specifies how far outside the maximum theoretical section the sections will be on each side.

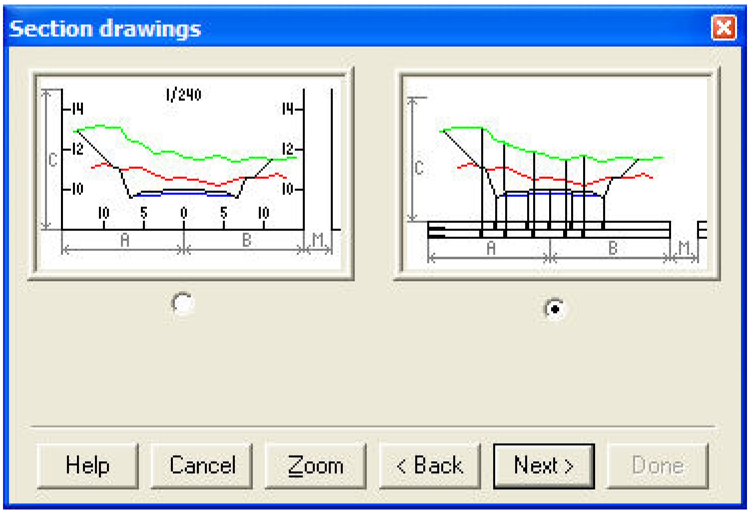
Create sheets
Check if you want to create sheets.

Name, Columns, Template
The settings controls the name of the sheets, number of columns, sheet, template and scale of the drawing view.
If the *Section prefix* is checked, a start and an end cross section will be added as a prefix to the name. If the selected template has more than one view only the first view will be used.
The button *Fit to sheet* sets the highest amount possible of rows and columns that fit in selected template and scale.

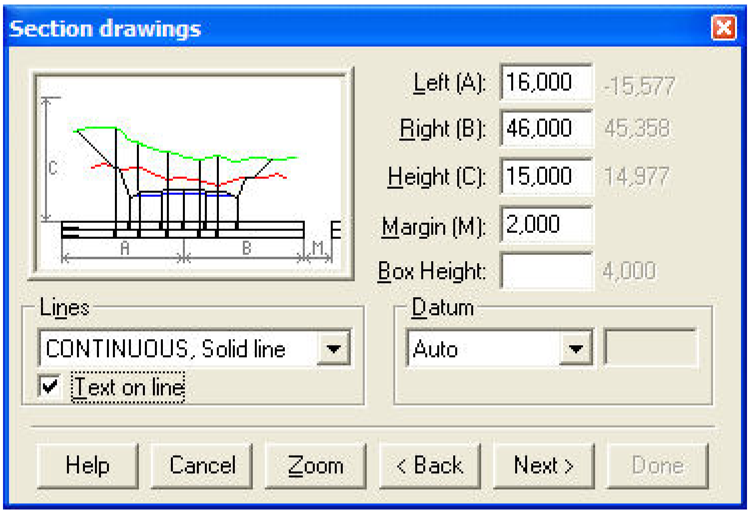
When you have done all this, place your sections in the drawing. You can place the next set of cross sections in the next drawing view immediately. If you are running out of drawing views, place the sections in the blank drawing and create drawing sheets afterwards.

Form method

This method uses more information for each section.



Layout



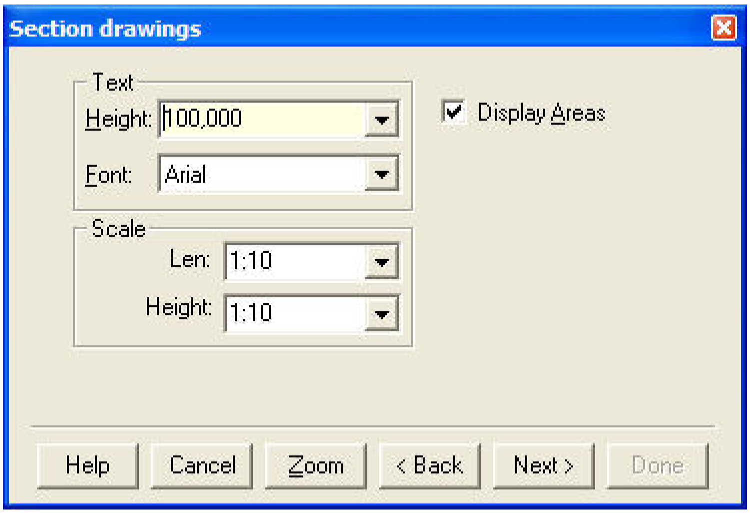
Select the distances and enter them in the dialogue box.

Box height
The height for each box and form below the section.

Lines
Line type for the form. If you want the text to be placed on the line, select this option.

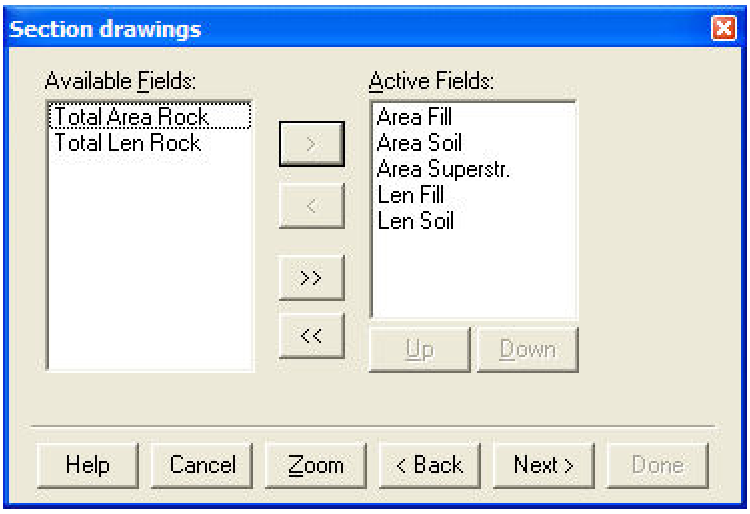
Date
Position for the first form/box according to the sections. The options are automatic, distance or actual height, where distance represents the distance between the box and the form.

Text



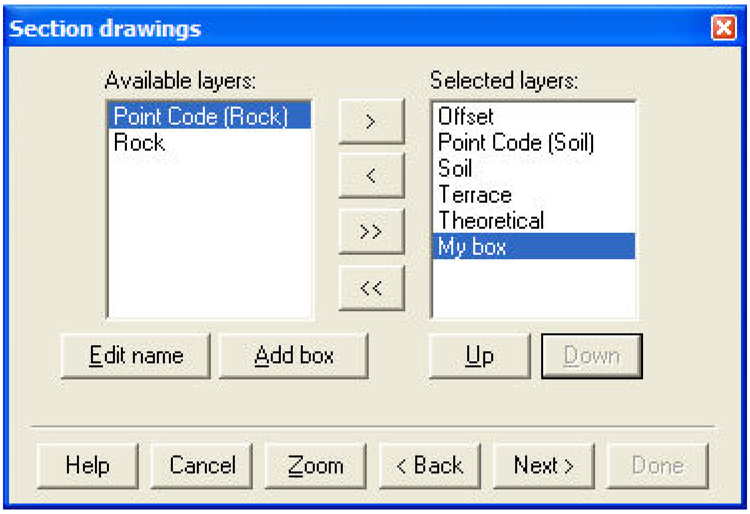
Select the text height and font and whether you want the areas to be displayed.

Field



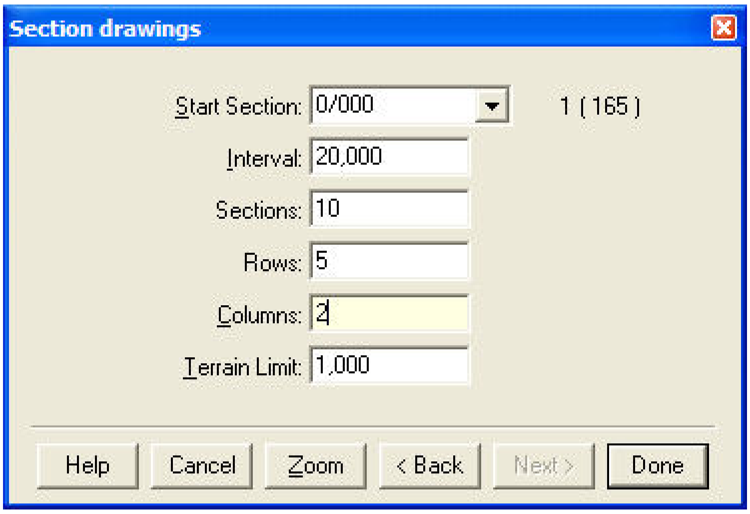
This window is only used if you are using areas. All areas used in the cross sections will be available, including those fields you created yourself.

Selecting layers



Select the layers (forms) that you want to use for each cross section. The name can be edited when they are on the left-hand side. You can add boxes that will be empty. The information to be added here is the height of each break point in the selected layer.

Sections



Select how many and which sections you want for each drawing. You can see their size by clicking once in the drawing. You need to fit them into the drawing view you have placed in the drawing.

Sections
Total number of sections for each drawing

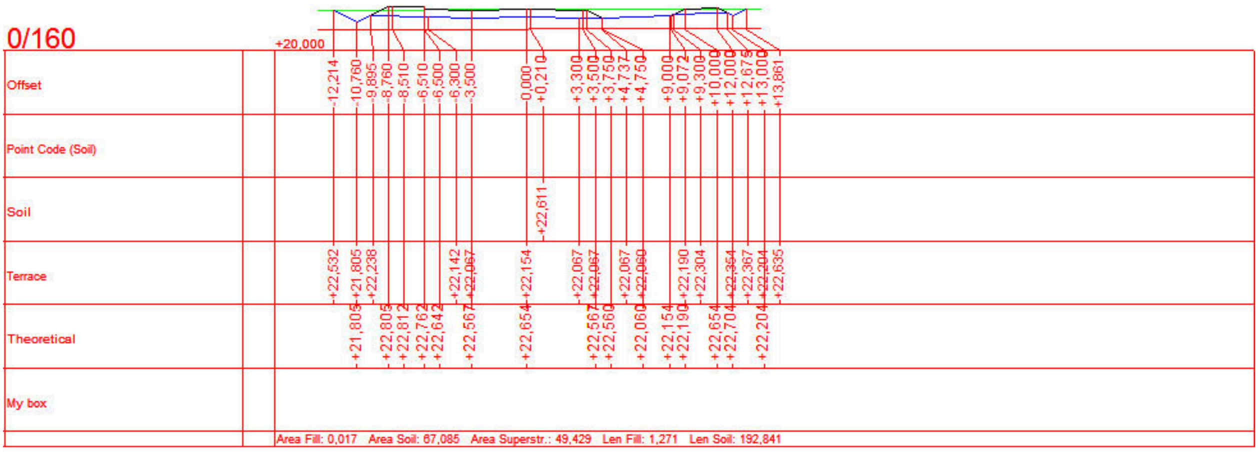
Rows
How many rows you want to use in your drawing.

Columns
For your information only, shows how many columns there will be depending on the total number and how many rows you are using.

Terrain limit
The terrain limit specifies how far outside the maximum theoretical section the sections will be on each side.

When you have done all this, place your sections in the drawing. You can place the next set of cross sections in the next drawing view immediately. If you are running out of drawing views, place the sections in the blank drawing and create drawing sheets afterwards.

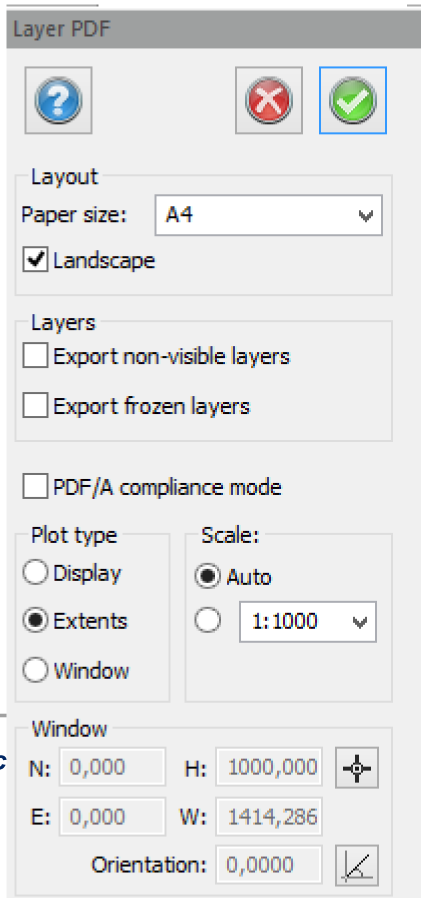
Cross section example:



Insert cross sections

Layer-PDF

Drawing|Export-Layer PDF



Print with build-in Layer-PDF.

Use the build-in layer-PDF to print your drawings. It supports both layer-PDF and PDF/A. Layer-PDF means that the layers in Topocad will be added as layers in the PDF.

Go to Home|Export - Layer-PDF

Size: Select A0, A1, A2, A3 or A4.

Lanscape: Select orientation, landscape or portrait. There is no preview here.

Layer: Select if only visible layers or frozen layers should be added or not.

Select if the PDF shall support archive function, PDF/A.

Plot type
Screen: Prints what is visible on the screen.
All: Prints all
Windows: Select coordinates for an exact surface to print.

Scale: Select scale.

Misc content

Drawing|Misc

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Coordinate system
Drawing Settings
Hatch settings

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Macros
COGO
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Coordinate input

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Copy
Convert (attributes)
Generate layers

Convert symbols to points (To points)
Fill area

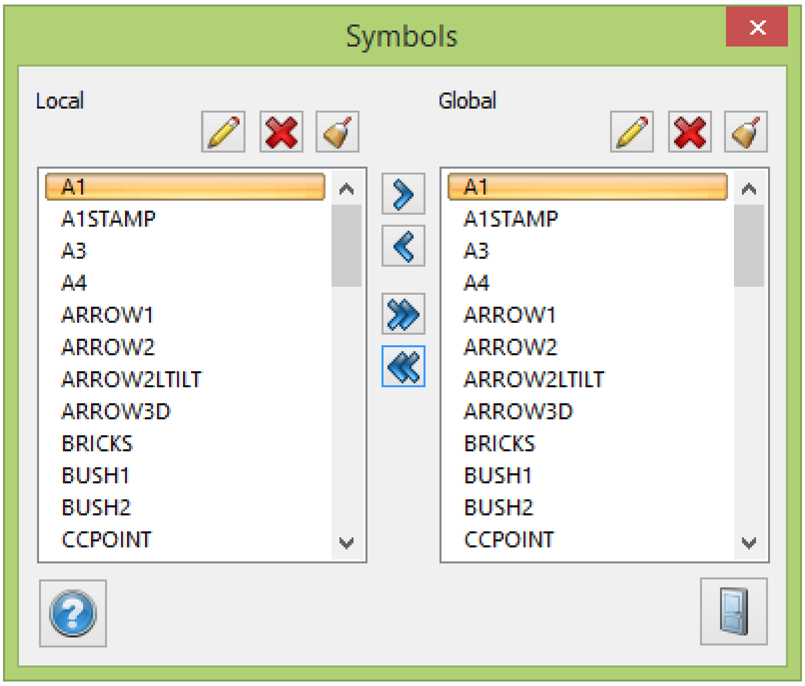
Mean points
Least square line
Point differences
Pile differences
Slope hatching
Subdivide area
Rectify

Area report
Label
Intersection

Symbols

Drawing|Misc|Symbols

In Symbols in the Drawing menu there are two tables of symbols: the local (drawing) symbols and global (tsy) symbols. You can copy them from one table to the other.



If you copy a local symbol to the global table you can then use it in other drawings and point codes which are to be edited in Edit codetable. If you copy a global symbol to the drawing you will be able to include this symbol with the drawing even if it has not been inserted into the drawing.

When you create a symbol it will only appear in the local (drawing) table. This is also the case when you import a file with symbols - the symbols will only be saved locally.

A number in parenthesis means there are several symbols made in different displaying scales.

Find out more about attributes and symbols:

- **Drawing|Symbols**
  Created symbols are stored in the local drawing. You add them to the global table here.
- **System|Symbol**
  All symbols in the global table are displayed here. You can delete symbols from this dialogue box.
- **System|Attribute**
  Create the attribute itself and all associated data.
- **Define attribute**
  Defines the attribute with the symbol when creating the symbol.
- **Create symbol**
  How to create symbols and associate attributes with them.
- **Attributes for point codes**
  How to associate attributes with point codes.
- **Edit attribute**
  How to edit an attribute in the drawing when associated with a point code, a symbol or both.
- **Settings|System files**
  The global file for symbols is selected in the settings and system files. System files have the extension .tsy for symbols and .tat for attributes.

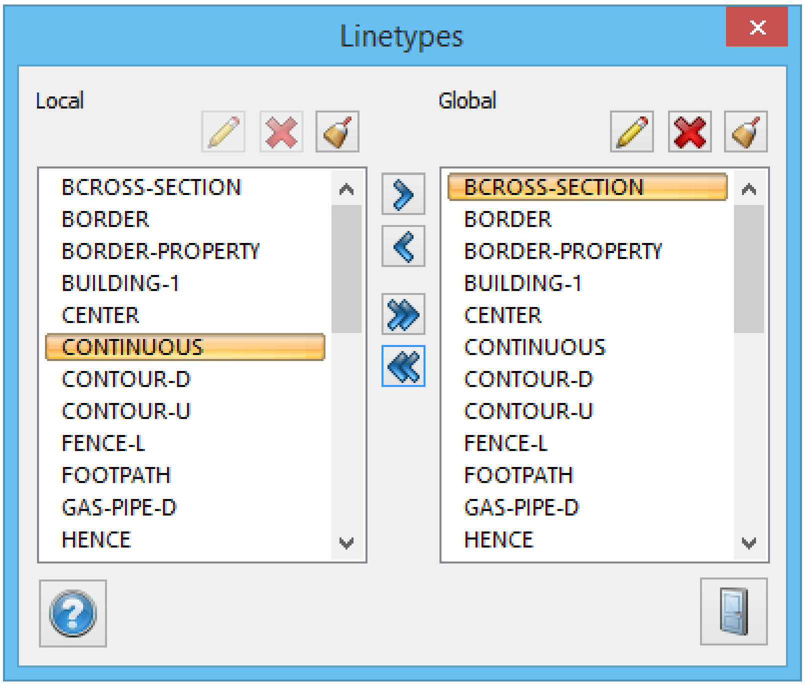
See also

Insert symbol
Create symbol

Preferences - System files

Line types

Drawing|Misc|Line types



In Line types in the Drawing menu there are two tables of line types: local (drawing) line types and global (tlt) line types. You can copy them from one table to the other.

If you copy a local line type to the global table you can then use it in other drawings and point codes which are to be edited in Edit codetable. If you copy a global line type to the drawing you will be able to include this line type with the drawing even if it has not been inserted into the drawing.

When you create a line type it will only appear in the local (drawing) table. This is also the case when you import a file with symbols - the line types will only be saved locally.

See also

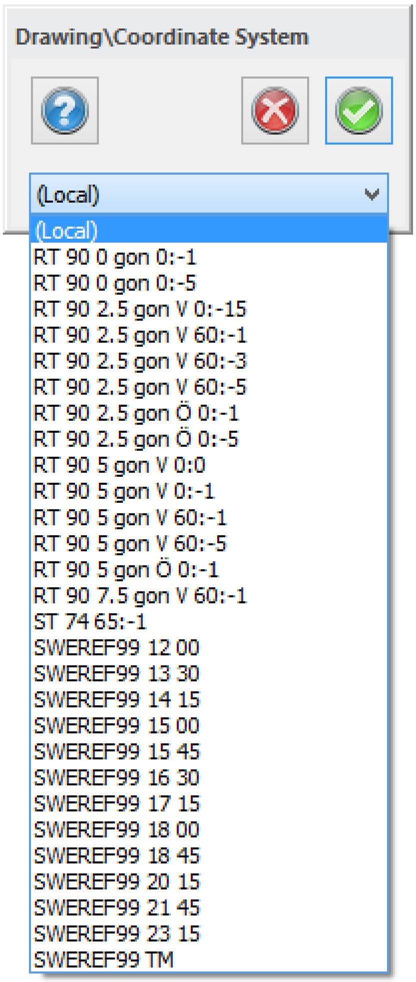
Settings - System files

Edit codetable

Create line type

Coordinate system

Drawing|Misc|Coordinate system
Terrain|Coordinate system



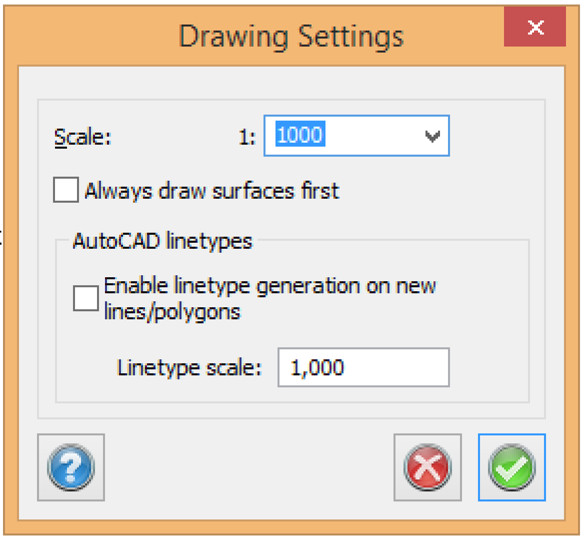
The drawing can use a specific coordinate system. When importing data to a drawing, a warning will appear if the drawing you are trying to import to uses a different coordinate system.

See also

System settings - Coordinate system.

Drawing settings

Drawing|Misc|Drawing settings



The drawing scale should ideally be corrected at the start of the drawing. The drawing scale will influence any symbols and text which are inserted. It is possible to select any scale when inserting symbols but by default it will be compared with a scale of 1:1000.

When inserting a symbol you can select the scale size. All symbols in the symbol lists are saved with a scale of 1:1000. If you have selected 1:500 as the drawing scale, the default scale when inserting a symbol will be 0.5. This can be changed if required. Information is saved in the drawing.

Always draw surfaces first
Click the checkbox to prevent line types/line widths to be hidden under overlaying surface.

See also

Insert symbol.

TIP! If you use default drawings it is better to use the default drawing scale.

TIP! If you import a drawing that is in mm it may be better to set the drawing scale to 1:1 000 000 first if you have a non-continuous line style. If not it will take a long time to display.

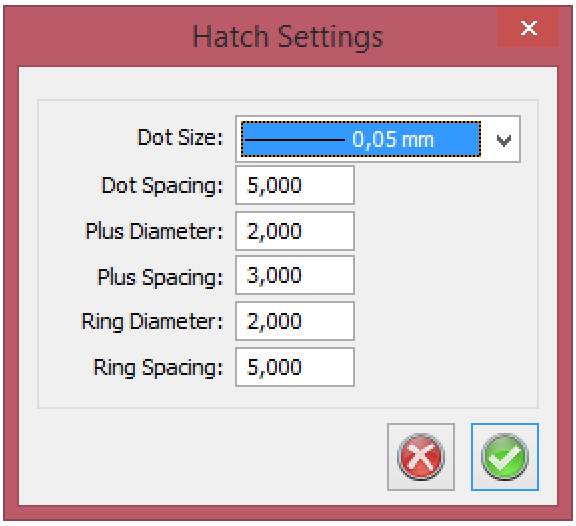
Hatch settings

Drawing|Misc|Hatch settings

Applies to polygons or circles which have have Filled - dots, plus, rings or rings 2 as properties.

Select the object and Pattern to bring up the dialog Hatch Settings.

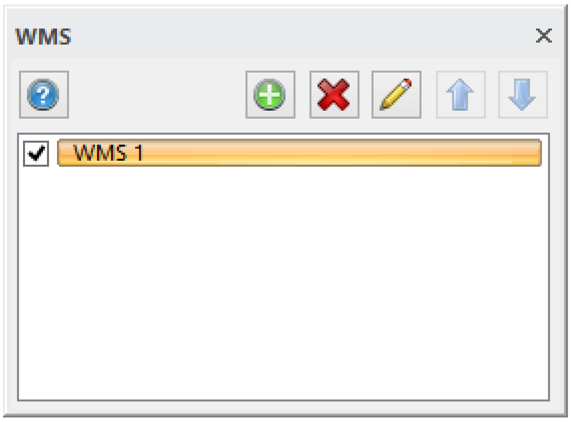
In this dialog the pattern can be edited on the basis of dot size and spacing, plus diameter and spacing and ring diameter and spacing.



WMS

Drawing|Misc|WMS

Function to add a WMS (Web map service) as a layer.



Turn on/off the layer in the dialog.

If you do not already have a WMS service posted, click on the + to add a WMS service.
Then the settings dialog appear.

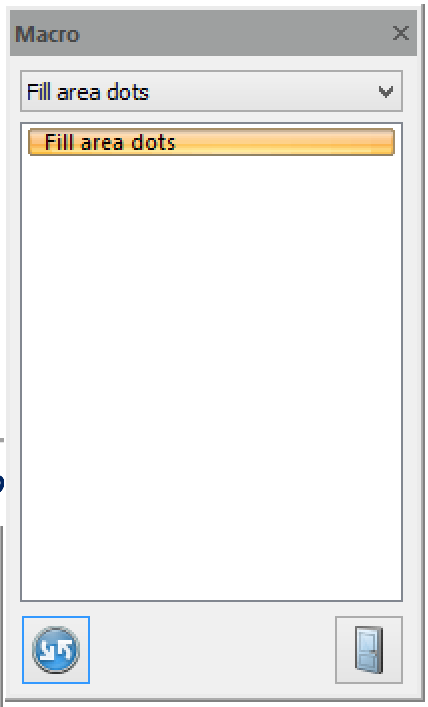
Read more about in System Settings | WMS.

The arrows determines the order in which the images will be downloaded.

To add a WMS layers in a drawing:
1. Create a new layer in the drawing and name it WMS.
2. Select the layer in the Layer Properties Manager and click Edit.
3. Click the WMS and fill in the information as described under System Settings | WMS.

Macros

Drawing|Misc|Macros



Function for macros in a Topocad drawing.

Add macros in Home|System Settings - Macros.

Click the Refresh button to show your new macros.

Settings

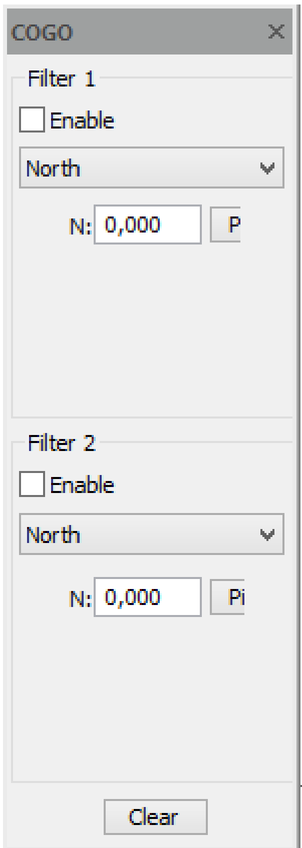
Go to Home|System Settings - Macros for settings in Macros.

COGO

Drawing|Misc|COGO

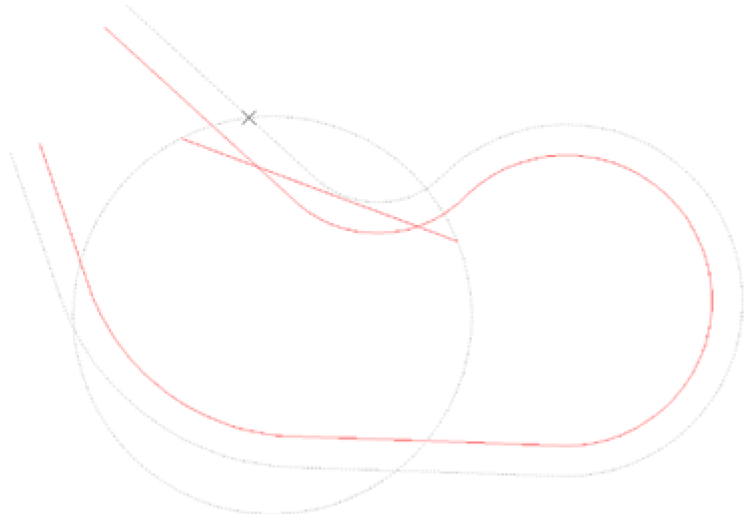
Drawing tool which filter coordinates in drawing. Select one or two filters to place points.

The following filter are available:



North	Select North coordinate and a help line will be drawn along the northern coordinate.
East	Select East coordinate and a help line will be drawn along the eastern coordinate.
Bearing	Select a coordinate and an angle and a help line will be drawn.
Distance from point	Select a coordinate and a distance and a circular help

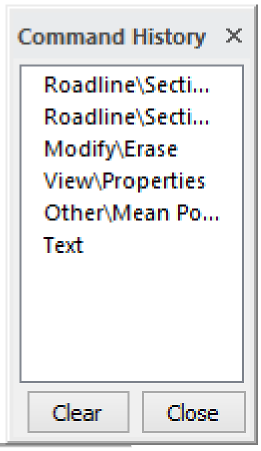
	line will be drawn.
Offset from line	Select line and distance and a help line will be drawn. It is optional to use only the selected line segment and also to lengthen it. The help line will adjust itself to the side where the cursor is.
Offset from plane	Choose a plane and a distance. The plane is indicated by selecting three points from that plane or by choosing one point from that plane and one standard point. The distance can be negative. A support plane is then created at the selected distance from the indicated plane.



If two filter are selected, the intersection points between these filter will be used.

Command history

Drawing| Misc|Command History
DTM|Command History
Survey data|Command History
Net adjustment|Command History



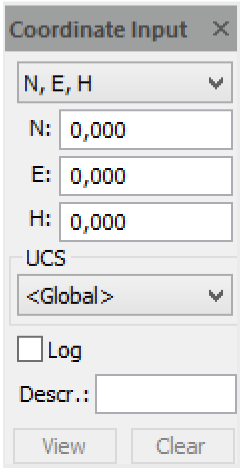
Function for saving history for drawings, terrain models, survey data and net adjustment. Open Drawing/DTM/Suvey data/Net adjustment|View history and click on Enable to activate the function.

All the actions that are regret able will be saved in a separate log file (the files name + .log) when saving the file.

Clear
Clear the log file.

Coordinate Input

Drawing|Misc|Coordinate Input



The Co-ordinates dialogue box shows the co-ordinates for the last selected point. You can use it to enter co-ordinates when you have closed the ordinary dialogue box.

This is often used when you need to enter a point or polyline. It can also be used for the other Construct and Modify commands. Different types of entry are possible, and you can also select different types of entry for different points in the same polyline.

- **Co-ordinates**
  Used to enter co-ordinates in the current co-ordinate system. If a user co-ordinate system is being used the local co-ordinates are entered here. Press Enter when the co-ordinates have been entered.
- **Delta-distance**
  This is used to input a delta distance in the current co-ordinate system. Enter dX, dY and/or dZ.
- D**istance/bearing**
  Contains the values for distance and bearings from the last point. The bearing is specified in the current co-ordinate system. .

Command

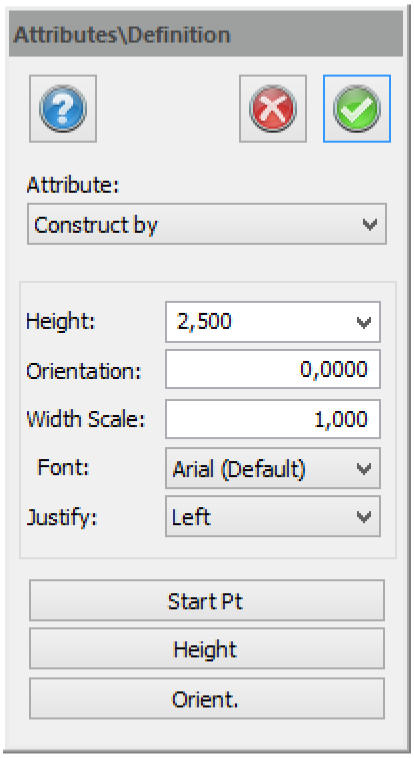
The command toolbox is used to view the command dialogue boxes. The command dialogue boxes are the ones open when you are modifying or constructing. If you prefer you can close them and work completely from the context menus. You can use the command toolbox to open up the dialogue boxes again.

Attribute definition

Drawing|Misc|Definition

Attributes are additional values for points. They can be diameters, ownership, dates, etc. To define an attribute it first has to be created. You create attributes under *Attributes*.

Define attributes is the function used to place attributes next to a symbol. You can place several attributes next to a symbol. You select the height, orientation and width of the font and then the font itself.



To create an attribute:

1. Select *Create|Define attribute*.
2. Select the attribute to be placed next to the symbol. It is possible to have several attributes but they can only be defined one at a time.
3. Select the height, orientation, width, font and justification for the attribute. Snap commands can be used to place attributes. Values can also be entered manually.
4. To place the attribute, select the base point and then click on the base point for the attribute. The point that will be used as the base point of the attribute is the first character in the lower left-hand corner. Notice that attributes may have a prefix or suffix.
5. The attribute will now be drawn in the drawing: [ATTRIBUTE]. If it is not a symbol it will look like this. When it is imploded into the symbol it will use the value for the attribute instead.

For more information about attributes:

System|Attributes
Create the attribute and all associated data.

Define attribute
Defines the attribute associated with the symbol when creating the symbol.

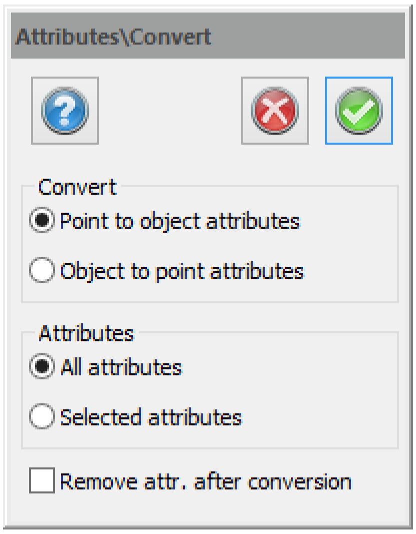
Create symbol
How to create symbols and associate attributes with them.

Attributes at point codes
How to associate attributes with point codes.

Edit attribute
How to edit an attribute in the drawing whether it is connected to a point code, a symbol or both.

Convert attributes

Drawing|Misc|Convert



Function for conversion of point attributes to object attributes and object attributes to point attributes.

Object attribute is used in GIS applications and can be converted from point attributes in Topocad. Point attributes can be connected to all points in one object but object attribute is just one per object.

The conversion works with points and lines. Only attributes from point no 1 in the line are concerned when converting point attributes on lines.

Convert - Select between convert point attributes to object attributes or vice versa.

All attributes - All attributes on the point are concerned.

Selected attributes - All selected attributes on the point are concerned.

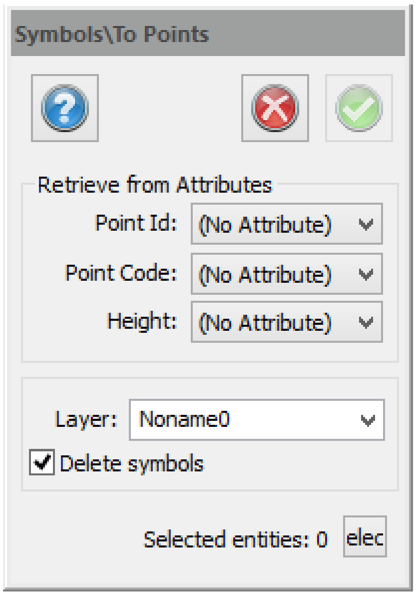
Remove point attributes after conversion - Cleans concerned attributes from the point attributes.

See also Settings|Survey for more information about how to measure and connect to object attributes.

Convert symbols to points

Drawing|Misc|To points

This command converts symbols to points. It is necessary if you want to use symbols as input data for a DTM or if you want to set out the symbols.

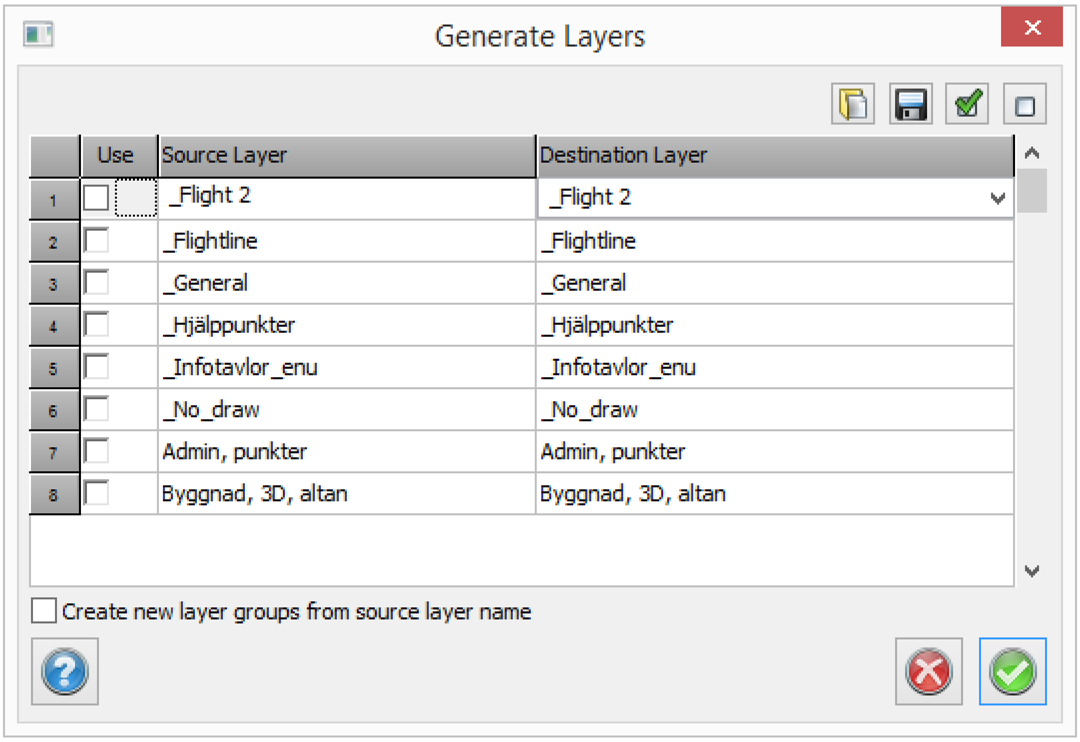


Some information can be converted from attribute data to Z-values, point codes and/or heights. For more information on attributes see System|Attributes.

Generate layers

Drawing|Misc|Generate layers

The function Generate layers imports all layers from the drawing. Select attributes to the destination layer.



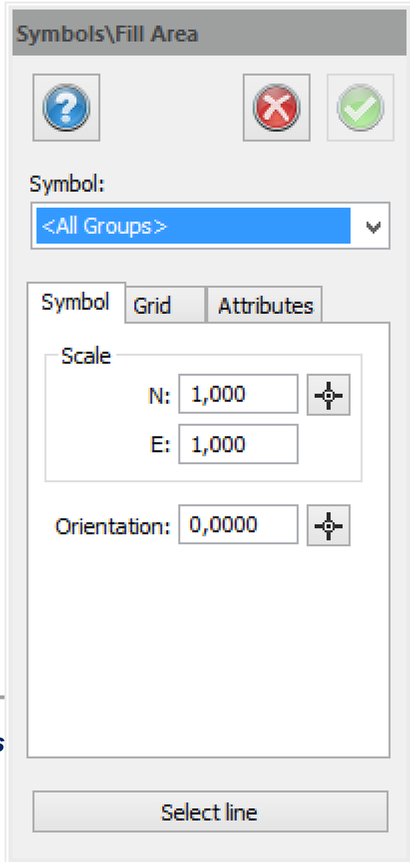
Procedure

1. Click on the layer and add the attribute as you want it, before or after the name. For example Building_[DETAILTYPE]
2. Click OK to see a Message Log. The log shows which layers that will be created.
3. Click Continue to move all objects to its layer.

Fill area (with symbol)

Drawing|Misc|Fill area

Fill area is a command that fills areas and polygons with any symbol. You can insert the symbol within the polygon by choosing a polygon, symbol, direction and grid.



Three different tabs are used for this function:

Symbol
Select the symbol and the direction and scale for the symbol.

Grid
Input the origin and direction for the grid, and the interval between symbols.

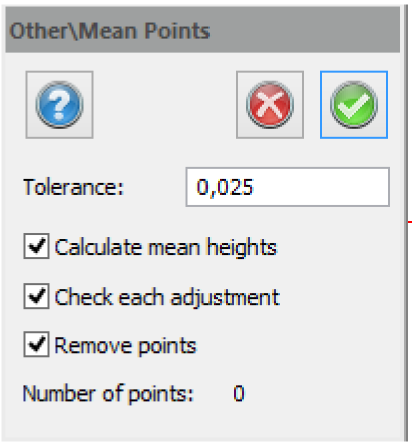
Attribute
If the symbol has attributes they can be inserted.

Polygon
Select the polygon to limit the fill area.

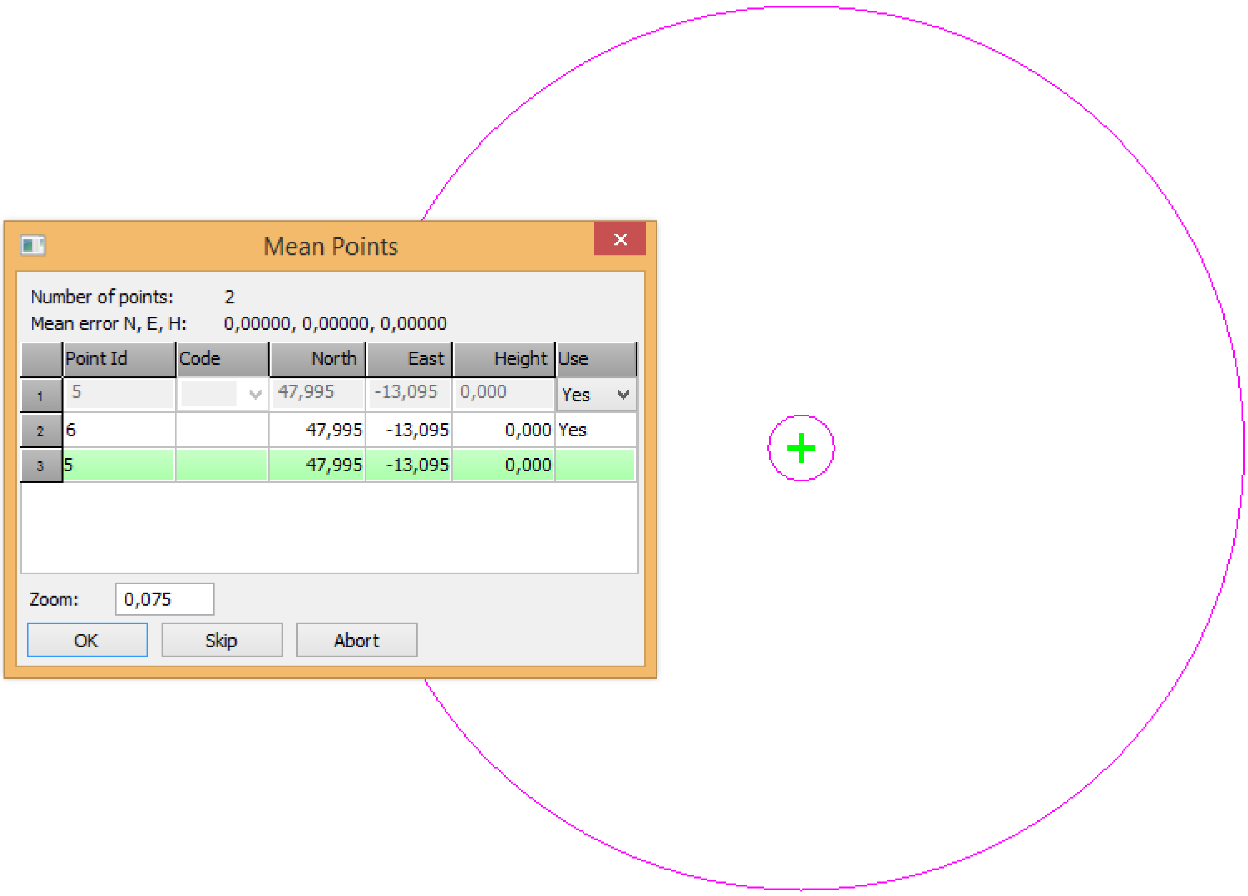
Mean points

Drawing|Misc|Mean points

The command calculates mean points from selected tolerance. Calculate mean heights: Control every calculation and if you want to reduce points.



When you run the command you will see a dialogue of the results from the mean points calculation. You can also select to use or not use selected points in the calculation. Click OK to calculate the mean point. If you click Skip you will move to next point cloud.



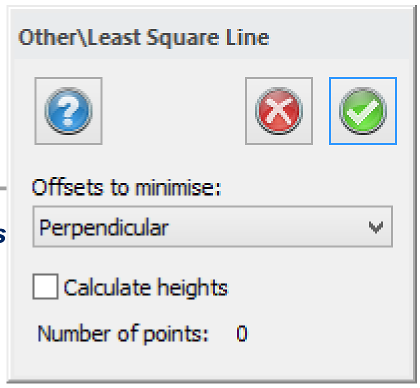
Least square line

Drawing|Misc|Least Square Line

Command to calculate the least square line by using the least squares method. The sum of all perpendicular distances are minimized to the lowest possible.

Offset to minimize

Choose between perpendicular and vertical. Either you minimize perpendicular to the line or vertical to the line.



Point differences

Drawing|Misc|Point differences

A command that compares two points with one other.

You can select two points settings - theoretical and measured - and check the difference between them using either the global co-ordinates system or any other UCS you may have.

You can create a report if required.

You can choose to compare points to the nearest point (within a limit) or to the point ID.

Tolerance

If the distance between the points is greater than the tolerance, a circle will be displayed.

Selection

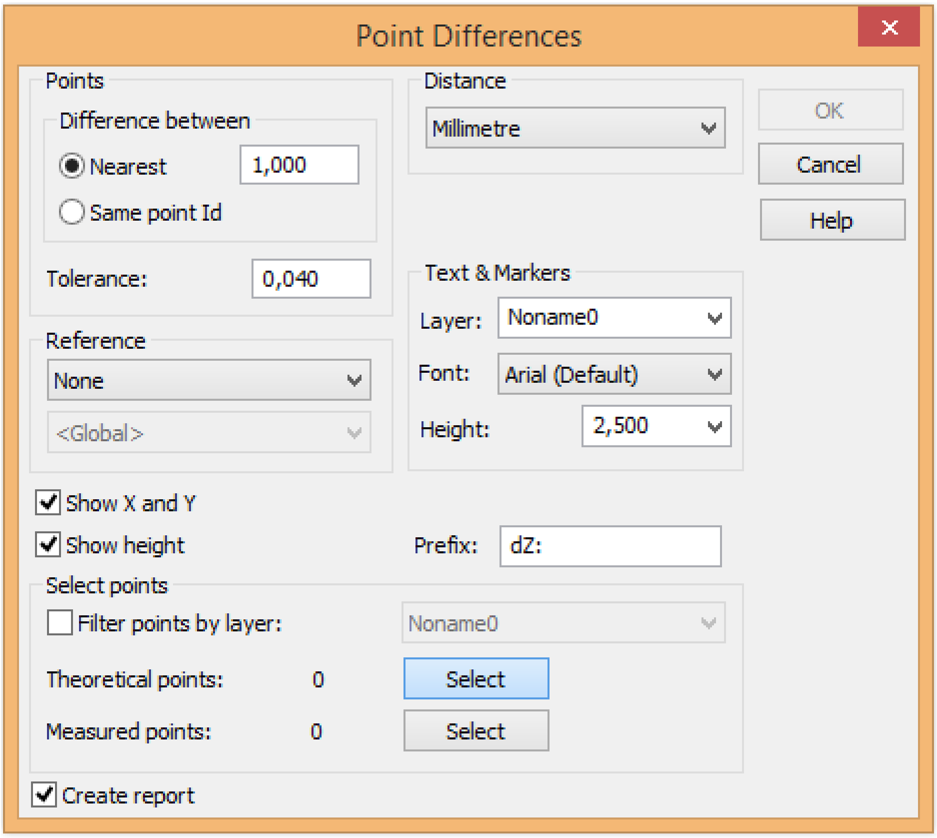
Selections are made by using the layer filter.

Distance

Select mm, cm or m as the unit to be used to display the distance.

Text

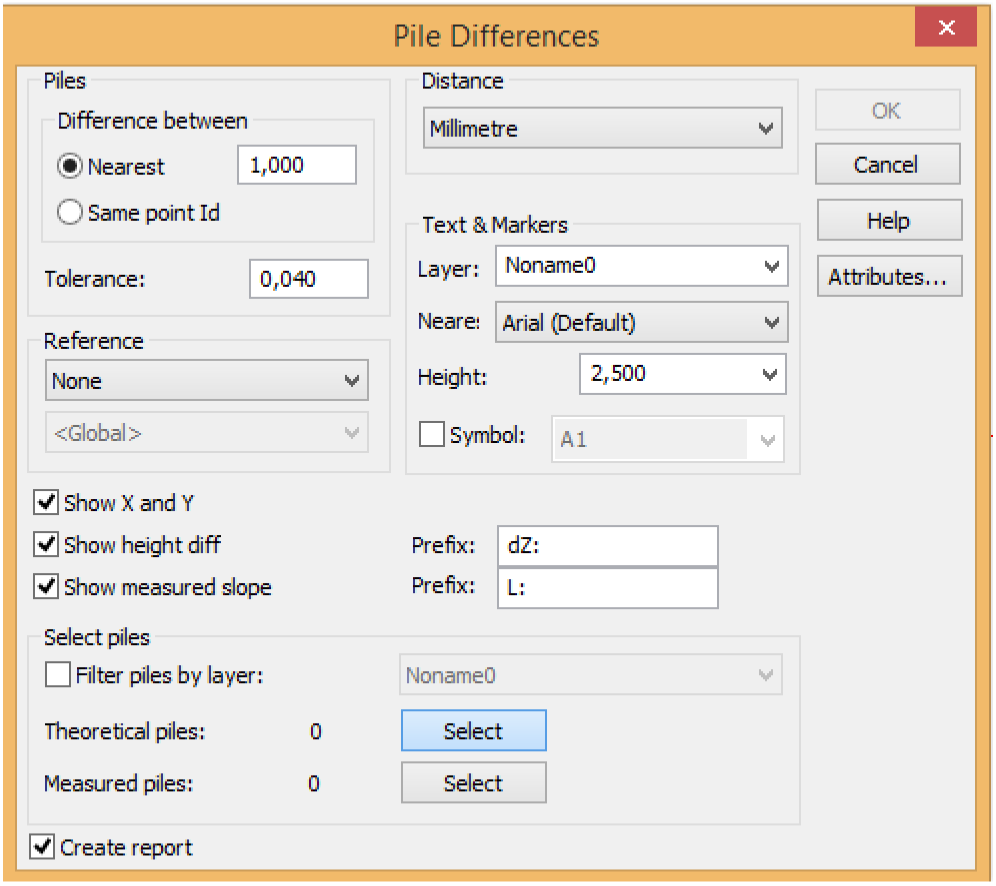
Select font and height.



Pile differences

Drawing|Misc|Pile differences

A pile can consist of a line alt. a point with the attributes of length, direction and inclination.



Survey

A pole is surveyed by 3 points. Two points at the top and a third point at the ground to represent the slope of the pile (the slope between point 2 and point 3). The length can be specified as an attribute in Point 1.

Configuration of code table

Open *Edit code table.*

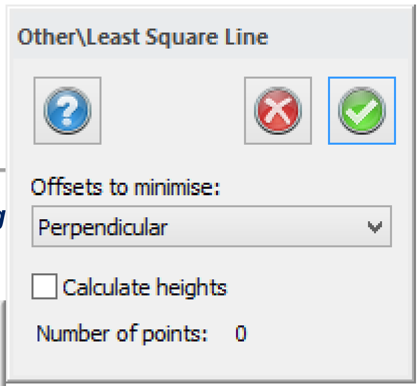
Least square line

Drawing|Misc|Least Square Line

Command to calculate the least square line by using the least squares method. The sum of all perpendicular distances are minimized to the lowest possible.

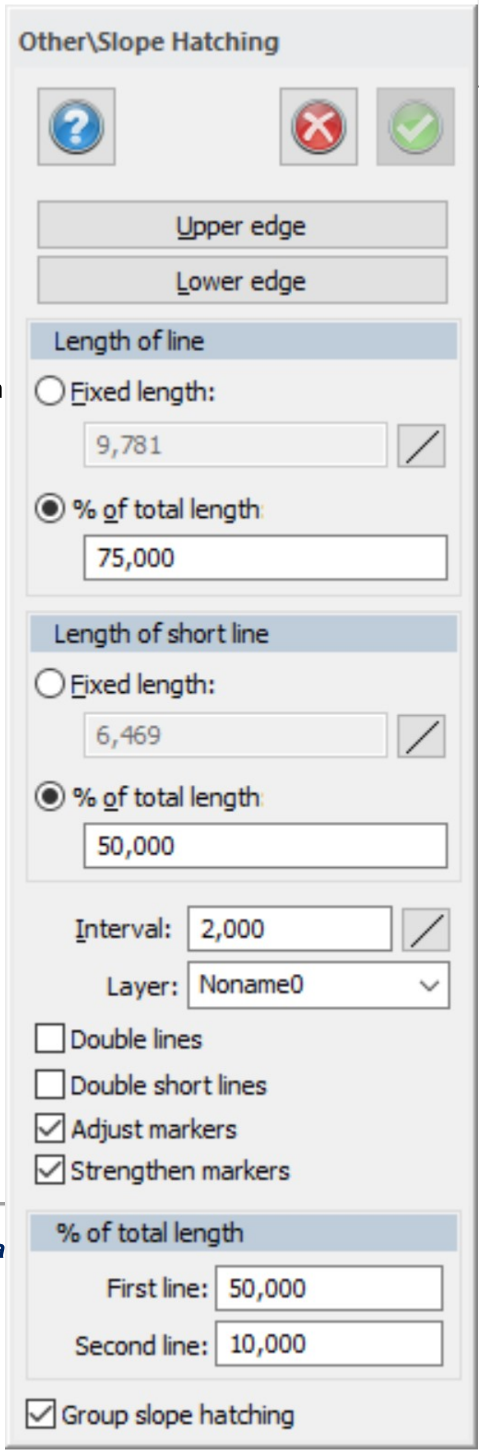
Offset to minimize

Choose between perpendicular and vertical. Either you minimize perpendicular to the line or vertical to the line.



Slope hatching

Drawing|Misc|Slope hatching



There are choices for the text to be deleted or kept. If you select parallel, or almost parallel, lines you can create slope hatches between them. The function finds a height from a text and create a point, and out of this height. Here you can choose whether the text should be disabled or be retained as well as the height, obtained from the text height or text in question. You can also select the insertion point.

Length of line

The line can be a set as a fixed value or a percentage of total length.

Length on short side of line

The line can be a percentage of the total distance or a fixed value.

Interval

Enter the interval between the lines.

Select the upper and lower edges.

Select double lines and/or double short lines.

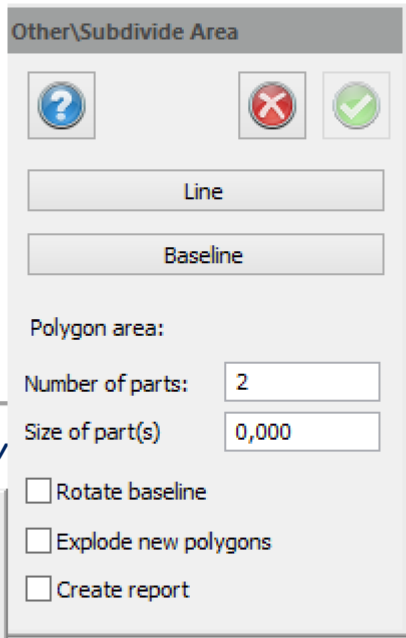
Subdivide area

Drawing|Misc|Subdivide area

Subdivide area is a function that divides a polygon into two or more polygons with equivalent areas. You can state whether you want the surface to be parallel to a baseline or to extend straight from any of the points in the polygon.

The "Explode new polygons" command explodes all polygons to single lines.

The "Create report" function works with the Crystal reports generator.



Rectify

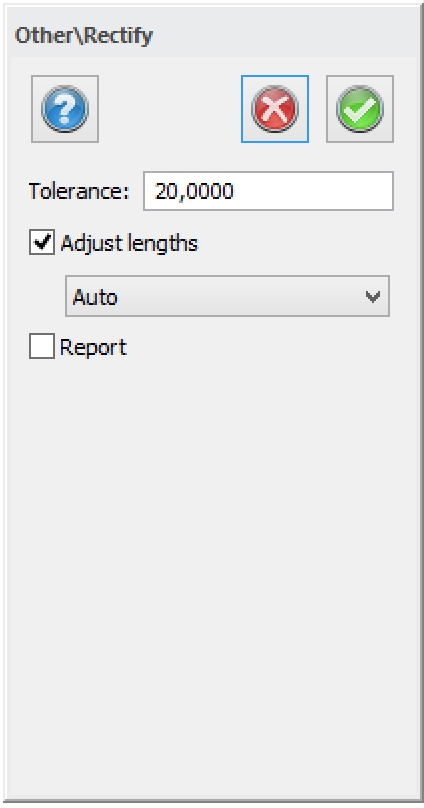
Drawing|Misc|Rectify

Rectify a polyline or a polygon. The command rectifies the angles to 90 degrees.

Enter tolerance
Only angles within the tolerance will be rectified.
The tolerance default is 20 = 20 gon. Gon can be changed to degrees in system settings.
0 = already straight angle, no rectifying will be done.
Max: 50.

Adjust the lengths
Tick off this box to retain the lengths of the elements.
Tick and select Auto, the nearest centimeter, the nearest decimeter or the nearest meter.
Nearest meters: All lengths will have even meters.

Create Report
Tick to create a report. The report lists the new coordinates and how much they have been changed.



Note!

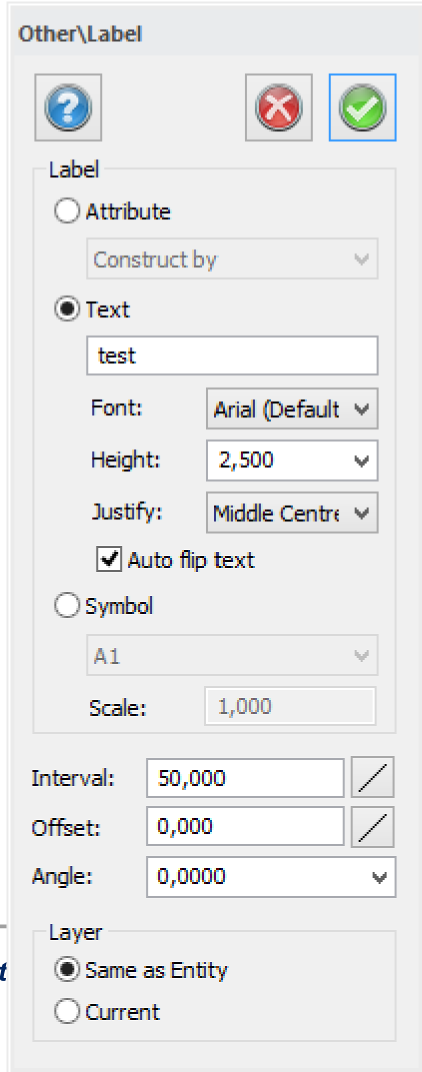
Depending on where on the rectangle you click, you start from this segment. The line you click on is the "correct" one, and the following lines will be rectified from this one.

Clicking on the top line, near the right corner, will make the direction go towards this right corner and rectifying the angles in this direction. Clicking near the left corner, the direction will go to the left and rectifying the angles in this direction.

Label

Drawing|Misc|Label

Function to label objects. Insert a text, symbol or an attribute of a line, etc.



The procedure is as follows:
1. Select in the drawing what is to be labeled.
Attribute - the attribute will be printed.
Free text - optional text will be printed.
Symbol - select a symbol will be shown.

2. In this example we select text. Enter the text, select font (typeface), height
and adjustment. Tick *Auto flip text* to flip the text so it will be easier to read from your point of view.

3. Offset means that the text appears a bit away from the line.

4. Layer: Select the layer that the text should be on.

5. Click on the object and the text will be printed. If the object is already selected, the text will be printed directly.

Note!

The text is not dynamic. If you move the polyline, the text will not follow.

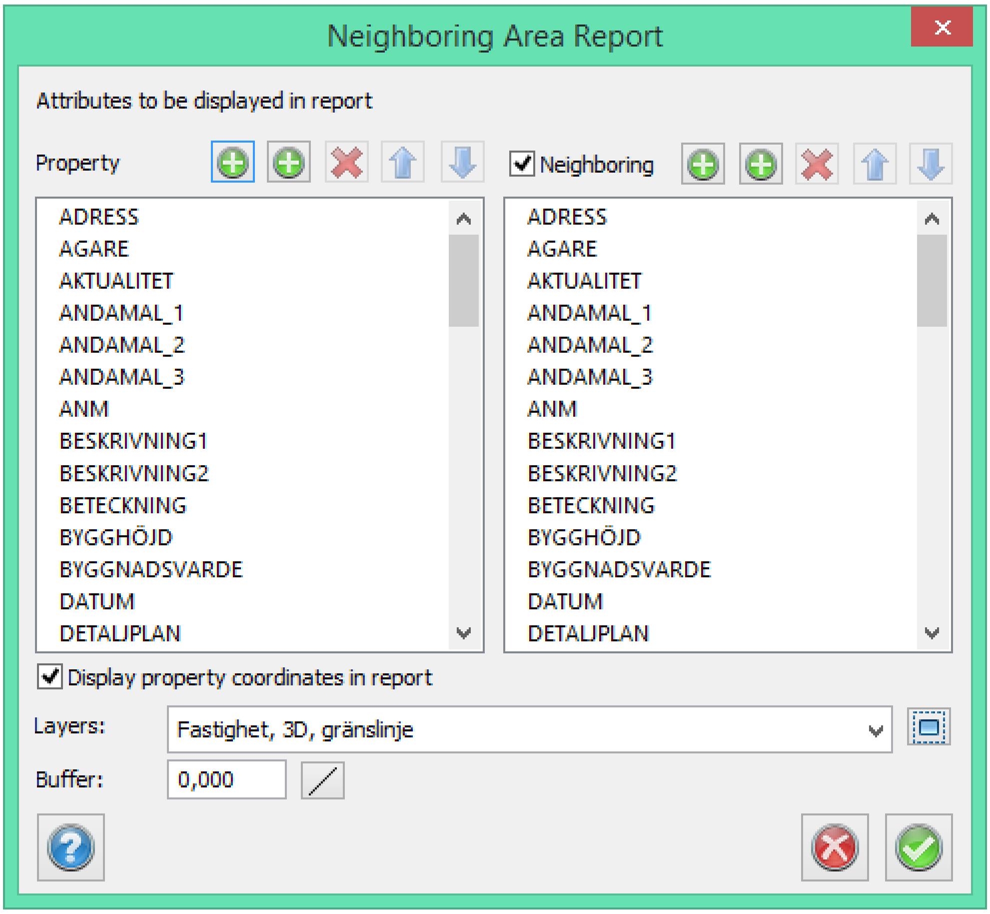
Neighboring area report

Drawing|Misc|Neighboring area report

Function to search and get a report on a property and/or neighboring properties.

The procedure is as follows:

1. Click to select the property to start from.
2. Select Area Report in the menu to open the following dialog.



3. Add the attributes you want.
4. Insert separators to divide the report.
5. Set the buffer.

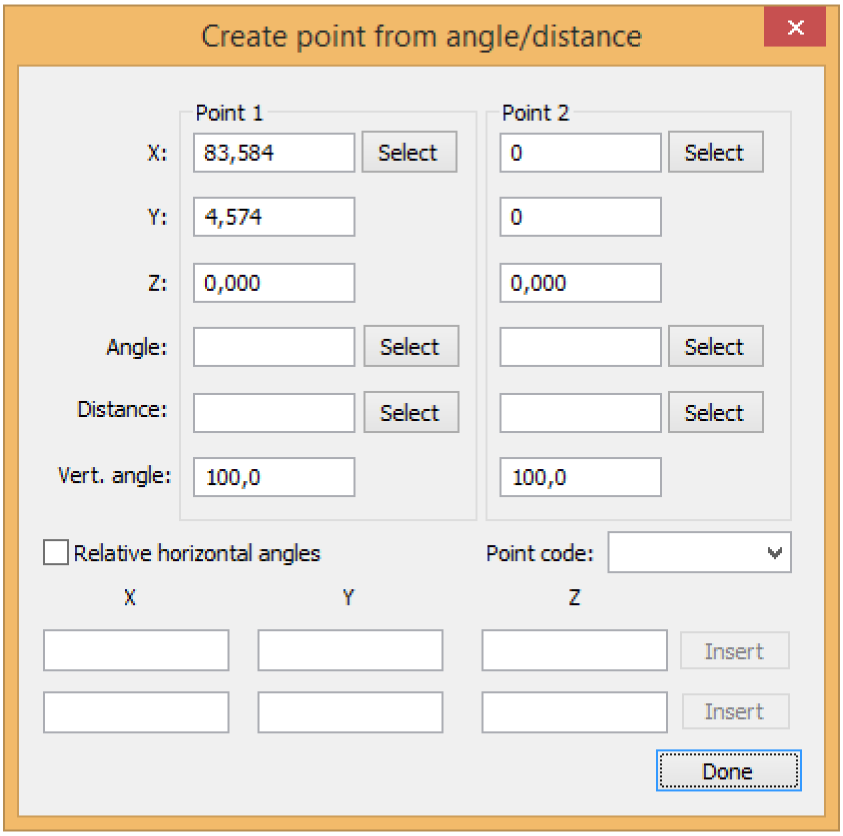
Buffer
0 = the edge of the property
10 = within 10 meters

6. Layer: Click to select the layer from where the attributes will be added from.
7. What is displayed on the screen will included in the report.

It is also possible to display the coordinates in the report.

Intersection point

Drawing|Misc|Intersection point



Function to create a point in the drawing, by setting length and direction from two known points.

Point 1 and Point 2

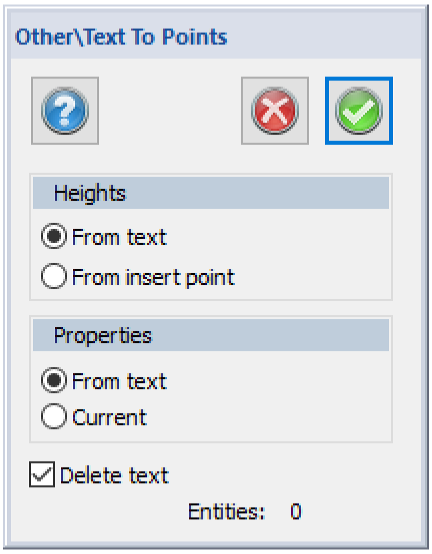
The command needs two reference points. They can be typed in or selected from the drawing. The reference points must have the X and Y coordinates typed while the Z coordinates only are needed if the points will have a height. COGO calculations and all the variation of this can be made from these two reference points by setting length and/or angle. The values for distance and direction can either be typed directly in the dialogue or drawn graphically in the drawing view by pressing the Select button for respective parameter. Typed distance and angles are drawn graphically in the view. The distance is drawn like a circle with the reference point as centre and the distance as radius. Angles are drawn as a beam with start in the reference point and direction according to the angle.

Relative horizontal angles

If the check box "Relative horizontal angles" is checked the angles are stated relative to the line that breaks through the both reference points. If the box is unchecked the angles are stated relative to the Azimuth (direction angle 0).

The application tries to find the points that agrees with all stated parameters. None, one or two points can be found depending on which parameter that has been selected. The position for a point that was found is a mean value, if the stated parameters don't find one and the same position. In the bottom of the window you find the coordinates of the found points. By clicking the Insert button next to a found point, the point will be inserted in the drawing. The inserted point will get the selected point code.

Text to points

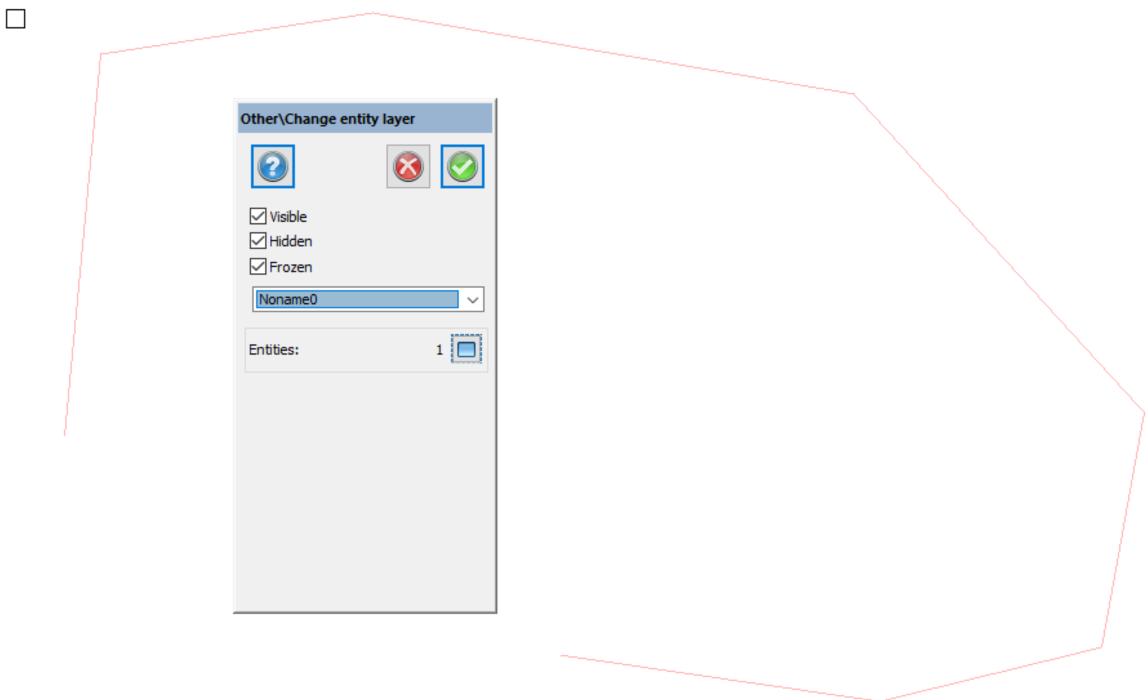


The function finds a height from a text and create a point, and out of this height.

Here you can choose whether the text should be disabled or be retained as well as the height, obtained from the text height or text in c
There are choices for the text to be deleted or kept. You can also select the insertion point.

Change entity layer

Drawing|Misc|Change entity layer



Change entity layer of objects,

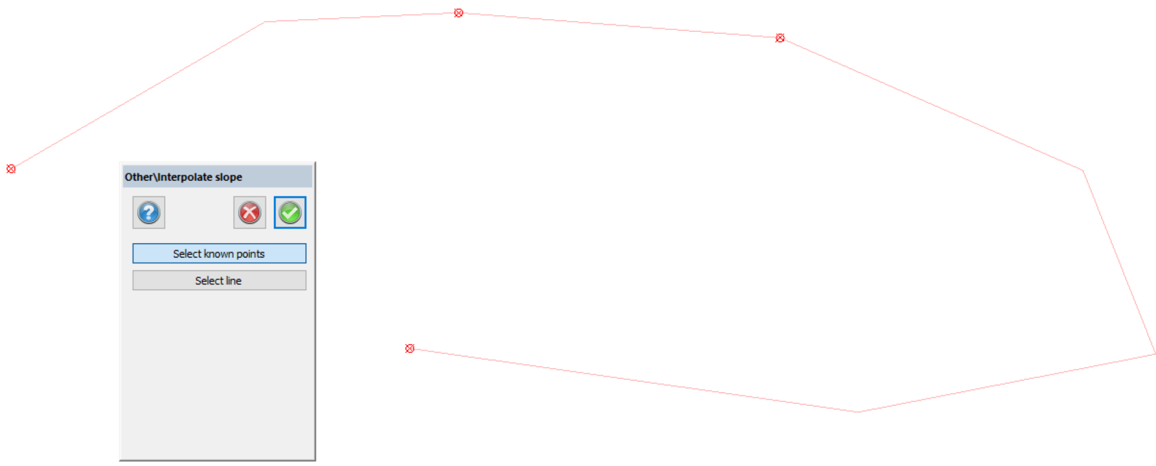
Keywords: Change layer, entity, filter layers

You can filter layers with the Visible, Hidden and Frozen checkboxes.

Tip: You can also change layers from entities through the properties window.

Interpolate slope

Drawing|Misc|Interpolate slope



Interpolate slope on a line.
The function interpolates slopes from the nodes with known height values in the line.
warning! 0,000 is interperated as a unknown height and will be written over.

Keywords: Interpolate slope, Calculate height, Change height value, line

Field

Field

Function	Description
Instrument	Select instrument and station establishment

Survey	Measurement
Set out	How to set out
Road line	To work with road line reference
GPS	How to work with GPS instrument
Attribute settings	
Logging	Log to a file
Surface	

Field is an add-on module included in the base module, for connection to certain instruments, total stations, and GPS instrument directly into the drawing. The Field module makes it possible to follow the position directly in the drawing and mark points for survey and stake out.

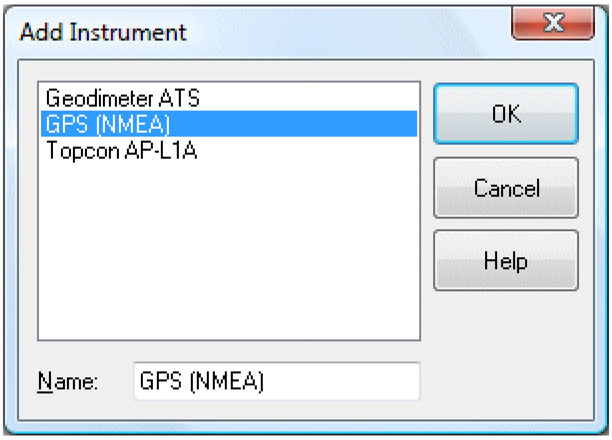
Instrument

Select instrument under Settings in Topocad.ini. Choose between total stations Topcon AP-L1 and Geodimeter ATS series. For more information regarding settings for each instrument please contact Adtollo AB. The settings are different for different instruments.

Station
Select which station type you want to establish. Known station or free station.

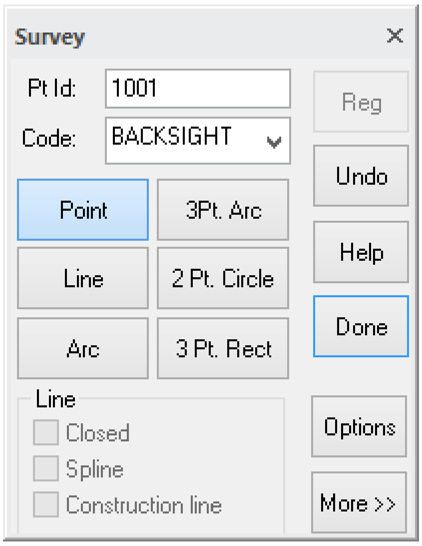
Settings
Settings for this type of instrument.

Special
Special commands for this instrument.



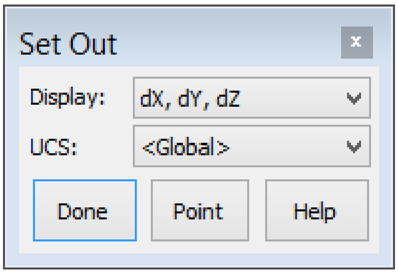
Survey

Function for measurement. Register for line or point. Set point ID, prism height and code.



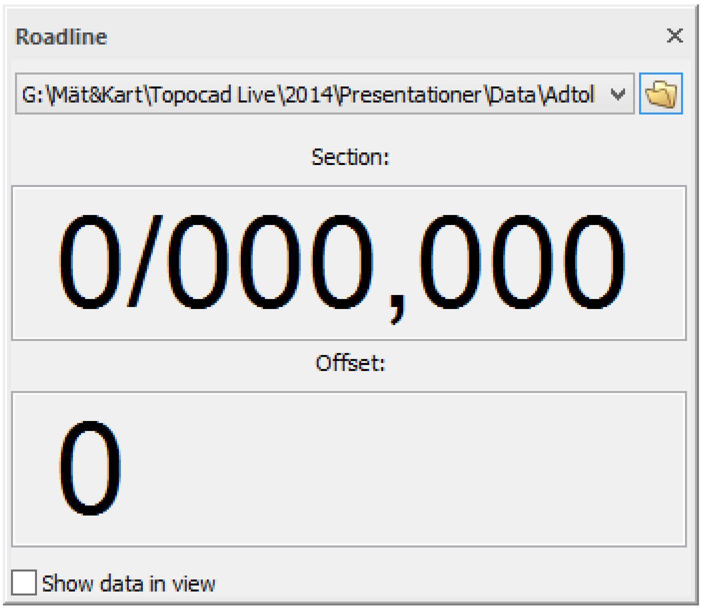
Set Out

Set out by marking a point in the drawing. Either co-ordinates or section/offset are displayed.



Road line

Usage of road line as reference. Section and offset are displayed continuously.



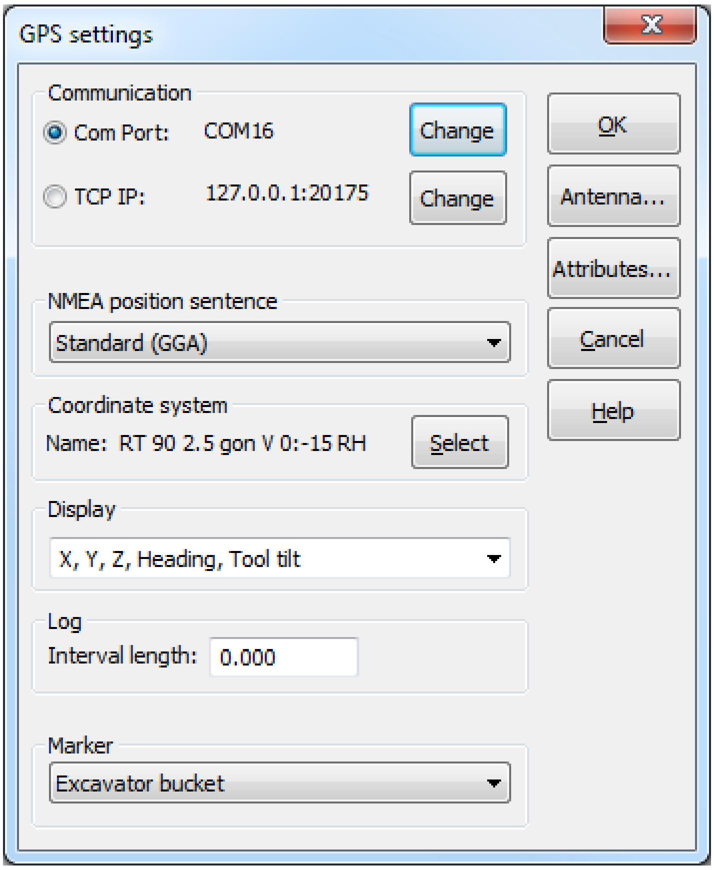
GPS

When having a GPS instrument, TopGPS is used as a software system between the GPS instrument and

Topocad. This software system can transform co-ordinates interactive and Topocad reads the data directly. No more instrument connection is necessary. Please contact Adtollo AB for further information regarding TopGPS.

Settings for GPS

Go to Field | Instrument | Settings and the dialogue are displayed.



Communication

Com Port: The connected instrument is displayed here.

TCP IP: Specify a TCP IP to connect to instruments. Click change and a new dialog opens. Localhost is the default. Change the IP address if needed.

Marker

It is possible to select the cursor to be plotted as a bucket. To show the bucket, the instrument must send an NMEA sentence of the type PDGGT, which gives information of the width and slope of the bucket.

NMEA position sentence

The position sets in the drop down list NMEA position sentence.

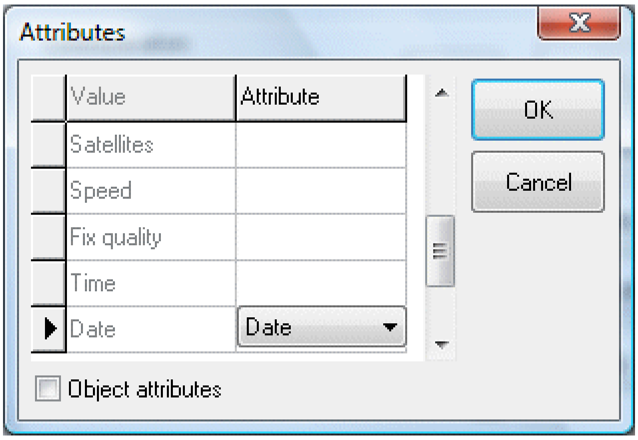
Standard (GGA)

Standard (GGA) sets the position in geodetical co-ordinates (latitude, longitude and ellipsoid height). Get the geocentric co-ordinates by transformation via Gtrans to an appropriate co-ordinate system.

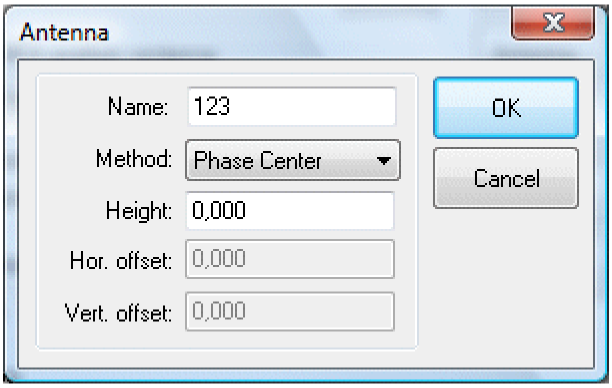
Leica (LLK) and **Trimble (PTNL,PJK)**

Leica and Trimble sets the position in a north east direction and height. Transformation is not necessary.

Attribute settings



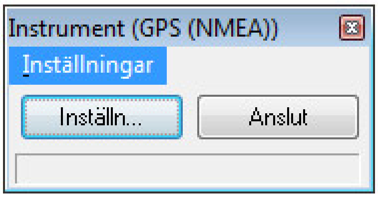
Matches different attributes for different GPS values. The attributes will be inserted at this attribute for every measured point.



Select method.

Logging

To start the logging, select Field|Instrument in the menu. Following dialogue appears. Select Options.



A new dialogue appears and you can select "Start logging to file". Select where to save the file. If nothing is selected, the file will not be saved.

Surface

Select: Enter area by clicking Select.

Select single object or layer.

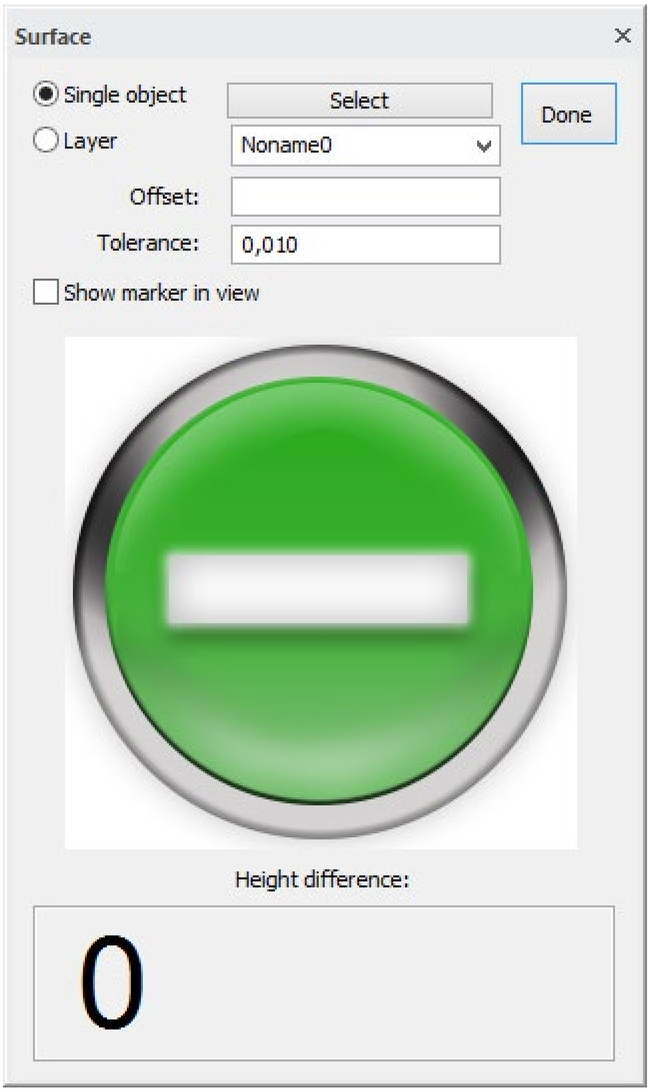
Offset: Select if you want to be, for example, one meter above or below.

Select tolerance.

Show marker in view: Optional if you want to display the marker.

The icon changes depending on whether you are too high, too low or within tolerance (as this image).

The figures at the bottom of the dialog displays the difference in height in meters.



Field

Field

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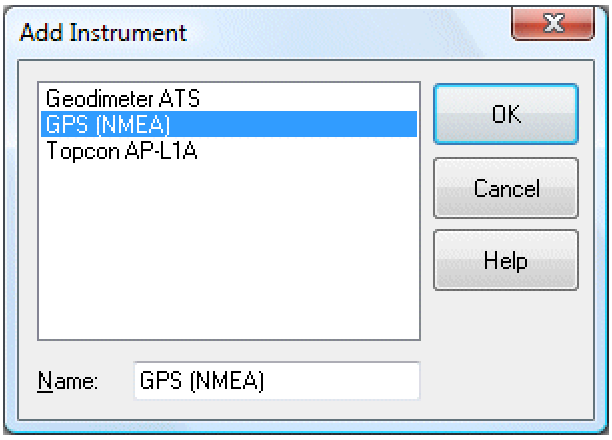

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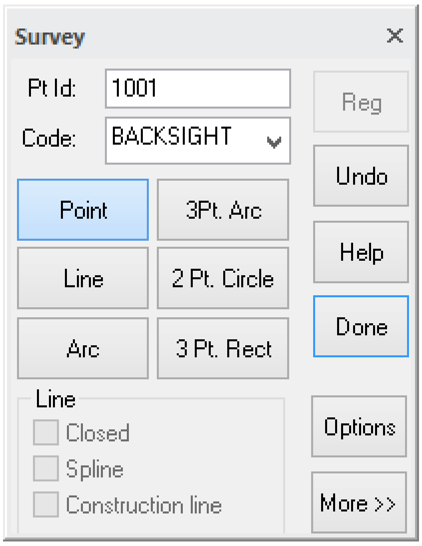

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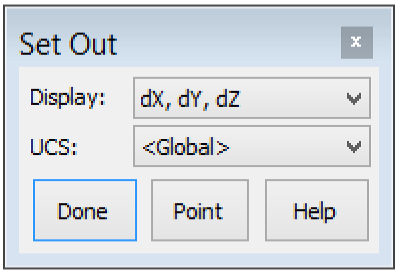
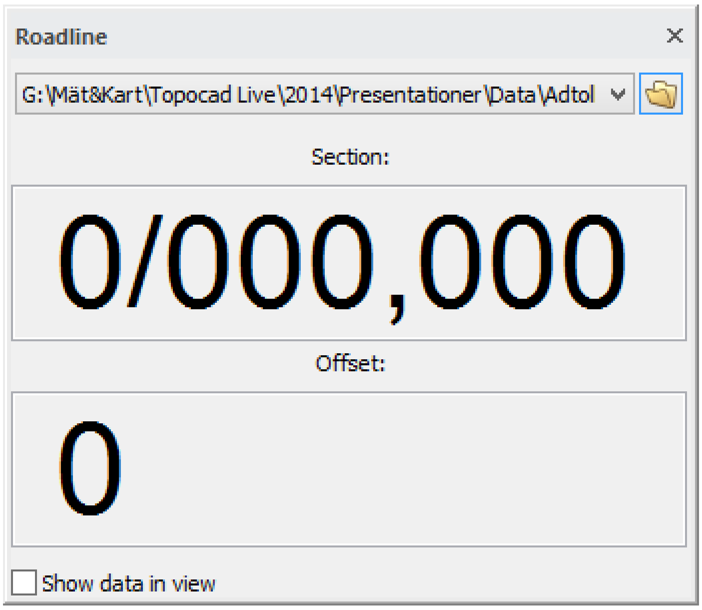


Road line

Usage of road line as reference. Section and offset are displayed continuously.



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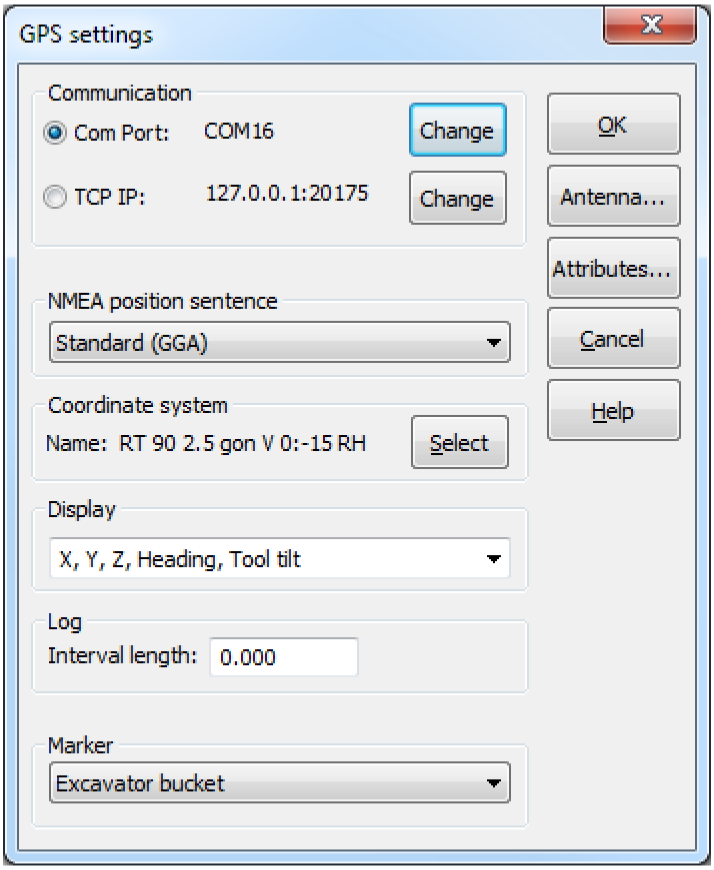

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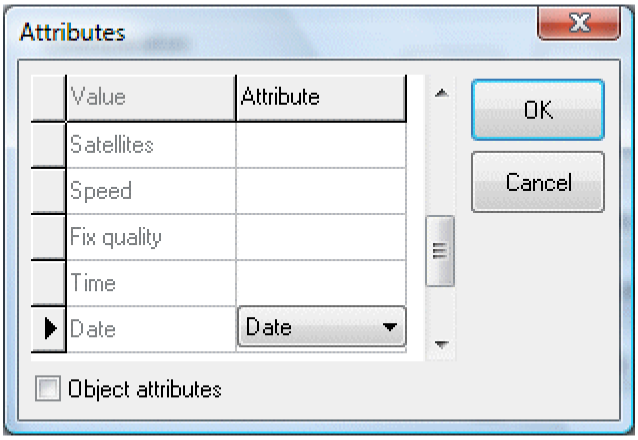

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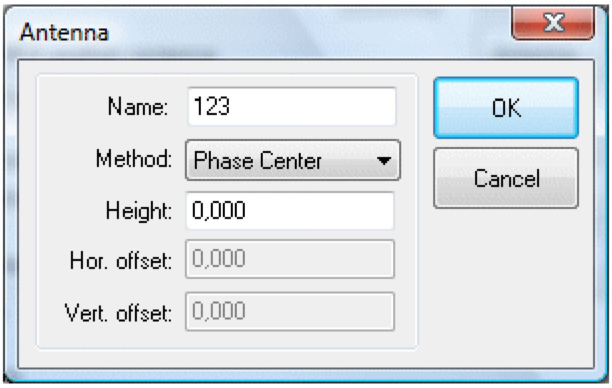

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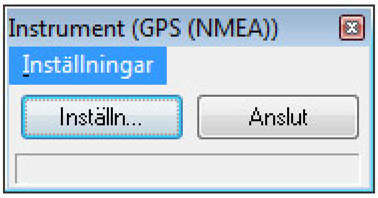

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Select single object or layer.

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Select tolerance.

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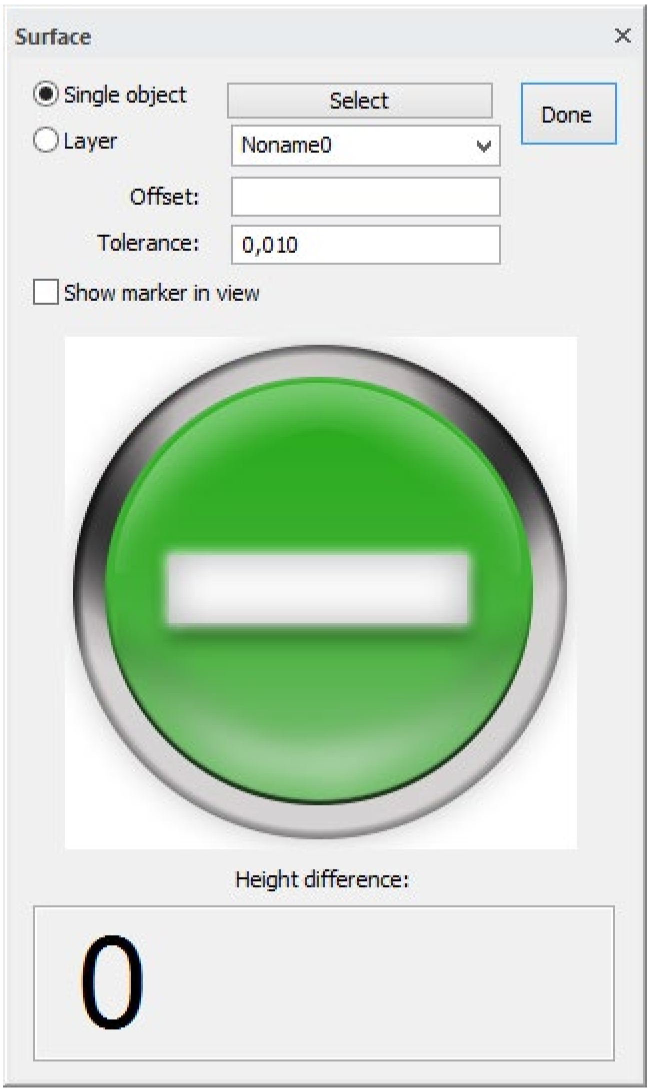

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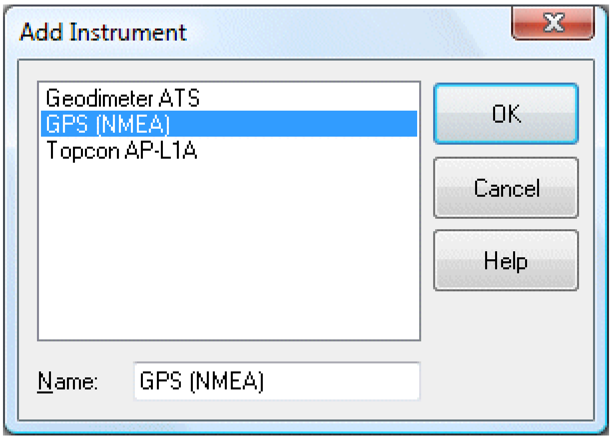

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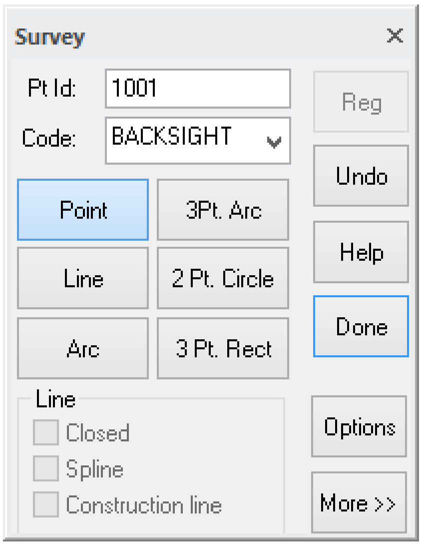

Set Out

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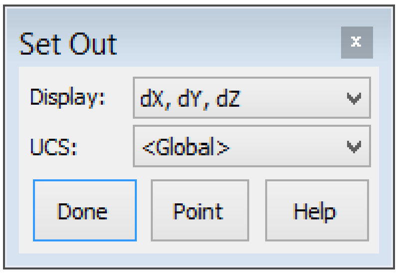
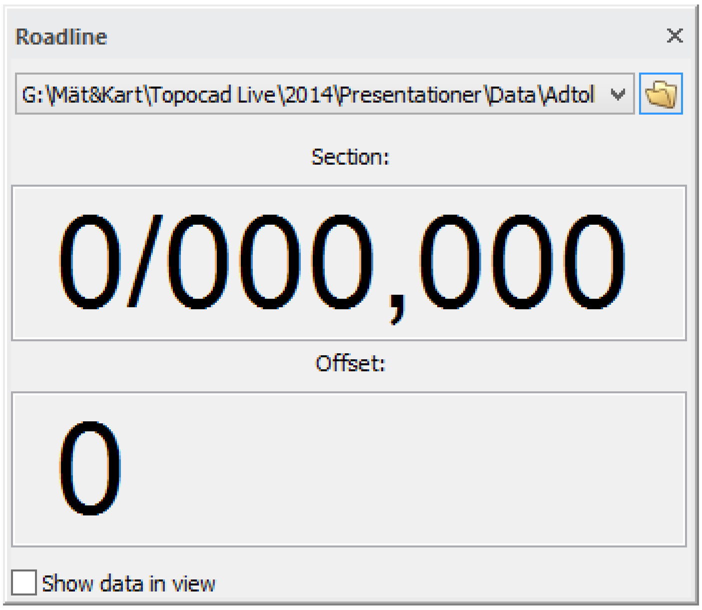


Road line

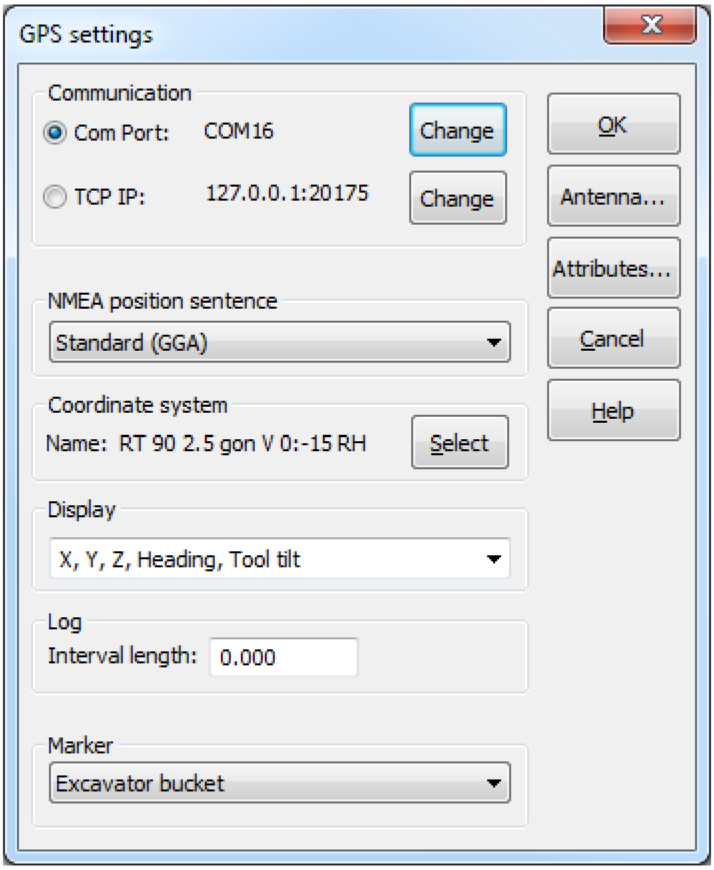
Usage of road line as reference. Section and offset are displayed continuously.



GPS

When having a GPS instrument, TopGPS is used as a software system between the GPS instrument and Topocad. This software system can transform co-ordinates interactive and Topocad reads the data directly. No more instrument connection is necessary. Please contact Adtollo AB for further information regarding TopGPS.

Settings for GPS
Go to Field | Instrument | Settings and the dialogue are displayed.



Communication

Com Port: The connected instrument is displayed here.

TCP IP: Specify a TCP IP to connect to instruments. Click change and a new dialog opens. Localhost is the default. Change the IP address if needed.

Marker
It is possible to select the cursor to be plotted as a bucket. To show the bucket, the instrument must send an NMEA sentence of the type PDGGT, which gives information of the width and slope of the bucket.

NMEA position sentence

The position sets in the drop down list NMEA position sentence.

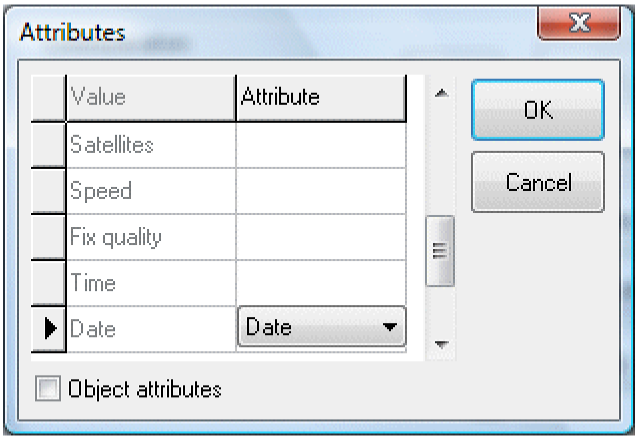
Standard (GGA)

Standard (GGA) sets the position in geodetical co-ordinates (latitude, longitude and ellipsoid height). Get the geocentric co-ordinates by transformation via Gtrans to an appropriate co-ordinate system.

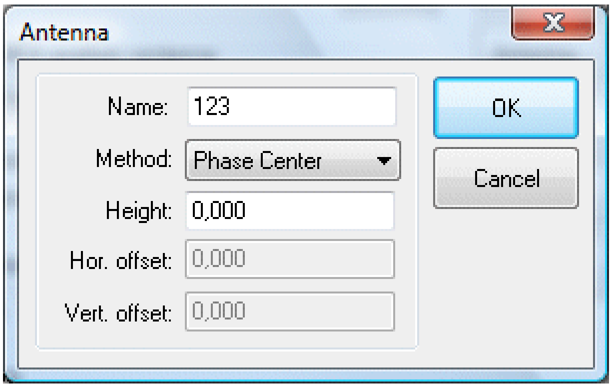
Leica (LLK) and **Trimble (PTNL,PJK)**

Leica and Trimble sets the position in a north east direction and height. Transformation is not necessary.

Attribute settings



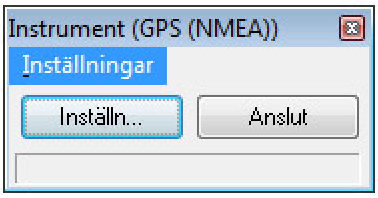
Matches different attributes for different GPS values. The attributes will be inserted at this attribute for every measured point.



Select method.

Logging

To start the logging, select Field|Instrument in the menu. Following dialogue appears. Select Options.



A new dialogue appears and you can select "Start logging to file". Select where to save the file. If nothing is selected, the file will not be saved.

Surface

Select: Enter area by clicking Select.

Select single object or layer.

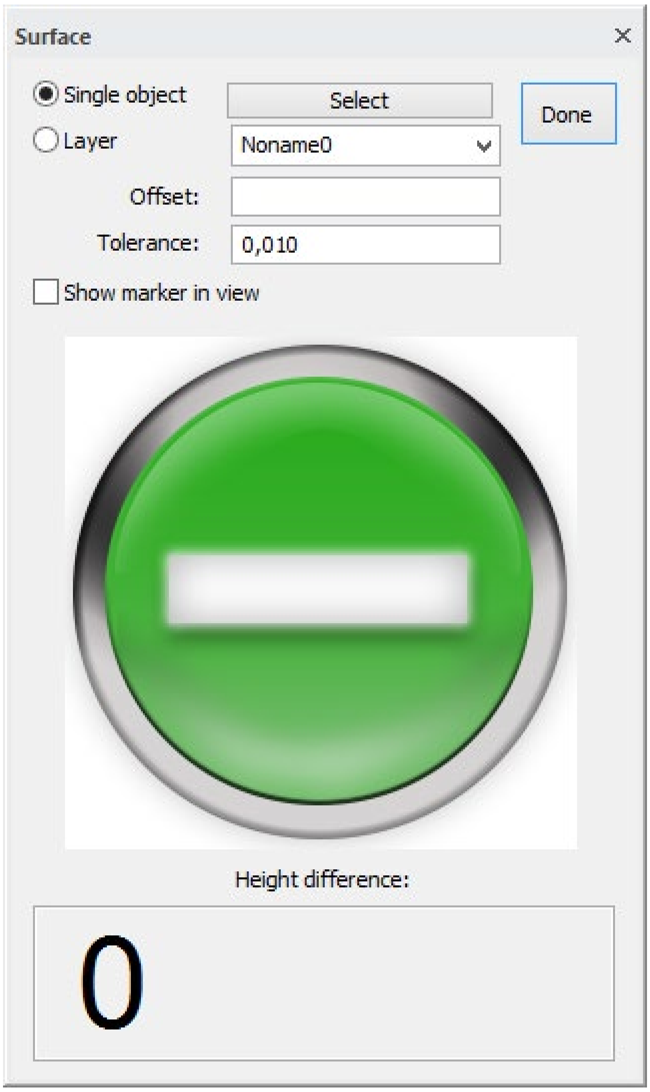
Offset: Select if you want to be, for example, one meter above or below.

Select tolerance.

Show marker in view: Optional if you want to display the marker.

The icon changes depending on whether you are too high, too low or within tolerance (as this image).

The figures at the bottom of the dialog displays the difference in height in meters.



Field

Field

Function	Description
Instrument	Select instrument and station establishment
Survey	Measurement
Set out	How to set out
Road line	To work with road line reference
GPS	How to work with GPS instrument
Attribute settings	
Logging	Log to a file

Surface	

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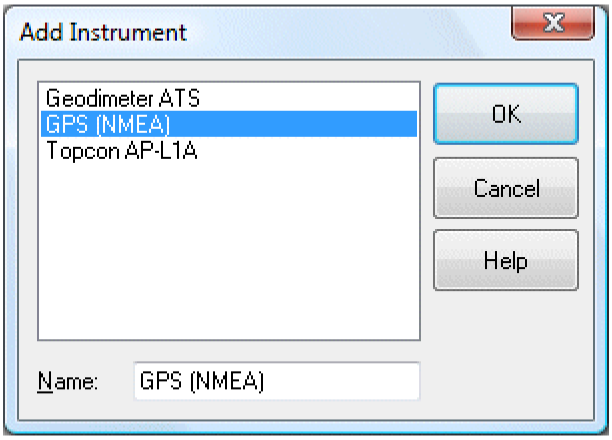
Station
Select which station type you want to establish. Known station or free station.

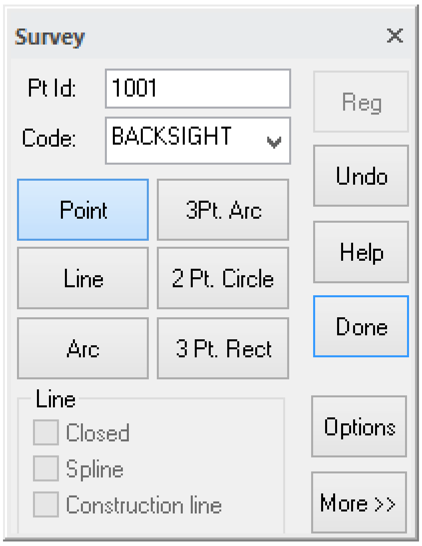
Settings
Settings for this type of instrument.

Special
Special commands for this instrument.



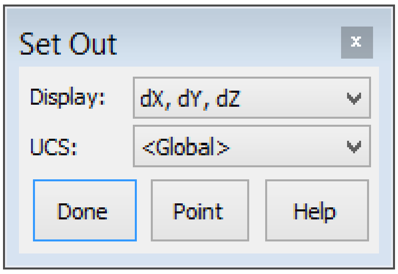
Survey

Function for measurement. Register for line or point. Set point ID, prism height and code.



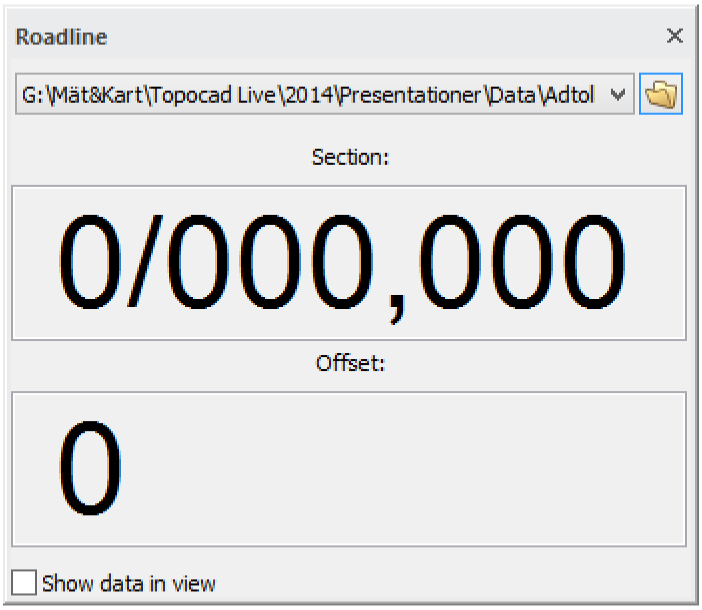
Set Out

Set out by marking a point in the drawing. Either co-ordinates or section/offset are displayed.



Road line

Usage of road line as reference. Section and offset are displayed continuously.



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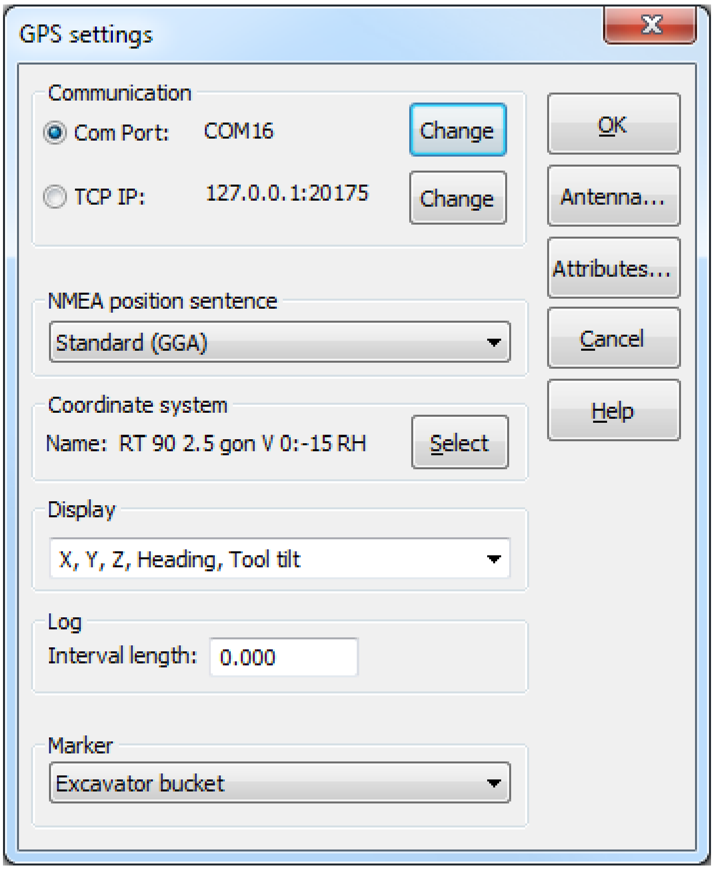

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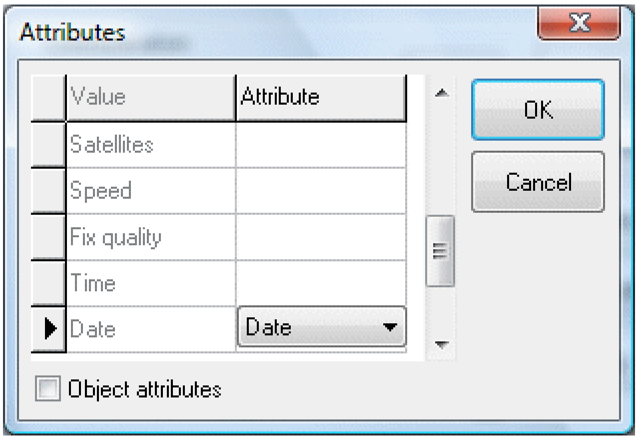

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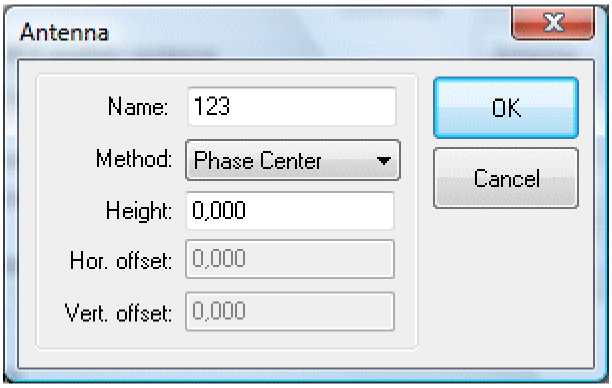

Select method.

Logging

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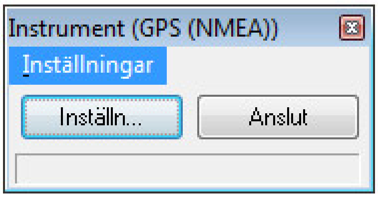

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Surface

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Select single object or layer.

Offset: Select if you want to be, for example, one meter above or below.

Select tolerance.

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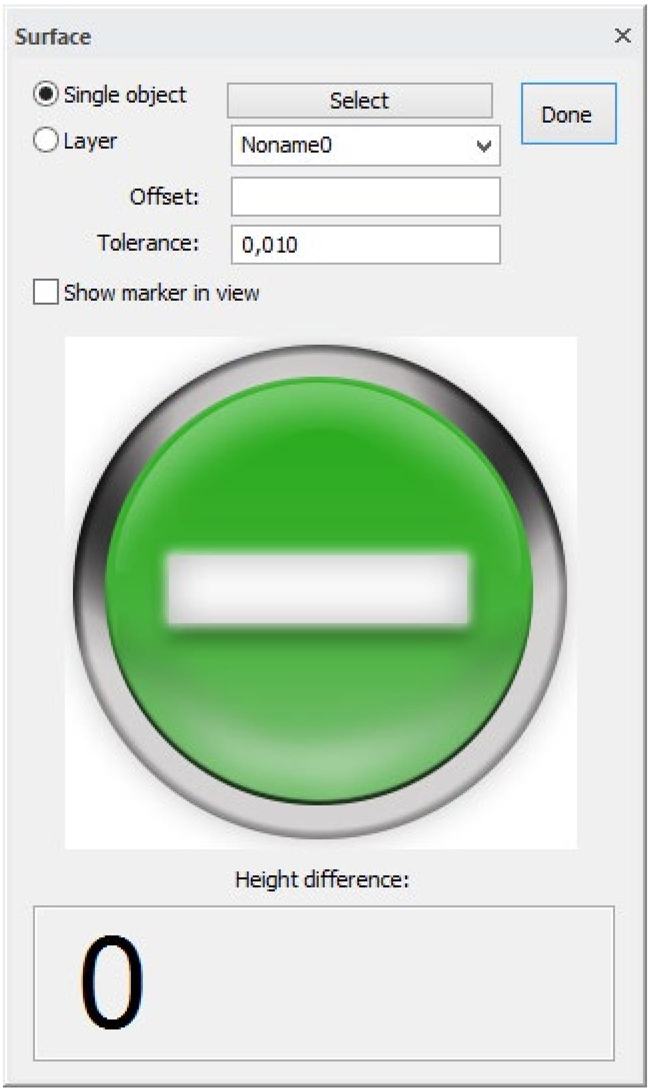

Field

Field

Function	Description
Instrument	Select instrument and station establishment
Survey	Measurement
Set out	How to set out
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Attribute settings	
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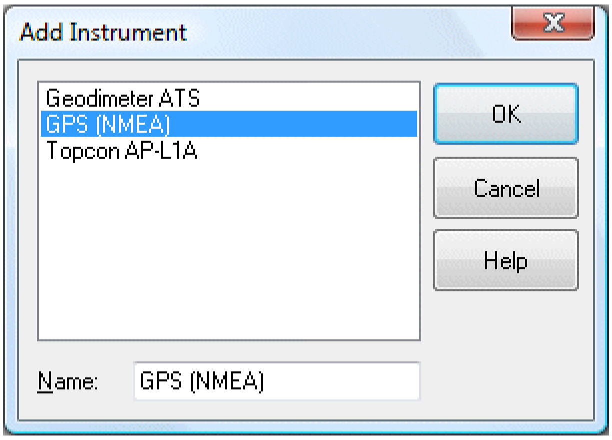
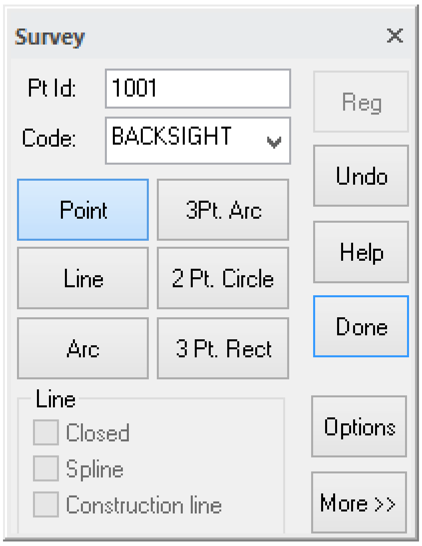
Special commands for this instrument.



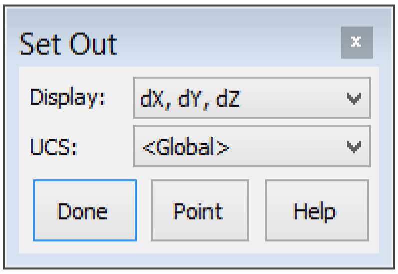
Survey

Function for measurement. Register for line or point. Set point ID, prism height and code.



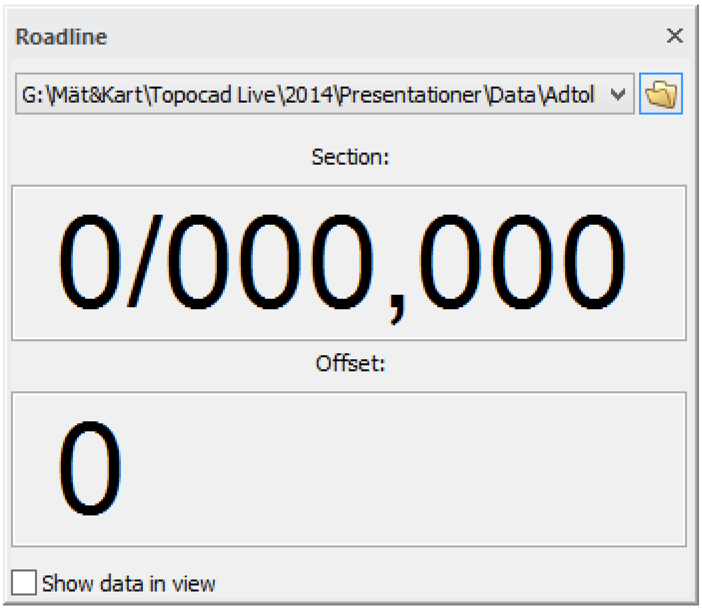
Set Out

Set out by marking a point in the drawing. Either co-ordinates or section/offset are displayed.



Road line

Usage of road line as reference. Section and offset are displayed continuously.



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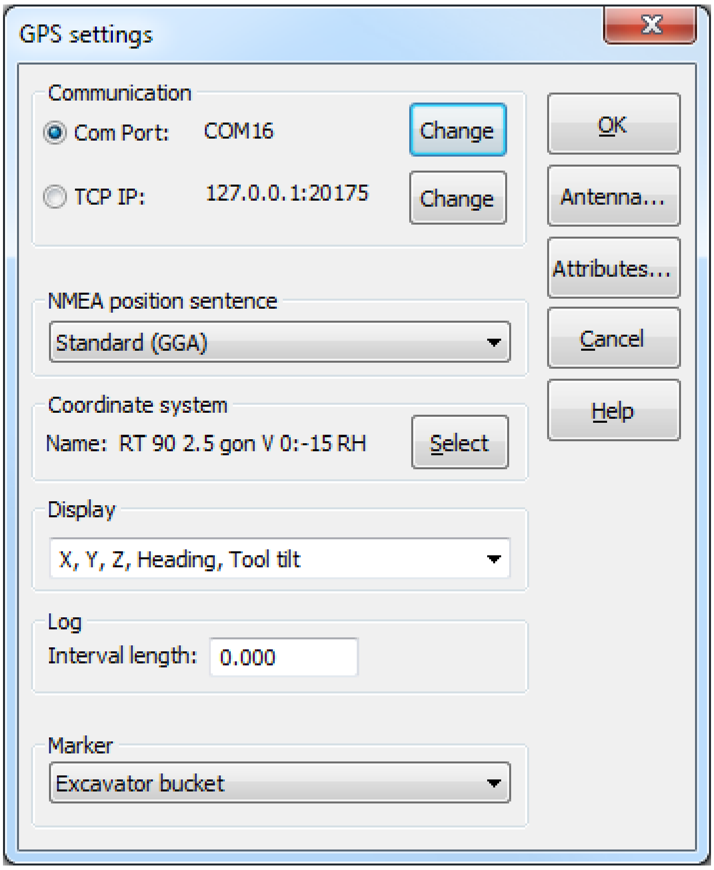

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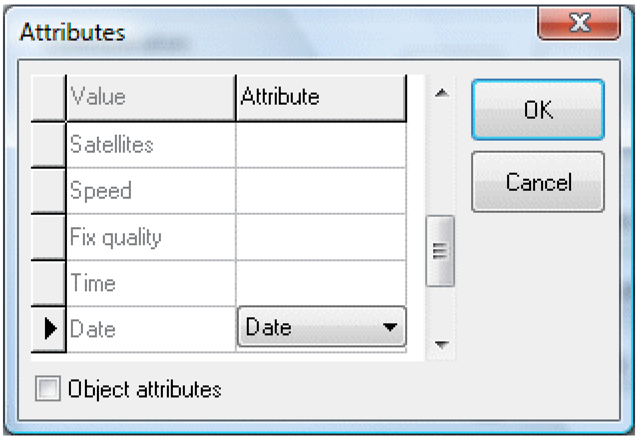

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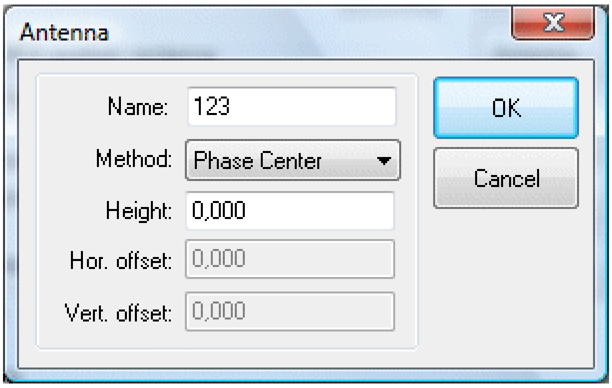
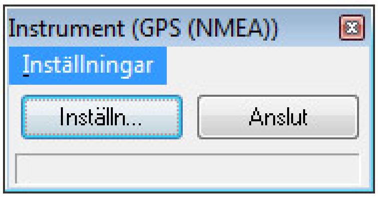


Select method.

Logging

To start the logging, select Field|Instrument in the menu. Following dialogue appears. Select Options.



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Surface

Select: Enter area by clicking Select.

Select single object or layer.

Offset: Select if you want to be, for example, one meter above or below.

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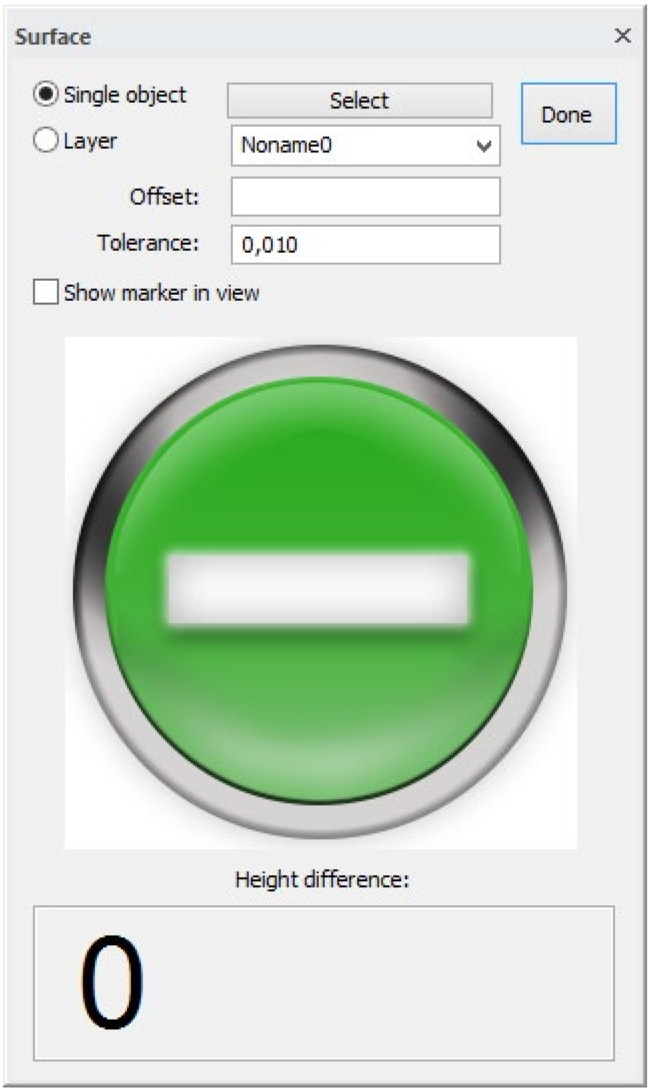

Field

Field

Function	Description
Instrument	Select instrument and station establishment
Survey	Measurement
Set out	How to set out
Road line	To work with road line reference
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Attribute settings	
Logging	Log to a file

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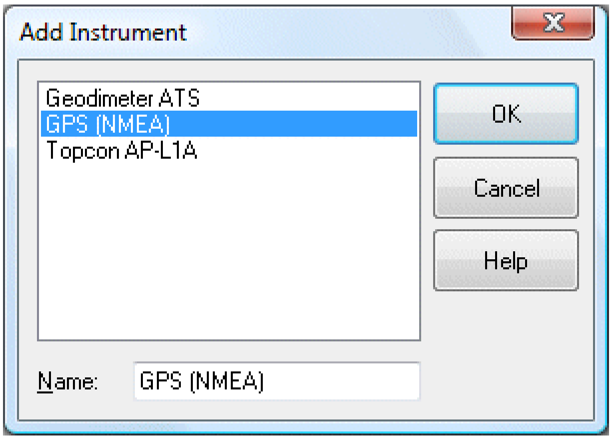
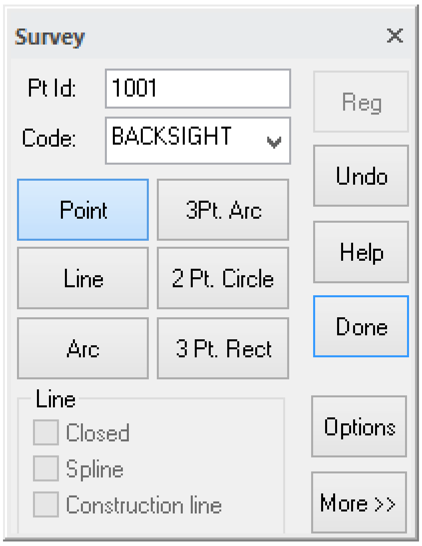
Special
Special commands for this instrument.



Survey

Function for measurement. Register for line or point. Set point ID, prism height and code.



Set Out

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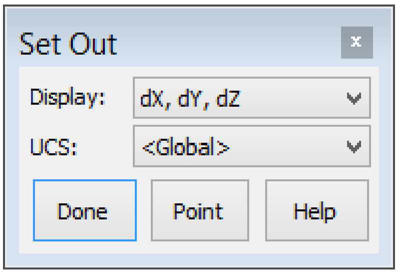
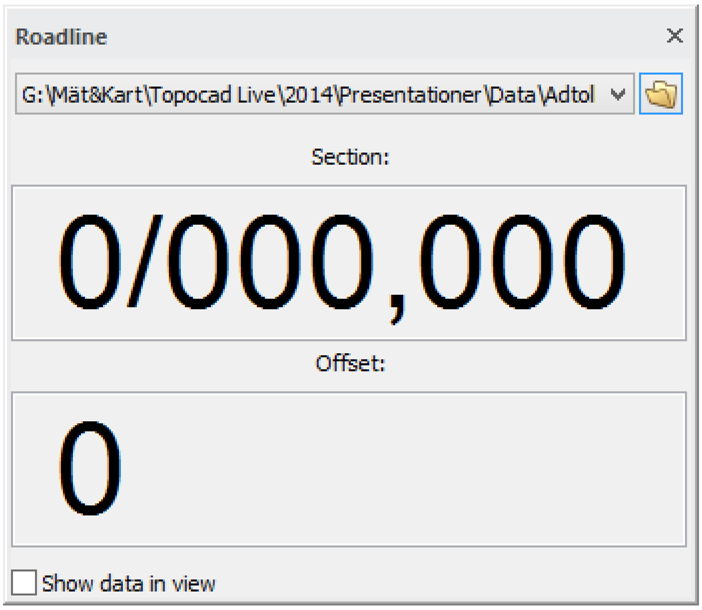


Road line

Usage of road line as reference. Section and offset are displayed continuously.



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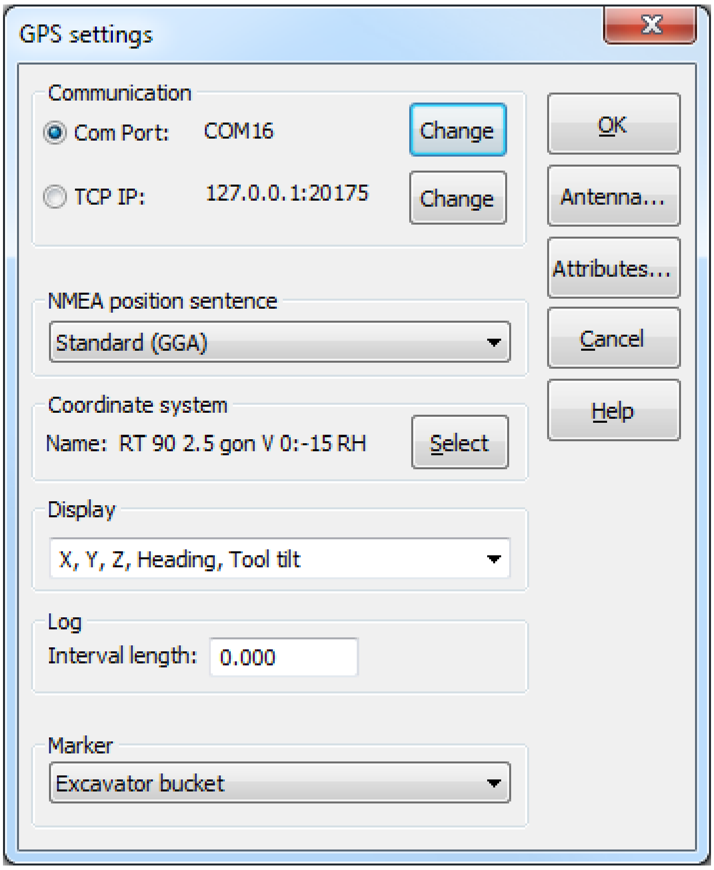

Communication

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Marker
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NMEA position sentence

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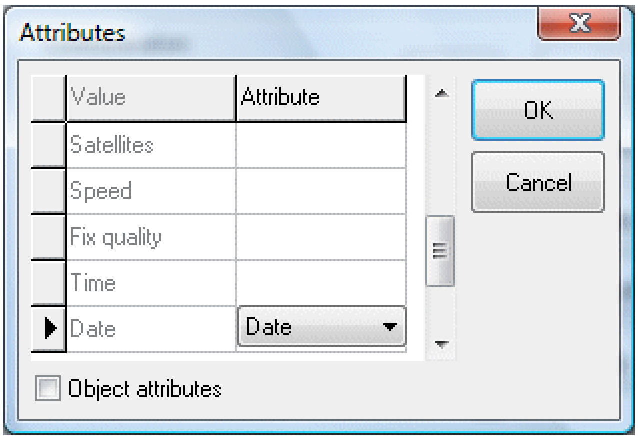

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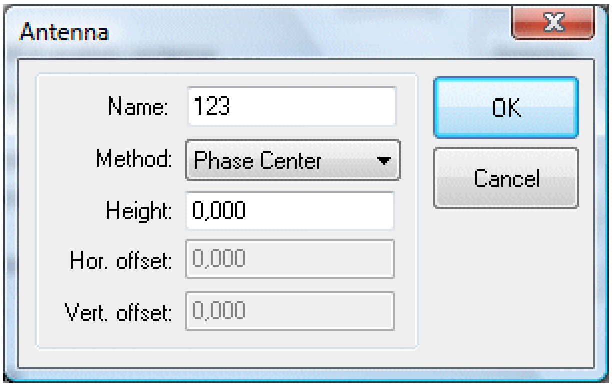

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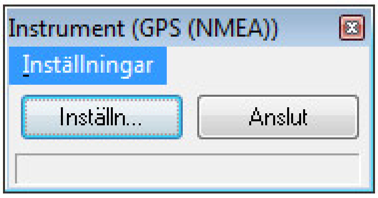

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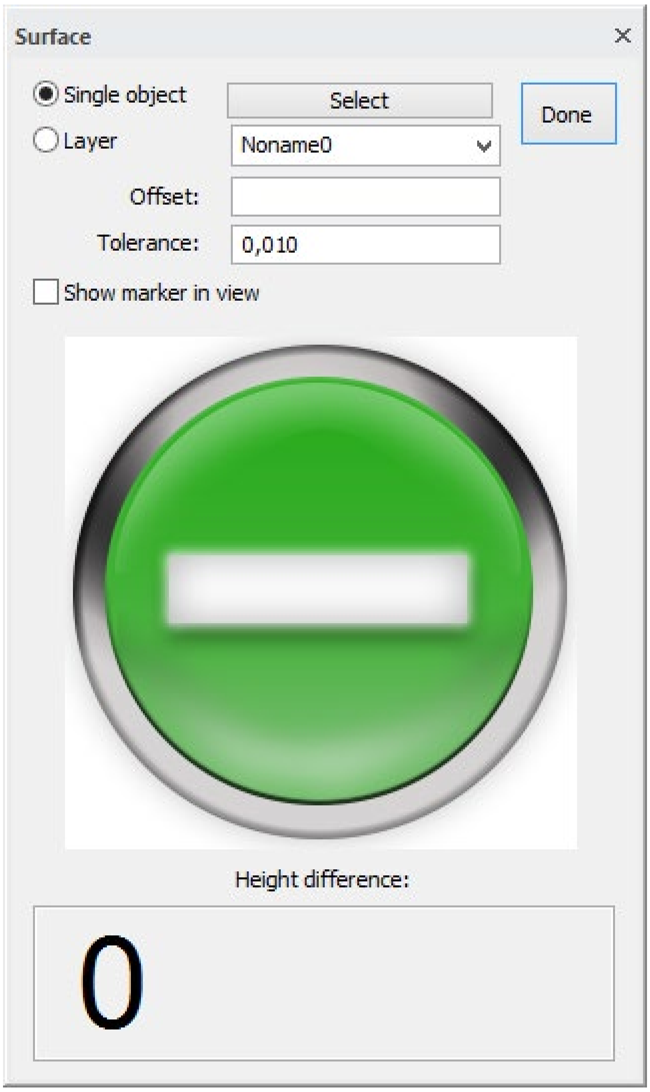

Field

Field

Function	Description
Instrument	Select instrument and station establishment
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Set out	How to set out
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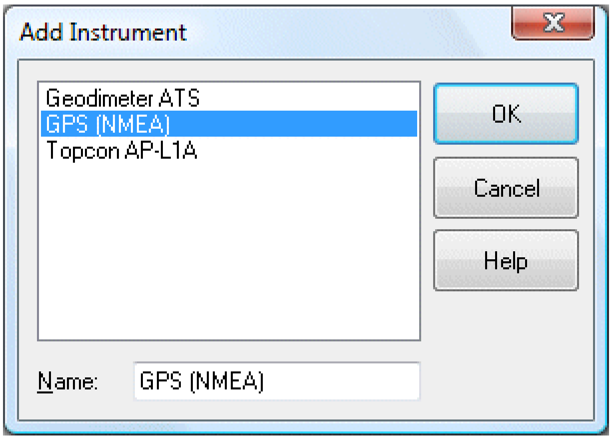

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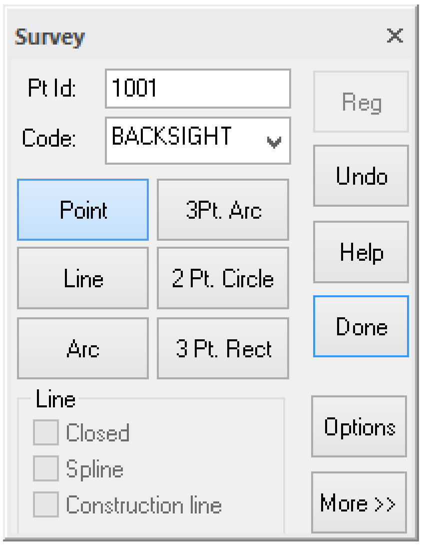

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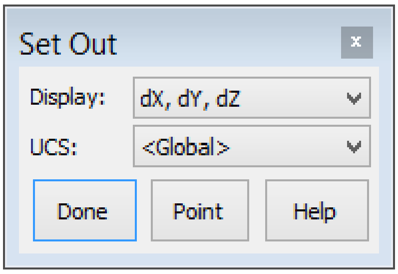

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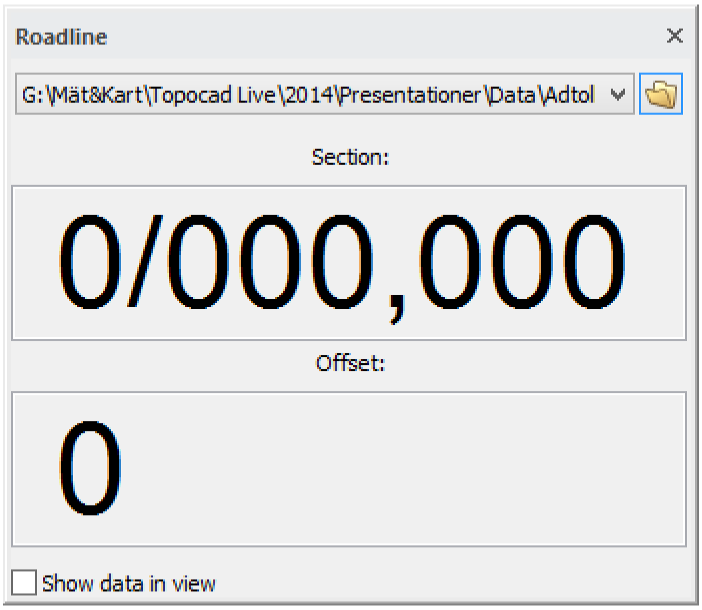

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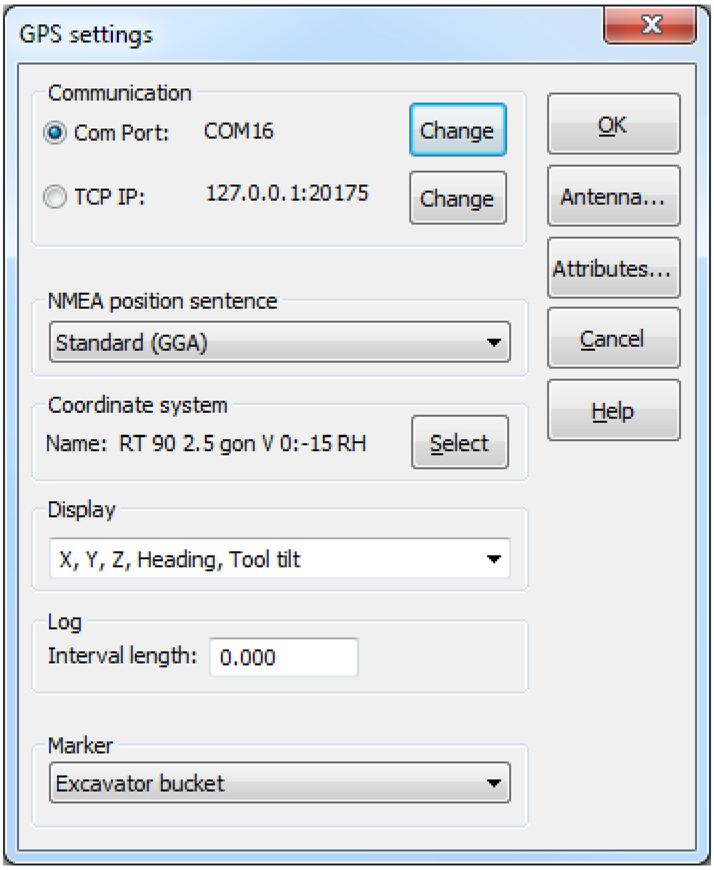

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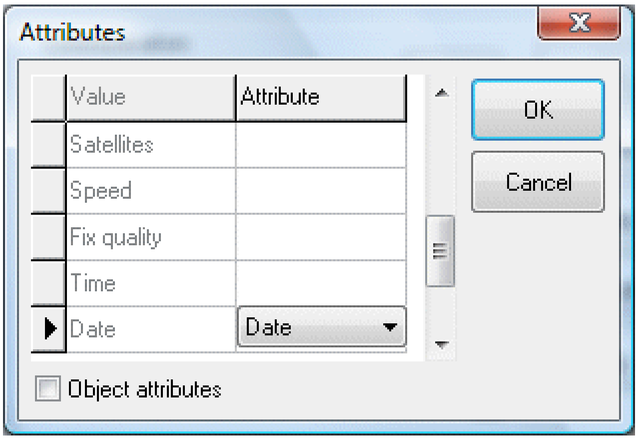

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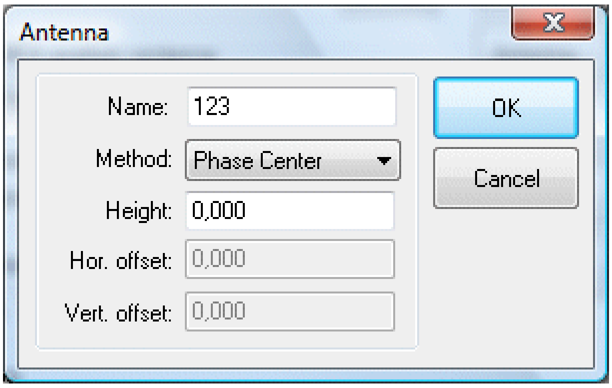

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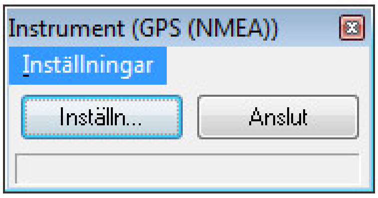

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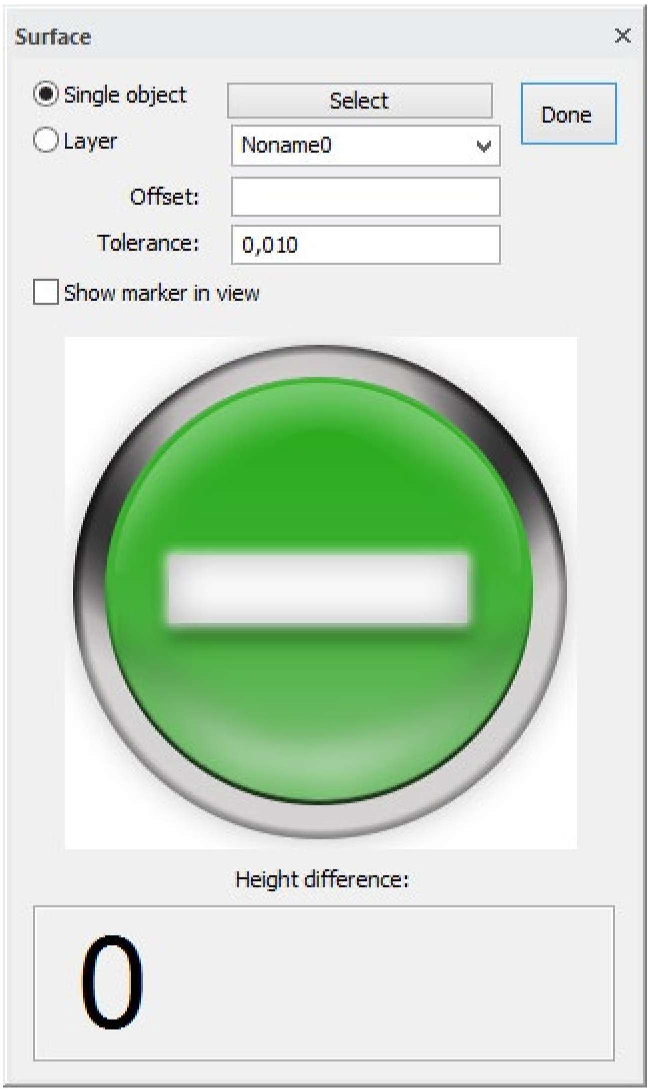


Field

Field

Function	Description
Instrument	Select instrument and station establishment
Survey	Measurement
Set out	How to set out
Road line	To work with road line reference
GPS	How to work with GPS instrument
Attribute settings	
Logging	Log to a file

Surface	

Field is an add-on module included in the base module, for connection to certain instruments, total stations, and GPS instrument directly into the drawing. The Field module makes it possible to follow the position directly in the drawing and mark points for survey and stake out.

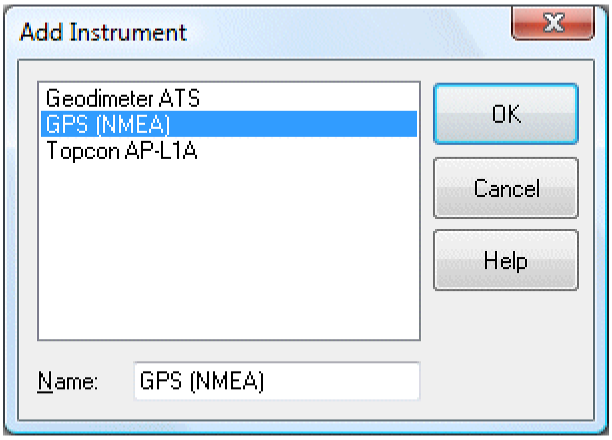
Instrument

Select instrument under Settings in Topocad.ini. Choose between total stations Topcon AP-L1 and Geodimeter ATS series. For more information regarding settings for each instrument please contact Adtollo AB. The settings are different for different instruments.

Station
Select which station type you want to establish. Known station or free station.

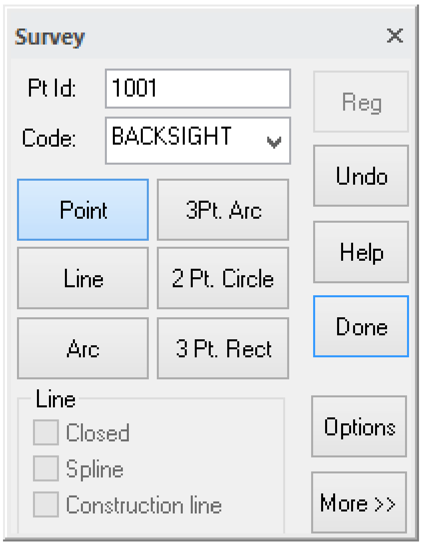
Settings
Settings for this type of instrument.

Special
Special commands for this instrument.



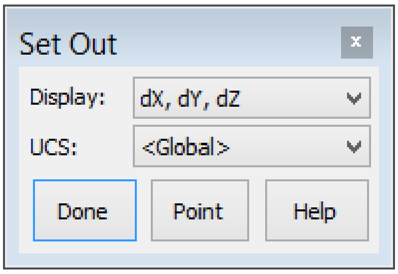
Survey

Function for measurement. Register for line or point. Set point ID, prism height and code.



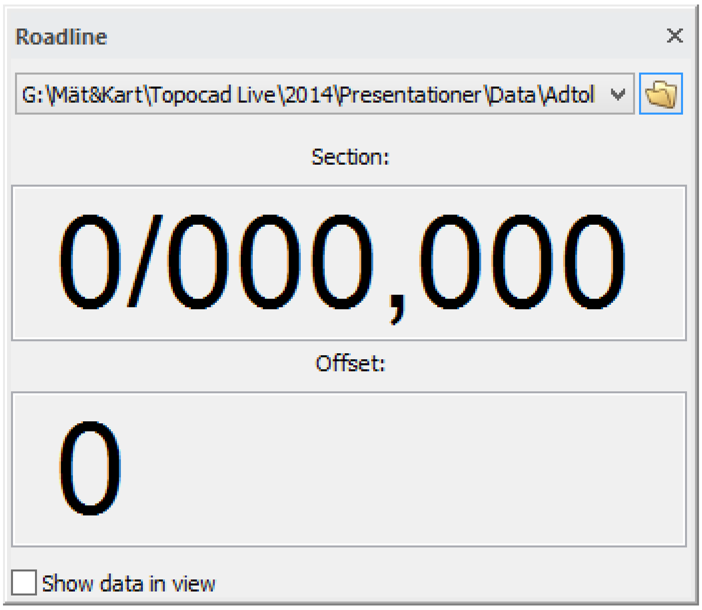
Set Out

Set out by marking a point in the drawing. Either co-ordinates or section/offset are displayed.



Road line

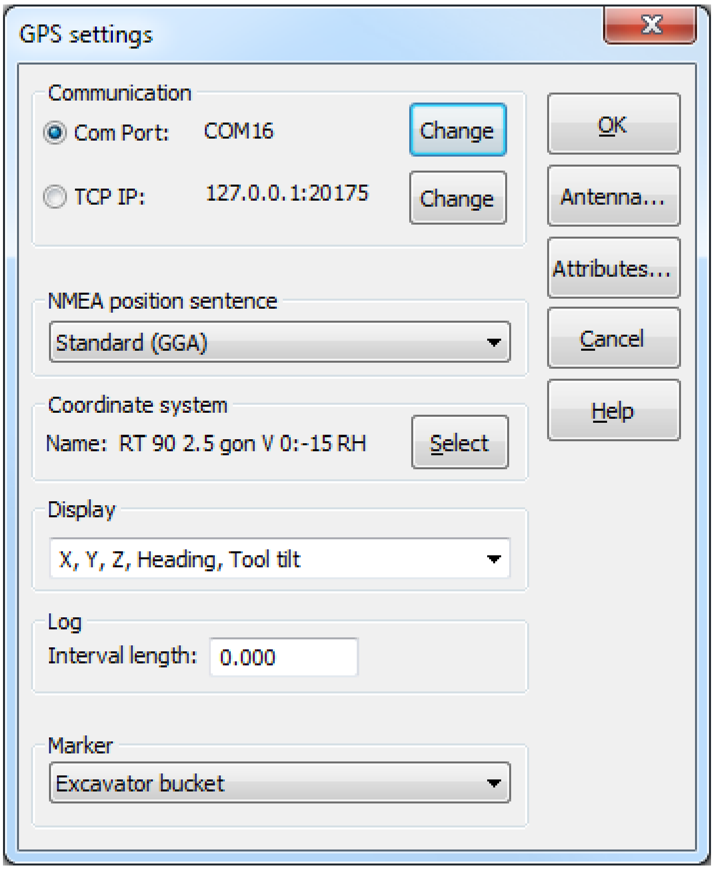
Usage of road line as reference. Section and offset are displayed continuously.



GPS

When having a GPS instrument, TopGPS is used as a software system between the GPS instrument and Topocad. This software system can transform co-ordinates interactive and Topocad reads the data directly. No more instrument connection is necessary. Please contact Adtollo AB for further information regarding TopGPS.

Settings for GPS
Go to Field | Instrument | Settings and the dialogue are displayed.



Communication

Com Port: The connected instrument is displayed here.

TCP IP: Specify a TCP IP to connect to instruments. Click change and a new dialog opens. Localhost is the default. Change the IP address if needed.

Marker
It is possible to select the cursor to be plotted as a bucket. To show the bucket, the instrument must send an NMEA sentence of the type PDGGT, which gives information of the width and slope of the bucket.

NMEA position sentence

The position sets in the drop down list NMEA position sentence.

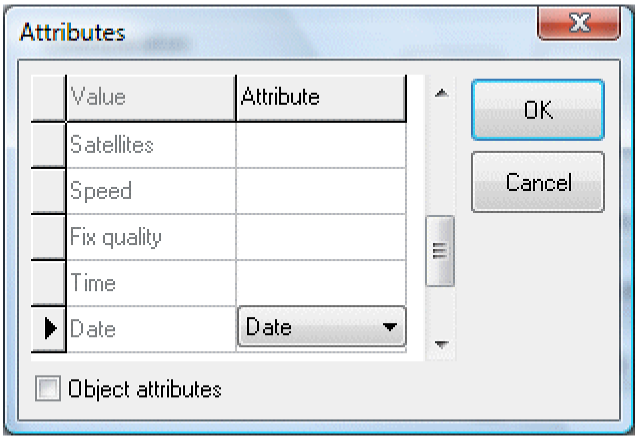
Standard (GGA)

Standard (GGA) sets the position in geodetical co-ordinates (latitude, longitude and ellipsoid height). Get the geocentric co-ordinates by transformation via Gtrans to an appropriate co-ordinate system.

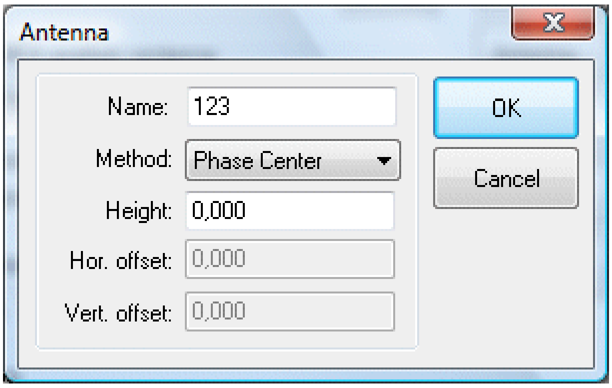
Leica (LLK) and **Trimble (PTNL,PJK)**

Leica and Trimble sets the position in a north east direction and height. Transformation is not necessary.

Attribute settings



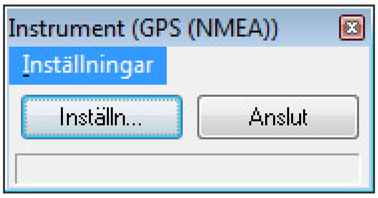
Matches different attributes for different GPS values. The attributes will be inserted at this attribute for every measured point.



Select method.

Logging

To start the logging, select Field|Instrument in the menu. Following dialogue appears. Select Options.



A new dialogue appears and you can select "Start logging to file". Select where to save the file. If nothing is selected, the file will not be saved.

Surface

Select: Enter area by clicking Select.

Select single object or layer.

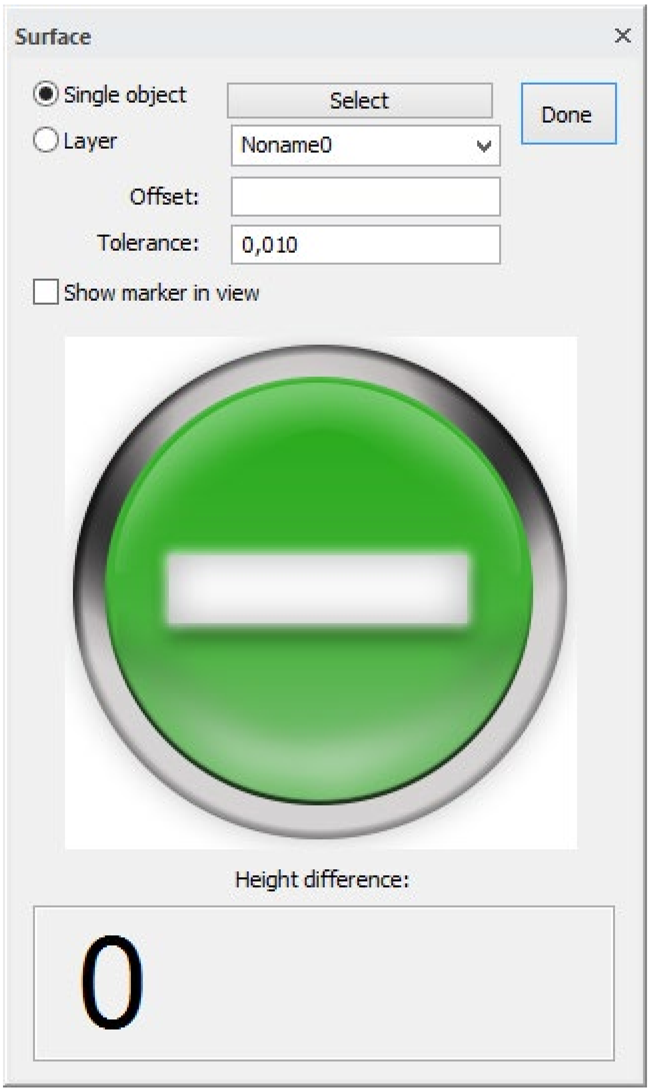
Offset: Select if you want to be, for example, one meter above or below.

Select tolerance.

Show marker in view: Optional if you want to display the marker.

The icon changes depending on whether you are too high, too low or within tolerance (as this image).

The figures at the bottom of the dialog displays the difference in height in meters.



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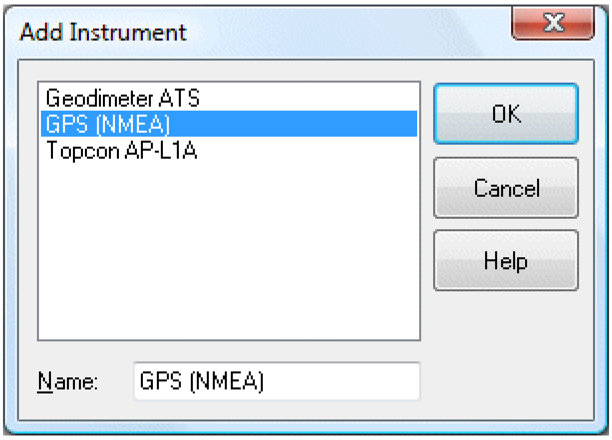

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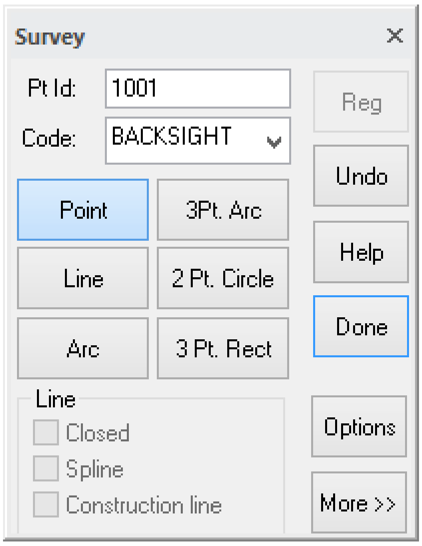

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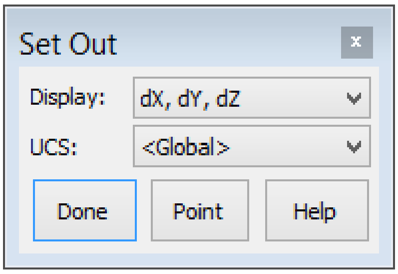

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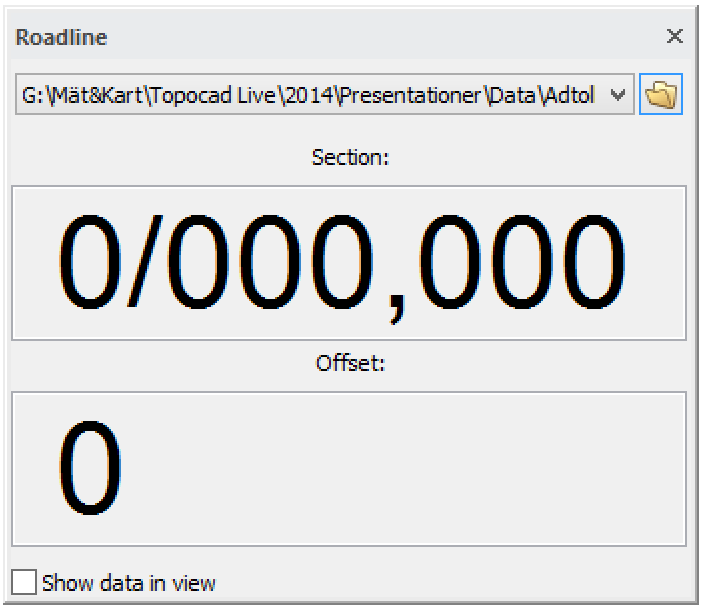

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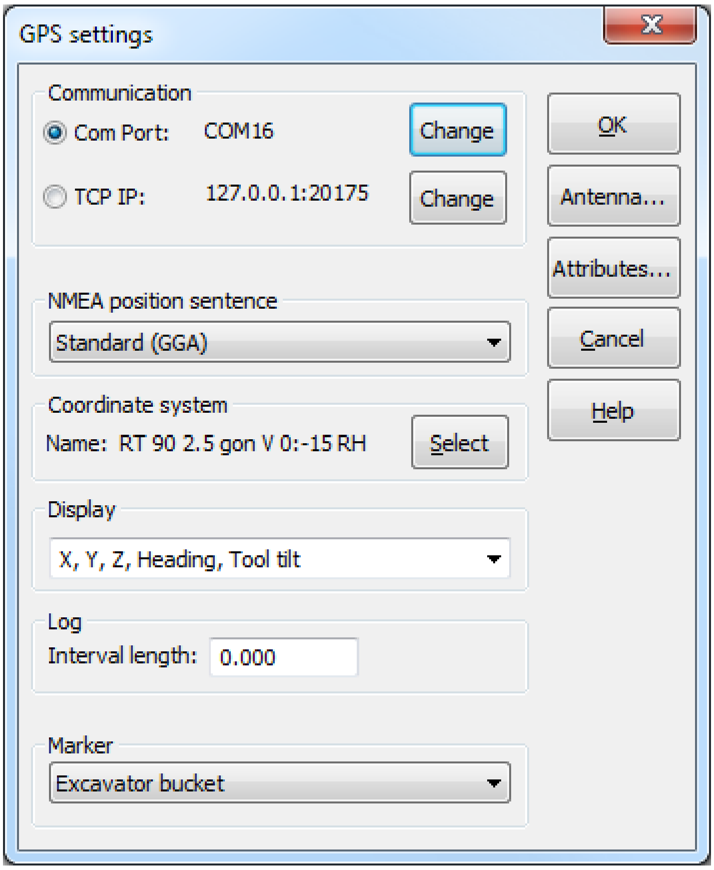

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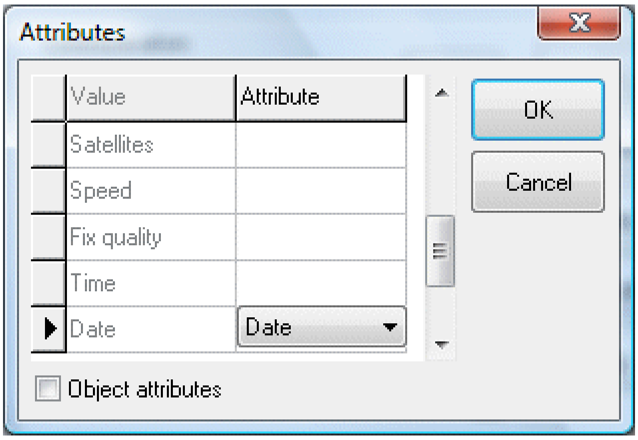

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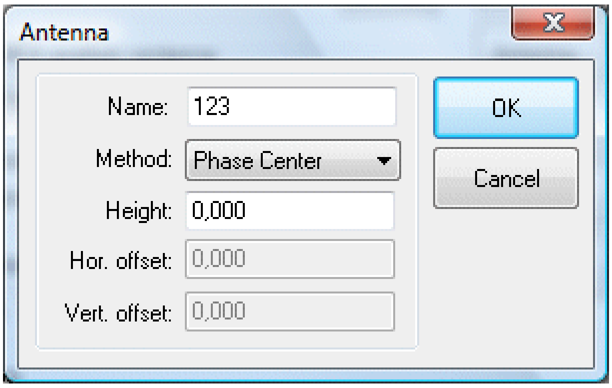

Select method.

Logging

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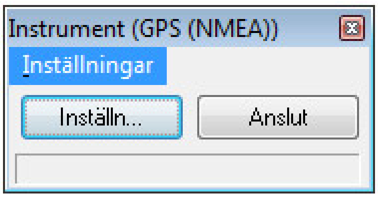

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Surface

Select: Enter area by clicking Select.

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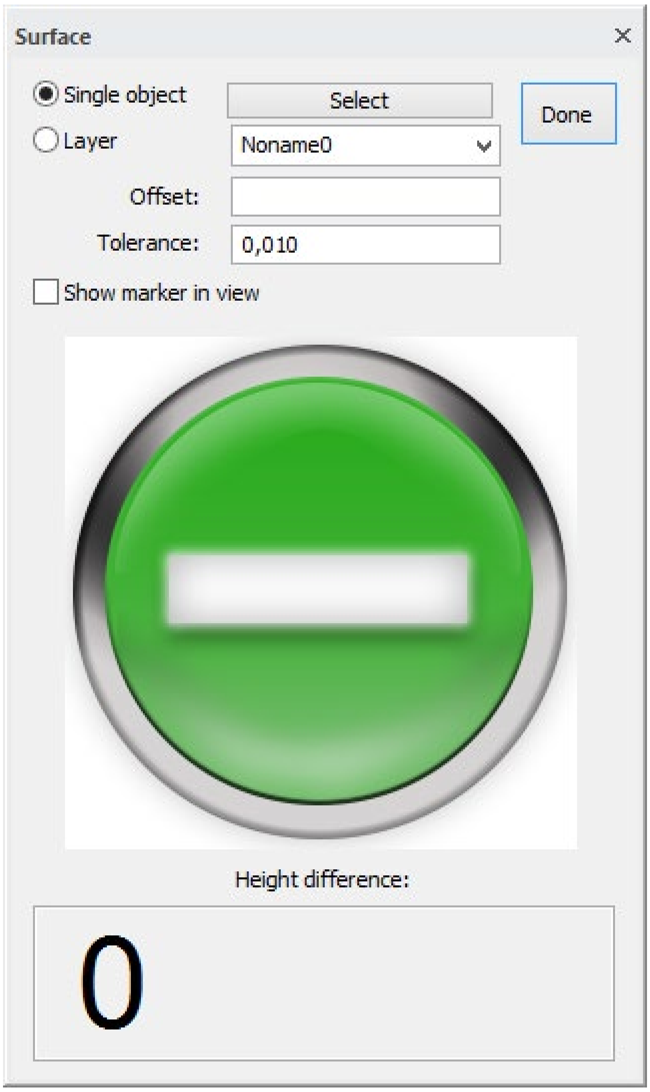


Digital terrain model contents

Terrain model .DTM
Drawing|Terrain

Function	Document	Description
Move point	DTM	Move dtm point in plan or in height
Delete point	DTM	Delete point from dtm. Point still exist in drawing.
Move	DTM	Move digital terrain model in height.
Erase	DTM	Erase triangle - triangle will go from active to passive.
Restore	DTM	Triangle mode goes from

		passive to active.
Swap	DTM	Swap triangles. Changes the digital terrain model.
Extract	DTM, TOP	Extract parts of dtm using a window or polygon
Merge	DTM, TOP	Merge two digital terrain models to one. First selected dtm is primary.
Display	DTM	Colour of triangles, measured lines, hidden (erased) triangles, contour lines and direction arrows are set.
Statistics	DTM	View statistics from digital terrain model.
XRef	DTM	Use external references as background data to the digital terrain model.
Coordinate system	DTM	Change coordinate system.
Log	DTM	View document log.
Raster	DTM	Insert and modify raster pictures.
3D view	DTM	DTM - View - 3D view of digital terrain model in seperate window.
Create DTM	TOP	Create digital terrain model frpm selected objects
Extract	TOP, DTM	Extract parts of dtm using a window or polygon
Merge	TOP, DTM	Merge two digital terrain models to one. First selected dtm is primary.
Update	TOP	Update existing dtm with one or many objects
Extrude	TOP	Create one or many digital terrain models using one or many polylines
DTM Heights	TOP	Several funtions for using heights in digital terrain models and point clouds
Contour	TOP	Create contour lines in drawing
Contour Text	TOP	Create contour text from

		selected locations
DTM Calculation	TOP	Calculate volumes between two digital terrain models, point clouds or tunnel digital terrain models
DTM Slopes	TOP	Calculate volumes using slopes
DTM Sections	TOP	Calculate volumes using cross sections

Edit DTM

Terrain|Edit

In Terrain - Edit, there are several commands to edit the terrain model.

Move Point

It is possible to edit and move points in all directions and also to give them a point code. You can also delete a point in the DTM. It will only be deleted in the DTM and not in the drawing.

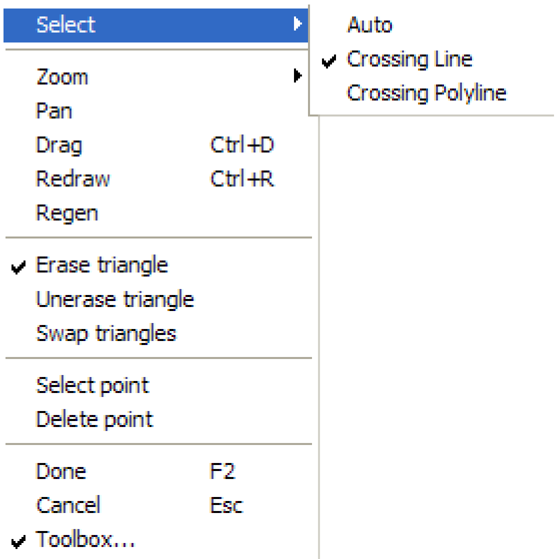
Delete Point

Unerase - Create new triangle
Point to a triangle outside the DTM to create a new triangle. An easy way to do this is to go to View in the DTM and display Deleted triangles.

Erase triangle
Click inside the triangle you want to delete.

Swap triangle in the DTM
To rotate two triangles inside the DTM click inside two triangles which have the same baseline.

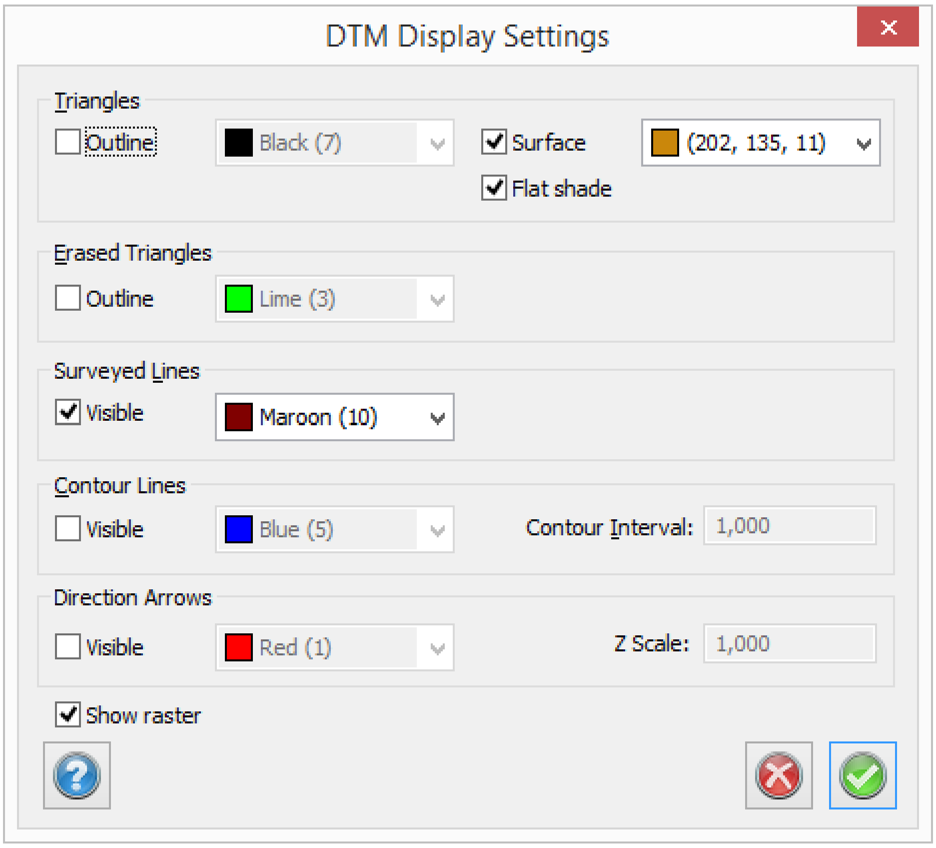
Pop-up menu
Right click on the terrain model and a pop-up menu will appear for the command. Create or erase triangles with line or polyline by selecting Select|Crossing line and Select|Crossing Polyline.



Display

Select *Display*

1. Click OK when you are ready.



Direction Arrows

The direction arrows display slopes of the triangles in a terrain model. The direction arrow of a triangle starts from the middle point of the triangle and points to the direction of the slope. The length of the arrow depends on how steep the slope is and also the scale of the height.

You can view Triangles, Erased Triangles, Surveyed Lines and Contour lines. This makes it easier to understand what you are looking at and what you can edit.

Triangles

Select if required and choose which color you want to use for created triangles. We recommend that black is used for created triangles.

Erased triangles

Select if required and choose which color you want to use for erased triangles. These triangles are not actually in the DTM but can easily be created. It is also easy to delete a created triangle and these will then appear in the color you select here. We recommend that grey is used for deleted triangles.

Surveyed Lines

Select if required and choose which color you want to use. If you edit the Digital Terrain Model on top of your drawing you will also see the drawing underneath.

Contour Lines

Select if you want to see where contour lines will be created. Choose which color you want to use for this. You can also select the intervals at which the contour lines will be displayed. Note that this does not create contour lines; it just shows a preview of what they will look like.

Edit DTM

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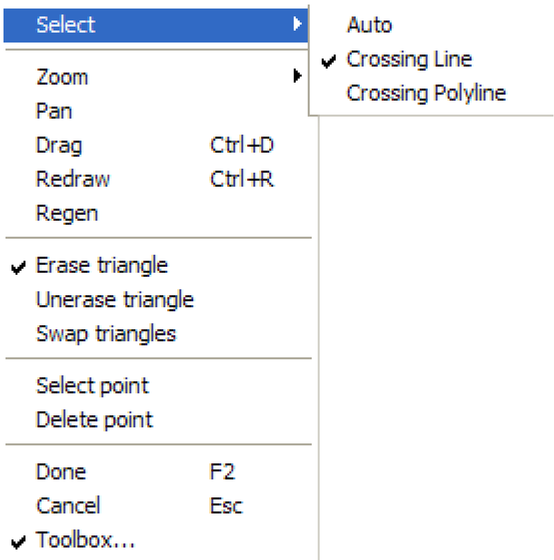

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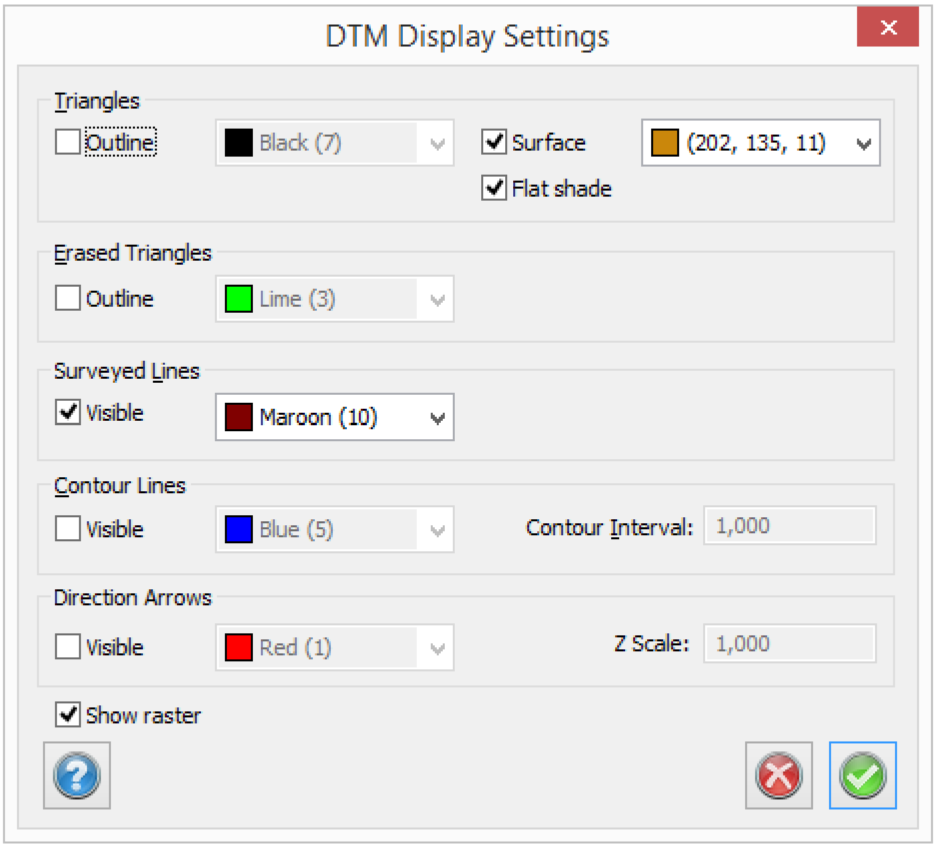

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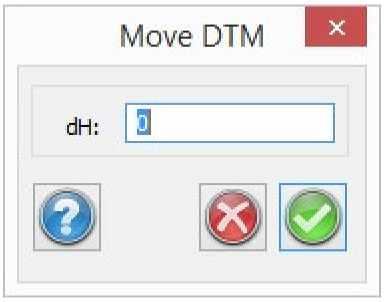
Move DTM

Terrain|Move

Shortcut key Ctrl + M

This command can be used to move the height of the terrain model. Moves the complete DTM.



Edit DTM

Terrain|Edit

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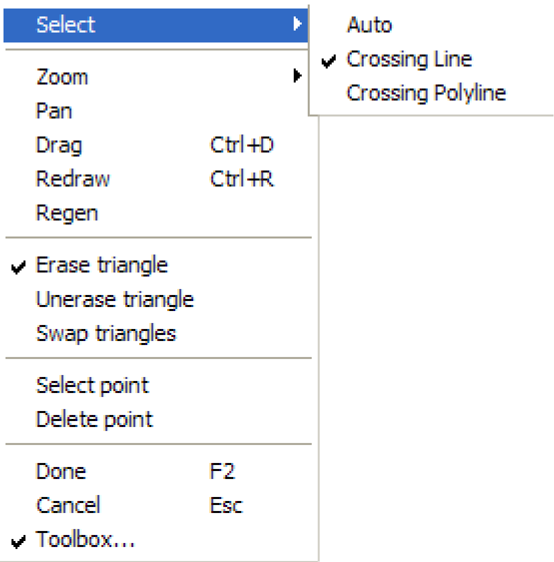

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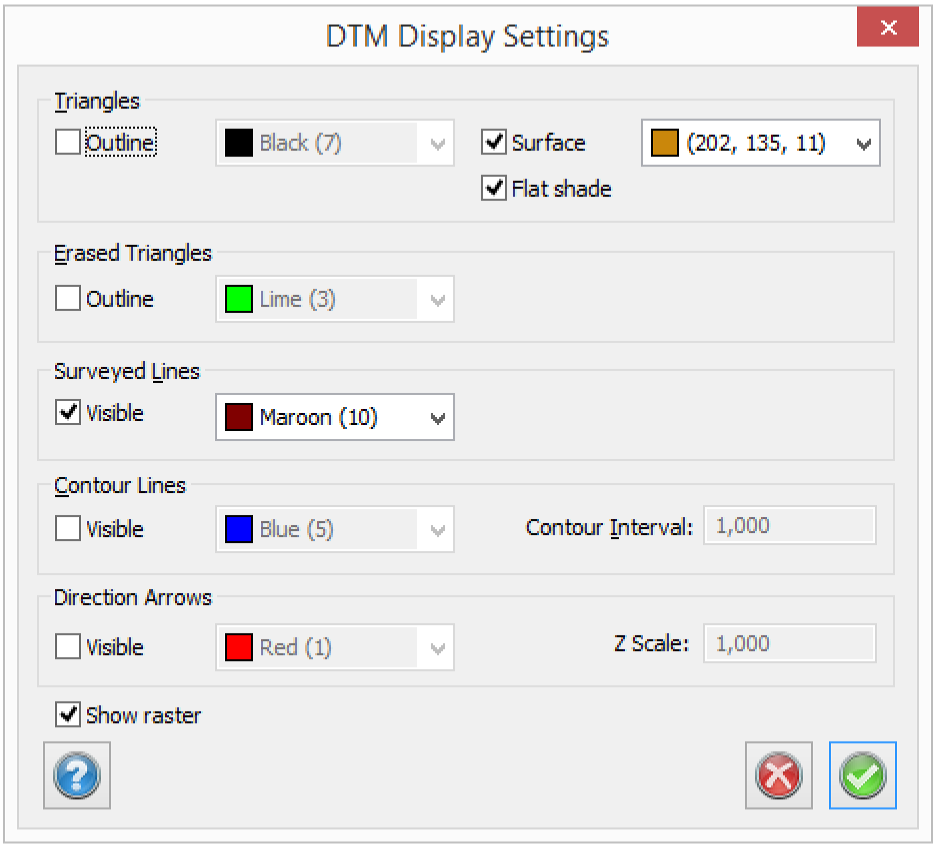

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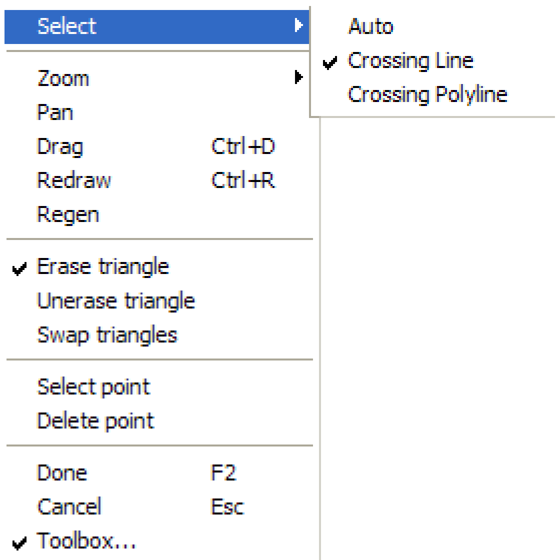

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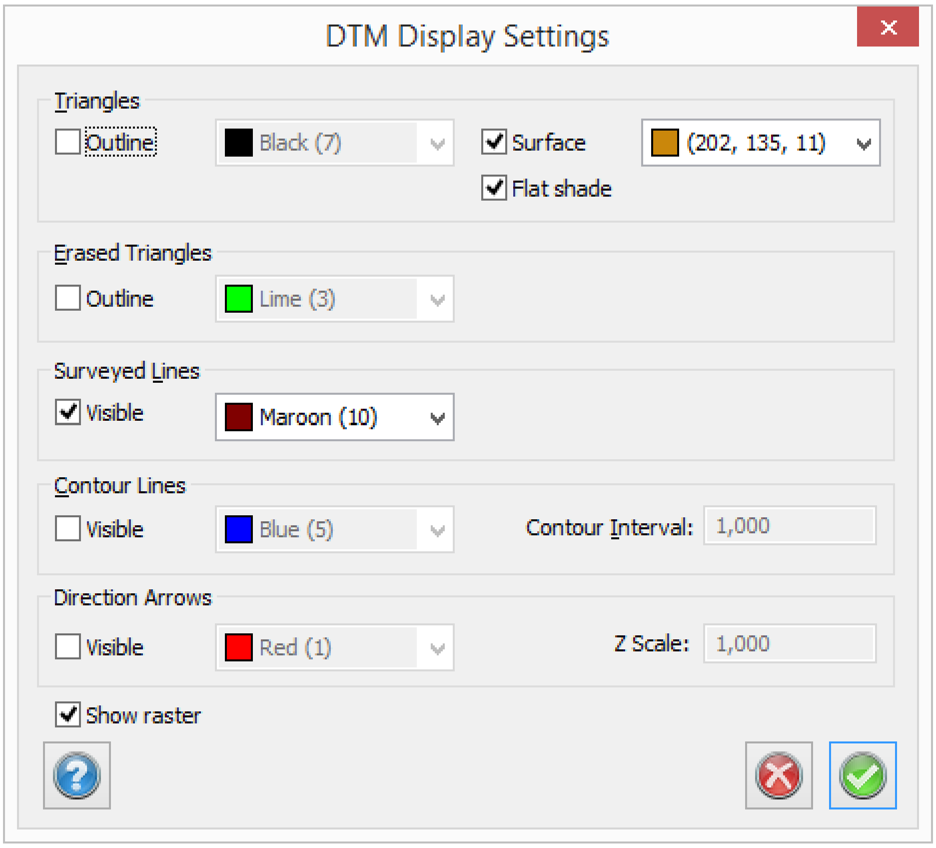

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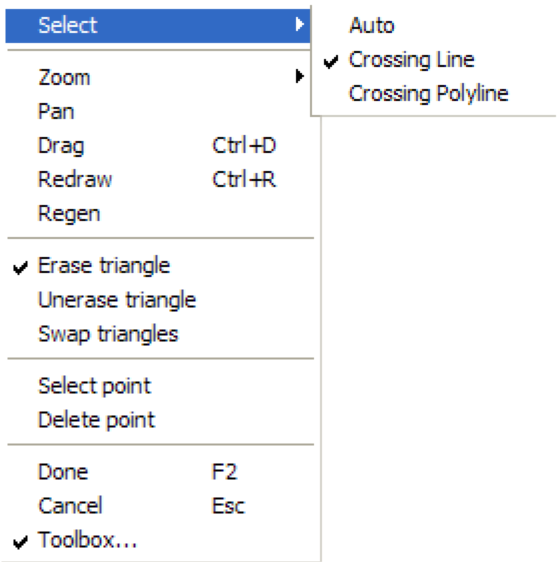

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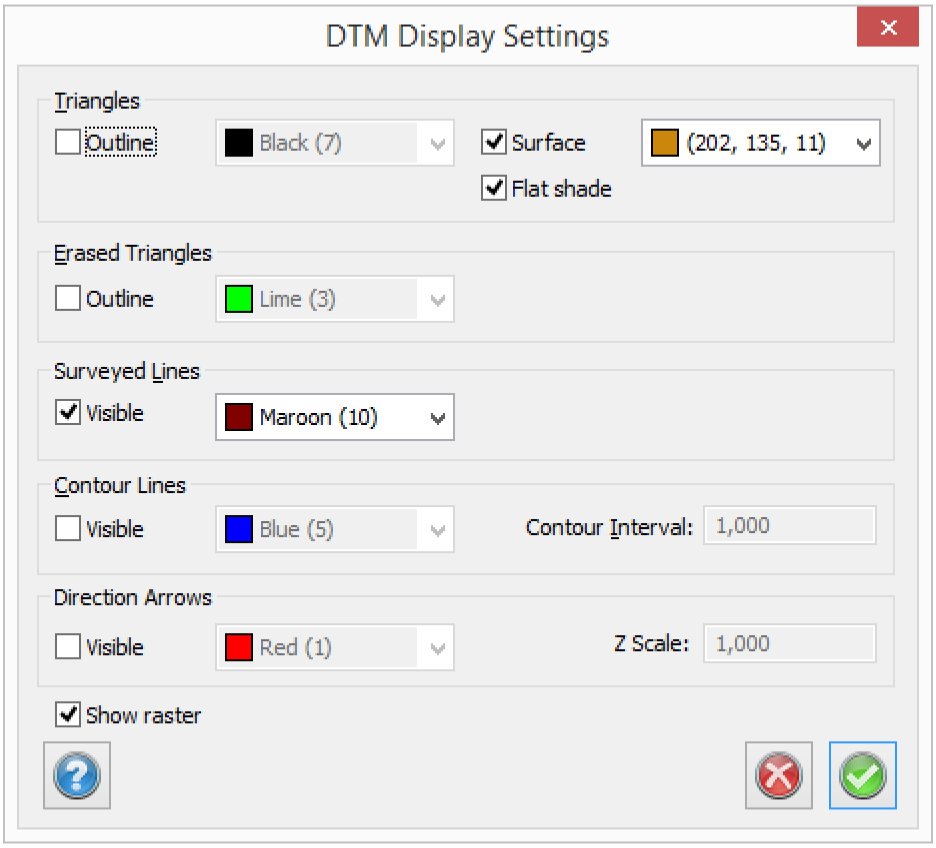

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Water simulation

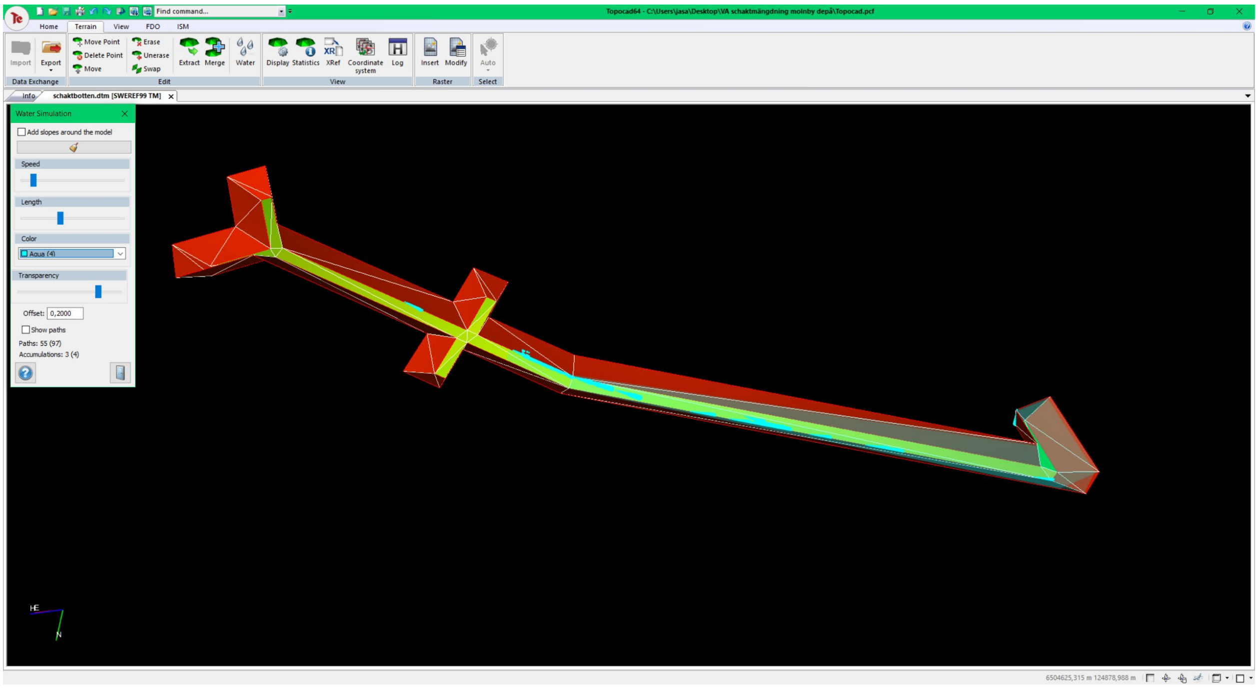
Drawing | Terrain | Edit | Water

A function where you simulate water on a terrainmodel for to see where the water goes.

You have settings for speed, transparency, colour, thickness and if only the drops or the path of the water will be shown.

Open a DTM to a terraindocument or select a DTM from a drawing to analyze.

From the drawing you can save the water accumulation.

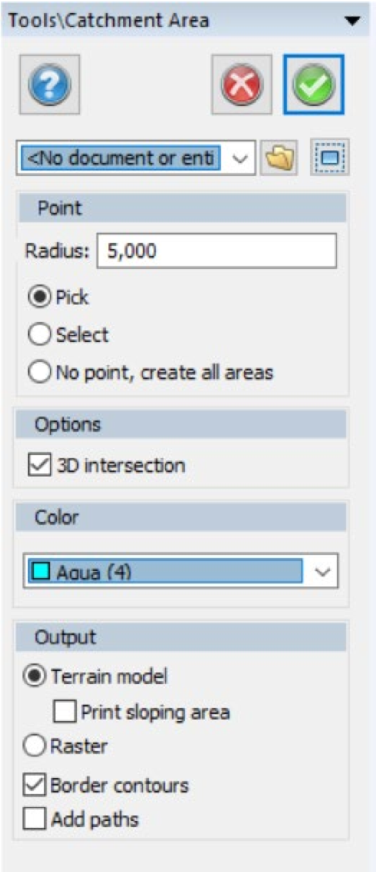


Keywords: Water simulation, Water on DTM, Pour water on DTM

Catchment Area

Drawing | Terrain | Tools | Catchment Area

Funktion som analyserar en terräng och delar upp den i avrinningsområden. Välj först vilken terrängmodell som ska analyseras.
Function that analyzes a terrain and divides it into catchment areas. Firstly choose the terrainmodel to be analyzed.



Point

Radius
Input the radius of choosen point, to be the area to analyze water paths to.

Pick
Pick a point to be the center of the circlearea which water paths will be analyzed to.

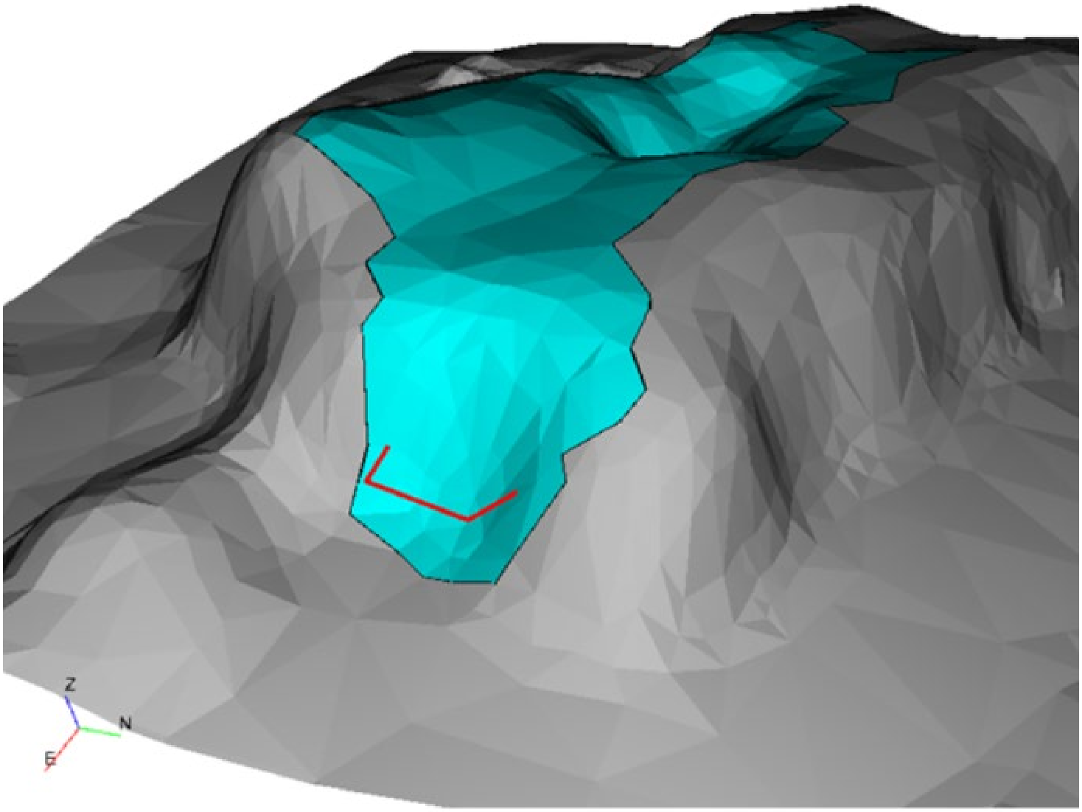
Select
Select a point in the drawing

No point, create all areas
Analyze catchment areas for the whole terrain model.

3D Intersection

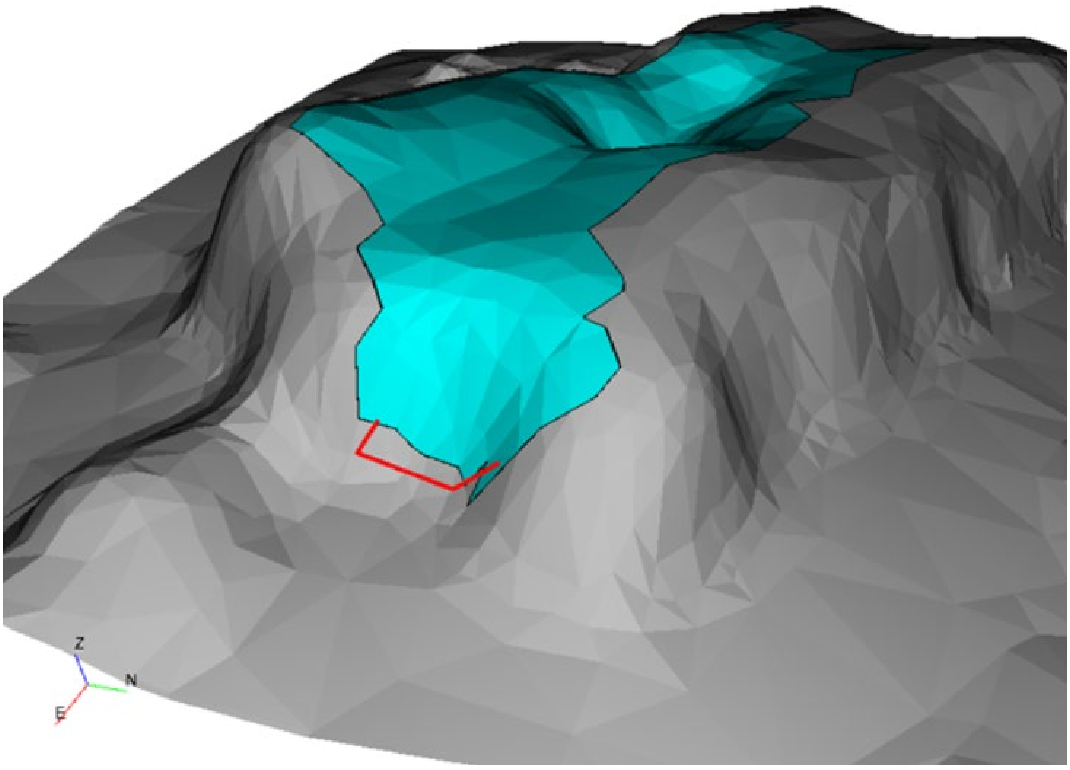
without 3D intersections

If 3D intersection is not active the triangles over and under the chosen point will be analyzed.



with 3D intersections

If 3D intersections is active only triangles above the chosen point will be analyzed.
This suits for analyzing if water flows to a point on a mountainside for example.



Colour

Pick colour for catchment area to chosen point.

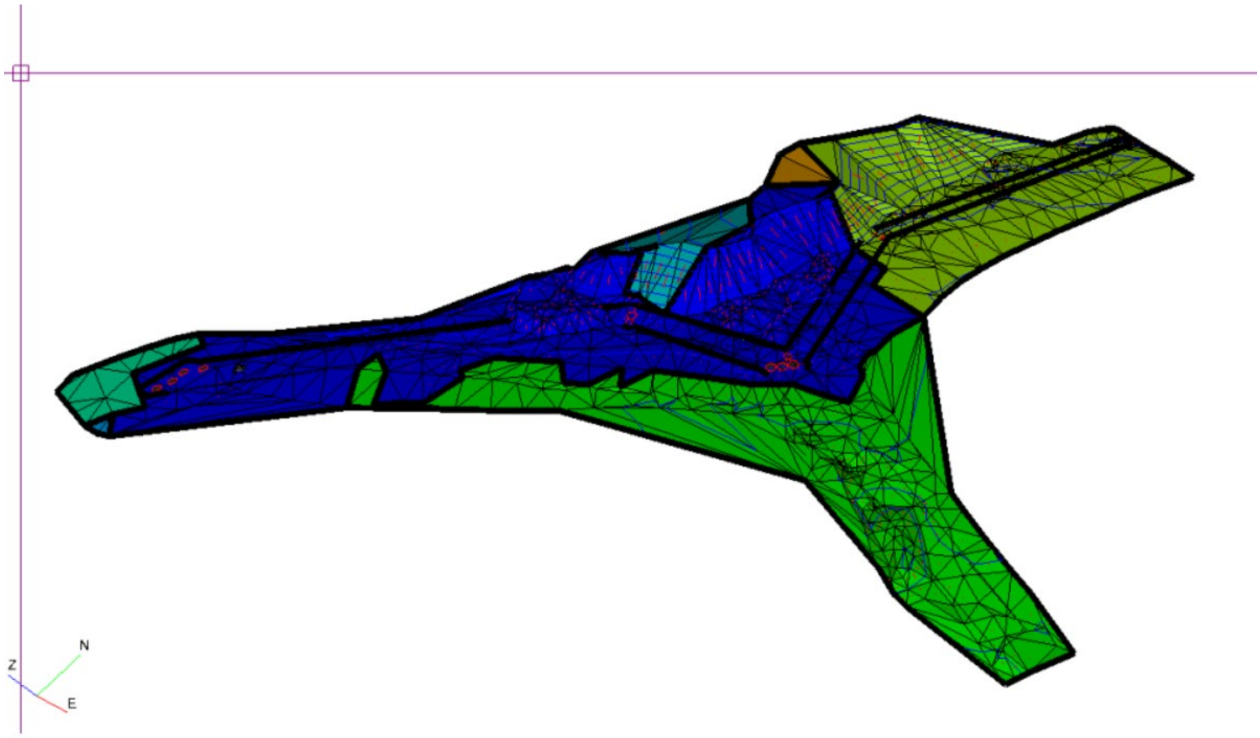
Output

Terrain model
Output terrainmodels of different colours for each catchment area.

Print sloping area
Get area in text for each catchment area.

Border contours
Creates lines around each catchment area, this can be used for many other purposes.

Add paths
Lines in blue are drawn to represent simulated flow of water.

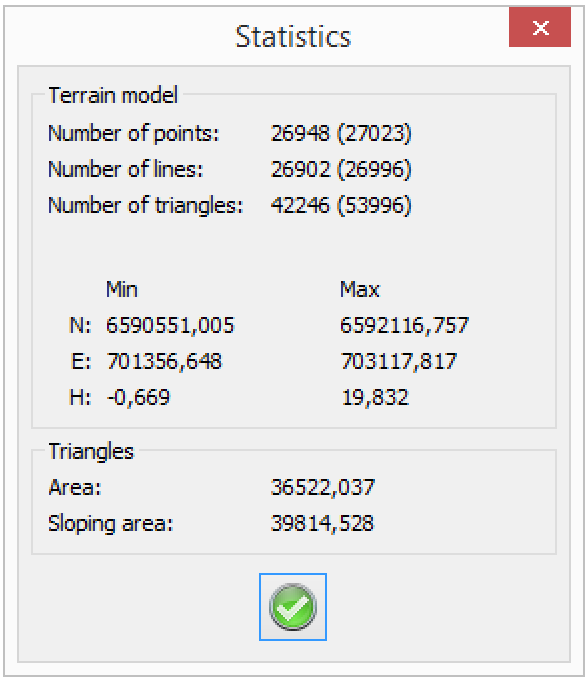


Nyckelord: Hälla vatten på terrängmodell, Avrinning på DTM, DTM avrinning, DTM hälla vatten, Vatten

Statistics

Terrain|Statistics

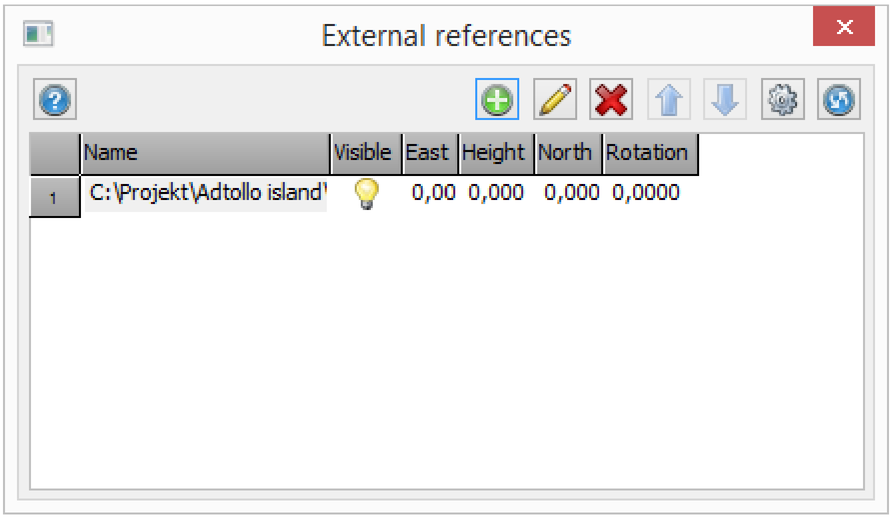
Statistics of the DTM, showing the number of points, triangles and lines and the minimum and maximum X, Y, Z values in the DTM.



External references in DTM

Terrain|XRef

This command is the same as that for external references to the drawing. It adds one or more drawings as background files for editing the DTM.



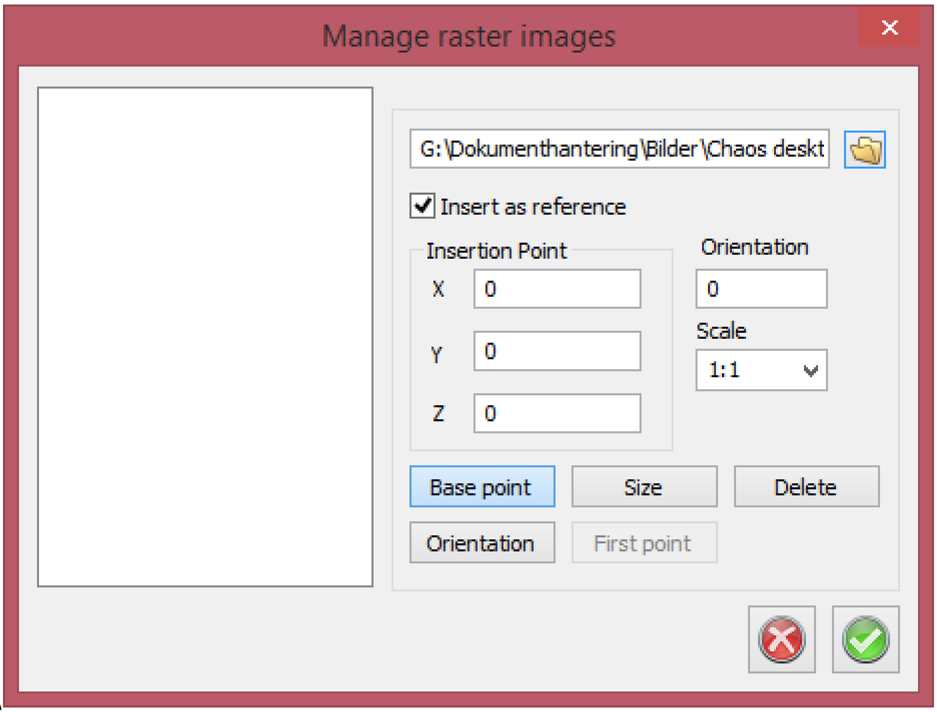
See also

External references for the drawing.

Modify raster in digital terrain model

DTM|Modify raster

Raster images can be imported into DTM documents just like Topocad drawings. In the DTM menu you find the command "Modify raster". A file dialogue appears when the command Modify raster is activated. Here you are able to import one or several images into the terrain model. If more than one file is selected will images with georeferenced data be inserted in the positions according to the georeferenced data. Remaining images will be inserted at origin. If only one file is selected a new dialogue appears.



Enter the images position, orientation and scale. The data can either be typed in or by clicking the DTM view. The data will already be entered if georeferenced data is available for the file. If Insert as reference is checked, only the file name will be saved in the DTM file, or else the raster image will be included in the DTM and the file will require much more space.

Raster images inserted in a DTM document can be modified in the same command.

There is a list to the left of the dialogue, listing the raster images inserted in the DTM document. By selecting an image in the list, the position, orientation and scale is entered in the same way when a new image is inserted. It is also possible to delete raster images from the DTM document in this dialogue.

3D View

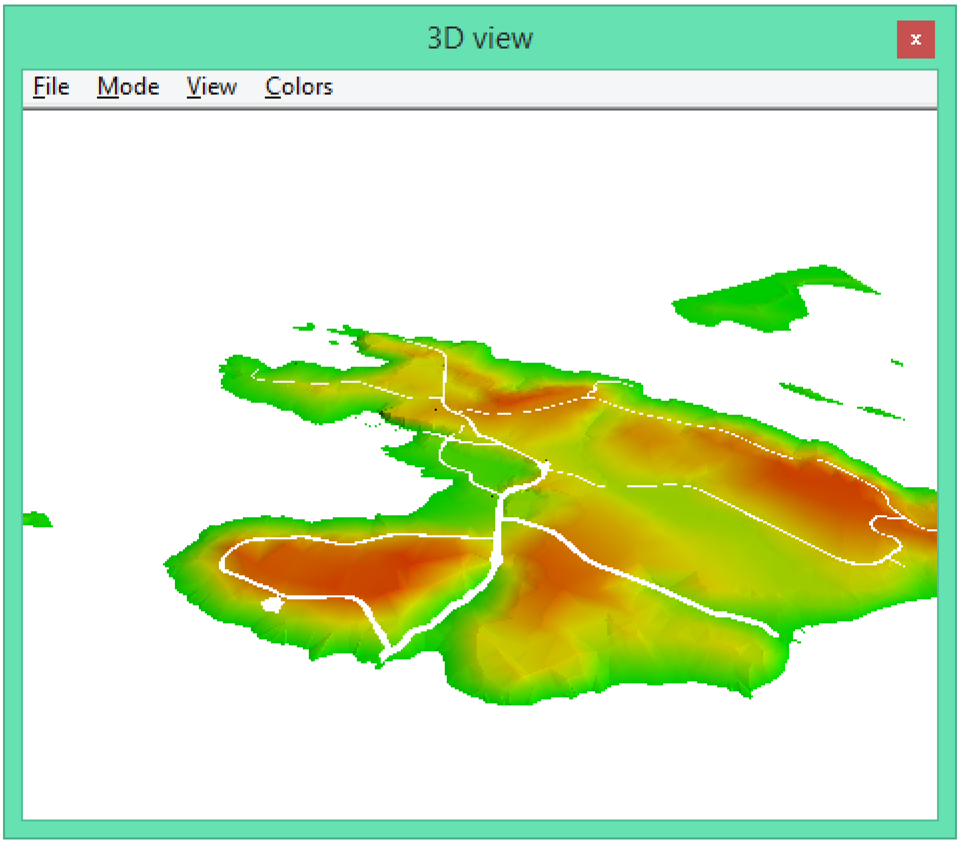
Terrain|View|3D view

Terrain models (DTMs) can be displayed in the 3D view. The object can be rotated and panned in three dimensions so that you can view the object in perspective.

The DTM is selected and displayed in 3D view. It is possible to display just a small part of the DTM in 3D. The command is accessed from *View|3D View*.

Also symbols can be viewed in 3D.

Explanation of the menu



File

Add Ctrl + A
Adds another DTM or tunnel DTM to the view. This command is not active in the 3D view of drawings.

Remove Ctrl + R
Remove DTM

Save image Ctrl + S
Saves the image in bmp format.

Mode

Wireframe Shift + W
Displays a wire model with triangles and measured lines.

Flatshade Shift + F
Displays the surfaces in the model without the wireframe.

Outlined Shift + O
Displays the surfaces and network at the same time.

Alpha blending Shift + A
Alpha blending puts a filter on the colours to make them softer.

Smooth shade Shift + S
Smoothes the triangles in the DTM.

View

View|Zoom|Extents Shift + Home
Zoom extent of current selection.

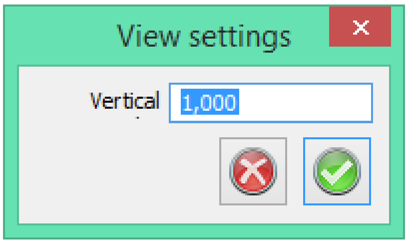
Triangles Shift + T
Views the triangles in the DTM.

Surveyed lines Shift + L
Displays the measured lines in the terrain model.

Erased triangles Shift + E
Displays the erased triangles.

Set Z scale

You can set a Z Scale in the View menu.



Colors

Gray Shift + G
Views the DTM in grey.

Thermic Shift + C
Views thermic colors - the colours are sorted into darker colors (dark blue) at the bottom for lower heights and brighter colors (yellow) for the higher parts.

By code Shift + B
The colors are created from the code table.

Raster image
Displays inserted raster image. See also DTM document.

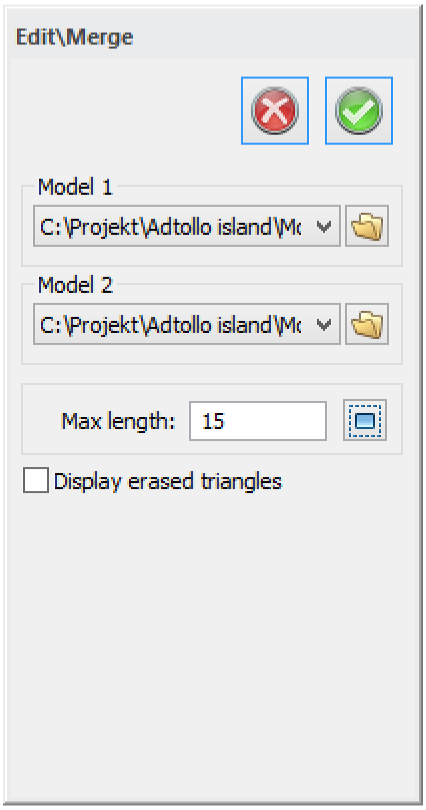
Merge DTM

Addons|DTM|Merge DTM
DTM|Merge DTM

This command can be used to merge two DTMs together. This creates a third DTM.
The command can be selected from the drawing and from the DTM window.

Merge from drawing

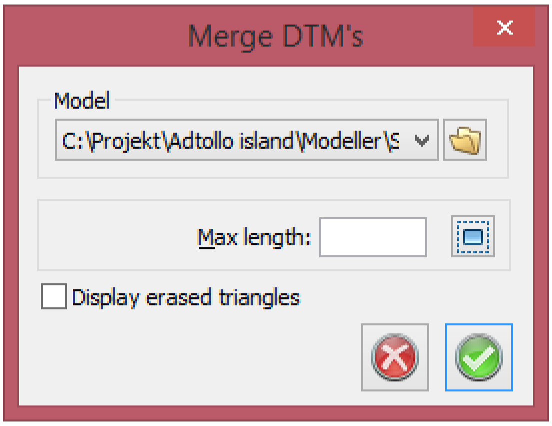
Select *Merge.*



Select the two DTMs to be merged. Enter the maximum length of the triangle leg.
If the terrain models overlap, the first DTM is the valid one.

Merge from DTM

Command *Merge*



The current DTM will be merged with the selected one.

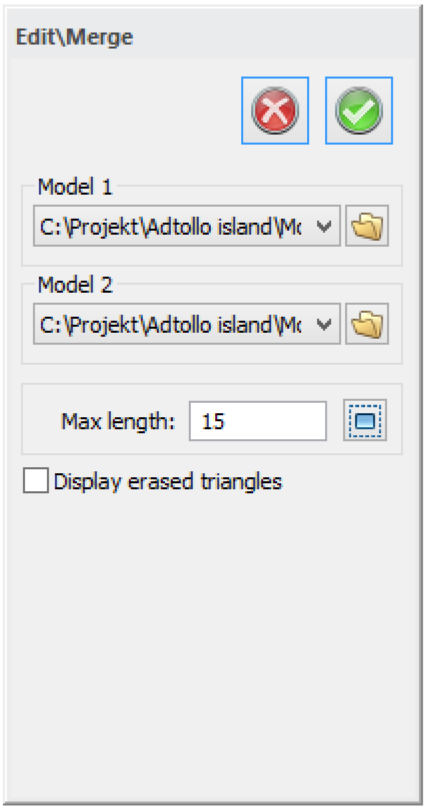
Merge DTM

Addons|DTM|Merge DTM
DTM|Merge DTM

This command can be used to merge two DTMs together. This creates a third DTM.
The command can be selected from the drawing and from the DTM window.

Merge from drawing

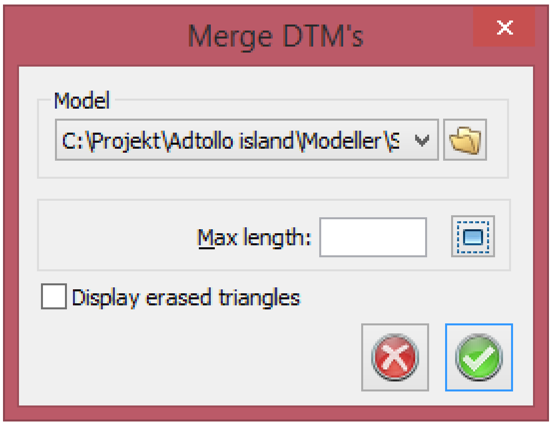
Select *Merge.*



Select the two DTMs to be merged. Enter the maximum length of the triangle leg.
If the terrain models overlap, the first DTM is the valid one.

Merge from DTM

Command *Merge*



The current DTM will be merged with the selected one.

Import and export DTM

DTM||Import/Export

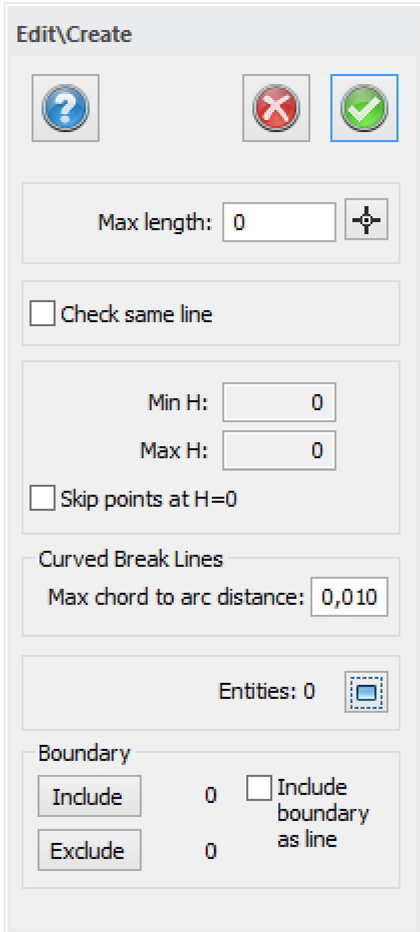
Terrain models can be exported to LandXML and 3D Surface in AutoCAD. These formats can also be imported.

The export is carried out by opening a DTM and selecting *Export|File* - or *LandXML*. See more about LandXML export.

An import is carried out by opening a new DTM file and selecting *Import|File* or *LandXML*. Data from LandXML can be imported in two ways: directly to the document or by importing from the LandXML format.

Create DTM

Drawing|Terrain|Create DTM



The DTM (Digital Terrain Model) can be used for various calculations, e.g. volume calculations and contour lines. The Topocad DTM is a triangle model which creates a triangle using the three closest points in each case. However, there are some exceptions.

The result will be a set of triangles: from above they look like just triangles, but each point will have a height attributed to it.

Select object:
Select the objects you want to use to create a DTM. To select objects, see Select entities

It is possible to hide, freeze or make layers invisible to ensure that the wrong objects cannot be selected. It is important that you do not select co-ordinates with a height of zero as this will create a gap in the DTM.

Max. length:
This length limits the maximum length of a triangle side on the outer side of the model. Triangle sides that are longer than this will not be included in the model. This is a quick way to limit the editing of the model. You can either type in a value, or select one by clicking in the drawing. Click on two different points. The length between them will be the maximum length:

Check same line:
By default this is unchecked. This limits the triangle so it is impossible to create a complete triangle with all three points on the same surveyed polyline. It will also calculate using polylines as break lines.

Max. Z/Min. Z:
This displays the maximum and minimum heights of the selected objects.

Skip Z = 0
Selecting this box will exclude all points which have a height of 0. (These will usually be theoretical points).

Curved break lines
This feature is used to calculate break lines in the DTM. It divides the radius at various intervals so that each one can be used to calculate triangles. Creates really accurate models.

Polygons
You can choose to include or exclude polygons.

Boundary
If the box "include boundary as line" is checked, the selected (if there are any) boundary will be included as a line in the model. The boundary's points will be included as points in the model if the box is unchecked. When the boundary is included, the Z values collects from the boundary. If the boundary includes as points, the Z values are calculated on the basis of the model, as the models looks before it cuts off at the boundary.

See also:

Edit DTM

Note:
When creating the DTM, check that it does not contain duplicate points as this can create errors. If you have trouble creating a DTM, you can export the objects to a co-ordinate file and then import it to a new blank drawing and create the DTM from that.

Extract DTM

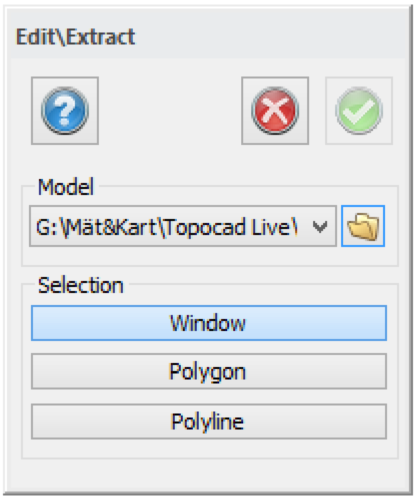
Drawing|Terrain|Extract DTM
Terrain|Extract DTM

Extract terrain model

This command is used to divide the Digital Terrain Model (DTM) into smaller sections. The command can be selected both from the drawing and from the DTM file itself. The commands are not the same.

From the drawing (TOP)

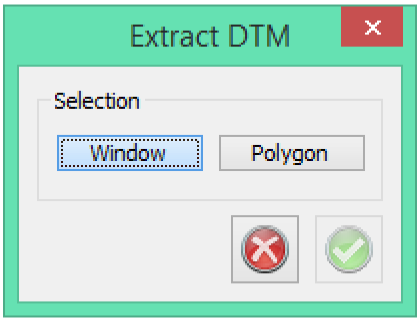
Select *Terrain|Extract DTM*



Select the terrain model. Use a window or polygon, or select a polyline where you want to make the extraction. Click OK.

From the terrain model window

Select *Terrain|Extract DTM.*

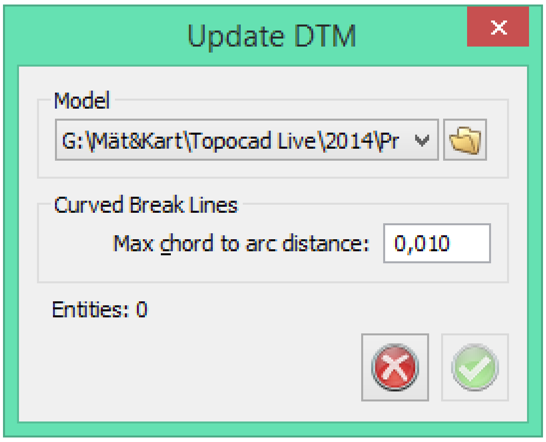


Select the terrain model. Use a window or polygon where you want to make the extraction. Click OK.

Update DTM

Drawing|Terrain|Update

The DTM can be updated with new lines and points.

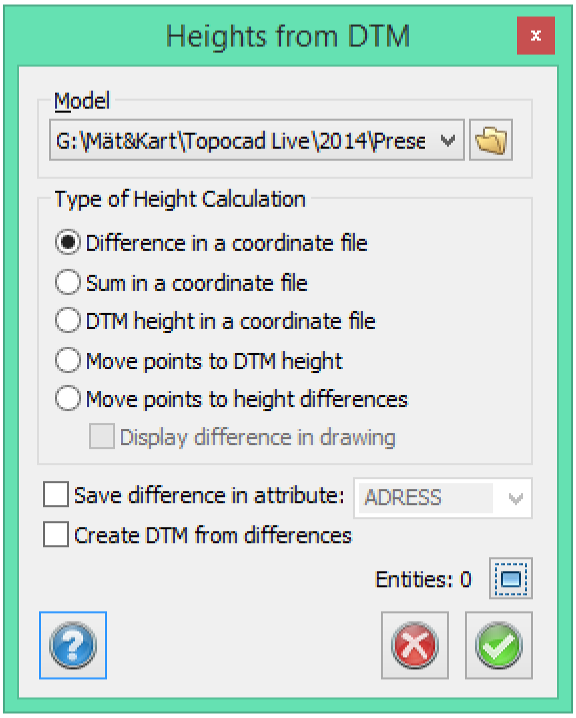


Select Terrain|Update. Select the terrain model. Select the objects that you want to use to update the model. The settings made when you created the DTM are still valid: there is a maximum length for the triangle's side and Z=0 is not a permissible value.

It is only possible to update the DTM within its origin area.

Heights from DTM or Point cloud

Drawing|Terrain|DTM Heights/Point cloud



There are several ways to get the heights from a DTM or a Point cloud.

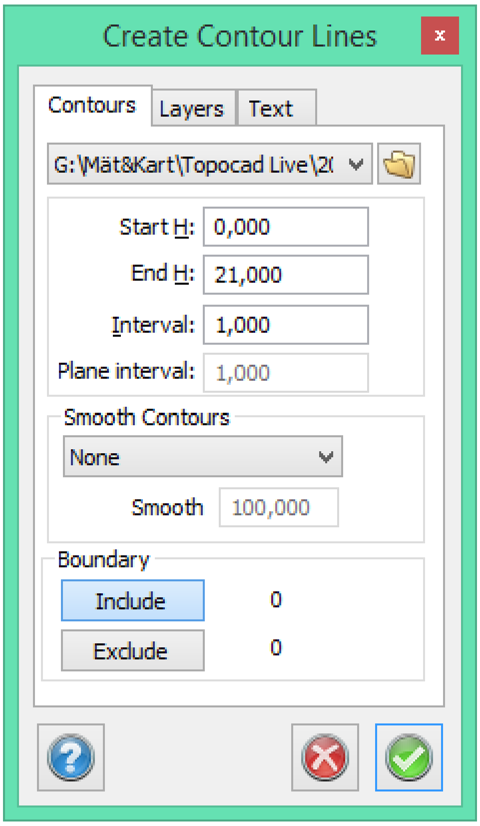
- Take the difference in heights of the selected object(s) in the DTM/Point cloud and save it to a co-ordinates file.
- Take the sum of the heights of the selected object(s) in the DTM/Point cloud and save it to a co-ordinates file.
- Take the heights of the selected objects from the DTM/Point cloud and save them to a co-ordinates file.
- Move points from the selected object(s) to the DTM/Point cloud .
- Move points to height differences.

You have to select the DTM/Point cloud to use before you begin. You can select an existing DTM/Point cloud by using the drop-down arrow or the Browse button.

Create contours

Drawing|Terrain||Contour

Contour lines will be created from a DTM or a point cloud with a selected interval. It is possible to split the elevations into separate layers for different levels. There are also various ways to smooth out the contours.



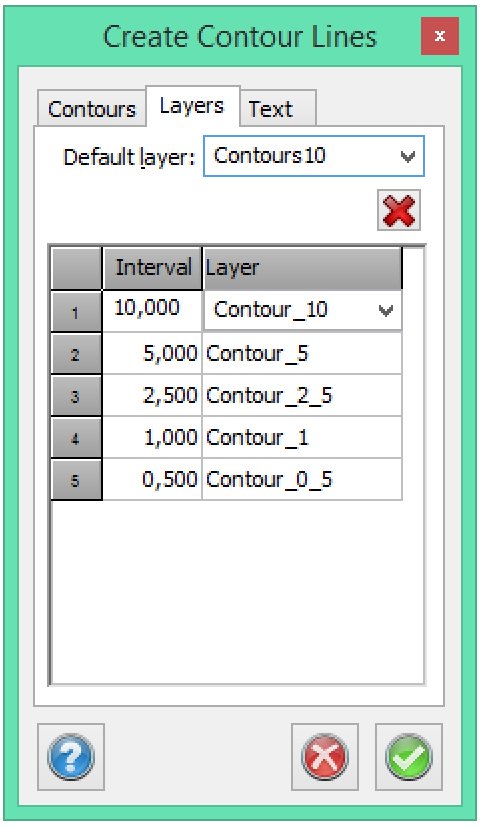
Model
Select the DTM/point cloud you want to create the contour lines from. By clicking on the drop-down arrow you can choose from the DTMs currently listed in the DTM manager. By clicking on the Browse button you can choose from all of the stored digital terrain models.

Interval
Enter a value for the interval you want to use to create the contour lines.

Plane interval
Determines how close it is between points in the point cloud. (1.000 = 1 m) The distance is important to get good contour lines and should be slightly larger than an overall distance of the point cloud.

Smooth contours
There are four ways to smooth out the contours. Three involve creating splines and one uses the radius. If using the radius you need to enter a factor. Anything between 50 and 400 is acceptable.

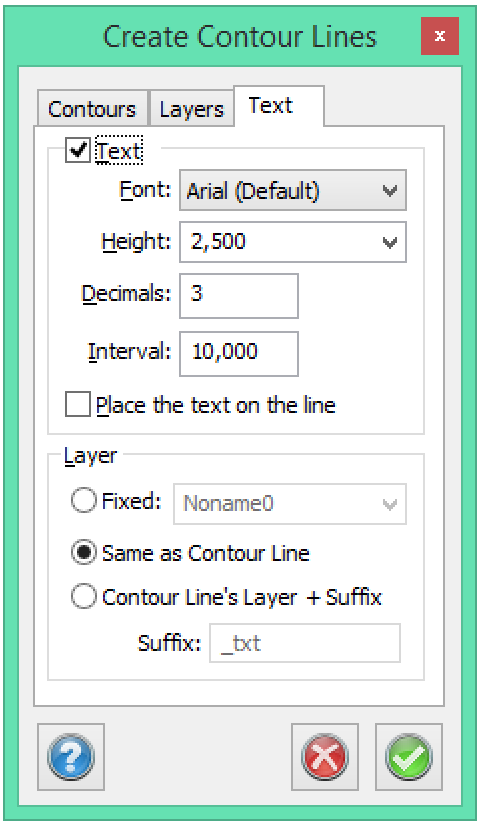
Layers



Default layer
You can select a default layer which is used for any elevation that does not have a specific layer.

Interval/Layer
Define which elevations are to be moved to a specific layer and name each layer. It is possible to use the default elevations and layer names.

Text



This command allows you to place text on the contour lines. Text is displayed at a specified interval along the contour line. Text can be placed either on or above the line.

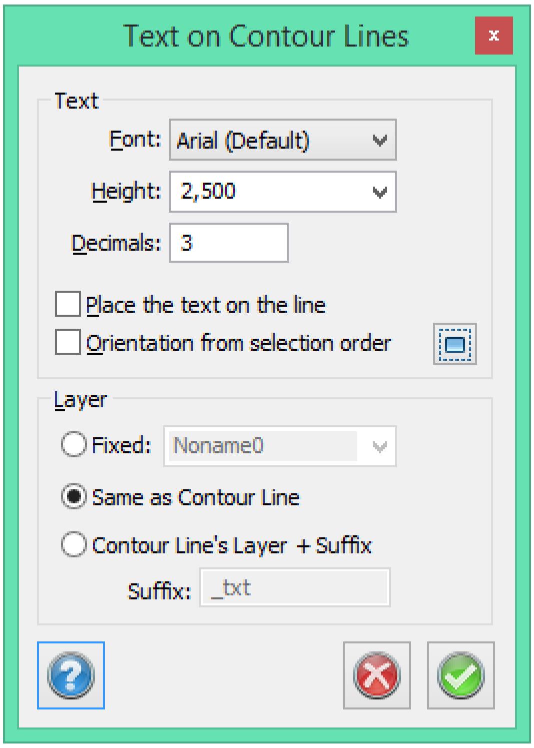
See also

Text on contours
Create DTM
Modify DTM.

Text on contour lines

Drawing|Terrain|Contour Text

It is very easy to enter heights for contour lines, or even for all lines that appear in the drawing. You need to define the font and text height, which layer to put the text in and where the text should appear.



By default the text will be placed above the contour line. If the area is flat, the text will be placed in the direction indicated. You can also tick the "Orientation from selection order" box, which will create text in the direction indicated, from bottom to top.

Font
Select which font you want to use for the heights.

Height
Select the height in millimeters that you want to appear on the drawing.

Decimals
Enter the number of decimal places to display.

Layer
It is possible to select different settings for layers:

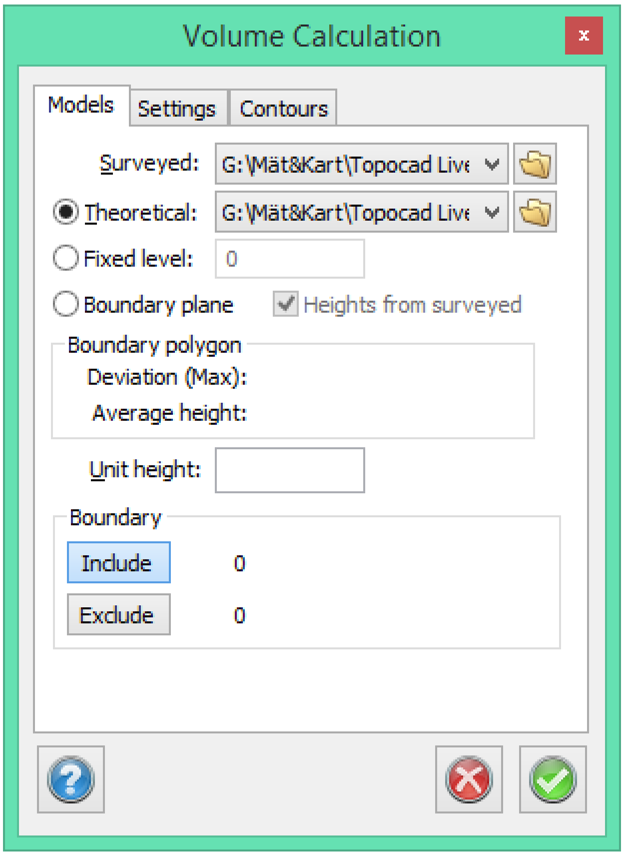
- · Fixed layers: select a layer for the text.
- · Same as contour lines
- · Same as contour lines + suffix for the layer.

Select
Draw a hidden line across the contour lines. The heights will be placed where the lines cross.

Calculate volumes between two DTMs

Drawing|Terrain|DTM Calculation
Terrain|DTM Calculation

The Volume model compares two digital terrain models with one another, or one model with a flat surface. The calculation is made using a grid and calculates the height differences between two models.



To calculate the volumes between a terrain model and a fixed surface you need

- A created terrain model (DTM) or a point cloud (.TPC)
- A level to calculate from.
- If required, polygons can be used to limit the area to be calculated.

To calculate volumes between two terrain models you need

- Two created digital terrain models (DTM) or point clouds (.TPC).
- If required, polygons can be used to limit the area to be calculated.

Explanation of the dialogue box

Surveyed (models)
Measured model or soil model.

Theoretical
Theoretical model or rock model. Bottom model.

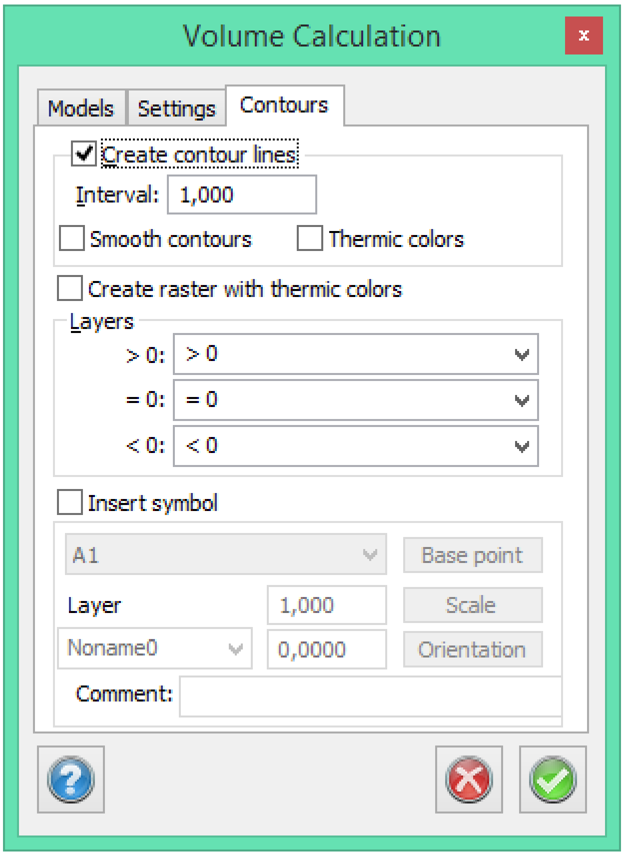
Fixed level
It is possible to use a fixed level for calculations instead of a theoretical model.

Boundary plane
Draw a polygon around the height to be volume calculated. Select Boundary plane in the dialog and then select the polygon in the drawing. Tick box *Heights from surveyed* to move the polygon up/down to the surveyed level.
Deviation: Indicates the deviation in height.
Average heights: The average height of the line.

Unit height
This calculates the volume and area for a model that is situated at [Unit height] below the theoretical (bottom) model.

Boundary
A polygon can be used to include or exclude any areas that should/should not be included in the calculation.

Contours



Selected if you want to calculate different contours. Enter a distance or interval between contours.

You can select smooth contours if required (see also contour lines).

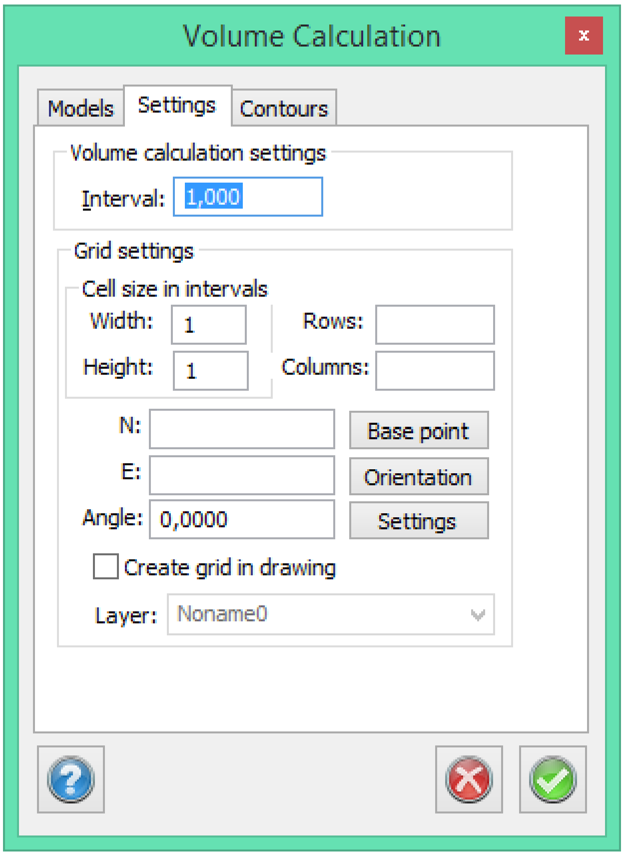
Thermic colours can be created both on contour lines and as grids (polygon quadrates). We recommend that you do not mix too much here.

Layers
> 0 = the measured DTM is above the theoretical model (fixed surface)
0 = the intersection between the two models.
< 0 = the measured model is below the theoretical model.

Insert symbol
Tick box to insert a symbol. Select the symbol from the list.
Base point: Select Base point to position the symbol at any point. If no selection is made, the symbol will be placed in the middle.
Scale: Change the size of the symbol.
Orientation: Change the direction.
Layer: Select which layer the symbol should be placed in.
Comment: Add a comment.

If you have a symbol inserted, you can then choose to add a link to the report, as an attribute to the symbol.

Settings



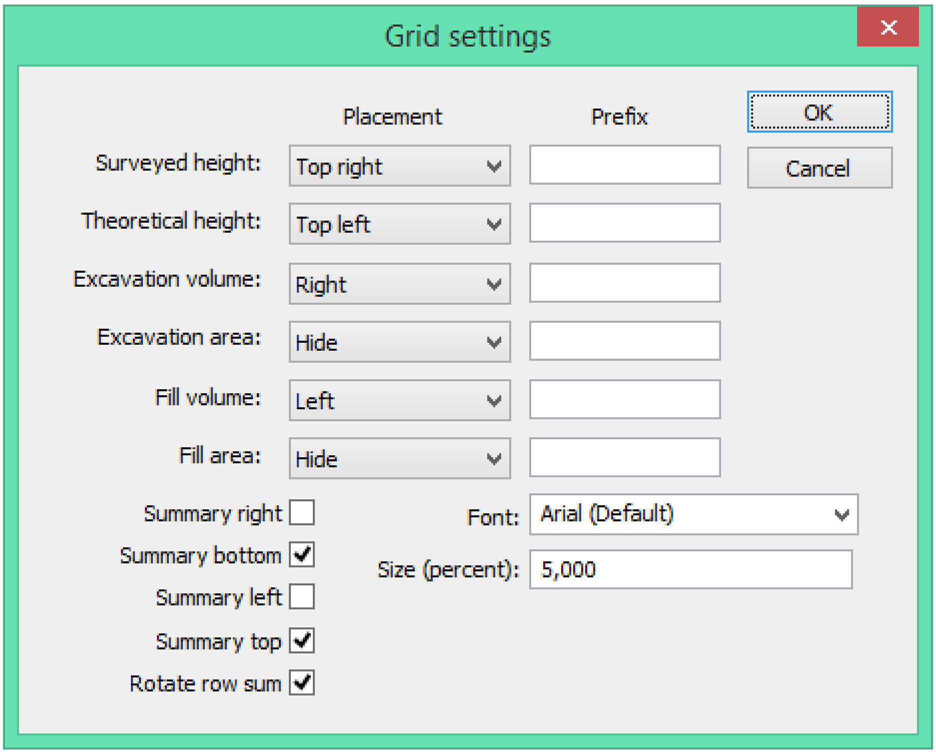
The accuracy of the calculation. The interval used to calculate the areas and volumes. The default value is 0.25 m which means that every m² is calculated using 16 points or distances. Reducing this value will slow down the calculation but produce a more accurate result.

Interval
4 is 4 meter

Grid settings
Cell size in intervals
W*idth, height:* The side of the grid's square is (4) x width (5) = 20 meters in this example.
Rows, Columns: Enter the number of rows and columns. Leave blank to fill the entire drawing.
X, Y: Leave blank to begin the grid in the lower left corner.
Starting point: Click the starting point to set the grids starting point manually in the drawing.
Create grid in drawing: Leave blank to show only the squares in the report.

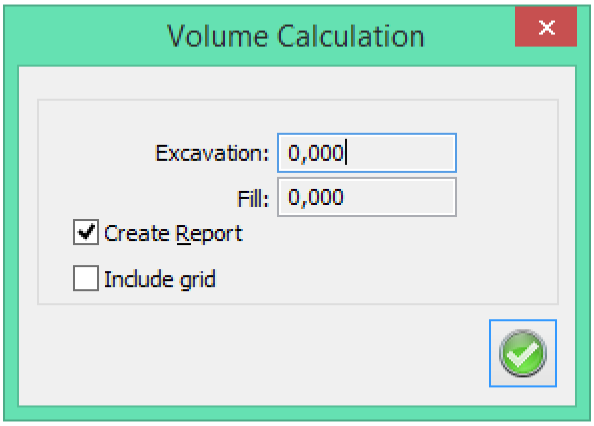
Settings

Select Settings button to open the following dialogue:



To place the values in the grid in the drawing, select from the options under *Placement*. To hide the values select *Hide*.
Enter a *prefix* for each value to help identify your different values.
Summary right: Check box to calculate the sum of each row and to print it at the right of the grid.
Summary bottom: Check box to calculate the sum of each column and to print it at the bottom of the grid.
Font: Select the font you want to use.

Create report



Select *Include grid* to add the volume calculation based on the grid in the report.

Report of volume calculation

Topocad

Sida 1 av 5

Volymberäkning

Filnamn: Namnlös6.top **Koordinatsystem:**

Mätt DTM : Markmodell.dtm
Teoretisk DTM : Bergmodell.dtm
Enhetshöjd : 0.000
Beräkningsintervall : 4.000

Schaktvolym : 90,615.900 m³
Schaktarea : 88,082.332 m²
Schaktarea, lutande i mätt : 88,906.205 m²
Schaktarea, lutande i teoretisk : 88,653.063 m²
Fyllvolym : 276.153 m³
Fyllarea : 1,344.000 m²
Fyllarea, lutande i mätt : 1,369.415 m²
Fyllarea, lutande i teoretisk : 1,360.254 m²

Exkluderad area : 0.000 m²
Exkluderad area, lutande i mätt : 0.000 m²
Exkluderad area, lutande i teoretisk : 0.000 m²
Inkluderad area : 0.000 m²
Inkluderad area, lutande i mätt : 0.000 m²
Inkluderad area, lutande i teoretisk : 0.000 m²

Oanvänd area i mätt DTM : 203,331.015 m²
Oanvänd area i mätt, lutande : 205,233.387 m²
Oanvänd area i teoretisk DTM : 194.252 m²
Oanvänd area i teoretisk, lutande : 210.596 m²

Rad	Summa	Schaktvolymer
35,908.000	511.934 m3 511.934 m3 338.149 m2 338.149 m2	0.000, 26.149, 248.248, 237.537
35,928.000	1,274.096 m3 1,786.030 m3 880.000 m2 1,218.149 m2	0.000, 492.953, 560.424, 220.719
35,948.000	1,772.834 m3 3,558.864 m3 1,120.000 m2 2,338.149 m2	0.000, 131.667, 624.711, 600.423, 416.032
35,968.000	3,238.620 m3 6,797.483 m3 1,520.000 m2 3,858.149 m2	0.000, 0.000, 0.000, 0.000, 219.019, 287.655, 37.066, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 0.000, 395.935, 702.043, 1051.617, 545.285

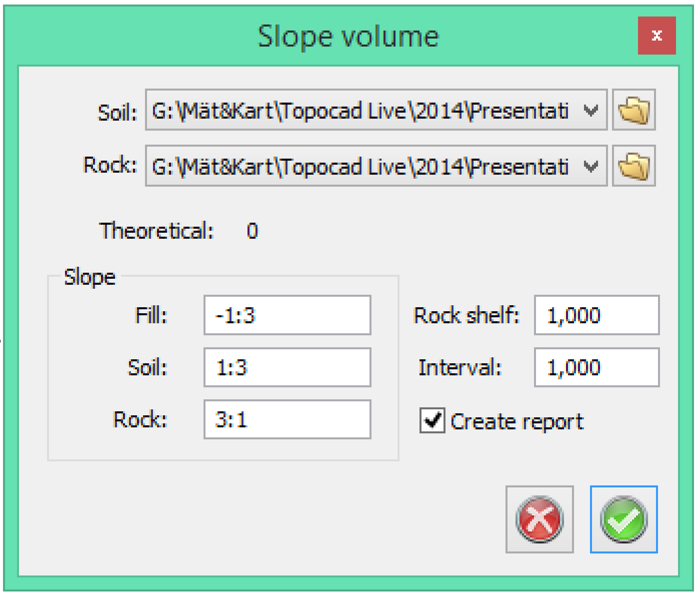
Rapport skapad av Topocad

Namnlös6.top
Skapad 2012-10-30 14:21:46

Calculate volume using slopes

Drawing|Terrain|DTM Slopes

The function is used for volume calculation between theoretical and terrain models. The slope can be set for Fill, Soil and Rock, and also for the width of the Rock. It is also possible to set the width of the rock shelf.

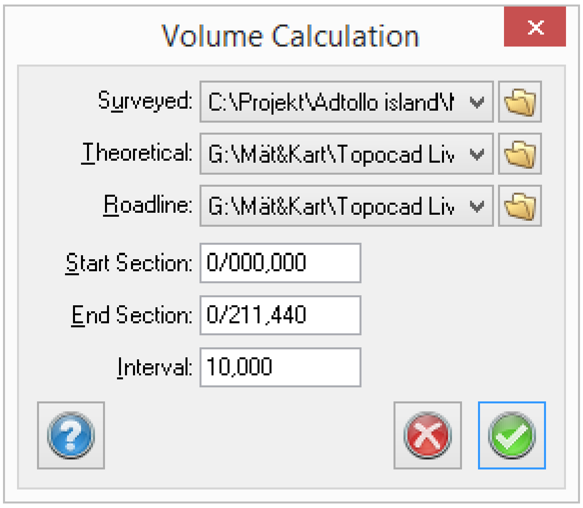


The procedure is as follows:

1. Open a terrain model for the soil layer. Also, open a model for the rock layer if needed.
2. After that, create a new drawing. Draw the excavation surface as a closed polyline. Make sure the excavation surface is placed so it is covered by the terrain models. Also make sure the point's z coordinates are correct. The excavation surface doesn't have to be flat, the z coordinates can vary. Be aware of that it is not sure how the excavation surface will look in 3D if the z coordinates varies. Draw all of the excavation surfaces if several shall be used.
3. Select all the excavation surfaces and select command DTM | Volume using slopes.
4. Select soil model (and possible rock model) in the dialogue. Set the slopes for Fill, Soil and Rock. If a rock shelf shall be created - set the width, or the value 0. If no rock shelf is needed, the values for rock shelf and slope in Rock doesn't have to be set. Interval sets the accuracy in the volume calculation. Lower value gives higher precision but takes more time. The volume is calculated by splitting up the area in a grid, where all the squares's sides are equal and with a width the same as the Interval. The height difference is calculated for every square between theoretical and the terrain models. These values are summarized and multiplied with the area of the square to get the total volume.
5. When all the values are set, click "OK". The software system will first create a DTM for the theoretical layer including the excavation surface and its slopes. Then the volumes are calculated and the result is shown in a window. The rock volume is the volume between the underside of the rock model and the theoretical. The soil model is the volume between the underside of the soil model and the theoretical minus the rock volume. The fill volume is the volume between the soil models upper side and the theoretical. The software system doesn't make a control if the drawn bottom excavation surfaces are "normal".

Calculate volumes using cross sections

Drawing|Terrain|DTM sections



This function calculates volumes between two terrain models by using cross sections.

Surveyed (model)

Enter the surveyed model, the soil model or the upper model that you are using. This model will be displayed in green.

Theoretical (model)

Enter the theoretical model, or rock model. This is the bottom model and will be displayed in red.

Roadline

Enter the roadline to be used for the calculation.

The result be saved as a TCS file (Created sections). This file can be used when creating drawings.

See also

Volume model vs. model

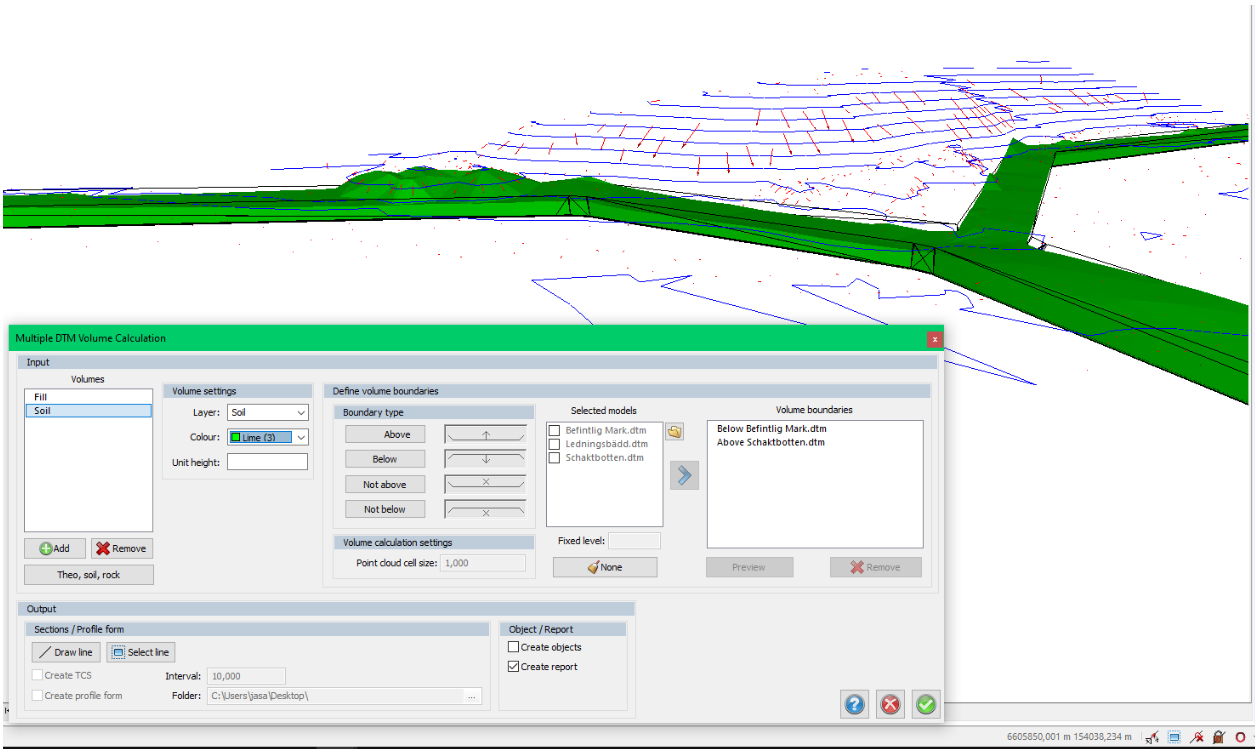
Creating a DTM.

Creating a cross section in a drawing

Calculate volumes using cross sections

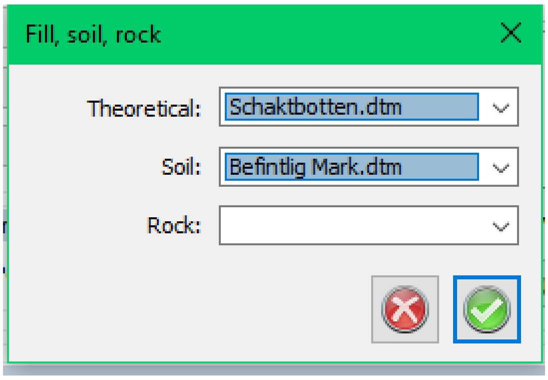
Drawing|Terrain|multi DTM

This function calculates volumes between two or more terrainmodells or pointclouds. You can also use a flat height level as a surface to calculate against.
The result can be shown in calculated sections documents, 3D- terrainmodells with volumes, and reports.



workflow:

1. Browse your terrainmodells and pointclouds in the select models browser.
2. Define your volumes, we have a quick definition to get Fill, Soil and Rock volumes, you will find the remove and add volume buttons above it.



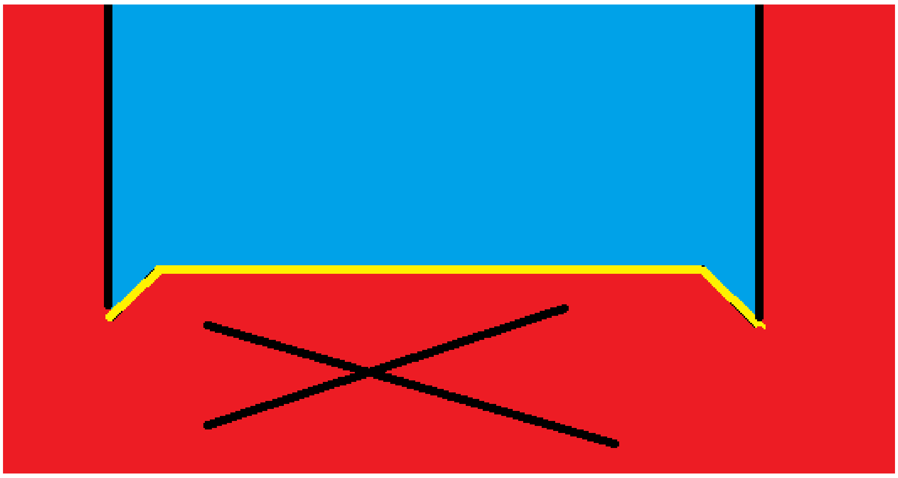
3. IF you want to calculate volumes other than that you can click the add button, name the volume, and set the boundarys of the volume with your models or with a fixed level. There are four types of boundaries to choose from:
    1. Above
    2. Below
    3. Not above
    4. Not below

This should be used as this: Above > select model A > click the blue arrow, Below > select model B > click the blue arrow.

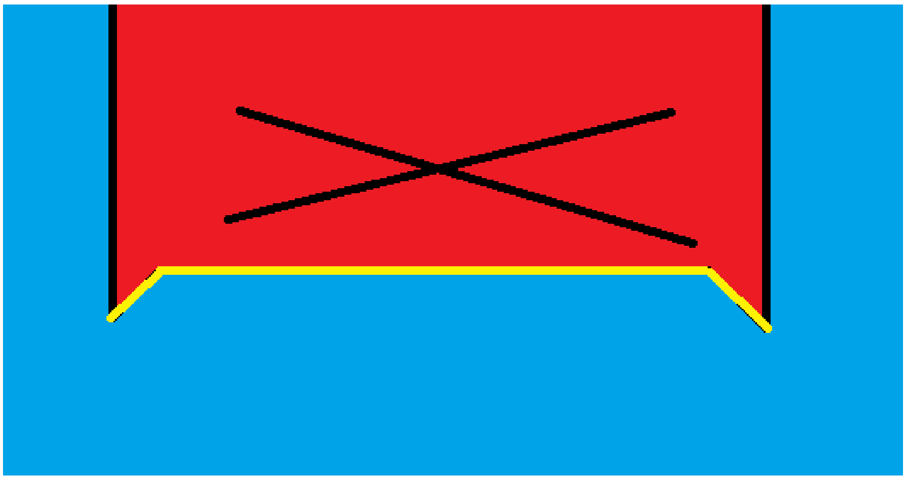
Now the volume will be defined as above model A and below model B.

This can be abit tricky at first, you can look at how soil is defined if you use a rock modell get the hang of how the not below boundary often is used.

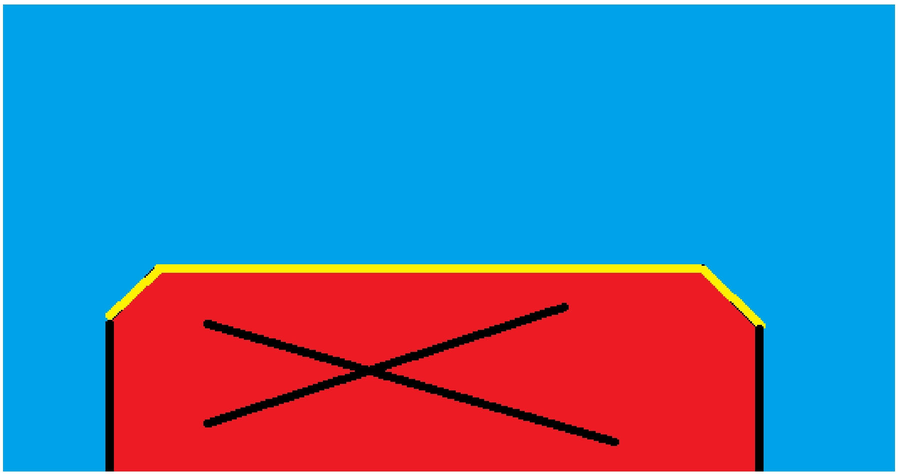
Here is some aditional explanation of how the boundaries work.



the image above illustrates an "Above", boundary, the red part is not included in the boundary, the blue part is included, the model is in yellow.



the image above illustrates a "Not above", boundary, the red part is not included in the boundary, the blue part is included, the model is in yellow.



the image above illustrates a "Not below", boundary, the red part is not included in the boundary, the blue part is included, the model is in yellow.

5. Pick a colour for the volume, the created 3D solid will get this colour.
6. Preview the defined volume, it will be shown in the colour that you have selected for the volume as a 3D volume in the drawing, here you can control that you have defined the volume as you meant to.
7. If you want to do sections and profile documents for the calculation proceed with step 8-10 otherwise skip to 11.
8. Draw a line through the models, this will be used to create a profile and calculated sections document as output when you are done.
9. Set the interval for the sections.
10. Set the folder for the resulting output, this is for the profile and calculated sections.
11. Decide if you want 3D solids as output or not, oftentimes you want to have them to controll that everything looks right.
12. Click ok with the green checkmark, your report will be made along with the additional output you have choosen.

To make the calculations more accurate you can add slope to your models to make them more realistic.

Keywords: MultiDTM, calculate volumes

Geometry contents

Geometry

Geometry contents describes usage of geometry files, this includes roadlines, which is lines with sections in plane 2D, profiles which is the profile line with sections and height, cross fall and the Profile Form.

Function	Description
Railway	Railway commands in drawing, this section uses a variety of geometry files
Roadline in drawing	Roadline commands in drawing, this section uses a variety of geometry files
Road line document	The roadline document (.trl)
Cross fall	The crossfall document
Profile	The profile document (.trp)
Profile form	The profile form document, this is where you can design your profile file and profile drawing.

Railway contents

Drawing|Geometry -|Railway commands

The railway menu is an add-on module called Railway. It has specific settings for surveying in the rail industry.

Command	Description
Overlap	Overlap measurement for control.
Slew/lift	Slew/lift log
Compare	
Switch	
FOMUL	Calculate clearence for objects close to tracks in a coordinate system based around the trackheight, leaning with the turns along with the track

See also

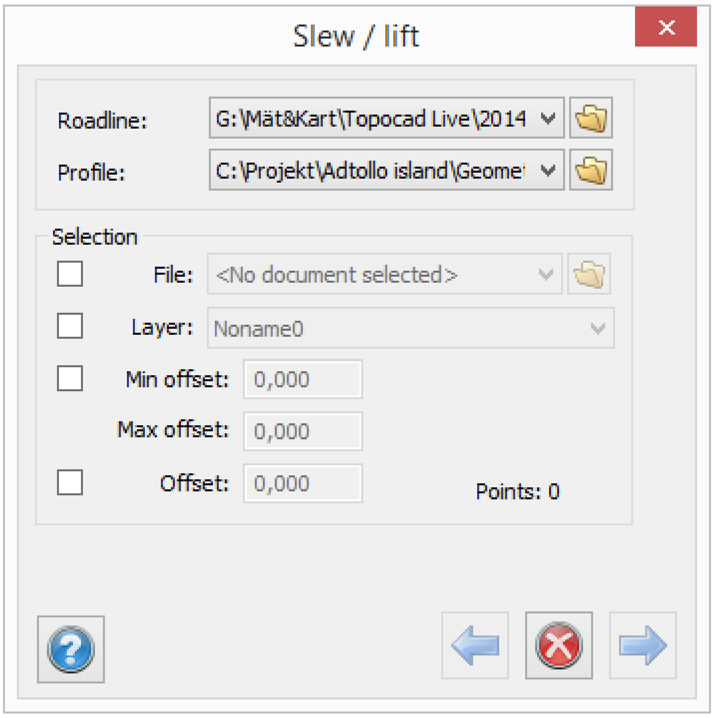
System settings - Geometry

Slew/lift

Drawing|Geometry|Slew/lift

To place the track in the right position it is necessary to make adjustments to the side and height.

Various points along the rail are measured and checked against the design geometry. A log of differences between the measured points and the rail design can be displayed in a graphic or in a text file.

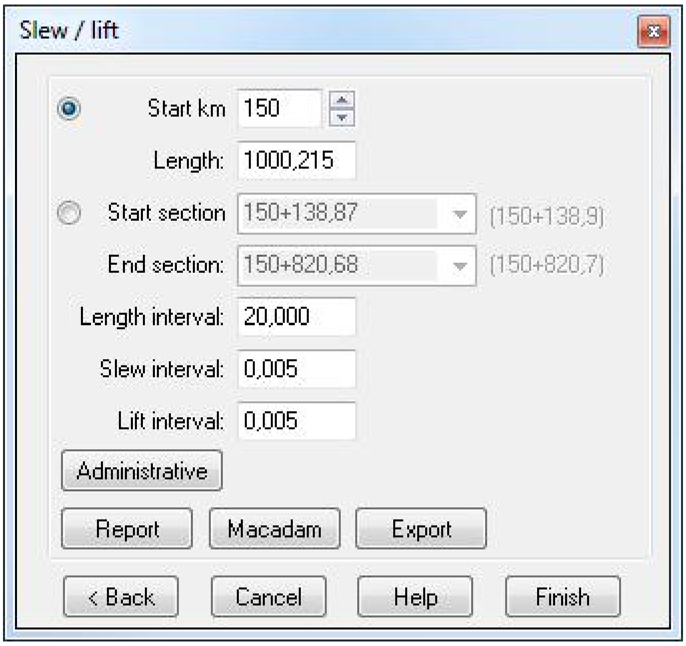


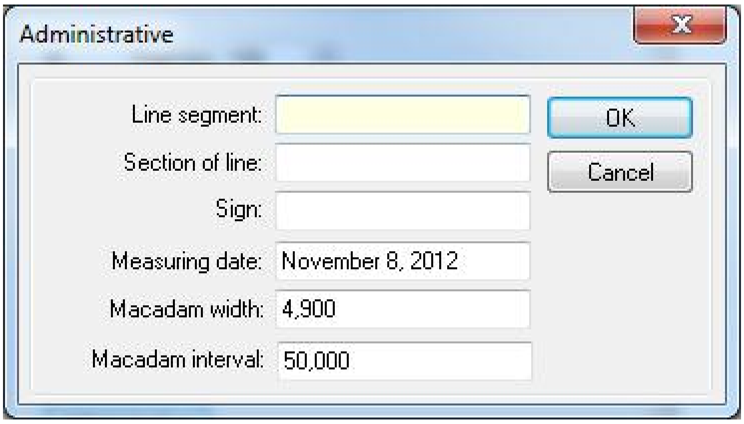
The measured points can be selected from either

- a file
- from a certain layer
- from an offset from the road line

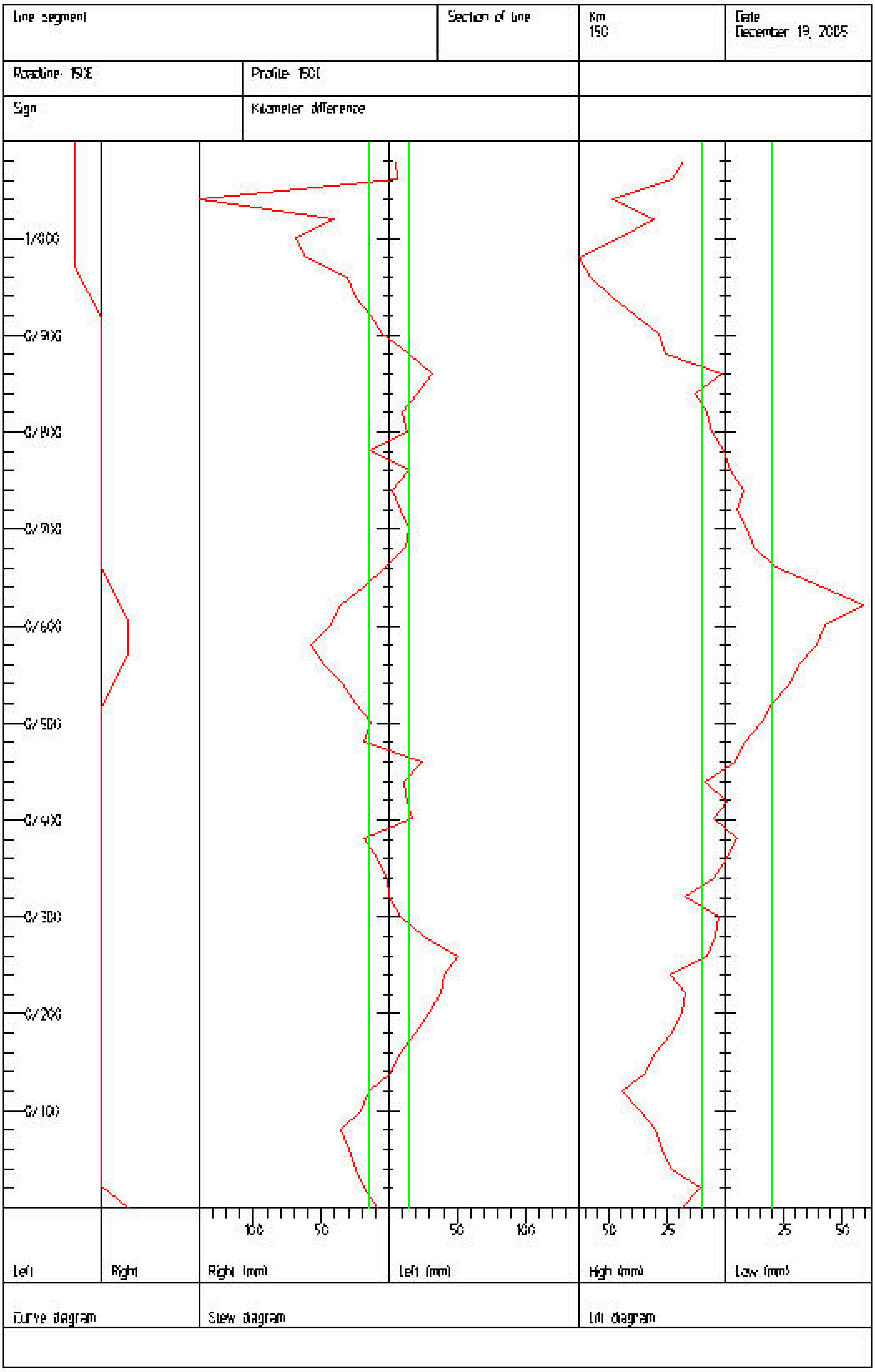
The next dialogue shows the settings for the graphic log that will be inserted into the drawing.

Slew/lift runs only with road or only with profile.





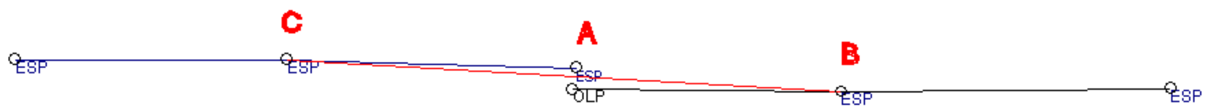
Graphic representation of slew/lift:



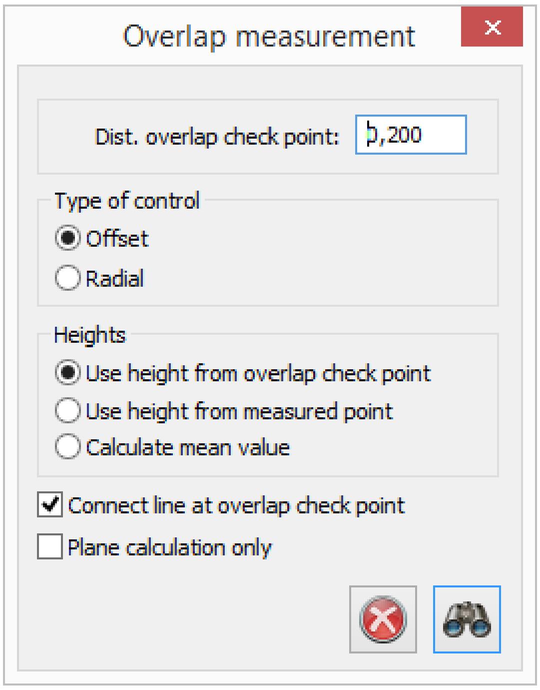
Overlap measurement

Drawing|Geometry|Overlap

The measurement of rails requires at least two rail points in the area to be measured from both stations (from opposite sides). The measurement is made to check that the difference in angle between the points is not too great. The tolerance for this is specified in File|settings|System settings - Threshold.



Overlap measurement The point coded as OLP (overlap) checks the code for the nearest point. In the example above this is code ESP at point A. (The point code used is defined in the system settings). The nearest points with the same code (ESP) are found and then the check is made for all of these points. Point A is moved to a point in between.



Roadline contents

Drawing|Geometry - Roadline commands

Function	Description
Save roadline	Saves the roadline from a polyline
Track roadline	Center view on roadline section
Edit roadline	Roadline editor

Calculate points	Calculates co-ordinates from section/offset or a file containing section/offset values.
Sections markers and points	Creates sections along a roadline
Offset/Stake out	Calculates the section and offset from co-ordinates relative to a roadline.
Quick profile	Calculates a terrain profile relating to one or more terrain models.
Check surface	Calculates the difference in level at specific points relative to the road geometry.
Create polyline	
Create crossfall	
Roadline toolbox	

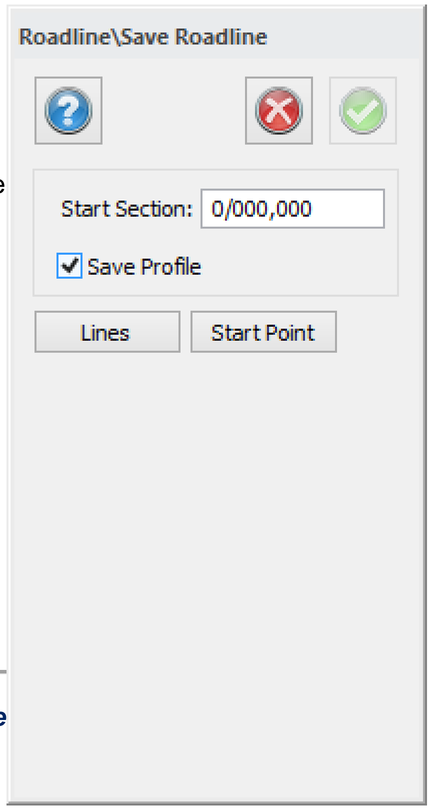
See also

Roadline document

Save roadline

Drawing|Geometry|Save Roadline

This command saves and converts a polyline to a roadline.



To save a roadline:

1. Create your line (roadline) using the appropriate commands. See also the Roadline current point toolbox.
2. Note that if you have created a line with lots of small vectors you will need to join these together before you save the roadline.
3. Select the line. Select *Save Roadline.*

TIP! You can use straight lines, radii and clothoids (spirals) in your roadline. If you are using clothoids you cannot join the elements together but you can still create the roadline by selecting the elements. It is not necessary to select them in the correct order

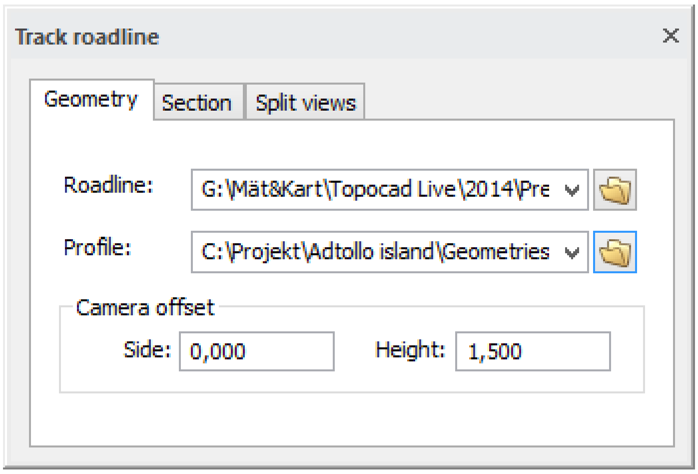
Track roadline

Drawing|Geometry|Track roadline

Function for center view on roadline section. Open a roadline and a profile. Go to the tab section to move the cursor to track the roadline forwards and backwards. Select split views to get a good overview.

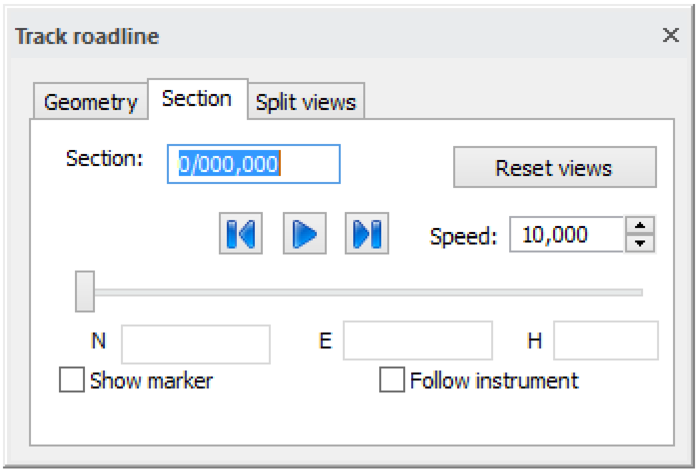
The procedure is as follows:

1. Select *Geometry|Track roadline* to start the command.



2. To use the command, a roadline and a profile must be selected.

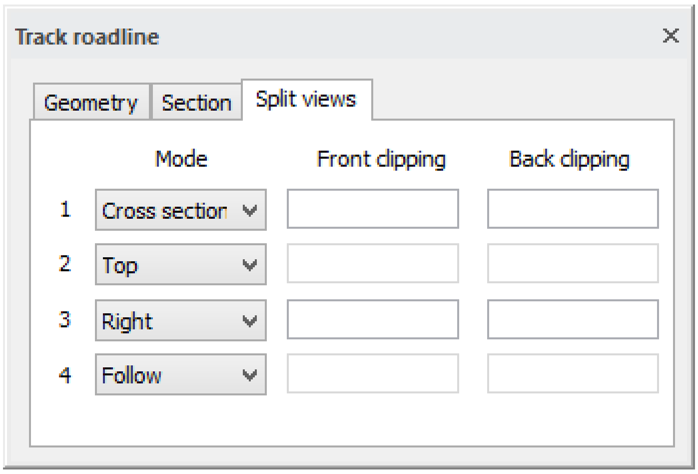
Camera offset: The position of the camera can be moved horizontally and/or vertically.



3. Select section or click the play button for playback. Select the speed (meters/second).

Show marker: Shows marker in the track roadline view.

Follow instrument: If you are connected to a GPS instrument, you can get the position from the instrument.



4. Select split views.

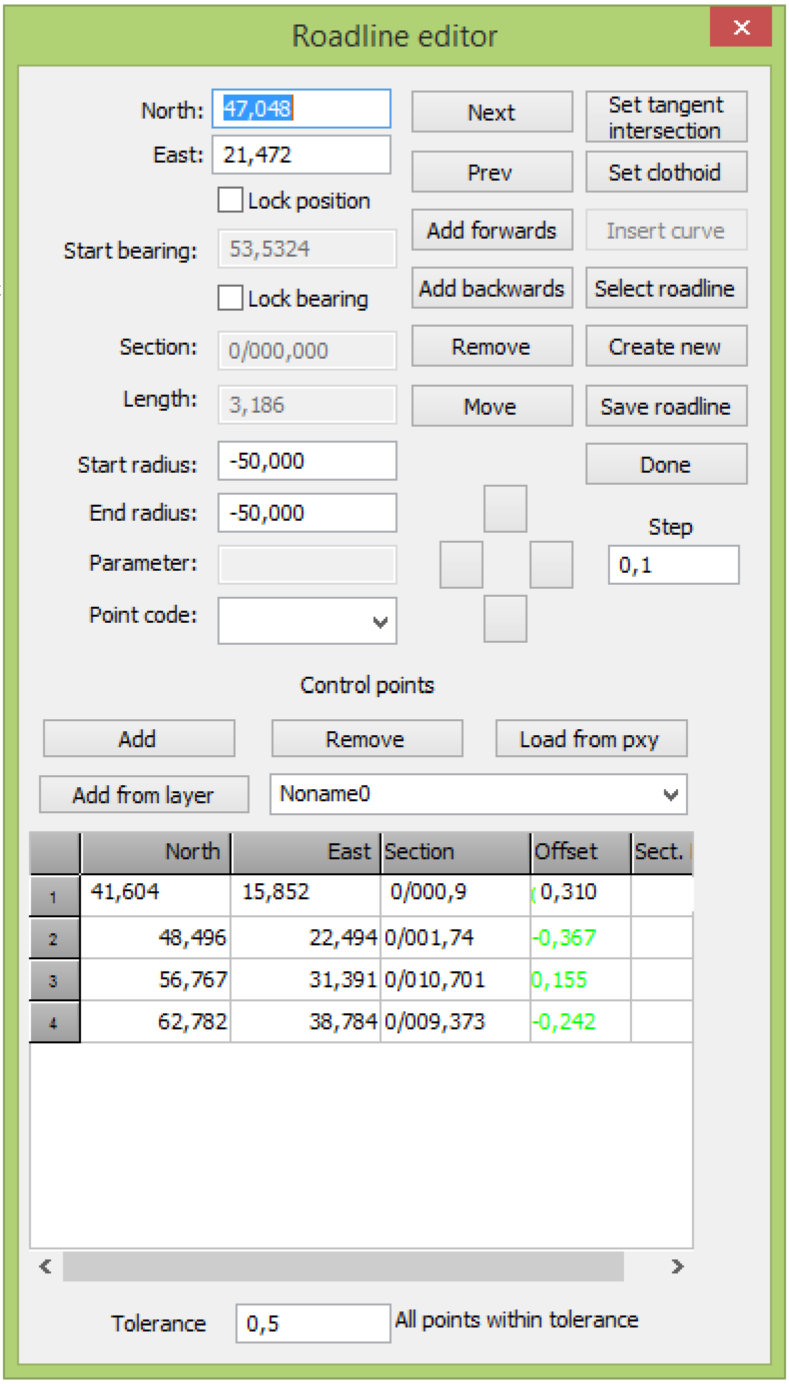
Front and back clipping: If you select 1, only a cut section will be displayed, 1 meter to the front and 1 meter to the back.

Edit roadline

Drawing|Geometry|Edit

The command starts either from the menu, or from the Roadline toolbar. The command can be used to edit and create new road lines in drawings.

The procedure is as follows:



1. Create a new roadline by clicking the Create button.

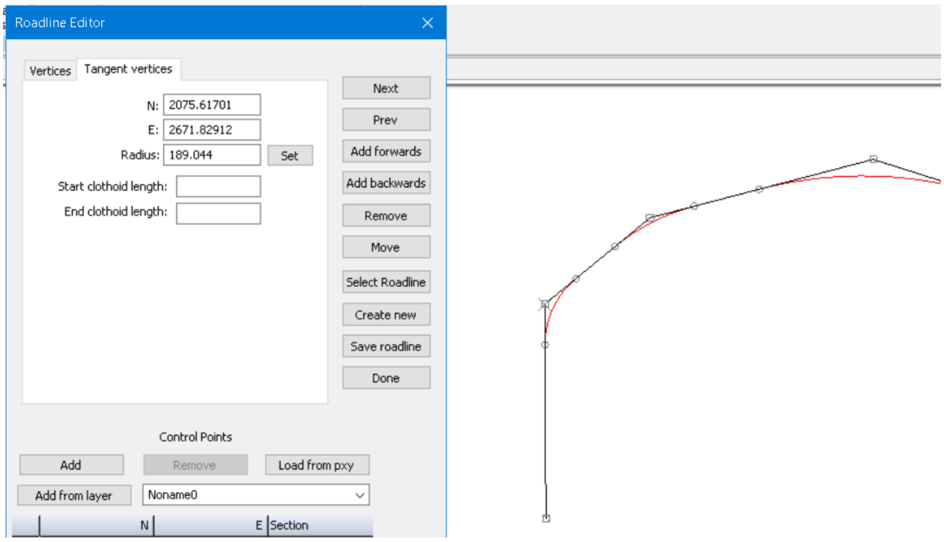
2. Point at the starting point of the roadline in the drawing.

3. Edit current roadlines by first selecting Select roadline, then click at the roadline that is to be edited. The command window displays data for the selected point. The buttons Next and Previous are used to select next and previous point in the roadline. Add forwards and Add backwards are used to create a new point before and after selected point.

4. To add a new point, its position must be set by clicking in the drawing. The Remove button removes selected point. Move let the user move selected point by clicking in the drawing.

5. After making the points in the drawing you

can insert radius from the tangent

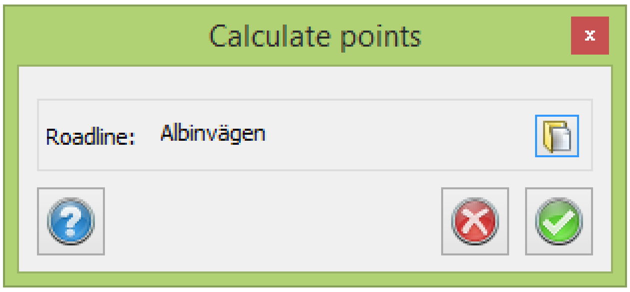


6. Save the roadline with the button save roadline.

Roadline - calculate points

Drawing|Geometry|Calculate

The Roadline/Points command calculates co-ordinates from files containing sections and offsets (orthogonal points). The calculated points are then used in the drawing.



To calculate co-ordinates from orthogonal points:

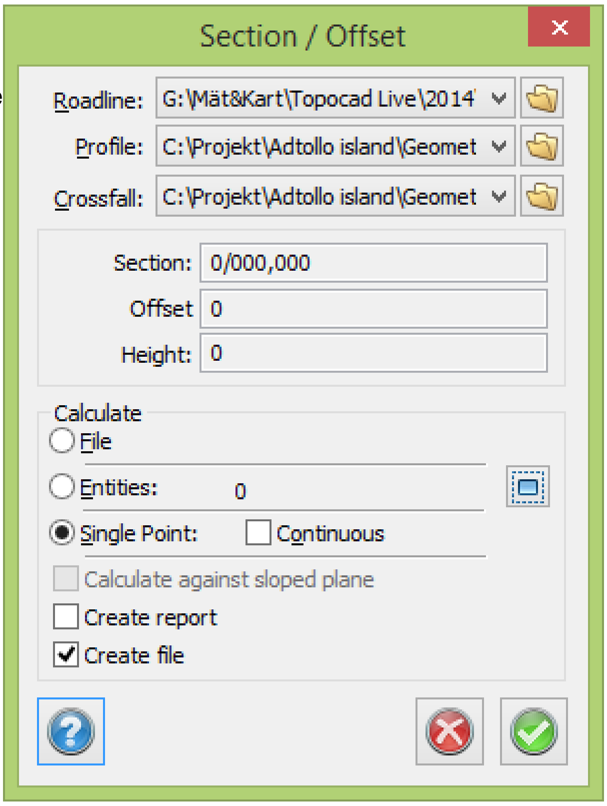
1. Select or create the layer where you want the co-ordinates to appear.
2. Select the command *Calculate.*
3. Select the roadline by clicking the button ... If you have selected a roadline previously this will be the default selection. You can find a previously loaded roadline in the Roadline Manager or load a new one. This will activate the Roadline. You can close it straightaway and it will remain activated.
4. Click on OK.
5. The Open dialogue box appears. Select the co-ordinate file (.PXY) in which you have saved sections and offsets.
6. Click on OK. The co-ordinates are imported into the drawing.

See also

Roadline for more information about the format of the roadline.

Road line - Section/Offset

Drawing|Geometry|Section/Offset



This command calculates co-ordinates in the drawing or in a file for sections and offsets. It is also possible to calculate heights from the road profile and even from the road profile and the camber form. The last two commands are only available if you have the Longitudinal Section Module in Topocad.

To calculate the section/offset (heights/reduced by camber):

1. Select Section/offset.
2. Select the roadline by clicking the button ... You can also select a road profile (.TRP) and calculate the heights from the road profile in that section. It is also possible to load the camber form (.TCF) and reduce or add the heights from the road profile with the current camber in the section.
3. Select whether you want to calculate the objects in a file or drawing or just a single point.
4. Click OK.
5. If you have selected objects from a file, the Open dialogue box will appear. Select the co-ordinates file you want to use to calculate the section/offset for the selected road line. Click OK.
6. The result appears in a co-ordinates file. You can now edit and save it.

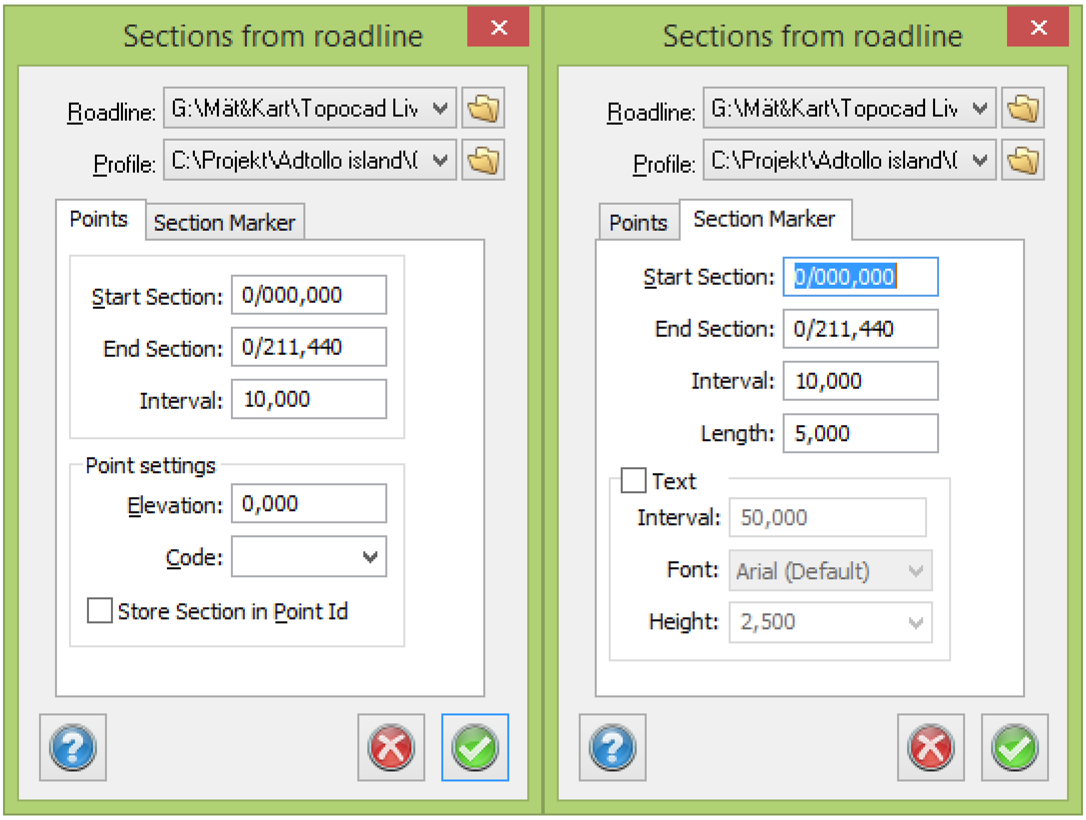
See also

Roadline for more information about the format of the roadline.
Surface check for a similar command using the comparison between the road geometry and measured points.

Roadline - Sections Markers and Points

Roadline|Sections Markers and Points

This command calculates sections along the road line. It is also possible to take the heights from a road profile if one has been selected. This feature is only available if you have the Longitudinal section module in Topocad. See Road line for more information about the format of the roadline. You can also create lines for a fixed interval and section information for another interval from the Section Marker tab.



To calculate sections along the road line:

1. Select the layer where you want the created sections to appear.
2. Select *Sections Markers*
3. Select the roadline by clicking the Browse button.
4. If necessary select the road profile by clicking the button in this row.
5. Select the start and end sections from which you wish to calculate sections. Select the interval between sections.
6. Specify whether the created points will use the default point code.
7. Decide whether you want to use the point ID as the section. If so, tick the box.
8. Click OK. The created sections will appear in the current layer.

TIP! The thousand meter separator can be selected in Roadlines.

TIP! The Point ID can be selected and displayed with the Point info command.

TIP! Selecting a symbol with a defined attribute for the Point ID means that the section is placed around that symbol.

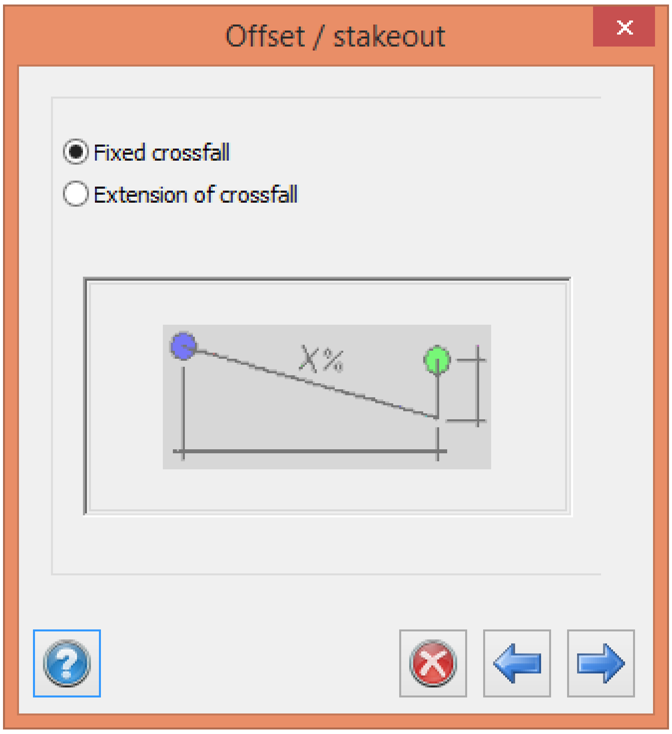
Offset/stake out

Drawing|Geometry|Offset/stake out

Offset/Stake out for roadline. There are two ways to determine how to stake out the roadline.

1. Using a fixed crossfall from a roadline.

2. Using a designed or measured crossfall from a roadline, the road profile (height) and the road camber.

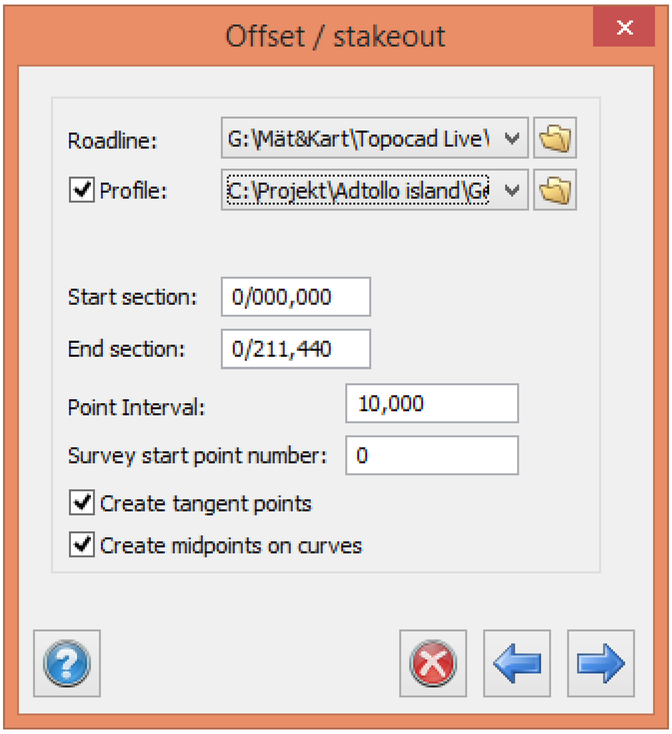


If you choose the second method you need to enter a roadline, a profile and ideally a camber diagram.

Decide on the start and end section and the point interval.

Decide whether you want to create tangent points and midpoints on curves.

The next step is to decide on the width and height for the points offset from the edge of the road.



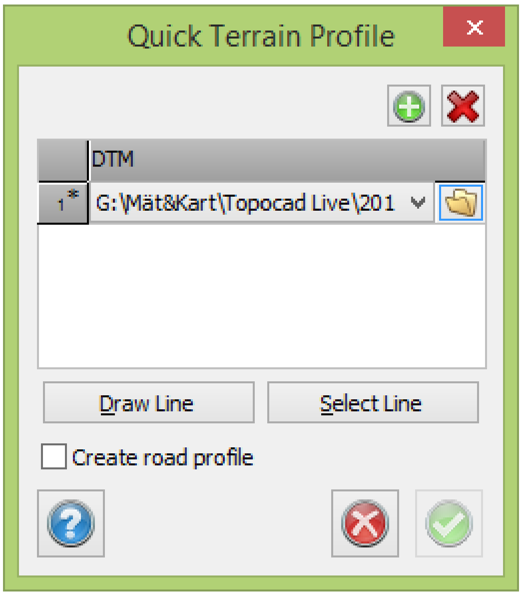
See also

Roadline for more information about the format of the roadline.
Surface check for a similar command using the comparison between the road geometry and measured points.

Quick profile

Drawing|Geometry|Quick profile

This command creates a terrain profile from the selected line and a previously created digital terrain model (DTM). The result is displayed in the profile form. The profile form (TPF) can be inserted into a drawing and then printed.



DTM
Select the terrain model(s) you want to use to create a terrain profile.

Draw line/ Select line
Draw or select a line at the position where you want the terrain profile to appear. You can either select an existing line or add a new line to the drawing.

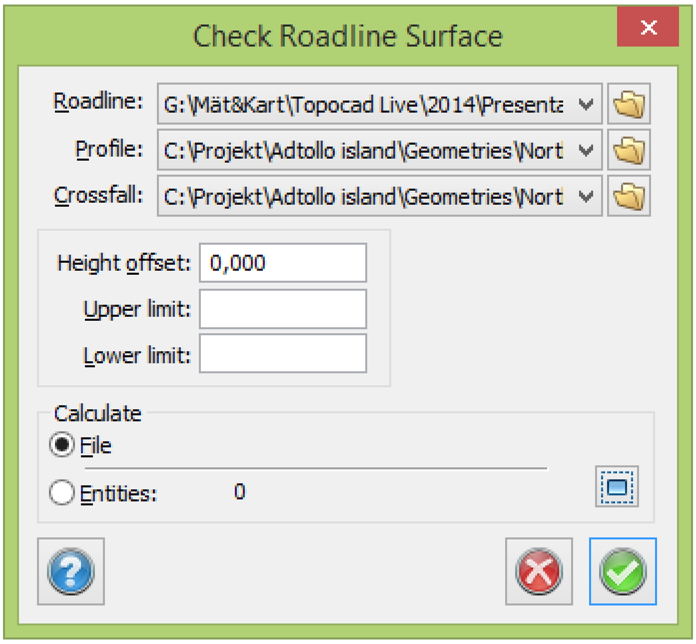
Create road profile
If the box is checked when you run the command, a road line profile (*.trp) will be created for each created terrain profile.

See also:

Create DTM
Profile form
Profile form in drawing

Surface check

Drawing|Geometry|Check surface



The function is similar to the *Section/Offset* function except that it calculates the difference between measured and theoretical points and stores the result in a text file. The result can also be printed out.

The surface check can only be carried out if you have installed the Topocad Profile (Earthworks/design) section module.

To create a surface check:

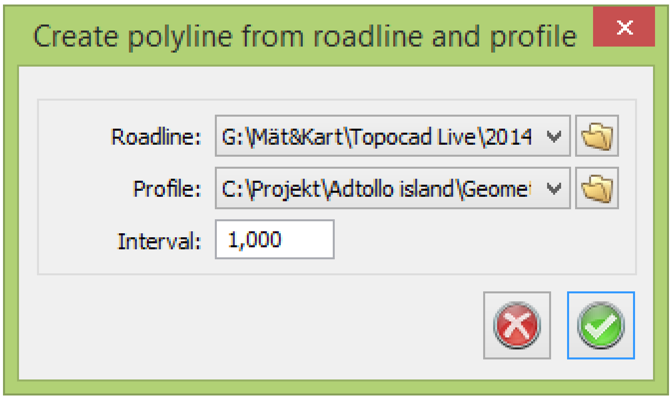
1. Select the roadline and road profile and the camber form if applicable.
2. If there is a height difference between the road profile and the measured level it can be defined here. For example, this would be the case if the road profile was created for the theoretical road but the measurement is carried out towards the terrace.
3. Select the upper and lower limits if applicable.
4. You can then choose to calculate the points from the file or from the drawing.
5. Specify whether you want the results to be saved in a text file. Printout is the default setting.

Create polyline from roadline or profile

Drawing|Geometry|Create polyline

The function creates a polyline in the drawing of a roadline or a profile.

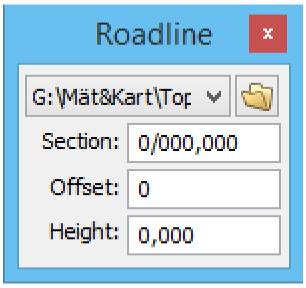
The interval is referring to the distance between the points in the polyline, where the change in plan or height is made.



Roadline toolbox

Roadline|Roadline

This dialogue box is used to view different sections and offsets from the roadline. Select roadline in the scroll-down menu. If there is no current roadline open or available, click the Browse button to add your roadline.



Roadline current point

This toolbox is for roadline construction and displays:

- · The X- co-ordinate
- · The Y- co-ordinate
- · The section
- · Any radius the point may have.
- · The bearing from the point

To the right is a small column where you can mark and lock the specific field for this specific point.

When this toolbox is highlighted and a line is selected you will see the cross of the angle at every point in the line. These are the points which can be modified with this command. When the roadline is finished you need to select Save roadline.

Roadline document

Roadline document (TRL)

In the road line document do you input the roadline. You can then import the road line to the drawing document to be calculated from.

Do like this to input a road line:

1. Create a new Roadline document. Select New - Road line document (*.TRL).
2. Input co-ordinates, eventual radius and parameters for clothoides.
3. The road line is automatically generated and calculated.
4. Save the road line.
5. You can now import the road line to the document and use it for section, section/offset calculations.

Albinvägen [(Local)]

	Point Id	North	East	Section	Radius	End Radius	Parameter	Code	Bearing	End Bearing	Length
1		6591614,17	702285,873	0/000,000					12,8852	12,8852	15,809
2		591629,657	702289,051	0/015,809	15,000	15,000			12,8852	75,8617	14,839
3		591640,576	702298,193	0/030,648					75,8617	75,8617	9,040
4		591643,923	702306,591	0/039,688	-20,000	-20,000			75,8617	2,8708	22,931
5		591661,600	702319,168	0/062,619					2,8708	2,8708	12,031
6		591673,620	702319,710	0/074,650	30,000	30,000			2,8708	104,3193	47,806
7		591702,198	702351,713	0/122,457					104,3193	104,3193	28,392
8		591700,274	702380,040	0/150,849	50,000	50,000			104,3193	158,6076	42,638
9		591680,655	702416,449	0/193,487					158,6076	158,6076	17,953
10		591666,365	702427,316	0/211,440					158,6076		

Roadline Cant Preview

Explanations to the document:

Point Id
Even called element when in Road line. Not important for the road line.

X- respectively Y- co-ordinates
The co-ordinates in plane where you have an element.

Section
The section number. If you leave it empty the software system will calculate the section for you. You can also give ”r;wrong”r; section number and this will take effect on all sections after this section. You can also use negative section values.

Radius
if it is a curve give the start radius here. Negative values for curves turning left.

End radius
End radius for this element if it is such. When using parameters it is important to type in the end radius.

Parameter
Enter the parameter for the clothoide. The parameter is always positive even if it is a left curve.

Code
Code for the tangent point.

Bearing
The bearing is calculated from other data.

End bearing
The end bearing is also calculated from other data.

Length
The length of the element is always calculated.

Export from road line

It is possible to export to other road line formats from the road line. The formats supported are:

- LIN Point road line format
- GVL Geosis road line format

Preview of road line

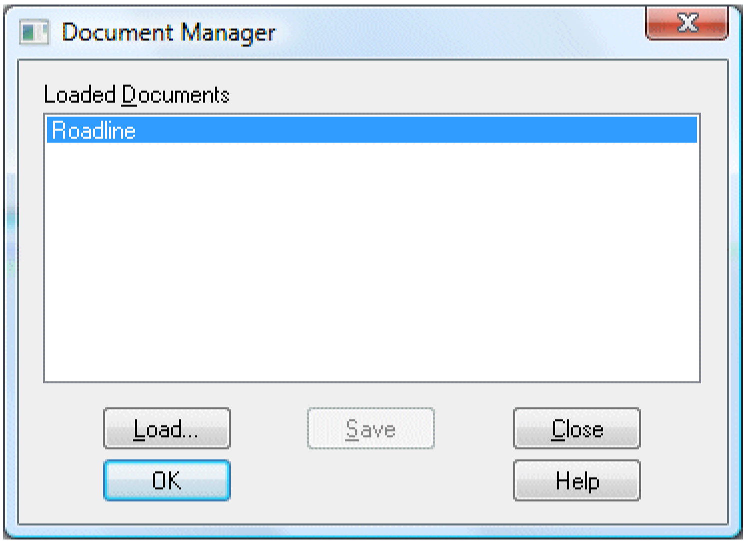
The tab shows current row in road line document marked by a circle in the preview. With possibilities to show all road line nodes.

Roadline manager

System|Roadline manager

The roadline manager is where you select which roadline will be the current one. This is the roadline that will be used for calculating sections and section/offsets. You can also save roadlines and open roadlines from the roadline manager.

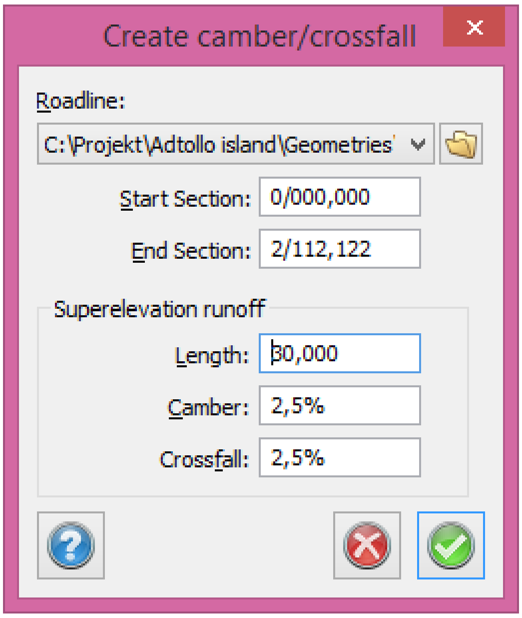
It is possible to have several roadlines loaded but you can only select one to be the current one.



Crossfall: Create camber diagram

Crossfall|Create

The crossfall log is used in both the profile form and the cross section construction. It has a .tcf (Topocad camber form) extension. The sections can also be created directly from the volume calculation sections but this will not create a .tcf file.



The procedure is as follows:

1. Go to *New document* and select Cross fall.
2. Go to Create
3. Load the calculated roadline for which you want to calculate the camber and crossfall.
4. Enter the start and end sections for the crossfall log.
5. Enter the crossfall you want to use for the camber (straight roadline) and for the cross slope/crossfall (radius/curves).
6. Enter the required distance for the change from camber to crossfall.
7. Click OK.
8. The crossfall log will now be created. It is now possible to edit sections, crossfalls etc. and to add new sections. Note that if the radii are very close to each other you will need to edit the log. In theory it is not possible to calculate if the radii are too close to each other.
9. Save the crossfall.

Profile contents

Profile

Command	Description
Road profile	
Adjust profile	
Check profile	
Extract Kilometer	
Height	
Set/Remove length table	
Settings/Nodes preview	
Import/Export of road profile	

You enter the complete profile for your roadline in the road profile document (.trp).

It is used to place the sections at the correct height.

Info | North_road_2

	Point Id	Section	Height	Radius	Start Slope	End Slope	Length	lothoid Param
1	1	0/000,000	9,900		3,477%	3,477%	61,062	
2	2	0/061,062	12,023	-2000,000	3,477%	-0,843%	86,356	
3	3	0/147,418	13,159		-0,843%	-0,843%	42,844	
4	4	0/190,262	12,798	-1200,000	-0,843%	-3,333%	29,858	
5	5	0/220,120	12,175		-3,333%	-3,333%	27,730	
6	6	0/247,850	11,250	800,000	-3,333%	0,275%	28,849	
7	7	0/276,698	10,809		0,275%	0,275%	181,392	
8	8	0/458,091	11,307	-1500,000	0,275%	-5,334%	84,012	
9	9	0/542,103	9,184		-5,334%	-5,334%	119,350	
10	10	0/661,453	2,818	1000,000	-5,334%	-0,381%	49,452	
11	11	0/710,905	1,406		-0,381%	-0,381%	7,510	
12	12	0/718,415	1,377		-0,381%			

Profile | Preview

To enter a profile:

1. Create a new profile document. Go to *New* and select Profile file (*.trp).
2. Enter the element number, section, heights and any radius.
3. The profile is automatically calculated. Note that it is possible to adjust the profile by going to *Adjust.*
4. Save the profile under any name.
5. It is now possible to use it for calculations.

Explanations for the document:

Point ID
This can be any number. It may also be called an Element no.

Section
The section. It is important that the section is correct compared to the one used in the appropriate roadline.

Height
Enter the height for the section.

Radius
Any radius for this point ID. A negative value for the radius means that the centre point is below the radius. Think of it this way - A sad face (radius) means a negative value and a happy face (radius) is a positive value.

Start slope
The start slope is calculated based on the data entered.

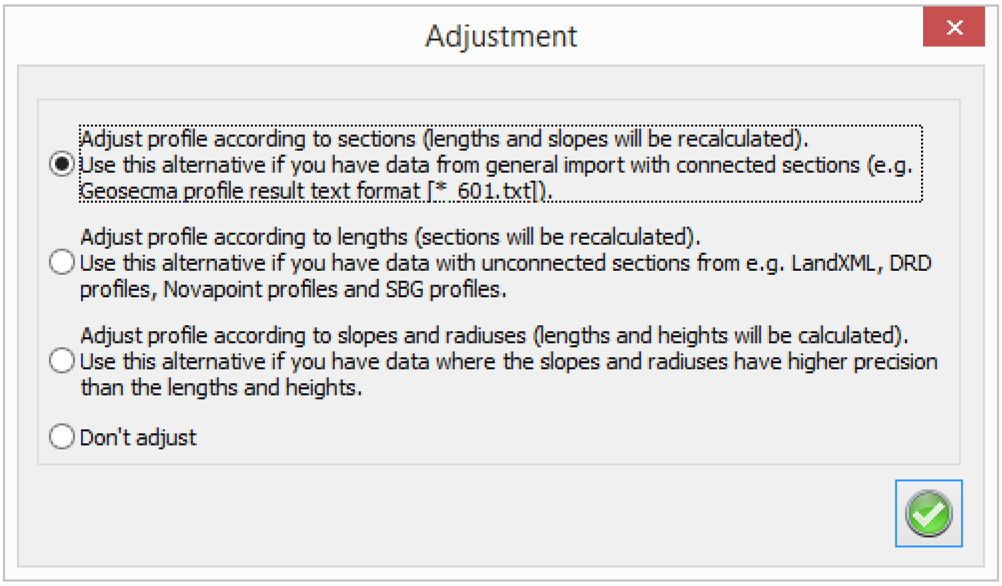
End slope
The end slope is calculated based on the data entered.

Length
The length of the element. This is always calculated based on the data entered.

You can enter an element (section, point ID) into a profile by rignt-cklick on grid and select Insert row. To delete a row, right-click and select *Delete row(s).*

Adjust profile

The profile can be adjusted and possible errors can be corrected, however, the geometry will not be changed when adjusting.



Check profile

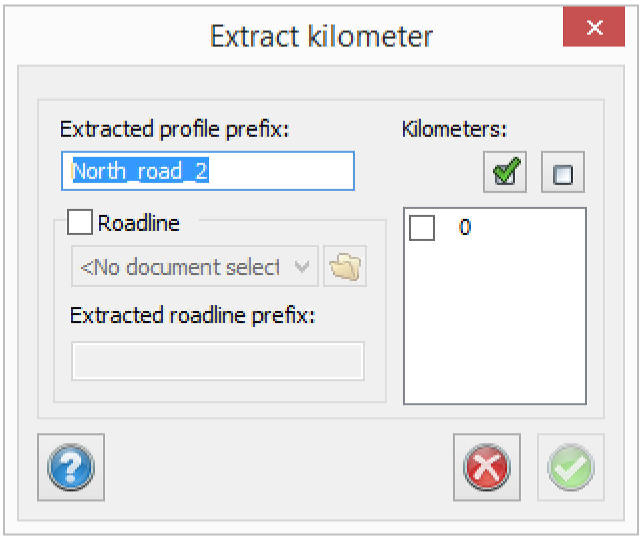
Control of profile gives a report regarding errors in bearing between different elements, if elements are too short or too long (discontinuity).

If there are no errors, you will get a message that says "No profile discontinuities found".

Extract kilometer

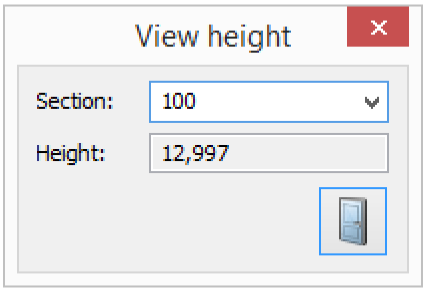
The profile is divided into every kilometer, with start before the kilometer and end after the kilometer, considering the length of the length table and also the first and the last element.

The command is also done in combination with the roadline, and the result will be a number of profiles and roadlines with name of kilometers.



Height

Select section and view the height of this section.



Set/remove length table

The length table can be connected to the profile (if you have the railway module) which gives reports so the sections will follow this length table.

Settings/Nodes preview

You find the tab for preview of profile directly in the profile document. The current row in the profile document is marked with a circle in the preview.

There are settings for height scale and possibilities to show all profile nodes.

Profile contents

Profile

Command	Description
Road profile	
Adjust profile	
Check profile	
Extract Kilometer	
Height	
Set/Remove length table	
Settings/Nodes preview	
Import/Export of road profile	

You enter the complete profile for your roadline in the road profile document (.trp).

It is used to place the sections at the correct height.

	Point Id	Section	Height	Radius	Start Slope	End Slope	Length	lothoid Param
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Explanations for the document:

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This can be any number. It may also be called an Element no.

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Start slope
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End slope
The end slope is calculated based on the data entered.

Length
The length of the element. This is always calculated based on the data entered.

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Adjust profile

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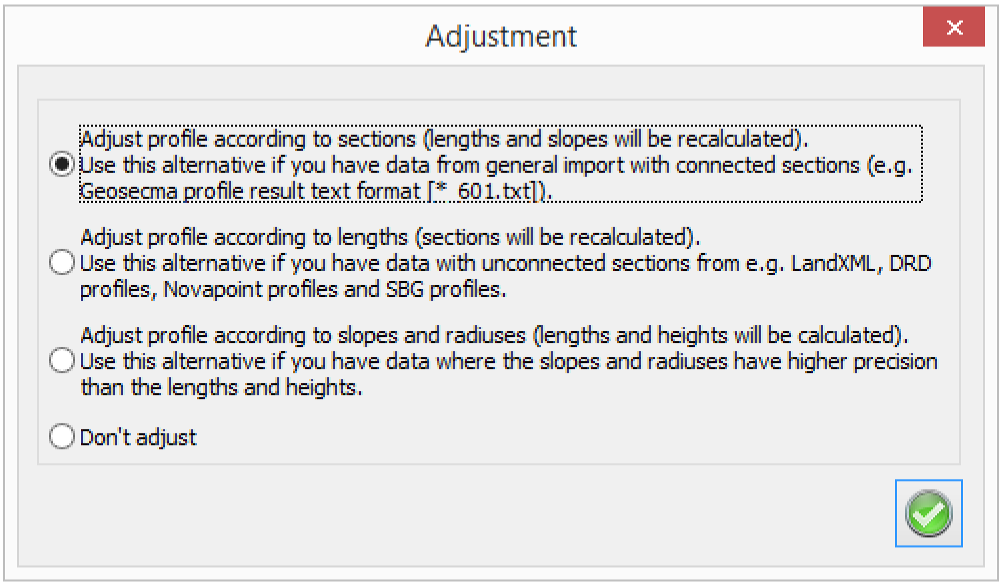

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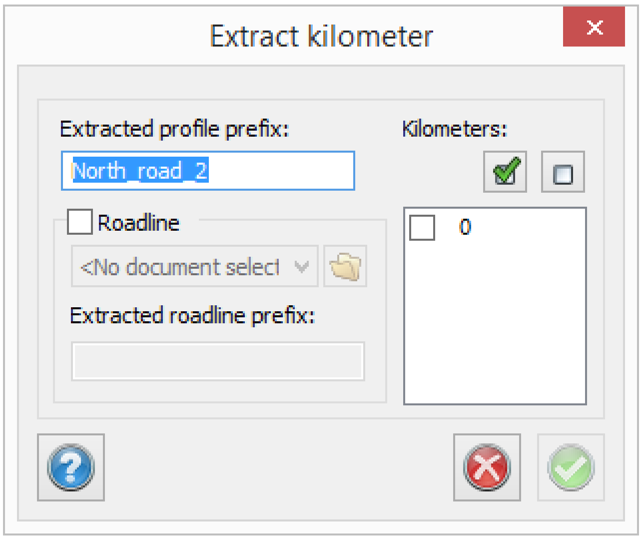
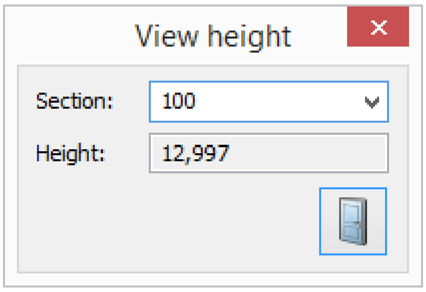


Height

Select section and view the height of this section.



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There are settings for height scale and possibilities to show all profile nodes.

Profile contents

Profile

Command	Description
Road profile	
Adjust profile	
Check profile	
Extract Kilometer	
Height	
Set/Remove length table	
Settings/Nodes preview	
Import/Export of road profile	

You enter the complete profile for your roadline in the road profile document (.trp).

It is used to place the sections at the correct height.

Info | North_road_2

	Point Id	Section	Height	Radius	Start Slope	End Slope	Length	lothoid Param
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Explanations for the document:

Point ID
This can be any number. It may also be called an Element no.

Section
The section. It is important that the section is correct compared to the one used in the appropriate roadline.

Height
Enter the height for the section.

Radius
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Start slope
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Length
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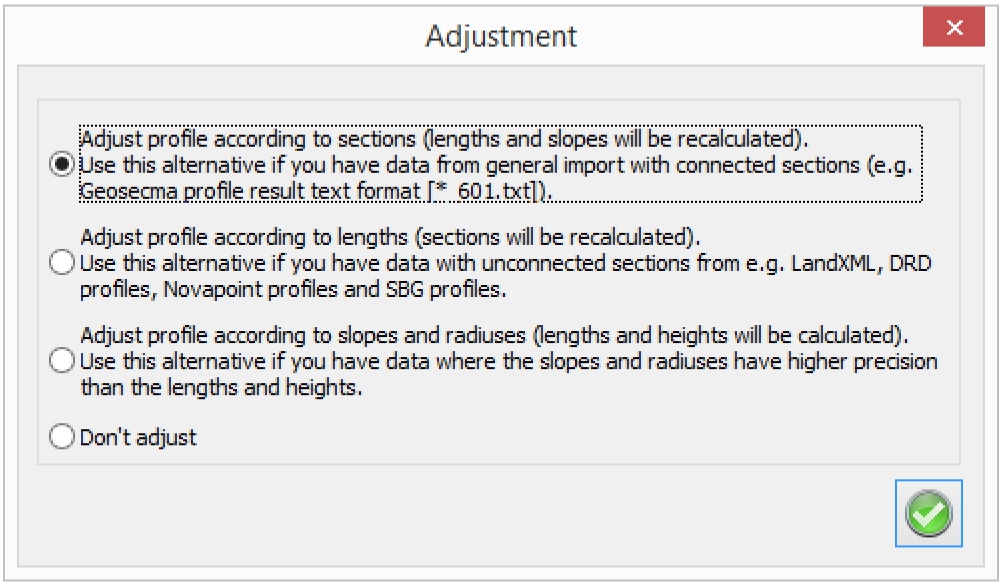

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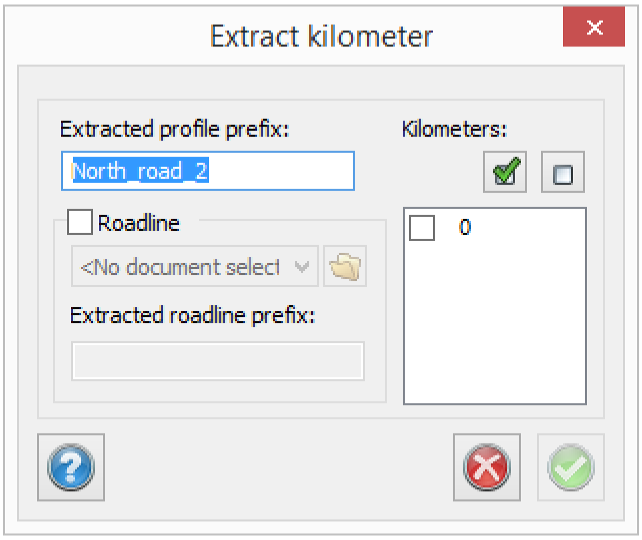
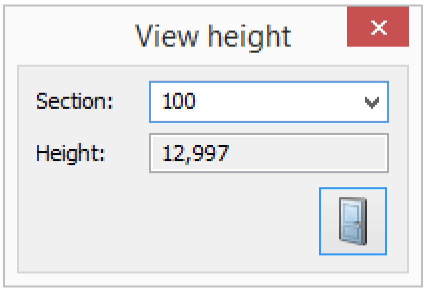


Height

Select section and view the height of this section.



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Profile

Command	Description
Road profile	
Adjust profile	
Check profile	
Extract Kilometer	
Height	
Set/Remove length table	
Settings/Nodes preview	
Import/Export of road profile	

You enter the complete profile for your roadline in the road profile document (.trp).

It is used to place the sections at the correct height.

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2	2	0/061,062	12,023	-2000,000	3,477%	-0,843%	86,356	
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Explanations for the document:

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This can be any number. It may also be called an Element no.

Section
The section. It is important that the section is correct compared to the one used in the appropriate roadline.

Height
Enter the height for the section.

Radius
Any radius for this point ID. A negative value for the radius means that the centre point is below the radius. Think of it this way - A sad face (radius) means a negative value and a happy face (radius) is a positive value.

Start slope
The start slope is calculated based on the data entered.

End slope
The end slope is calculated based on the data entered.

Length
The length of the element. This is always calculated based on the data entered.

You can enter an element (section, point ID) into a profile by rignt-cklick on grid and select Insert row. To delete a row, right-click and select *Delete row(s).*

Adjust profile

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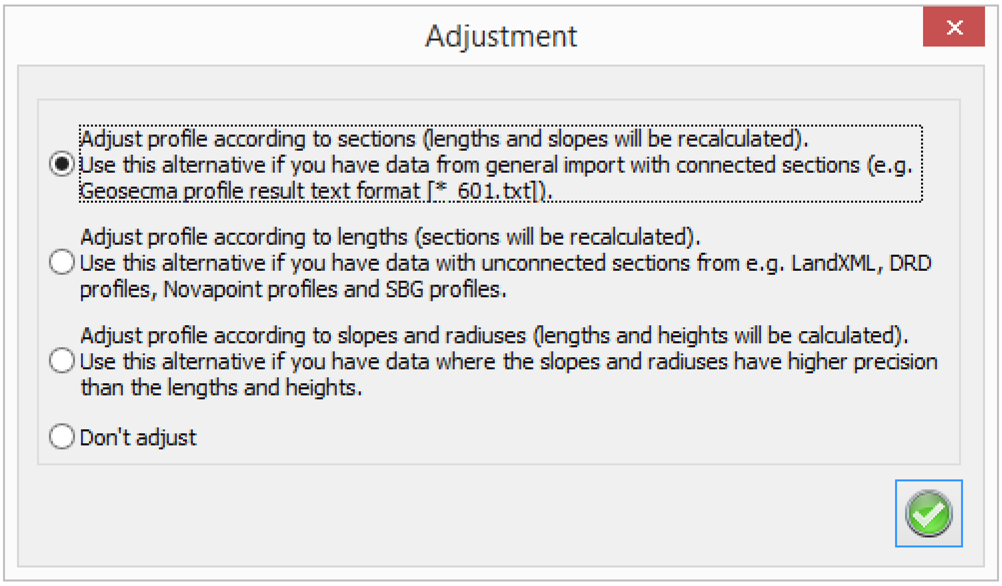

Check profile

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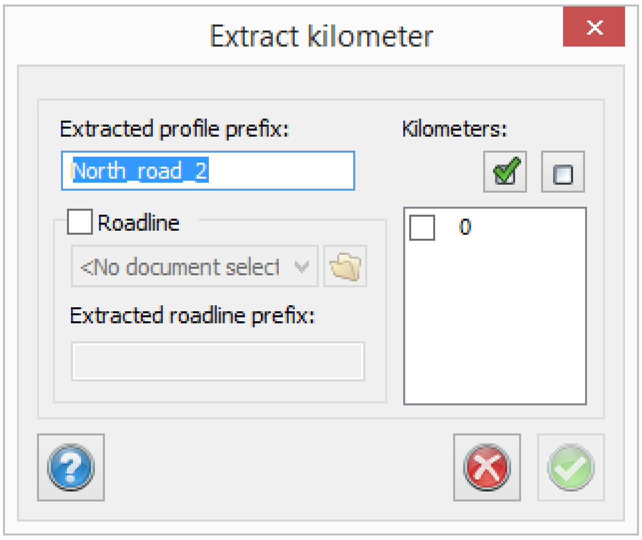
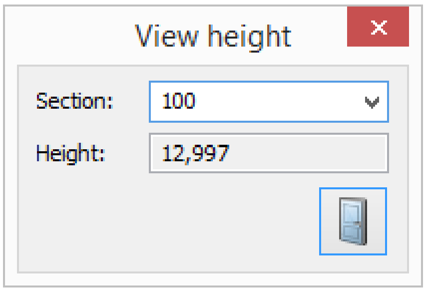


Height

Select section and view the height of this section.



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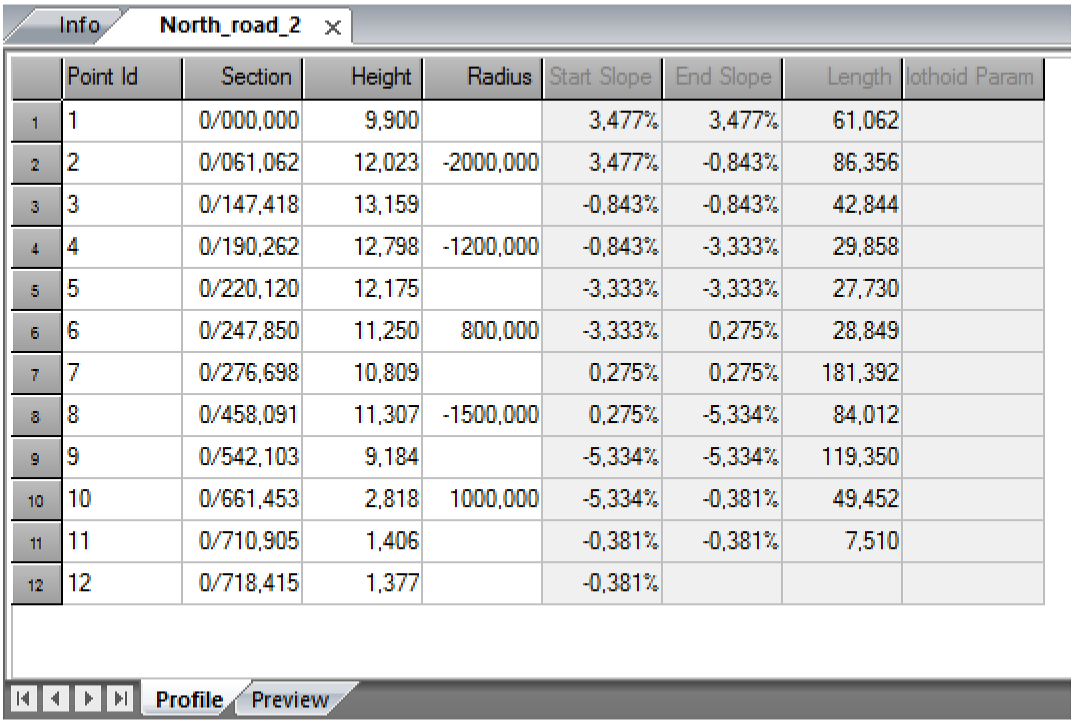

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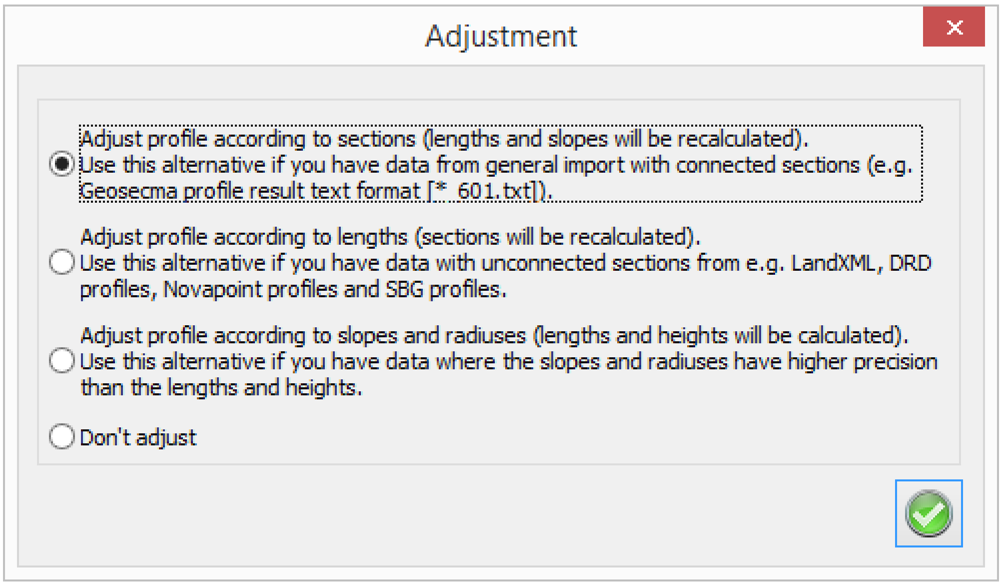

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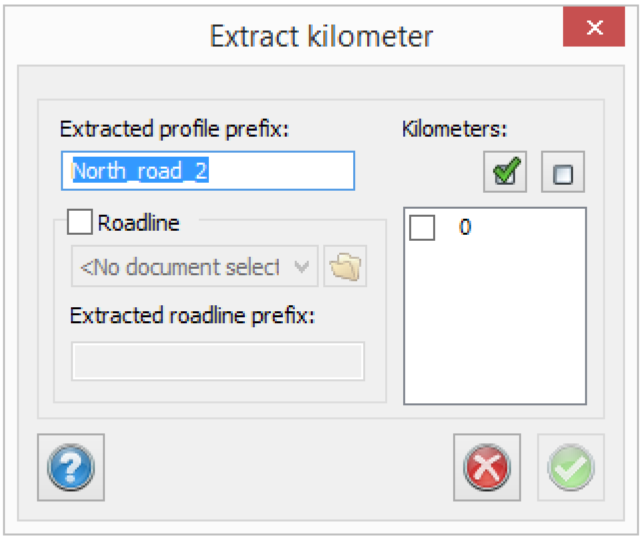
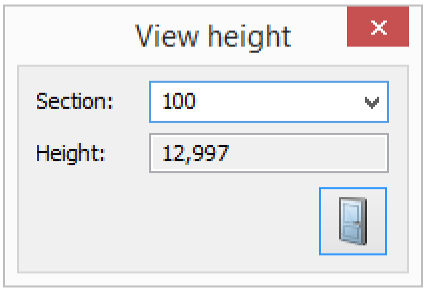


Height

Select section and view the height of this section.



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3	3	0/147,418	13,159		-0,843%	-0,843%	42,844	
4	4	0/190,262	12,798	-1200,000	-0,843%	-3,333%	29,858	
5	5	0/220,120	12,175		-3,333%	-3,333%	27,730	
6	6	0/247,850	11,250	800,000	-3,333%	0,275%	28,849	
7	7	0/276,698	10,809		0,275%	0,275%	181,392	
8	8	0/458,091	11,307	-1500,000	0,275%	-5,334%	84,012	
9	9	0/542,103	9,184		-5,334%	-5,334%	119,350	
10	10	0/661,453	2,818	1000,000	-5,334%	-0,381%	49,452	
11	11	0/710,905	1,406		-0,381%	-0,381%	7,510	
12	12	0/718,415	1,377		-0,381%			

To enter a profile:

1. Create a new profile document. Go to *New* and select Profile file (*.trp).
2. Enter the element number, section, heights and any radius.
3. The profile is automatically calculated. Note that it is possible to adjust the profile by going to *Adjust.*
4. Save the profile under any name.
5. It is now possible to use it for calculations.

Explanations for the document:

Point ID
This can be any number. It may also be called an Element no.

Section
The section. It is important that the section is correct compared to the one used in the appropriate roadline.

Height
Enter the height for the section.

Radius
Any radius for this point ID. A negative value for the radius means that the centre point is below the radius. Think of it this way - A sad face (radius) means a negative value and a happy face (radius) is a positive value.

Start slope
The start slope is calculated based on the data entered.

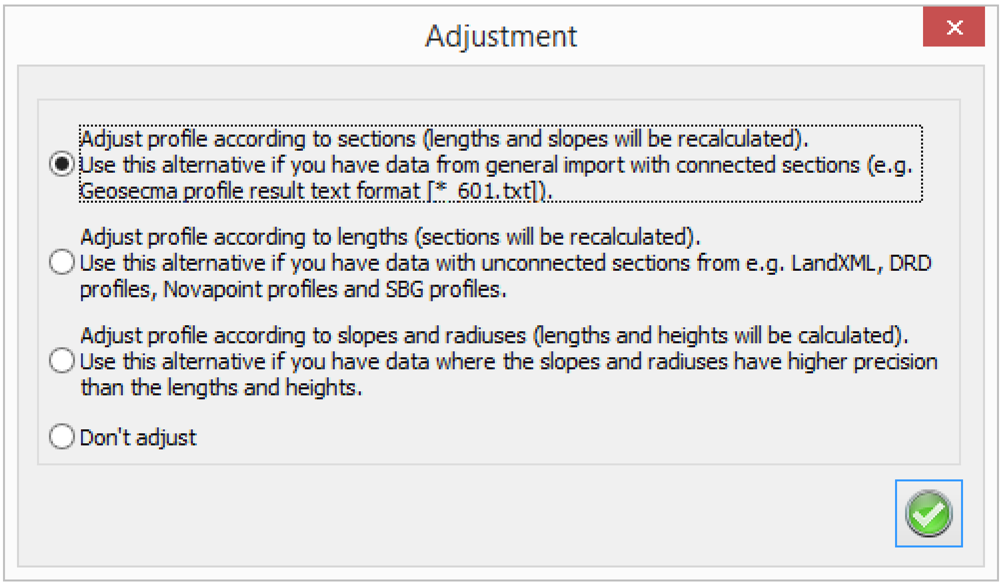
End slope
The end slope is calculated based on the data entered.

Length
The length of the element. This is always calculated based on the data entered.

You can enter an element (section, point ID) into a profile by rignt-cklick on grid and select Insert row. To delete a row, right-click and select *Delete row(s).*

Adjust profile

The profile can be adjusted and possible errors can be corrected, however, the geometry will not be changed when adjusting.



Check profile

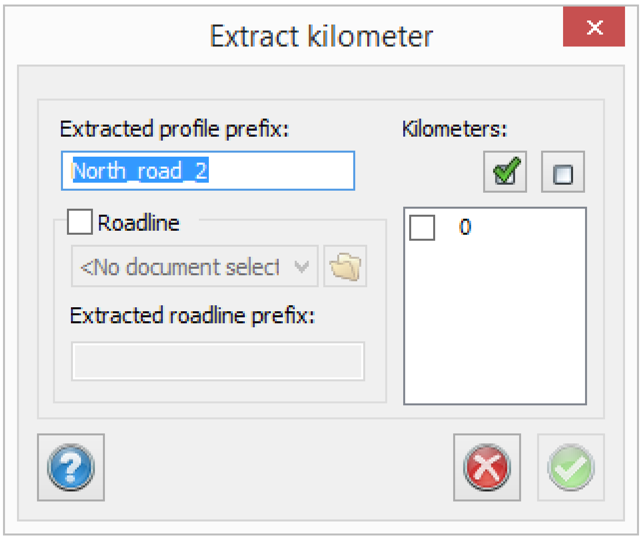
Control of profile gives a report regarding errors in bearing between different elements, if elements are too short or too long (discontinuity).

If there are no errors, you will get a message that says "No profile discontinuities found".

Extract kilometer

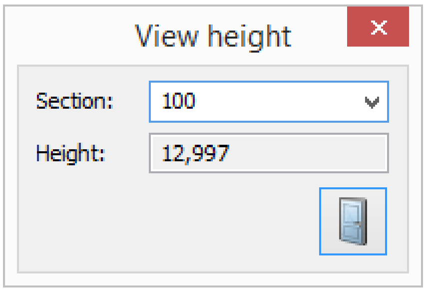
The profile is divided into every kilometer, with start before the kilometer and end after the kilometer, considering the length of the length table and also the first and the last element.

The command is also done in combination with the roadline, and the result will be a number of profiles and roadlines with name of kilometers.



Height

Select section and view the height of this section.



Set/remove length table

The length table can be connected to the profile (if you have the railway module) which gives reports so the sections will follow this length table.

Settings/Nodes preview

You find the tab for preview of profile directly in the profile document. The current row in the profile document is marked with a circle in the preview.

There are settings for height scale and possibilities to show all profile nodes.

Profile contents

Profile

Command	Description
Road profile	
Adjust profile	
Check profile	
Extract Kilometer	
Height	
Set/Remove length table	
Settings/Nodes preview	
Import/Export of road profile	

You enter the complete profile for your roadline in the road profile document (.trp).

It is used to place the sections at the correct height.

Info North_road_2

	Point Id	Section	Height	Radius	Start Slope	End Slope	Length	lothoid Param
1	1	0/000,000	9,900		3,477%	3,477%	61,062	
2	2	0/061,062	12,023	-2000,000	3,477%	-0,843%	86,356	
3	3	0/147,418	13,159		-0,843%	-0,843%	42,844	
4	4	0/190,262	12,798	-1200,000	-0,843%	-3,333%	29,858	
5	5	0/220,120	12,175		-3,333%	-3,333%	27,730	
6	6	0/247,850	11,250	800,000	-3,333%	0,275%	28,849	
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9	9	0/542,103	9,184		-5,334%	-5,334%	119,350	
10	10	0/661,453	2,818	1000,000	-5,334%	-0,381%	49,452	
11	11	0/710,905	1,406		-0,381%	-0,381%	7,510	
12	12	0/718,415	1,377		-0,381%			

Profile Preview

To enter a profile:

1. Create a new profile document. Go to *New* and select Profile file (*.trp).
2. Enter the element number, section, heights and any radius.
3. The profile is automatically calculated. Note that it is possible to adjust the profile by going to *Adjust.*
4. Save the profile under any name.
5. It is now possible to use it for calculations.

Explanations for the document:

Point ID
This can be any number. It may also be called an Element no.

Section
The section. It is important that the section is correct compared to the one used in the appropriate roadline.

Height
Enter the height for the section.

Radius
Any radius for this point ID. A negative value for the radius means that the centre point is below the radius. Think of it this way - A sad face (radius) means a negative value and a happy face (radius) is a positive value.

Start slope
The start slope is calculated based on the data entered.

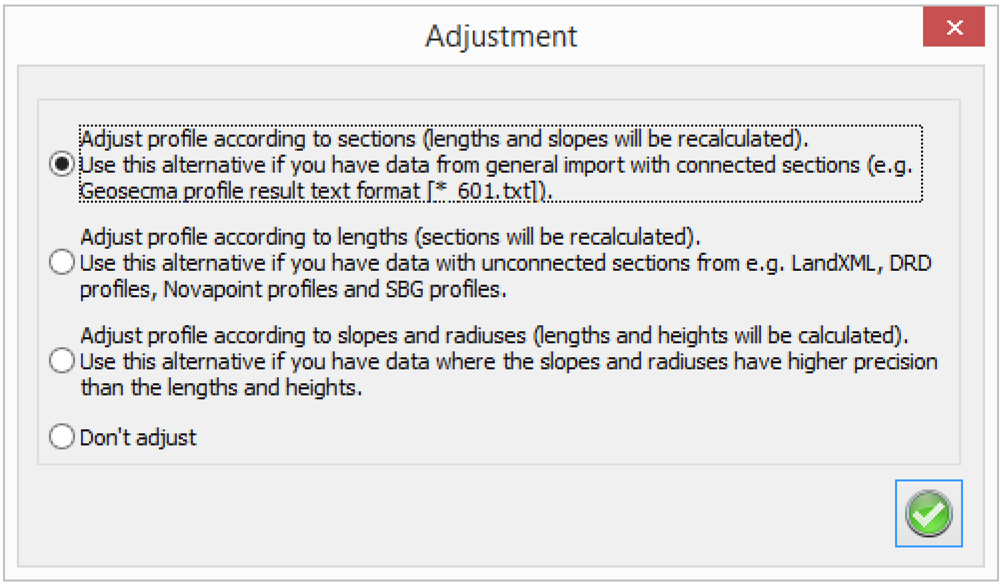
End slope
The end slope is calculated based on the data entered.

Length
The length of the element. This is always calculated based on the data entered.

You can enter an element (section, point ID) into a profile by rignt-cklick on grid and select Insert row. To delete a row, right-click and select *Delete row(s).*

Adjust profile

The profile can be adjusted and possible errors can be corrected, however, the geometry will not be changed when adjusting.



Check profile

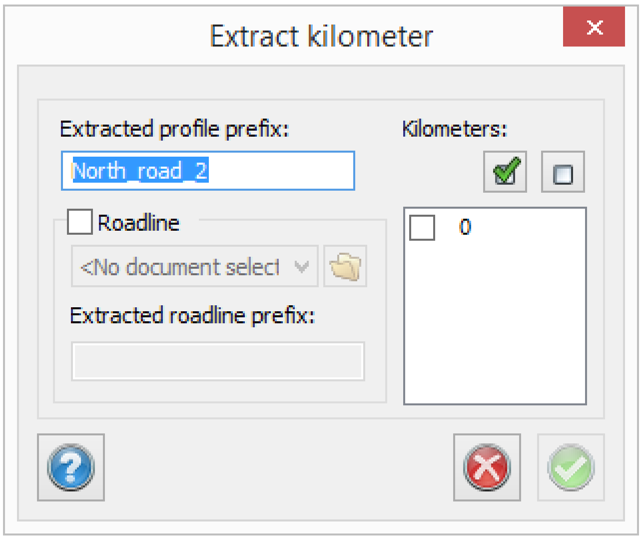
Control of profile gives a report regarding errors in bearing between different elements, if elements are too short or too long (discontinuity).

If there are no errors, you will get a message that says "No profile discontinuities found".

Extract kilometer

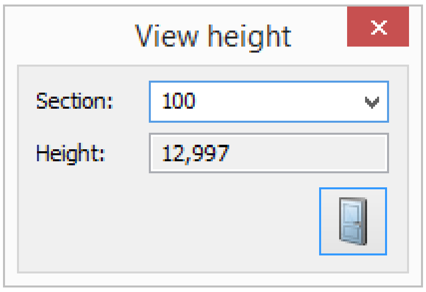
The profile is divided into every kilometer, with start before the kilometer and end after the kilometer, considering the length of the length table and also the first and the last element.

The command is also done in combination with the roadline, and the result will be a number of profiles and roadlines with name of kilometers.



Height

Select section and view the height of this section.



Set/remove length table

The length table can be connected to the profile (if you have the railway module) which gives reports so the sections will follow this length table.

Settings/Nodes preview

You find the tab for preview of profile directly in the profile document. The current row in the profile document is marked with a circle in the preview.

There are settings for height scale and possibilities to show all profile nodes.

Import and export of road profile

Profile|Import/Export

The road profile can be exported to certain instruments with a roadline. It can be imported to and exported from various formats.

The following file formats are supported:

- Export and import: prf profile line in point and GEO
- Import: drd profile file .dpl.
- General import of road profile data.

Import of road profile

Topocad reads lots of different file format to import road profiles. File formats that can be imported are PRF files from Point/Geo, DPL files from the DRD of the Swedish Road Administration, LandXML and a general import of text files. Read more at Communication - Import files.

Export of road profile

A profile can be exported by marking the road profile in text form, copy (use right click) and from here paste, to for example MS Excel. It is also possible to export the profile to the PRF format used in Geo and partly Point and to LandXML. You are able to export a profile directly to most of the instruments and field computers.

See also

Road profile.

Profile form

Profile form

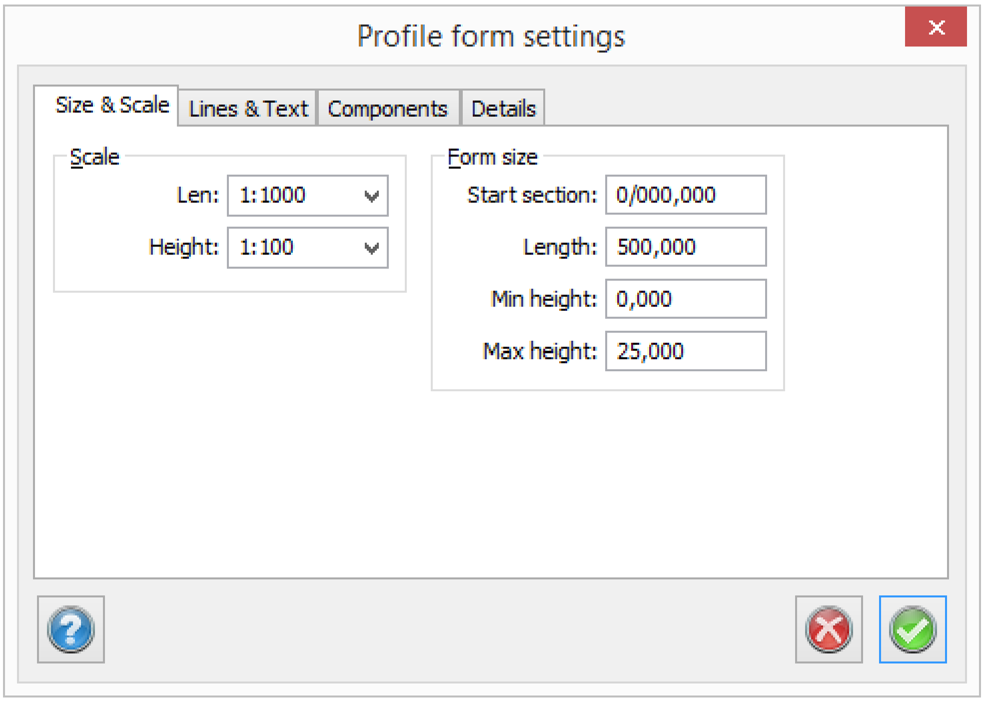
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

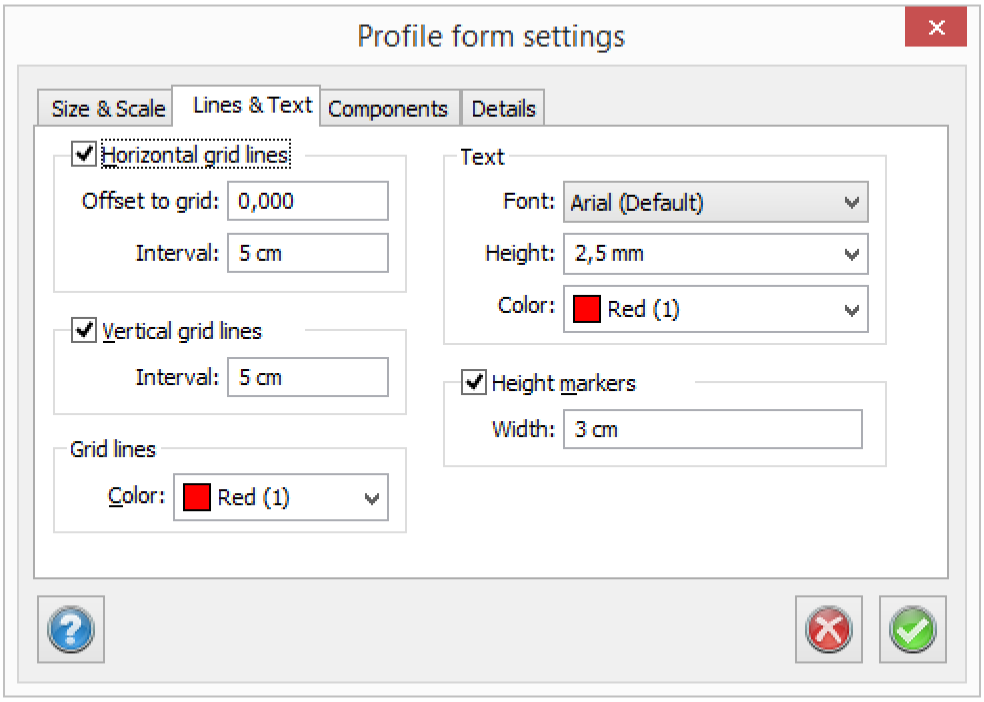


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

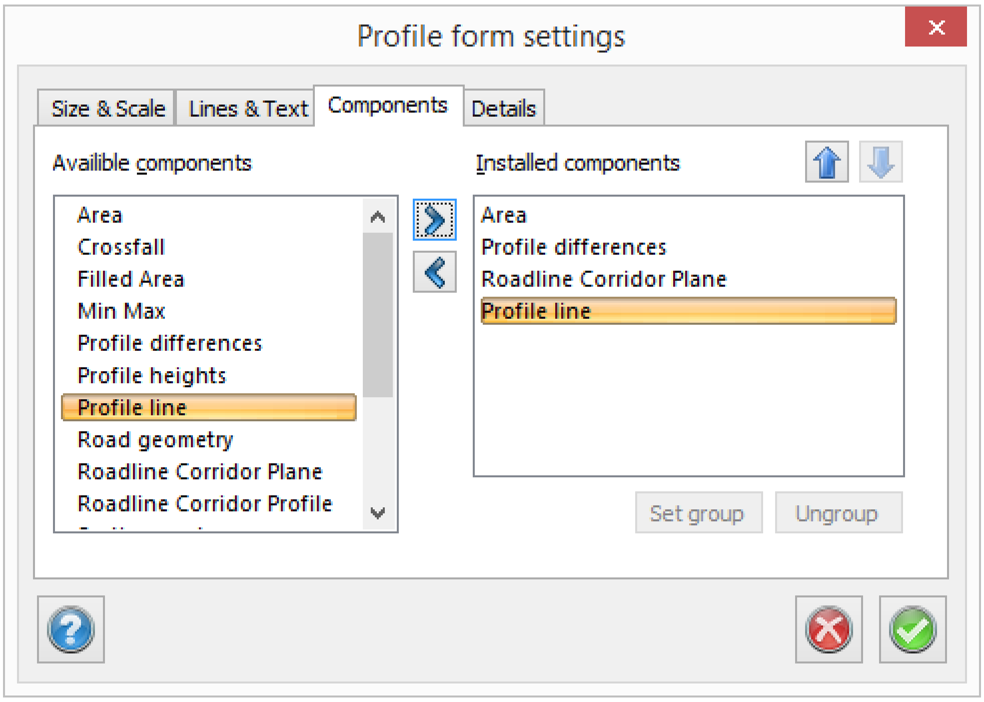
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

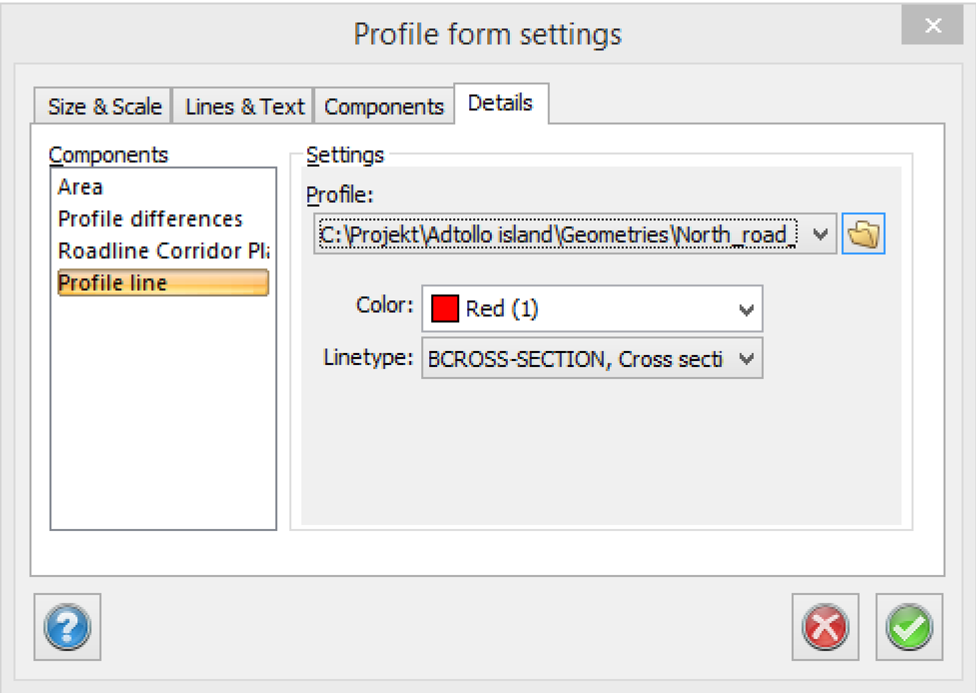
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



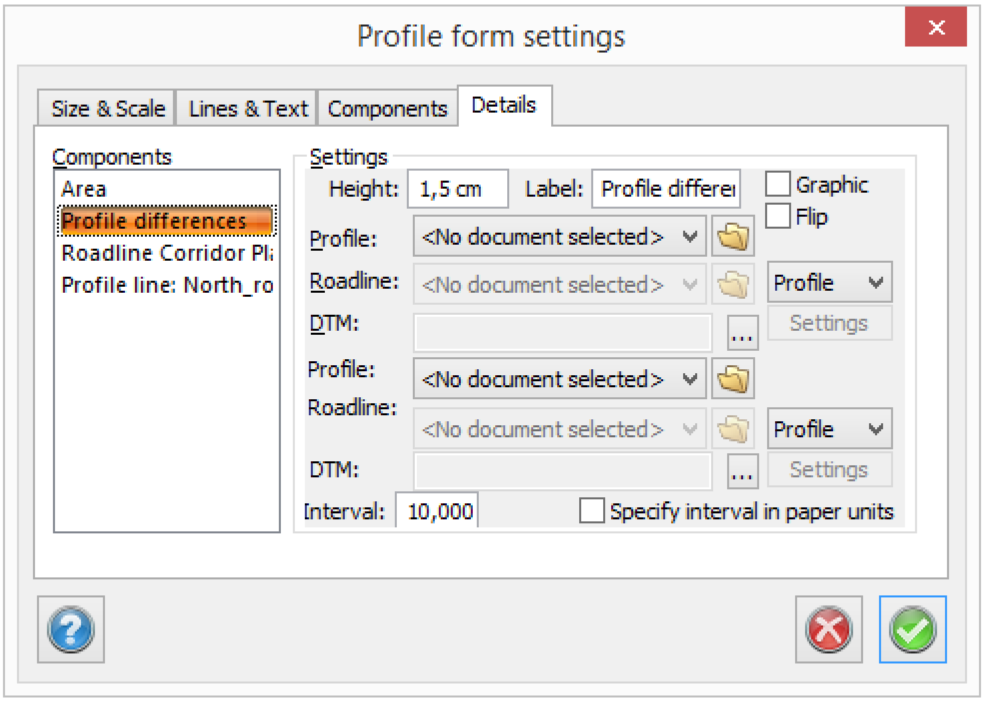
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

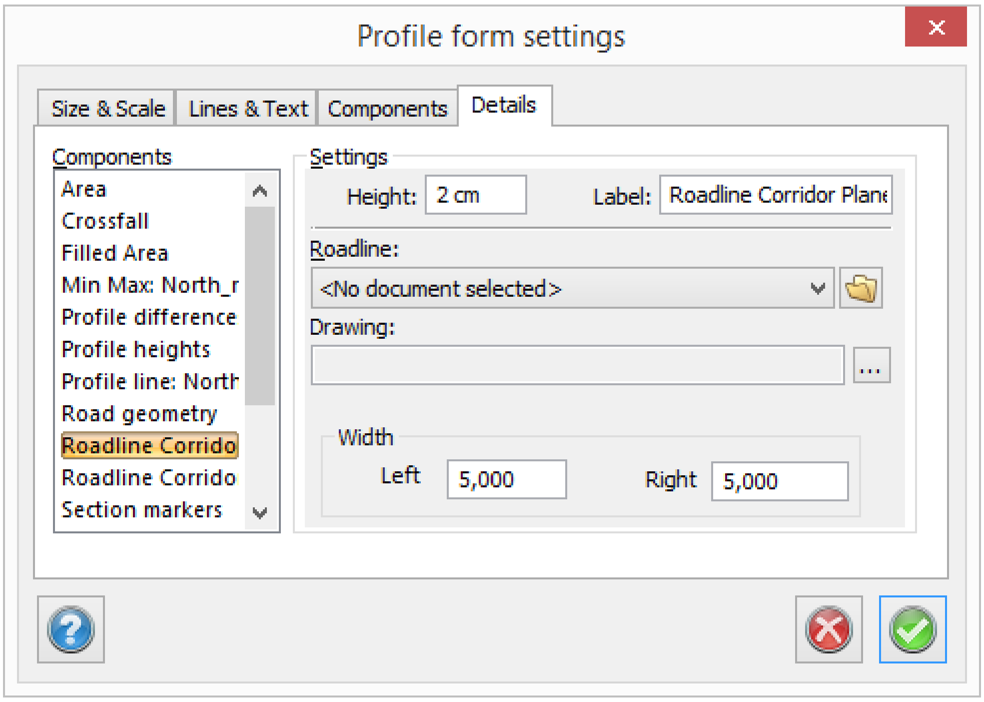
It is possible to display several different road profiles in the form.

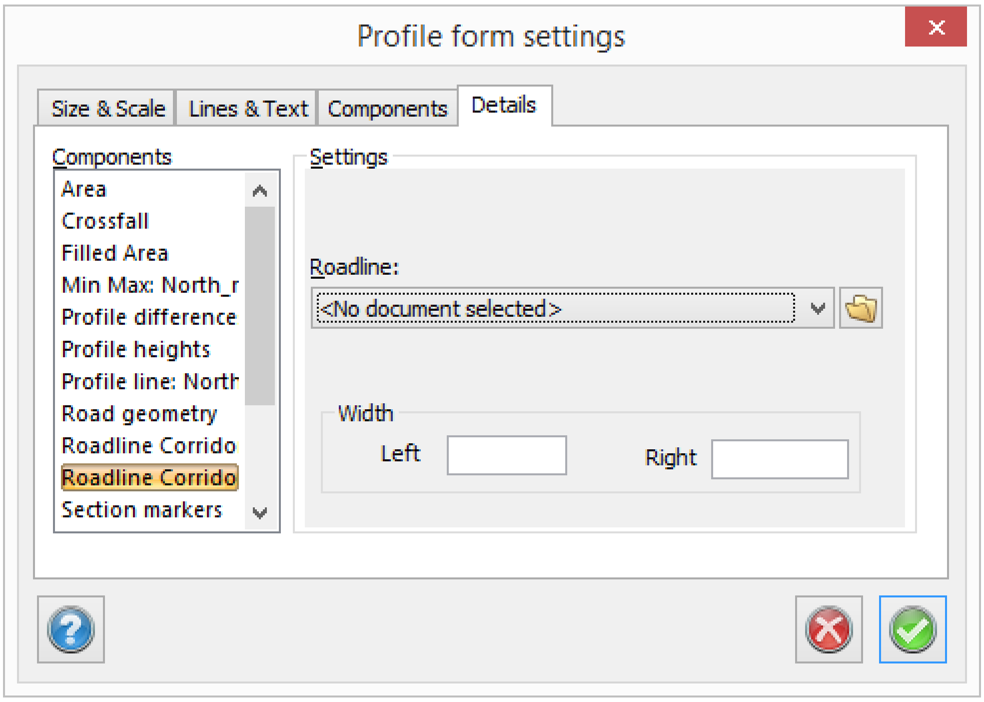
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



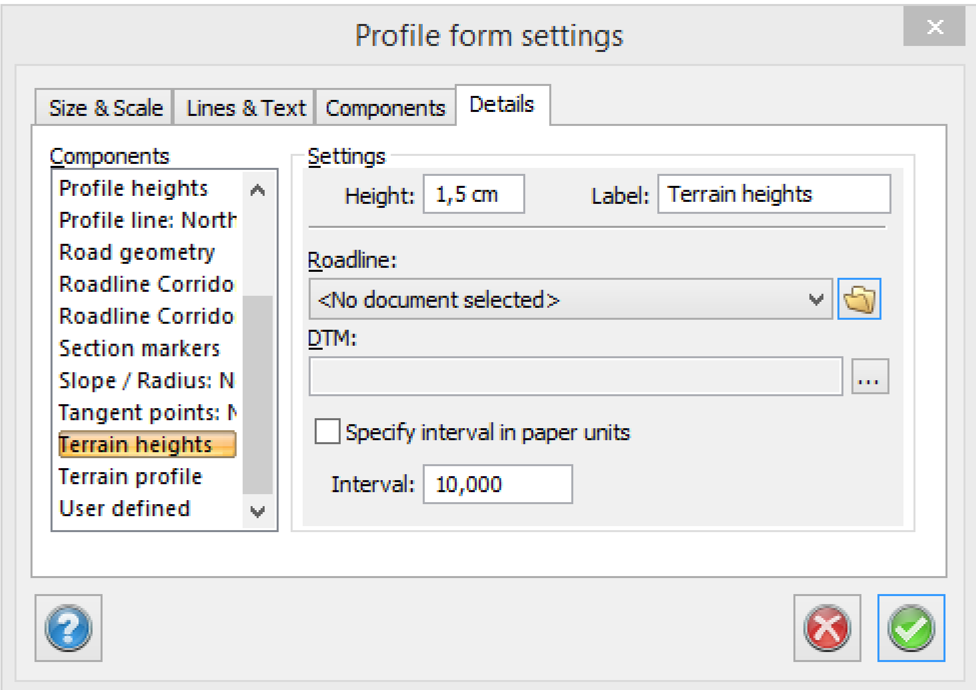
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

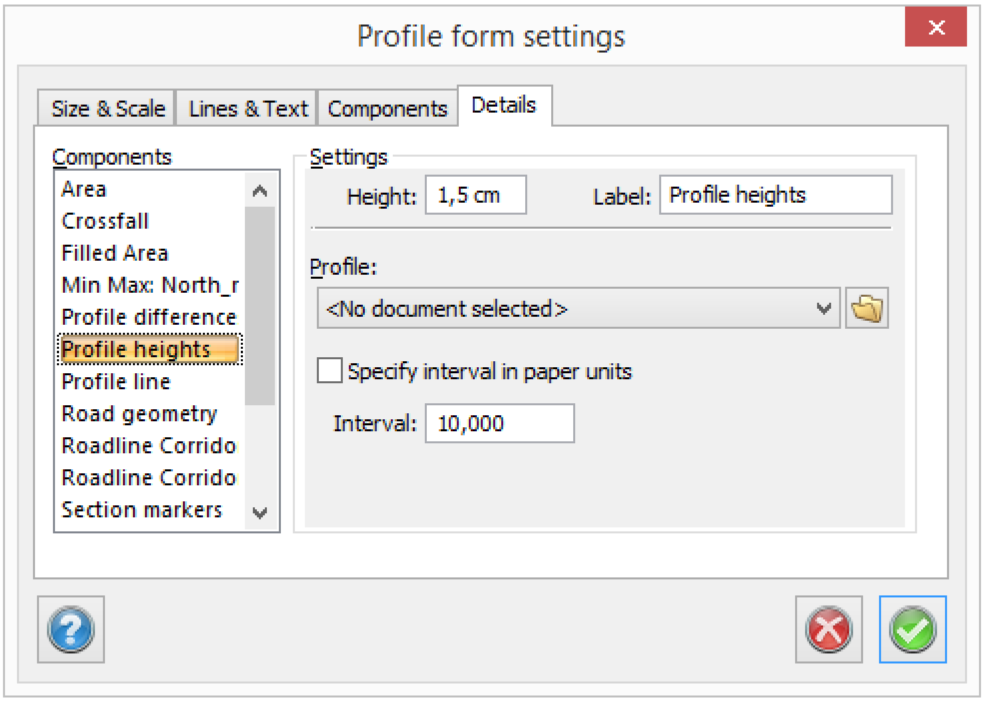
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

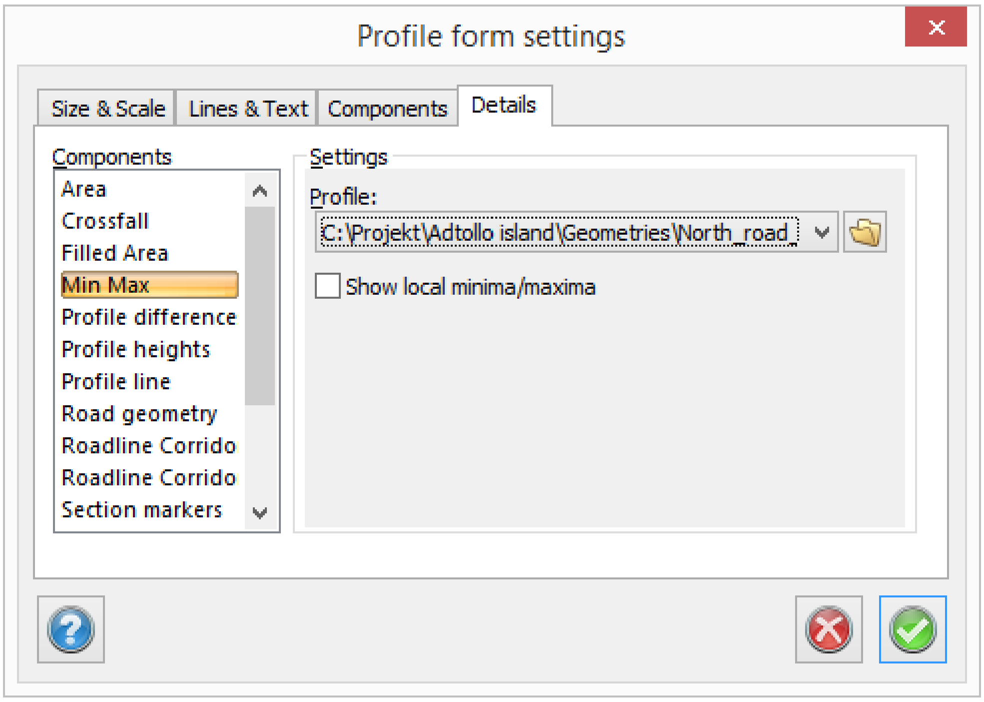
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

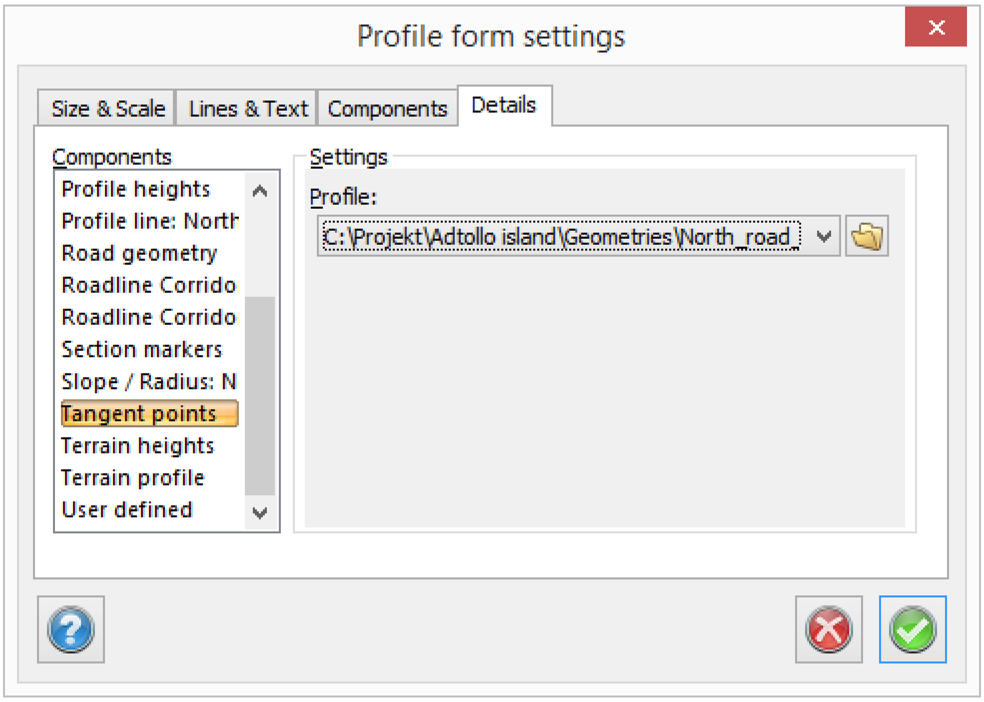
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

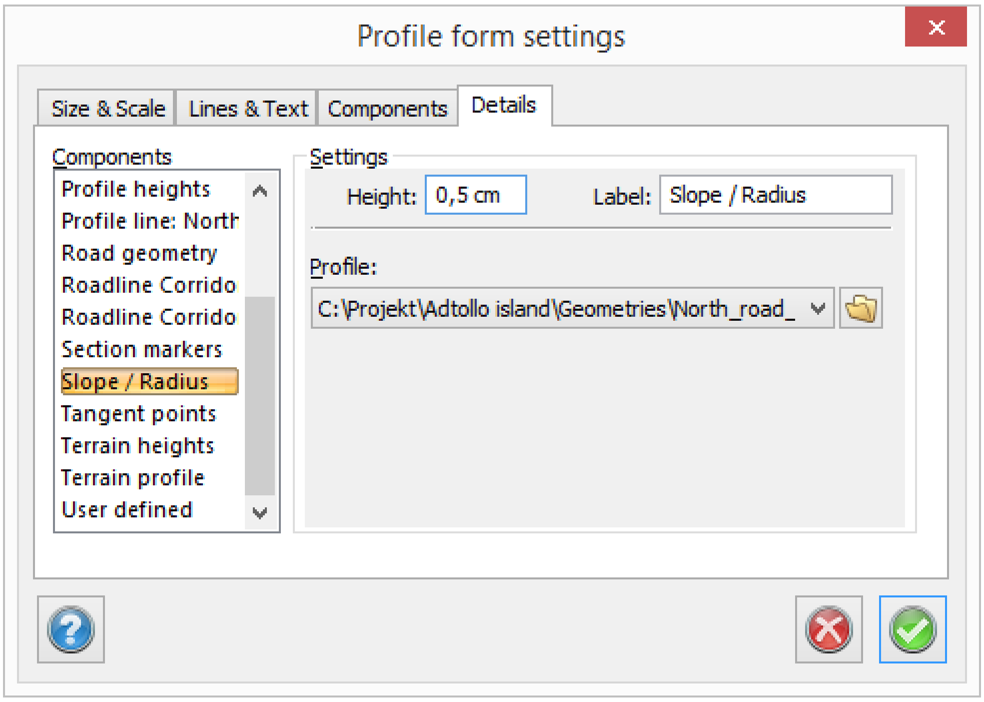
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

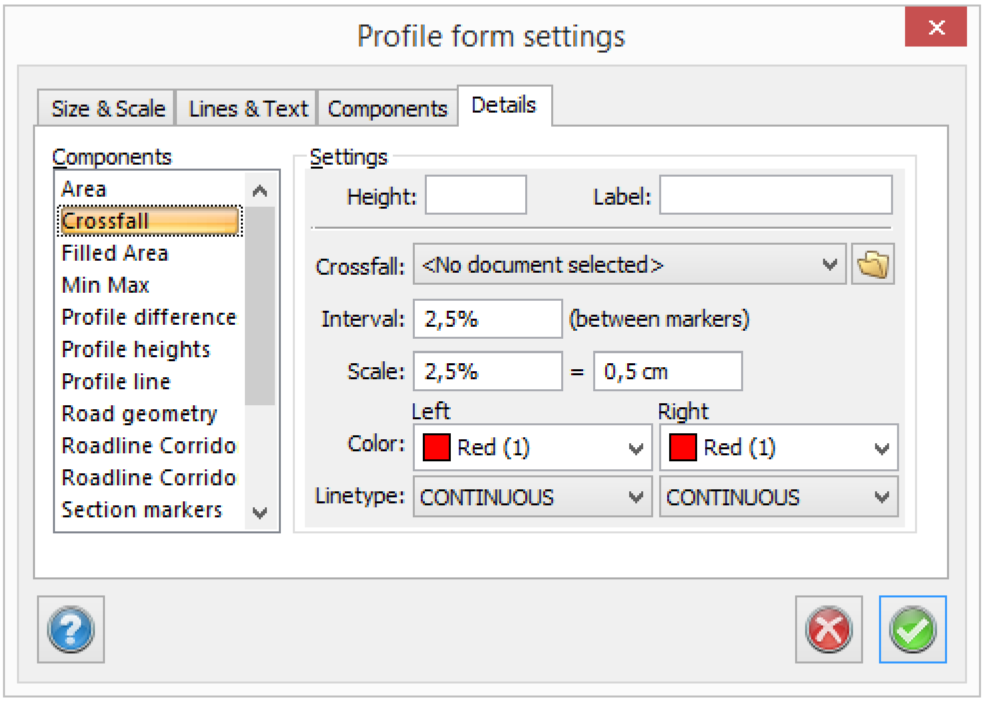
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

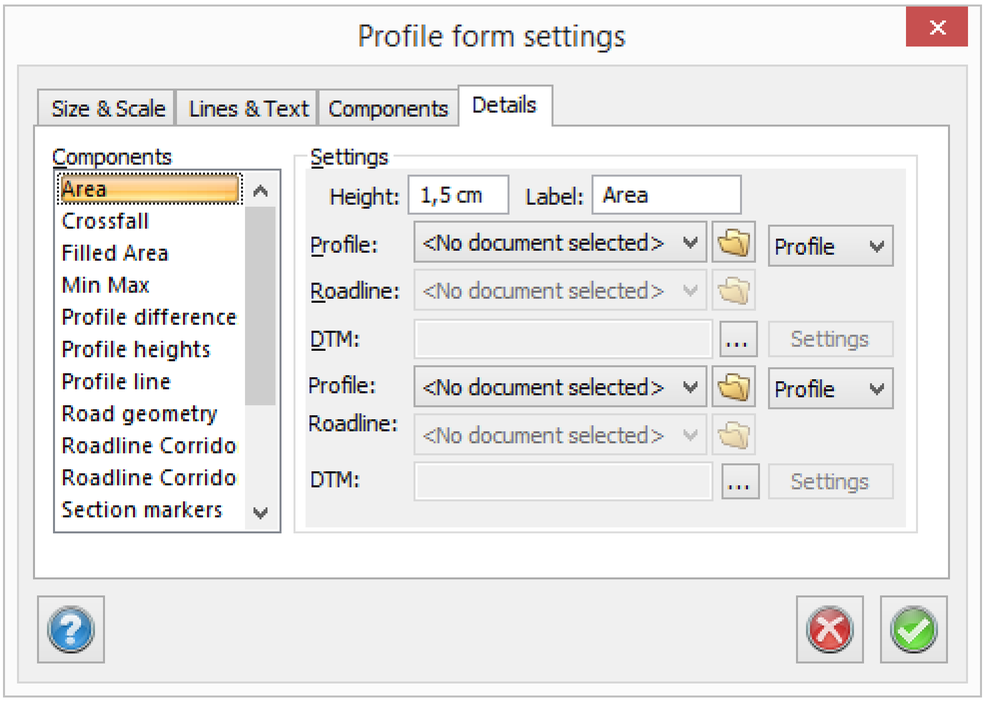
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

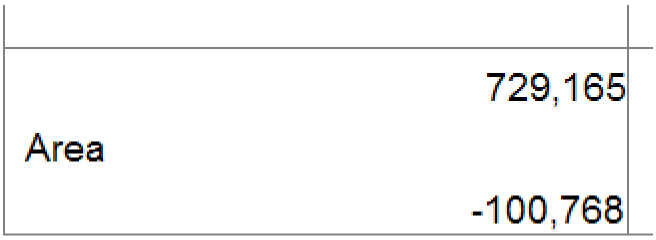
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

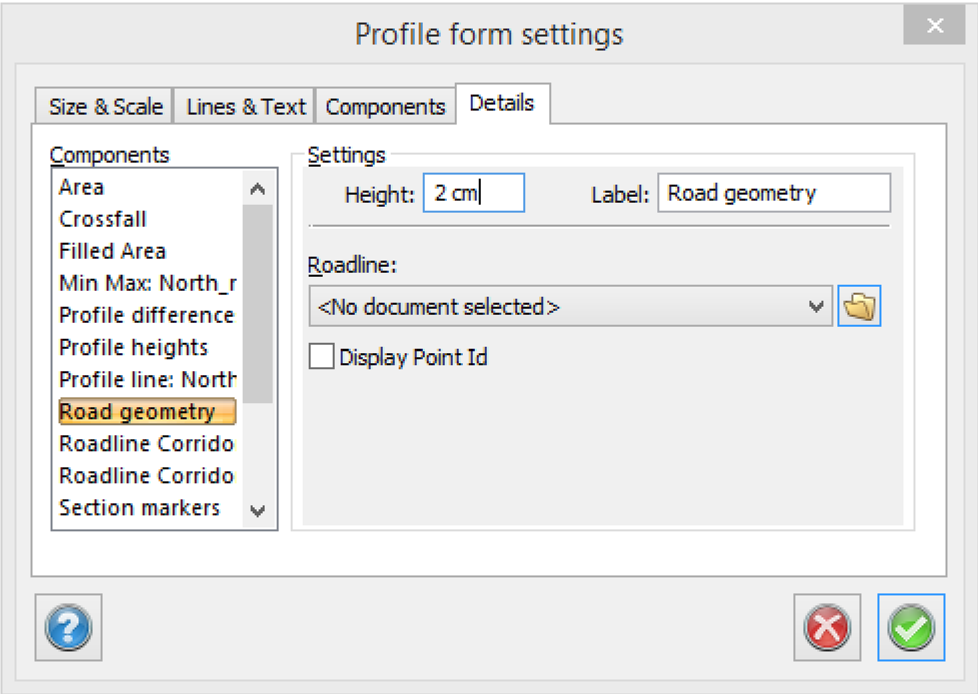


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

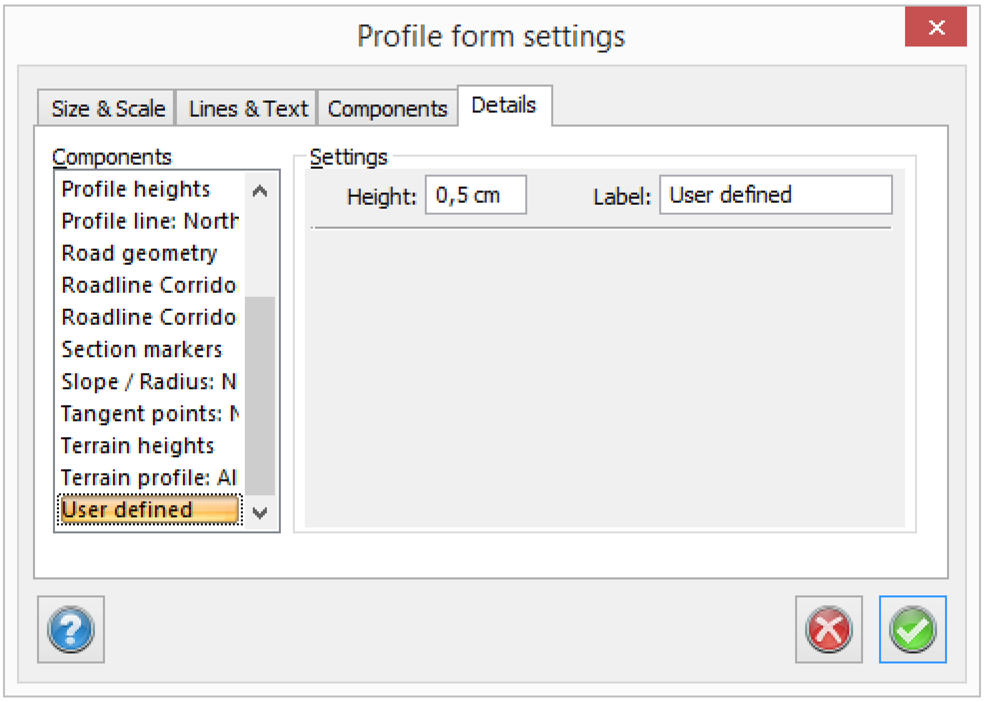
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

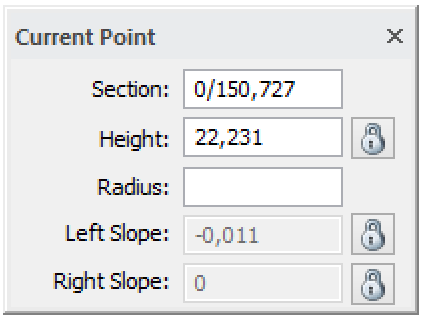
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

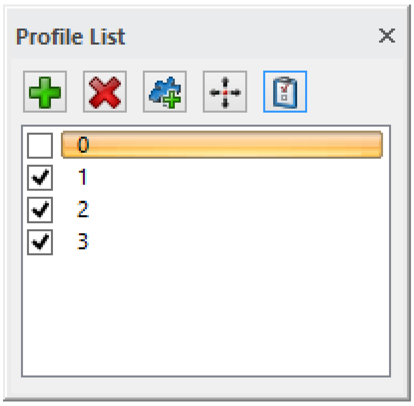
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



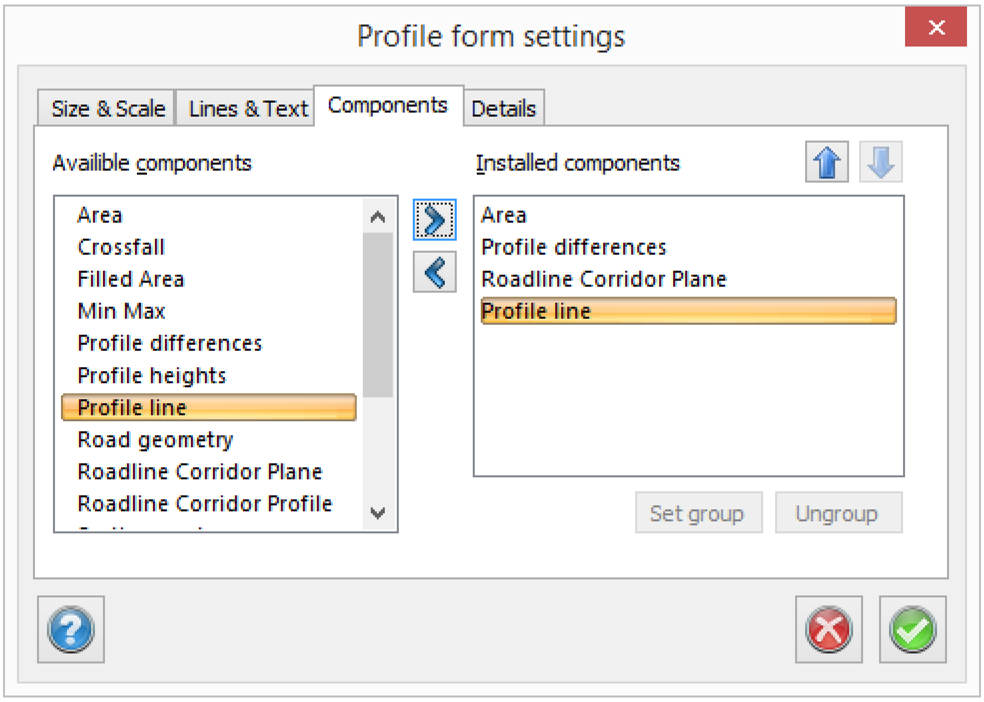
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

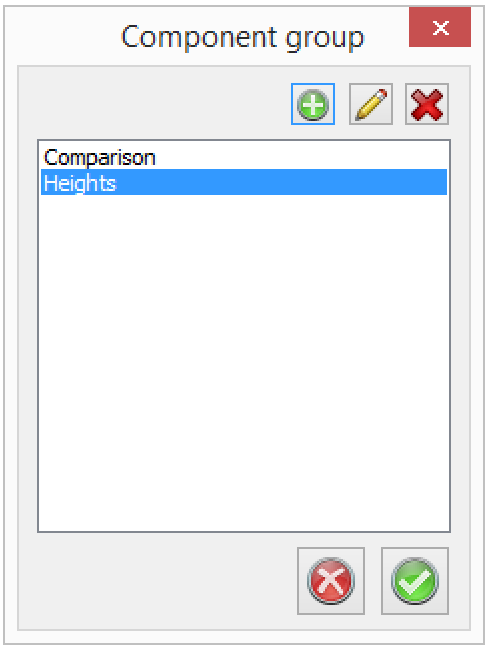
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

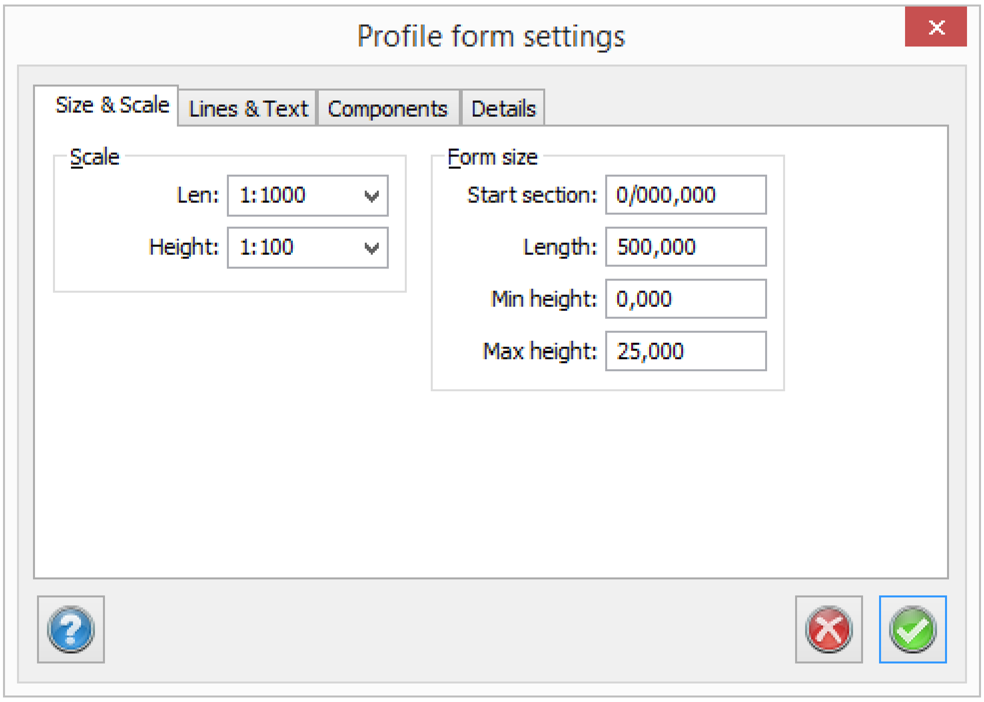
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

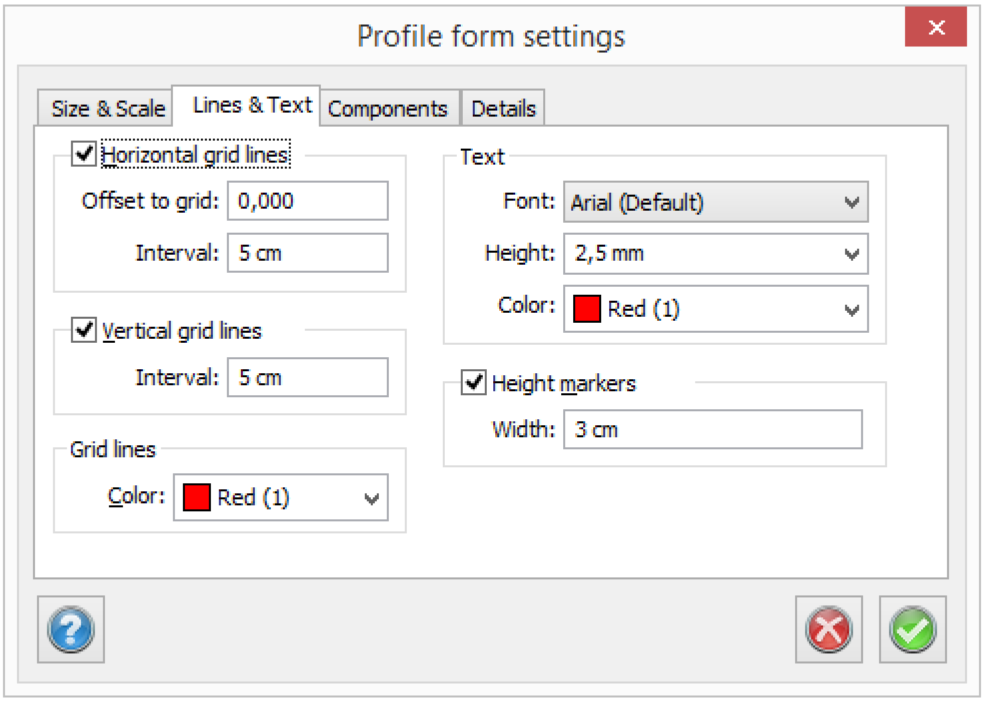


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

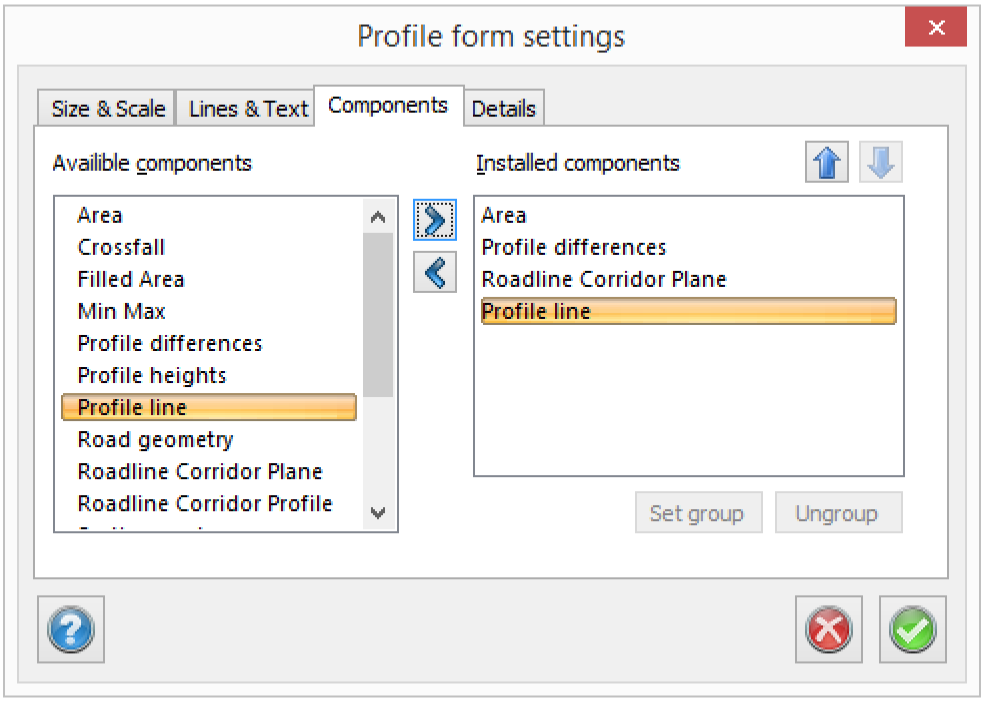
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

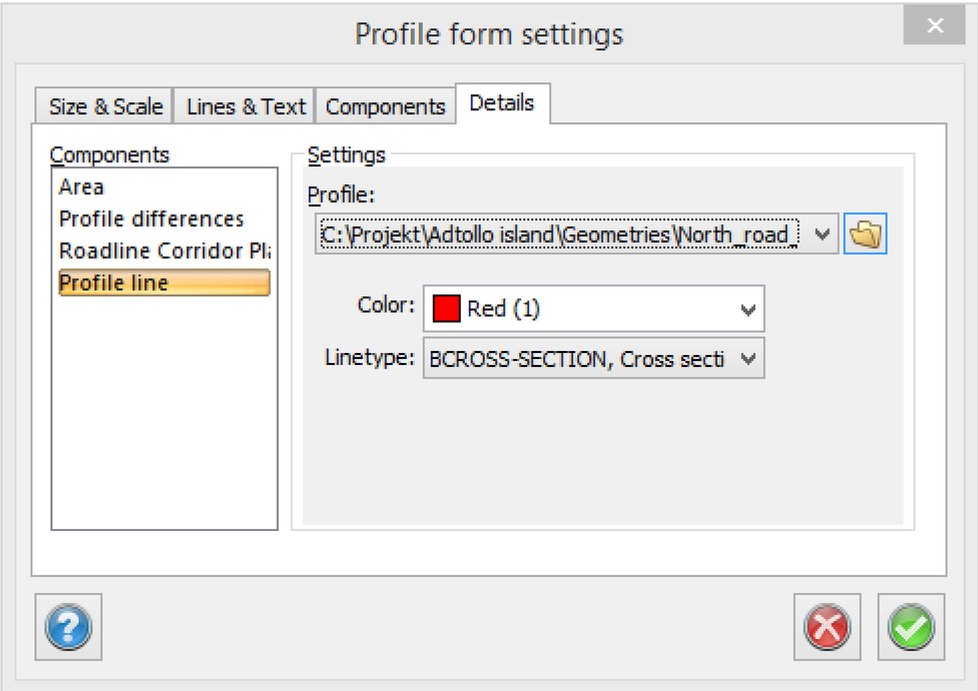
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



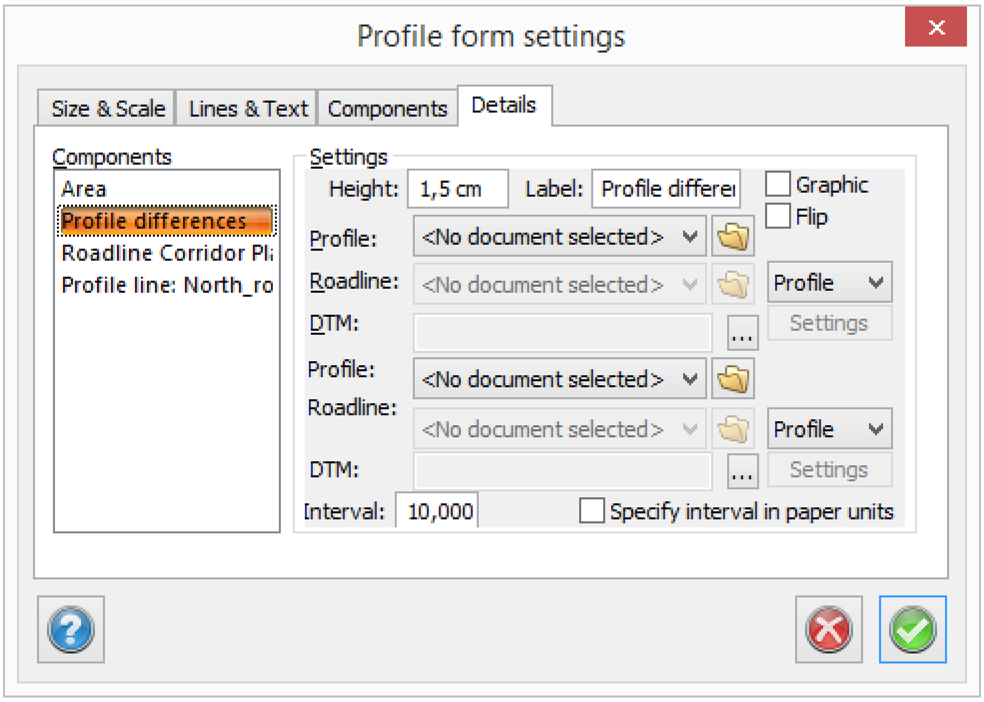
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

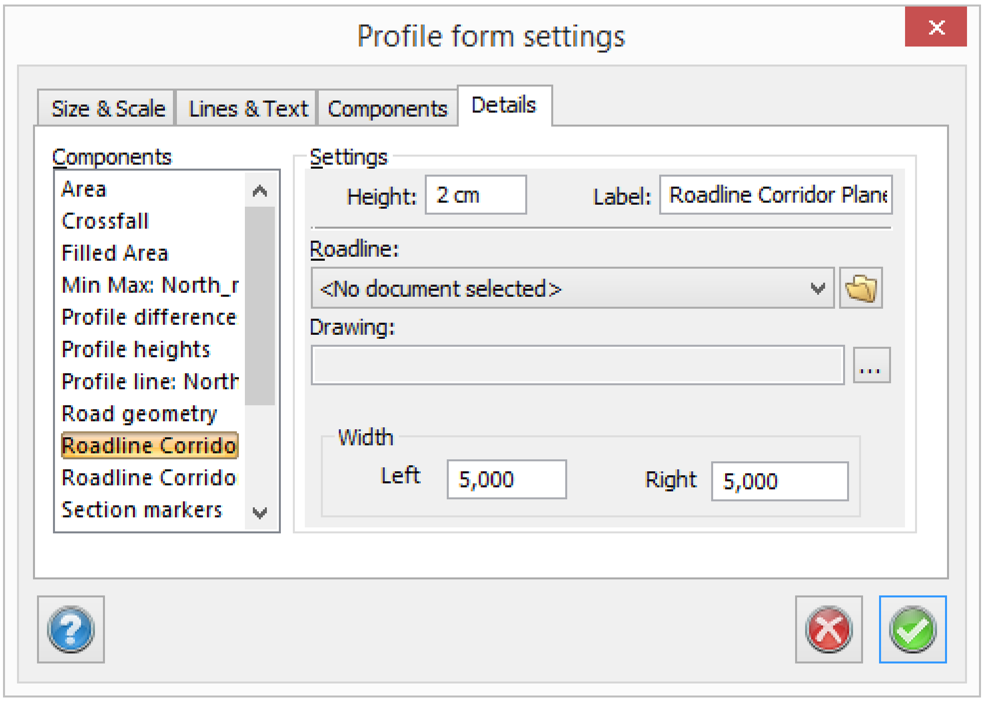
It is possible to display several different road profiles in the form.

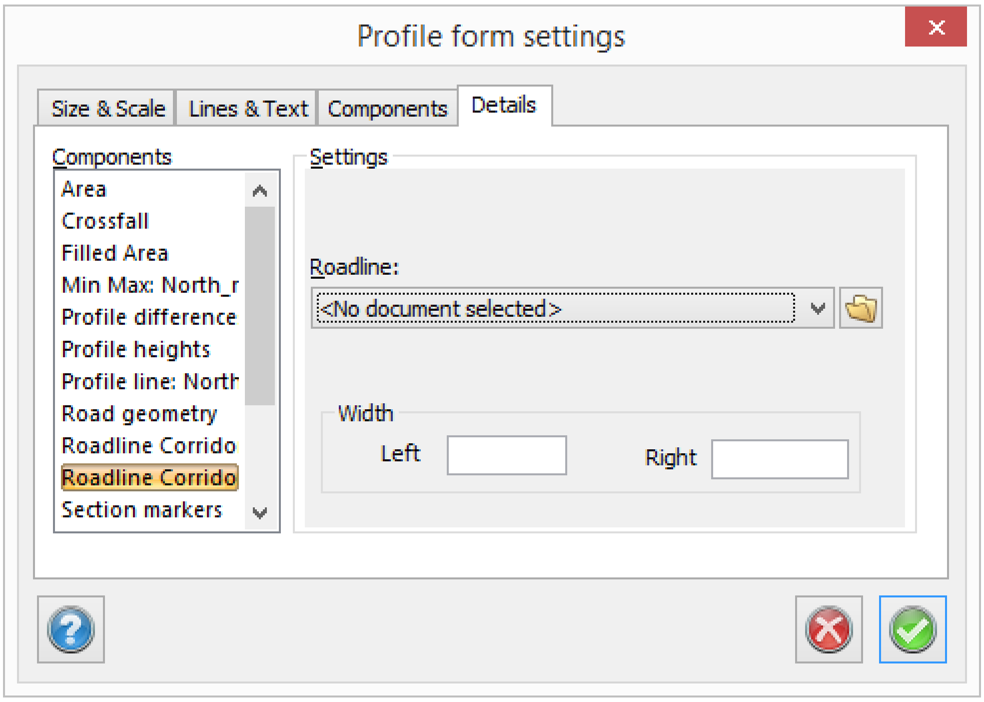
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



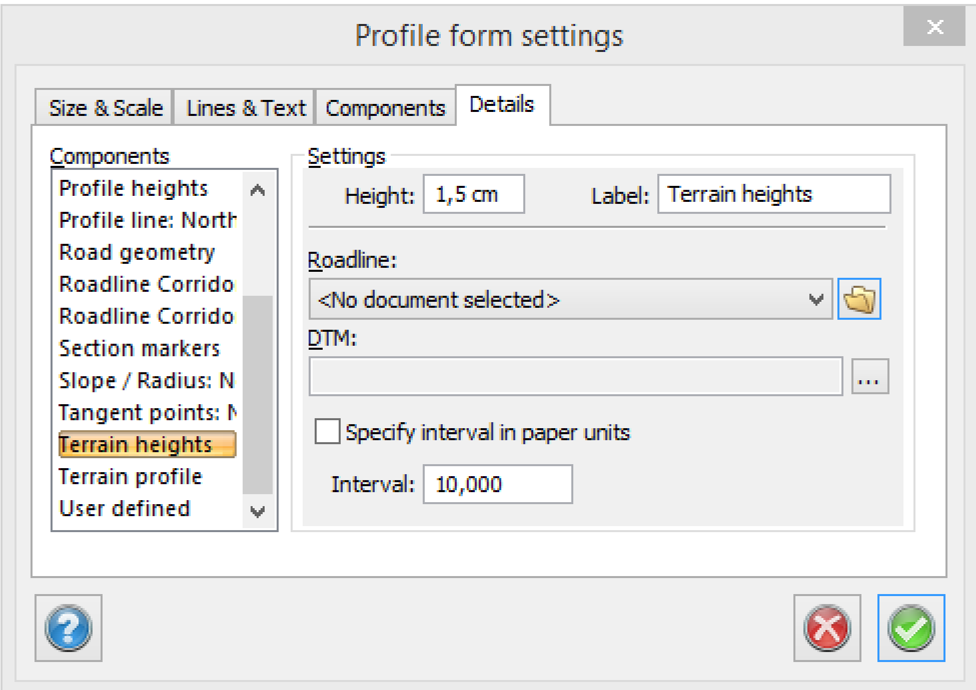
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

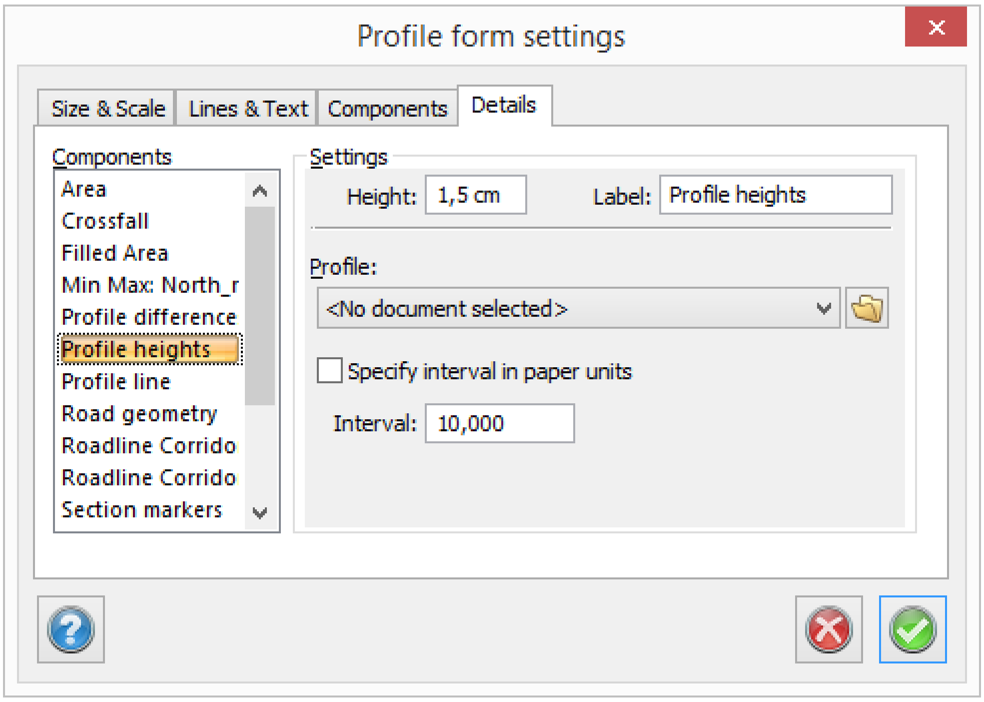
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

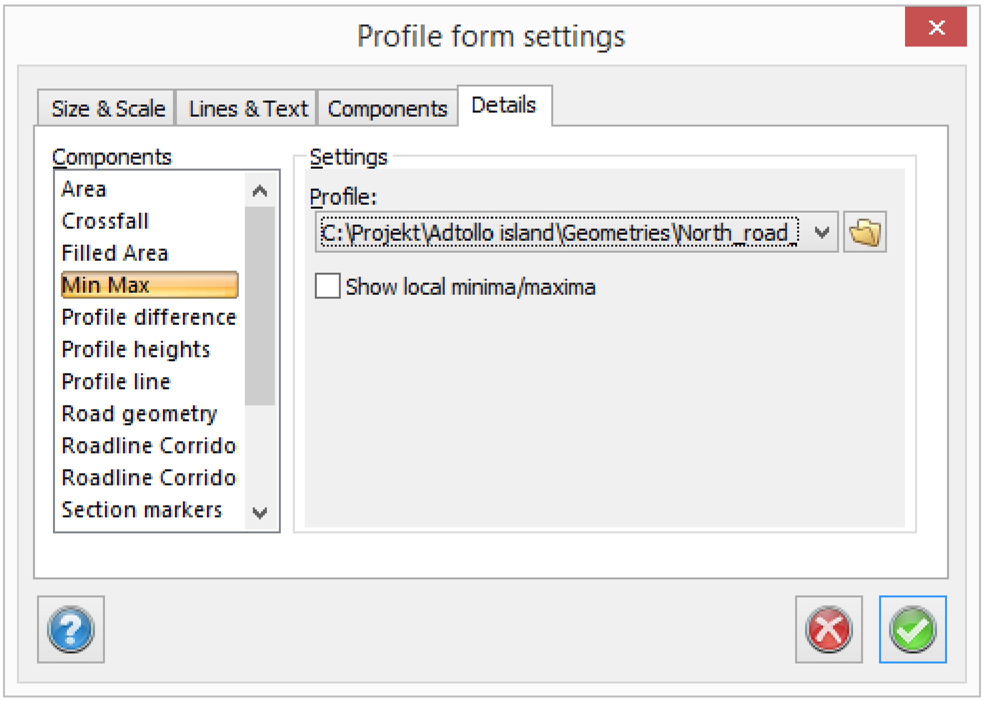
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

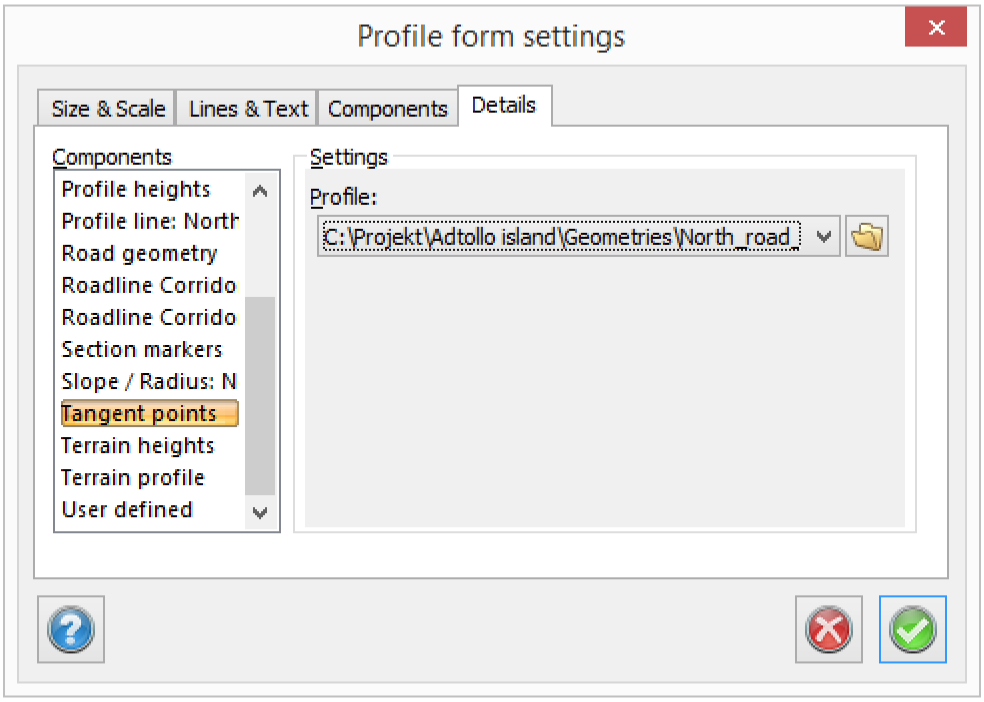
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

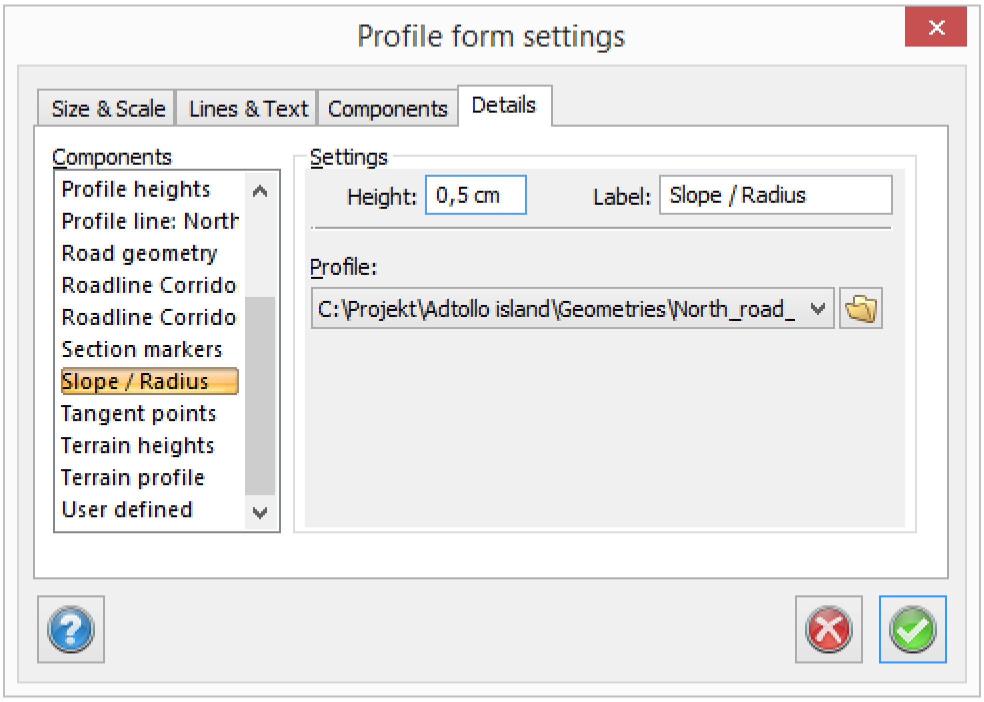
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

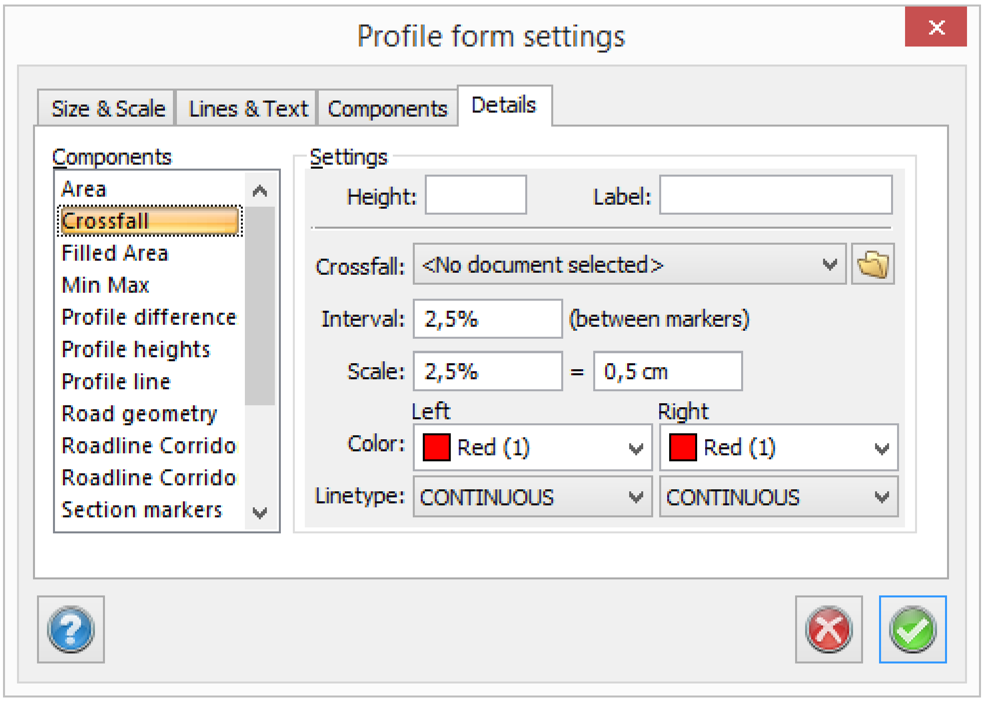
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

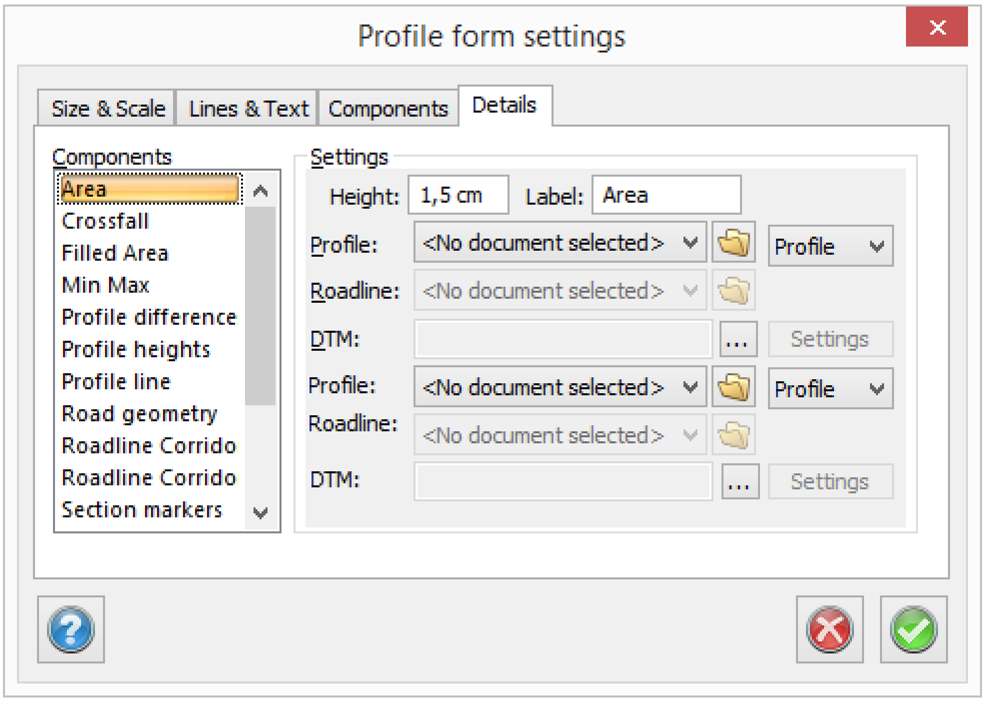
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

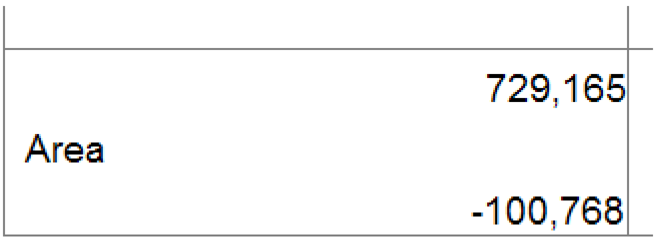
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

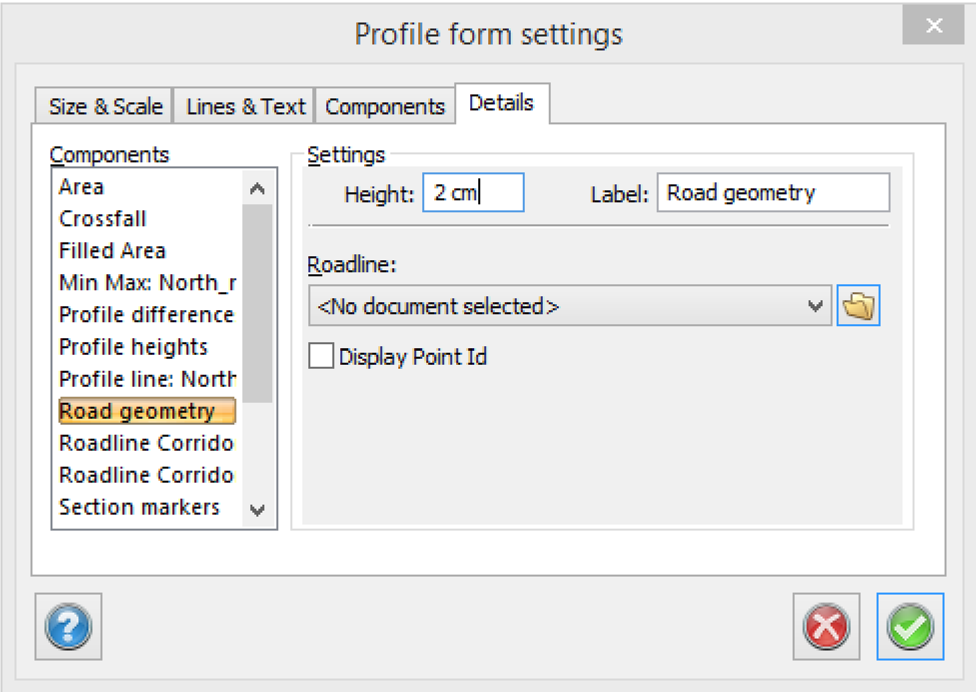


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

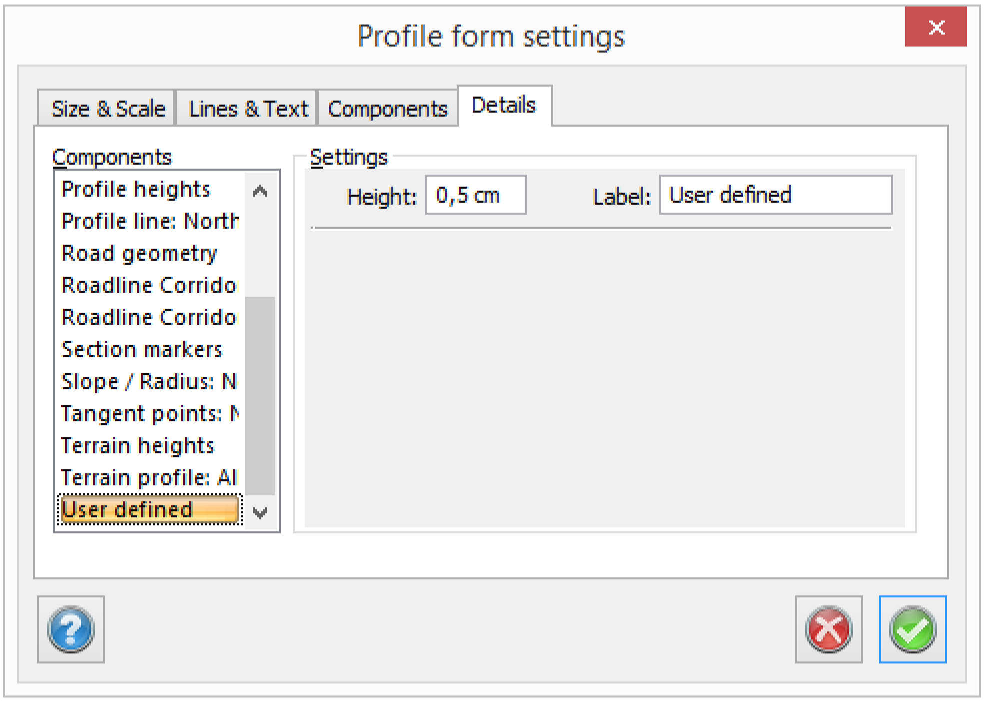
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

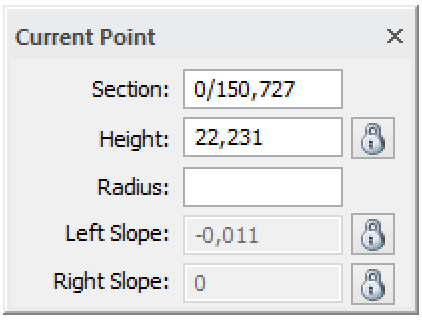
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct|Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

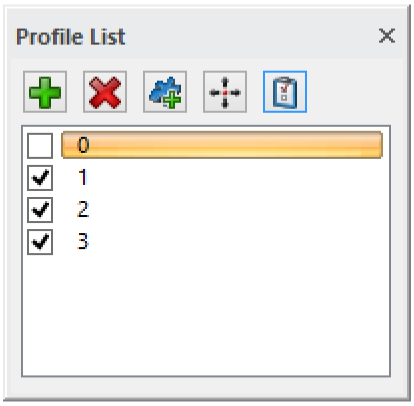
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



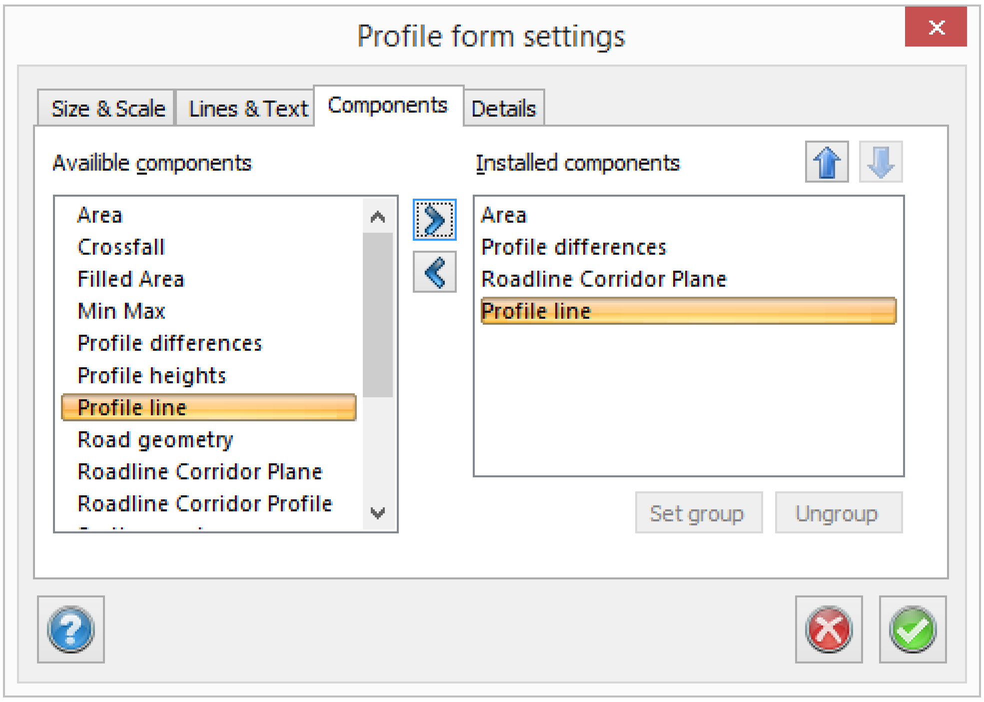
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



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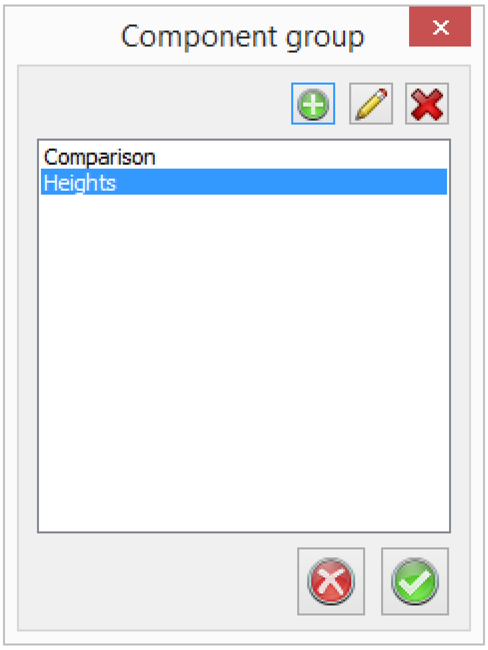

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See also:

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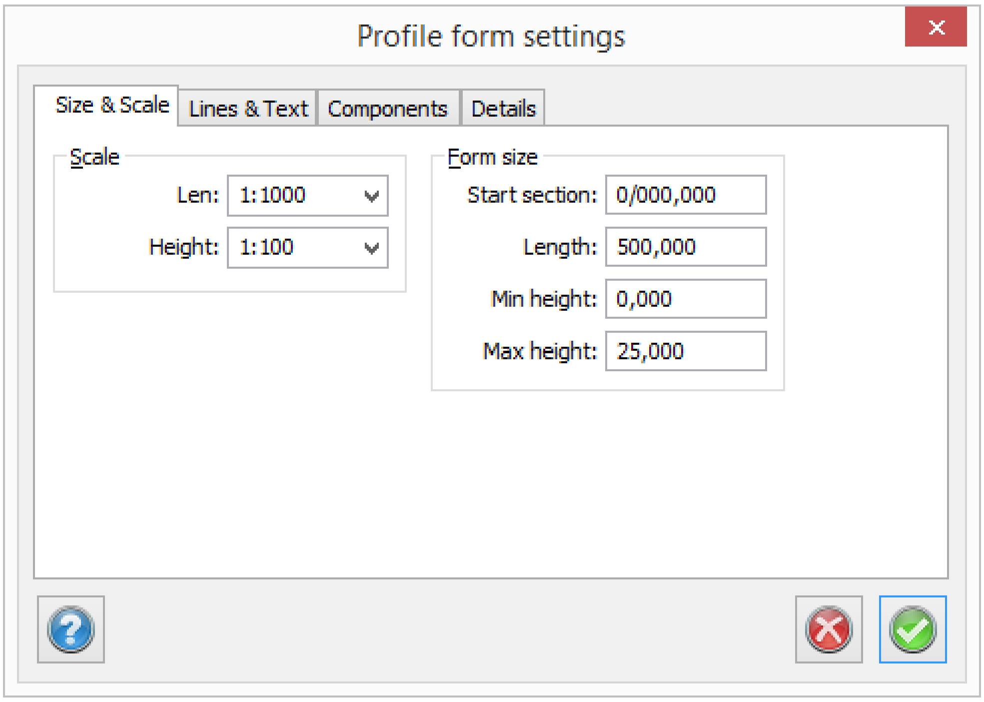
Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

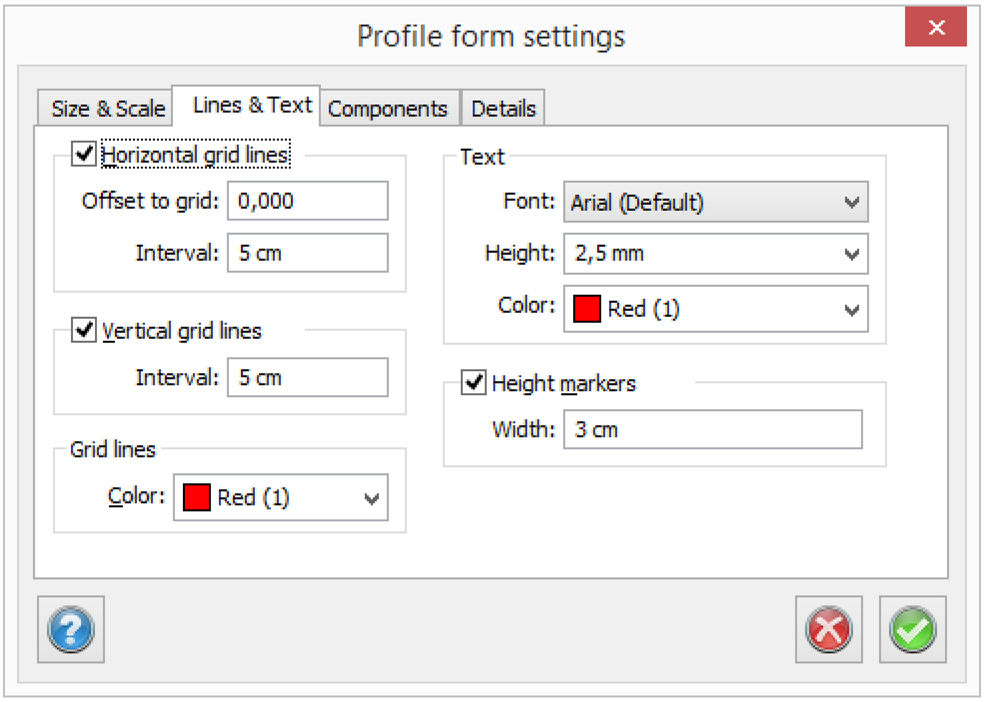


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

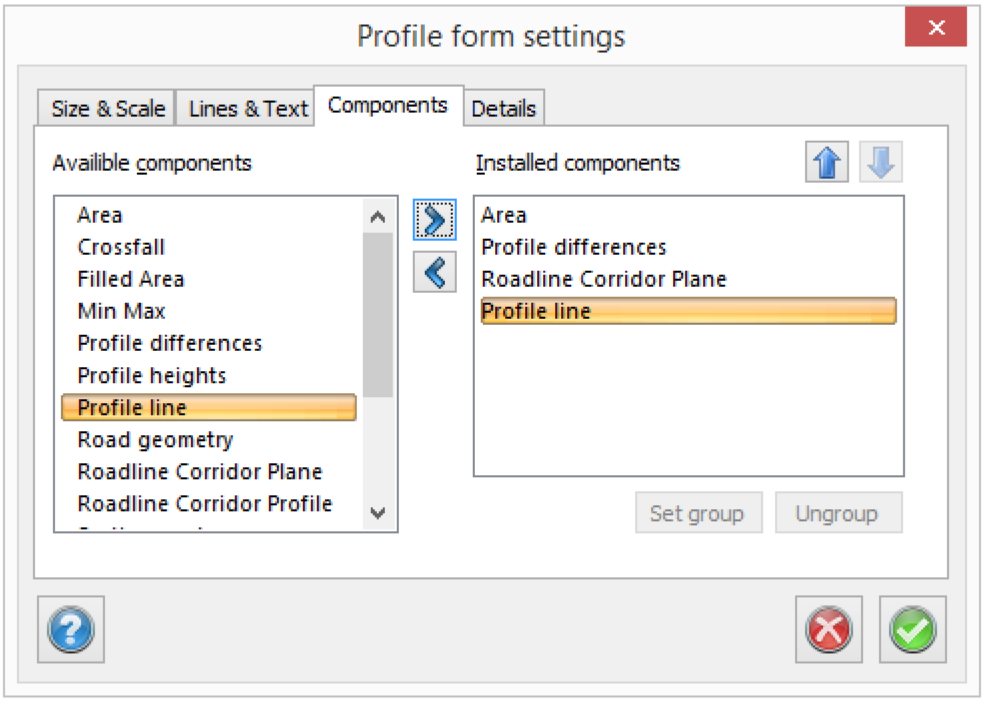
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



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- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
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- Terrain heights
- Terrain profile
- User defined

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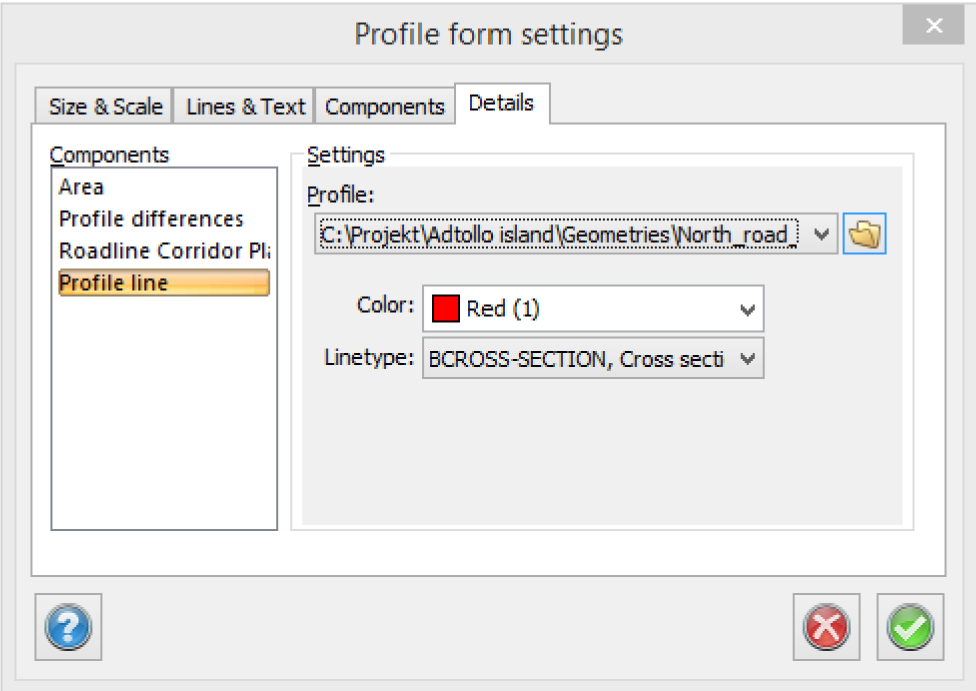
Details, profile line



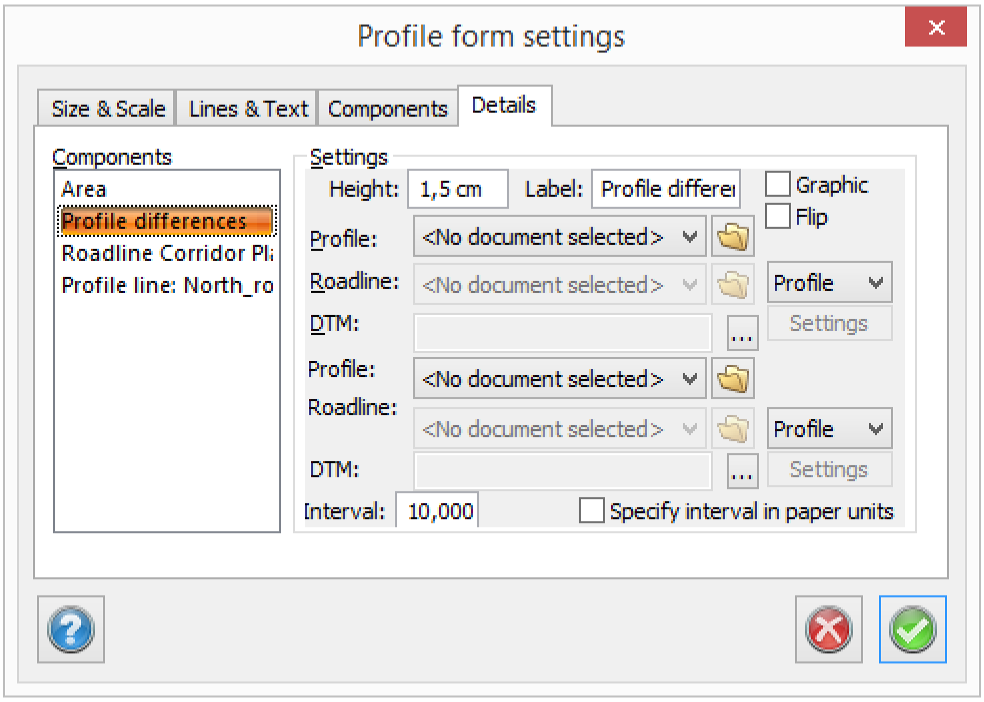
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

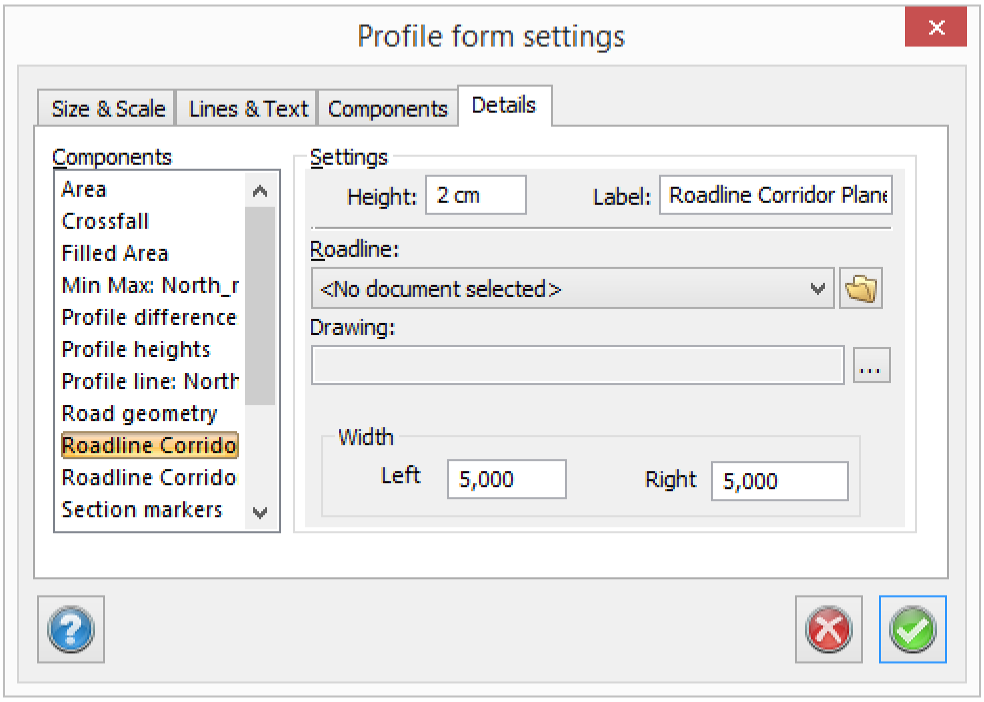
It is possible to display several different road profiles in the form.

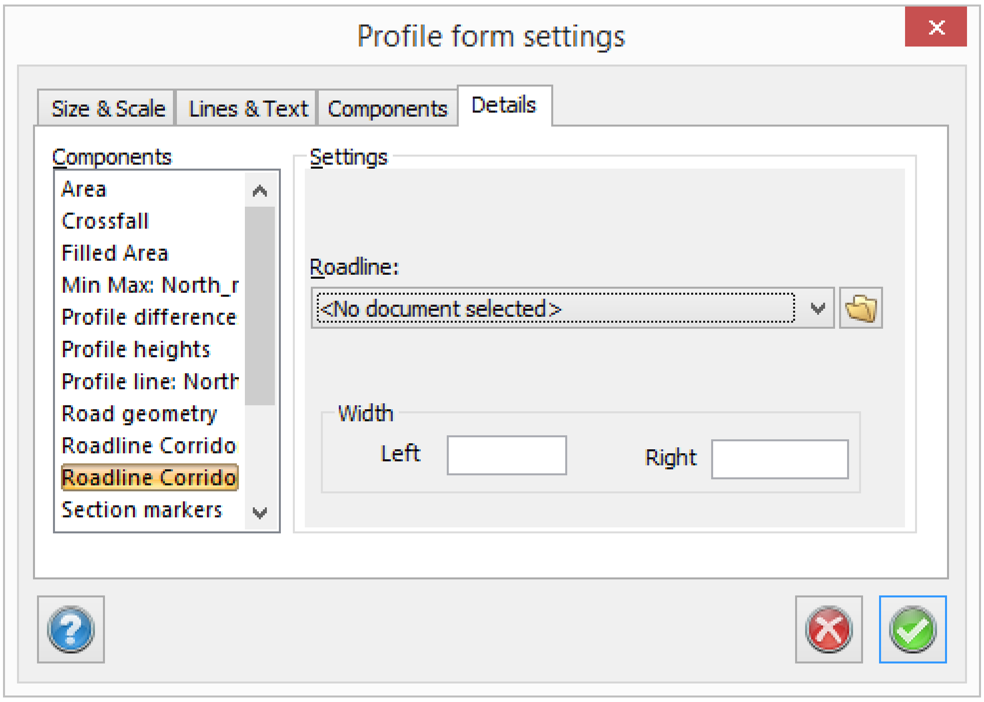
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



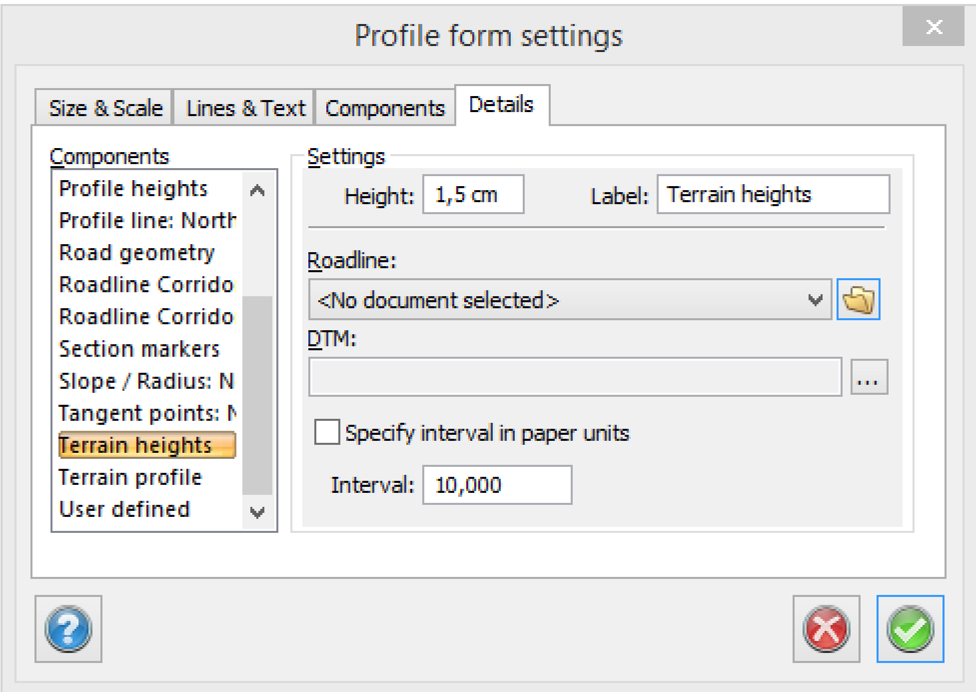
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

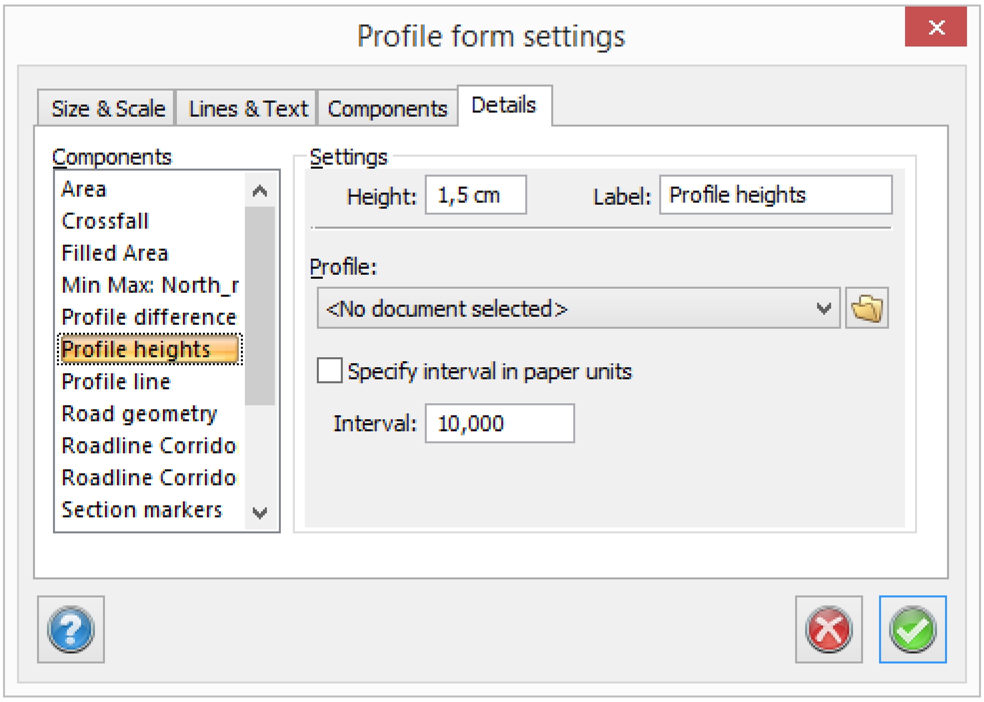
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

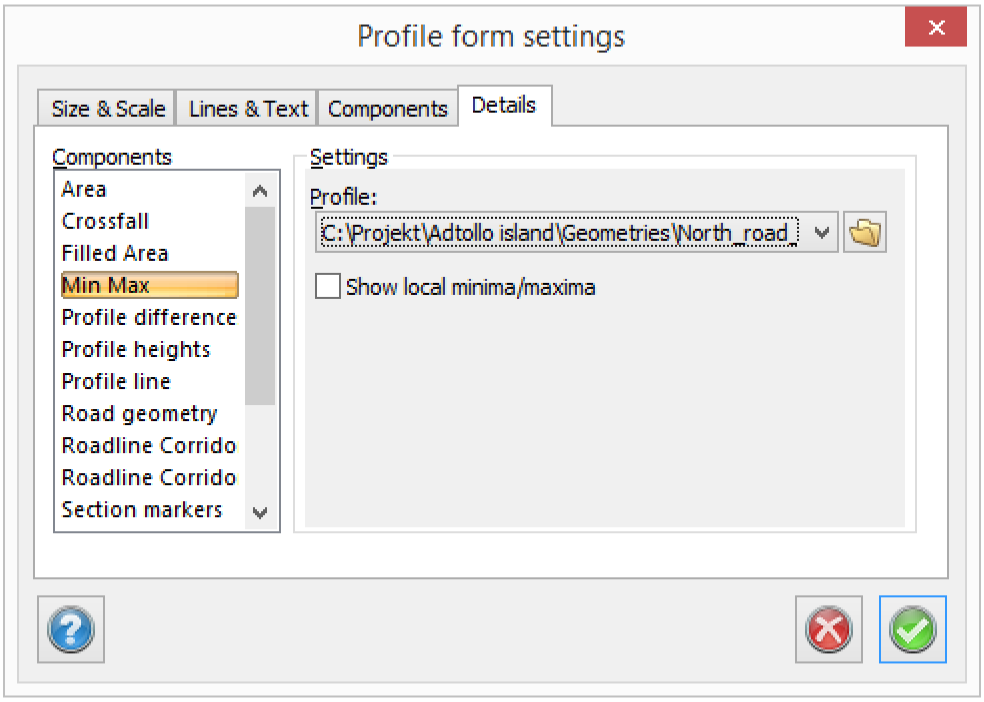
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

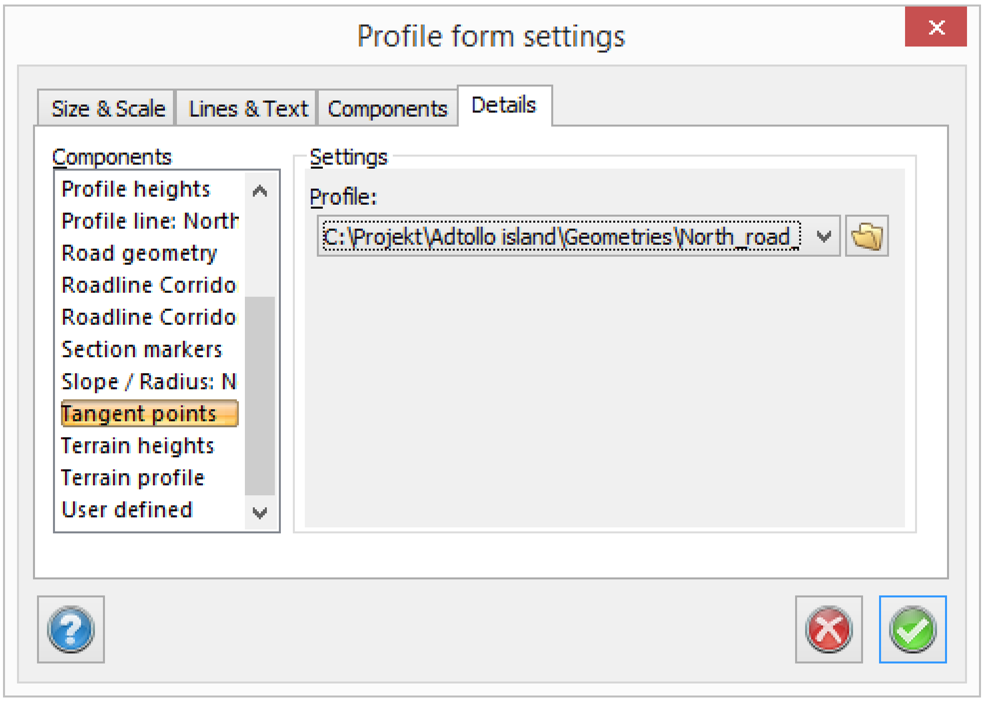
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

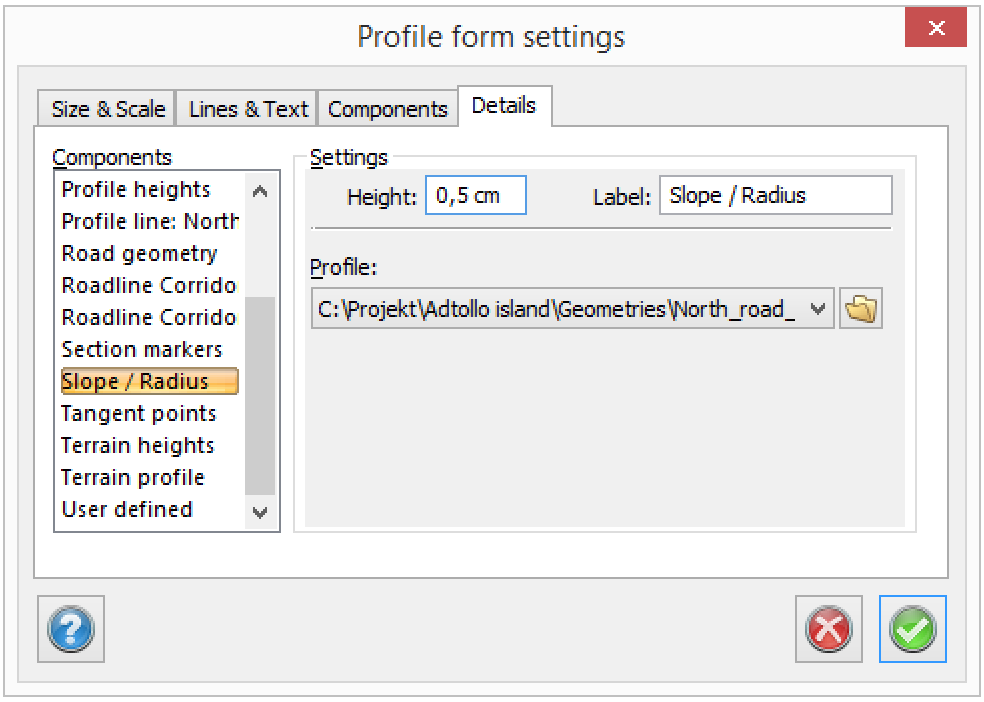
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

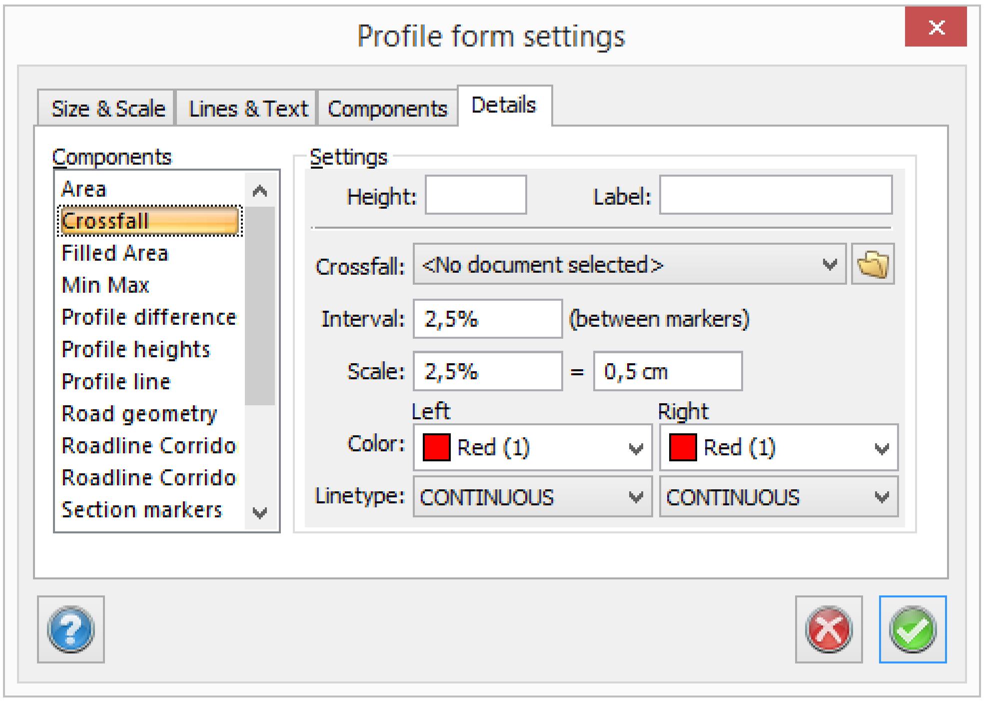
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

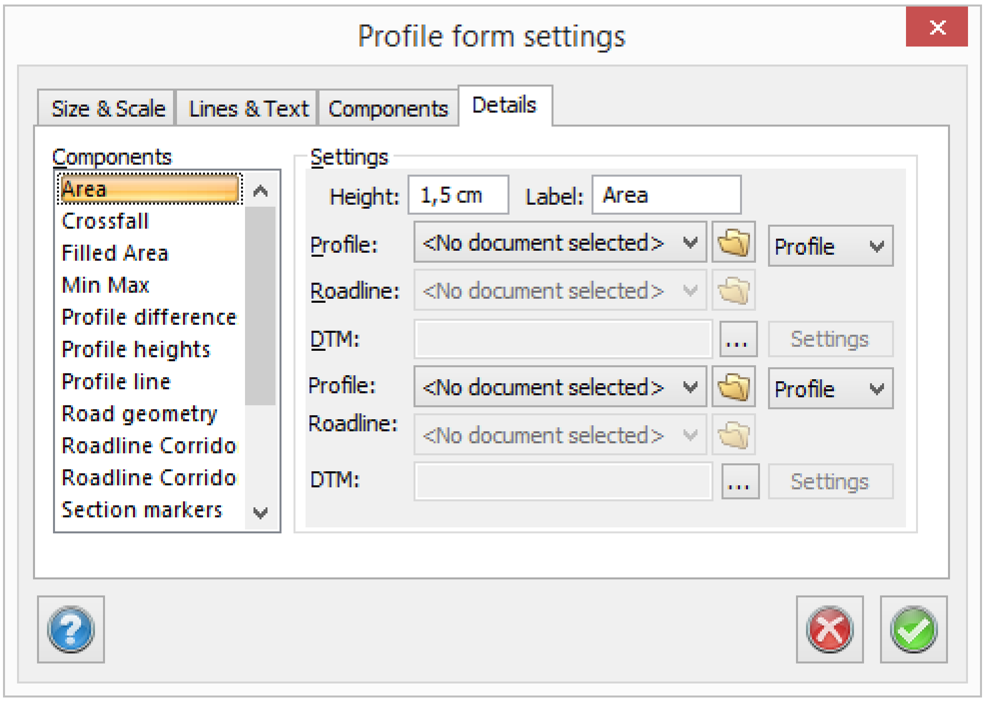
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

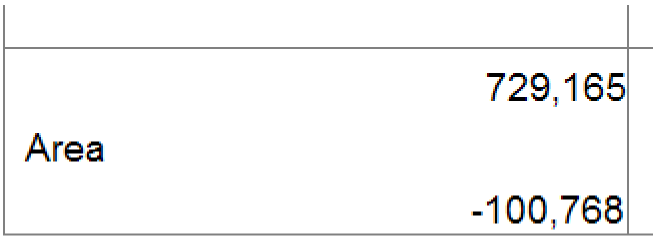
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

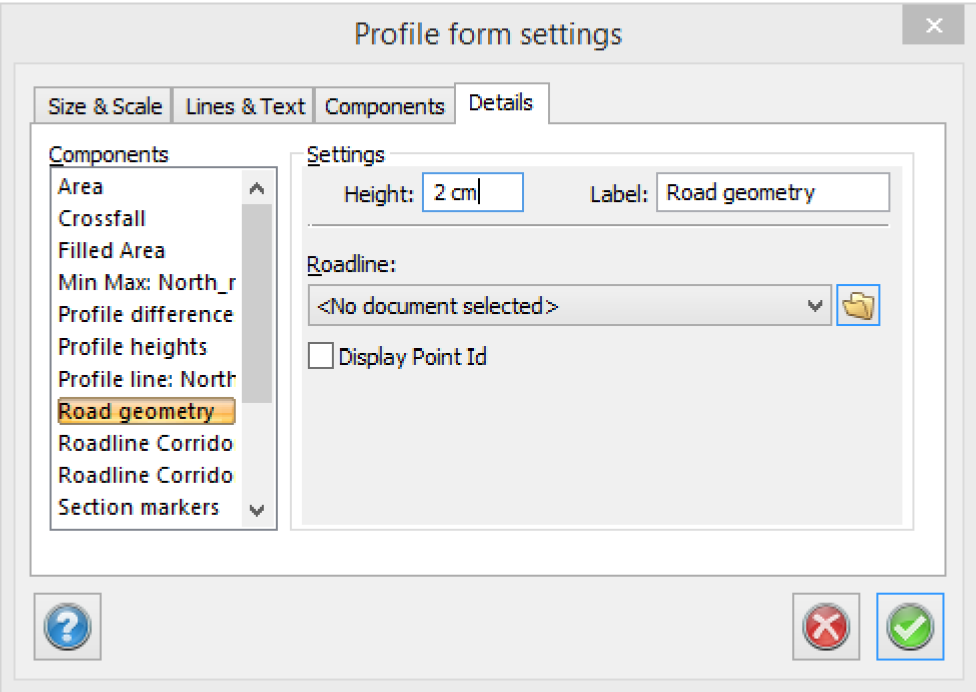


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

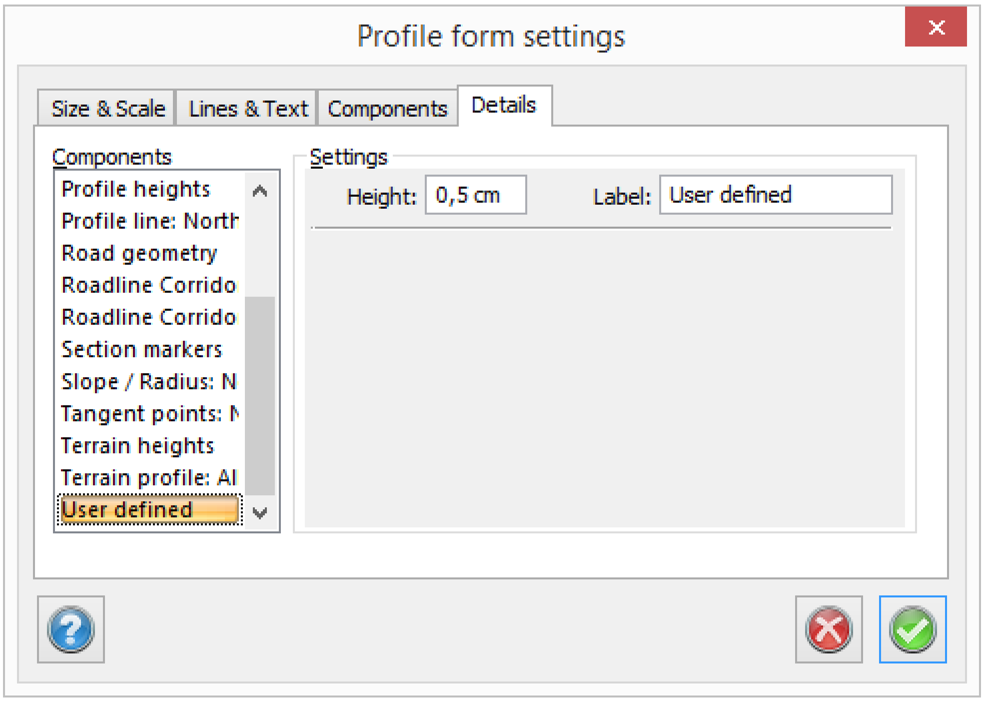
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

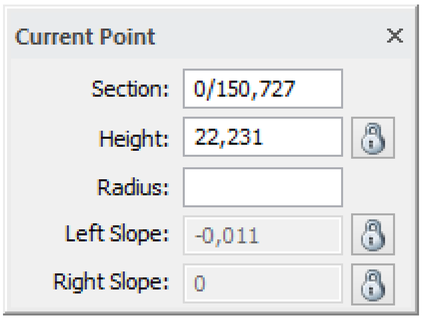
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

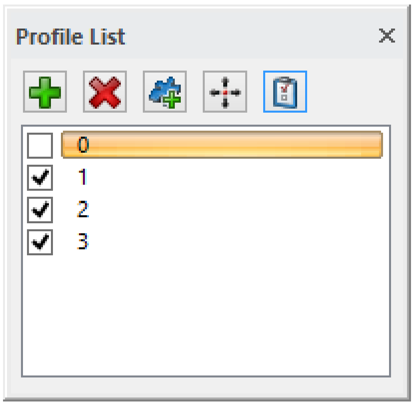
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



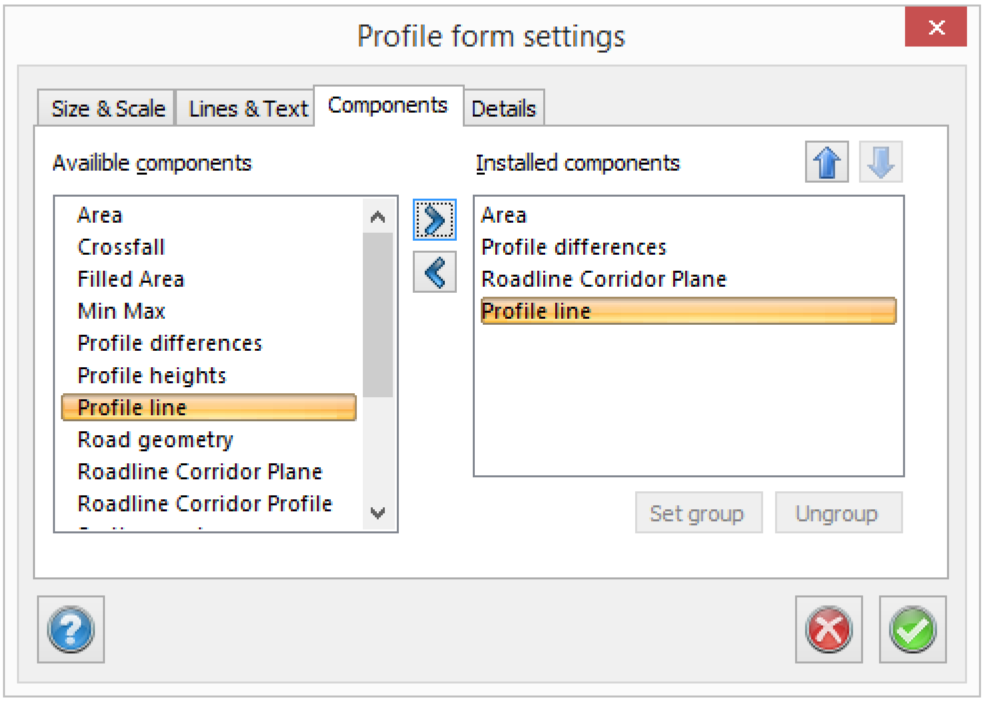
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

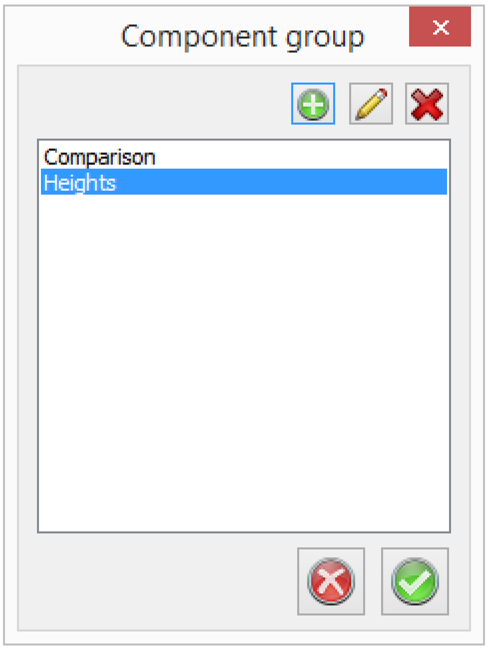
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

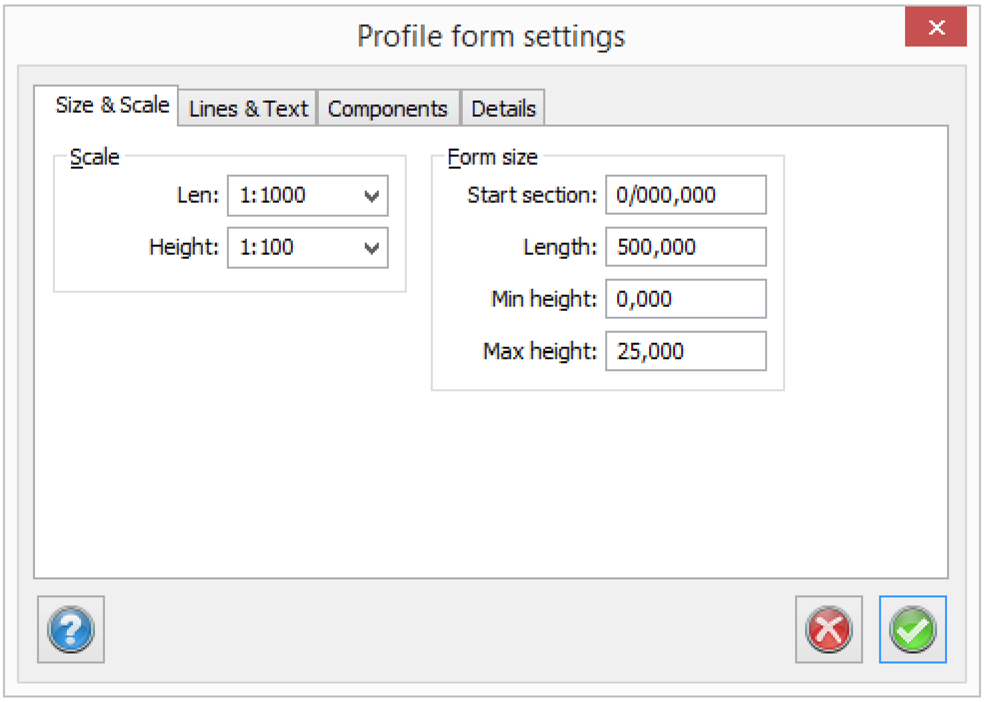
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

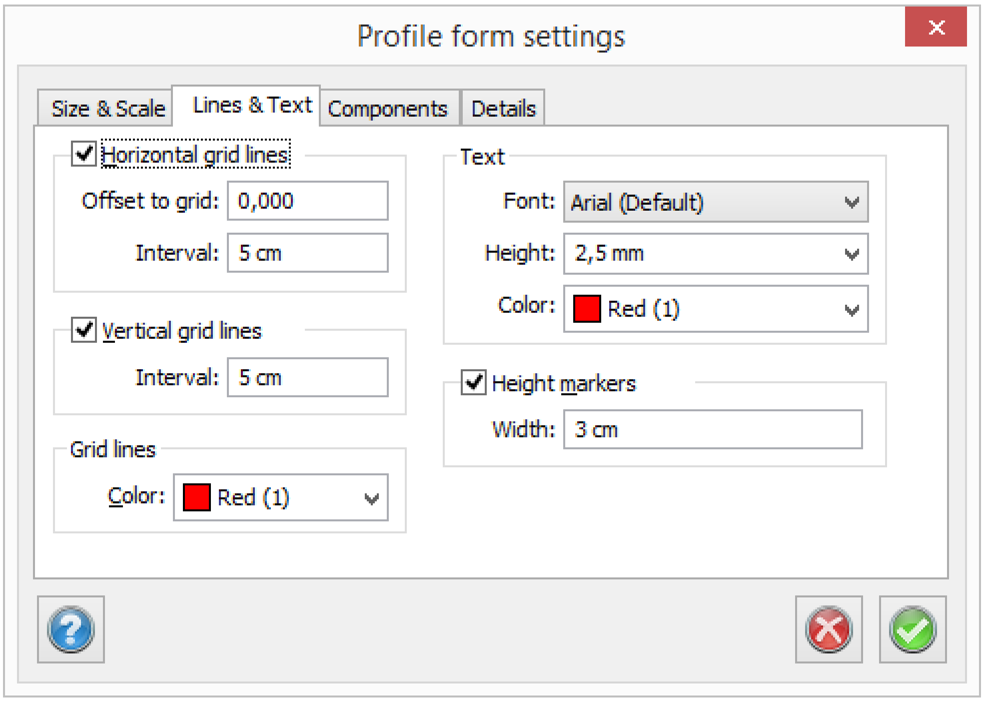


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

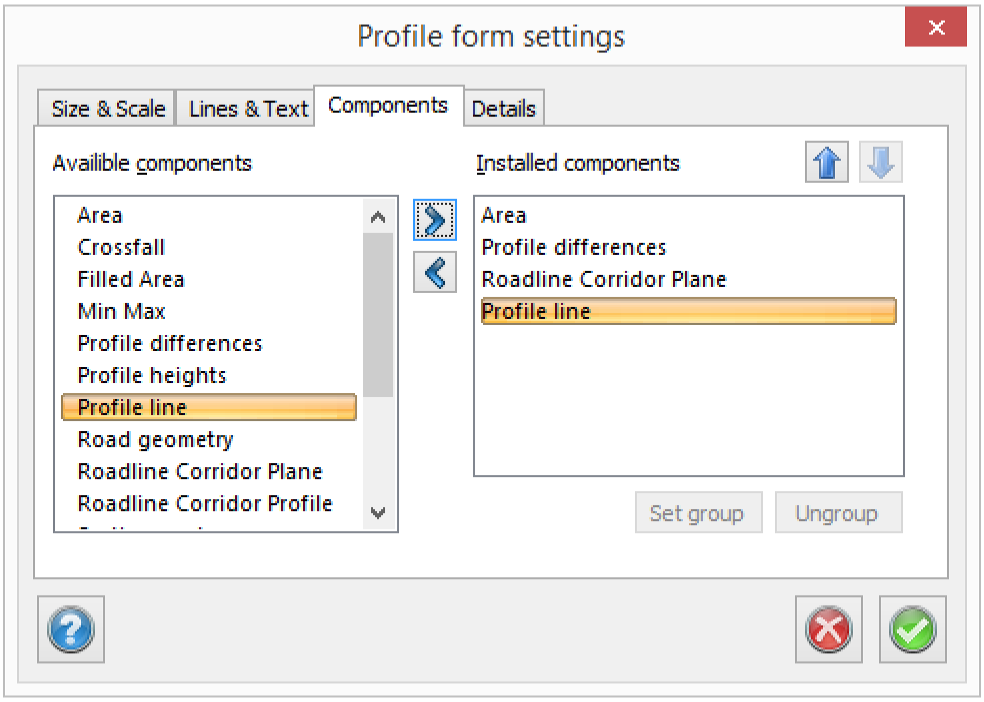
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

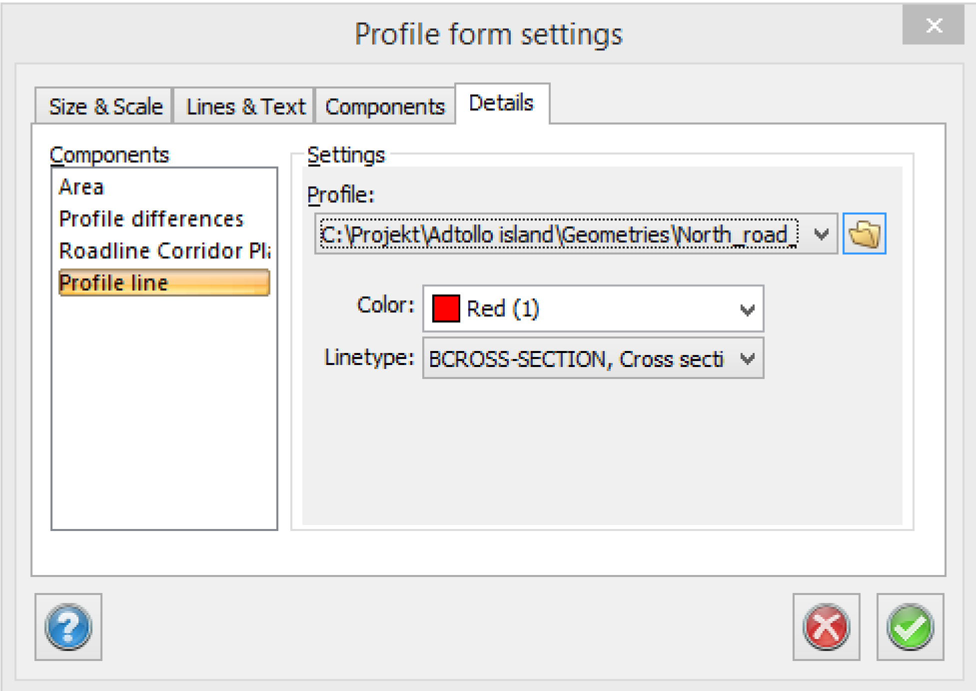
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



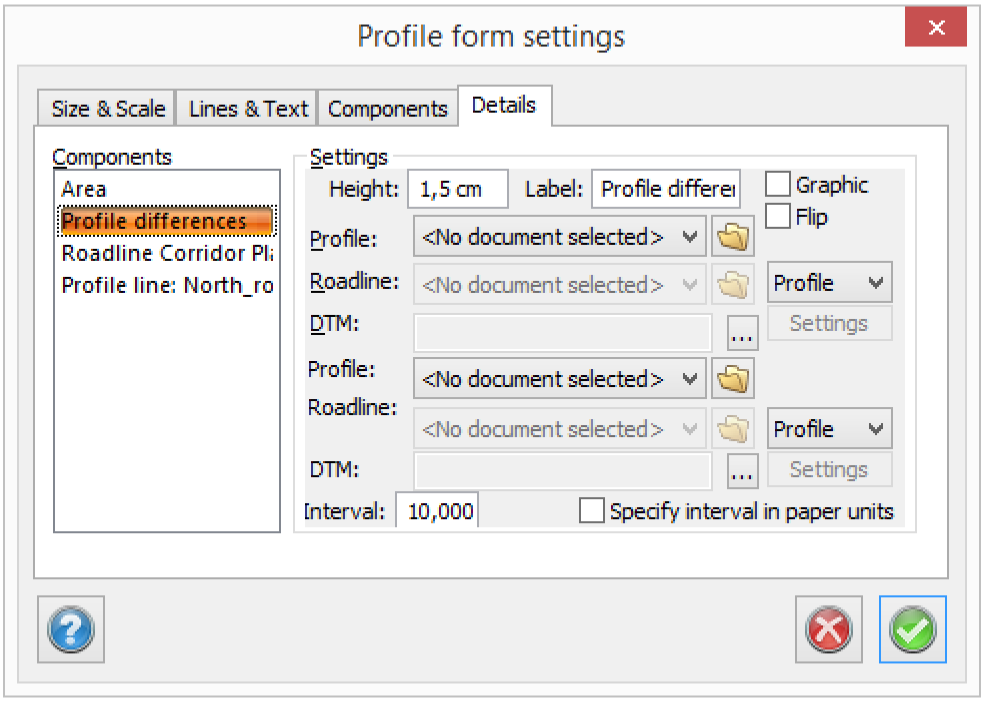
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

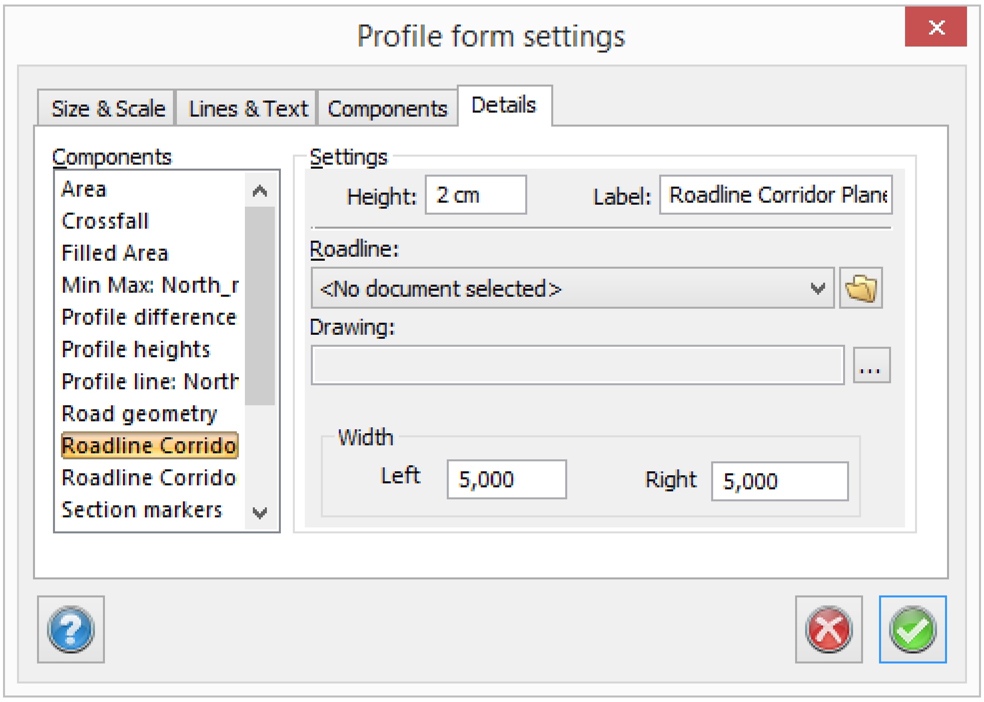
It is possible to display several different road profiles in the form.

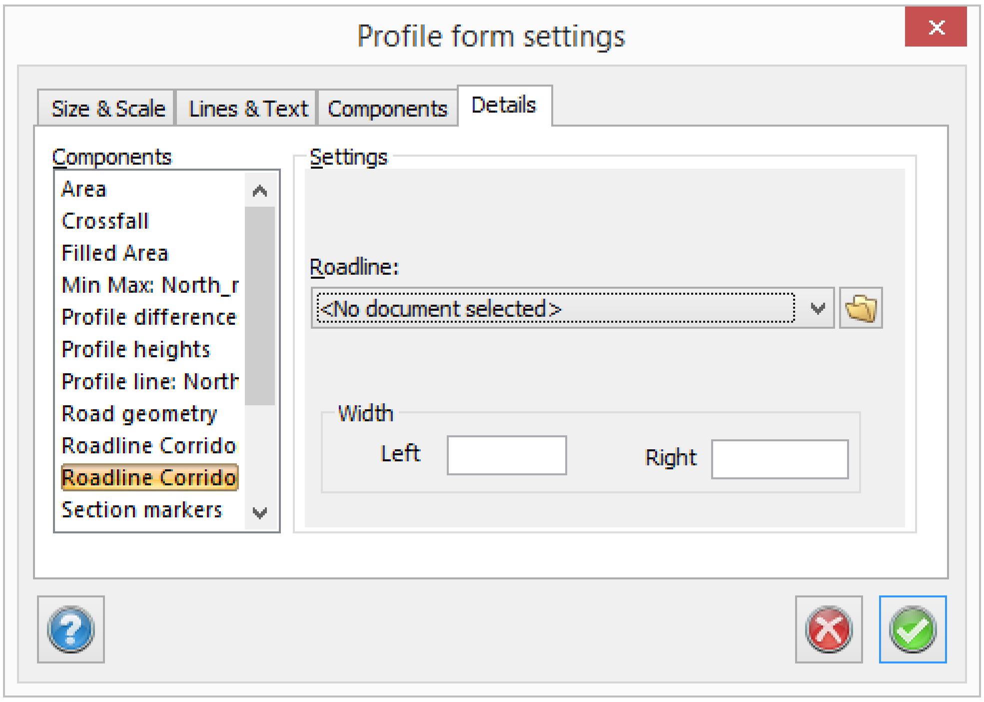
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



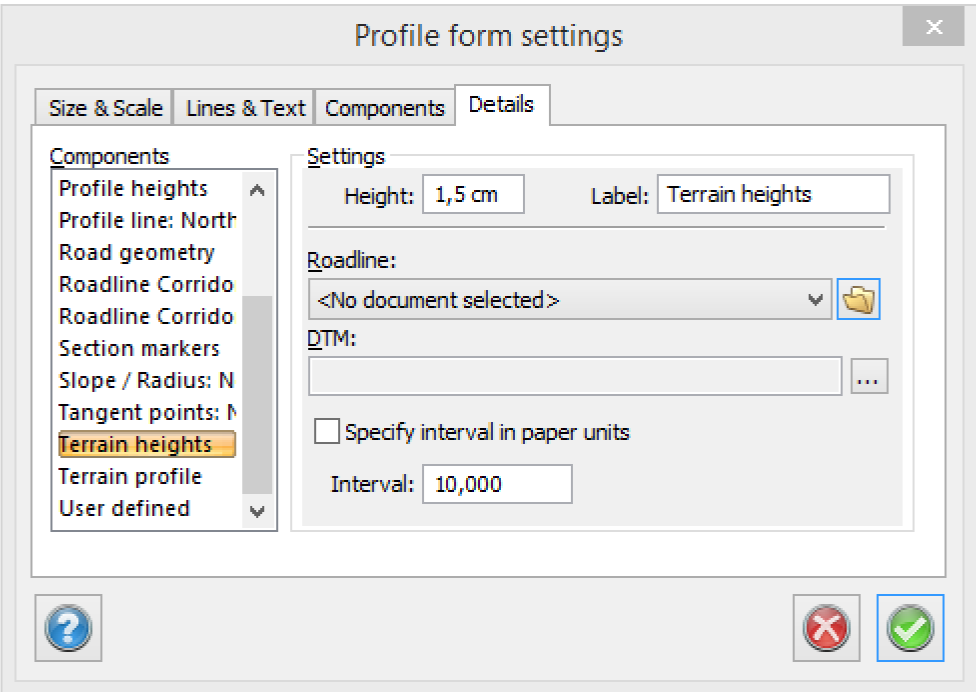
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

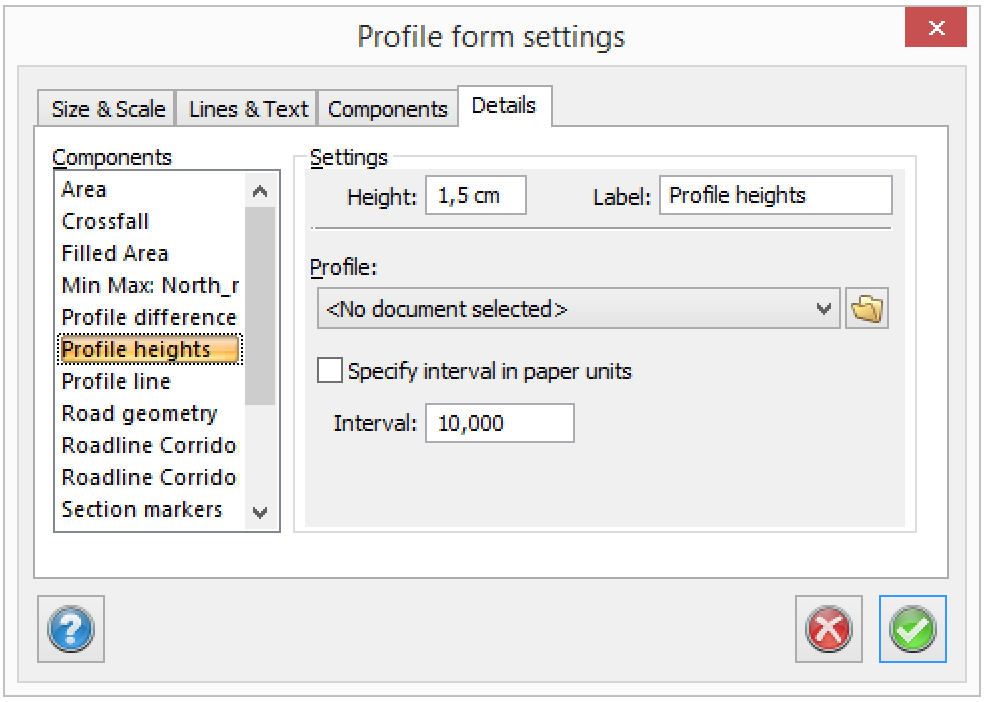
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

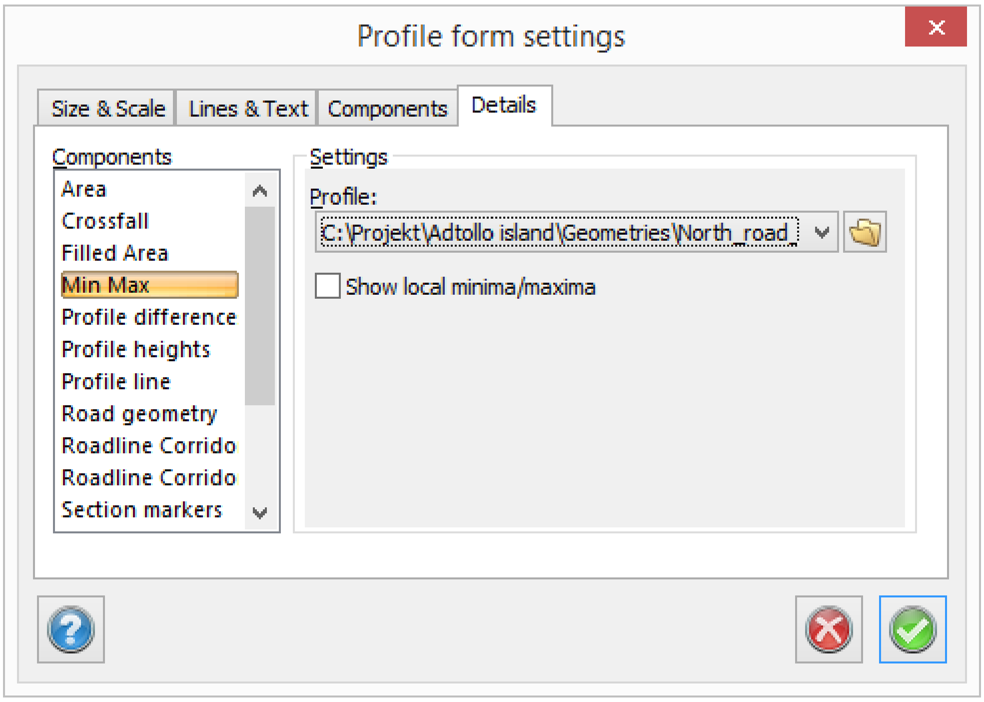
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

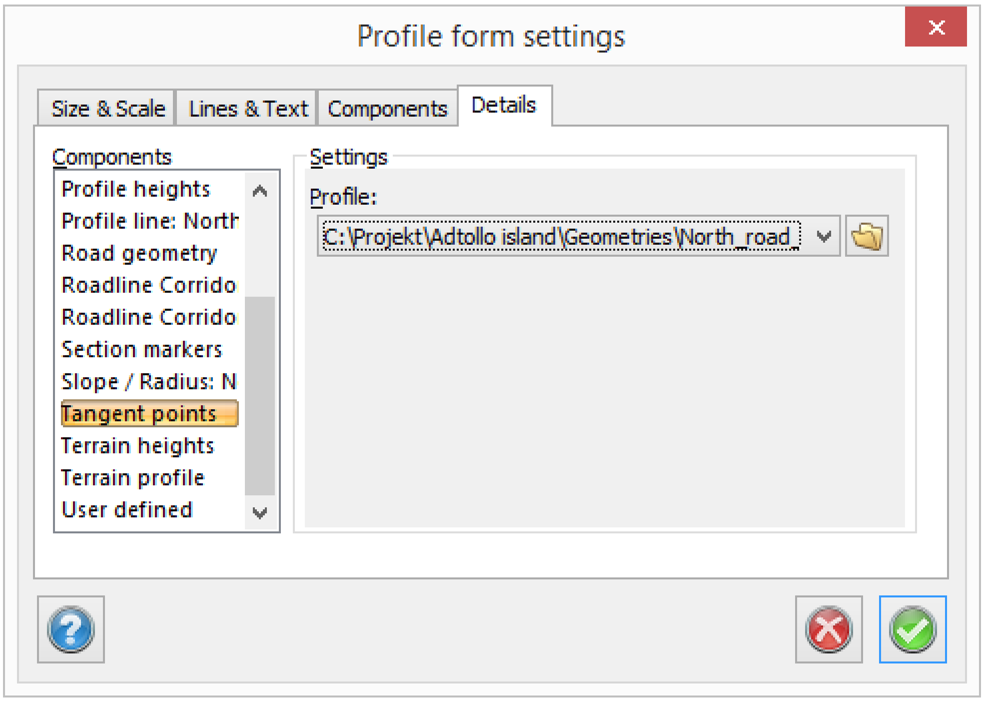
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

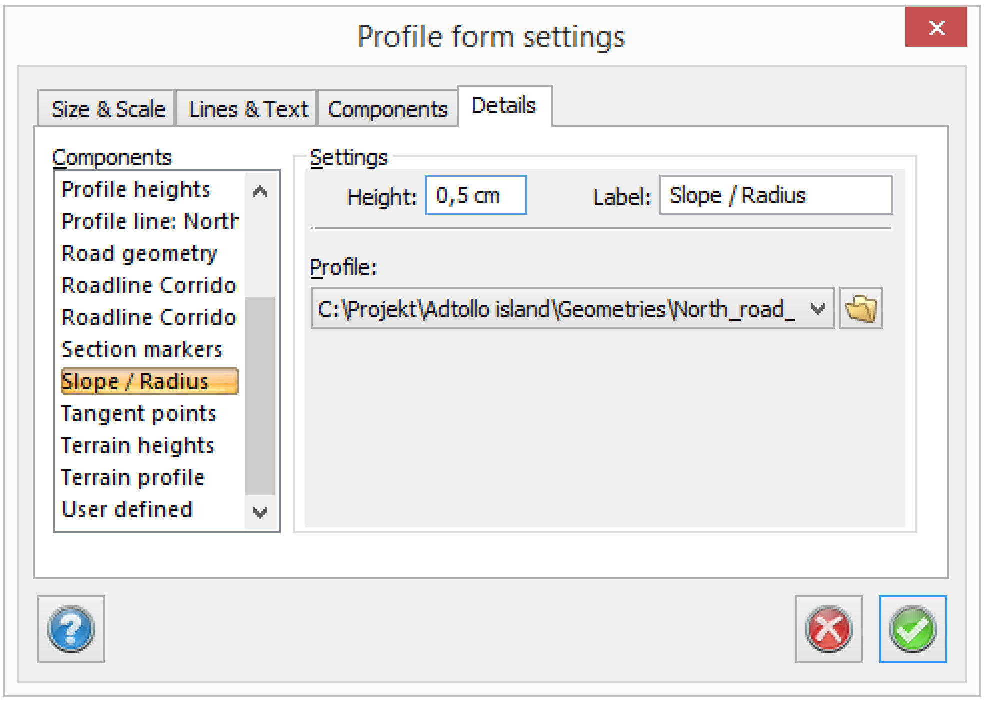
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

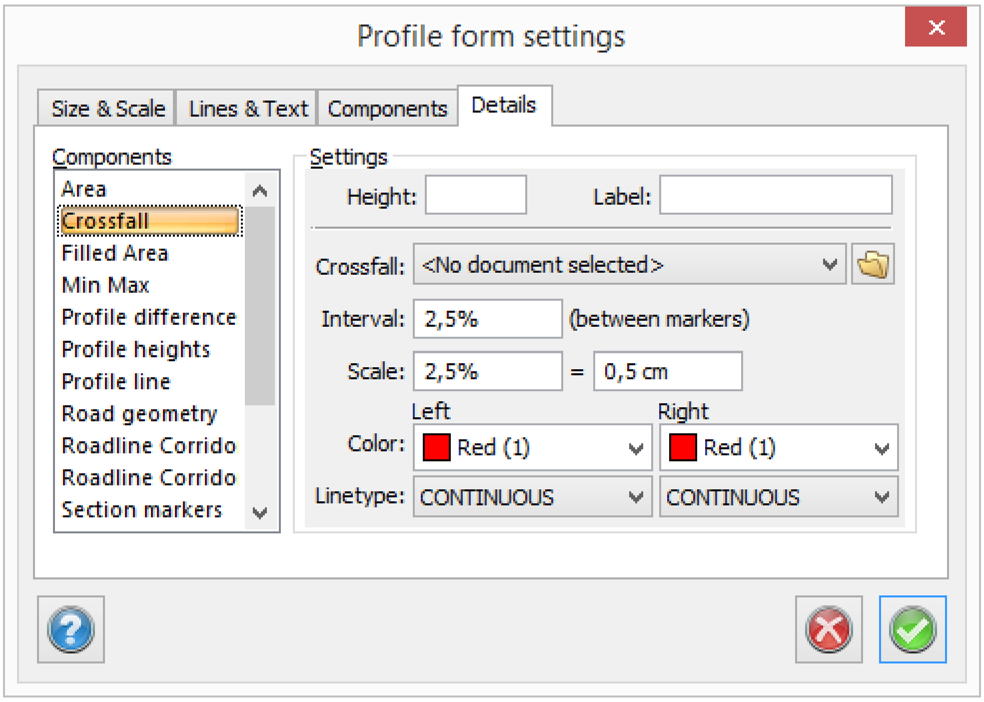
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

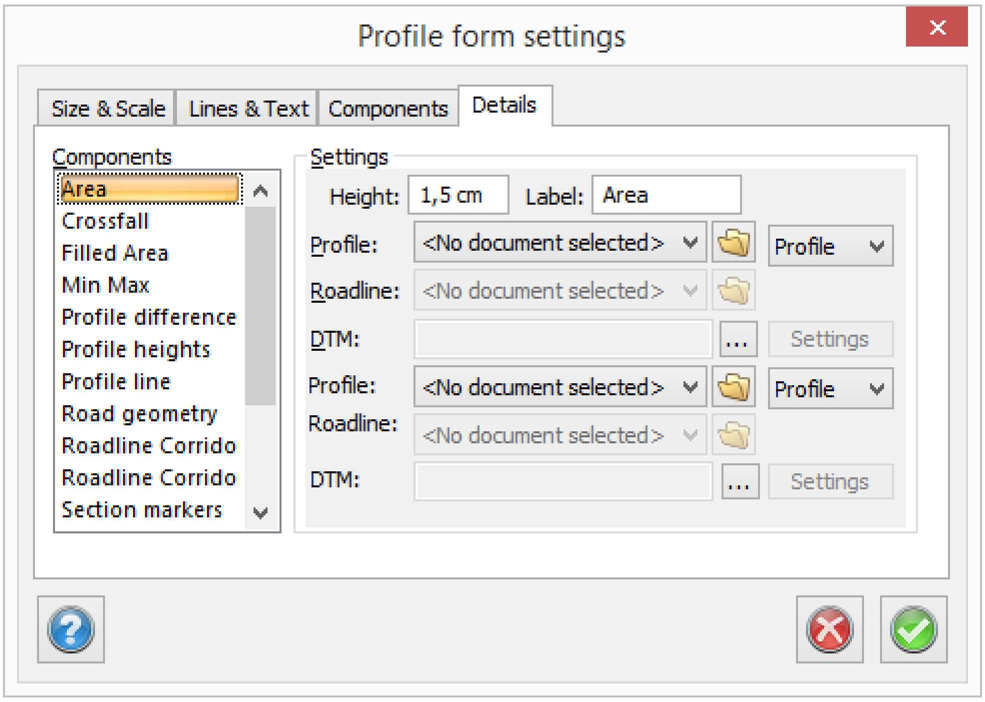
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.



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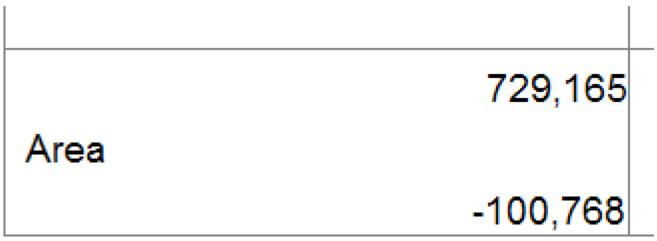
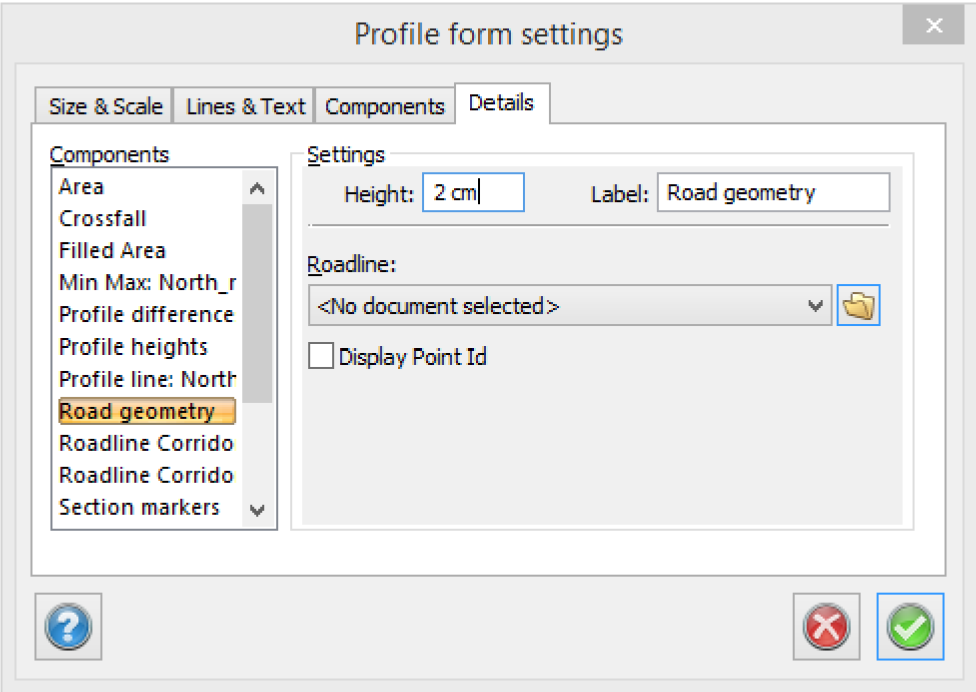


Example of a profile form with an area component inserted.

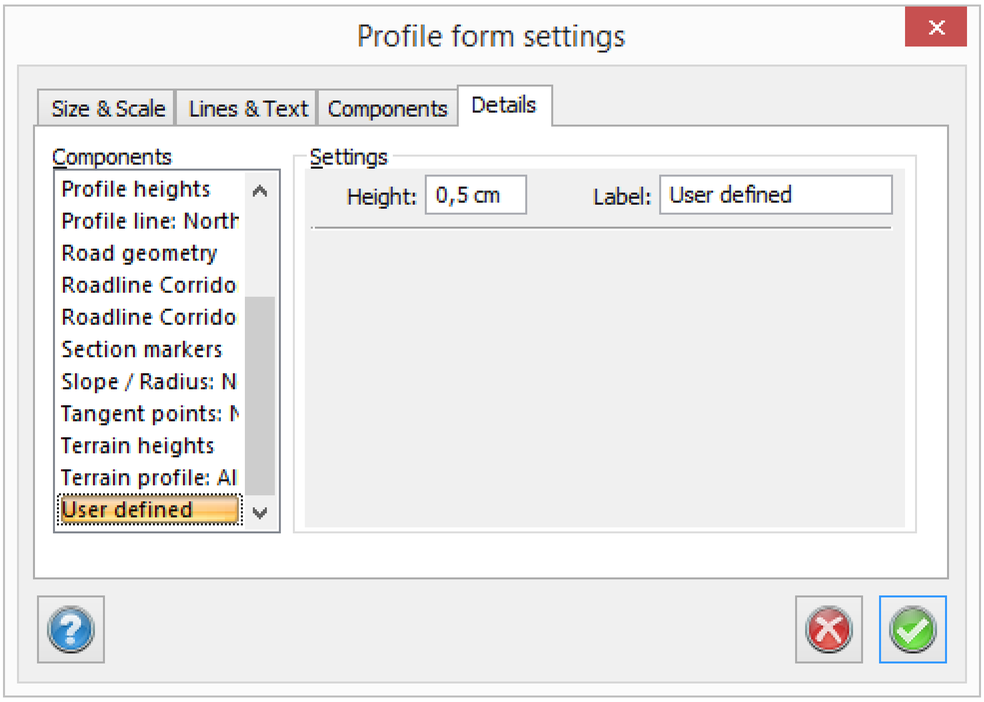
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



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It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

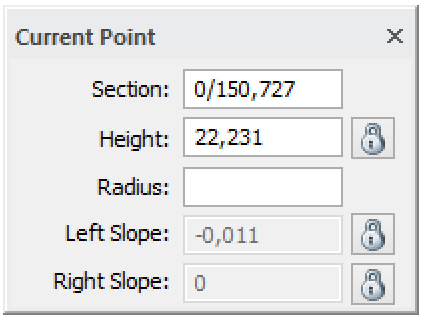
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

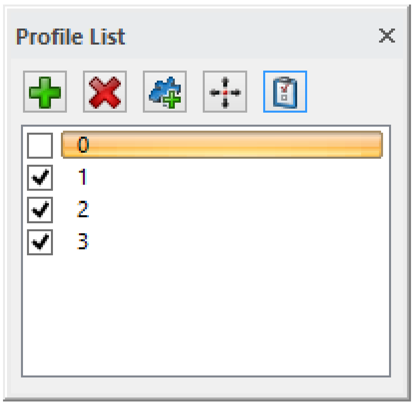
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



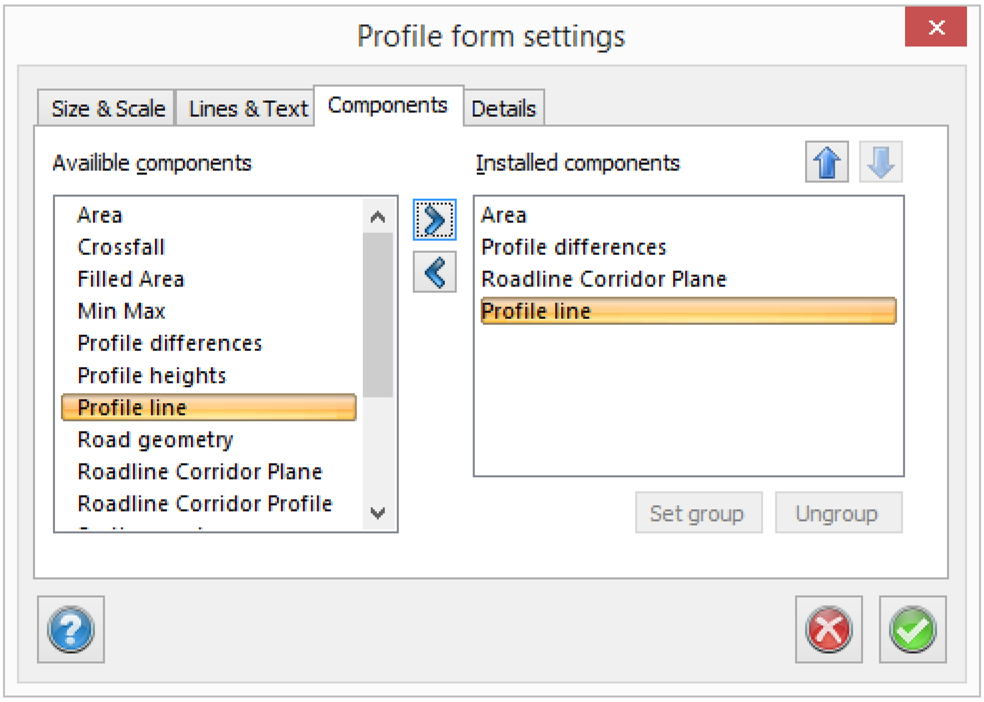
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

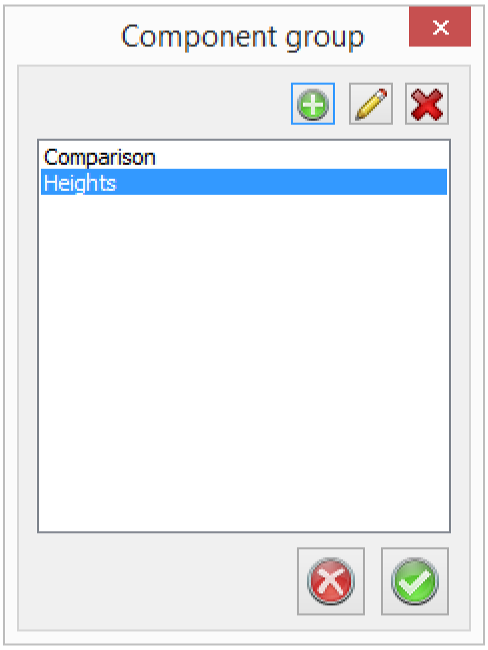
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

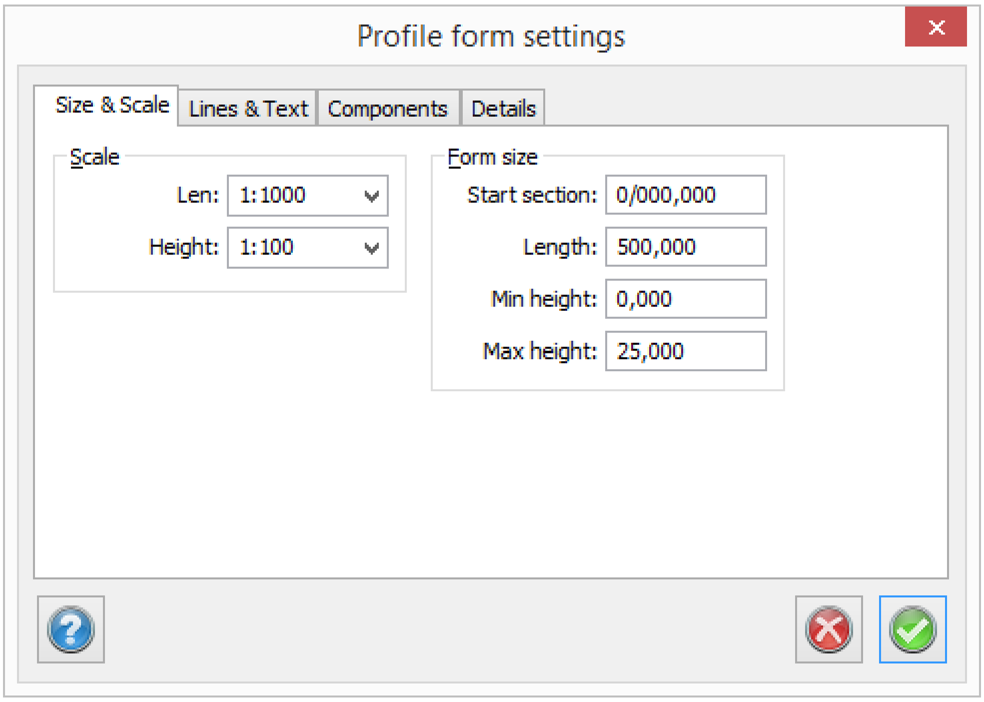
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

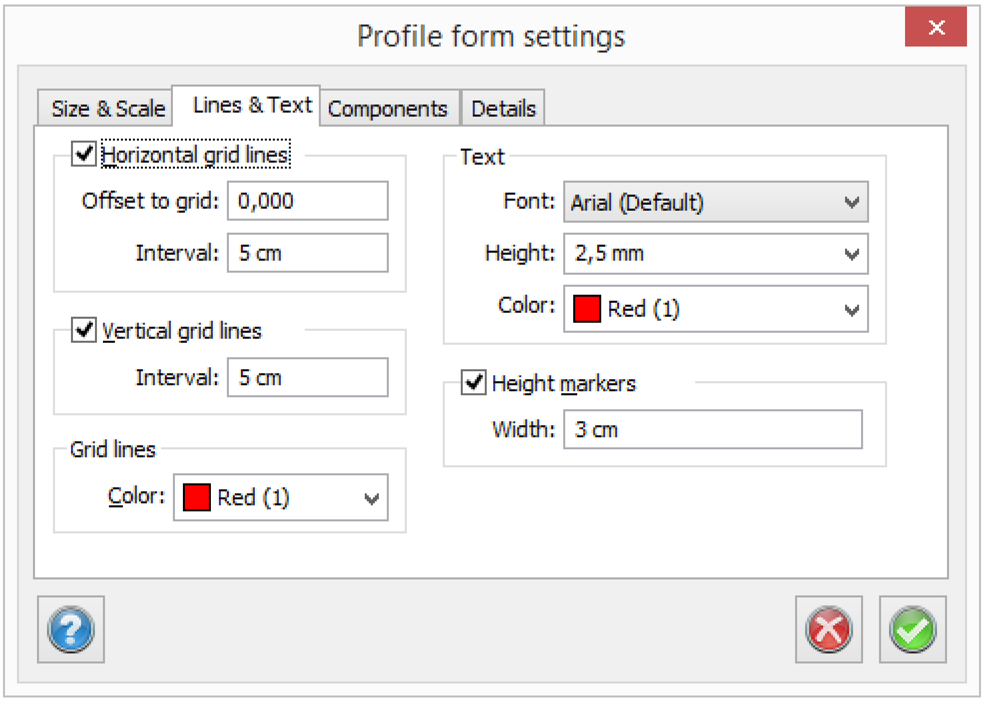


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

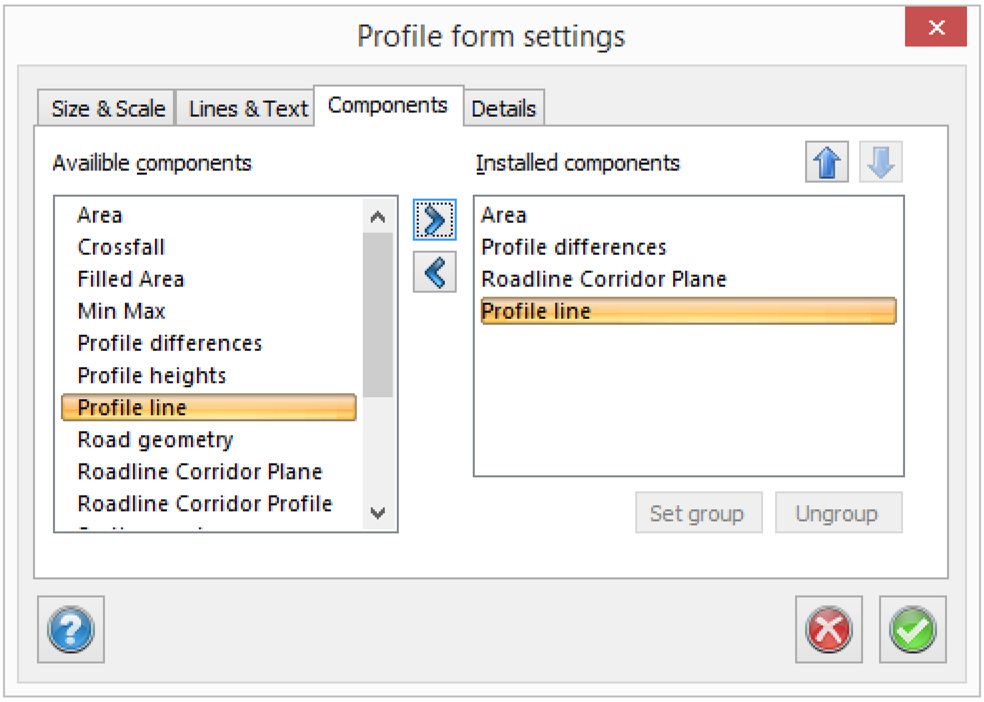
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

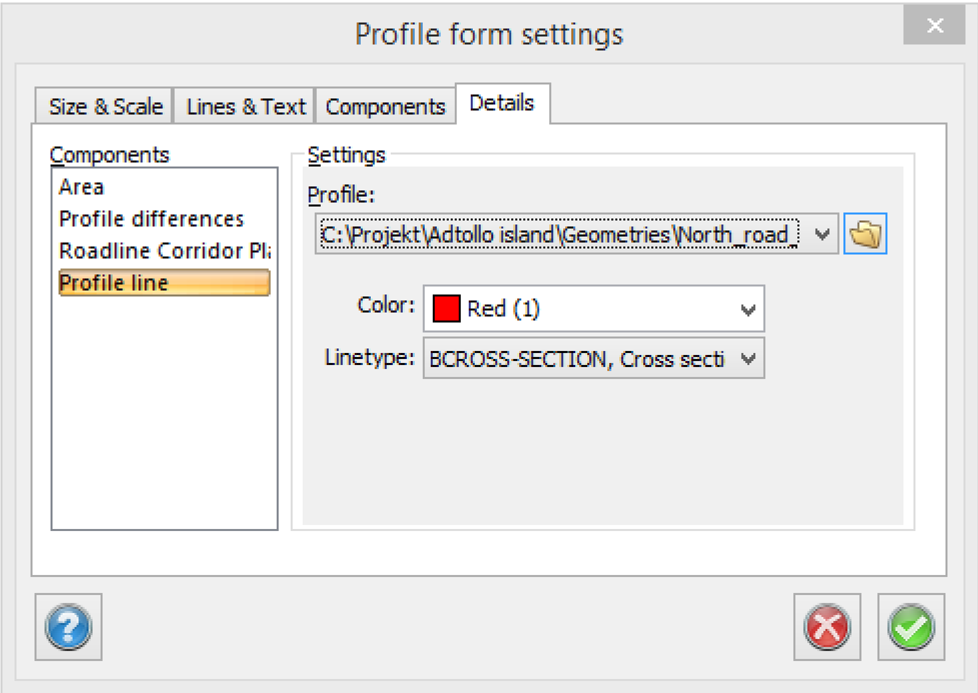
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



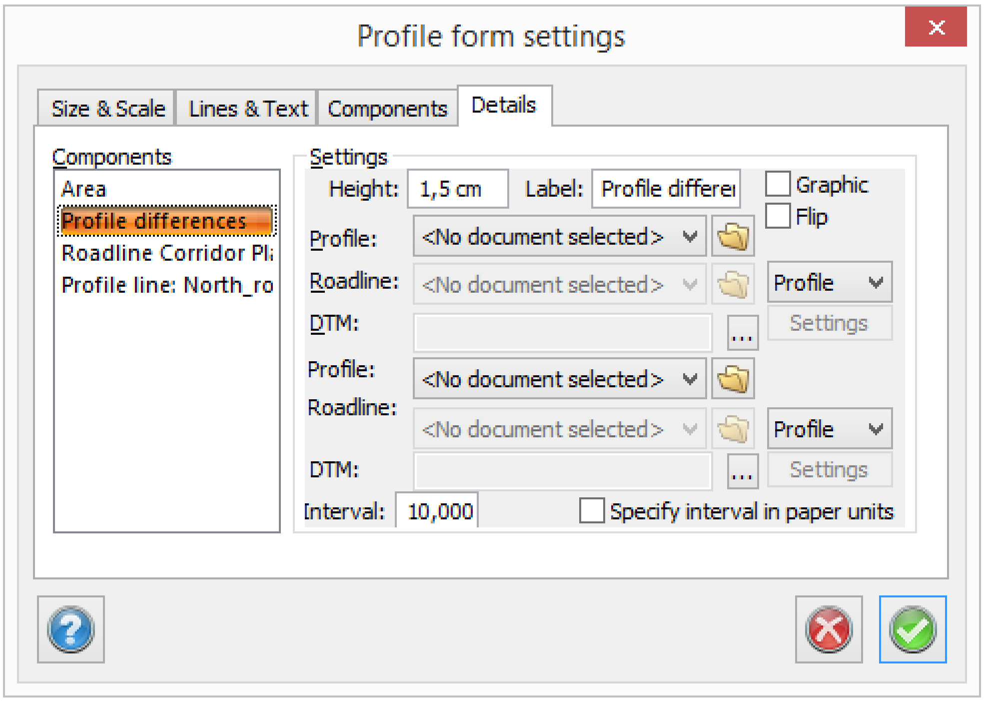
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

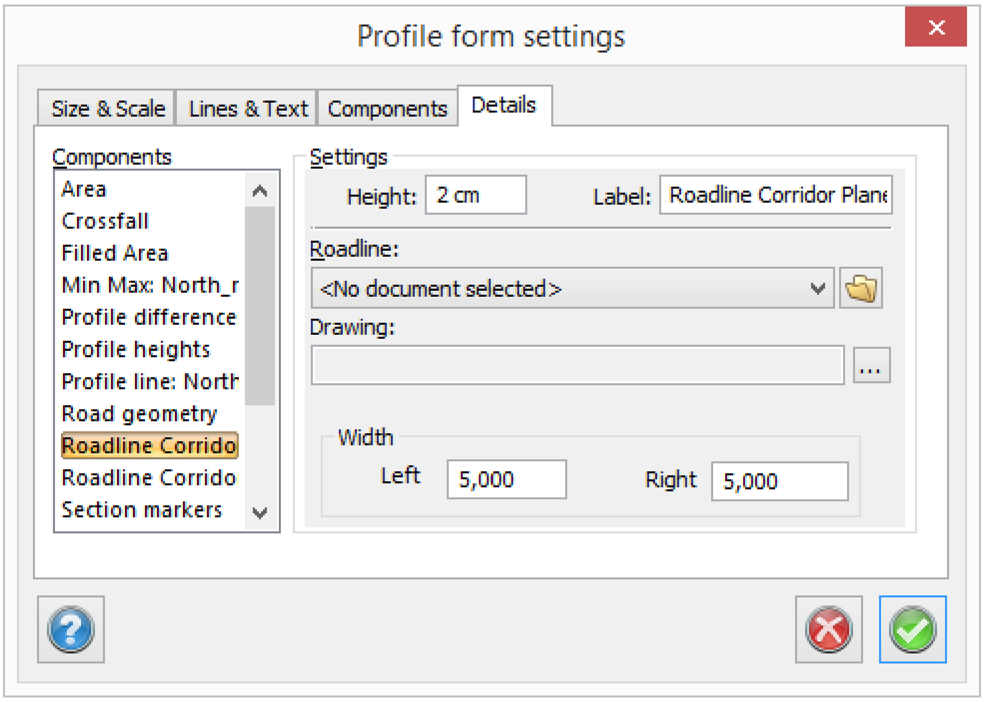
It is possible to display several different road profiles in the form.

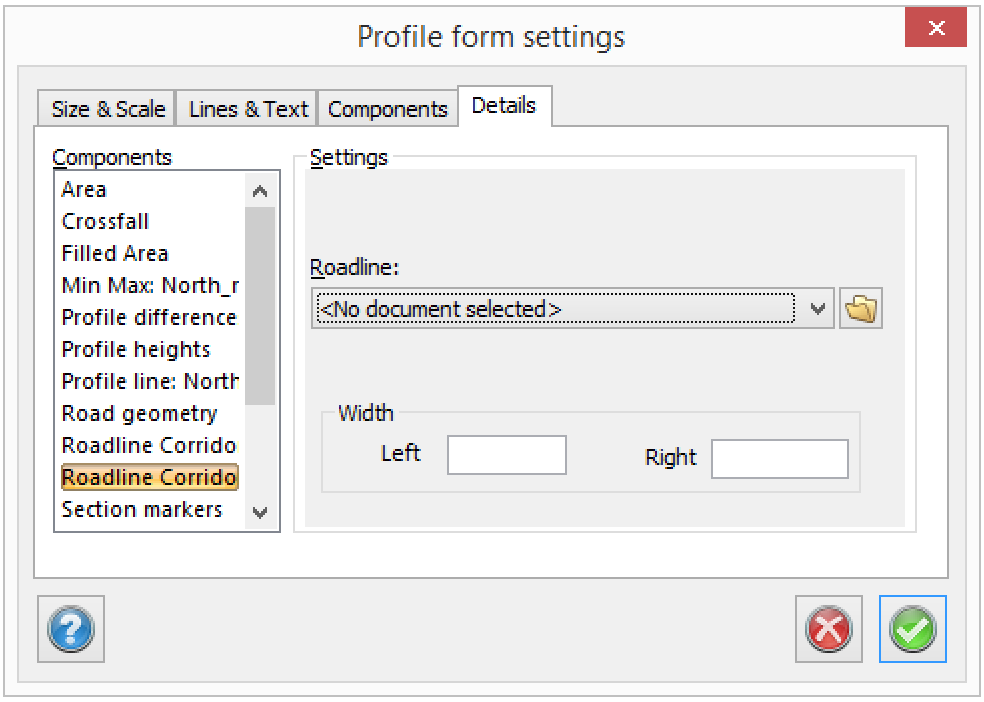
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



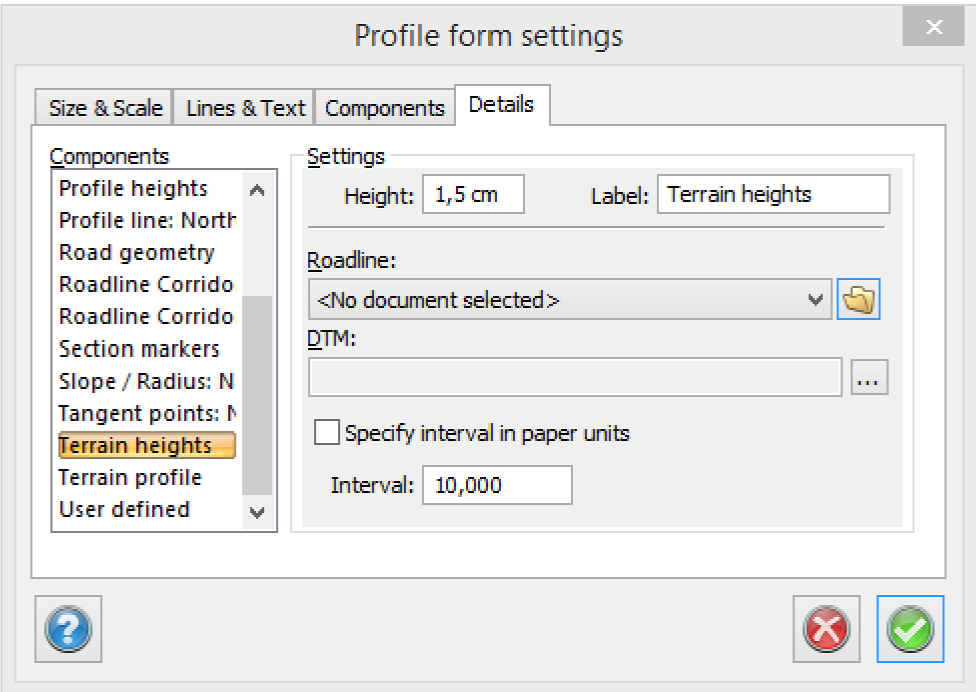
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

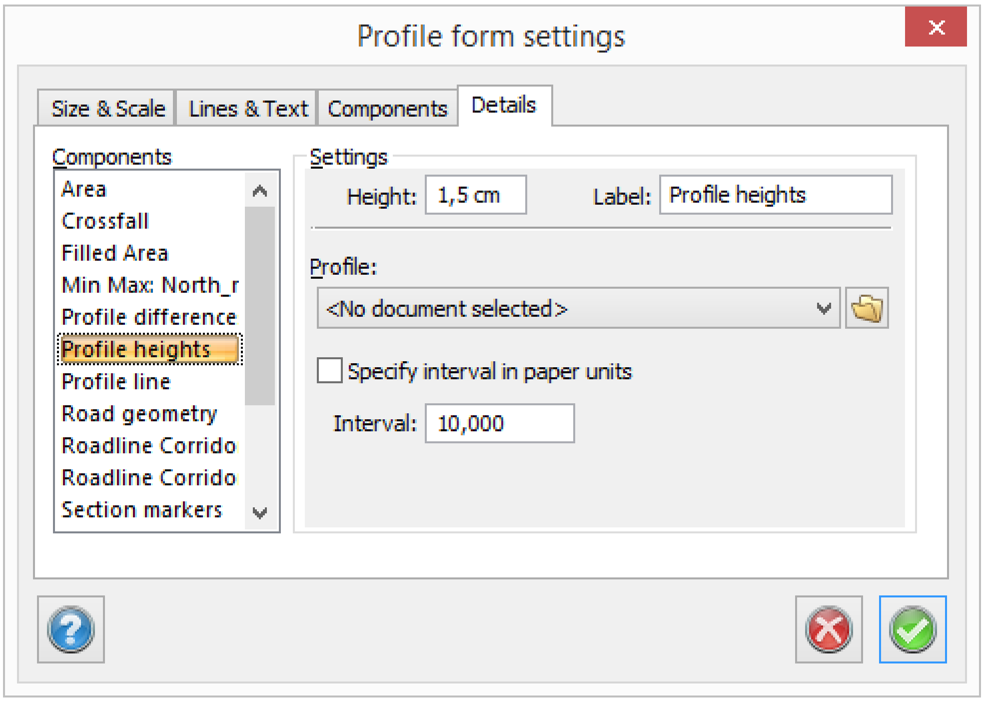
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

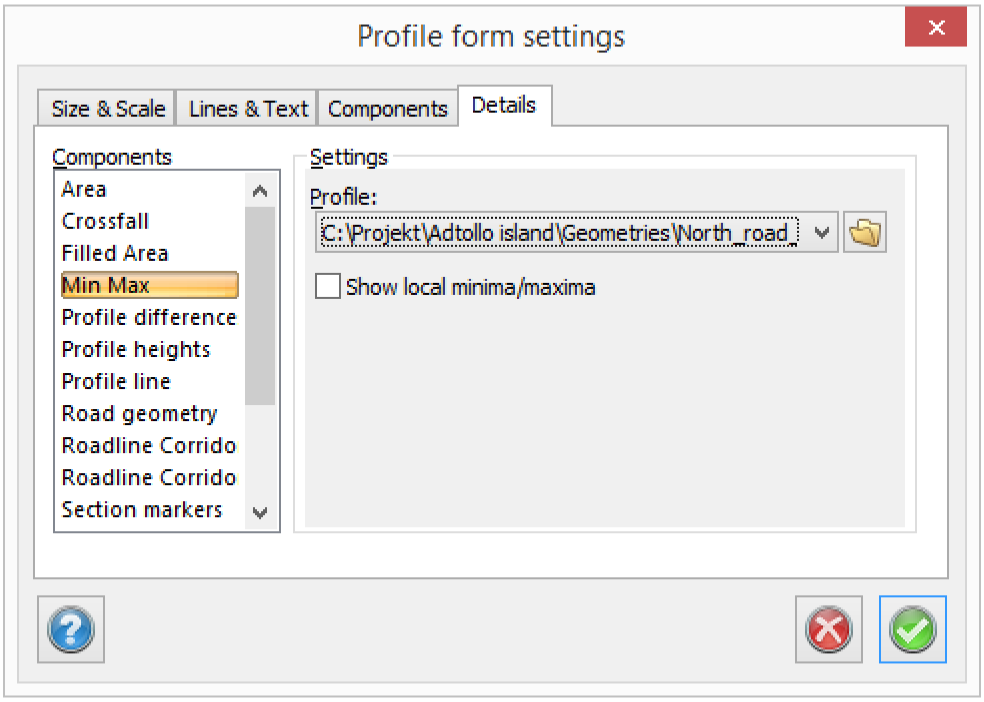
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

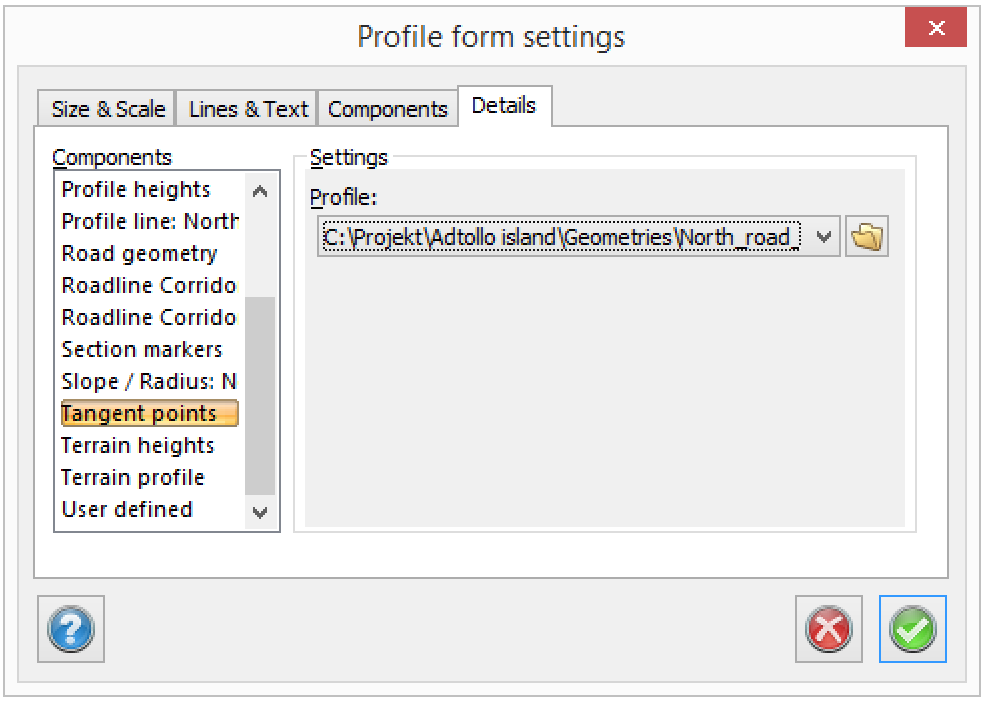
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

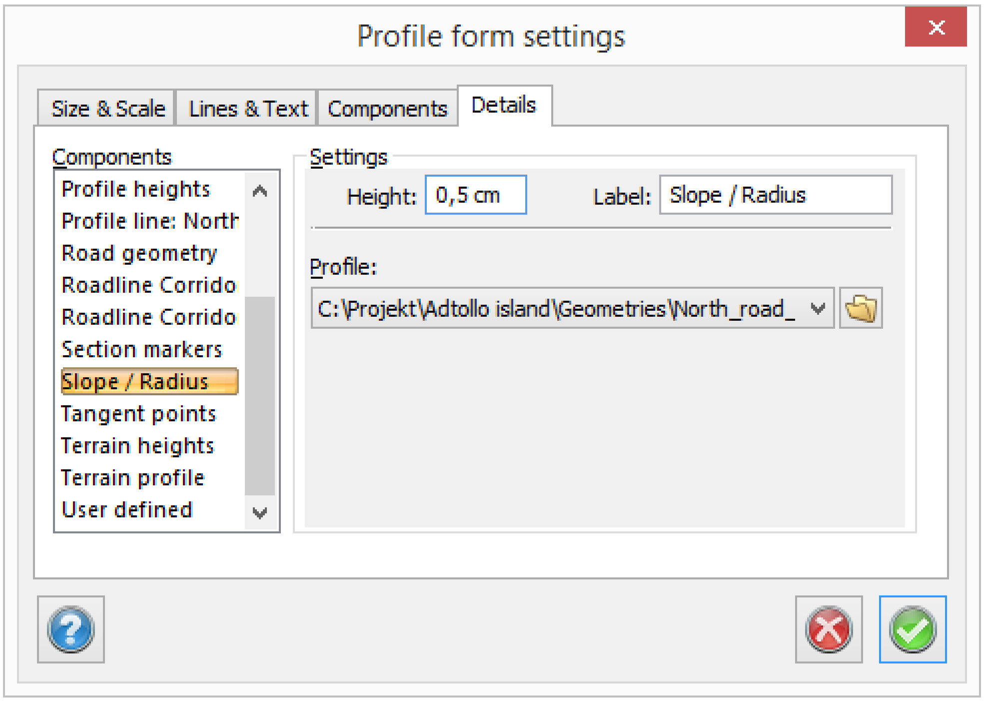
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

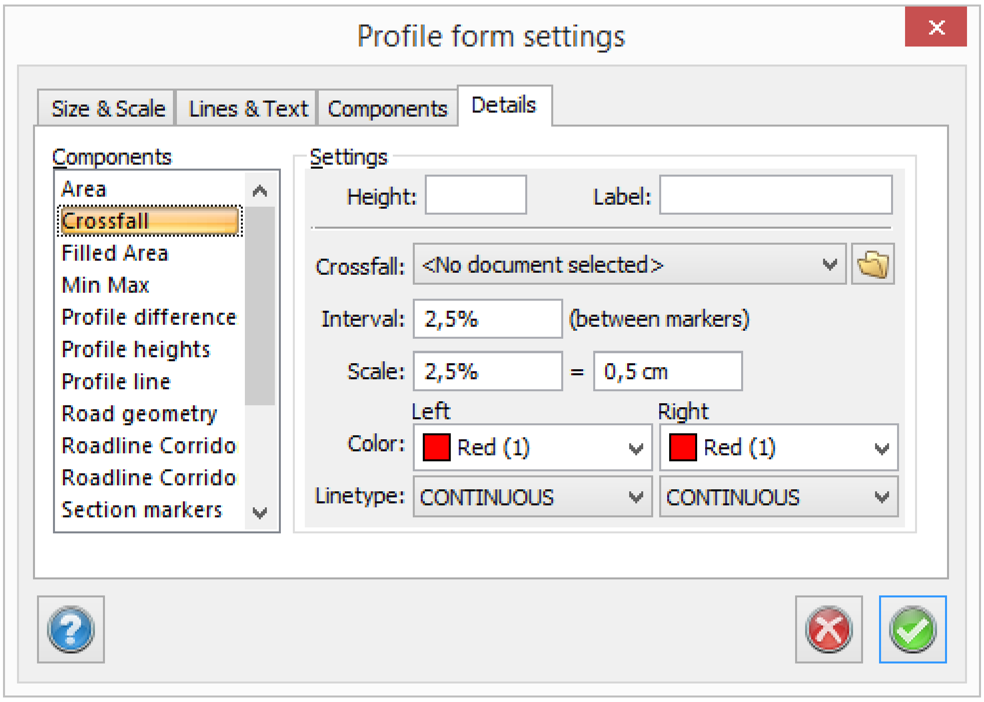
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

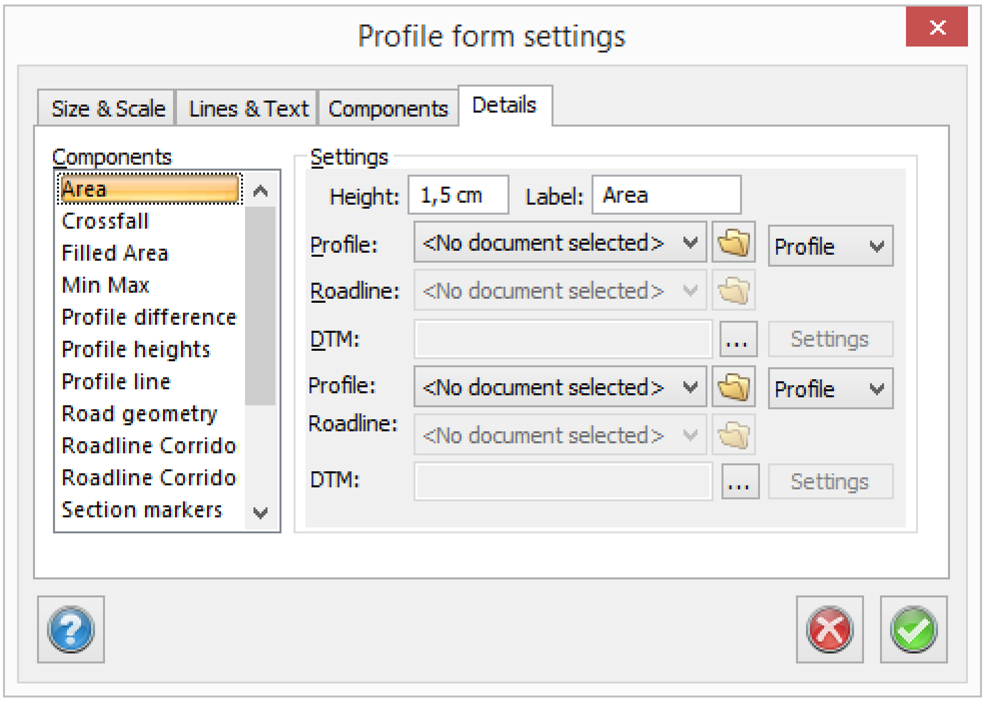
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

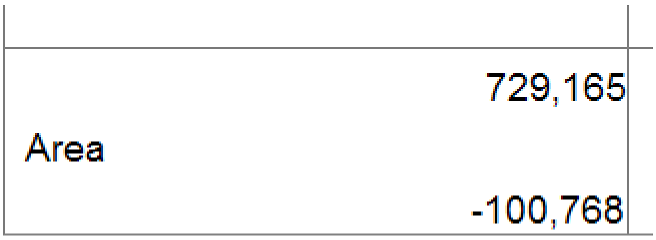
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

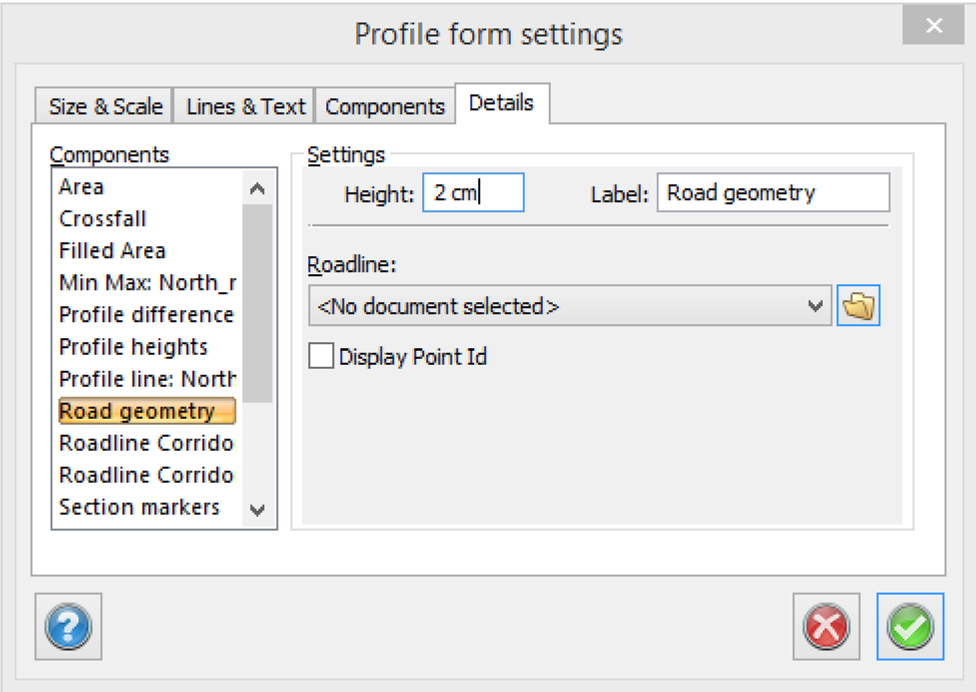


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

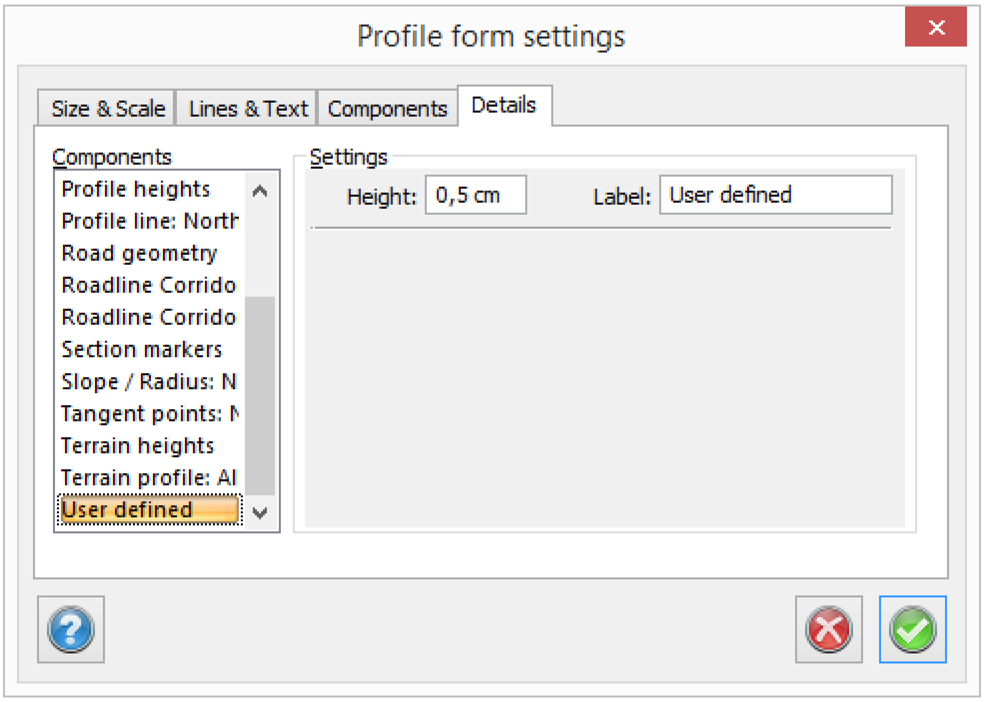
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

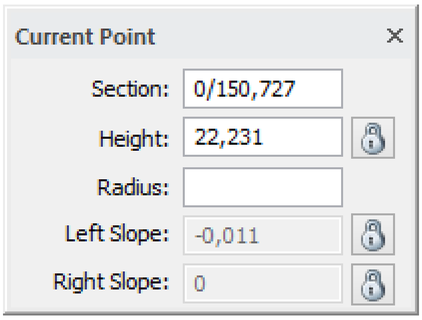
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

The procedure is as follows:

1. Go to *Insert points.*
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4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
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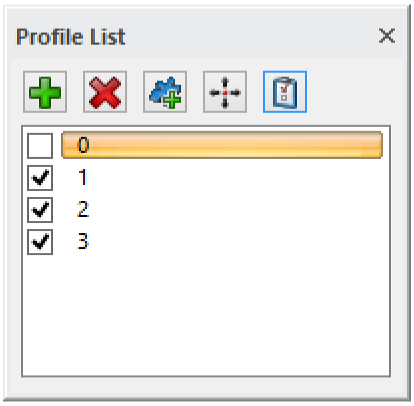
Properties Select properties to rename a profile.



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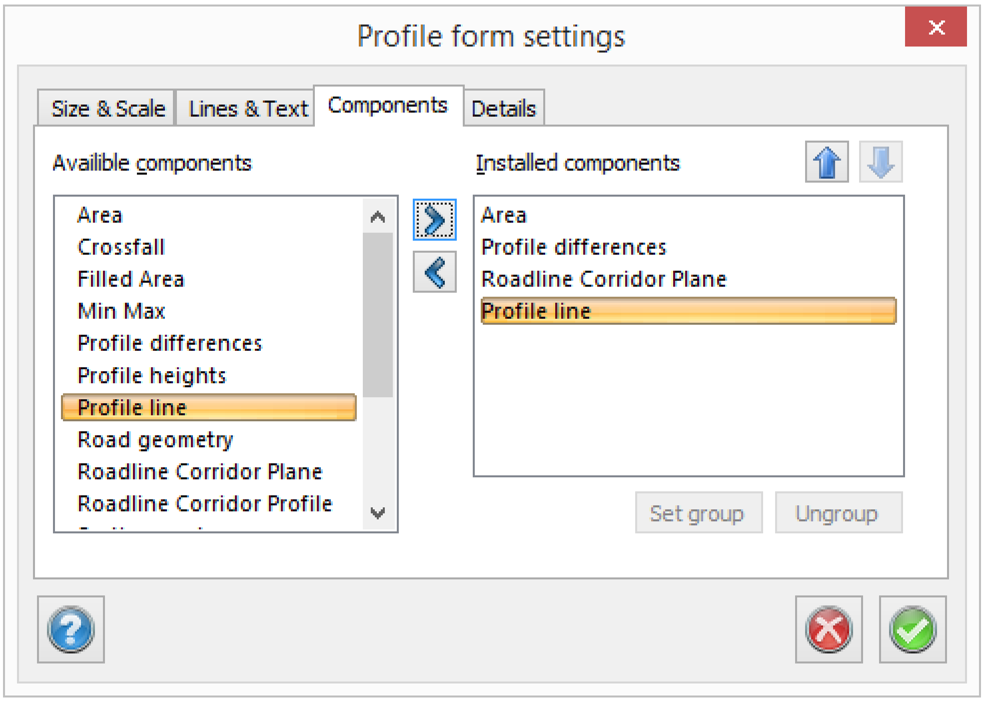
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



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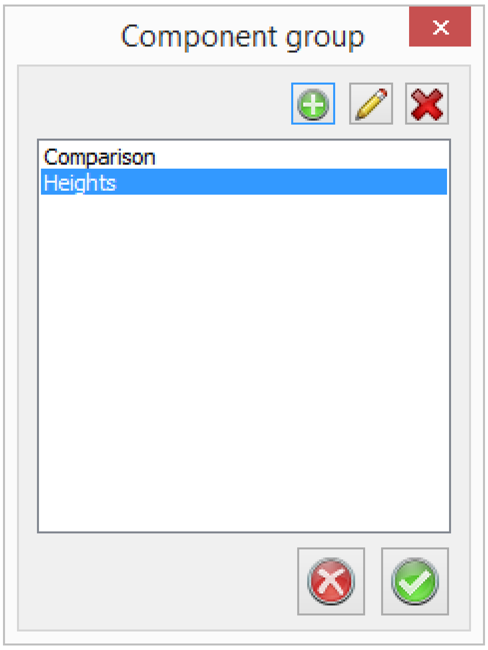

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Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

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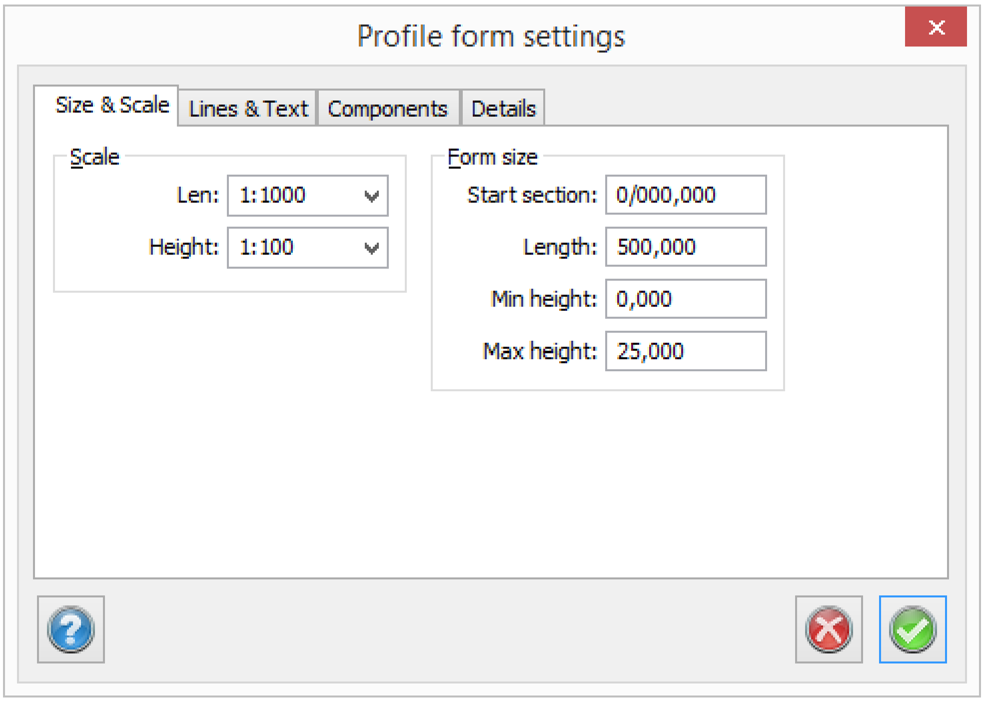
Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

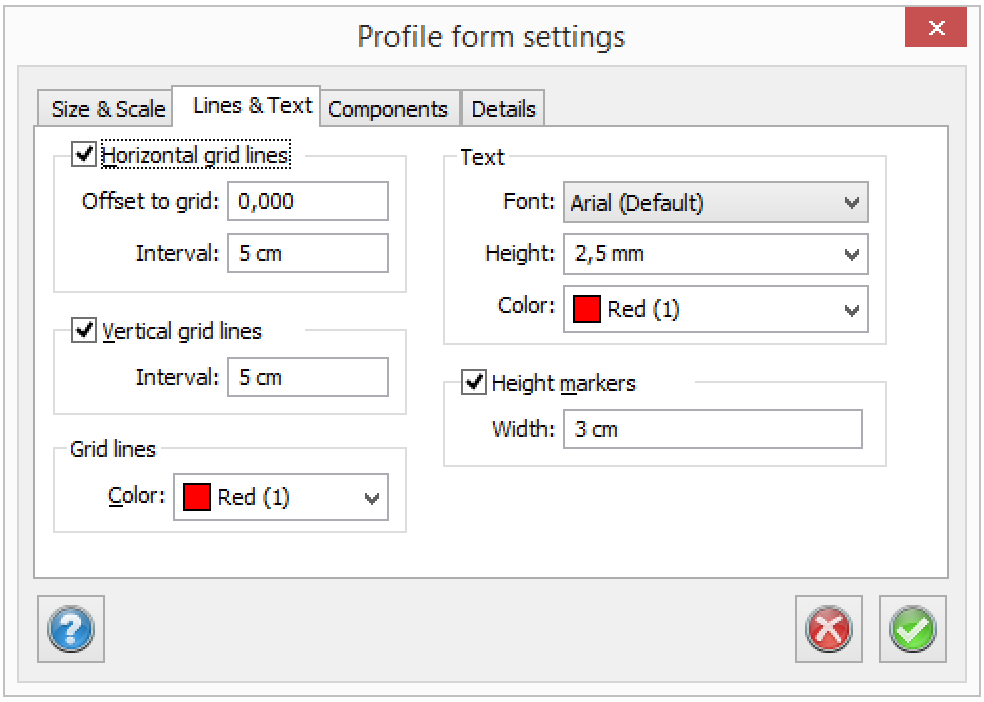


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

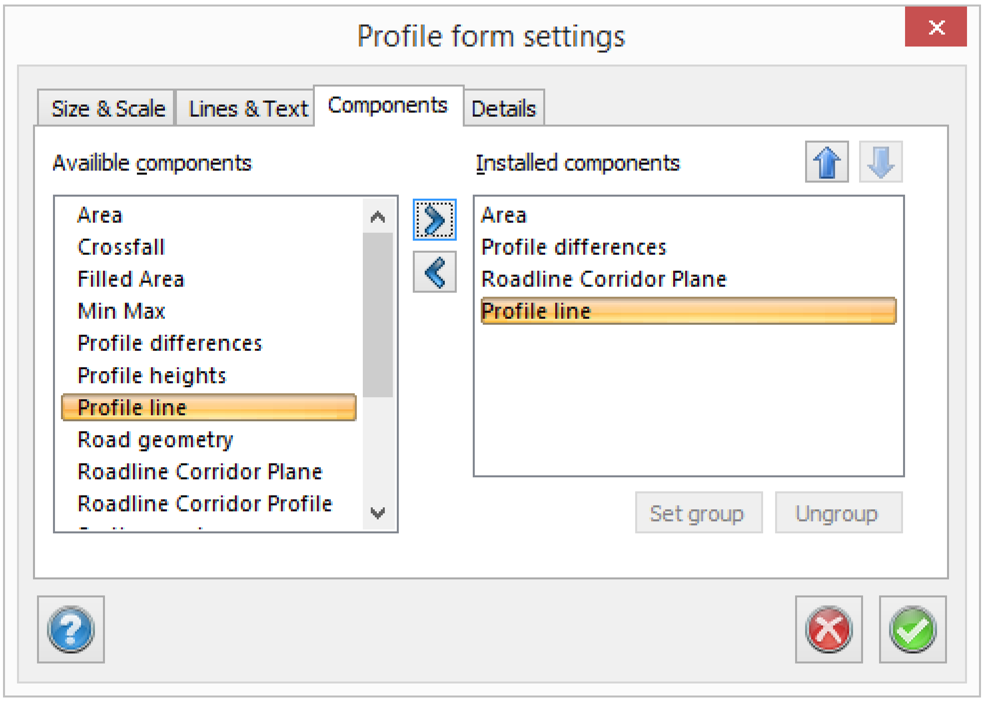
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

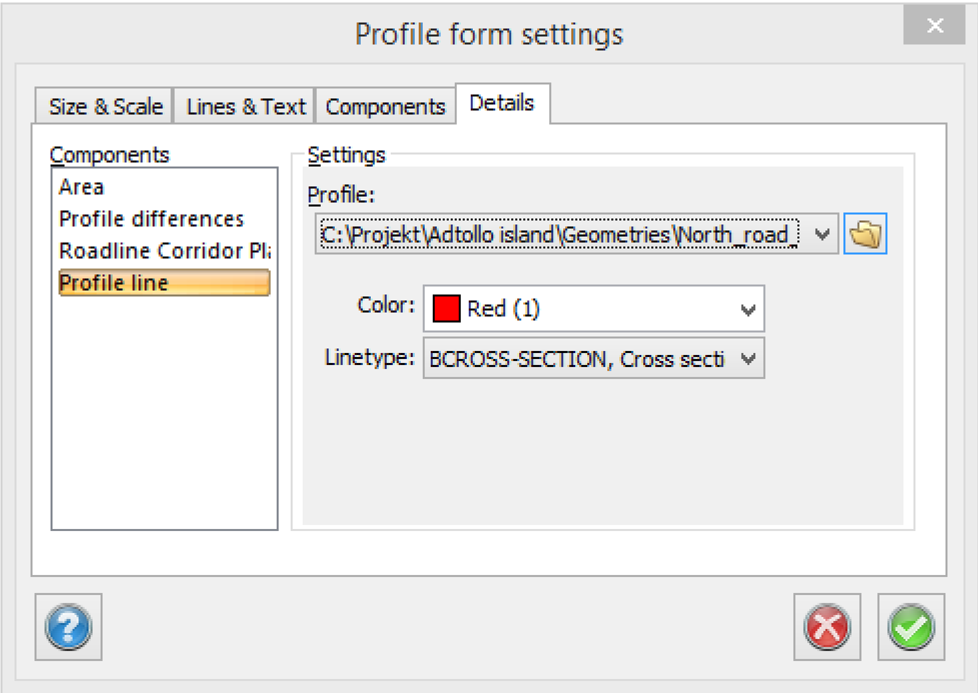
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



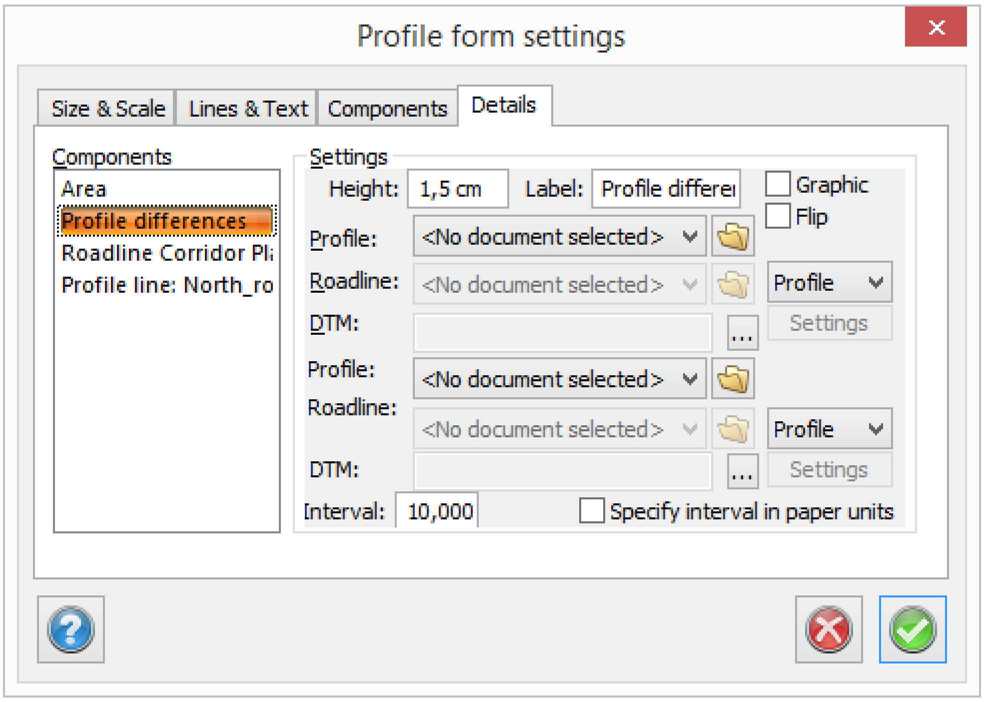
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

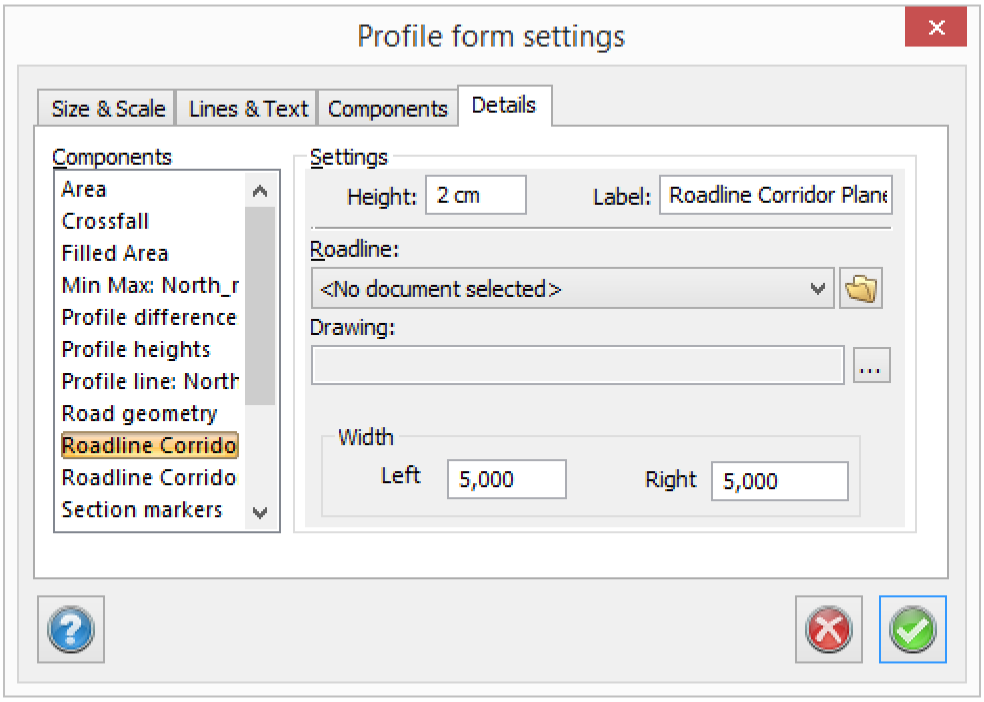
It is possible to display several different road profiles in the form.

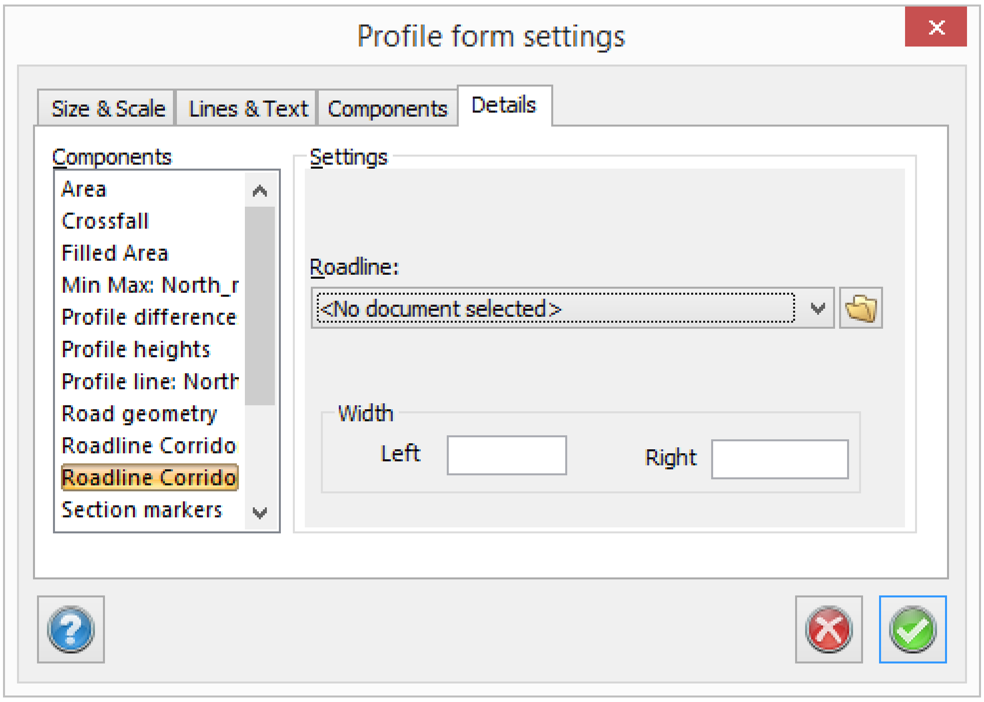
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



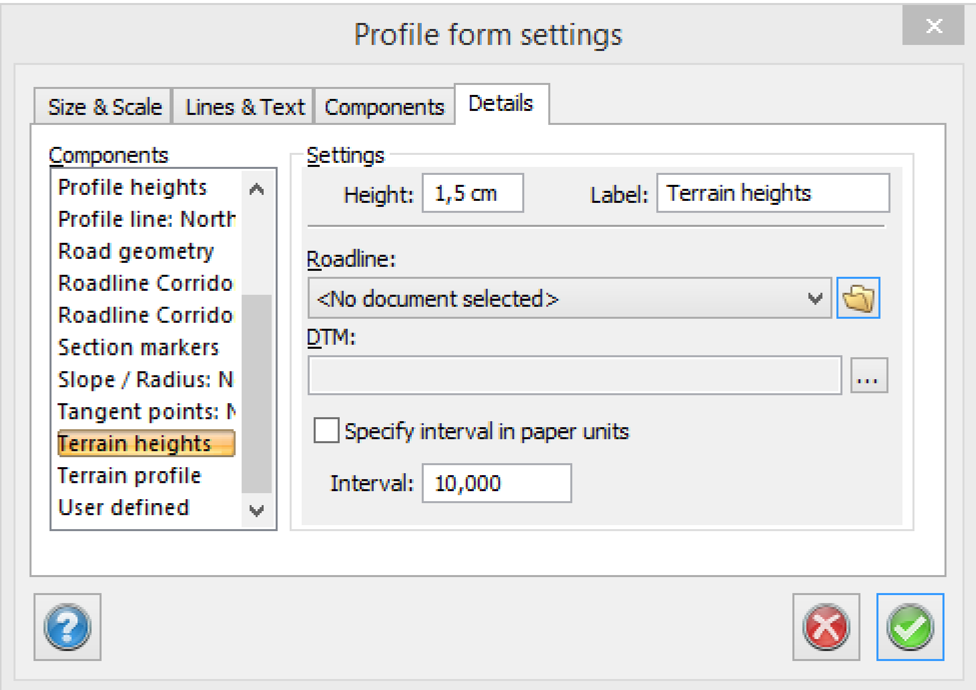
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

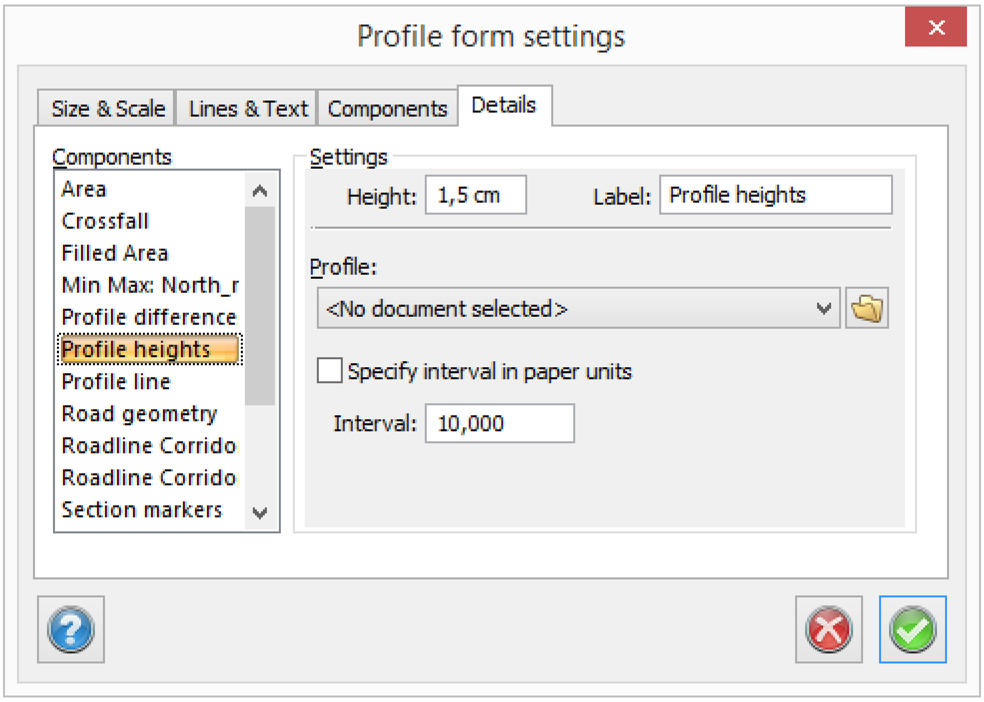
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

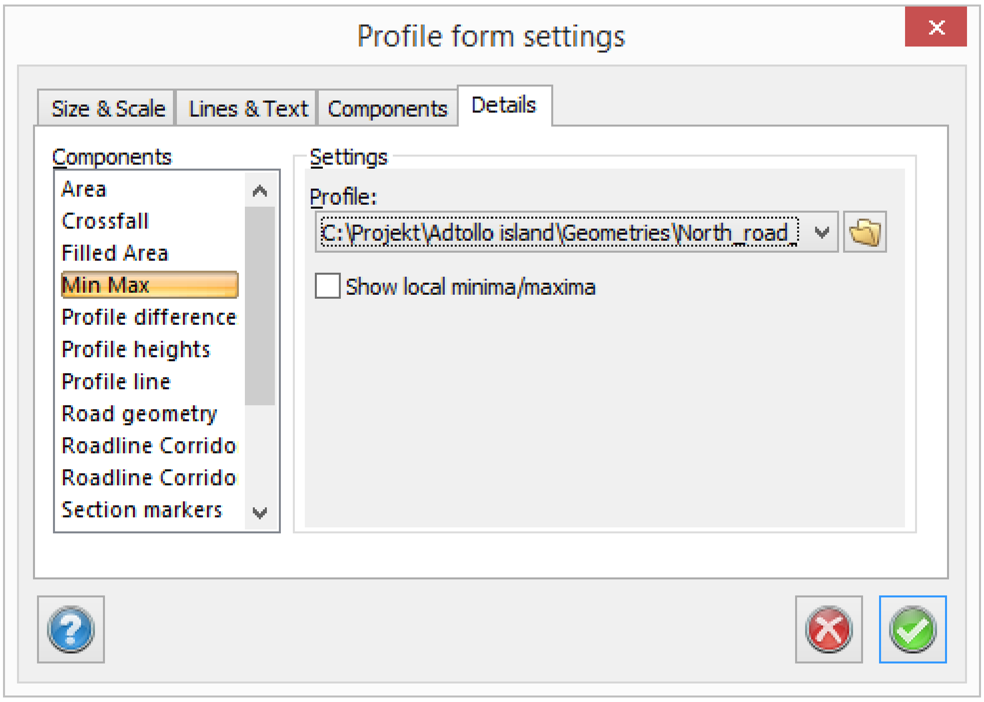
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

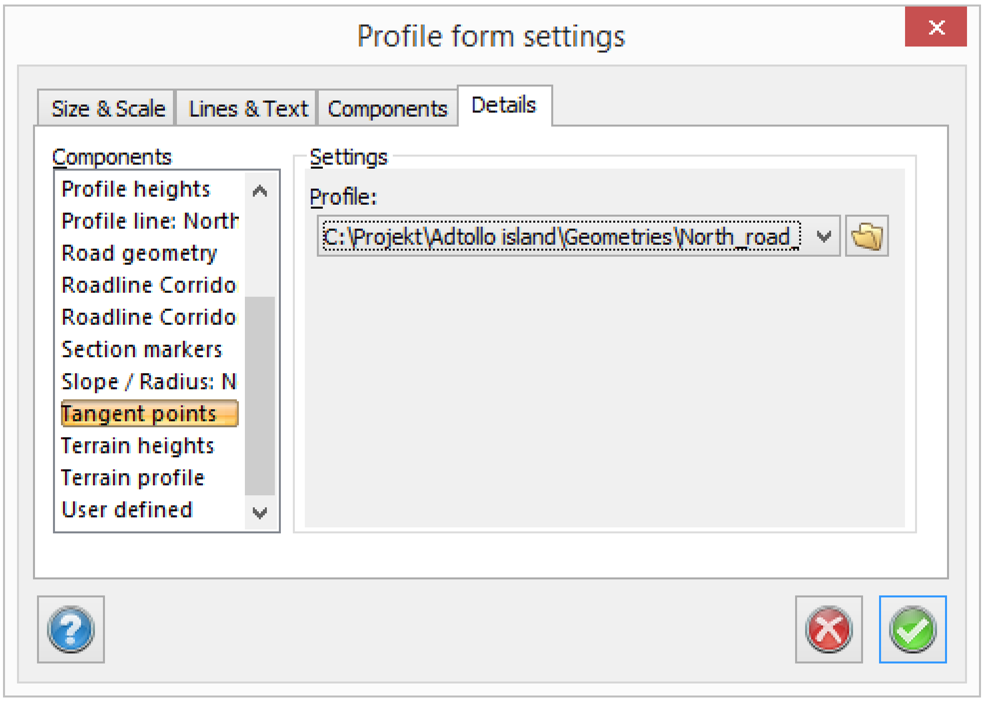
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

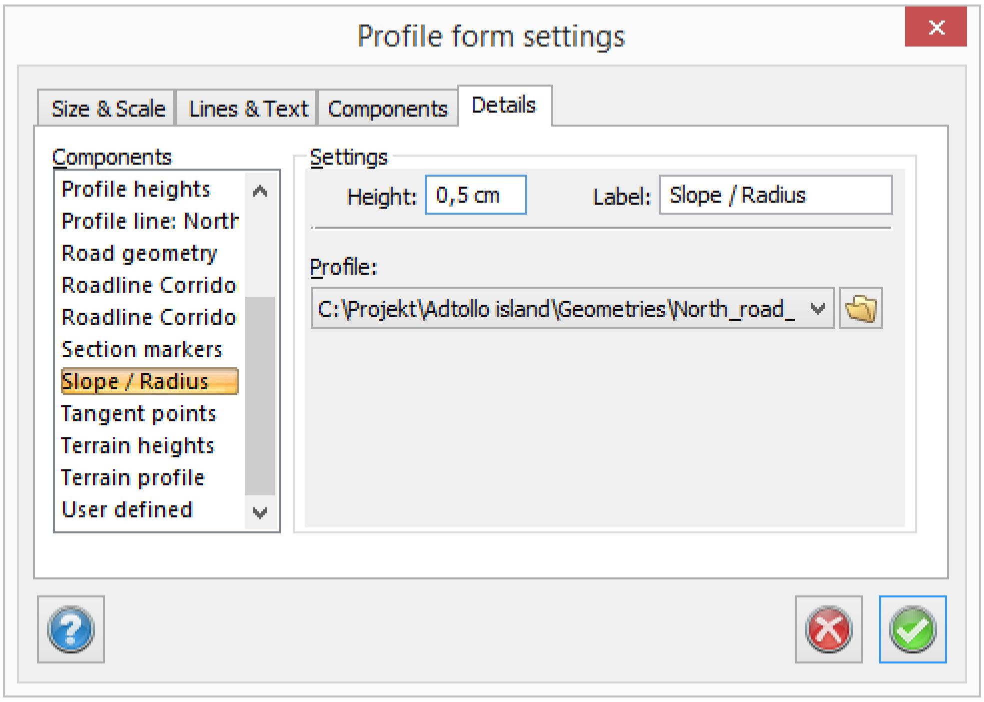
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

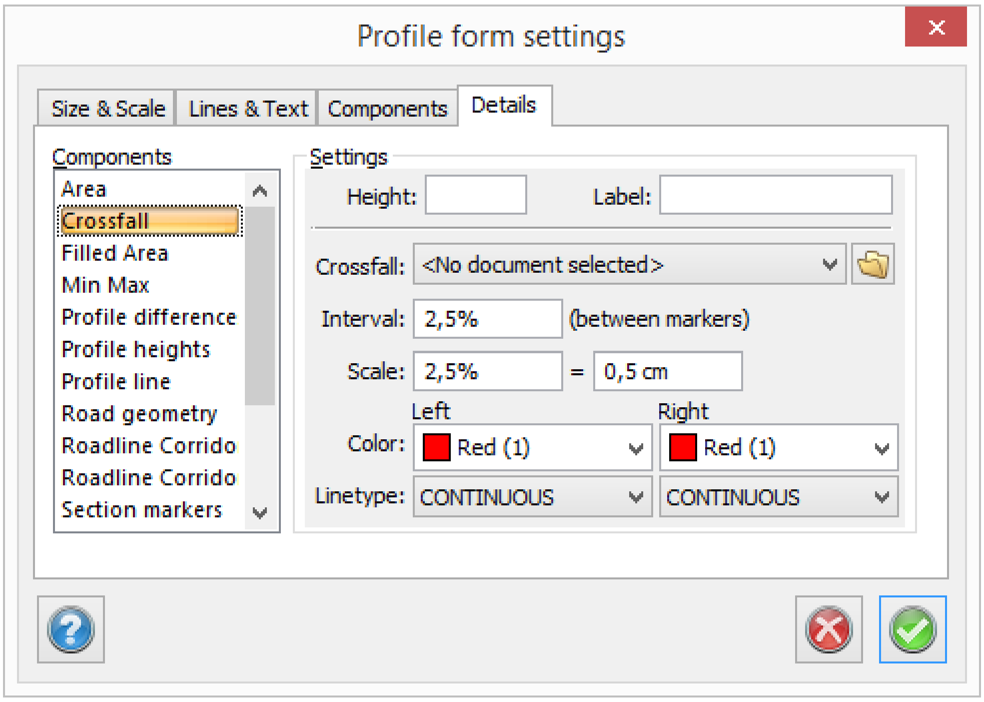
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

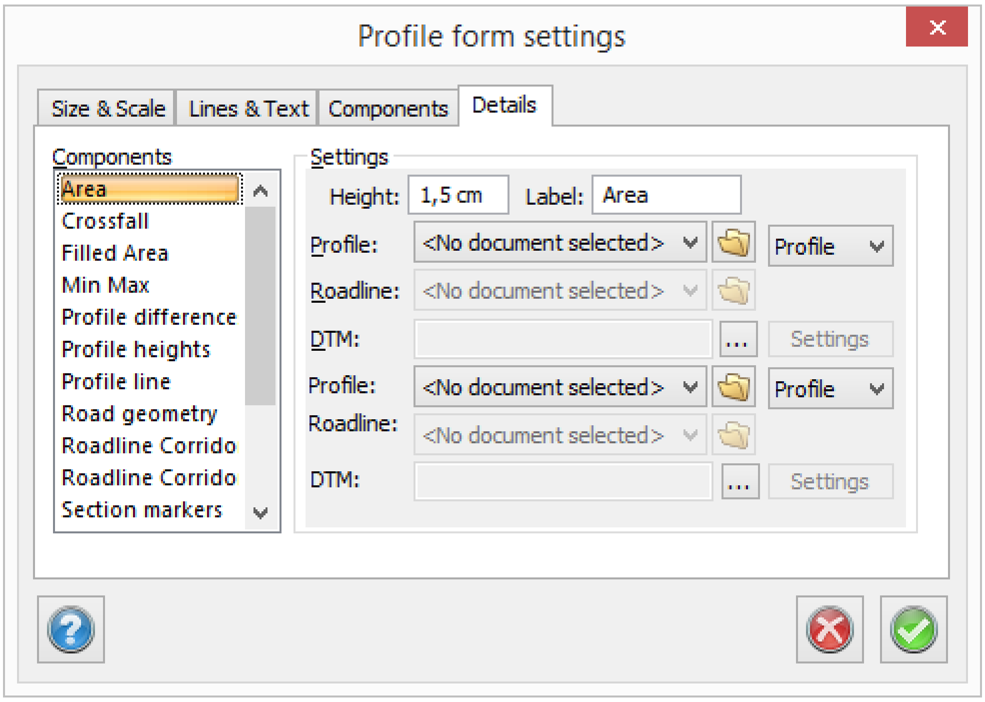
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

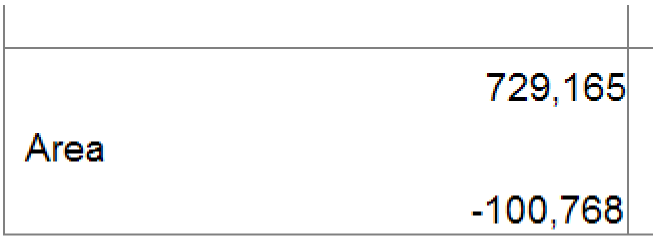
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

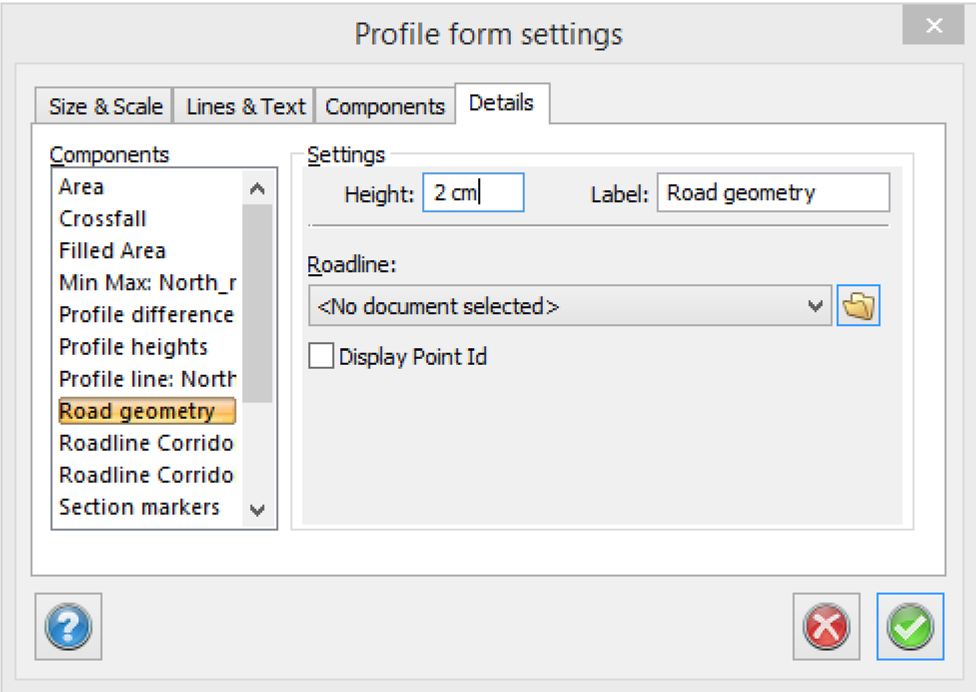


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

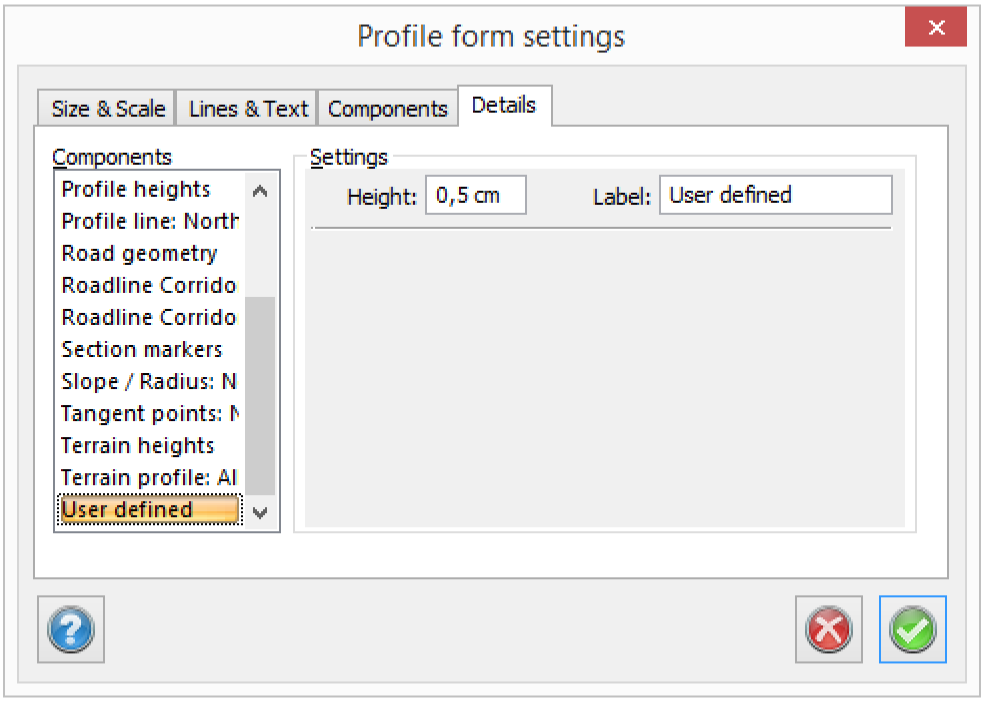
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

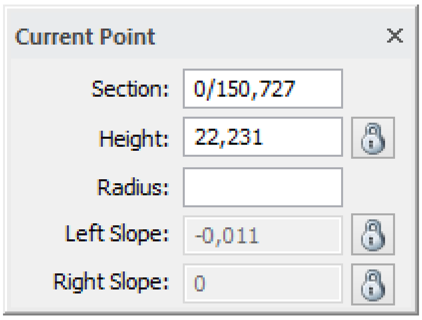
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue.
To unlock a height or a slope just click the checkbox.

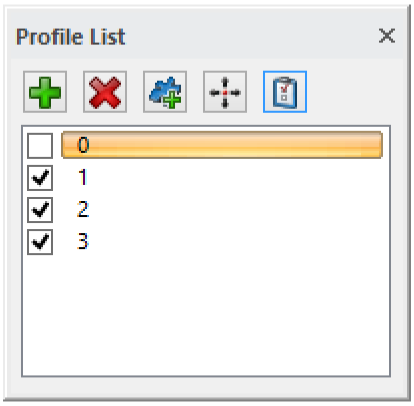
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



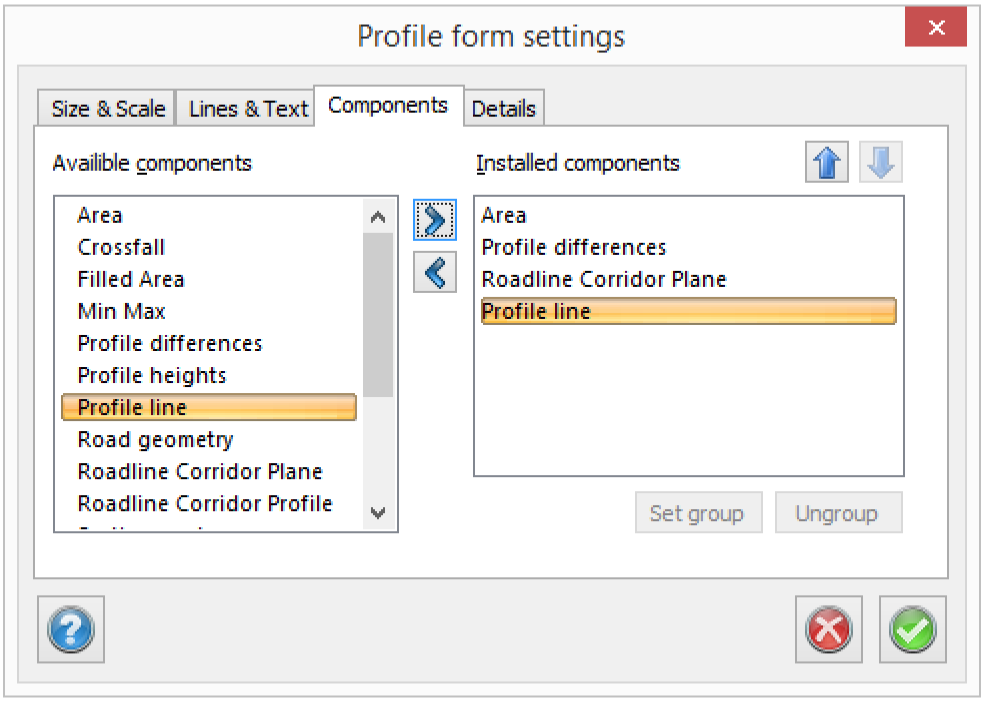
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

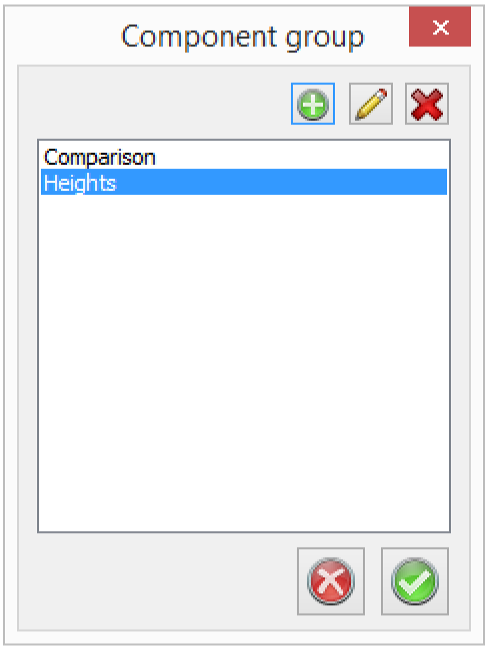
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

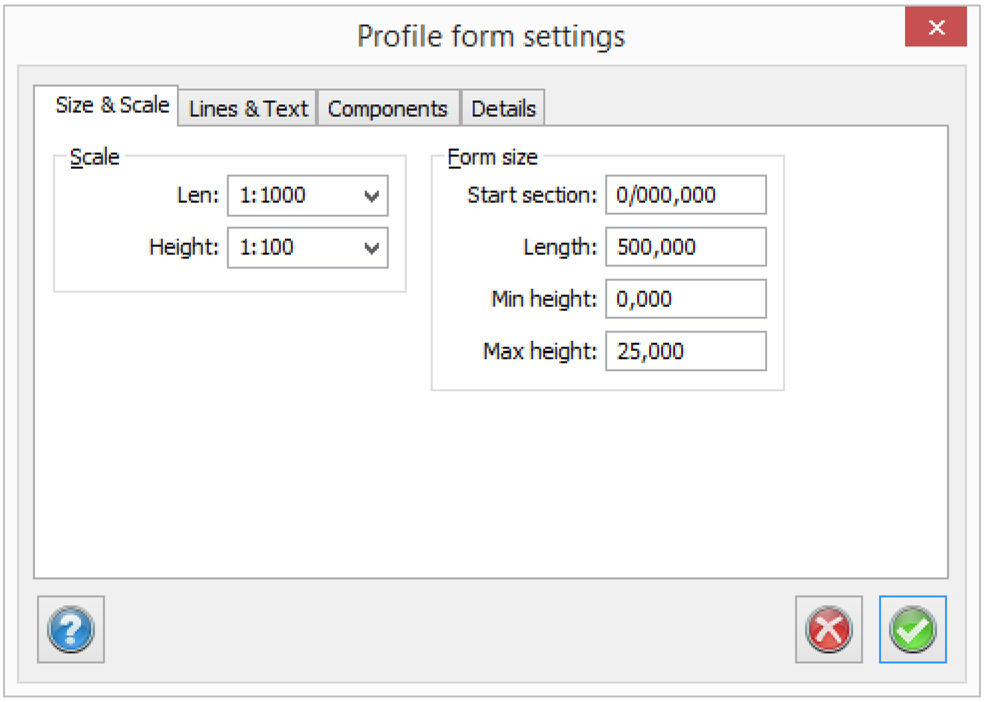
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

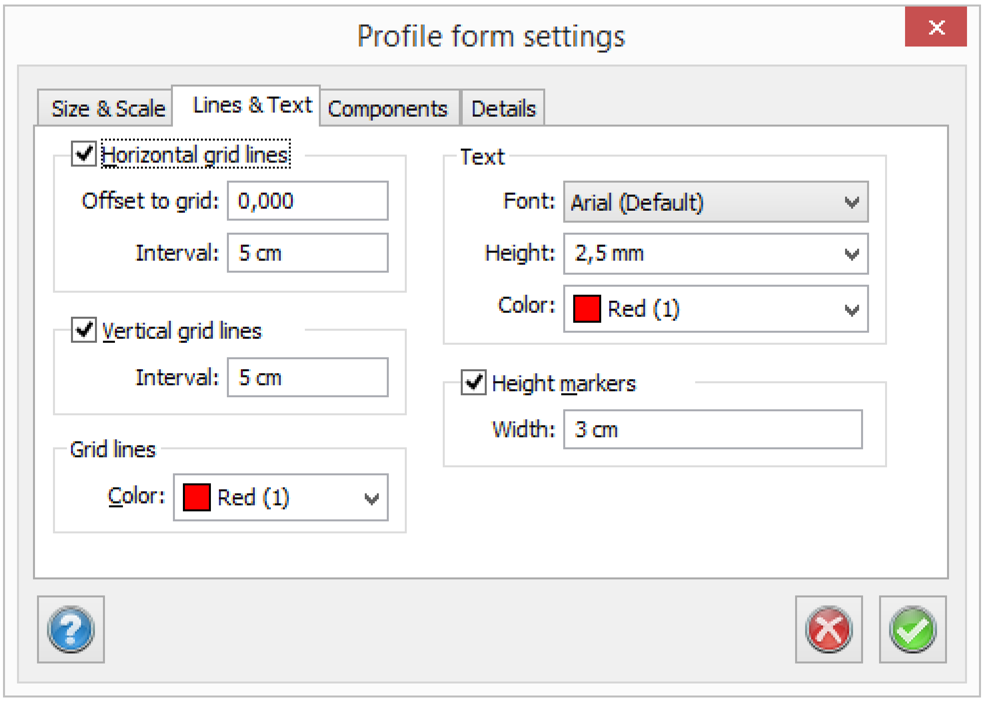


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

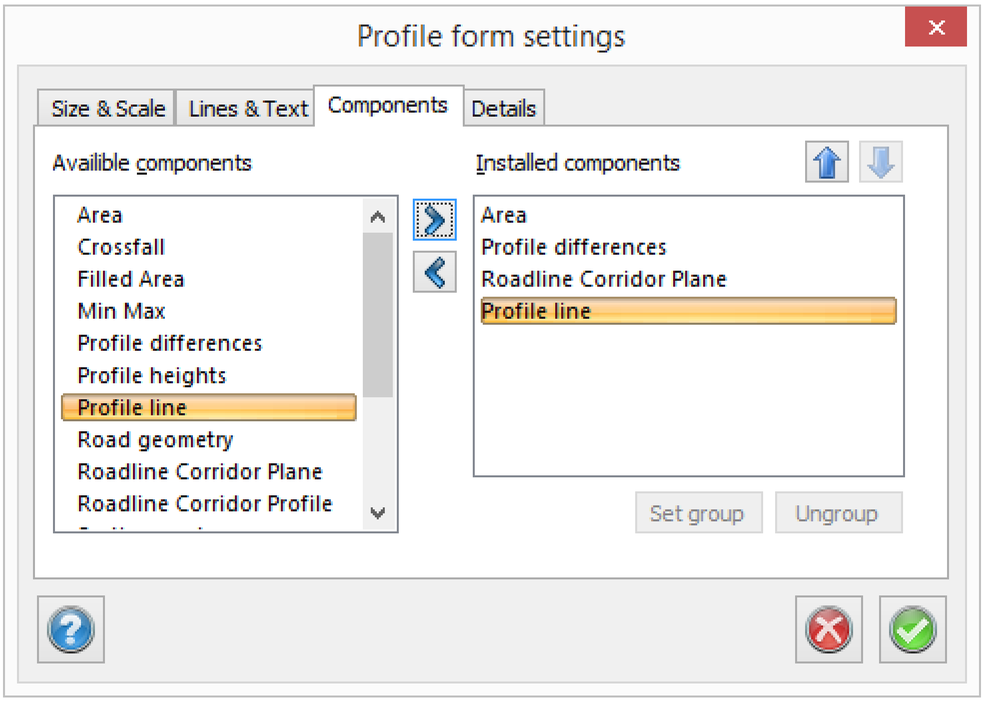
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



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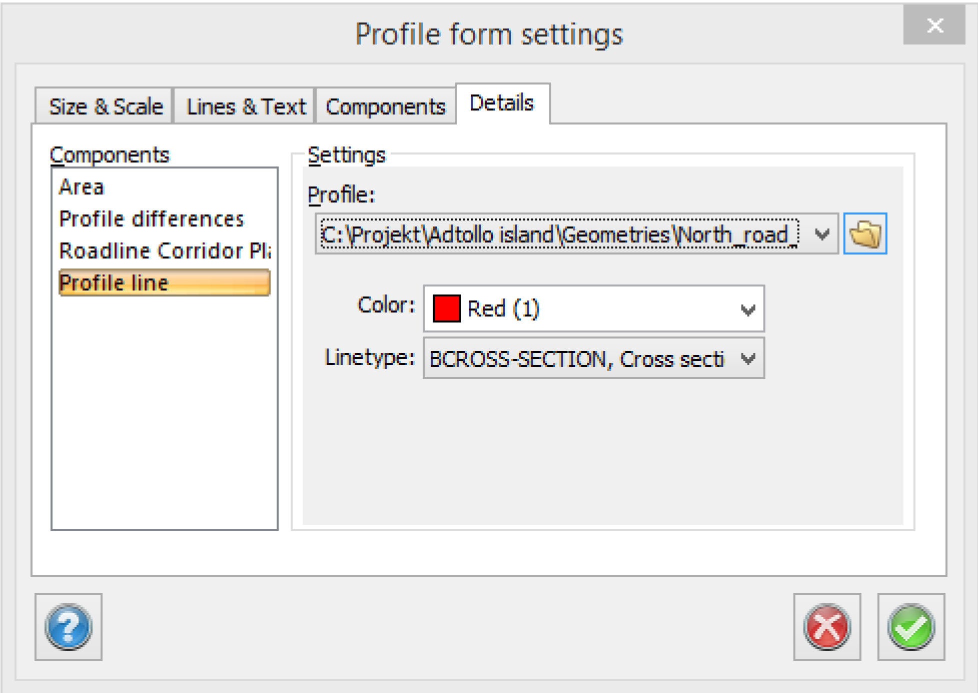
Details, profile line



The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

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Component to compare profiles in profile form
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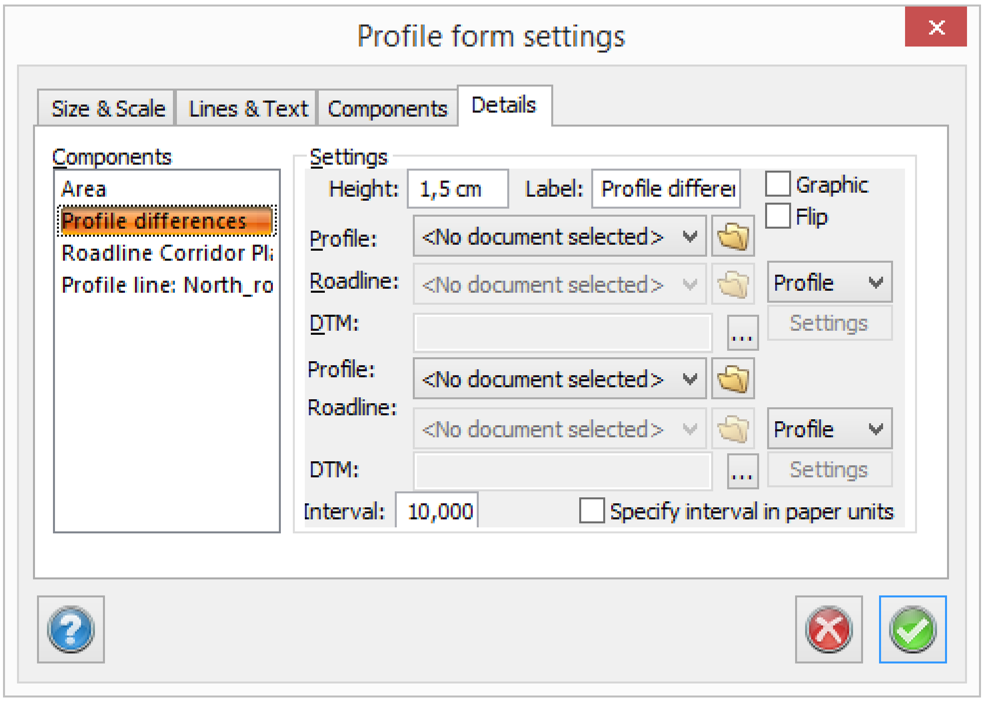
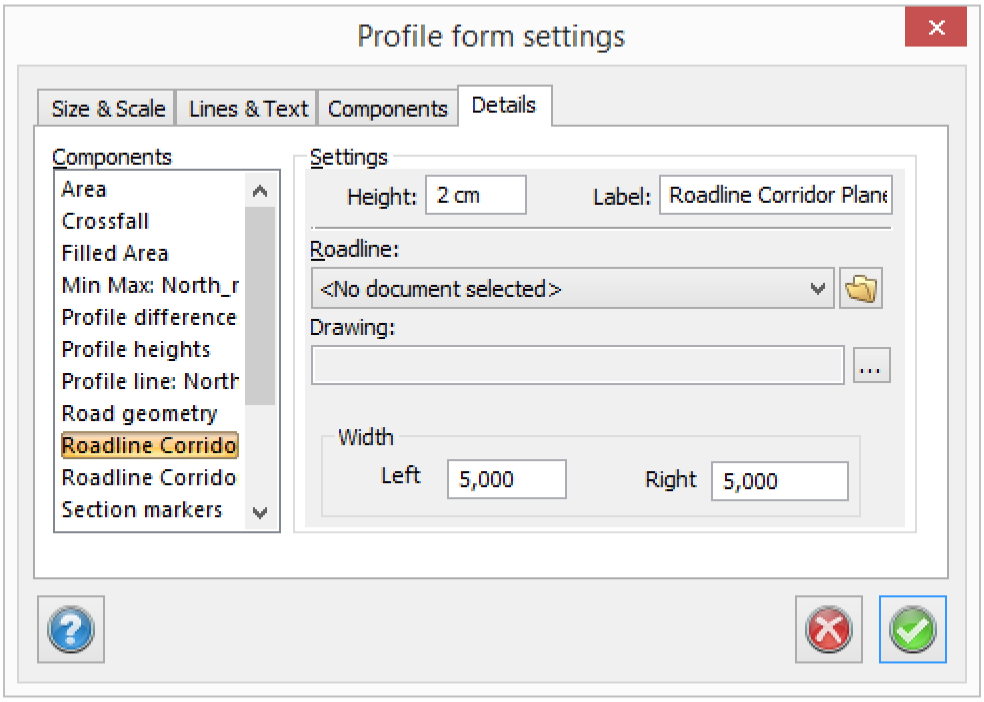
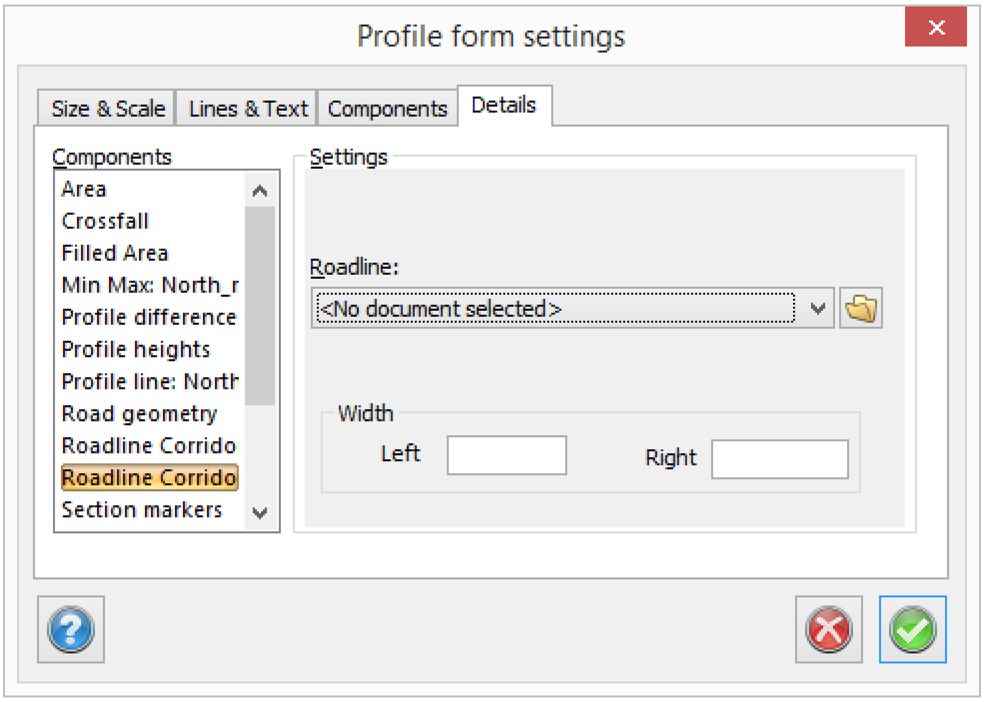
Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



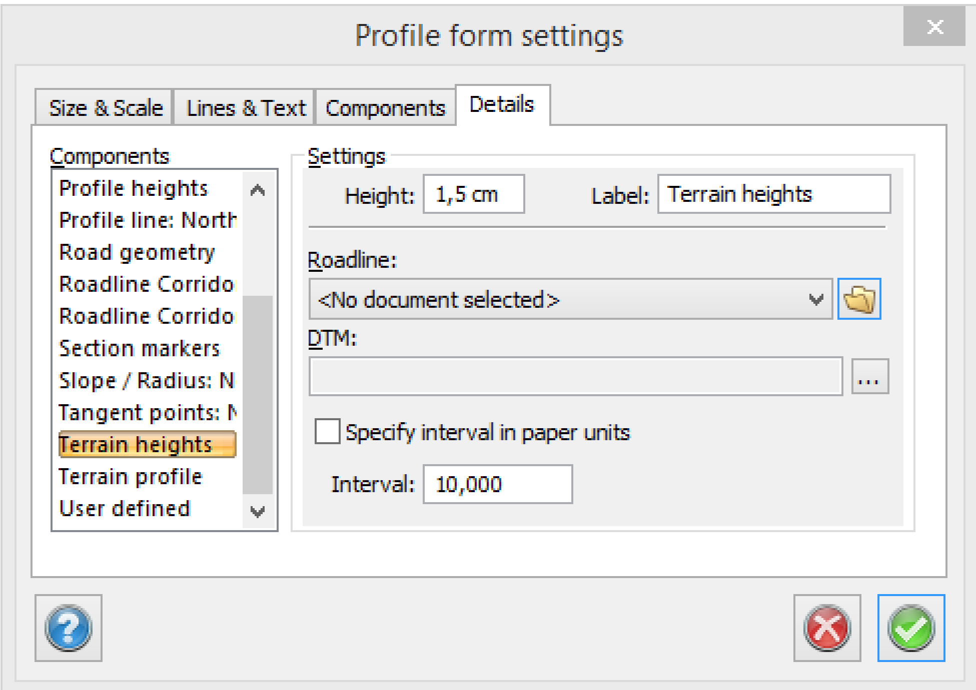
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



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Roadline
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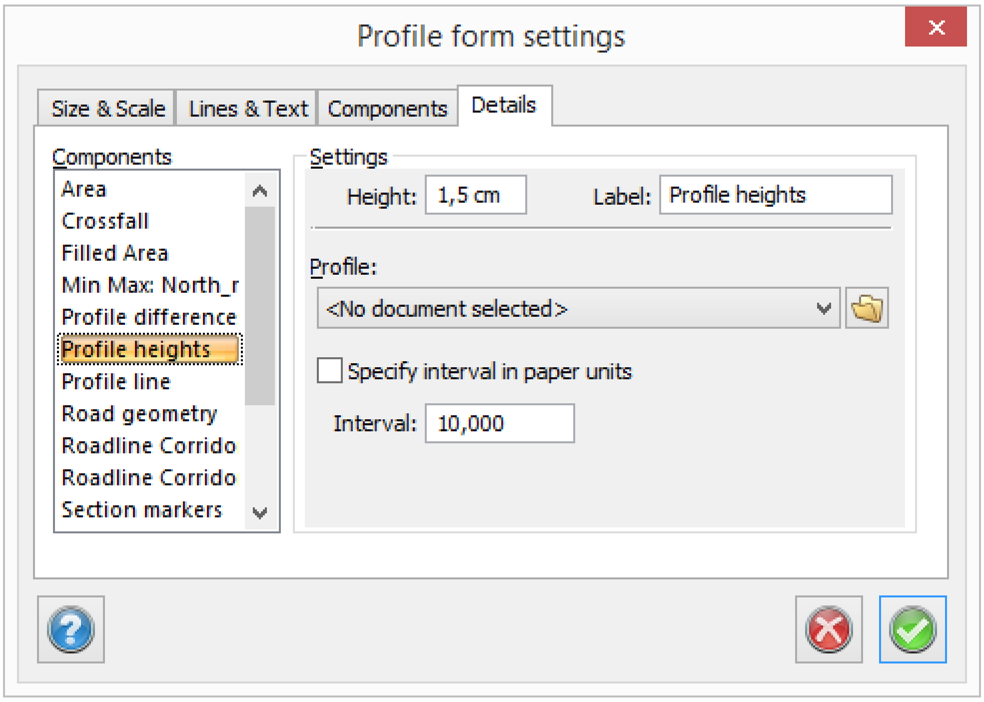
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

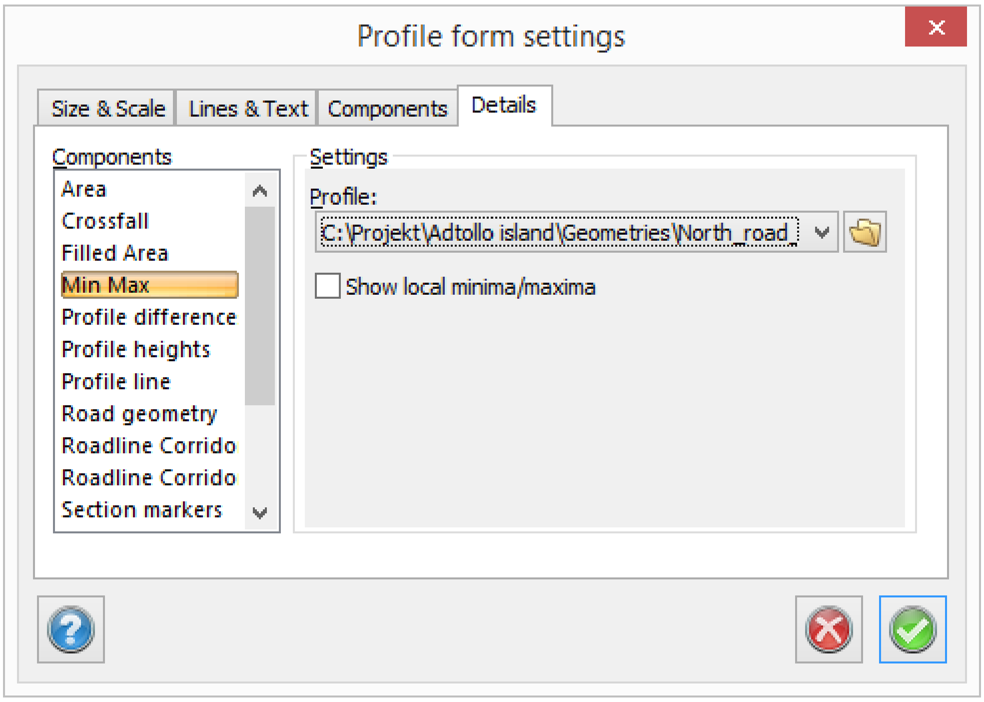
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



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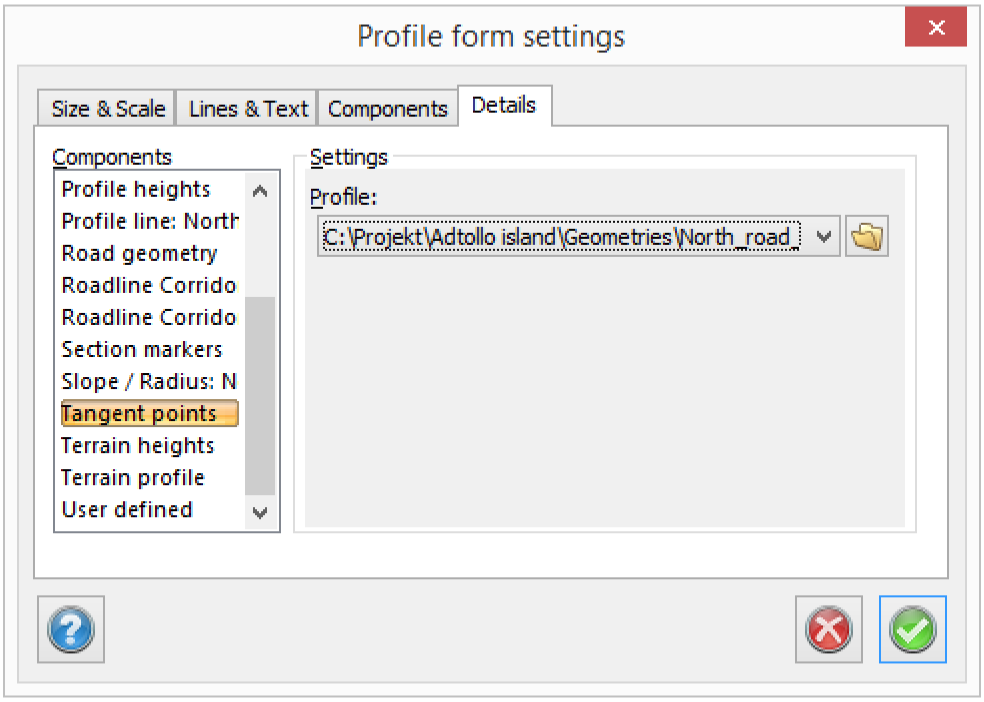
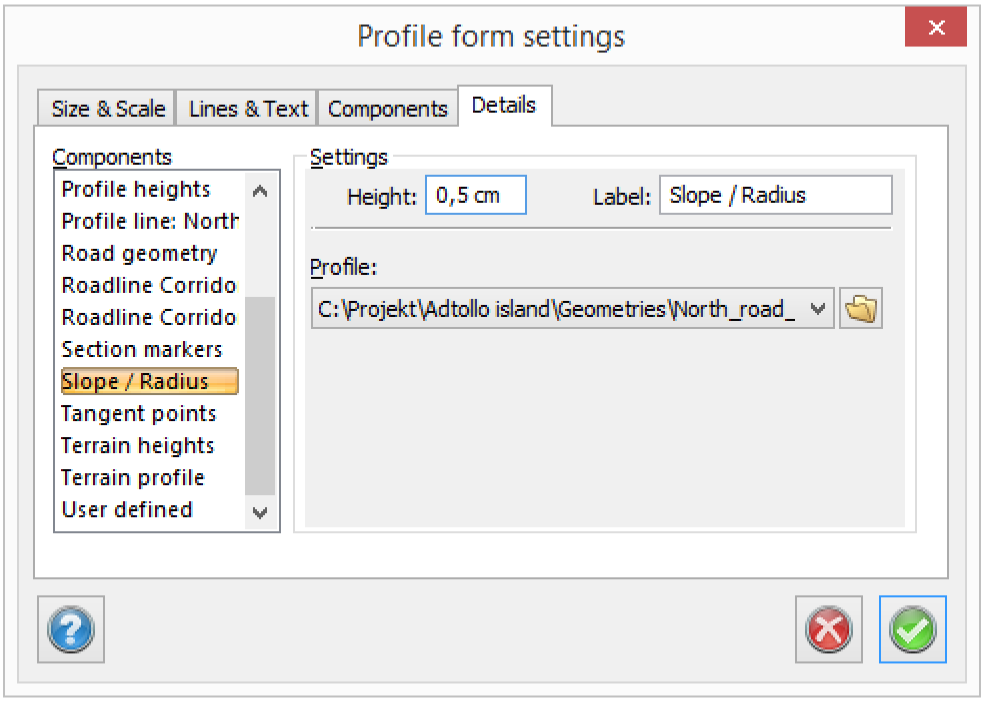
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

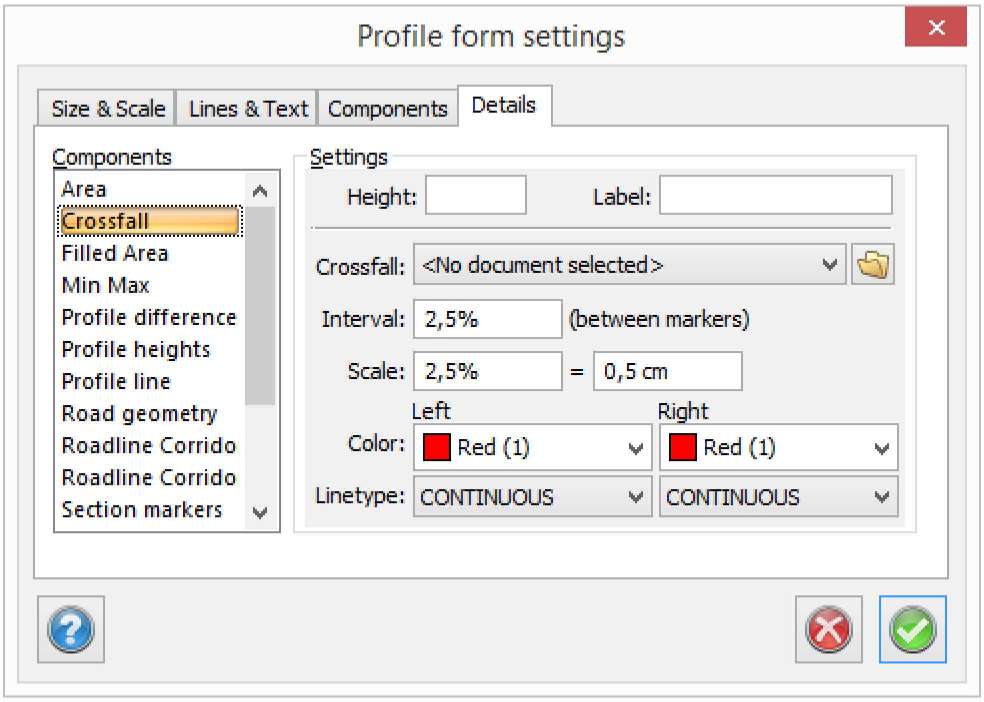
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

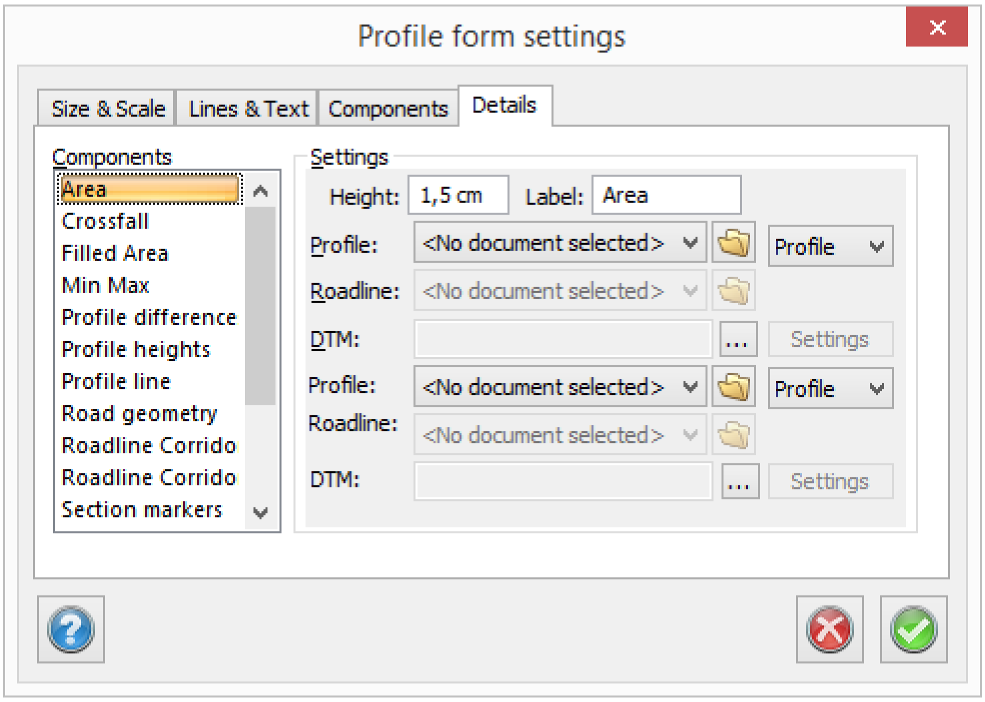
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

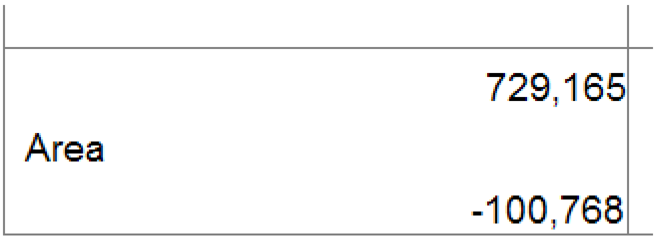
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

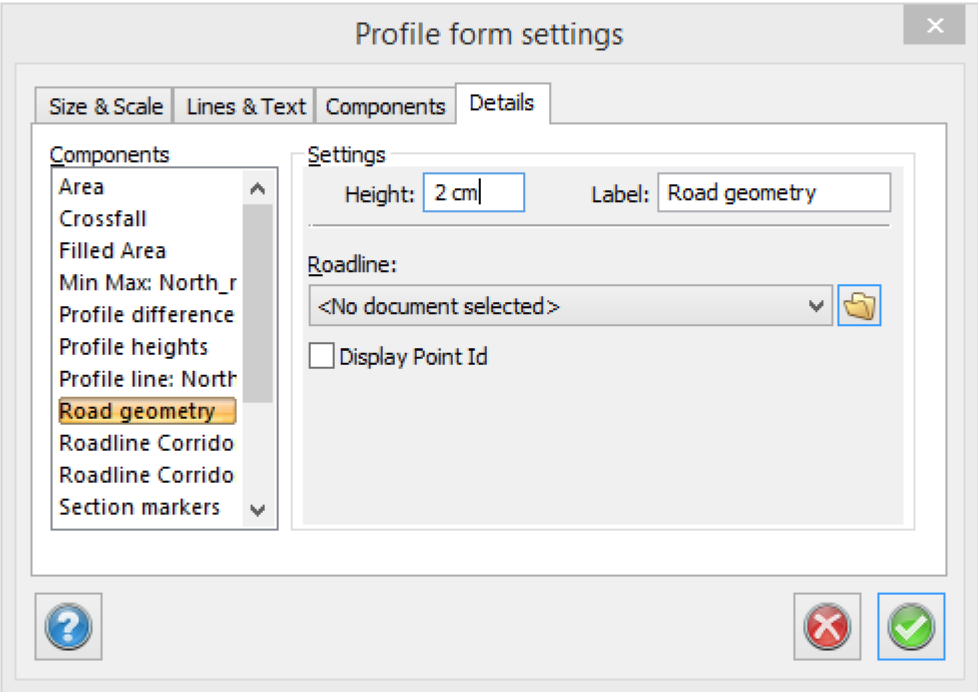


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

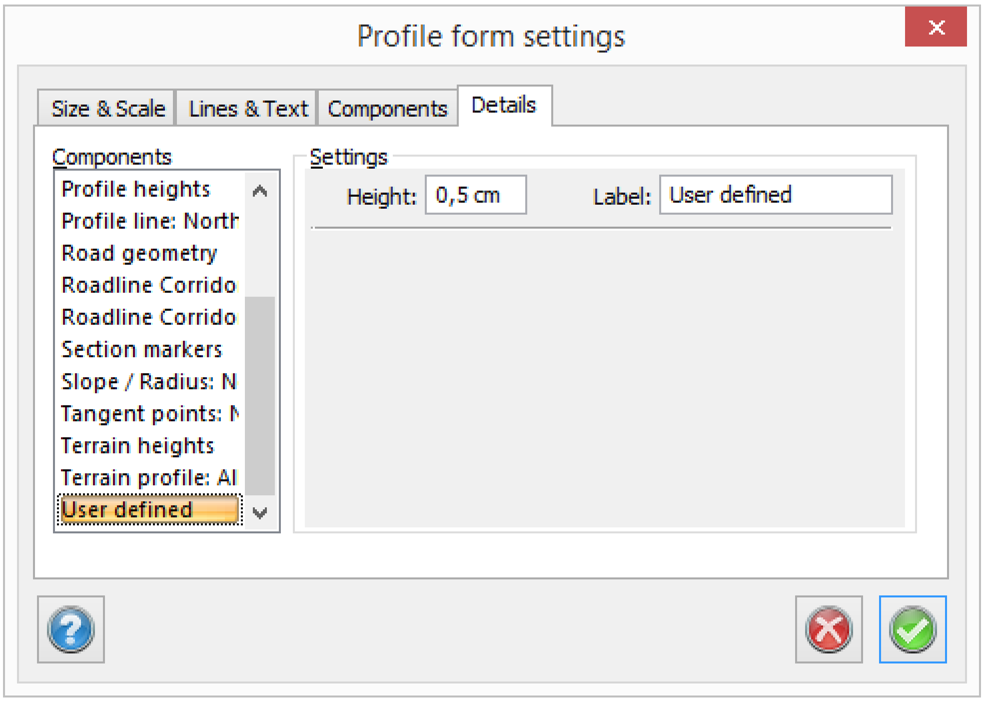
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

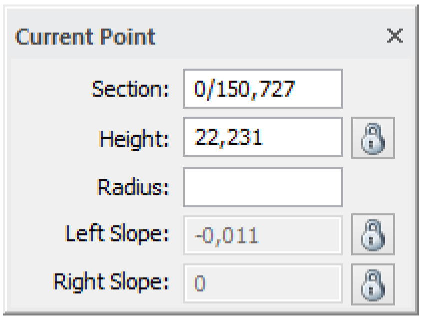
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

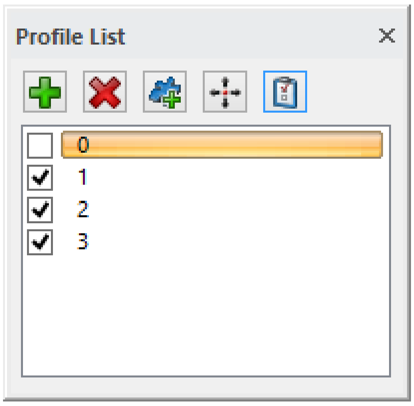
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



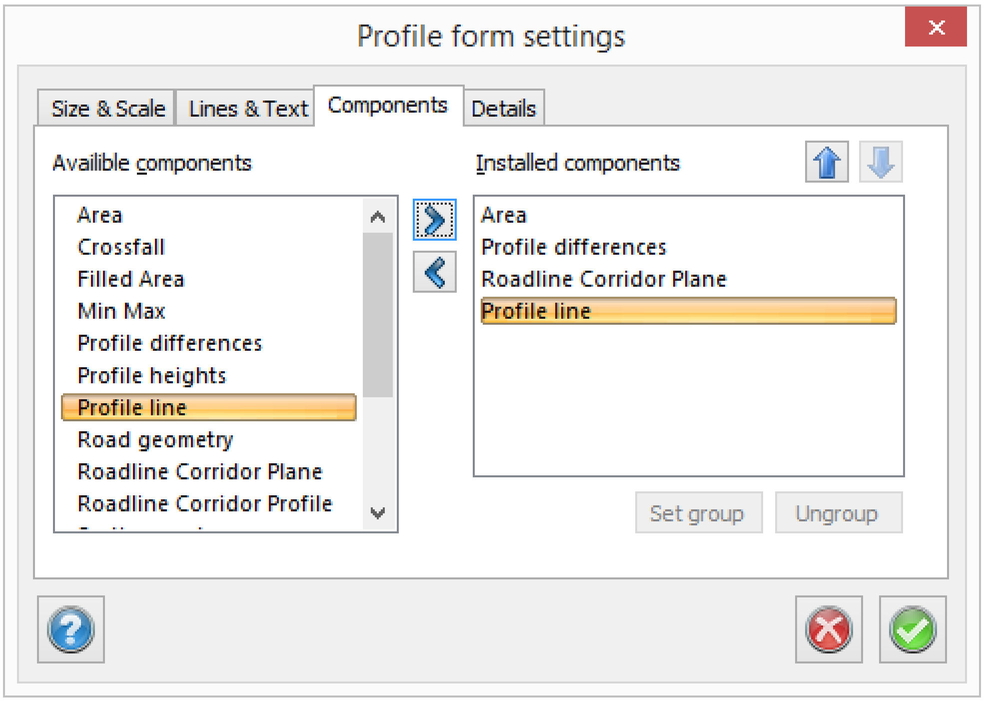
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

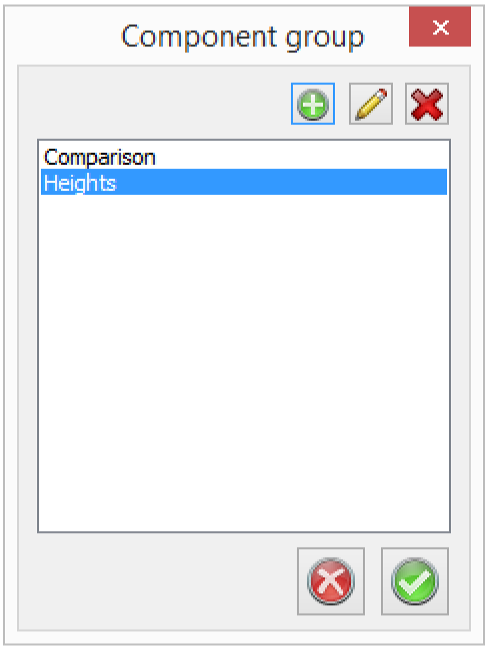
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

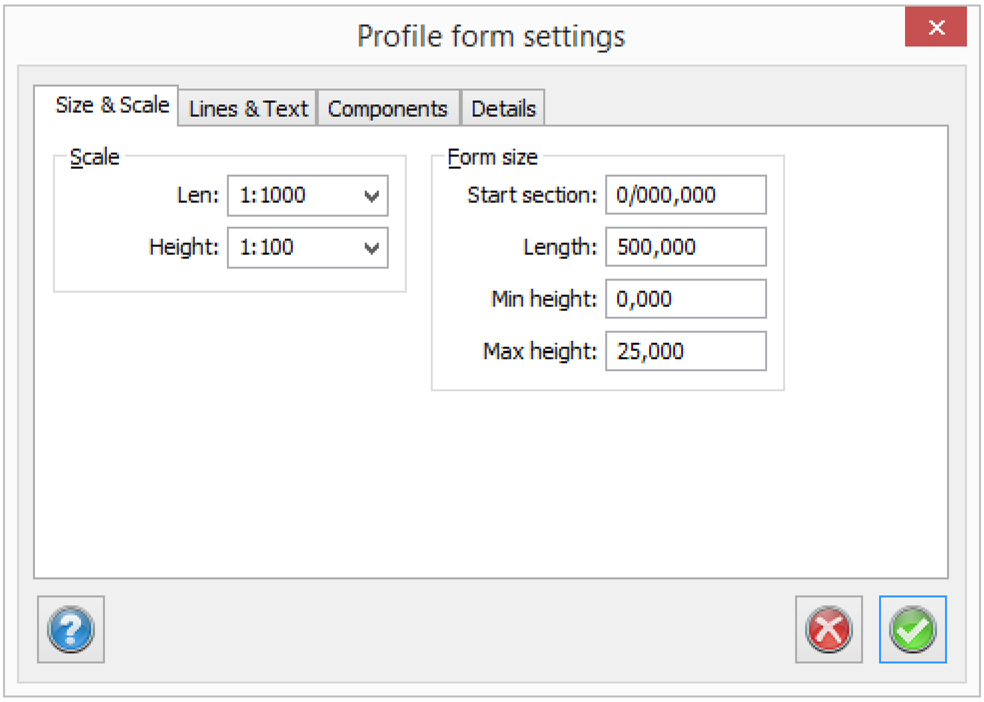
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

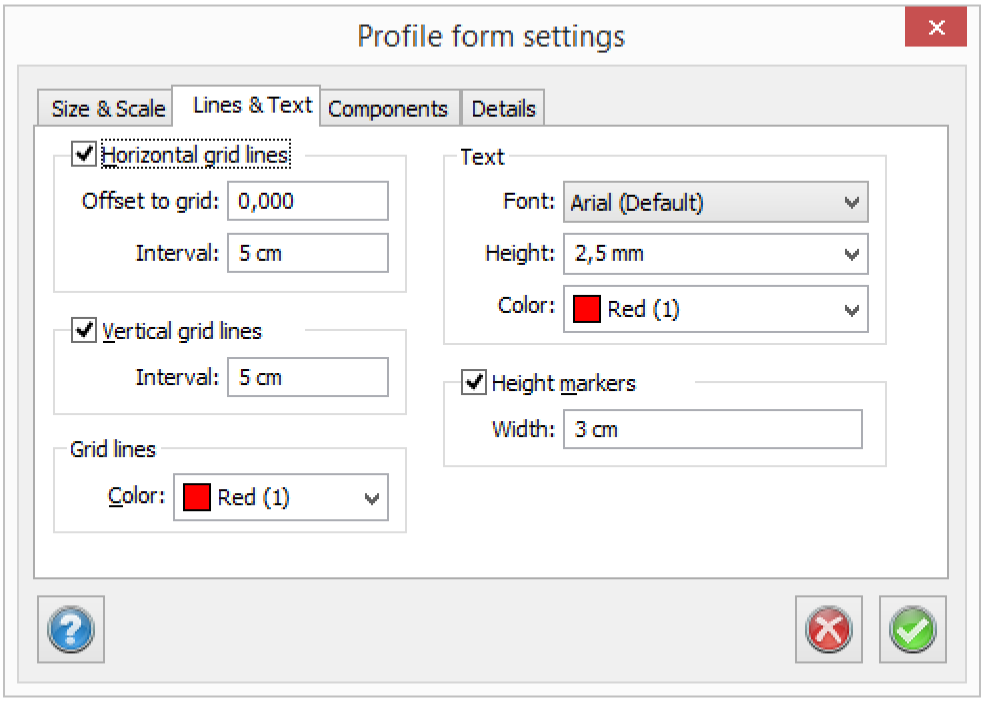


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

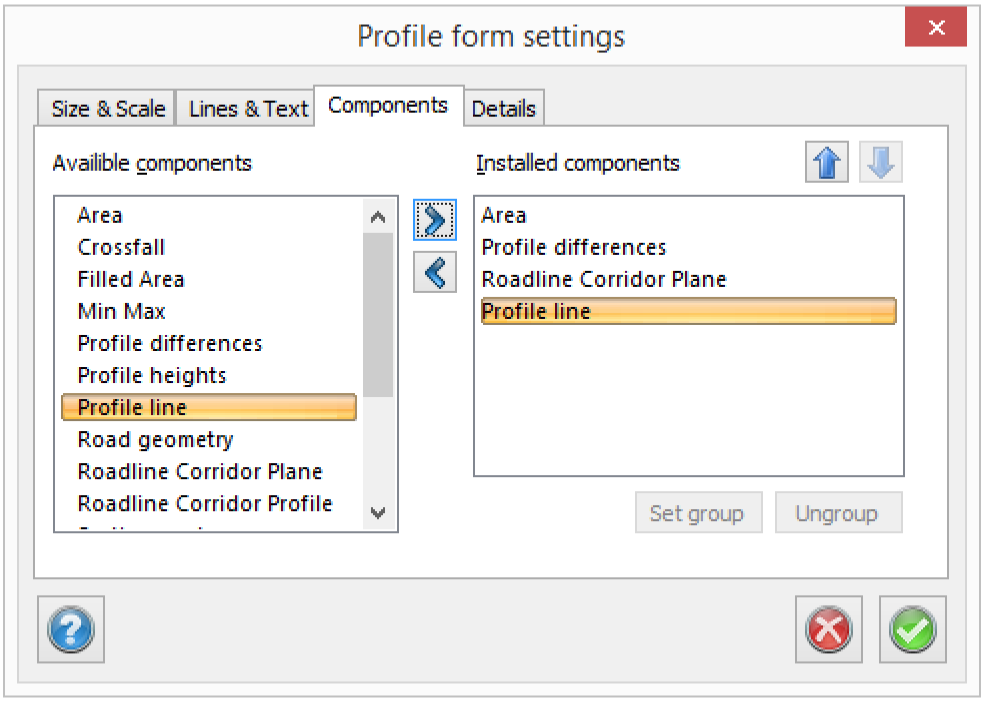
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

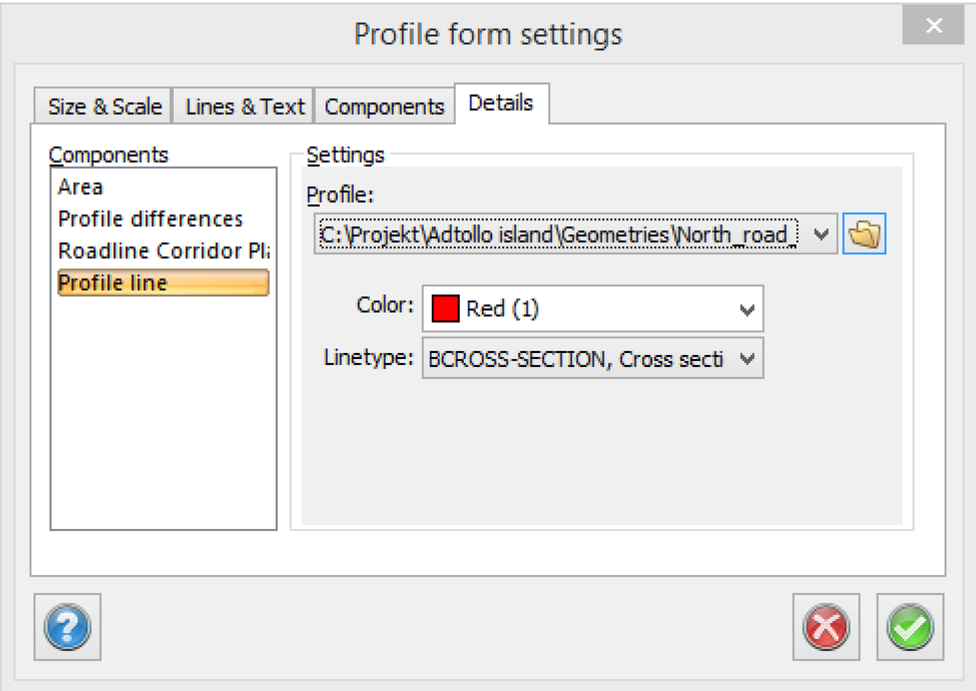
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



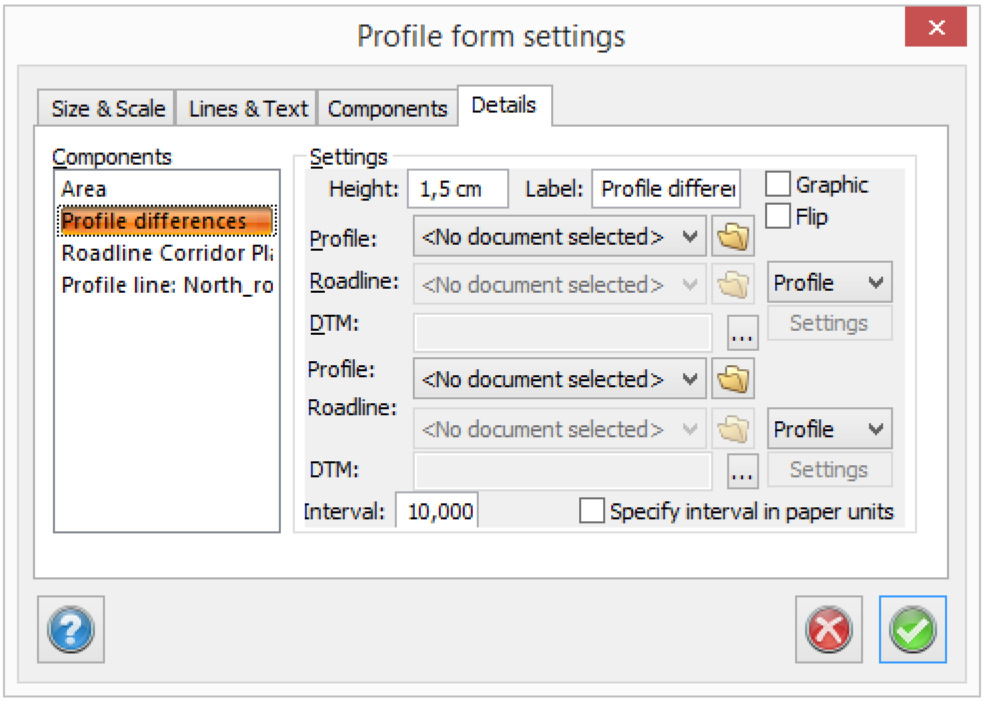
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

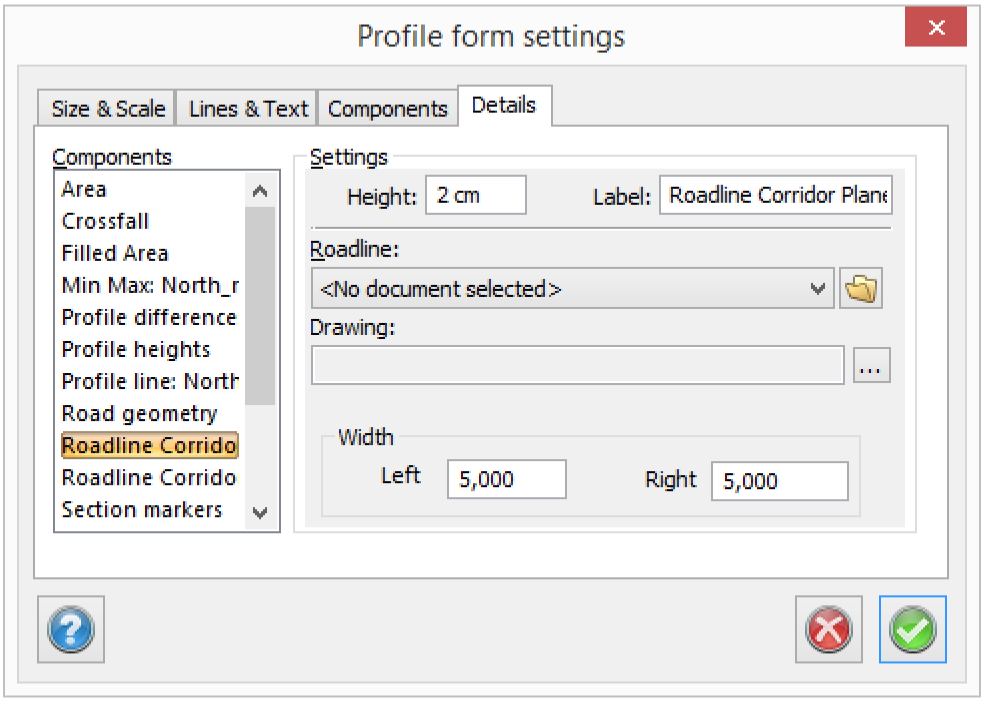
It is possible to display several different road profiles in the form.

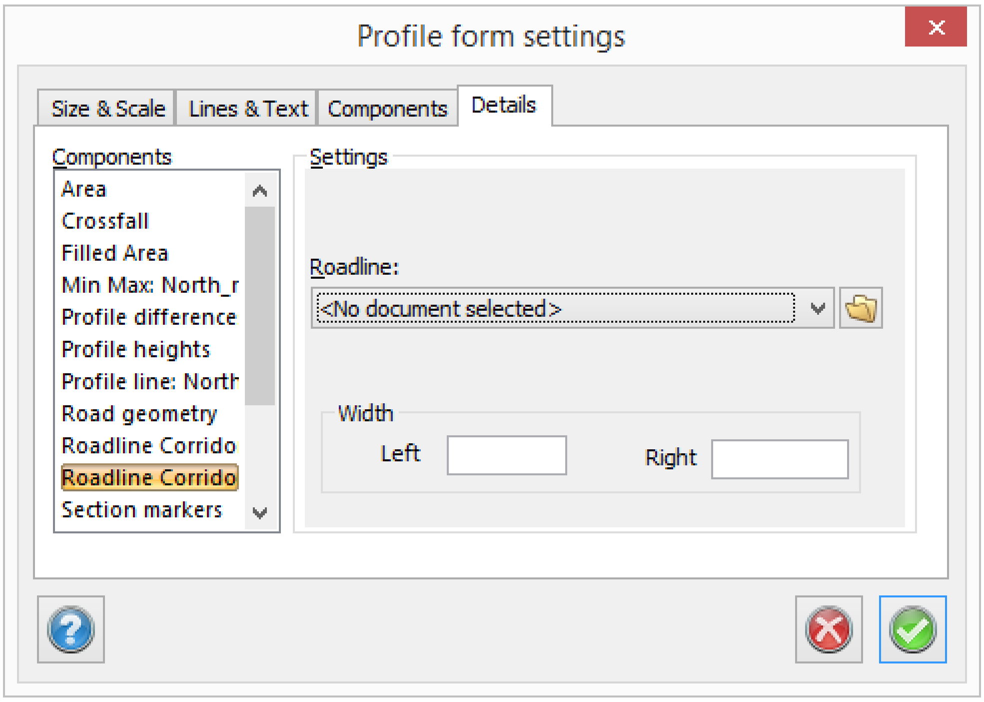
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



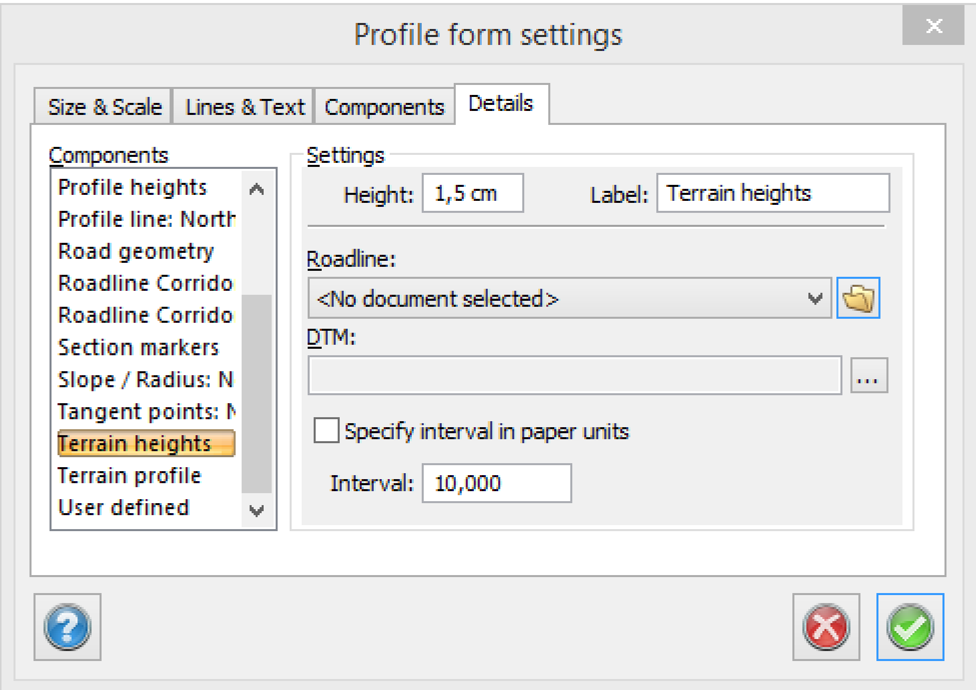
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

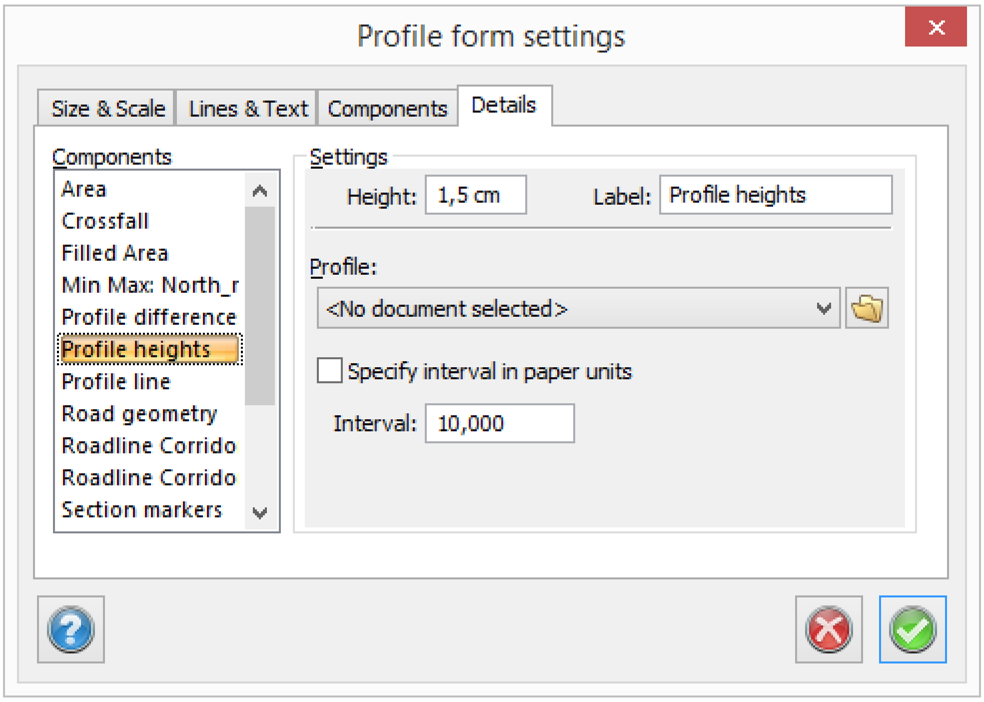
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

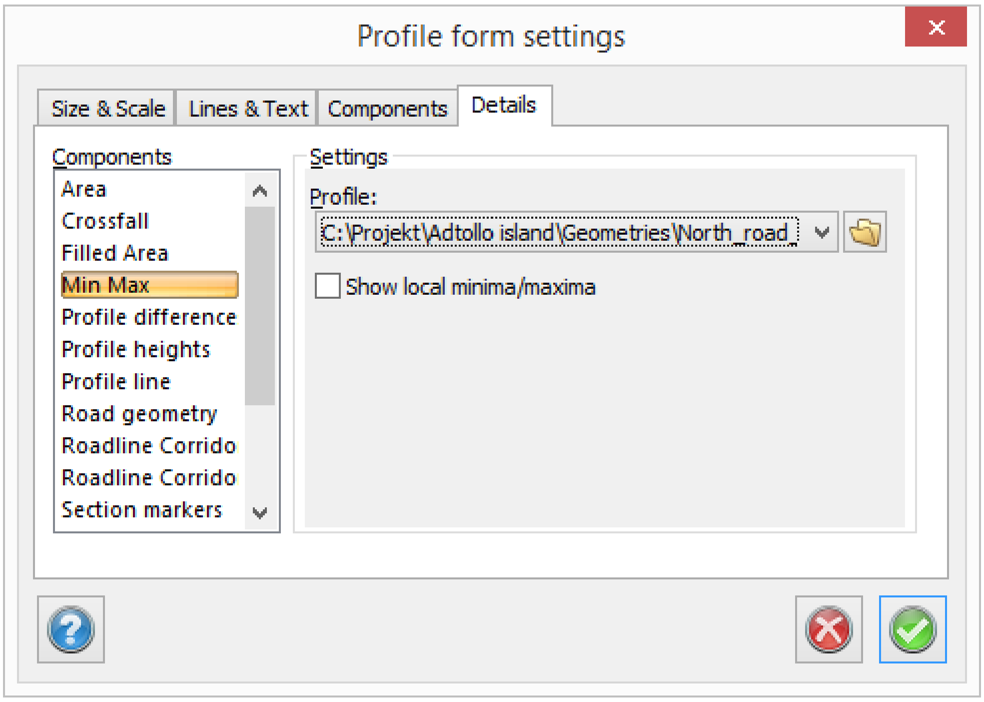
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

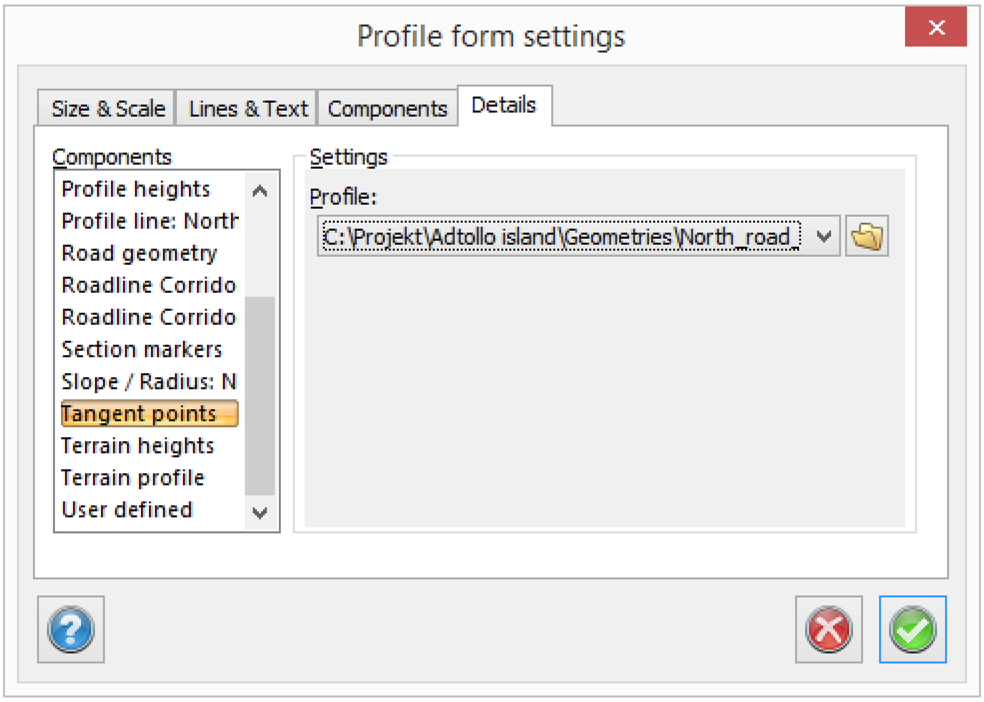
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

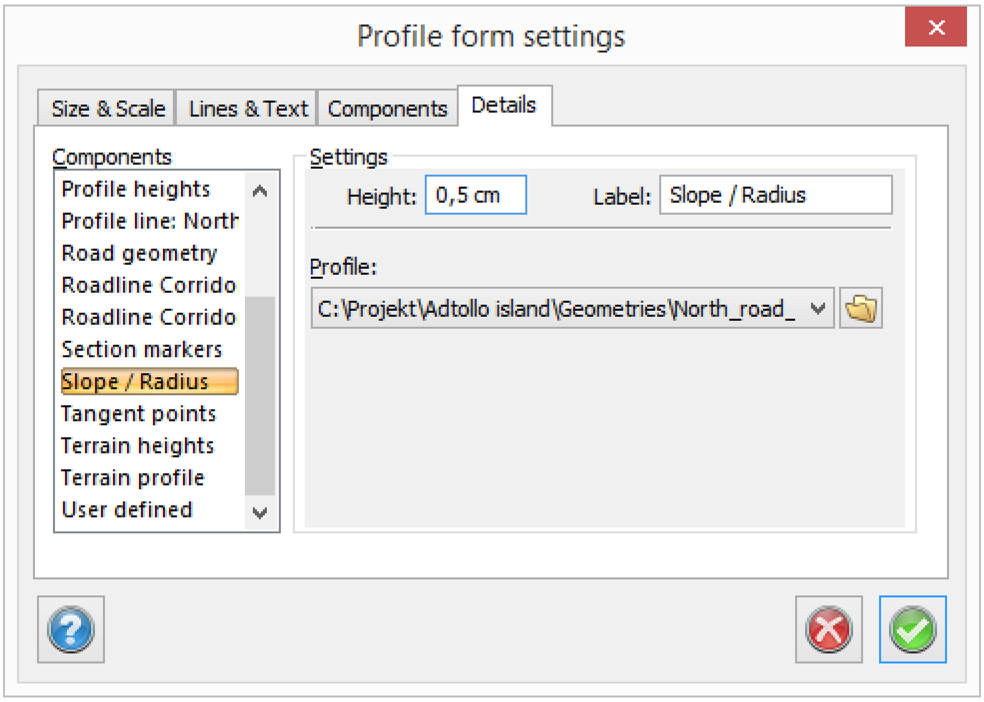
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

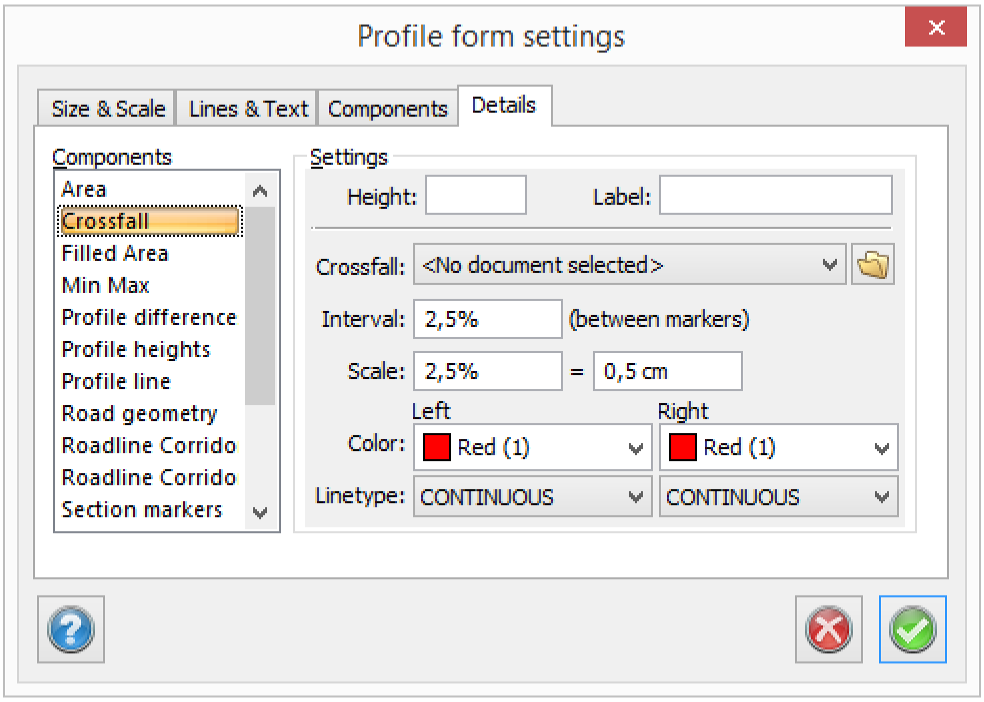
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

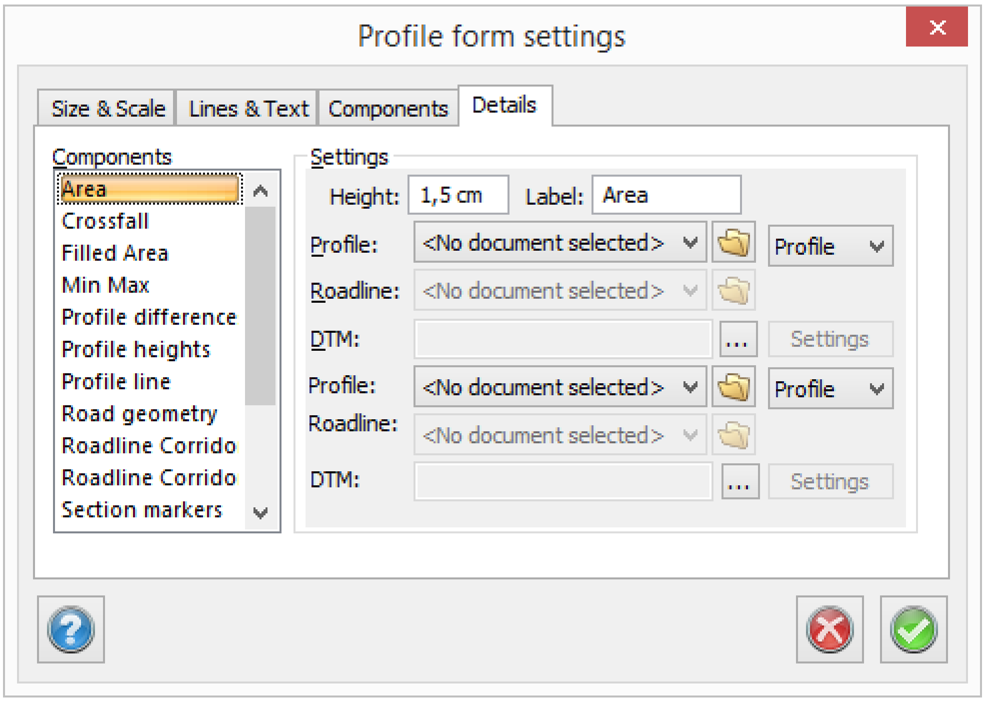
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

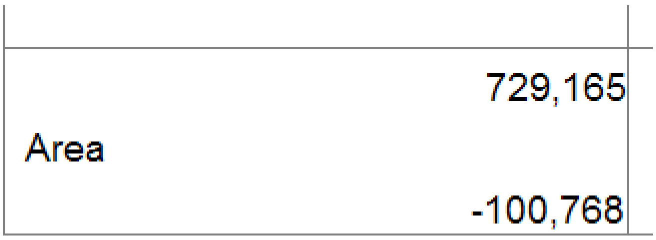
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

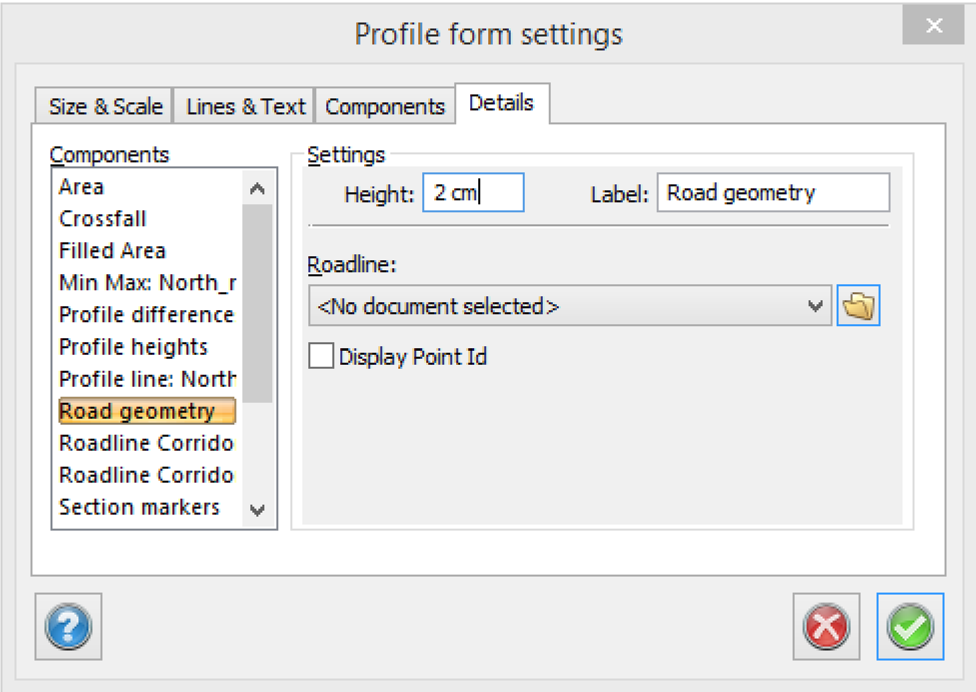


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

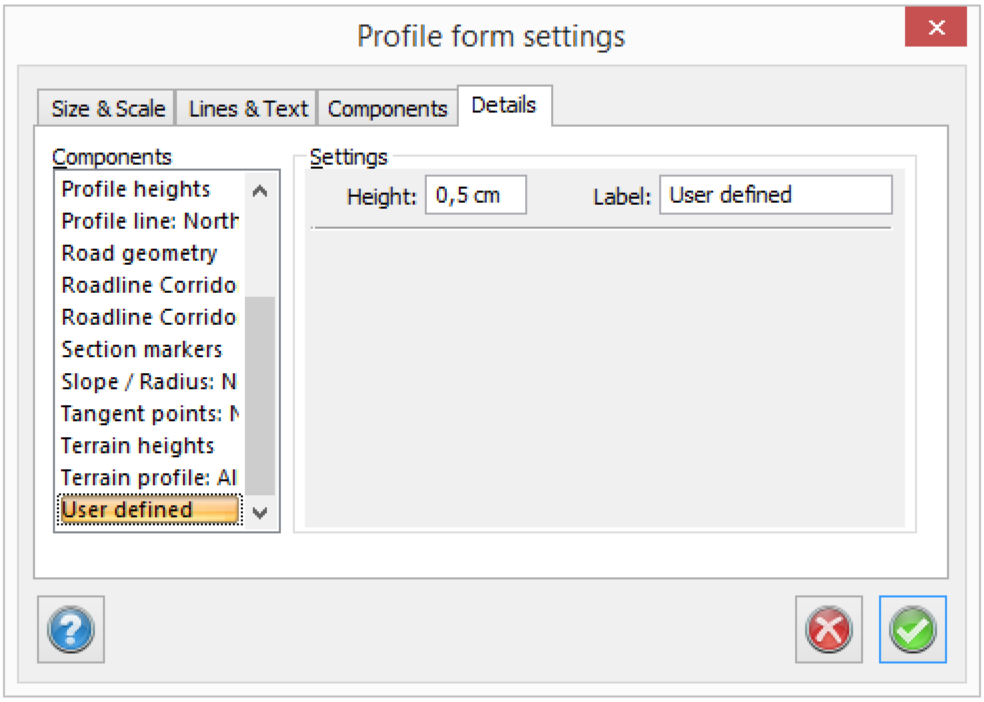
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

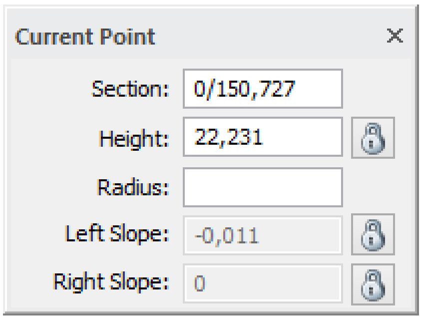
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

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The procedure is as follows:

1. Go to *Insert points.*
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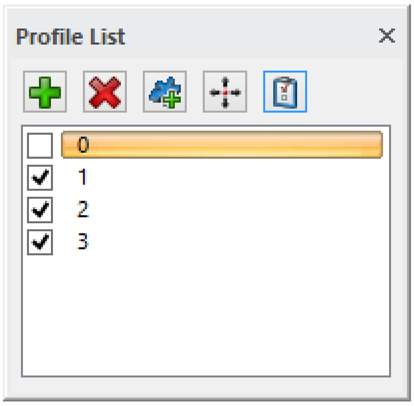
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



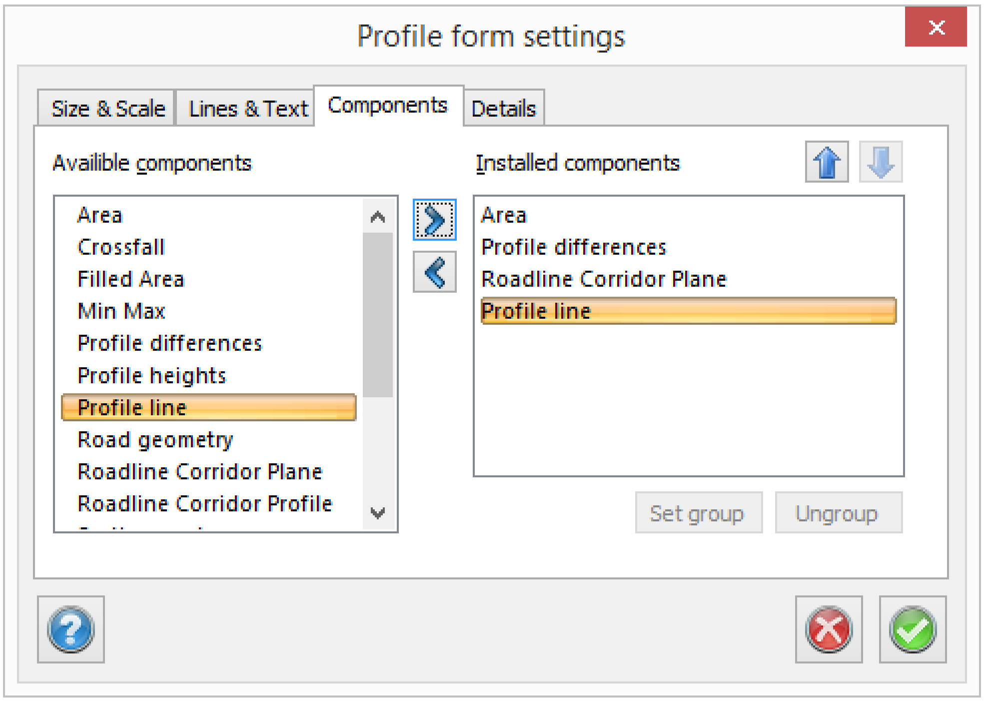
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



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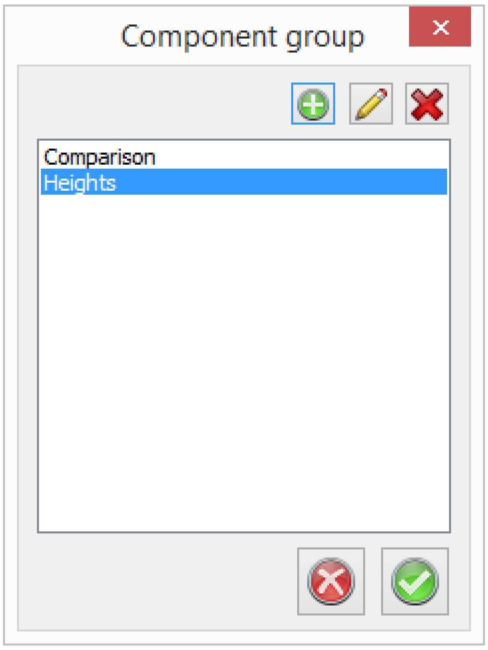


To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

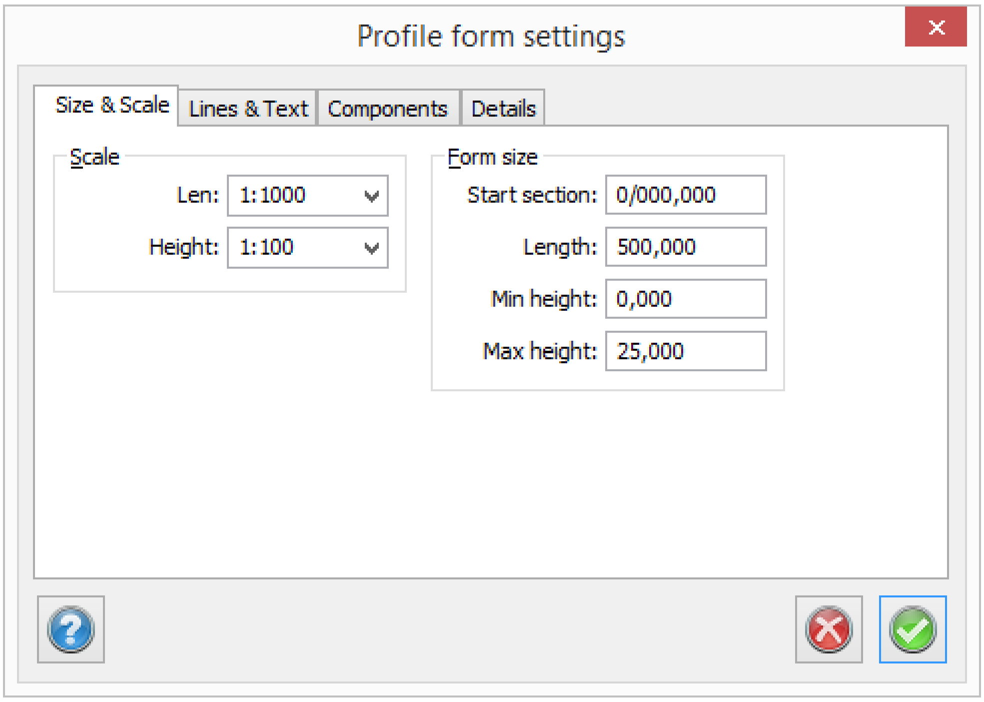
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

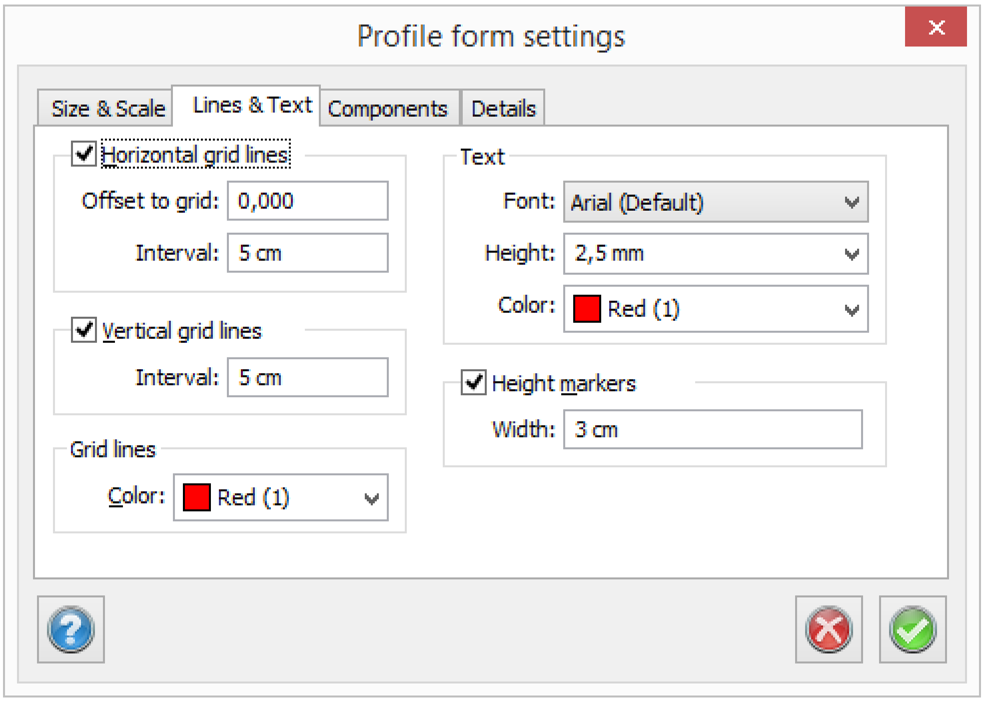


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

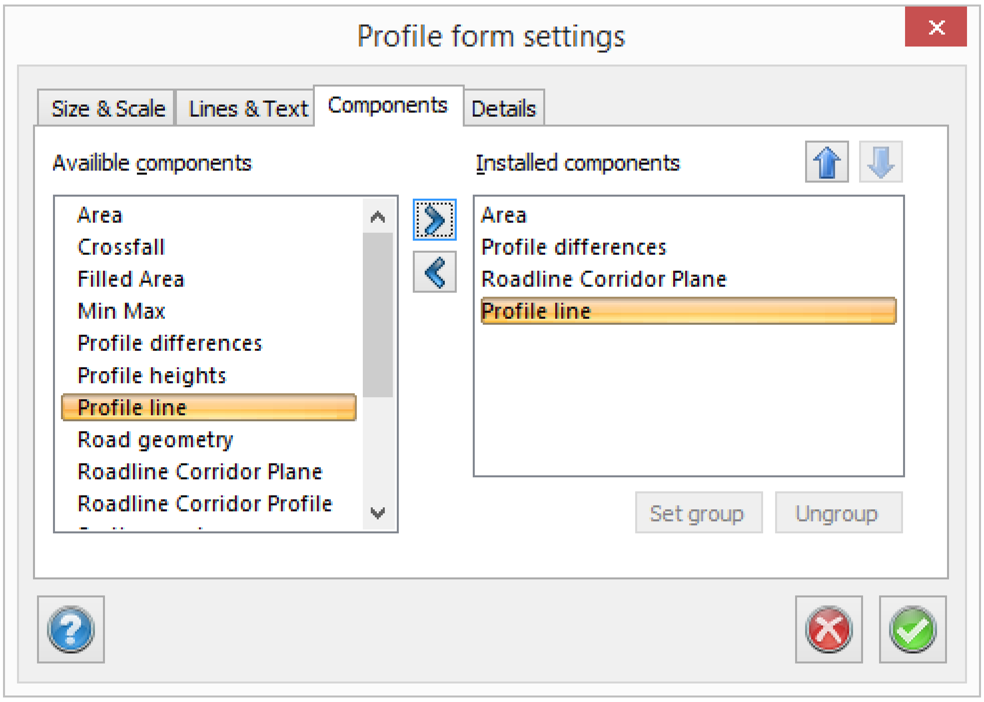
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

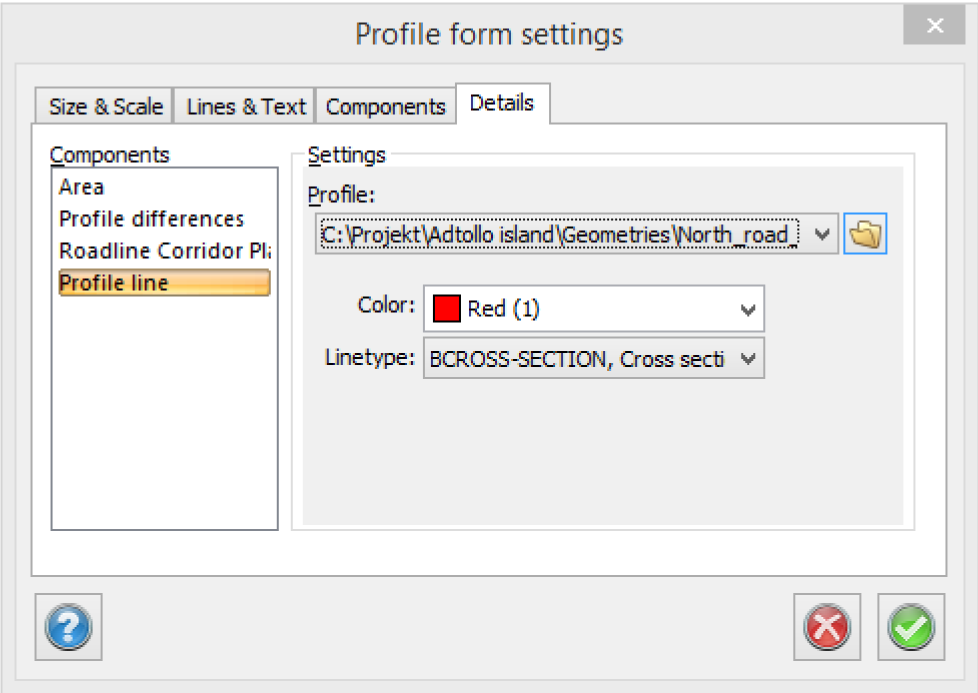
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



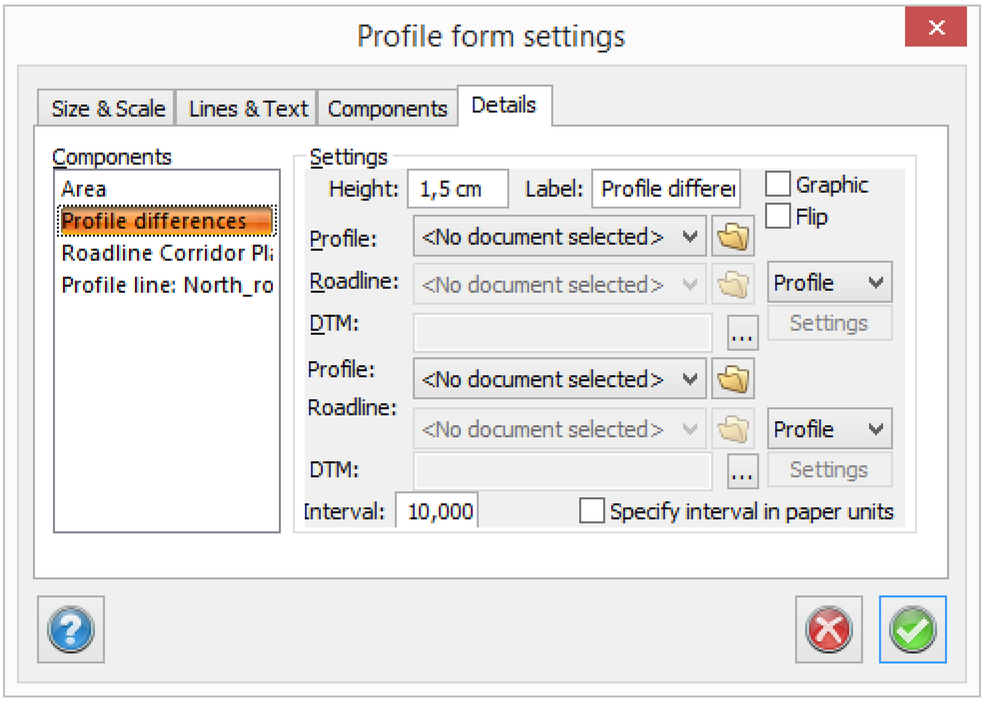
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

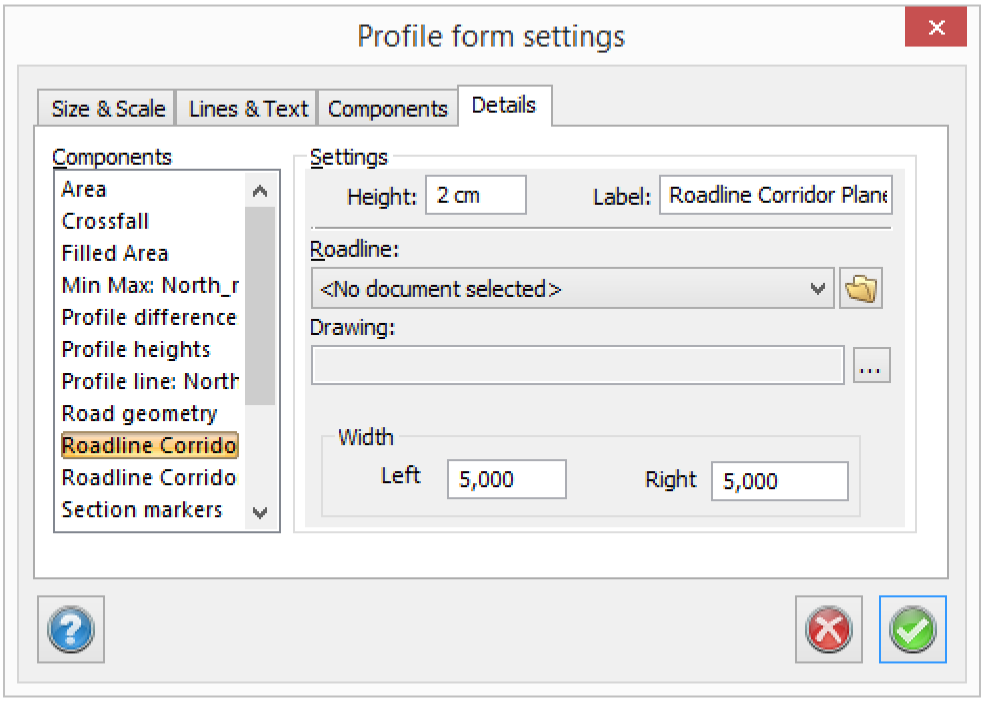
It is possible to display several different road profiles in the form.

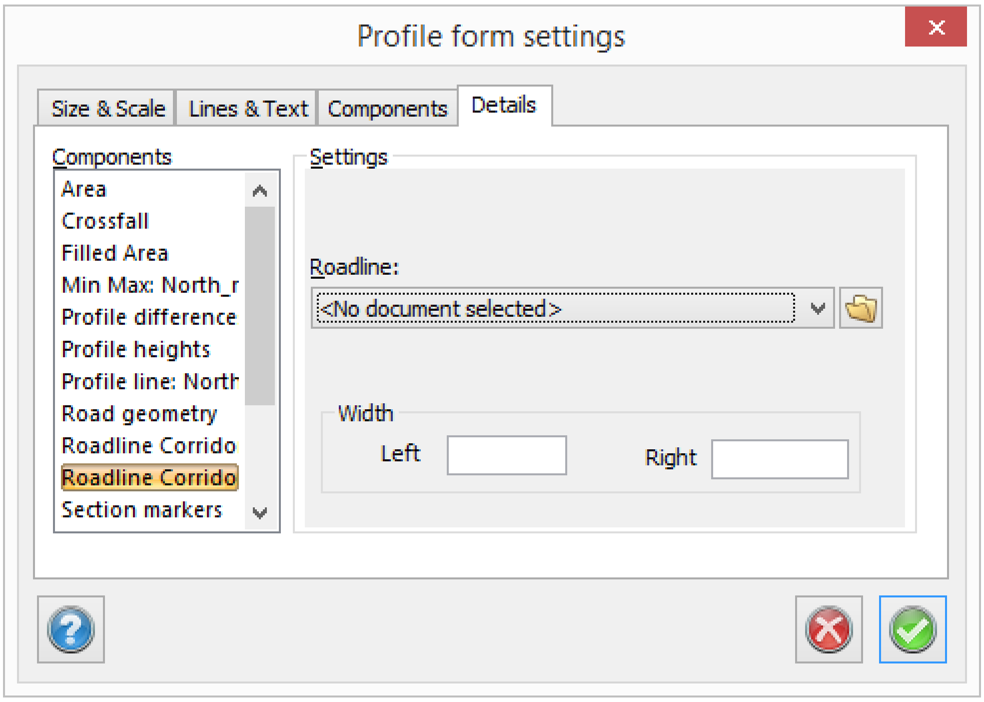
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



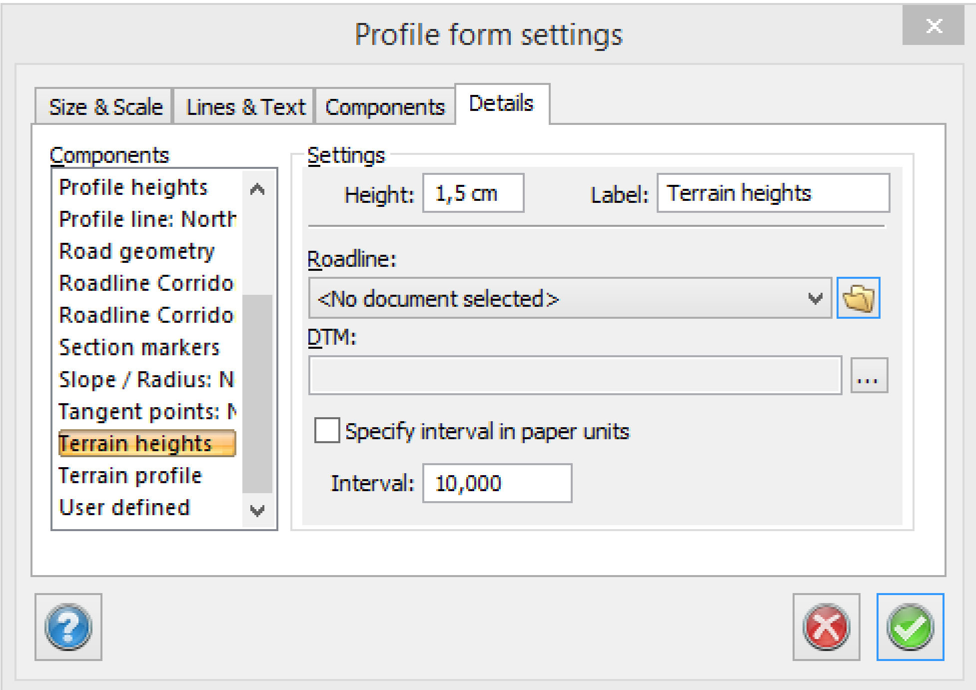
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

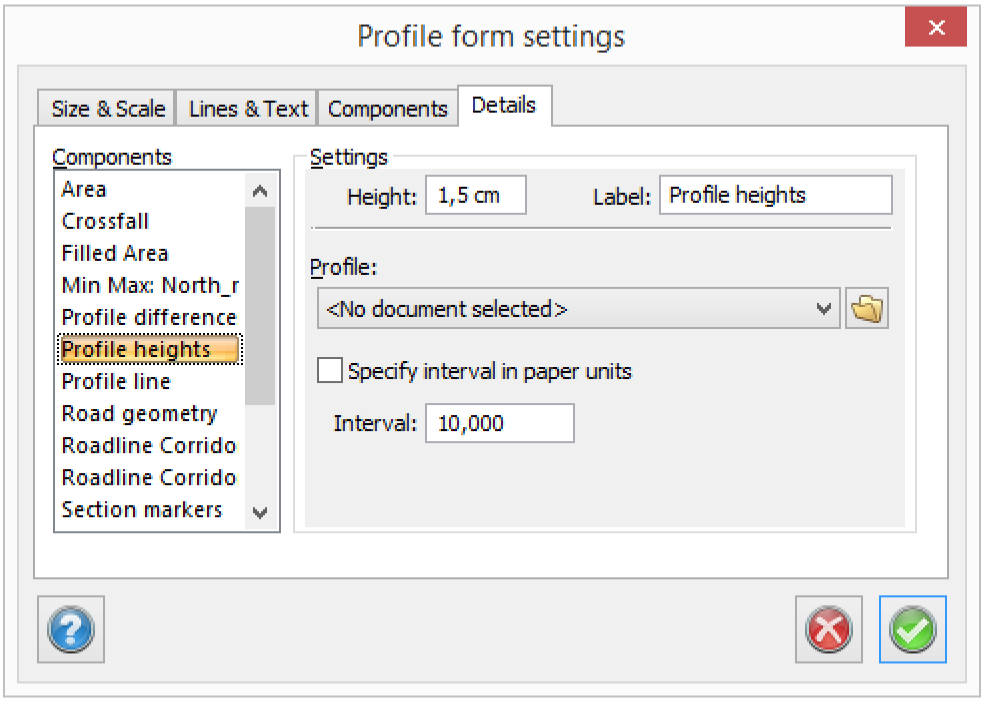
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

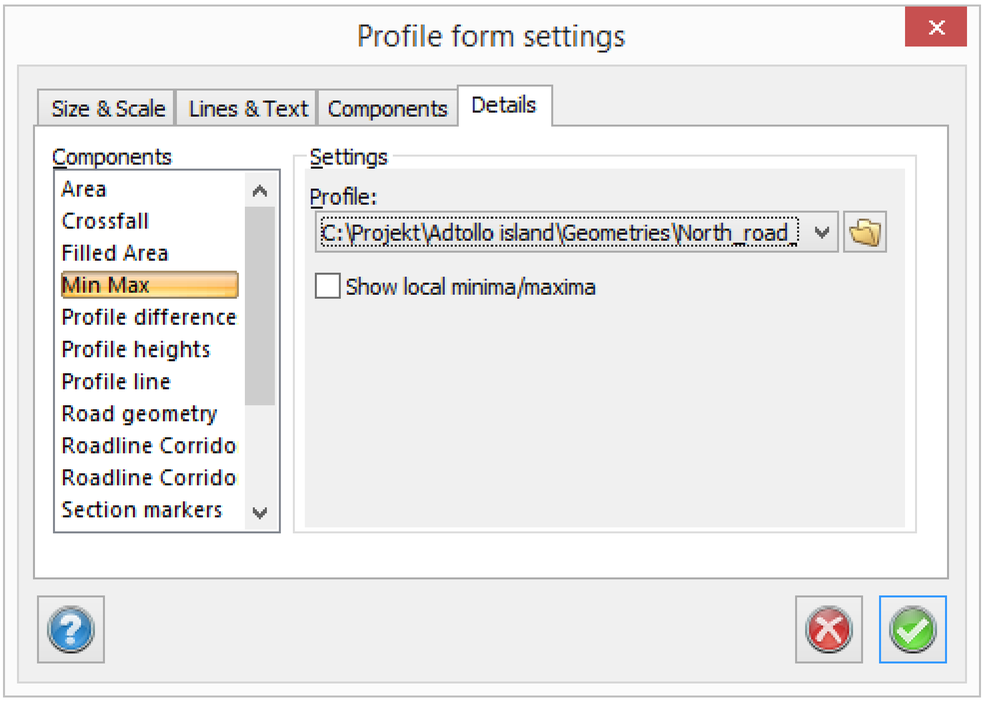
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

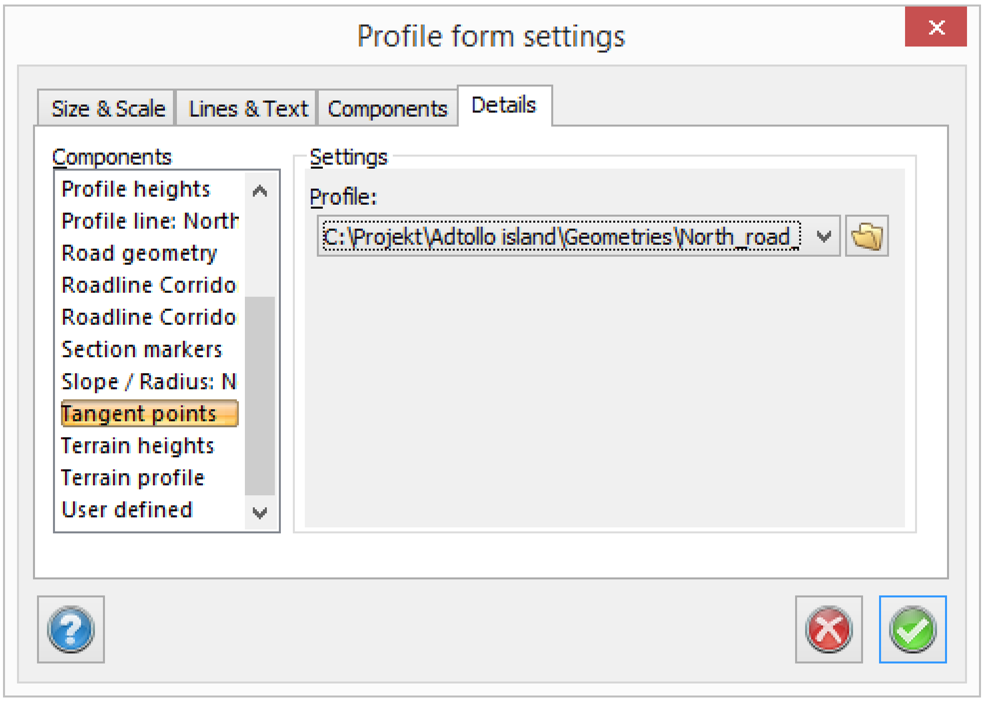
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

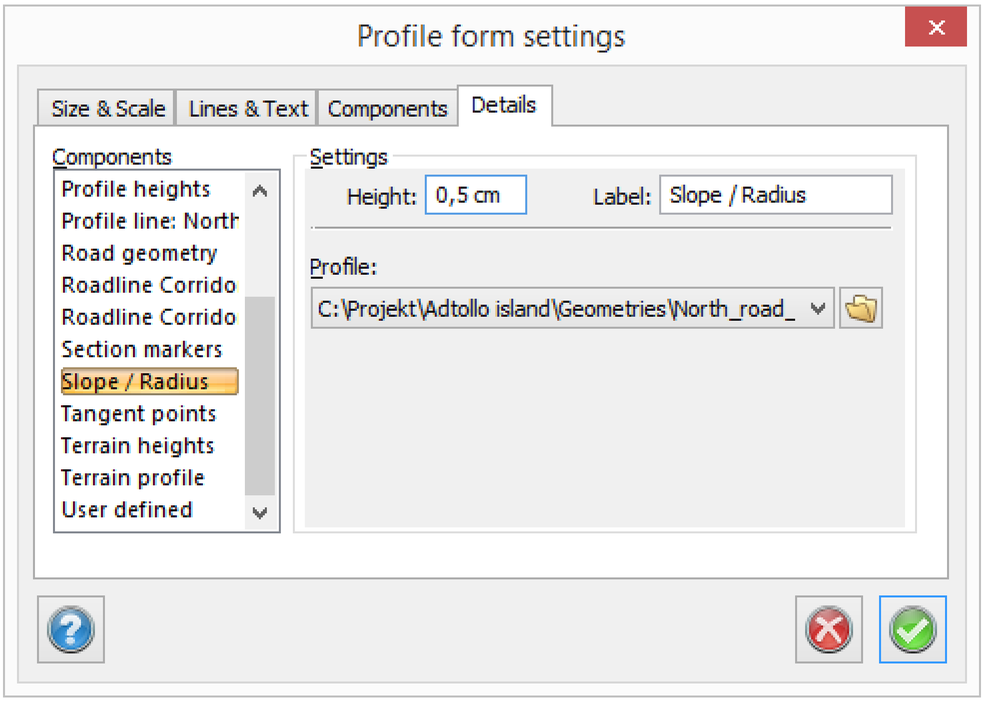
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

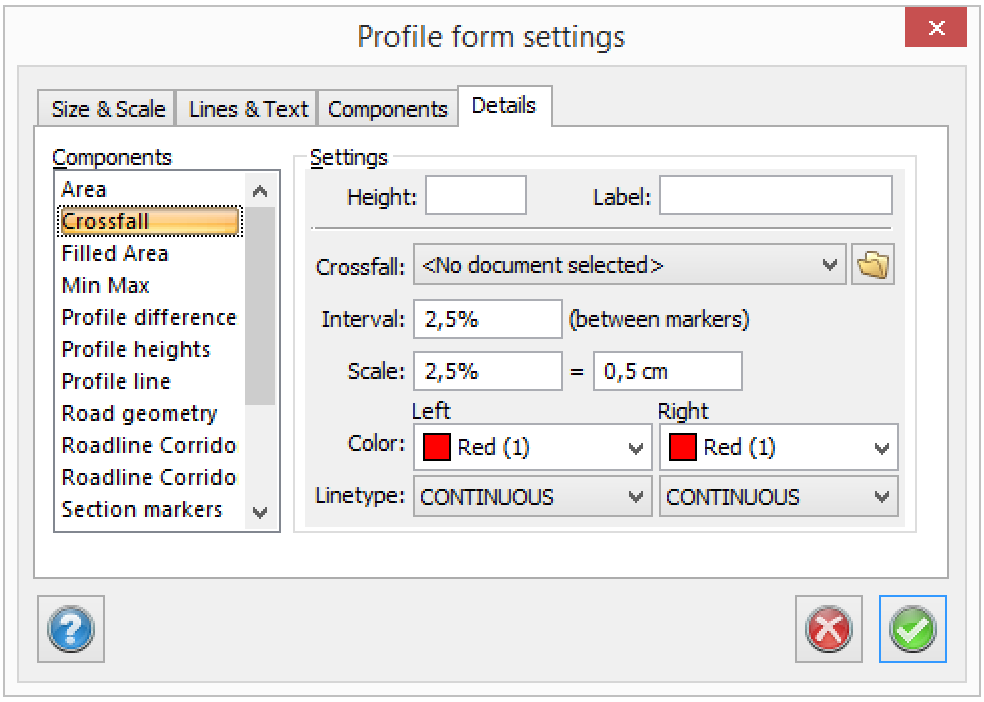
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

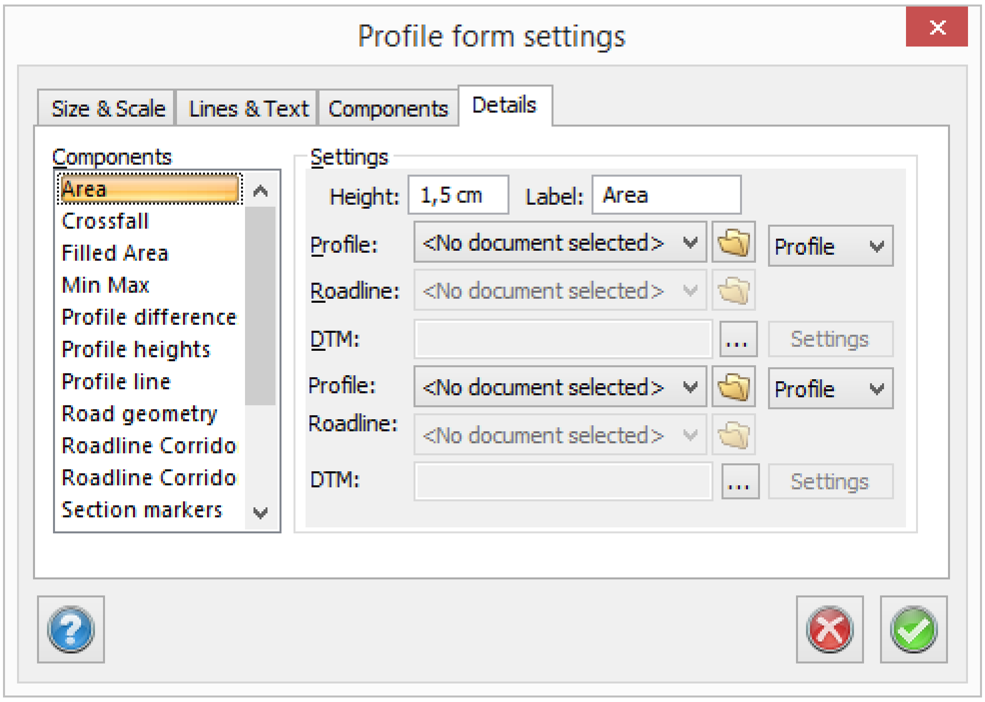
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

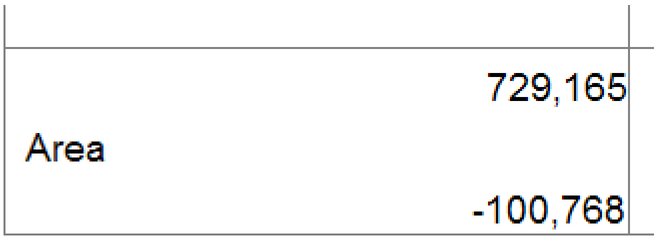
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

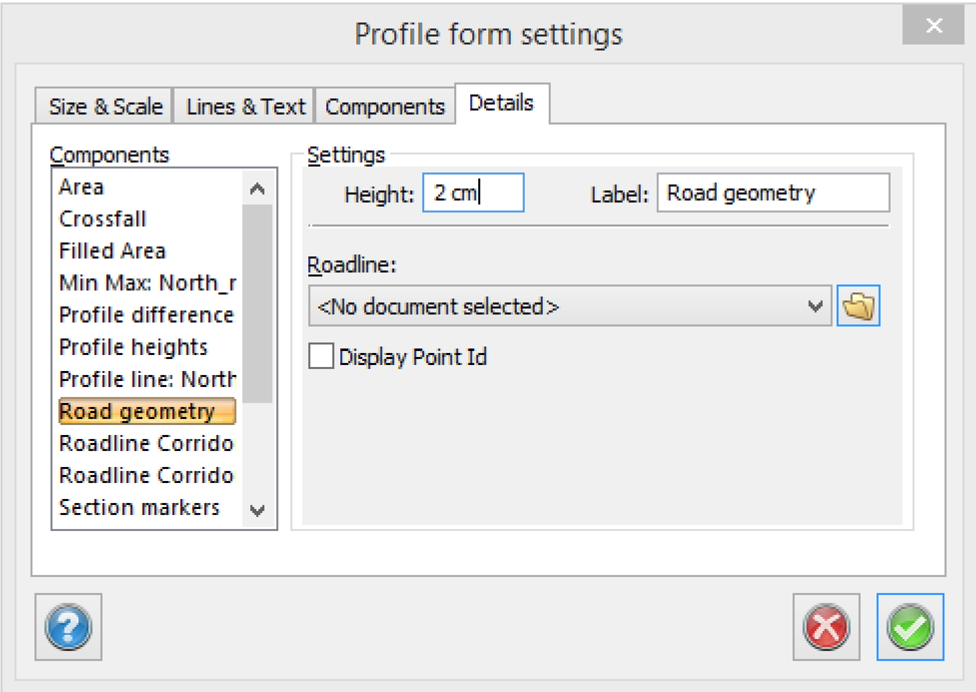


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

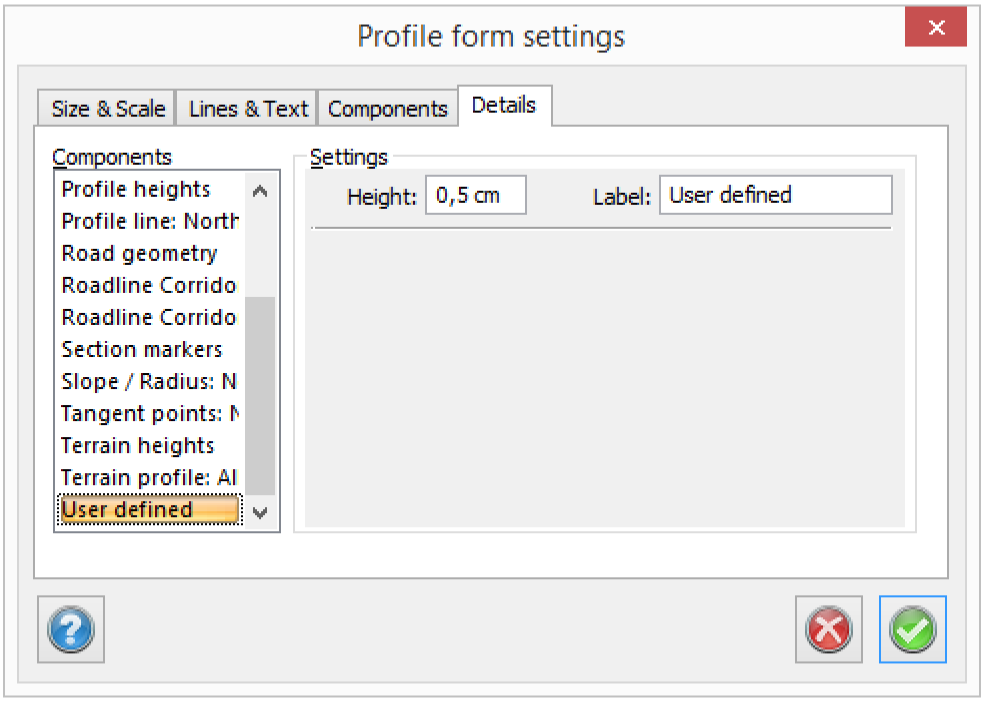
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

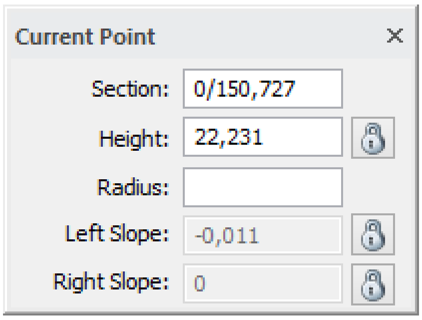
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

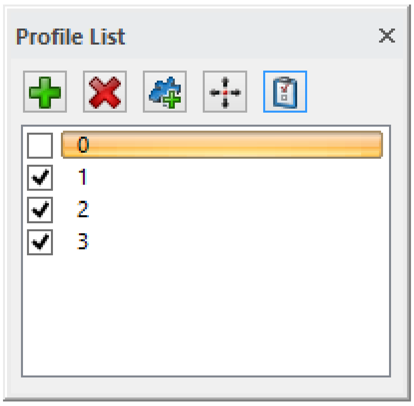
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



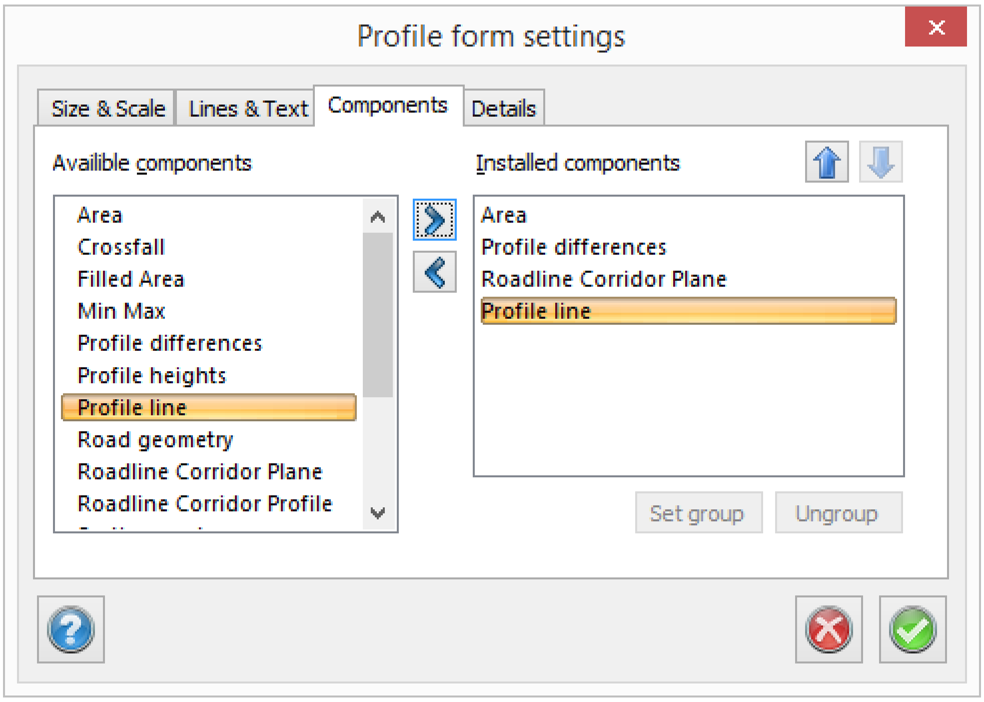
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

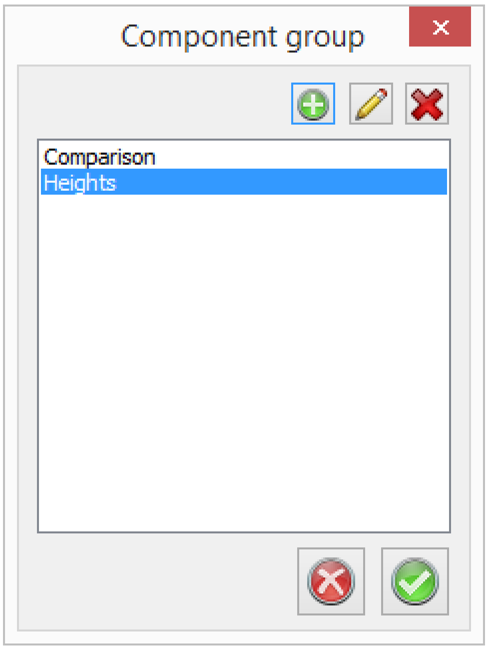
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

Function, command	Description
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Roadline	
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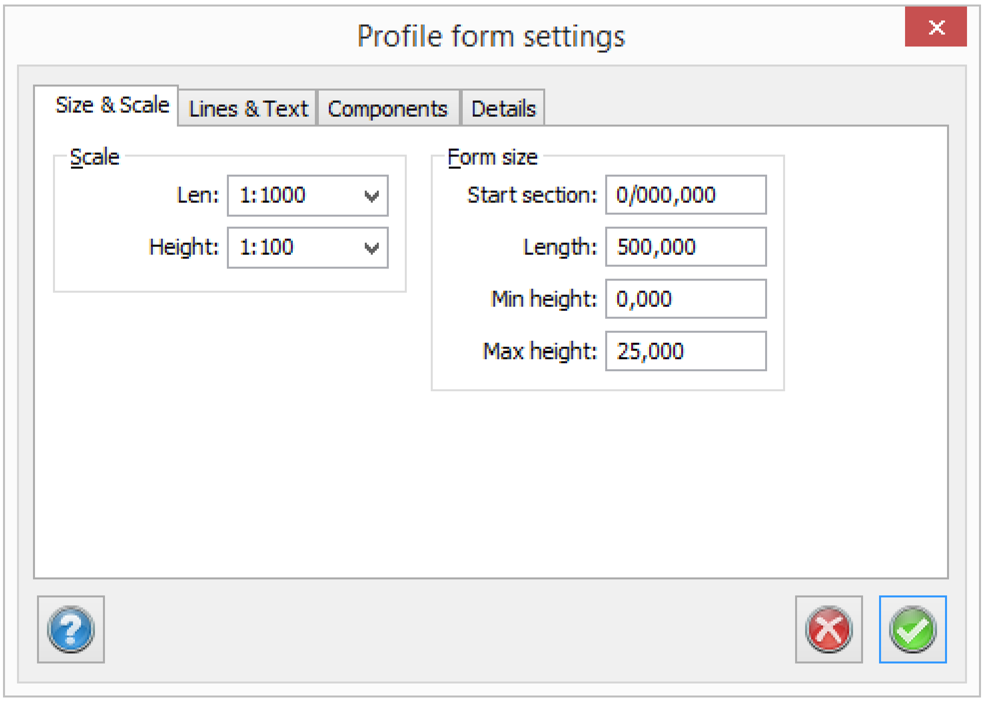
In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

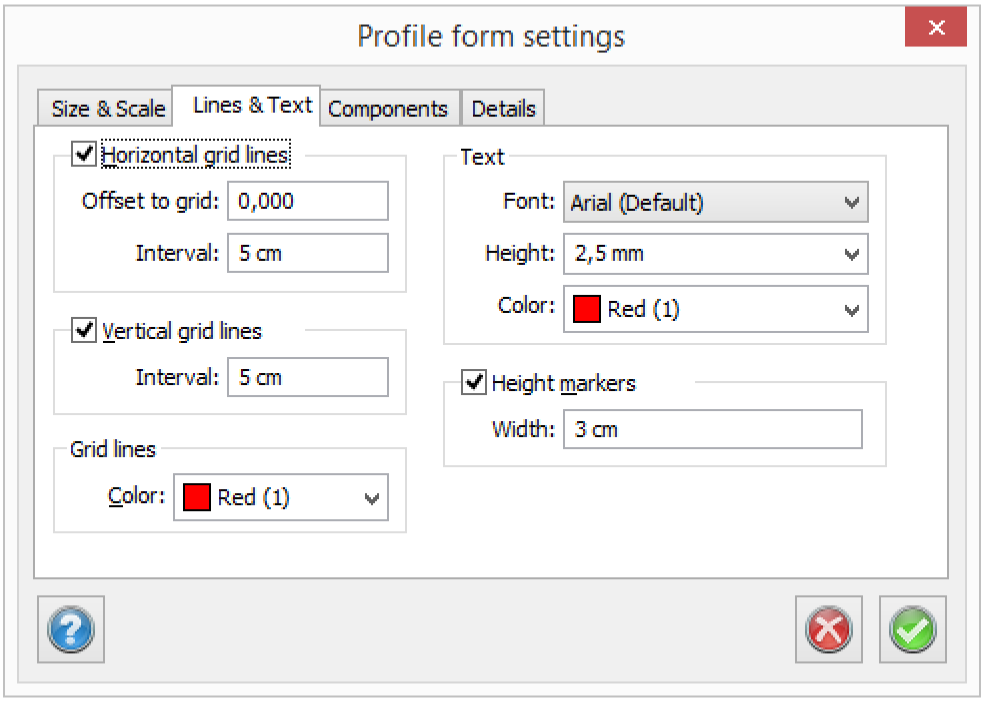


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

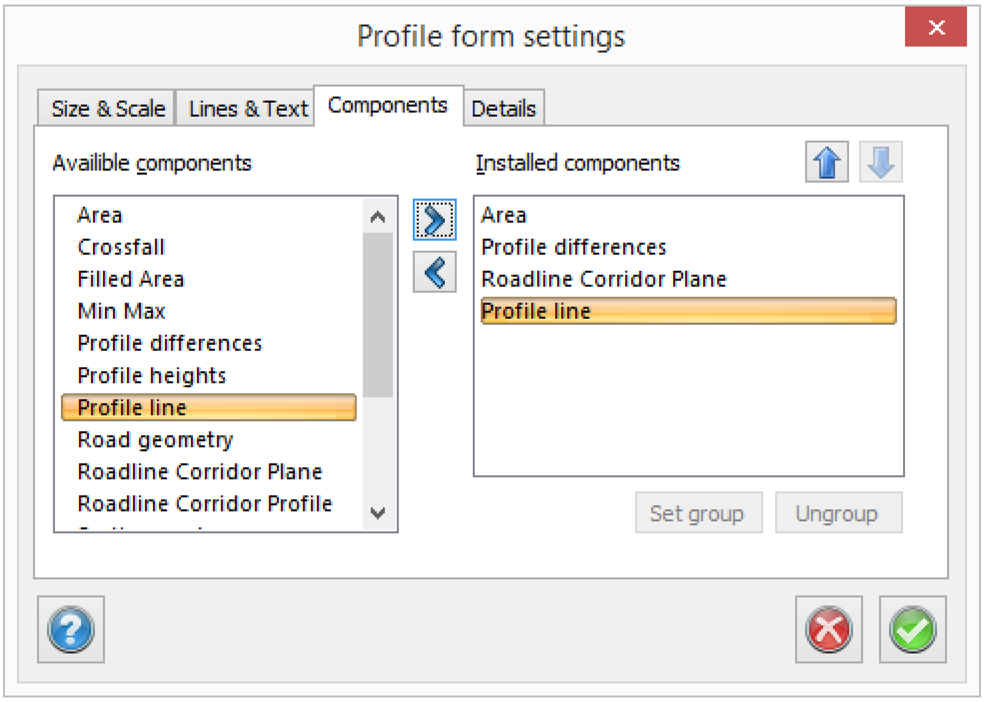
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

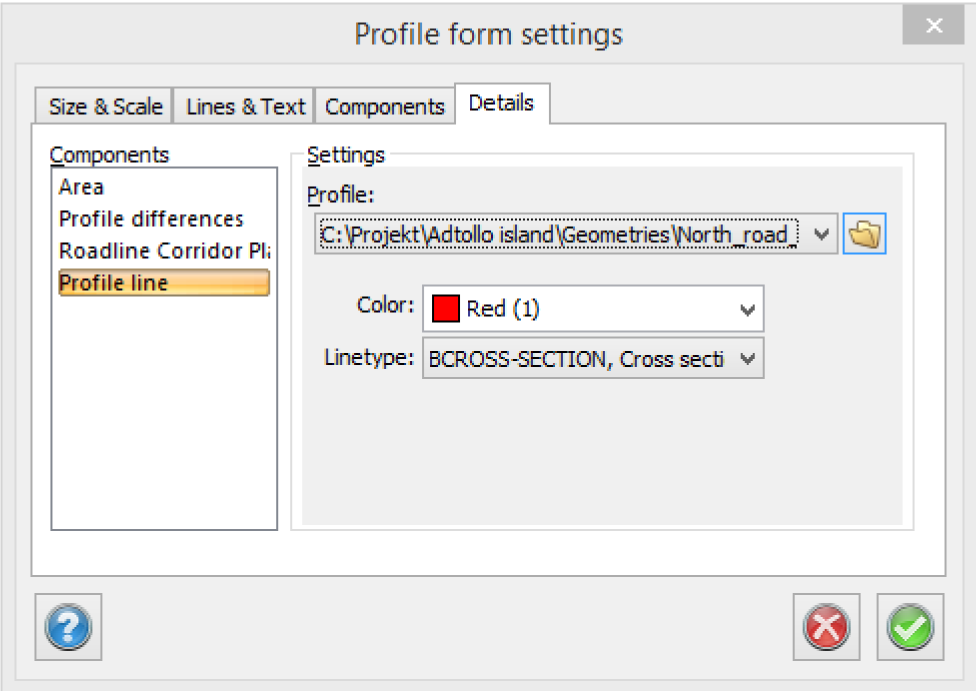
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



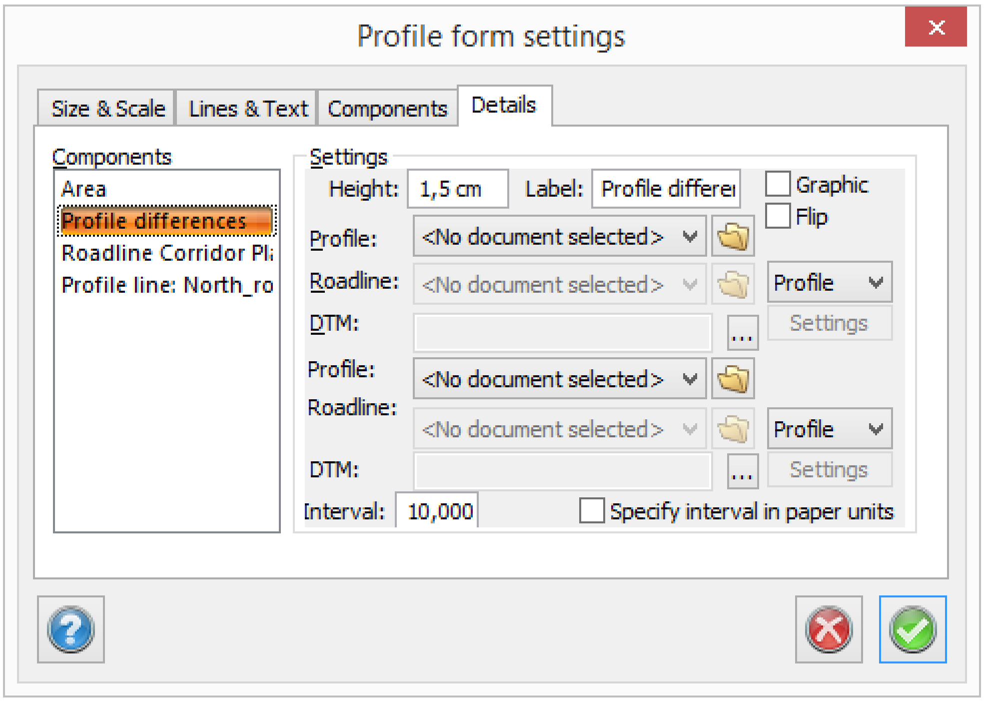
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

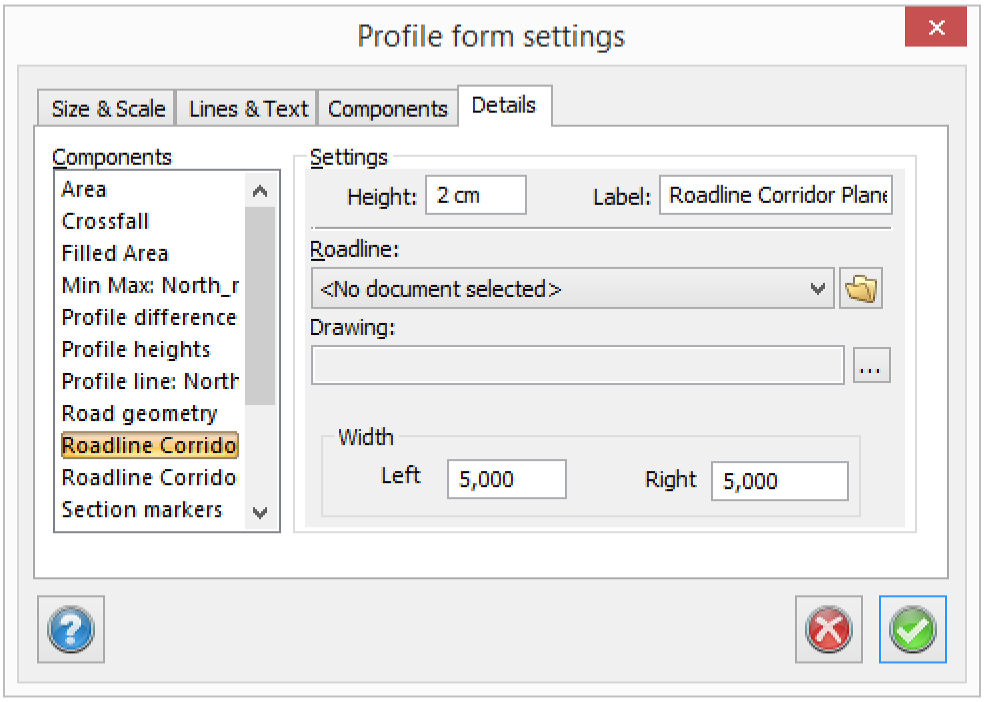
It is possible to display several different road profiles in the form.

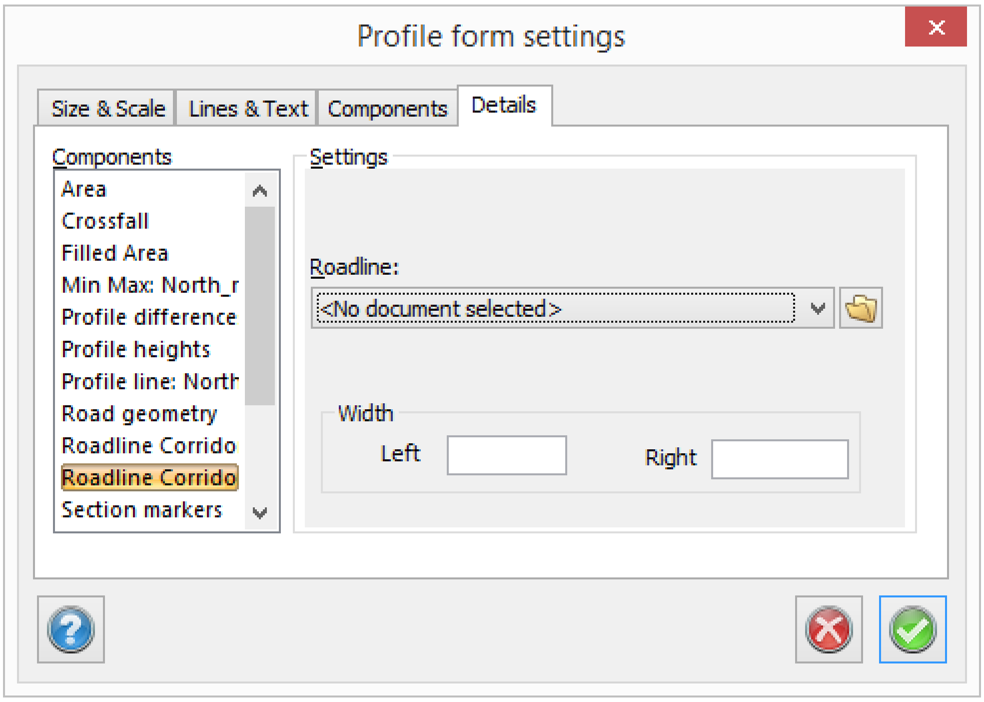
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



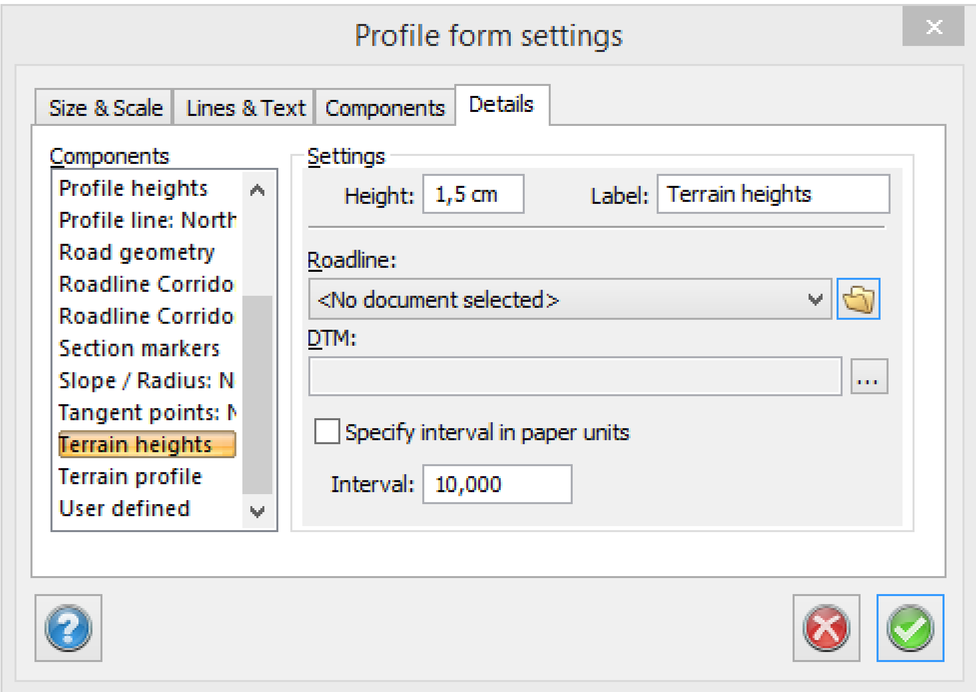
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

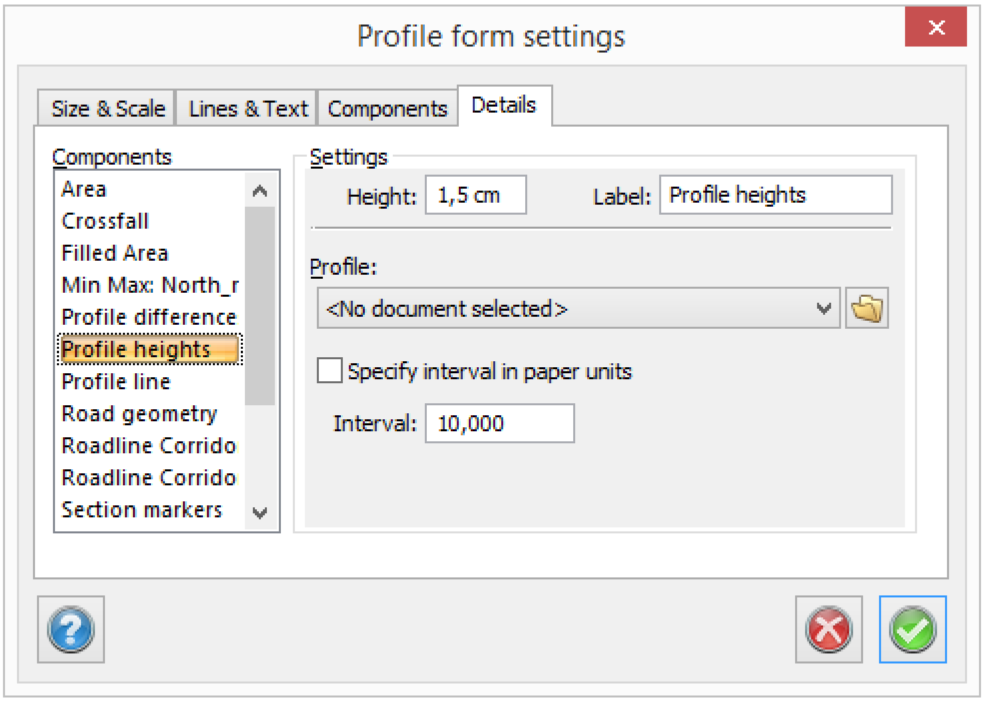
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

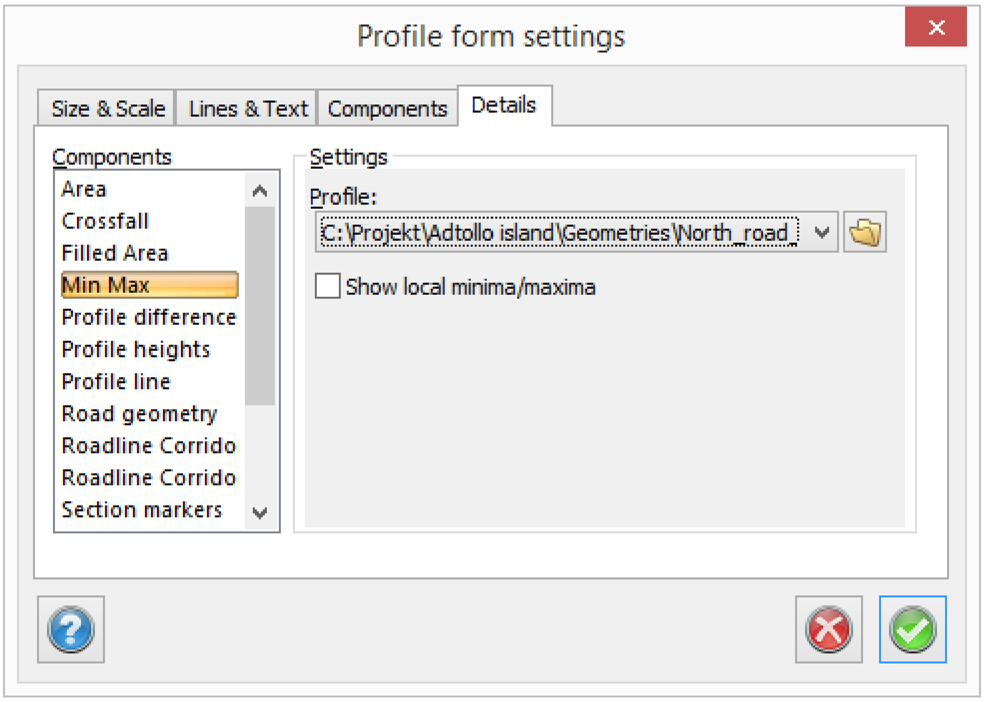
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

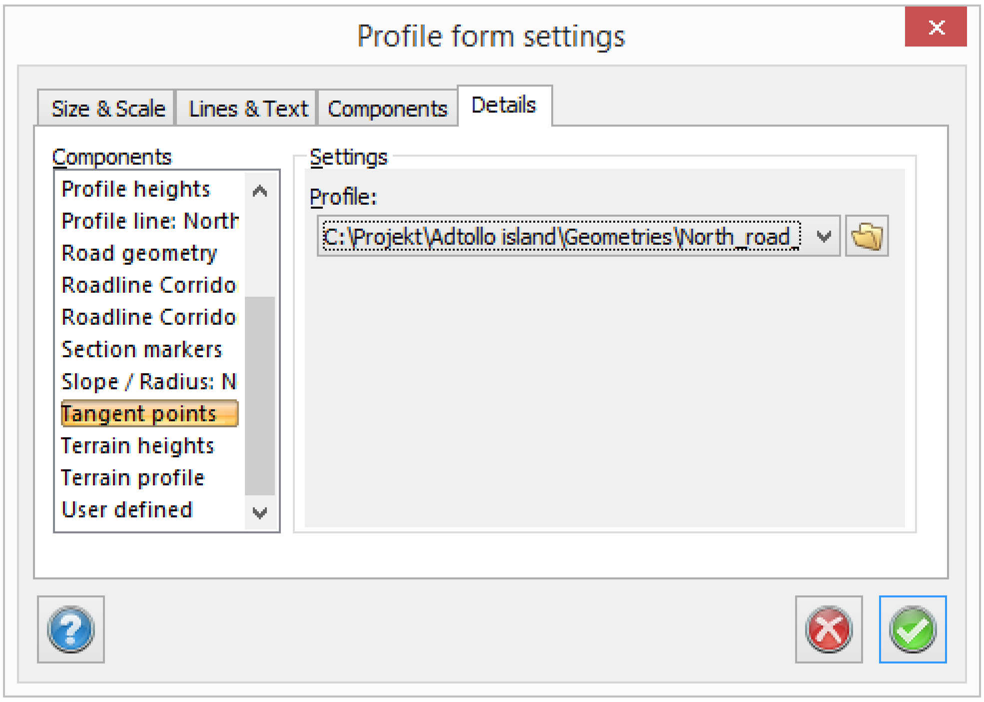
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

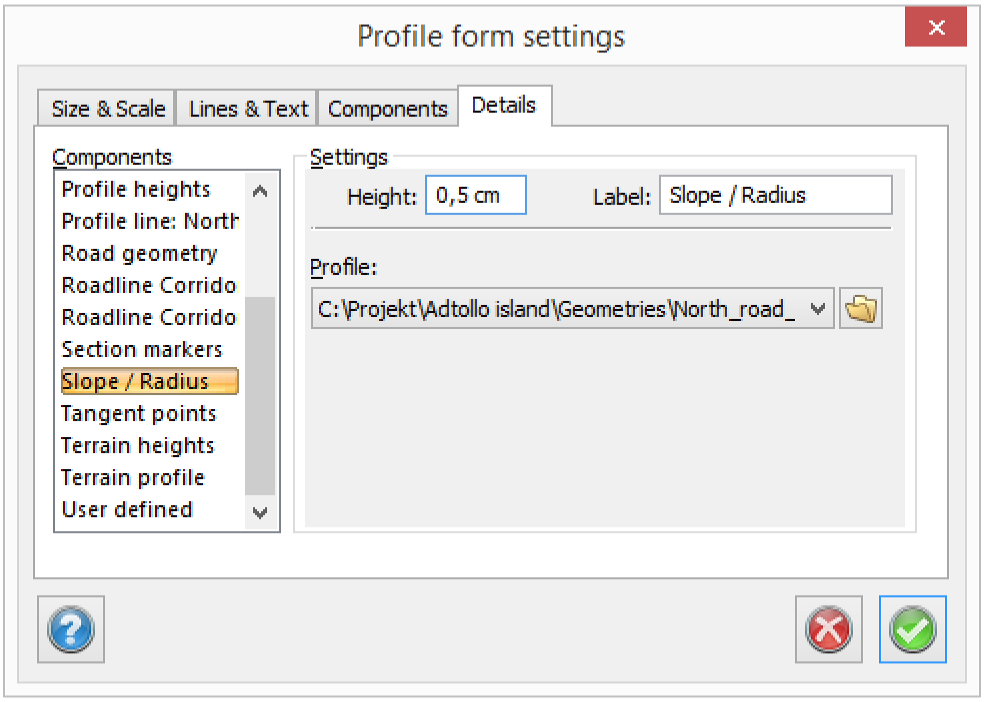
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

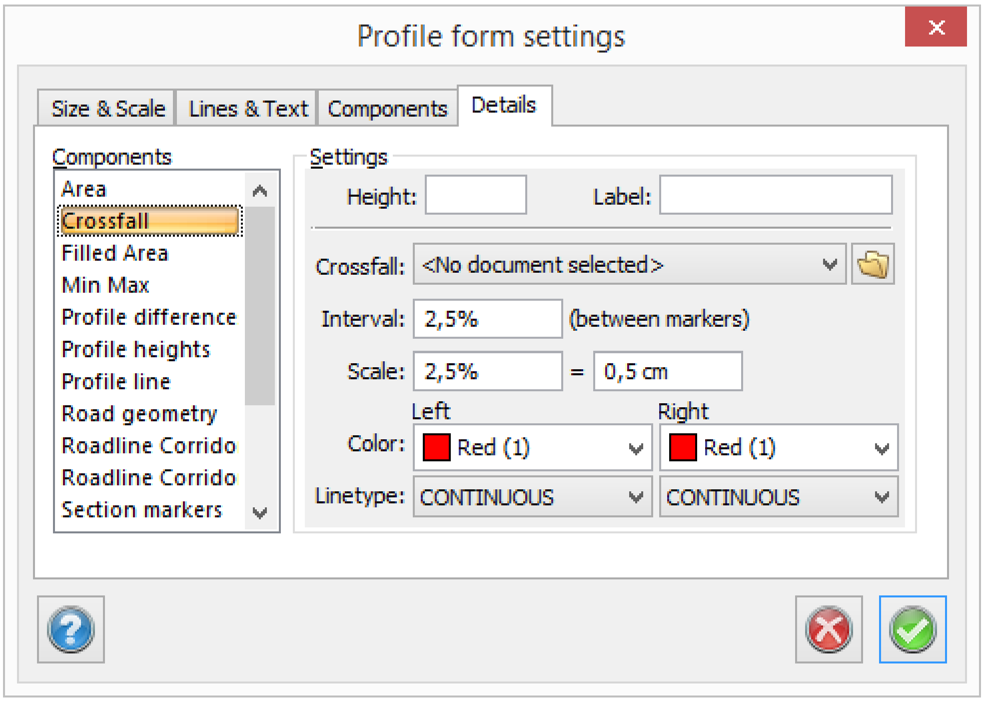
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

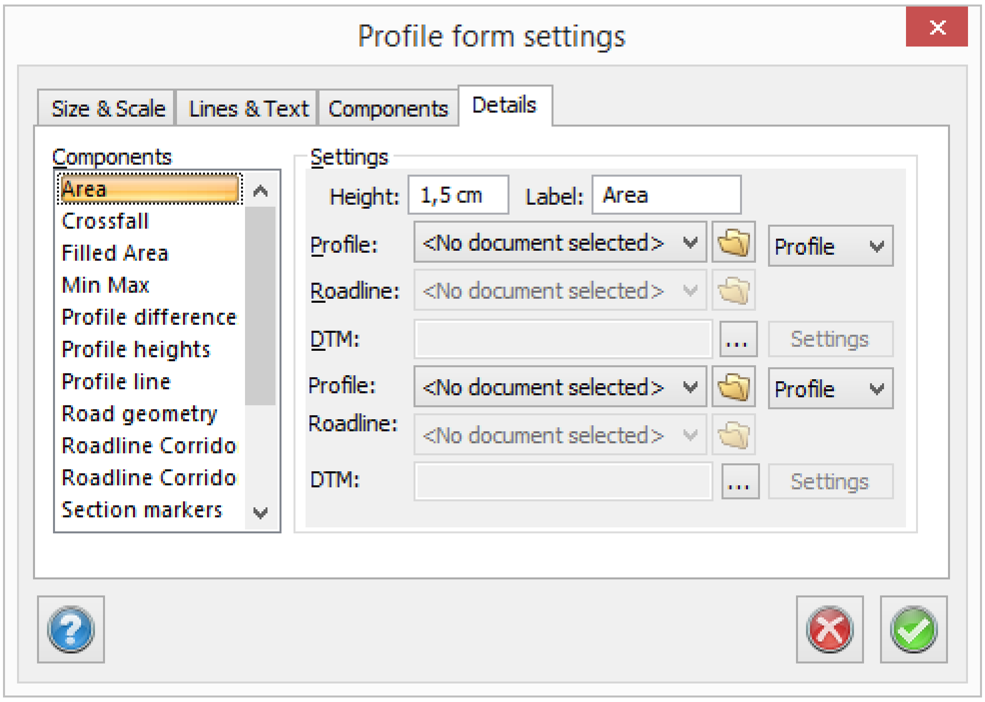
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

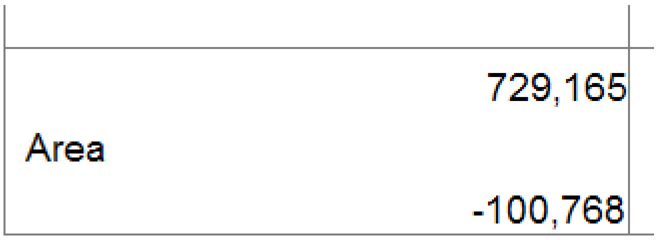
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

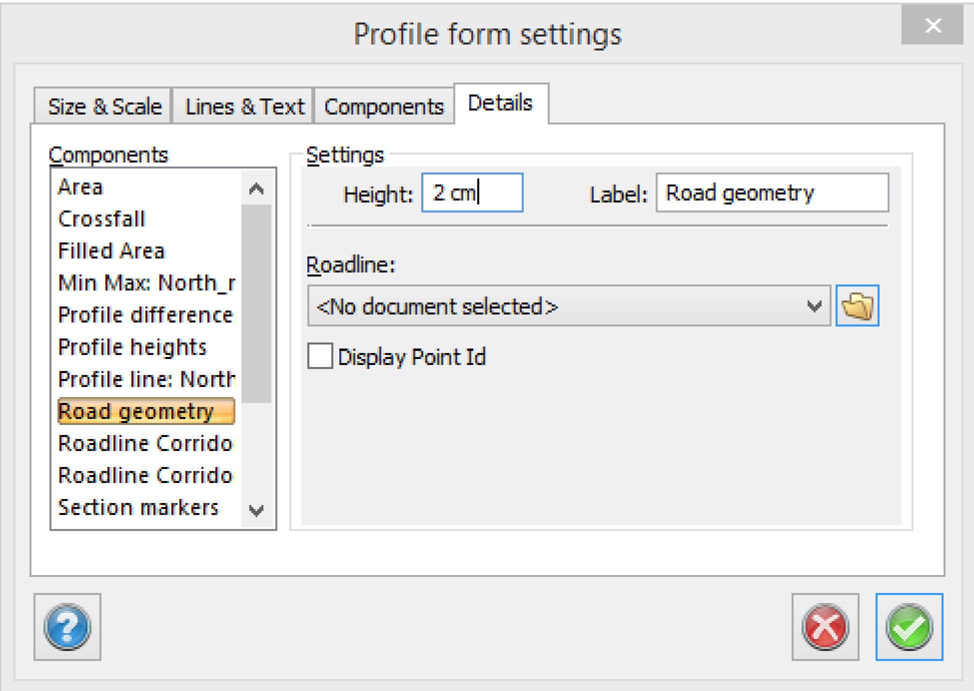


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

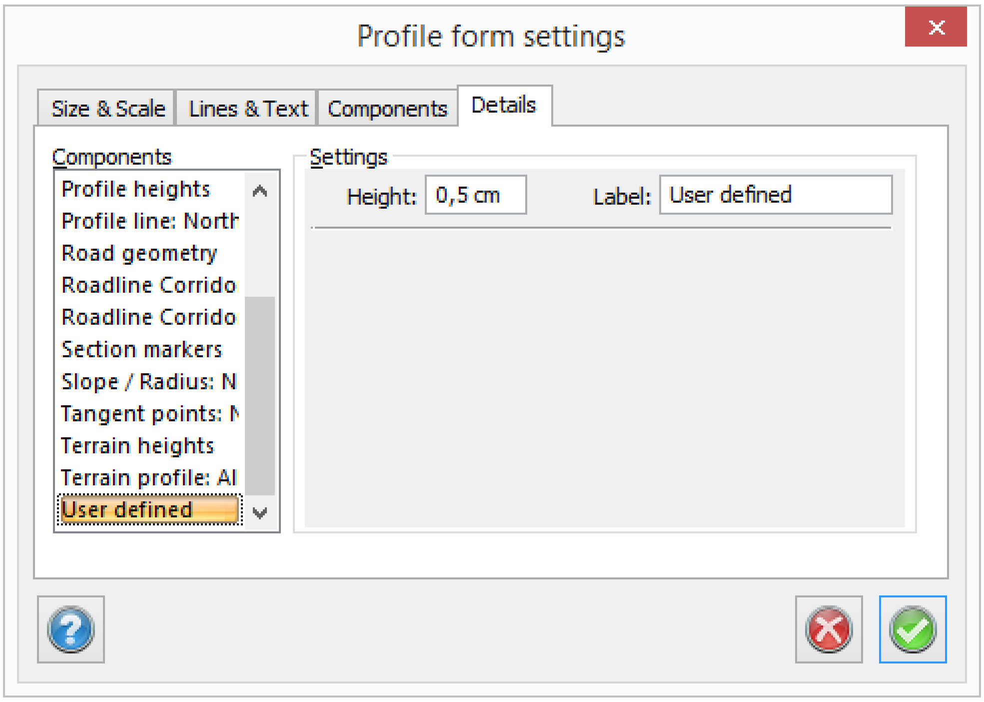
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

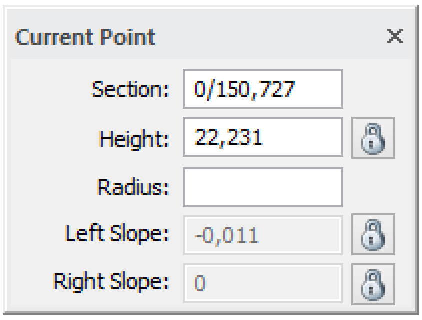
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

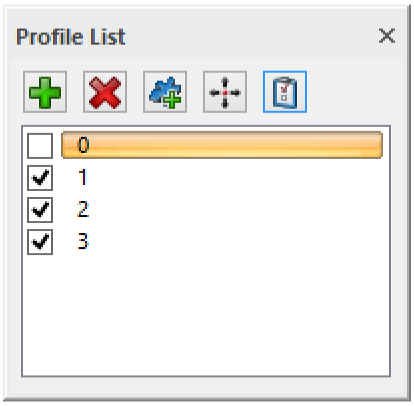
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



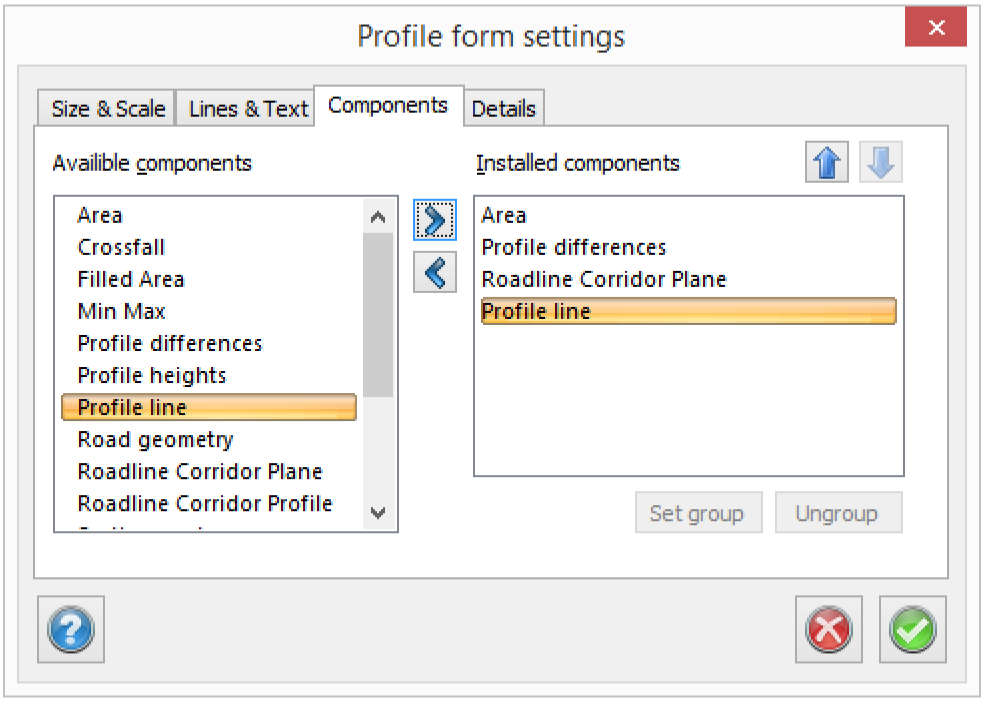
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

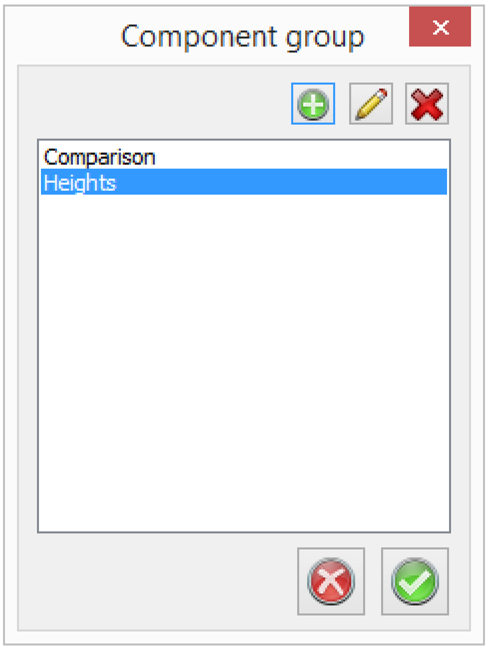
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

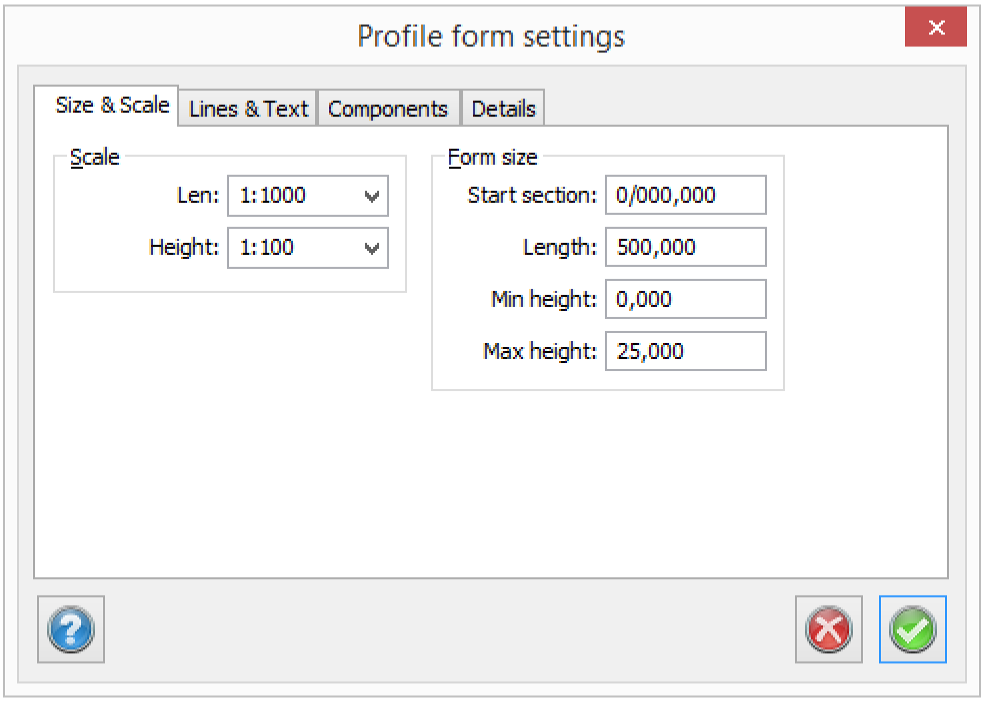
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

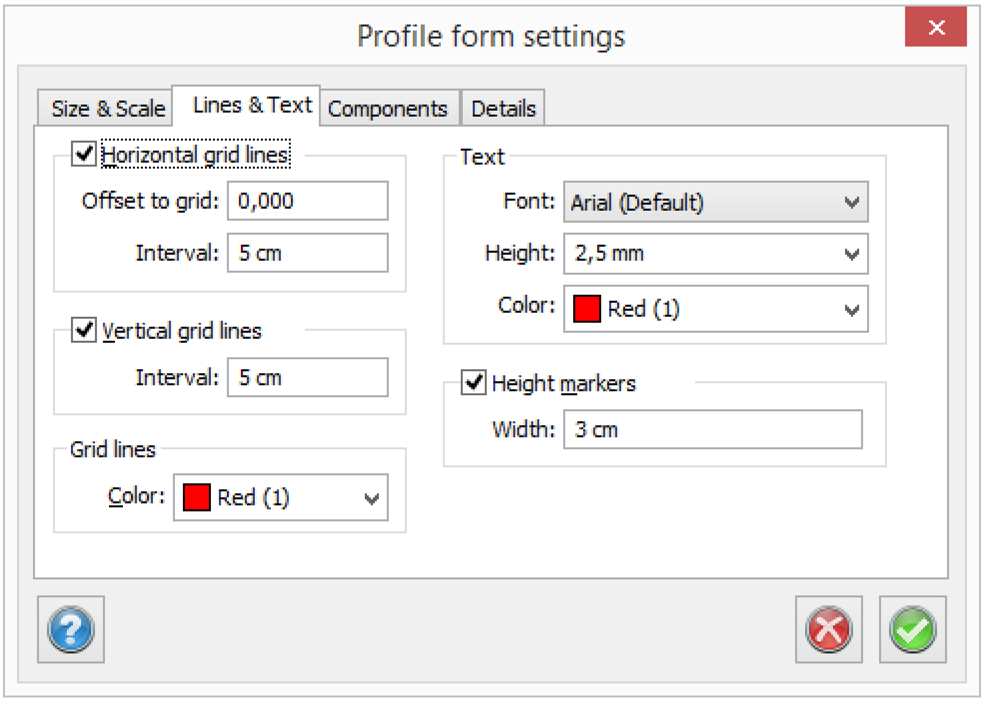


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

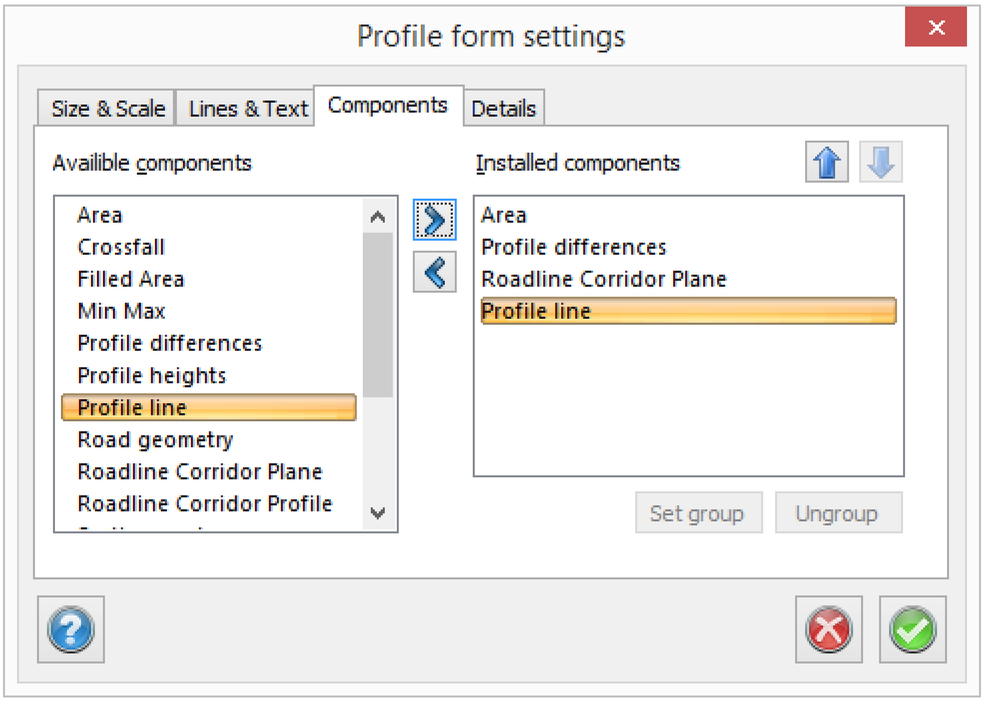
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

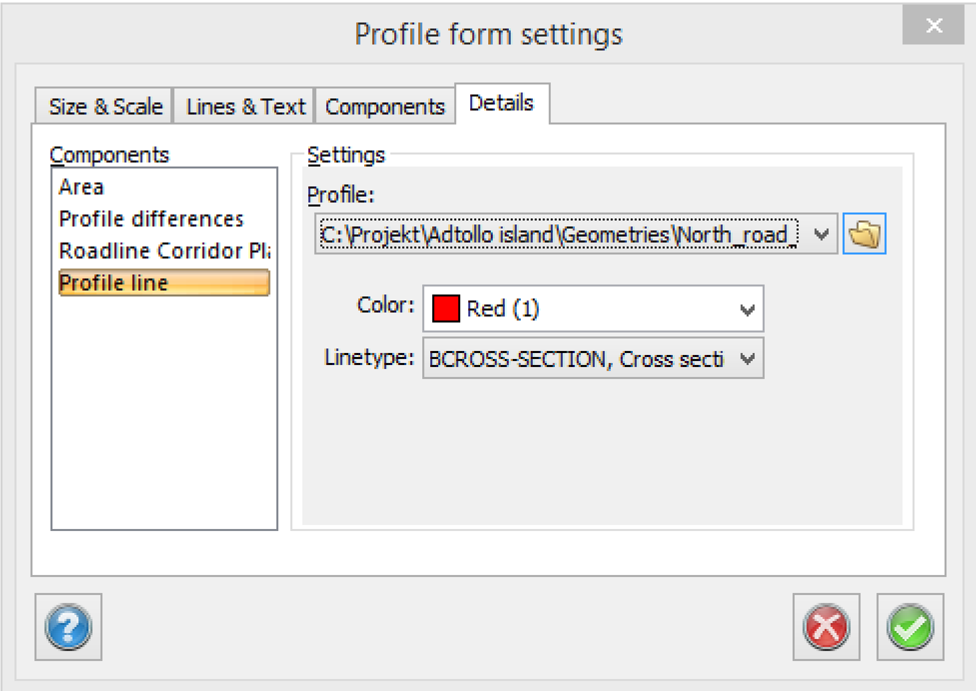
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



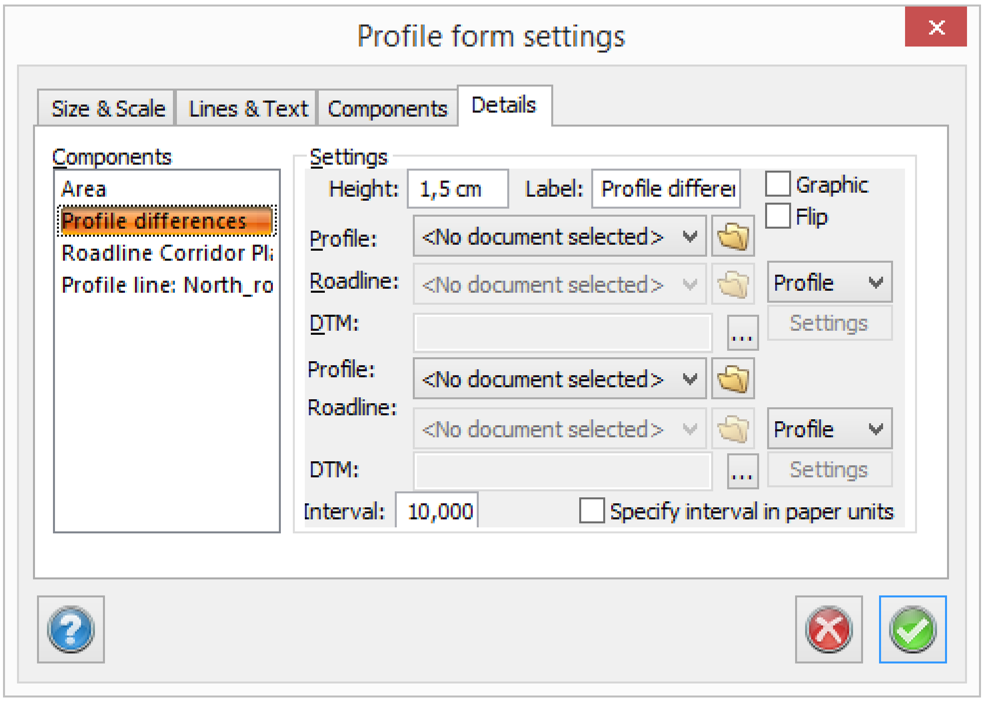
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

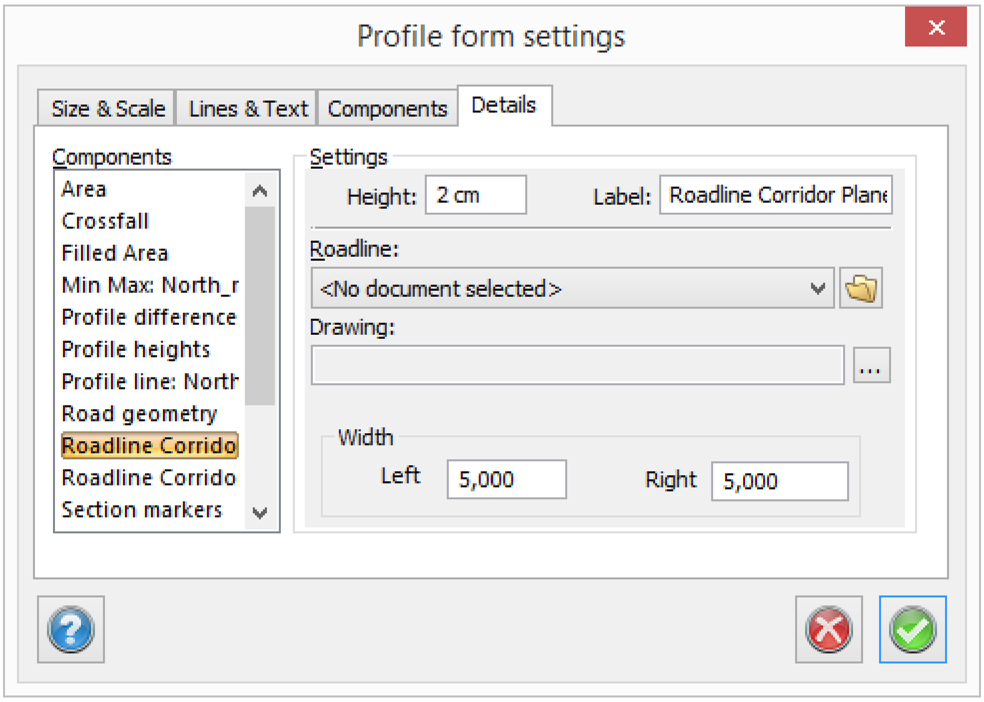
It is possible to display several different road profiles in the form.

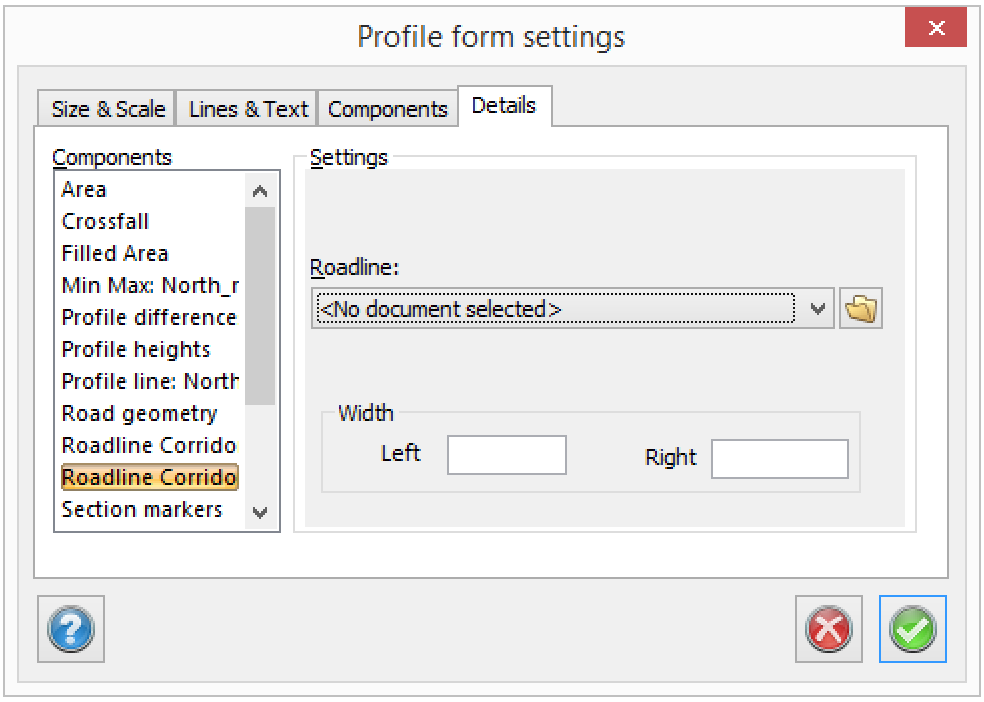
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



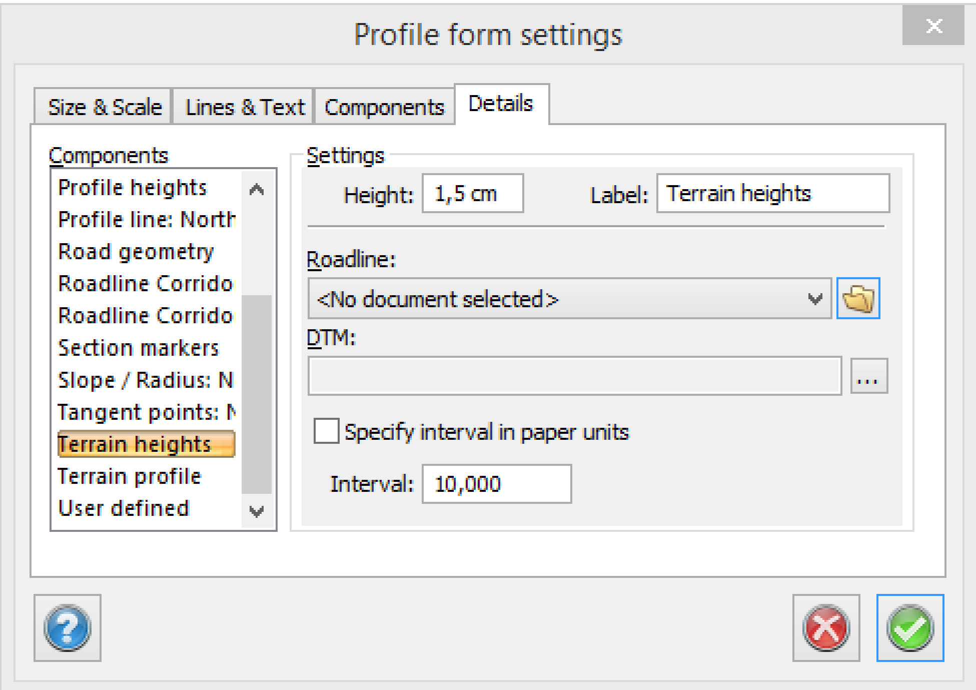
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

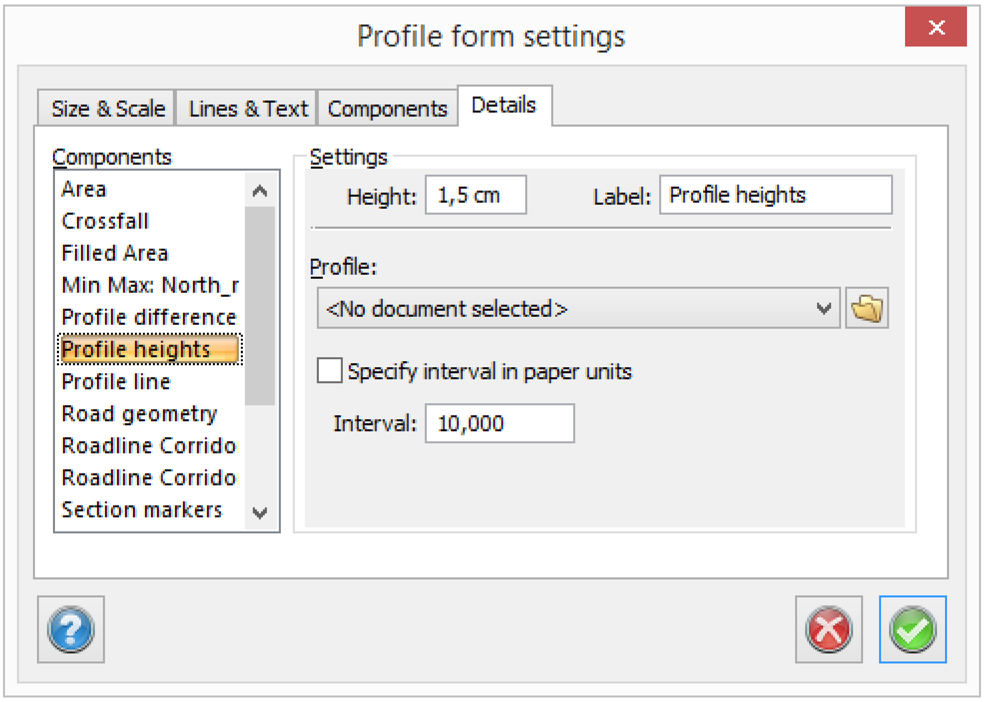
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

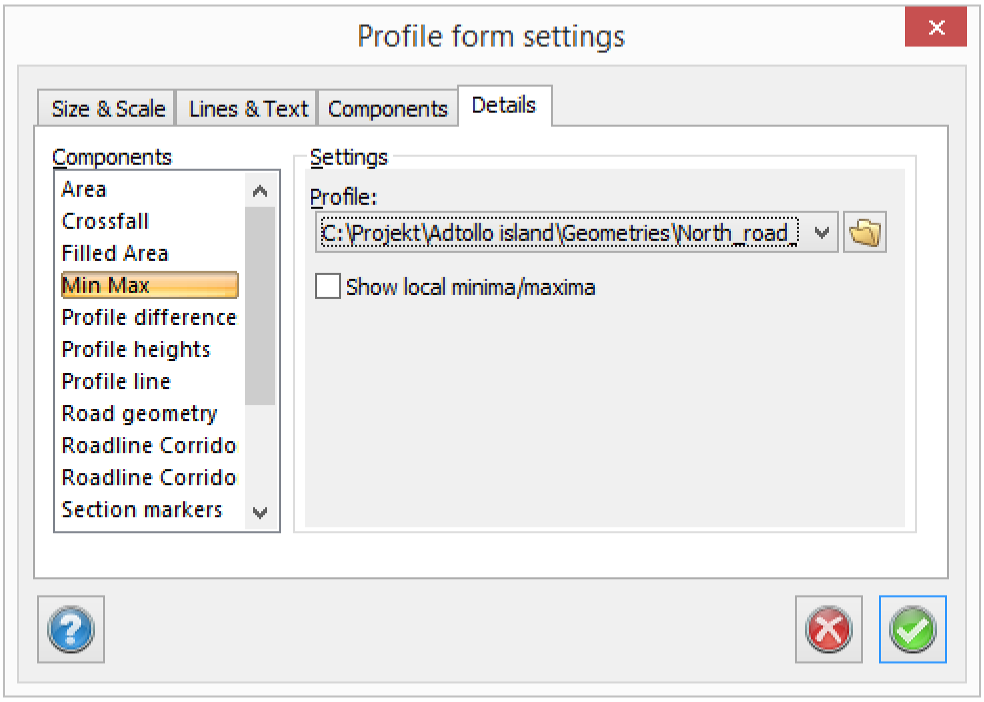
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

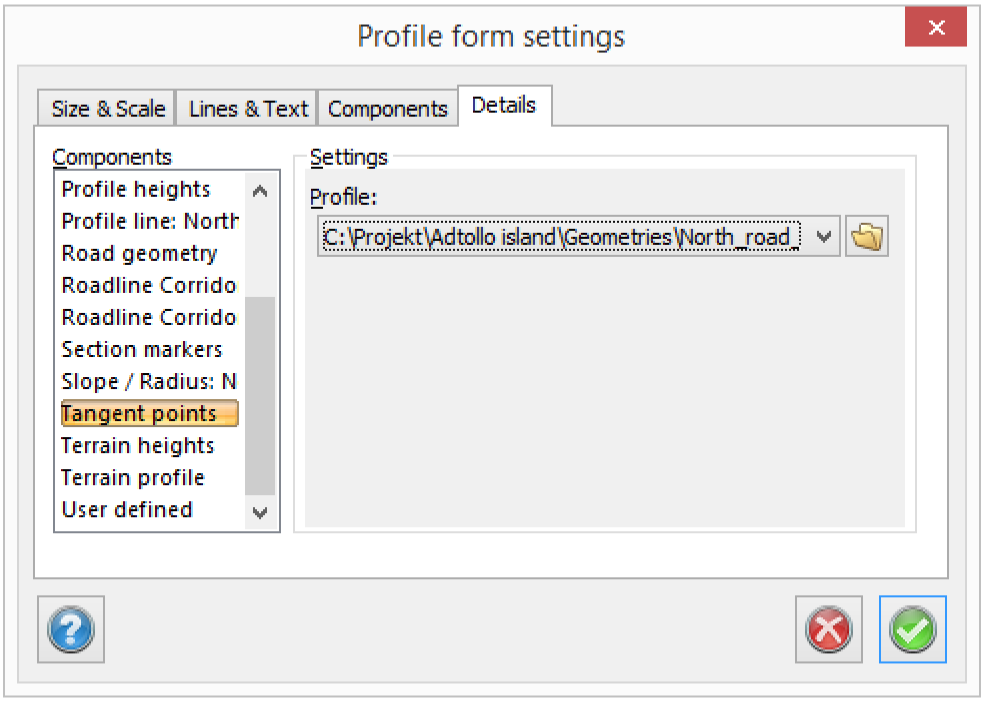
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

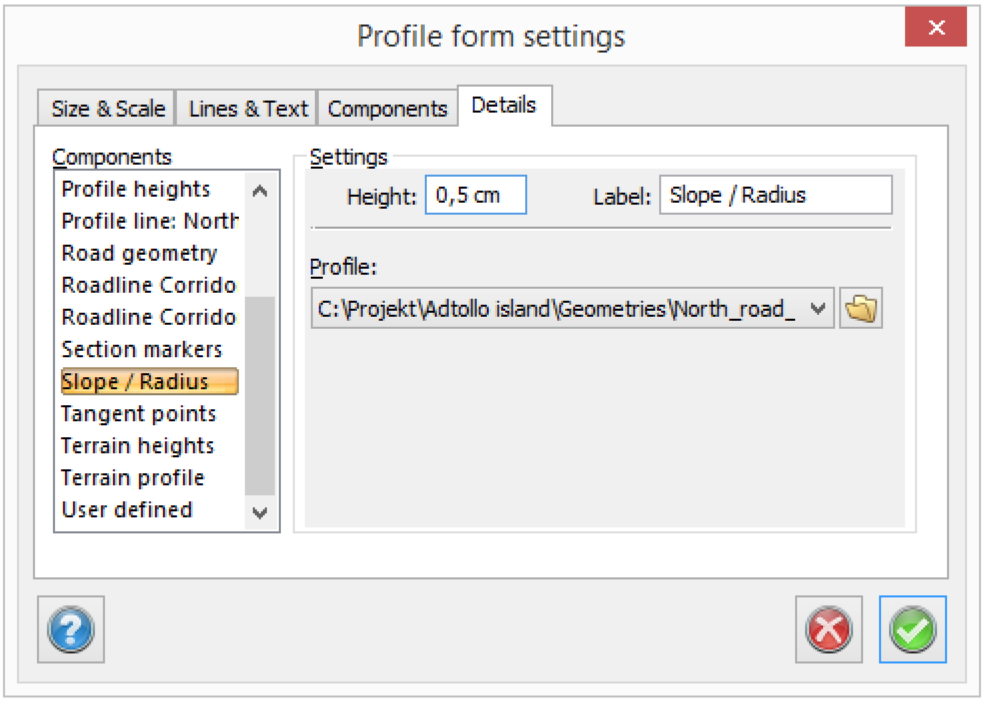
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

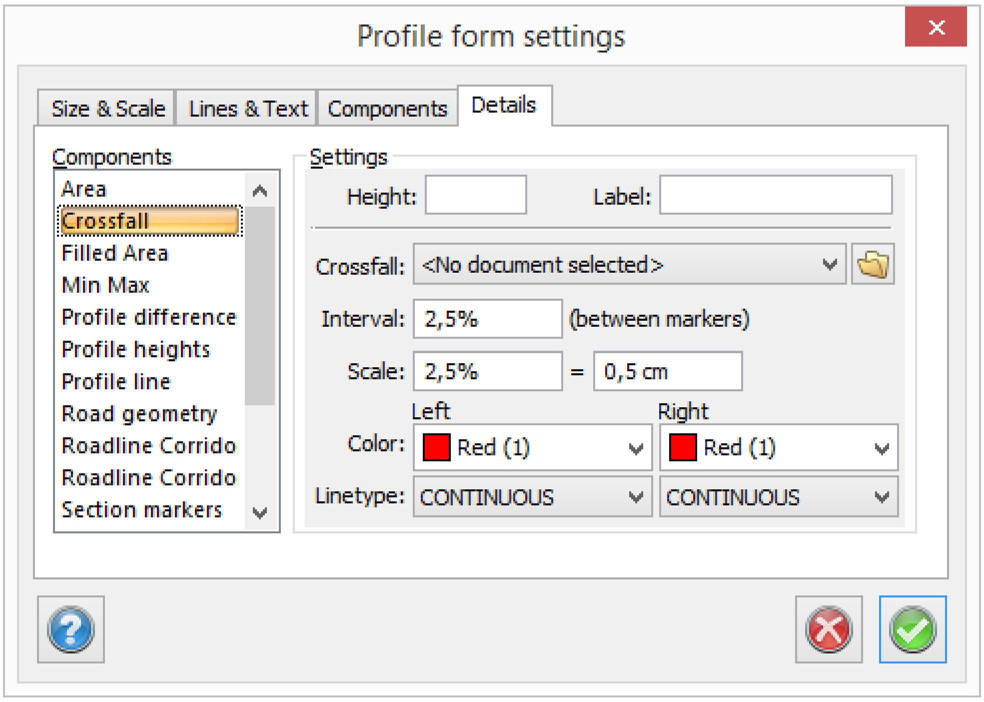
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

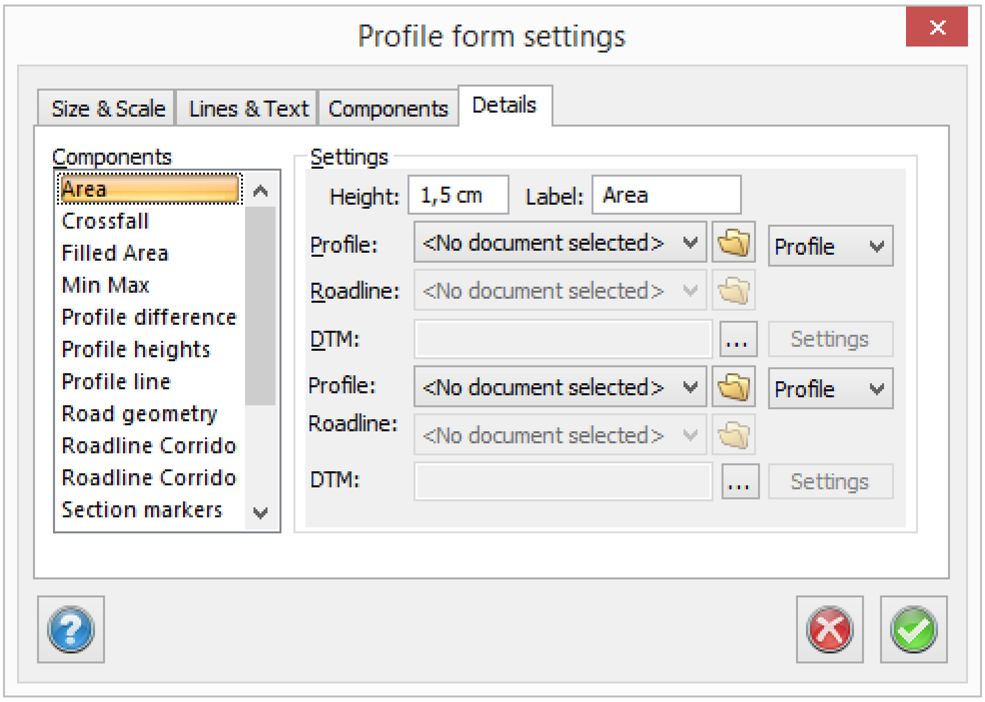
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

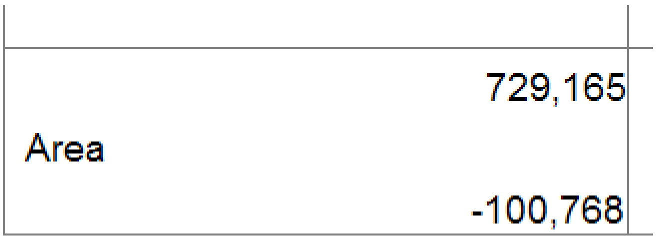
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

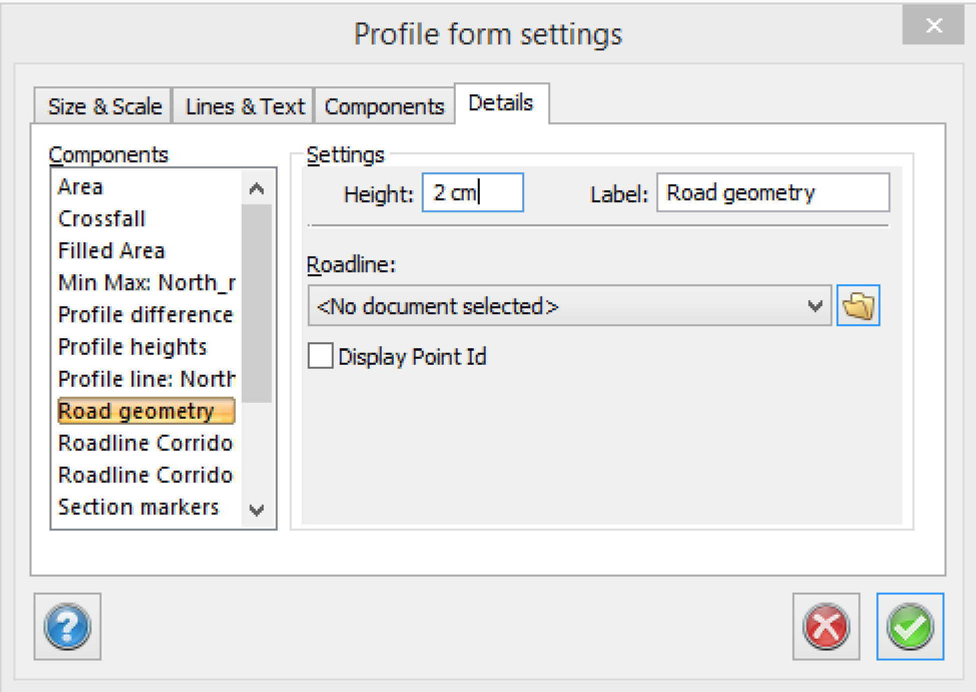


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

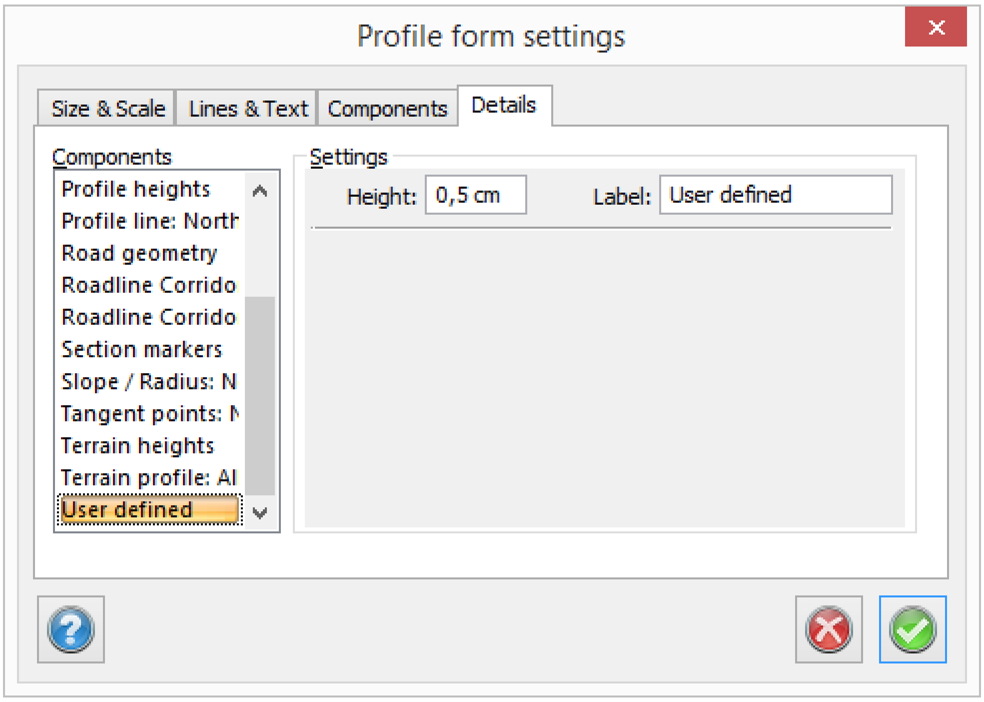
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

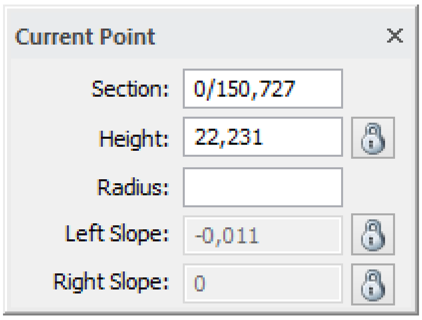
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

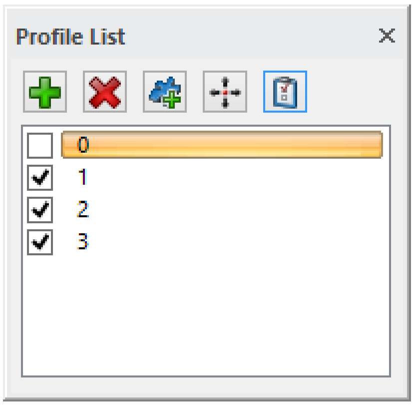
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



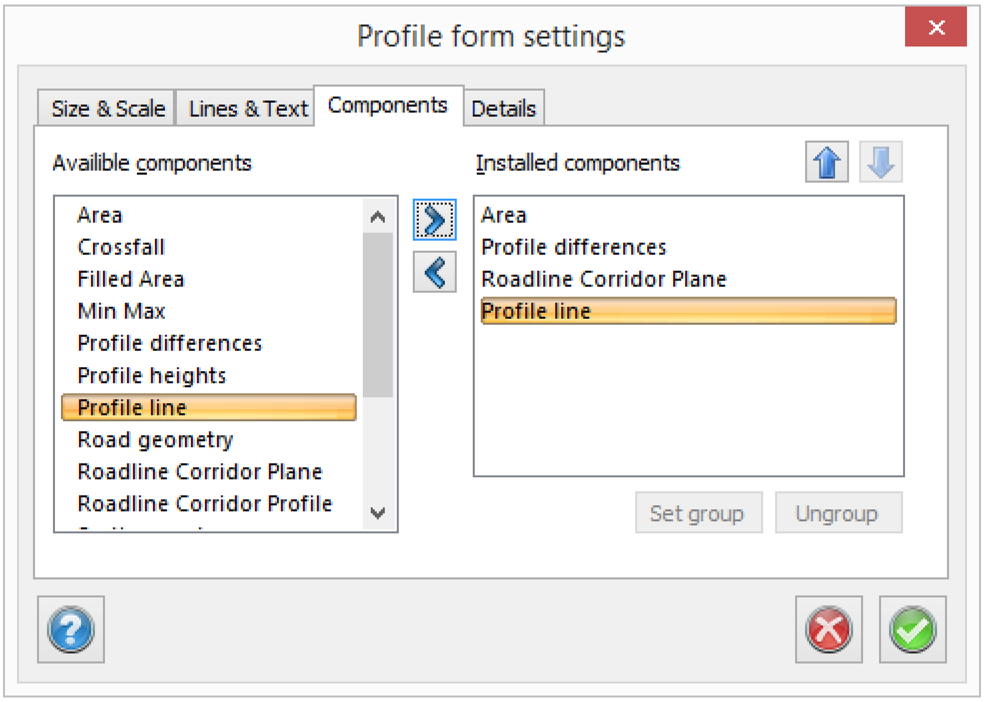
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

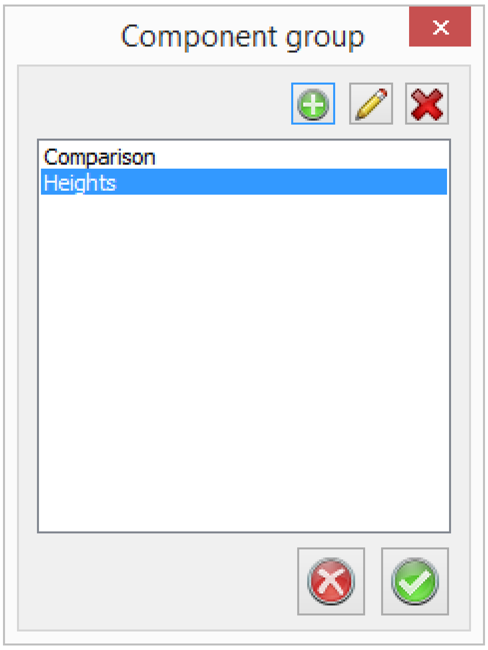
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

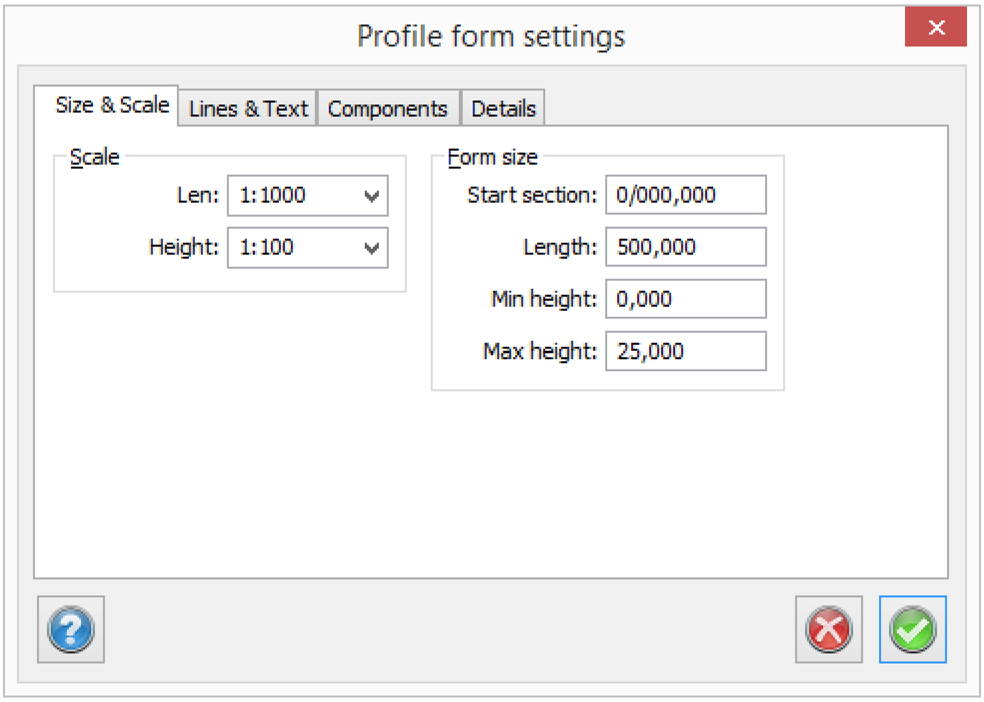
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

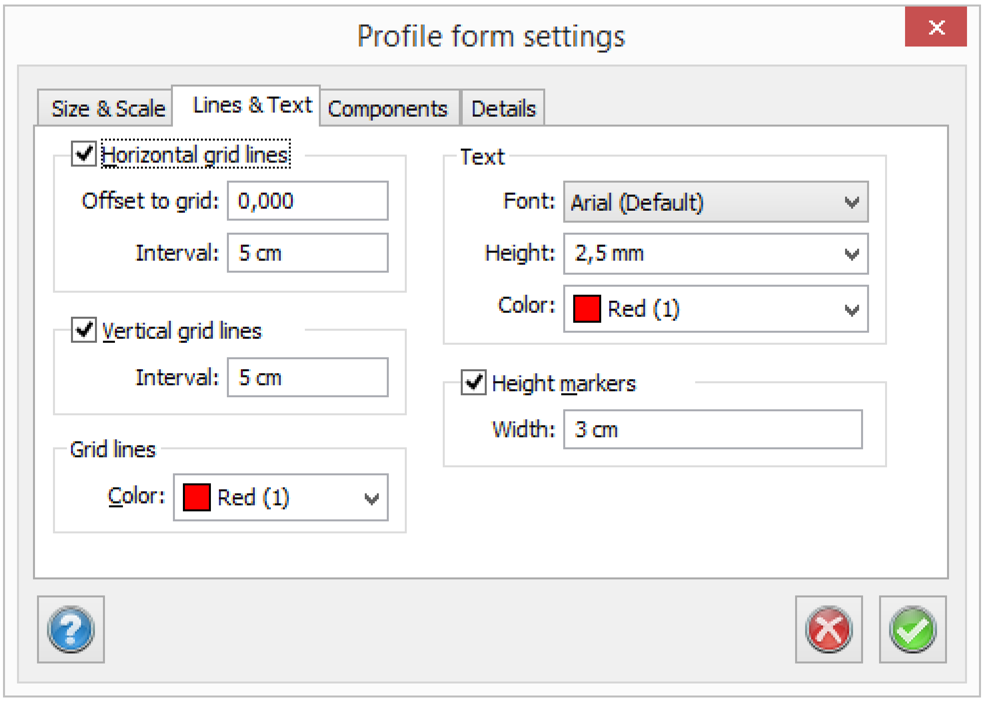


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

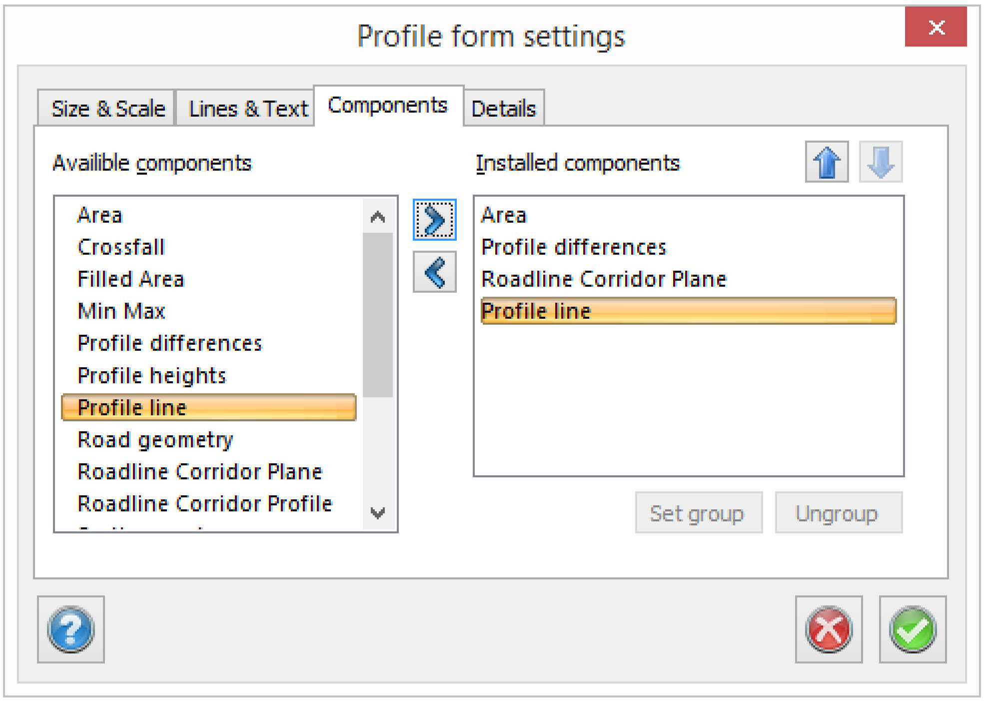
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

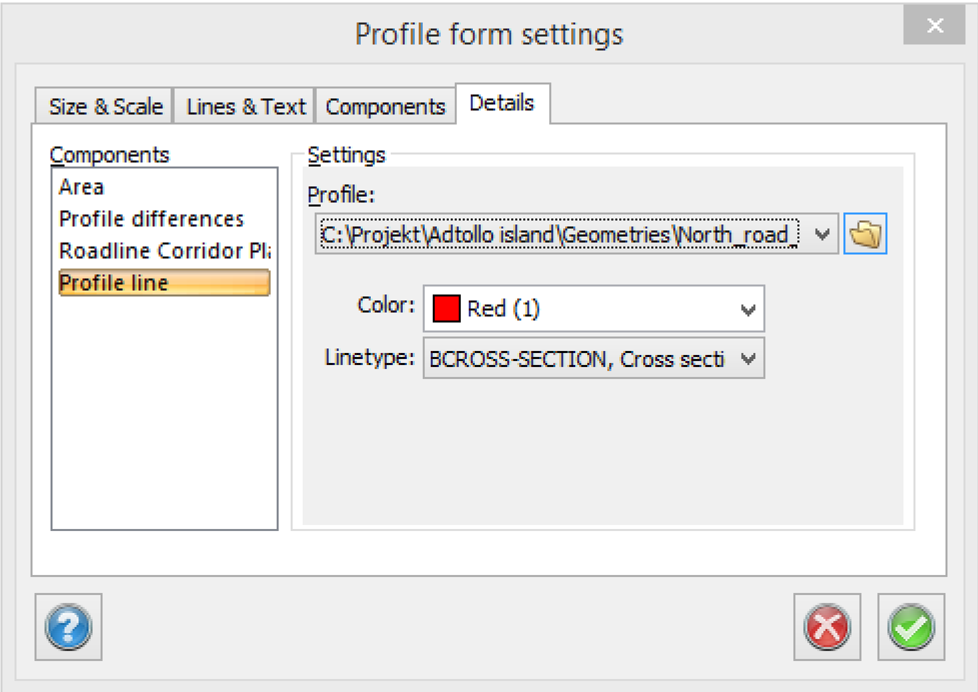
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



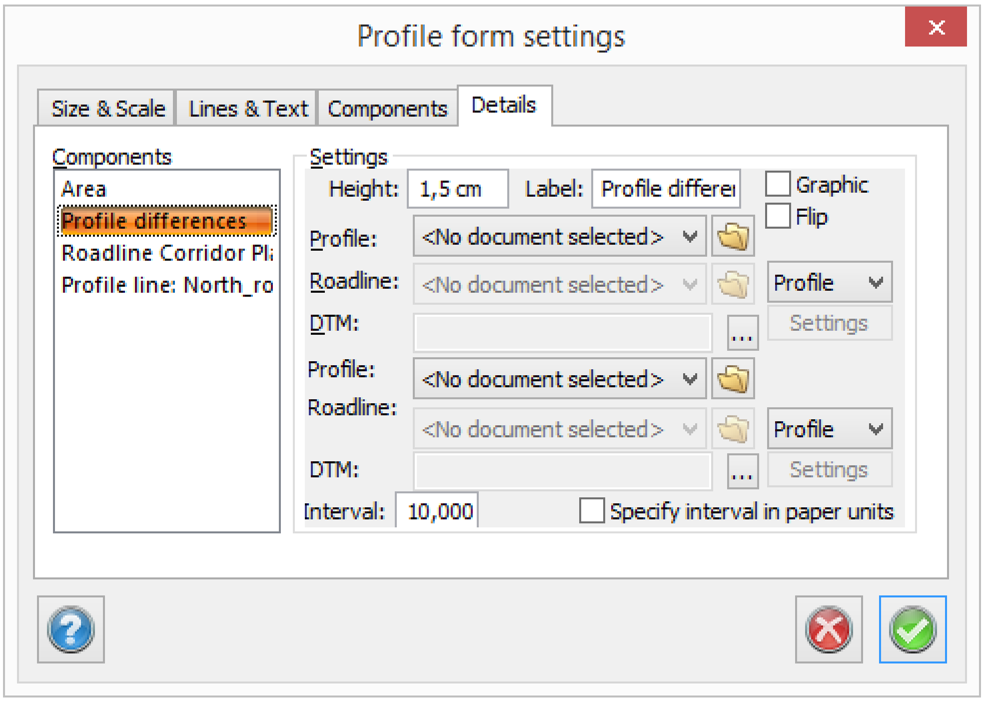
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

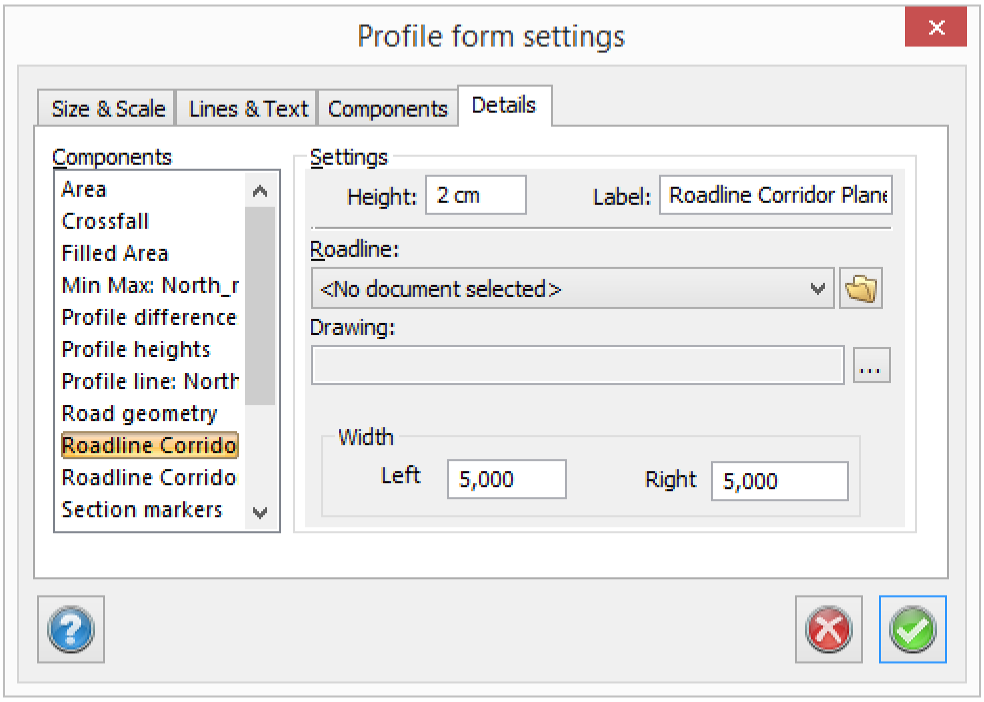
It is possible to display several different road profiles in the form.

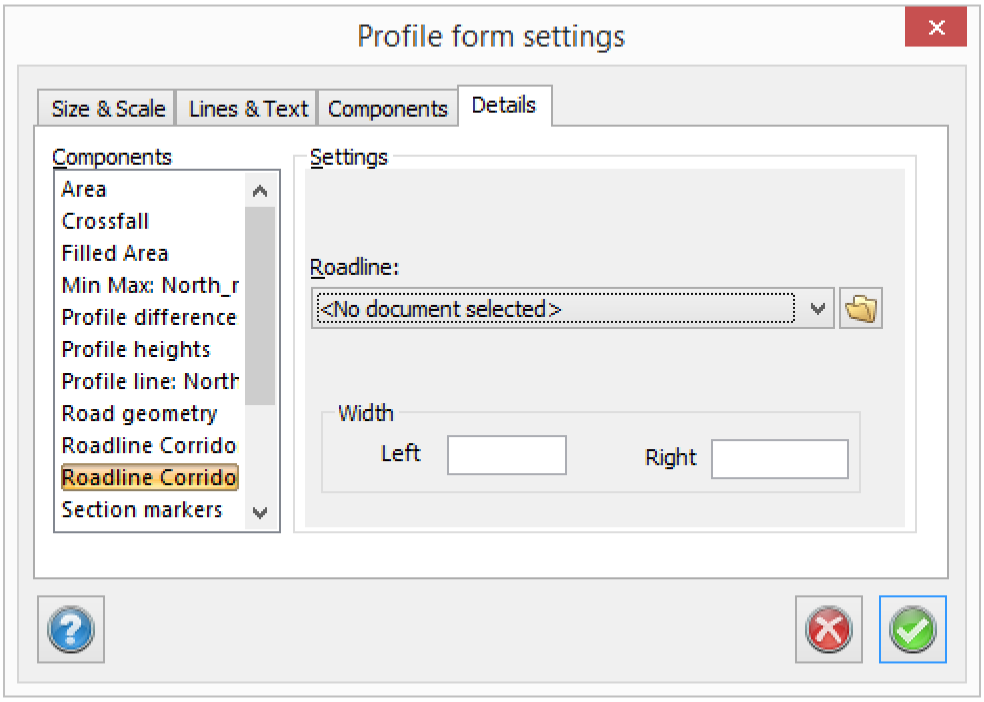
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



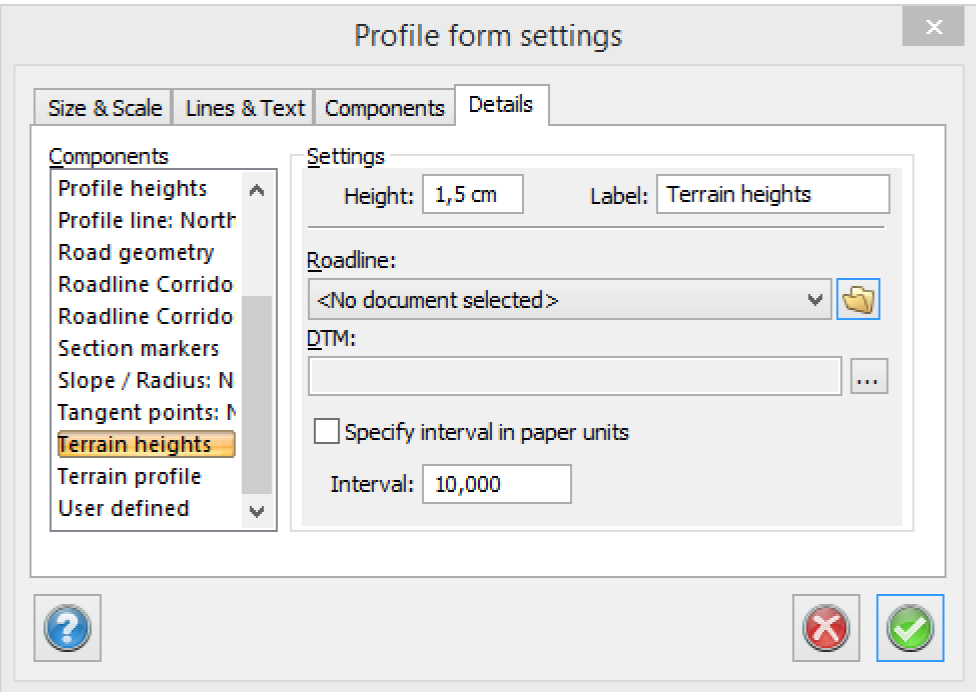
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

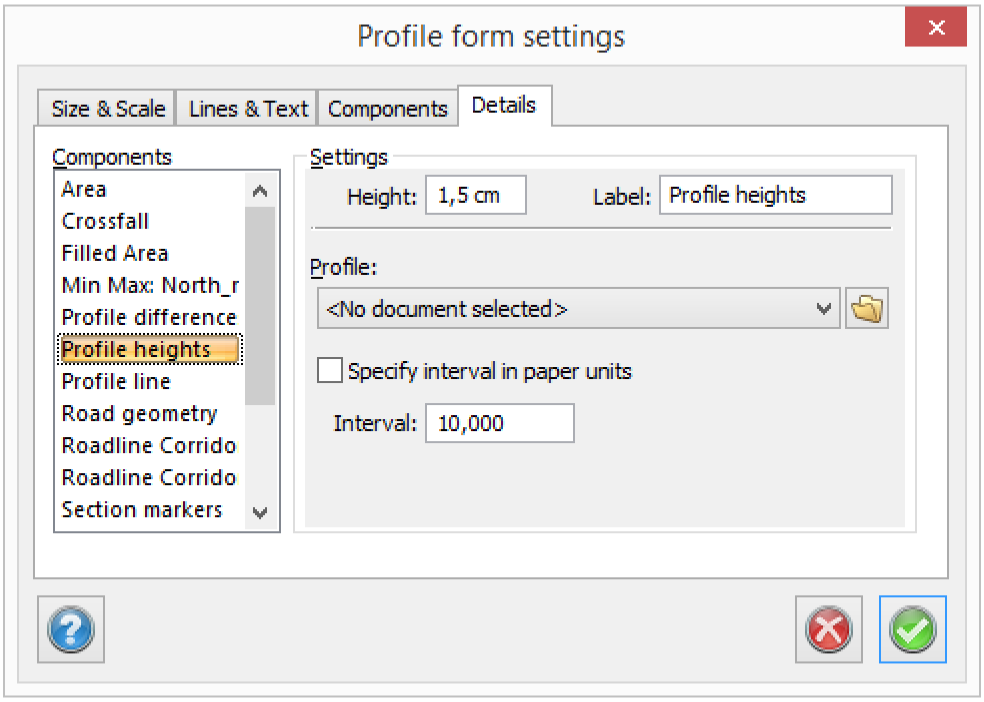
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

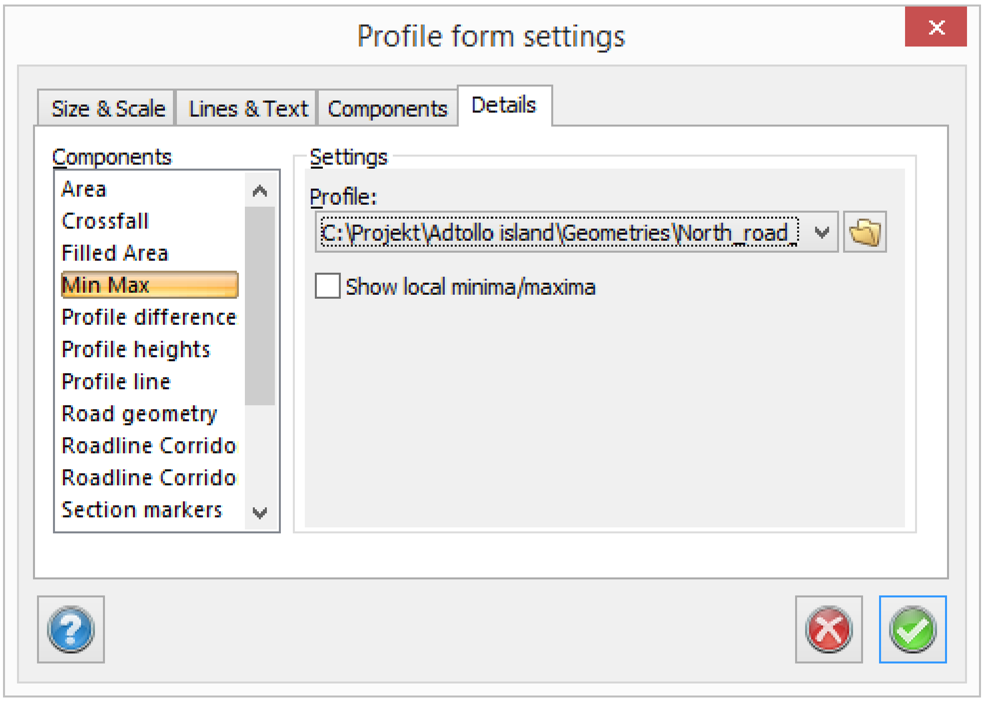
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

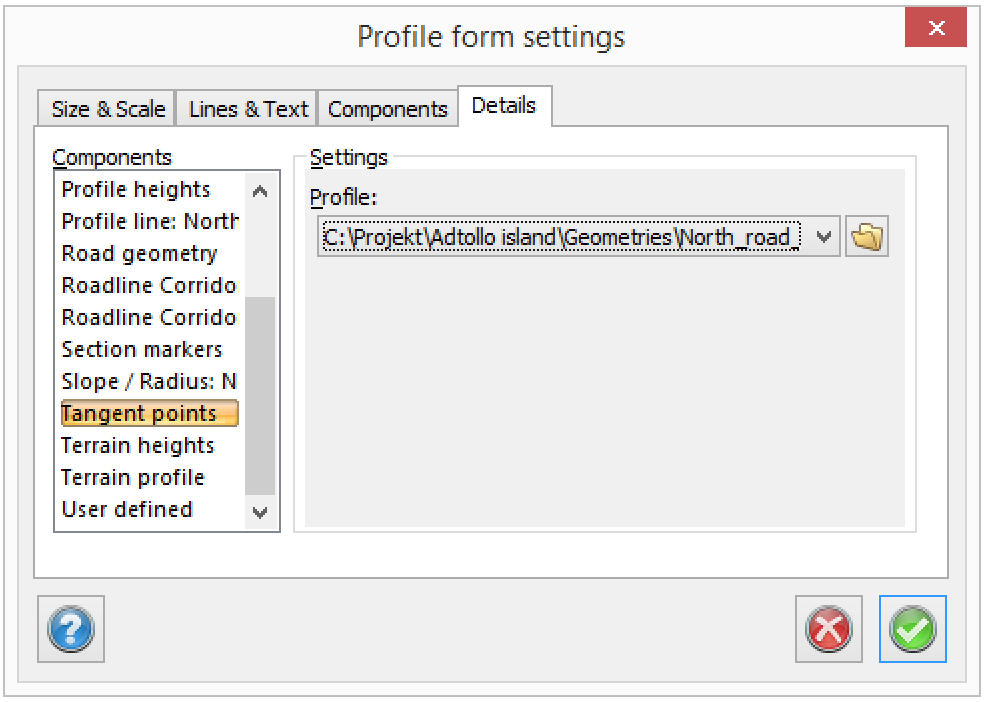
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

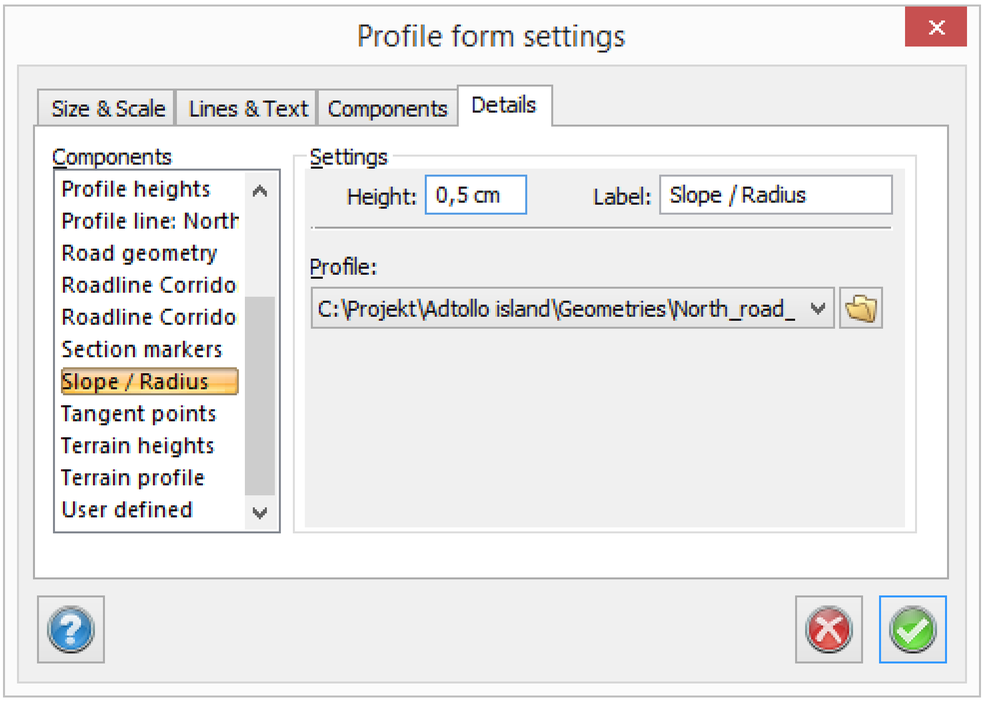
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

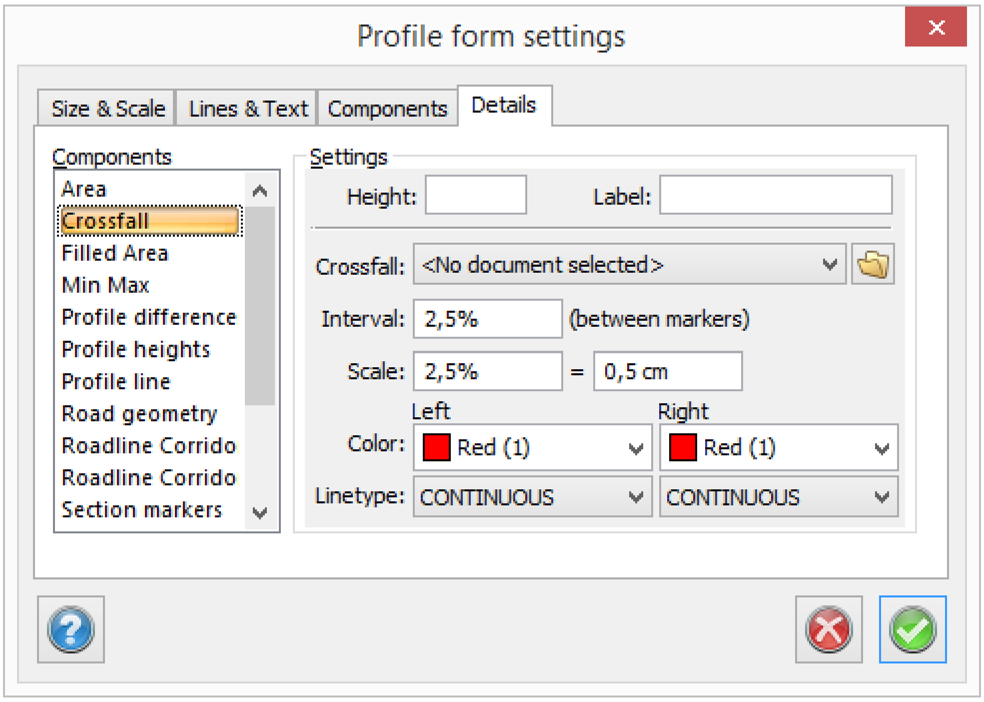
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

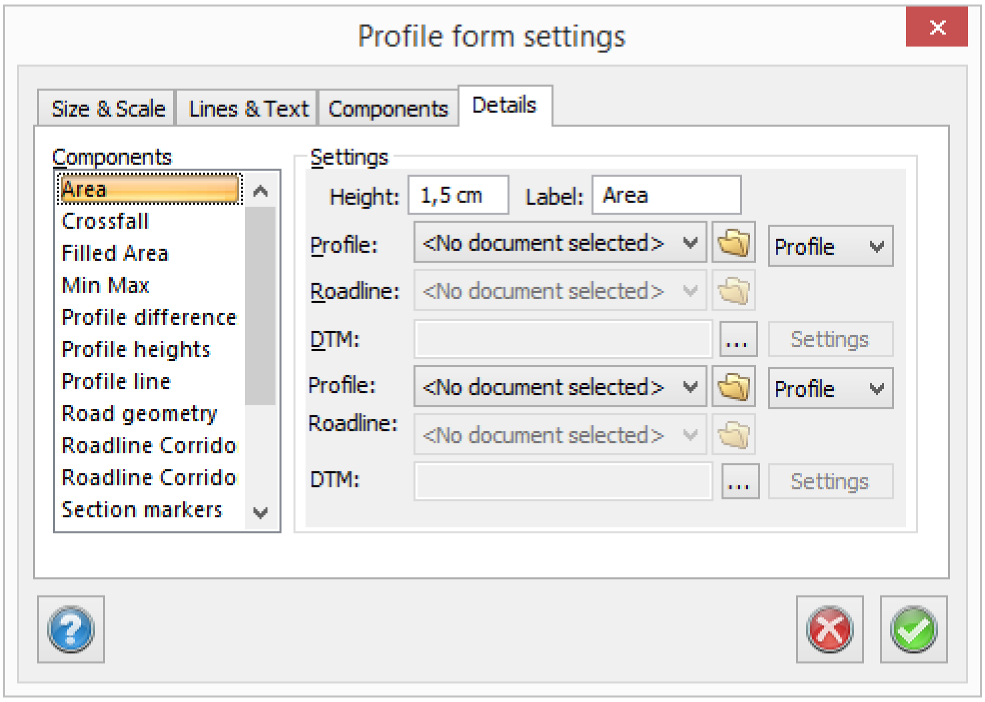
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

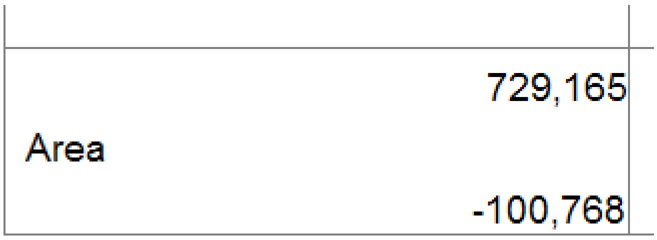
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

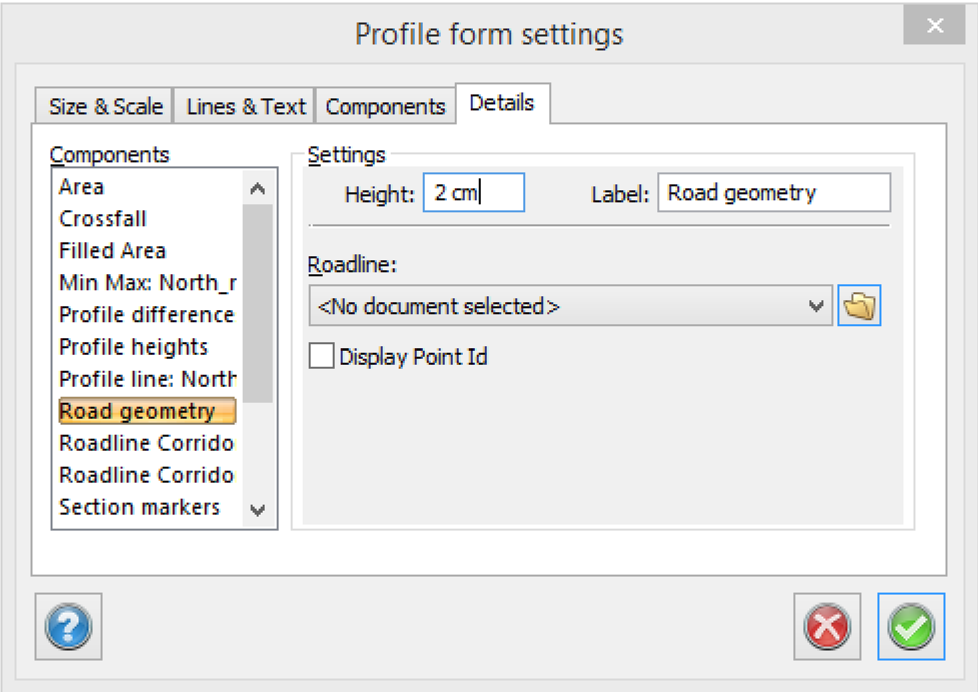


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

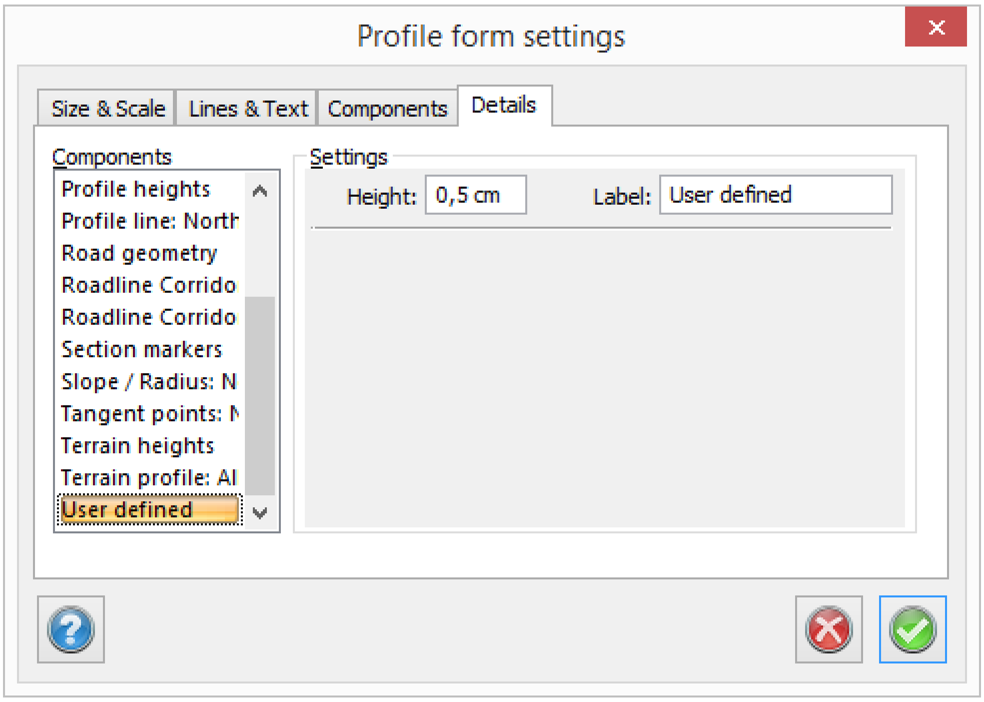
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

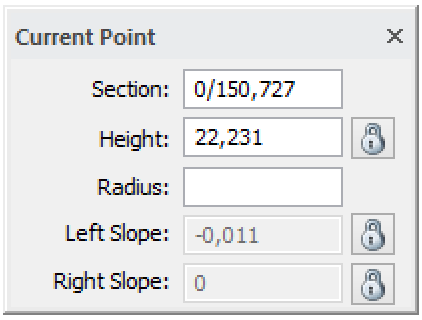
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct|Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

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The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
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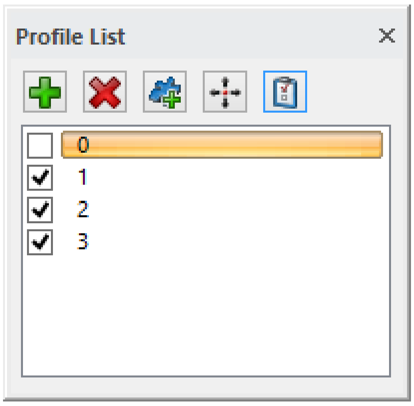
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



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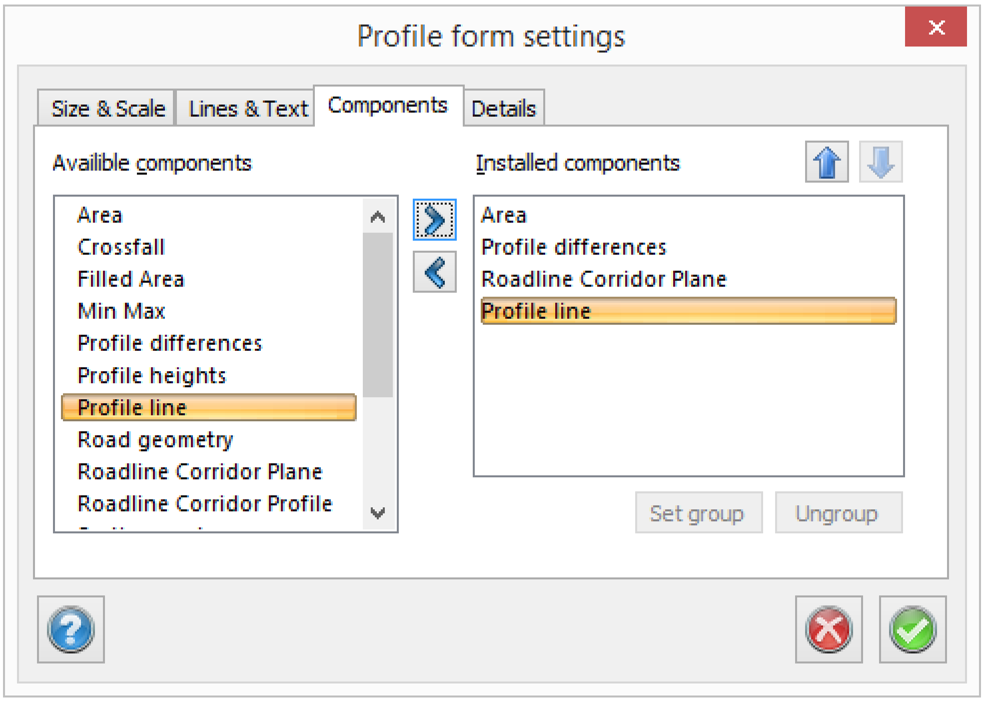
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



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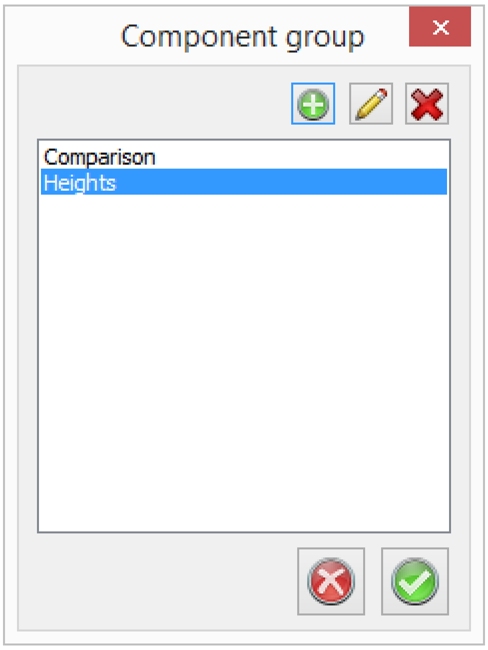

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See also:

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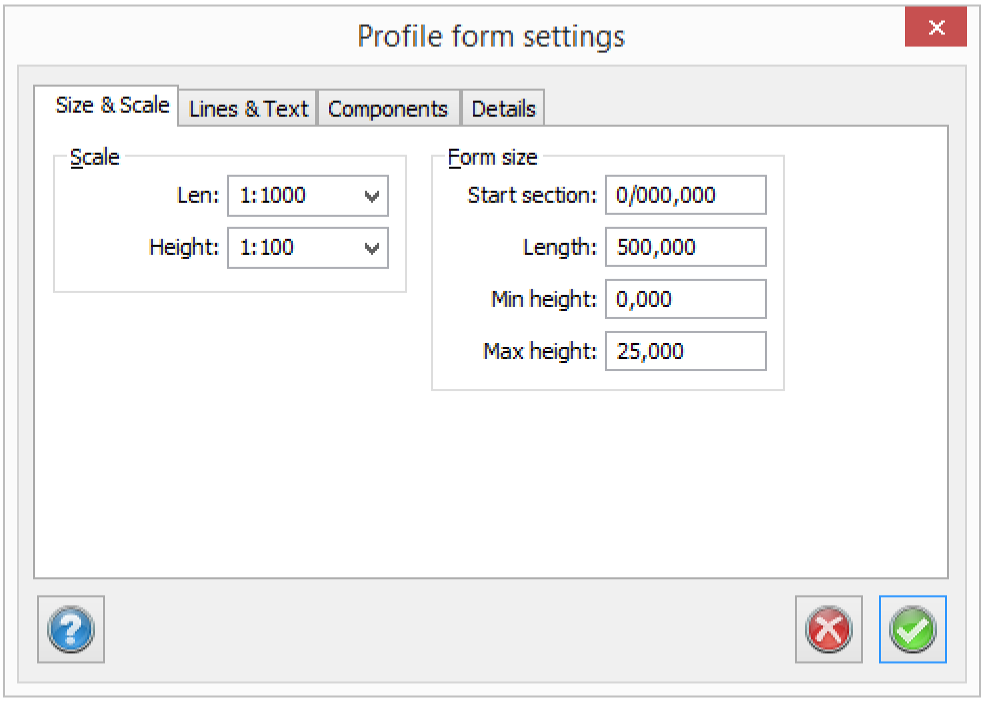
Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:



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Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

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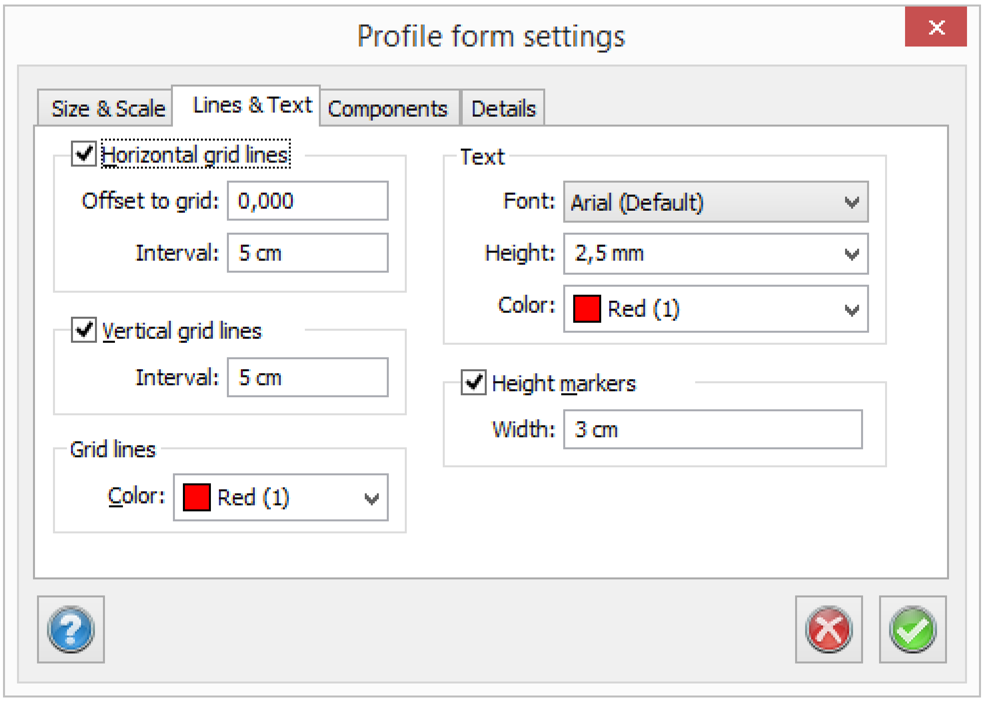

Horizontal grid
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size of the printout.

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Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
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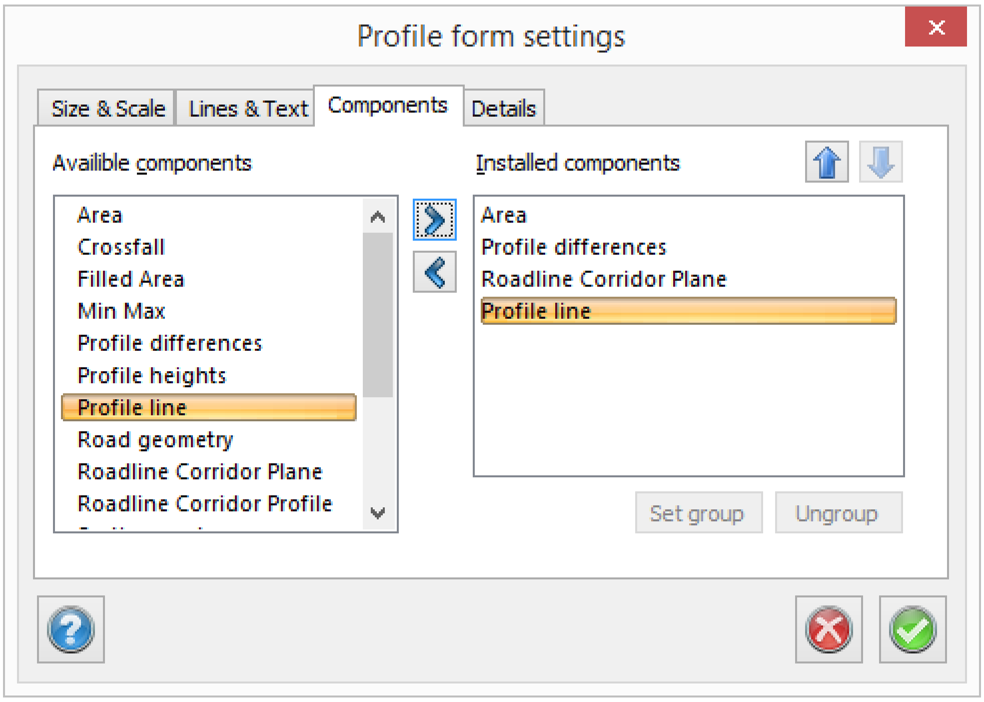
Profile form, components



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- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
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- Terrain profile
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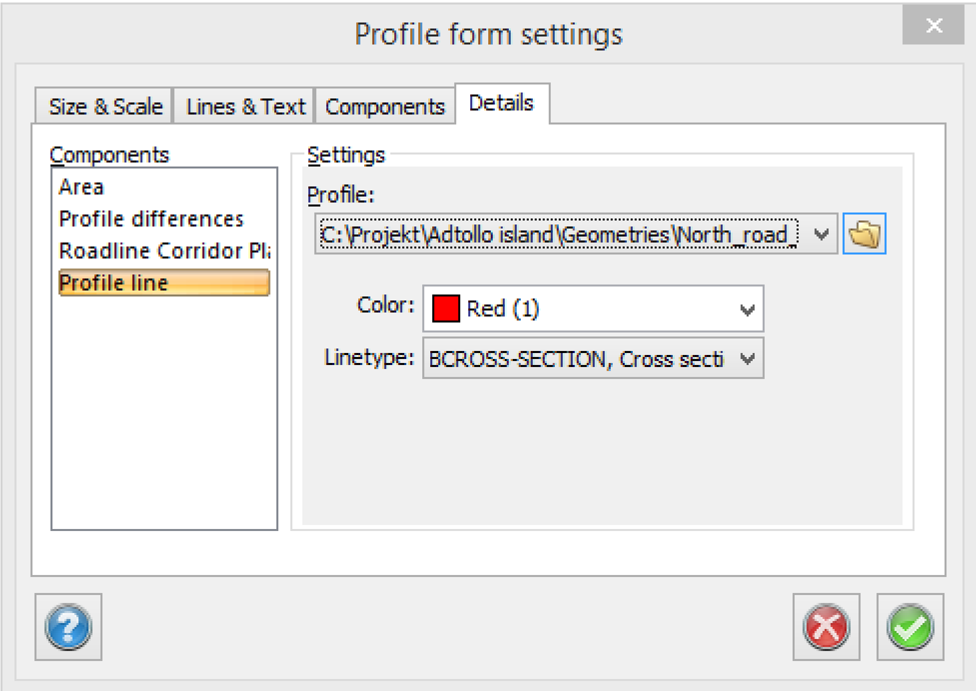
Details, profile line



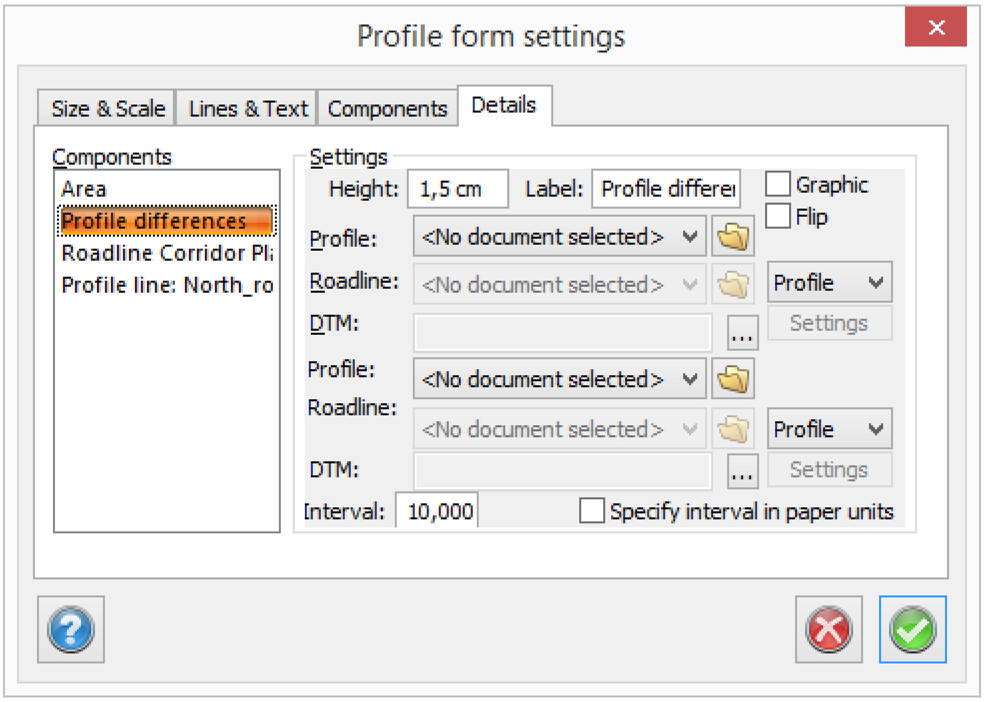
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

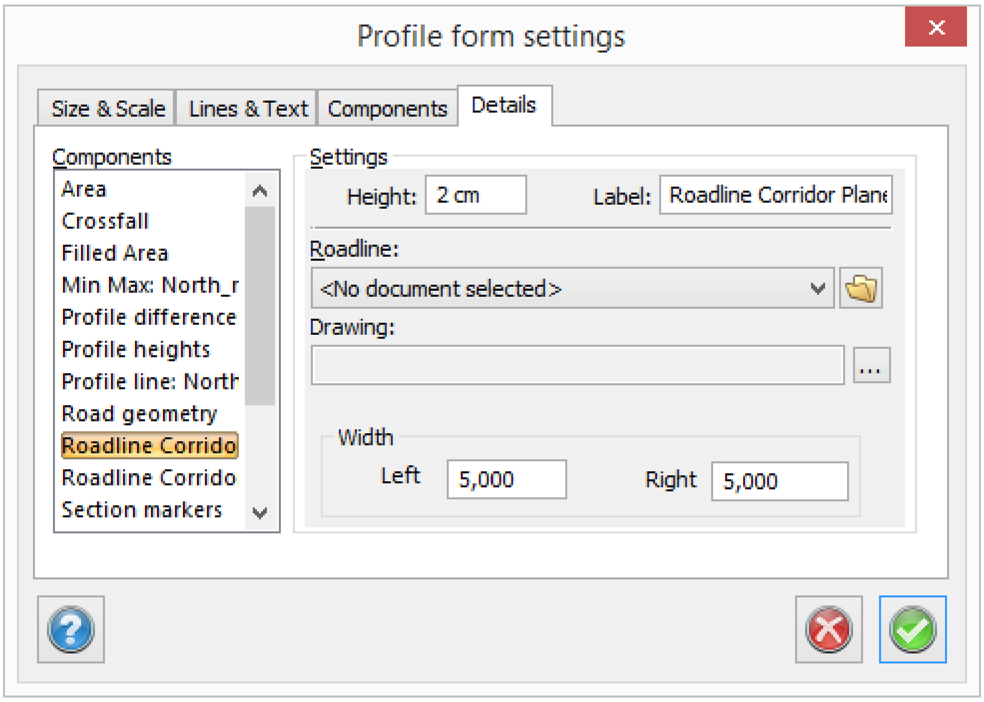
It is possible to display several different road profiles in the form.

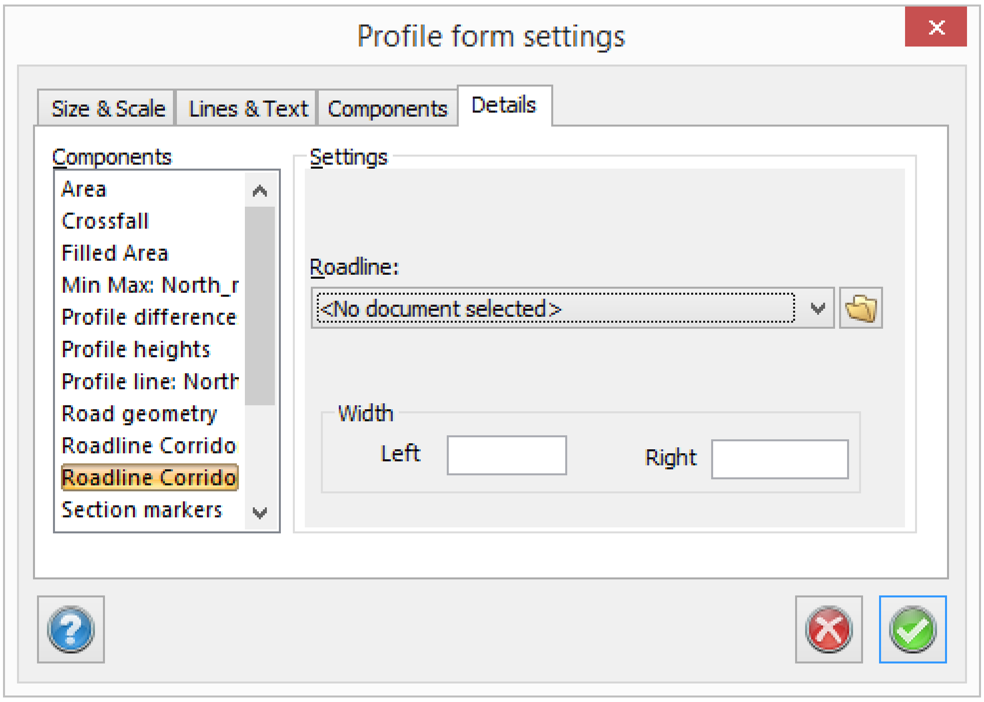
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



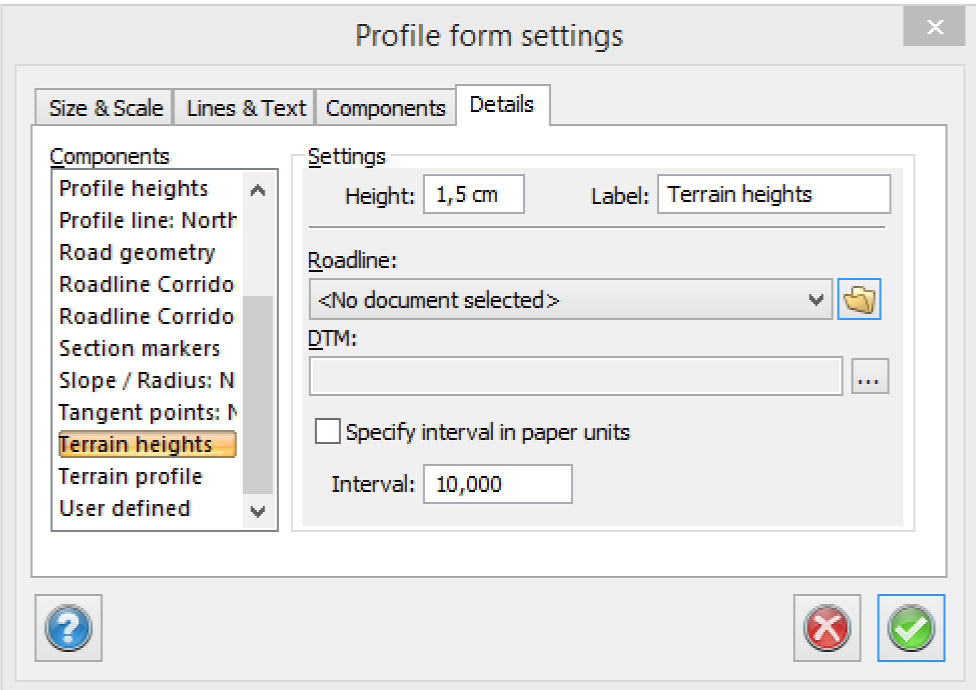
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

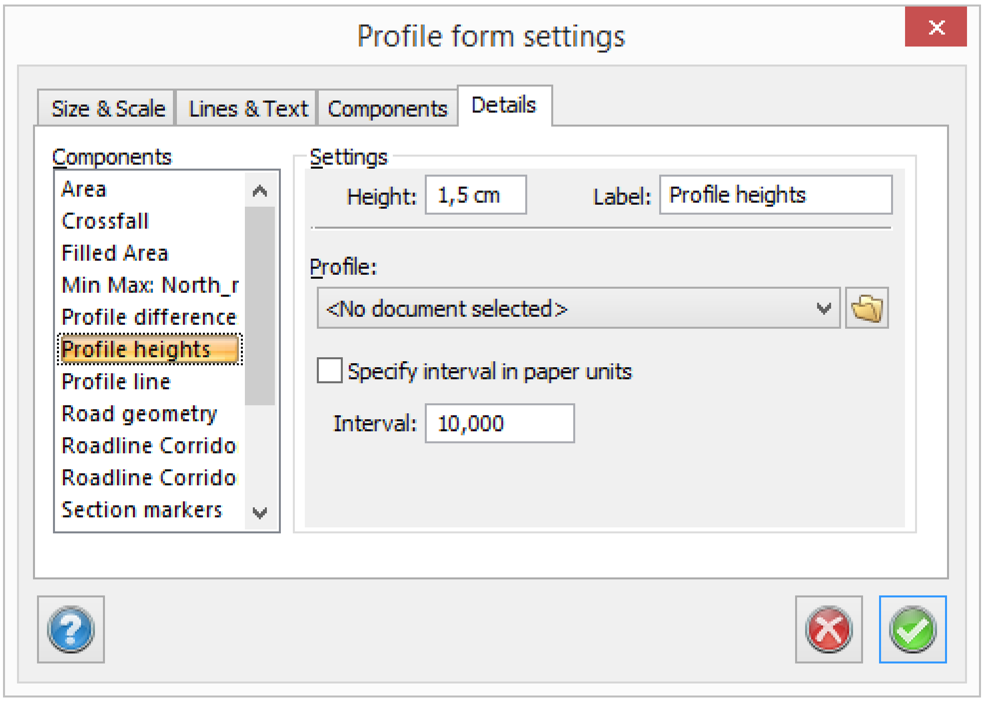
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

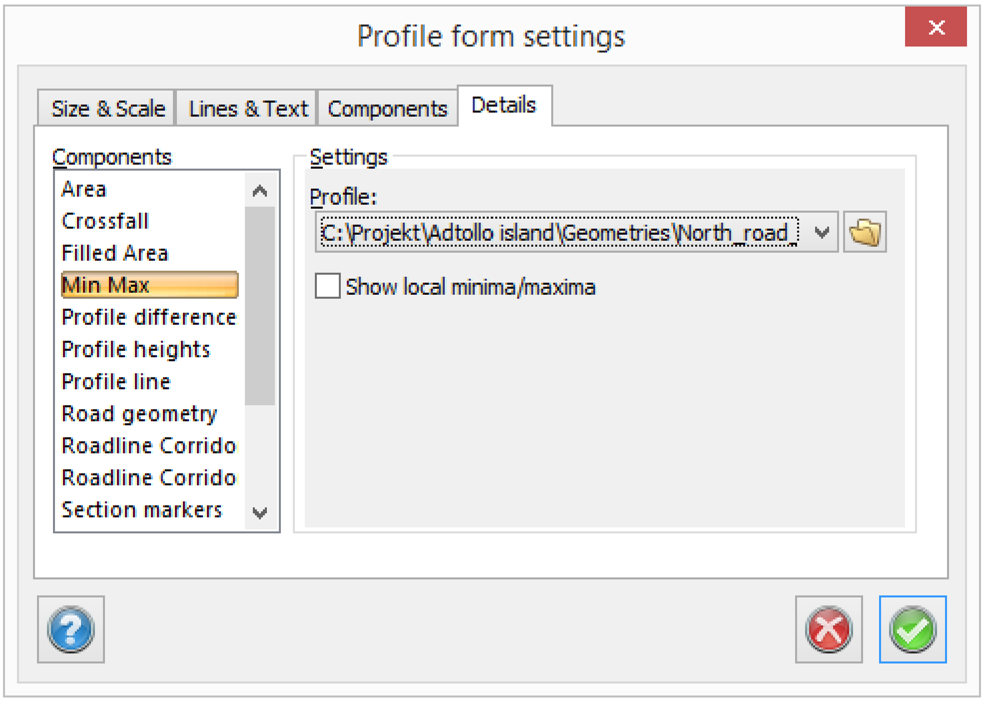
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

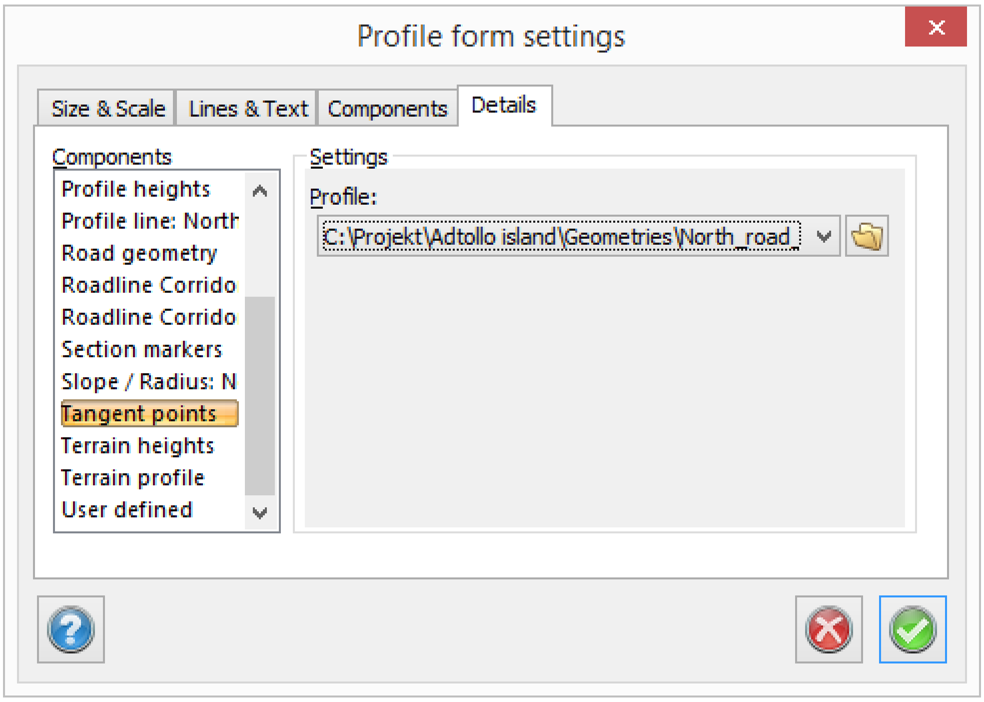
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

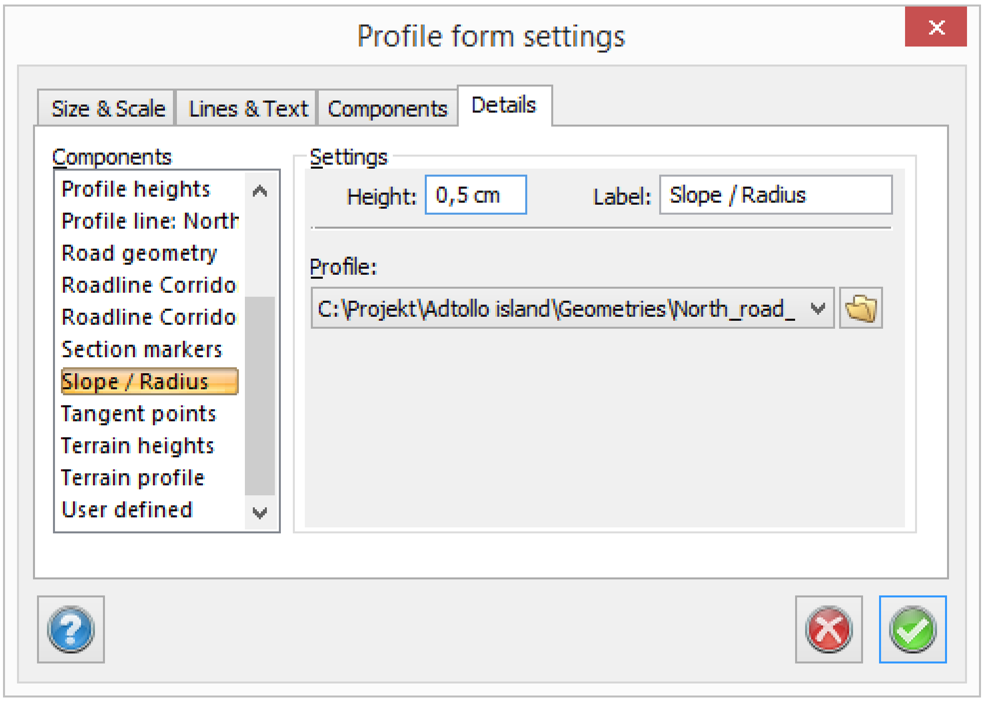
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

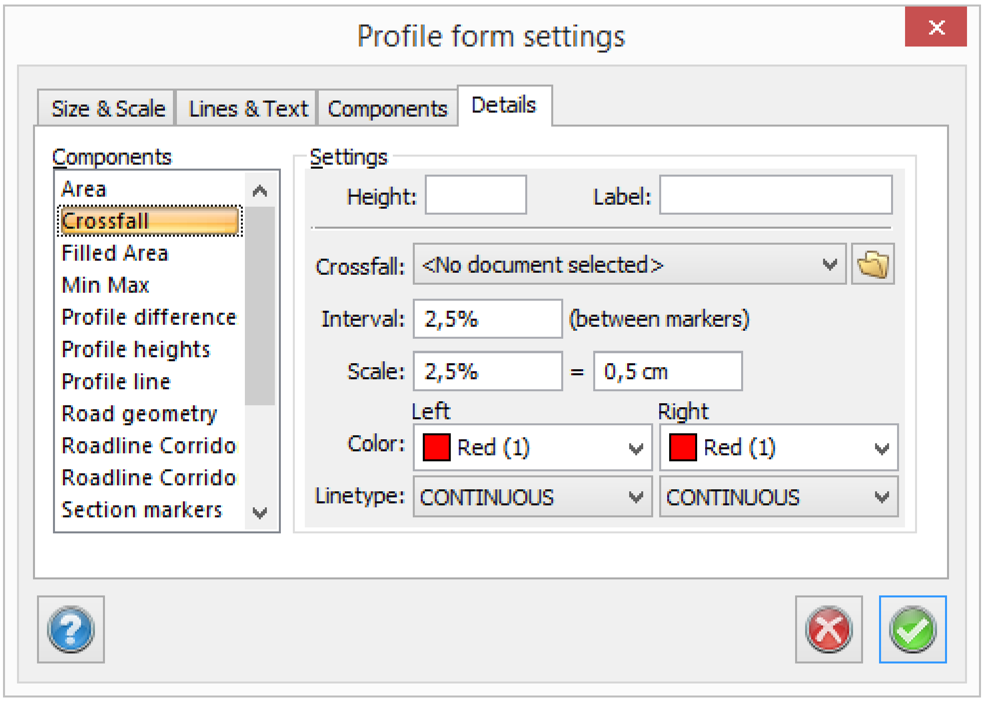
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

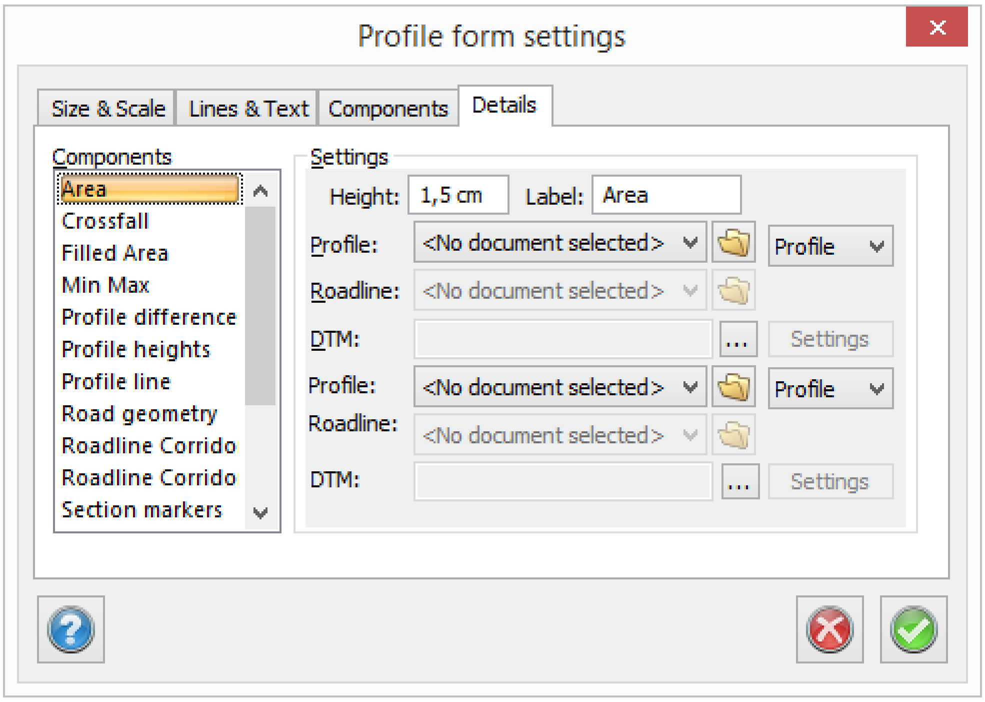
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

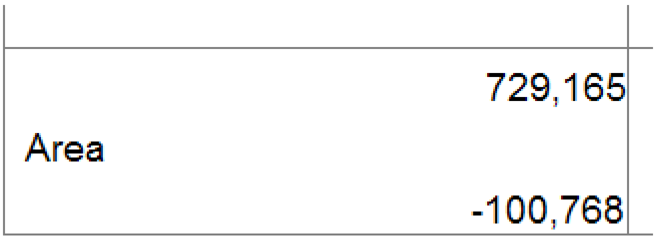
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

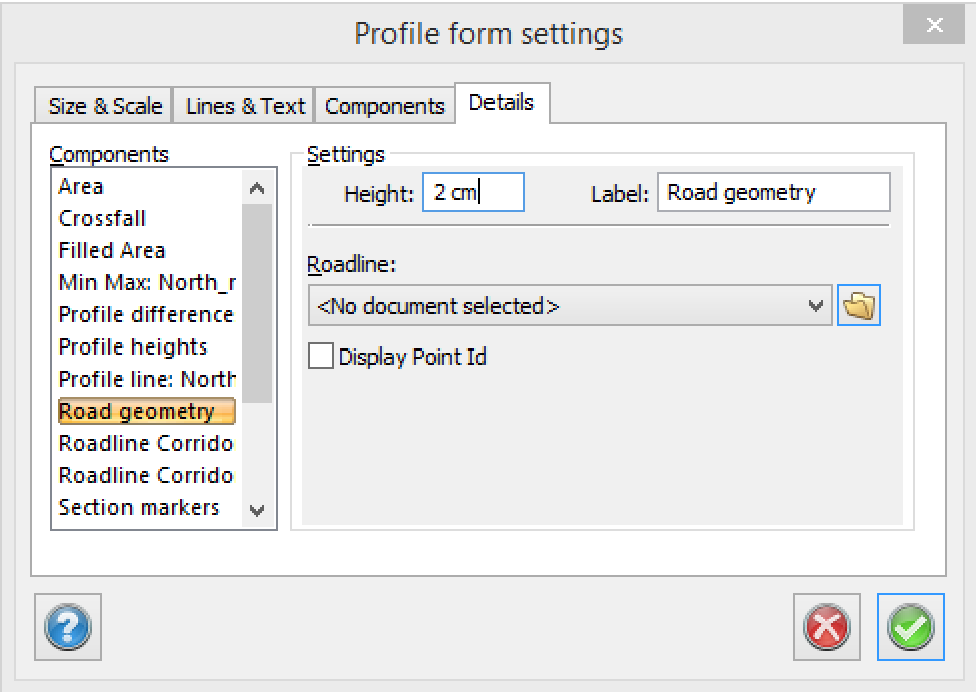


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

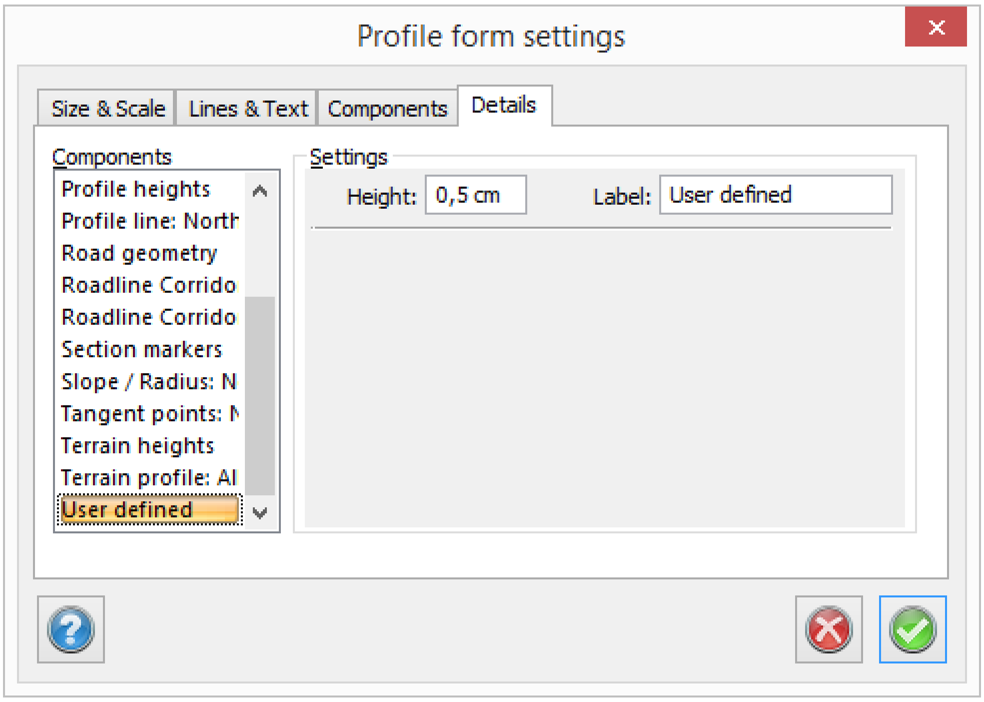
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

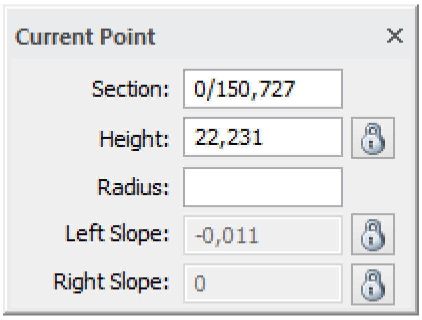
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct|Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

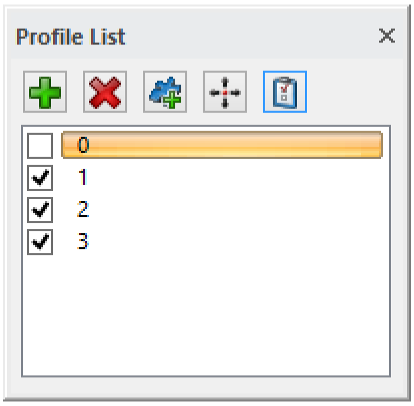
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



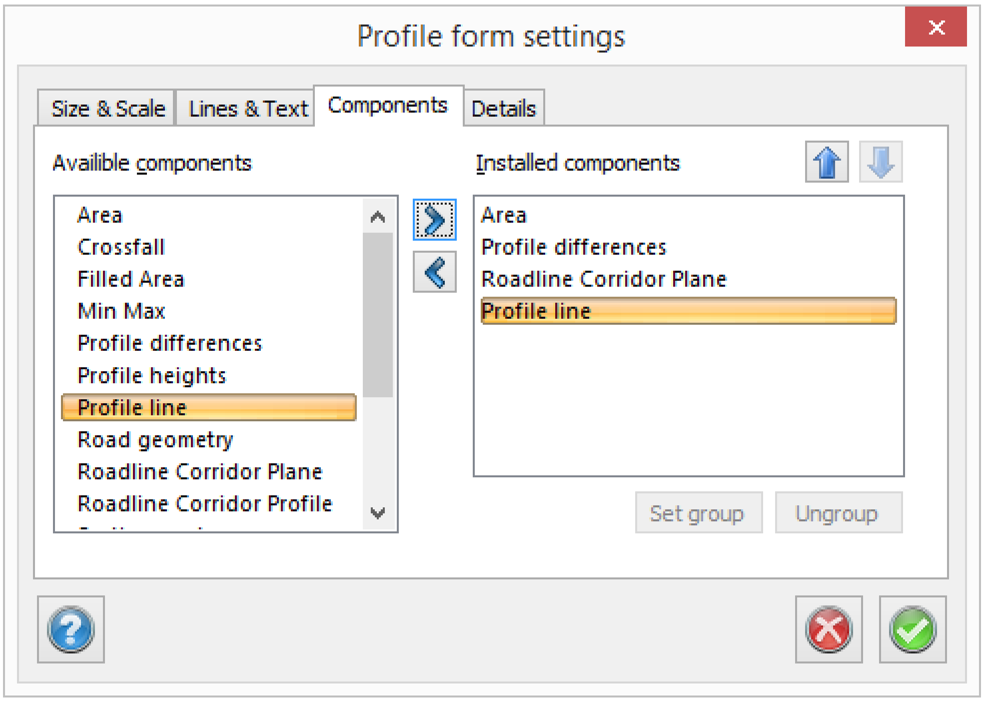
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

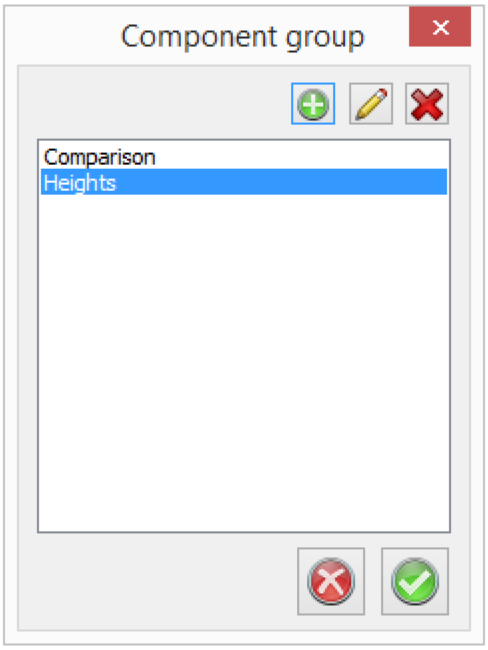
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

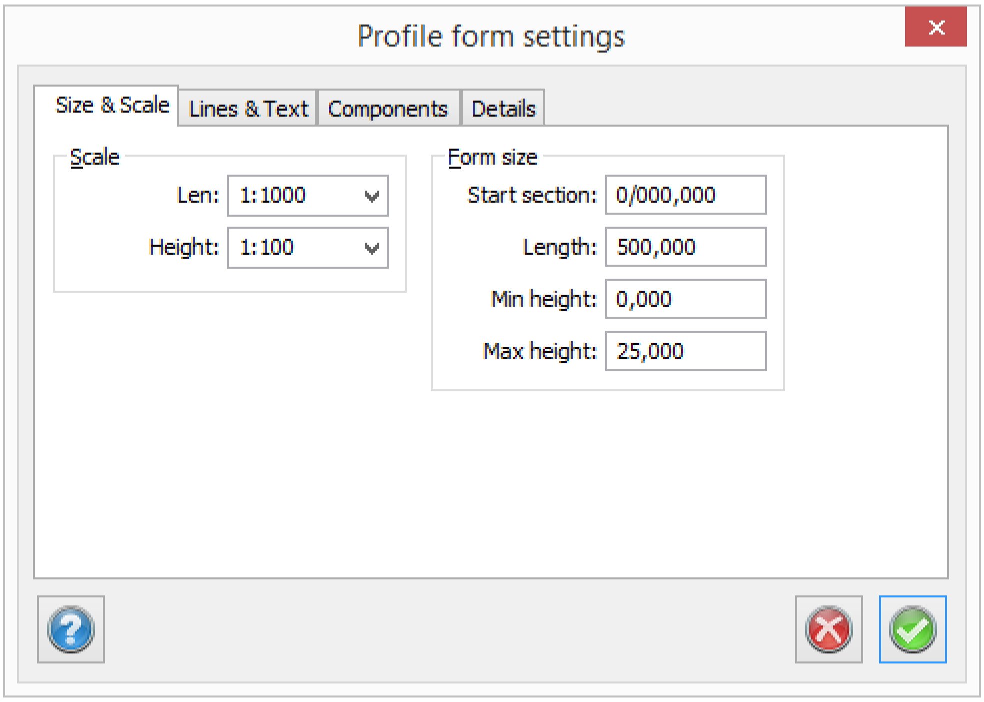
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

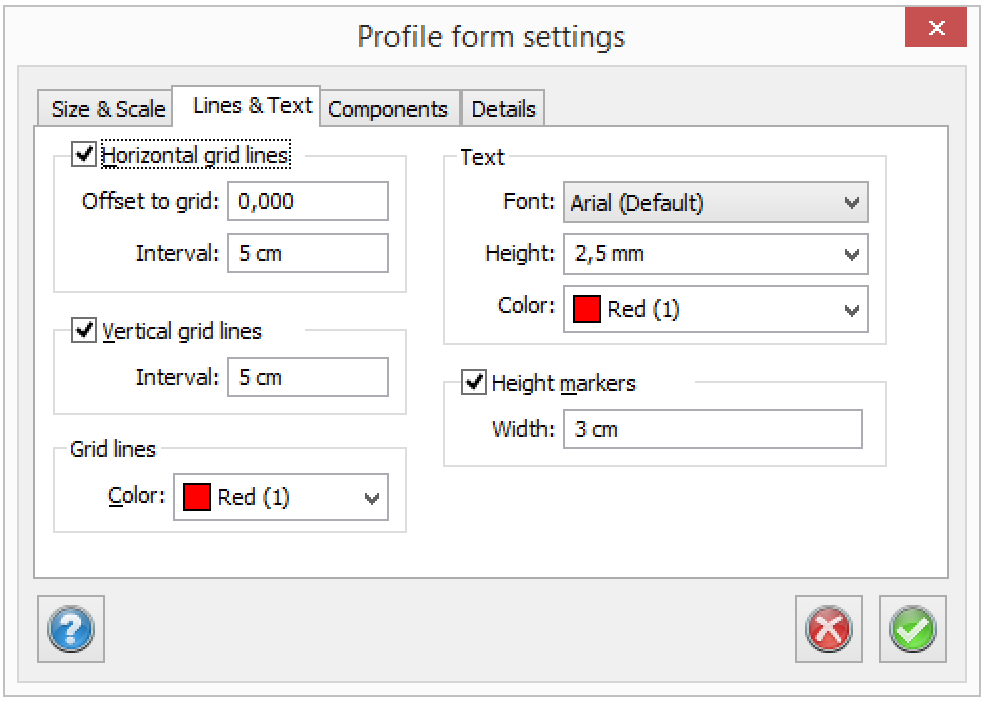


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

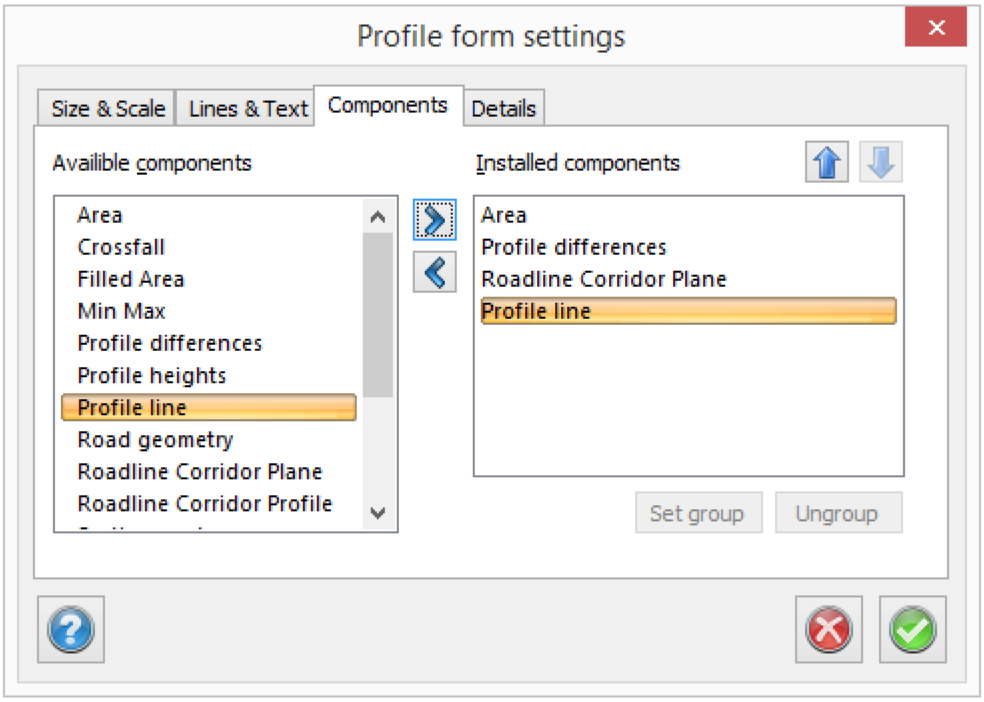
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

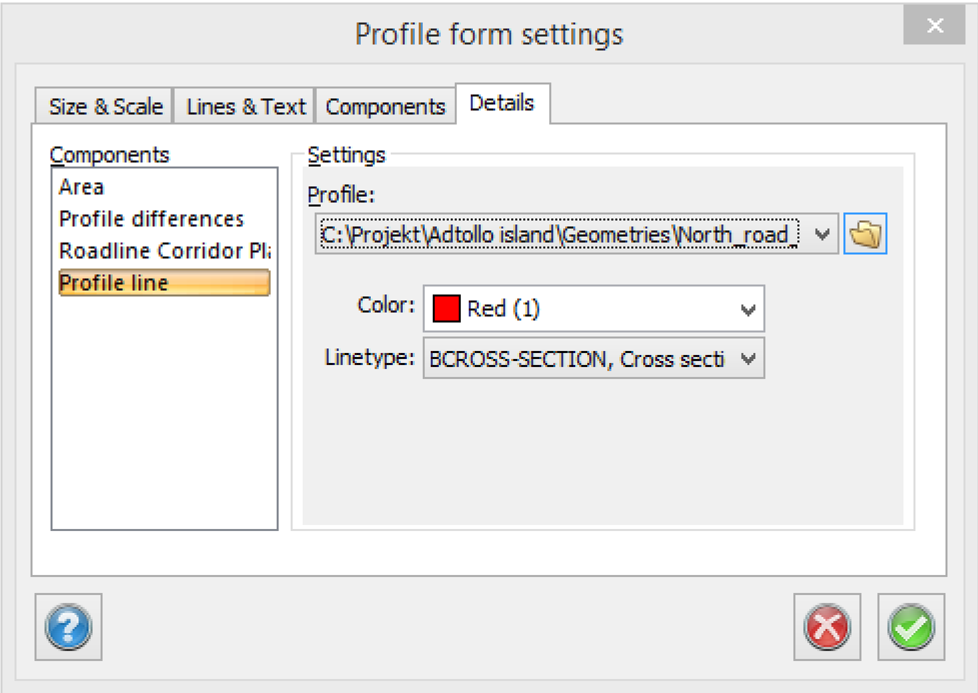
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



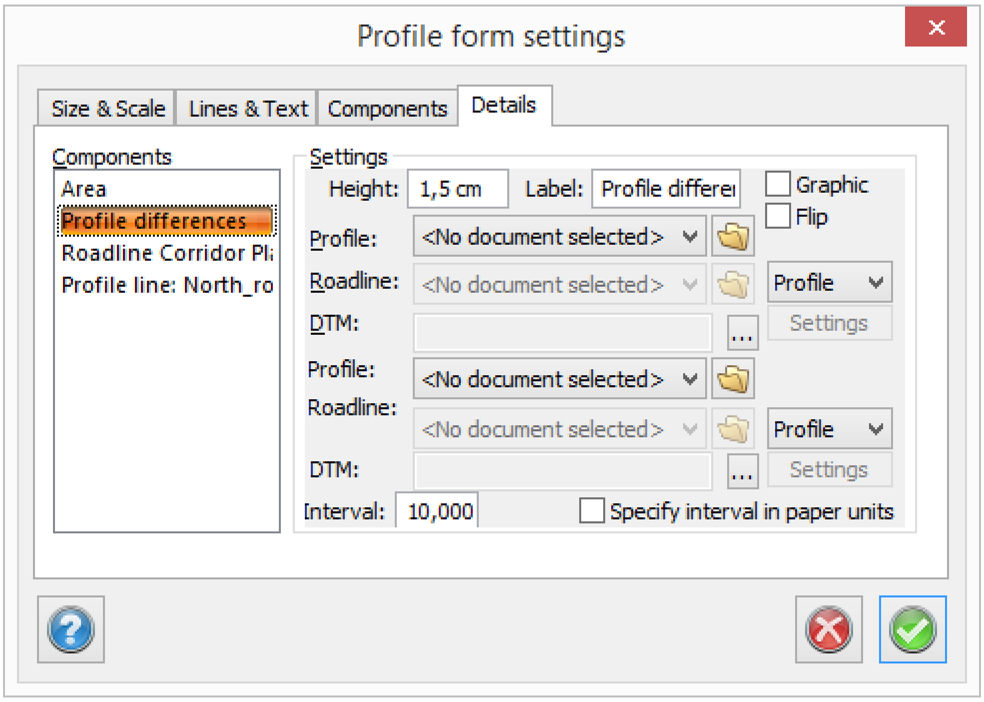
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

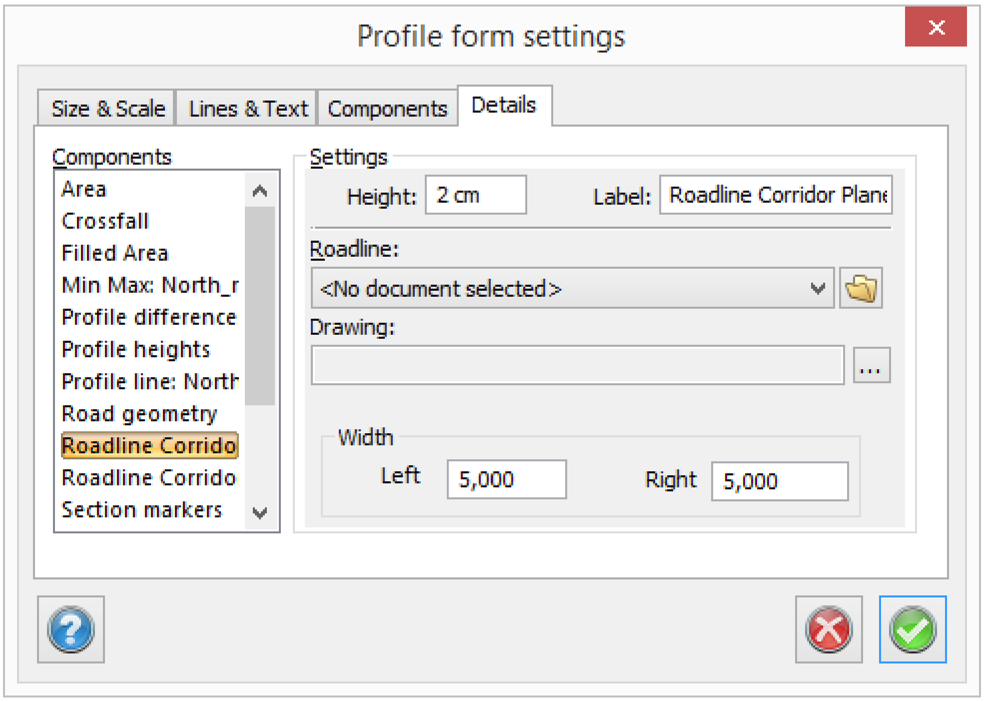
It is possible to display several different road profiles in the form.

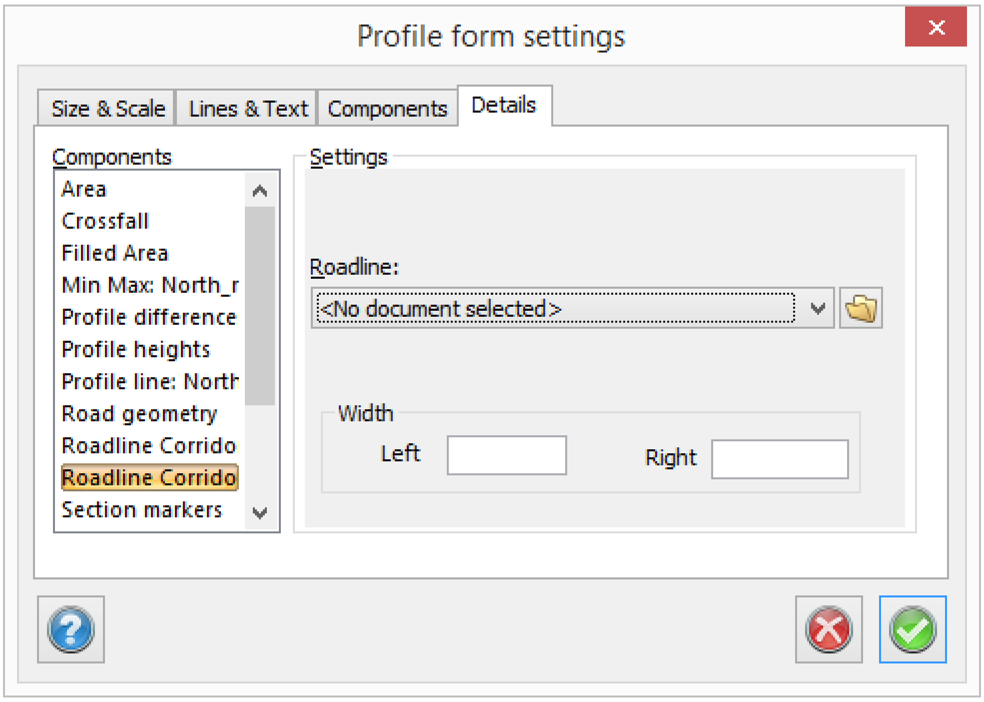
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



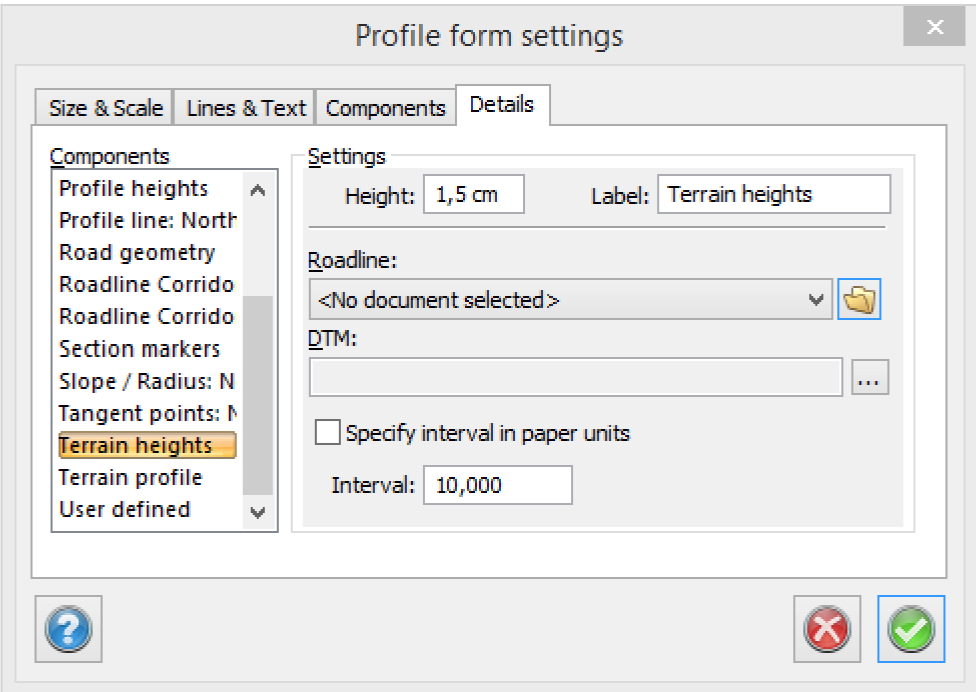
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

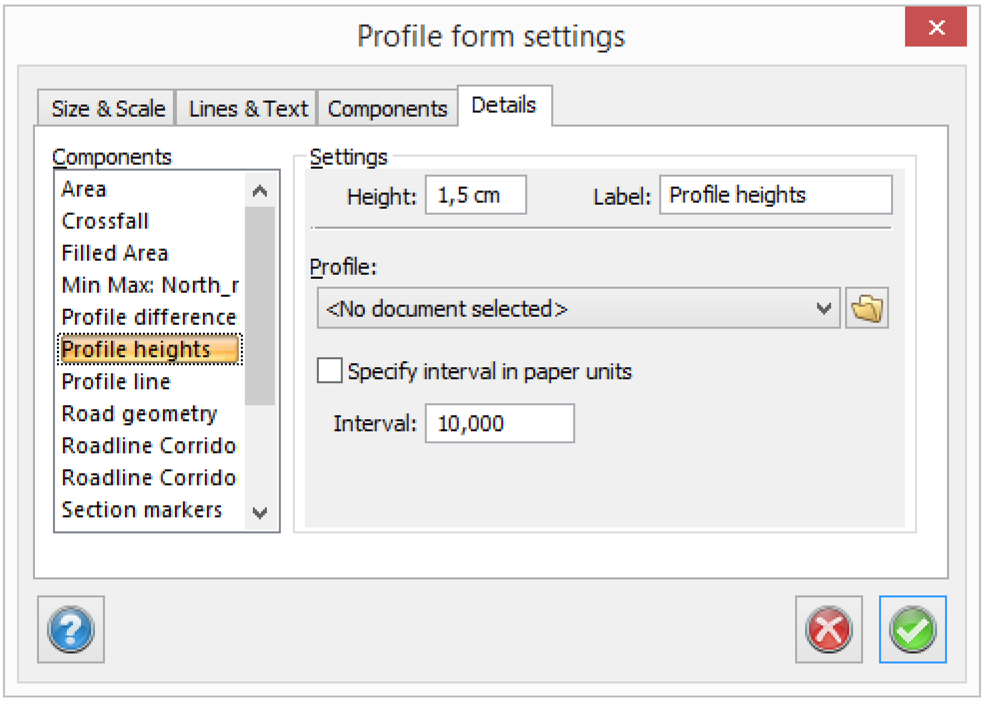
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

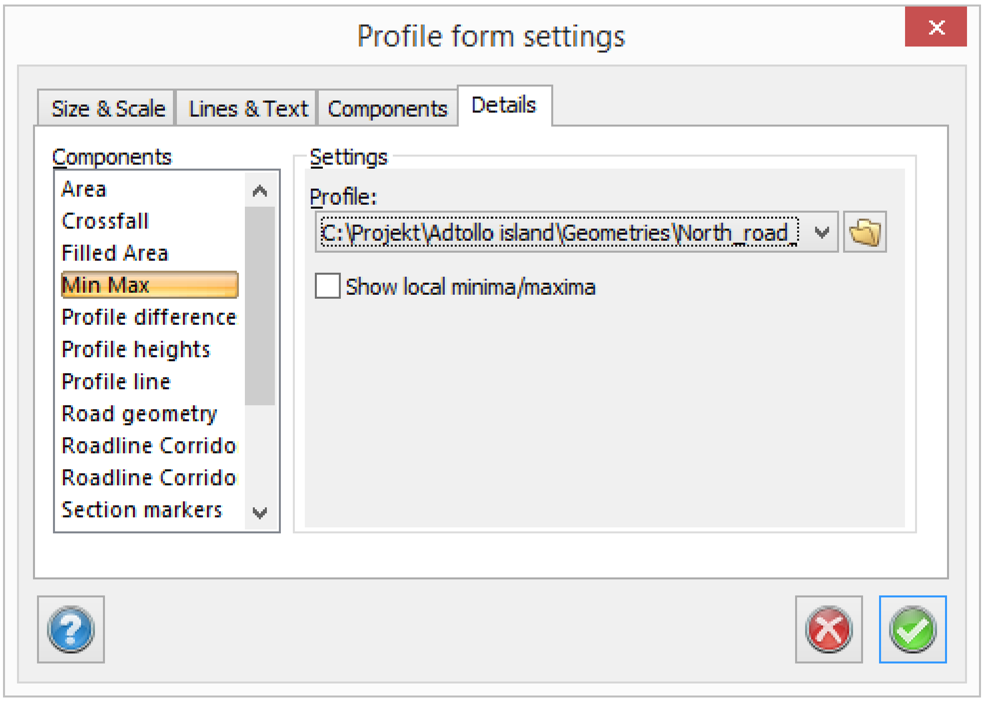
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

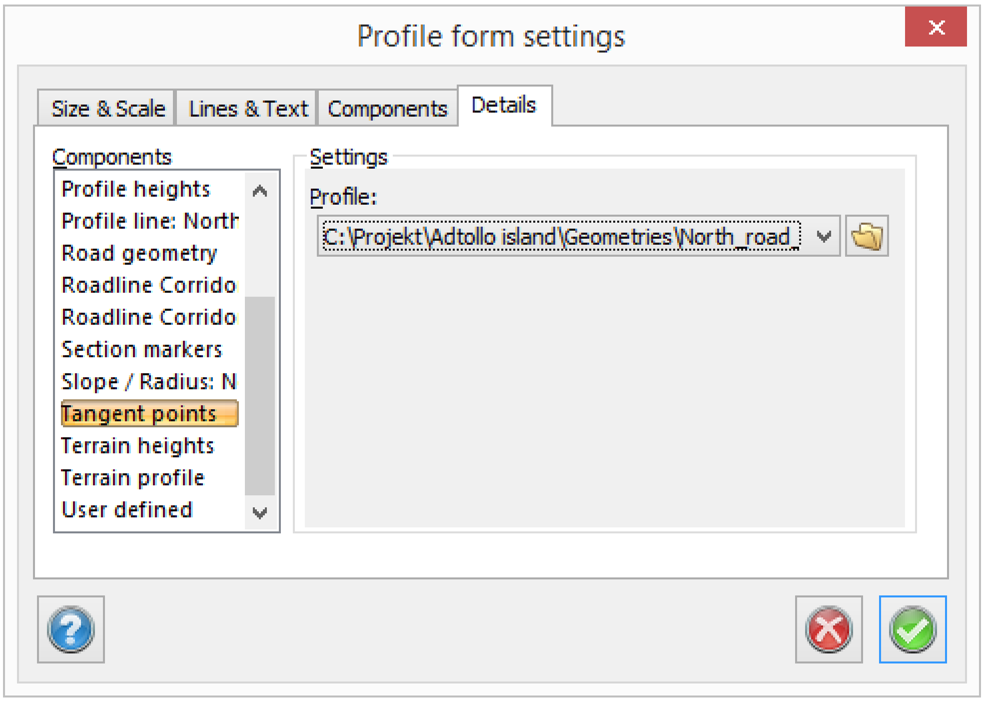
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

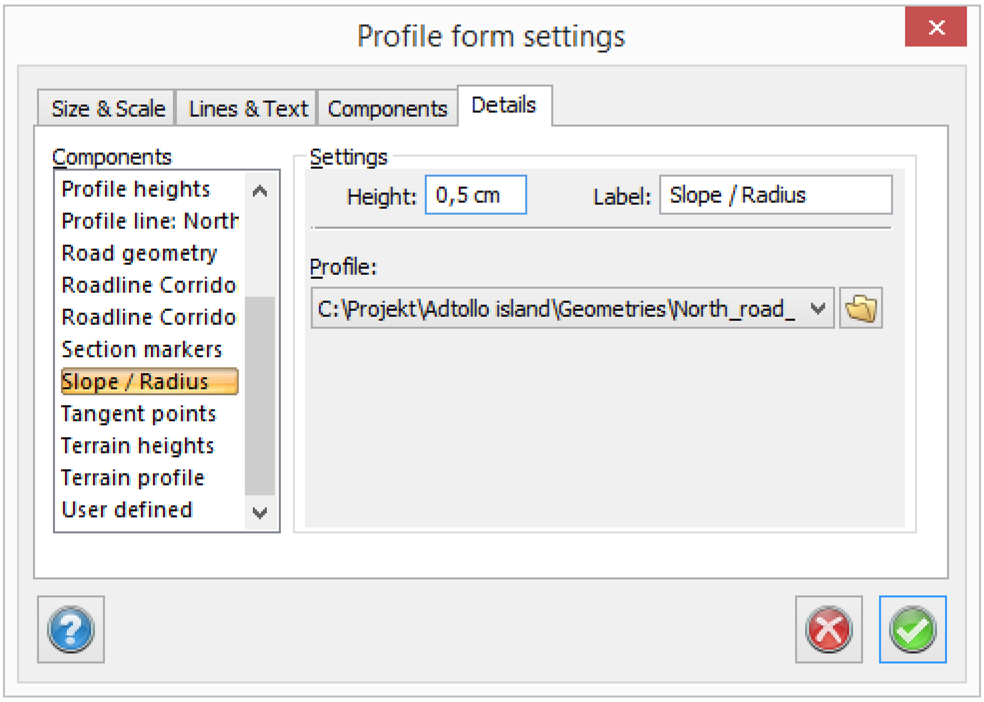
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

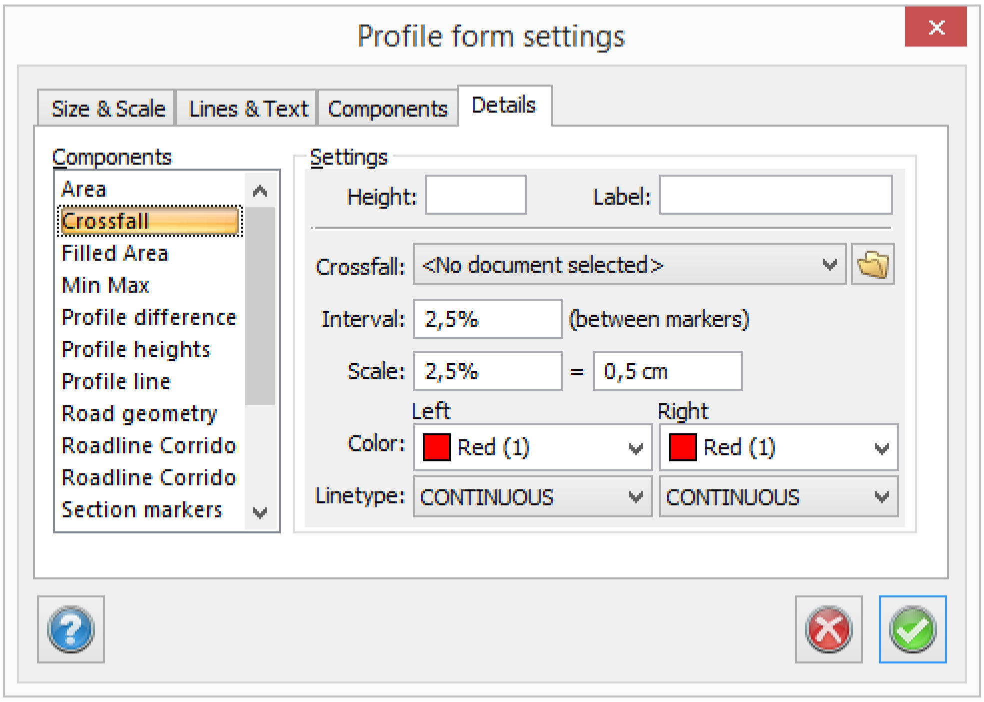
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

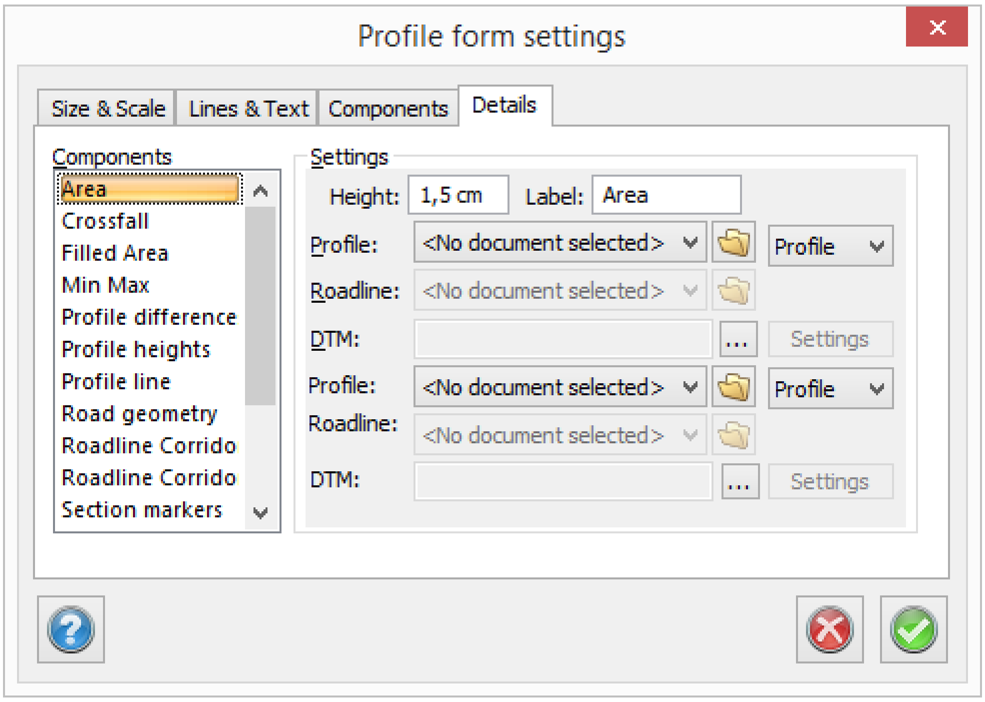
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

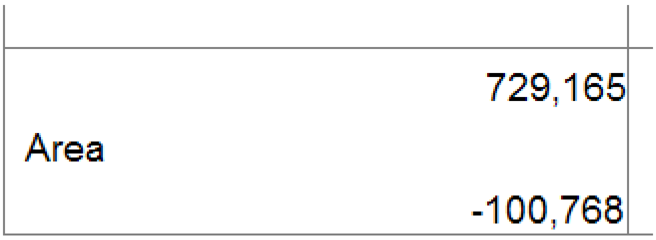
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

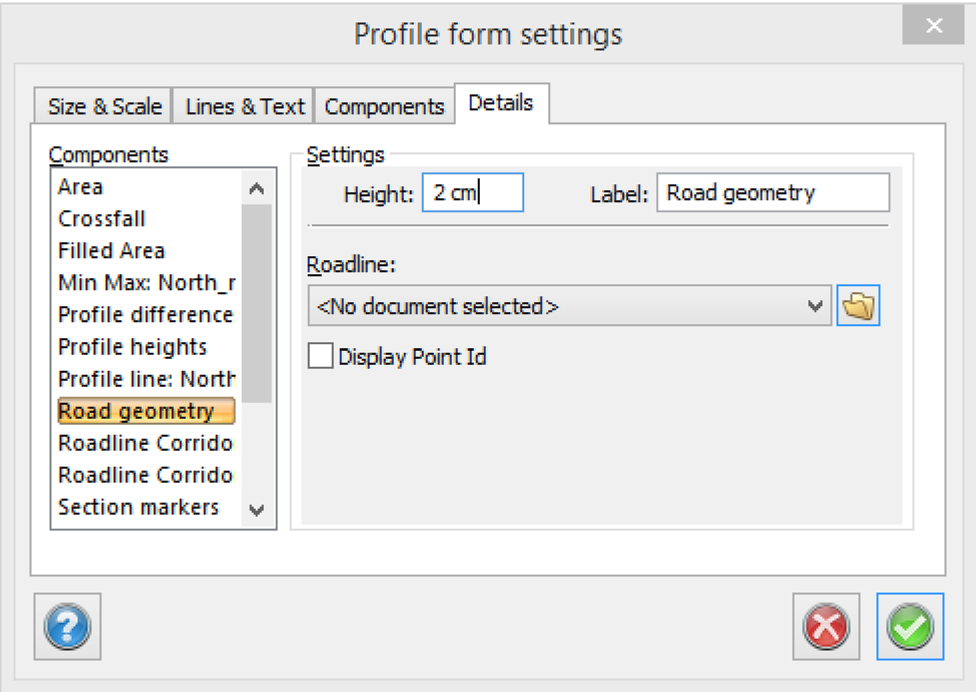


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

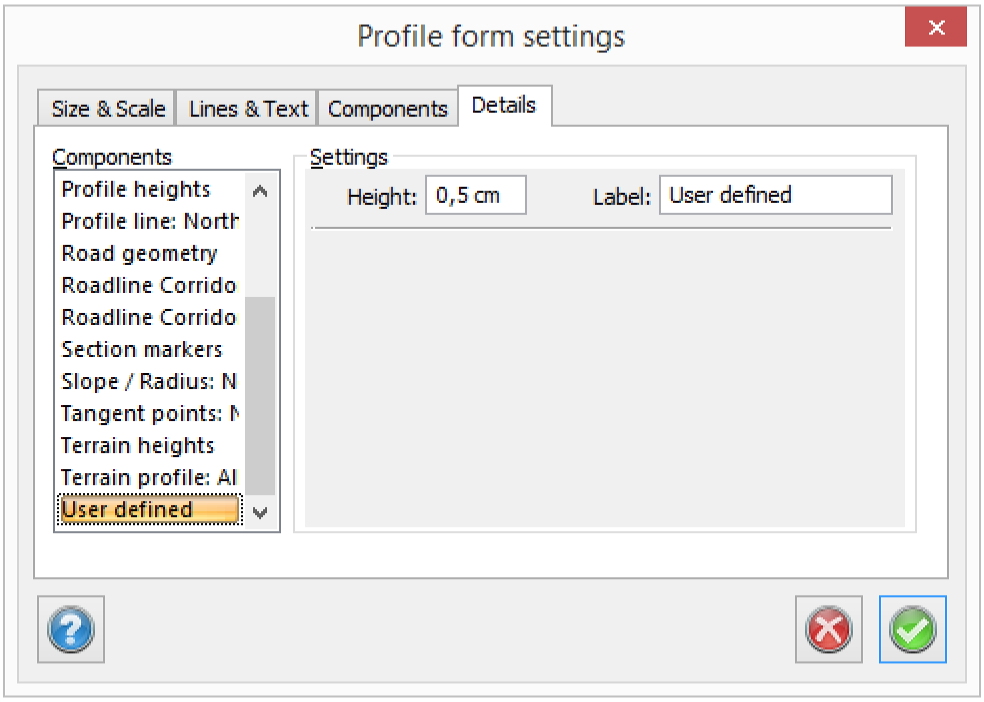
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

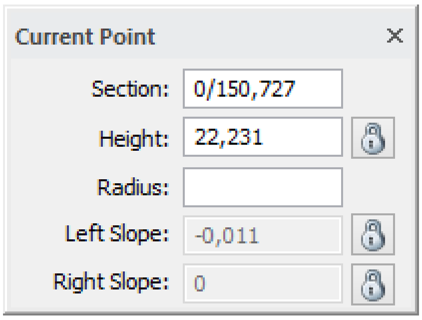
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

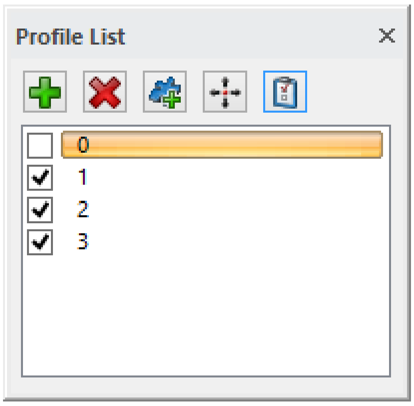
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



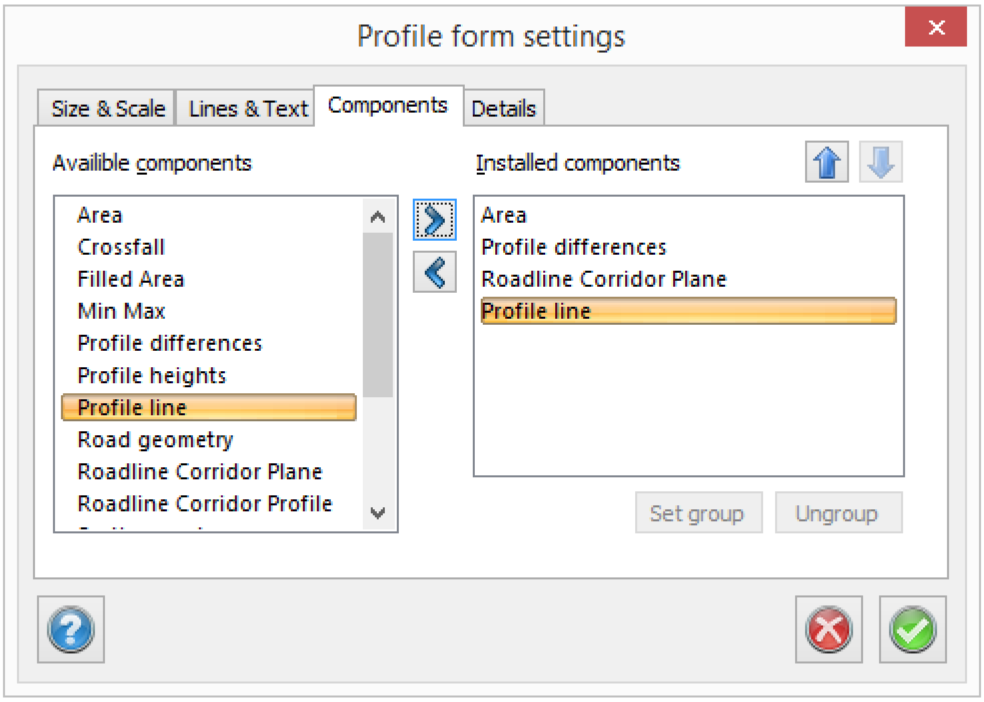
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

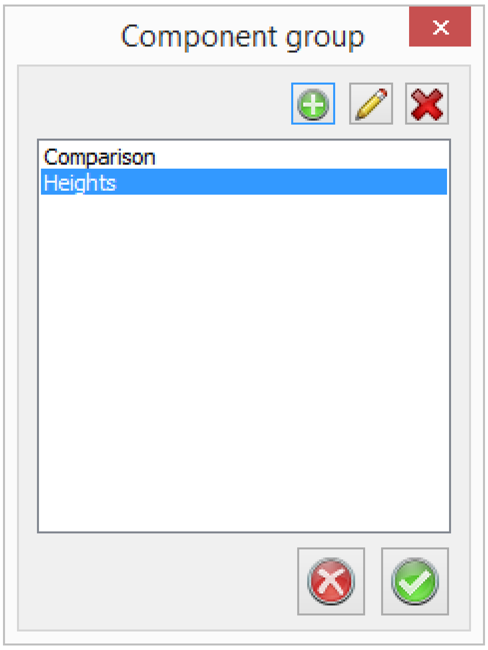
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

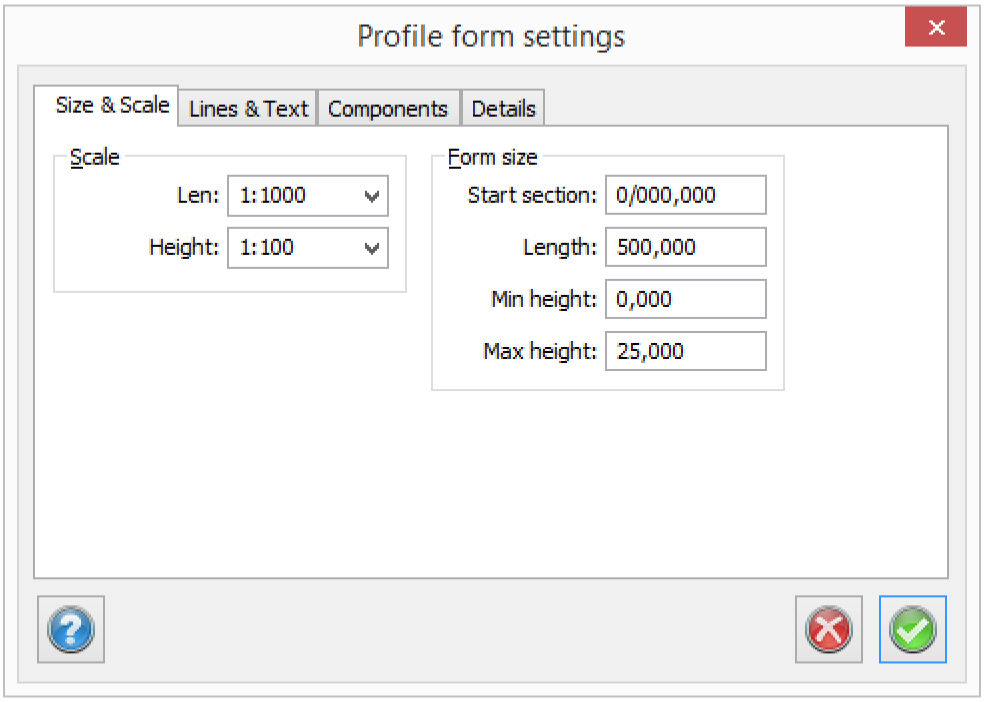
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

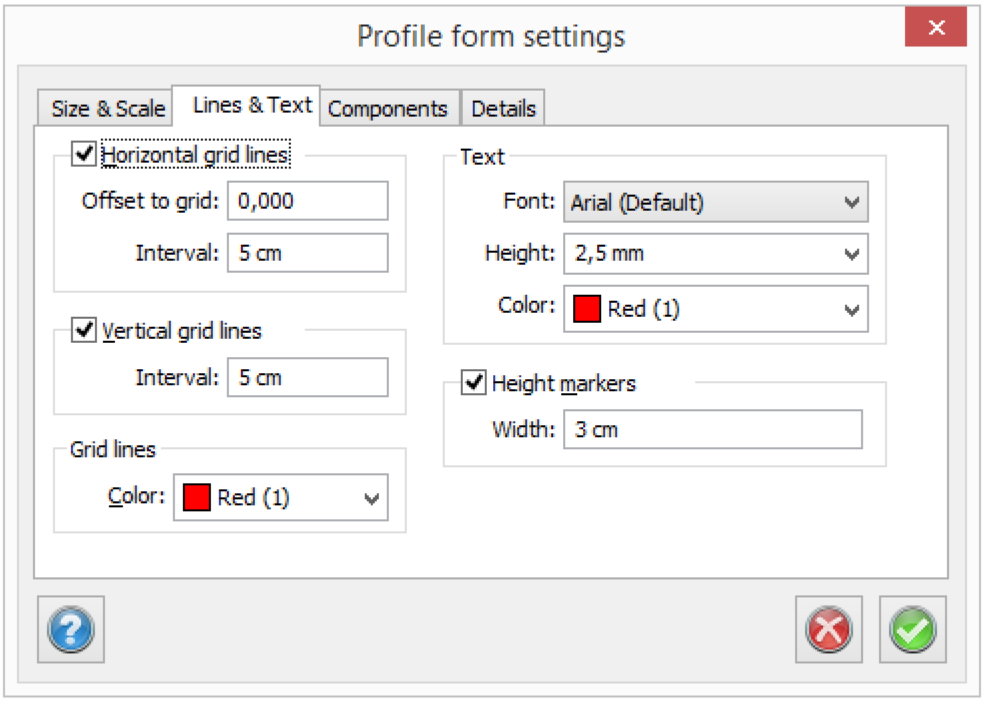


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

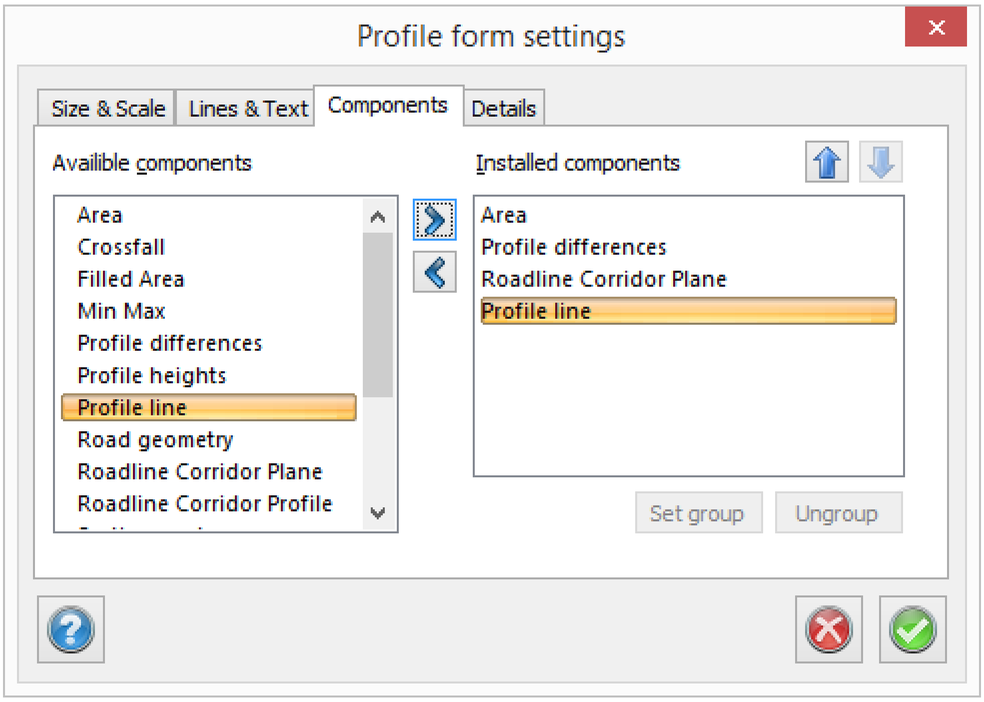
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

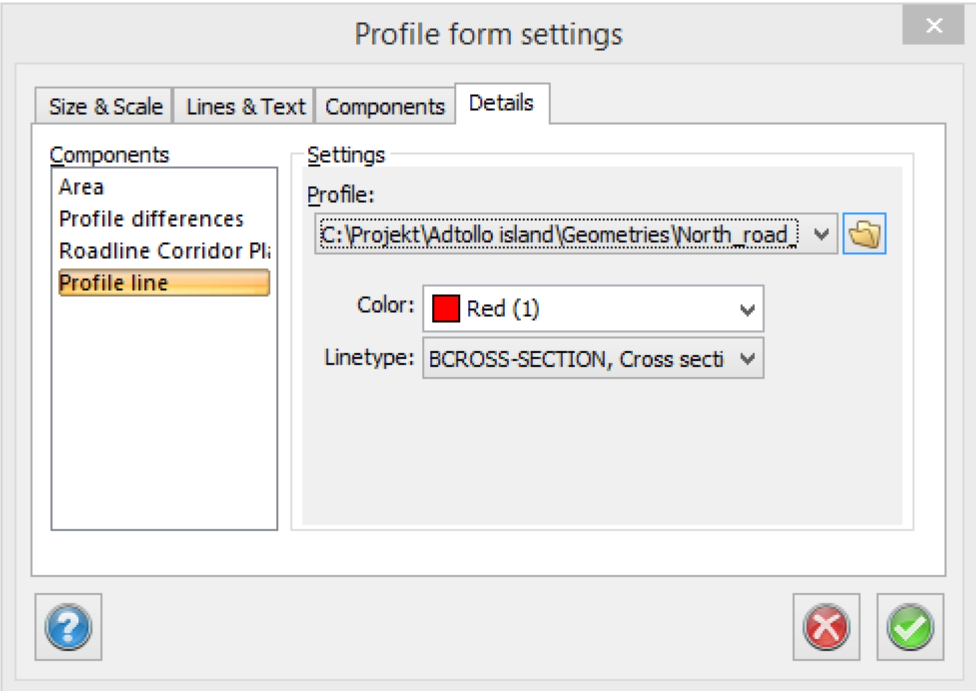
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



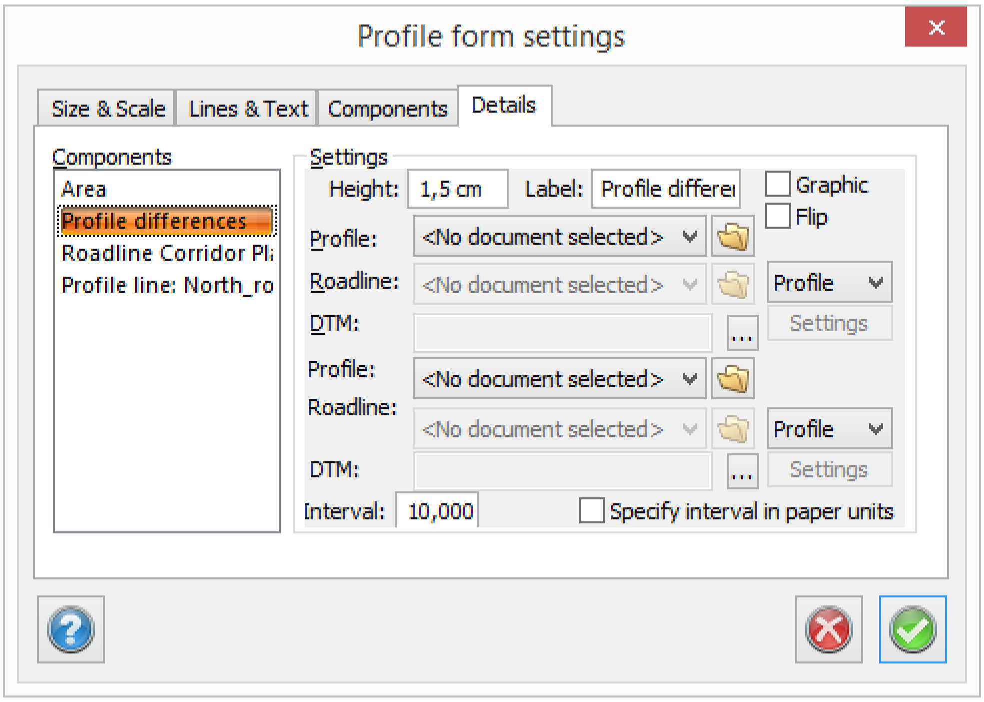
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

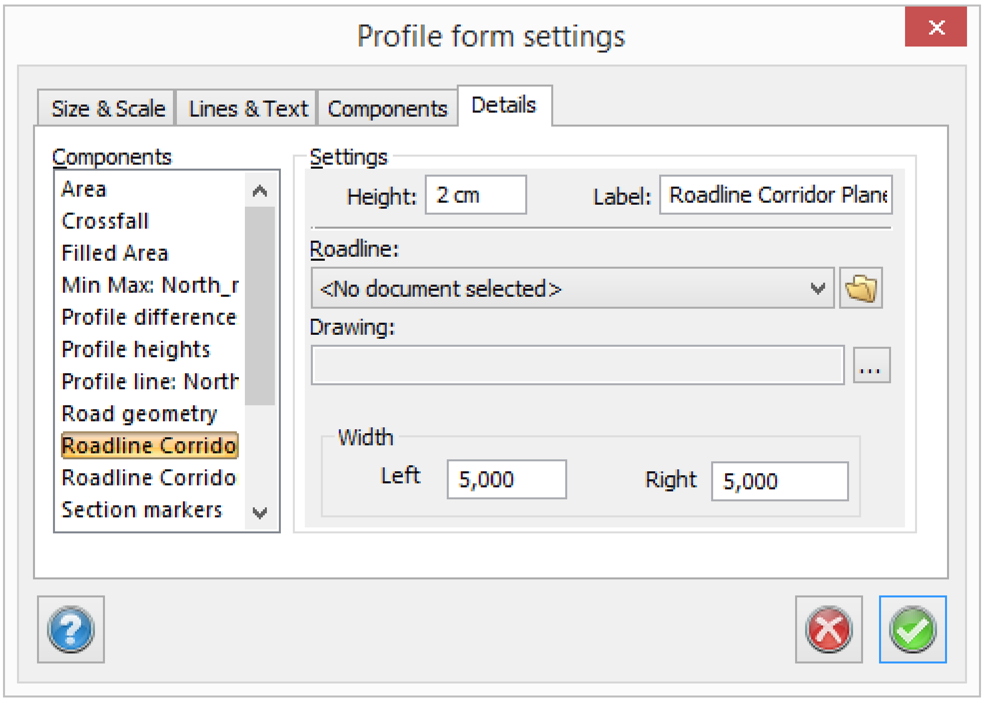
It is possible to display several different road profiles in the form.

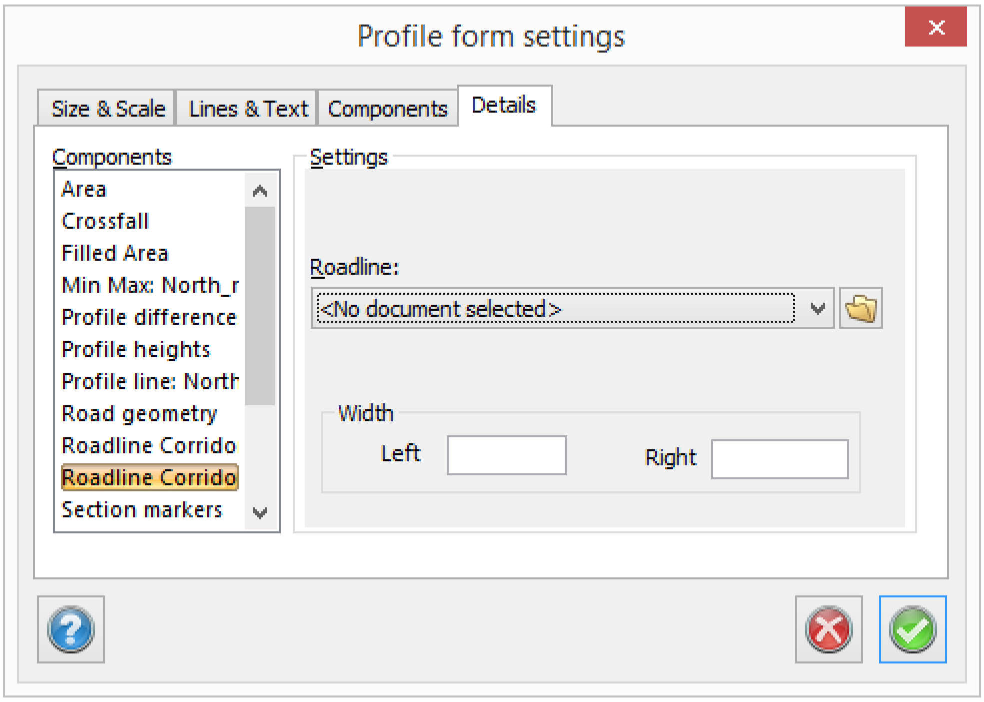
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



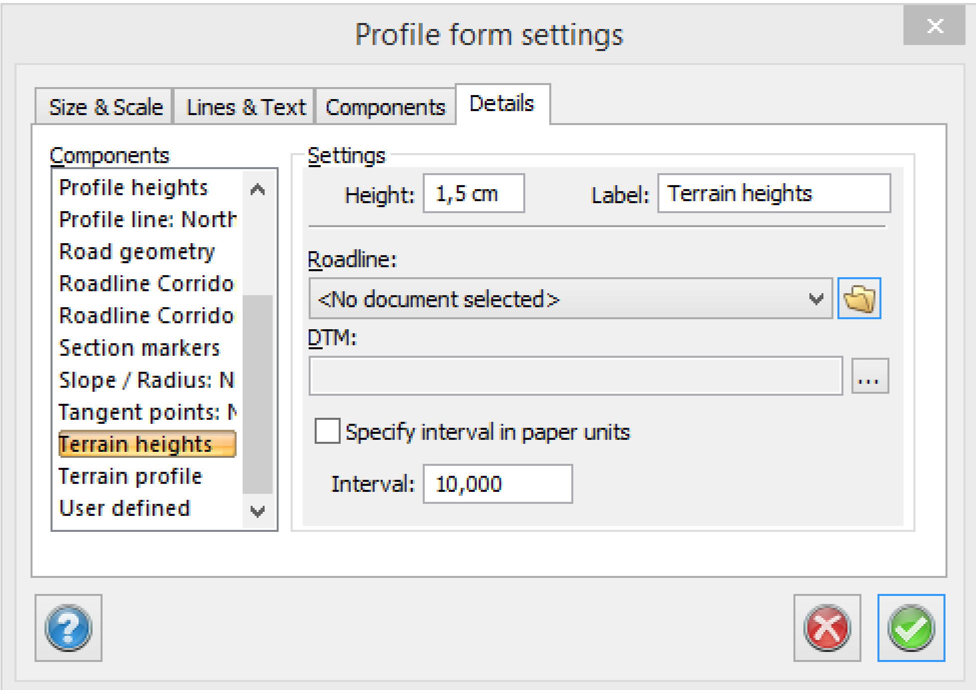
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

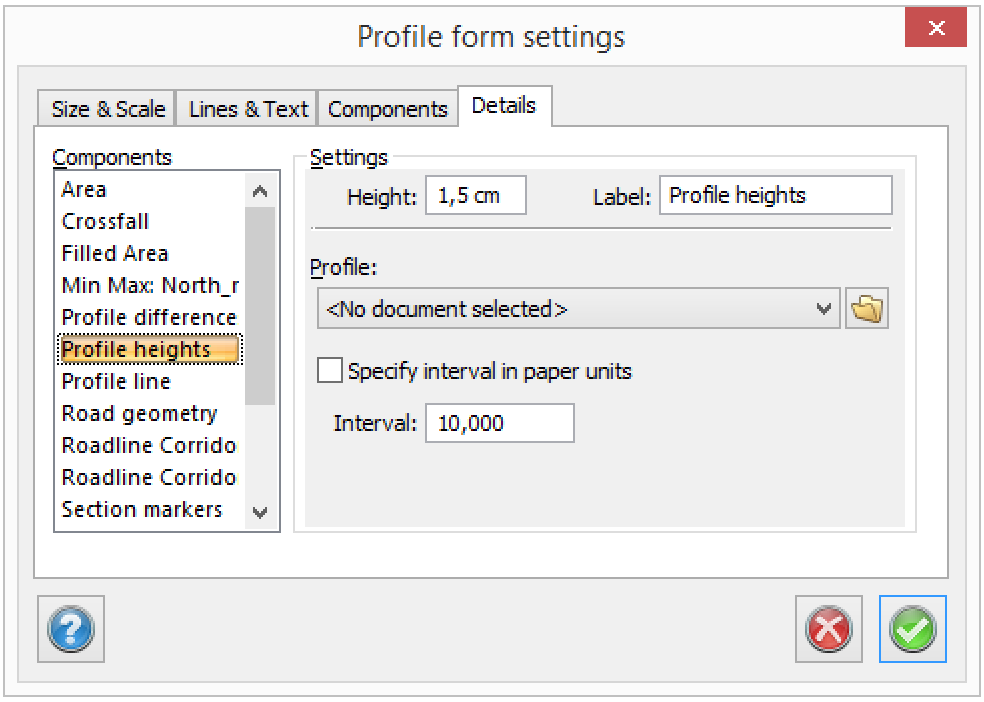
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

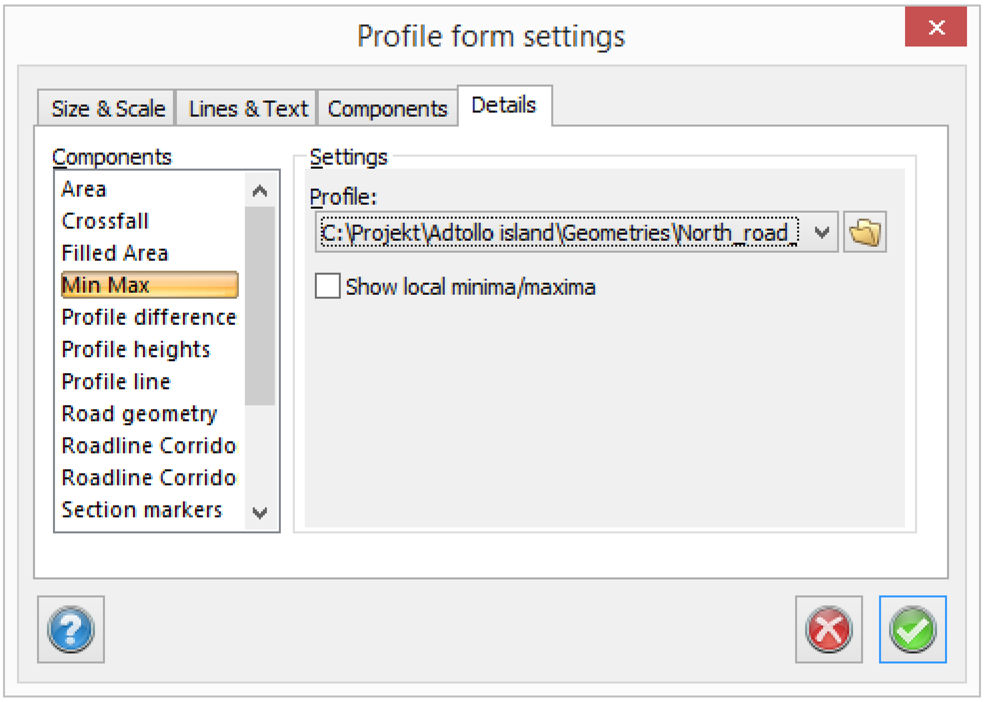
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

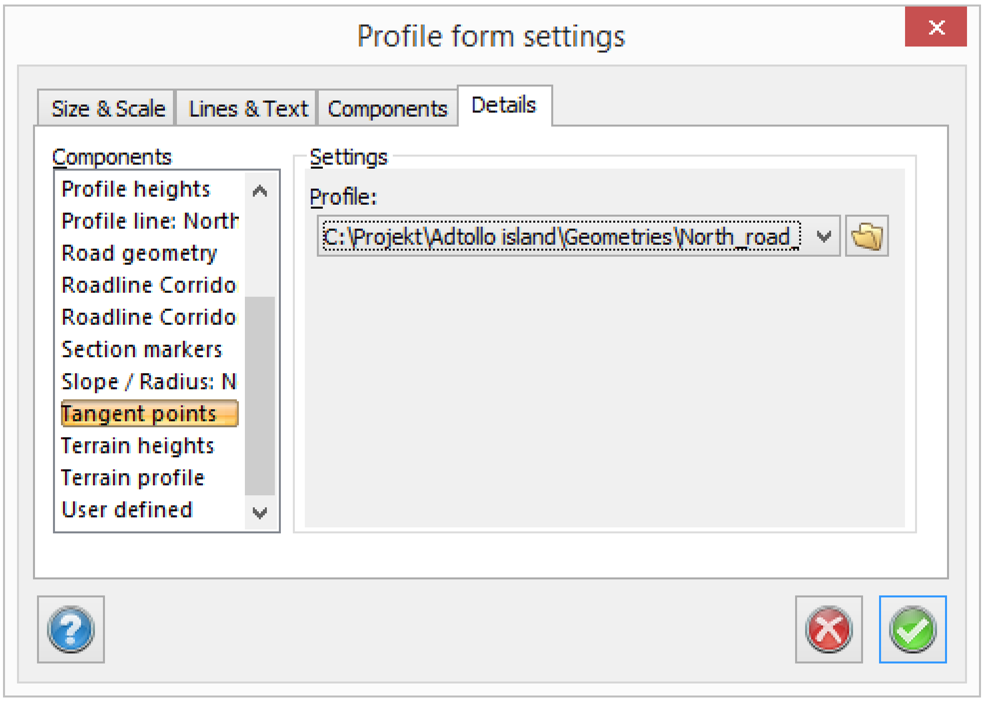
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

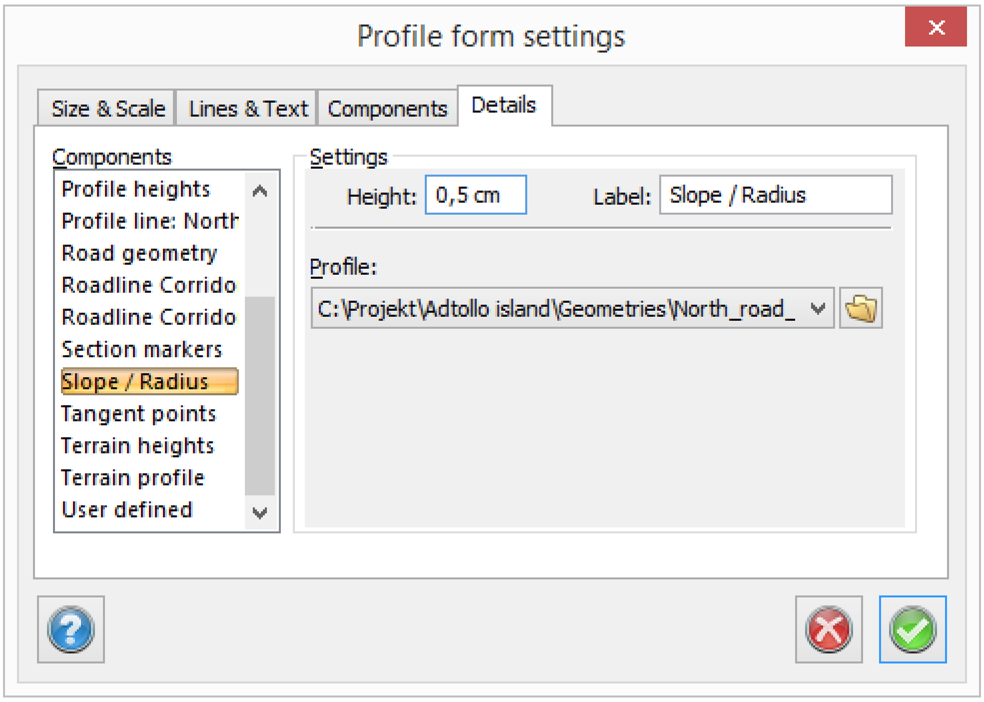
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

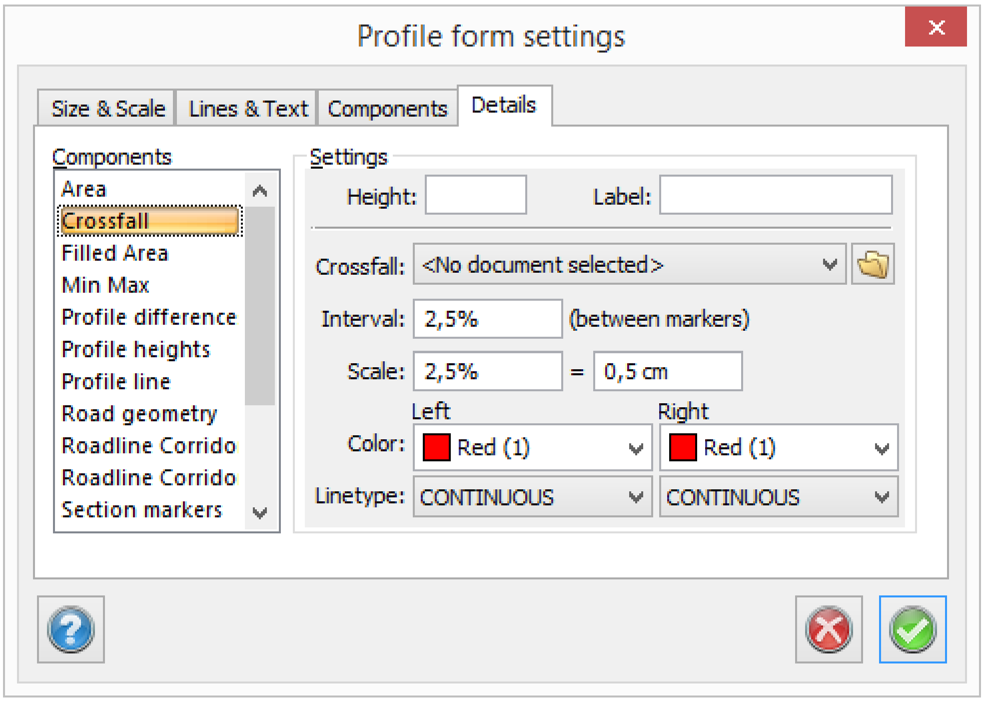
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

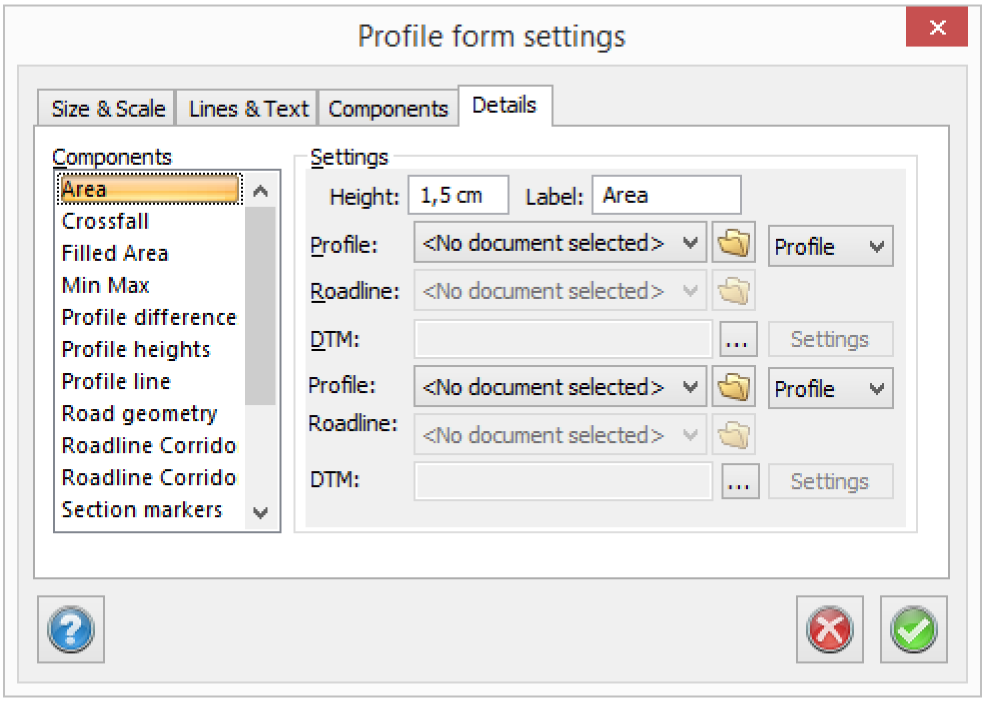
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.



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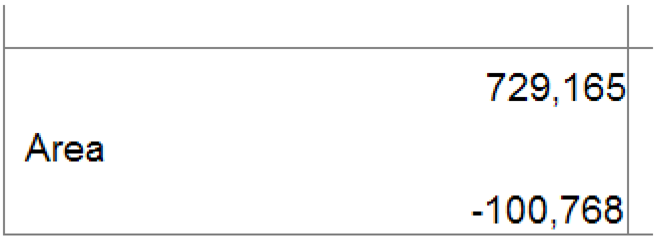
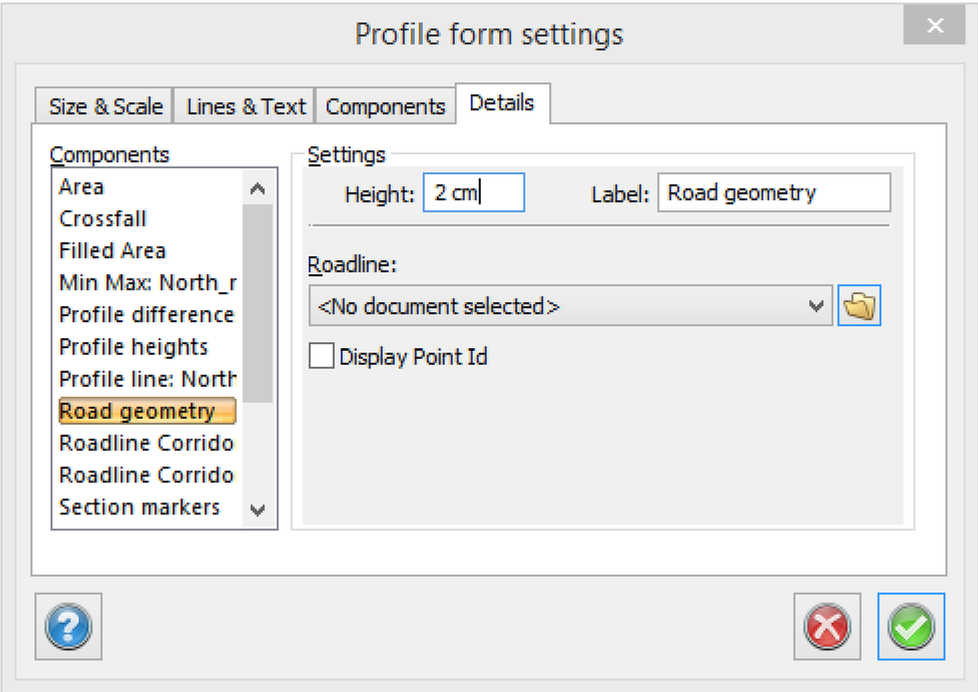


Example of a profile form with an area component inserted.

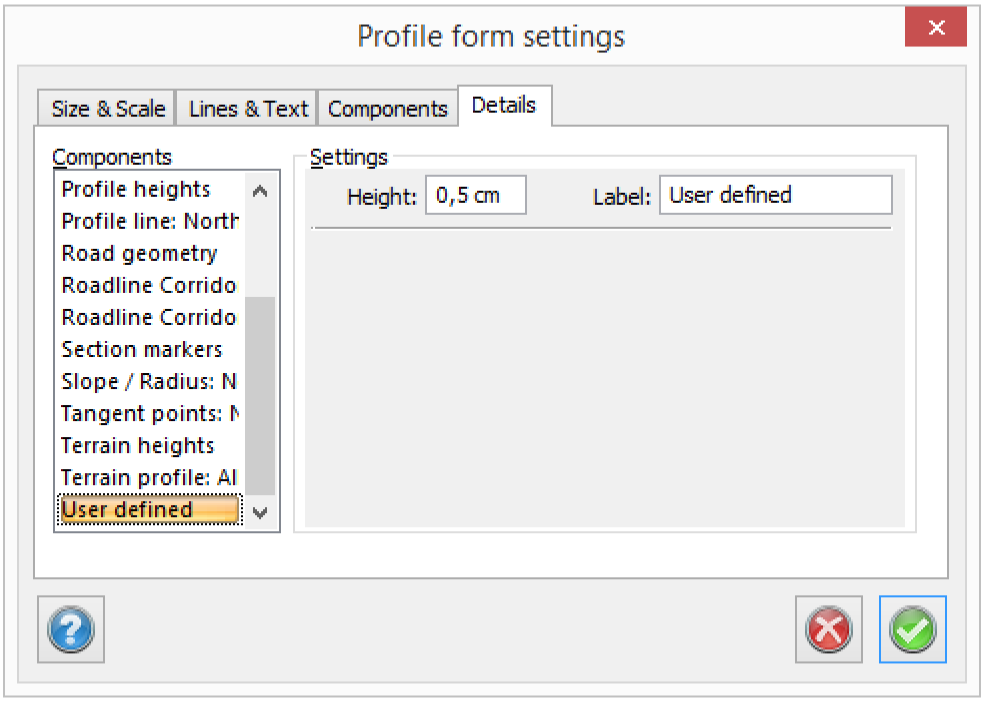
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



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Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

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Deletes the selected tangent point.

Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

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The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

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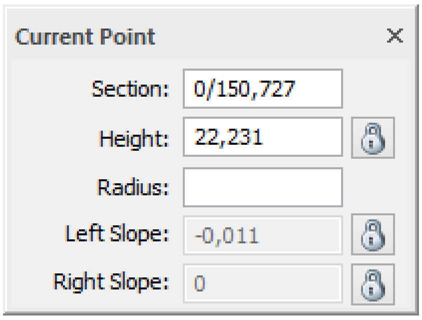
Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

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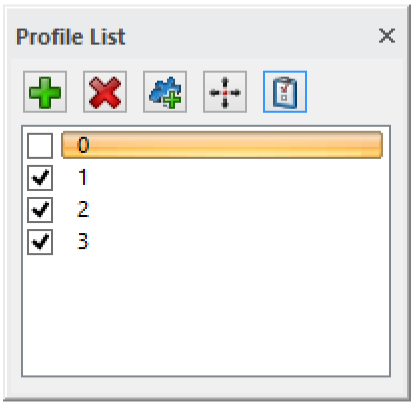

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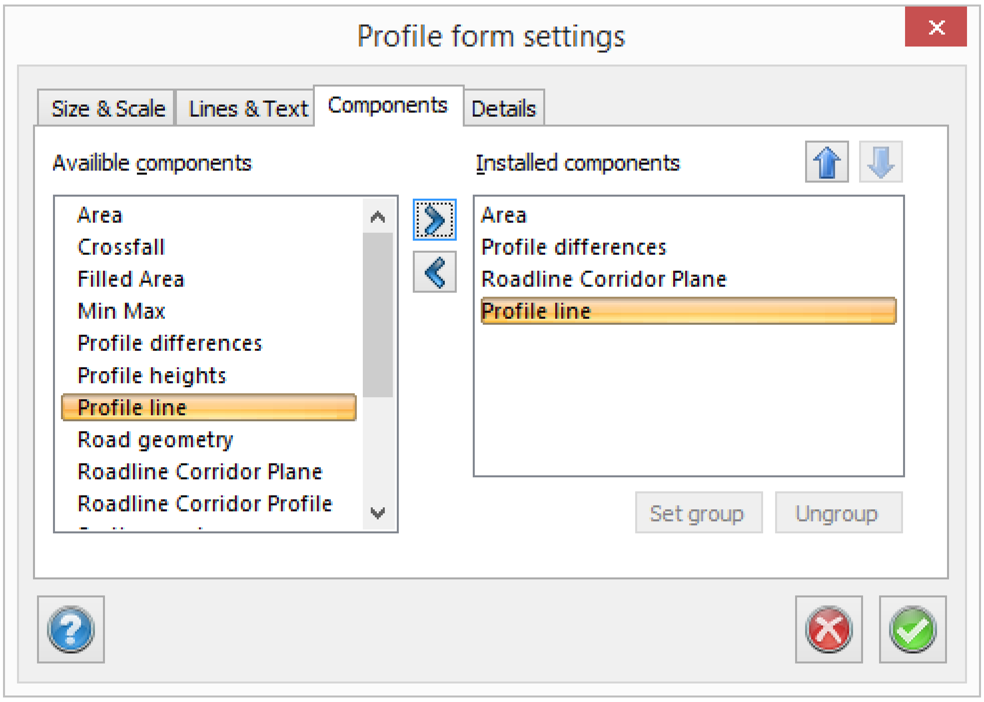
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



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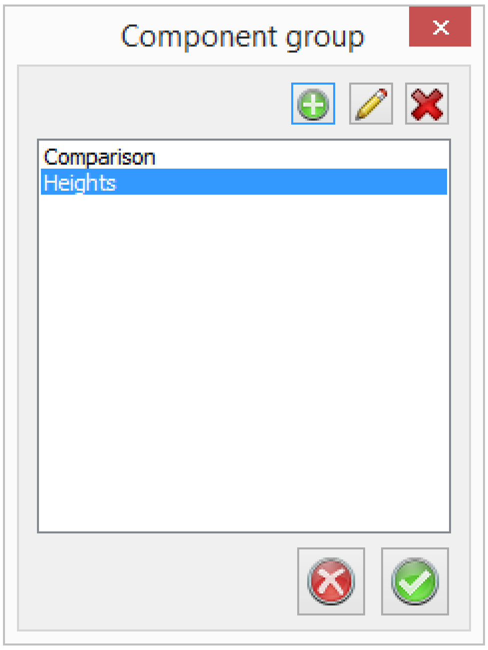

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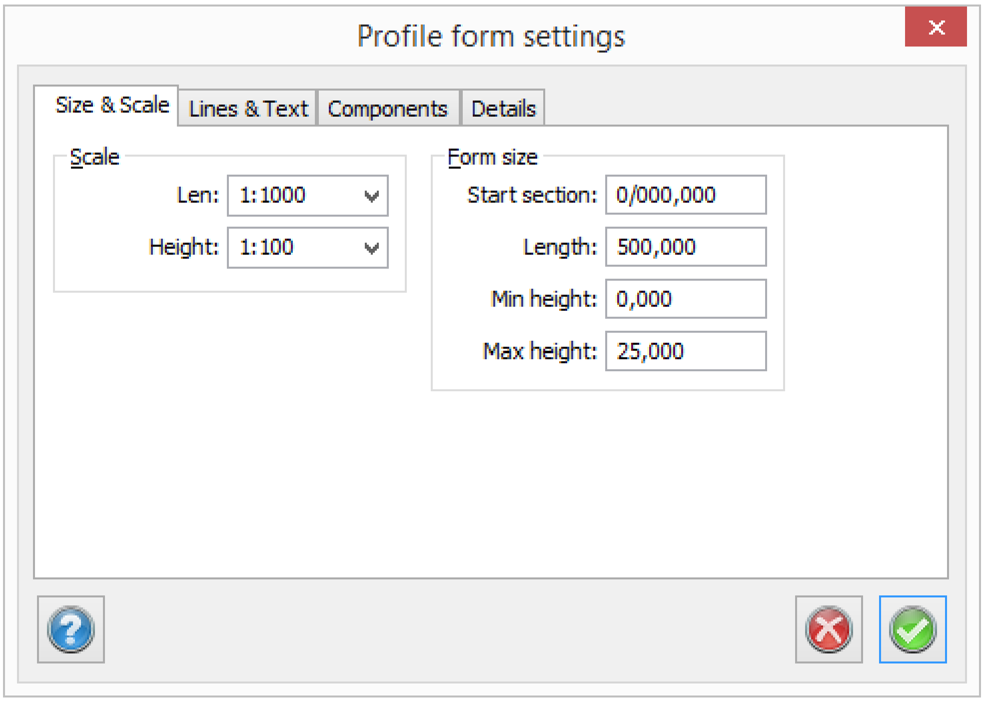
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

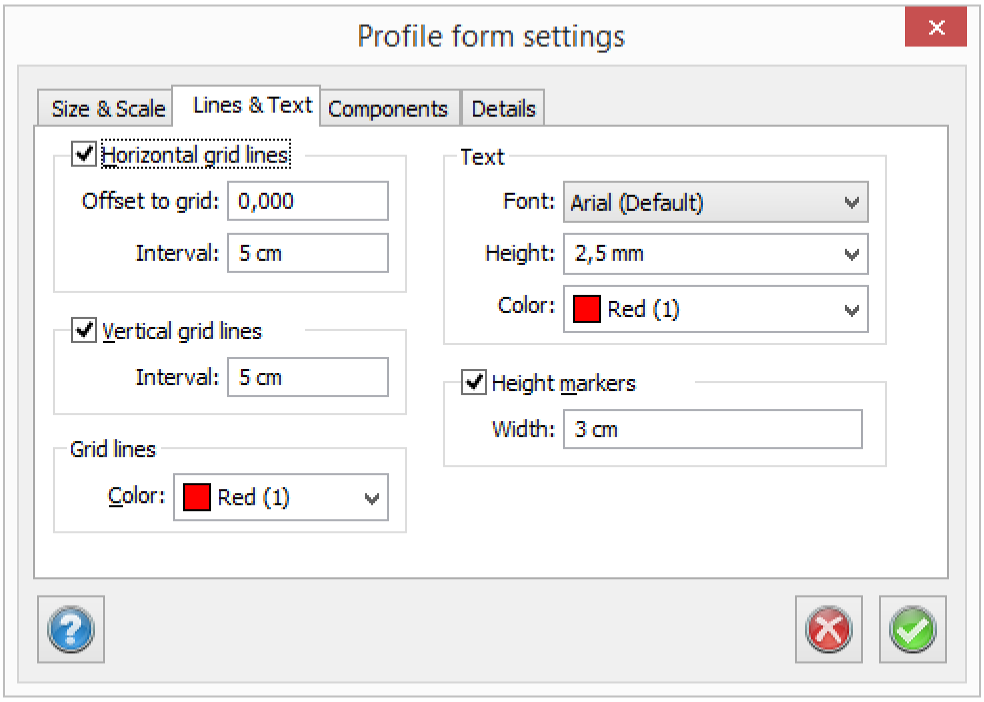


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

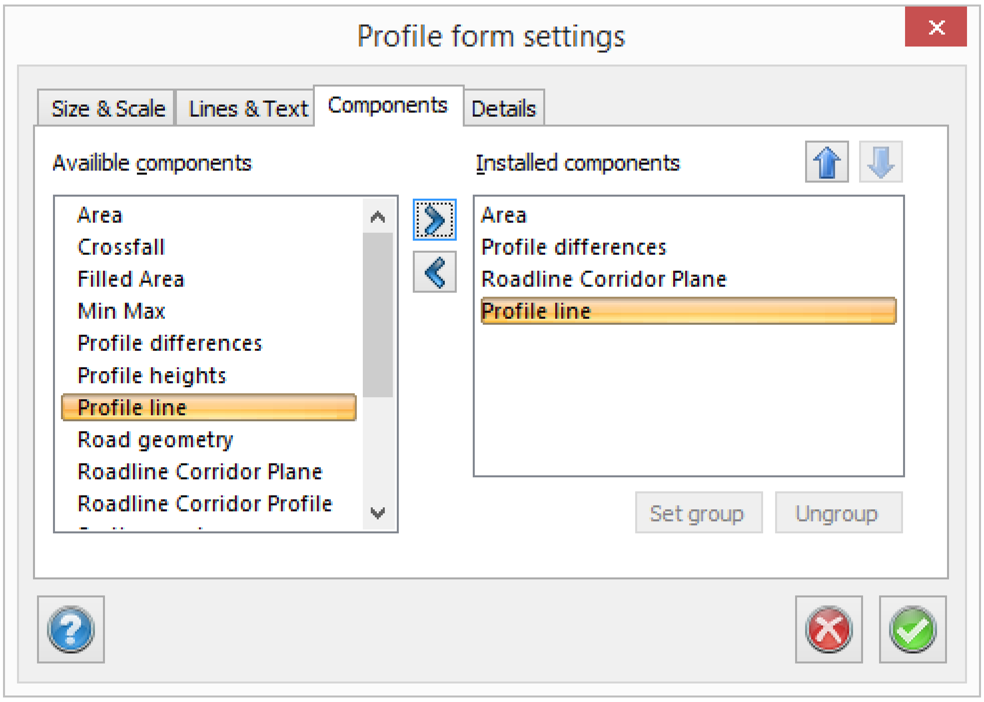
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

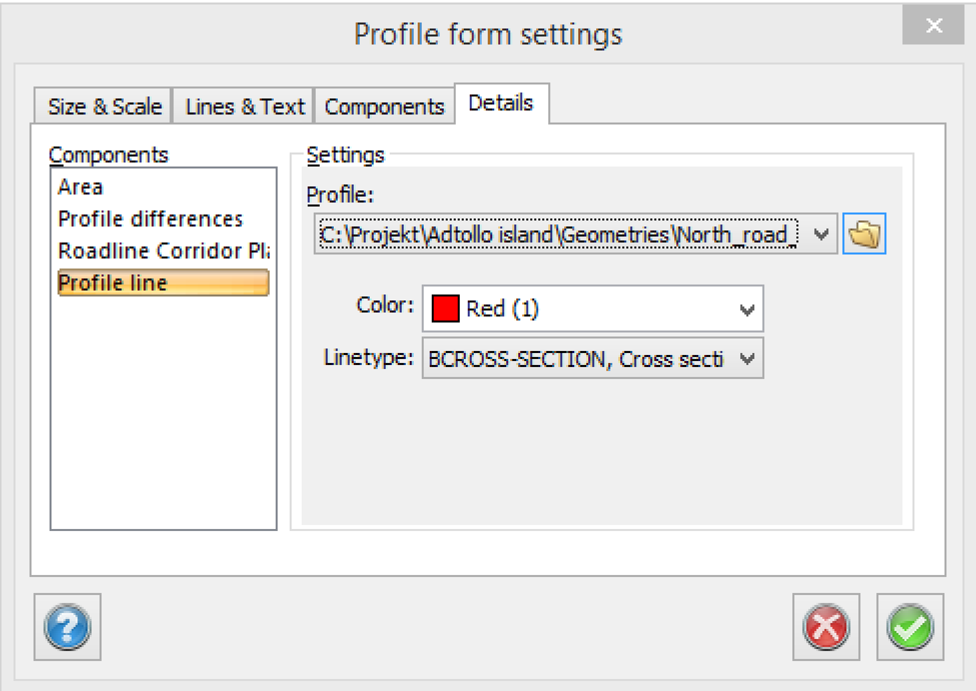
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



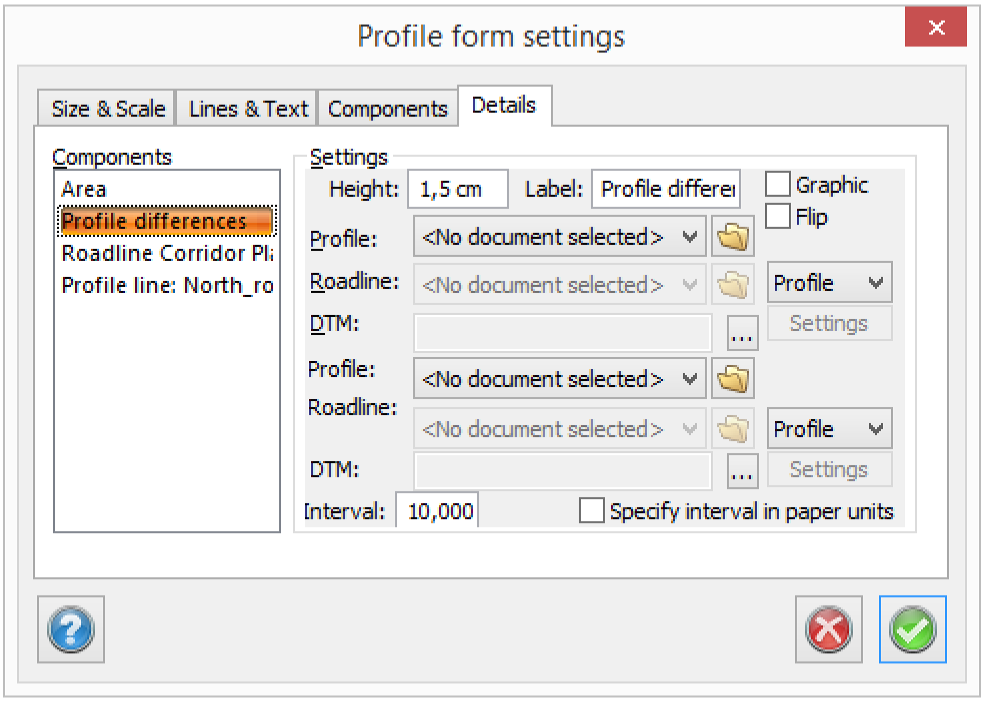
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

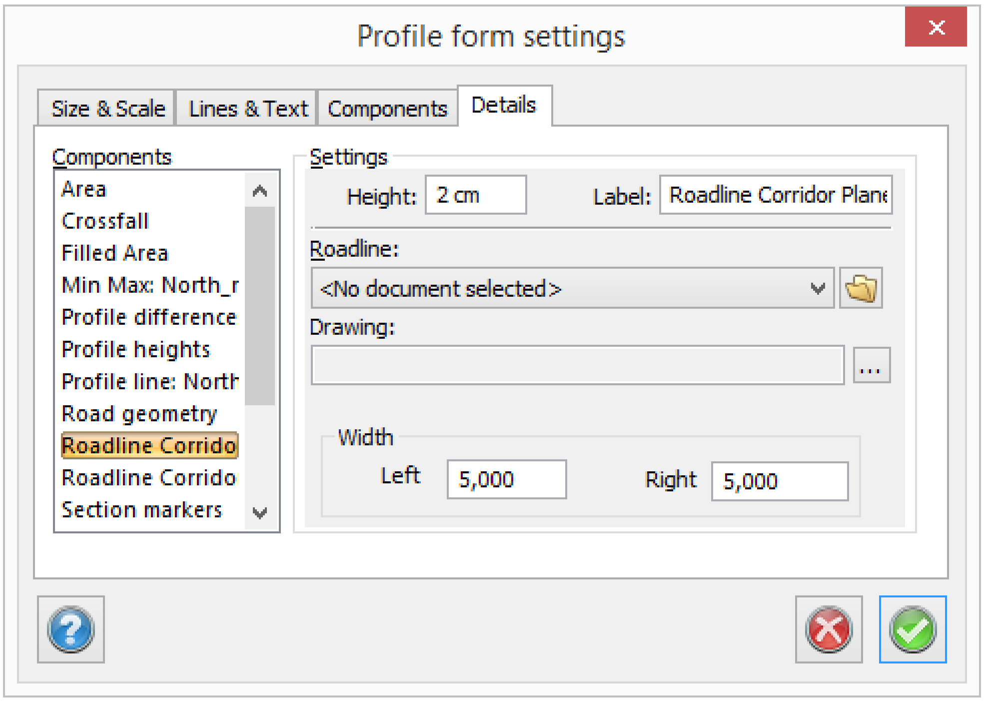
It is possible to display several different road profiles in the form.

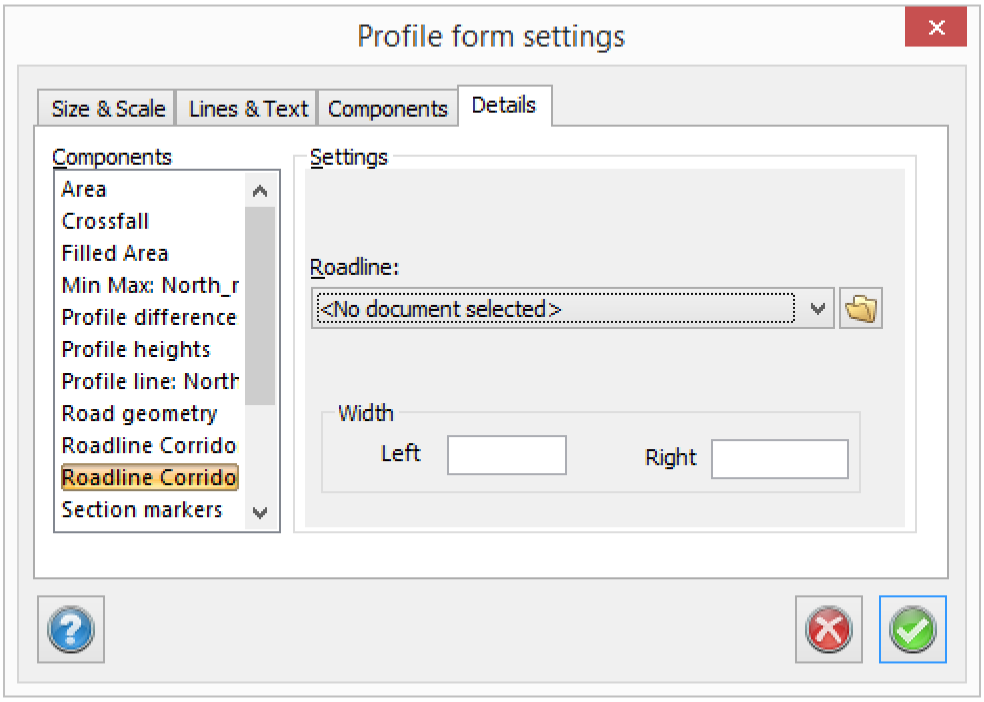
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



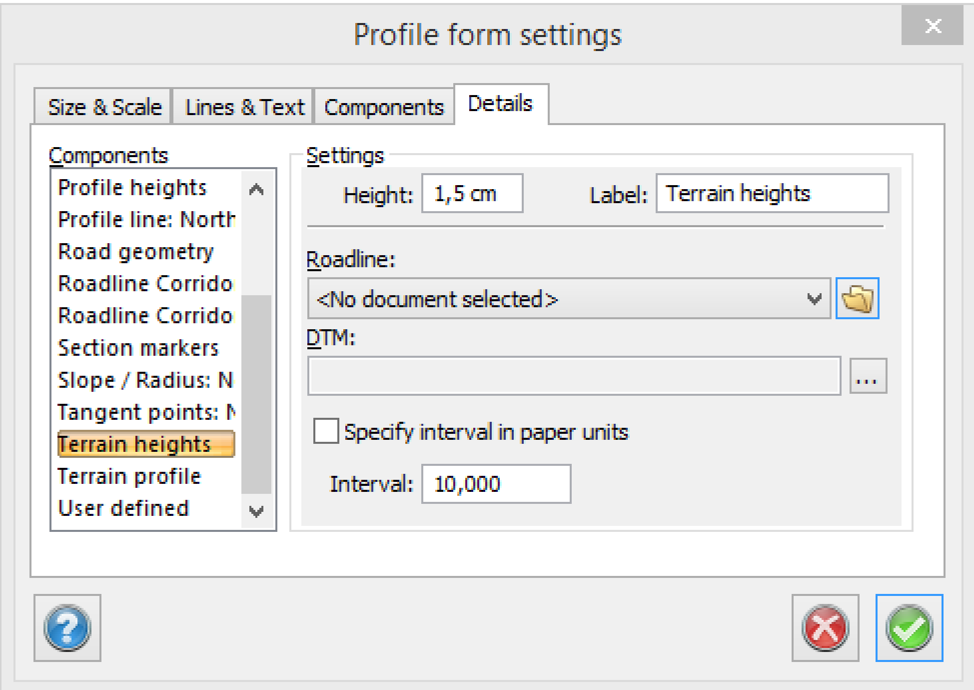
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

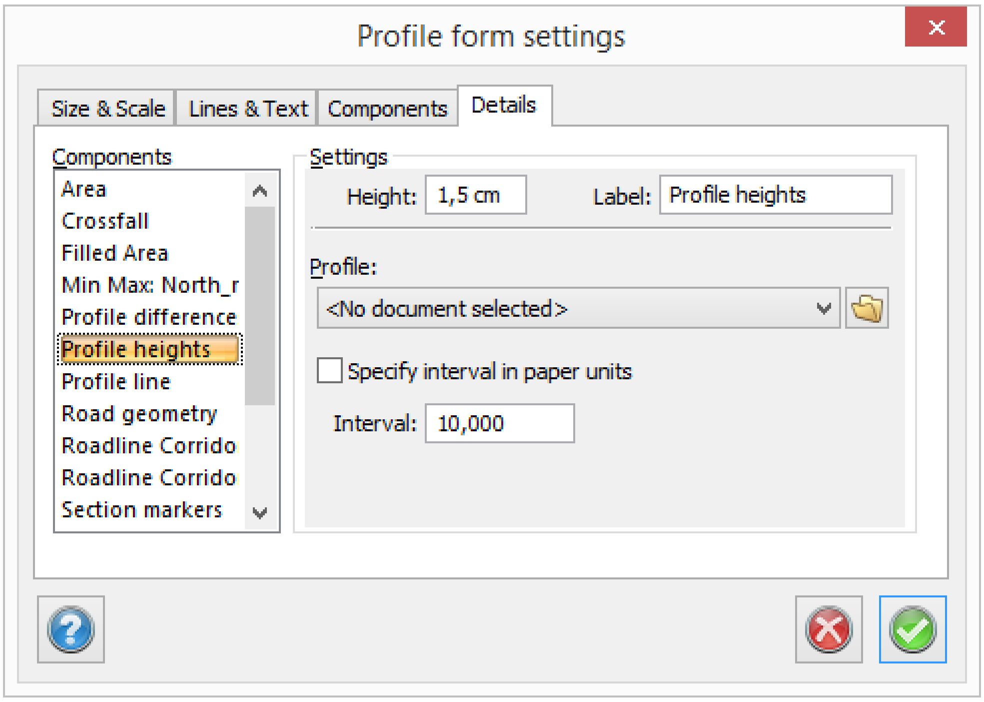
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

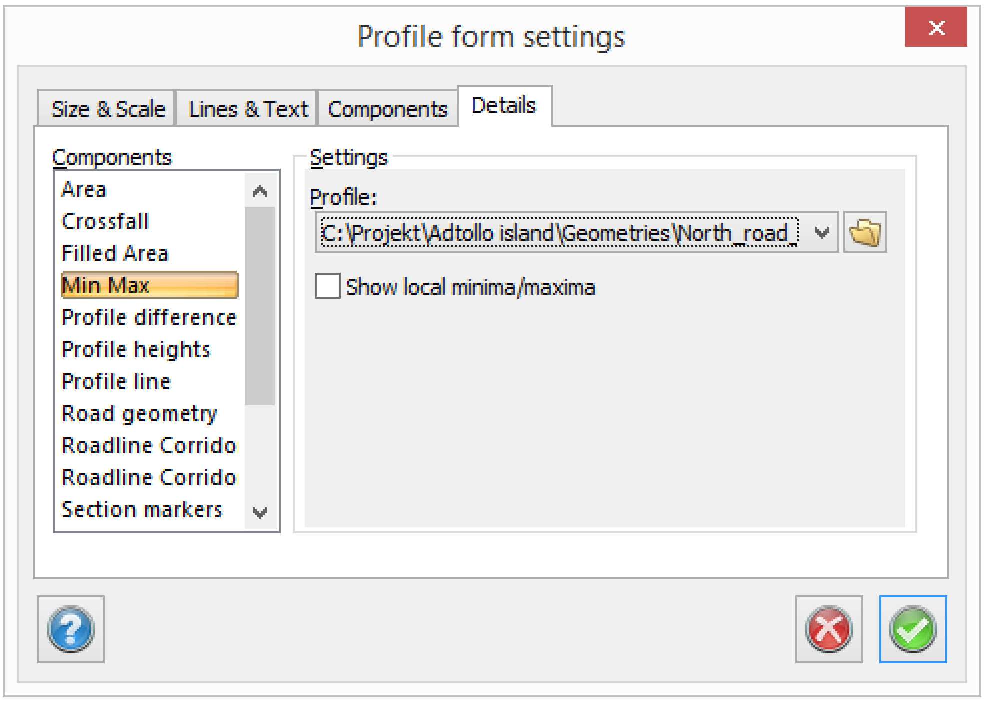
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

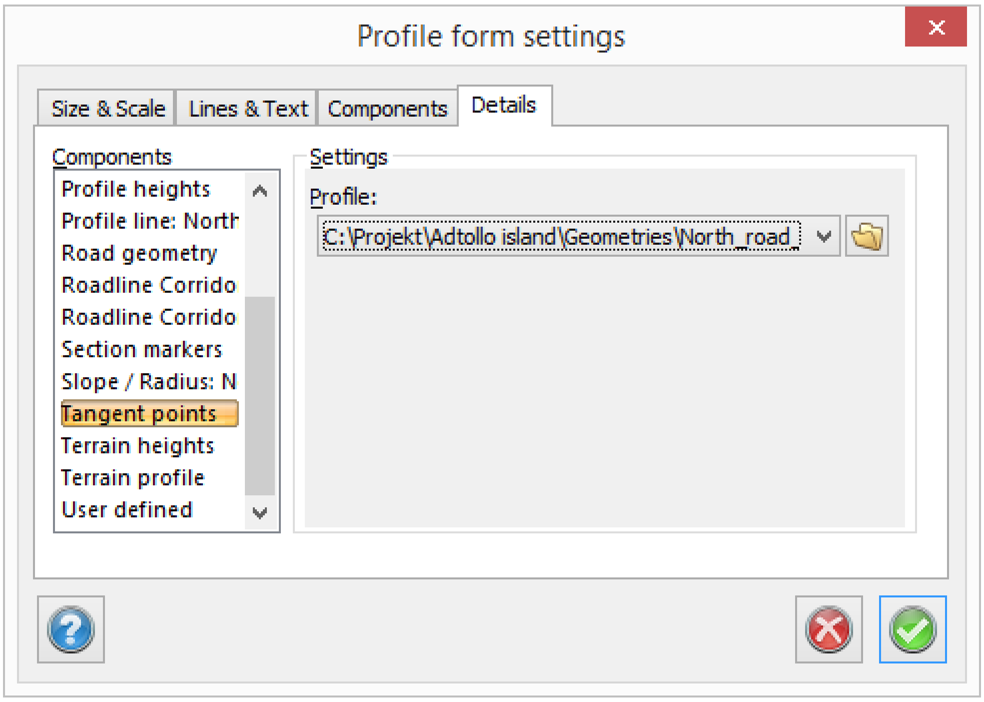
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

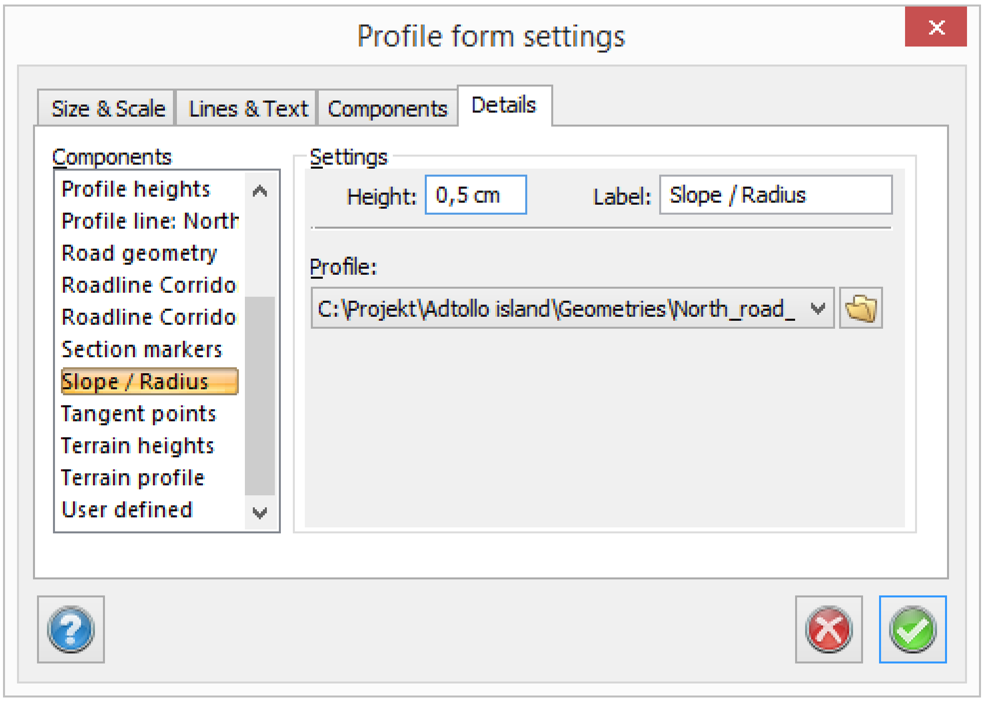
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

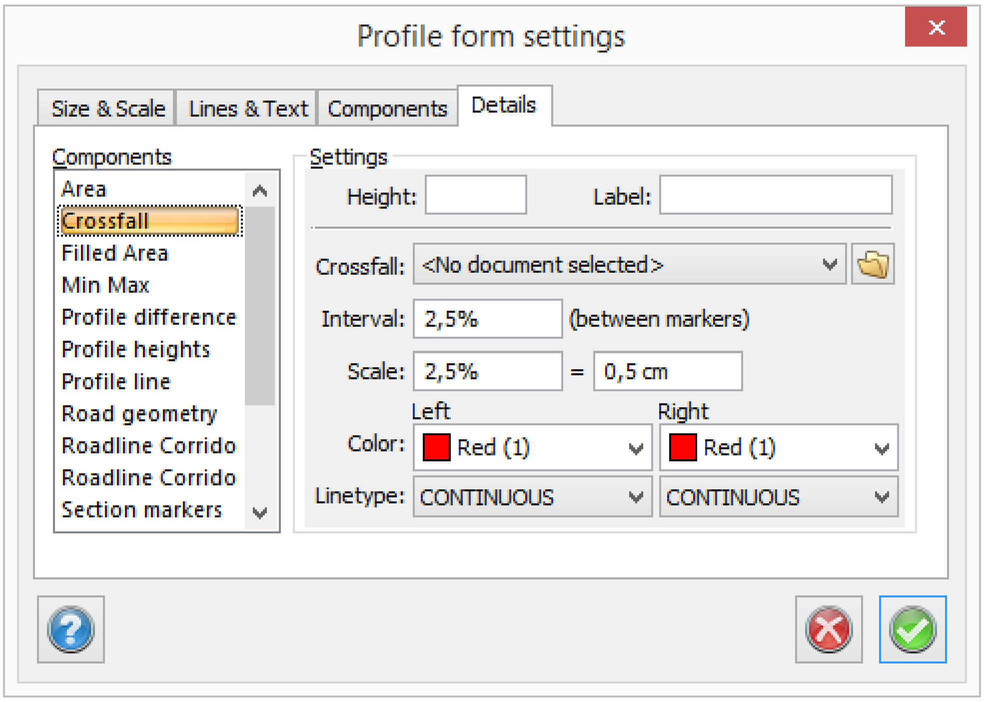
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

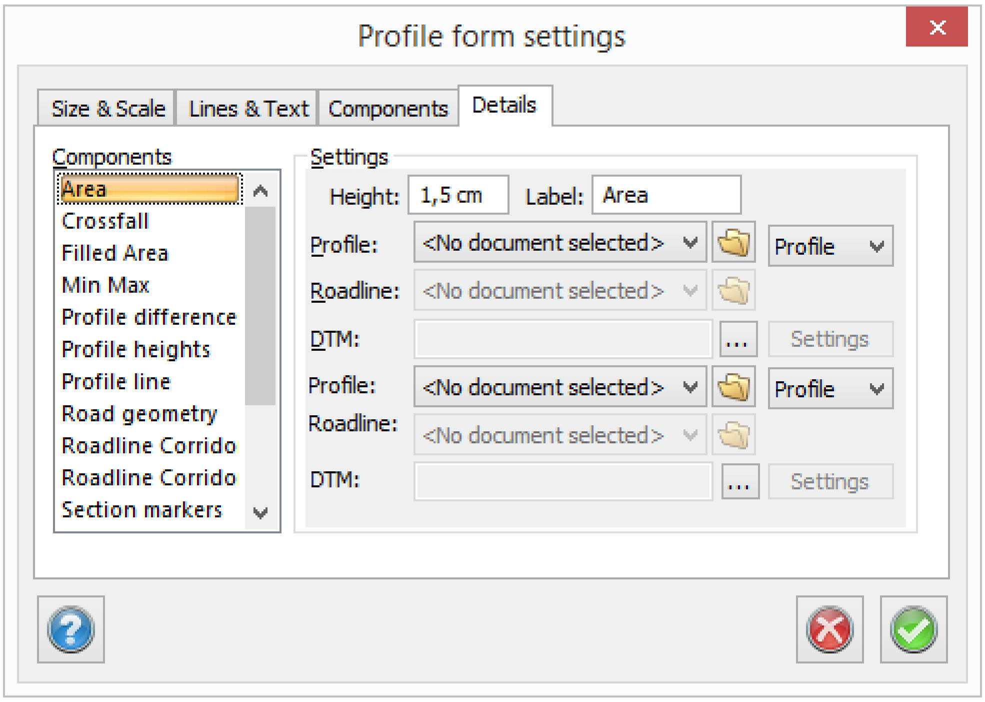
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

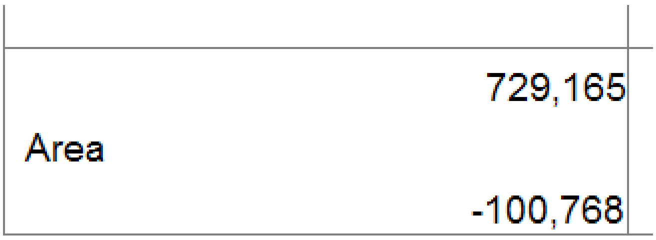
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

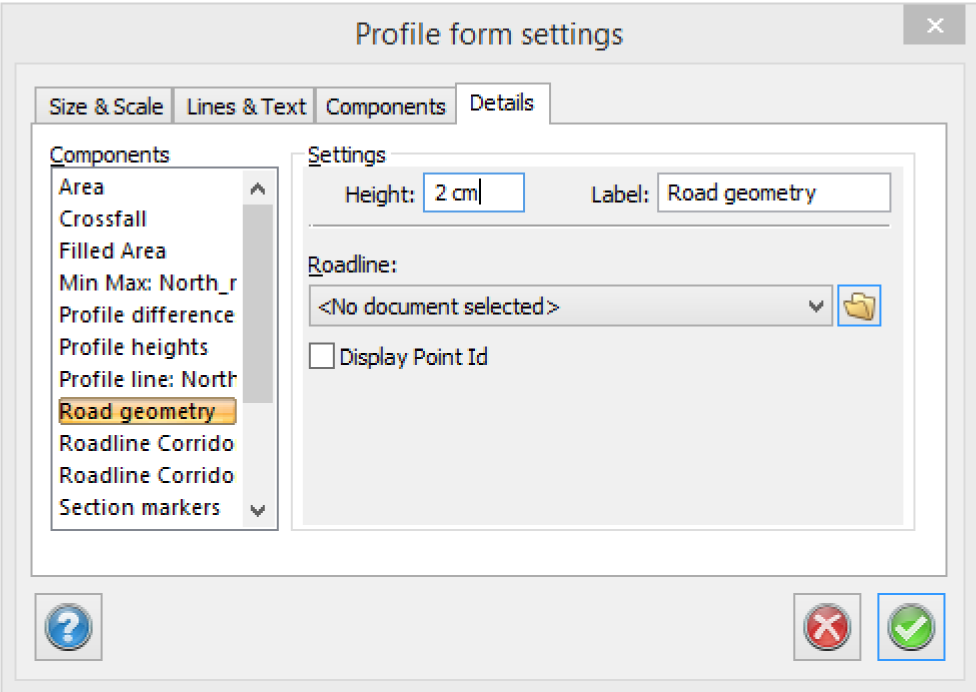


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

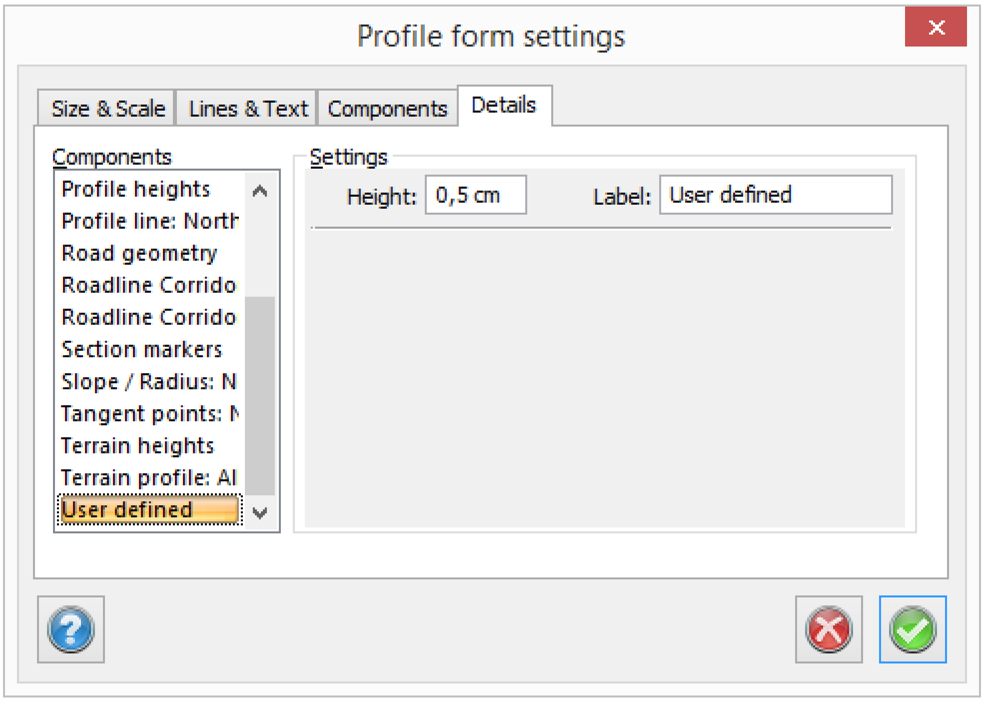
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

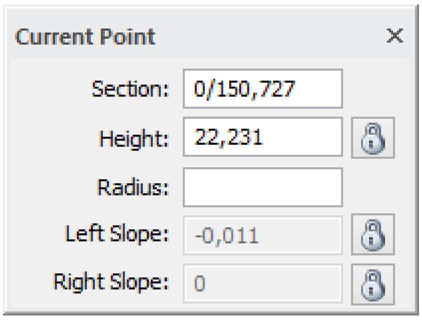
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

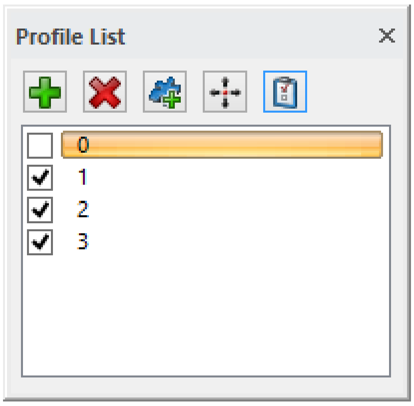
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



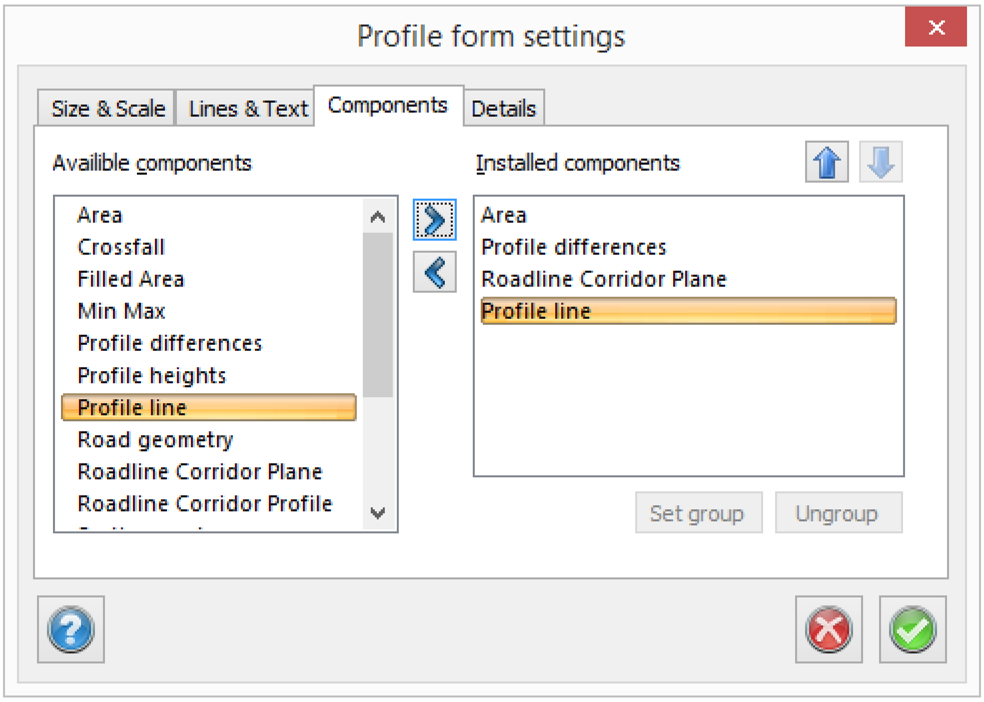
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

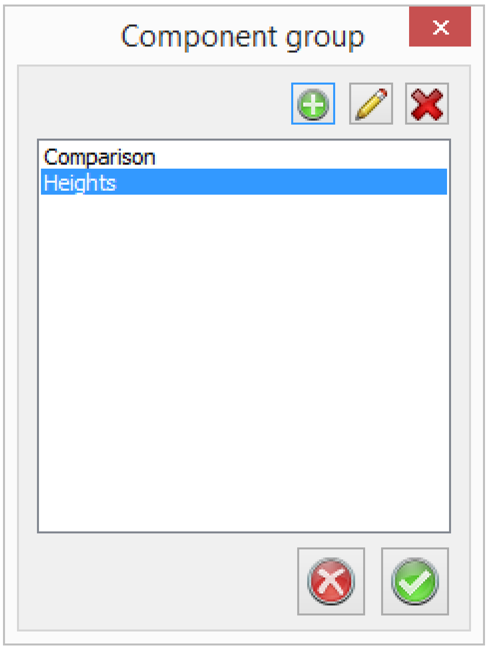
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
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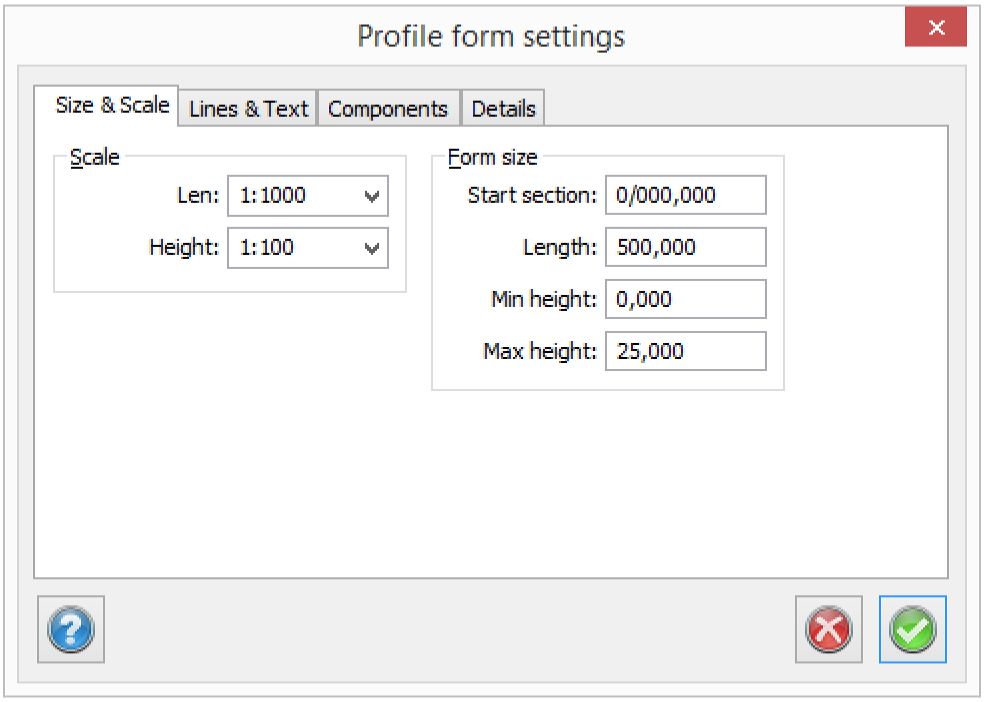
In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

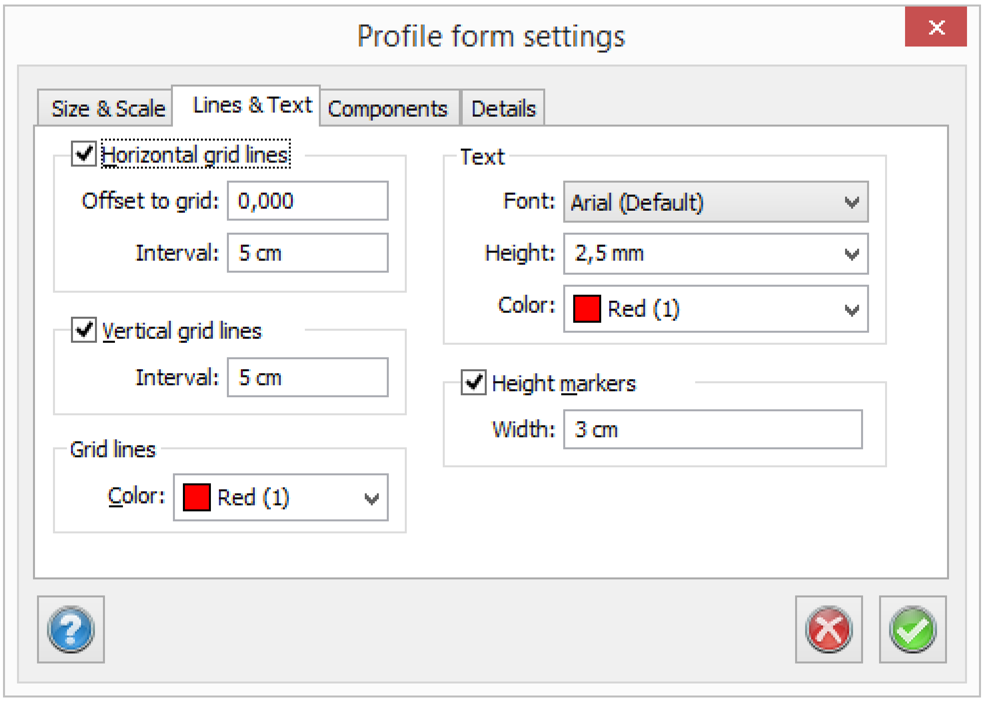


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
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size of the printout.

Vertical grid
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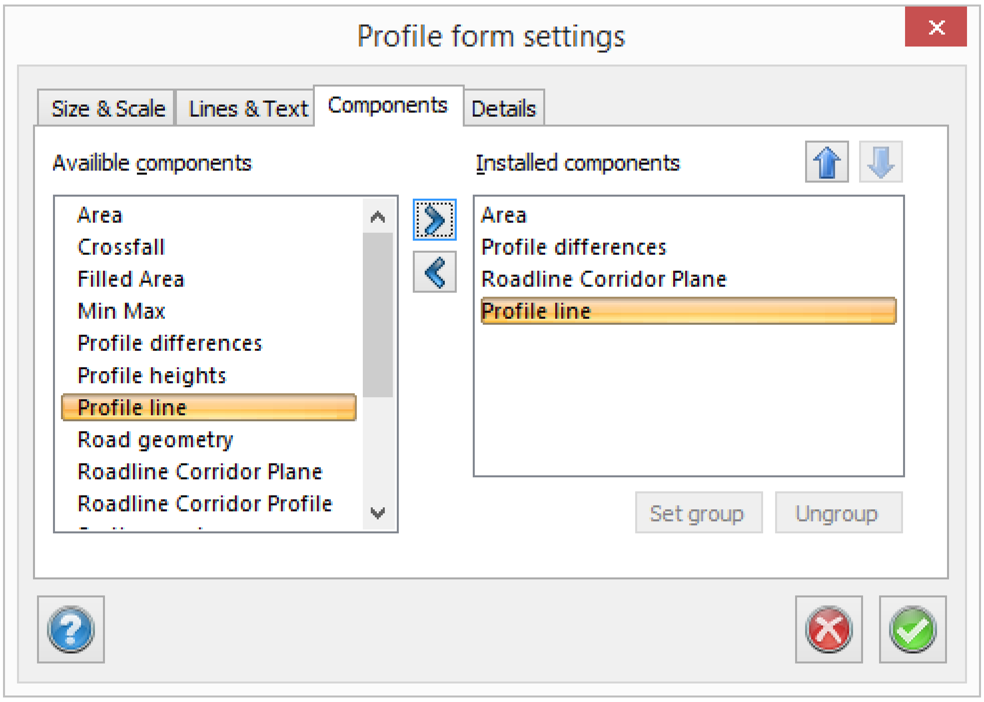
Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



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- Terrain profile
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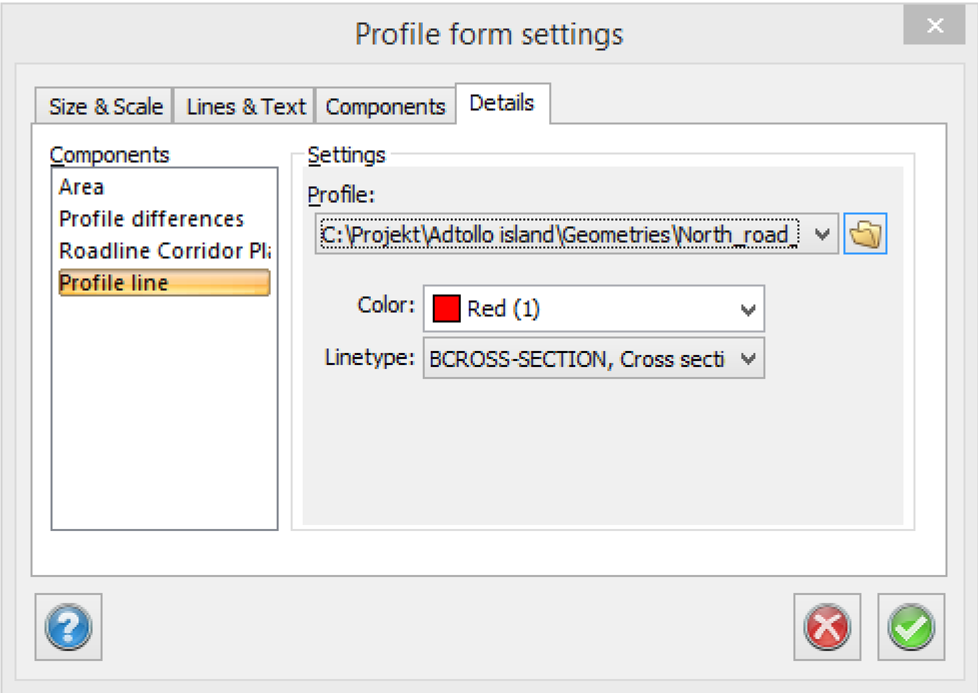
The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



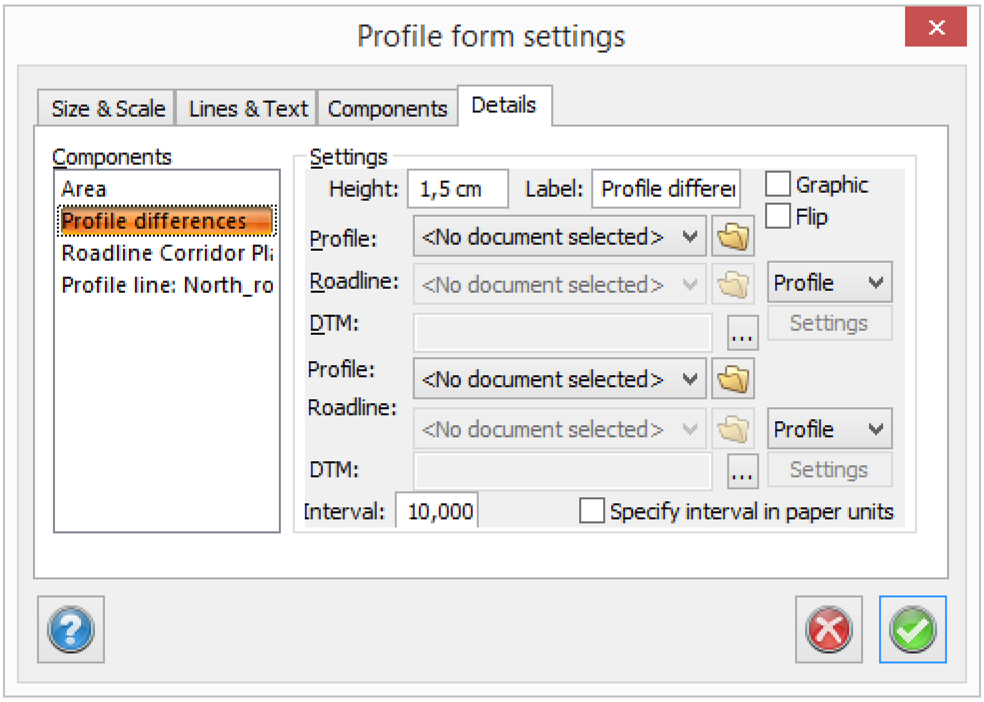
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

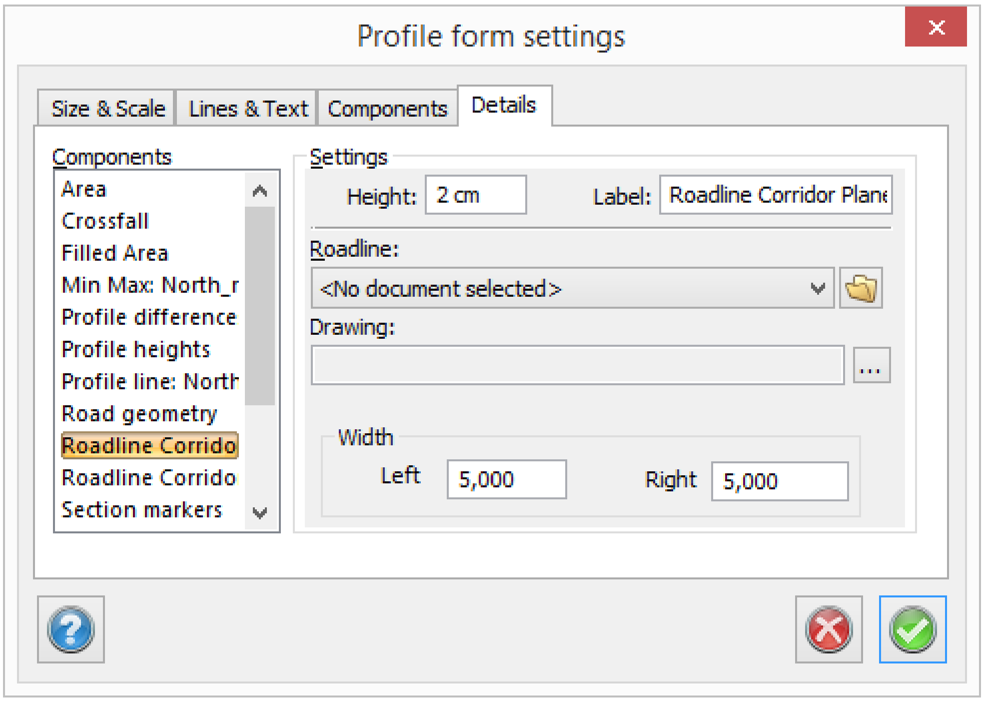
It is possible to display several different road profiles in the form.

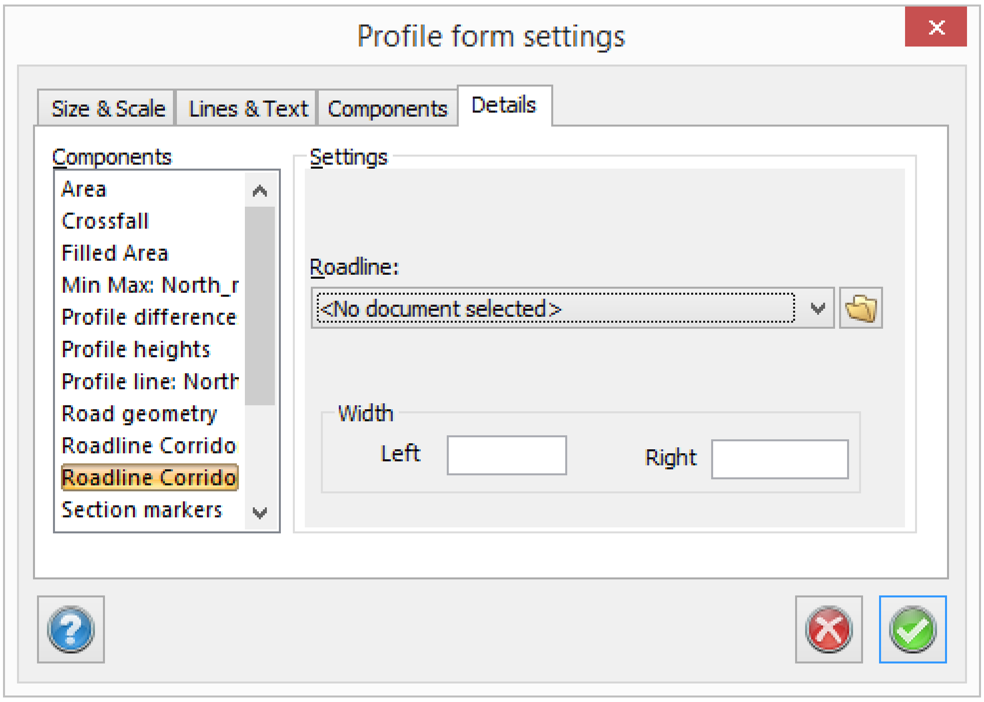
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



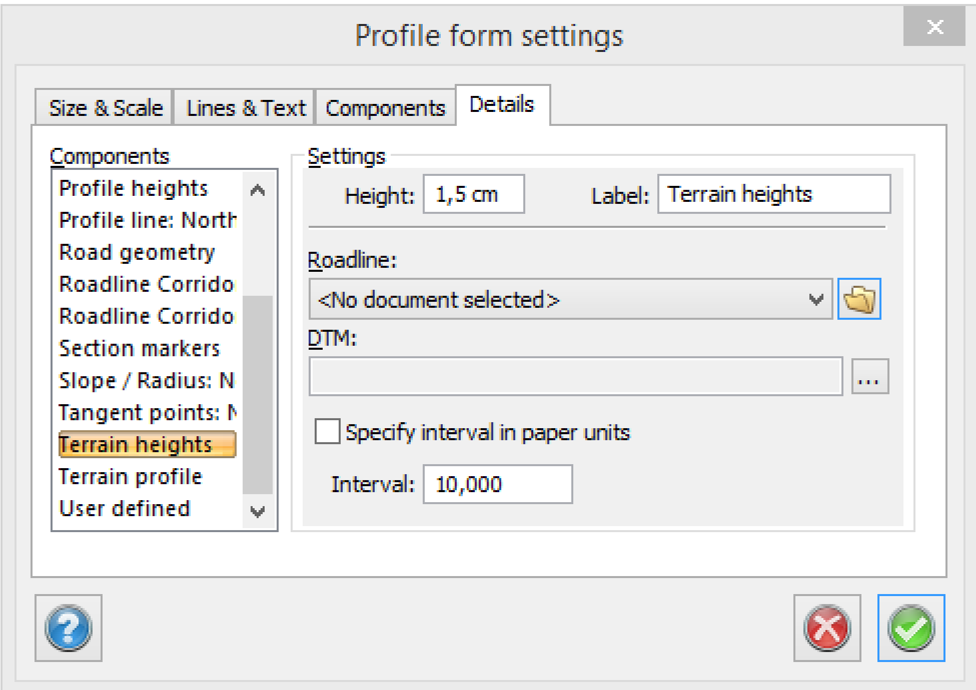
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

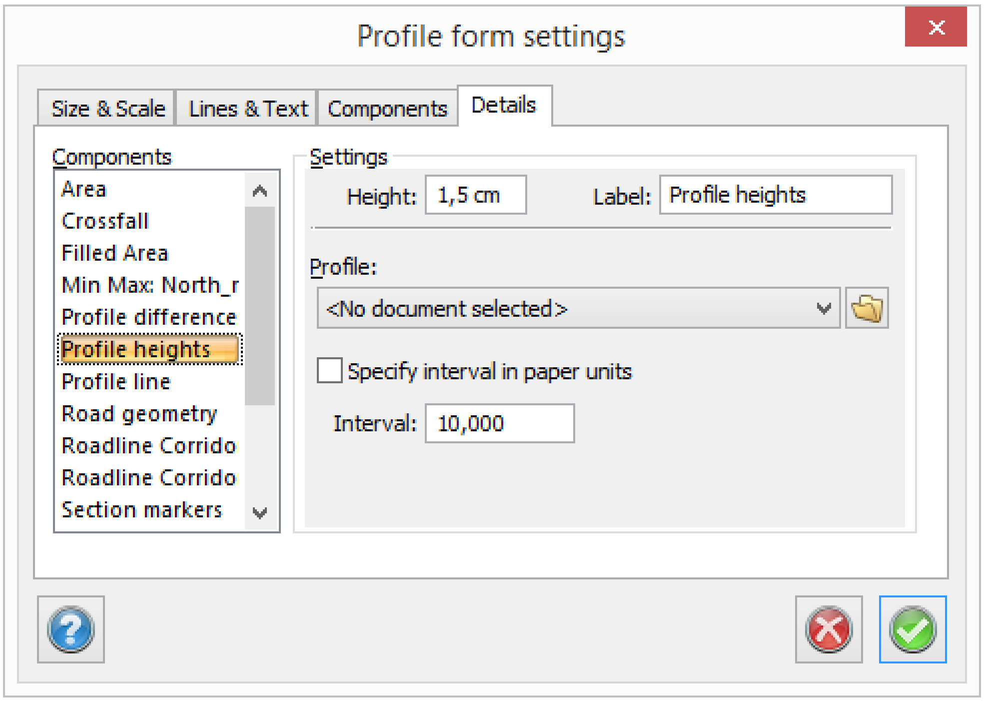
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

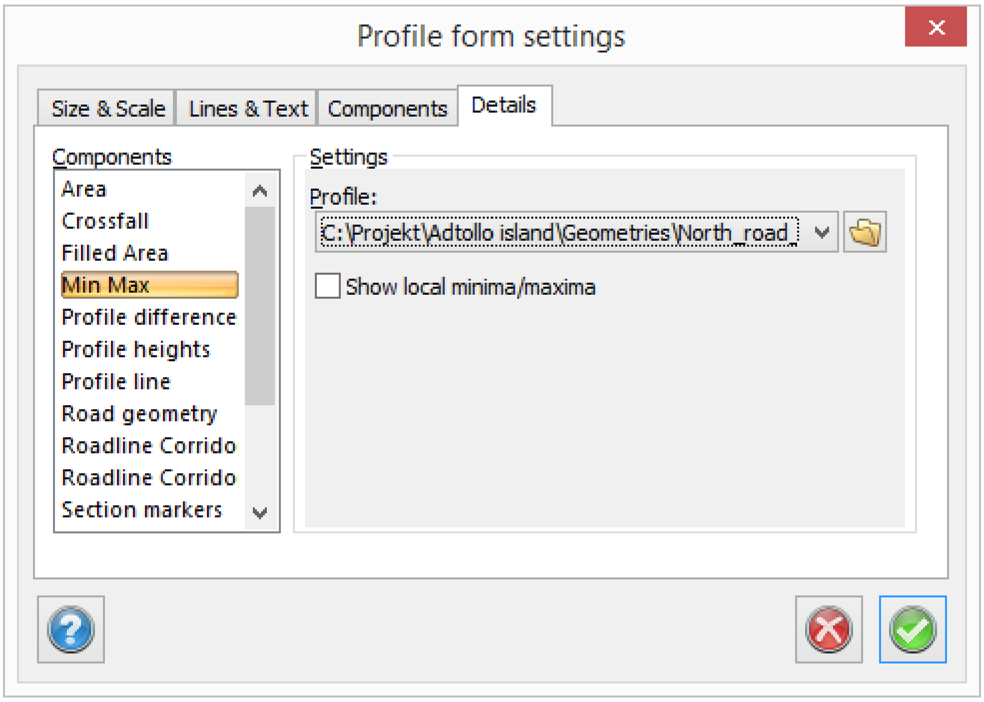
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

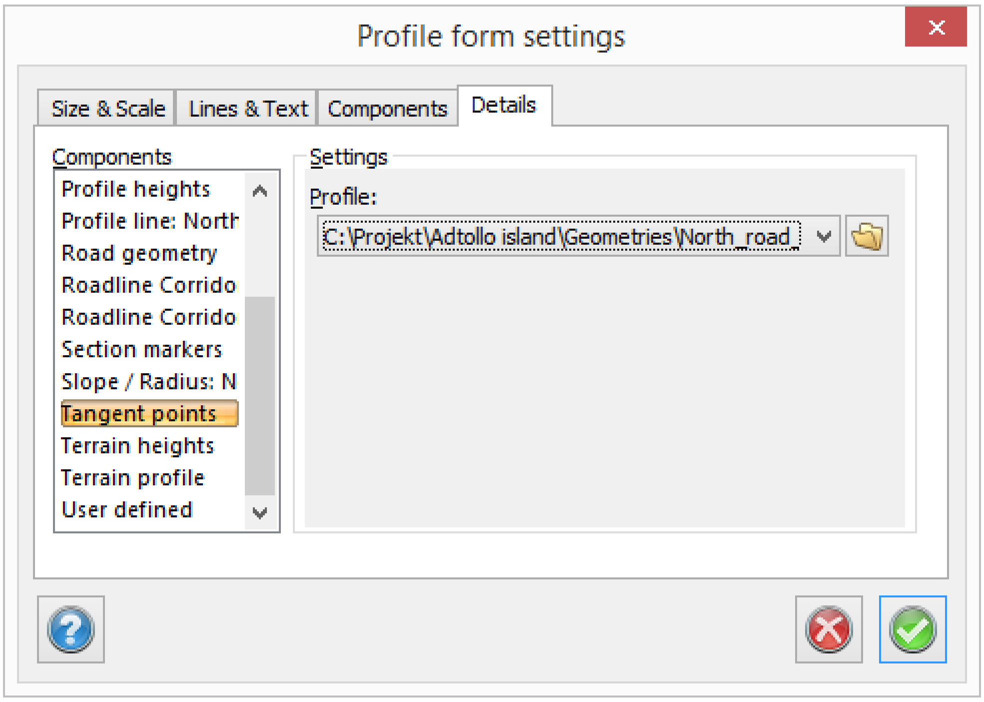
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

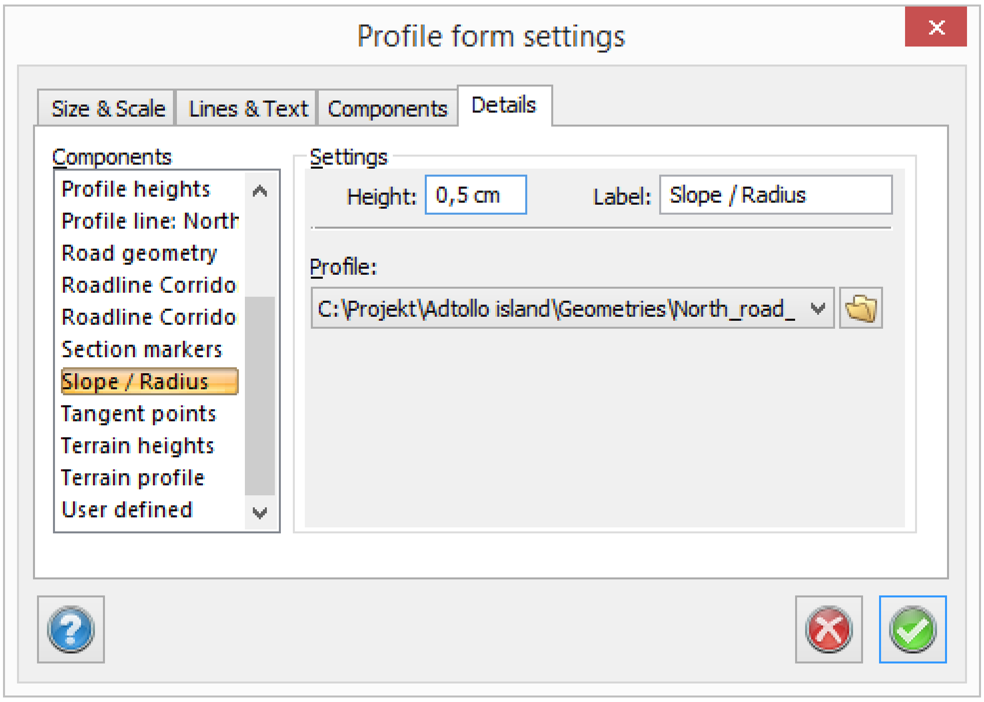
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

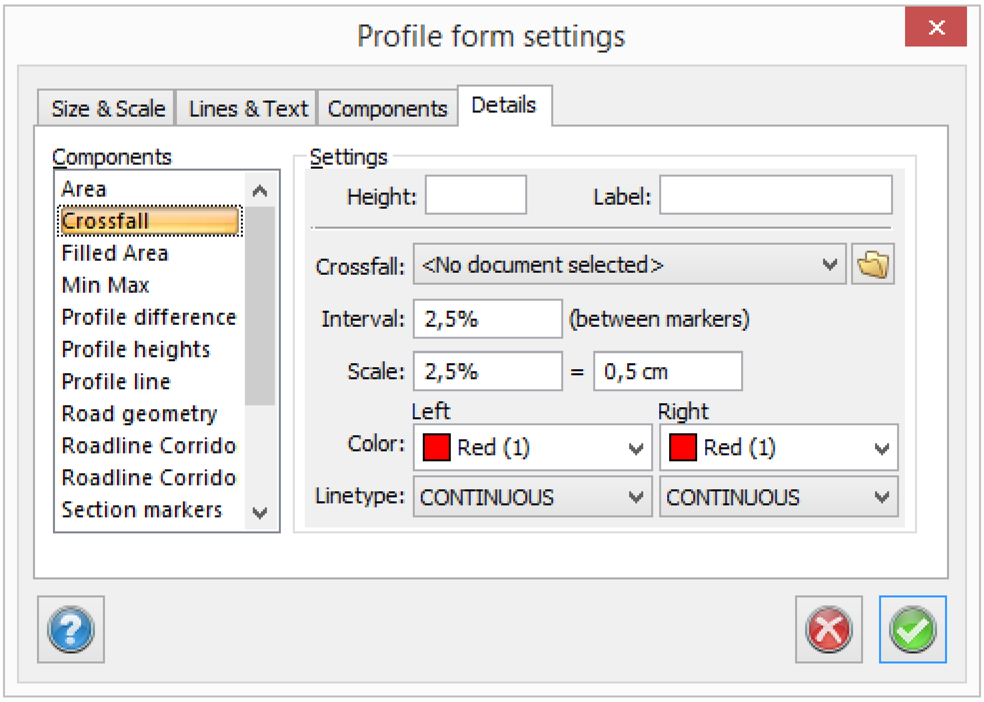
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

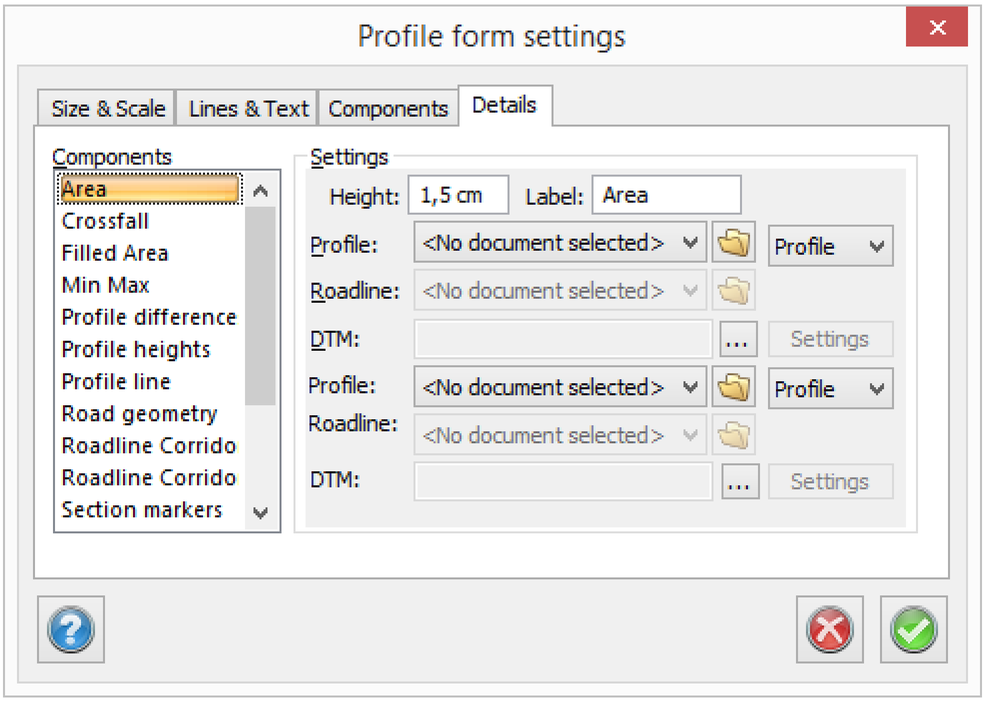
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

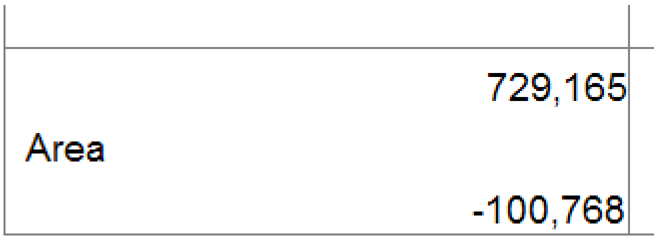
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

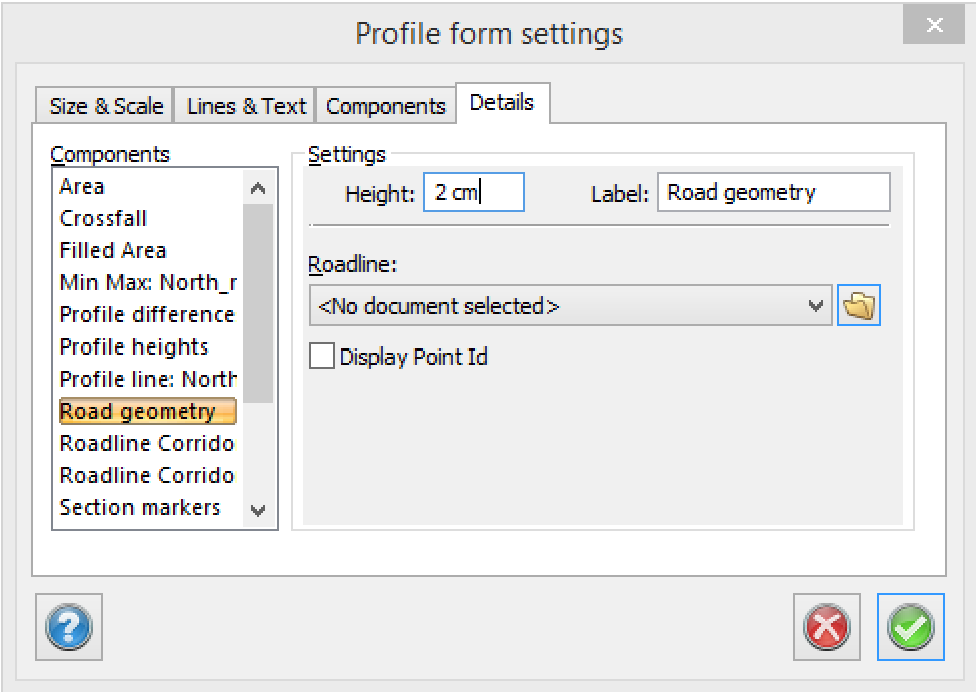


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

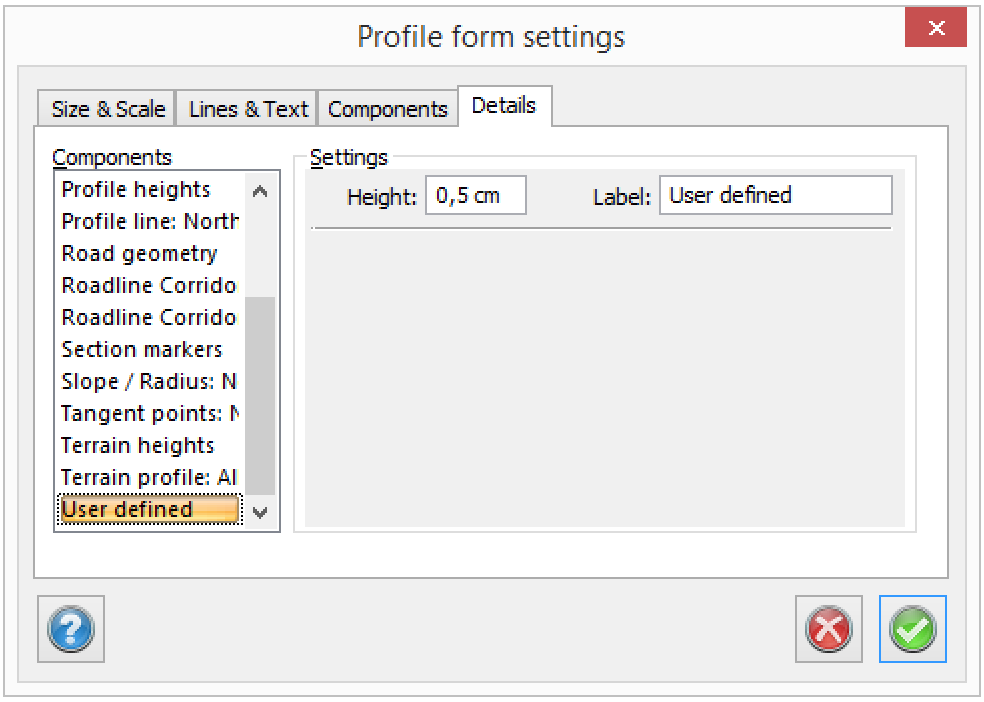
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

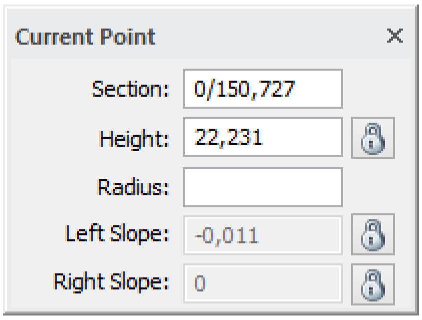
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

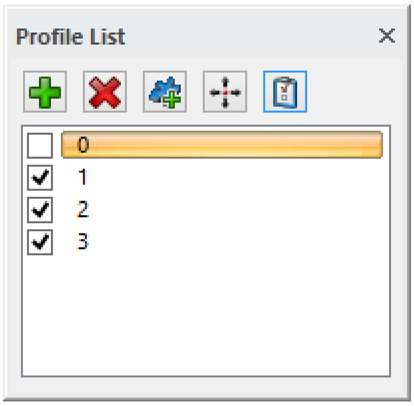
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



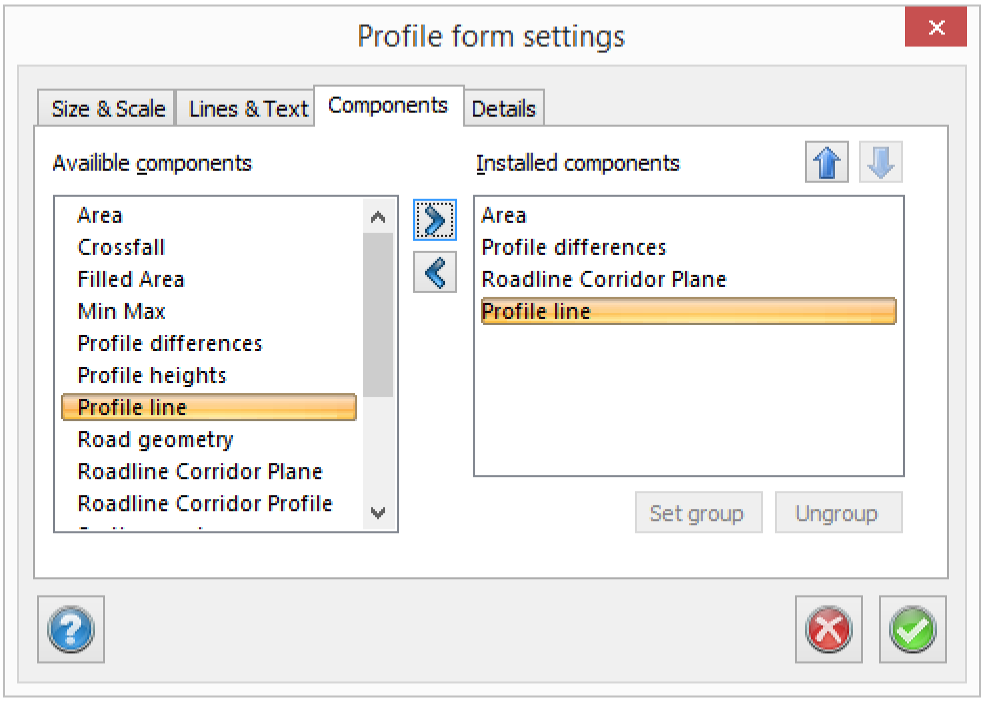
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

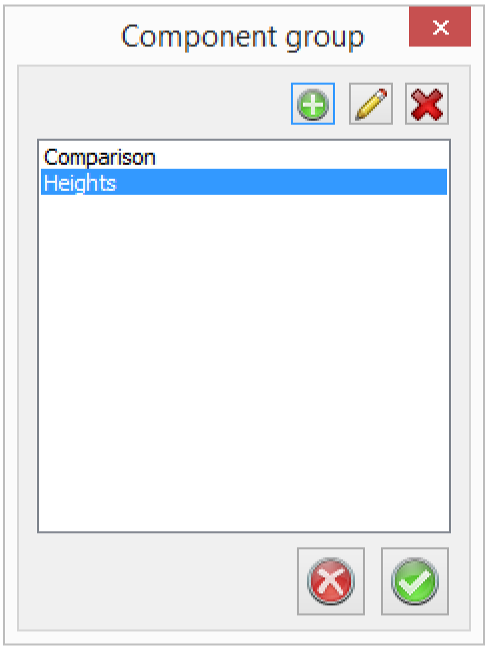
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

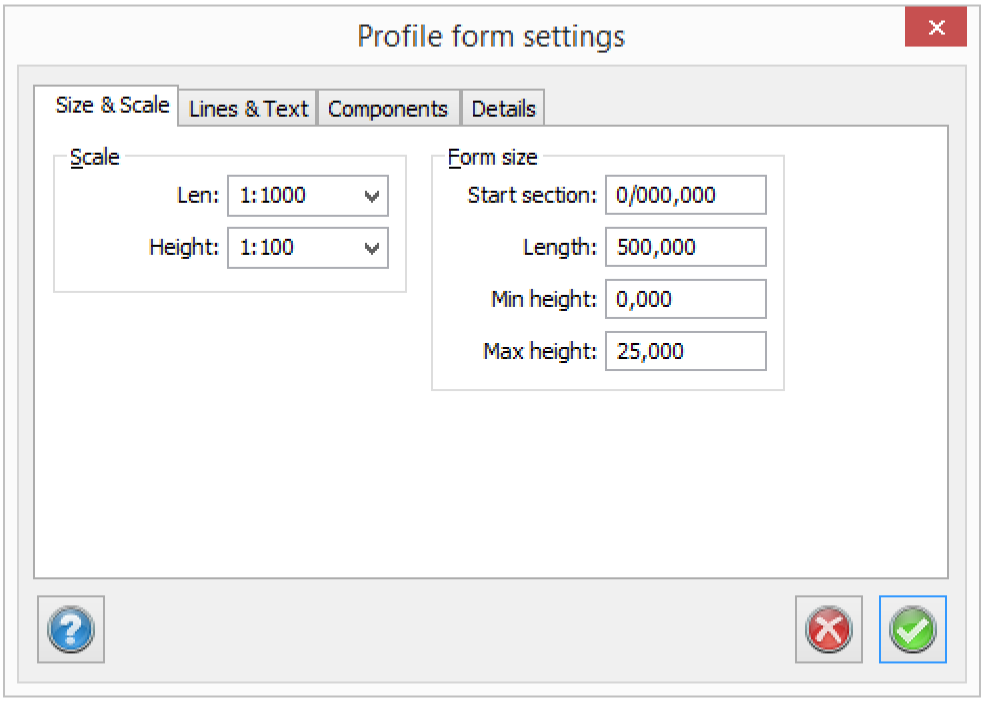
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

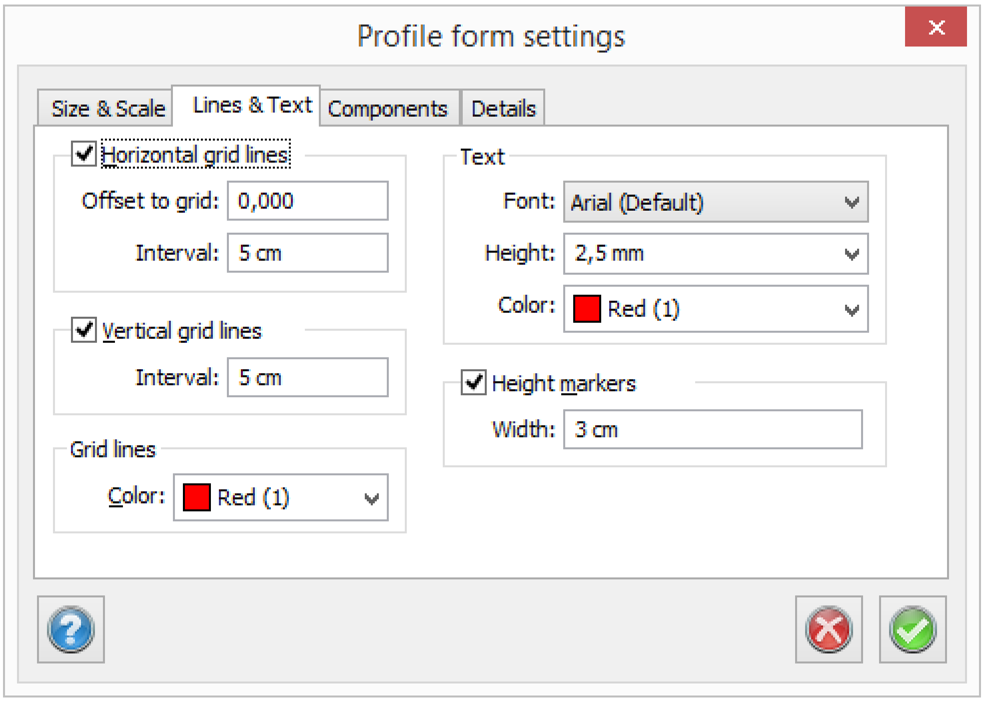


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

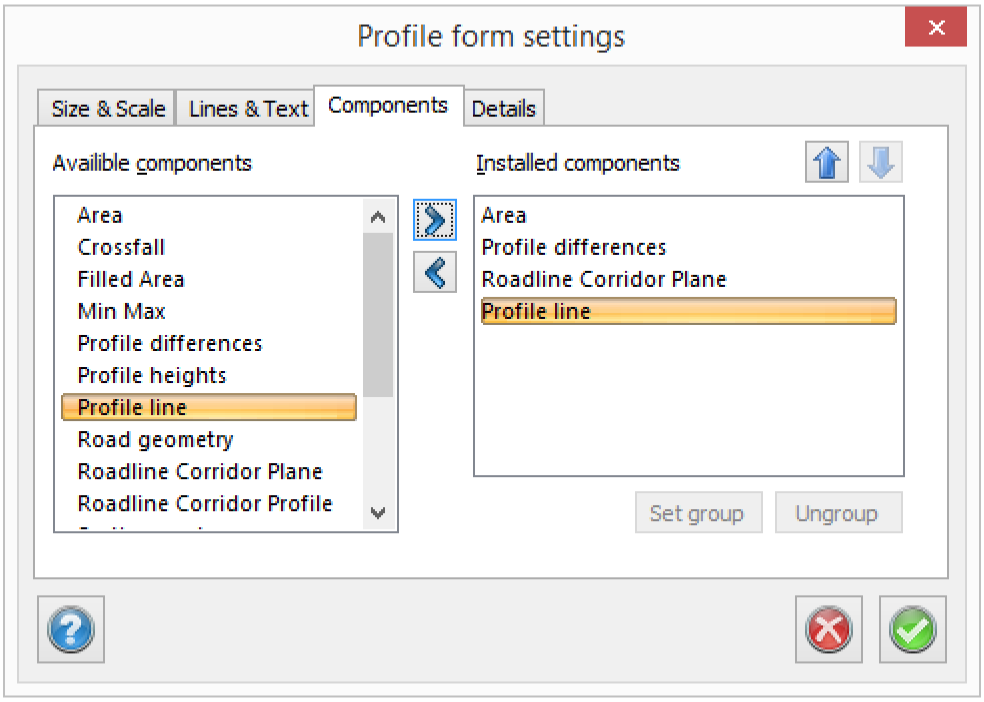
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

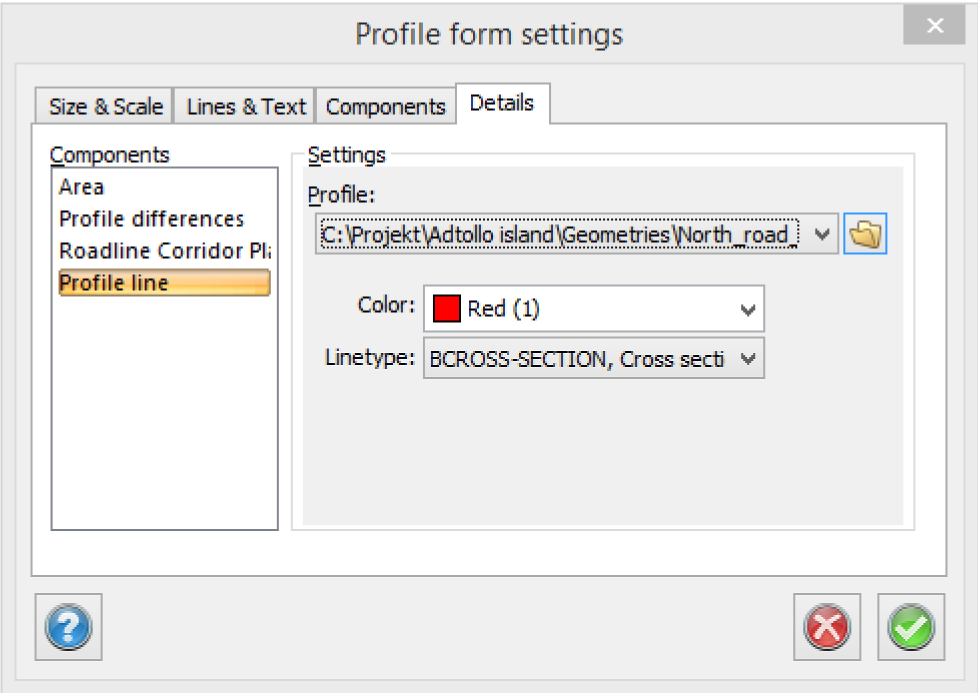
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



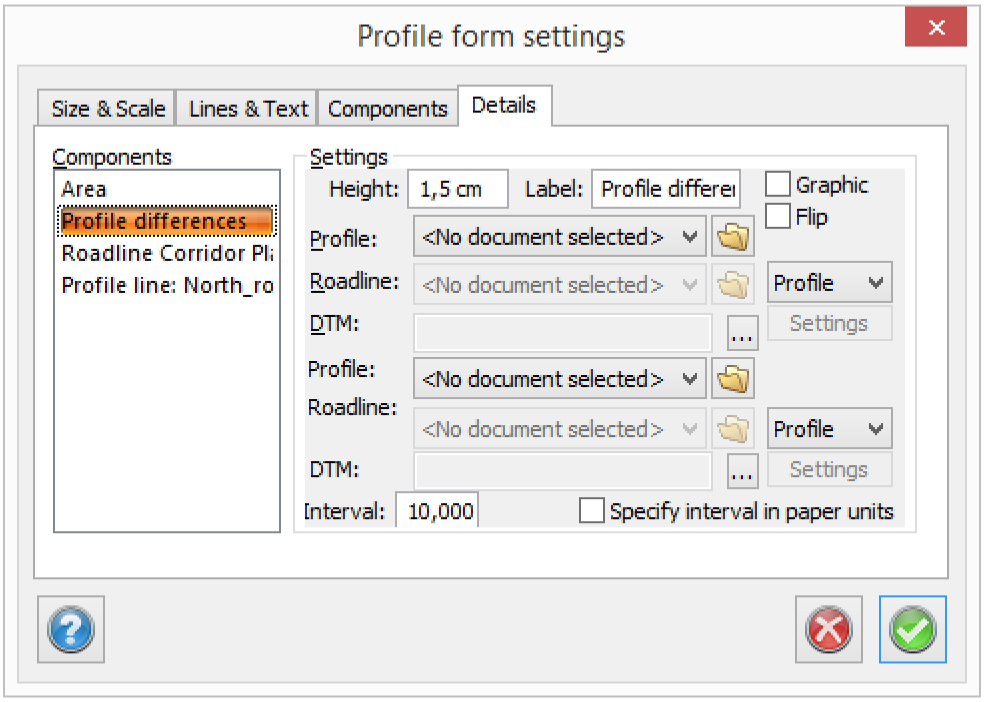
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

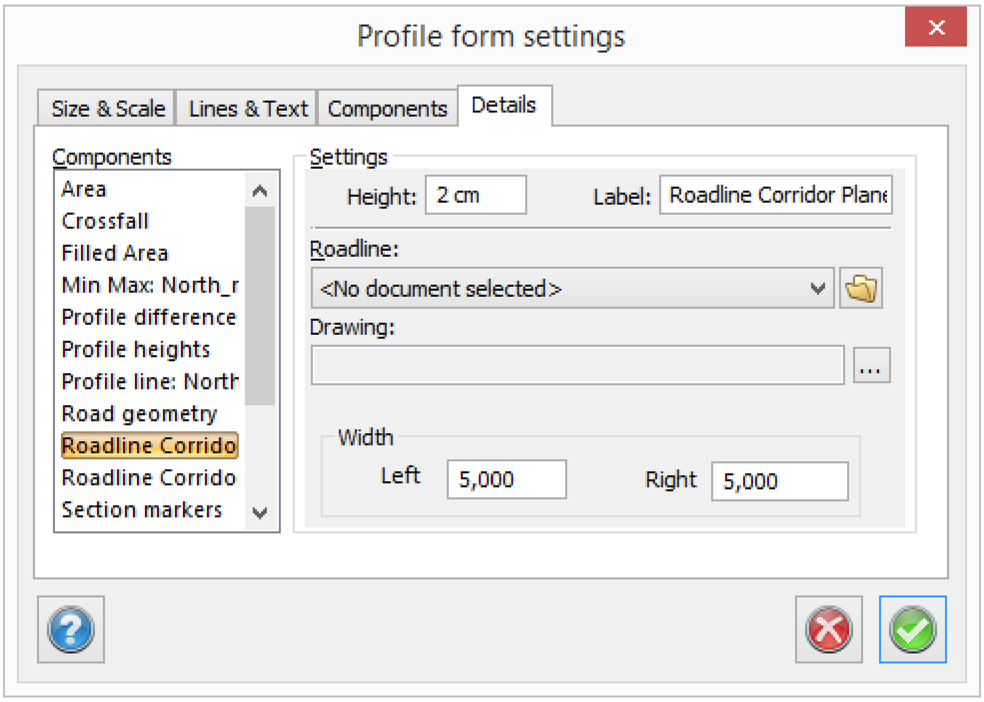
It is possible to display several different road profiles in the form.

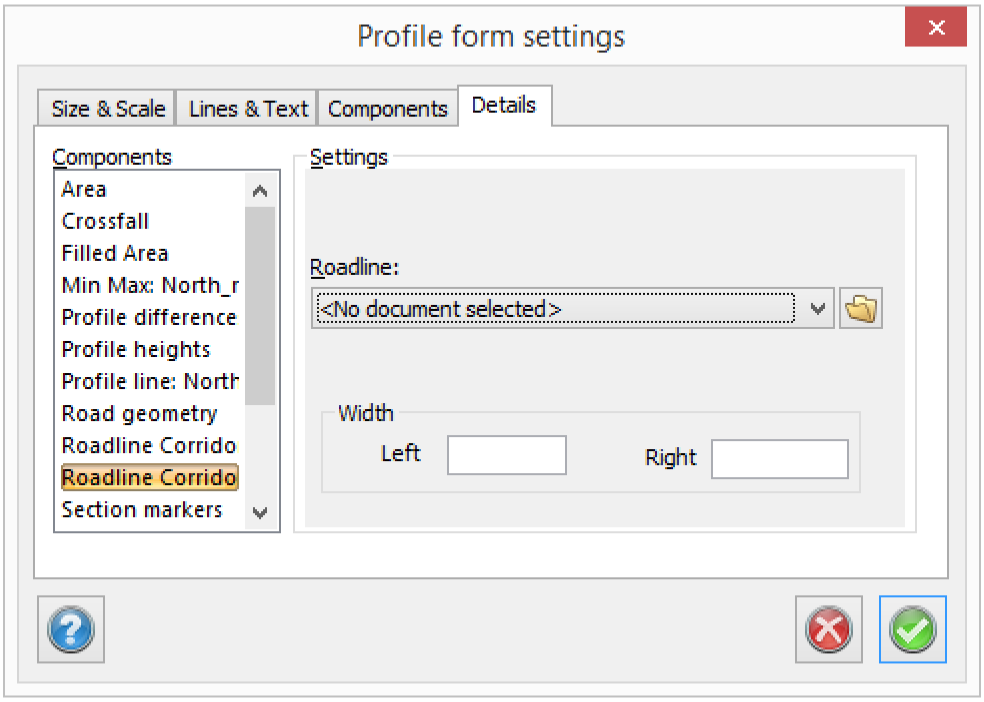
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



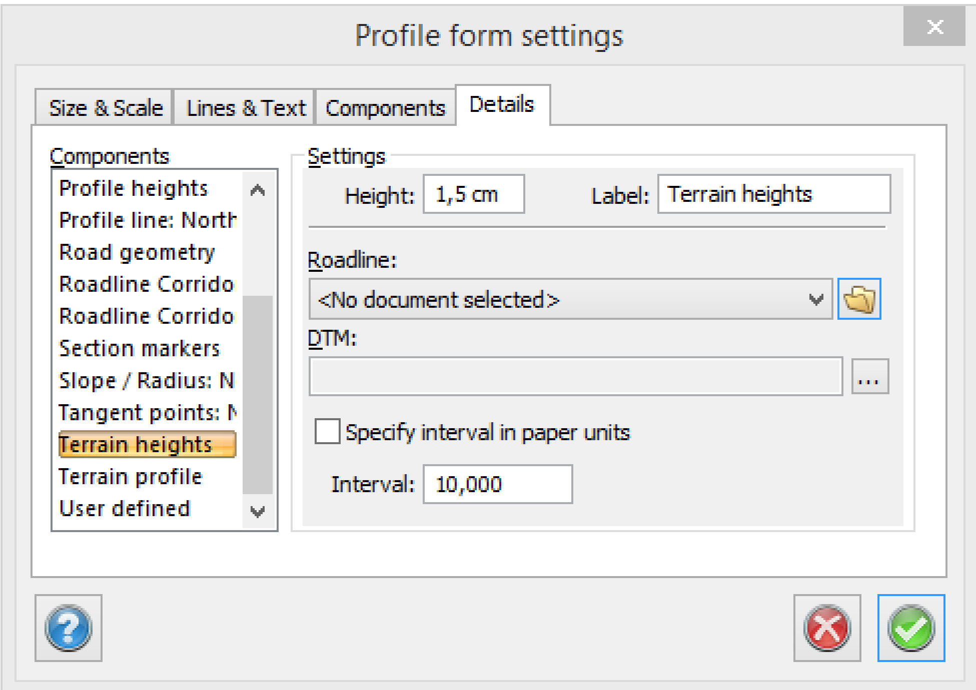
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

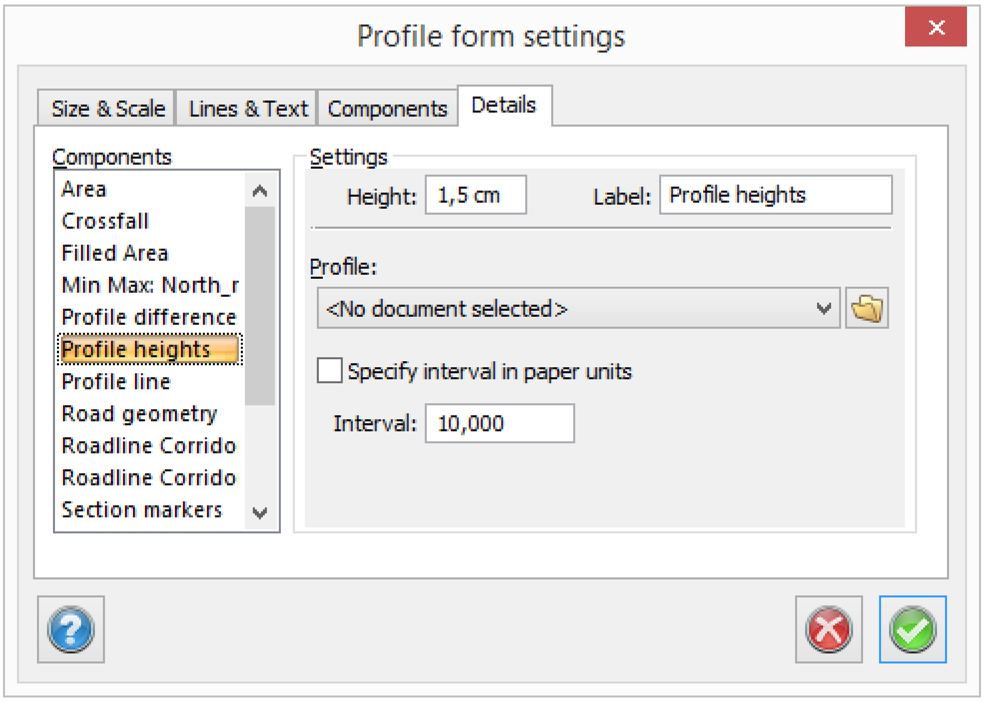
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

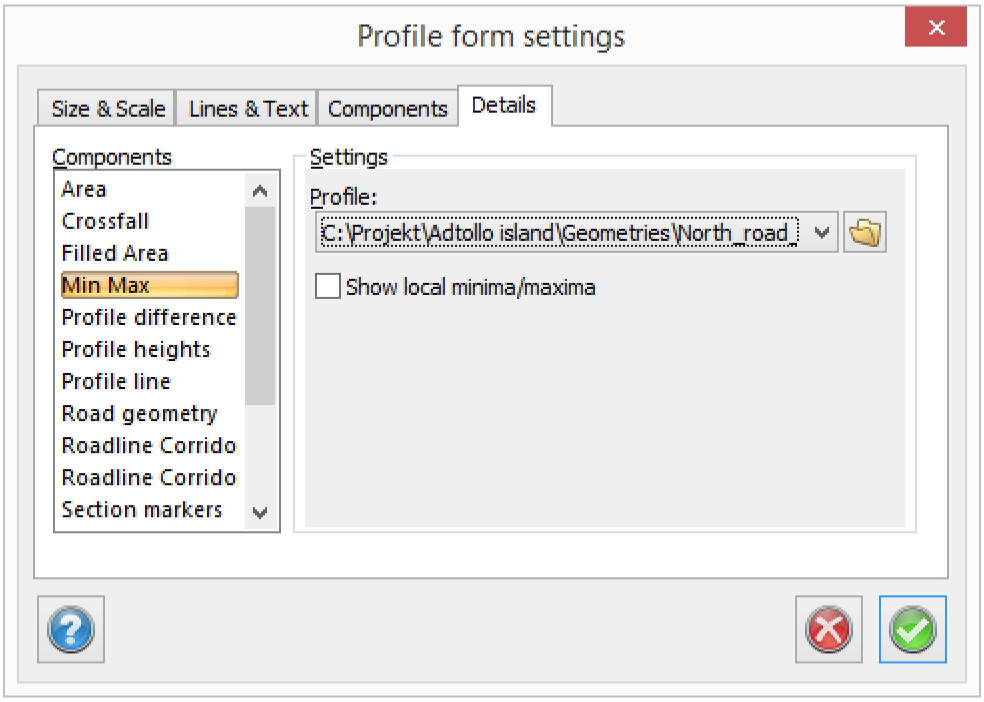
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

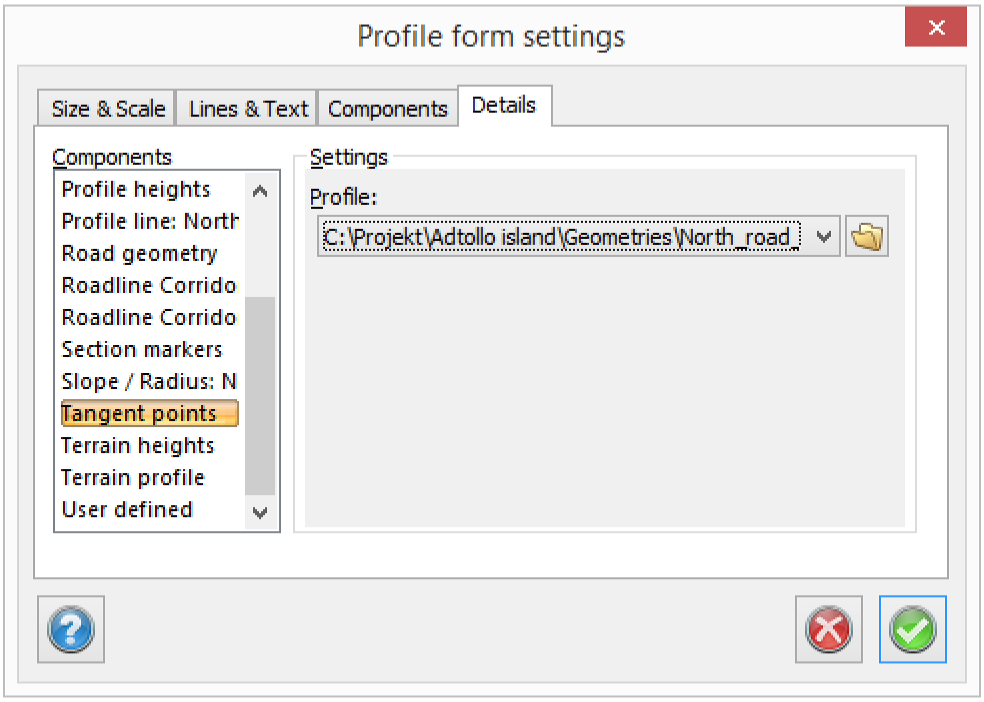
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

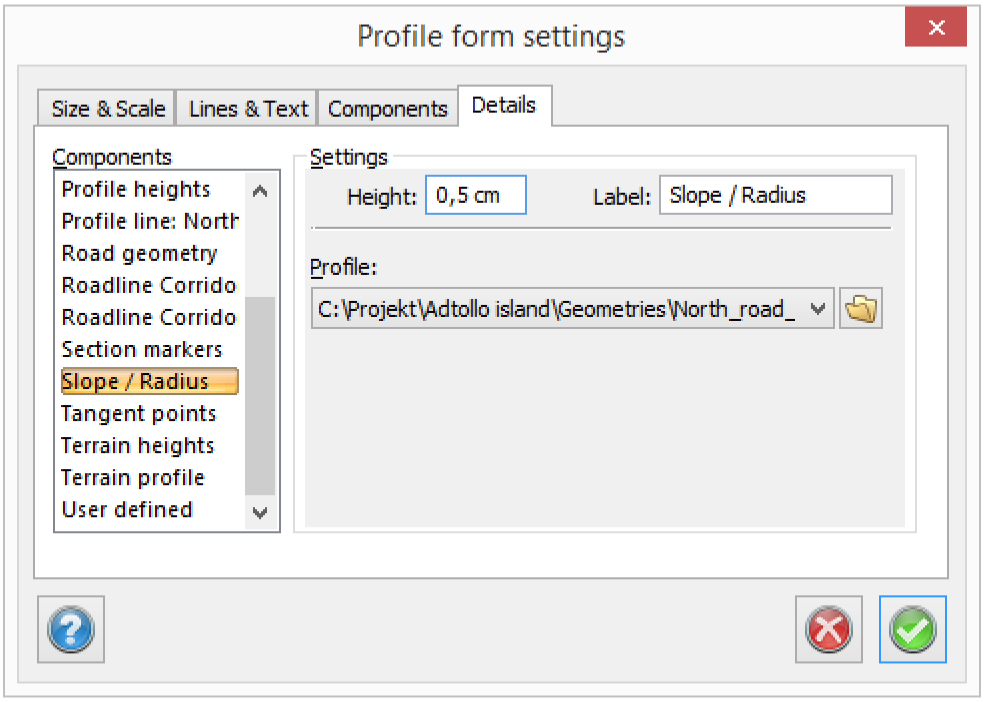
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

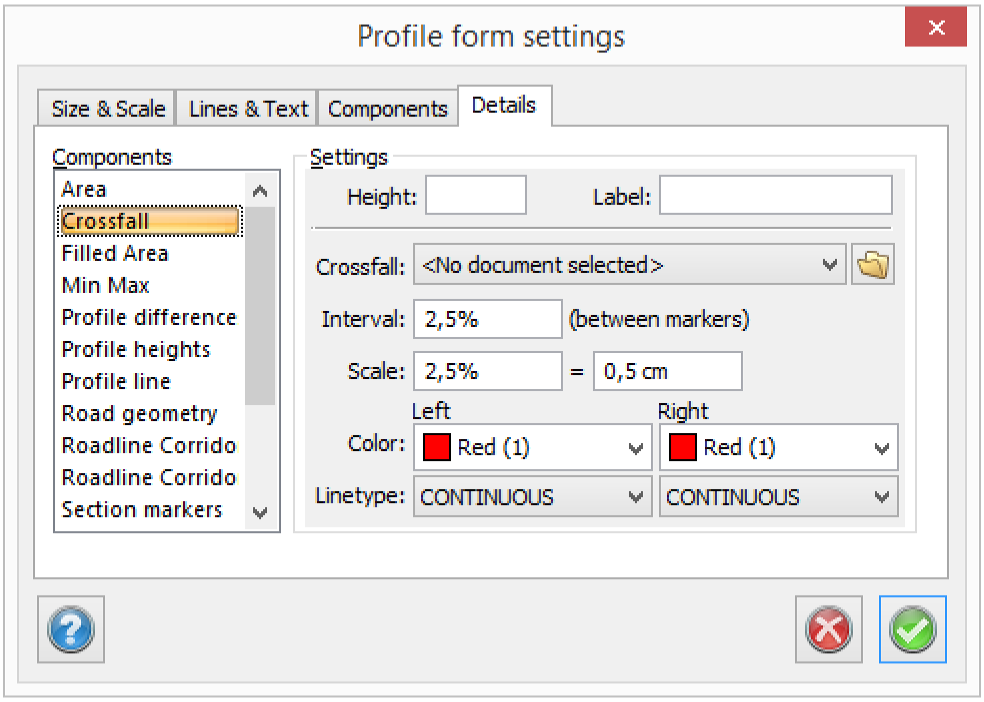
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

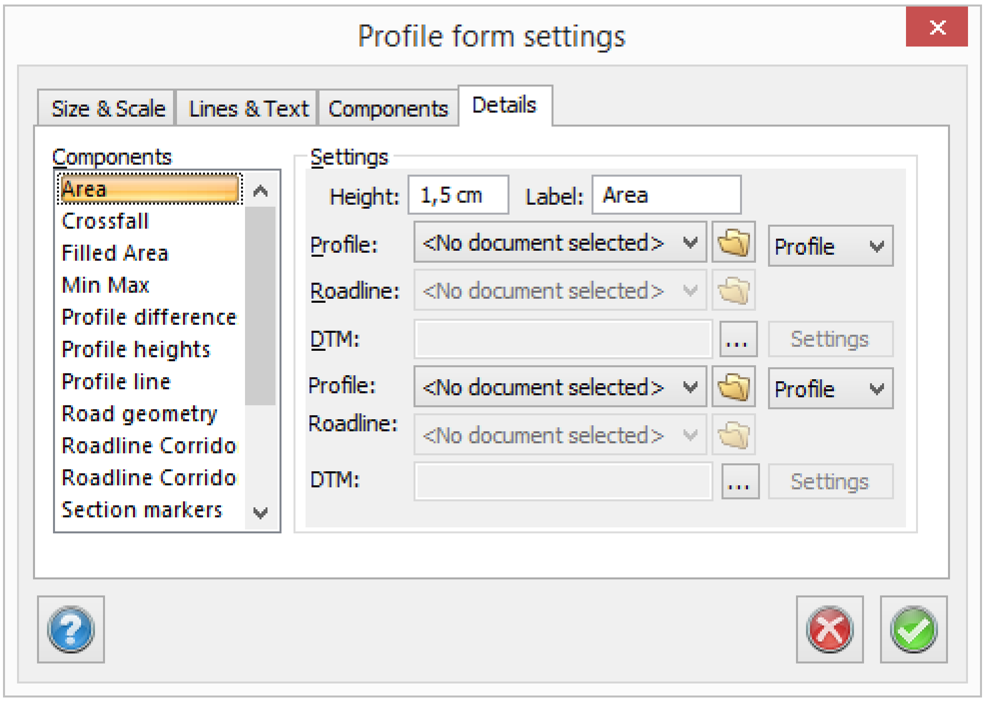
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

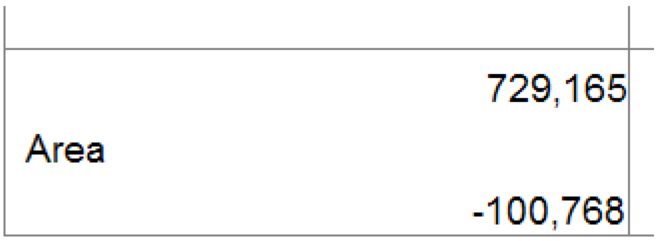
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

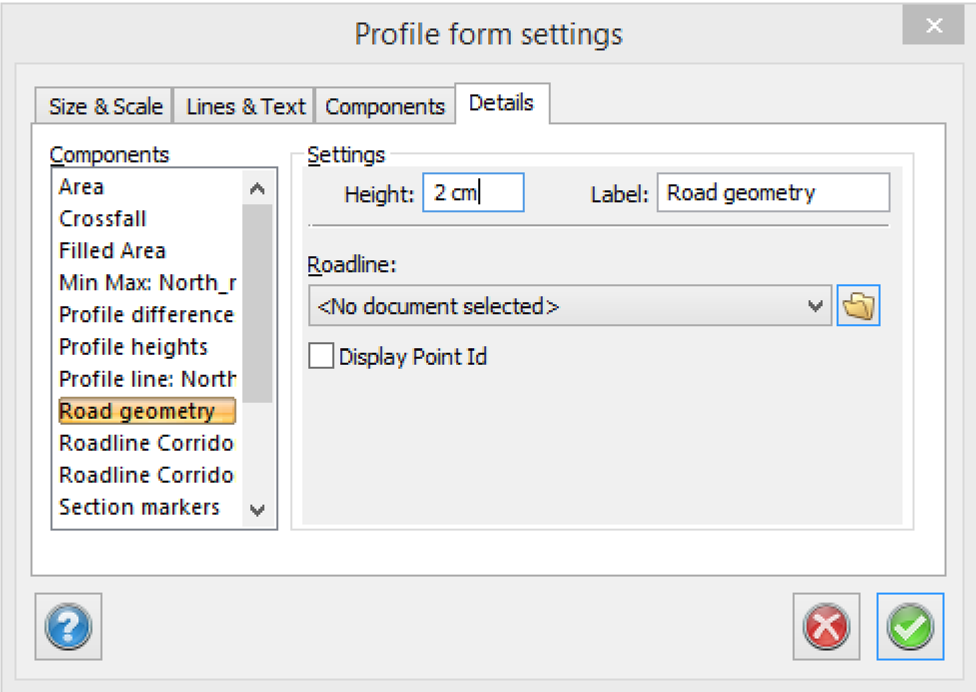


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

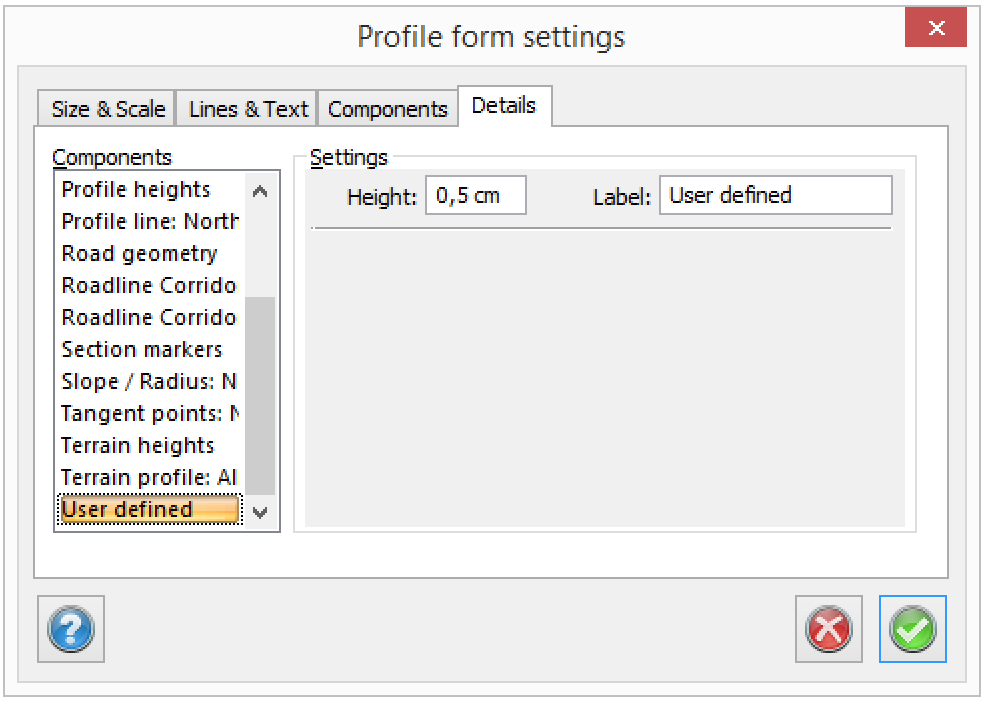
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

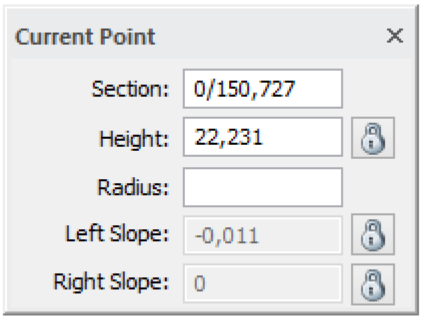
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct|Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

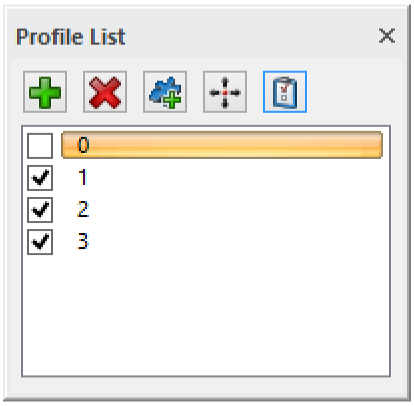
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



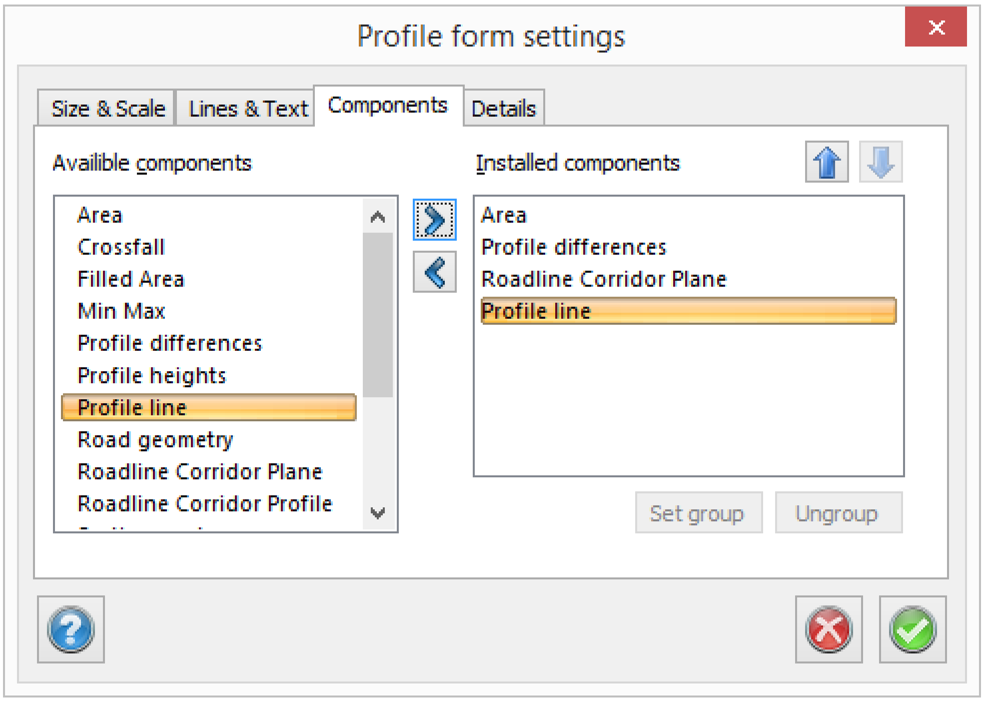
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

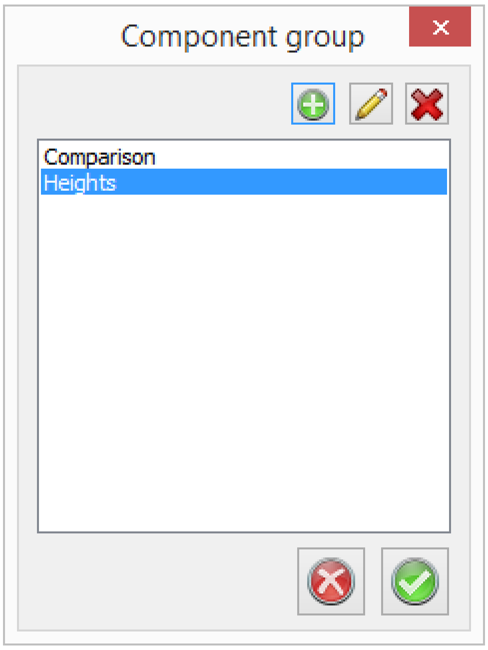
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

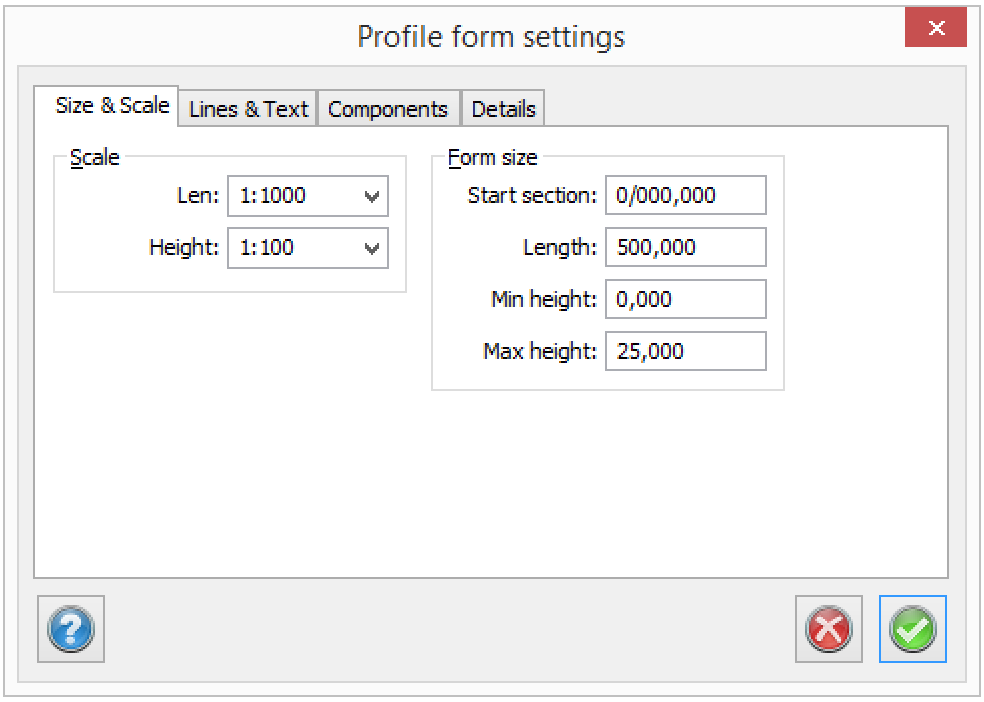
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

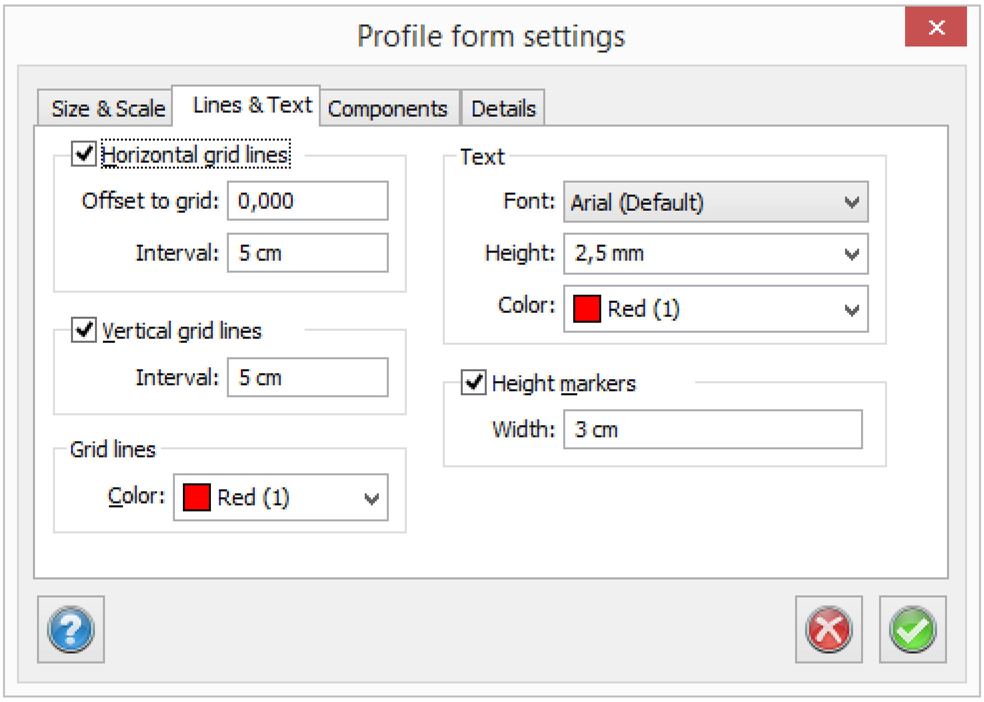


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

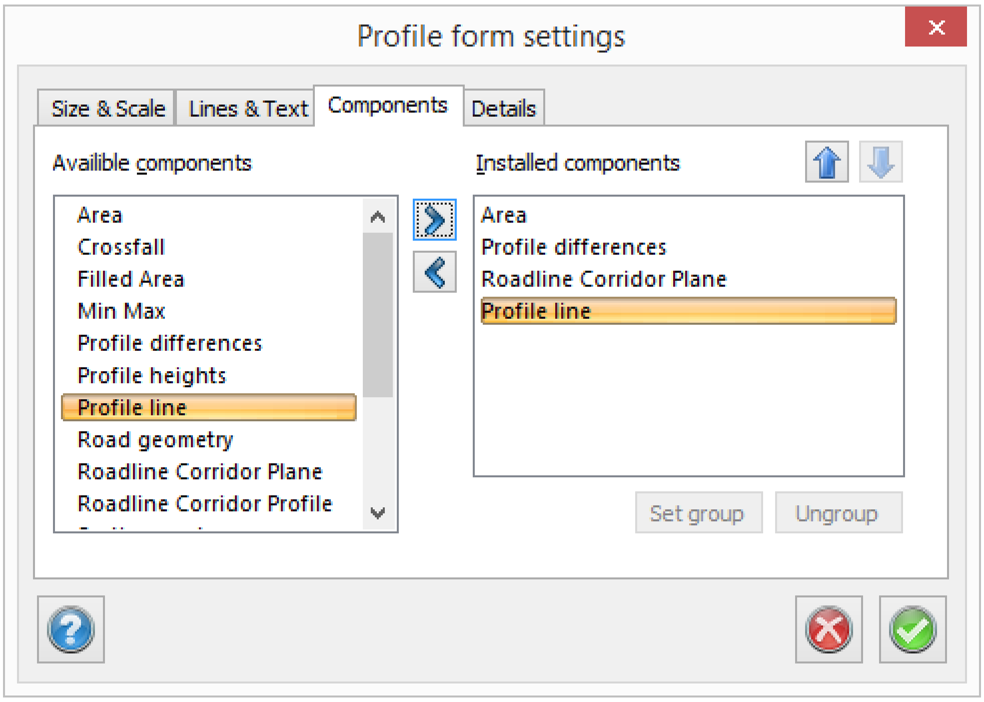
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

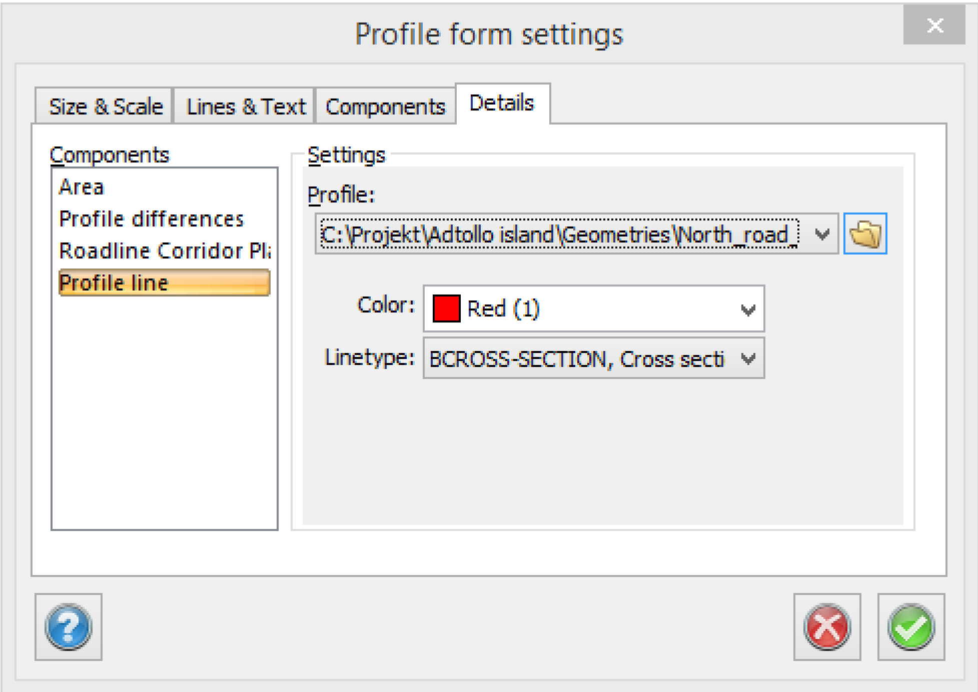
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



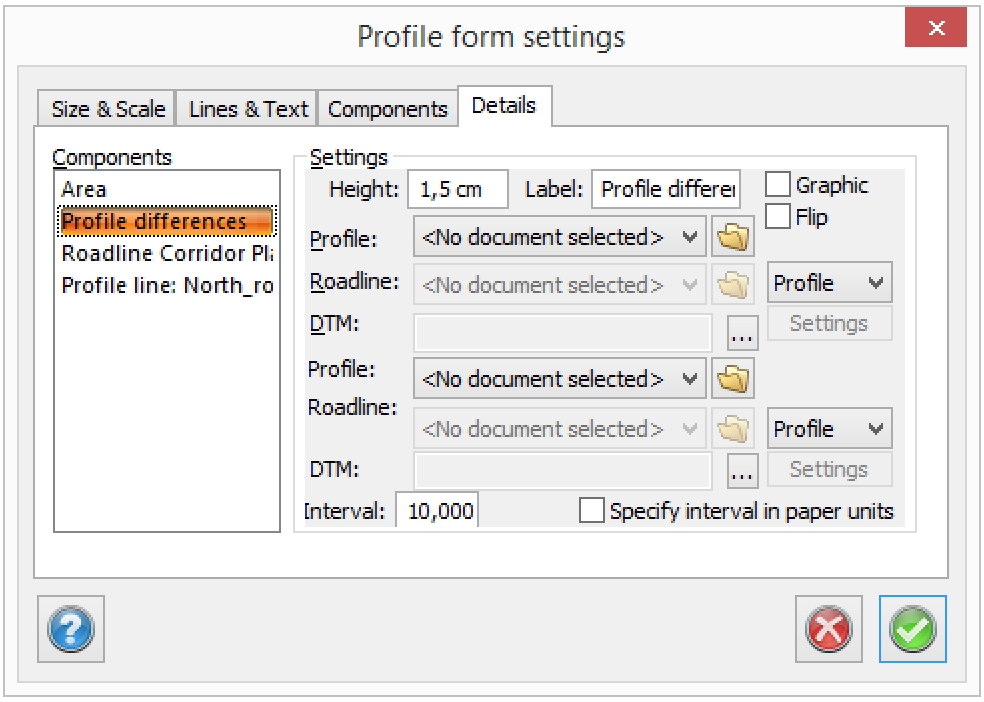
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

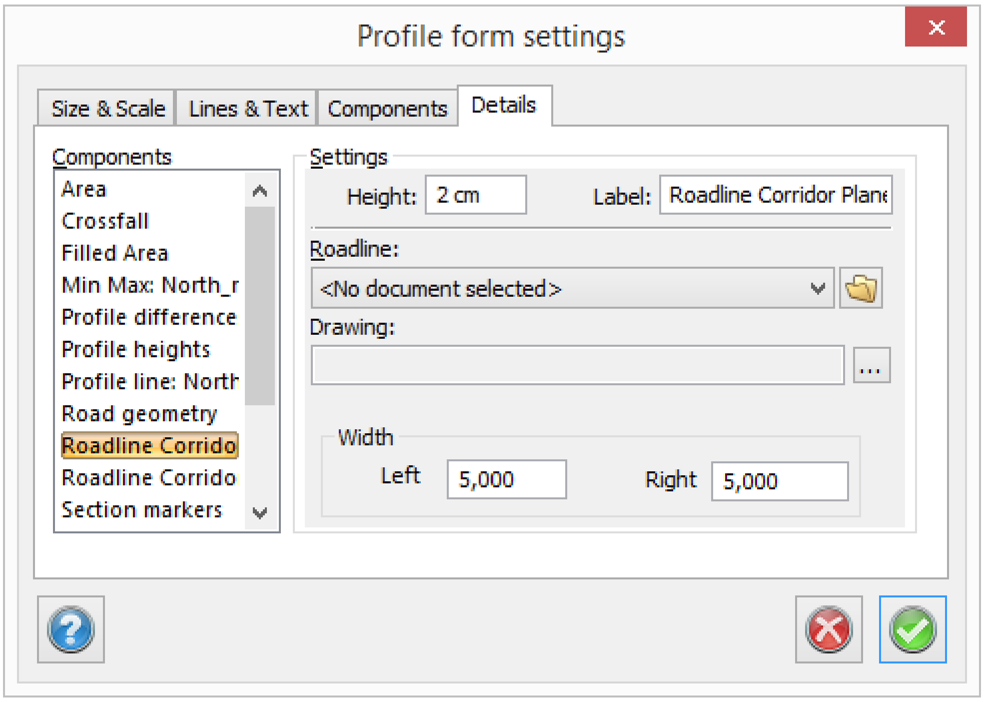
It is possible to display several different road profiles in the form.

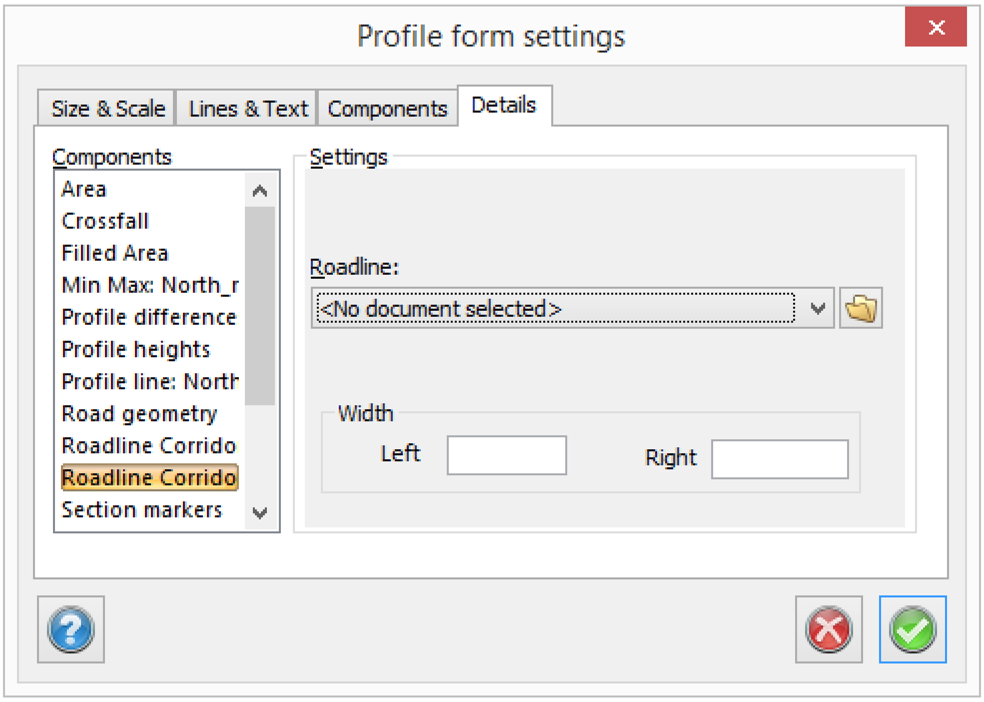
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



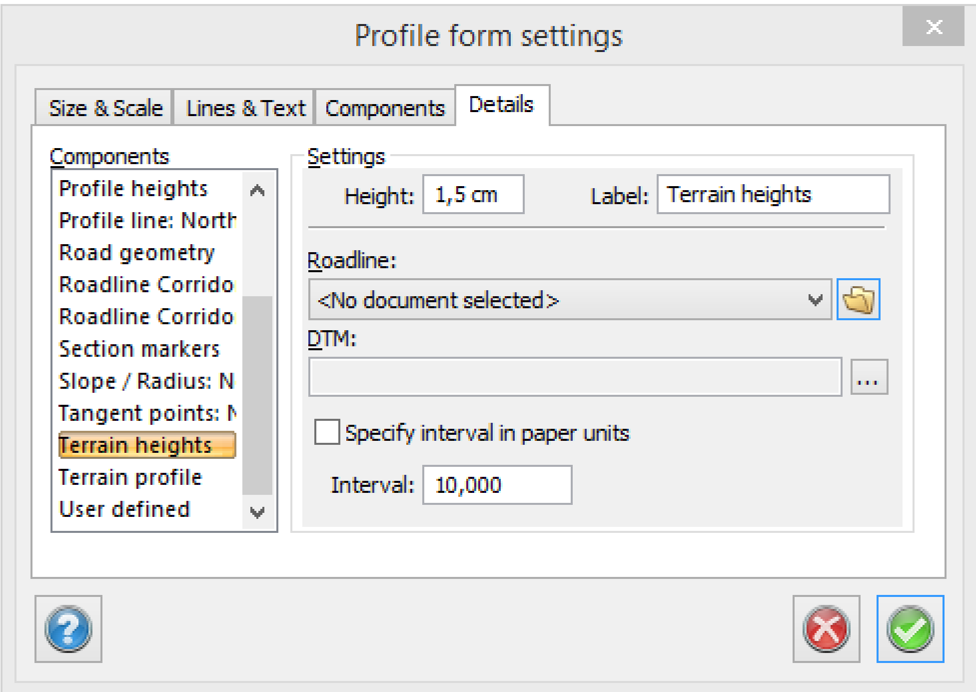
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

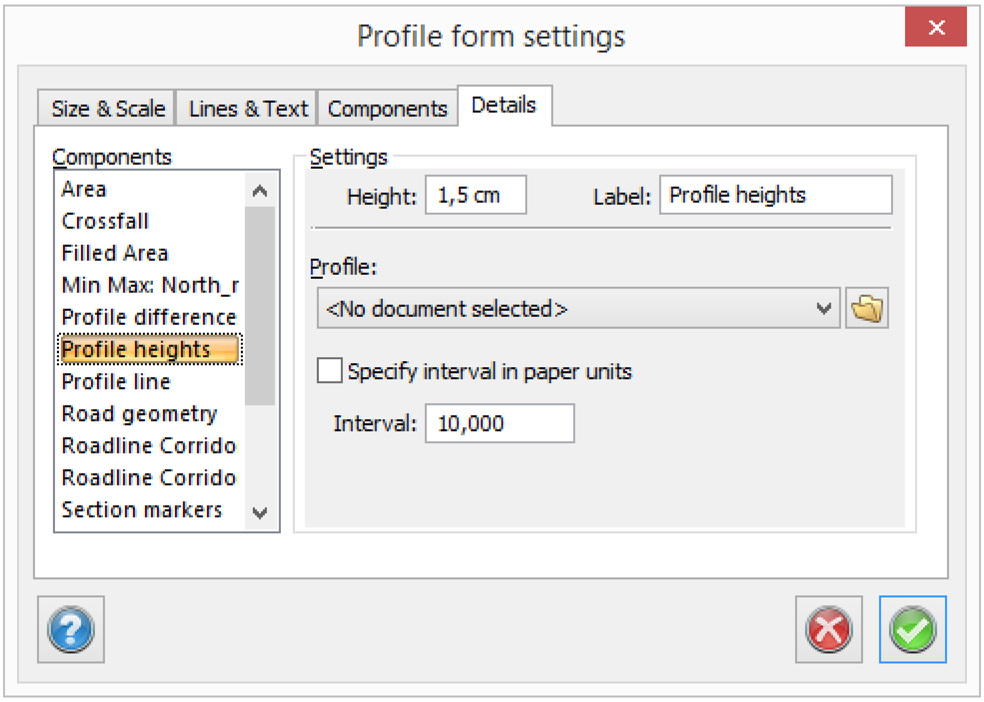
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

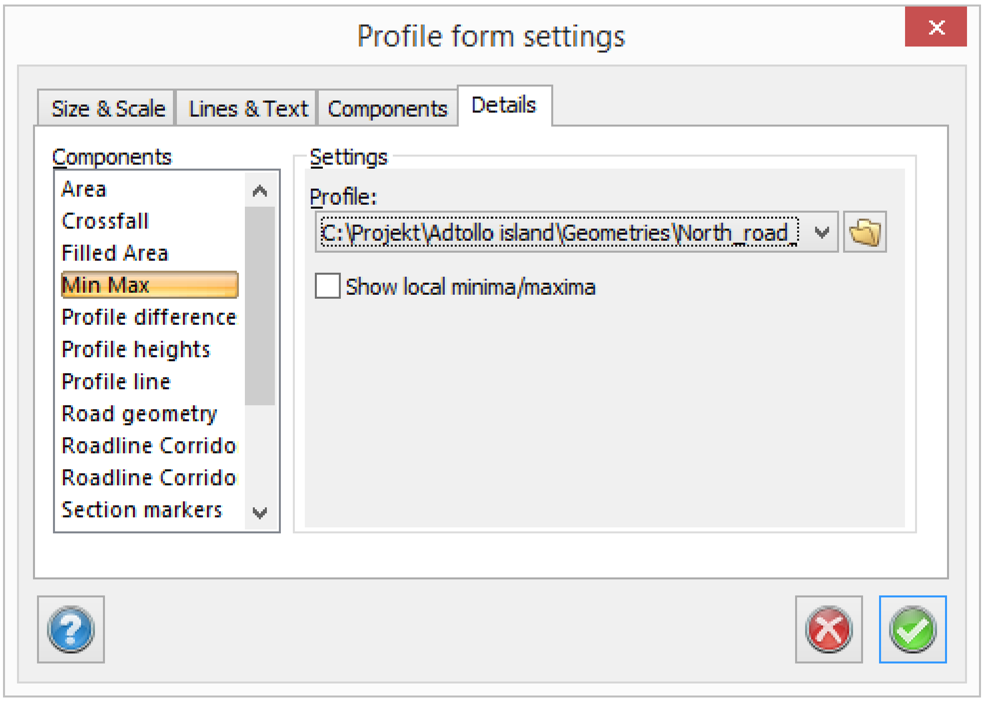
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

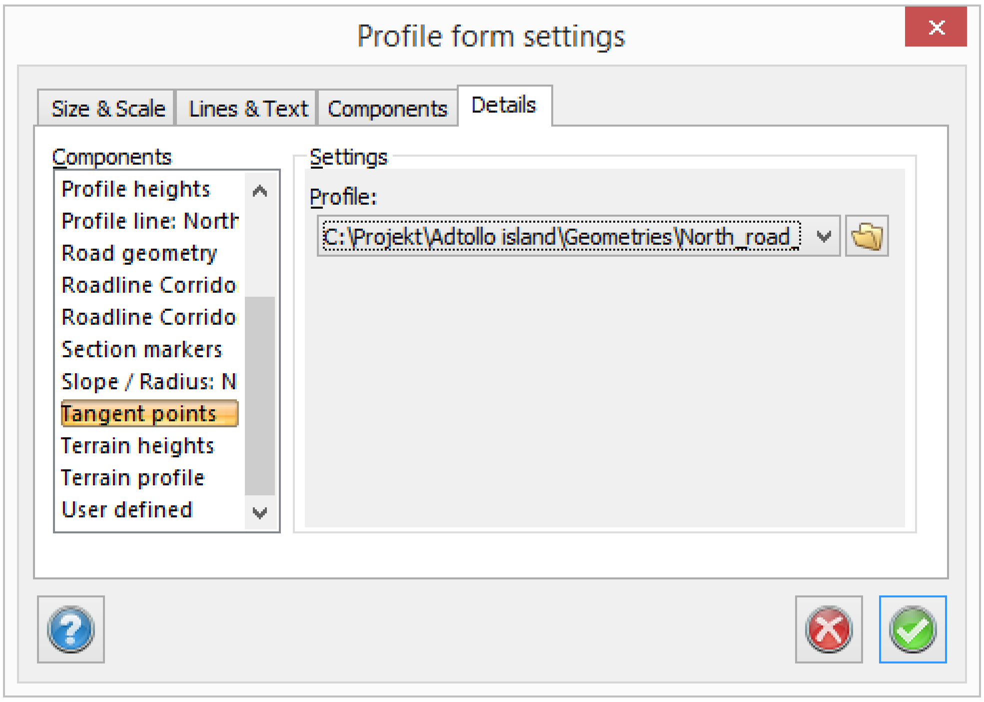
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

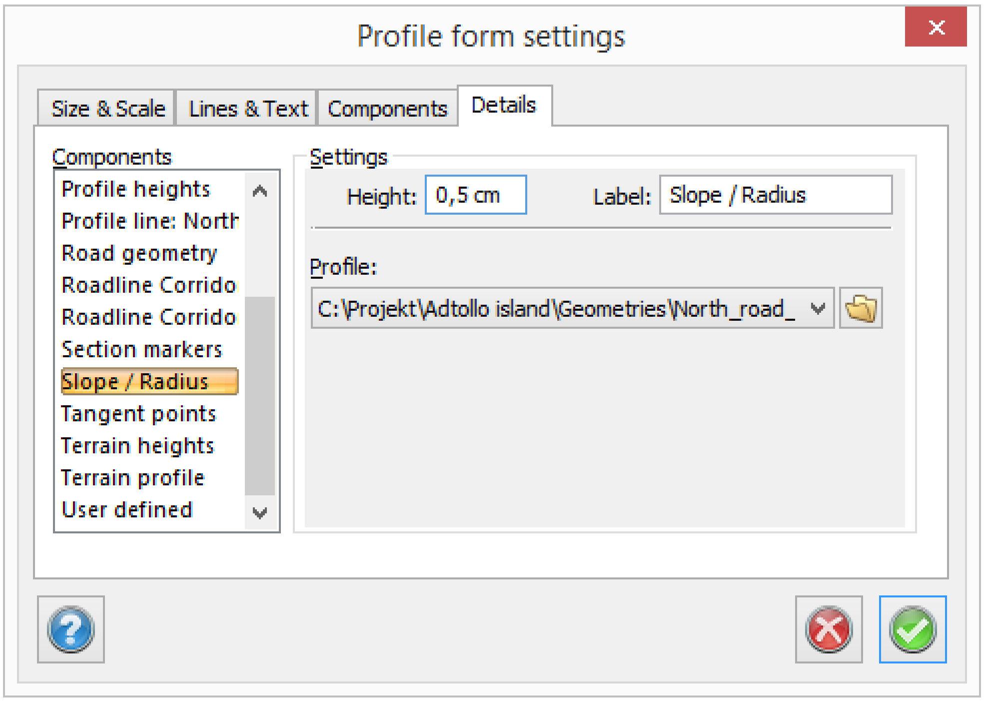
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

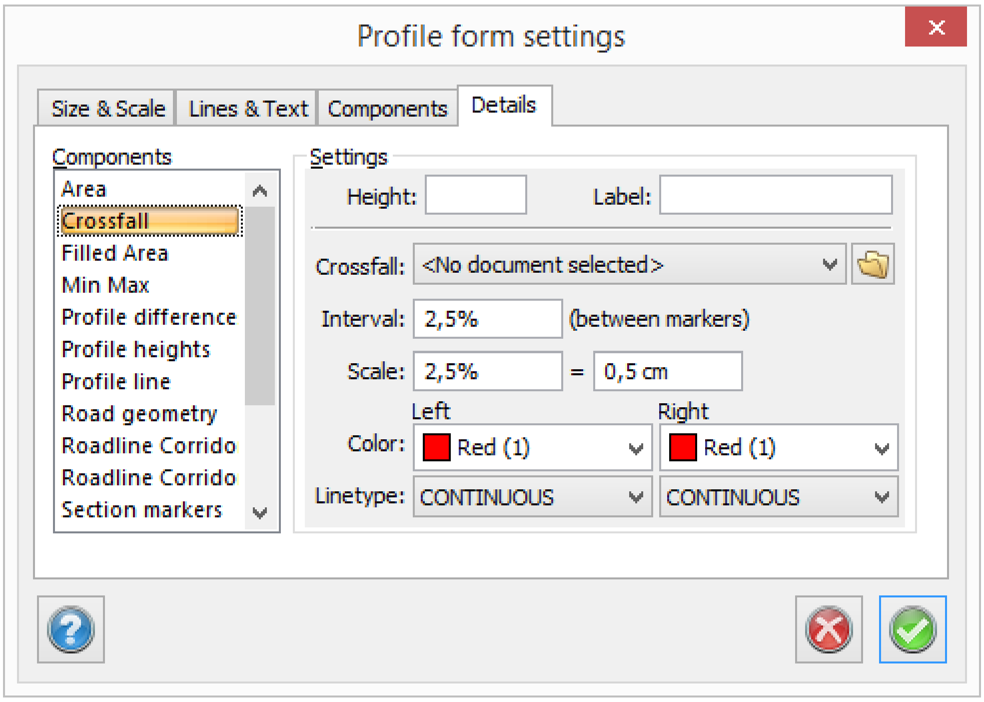
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

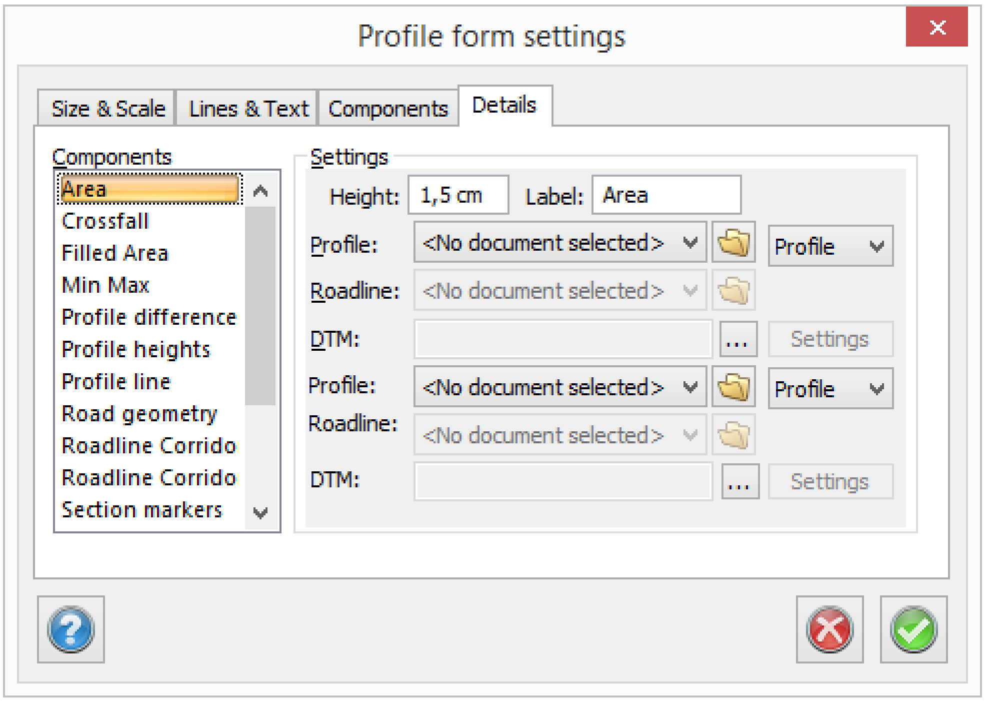
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

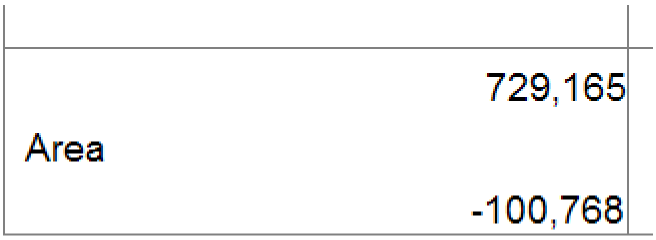
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

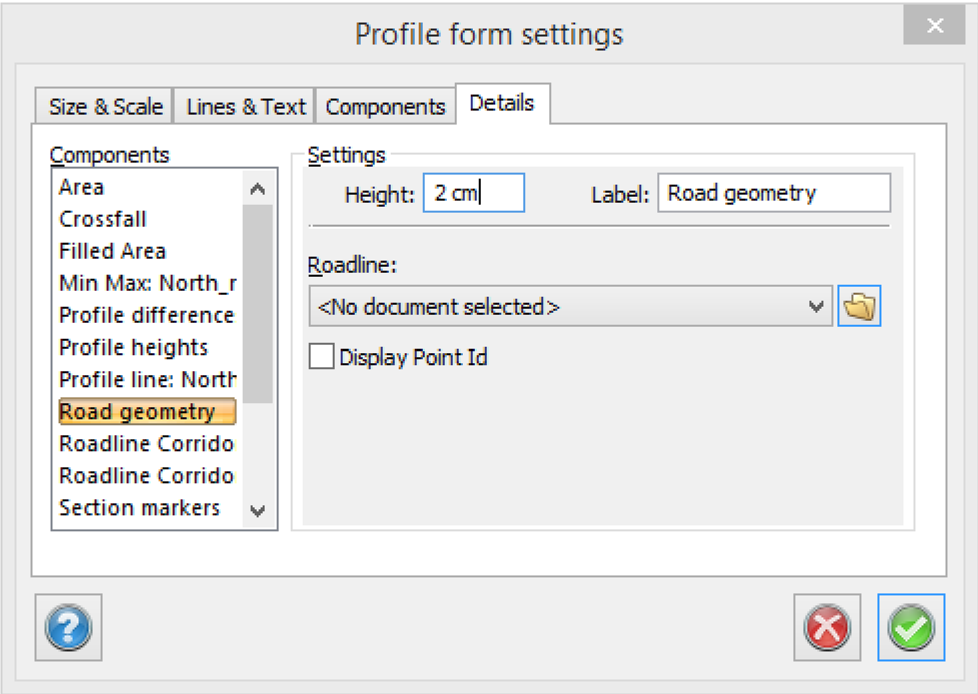


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

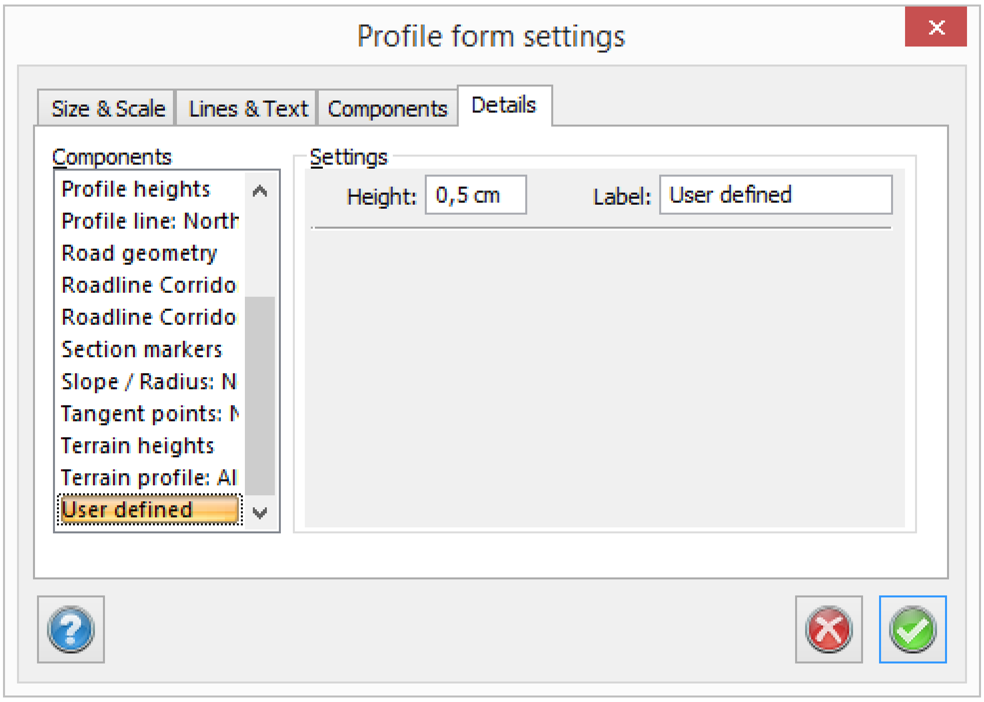
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

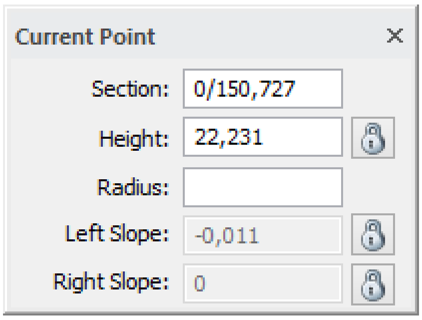
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
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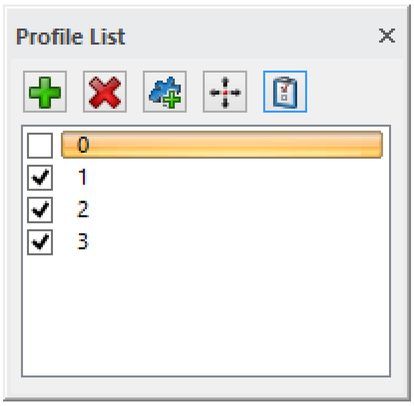
Properties Select properties to rename a profile.



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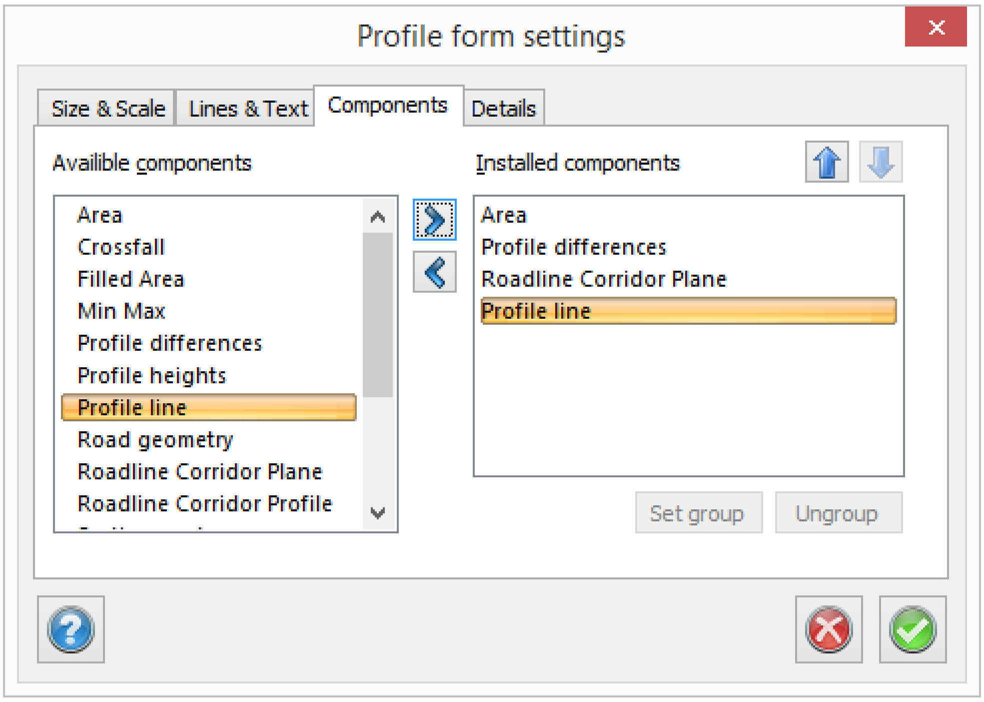
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



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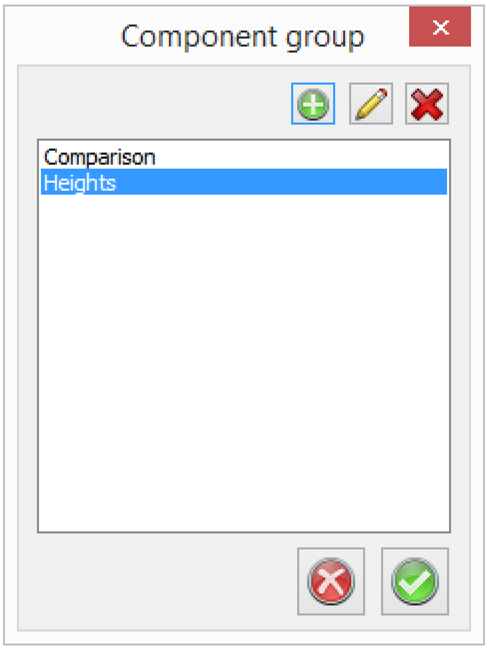

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See also:

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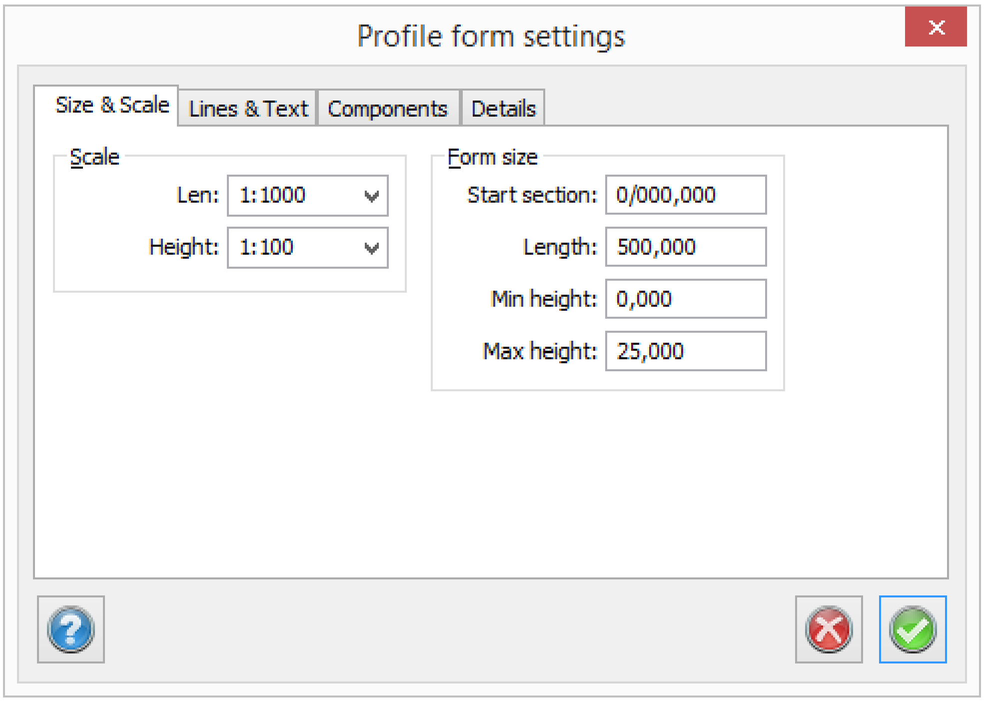
Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:



Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
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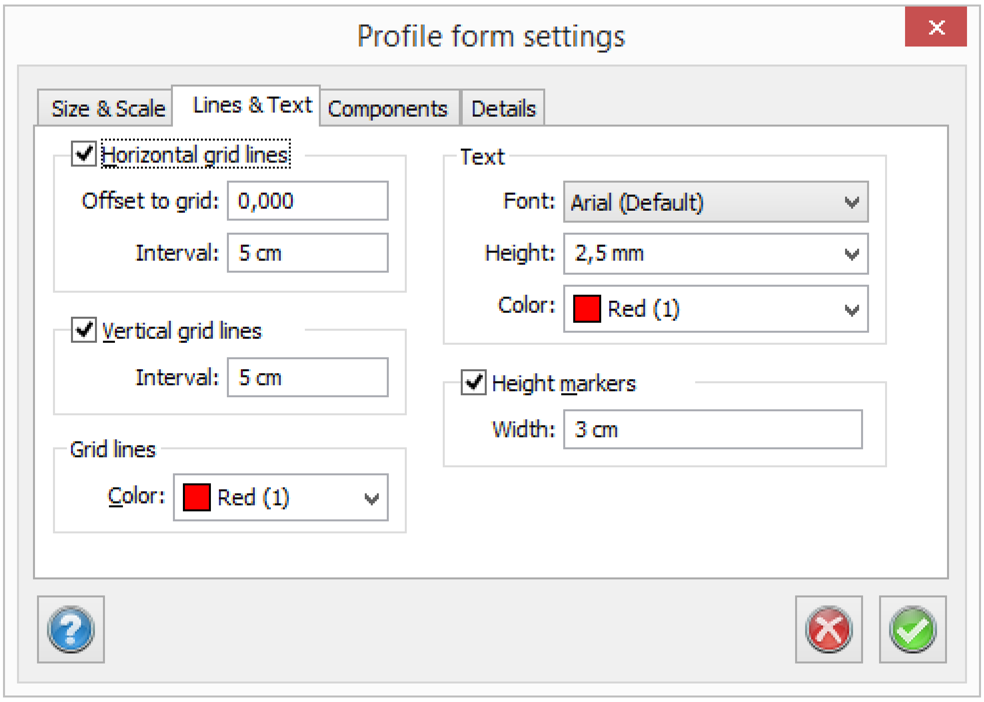
Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



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size of the printout.

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Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
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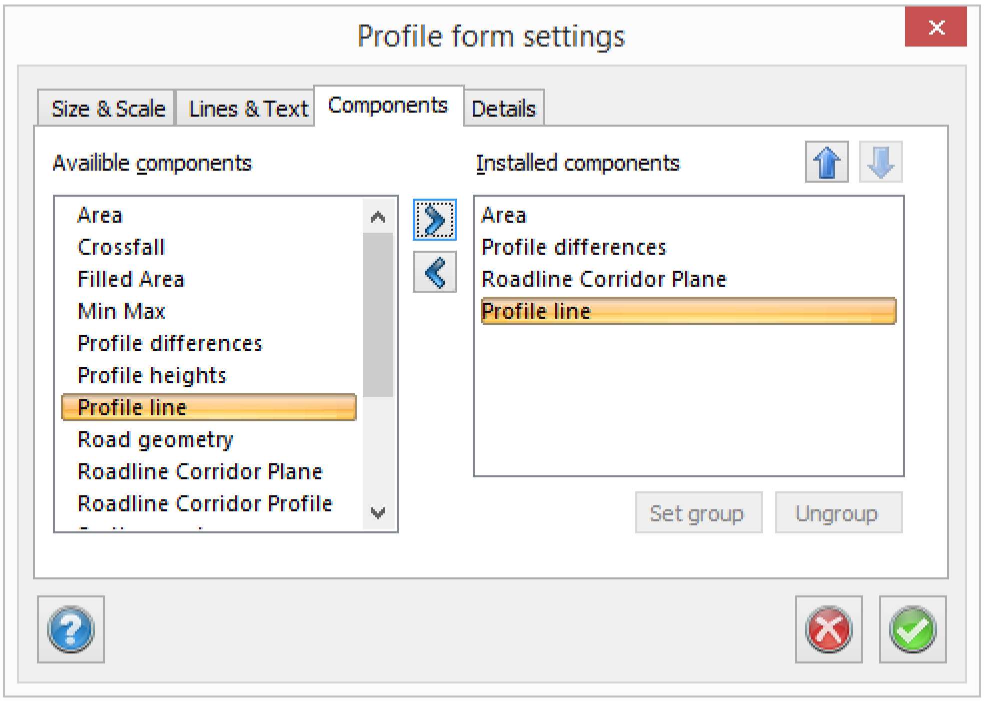
Profile form, components



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- Roadline Corridor Profile
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- Terrain profile
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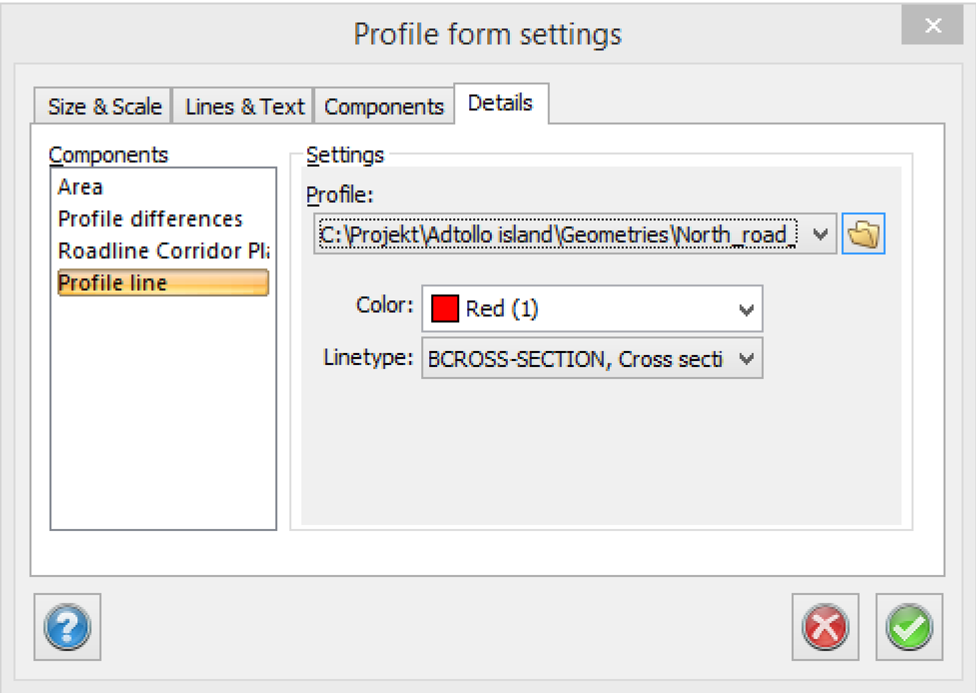
Details, profile line



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The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

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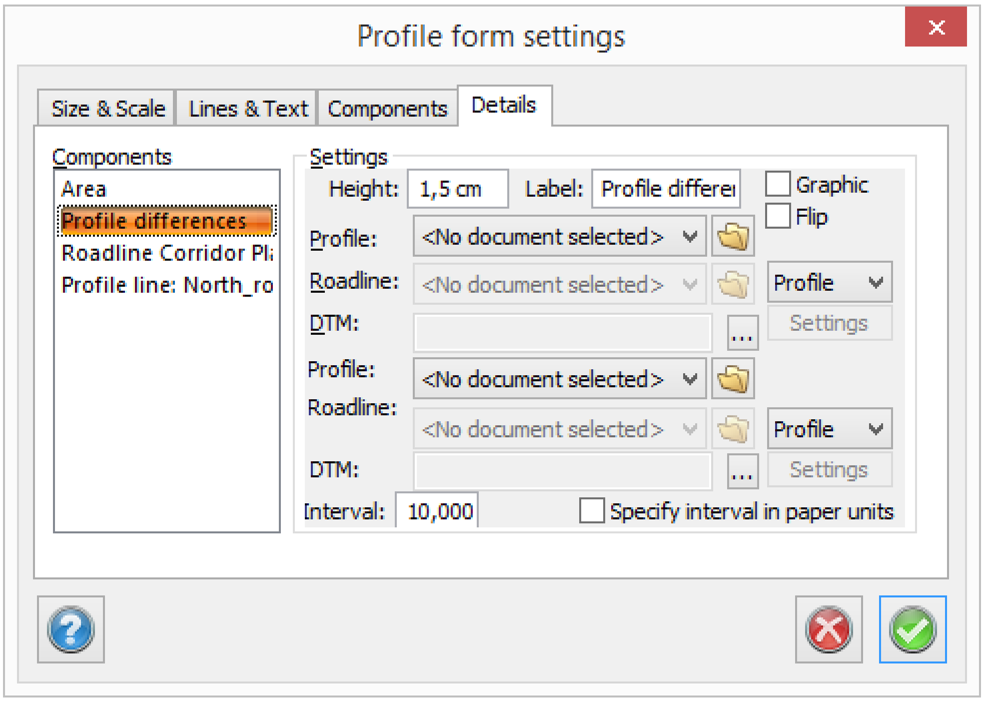
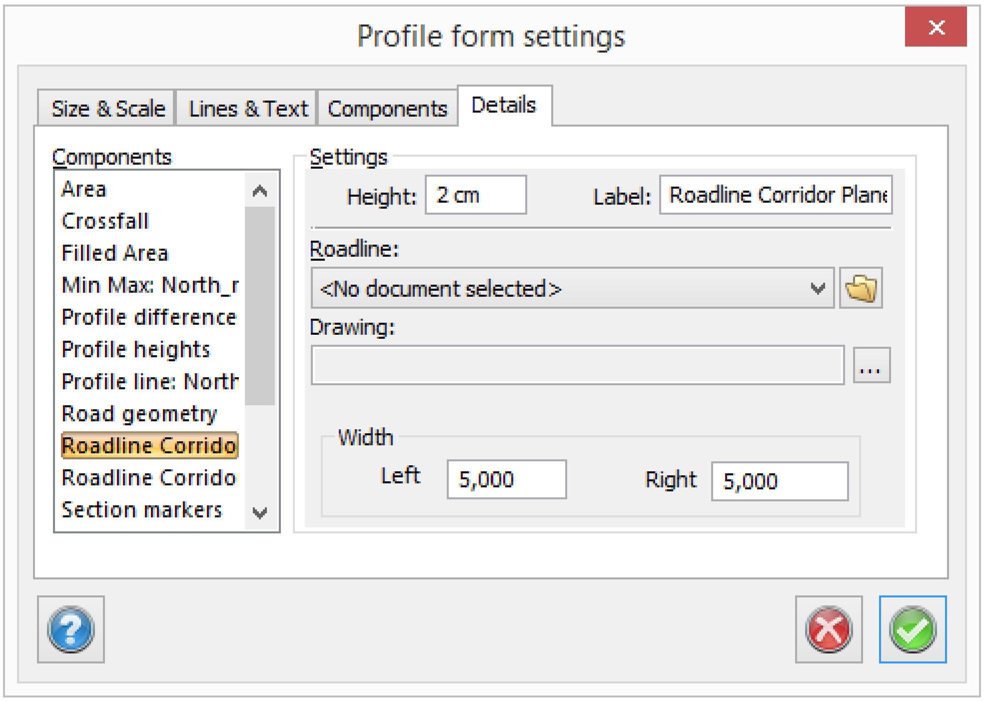
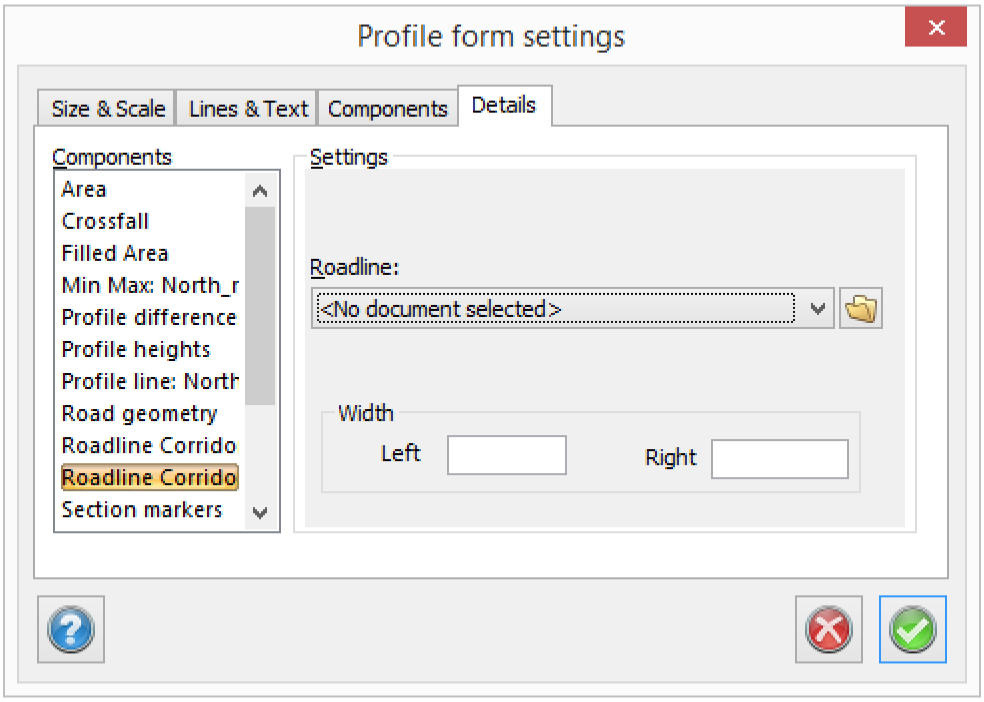
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



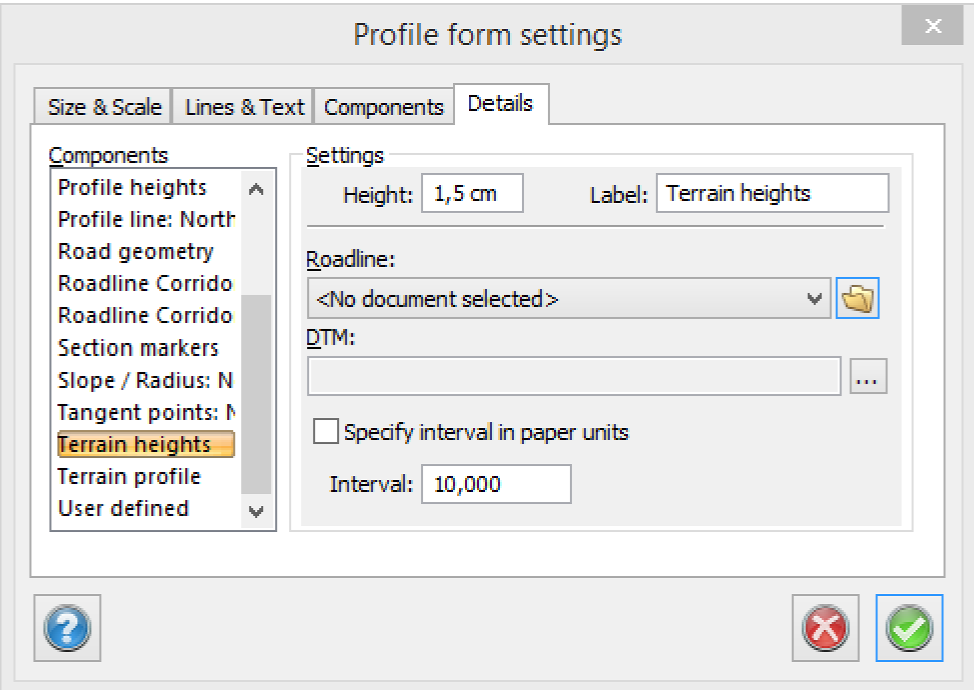
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

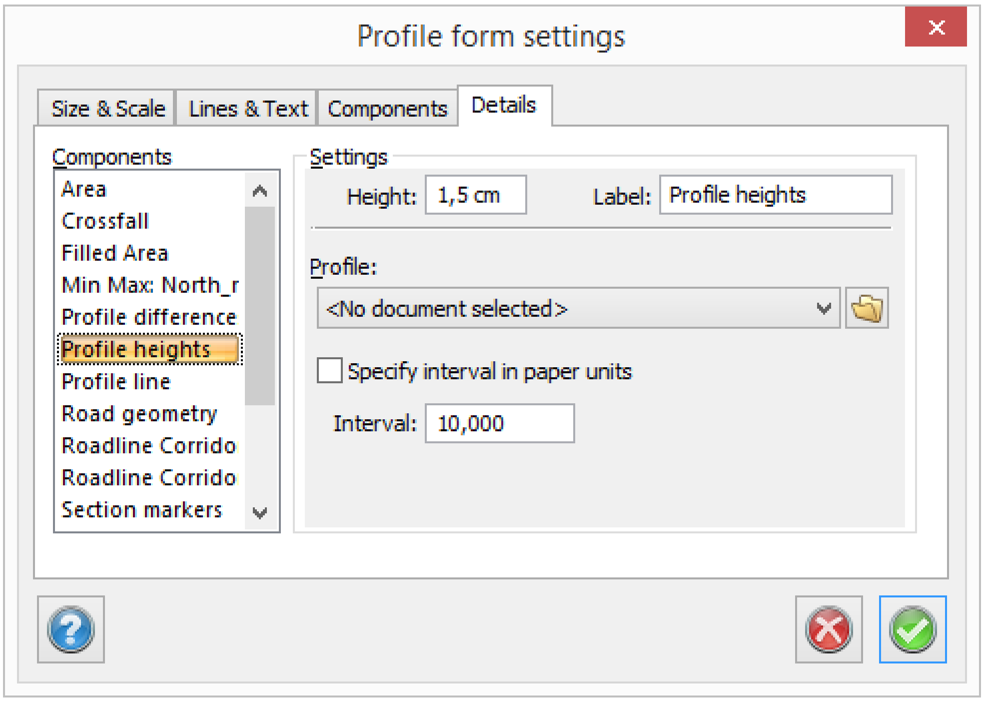
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

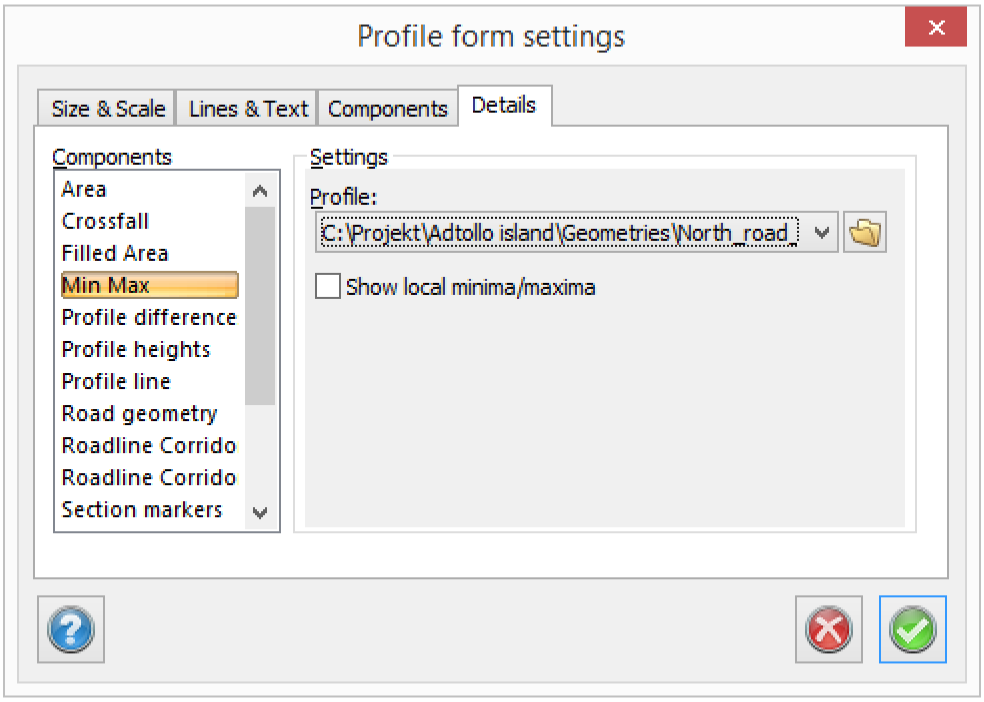
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

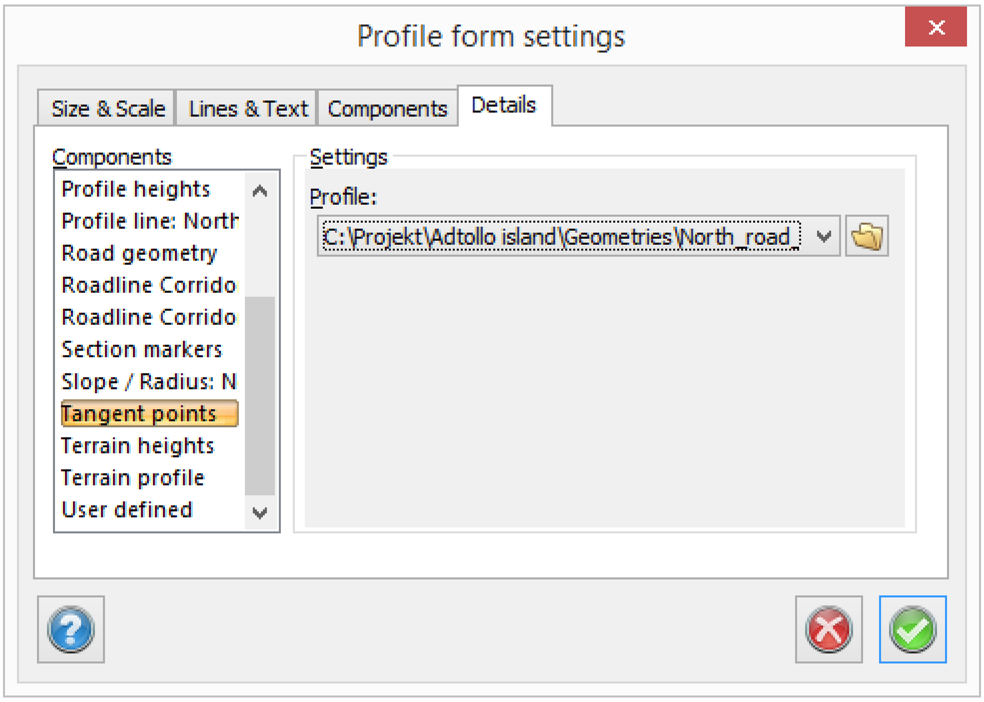
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

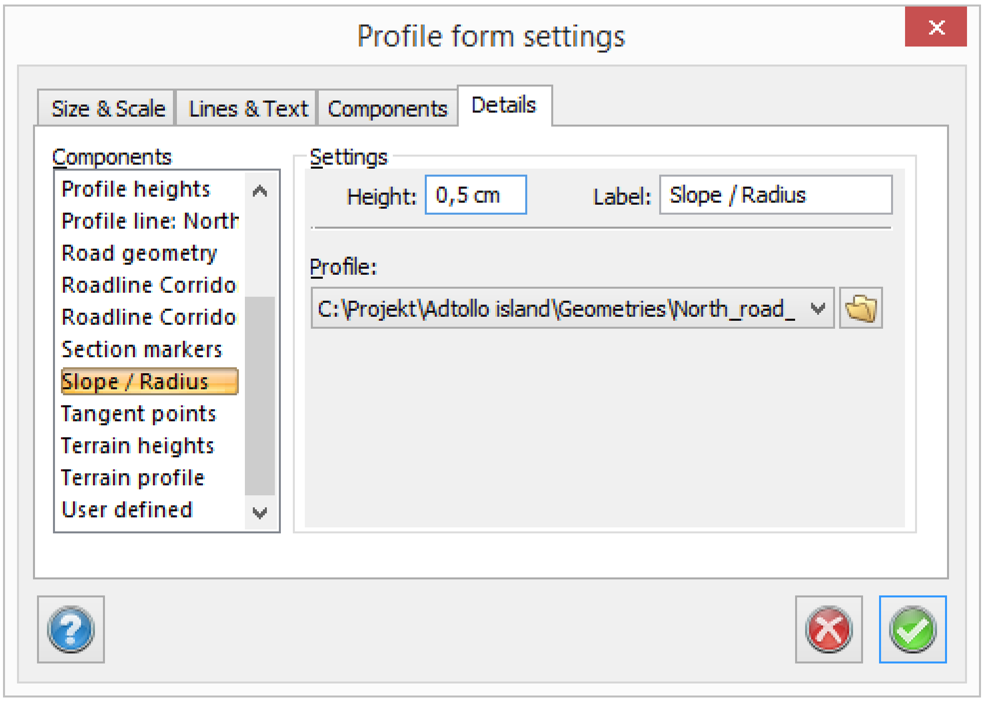
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

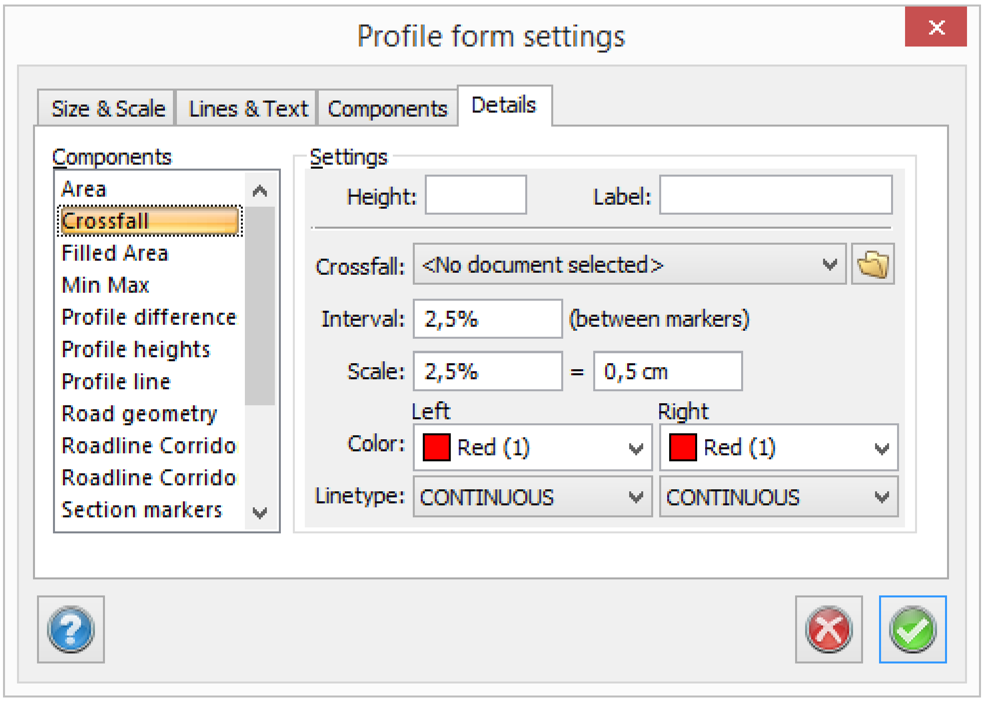
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

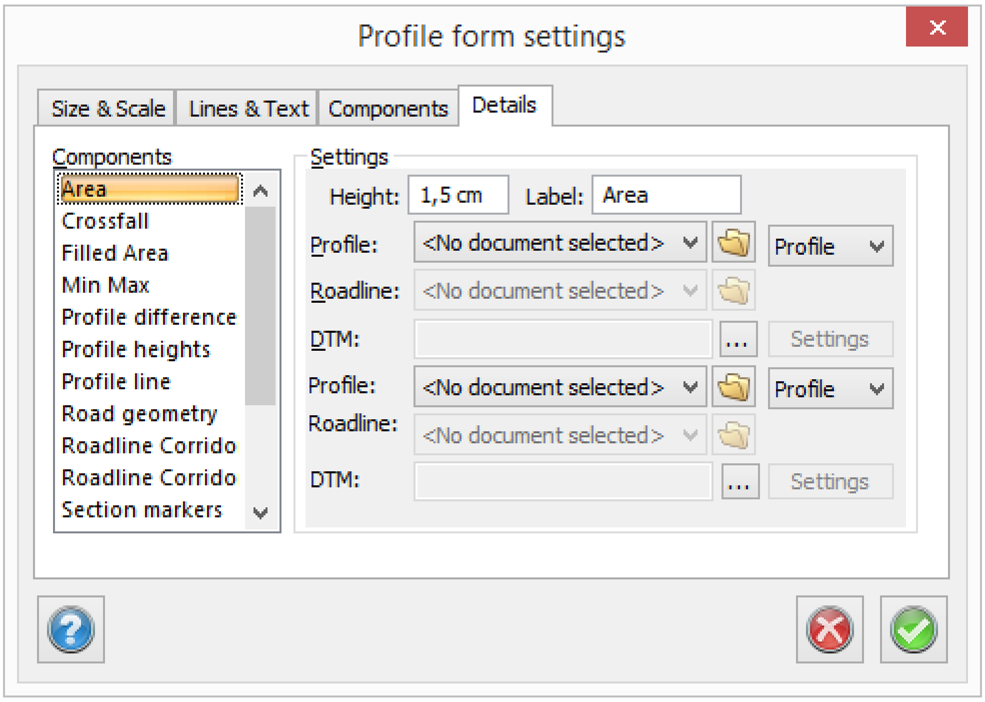
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

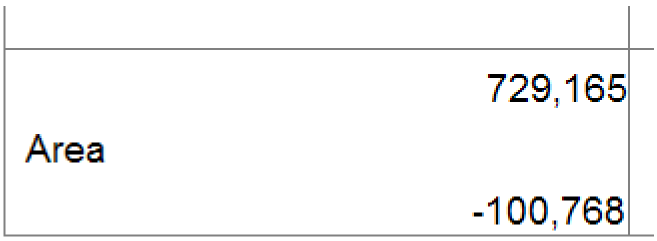
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

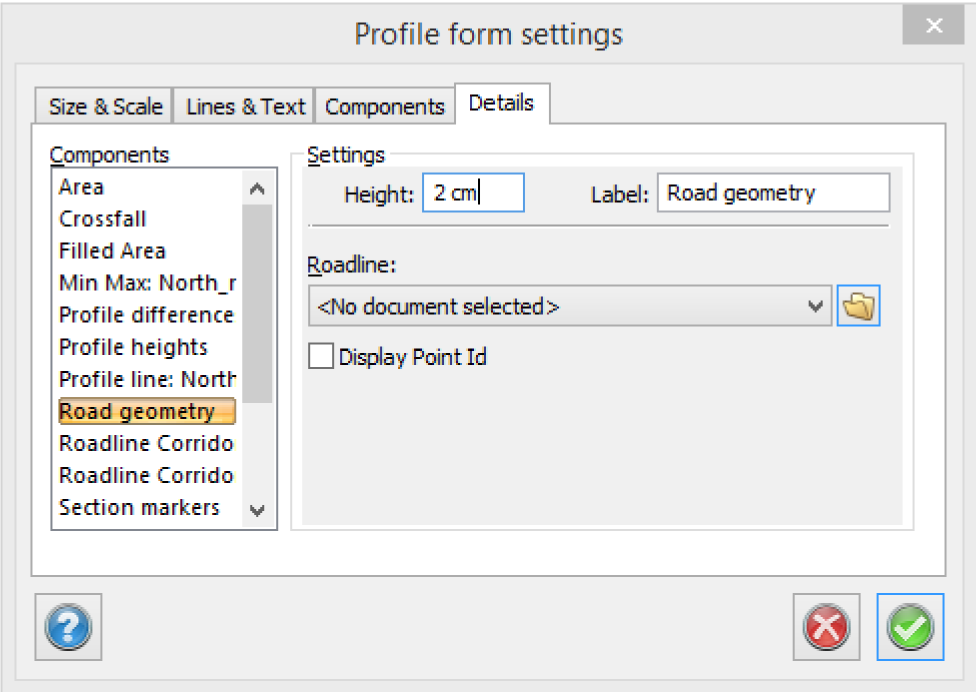


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

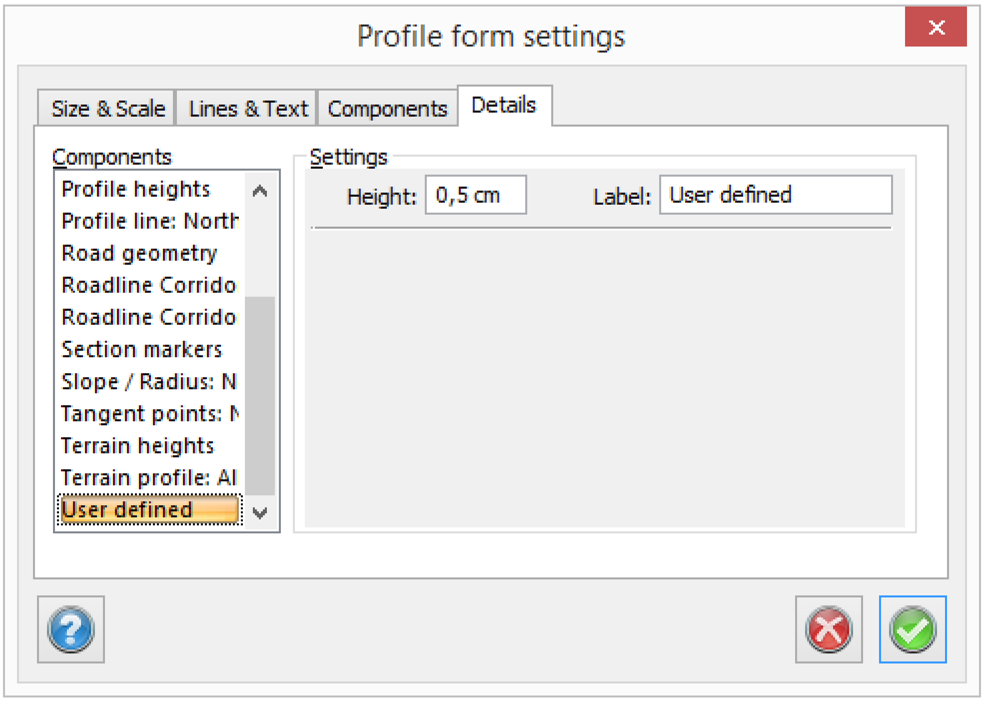
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

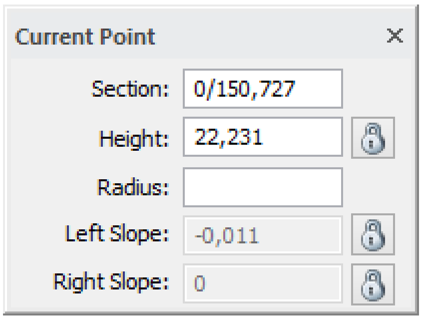
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

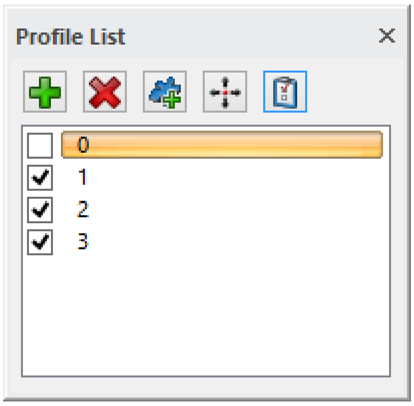
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



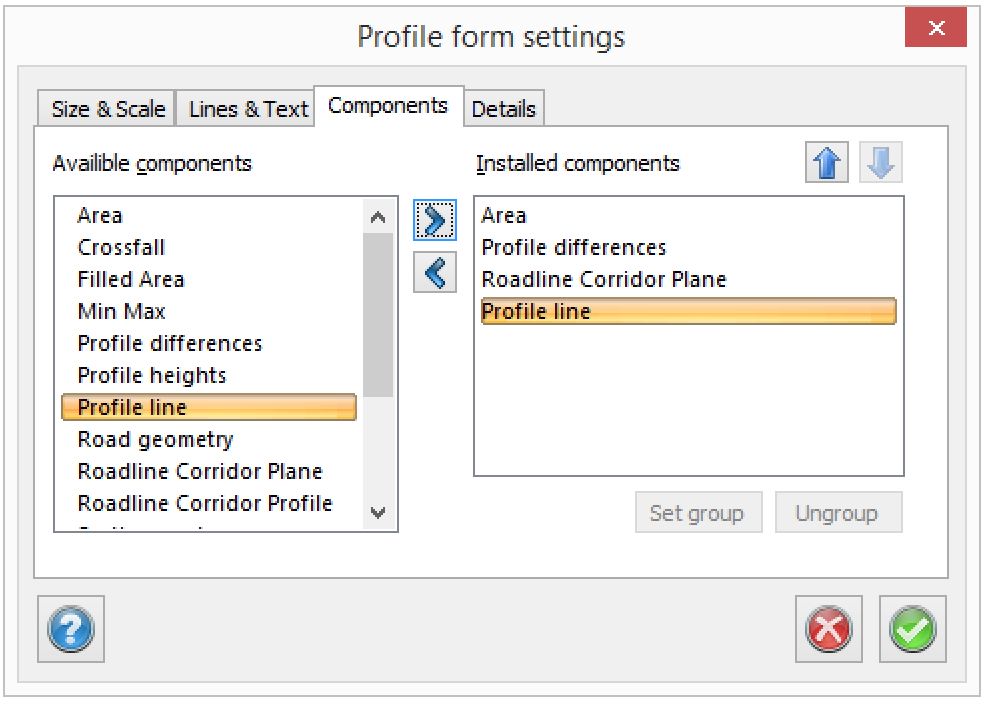
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

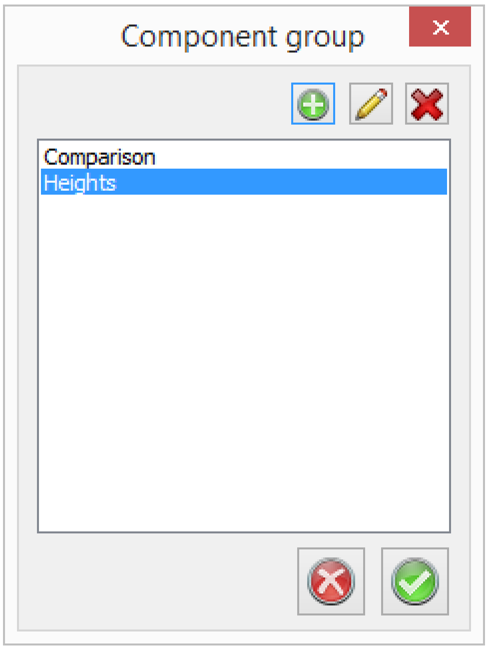
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Profile form

Profile form

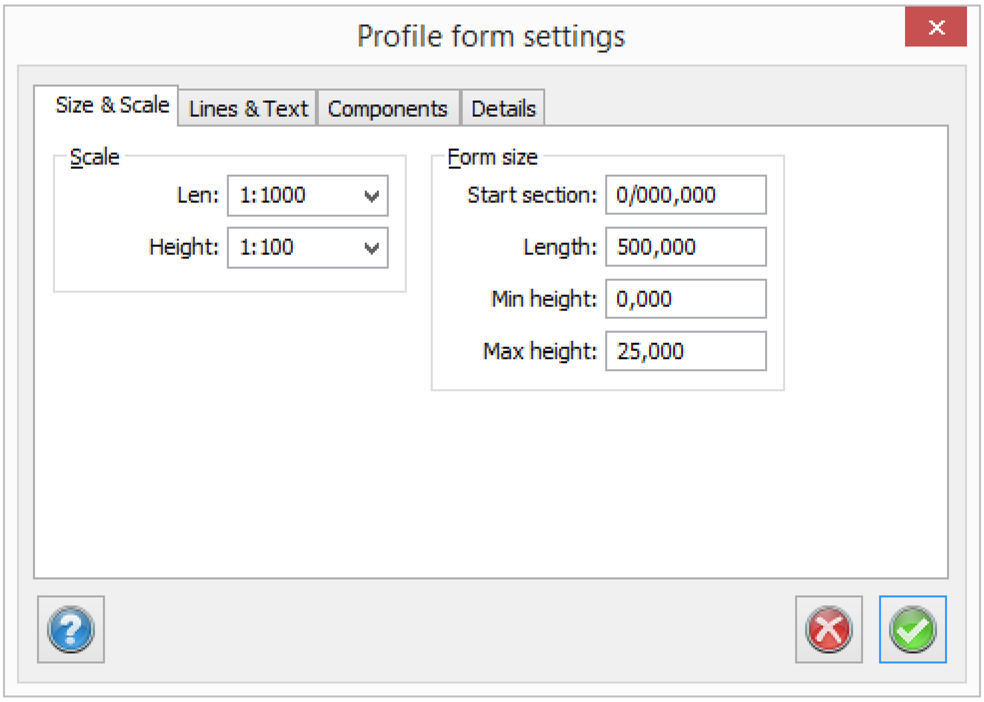
Function, command	Description
Profile form	
Size and scale	
Lines and texts	
Components	
Profile line	
Details, Corridor	
Terrain profile	
Profile height	
Minimum/Maximum	
Tangents	
Slope	
Length	
Crossfall	
Area component	
Roadline	
User defined	
Interpretate	
Multiple profiles	
Current Point	
Explode profileline	
Croup components	

In the Profile form, you enter not only the components but also the form itself, which everything else is based on. Like everything else, this form can be edited later or while working on the profile form.

The form dialogue box contains four tabs. The first two, Size & Scale and Lines & Text, are used to adjust the appearance of the form, while the other two tabs, Components and Details, relate to the items involved in the profile form. There are default sizes for the profile, but it is better to always change these first to suit your own requirements.

Profile form settings, size and scale

The settings that can be made in Tab 1, Size & Scale, are as follows:

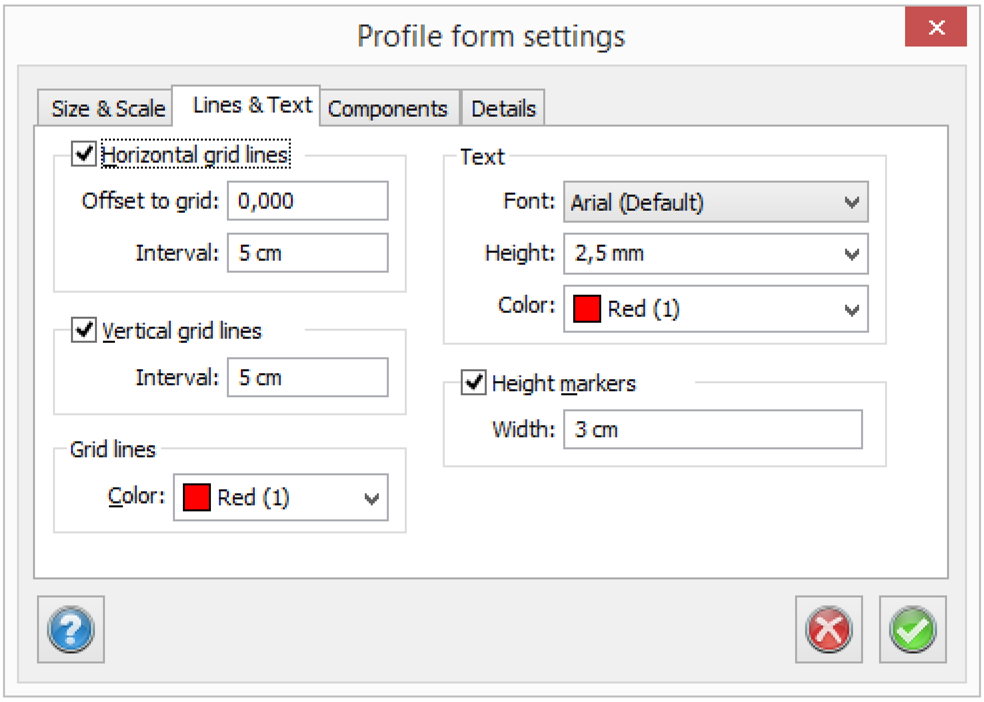


Scale
Vertical and horizontal scale. The relationship between these two settings also determines the relationship between the height and length of the profile. You can enter any values. This scale will be the default when you come to insert this profile form into a Topocad drawing. The default scales are: Vertical 1:1000, Horizontal 1:200

Form size
The start and end section and the minimum and maximum heights are entered here. If you do not know the lengths and heights, you can guess at a value, ideally a high one.

Lines and texts

The settings that can be made in Tab 2, Lines & Text, are as follows:



Horizontal grid
Enter the side offset from the frame to the grid and the interval between grid lines. The size is given as the

size of the printout.

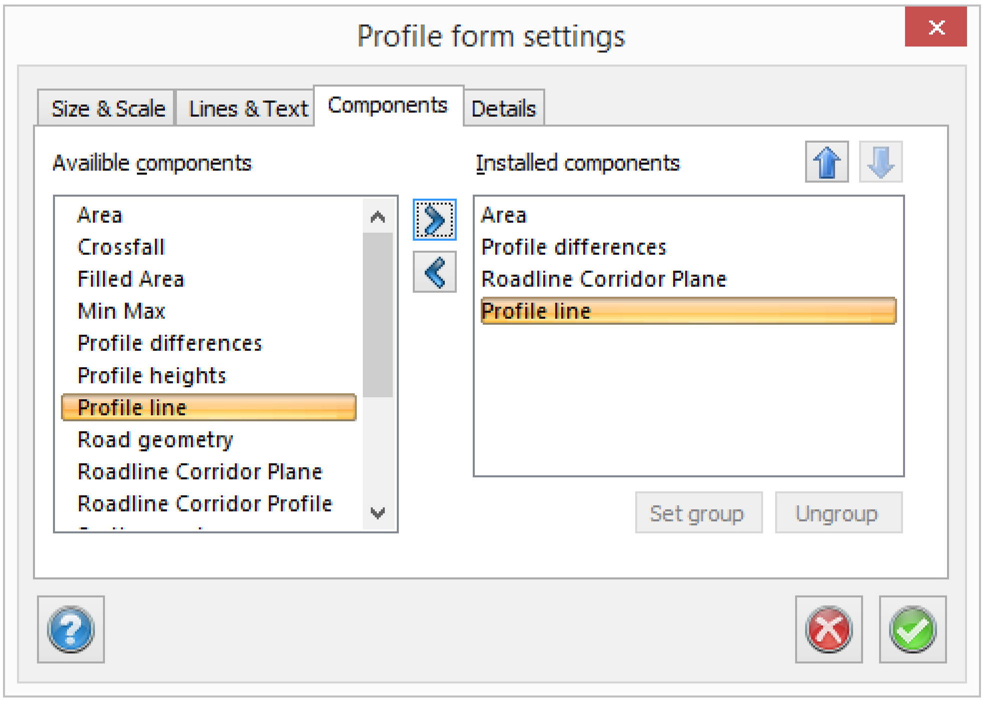
Vertical grid
The vertical interval between the grid lines is entered here. You can choose any unit for the size.

Grid
Enter the colour for the grid. This colour will also be used when the profile form is imported to a Topocad drawing.

Text
Enter the font style, the text height and the colour in which you want the text to appear in the profile form, in this case the form itself.

Height markers
Enter the size (width) for the height markers. These height markers are displayed on both the left and right-hand side of the profile form.

Profile form, components



The dialogue box contains two columns - the left-hand column shows available components and the right-hand column installed components. This is similar to the one used for survey data settings and text edit settings.

Data contained in profile form:

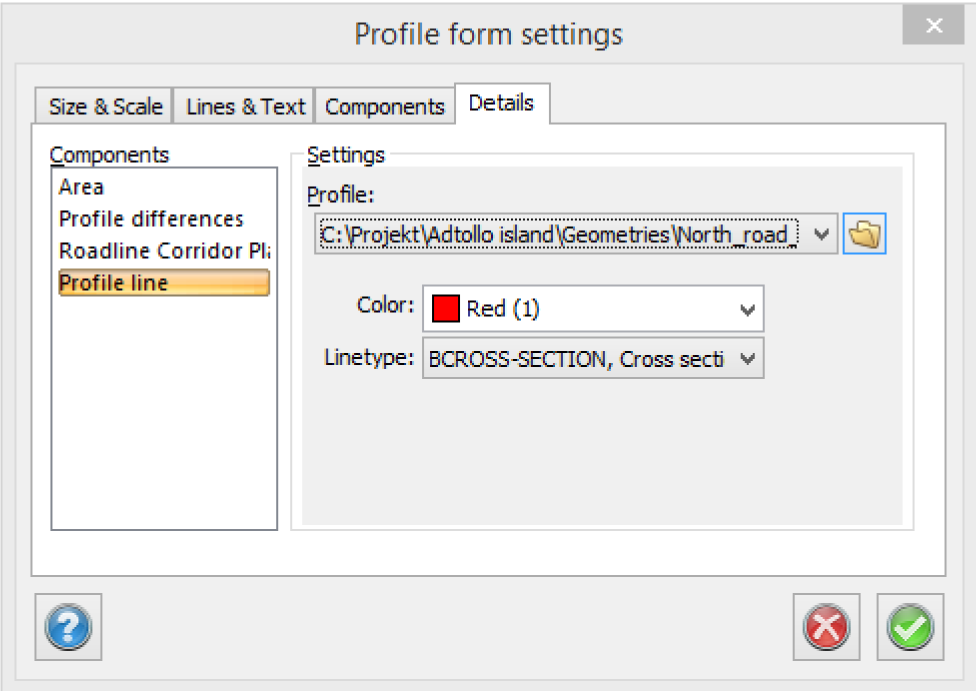
- Area
- Crossfall
- Filled Area
- Min max
- Profile differences
- Profile heights
- Profile line
- Road geometry
- Roadline Corridor Plan
- Roadline Corridor Profile
- Section markers
- Slope/Radius
- Tangent points

- Terrain heights
- Terrain profile
- User defined

You can add components you require by clicking on the header to the left and then clicking Add; alternatively you can double click. Note that the header/label remains on the left-hand side because it is possible to use several components of the same kind in the profile form. For example, is it possible to have several terrain profiles/sections for different roadlines or for different digital terrain models.

The order in which the components appear in the right-hand column is the order in the profile form.

Details, profile line



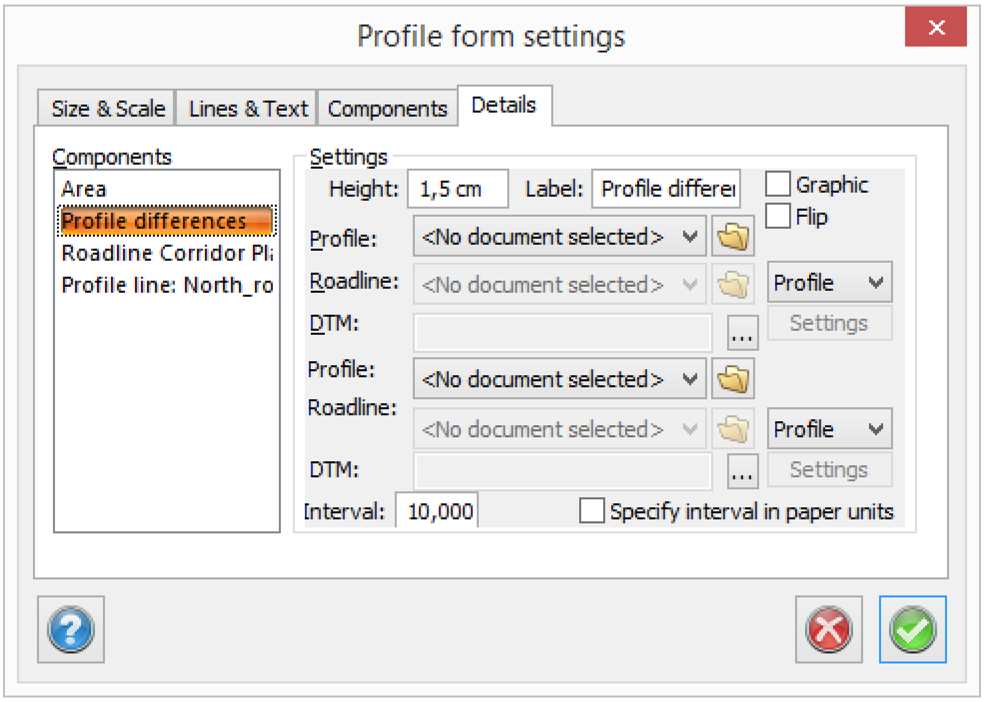
The road profile is displayed in the profile form by adding it on the Components tab. On the Details tab, click on Road profile and select the desired road profile. Also select the colour and line type for the road profile.

The road profile will be displayed in the upper section of the profile form. If the profile form is not of sufficient length or height, the profile will not be displayed outside the form. This can easily be corrected by using the Size & Scale tab to enlarge the form.

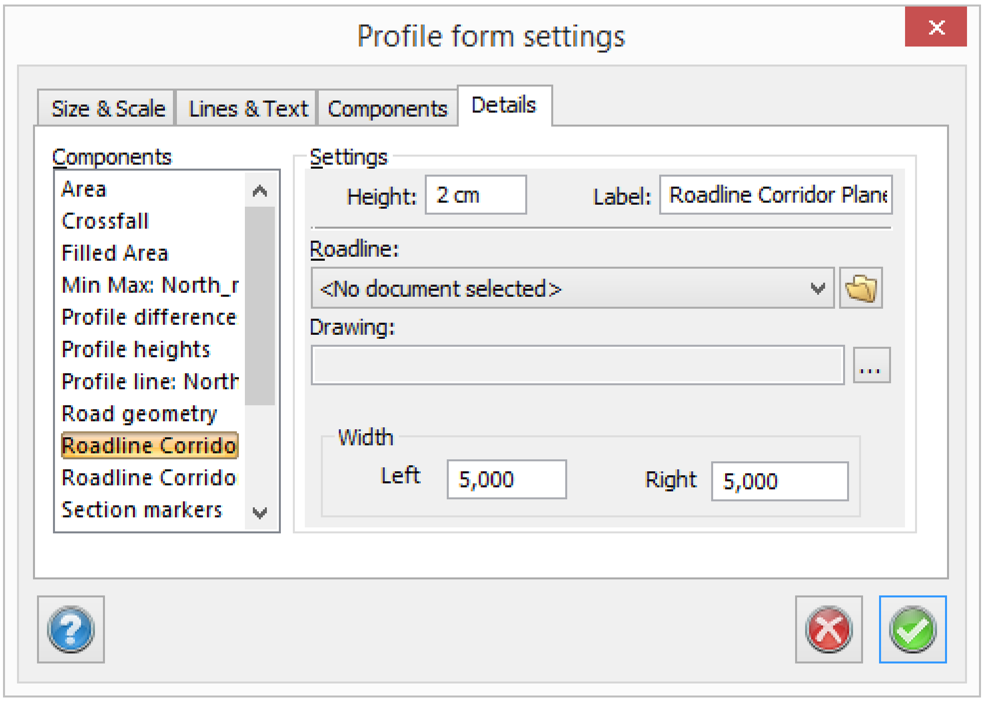
It is possible to display several different road profiles in the form.

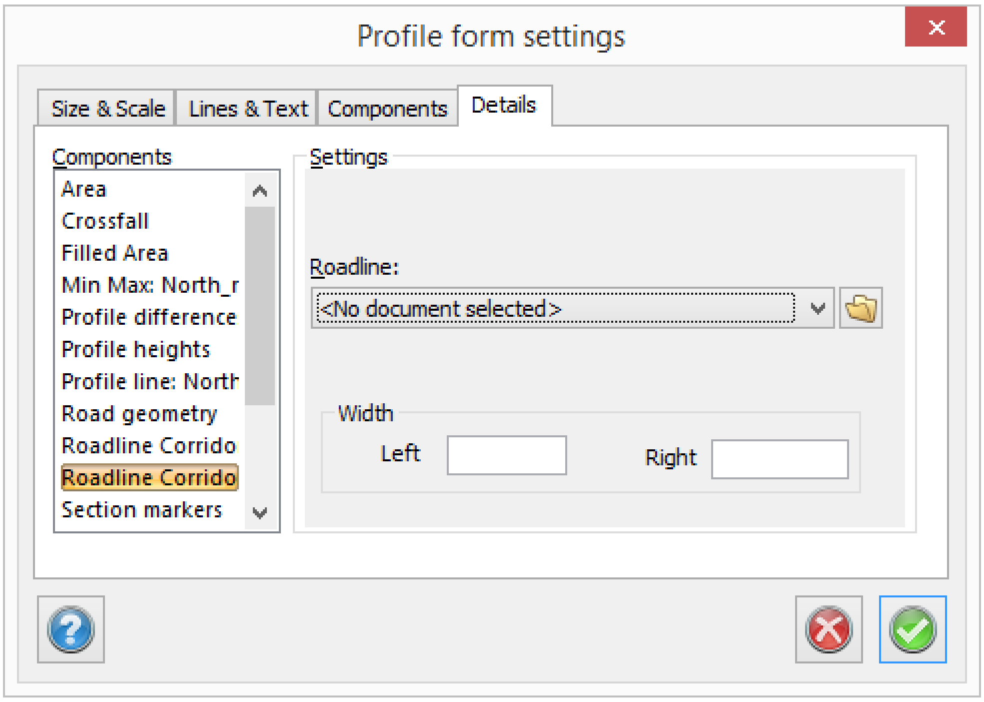
Component to compare profiles in profile form
The component compares two profiles and presents the differences either graphic or with numbers with even intervals. A profile can either be represented by a profile file, or by a combination between a road line or a terrain model file. Select how the two profiles shall be represented in the two combo boxes to the right.

Negate: Changes plus to minus. If the box is unchecked, the result is the first profile minus the second profile. If the box is checked, the result is the second profile minus the first profile. The first profile is the one on top in the dialogue, the second is the lower in the dialogue.



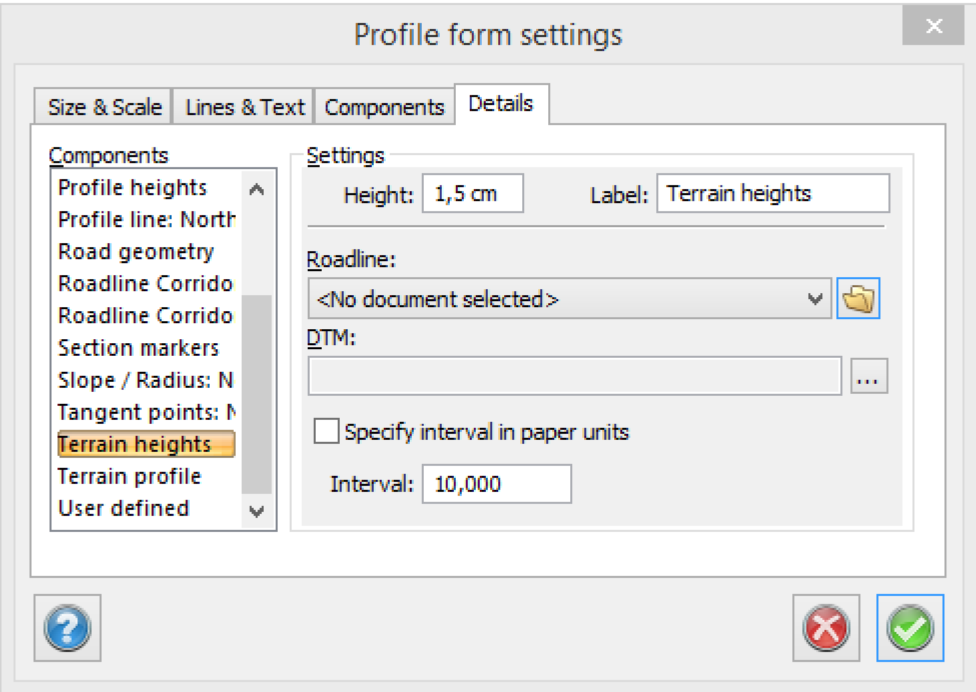
Details, Corridor Plan





Component Roadline Corridor Plan
Alignments plotted as a line with the surrounding heights and items reported. Surveyed object beside roadline, as a corridor around the alignments, shown in profile form.

Details, terrain profile



The component Terrain heights adds the height of the selected terrain model along the road line with even intervals.

The terrain section is created by using a roadline and a digital terrain model. The heights at which the roadline crosses the triangles in the digital terrain model will be used for the terrain section. The data required is a calculated roadline and a digital terrain model.

Roadline
Load the roadline to be used for the terrain section. The roadline has the extension .trl (Topocad roadline).

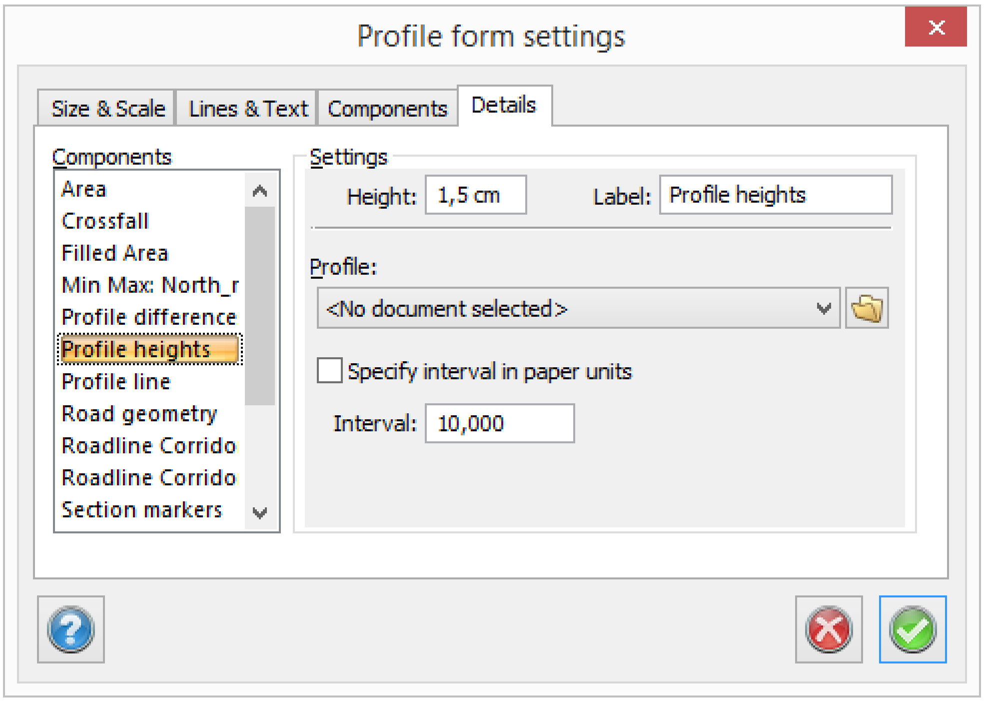
The roadline must cross the digital terrain model to be used at some point.

Digital Terrain Model, DTM
Load the digital terrain model to be used for the terrain section.

Colour
Enter the colour for the terrain section.

Line type
Enter the line type for the terrain section.

Profile height



The profile height can be displayed and calculated at any interval along the roadline. This interval can actually be specified as the actual value in meters or in any other paper units.

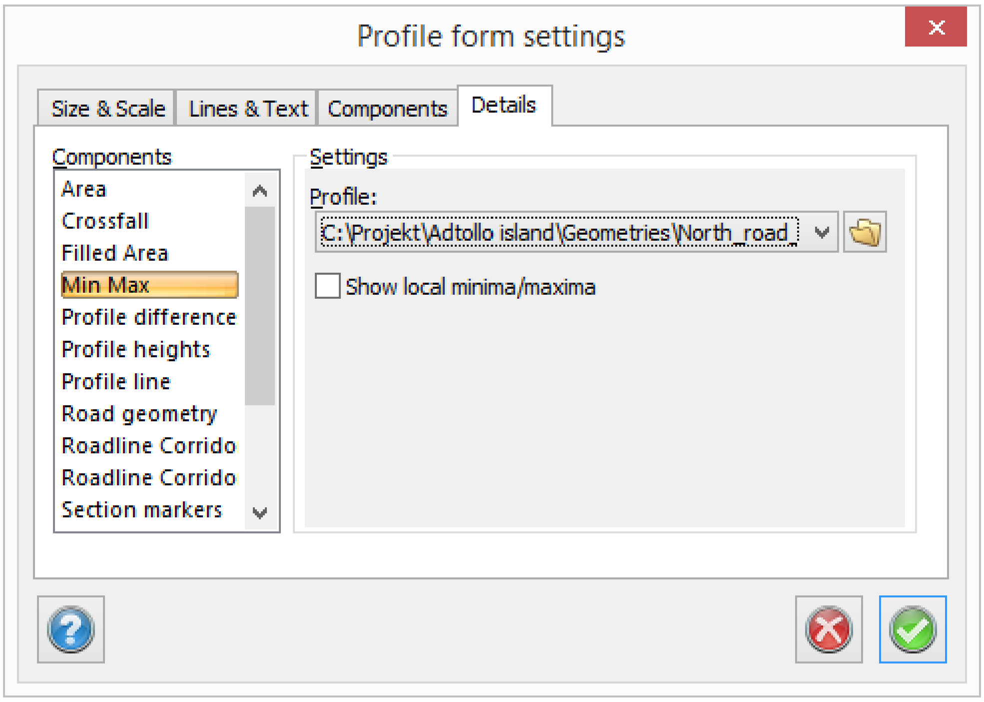
Settings, height
Enter the height at which the block for the profile height is to be displayed. The unit can be m, cm or mm.

Settings, header/label
Enter the label to be used for this block. The default is the profile height, but it can also be the section height, road profile height etc.

Road profile
Select the required Road Profile, the extension is .trp.

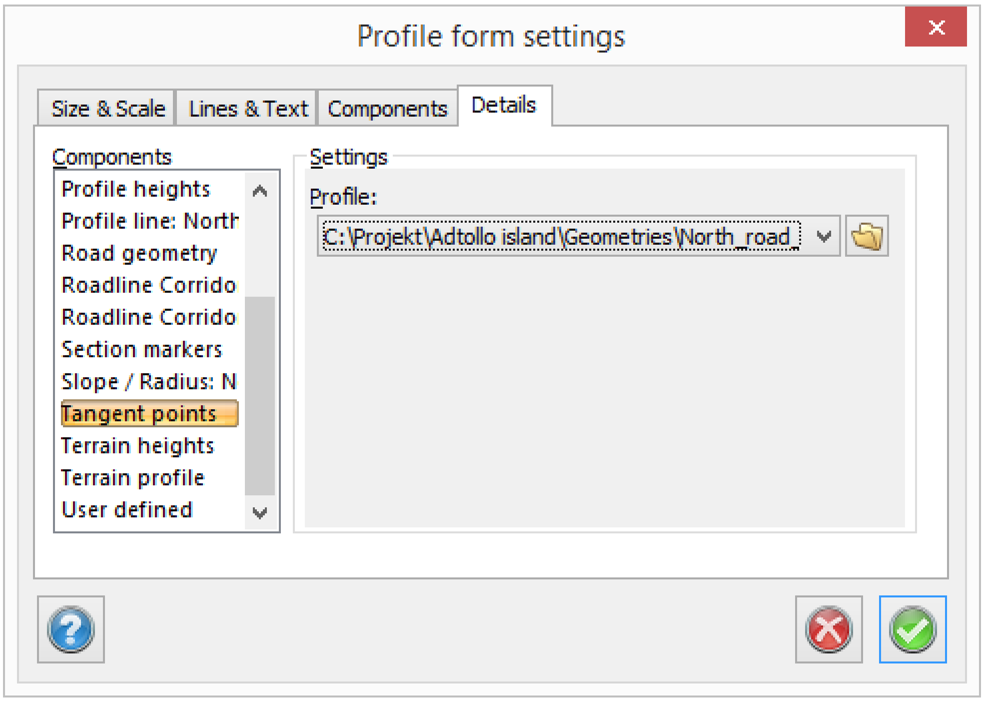
Interval
Enter the interval as an actual value or in paper units.

Minimum/Maximum height



The component minimum and maximum height in profile form displays height and section for a profile's height and low points. Tick the box for Show local minima/maxima (default) to view all height and low points. If the box is not ticked only the highest and lowest point will be viewed. The component does not display height and low points from terrain models.

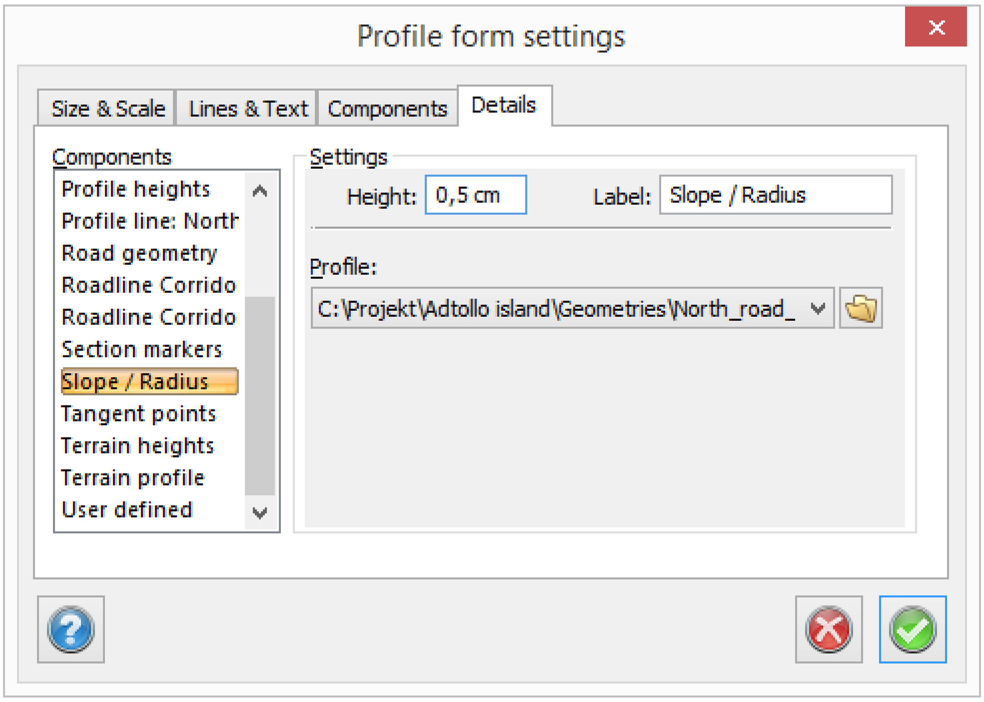
Tangent points



Tangent points specify the tangent points for the radius and other elements in the road profile.

Enter the road profile; the tangent points for this road profile will then be calculated and displayed in the upper section of the profile form.

Slope/Radius



This component displays the slopes and radius in the lower section of the profile form. Slopes can be specified in percent or in per mill. This selection is made under *Settings*|*Roadline*.

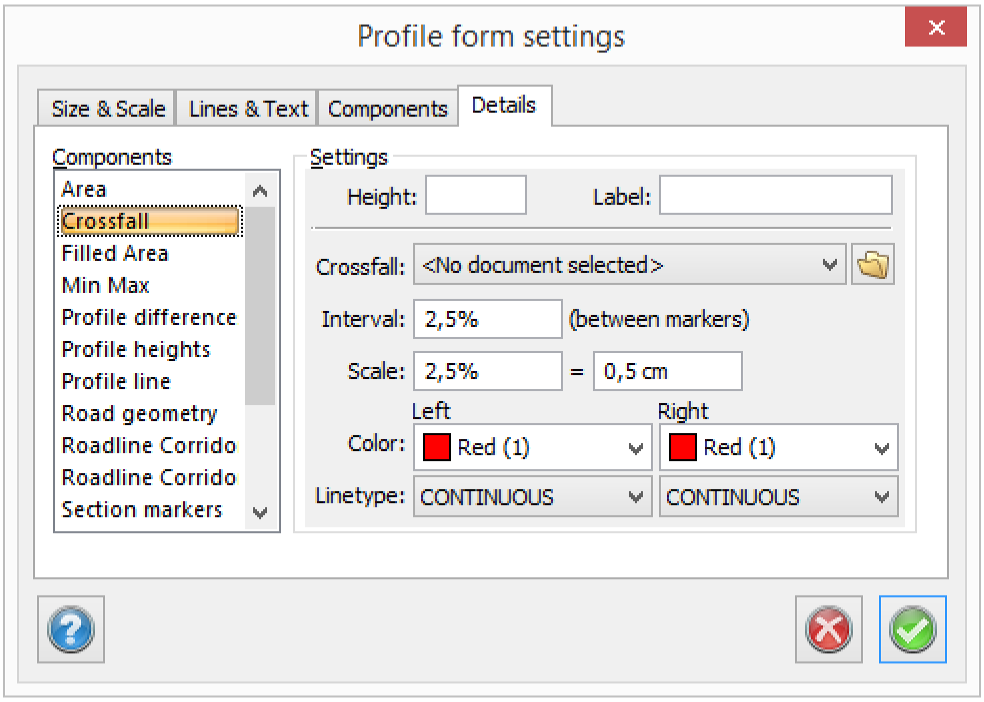
Enter the height and label for this block and select the road profile to be displayed in the block. Several road profiles can be used in the same profile form and, in turn, several slope/radius blocks for different road profiles.

Length/section

The section measurement / length measurement are used to indicate sections of any given interval. The length can be specified in paper units or as the actual length.

You should also enter the height for the block and the label. You can use any label.

Crossfall



The crossfall is loaded from a Camber diagram and can be displayed in several different ways. Numbers in crossfalls (*.tcf) are interpreted as per cent. Writing 2 becomes 2 %.

Settings, height
Enter the height for the block.

Settings, label (header)
Enter the label for the block - this can be Crossfall (default), Cross slope, Cross section slope, Camber etc.

Crossfall
Load the crossfall document, extension .tcf. If it has not yet been created, go to *File*|*New*, select Crossfall and create the crossfall.

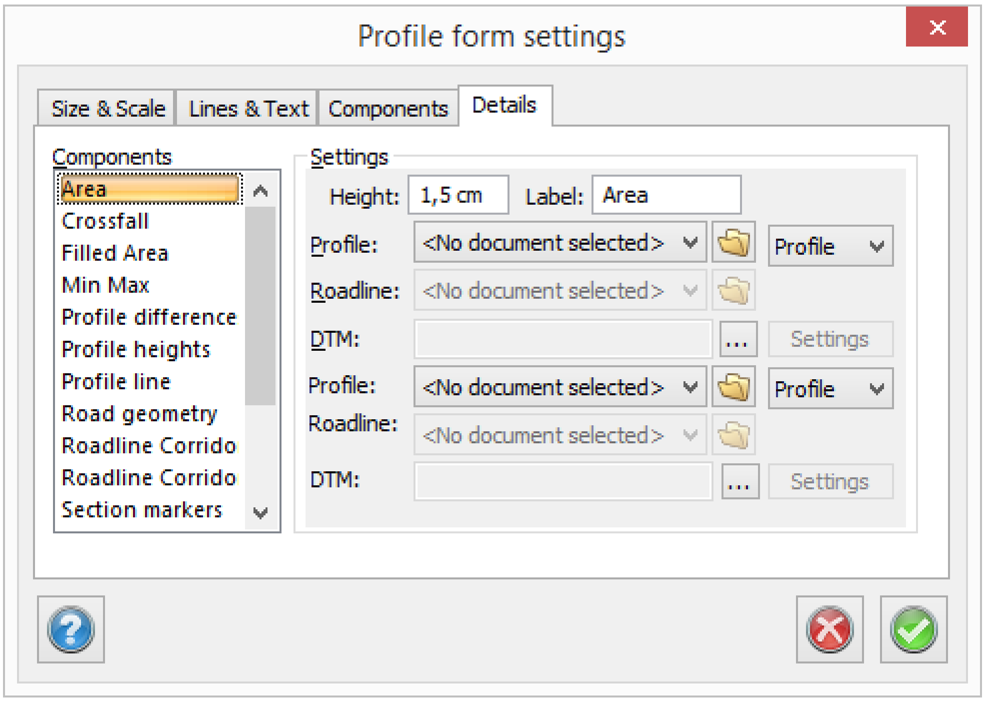
Interval
Enter the height interval at which the block will be divided. The default is 2.5% but you can choose any other value. It depends on the type of road and the slopes used.

Scale
Enter the scale to be used. The default is 2.5% = 0.5 cm. If the height is selected as 2 cm (default), this will enable you to have a maximum crossfall of 5% without exceeding the block limits. The distance is in paper units.

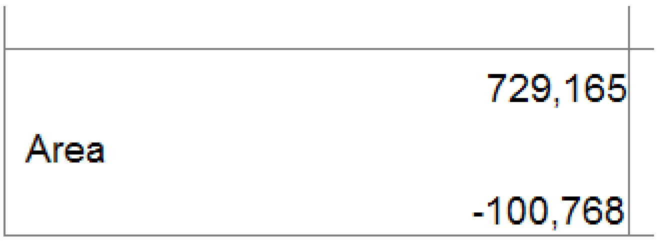
Colour and line type
Enter the colour and line type for the right and left side of the road. It is good to select different colours or line types to enable you to differentiate them in the profile form.

Area component

The area component is a component to the profile form for calculation of areas between profiles.

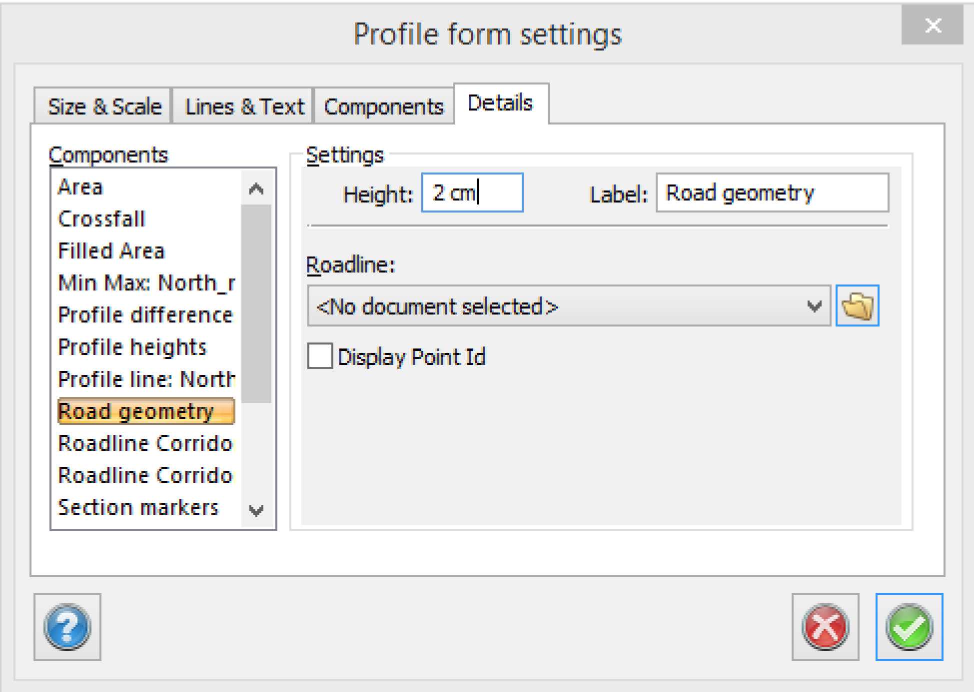


Two profiles must be selected to calculate the area. In this case the profile can be either a profile (*.trp) or a Terrain profile created from a roadline (*.trl) together with a terrain model (*.dtm). Each intersection between the profiles is presented in the form with a vertical line together with its section. The area between two intersections is written between the two intersections. If the first profile is positioned above the second, the area gets a positive value, otherwise a negative. The sums of all the positive and negative areas are presented to the left in the profile form.



Example of a profile form with an area component inserted.

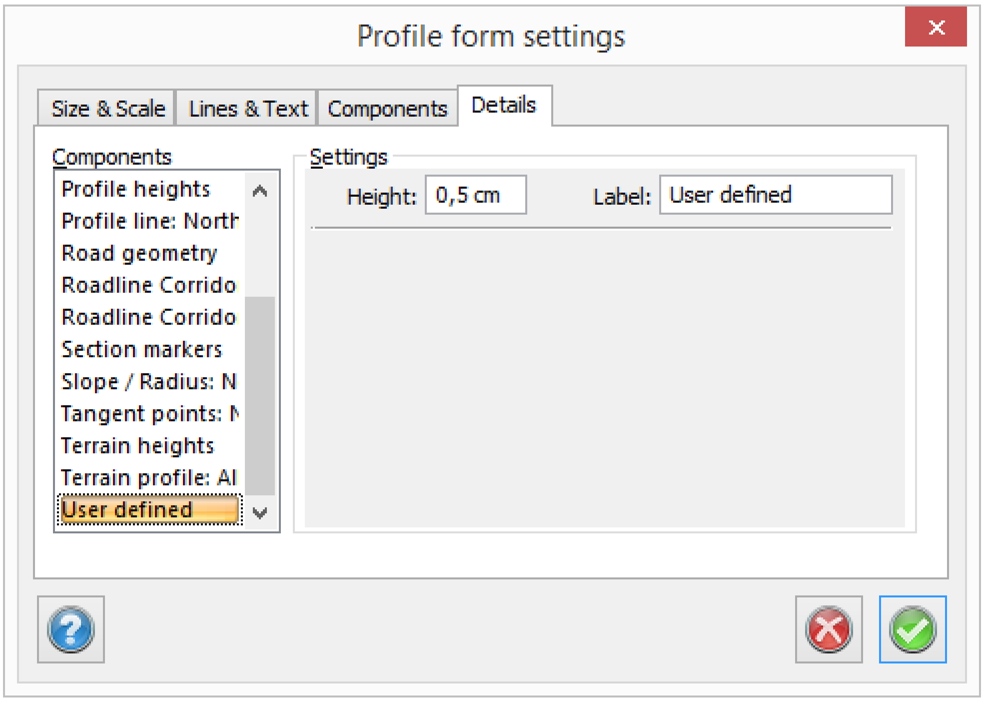
Road geometry



This component is used to display the tangent points for the roadline. It displays the points between elements (straight lines, radius and clothoids) in the road.

Enter the height for this block and selected the desired calculated roadline, extension .trl. You should also enter the label for the block - this could be Road geometry, Roadline data, Plane data etc.

User defined



It is possible to enter user defined blocks in the profile form. You can select the height and label for the block. The block is then displayed in the profile form drawing and you can use it to enter any type of data.

Interpret road profile

It is very easy to interpret a road profile direct from the profile form. Start by creating the terrain section, so you have something to check.

The different commands available under Interpret profile are:

Add points before/after current point
Indicates the direction in which points are added in the road profile. You can create the profile from any direction or from the middle. The setting is also indicated by the +/- icons in the menu. Compare with section template/cross sections.

Add points
Add points in the direction displayed above.

Edit point
Enables you to edit any tangent point in the road profile.

Delete point
Deletes the selected tangent point.

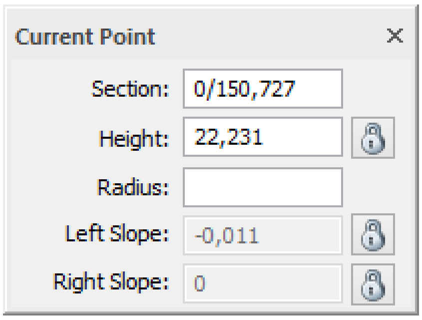
Select point
You can select a tangent point using the left/right arrows in the menu or by clicking on the point using the icon to the right of the arrows in the menu.

Save profile
Opens the calculated road profile document, which you can then edit in text mode and/or save.

Set radius
The button Set radius let the user set the radius for selected point. Select a point, click Set radius, and by moving the mouse in the profile form you draw a radius from the selected point. Click again to finish.

Create transition curves / spirals in profile
It is possible to select transition curves, spirals, in the profile. By selecting *Construct*|*Left spiral* respectively Right spiral, this is made graphical. Then the spiral and its tangent points appears. Observe that the command is sensitive. After the spirals have been added, they can be edited. It is also possible to edit the radius afterwards, which then edits the detailed spirals at the same time.
Spirals can also be selected directly in the profile.
Read more in Road profile

Current Point



Shows the section, height, radius and slope for the current point. To the right is a column in which you can select and lock any of the above fields for the specific Point. This box is similar to the one used in Roadline - Current Point. This box is vital for editing the road profile.

Lock height: If lock height is selected the point's height cannot be changed in any way except by selecting a value in the dialogue, when the point is selected. If the height is unlocked it changes depending on how the user changes contiguous points.

Lock left slope / Lock right slope: Locks the slope on the right or left side of the point. Then the user can edit the value for the slope. A locked slope can only be changed by selecting a new value in the dialogue. To unlock a height or a slope just click the checkbox.

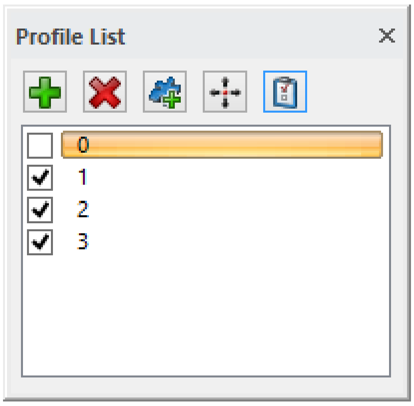
The procedure is as follows:

1. Go to *Insert points.*
2. You can now click on the positions in the profile form at which you want to place your tangent points. Note that the tangent points are inserted even for a radius - the tangent point for any radius is in the fillet of the two slopes that are involved in the radius.

3. The simplest method is to click on the approximate point where you want to place the points and then change the position in the "Current Point" toolbox. As soon as you input a radius at the point, it will be calculated and displayed. The new tangent points will be calculated with no bearing difference.
4. When you are satisfied with your road profile go to *Save profile.* The road profile document is displayed and you can save the profile.

Multiple profiles and profile sketches

You can interpret and work with several profiles at the same time. See View|List Calculated profiles.
The checkbox decides if the profile displays or not.
Add creates an empty profile in the profile form.
Remove removes selected profile. It is not possible to remove all profiles, as the profile must contain at least one editable profile.
Add from component is useful if a profile has been added as a component. Click the button Add from component, click on a profile in the profile form. Now the profile has been editable and added to the list.
Properties Select properties to rename a profile.



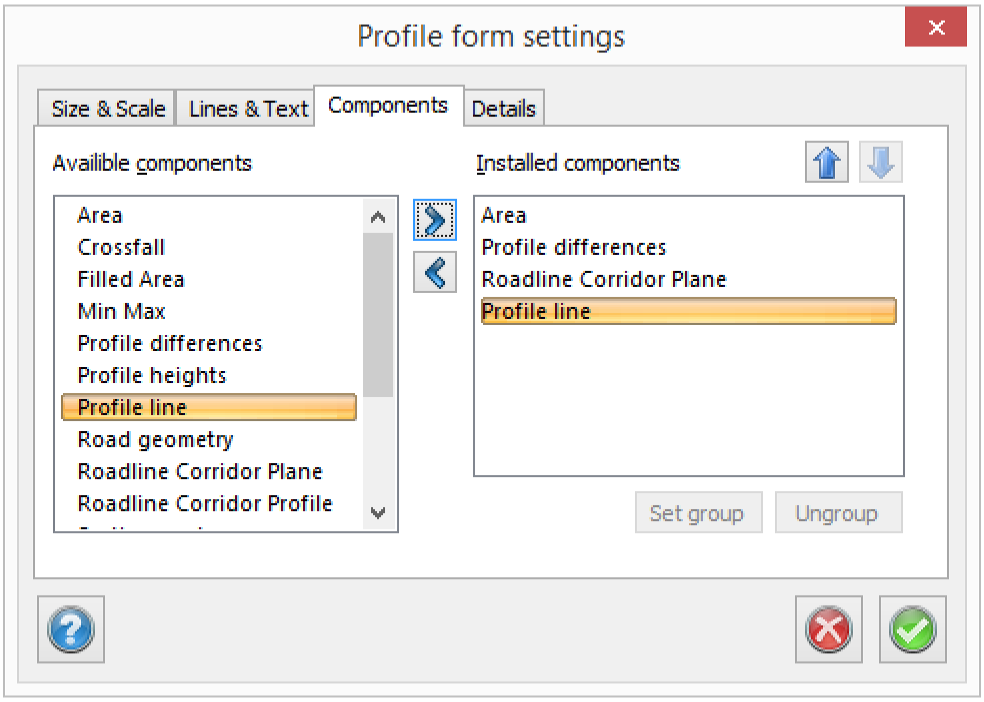
Explode profile

When you have added a profile line to the profile form you can explode this profile by clicking on the command "Add from component" and then click on the profile you want to explode. You will then have a sketch image with points of that profile.

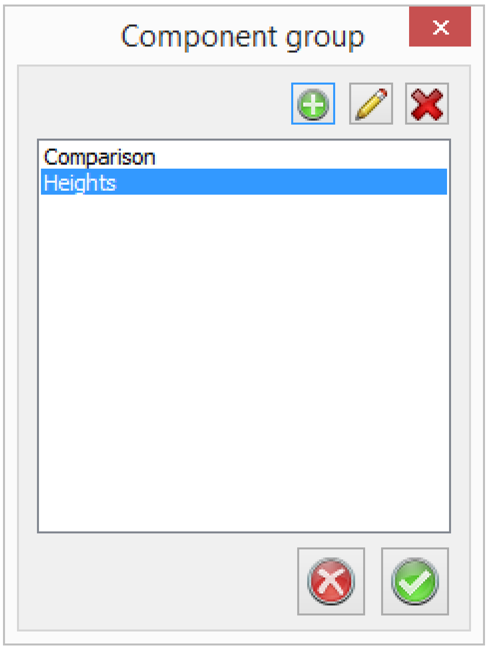
To add the profile to the drawing read more at Drawing|Profileform

Component group

The components can be grouped. This will give a headline to the component, to the left in the profile form. To group the components select Form - Settings - Components. Add components and click on the button *Set group.*



Select between the components in Available components. Components belonging to the same group is placed next to another in profile form and have the same heading.
The button Set group opens a dialogue with a list containing all groups that are created in current profile form. The dialogue also contains three buttons for create new, edit and delete group.



To create a group: Add a component to the group, select the component in the list, click on "Set group" and then choose group.
Each group has a name and a width. The name becomes the heading that can be viewed in the form and the width is for the horizontal spreading for the heading box.
Ungroup - select a component and click the button Ungroup to remove a component from a group.

See also:

Roadline document
Road profile
Create DTM
Quick profile

Point cloud contents

Point cloud .TPC

Function	Description
Import	Point clouds (.TPC) can import files from these formats.
Filter by ball	Function to filter (erase) points from point cloud.
Filter by grid	Filter by grid, one point per grid remains in point cloud.
Color from raster	Color your point cloud using a raster image.
Create DTM from TPC	Function to create a digital terrain model (.DTM) from a point cloud (.TPC).
Coordinate system	Change coordinate system
Display settings	Function to change how the point clouds are displayed.

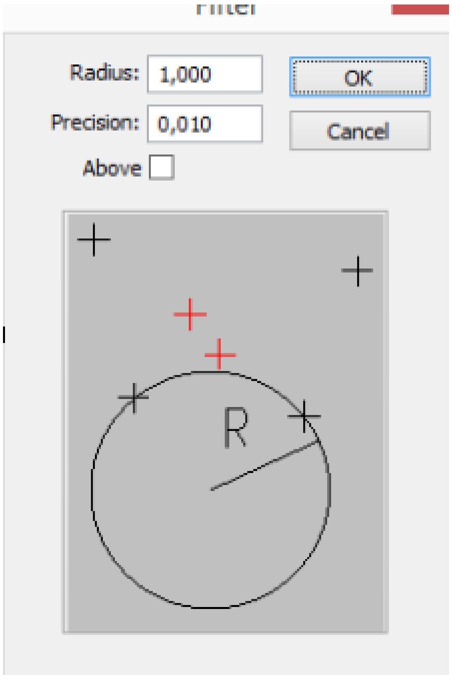
Filter by ball

Point cloud|Ball

The function filters (erases) points by a bowl with a certain radius. A point will be reduced if the bowl cannot be dropped from above (or from below depending on which side that has been selected) so the point will be hit, without the bowl first hitting another point.

Imagine a bowl rolling under a point cloud. The points tangent by the bowl are the points that will remain in the point cloud, the rest will be erased. Select different radius to add more/less points.

Precision decides how large steps the bowl "rolls" over the surface - higher value means faster filtration.

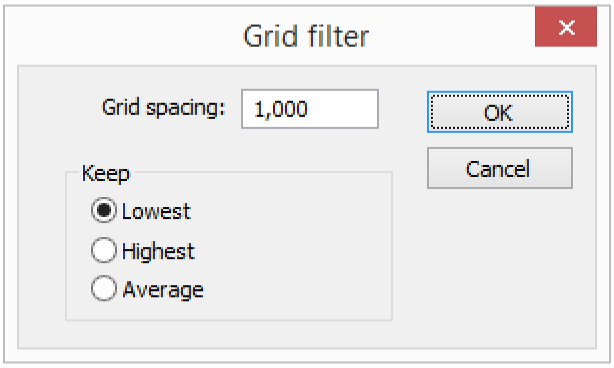


Keywords: Filter, point cloud, ball

Filter by grid

Point cloud|Grid

Use a grid to reduce the amount of points in your point cloud file, making it more manageable. After filtering one point per frame is kept.



Grid spacing

The size of the grid is determined by the grid spacing - 1.000 stands for 1 x 1 meter.

Keep

Lowest: The lowest point in the square
Highest: The highest point in the square
Average: Keeps the point which is closest to the average.

Import to point clouds

Point clouds

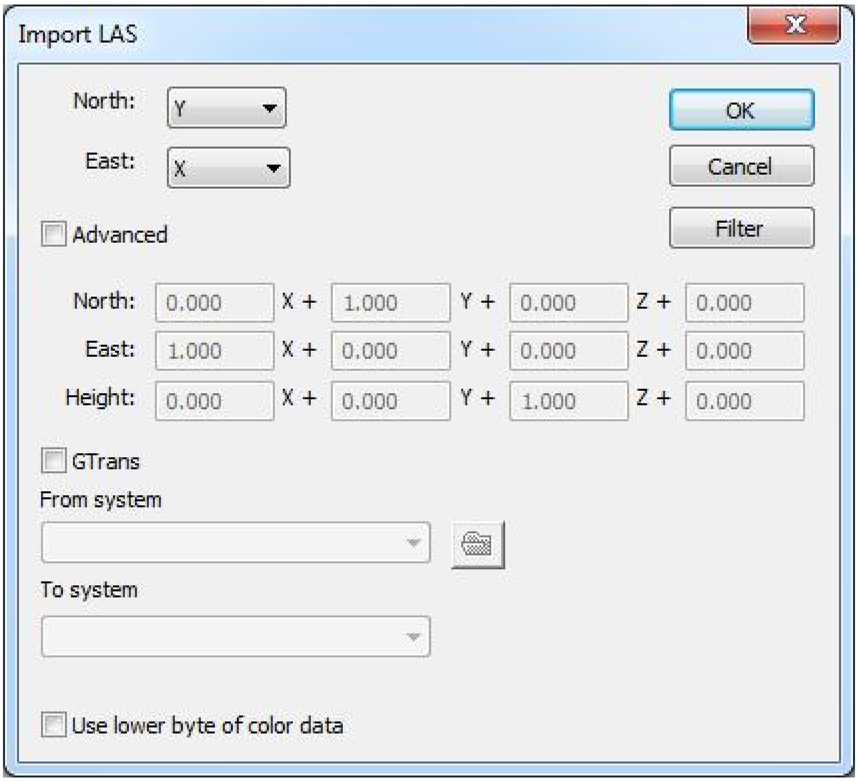
Point clouds (.TPC) can import files from

- LAS files
- ASCII files, general import
- PXY
- XYZ, Marit

The point clouds are only displayed in 2D. The file format TPC can be used as a template to

- Volume calculation model to model where you can use the TPC file instead of one or two terrain models. You can also create counter lines in the same command, by volume calculate a TPC file to a fixed level = 0.
- In calculation of cross sections (.TCS) you can use point clouds instead of terrain models.

Import LAS



If the colors doesn't look good when importing LAS files, there is an alternative way to get colors by checking the box "Use lower byte of color data".

See also

Extract point cloud

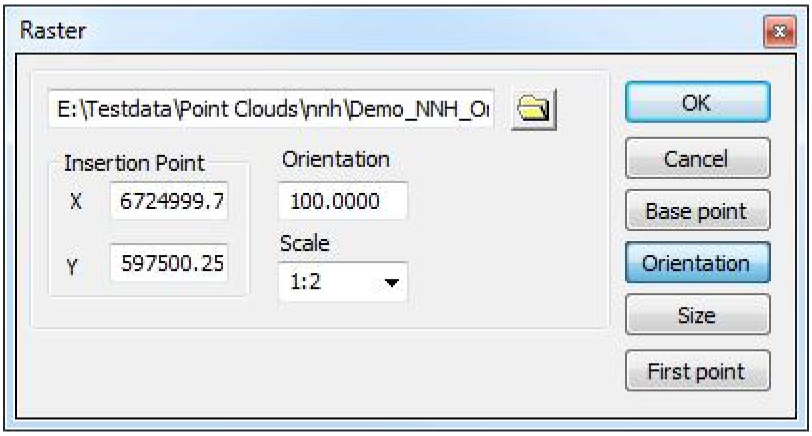
Colour from raster

Point cloud|Colour from raster

Colour your point cloud using a raster image.

The procedure is as follows:

1. Start by selecting a raster image.
2. Select raster, for example .Tiff, and the following dialog opens:



3. Place the image by entering the coordinates of x and y, or click in the point cloud.

The raster image has not been imported into the point cloud, but have only given its colors to the points.

Colour from Solid

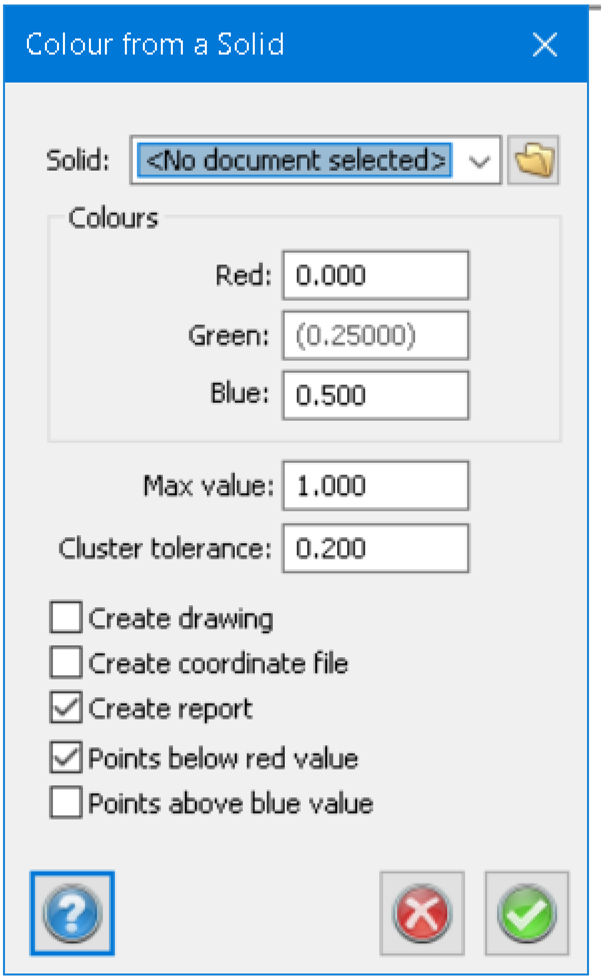
Colour from Solid

Point cloud|Colour from Solid

Colour your point cloud using a Solid

The procedure is as follows:

1. Create a solid by exporting a Solid object to a .tsm file
2. Browse the solid



3. Input the distance from the point cloud to the solid for colouring
4. Decide outputs

GTrans

Gtrans

Point cloud|Gtrans

Transform your pointcloud using known coordinate systems with Gtrans.

Read more here: Gtransform

Proj4

Proj4

Point cloud|Proj4

Transform your point cloud using the database proj4 to find the coordinate systems you want to transform between. Input a part of the name of the coordinate system you are looking for and press enter to get suggestions from the database.

read more here:

Move

Move

Point cloud|Move

Move point cloud in height, input delta height.

Create DTM from TPC

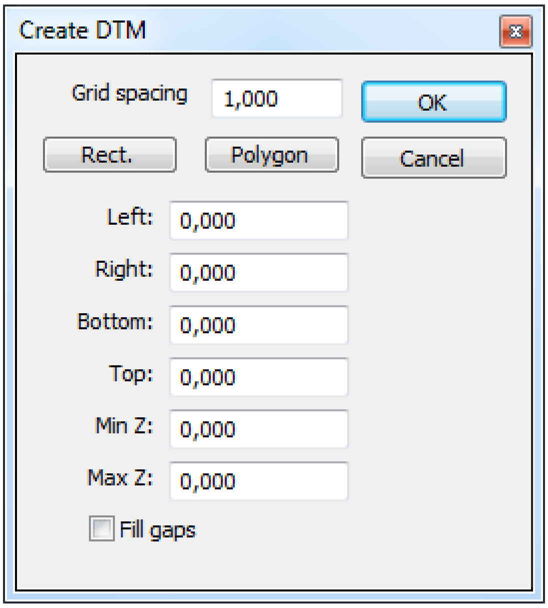
Point cloud|Create DTM

Function to create a terrain model (. DTM) from a point cloud (. TPC).

Specify the *Grid spacing* that determines how close points should be in the terrain model you want to create.

Select the *Rectangle* or *Polygon* and select the part of the point cloud as a terrain model is created from.

Select Fill gaps to avoid gaps in the terrain model. If the grid spacing is small, there may be gaps. Select a space that is at least as close as the points are in the point cloud.



Vectorize

Point cloud|Vectorize

Vectorize the cloud into one or more mesh surfaces. This will become raster objects in a drawing. These can easily become terrain models with overhang or serve as a 3D image background in your drawing.

***Pre filter-** takes out loose points before starting the vectorization, this is recommended*

***Max gap:** This set how far distance you will have between the points in the vectorized raster.*

***Height tolerance:** Here you set how much rough the surface is, with a more narrow tolerance less verified surfaces will be found.*

***Store in:** Choose a drawing to store output in*
***Layer:** Choose layer in the drawing to store output.*

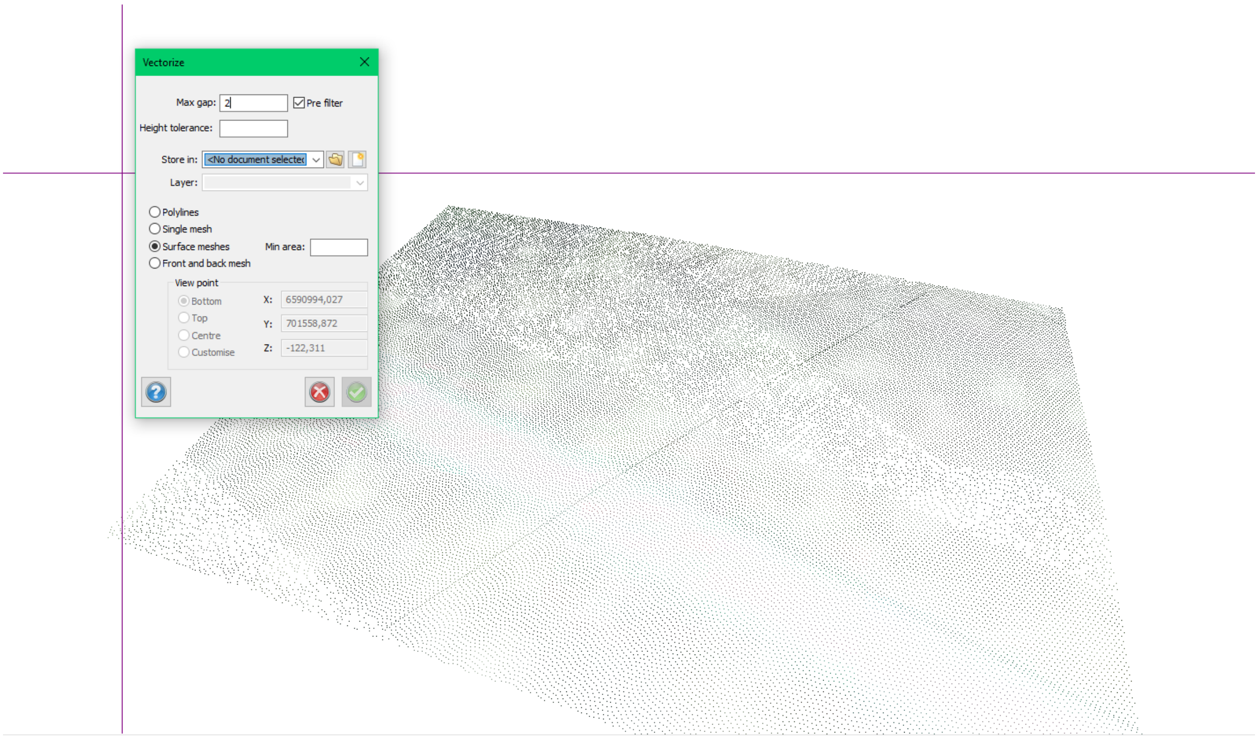
Get output in one of the following formats.

Poly-lines

***Single mesh.** one mesh object in raster format*

***Surface meshes**, this will be many mesh objects in raster format*

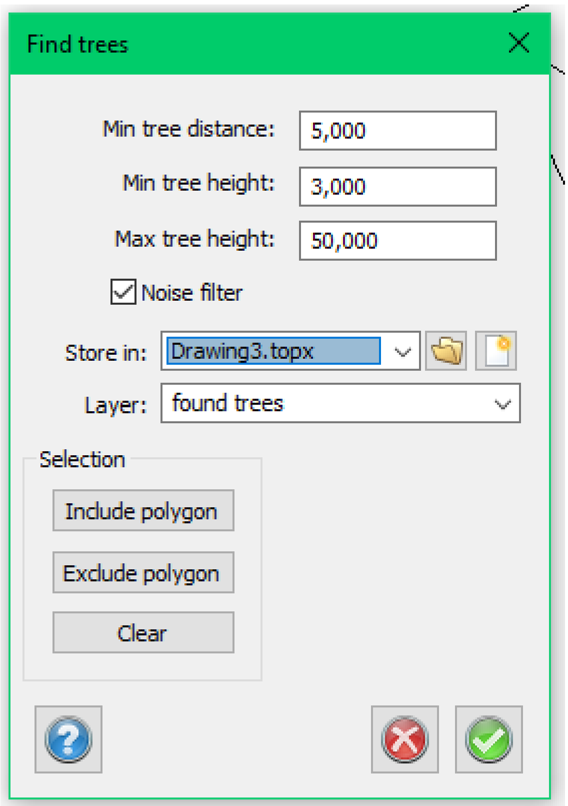
***Front and back mesh**, this will be 2 meshes and aims to give two sides of the same object*



Keywords: vectorize, surfaces, point cloud, find surface, meshes, vectorization

Find trees

Point cloud|Find trees



Parameters

Minimum tree distance*: this is where you set how far apart the trees you are looking for are.*

Minimum tree height*: set how short the smallest trees you are looking for are.*

***Maximum tree height:** set how tall the largest trees you are looking for are.*

***Noise filter:** clean up stray points from the cloud before search. It is recomended to keep this turned on.*

Output location

***Store in:** select a dawing to store the found trees in.*

***Layer:** name the layer you want to store the found trees in.*

Selection

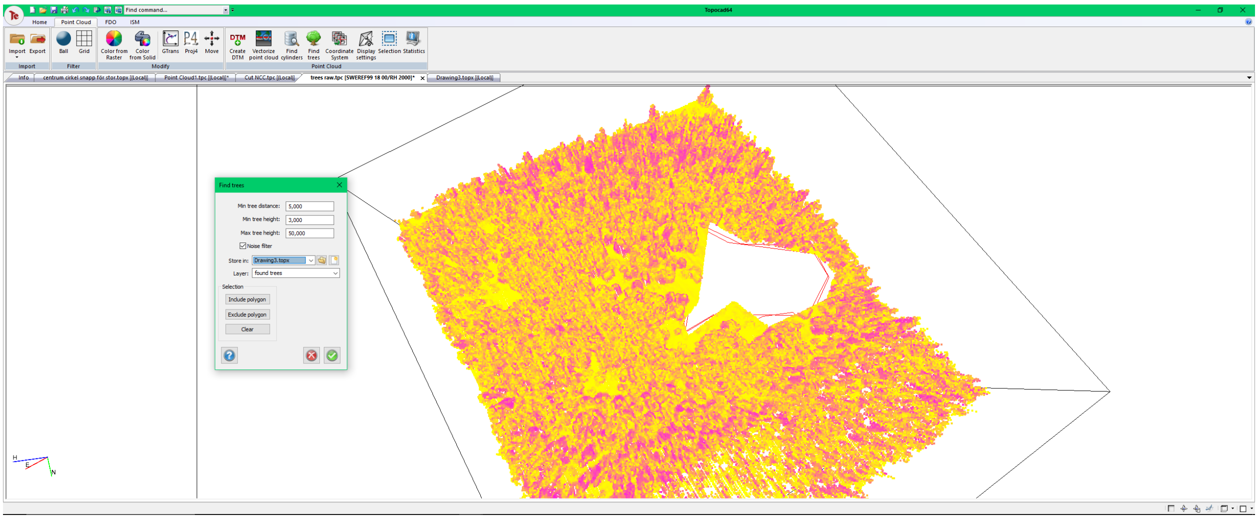
Include polygon: make a polygon to search within

Exclude polygon: make a polygon that the search will skip.

Clear: Clear polygon

Tip:

Remember that you can use the other selection tools from the selection toolbox to hide parts of the cloud that you dont want to search.
Make a selection and right click > hide selected OR hide unselected areas. Do this before you run the find trees function.



Coordinate system

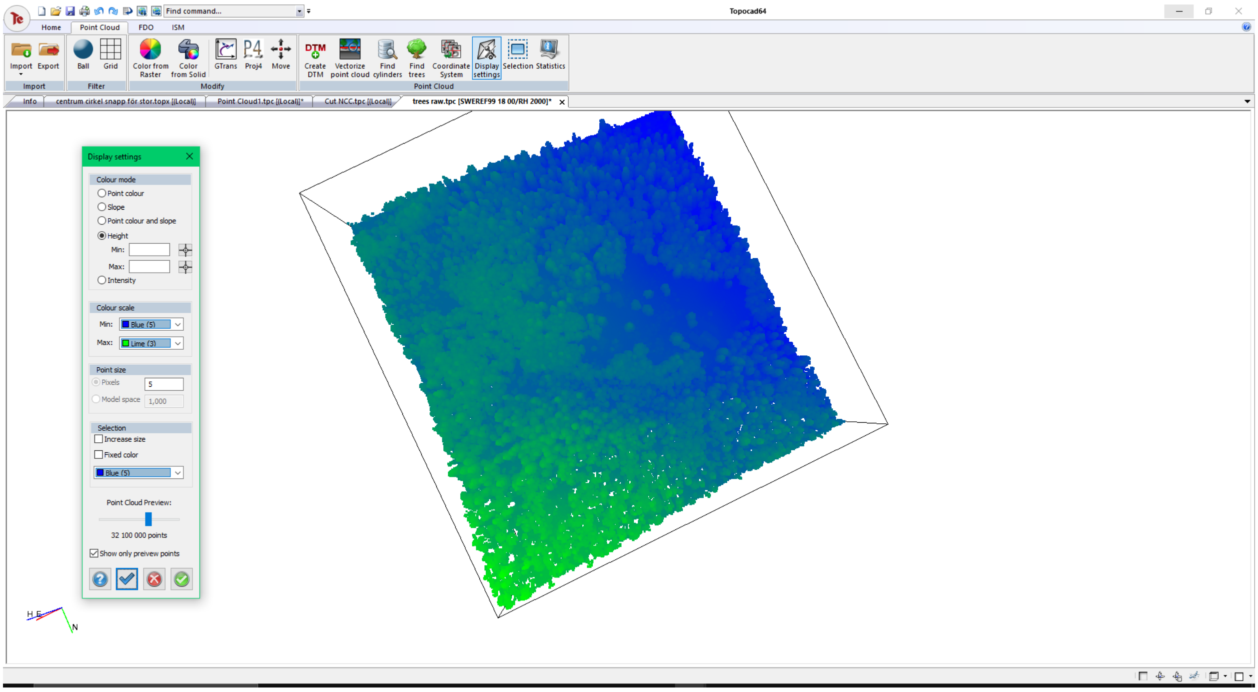
Coordinate system

Point cloud|Coordinate system

Set your coordinate systems here, this will not impact the coordinates, only add this information on the document as meta data,

Display settings

Point cloud|Display settings



Function to change how the point clouds are displayed. The function will not change the point cloud, only the view.

Color mode: Select what you want to focus on, for example height.

Color scale: The scale will change from min to max. In this example the heights will change from navy to orange.

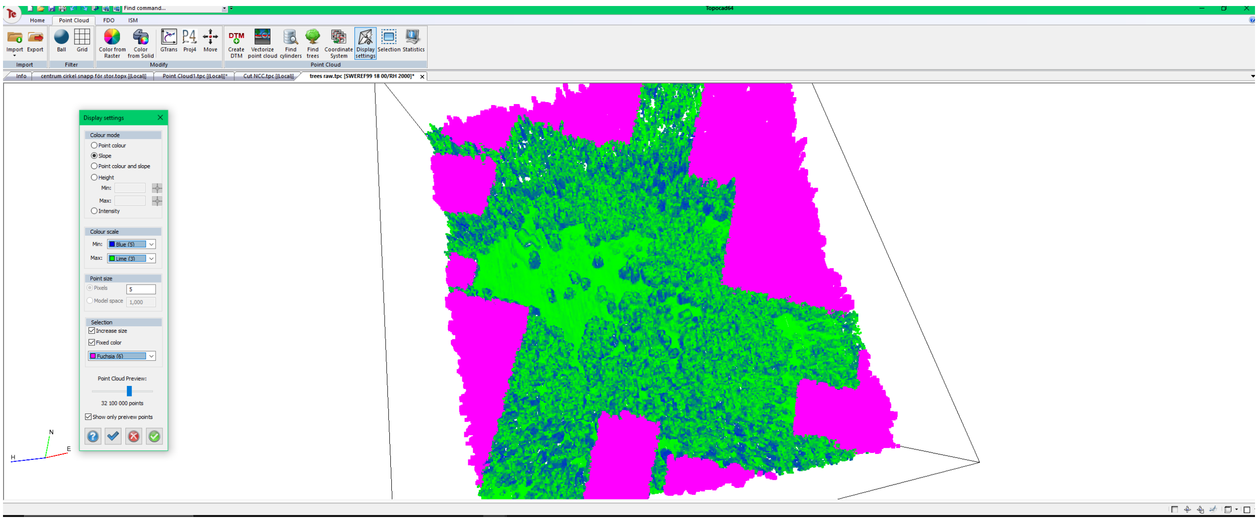
Point size: Select how large each point is

Selection: You can increace the size of selected points here.

With Fixed colour you can select a colour that goes for all the selected points. Otherwise the selected points will be a lighter tone of the original colour.

Point Cloud Preview: This set how many points that gets drawn out while rotating or panning the pointcloud. The span of this setting depends on your graphics card.

With show only preview points, you will not generate a denser cloud while the camera is standing still. This will make the experience smoother.



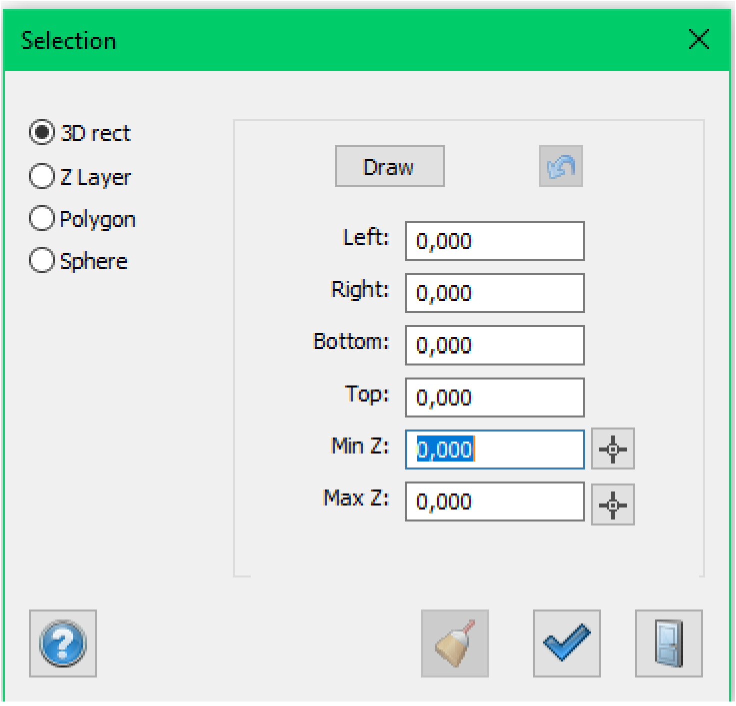
Selection

Point cloud|Selection

Select parts of your Point Cloud with an array of different selection tools.
Selected areas can be hidden to not include them in other functions as generate DTM, filtering etc.
We also have more options to execute from the right-click options on selected parts.

Reset selections and confirm selection

Reset selected areas with the broomstick button.
Confirm selections with the blue check mark button.

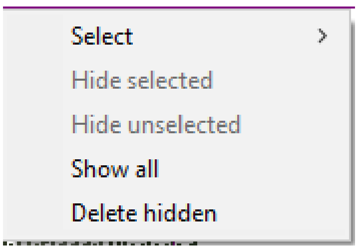


The right-click menu

Hide selected / Hide unselected
After you have selected areas you can choose to either hide the selected areas or hide the unselected areas.

Show all
If the have hidden parts of the point cloud we can return the the point cloud with the show all button.

Delete hidden
We can delete the hidden parts of the cloud with this option.



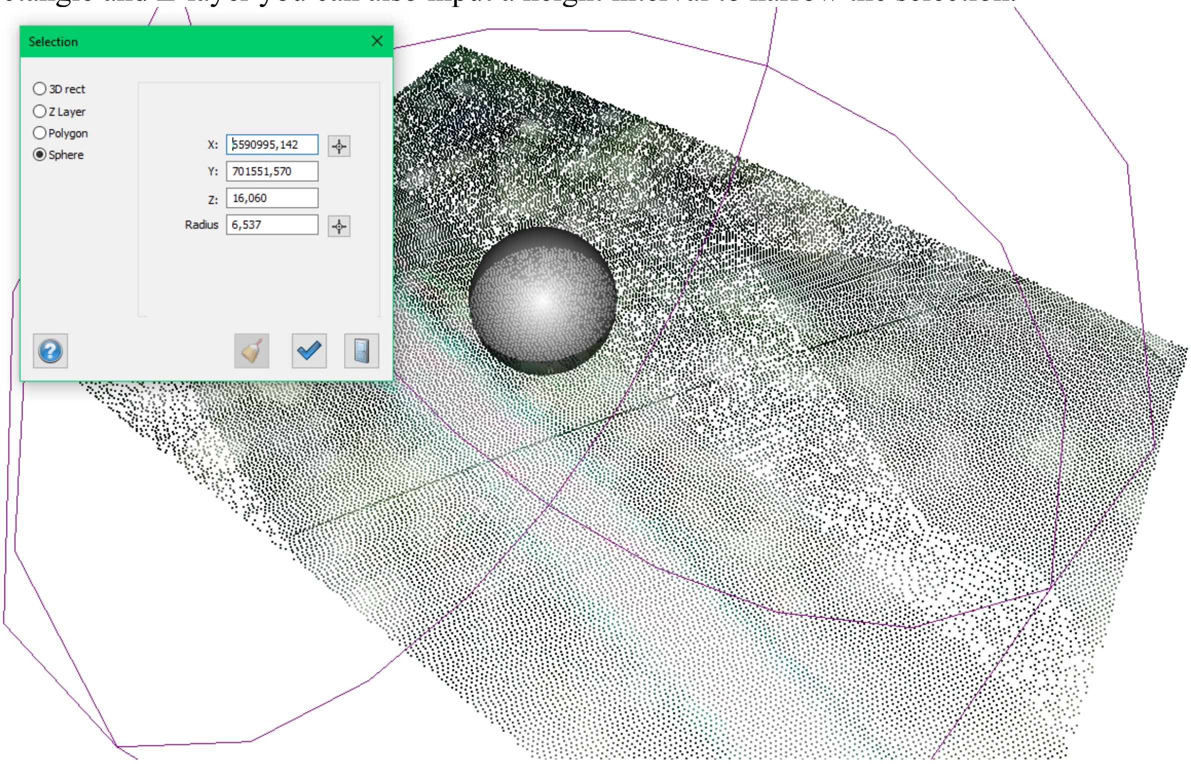
Select
Here you can find simplified version of the selection-methods

Selection-methods

3D-rectangle
Work as the usual box selection but you can also input coordinates in the field, and choose a height interval to narrow the selection.
You can first make a box and finetune the rectangle with the help of addition and subtraction in the coordinate fields.

Z-layer
Selects the entire pointcloud from height-coordinates. You can input the intervall in the field or use the crosshair buttons to point at the clouds to get a value from the screen.

Polygon
Draw a polygon for your selection, this is easiest done from the ortho -2D view. Like with the 3D rectangle and Z-layer you can also input a height interval to narrow the selection.



Sphere
Select a point in the point cloud to be the centre of the sphere, you can then click out the radius of the sphere.
Here you can also fine-tune the sphere by imputing addition or subtraction to the coordinate fields. You can also input the radius from the input field.

XRefs

XRefs

Point cloud|XRefs

External references. Here you can add in other types of data, such as .topx or .dxf for example. Any kind of data you would use in a drawing you can add here to view it along with the point cloud.

see XRefs

Section template contents

Section template .TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers
Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	

Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection
- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.

These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

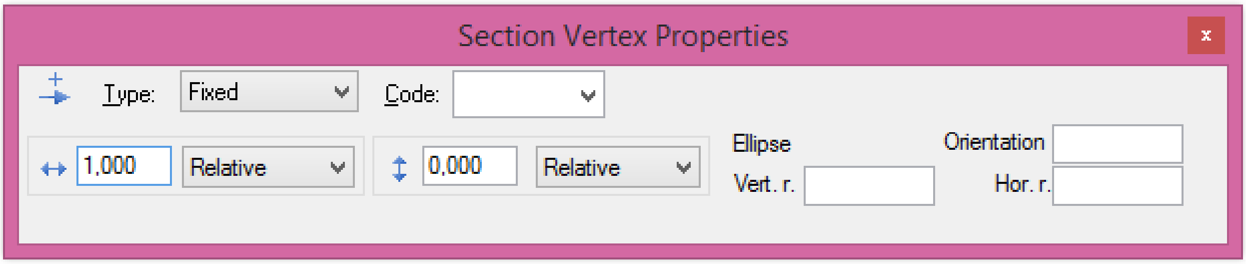
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

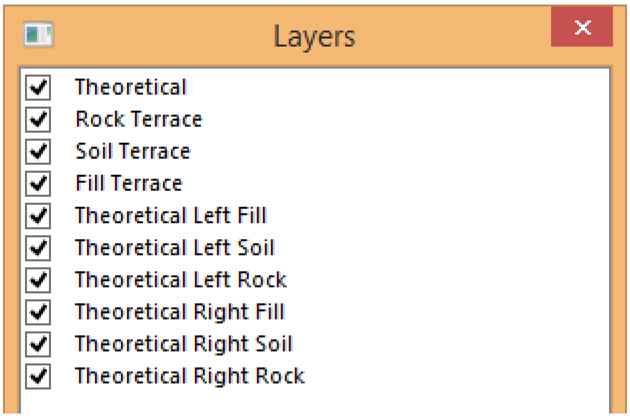
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

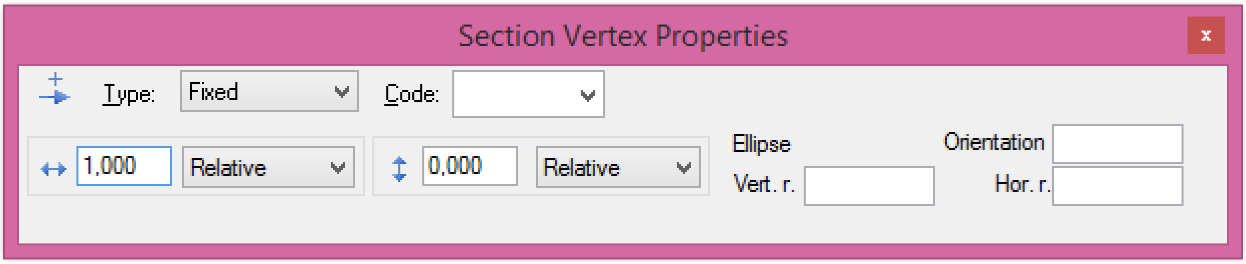
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

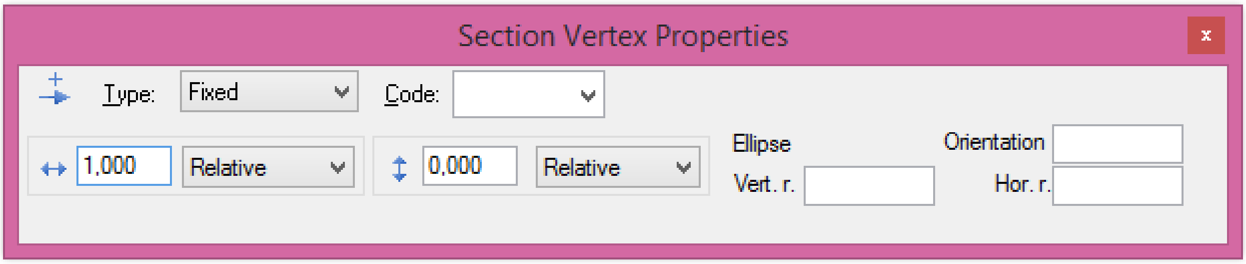
You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).
2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

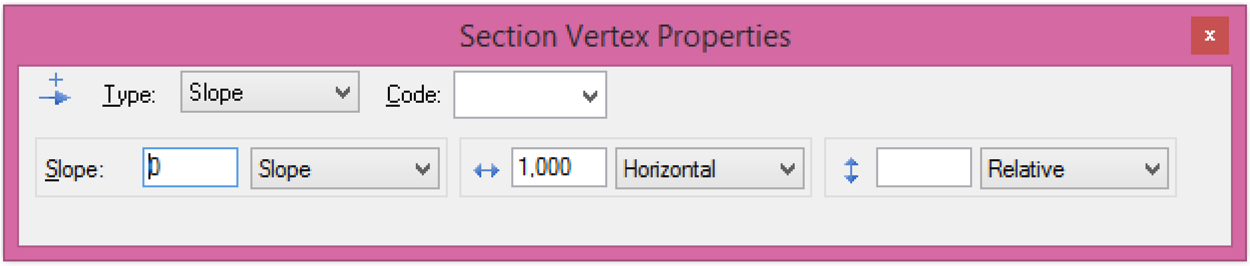
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

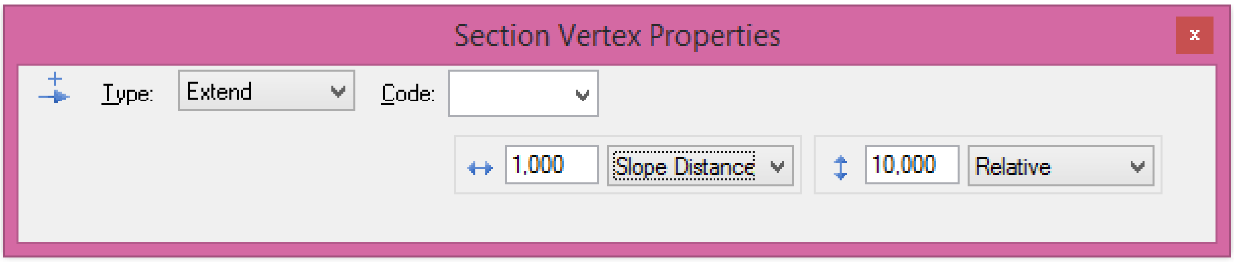
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

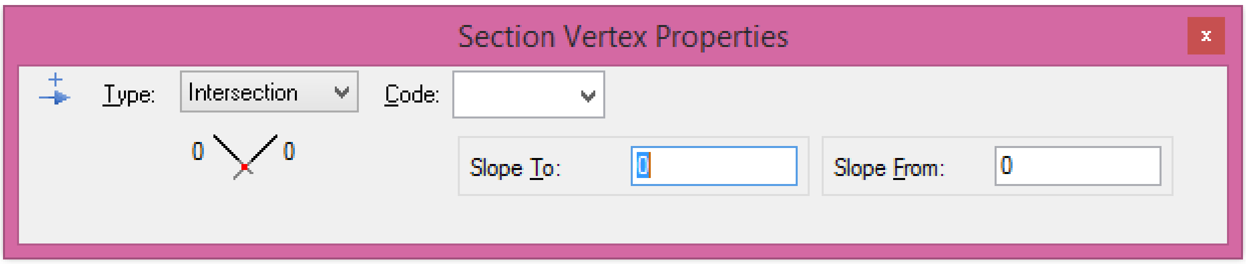
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

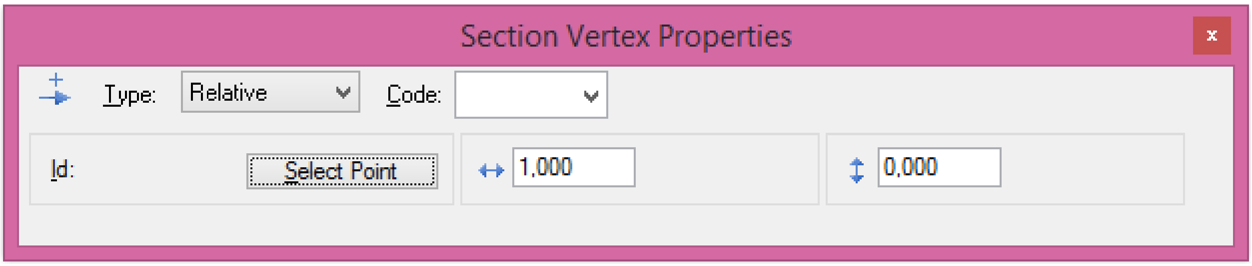
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

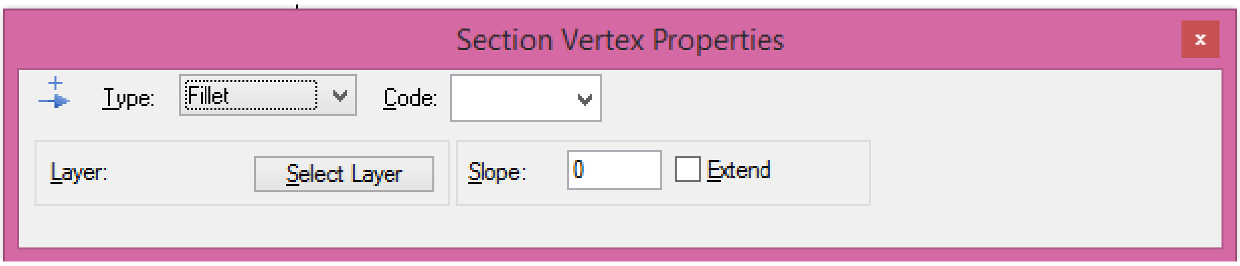
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

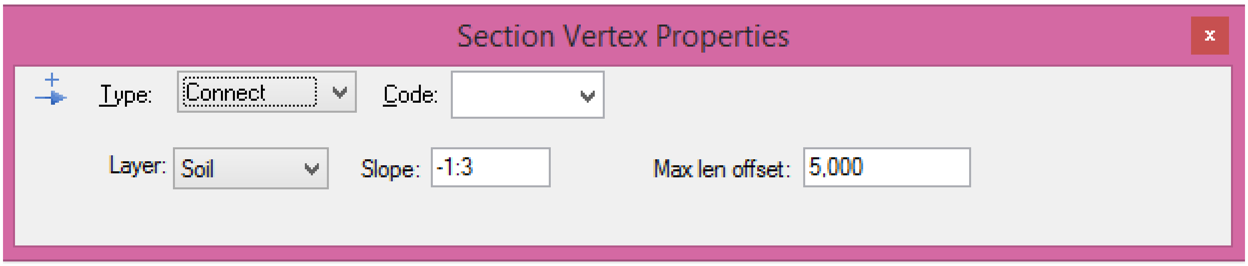
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

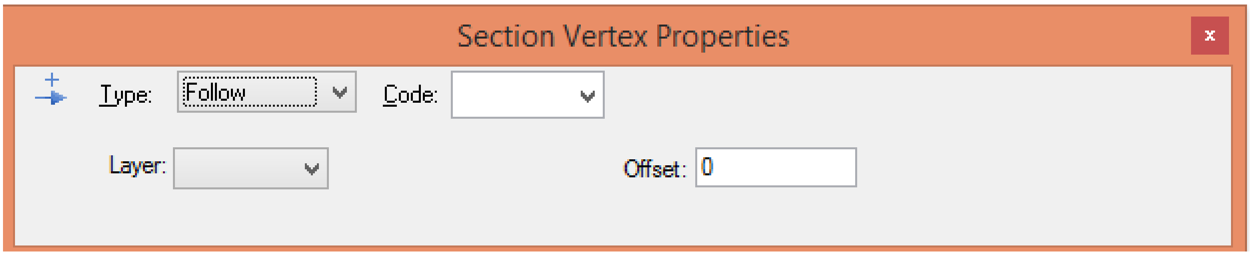


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

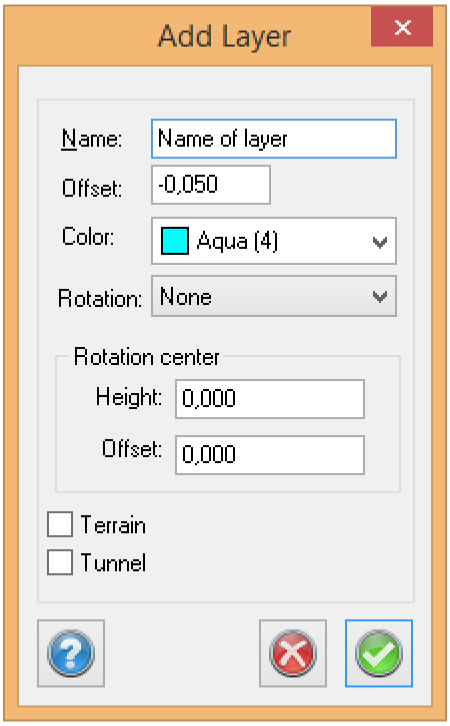


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

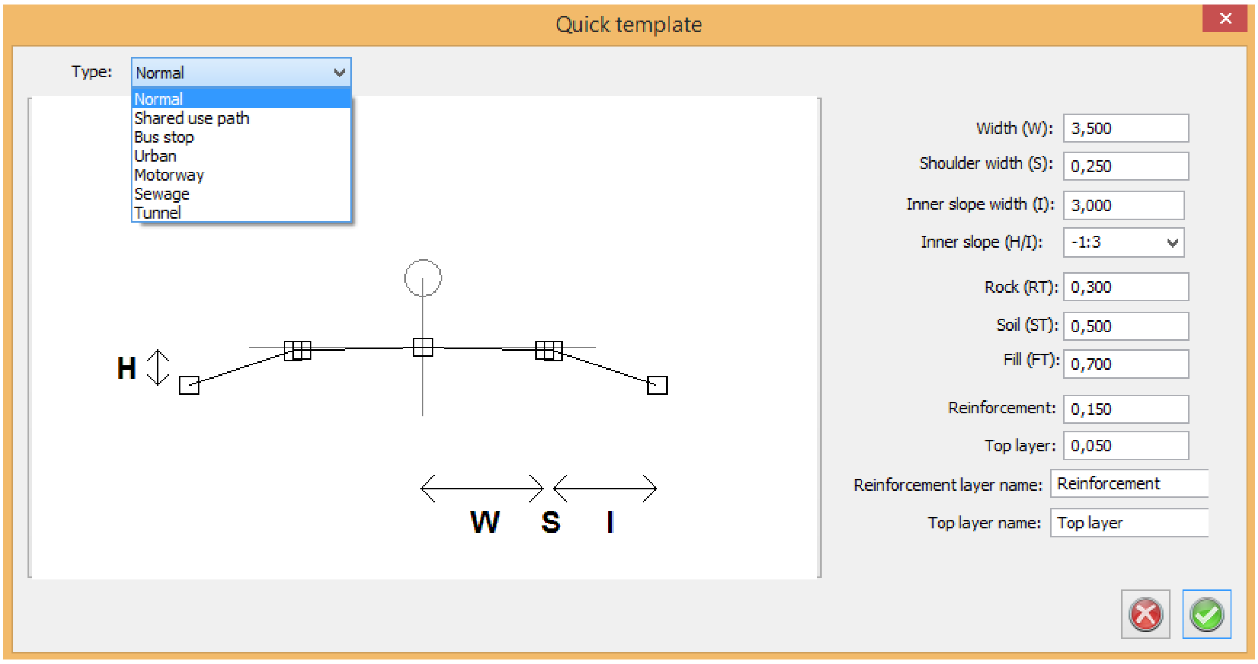
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

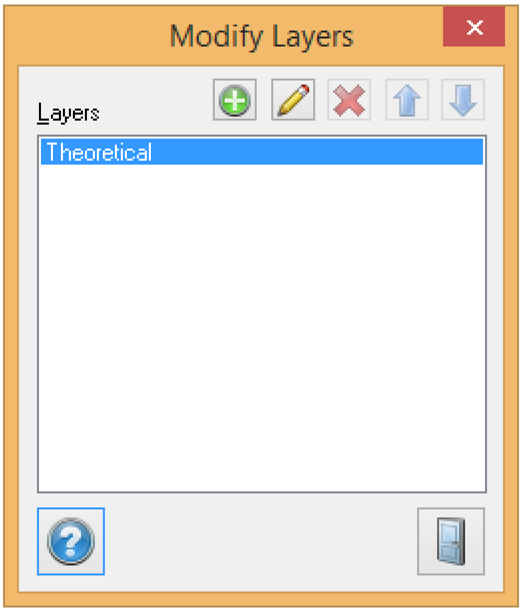
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

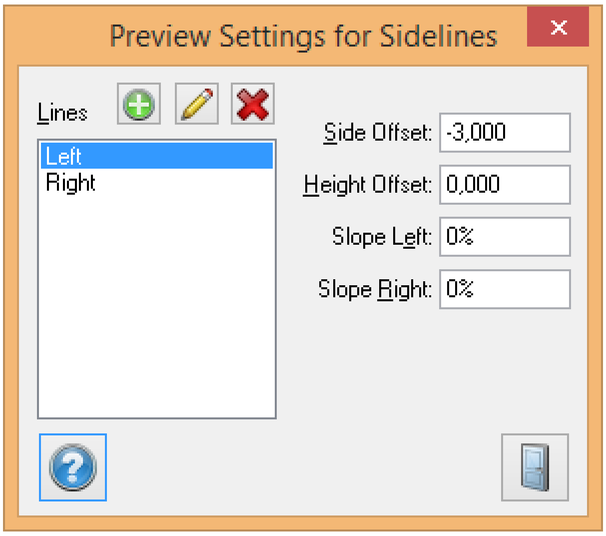


Modify layers in section template.

Edit side lines

Section template|Side lines

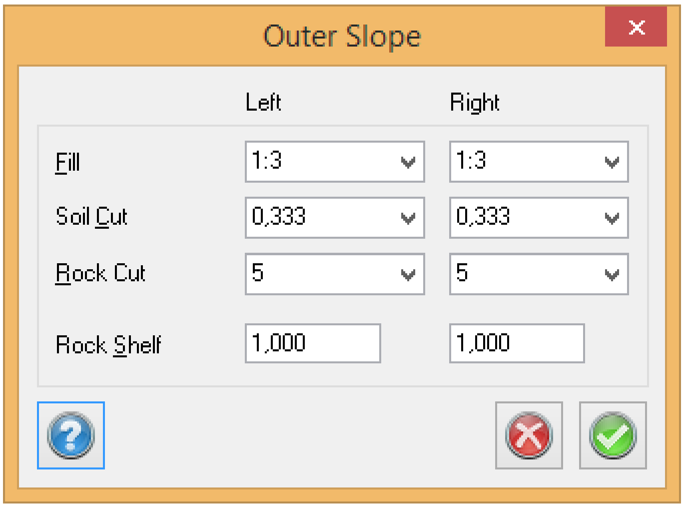
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

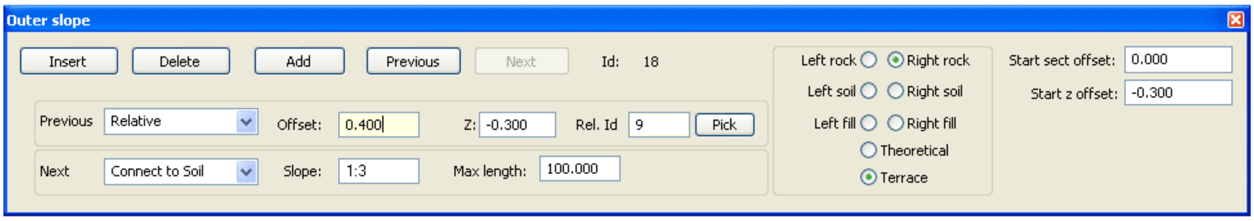
Section template|Quick outer slope

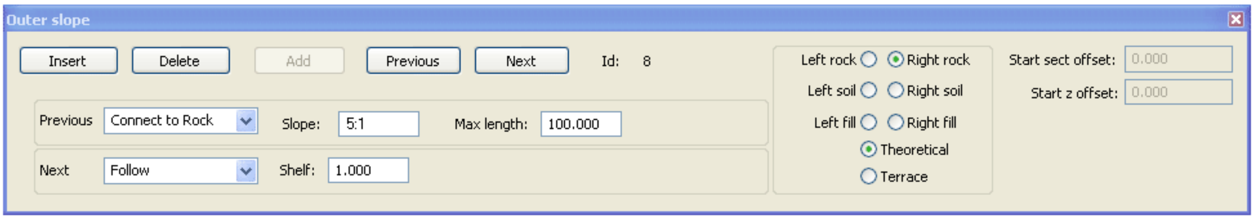
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

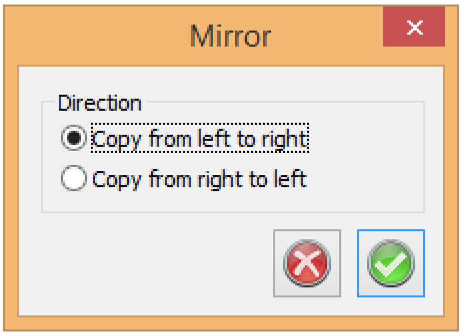
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

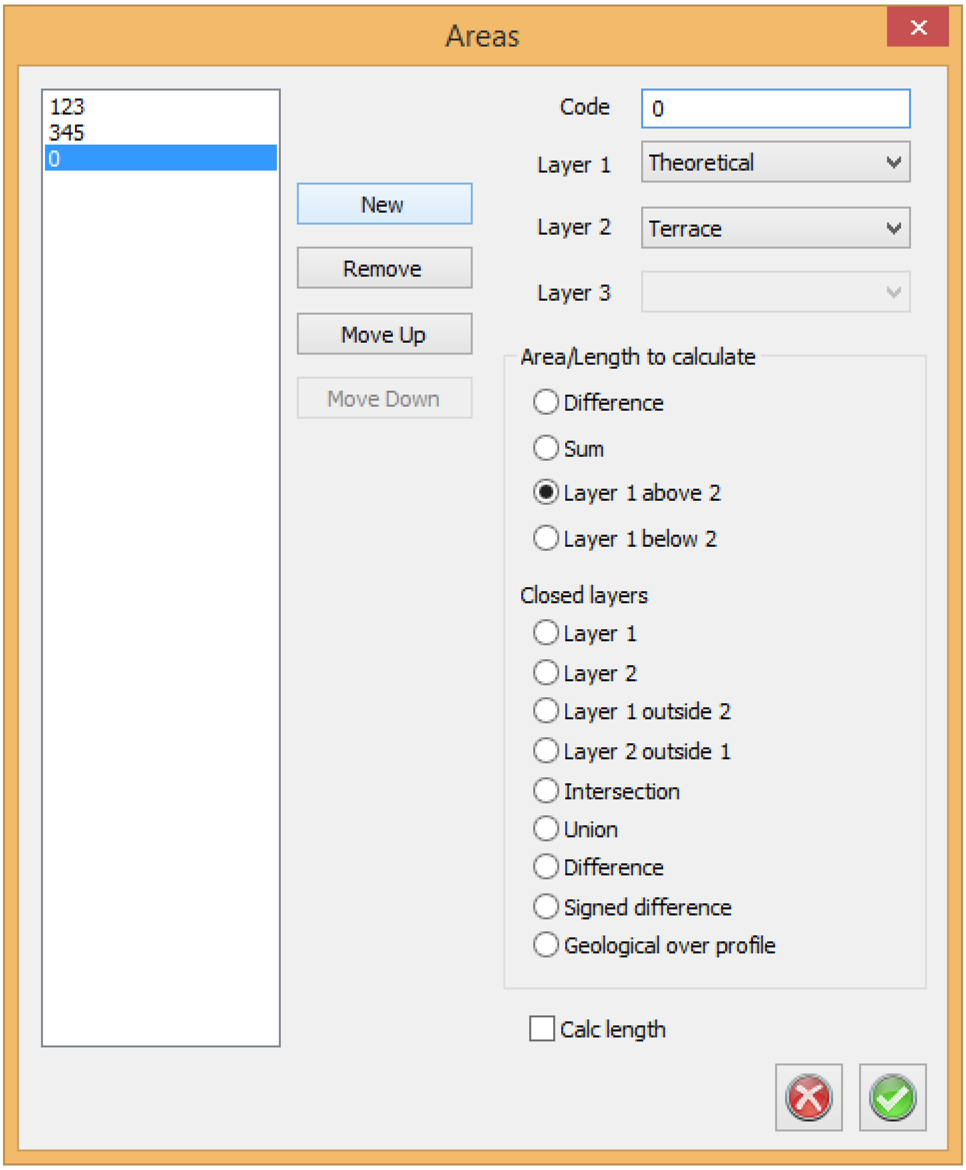
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template | General

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection
- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

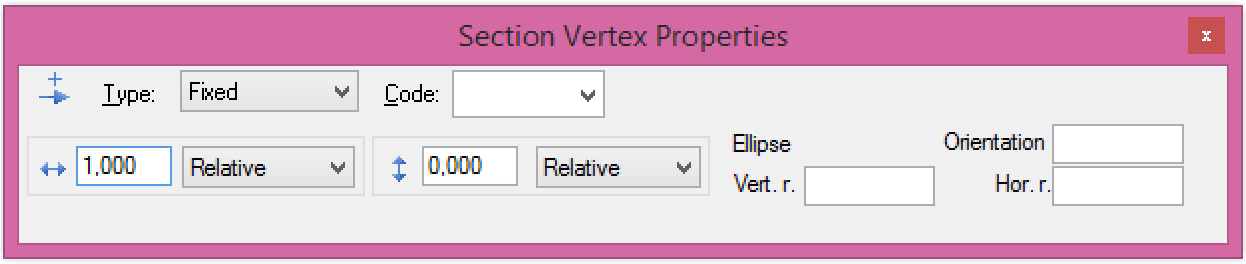
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

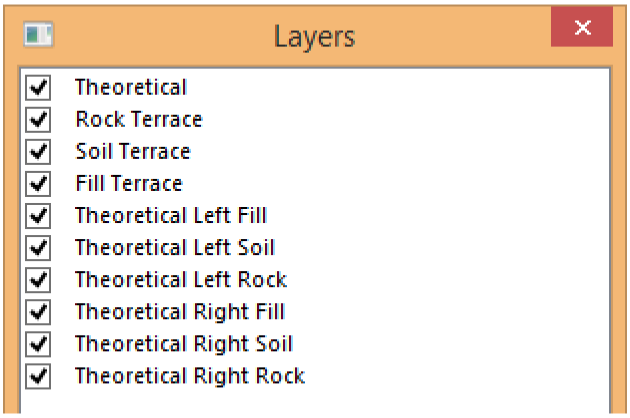
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

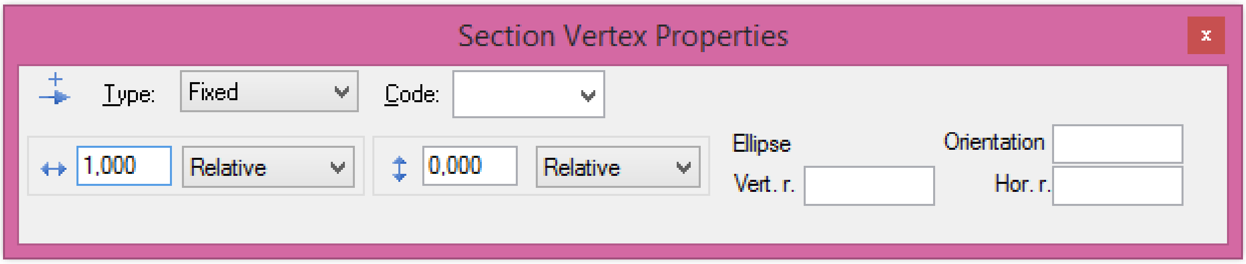
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

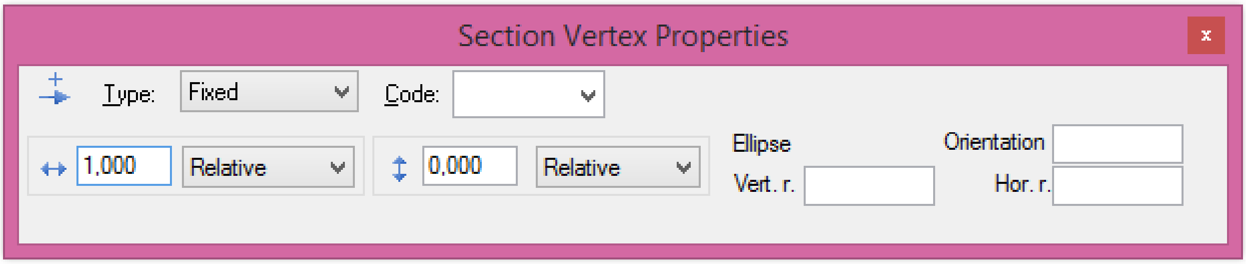
You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).
2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

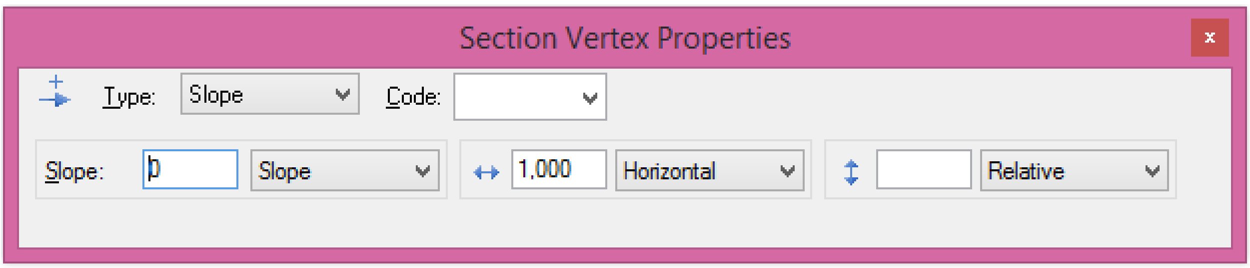
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

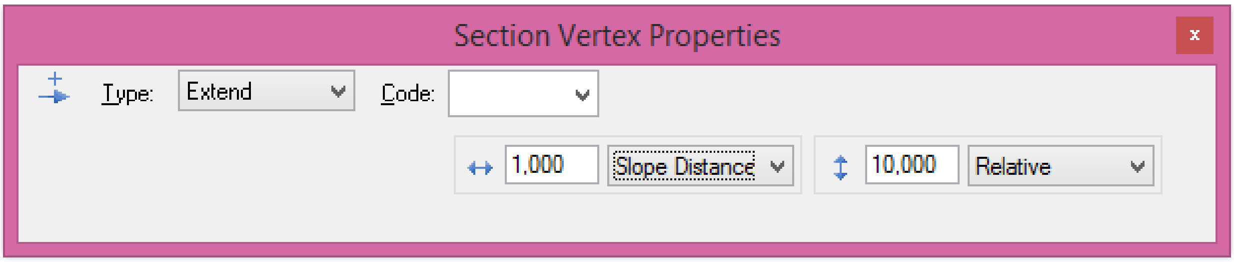
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

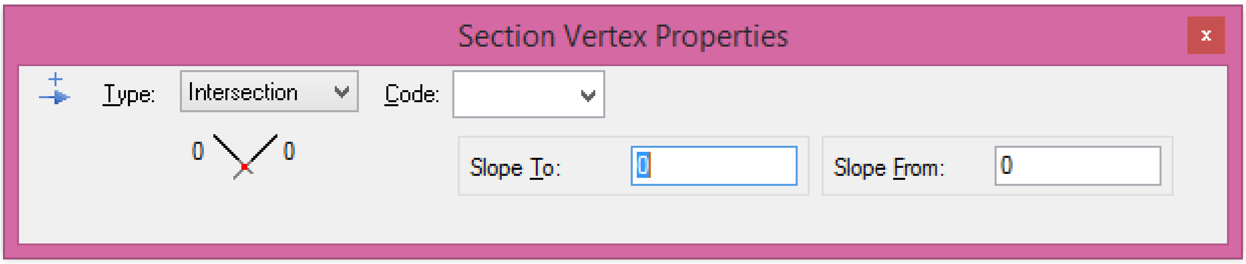
1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on

this instead.

3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

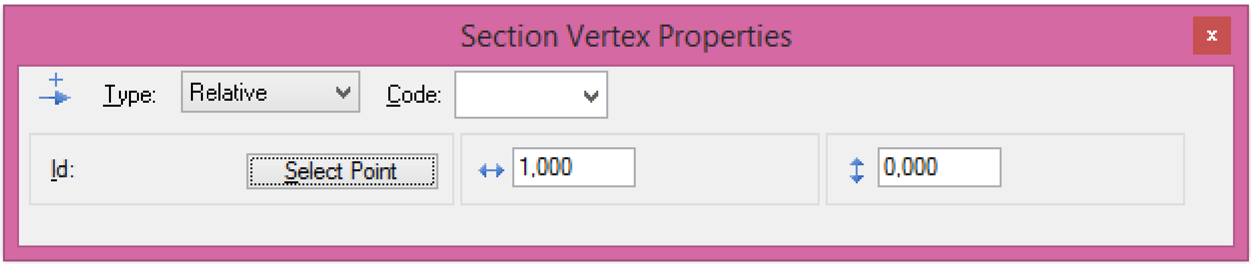
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

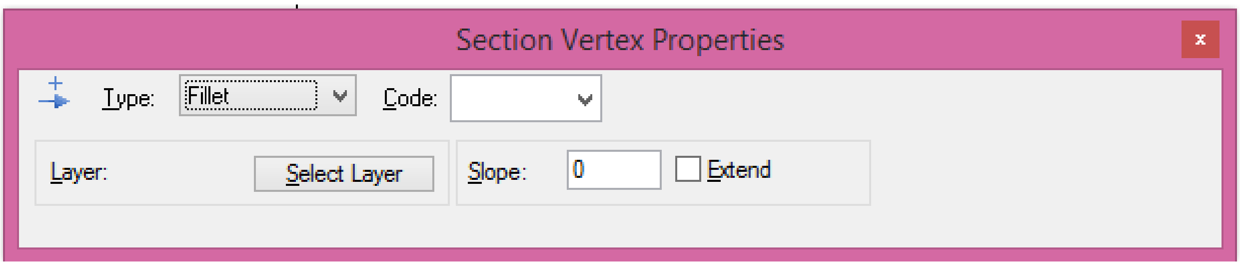
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

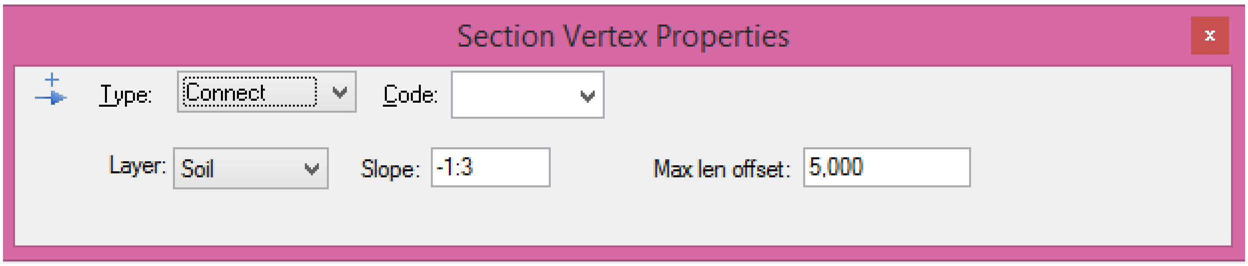
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

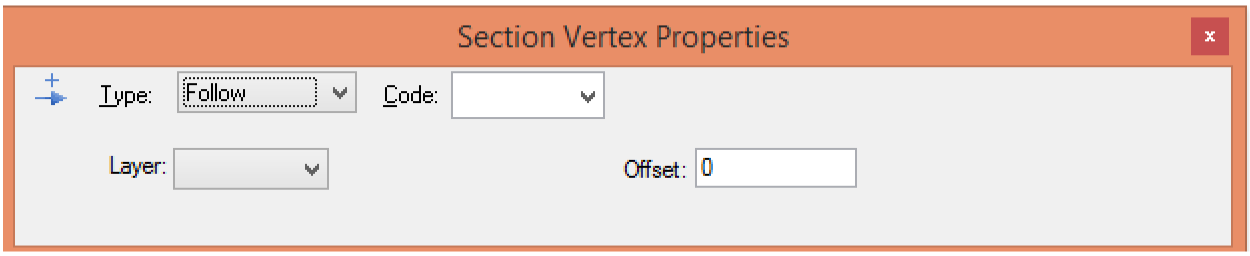


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

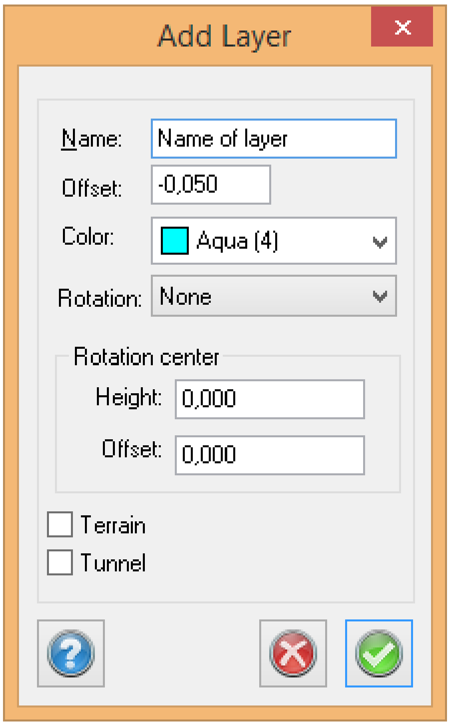


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain
Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

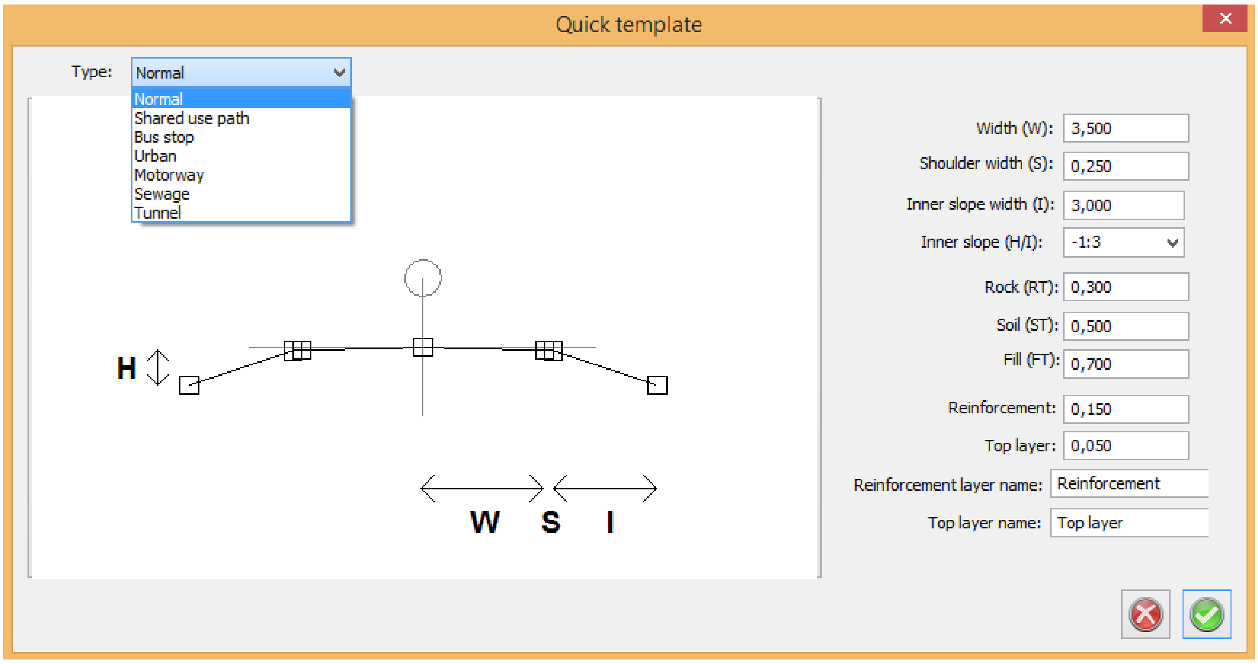
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

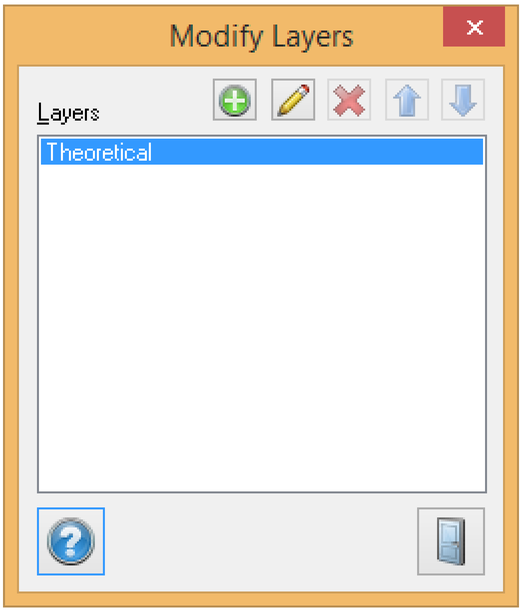
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

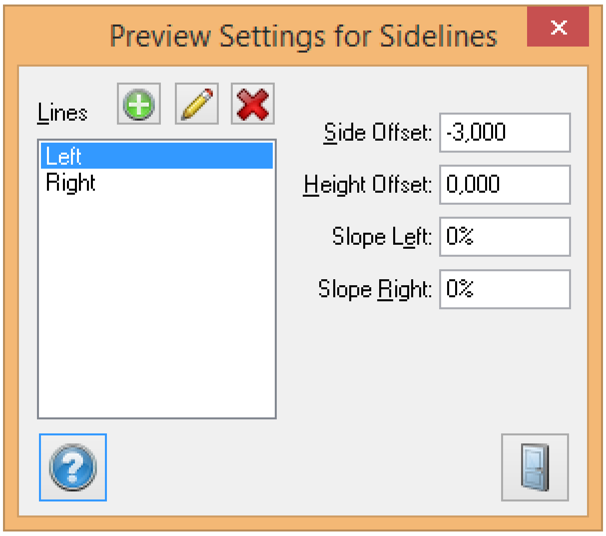


Modify layers in section template.

Edit side lines

Section template|Side lines

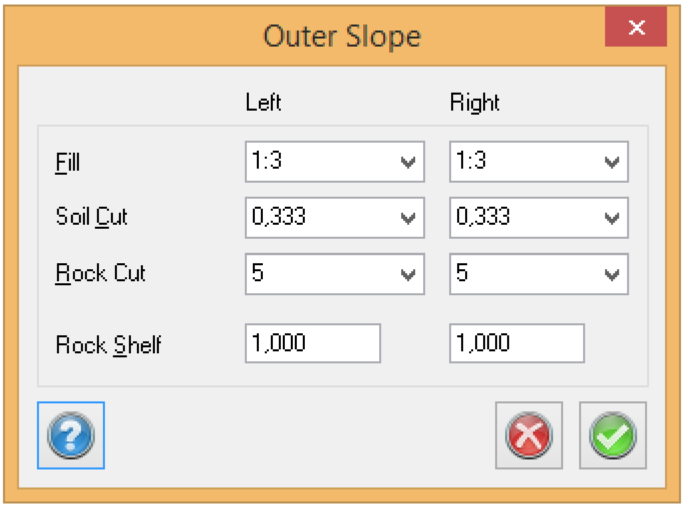
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

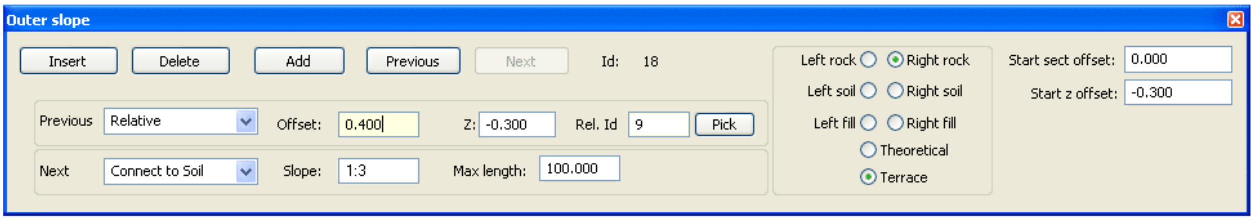
Section template|Quick outer slope

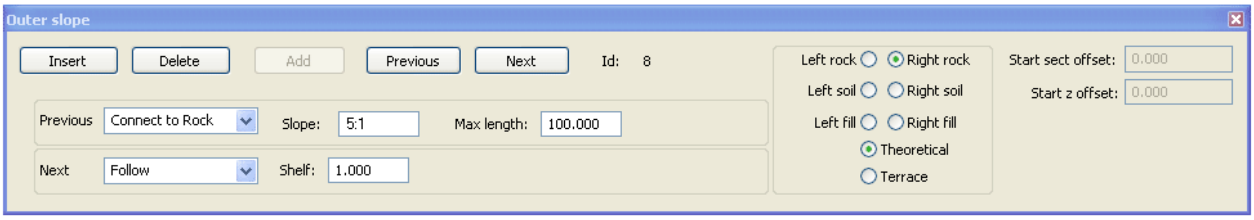
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

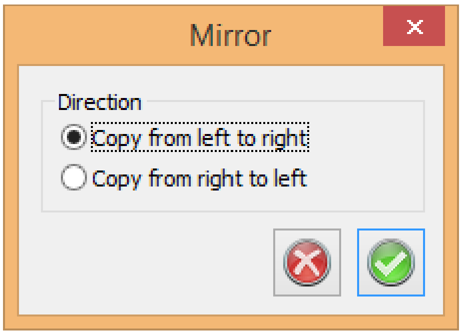
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

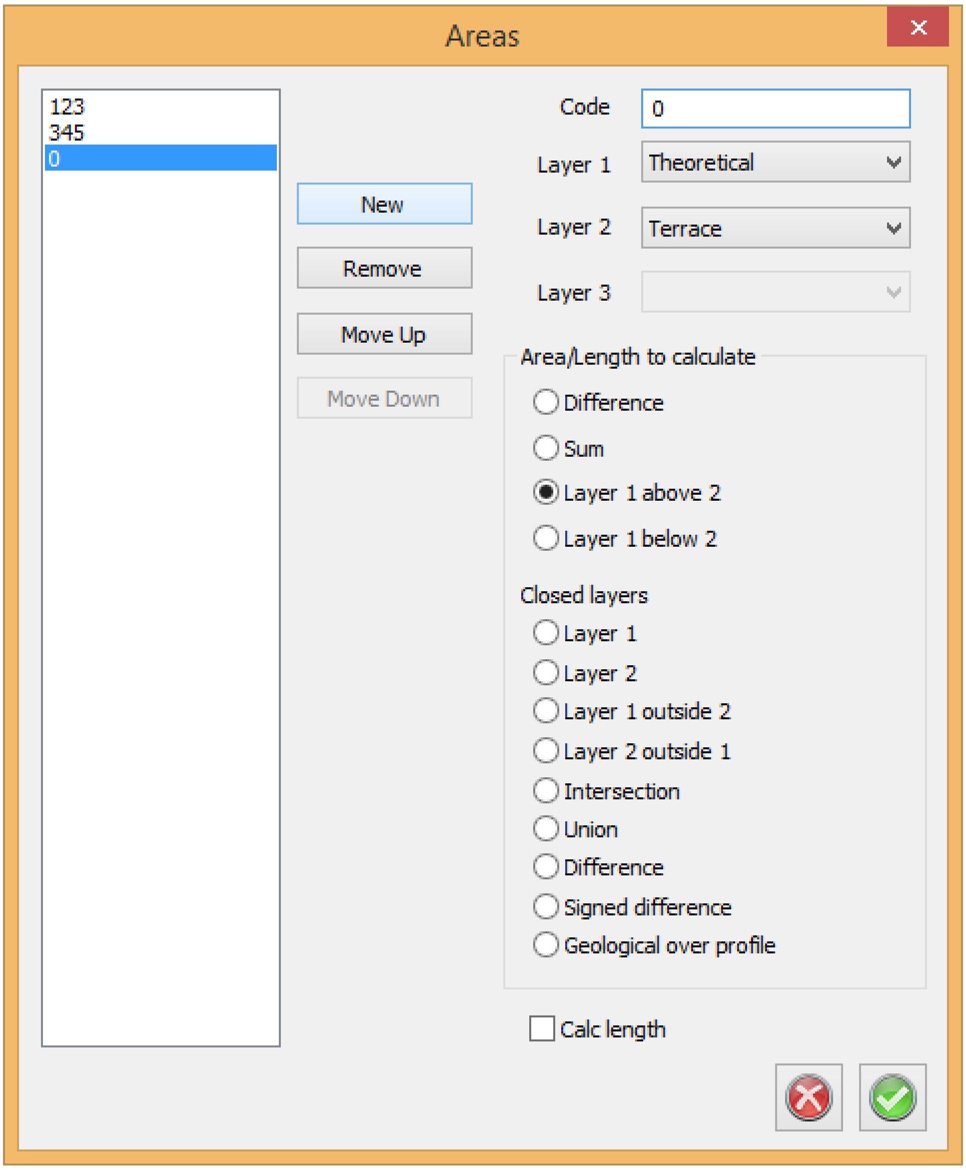
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

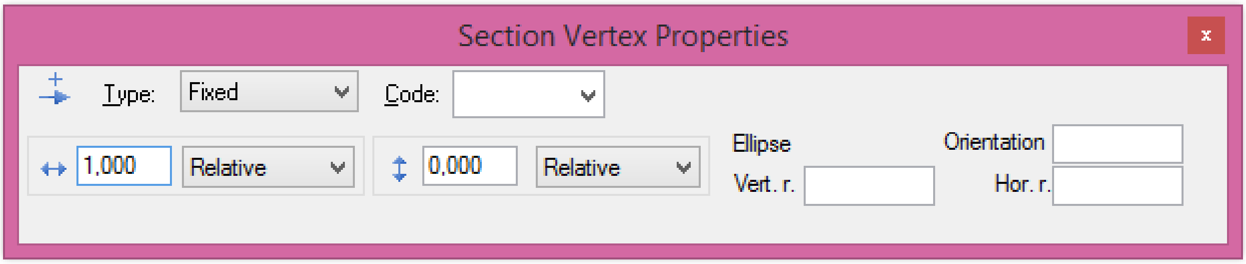
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

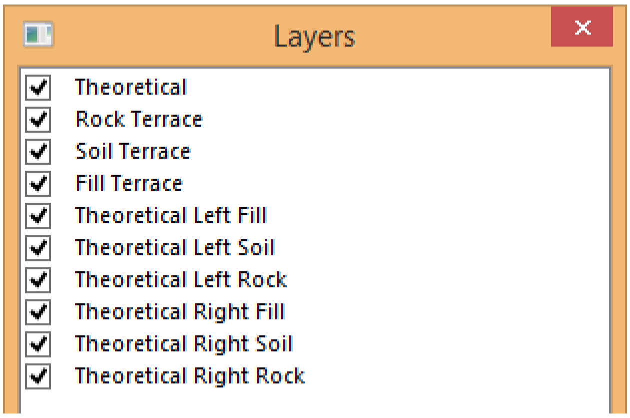
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

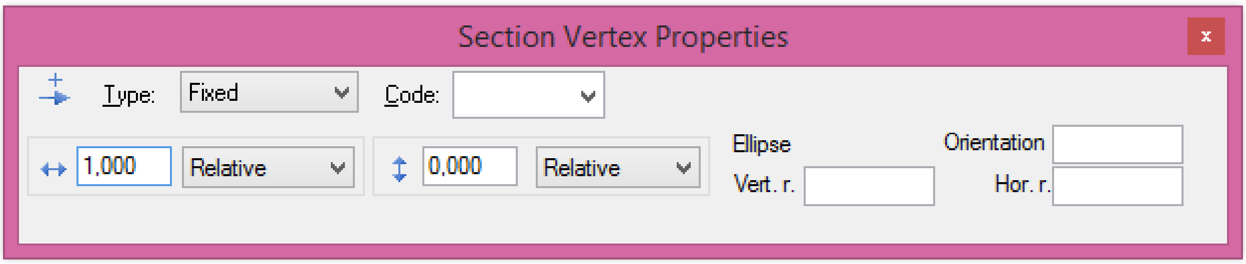
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

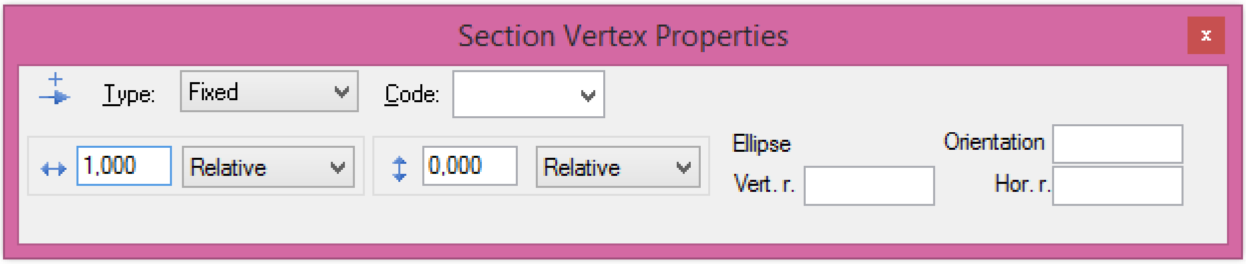
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

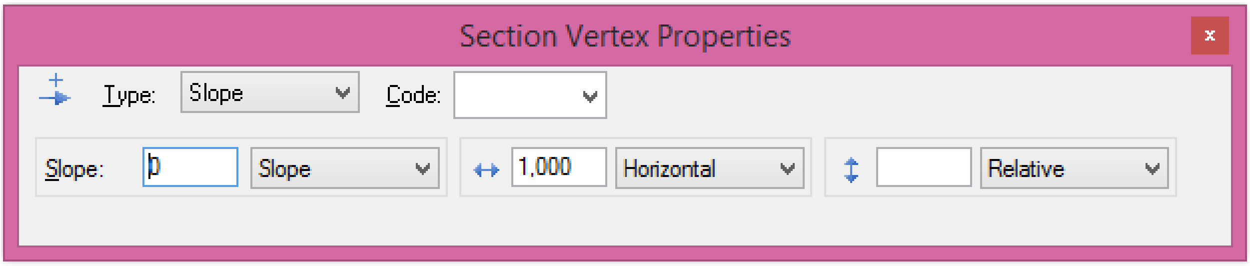
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

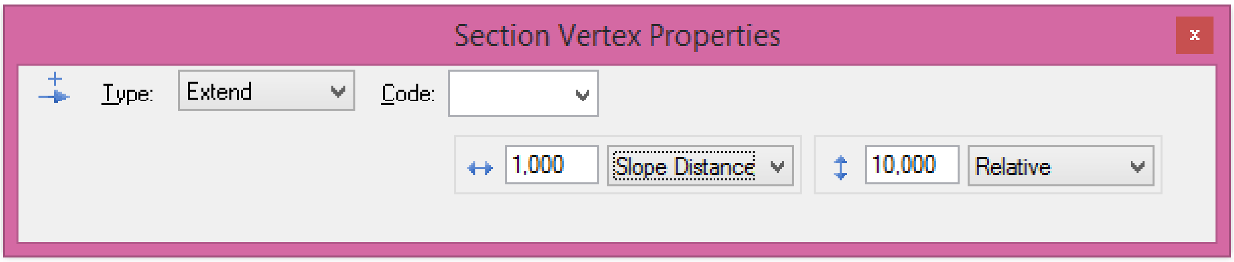
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

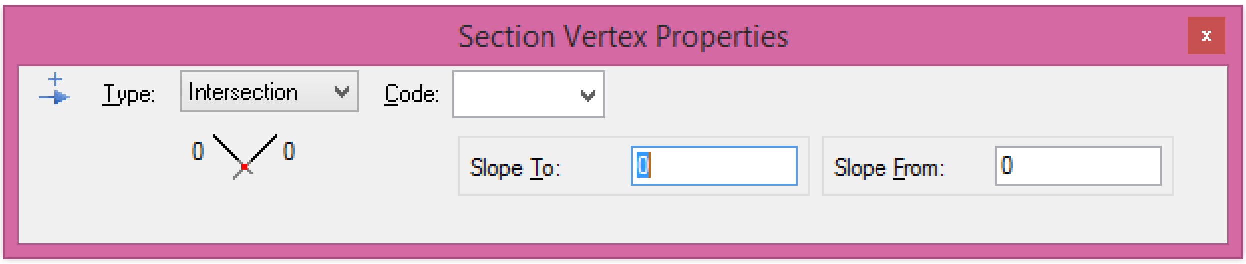
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

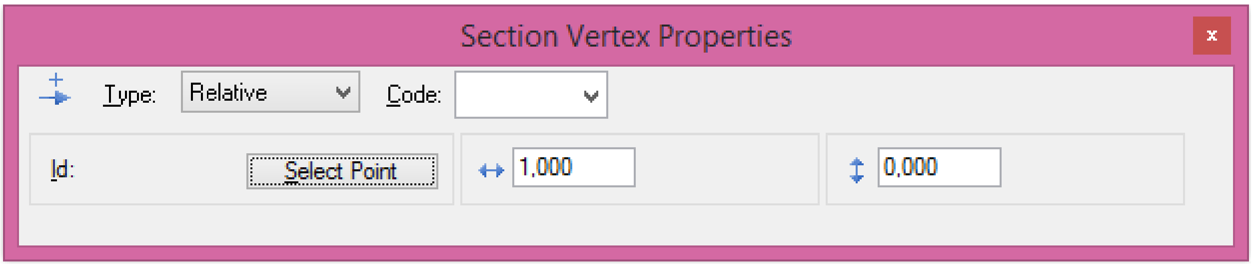
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

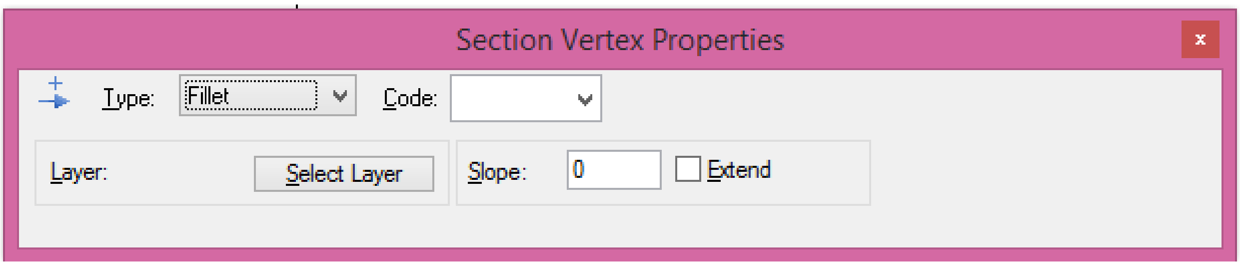
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

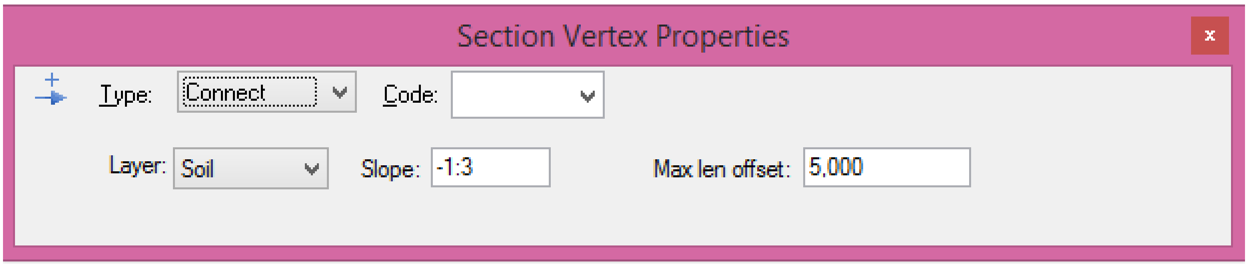
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

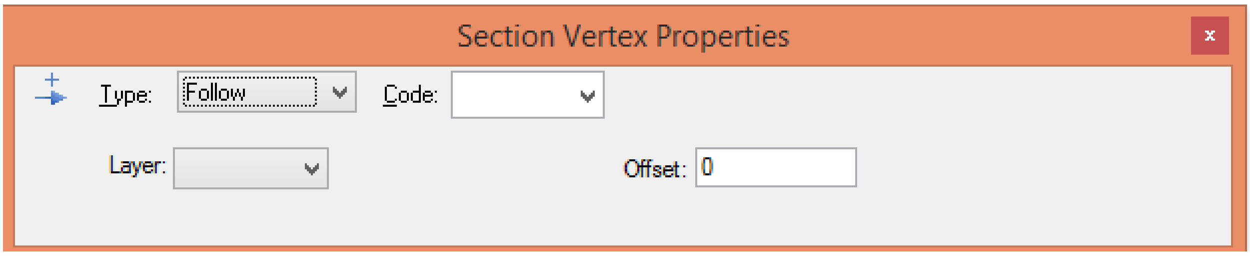


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

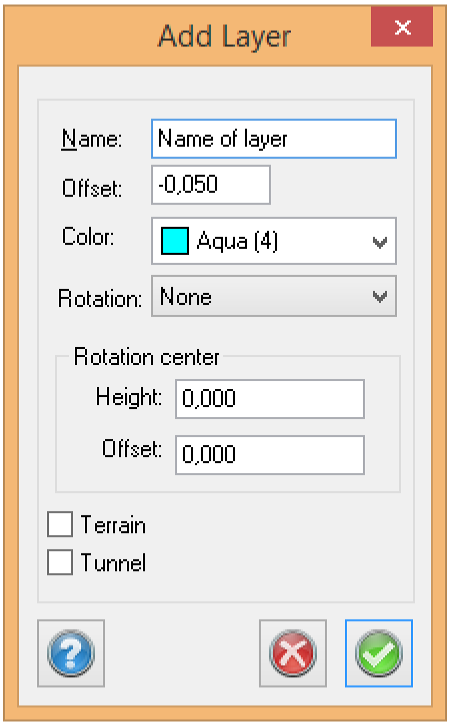


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

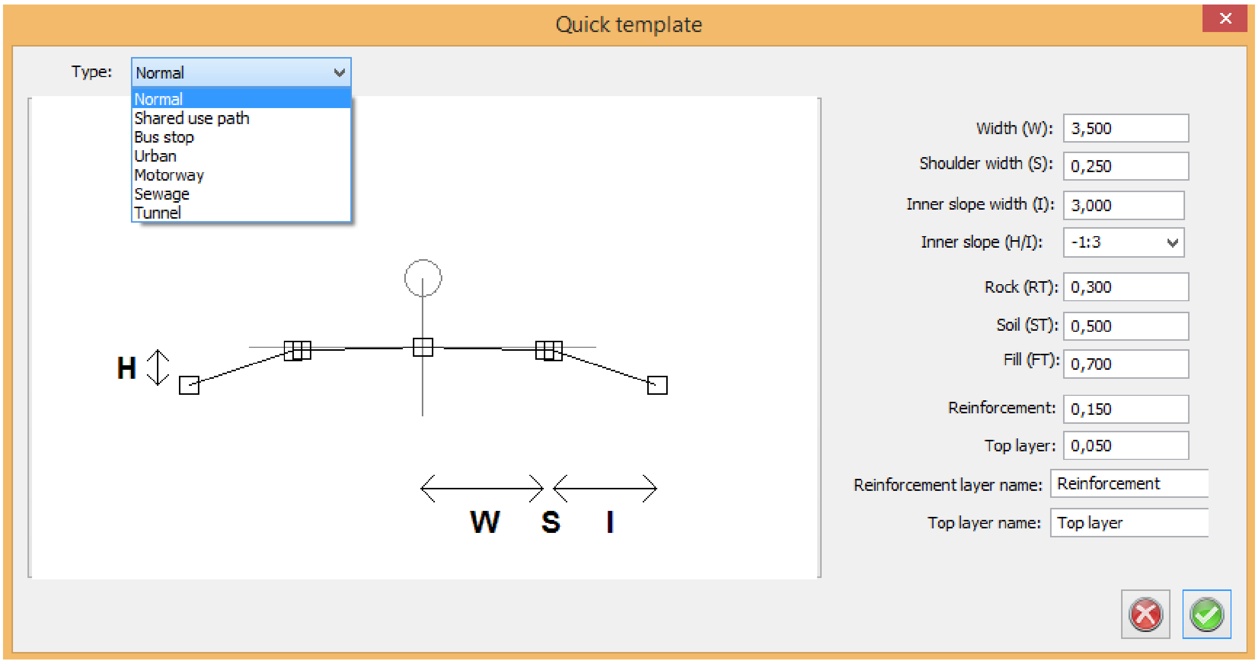
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

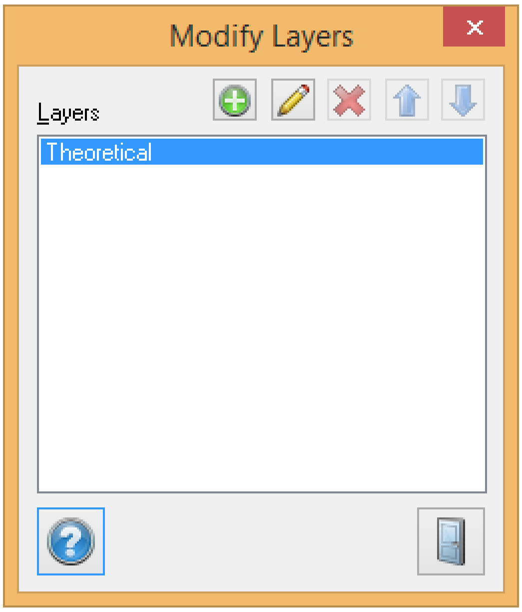
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

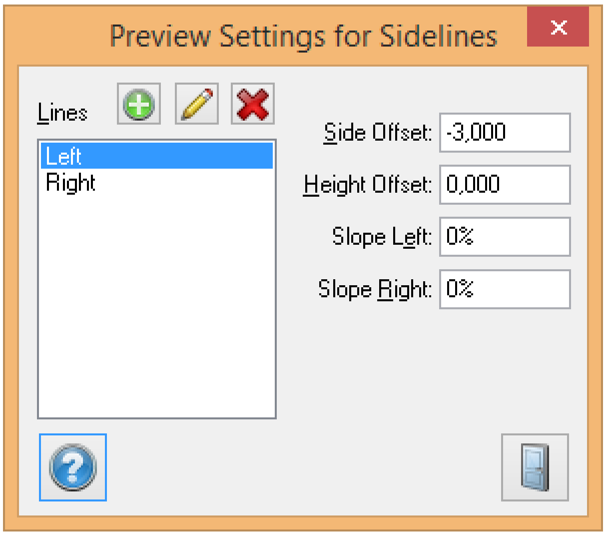


Modify layers in section template.

Edit side lines

Section template|Side lines

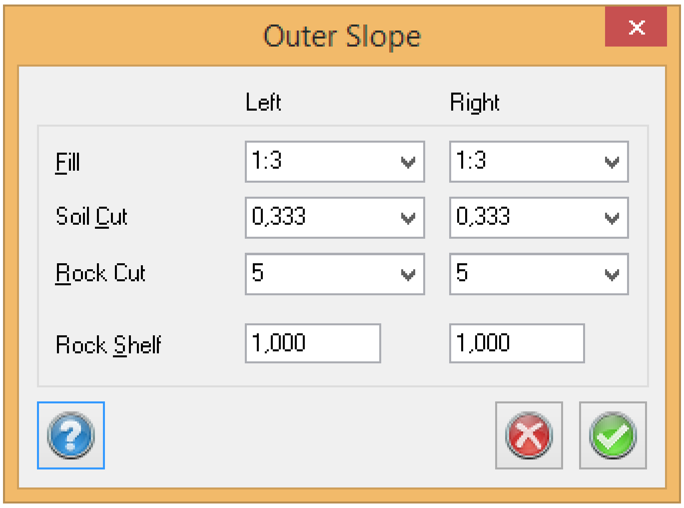
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

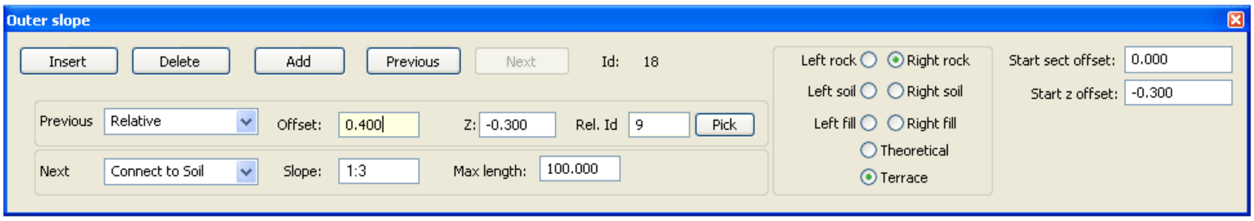
Section template|Quick outer slope

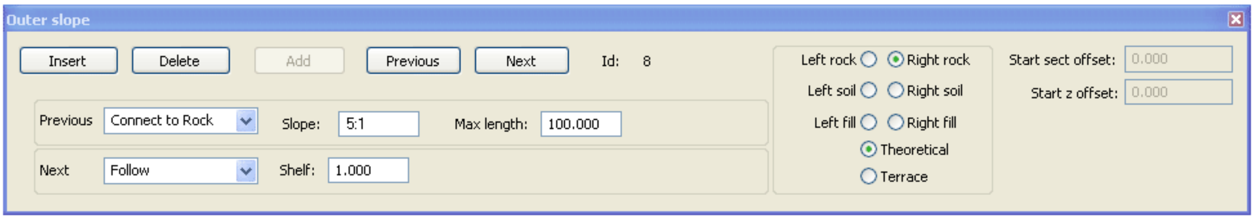
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope

To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert

Adds a new point inside selected point.

Add

Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete

Deletes selected point.

Previous and Next

To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

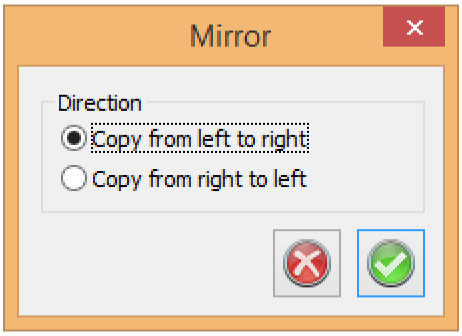
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

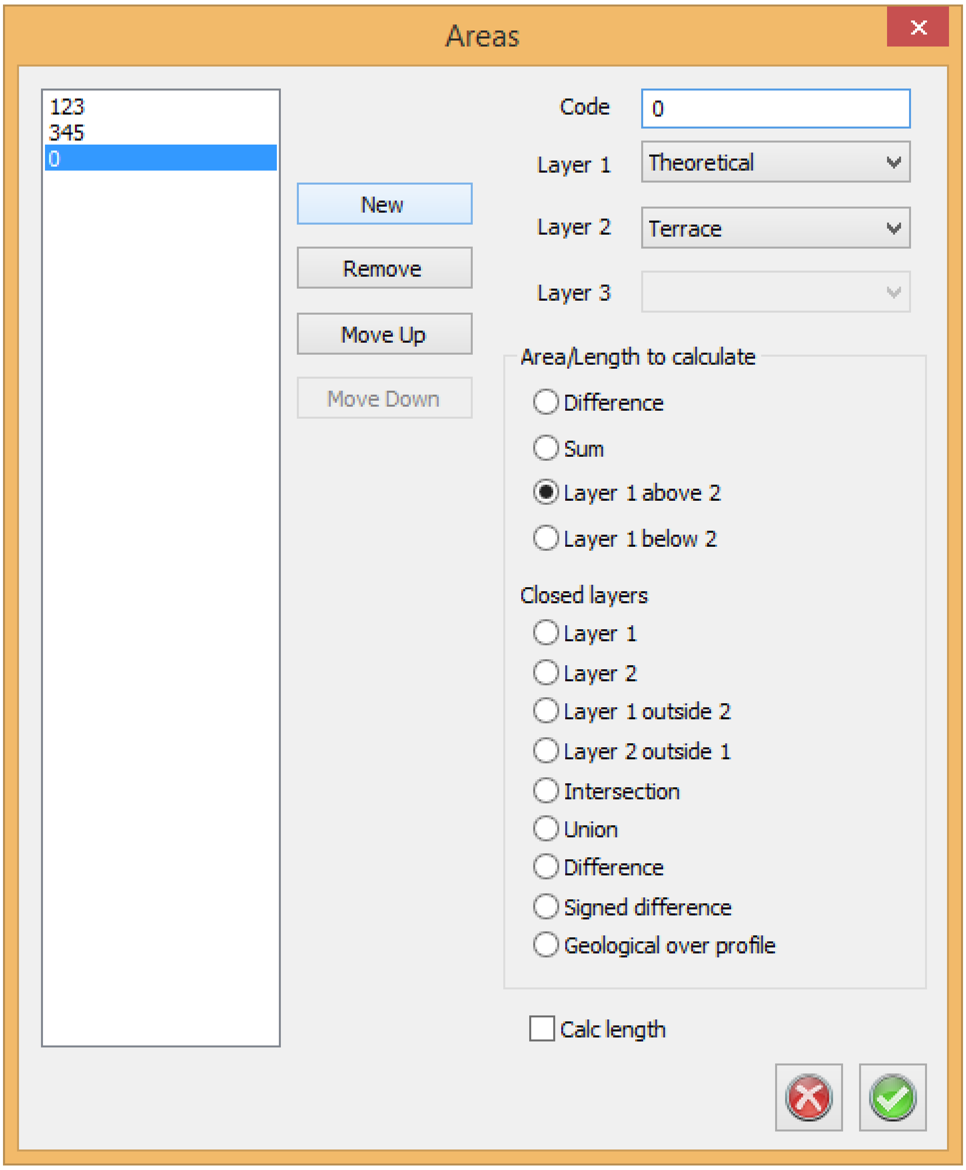
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

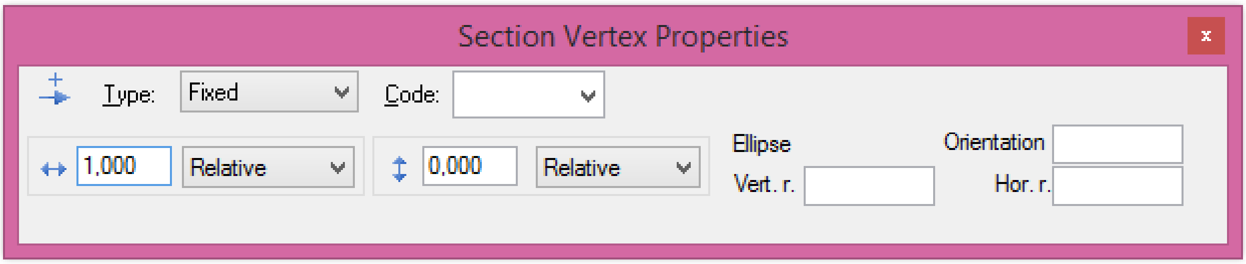
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

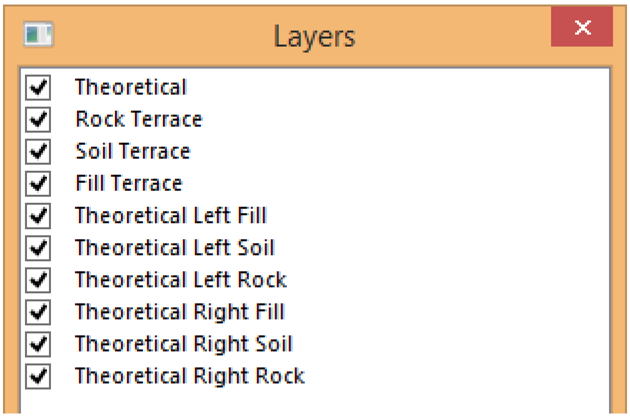
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

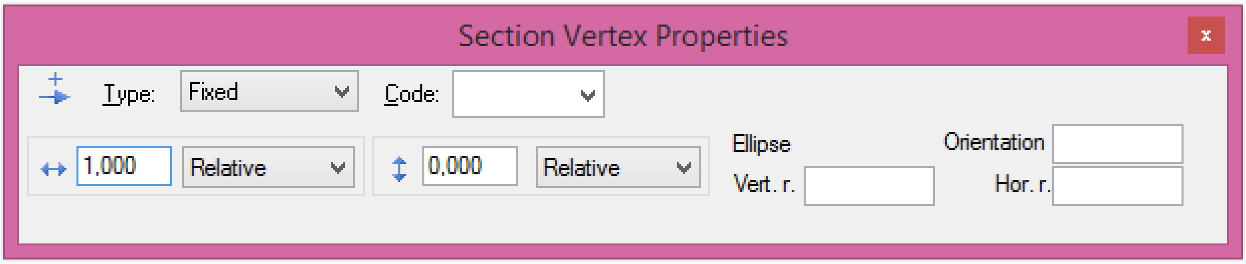
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

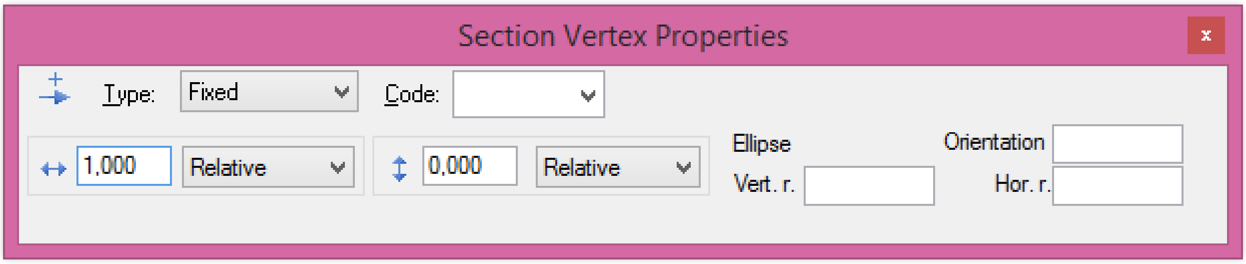
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

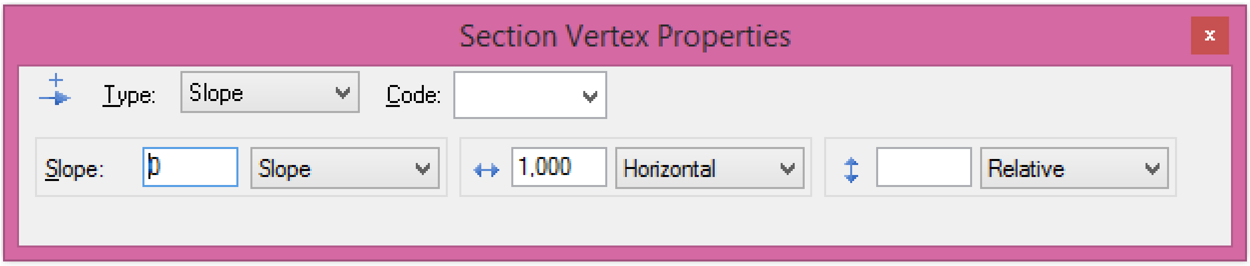
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

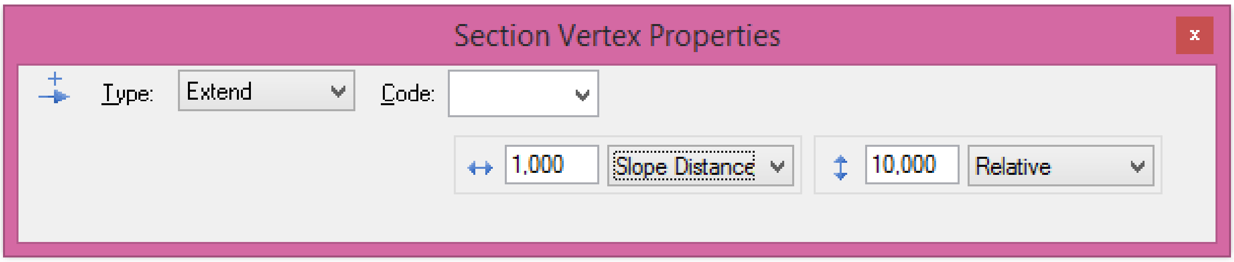
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

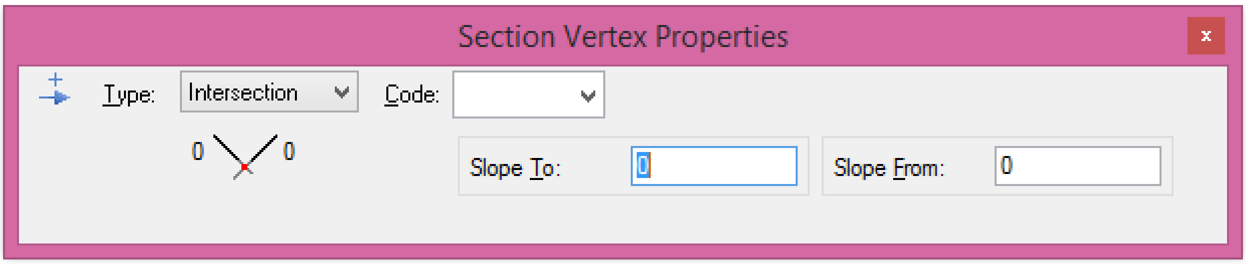
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

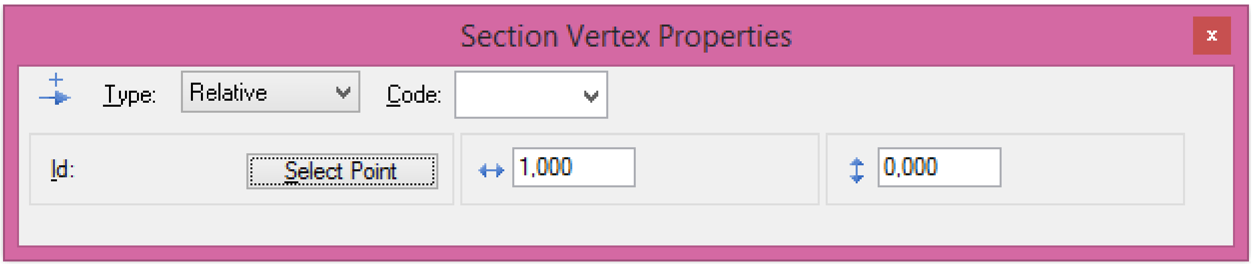
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

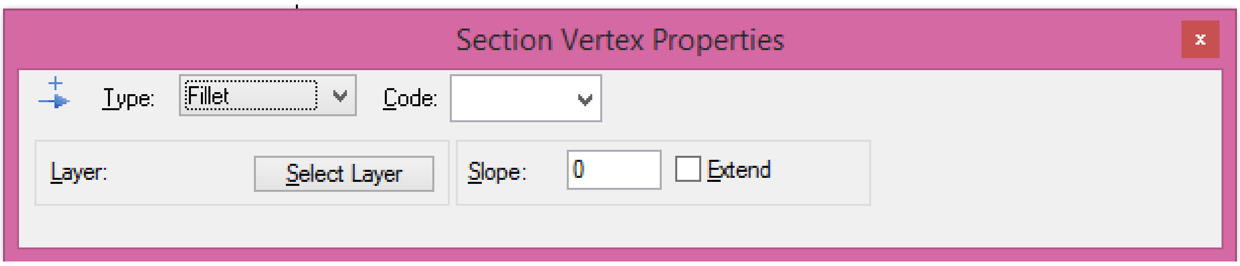
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

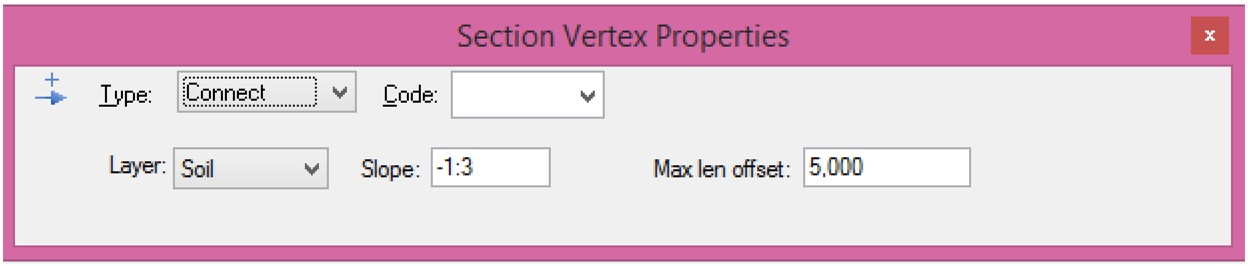
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

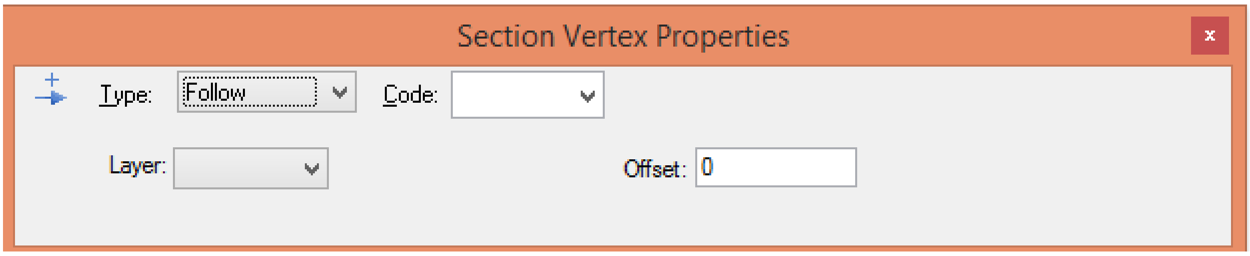


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

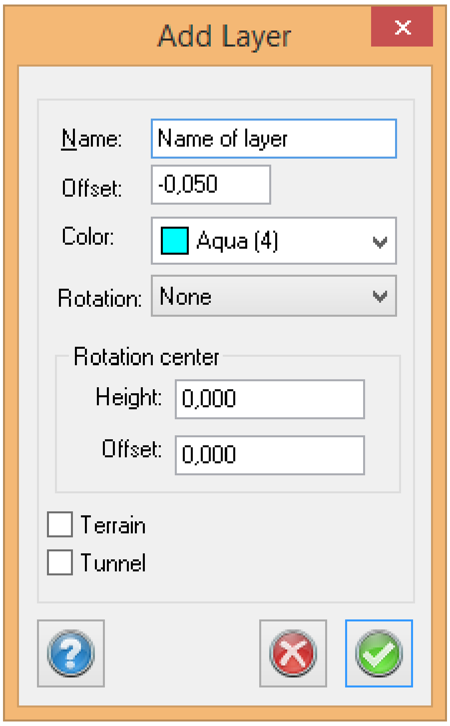


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

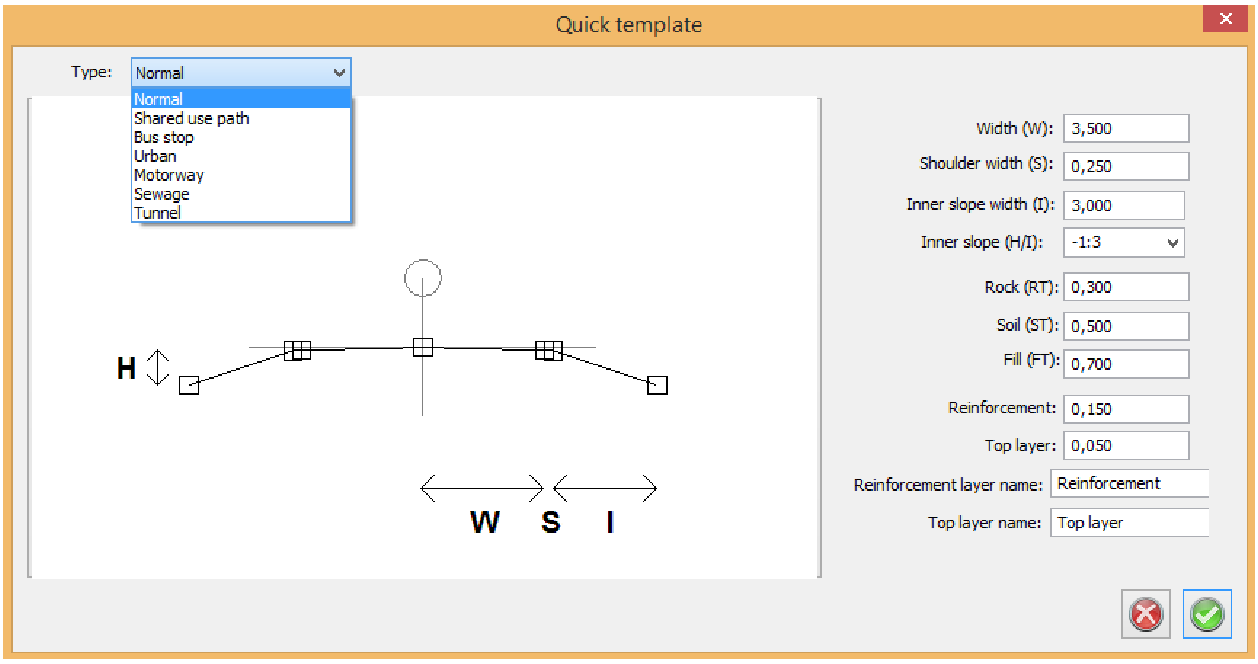
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

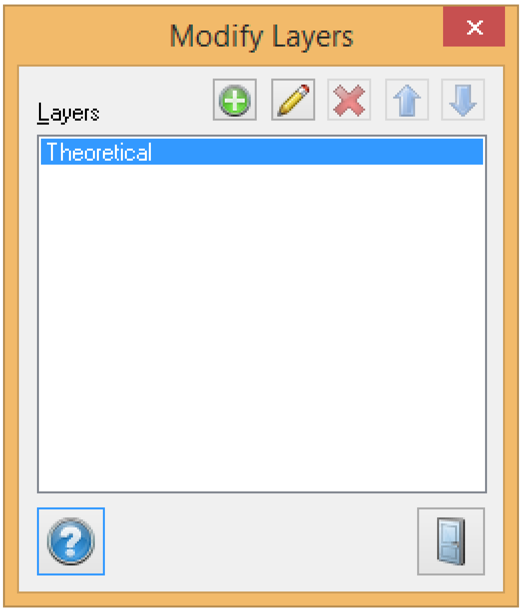
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

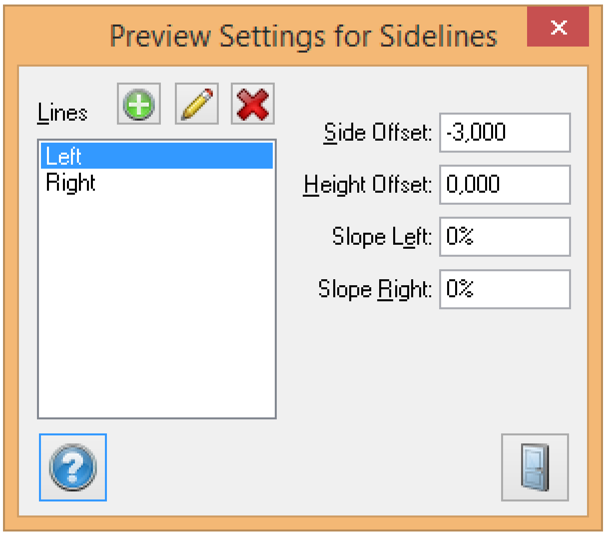


Modify layers in section template.

Edit side lines

Section template|Side lines

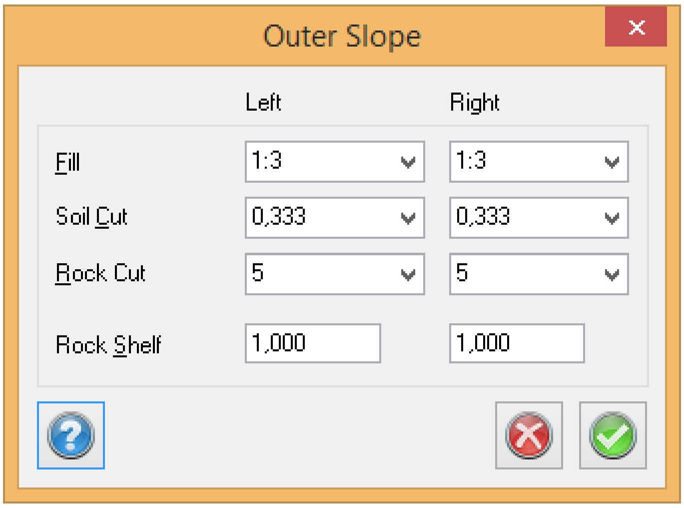
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

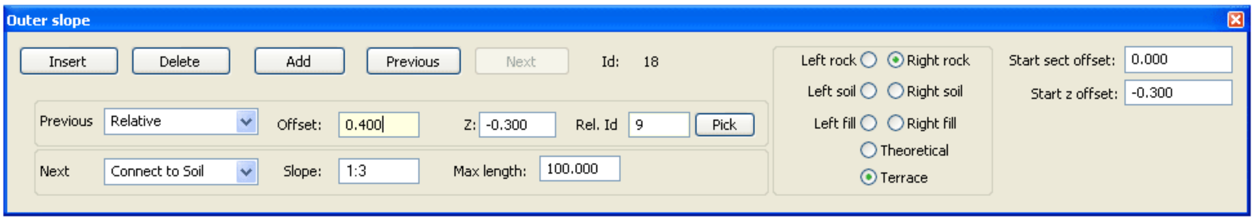
Section template|Quick outer slope

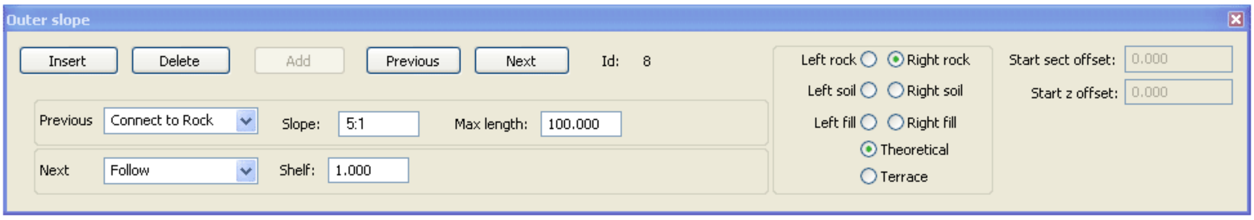
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

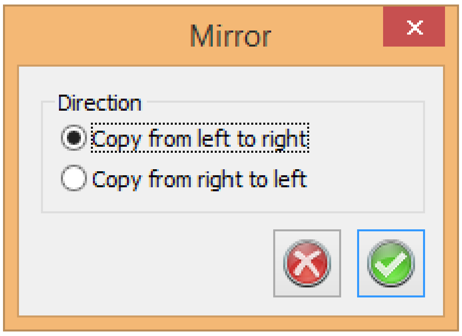
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

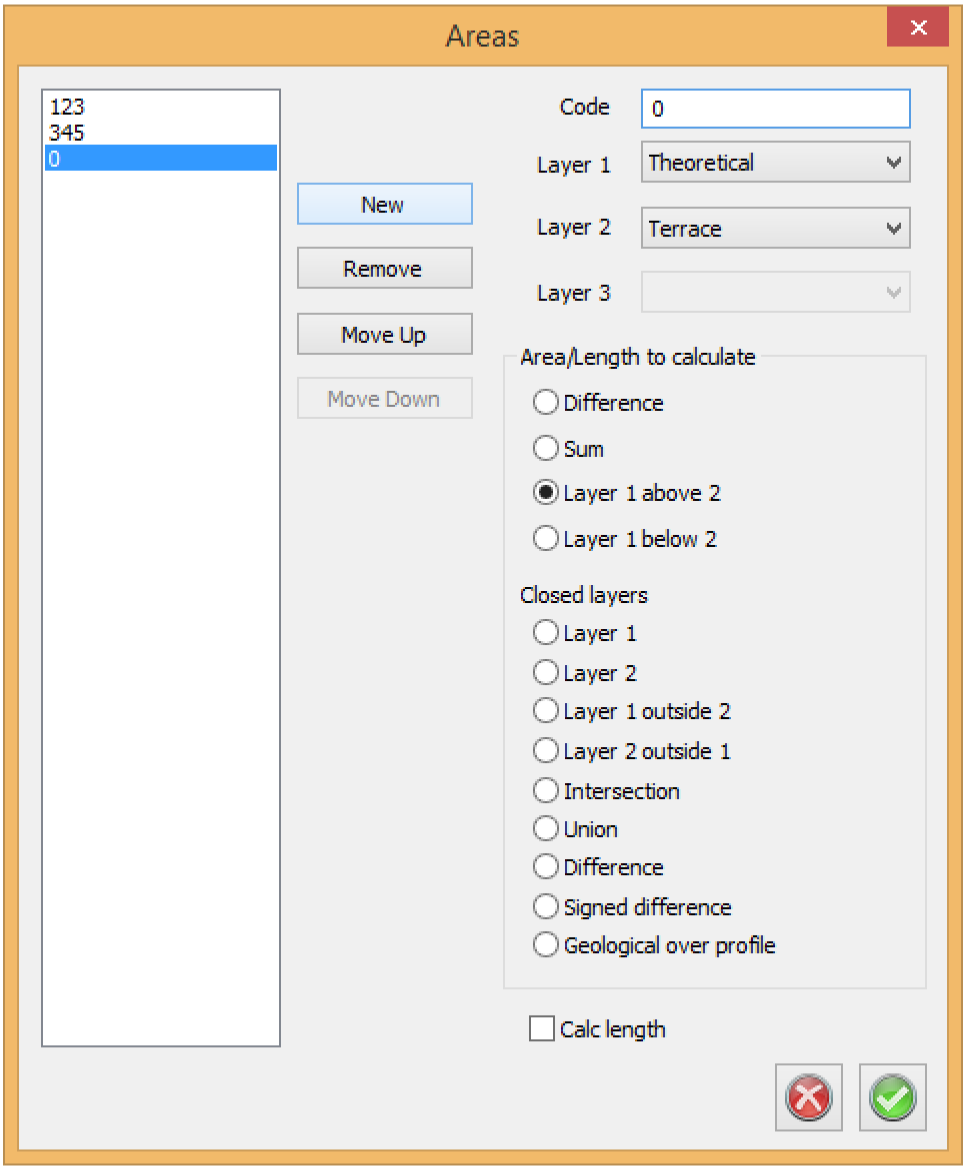
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

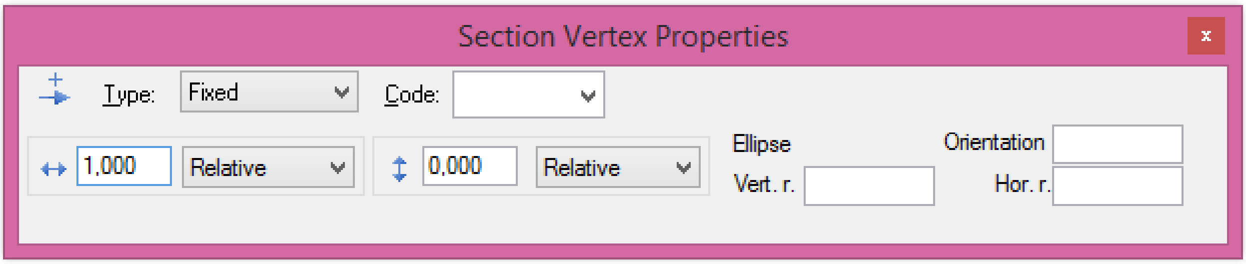
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

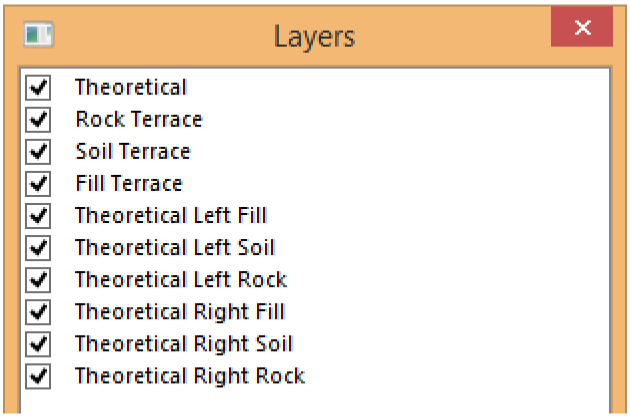
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

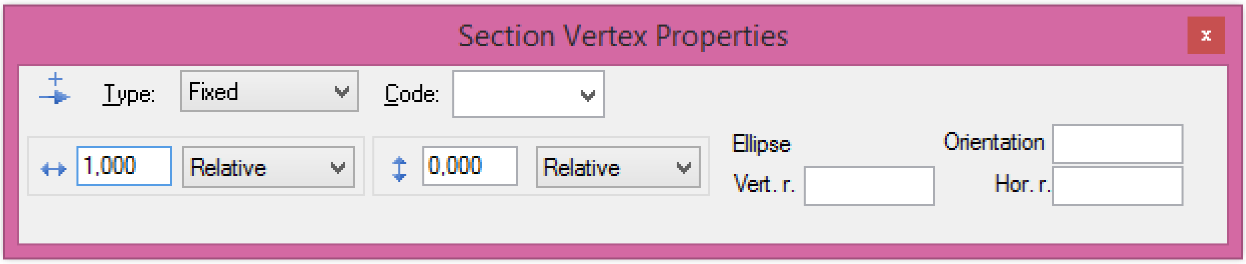
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

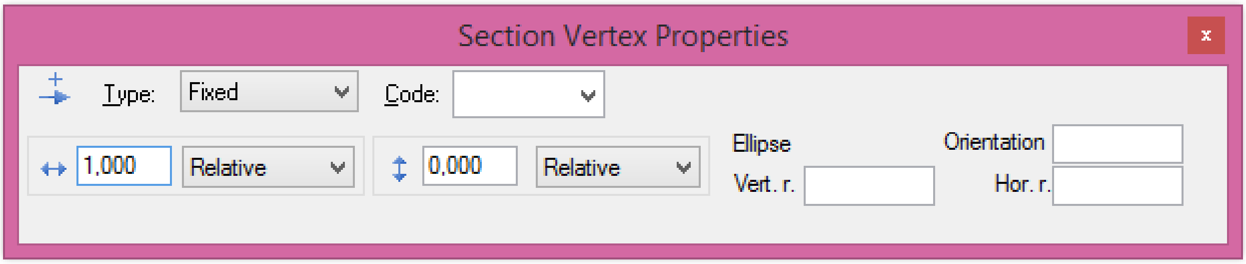
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

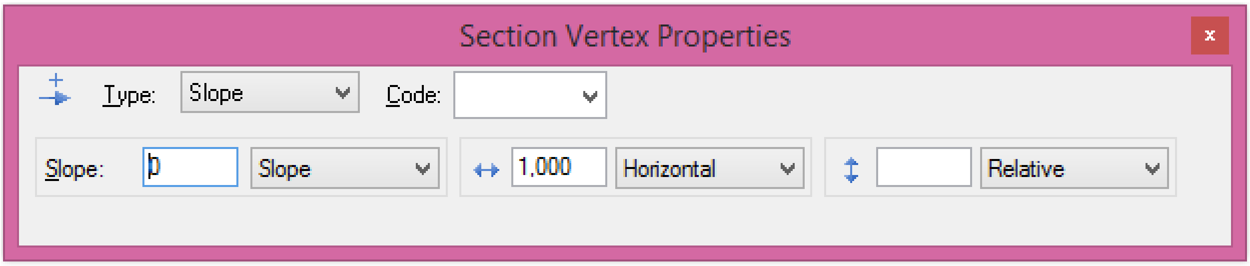
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

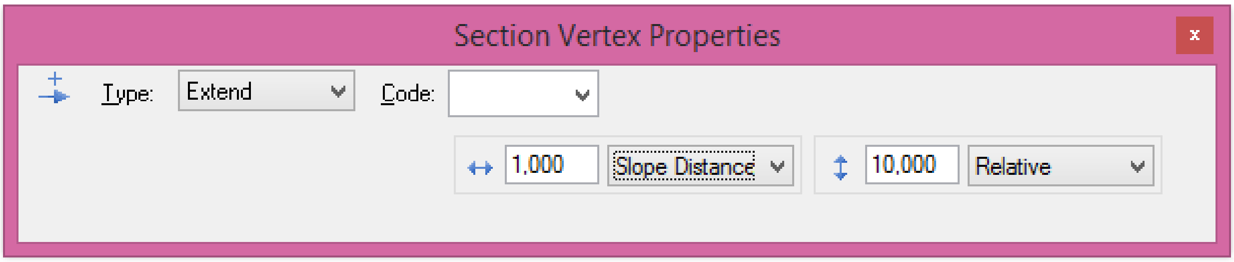
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

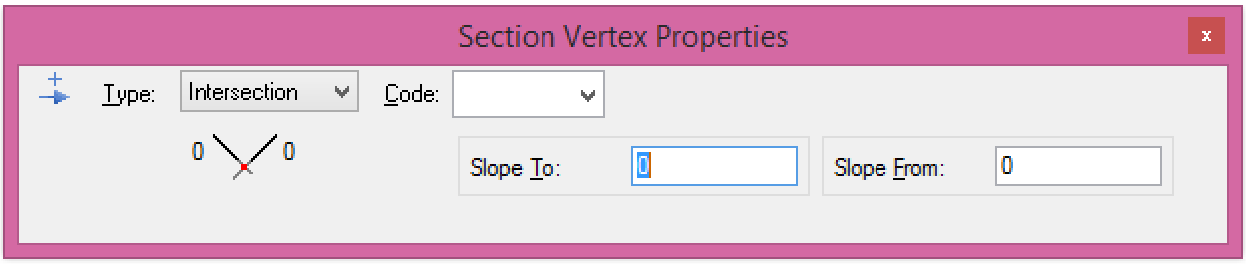
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

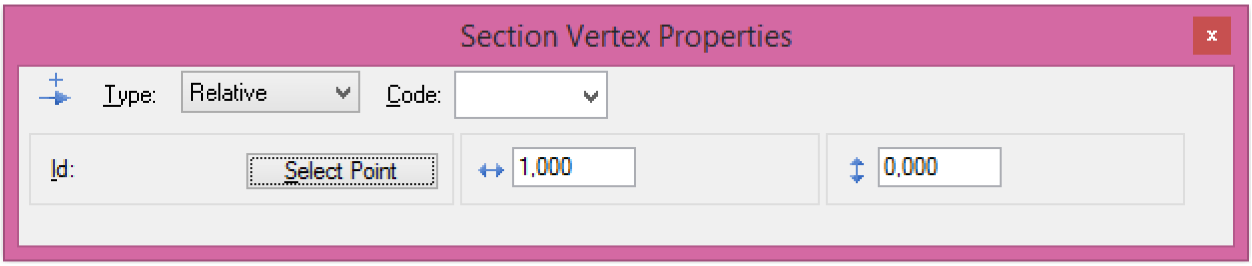
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

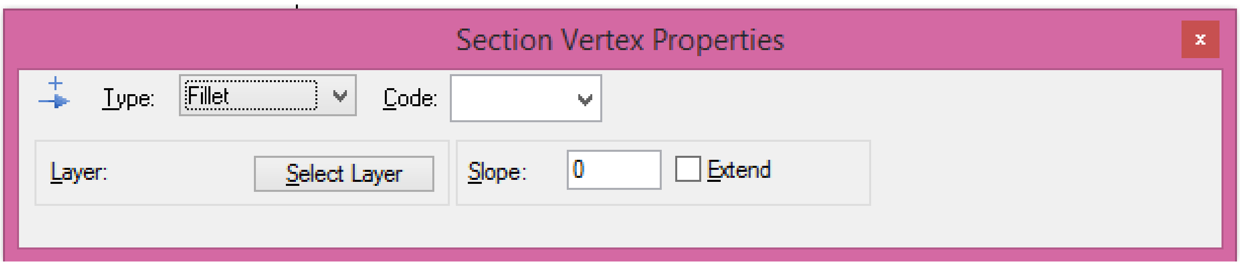
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

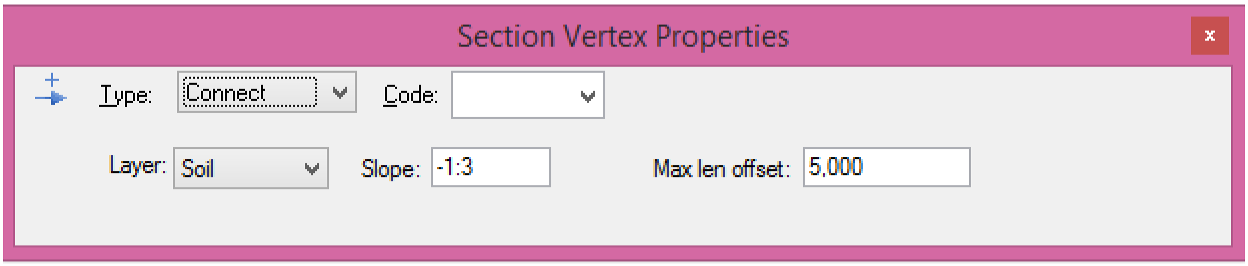
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

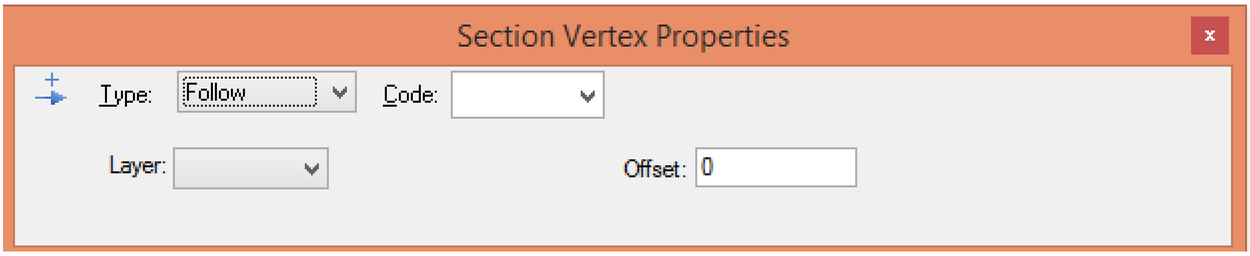


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

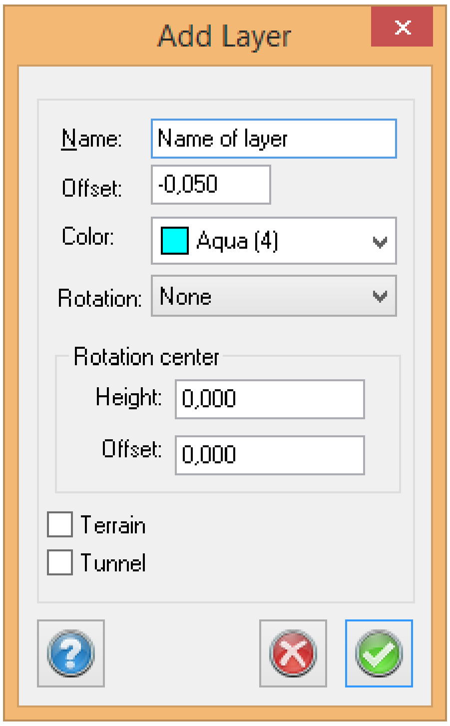


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

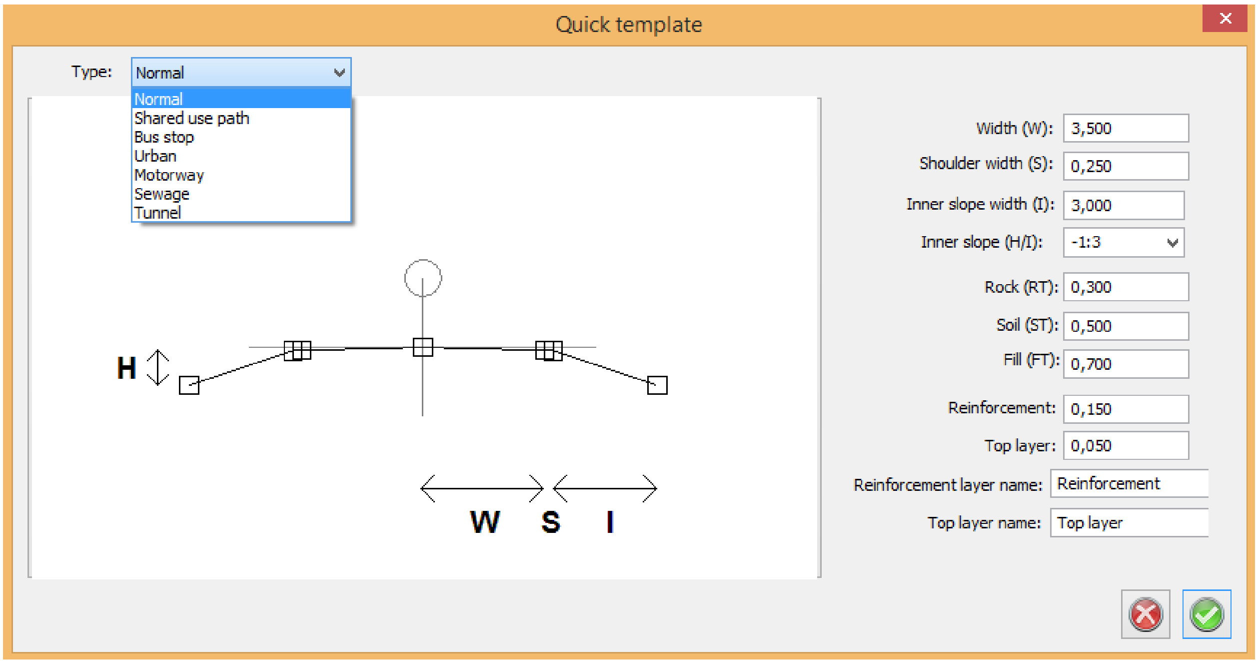
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

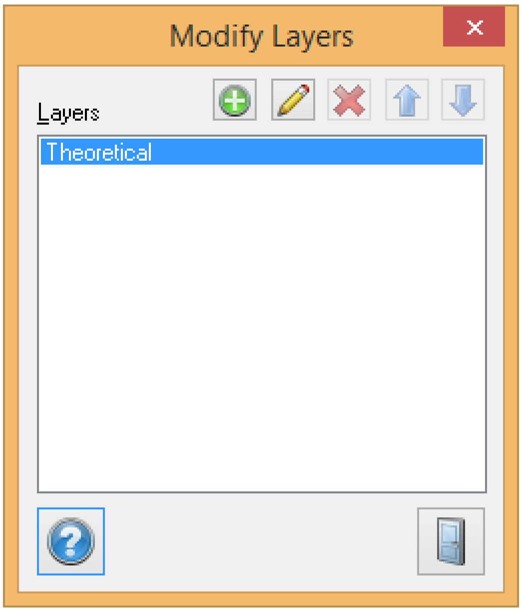
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

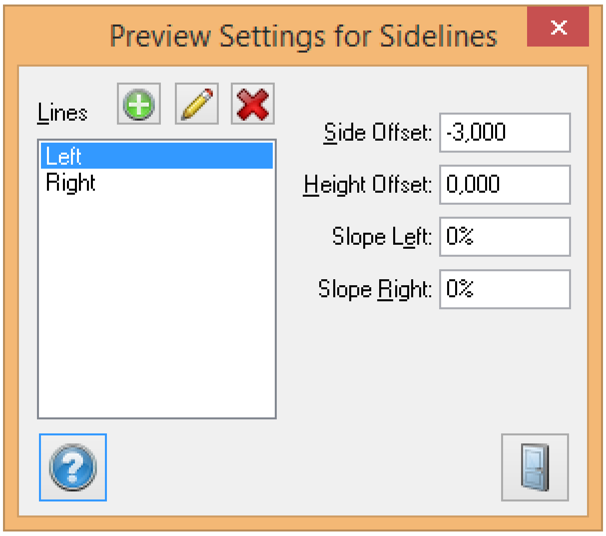


Modify layers in section template.

Edit side lines

Section template|Side lines

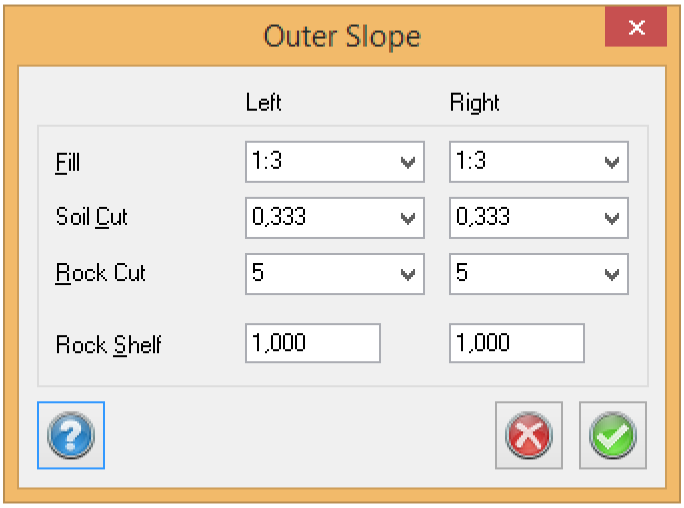
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

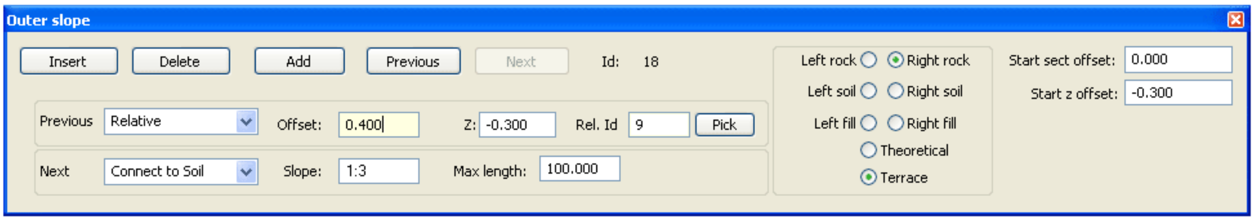
Section template|Quick outer slope

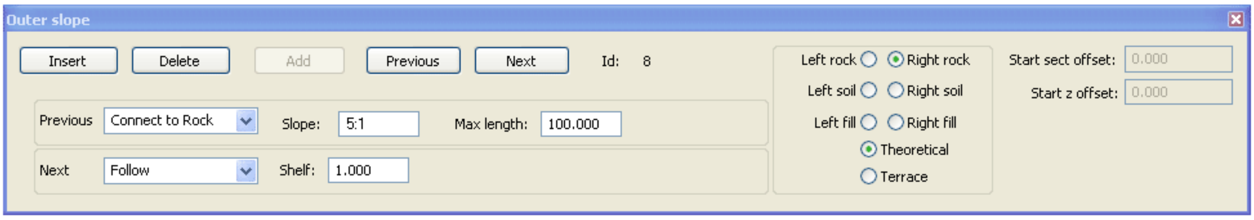
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

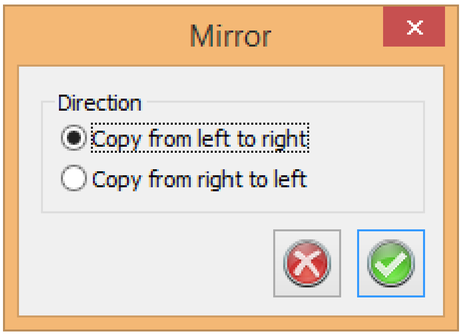
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

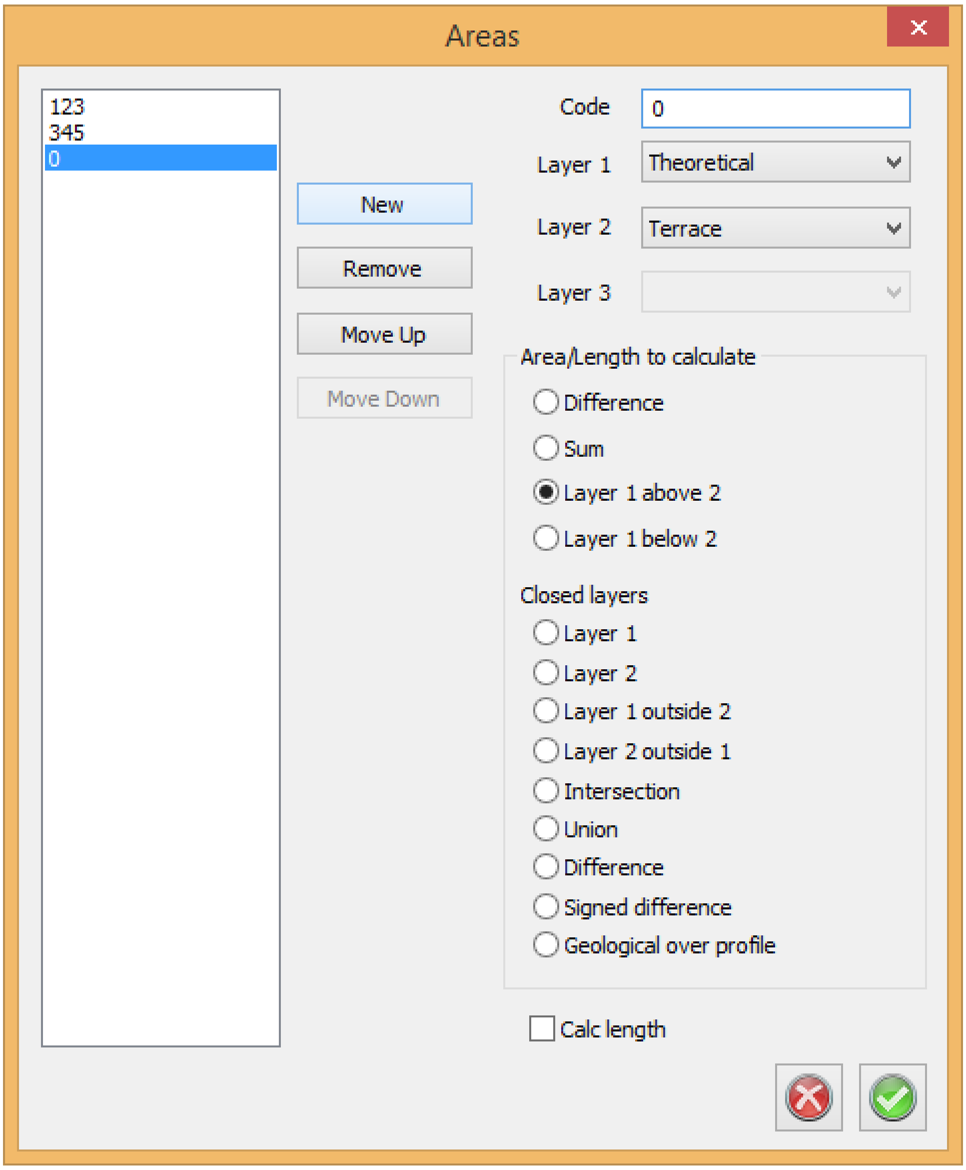
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

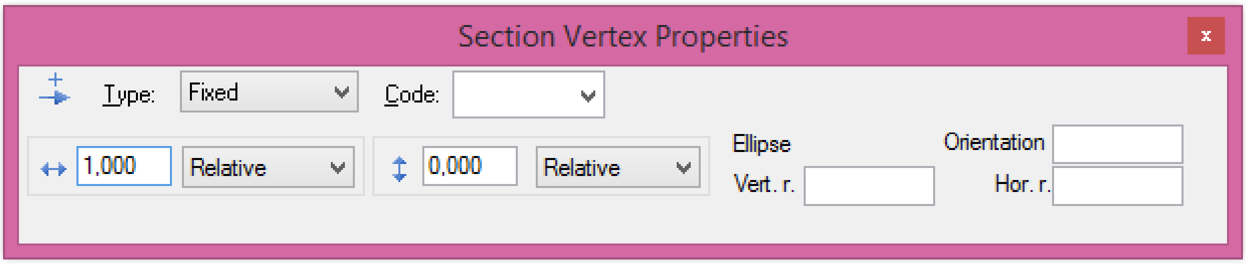
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

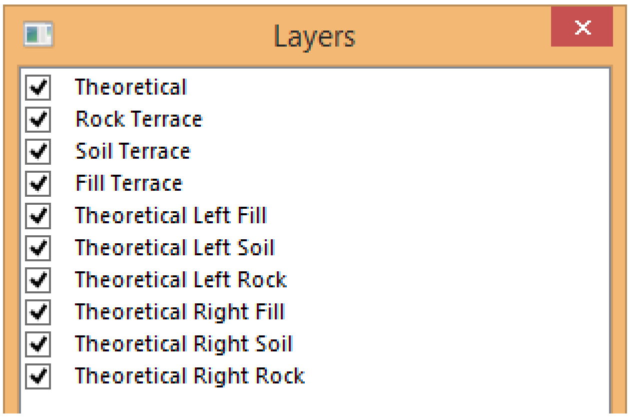
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

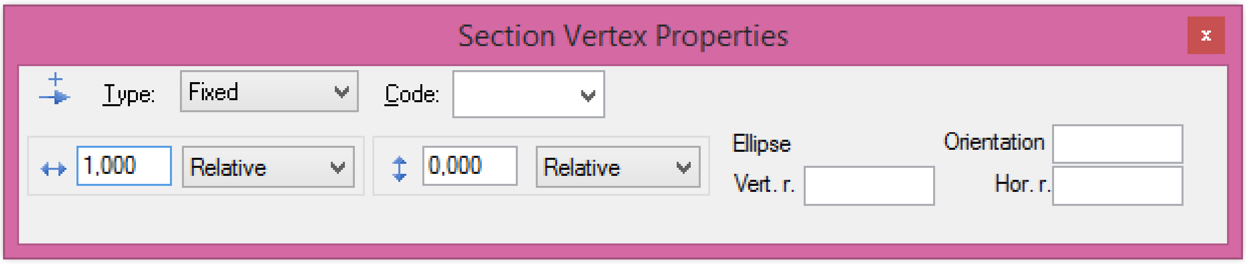
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

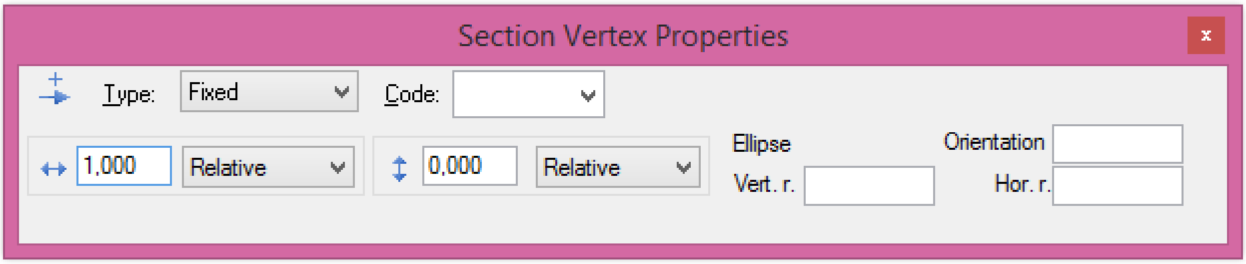
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

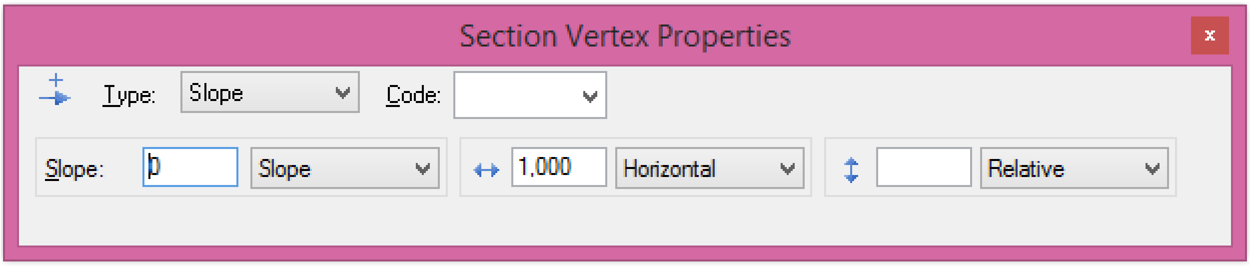
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

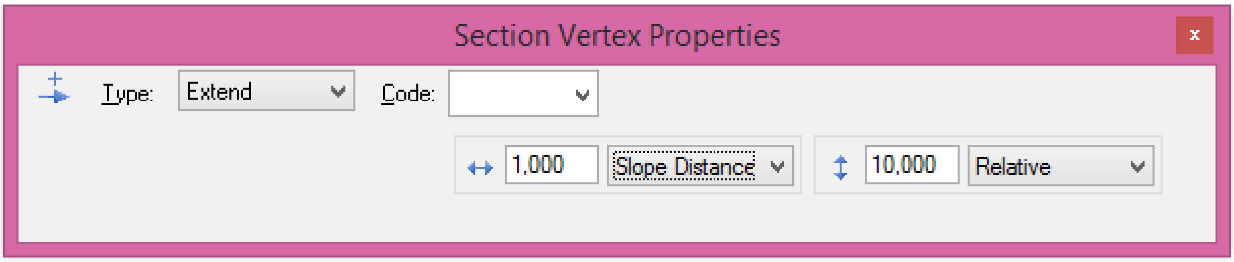
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

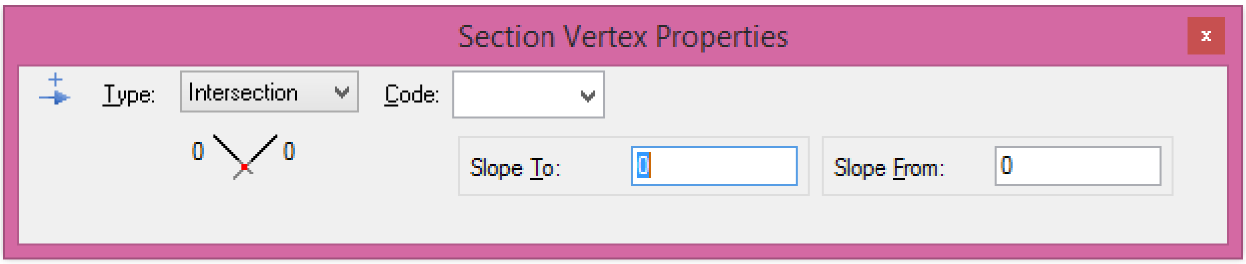
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

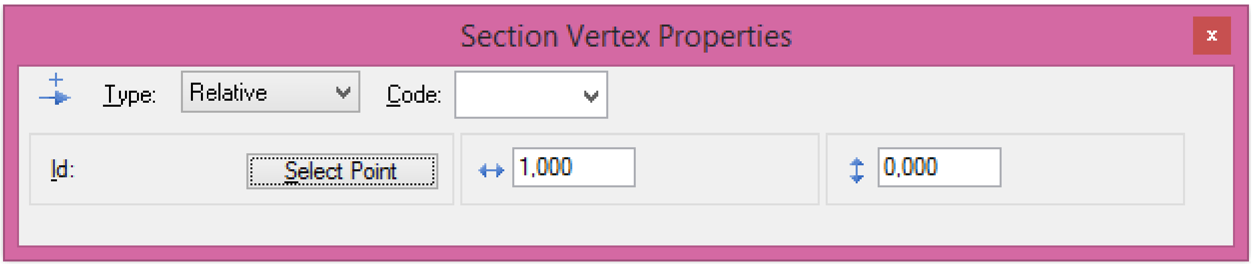
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

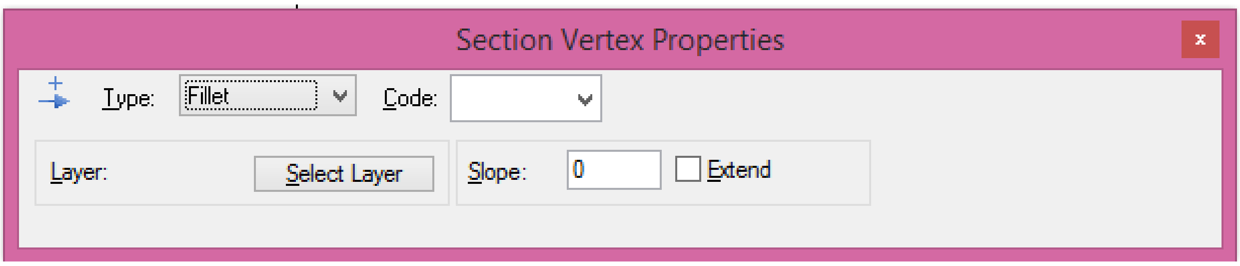
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

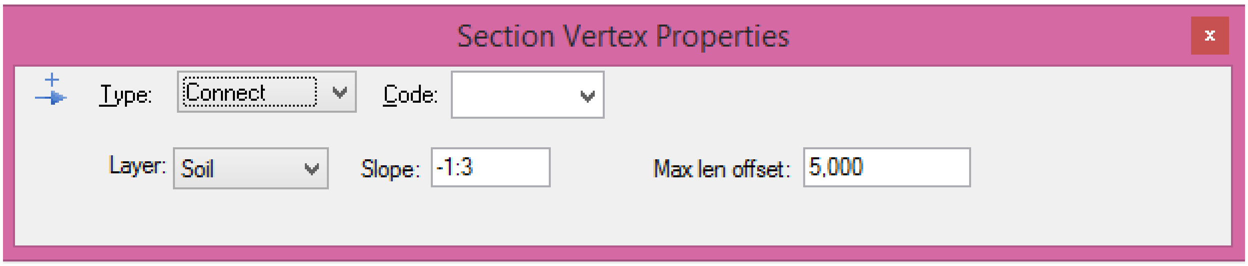
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

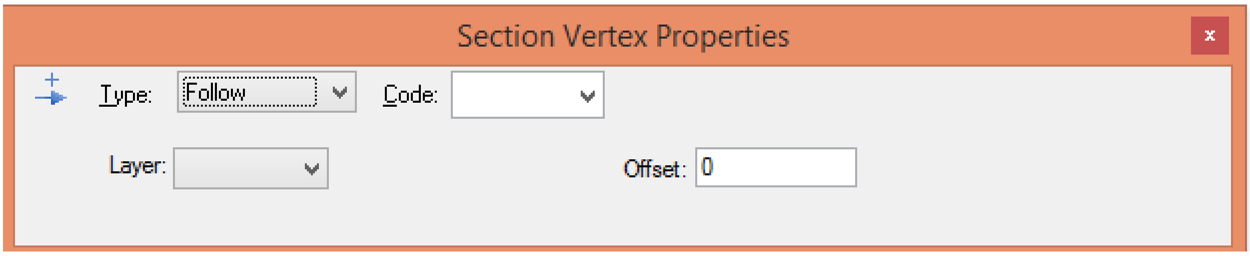


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

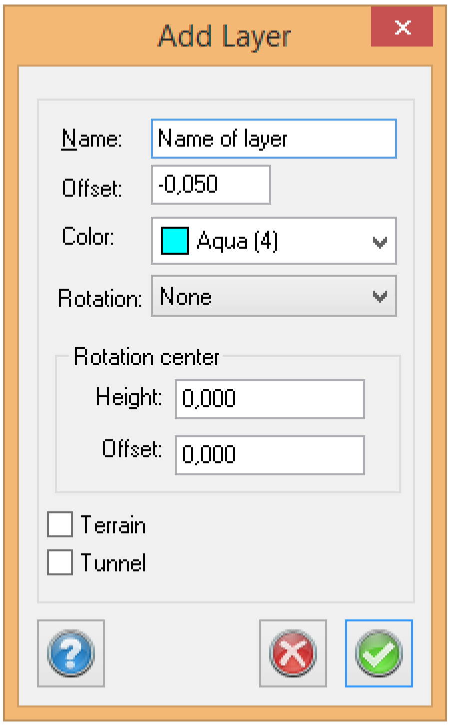


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

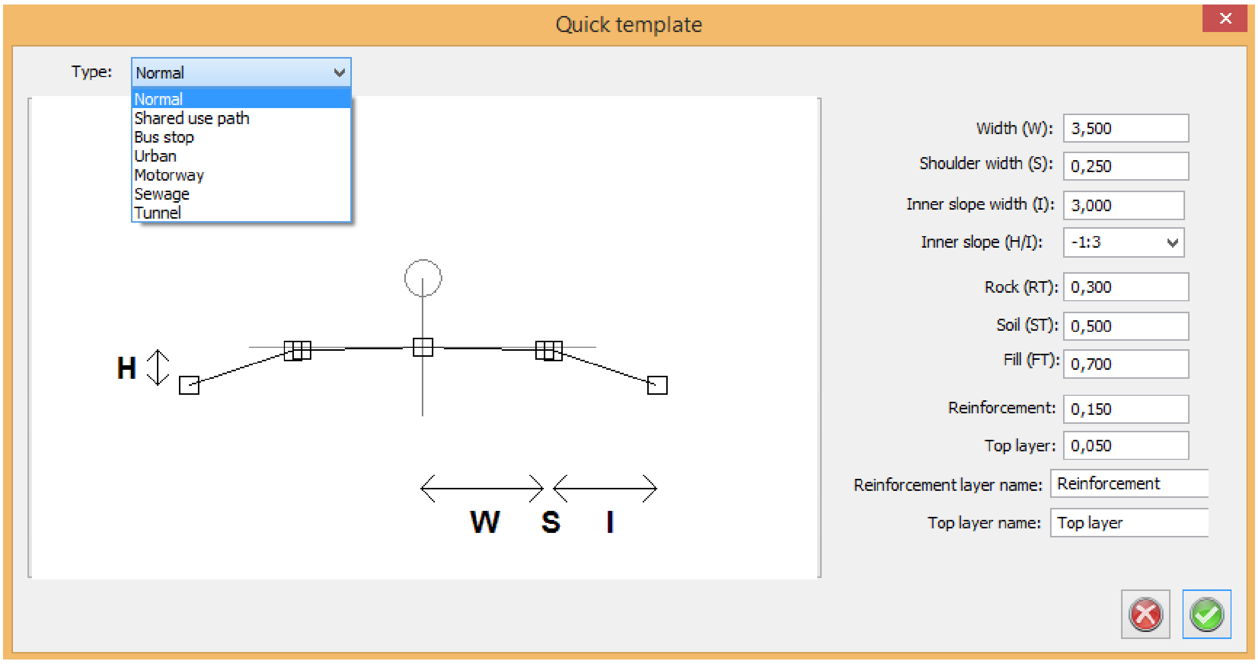
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

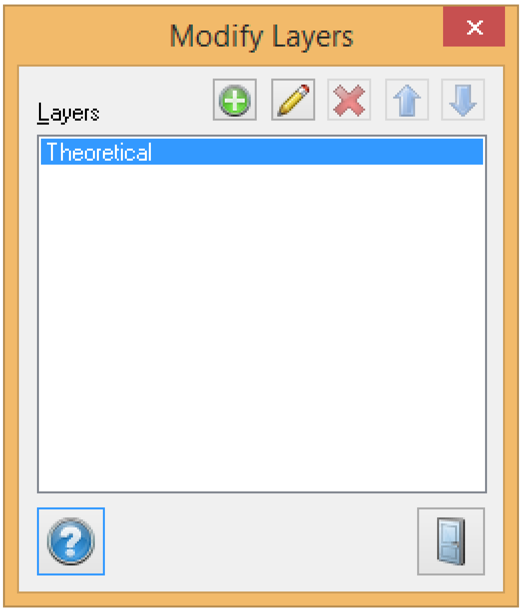
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

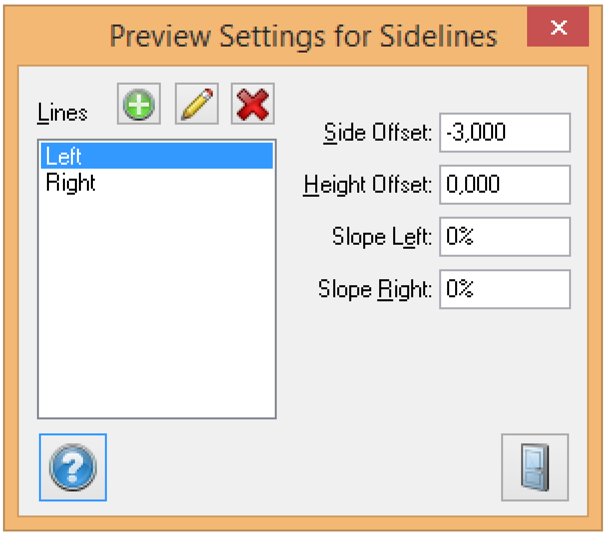


Modify layers in section template.

Edit side lines

Section template|Side lines

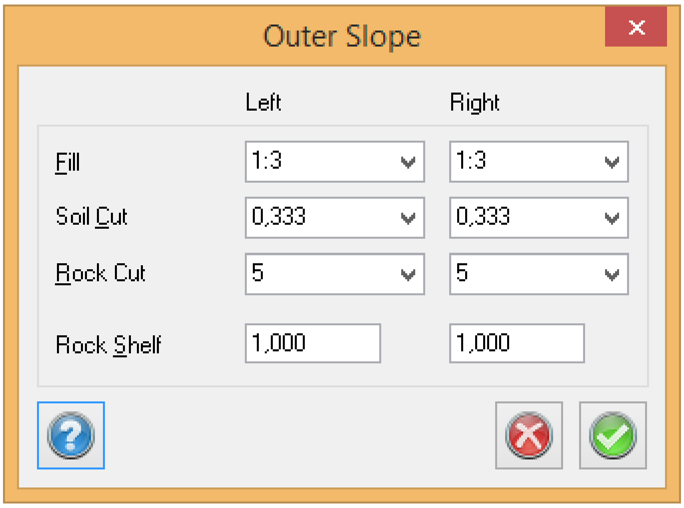
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

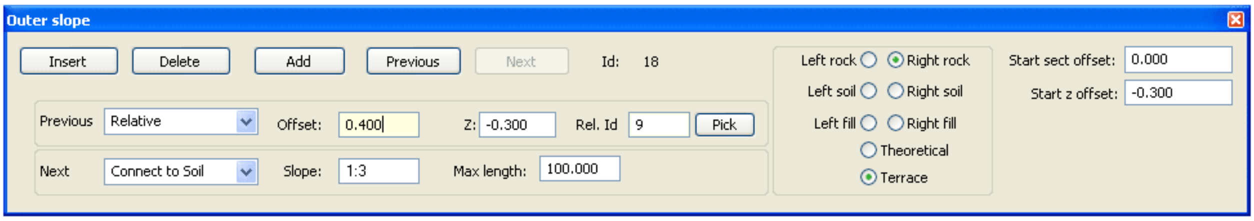
Section template|Quick outer slope

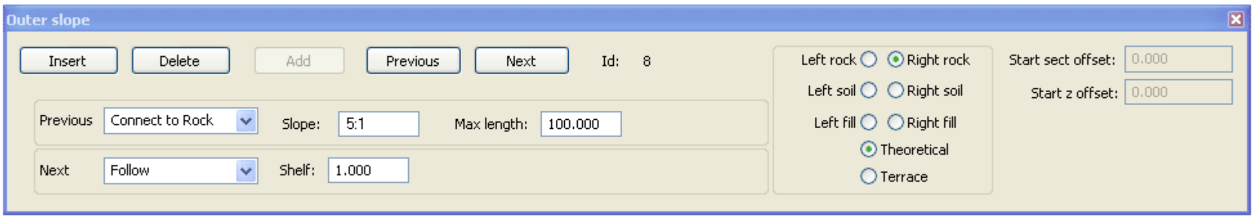
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

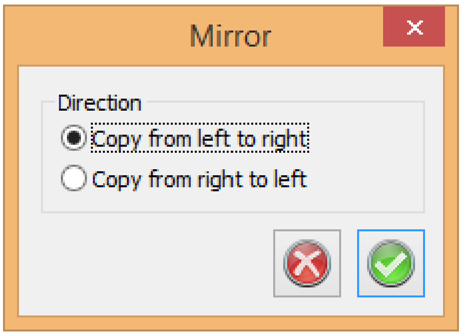
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

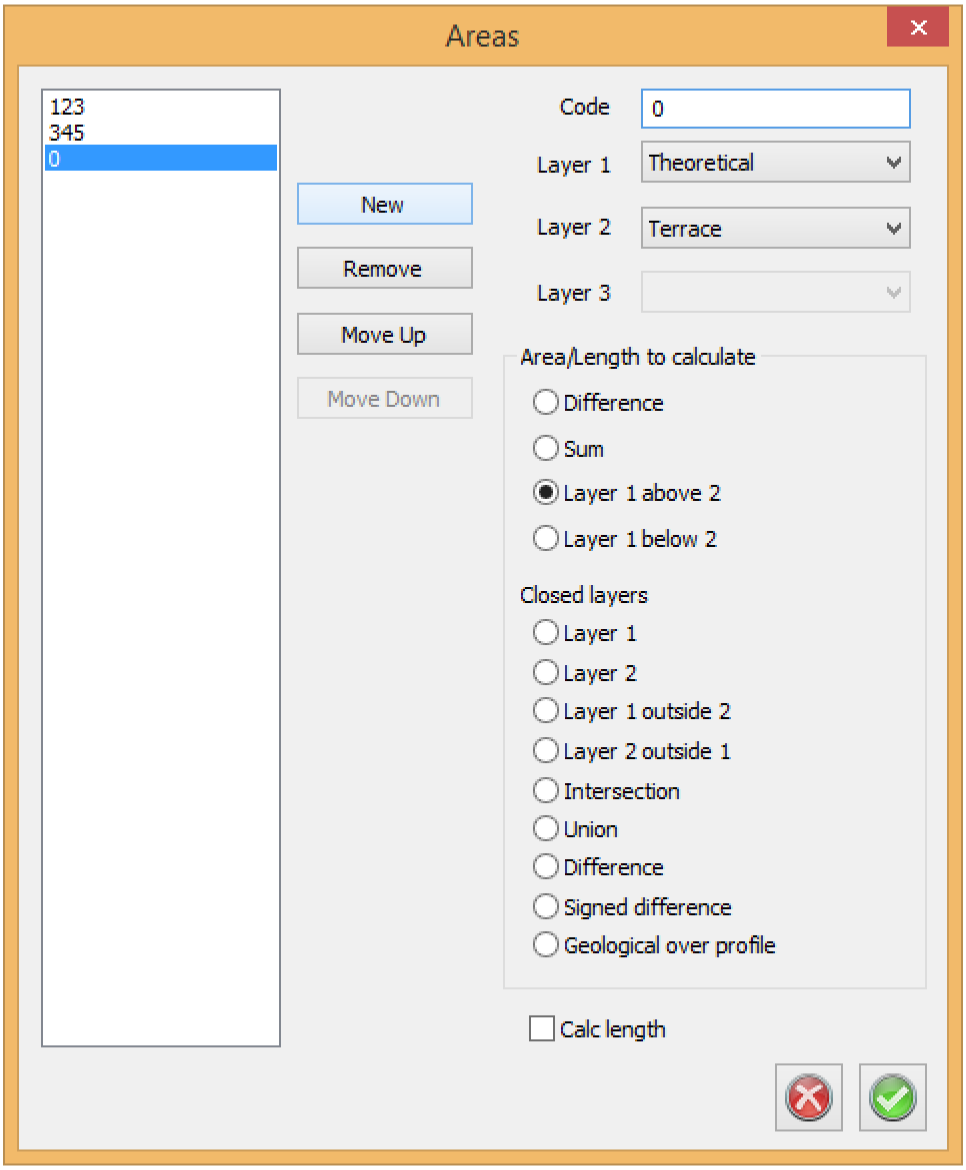
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

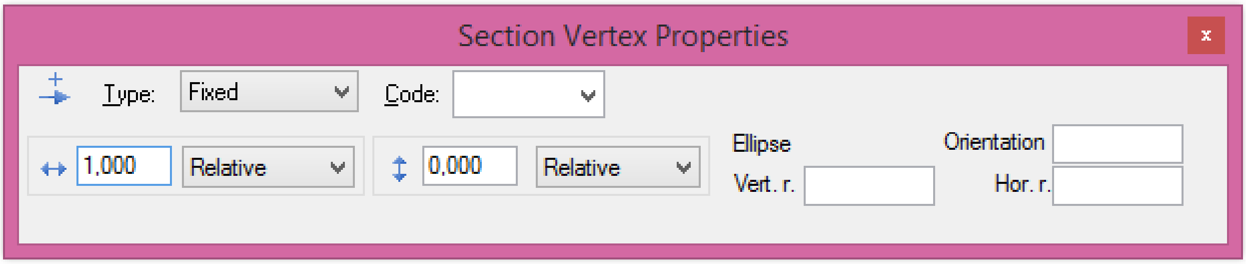
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

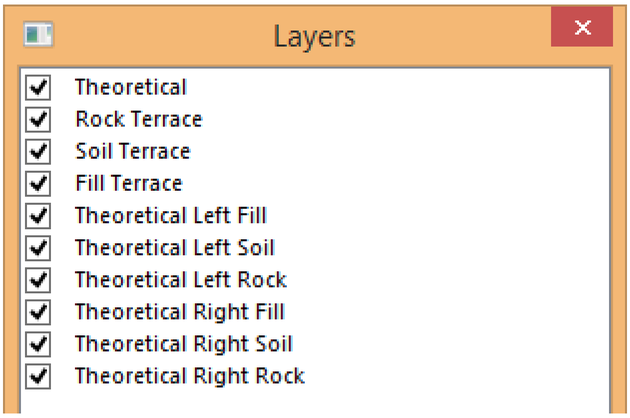
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

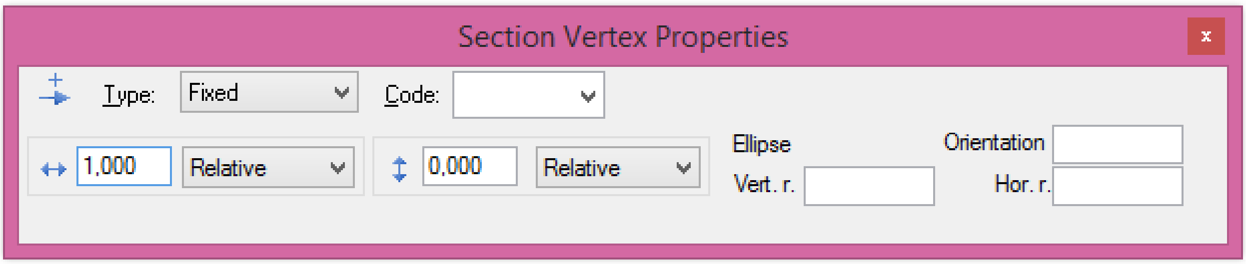
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

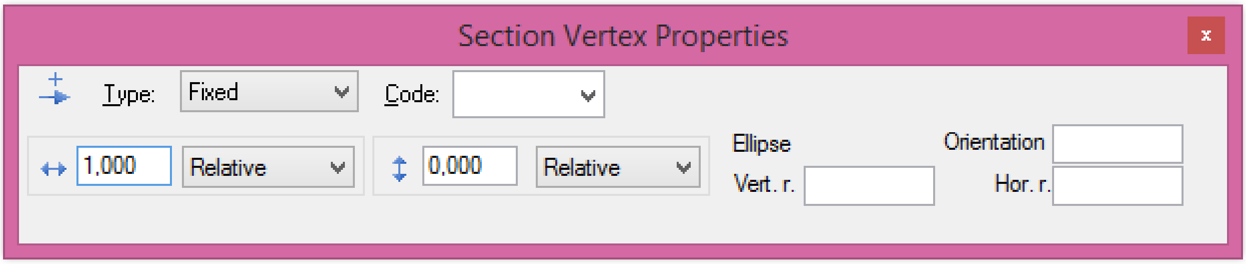
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

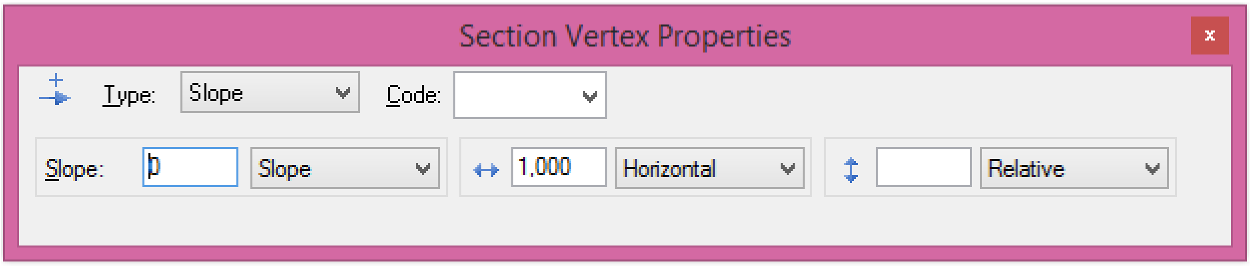
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

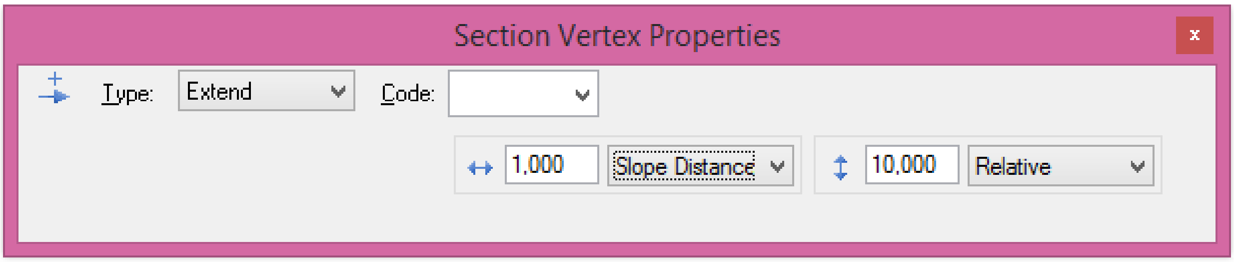
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

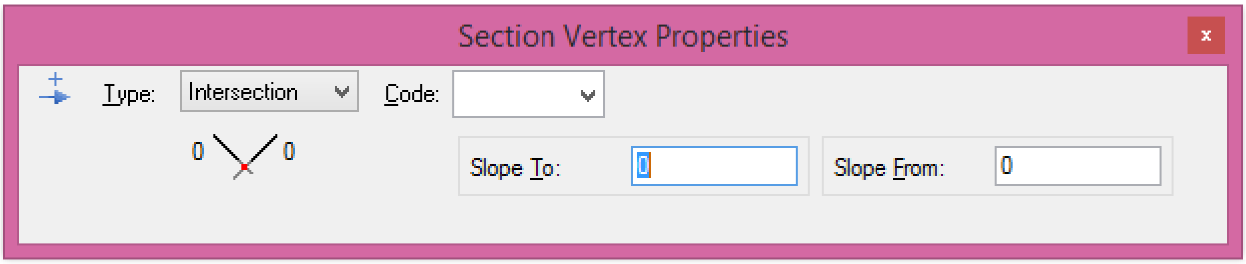
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

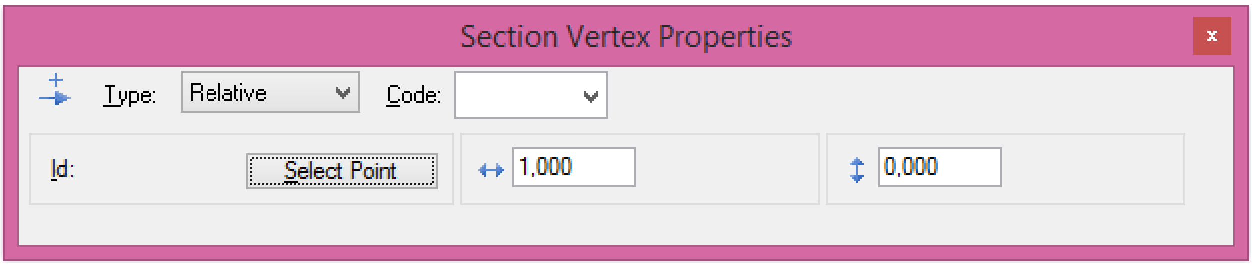
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

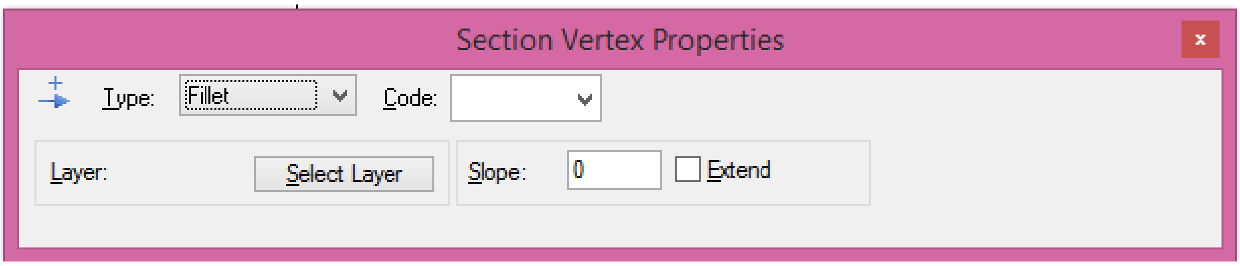
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

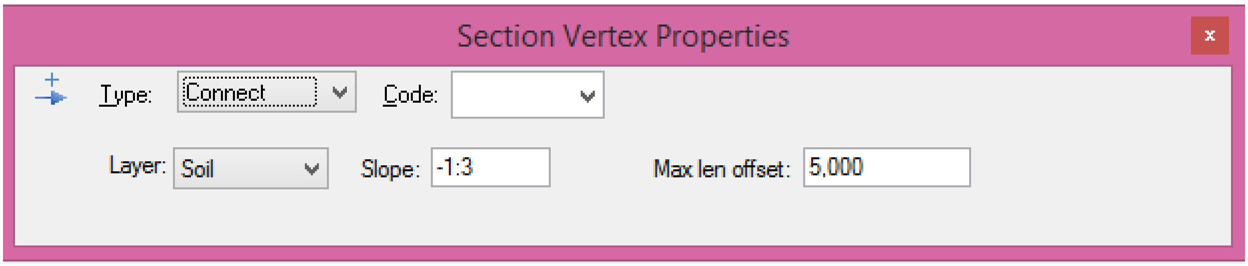
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

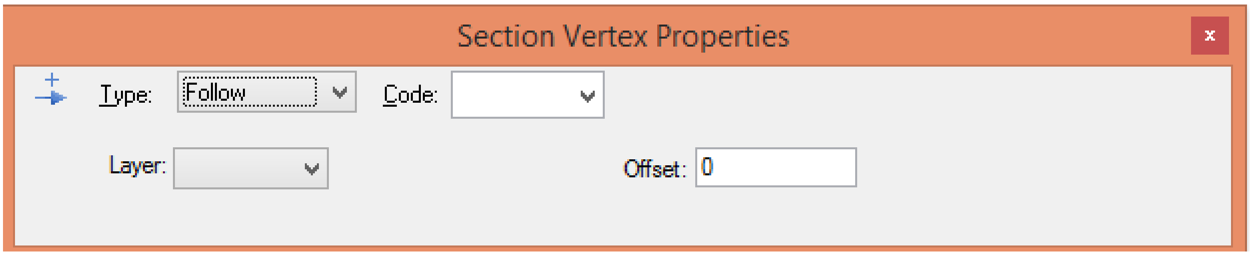


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

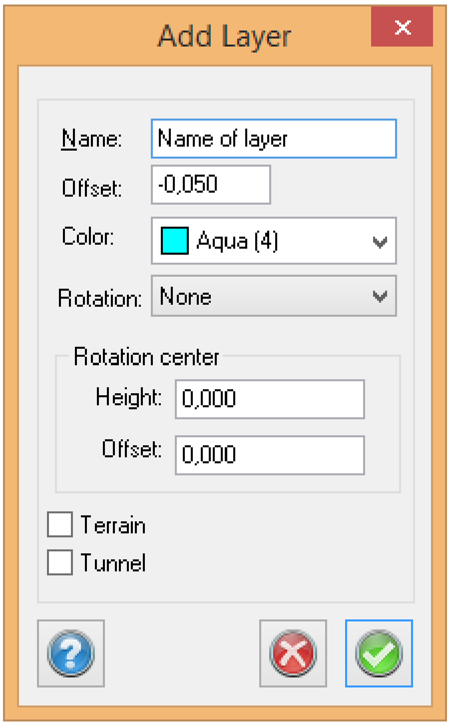


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

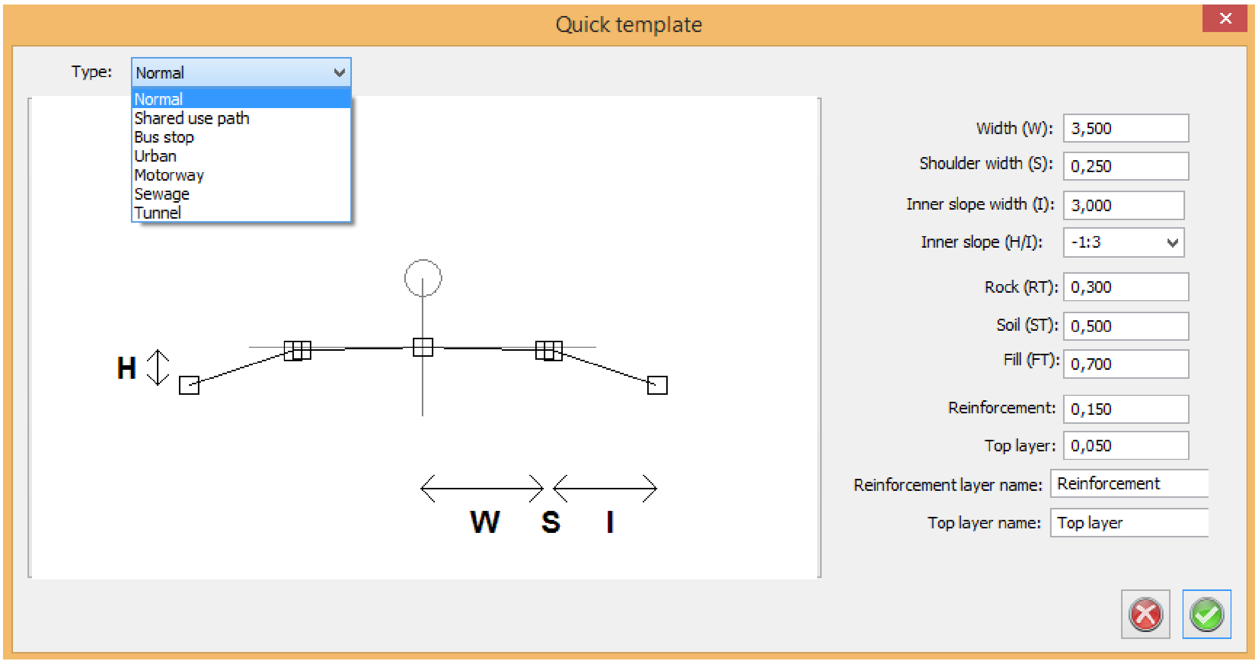
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

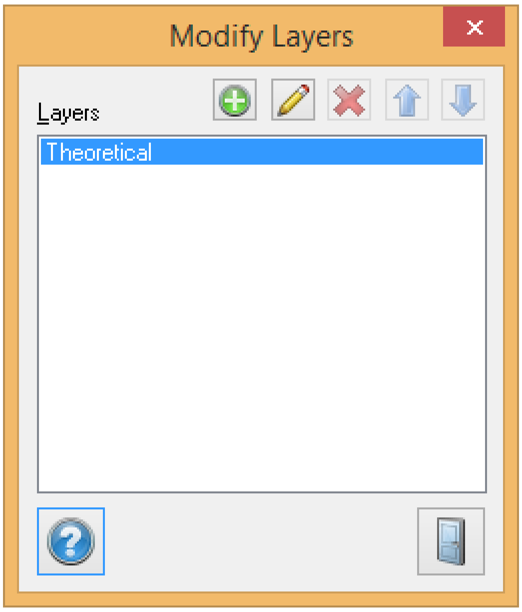
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

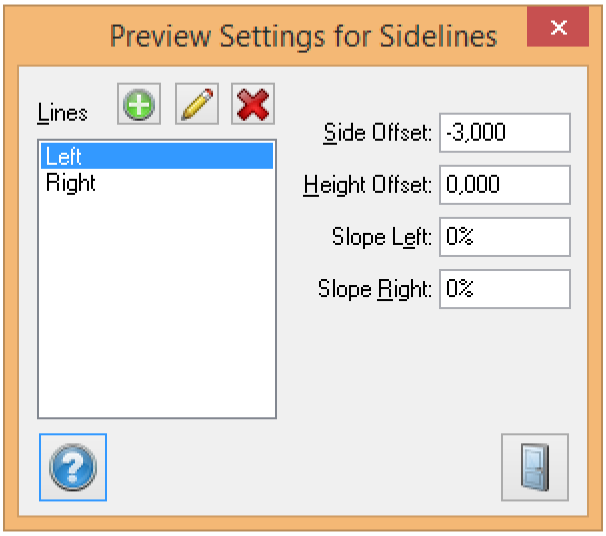


Modify layers in section template.

Edit side lines

Section template|Side lines

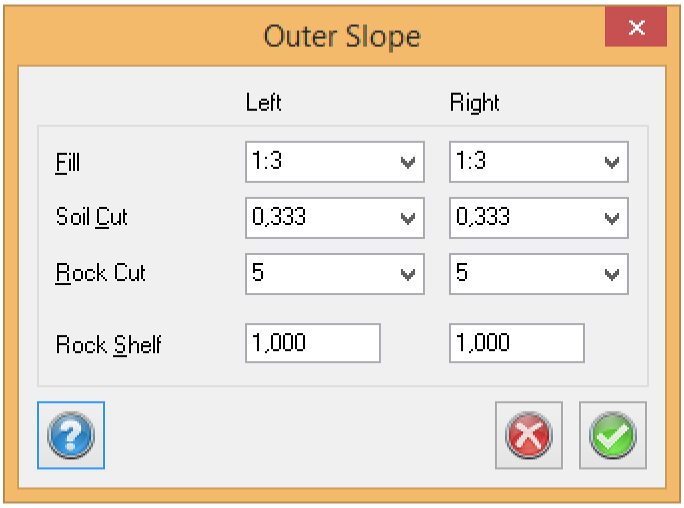
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

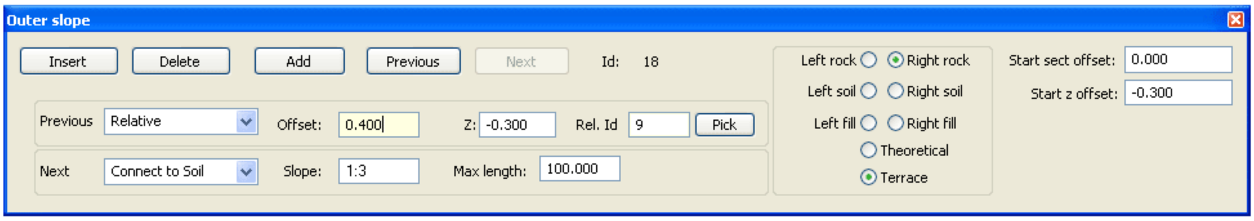
Section template|Quick outer slope

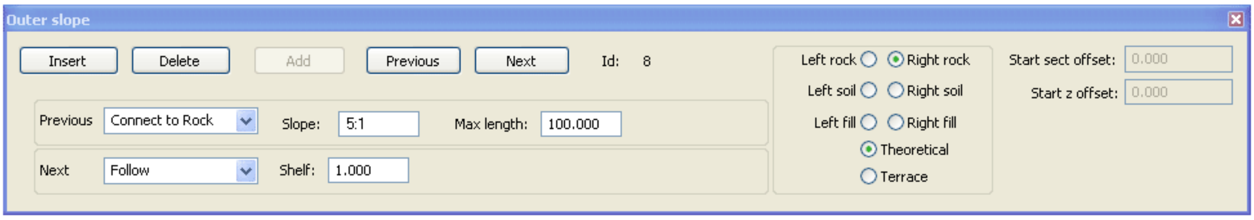
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

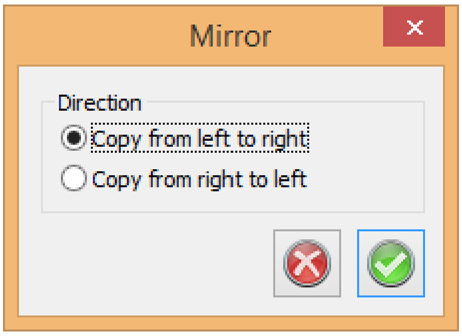
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

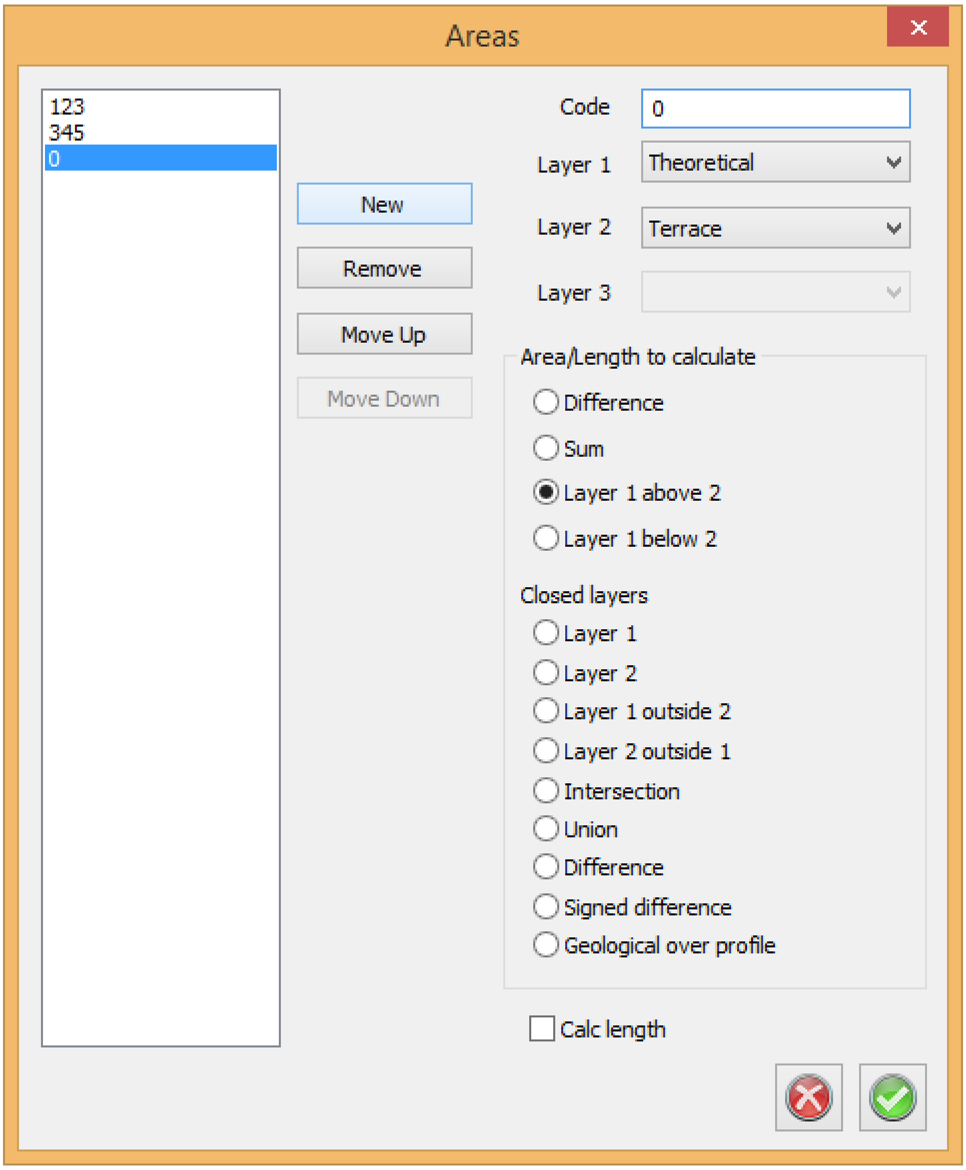
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

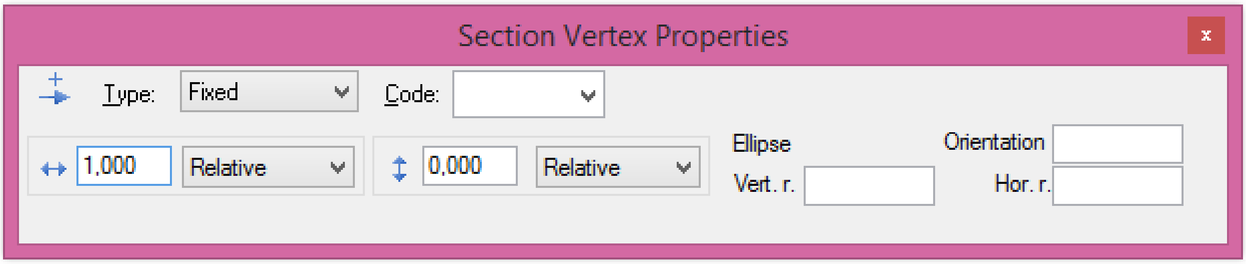
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

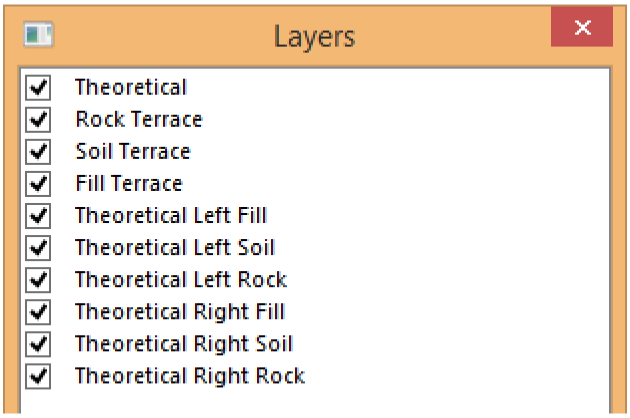
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

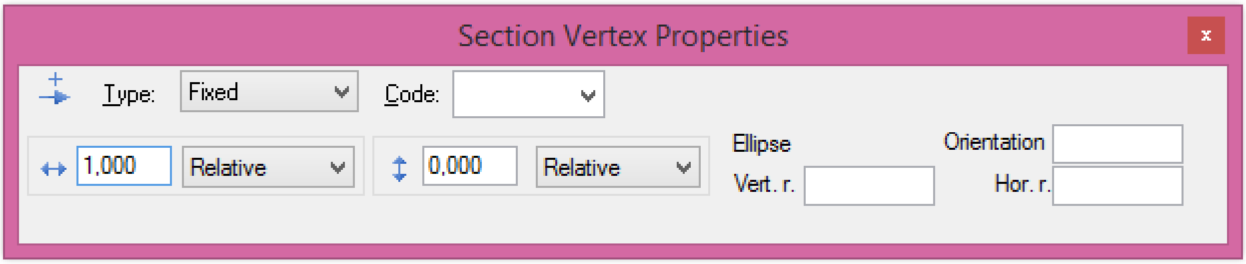
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

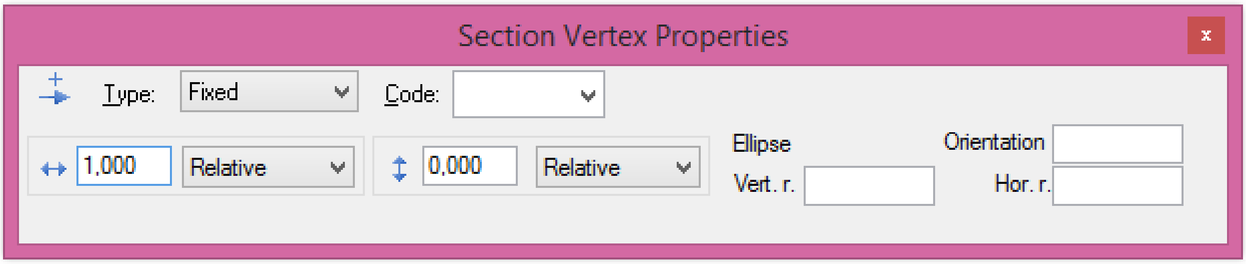
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

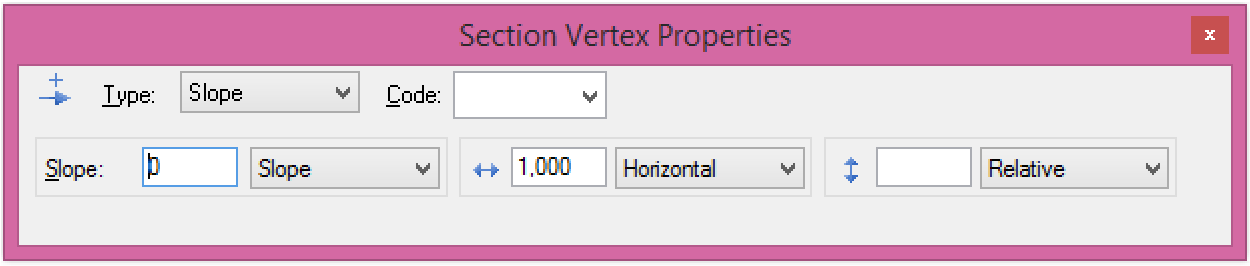
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

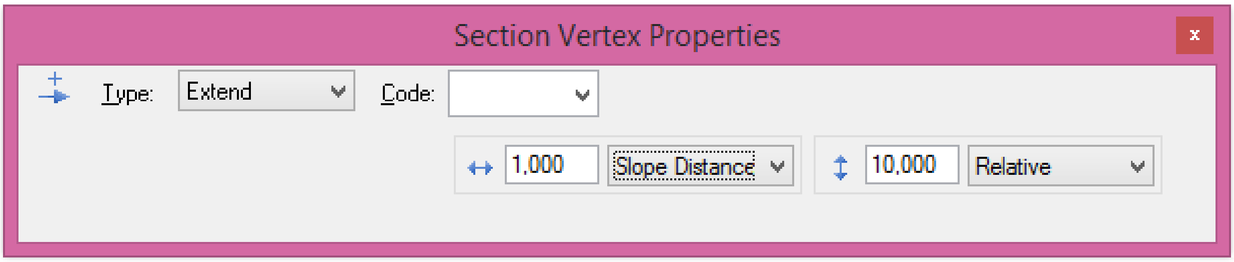
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

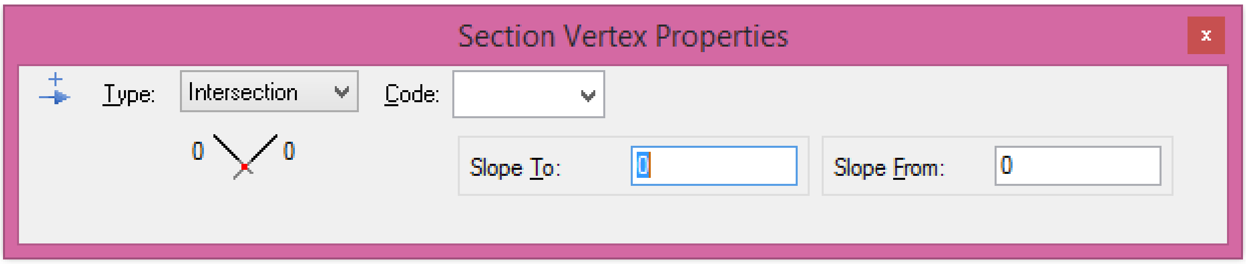
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

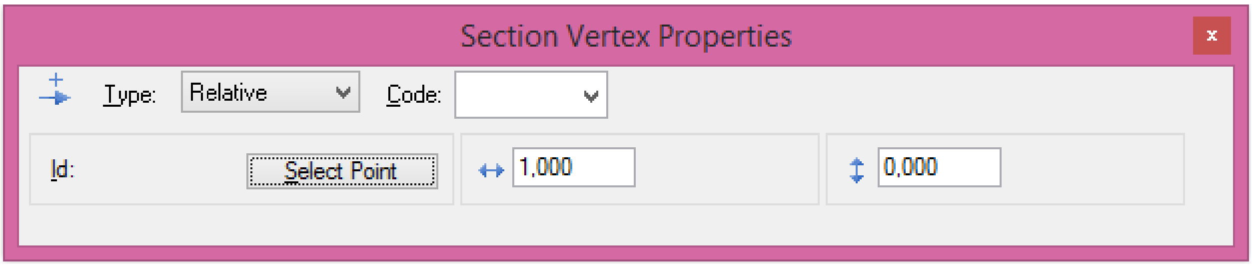
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

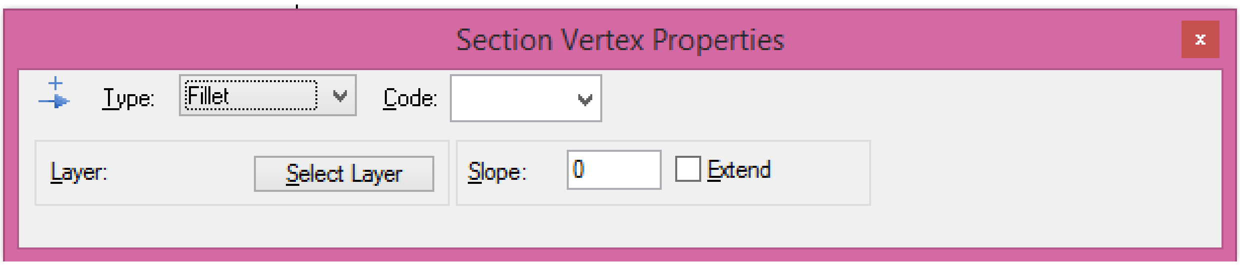
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

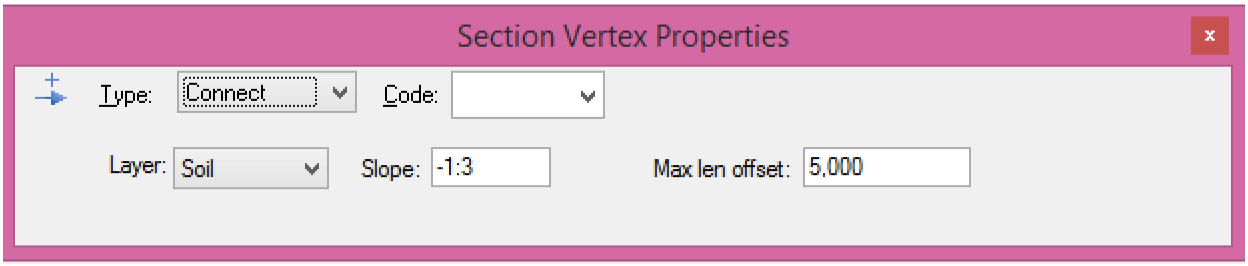
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

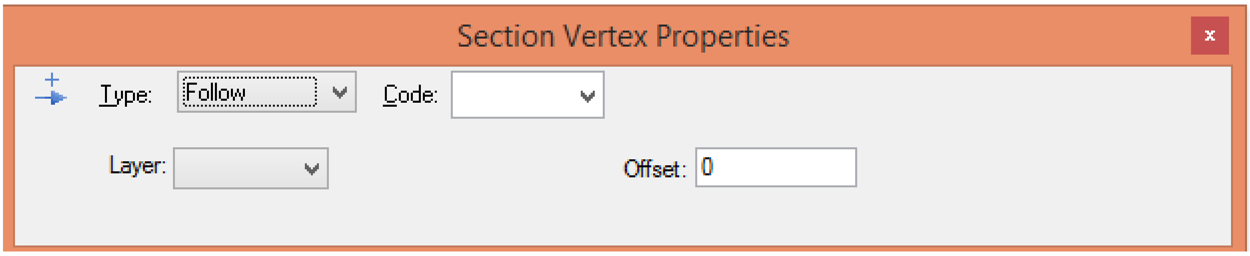


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

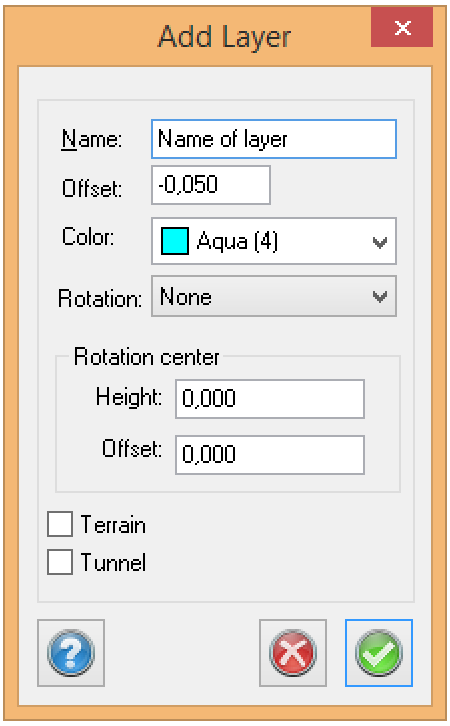


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

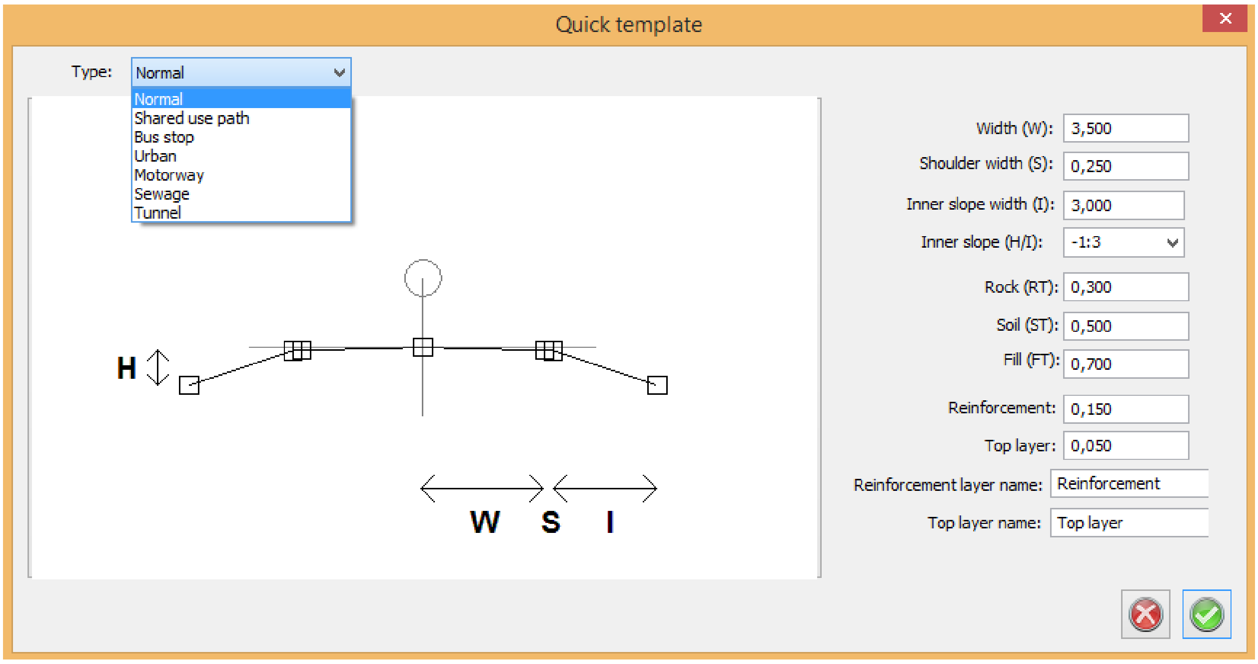
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

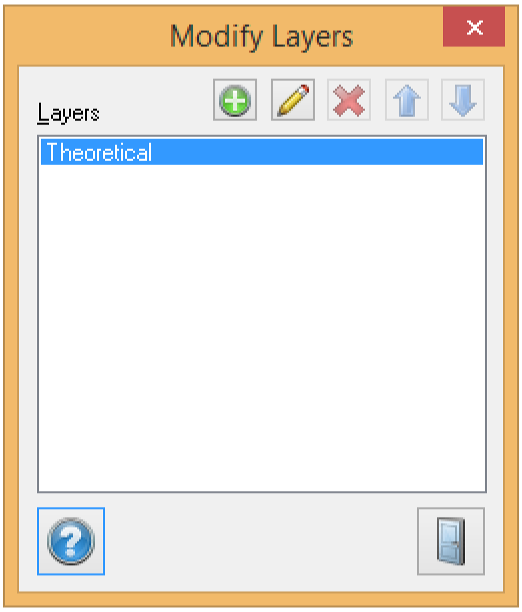
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

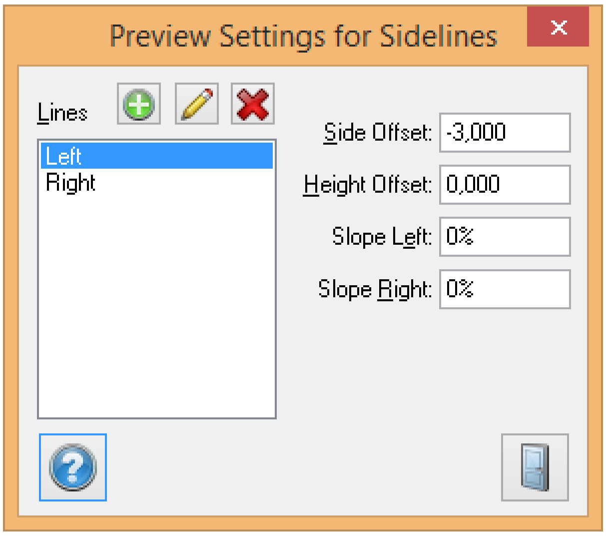


Modify layers in section template.

Edit side lines

Section template|Side lines

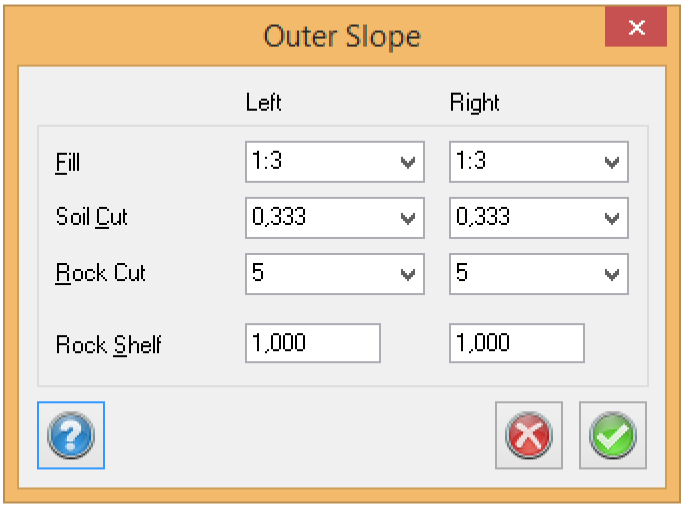
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

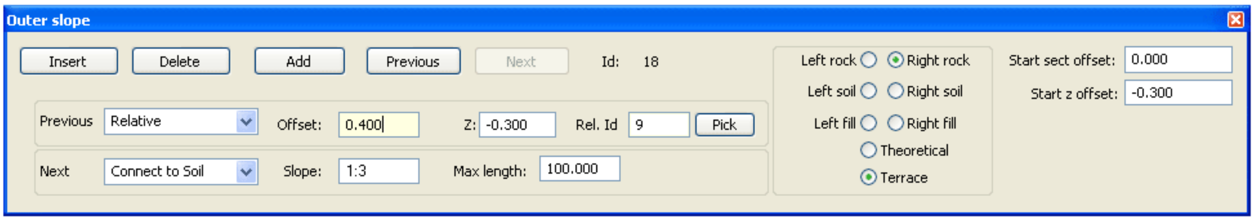
Section template|Quick outer slope

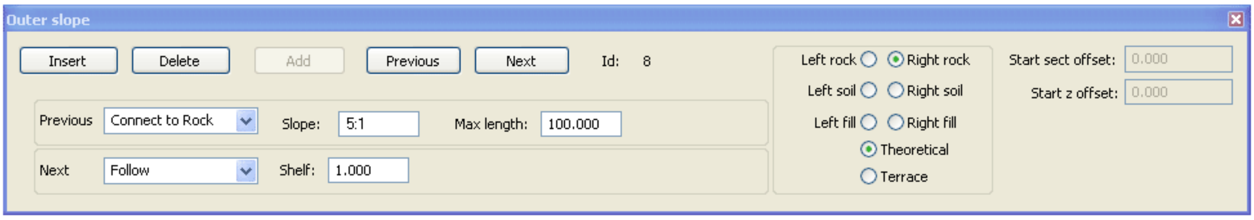
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

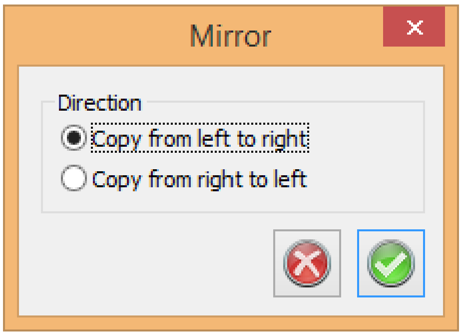
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

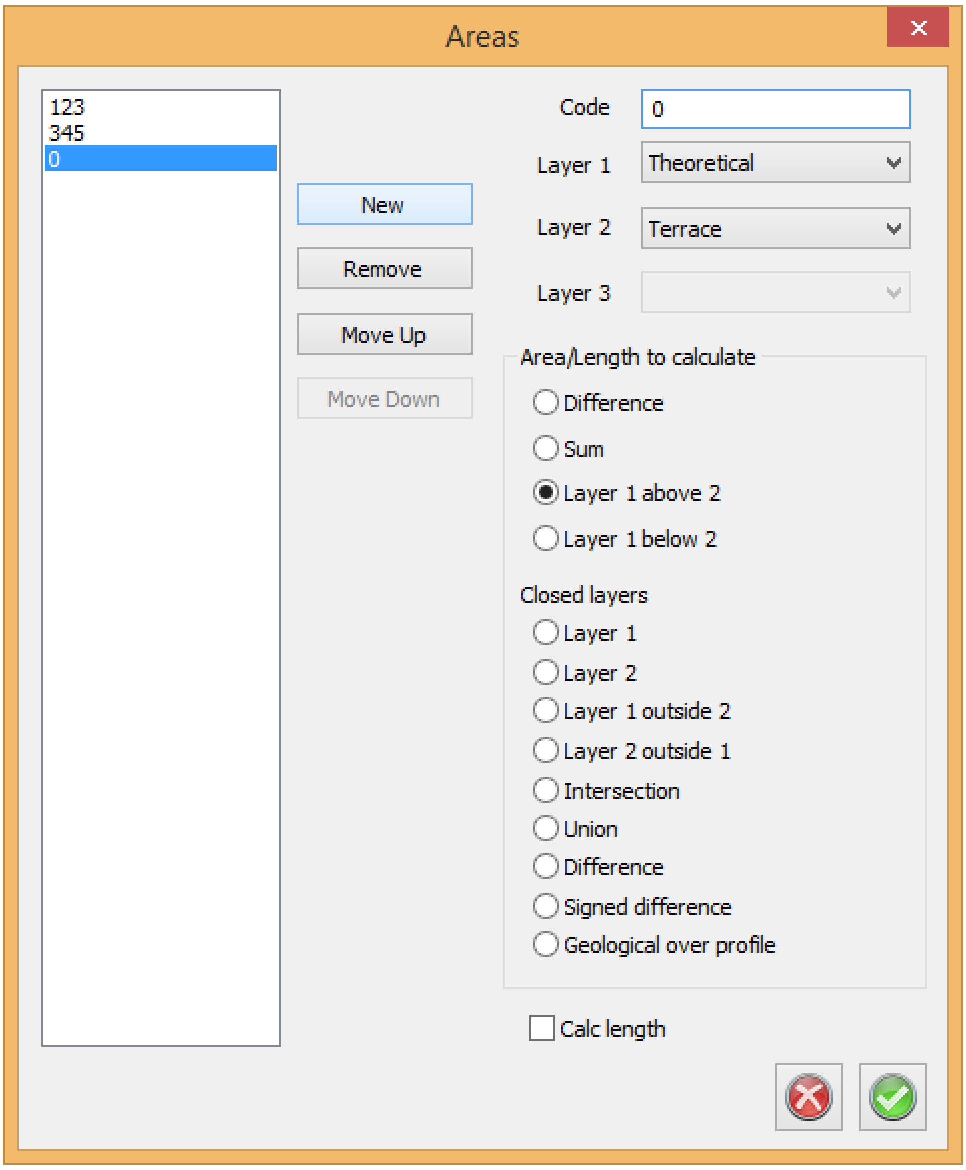
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

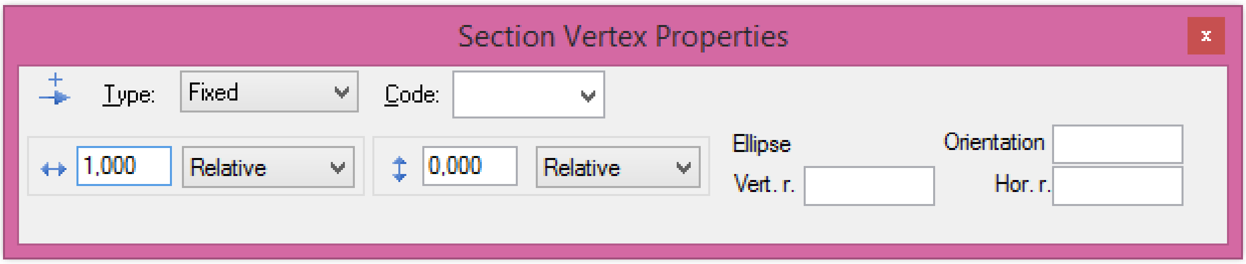
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

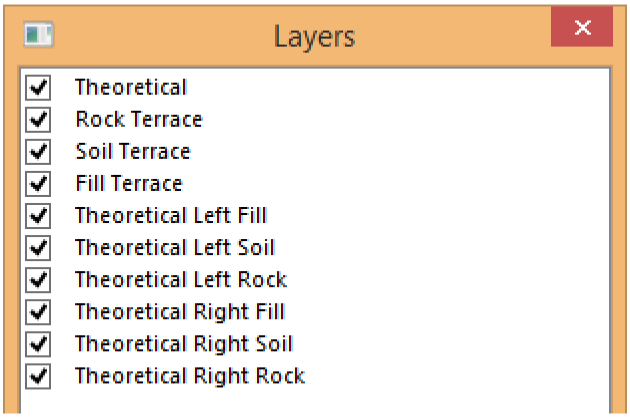
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

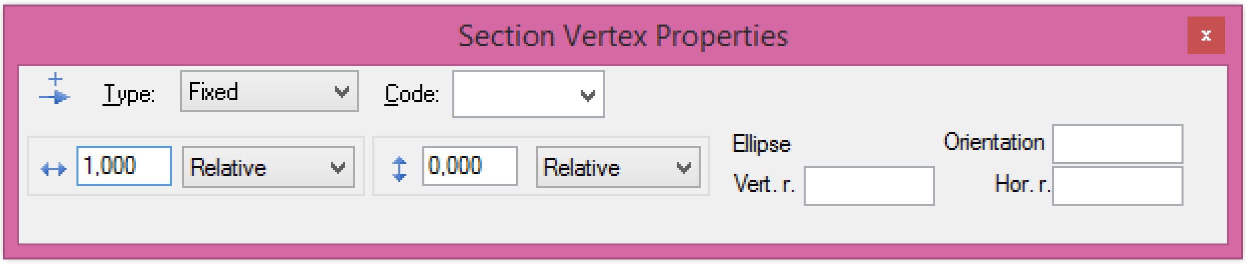
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

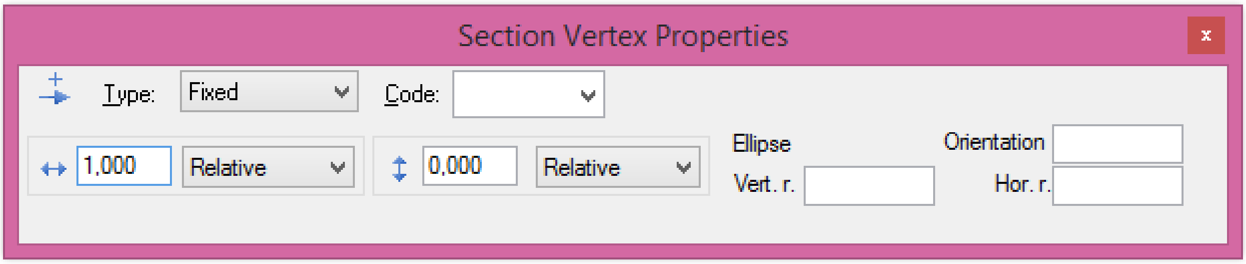
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

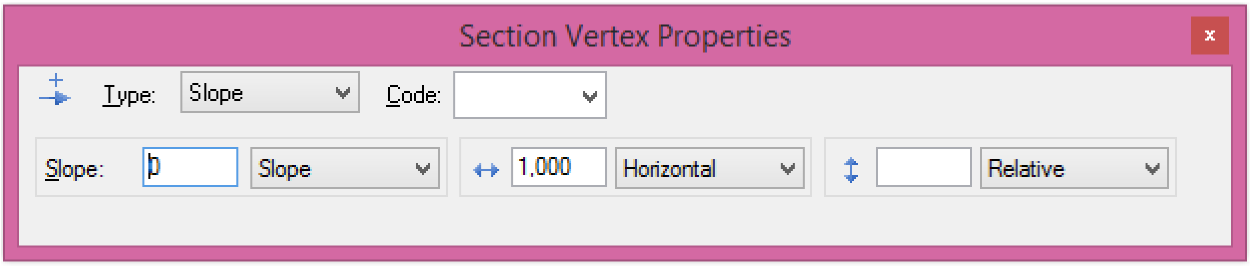
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

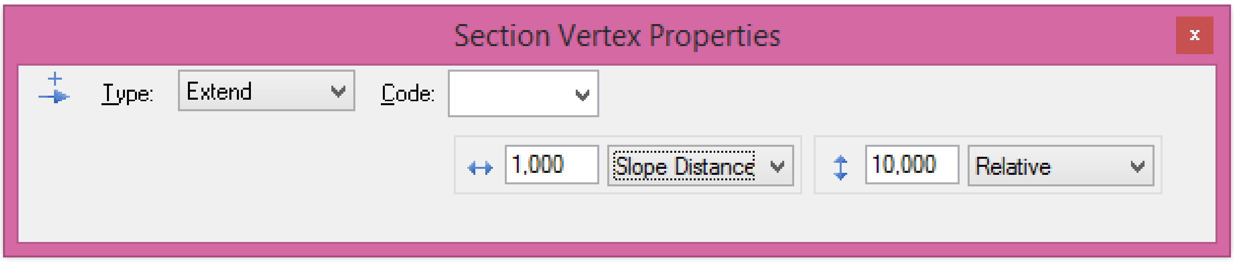
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

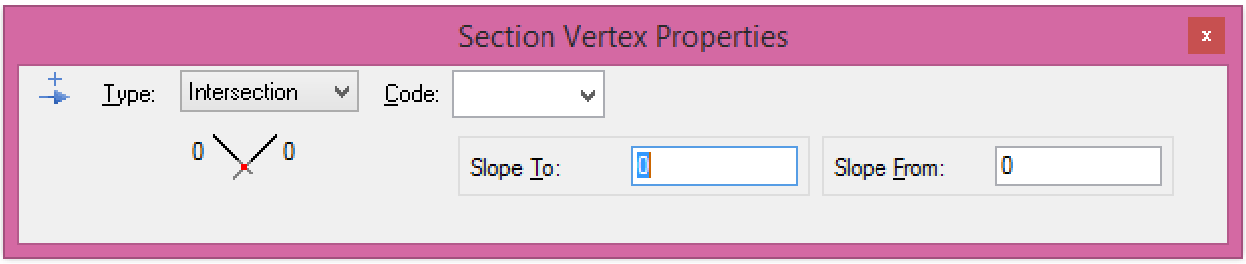
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

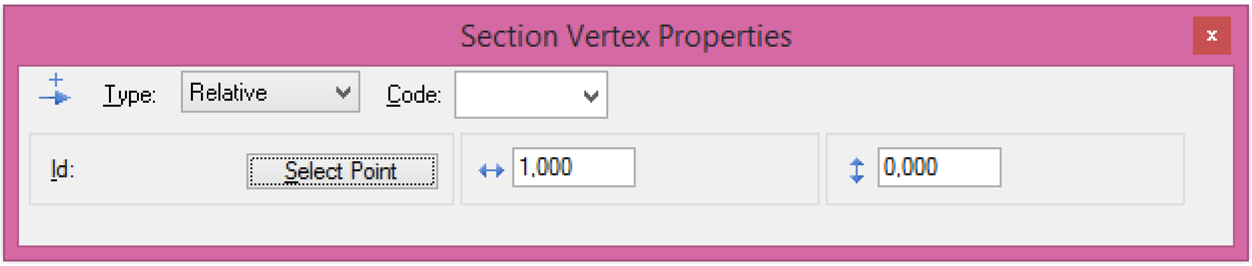
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

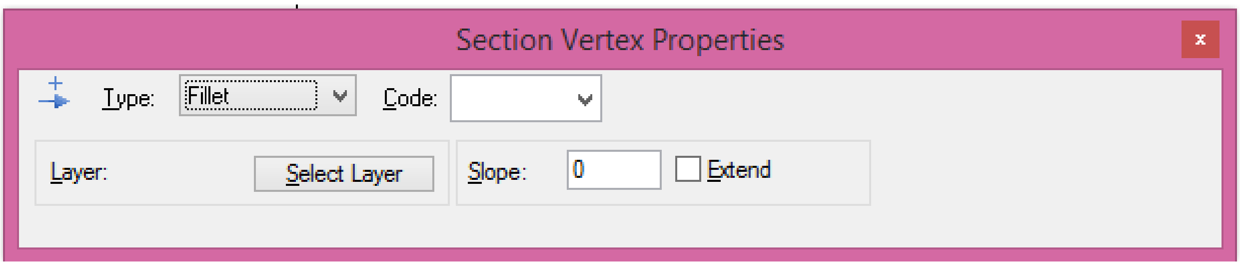
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

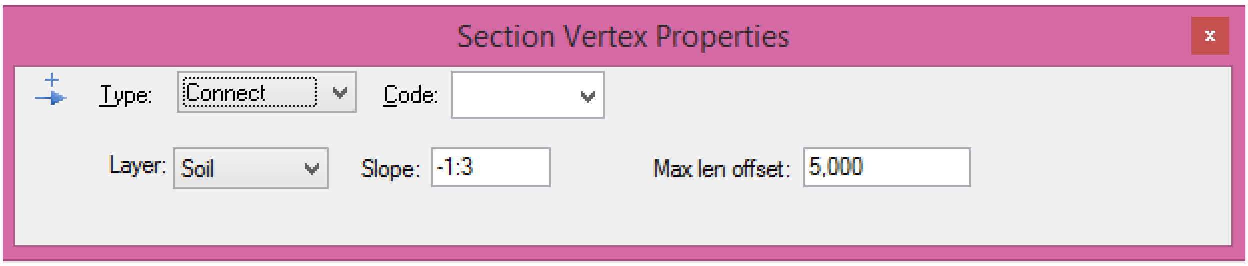
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

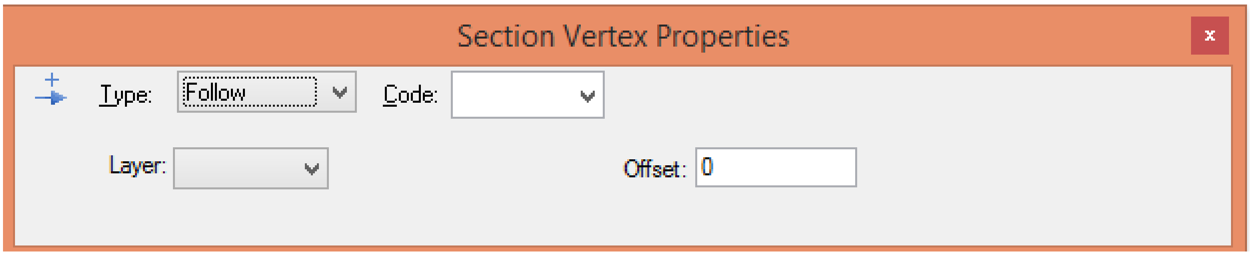


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

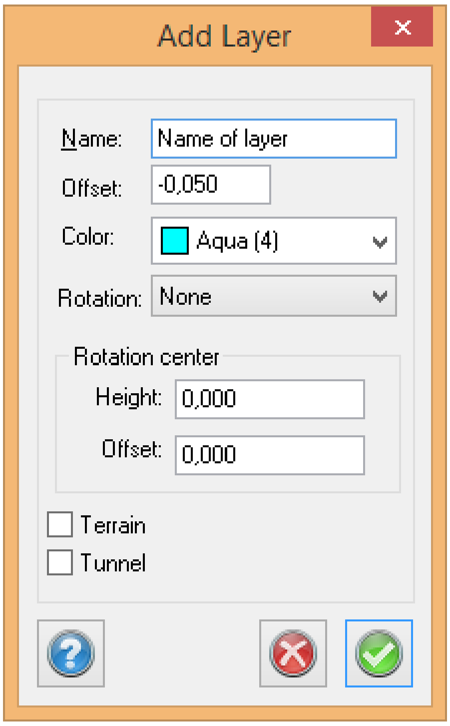


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

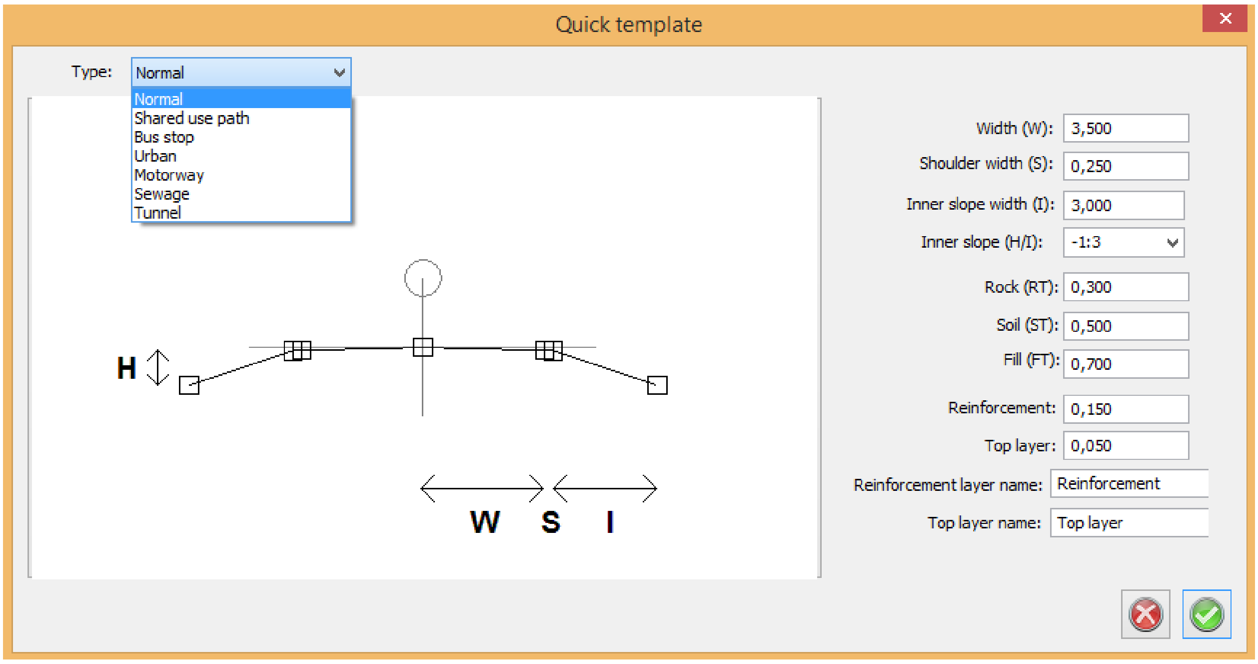
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

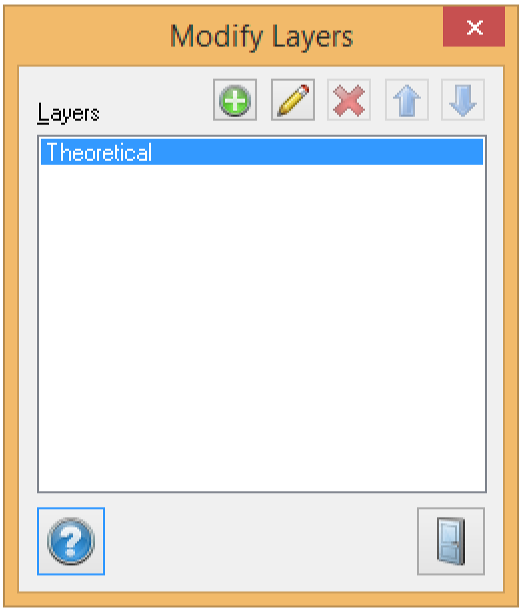
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

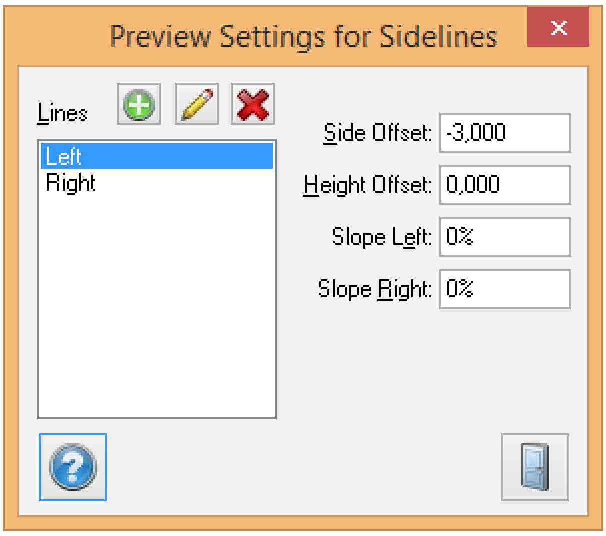


Modify layers in section template.

Edit side lines

Section template|Side lines

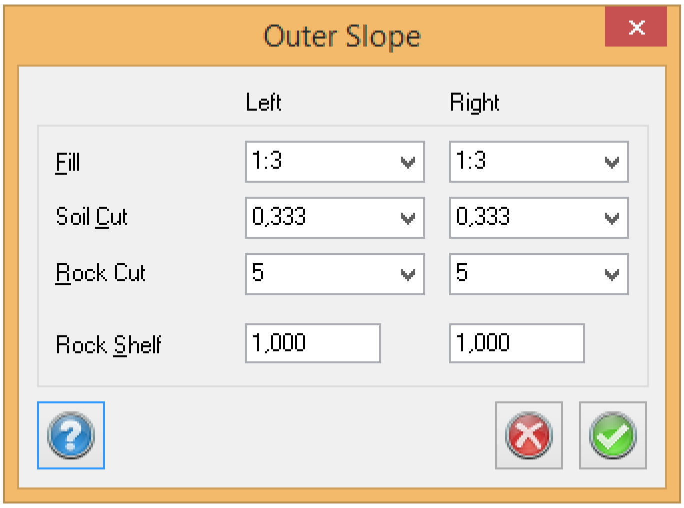
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

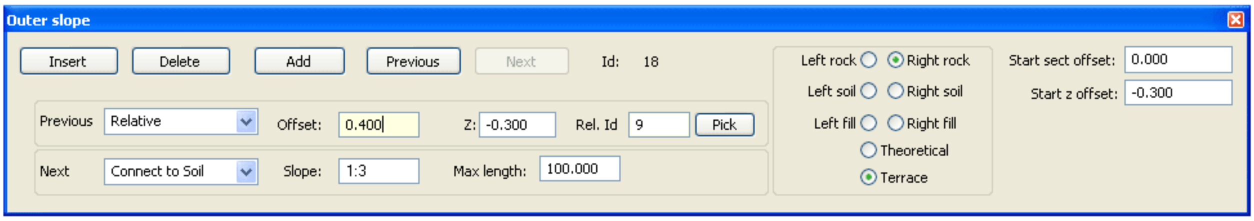
Section template|Quick outer slope

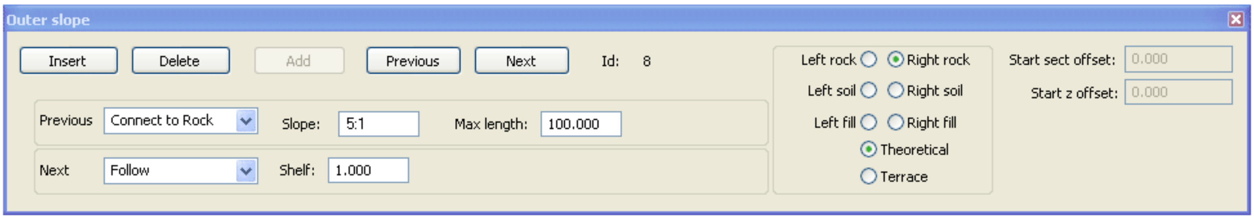
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

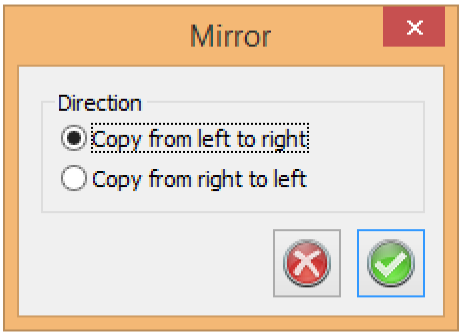
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

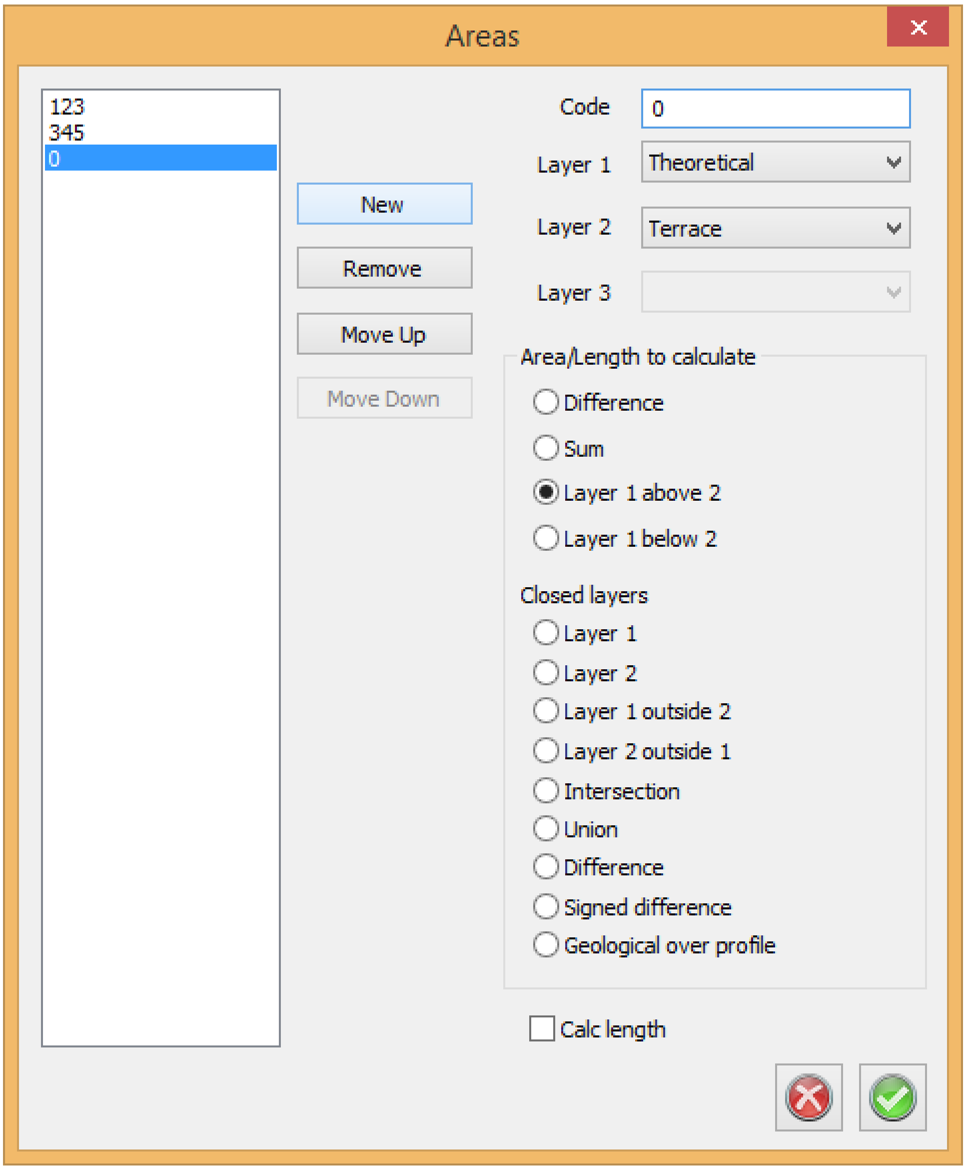
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

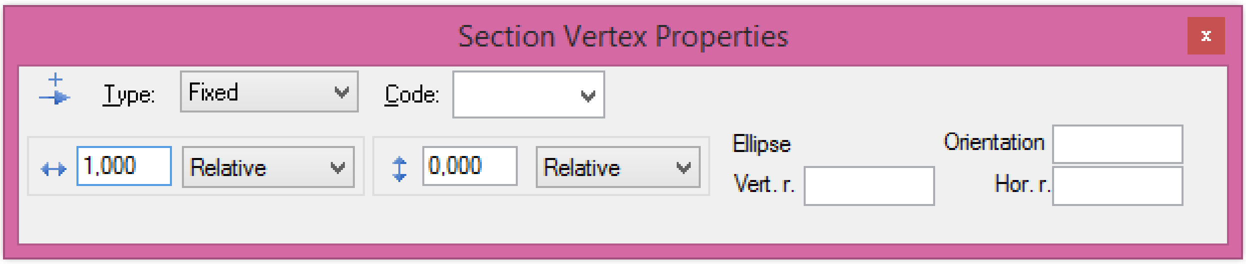
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

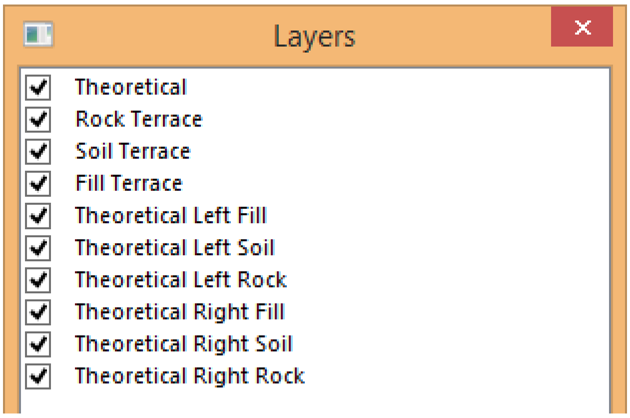
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

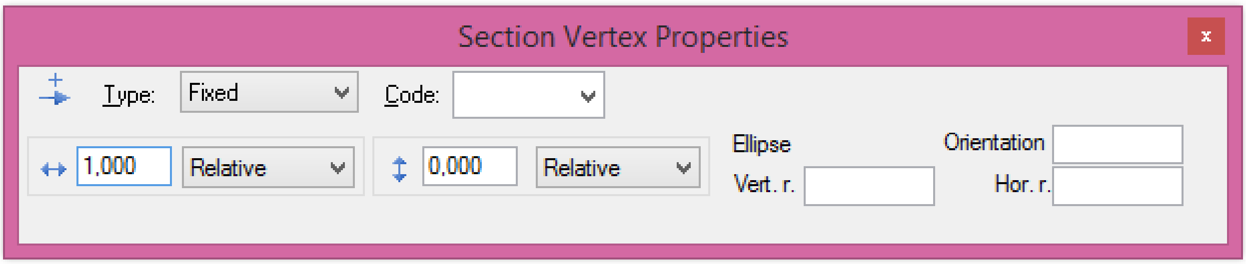
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

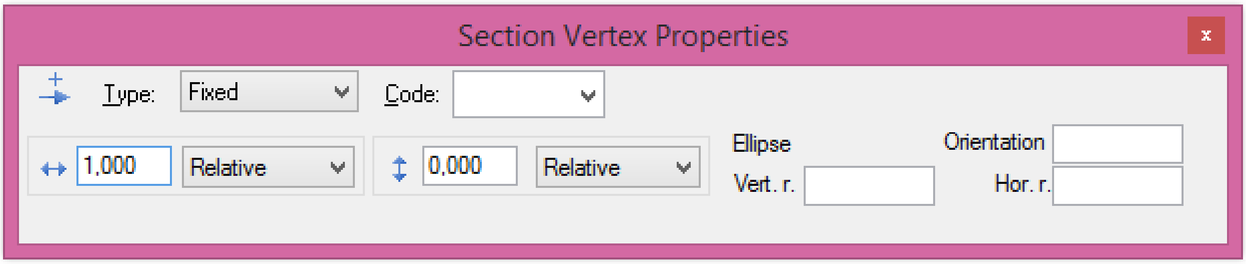
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

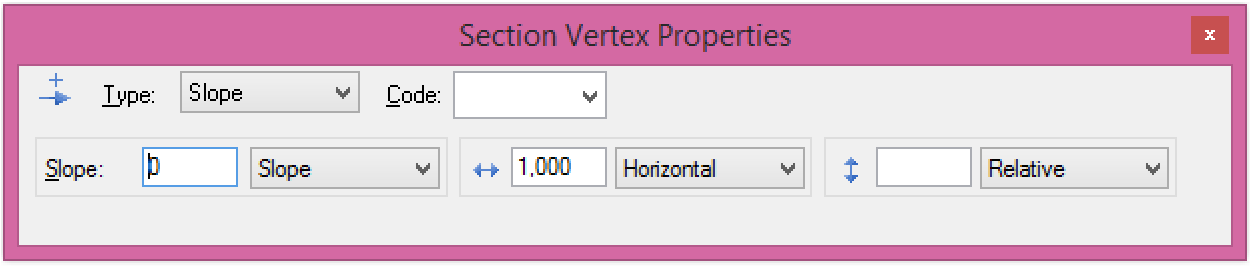
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

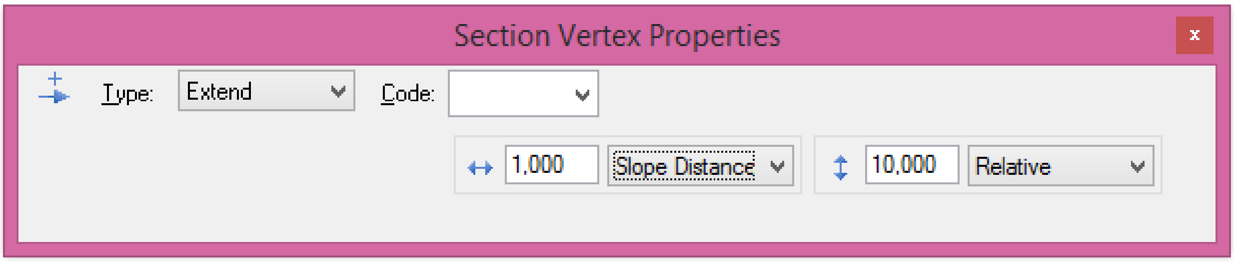
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

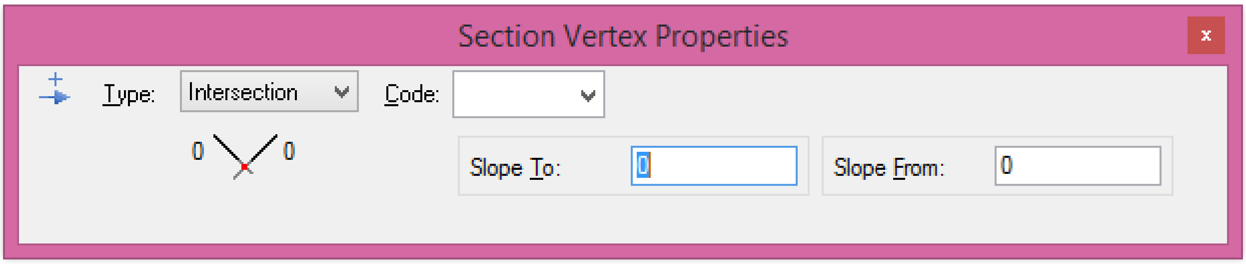
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

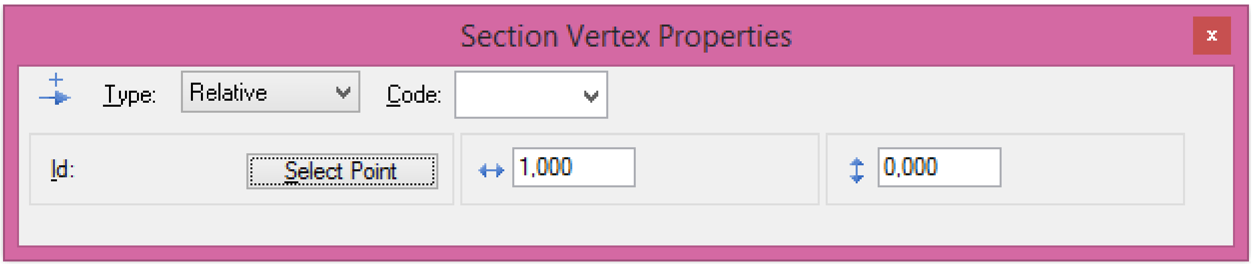
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

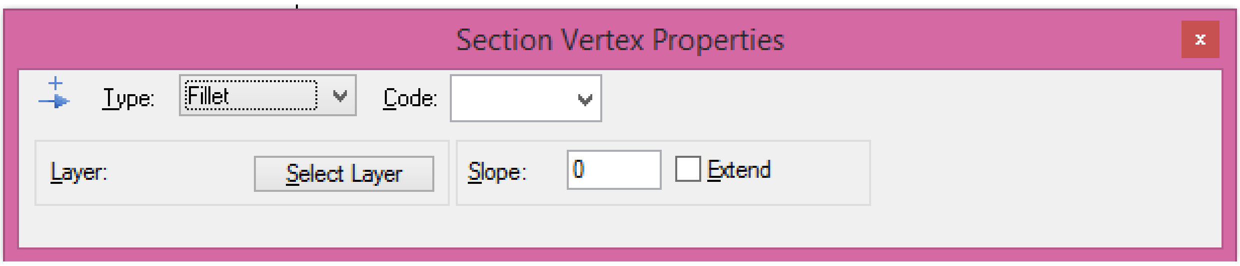
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

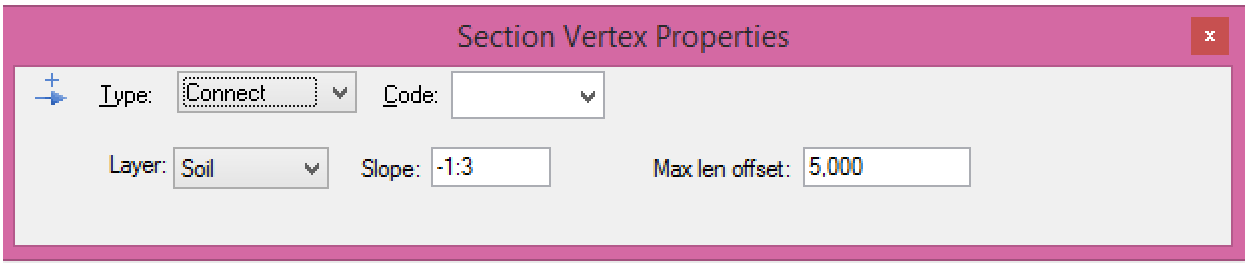
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

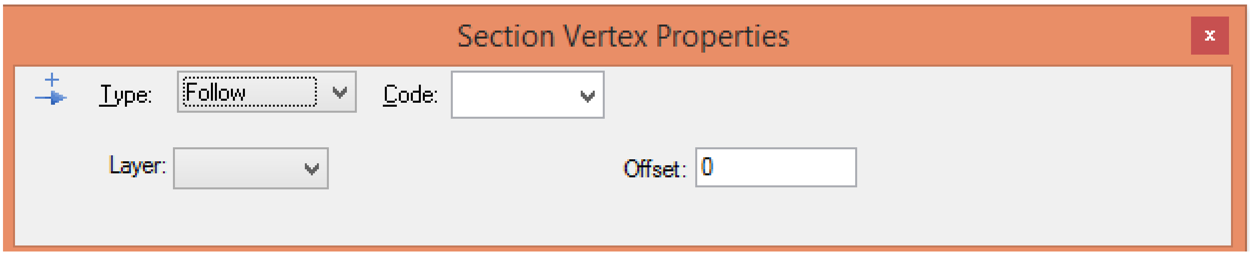


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

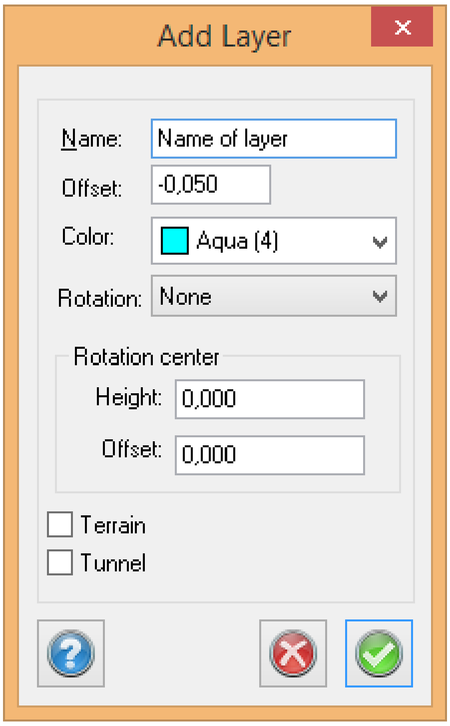


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

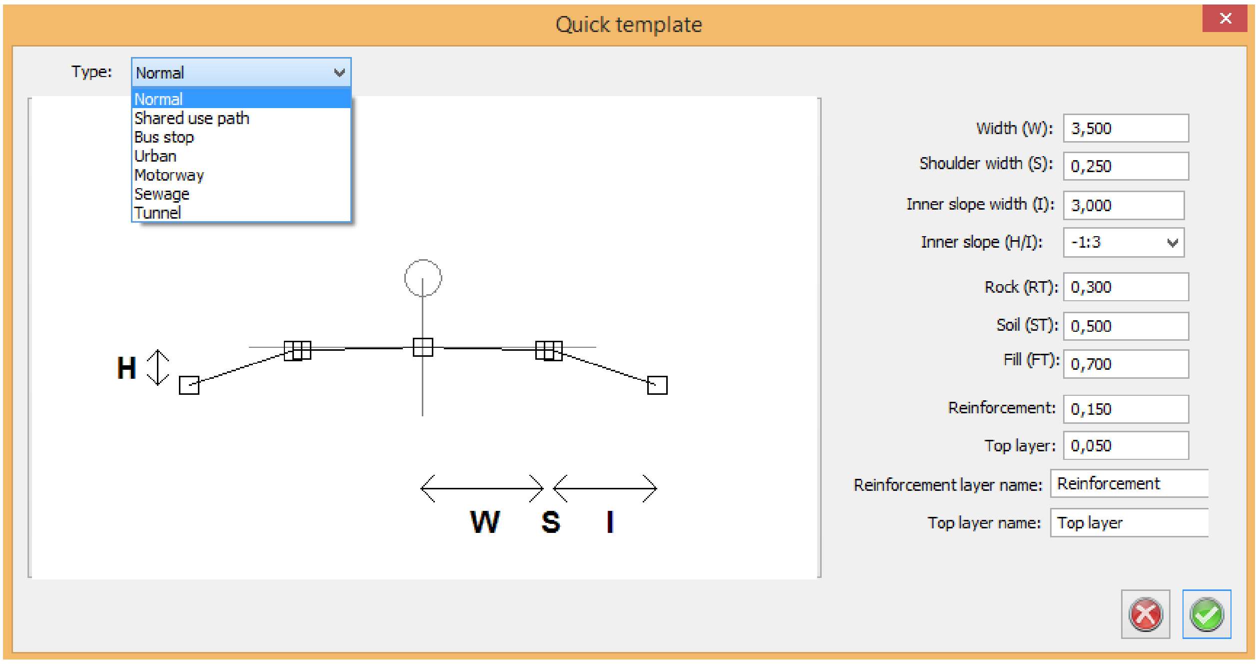
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

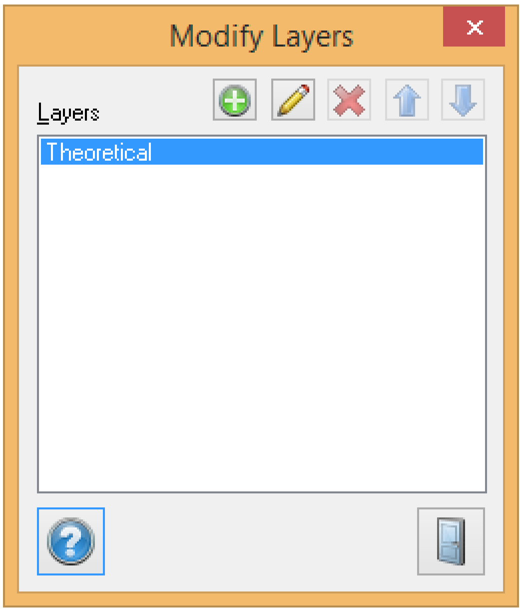
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

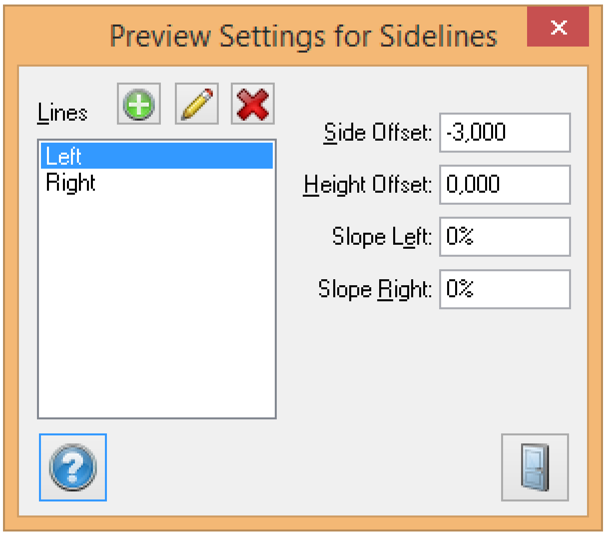


Modify layers in section template.

Edit side lines

Section template|Side lines

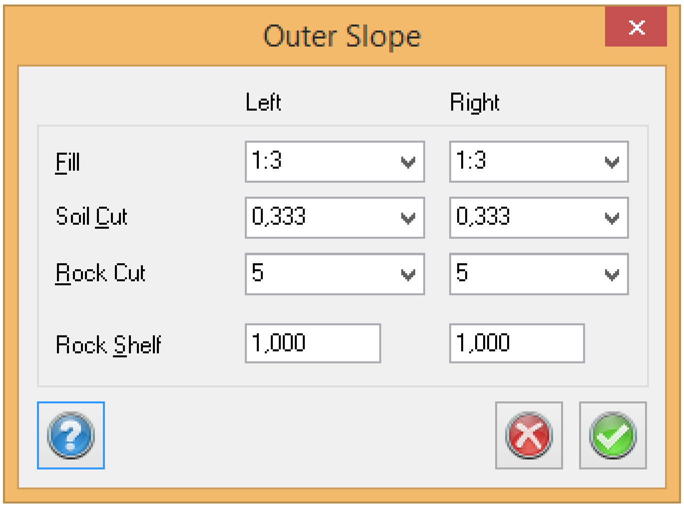
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

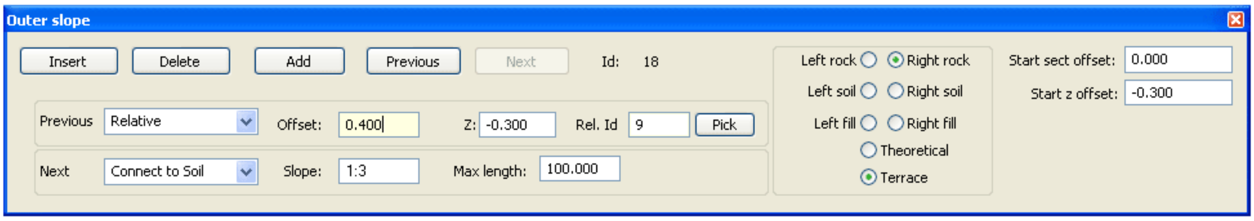
Section template|Quick outer slope

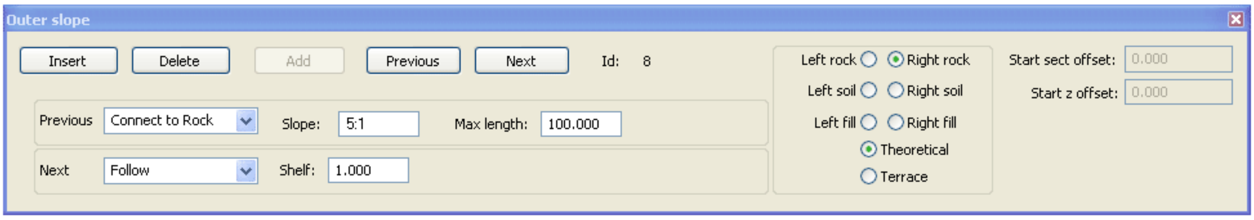
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

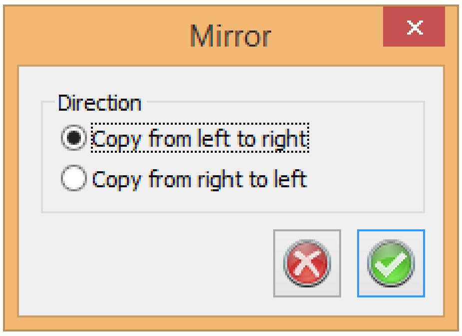
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

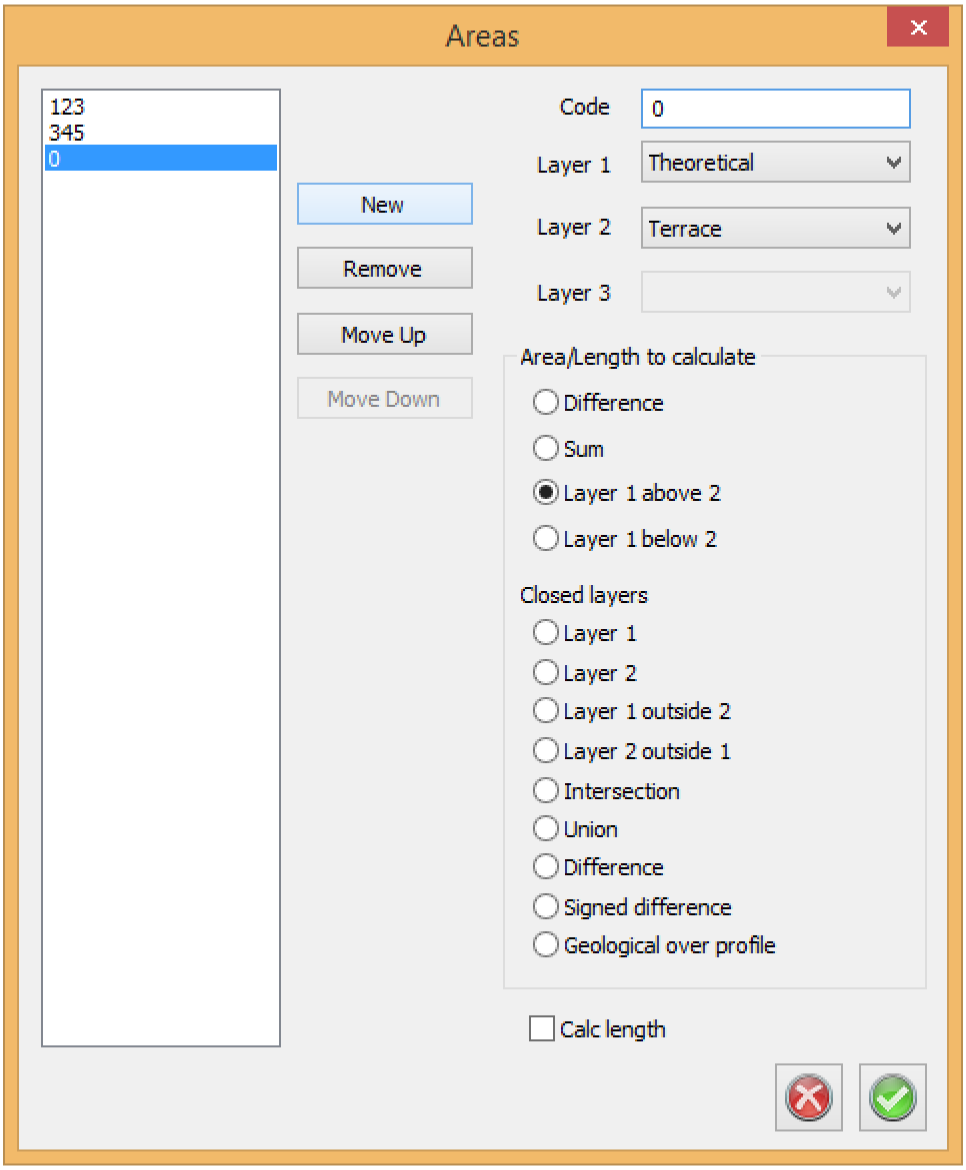
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
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- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

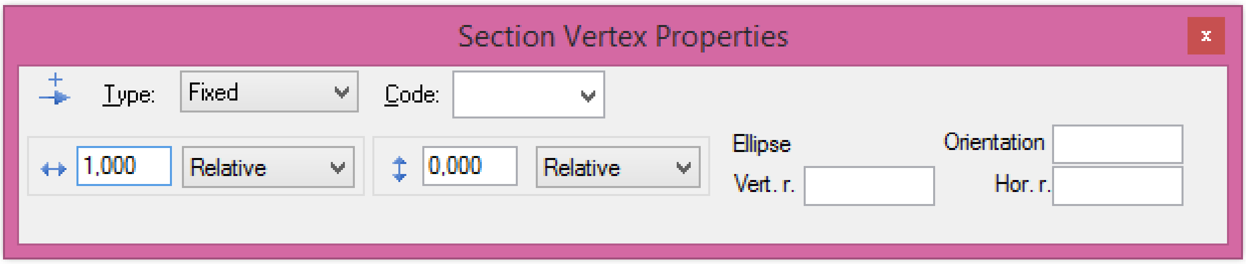
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

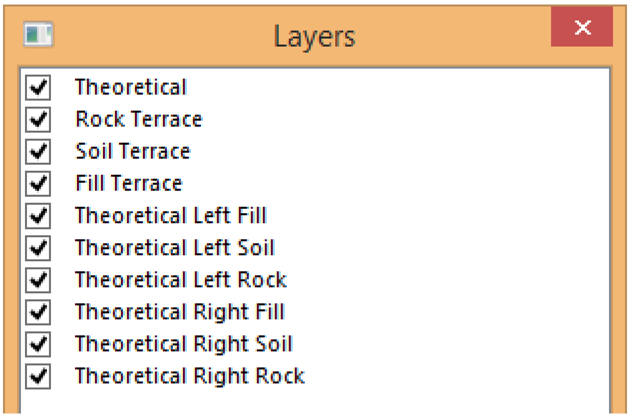
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

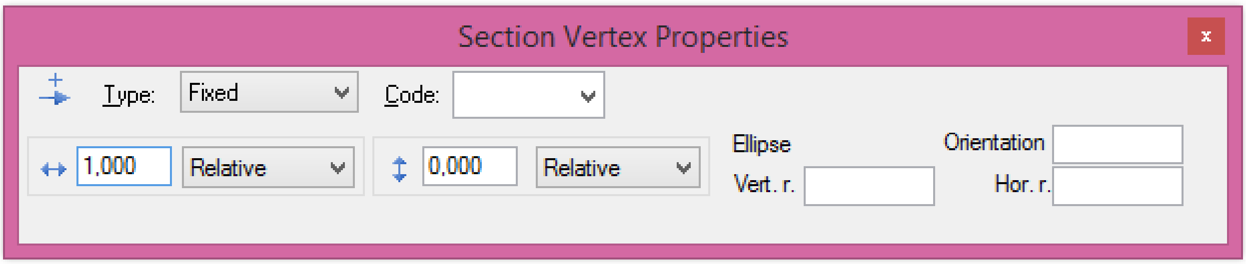
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

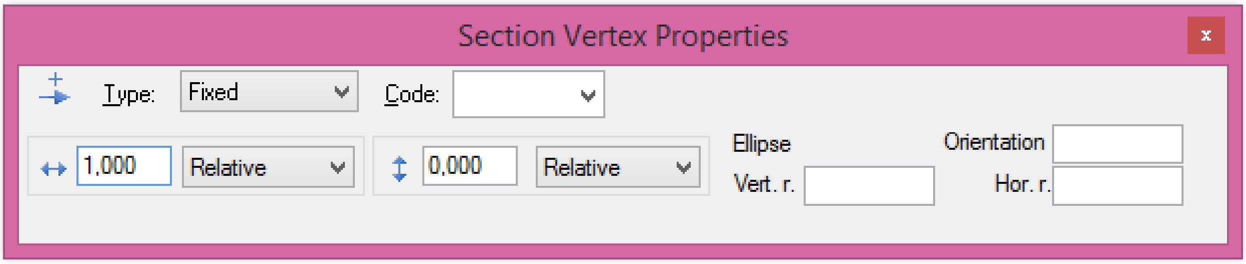
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

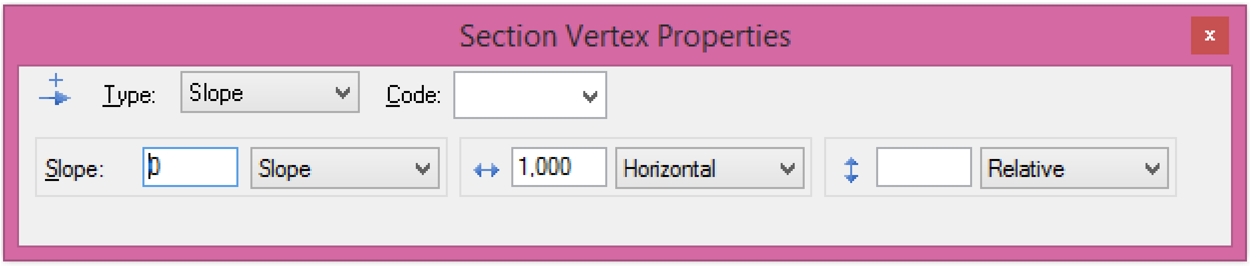
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

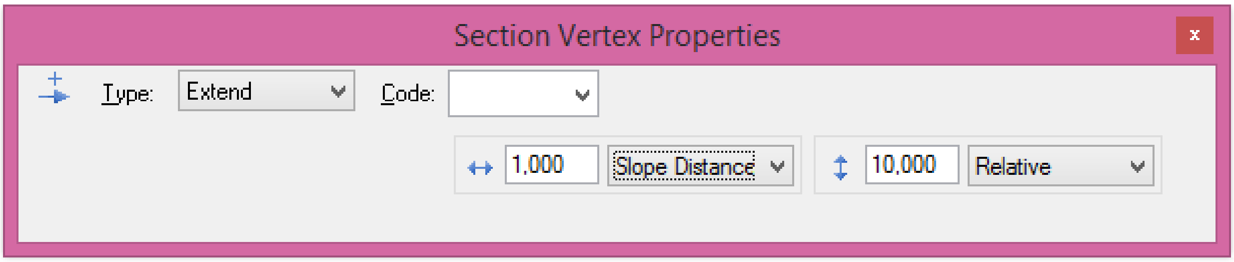
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

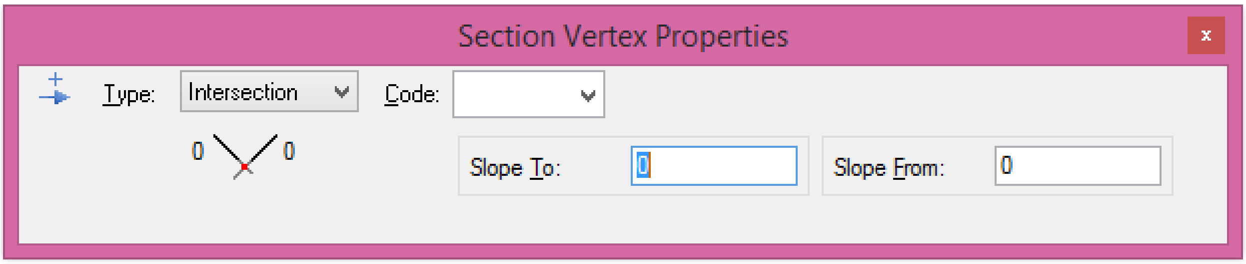
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

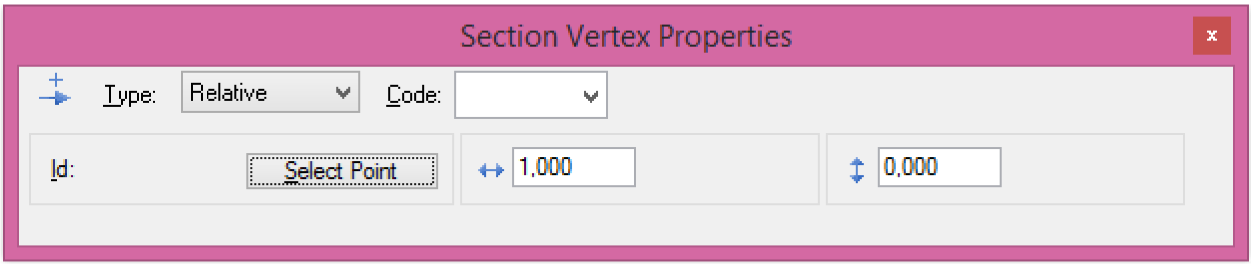
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

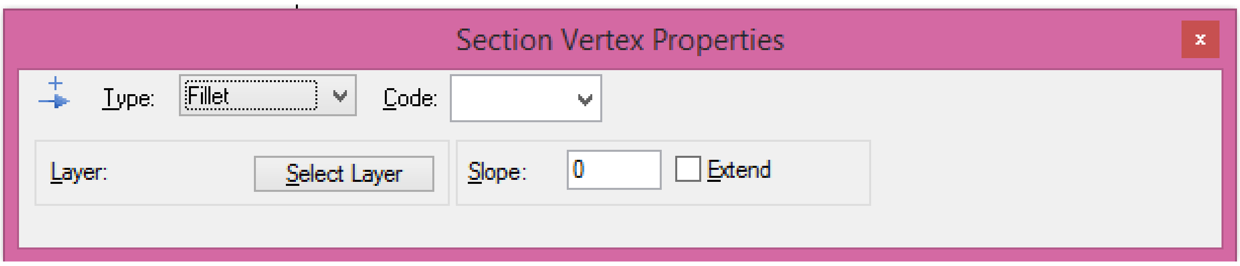
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

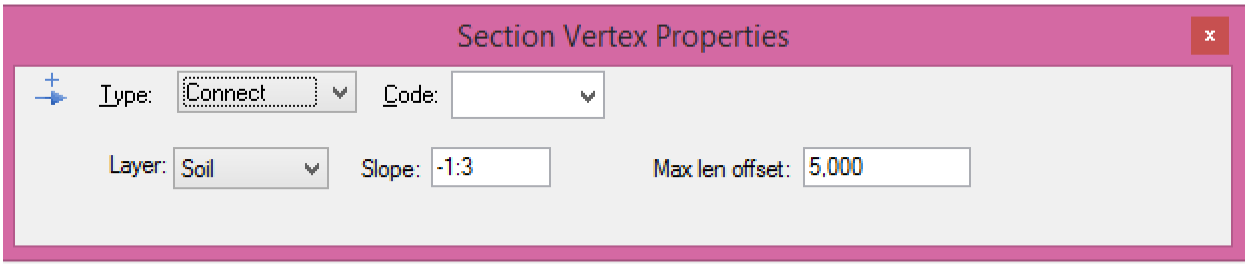
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

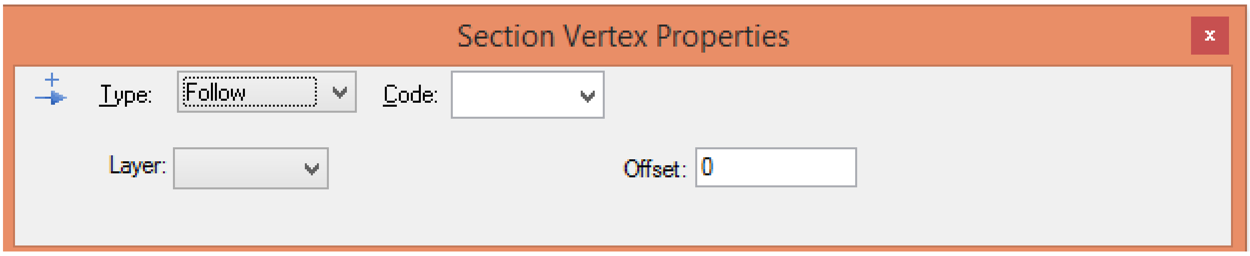


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

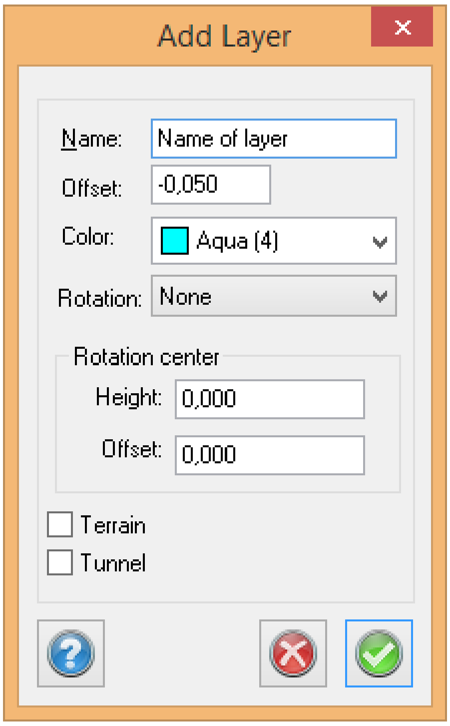


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

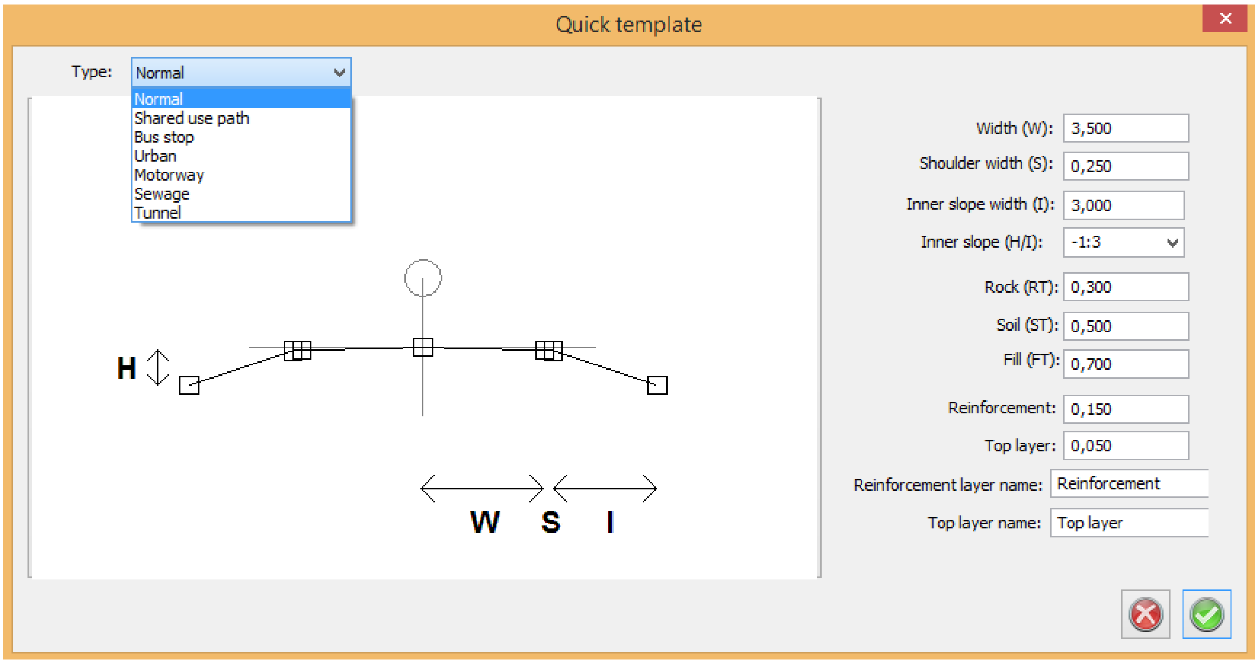
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

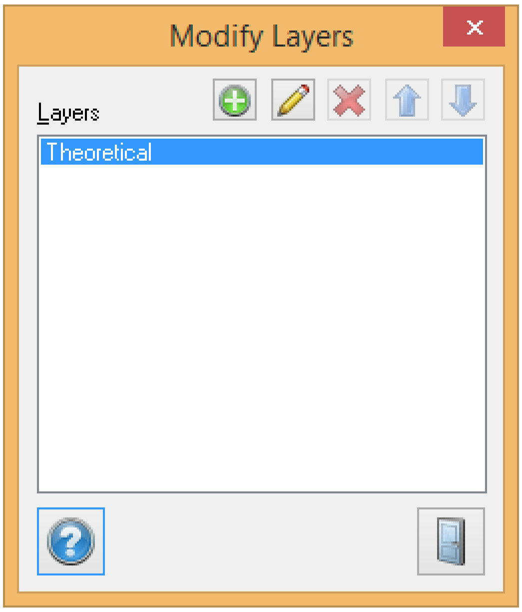
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

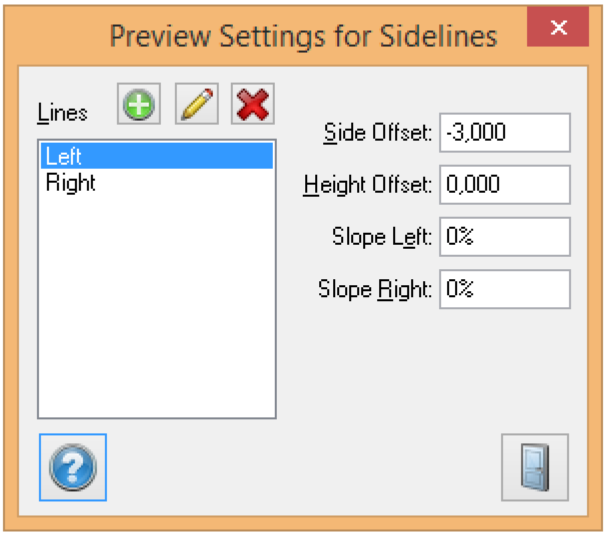


Modify layers in section template.

Edit side lines

Section template|Side lines

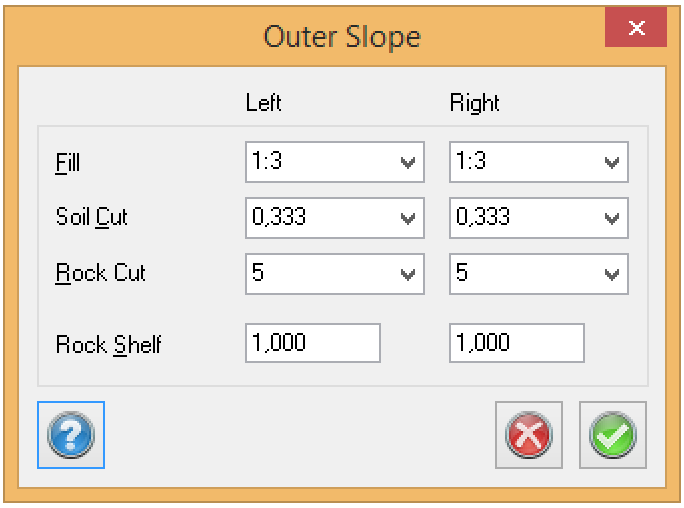
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

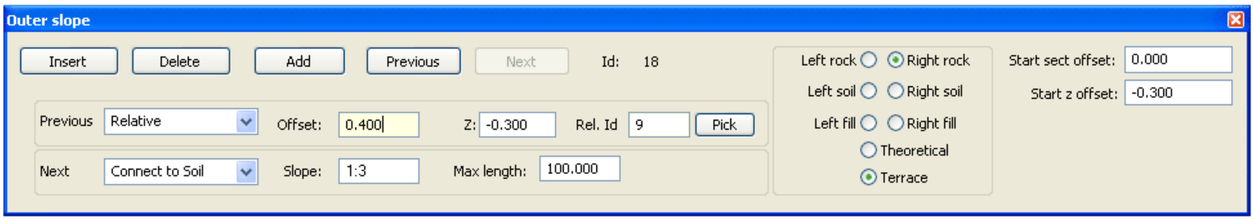
Section template|Quick outer slope

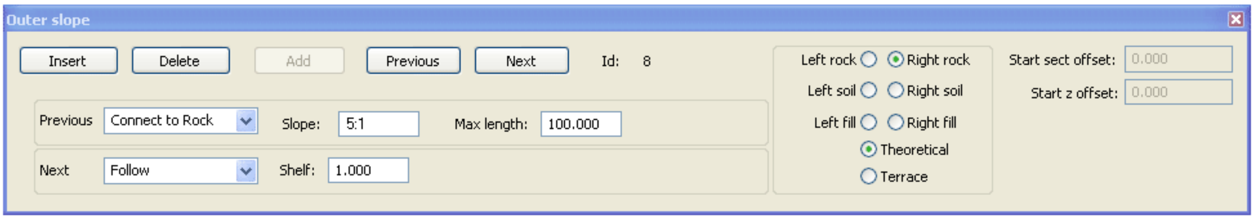
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

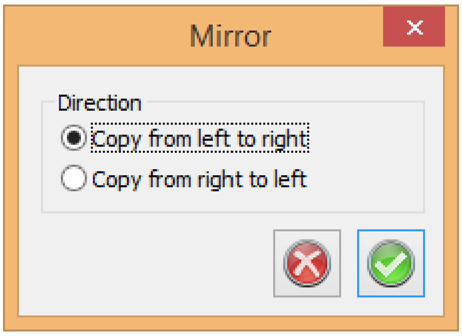
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

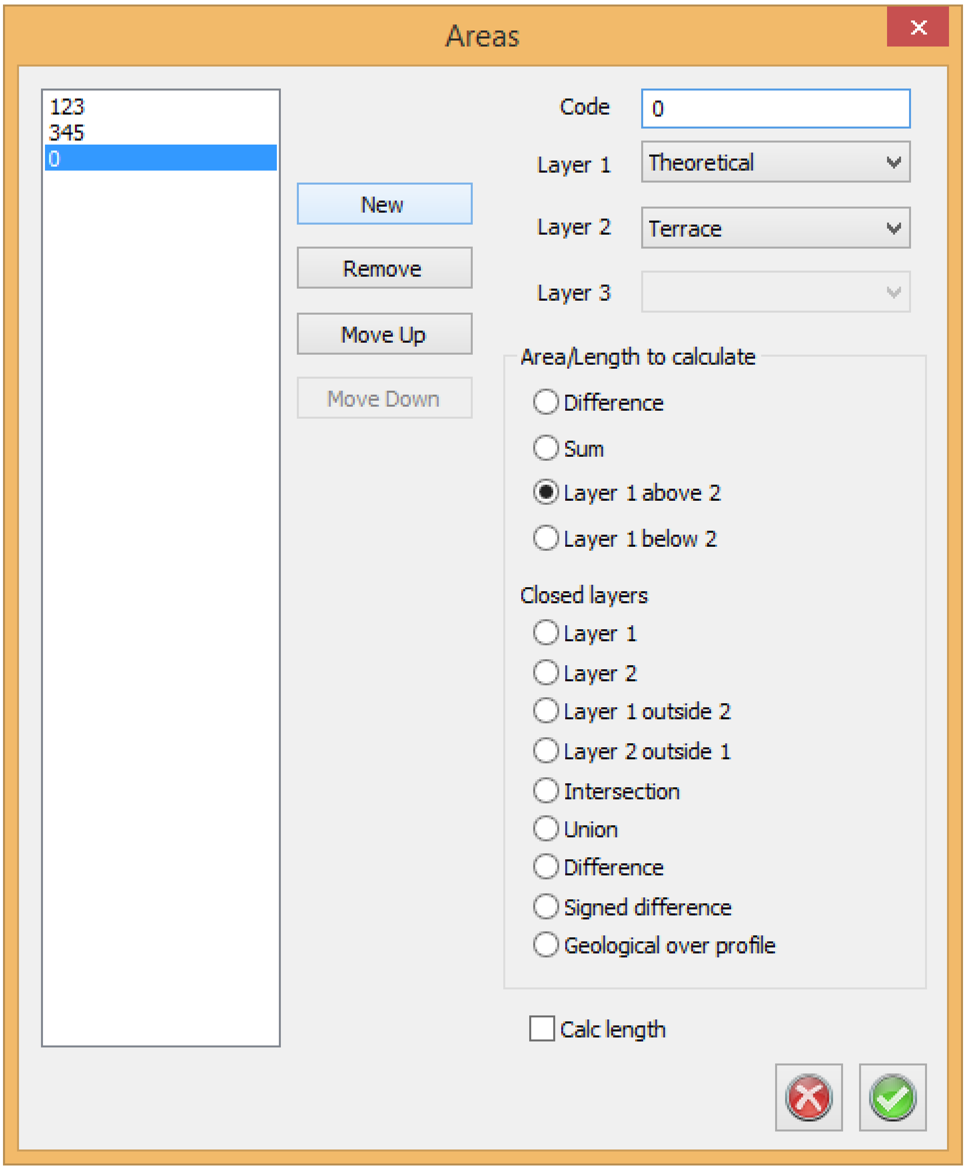
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

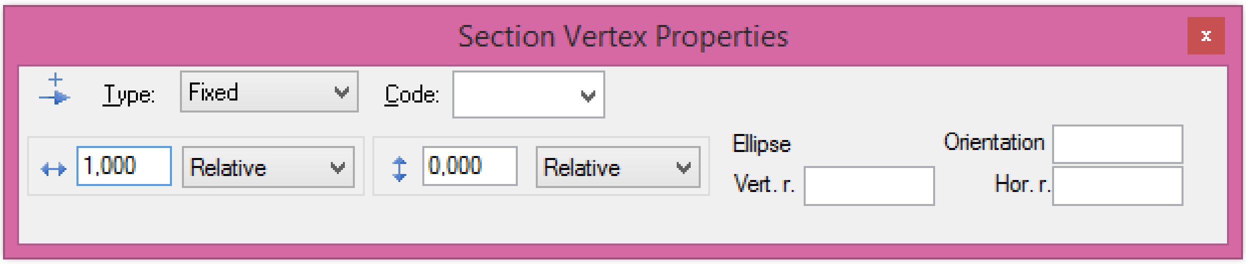
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

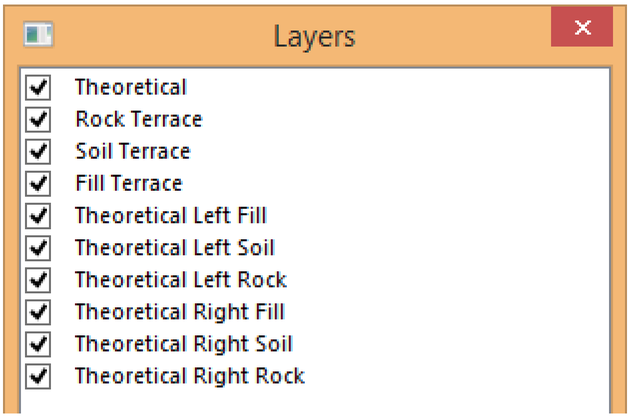
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

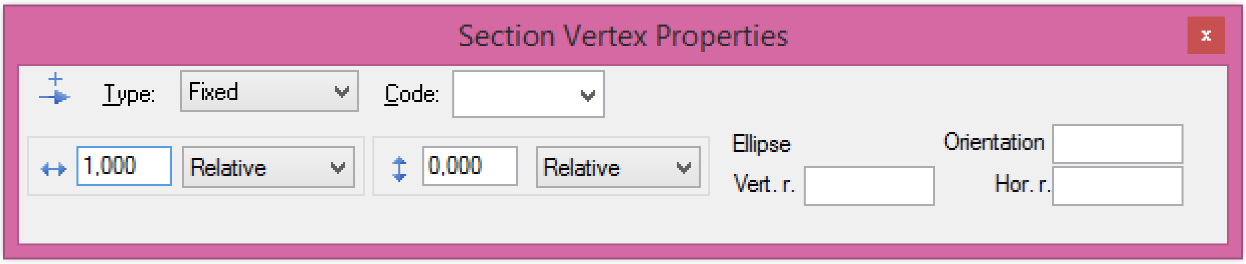
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

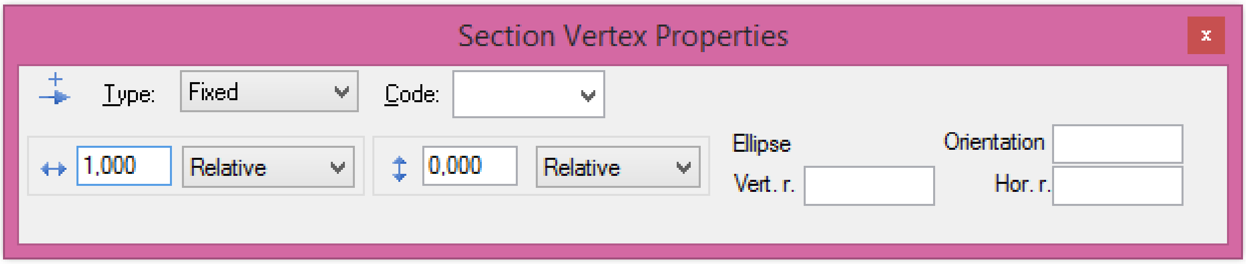
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

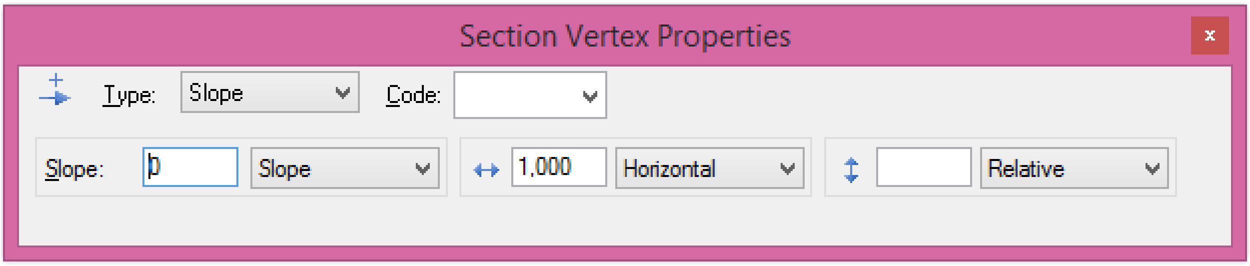
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

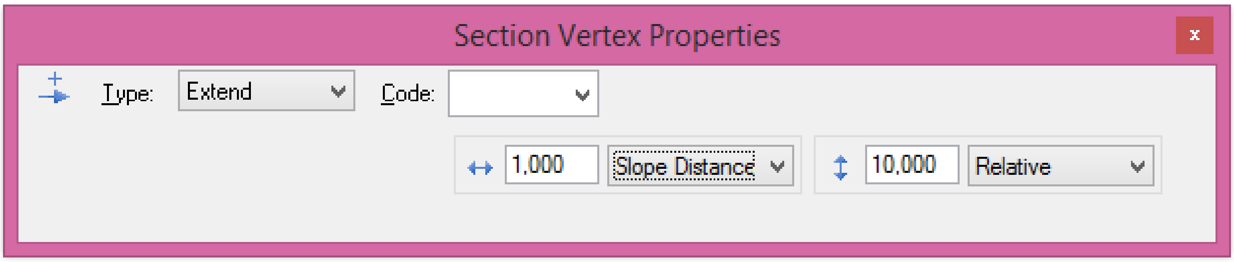
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

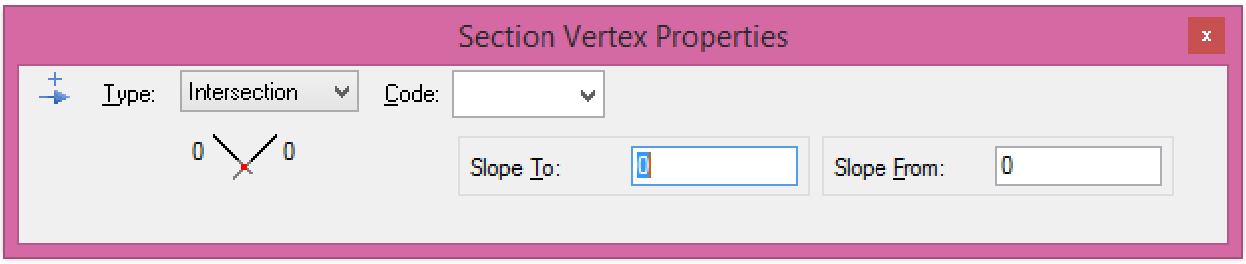
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

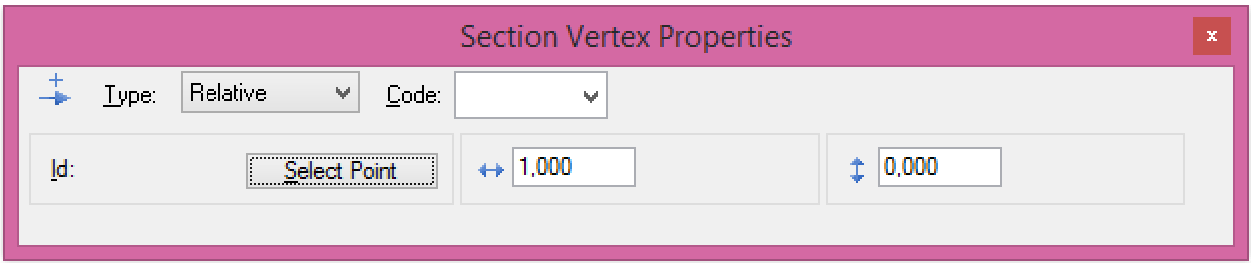
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

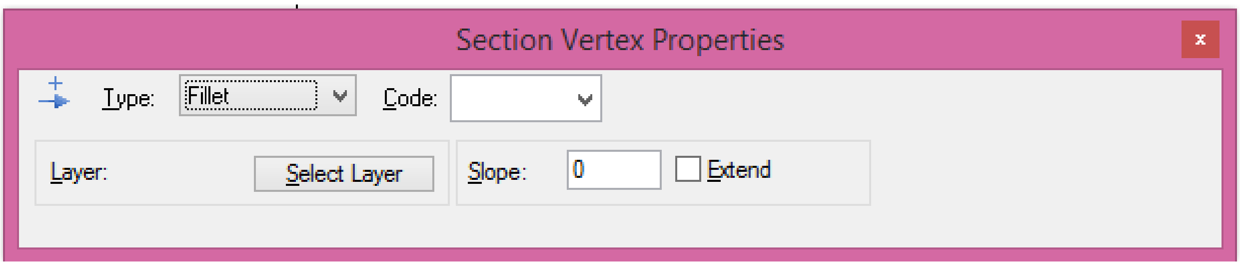
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

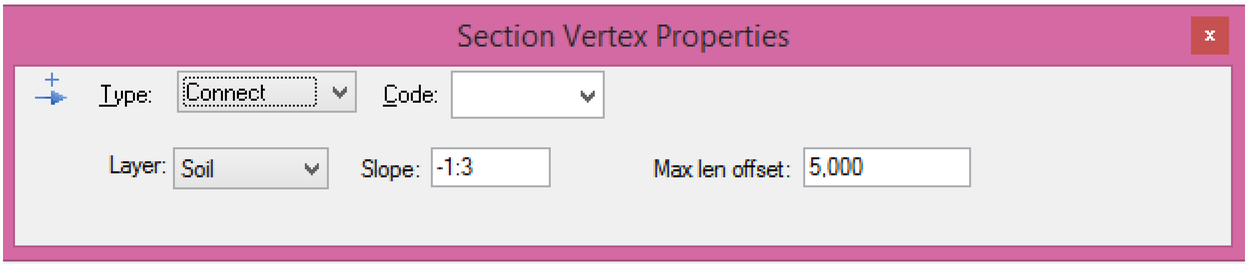
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

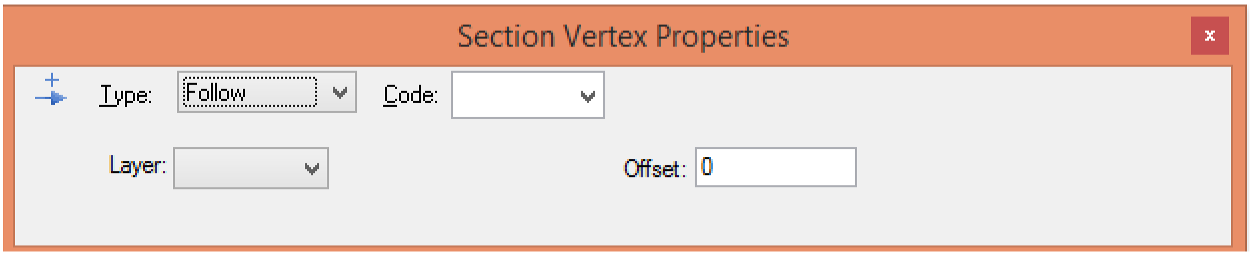


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

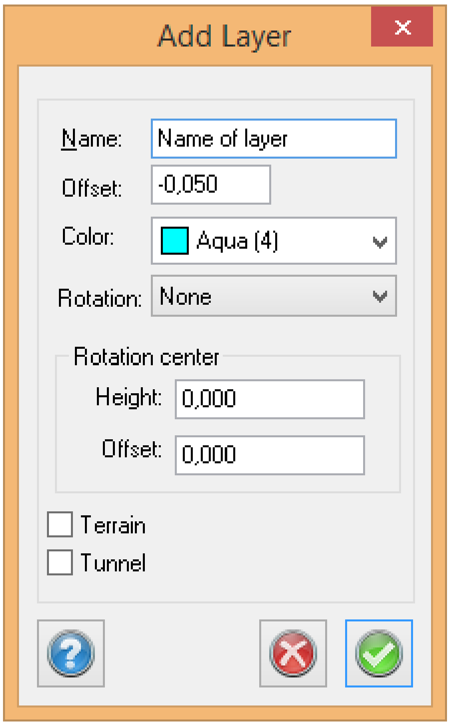


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

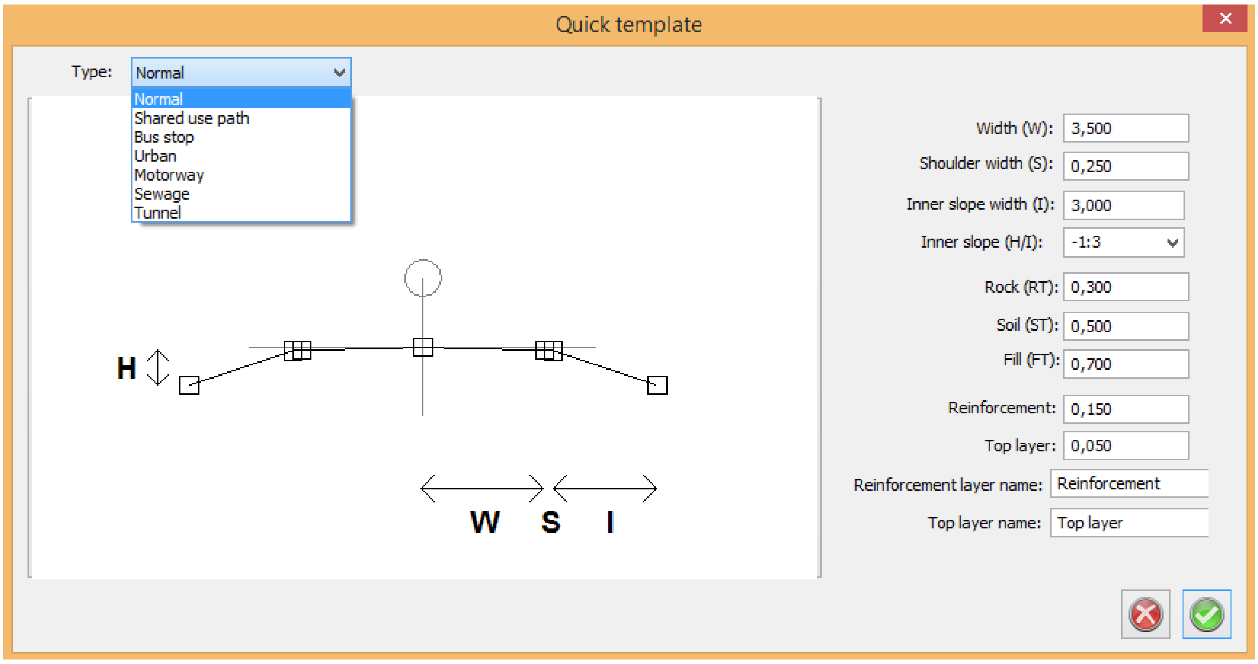
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

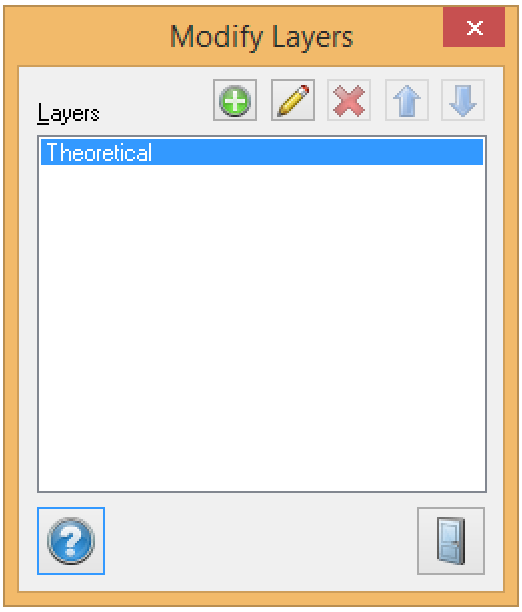
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

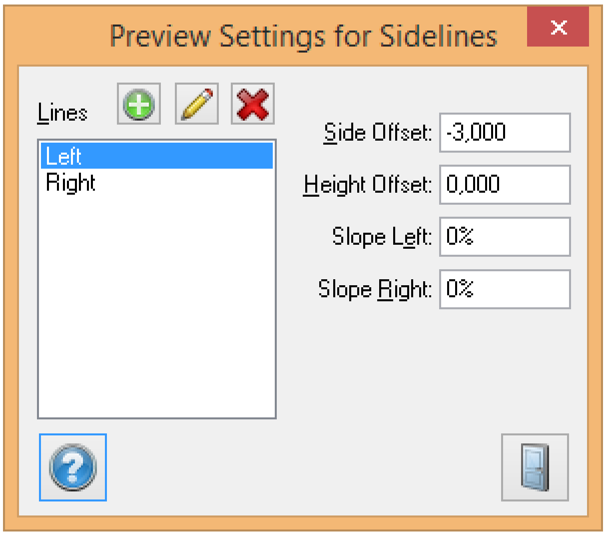


Modify layers in section template.

Edit side lines

Section template|Side lines

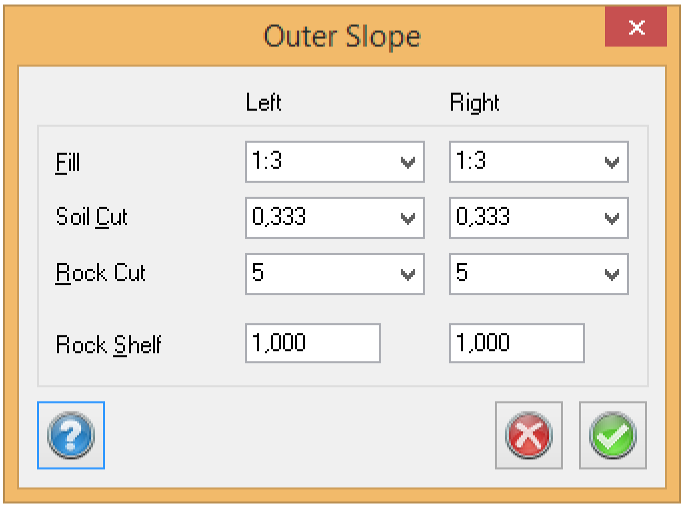
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

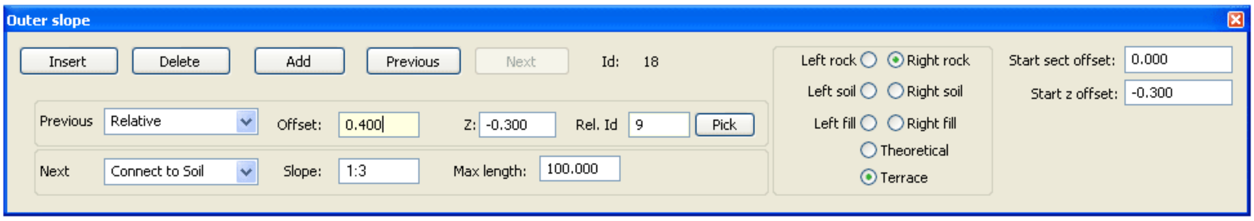
Section template|Quick outer slope

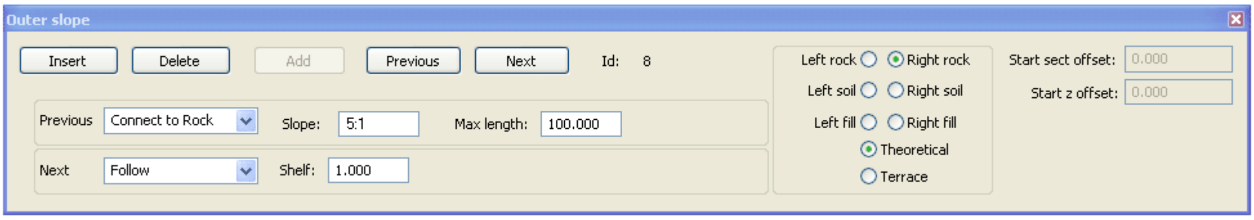
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

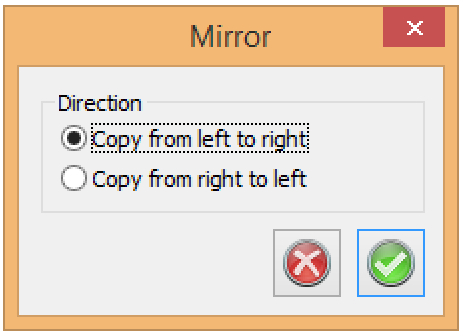
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

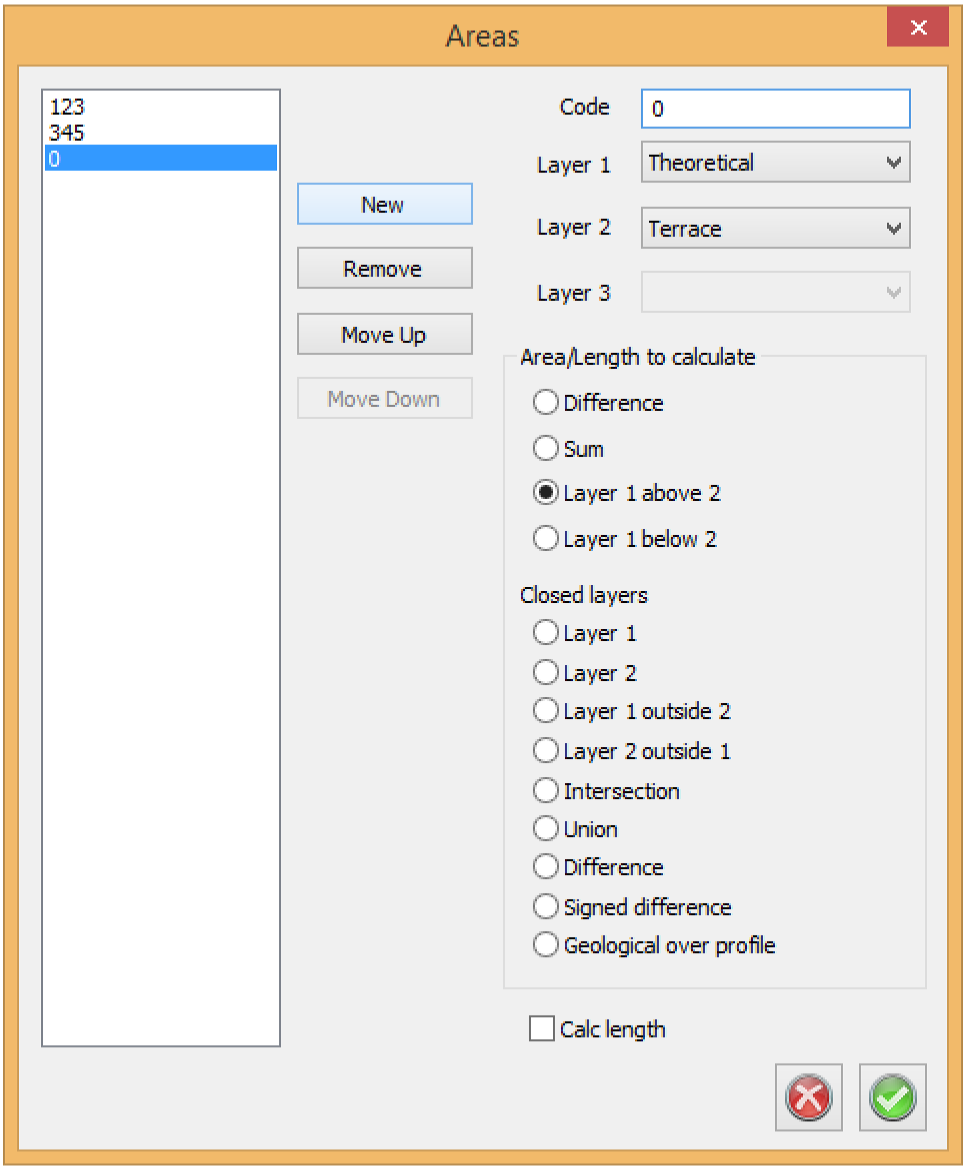
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

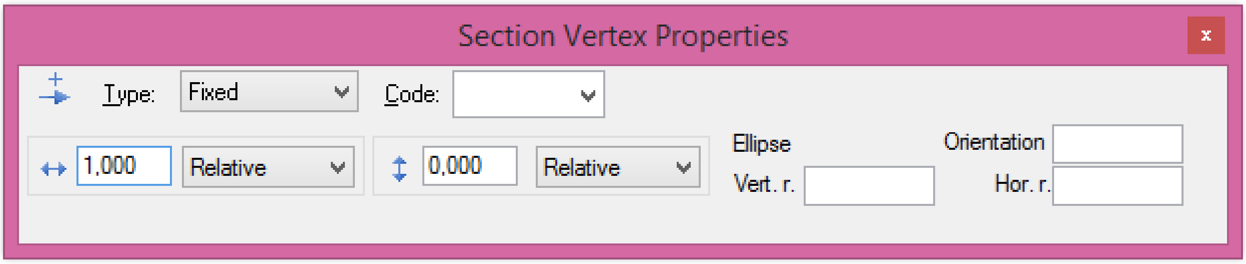
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

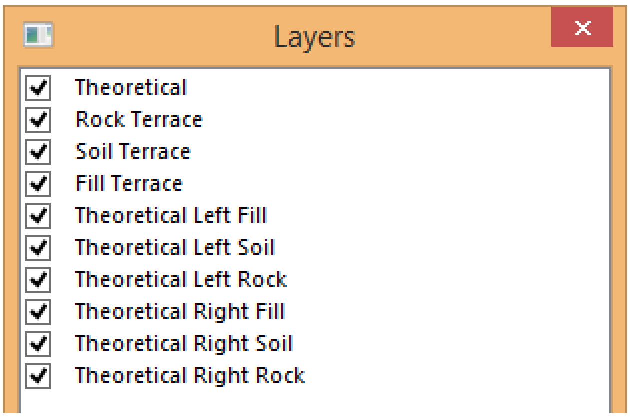
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

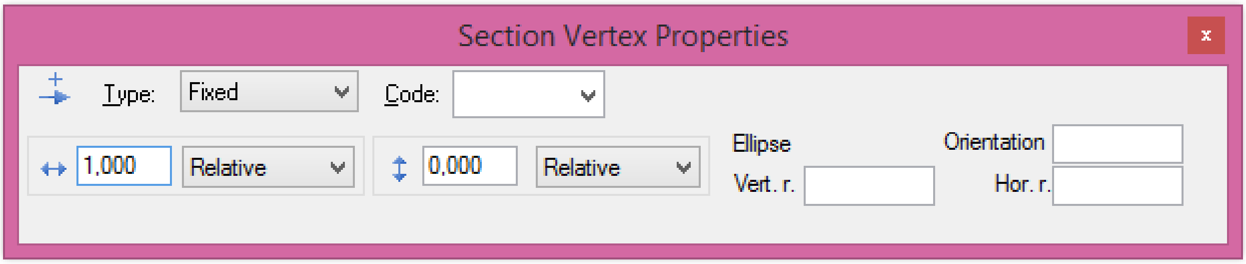
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

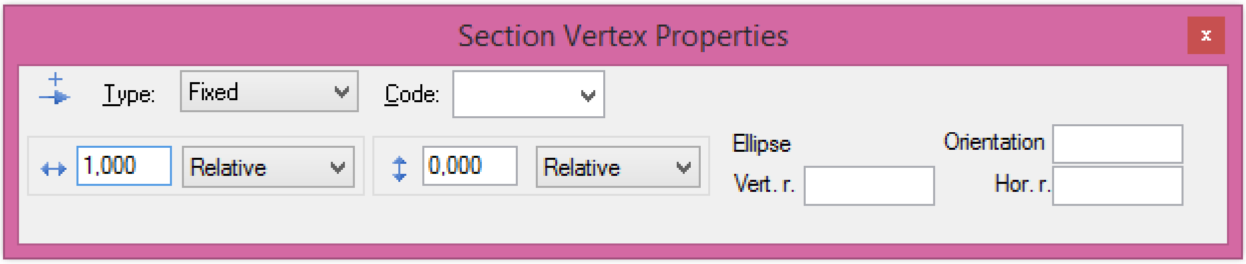
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

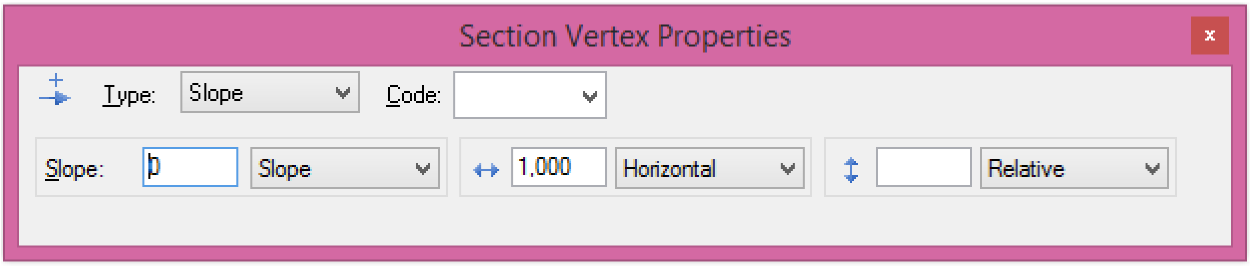
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

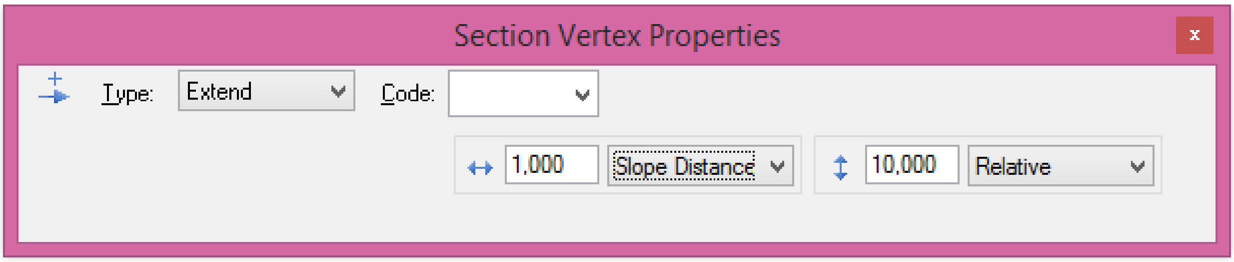
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

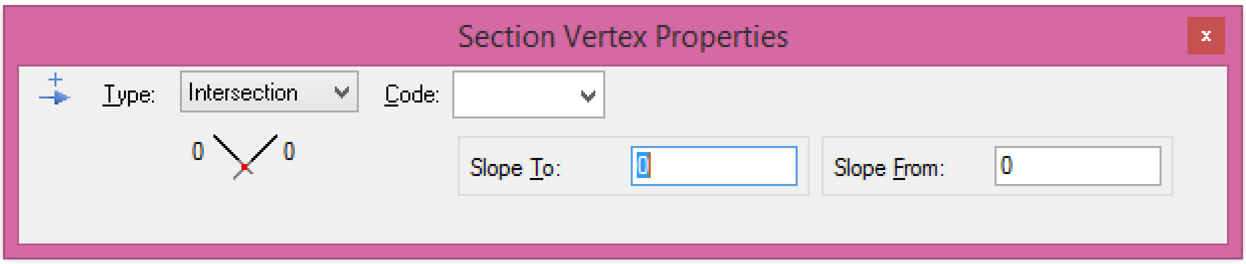
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

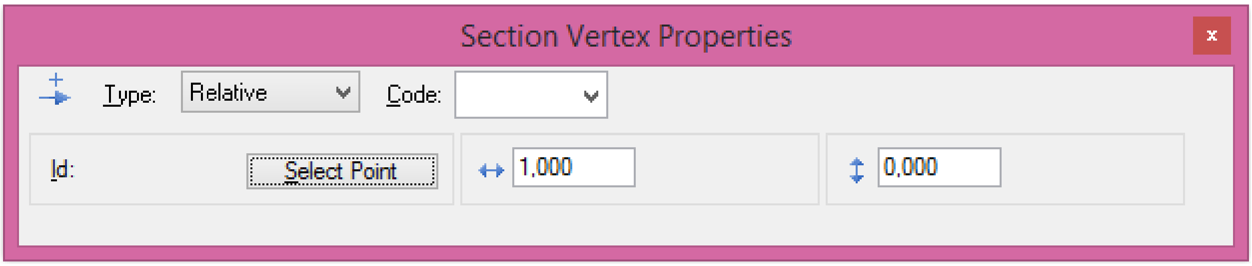
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

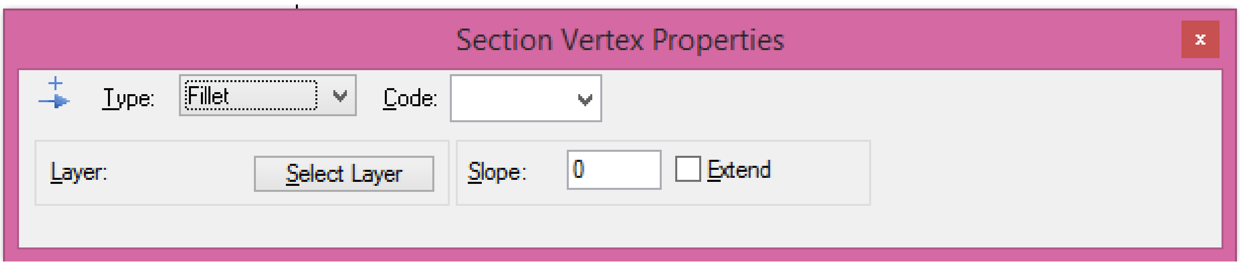
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

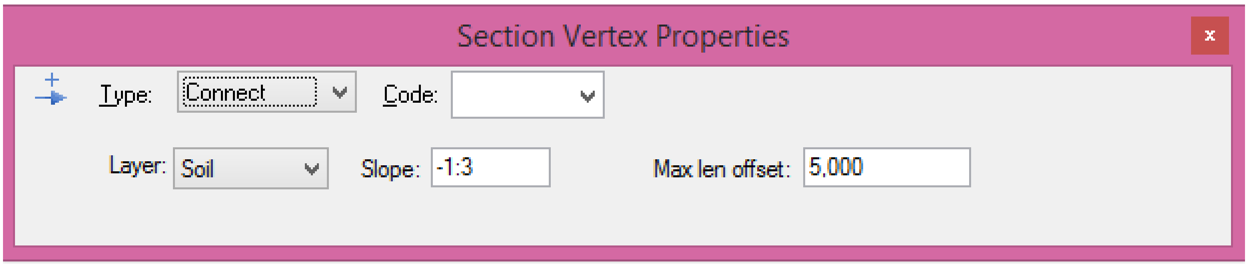
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

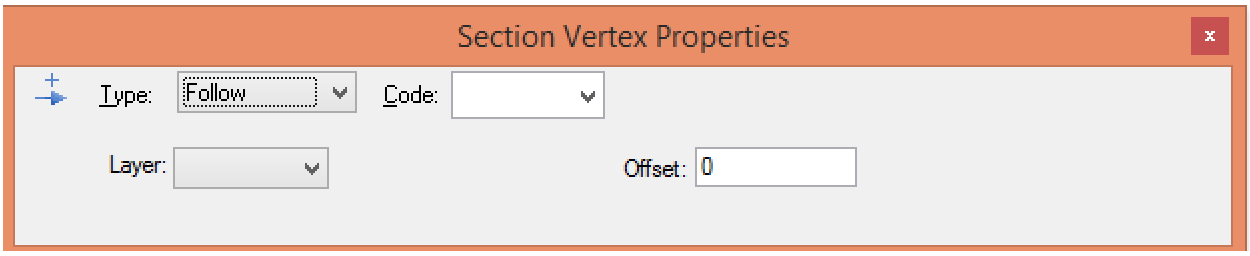


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

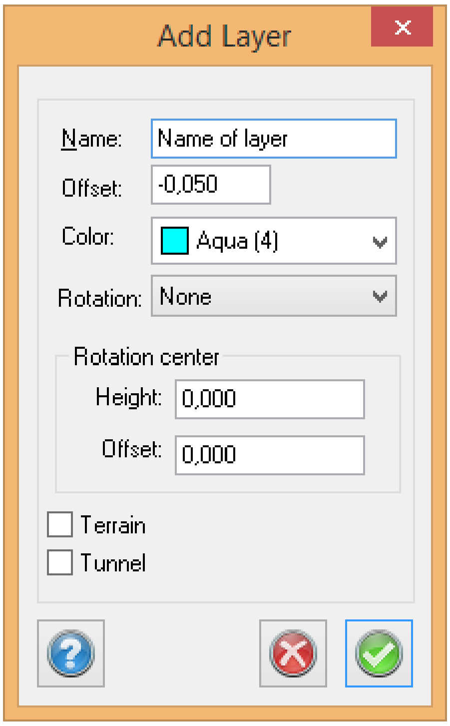


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

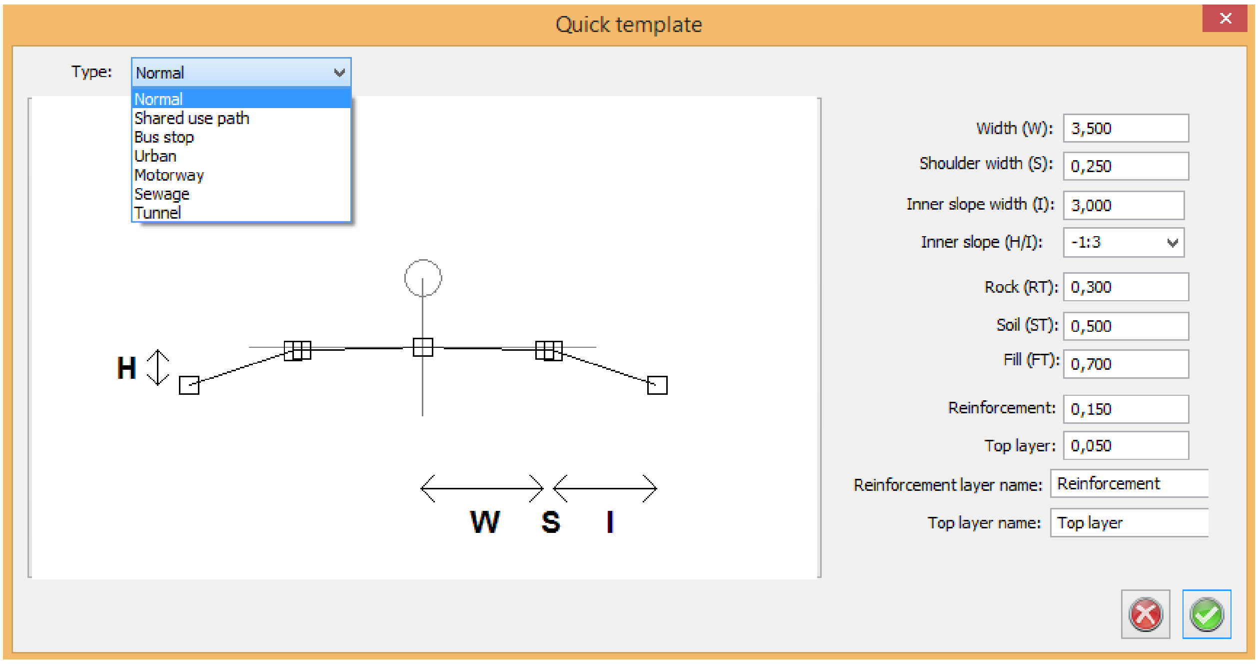
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

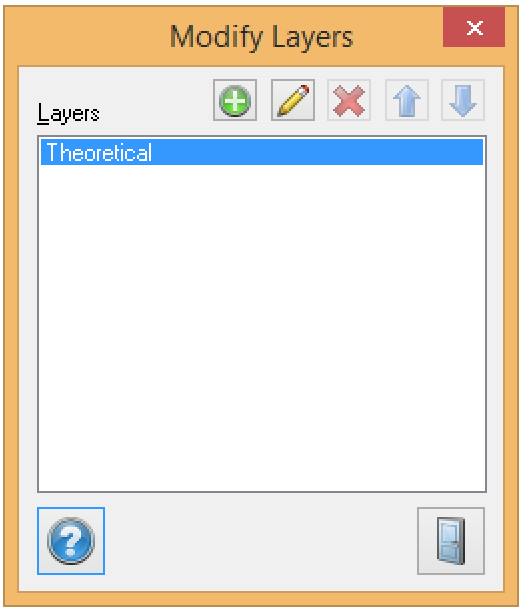
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

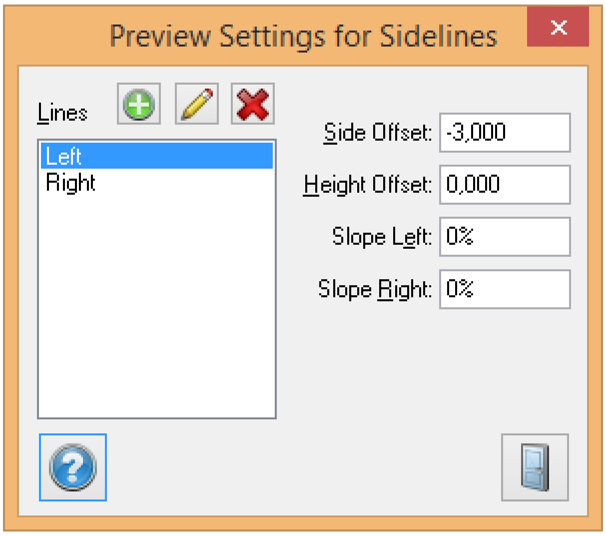


Modify layers in section template.

Edit side lines

Section template|Side lines

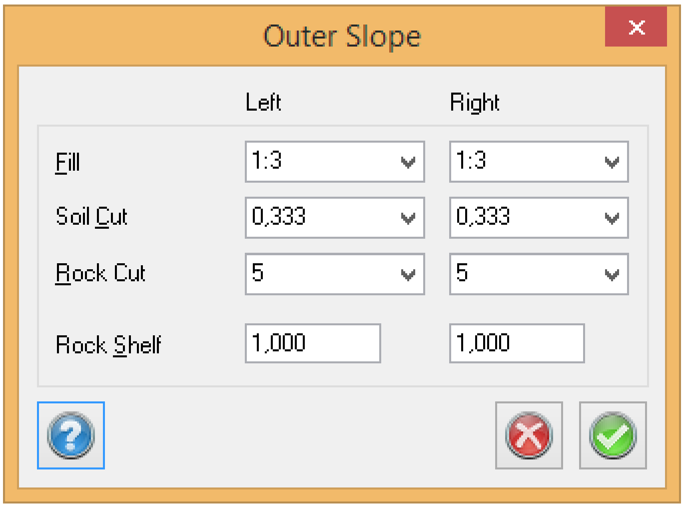
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

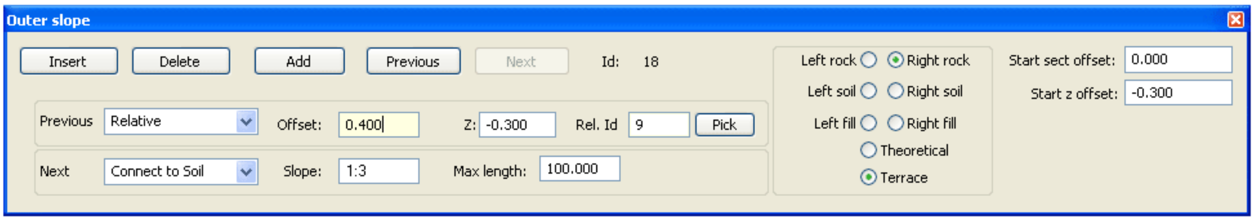
Section template|Quick outer slope

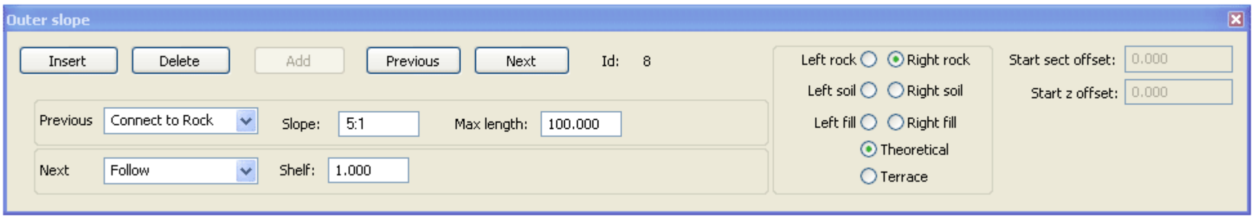
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope

To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert

Adds a new point inside selected point.

Add

Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete

Deletes selected point.

Previous and Next

To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

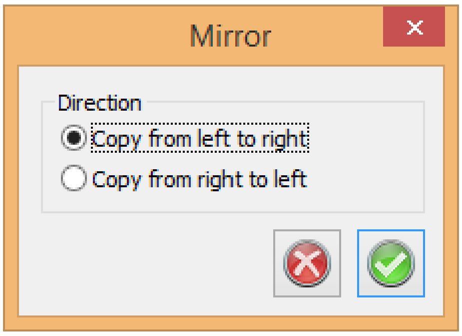
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

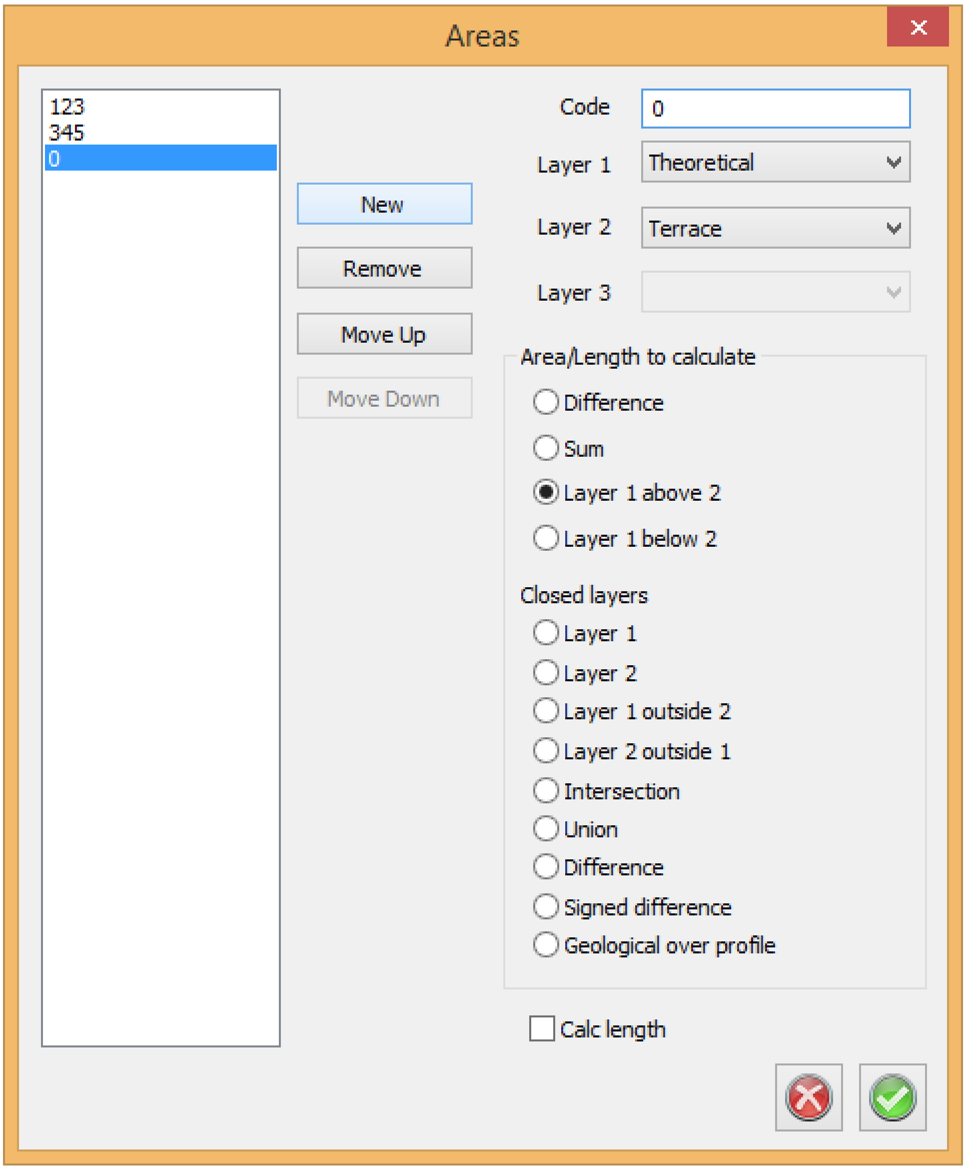
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

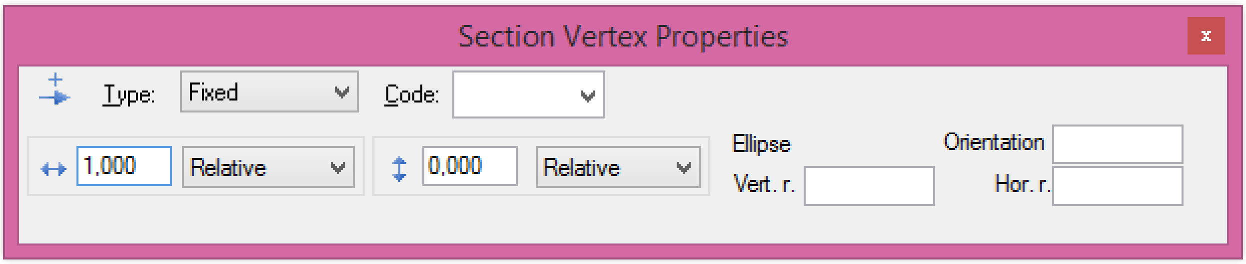
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

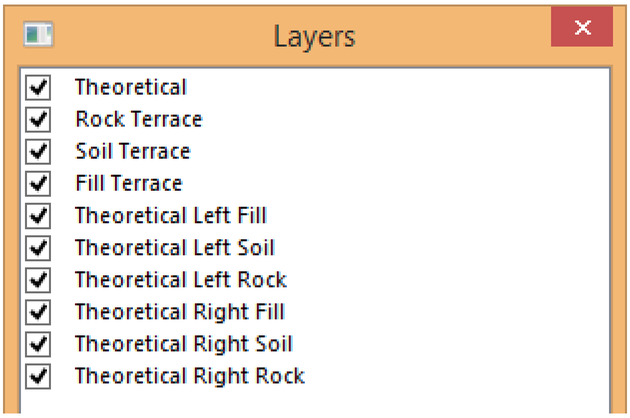
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

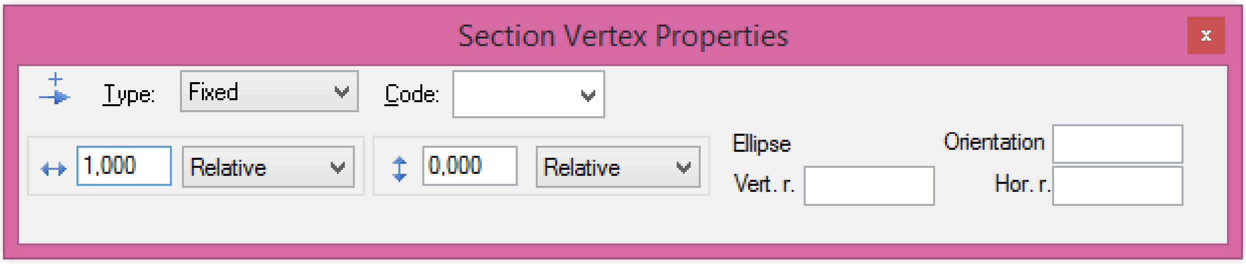
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

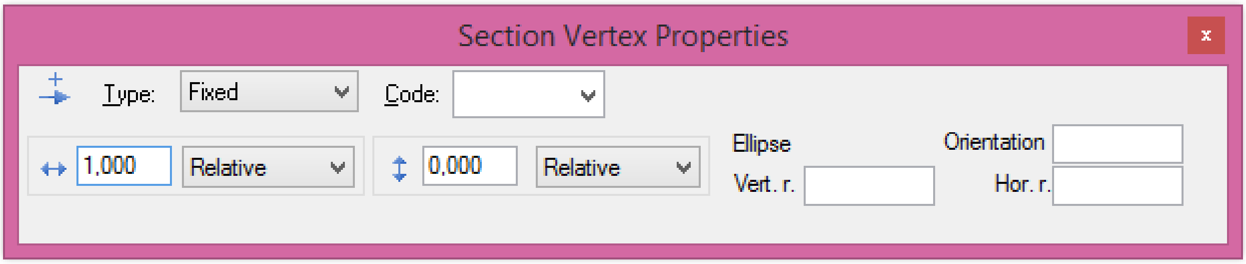
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

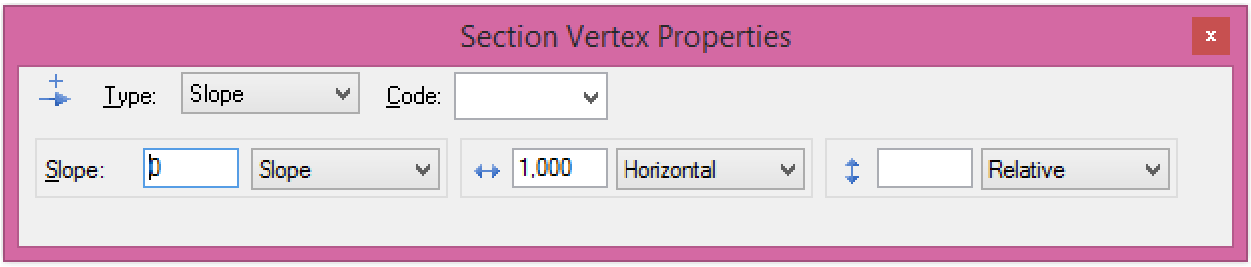
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

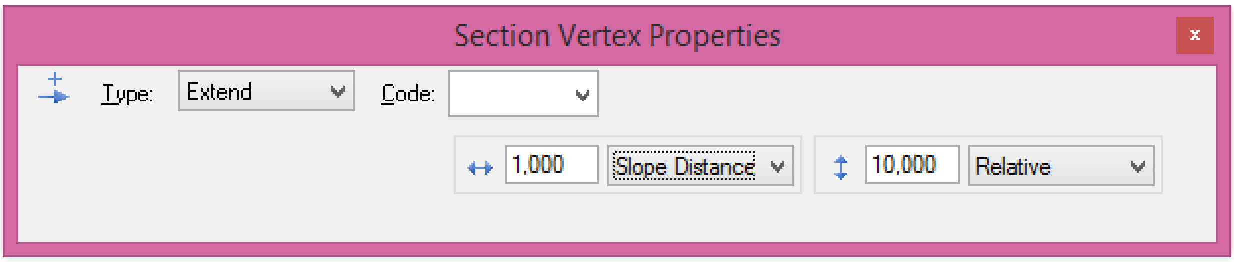
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

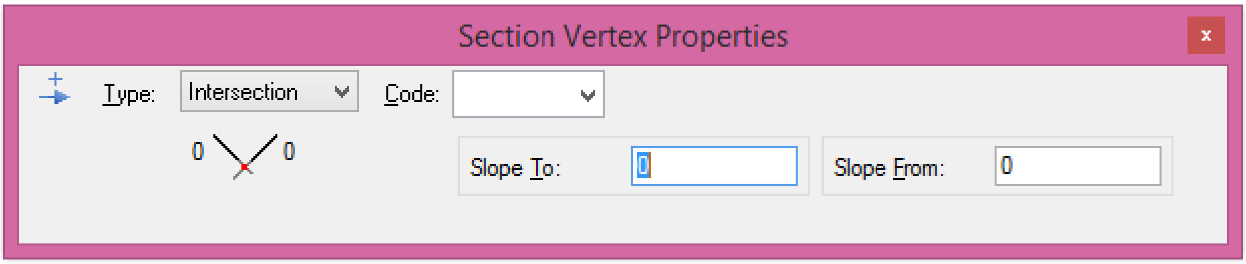
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

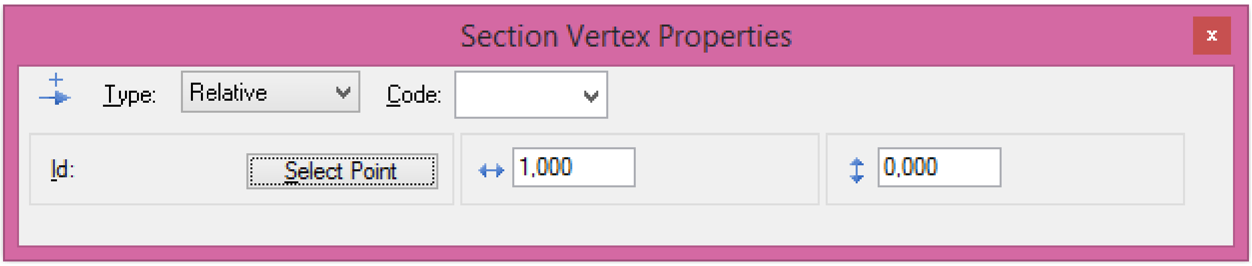
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

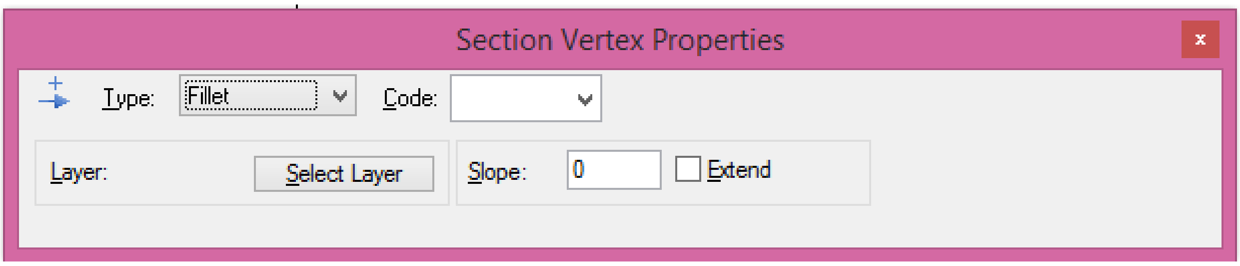
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

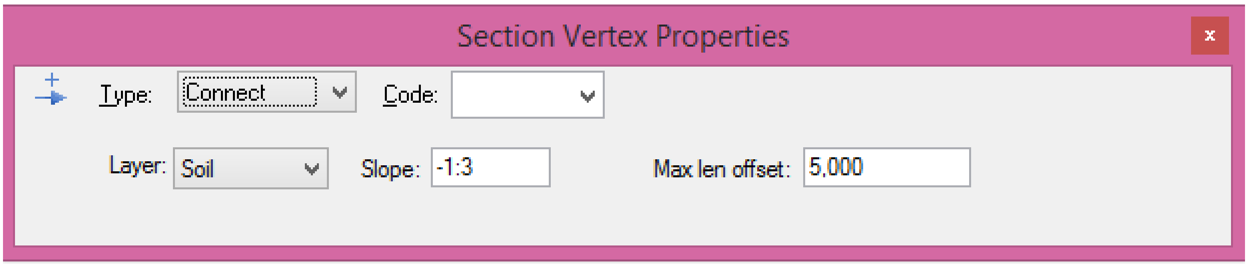
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

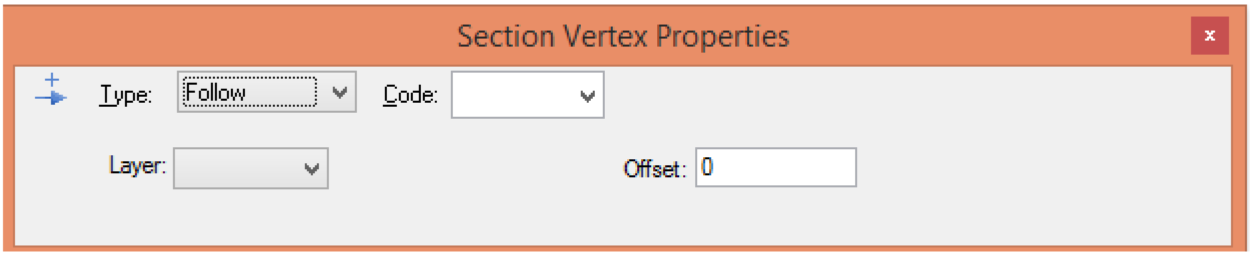


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

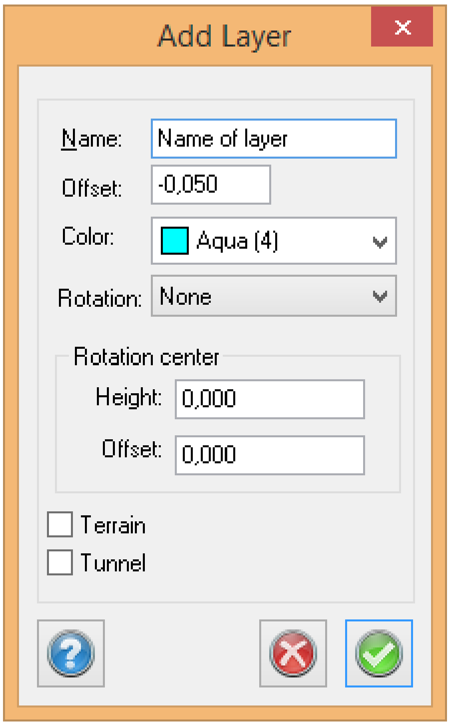


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

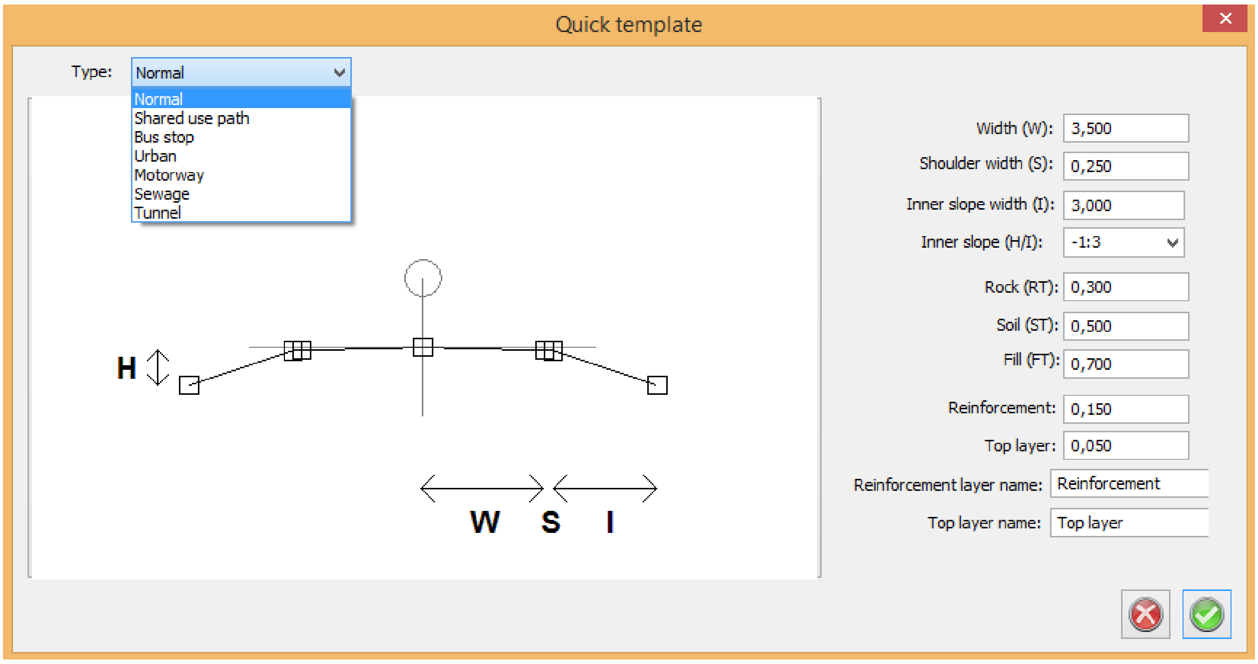
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

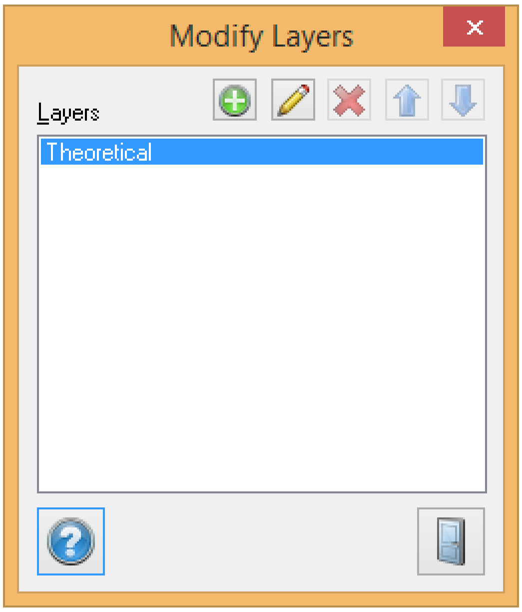
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

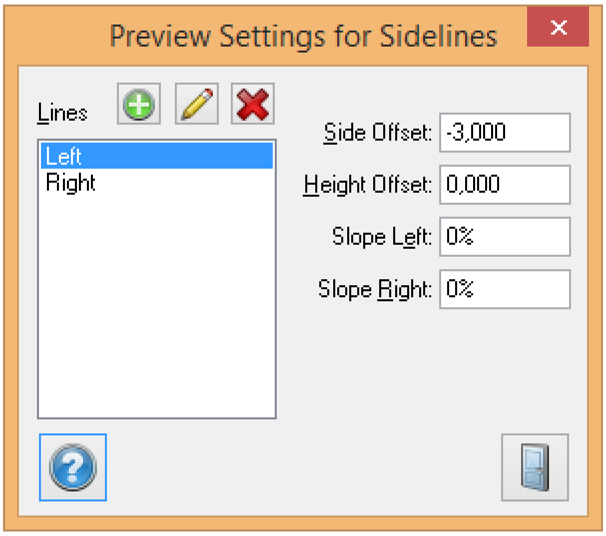


Modify layers in section template.

Edit side lines

Section template|Side lines

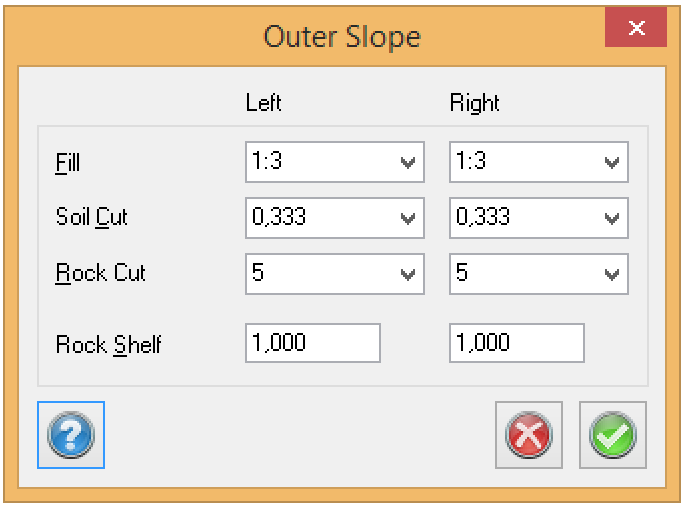
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

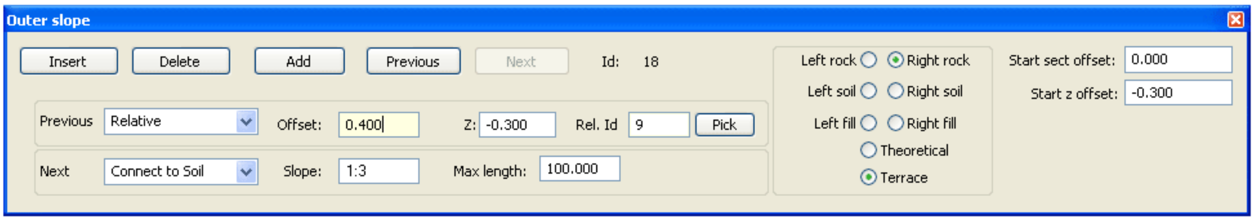
Section template|Quick outer slope

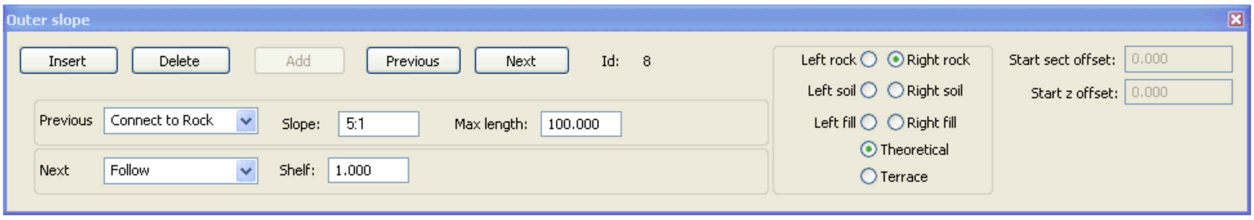
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

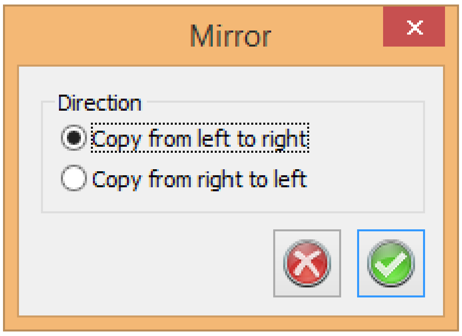
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

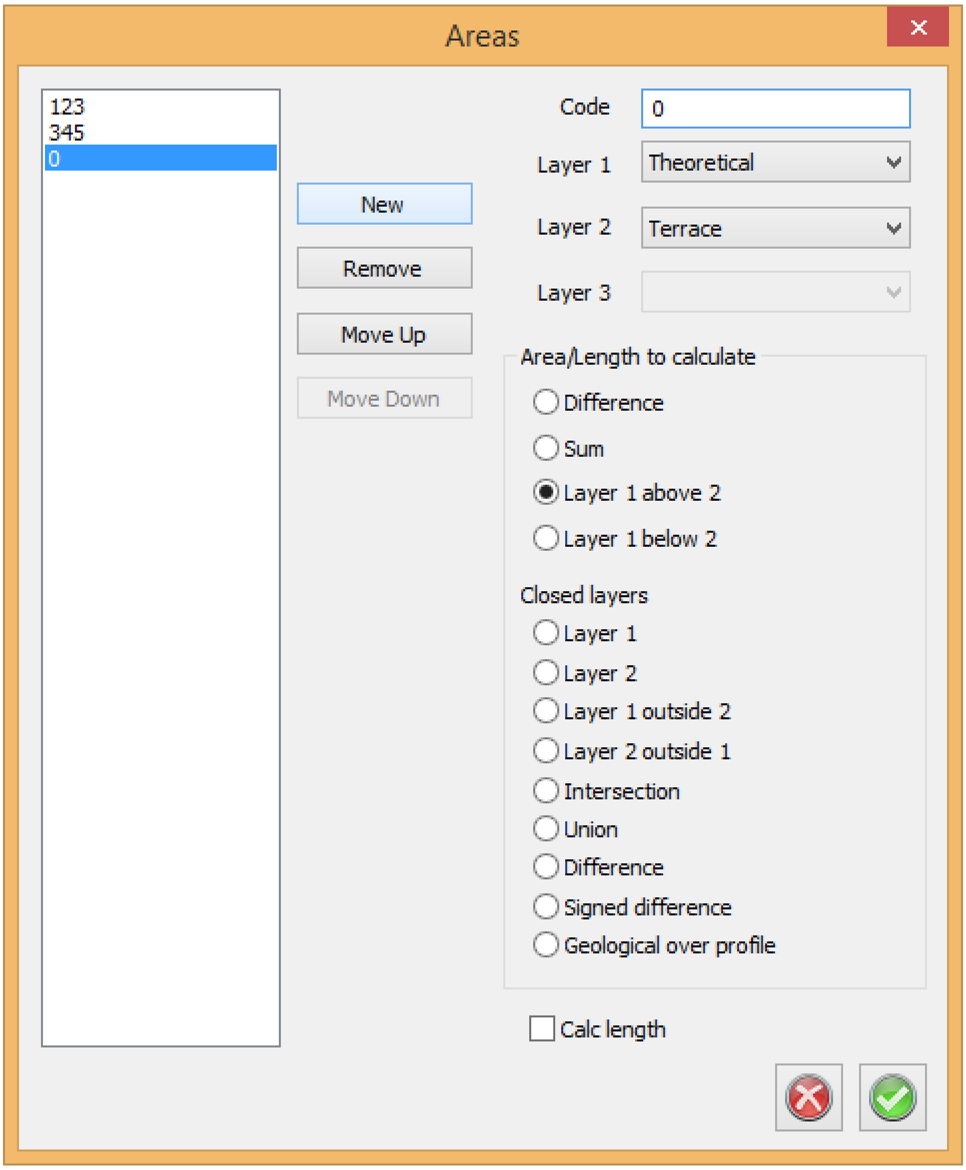
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

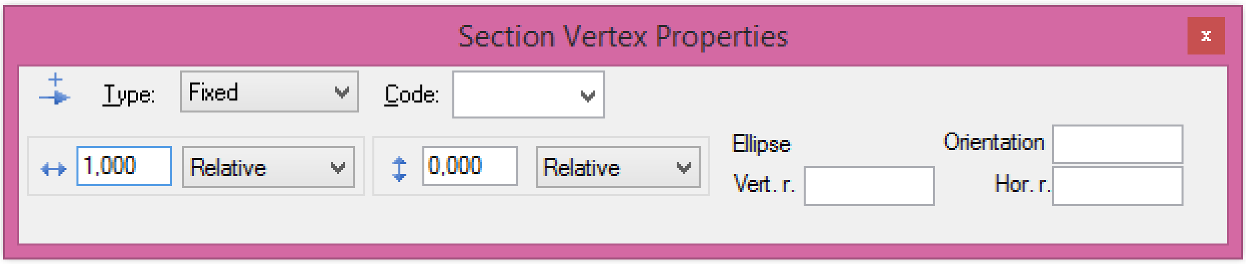
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

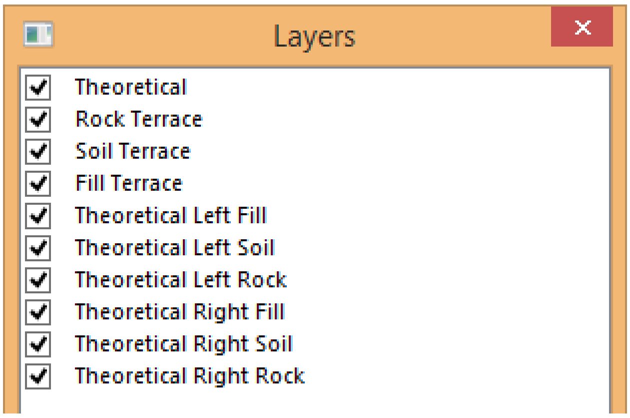
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

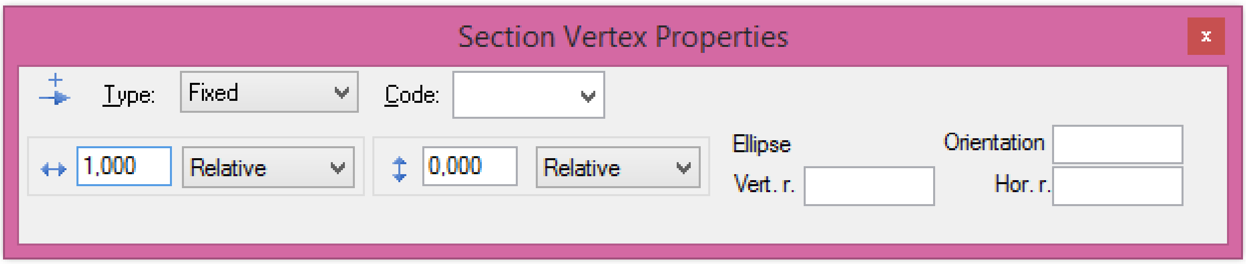
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

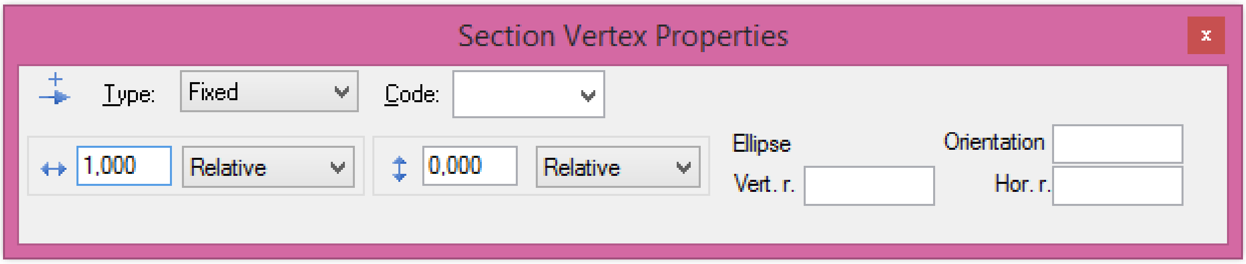
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

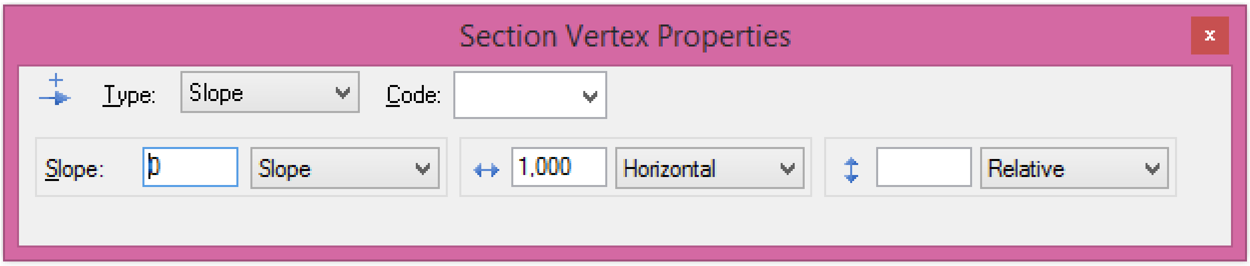
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

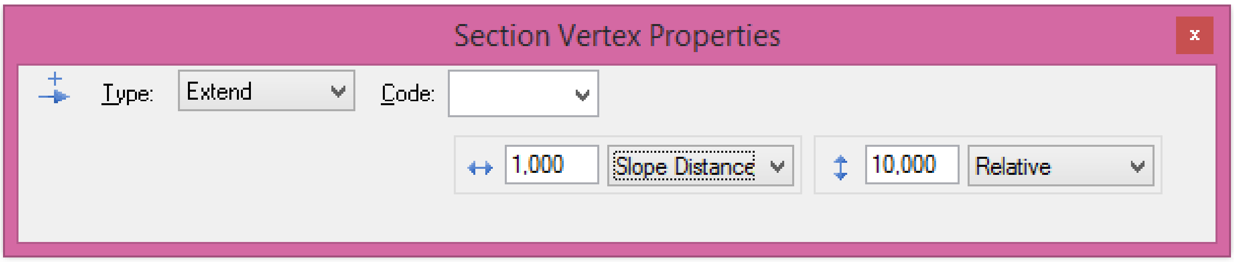
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

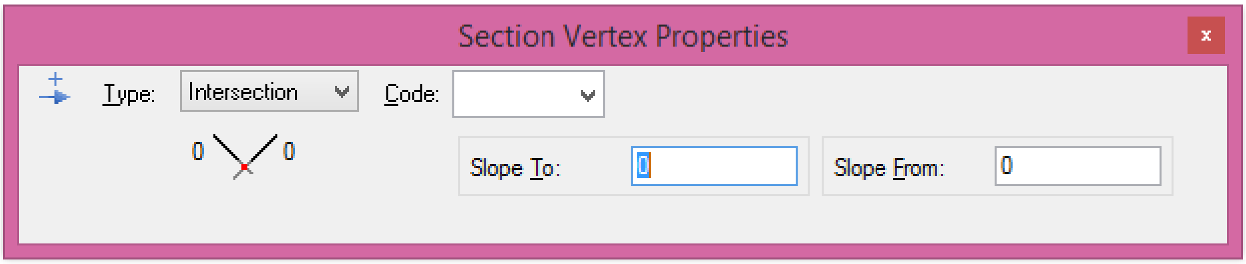
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

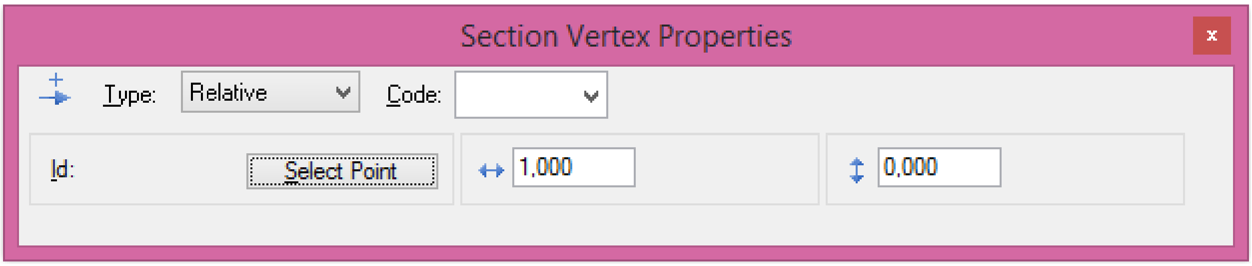
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

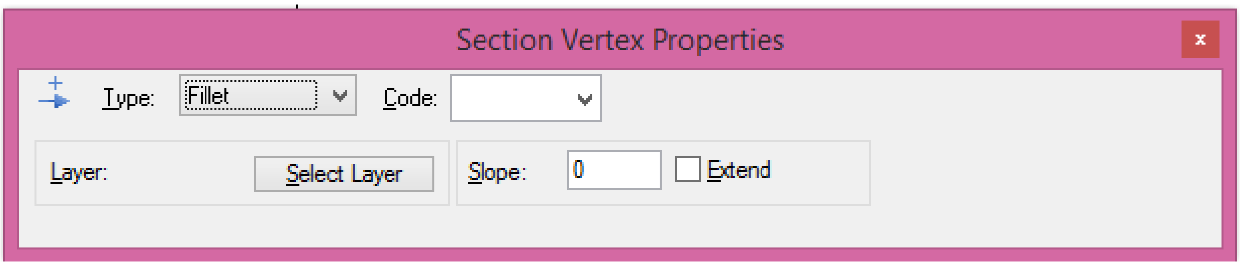
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

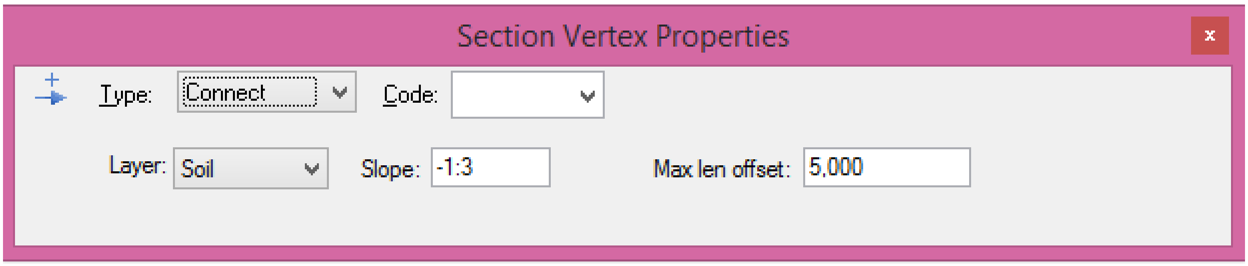
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

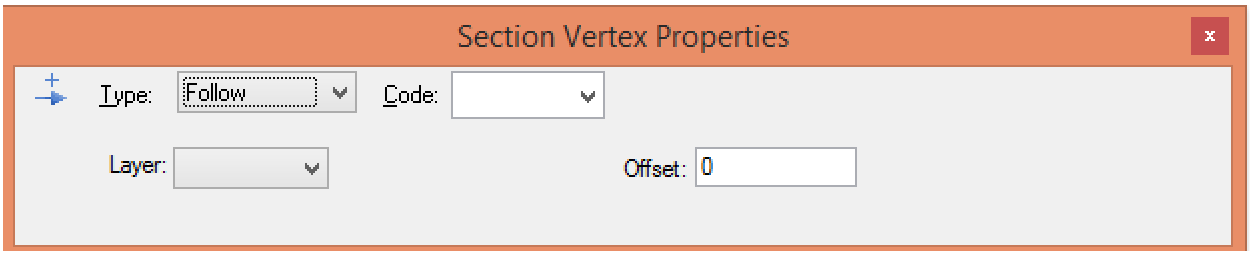


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

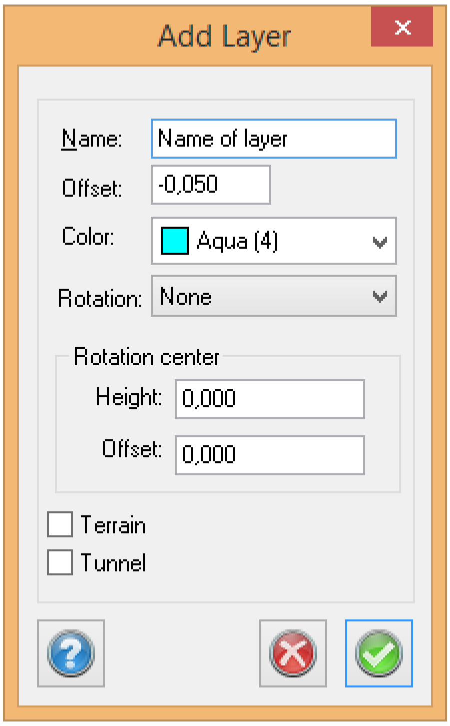


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

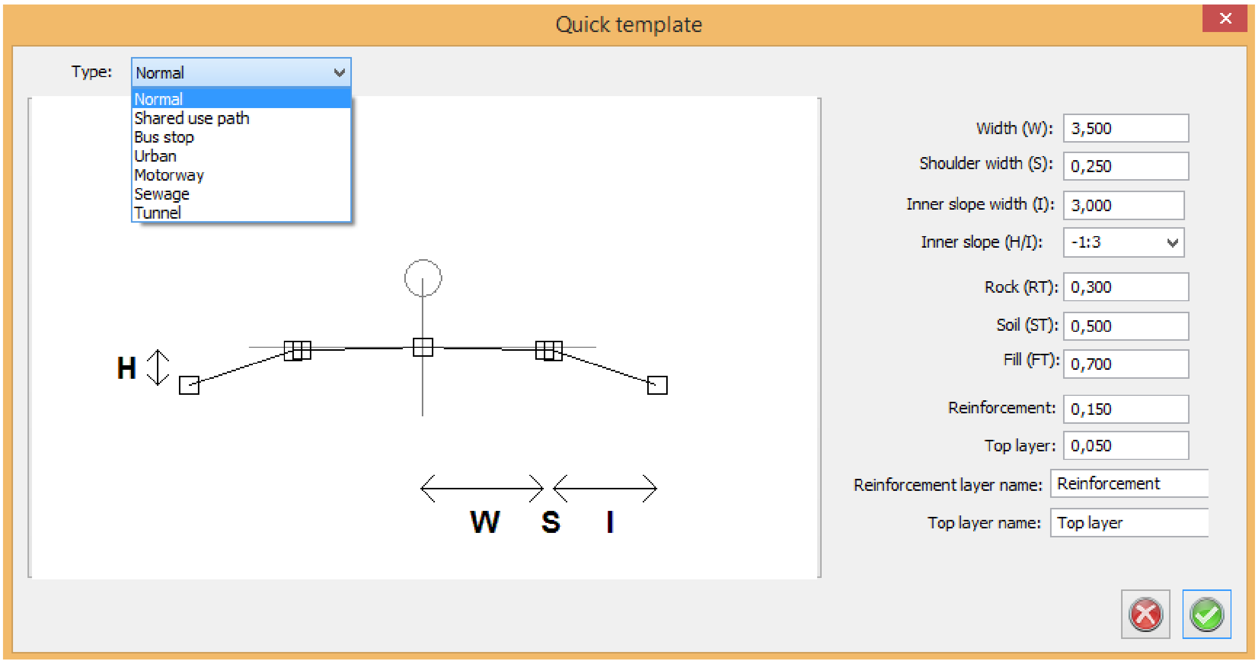
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

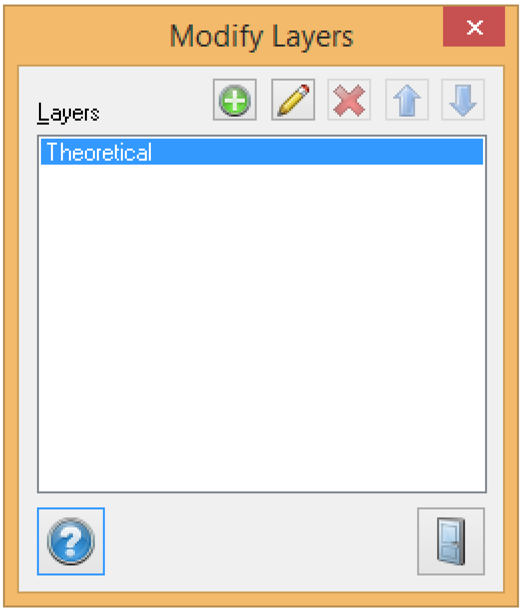
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

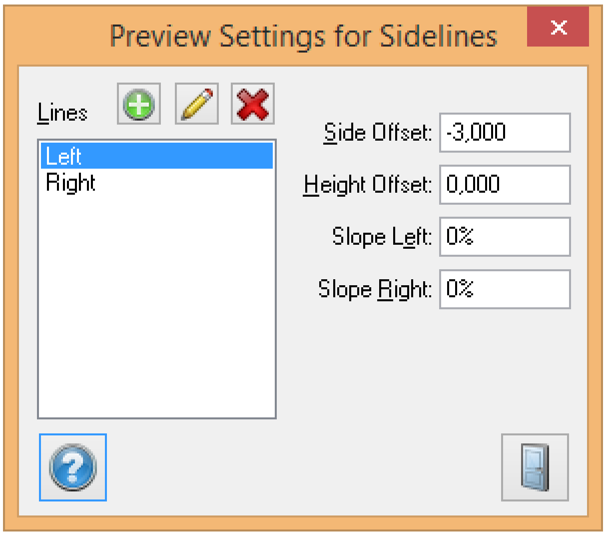


Modify layers in section template.

Edit side lines

Section template|Side lines

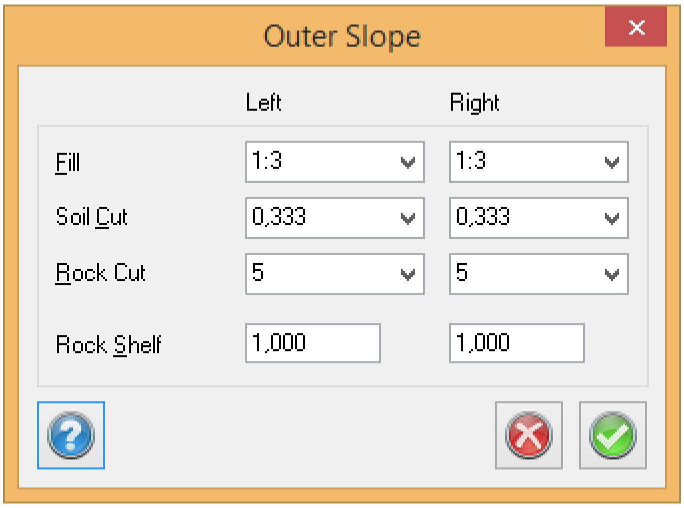
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

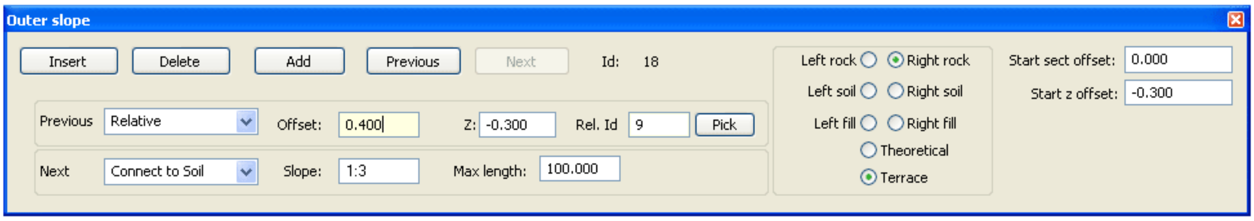
Section template|Quick outer slope

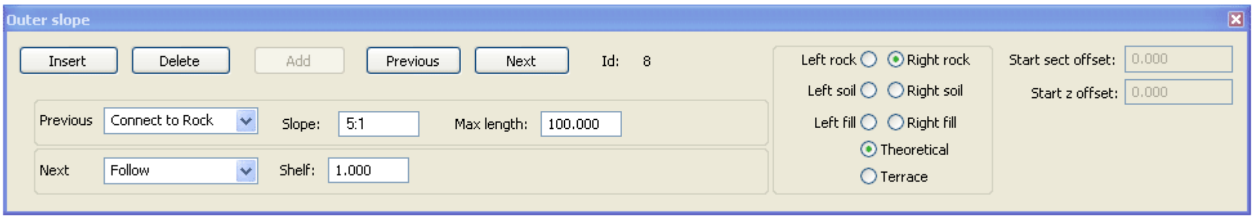
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

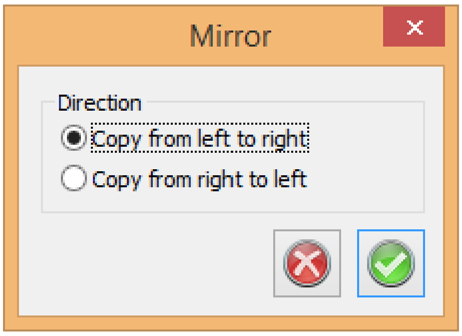
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

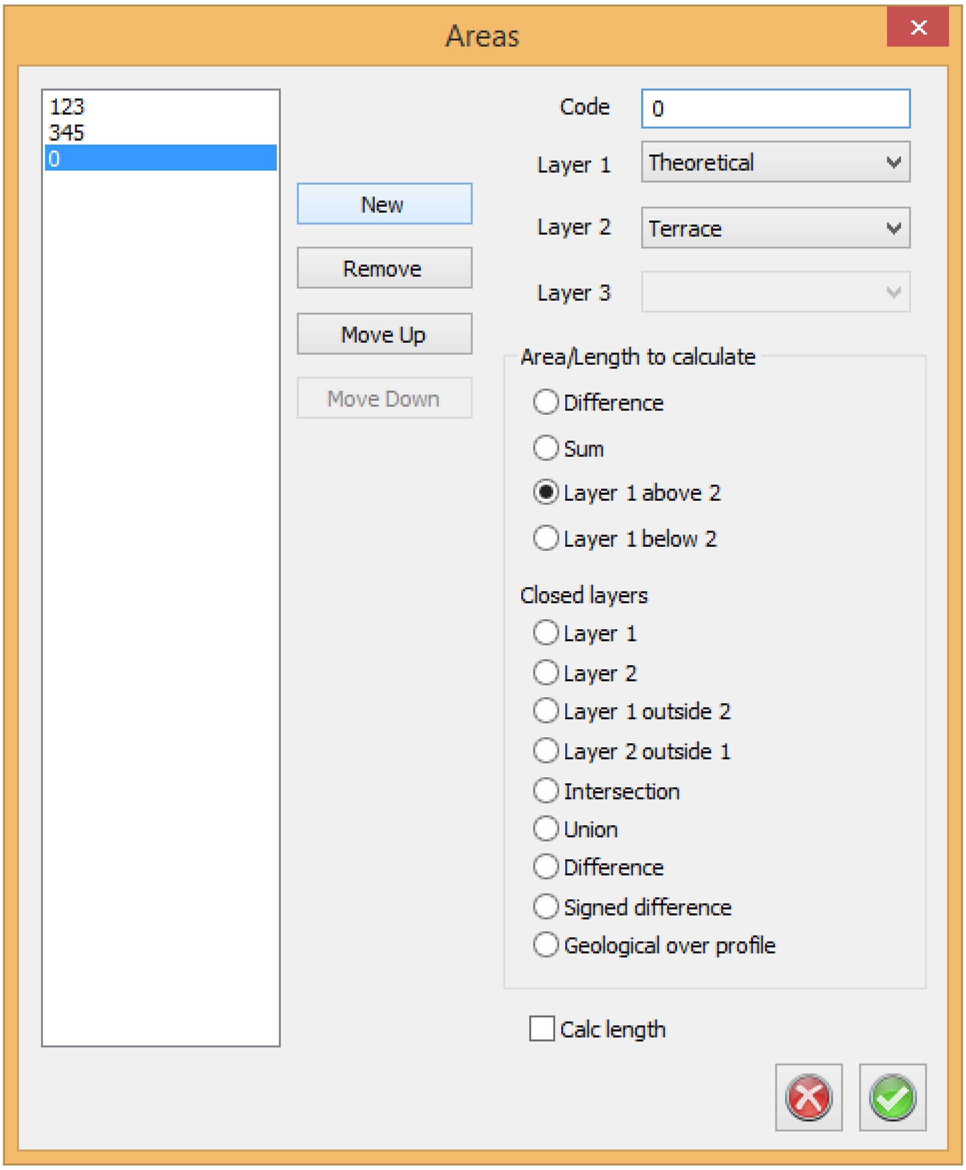
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
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- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

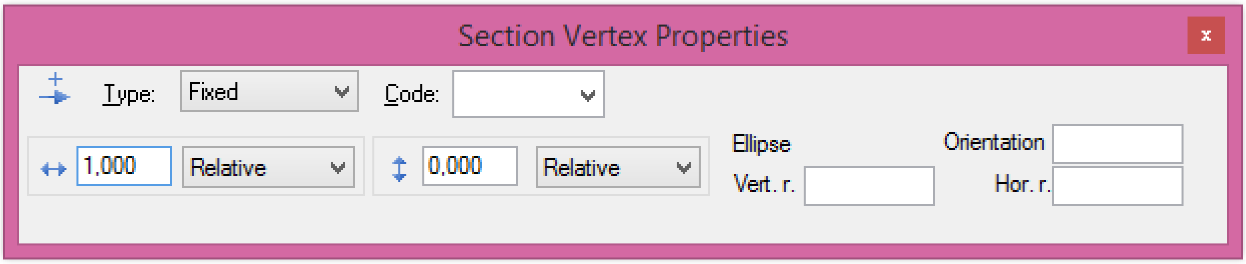
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

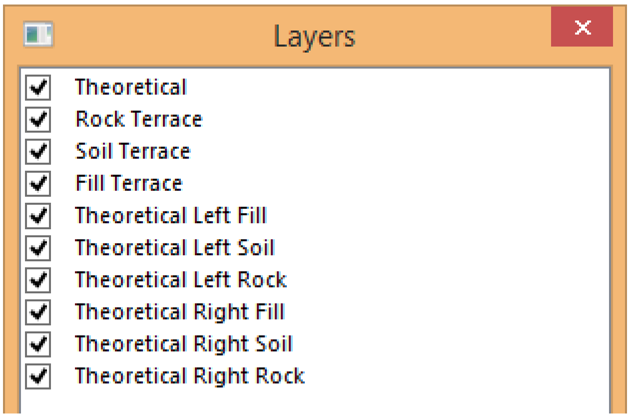
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

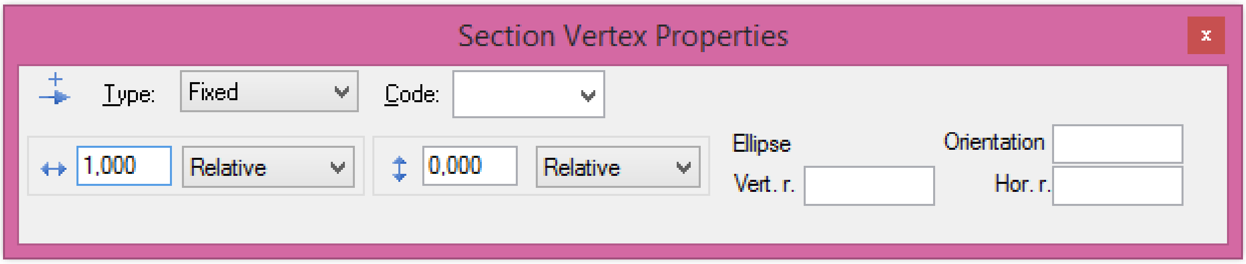
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

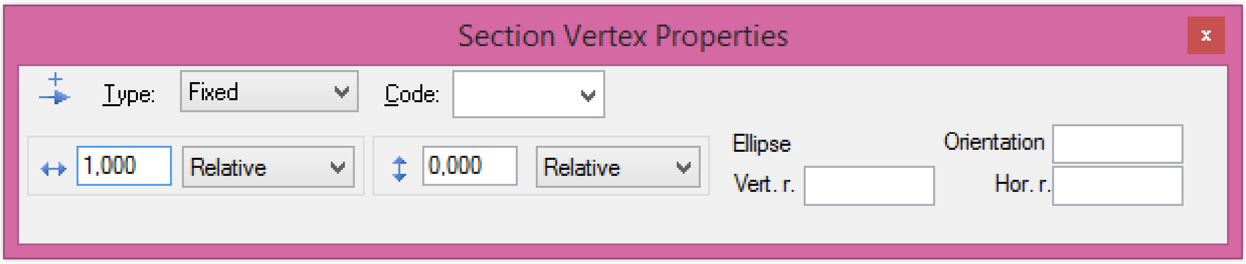
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

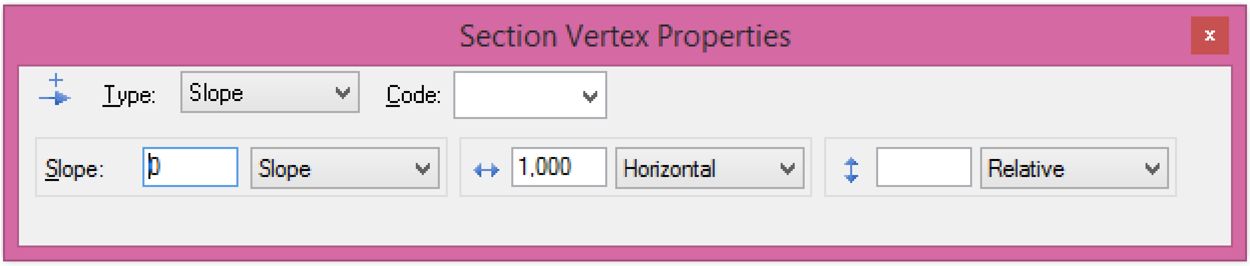
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

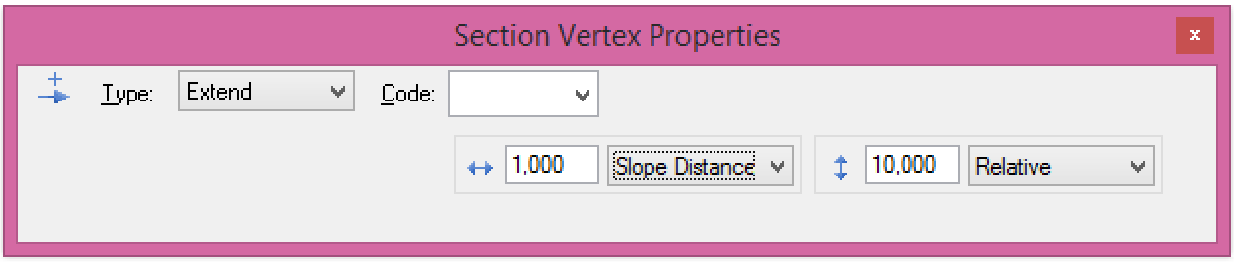
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

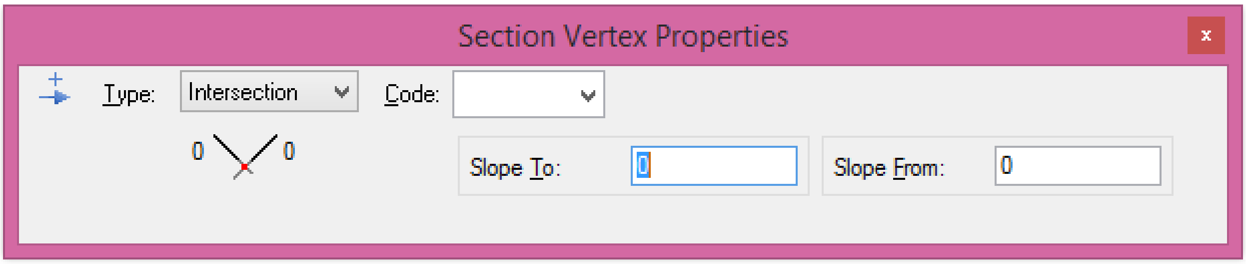
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

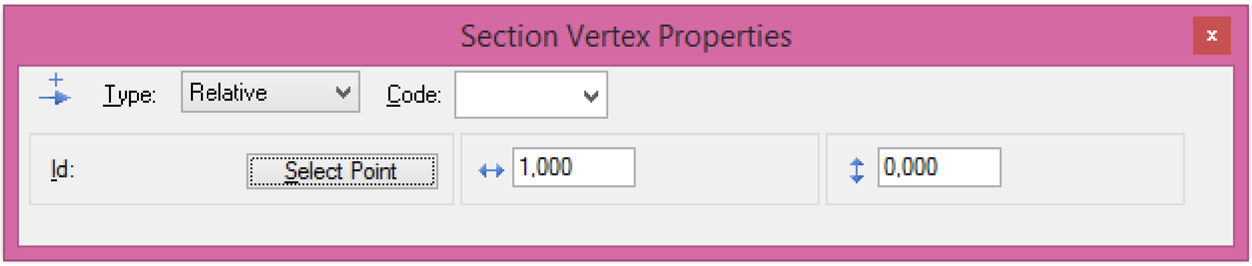
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

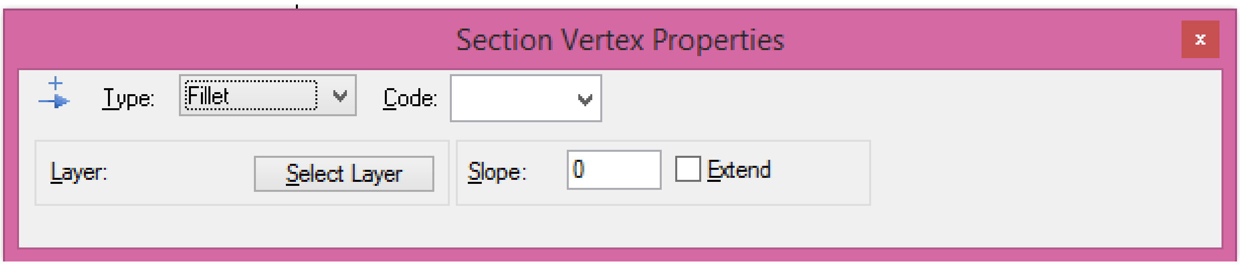
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

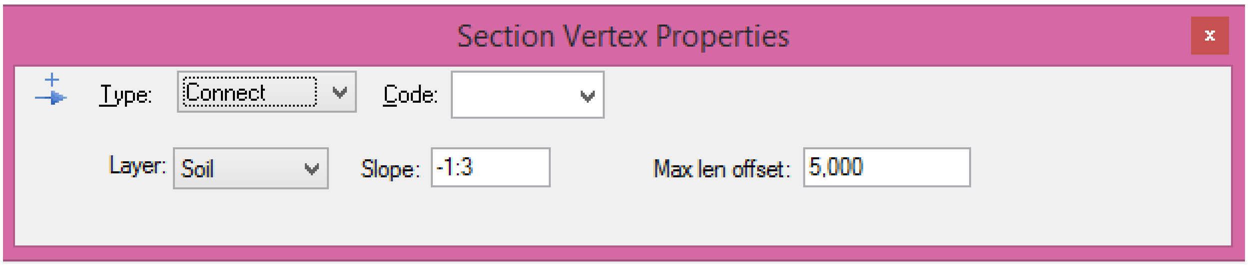
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

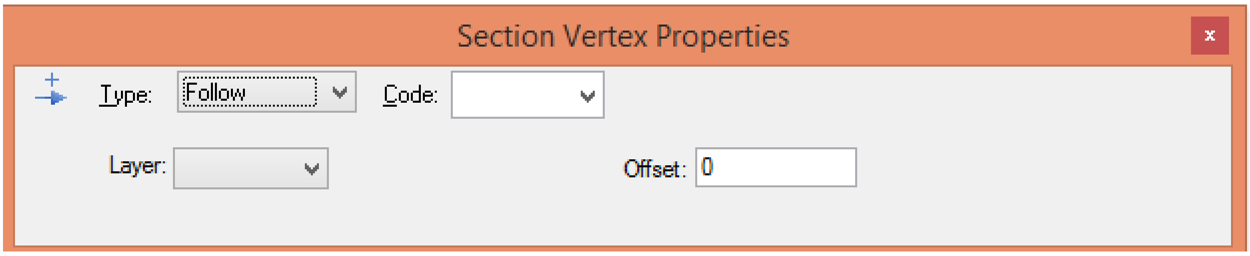


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

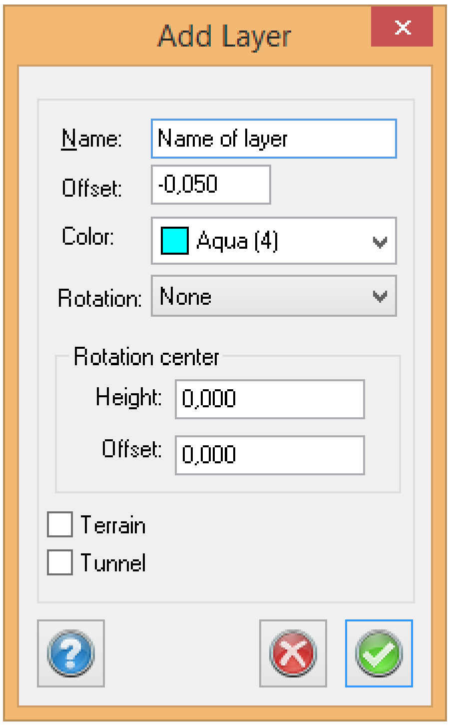


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

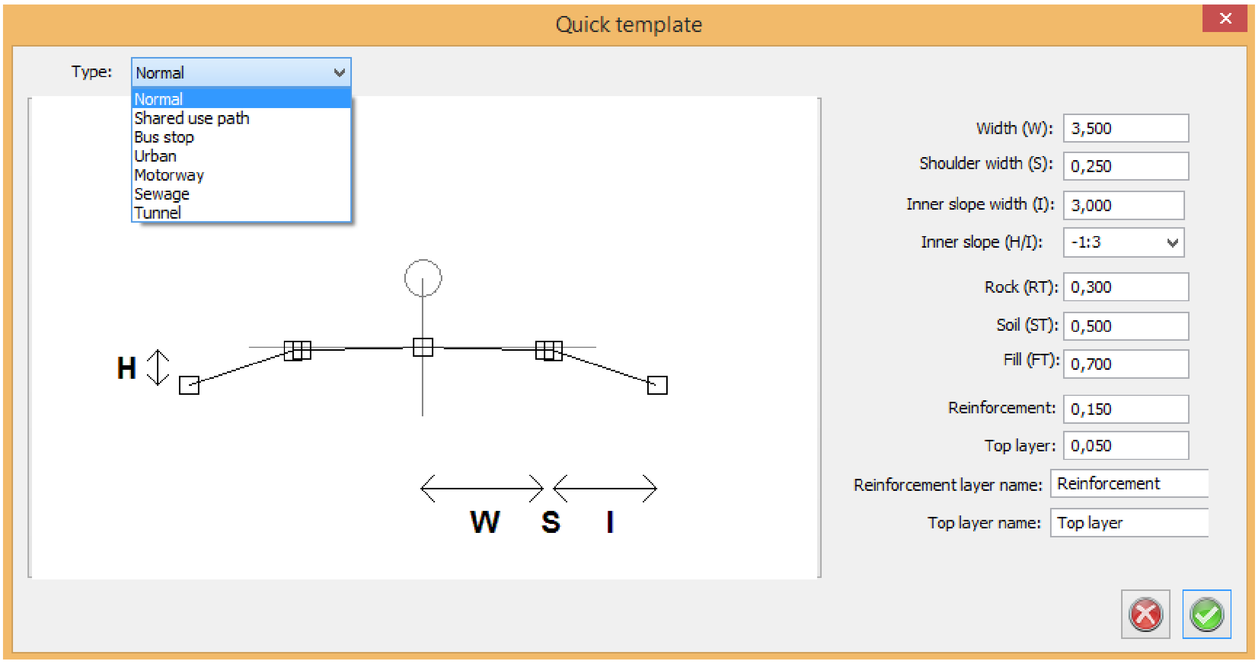
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

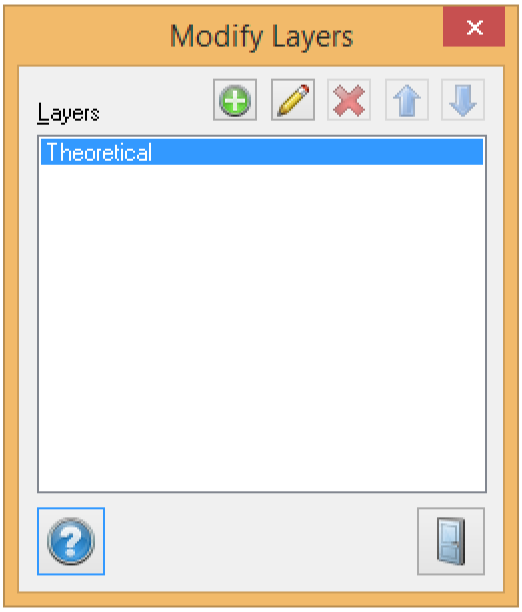
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

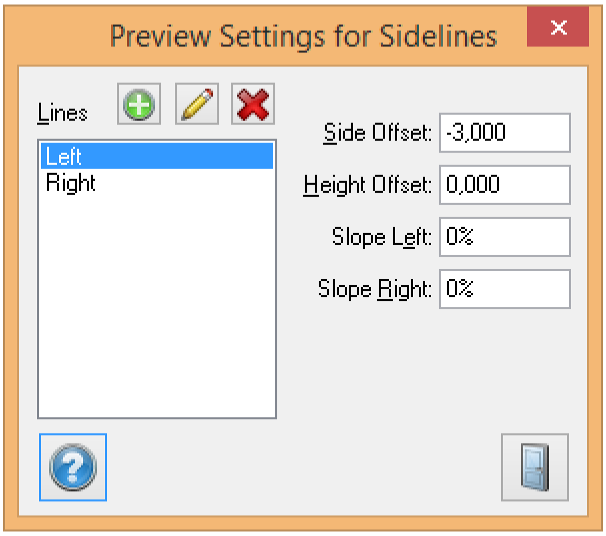


Modify layers in section template.

Edit side lines

Section template|Side lines

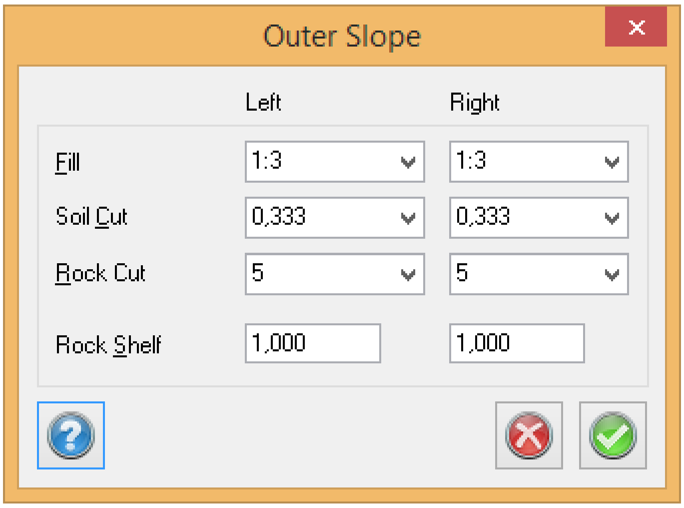
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

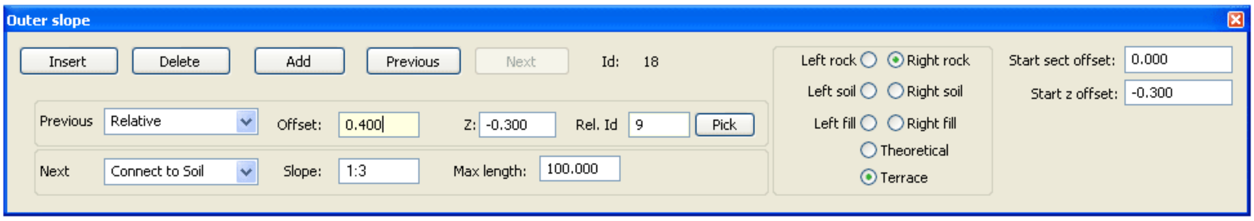
Section template|Quick outer slope

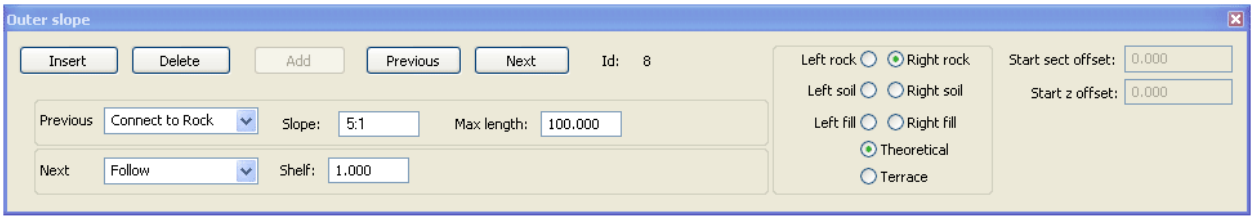
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

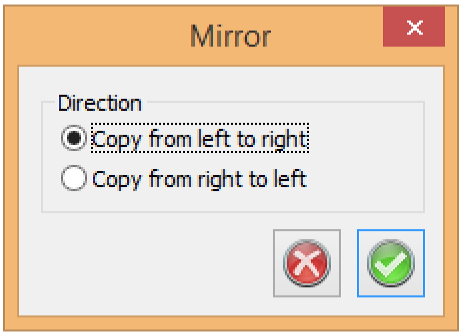
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

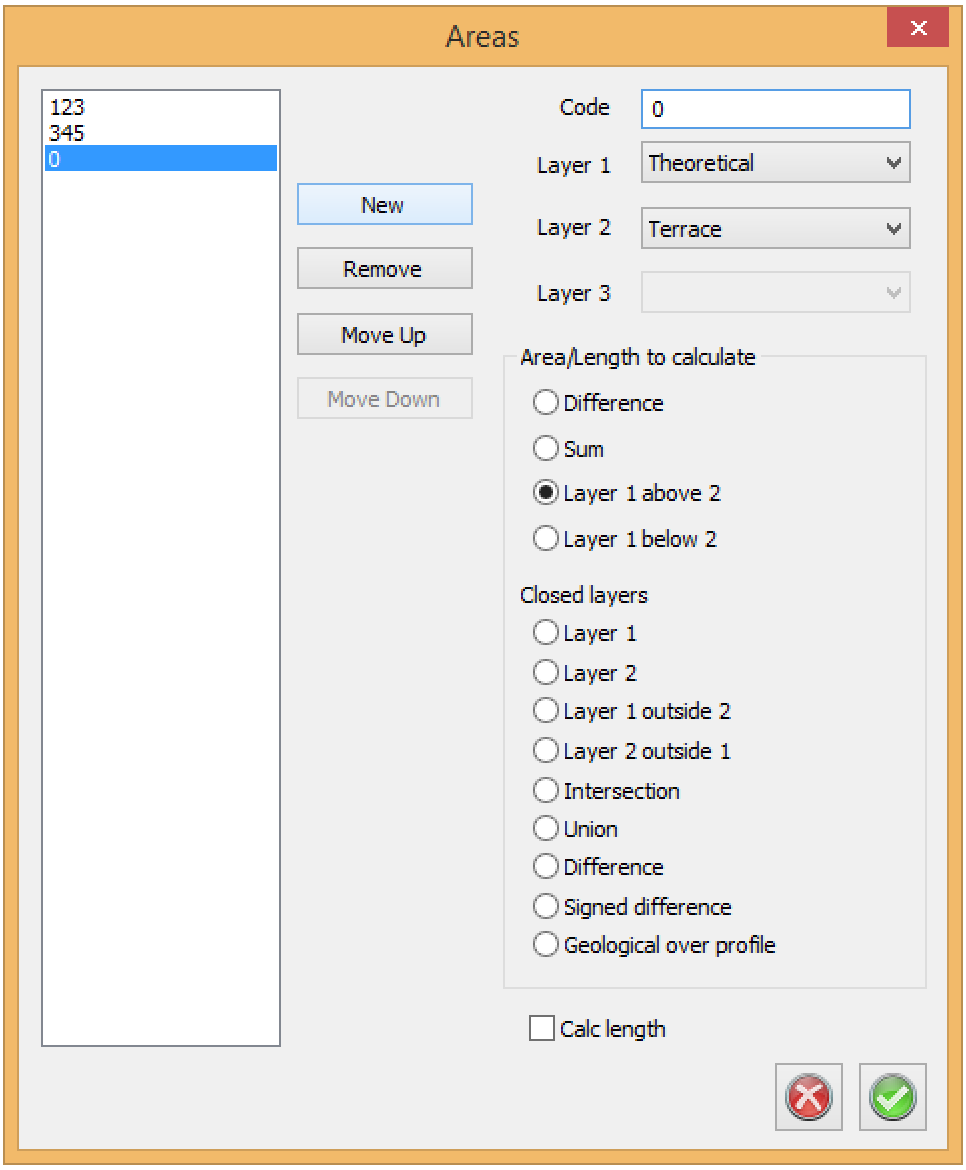
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

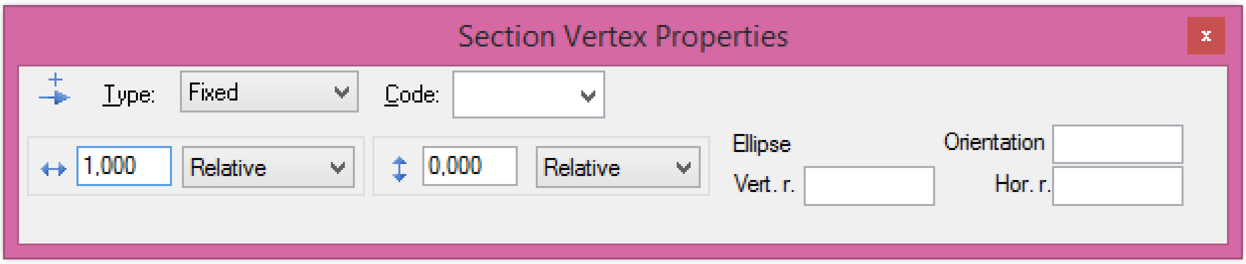
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

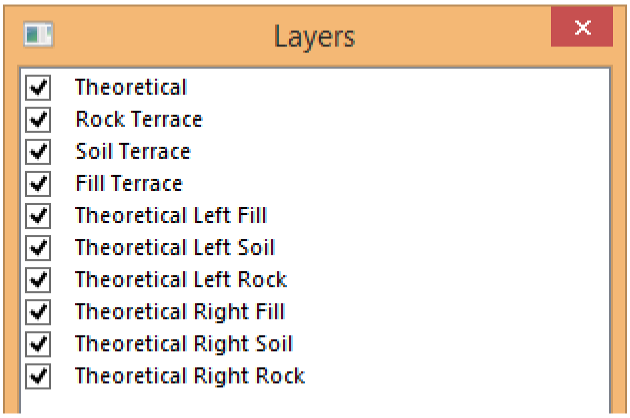
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

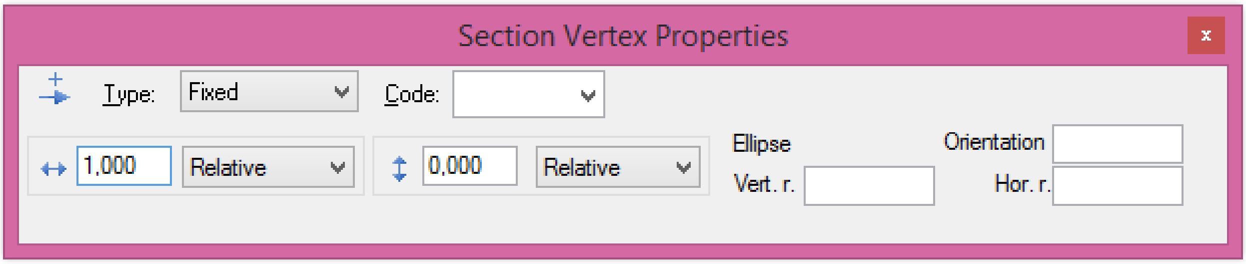
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

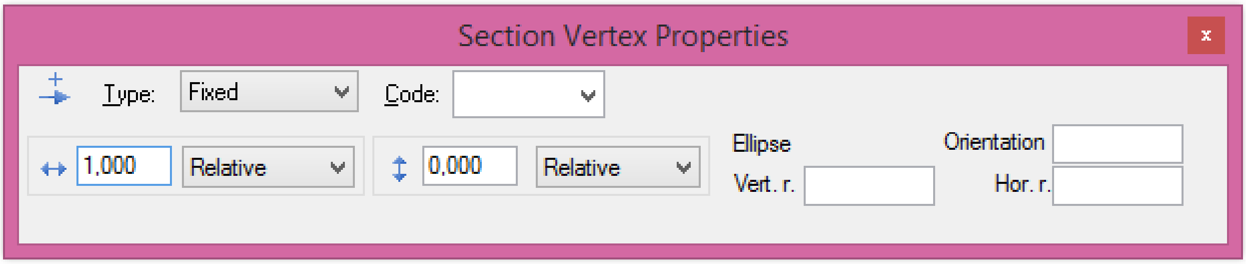
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

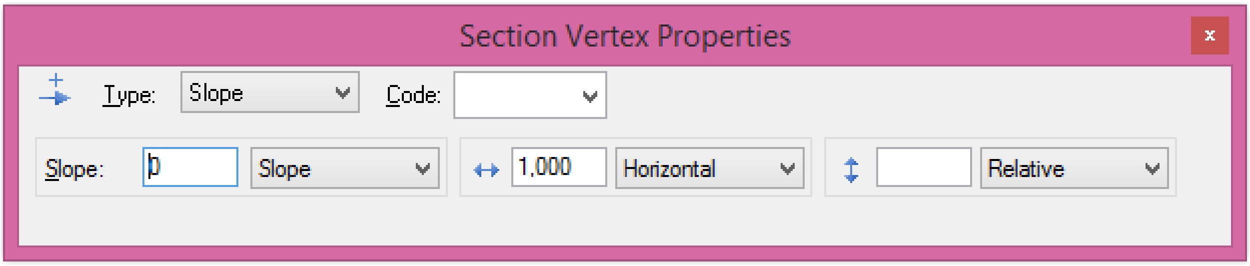
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

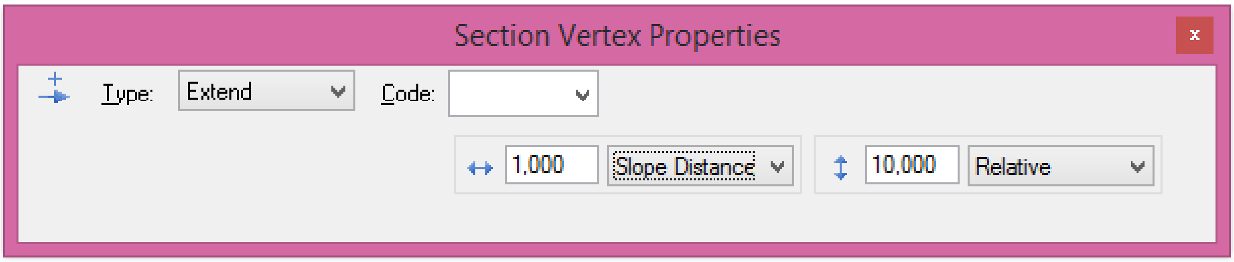
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

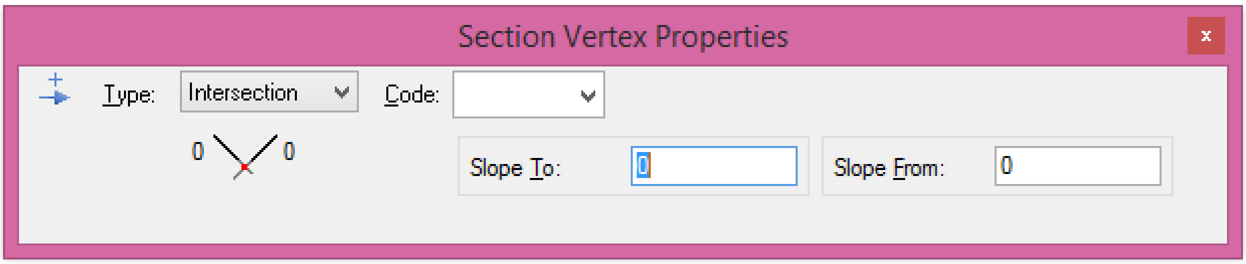
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

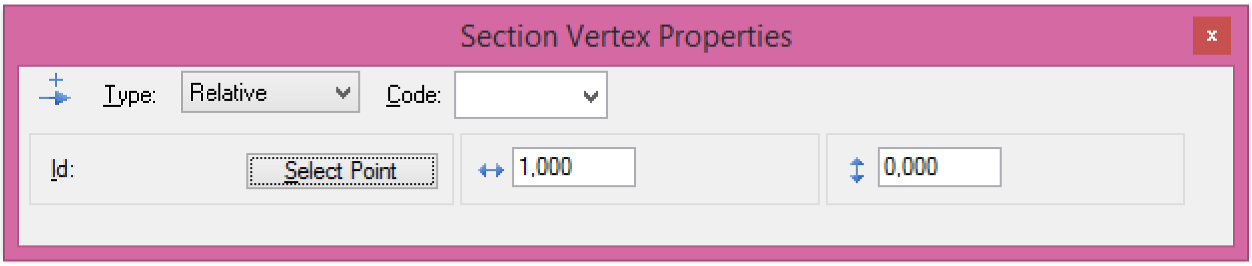
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

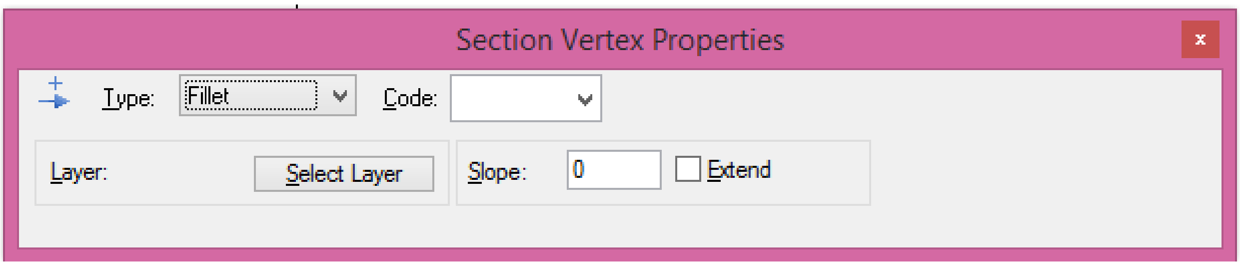
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

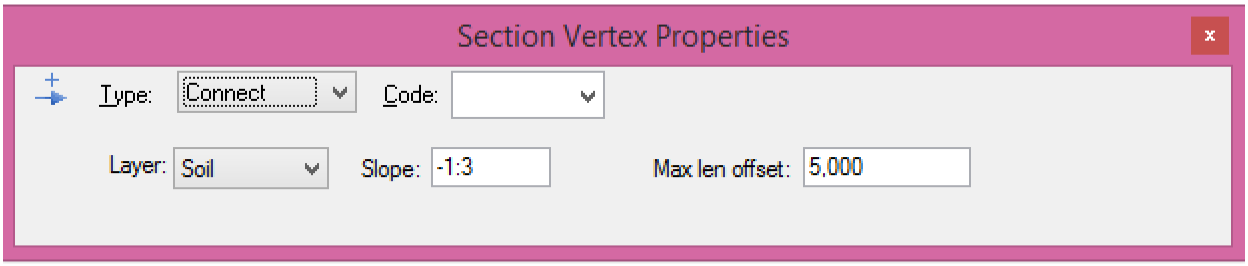
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

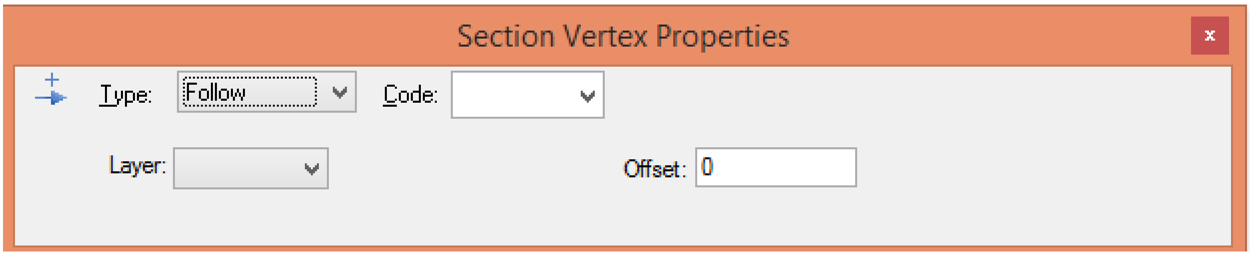


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

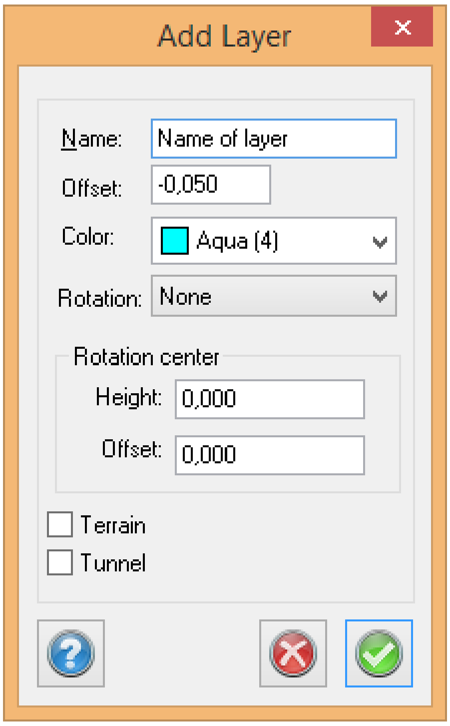


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

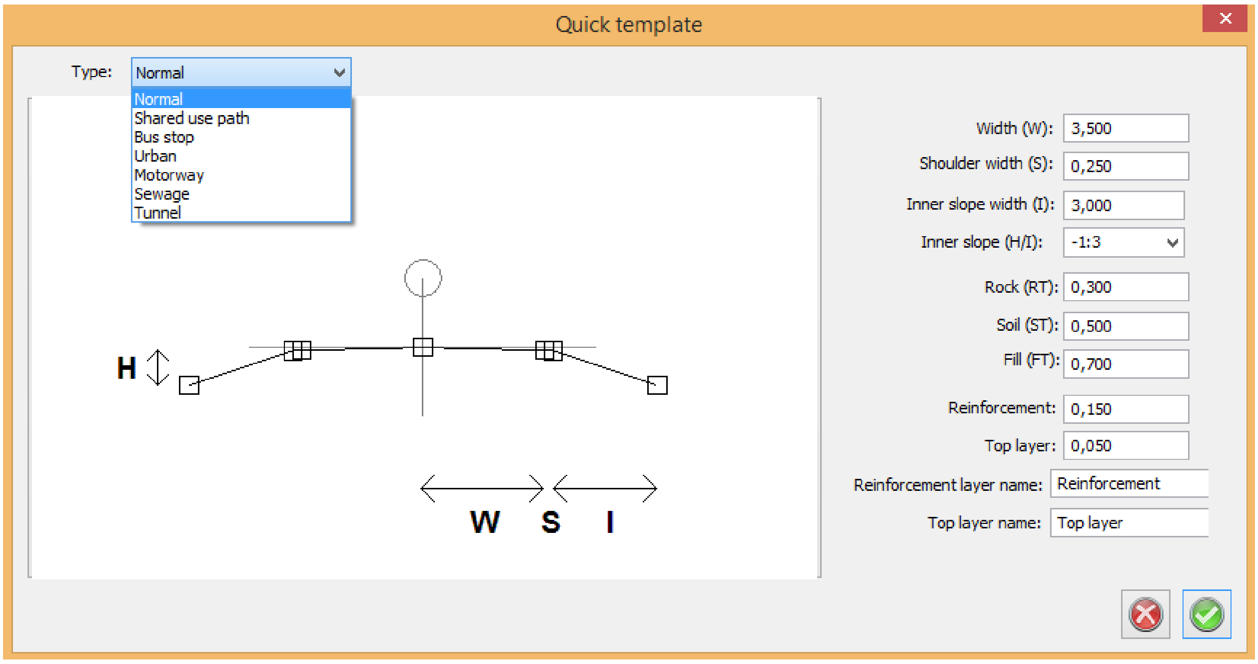
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

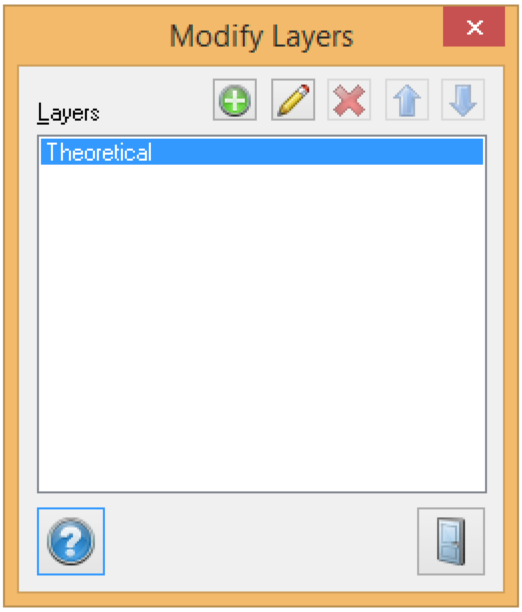
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

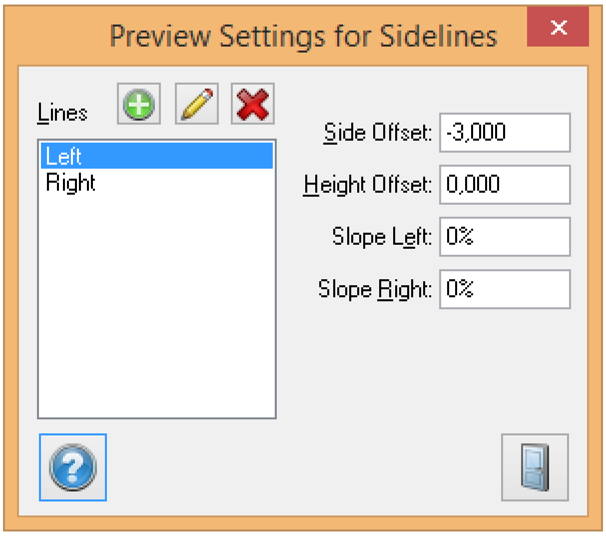


Modify layers in section template.

Edit side lines

Section template|Side lines

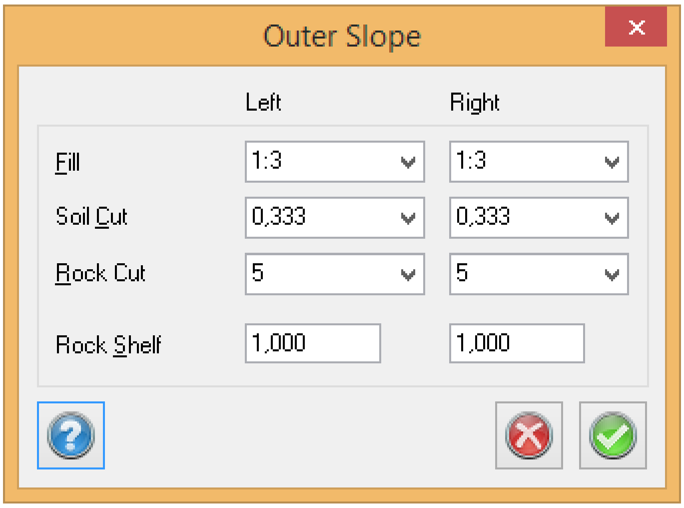
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

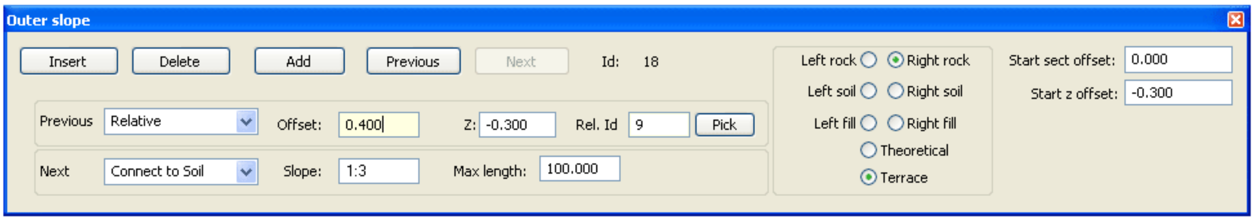
Section template|Quick outer slope

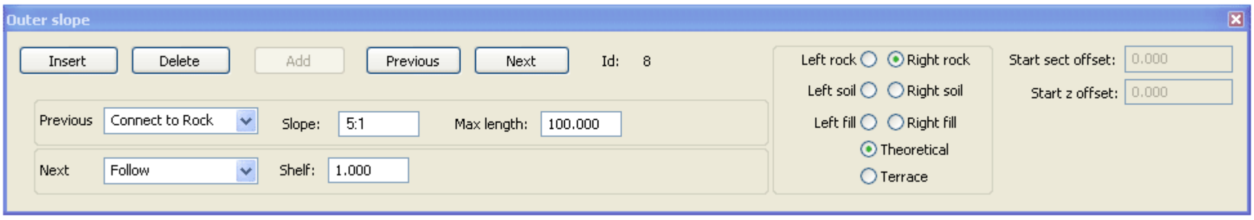
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

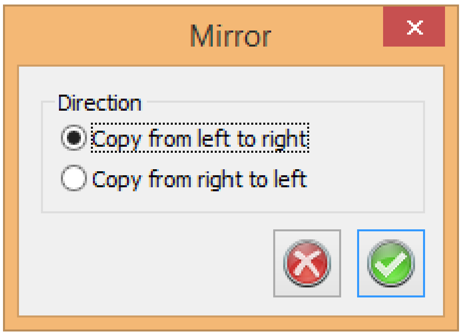
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

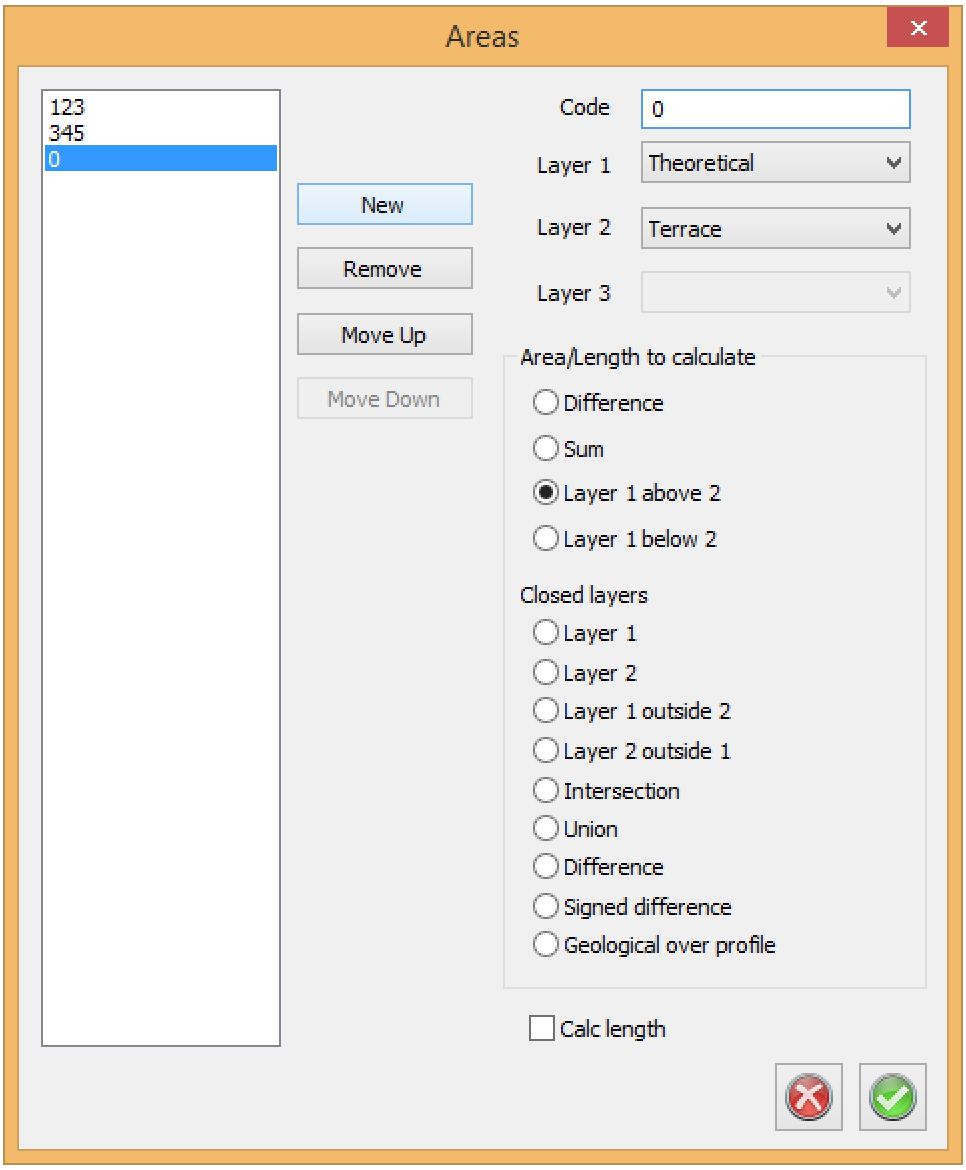
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

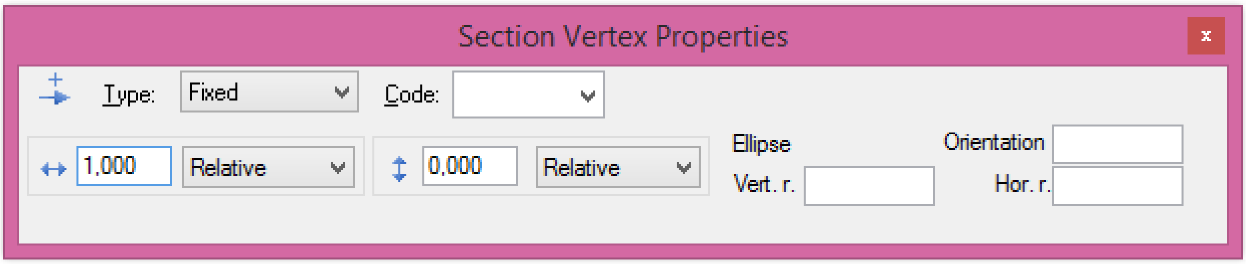
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

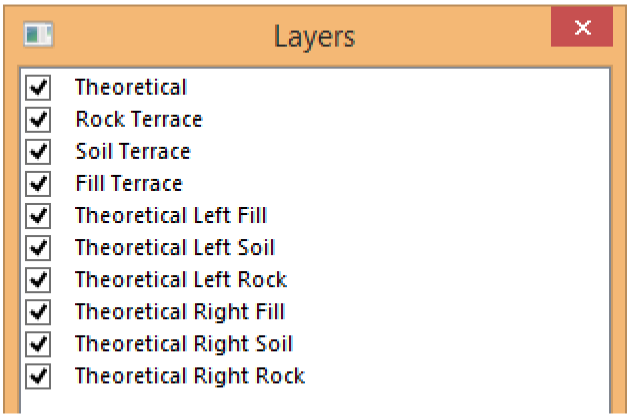
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

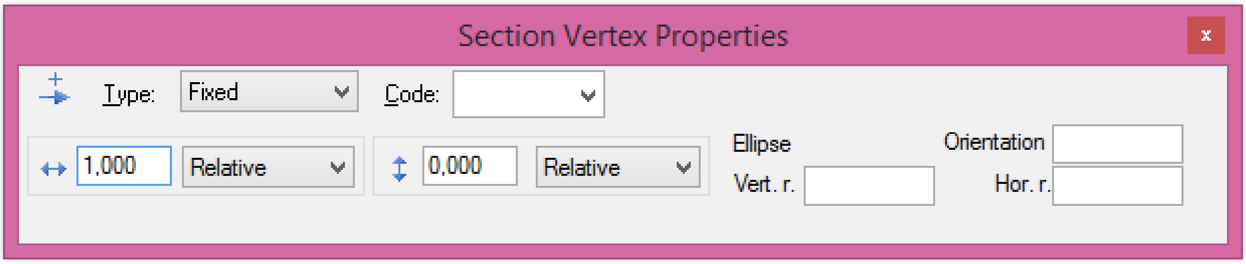
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

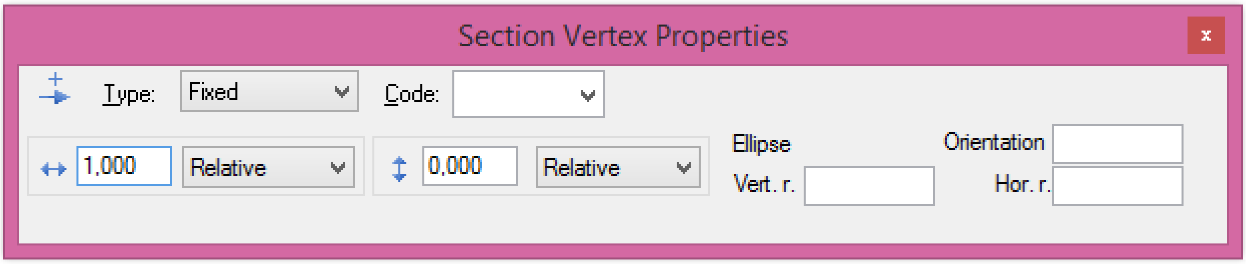
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

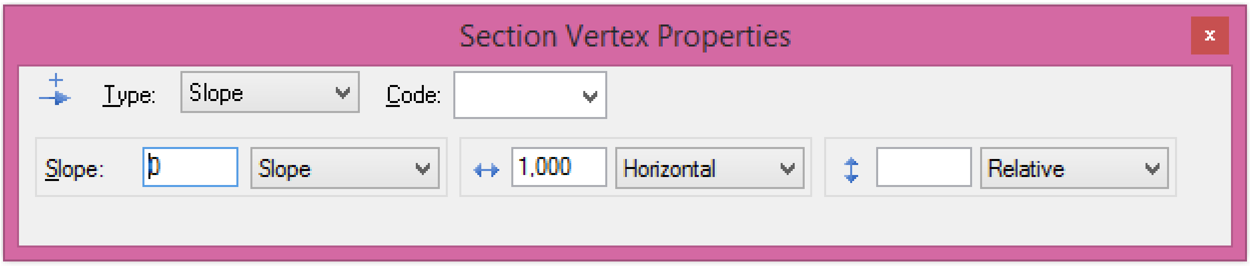
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

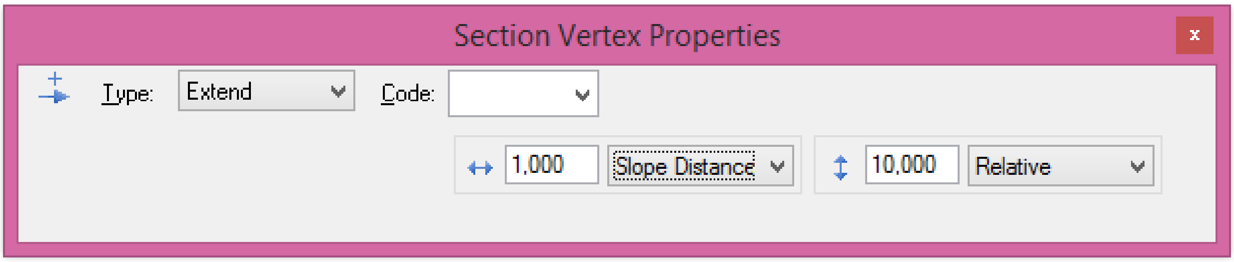
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

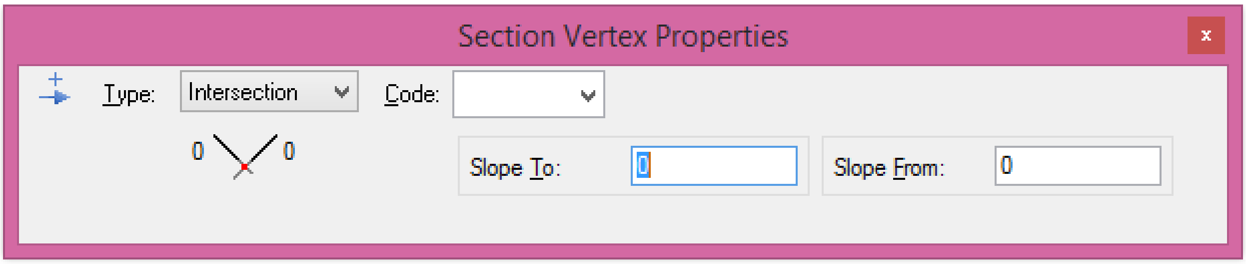
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

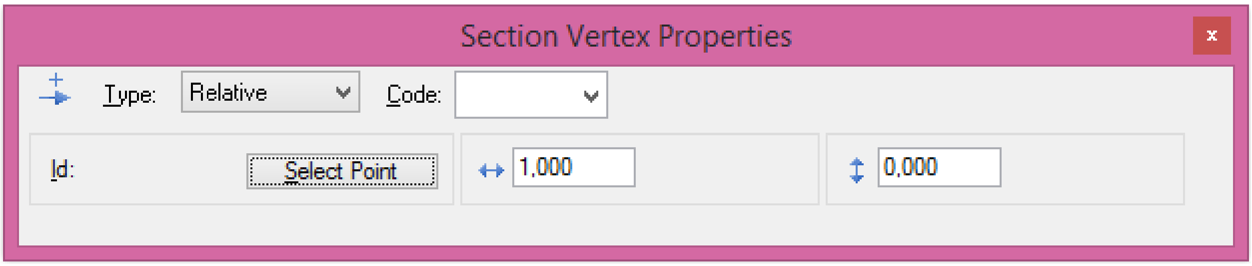
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

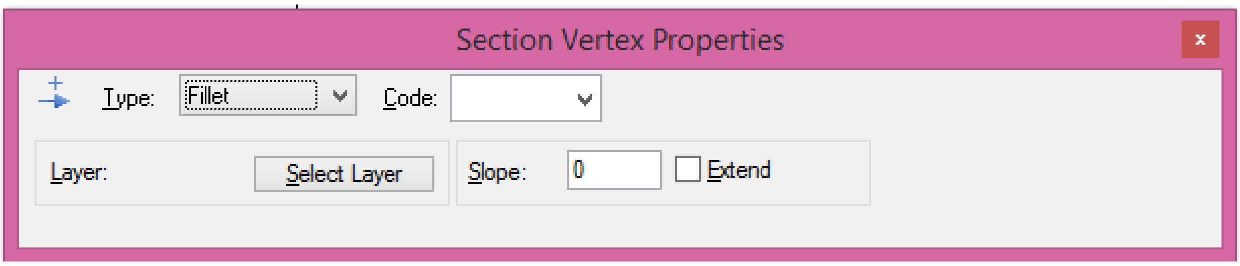
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

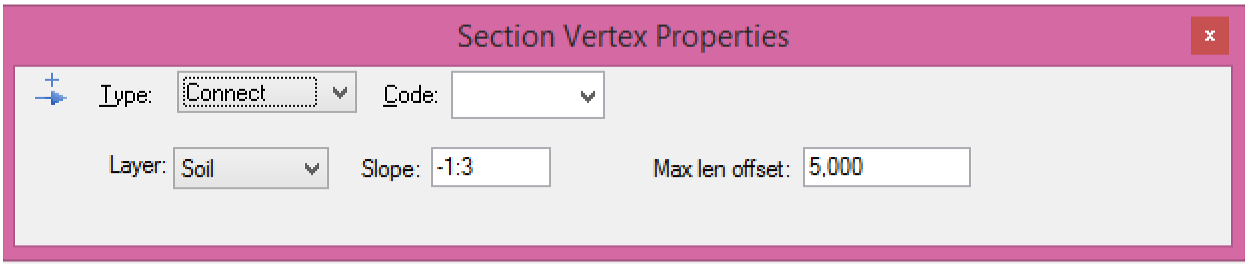
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

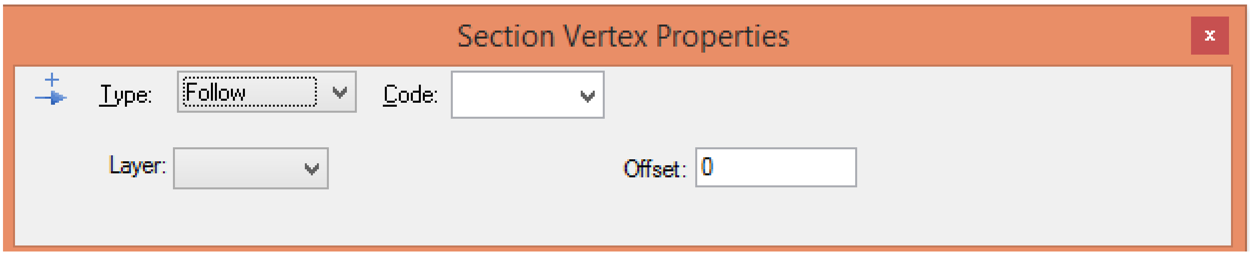


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

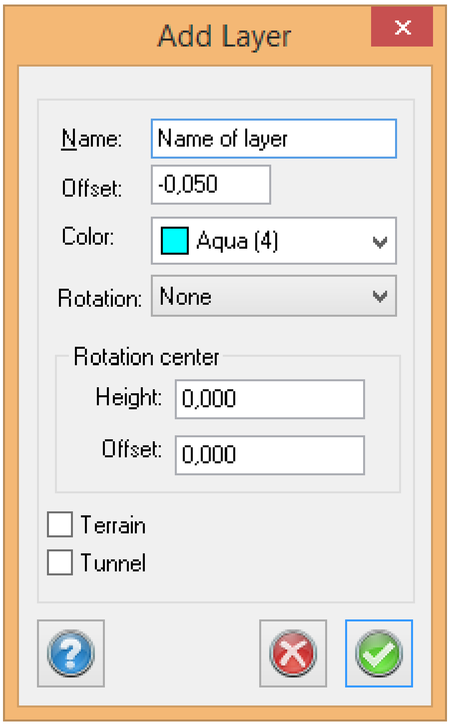


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

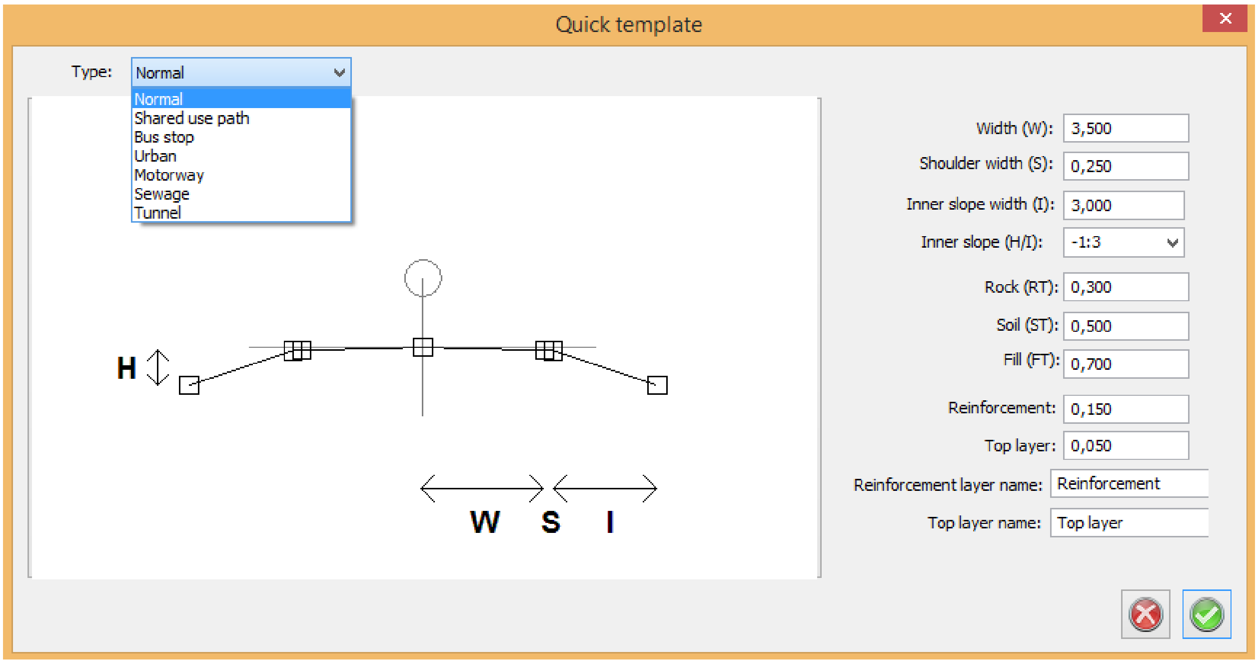
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

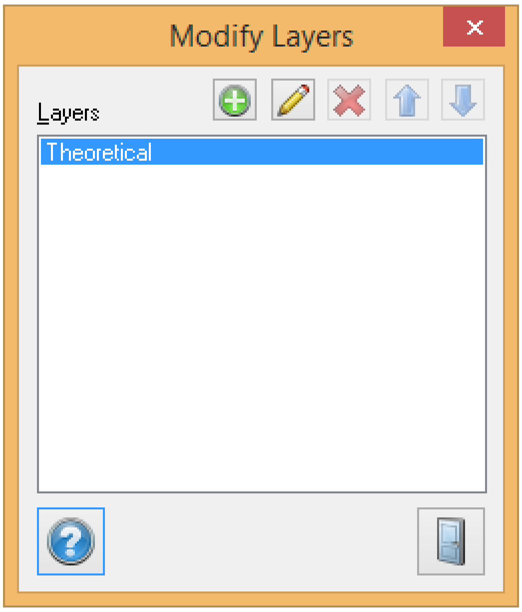
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

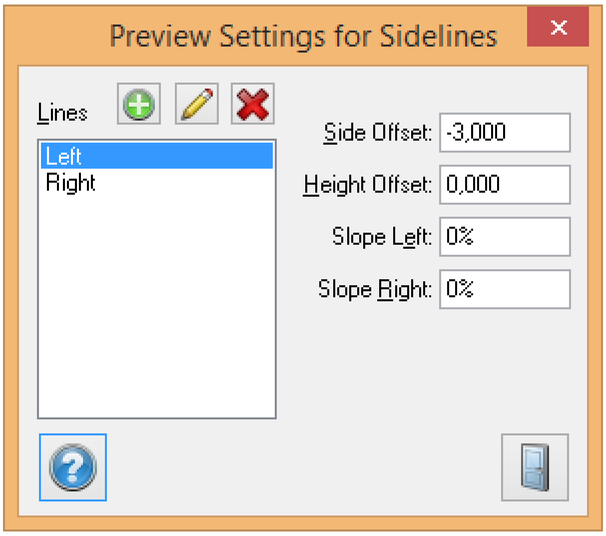


Modify layers in section template.

Edit side lines

Section template|Side lines

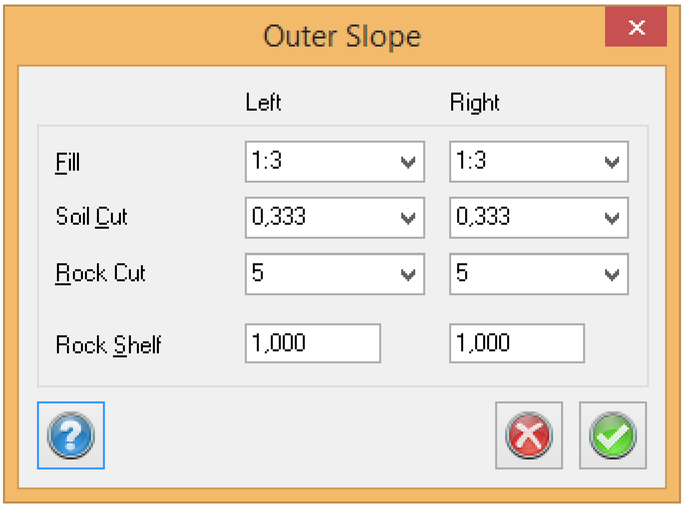
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

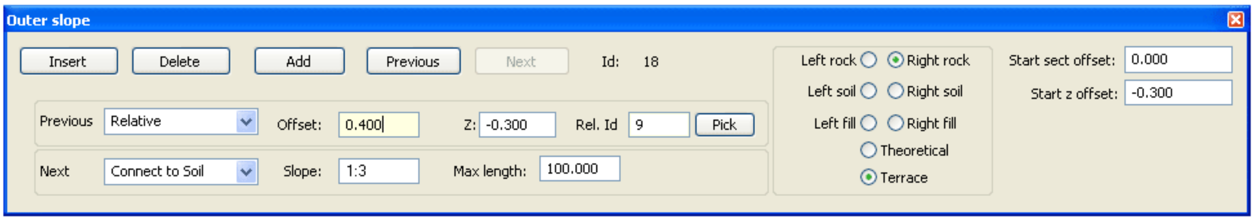
Section template|Quick outer slope

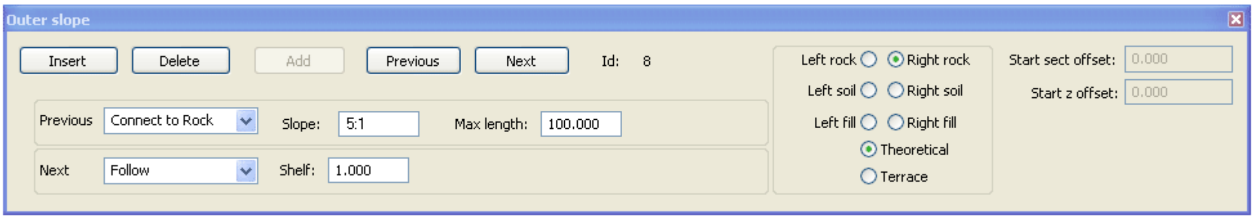
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

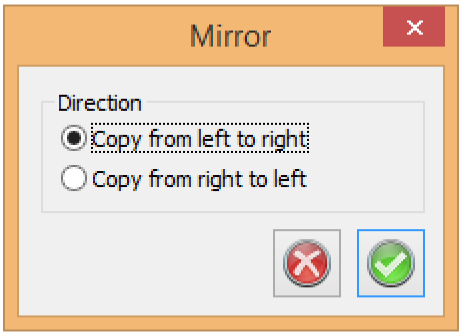
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

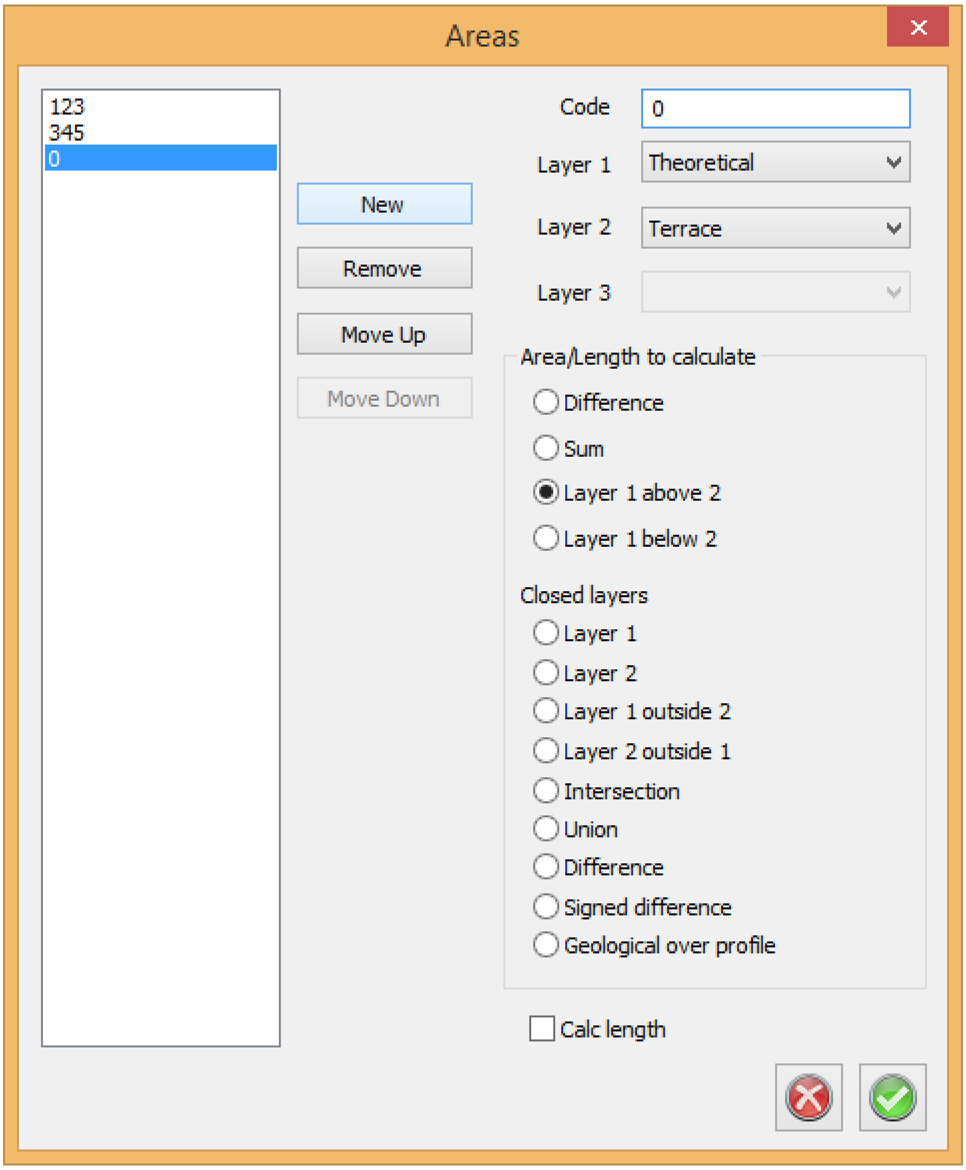
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

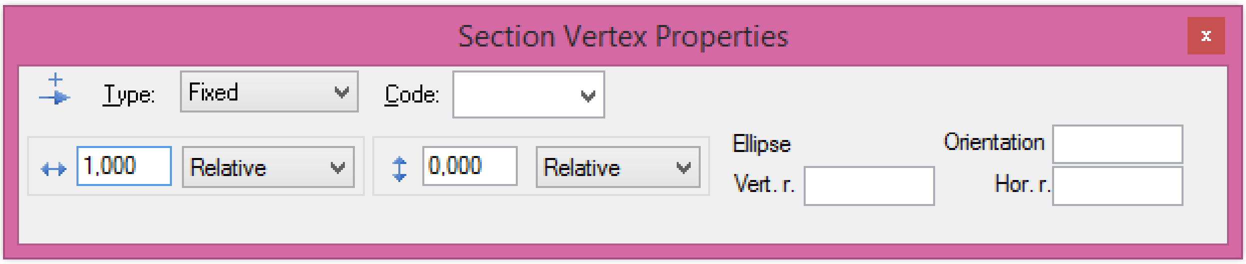
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

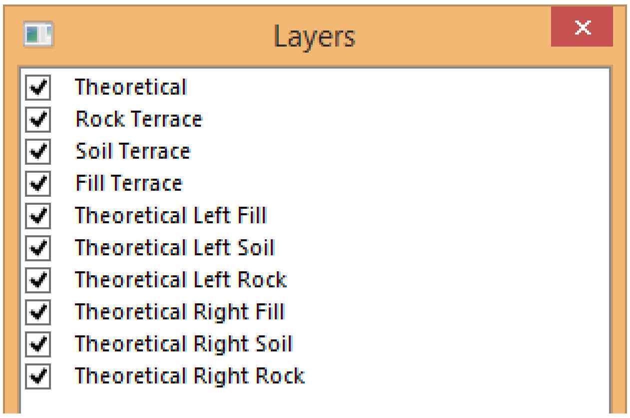
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

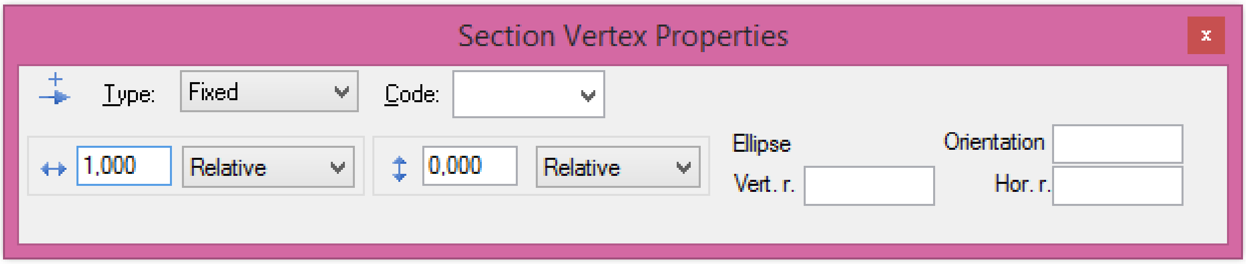
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

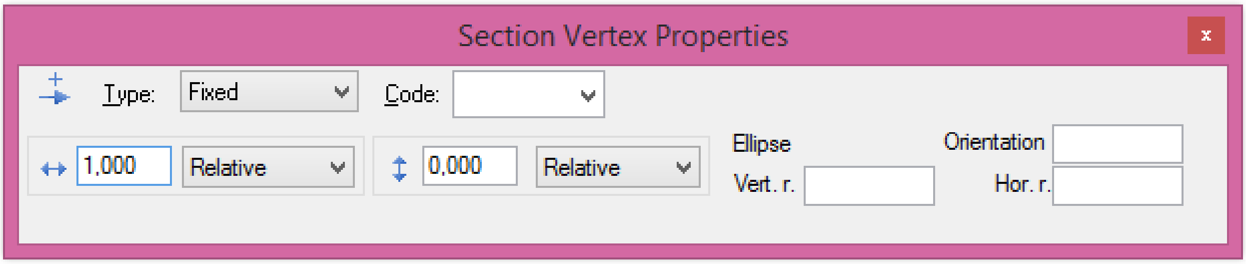
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

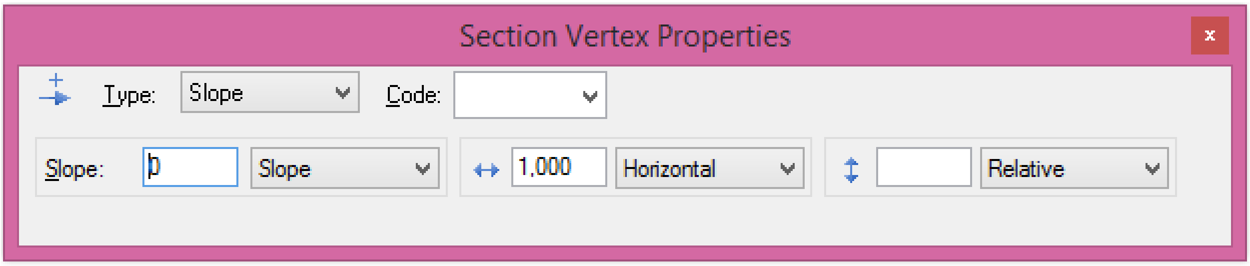
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

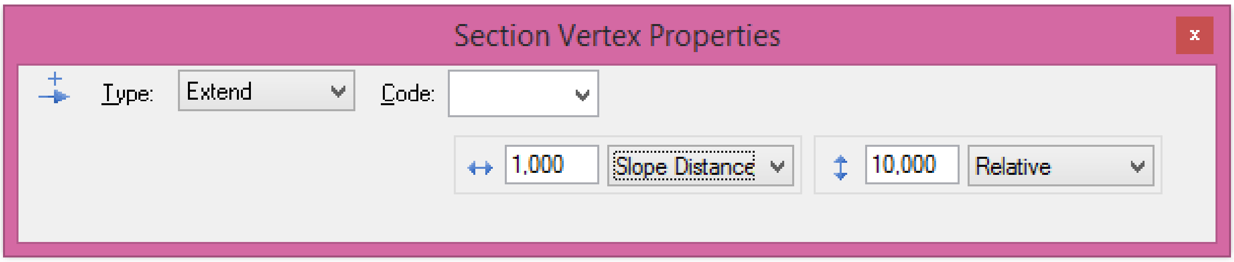
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

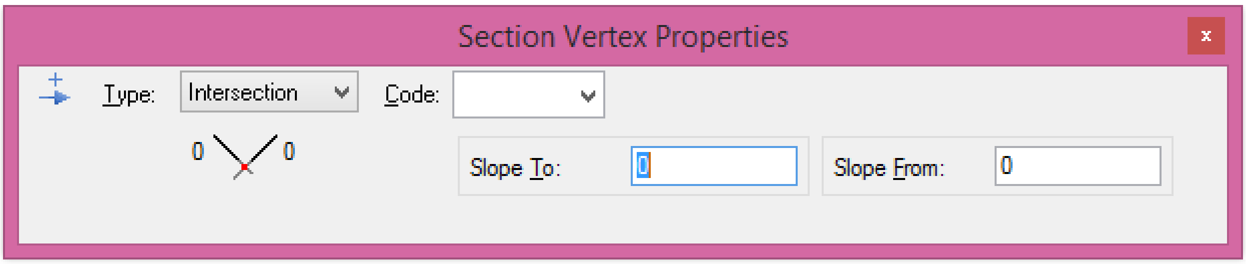
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

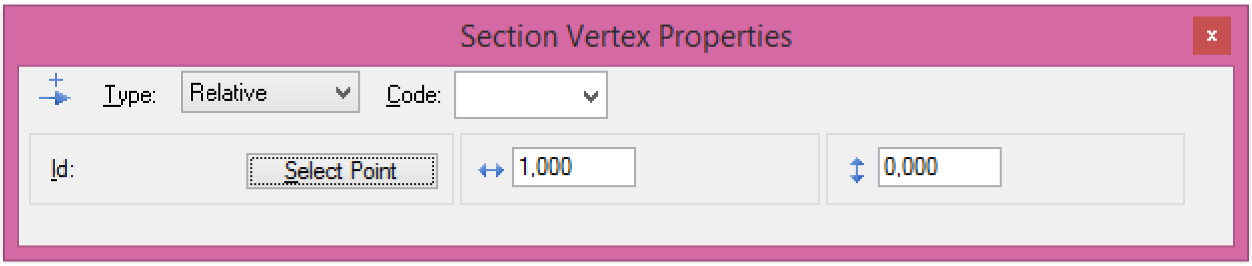
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

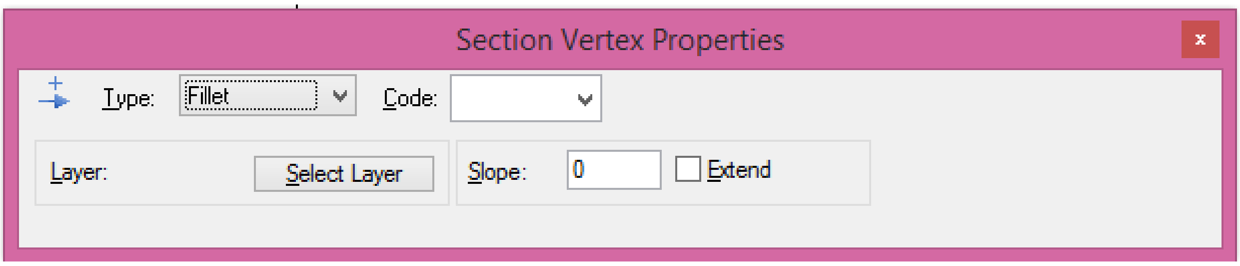
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

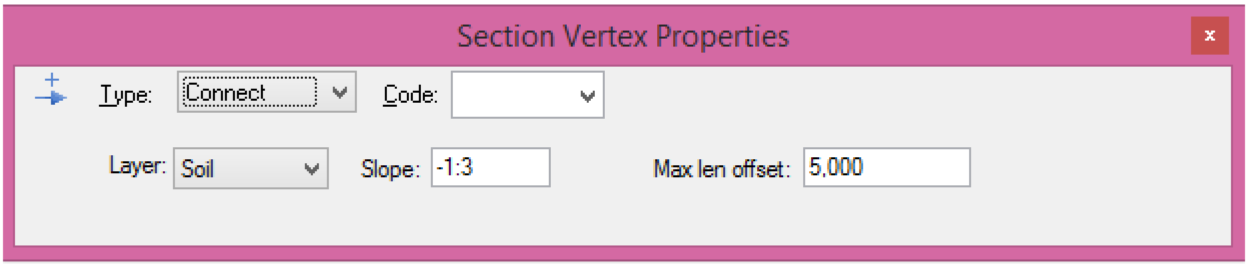
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

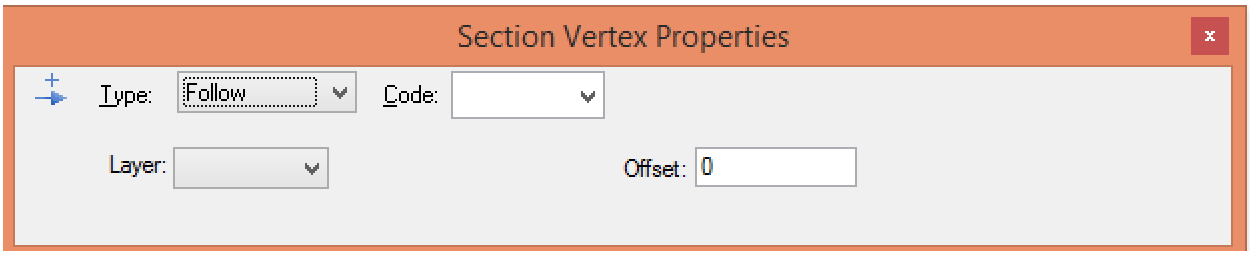


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

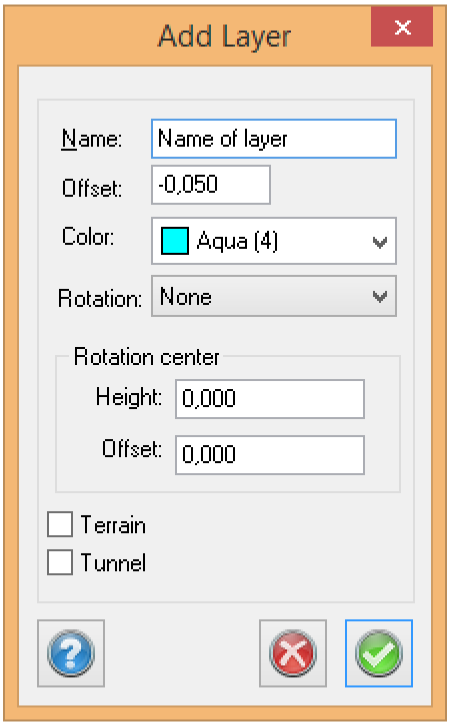


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

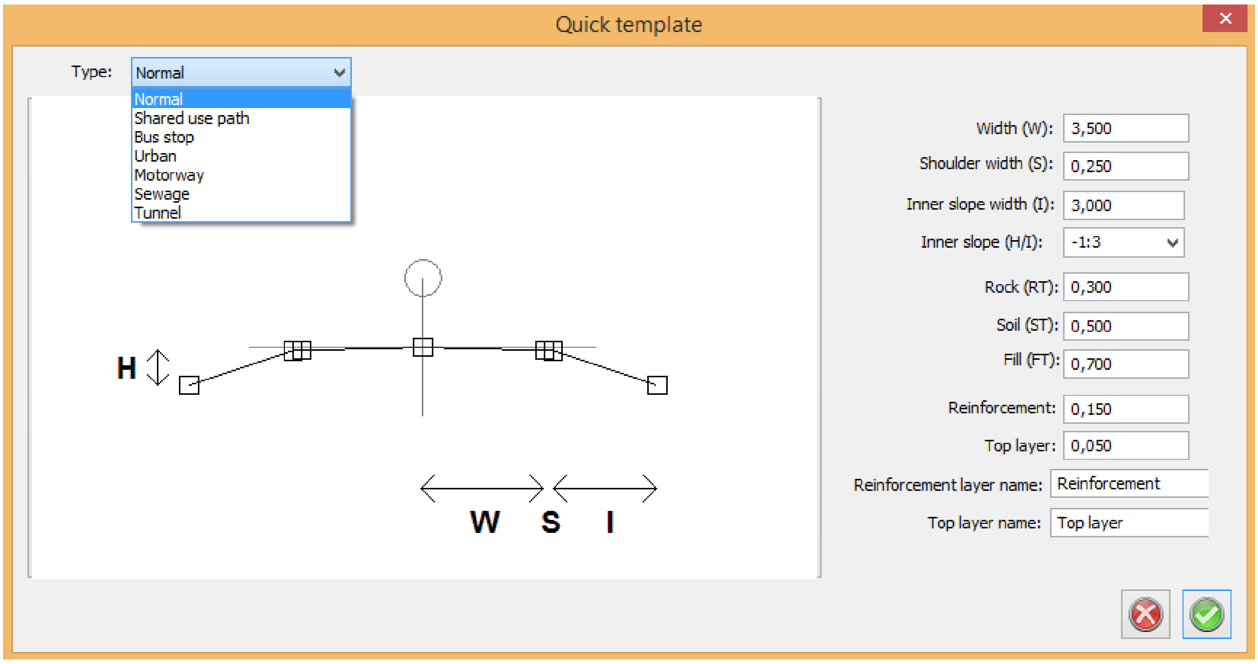
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

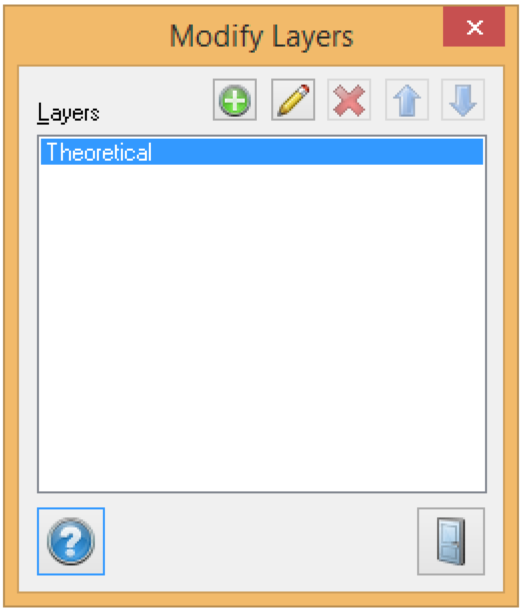
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

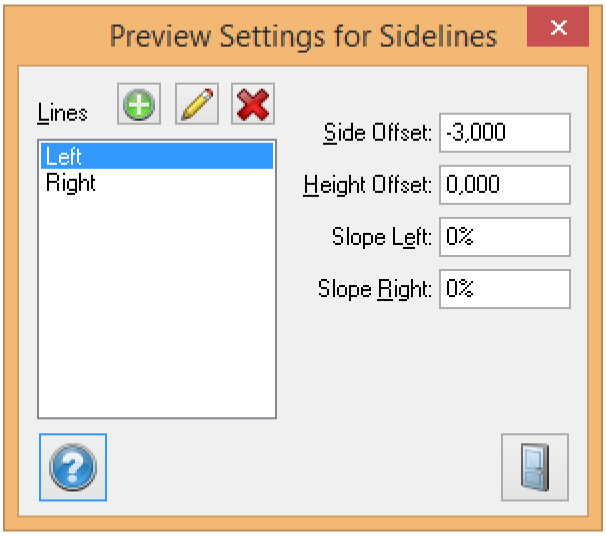


Modify layers in section template.

Edit side lines

Section template|Side lines

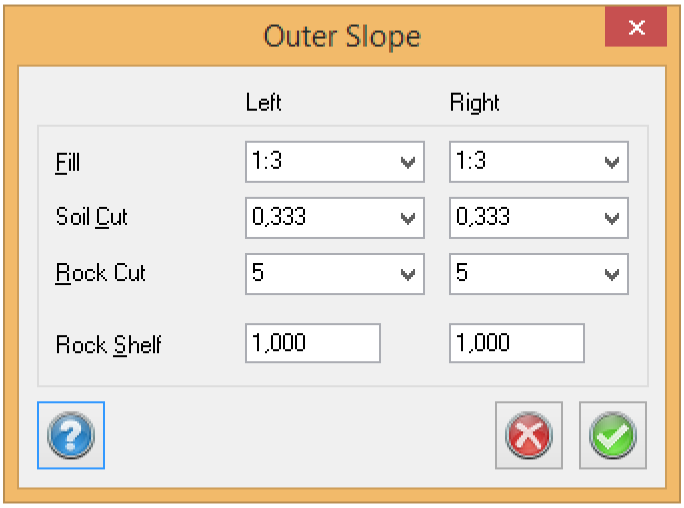
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

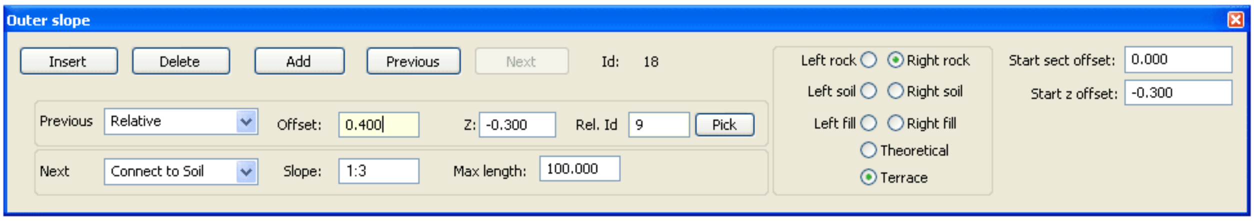
Section template|Quick outer slope

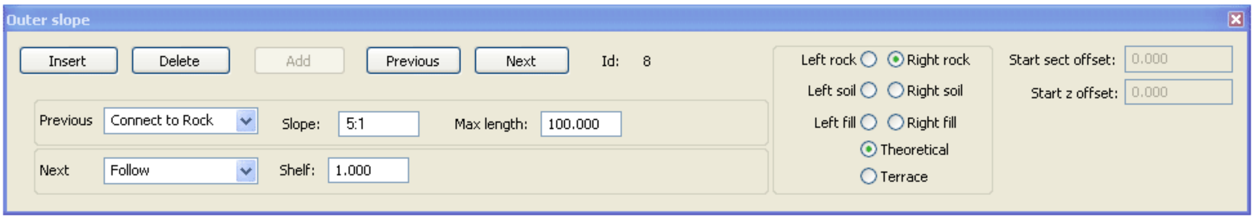
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

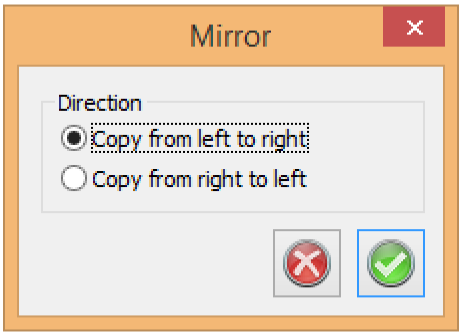
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

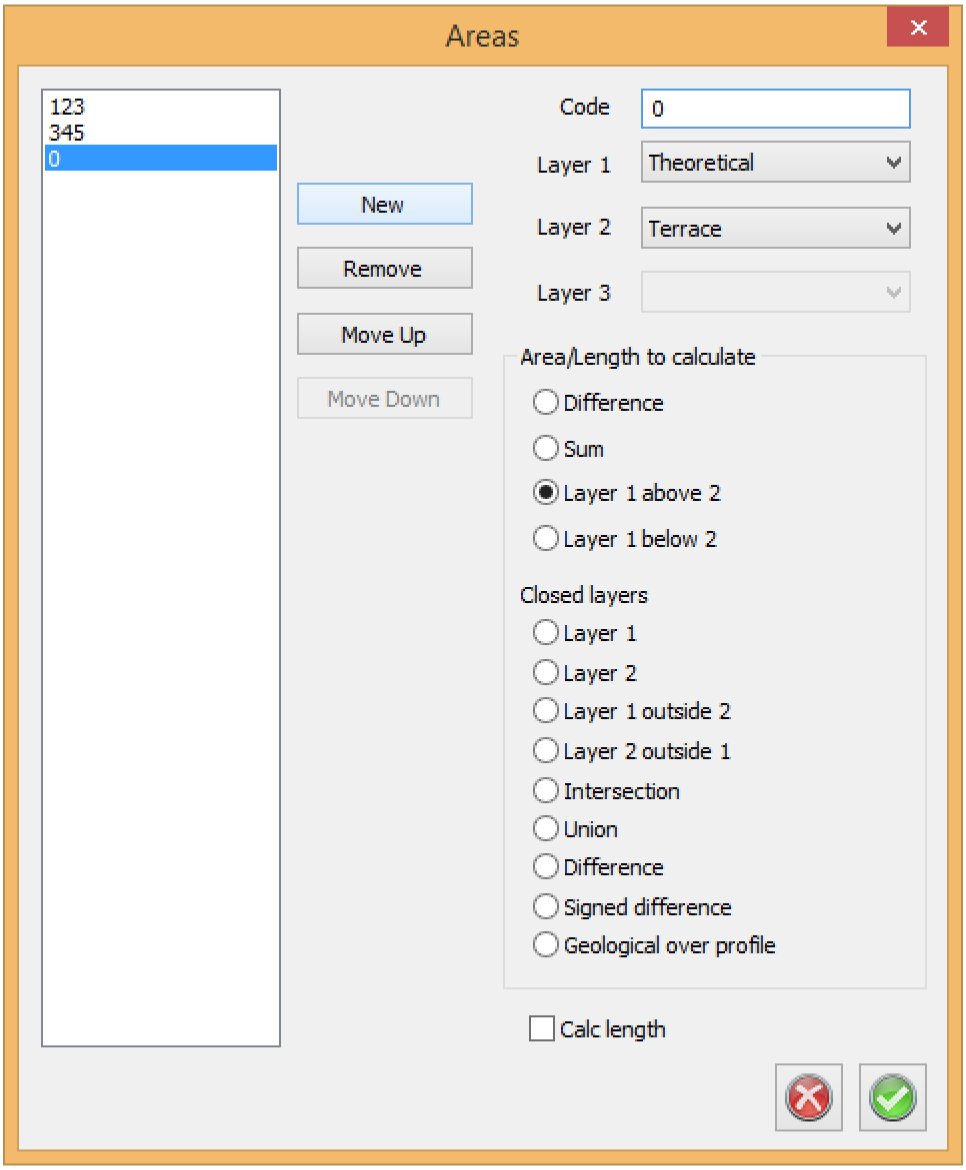
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

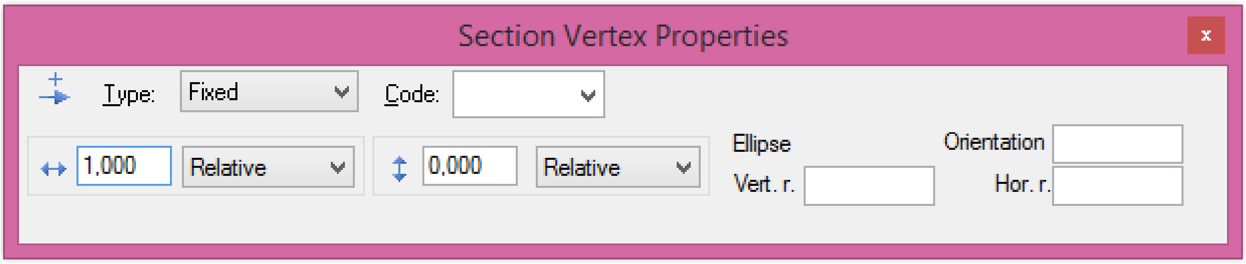
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

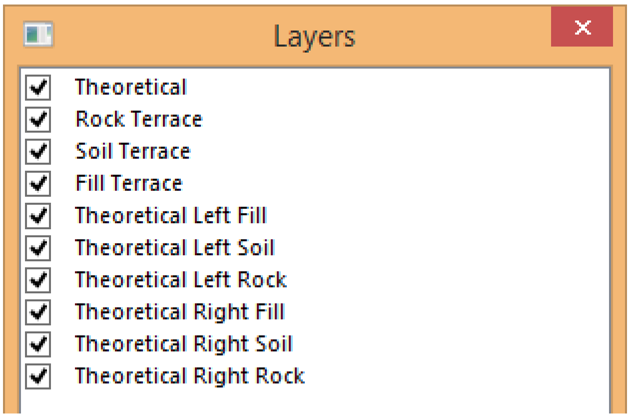
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

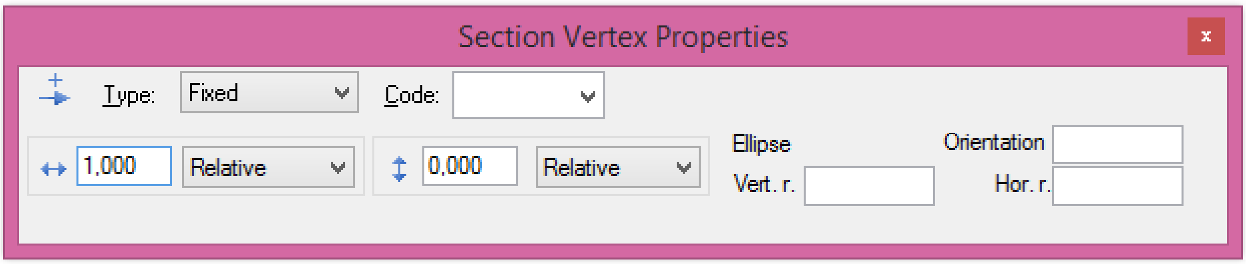
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

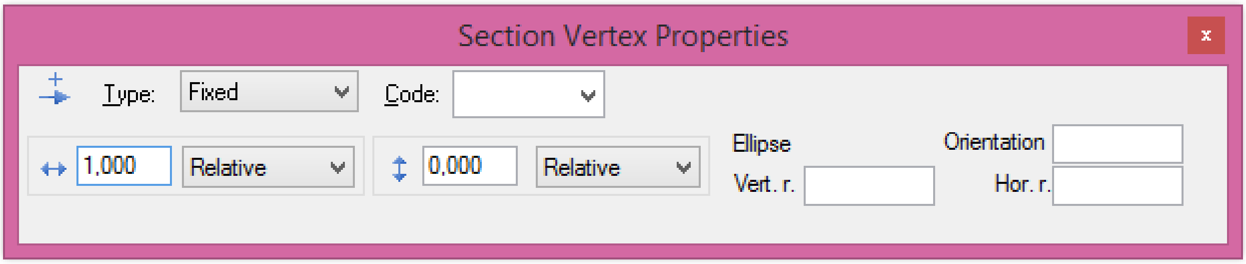
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

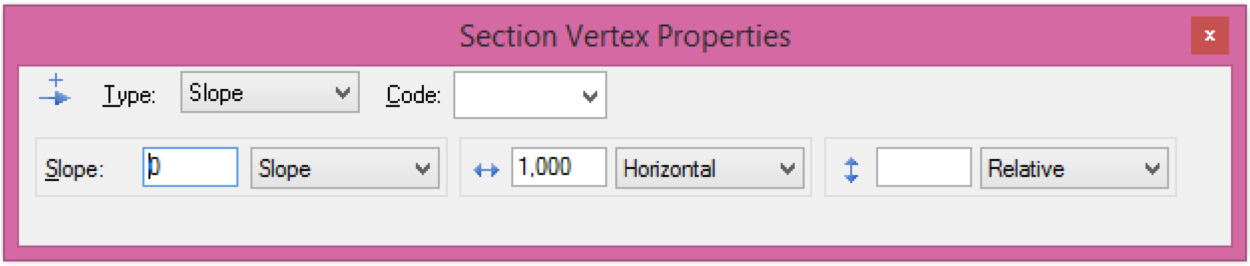
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

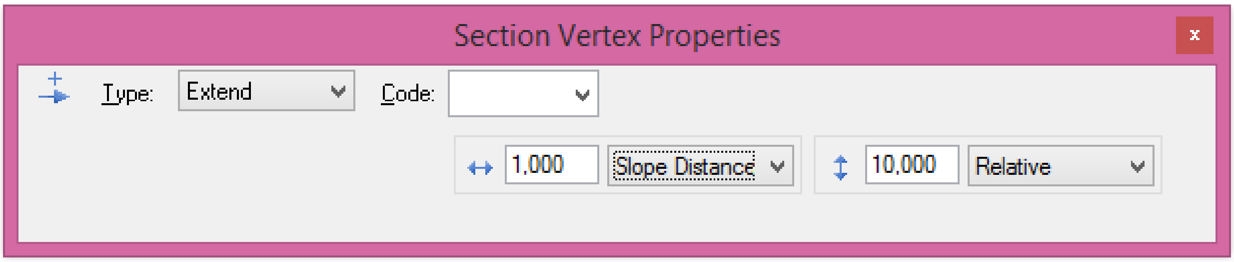
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

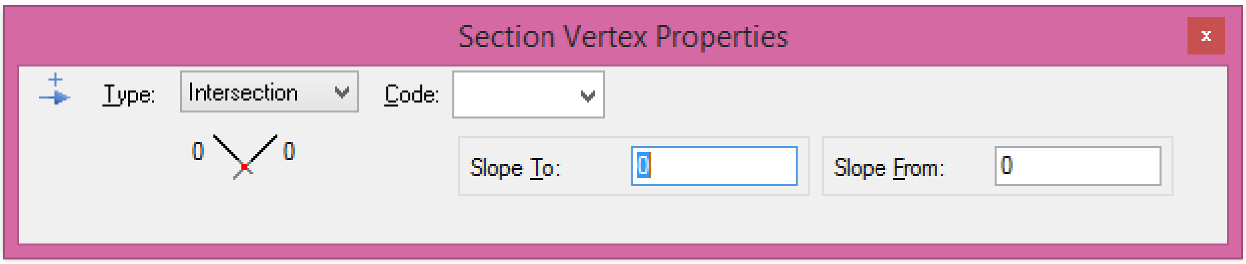
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

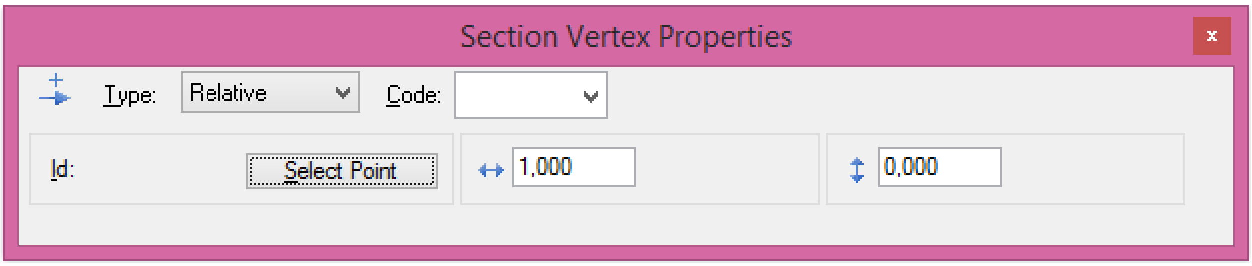
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

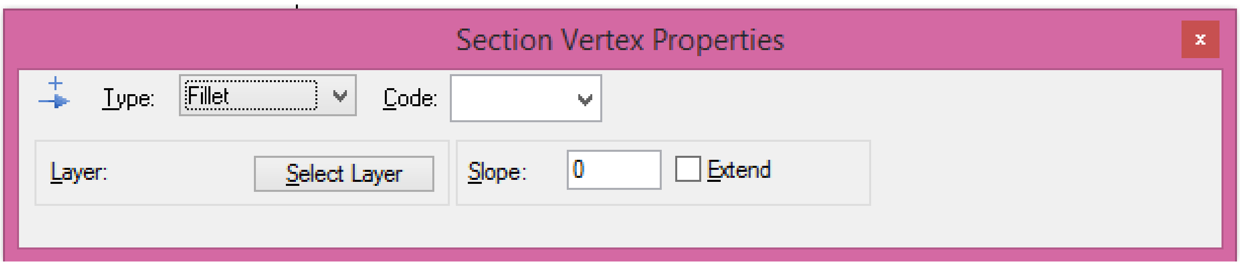
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

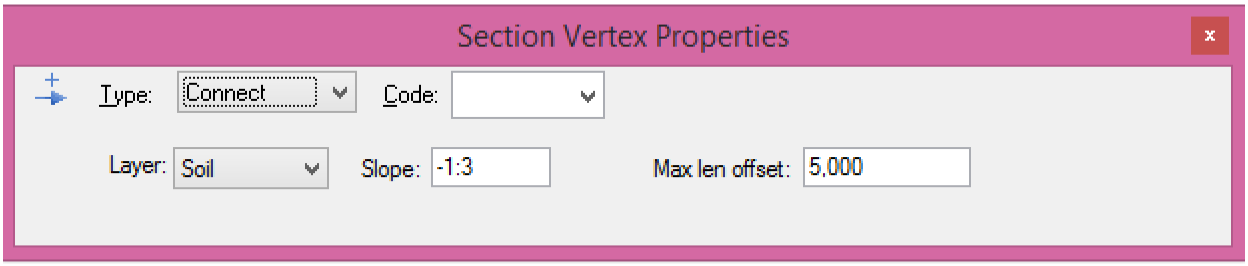
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

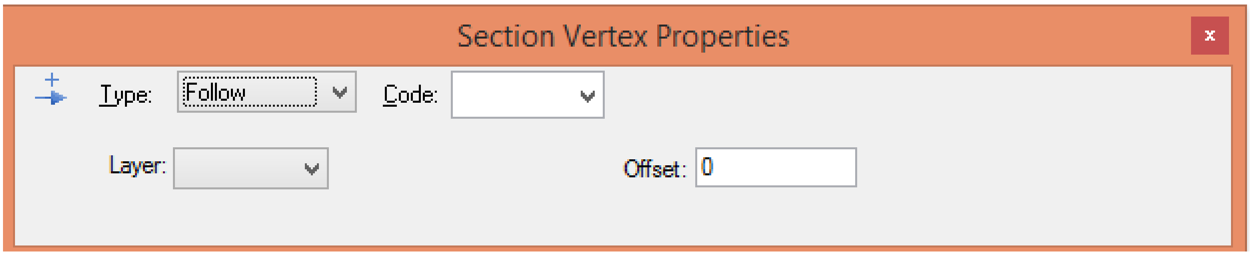


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

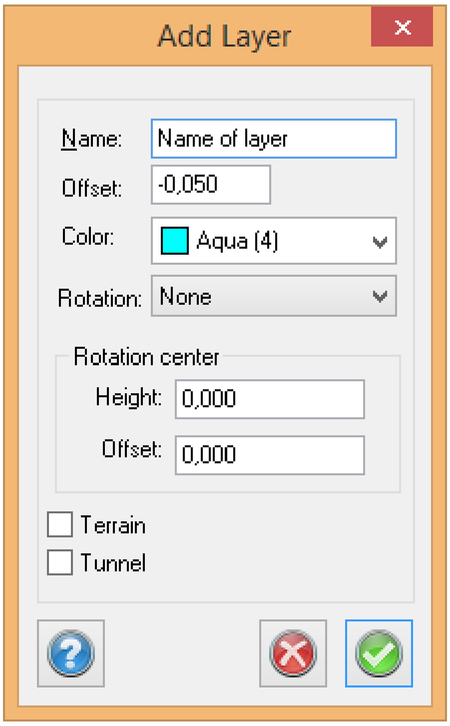


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

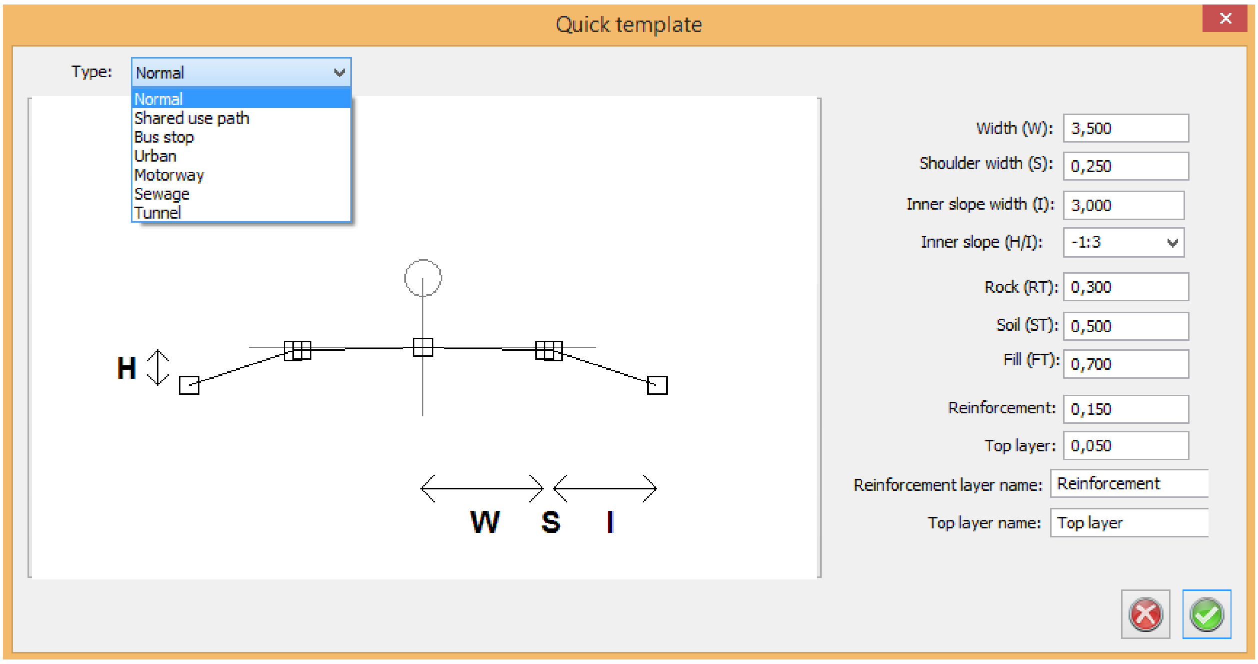
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

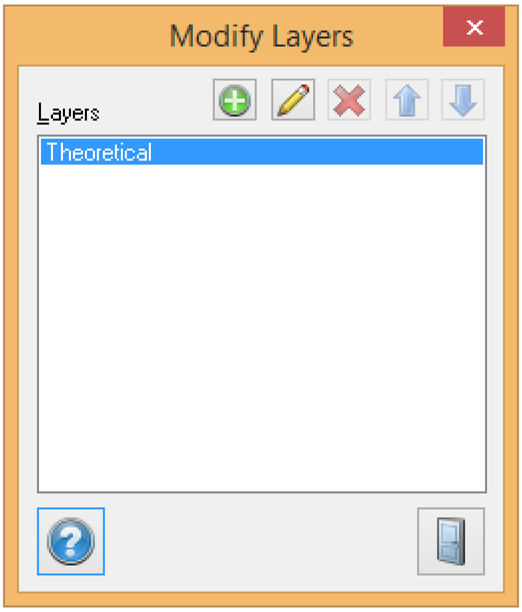
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

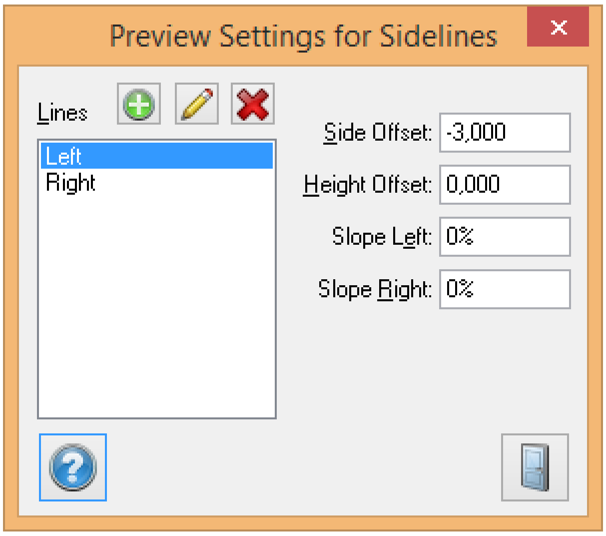


Modify layers in section template.

Edit side lines

Section template|Side lines

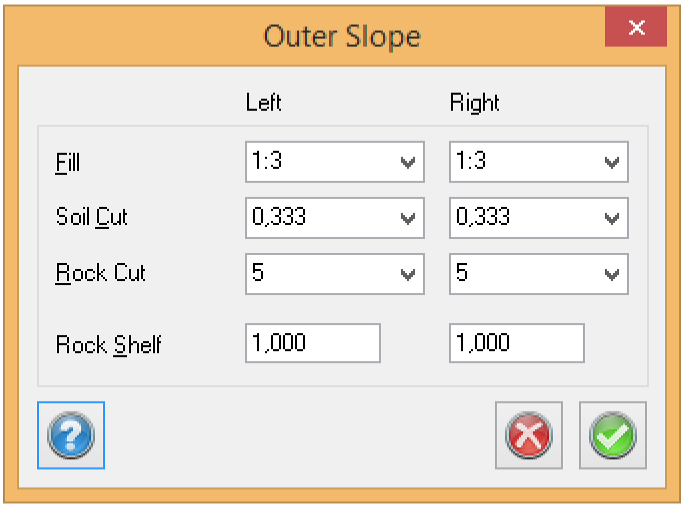
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

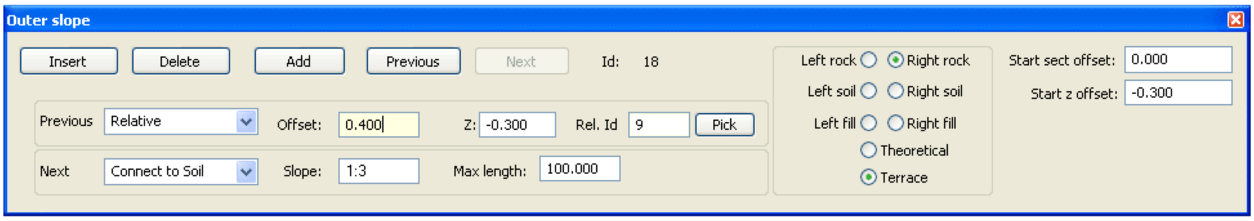
Section template|Quick outer slope

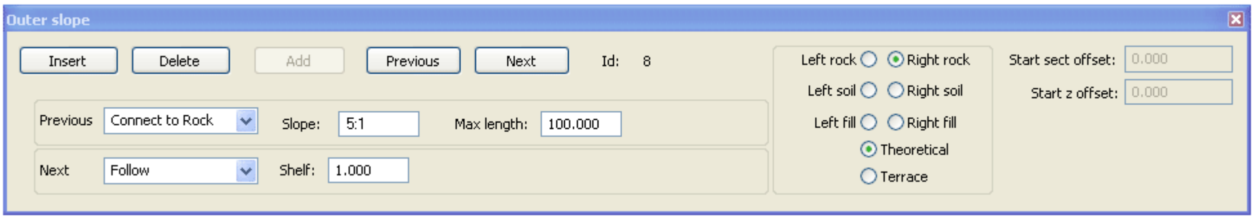
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope

To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert

Adds a new point inside selected point.

Add

Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete

Deletes selected point.

Previous and Next

To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

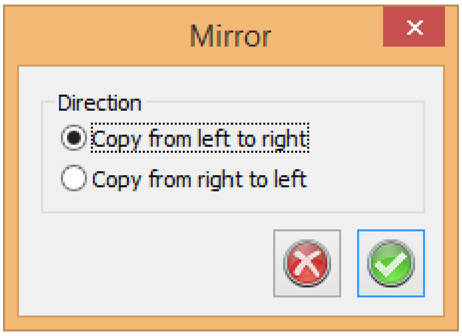
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

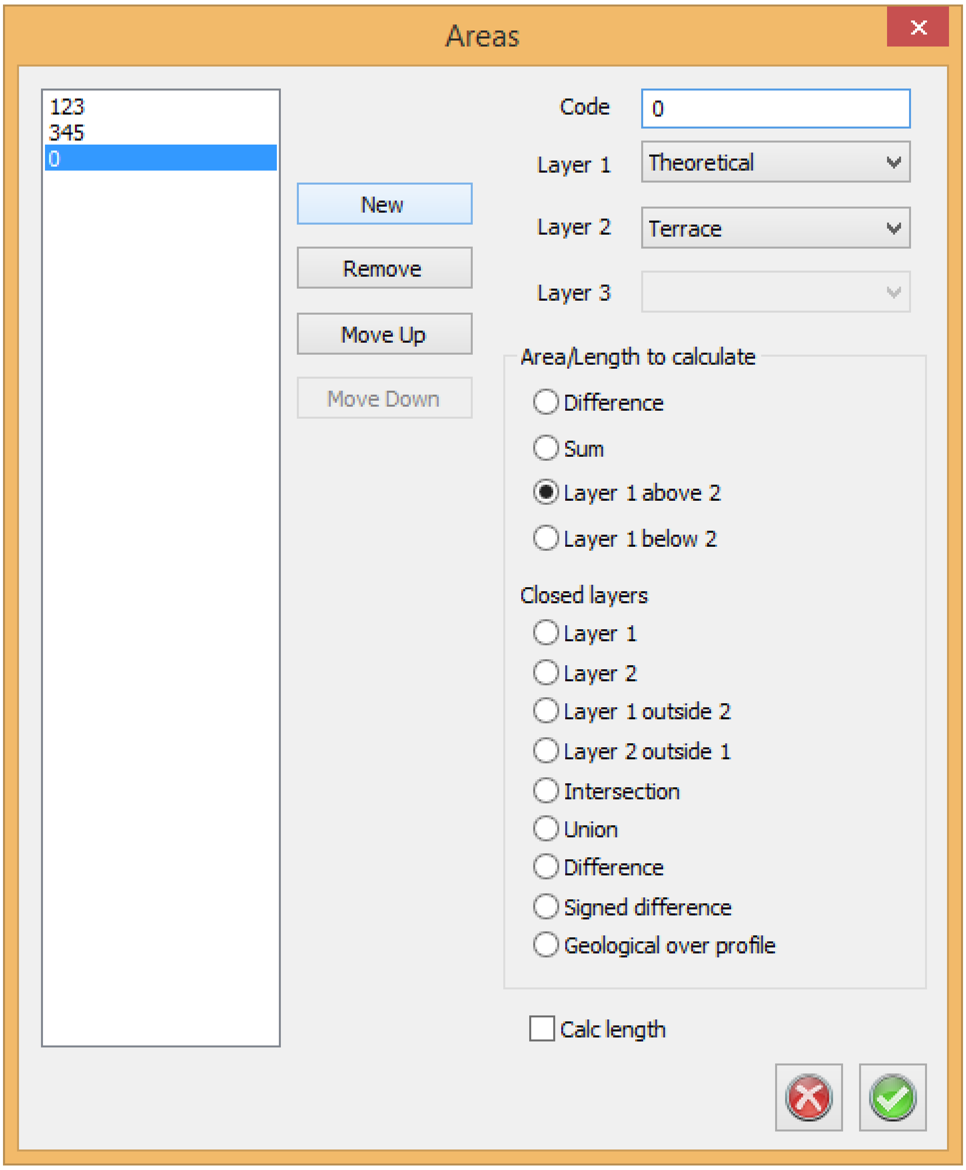
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

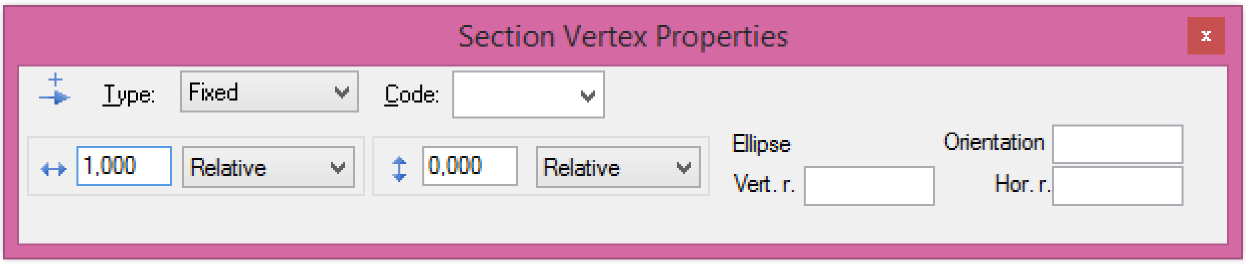
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

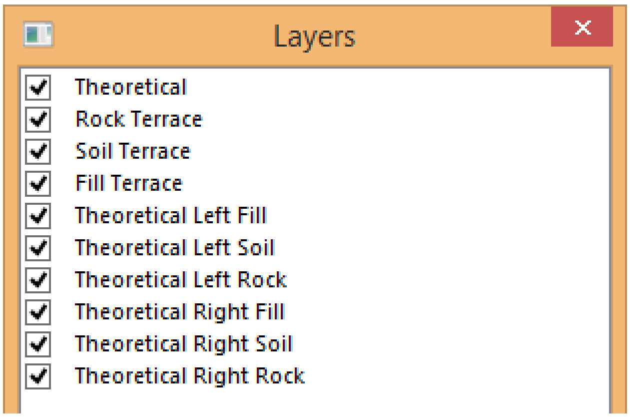
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

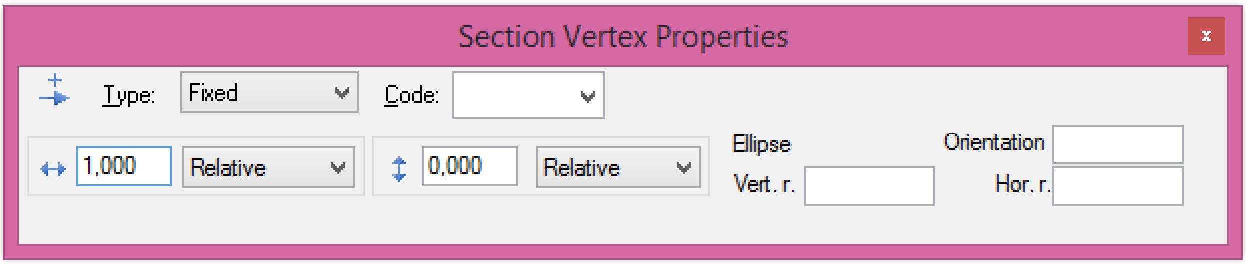
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

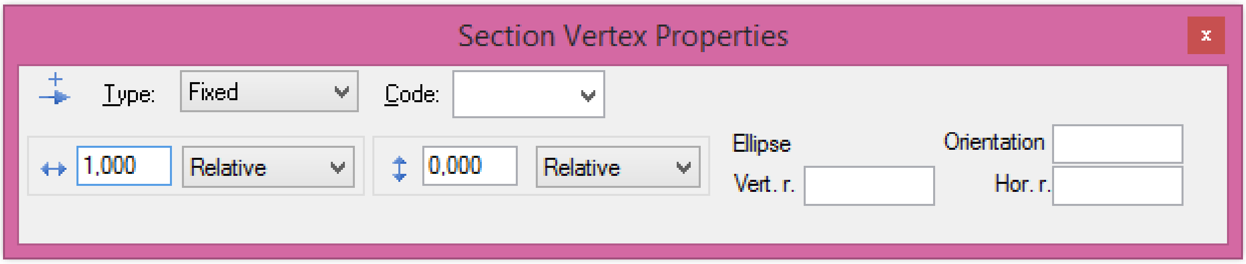
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

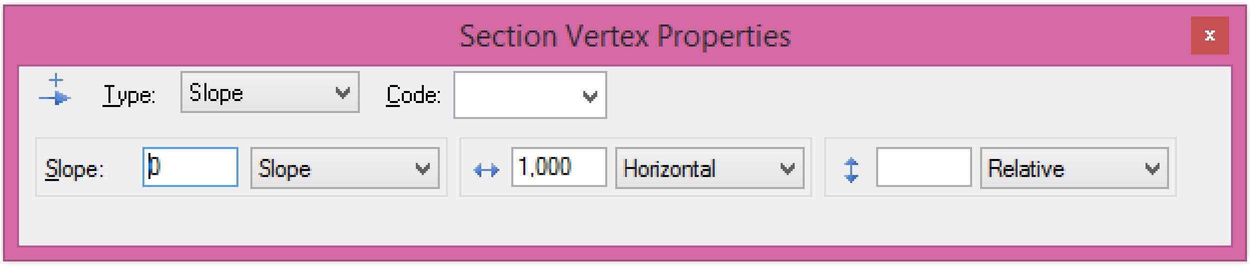
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

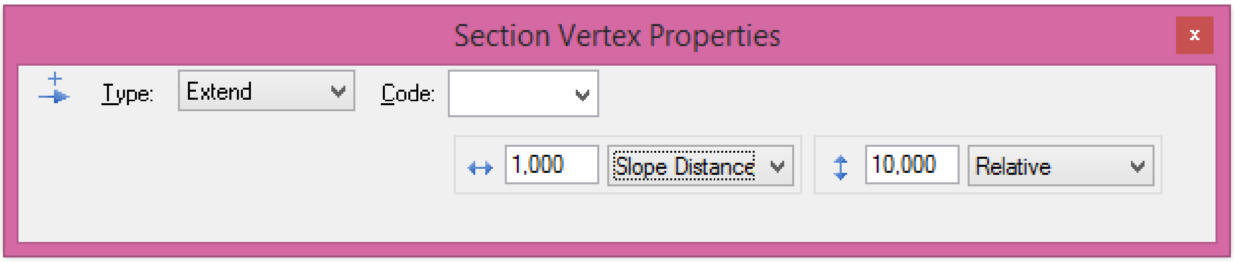
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

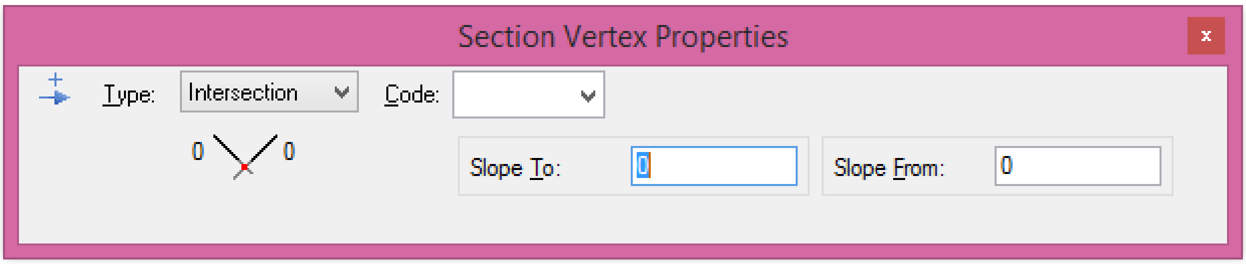
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

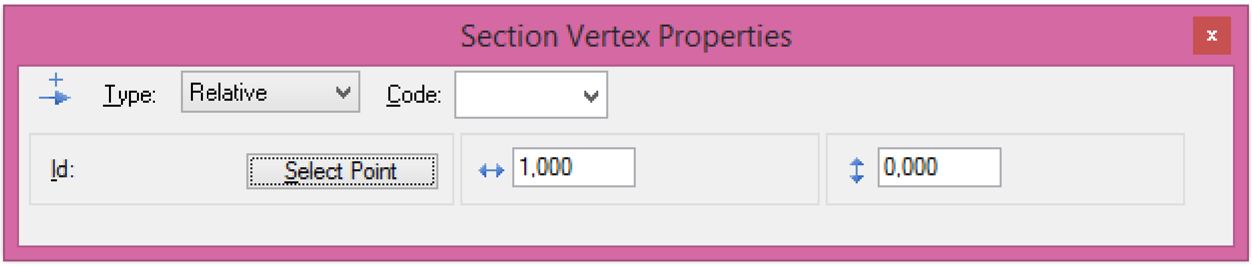
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

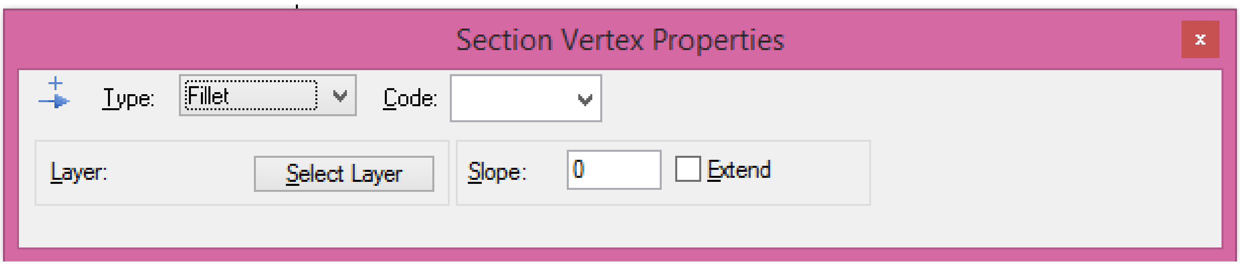
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

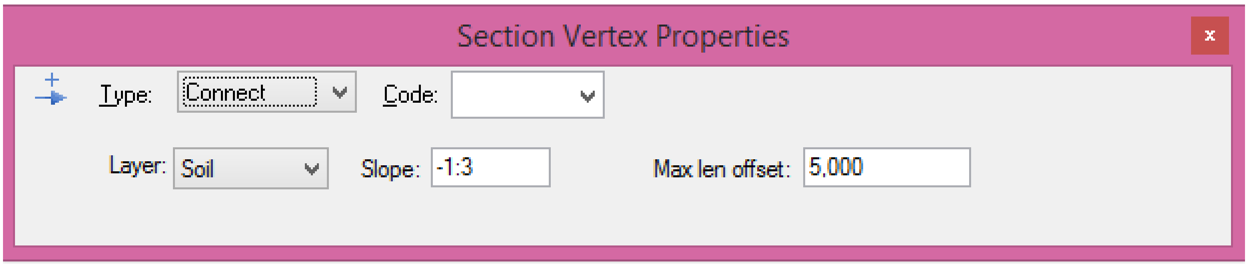
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

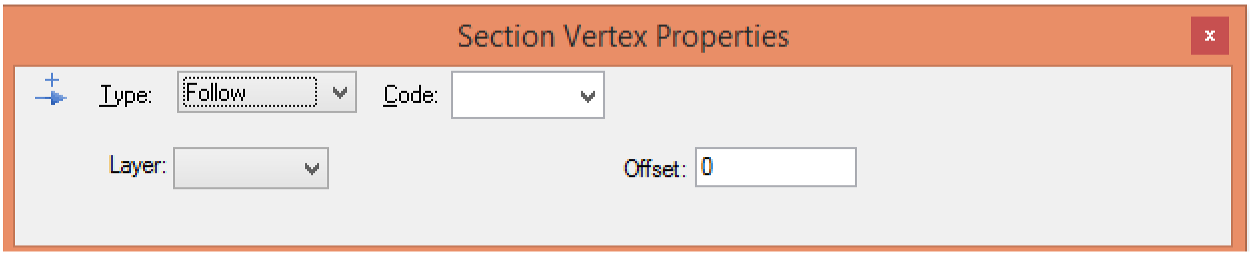


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

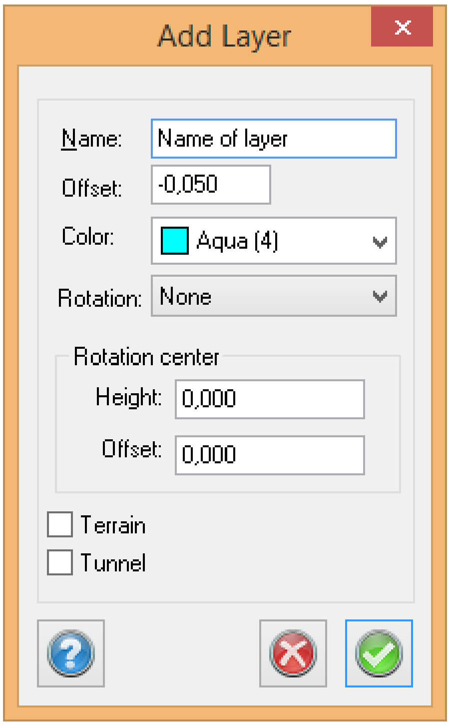


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

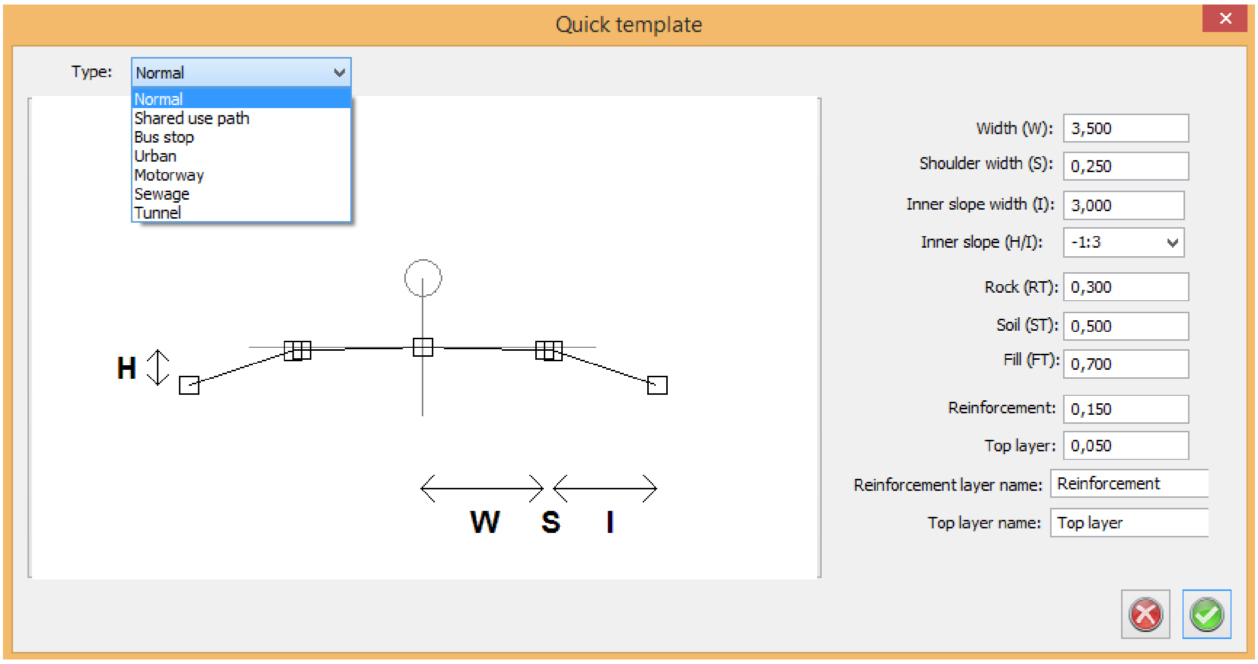
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

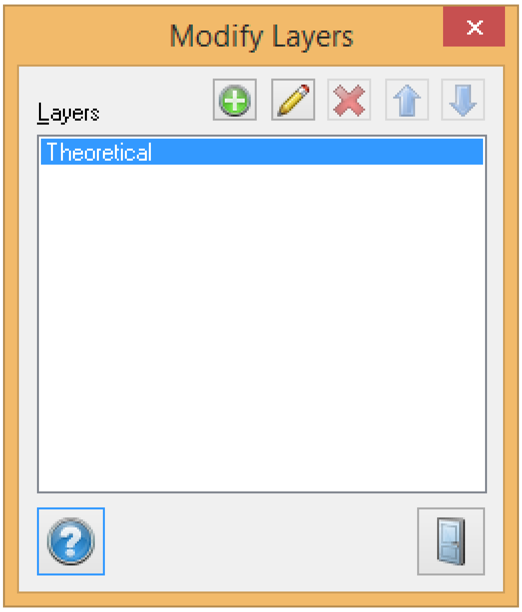
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

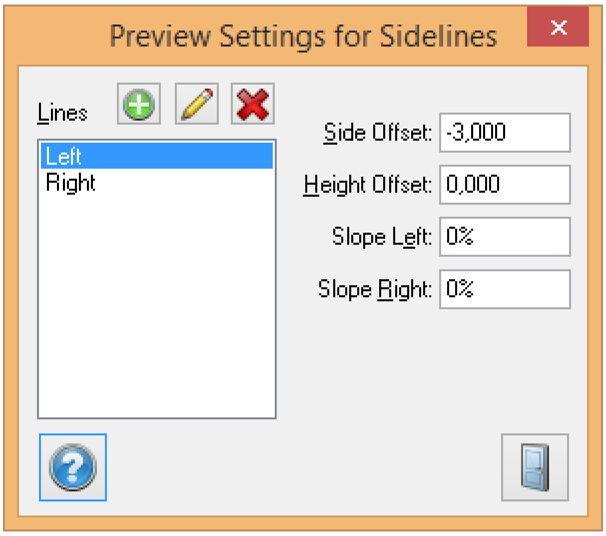


Modify layers in section template.

Edit side lines

Section template|Side lines

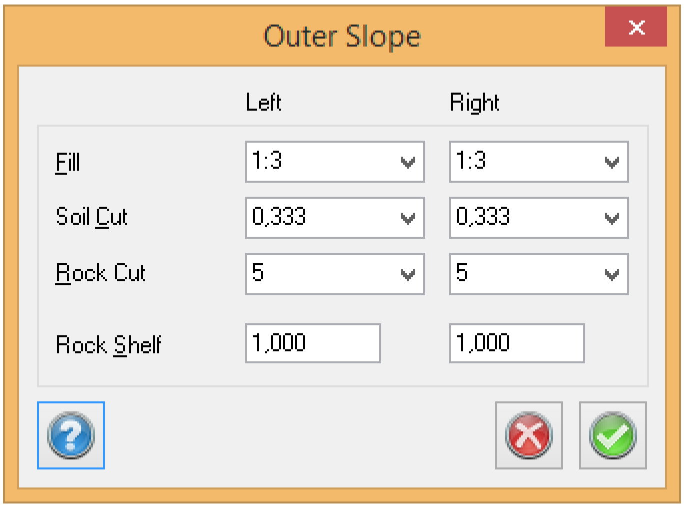
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

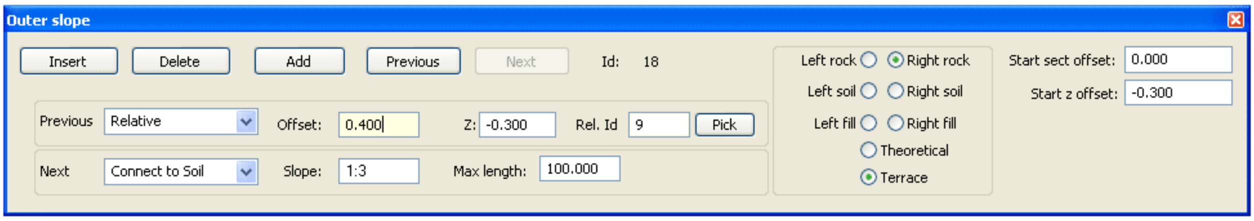
Section template|Quick outer slope

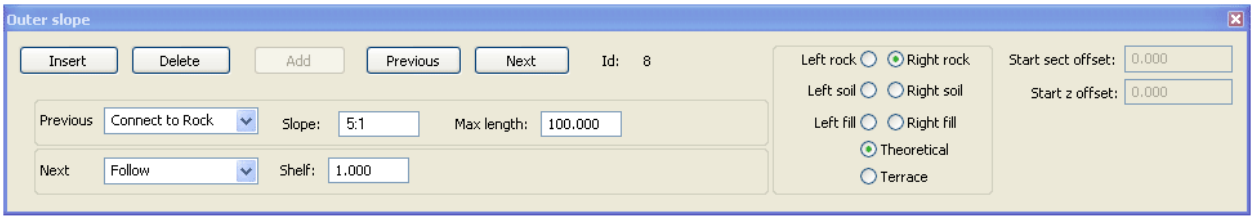
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

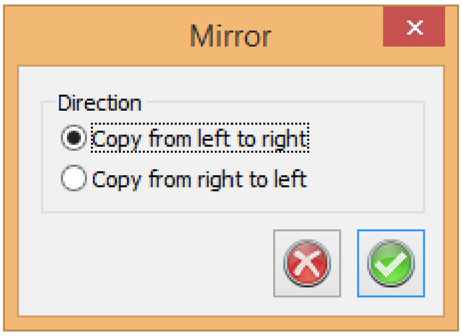
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

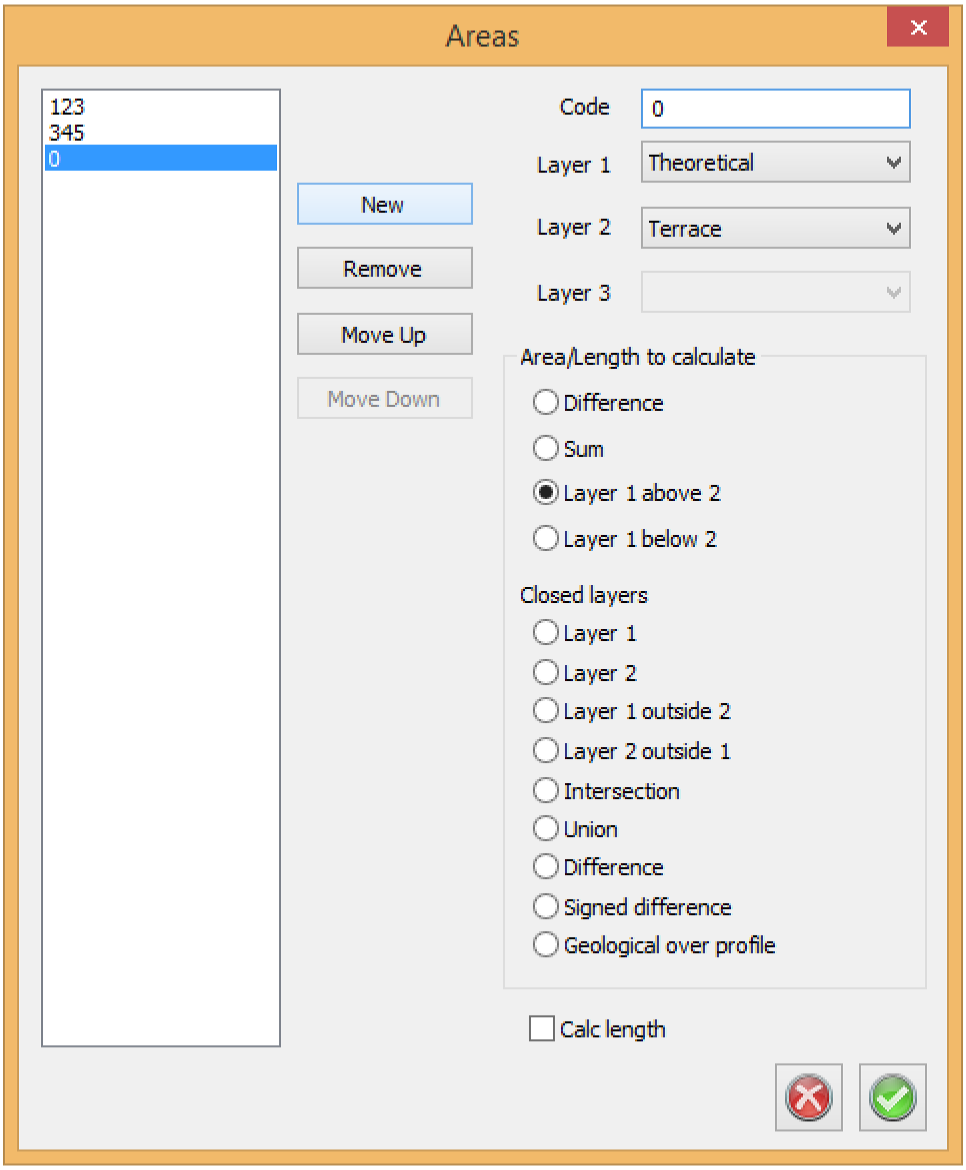
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
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Section properties	Section Vertex Properties
- Fixed	
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- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

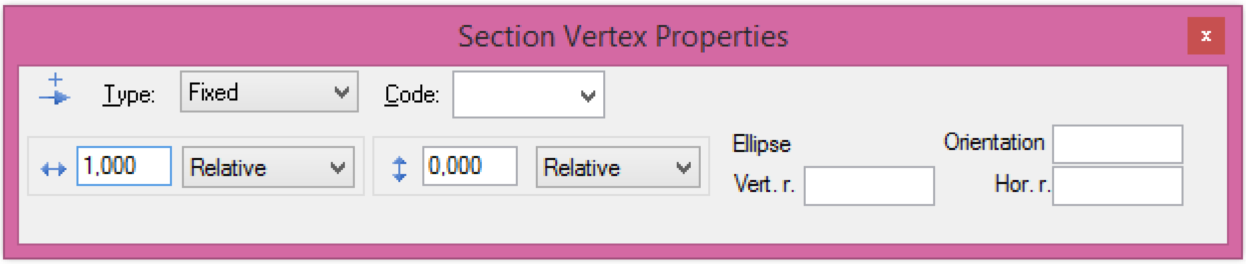
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

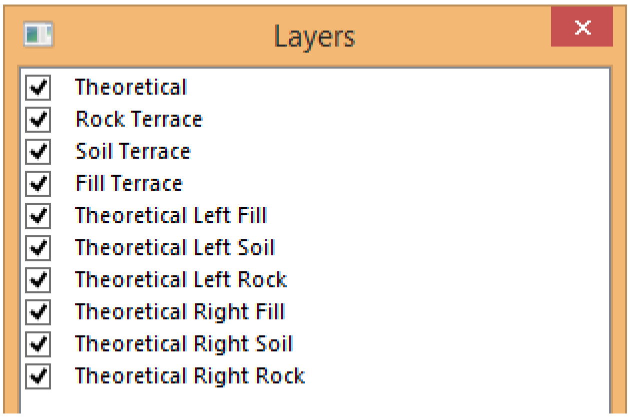
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

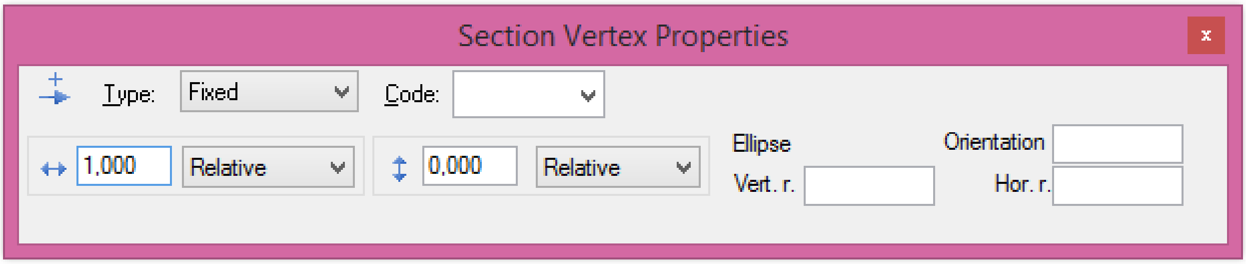
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

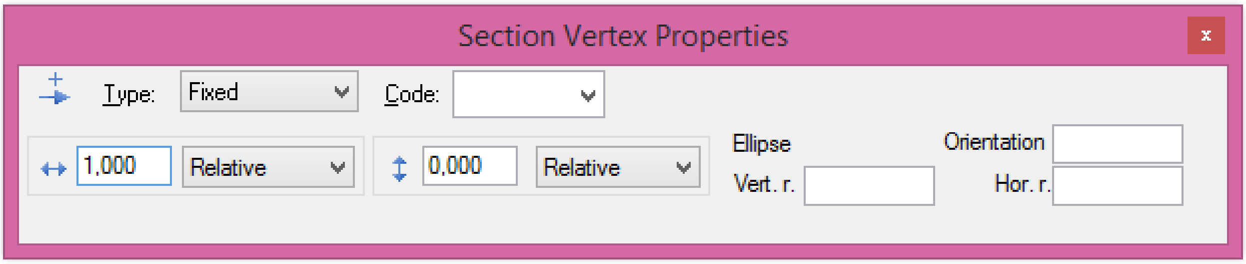
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

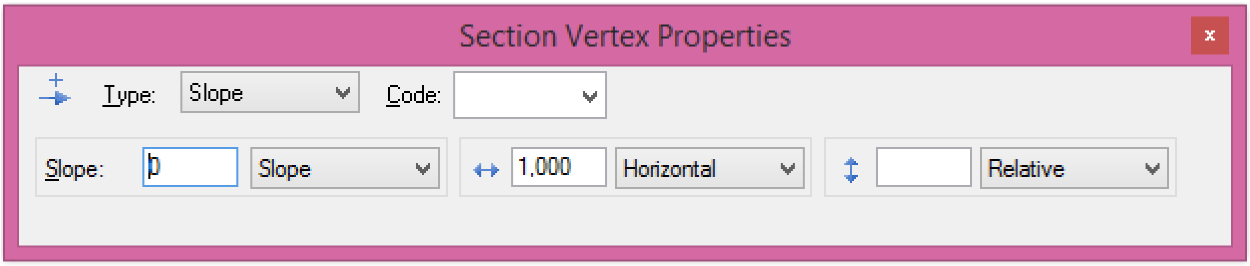
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

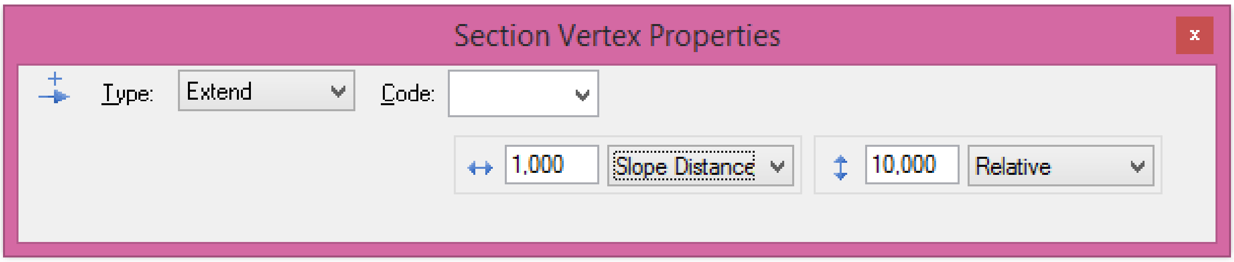
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

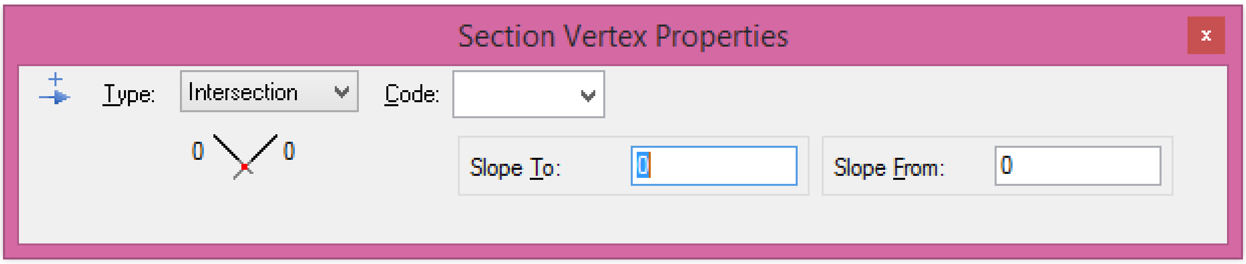
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

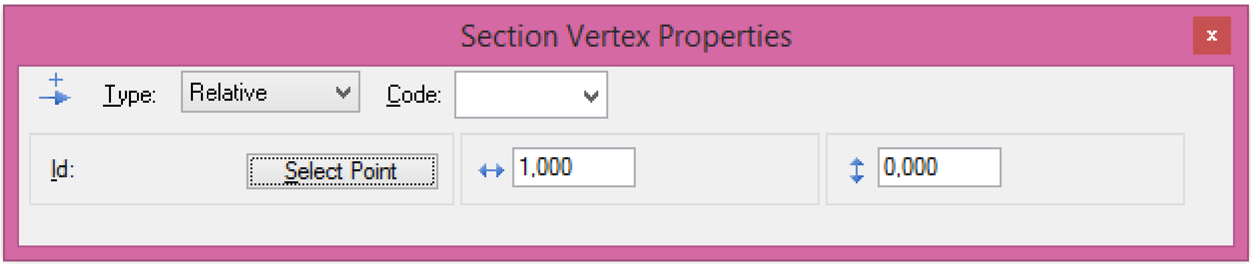
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

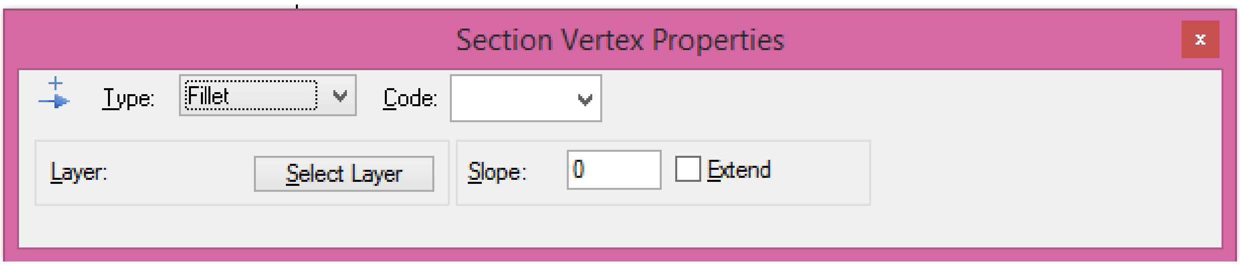
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

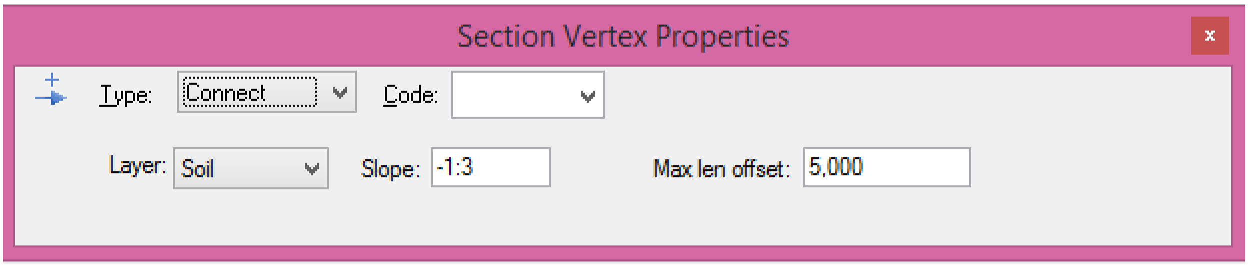
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

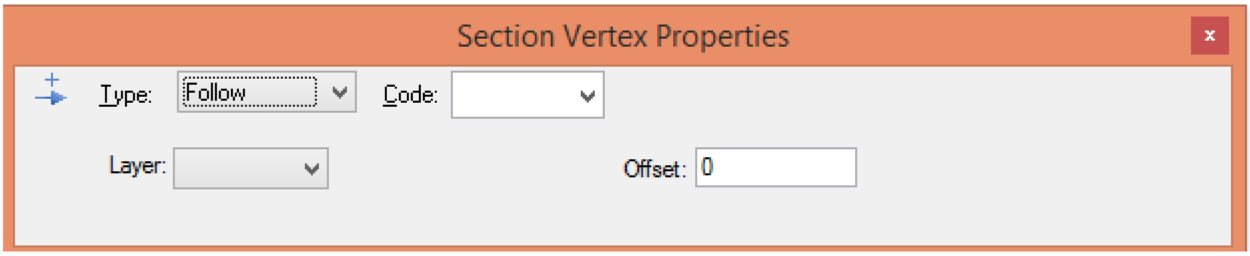


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

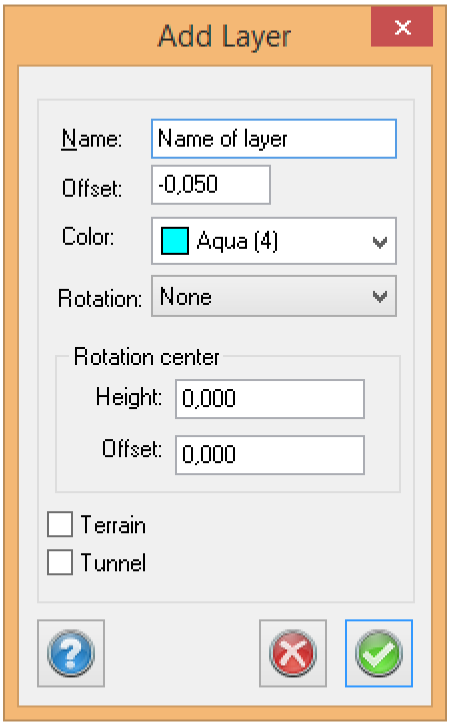


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

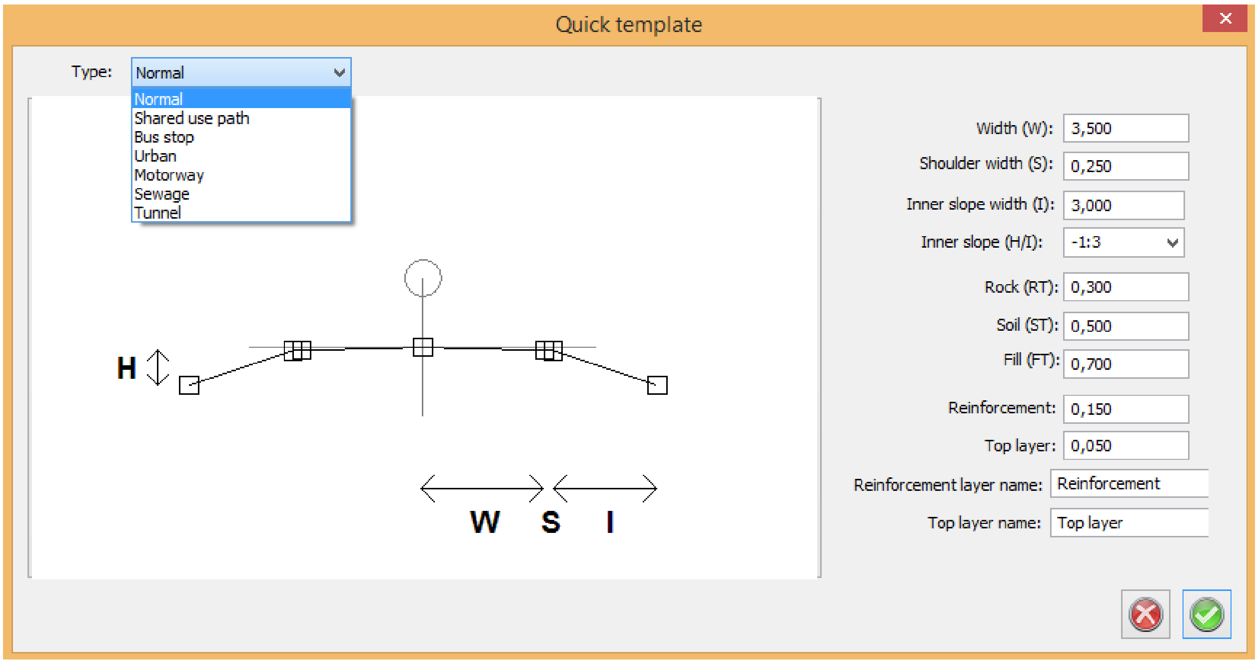
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

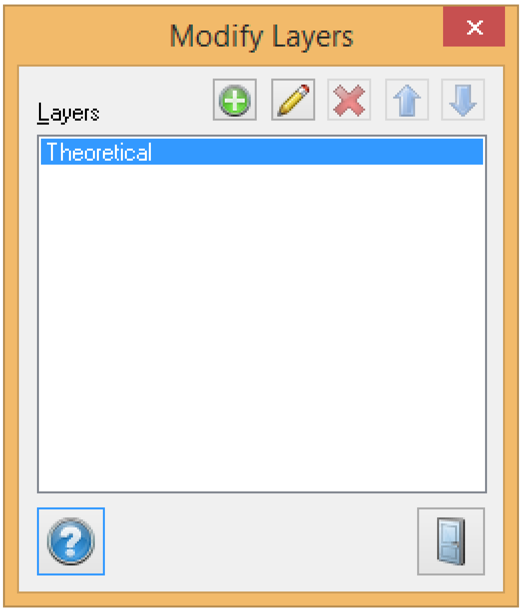
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

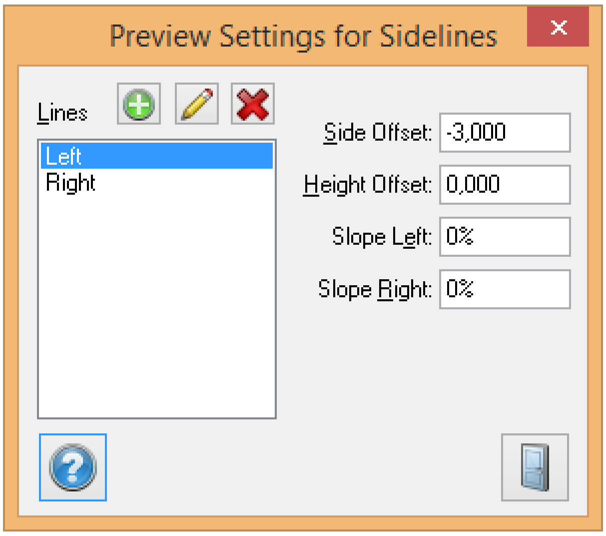


Modify layers in section template.

Edit side lines

Section template|Side lines

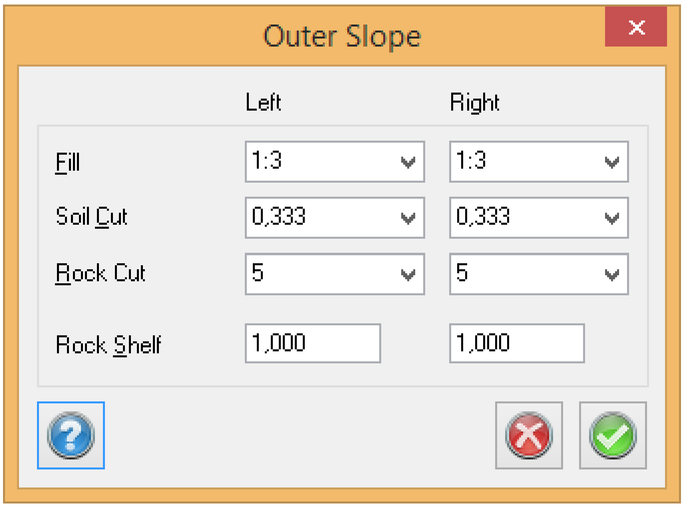
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

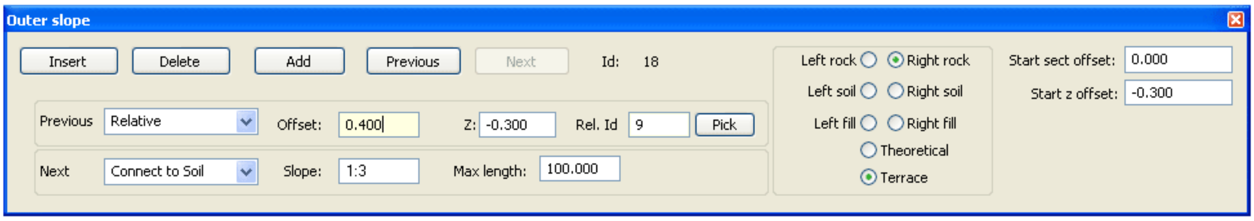
Section template|Quick outer slope

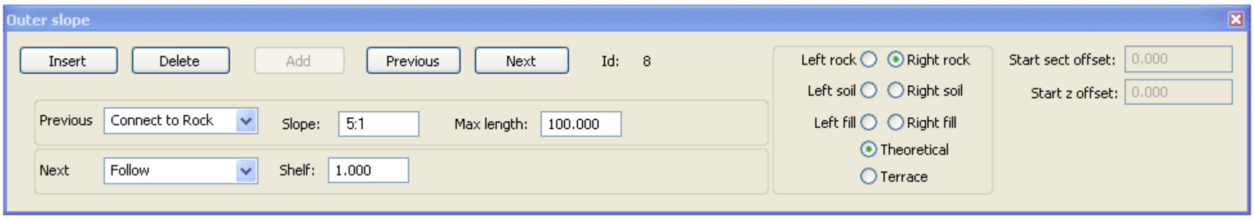
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

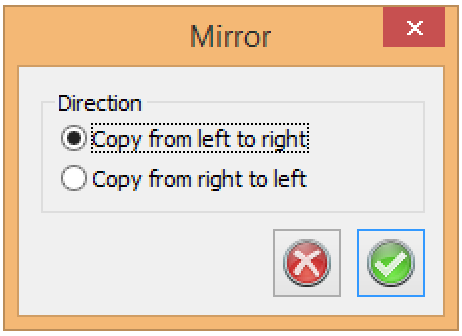
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

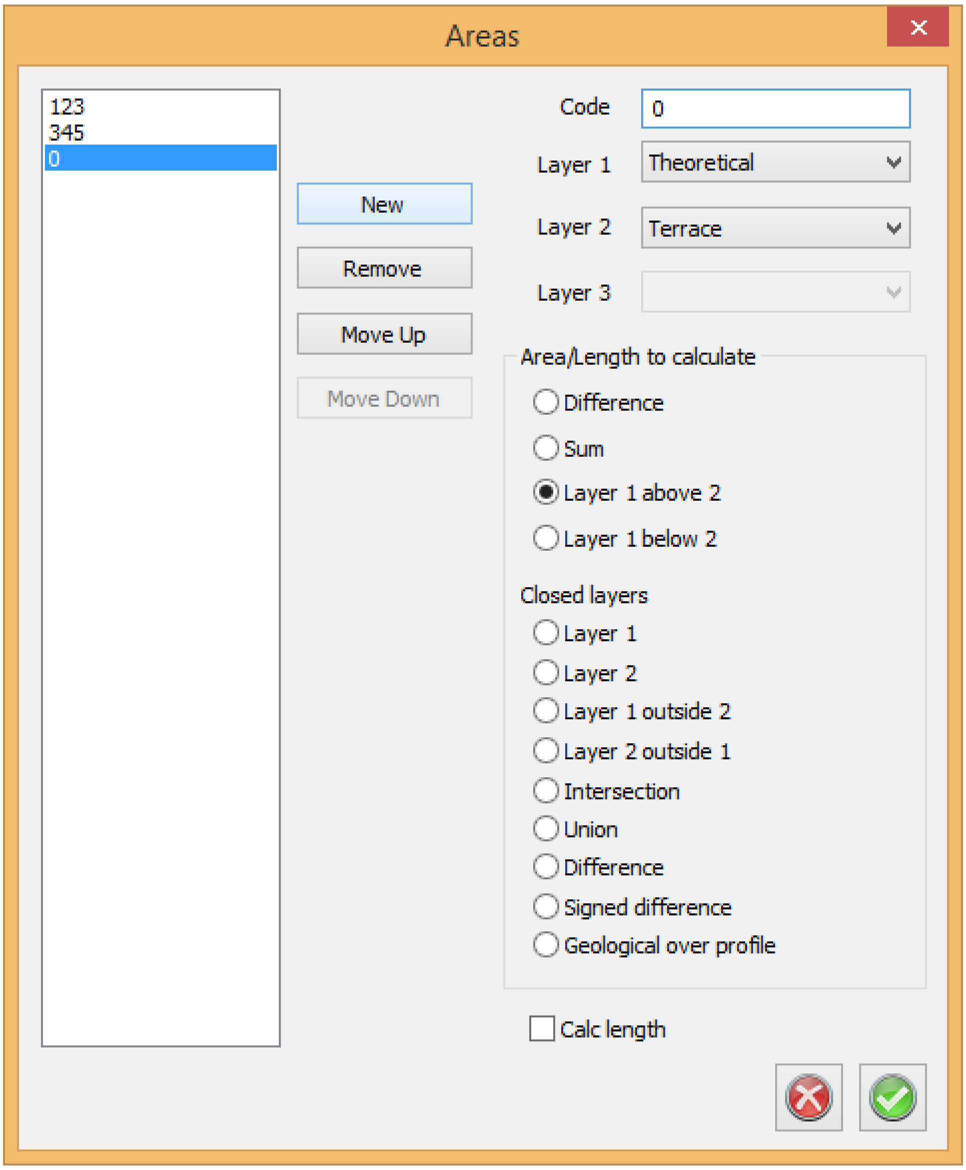
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

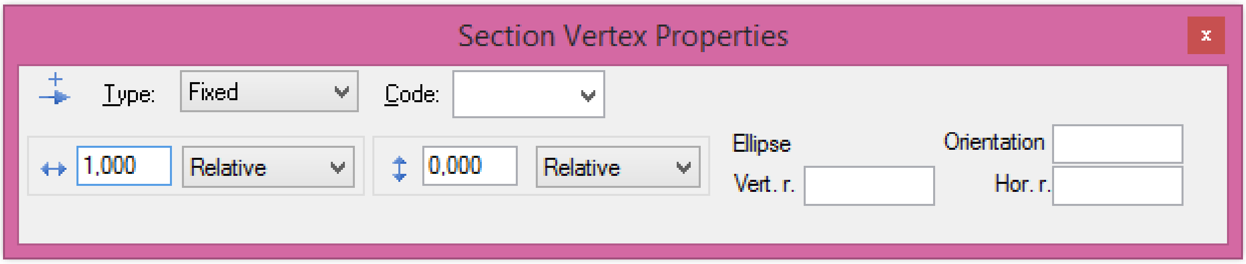
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

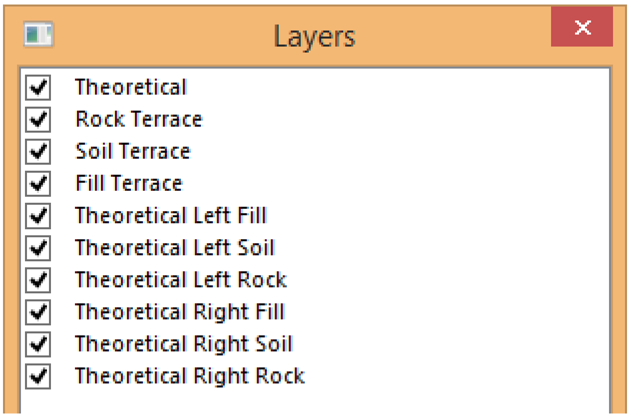
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

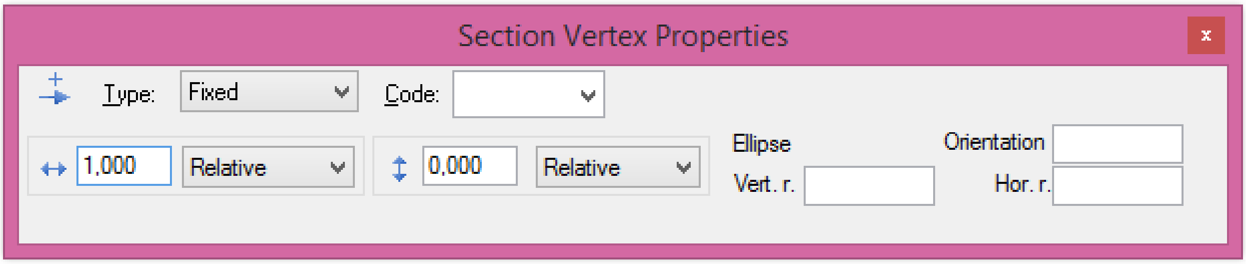
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

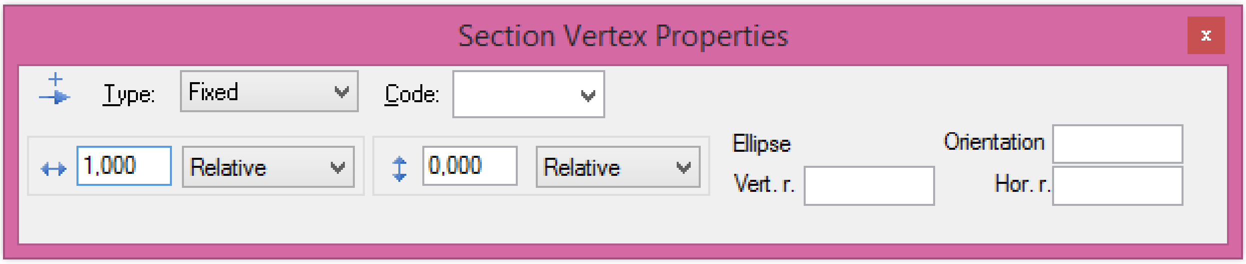
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

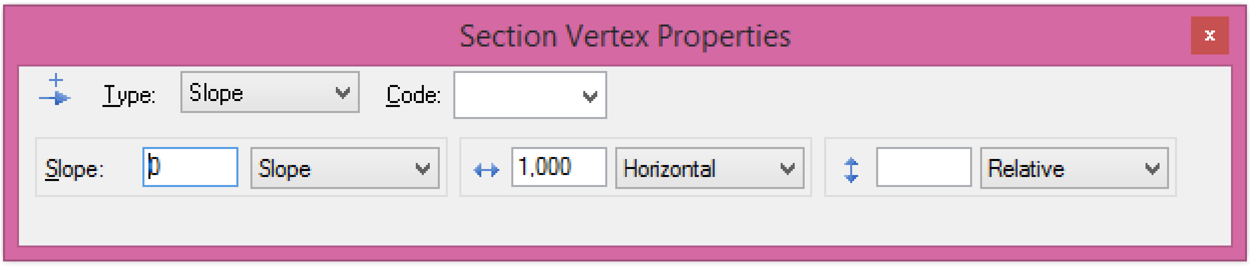
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

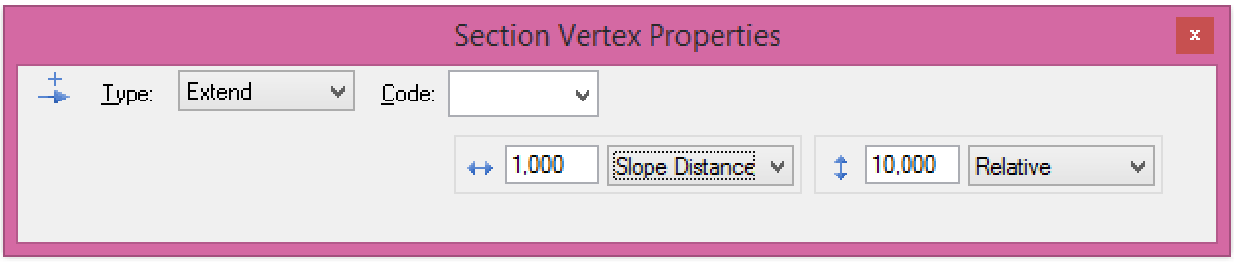
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

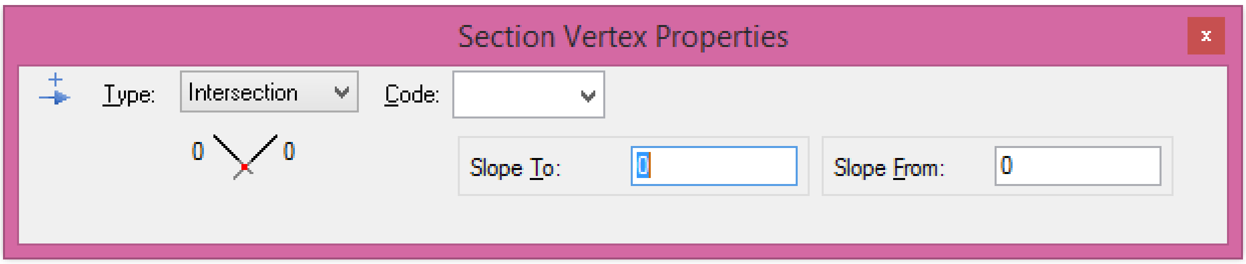
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

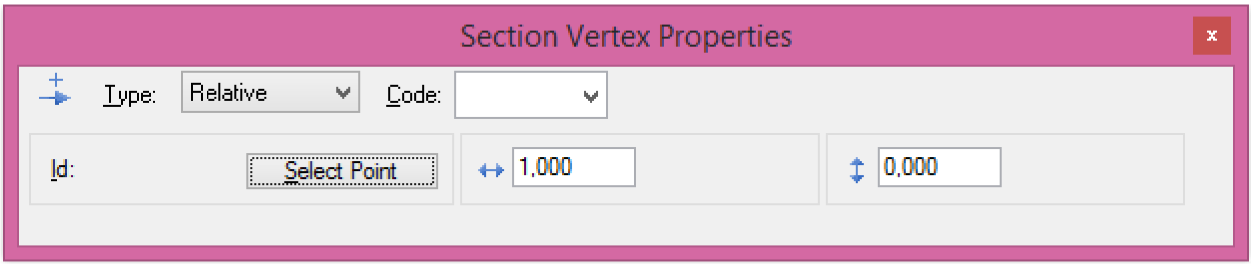
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

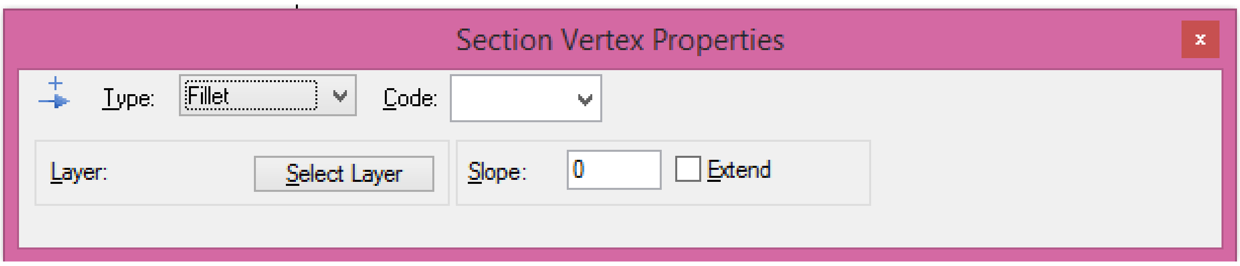
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

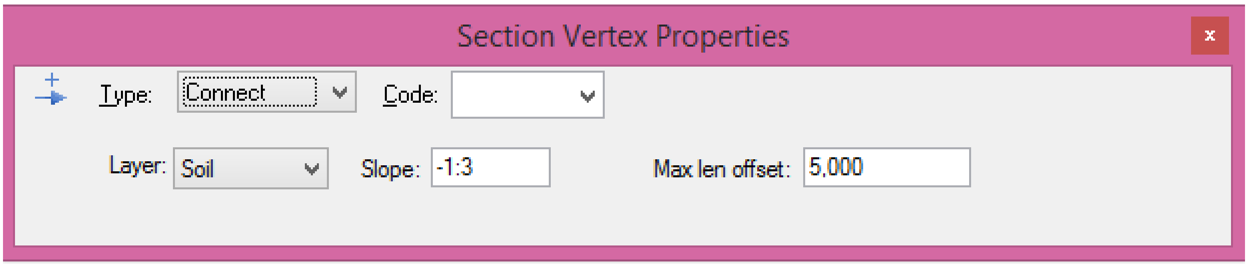
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

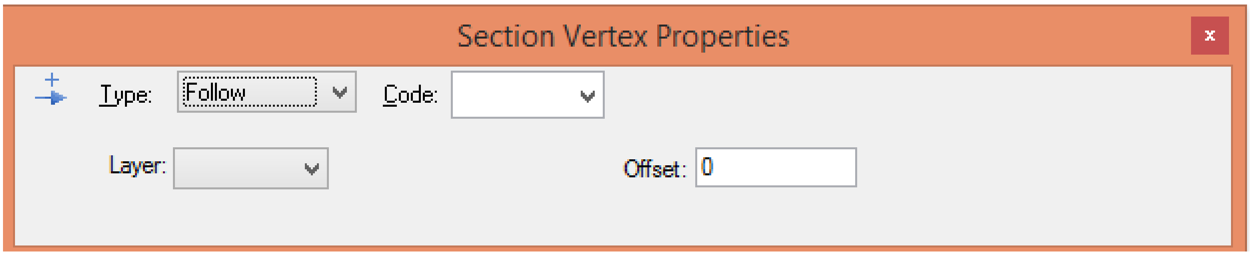


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

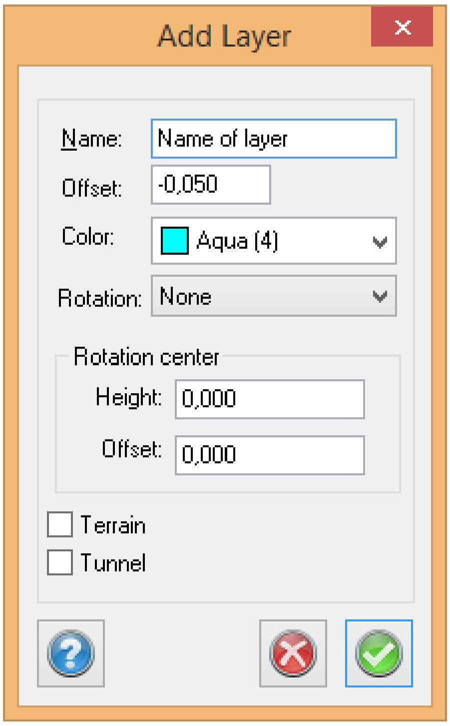


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

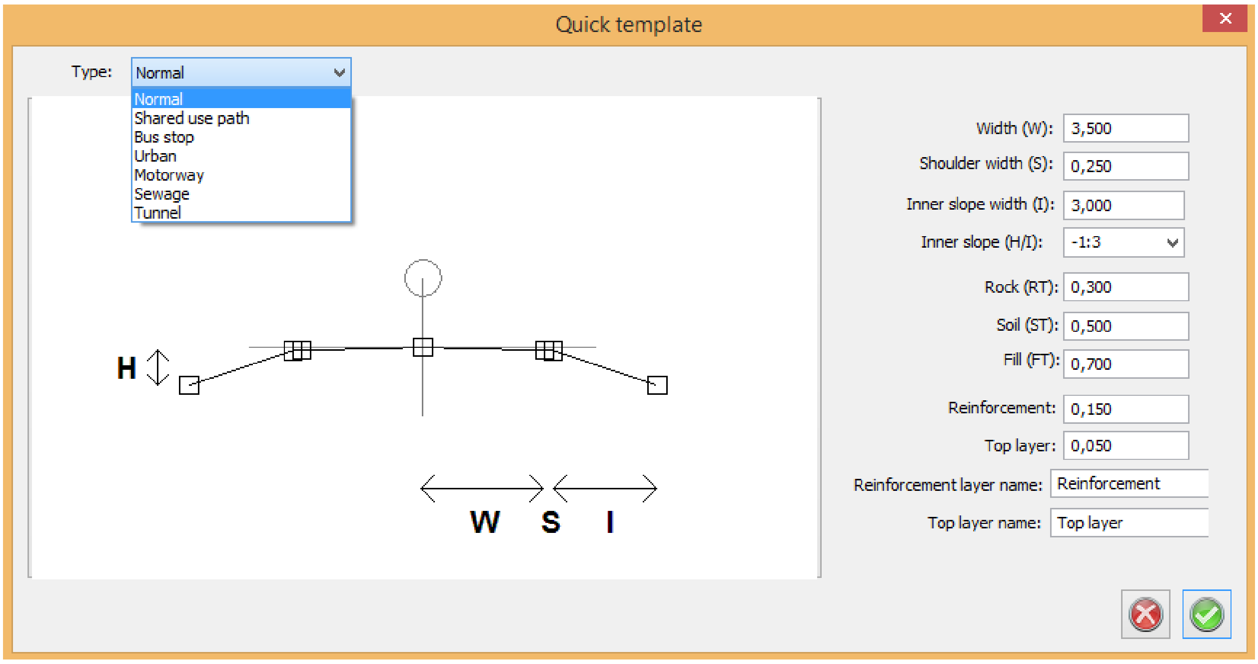
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

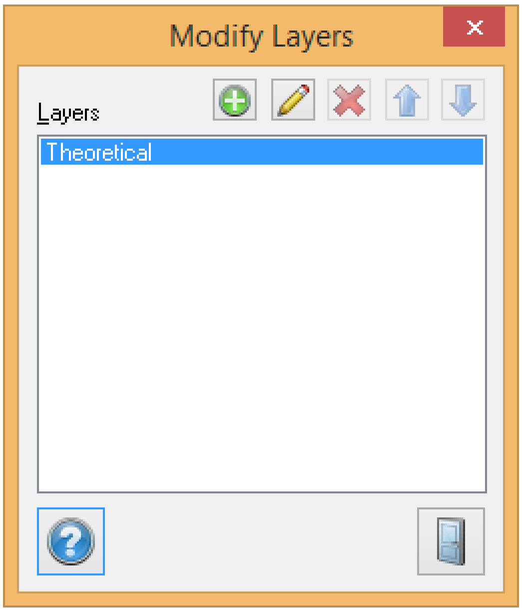
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

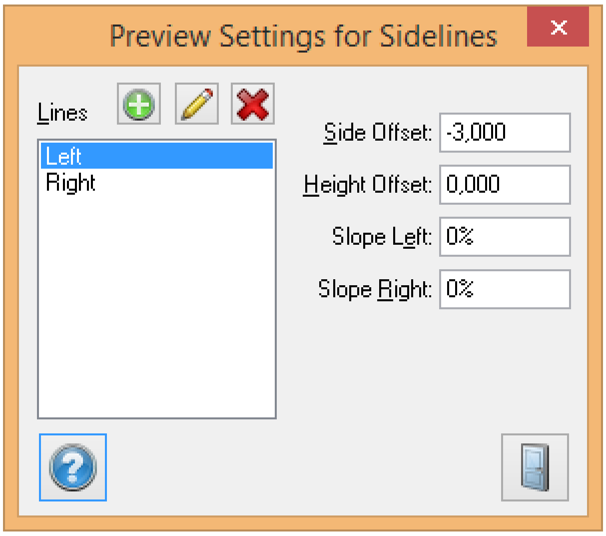


Modify layers in section template.

Edit side lines

Section template|Side lines

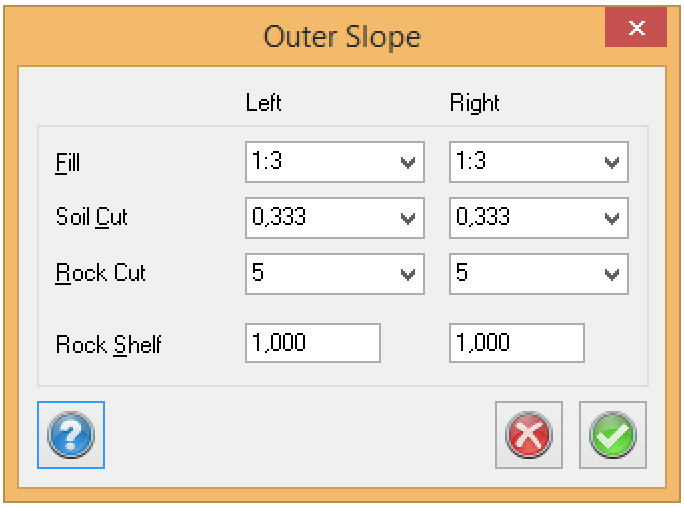
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

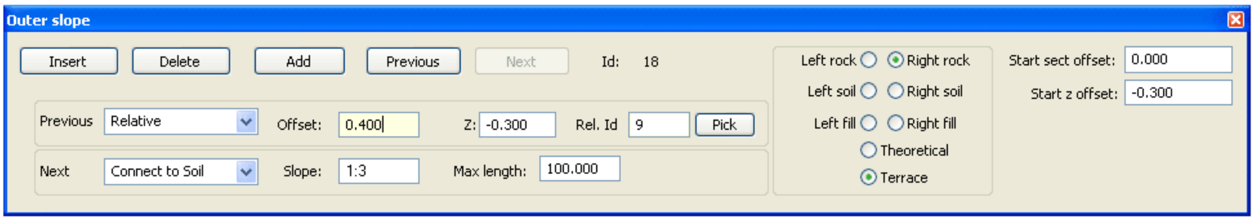
Section template|Quick outer slope

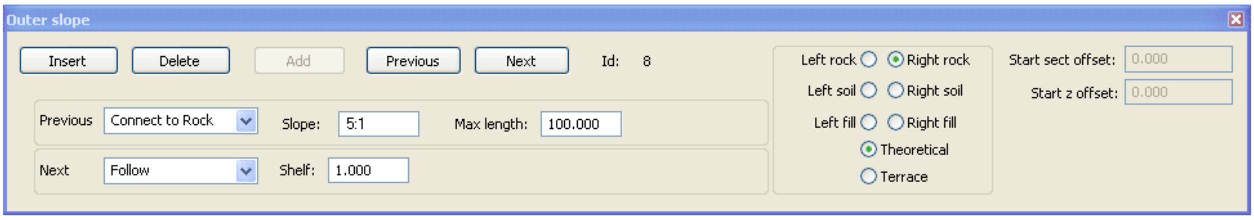
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope
To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert
Adds a new point inside selected point.

Add
Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete
Deletes selected point.

Previous and Next
To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

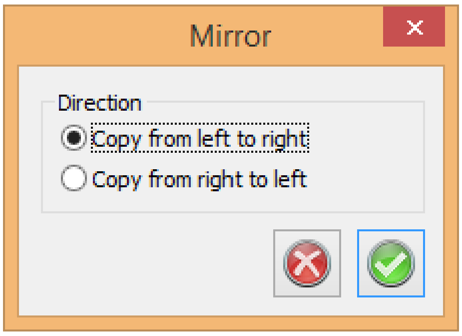
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

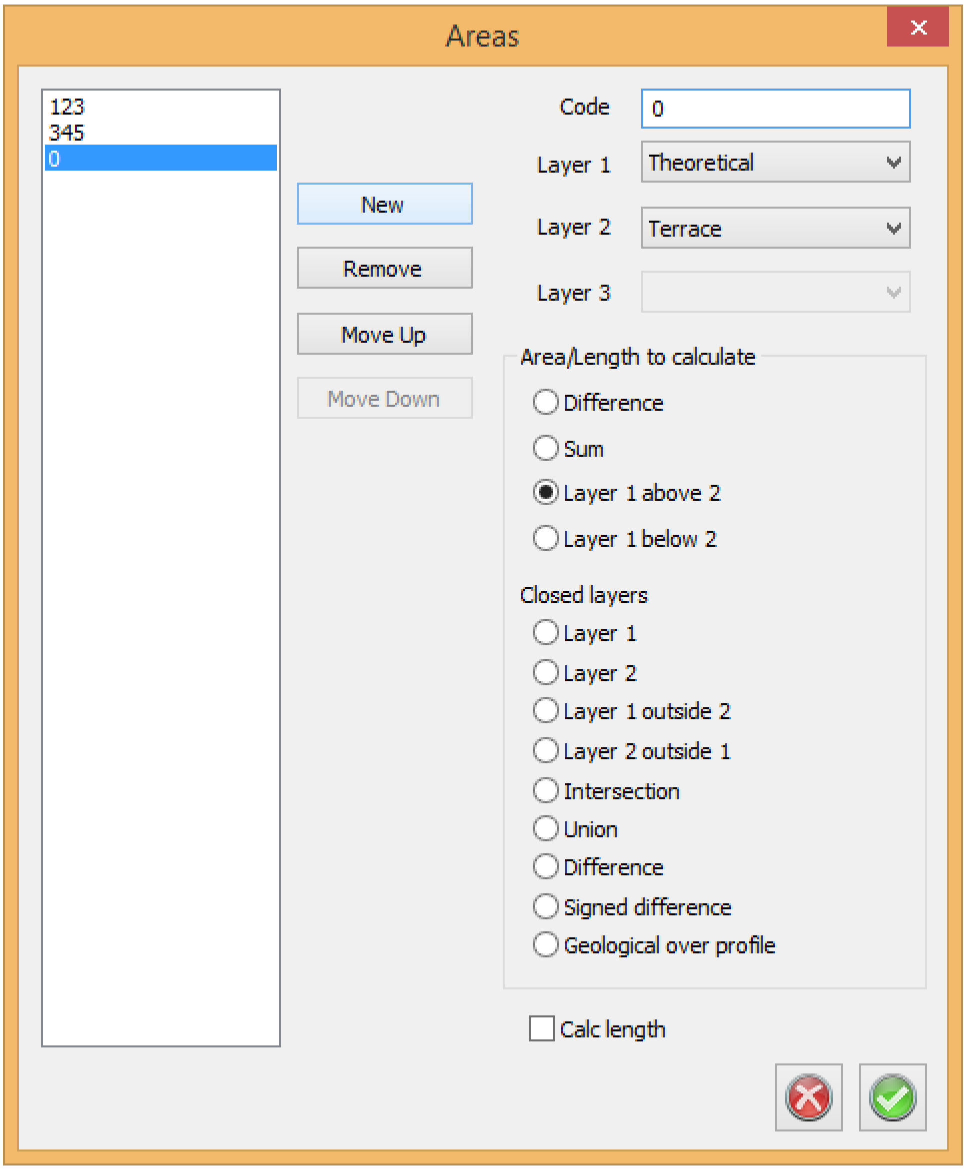
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

Section template contents

Section template - TST

Function, command	Description
General	
View toolbox	
Wordlist	
Layers	View layers

Section properties	Section Vertex Properties
- Fixed	
- Delta	
- Slope	
- Extend	
- Intersection	
- Relative	
- Fillet	
- Connect	
- Follow	
Add layer	
Quick template	
Delete points	
Modify layers	
Modify section template	
Quick outer slope	
Edit side lines	
Mirror	
Areas	

General

When you create a new cross section/section template or change an existing cross section you add an element by going to Construct and clicking on the type of element you want to add or by clicking on the icon for this element in the toolbox. If you click on the wrong element is it easy to change the type of element from the dialogue box.

In this dialogue box you enter the values you want to assign to this element. For example, it can be a slope with given distances, fixed distances, extend etc. It is possible to add an element in both directions regardless of which side of the section you are on. This is indicated by the toolbox direction and also appears in *Add to left* or *Add to right*. For example, if you want to add an element belonging to an element outside it, select the direction towards the centre point. (Left if you are on the right side of the section and vice versa.)

You always edit a point and the path to that point. When adding an element, this element is created with its default values and you then change its default values to suit your requirements. You cannot delete points that any other points have a relation to.

The section normally starts from the centre of the roadline and runs towards the edges but some of the points in the section can be fixed points even if they are not in the centre. For example, the road profile can be offset from the centre - this is often the case for highways.

The different properties for a section element are:

- Fixed
- Slope
- Extend
- Intersection

- Relative
- Fillet

View toolbox

The section template document and the section document have four and five special toolboxes respectively - these do not appear in the standard Topocad. They are unique to the section and should preferably be used all at the same time. However, it is possible to only use the menu rather than the toolboxes.

Direction
Indicates the direction in which you add an element in the section. You will also find it in *Add to left* and *Add to right.*

Step/Select
The icon shows four different arrows - the two outer arrows move to the extreme left and right elements and the other two arrows move one element at a time. These commands also appear under Select in the menu.

Construct
This box contains five or six different ways to add an element in a section template (fixed, slope, intersection, extend, relative and camber) as well as delete, show outer slopes and finally mirror turnover.
These are also available under Construct in the menu.

Point info
Shows the information for that element (point) in the section template and in the cross section. This box is also used to edit the point.

In a calculated section document only:

Select section
This box only appears in cross sections (.tcs) and you can move between the sections by clicking the up or down arrow or move to the first or last sections by clicking on the double arrows. This command also appears under Select in the menu.

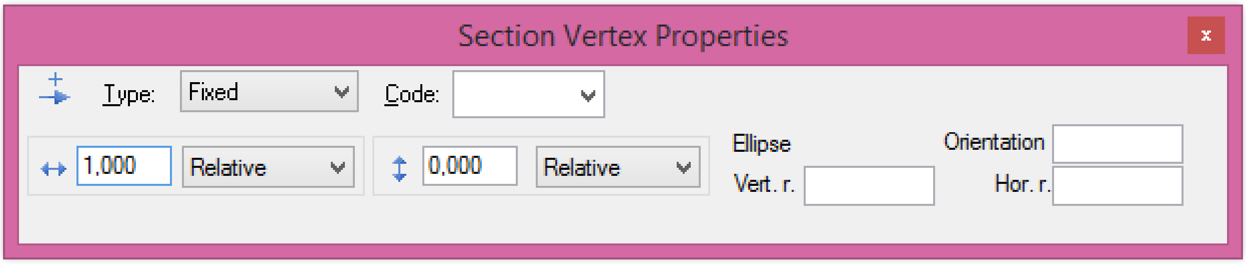
Current section
From this list you can point at any section from the cross section calculation. The list contains all calculated sections.

Area
Shows the calculated area of the section. The areas are divided into Soil, Rock, Fill and Superstructure.

Wordlist/Explanations

Frequently occurring words in dialogue boxes:

Code
A point code can be entered to simplify control and stake out.



Directions:
Slope
Slope can be expressed in percent (%), in per mill (‰) or as a fraction (01:03) and can be expressed using negative values.

Crossfall
Crossfall is the slope across the road section and the term crossfall is a combination of both camber and cross slope.

Camber
The camber is calculated from the plane data for the road. In the dialogue boxes you can enter camber left or camber right.

Horizontal distances:
Absolute
Absolute horizontal distance measured from the centre.

Horizontal
Horizontal distance from last point.

Slope distance
Slope distance from last point.

Vertical distances:
Absolute
Absolute distance in height. This is the absolute height in the co-ordinate system.

Relative
Relative distance in height from last point. Note that the last point may be a point further to the outside if the set direction is towards the centre.

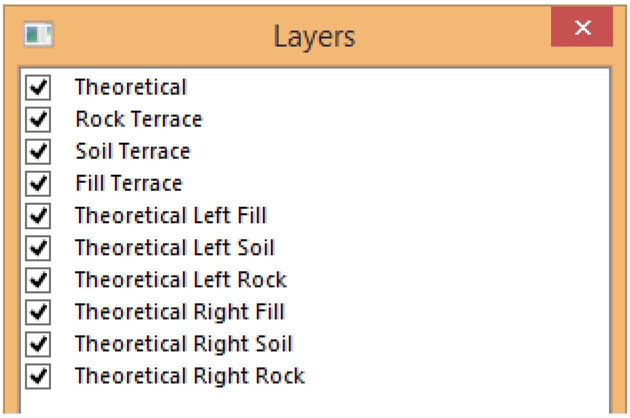
Relative profile
Relative height from the height of the profile in this section.

Vertical distances can be negative!

Layers

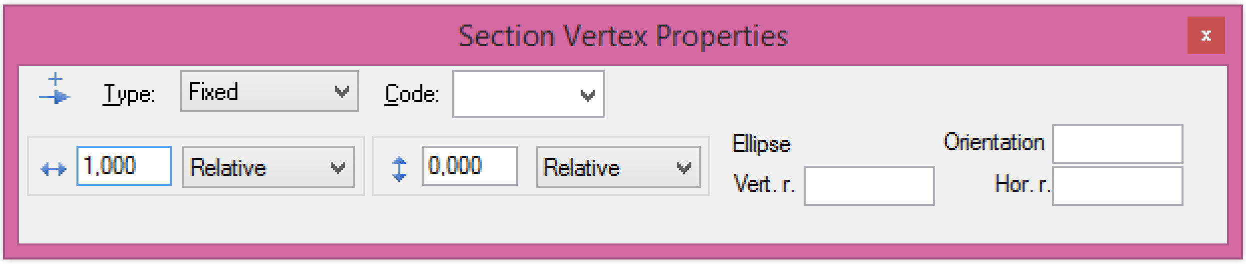
Sections template|Layers

View layers in section template.



Section properties

Fixed



Enter a vertical and horizontal distance and select whether you want these distances to be calculated from the last point, from the centre point or whether they are absolute distances. (Offsets/Heights)

Example 1:

You want to add an element for inner slope towards the ditch. You know that this should be three metres from the outer edge of the road and one metre lower in terms of the vertical distance.

The procedure is as follows:

1. First **click** on the point that indicates the outer edge of the road.
2. **Click** on *Construct|Fixed* in the menu or click on the corresponding icon in the toolbox.
3. **Enter** 3.0 metres **relative** as the horizontal distance (indicated by arrows) and 1.0 metres **relative** as the vertical distance, also indicated by arrows.

Example 2:

You have a highway with an inner area that has a width of 4.0 m. The profile is fixed on a point 0.75 m from the edge of the road. This is 3.0 m from the centre assuming a 0.25 m prop strip. This is the same example used as example 2 for Slope and Extend.

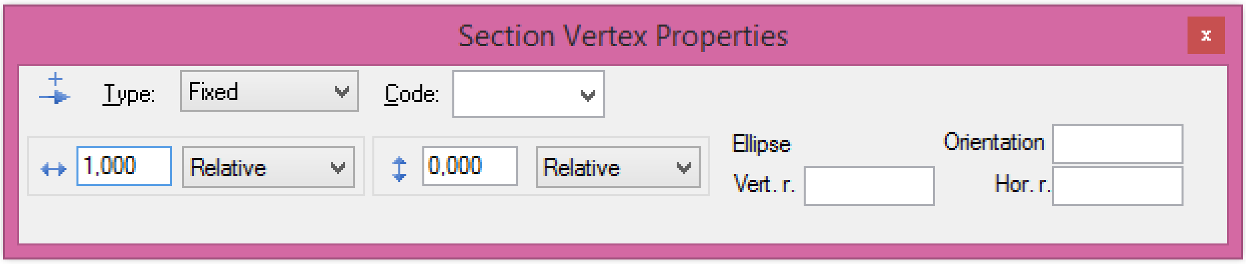
The procedure is as follows:

1. **Add** a point from the centre line using the *Construct|Fixed* command in the menu (or use the toolbox).

2. **Enter** 3.0 metres **absolute** as the horizontal distance (indicated by arrows) and 0.0 metres **relative** profile as the vertical distance, also indicated by arrows.

Delta

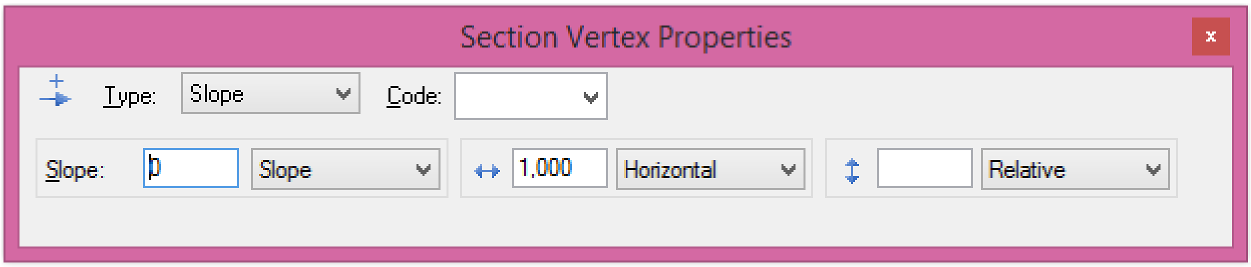
Section template|Delta



Construct delta.

Slope

Section template|Slope



Apart from the code, three different items can be entered here. First of all, the value of the slope is entered. It can be expressed in percent, per mill or as a fraction. Positive values indicate an element that points upwards and thus has a higher point at the end than at the beginning, and vice versa. The slope can also be specified by the camber, which is calculated from the plane data for the road.

You can also enter the limits for the vertical and horizontal distances. These can be relative to the last point, the profile (in height/vertical), the centre (in plane/horizontal) or an absolute height. Note that it is the slope that is fixed and the horizontal and vertical distance that is the shortest compared to the slope limits the length of the element.

Example:

You want to use an inner slope from the outer edge of the road towards the ditch with a slope of 1:3 and the horizontal distance will be 3.0 metres from the edge of the road.

The procedure is as follows:

1. **Click** on the point that indicates the outer edge of the road.
2. If there are no elements outside this element, add the element by going to the menu and **clicking** on *Construct|Slope* or using the toolbox. If there is an existing element that you want to correct, click directly on this element.
3. **Enter** the slope of -01:03. (Or -33%)
4. Enter the **horizontal** distance of 3.00 **relative** (relative to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Example 2:

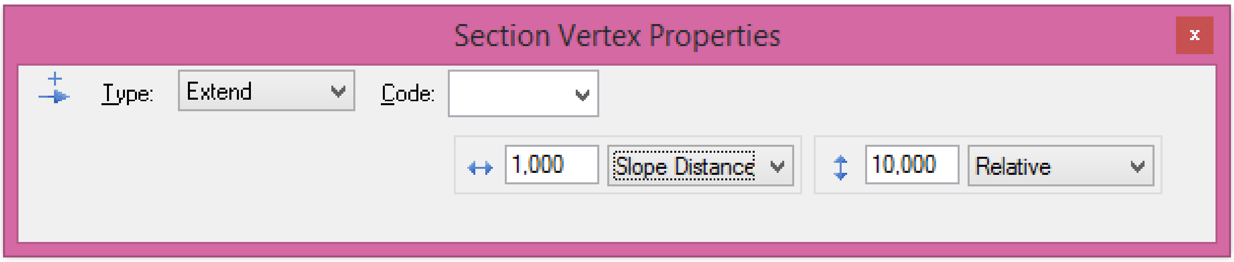
Extend from Example 2 from last page. Enter the road that ends at the outer edge of the road element. The road uses a camber and crossfall. The road is 7.0 metres wide. Note that last point is already 0.75 into the road. (The profile is at this point.)

The procedure is as follows:

1. **Click** on the point that indicates the profile point.
2. If there is no element outside this element, you can **add** an element by going to *Construct|Slope* in the menu or by using the toolbox. Note that the direction will point outwards from the centre line. If you already have an element you want to change, click on it first.
3. **Enter** that the slope will be **camber** (right or left).
4. **Enter** a horizontal distance of 6.25 **relative** (compared to the last point). The vertical distance has no effect in this case so we only have to ensure that it is sufficiently high that it does not limit the element.

Extend

Section template|Extend



The Extend command extends the previous element direction by the specified horizontal and vertical length. As usual, these lengths can be expressed as absolute distance, distance relative to previous point or slope distance. The height can also be relative to the profile.

Extend is usually used for prop strips.

Example 1:

We will extend our road using a prop strip with a width of 0.25 m.

The procedure is as follows:

1. Click on the edge of the road.
2. If there is no element outside this element, add an element by clicking on *Construct|Extend* or by using the Extend icon in the toolbox. If you have an existing element for the prop strip, click on this instead.
3. Enter the horizontal length of 0.25 relative to the last point (edge of road). Make sure that the vertical length exceeds any intersection. (If the camber is 3% and the prop strip is 0.25 m you have to have at least 0.03 x 0.25 = 0.0075 m vertical length).

Example 2:

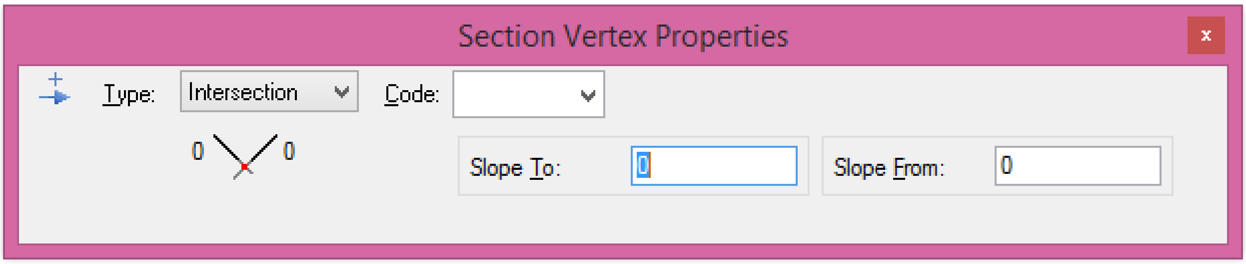
Example combined with example 2 for Fixed and Slope. Enter the inner edge of the road, which is 0.75 m from the profile and has the same slope as the road itself, which is the same as the camber.

The procedure is as follows:

1. Click on the profile.
2. If there is no element inside the profile, add an element by going to *Construct|Extend* in the menu or by using the toolbox. Note that in this case the direction will be towards the centre of the road. If you already have an element at this point, click on this instead.
3. Enter the horizontal distance of 0.75 relative to the last point (profile). Correct so that the vertical distance exceeds any intersection. (0.75 m x camber 3% = 0.0225 m)

Intersection

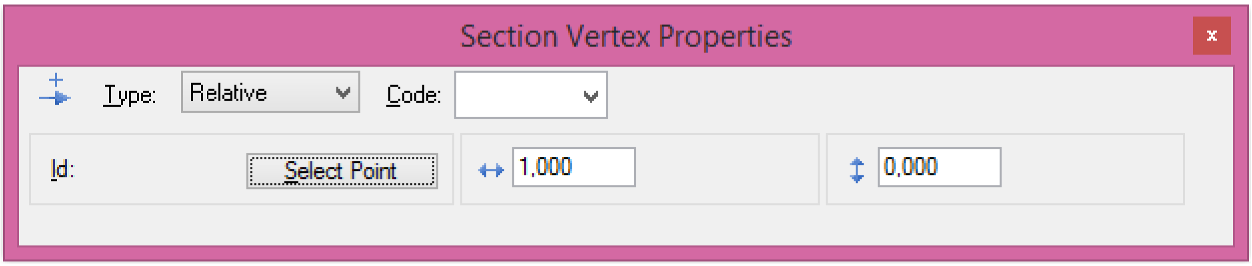
Section template|Intersection



The Intersection command is used when a point does not have a fixed position and is determined by two slopes running towards it. The required data is the two slopes towards the point.

Relative

Section template|Relative



Relative is used primarily to determine the superstructure thickness. You determine a relative value for the horizontal or vertical distance and click on the object you want to relate it to.

Example:

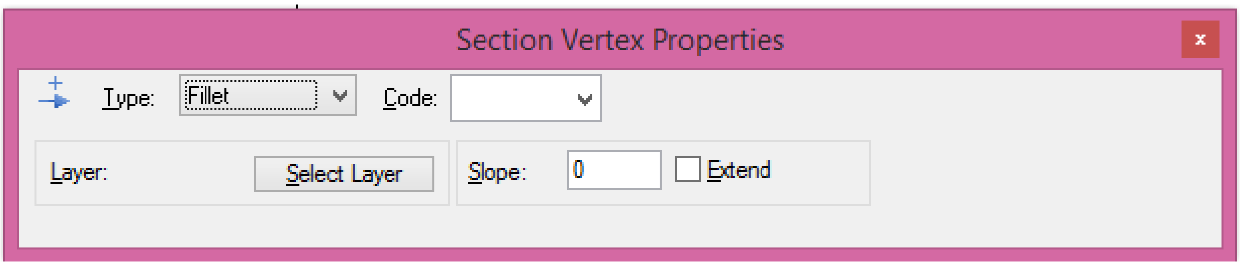
The superstructure thickness for Fill will be 0.7 m below the road, parallel to the road.

The procedure is as follows:

1. **Click** on the superstructure line for Fill, which is the blue line.
2. If there is no element outside this element, **add** an Extend element by clicking on *Construct|Relative* or by using the relative icon in the toolbox. If you have an existing element for the superstructure, click on this instead.
3. Enter the **vertical** height (indicated by up and down arrows) of 0.70. As the horizontal length has no influence enter a value = 0 m.
4. Click on **Select** point.
5. Click on the point in the road towards which you want to have a parallel thickness of 0.7 m. This is normally required for two points on each side for a (normal) road - in the centre of the road and at the outer edge (or under the prop strip). For a highway with an inner strip or ditch, it will probably be necessary to click on several points. However, it is disadvantageous to click on several points below the road using the relative distance.

Fillet

Section template|Fillet



Fillet is the command that is used for the point at which the superstructure intersects with the inner slope. You enter the kind of slope (normally extend) and then click on the element with which the superstructure will intersect.

Superstructure colours:
Rock has a red line, Soil has a green line and Fill has a blue line.

Example:

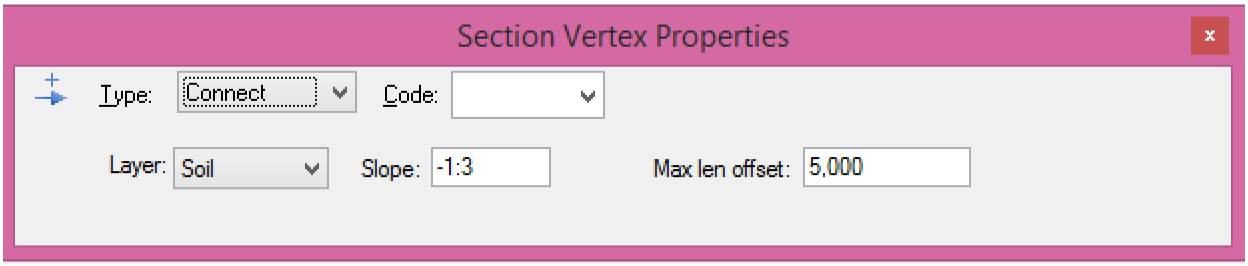
You have constructed a superstructure for Fill with a thickness of 0.7 m and you have reached a point below the outer prop strip. You now want to extend this line to intersect with the inner slope.

The procedure is as follows:

1. **Click** on the superstructure for Fill, which is the blue line. Click on the point that is below the outer prop strip.
2. Is there is no element outside this element, **add** a Fillet element by clicking on *Construct|Extend* or by using the Fillet icon in the toolbox. Note that the direction will be outwards from the centre line.
3. Click on the **Extend** box.
4. Click on the **Select** layer box.
5. **Click** on the element you want to intersect with, i.e the road, with the black line on the top. It does not matter which position along this line you click on.

Connect

Section template|Connect

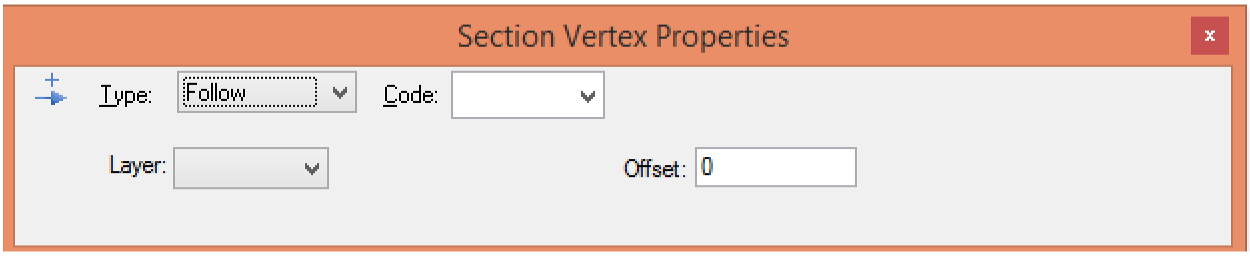


The section template type Connect (in earlier versions called Terrace) is used to connect to the theoretical layer towards the terrace.

Two parameters must be set; slope and max offset. The slope defines which slope the connection shall have. Max offset puts a limit to how large the distance of the offset can be. If no intersection with the terrace has been found before the offset, the new point will be beside the maximum limit.

Follow

Section template|Follow

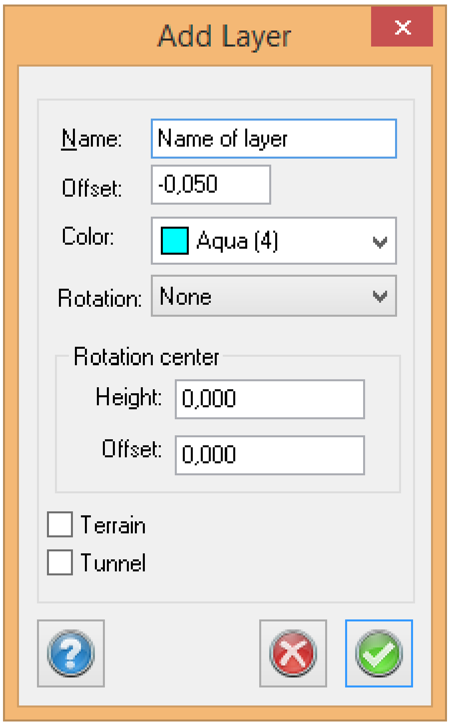


Follow layer.

Add layer

Section template|Add layer

In Topocad you can work with an infinite number of layers in the superstructure. These layers can only be above the terrace and under the theoretical road. All the added layers will be in the volume reports as layers that can be switched on and off.



Color
Select which color the layer shall be drawn in.

Terrain

Check if you want the layer to follow a terrain model.

The same type of command is on the calculated sections (TCS).

To add calculated sections in the drawing, see Create Section drawing

In Topocad is it possible to work with any number of layers in the superstructure. These layers have to be under the theoretical road and above the terrace. All of these layers can be displayed in area and volume calculations. Areas and volumes in these layers are not subtracted from the total superstructure area and volume. The layers such as asphalt should not be on the same line as the theoretical road.

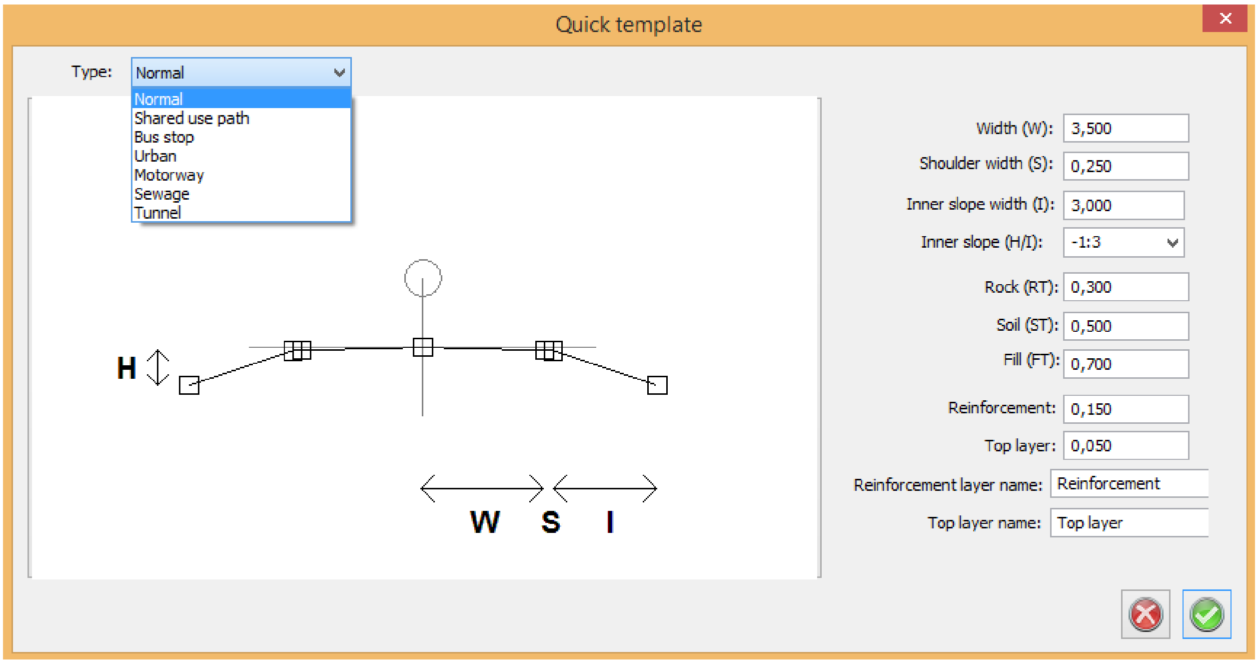
This command is available in both the section template and in calculated cross sections.

Quick template

Section template|Quick template

Function for quick templates for different types of roads.

Select between normal, shared use path, bus stop, urban, motorway, sewage or tunnel.



Modify section template

The section template can be edited in various ways and several of these commands are actually in the Modify menu. The Modify menu contains commands for deleting points in the section (also available in the toolbox) and for editing outer slopes.

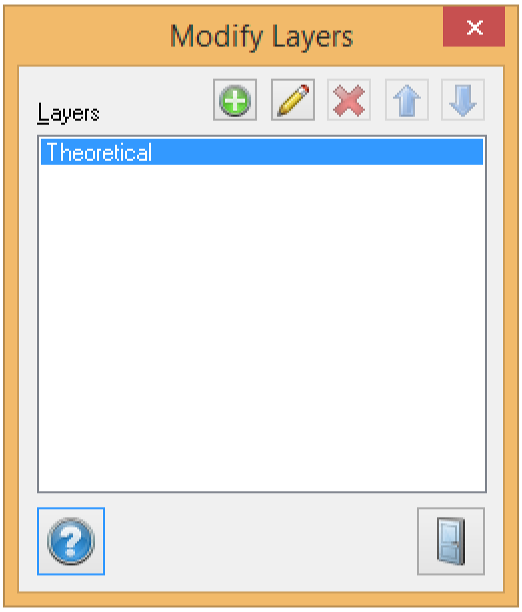
Delete points

Section template|Delete points

Delete points in section template.

Layers

Section template|Layers

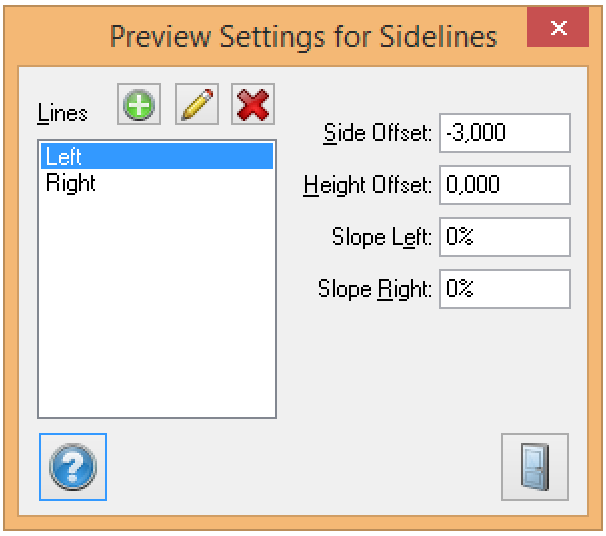


Modify layers in section template.

Edit side lines

Section template|Side lines

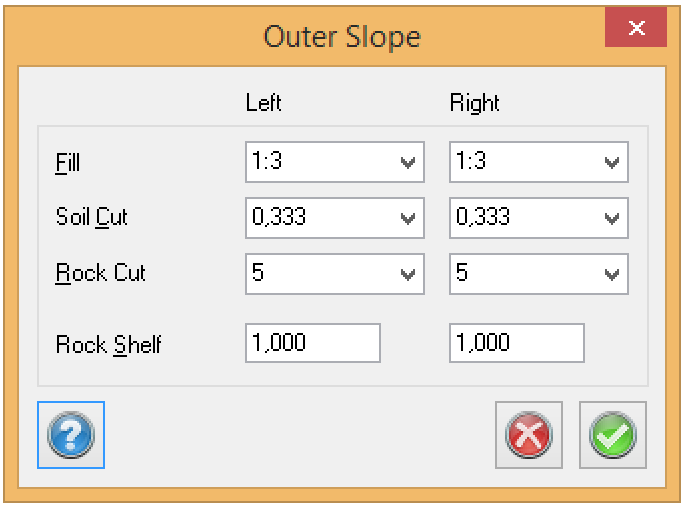
This command enters side lines and any names they have. If you are using side lines in your section template, you also need to have side lines (created as .trl lines) in the calculated cross section. However, it is an excellent way to control the sections.



Quick outer slope

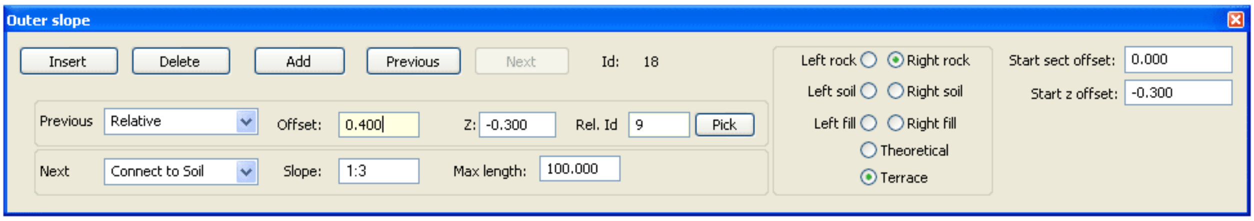
Section template|Quick outer slope

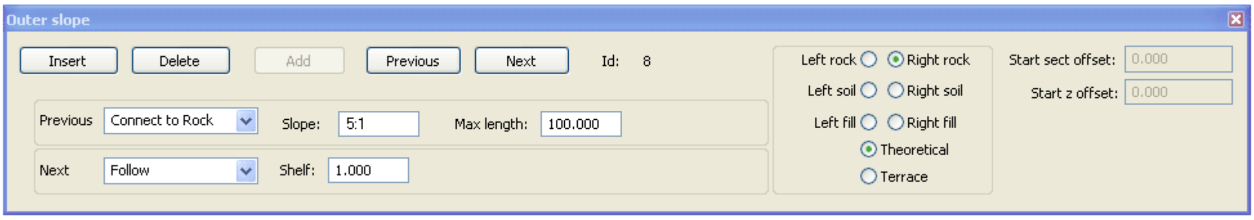
The Quick outer slope command edits the rock, soil and fill slopes on the left and right-hand sides. A rock shelf can also be entered. Every outer slope can contain several points and to separate the theoretical layer and the terrace in the outer slopes.



The default settings are:

- Rock intersection: 05:01 Red
- Soil intersection: 01:03 Green
- Fill intersection: 01:03 Blue
- Rock, shelf: 1 m Red





A complete section template shall have outer slopes defined for rock, soil and fill on both the right and left side. Which outer slope used for a side in a section calculation is determined by the place of the slope edge. In this case, slope edge is the end point on the theoretical layer. If the slope edge is placed under the rock model but, the rock slope is used. If the slope edge is placed under the soil model (but above the rock model), the soil slope is used and in remaining cases the fill slope is used. If a rock model is not used the soil slope is used for everything under the fill.

Define outer slope

To define an outer slope you have to select which slope you want to start with. As a suggestion; start with the outer slopes in the theoretical layer. To define for example the theoretical layer for left rock click on "Left rock" and "Theoretical".

Insert

Adds a new point inside selected point.

Add

Useable if the outer slope is selected. Adds a new point at the very end of the slope.

Delete

Deletes selected point.

Previous and Next

To move between the points on the outer slope, use the Previous and Next buttons. Next selects adjacent

point, situated furthest from the middle, while Previous selects adjacent point closer to the middle. It is also possible to select a point by clicking on it in the view. Selected point is marked with an x and data for current and Next point is displayed in the dialogue.

The points on an outer slope can be divided up in three types: Relative, Connect and Follow

Relative
A Relative point means that the next point will have a place relative to another point. Which point this will be shall be written in the field "Rel. Id". This value can be written, and also added by clicking at Pick and then at the point in the view. If "Rel. Id" is -1, which is the default value, the position is stated in relation to current point.

Connect
A point of the type "Connect" connects to either rock, soil or theoretical with certain slope. Only points in the terrace can be connected to the theoretical layer. It is possible to state a maximum length. If no connection is found within the maximum length, the next point will be placed on the stated distance from the current point. The maximum length states the distance in a sideways direction. The format is prepared to enable adding a maximum length in both sideways and diagonal and also as height different from terrain model or theoretical layer.

Follow
Follow points follows a terrain model. A point of the type Follow must be followed by a point that connects to the terrain model, or after another Follow point.

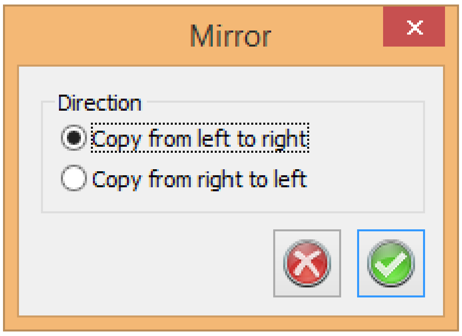
Shelf
Shelf sets how far a terrain model shall be followed.

Offset value
To the upper right in the dialogue you can set an offset value for the staring point on selected outer slope. Offset values can only be set for outer slopes in the terrace layer.

Mirror

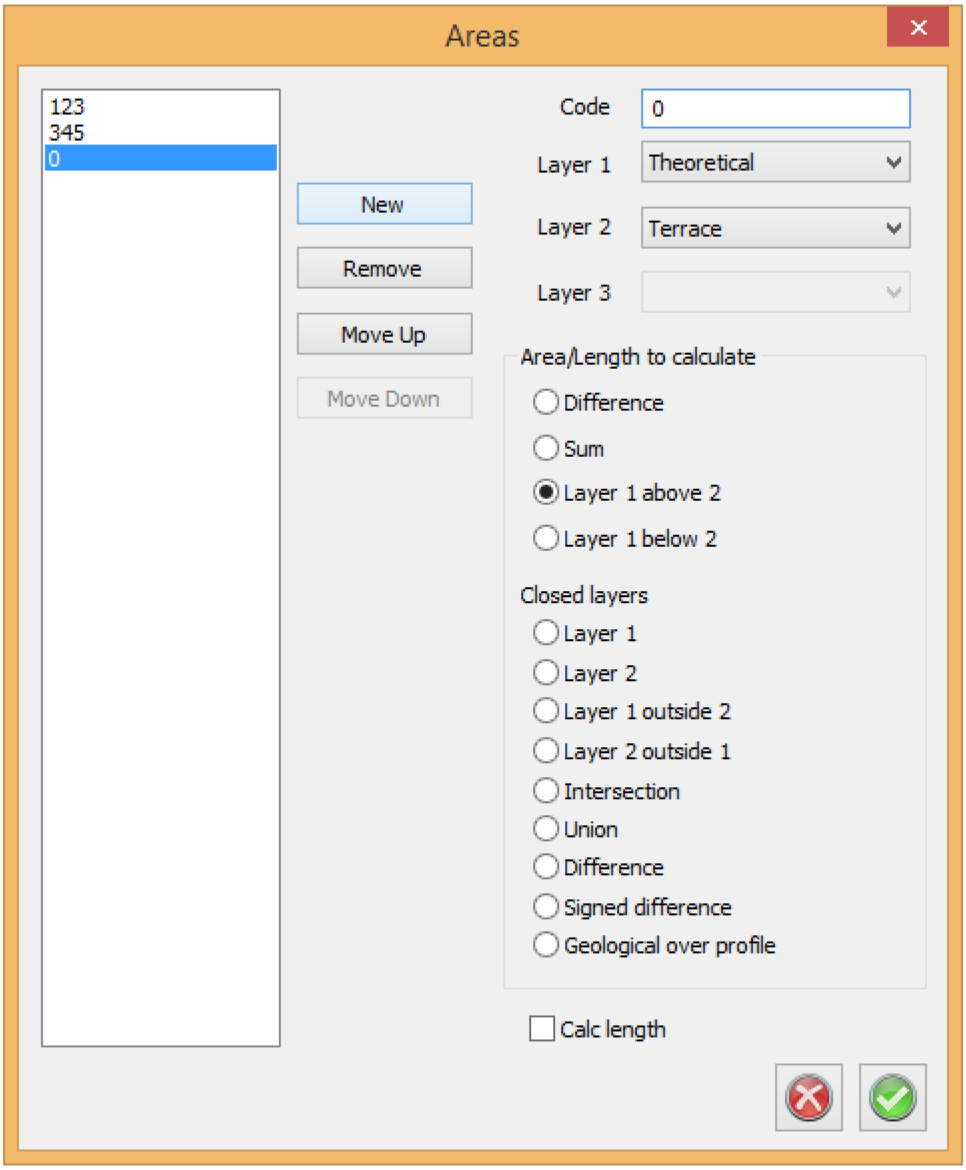
Section template|Mirror

Mirror command to section templates, select between copying from left to right side, or from right to left side.



Areas

Section template|Areas



See also

For details of how to display sections in a drawing, refer to *Section* .

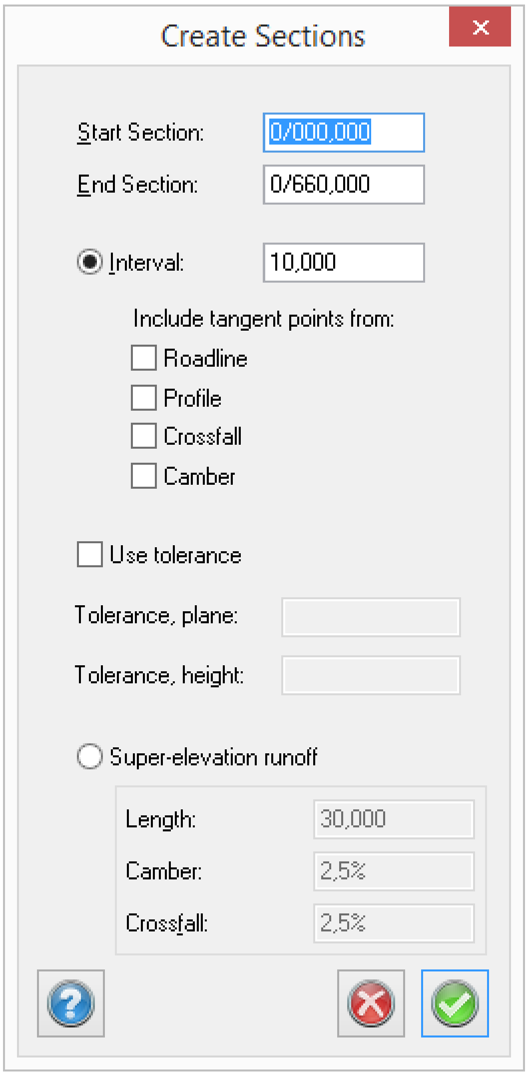
Calculated sections contents

Calculated section .TCS

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.

Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

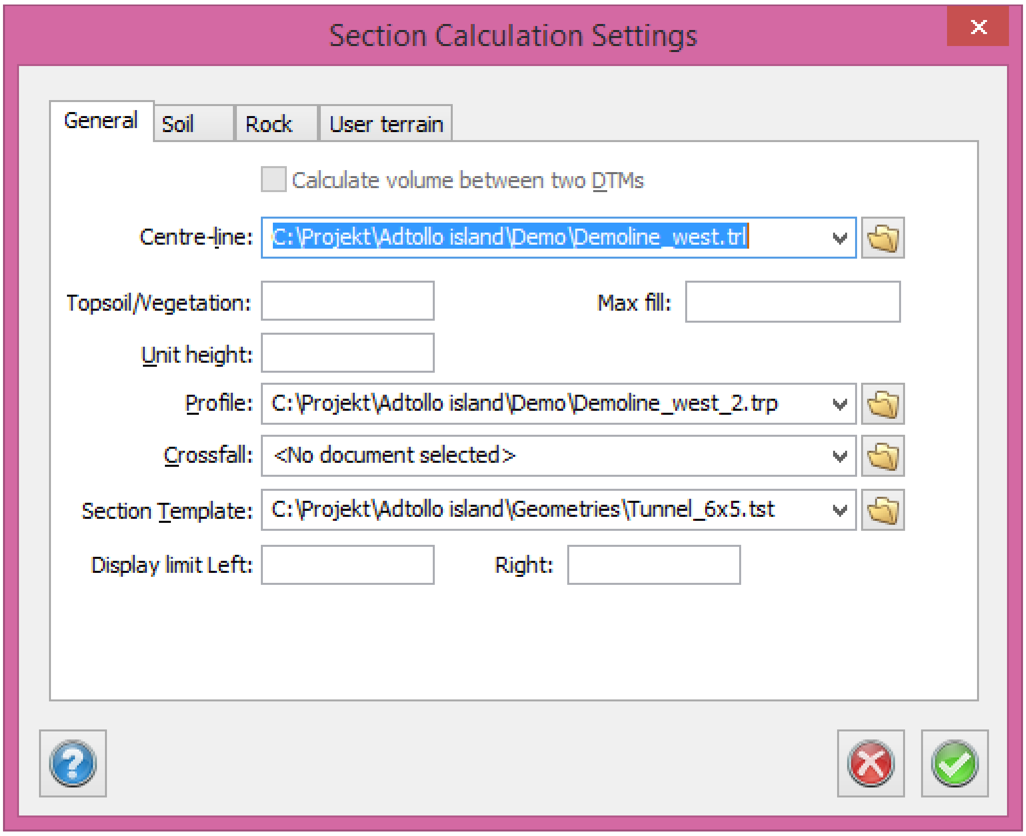
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

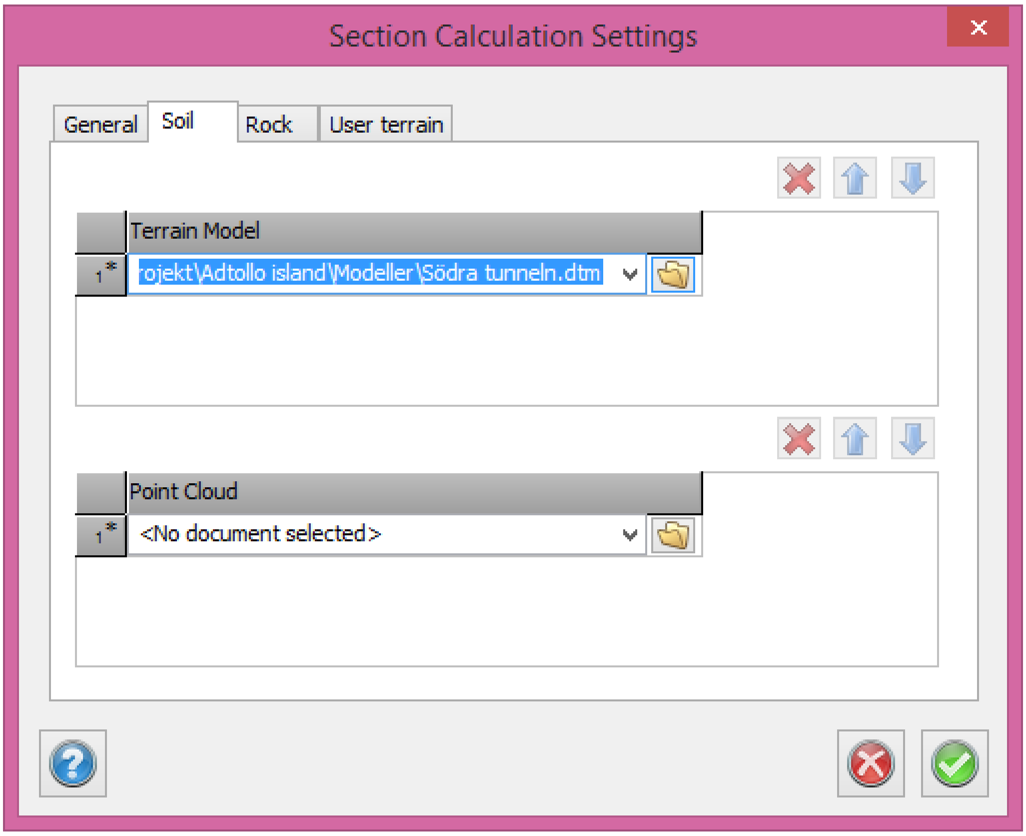
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

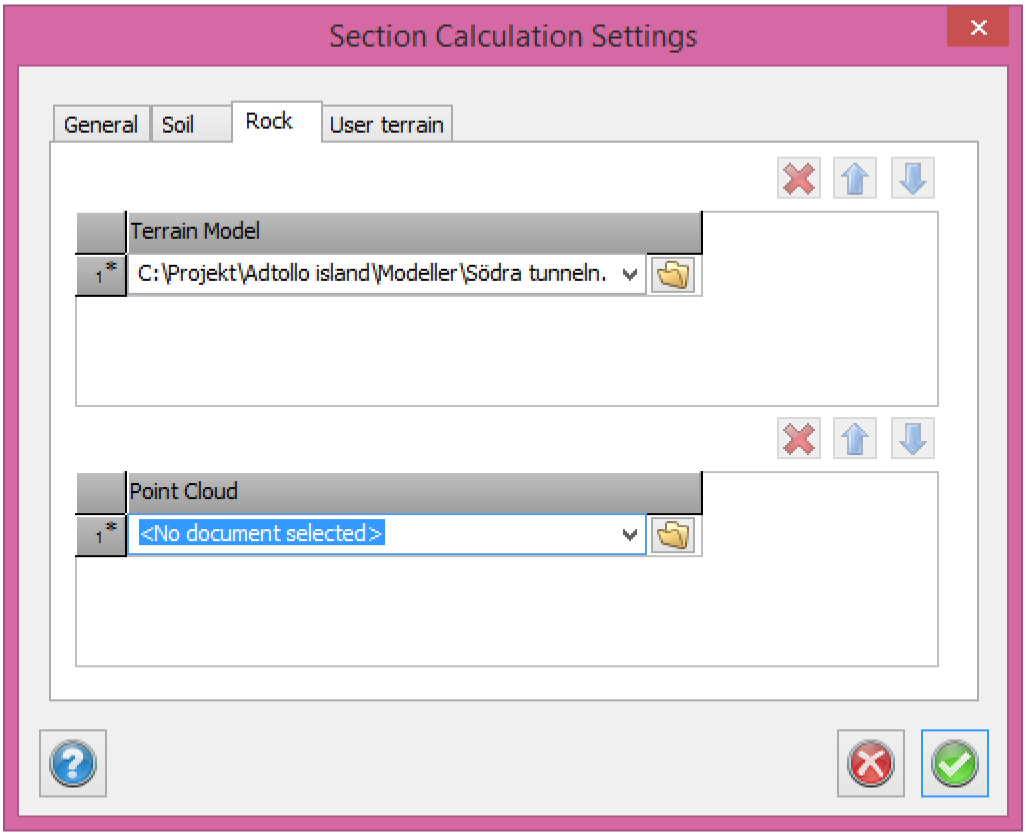
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

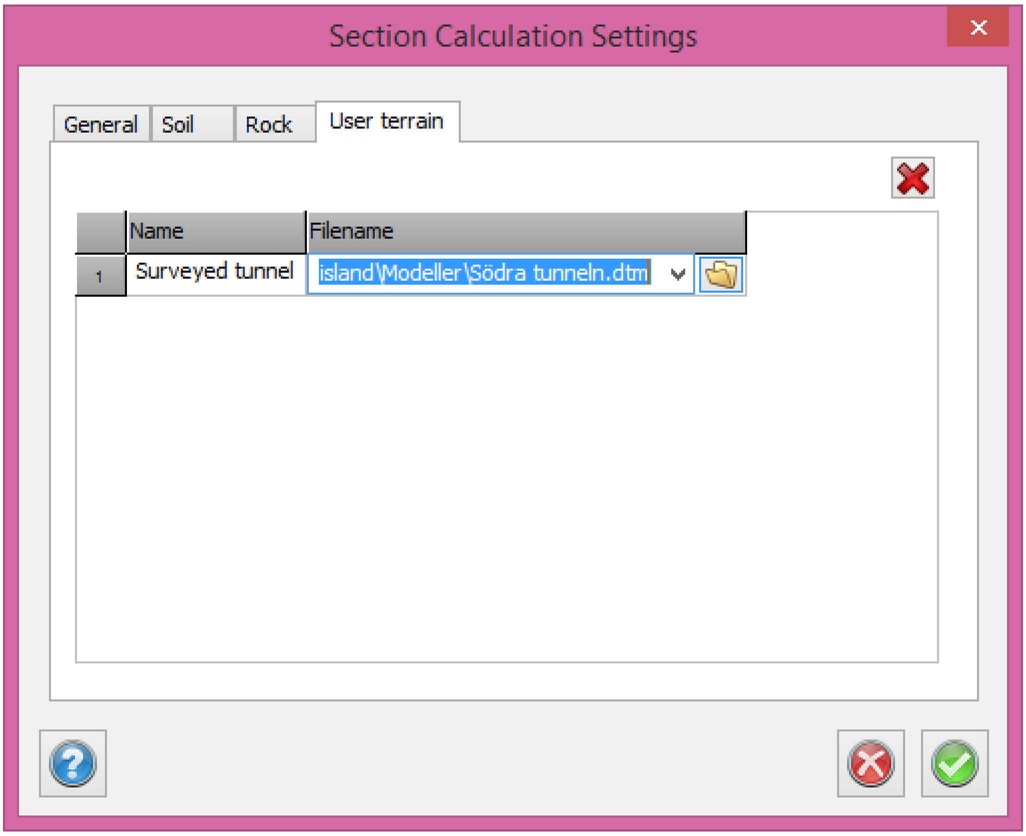
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

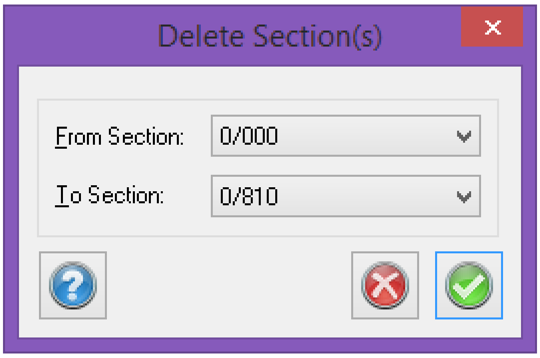
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

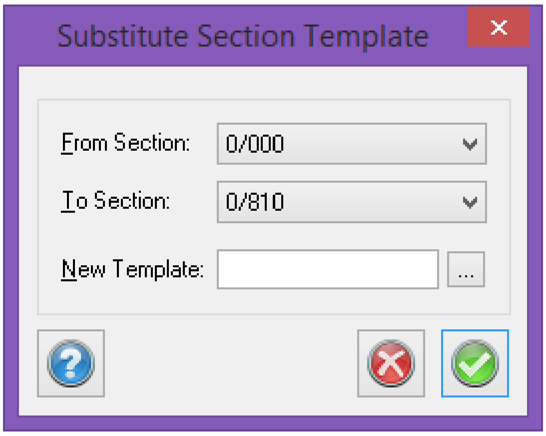
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

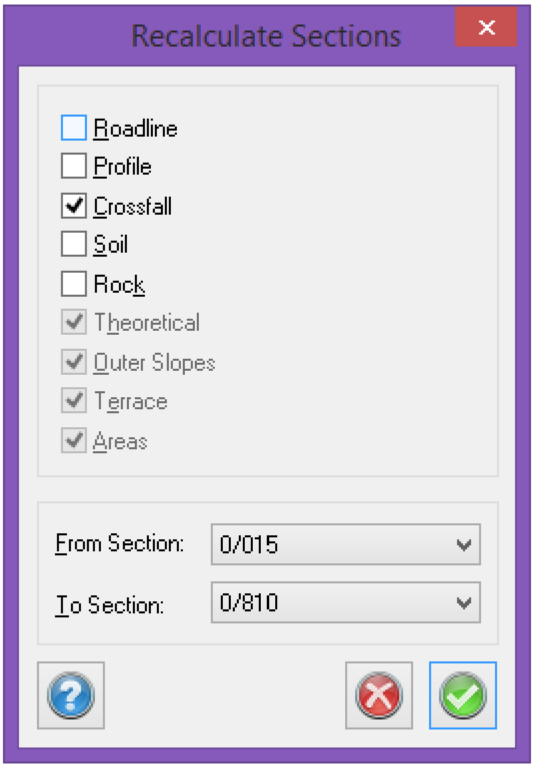


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

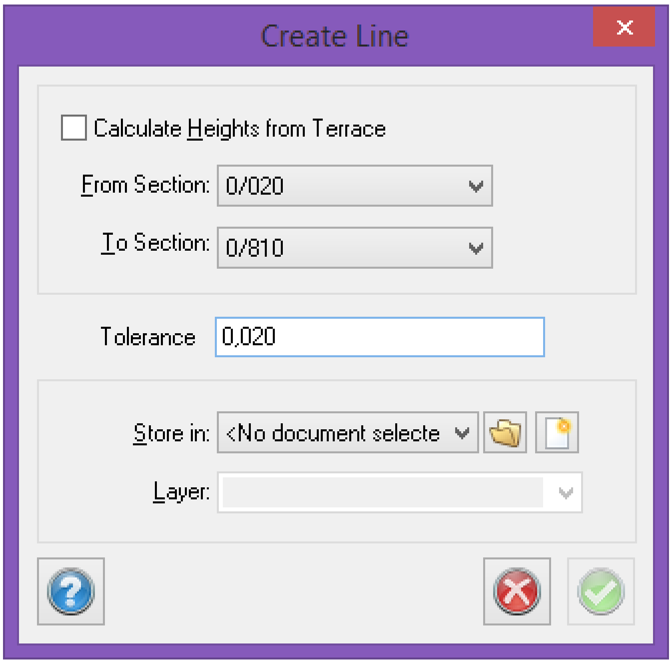
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

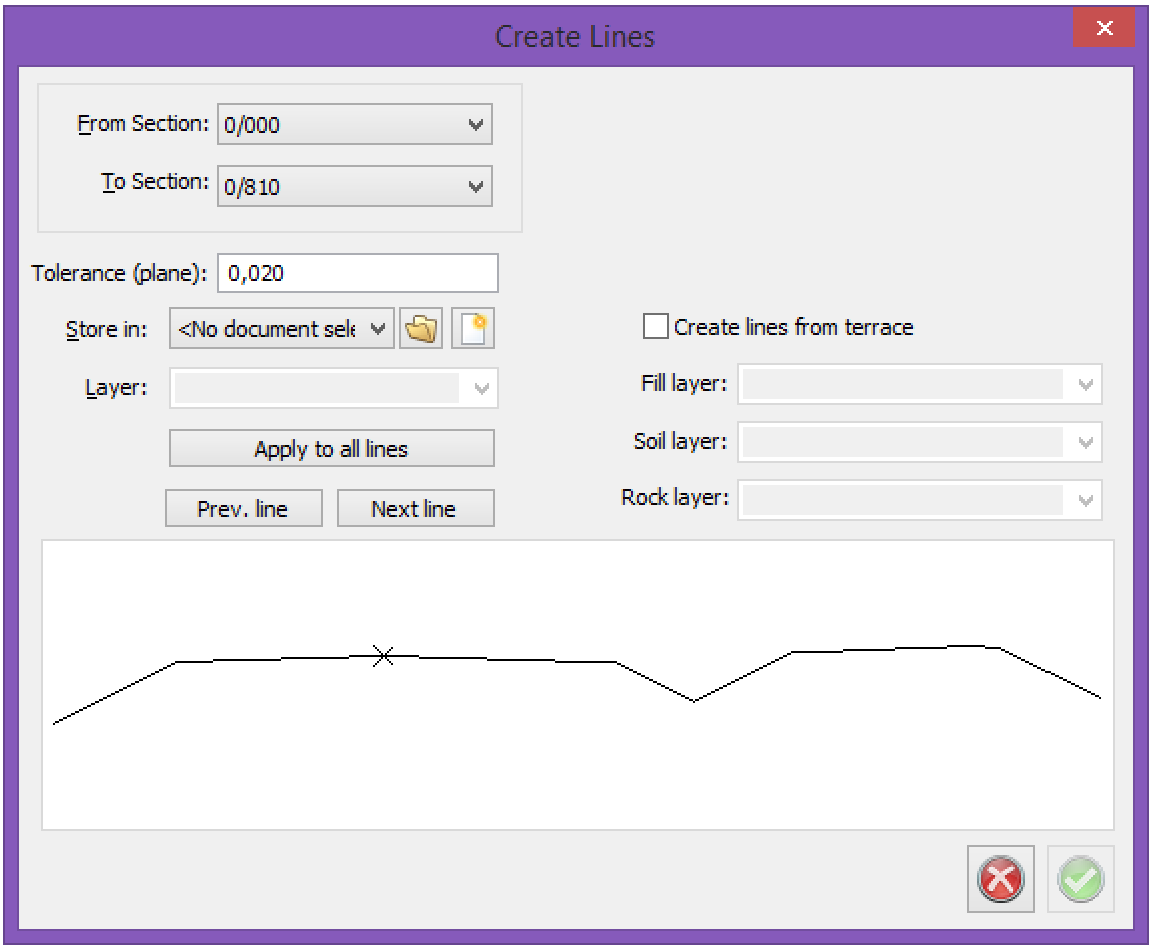
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

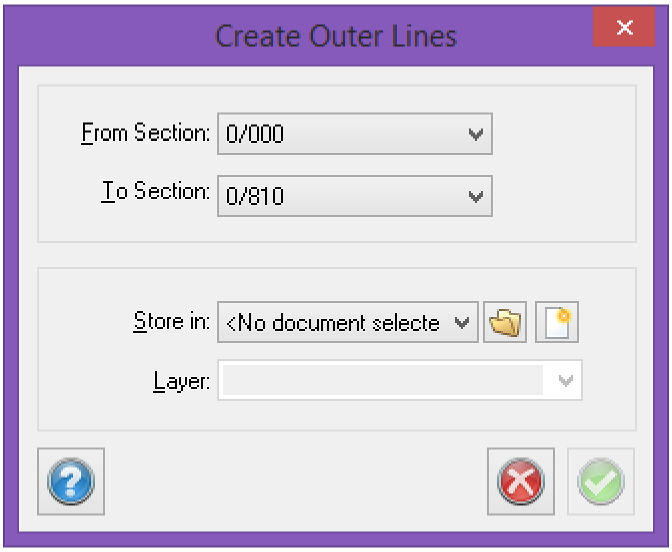
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

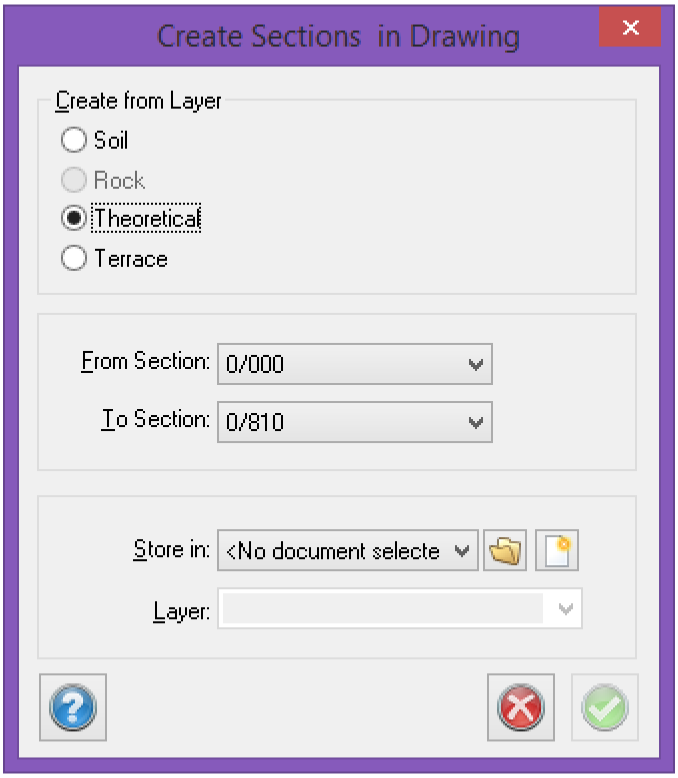
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

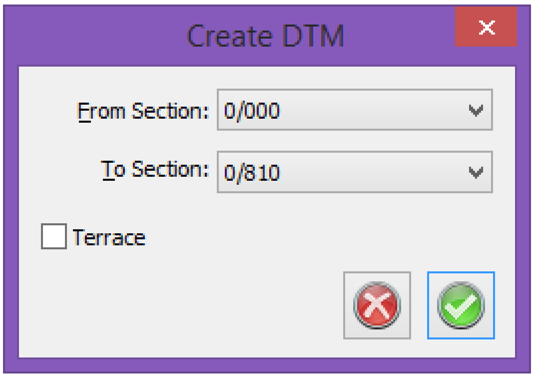


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

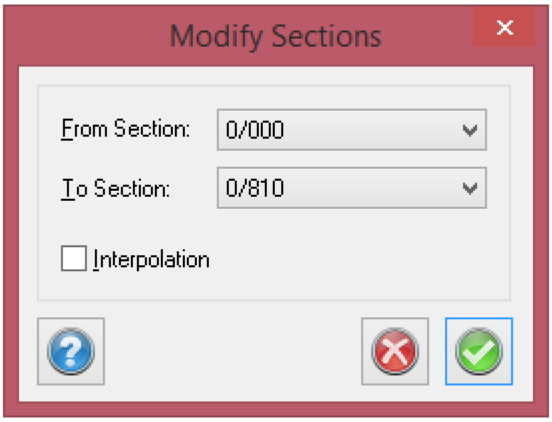


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

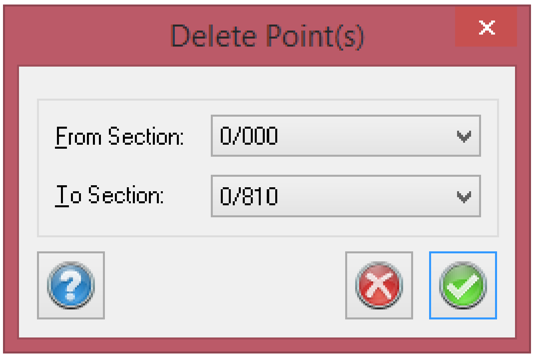
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

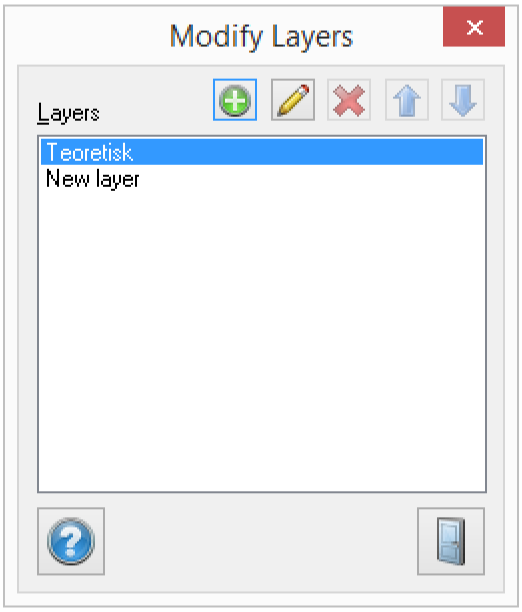
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

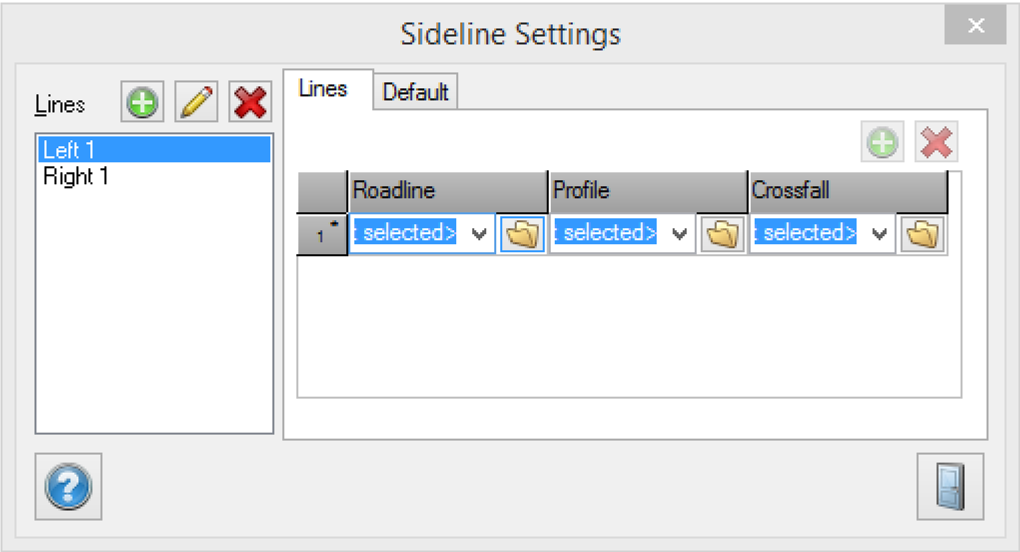


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

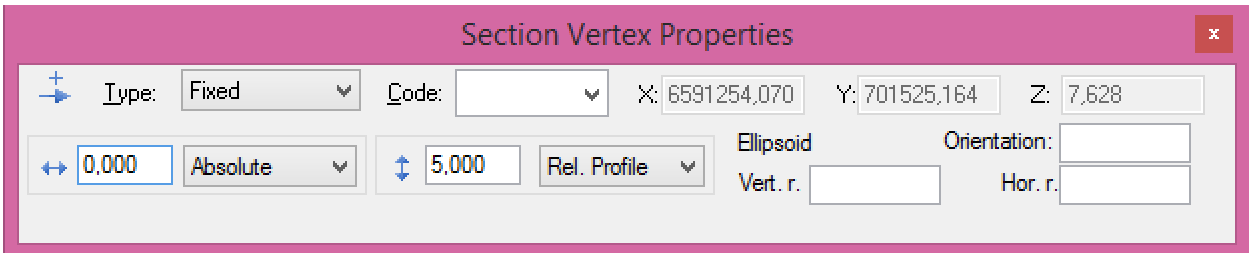
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



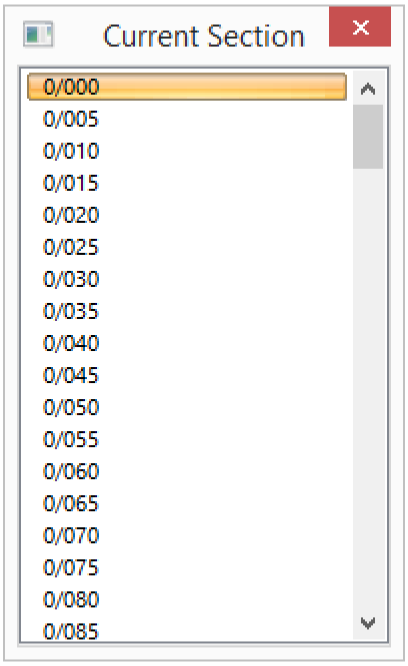
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

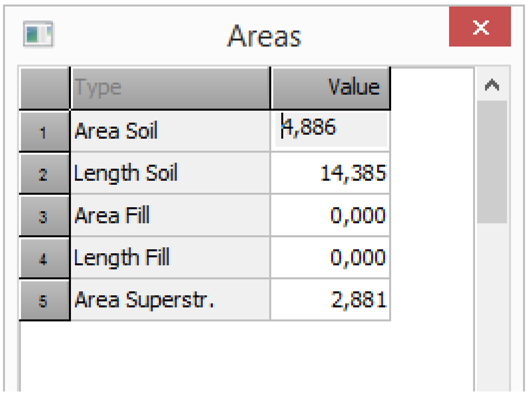
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



	Type	Value
1	Area Soil	4,886
2	Length Soil	14,385
3	Area Fill	0,000
4	Length Fill	0,000
5	Area Superstr.	2,881

Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

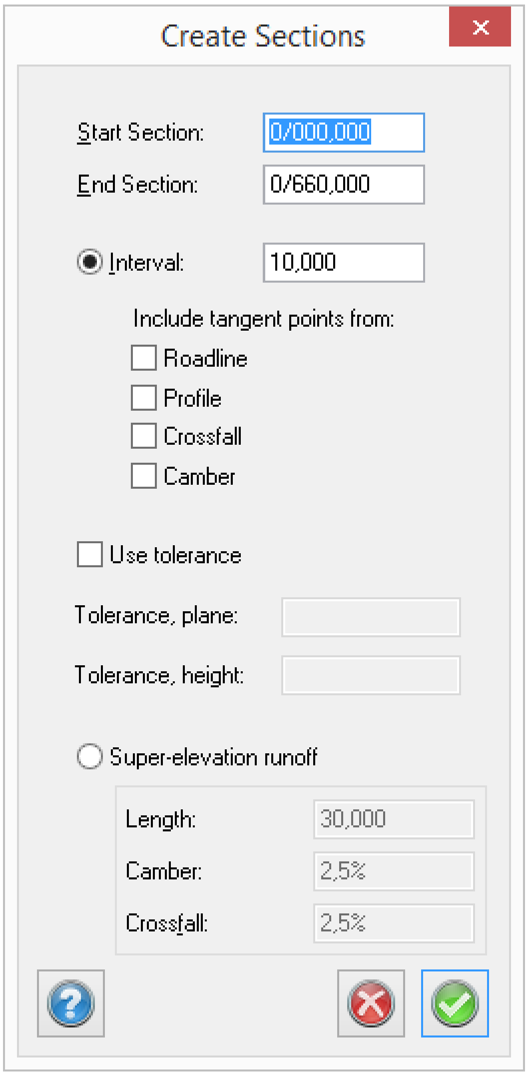
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

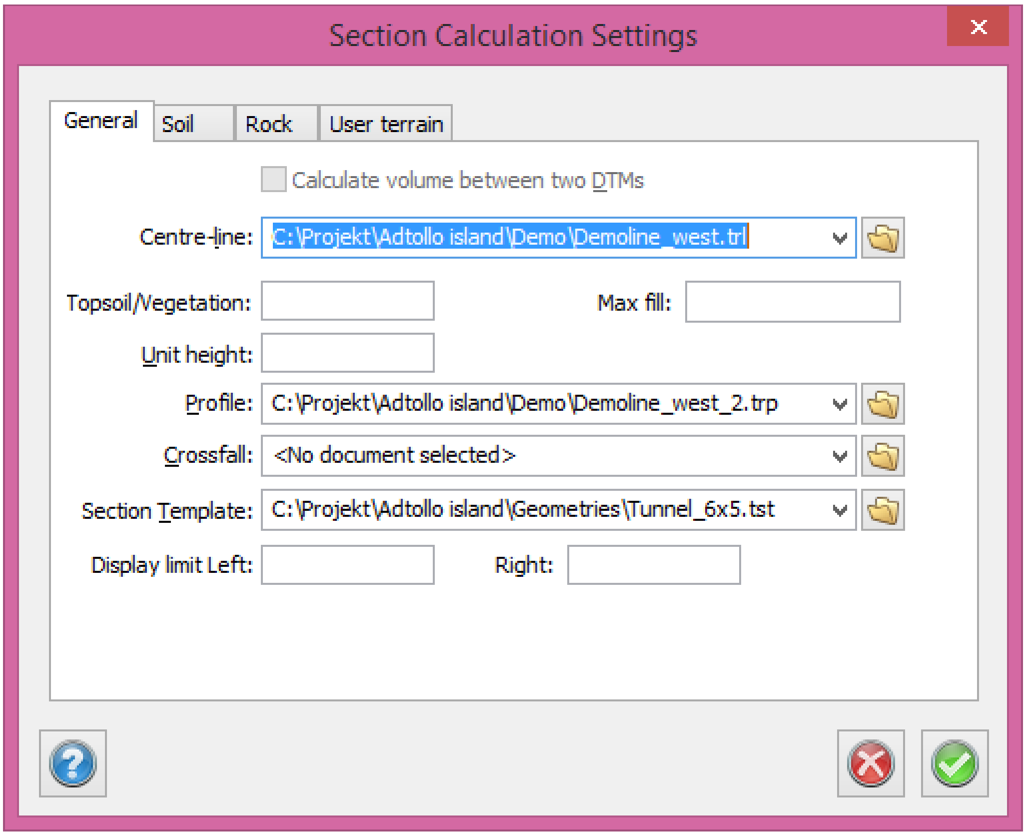
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

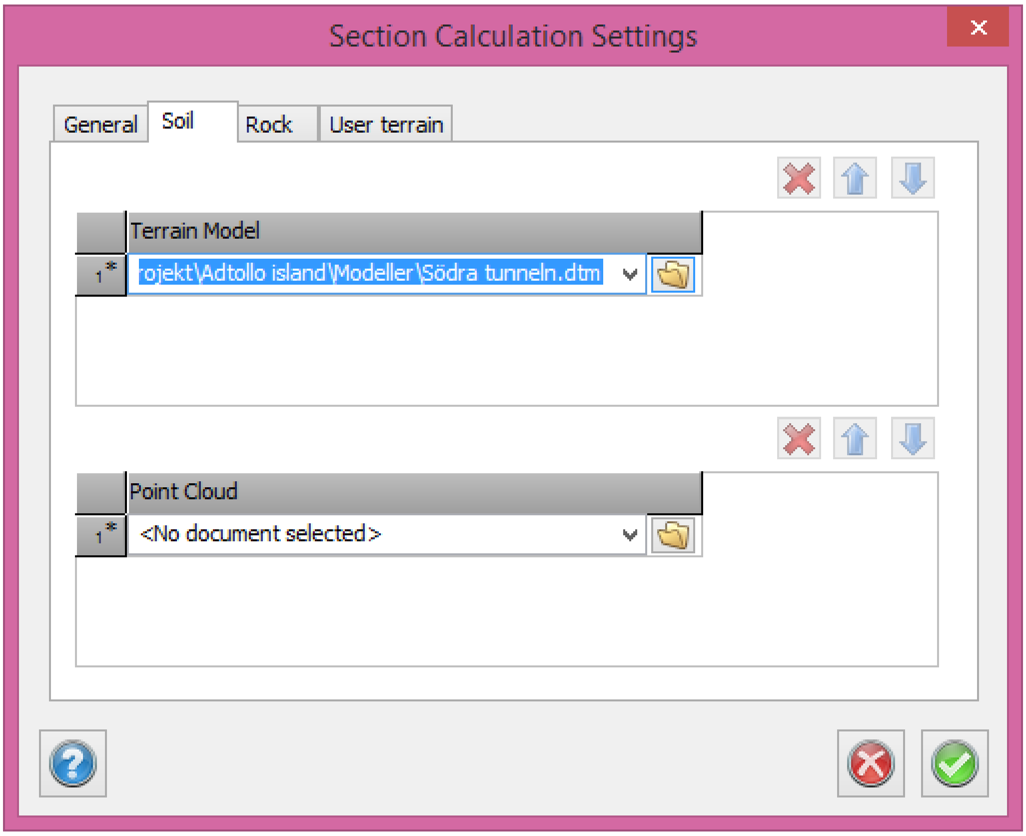
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

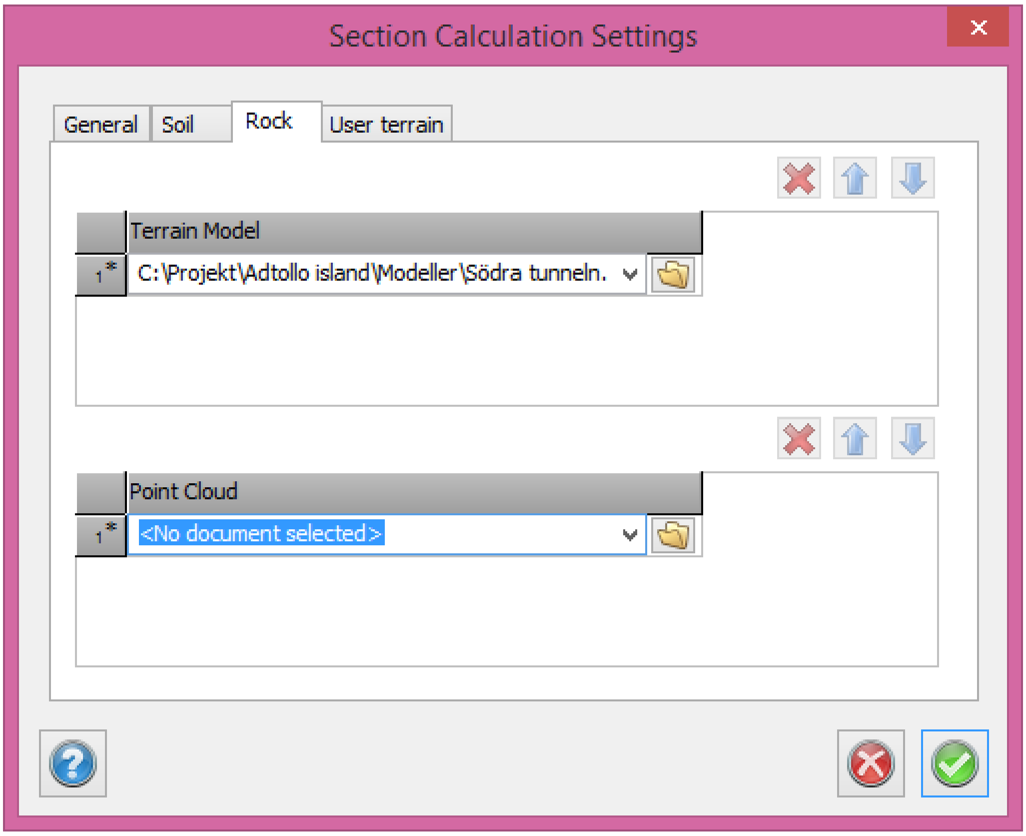
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

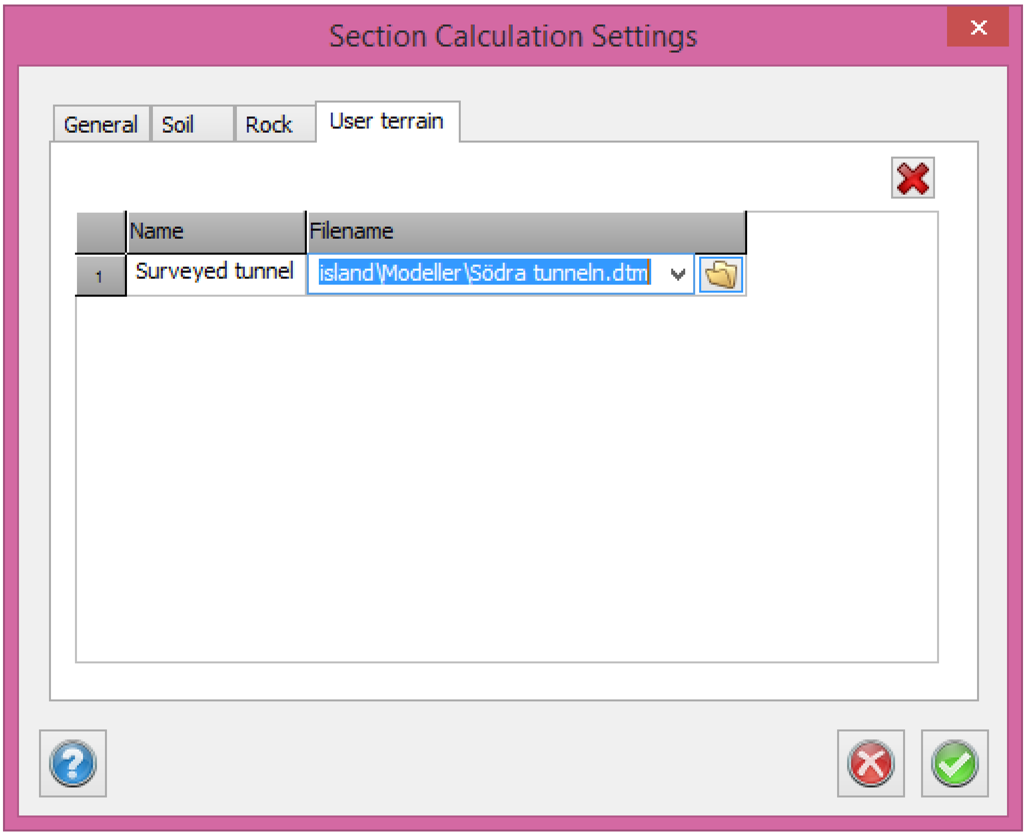
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

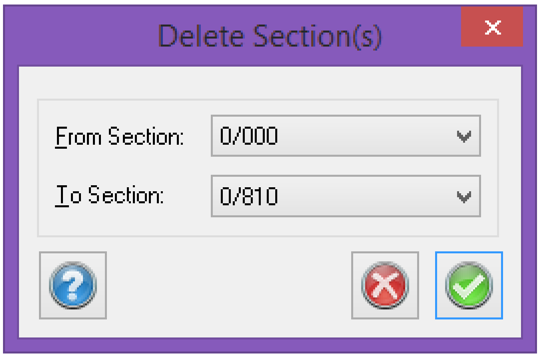
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

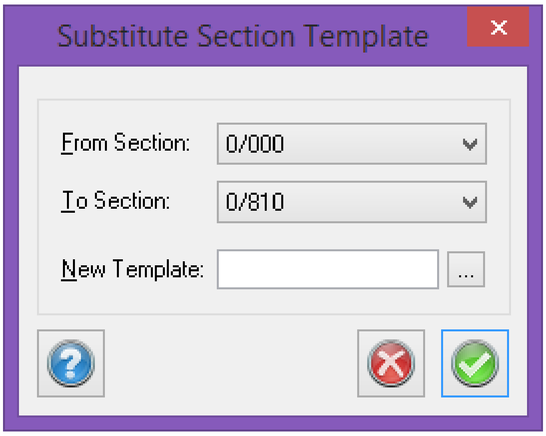
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

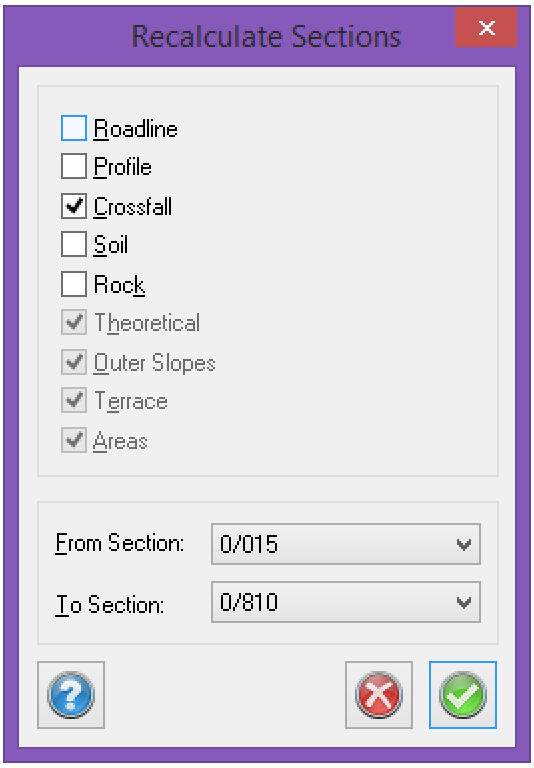


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

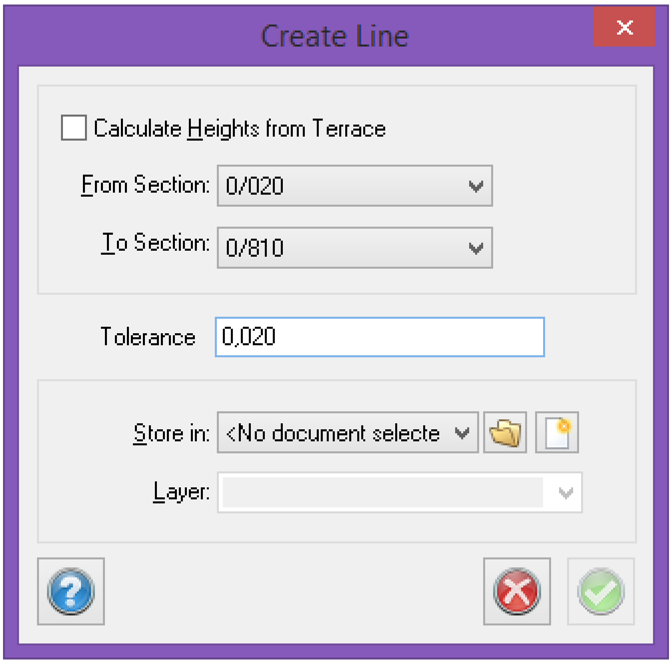
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

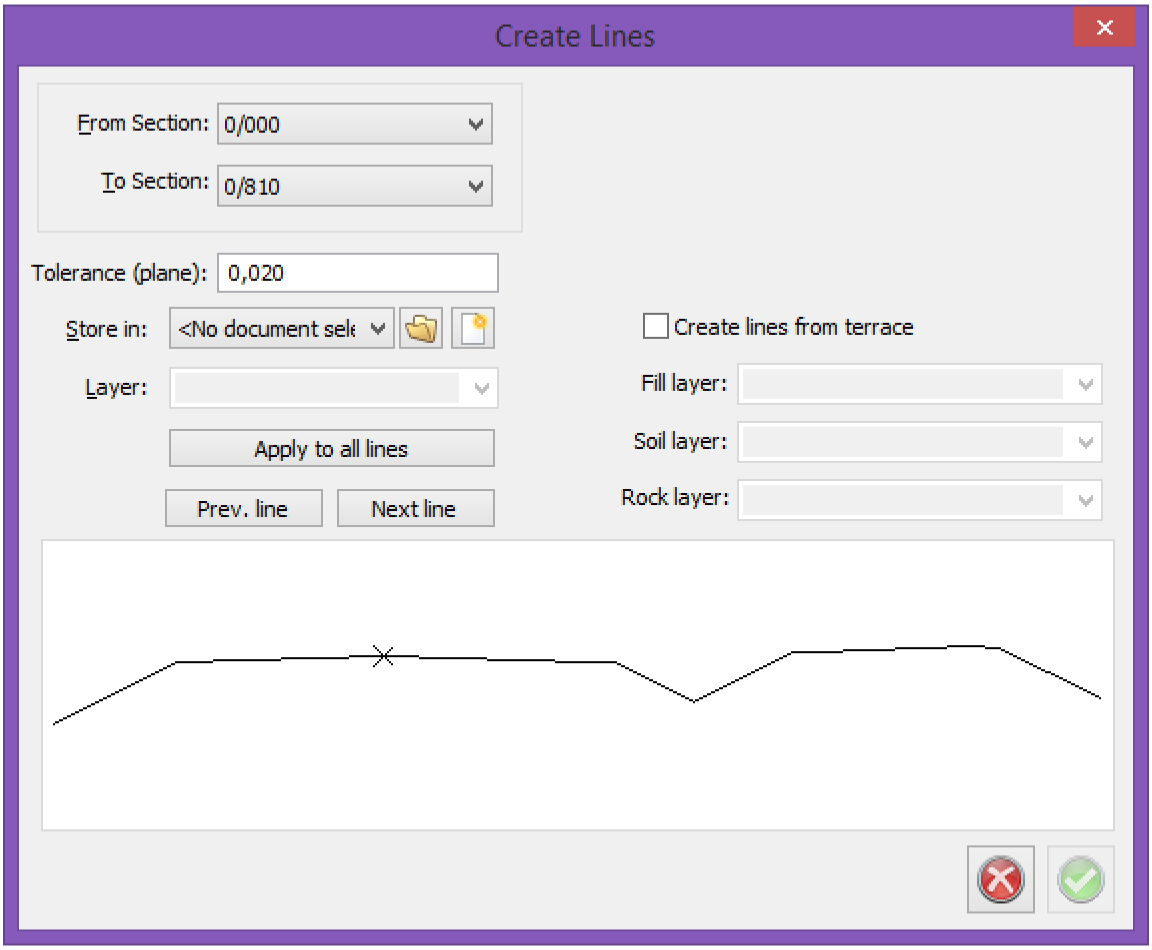
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

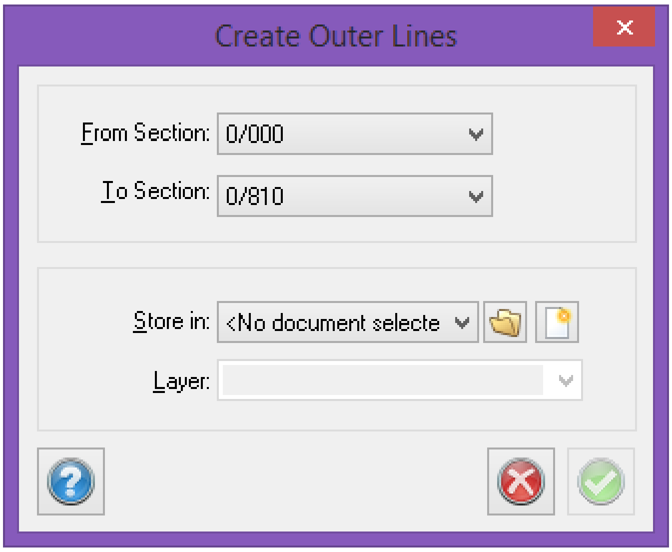
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

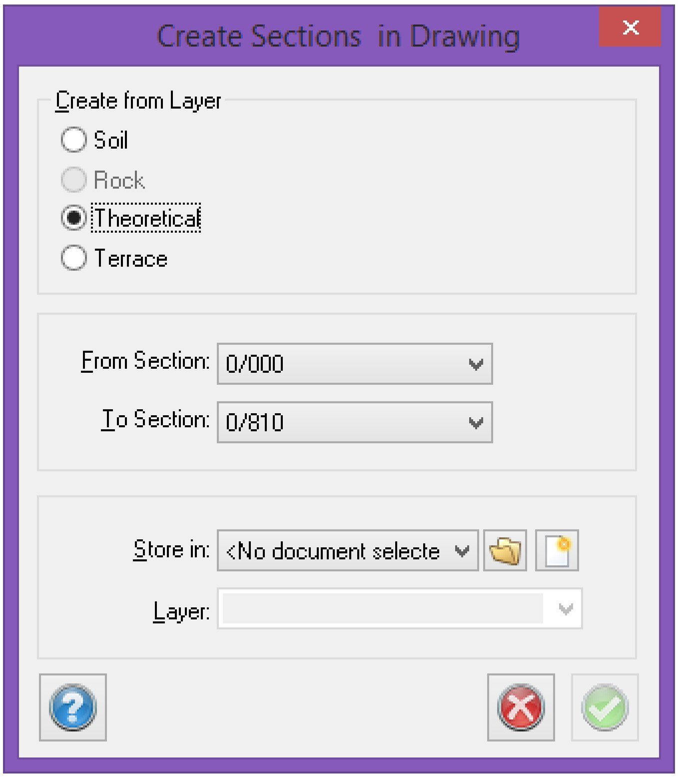
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

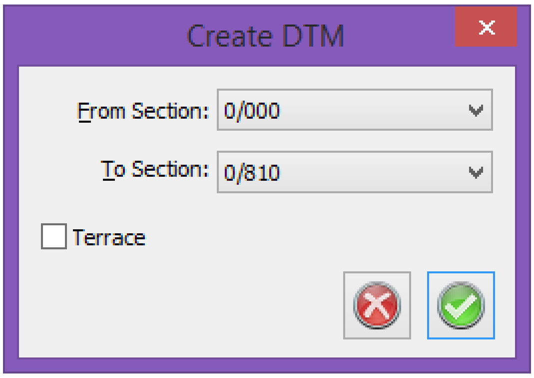


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

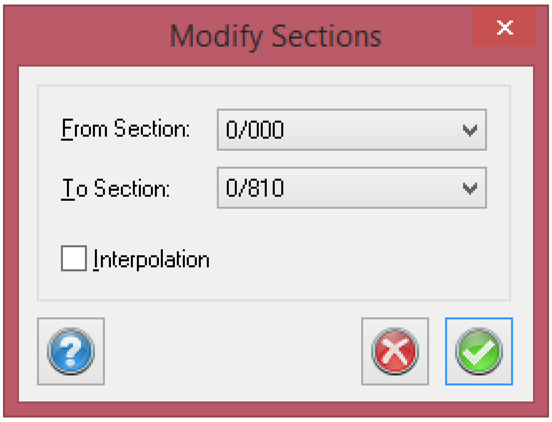


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

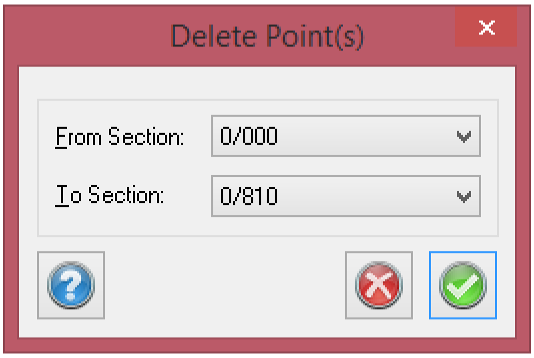
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

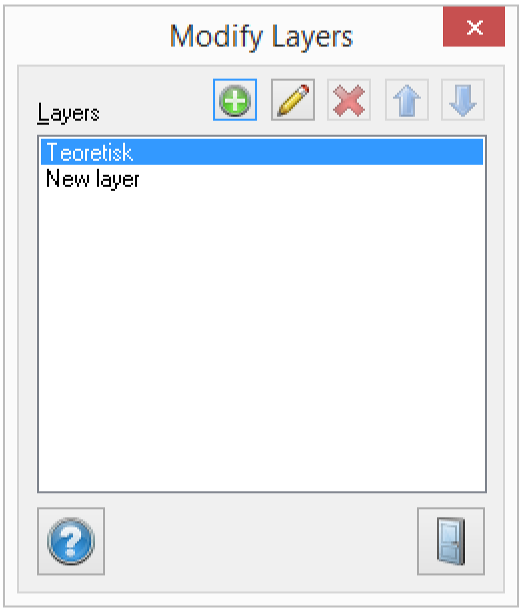
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

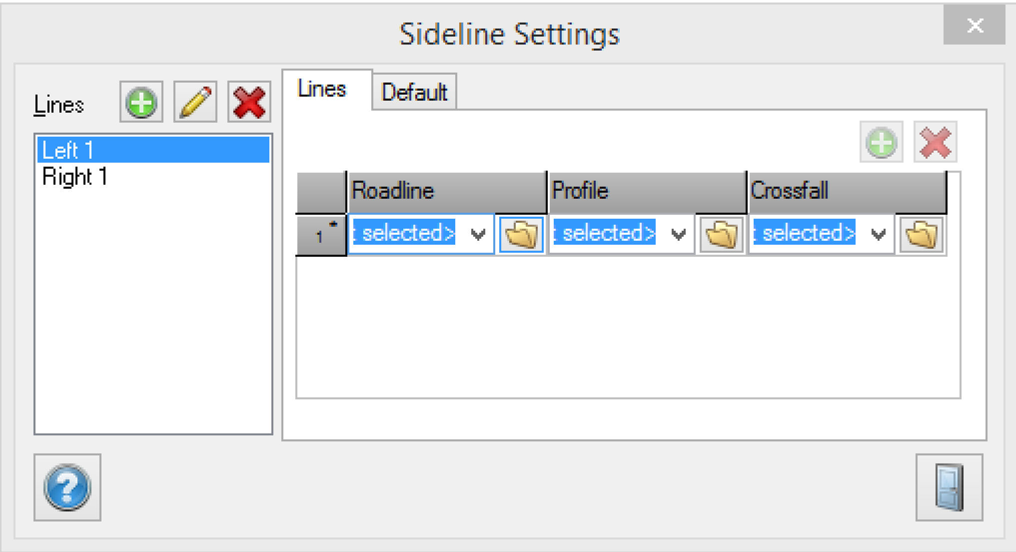


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

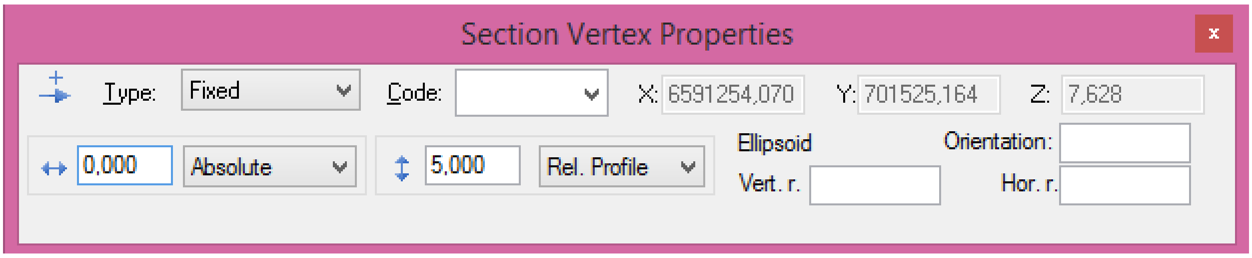
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



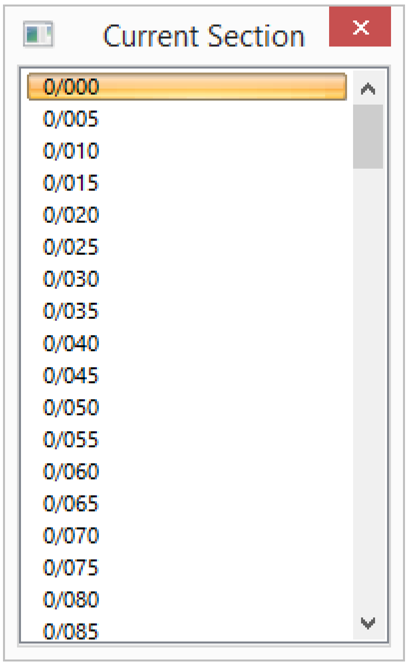
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

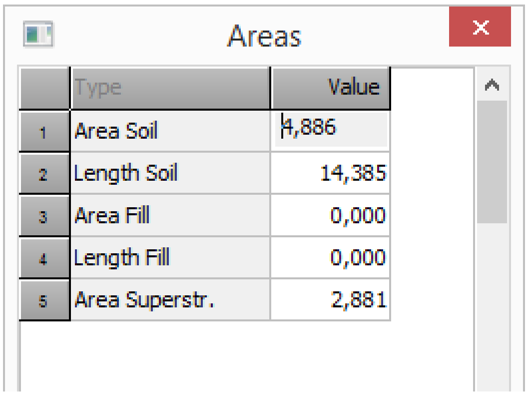
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

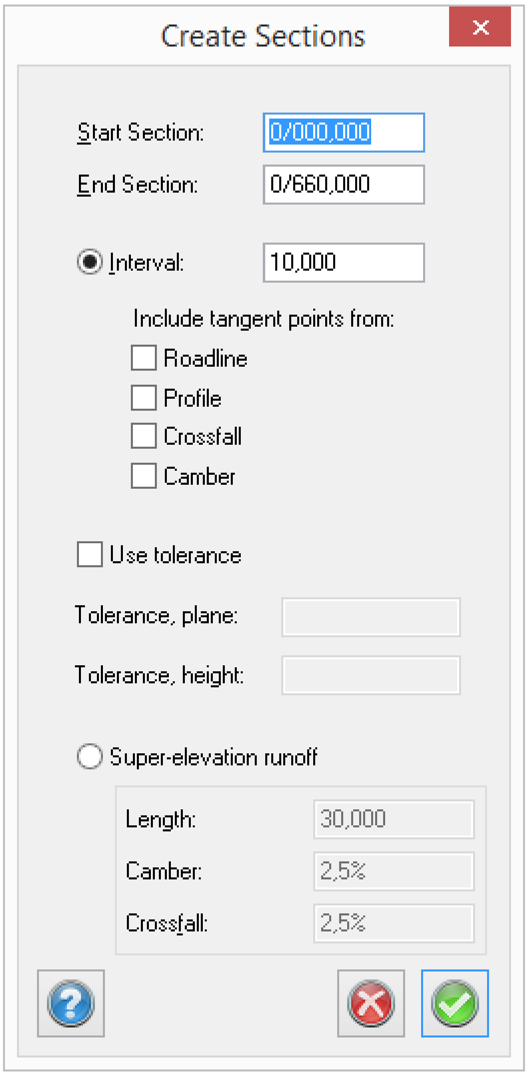
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

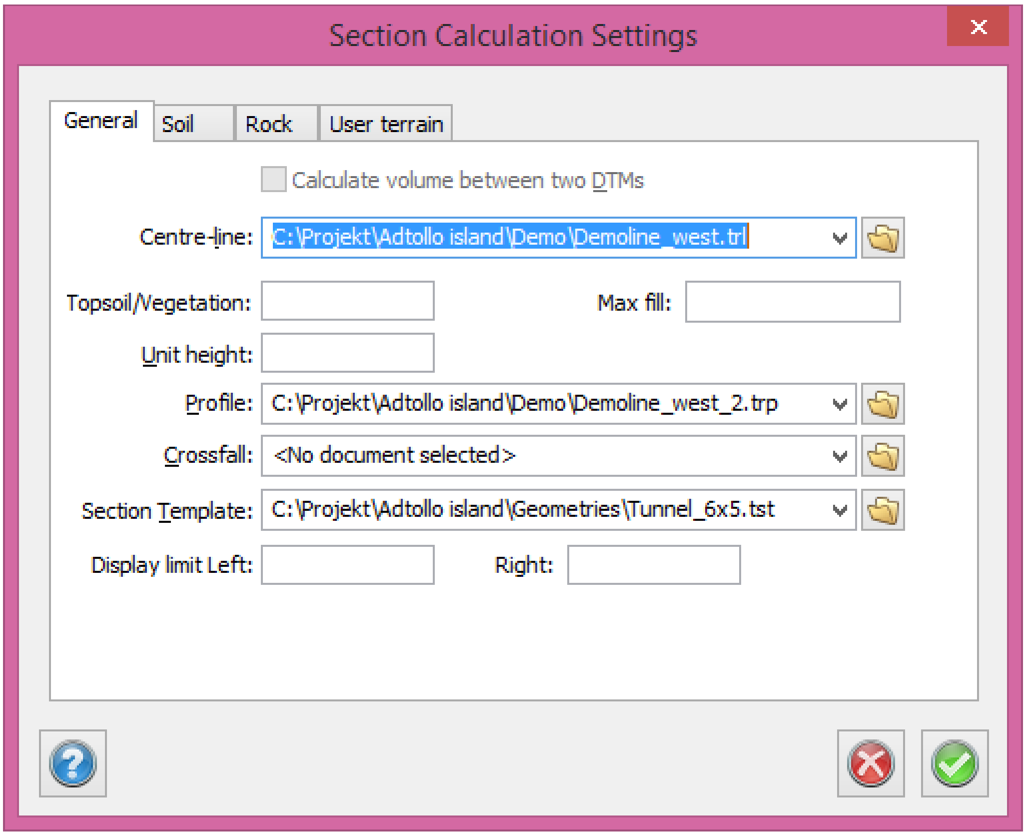
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

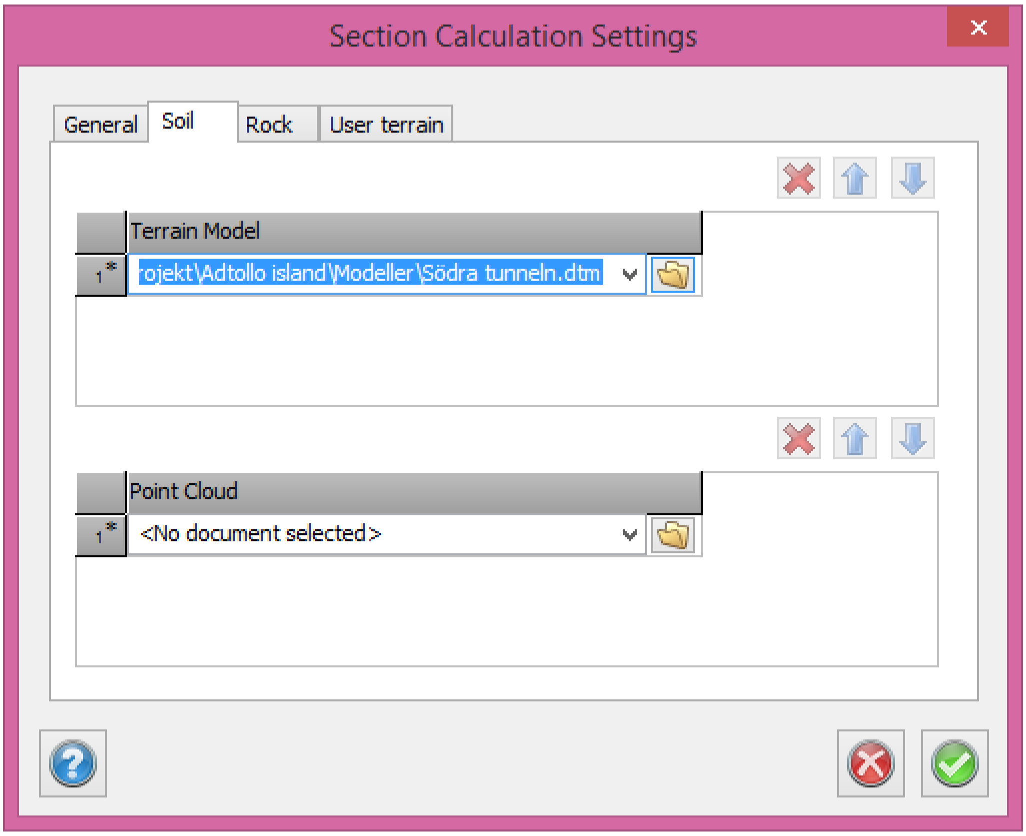
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

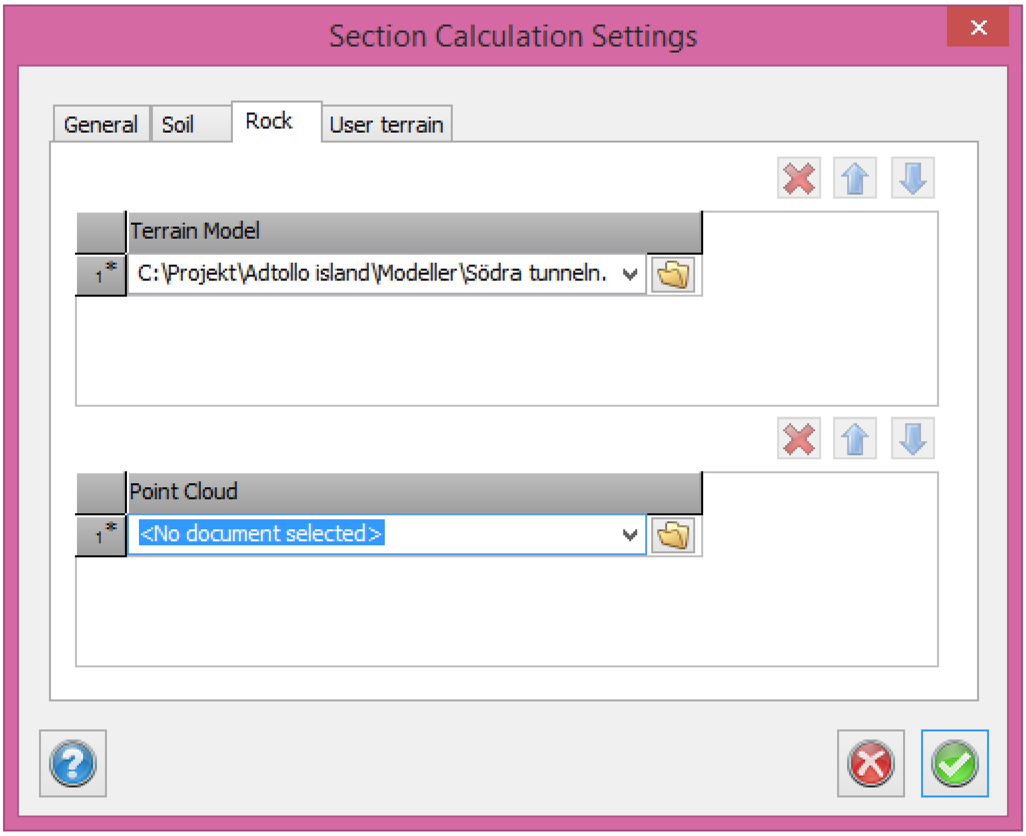
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

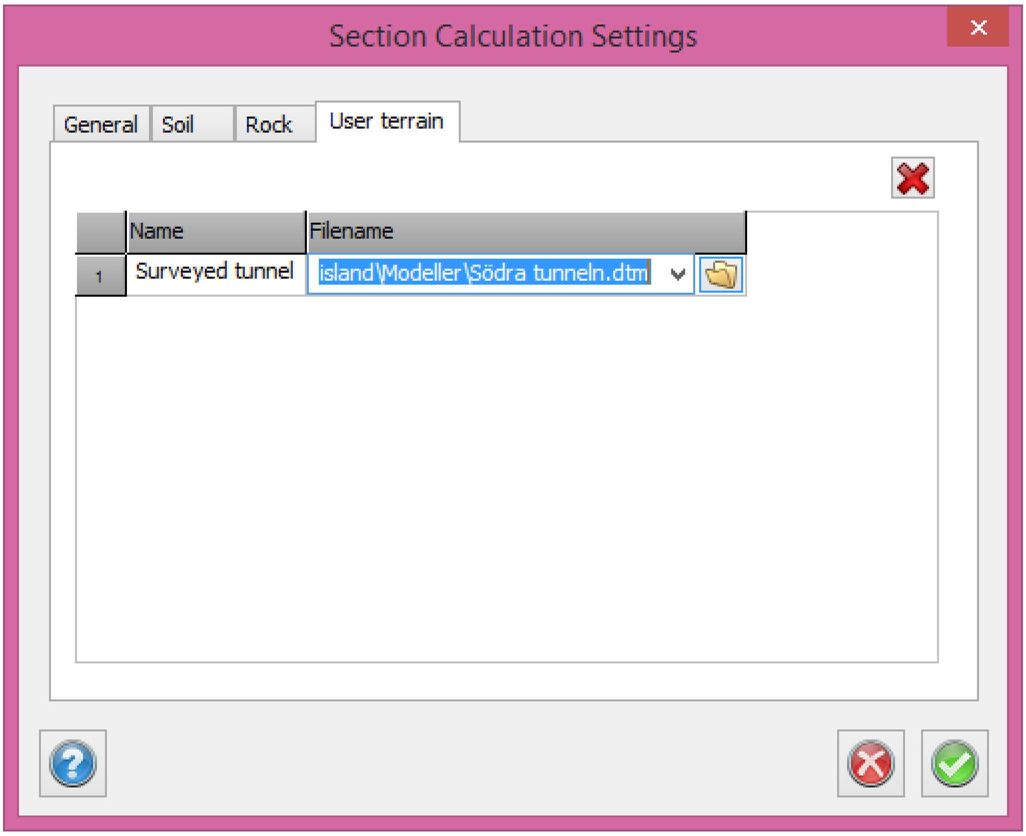
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

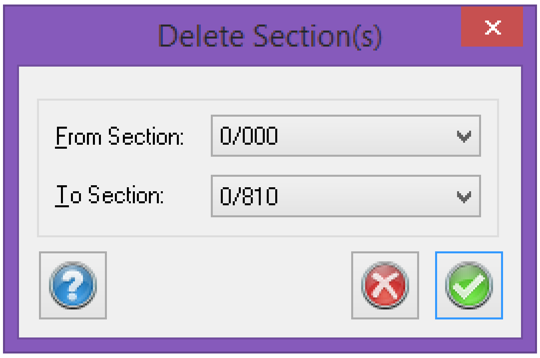
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

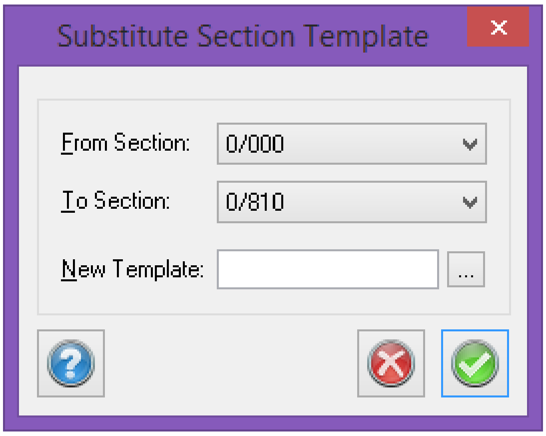
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

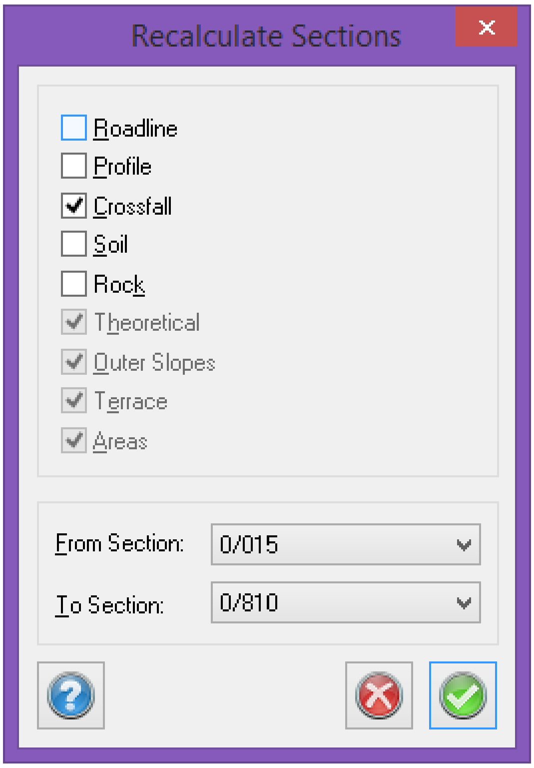


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

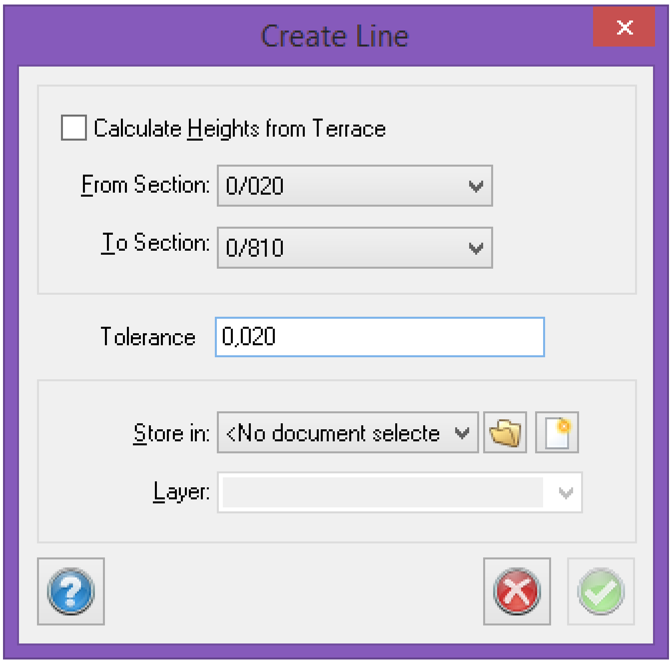
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

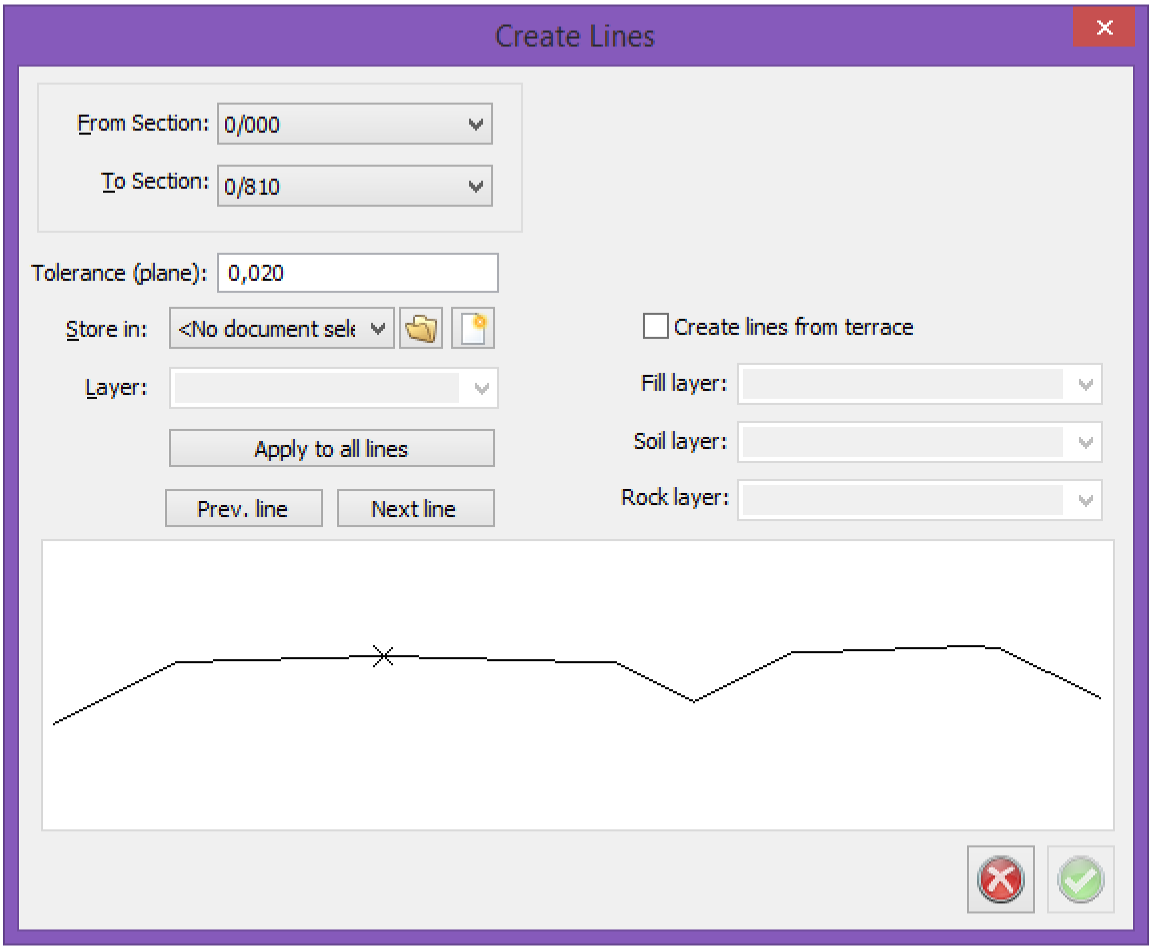
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

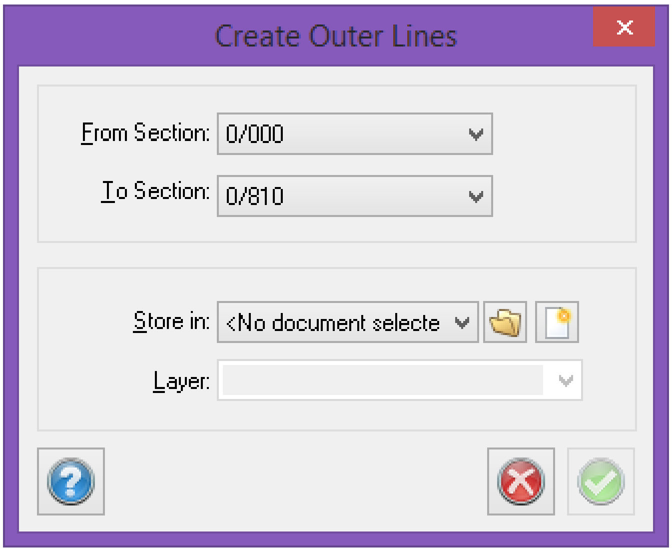
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

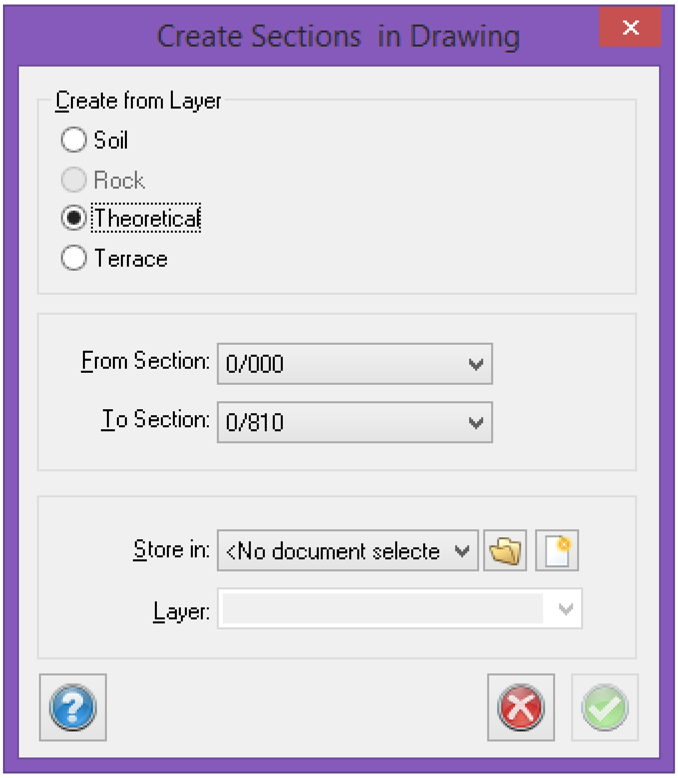
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

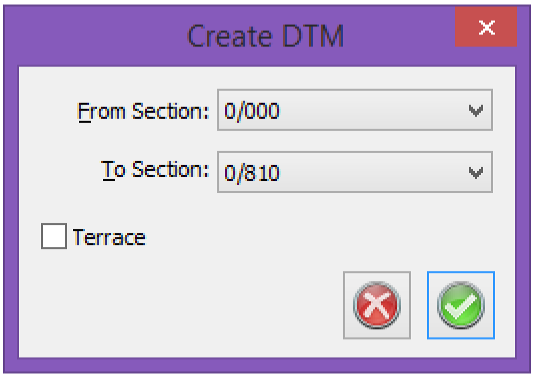


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

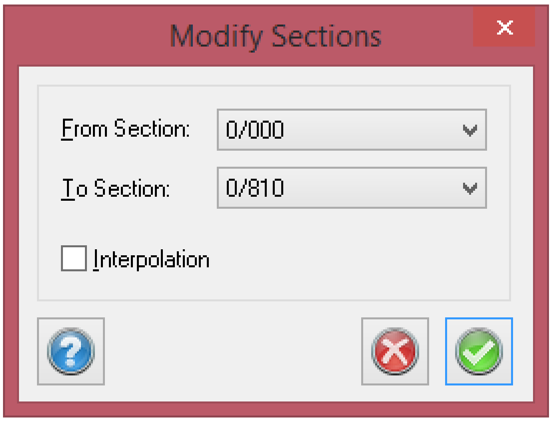


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

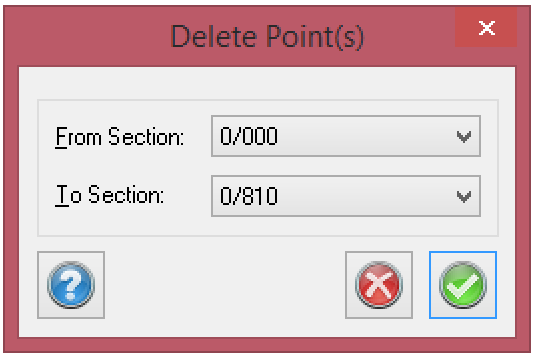
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

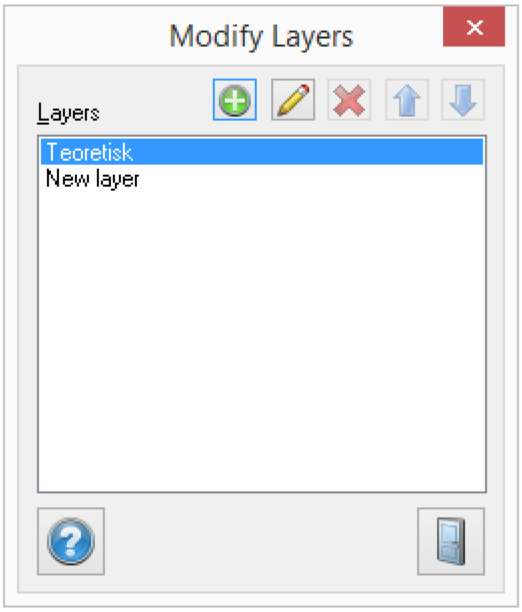
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

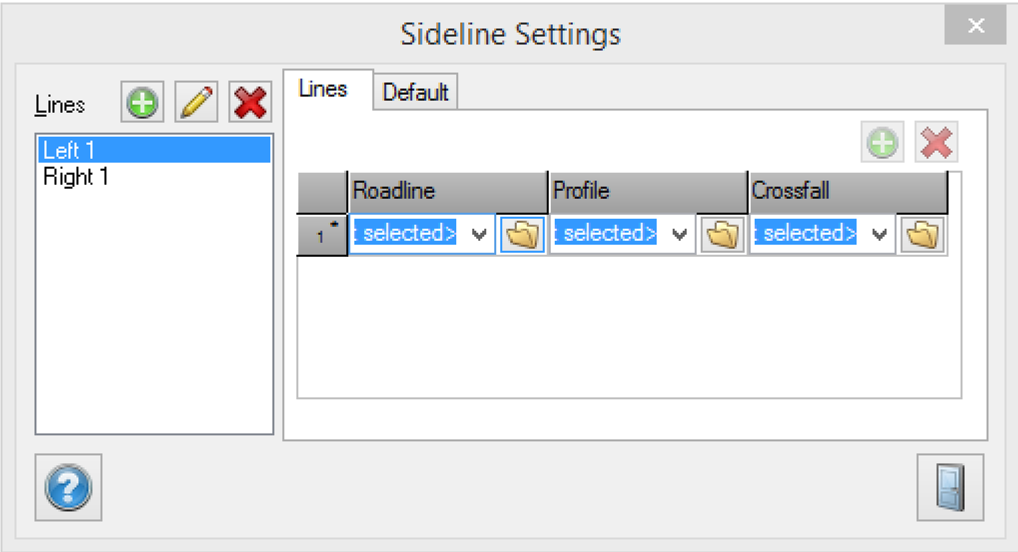


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

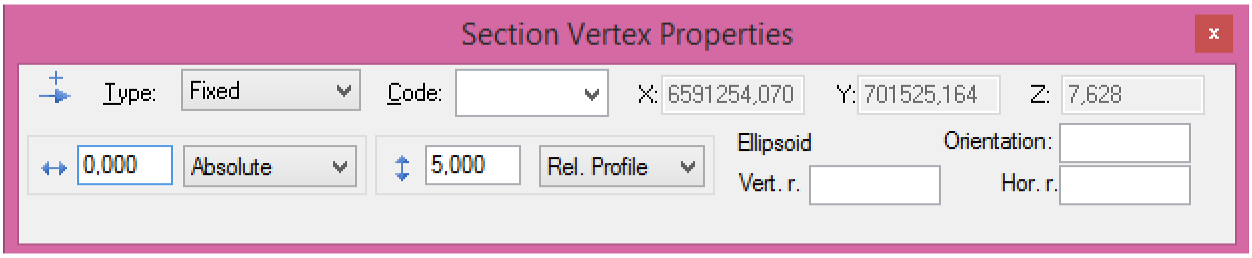
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



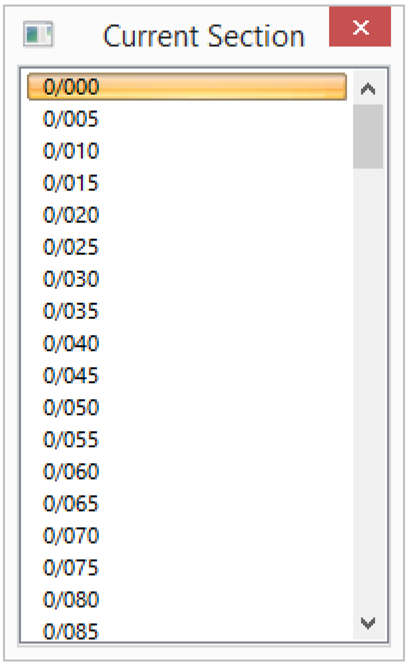
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

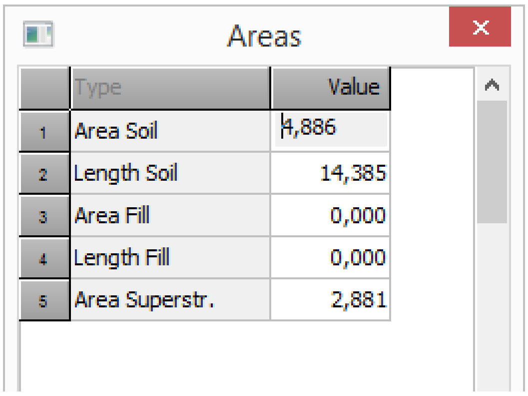
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

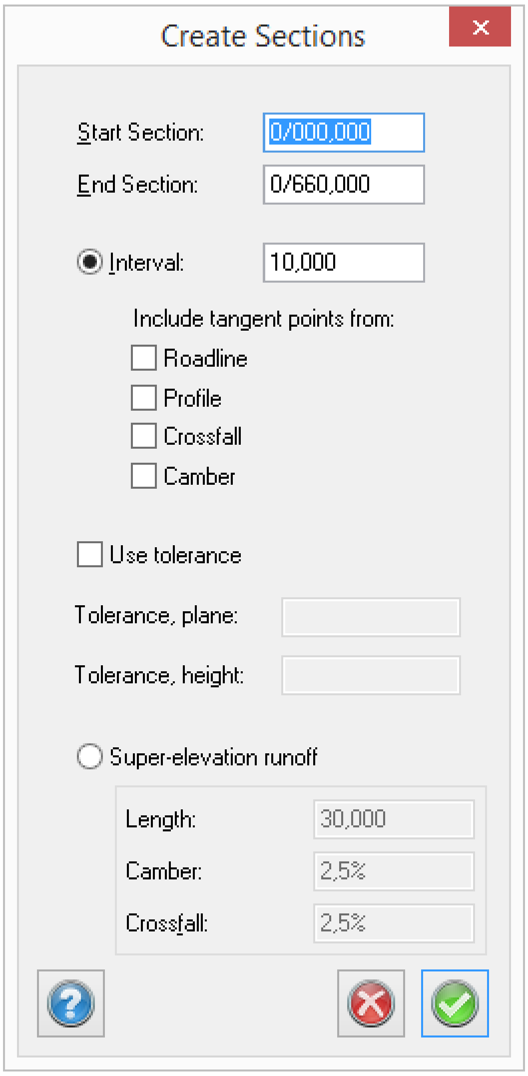
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

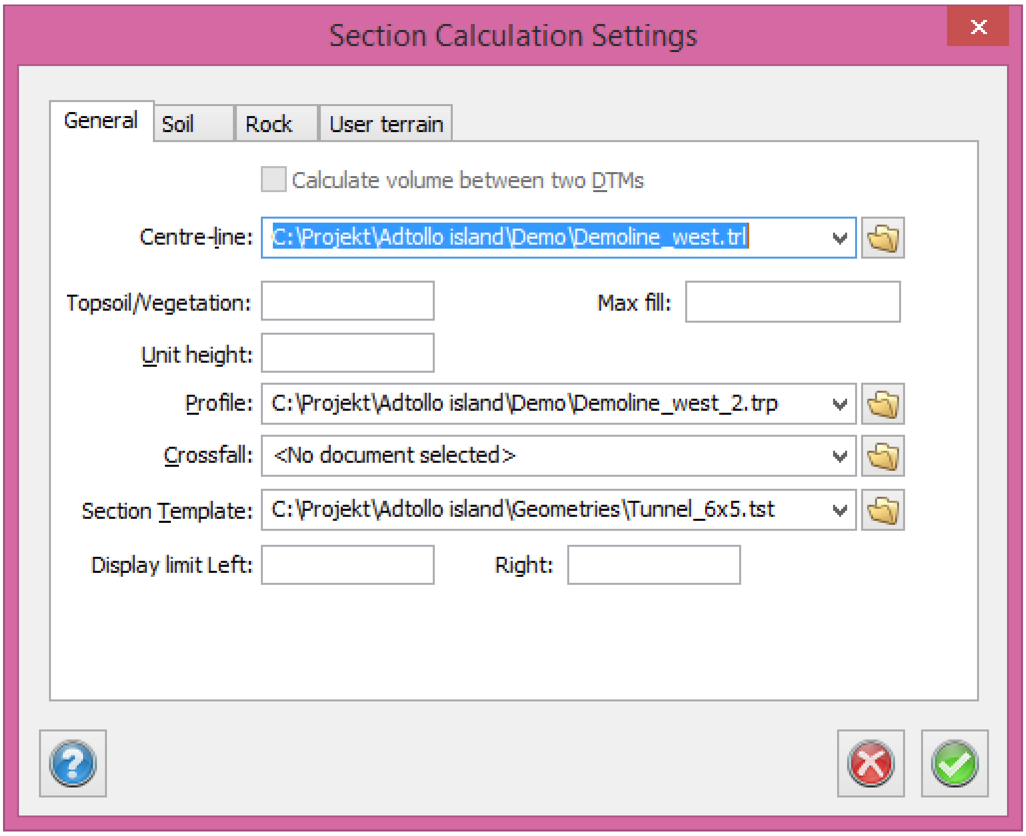
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

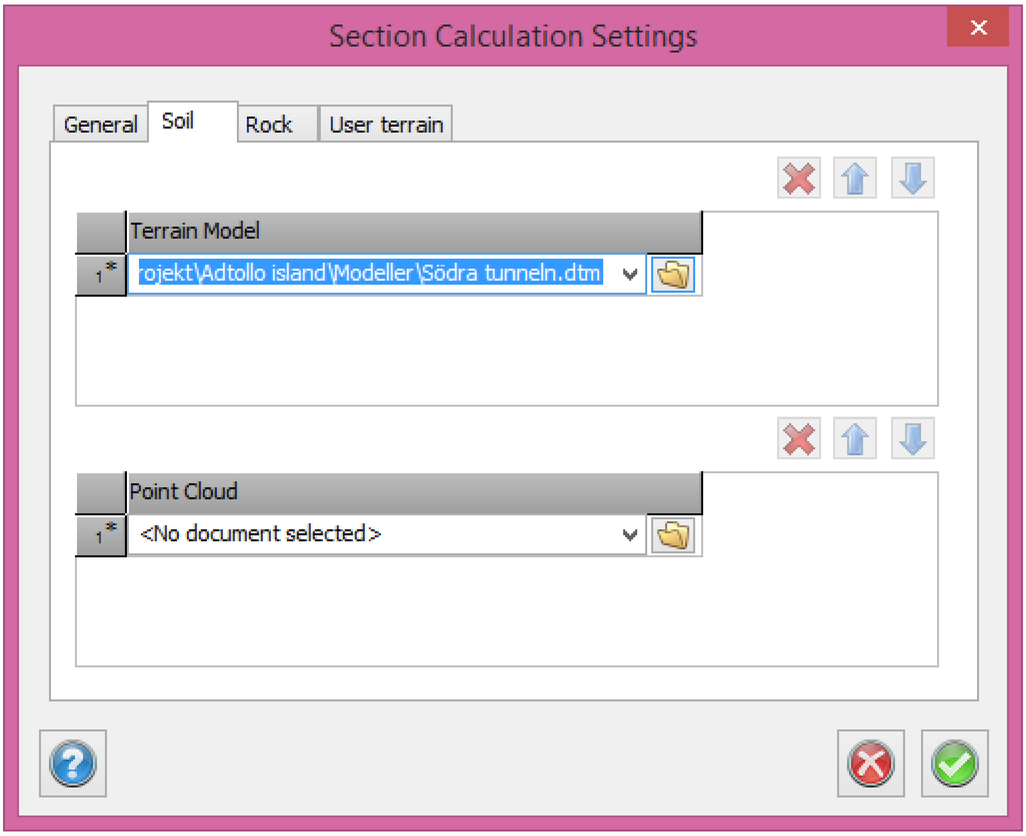
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

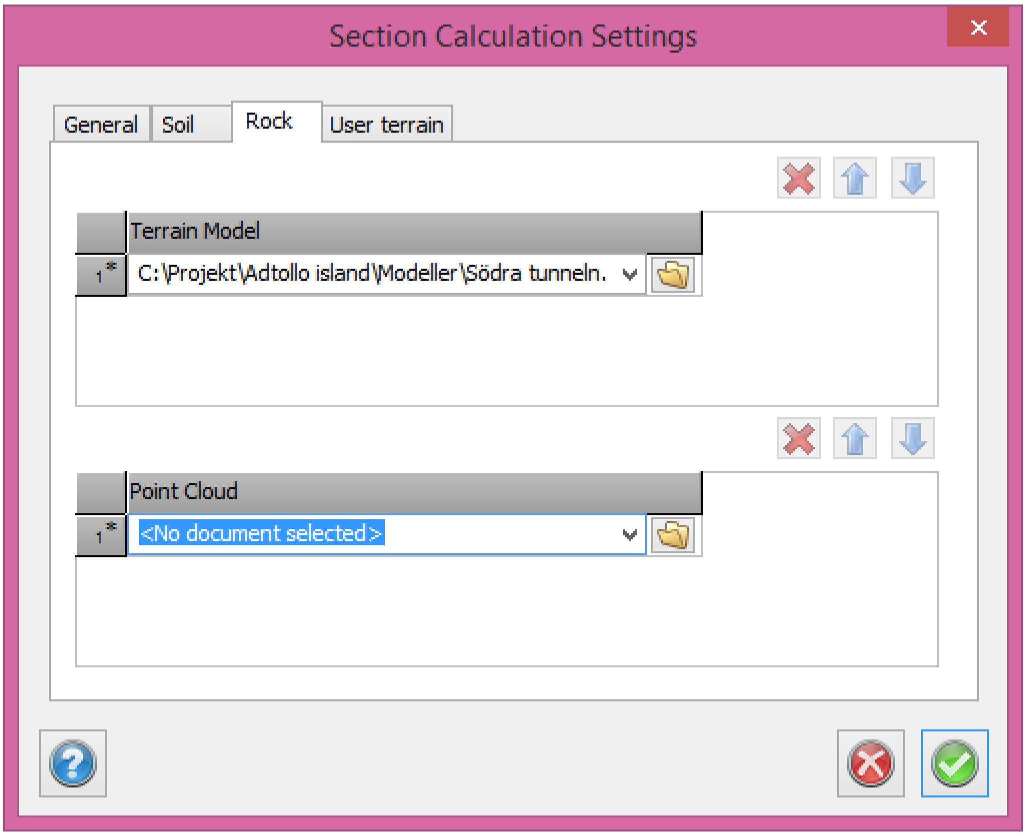
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

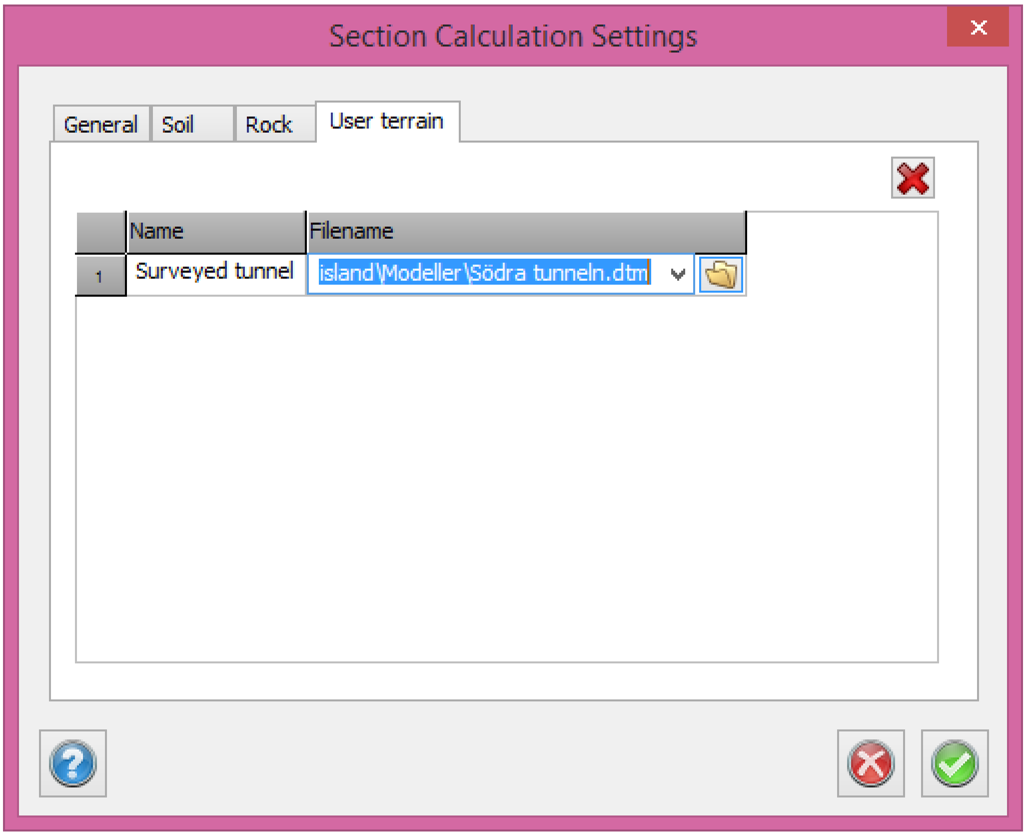
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

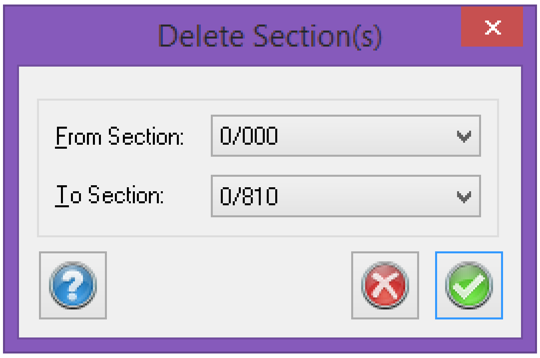
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

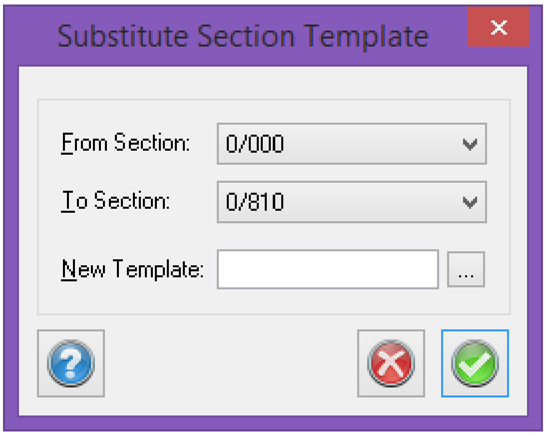
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

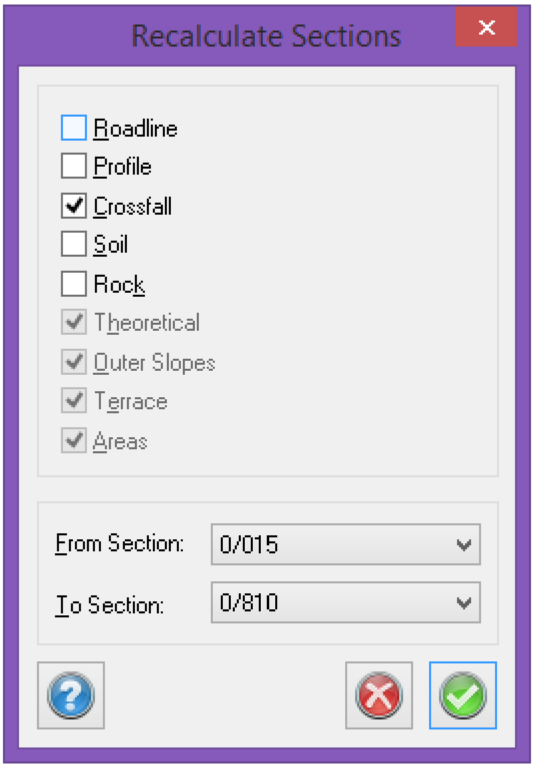


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

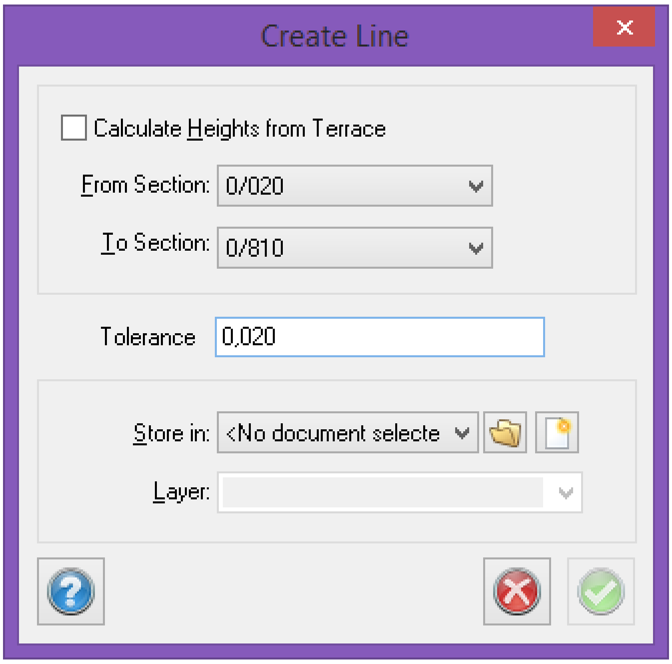
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

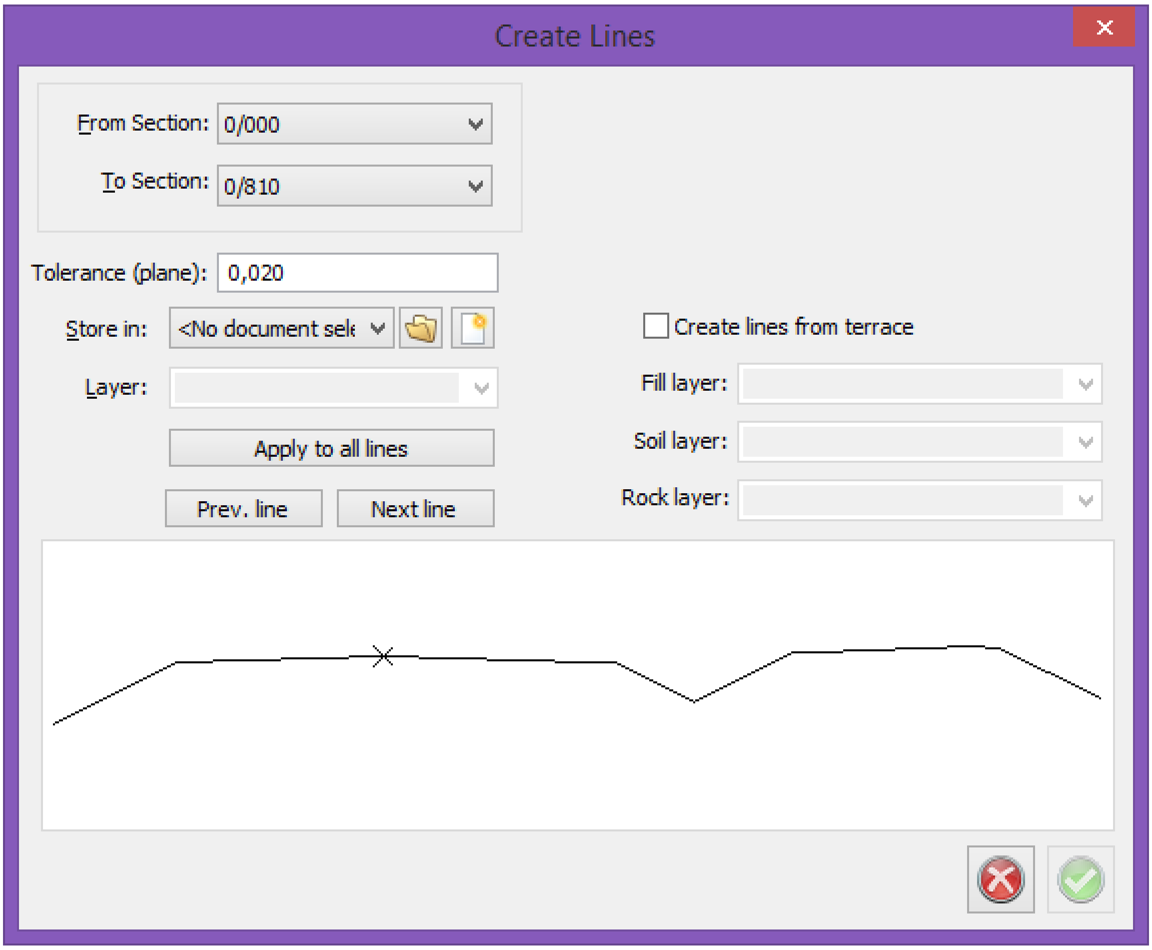
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

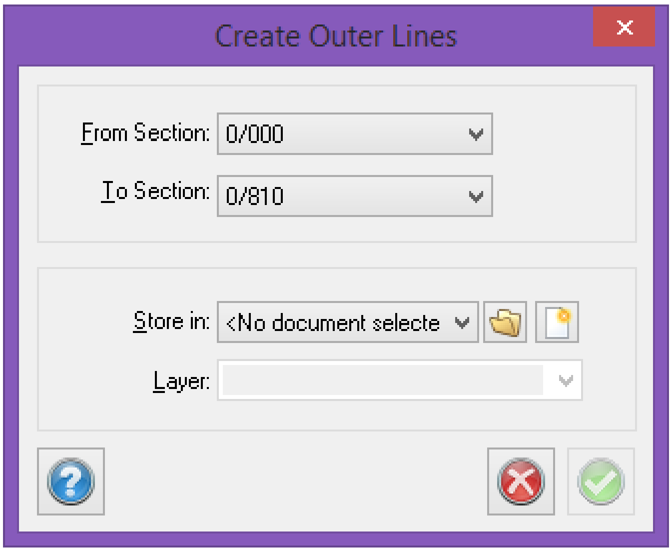
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

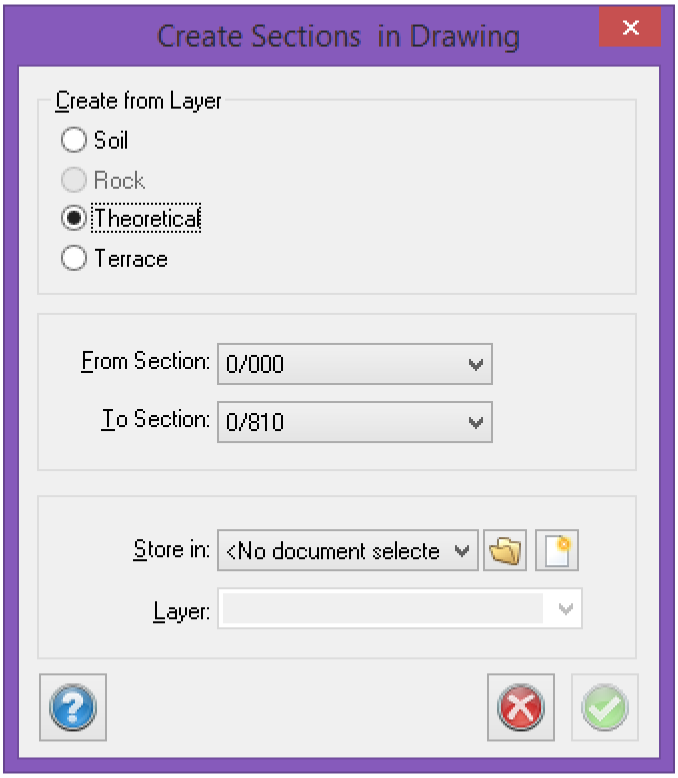
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

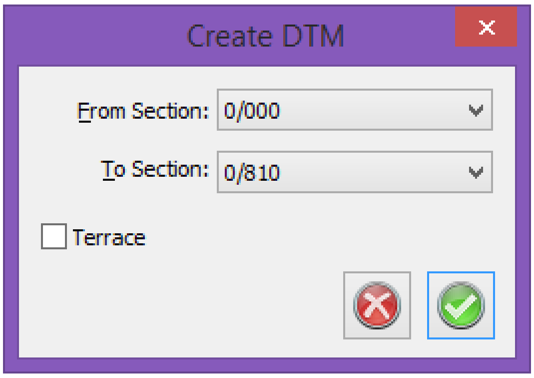


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

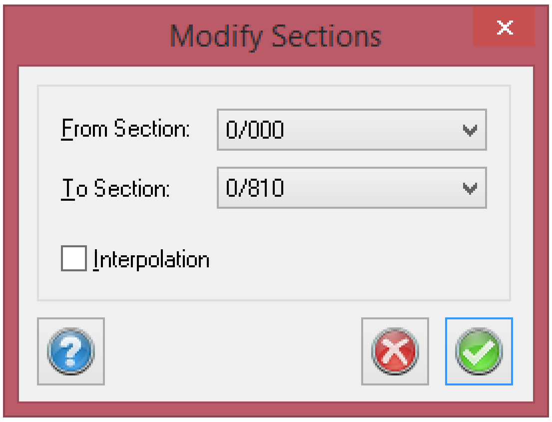


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

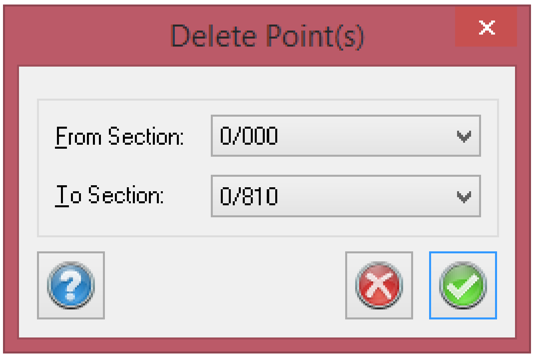
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

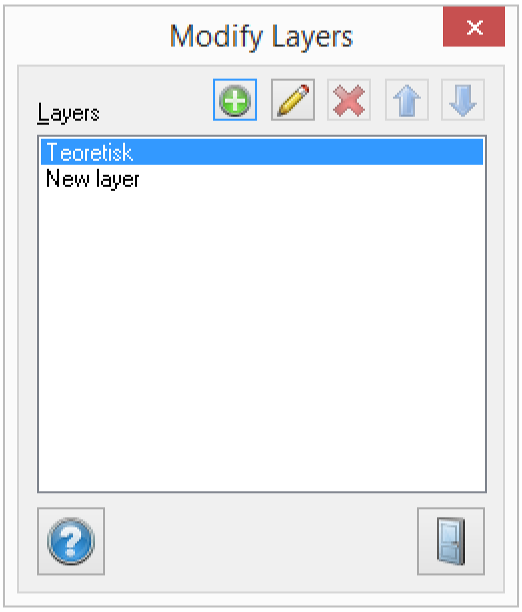
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

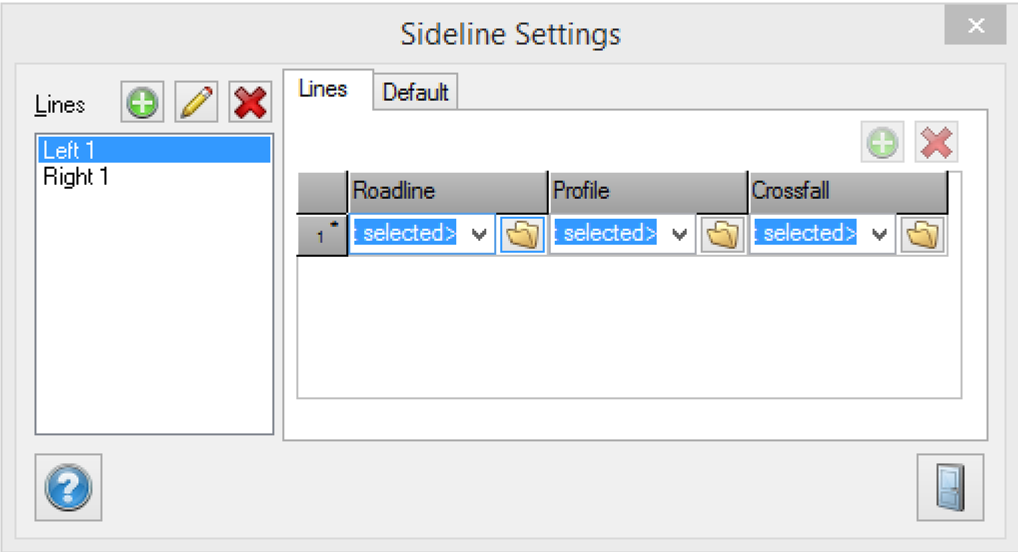


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

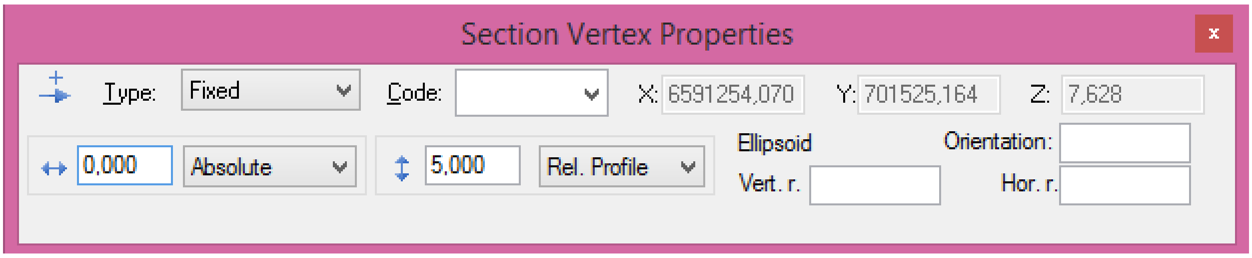
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



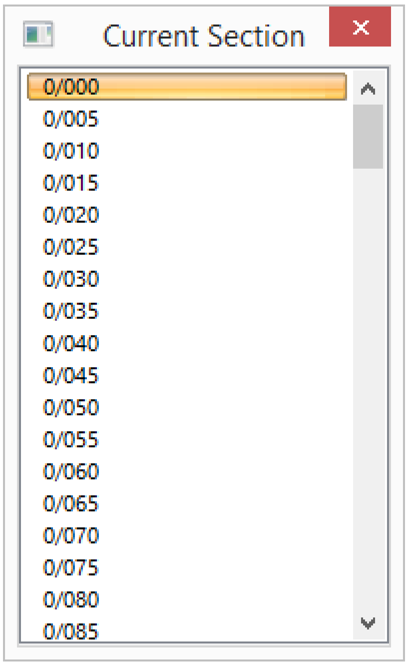
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

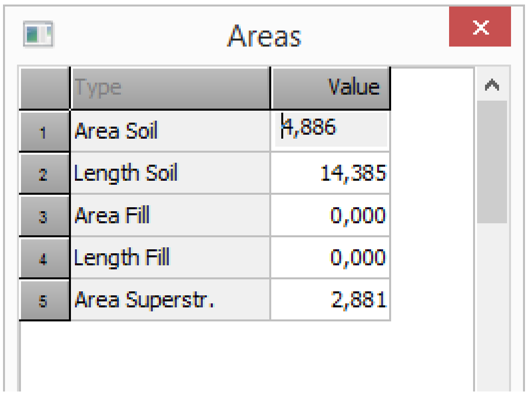
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

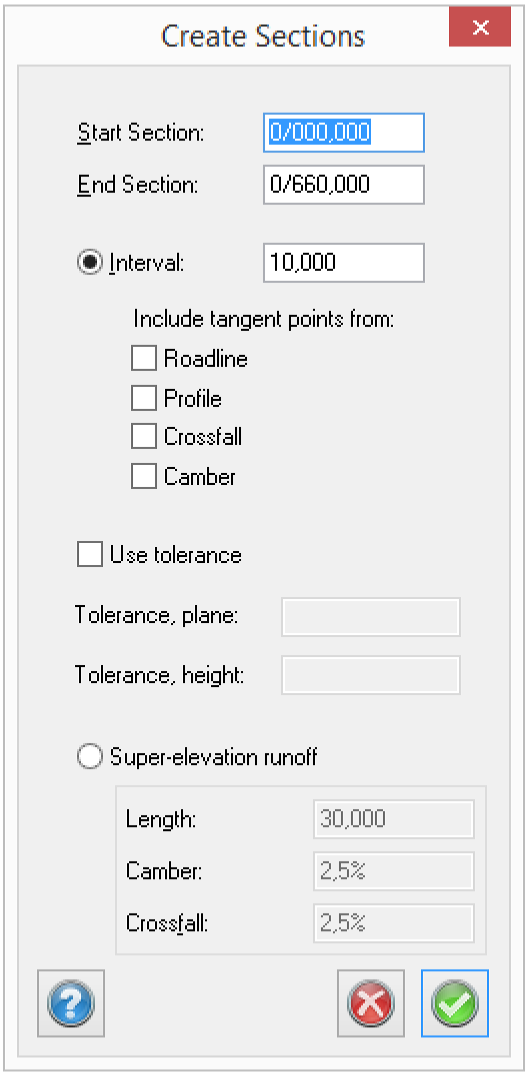
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

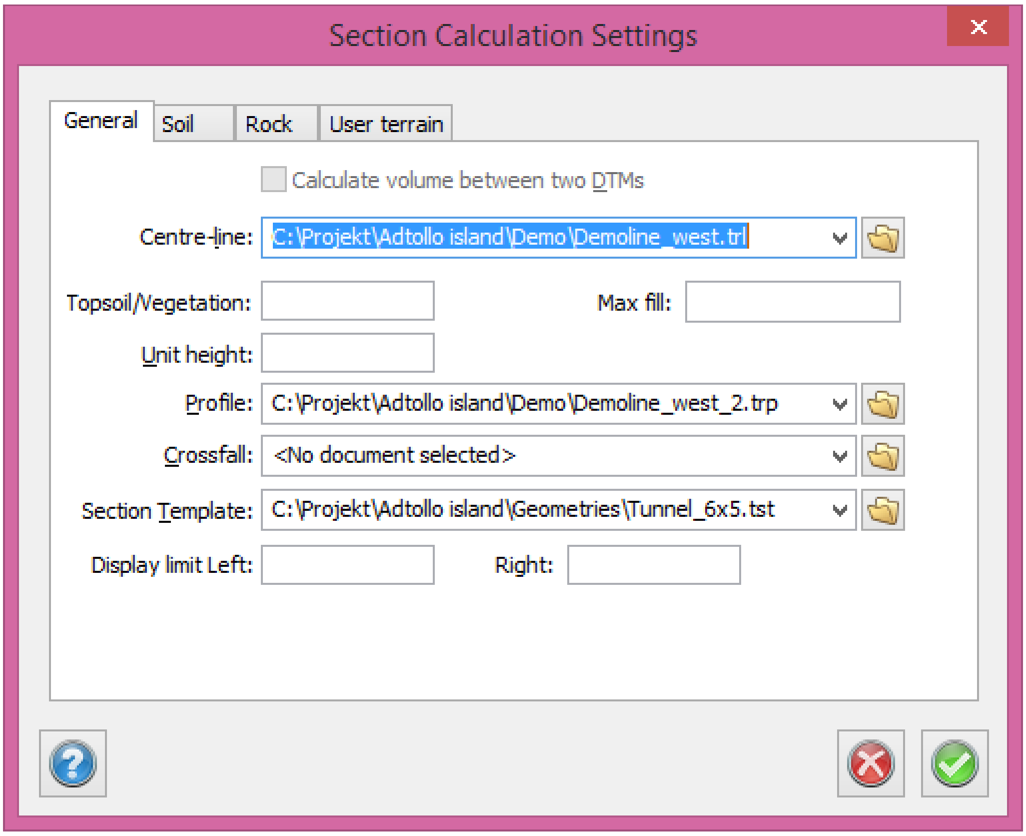
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

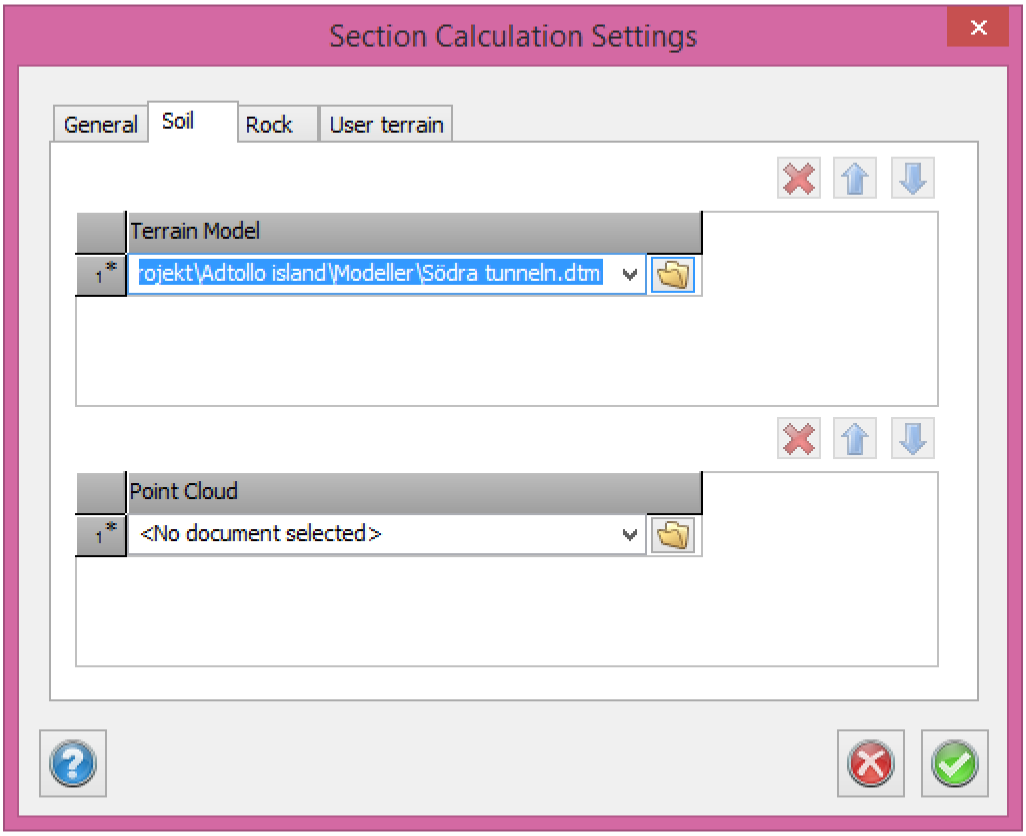
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

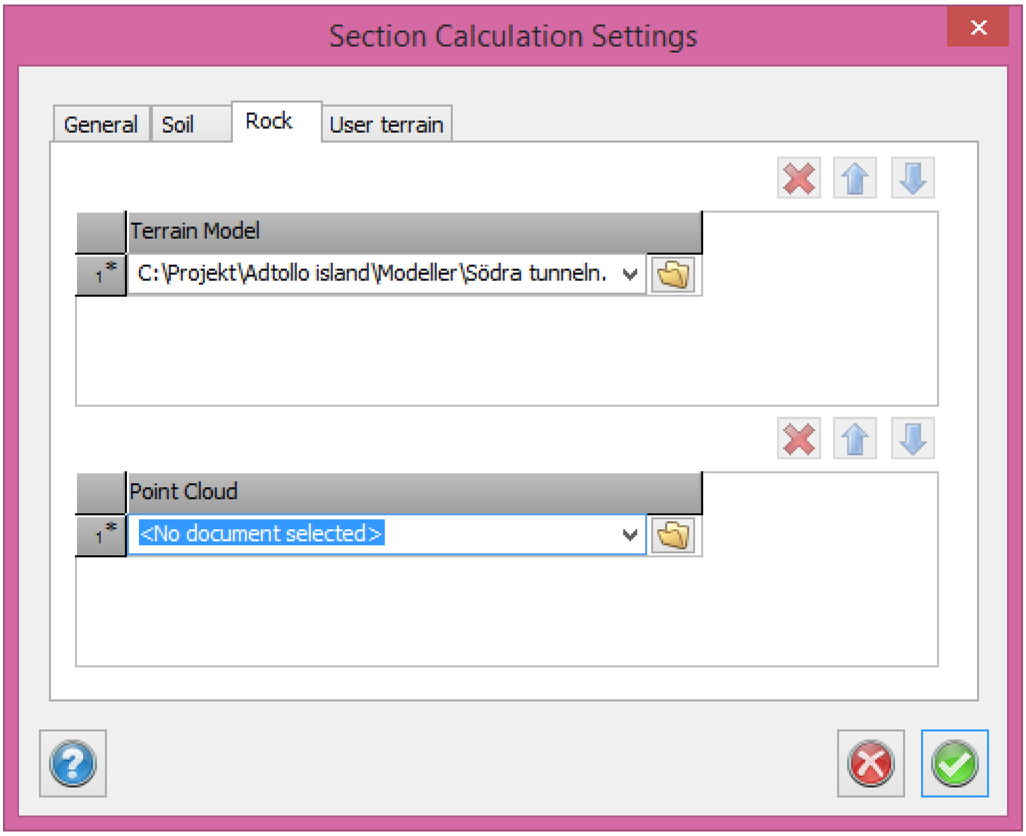
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

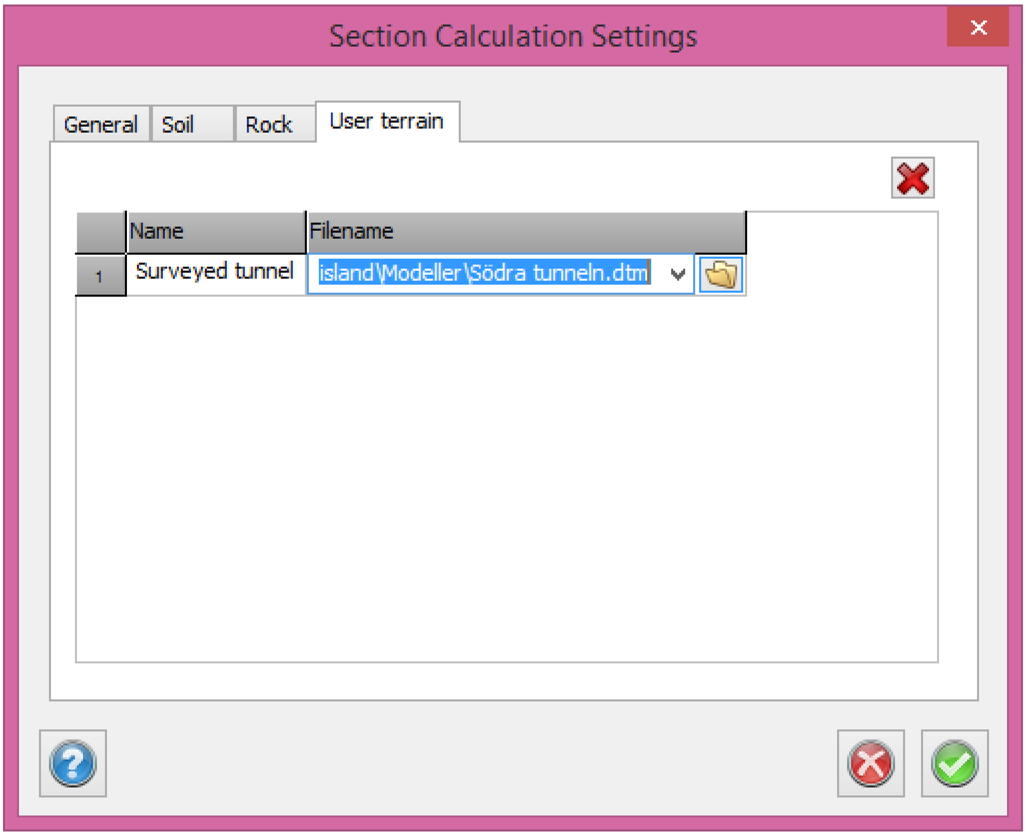
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

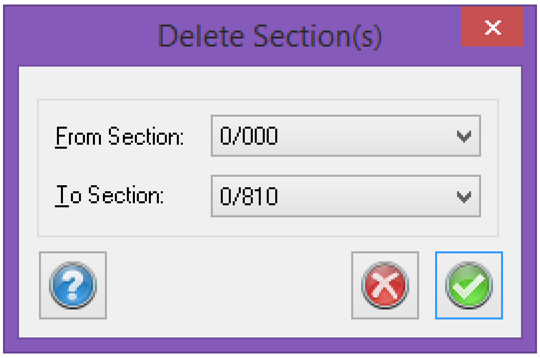
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

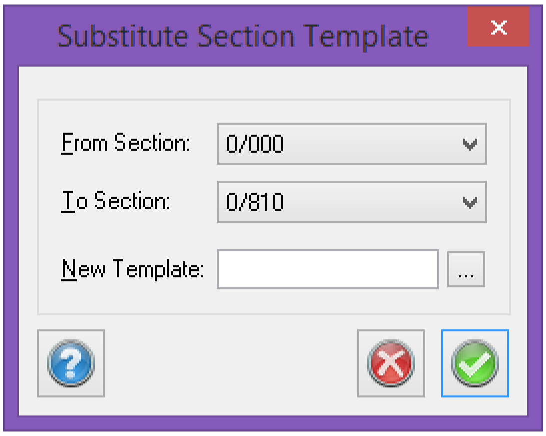
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

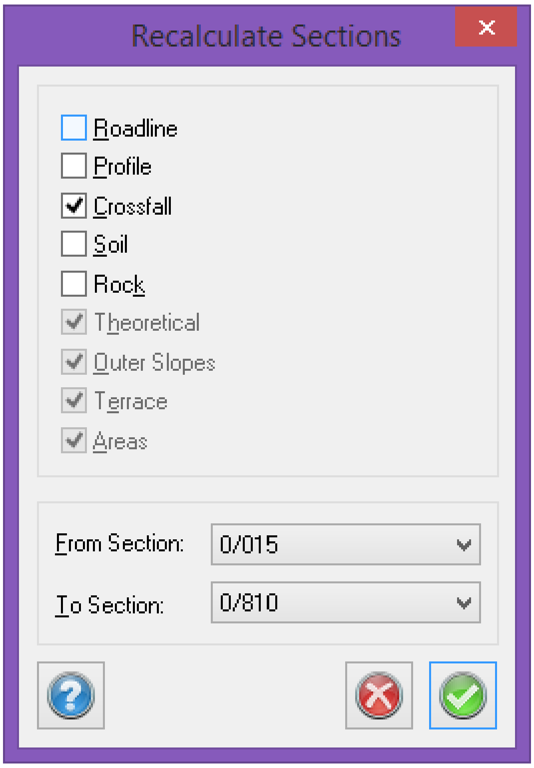


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

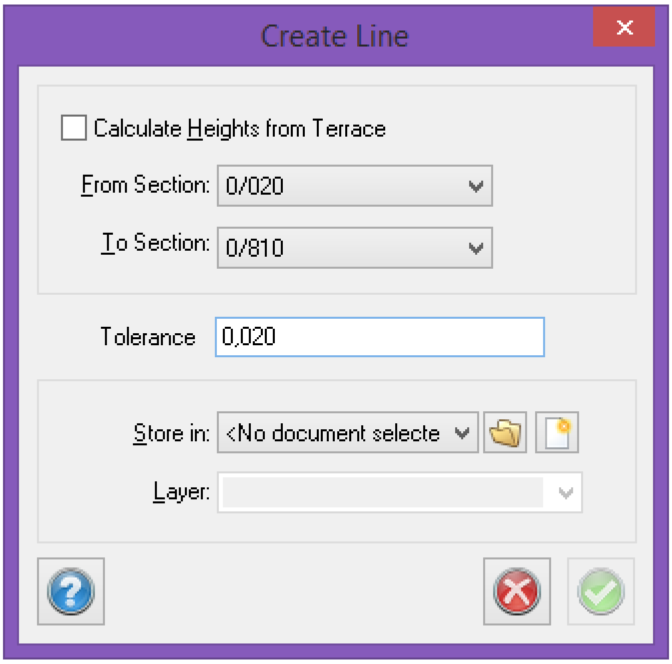
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

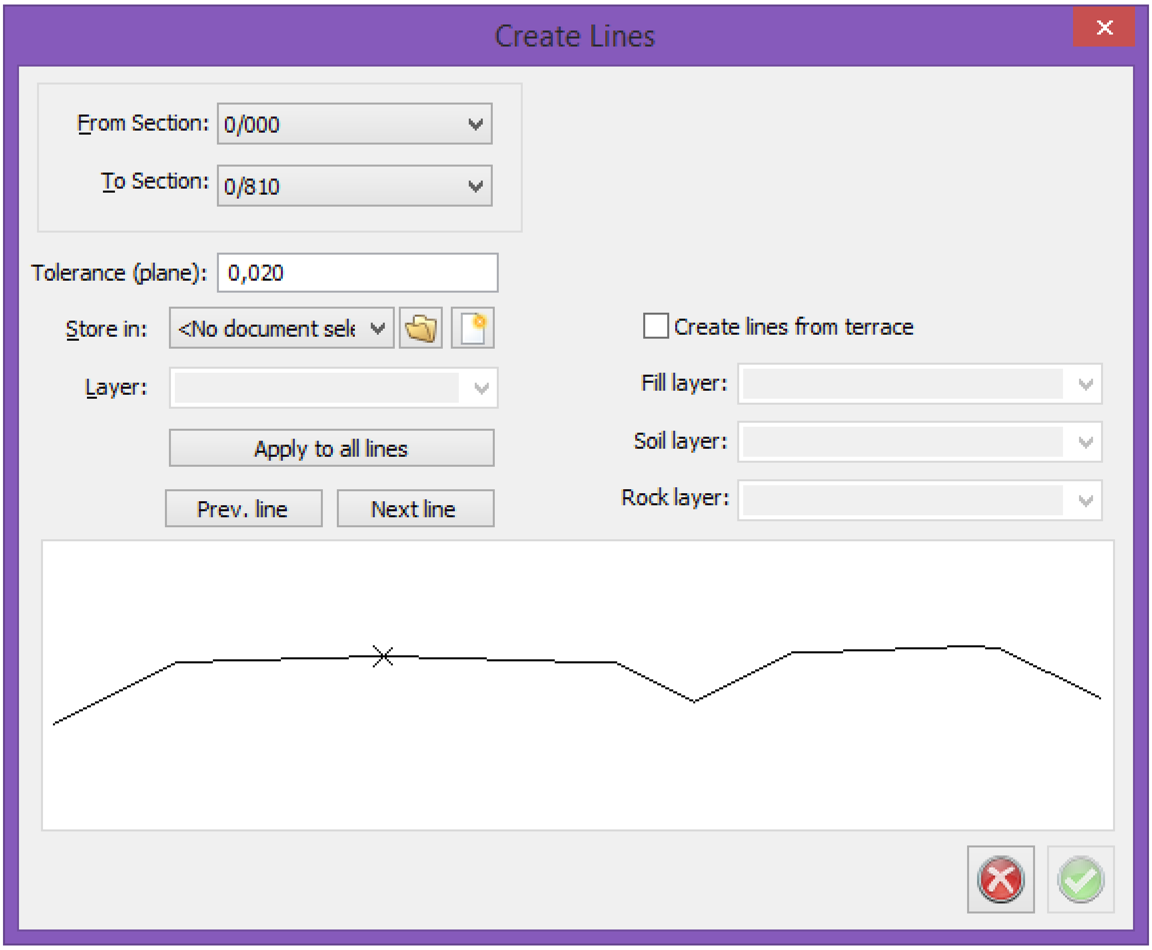
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

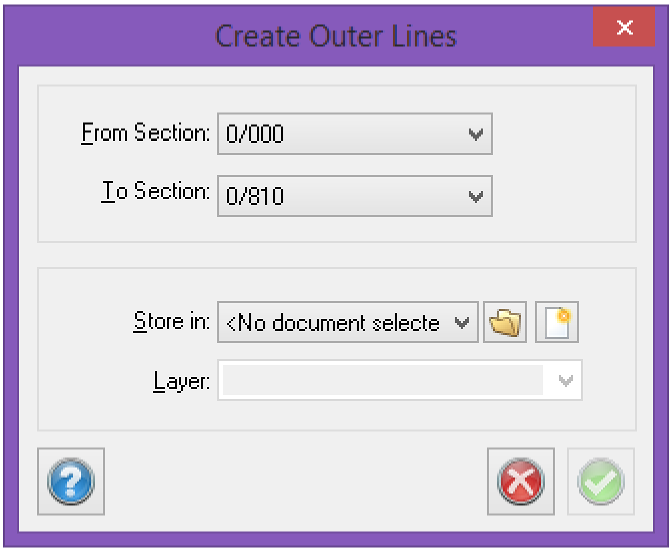
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

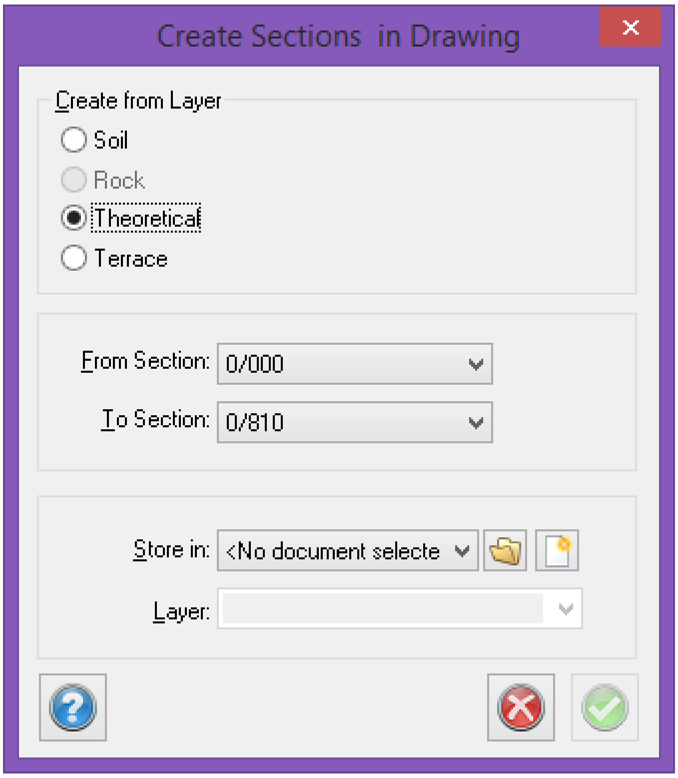
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

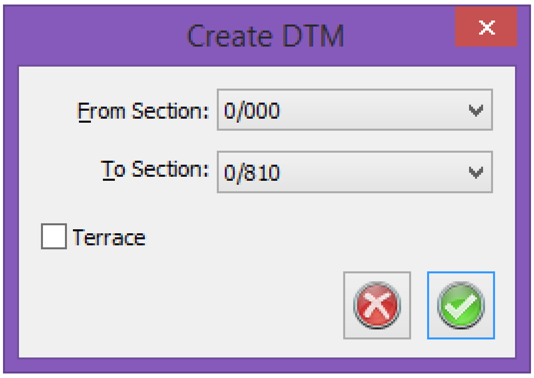


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

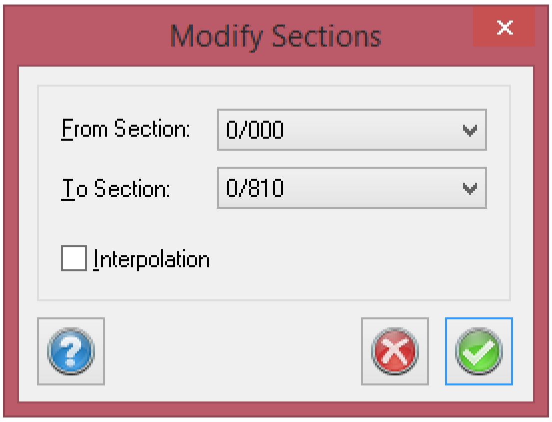


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

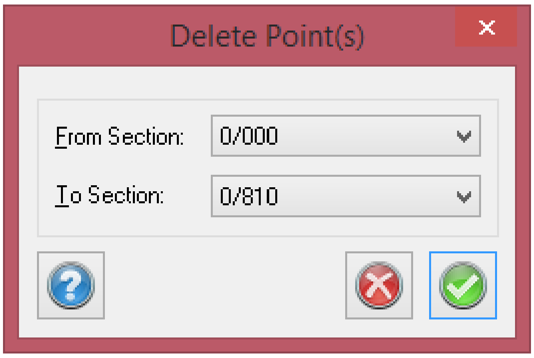
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

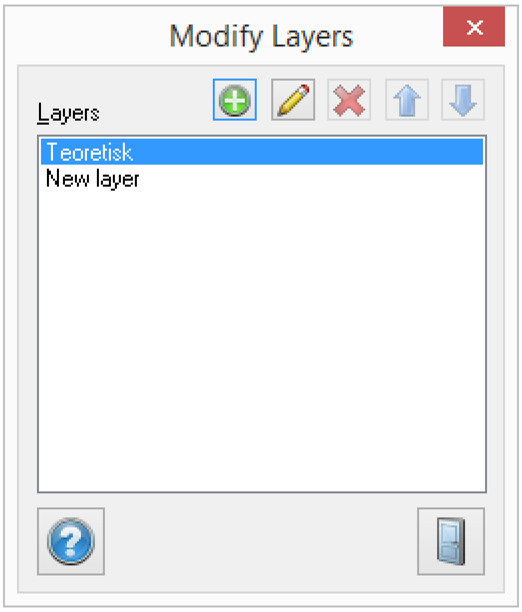
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

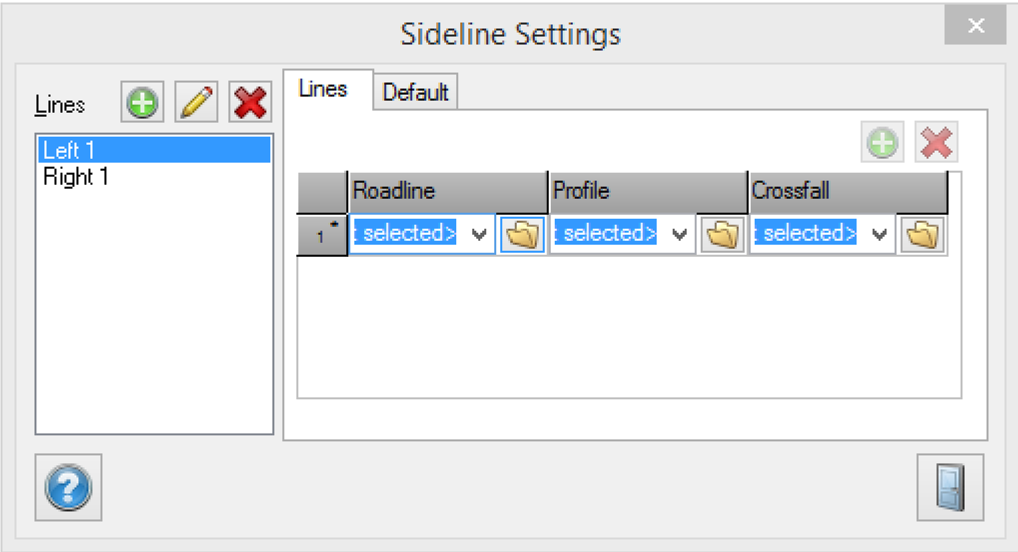


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

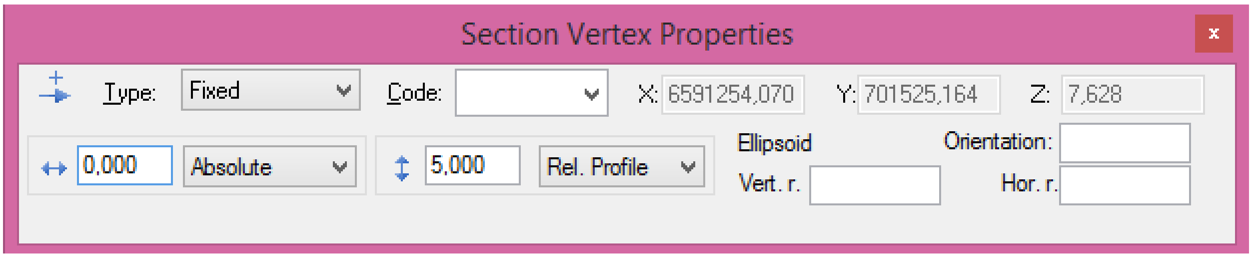
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



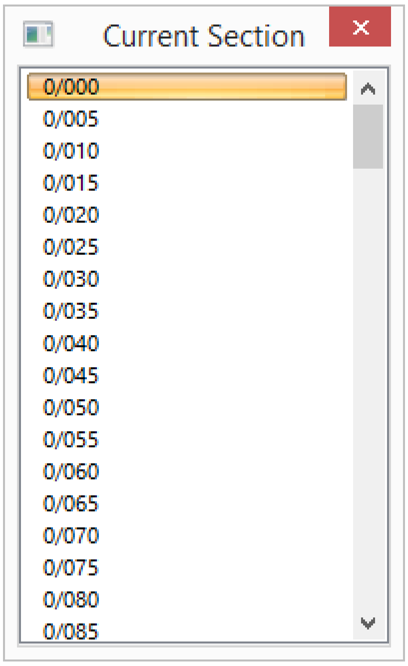
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

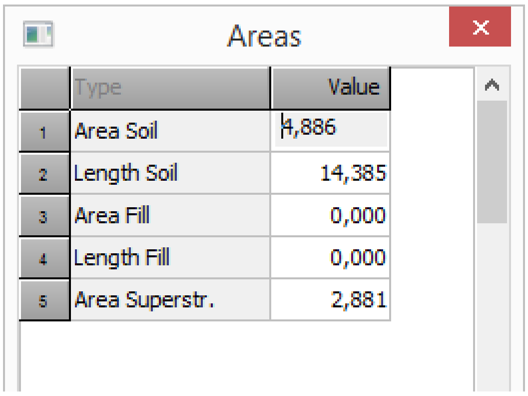
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

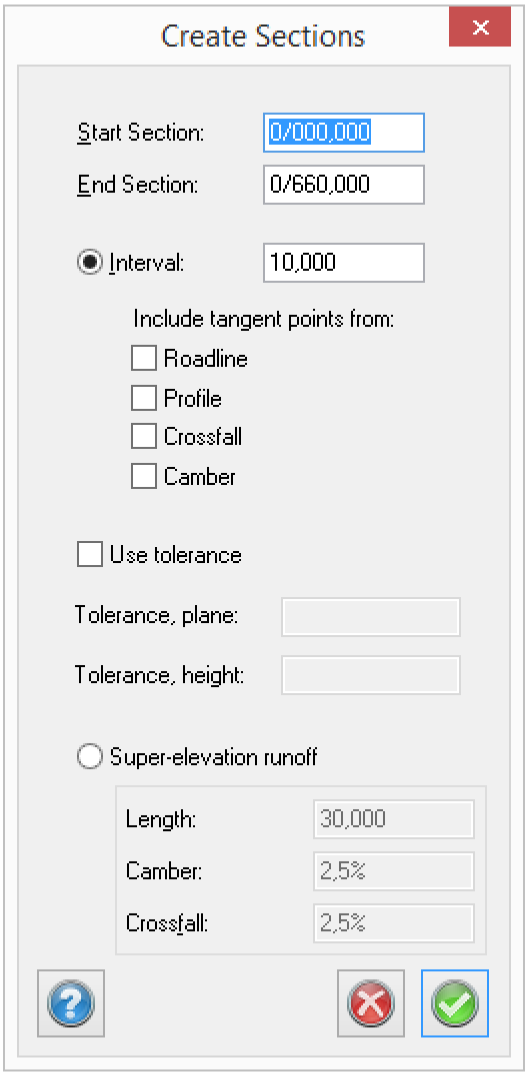
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

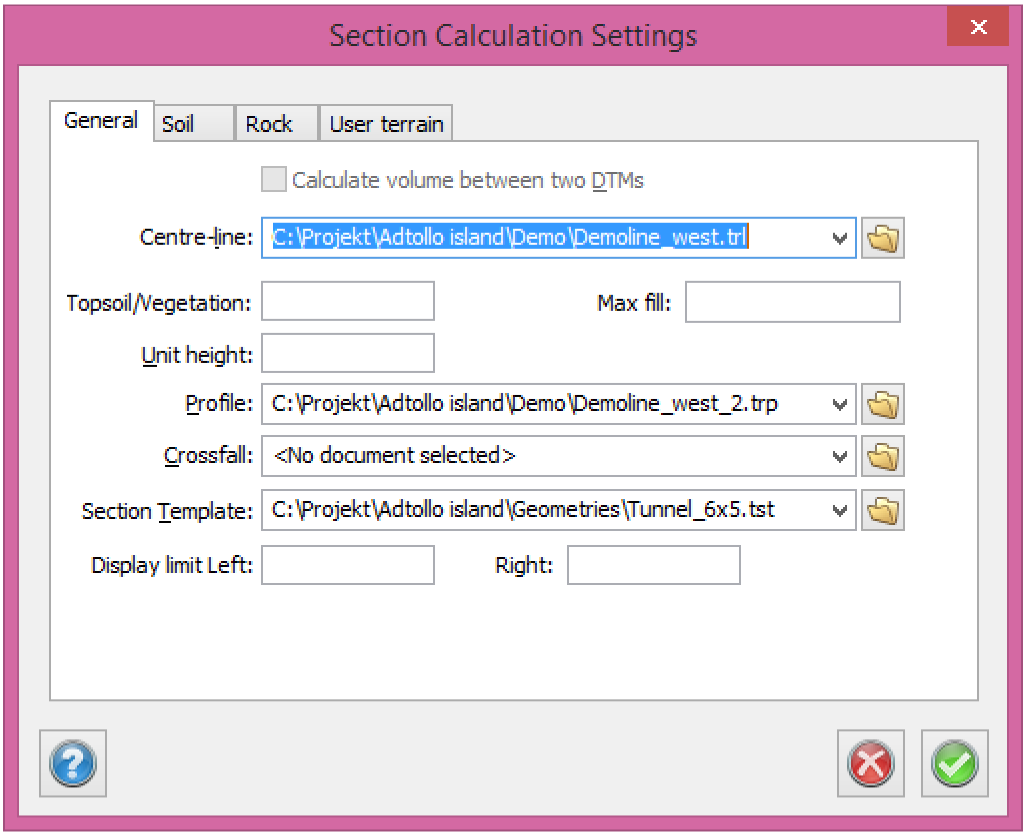
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

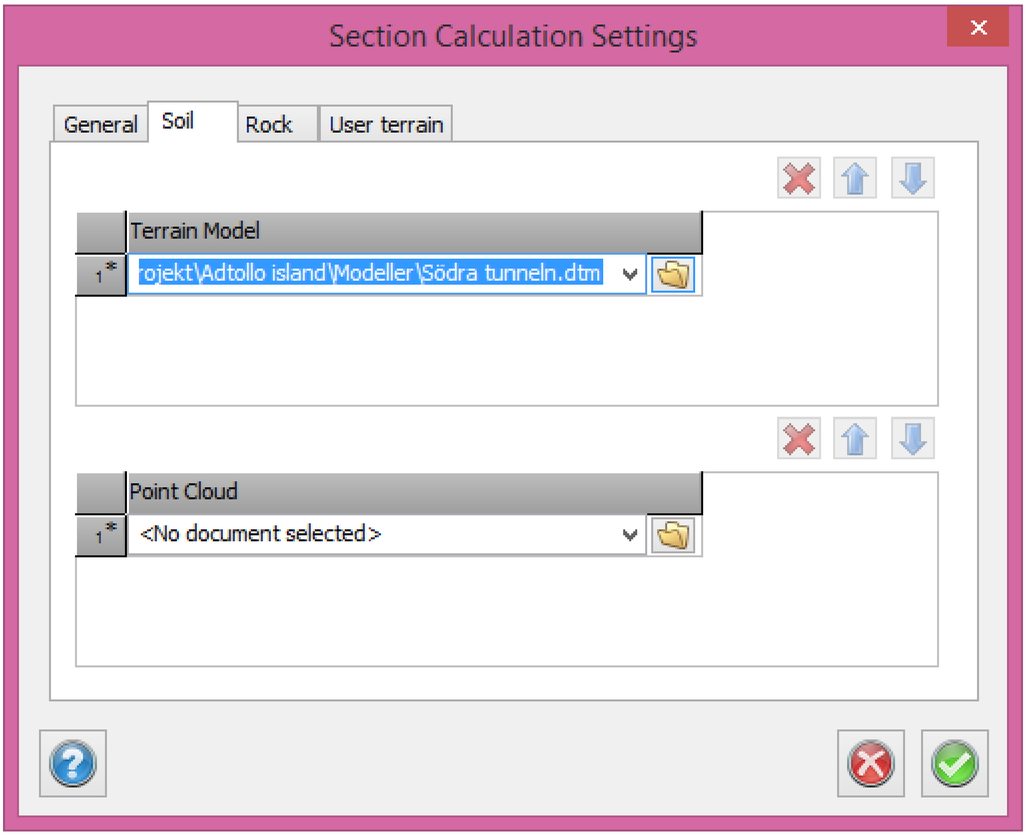
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

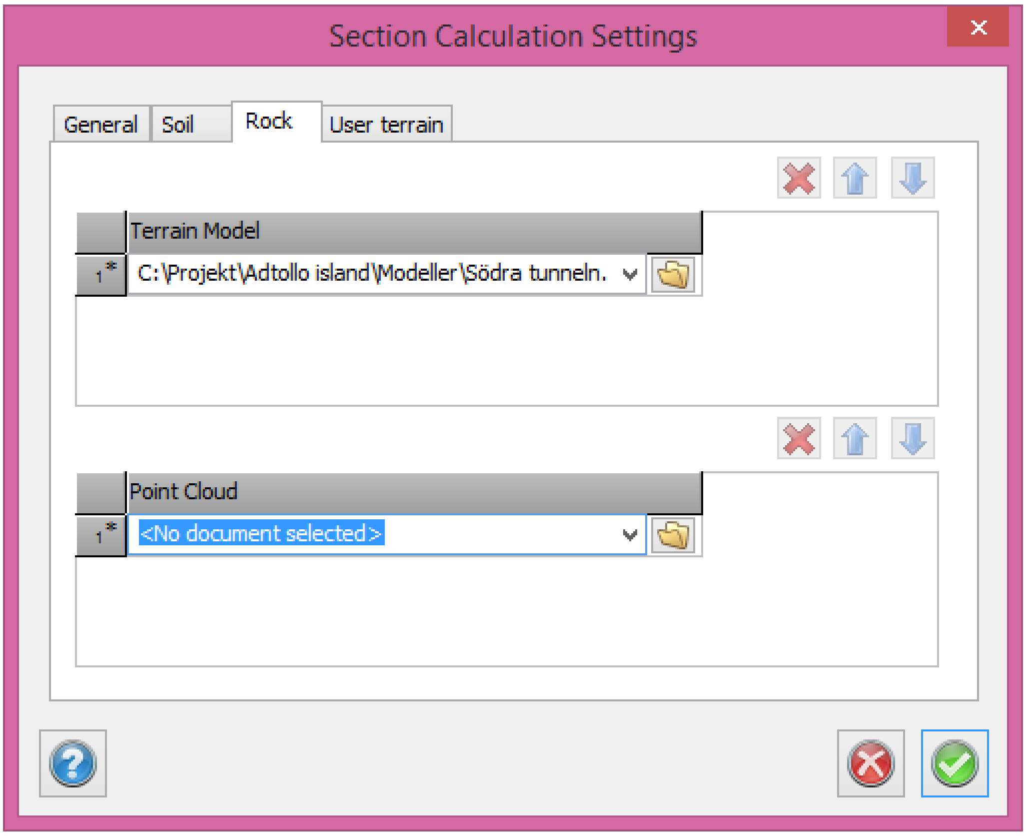
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

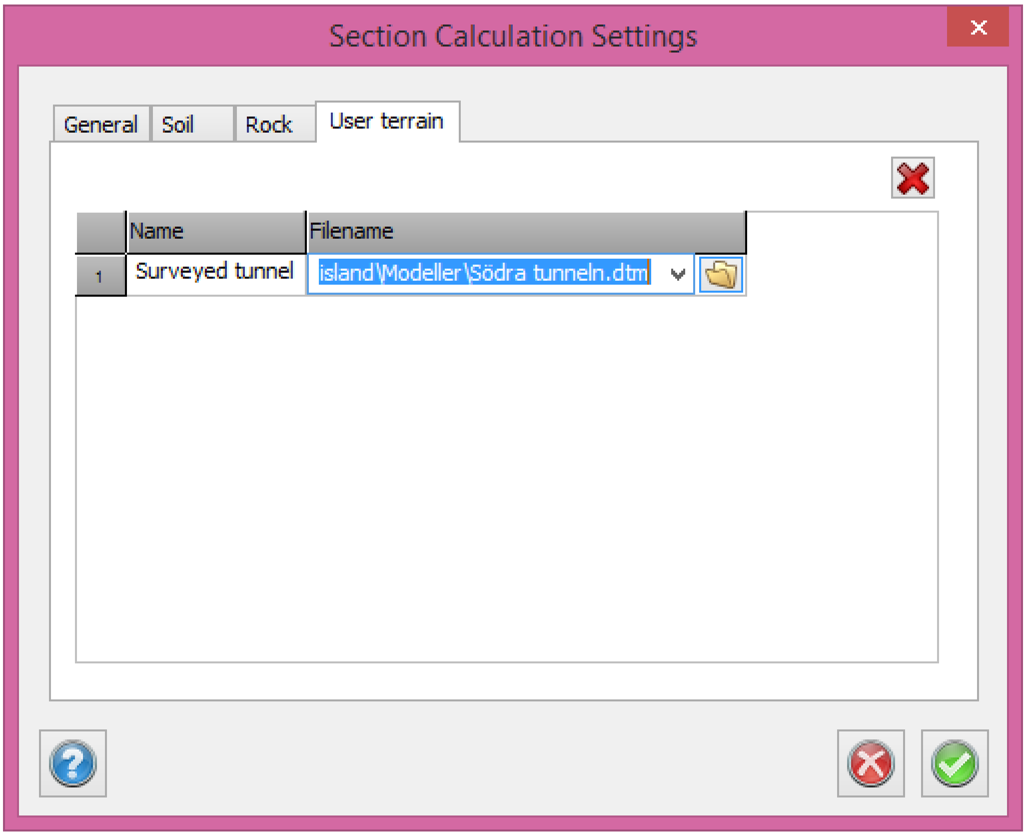
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

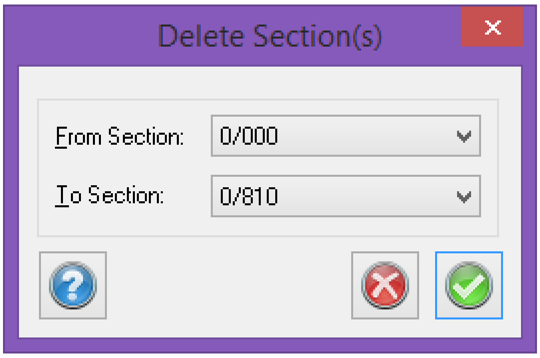
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

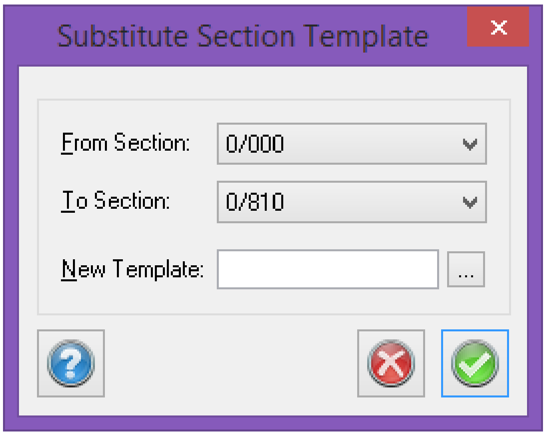
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

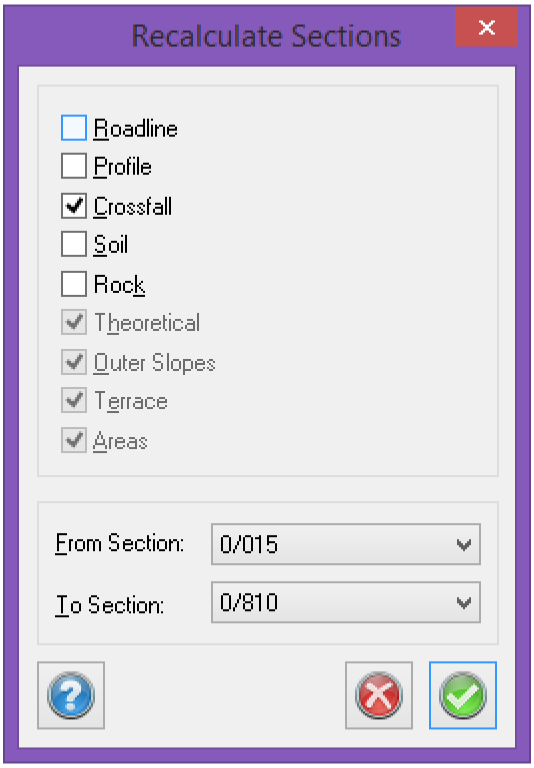


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

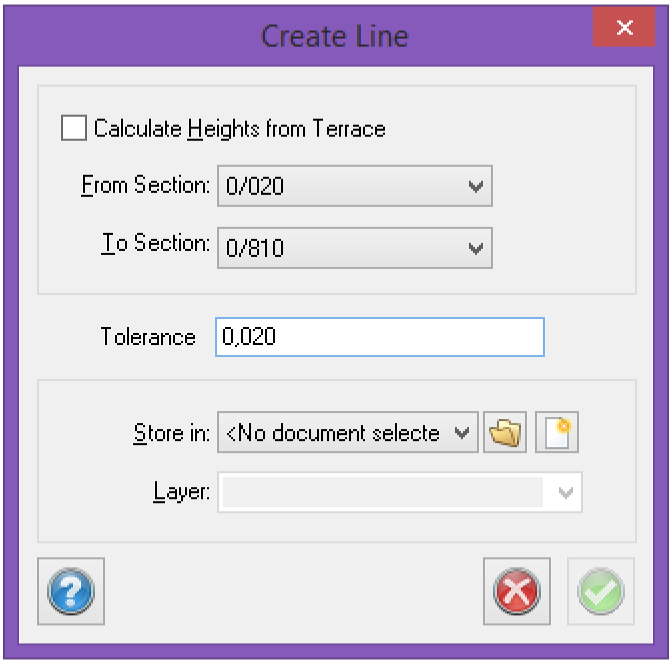
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

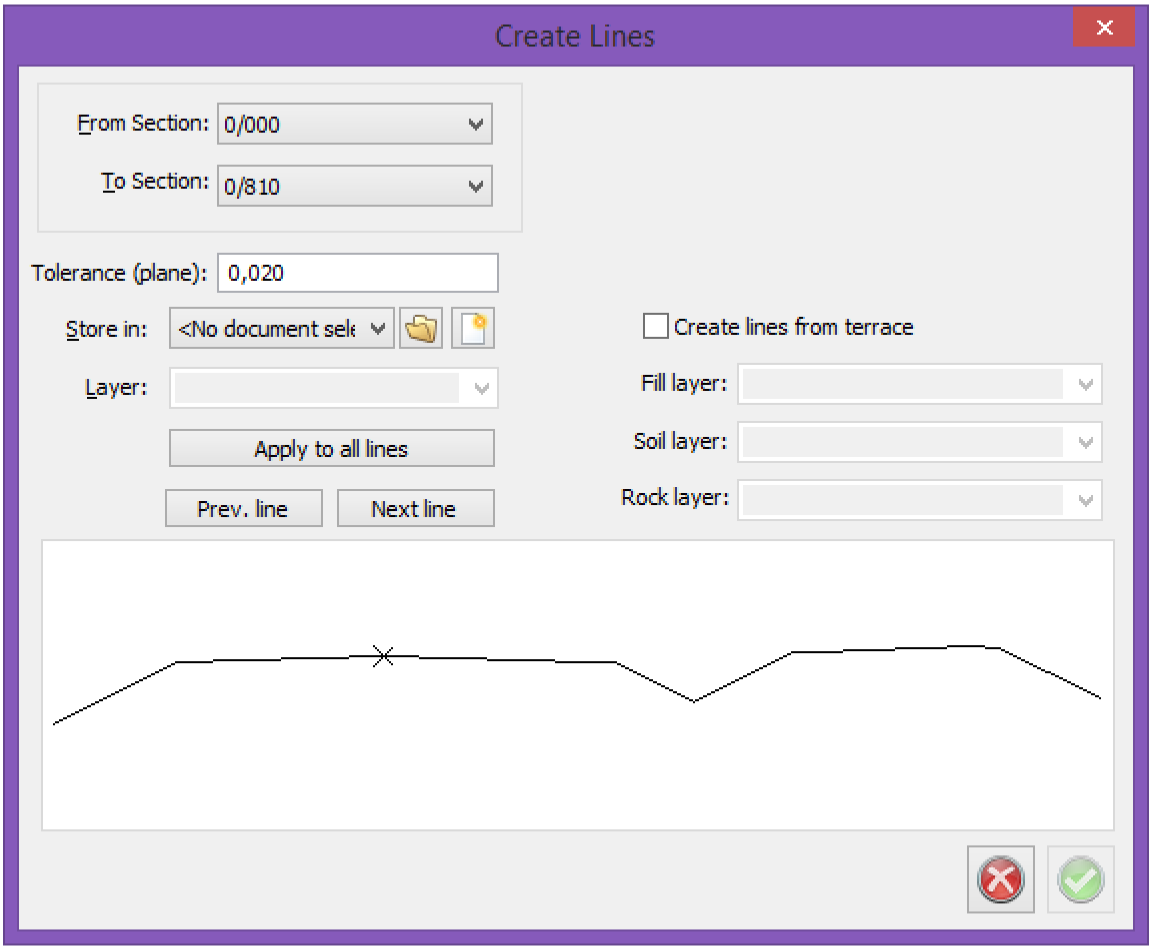
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

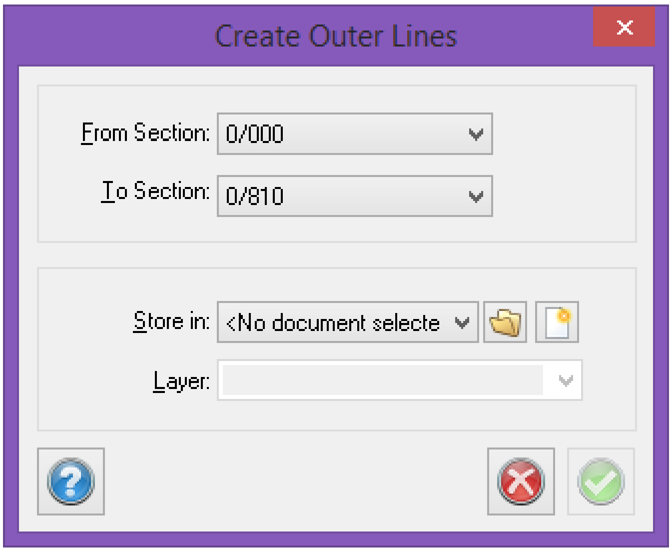
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

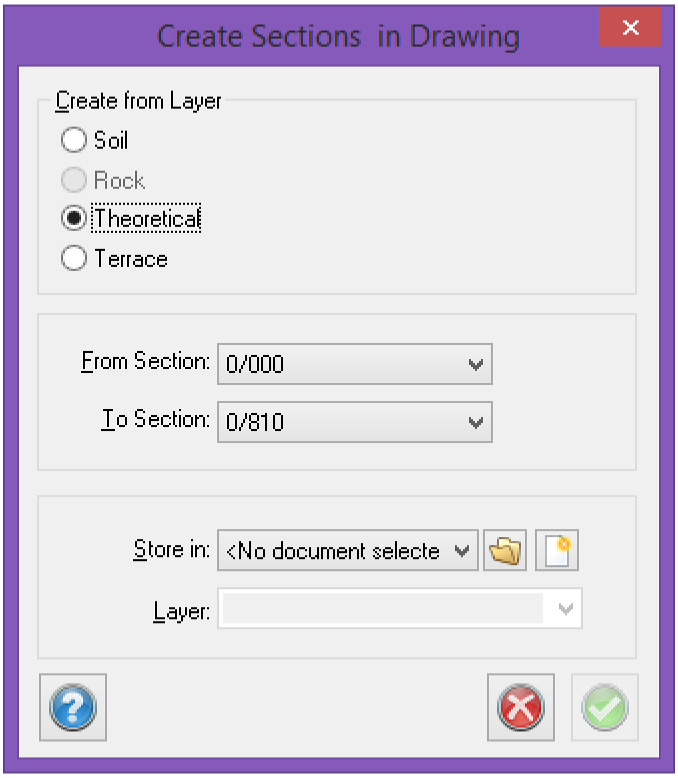
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

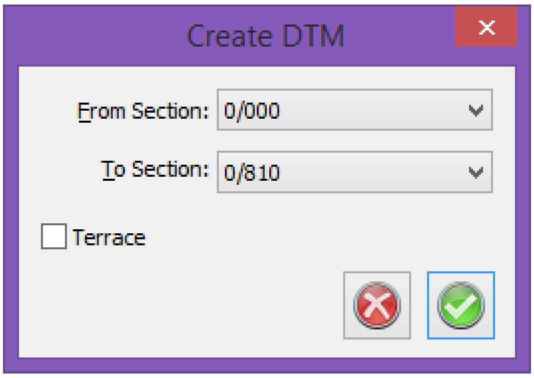


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

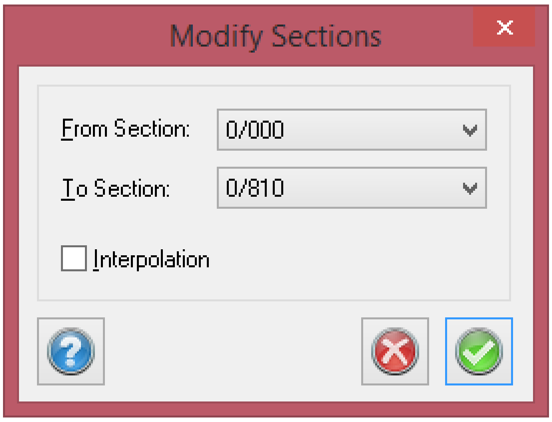


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

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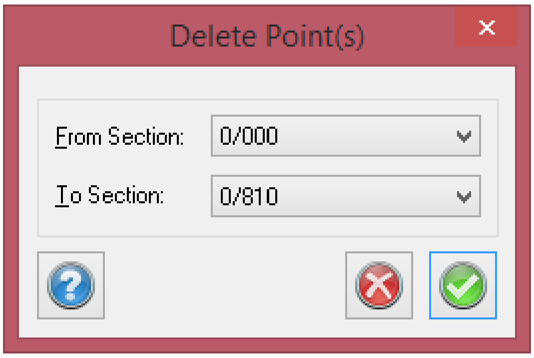
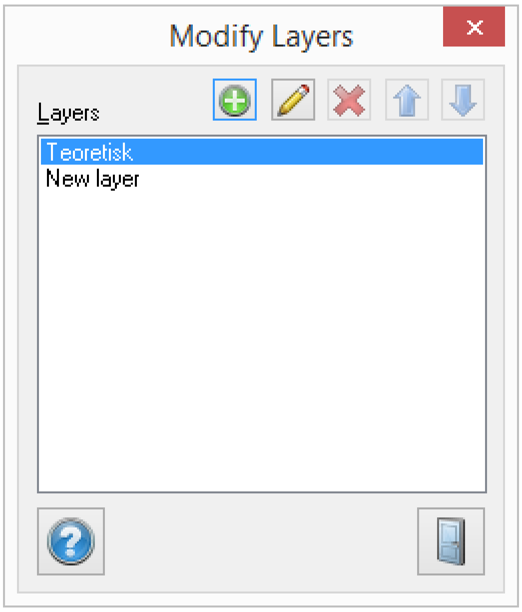


Modify layers

Calculated section|Modify|Layers

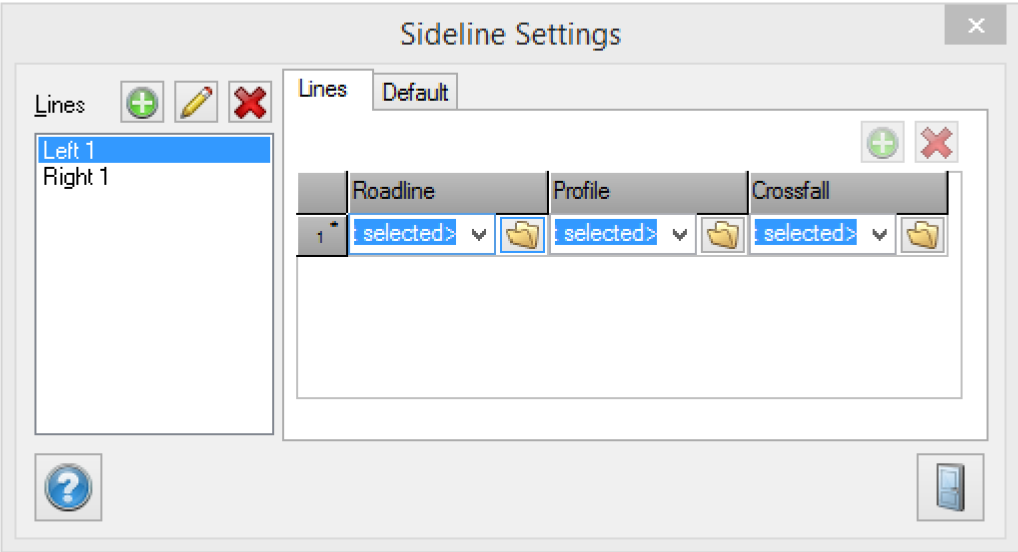


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

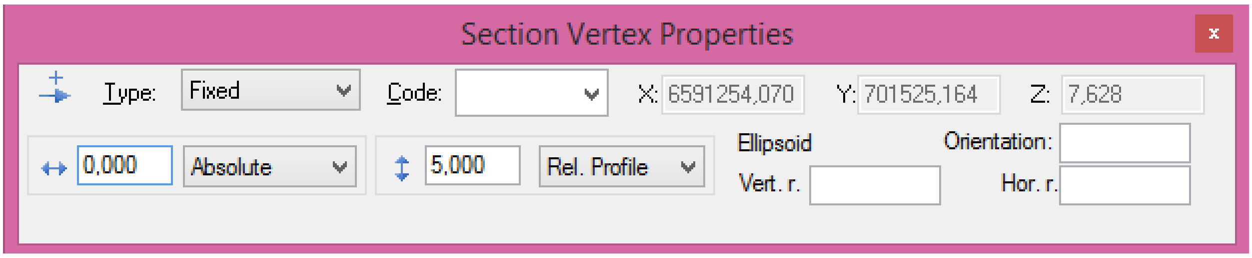
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



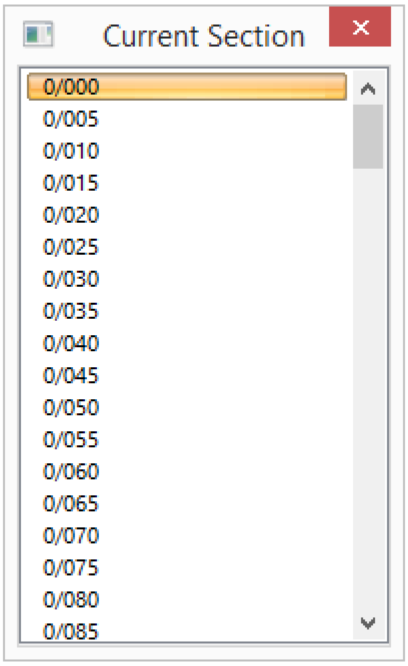
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

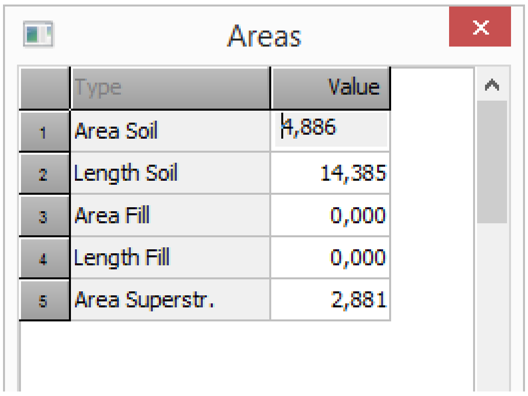
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

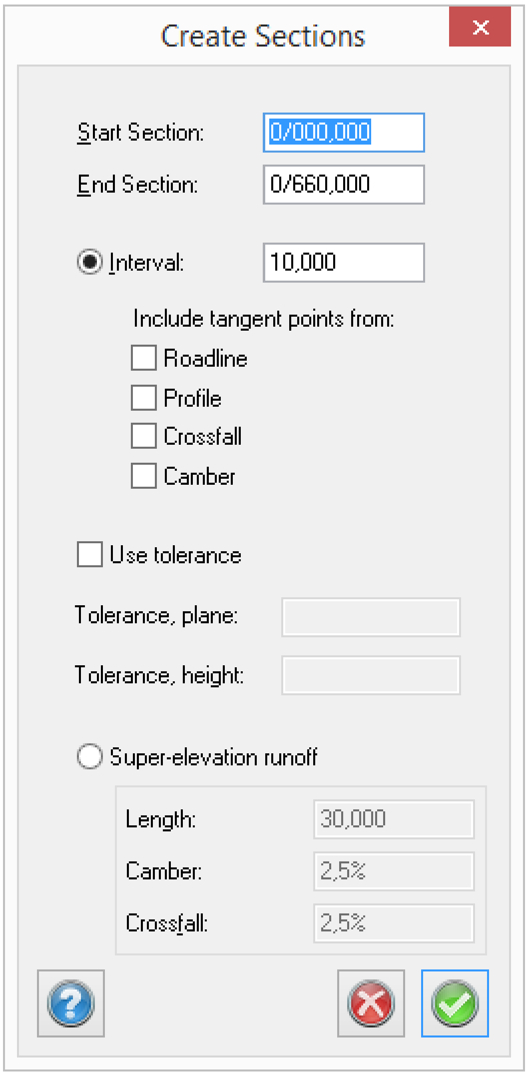
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

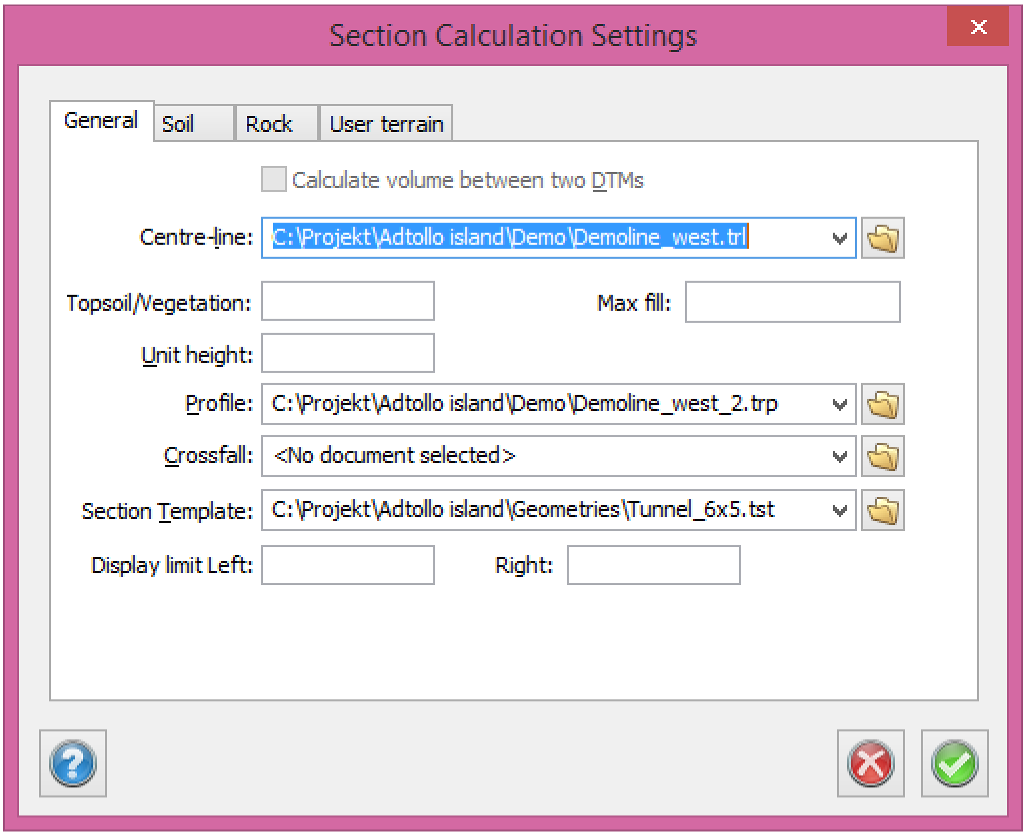
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

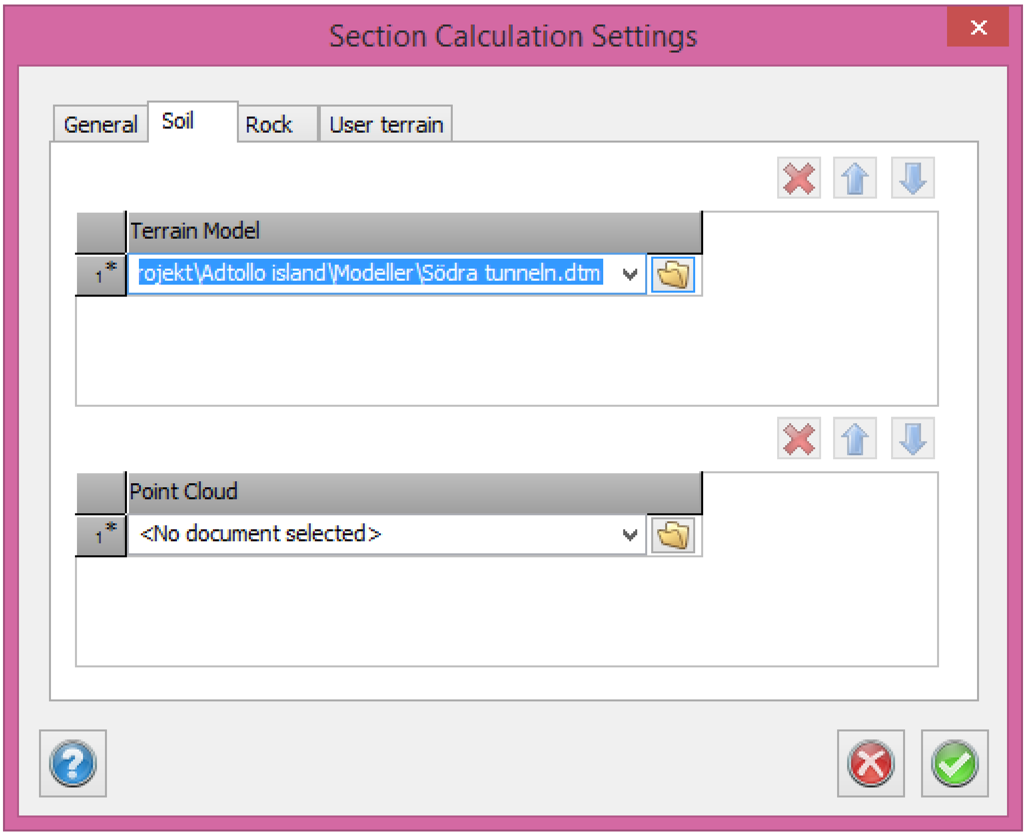
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

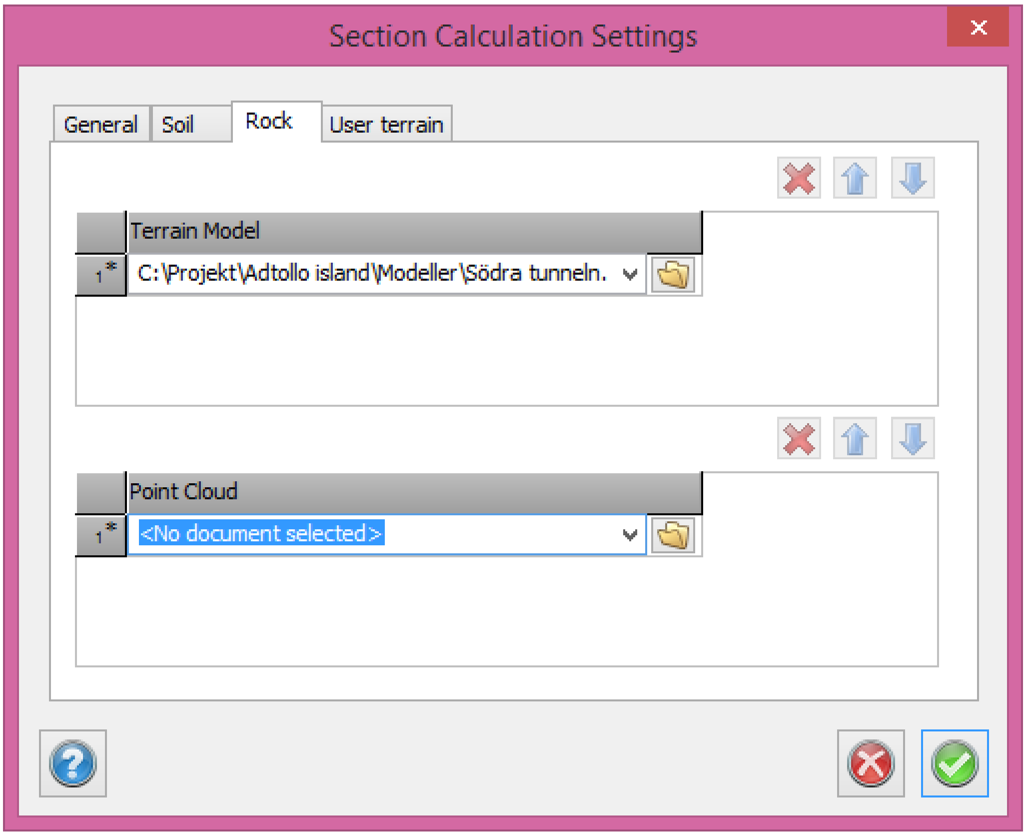
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

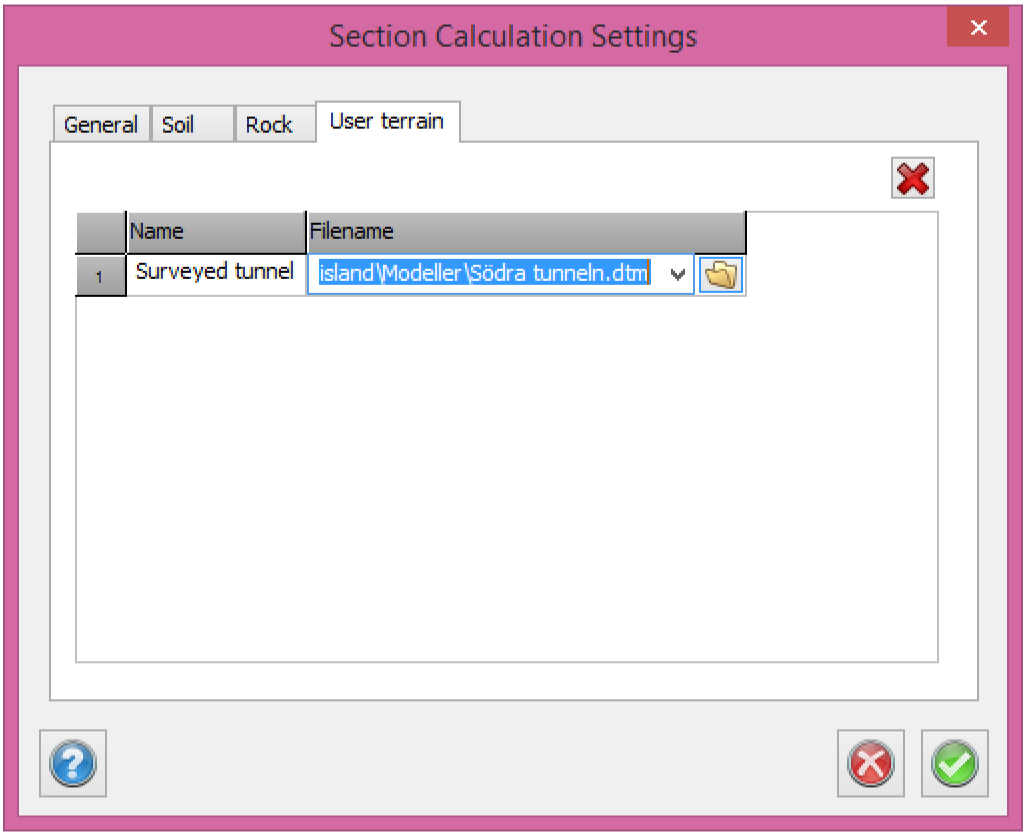
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

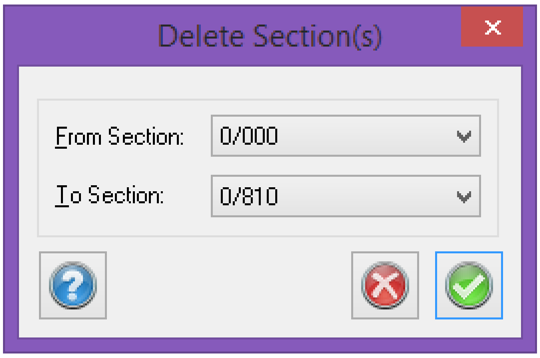
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

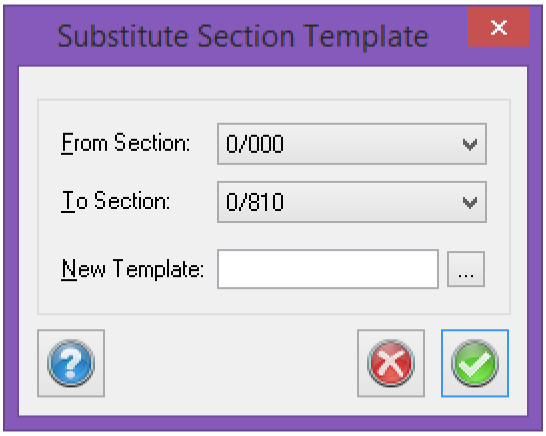
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

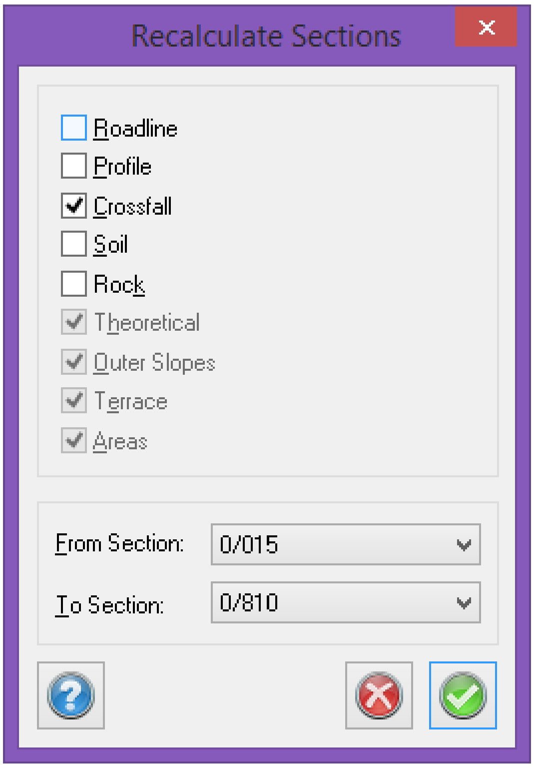


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

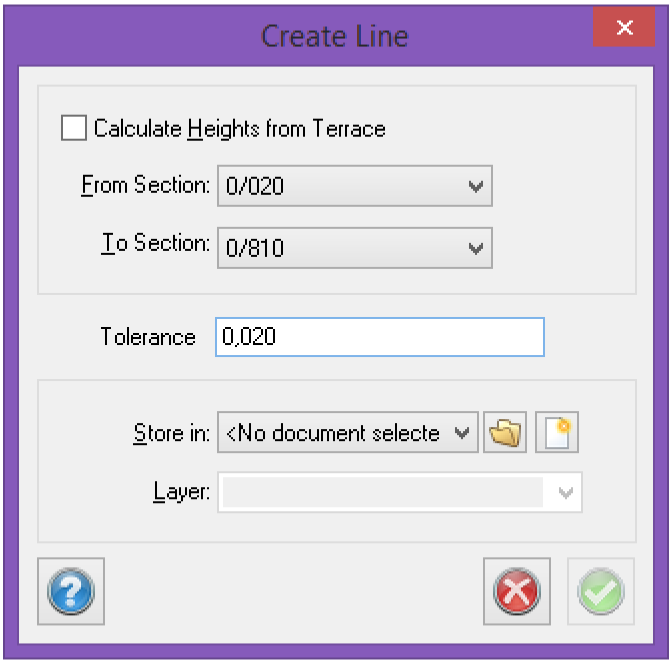
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

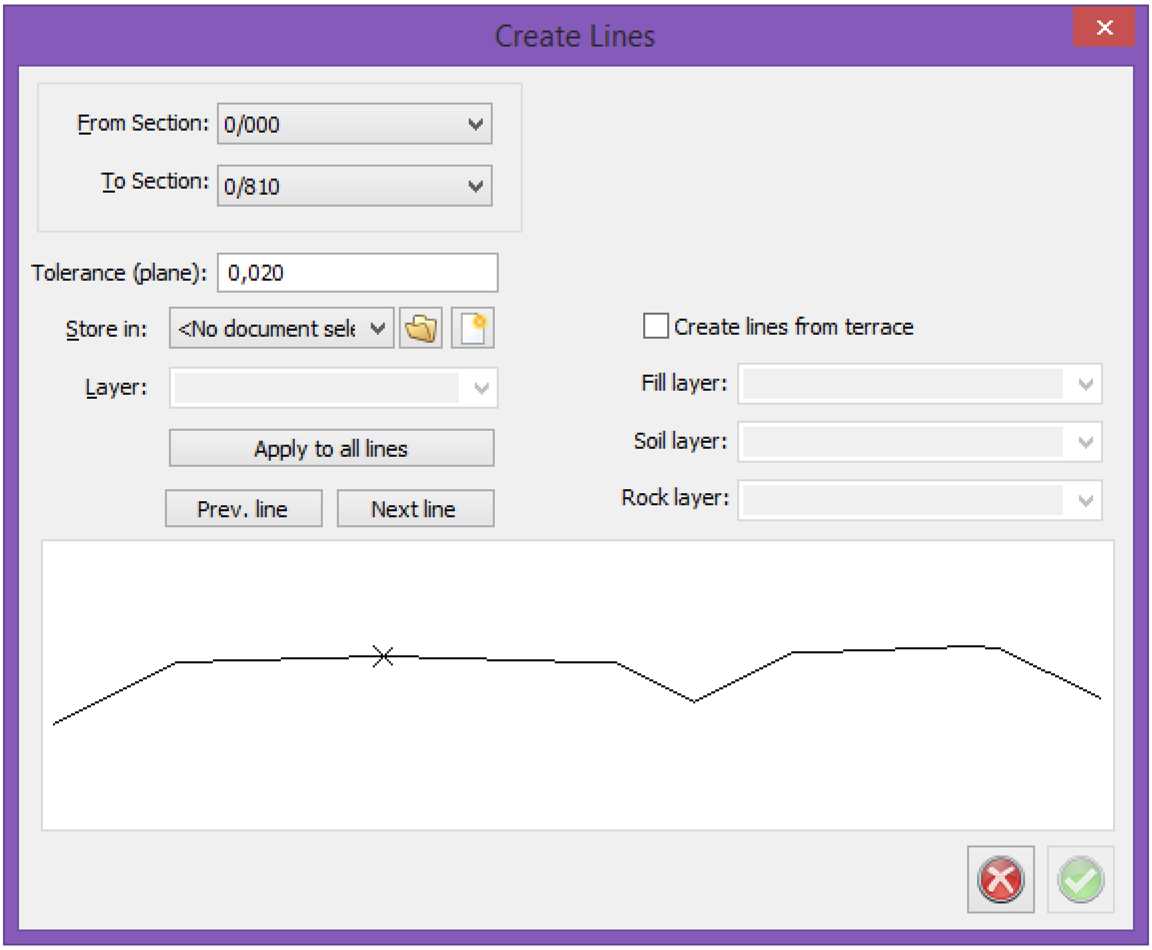
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

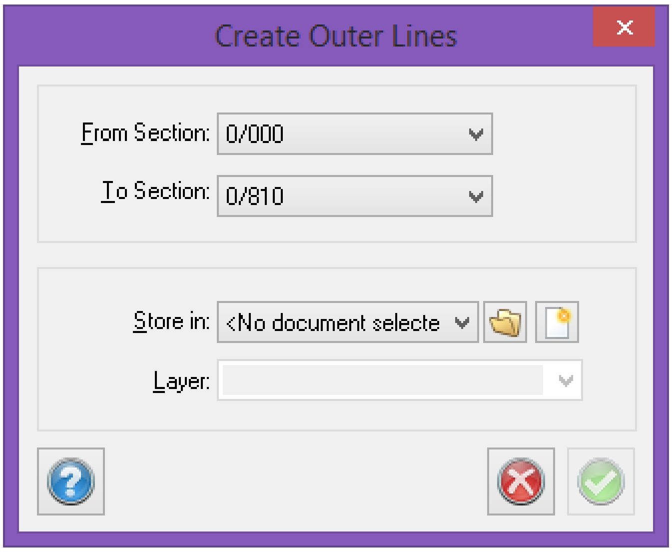
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

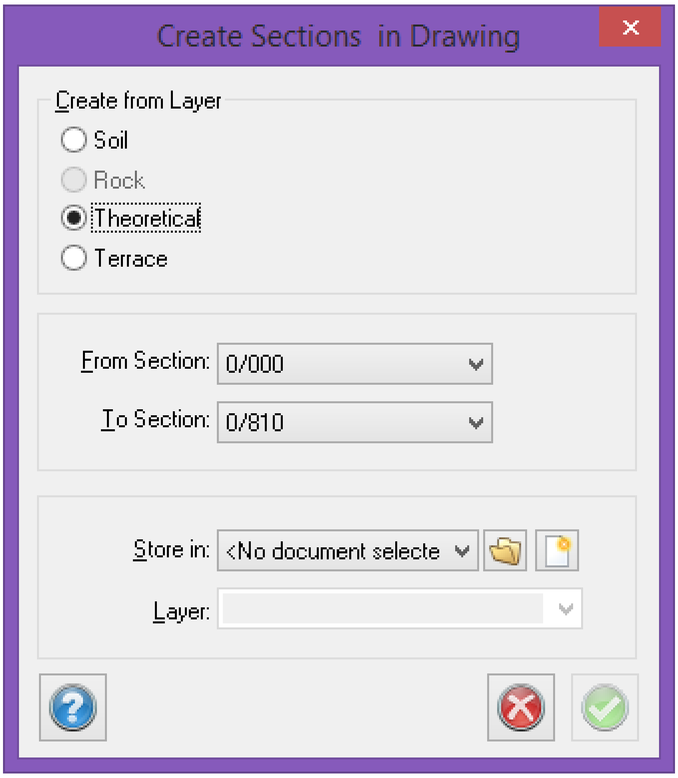
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

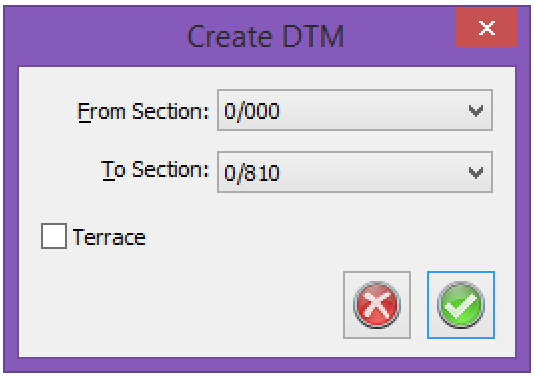


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

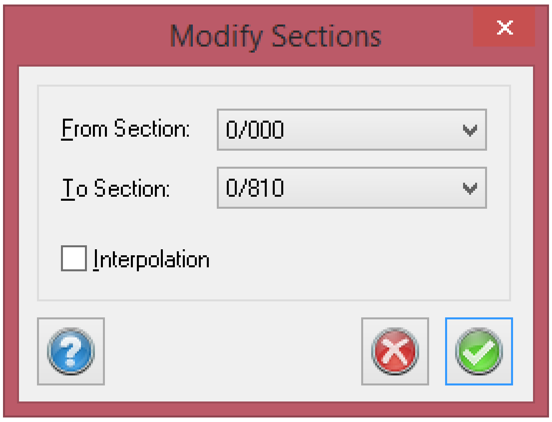


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

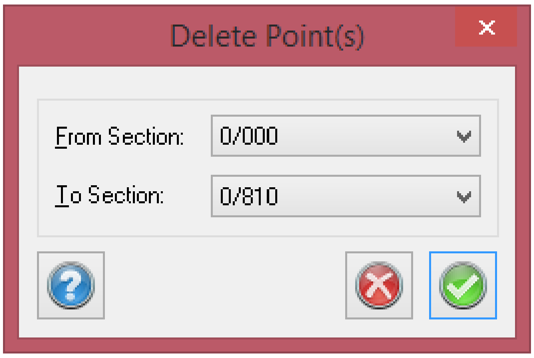
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

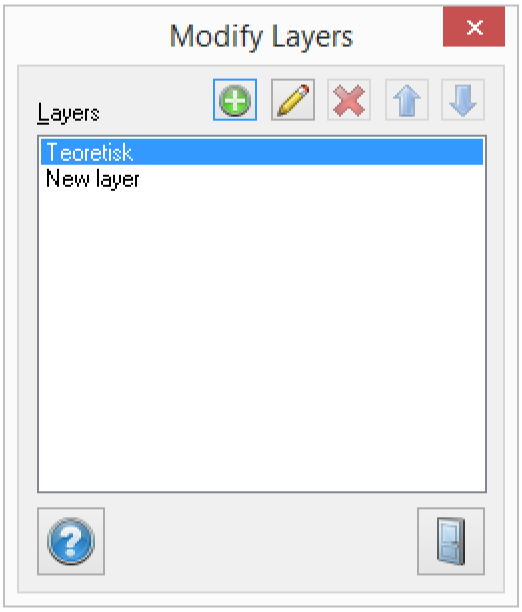
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

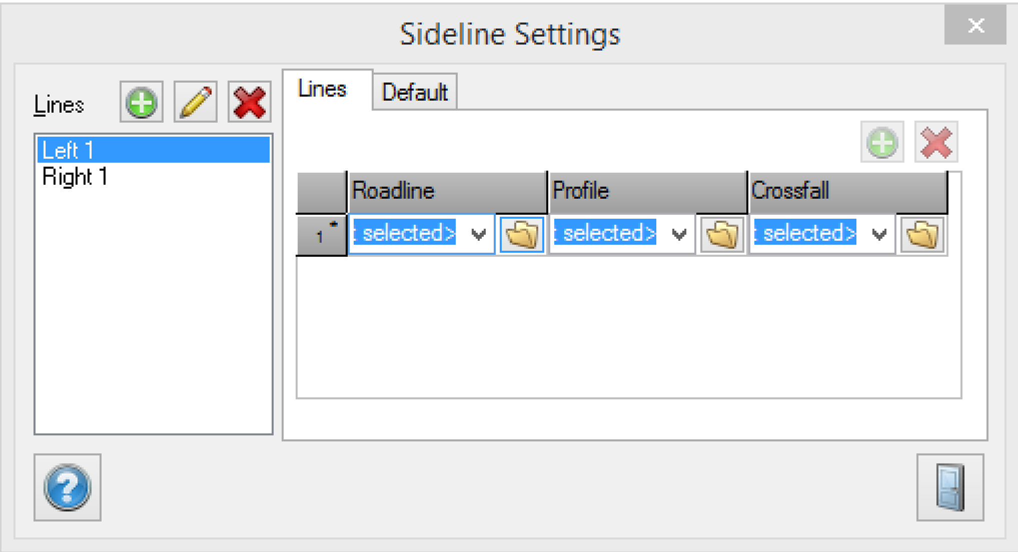


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

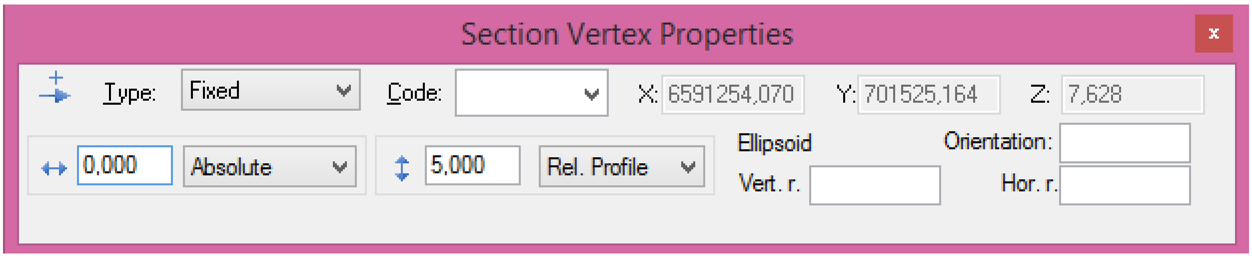
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



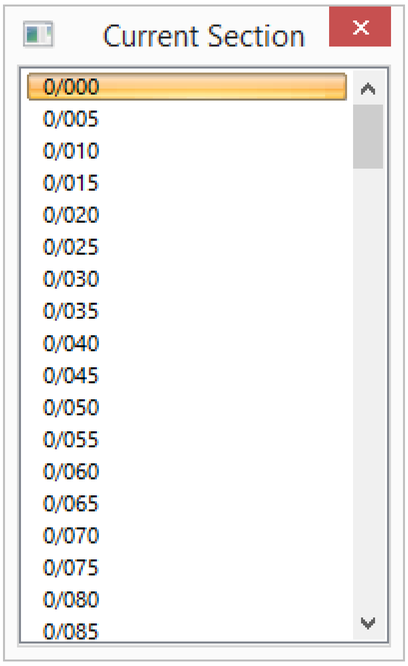
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

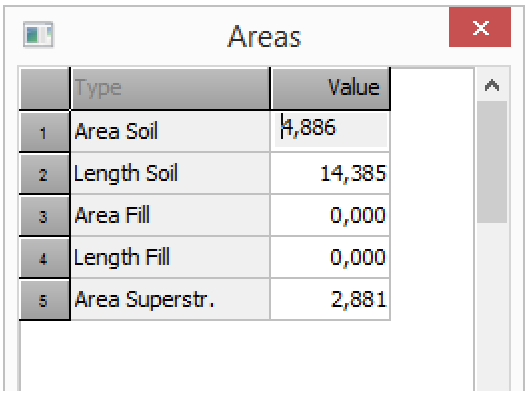
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

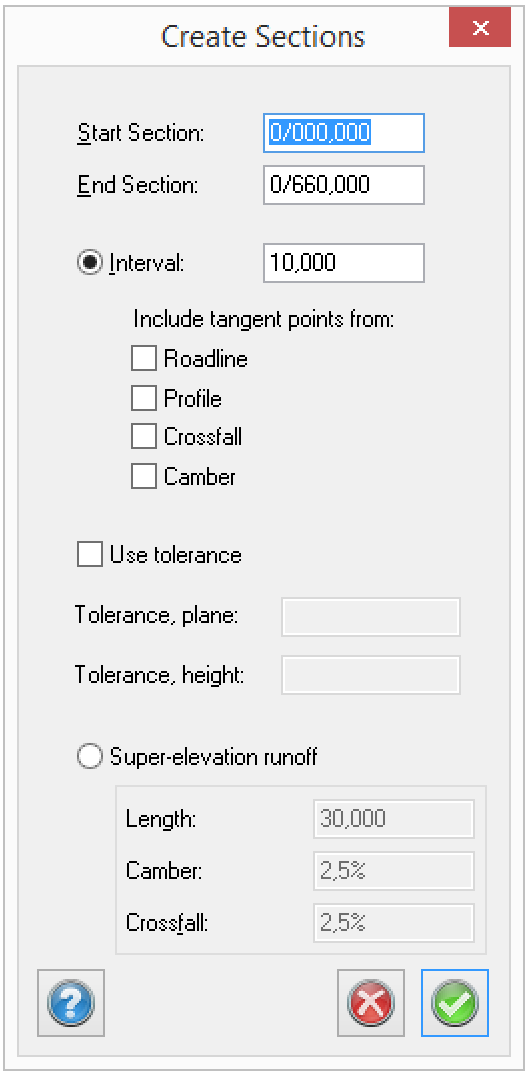
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

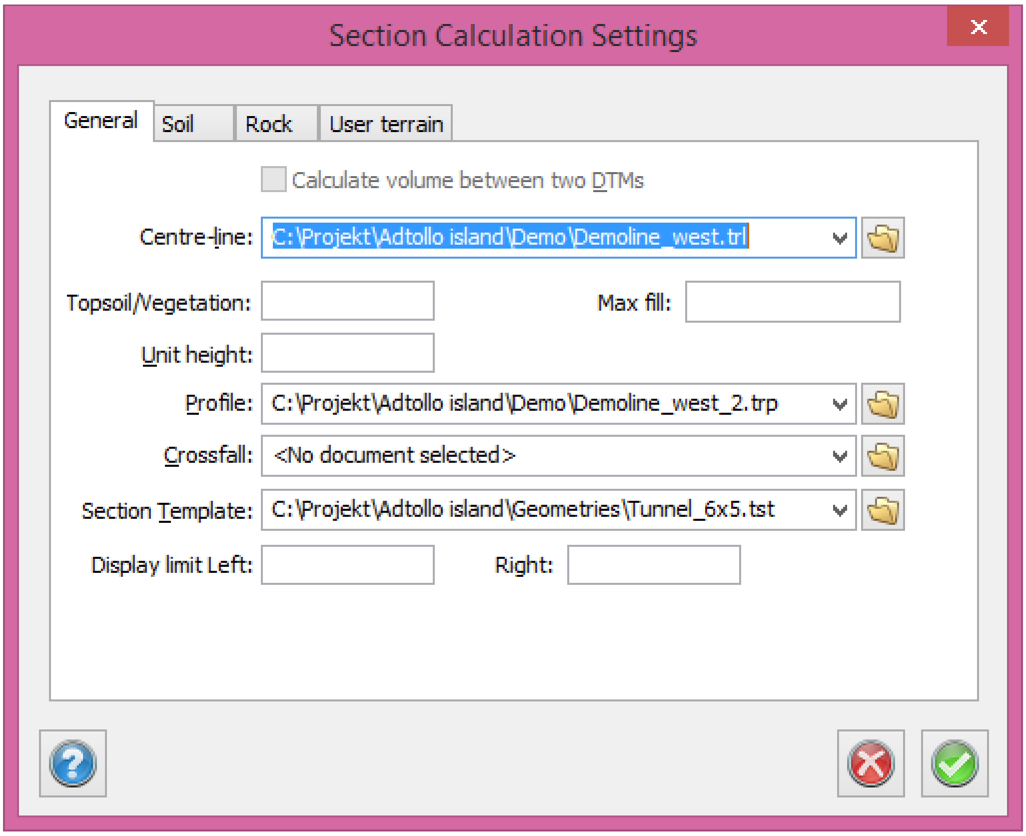
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

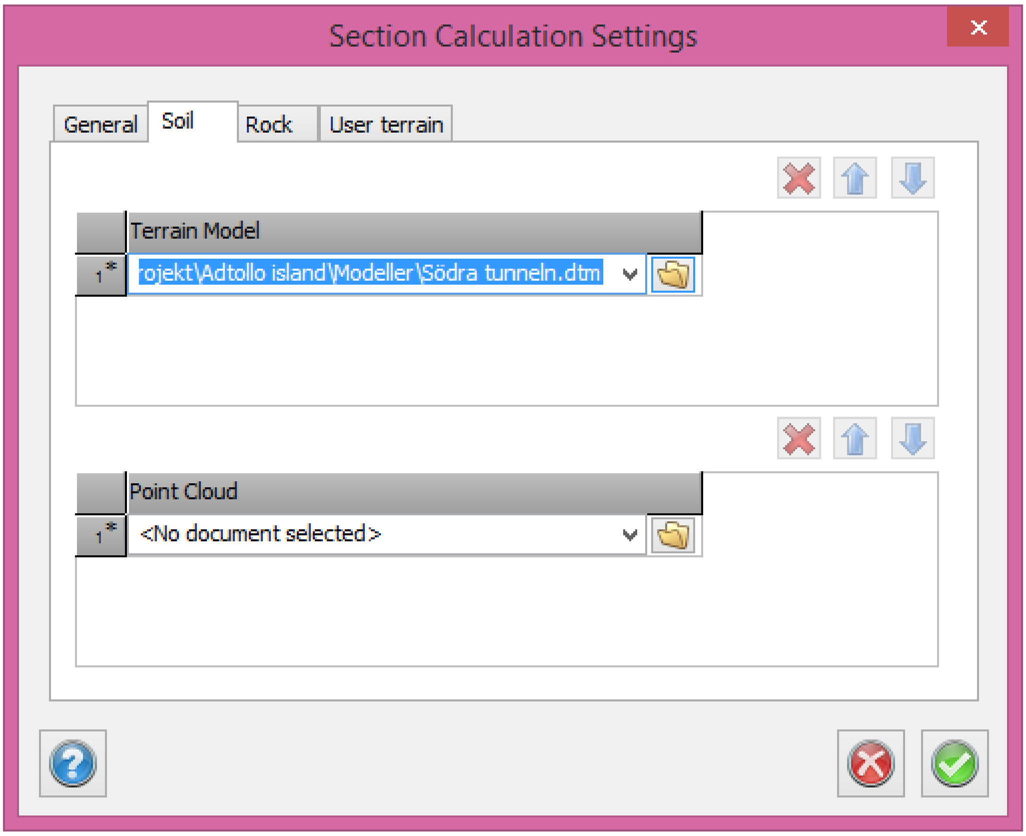
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

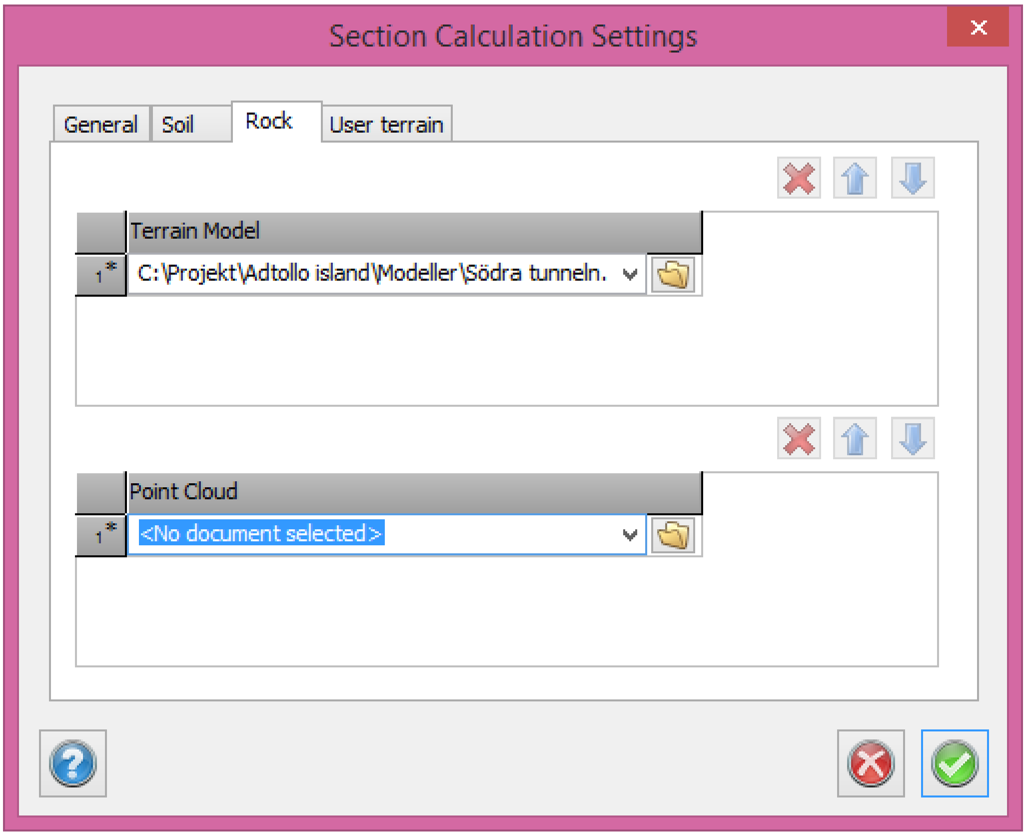
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

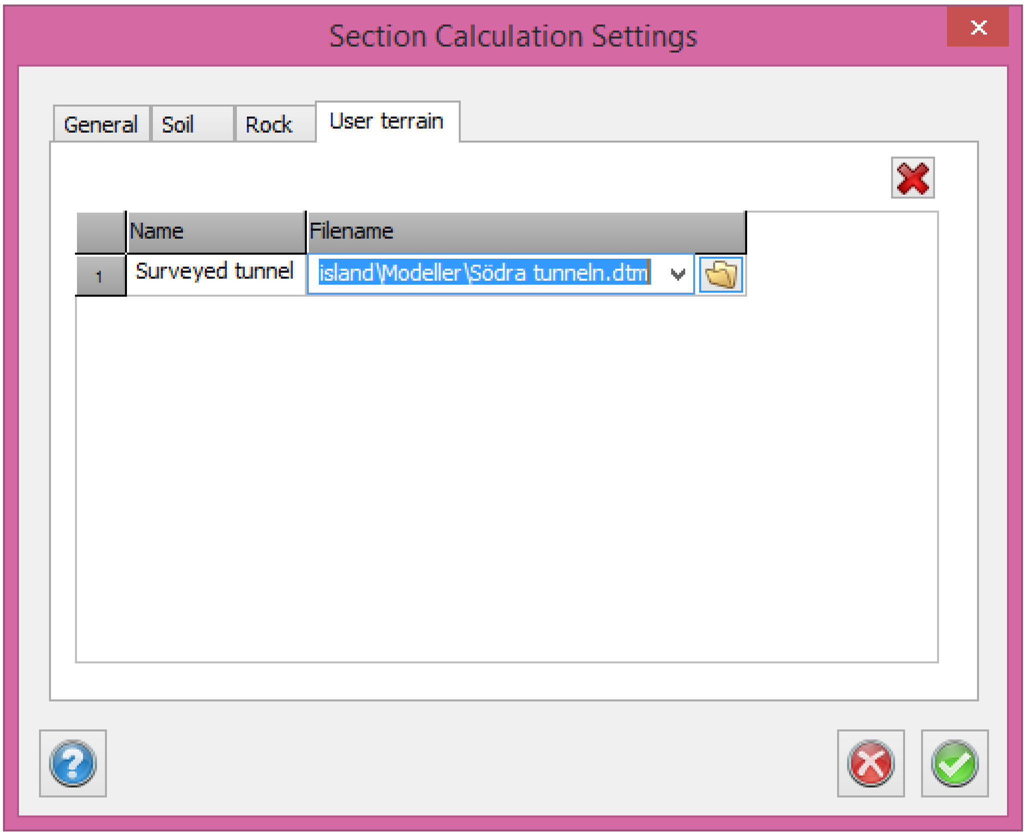
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

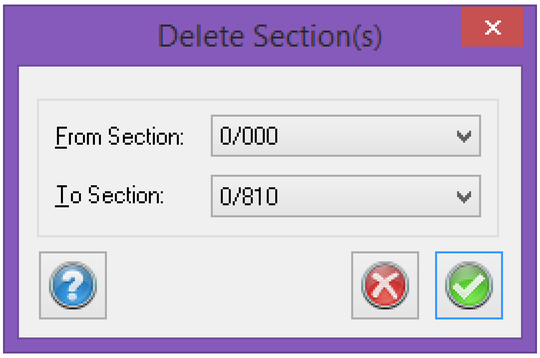
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

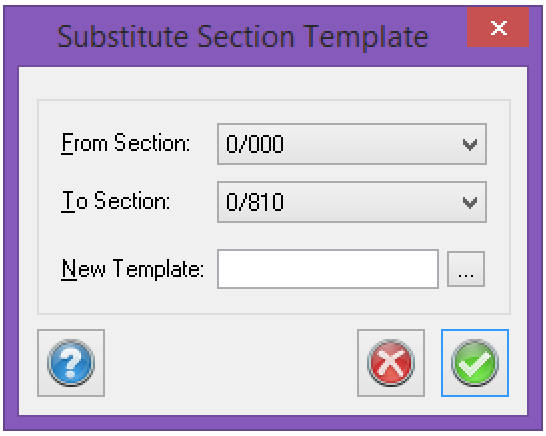
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

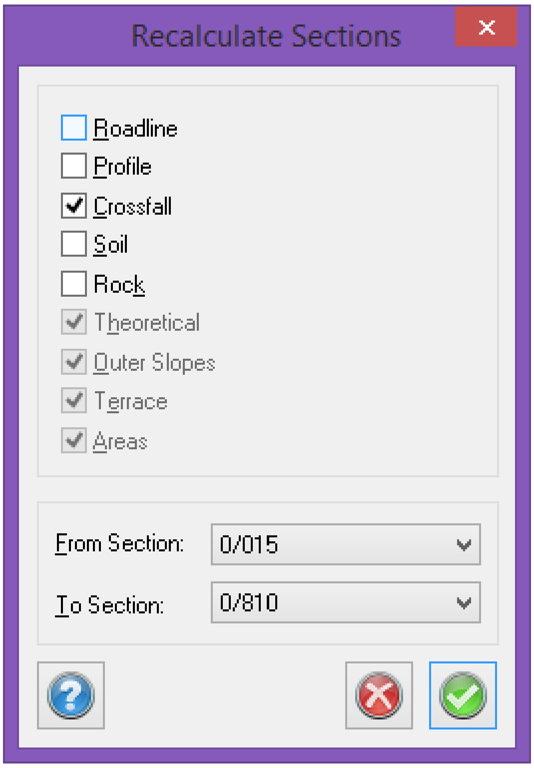


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

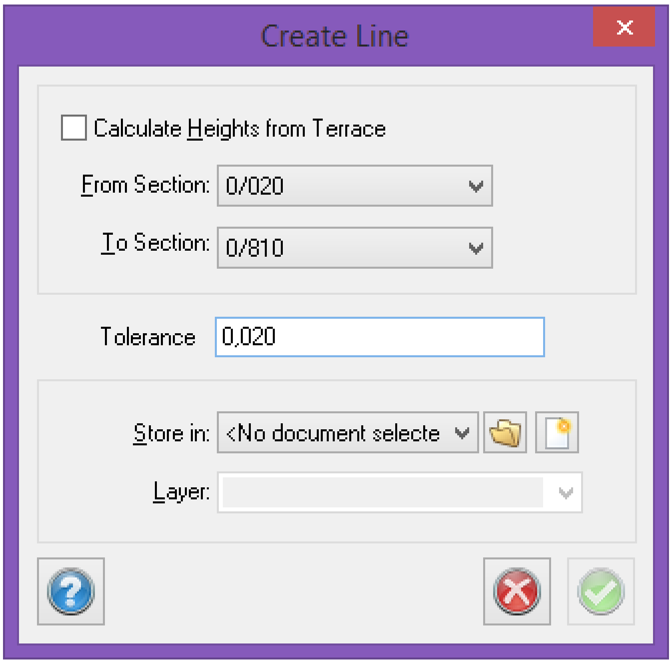
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

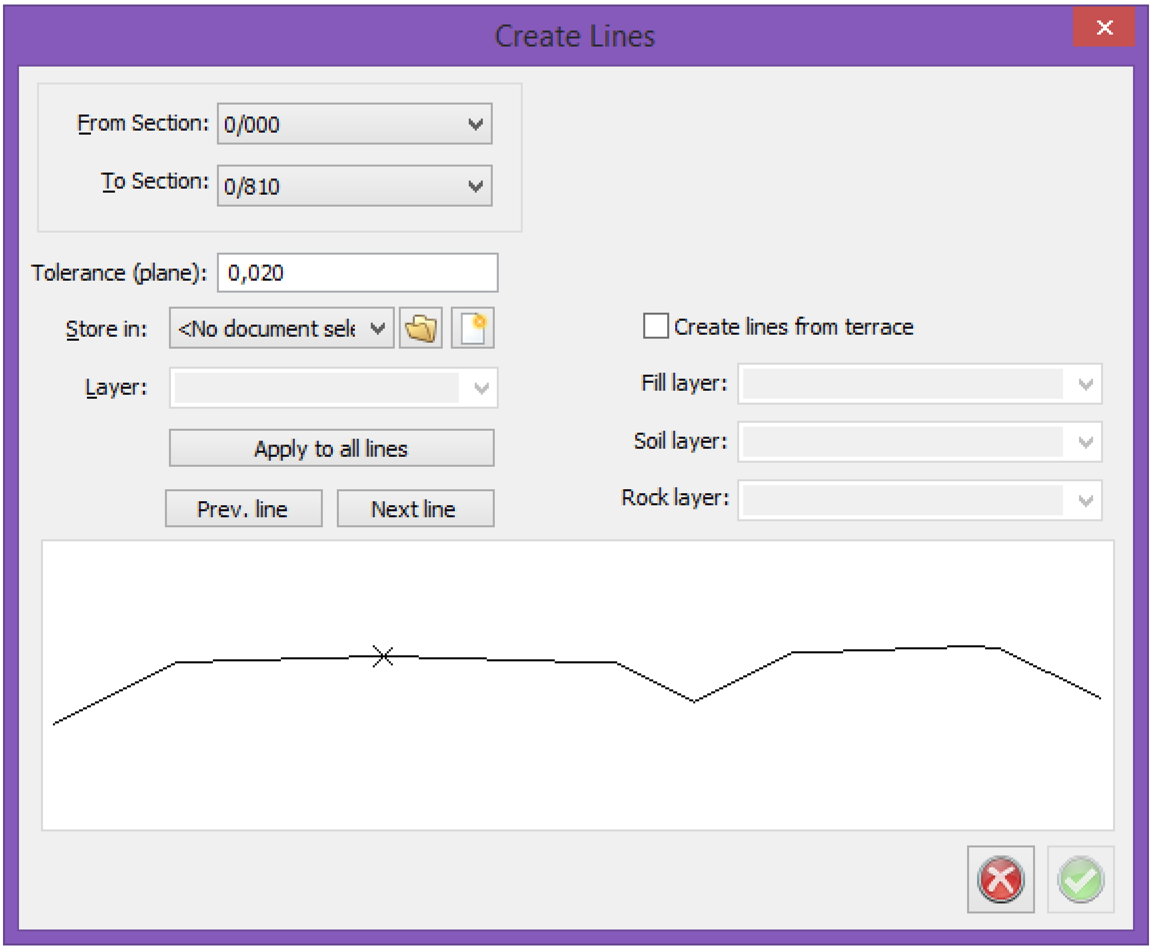
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

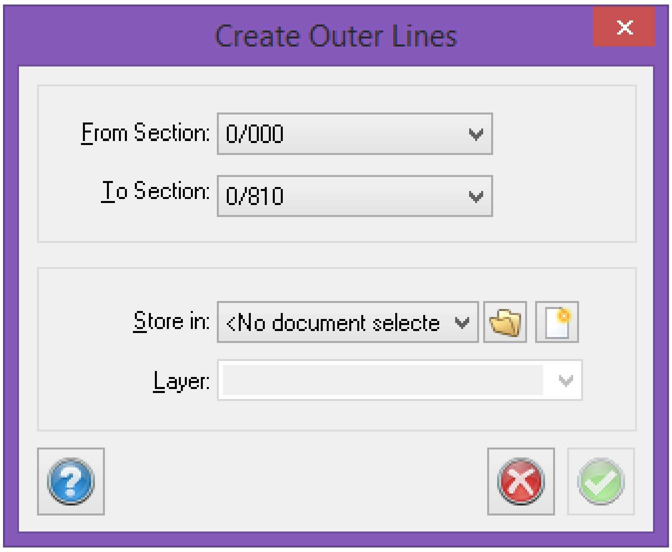
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

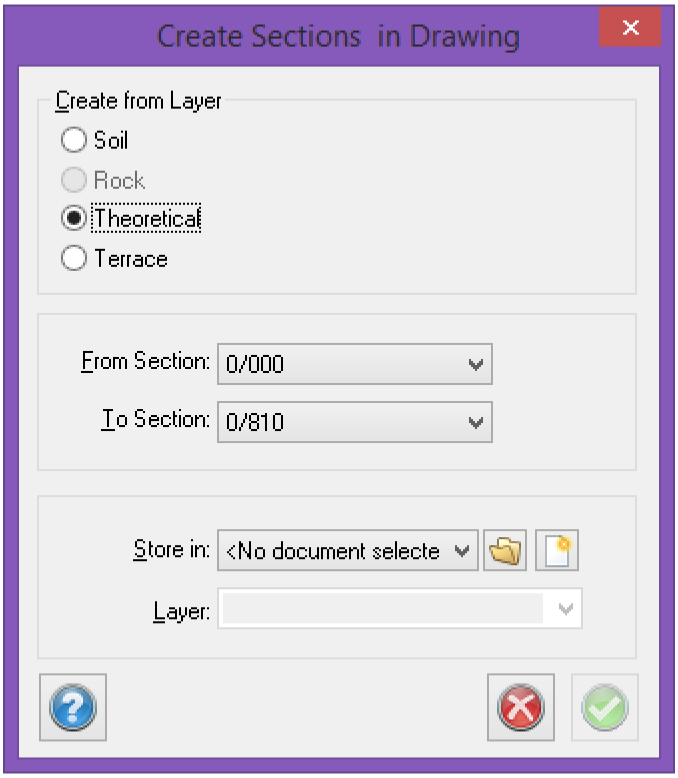
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

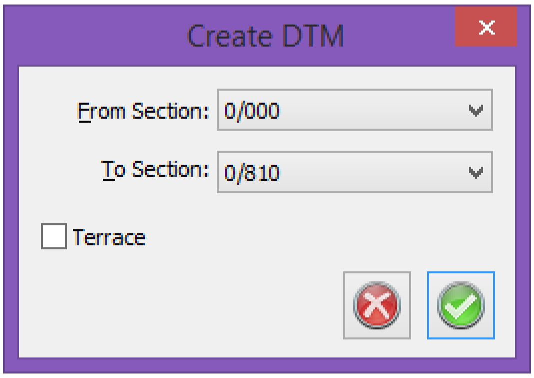


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

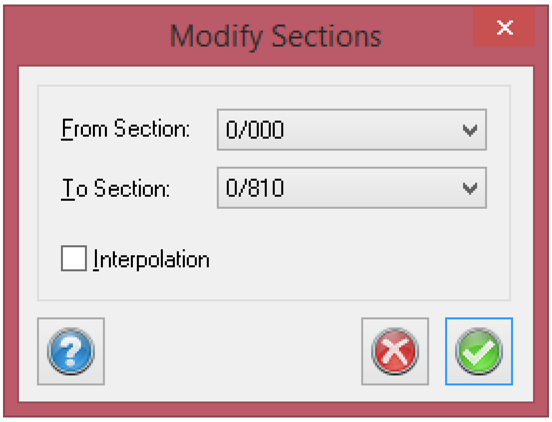


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

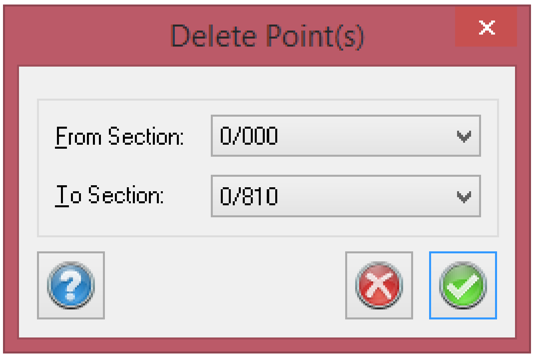
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

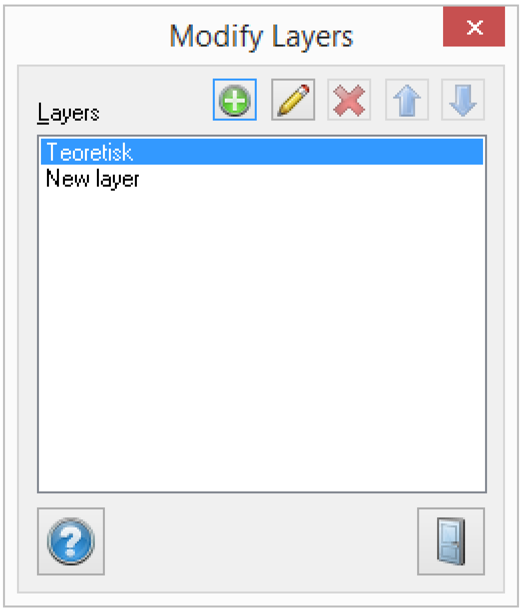
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

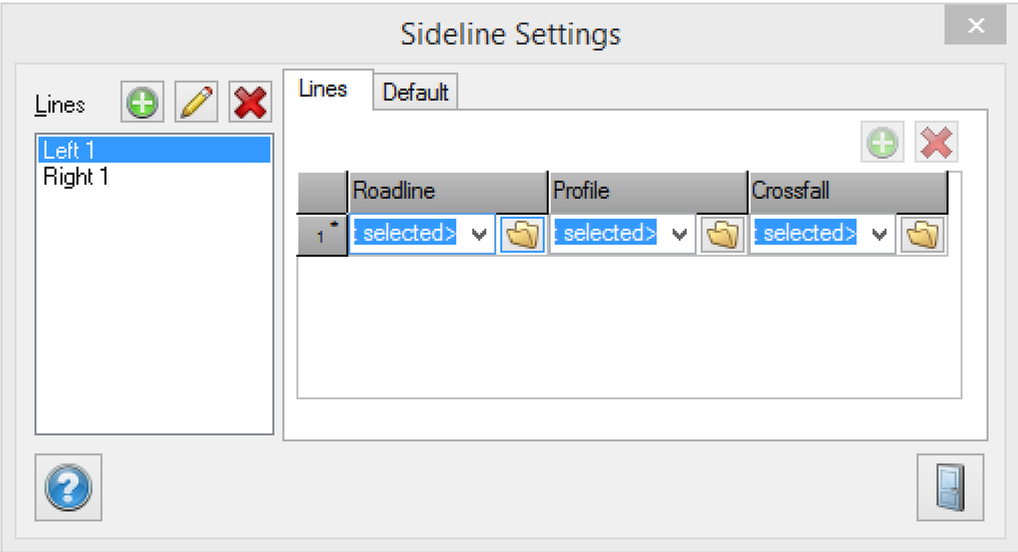


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

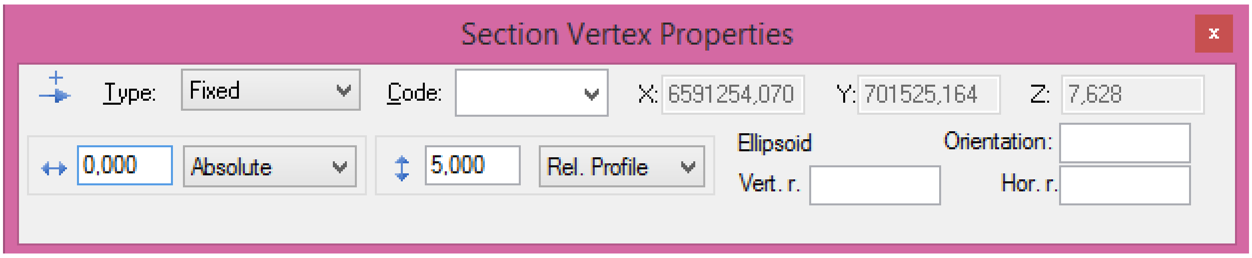
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



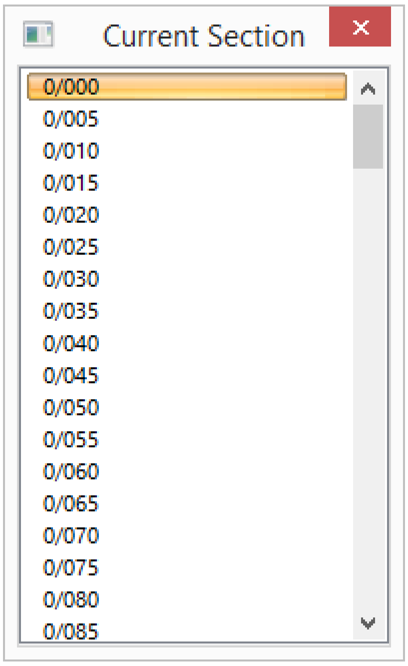
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

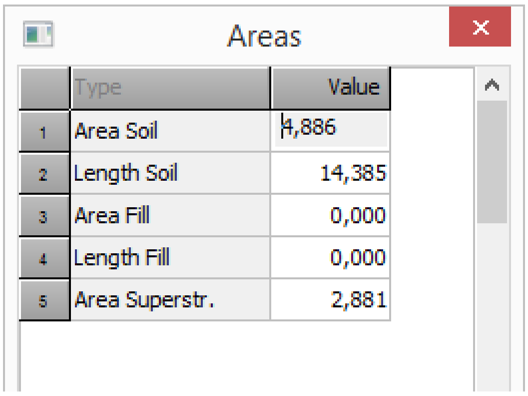
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

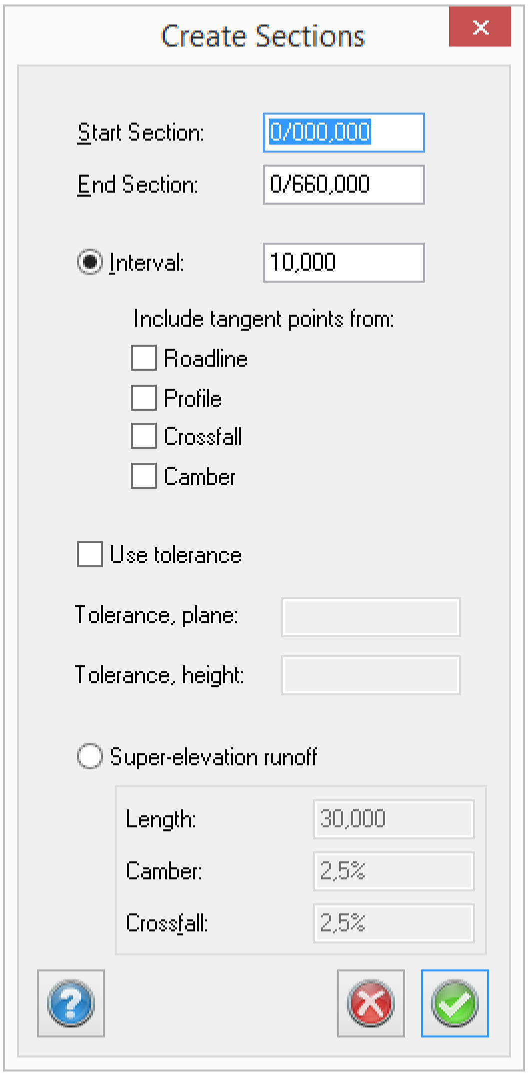
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

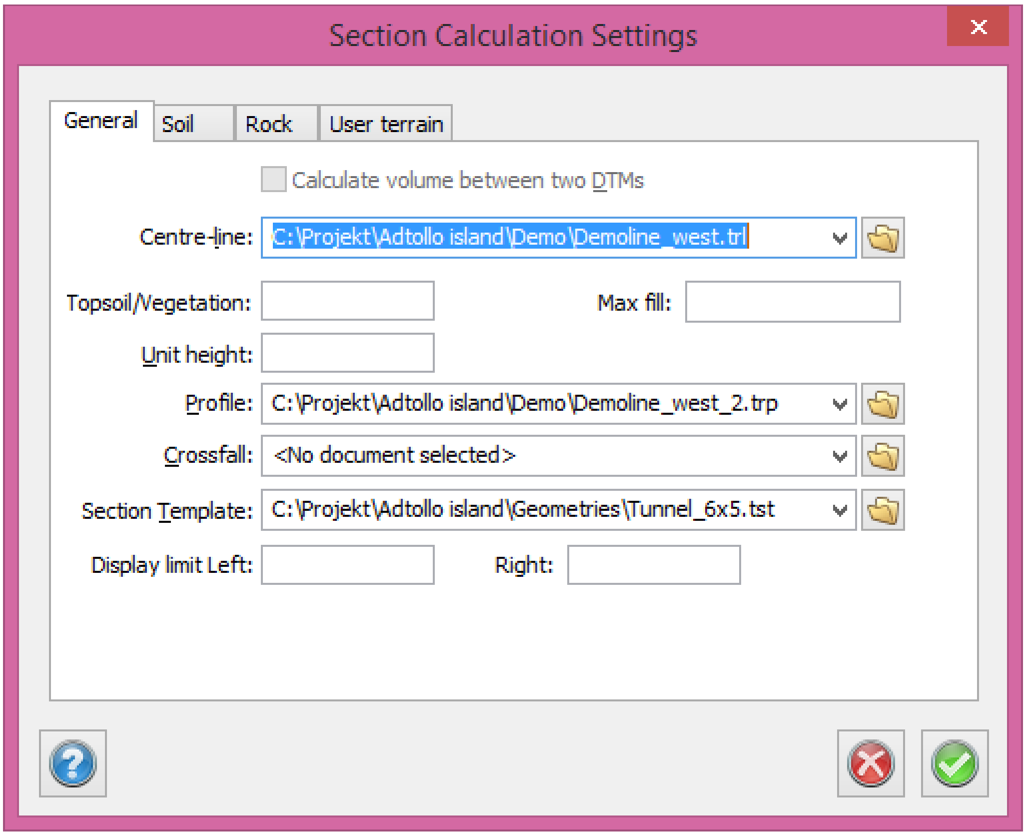
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

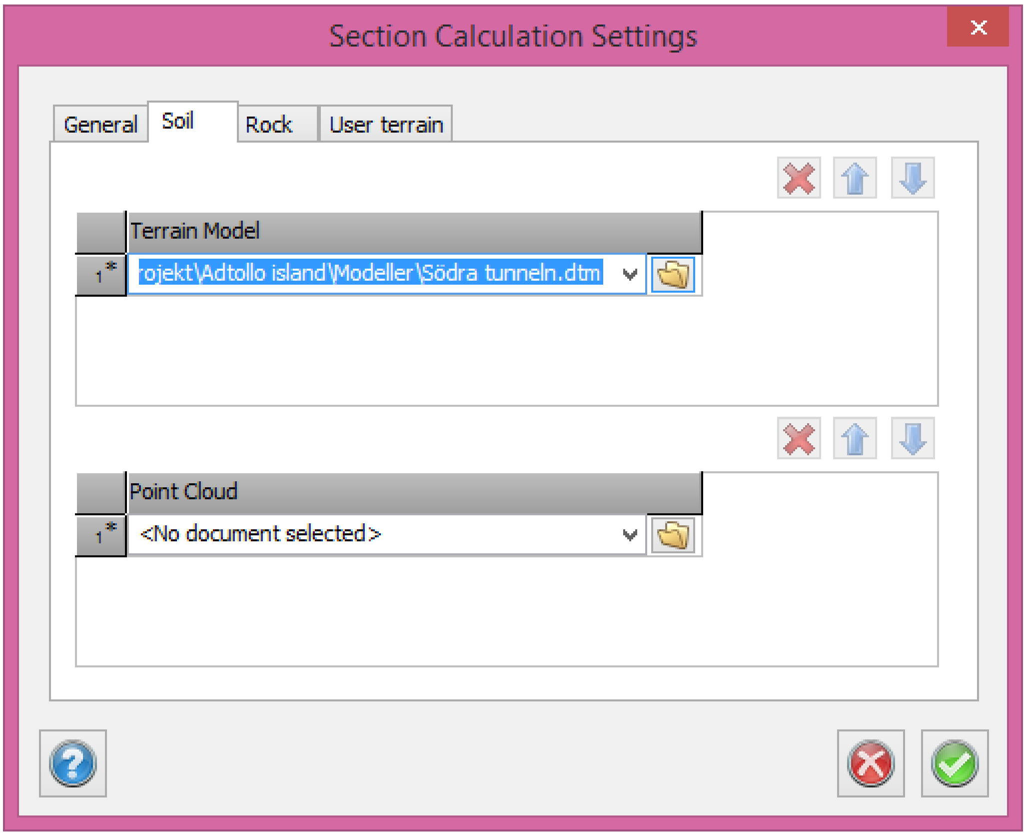
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

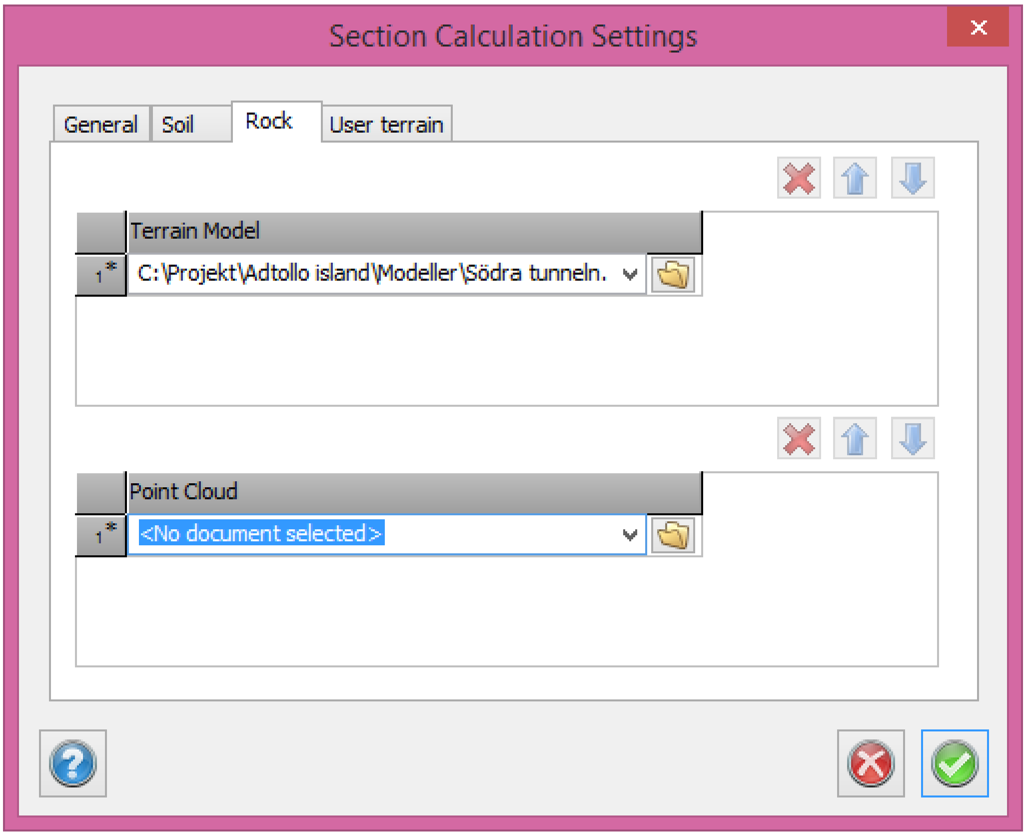
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

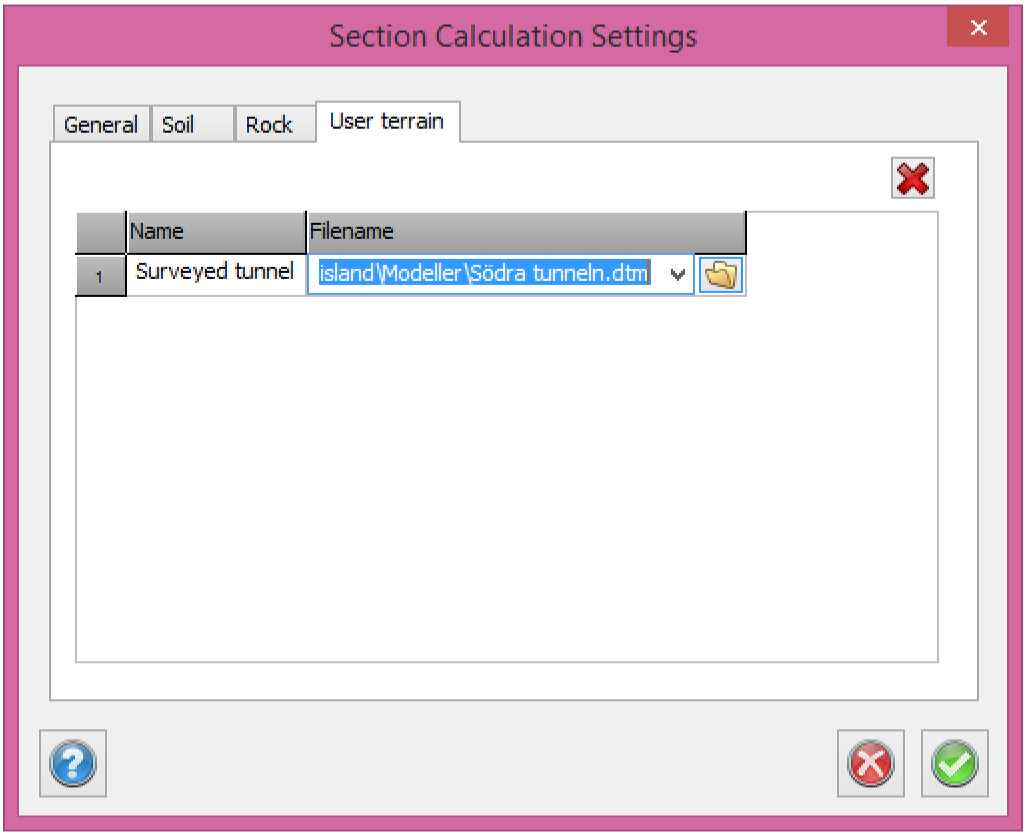
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

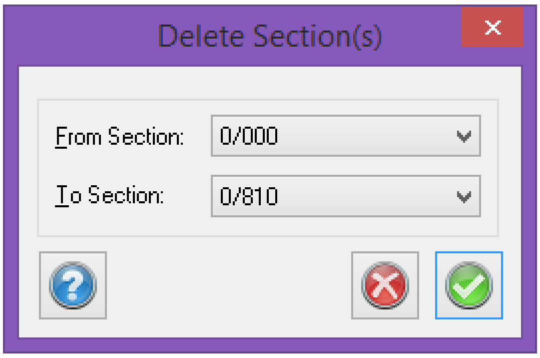
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

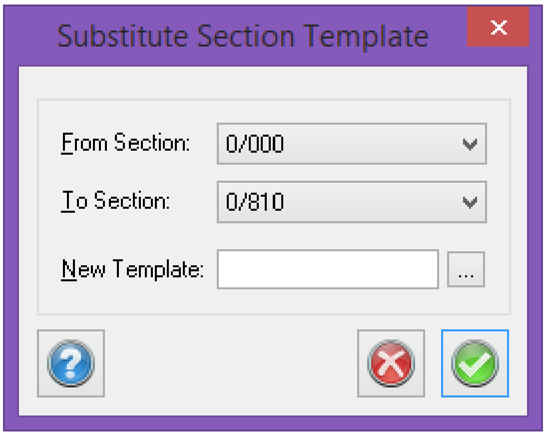
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

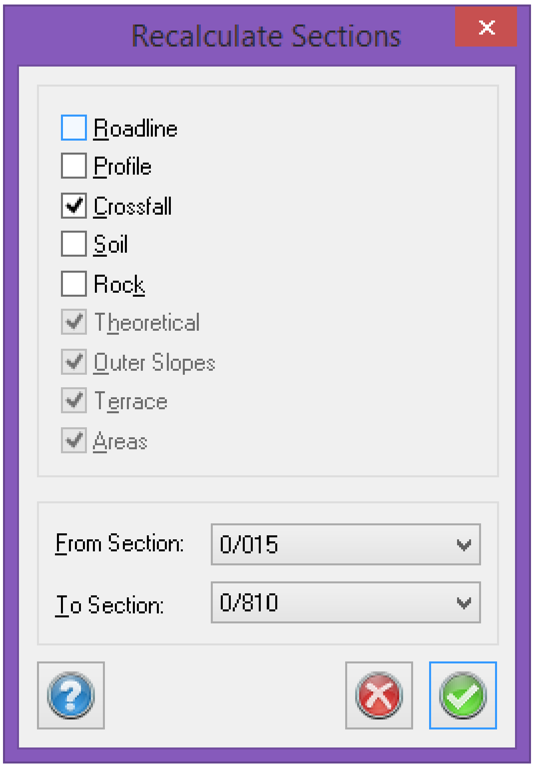


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

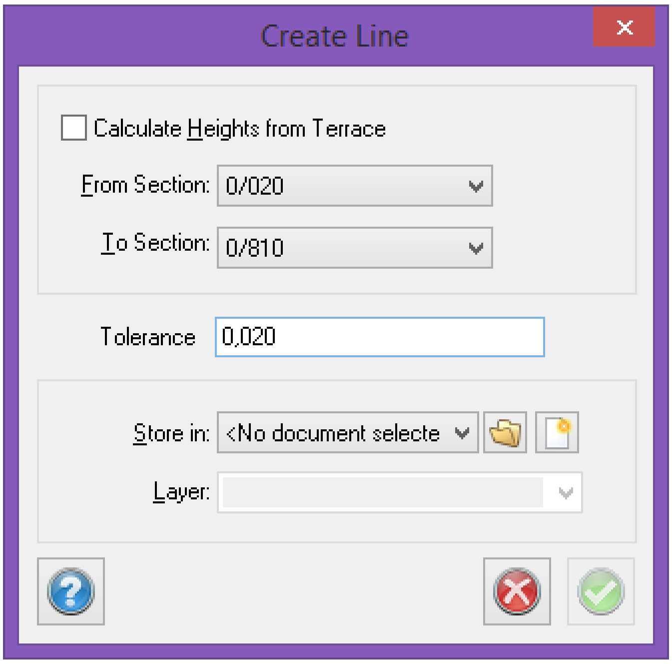
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

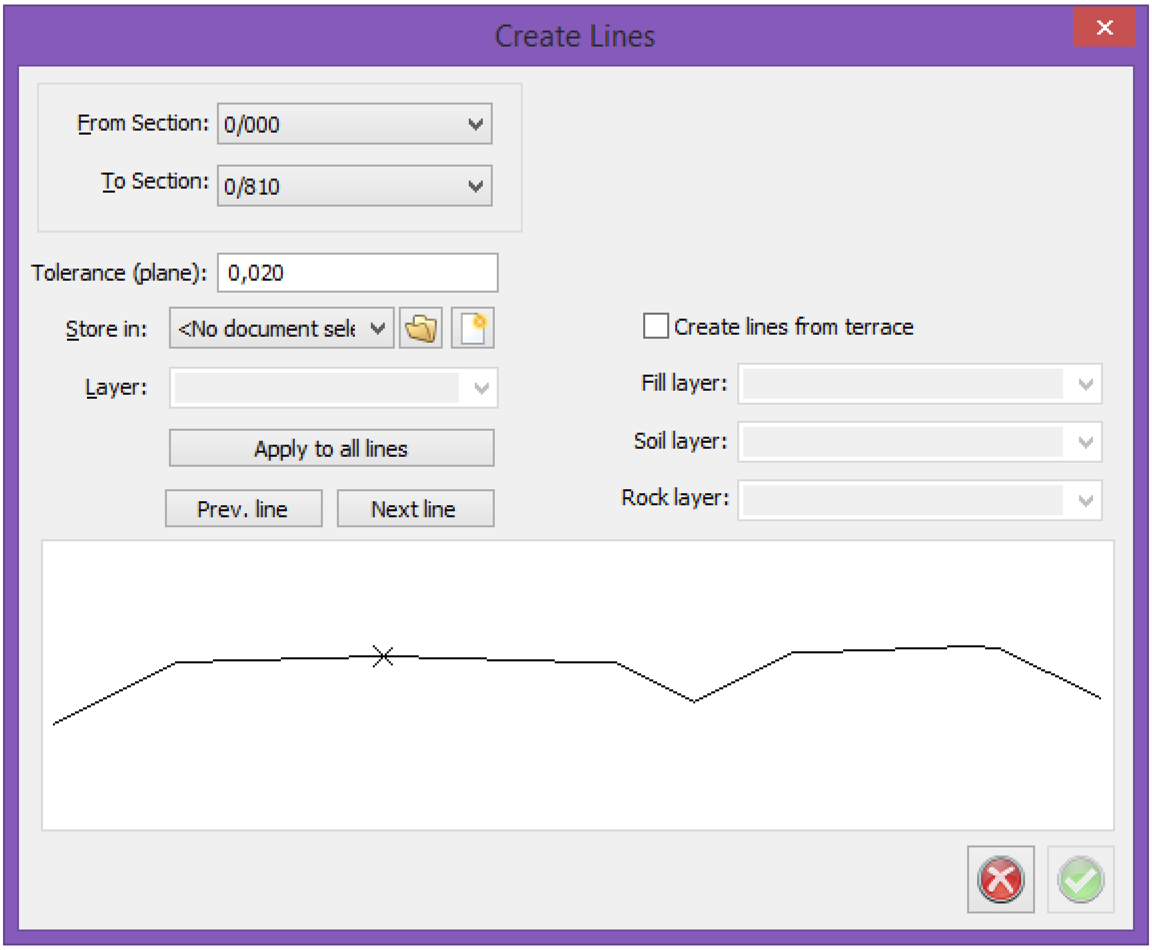
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

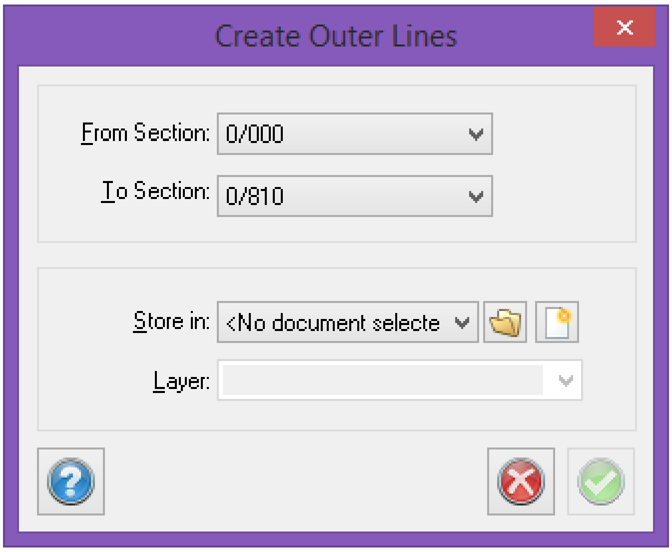
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

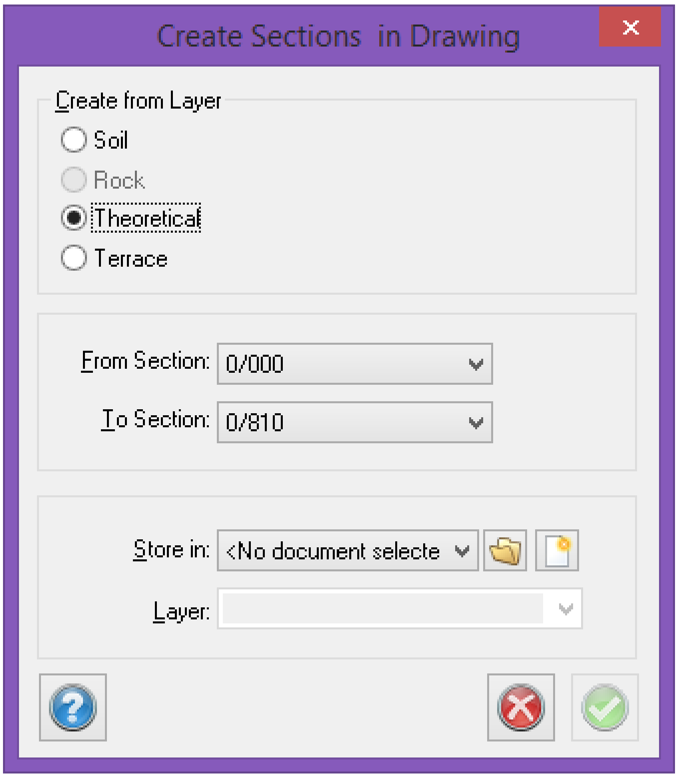
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

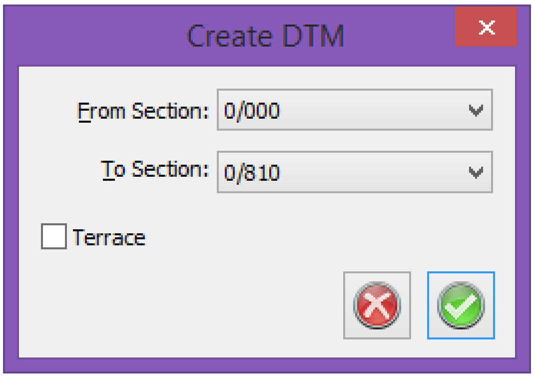


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

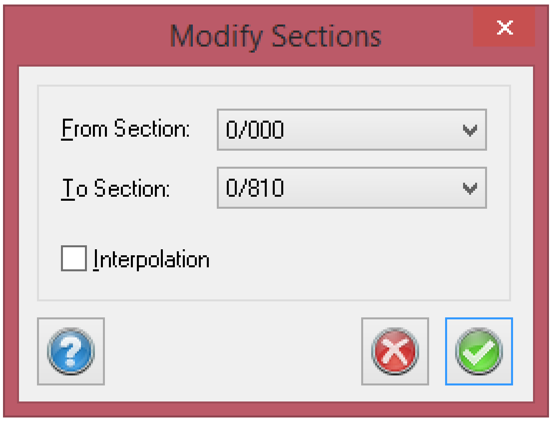


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

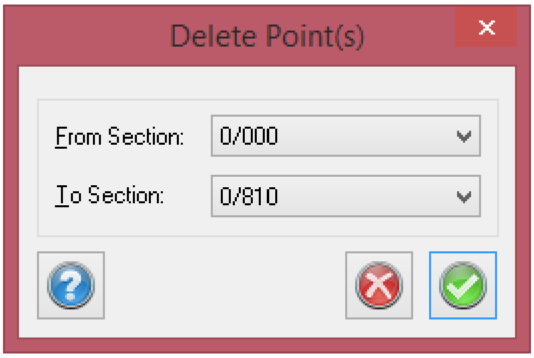
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

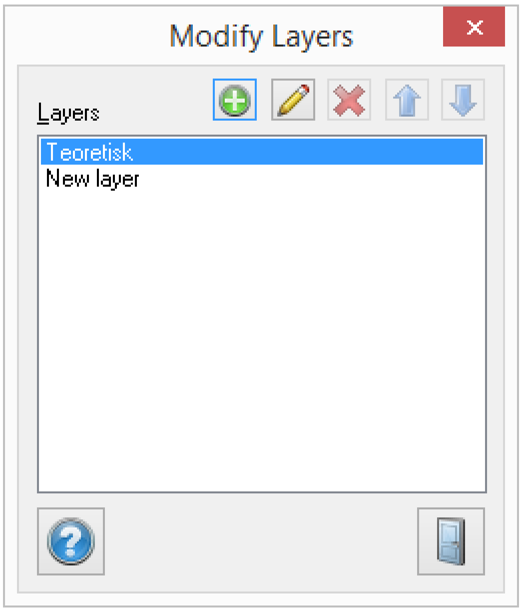
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

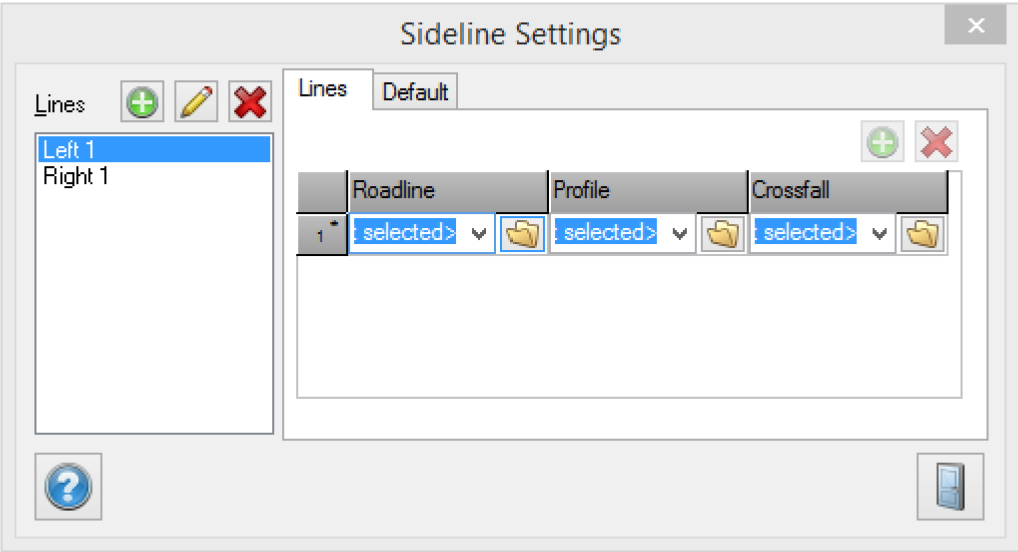


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

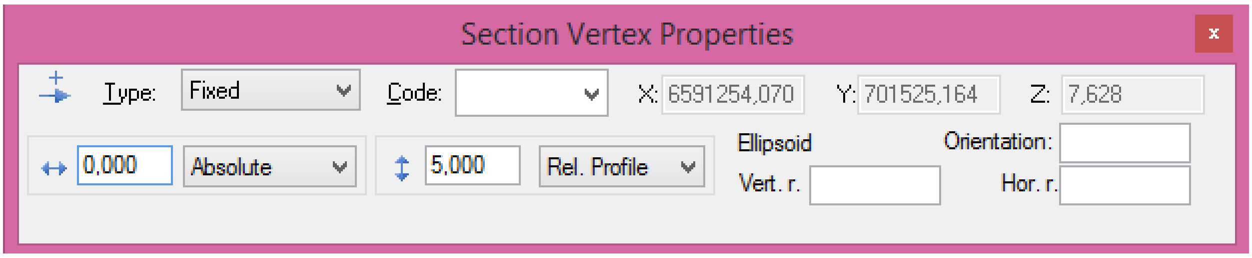
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



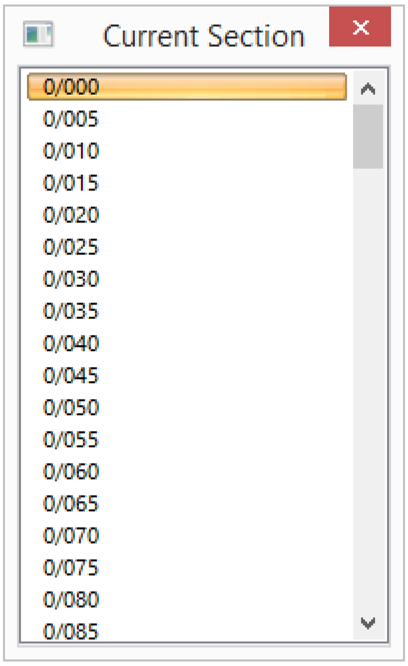
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

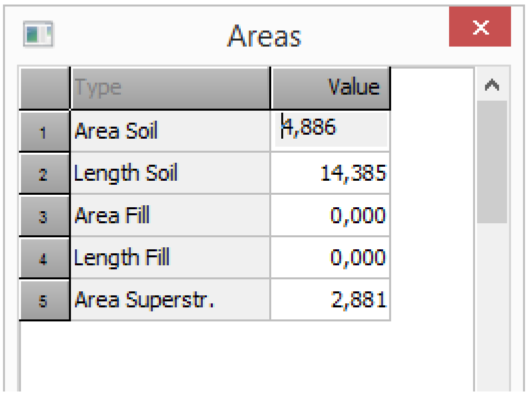
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

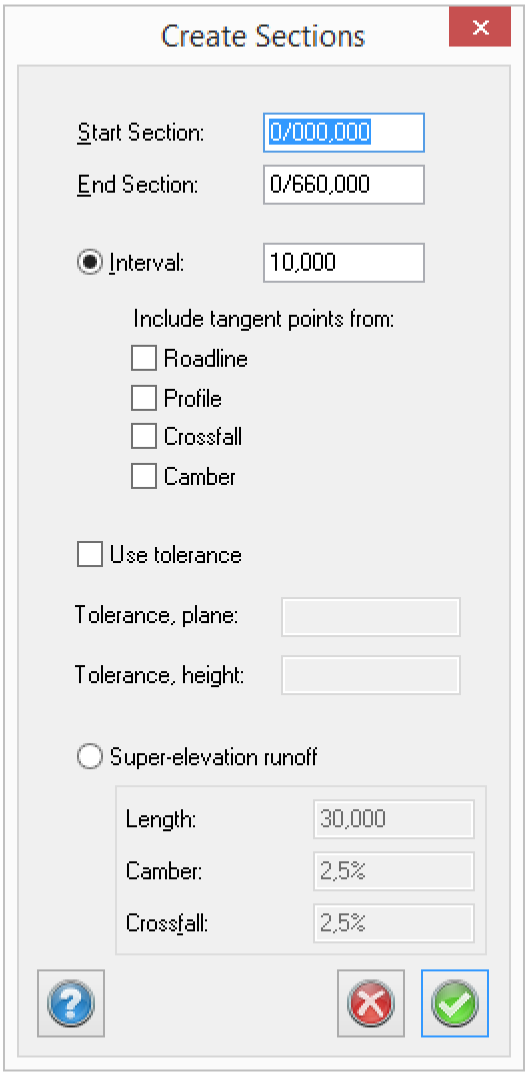
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

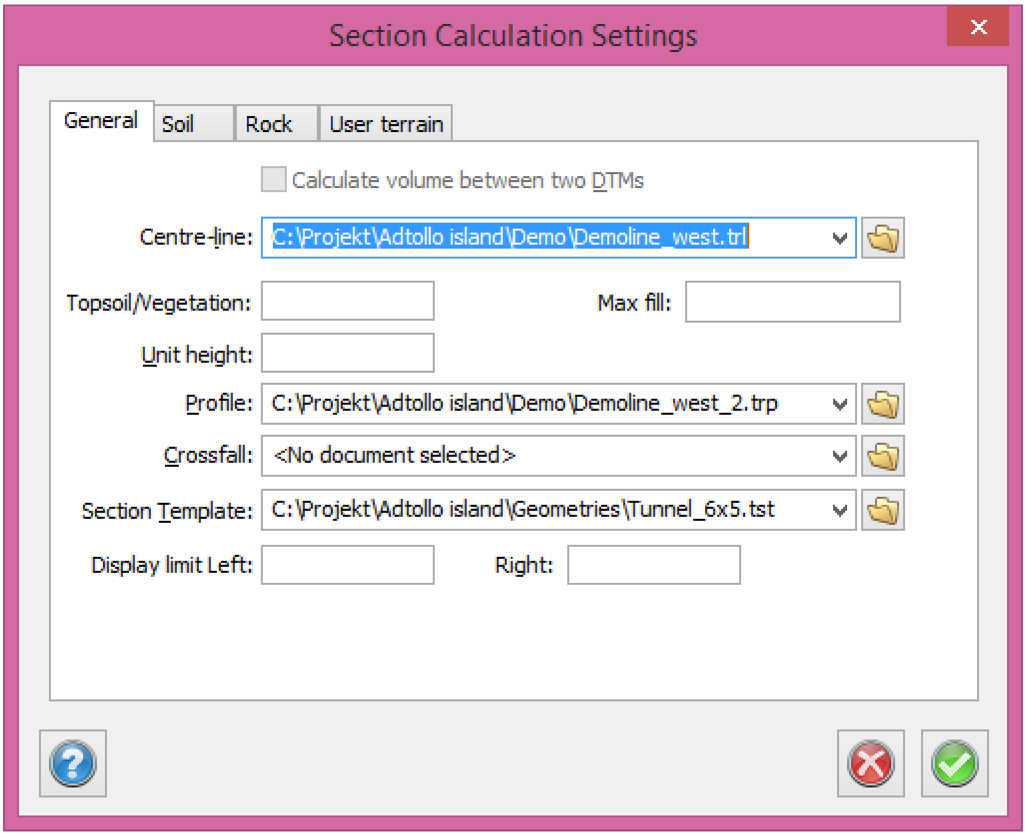
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

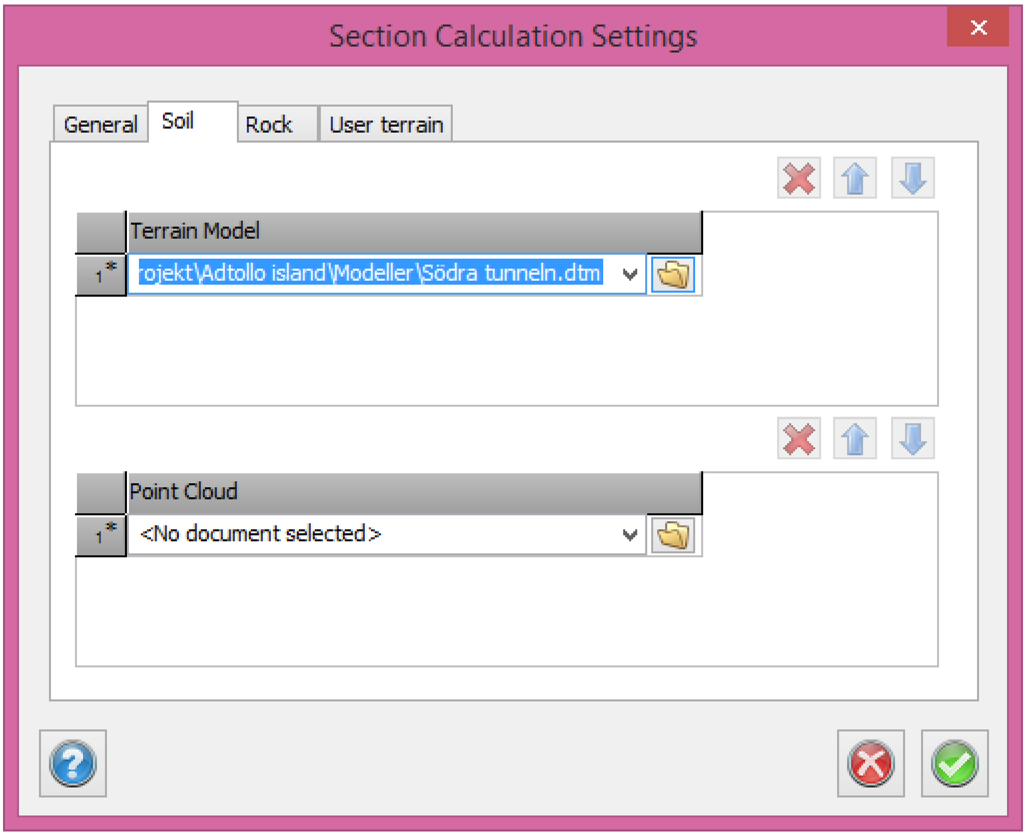
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

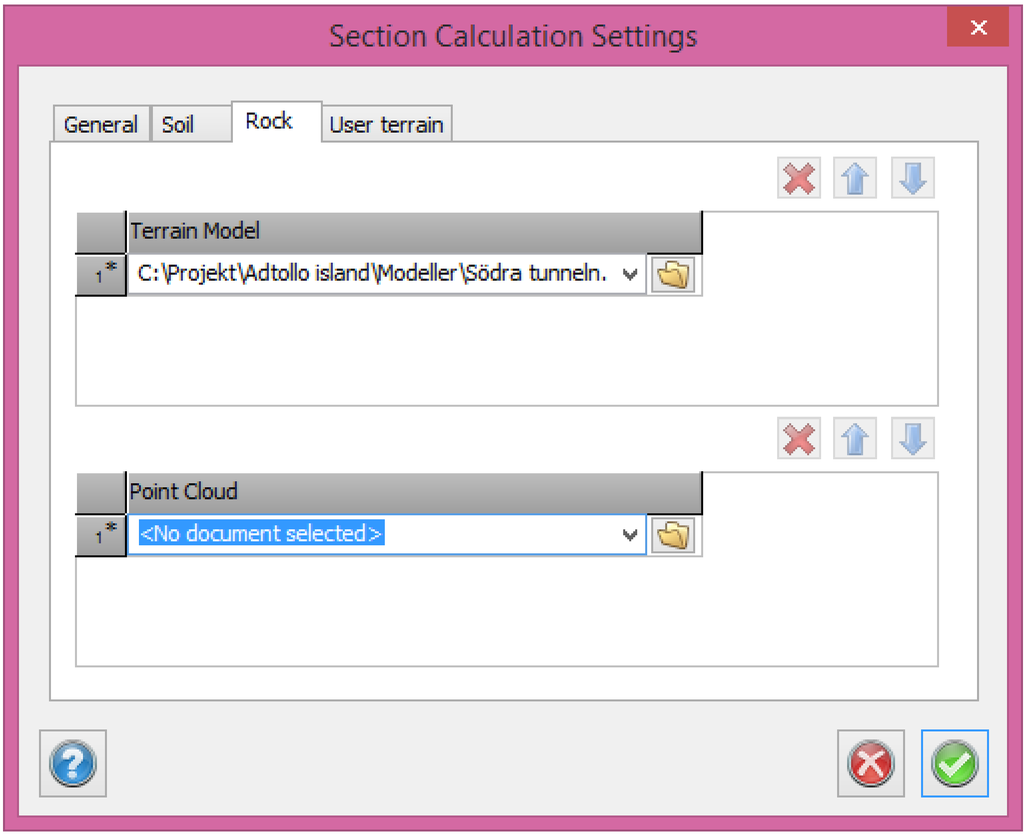
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

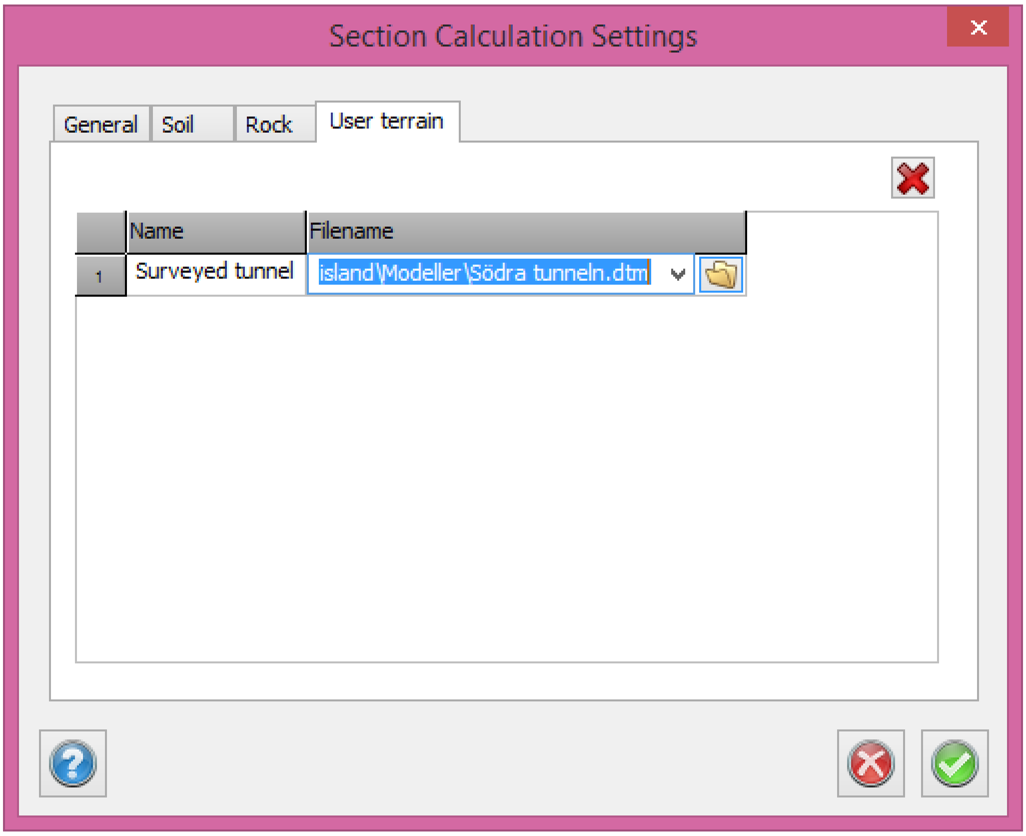
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

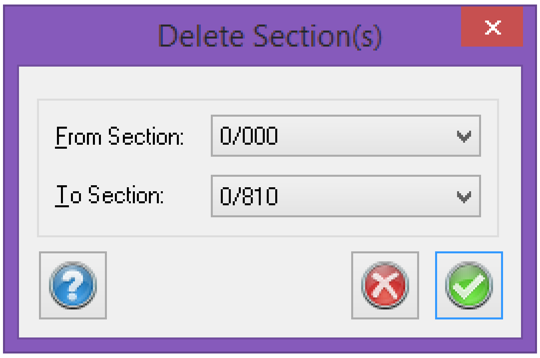
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

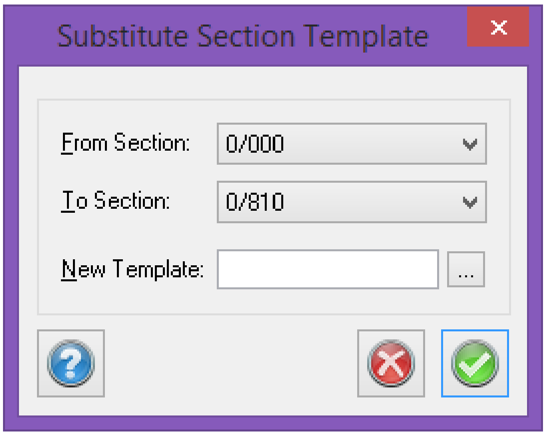
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

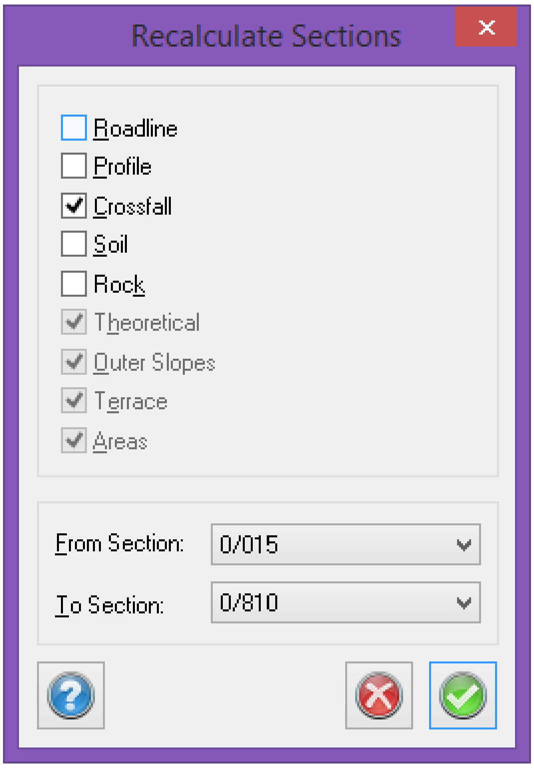


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

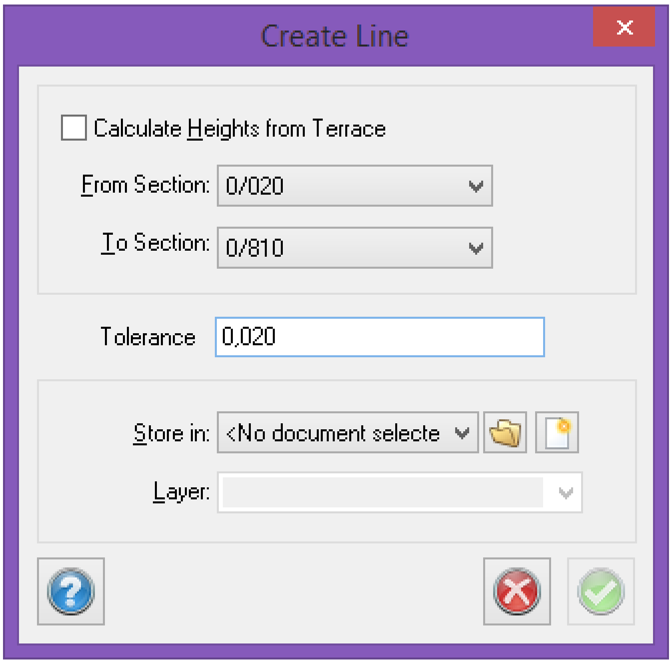
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

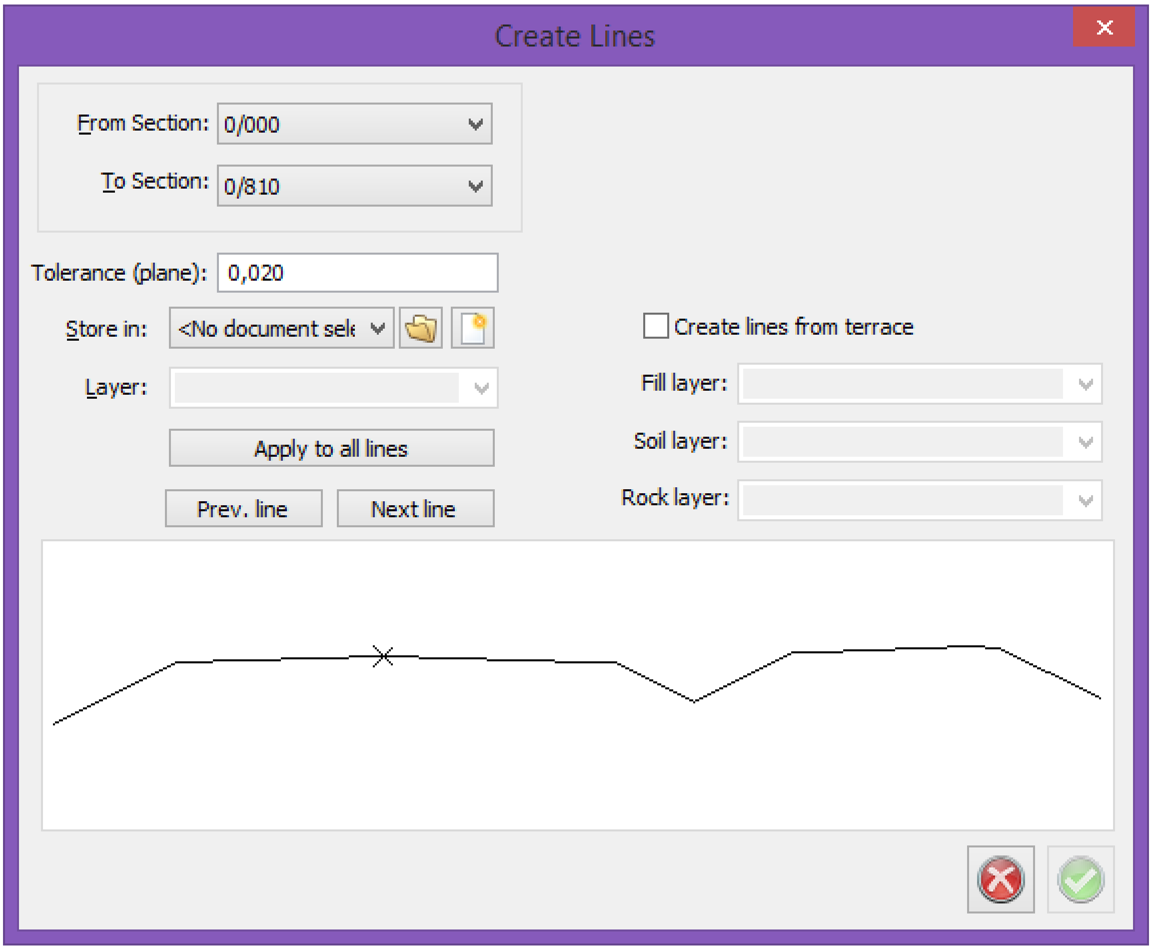
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

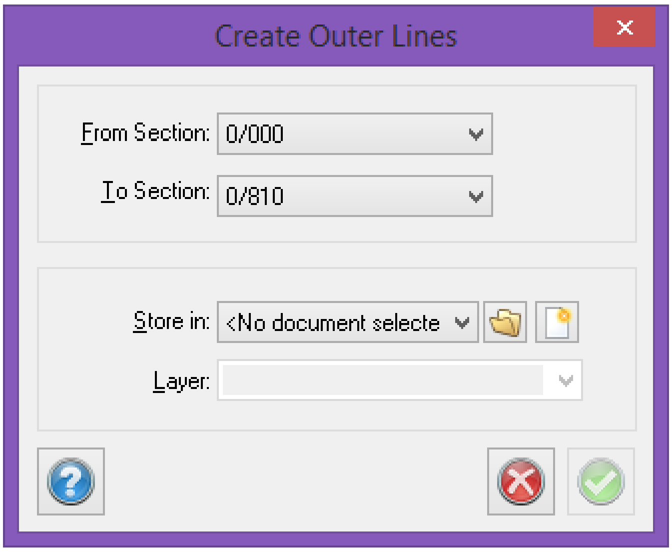
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

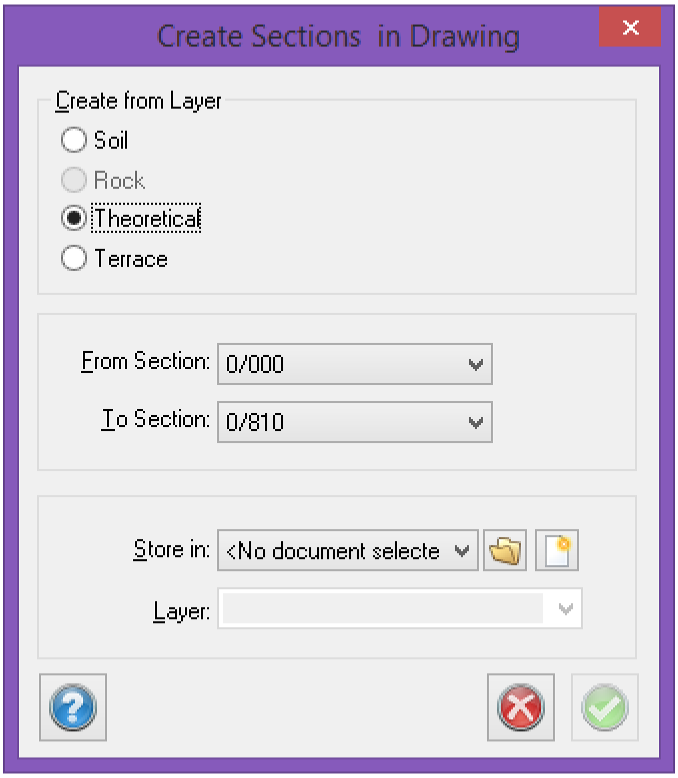
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

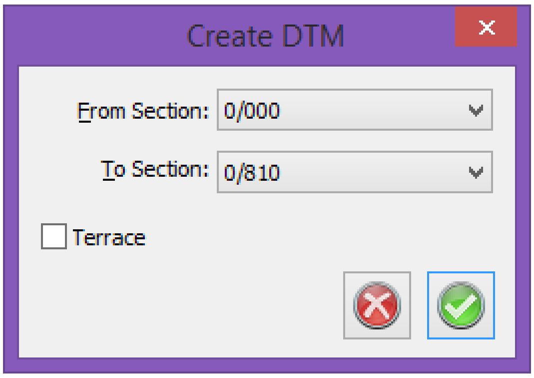


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

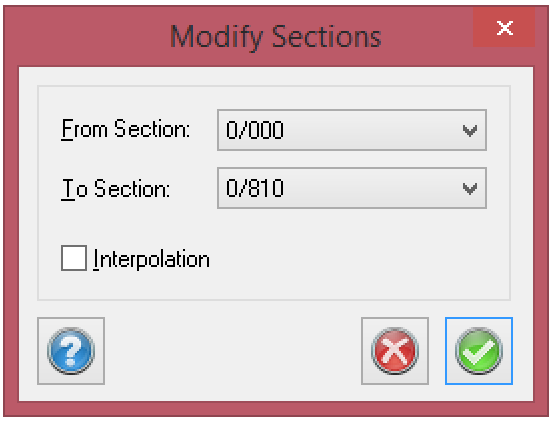


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

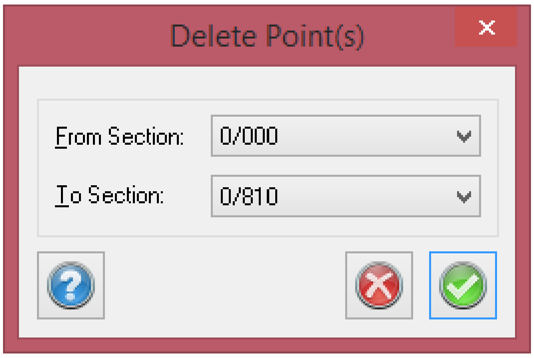
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

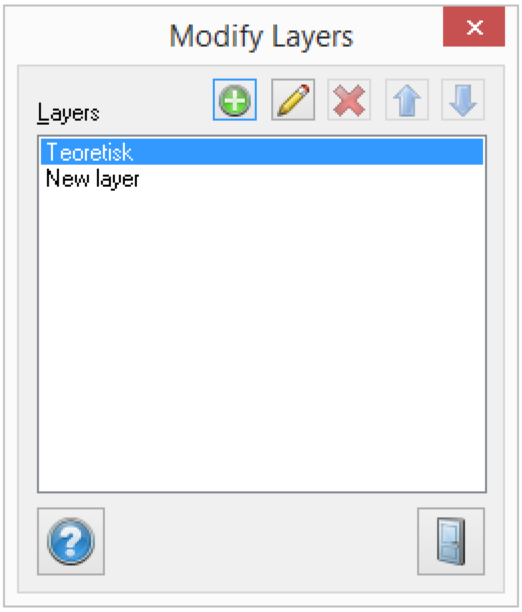
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

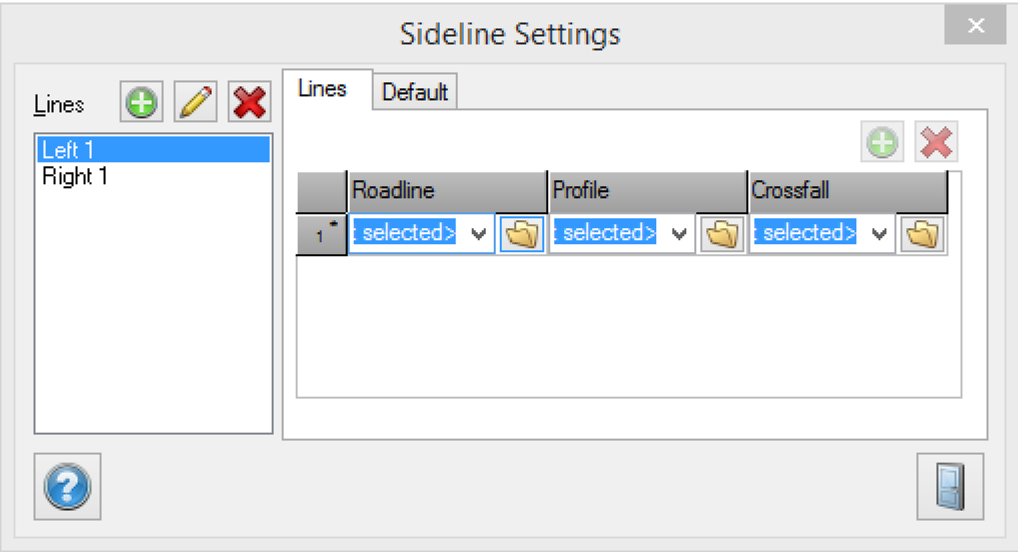


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

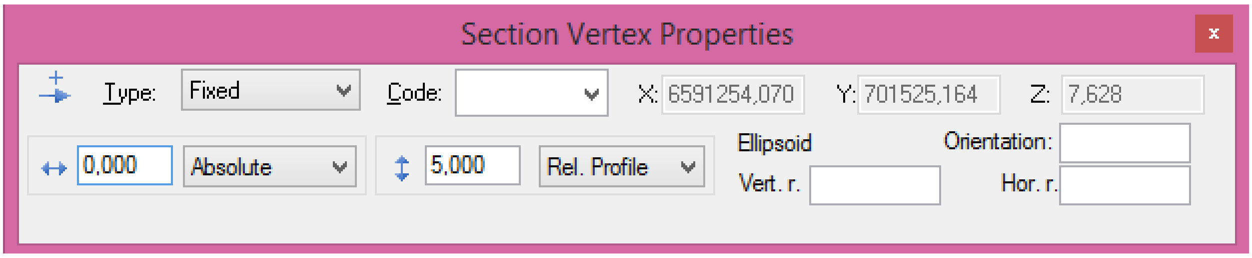
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



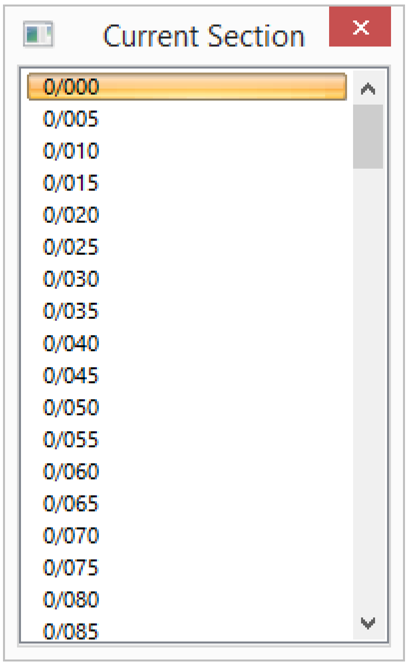
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

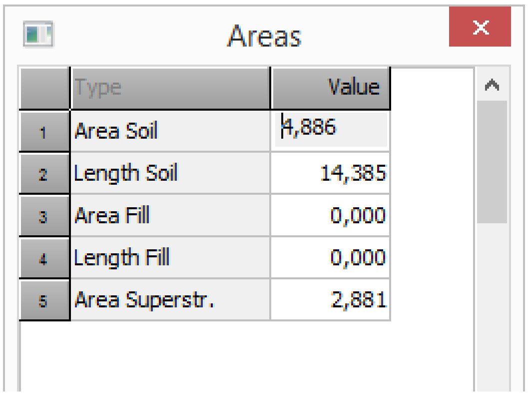
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

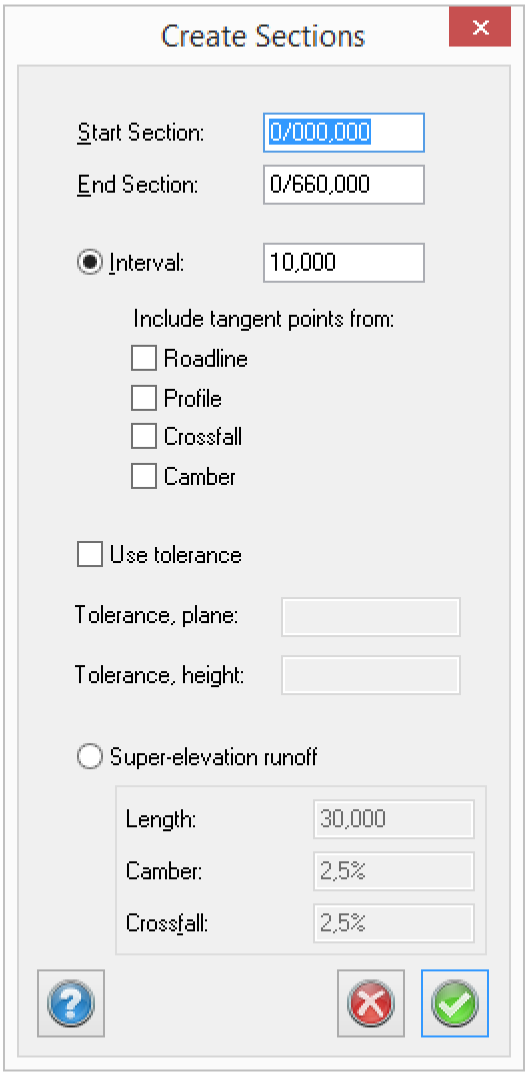
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

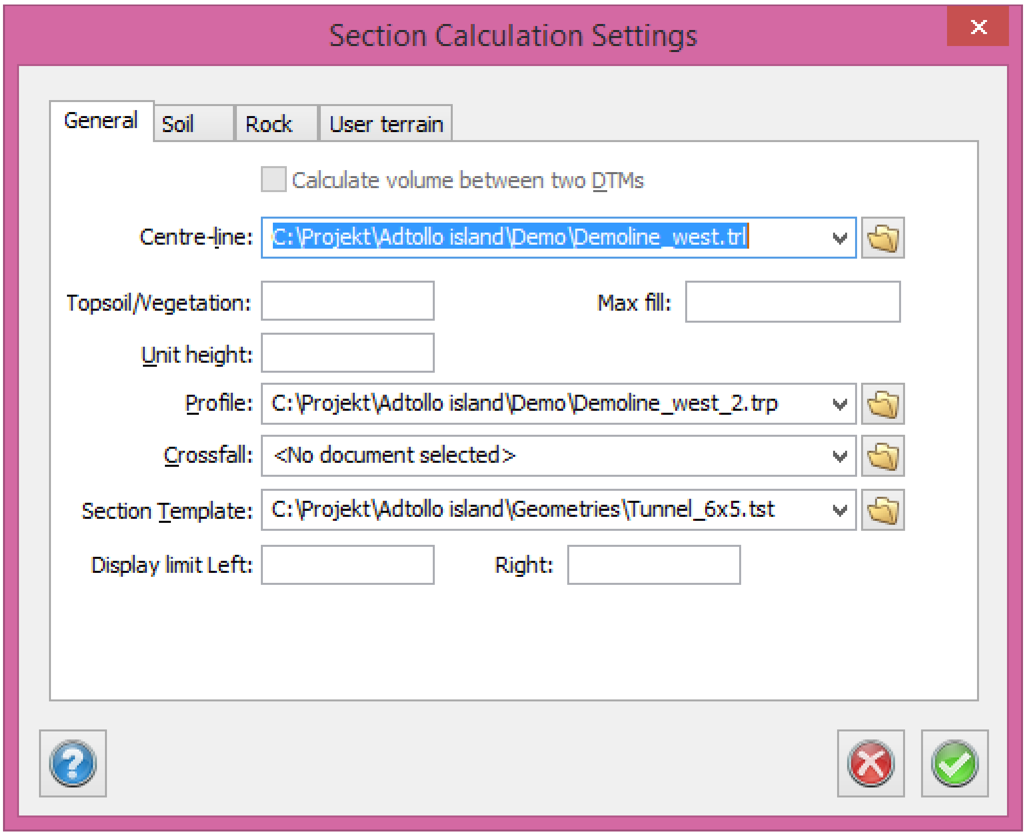
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

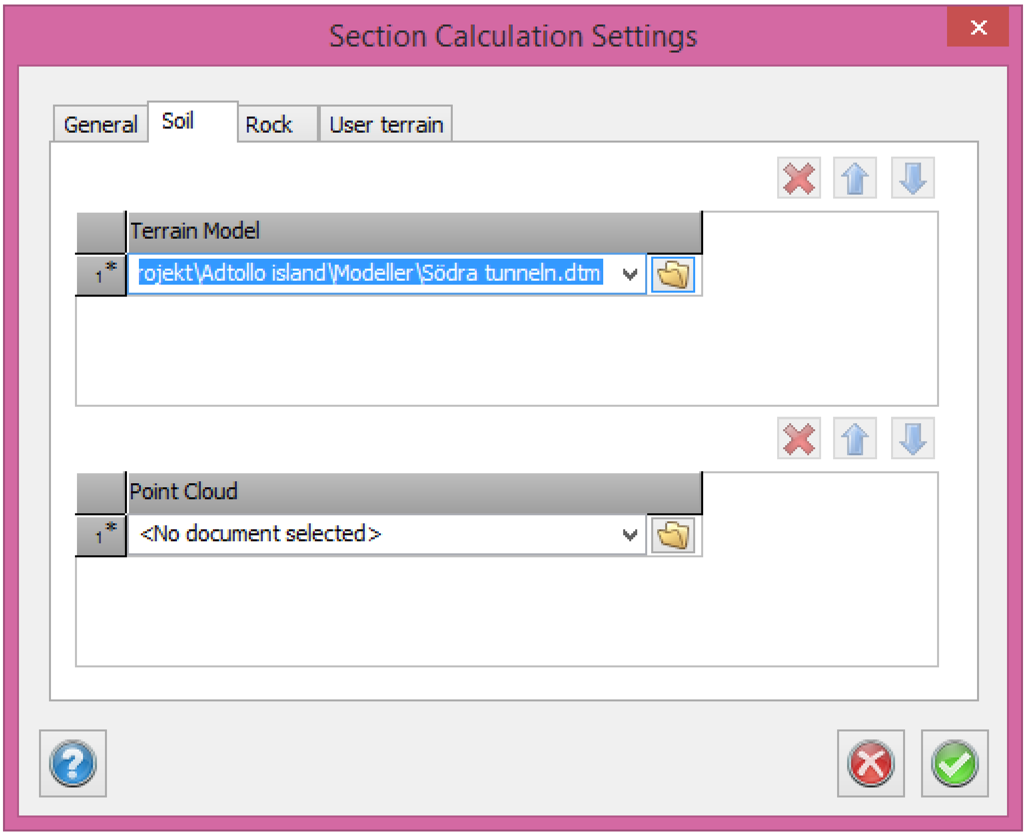
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

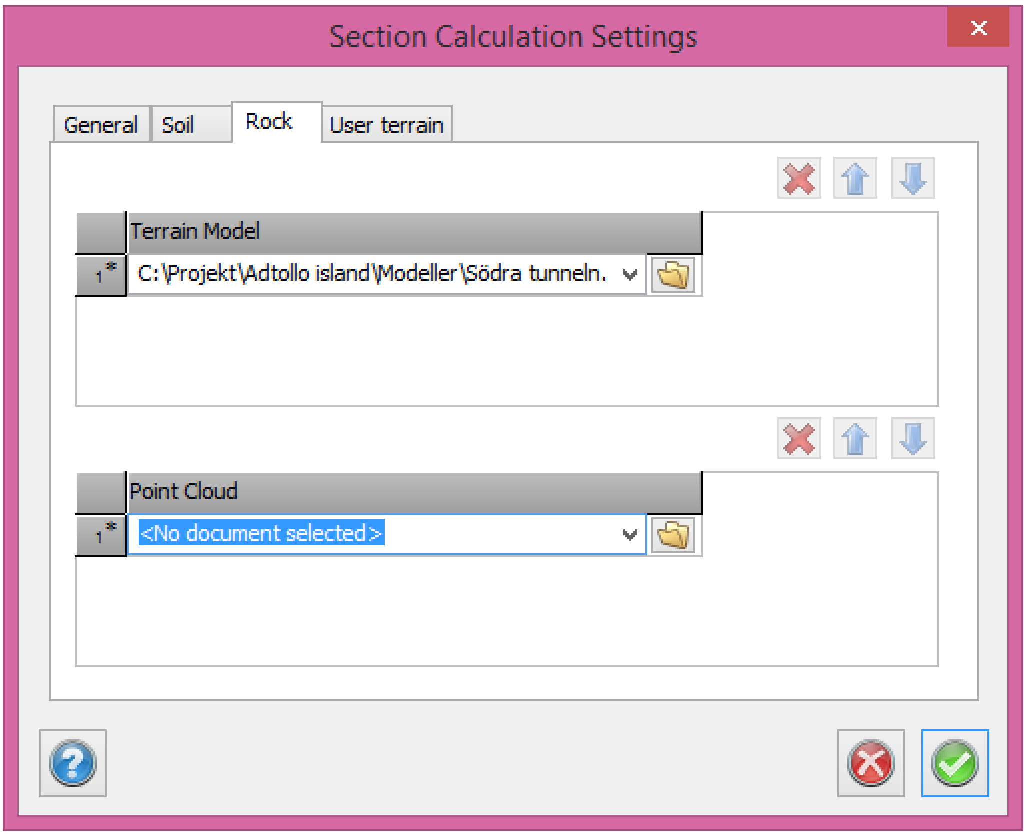
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

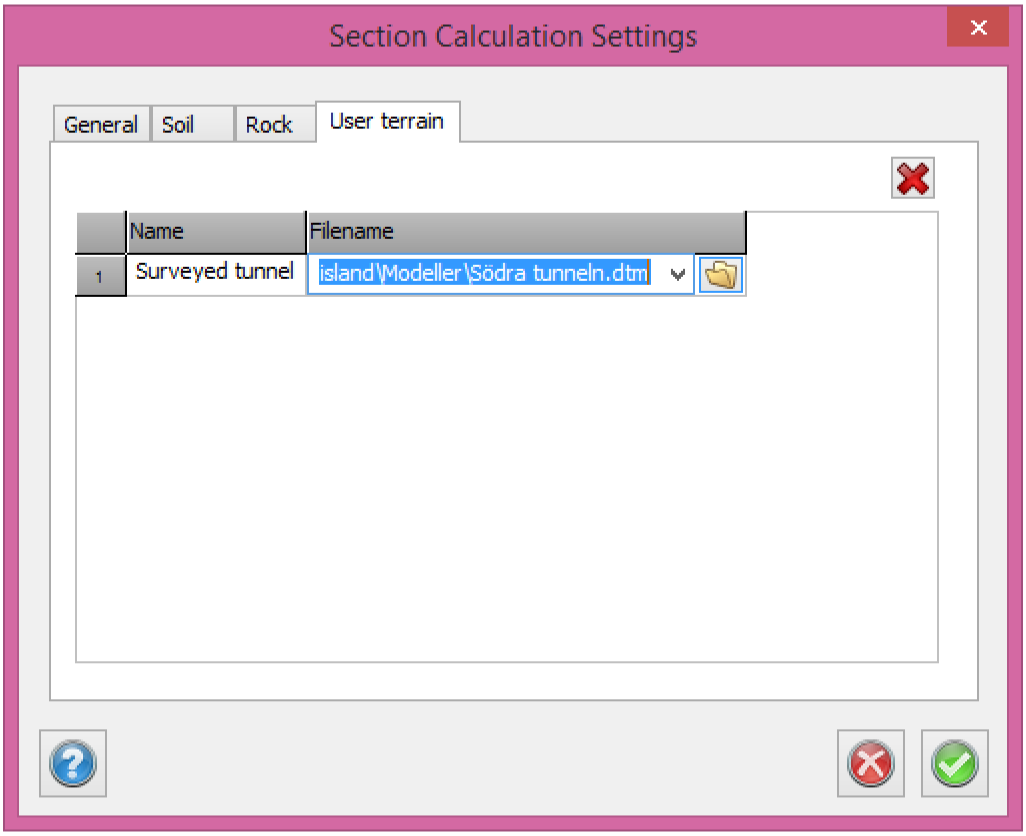
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

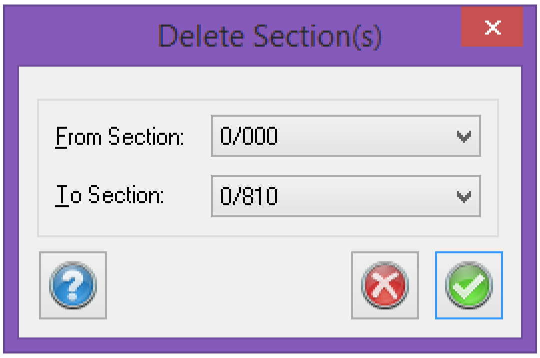
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

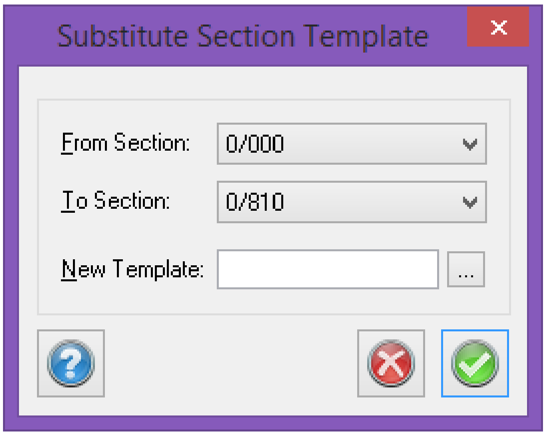
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

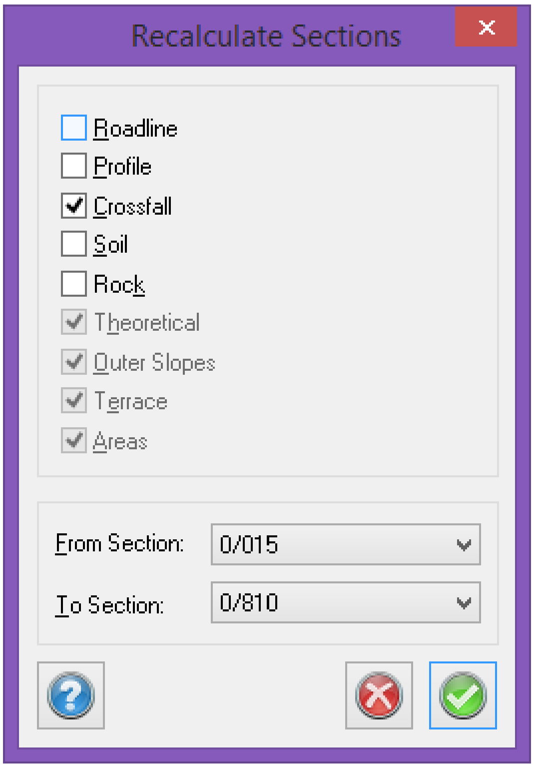


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

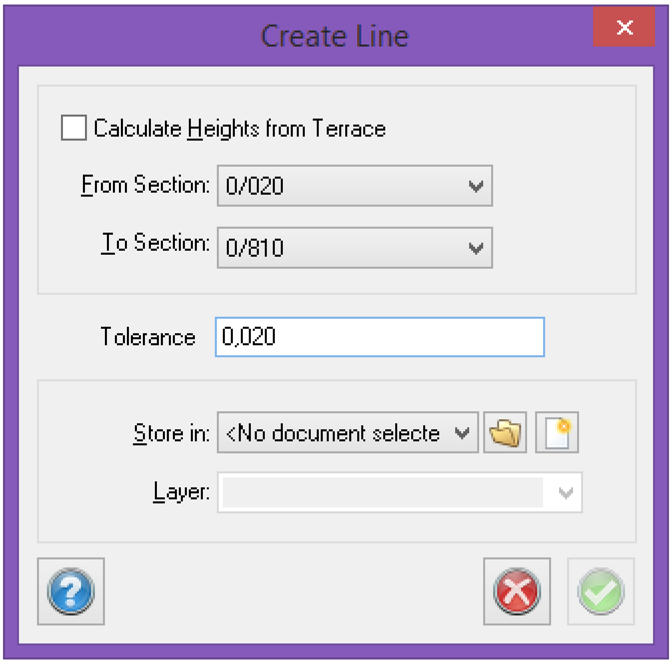
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

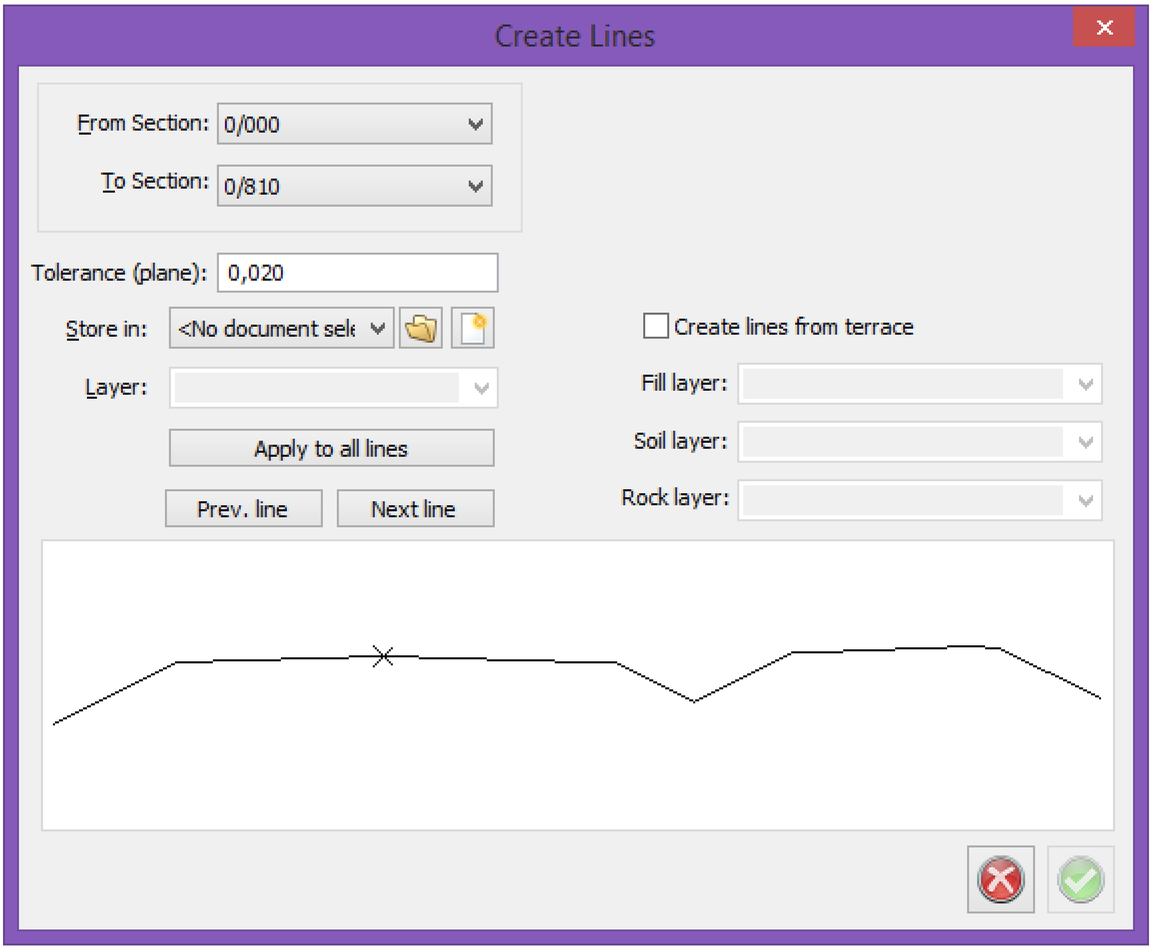
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

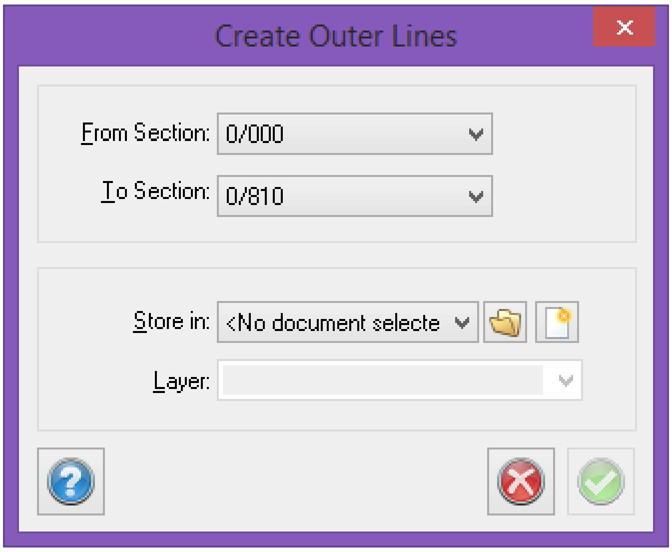
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

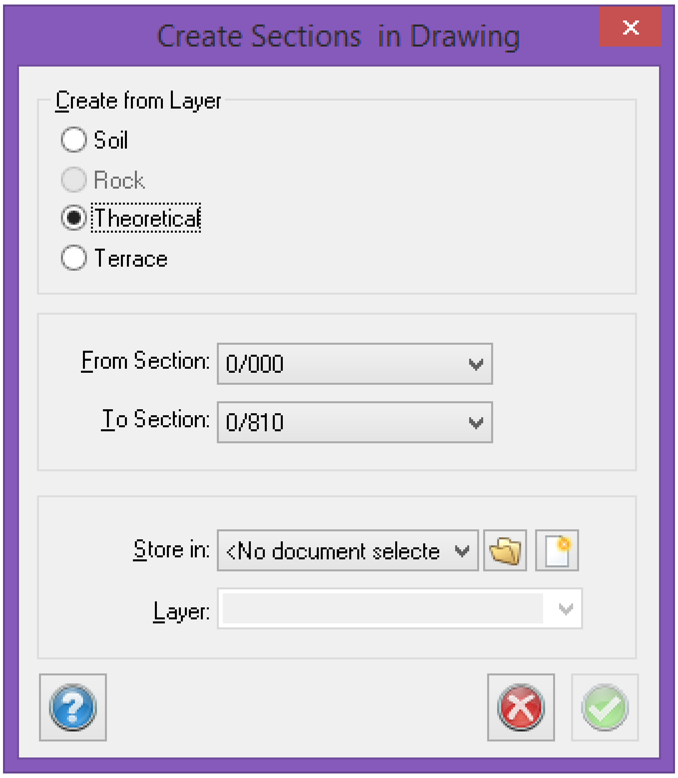
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

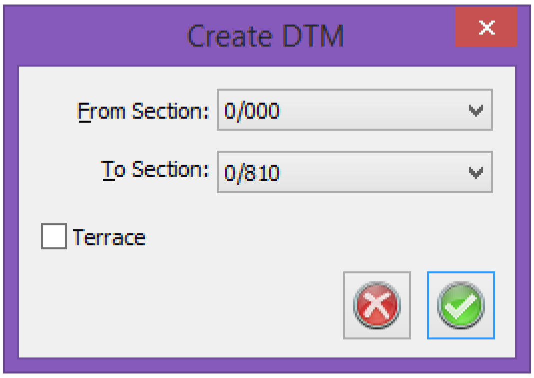


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

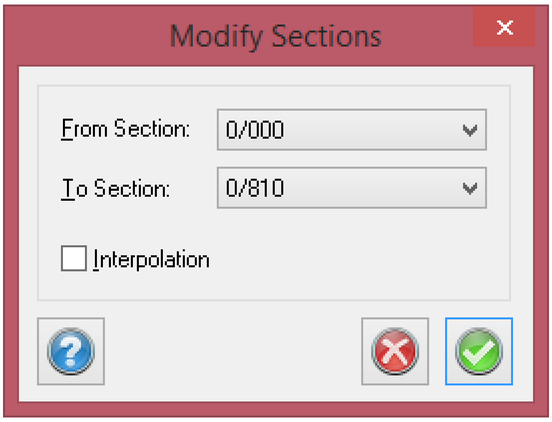


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

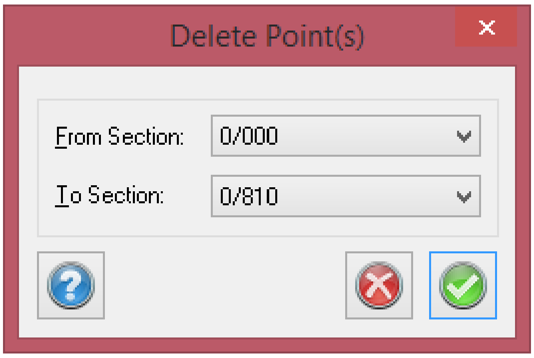
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

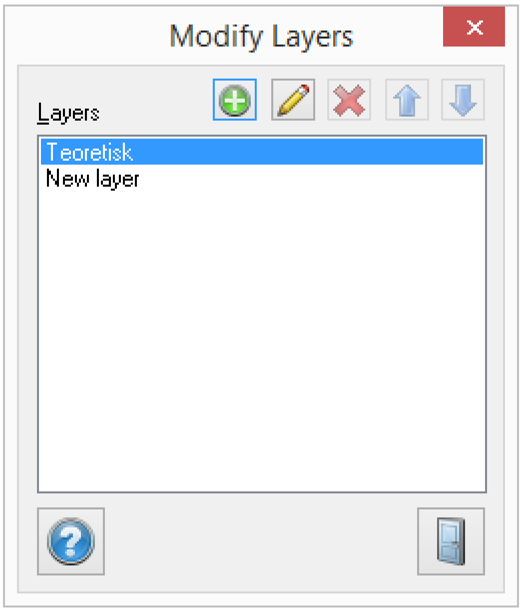
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

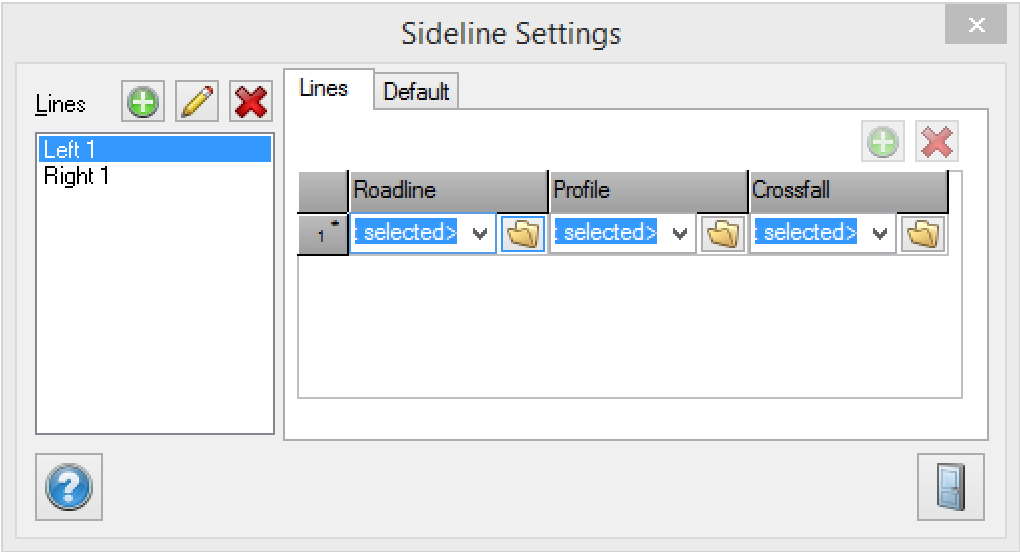


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

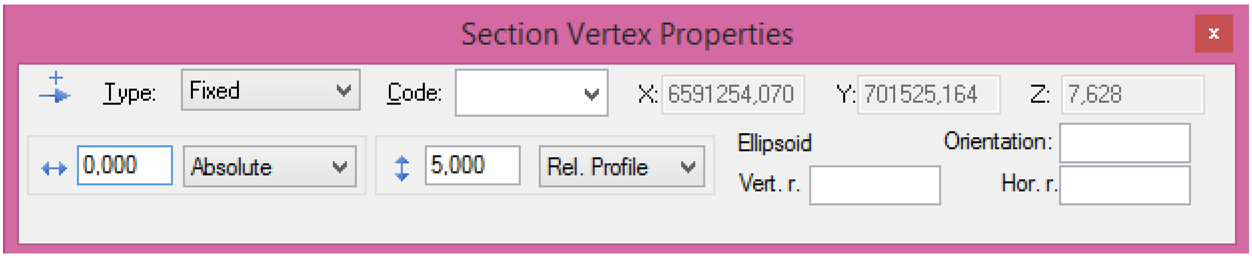
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



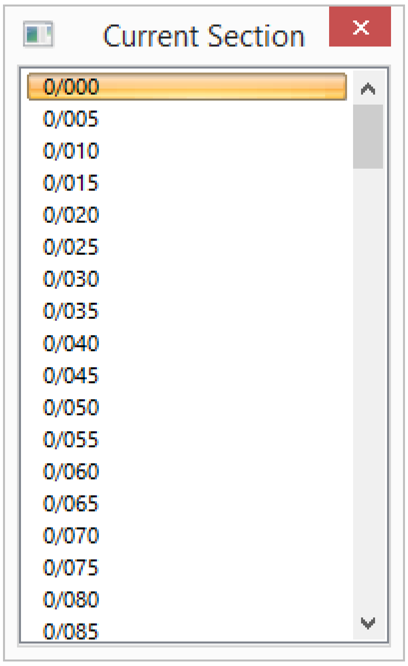
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

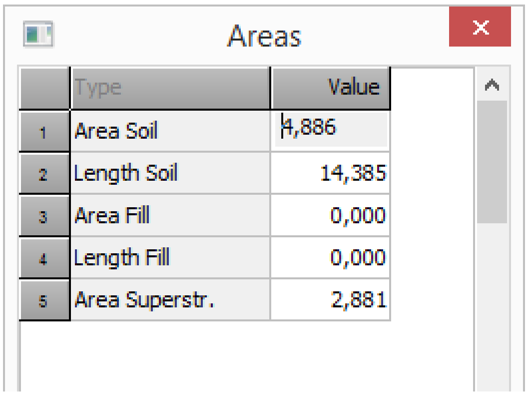
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

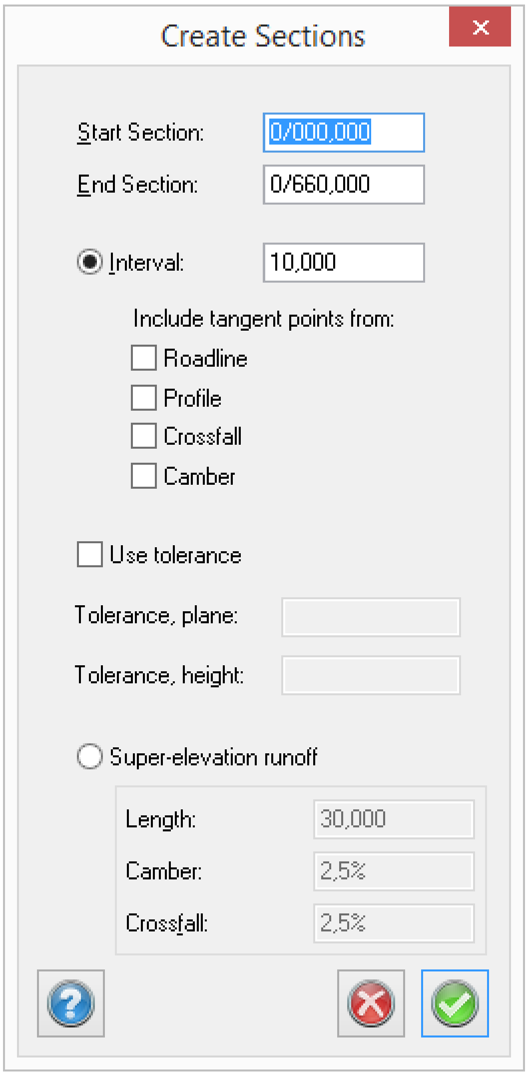
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

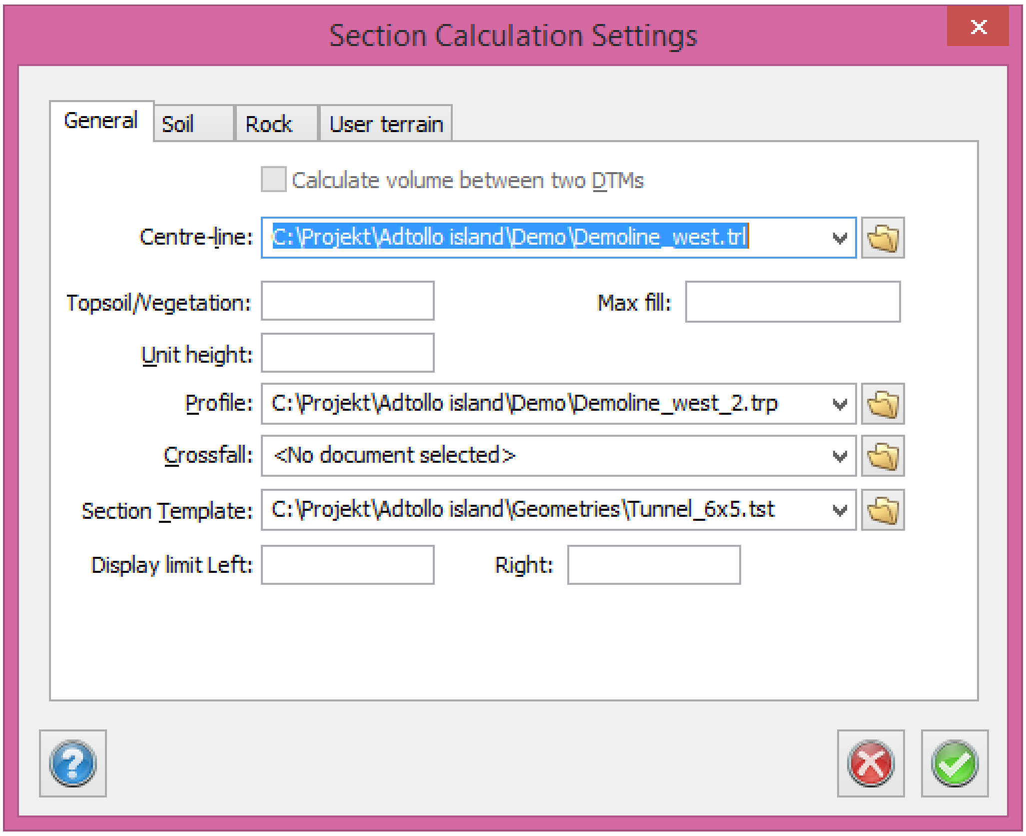
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

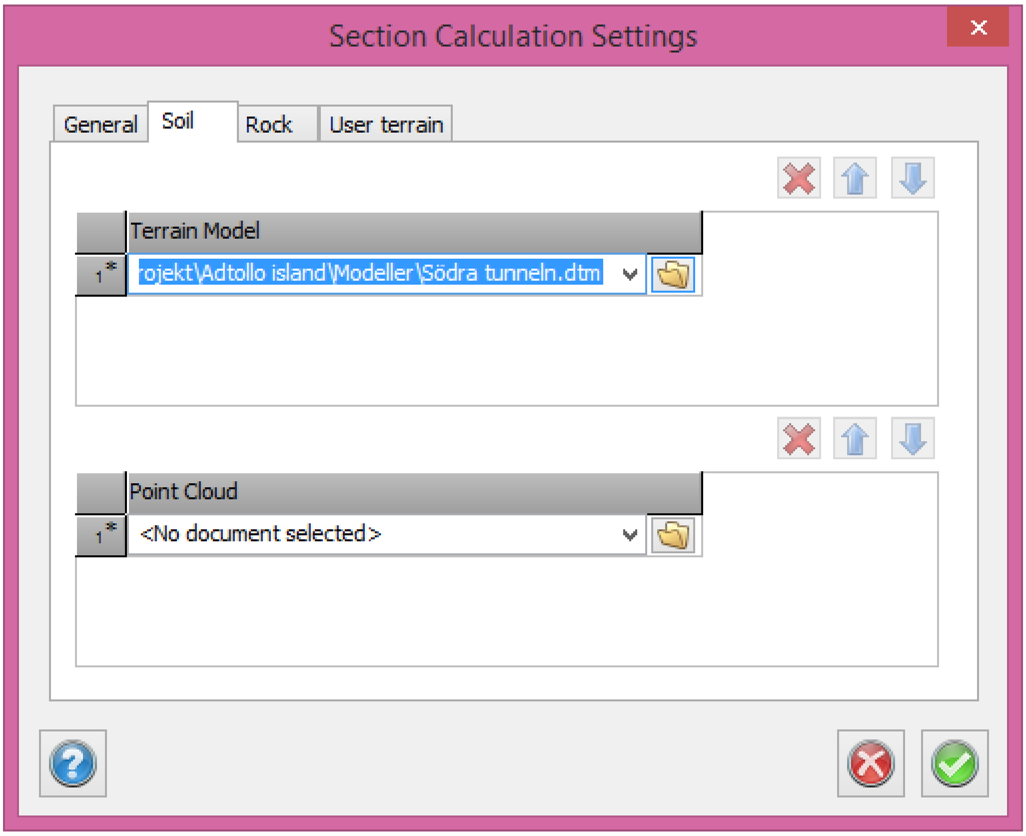
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

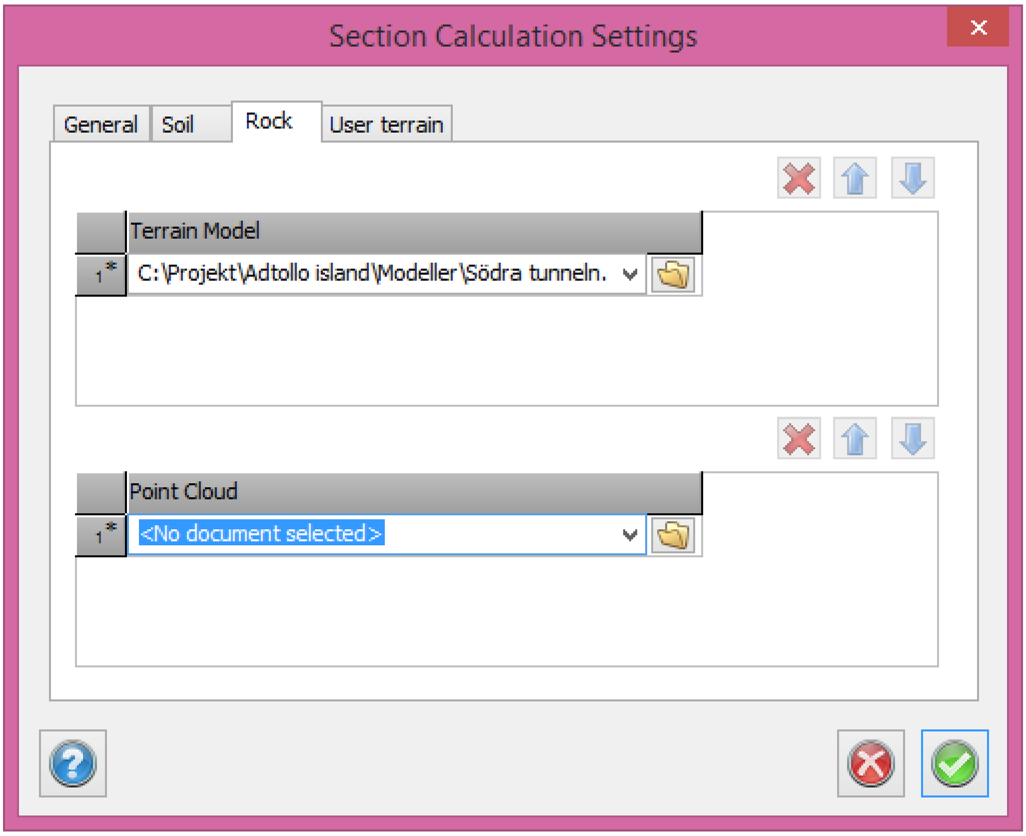
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

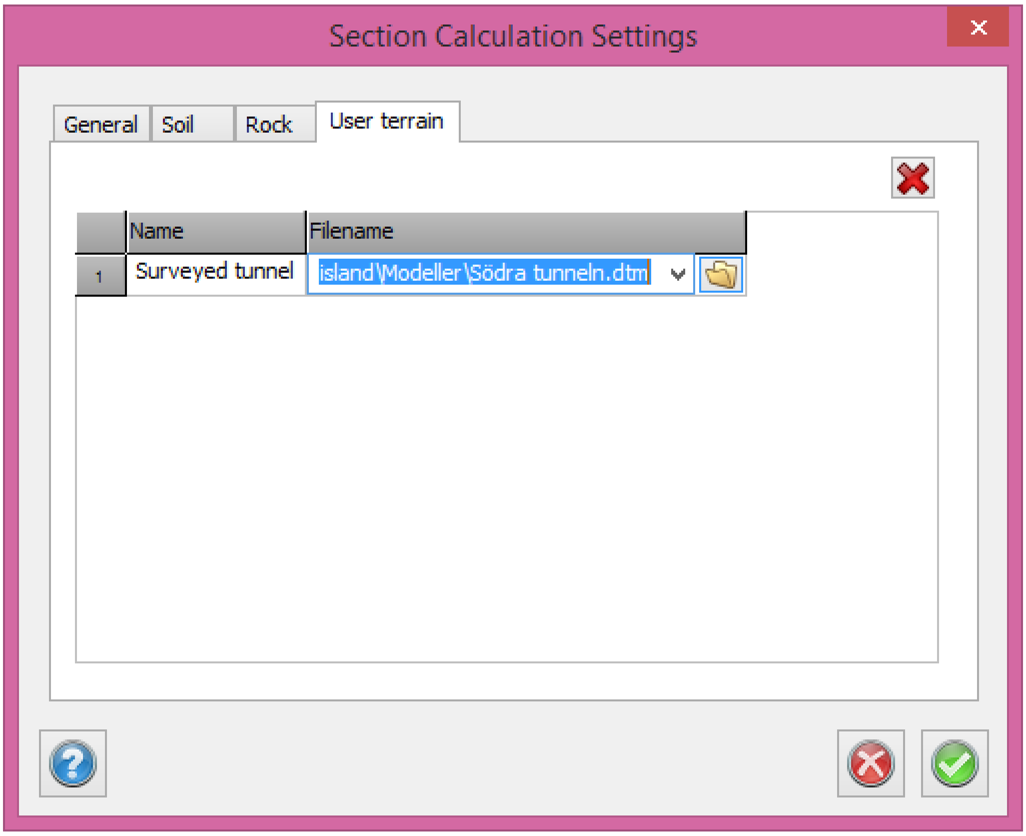
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

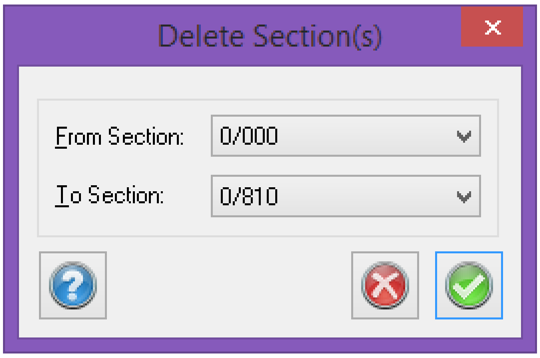
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

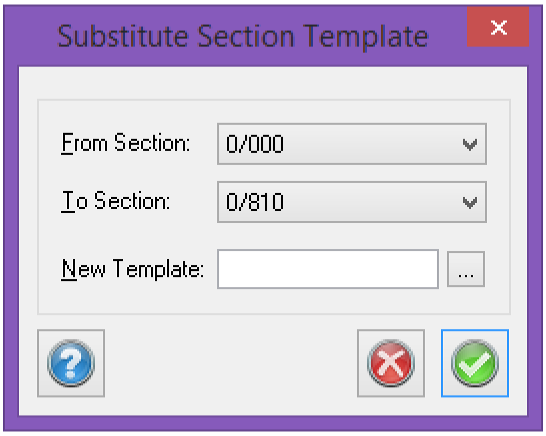
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

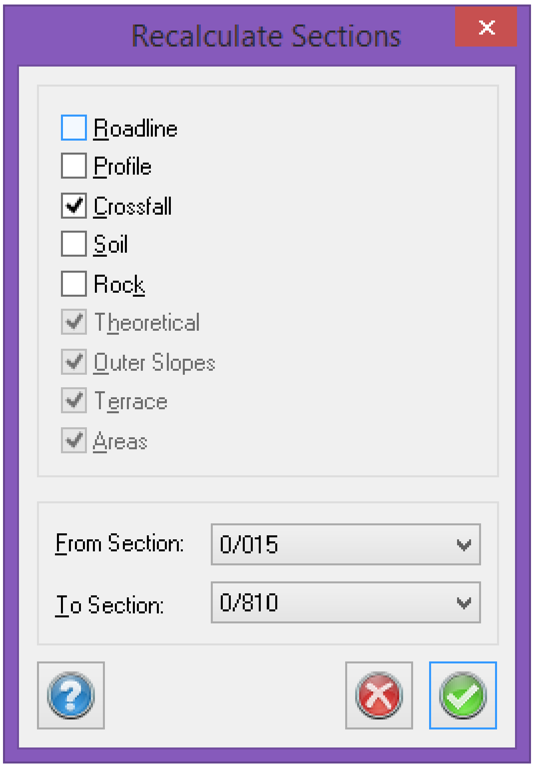


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

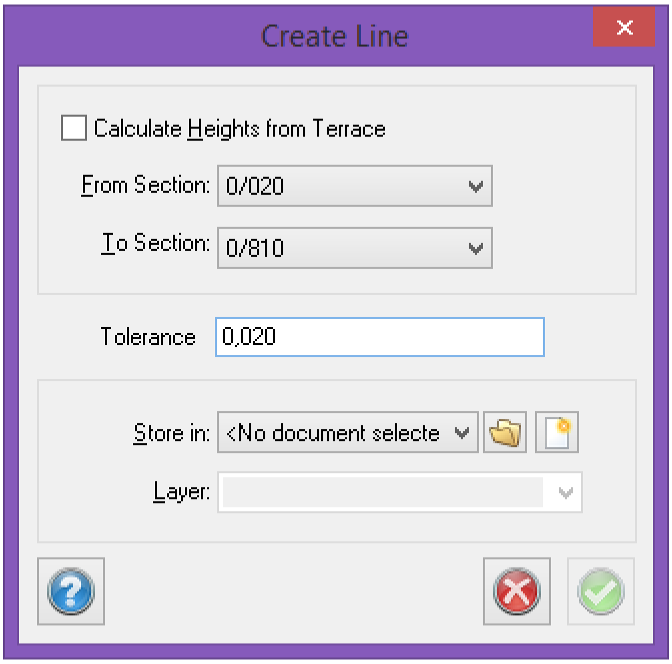
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

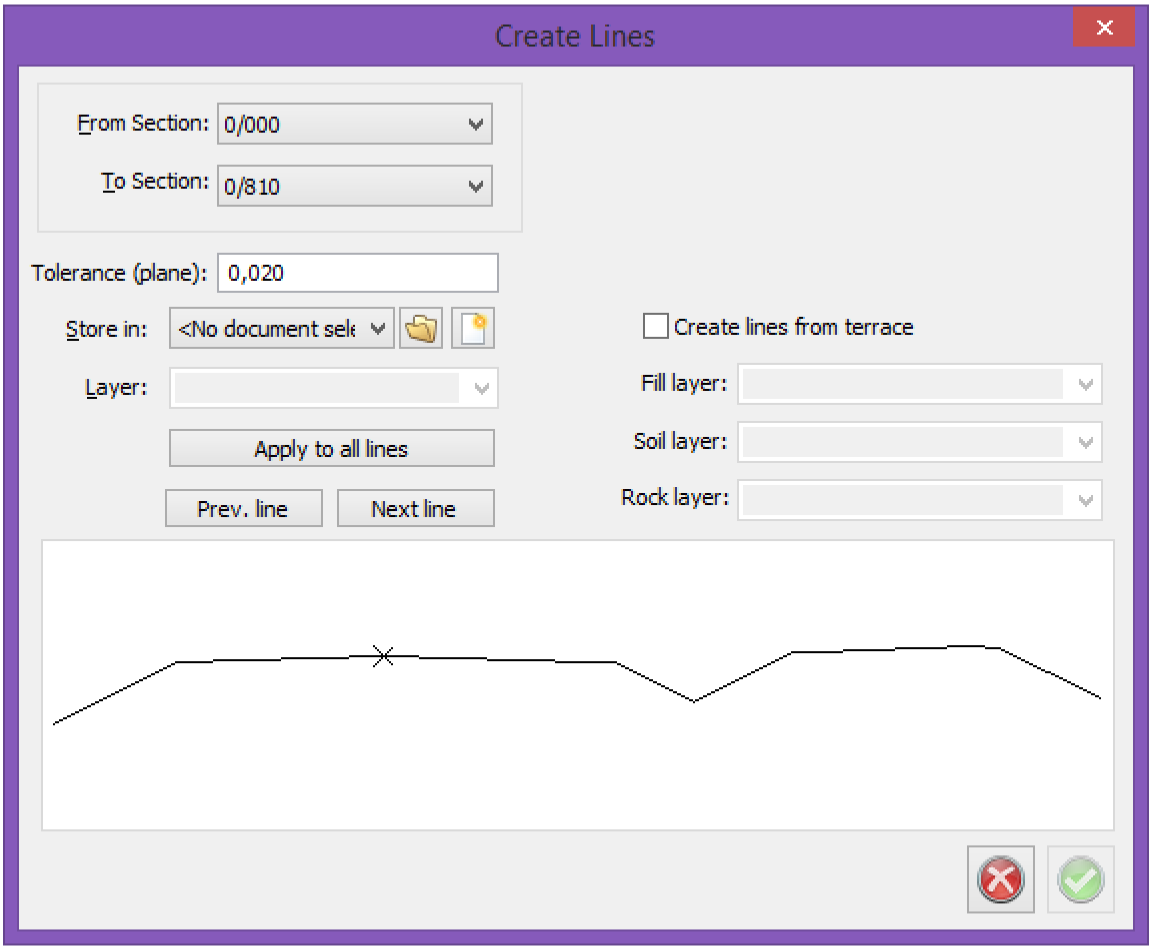
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

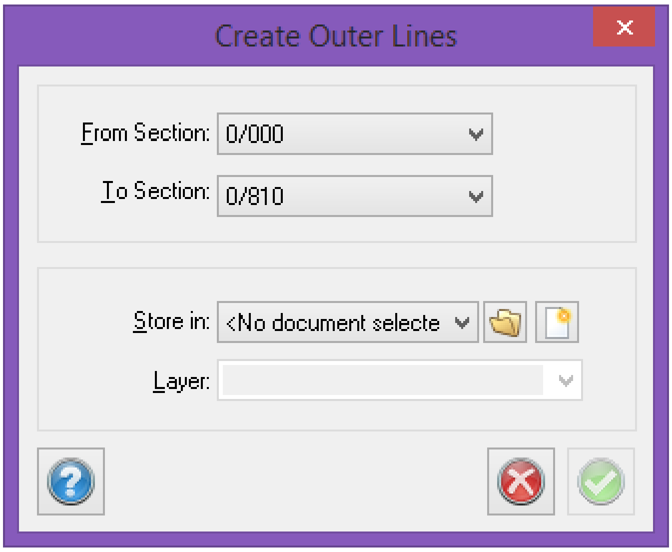
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

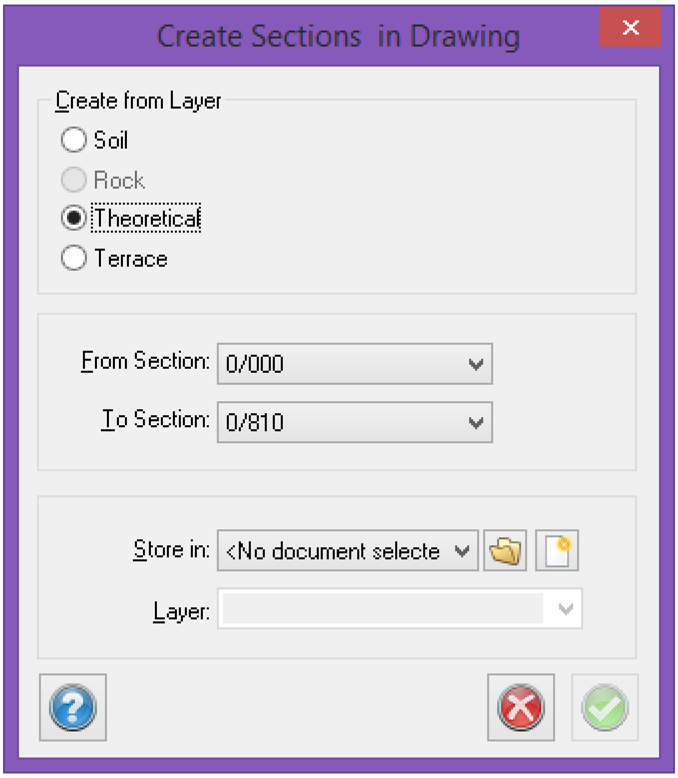
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

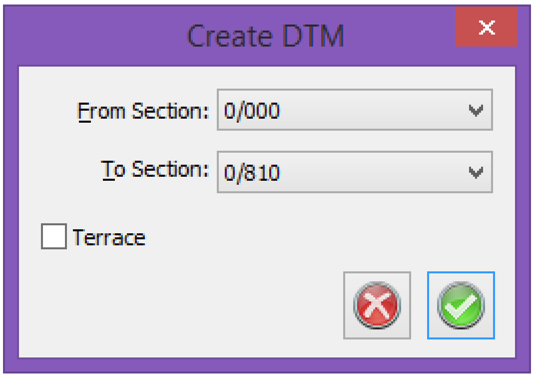


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

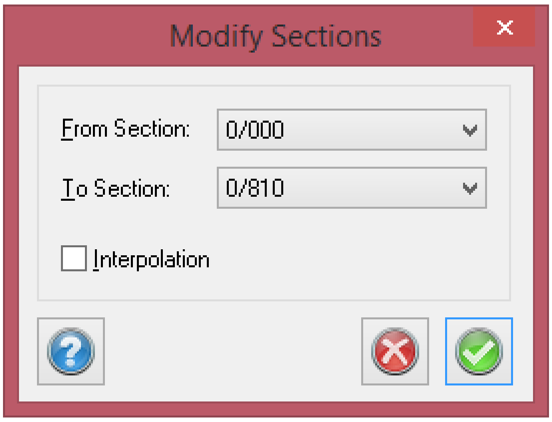


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

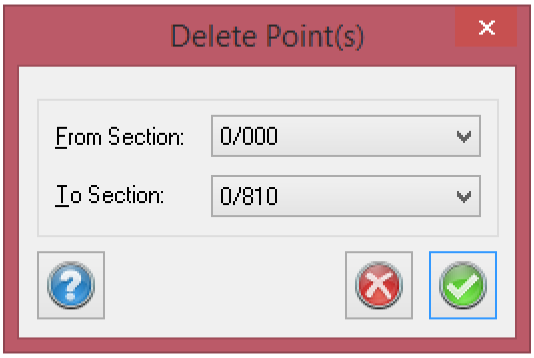
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

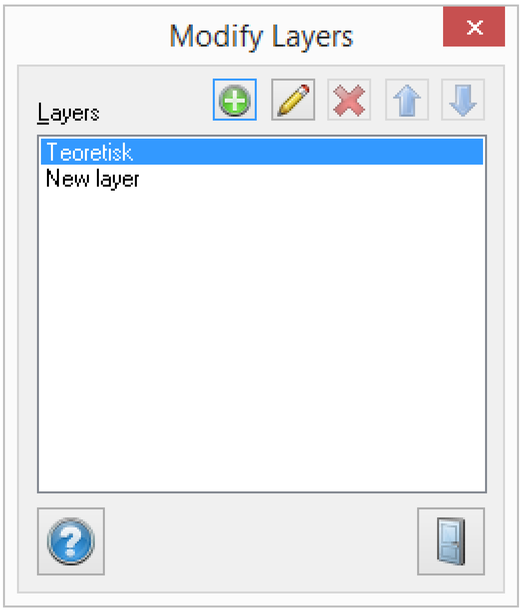
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

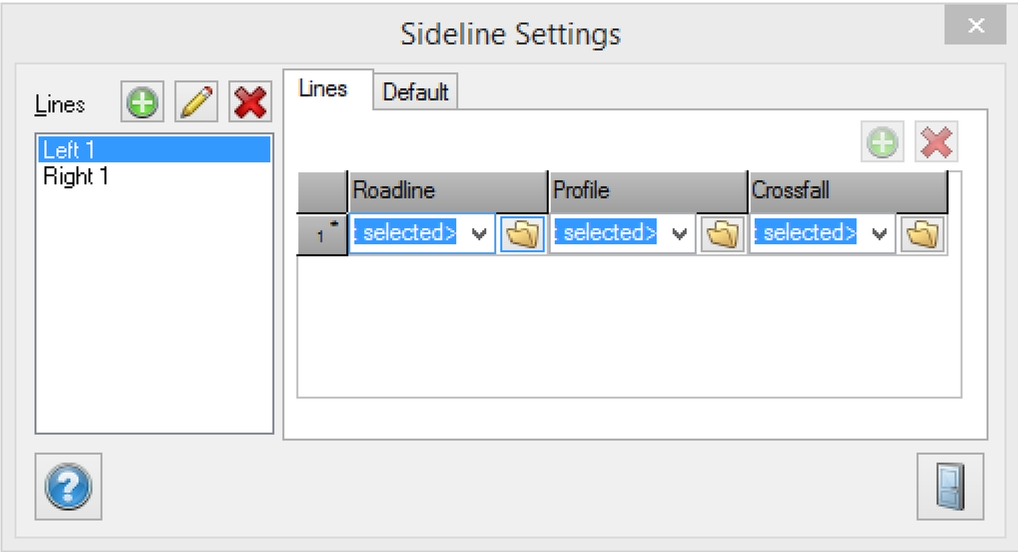


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

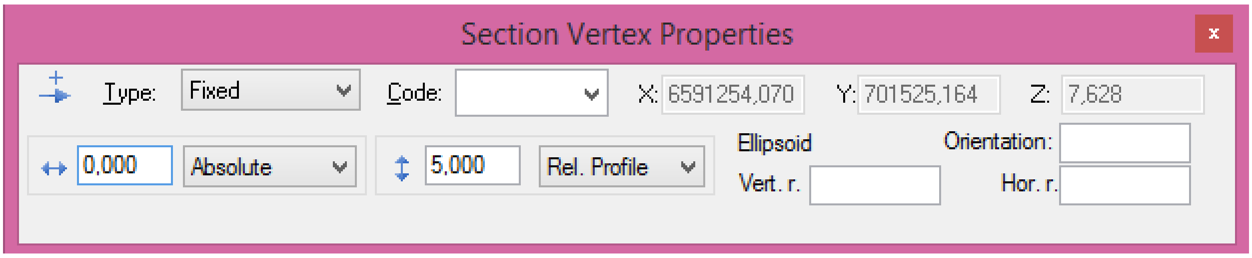
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



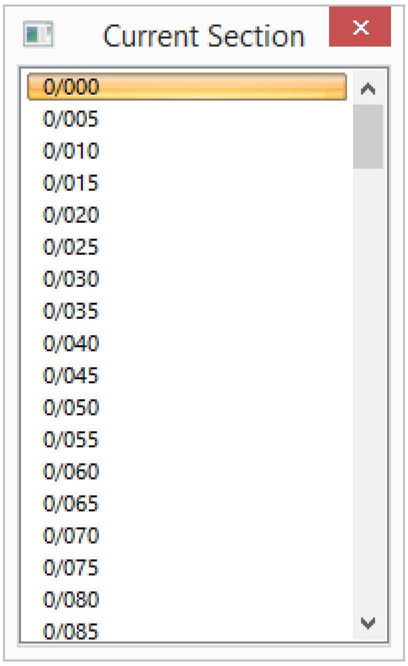
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

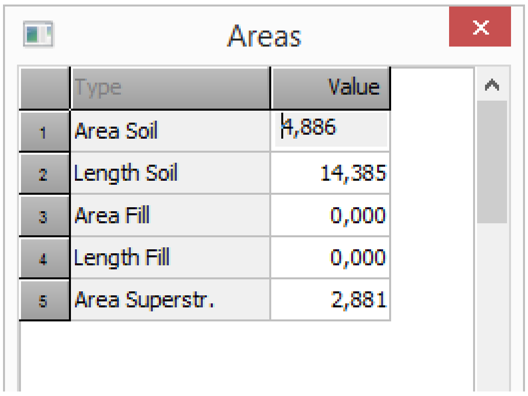
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

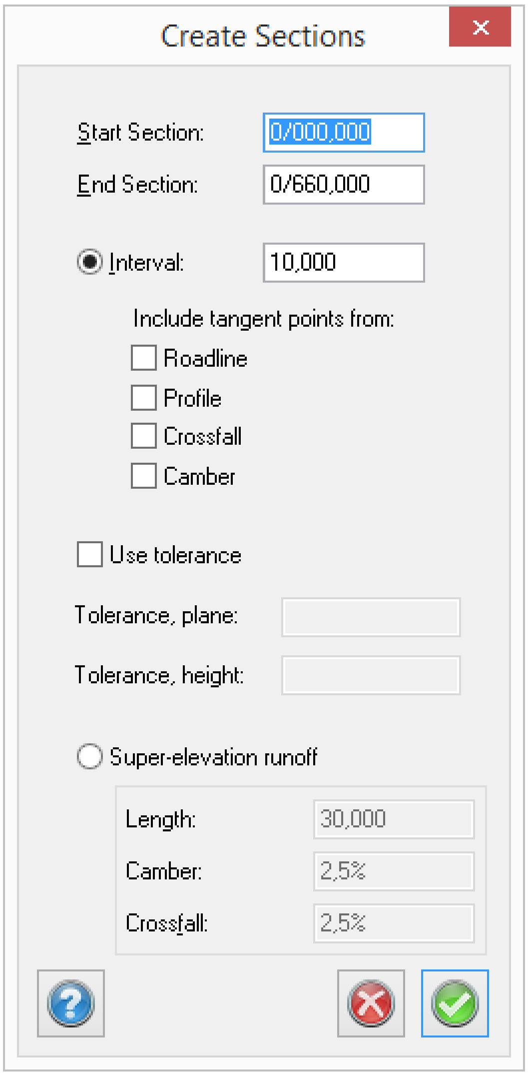
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

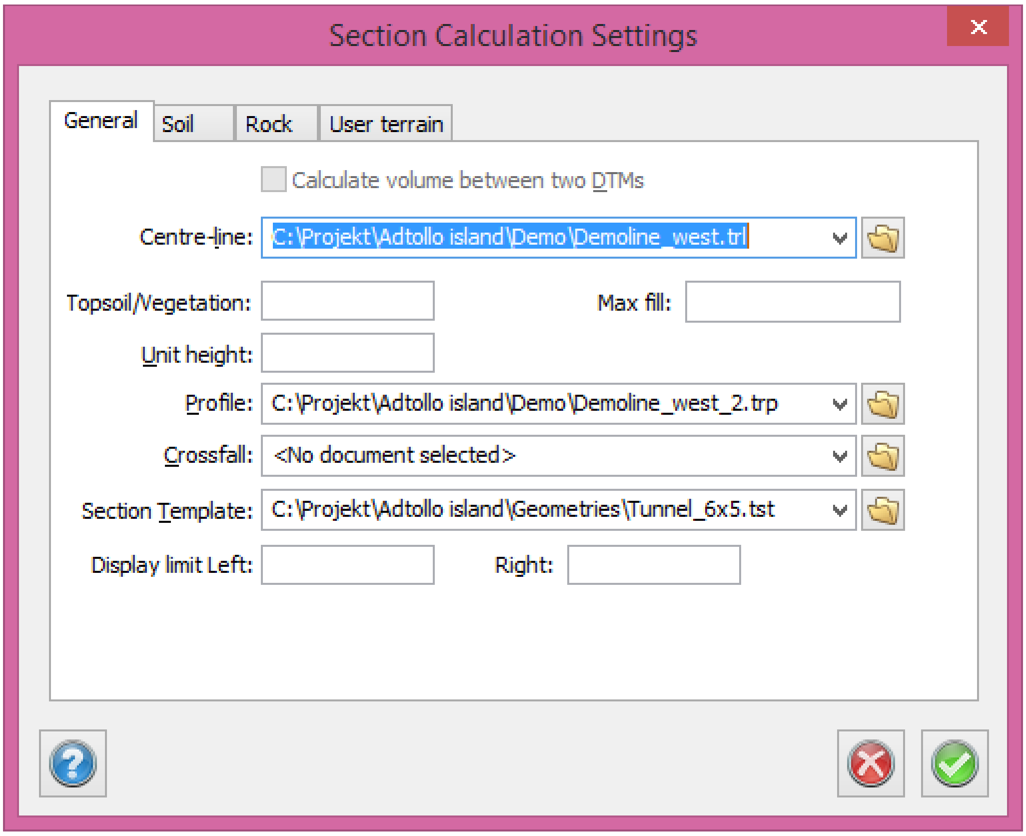
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

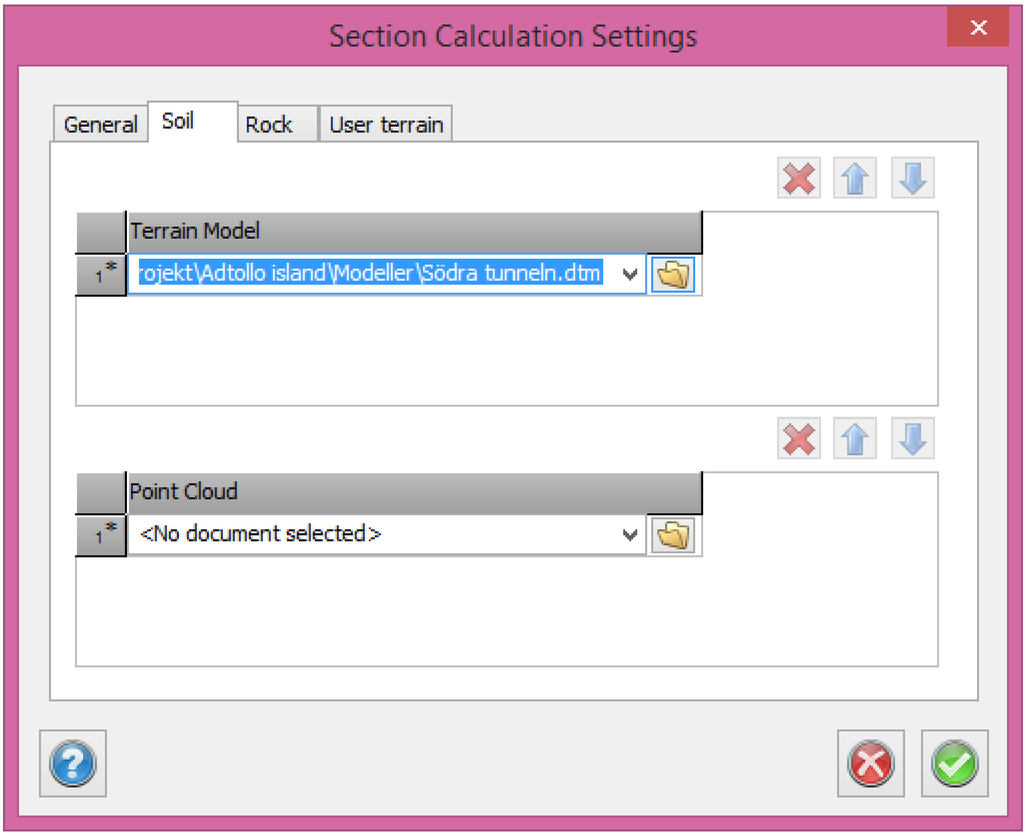
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

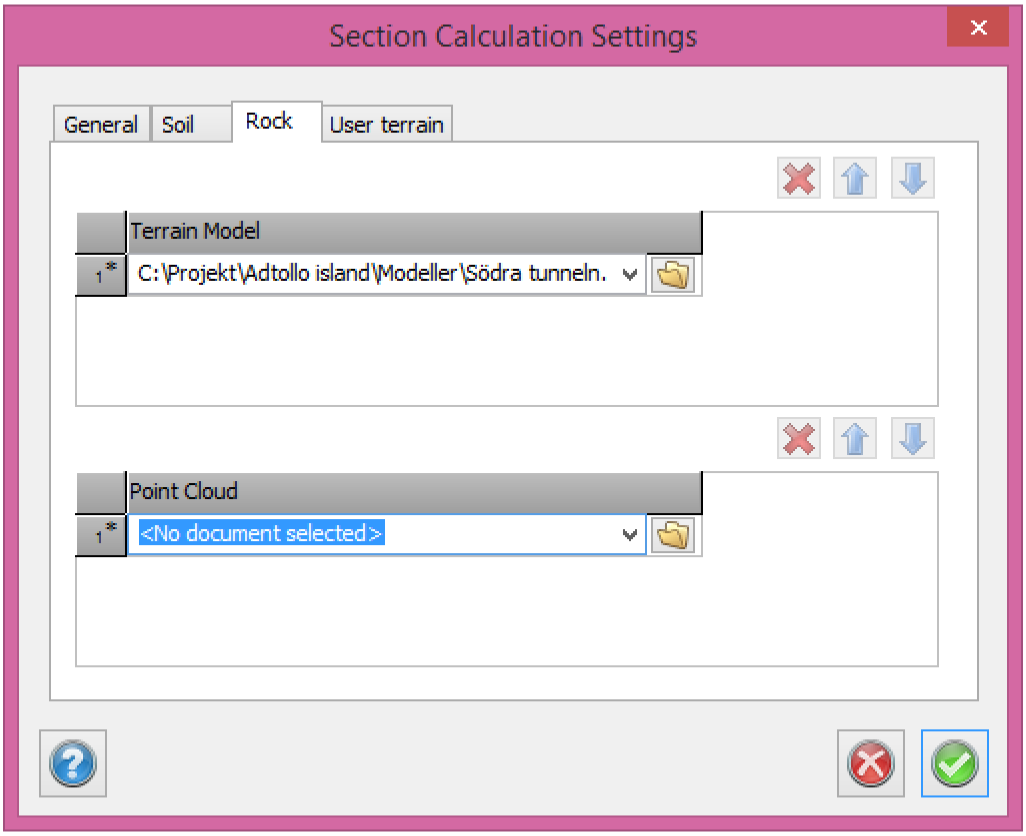
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

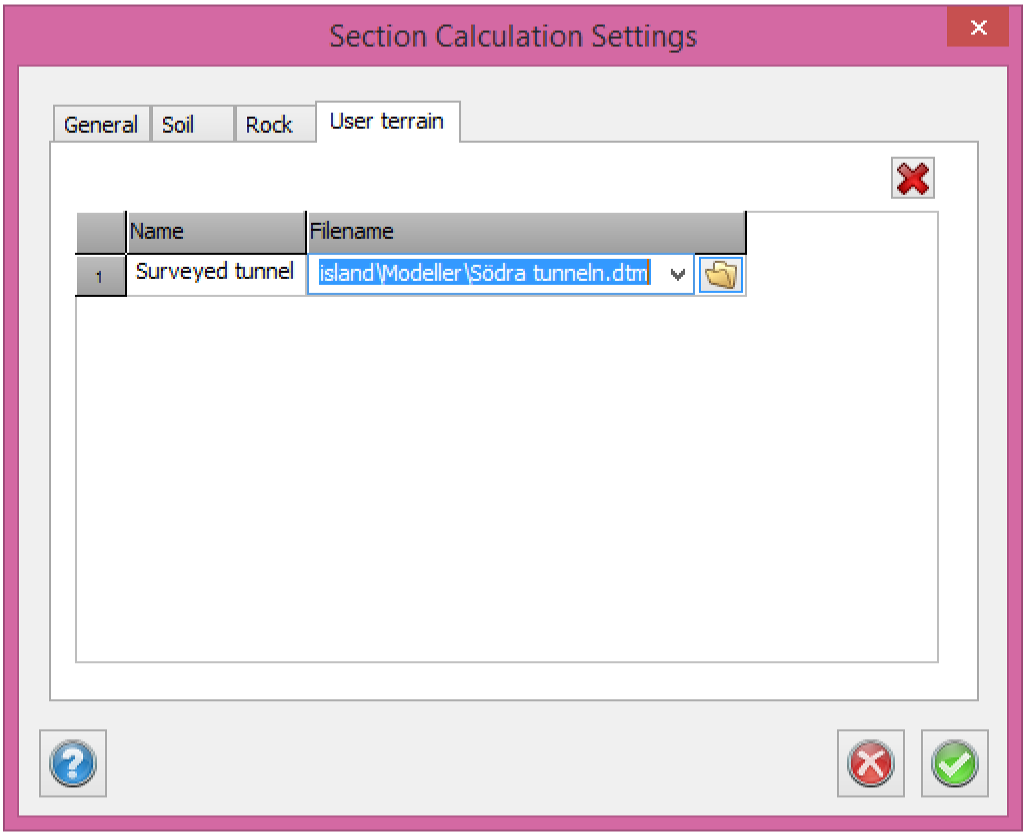
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

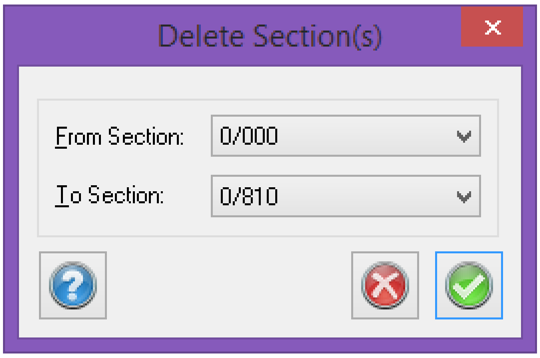
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

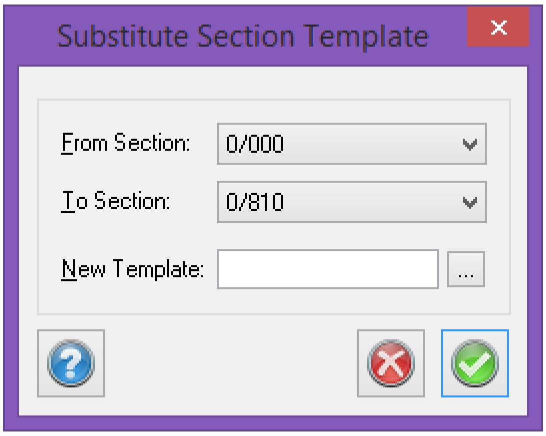
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

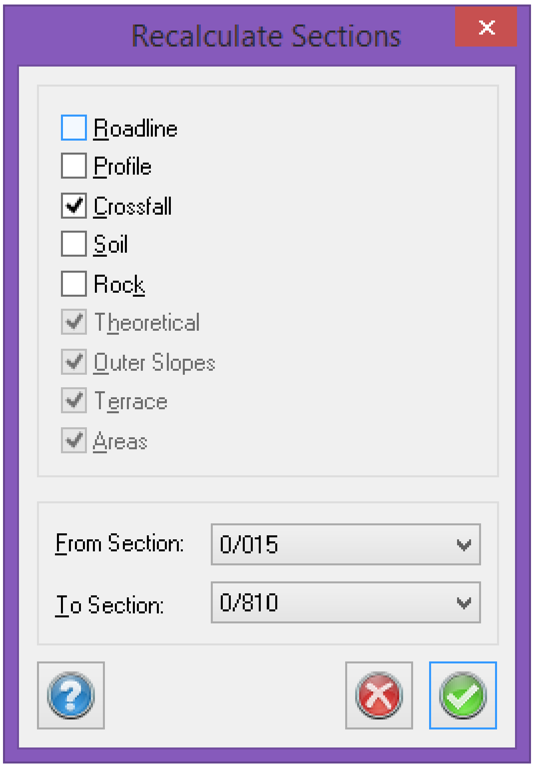


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

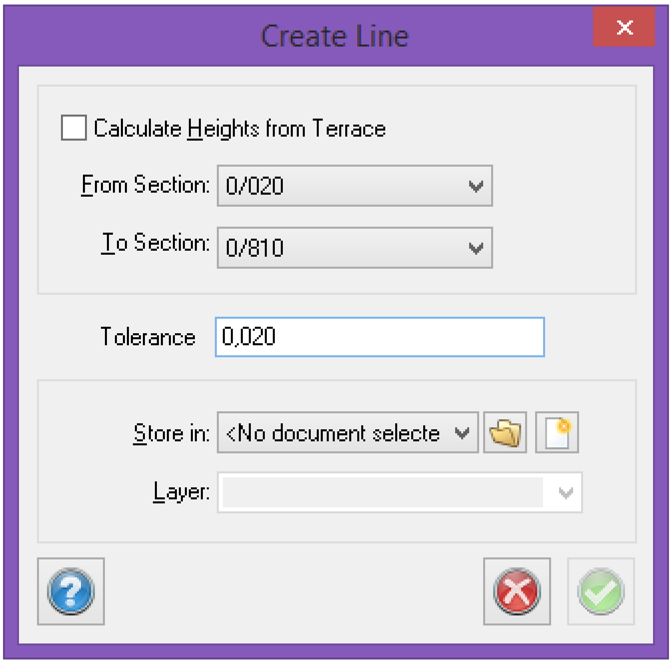
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

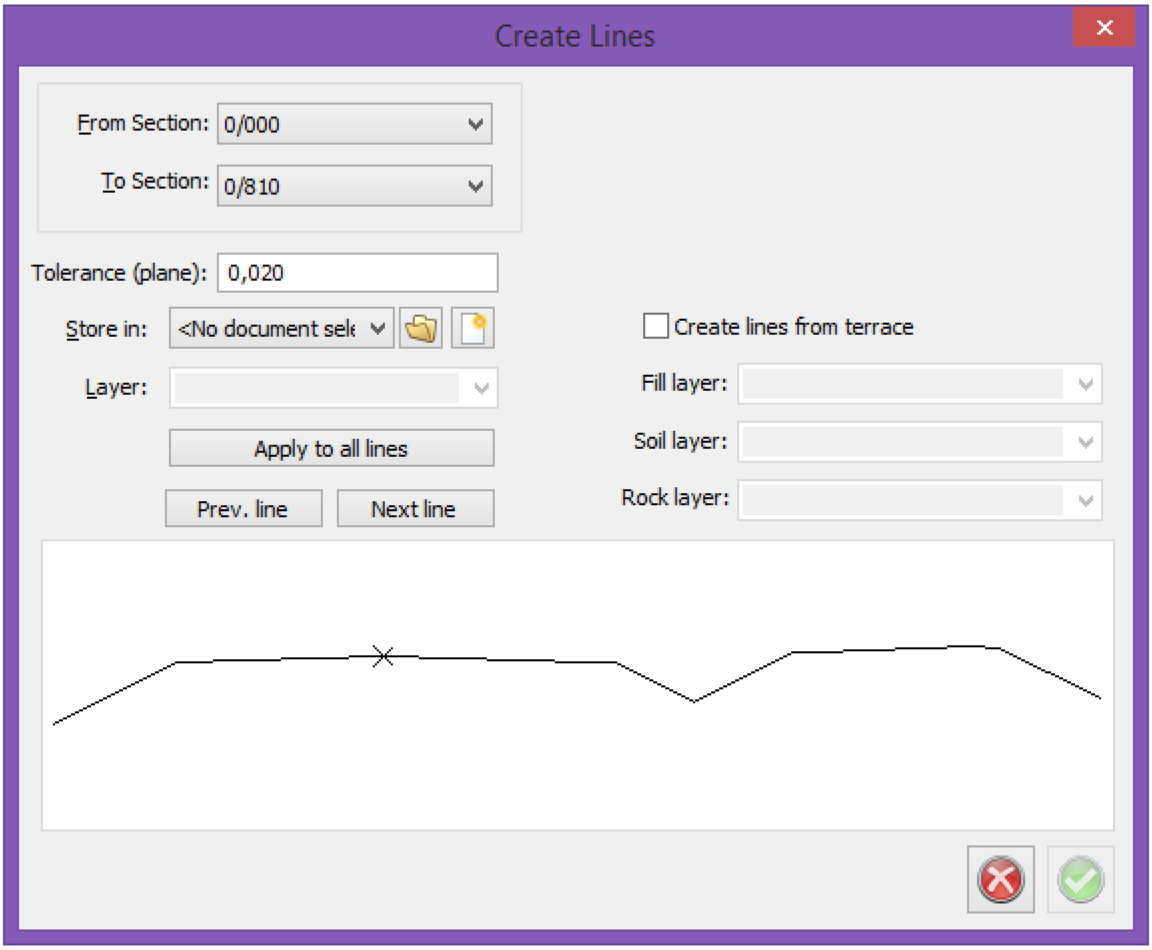
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

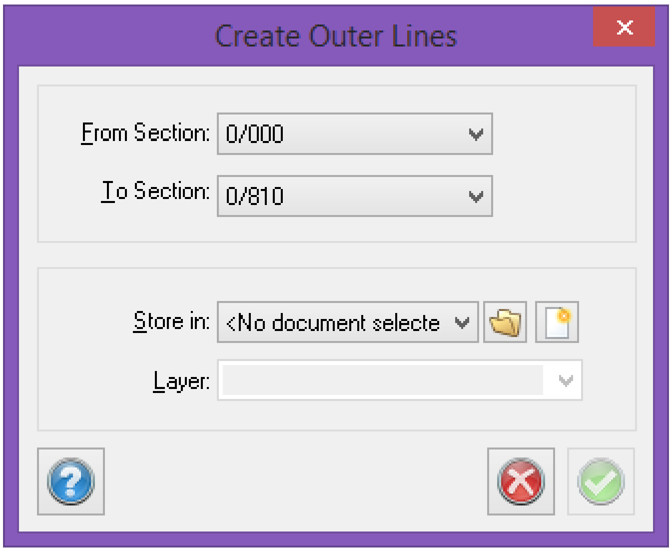
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

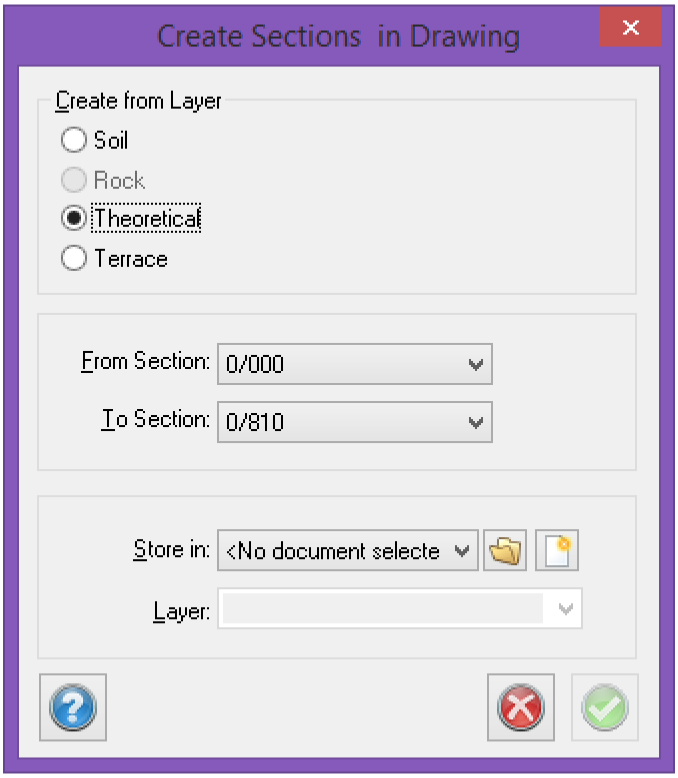
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

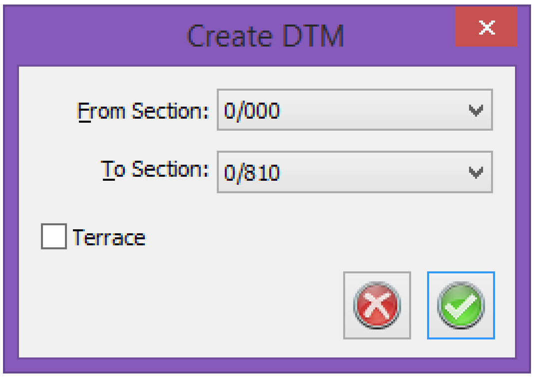


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

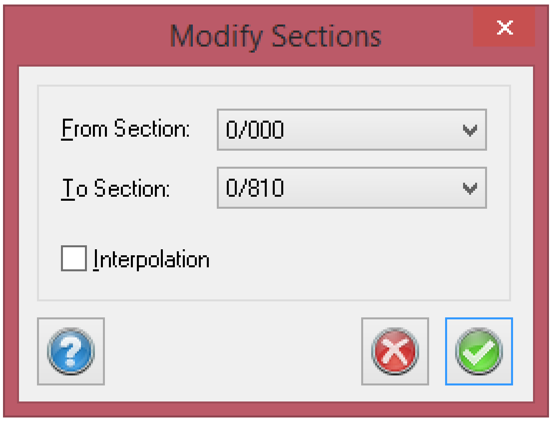


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

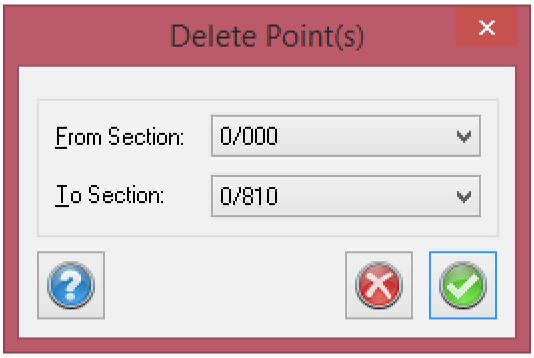
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

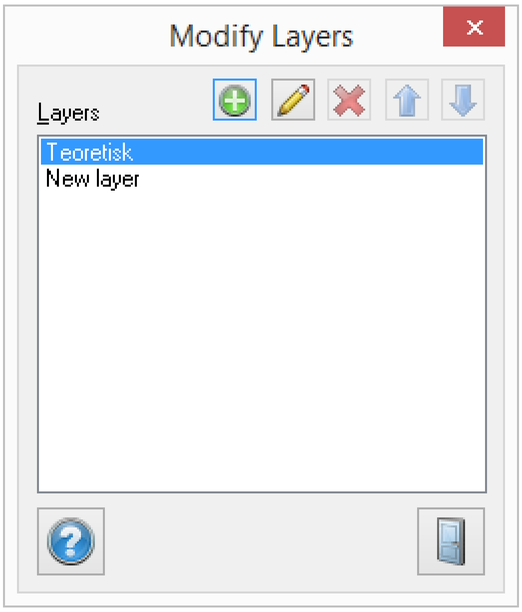
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

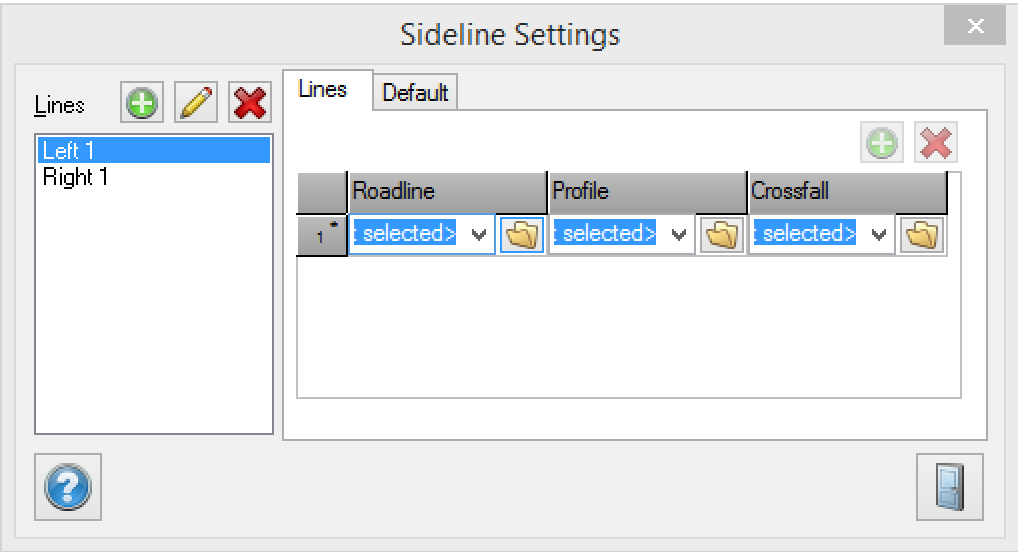


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

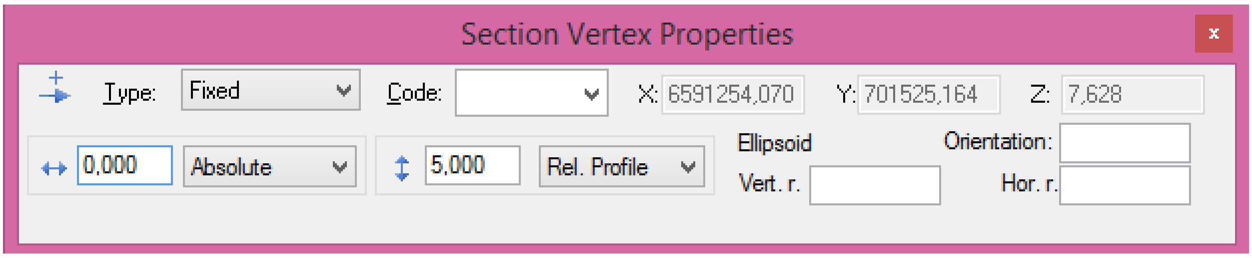
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



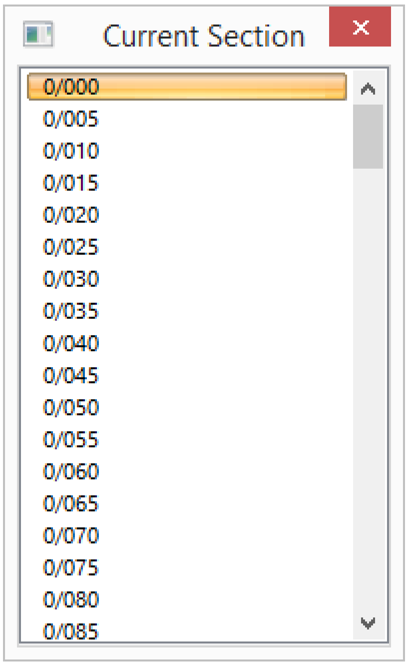
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

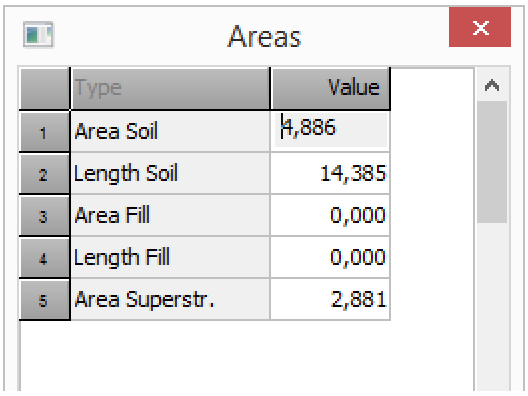
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

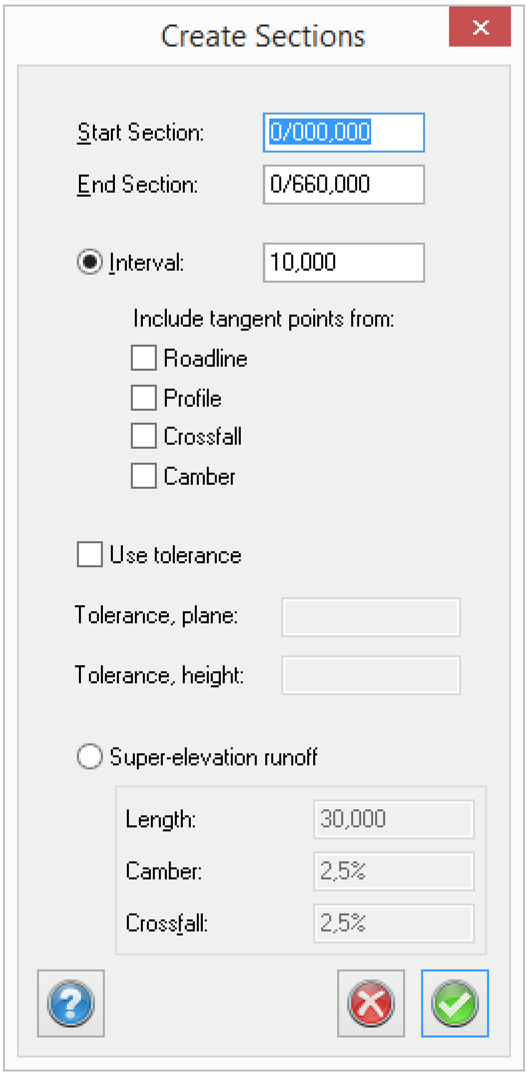
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

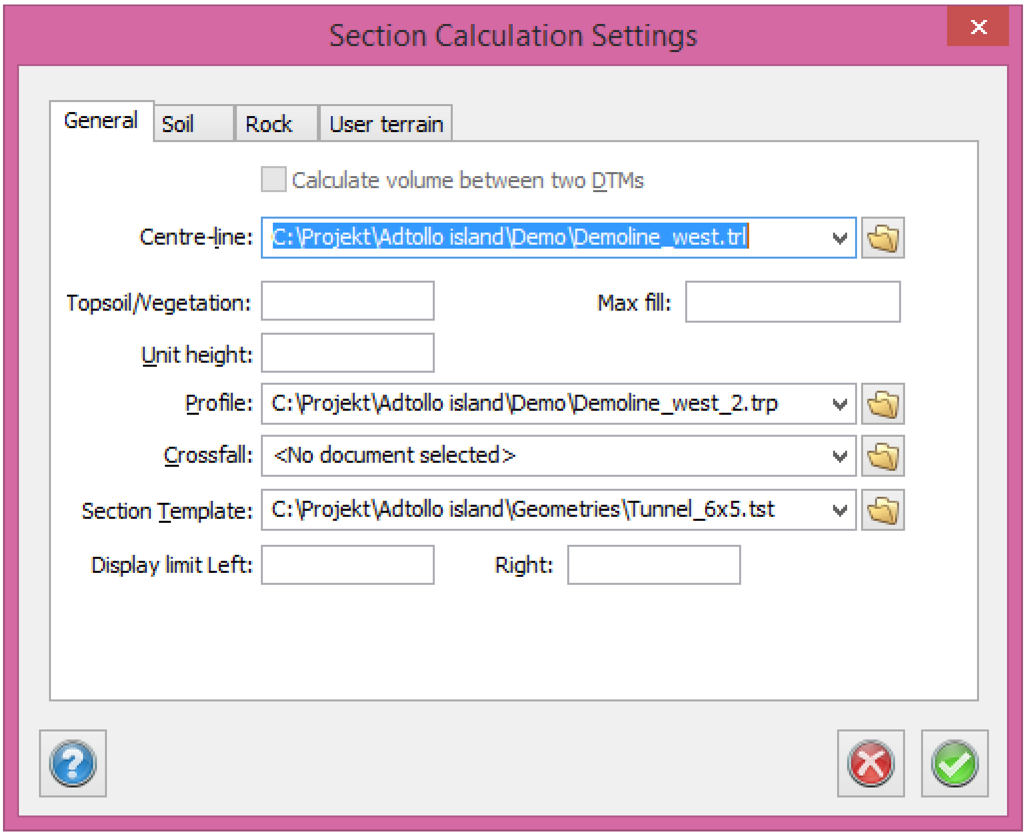
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

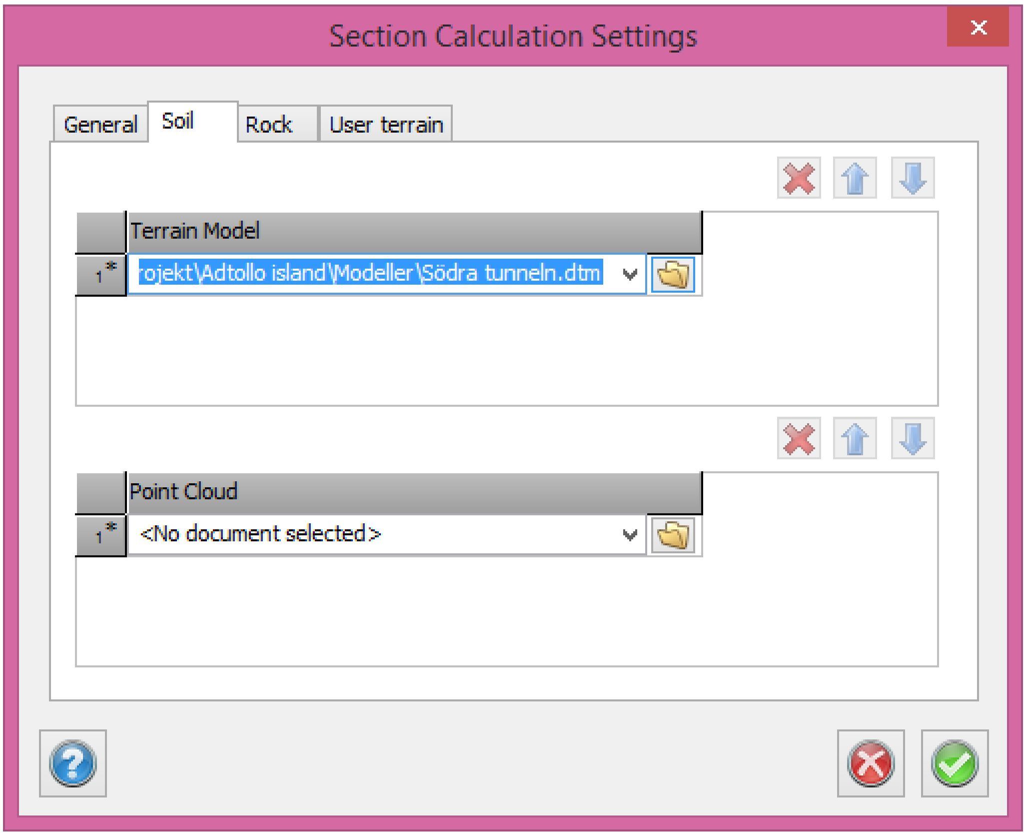
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

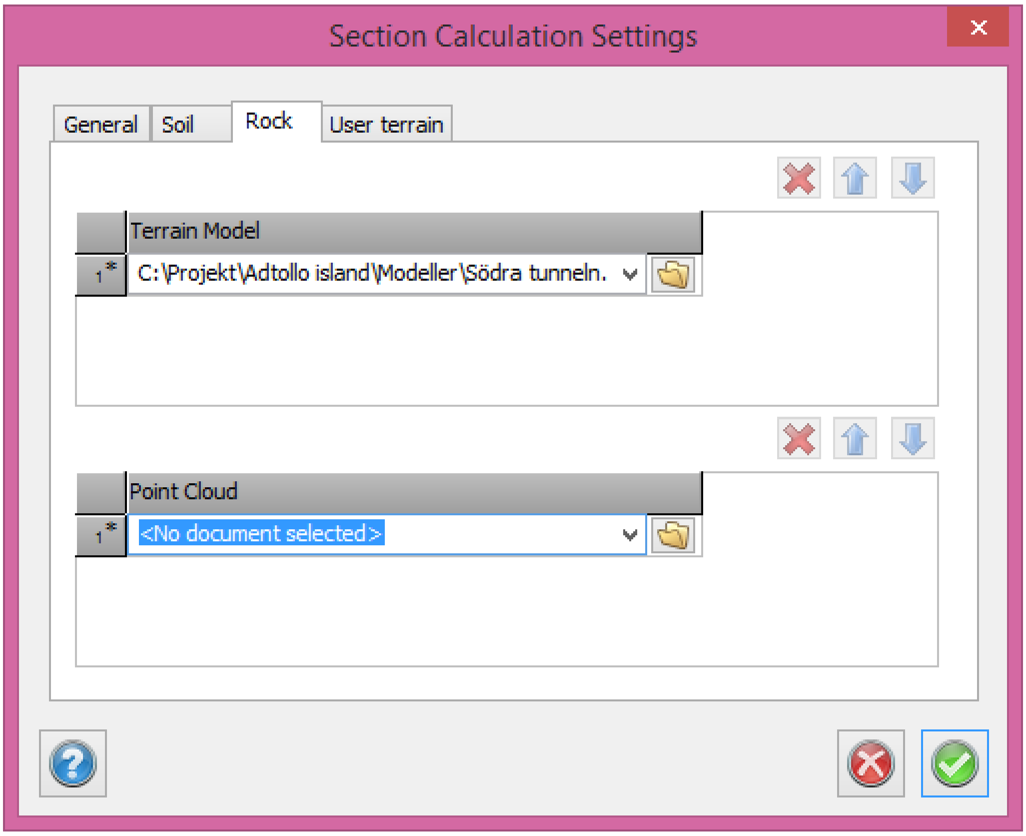
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

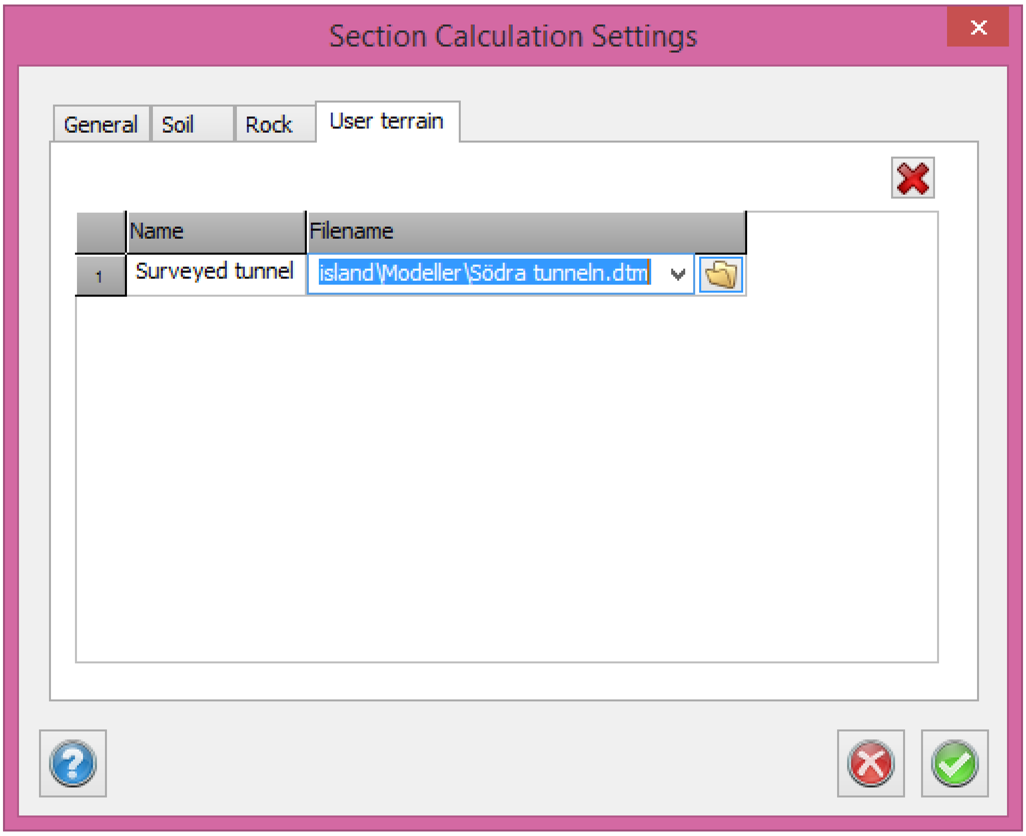
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

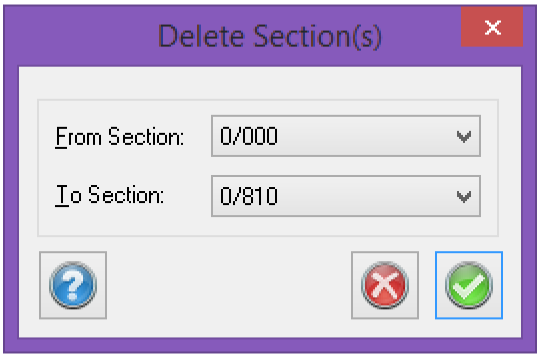
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

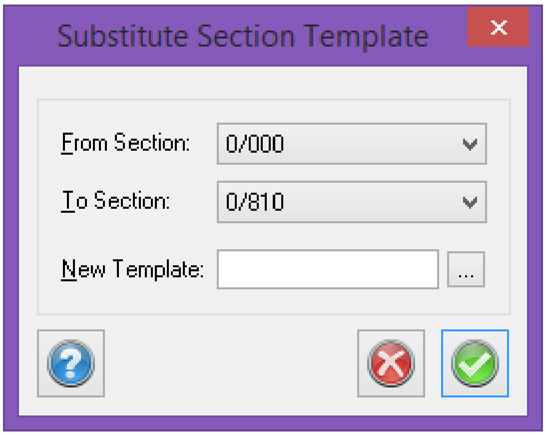
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

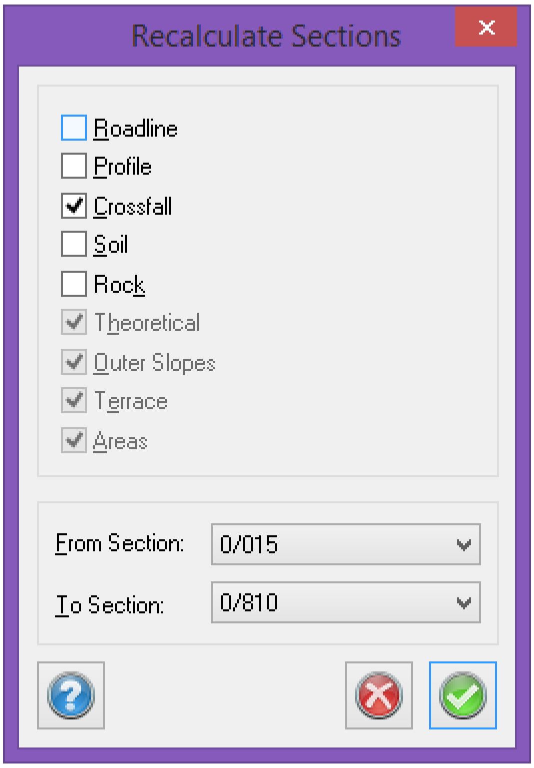


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

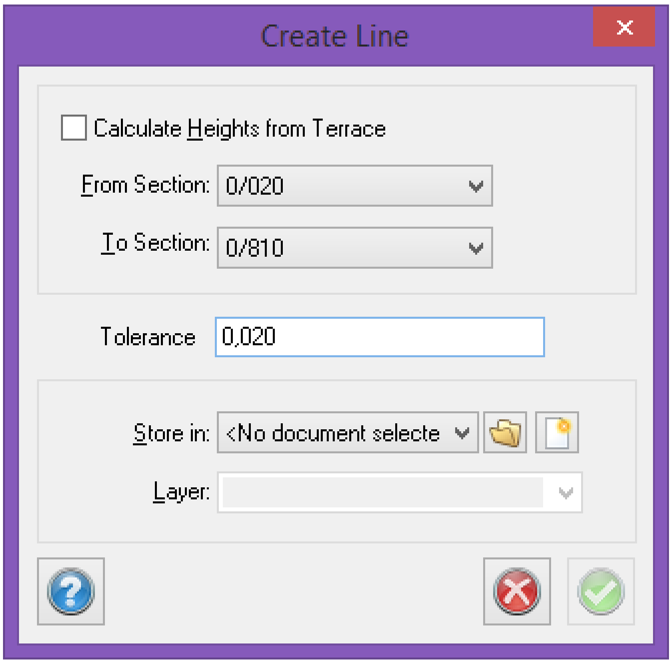
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

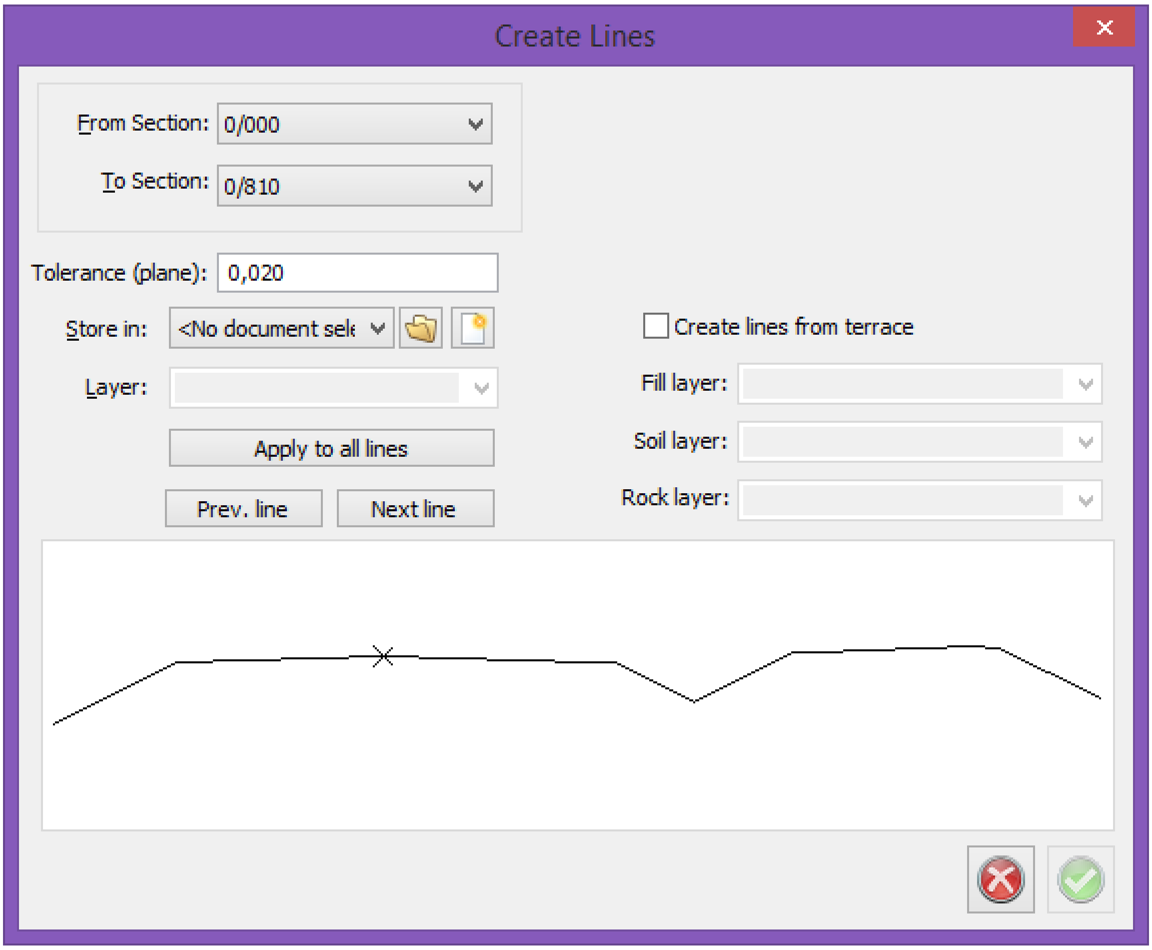
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

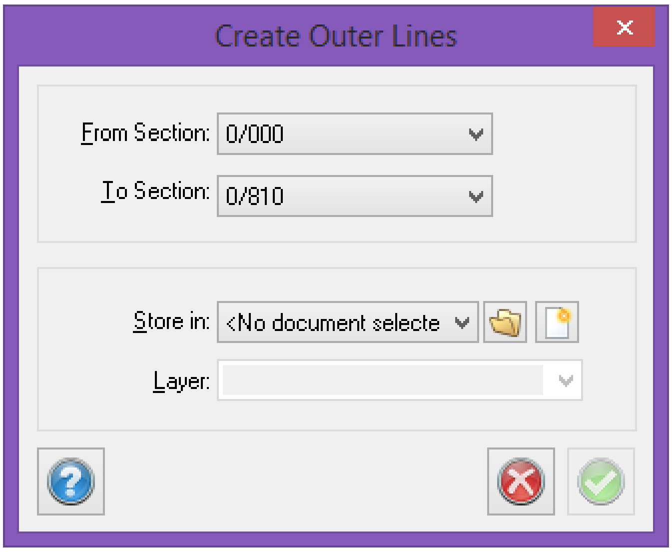
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

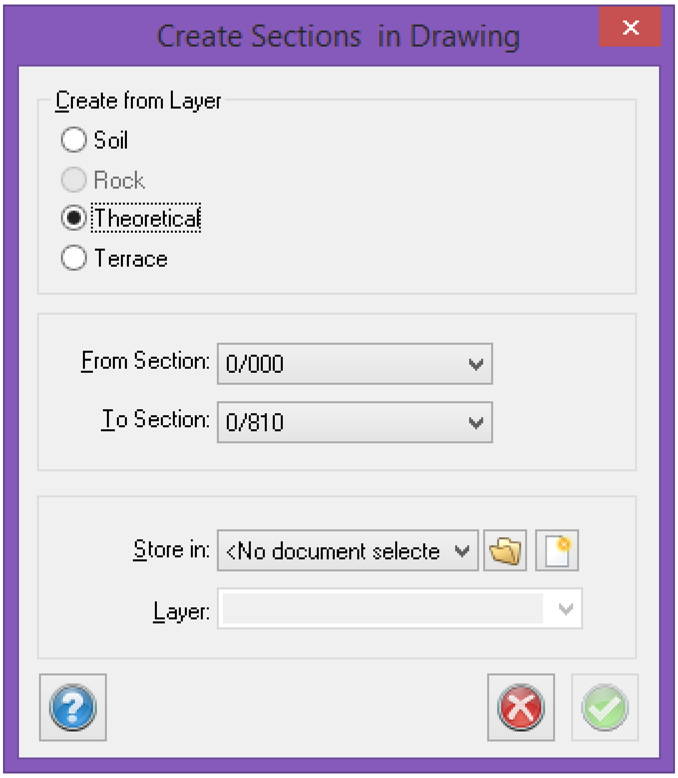
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

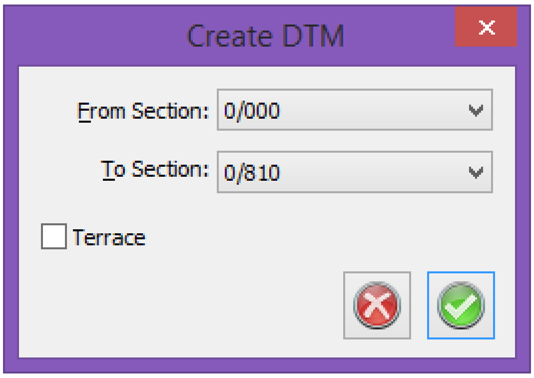


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

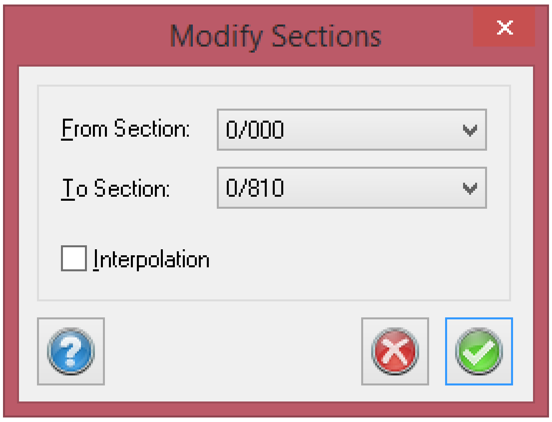


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

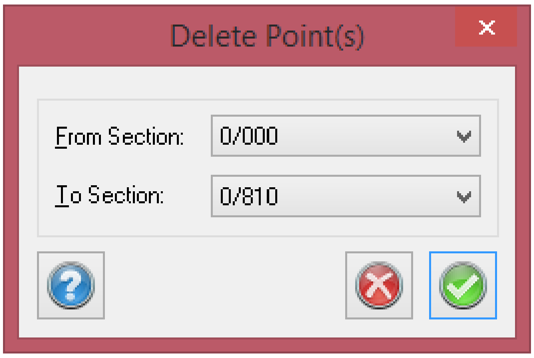
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

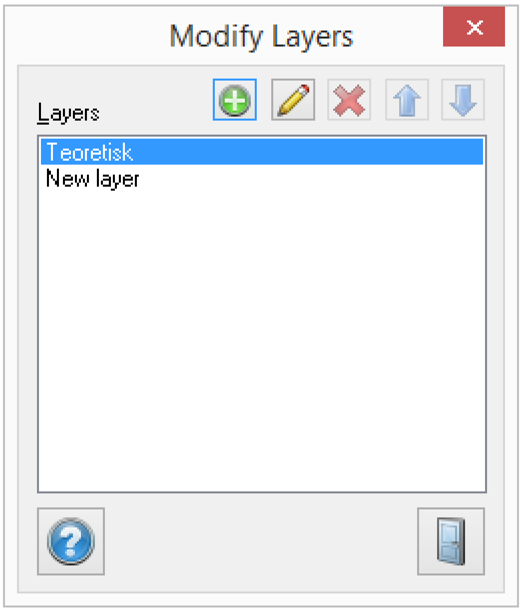
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

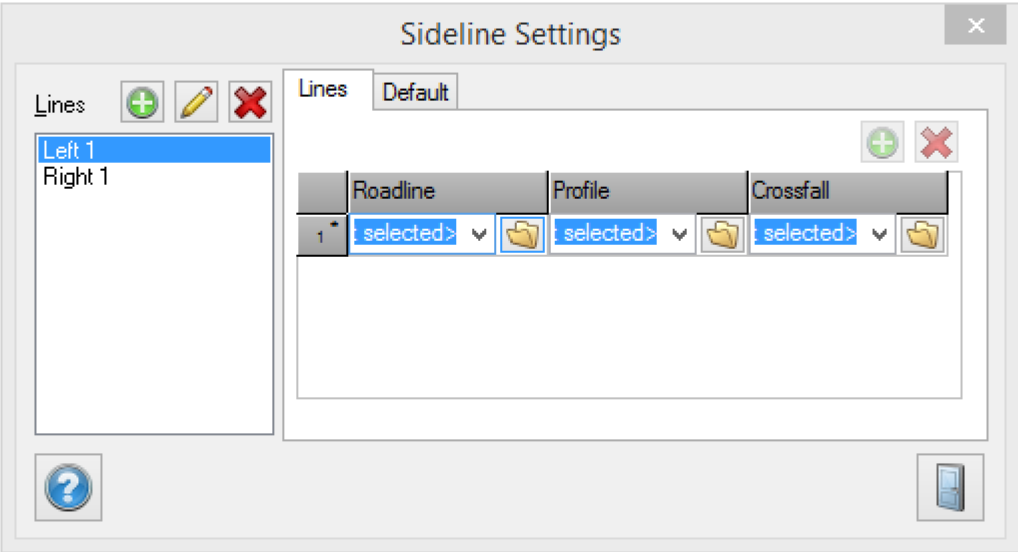


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

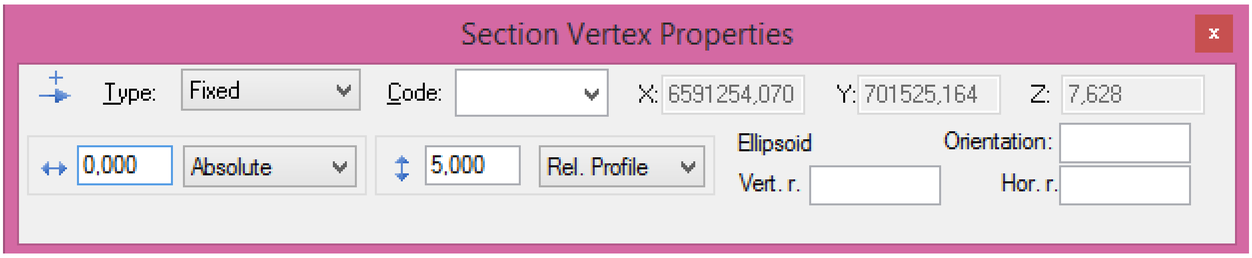
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



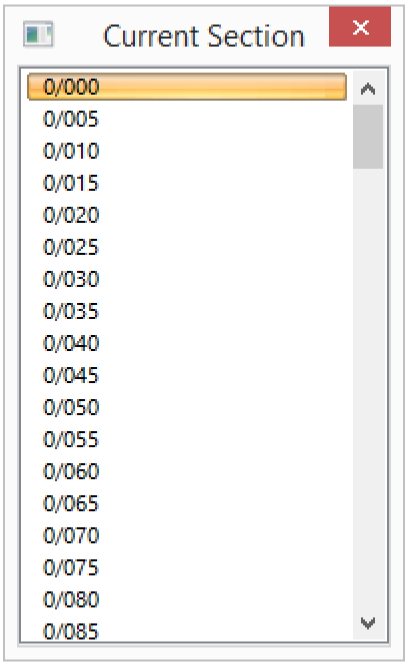
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

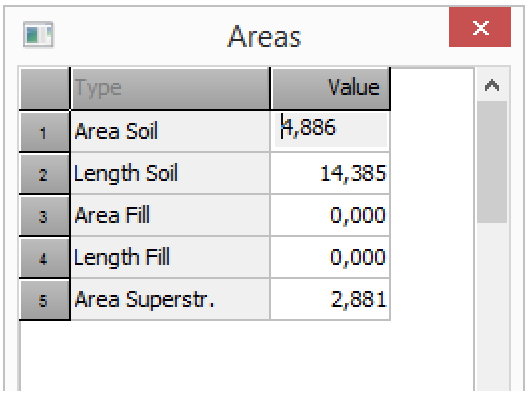
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

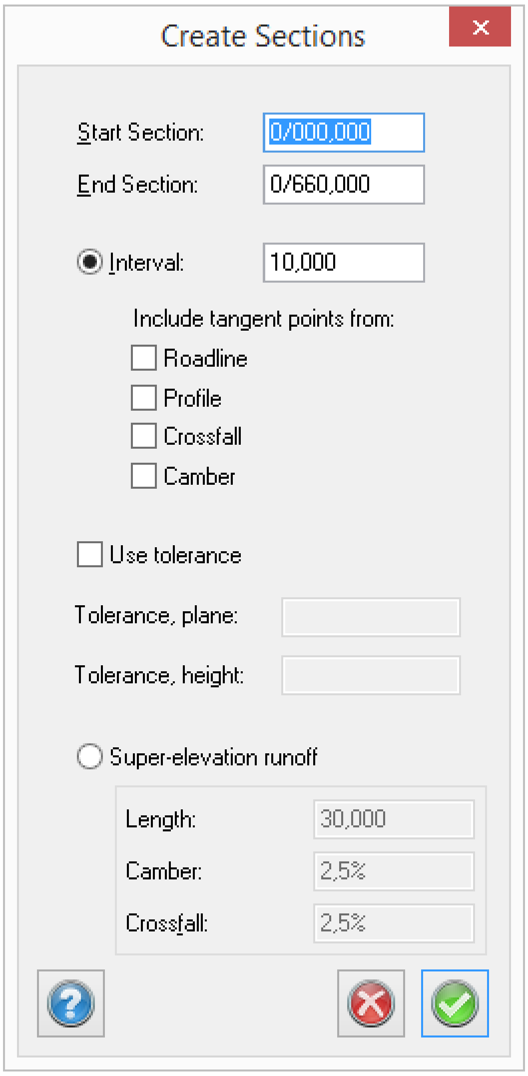
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

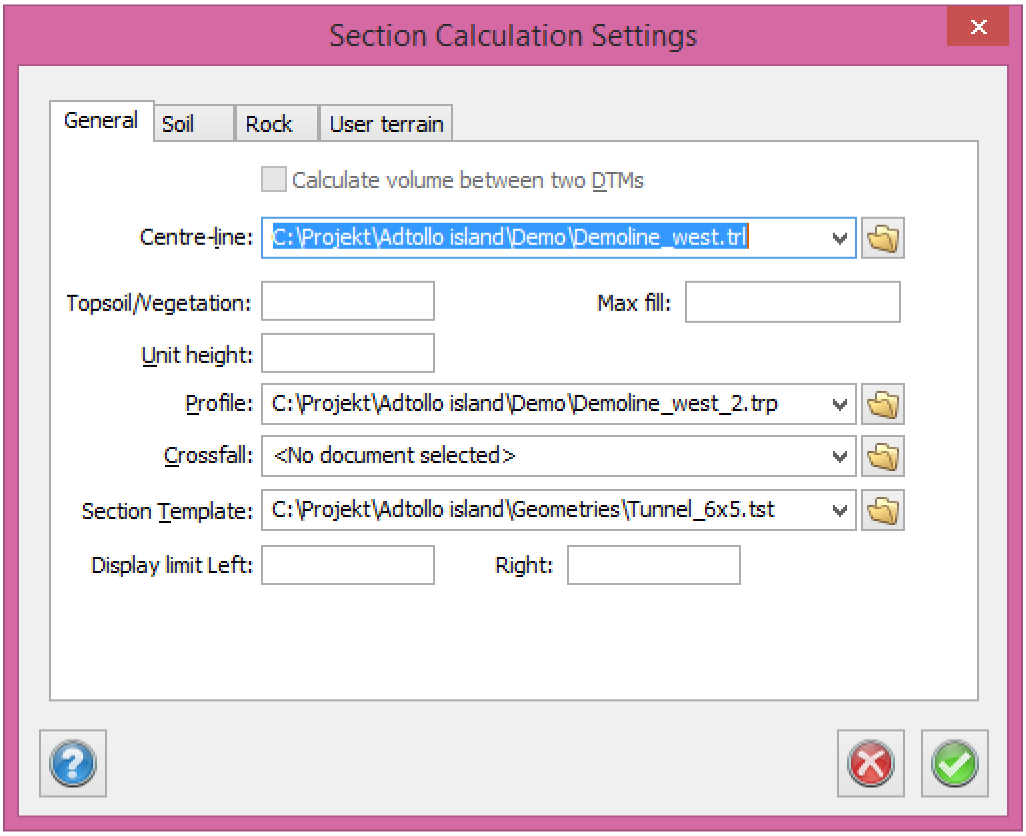
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

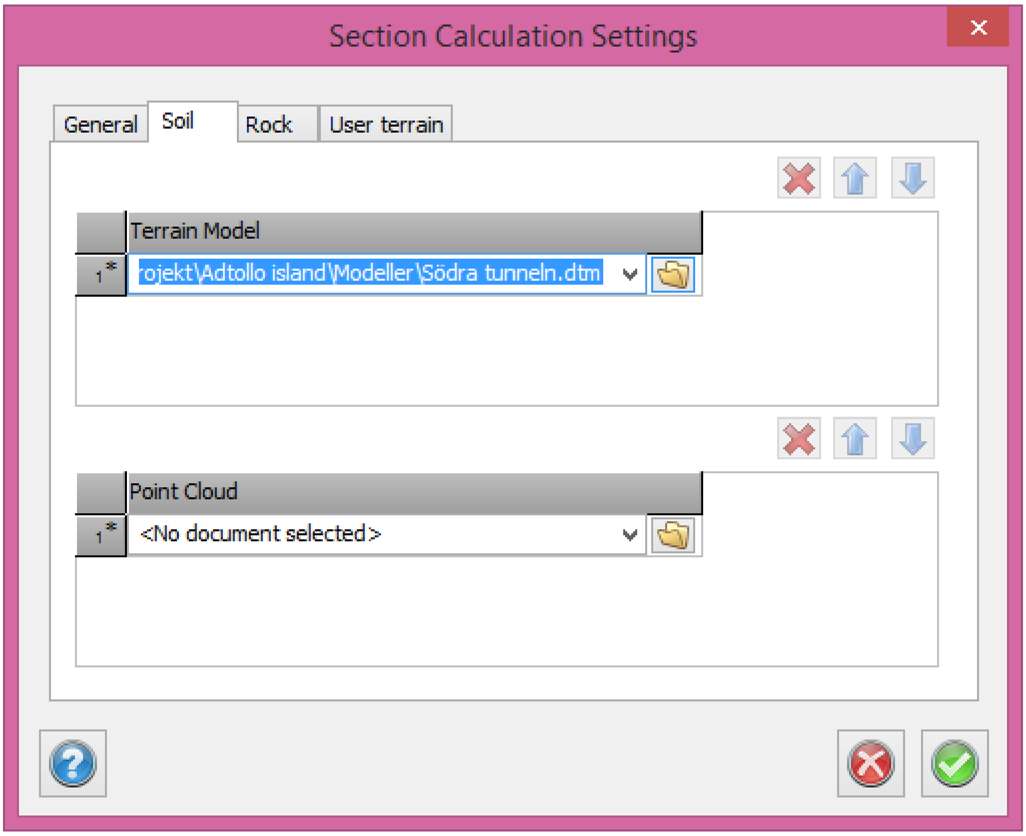
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

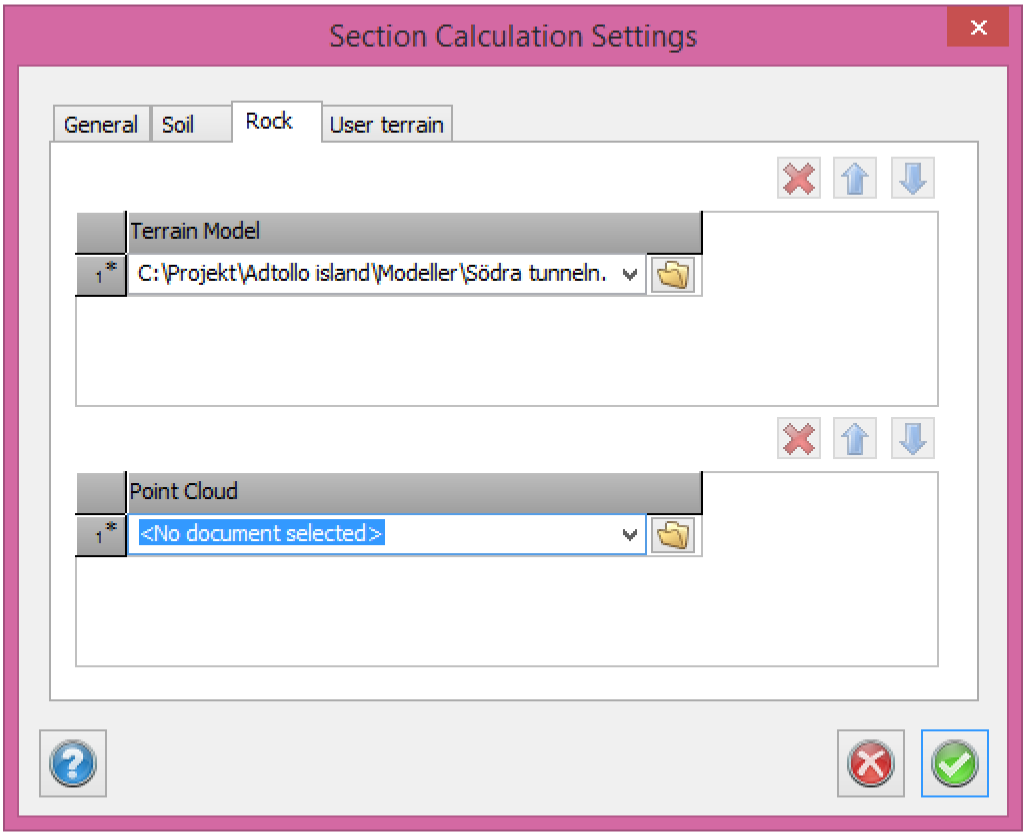
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

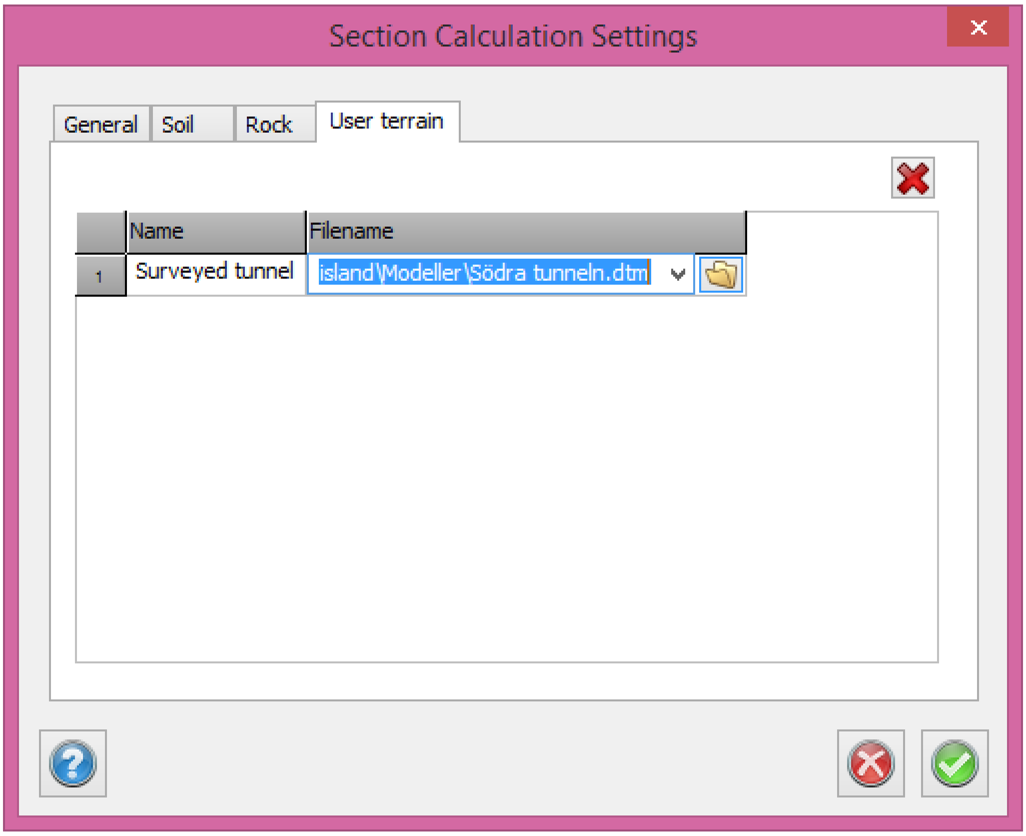
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

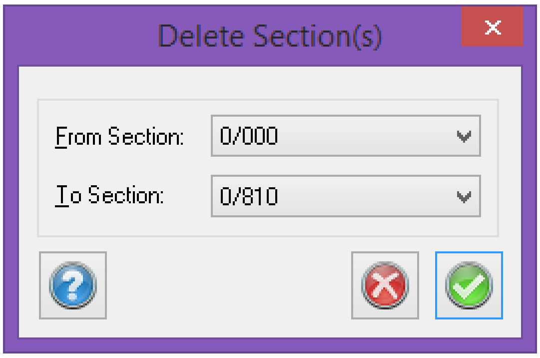
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

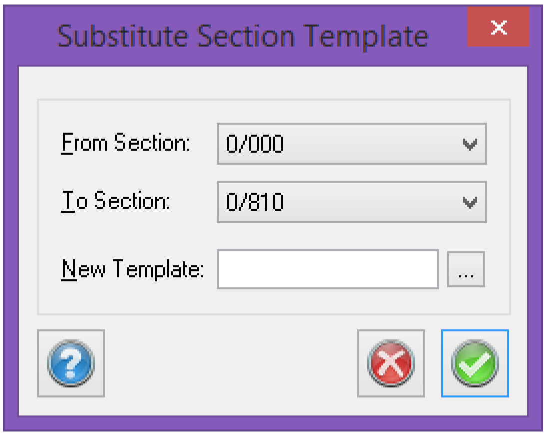
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

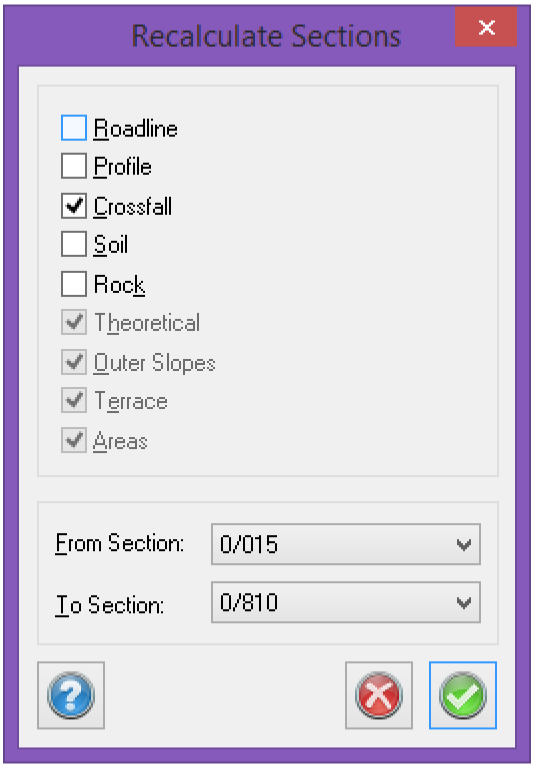


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

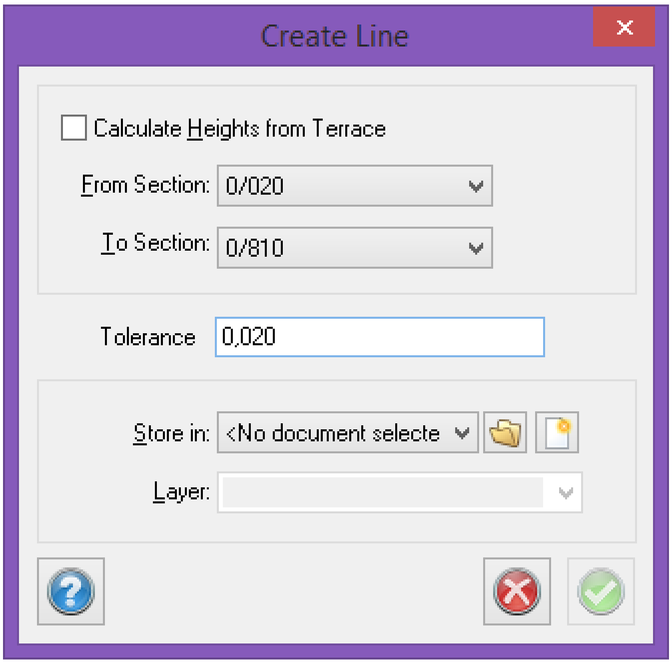
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

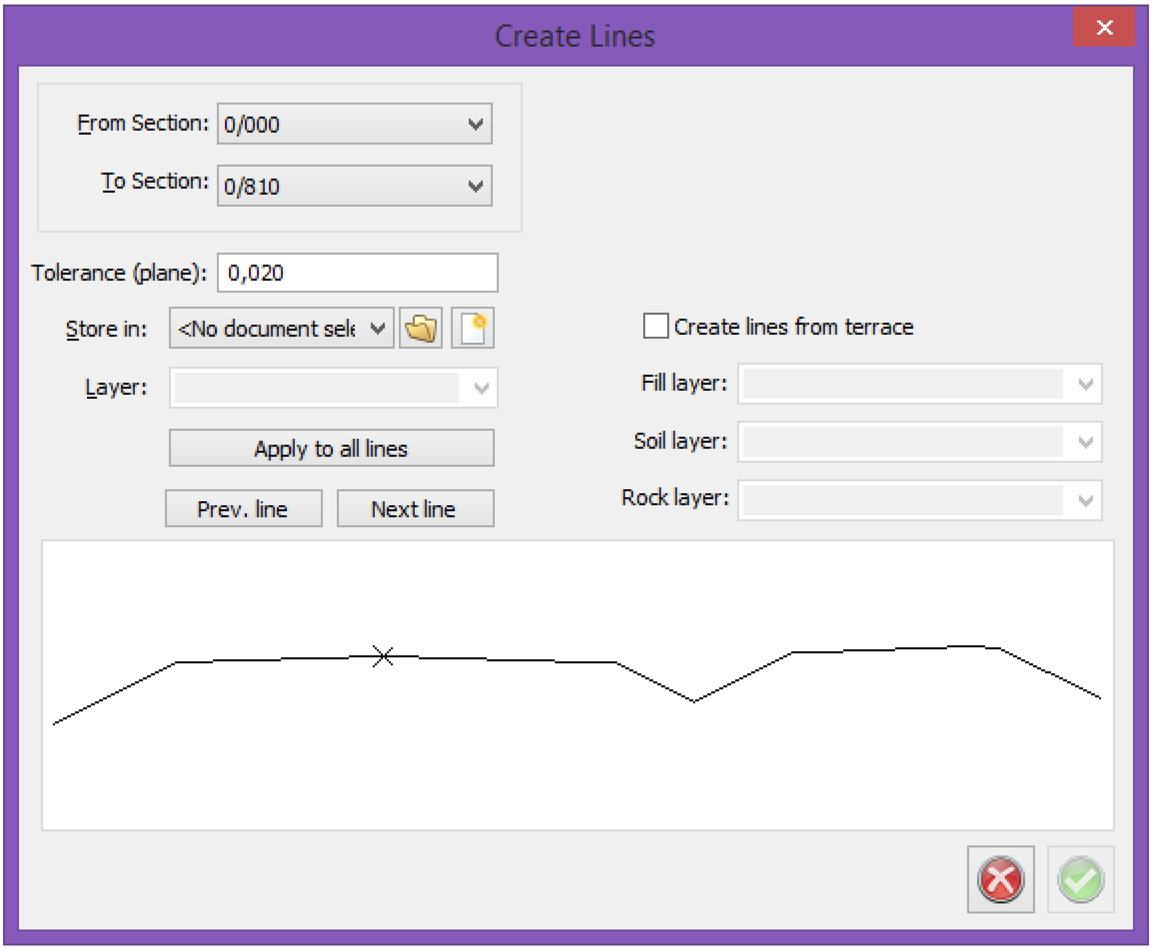
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

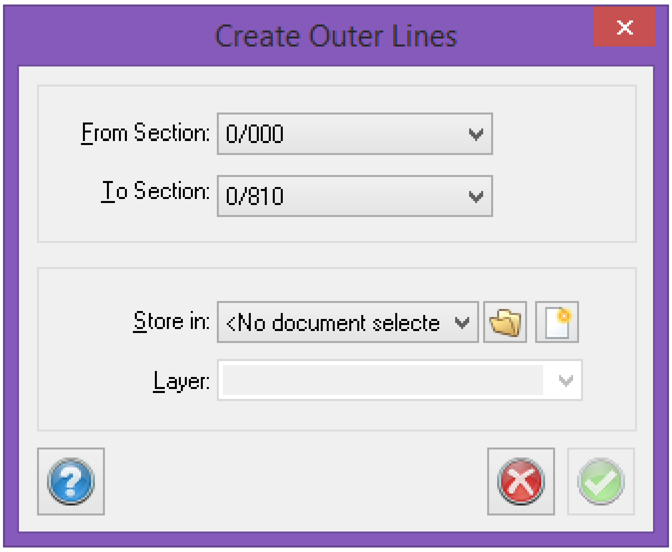
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

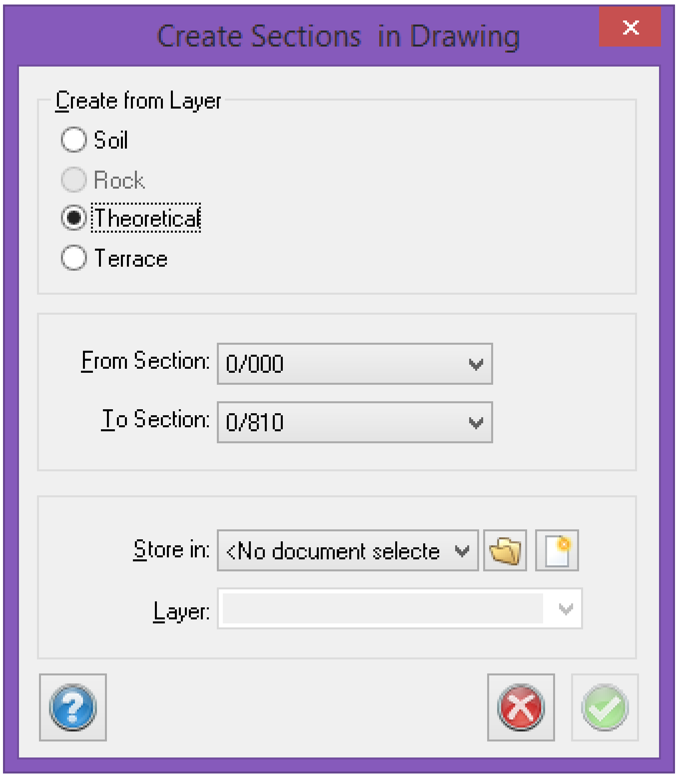
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

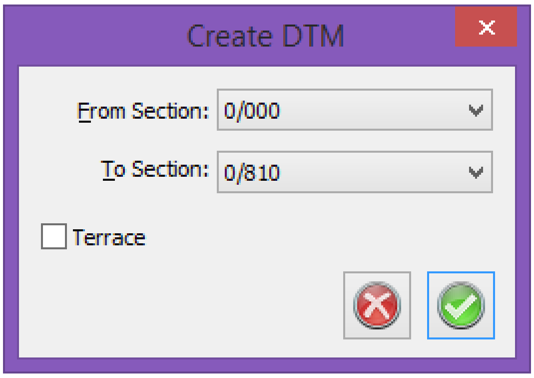


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

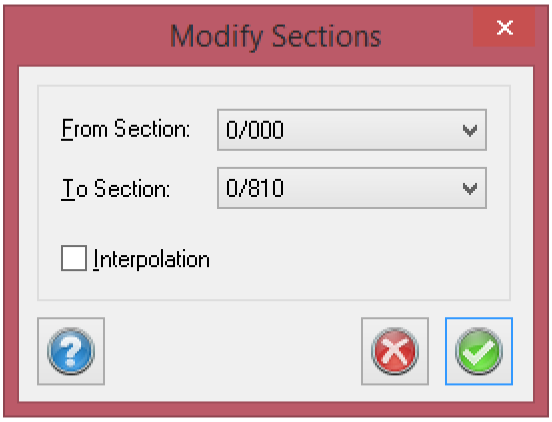


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

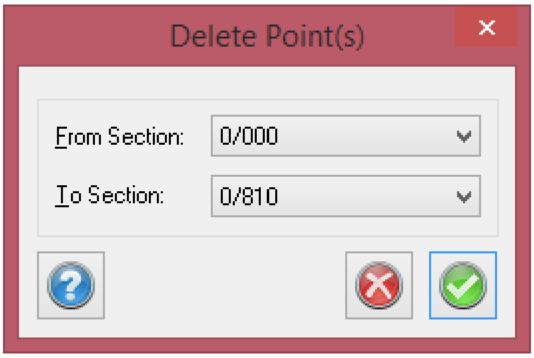
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

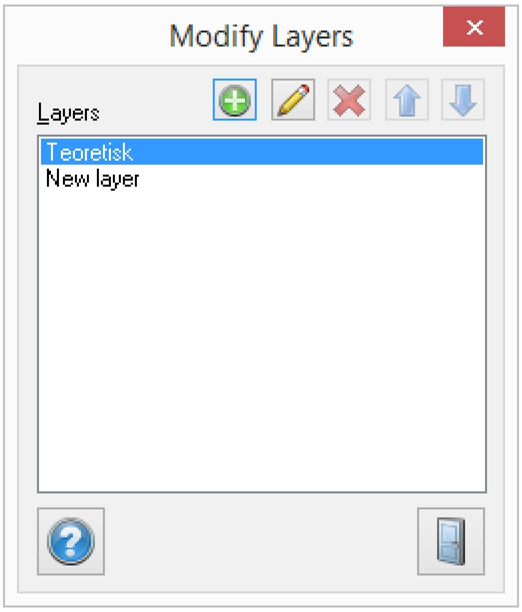
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

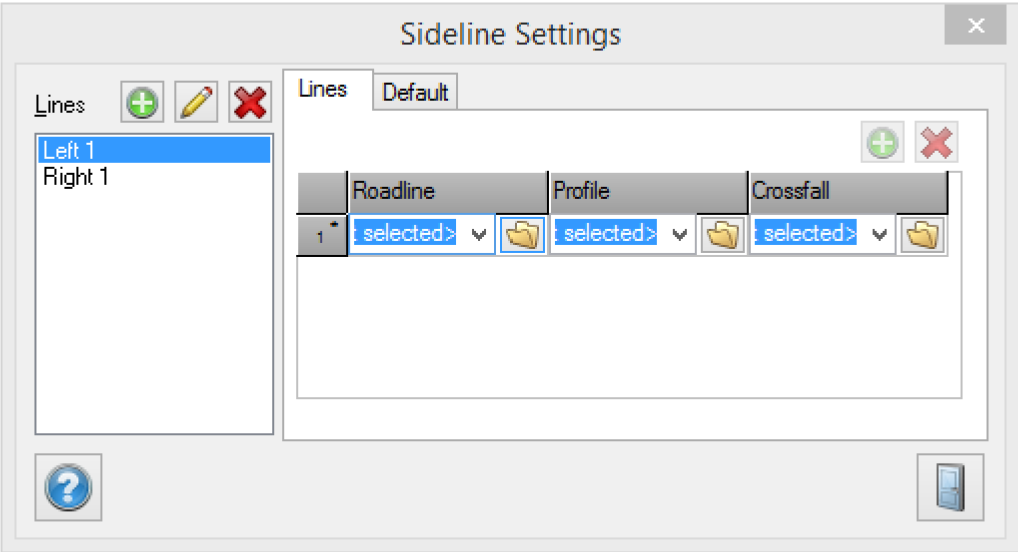


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

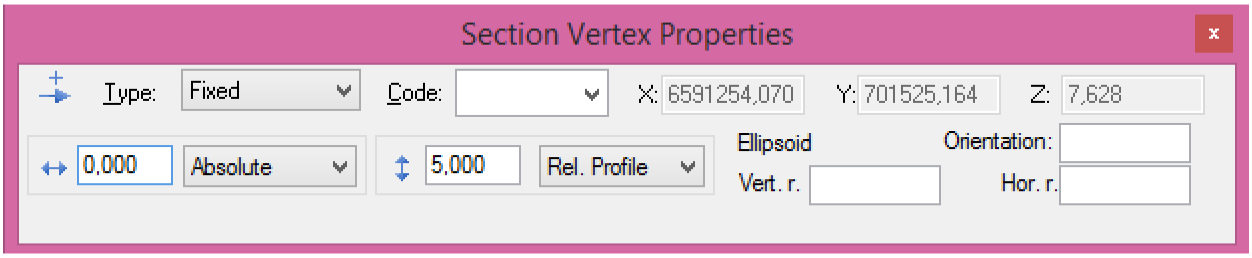
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



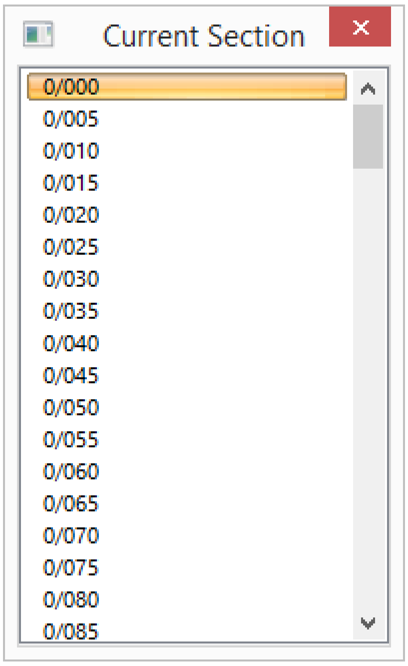
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

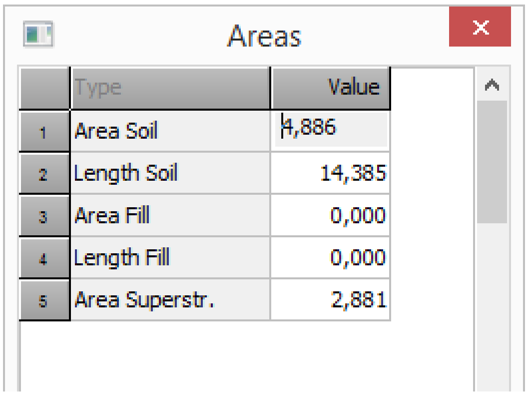
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

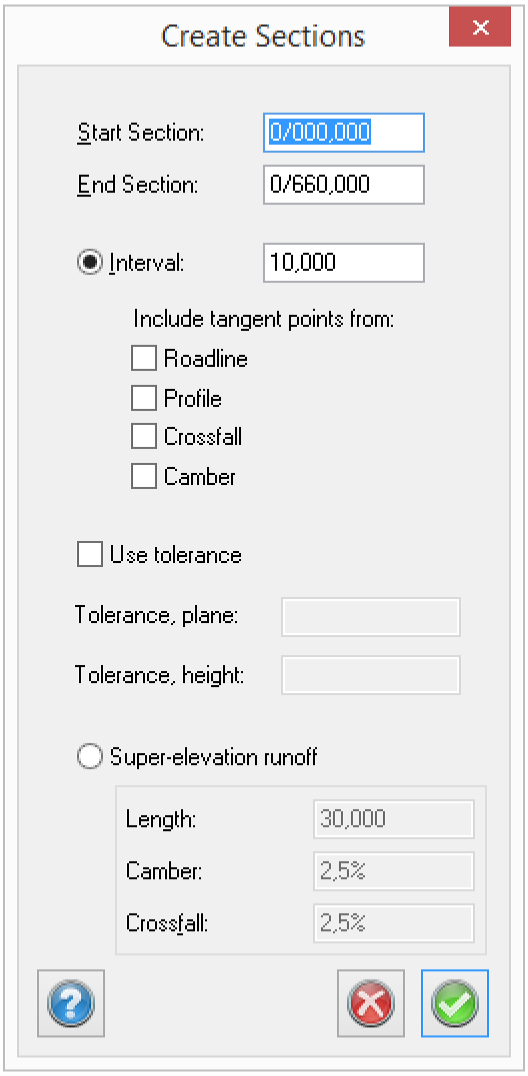
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

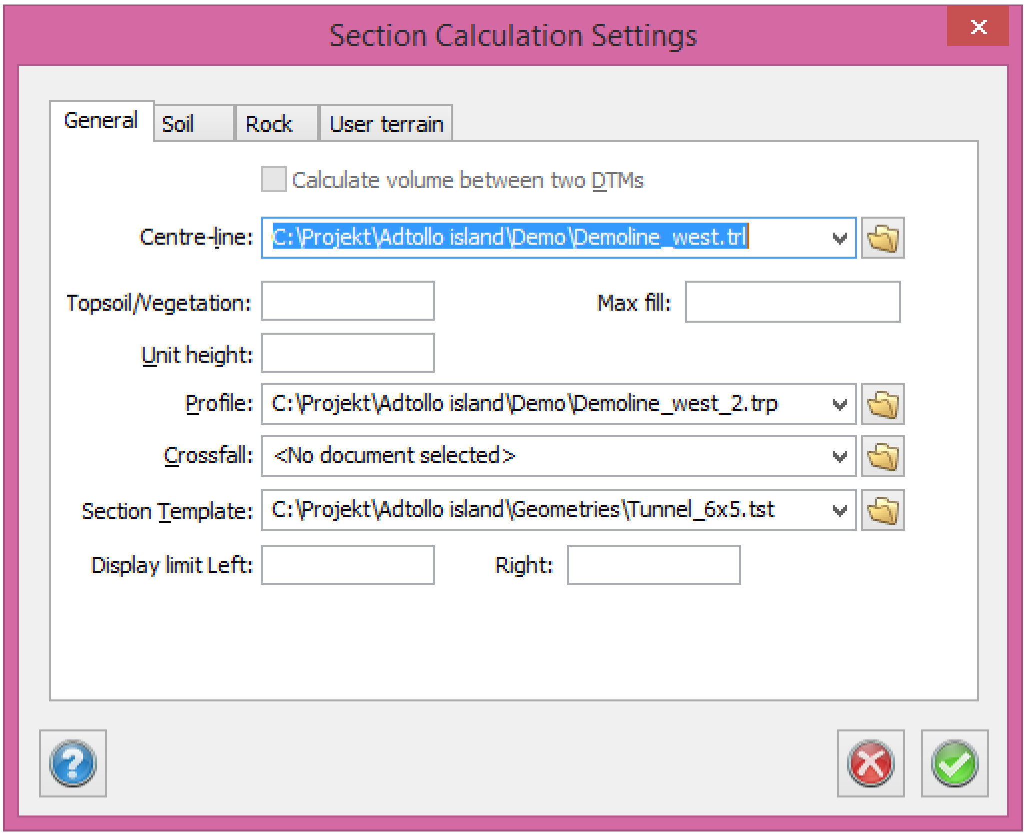
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

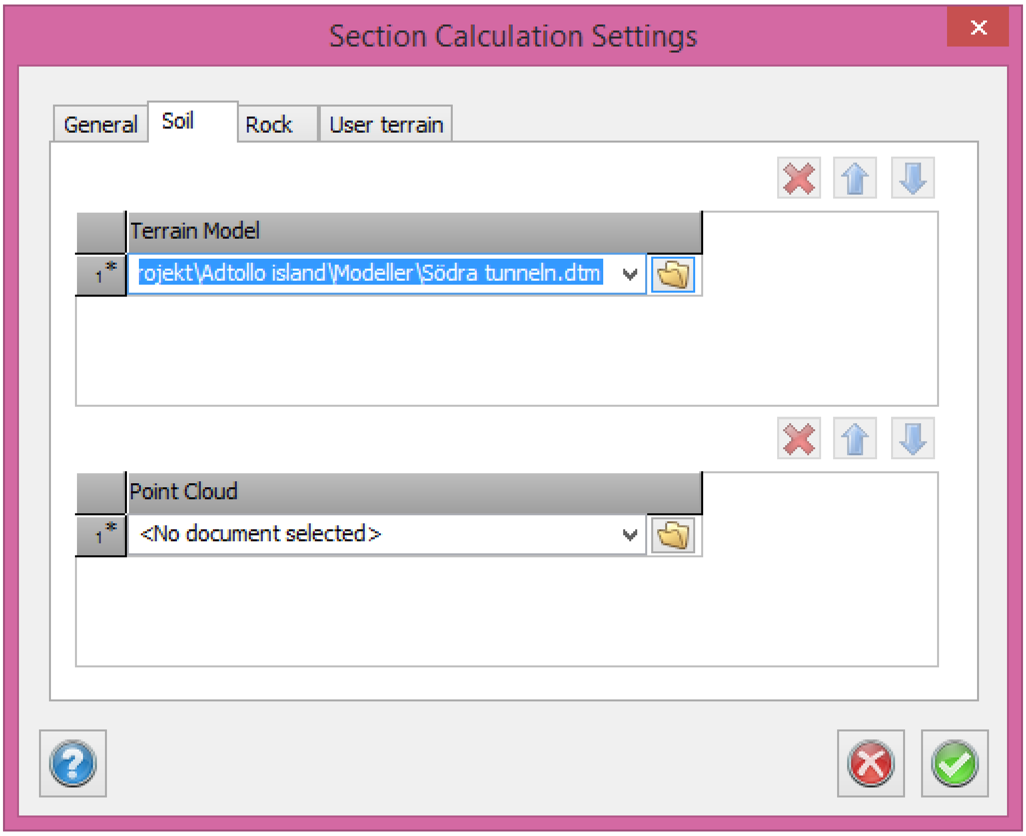
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

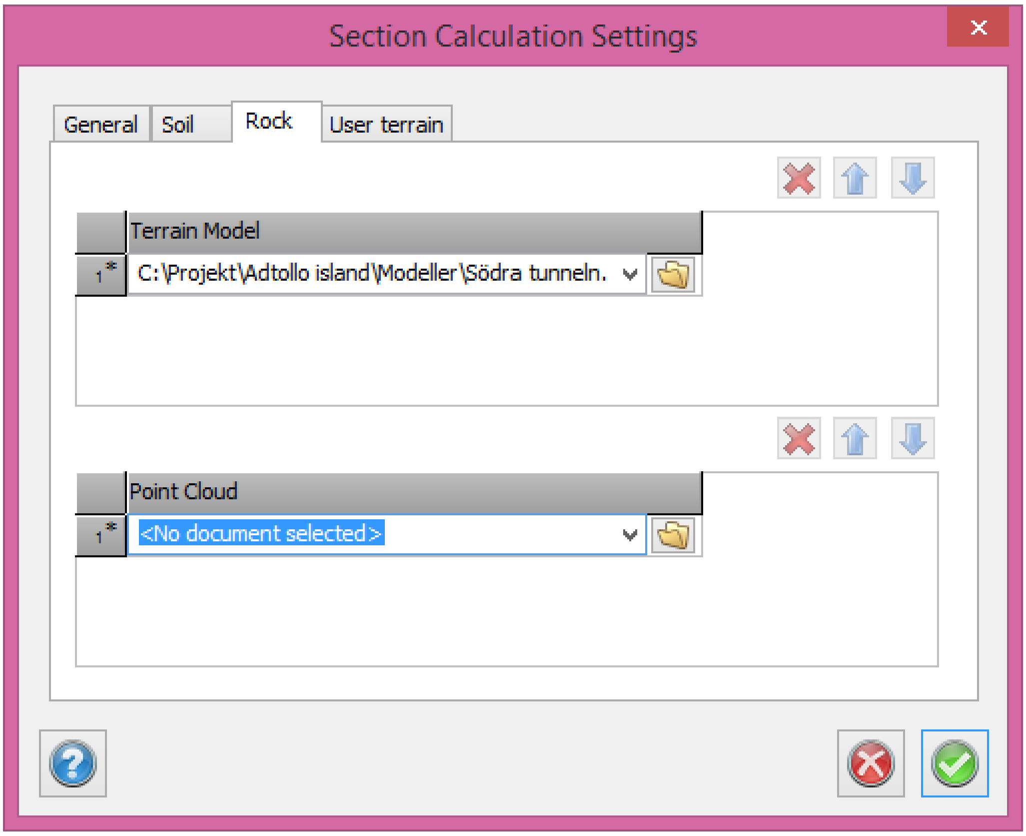
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

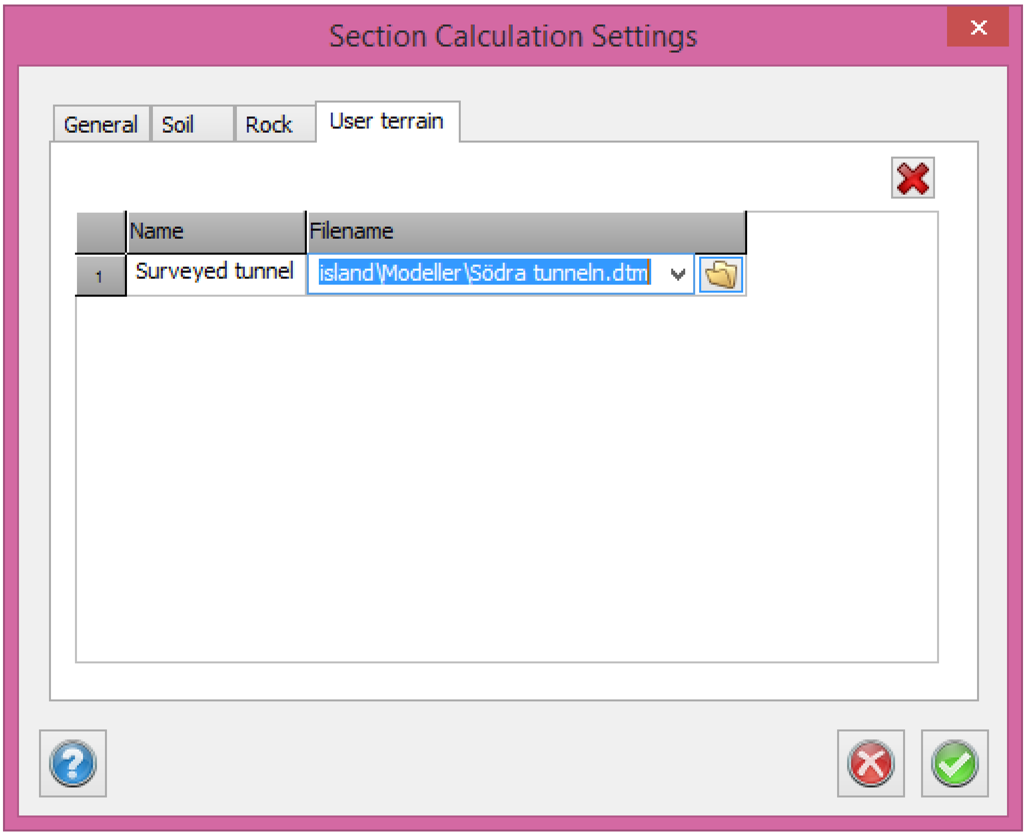
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

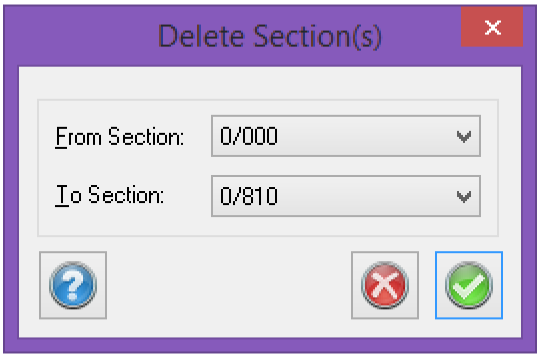
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

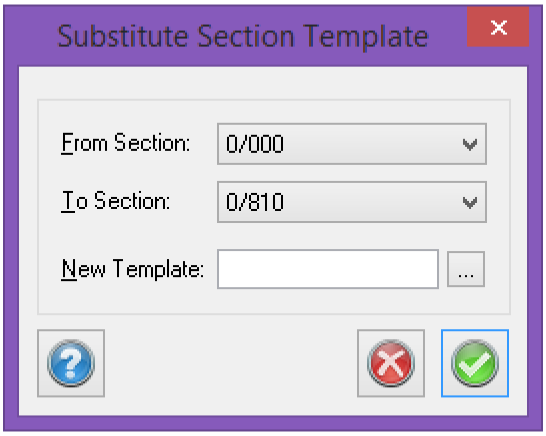
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

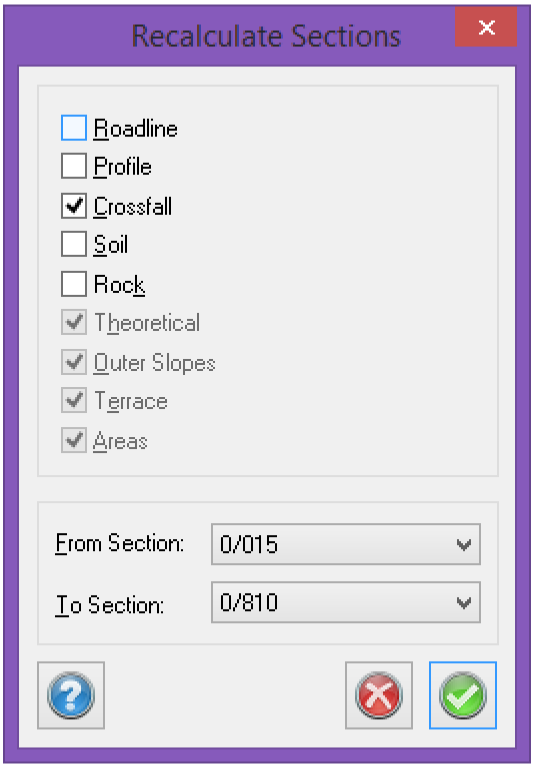


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

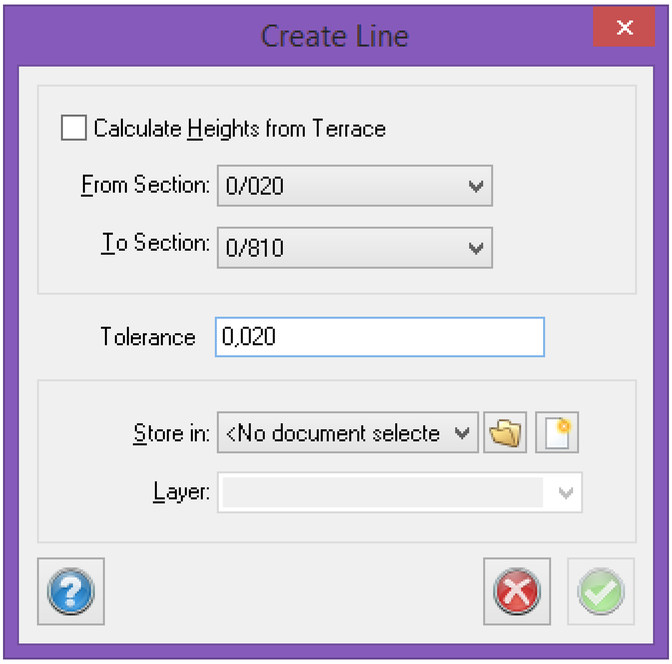
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

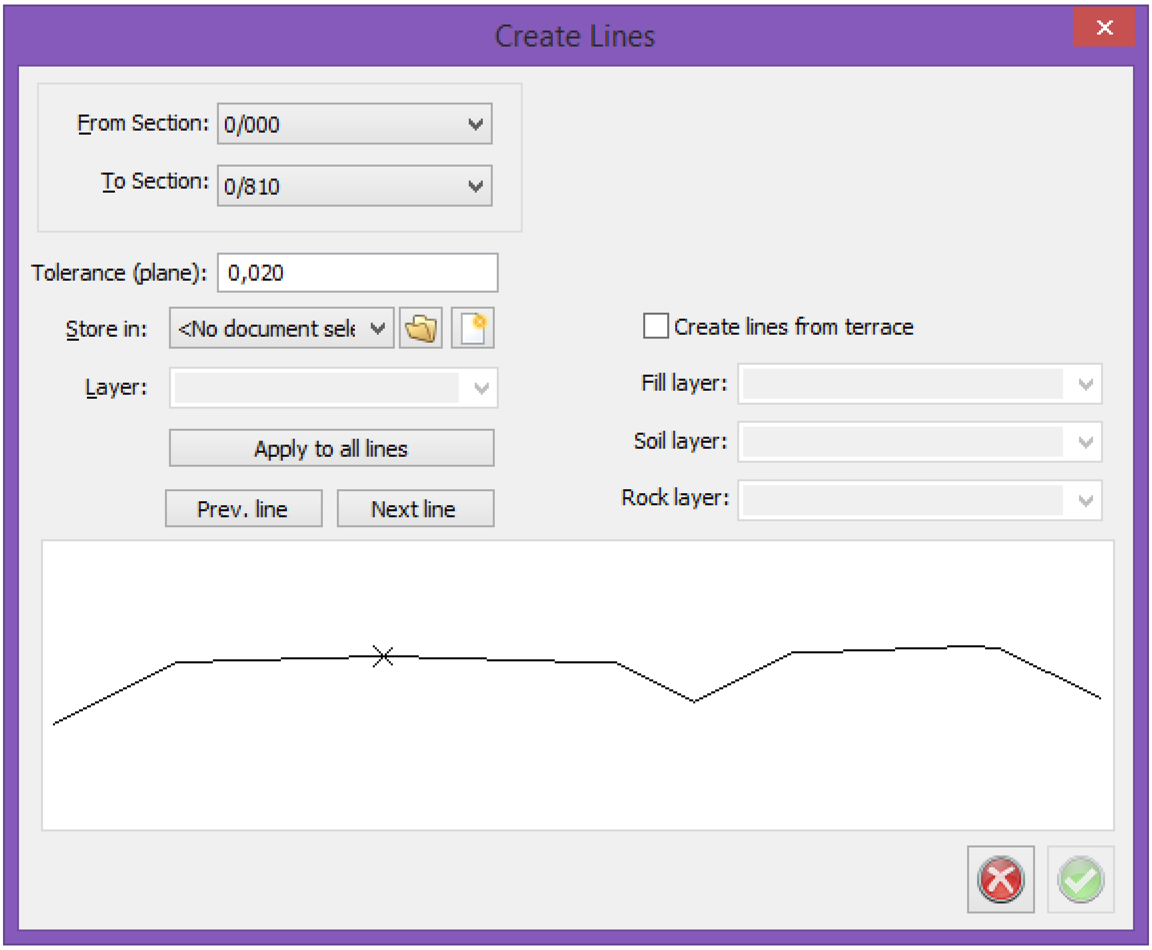
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

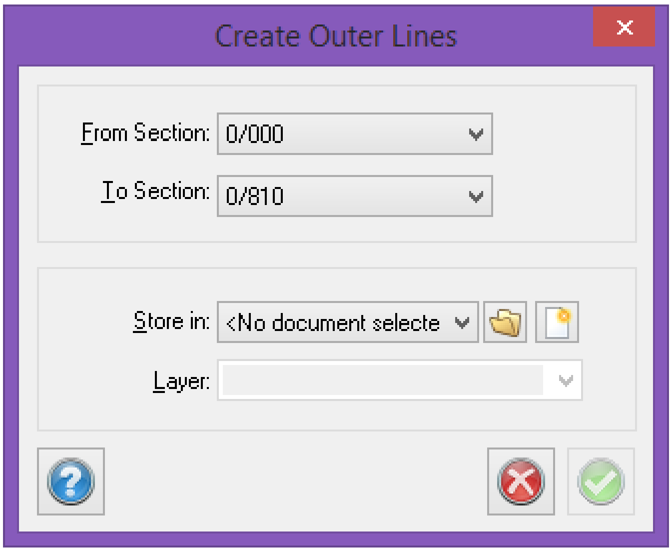
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

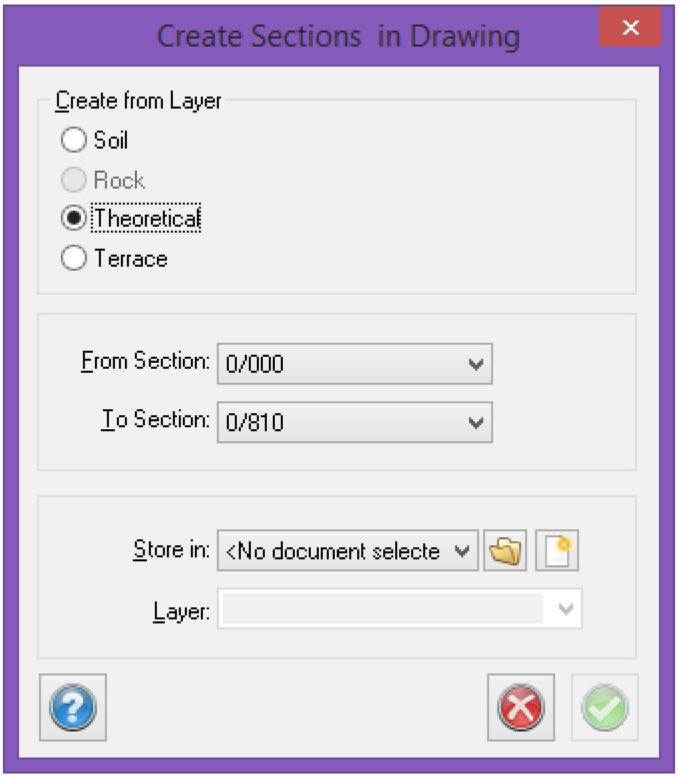
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

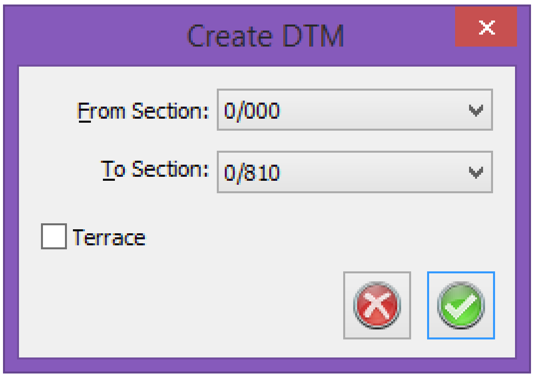


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

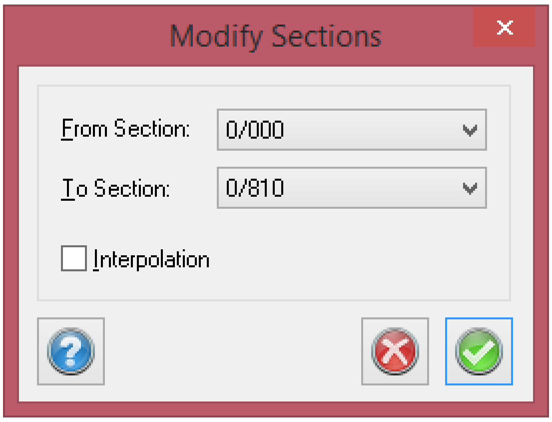


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

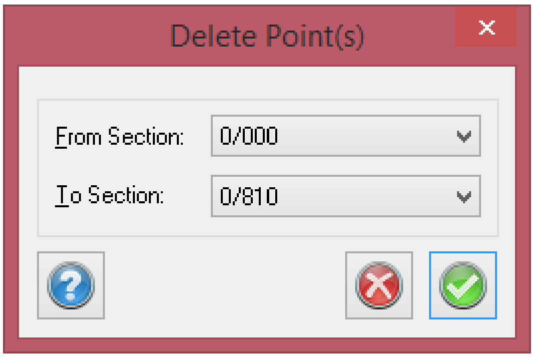
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

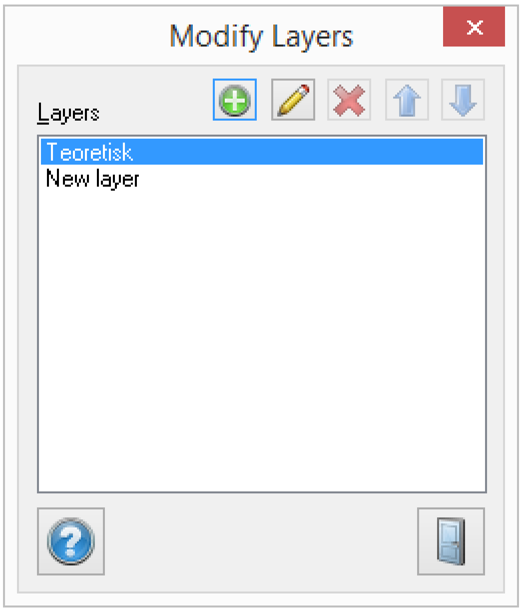
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

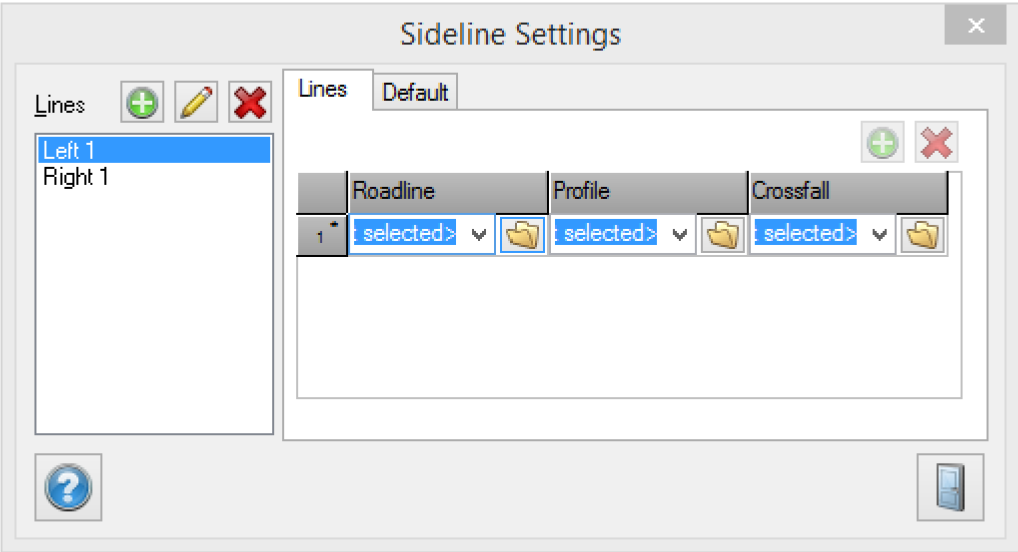


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

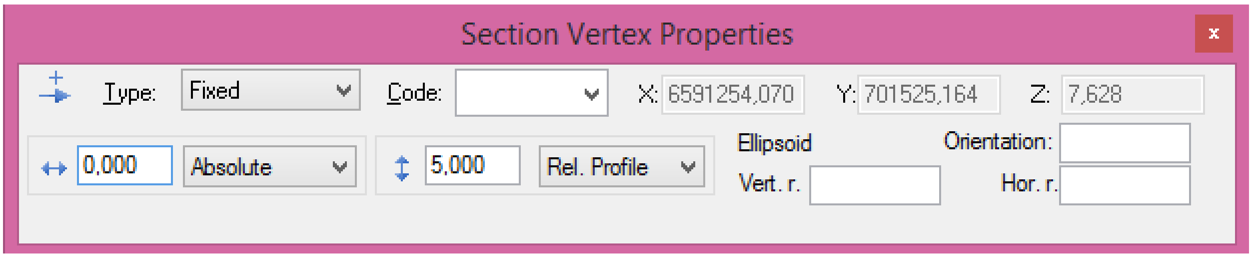
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



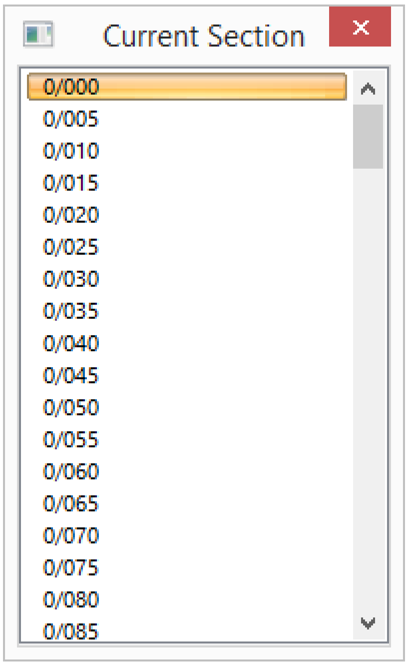
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

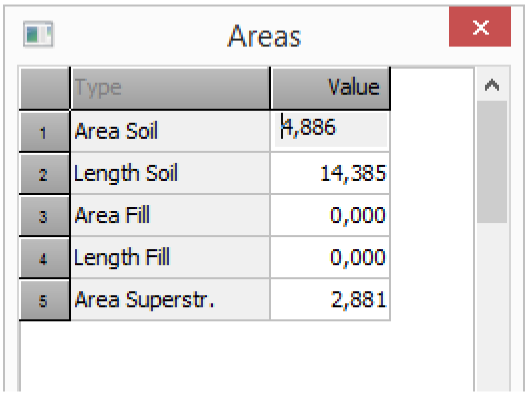
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

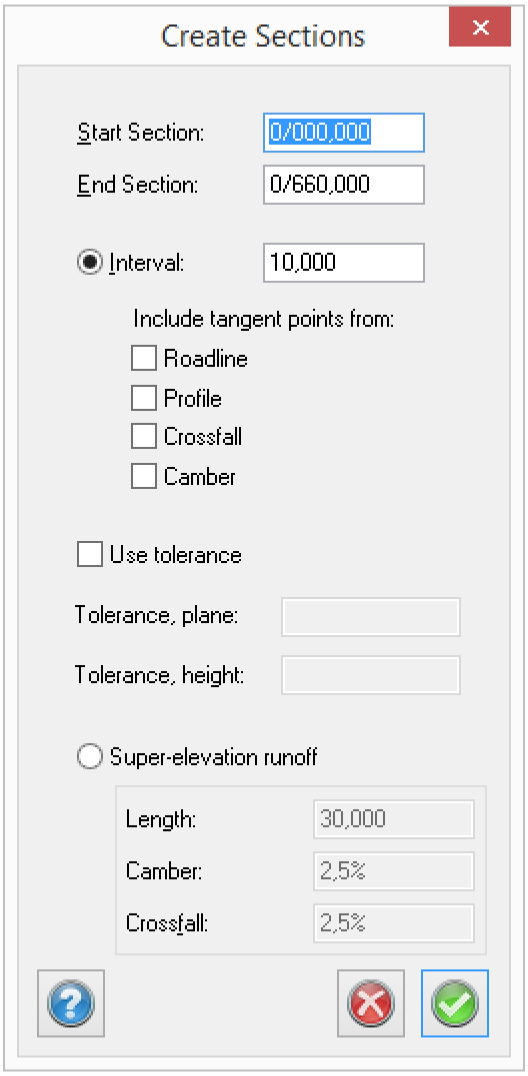
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

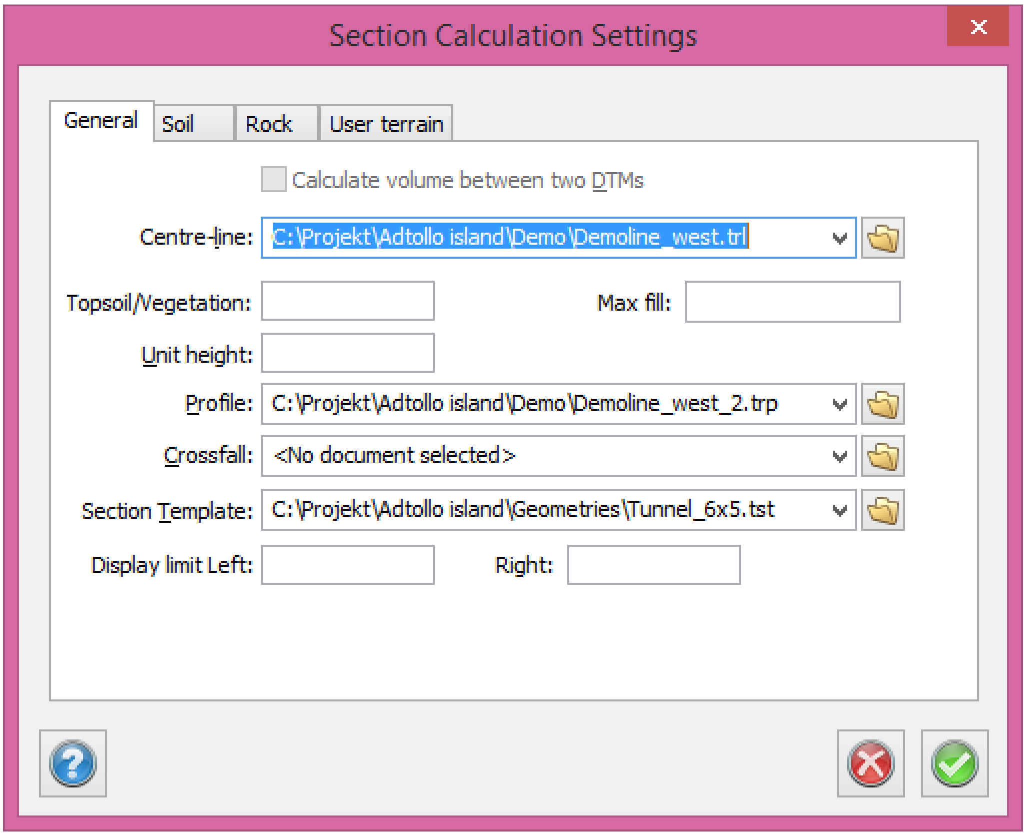
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

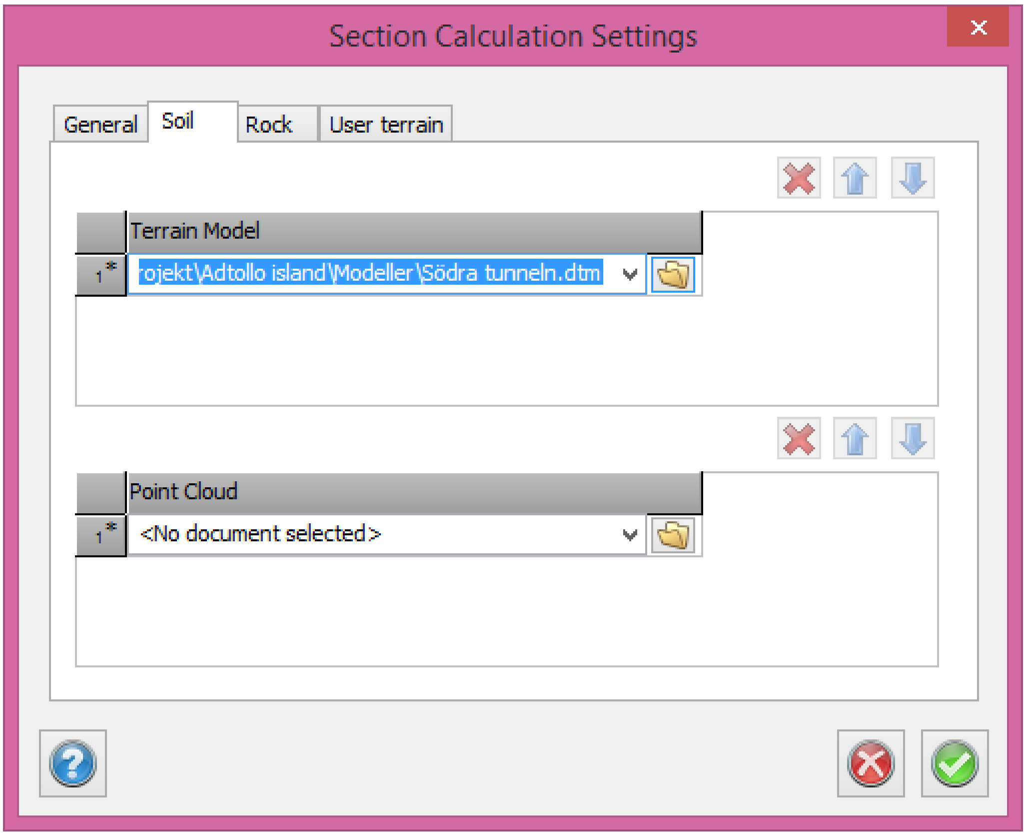
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

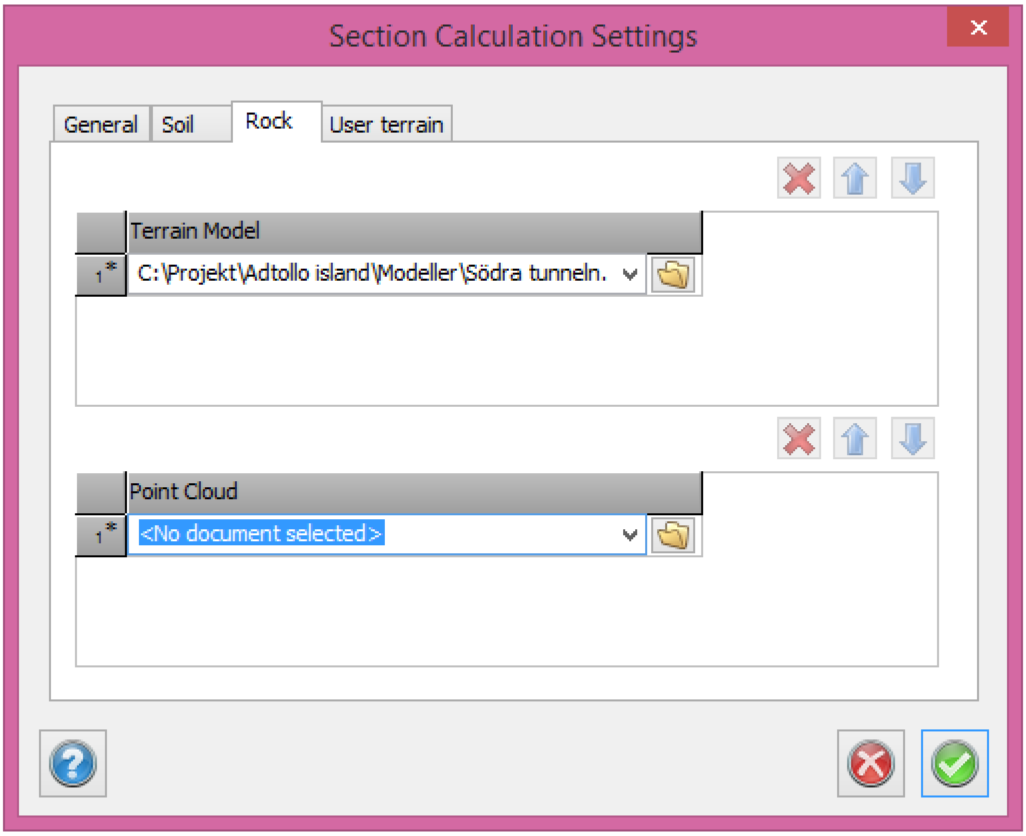
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

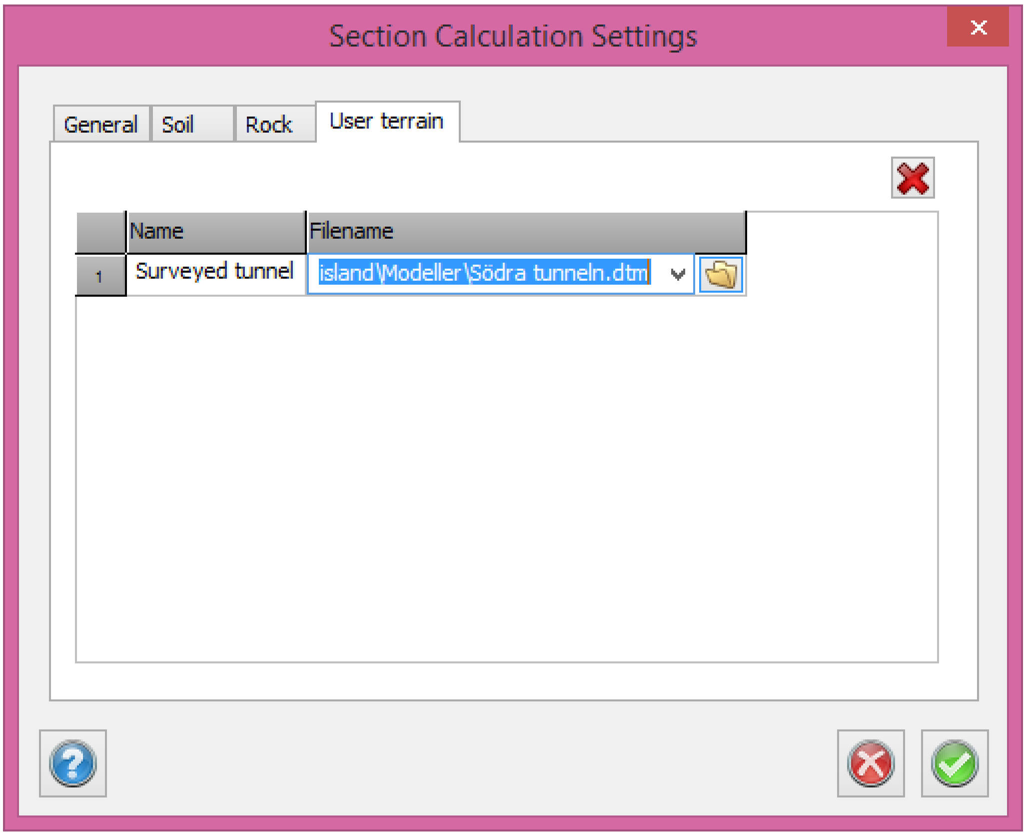
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

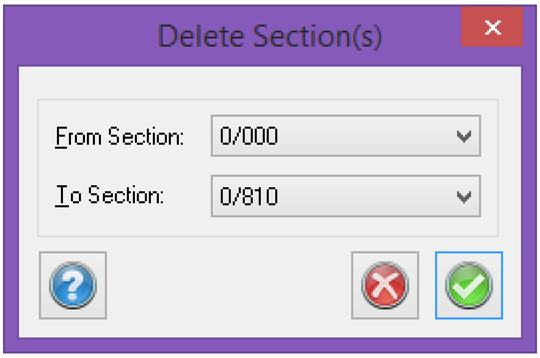
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

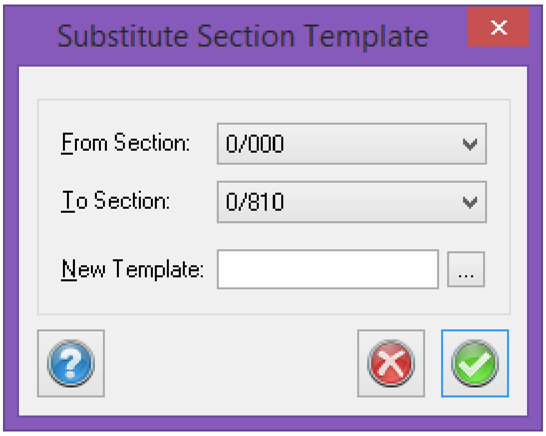
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

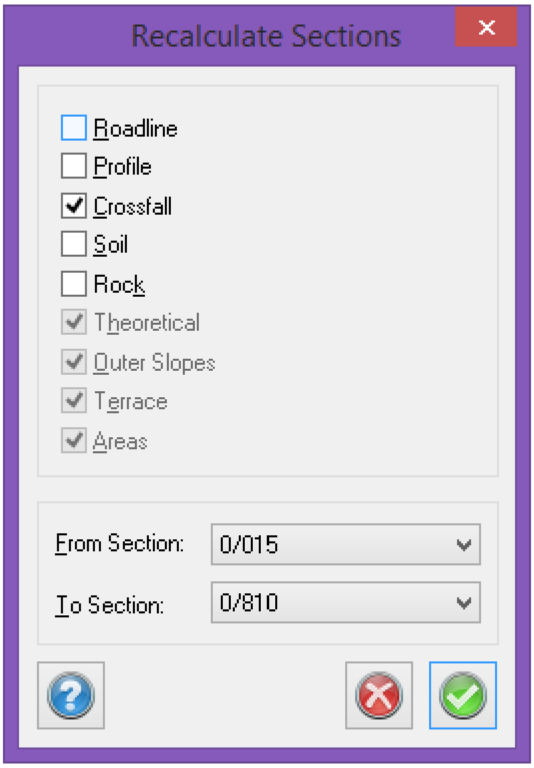


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

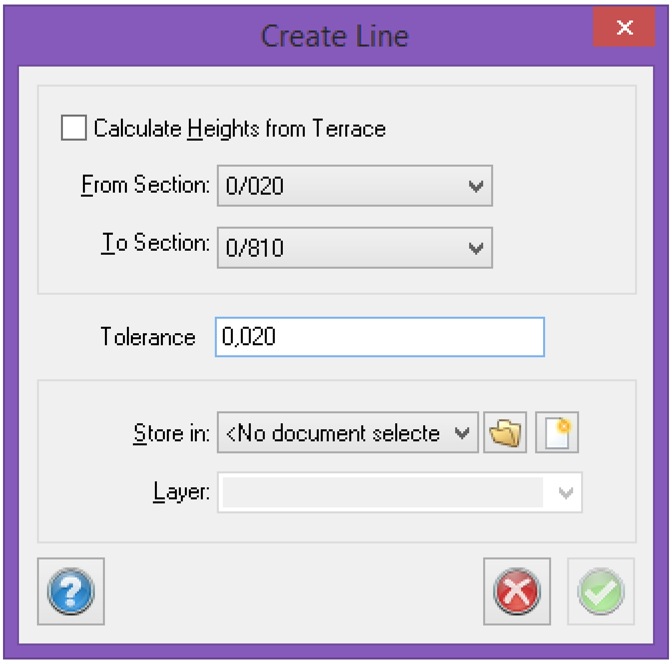
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

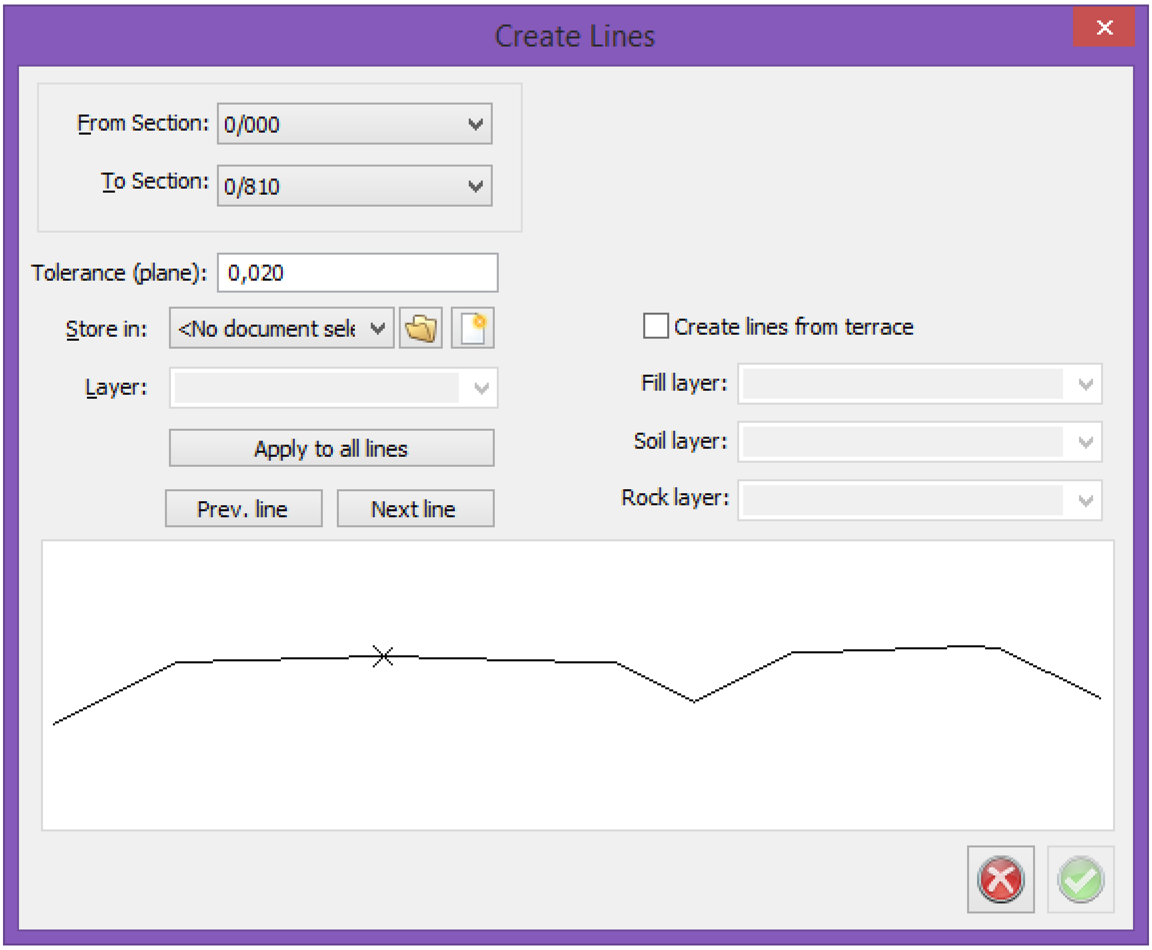
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

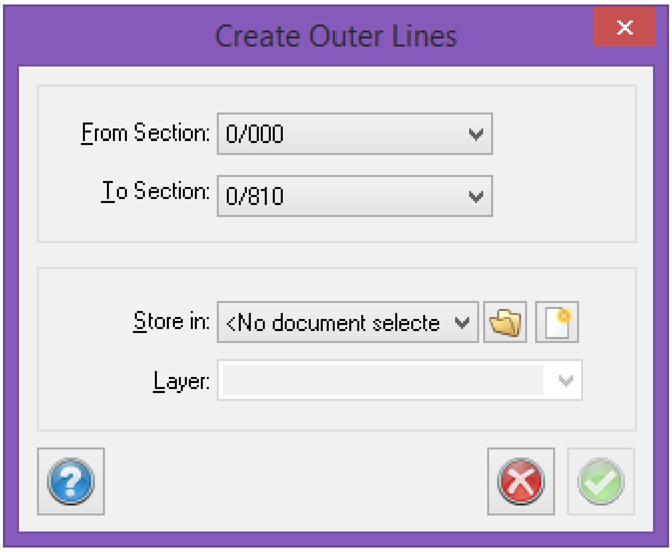
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

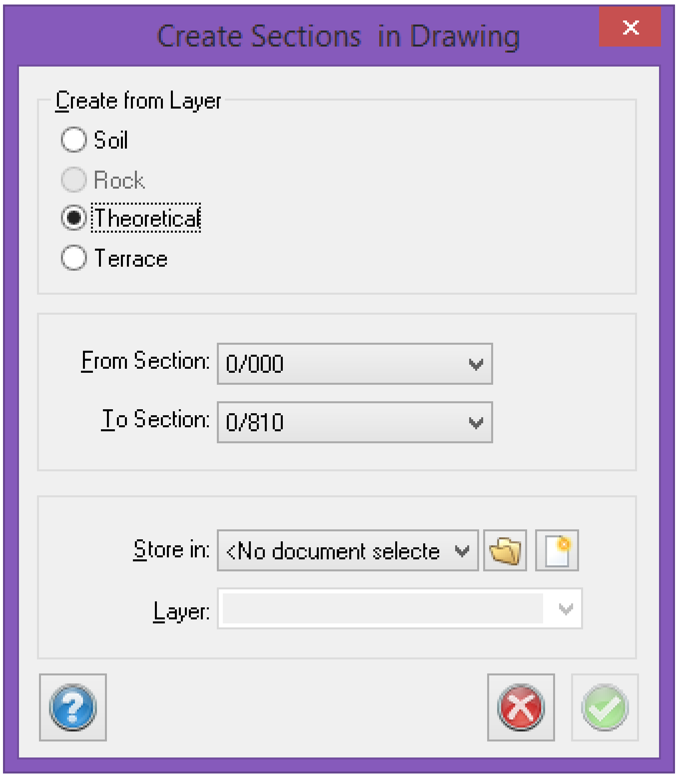
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

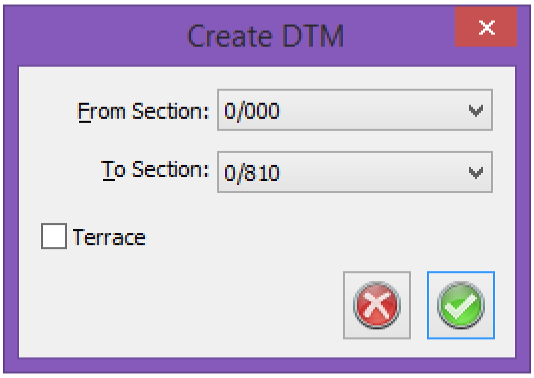


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

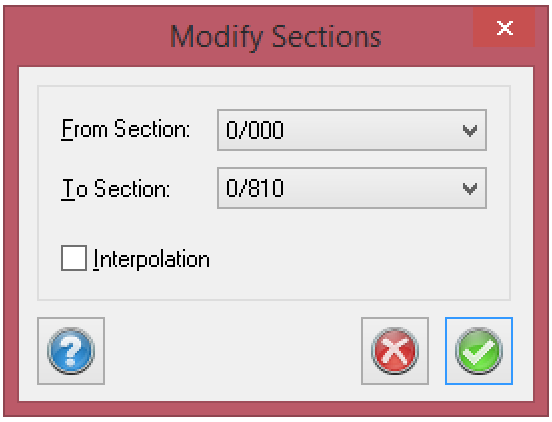


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

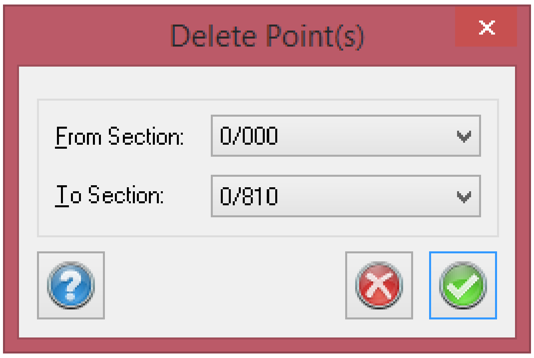
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

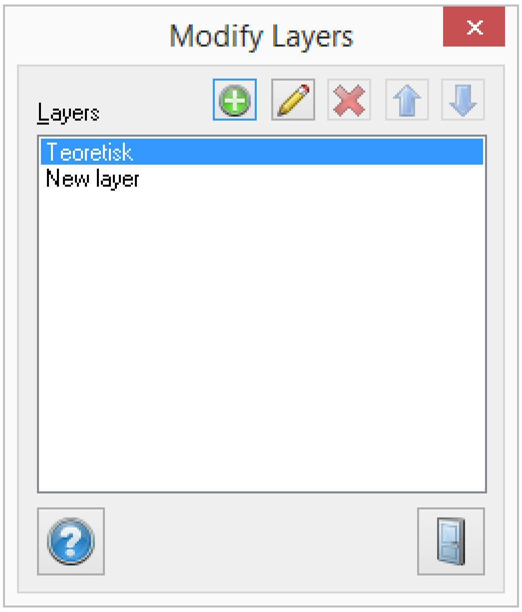
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

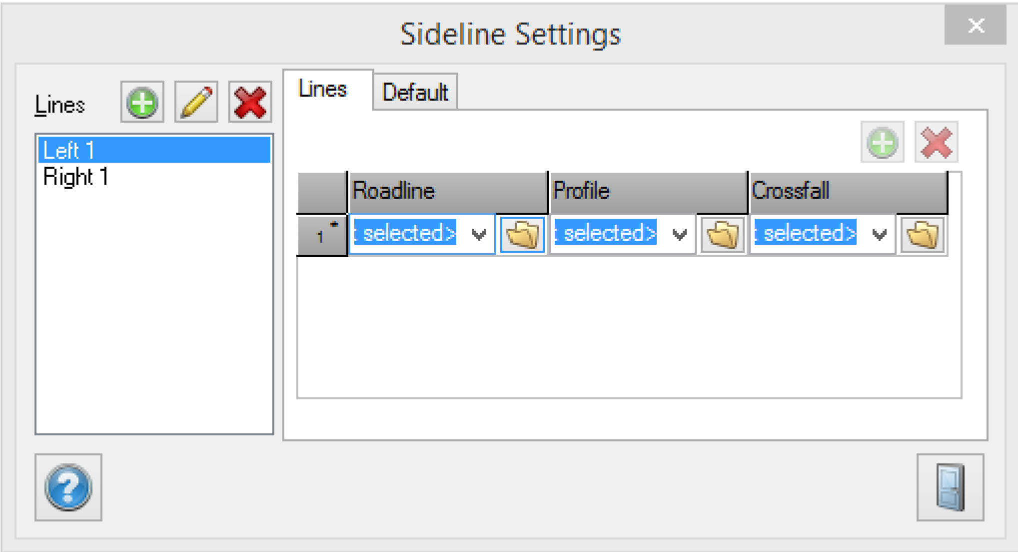


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

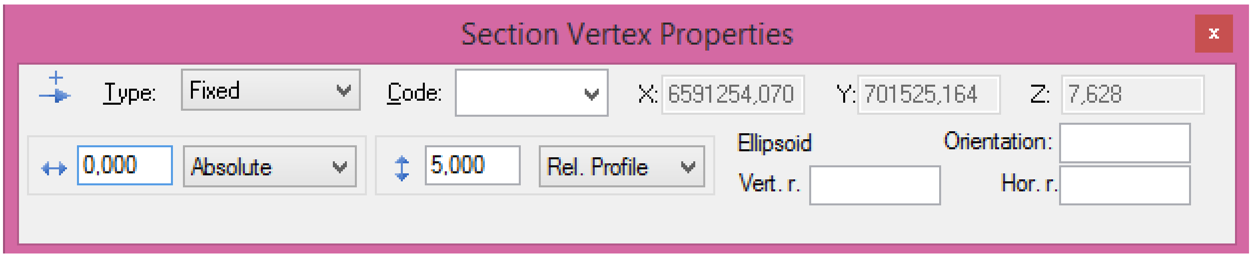
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



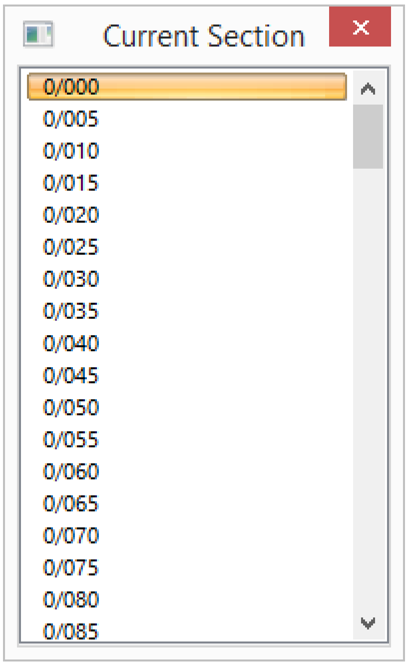
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

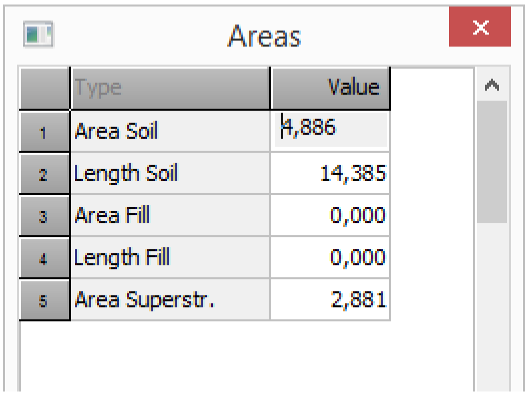
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

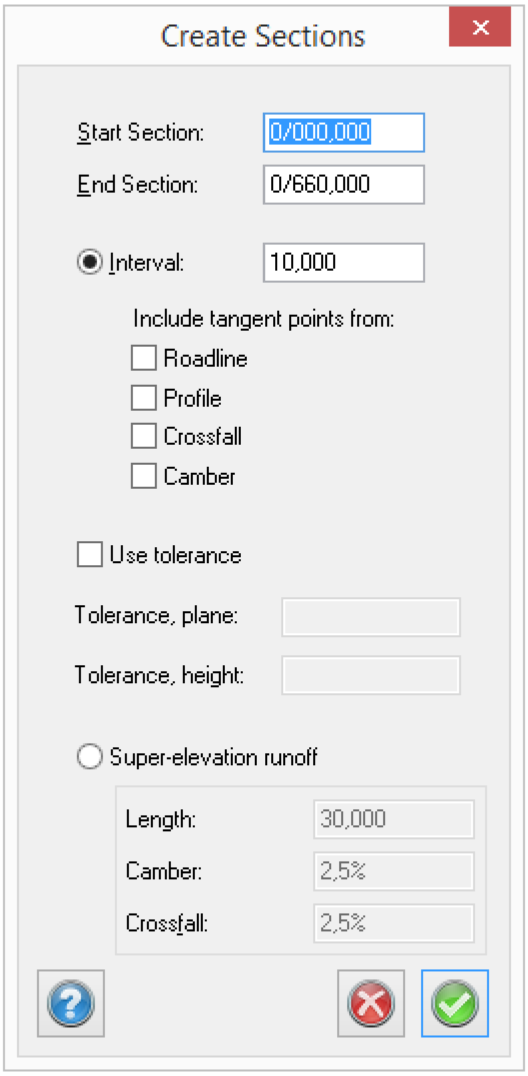
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

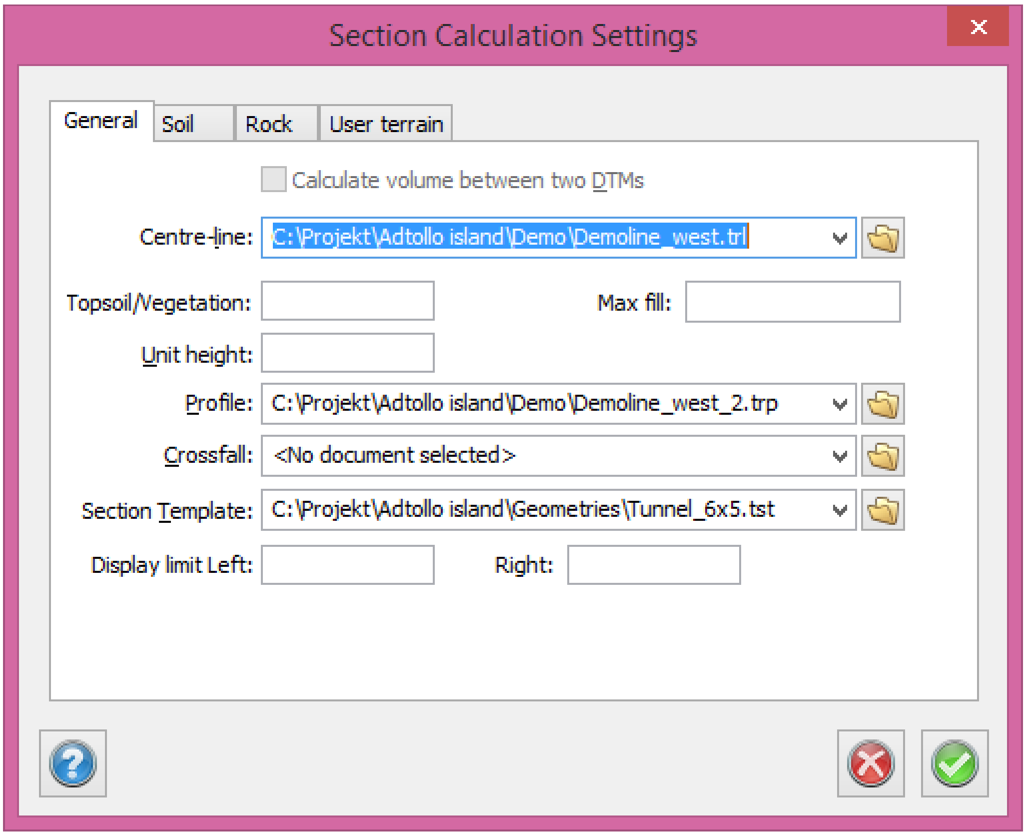
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

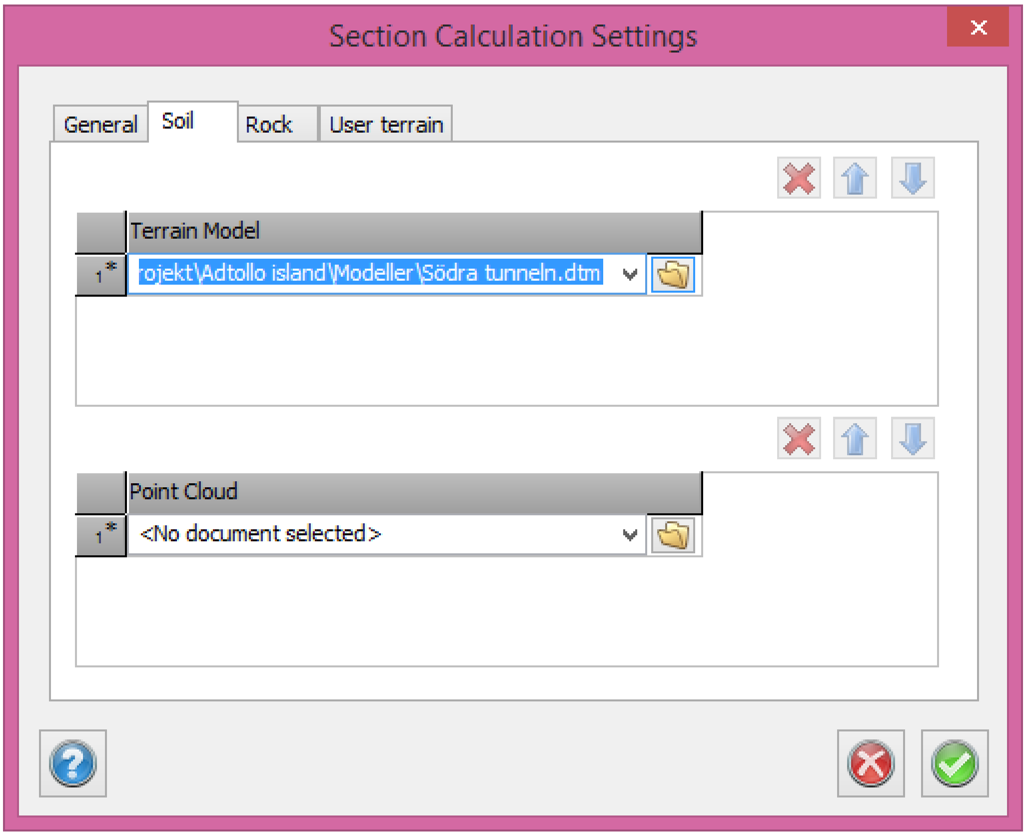
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

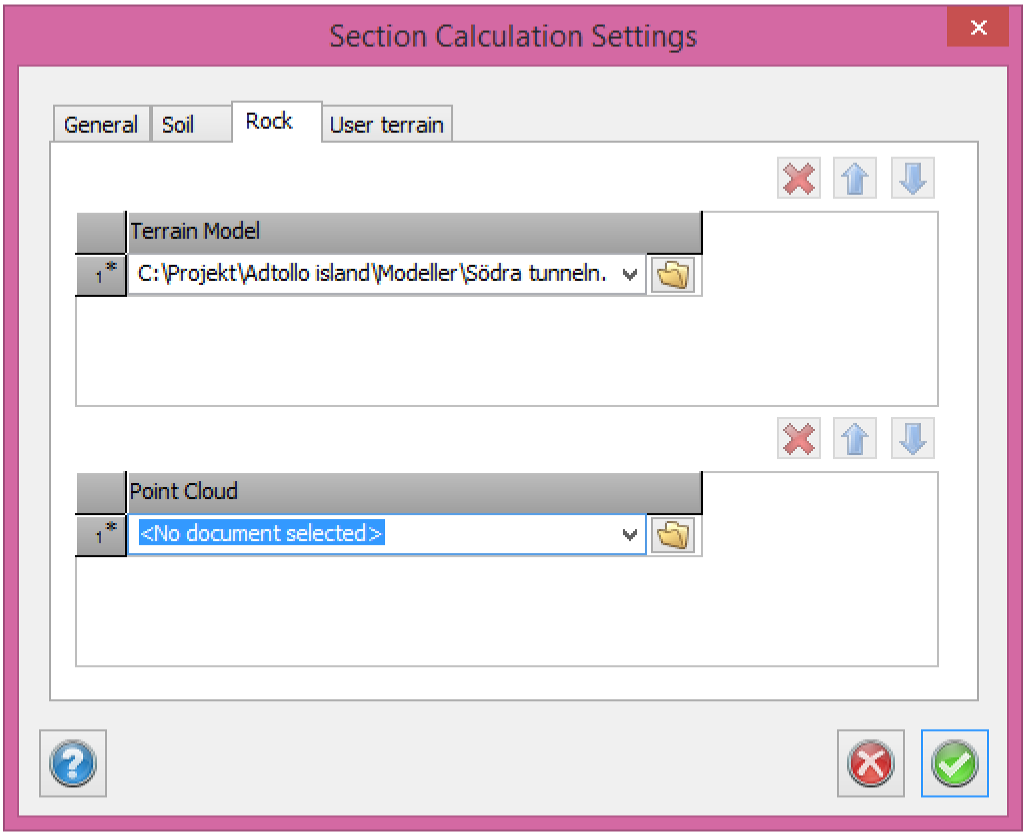
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

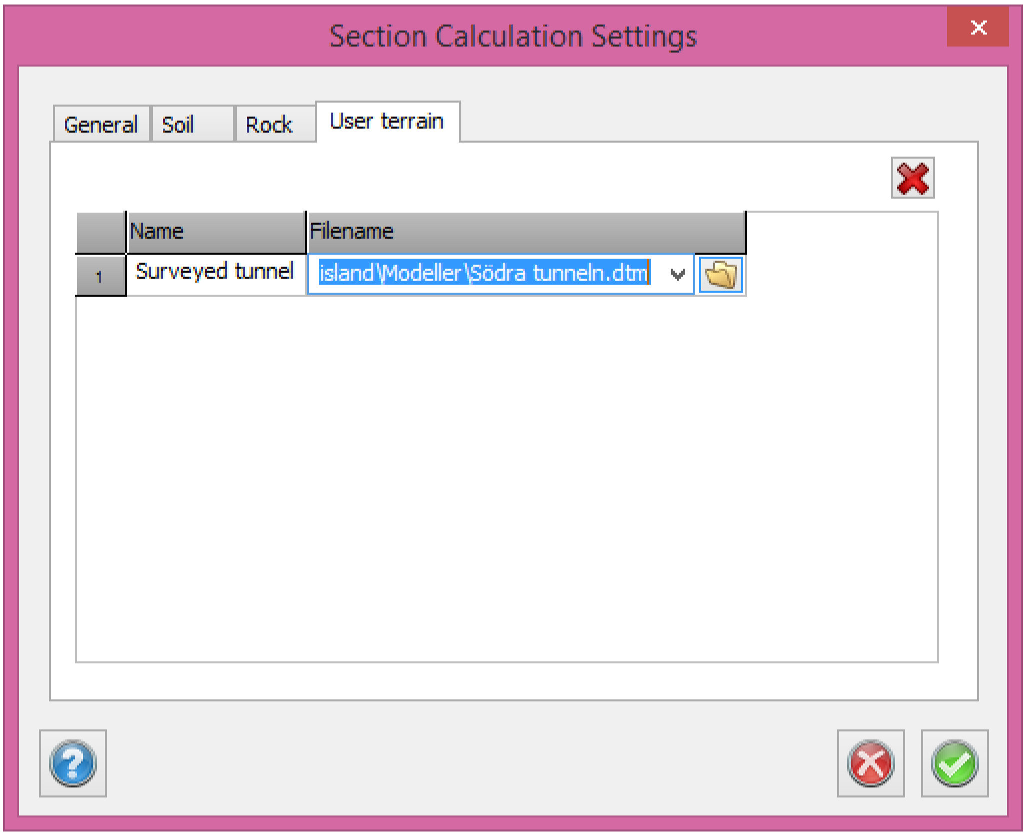
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

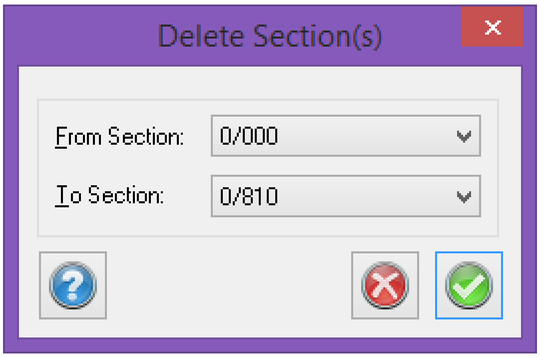
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

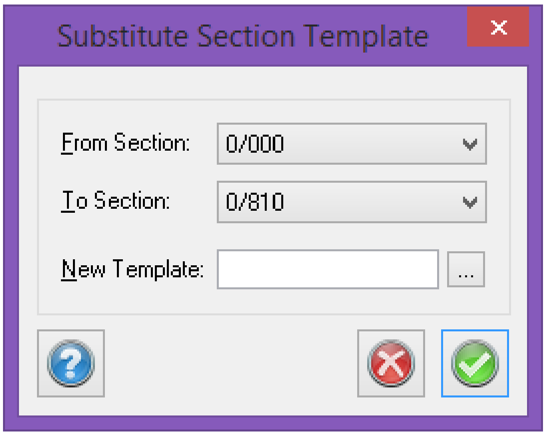
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

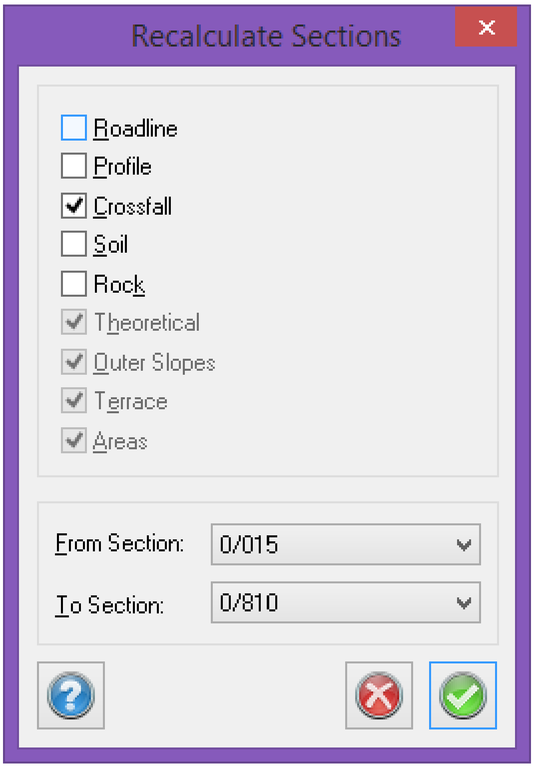


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

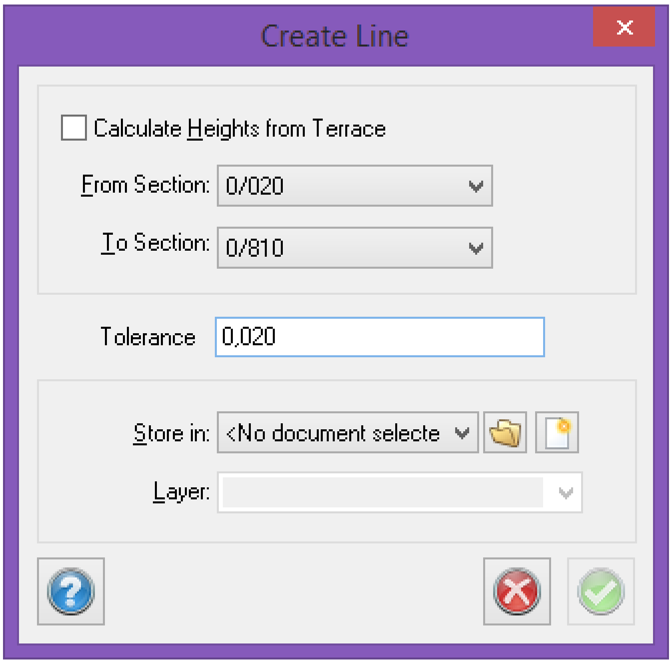
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

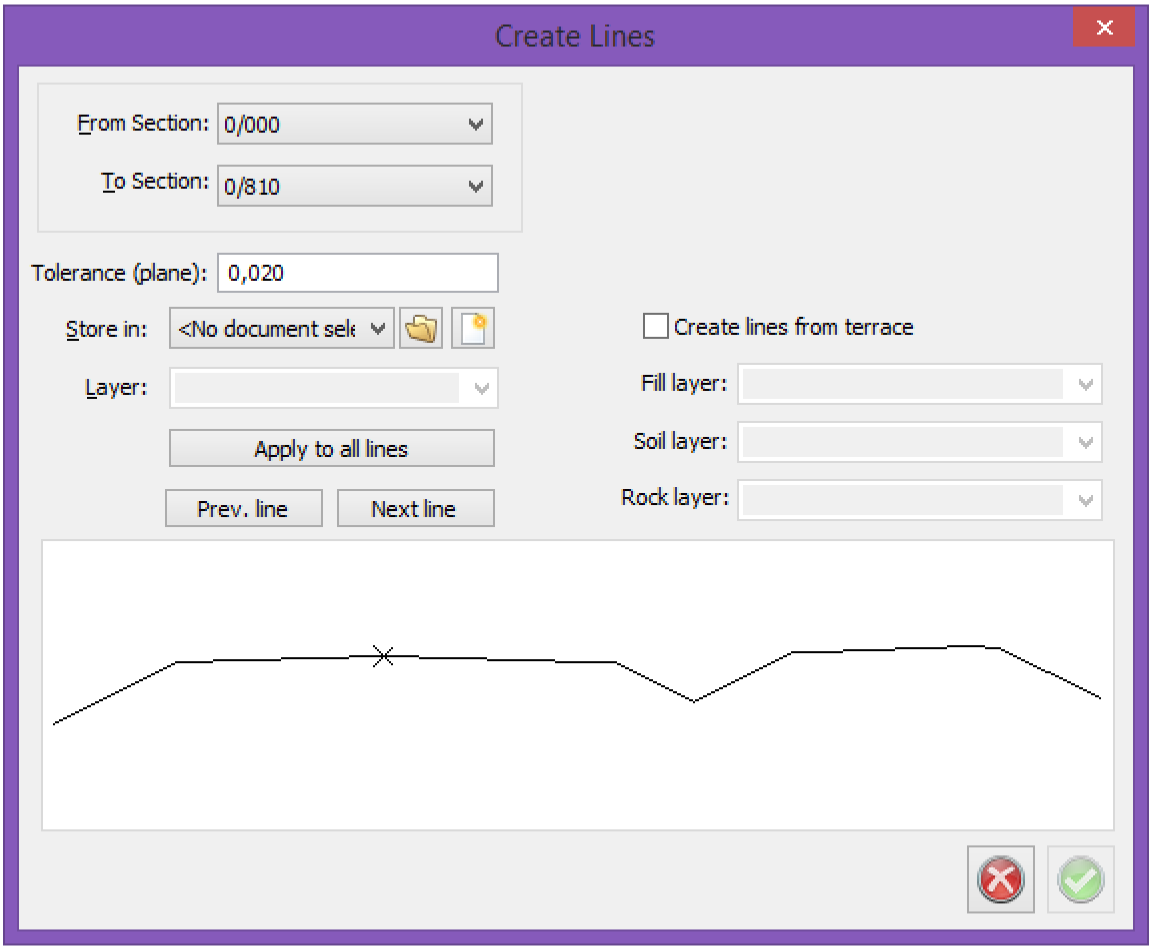
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

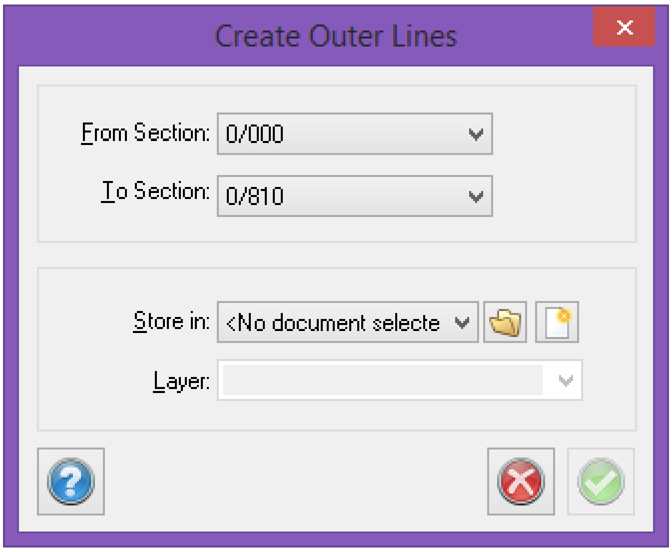
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

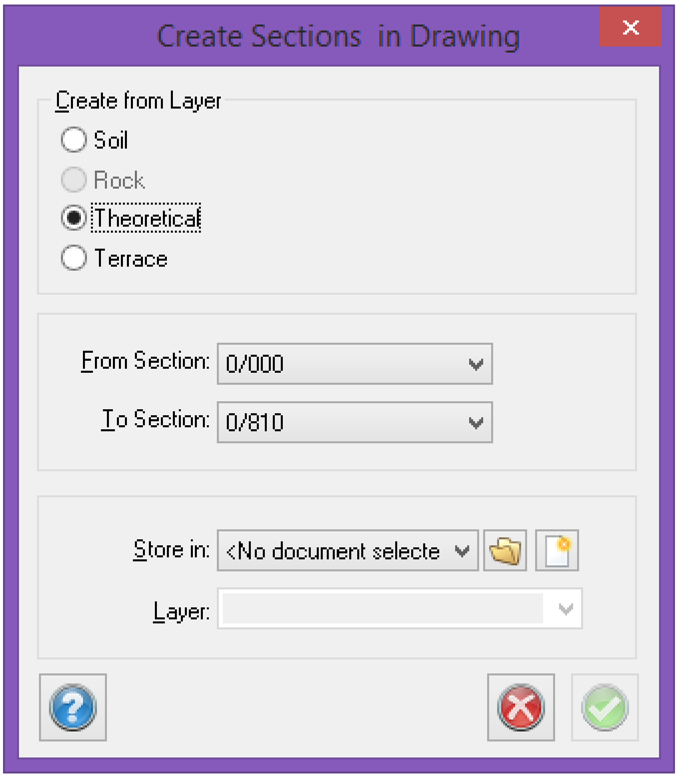
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

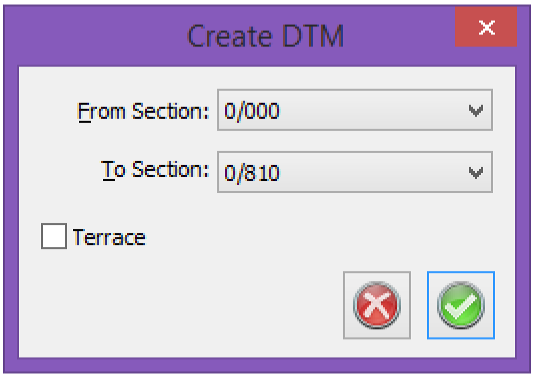


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

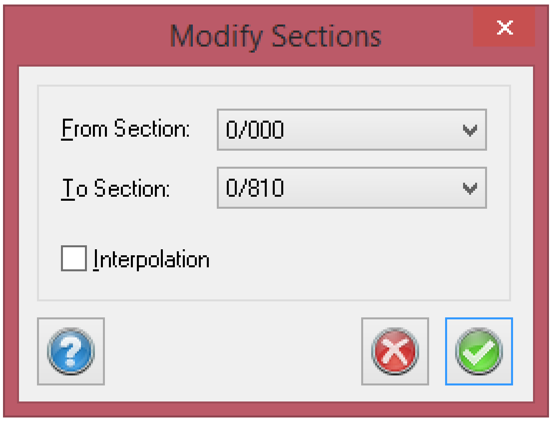


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

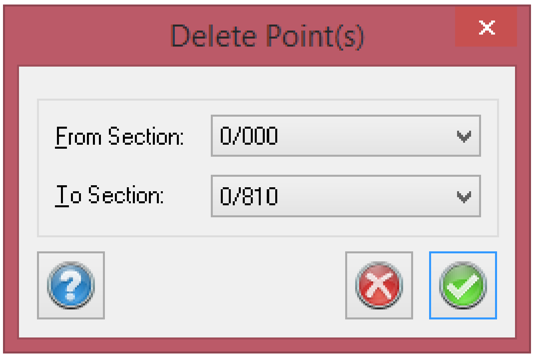
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

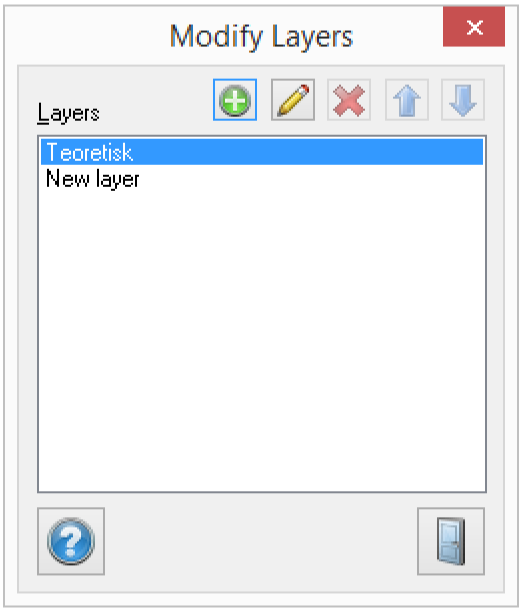
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

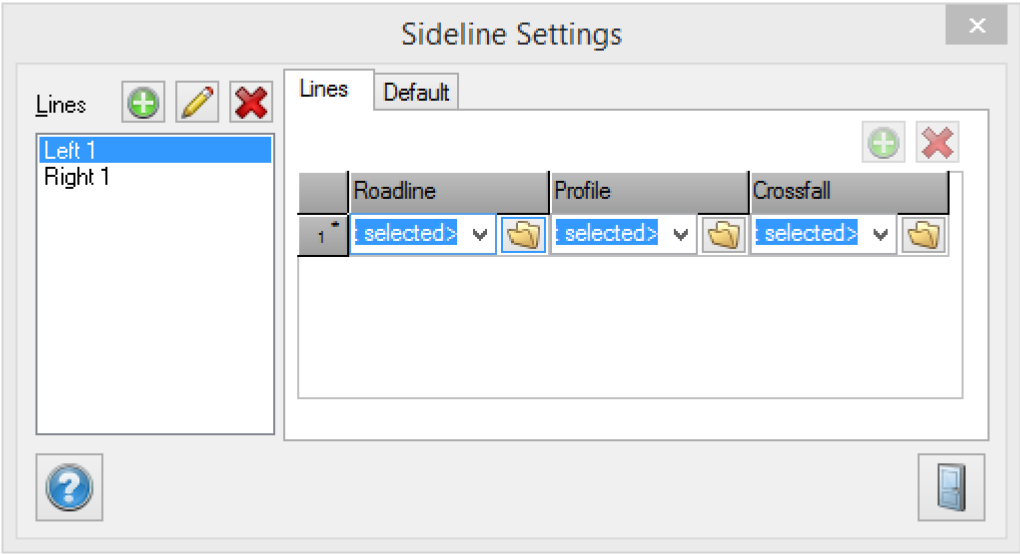


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

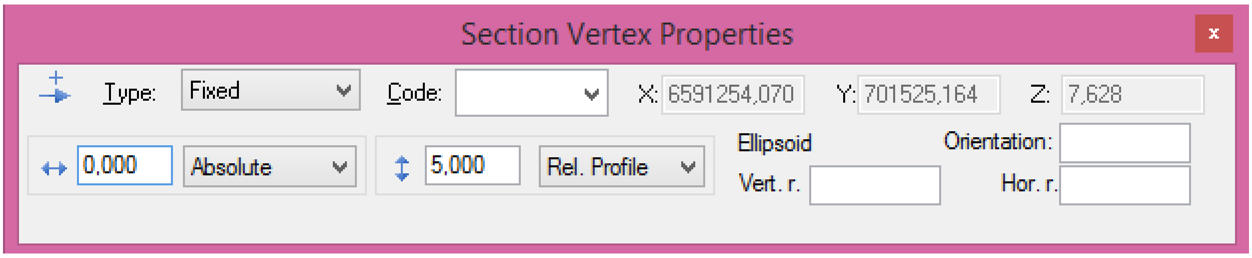
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



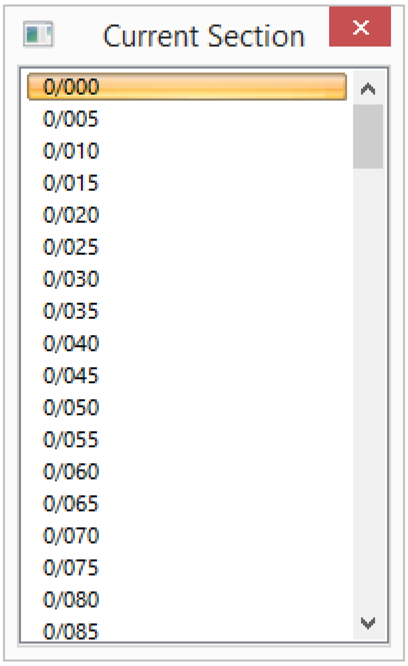
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

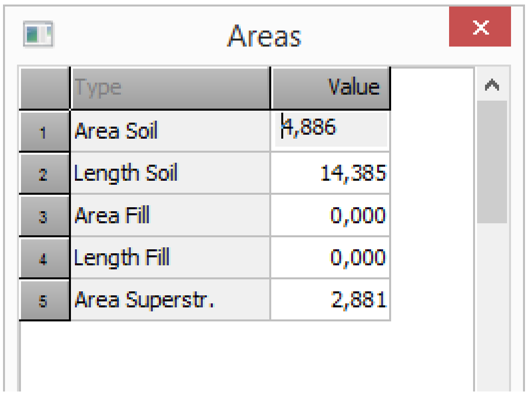
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

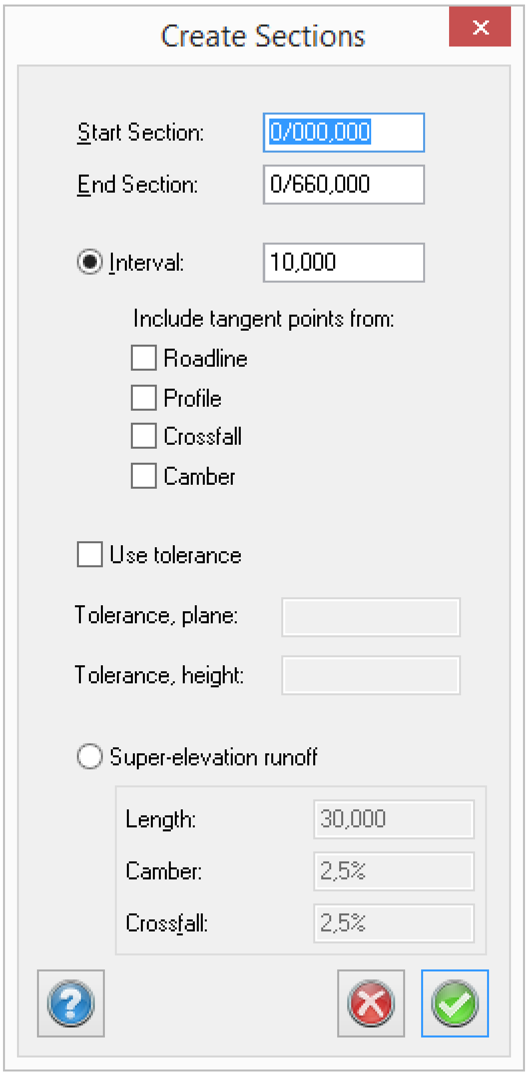
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

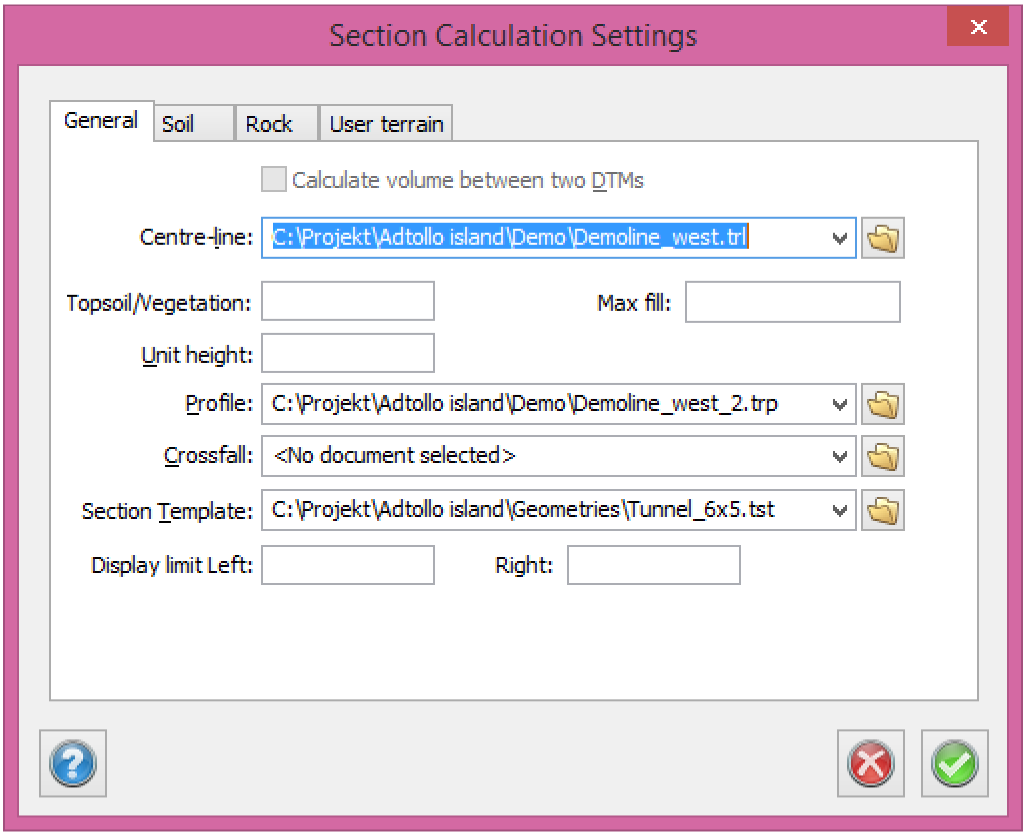
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

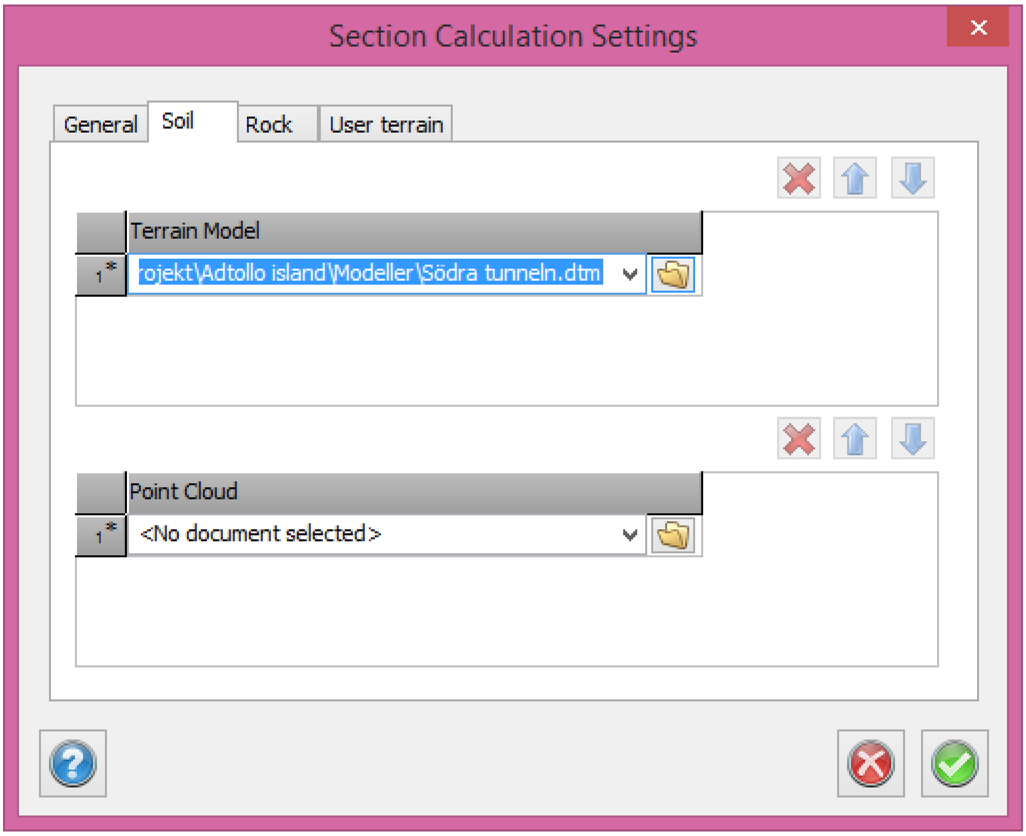
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

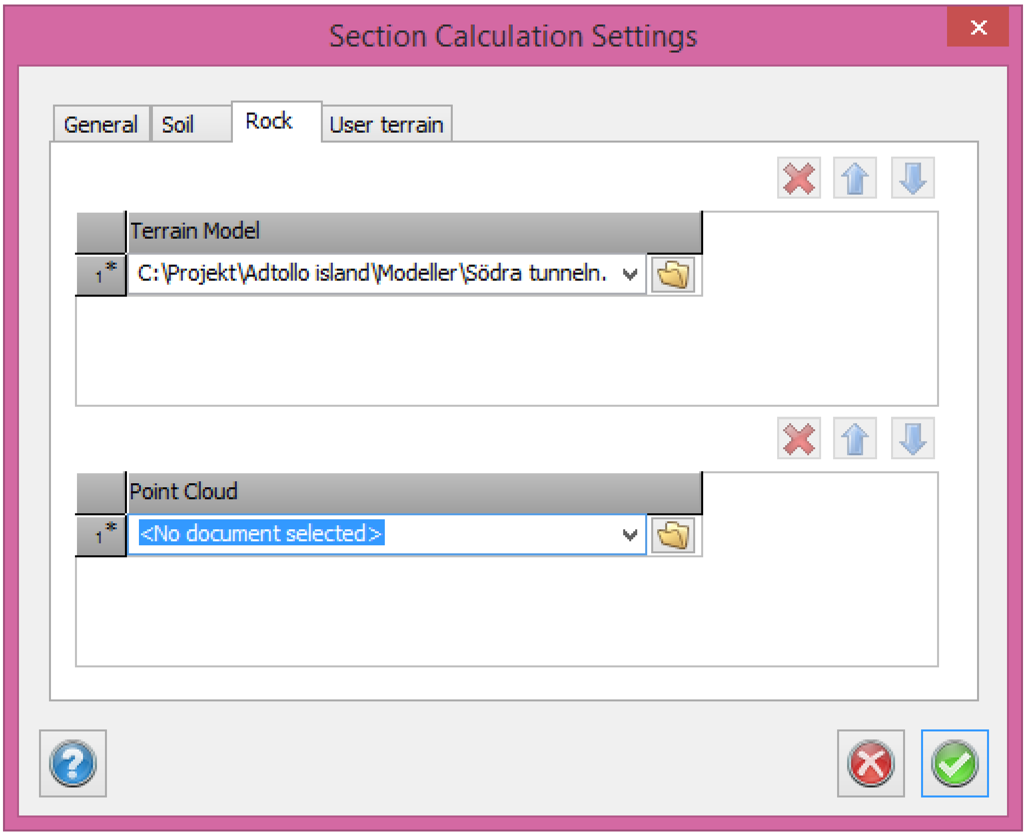
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

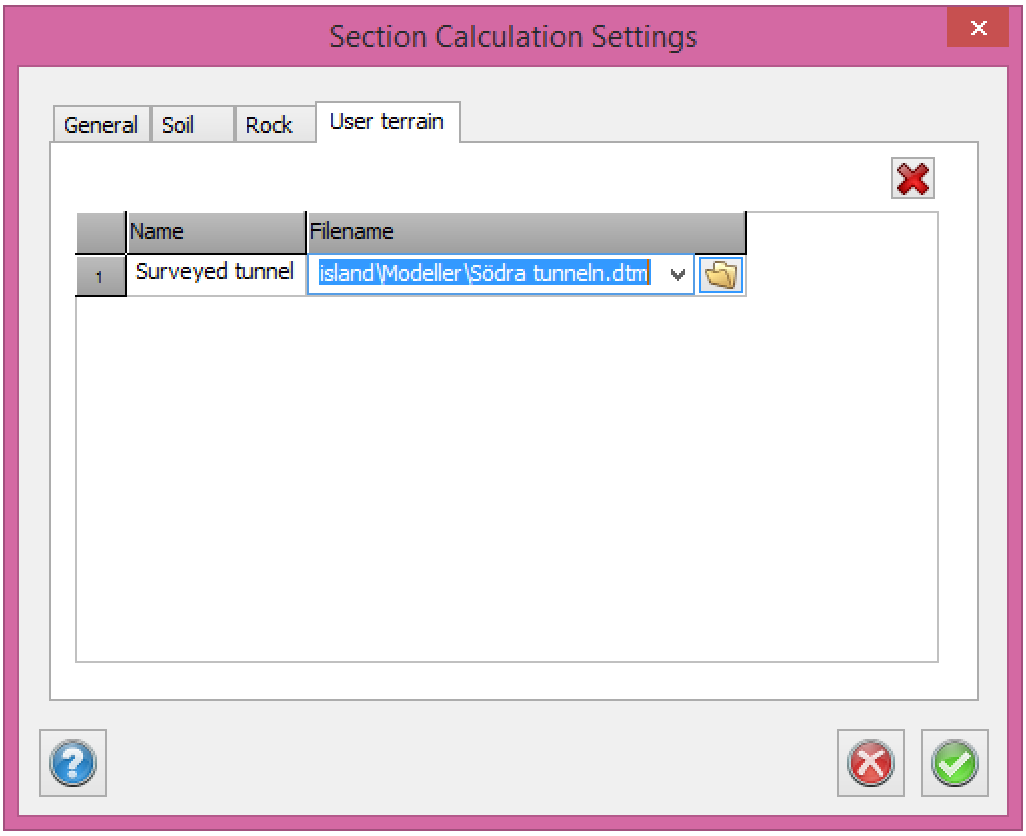
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

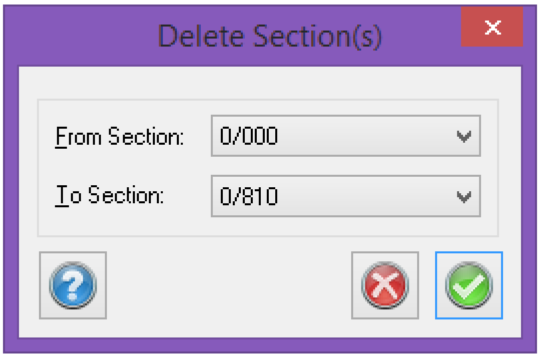
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

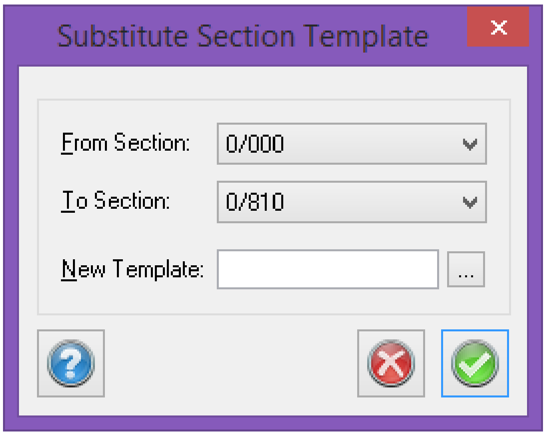
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

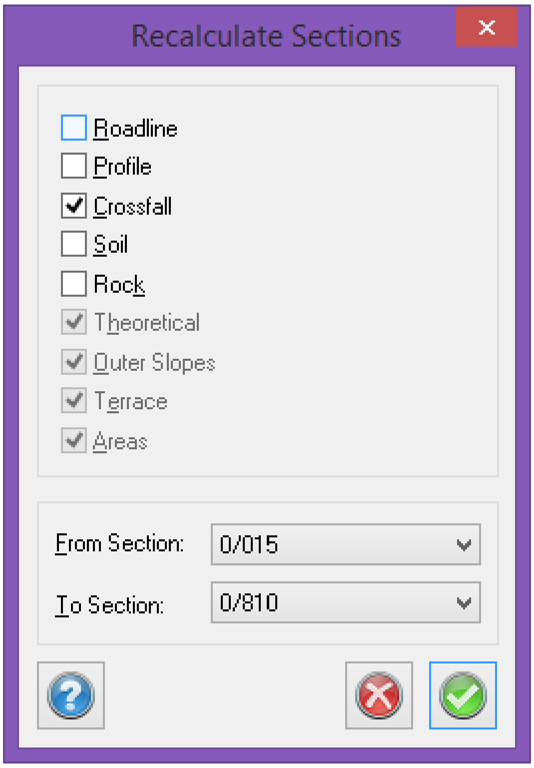


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

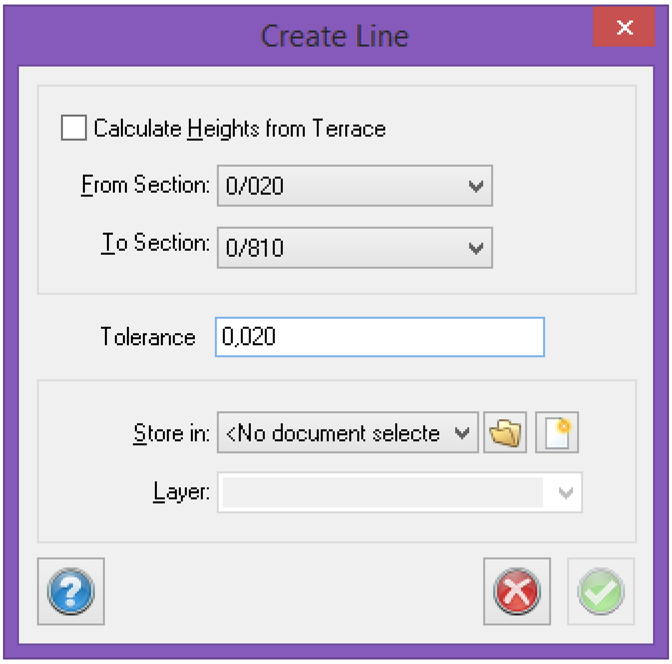
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

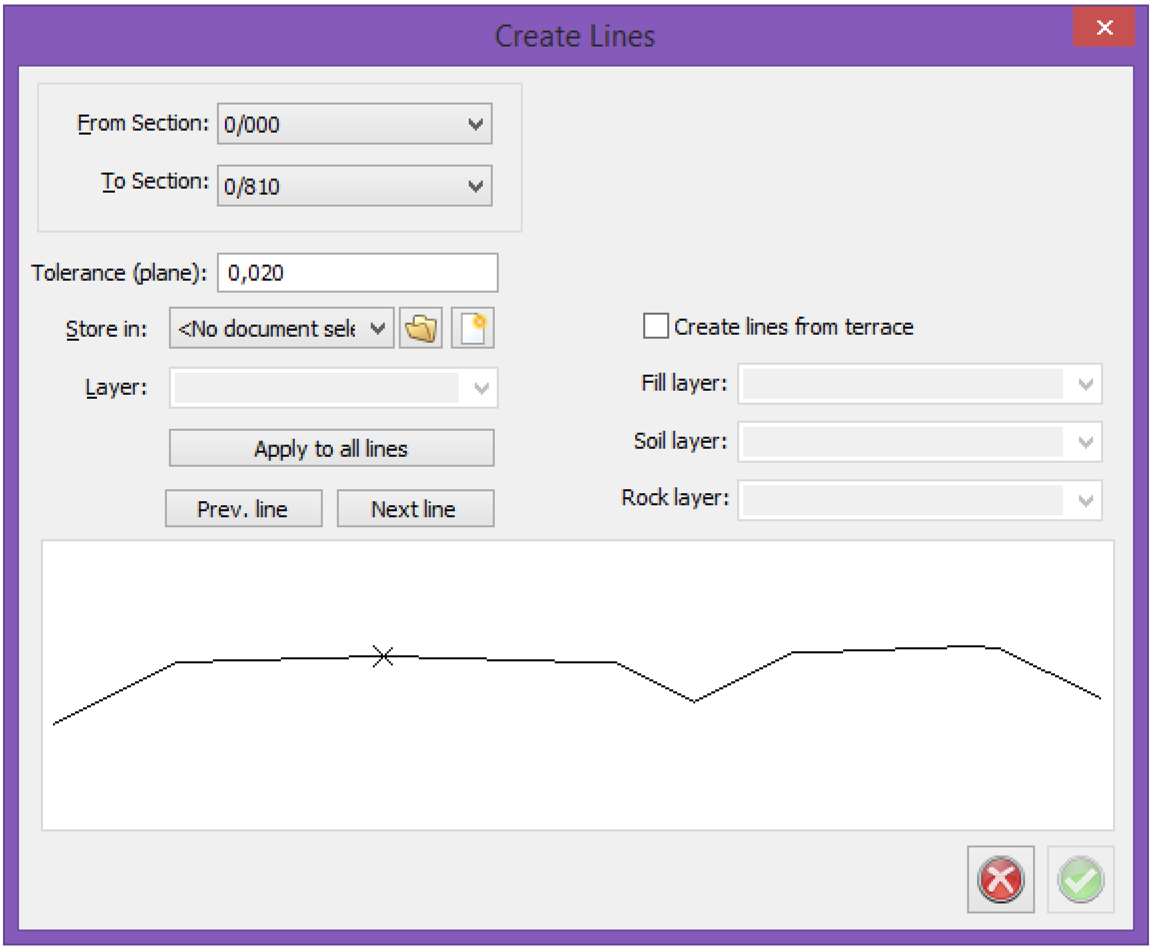
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

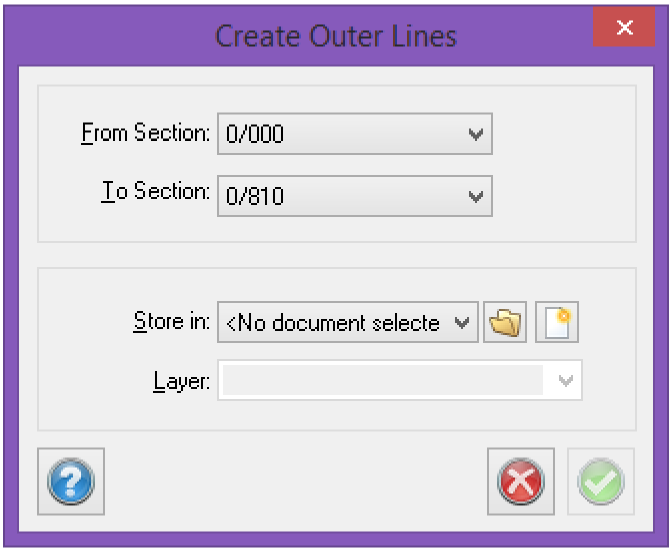
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

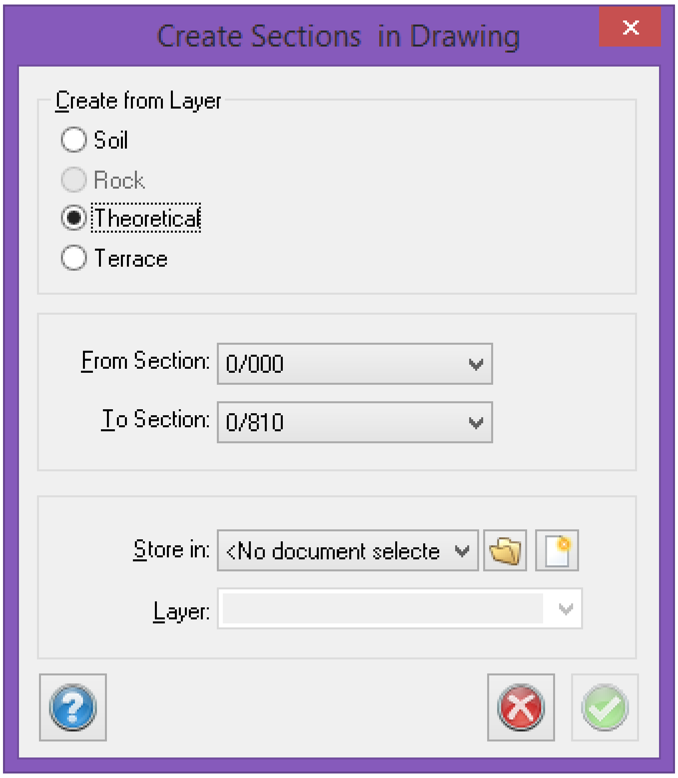
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

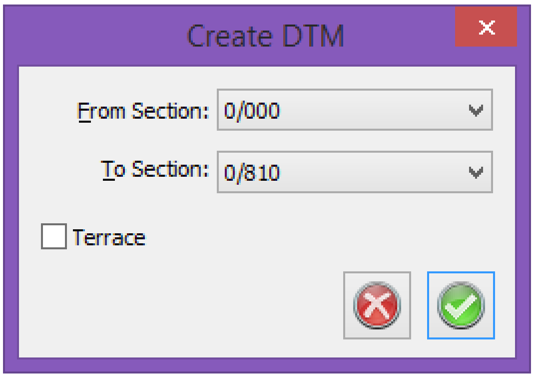


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

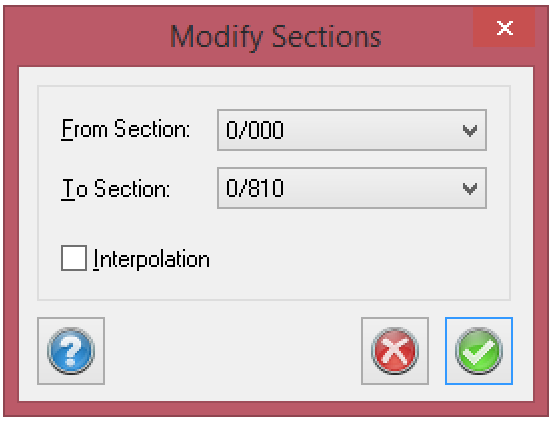


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

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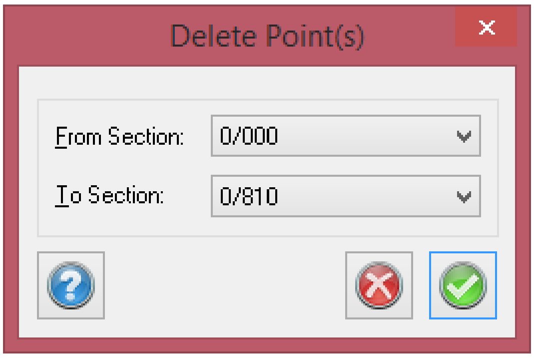
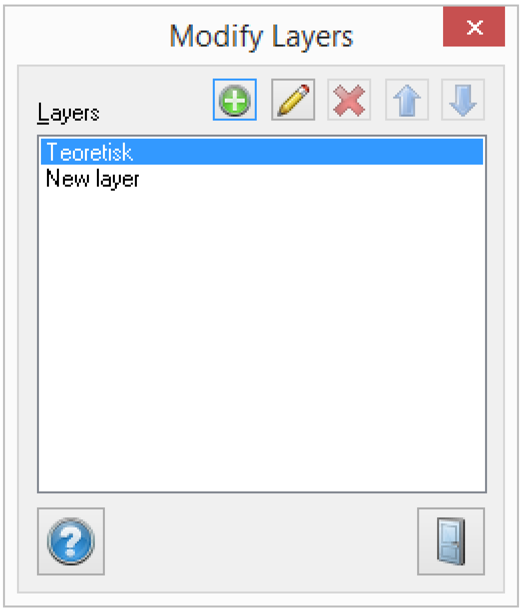


Modify layers

Calculated section|Modify|Layers

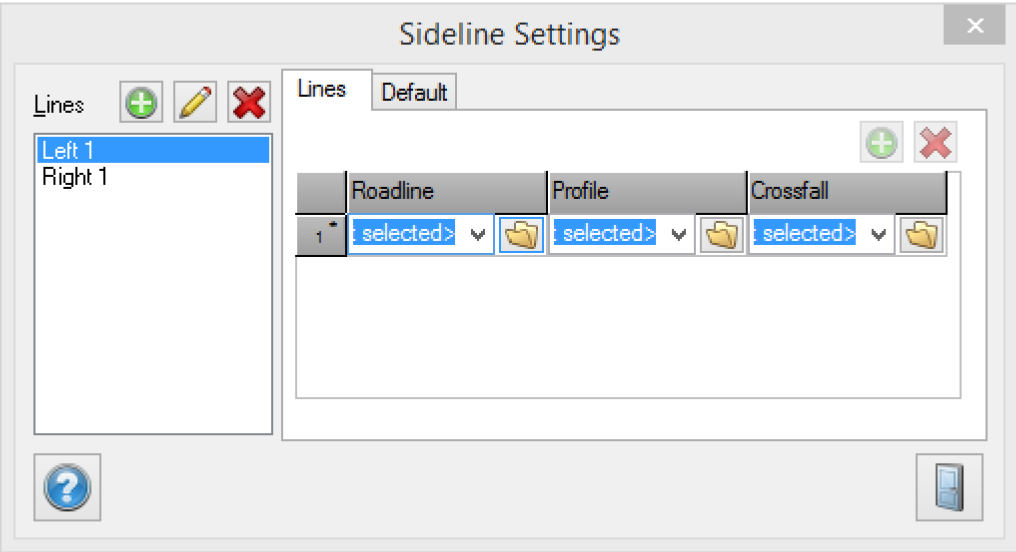


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

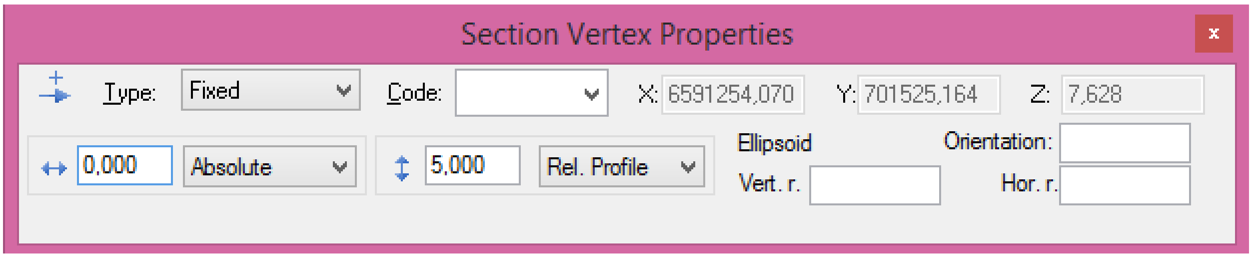
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



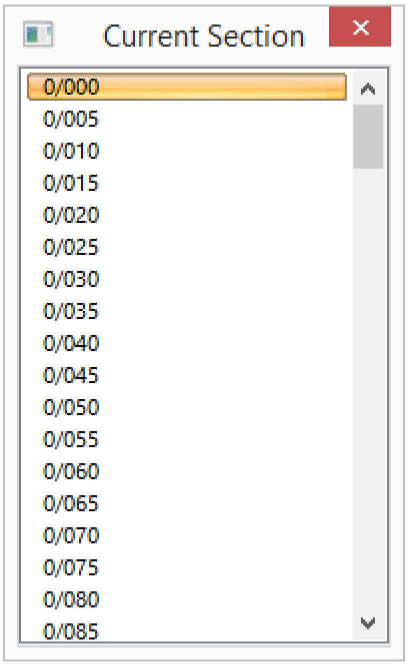
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

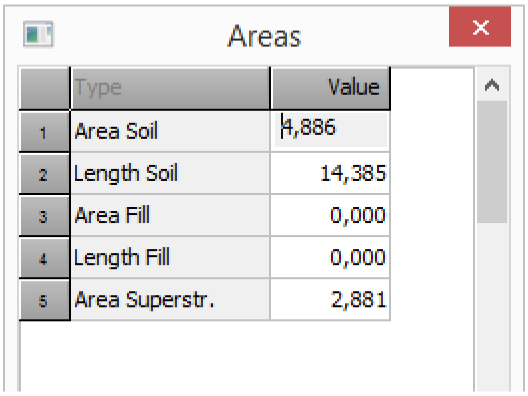
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

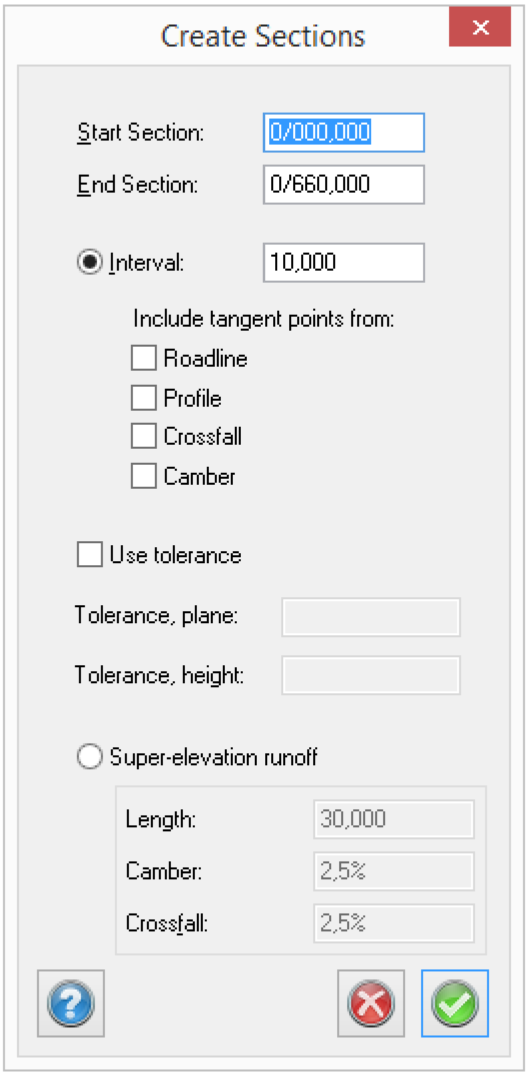
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

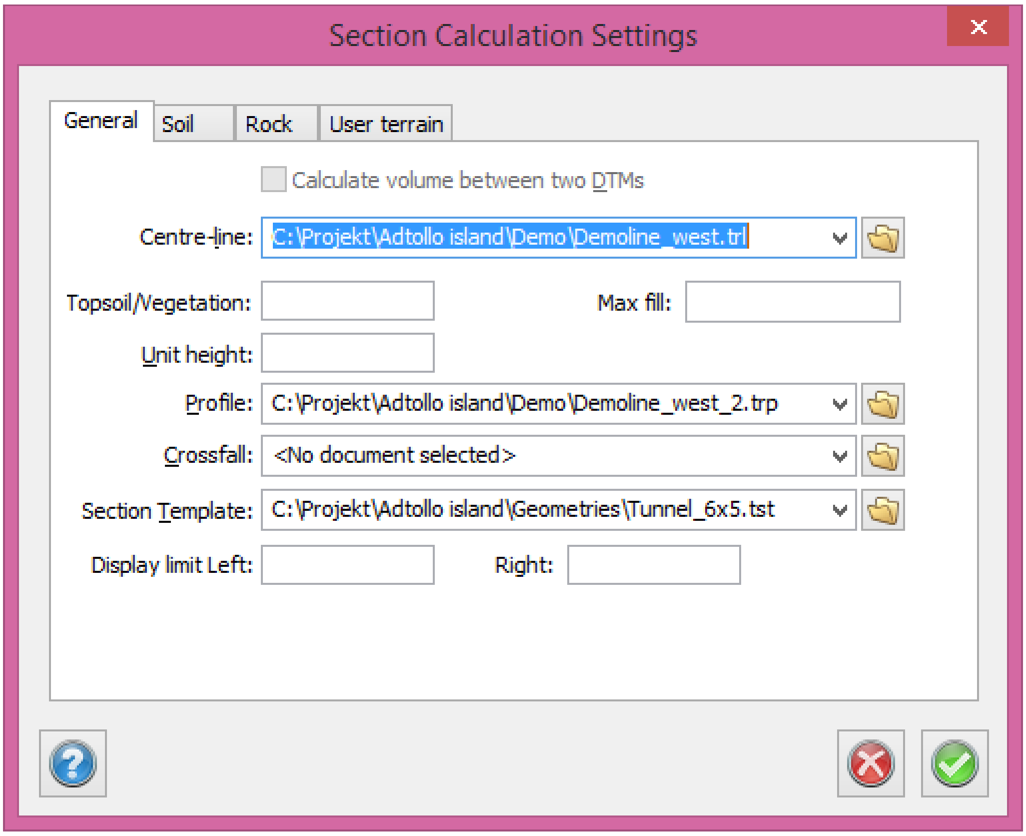
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

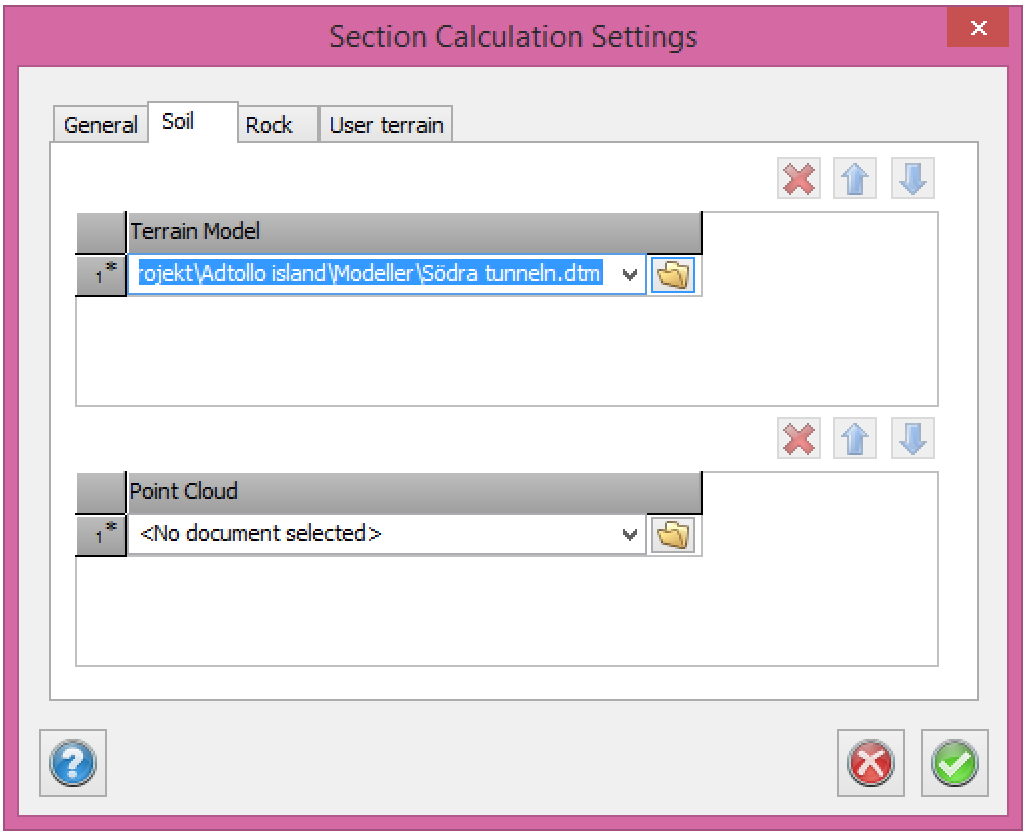
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

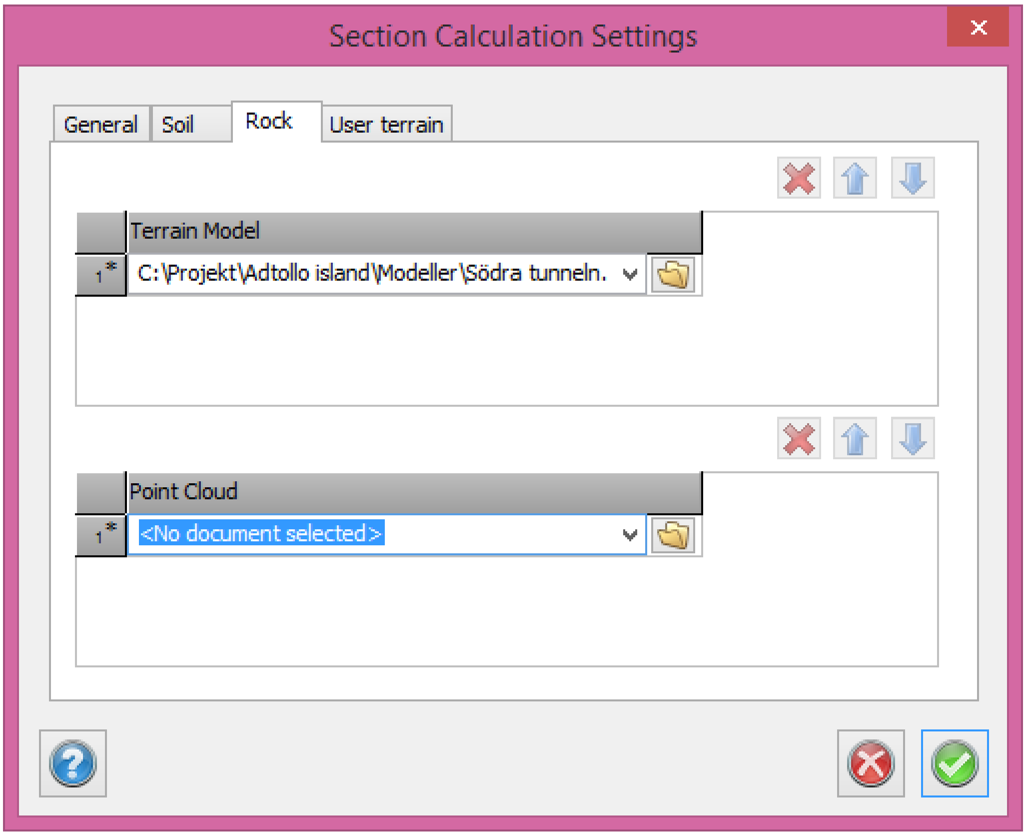
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

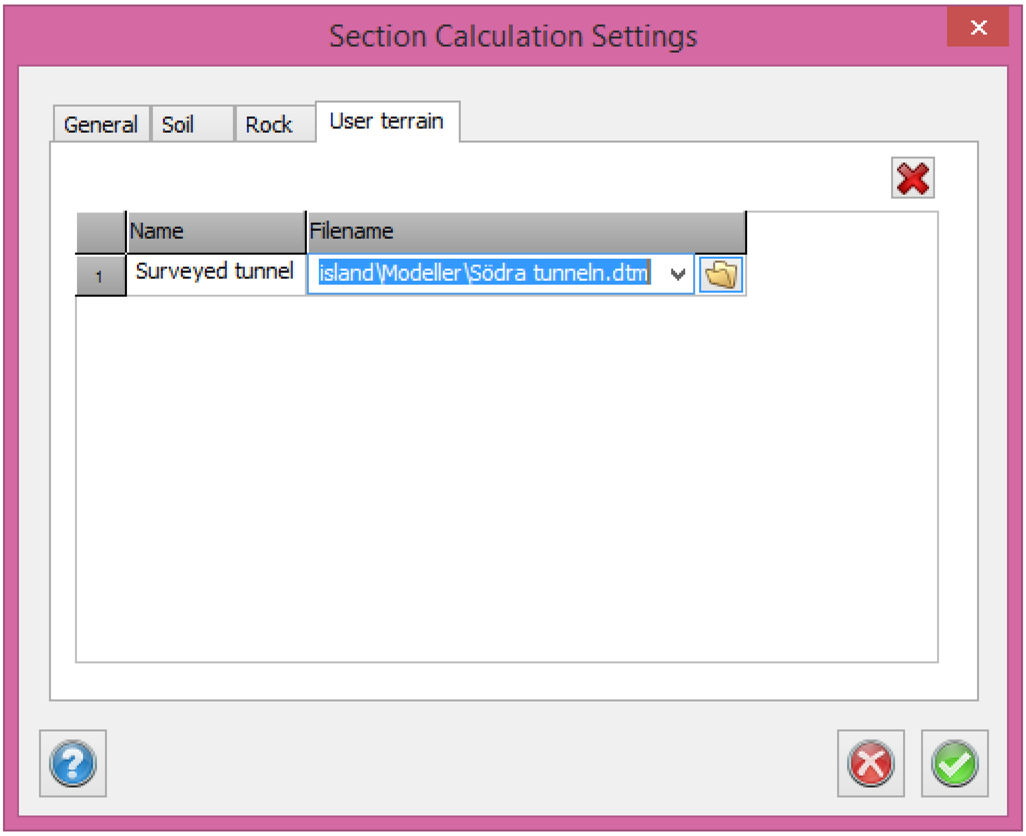
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

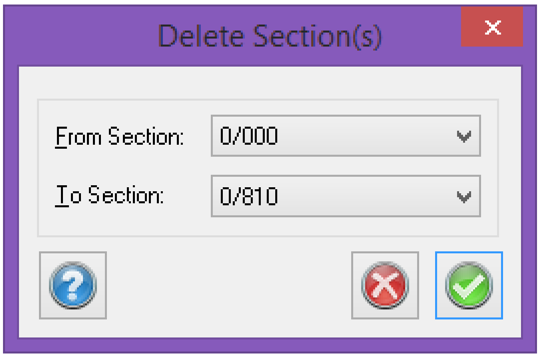
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

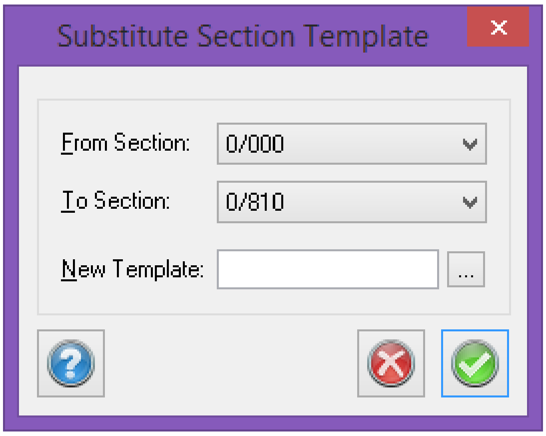
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

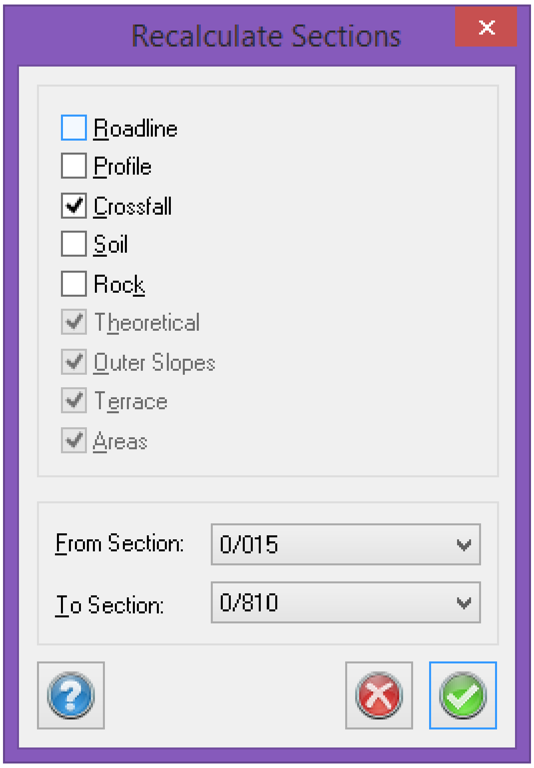


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

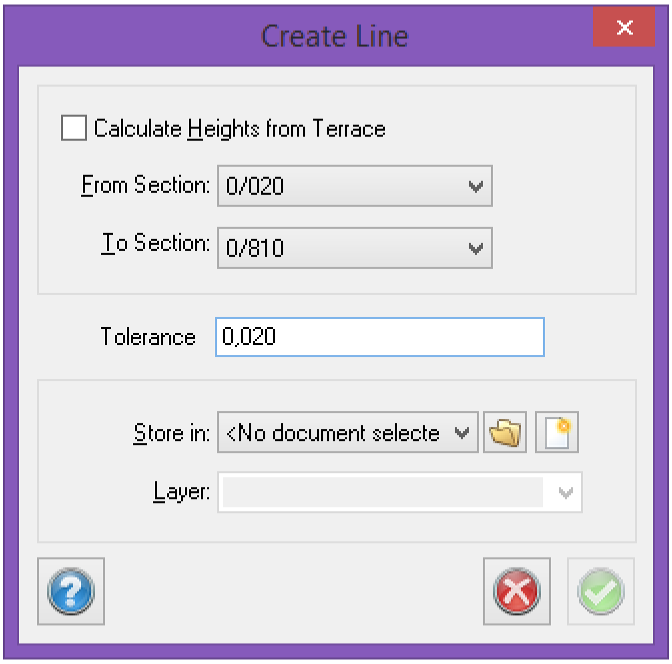
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

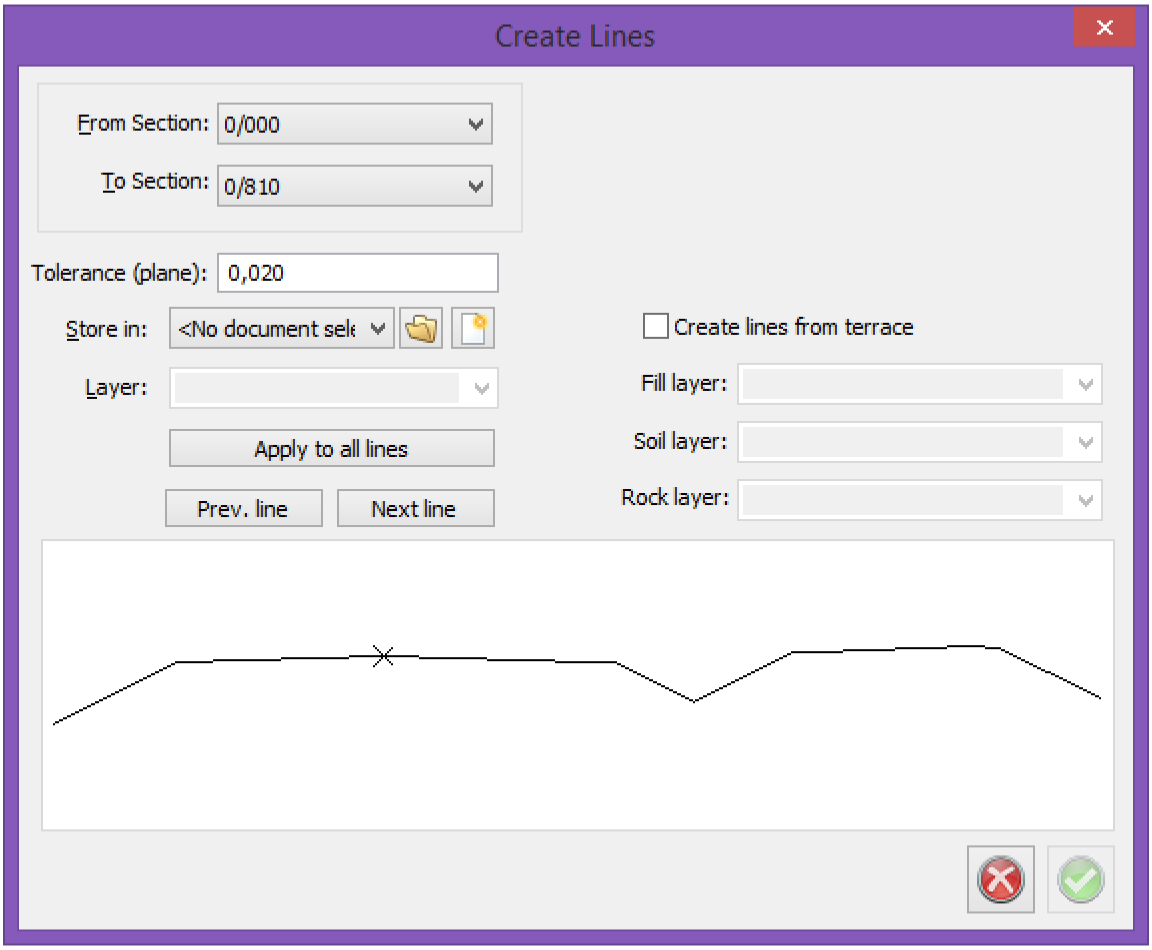
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

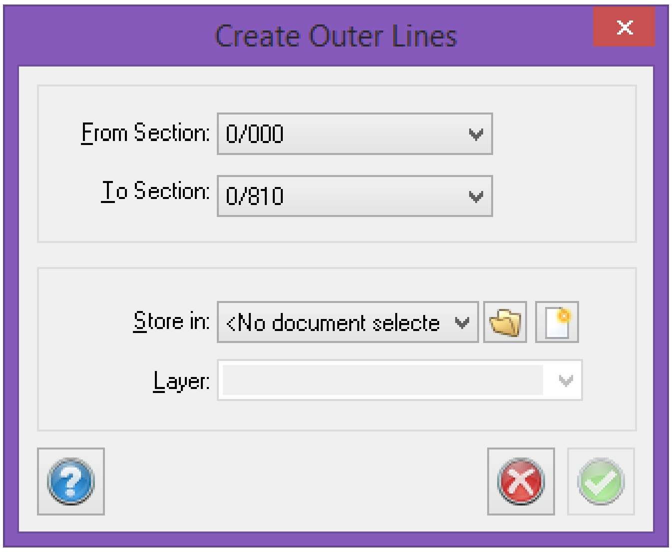
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

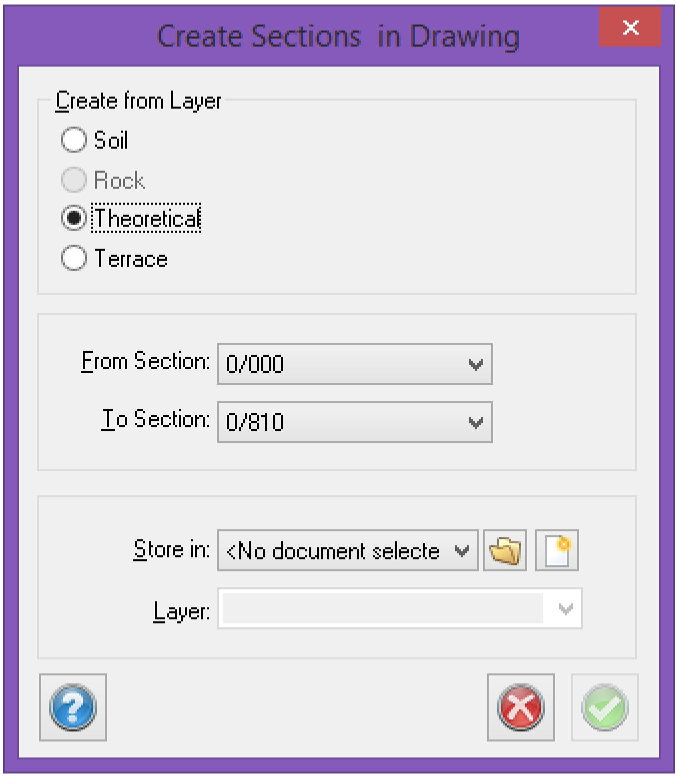
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

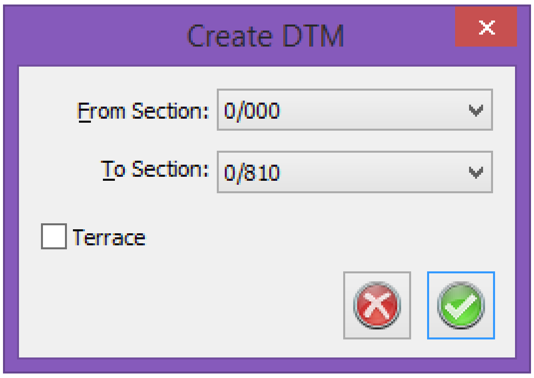


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

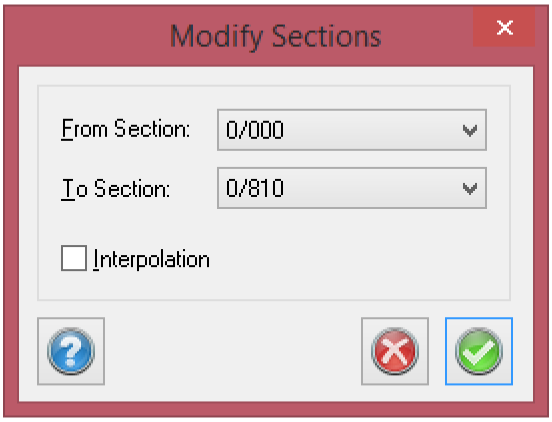


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

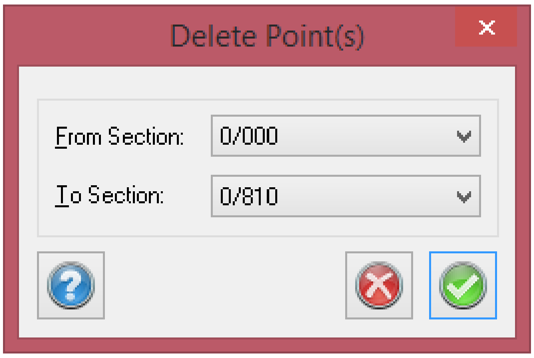
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

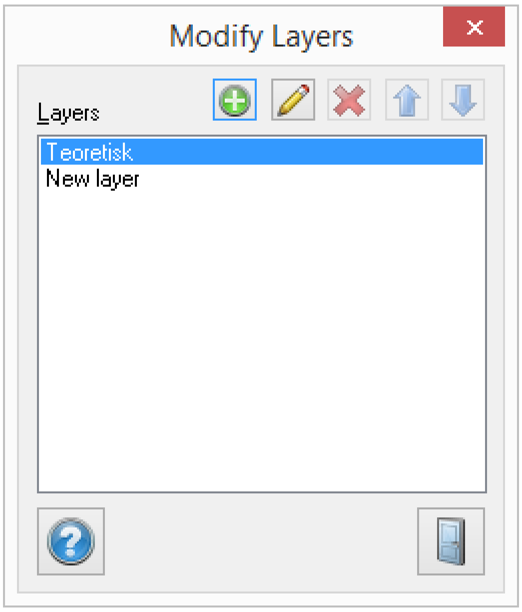
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

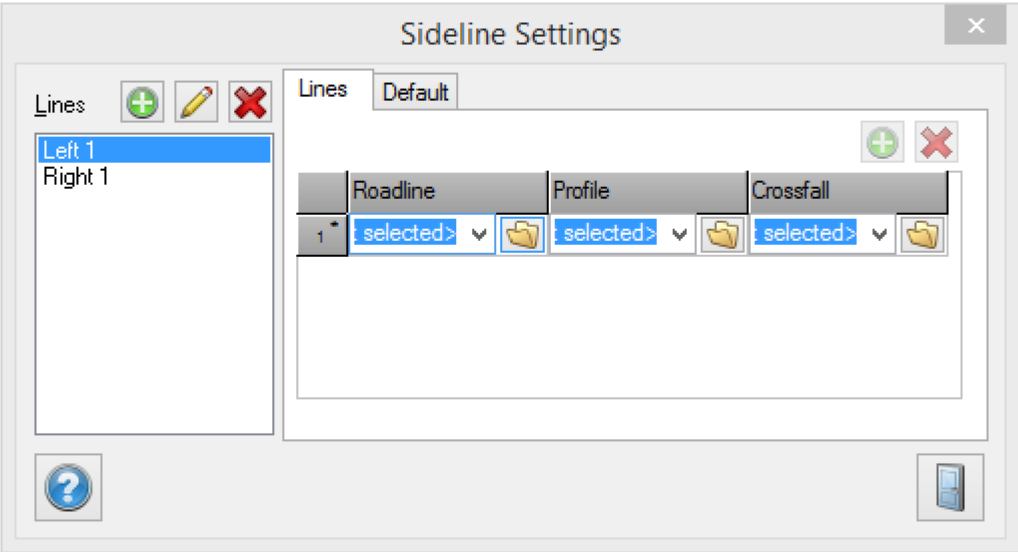


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

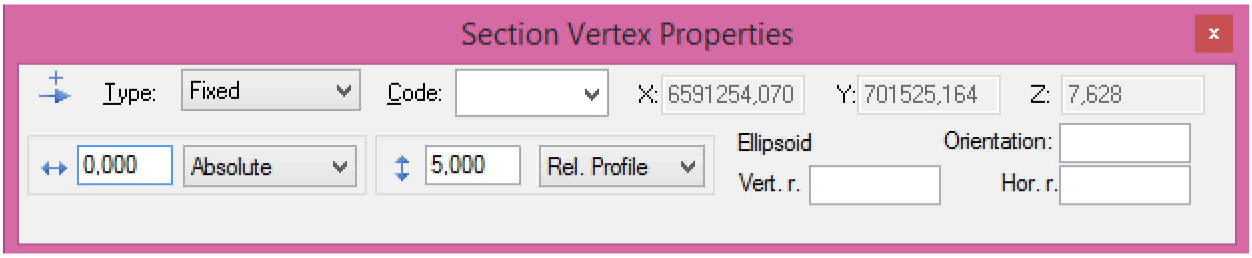
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



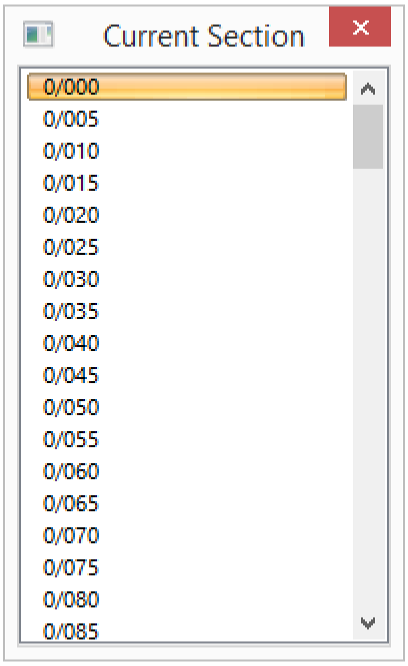
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

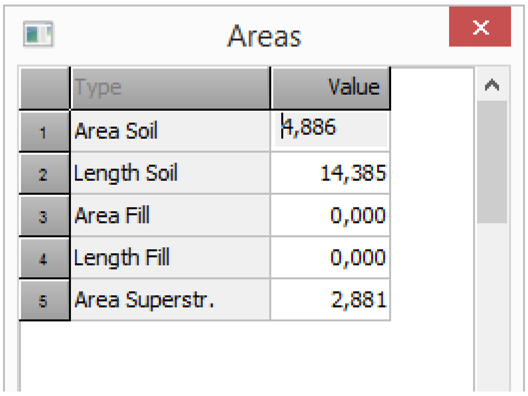
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

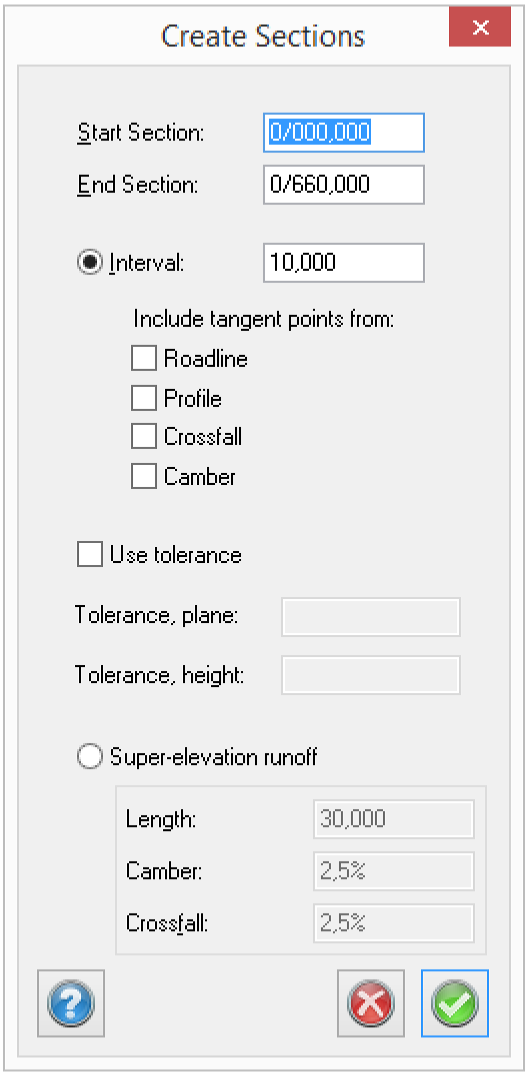
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

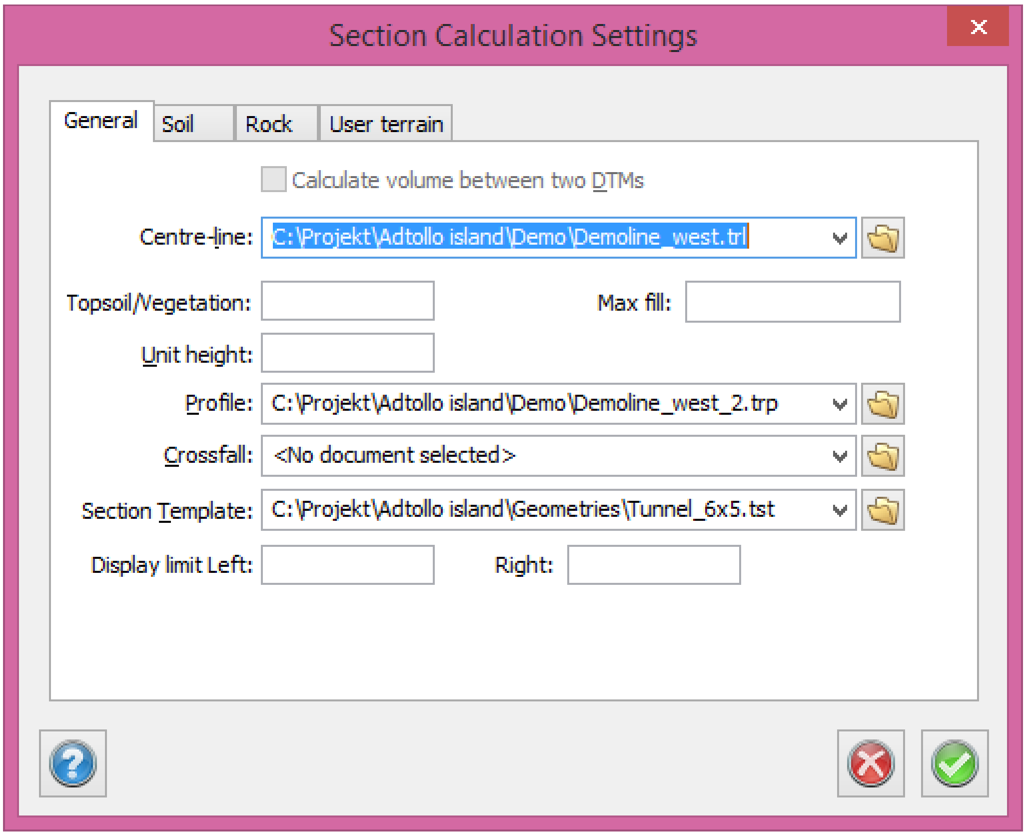
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

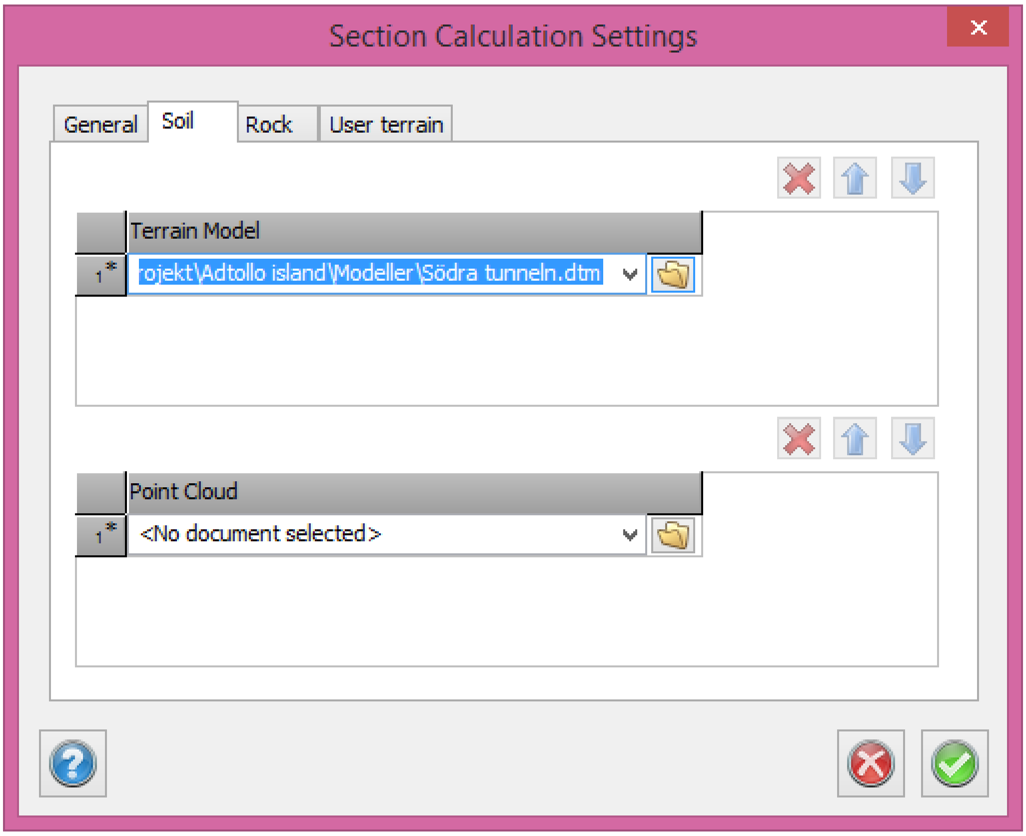
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

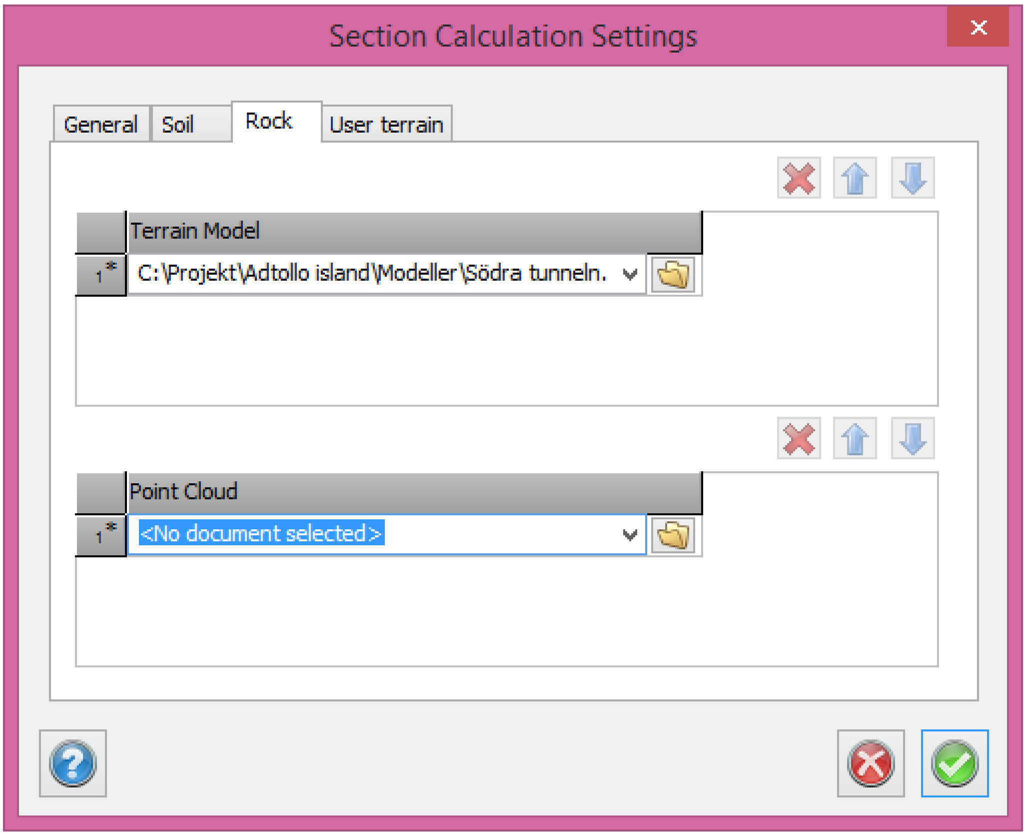
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

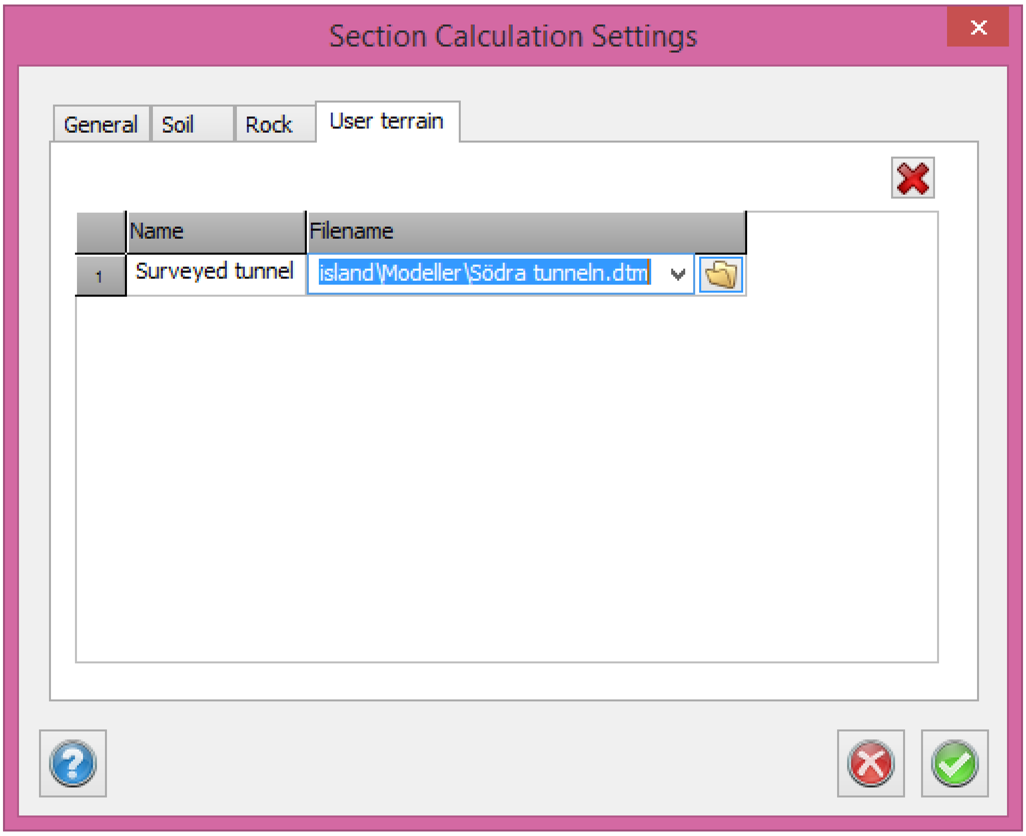
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

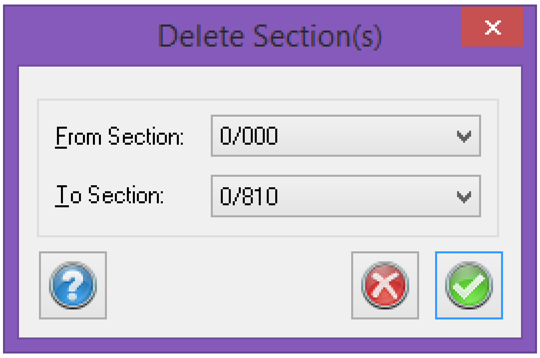
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

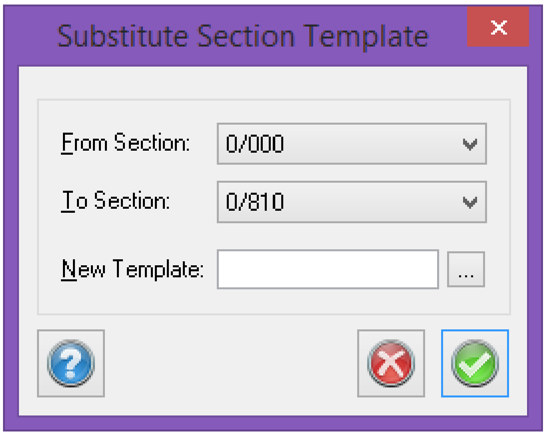
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

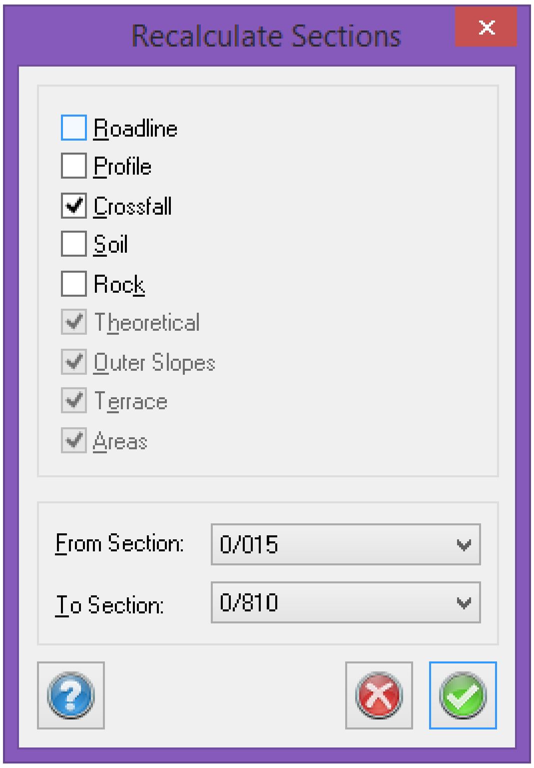


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

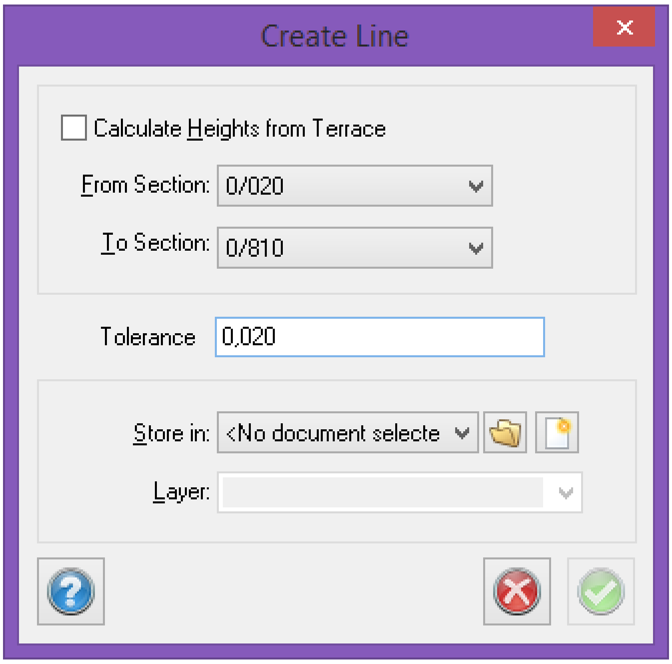
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

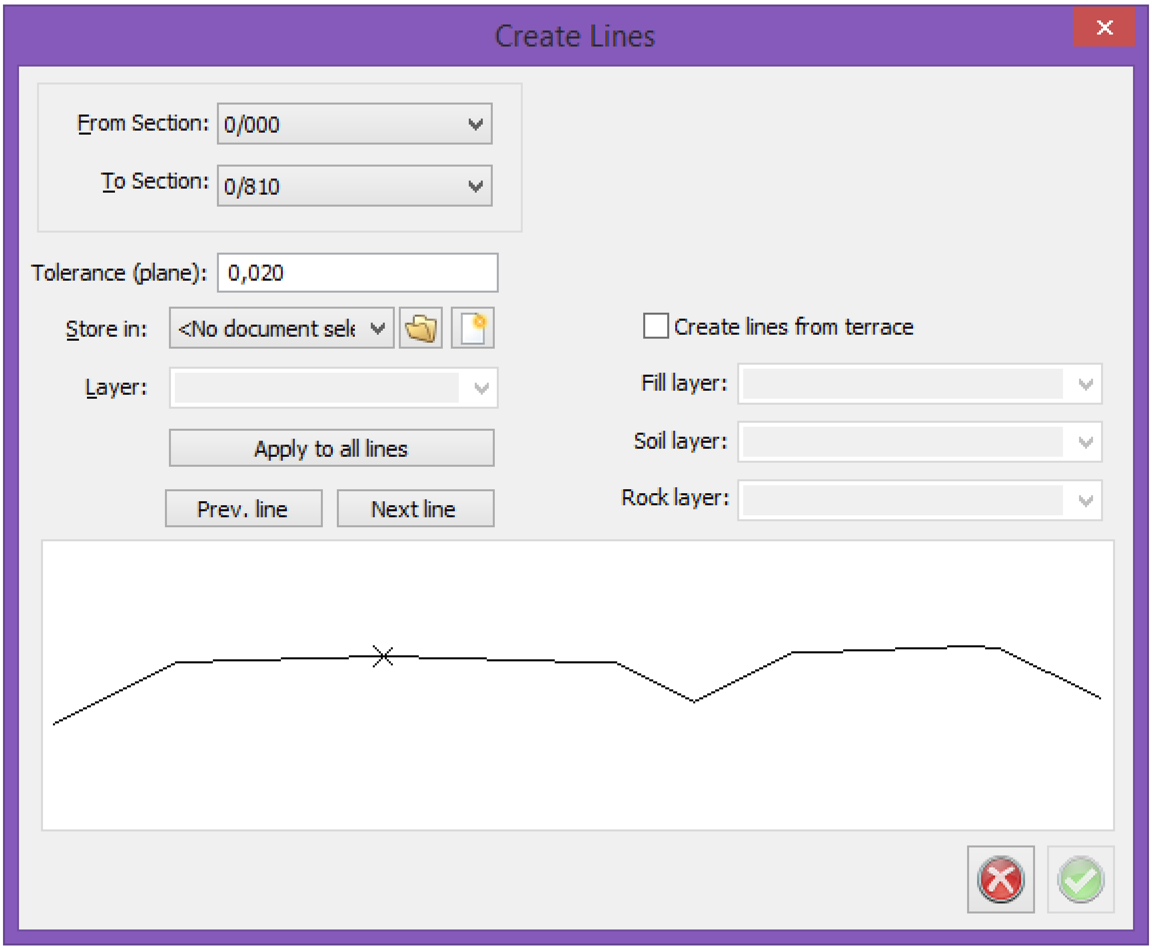
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

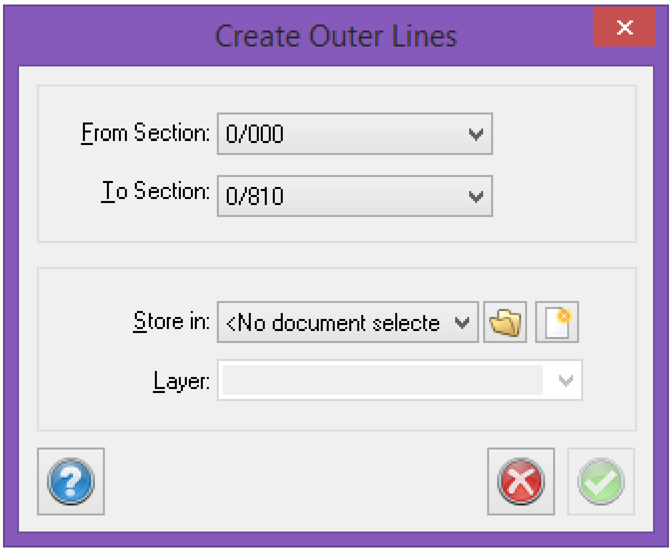
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

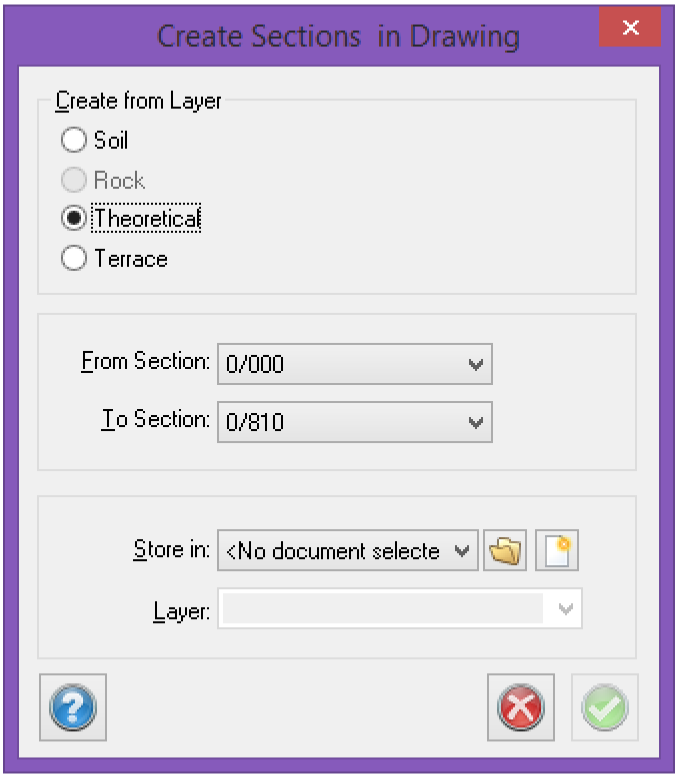
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

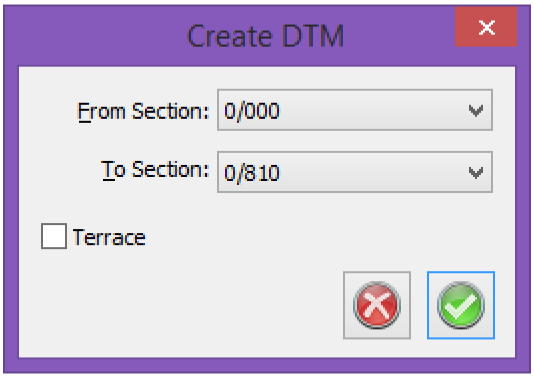


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

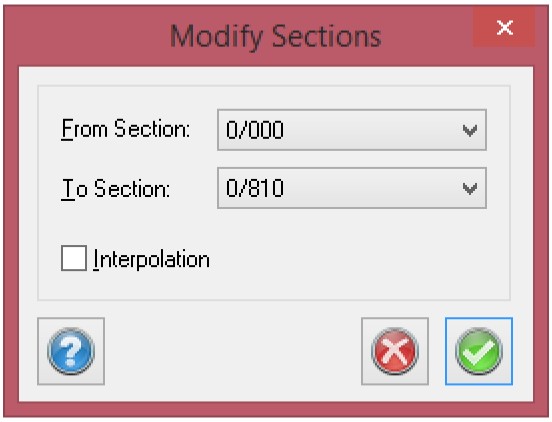


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

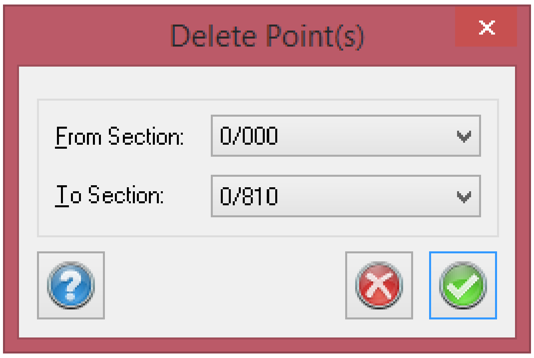
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

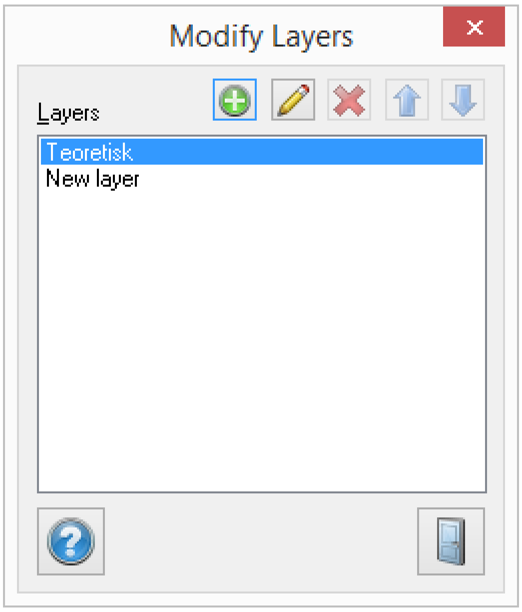
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

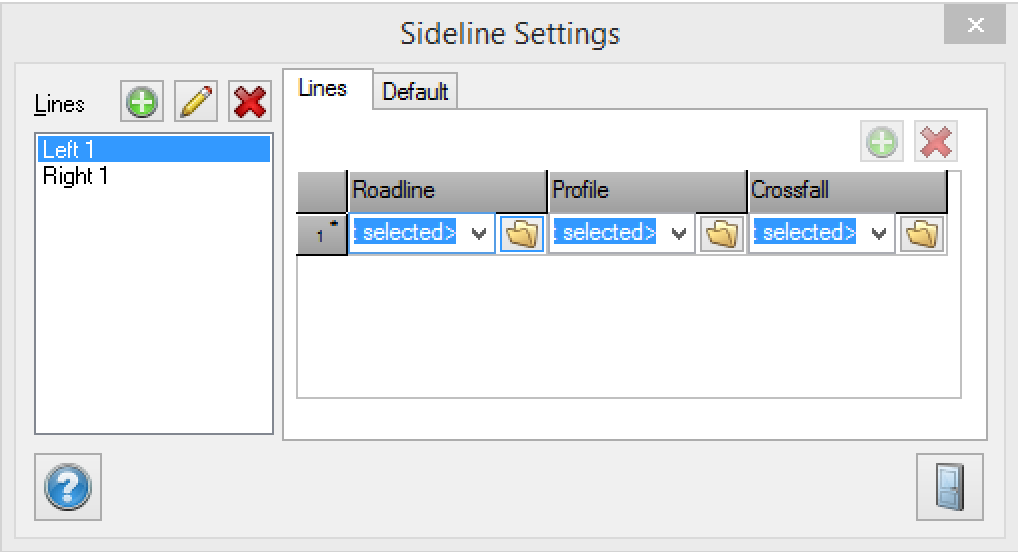


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

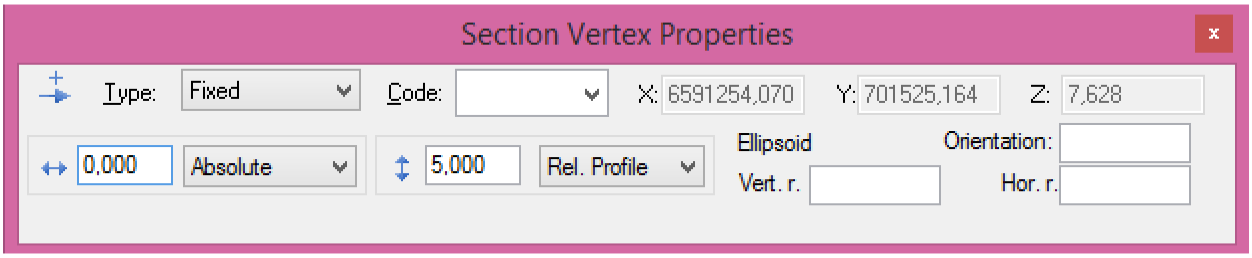
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



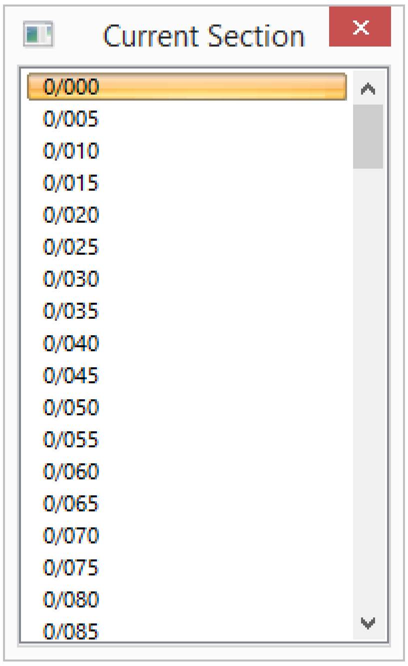
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

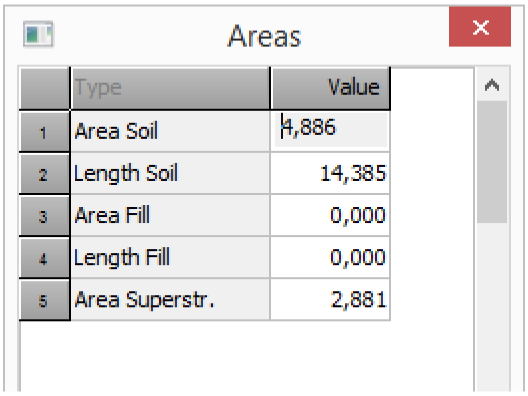
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

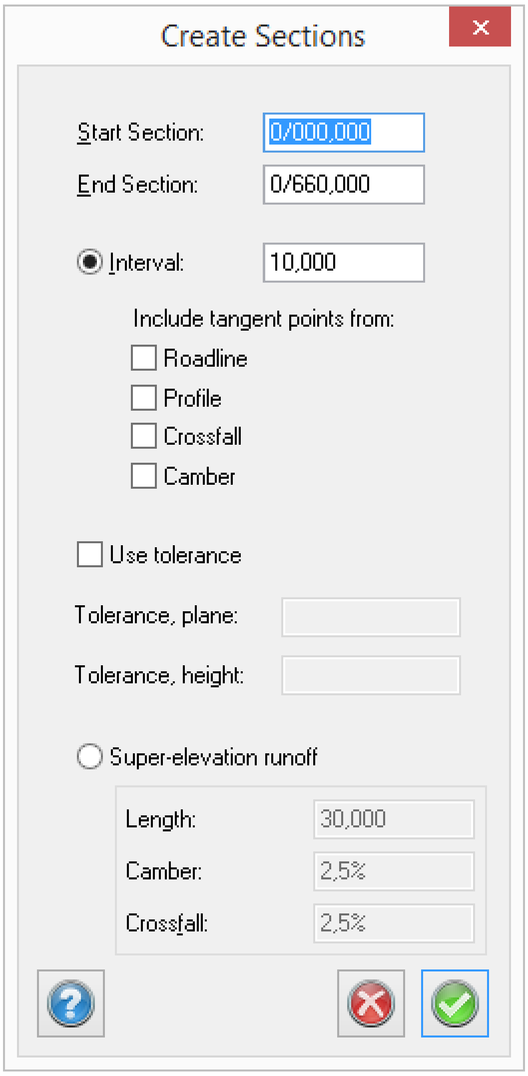
Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Calculated sections contents

Calculated section (.TCS)

Function, command	Description
Create sections	Create sections
Global options	
Delete sections	Delete selected sections
Substitute sections	Creates new sections with this new section template.
Recalculate	Select any sections and recalculated with any values.
Create line	Create 3D lines from a cross section in a plane drawing.
Create line from offset/height	
Create multiple lines	Create all lines in the section to a plan drawing at the same time.
Create outer lines	Insert the outermost lines from the section into the drawing in 3D.
Create sections in drawing	Make a new DTM of the theoretical road.
Create DTM from sections	Creates a DTM directly from cross sections.
Delete points in cross section	
Change/Interpolate	Edit multiple cross sections at the same time, edit cross sections and edit section templates.
Modify layers	Edit the layers in the cross sections
Side lines	Specify side lines in calculated sections.
View point info - section vertex properties	
Current section	View toolboxes and parts of the section.

Create sections



Start section
The default value is the start of the roadline. If you want to use something else, enter it here.

End section
The default value is the section after the end of the roadline. If you want to use something else, enter it here. Make sure that the start and end sections are inside the length of both the road profile and the roadline.

Interval
Enter the interval at which you want to create sections.

Select between creating sections at the tangent points from the roadline, profile, crossfall or cant.

Tolerance in plane and height
If at least one tolerance is set, extra sections may be created to make sure the result stays within the tolerance. Only the theoretical layer is controlled. Outer slopes can only be controlled towards the height tolerance. If no tolerance is set, no control is made and no sections will be created.

Superelevation runoff
This creates the crossfall, camber and superelevation based on the roadline used in the calculation. You need to enter the superelevation length for the road curves and the slope that the road will have in curves and straight lines. If the camber document is selected in the global options, the superelevation runoff is already made so this option is not default selected. See camber.

When the cross sections are calculated, the areas for each section are also calculated. These will appear in the cross section document (.tcs).

To create cross sections

1. **Activate** the *Create* command.
2. If it is a road that you are going to calculate you will need the crossfall document or to create it first. If you have

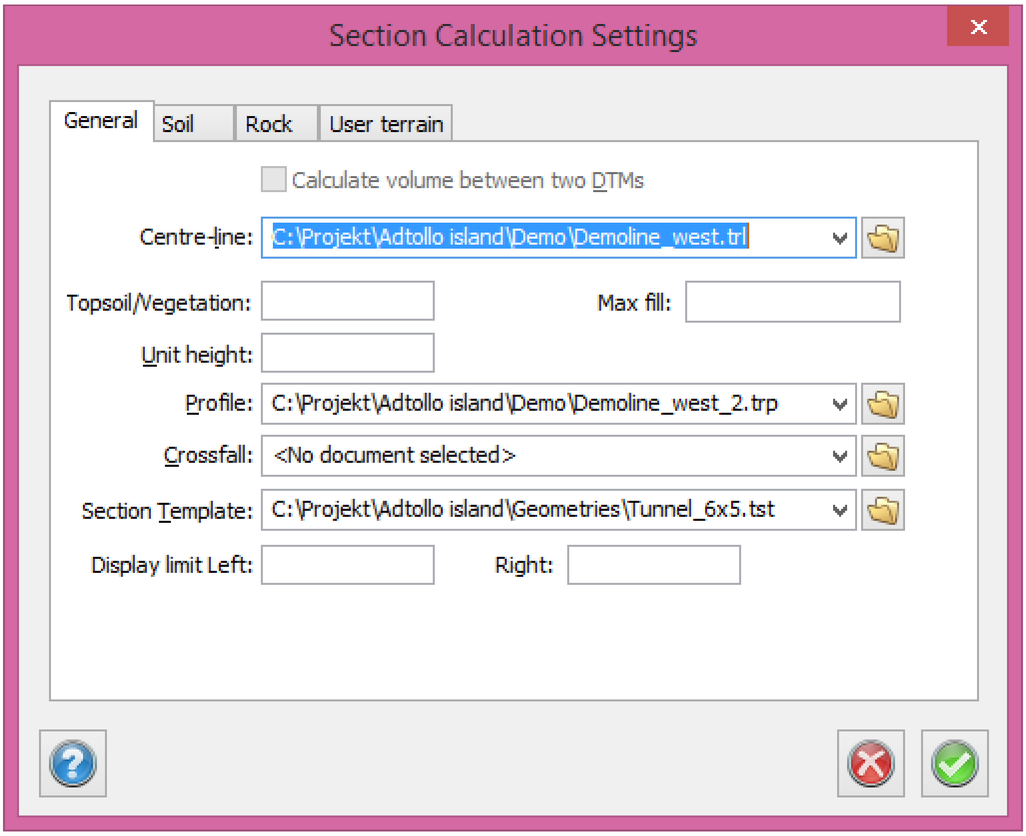
previously created the crossfall document, enter it now. If not, enter the settings for superelevation runoff, length and camber in the dialogue box.

3. Click **OK**. The cross sections that are involved in the superelevation runoff and crossfall are created. You can now modify them if required. The next sections will be interpreted using these settings.
4. Go back to **Create sections**. This time, you create the sections with the interval. This will also be the default selection. Enter any interval for the calculation.

To calculate cross sections, certain data is required that is stored under *Global options* and also appears in a dialogue that is automatically activated when we click Create sections.

Global options - general

Calculated sections|Global optios - General



Centreline/Roadline
A roadline is required to create sections.

Removal of top soil / Max fill

This is where the thickness of the top soil removal is filled in. Max fill is the maximum depth at the road centre. If the maximum depth exceeds this value, the top soil will not be calculated for this section.

If the theoretical layer's outer point on one side is above ground, the removal of the soil on this side will start with maximum depth at the outer point of the terrace.

If the theoretical layer outer point on one side is below ground, the removal of the soil on this side will follow the terrace to the outer point on the theoretical layer, or until the terrace is under the chosen depth for soil removal. Afterwards the soil continues on chosen depth.

Profile
A profile is only needed if you are using a section template.

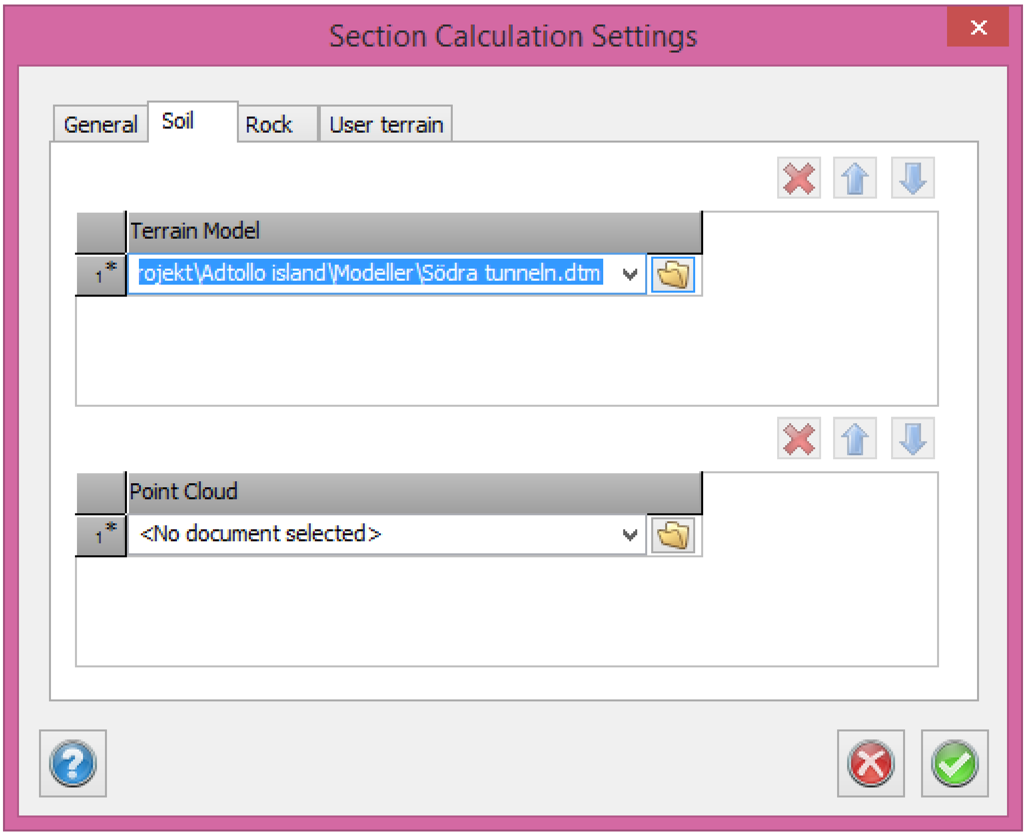
Section template
If you only are going to create terrain cross sections you do not have to use a section template.

The above dialogue also appears if anything is missing when you want to create the sections. If the data is all stored correctly, the following items will appear in a dialogue box.

Display limit left/Right
Set a limit on how far the cross sections shall be drawn. Leave blank to draw the entire cross section. This is a display mode and change no data.

Soil

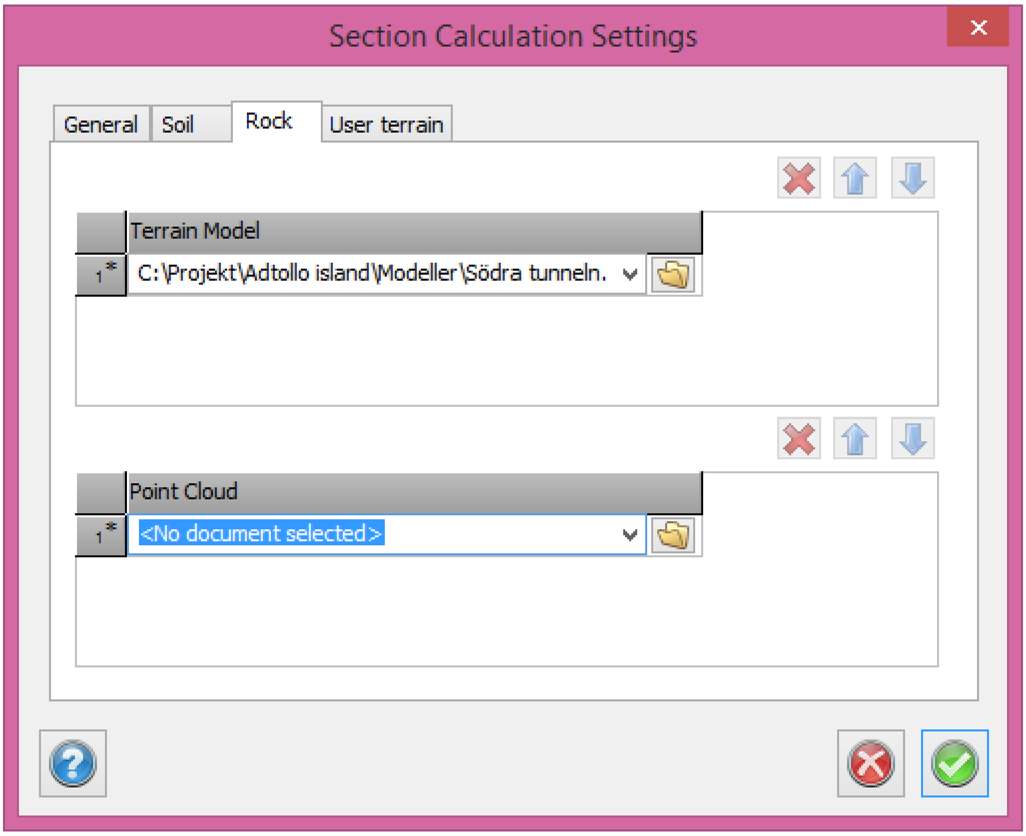
Calculated sections|Global optios - Soil



In calculated sections it is possible to set several terrain models for soil and rock. When a section is calculated, the center point of the section is used to decide which terrain model that should be used for this certain section. The first terrain model that covers the center point will be used for the section. If none of the terrain models covers the center point, the first one in the list will be used.

Rock

Calculated sections|Global optios - Rock



Note! If h>Max fill, the top soil is not removed.

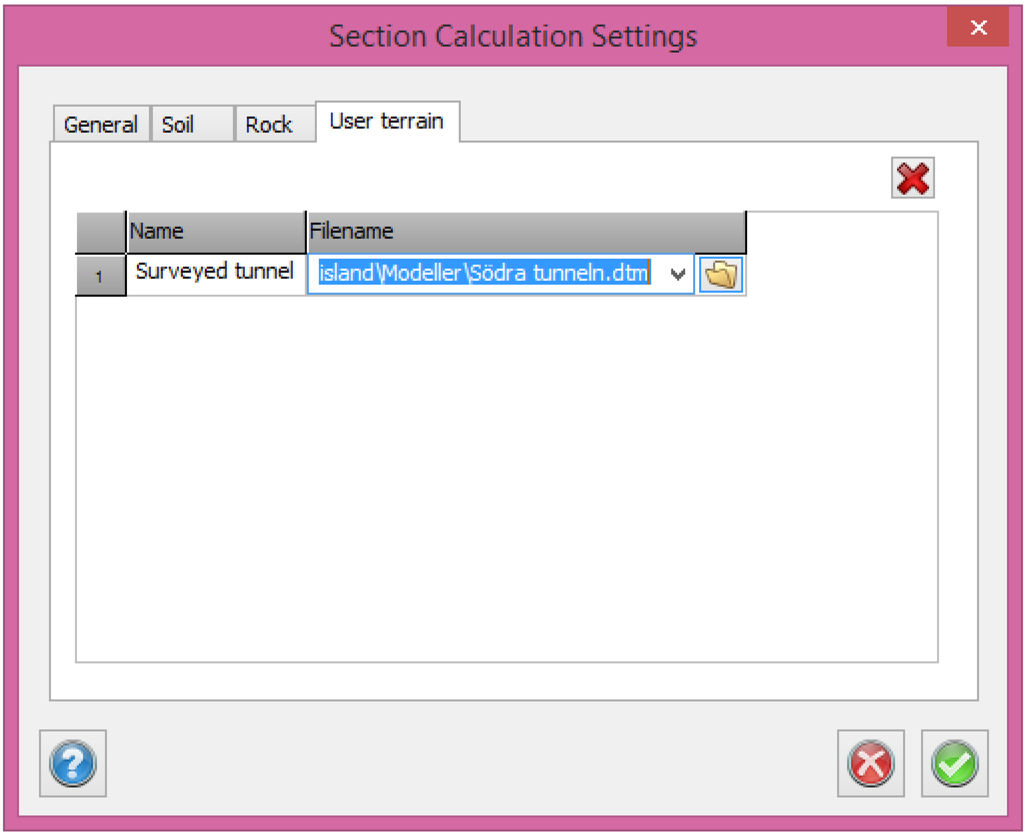
At least one soil or rock DTM must exist to create cross sections.

Point cloud
Terrain Models have the highest priority, followed by point clouds. Possibility to select multiple point clouds at the same time in the dialogue.

A unit height can be specified for to a calculation of rock above and below this height compared with the surface DTM.

User terrain

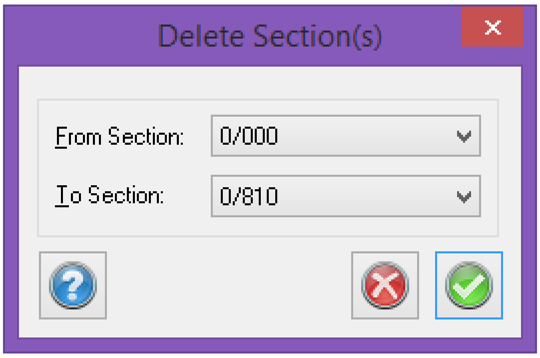
Calculated sections|Global optios - User terrain



Select section template, if it contains terrain layers, you can specify which models the terrain layers shall use.

Delete sections

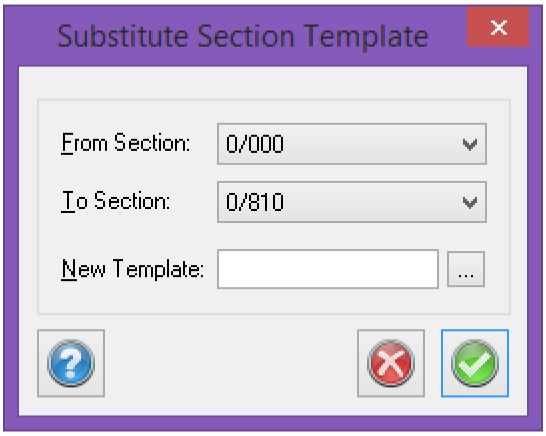
Calculated sections|Delete



Delete selected sections.

Substitute sections

Calculated sections|Substitute

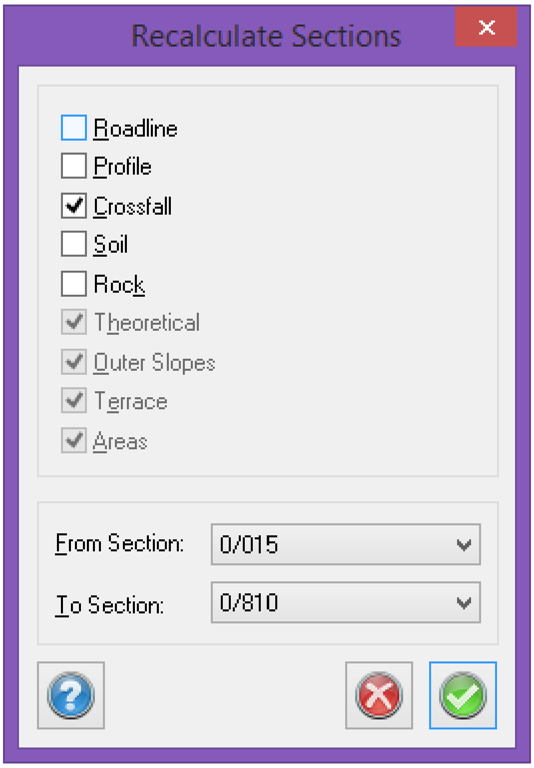


Creates new sections with this new section template. Note that it will not be possible to interpolate between different sections using different section templates.

Recalculate/update

Calculated sections|Recalculate

This function allows any sections to be selected and recalculated with any values. For example, if a digital terrain model has been changed, you can recalculate the sections where the DTM has been changed and you can choose to only recalculate those sections and the specific part that actually needs to be recalculated. All defined values for the section will be stored even if you have made manual changes to the section.



Create lines in plan

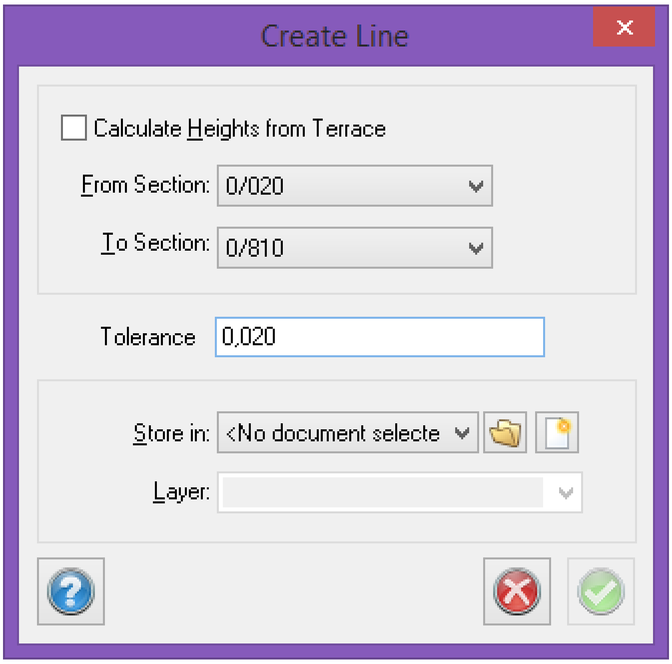
Calculated sections|Create line

From the cross sections it is simple and fast to create 3D lines in a plane drawing. You can either create them in an existing, currently open drawing or a new drawing.

There are five different ways to display the cross sections in a plan drawing or a DTM:

- Create lines in plan one by one
- Create multiple lines

- Create line for the outer slopes edge
- Create cross sections in a plan view
- Create a DTM



Dialogue explanation:

From section:
Select the section from which you want to create plane data from the drop-down list.

To section:
Select the end cross section, up to which the plane data should be created.

Store in:
Select the drawing in which you want the plane data to be stored. You can select an existing, opened drawing, a drawing you have previously created and saved or a new drawing.

Layer:
Select the layer - enter an existing layer name or a new one.

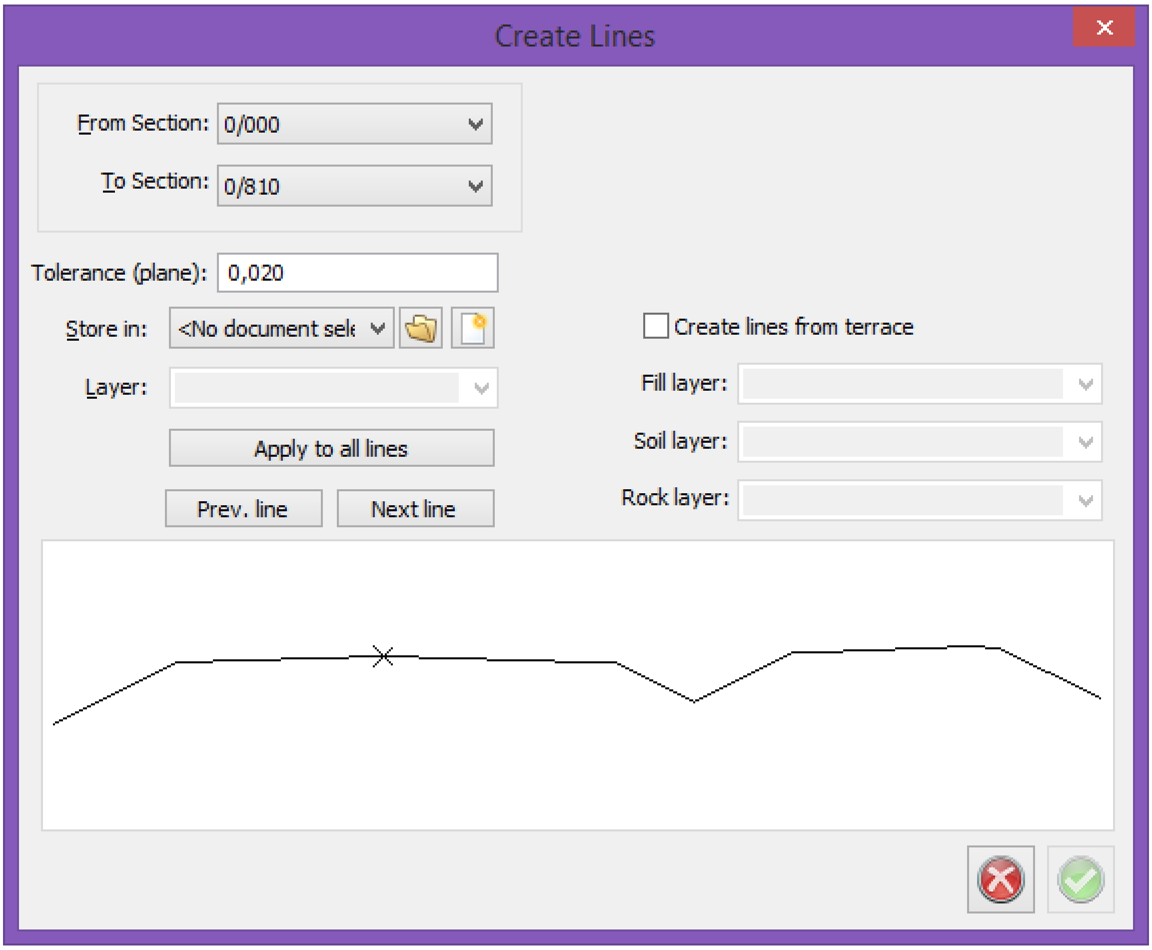
The procedure is as follows:

1. Click on the point you want to create in the plane drawing.
2. Go to the Create Line command in the drawing.
3. Select the start and end sections to be created.
4. Select the drawing and layer in which you want the line to be placed.
5. Click OK.
6. Repeat for the next point/line.

Create multiple lines

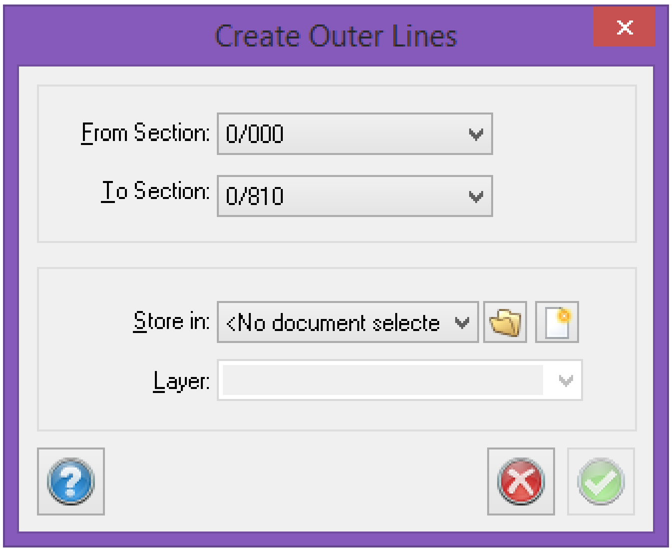
Calculated sections|Create multiple lines

This command is similar as the above one but you can create all lines in the section to a plan drawing at the same time. The figure shows your cross section, click on each point and decide which layer the line shall end up in.



Create outer lines

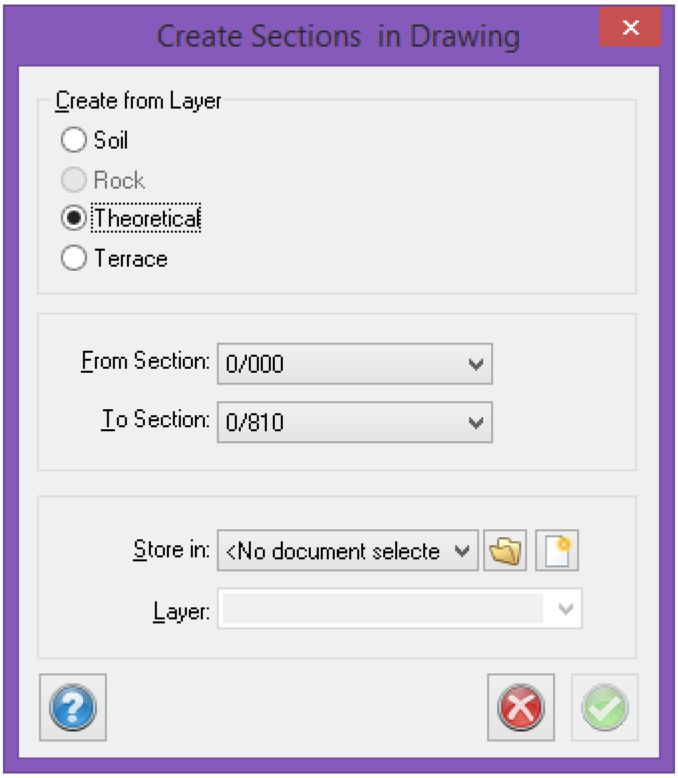
Calculated section|Create outer lines



This command inserts the outermost lines from the section into the drawing in 3D. You can select the drawing and layer in which you want to create the edges.

Create sections in drawing

Calculated section|Create sections

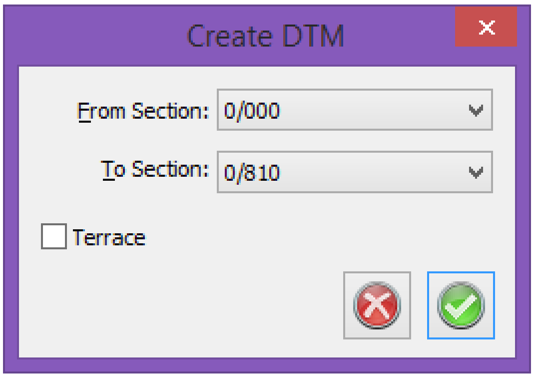


It is also possible to create calculated sections in a drawing. This is the most convenient way to make a new DTM of the theoretical road.

You can select the drawing and layer in which you want to create the sections.

Create DTM from sections

Calculated section|Create DTM

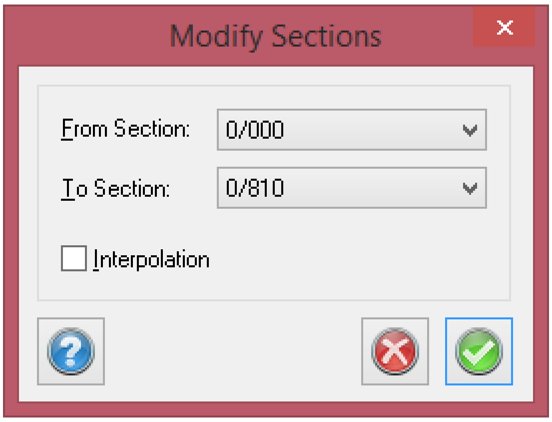


Creates a DTM directly from cross sections.

Decide if you want to create a theoretical finished upper surface or the terrace.

Change/Interpolate

Calculated section|Change/Interpolate



This function enables you to edit multiple cross sections at the same time. This can be useful if you want to make the same change to the cross sections or if you want to interpolate between them. The same command is used to edit cross sections as to edit section templates.

To modify several cross sections:

1. **Modify** one of the sections to achieve the desired result.
2. **Activate** the *Change/Interpolate command.*
3. Enter **from** which section and **to** which section you want to make this change in the sections. It is possible to modify from any section to any other section.
4. Click **OK**.

To interpolate between several cross sections:

1. Edit the end sections of the interpolation to achieve the desired result. For example, if you are going to create a bus station along the road and want to interpolate the additional offset from section 100 to 130, you need to modify sections 100 and 130. Make the necessary modifications.
2. Activate the *Change/Interpolate command.*
3. Enter from which section and to which section (the last section is the current section) you want to make this change in the sections.
4. Click Interpolate.
5. Click OK

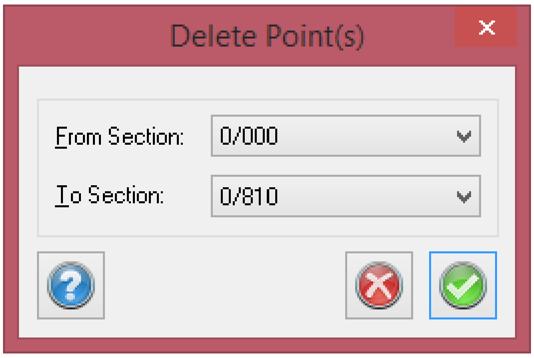
Note 1: It is the current cross section that determines the outcome of the interpolation.
Note 2: The modified element in the cross sections has to be of the same type. You cannot extend a slope in one cross section and a fixed element in another cross section.

Delete points in cross section

Calculated section|Delete points

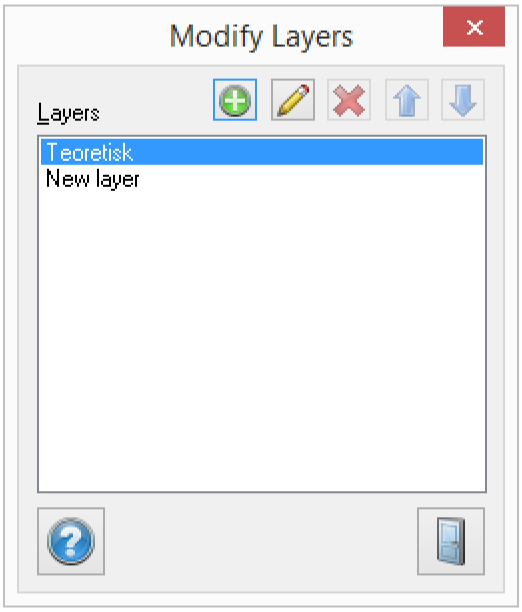
You can easily delete a point in the cross section by clicking on the point you want to edit and then going to *Delete points* in the menu. Delete point is also in the toolbox and the icon looks like an eraser. Please note that you cannot delete a point that any other point is related to.

You can easily delete a complete cross section by going to *Delete section* in the menu. The complete cross section will be deleted. The volume calculation is then performed on the adjacent sections with an increased length.



Modify layers

Calculated section|Modify|Layers

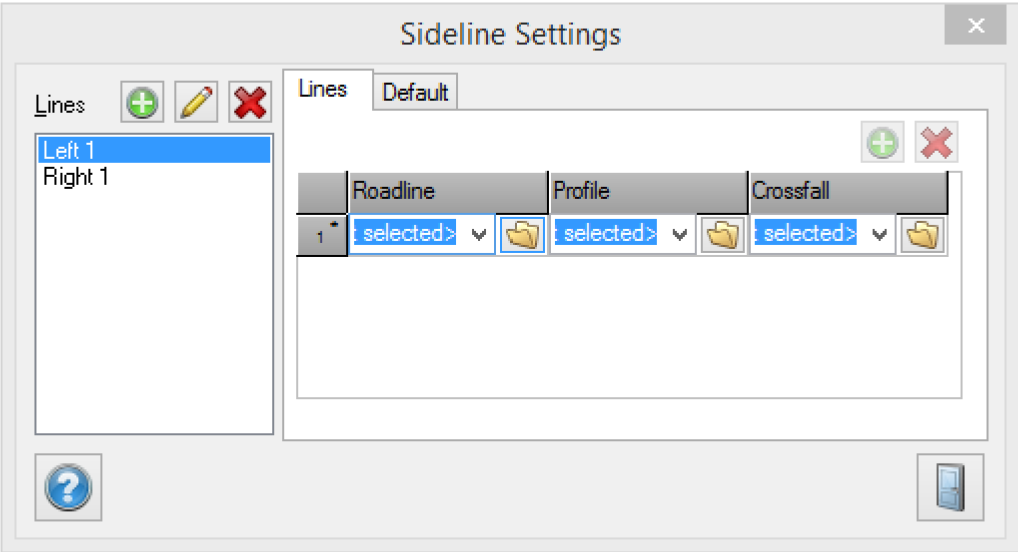


Edit the layers in the cross sections. You can add, delete, rename and move them up and down. The layers are defined between the terrace and finished upper surface.

Edit side lines (TCS)

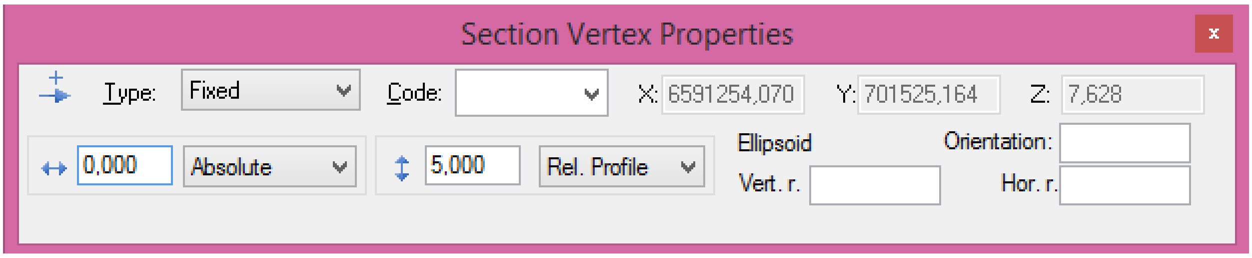
Calculated section|Side lines

If you have used side lines in the section template, Topocad requires you to specify the side lines in calculated sections. This is done using the Side lines command. You can have one side line (calculated roadline) along the entire section, default values only, multiple shorter side lines or a combination of these. You can also use profiles and camber diagrams here if you also want the section template to control the height of the vector.



View point info - section vertex properties

Calculated section|Point info



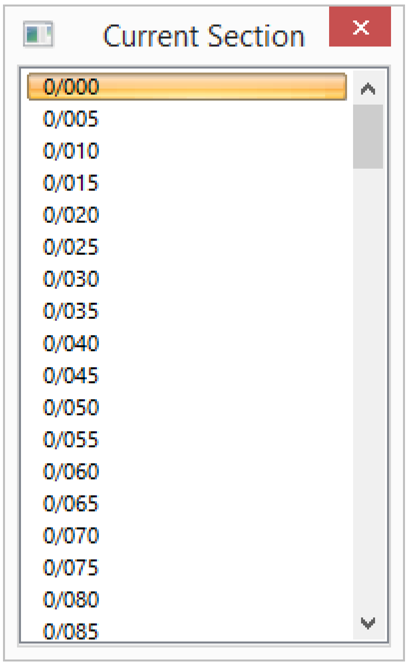
Points in calculated sections can be edited in the same way as in the section template.

Current section

Calculated section|Current section

View in calculated sections contains several options for viewing both toolboxes and parts of the section. These are the options:

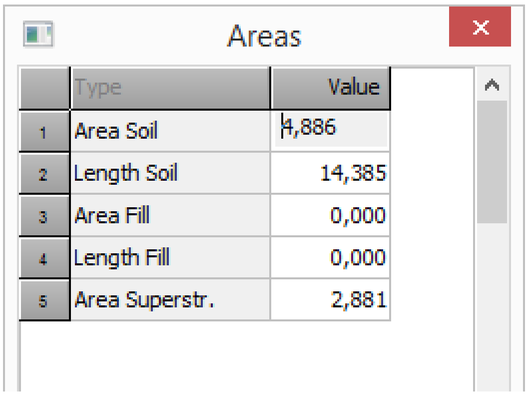
- Toolboxes
- Select section
- Sections
- Select point in section
- Element properties
- Areas
- Terrace layers
- Superstructure layers



Displays all sections in the cross section calculation and the current section is marked.

Area

Calculated section|Area



Layers

Calculated section|Layers

Displays the area and horizontal length for current section. The area is interactively calculated during editing.

Displays all the layers in the cross sections and you can turn them off and on from this command. Note! If all layers are turned off you will not see them in the dialogue but they can be turned on if you click on them in the section.

Theoretical tunnel section

Theoretical tunnel section (TTU)

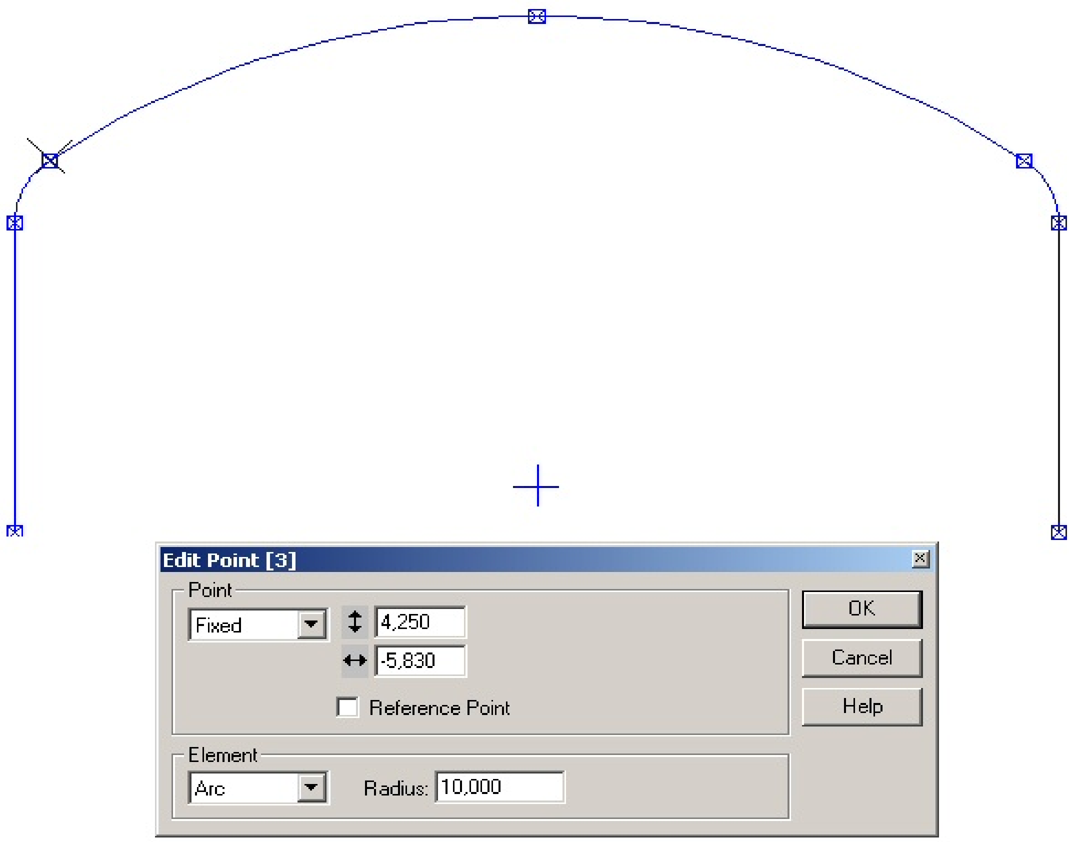
The tunnel section is used to create the tunnel digital terrain model and to calculate the cross-sections of the tunnel.

For optimum digital terrain modelling it is important not to have sharp edges. It should be possible to interpolate all measured points onto this tunnel section.

The tunnel section is created using lines and arcs relative to the roadline and profile.

The commands used are Add point and Edit point. You can also delete points. When you open a new tunnel section it will look like a tunnel. You can either delete all points and start again or edit existing points.

The tunnel section is built up from left to right.

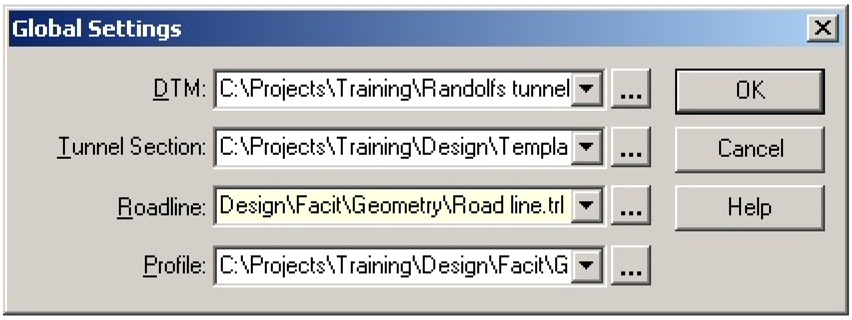


Calculated tunnel section

Calculated tunnel section (TTC)

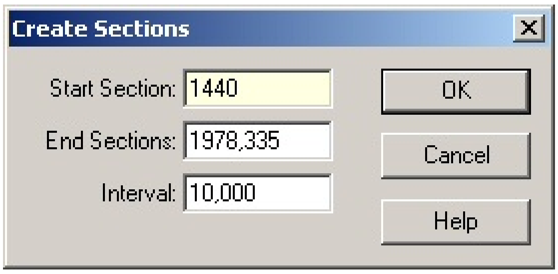
This command is similar to that used for calculating cross sections.

When a new calculated tunnel section is created the global settings are displayed.



Enter the tunnel DTM. The other figures will be automatically inserted. These can be changed if required.

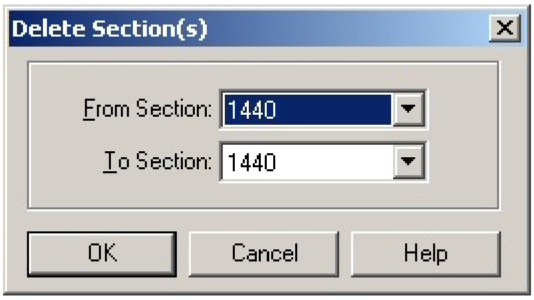
To create the tunnel sections, select *Tunnel|Create sections*.



Enter the start and end sections and the required interval between them. Further sections can be created as required. To create only one section, enter the same start and end sections (or a larger interval than the distance between the start and end sections).

The sections are created. The sections can be edited by selecting *Tunnel|Edit point.* Points can be added using *Tunnel|Add point* and deleted using *Tunnel|Delete point*. The volumes and areas are automatically recalculated when the tunnel cross section is edited.

Sections can be deleted using *Tunnel|Delete sections*.



The volume report is displayed by selecting *Tunnel|Show report*.

Several different toolboxes can be displayed in this window:

Sections - Shows all created sections. You can select a section to display from here.

Areas - Shows all areas in the tunnel section.

The above toolboxes can be shown or hidden using *View|Tool box*.

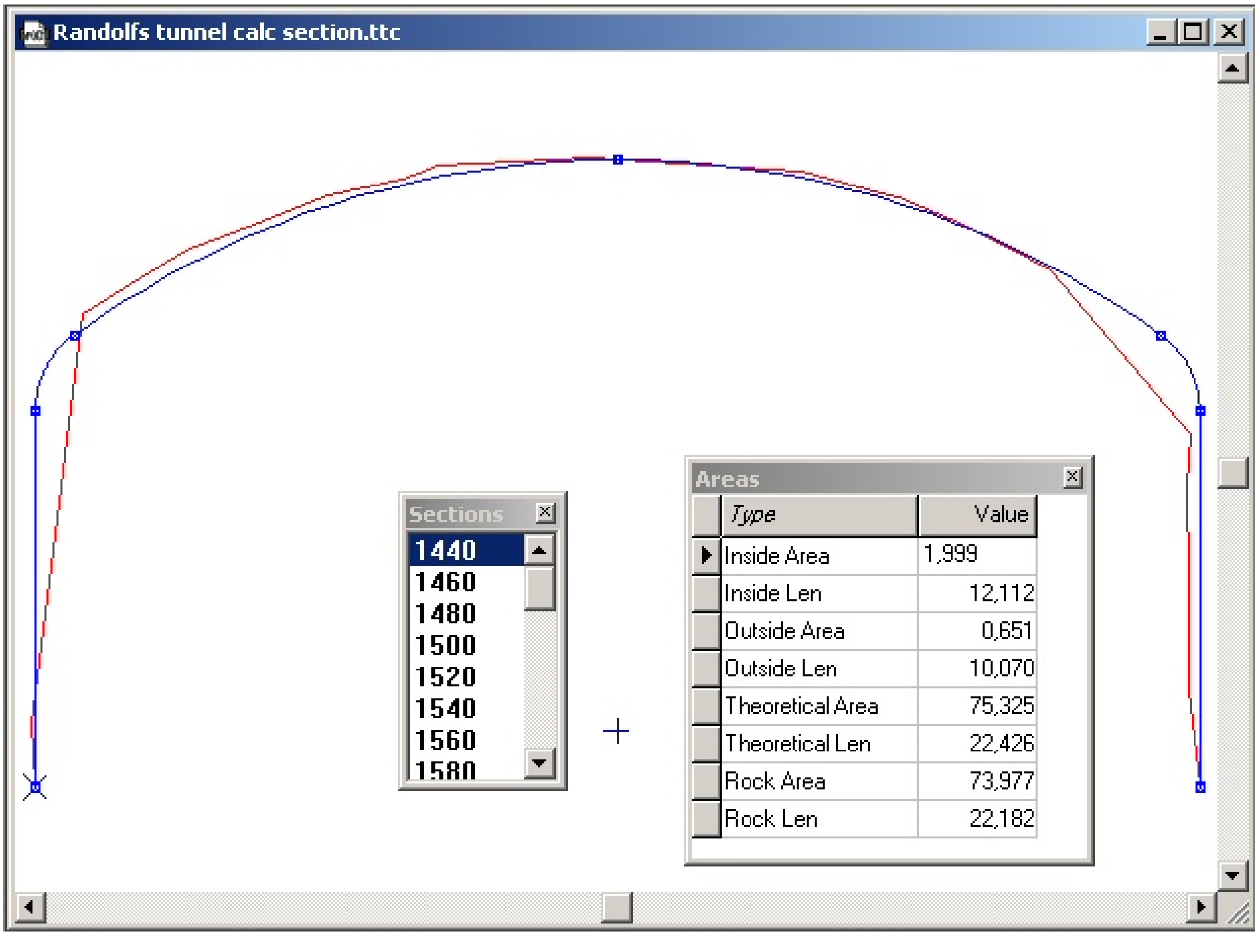
Other toolbars available are:

Select point - Use left and right (far left and far right) arrows to select any point in the tunnel section.

Select section - Use up and down (top and bottom) arrows to select one section at a time.

These toolbars are displayed on the *Settings|System settings|Toolbars* tab.

The section may look like this:



Print volumes

TCS|File|Print out
TCS|Settings|Report
TCS|View|Volumes

To print areas and volumes from the calculated sections (tcs file) click Print out. Select which form to use.

It is possible to edit the report in *Calculated sections|Report.*

To print cross sections you will need to insert them into a drawing and print from there. See Drawing sections for more information.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	
Lock heights	
Simulation of net adjustment:	Structure of simulation calculation

- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

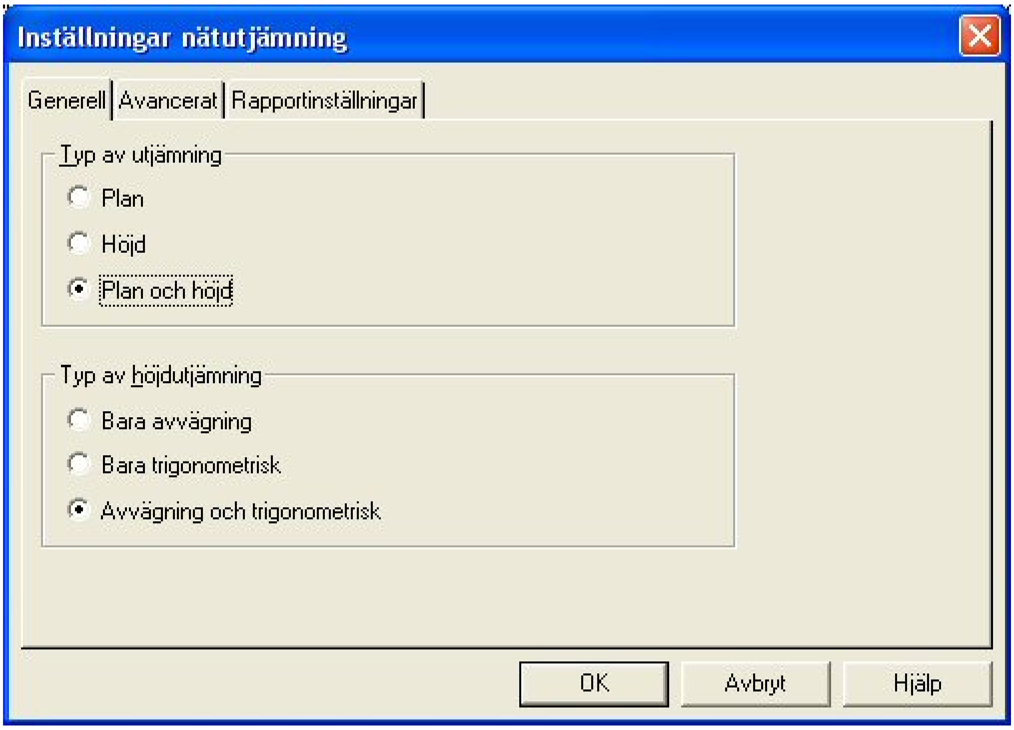
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



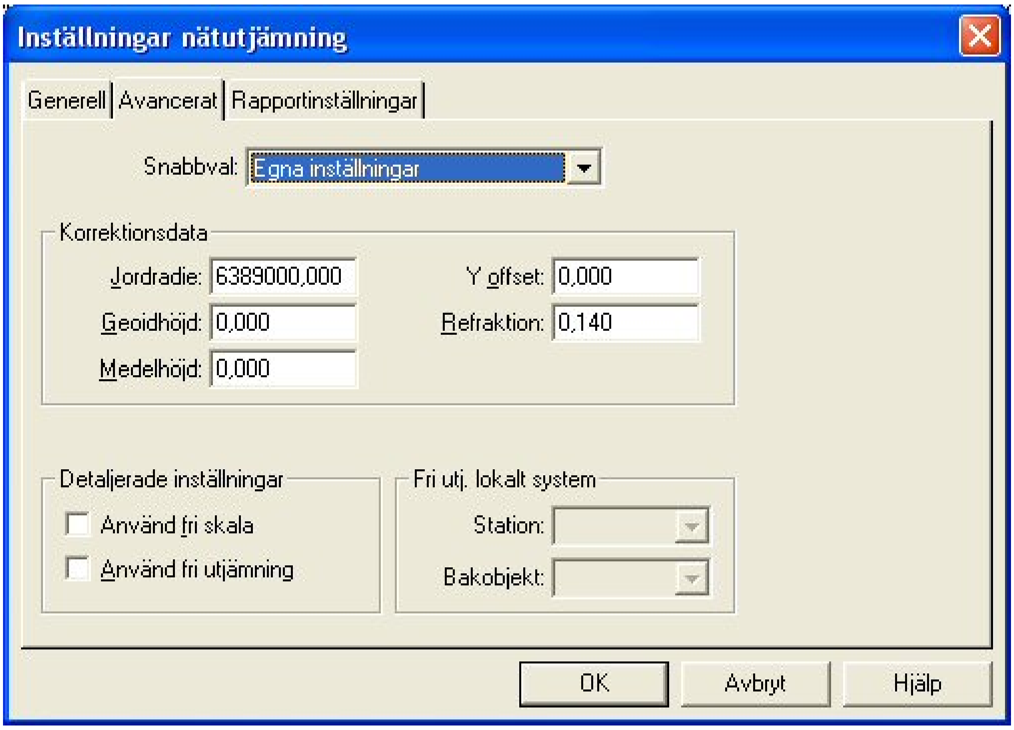
Type of adjustment:

- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)
- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system

Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK

Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

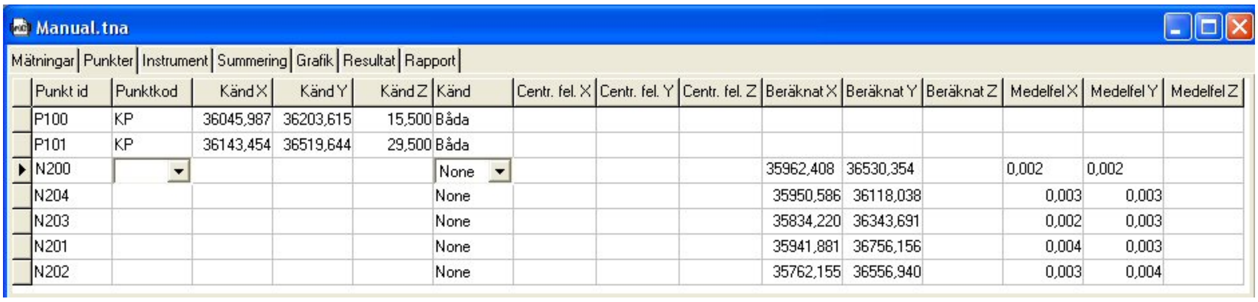
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description
None	No observation used for this row

Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

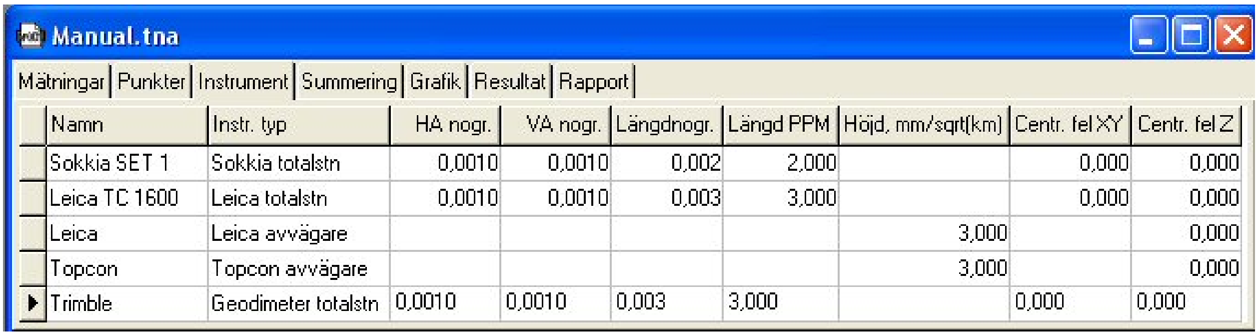
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd, mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Calculating of net

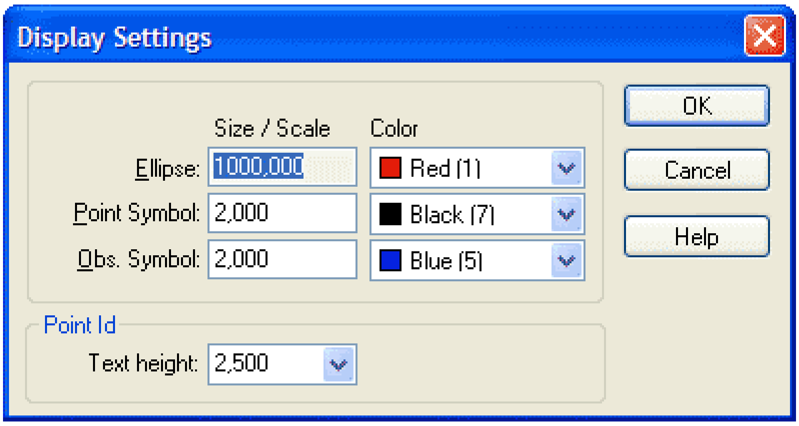
To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings

An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

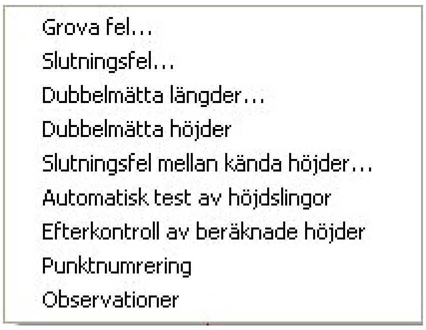


Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

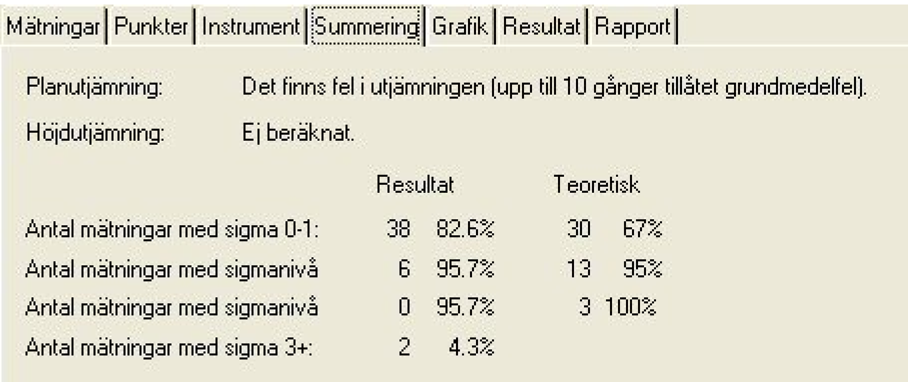
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

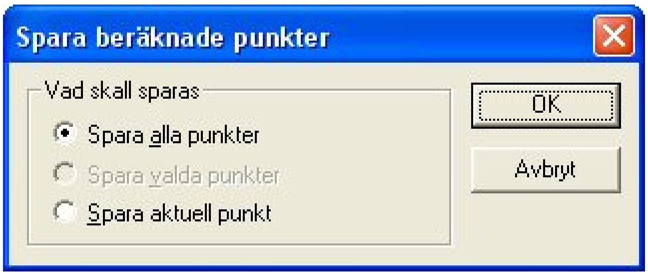
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



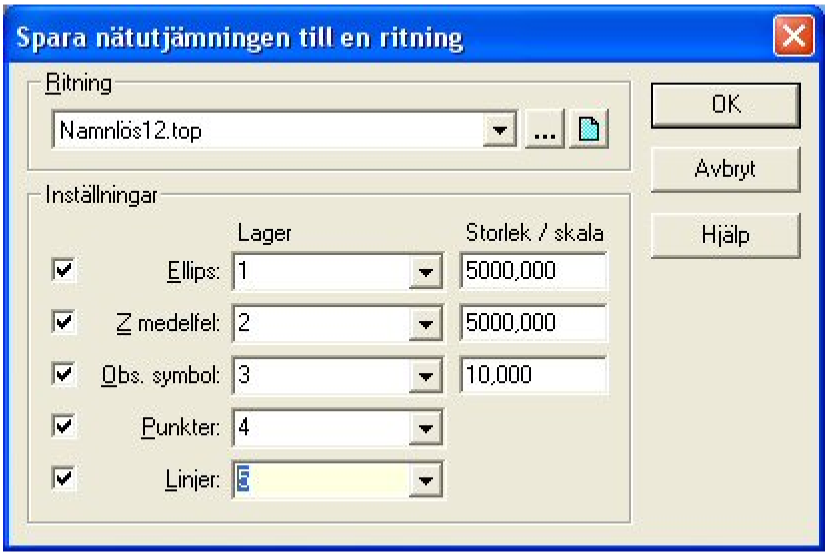
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

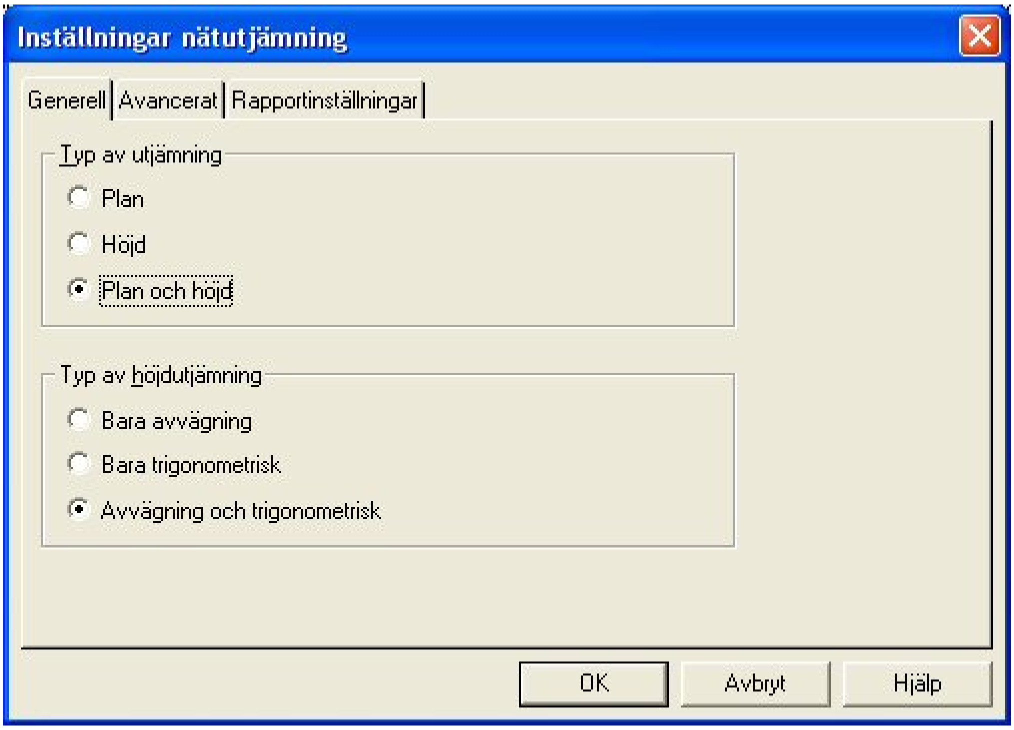
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

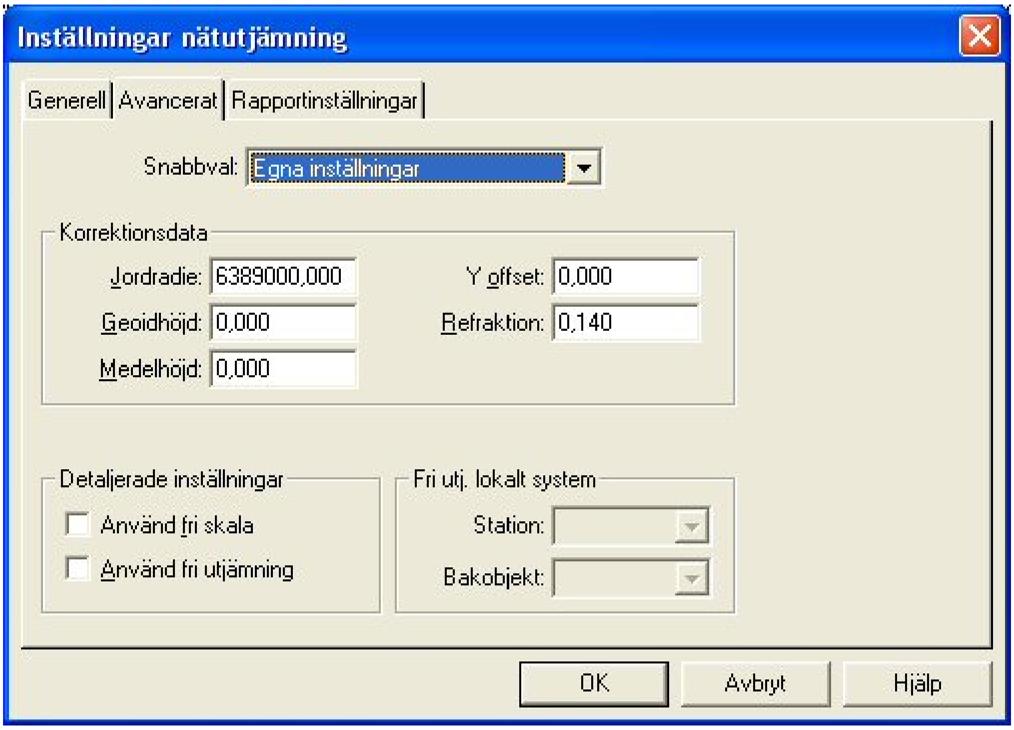
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

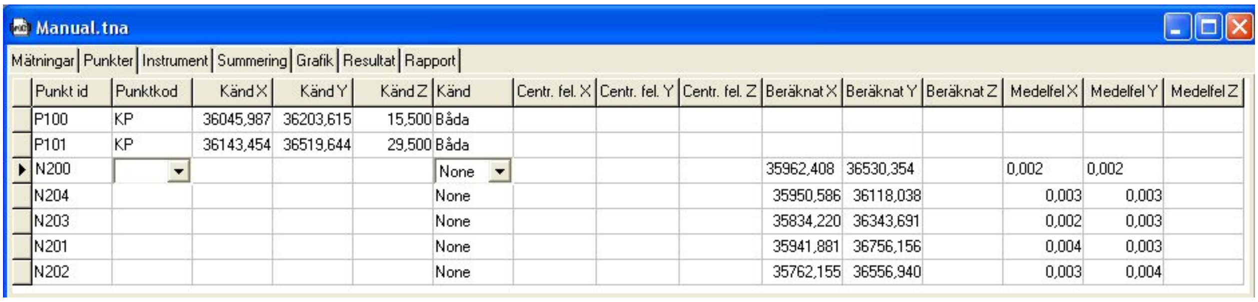
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

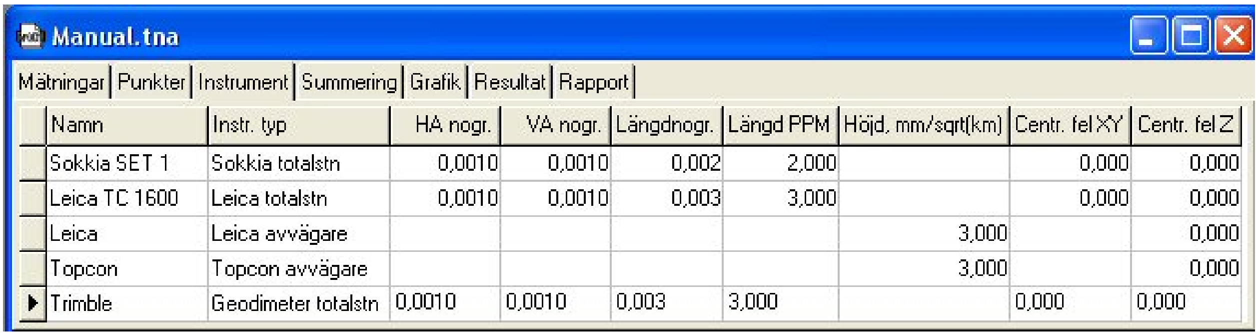
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

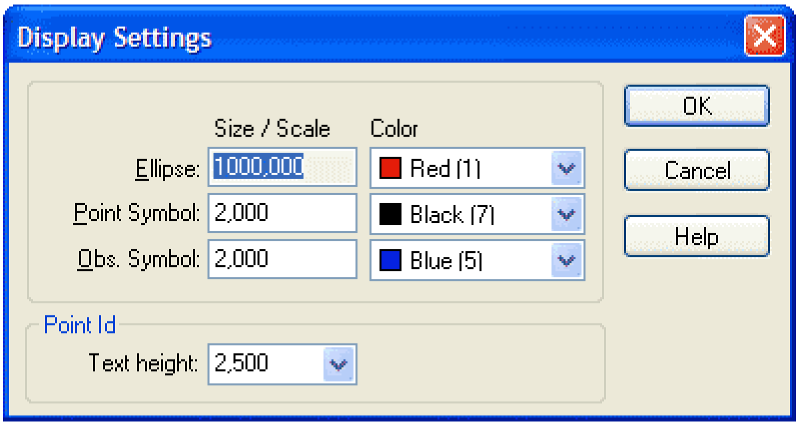
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



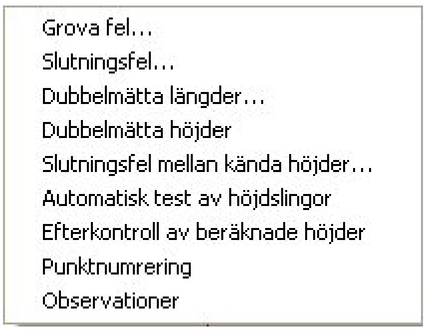
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

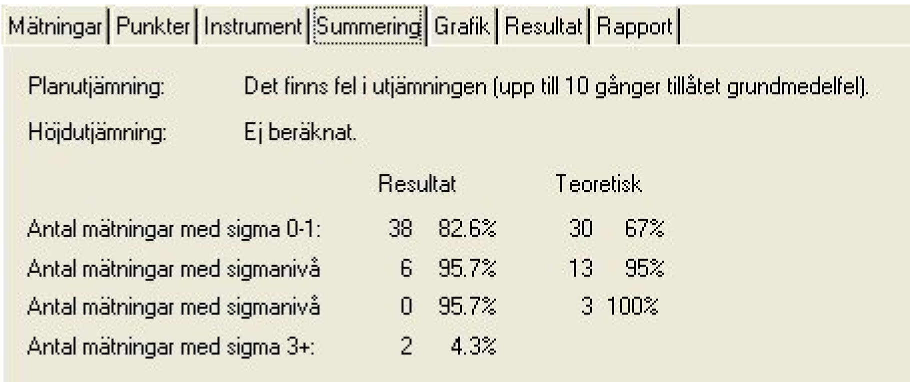
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

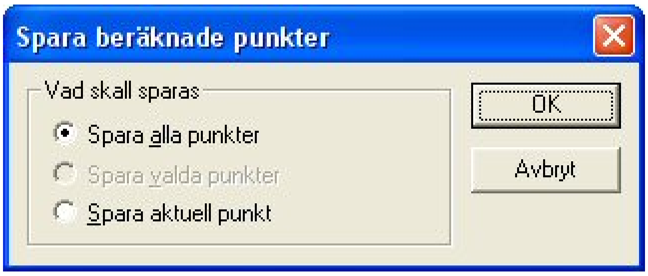
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



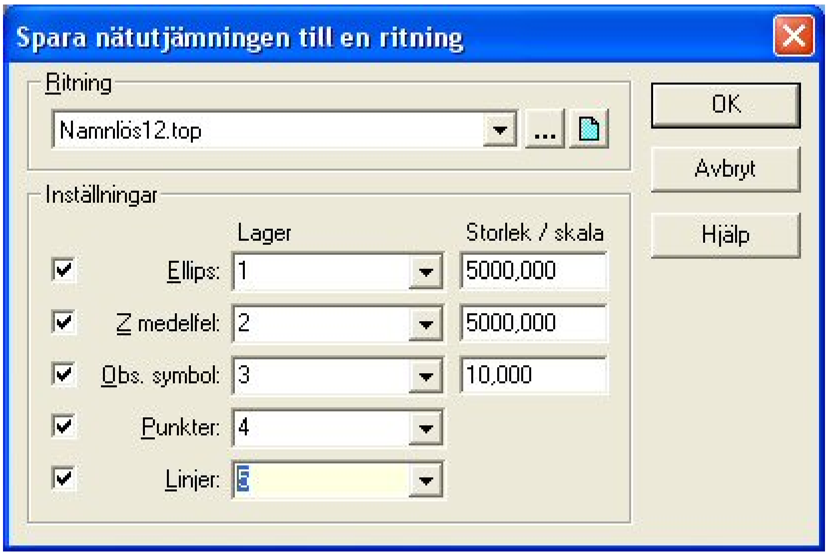
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

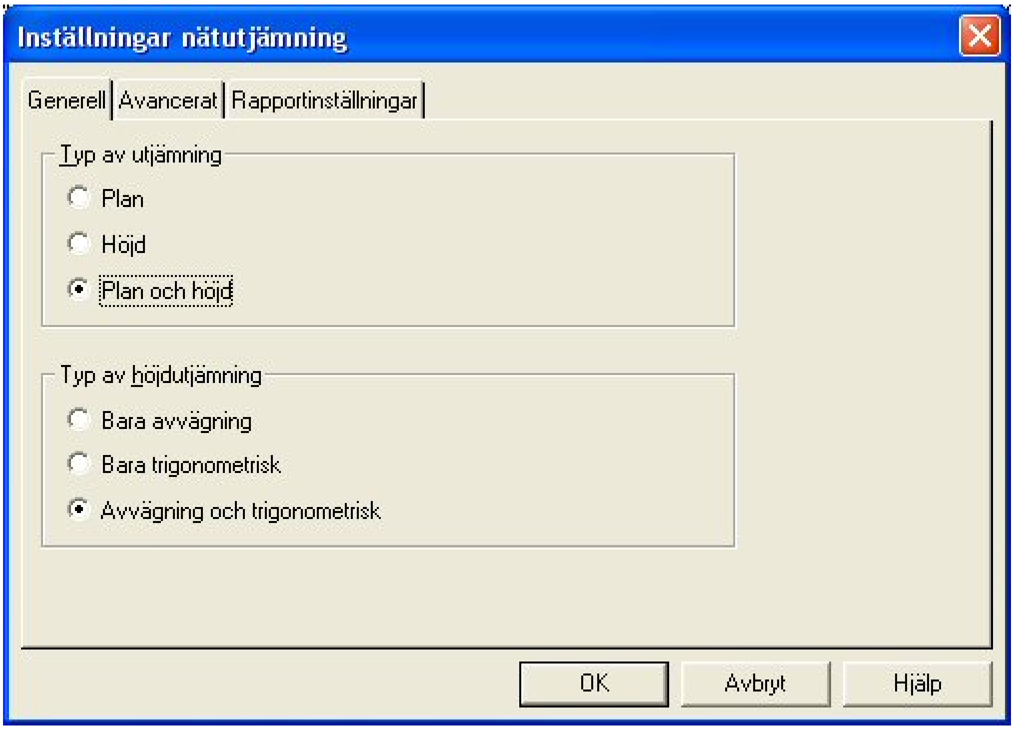
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

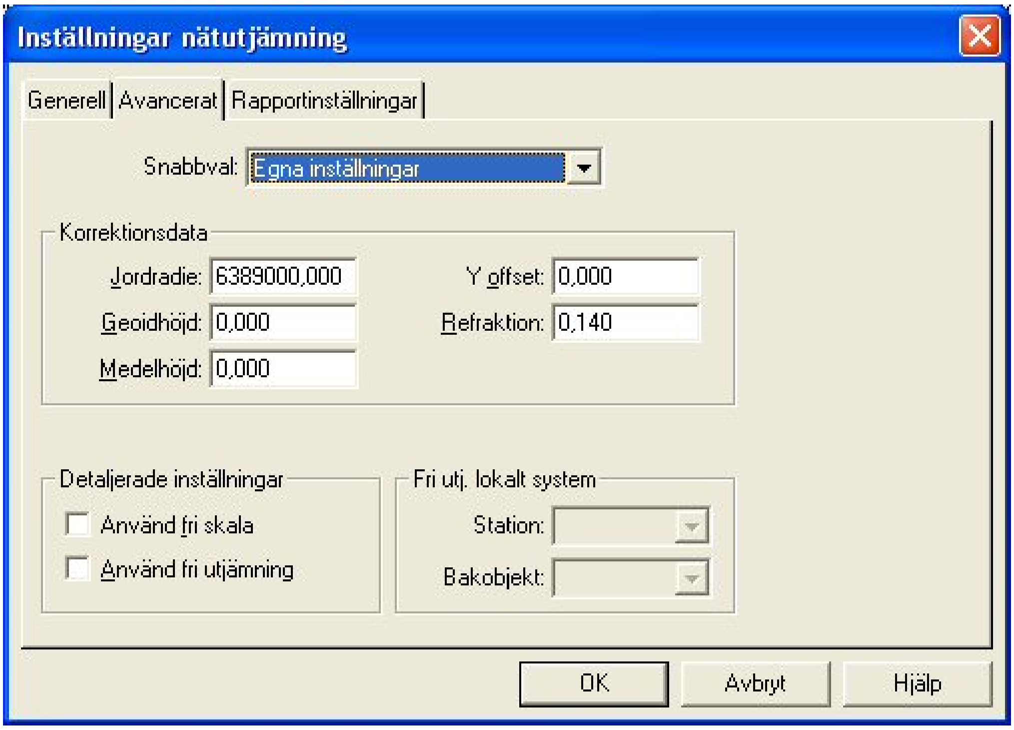
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

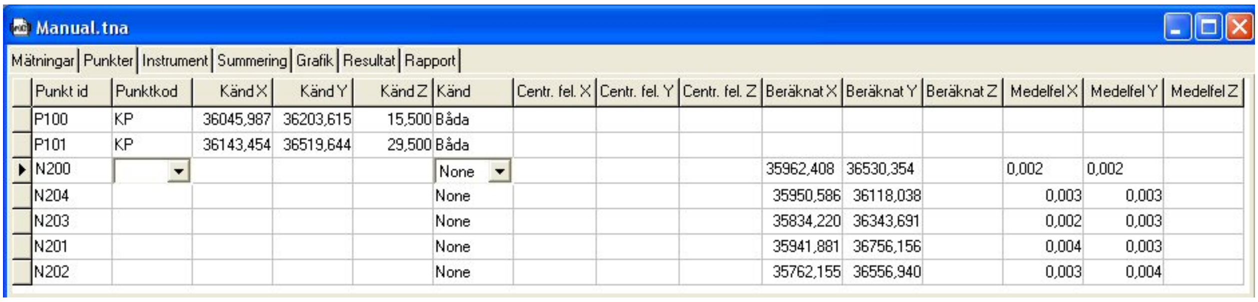
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

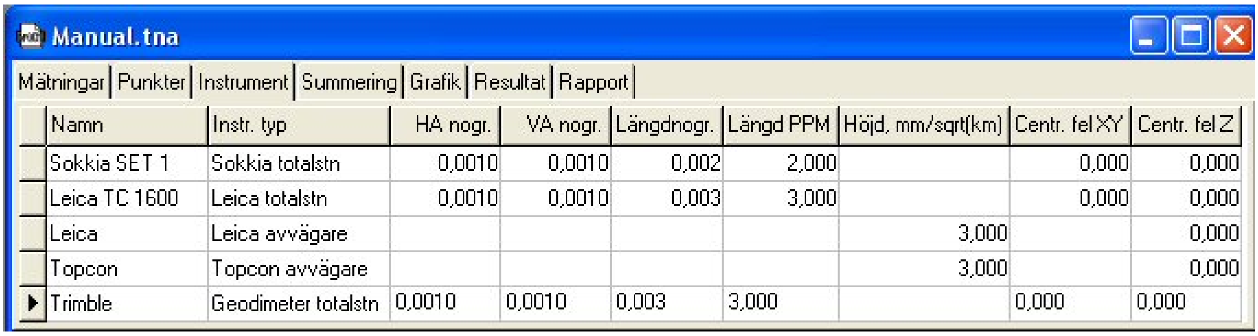
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

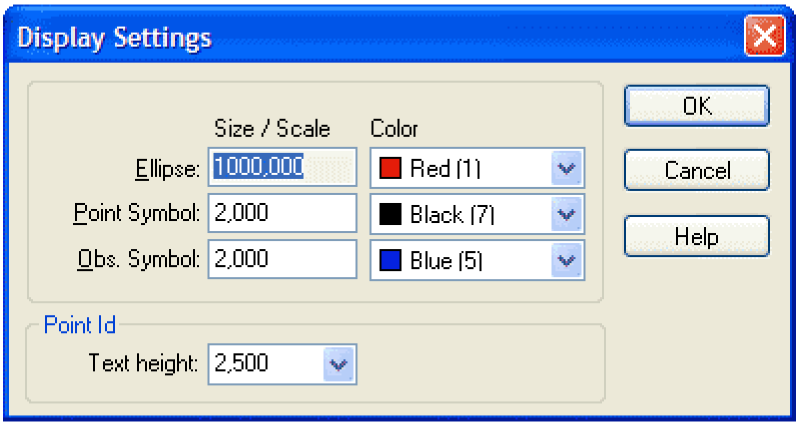
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



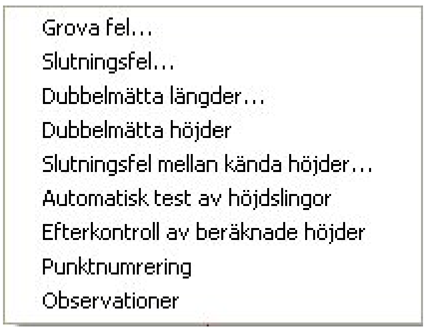
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

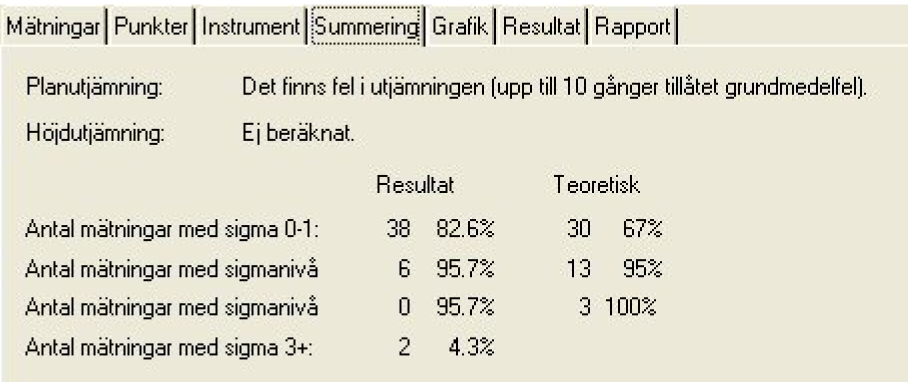
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

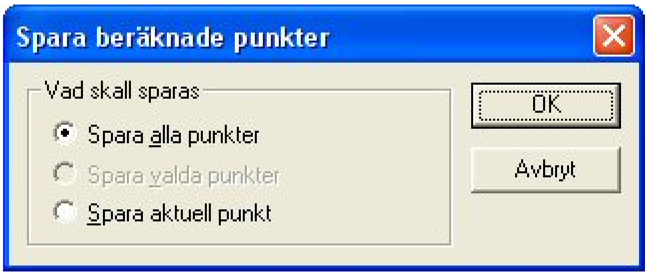
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



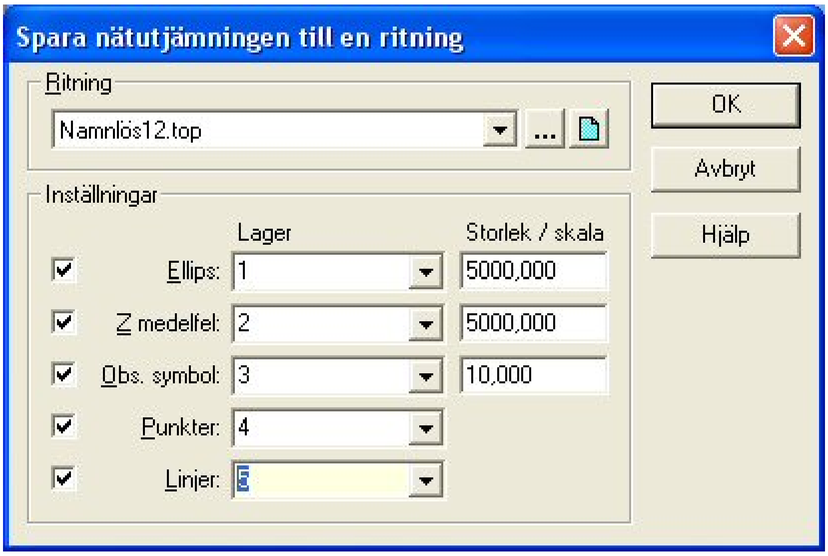
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

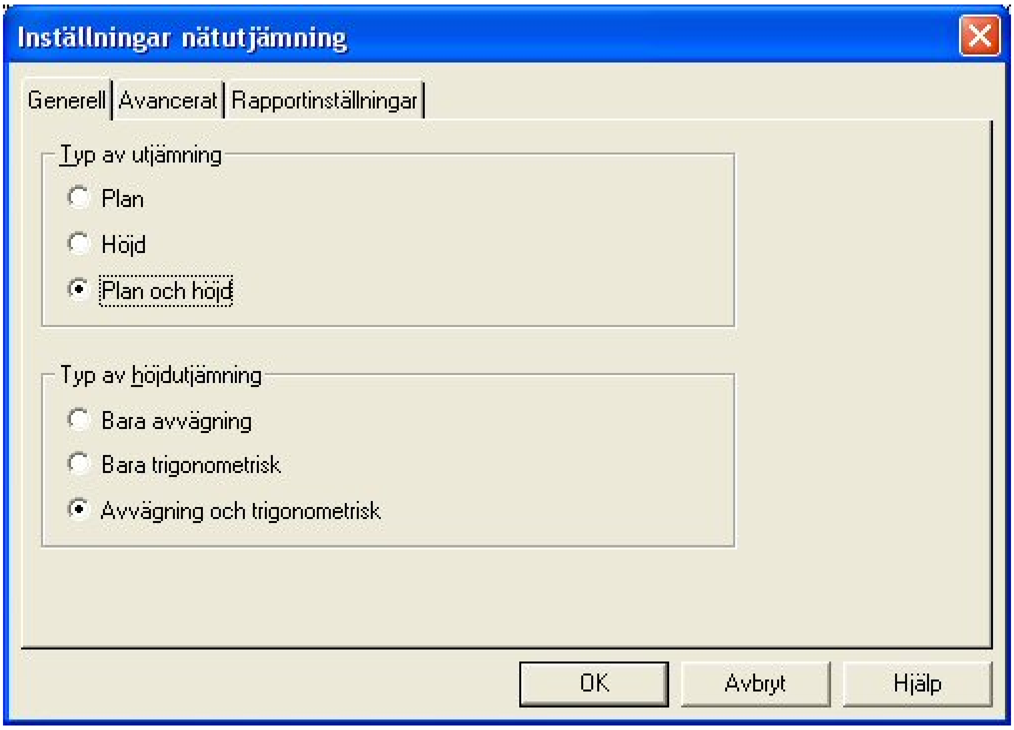
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

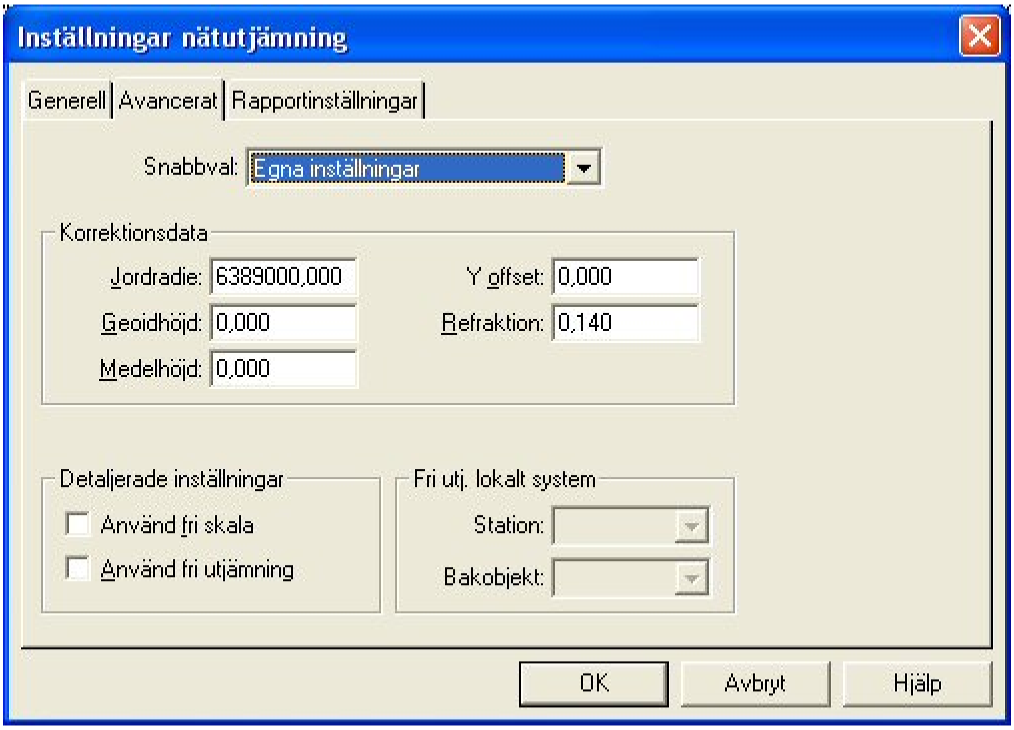
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File*|*Settings*|*Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

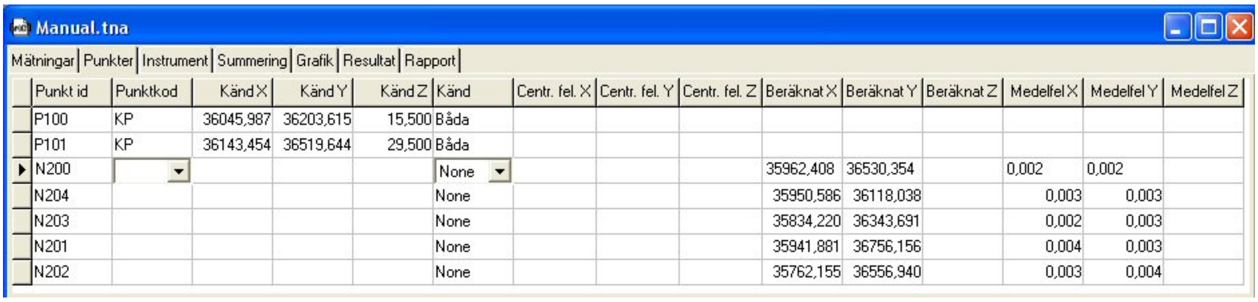
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

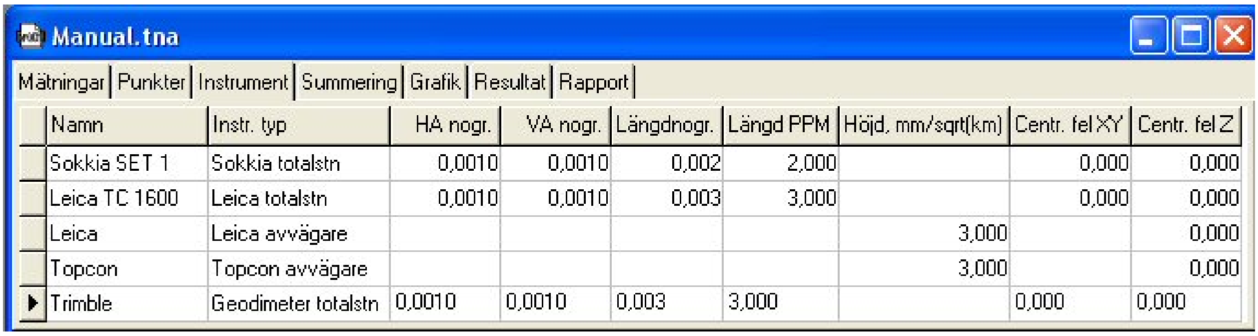
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

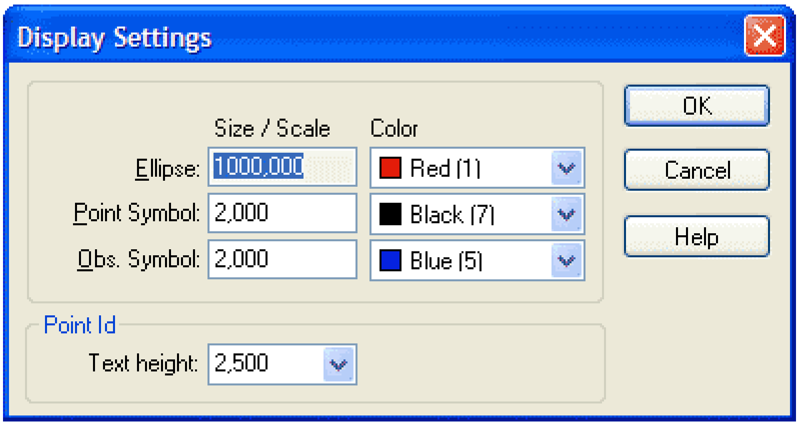
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



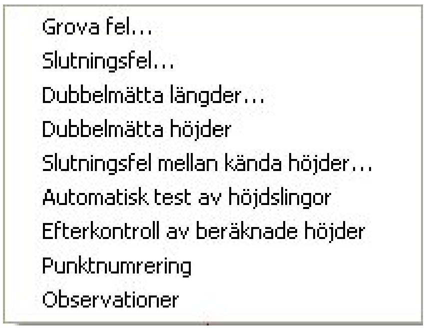
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

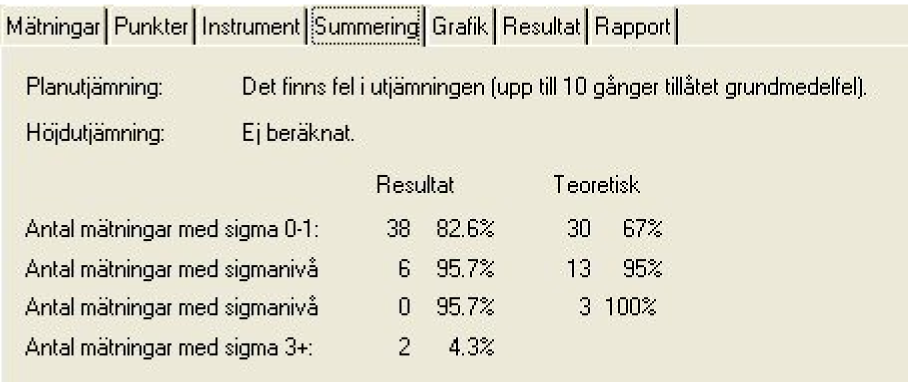
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

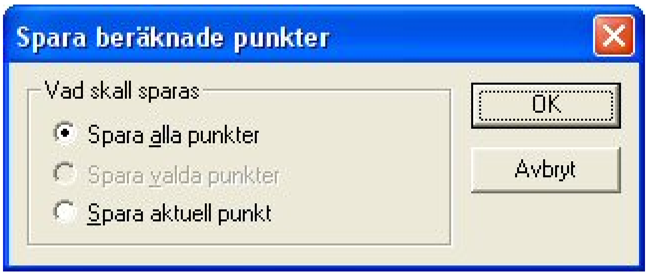
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



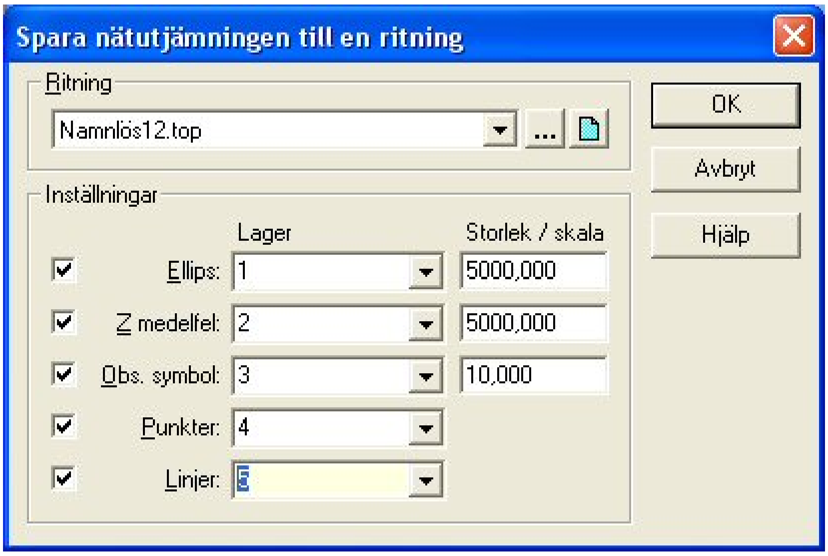
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

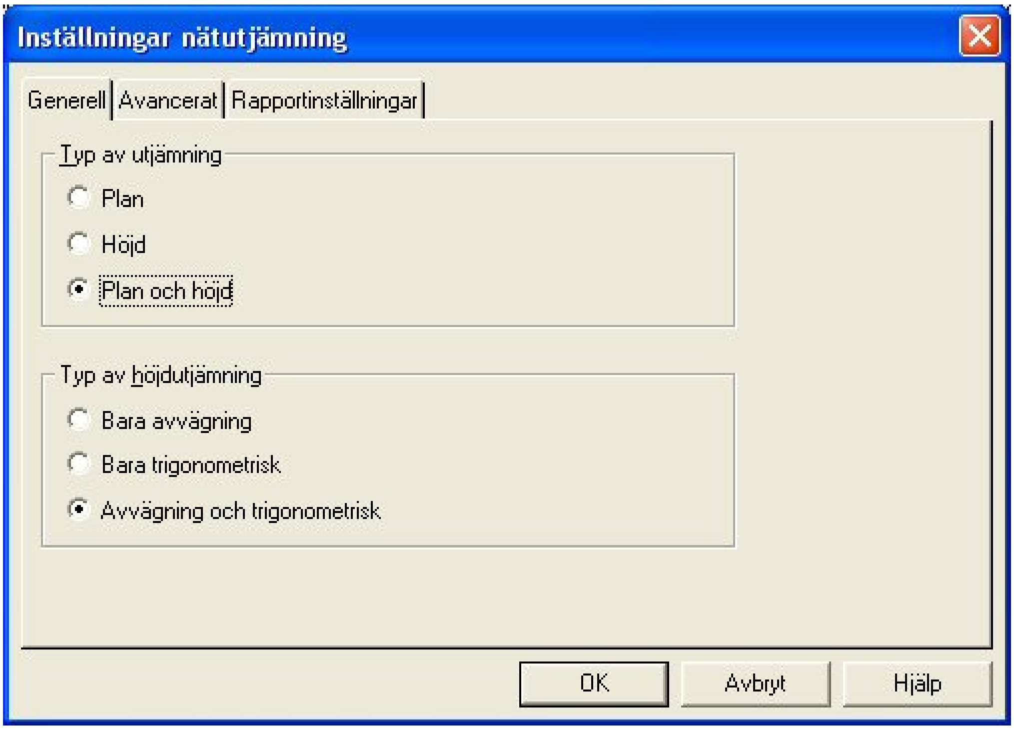
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

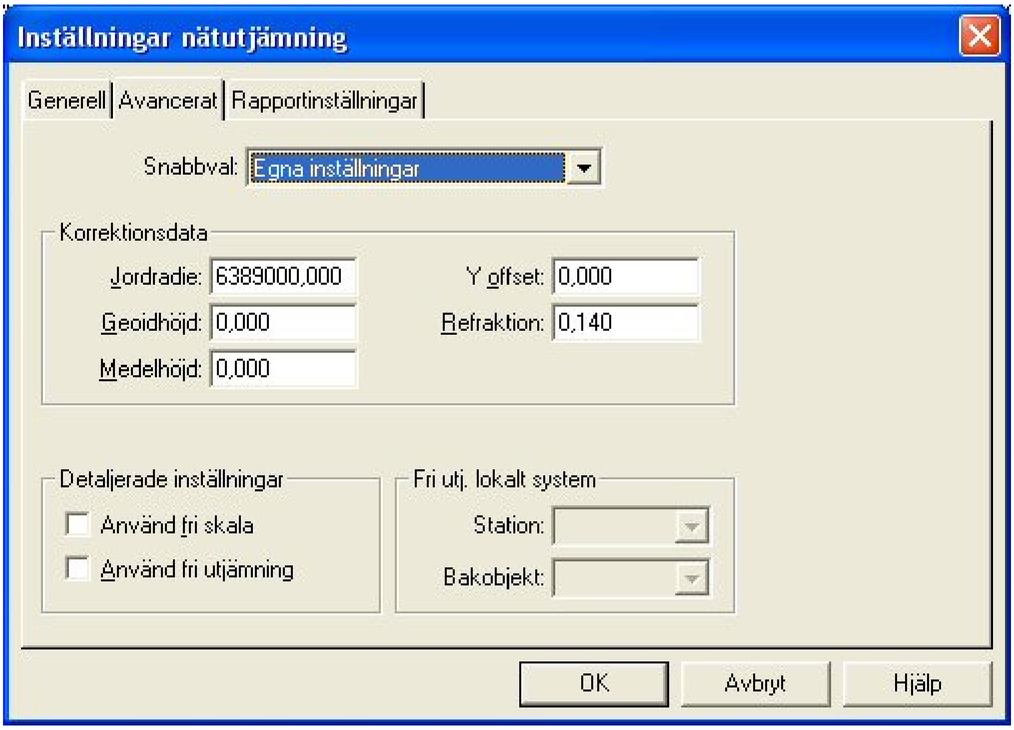
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

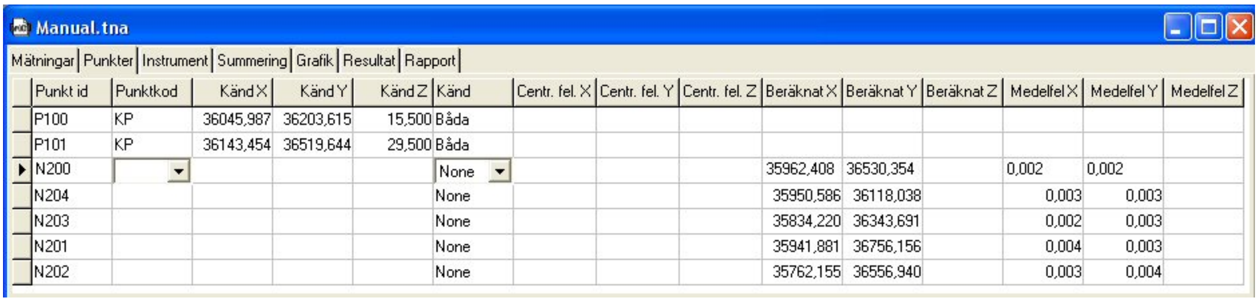
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

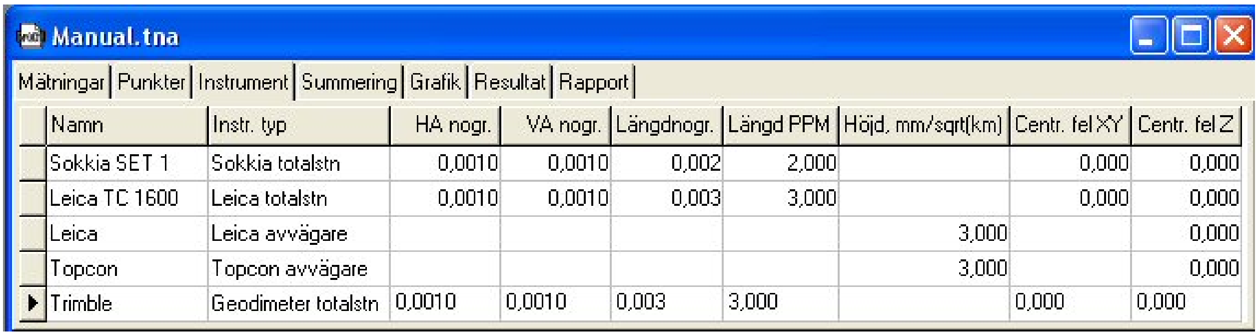
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

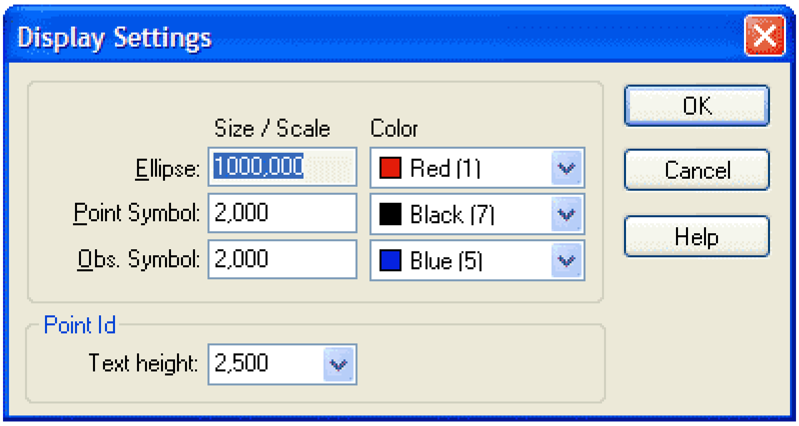
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



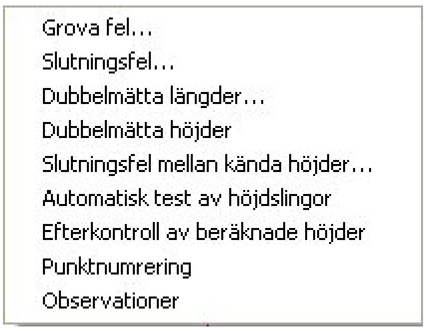
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

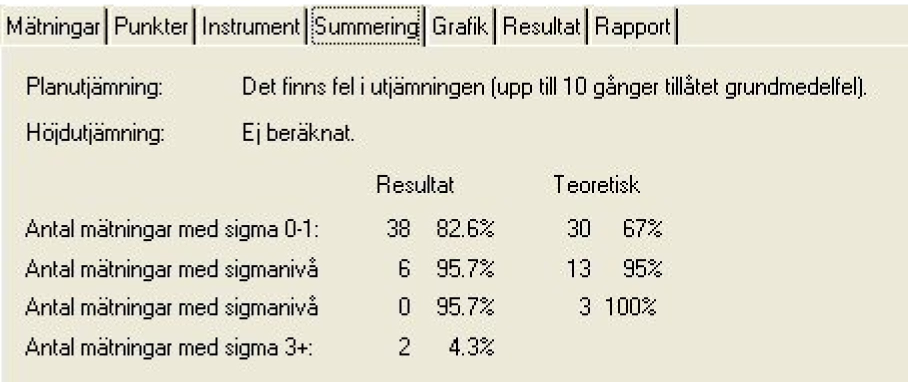
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

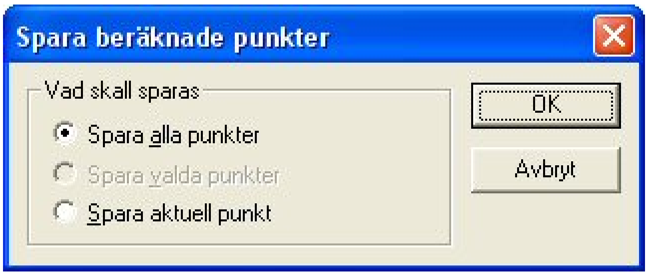
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



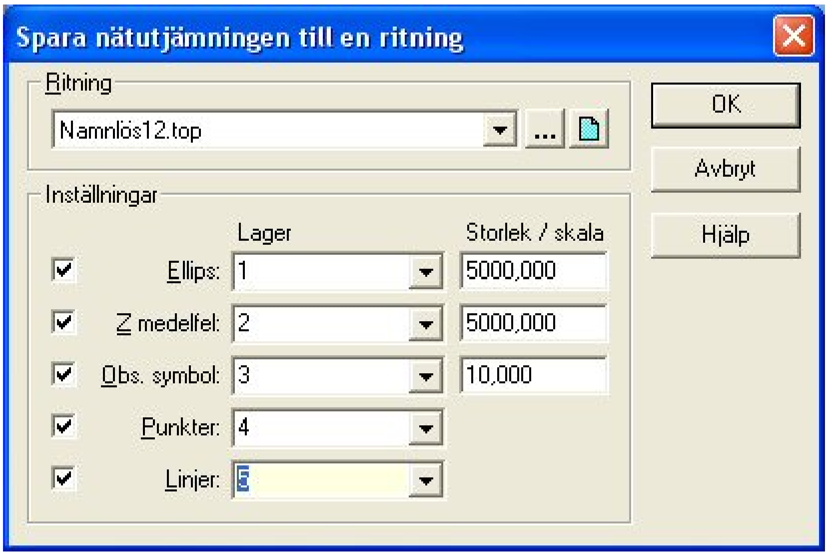
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

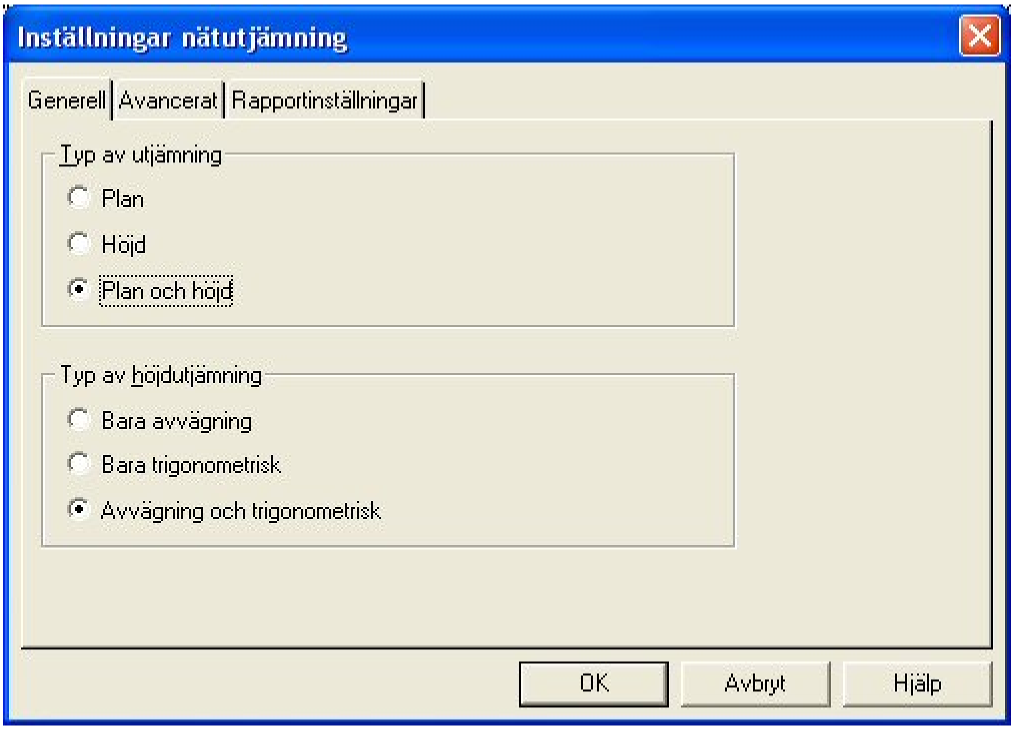
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

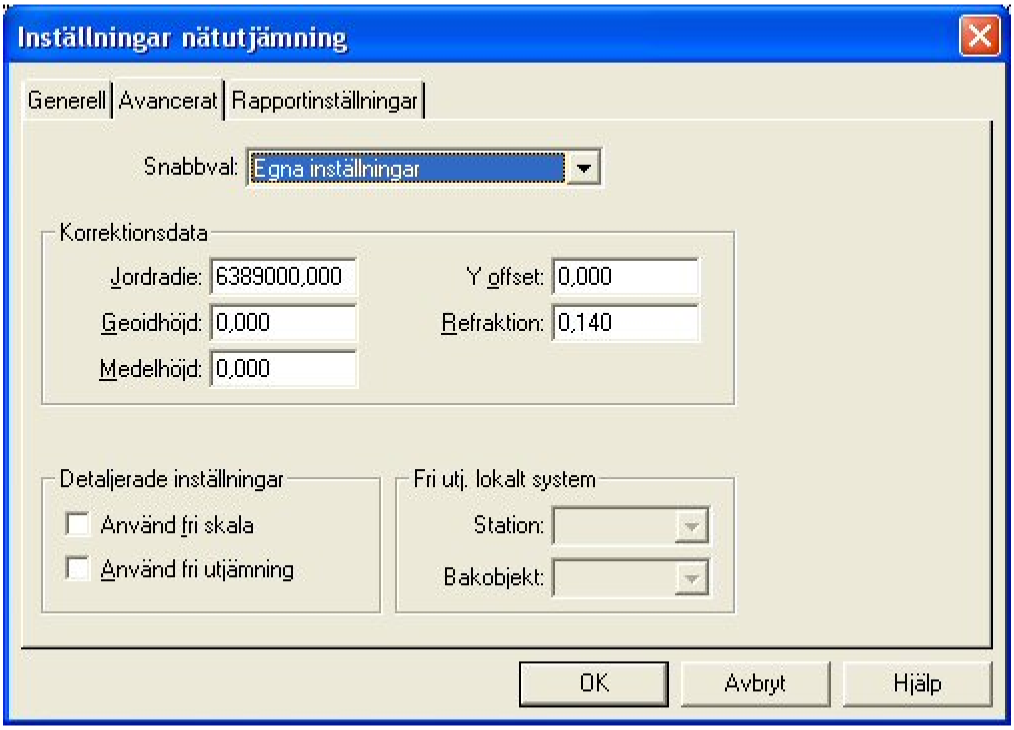
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

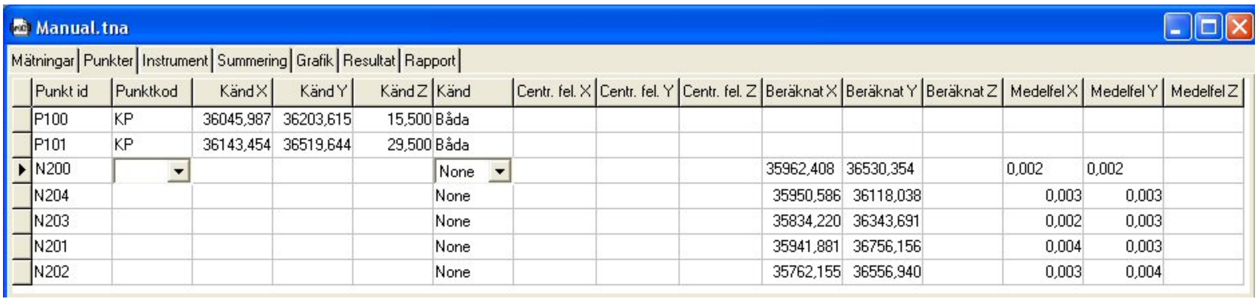
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

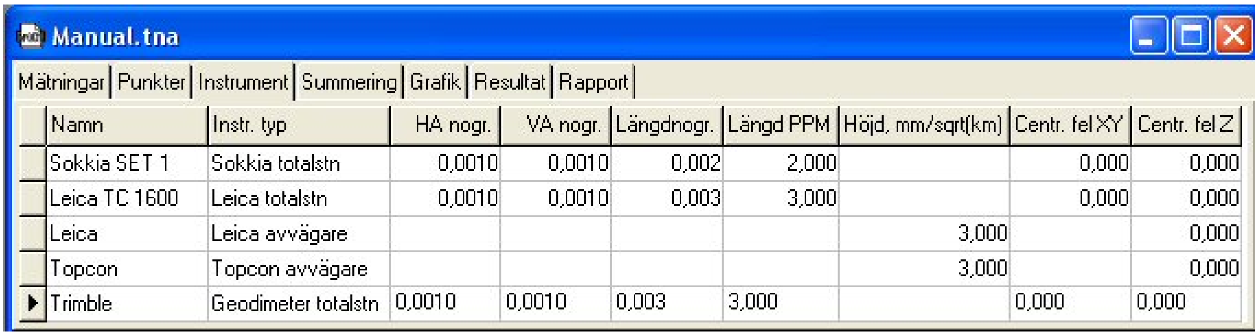
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments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Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

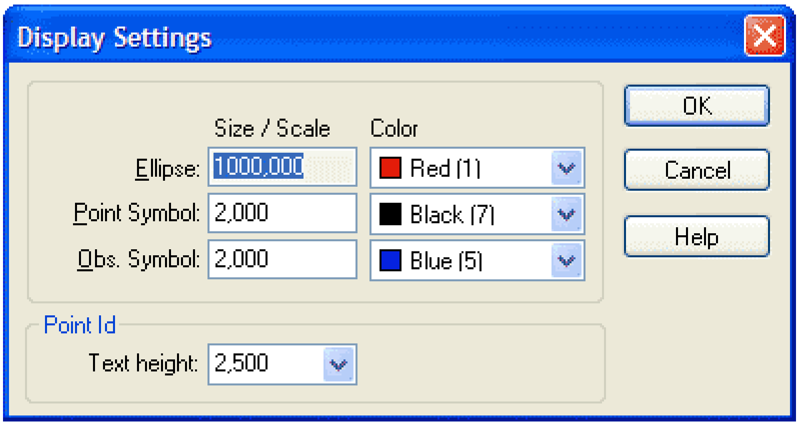
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



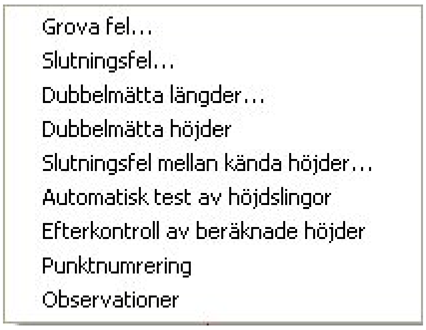
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

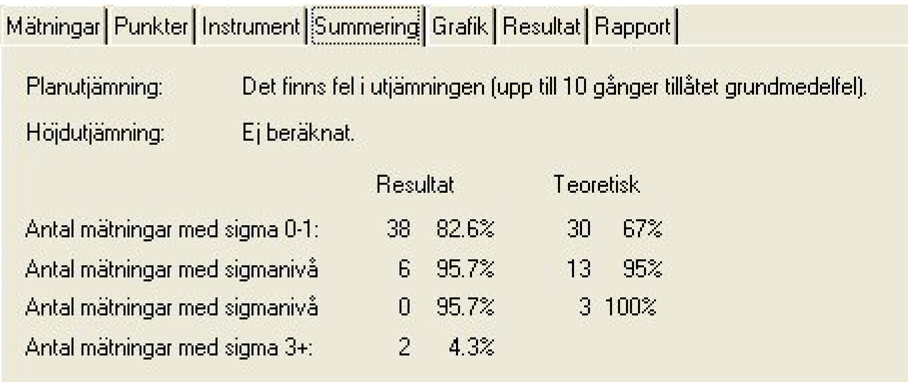
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

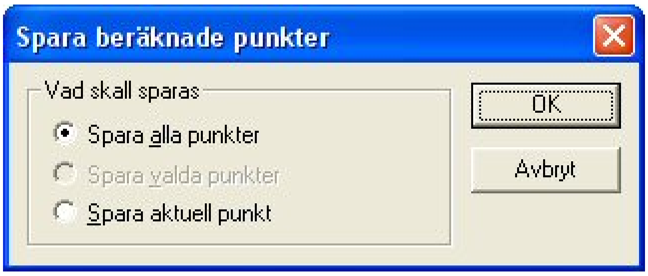
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



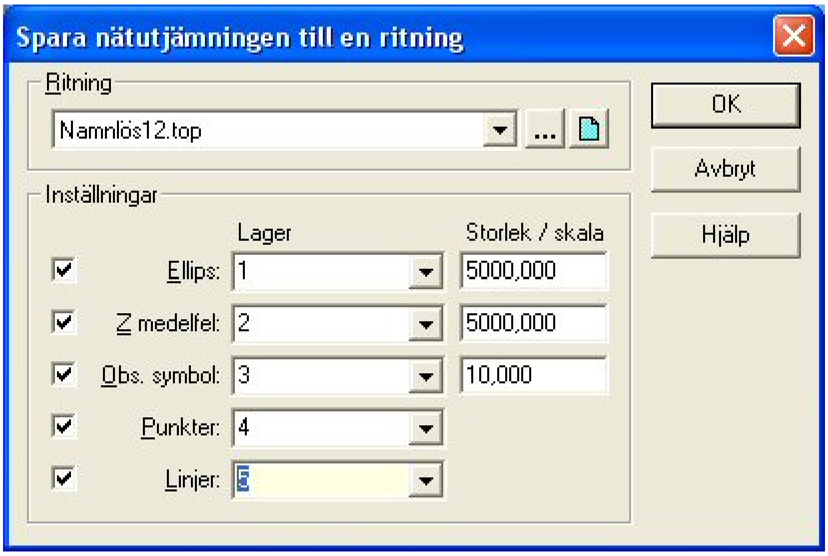
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

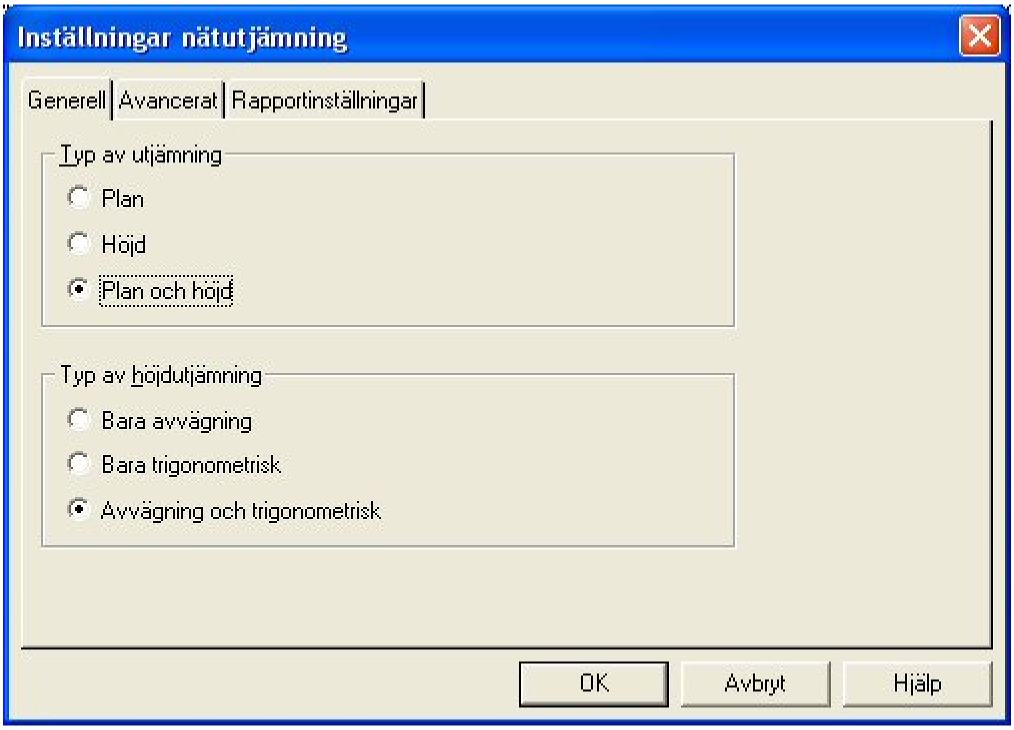
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

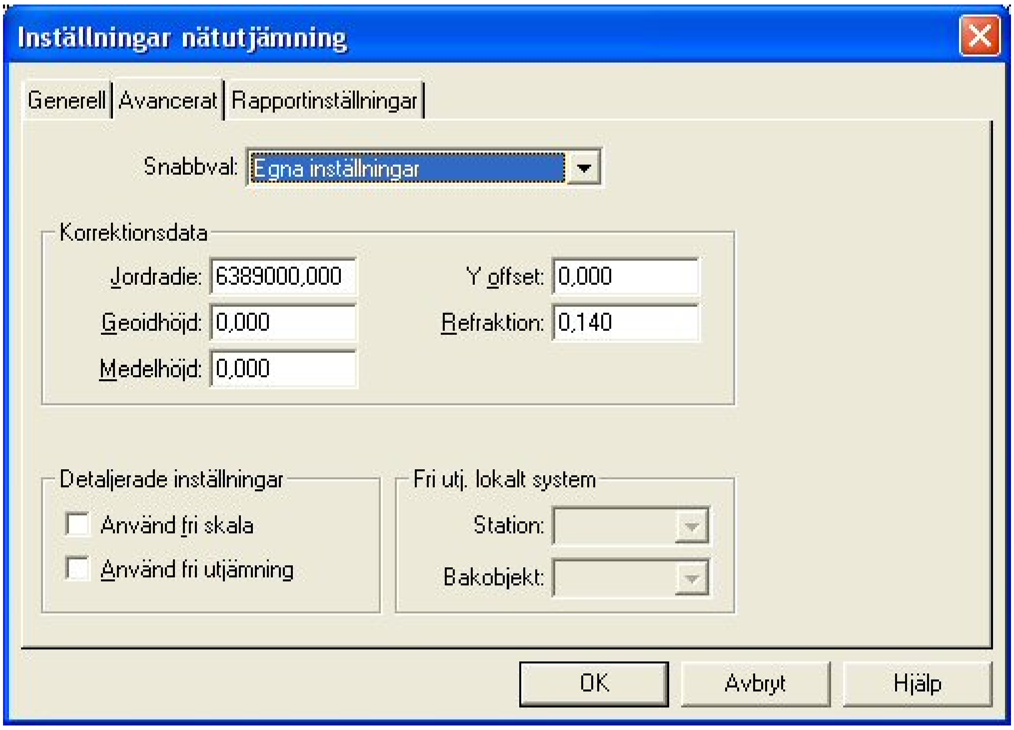
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

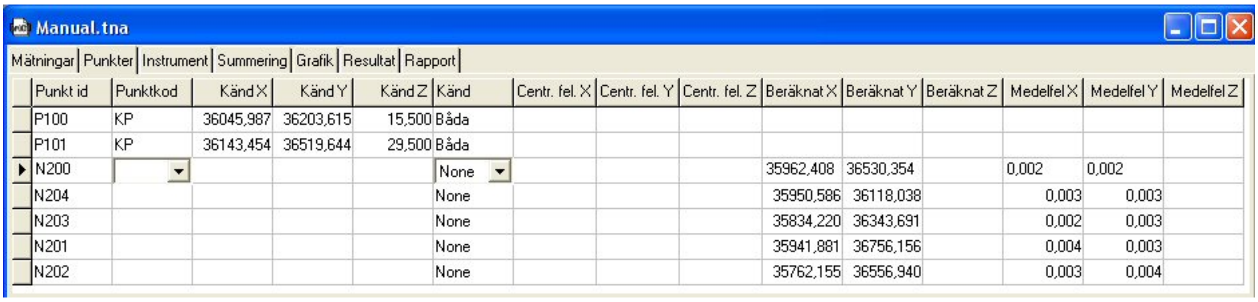
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

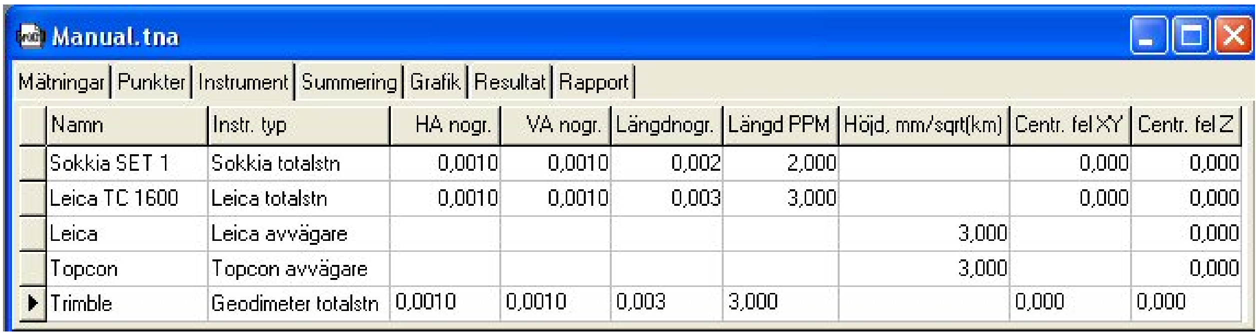
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Calculating of net

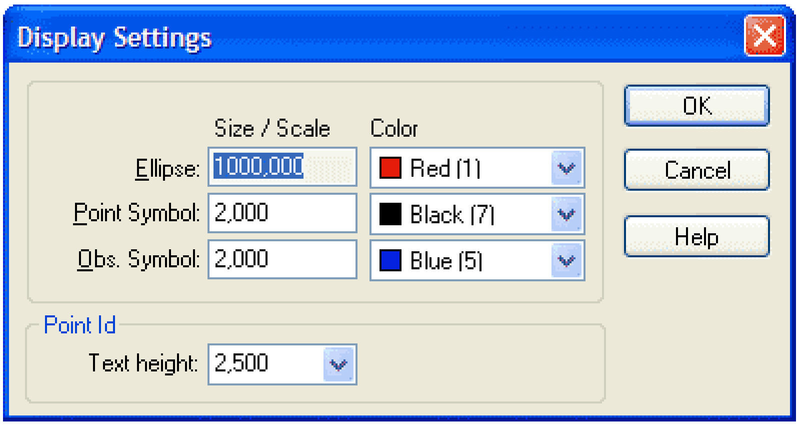
To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings

An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

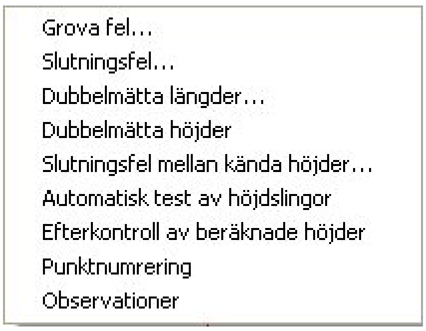


Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

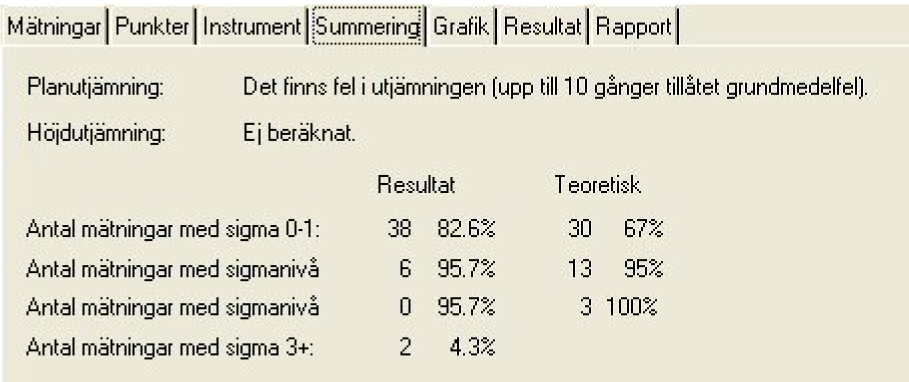
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

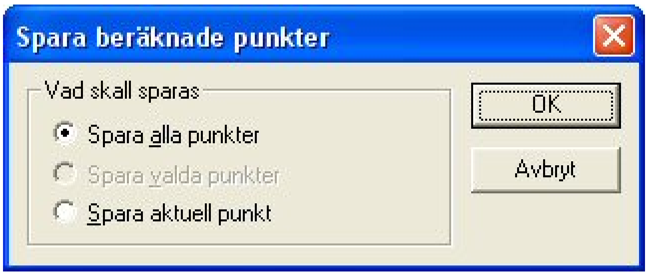
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



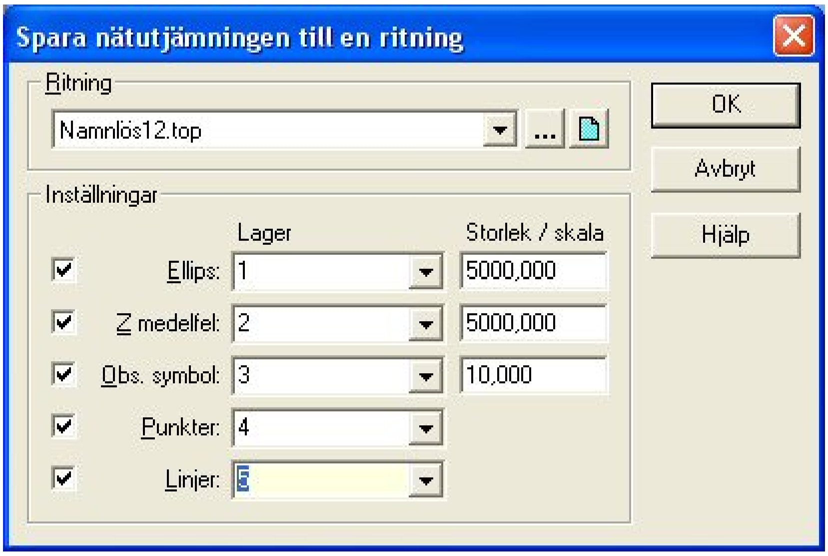
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

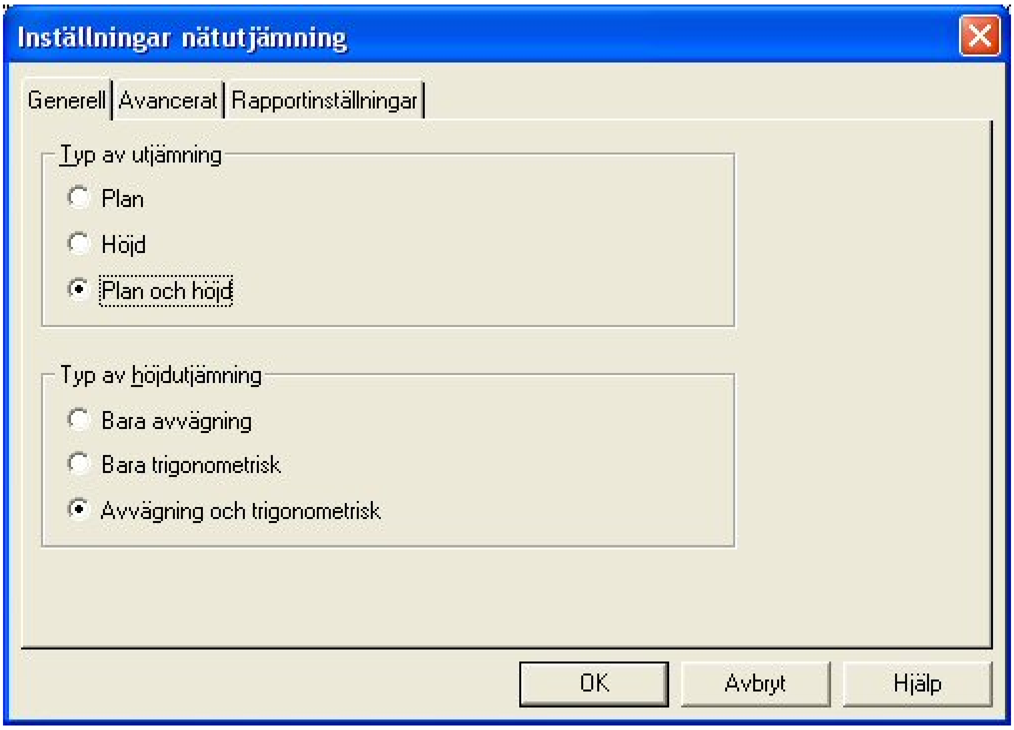
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

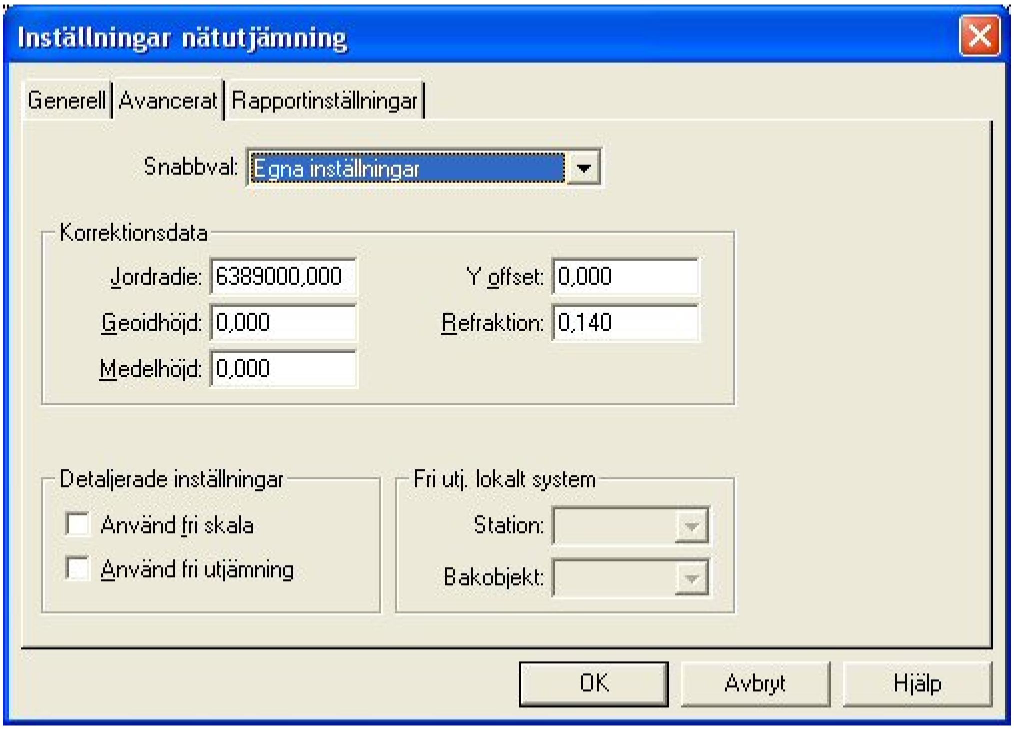
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

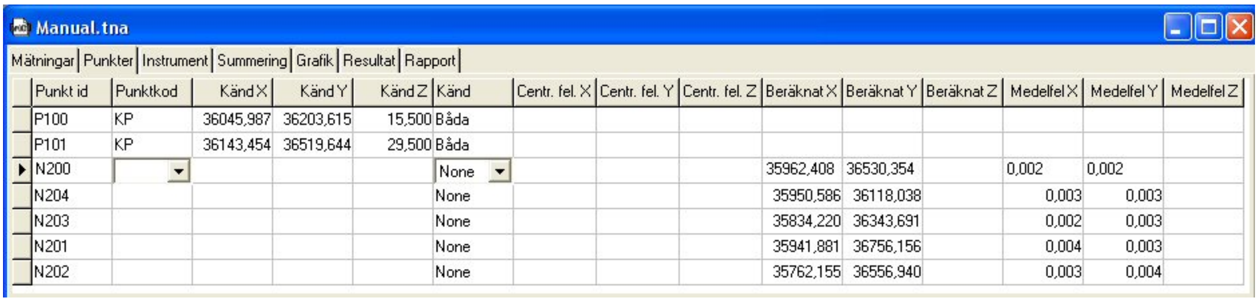
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna
Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

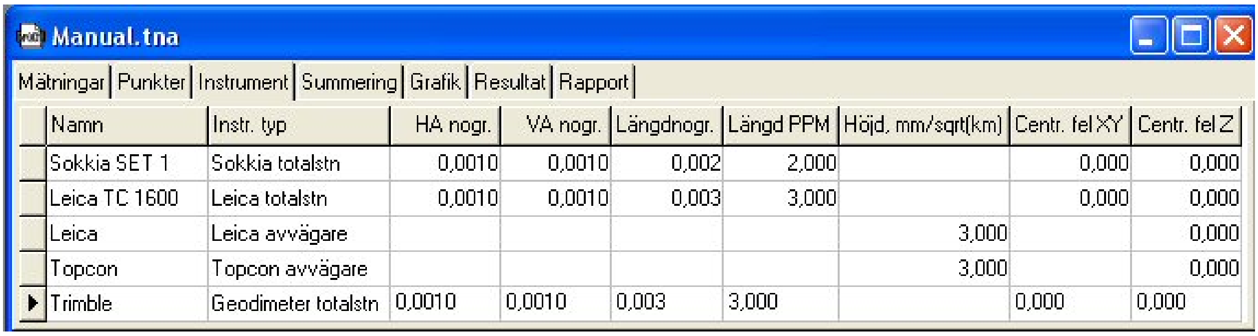
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

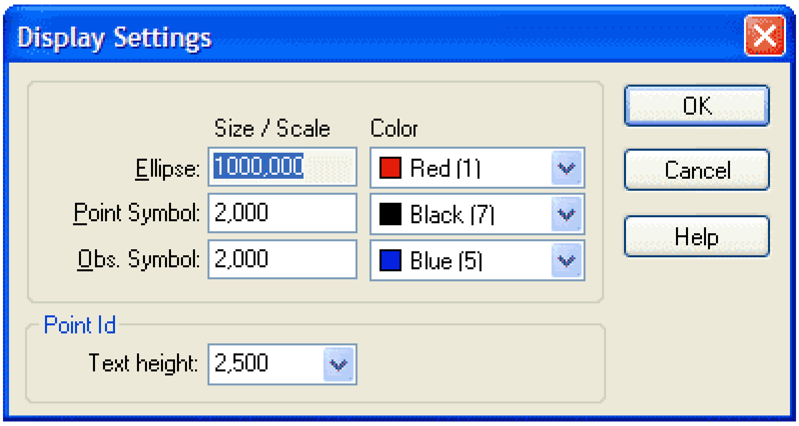
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



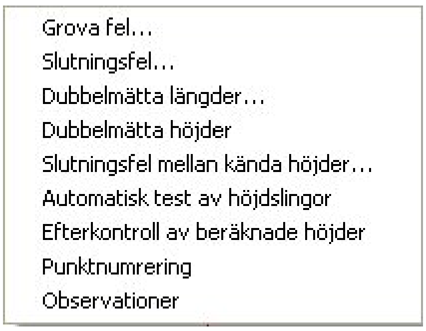
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

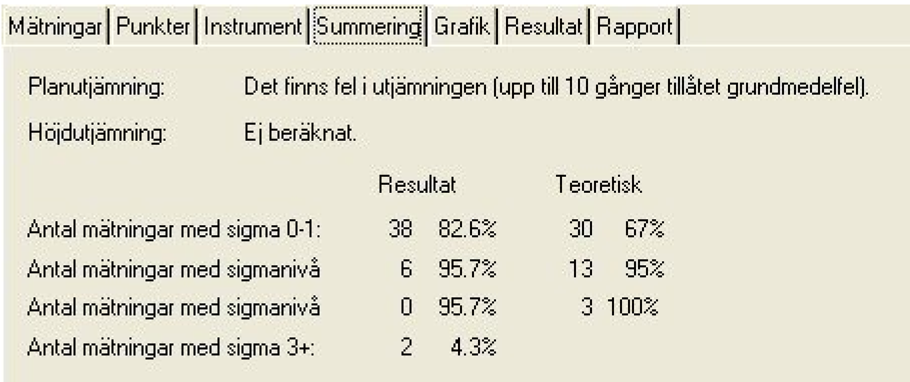
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

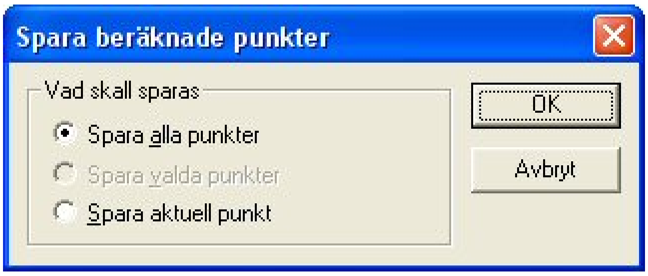
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



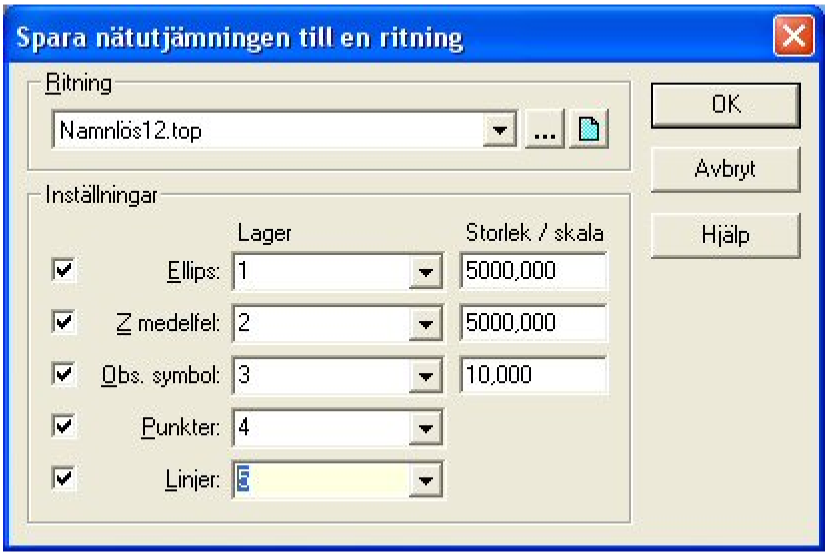
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

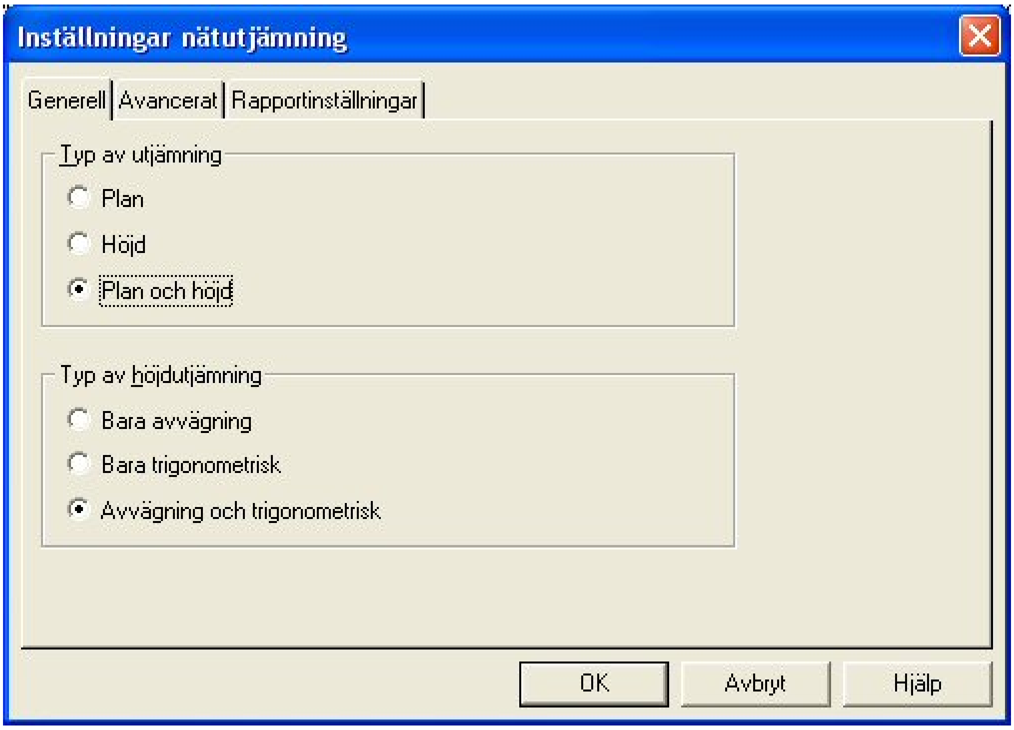
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

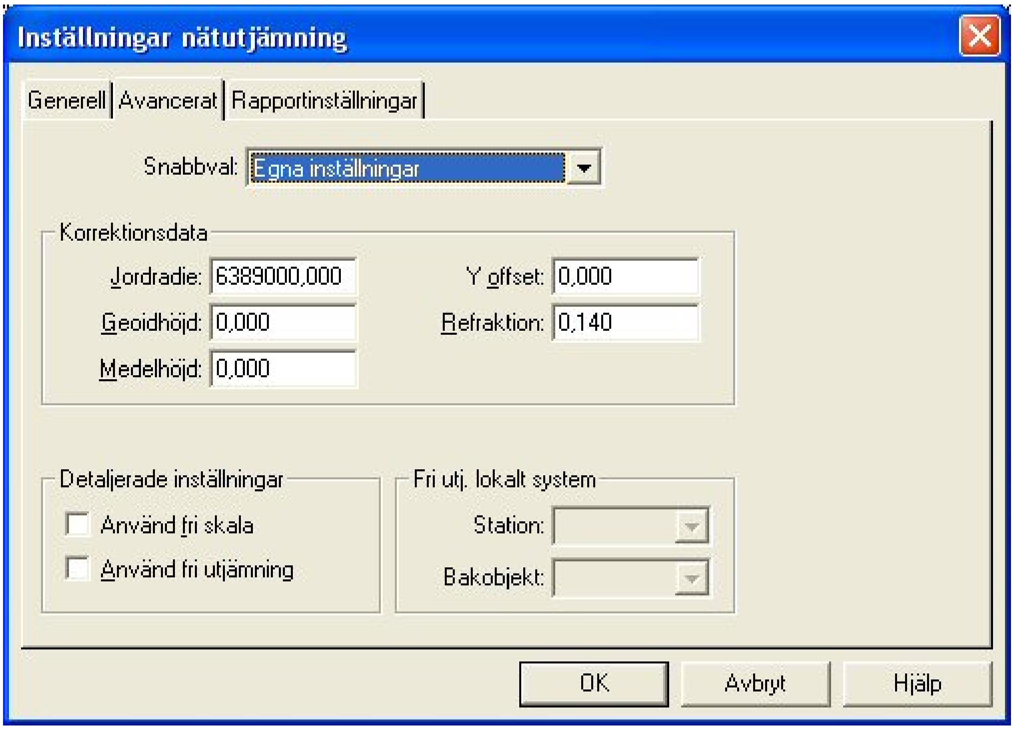
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

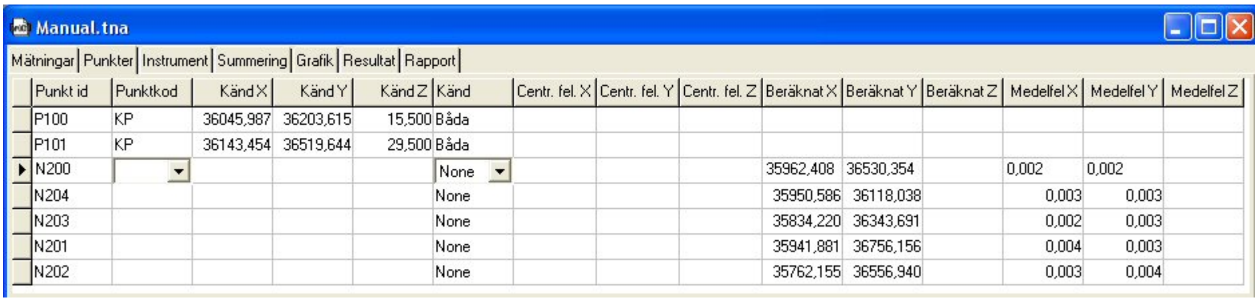
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

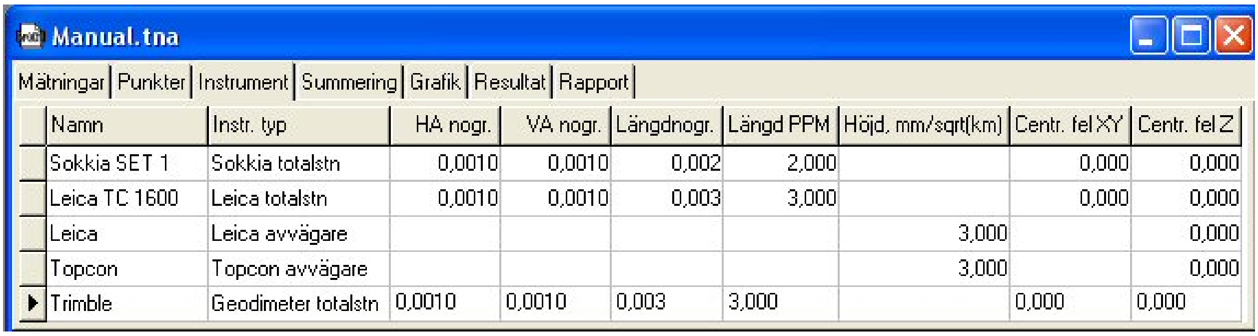
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

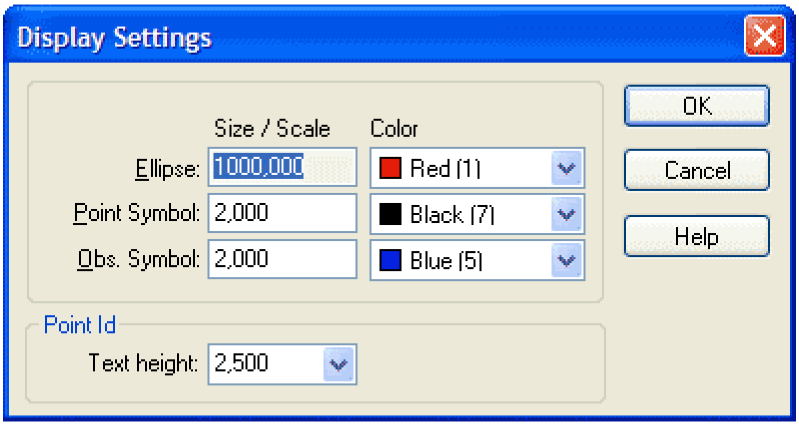
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



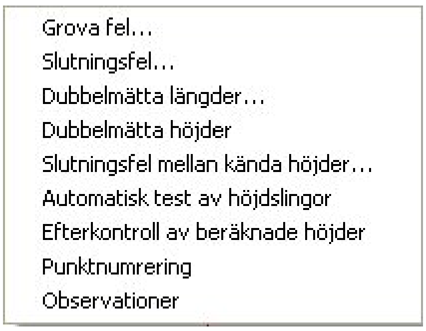
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

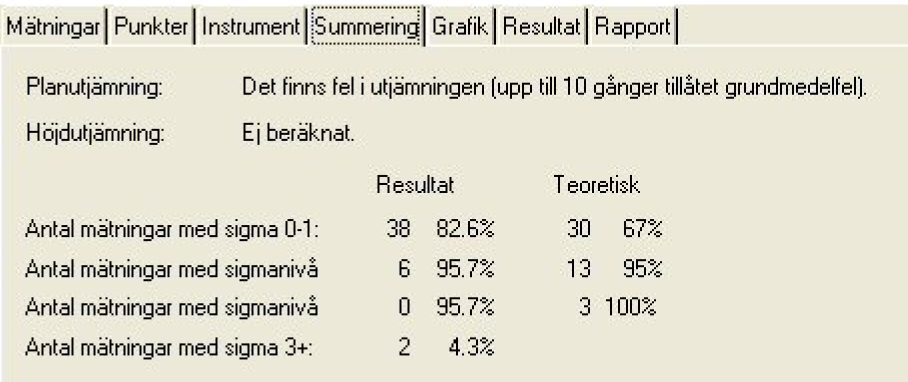
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

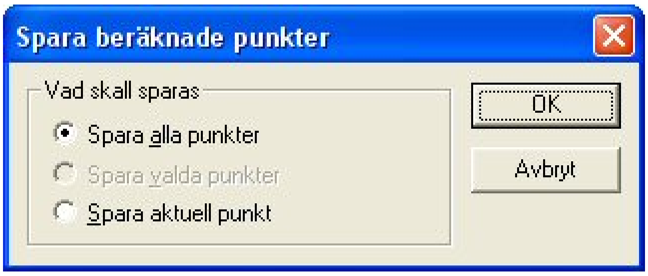
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



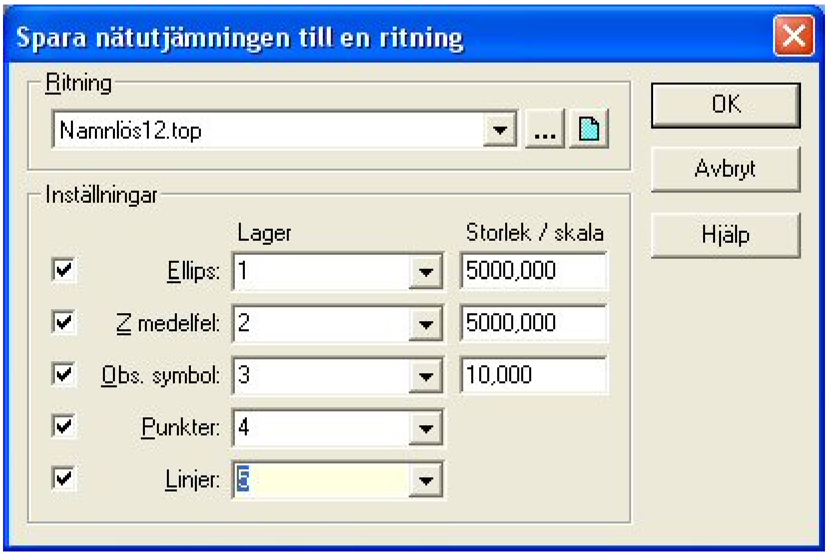
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

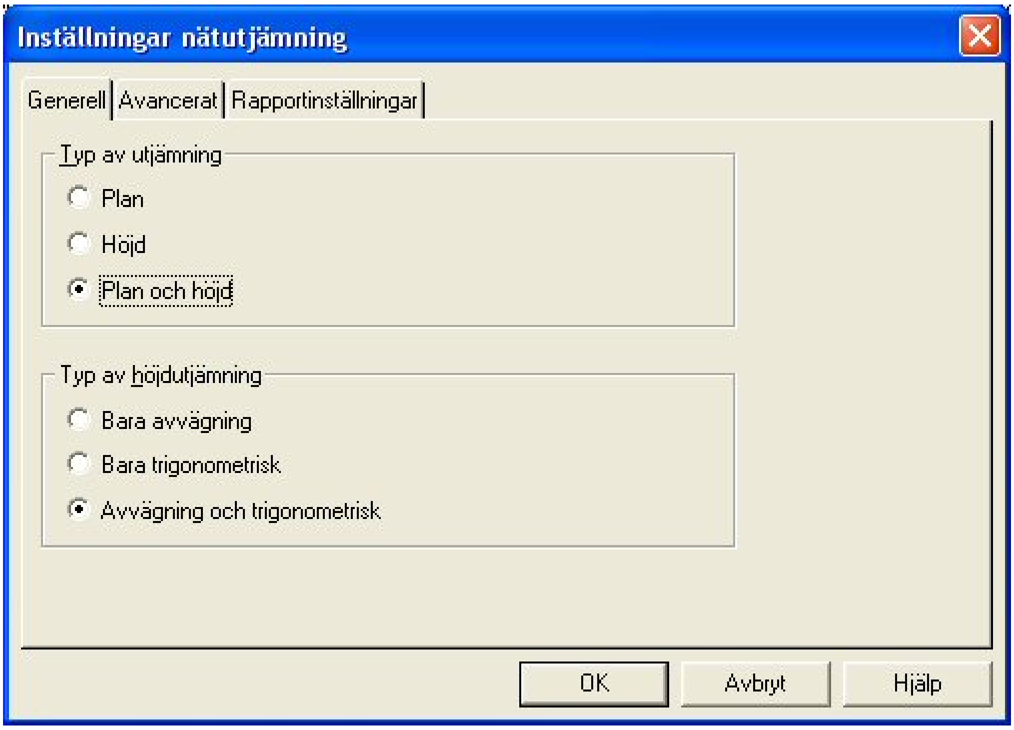
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

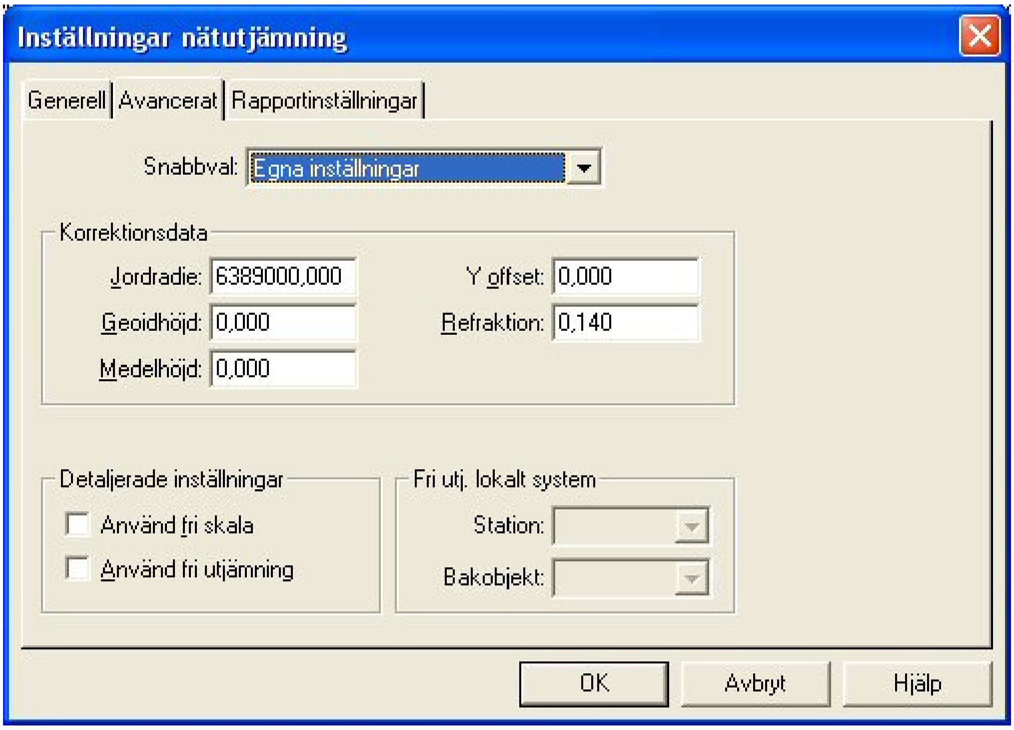
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

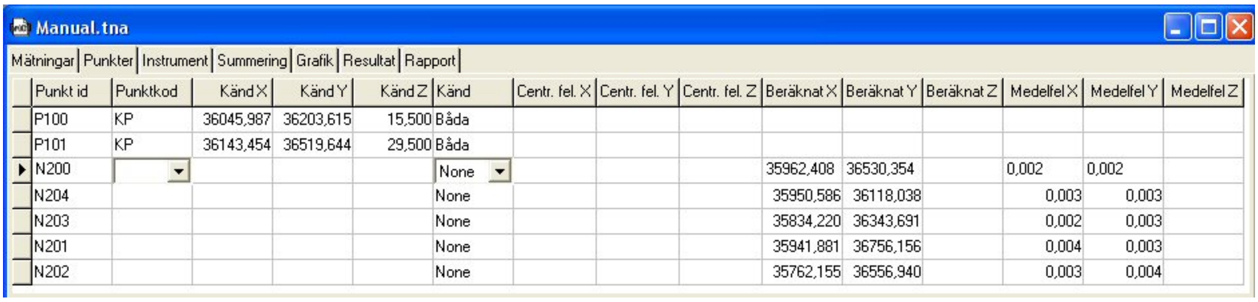
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

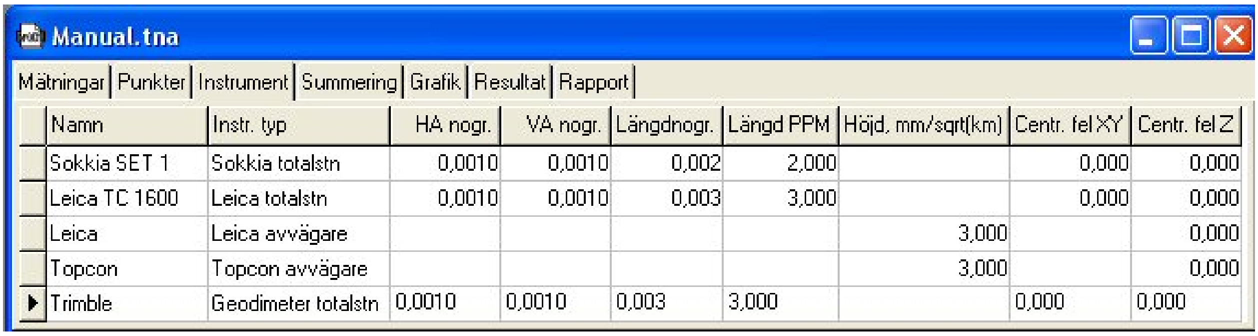
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

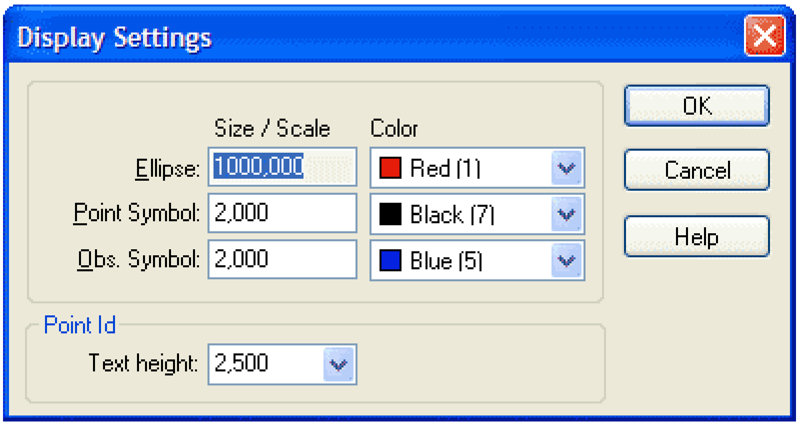
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



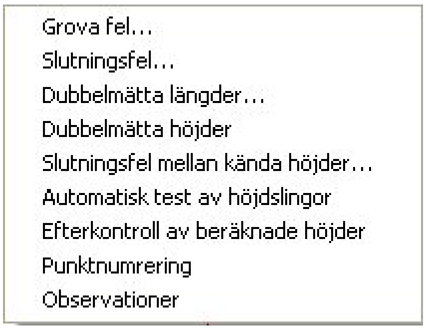
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

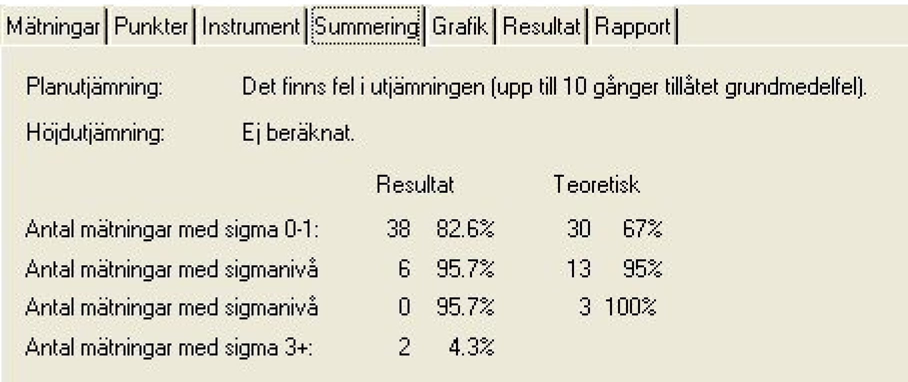
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

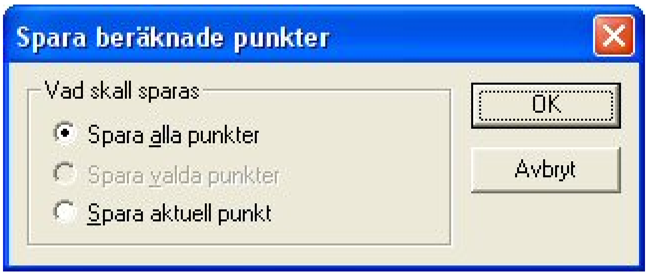
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



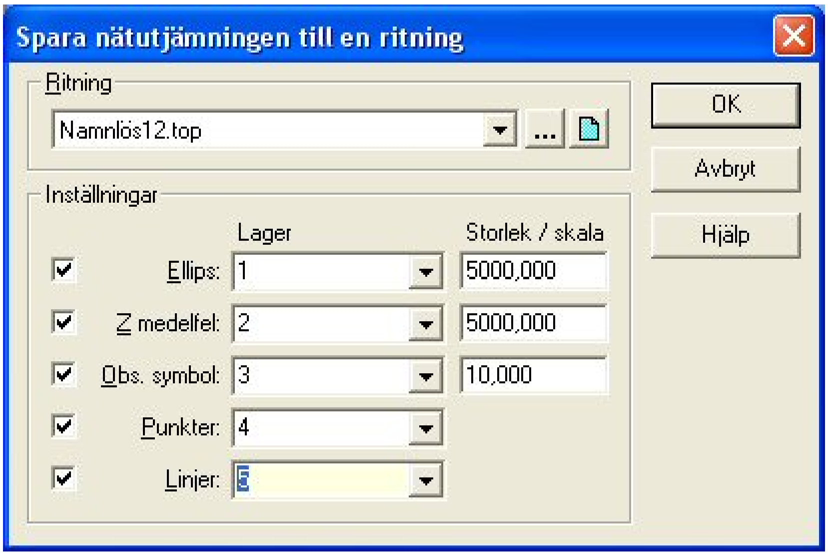
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

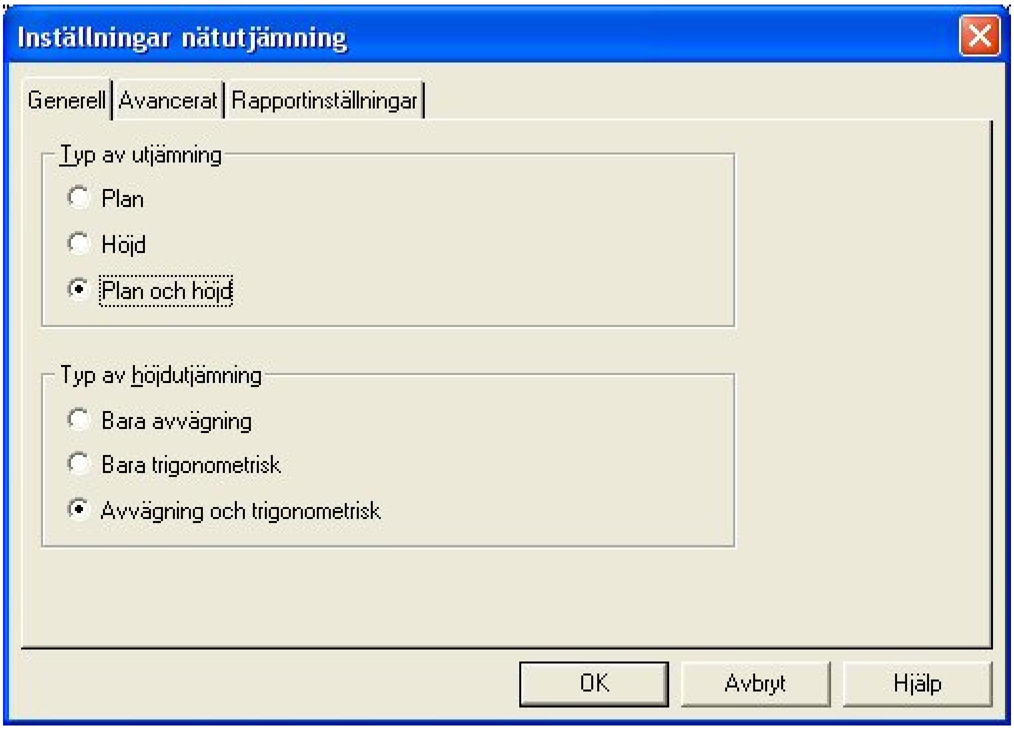
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

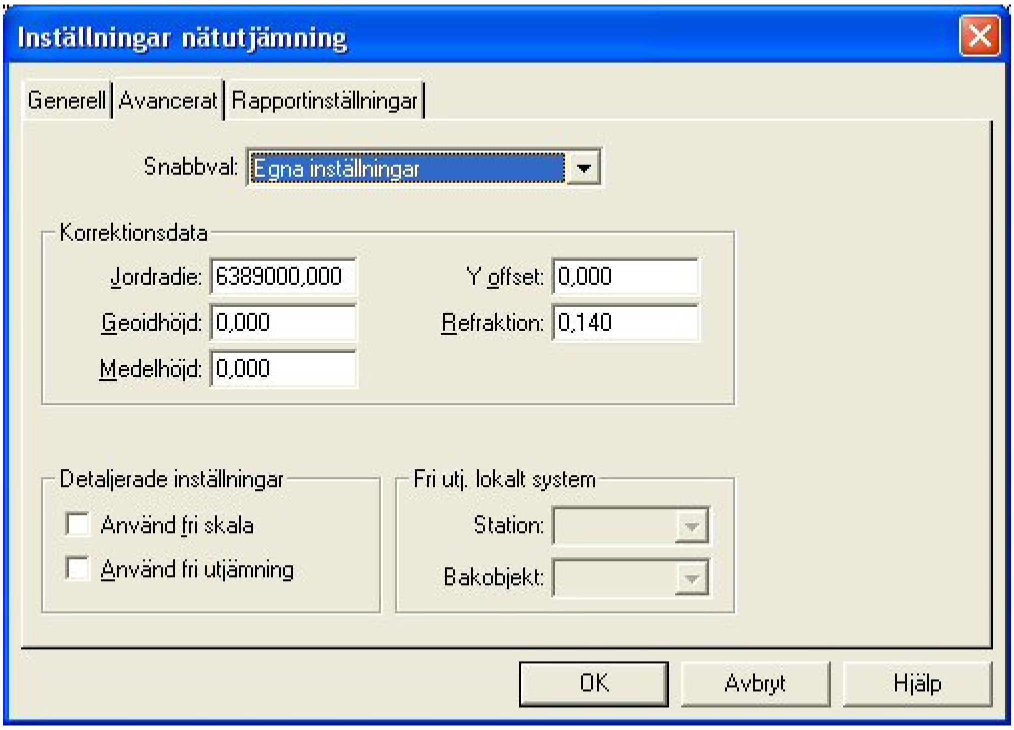
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

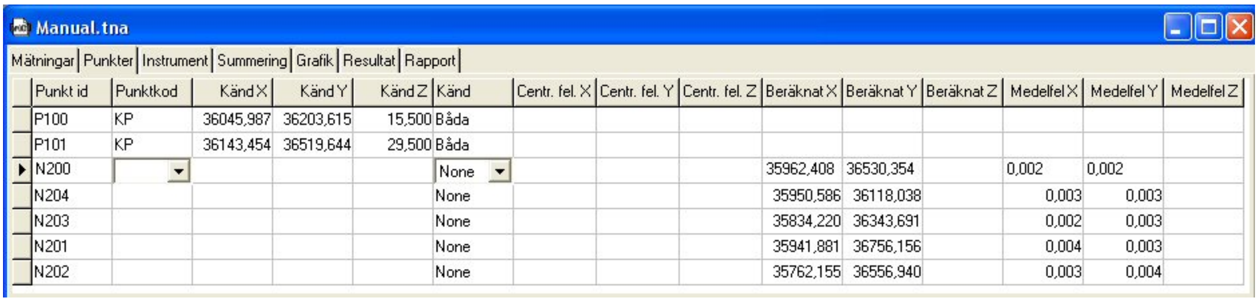
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

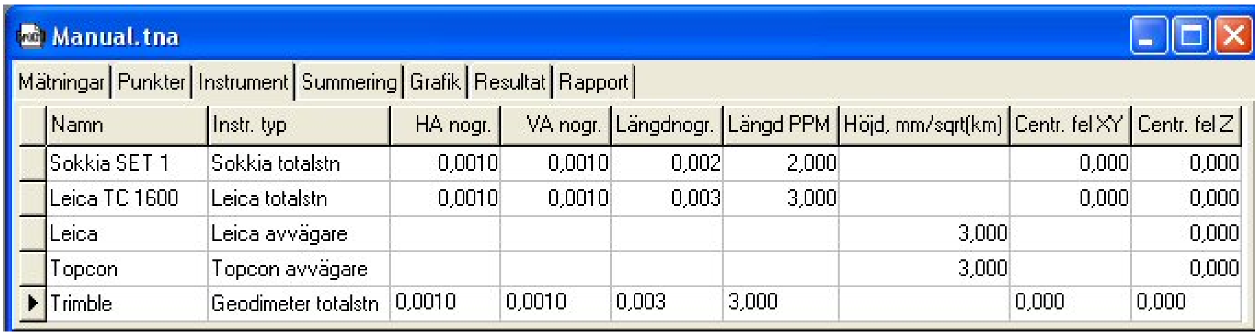
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

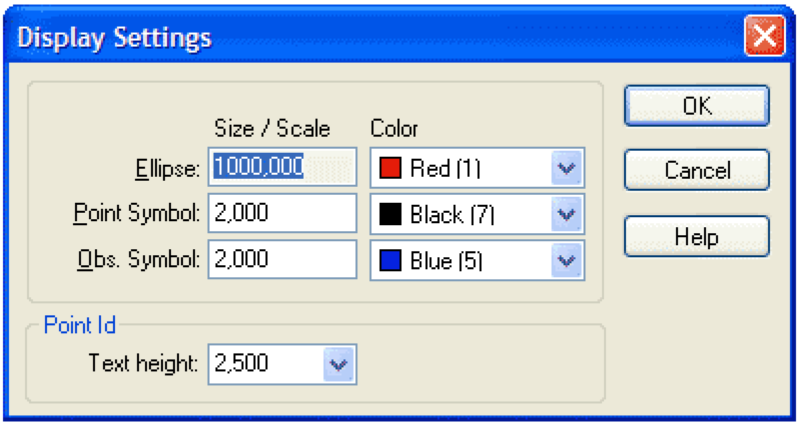
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



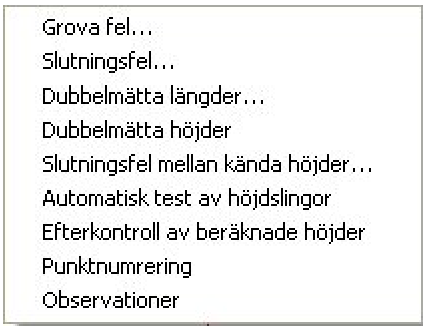
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

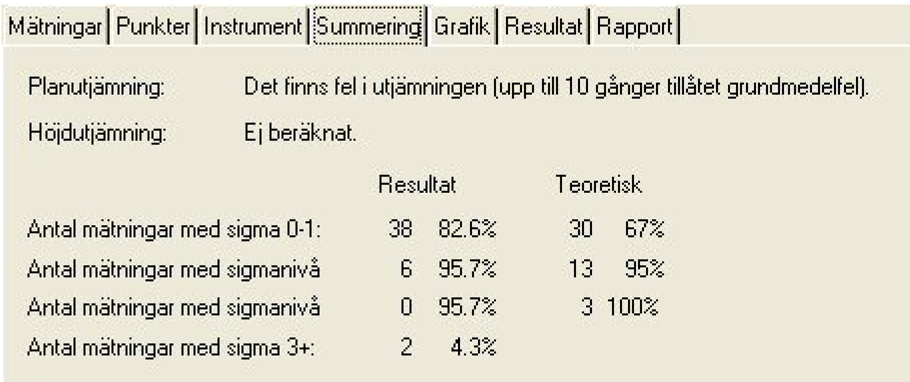
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

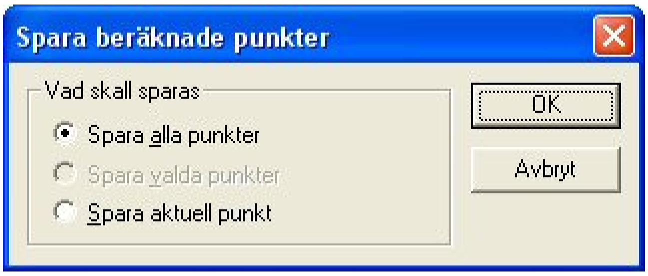
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



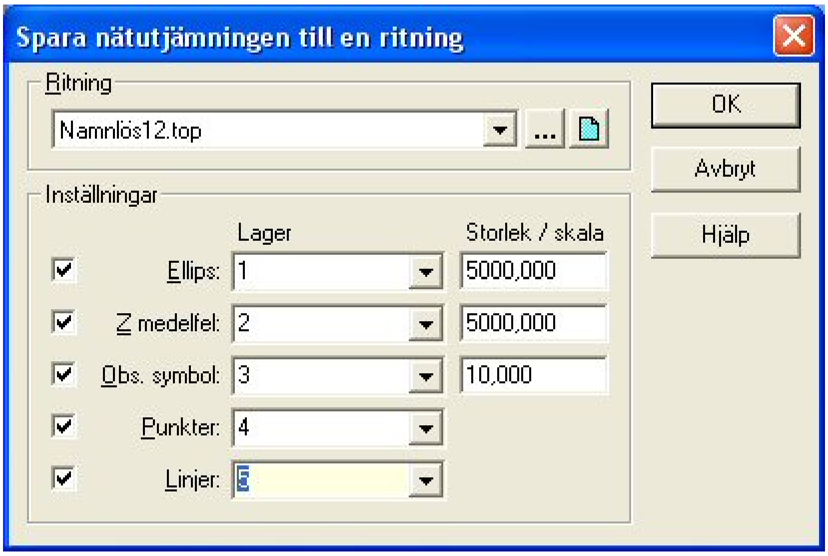
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

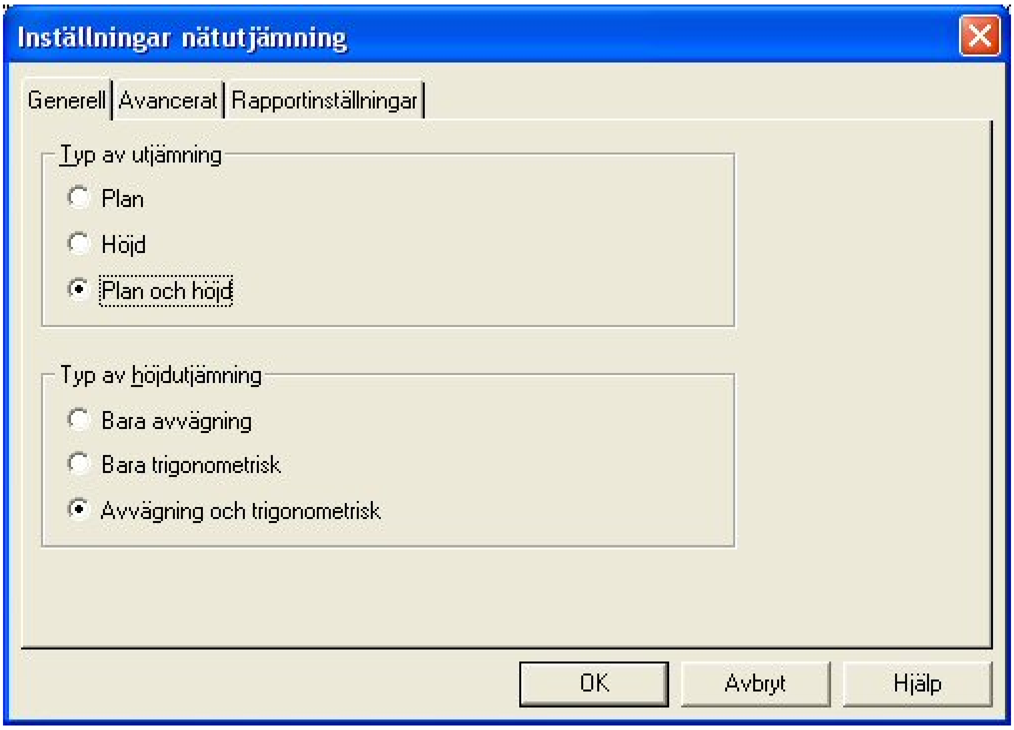
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

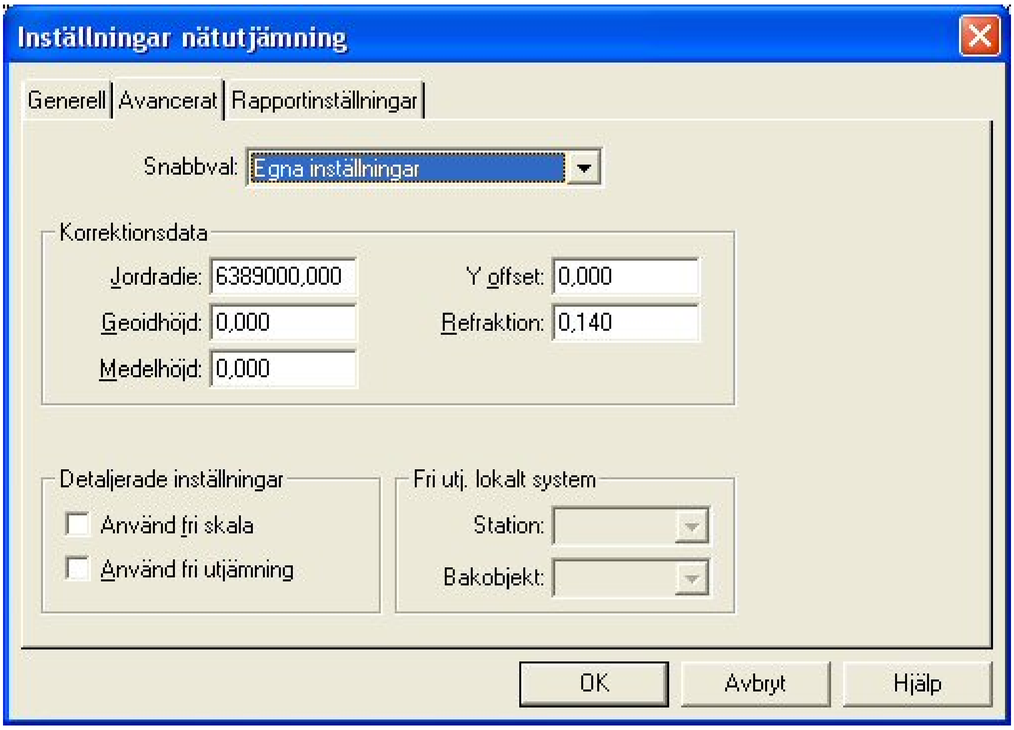
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

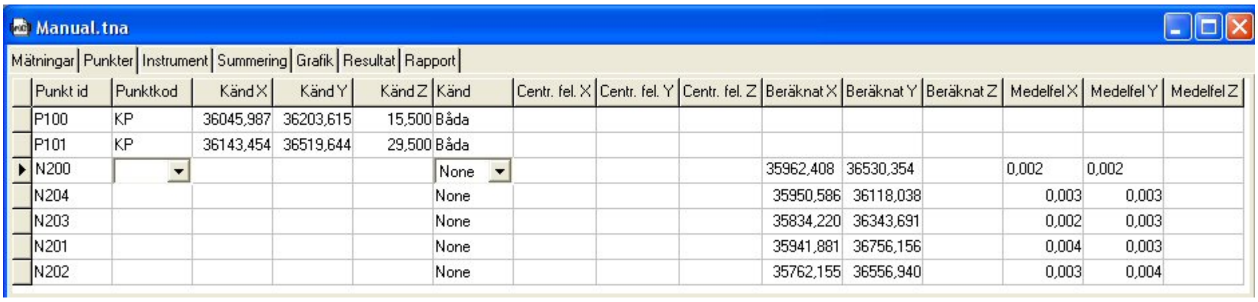
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

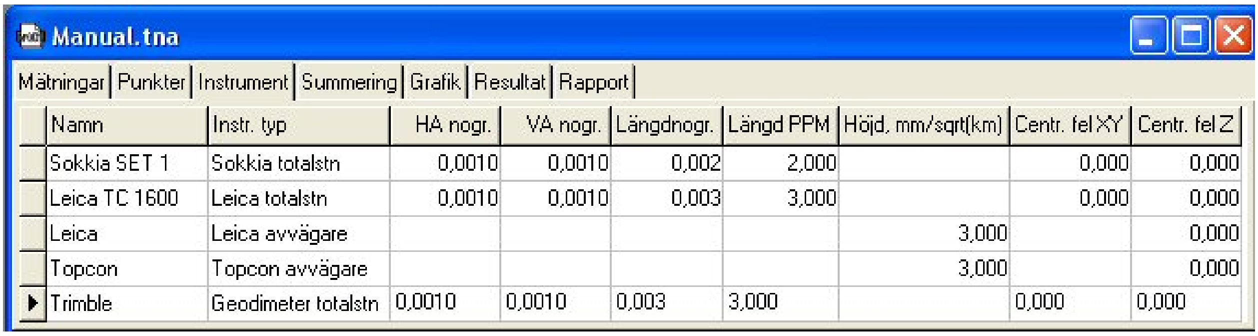
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

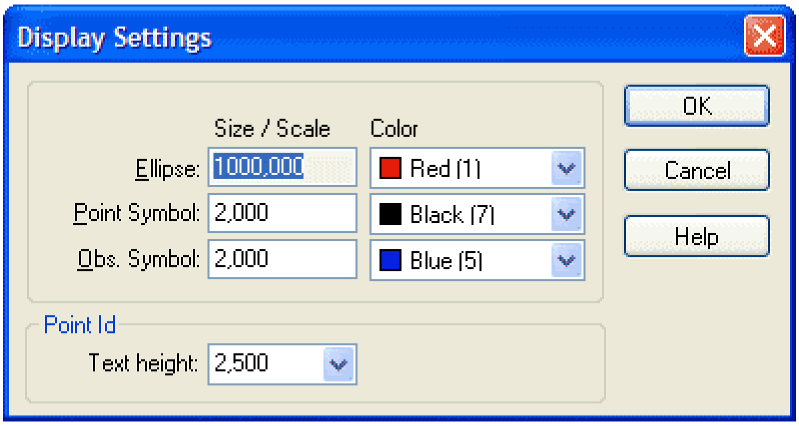
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



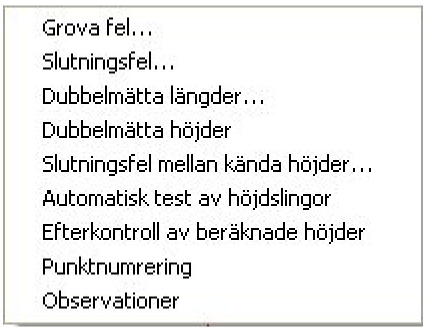
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

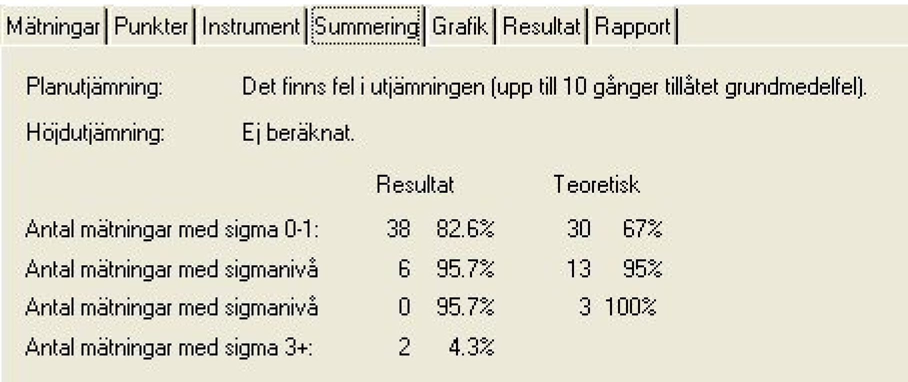
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

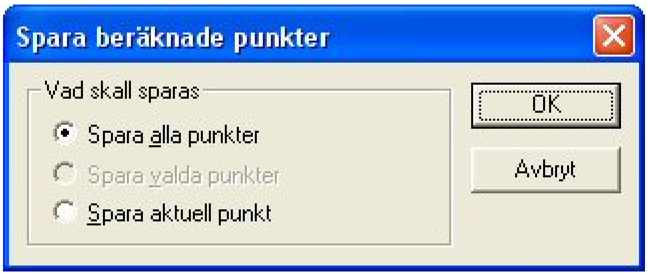
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



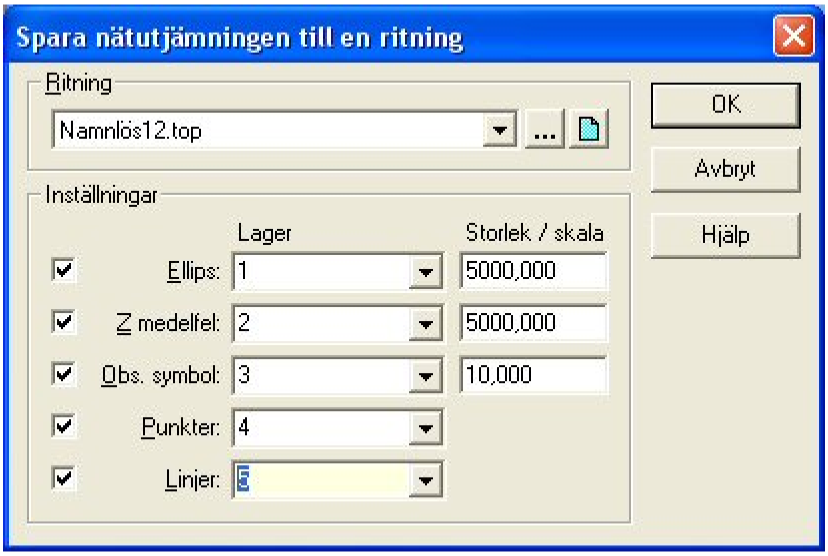
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

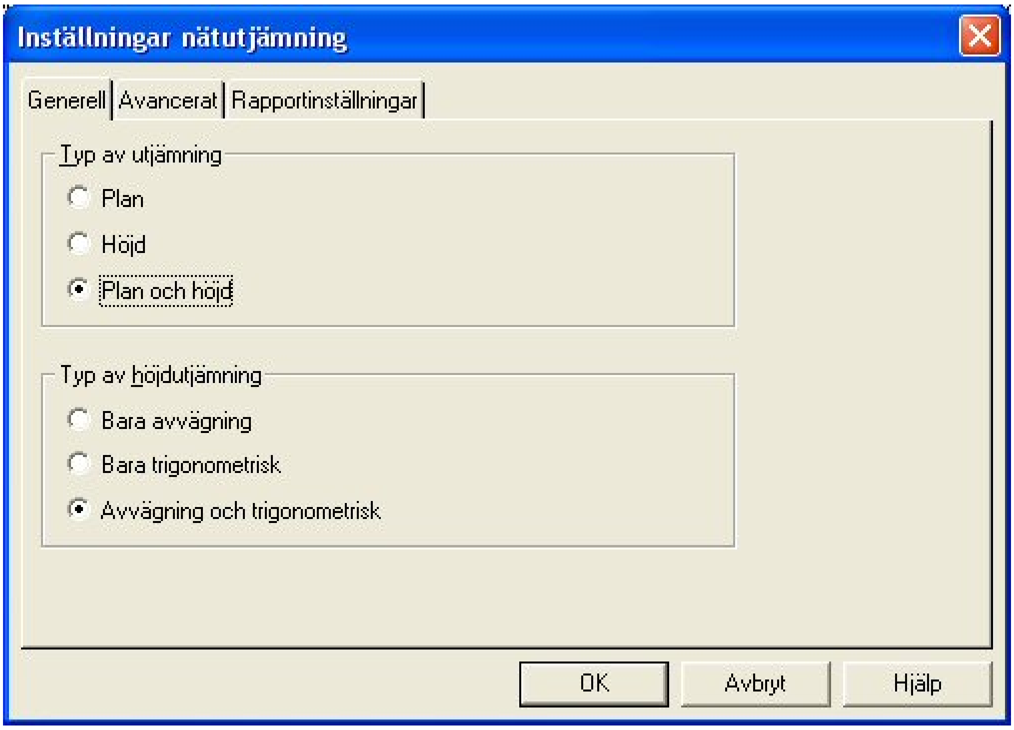
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

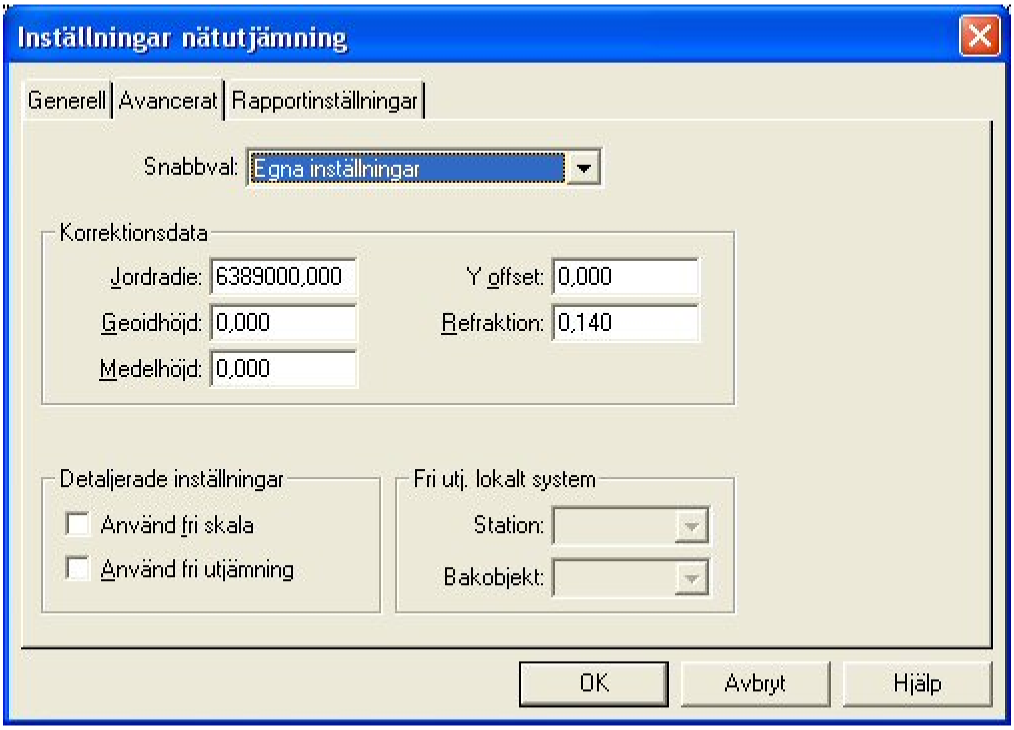
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

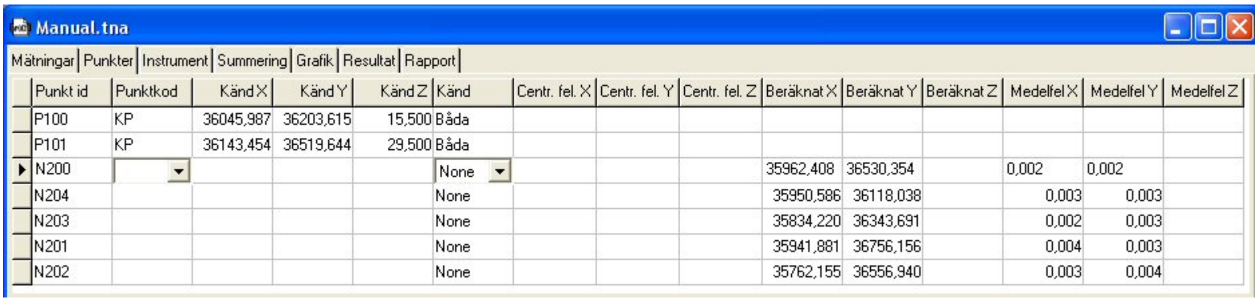
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

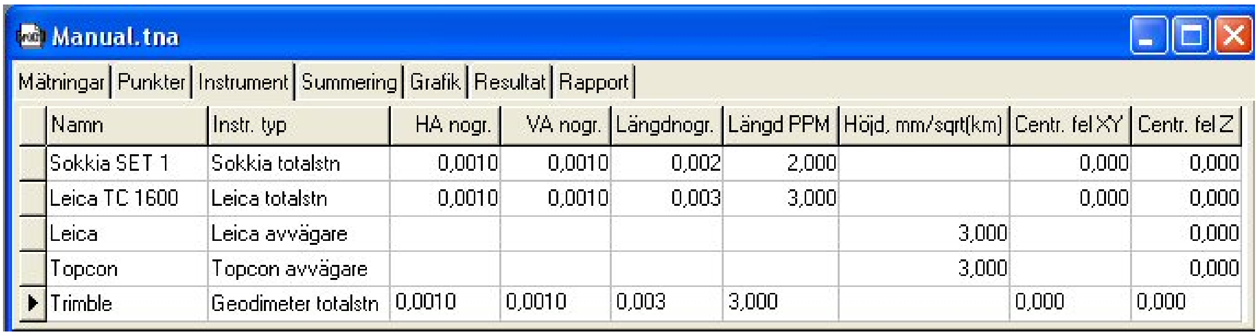
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

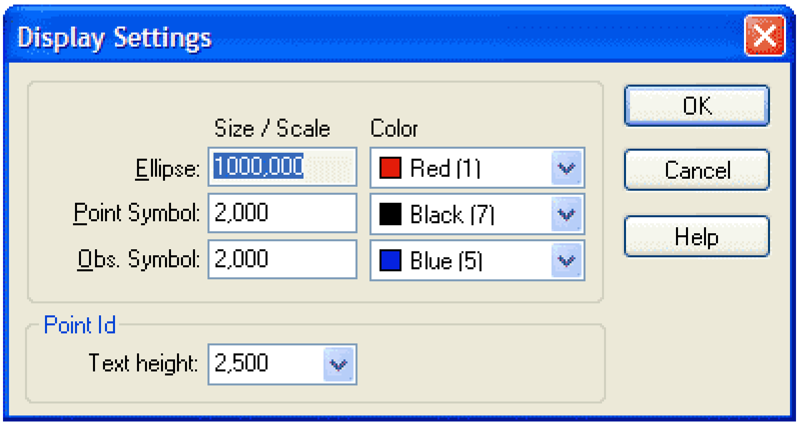
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



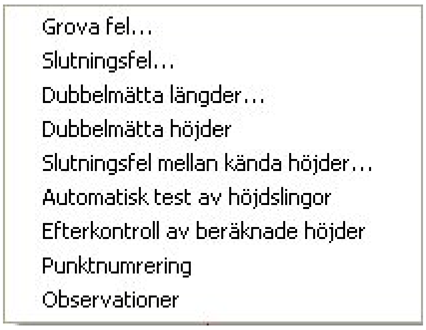
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

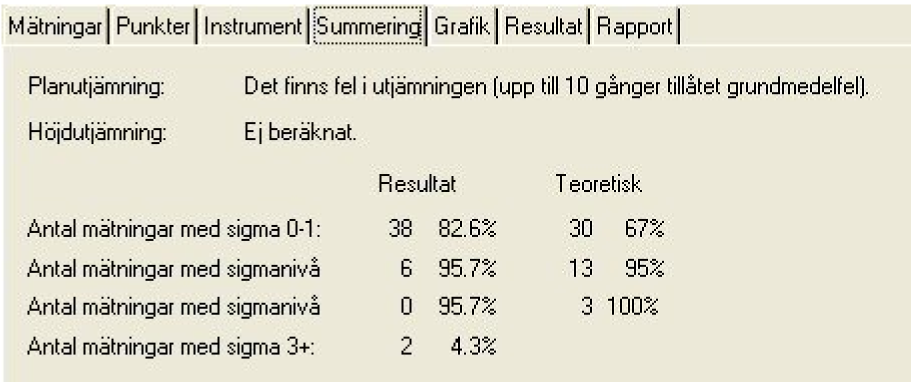
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

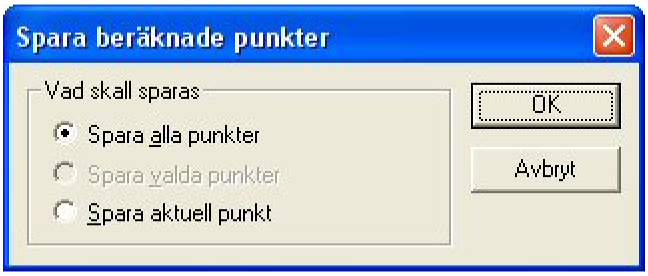
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



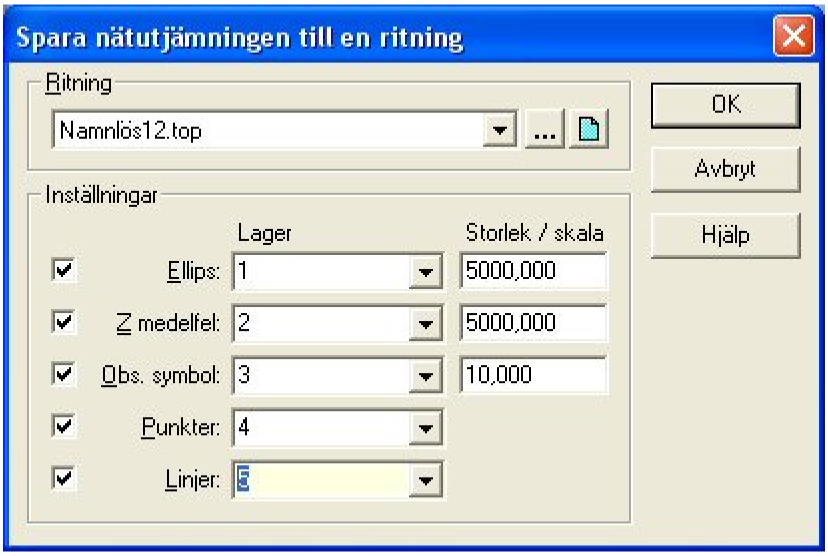
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

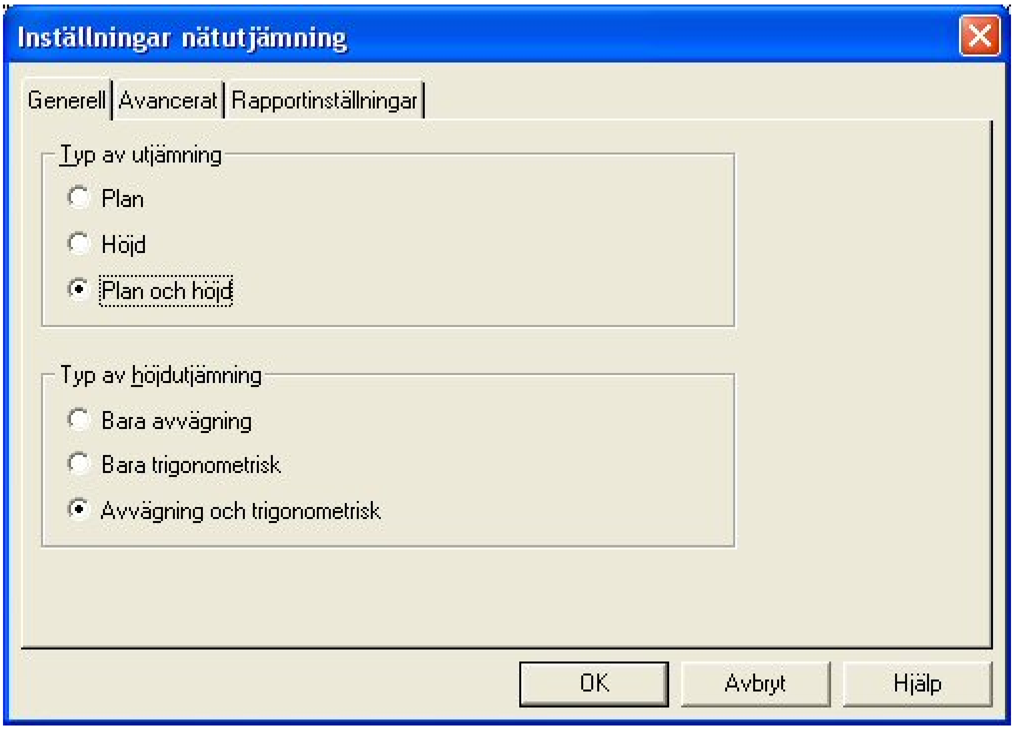
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

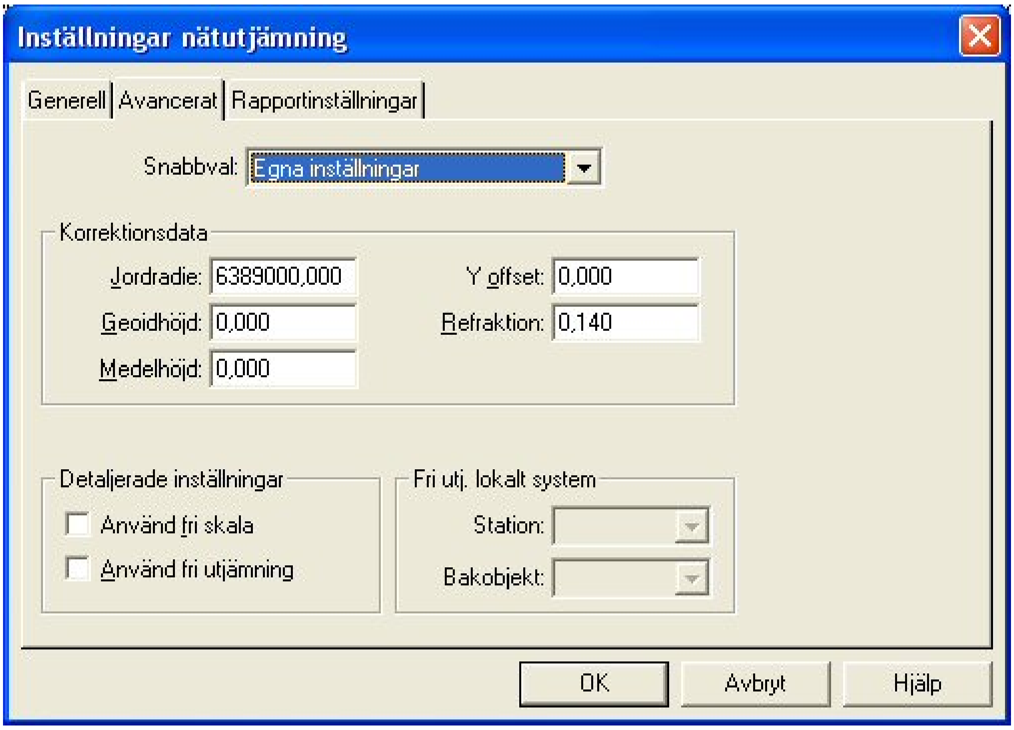
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

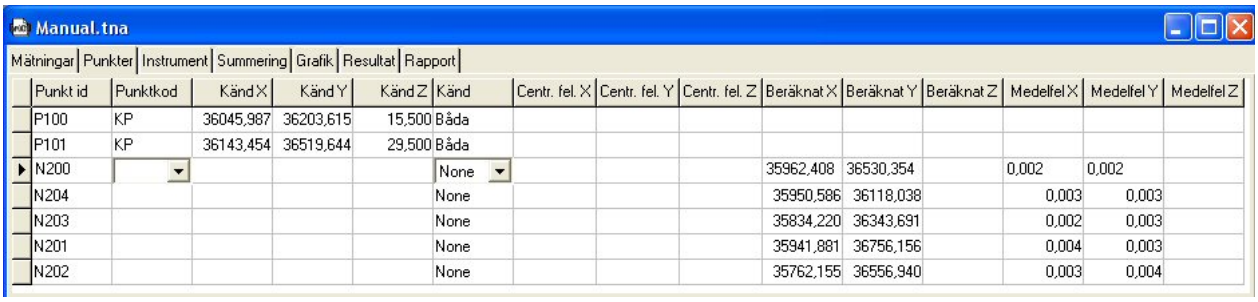
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments

Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

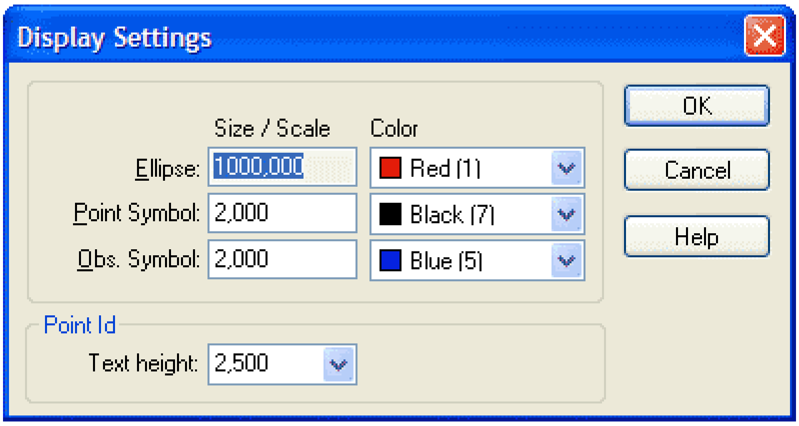
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



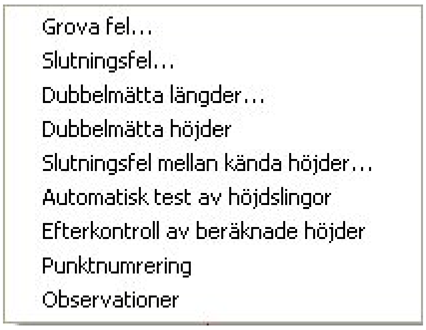
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

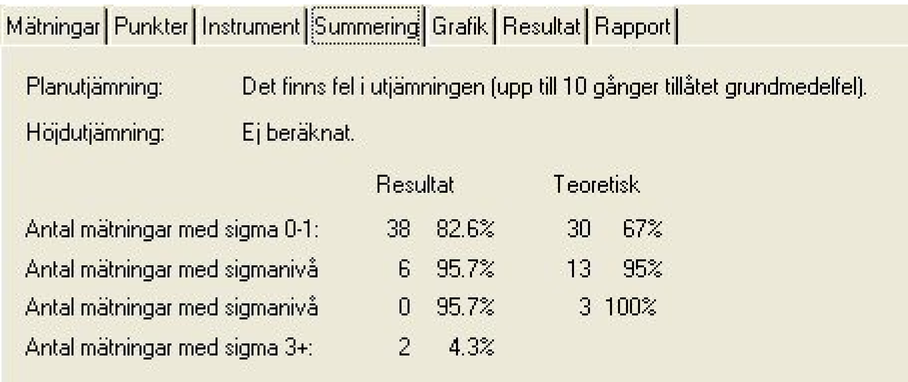
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

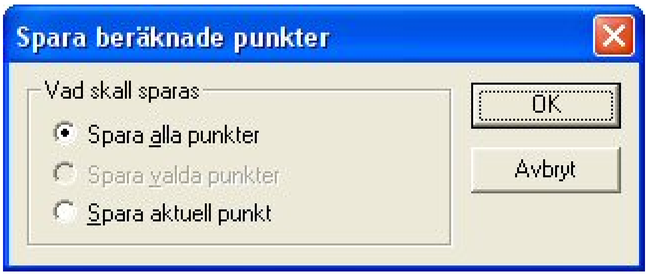
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



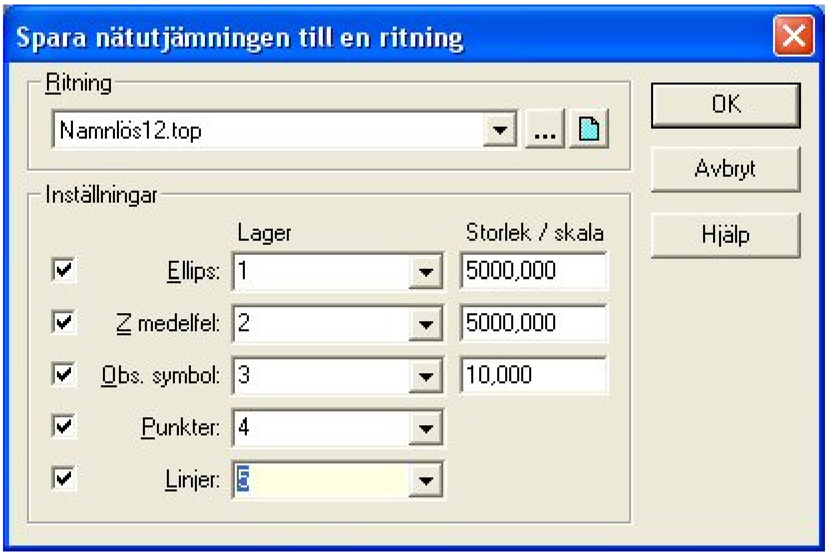
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

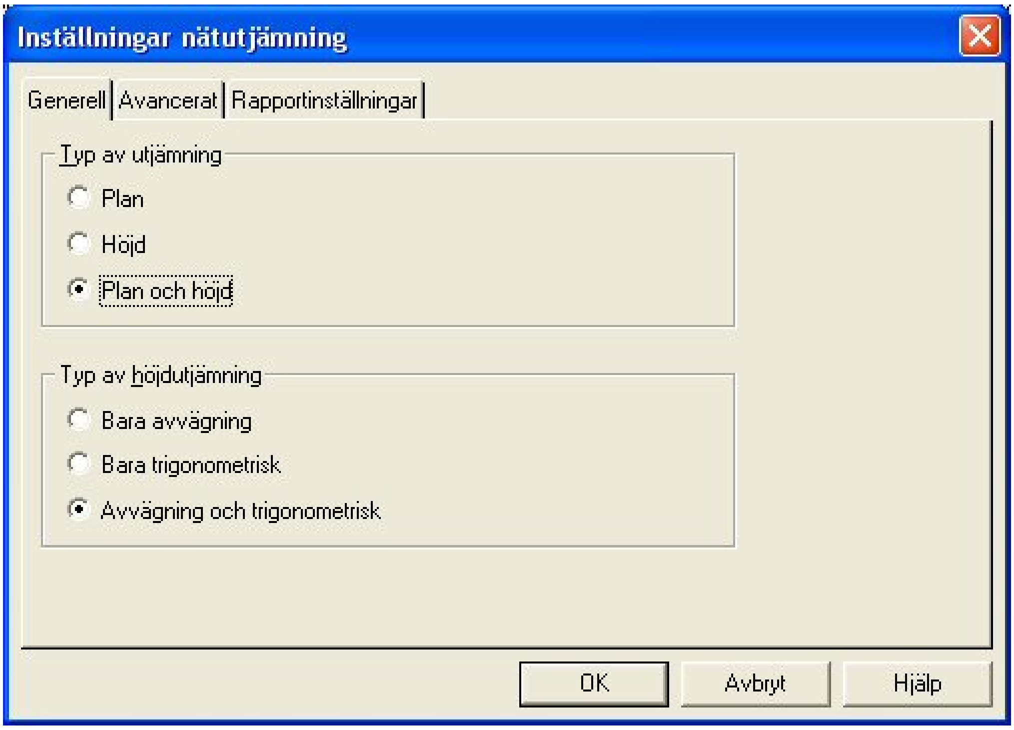
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

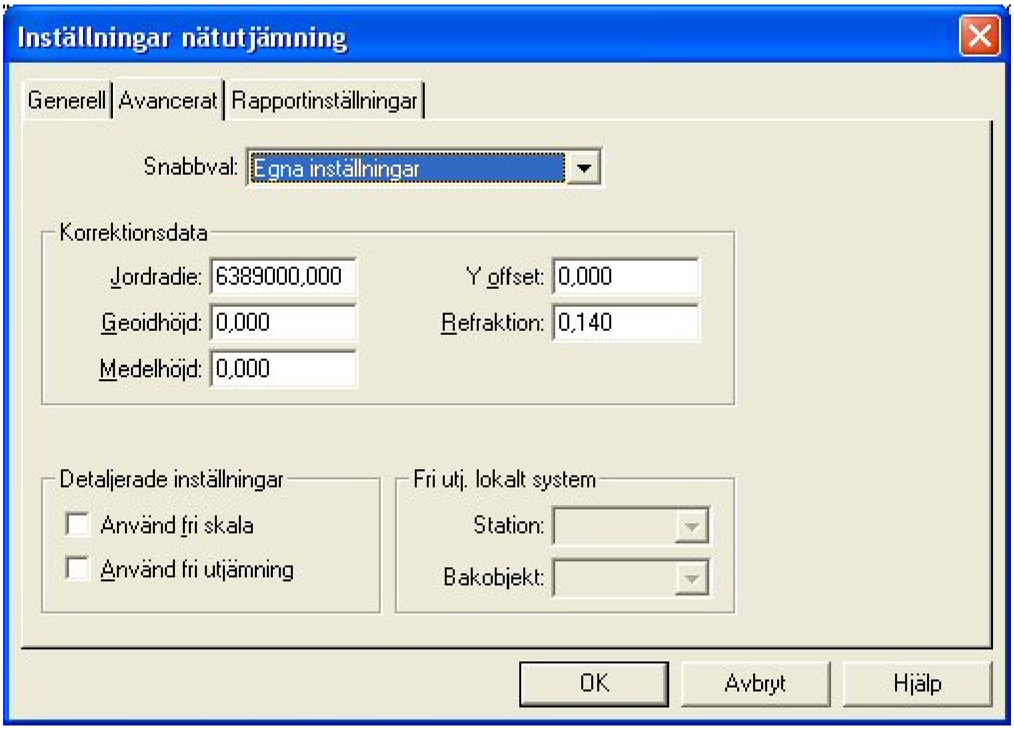
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

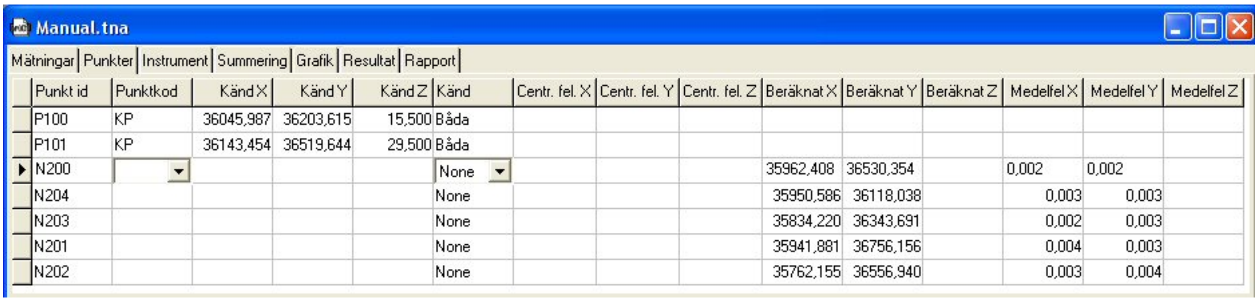
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

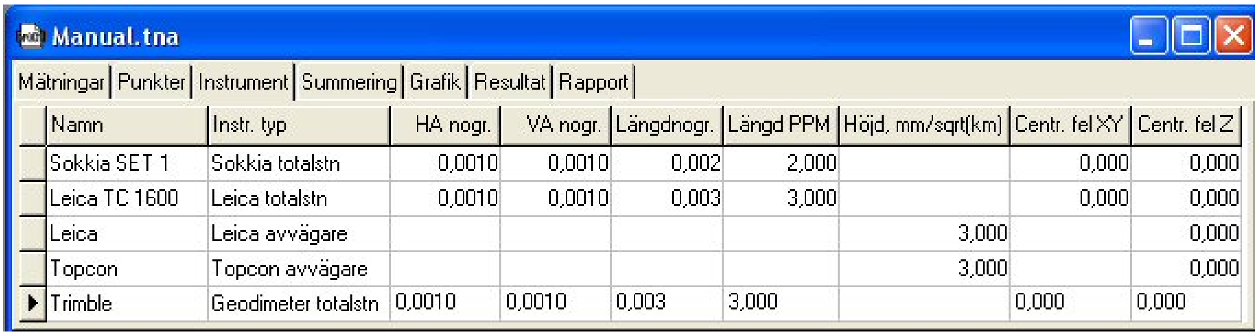
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

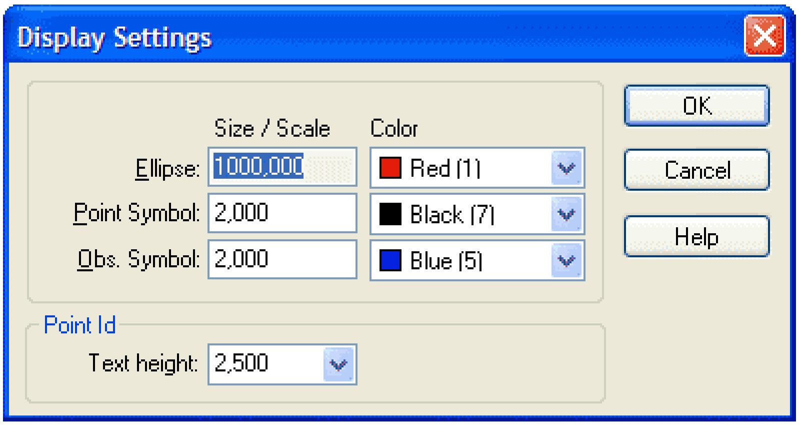
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



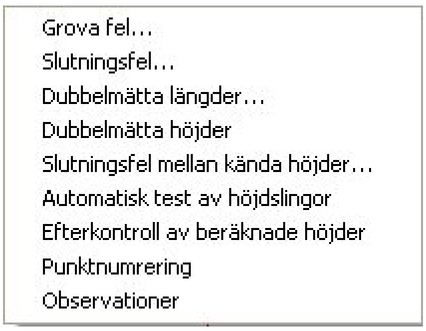
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

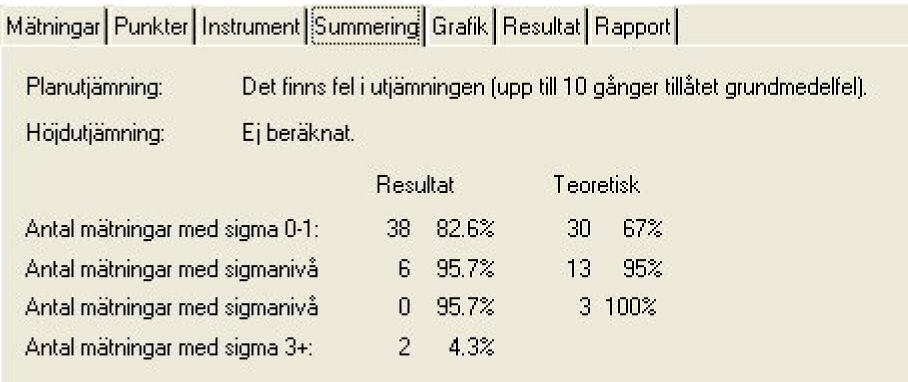
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

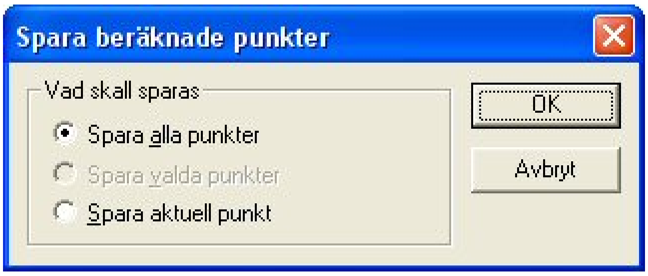
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



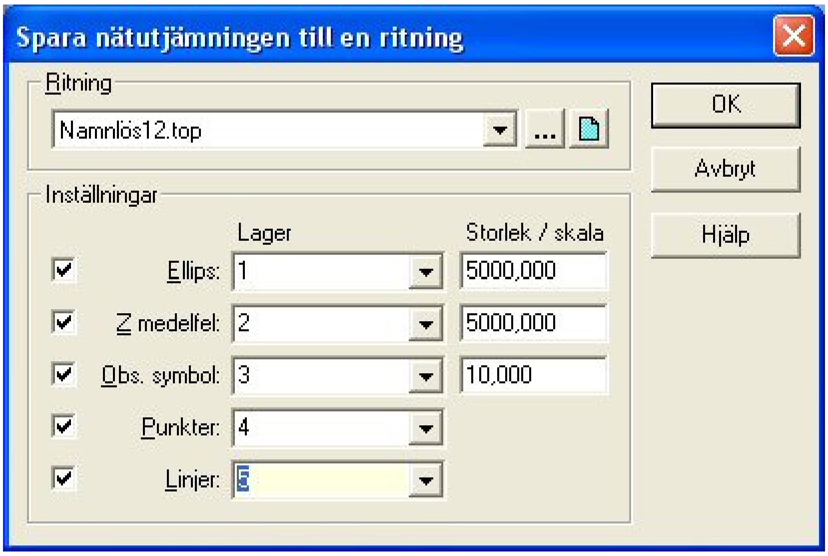
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

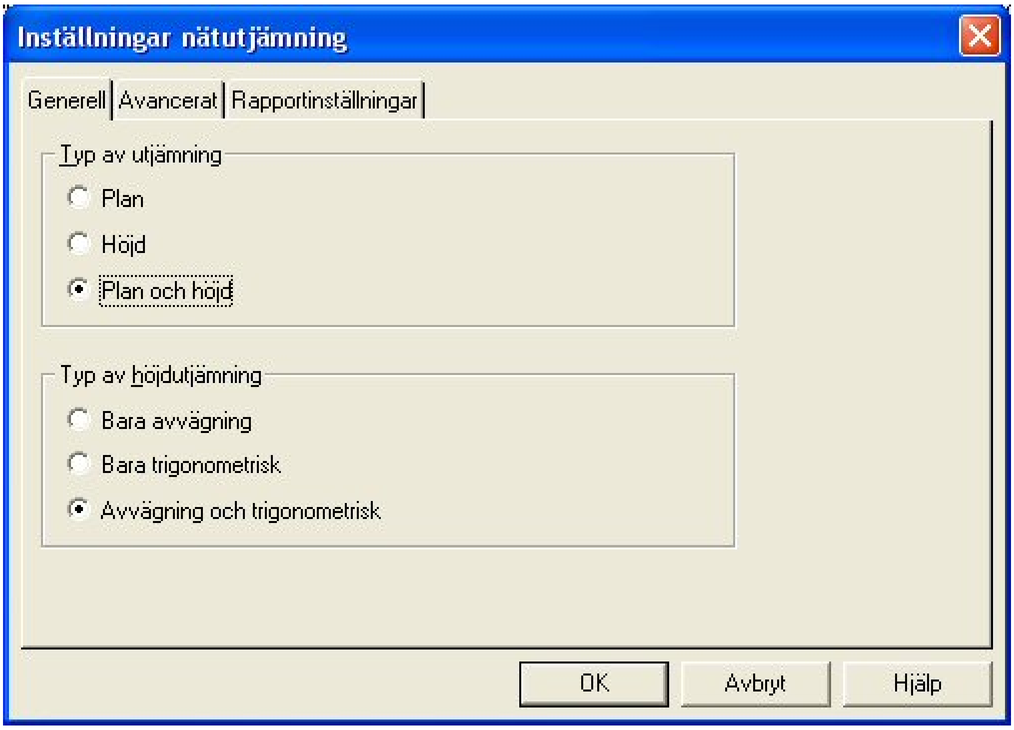
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

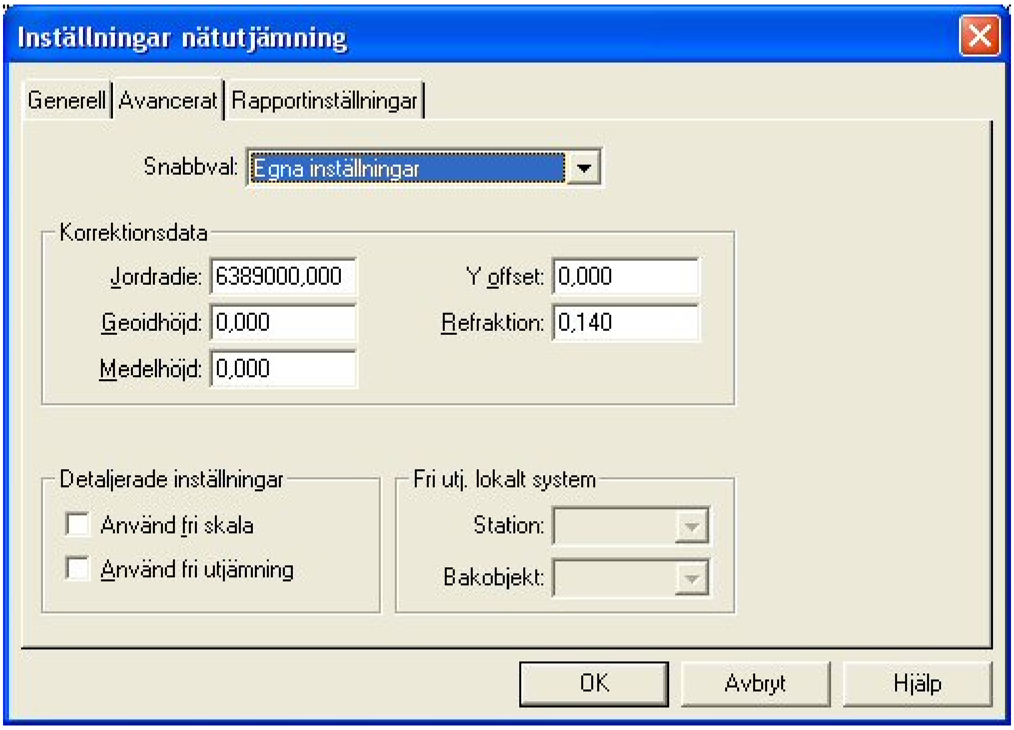
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File*|*Settings*|*Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

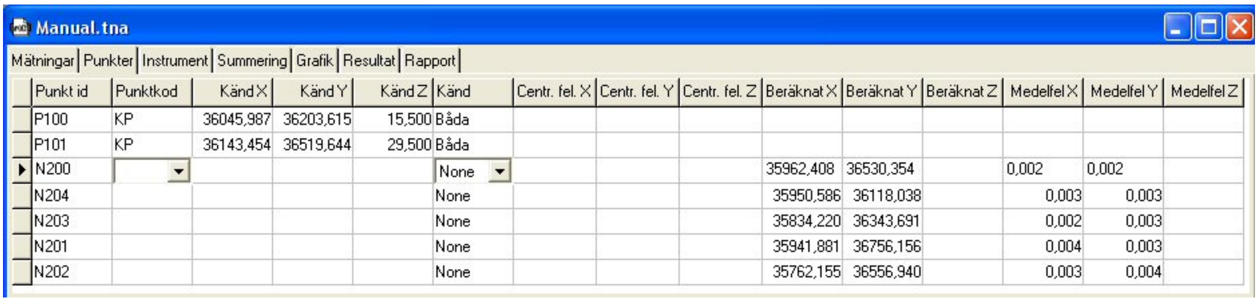
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

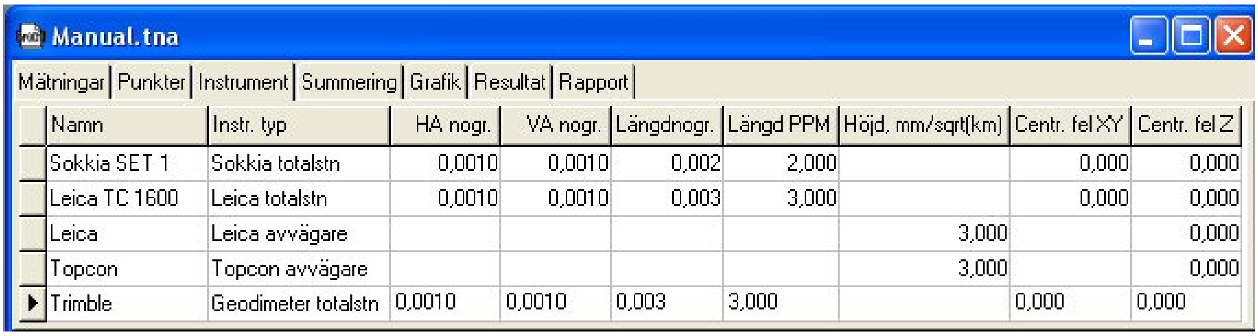
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

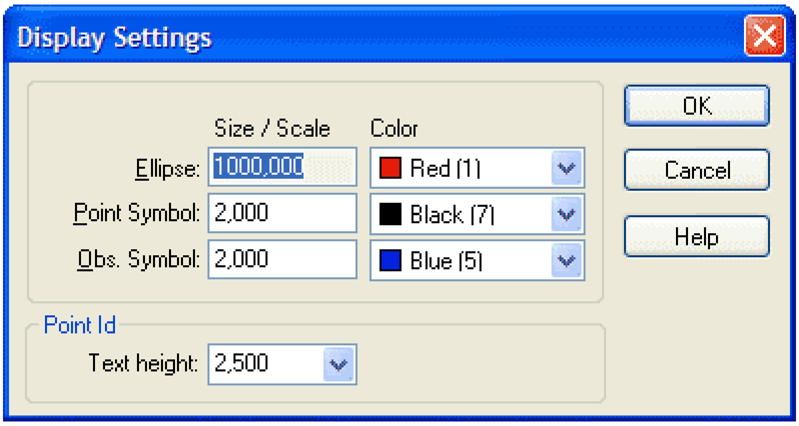
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



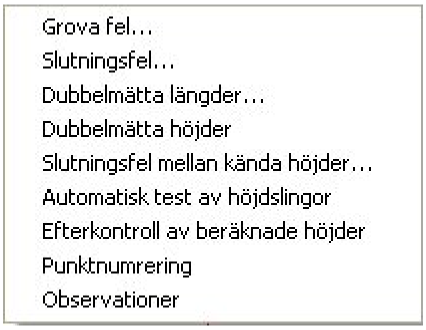
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

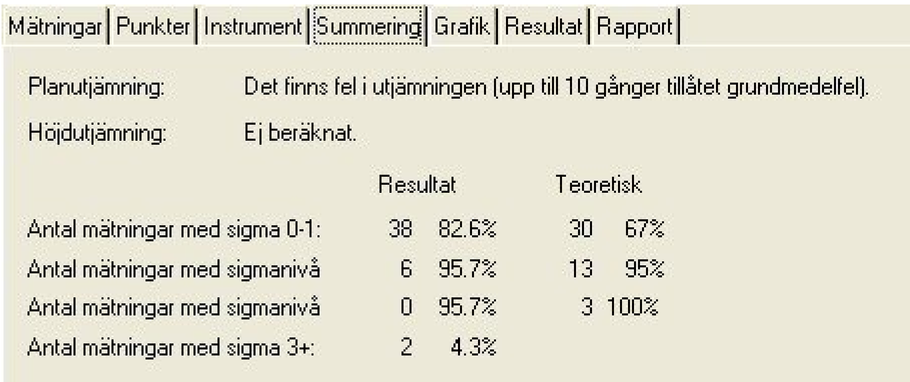
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

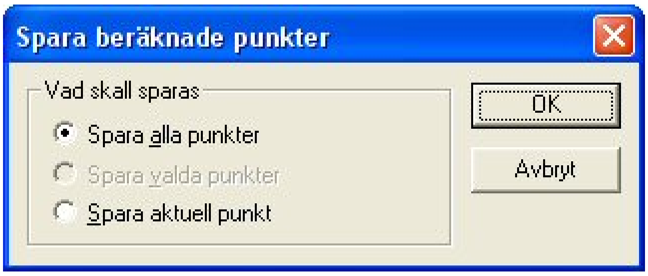
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



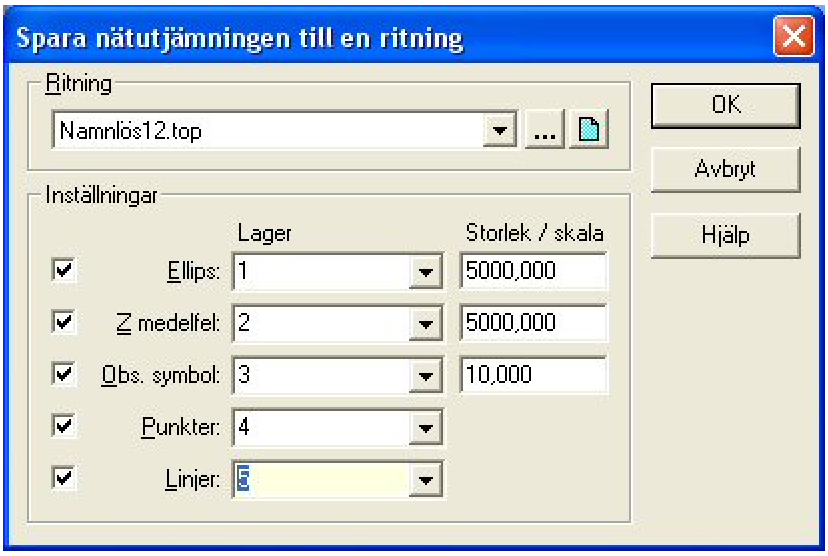
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

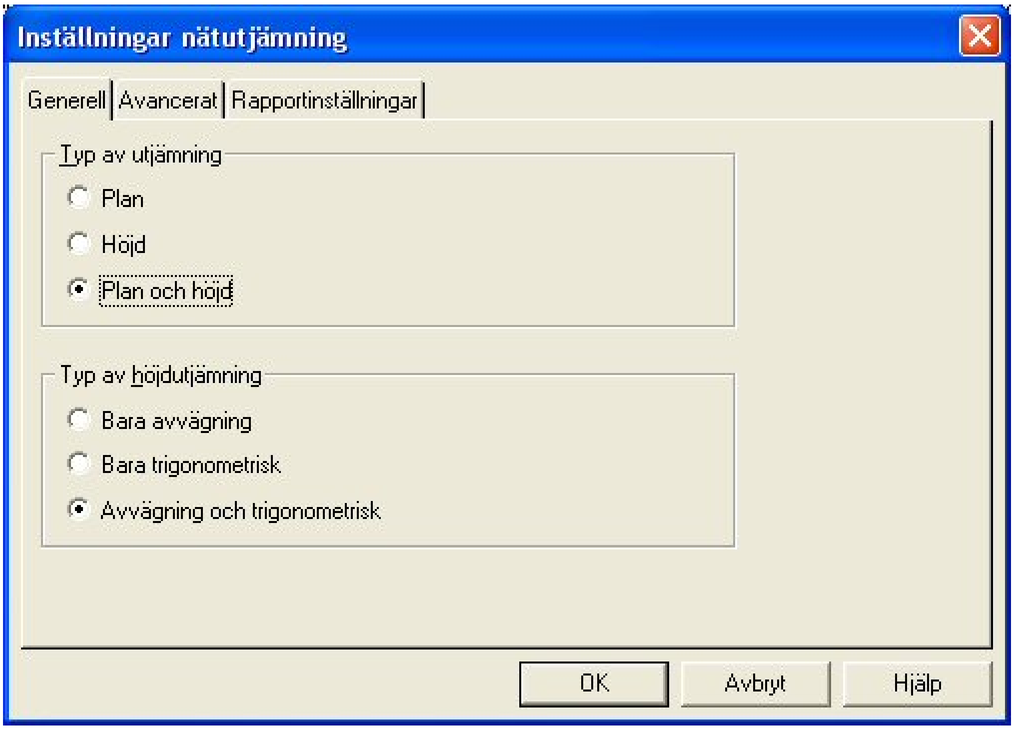
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

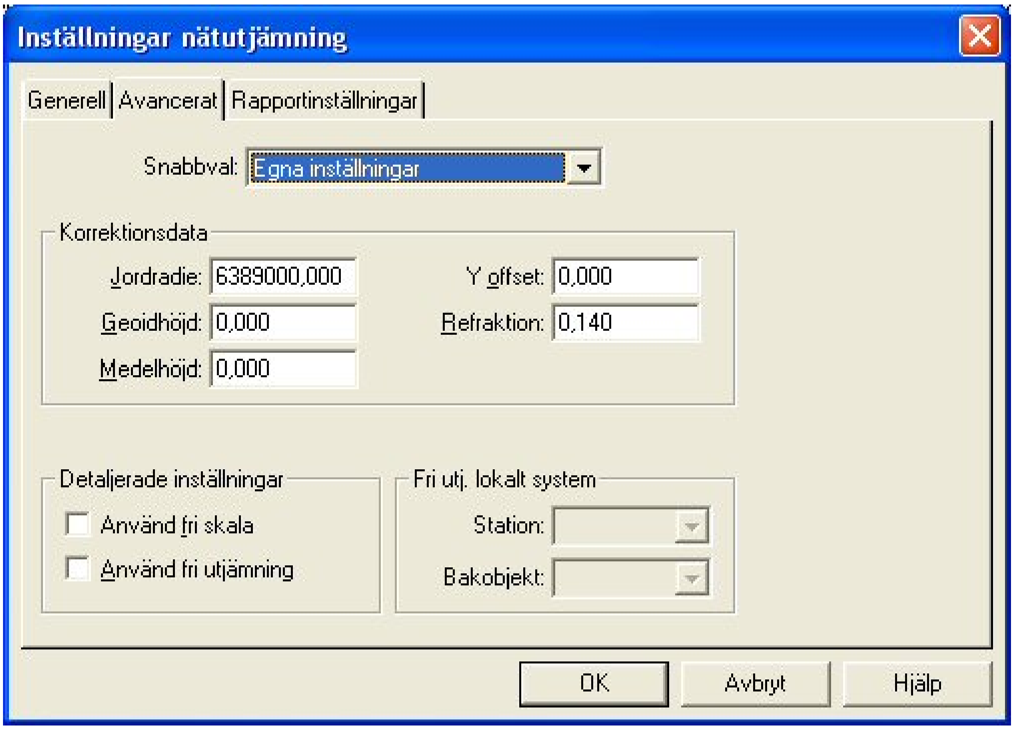
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

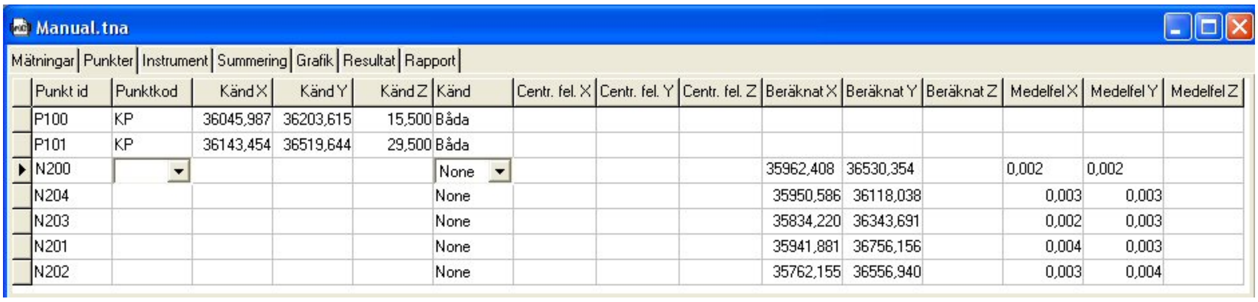
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

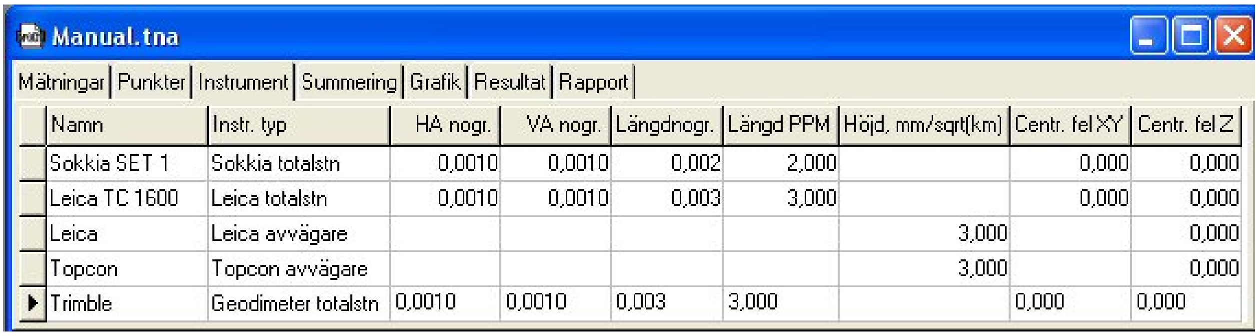
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

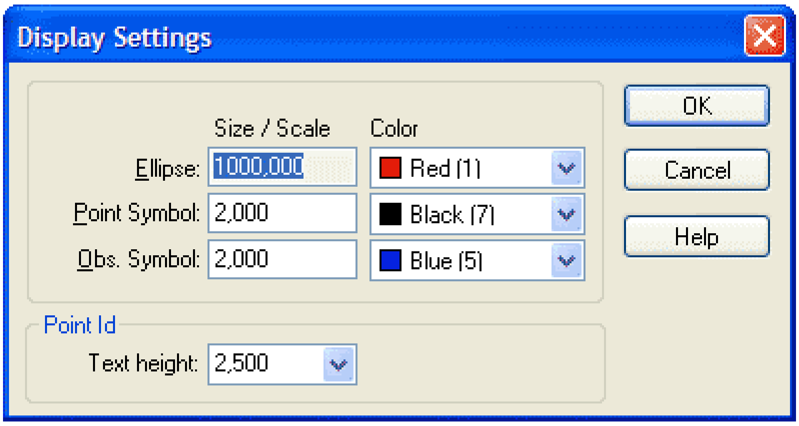
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



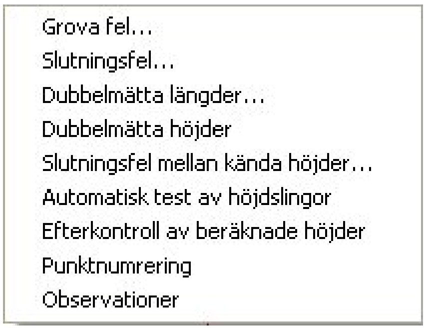
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

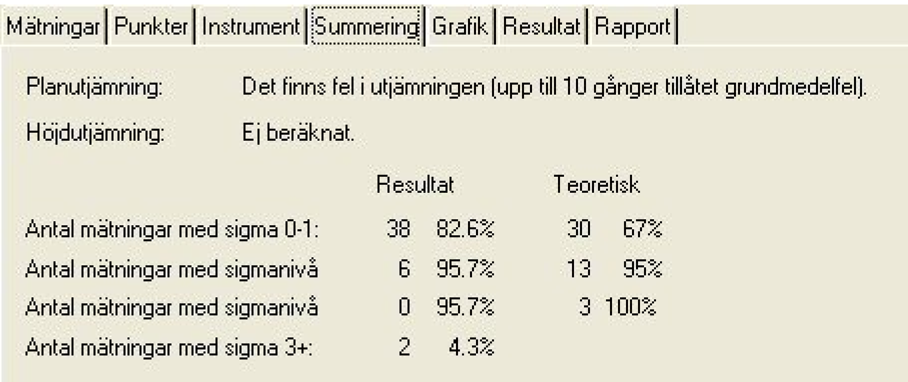
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

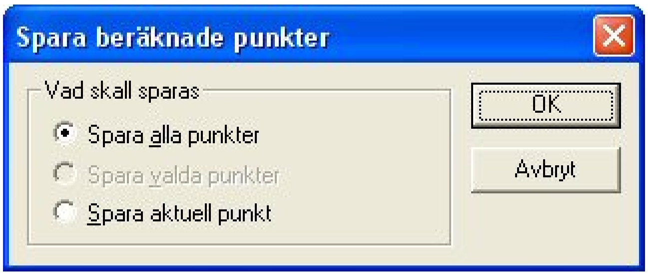
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



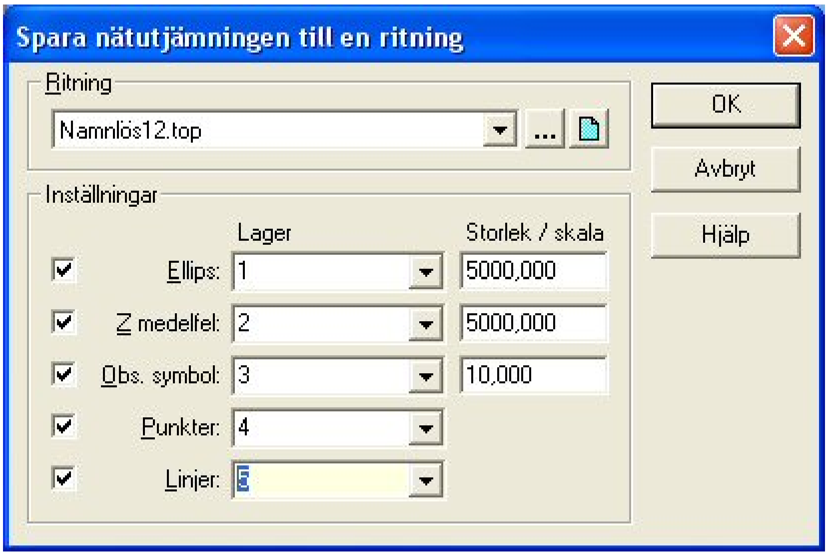
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

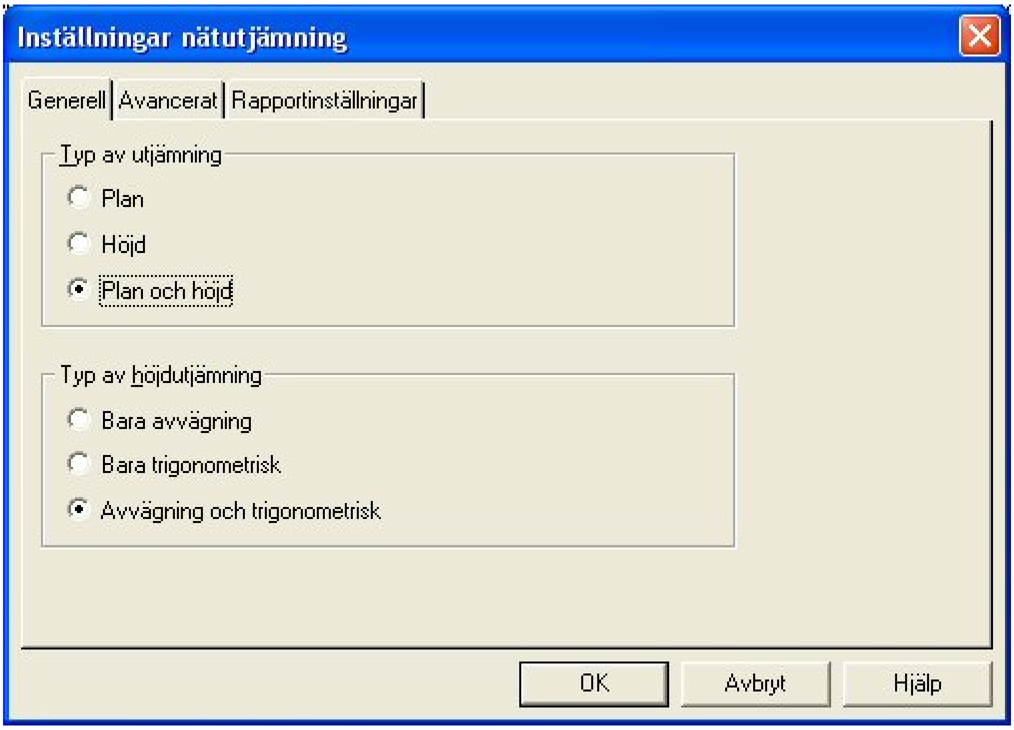
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

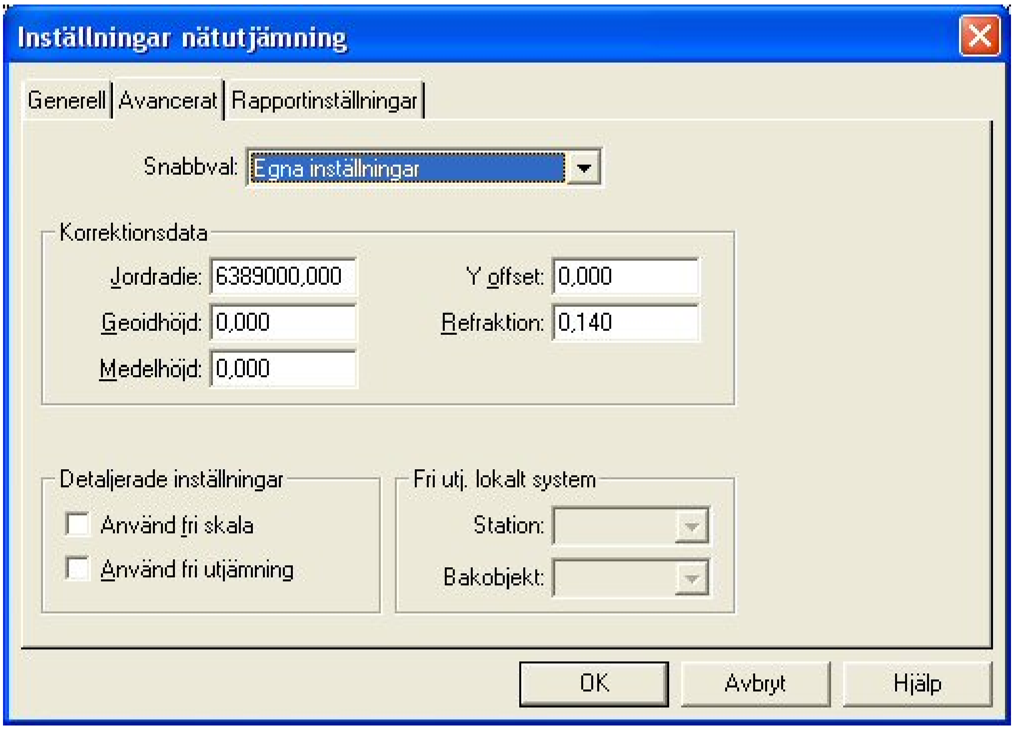
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

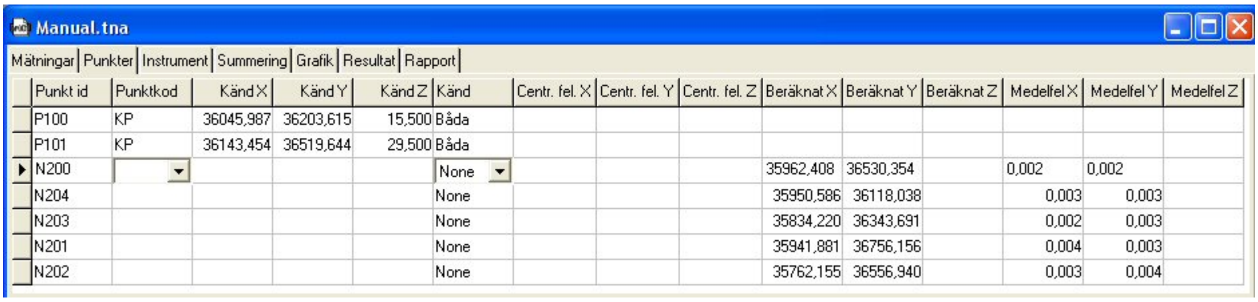
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

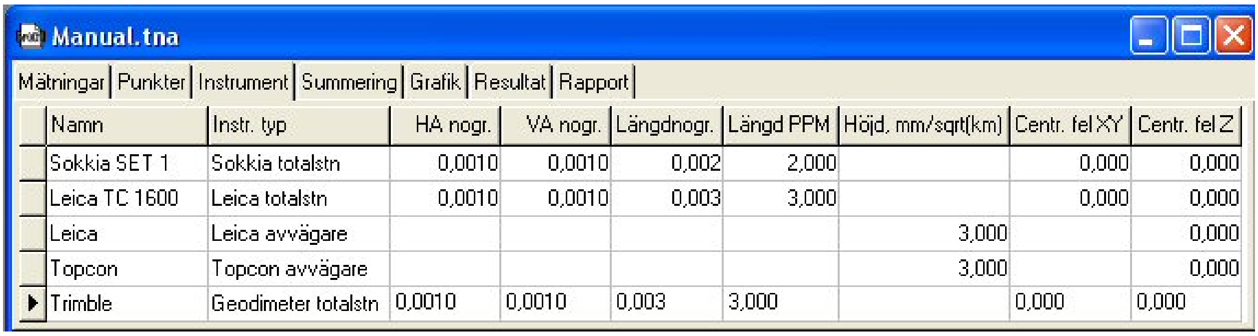
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

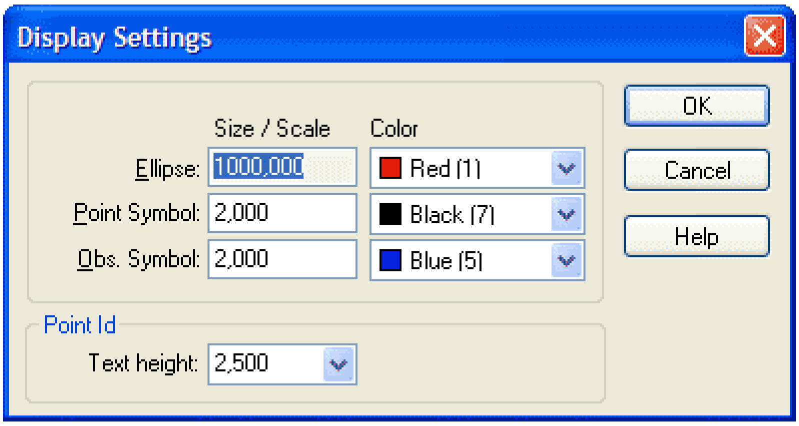
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



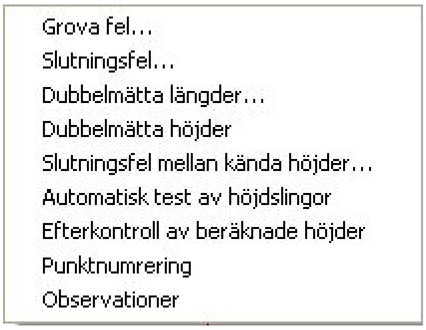
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

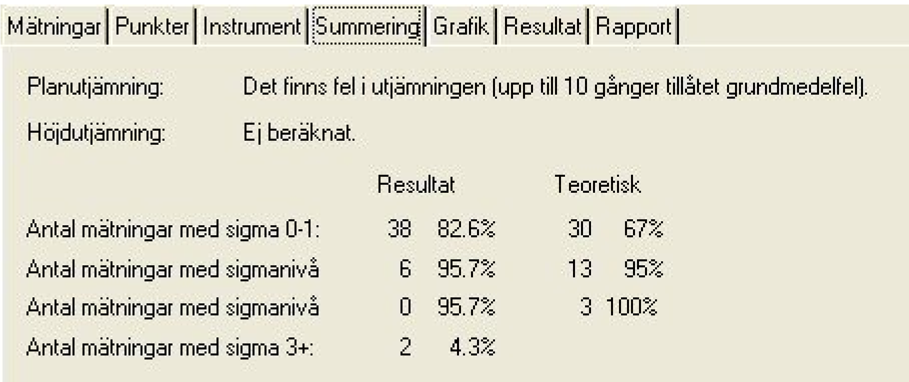
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

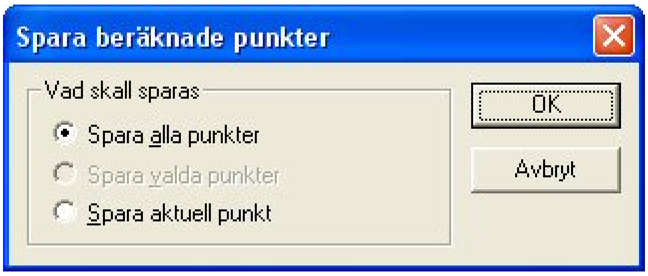
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



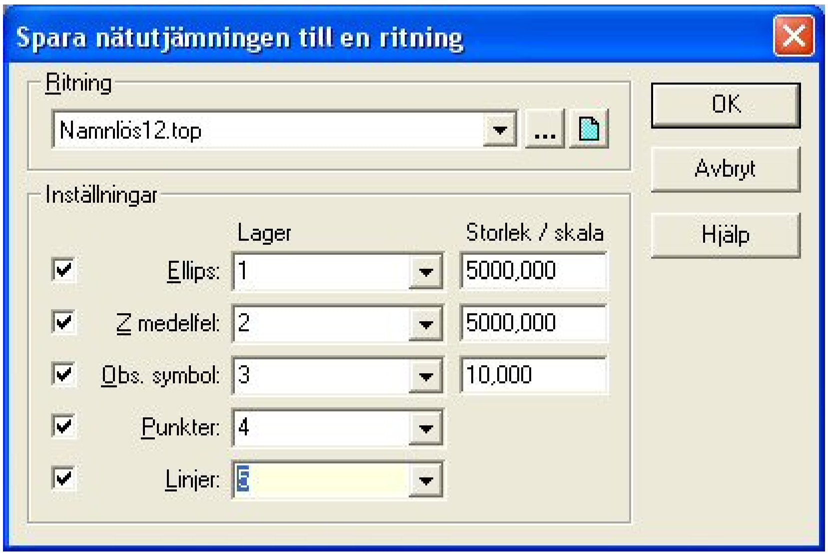
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

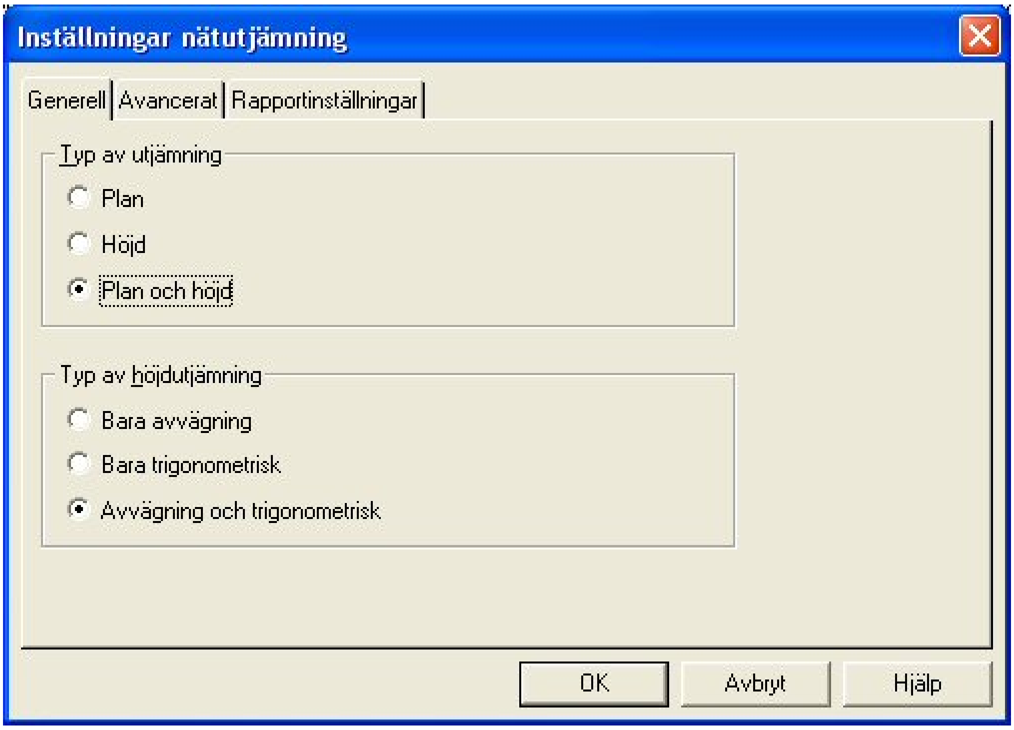
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

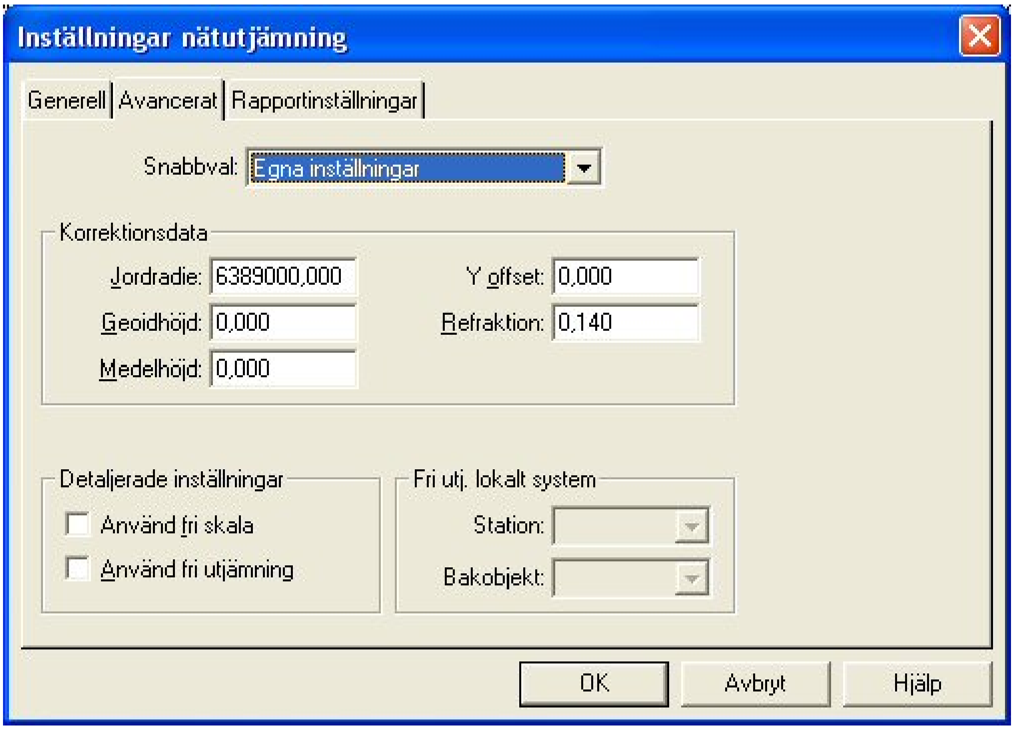
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

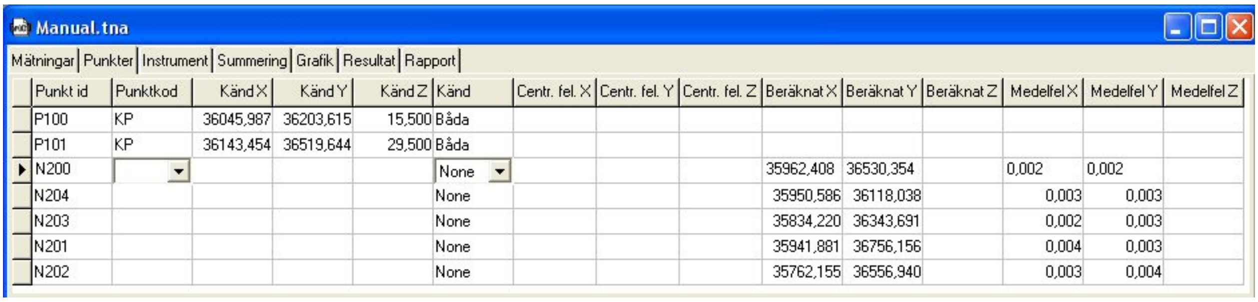
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

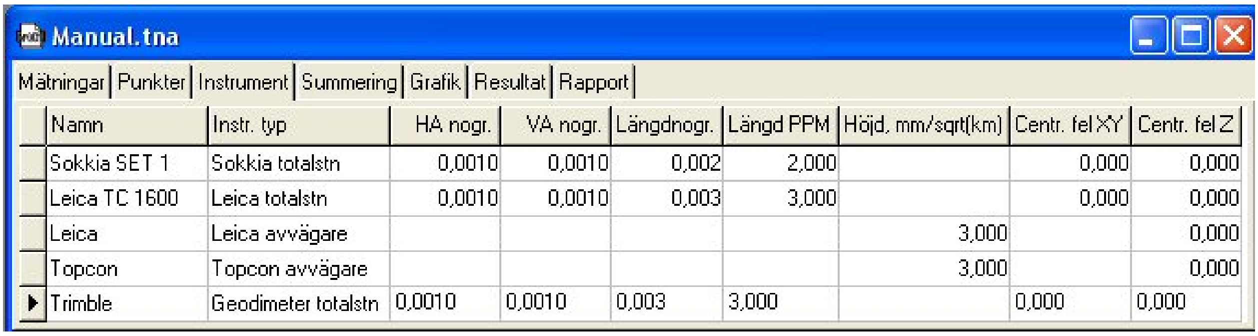
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

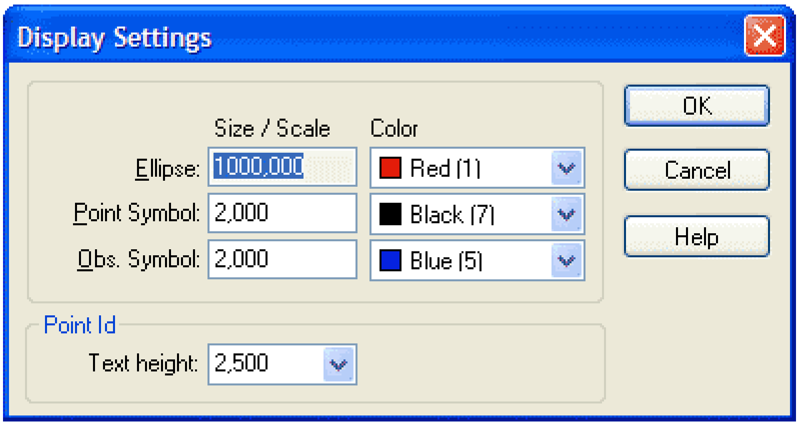
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



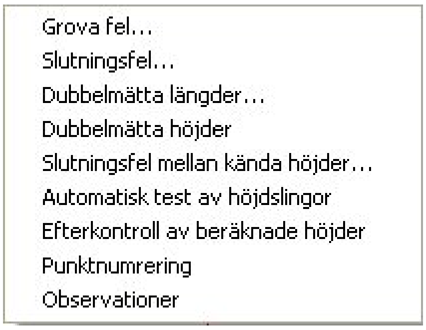
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

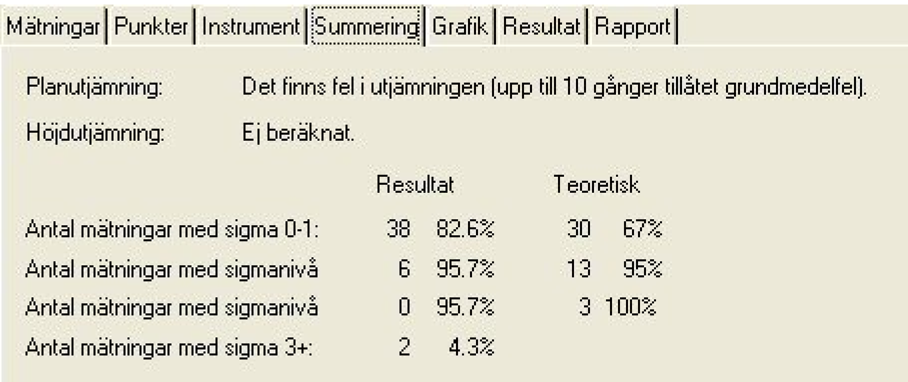
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

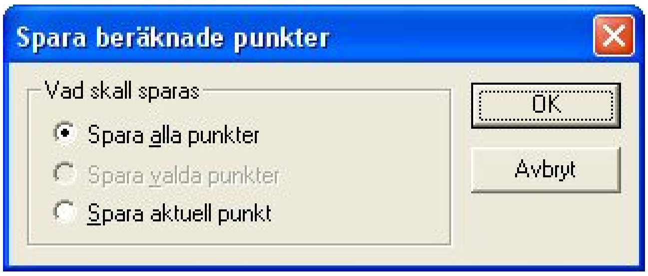
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



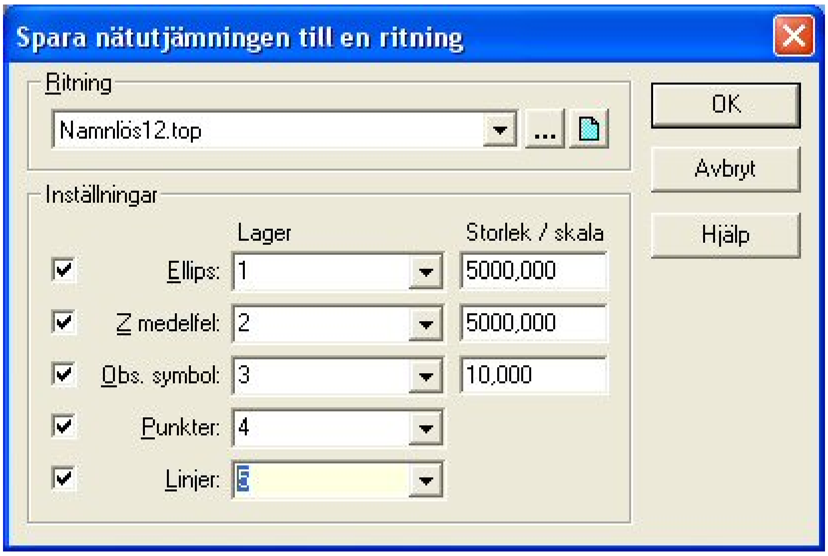
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

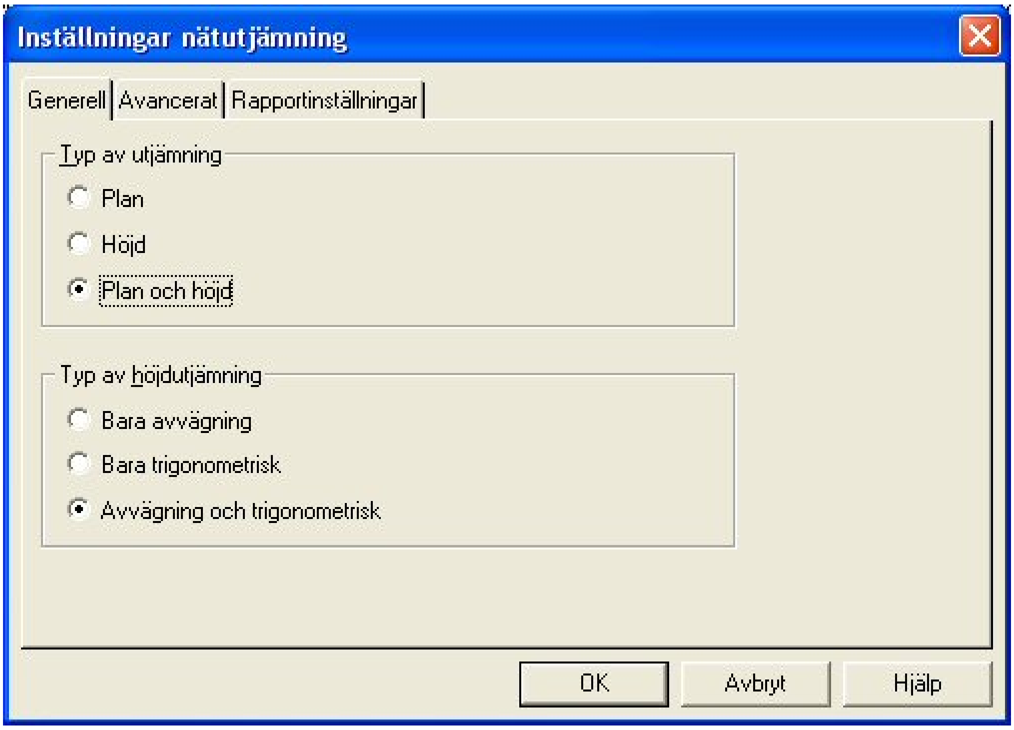
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

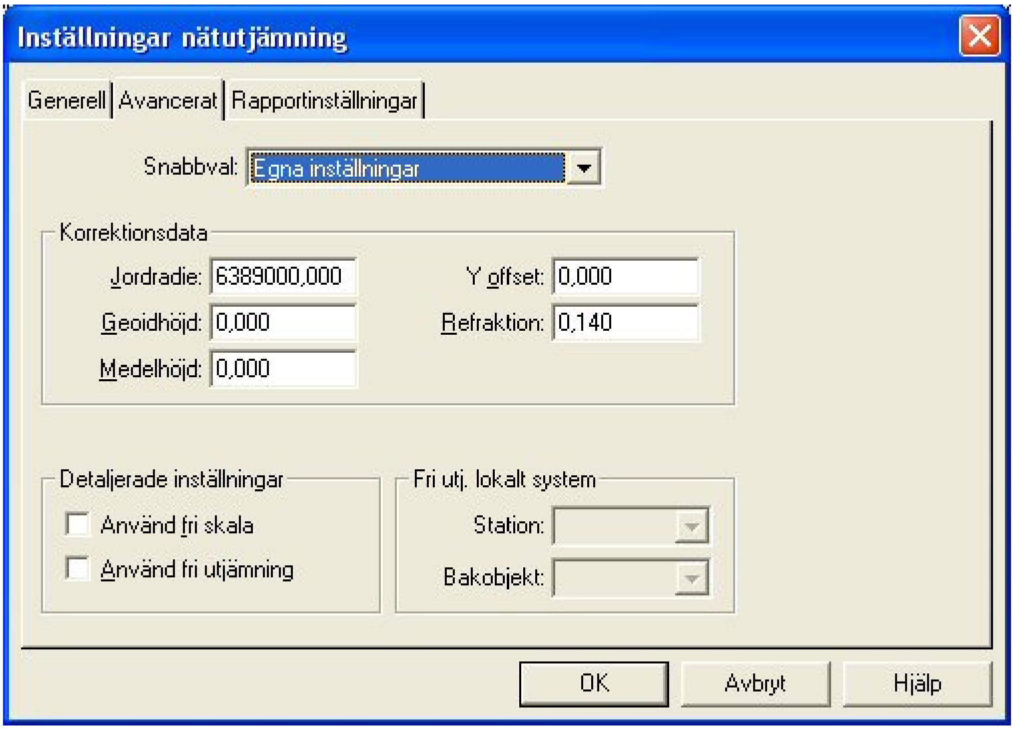
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

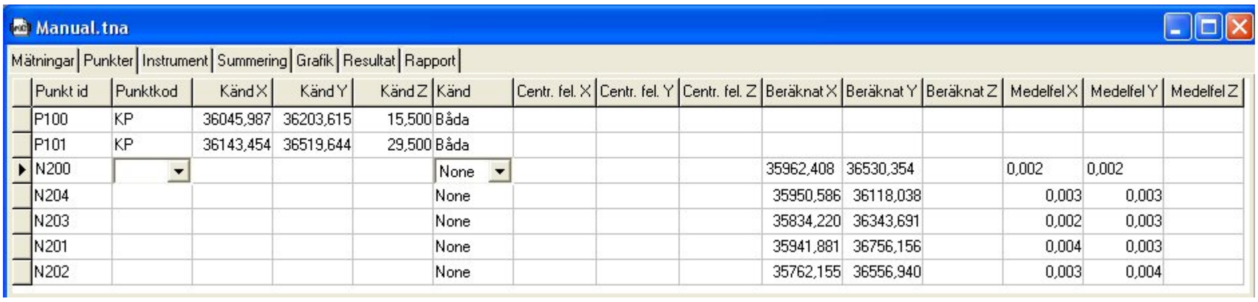
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna
Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

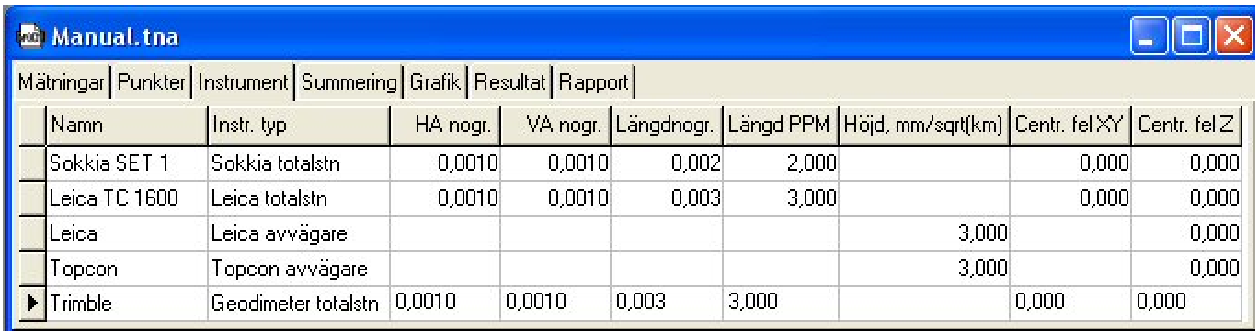
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

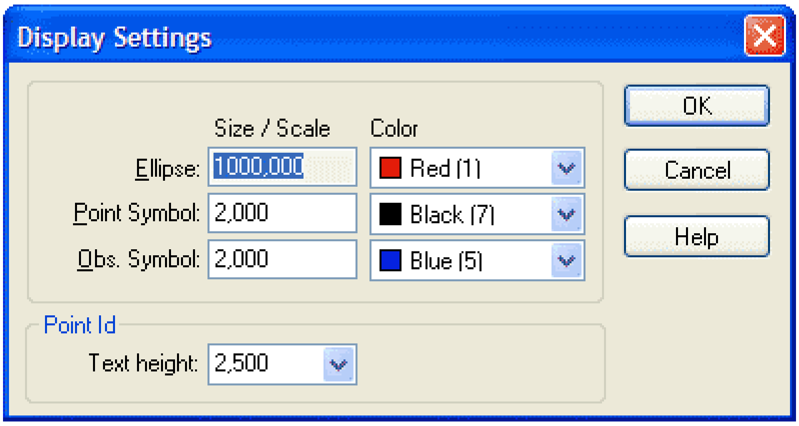
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



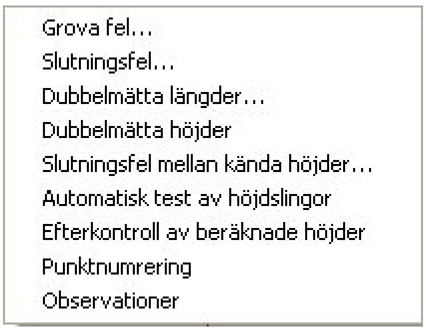
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

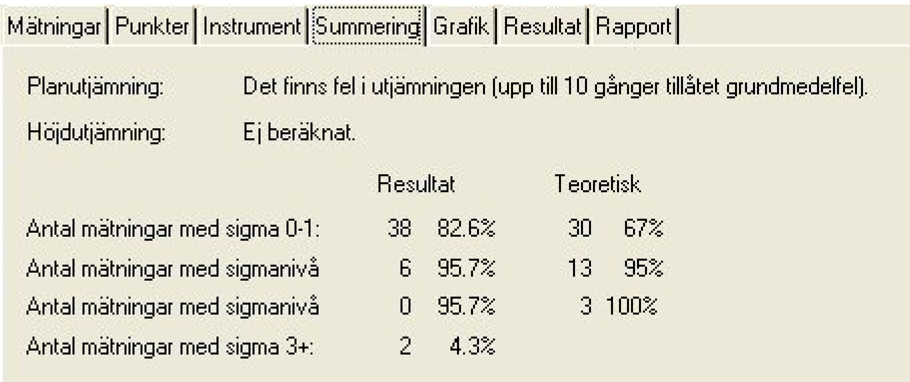
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

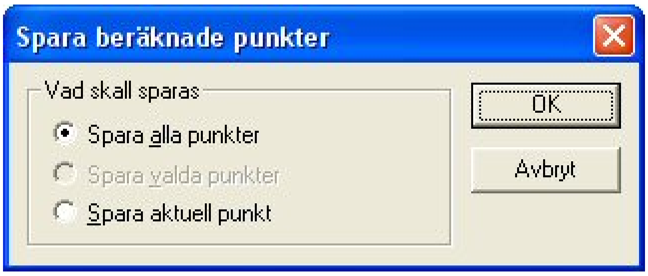
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



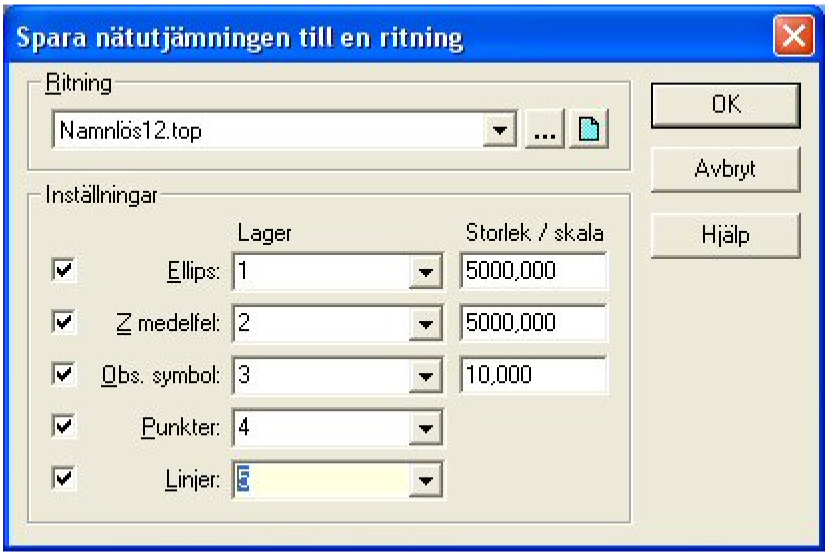
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

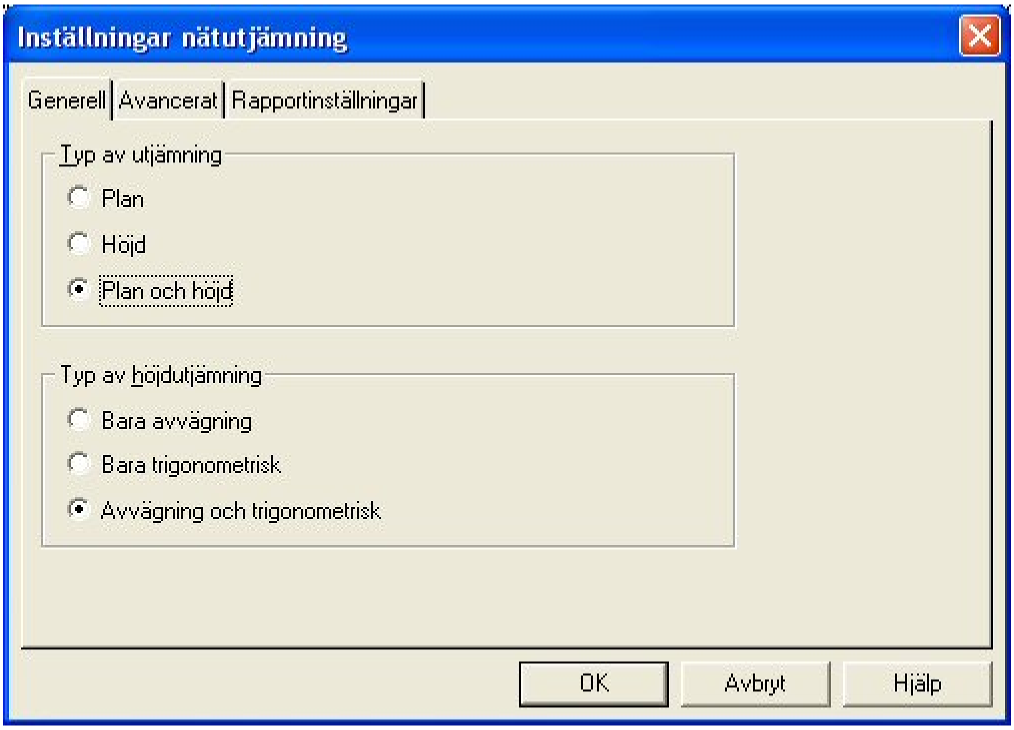
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

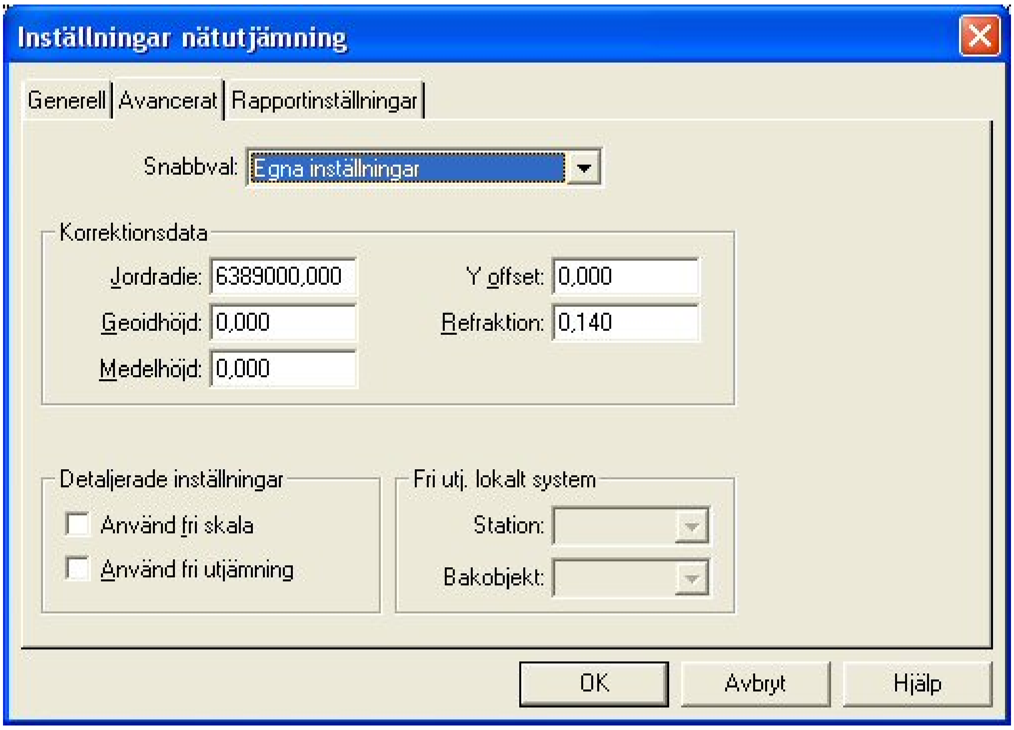
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

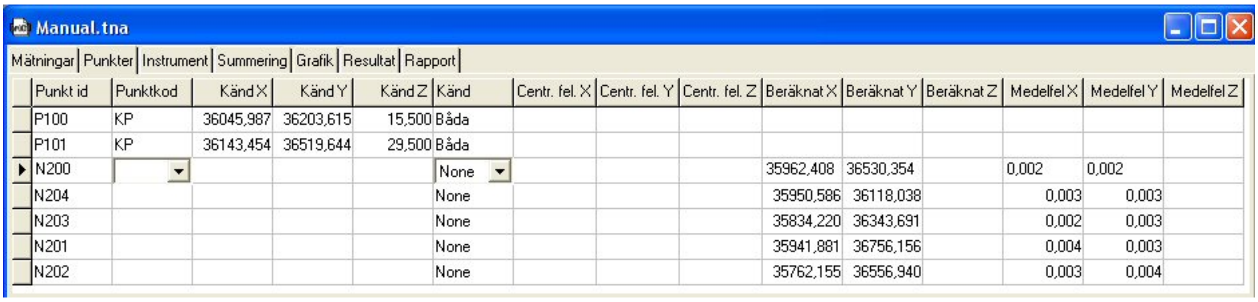
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

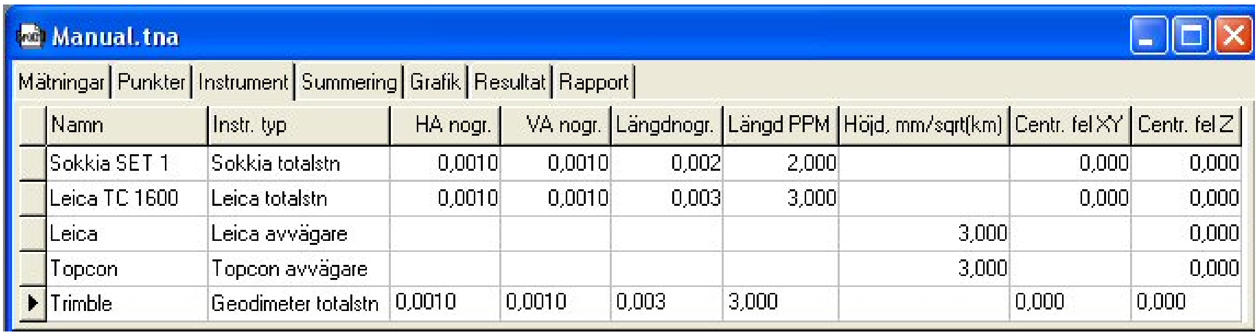
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

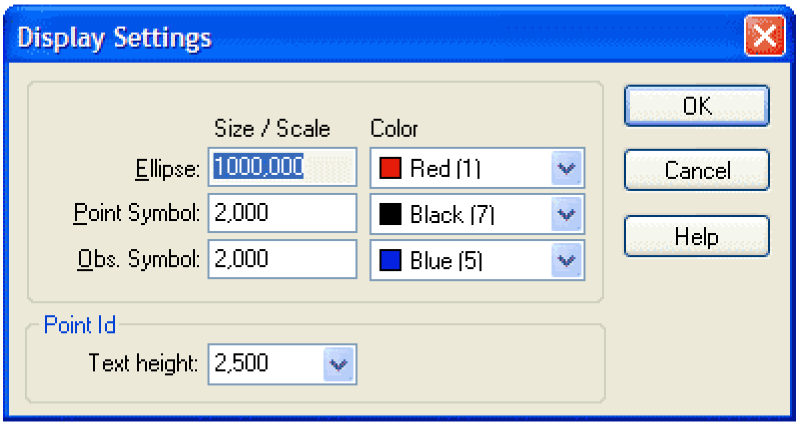
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



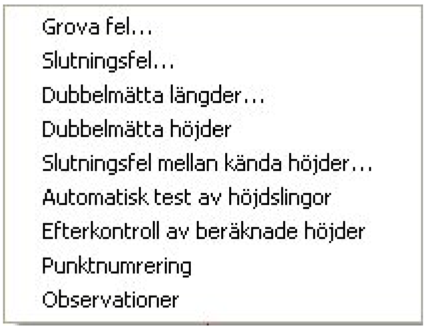
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

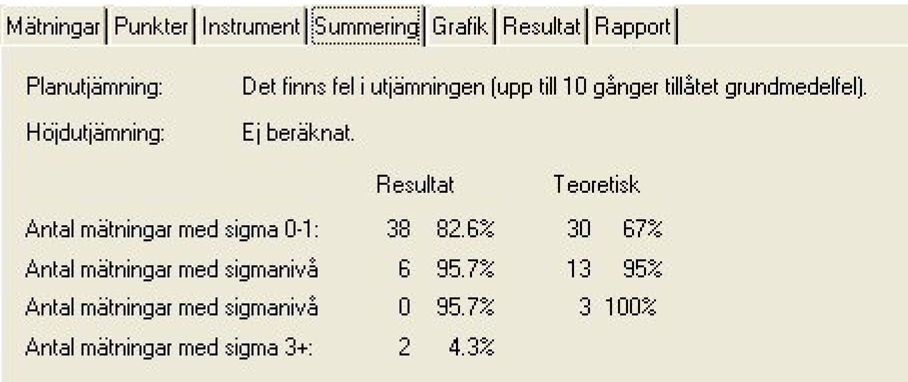
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

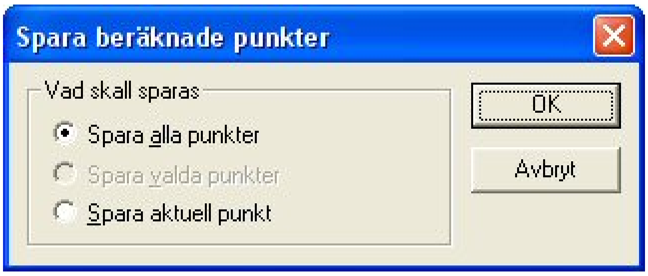
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



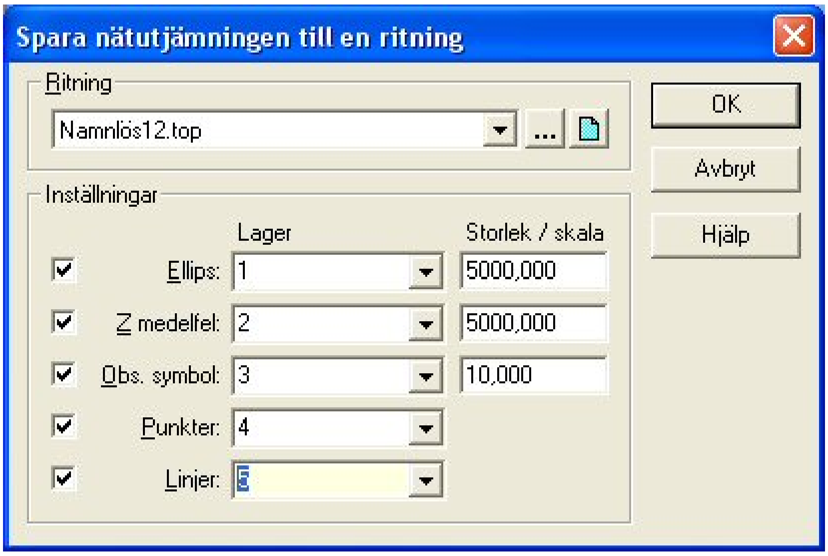
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

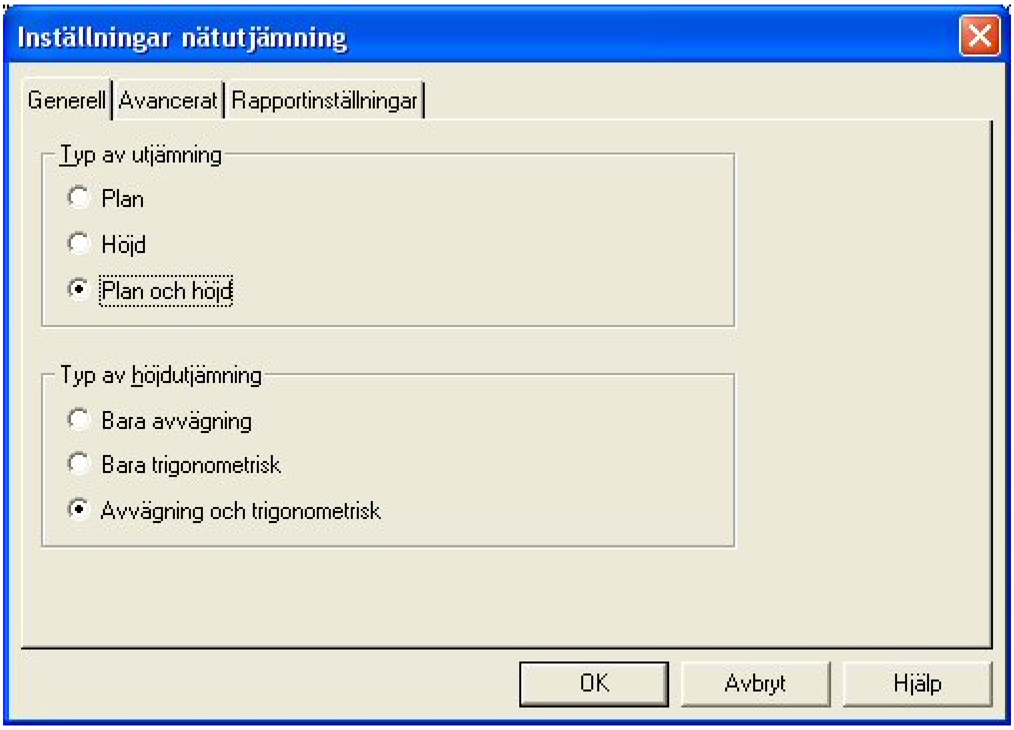
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

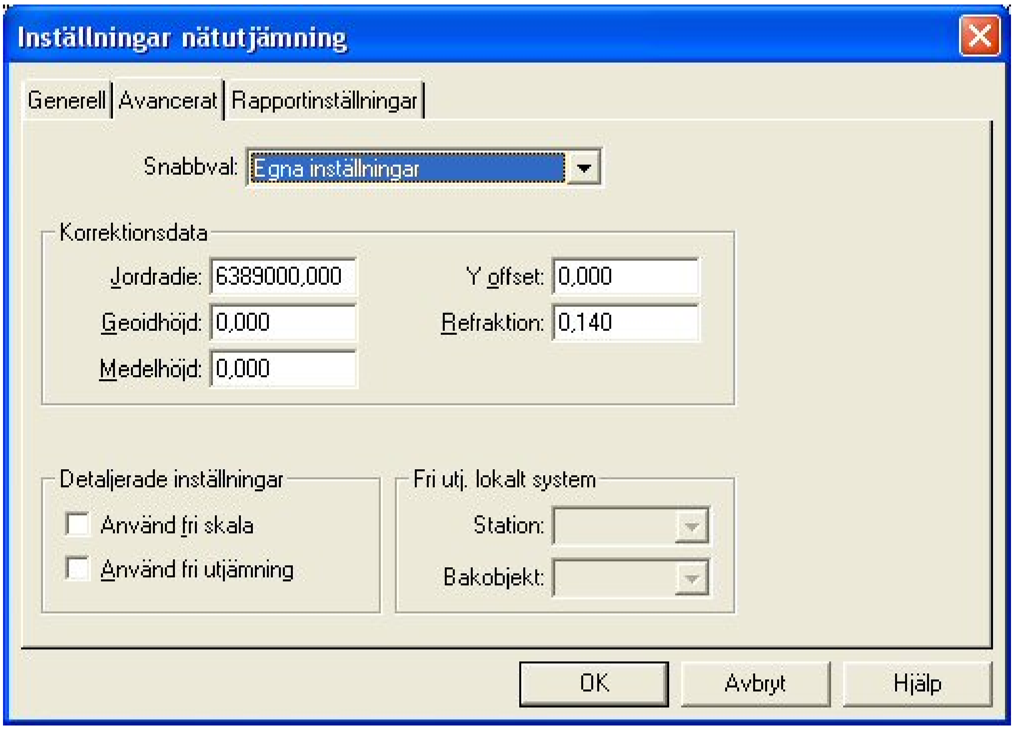
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

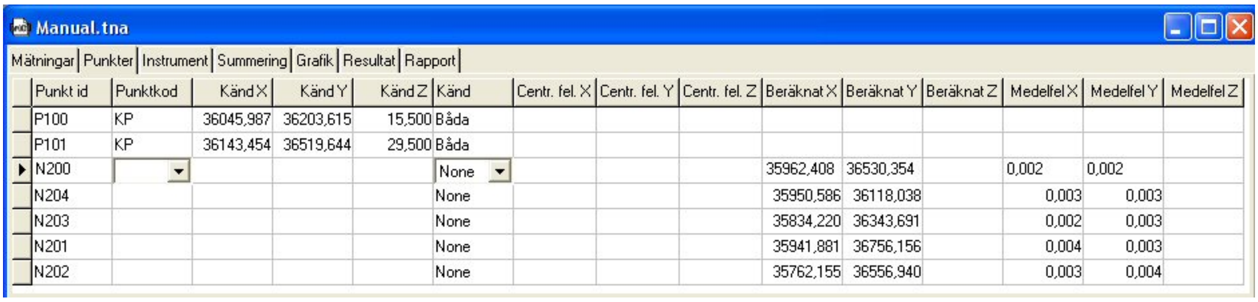
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

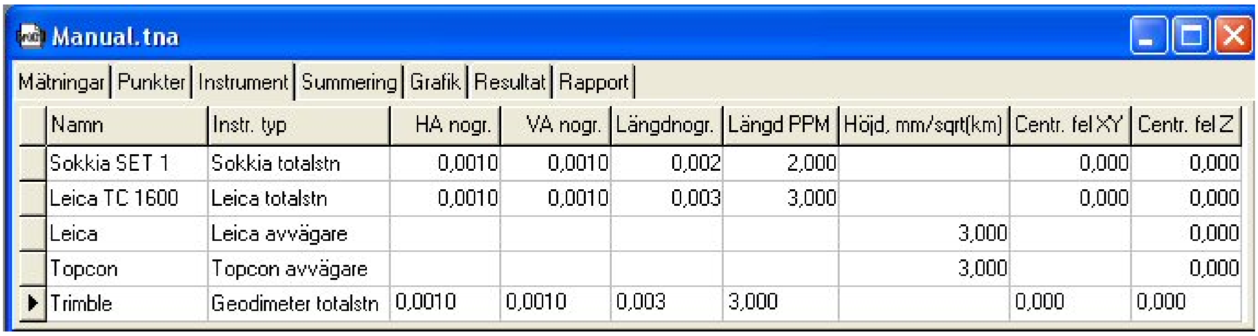
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

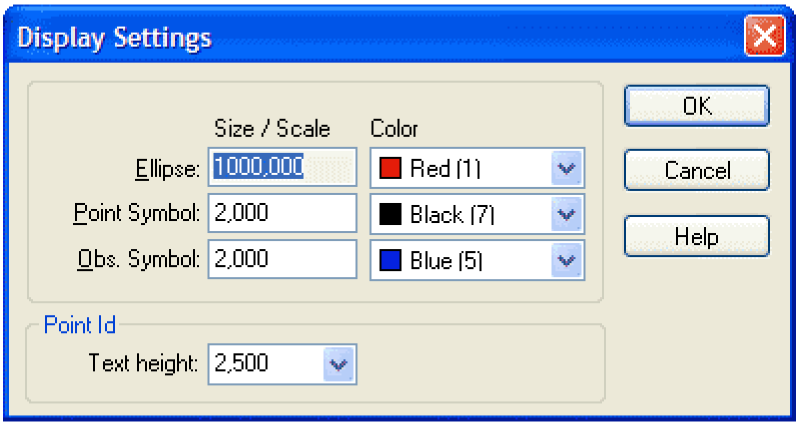
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



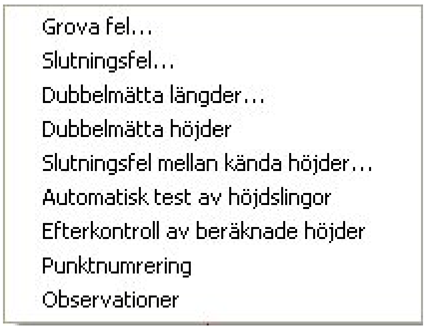
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

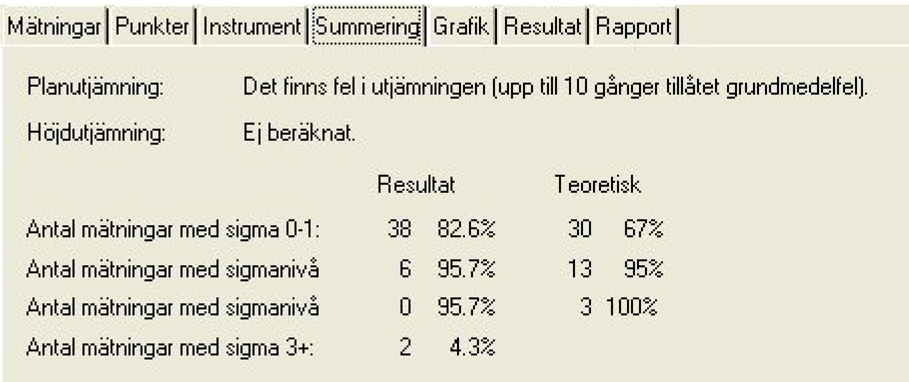
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

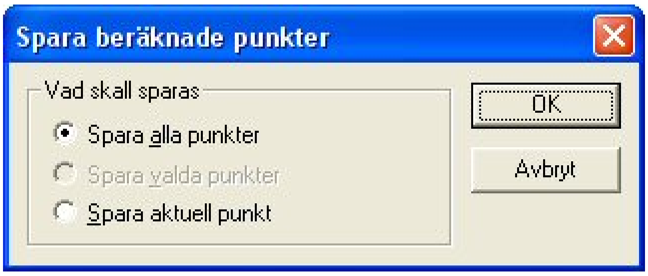
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



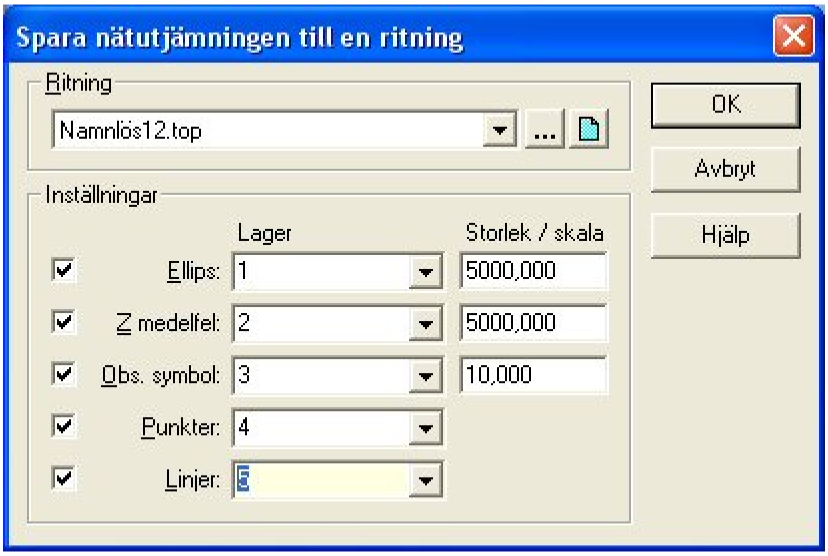
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

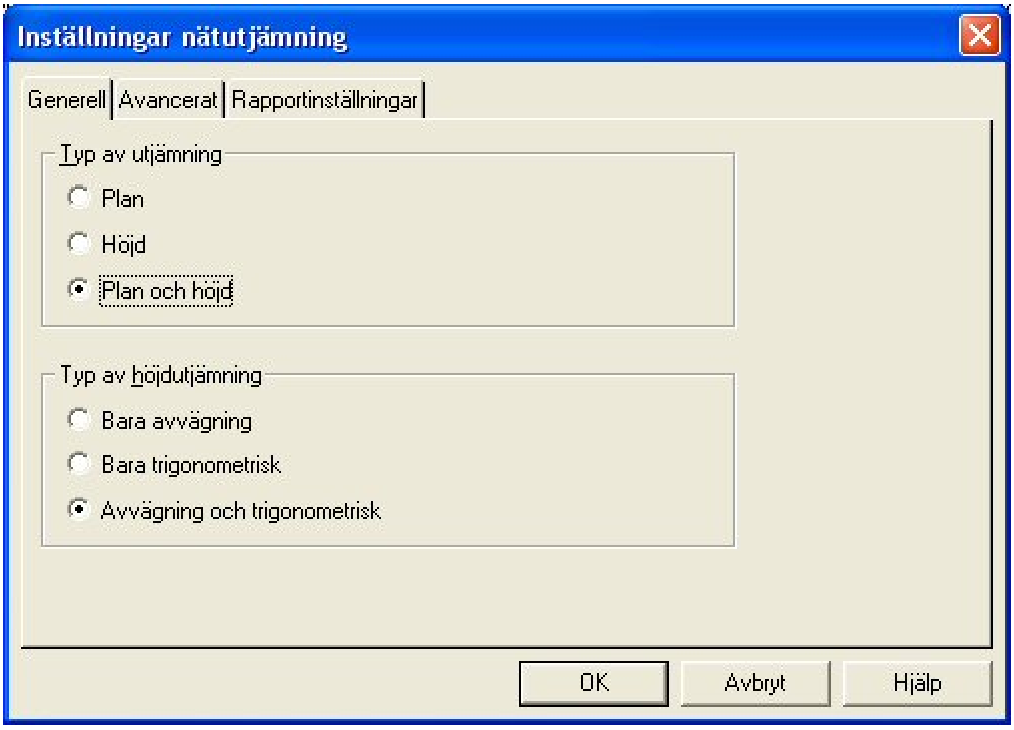
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

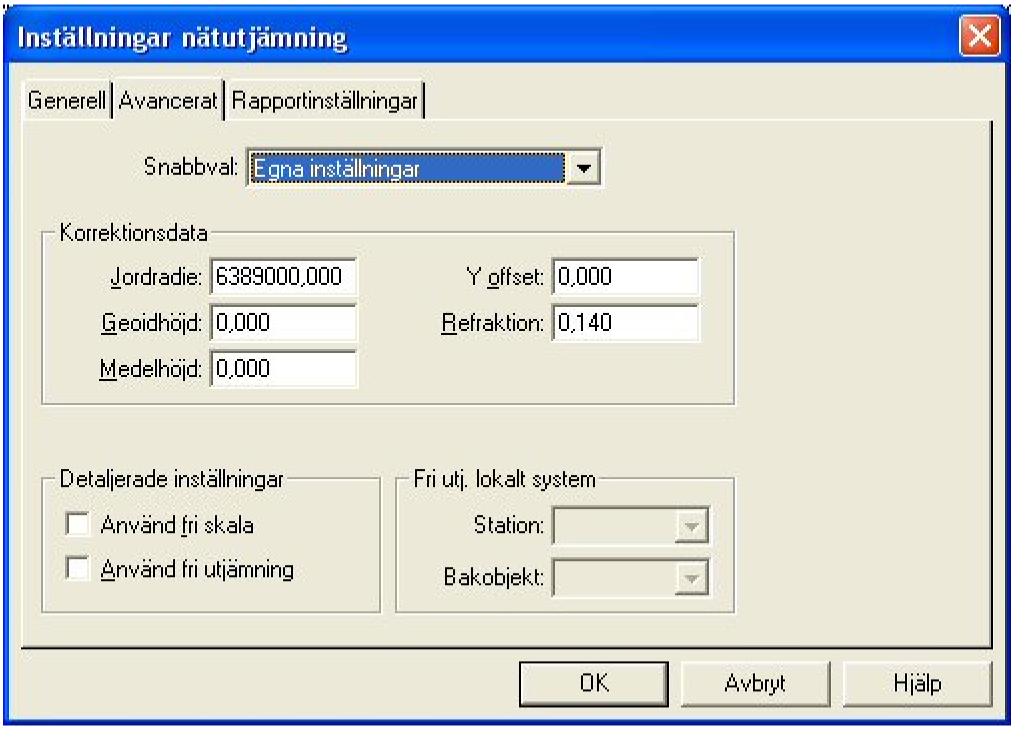
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

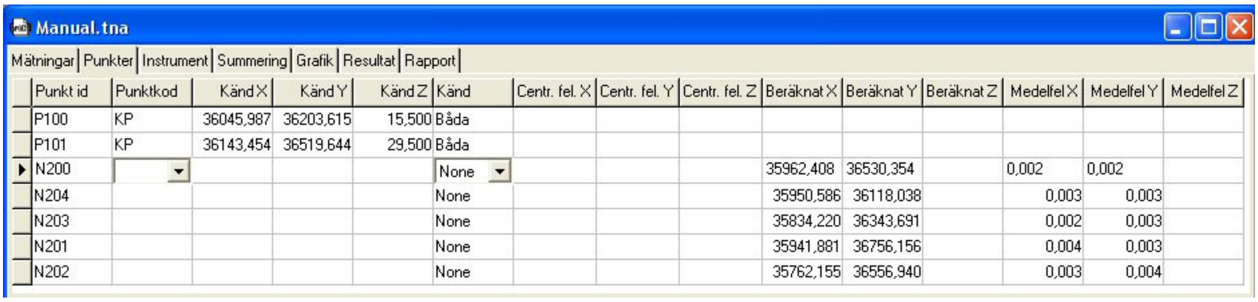
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

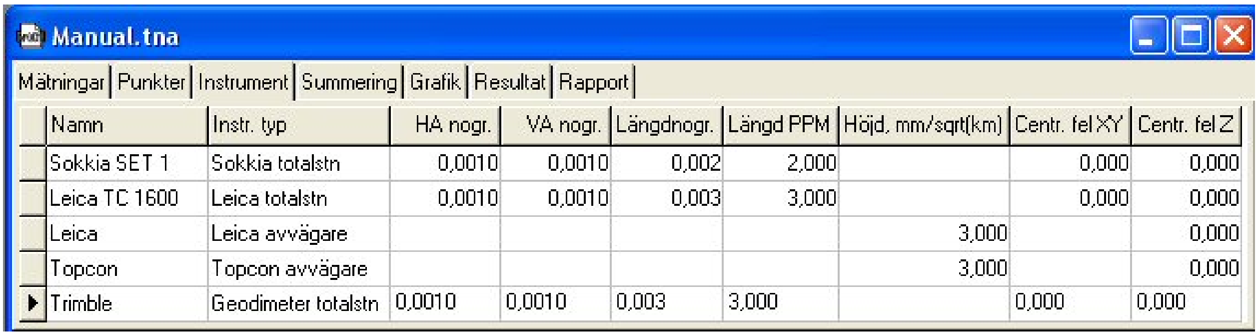
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

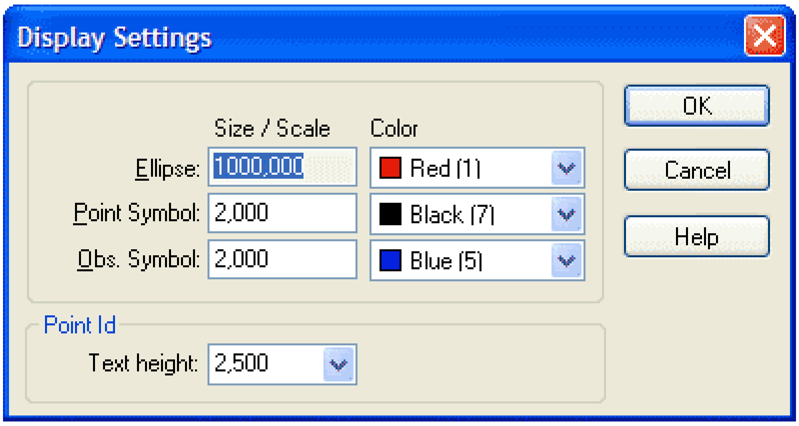
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



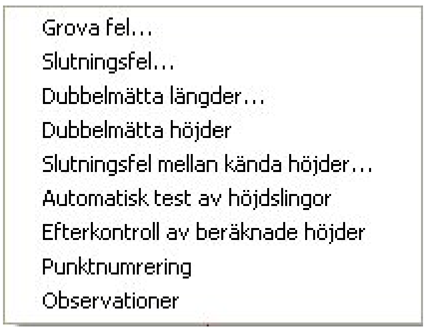
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

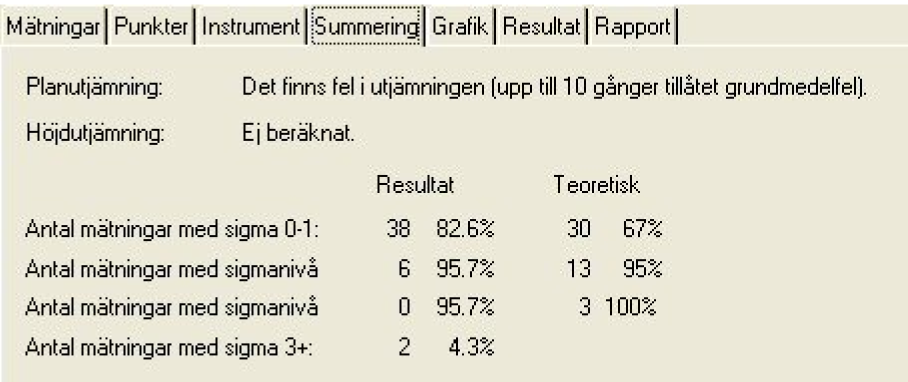
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

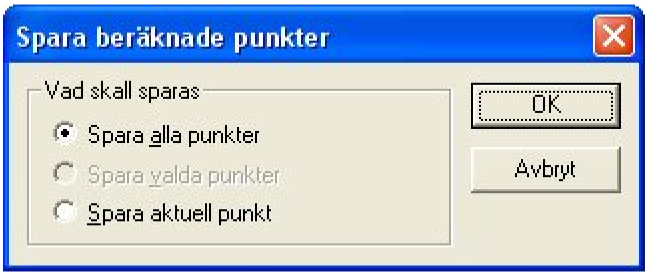
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



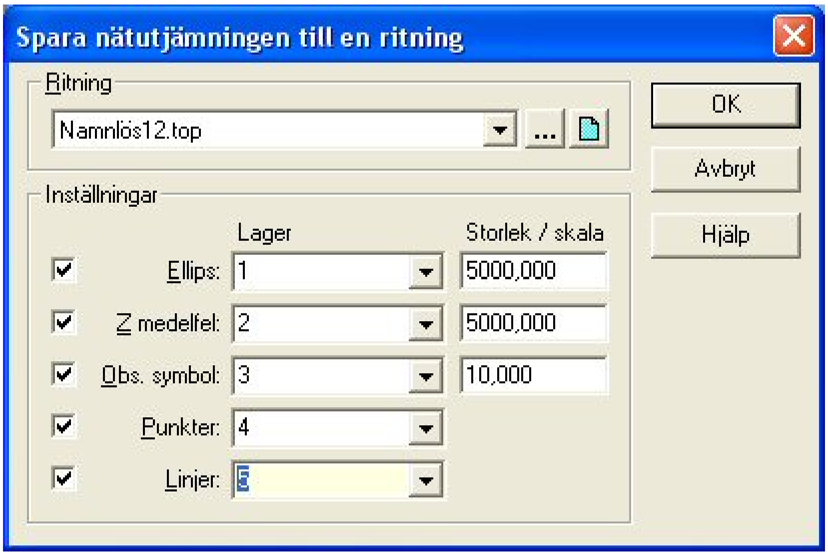
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

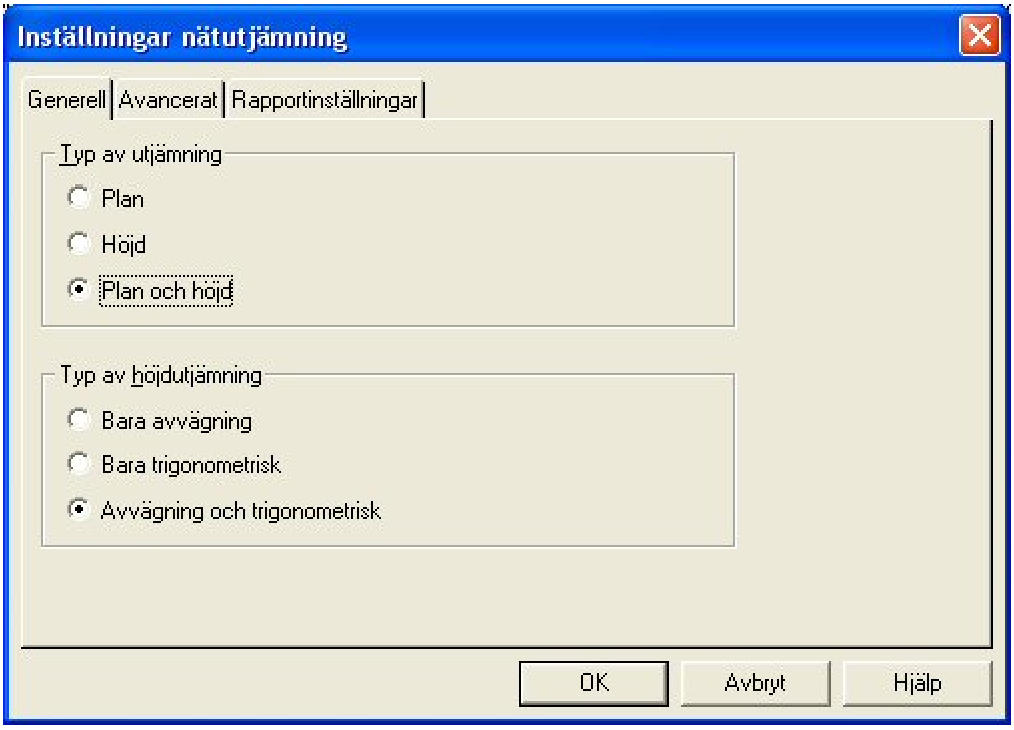
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

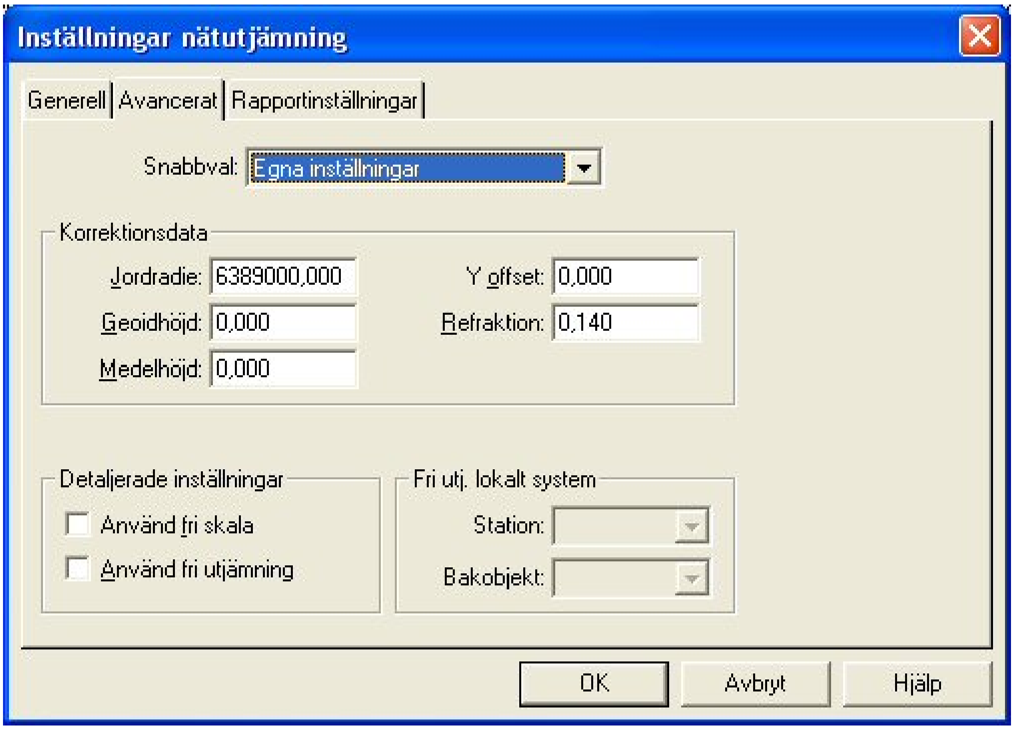
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

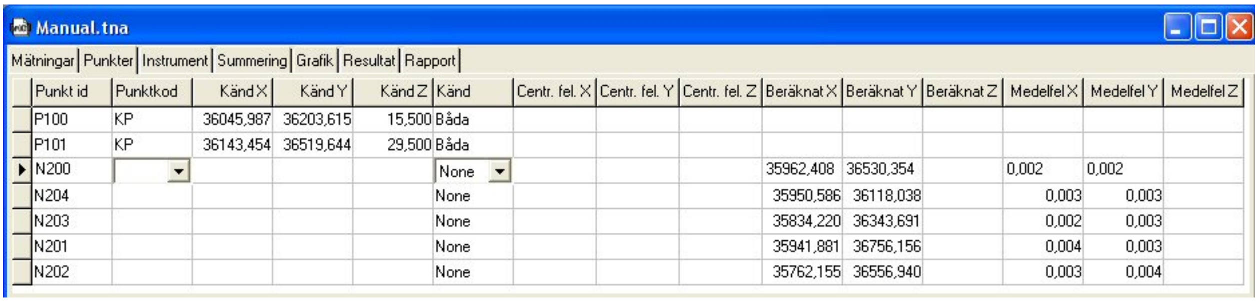
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

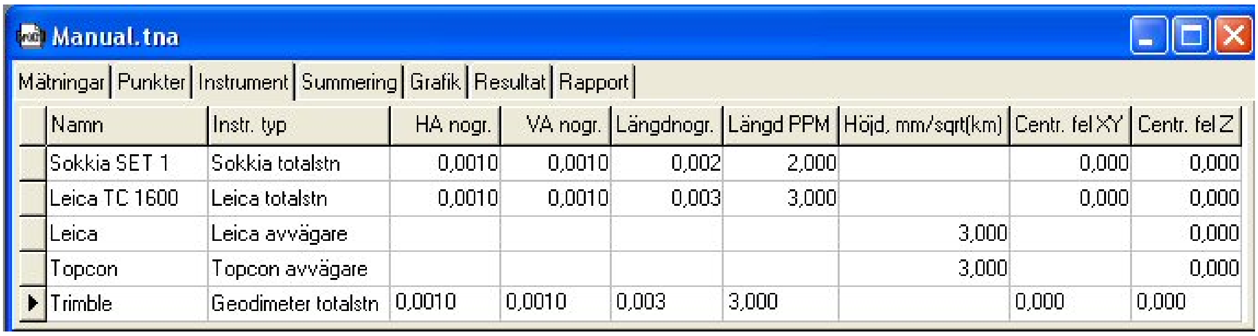
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

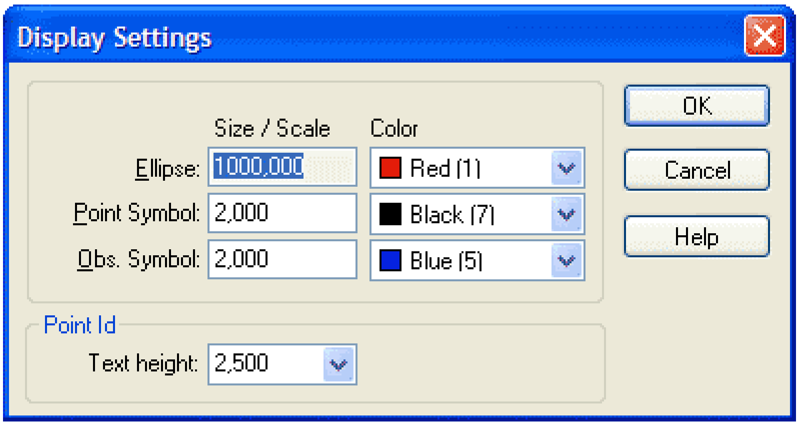
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



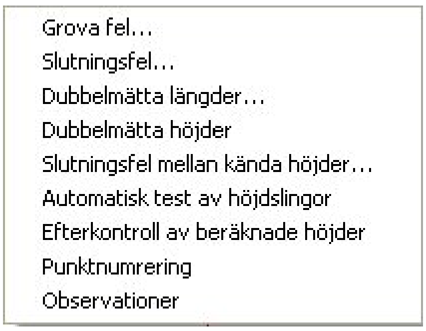
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

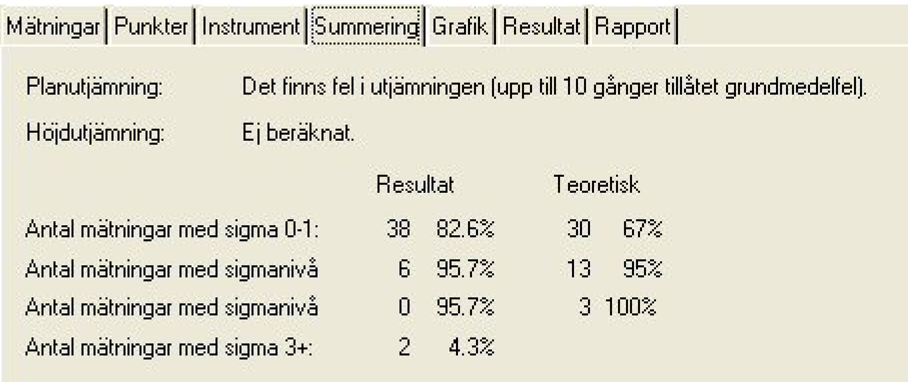
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

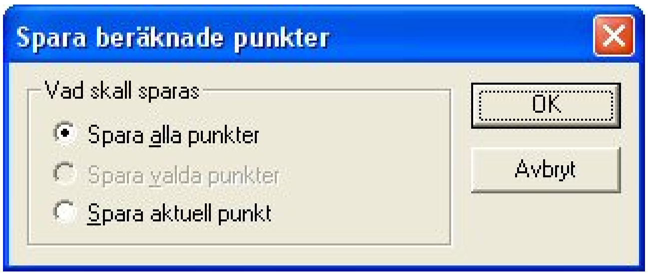
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



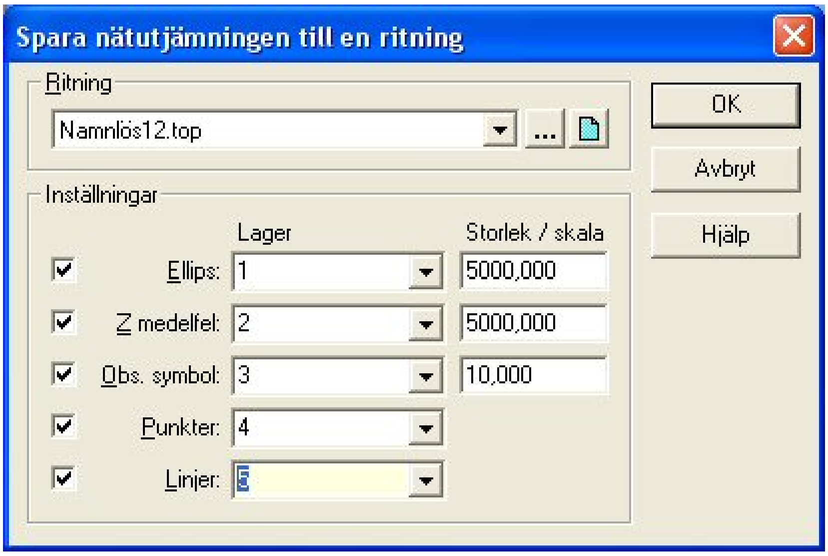
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

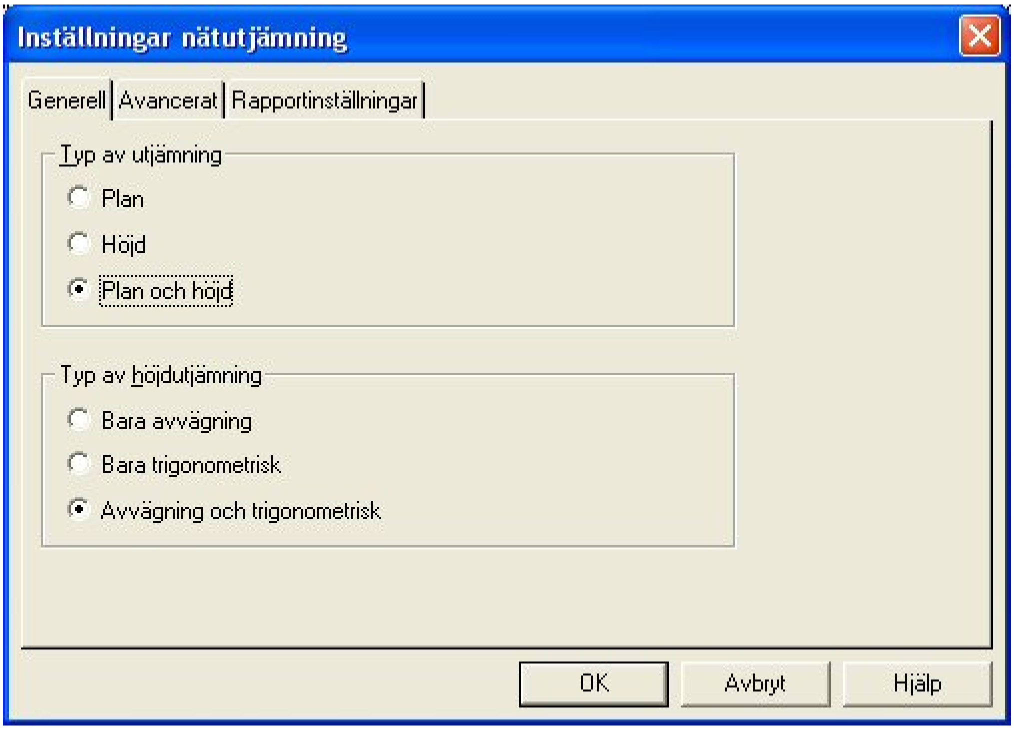
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

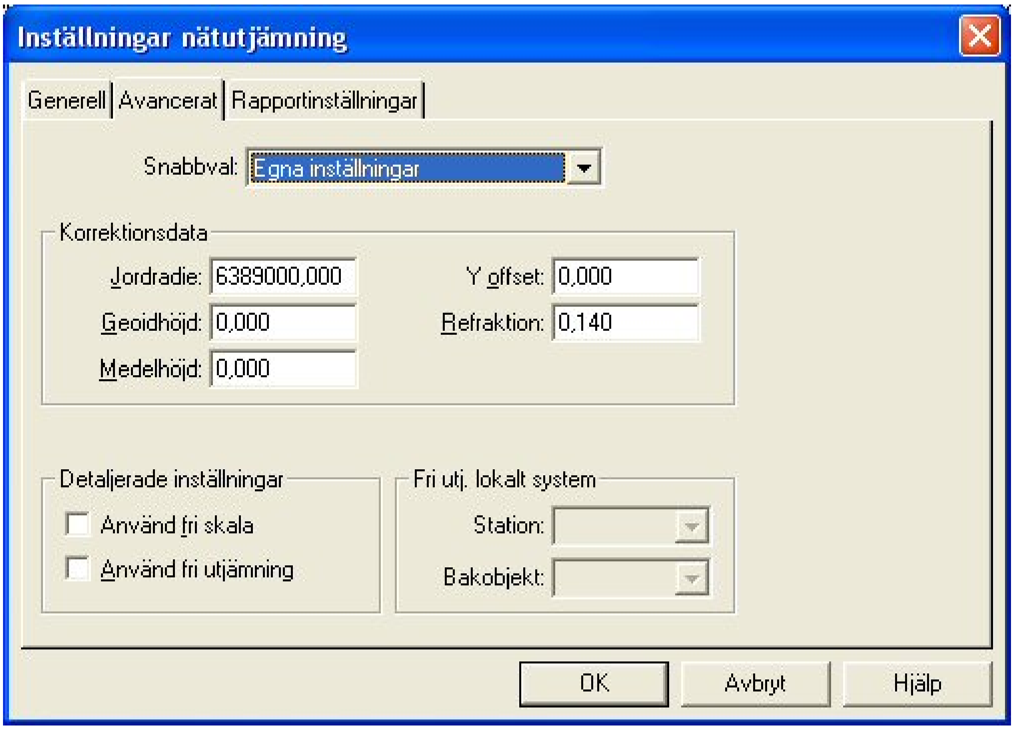
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

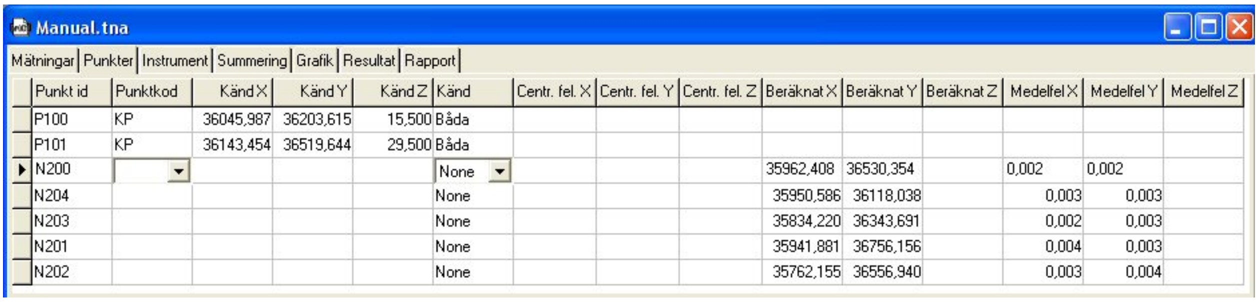
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

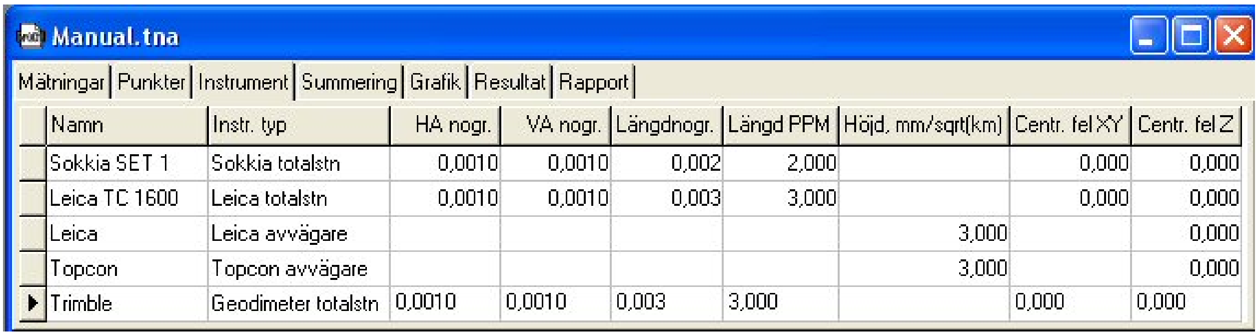
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

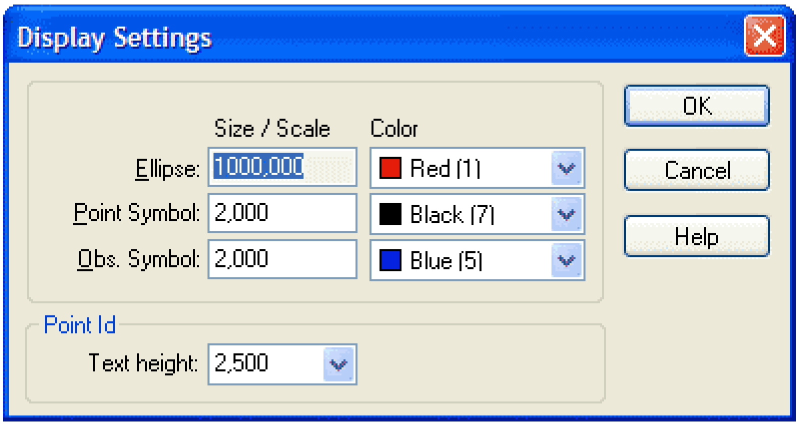
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



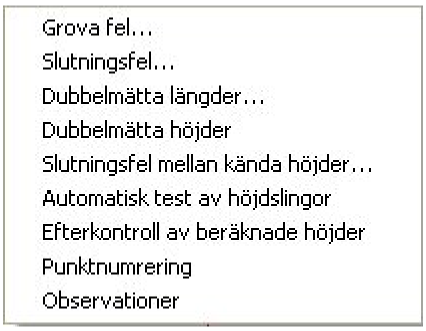
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

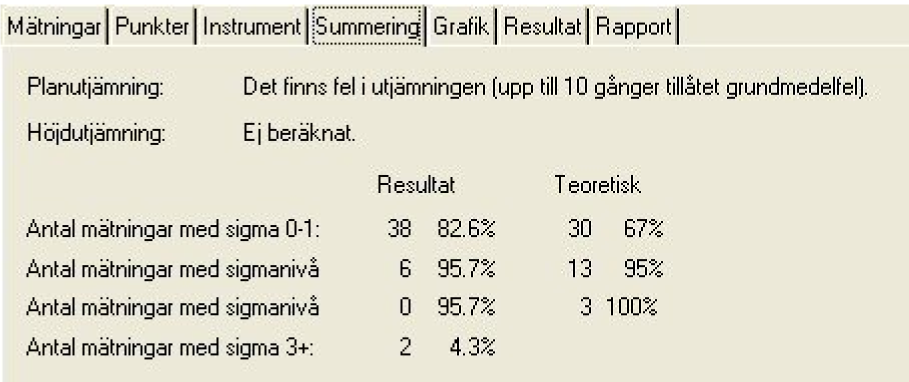
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

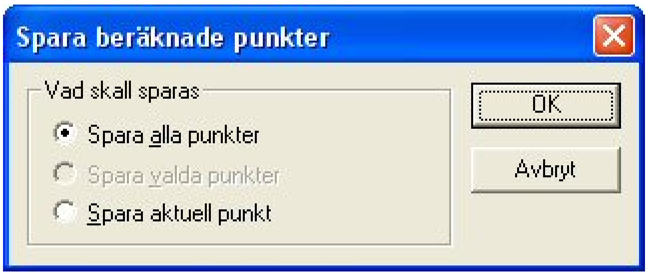
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



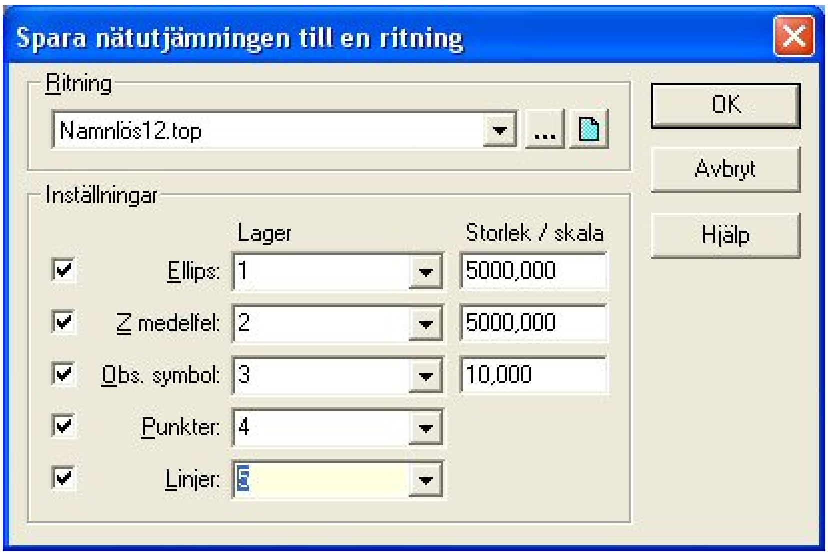
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

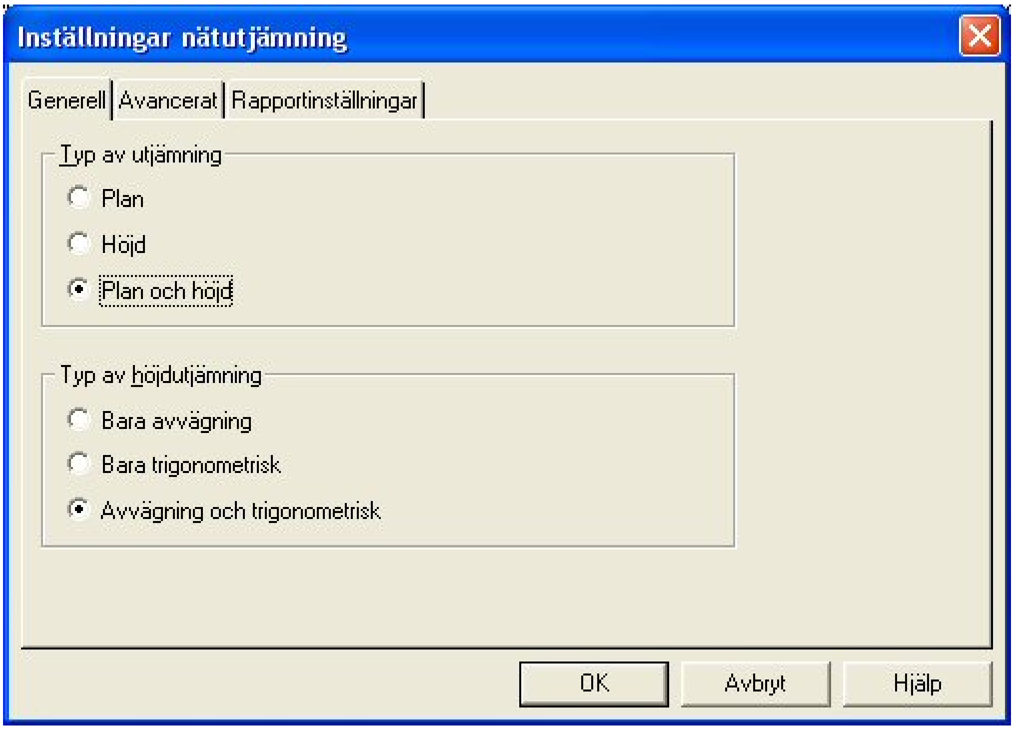
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

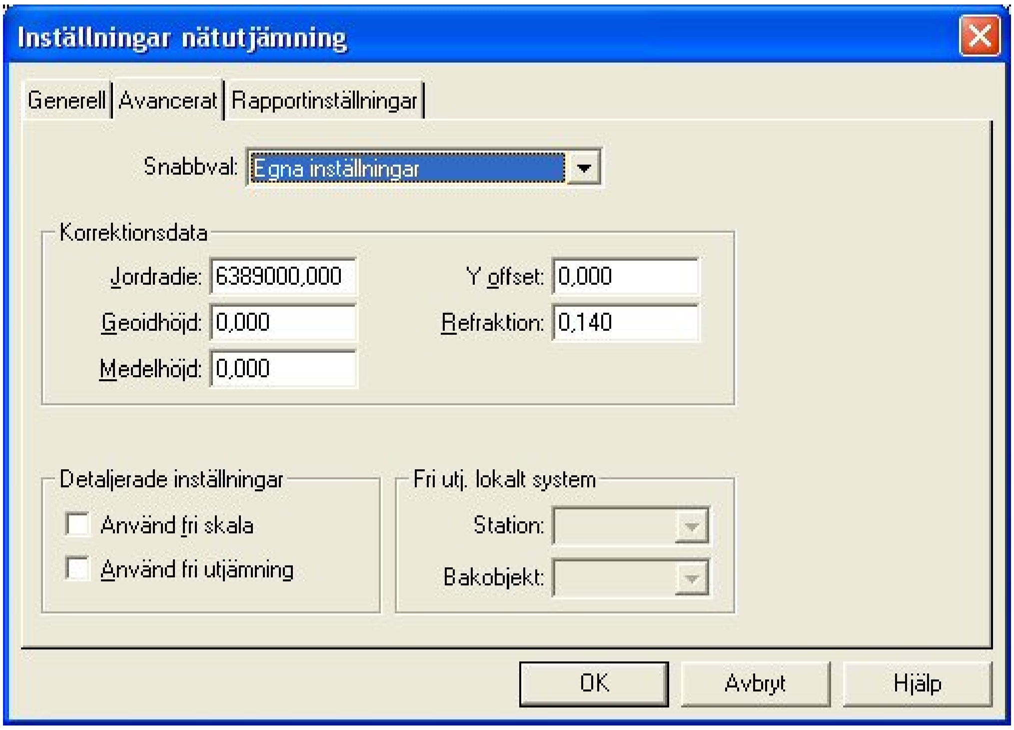
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

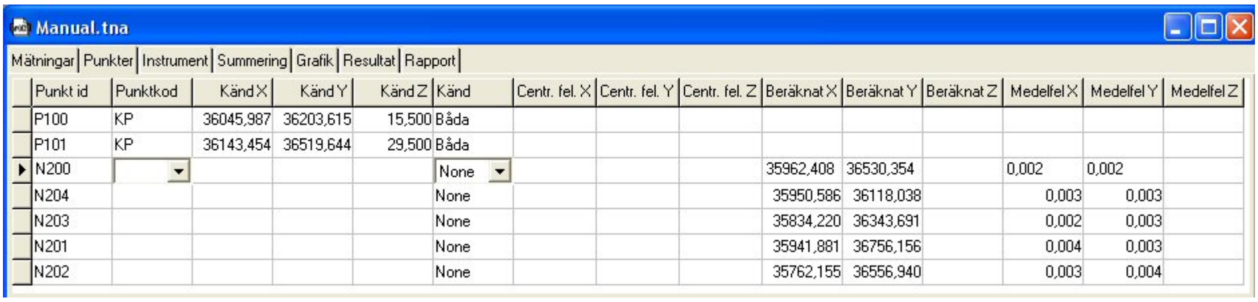
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

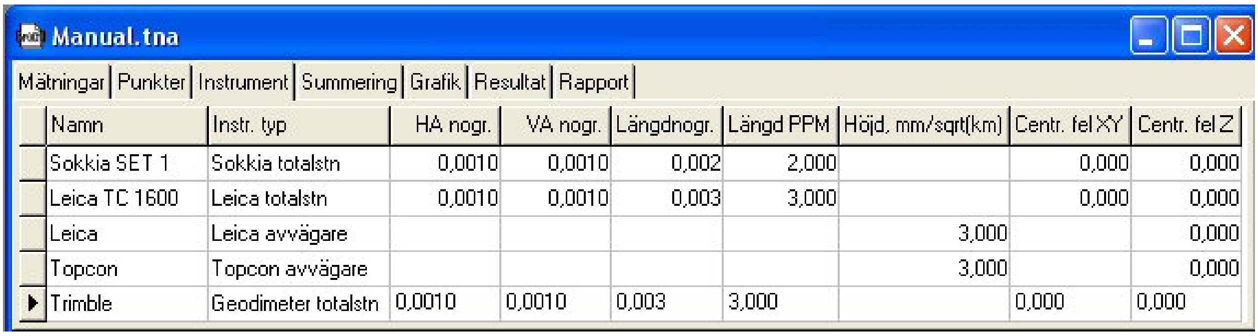
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

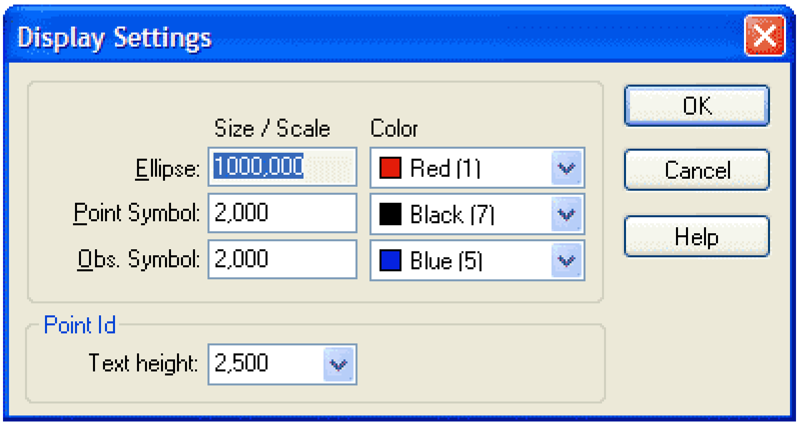
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



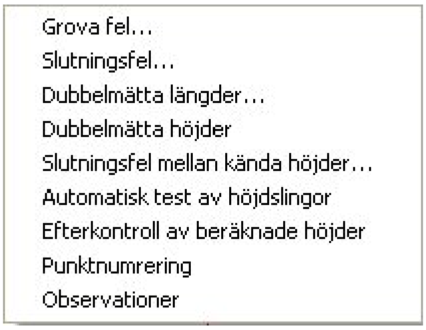
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

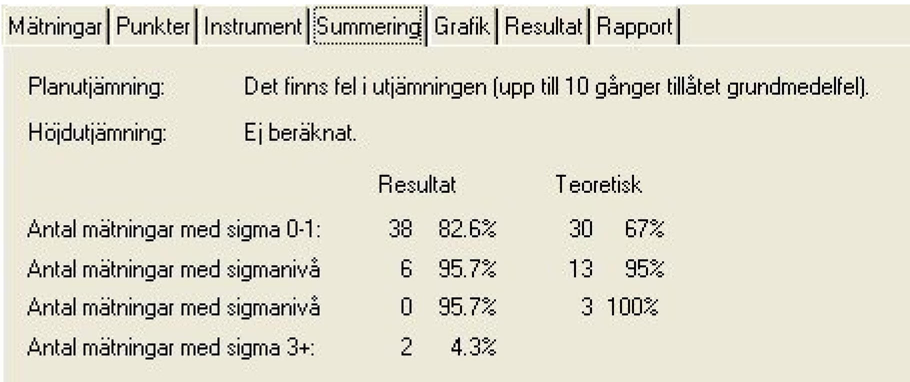
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

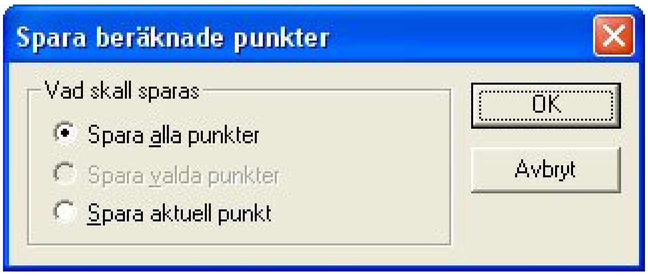
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



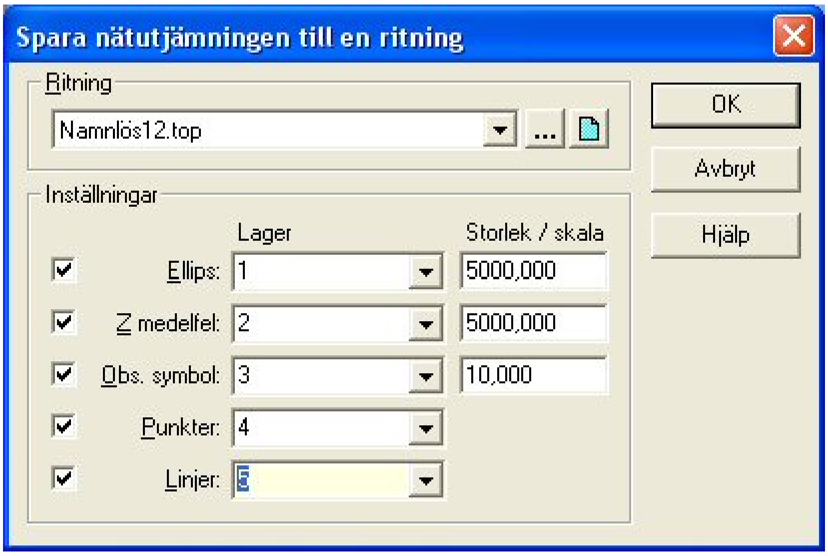
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

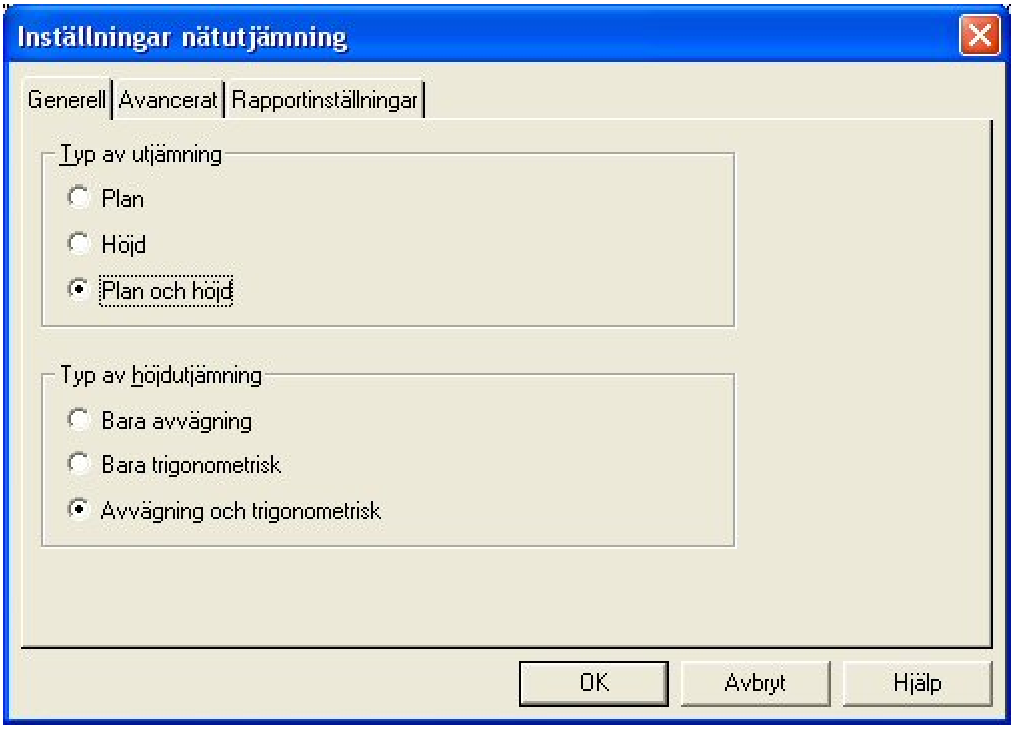
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

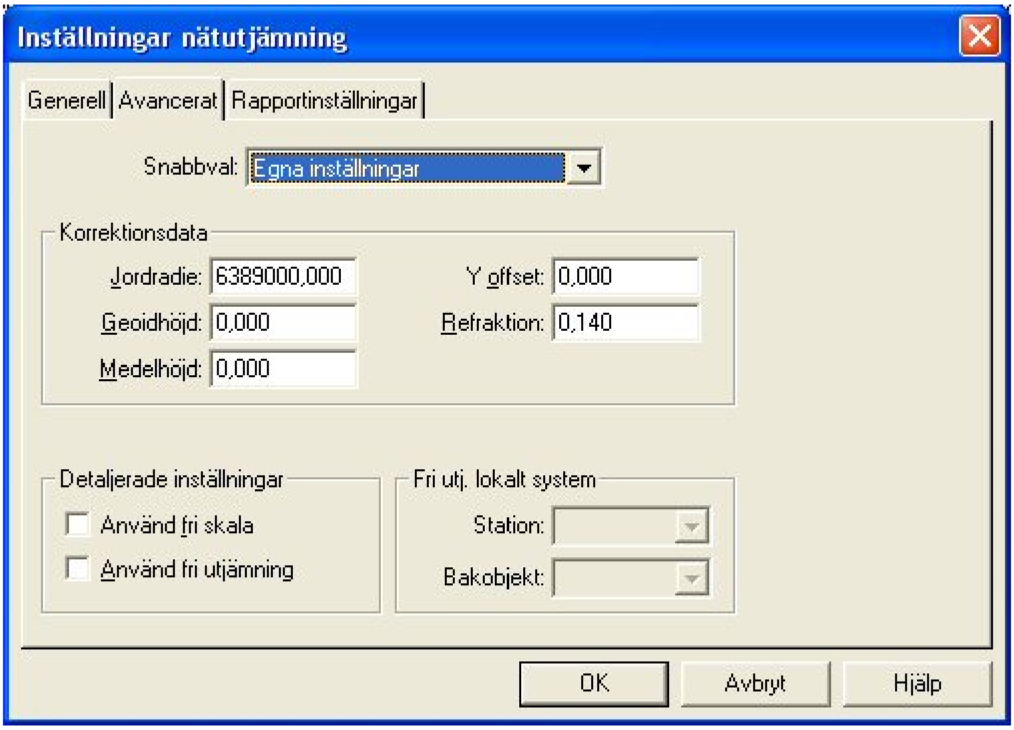
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File*|*Settings*|*Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File*|*Settings*|*Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

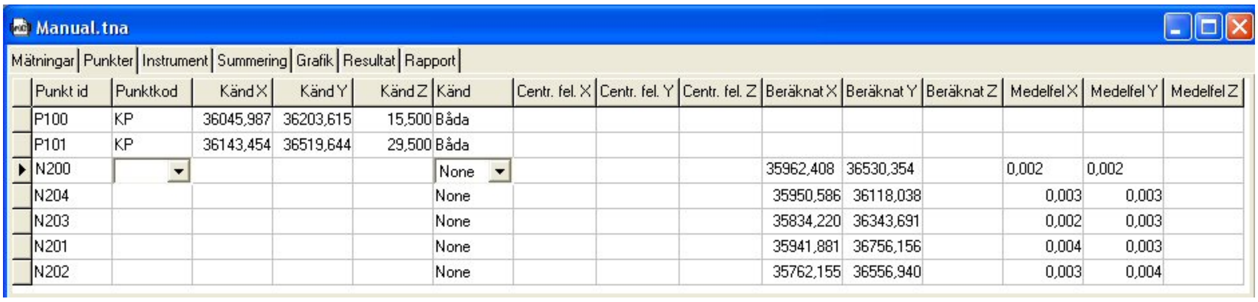
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

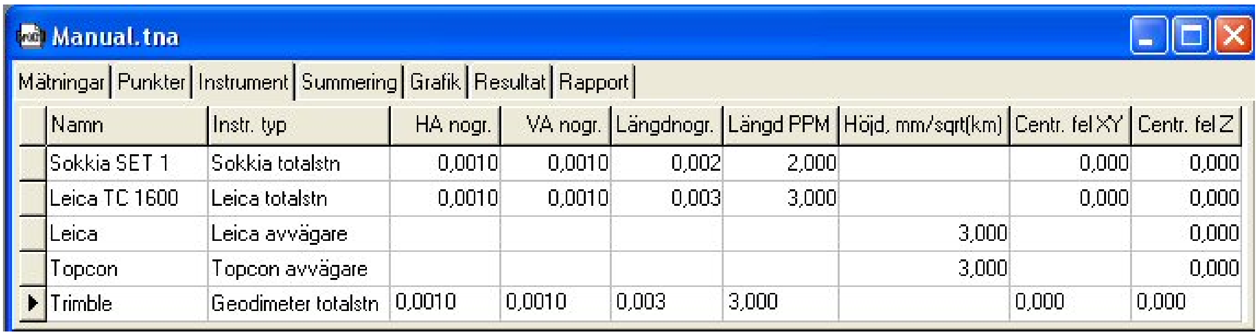
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

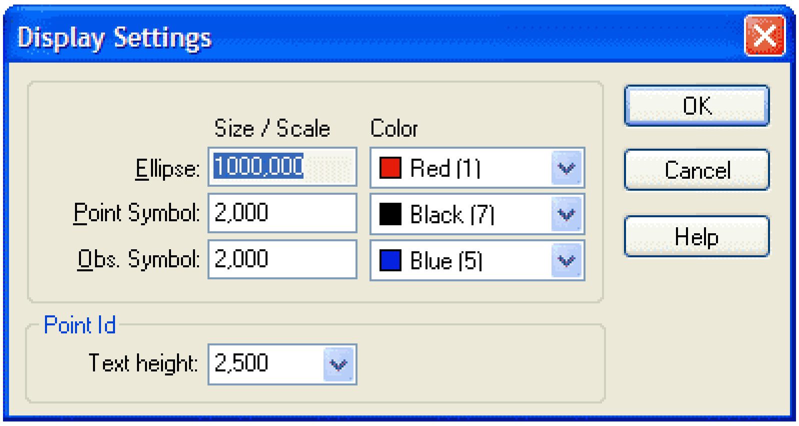
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



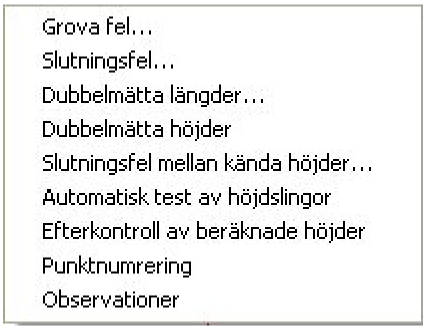
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

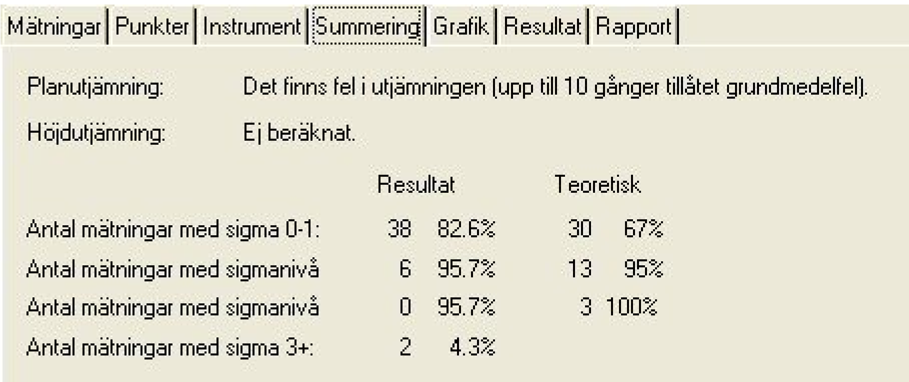
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

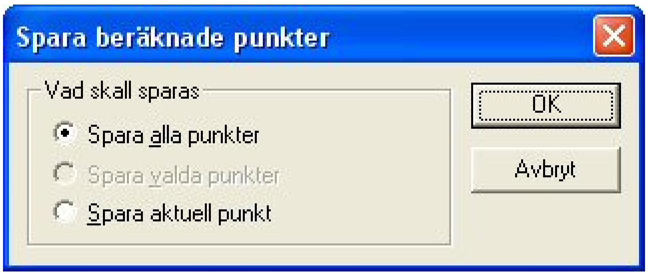
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



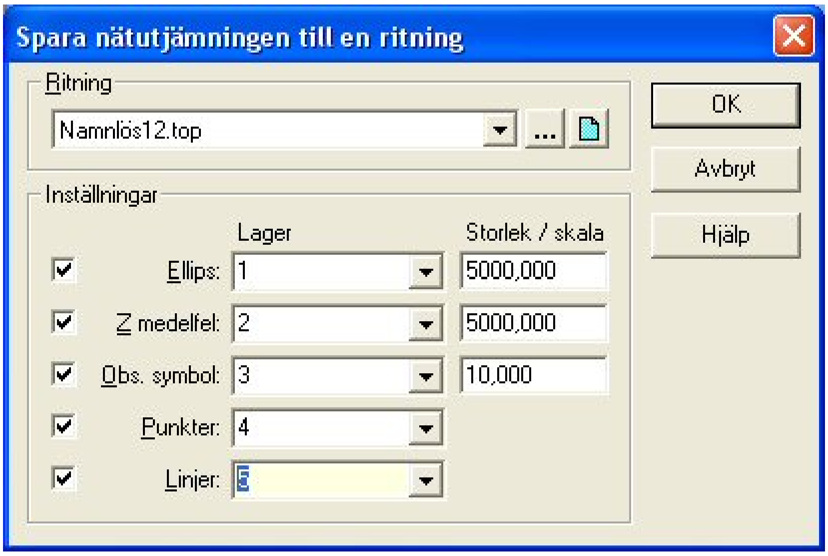
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

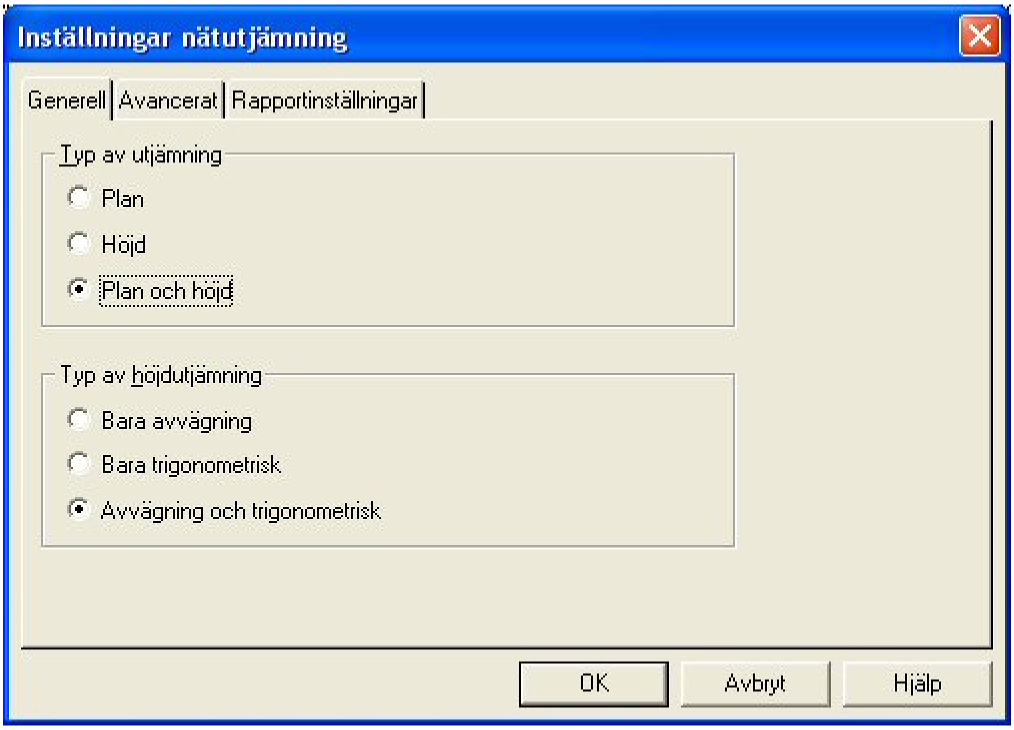
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

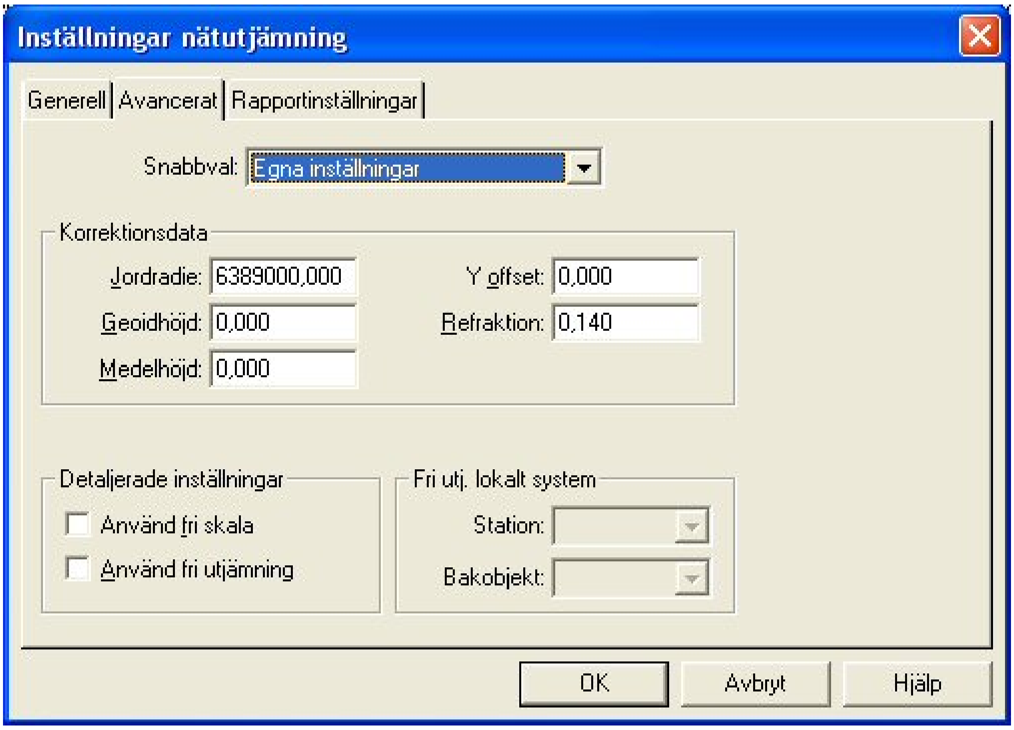
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

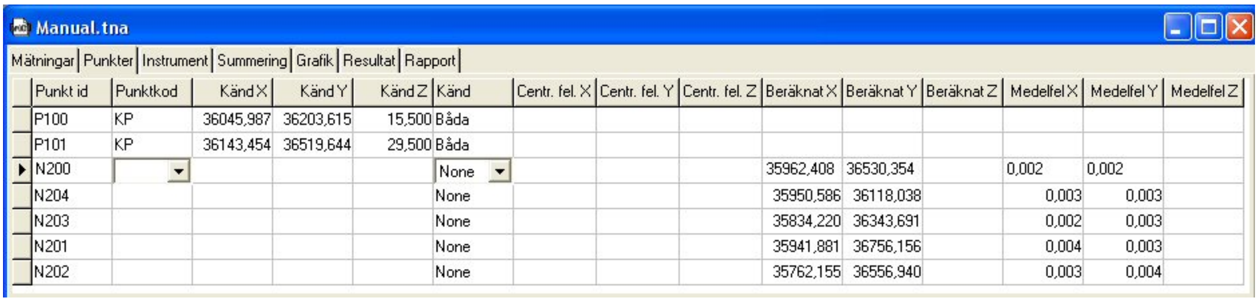
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

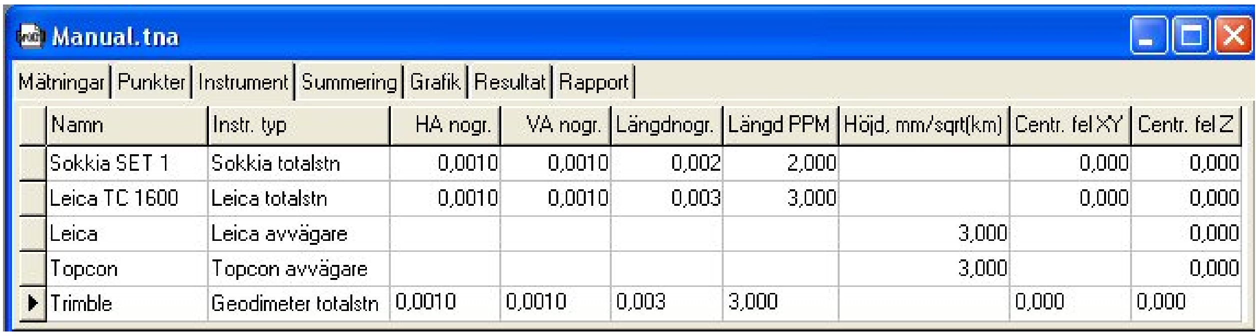
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

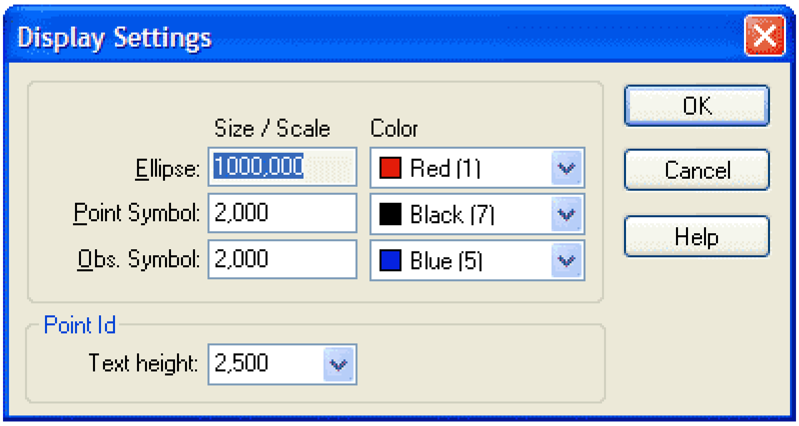
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



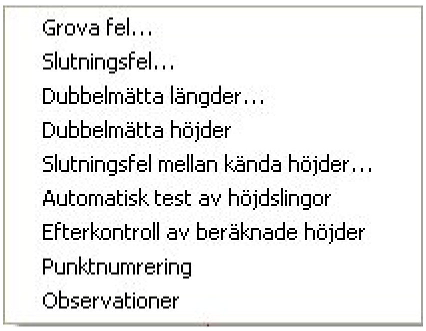
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests|Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

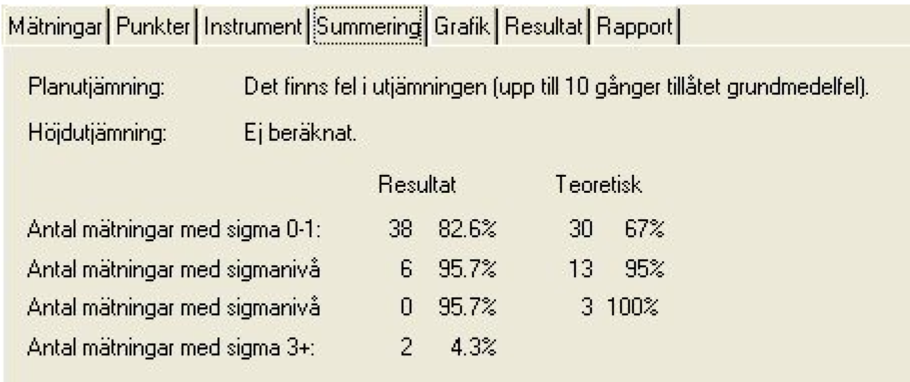
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

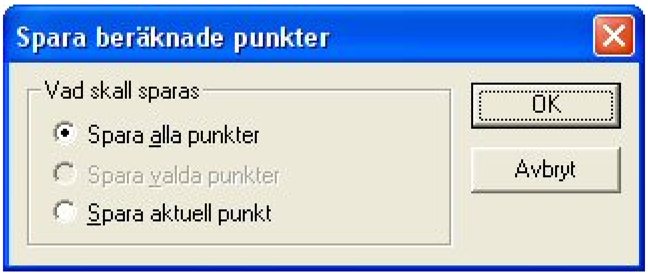
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



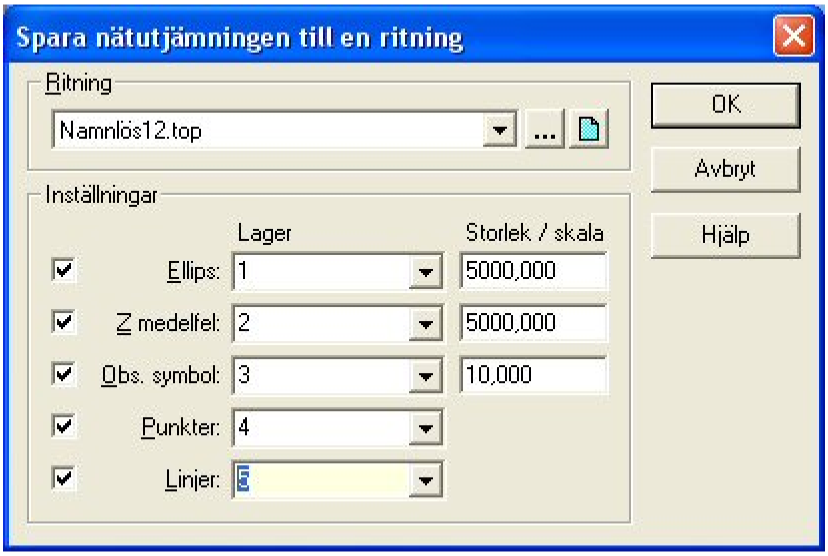
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

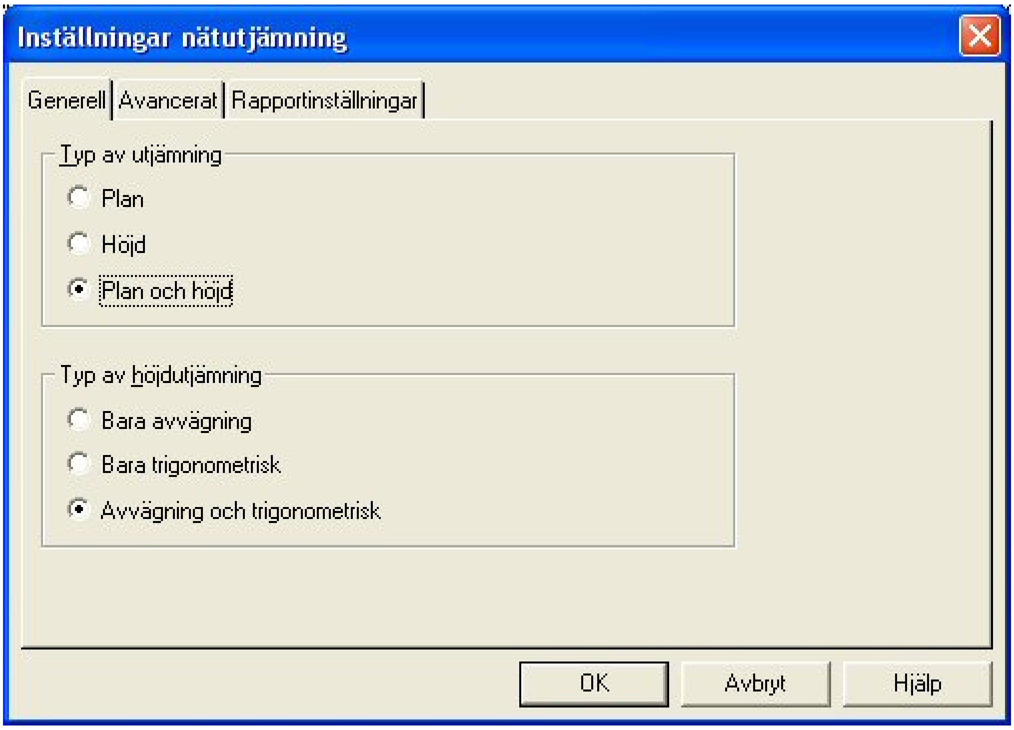
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.|Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

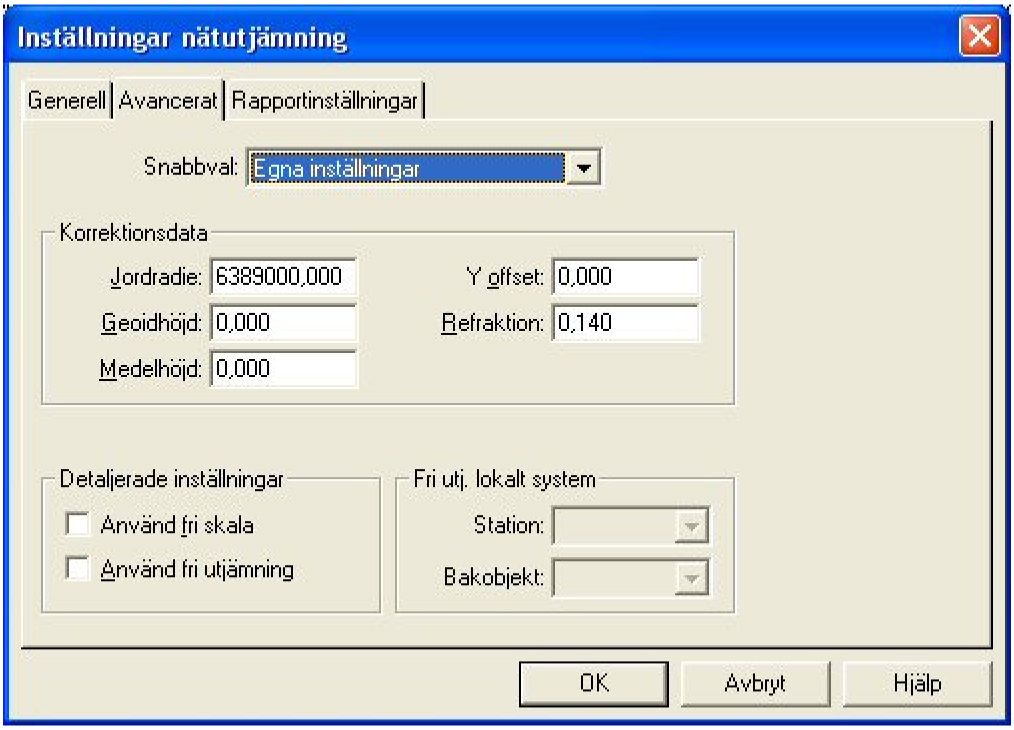
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File*|*Settings*|*Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File*|*Settings*|*Project settings*|*Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

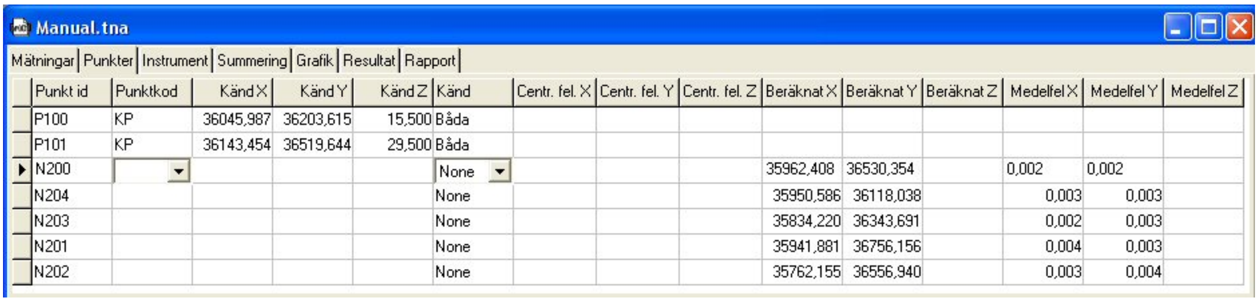
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.



Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

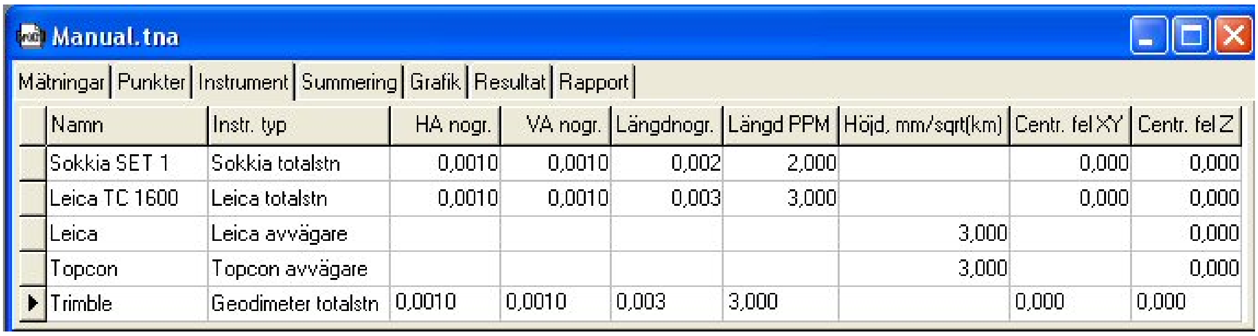
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

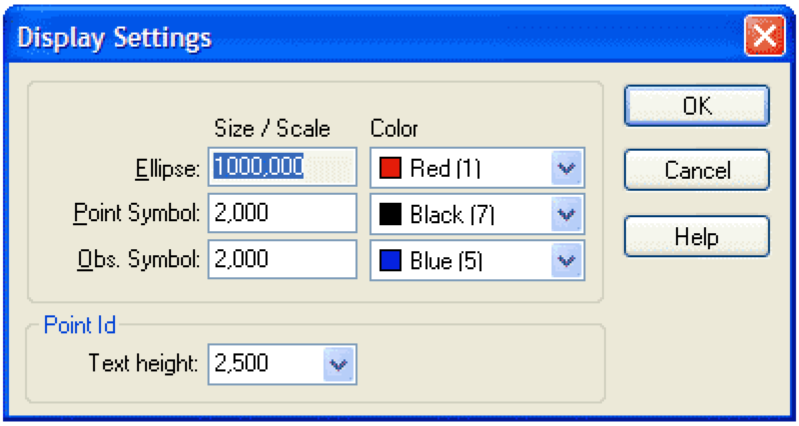
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



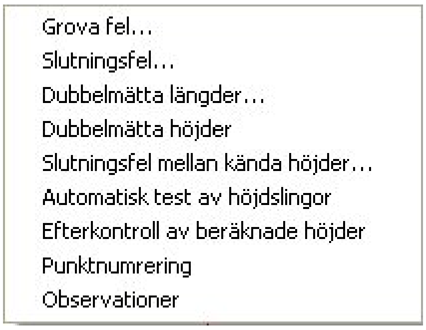
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

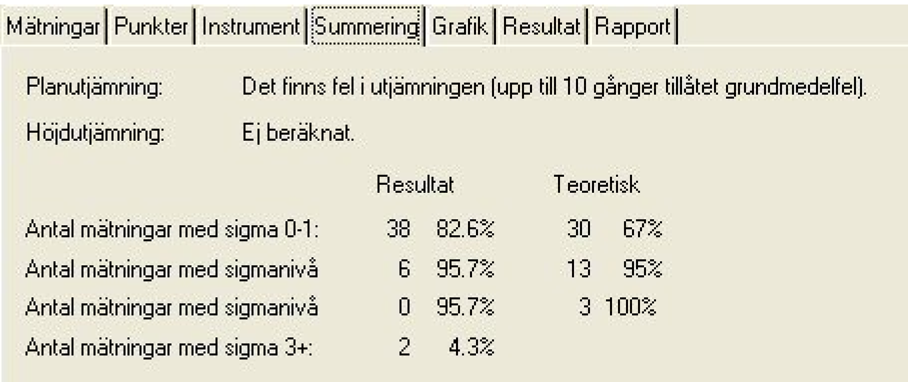
- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

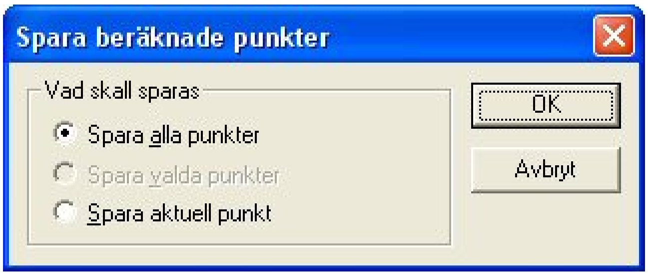
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



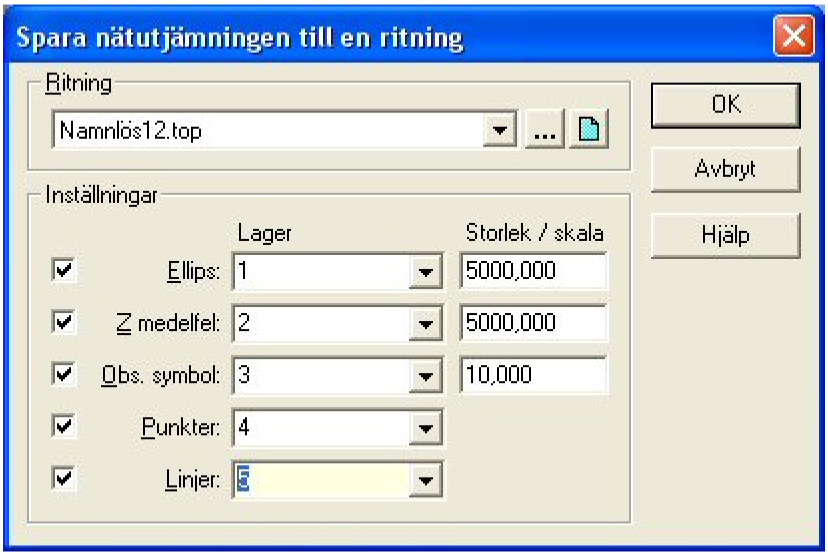
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Net adjustment contents

Net adjustment

Topocad Net adjustment is based on calculations using the Least Squares Method, and a number of

functions have been created for this to bring in data in appropriate ways and as methods for searching for errors. There are also a range of functions to customize the appearance of the results you want to present.

Function	Description
Input data for net adjustment	
Load survey data	Loading of survey data into the net adjustment protocol.
Settings survey data	Settings for importing survey data
Explanations of measurements	Explanation of terms
Explanation to the Net adjustment document:	
- Points	New and known points
- Instruments	Selection of instruments, list
- Summary	Quick summary of the net
- Results	
- Report	Explanation of terms in the report
Calculating of net	Calculate the net
Settings calculations	Settings for different net adjustment calculations.
Tests and reports:	
- Search gross errors	
- Connection Error	
- Double measured points	
- Double measured heights	
- Post checking of heights	
- Automatic height test	
- Point numbering check	
- Connection error heights	
- Measurements	
- Test of known points	Test of known points
Other commands:	
Save polygon points	
Save net adjustment to drawing	
Display settings	

Lock heights	
Simulation of net adjustment:	Structure of simulation calculation
- Import of known points	
- New points	
- Observations	

Entry data is based on a purge having been made to Topocad's survey data file using the SUR file format, and this data is then imported to the net adjustment; but entering data directly to the net adjustment measurements works equally well.

The known points are loaded from the preset polygon point file (default is Topocad.PP) but you can also enter known coordinates under the New Points tab.

Load survey data to net adjustment

The net adjustment uses Topocad's normal survey data protocol (*.SUR) as a basis for the observation. The survey data file of individual observations, observation series, free stations, traverses, detail observations as well as repeated observations of the same object.

To load the observation to the net adjustment form:

1. Create a new net adjustment file from *File|New - Net adjustment.*
2. Import data from *File|Import|File* and select your survey data file. Note that it must be closed
3. Select the instrument you have used.
4. Select the stations and the type of data for import. See below.
5. The imported measurements appear under the Observations tab,
6. where you can also enter or edit other measurements.

Instruments

Enter the instrument to be used in the survey data file. You must have defined the instrument under *File|Project Settings|Instruments*. Click the Add button to enter an instrument name and then define the properties the instrument has. Note that the instrument must have been defined before importing the survey data file.

Settings for import - What kind of Stations would you like to import?

- Known stations (polar configuration)
- Free Stations
- Traverse (standard mode, only the points that are highlighted with the traverse survey type are usually calculated)
- Leveling

Settings - What kind of observations?

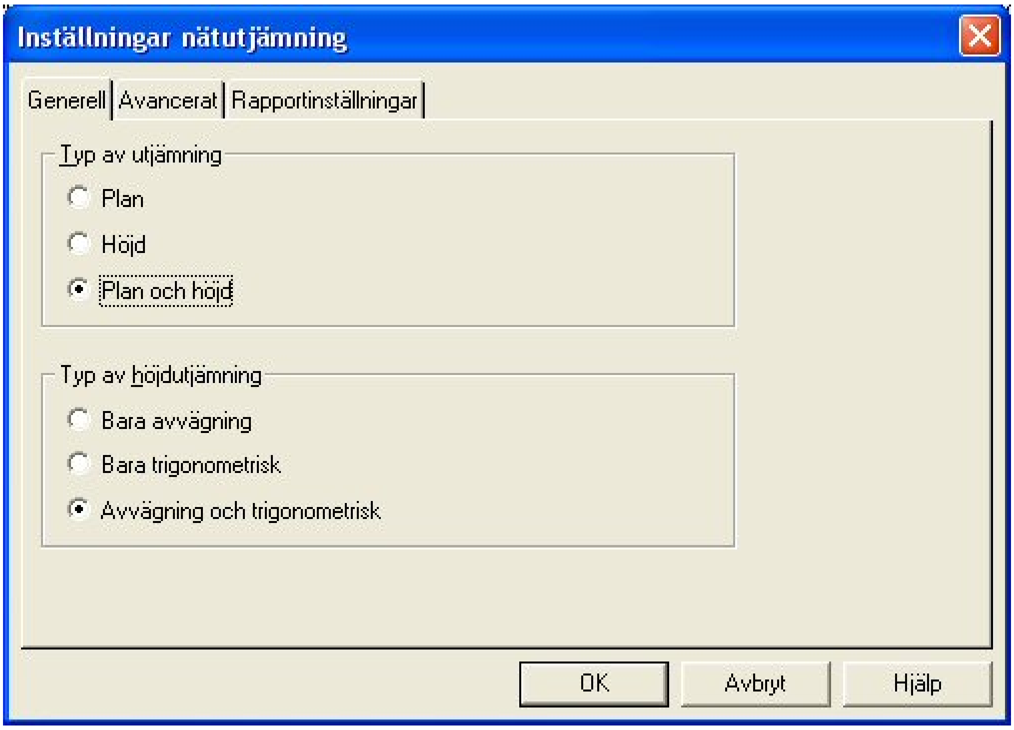
- All observations - also includes detail points.
- Observations that are part of the station establishment, i.e. those that have the survey type "station" and have been coded with the point type backsight or polygon point.
- Observations that are used for something else. This means those points that have been marked with the survey type "Other".

Settings

You can make several speed settings under *Net adj.*|*Settings* in the main menu. These settings do not affect the survey data/measurements but only give the program instructions on how to calculate. This means that even though plane and height are to be calculated for a measurement, the speed setting is to be set to plane alone.

You can make these settings under three different tabs:

General



Type of adjustment:

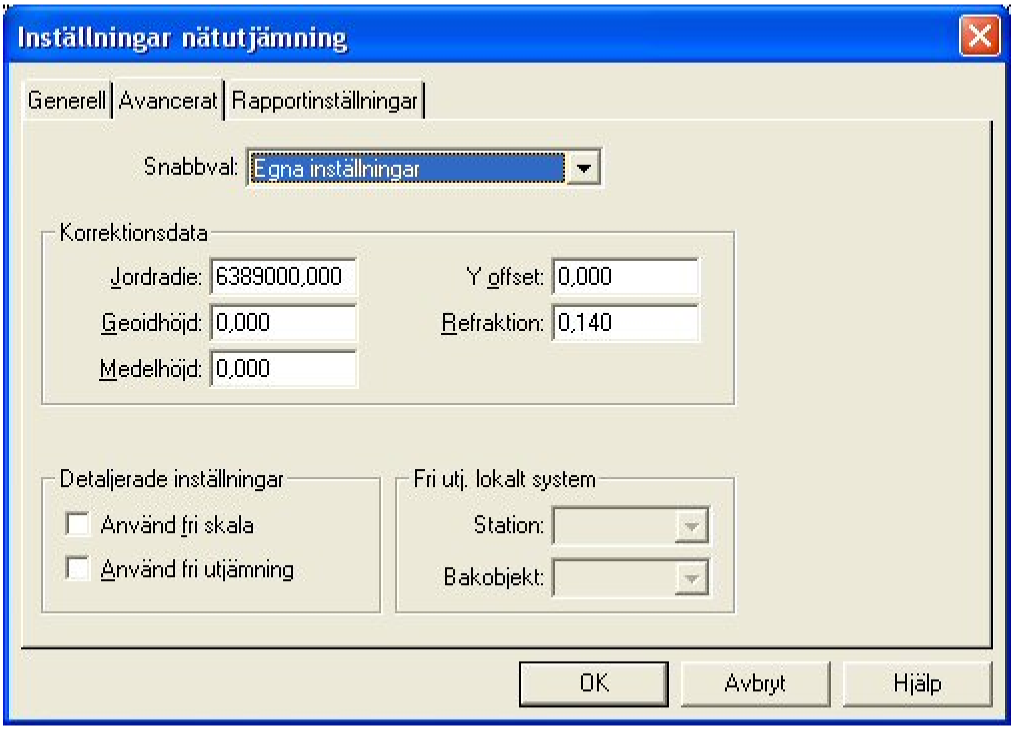
- Plane
- Height
- Plane and height

Type of height adjustment: (only when adjusting height or plane and height)

- Only leveling (only leveled survey data is included in the height adjustment)
- Only trigonometric (only trigonometric observations included)

- Leveling and trigonometric (both survey types included)

Advanced



Speed settings

These speed settings control the calculation and take precedent over the settings made for each individual observation under the observation tab. The advantage of this is that you are sure that the selected type of calculation really applies to all observations. In order to use the individual settings for each individual observation, you must select *Own settings* in this list.

Use project settings
Use the settings made under *File|Settings|Project settings*. It is principally the Coordinate tab that is of interest when selecting the coordinate system. If this is not Local, an ellipsoid correction will occur (height correction projection of length of the ellipsoid) and the projection correction for all observations.

Own settings
Use the settings under the Observations tab exclusively, i.e. if the ellipsoid or projection correction is to be calculated for each observation.

Free adjustment
Release all points to ensure the error for the known coordinates does not affect the net. This is good for a local net that is to be as tension free as possible, or if you suspect that there is an error in the known coordinates. If this adjustment gives good results in a well-balanced net, this indicates that all observations are OK, and that an error in a normal (forced) adjustment depends on an error in the known coordinates. Remember that an observation in a traverse of observations that ends at a known point is calculated as a detail observation in free adjustment, which means that gross errors cannot be traced for observations of this type. In order for a free adjustment to be implemented successfully, the net should be designed as loops or triangles. Traverses without loops may produce uncertain results.

Projection and ellipsoid correction is deactivated for this adjustment. If you want to carry out a free adjustment with the corrections activated, you must use the speed setting Own settings instead; select Free adjustment under Detailed settings and then select Yes for all the corrections for the observations in the observation tab.

Free adjustment, local system
You restrict the known points here to two and allow the program to calculate a bearing from the station

point, which retains its coordinates. This method also removes tension in the known points, but retains the station point coordinates (all known coordinates are affected in a totally free adjustment).

Local coordinate system
Does not use corrections for projection and ellipsoid.

Unknown coordinate system
Uses a free scale to eliminate the affect of a scale error on the lengths. This method is ideal if you have major errors in the lengths and suspect that you have an incorrect Y-offset for the coordinates (affects the projection correction) or has a length gauge with a scale error. If an adjustment with free scale drastically reduces the length errors, you may assume that you have an error of this type.

Correction data

The values specified here are inactive (grey) if you have selected a speed setting option where the values have either been loaded from the project settings *(File|Settings|Project Settings)* or are not used in the calculation.

Earth radius-
required for correction calculations. As a standard value 6370000 is used for Sweden. If you use a RT90 coordinate system in the project settings and have specified the *Use project settings* speed setting, the program will calculate an earth radius as per the formulas in HMK Geodesi Stommätning *(HMK Geodetics Control Point Surveying)* Chap B.1.1 and data for Bessel's ellipsoid.

Geoid height-
the height (water surface) of the geoid compared to the map projection's reference ellipsoid (Bessel's ellipsoid applies to RT90). If you use a RT90 coordinate system in the project settings and have specified the Use project settings speed setting, the program will calculate a geoid height using the geoid height model RN92.

Y offset-
offset in Y which is often 1,500,000 for RT90 coordinates to avoid negative Y values. It is very important to check this value if you allow the net adjustment to calculate the projection correction. If you use coordinates with the specified offset, but forget to specify it as Y offset, a length of 100 m will have an error of around 2.7m. In *File|Settings|Project settings|Coordinate* you select a system with a specified offset. This is often abbreviated; e.g. RT90 5 GON V 60: -1 means that you subtract 6,000,000 from the X-coordinate and add 100,000 to the Y-coordinate. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Refraction-
the refraction of the light in the atmosphere. The standard value for the refraction coefficient is 0.140 for Swedish conditions. The refraction influences the calculation of the height difference and is used in calculations according to the definitions in HMK Geodesi Stommätning Chap. C3.

Mean height-
if you are to calculate the ellipsoid correction but do not have the z coordinates for your points (required in the calculation), you can specify the mean height above sea level for the net you want to calculate. For a length of 1,000m, a height error of 10m will result in a correction error of just 2mm, so you only need an approximate height for the points; meter accuracy is often enough. The height correction formulas are described in HMK Geodesi Stommätning Chap. C1.

Detailed settings: (active for the speed setting Open Settings)

Use free scale-
used if you want to calculate the scale if it is unknown, for searching of scale errors in nets with major improvements for lengths, or for tests of a net with known scale to see if the specified scale factor seems to tally.

Use free adjustment-
Use free adjustment- adjusts the net without taking fixed known coordinates into consideration. Good for nets that need to be free from tension. See Free adjustment under Netadj.|Settings Speed settings. As free adjustment here occurs under the Own settings speed setting, the ellipsoid and projection correction will be carried out for a certain observation if you have specified the observation's row in the survey data tab.

Use centering error for new points

If you have used forced centering consistently during the observations (had the tripod in the same place but changed the places of instruments and prisms) you will be aiming at the exact same point that you measured from. In practice, this means that the effects of the centering error will not influence the precision of the observations. The centering error is added to the mean error of the calculated new points instead. However, when you connect to a known point, the centering point will have an effect as the known coordinates apply to the point on the ground and not the position of the tripod over the point. The program will therefore include the centering error from known points in normal mode, but not new points when calculating the observation's apriori mean error. This is closest to reality if forced centerings dominate in the net. However, if you take the tripod down for the majority of the observations, you should also take the centering errors of the new points into consideration when calculating the apriori mean errors.

To sum up this means the following: If you have used forced centering predominantly in the net, the Use centering errors for new points box should NOT be checked; whereas is should be checked in reverse position.

Explanations for Observations

An explanation of the columns follows under the Observations tab:

From Point
Select from which point you have made the observation, i.e. the station point. This may be both a known point and a free station, or a new point in the centre of the traverse.

To point
Marks the point to which the measurement is made. This could be both a known or a new point.

Series no.
Normally you measure one direction series at a time per station and then change the station point. If you have measured in this way, you do not need to worry about this column which will then have a default value of 1 for all observations. However, if a special case occurs where you measure one more direction series from the same station straight after the first series, the series need to be separated from each other in some way. If this does not happen, the program treats both series as one which may lead to errors. We differentiate between the series by manually assigning the value of 2 in the series column to the other direction series. If we have a third series from the same station immediately after the second we assign these observations the value of 3 etc. If several station establishments occur in a row from the same point in a survey data file, the net adjustment when importing will set different series numbers automatically to separate the measurement series.

Hor. angle
Horizontal angle.

Vert. angle
Vertical angle.

Length
Slope distance. If the vertical angle field on the same row is blank, the length is treated as horizontal.

Height diff.
Measure the height difference between the from and to point. Used primarily for leveling data.

Bearing
Here you can enter a known bearing between two points. It could either be a fictitious bearing to give the net the desired orientation (turned facing north), or a bearing measured using gyrotheodolite.

Instr. elevation
Height of instrument above the point.

Refl. height
Reflector (prism) height above the point.

Instruments
Specify the instrument used, which in turn defines the precision of the observations (measured as accuracy), which is displayed under the instrument tab.

Proj. corr
Projection correction - specifies if this is to be used or not for the observation. Speed settings are available

in Settings (see this chapter for a more detailed description) if you have selected Use project settings, which generally activates/deactivates this function for all observations regardless of what has been specified for each individual observation. The projection correction formulas used are described in HMK Geodesi Stommätning Chap. C2.

Ellips. corr
Ellipsoid correction - specifies if this is to be used or not for the observation. The correction reduces measured lengths to the ellipsoid. The height correction formulas used are described in HMK Geodesi Stommätning Chap. C1. Just as for the projection correction, the speed settings will take precedent over the individual settings for an observation.

Atm. corr.
Atmosphere correction to lengths. This function is affected in the same way as the projection correction to the speed settings in Settings. The corrections are calculated as follows (obtained from instrument manuals from the manufacturer in question):

Leica
ppm=281.5-((0.29035* pressure)/(1+0.00366* temp))

Trimble/Geodimeter
ppm=275-((79.53*pressure)/(273+temp))

Topcon
ppm=279.6-((79.53*pressure)/(273.2+temp))

Sokkia Laser
ppm=282.59-((0.2942*pressure)/(1+0.003661*temp))

Sokkia Reflector
ppm=278.96-((0.2904*pressure)/(1+0.003661*temp))

Pressure and temperature are specified as mbar and degrees. The lengths are then corrected by multiplying by the ppm figure. If the length is specified in km, the correction is given in mm.

Pressure
Atmospheric pressure. Consideration is taken to this only if Yes had been entered in the Atm. corr. column. If you have the values in mmhg you recalculate them to mbar by multiplying by 1.3333, which is simply done using the Search/Modify function that you activate by right-clicking.

Temp
Temperature in degrees. Consideration is taken to this only if Yes has been entered in the Atm. corr.

Weight f. length
Weight factor length. Weights for lengths are automatically calculated through the formula P= 1 / mf2, where mf is the observation's mean error that is obtained from the instrument data. This value does not need to be changed by the user. If you end up in a situation where you know that an observation is worse than expected due to external circumstances (e.g. weather, light conditions, instrument errors), or if you, for whatever reason, would like certain observations to have less of an effect on the results, you can reduce the weighting of the observation. For lengths, this is done by changing the weight factor from 1 (=unaffected) to a lower value. If we change to 0.5, for example, this particular length will affect the result half as much as normal (the previously calculated weight is halved).

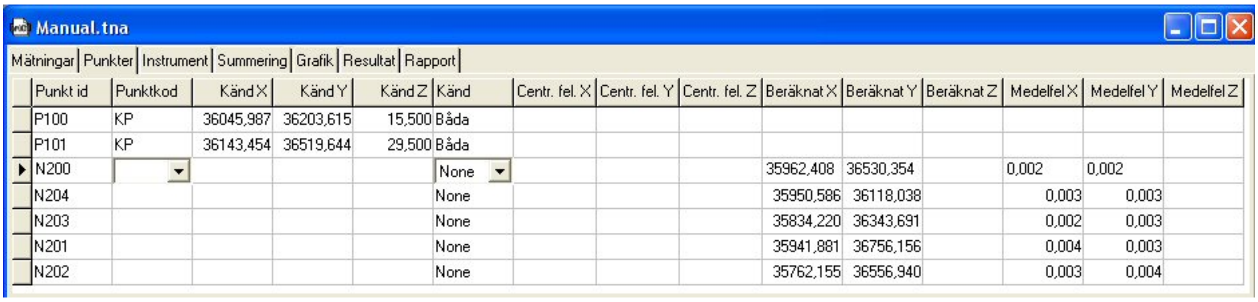
Weight f. angle
Weight factor angle. See above for explanation.

Weight f. height
Weight factor height. See above for explanation. Apart from leveled heights, this can also be used for an observation of the vertical angle and length if trigonometric heights are to be used. Weights for heights are calculated for leveling automatically using the formula P= k / L where L is the length between the points in km. k is a constant that is set to one if only one instrument is used. If several instruments have been used, k is set for the observations with the best instrument to one and for the others to one divided by how many times worse the observation's instrument is compared to the best instrument (calculated from the instruments' apriori mean errors).

Use observation
This tab has a number of selections and all of them specify the observations for the current row to be included in the calculations:

Observation	Description

None	No observation used for this row
Hor. Angle	Only the horizontal angle is used.
Length	Only the length is used.
HA + Length	The horizontal angle and the length are used from this row. In other words, no height data.
Height	The height measurements are used, that is the vertical part of the slope distance or a leveled height difference.
HA + Height	The horizontal angle and height are used but not the horizontal part of the length if this is measured.
HA + L + Height	Horizontal angle, length and height observations are used.
Length + Height	Length and height are used but not the horizontal angle.
Bearing	Only the bearing is used.


Manual.tna
Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Punkt id	Punktkod	Känd X	Känd Y	Känd Z	Känd	Centr. fel. X	Centr. fel. Y	Centr. fel. Z	Beräknat X	Beräknat Y	Beräknat Z	Medelfel X	Medelfel Y	Medelfel Z
P100	KP	36045,987	36203,615	15,500	Båda									
P101	KP	36143,454	36519,644	29,500	Båda									
N200					None				35962,408	36530,354		0,002	0,002	
N204					None				35950,586	36118,038		0,003	0,003	
N203					None				35834,220	36343,691		0,002	0,003	
N201					None				35941,881	36756,156		0,004	0,003	
N202					None				35762,155	36556,940		0,003	0,004	

Points

Under the points tab we can see all points (known and new) that are included in the adjustment. Known points are loaded automatically from the current polygon point file when we import a survey data file or enter survey data directly in the net adjustment. Both station (from) and object (to) points are checked.

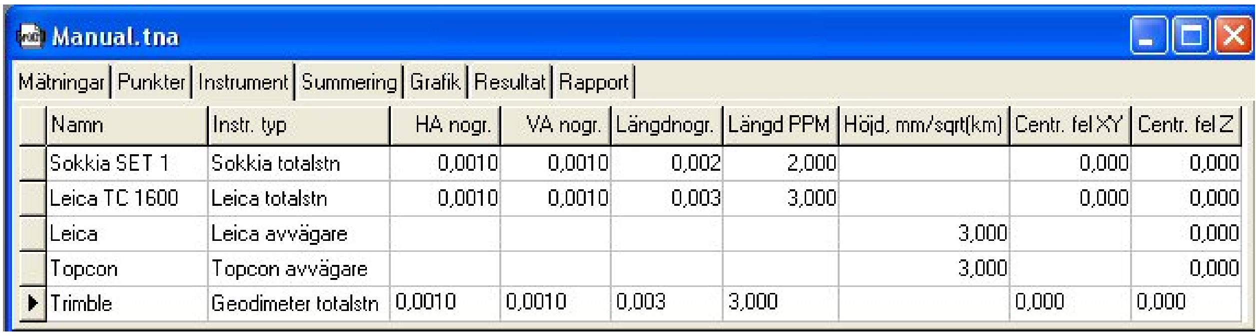
It is also possible to change the coordinates of a known point manually, and to change points from known to new points if you want these to be calculated in the adjustment and not be used as fixed points (e.g. if you suspect that the known coordinates are wrong). A new point can be made known by entering the coordinates in the columns Known X, Y, or Z. To change this, go to the Known column, where you can also enter a point as known in plane but not in height or vice versa. If the coordinates for a point have been calculated, you can lock them by changing in the known column as mentioned previously. The calculated coordinates are then copied to the columns for known coordinates.

In addition to the coordinates, there are columns for centering errors X, Y, and Z. Here you can enter a centering error that you know applies to the point irrespective of the instrument. If we have blank cells here, the values we have entered for centering errors under Instruments will apply. For a normal tripod set up, 3mm is a normal error, but if we use wall prisms for example it is lower. A free station point always has the centering error 0, but its coordinates are usually of no interest.

We can also use the centering error if we use calculated points as known points from an old adjustment. Normally, all known points have a great accuracy, but by using the point mean errors from the old adjustment, we can provide observations in relation to worse known points with a little greater margin. As a result, uncertainty from these points (with greater mean errors from the old adjustment) will have less of an impact on our new adjustment.

Following the completion of the calculation we see Calculated X, Y, and Z, as well as Mean errors X, Y, and Z for the points, that tell us the calculated position of the new points and the precision they have. For a more detailed explanation for these headings, see Report.

Instruments



Manual.tna

Mätningar | Punkter | Instrument | Summering | Grafik | Resultat | Rapport

Namn	Instr. typ	HA nogr.	VA nogr.	Längdnogr.	Längd PPM	Höjd. mm/sqrt(km)	Centr. fel XY	Centr. fel Z
Sokkia SET 1	Sokkia totalstn	0,0010	0,0010	0,002	2,000		0,000	0,000
Leica TC 1600	Leica totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000
Leica	Leica avvägare					3,000		0,000
Topcon	Topcon avvägare					3,000		0,000
Trimble	Geodimeter totalstn	0,0010	0,0010	0,003	3,000		0,000	0,000

A list appears under instruments showing those instruments that have been selected when importing one or more survey data files. The type of Instrument can then be selected for each observation under the observations tab in the Instrument column.

Data on the instruments can be obtained from the relevant supplier. The weights are calculated from these values, which means that an observation with a good instrument will affect the result more than the observations with an inferior result. The values you enter are the instrument's factory tested apriori mean error (see Report).

In general you could say that it is the standard mean error in particular that is directly influenced by the instrument data, as it is a comparison with the capacity of the instrument (1.000 means that you have measured exactly at a level the instrument can handle). As a result of this, the standard and observation mean errors as well as the sigma levels vary depending on the instrument data we choose. It should also be noted that the instrument data affects how the various observations are weighted in relation to each other, i.e. how much they affect the results. NOTE: It is therefore of the utmost importance that we have specified the correct values for the instrument's data if we want reliable assessments of the quality of the net. Note that you may not specify a value to 0.0000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

Settings

Instr.type
Different makes of instrument handle the corrections for pressure and temperature in different ways, which is taken into consideration under this setting. See also Atm. corr in the observations chapter.

HA Accuracy
Horizontal angle accuracy. Entered in GON (adjustable to mgon or degrees)

VA Accuracy
Vertical angle accuracy. Entered in GON (adjustable to mgon or degrees)

Length accuracy (constant)
Specified in meters (adjustable to millimeters)

Length accuracy (PPM)
Entered in PPM

Centering error in plane
A centering error can either be specified for each point or generally for from and to points where the instrument is used. The centering error will give all observations that have been made using the instrument and offset in the accuracies specified above. E.g. the length accuracy will be calculated as a bit worse depending on the effect the centering errors have. If a field is blank in the Centering error columns X and Y under the Points tab, the centering error specified for the instrument will be used.

Centering error in height
See above.

Note that you may not specify a value to 0.00000 as this is an unreasonable value that would apply to a completely error free instrument, which makes the weights impossible to calculate.

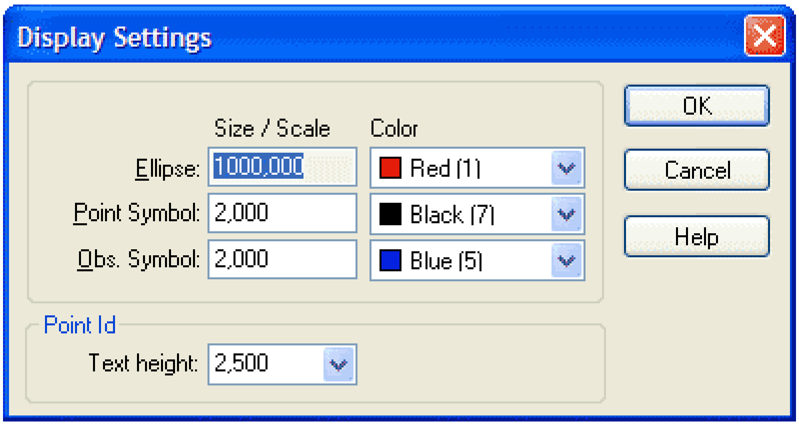
Calculating of net

To calculate a net, go to *Net adjustment|Calculation*, or click on one of the Graphics, Results or Report tabs. If a change has been made to the input data or if we make our initial calculation, we see the message The net adjustment has been changed, do you want to calculate the net? under these tabs, to which you answer yes.

Note that the speed settings you have made in *Netadj.|Settings* apply. If you want to use your own settings for atmosphere, ellipsoid and/or projection correction, the speed setting must be specified as *Own settings*.

Calculation is made immediately and you can go to the Summary, Graphics, Results or Report tabs to see the results.

View screen settings



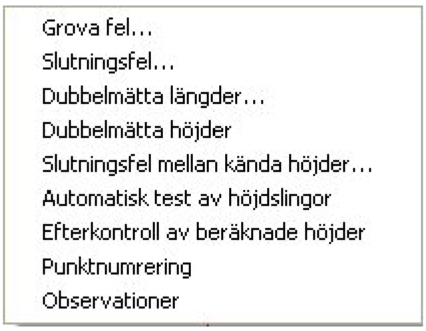
An appropriate size to symbols for the screen depends entirely on how extensive the net is and what zoom setting you are in, which is why you have the option of adjusting the symbol size. The symbols are triangular for known points in plane, circular for new points and triangular with a circle for known points in both plane and height. Measurements are marked with straight dashes for measured lengths and angles for measured angles.

Error ellipses are obviously shown by ellipses and height errors by a vertical dash through the point. If the ellipses had the same scale as the net they would not be visible. Instead you can set the scale factor here that they are to be enlarged by in relation to the net. You can also change the colors of the ellipses and symbols.

It should also be noted that the same graphical functions are available under View as for other applications in Topocad, e.g. zoom, pan, drag, redraw etc.

Point ID with possibilities to change the size of the text. The point symbols can also be changed by going to File|Settings|System settings and selecting the Point info tab. The PointID box you can change placement, font and size of the point symbols.

Tests



This menu has a number of tests to see if our survey data contains gross errors. The specified tests observe the descriptions in HMK Geodesi Stommätning.

Search for gross errors

Searching for gross errors enables you to run a quick check over the measurements in the net. By activating the *Tests*|*Gross errors* command, the program zooms in automatically on the biggest error in the net, that is the measurement (length or angle) that has the largest standard improvement. This is calculated in line with HMK's definition as the so called sigma level, which is the observation's improvement divided by the observation's apriori mean error. For each measurement you can determine whether you are to edit the measurement, retain it, or erase (delete) it. Click Next to view the second largest error, and so on. If you want to return (to larger errors), click Previous.

If you specify Edit, the program skips to the measurement tab and selects the current measurement. It is then possible to edit and go back to the graphics, whereupon the question is asked if the net is to be recalculated.

Connection error

This check is manual and can be used for gross error searching by going traverse in the net. Start by clicking somewhere in the screen to form a square. By selecting point by point and then returning to the starting point, the connection error is calculated for the loop. This process gives a safe and quick check of the net, and you can quickly find any errors by using several different loops.

Undo delete of the last added point, restart by clearing memorized points.

Double measured distances

This test method searches for all distances that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested distances.

Double measured heights

This test method searches for all height differences that are measured in both directions and compares them with each other. The difference is then checked against a threshold specified in System settings. The program will immediately create a finished report with the tested height differences.

Connection error between known heights

This test method automatically calculates the height traverse between known heights the program can find in the net. The total height difference for the observations are compared with the height difference between the known heights. A report is created where a comparison to the threshold is made.

Automatic test of height loops

The program automatically calculates height loops that can be created in the net. The connection errors are compared to the thresholds and are printed in a report.

Post checking of calculated heights

This test method compares the adjusted heights with the observations that were included in the adjustment. A comparison is made with the thresholds and the results are printed in a report.

Point numbering

The test method checks to see if any points have similar coordinates, which may be a sign that they are actually different names for the same point. Similar point coordinates are compared to a threshold in a report.

Measurements

The test checks if any stations have fewer than four objects (not preferable in Banverket's (*Swedish Rail Adm*) lattice polygon), and lengths that are only measured in one direction. These stations are listed in a report.

Known points

If we have carried out a forced adjustment (adjustment with known points locked) and had several observations designated as incorrect, this does not always need to be due to the error in the observations. It could instead be that the known points have incorrect positions. This could be due to them moving, that you have use the wrong error point, or that we have specified the wrong coordinates. All known points are calculated in the adjustment as perfect and any errors they may have are interpreted as observation errors instead.

In order to test the observations without any influence from coordinate errors, you should therefore carry out a free adjustment (all points treated as new) in order to remove all errors in the observations. This assumes that the net is linked in loops as far as possible traverses to connection points produce uncertain results for free adjustment.

If you have removed all the observation faults in the net, it simply remains to test the positions of the known points. You do this via the following steps:

- If you have selected Plane or Plane and height under *Netadj.*|*Settings*|*General* the known coordinates in plane are tested. If the selection is Height, the Z coordinates are tested instead.
- The test starts by selecting *Tests*|*Known points*. The following window appears:

1. Here we select the points we want to test in the list first Lock/release known points. The points that are pre-checked will be included in the test. If we click the Extents button, all points will be included. The None button releases all points allowing you to make your own selection. This gives us the option of testing known points in a certain part of the net, which can be useful in expansive nets.
2. The program can then be set to stop when a calculation has been made (Only release point with greatest error) or release the worst point and recalculate until all points meet the threshold (Release points until the net is approved). The latter is as quick and easy as an initial test, but the final check should preferably be carried out point by point where you make a thorough analysis before proceeding.
3. When the program calculates length observations, you can specify under Corrections if the lengths are to be corrected for Ellipsoid and Projection. If you select *Use project settings*, the corrections apply that have been set generally for the project. Settings can be checked under *File*|*Settings*|*Project settings*|*Coordinate*. If you select According to settings, the settings are used for each individual observation's corrections (the Projection and Ellipsoid columns) in the observations tab. Note that these selections apply regardless of what you have set as speed settings under *Net adj.*|*Settings*|*Advanced.*

In order to describe other settings, we go through what happens if you start the test by pressing ***Calculate***:

- A free adjustment is carried out. For the points to be tested, the coordinates are picked that the points were given in the free adjustment. These are incorrect in that they originate from a free adjustment, but if this is correct the points will be right in relation to each other.

- The program then takes test points coordinates from the free adjustment and transforms them so they fit as well as possible with the known coordinates for the same points.
- This is done to test in plane by *moving in X and Y, rotating* and, if you have selected it in the program, *scale changing*. Do this by selecting *Congruent* or *Helmert as Transformation*. The latter type also adjusts the scale of the free net, which means that you remove the influence of the scale error at the length gauge. If you are sure that the scale of the lengths is correct, you should use *Congruent*, which retains the scale of the lengths. Otherwise there is a small risk of fitting errors at the points being partially interpreted as scale errors in the calculation instead.
- For heights, the transformation takes place via the program calculating the average values for both the known and the adjusted points. The mean value is then removed from known and adjusted coordinates making both averages zero (center of mass reduction).
- For heights, mean errors are also calculated for connection height fixes even though they are not part of the free adjustment. The program then looks up the nearest adjusted height and uses the mean error's law of error propagation for the connection observations and the nearest adjusted point to set a mean error for the height fix you have connected to. Naturally, this value does not have the same certainty as the height mean error that is included in the free adjustment. However, excluding them would mean that you would not get any connection height fixes at all in the test, which is often a major disadvantage as this measurement situation occurs quite often.
- In plane position only the known points that are included in the free adjustment, i.e. connection points are excluded from the test unless the observations are over-determined in relation to them. This is due to them being uncertain in relation to the other net, where at least two unchecked observations (angle and length) are used. However, it is normal in plane mode that the connection observations are over-determined to ensure the points are included in the free net. We also have situations when just one angle is measured in relation to a known point that is a backsight. In that case this point is impossible to test and is excluded from the test.
- If the known coordinates are correct (and also the observations in the free adjustment) the adjusted and known coordinates fit exactly with each other for a transformation. If any point is incorrect, this is noticeable by it having a fitting error between the free and known coordinates. The fitting error is reported as an error divided into X and Y as well as radial (total) errors. The problem now is where to draw the boundary line for when a point is incorrect and, in connection with this, take into consideration the error sources included in the calculation. These are primarily the mean errors of the points from the transformation and the free adjustment. A point that is at the edge of the net will be more uncertain in the transformation than one in the middle.
- In order to have a tool that is as certain as possible when identifying errors, a test quota is calculated. This specifies how large the fitting error is compared to the total mean errors of the point from the transformation and the free adjustment in the direction of the fitting error. This test value can be compared with standardized improvements (sigma levels) for observations. Following this, HMK's three level principle can be applied in order to assess if a point is wrong or not. You can set the program if the limit for errors is set at factor 2 (95% error probability), 3 (99.8%) or your own level.
- When the calculation is complete, the number of points is reported that are locked or released following the calculation. In the Current point box you can see the worse point's ID and test quota together with the error in X and Y, radial (total) and the direction (bearing) in which the point has moved.
- If you click Edit, the program jumps to the point tab and positions itself on the row of the current point. This is to enable you to quickly check and, if necessary, correct any wrong coordinates for the current point. If you click Next, the second worse point is displayed and so on. Previous then goes in the other direction.
- We can also tick the box if the point is to be known (Locked) or released in the next calculation.
- You get a summary of a calculation by clicking Report. You then select the report template you want to use (normally Standard) and then get a summary of the calculation. The report shows the following details first:

Net adjustment	Name of net adjustment file.
Transformation type	Helmert (scale change) or Congruent (no scale change).

Number of known points	Number of known points overall in the net.
Number of known points tested	Number of known points that are included as locked in the test.
Number of released points	Number of points released prior to or during the test.
Number of remaining locked points	Number of points that are locked after the test.
Number of remaining locked points tested	Number of points that are locked after the test and have been included.
Number of new points	Number of calculated new points in the net.
T-threshold for approval	The threshold that defines whether a point is incorrect (the T-value for a point is a quota between the point's fitting error and mean error)

- *The standard mean error is then displayed, HMK's approval limit*, *over-determinations and K-Value for* the *free adjustment* that form the basis of the test. Following this the same parameters are shown for the forced adjustment with all points locked and finally a forced adjustment with *only the remaining locked points* as known. The idea here is that you can see if the deleted points improve the net as a whole at the last adjustment.
- The data is then displayed for the point(s) that have been released. The following data is displayed:

Point ID	Point name
dX	Fitting error in X axis
dY	Fitting error in Y axis
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Change X	A measurement of how much the point has moved in the X axis for the adjustment after the incorrect points have been released.
Change Y	As above but in the Y axis.
Distance known	The distance from the current point to the nearest known that is included as known in the adjustment and has not been released. If there is a long way to a known point, the change described above will be greater.
ppm	Comparison in mm/km between the radial (total) change and the distance to the nearest remaining known point. Points that lie close to a known point and that have moved a lot are a greater source of errors than those that have the same change but are a long way from the nearest known point. A high ppm value indicates that the point is uncertain and has a significant effect on the net.

- The next part of the report is a record of each individual search and its results. If we have set the

program to only make one calculation, it is shown here. If we have selected Release points until the net is approved all the separate calculations are reported. The following data is included:

Number known	Number of known points overall in the net.
Number released	Number of points released prior to the test.
Number locked	Number of points that are locked prior to the test.
Scale	The scale factor calculated for the transformation between the free and known points. If we have used congruent transformation, the scale is 1.000000. If we have selected Helmert, any major deviations from one indicate that we have a scale error in the lengths.
Standard mean error from the transformation's calculation	This value can be interpreted as the mean error that the points have on average from the transformation.
Point ID	Point name
dX	Fitting error in X axis
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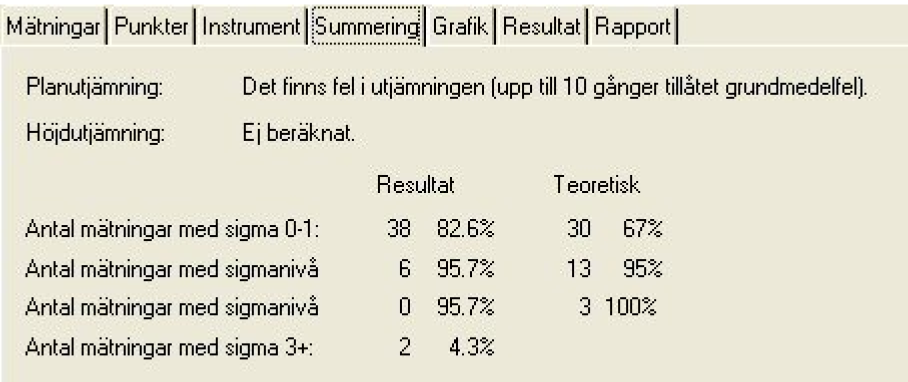
Row	Radial (total) fitting errors
mTraR	Mean error from the transformation for the point in the direction of the fitting error.
mFriR	Mean error from the free adjustment for the point in the direction of the fitting error.
mR	Total mean error for the point in the direction of the fitting error
T	Test value, quota between the fitting error and mean error for a point
Incorrect point or Test approved	Results from the test If a point is incorrect, it is reported here, plus that it has a star in front of its ID

- When you have finished analyzing the results, you can print or save the results file in various formats using the icons top left. To return to the test settings, close the results window and select OK, whereupon you return to the test's initial window. If points have been released during or after the latest calculation, they are now released in the list Lock/release known points. We can now choose to change the settings, release or lock points, and recalculate.
- When we have finished with the test, we press Apply. We are then asked if we want the points that have been released in the test to be released under the point tab as well. To give known points new coordinates could be delicate and you should be aware of the consequences. The danger is that you could easily have different coordinates for a certain point in different projects, so the points that are released should not be uncertain.

Summary



When you have made a calculation you can see the general results by selecting the Summary tab. The calculation primarily specifies if a standard mean error is approved in plane and/or height (see Report). If this is not the case, either the error is specified as large but the calculation was still possible or it was too large to allow an adjustment.

We will then identify the most important results which means that you can assess if the adjustment is to be approved or not for plane and height. Here the net's standard mean error is included, K-value, and the largest point mean error in plane (error ellipse large axis) and height. You also get the observations' largest sigma level, improvement (for angle, length, and height difference) and lowest relative redundancy (individual K-value). See the description of these parameters in the Report chapter.

In addition to this, a summary of the observations' sigma levels is listed to ensure that you can assess whether the observations contain gross errors. The distribution of the sigma levels is compared with the theoretical values that an average calculation would give.

Results

You can view the most important values under results which specify how the latest adjustment went. In addition to received and permitted (as per HMK) standard mean errors, we see how many gross errors we are estimated to have in the net, and a comment that describes how the adjustment went overall. If it was not possible to implement, the reason for this is given.

Report

The report is divided into a number of main headings. If these headings are included, and the type of data they cover, depends on the report settings you select. The data the program can include in the report are as follows:

Total

Term	Description
K-Value	Enter checkability value for the plane net, i.e. the number of over-determinations divided by the number of observations. If you have measured the exact number of observations required to get the coordinates for the points, the K-value is 0, but HMK recommends 0.5 and higher for the backbone net. The normal values for polygon nets are 0.1-0.2.
No. over-determ.	Number of over-determinations in plane or height
Standard mean error	Size of net's standard mean error
Appd threshold fr. HMK	The threshold for the standard mean error that HMK has set up for the backbone net to be regarded as approved.
Scale factor	Calculated scale factor in plane for free scale. If this is not used the value

	1.000000 is shown
Iterations	For plane adjustment a calculation is made of how much you need to adjust the approximate values of the point coordinates in order for the improved observations to correspond with them. If you have major errors in the net, the approximate values will be unsatisfactory and the results will not be correct. You then use the calculated coordinates as approximate values and readjust. The procedure continues until the observations agree with the points, and the number of calculations are specified as the number of iterations. 1-3 are normal values here, and the program has a maximum limit of 20 iterations to enable it to carry out an adjustment. This is due to the fact that if the observations are unsatisfactory enough, you will get values that are progressively worse for each calculation and thereby never arrive at a result.
Sigma levels	The number of observations that are within the various sigma levels are specified here. From a statistical perspective, 68% of the observations should be below level one, 95% below level two and 99.8% below level three. Observations with sigma levels above three are classed as gross errors, but also the levels between two and three should be checked in accordance with HMK.

Statistics

Number&
Here you specify the number of horizontal angles, vertical angles, direction series, horizontal lengths, measured distances and known points in plane and height. Also shown are max, min and mean values for the following values: sigma levels, length improvements, horizontal angle and bearing improvements, height improvements, largest influence in plane and height and point mean error in plane and height.

Known points

PointID
Name of point.

X, Y, Z coordinate
Specified known coordinates for the point.

Centr. incorrect X, Y, Z
Specified centering error for the point.

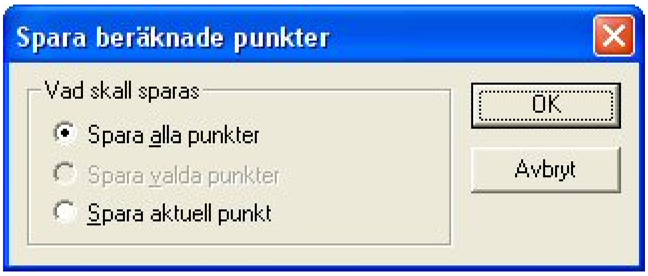
New points

Term	Description
PointID	Name of point.
X, Y, Z coordinate	Specified known coordinates for the point.
Mean error X, Y, Z	Calculated mean error for the point including centering error.
Centr. incorrect X, Y, Z	Specified centering error for the point in question.
Ellipse a	Error ellipse's large axis, i.e. the point's largest mean error in any direction.
Ellipse b	Error ellipse's small axis, i.e. the point's smallest mean error in any direction.
Ellipse bearing	The bearing for the error ellipse's large axis.

Observations

Term	Description
From Point	Specifies from which point you have measured. Normal station point
To point	The point to which the measurement runs.
Survey type	Shows length, horizontal angle, bearing or horizontal angle.
Survey value	For the actual observation, note that lengths, angles, bearings, and heights are separated, and that lengths are reported as horizontal. The direction series is reduced to zero for the backsight
Correction	The total correction for atmosphere, projection, and ellipsoid (height).
Improvement	How much the observation must be adjusted in order for it to tally with the calculated and known points. The greater the value, the worse the result. These values are used primarily to search for gross errors.
Aposteriori mean error	The calculated mean error for the measurement from the adjustment. If this error is greater than the apriori mean error for the measurement, your measurements are worse than what the instrument is capable of measuring.
Apriori mean error	This mean error is measured in the factory and describes the theoretical accuracy for angle, length, and height of the instrument. The mean error for heights varies depending on how long the length is.
Sigma (level)	Standardized mean error (1=the error is at level with the instrument's performance, 2 = twice as large error as the instrument's performance etc.). HMK specifies 3 as threshold in order for the observation to be classified as a gross error.
Smallest det. error	The smallest detectable error in the observation (inner reliability), i.e. the error that gives a sigma level of exactly 3.
Largest influence	Errors that are smaller than the smallest detectable errors cannot be eliminated. Here the maximum influence this error has on the coordinates for the points it is measured between is specified. Note that this value only applies to this observation's influence
Relative redundancy	Relative redundancy - how much the error that remains with the observation in the form of the improvement, (e.g. the value 0.43 means 43% of the error). If the error we measure is 35mm, this error will be spread out over the other observations and affect them. If we then have a K-Value of 0.43, the improvement will only be 15mm, i.e. the greatest share of the error remains, distributed over the other observations, and affects the results. This value is also called individual K-Value
Weight factor	The total calculated weight factor, which is calculated through $1/s^2$, i.e. A calculated apriori mean error square". For a mean error of 1 milligon the weight factor will be 1,000,000. If we have then specified a weight constant other than 1 for the observation, this will also be calculated here.
Bearing	Approximate bearing for the measurement (comparative figure).
Length	Approximate length between from and to point (comparative figure).

Save polygon points



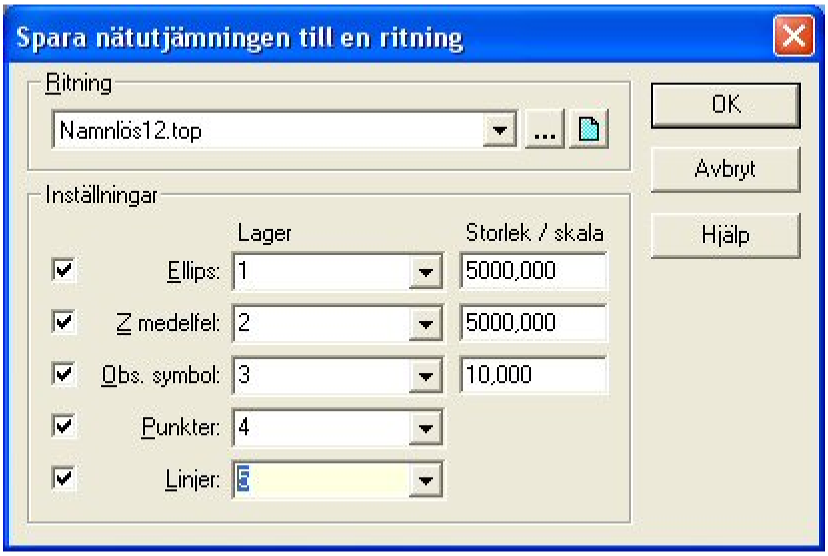
By placing yourself under the New points tab and then going to the *Netadj.|Save points to PP* command, the calculated points in the current polygon point file (.PP) are saved. Note that you must have selected the Points tab in order to use this function.

You can select between saving all new points, the current point you have selected or a range of points. If you want to save points in a new file, you create a new polygon point file via *New|Polygon points* and then connect it to the project via *Settings|System settings|Observation* whereupon you select the new file. Finish by saving the points as per the description above.

Lock all calculated heights

When the height adjustment has been carried out, you can then lock all calculated heights by selecting *Netadj.|Lock all calculated heights.* This locks all available heights, and can be used to trace all incorrect instrument heights and signal heights.

Save net adjustment to drawing



Going to the *Net adjustment|Save net adjustment to drawing* command saves all detail points and also over-determined points down to an optional drawing. Here you specify the drawing by specifying a previous save, an open or a completely new drawing.

Note that the codes of the points can be used to sort at different levels which is an excellent option for separating data from each other.

Simulation of net adjustment

Net adjustment|Simulation

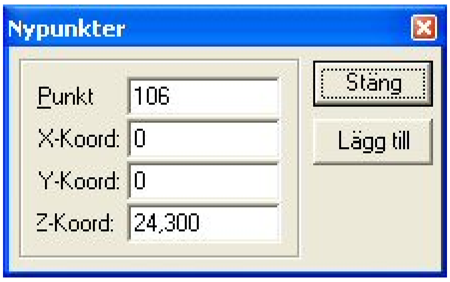
Topocad's net adjustment can generate simulations of nets. To do this you create theoretical observations where you believe you can measure, and get to select the type of observation you can make between different points. You can create points in an existing drawing, export them from here to PP or PXY coordinates and then import them to a new or existing net adjustment. From the net adjustment, you point out where the observations will be made, which will result in theoretical values. Normal settings are made for the net adjustment calculation and then a calculation is made to mirror the quality of the net, but obviously not the observation.

Function	Description
Import known points	Import of known points to net adjustment
New points	Create new points immediately in the net adjustment.
Observations	Identify where the observations can be made.

Import known points

Points of the PP format (Polygon points) or PXY can be imported. Their point numbers are automatically lit and the settings for these are made under *File|Settings|Point info.*

New points



New points can be specified directly in the net adjustment. If you would like to use points from the drawing, you can import these via the "Import known points" command, but edit them in the "Points" tab so that they are unknown in one or two planes.

Observations

Point out from where and to what points you believe you can measure. Select the measurements that can be made and whether the observation can also be made from the other direction. Change station by clicking "*Station*". Also select the instrument with its accuracy that you intend to use.

When this has been done, the observations you have specified here are created under "*Observations*". These are then as good as they can be theoretically. Editing can be done with respect to measurements. You then do a normal net adjustment calculation with its settings. See net adjustment calculation.

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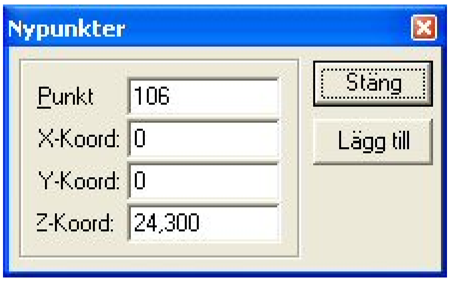

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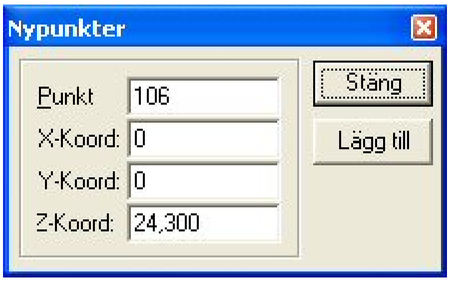

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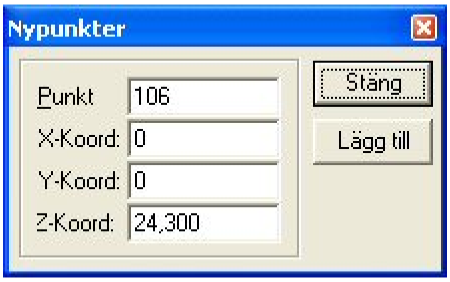

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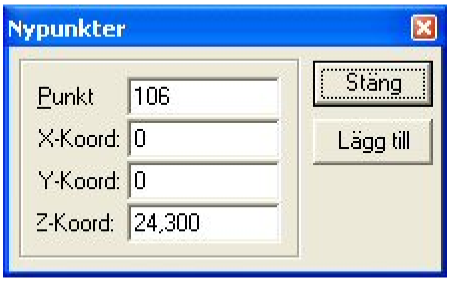

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Data Exchange contents

Import/Export

Function	Description
Data exchange files	
- Files - Import & export	Import and export files. Co-ordinates files, drawings etc
- Import and Export DWG	Import and export of DWG files.
- Import and Export DGN	Import and export of Microstation DGN files.
- Roadline export	
- Extract point clouds	

LandXML	
- Import and Export	LandXML, standard format
Trimble	
- Import	Import survey data and co-ordinates from Trimble instrument.
- Export	Export co-ordinates and roadline data to Trimble.
- Trimble label configuration Trimble	
Leica	
- Import Leica	Import survey data and co-ordinates from Leica.
- Export Leica	Export co-ordinates and roadline data to Leica.
- Leica configuration	
- Port settings for Leica	
Sokkia	
- Import Sokkia	Import survey data and co-ordinates from Sokkia instrument.
- Export Sokkia	Export co-ordinates and roadline data to Sokkia instrument.
Psion	
- Import Psion	Import survey data and co-ordinates from Psion.
- Export Psion	Export co-ordinates to Psion field computer.
Data exchange, other	
- Import Map sheet	Import data from map sheets.
- Import Database	Import points and geometry from databases.
- Toptrans	
- Layer PDF	Print to PDF - Layer-PDF and PDF/A available
- Import Wavefront file	Import 3D file

Data Exchange

Command	Description
Import files	File import
Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

Communication covers all types of communication that are possible in Topocad, including files as well as communication with field computers and all stations.

Import files

A wide variety of different file types can be imported into Topocad. The first step is to decide what type of data you want to import and then select the appropriate document.

Data type	Document	File format
Co-ordinates	Drawing	.TOPX
Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are totally within the rectangle.
3. *Export*|*File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing

OBJ	Wavefront file, 3D format	Drawing
ODB	Geodos co-ordinate format	Survey data/drawing
PLM	Polar measurements	Survey data
PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).

4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next

button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a column and enter its width in characters. Also select whether it will be left or right aligned. You specify the order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

Data Exchange

Command	Description
Import files	File import
Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

Communication covers all types of communication that are possible in Topocad, including files as well as communication with field computers and all stations.

Import files

A wide variety of different file types can be imported into Topocad. The first step is to decide what type of data you want to import and then select the appropriate document.

Data type	Document	File format
Co-ordinates	Drawing	.TOPX
Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window

and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are totally within the rectangle.

3. *Export|File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing
OBJ	Wavefront file, 3D format	Drawing

ODB	Geodos co-ordinate format	Survey data/drawing
PLM	Polar measurements	Survey data
PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).
4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a column and enter its width in characters. Also select whether it will be left or right aligned. You specify the order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

Data Exchange

Data Exchange - Import/Export

Command	**Description**

Import files	File import
Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

Communication covers all types of communication that are possible in Topocad, including files as well as communication with field computers and all stations.

Import files

A wide variety of different file types can be imported into Topocad. The first step is to decide what type of data you want to import and then select the appropriate document.

Data type	**Document**	**File format**
Co-ordinates	Drawing	.TOPX
Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are

totally within the rectangle.

3. *Export*|*File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing
OBJ	Wavefront file, 3D format	Drawing
ODB	Geodos co-ordinate format	Survey data/drawing

PLM	Polar measurements	Survey data
PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).
4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a

column and enter its width in characters. Also select whether it will be left or right aligned. You specify the order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

Data Exchange

Data Exchange - Import/Export

Command	Description
Import files	File import

Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

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Data type	**Document**	**File format**
Co-ordinates	Drawing	.TOPX
Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are totally within the rectangle.

3. *Export|File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing
OBJ	Wavefront file, 3D format	Drawing
ODB	Geodos co-ordinate format	Survey data/drawing
PLM	Polar measurements	Survey data

PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).
4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some

help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a column and enter its width in characters. Also select whether it will be left or right aligned. You specify the

order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

Data Exchange

Data Exchange - Import/Export

Command	Description
Import files	File import

Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

Communication covers all types of communication that are possible in Topocad, including files as well as communication with field computers and all stations.

Import files

A wide variety of different file types can be imported into Topocad. The first step is to decide what type of data you want to import and then select the appropriate document.

Data type	Document	File format
Co-ordinates	Drawing	.TOPX
Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are totally within the rectangle.

3. *Export|File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing
OBJ	Wavefront file, 3D format	Drawing
ODB	Geodos co-ordinate format	Survey data/drawing
PLM	Polar measurements	Survey data

PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).
4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some

help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a column and enter its width in characters. Also select whether it will be left or right aligned. You specify the

order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

Data Exchange

Data Exchange - Import/Export

Command	Description
Import files	File import

Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

Communication covers all types of communication that are possible in Topocad, including files as well as communication with field computers and all stations.

Import files

A wide variety of different file types can be imported into Topocad. The first step is to decide what type of data you want to import and then select the appropriate document.

Data type	**Document**	**File format**
Co-ordinates	Drawing	.TOPX
Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are totally within the rectangle.

3. *Export|File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing
OBJ	Wavefront file, 3D format	Drawing
ODB	Geodos co-ordinate format	Survey data/drawing
PLM	Polar measurements	Survey data

PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).
4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some

help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a column and enter its width in characters. Also select whether it will be left or right aligned. You specify the

order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

Data Exchange

Data Exchange - Import/Export

Command	Description
Import files	File import

Export files	File export
File format	
General import	General file import - coordinate files, survey files
General export	General file export - coordinate files, survey files
What do the files contain?	What is imported and exported?

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Drawing	Drawing	.TOPX
Survey data	Survey data	.SUR
General Co-ordinates	Can also be imported to a survey data document.	LansXML, .PXY, .K-files
Point cloud/scanning	Pointcloud. Point cloud files, LAS etc.	.TPC

How to import co-ordinate files:

1. First open the document (drawing) you want to import to. This can be an existing drawing or a new one. If you want the objects from the imported file to appear in a special layer, select/create this layer and set it as a current layer.
2. Select *Import*|*File*. The Open dialogue box is displayed. Select the appropriate file format (extension) you want to import from. If the file is not located in the selected project directory, you must navigate to the appropriate directory. Then click on the file.
3. To select multiple files, use the Shift and/or the Ctrl key.
4. Click OK.

Export files

The procedure is as follows:

1. Open the drawing document you want to export from.
2. Select the object(s) you want to export. You can select them one by one or by opening a window and selecting several (all) objects. Note that moving across the window from right to left will select all objects and moving across the window or rectangle from left to right will only select objects that are totally within the rectangle.

3. *Export|File*. Select the type of format you want to export to.
4. Enter a file name. Click OK.

See also

What do the files contain?

File format

The following file formats are supported in Topocad:

File type	File format/program	Imported to/from
281	Geosecma roadline data	Roadline
286	Geosecma cant	Roadline, cant
*	Generic import/export	Drawing, Profile, Length table, Roadline
242, 243	Geosecma co-ordinate files	Drawing
DGN	Microstation design file - 2D	Drawing
DPL	DRD road profile	Road profile
DTS	DRD sections	Drawing
DWG	AutoCAD drawing format	Drawing
DVL	DRD roadline format	Roadline
DXF	AutoCAD exchange format	Drawing
GDT	Trimble file format	Survey data/drawing/roadline/profile
GEO	Geo co-ordinate file	Drawing
GSI	Leica file format	Survey data/drawing/roadline/profile
JXL	Trimble JobXML	Survey data/drawing (import only)
KML	Keyhole Markup Language	Drawing
KOF	Co-ordination and observation format	Drawing
LAS	Scan data	Point cloud
LIN	Point/GEO roadline	Roadline
NIV	Co-ordinate file	Point cloud
MIF	MapInfo	Drawing
OBJ	Wavefront file, 3D format	Drawing
ODB	Geodos co-ordinate format	Survey data/drawing
PLM	Polar measurements	Survey data

PP	Topocad polygon point	Drawing
PRF	Point/GEO road profile	Road profile
PSI	Geodos roadline format	Survey data/drawing/roadline/profile
PXY	GEO/Point co-ordinate file	Drawing/Point cloud
RBB	DRD co-ordinate file	Drawing
RD3	Topcon	Export from calculated section
SDR/RDT	Sokkia SDR format	Drawing
SHP	ESRI Shape file	Drawing
SOSI	Norwegian standard	Drawing
SUF	Sokkia SUF2 files	Drawing
TCS	Topocd Calculated Section	Drawing
TGA	Raster format	Drawing, Terrain model, Point cloud
TGF	Topocad Geometry Format	Roadline/Profile/Crossfall/Cant/Length table
TOPX	Topocad	Topocad
TPC	Topocad Point Cloud	Point cloud
TRL	Topocad roadline	Drawing
TSD	Co-ordinate file	Point cloud
TUN	Co-ordinate file	Point cloud
TXT	MX Genio	Drawing
XML	LandXML	Drawing, survey data, profile, roadline, lenght table, DTM, calculated sections
XYZ	Marit co-ordinate file	Drawing

Generic import

Topocad has a generic import function that enables any text-based file in ASCII (DOS environment) or ANSI (Windows environment) format to be imported to Topocad. It also requires every point to be separated by a carriage return (new line).

The procedure is as follows:

1. Open a drawing document .TOPX.
2. Go to File - Import and select File.
3. Select Generic Import/Export as the file format (extension).
4. Click on the file you want to import. Click OK.

The file will now be read for generic import. You now have to describe the format of the file. First of all do you need to specify whether the file contains the co-ordinates etc. in straight columns or separated by separators such as a comma or semicolon. Topocad attempts to identify the file format but may need some

help to do so.

The format description can be saved and then reloaded. If you have previously saved a file of this kind, you can load the file and proceed directly with the import.

5. Select the row from which you want to start the import. Some files have initial rows containing additional information about the file that cannot be imported. You must also select the decimal separator used in the file (. point) or (, comma). Finally, specify whether it is a Windows ANSI or a DOS ASCII file format. Click the Next button.

Description for even columns/tabs/fields

The next step is to describe where the field limitations are located. Topocad will try to locate them but may miss them, e.g. if they use a longer point ID further down the file. You can drag the limitation field to change the width of any column, click at any point to create a new limitation or double click to remove a limitation. Click the Next button.

Description of delimitation characters

Select the type of delimitation characters. The pre-defined selections are tab (marked with a rectangle), semicolon, comma and space. It is also possible to select any other kind of separator. If several separators are used one after the other (as will probably be the case with spaces), they can be ignored by checking this box. Text can be marked with several different types of characters, e.g. ”r;”r;, ’r;’, (), [], // or **. To skip them, check this box. Click the Next button.

General

The next step is to define what each column contains. If the file has four numeric fields, Topocad assumes that the first column is the point ID, the second is the X co-ordinate, the third is the Y co-ordinate and the fourth is the Z co-ordinate. If there are only three columns, Topocad assumes that they are the X, Y and Z co-ordinates in that order. This may not be correct, and you can select any other order here. Note that it is also possible to import attributes and any other type of co-ordinate data. Click the Next button.

Register file format

Registering the file format enables you to open the same type of file from the Import file dialogue box in the future.

Generic export

The procedure is as follows:

1. Make sure you are currently in a Topocad drawing.

2. Go to Export and select File.

3. Select General Import/Export as the file format (extension).

Select the objects you want to export. Press Done. (You can start selecting objects before executing the command.

Enter the file name and extension you want to give the file. Click OK.

The Expert export dialogue box now opens - it contains three tabs. The second tab depends on the type of separation used in the file. The template describing the export file format can be saved and, if previously saved, can be loaded at this point.

6. Select whether you want to use comma, semicolon, tab or any other characters as separators in the file and whether the file is to be separated using aligned columns.

7. Enter any text you want to appear in the file header. Select the decimal separator you want to use - (. point) or (, comma). Also select whether it is a Windows ANSI file or a DOS ASCII file. Click the Next button.

Description for files with aligned columns/fields:

8. The next step is to describe where the columns are to be positioned and how wide they will be. Select a column and enter its width in characters. Also select whether it will be left or right aligned. You specify the

order by selecting from the list of active fields. You can also choose to add, insert or delete fields from the file. Click the Next button.

Description for delimitation fields:

8. First select which fields (observations) you want to be included in the file and the order in which they will appear. Select the separator type. The pre-defined options are tab (indicated by a square), semicolon, comma and space. You can also enter any other kind of character. Every field (column) can then be defined using the number of decimal places, the column width, right or left alignment, whether the field will have a prefix and/or suffix and finally whether text is to be wrapped using different kinds of characters. The pre-defined options are ”r;”r;, ’r;’, (), [] and **. Note that it is possible to export attributes. Click the Next button.

General:

Line connection.
Select the type of line connection you want for this kind of file. The following options are available:

None
No line connection.

Line code
You can specify a code for the line, i.e. 1 signifies the start of the line and -1 the end of the line. It is also possible to select a code for individual points.

Line number
You can also number your lines (polylines). Select the first line number. Every line in the export file is then numbered in increments of the last number +1.

Now enter whether or not you want to save the template for this export file format. If so, click Save and enter a name for the template. Now click Finish to create the file in the specified export format.

Register file format

Registering the file format enables you to open the same type of file from the Export file dialogue box in the future.

What do the files contain?

FORMAT	Point ID	X	Y	Z	Code	Symbols	Attributes	Layer
TOPX format	X	X	X	X	X	X	X	X
Co-ordinate files	X	X	X	X	X	-	-	-
Drawing format	-	X	X	(X)	-	X	X	X

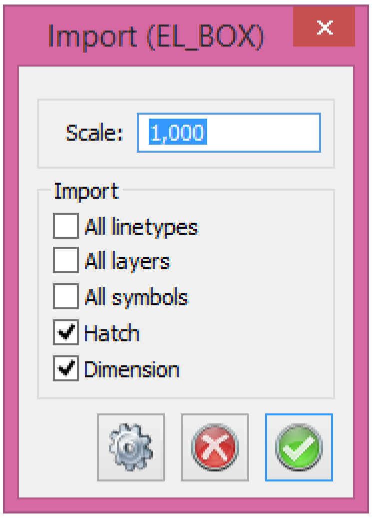
Import and export of .dwg files

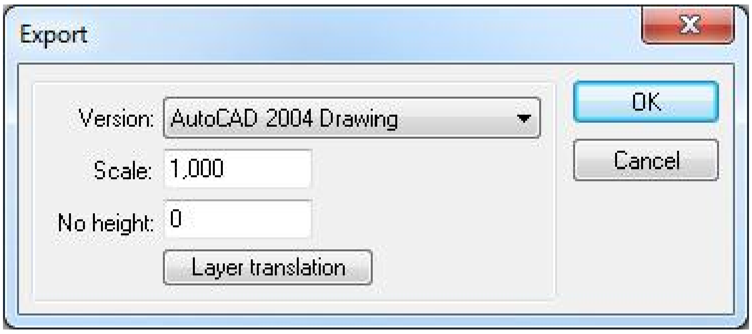
Drawing|Import|File
Drawing|Export|File

The .dwg format can be imported to and exported from Topocad.

Some of the import and export settings are made in System settings - Import/export. These settings are used to export a 3D polyline, for example.

When importing DWG files with integrated external references, you can select how to import these external references - either as one drawing or as the original external references in individual drawings.

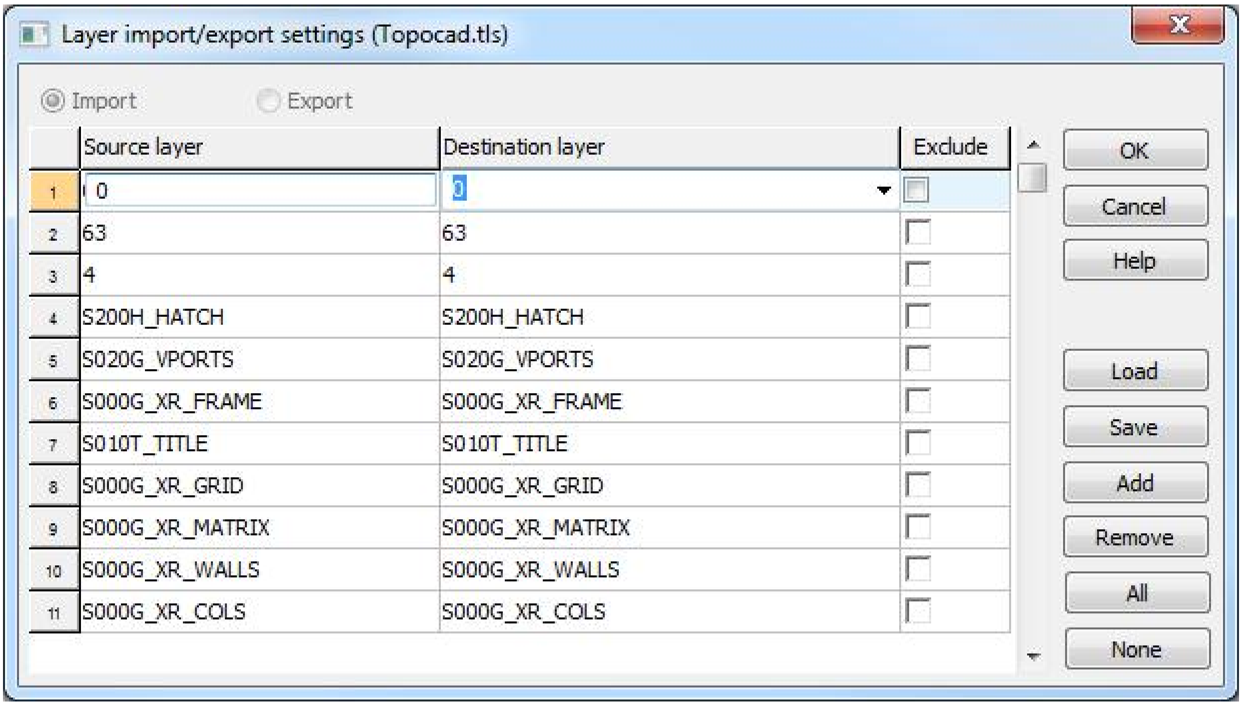


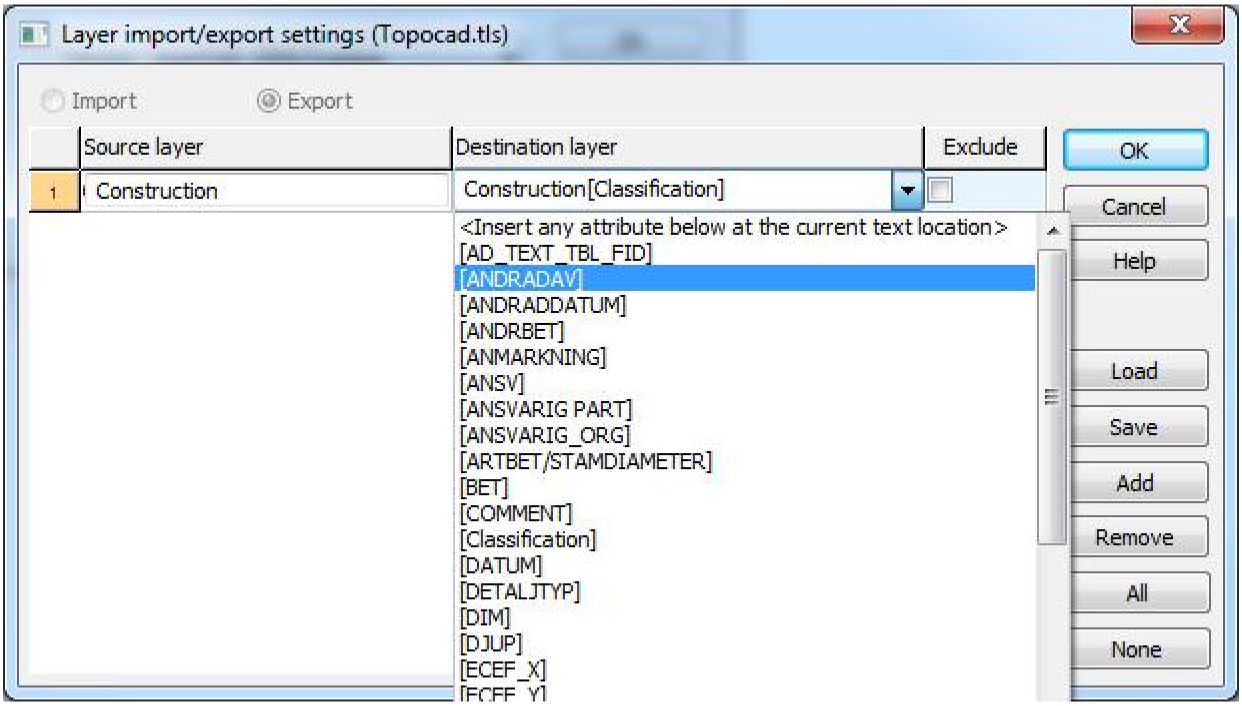


Scale
When importing, you can select the scale to be used. This is particularly useful when the .dwg drawing is in mm as Topocad uses meters.

Click the *Layer translation* button.

Layer translation





Destination layer
Add attributes to the destination layer.

Exclude
Select which layers that shall be imported/exported.

Load: Load layer setting file.
All/none: Select all/none layer for import/export.

Import of following objects from AutoCAD:
Point
Line
Polyline
2dPolyline
3dPolyline
Arc
Circle
Face
Text
MText
Block Reference
Solid
Attribute

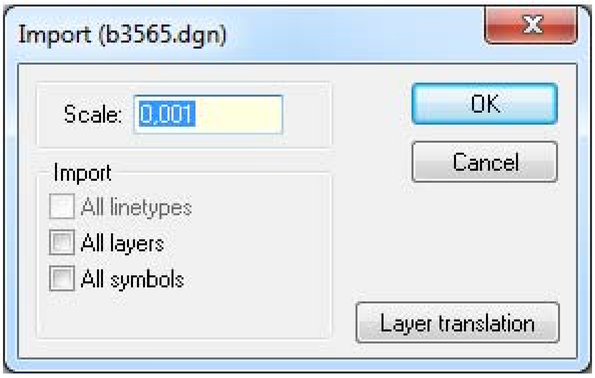
Attribute Definition
Trace
Spline
PolyFaceMesh
PolygonMesh

Also, all objects that are able to explode to the objects we support (for example Dimension, Hatch, Ellipse, Wipeout, Leader, MLine)

Import and export of DGN files

Drawing|Import|File
Drawing|Export|File

The DGN format can be imported and exported to Topocad and from Topocad.



If the DGN file contains external references you can select if you want to import these external references, either to one or separate drawings.

Scale: Option to select scale.

Object supported by Microstation DGN
PointString
Line
LineString
Curve
Arc
Ellipse
Shape
Text

ComplexString

ComplexShape

CellHeader

TextNode

SharedCellReference

Export roadline to instrument

Roadline

The roadline can be exported to different overall stations. If you also have the Profile add-on module you can export the profile line and camber to some instruments.

Export to Geodos

To export:

1. Open the roadline (.trl)
2. Click *Export|Geodos*.
3. Select Organizer or Workabout
4. The roadline is already selected. Select the profile if required and the camber file.
5. Select whether you want to send the data or store it in a file.
6. Click Send.

Export to Geodimeter/Trimble

To export:

Open the roadline (.trl)

1. Click *Export|Geodos*.
2. Select file name.
3. The roadline is already selected. Select the profile if required and the camber file.
4. Select whether you want to send the data or store it in a file.
1. Click Send.

Export to Leica

To export:

Open the roadline (.trl)

1. Click *Export|Geodos*.
2. Select the file name and instrument type.
3. The roadline is already selected. Select the profile if required and the camber file.
4. Select whether you want to send the data or store it in a file.
5. Click Send.

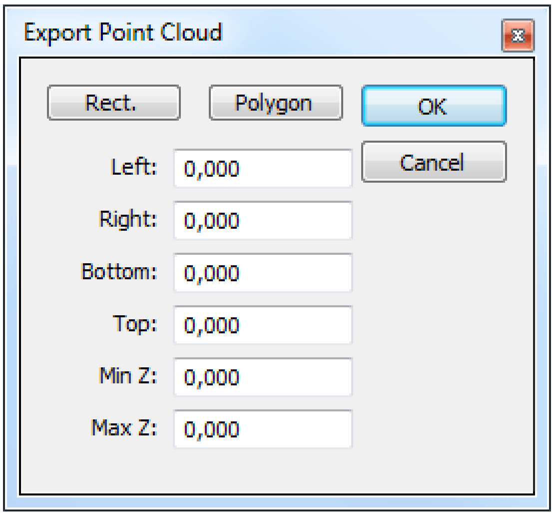
Extract point cloud

Drawing|Export

The command is performed from the point cloud and creates a new, smaller point cloud from the old point cloud.

Use the *Rectangle* or *Polygon* to draw out the part of the point cloud to be extracted.

Point Cloud can be exported to a point cloud, a coordinate or a Marit file.



LandXML Communication

Import LandXML(Upper menu)
Export LandXML(Upper menu)

LandXML is a standard format built on the XML format. XML, Extensible Markup Language, is originally a format from the Internet format SGML. LandXML is created by an organization who has established standards for how different types of geographical data should look like.

Topocad reads and writes a number of LandXML's established formats.

Import/Export can occur in two different ways. Either import/export directly to selected file format. The file will appear directly in the drawing, or select data in a drawing and export to a LandXML file. The other way is to import/export from file to file, which is able with all the file format Topocad supports in LandXML.

Topocad supports following file formats in LandXML

- Drawing data (lines, points, radius, circles, road lines)
- Survey data
- Road lines
- Road profiles
- Terrain models
- Cant

Import from Trimble

Drawing|Import|Trimble

It is possible to transfer data between a Spectra Precision instrument and Geodat, Geodimeter and the control unit (4000). All Geodimeter instruments from 400 and above are compatible. ACU is now also compatible.

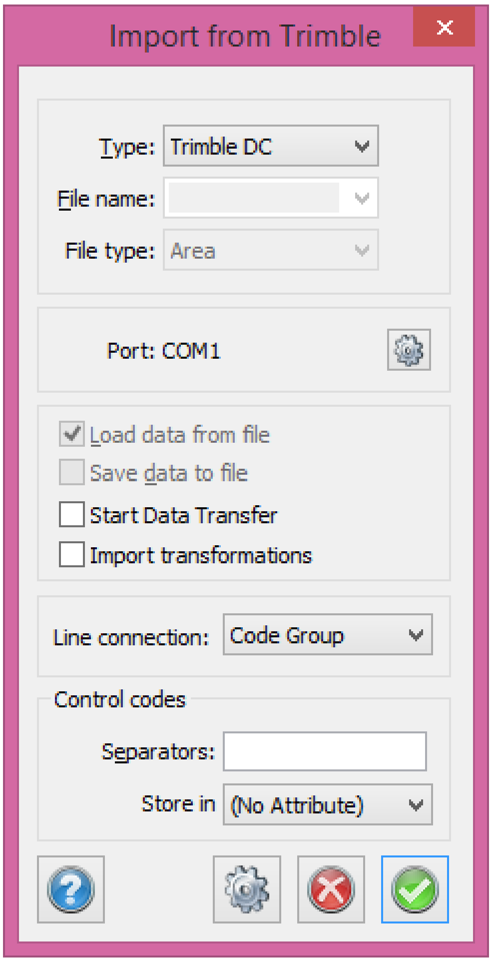
To import a file:

1. Open the document you want to import data into. To import survey data you will need to open a survey data document (SUR). To import co-ordinates you will need to open a drawing.
2. Connect the field memory/station to the computer. Note that the serial port is male on the computer and can be 9 or 25 pin.
3. Click File - Import - Trimble. In the upper field select the type of field memory to be used. This can be done automatically.
4. Select the file(s) to be imported. A file list will be displayed.
5. Click OK.

Line connections:

Label defined	The label specifies the start and end of the line
Line numbering 1 2, 3, 4, 6, 7,	Intermittent: When the point ID jumps a step, the start of a new line will be created.
Line numbering 1.01 1.02, 2.01, 2.02, 6, 7,	The first number is the line ID.
Control code	The control code specifies the start and end of the line as well as other items.
Code	The same code will give the same line each time.

Support for Zeiss M5 digital leveller.



Read more about point codes at Edit code table

Export to Trimble

Drawing|Export|Geodimeter

It is possible to transfer data between a Spectra Precision instrument (Geodimeter) and Geodat, Geodimeter and the control unit (4000). Geodimeter instruments 402 and above are compatible. It is possible to export co-ordinates from the drawing, roadlines (.TRL), road profiles (.TRP) and the road camber form (.TCF).

To export co-ordinates:

1. Open the drawing document to be exported.
2. Connect the field memory to the computer. Note that the cable connections may be a 25-pin contact. You may need an adapter.
3. Select the object(s) you want to export to your instrument. They can be selected one at a time or all in one go in Windows.
4. Click on File - Export - Spectra Precision. In the upper field select the type of field memory to be used. If you select Auto, Topocad will identify the type of Geodimeter or Geodat being used.
5. Click on the drop-down arrow next to Files. Topocad will list files in the Geodimeter/Geodat. You can use one of these files or type a new file name.
6. Click on Send.

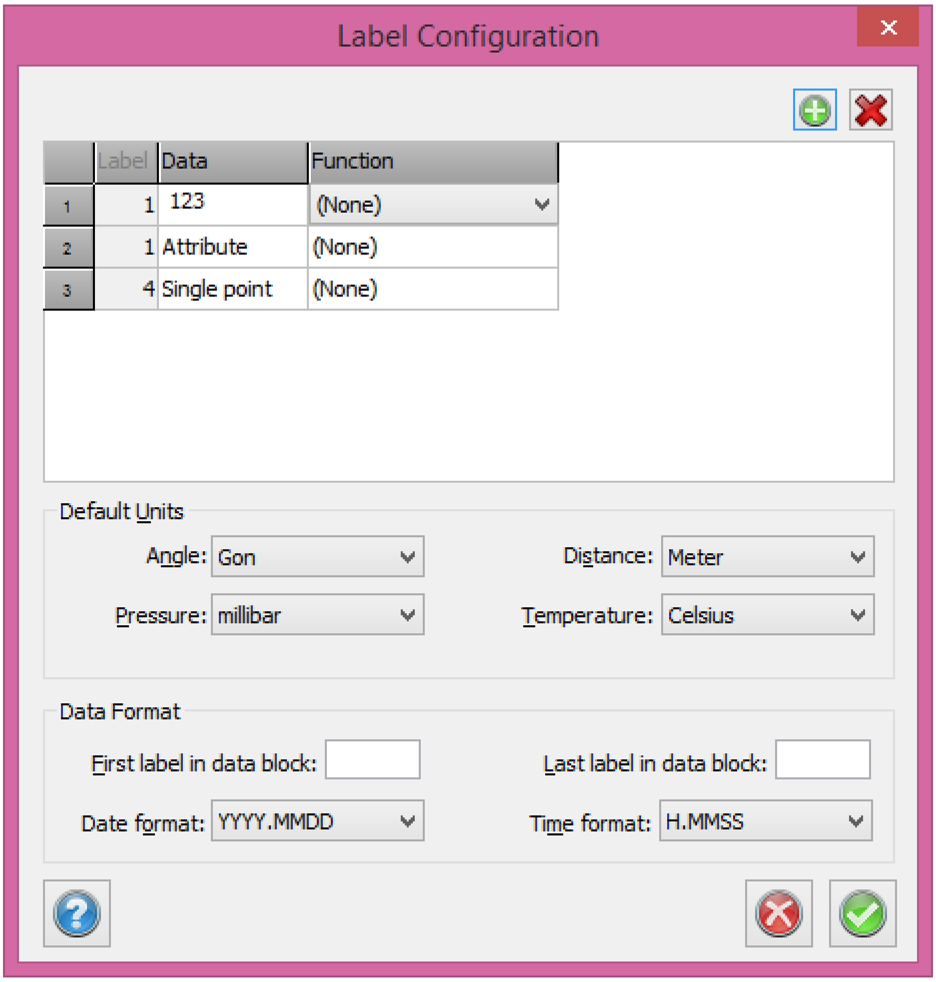
To export road information

1. Connect the field memory to the computer. Note that the cable connections may be a 25-pin contact. You may need an adapter.
2. Click on Export and then Spectra Precision. In the upper field select the type of field memory to be used. If you select Auto, Topocad will identify the type of Geodimeter or Geodat being used.
3. Check the [ ] Export road information box and Click OK.
4. A dialogue box is displayed. Select the roadline (.TRL), road profile (.TRP) and road camber form (.TCF) you want to export to your instrument.
5. Click OK. The data will now be exported to your instrument.

Geodimeter label configuration

Drawing|Import|Trimble

It is easy to define labels 84-99 in the Spectra Precision instrument. In the Geodimeter this is called U.D.S. - User Defined System. The instructions below are for Topocad. To learn how to create definitions in the Geodimeter see the bottom of this screen. You will find further instructions in the Geodimeter reference manual or you can contact your local Geodimeter dealer.



To define a label:

1. Click the Config button.

Some pre-defined label settings are listed. You can select from this list or delete them and add new ones.

Label settings

The pre-defined label settings are:

Start of line
End of line
Point
End of line + Start of line
Backsight (Rear of object)
Check point
Remark
Attribute type
Attribute (value)

Labels relating to the same type of observation should ideally be set up as the same label but with different data. For example Label 99 is used for line numbering: data 1 and -1 for Start of line, 2 and -2 for End of line, 3 and -3 for single point data and 4 and -4 for End of line and Start of new line at the same point. In practical measurements the instrument will request label 99 and you enter the data for 1, 2, 3 or 4.

The backsight and the check point can have the same label even when these functions do not appear at the same point. The backsight function can be used in free stations. If you do not want to measure all backsights at once, measure them when they are close to your normal survey point.

There is no need to enter a data value under Remark because text can be edited for this label.

Using U.D.S. in your Geodimeter:

In the Geodimeter the user can define the labels 84 to 99. First, set the instrument to On. Disconnect the double axle pendulum with function 22. (Function 22, [Ent], 0, [Ent]). To add a label press [PRG] [41] [Ent] (Create label). Select a label number between 84 and 99. Press [Ent]. If the display shows F99 it is free to use. You can now enter an alphabetic text by clicking the ASCII button and then entering the text. i.e. LINE = 78, 73, 78, 69. Press [Ent]. To finish press [Ent] again.

This tells the Geodimeter that you want to use your defined label. To create your own U.D.S. use [Prg] [40] and define all the labels that you want to use in the survey. See the Geodimeter manual for more information.

Import from Leica

Drawing|Import|Leica

It is possible to transfer data between the Leica instrument and GIF10, GRE3, GRE4 and GSI (8- and 16-bit files). It is also possible to import co-ordinates from Leica directly into the drawing.

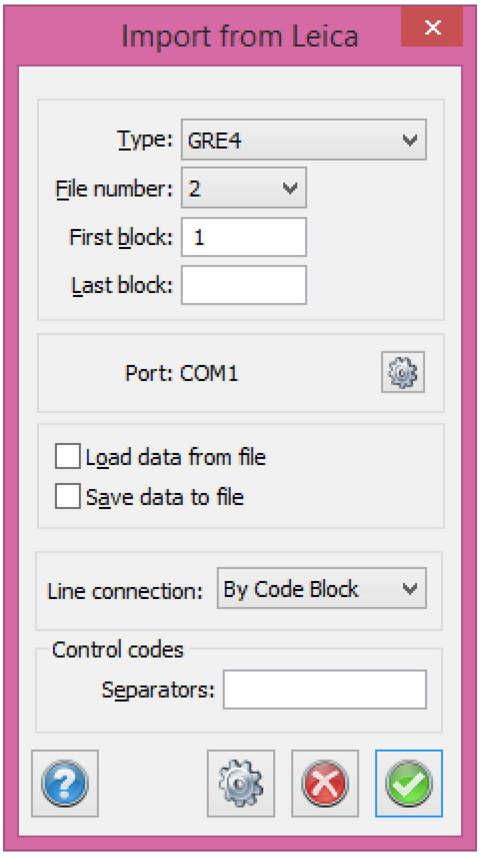
Line:
Select the line connection you have been using:

- *Line no/Point ID* - enter either the line number code or the point ID (2.01, 2.02, 2.03 etc.)
- *Intermittent:* Point ID jumps 1, 2, 3, 5, 6, 7
- *Code group* - Lines for each code group
- *Via code block* - The Leica code block specifies the start and end of the line.
- *Control code* - The control code specifies the start and end of the line.

Control codes
Enter the type of separator to be used for the control code.

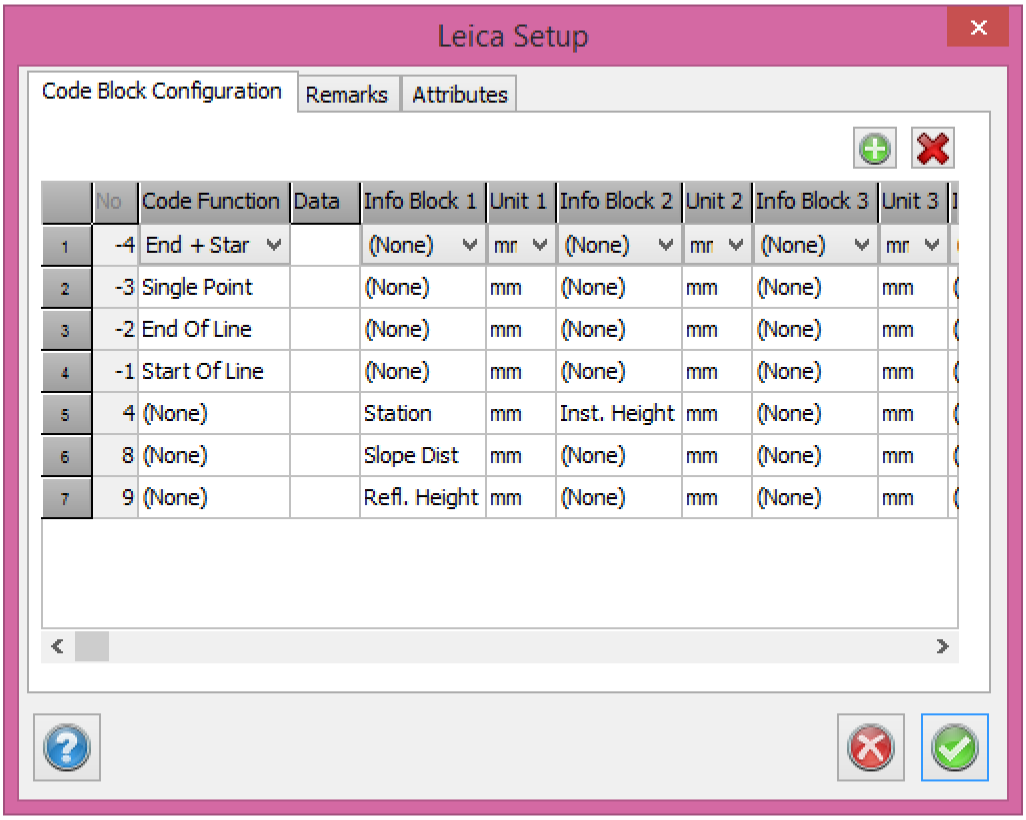
1. Open the document you want to import into. To import survey data you will need to open a survey data document (SUR). To import co-ordinates you will need to open a drawing.

2. Connect the field memory/station to the computer. Note that the serial port on the computer is male and can be 9 or 25 pin. The Leica cable is 25 pin so an adapter may be needed.
3. Click File - Import - Leica. In the upper field select the type of field memory to be used: GIF 10, GRE3 or GRE4.
4. Click OK.



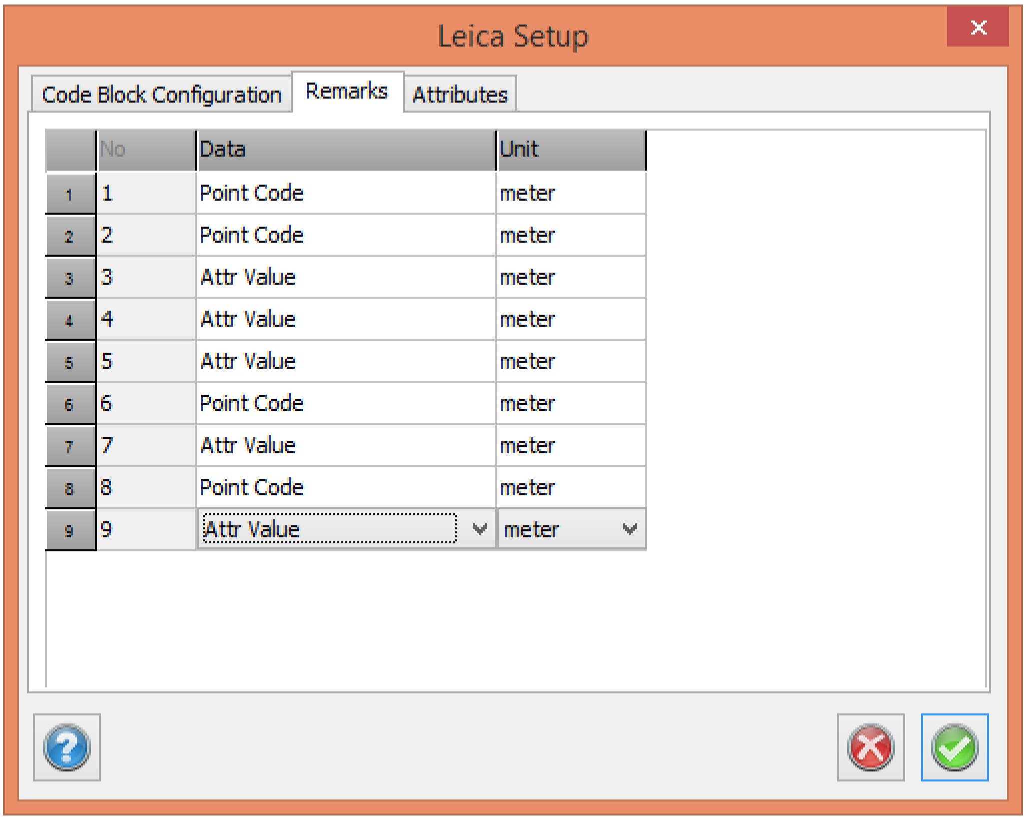
Configuration

Define the code blocks you are using for specific items such as line start, point, attribute, station, etc. Different setups in the instrument must be the same here in Topocad.



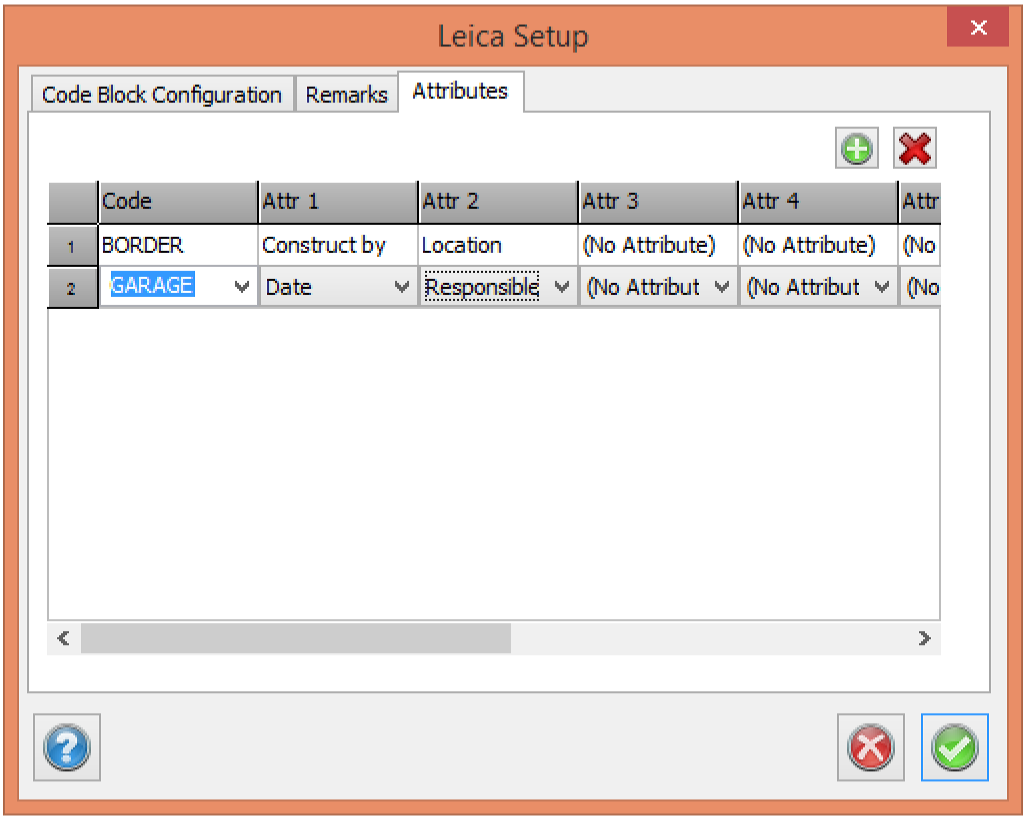
Remarks

The code blocks 71 to 79 is remark information. The remark field can be a point code (common for remark filed 1 = code block 71) or an attribute. The attributes should be connected to a point code because different point codes may have different attributes at the same remark field.



Attributes

Connect the attributes to use to the point codes. Different point codes may have different attribute types but are using the same remark field.



See also

Leica, port settings

Export to Leica

Drawing|Export|Leica

It is possible to transfer data between the Leica instrument and GIF10, GRE3, GRE4 and PC Card with GSI files (8- and 16-bit). It is also possible to export roadlines and road profiles.

To export to the instrument or field computer:

1. Open the document you want to export.
2. Connect the field memory to the computer. The Leica cable connection is a 25-pin contact. You may need to use an adapter.
3. Select the object(s) you want to export. You can select them one at a time or all together.
4. Click on *Export* and then Leica.
5. In the upper field select the type of field memory to be used: GIF 10, GRE3, GRE4 or GSI format. The settings will usually be correct but it is possible to change them under Port settings.
6. Click on Send.

To export to a file (PC Card):

1. Open the document you want to export.
2. Select the object(s) you want to export. You can select them one at a time or all together.
3. Click on *Export* and then Leica.

4. Mark the box ”r;Export to file”r;.
5. Click OK. Select file format - GSI8 or GSI 16.
6. Click OK.

Leica configuration

Drawing|Import|Leica

The Leica instrument settings are totally defined by the user. There are numerous settings that can be created on the Leica instrument or field book. Topocad has the same settings and values that can be set as follows:

Code functions:
Point code
Transfer code
Start of line
End of line
End and start of line
Point
Backsight
Check point

The different code blocks can either be controlled directly or connected to info blocks. In Topocad it is possible to input four info blocks for every code block.

With the default settings code block -1 indicates the start of a line, -2 indicates the end of a line and -3 indicates a point. In the survey, using code block 1 automatically indicates that it is the start of a line.

With the default settings, code block 4 is used for the station. In this case the code block has no function but the info block 1 is used for the point ID of the station and info block 2 is used for the station height. A unit is also specified for the station height. All units in Leica are in mm.

The values used in info blocks are:

Station
Instrument height
Prism height
Horizontal length
Vertical length
Point code
Remark
Point ID
Attribute type
Attribute value

Origin configuration

Code	**Code block**	**Info block 1**	**Info block 2**
23	-	Station	Instrument height
46	-	Point code	Reflector height
70	Point		
73	Start of line		

78	End of line		

Suggested new configuration

Code	Code block	Info block 1	Info block 2
23	-	Station	Instrument height
6	-	Reflector height	
1	Point		
3	Start of line		
8	End of line		
9	End and start of line		

Leica, port settings

Drawing|Import|Leica

GIF10

GIF10 has 3 switches under a shelf at the lower edge of the box. Set these to:

- Switch 1= Off (Up)
- Switch 2= Off (Up)
- Switch 3= On (Down)

Standard settings for Leica GRE 3 and GRE4 to be found in Leica using [SET] [MODE] 78 are:

Baud rate 2400 baud

Data bits 7

Stop bits 1

Parity equal (2)

Handshake RTS + DTR (ACK/NACK)

Import from Topcon/Sokkia

DrawingImport|Topcon/Sokkia

Line:
Select the line number or code to be used. These variables exist:

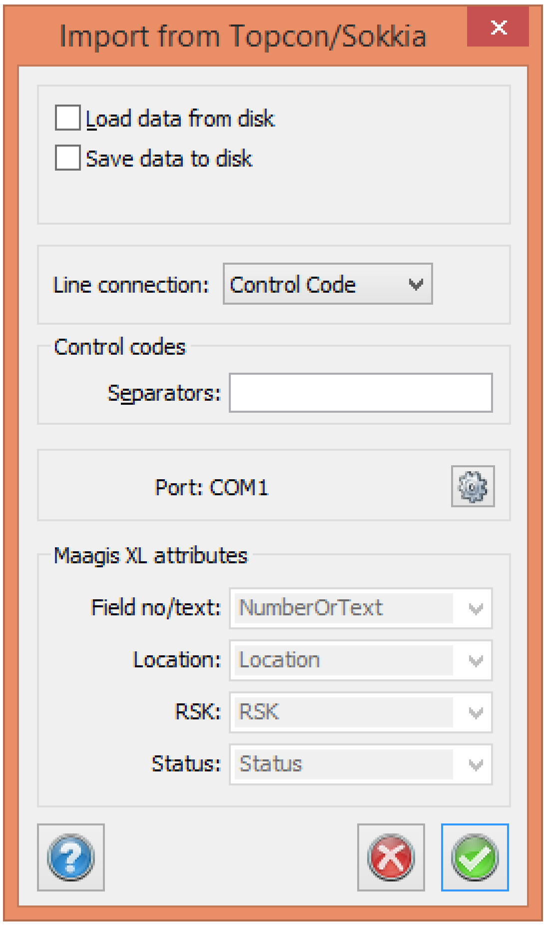
- *Line no/Point ID* - coded with line number or point id (2.01, 2.02, 2.03 etc.)
- *Intermittent:* The point number jumps and creates a new line.
- *Code group* - Lines for each code group.
- *Control code* - The control code specifies the start and end of the line. See also control code.
- Cross sections - special type for measurements in sections.

Roadline survey
All values for sections are stored in attributes. Enter the ones that have been used.

Control codes
Enter which separator has been used between the different control codes.

To import:

1. Open the document you want to import into. To import survey data you will need to create a .sur file. To import co-ordinates you will need to open an existing or new drawing.
2. Connect the Sokkia instrument or field computer to the computer.
3. Click Import - Sokkia. Check that the same protocol has been set on the Sokkia instrument. Check that the default settings are correct.
4. Click OK. Note that survey data is sent to the Topocad survey data document (*.sur) and co-ordinates directly to the Topocad drawing document (*.top).



Export to Sokkia

Drawing|Export|Sokkia

To export data to Sokkia, select the data and then click Export|Sokkia. Select the field computer/station to be used and click OK. You can choose to save to a file which will then be sent to the station.

Model:
Select the type of model you are using. Alphanumeric or numeric.

Job name:
Input the job name you want to use.

Import from Psion

Drawing|Import|Psion

Data transfer with Psion is very easy. Connect the Psion to one of the serial ports.

To import survey data:

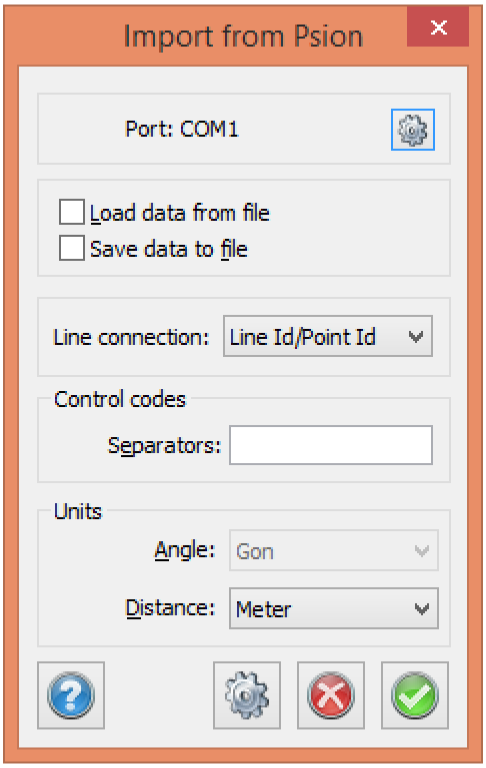
1. *New*. Create a new survey data document (.SUR). (It is also possible to import additional data into an existing survey data file.)
2. Connect the Psion to one of the serial ports on the computer. The Psion has an integrated Comms link.
3. Click on *Import* and then Psion.
4. On the Psion select transmit and then the file number.
5. Click on Receive in Topocad.

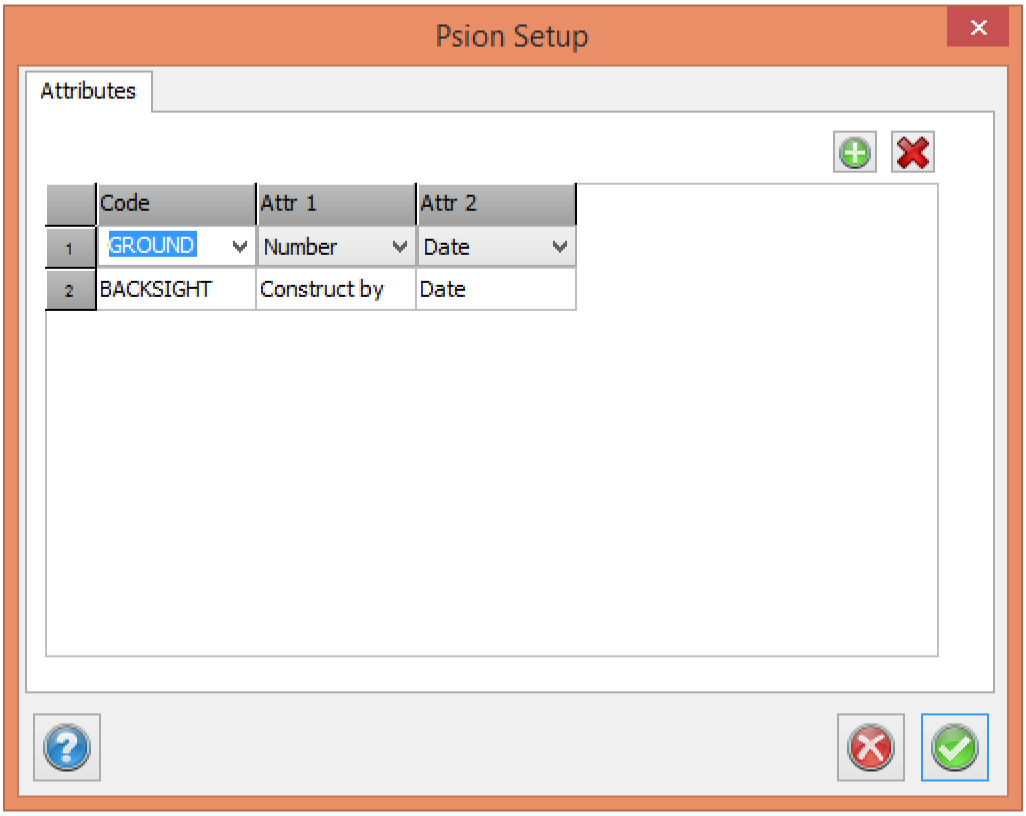
To import co-ordinate data:

1. *Click New.* Create a new drawing or open an existing drawing.
2. Connect the Psion to one of the serial ports on the computer. The Psion has an integrated Comms link.
3. Click on *Import* and then Psion.
4. On the Psion select transmit and then the file number.
5. Click on Receive in Topocad.

Line: Select line connection:

- *Line no/Point ID* - Line number or point ID (2.01, 2.02, 2.03 etc.)
- *Intermittent:* Point number jumps 1, 2, 3, 5, 6, 7
- *Code group* - Lines for each code group
- *Control code* - The control code specifies the start and end of the line.





Export to Psion

Drawing|Export|Psion

Data transfer between Psion and Geodos is very easy. The Psion is connected to one of the serial ports. You can export co-ordinates directly from the drawing, roadlines (.trl), road profiles (.trp) or road camber

(.tcf).

To export co-ordinates:

1. Open the drawing you want to export.
2. Connect the Psion to the computer with its own Comms link.
3. Select the object(s) you want to export. It is possible to select them one at a time or all together.
4. Click on Export- Psion. The settings will usually be correct but it is possible to change them under Port settings.
5. On the Psion click Receive and select where you want to store the data.
6. Click on Send.

To export roadlines/road profiles and camber form:

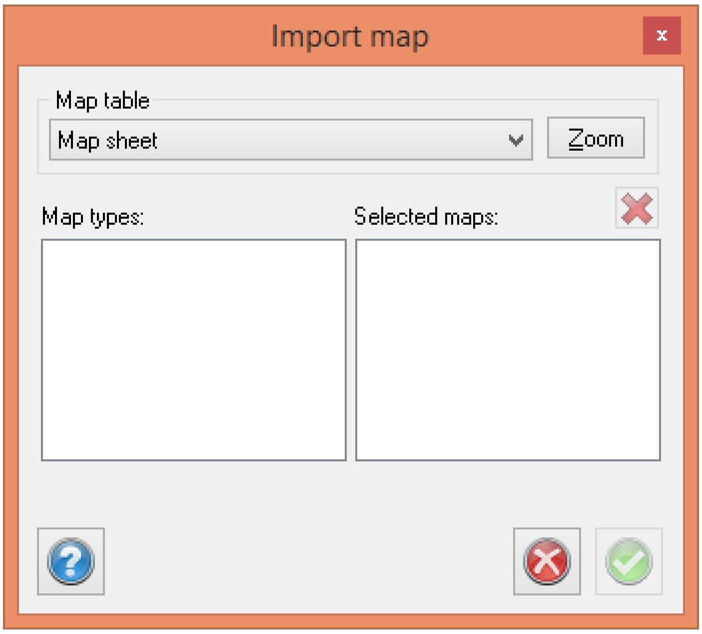
1. Click *Export|Psion.*
2. Connect the Psion to the computer with its own Comms link.
3. Check the [ ] Export road information box and click OK.
4. A dialogue box will be displayed. Select which roadline (.trl), road profile (.trp) and road camber form (.tvf) you want to export.
5. On the Psion click Communication and select an Excel file.
6. Click OK in Topocad.
7. Click Receive on the Psion.

Import map sheet

Drawing|Import map sheet

Map sheets can be imported into the drawing. Settings are made in *System Settings - Map*.

Select the terrain types that you want to import. Click in the drawing to display the map sheets. Click again to import the required map sheets.

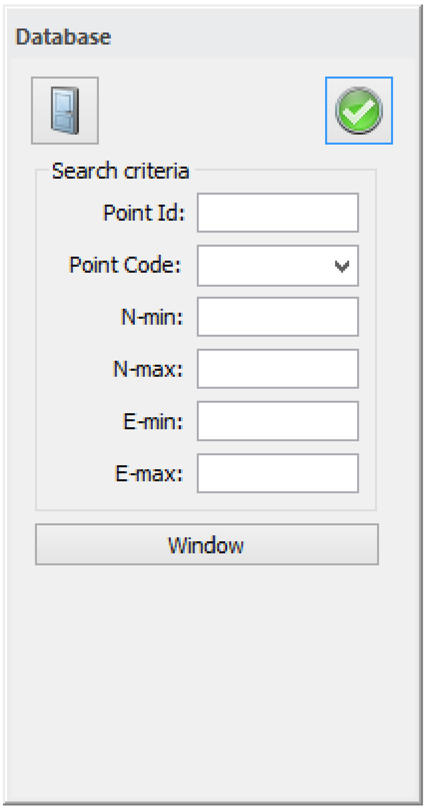


Import points from database

Drawing|Import |Database

The database configuration can be found in Home|System Settings - General database.

Enter your search criteria or hover the cursor over the drawing window to retrieve information from the database.



Import from Toptrans (Topcon)

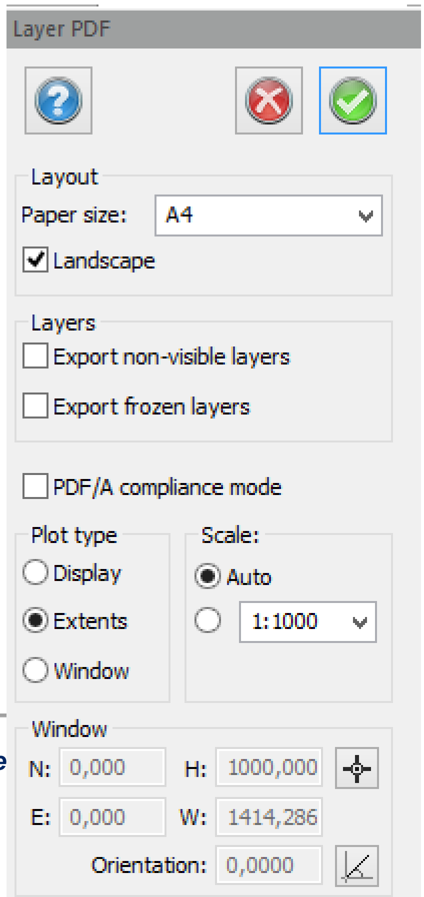
Drawing|Import|Toptrans(Topcon)

Levelling data from tcn files of Topcon are now importable to survey data files. In the survey data file, select File|Import|Topcon (DL 100c).Then select tcn file for import.

Layer-PDF

Drawing|Export-Layer PDF

Print with build-in Layer-PDF.



Use the build-in layer-PDF to print your drawings. It supports both layer-PDF and PDF/A. Layer-PDF means that the layers in Topocad will be added as layers in the PDF.

Go to Home|Export - Layer-PDF

Size: Select A0, A1, A2, A3 or A4.

Lanscape: Select orientation, landscape or portrait. There is no preview here.

Layer: Select if only visible layers or frozen layers should be added or not.

Select if the PDF shall support archive function, PDF/A.

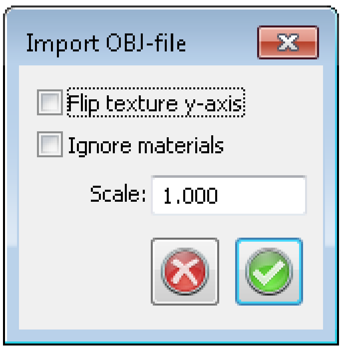
Plot type
Screen: Prints what is visible on the screen.
All: Prints all
Windows: Select coordinates for an exact surface to print.

Scale: Select scale.

Import Wavefront file

Import|File - .obj file

When you import a Wavefront file, a dialog will appear:



Flip texture y-axis: Reflect the image vertically. Tick box if you notice that the image is upside down.

Ignore materials: No attempt to load images, only surfaces will be colored with gray shades. Tick box if you, for example, want less memory to be used.

Scale: Choose scale.

Databases contents

Databases

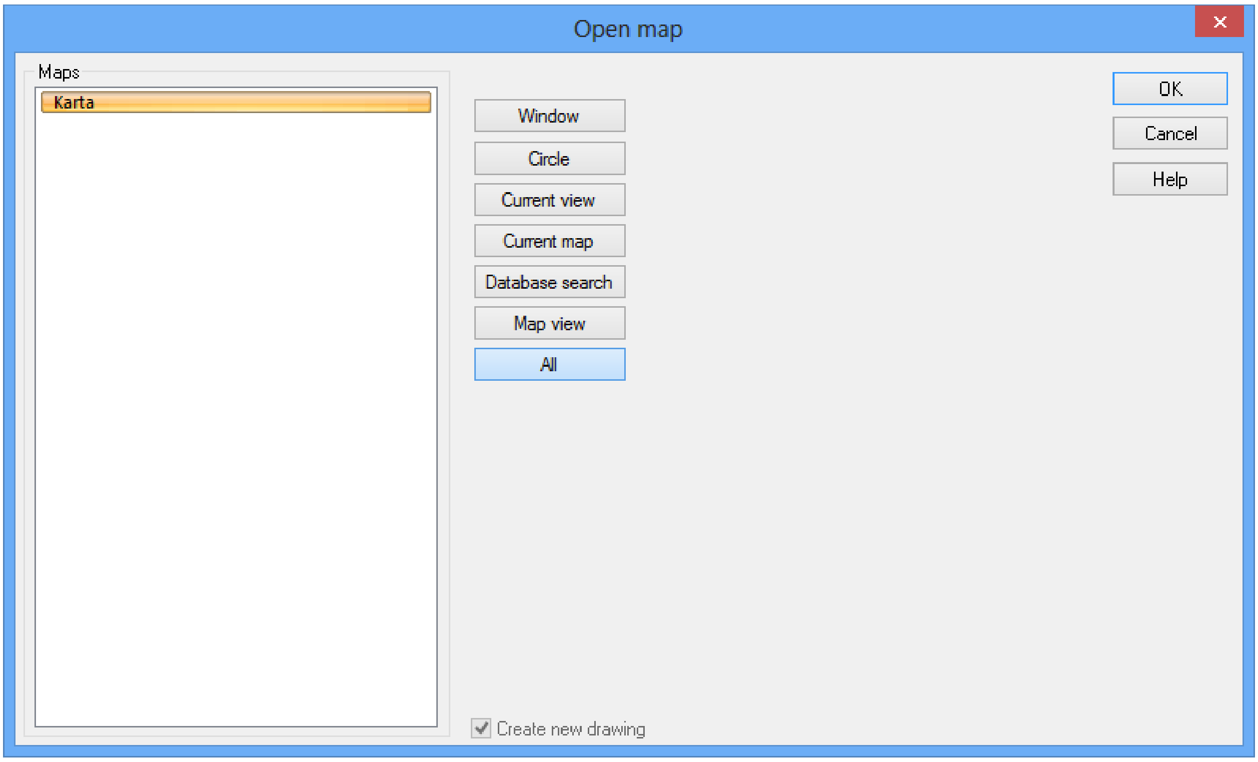
In Topocad you can work with many different Databases, ArcGIS, ISM and FDO are different modules that you can use to connect with your databases.

ArcGIS database adapter contents

ArcGIS database adapter

Command	Description
Open map	Opens the database for the drawing.
Disconnect	Disconnects the database
Add Data	Adds data from the database to the drawing.
Save Data	Saves the data
Save selection	Saves a selection of new or modified objects.
Refresh data	Refresh data, load from database
Reconcile and Post (save)	Reconciles and Posts data to the current version of the database.
Version manager	Manages different versions of the database.
Change version	The command allows version change of selected layers
Edit Attributes	Edit attributes handles domains and subtypes.
Group Objects	Command to group single objects into one.
System settings - Arc	Settings - including drawing method etc.
Generate Subtype layers	Move subtypes in a layer to a subtype layer
Geographical Constraint	View Geographical Constraint

Open map

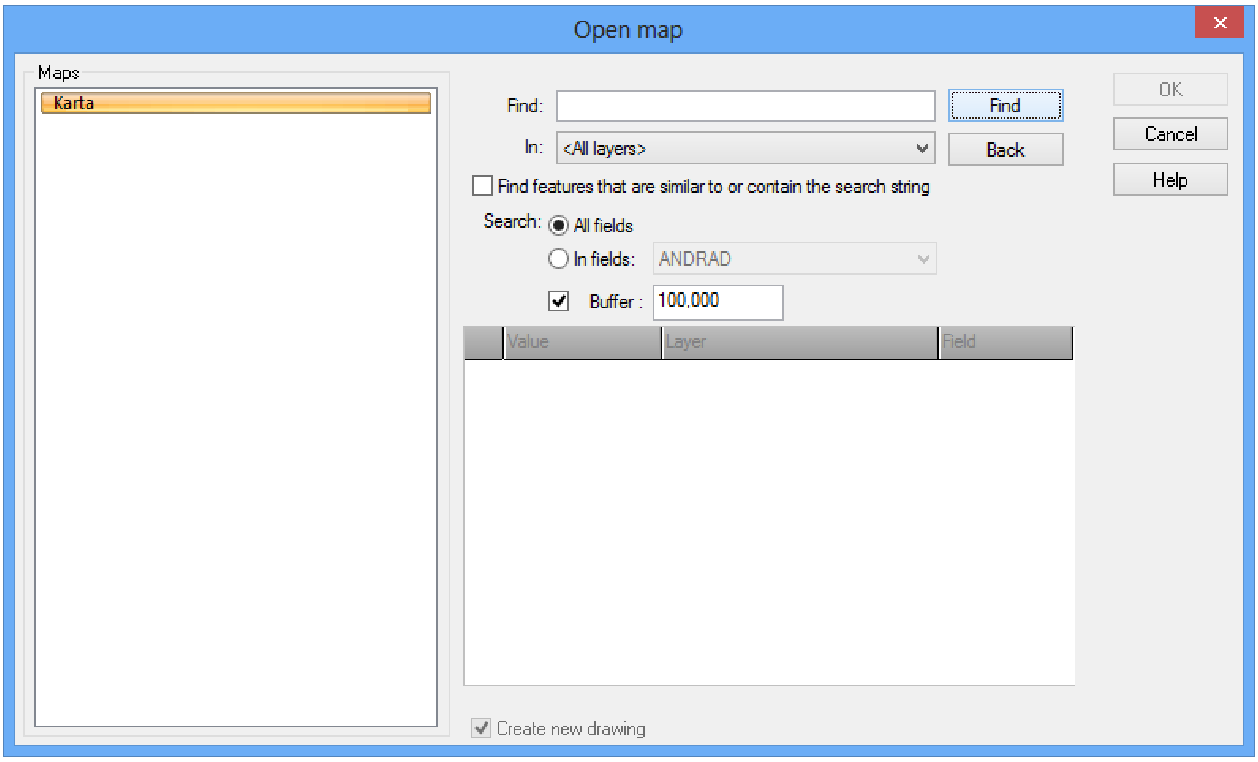


This function opens the map of the selected database.

Open map by database search

Searches can be made from one or more objects in the database and with a buffered zone around these objects. You can also select if you want to open the entire map, the current view (equal to the window that is now open) or by using the window which can either be selected in the drawing or specified by coordinates. When the map opens, the items you searched for will be highlighted.

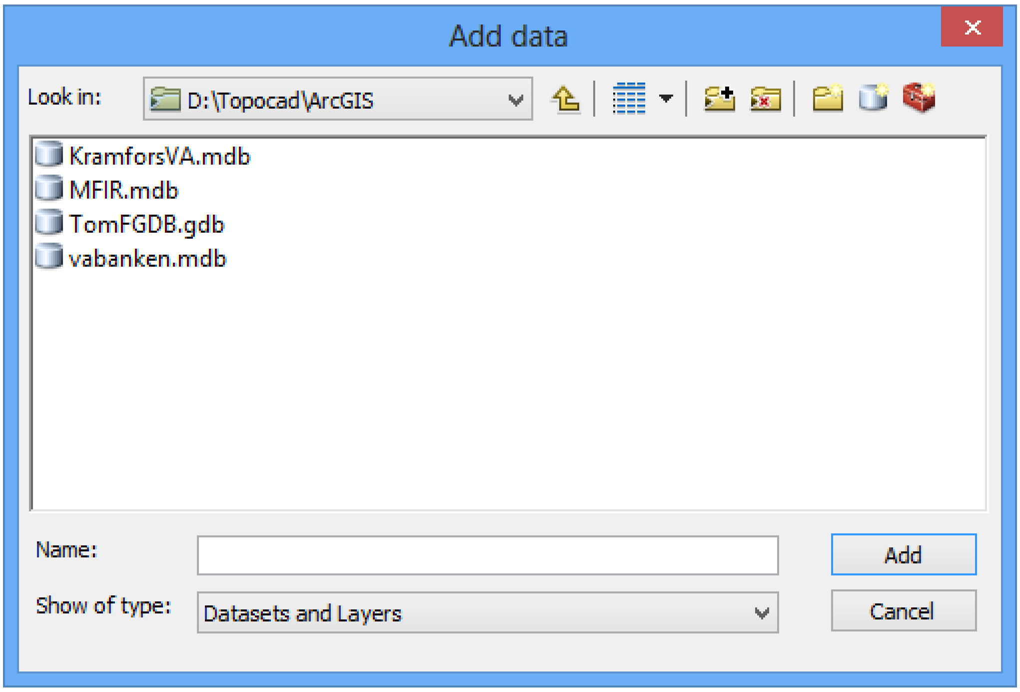
Find: Search for a value's attribute, for example address or road name.
In: Where to make the search.
Select whether to find features that are similar to or contain the search string
All fields/ In fields: Select if you want to search through All fields or a special field.
Buffer: Default is 100 meters, which opens the map with a radius of 100 meters around the selected attribute.



Disconnect

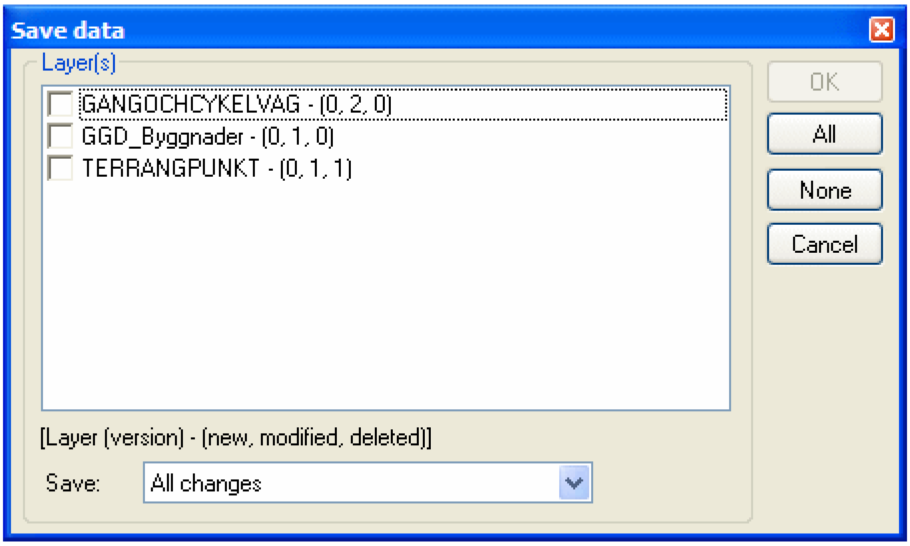
Disconnects the database The Arc license used is not free until you close Topocad.

Add data



Adds data from different layers. An area is selected.

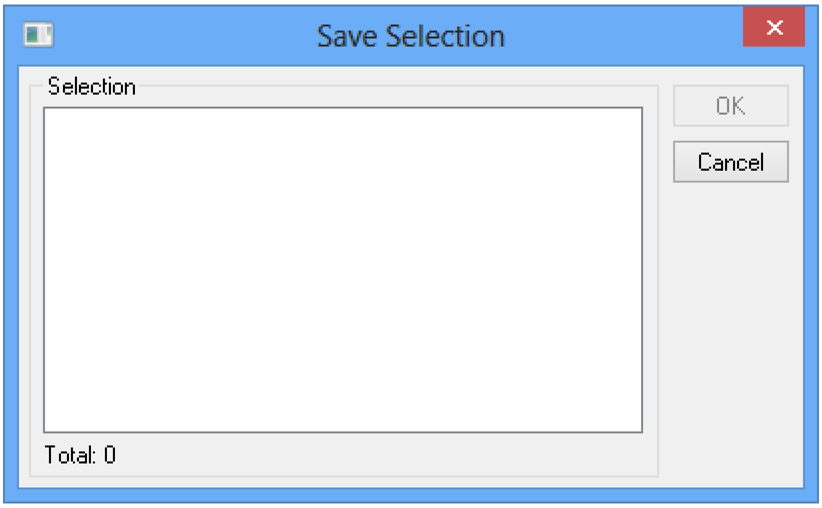
Save data



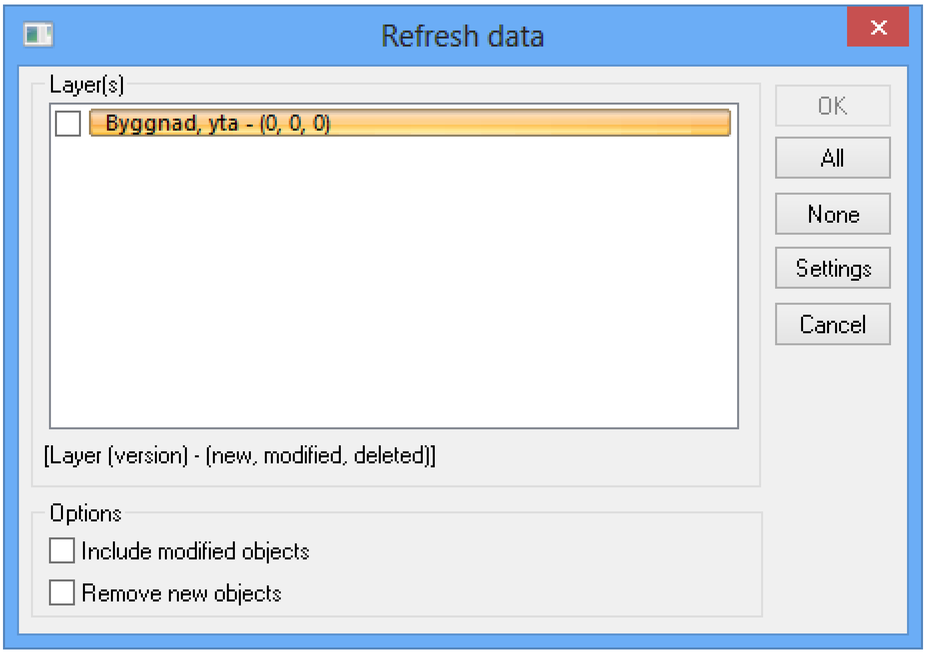
Saves the data. Select from the alternatives All changes, New features only, Modified features only, New and modified features only or Deleted features only.

Save selection

The command allows the user to save a selection of new or modified objects. Deleted object are not able to save.
The dialogue shows concerned layers, how many marked object in each layer and also the total amount of objects that will be saved.



Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

Reconcile and Post

Reconciles and Posts data to the database.

Any layers with differences from the database are displayed in a list. All layers with changes are displayed with three numbers in brackets, e.g. (1, 2, 3), where the first number indicates how many new objects are in this layer, the second number indicates how many changed objects and the third number indicates how many deleted objects - these must be deleted from both the drawing and the database.

Reconcile against version. Select layer to reconcile with.

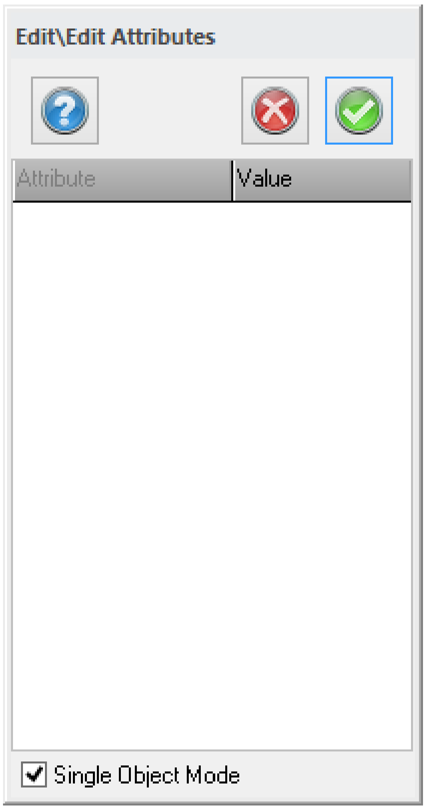
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



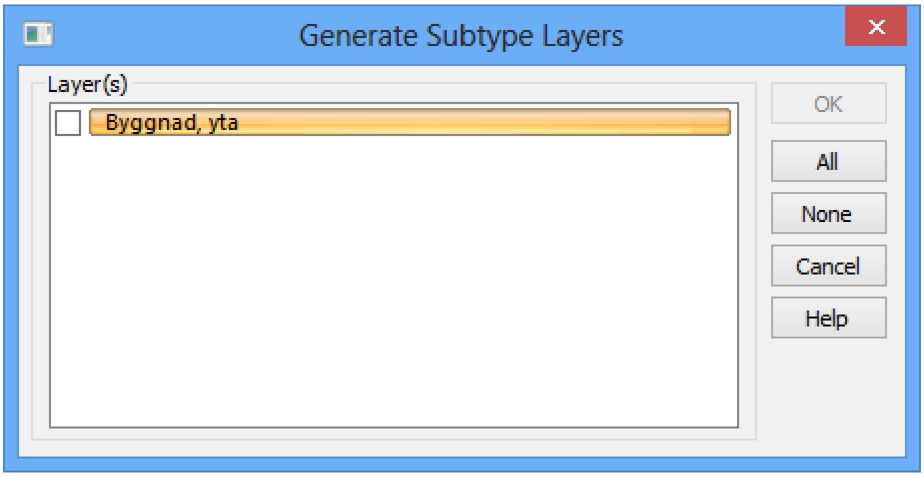
Edit attributes handles domains and subtypes.

Group object

Right click on objects and select group object. The object will now appear as one single object.

Generate Subtype layers

The function moves subtypes in a layer to a subtype layer. The new subtype layer will be named <layer> - <subtype>



View geographical constraint

Select *Constraint* to activate the command.

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Generate Subtype layers	Move subtypes in a layer to a subtype layer
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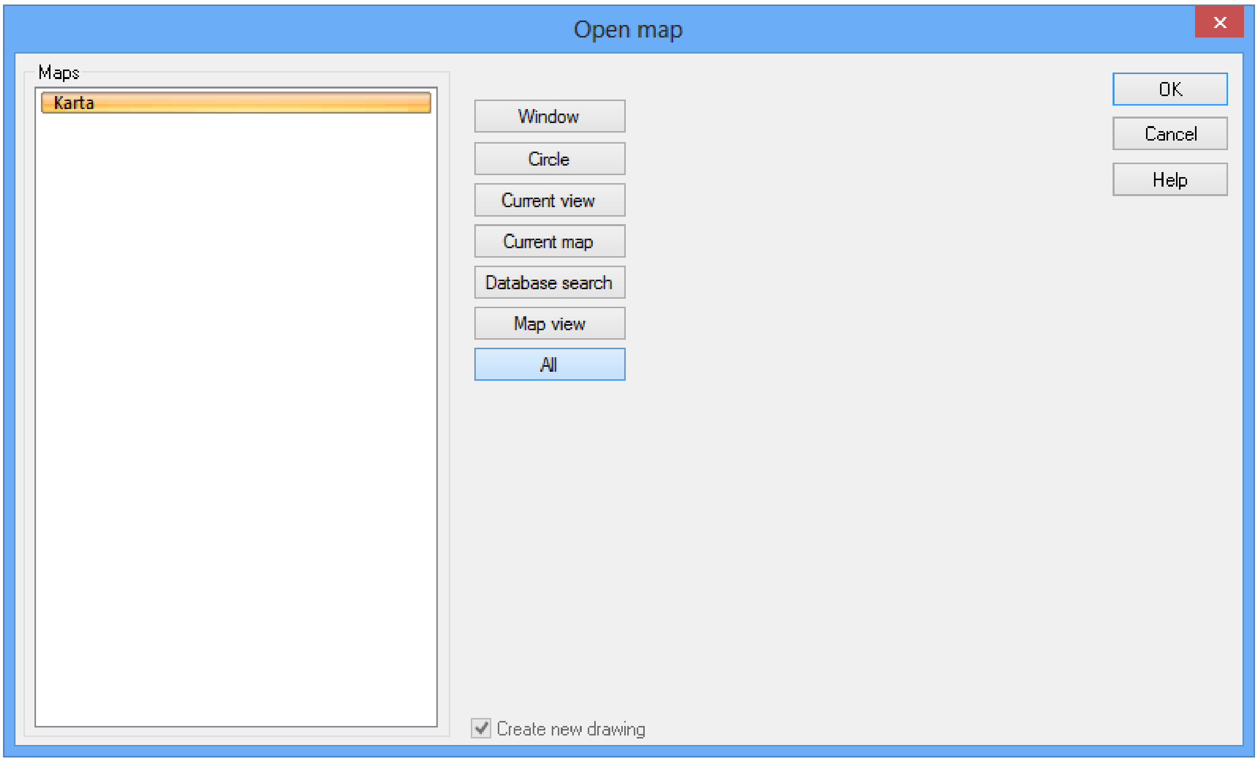
Open map



This function opens the map of the selected database.

Open map by database search

Searches can be made from one or more objects in the database and with a buffered zone around these objects. You can also select if you want to open the entire map, the current view (equal to the window that is now open) or by using the window which can either be selected in the drawing or specified by coordinates. When the map opens, the items you searched for will be highlighted.

Find: Search for a value's attribute, for example address or road name.
In: Where to make the search.
Select whether to find features that are similar to or contain the search string
All fields/ In fields: Select if you want to search through All fields or a special field.
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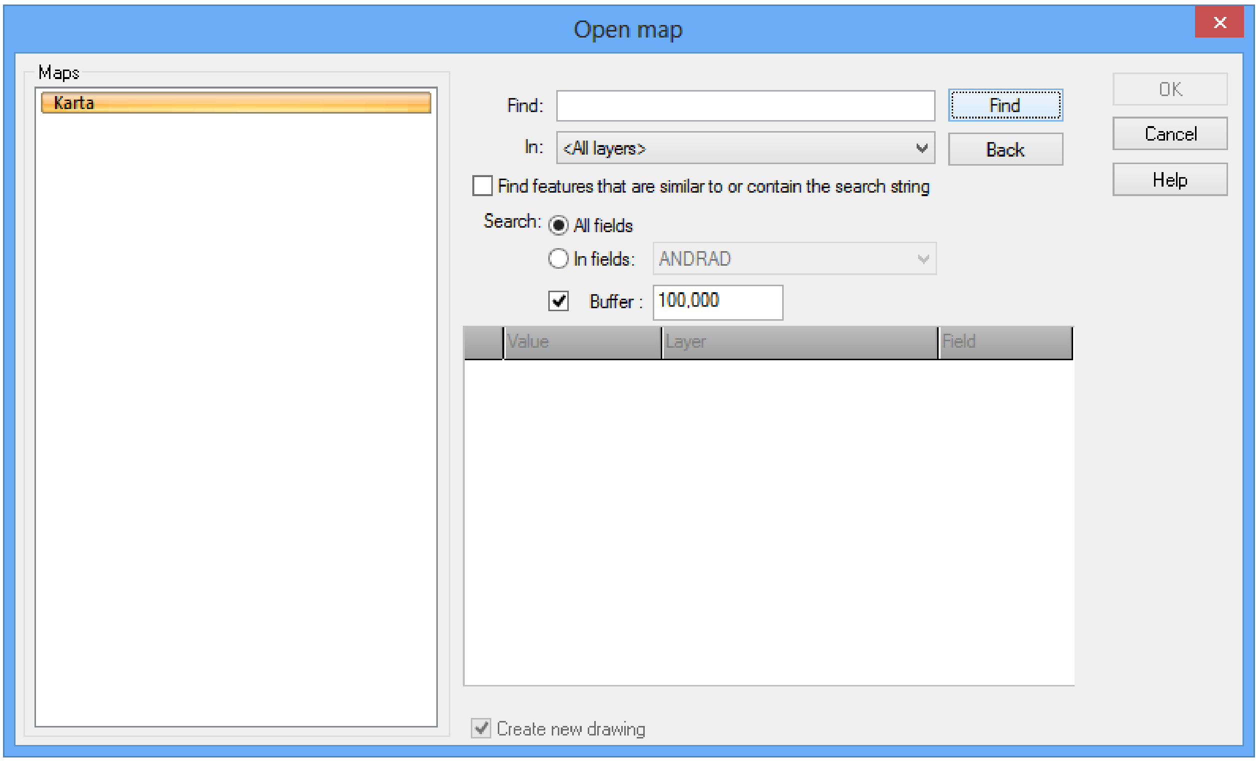
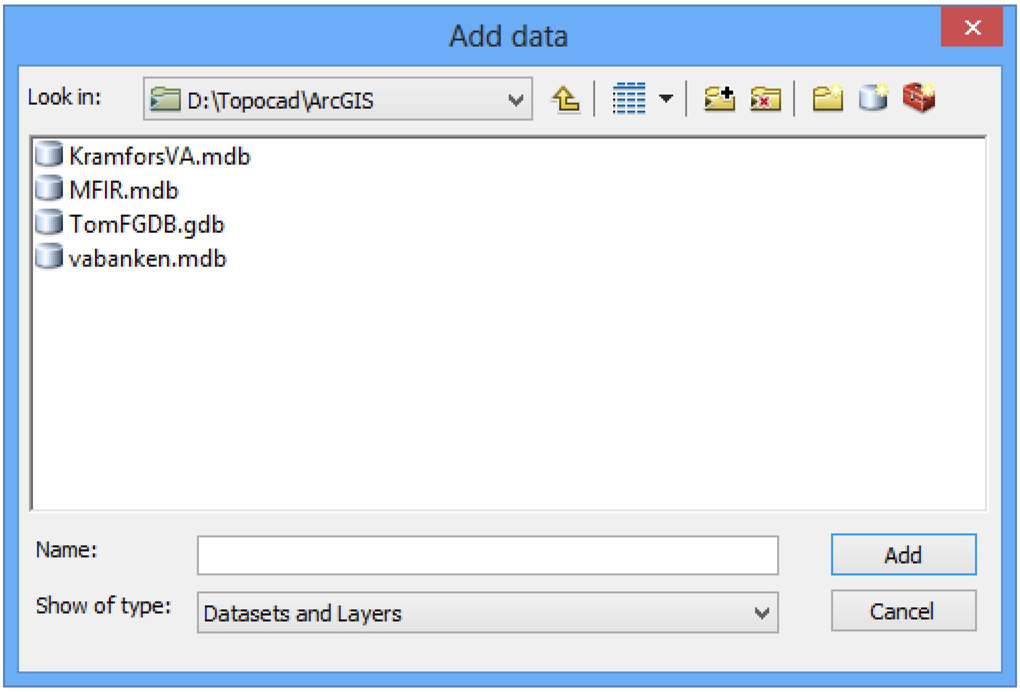


Disconnect

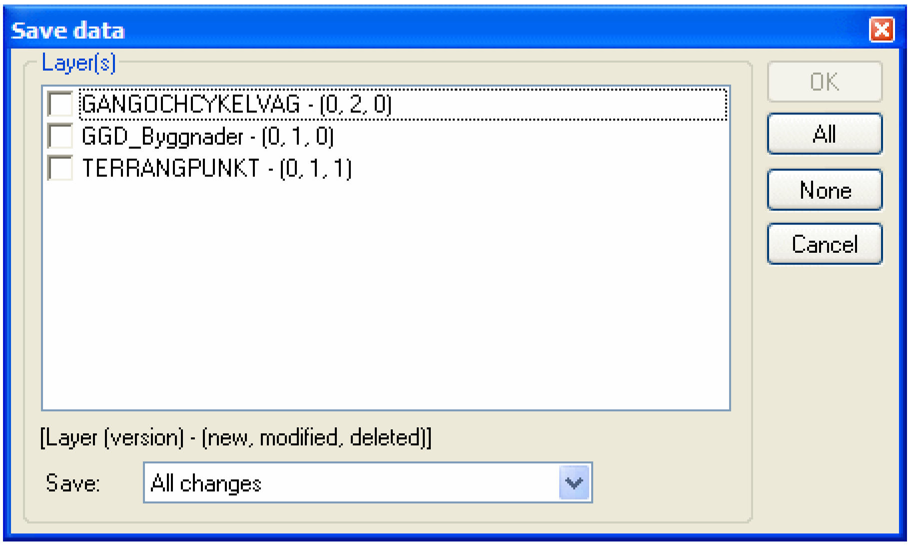
Disconnects the database The Arc license used is not free until you close Topocad.

Add data



Adds data from different layers. An area is selected.

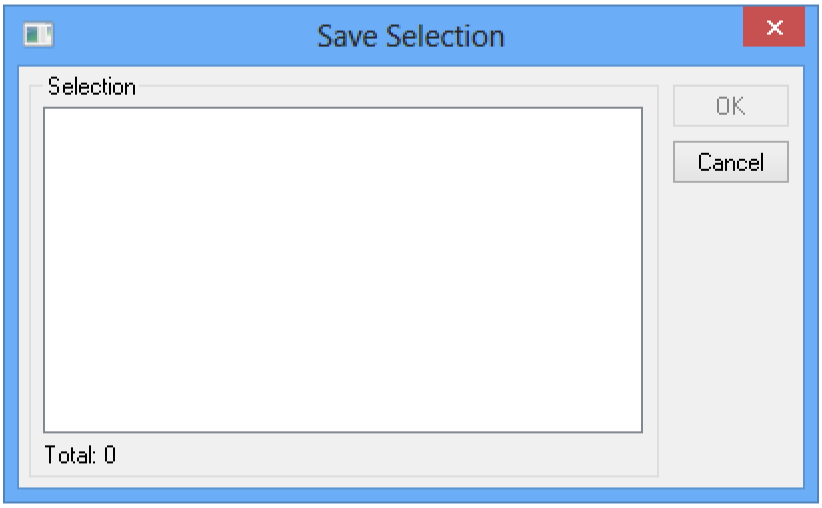
Save data



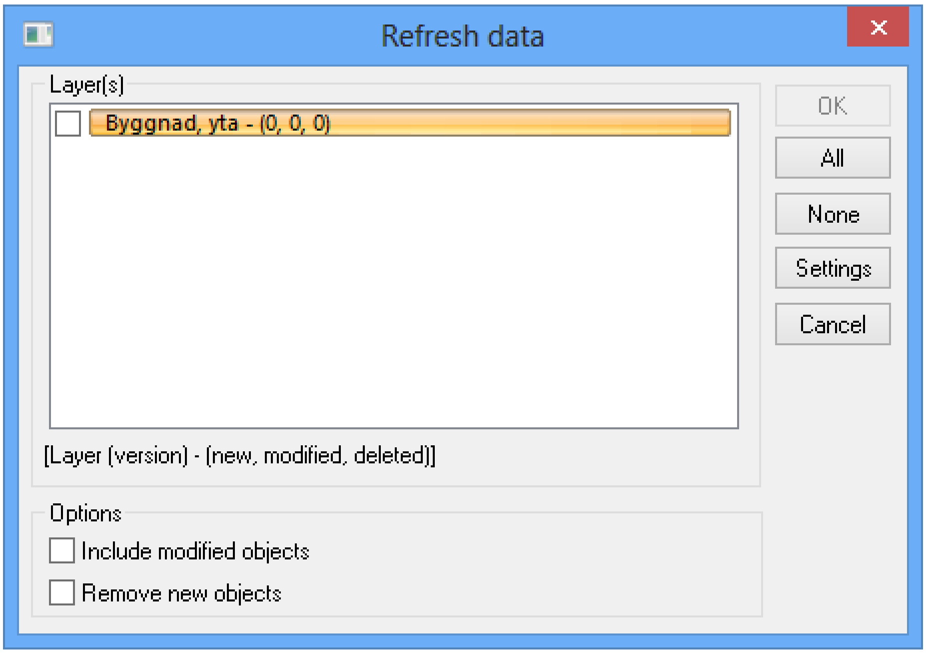
Saves the data. Select from the alternatives All changes, New features only, Modified features only, New and modified features only or Deleted features only.

Save selection

The command allows the user to save a selection of new or modified objects. Deleted object are not able to save.
The dialogue shows concerned layers, how many marked object in each layer and also the total amount of objects that will be saved.



Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

Reconcile and Post

Reconciles and Posts data to the database.

Any layers with differences from the database are displayed in a list. All layers with changes are displayed with three numbers in brackets, e.g. (1, 2, 3), where the first number indicates how many new objects are in this layer, the second number indicates how many changed objects and the third number indicates how many deleted objects - these must be deleted from both the drawing and the database.

Reconcile against version. Select layer to reconcile with.

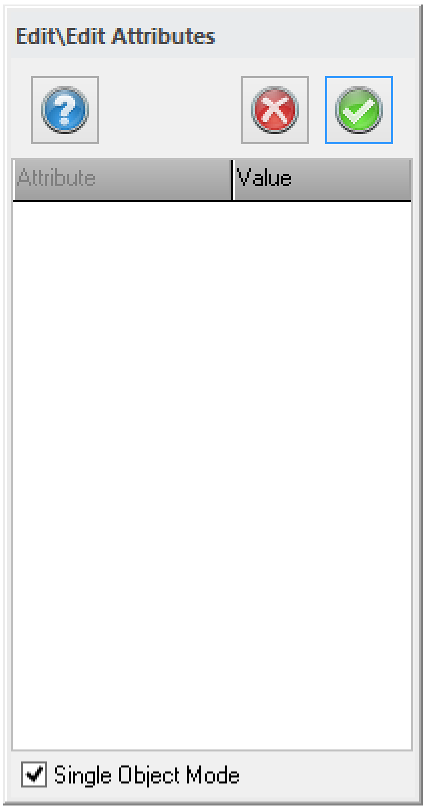
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



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Group object

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Generate Subtype layers

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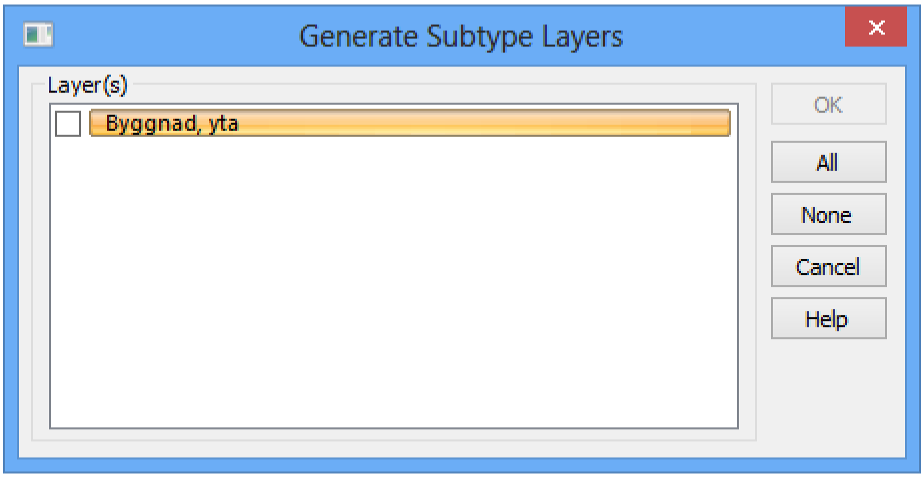

View geographical constraint

Select *Constraint* to activate the command.

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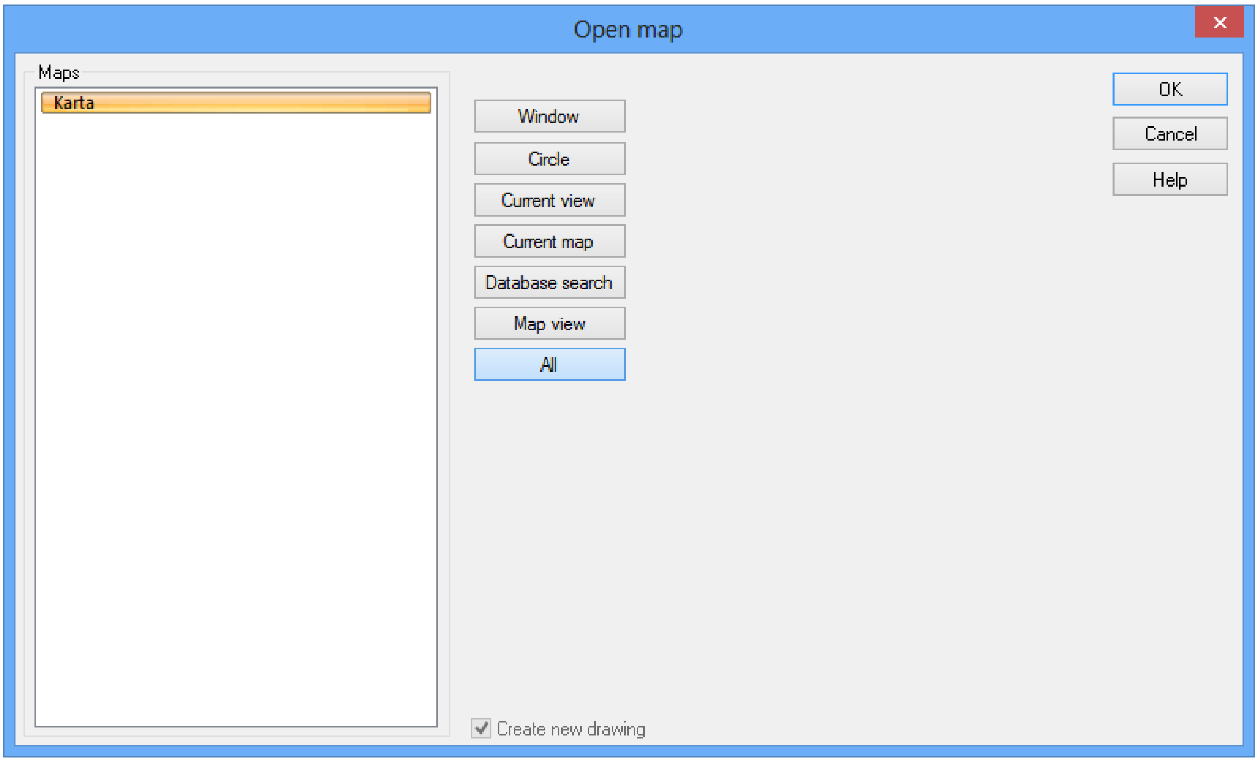
Open map



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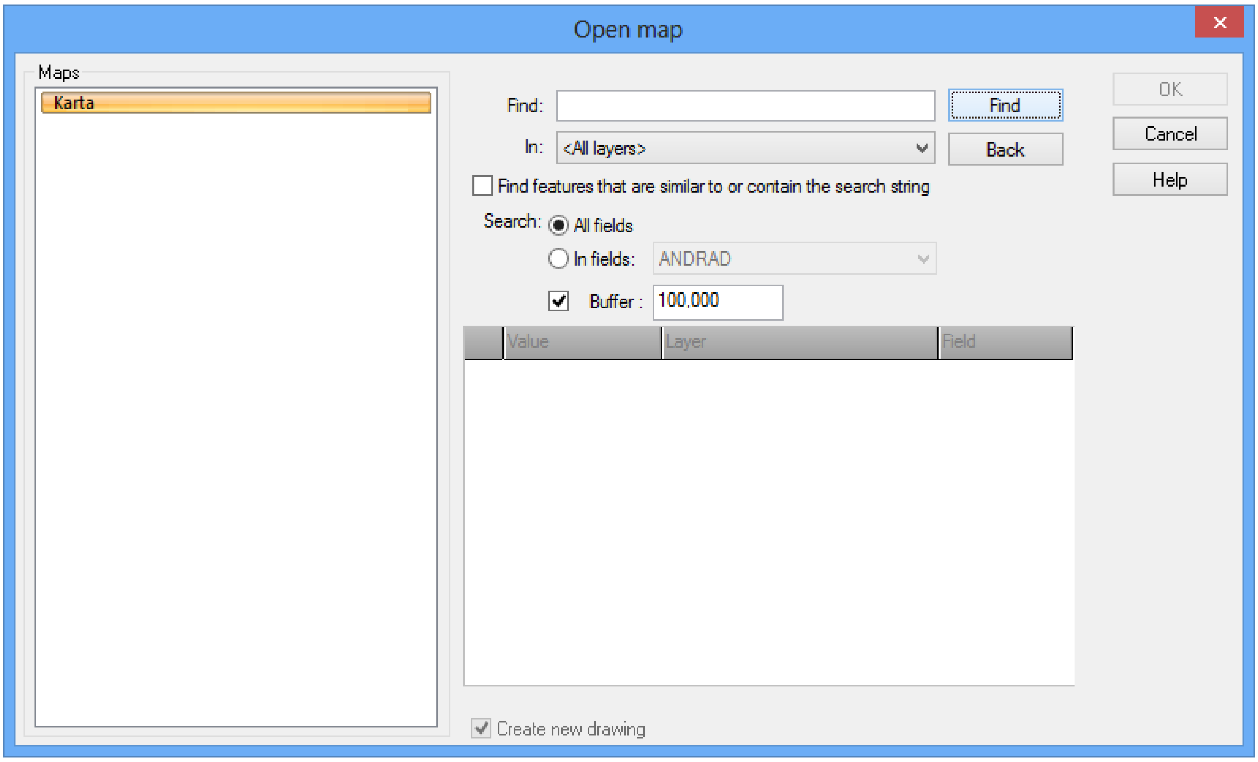

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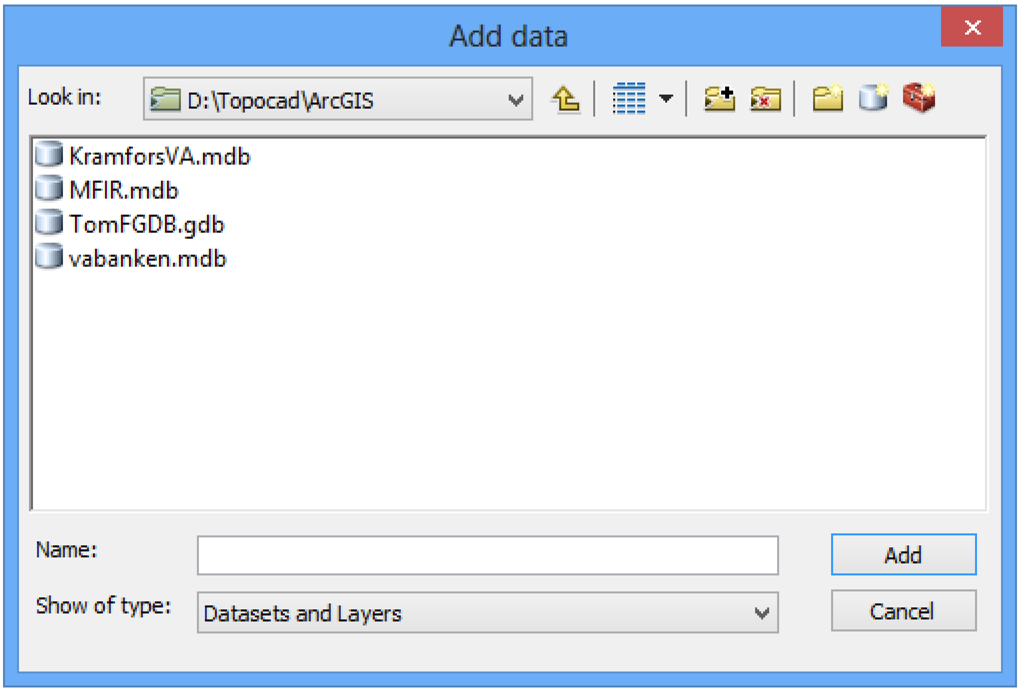
Add data



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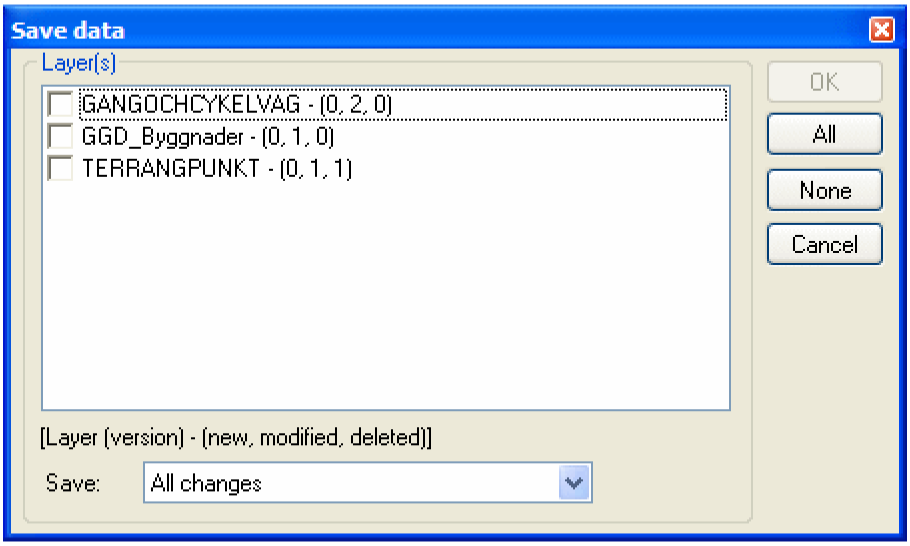
Save data



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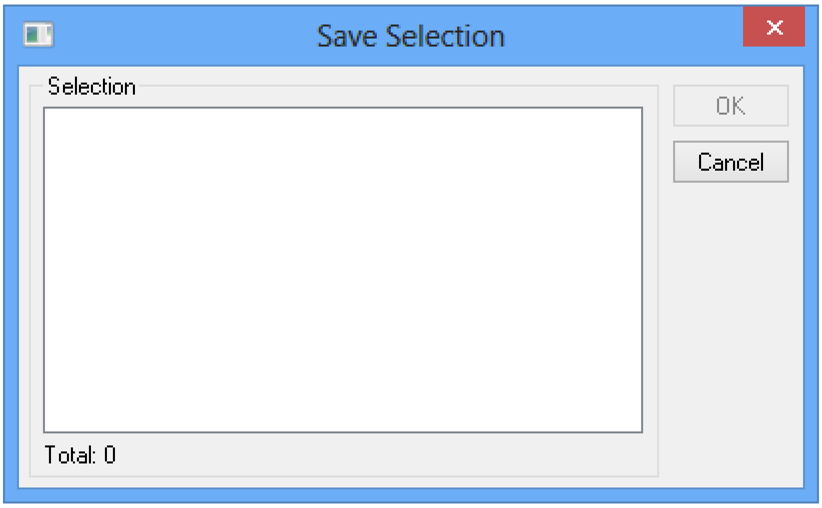
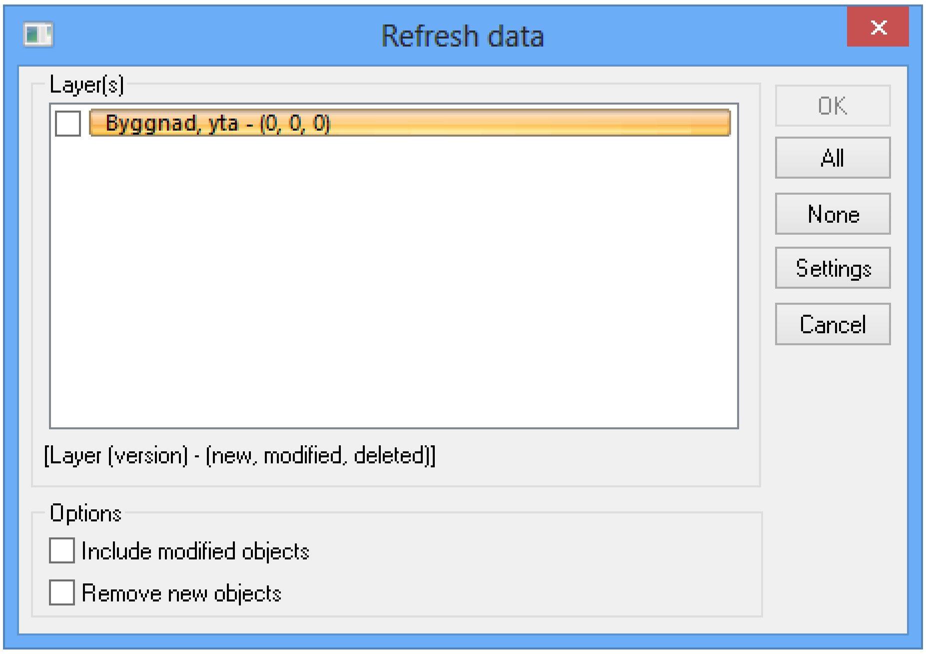


Refresh data



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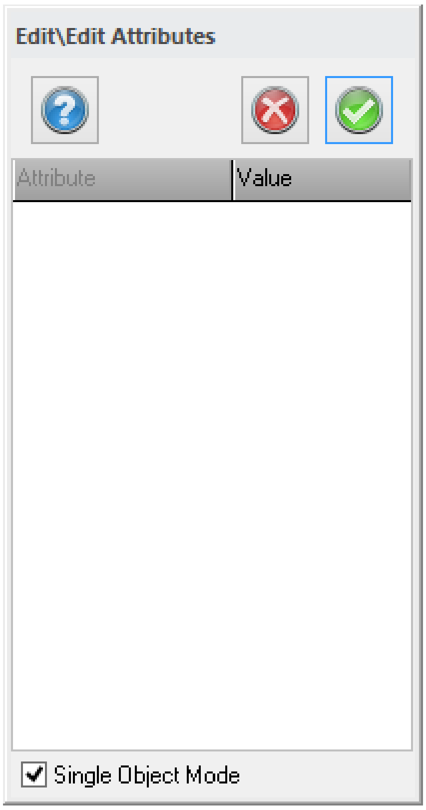
Edit Attributes



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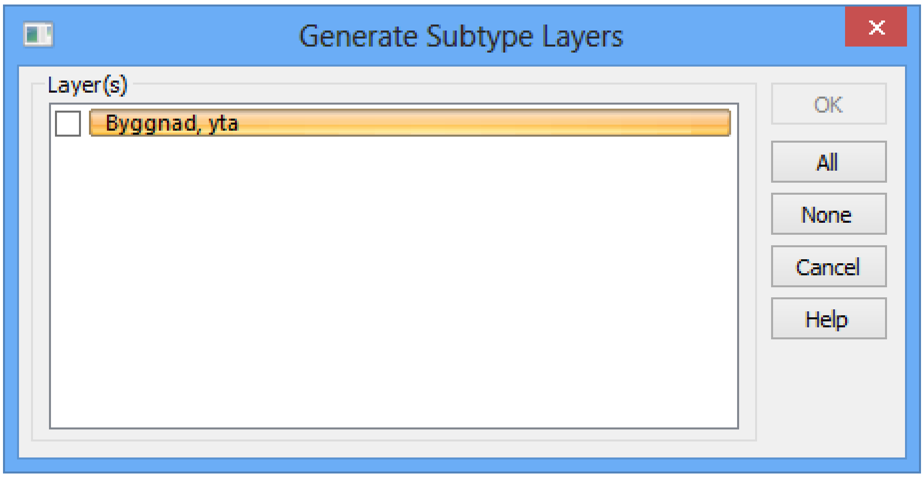

View geographical constraint

Select *Constraint* to activate the command.

ArcGIS database adapter contents

ArcGIS database adapter

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Open map	Opens the database for the drawing.
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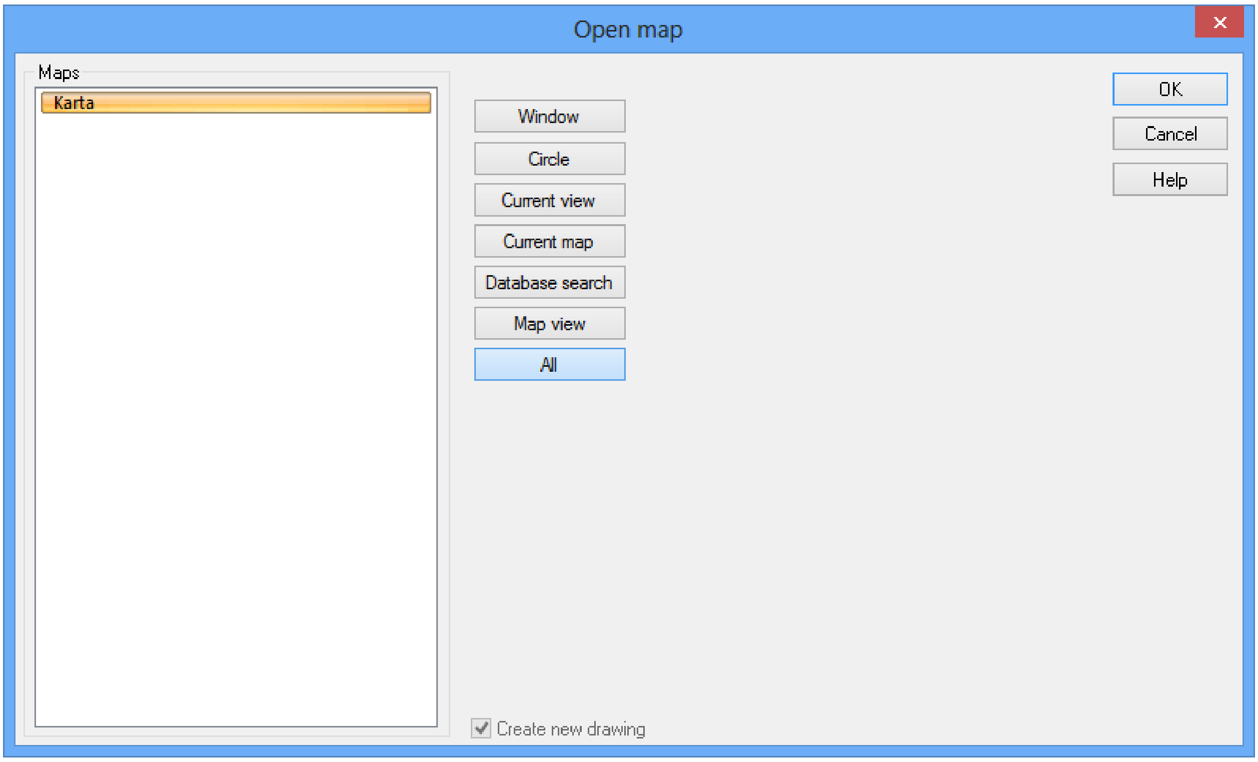
Open map



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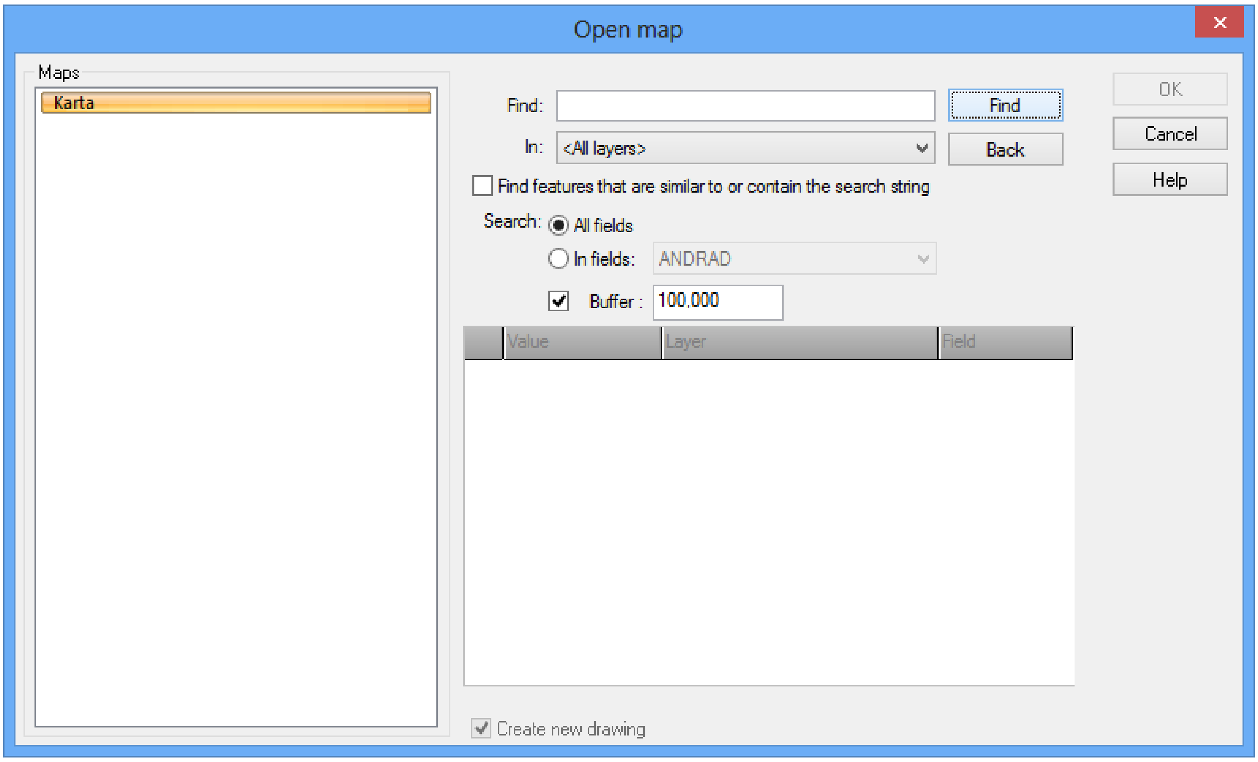

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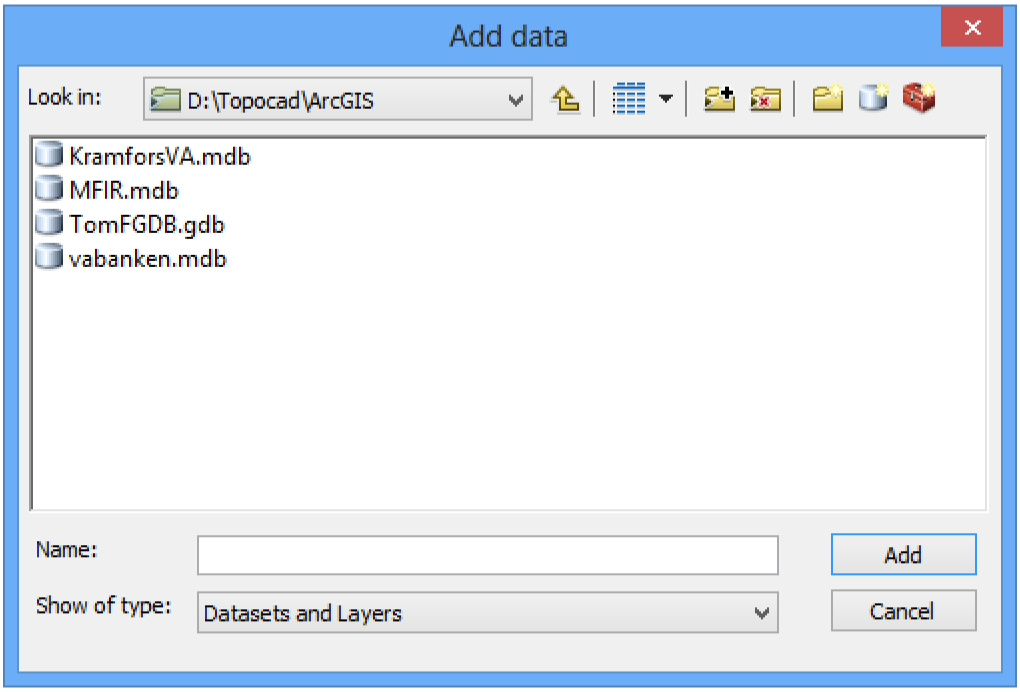

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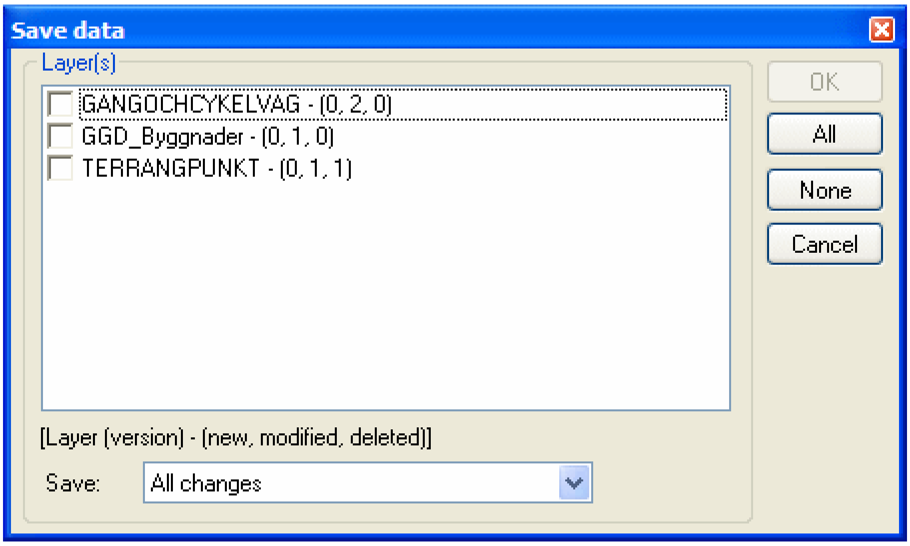

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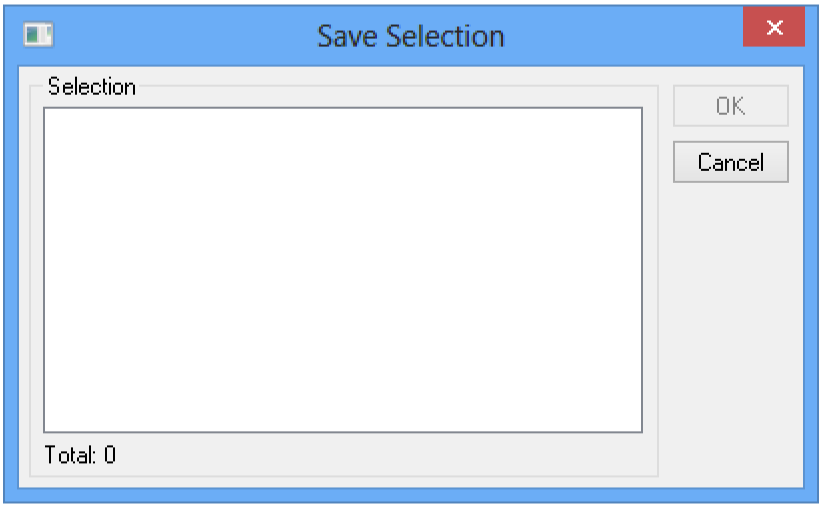

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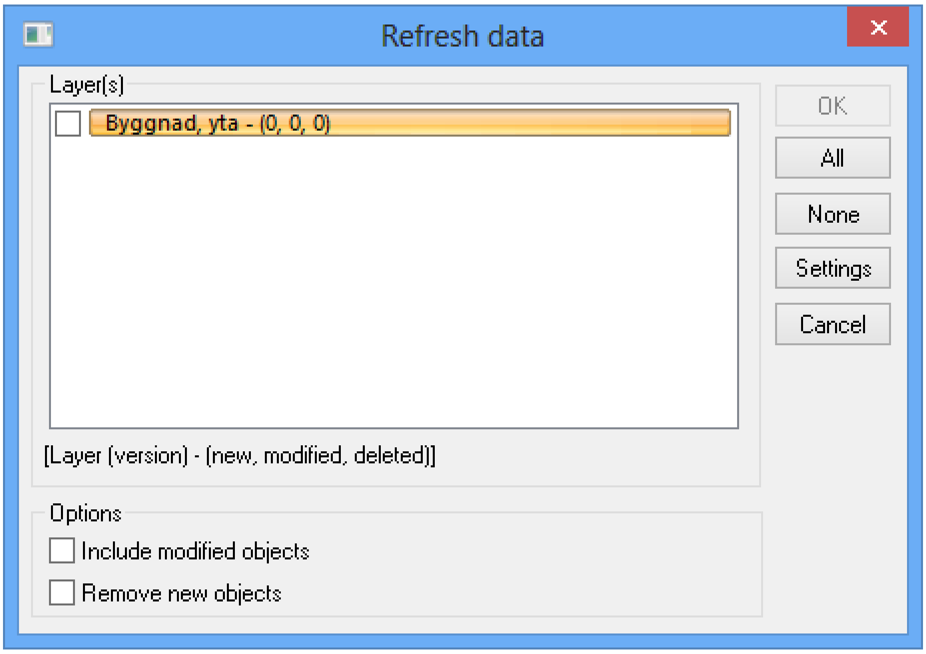

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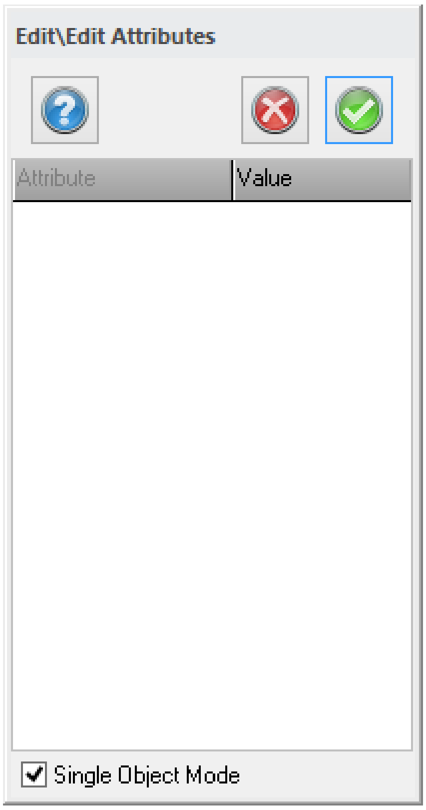

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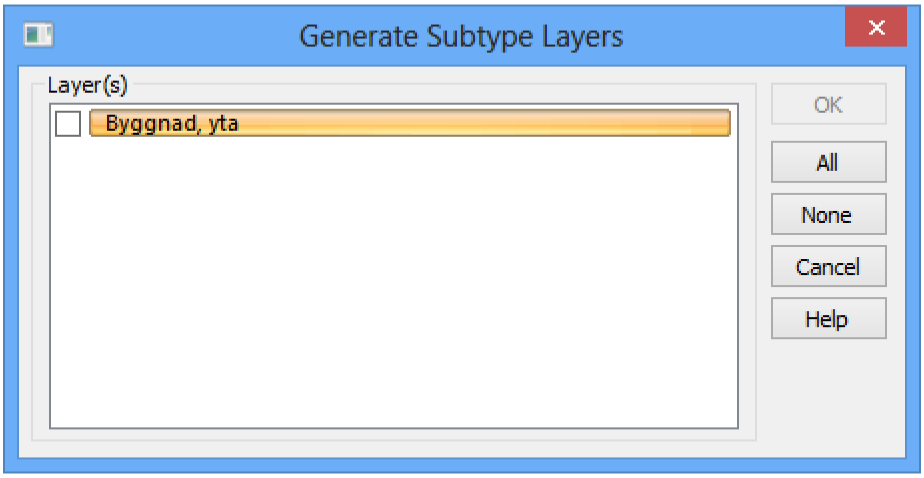

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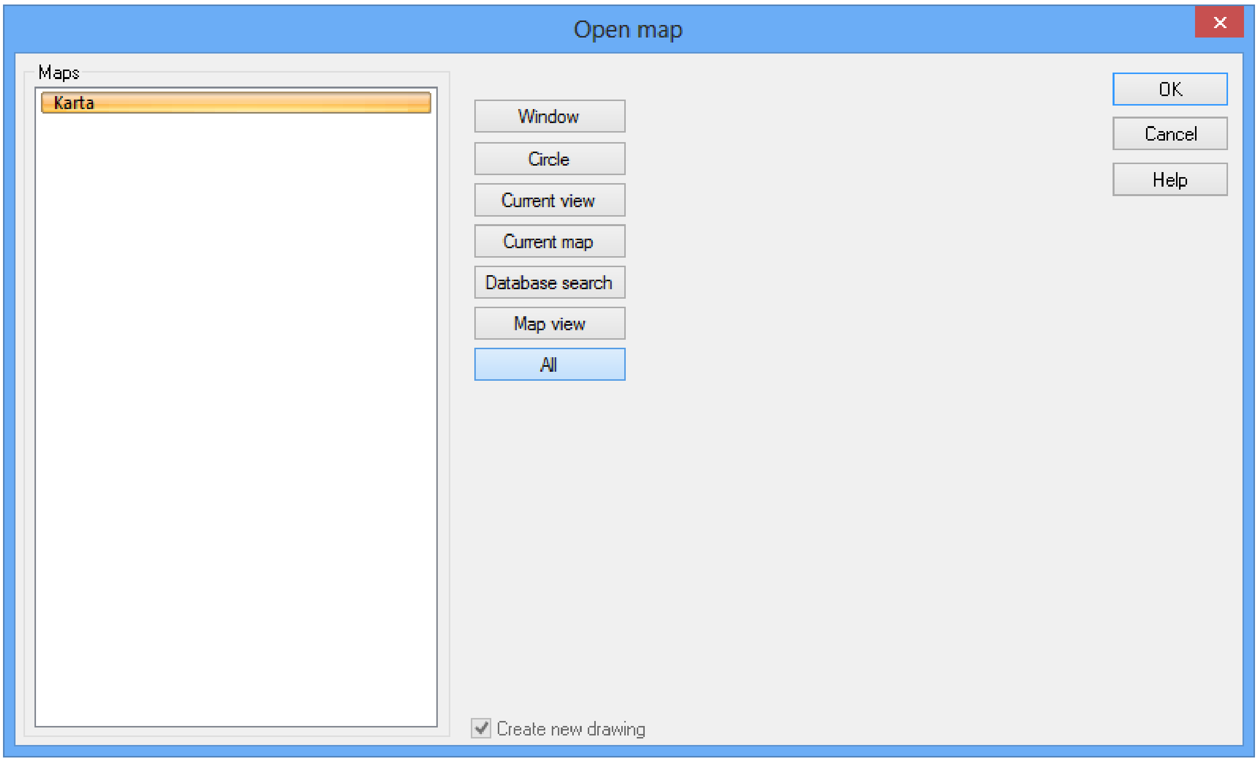
Open map



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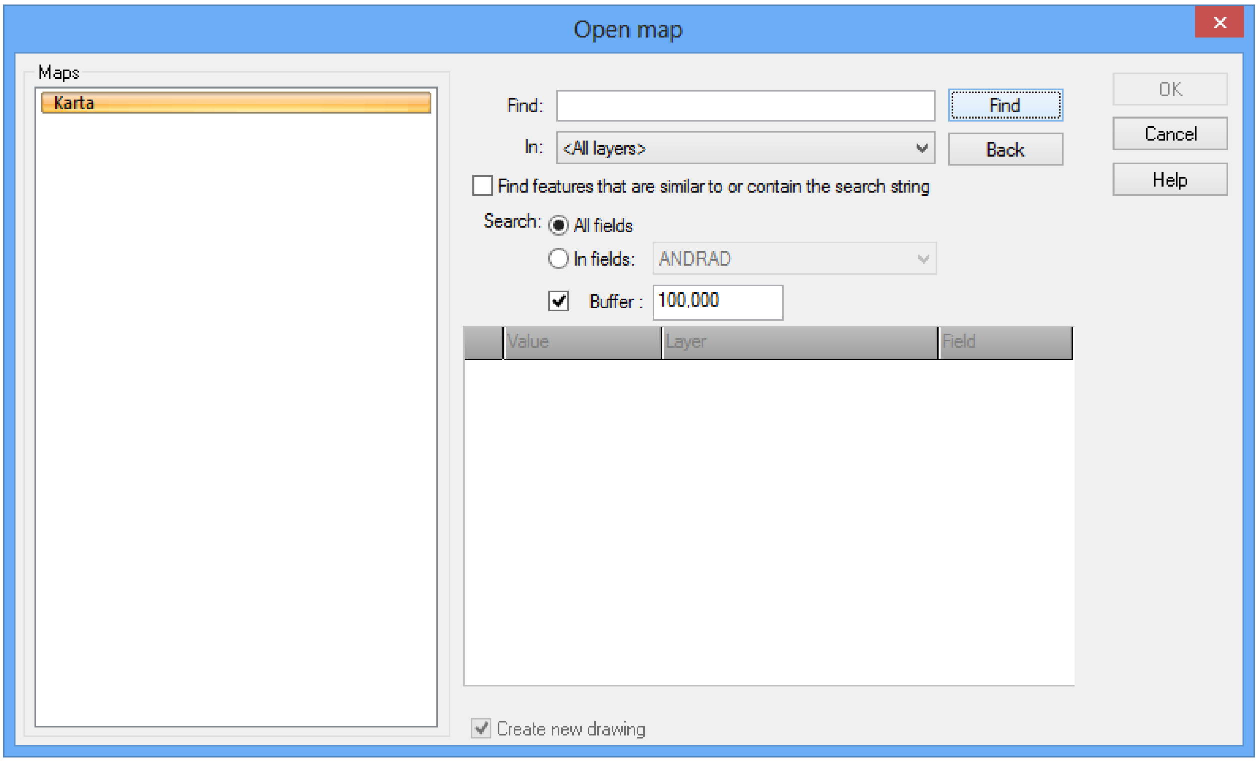
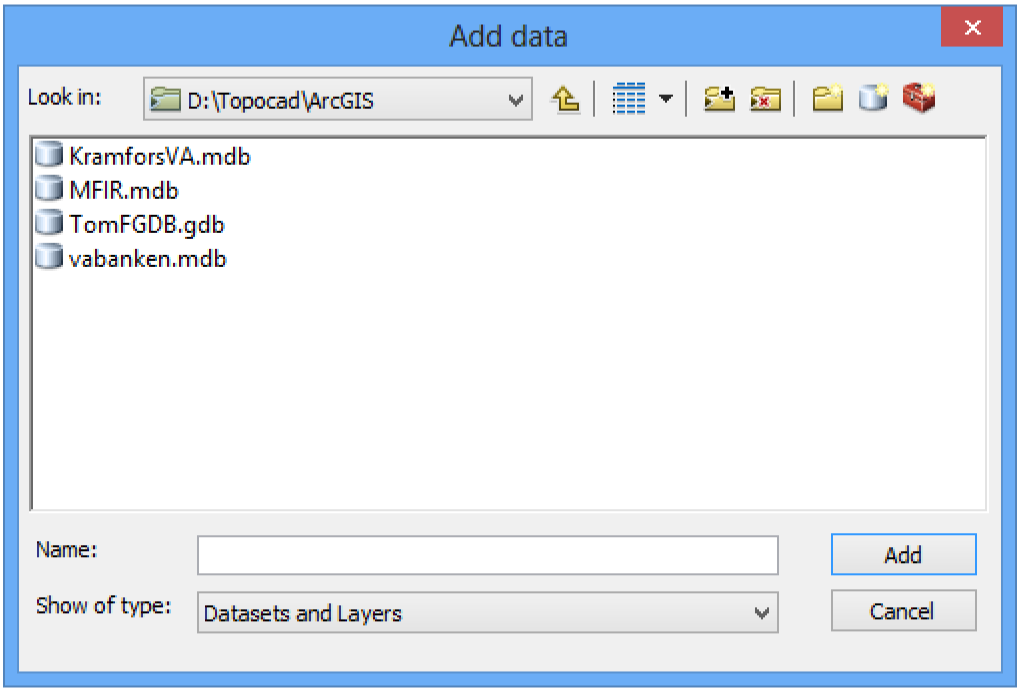


Disconnect

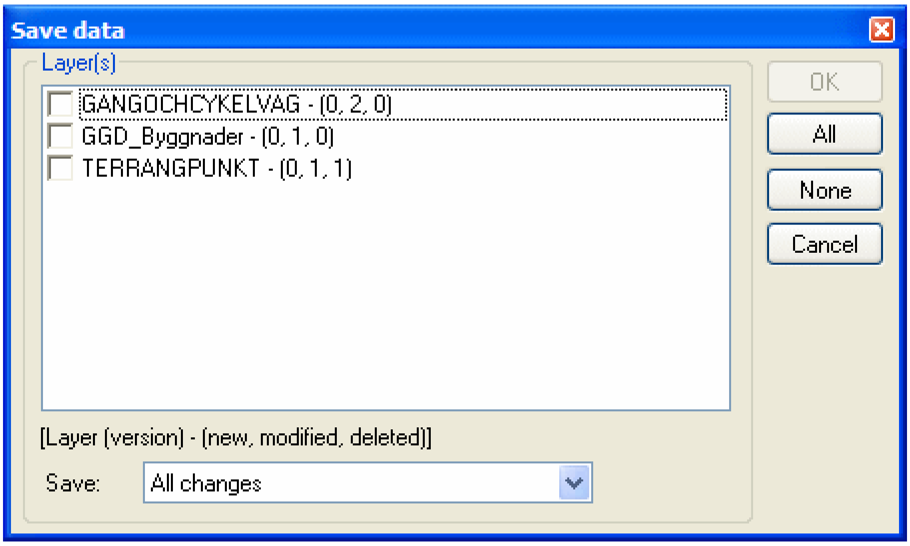
Disconnects the database The Arc license used is not free until you close Topocad.

Add data



Adds data from different layers. An area is selected.

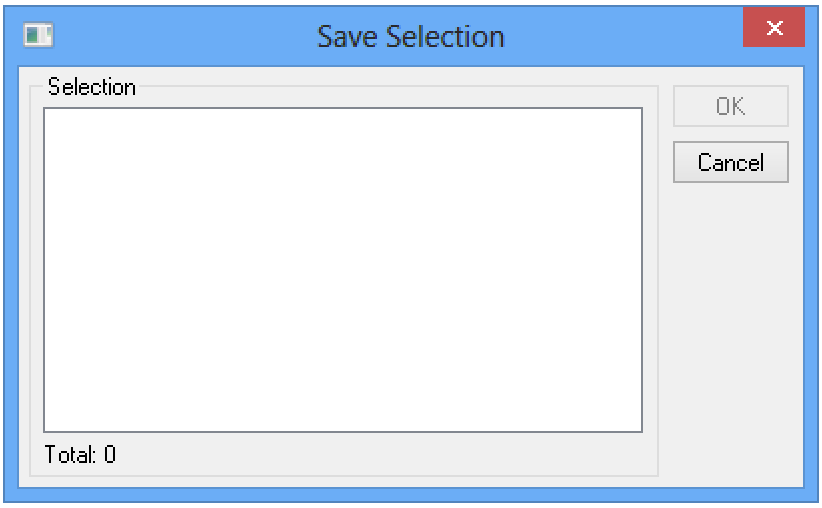
Save data



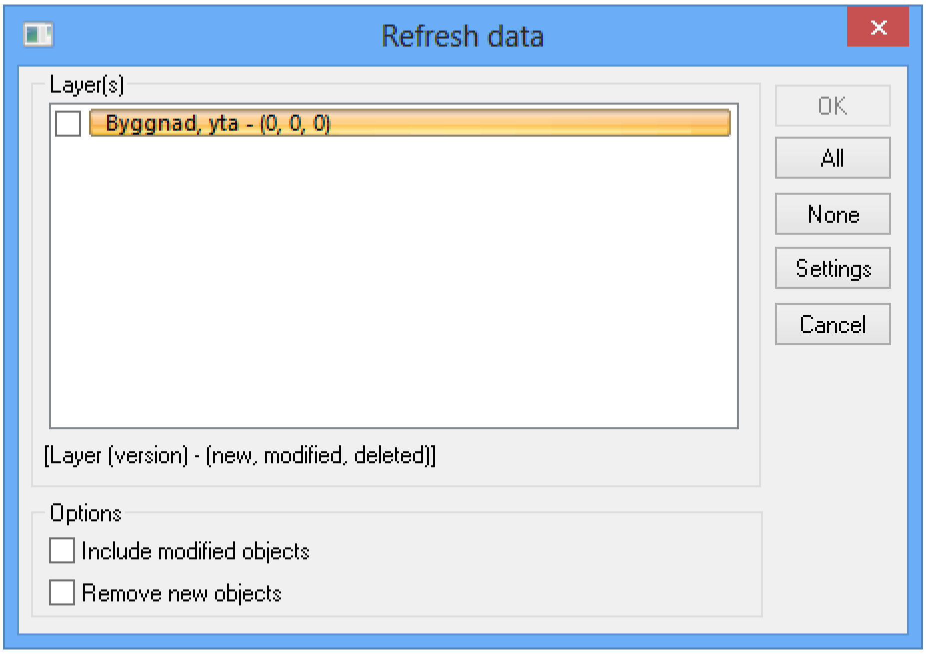
Saves the data. Select from the alternatives All changes, New features only, Modified features only, New and modified features only or Deleted features only.

Save selection

The command allows the user to save a selection of new or modified objects. Deleted object are not able to save.
The dialogue shows concerned layers, how many marked object in each layer and also the total amount of objects that will be saved.



Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

Reconcile and Post

Reconciles and Posts data to the database.

Any layers with differences from the database are displayed in a list. All layers with changes are displayed with three numbers in brackets, e.g. (1, 2, 3), where the first number indicates how many new objects are in this layer, the second number indicates how many changed objects and the third number indicates how many deleted objects - these must be deleted from both the drawing and the database.

Reconcile against version. Select layer to reconcile with.

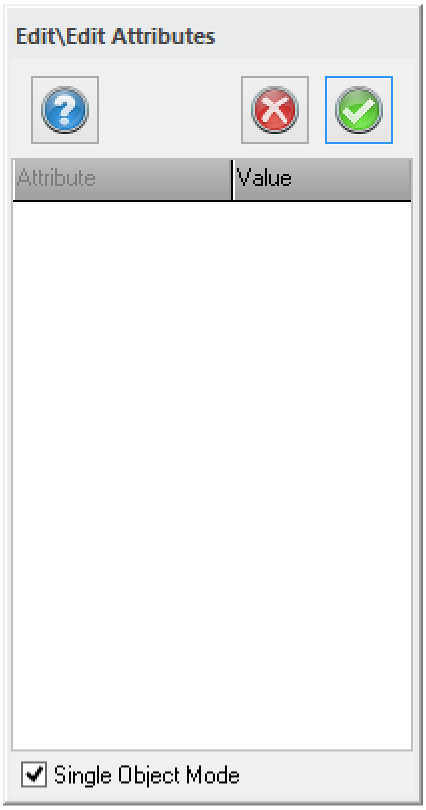
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



Edit attributes handles domains and subtypes.

Group object

Right click on objects and select group object. The object will now appear as one single object.

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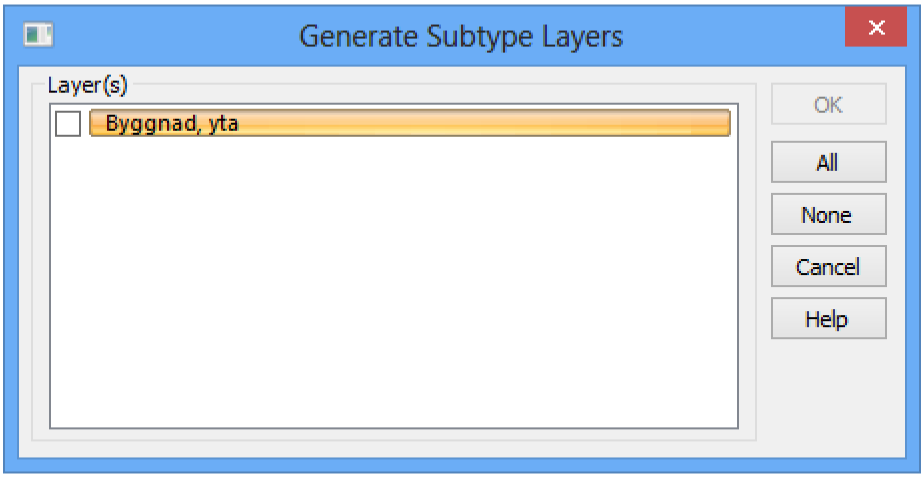
The function moves subtypes in a layer to a subtype layer. The new subtype layer will be named <layer> - <subtype>



View geographical constraint

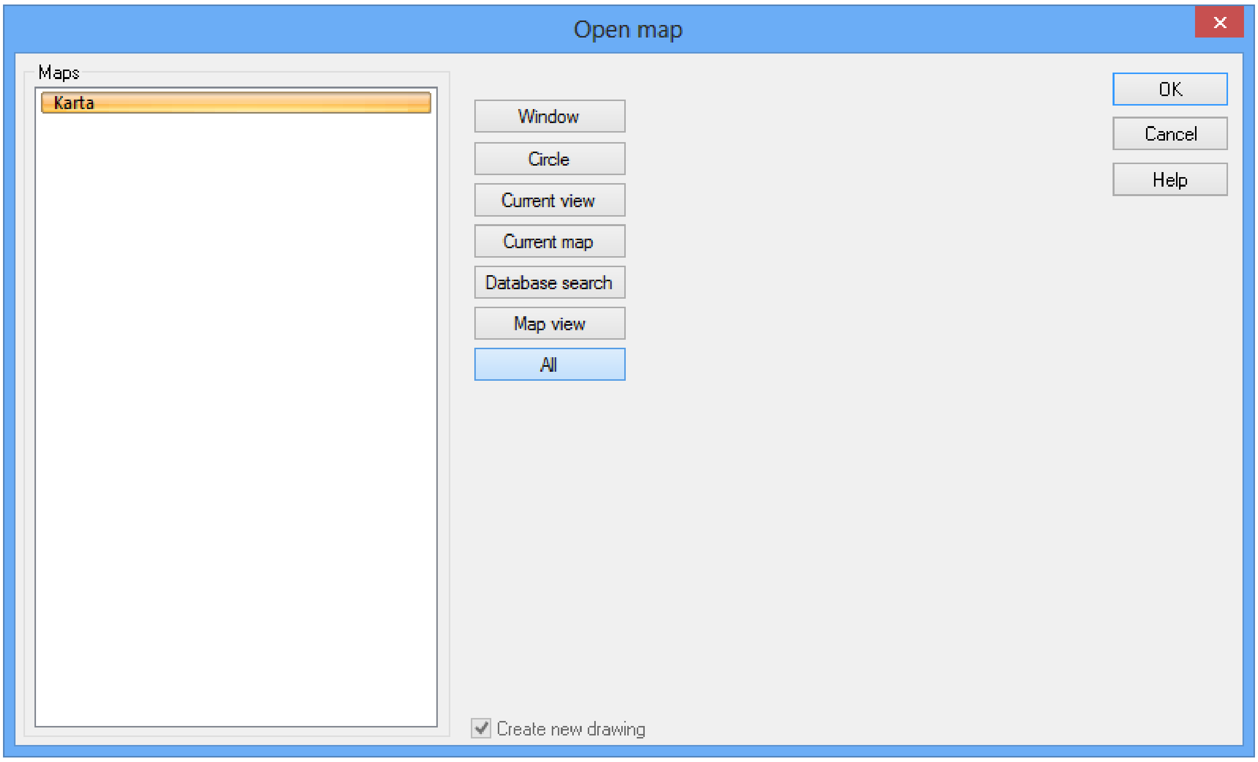
Select *Constraint* to activate the command.

ArcGIS database adapter contents

ArcGIS database adapter

Command	Description
Open map	Opens the database for the drawing.
Disconnect	Disconnects the database
Add Data	Adds data from the database to the drawing.
Save Data	Saves the data
Save selection	Saves a selection of new or modified objects.
Refresh data	Refresh data, load from database
Reconcile and Post (save)	Reconciles and Posts data to the current version of the database.
Version manager	Manages different versions of the database.
Change version	The command allows version change of selected layers
Edit Attributes	Edit attributes handles domains and subtypes.
Group Objects	Command to group single objects into one.
System settings - Arc	Settings - including drawing method etc.
Generate Subtype layers	Move subtypes in a layer to a subtype layer
Geographical Constraint	View Geographical Constraint

Open map

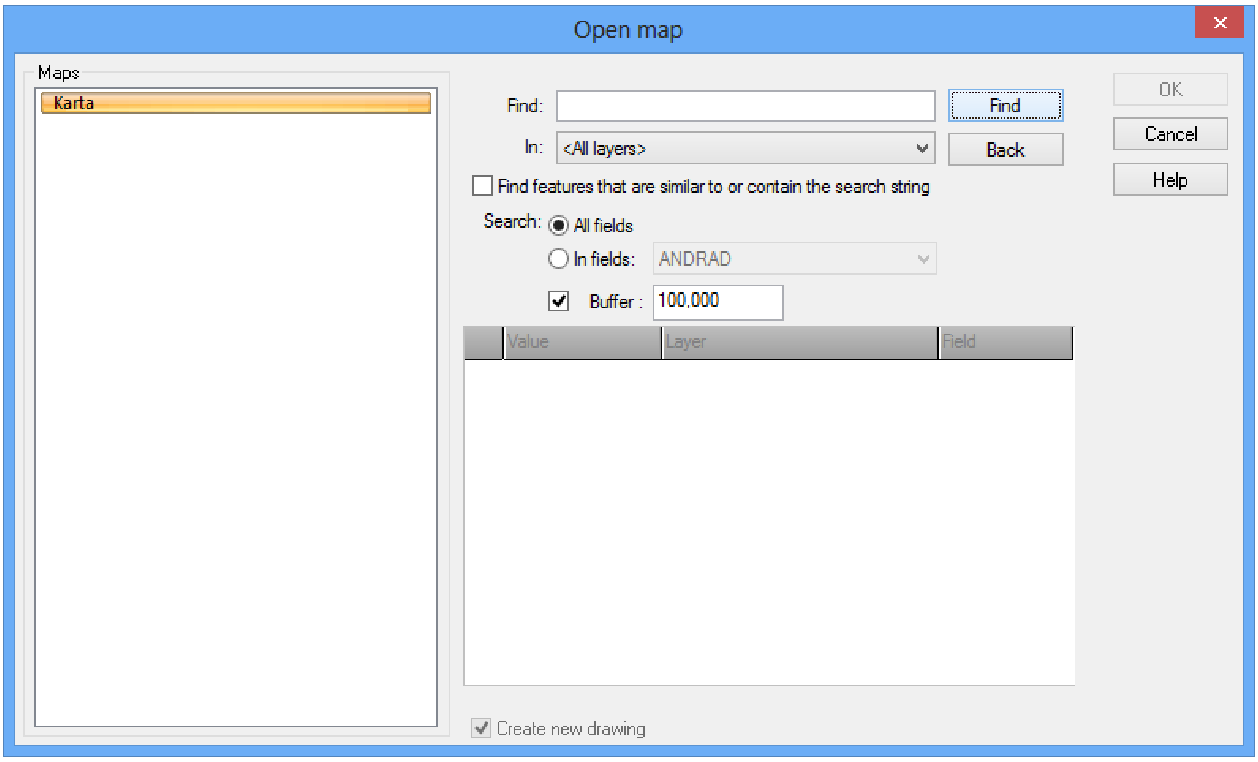


This function opens the map of the selected database.

Open map by database search

Searches can be made from one or more objects in the database and with a buffered zone around these objects. You can also select if you want to open the entire map, the current view (equal to the window that is now open) or by using the window which can either be selected in the drawing or specified by coordinates. When the map opens, the items you searched for will be highlighted.

Find: Search for a value's attribute, for example address or road name.
In: Where to make the search.
Select whether to find features that are similar to or contain the search string
All fields/ In fields: Select if you want to search through All fields or a special field.
Buffer: Default is 100 meters, which opens the map with a radius of 100 meters around the selected attribute.



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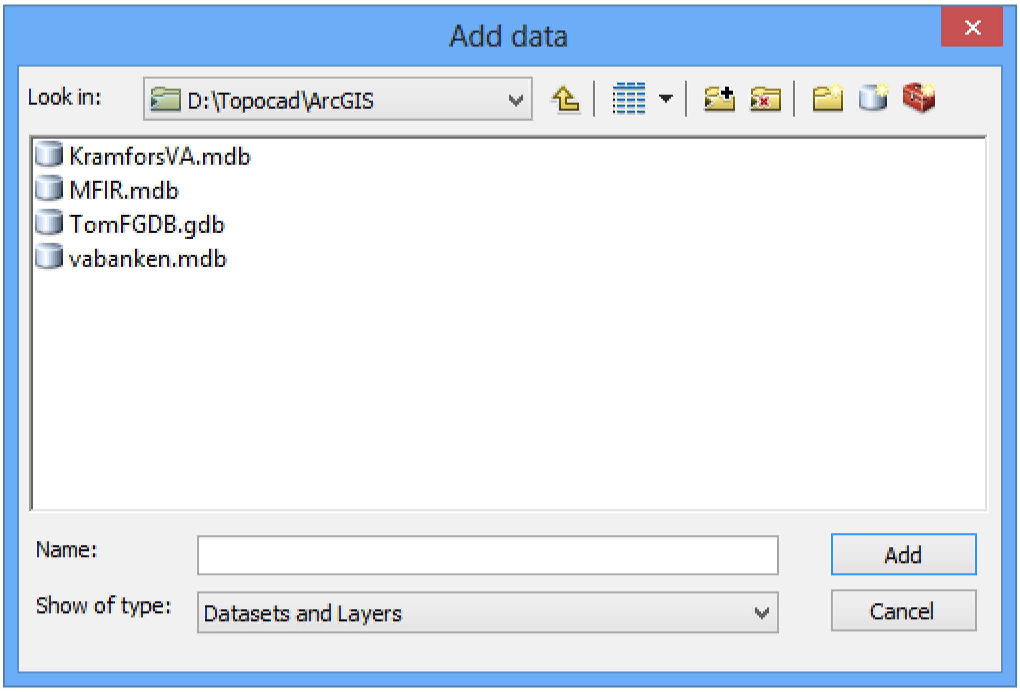
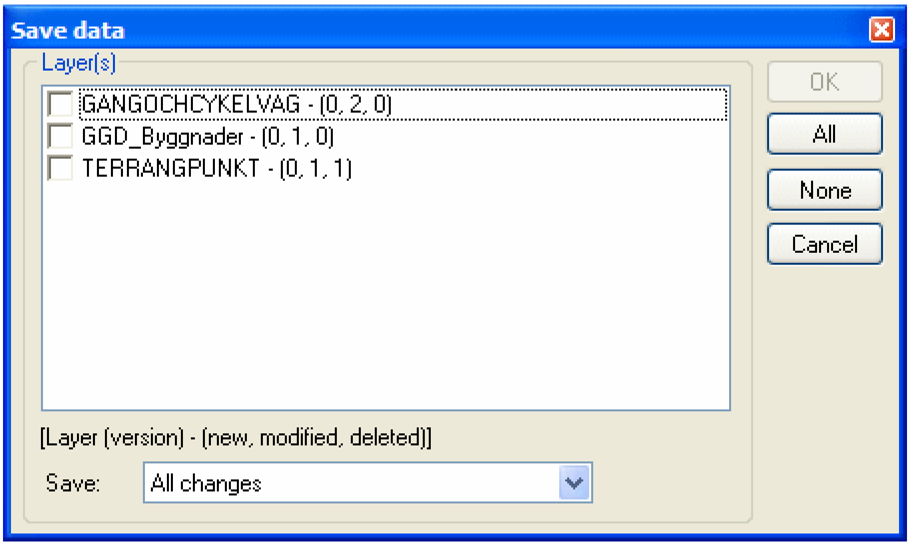
Add data



Adds data from different layers. An area is selected.

Save data



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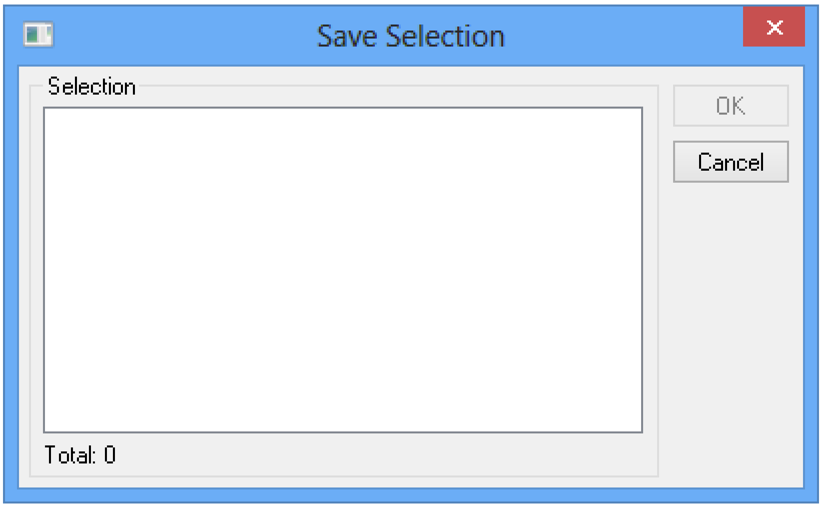
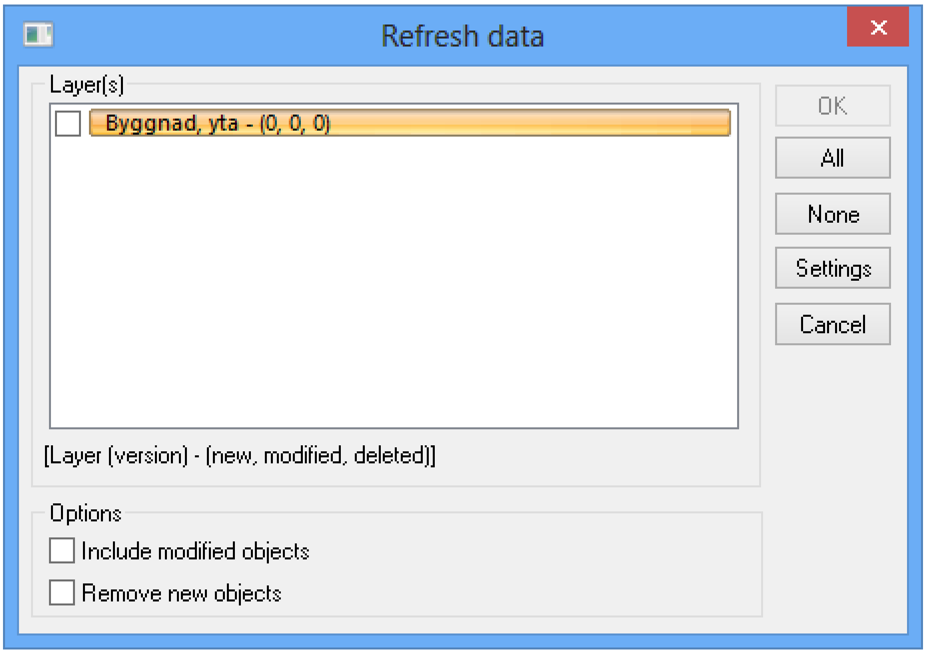


Refresh data



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Reconcile against version. Select layer to reconcile with.

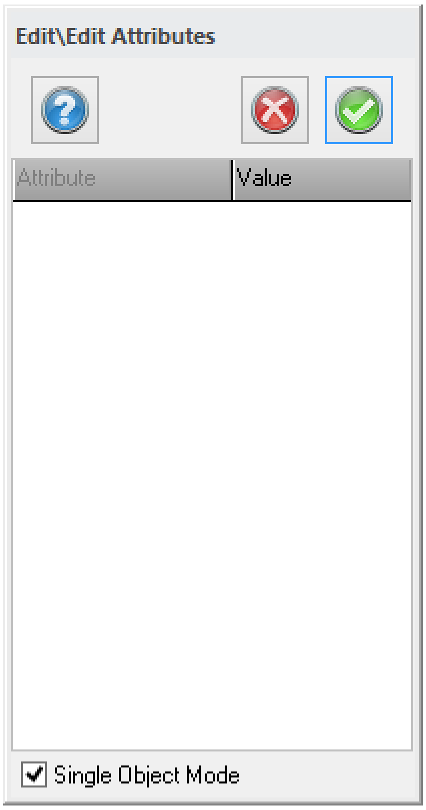
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



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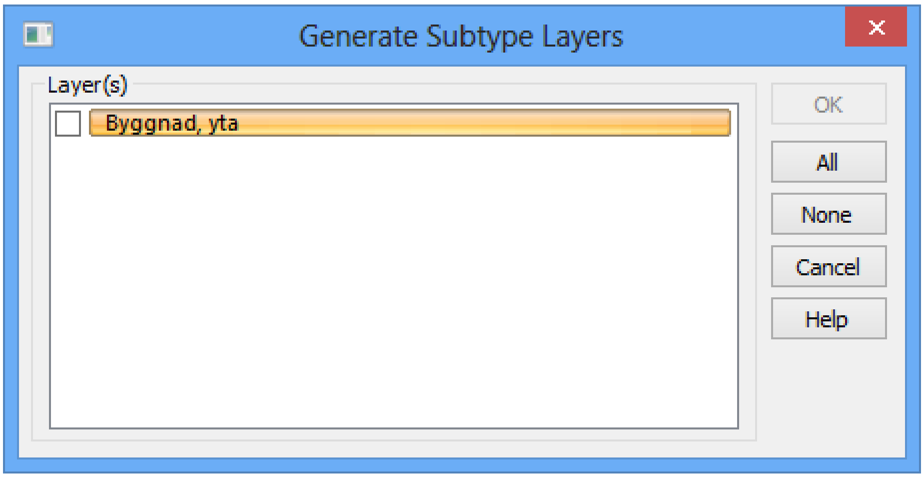

View geographical constraint

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ArcGIS database adapter contents

ArcGIS database adapter

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Save selection	Saves a selection of new or modified objects.
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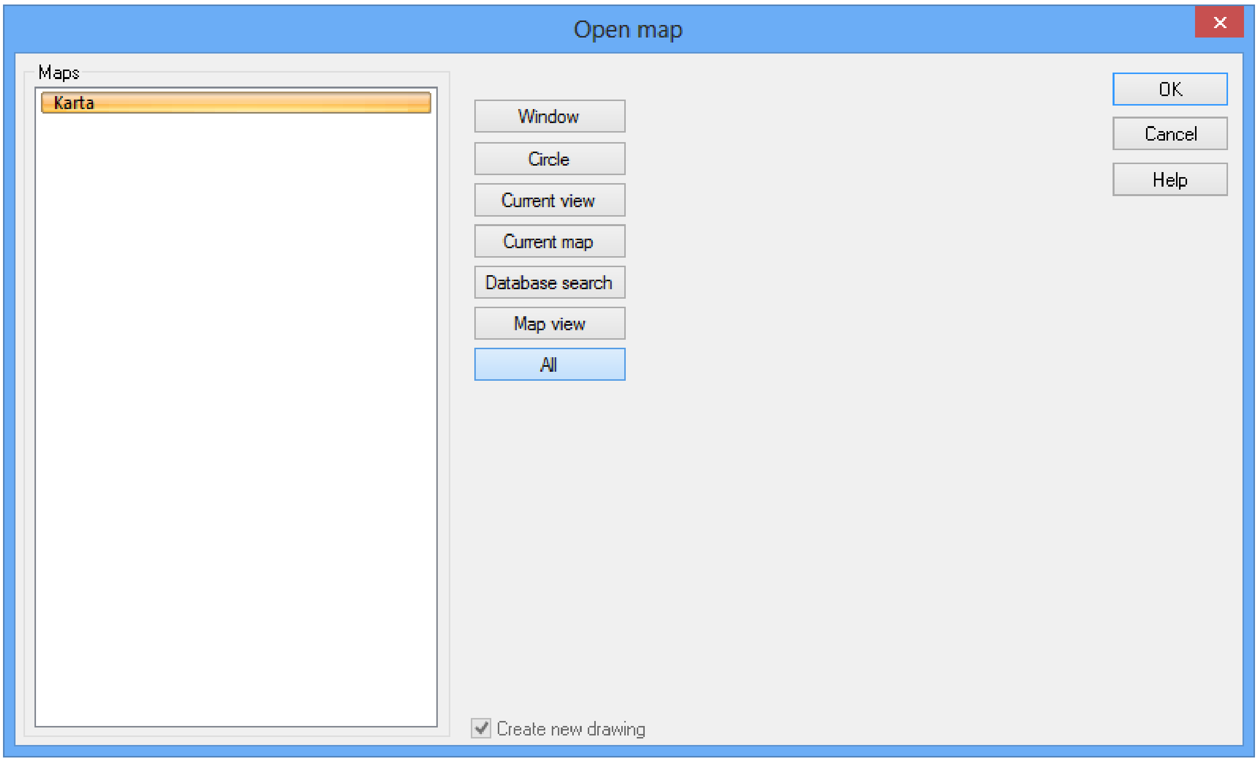
Generate Subtype layers	Move subtypes in a layer to a subtype layer
Geographical Constraint	View Geographical Constraint

Open map



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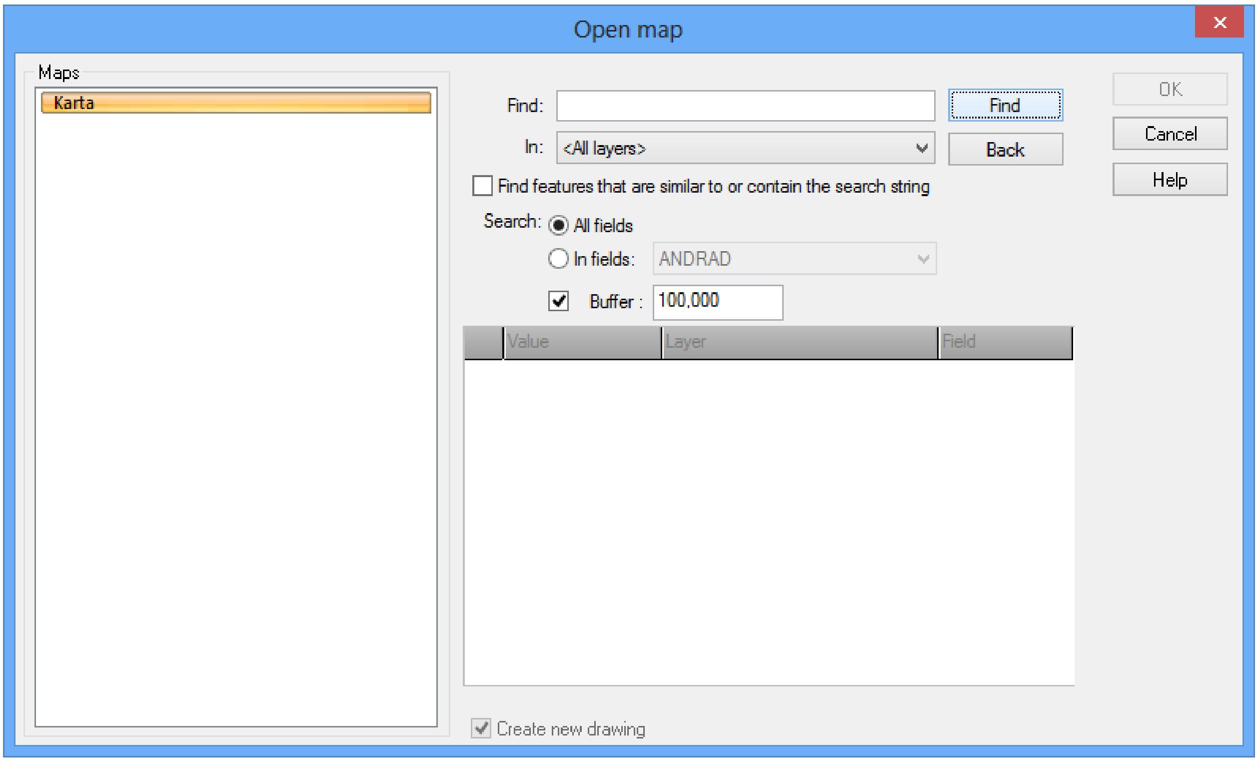
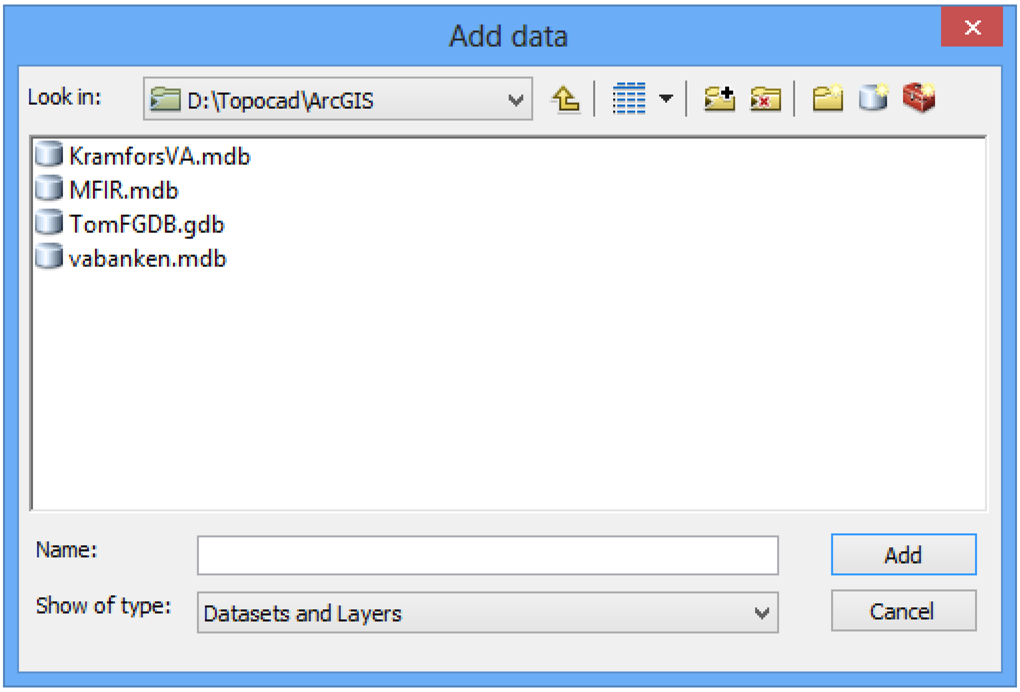


Disconnect

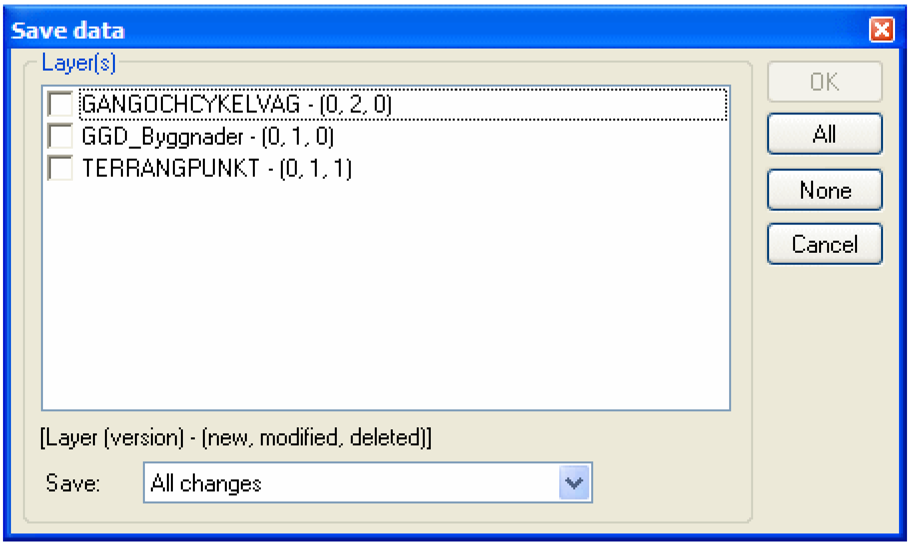
Disconnects the database The Arc license used is not free until you close Topocad.

Add data



Adds data from different layers. An area is selected.

Save data



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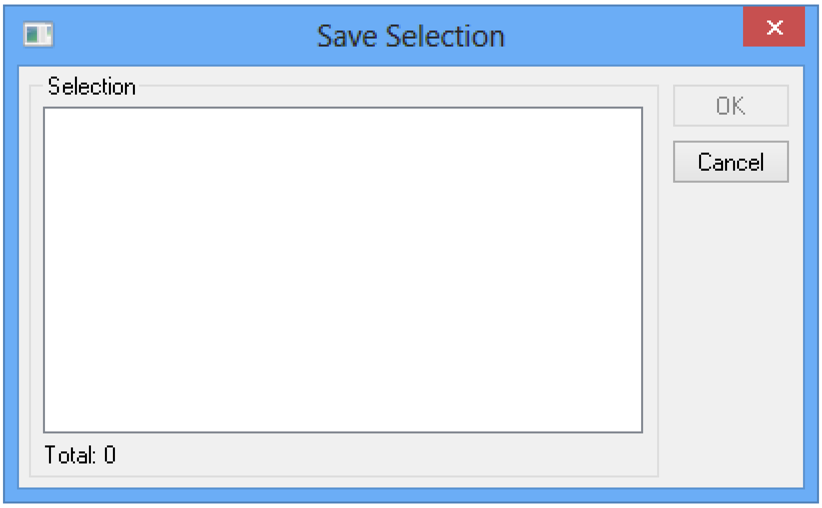
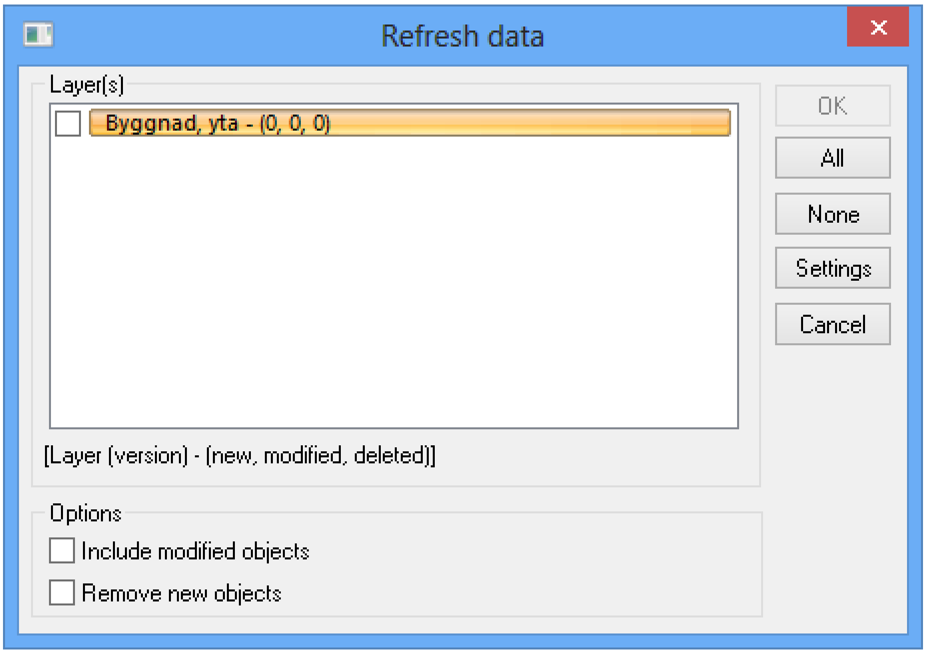


Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

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Reconciles and Posts data to the database.

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Reconcile against version. Select layer to reconcile with.

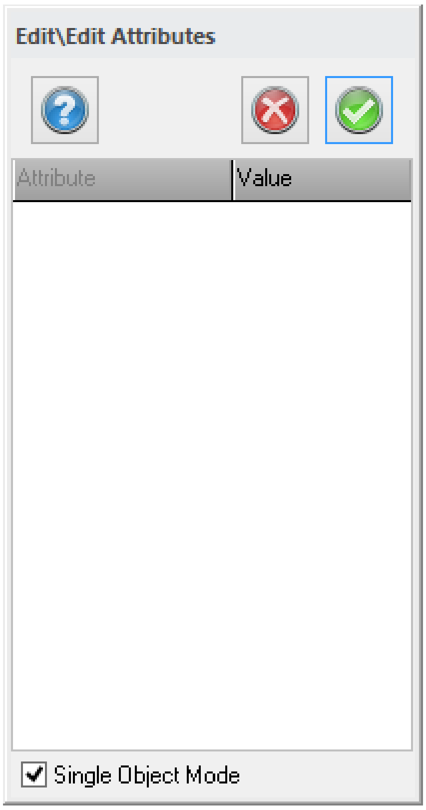
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



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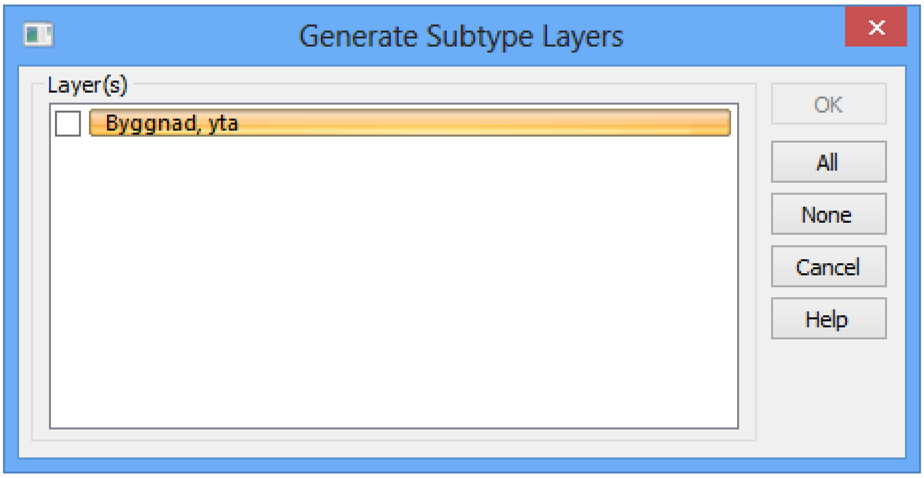

View geographical constraint

Select *Constraint* to activate the command.

ArcGIS database adapter contents

ArcGIS database adapter

Command	Description
Open map	Opens the database for the drawing.
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Save Data	Saves the data
Save selection	Saves a selection of new or modified objects.
Refresh data	Refresh data, load from database
Reconcile and Post (save)	Reconciles and Posts data to the current version of the database.
Version manager	Manages different versions of the database.
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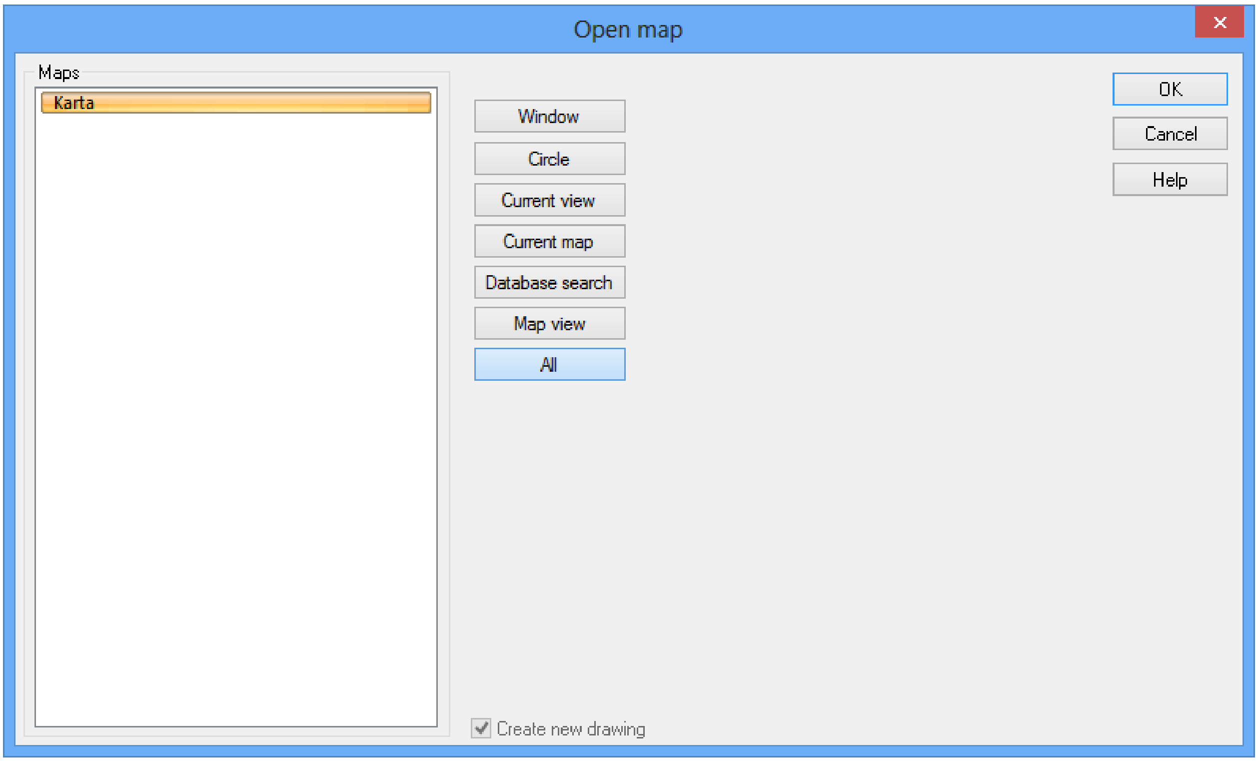
Open map



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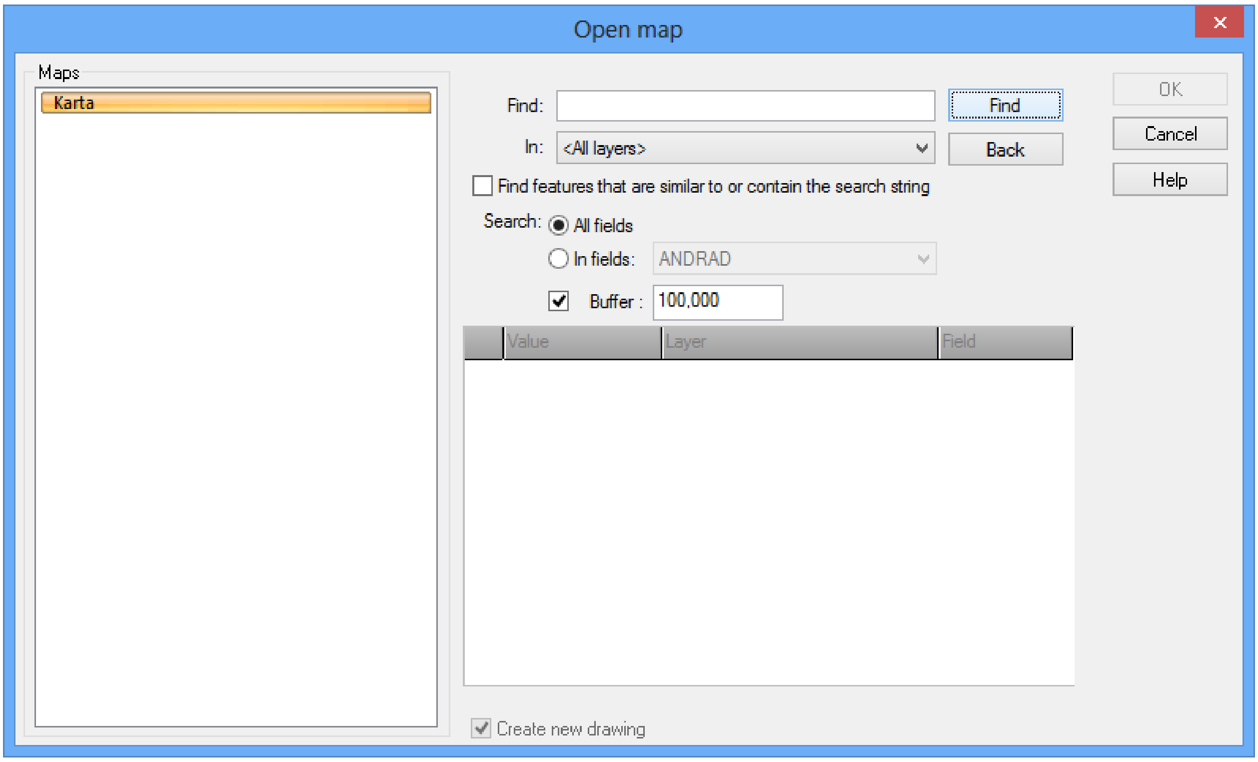

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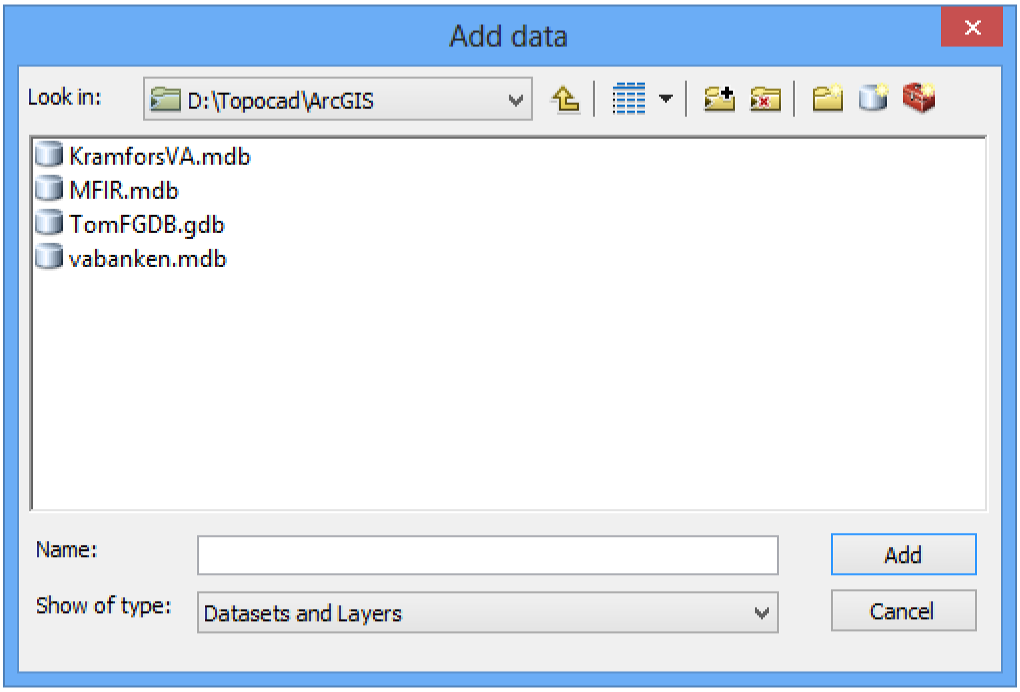

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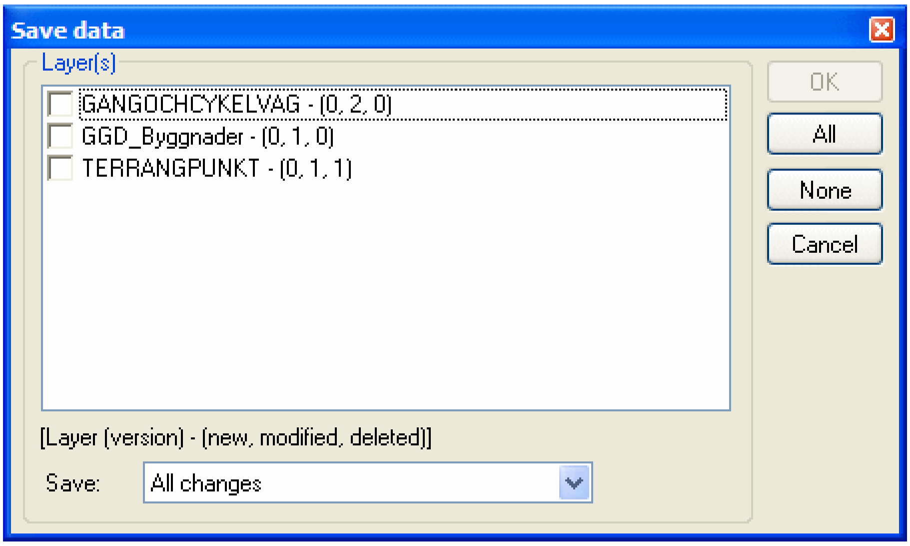

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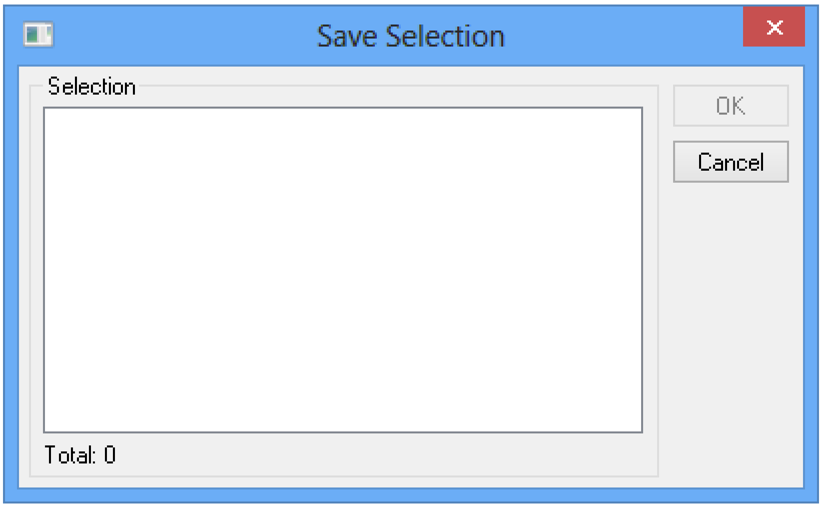
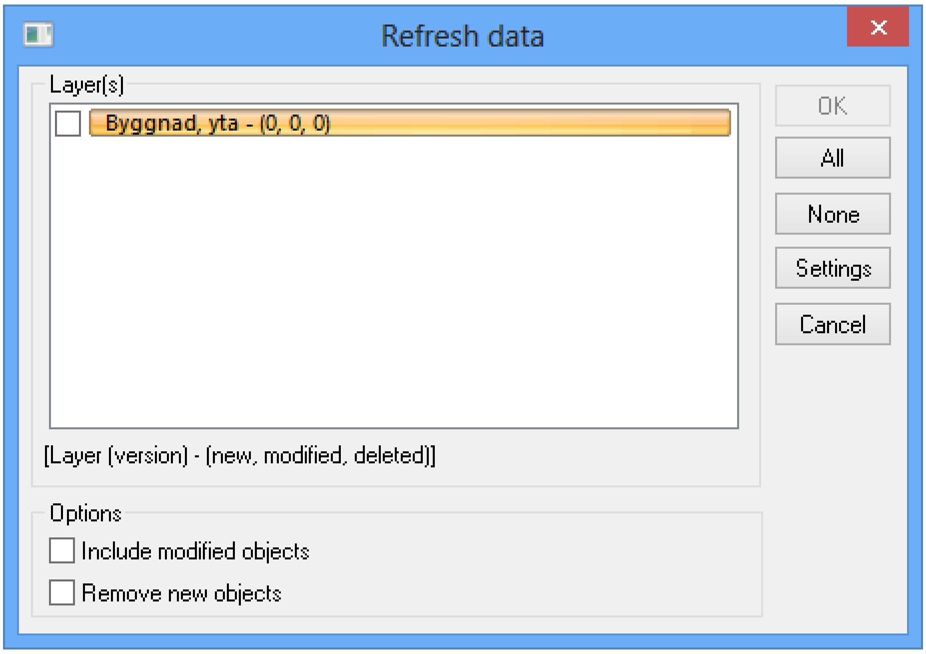


Refresh data



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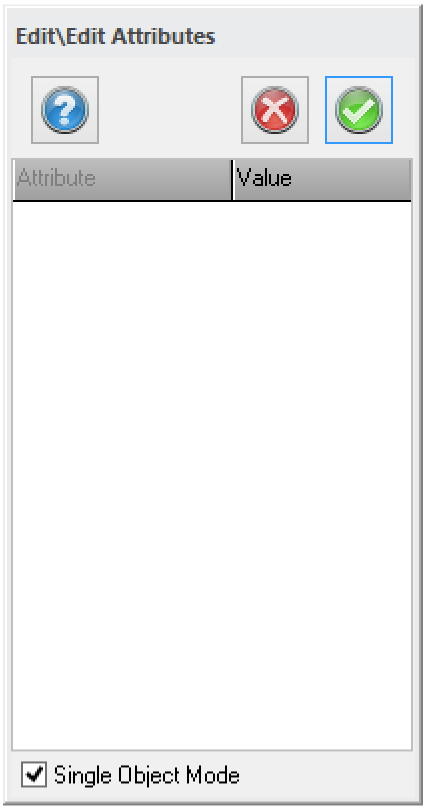

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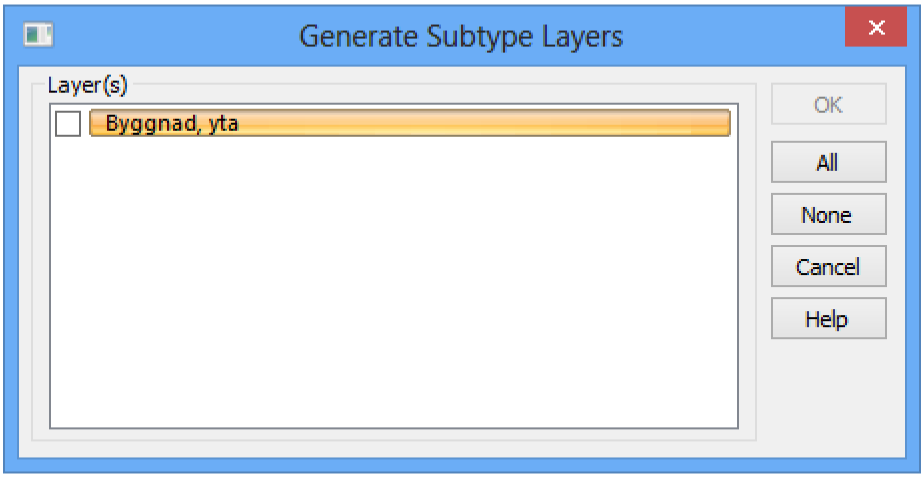

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ArcGIS database adapter contents

ArcGIS database adapter

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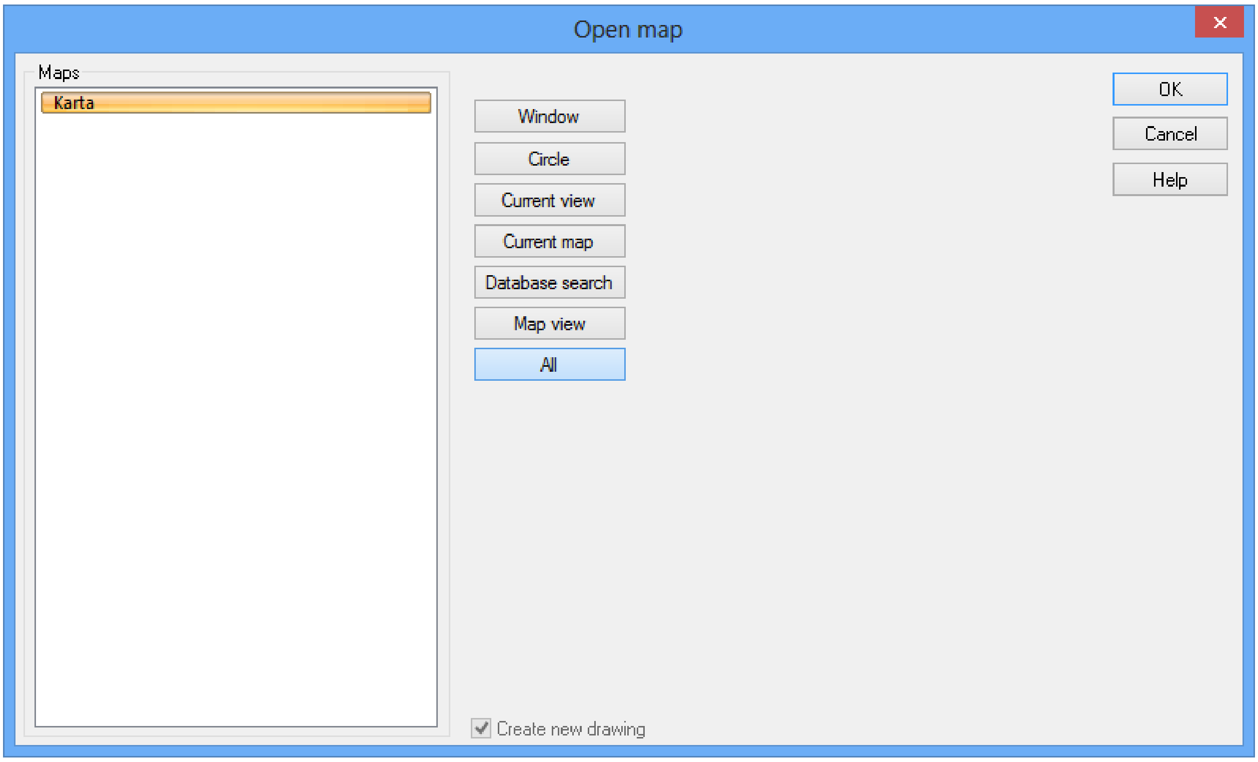
Open map



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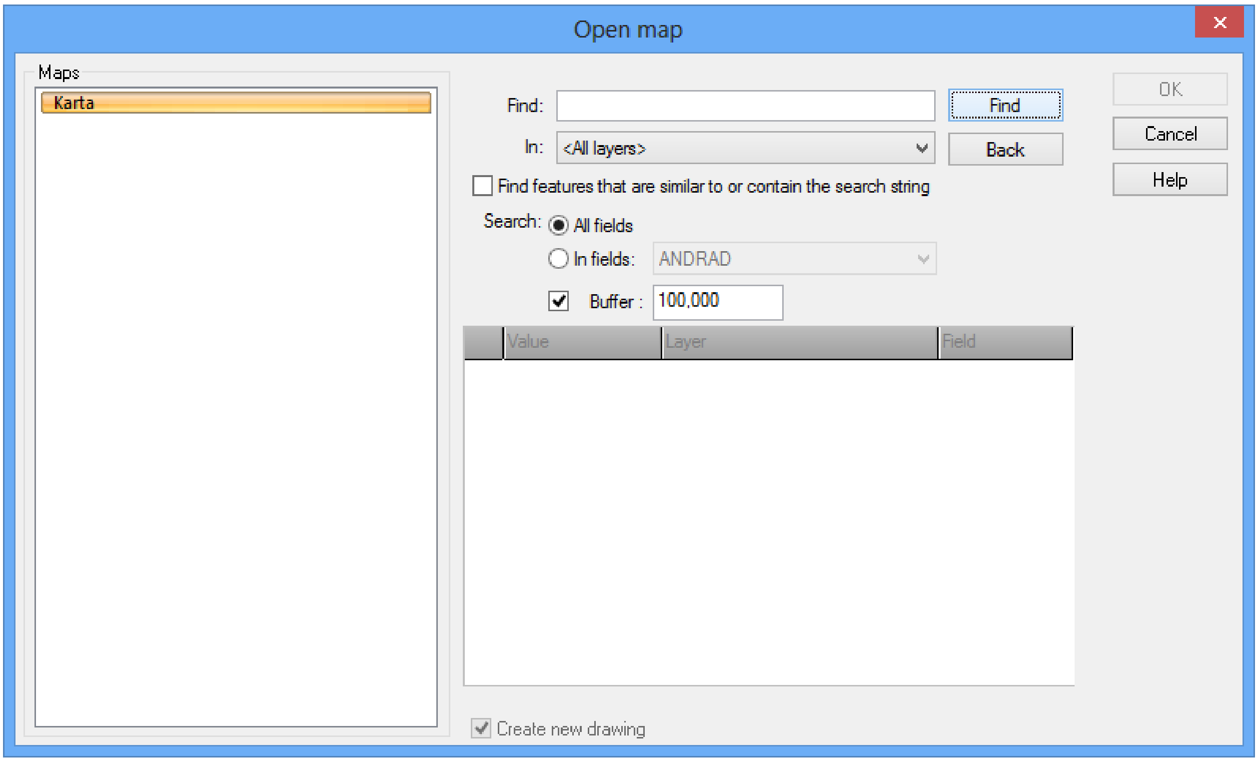

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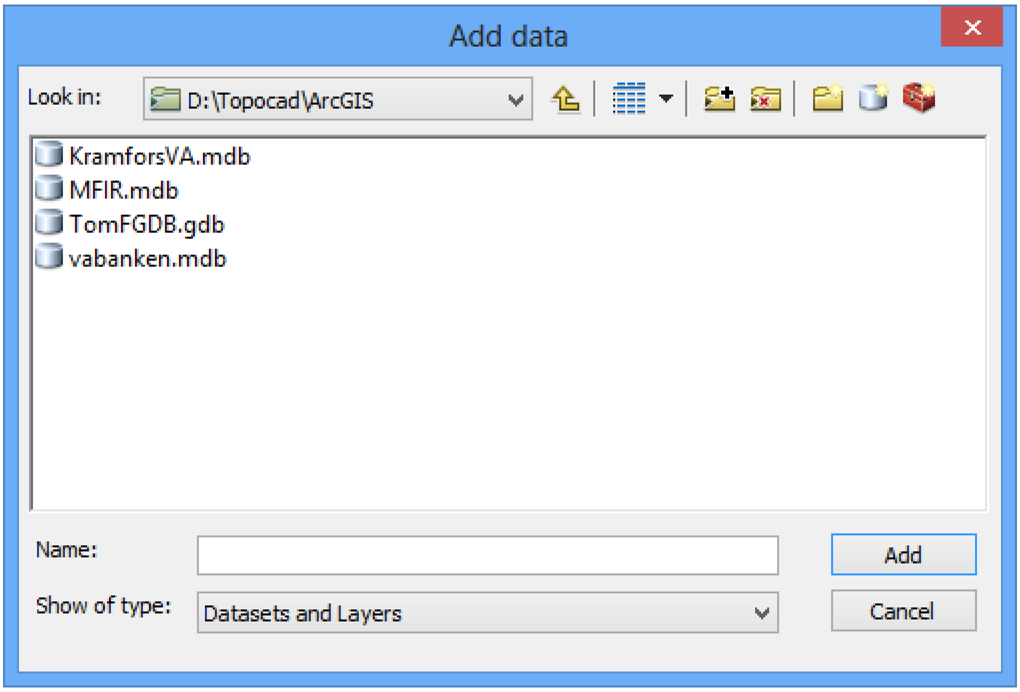

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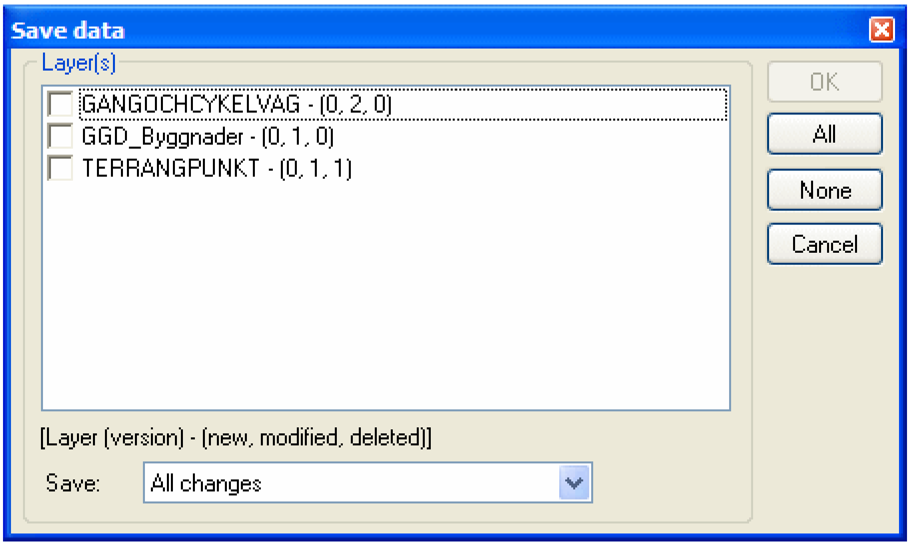

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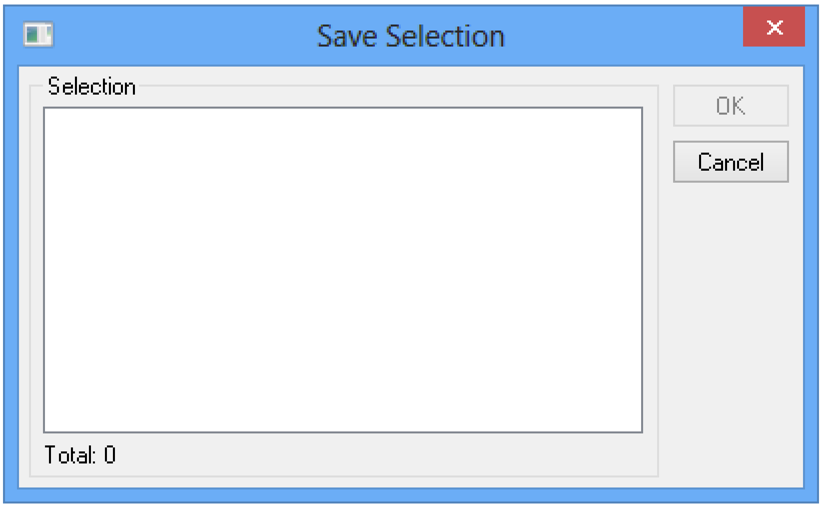

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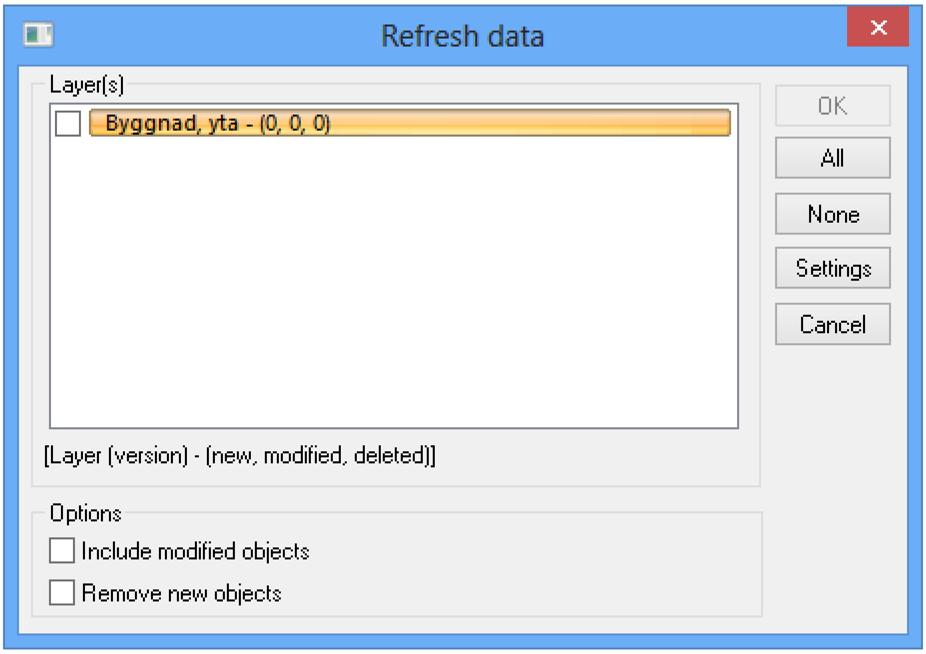

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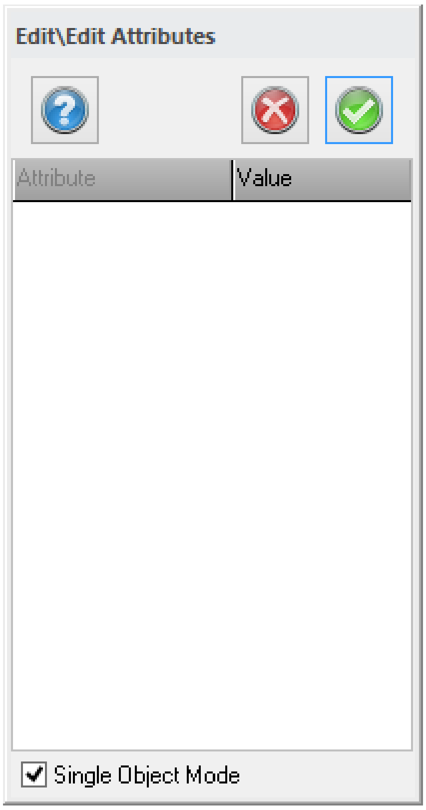

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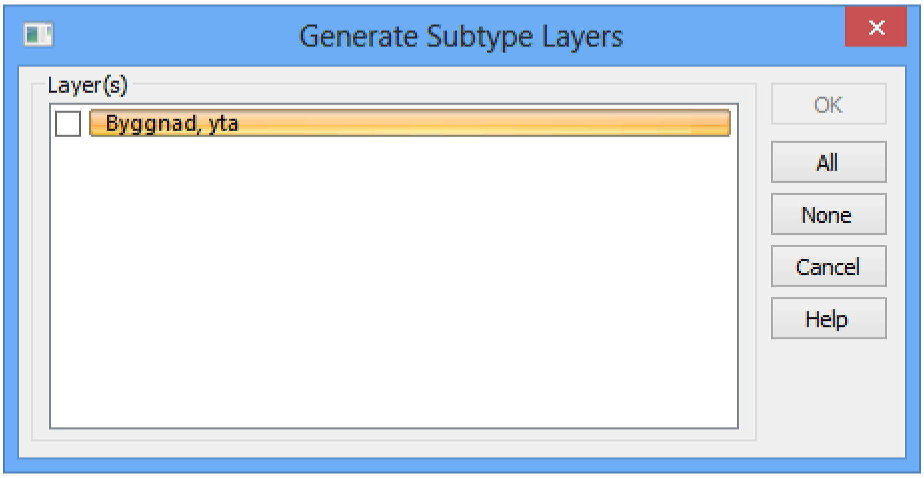

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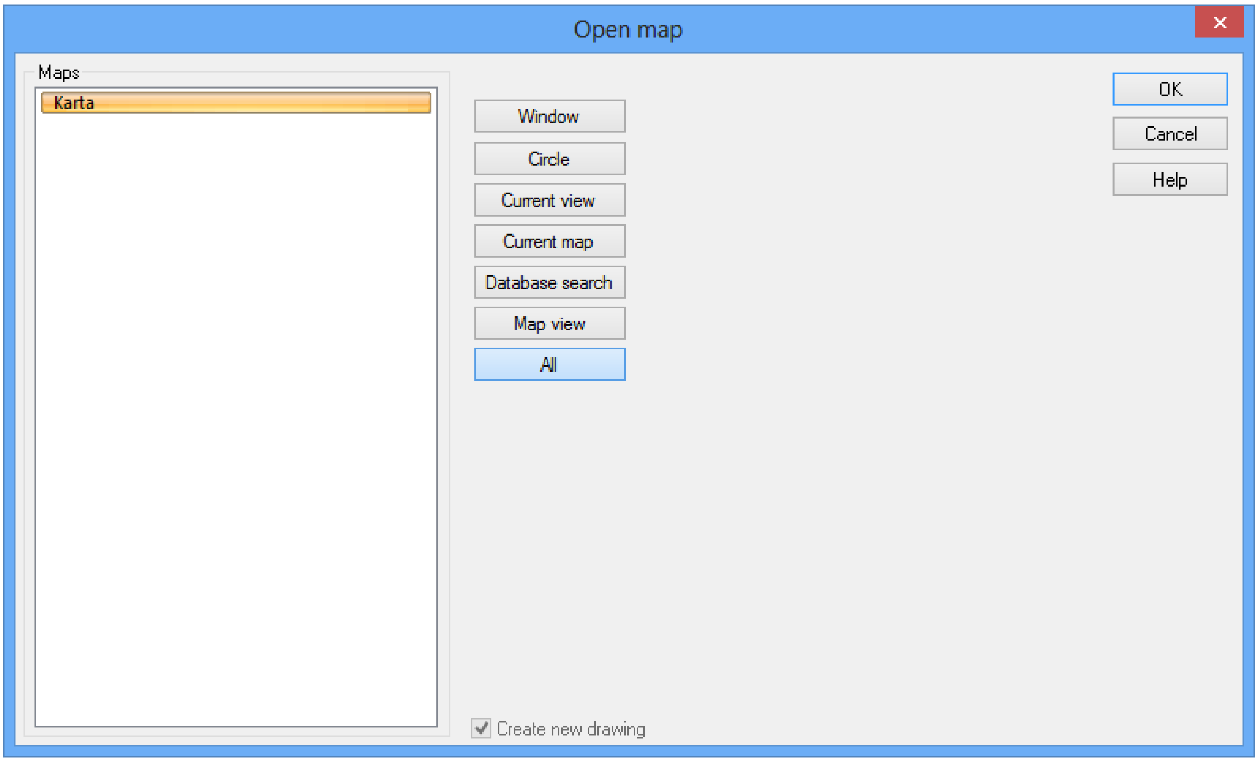
Open map



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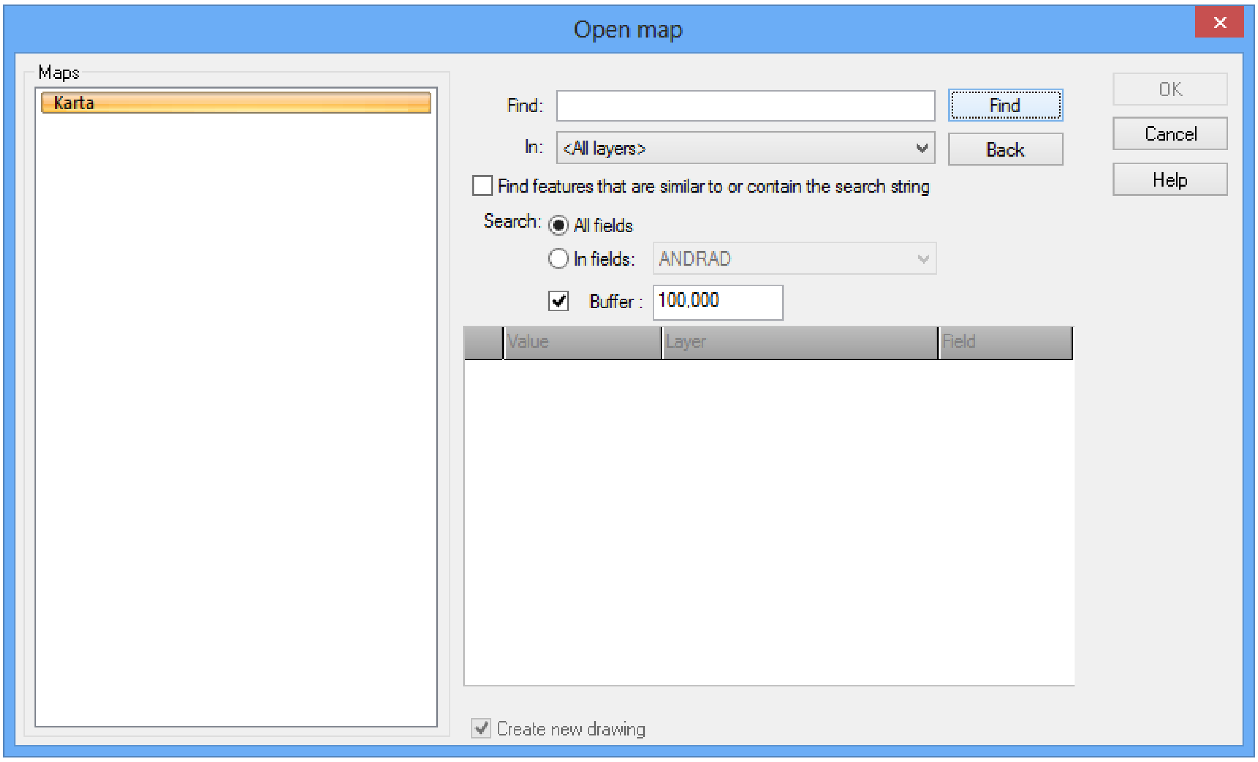
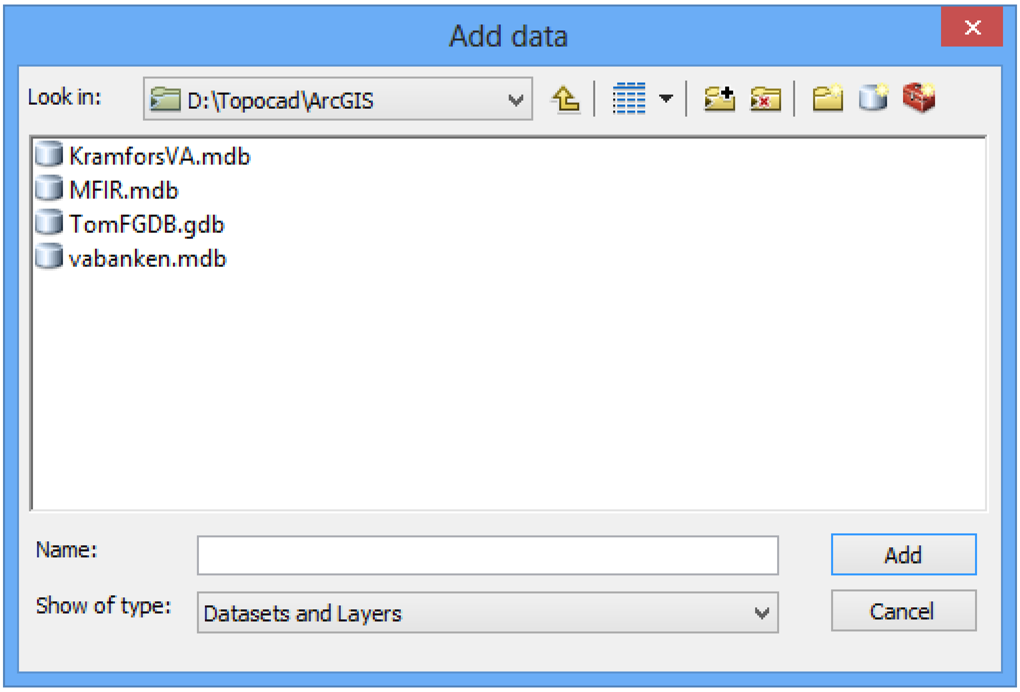


Disconnect

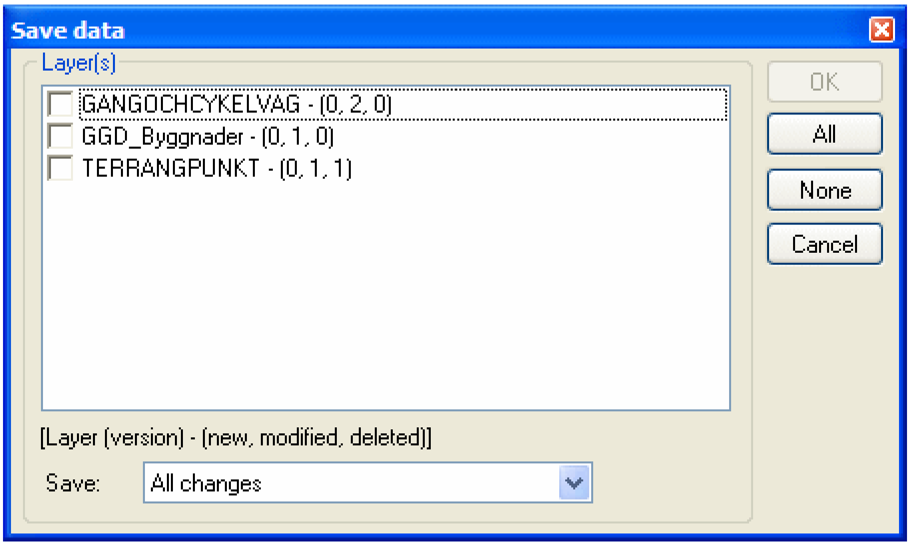
Disconnects the database The Arc license used is not free until you close Topocad.

Add data



Adds data from different layers. An area is selected.

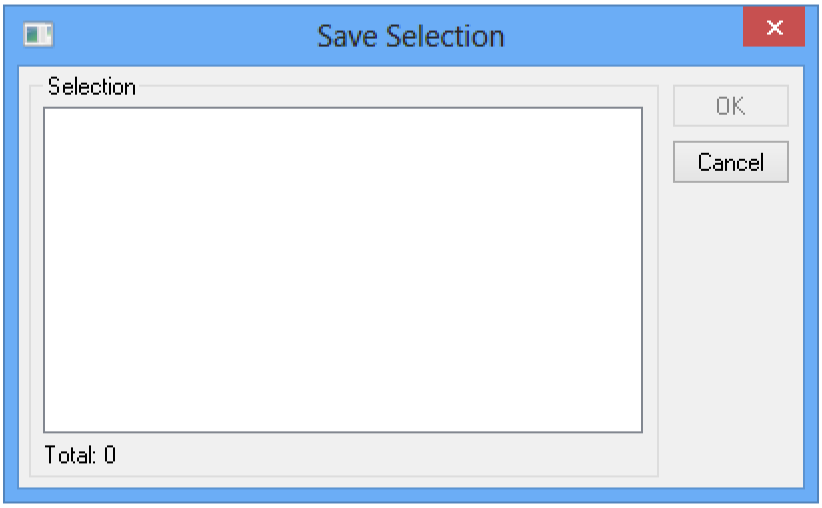
Save data



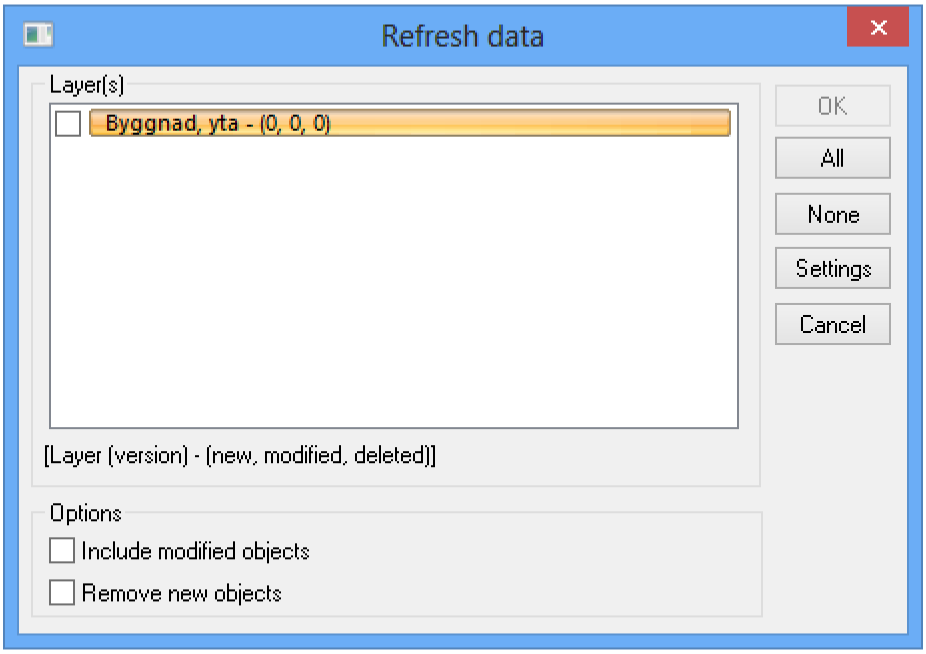
Saves the data. Select from the alternatives All changes, New features only, Modified features only, New and modified features only or Deleted features only.

Save selection

The command allows the user to save a selection of new or modified objects. Deleted object are not able to save.
The dialogue shows concerned layers, how many marked object in each layer and also the total amount of objects that will be saved.



Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

Reconcile and Post

Reconciles and Posts data to the database.

Any layers with differences from the database are displayed in a list. All layers with changes are displayed with three numbers in brackets, e.g. (1, 2, 3), where the first number indicates how many new objects are in this layer, the second number indicates how many changed objects and the third number indicates how many deleted objects - these must be deleted from both the drawing and the database.

Reconcile against version. Select layer to reconcile with.

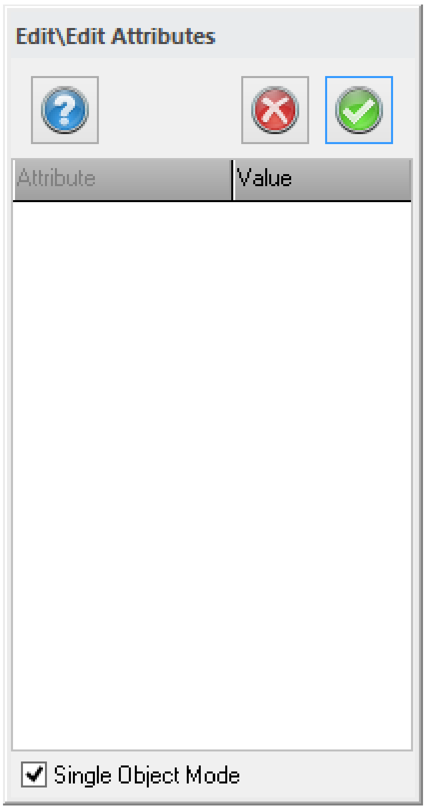
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



Edit attributes handles domains and subtypes.

Group object

Right click on objects and select group object. The object will now appear as one single object.

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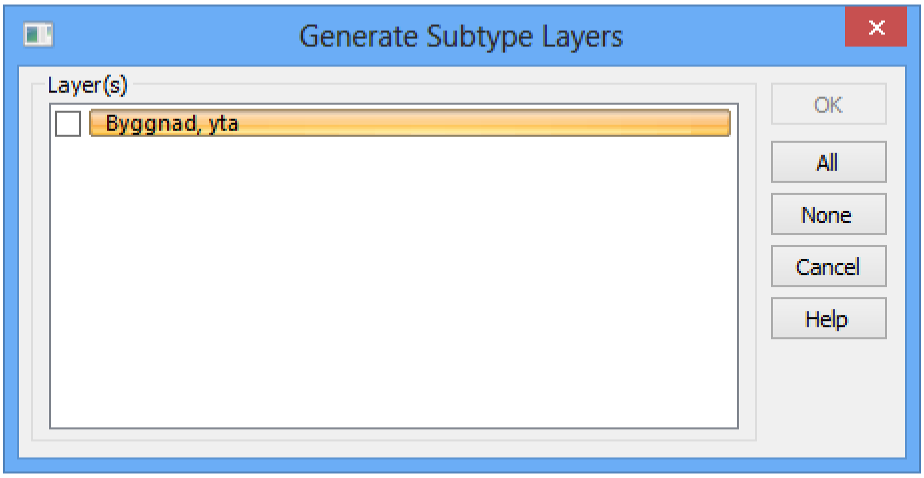
The function moves subtypes in a layer to a subtype layer. The new subtype layer will be named <layer> - <subtype>



View geographical constraint

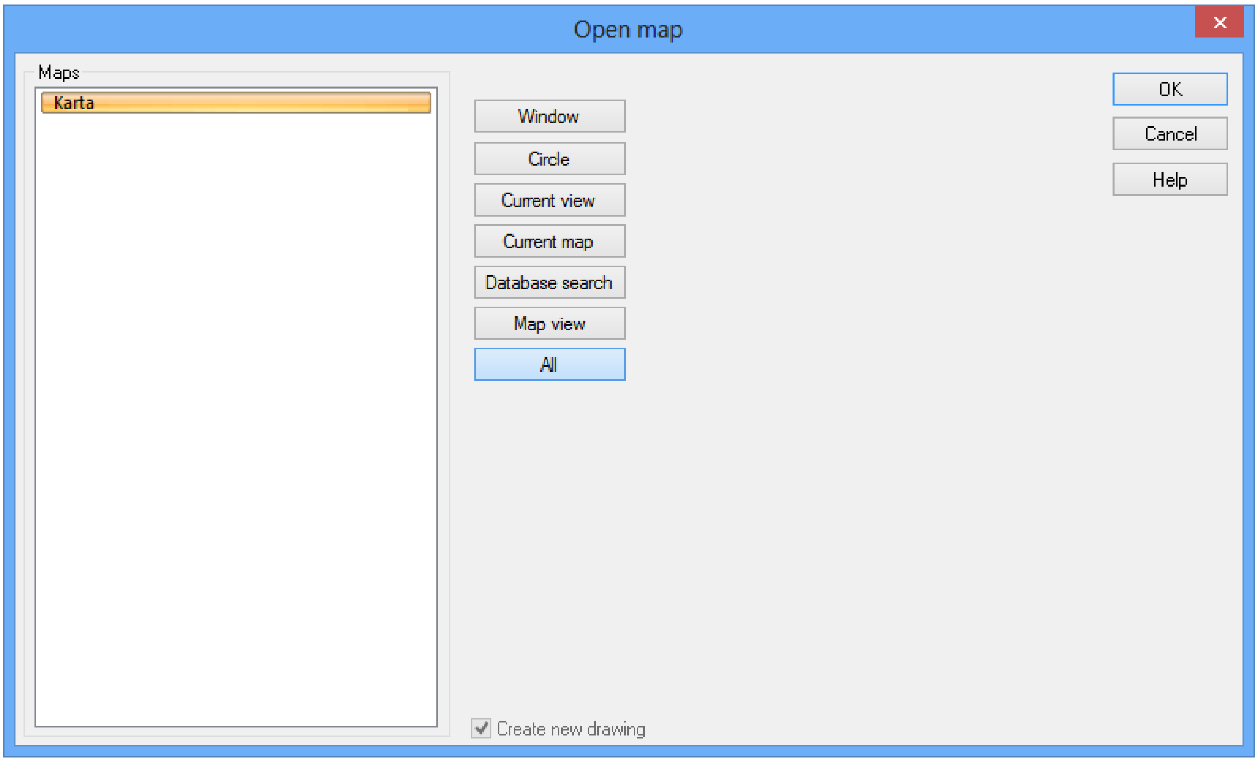
Select *Constraint* to activate the command.

ArcGIS database adapter contents

ArcGIS database adapter

Command	Description
Open map	Opens the database for the drawing.
Disconnect	Disconnects the database
Add Data	Adds data from the database to the drawing.
Save Data	Saves the data
Save selection	Saves a selection of new or modified objects.
Refresh data	Refresh data, load from database
Reconcile and Post (save)	Reconciles and Posts data to the current version of the database.
Version manager	Manages different versions of the database.
Change version	The command allows version change of selected layers
Edit Attributes	Edit attributes handles domains and subtypes.
Group Objects	Command to group single objects into one.
System settings - Arc	Settings - including drawing method etc.
Generate Subtype layers	Move subtypes in a layer to a subtype layer
Geographical Constraint	View Geographical Constraint

Open map

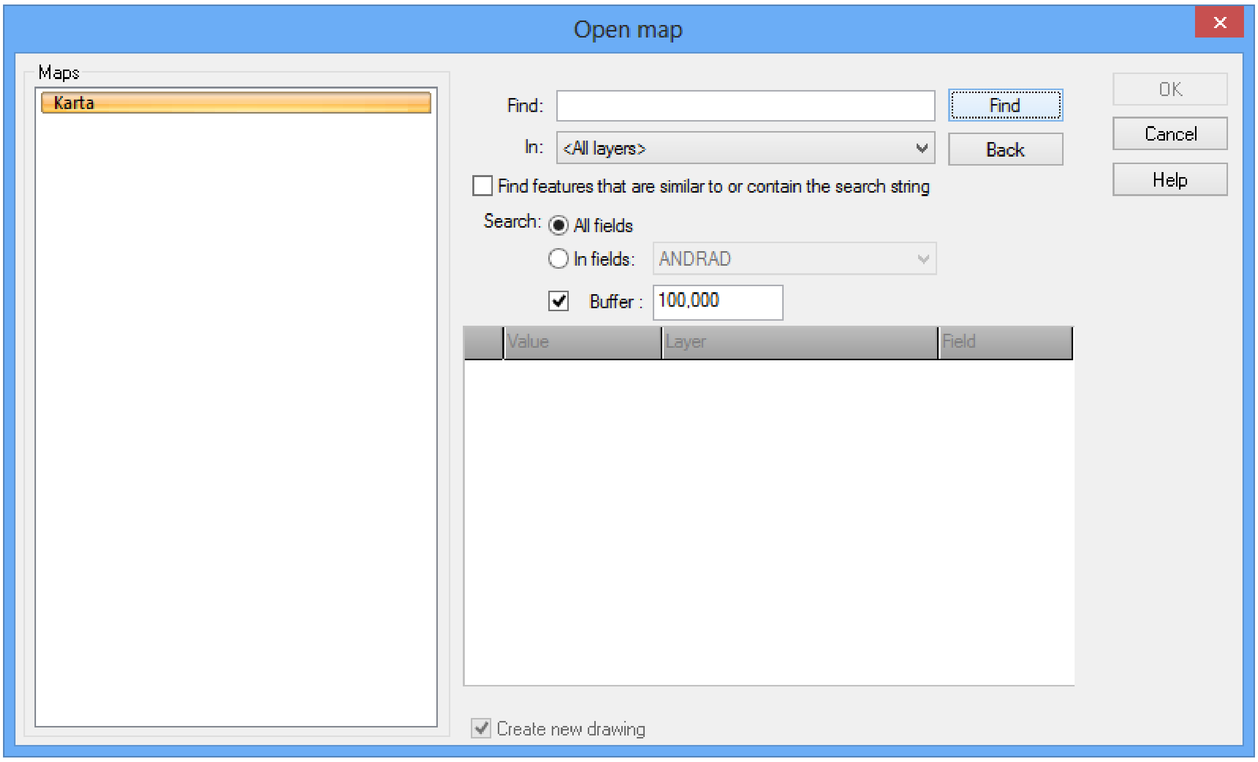


This function opens the map of the selected database.

Open map by database search

Searches can be made from one or more objects in the database and with a buffered zone around these objects. You can also select if you want to open the entire map, the current view (equal to the window that is now open) or by using the window which can either be selected in the drawing or specified by coordinates. When the map opens, the items you searched for will be highlighted.

Find: Search for a value's attribute, for example address or road name.
In: Where to make the search.
Select whether to find features that are similar to or contain the search string
All fields/ In fields: Select if you want to search through All fields or a special field.
Buffer: Default is 100 meters, which opens the map with a radius of 100 meters around the selected attribute.



Disconnect

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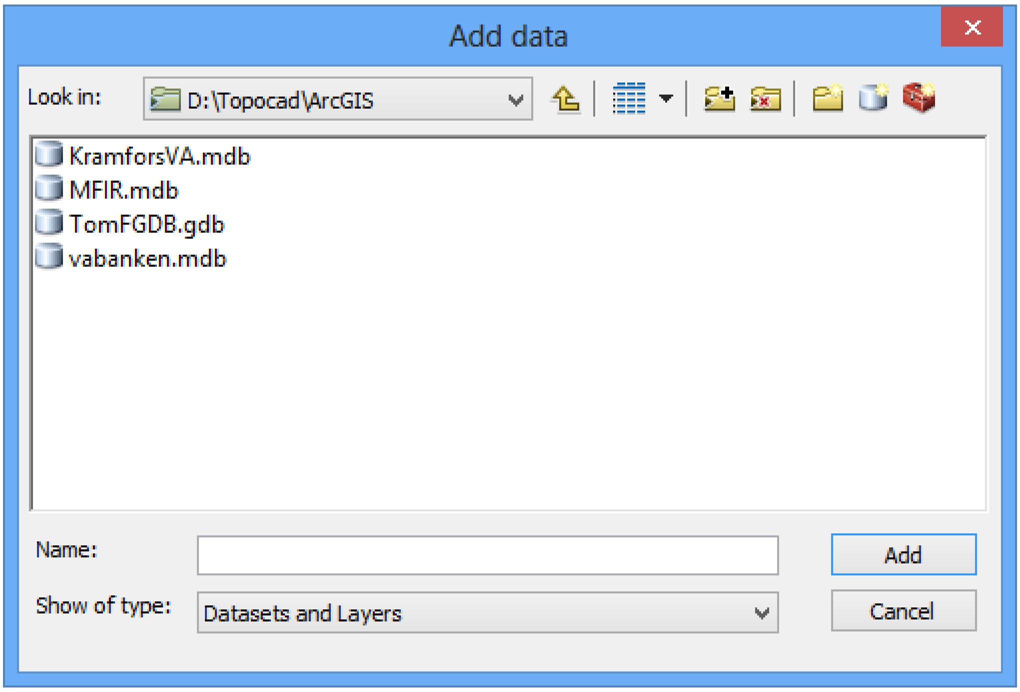
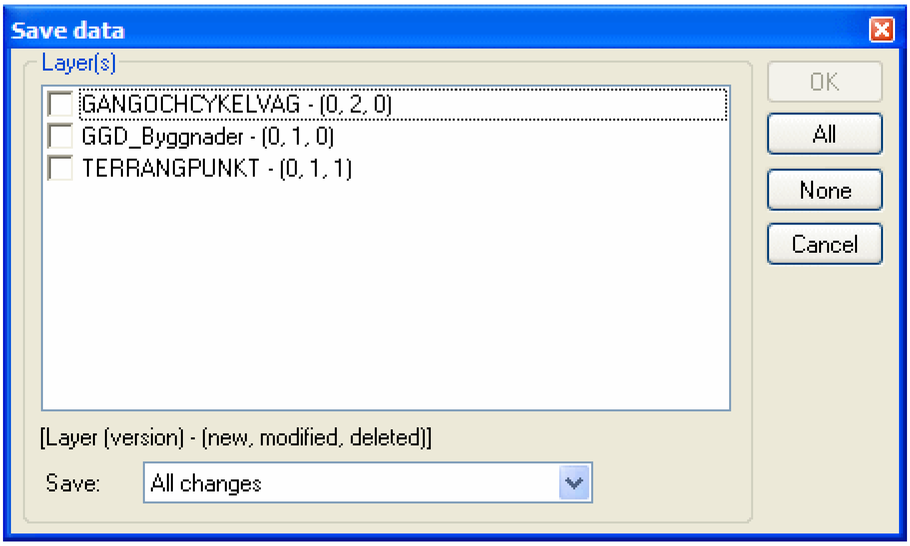
Add data



Adds data from different layers. An area is selected.

Save data



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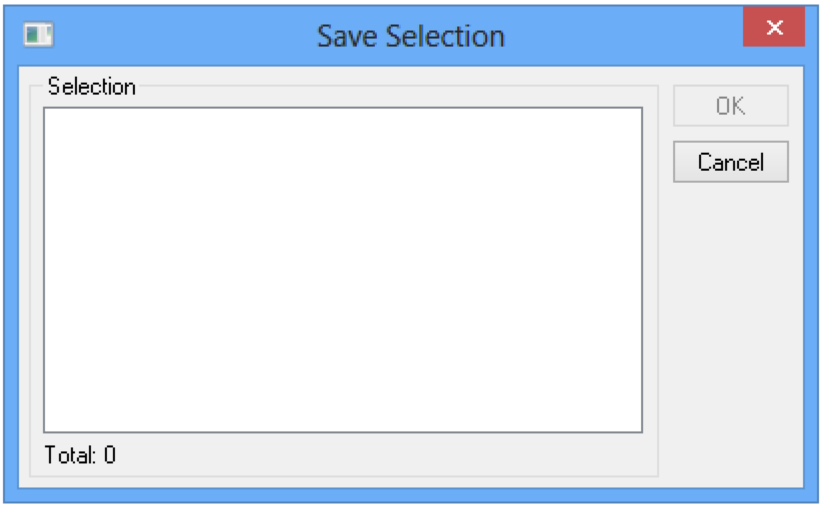
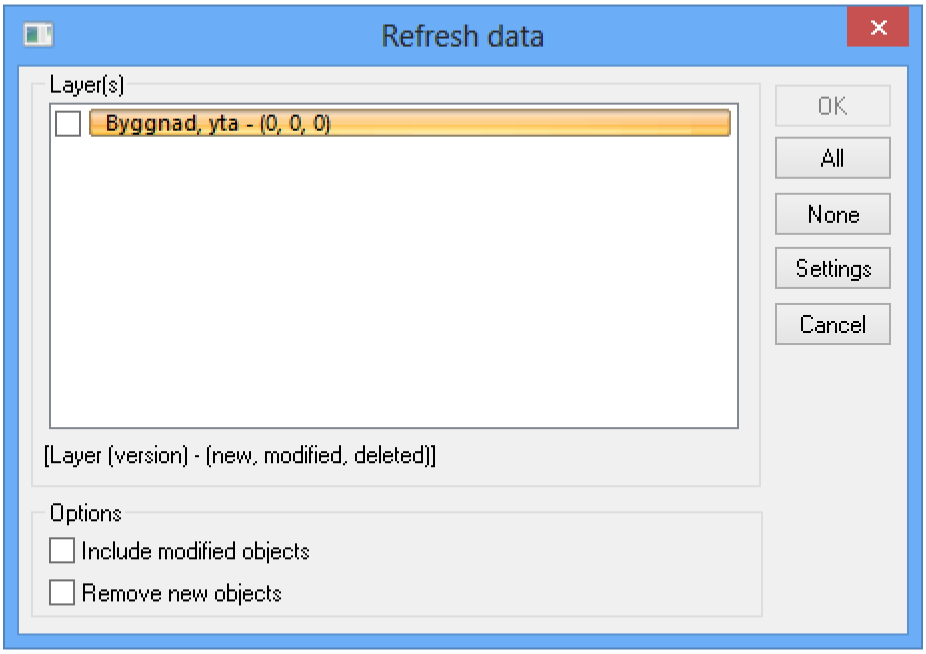


Refresh data



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Any layers with differences from the database are displayed in a list. All layers with changes are displayed with three numbers in brackets, e.g. (1, 2, 3), where the first number indicates how many new objects are in this layer, the second number indicates how many changed objects and the third number indicates how many deleted objects - these must be deleted from both the drawing and the database.

Reconcile against version. Select layer to reconcile with.

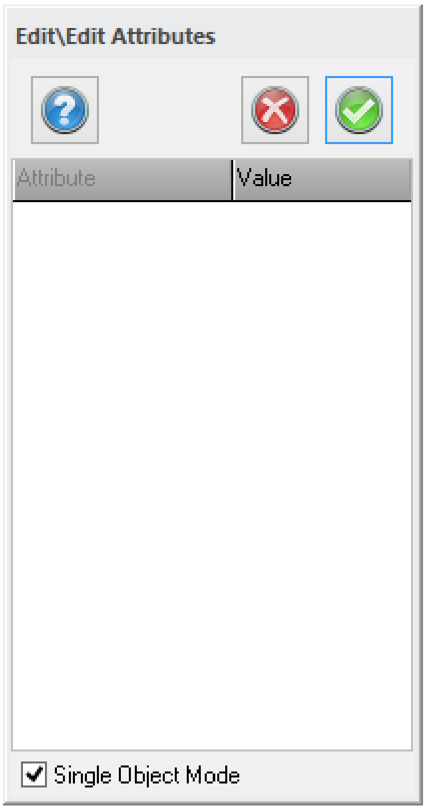
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



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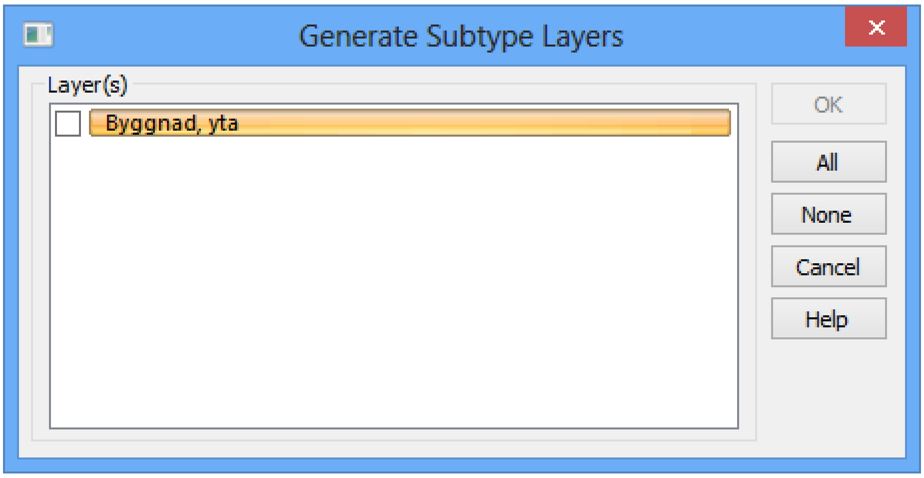

View geographical constraint

Select *Constraint* to activate the command.

ArcGIS database adapter contents

ArcGIS database adapter

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Open map	Opens the database for the drawing.
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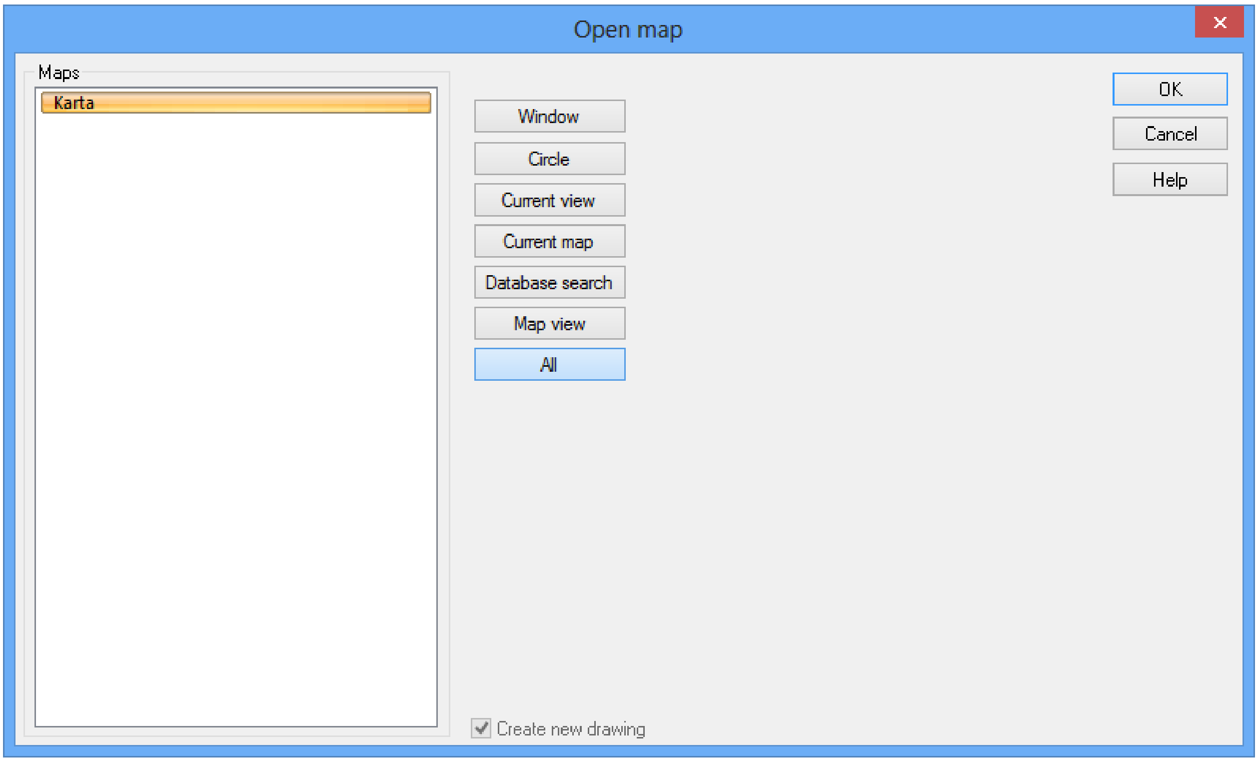
Add Data	Adds data from the database to the drawing.
Save Data	Saves the data
Save selection	Saves a selection of new or modified objects.
Refresh data	Refresh data, load from database
Reconcile and Post (save)	Reconciles and Posts data to the current version of the database.
Version manager	Manages different versions of the database.
Change version	The command allows version change of selected layers
Edit Attributes	Edit attributes handles domains and subtypes.
Group Objects	Command to group single objects into one.
System settings - Arc	Settings - including drawing method etc.
Generate Subtype layers	Move subtypes in a layer to a subtype layer
Geographical Constraint	View Geographical Constraint

Open map



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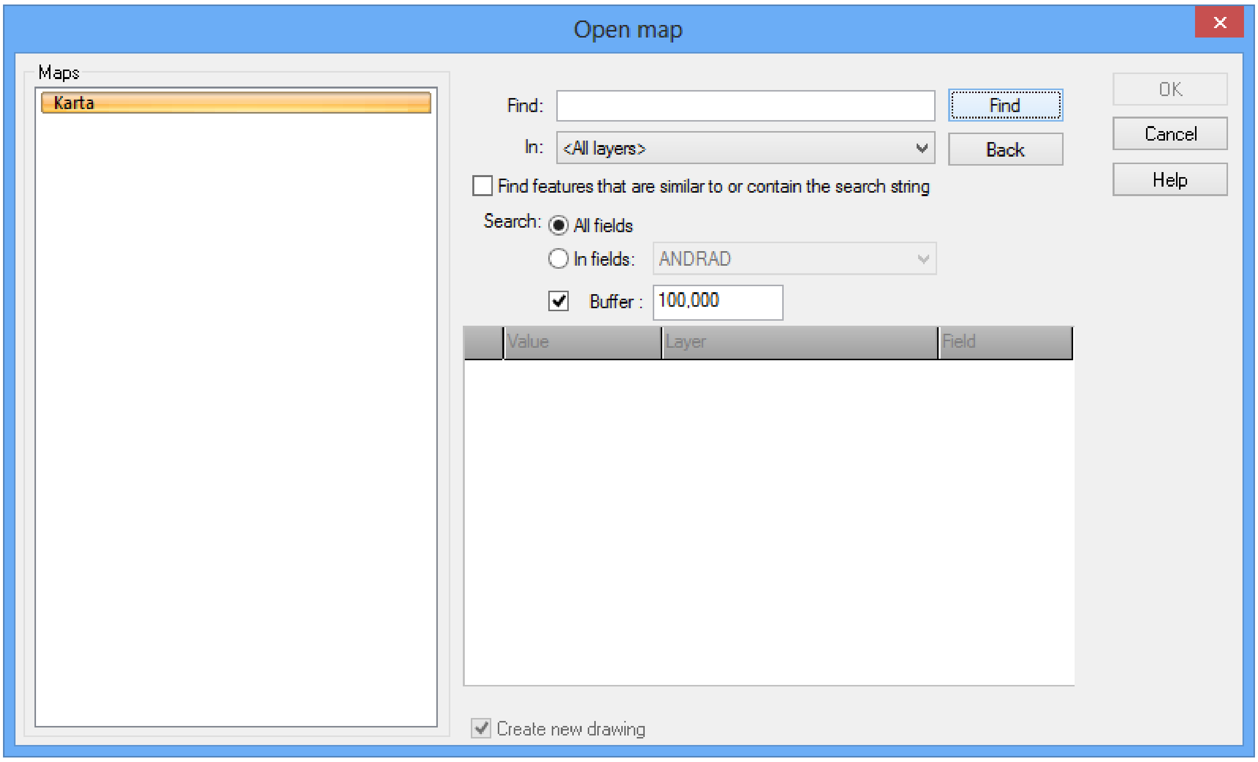
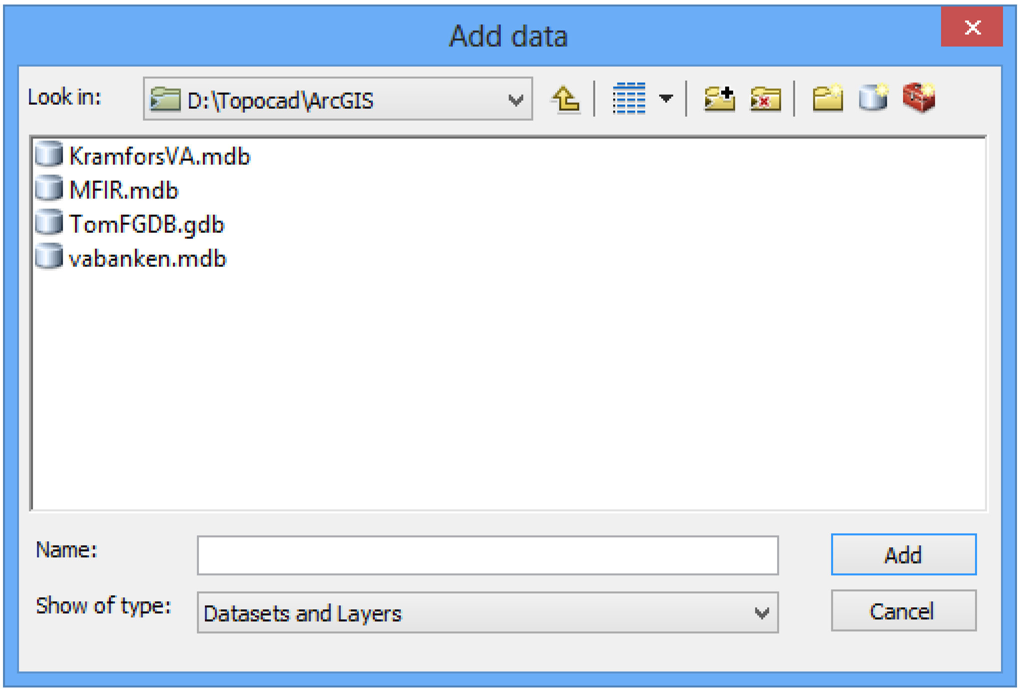


Disconnect

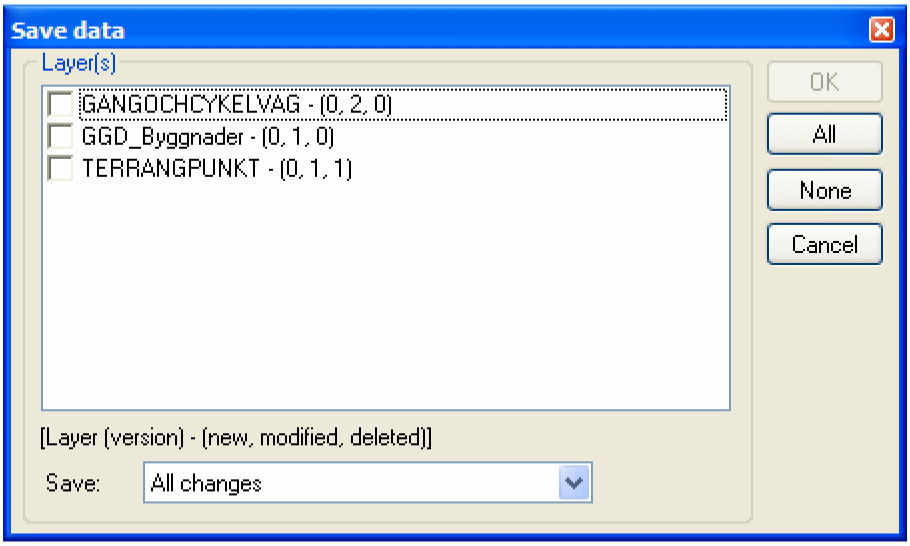
Disconnects the database The Arc license used is not free until you close Topocad.

Add data



Adds data from different layers. An area is selected.

Save data



Saves the data. Select from the alternatives All changes, New features only, Modified features only, New and modified features only or Deleted features only.

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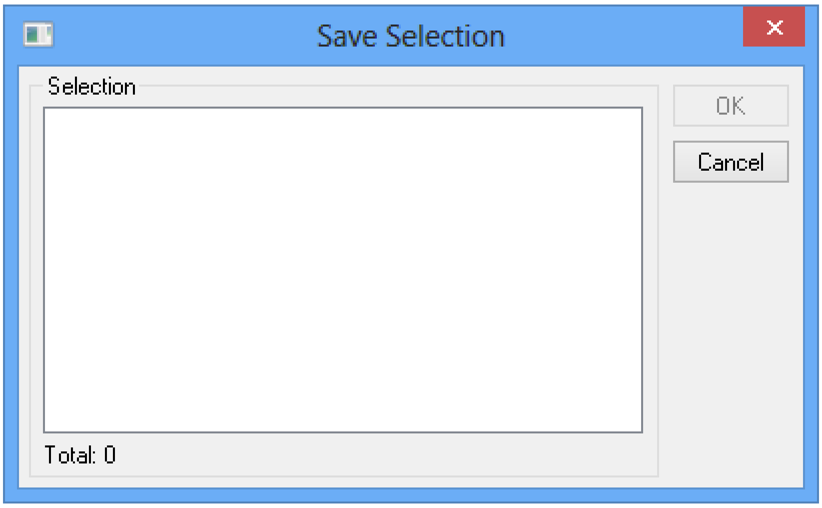
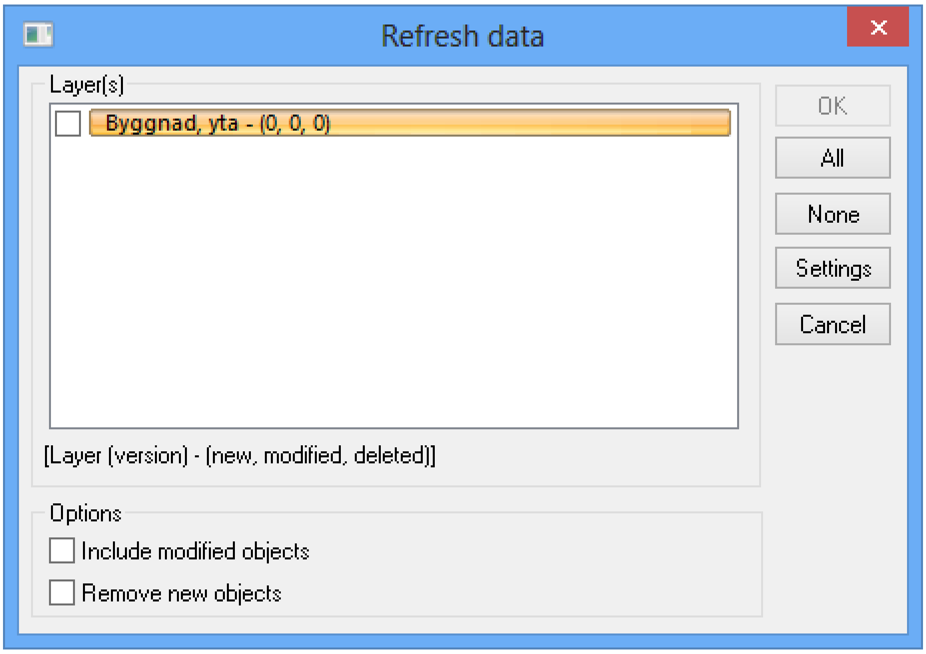


Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

Reconcile and Post

Reconciles and Posts data to the database.

Any layers with differences from the database are displayed in a list. All layers with changes are displayed with three numbers in brackets, e.g. (1, 2, 3), where the first number indicates how many new objects are in this layer, the second number indicates how many changed objects and the third number indicates how many deleted objects - these must be deleted from both the drawing and the database.

Reconcile against version. Select layer to reconcile with.

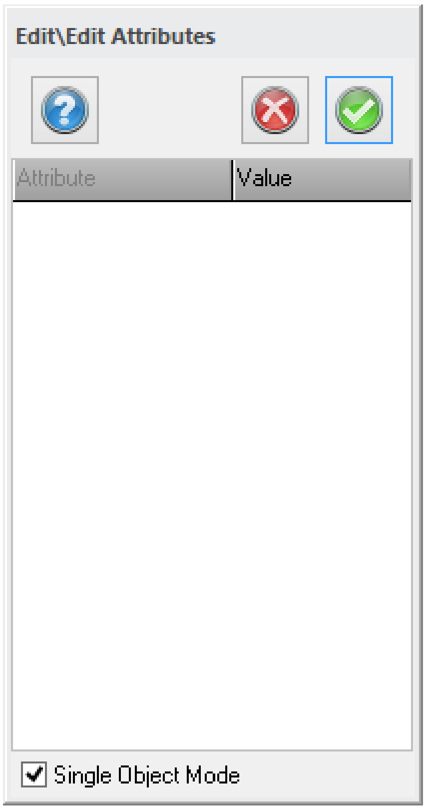
Version manager

A list of different versions of the database. New versions can be created by right clicking.

Change version

The command allows version change of selected layers. All changes of existing objects will be deleted. New object will not be affected.

Edit Attributes



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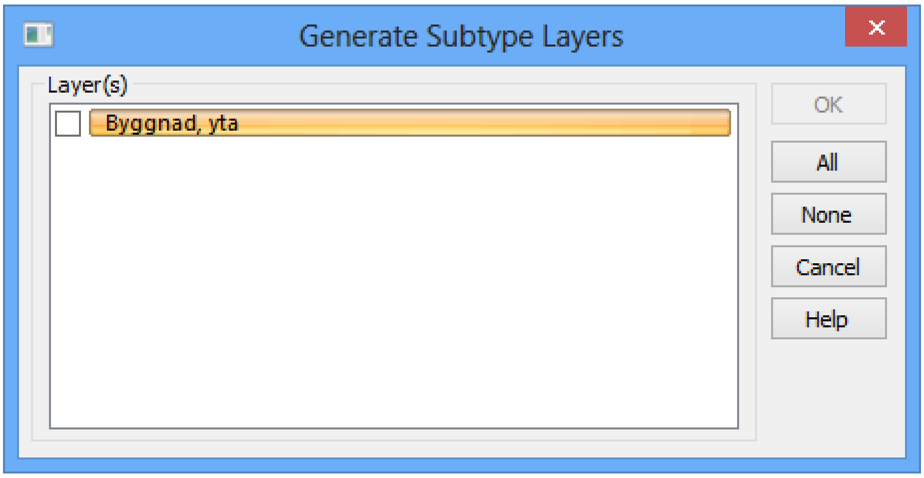

View geographical constraint

Select *Constraint* to activate the command.

ArcGIS database adapter contents

ArcGIS database adapter

Command	Description
Open map	Opens the database for the drawing.
Disconnect	Disconnects the database
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Save Data	Saves the data
Save selection	Saves a selection of new or modified objects.
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Reconcile and Post (save)	Reconciles and Posts data to the current version of the database.
Version manager	Manages different versions of the database.
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Edit Attributes	Edit attributes handles domains and subtypes.
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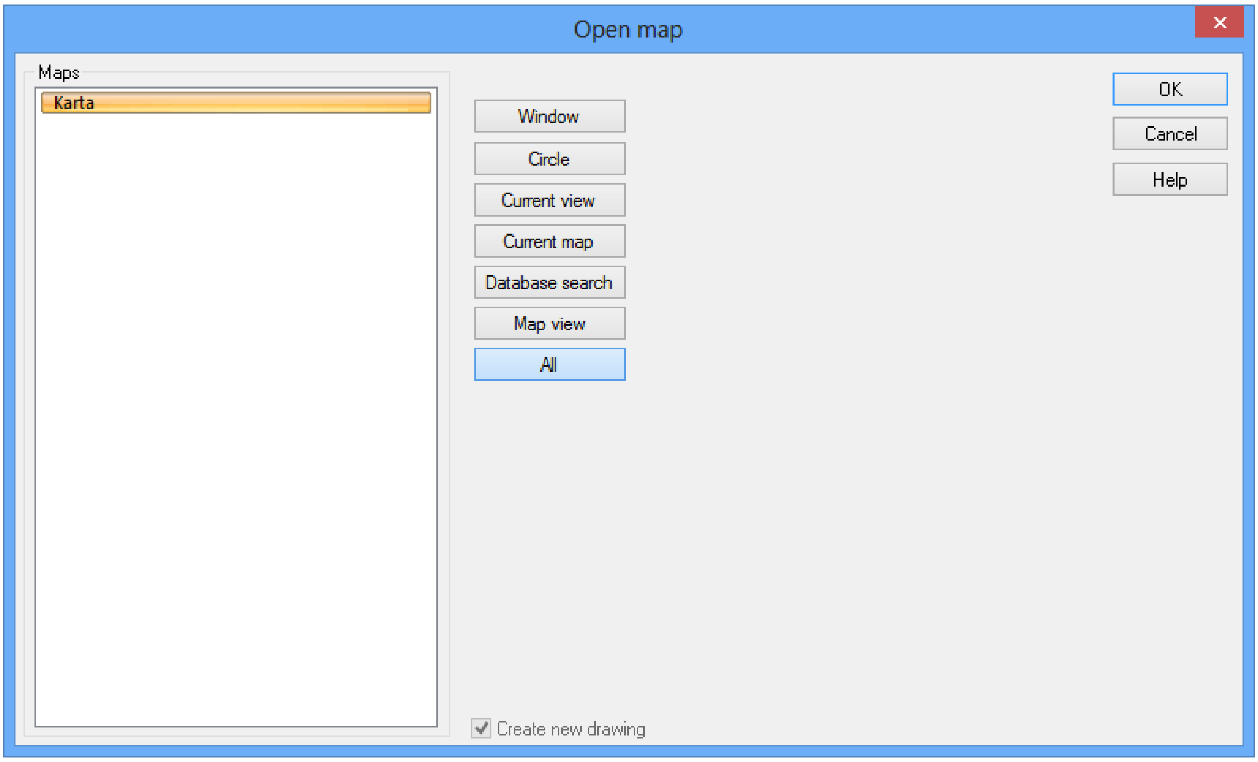
System settings - Arc	Settings - including drawing method etc.
Generate Subtype layers	Move subtypes in a layer to a subtype layer
Geographical Constraint	View Geographical Constraint

Open map



This function opens the map of the selected database.

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Searches can be made from one or more objects in the database and with a buffered zone around these objects. You can also select if you want to open the entire map, the current view (equal to the window that is now open) or by using the window which can either be selected in the drawing or specified by coordinates. When the map opens, the items you searched for will be highlighted.

Find: Search for a value's attribute, for example address or road name.
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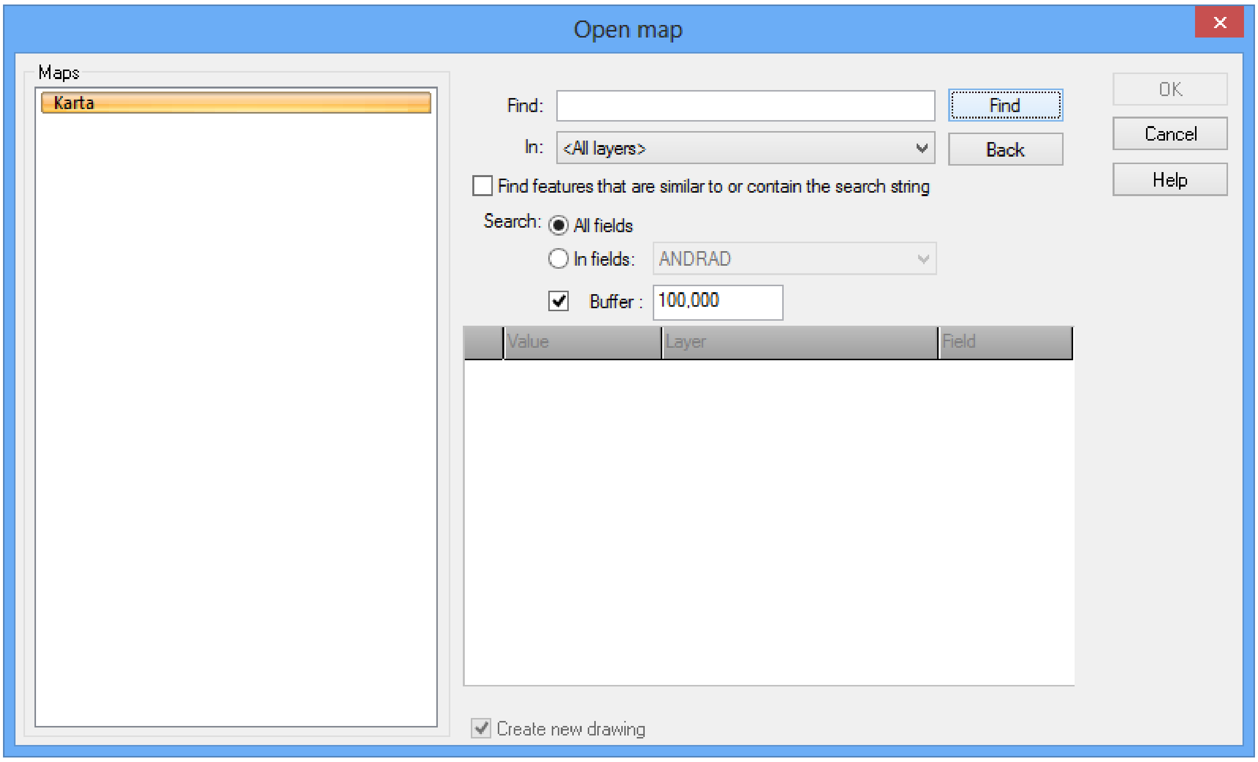

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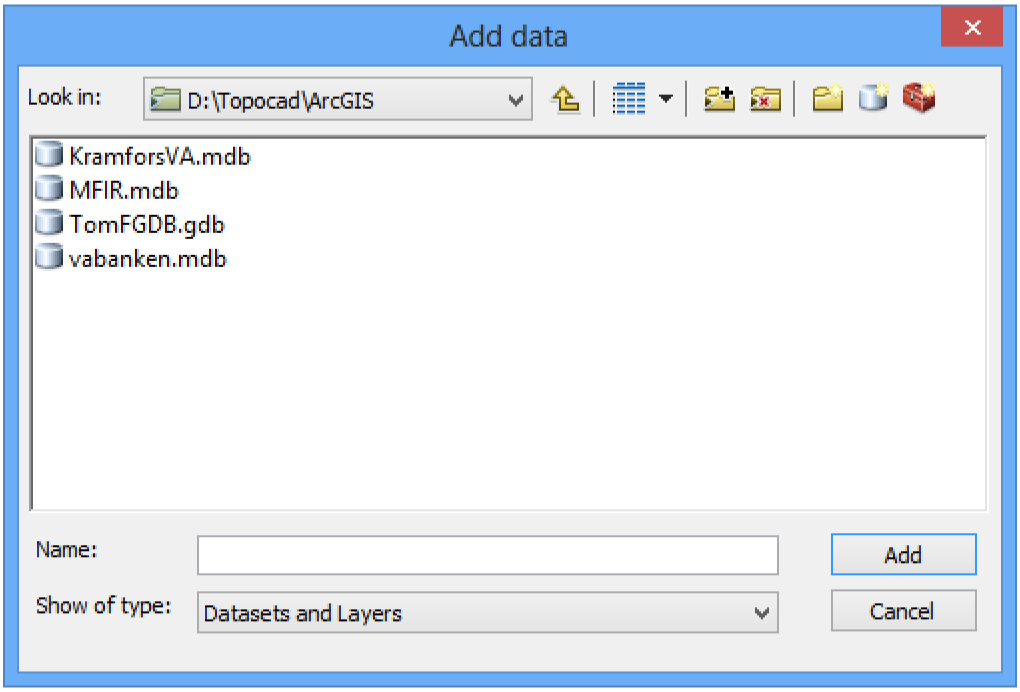
Add data



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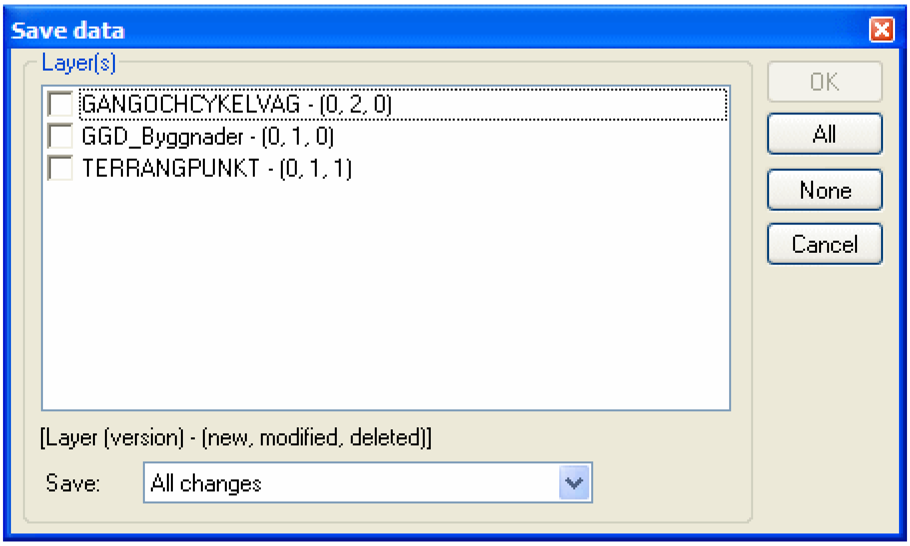

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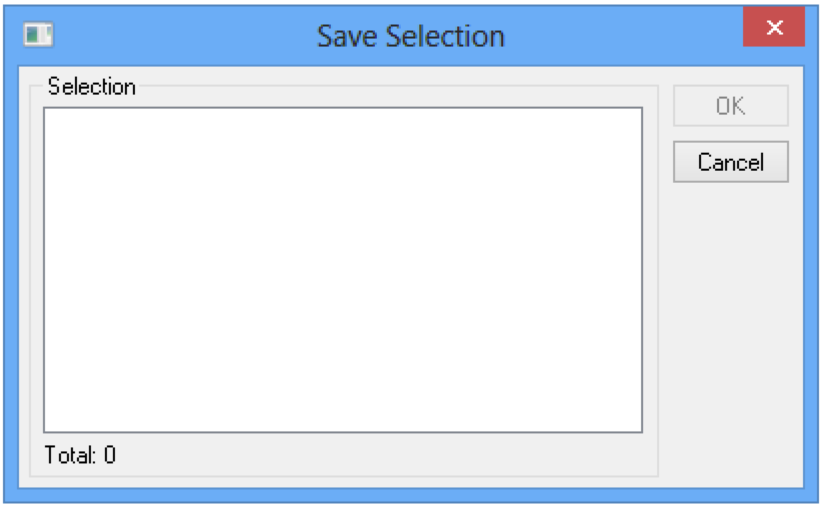
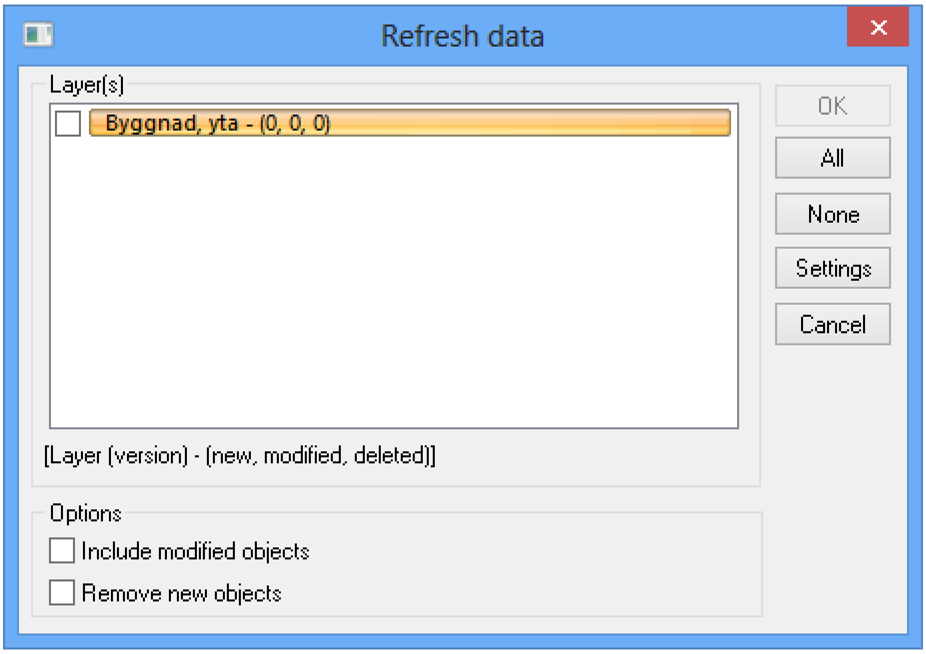


Refresh data



Update data and load new data from the database. You can ignore changes made in Topocad.

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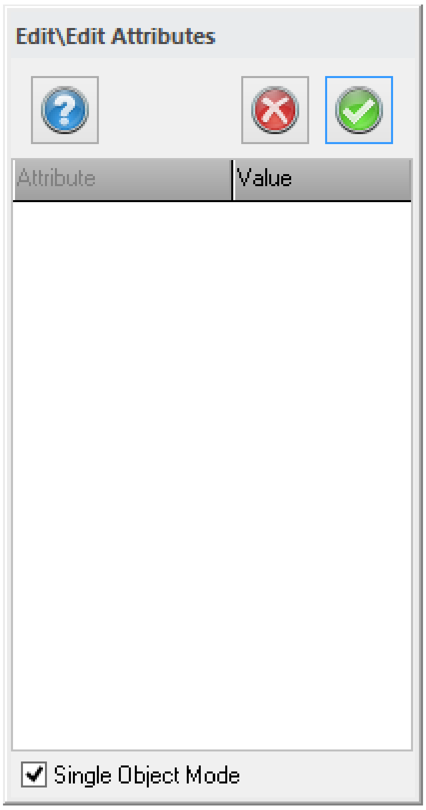
Edit Attributes



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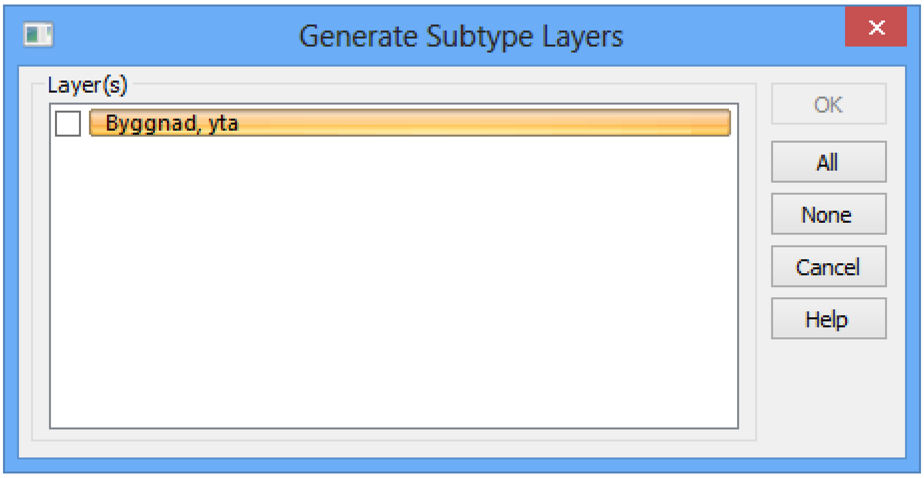

View geographical constraint

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ArcGIS database adapter contents

ArcGIS database adapter

Command	Description
Open map	Opens the database for the drawing.
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Add Data	Adds data from the database to the drawing.
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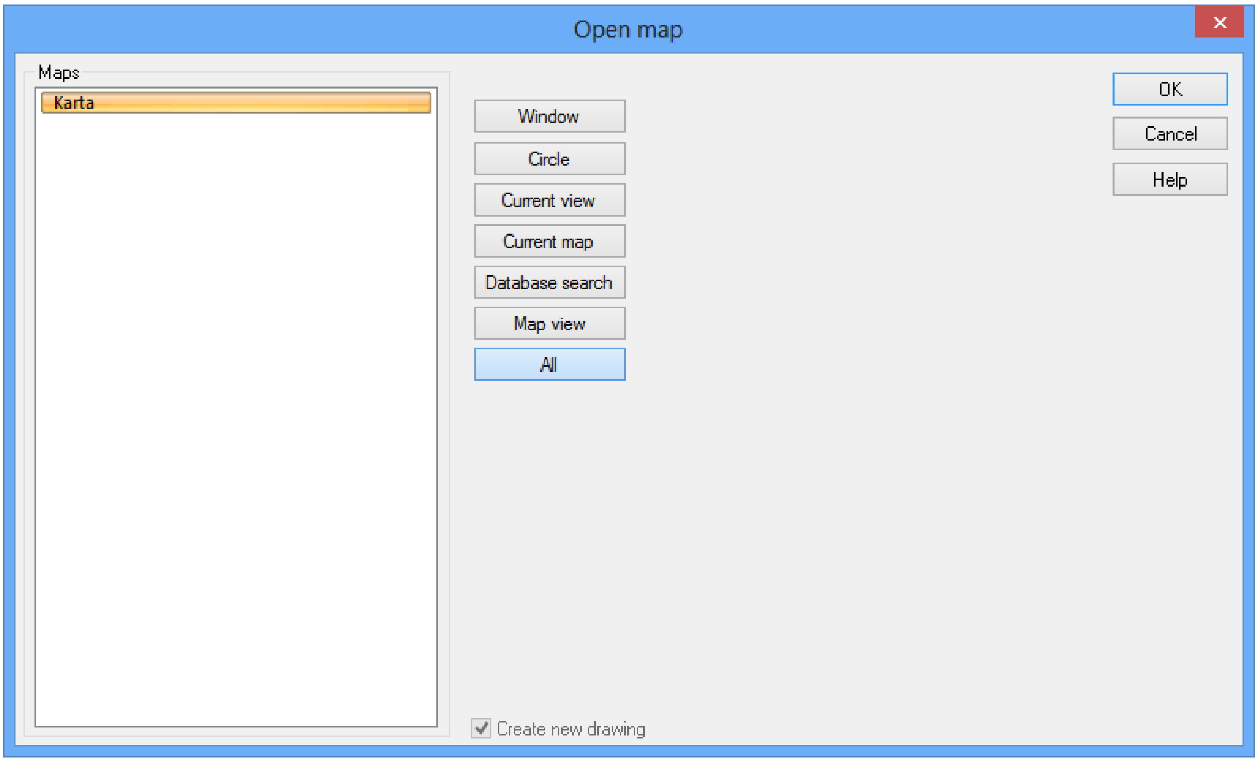
Open map



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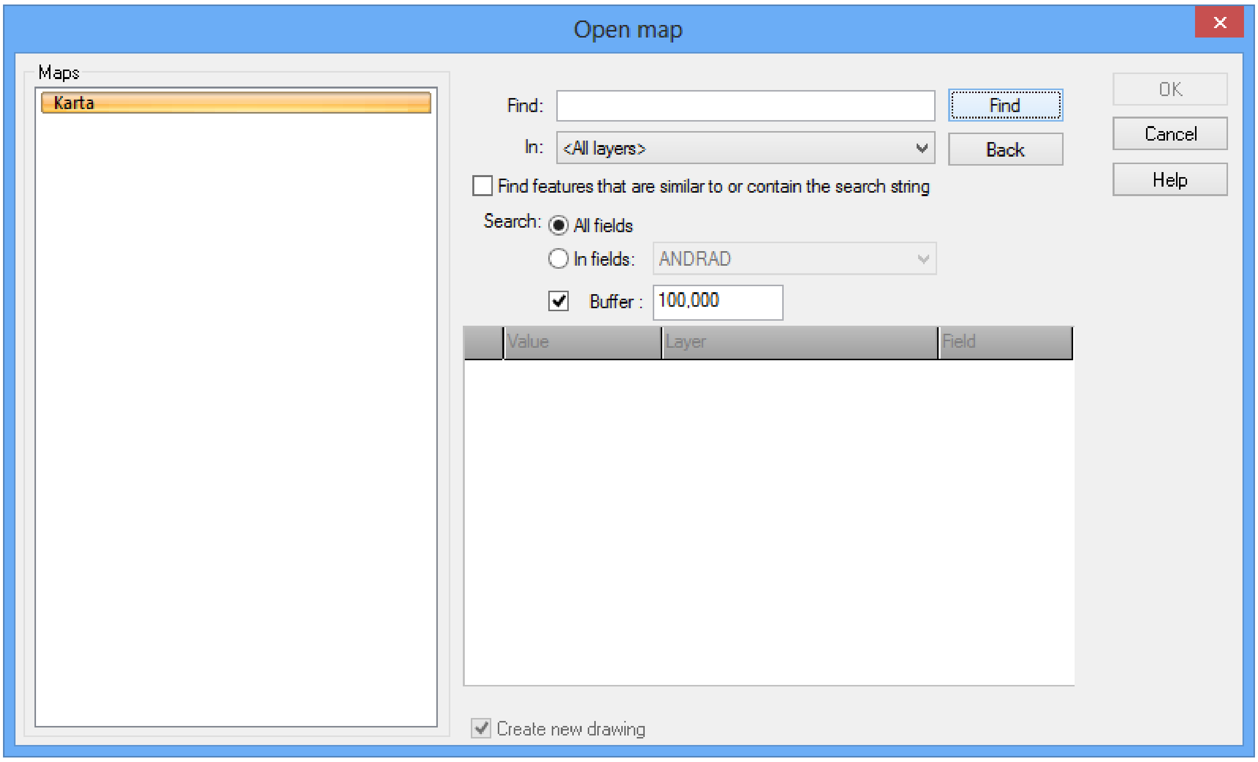

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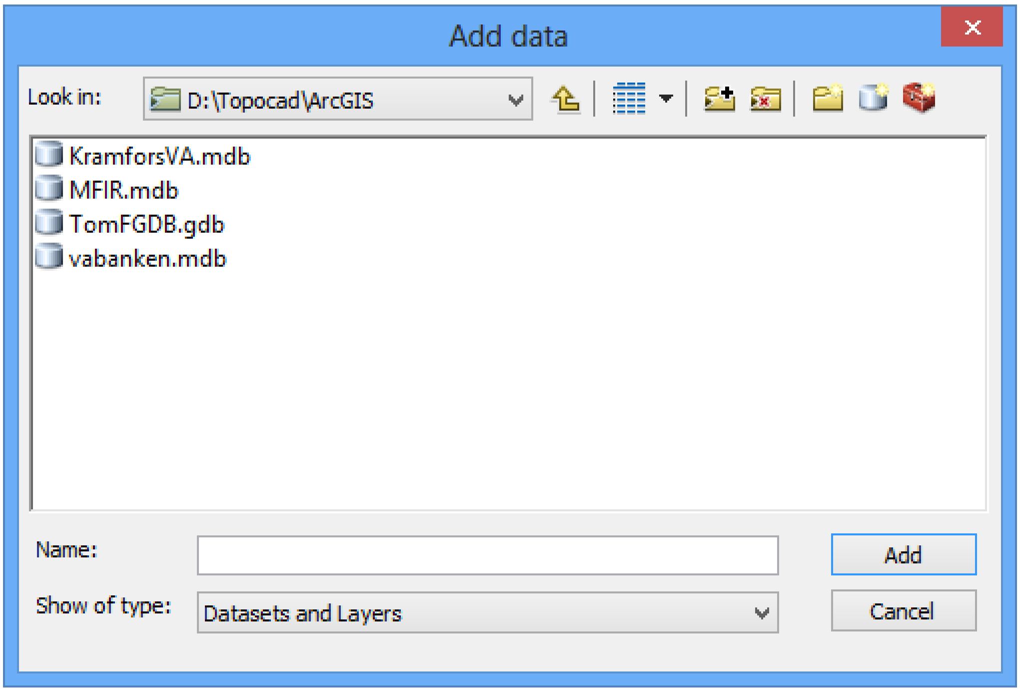

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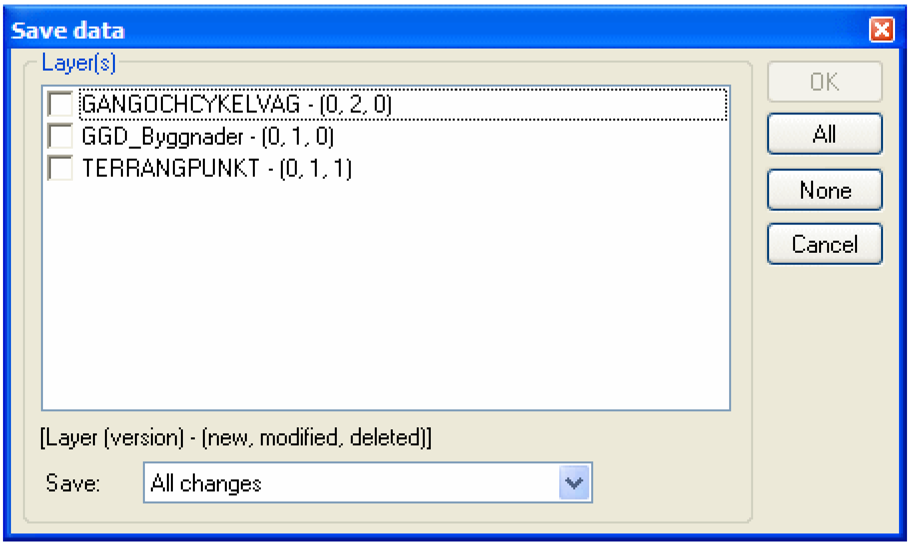

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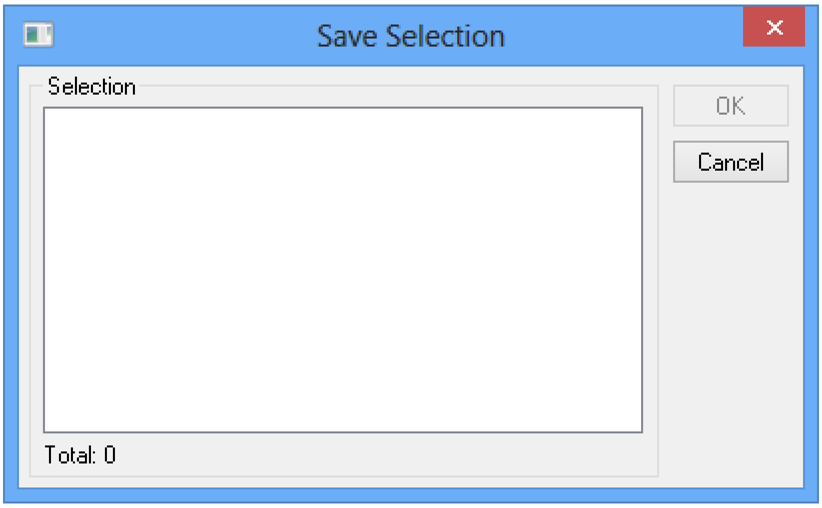
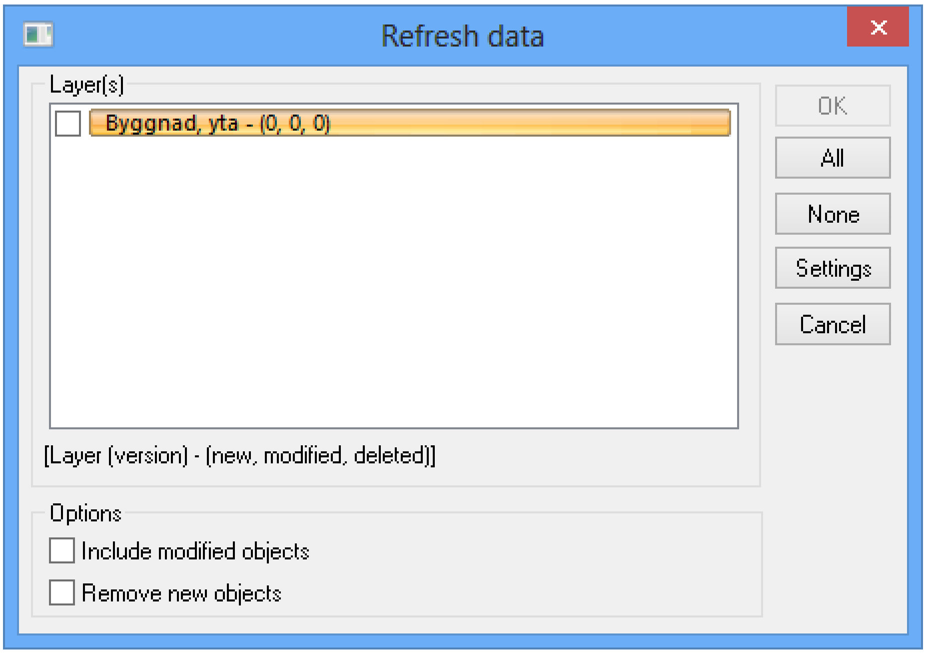


Refresh data



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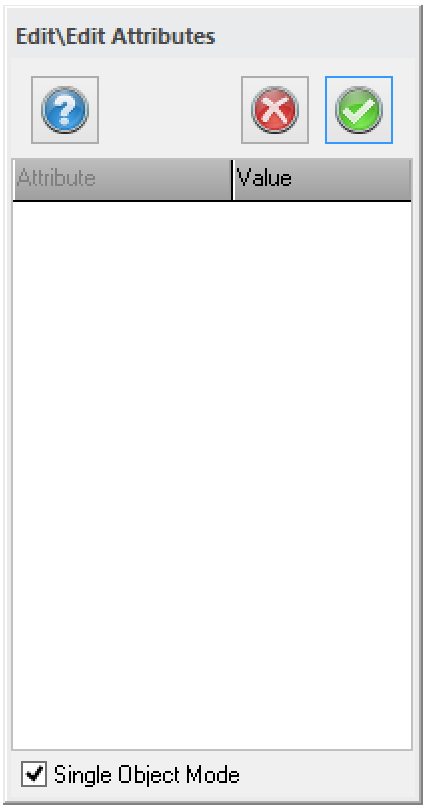

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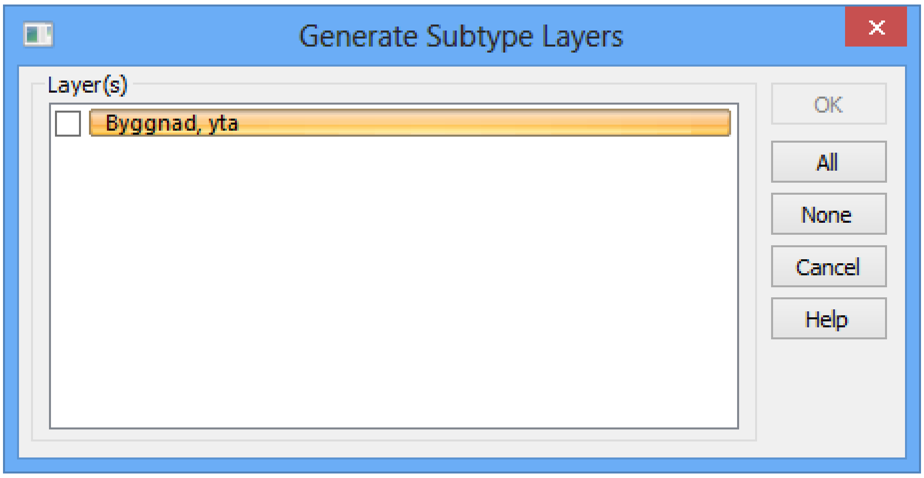

View geographical constraint

Select *Constraint* to activate the command.

ISM adapter

ISM

The ISM adapter is a method of saving data from the drawing to an Oracle Spatial database using the ISM (Independent Spatial Management) application. For more information about this module please contact your dealer.

FDO adapter

FDO adapter

FDO

The FDO adapter is a method of saving data from the drawing a database. For more information about this module please contact your dealer.

More info on FDO here.