TcpMDT

Reference Manual

Version 7.5

aplitop
Surveying and
Civil Engineering Solutions

C/ Sumatra, 9 E-29190 MÁLAGA (SPAIN)
web: www.aplitop.com		e-mail: soporte@aplitop.com

Content

1. Project

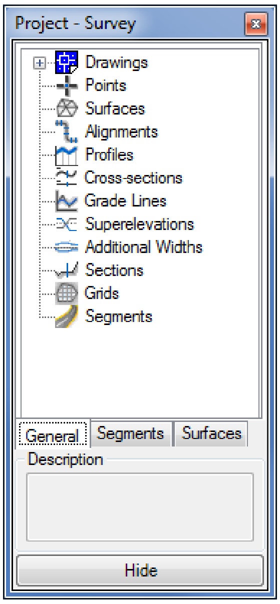
Project

A project file allows one to save all the files generated by MDT during the course of a project. Apart from being useful for users, this is also useful for the MDT program itself, as there are commands that take this information into account to set default options to specify files, detect files that should be regenerated, etc.

In addition, with MDT7 if we work on an active project we will have the possibility of automatically updating the drawing of the longitudinal profiles and the cross sections based on any change made either to the alignment or surface of the related drawing.

New Project

This command allows one to create a new MDT project file. When it is executed, a name for the file to be saved is requested. Should the current drawing have a name, the program asks if it is to be included within the project being created.



Window of an empty project

If the project file is kept in the same directory as the reference drawing files, the drawings are automatically loaded onto the project when any of them is opened.

Open Project

This command allows one to open a MDT project file that is displayed in the Project Window. Once the project is open, the successive MDT commands will update its information.

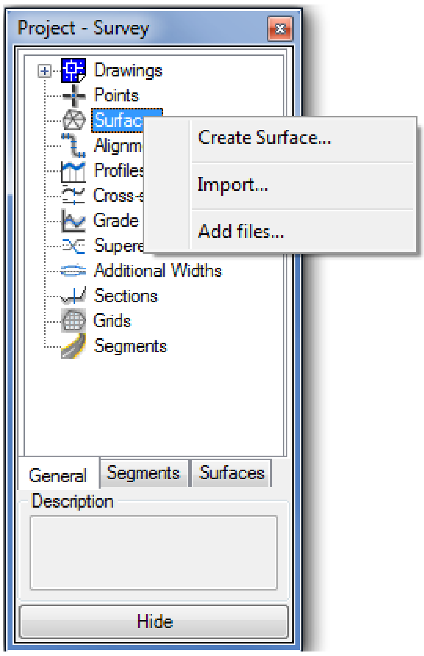
It is normally not necessary to use this command, as MDT searches for a project file where the drawing is stored when a drawing file is opened.

Close Project

This command closes the project associated to the drawing. This also means that the MDT commands will no longer change the project's information from that moment on.

Project Window

The project window allows one to have an overview of the files generated by MDT during the course of the project. The files a grouped together by categories according to the type of information they contain. Both the categories as well as the files they contain have contextual menus that are displayed when they are clicked with the mouse's right-hand button. They allow MDT commands to be executed.



Project window with the Surfaces category menu

All the categories are displayed by default. By clicking on ***Segments*** or ***Surfaces*** one can ensure that only the files in one of these two categories are displayed. All the files are displayed once again when ***General*** is clicked.

Once can type in a ***Description*** for each file included in the project. One merely has to select the file from the list in order to edit it in the lower part of the window.

The ***Hide*** button means that the window will be resized, so that it occupies less space on screen. It returns to its previous state when ***View*** is clicked. Additionally, each time an CAD command is executed, the project window automatically disappears and is displayed once again when the command finishes.

A description has been provided below of each of the categories as well as of the operations or commands that can be executed at each of them.

For each of the files associated with each category there will be three common operations:

1. **Delete**: Eliminates the file from the project and, optionally, from the computer.
2. **Copy**: This allows the carrying out of a file duplicate.
3. **Rename**: Tool for changing the file name.
4. **Add Files**: This allows us to add the specified file to the project.

Each of the categories and files related with the project have their own associated commands which are listed below and are described in detail in their respective sections.

Points: Points files associated with the project.

Associated operations:

Category	Action
Import	Import
Export	Check
List	

Surfaces: Surfaces files associated with the project.

Associated operations:

Category	Action
Create Surface	Set as Current
Import	Draw
	Represent As
	View
	Information
	Draw contours
	Create grid
	Export

Alignments: Horizontal alignment files associated with the project.

Associated operations:

Category	Files
Convert Polyline	Edit
Alignment Input	Check
Import	Draw
Draw Alignments	Dimension
Dimension Alignments	Locate
Delete Dimensioning	List
	List by interval
	Convert
	Get Longitudinal Profile
	Get Cross Sections
	Generate Widenings
	Generate Superelevations

Profiles: Longitudinal profile files associated with the project.

Associated operations:

Category	Files
Get Profile	List

Get Profile by Regression	Check
Profile Input	Draw Simple Profile
Convert Drawing Profile	Update
Convert from 3D Polyline	
Import	
Get multiple Profiles	

Cross sections: Cross sections files associated with the project.

Associated operations:

Category	Files
Obtain Profile	List
Import	Check
Obtain multiple Profiles	Draw
	Update

Gradients: Gradients files associated with the project.

Associated operations:

Category	Files
Convert Grade line from Polyline	List
Define Grade Line	Check
Import	Draw Compound Profile

Superelevations: Superelevation files associated with the project.

Associated operations:

Category	Files
Generate Superelevation	List
	Check

Widenings: Widenings files associated with the project.

Associated operations:

Category	Files
Generate Widenings	List
	Draw

Templates: Templates files associated with the project.

Associated operations:

Category	Files
	Edit

Grids : Grid files associated with the project.

Associated operations:

Category	Files
Create Grid from Surface	Draw
Read Drawing Mesh	Draw Heights Map
Import	

Segments : Segment files associated with the project.

Associated operations:

Category	Files
New Segment	Define/Edit
	List Profile
	Draw Compound Profile
	Draw Cross sections
	Generate Modified Terrain
	Get Modified Terrain
	Cubic Measurement List

2. Points

Introduction

A Digital Terrain Model is made from a job done with 3D and 2D drawing elements having height (contour lines, 3D lines, etc.), or alternatively with field data represented by points. These points, conveniently "joined together", make up what is called a scatter plot. The points are represented by their X, Y, Z coordinates and usually by an ordinal number and an associated code. These data organized in lines and columns with defined separators form a point data file. This application also allows one to modify the scatter plot by means of a set of tools that are described in this section.

Estimation of Uncertainties

As a new feature, MDT version 7.5 enables us to store the uncertainty of the X, Y, Z coordinates of each point. These values can be assigned using the following methods:

- If the points have been viewed using a **GNSS receiver**, depending on the format of the files, they may be included in the estimated horizontal and vertical positions. For example, if the data has been taken using the TcpGPS application, the uncertainties will be assigned automatically on importing the points.
- If the points have been viewed using a **total station** and calculated using the MDT Topography model, the uncertainties of each point are calculated based on the characteristics of the tool, which should be defined within the properties of the survey.
- Finally, the values of the uncertainties can be assigned by means of a **manual entry** using the ***Change Uncertainties*** command.

It should be taken into account that the confidence level for the estimation of uncertainties (95% by default) is established in the Topography settings. See the Customisation Manual for more details.

Point Objects

MDT has two ways of representing points: either as blocks having attributes or as special objects (MDT points). The former have the advantage that they can be handled on a computer that does not have MDT installed. Their disadvantage lies in the fact that processing such points is much slower. Independently of the object type, each point stores a name or number, a code and a level, in addition to its coordinates. When the entity is an MDT point, additional attributes can also be included with the observation data for the point (GPS or total stations), hyperlinks, and data defined by the user. To change between one or another representation use the command **Tools** > **Configuration** > **Points** and select at the top the type of representation to be used.

Point coordinates can be modified either with the application's own utilities or directly using the CAD commands, including: DELETE, MOVE, ROTATE, UNDO, etc. The difference between both command categories is that the program's commands offer greater possibilities and easier selection possibilities.

Depending on the type of object used to represent points, the attributes appear in separate layers (block type objects) or in the same layer (MDT point objects).

Classification by Levels

The possibility exists of classifying points by levels in accordance with the following initial table:

Level	Description	Use in Surface
0	Default	YES
1	Fillings	YES
2	Break lines	YES
3	Information	NO
4	Stake Out	NO

Points belonging to levels 0, 1 and 2 are the only points used to create the digital model with the default configuration. Points belonging to levels 3 and 4, on the contrary, are respectively considered as informative or setting out points.

The configuration can be changed using the **Utilities** > **Configuration** > **Points**, **Levels** button.

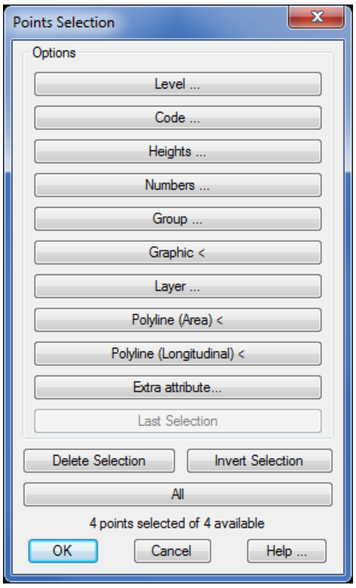
Separation into Groups

Apart from the possible classification by point levels, these can be grouped together in different ways to create point groups with a name. Groups can be created that correspond to different work phases, successive modifications, etc. A point may belong to several groups.

Select Points

Allows one to choose certain points in order to execute an action on them, including: delete, list, move, etc. Different selection methods are allowed, which are explained in the following sections.

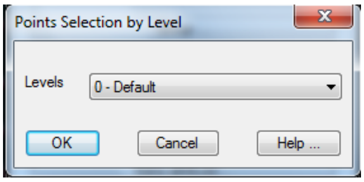
From the ***Select Points*** window, one can choose the most appropriate selection method for the job's needs or even combine various selection methods.



Once the points have been selected, the number of points selected and the total number of points in the drawing is displayed in the text line. The selection can then be validated or cancelled. In the latter case, the command that caused the points to be selected will not be executed.

Select by Level

One can select all the points belonging to a specific level by means of this command. A list containing all the names of the levels defined is displayed in the selection window.



Select by Code

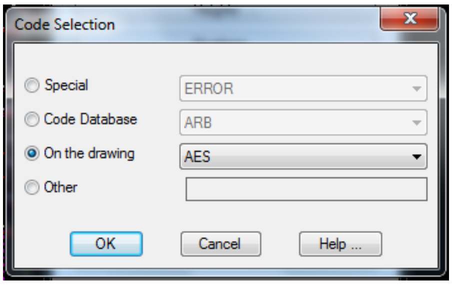
This option allows one to determine the code in four different ways inside the ***Select Codes*** dialog box:

Special: There are the default codes the program assigns in its different commands, for instance: Interpolated, Inserted, etc…

Codes Data Base: Lists all the codes included in the program's codes database.

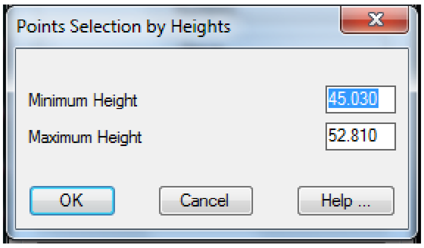
In the drawing: Shows all the codes that in the current drawing

Other: Allows one to enter a new or different code. Capitals and lower case letters are considered as equivalent. Wildcards such as asterisks (*), which indicate any series of characters, and question marks (?), which correspond to a specific character are allowed . In the case of points having composite codes (those that include a comma ","), these are selected if the code chosen coincides with any of the point code's parts. For example, AT, BR.



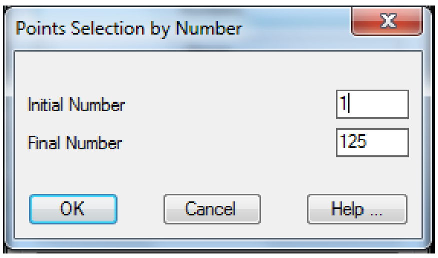
Select by Height

This possibility allows one to easily choose points using a specific height range. In order to do so, the minimum and maximum heights defining the interval are entered and points within these values are selected. The scatter plot's extreme values are taken by default.



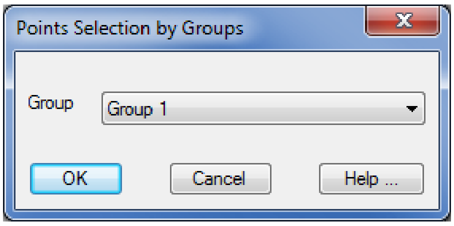
Select by Number

This option allows one to define a points interval to be selected from the first and last ordinal numbers entered.



Select by Group

Once the corresponding point groups are created, this option makes it possible to select the said groups individually. All the point groups created in the drawing are displayed in the Select by Groups window

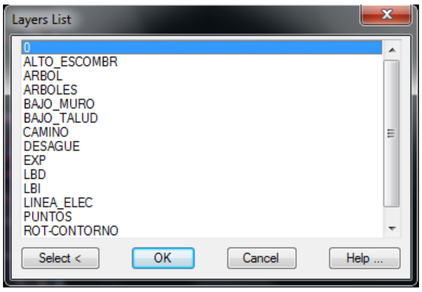


Select Graphically

This possibility allows one to select points graphically through the standard AutoCAD selection options, including: by window, capture, crossing capture, etc…

Select by Layer

By default, the program draws all points on the same layer, but if there are different groups of points represented in different layers, this option allows for the selection of all the points of a specific layer. When it is executed, a window containing a list of the drawing's layers is displayed. Select one of the layers and press **OK**, or press the **Select** < button to select an object in the drawing so that the layer to which it belongs is selected from the list. Only one layer at a time may be selected, but several selections can be made consecutively.



Selection by Polyline (Area)

This feature allows to select graphically a polyline in the drawing. All points inside the area delimited by polyline are selected.

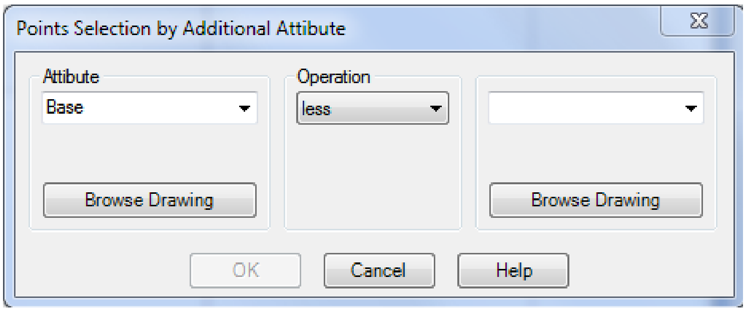
Selection by Polyline (Length)

This option asks for a polyline in the drawing. Then the program ask in command line for **Maximum Distance to Polyline.** Along the polyline, the program selects all points whose distance is less than this parameter.

Select by Additional Attribute

In the case that the points have additional attributes, this option facilitates their selection according to their distinct criteria.

First select the attribute for which the selection is being made. Initially, all the attributes possible are listed. Clicking **Search Drawing** updates it so that only the attributes present in the drawing are displayed. Then select the type of operation of comparison to be carried out with the value of the attribute (lower, equal to or lower, higher, distinct and between). Finally, the value to be used for the comparison is introduced. Clicking on the corresponding **Search Drawing** button creates a list with all the values present in the drawing for the attribute selected.



Last Selected

This button allows you to get the last selection carried out during the working session, with the aim of selecting the same points as the previous command.

Delete Selection

It clears any kind of selection carried out until the moment, with the aim of redoing a new one.

Invert Selection

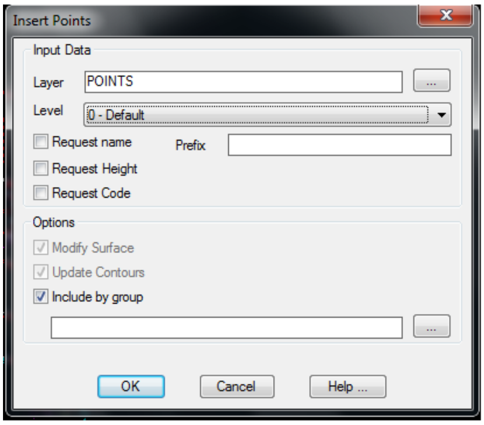
It reverses the state of each point, that is to say, it selects all those that are not currently selected, and vice versa.

Select All

You can select all the points of the work in order to do any operation on them through this option

Insert Points

This command allows on to add points manually to a drawing. Firstly a window is displayed where one can specify the level the points to be inserted belong and following options can be activated: ***Request Name, Request Height*** or ***Request Code***, so that when the point's coordinates are entered, the program will request the attributes enabled in the command line. Should there be a surface associated to the drawing, one can choose whether the point's insertion will entail the insertion of a vertex on the surface ***(Modify Surface)*** or if the contour lines will be changes ***(Update Contours)***. Also, the option **Include by group**, allows for including the new points in a group of points.



Once the options above are set, one proceeds to insert the points. The program will repeatedly request coordinates and then insert the point in the drawing. If not specified otherwise, the points inserted will be assigned with the number of the last drawing point plus one as their name. If the coordinates entered are at a null height, the program will attempt to replace it for the current surface at these X and Y coordinates. The code assigned is “Inserted”.

Another possibility is to enter points by reference, which is useful when one knows the relative position of the new point with regard to an existing point. If one answers **R** to the

Reference/<Point>:

question, the program requests the reference point’s number, which should be defined in the drawing. One then specifies the adjustment on plan either graphically or by means of AutoCAD’s usual syntax for two-dimensional points:

- If **x** and **y** are entered, the points absolute coordinates are directly specified.
- If **@ dx, dy** are entered, the program is informed about the coordinates relative to the reference point.
- Lastly, distance and angle from the reference point are indicated with the **@d<a** format.

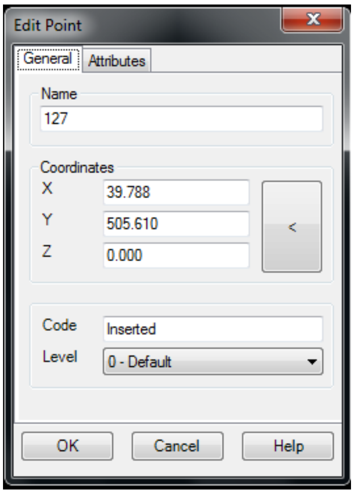
If a reference point is specified, the command carries on in this way until the command is finished.

Additionally, points can be inserted into the drawing in 2D or 3D, depending on whether the ***Draw in 3D*** check box is activated in the configuration of the **Utilities Configuration Points** command. It is usually advisable to draw them in 2D, as this subsequently facilitates editing lines connecting points and calculating surfaces.

Edit Points

This option allows one to change surveying point attributes (ordinal number, code and level), and X, Y and Z coordinates. Other related commands include **Points > Move** to change their X, Y coordinates and **Points > Change > Change Heights** to change their heights.

The ***Edit Point*** window is displayed after a point is selected. It allows one to complete or change the point’s coordinates and attributes.

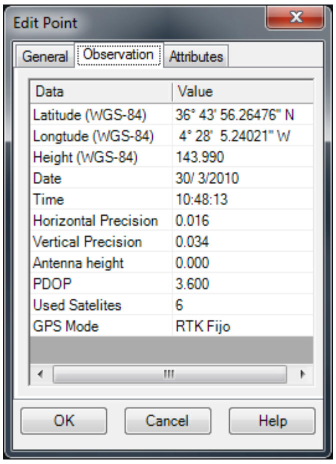


If the X, Y and Z coordinates are modified, the application moves the point to them and modifies the triangulation if necessary.

If a point’s name is changed, it should not coincide with another point’s name. Otherwise, the message “ERROR: Point name repeated" is displayed.

If level is changed, point visibility may vary depending on the configuration, as the program allows one to independently view the different levels’ attributes.

If the dialogue box features an **Observation** tab, the original data from the point reading, whether with a GPS or with the total station, is given therein.



On the other hand the **Attributes** tab allows for establishing additional information for the point, introducing the type of data and the value that this type takes in the edited point. There is a special attribute, **Hyperlink** that allows associating the point with a file link. The two buttons are used to modify the hyperlink and open the file with the associated application. This last operation can also be carried out with the command **Points > Open Hyperlink**.

Move Points

This command allows one to change a surveying point's position of point (X and Y coordinates). The elevation should be changed with the **Edit Points** command.

Any element of the point desired is selected and the program will take the point itself as the basis of movement. It then requests a new location, which may be specified in various ways:

- By moving the cursor to the new position.
- Using the keyboard to enter the absolute coordinates: x,y
- Using the keyboard to enter relative coordinates: **dx,dy**

If there is a vertex in the current surface that coincides with the point's initial coordinates, the surface is automatically updated when the point is moved. Additionally, when one moves or edits a point, the program modifies the vertices of the polylines whose vertices coincide with its original position or are at a distance less than the distance specified in the ***Max. Dist. between Vertices and Points*** option of the **Surfaces Configuration** section, as long as they are drawn in break line layers. These two operations – modifying the surface and the polylines– are not done when points are moved using an CAD command.

Delete Points

This option allows you to delete the drawing points you wish. If there is an active surface, the vertex corresponding to the surface is also deleted when the points are deleted. When the command is executed, three alternatives are displayed in the command line:

Choose <Point>/Number/Selection:

Point: Allows one to graphically select individual points from the drawing. It is the default option.

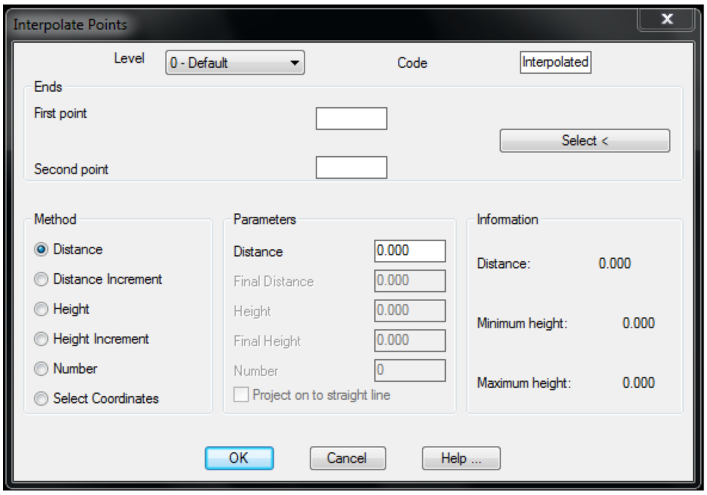
Number: Gives one the option of deleting points by indicating their ordinal number.

Selection: The points to be deleted are specified using the ***Select Points*** window.

Interpolate Points

For various reasons, some projects may have areas with a low point frequency, which makes triangulation and contouring processes difficult. This command allows one to create new interpolated points from other existing points.

Firstly, the ***Interpolate Points*** dialog box containing the following elements is displayed.



Level: Selects the level where the new points are created. The default level is the current level.

Code: Sets the code assigned to the new points created.

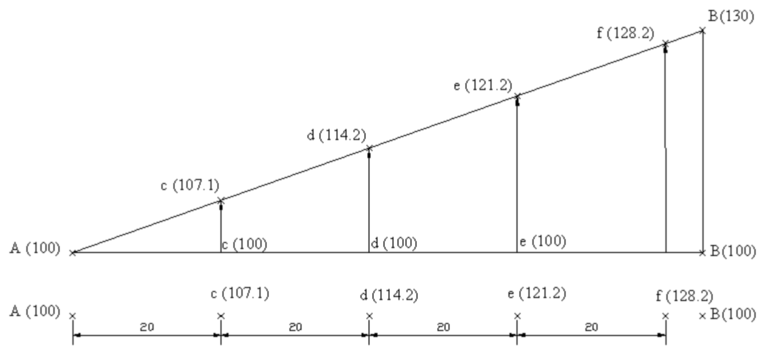
Select: Button used to successively mark the two points between which the interpolation will be carried out on screen.

Information: Provides details on the distance between the points selected and their minimum and maximum heights.

Should there be a defined triangulation, it is not modified. Consequently, it is necessary to triangulate once again if one wishes to include the interpolated points in the triangulation.

Interpolation by Distance

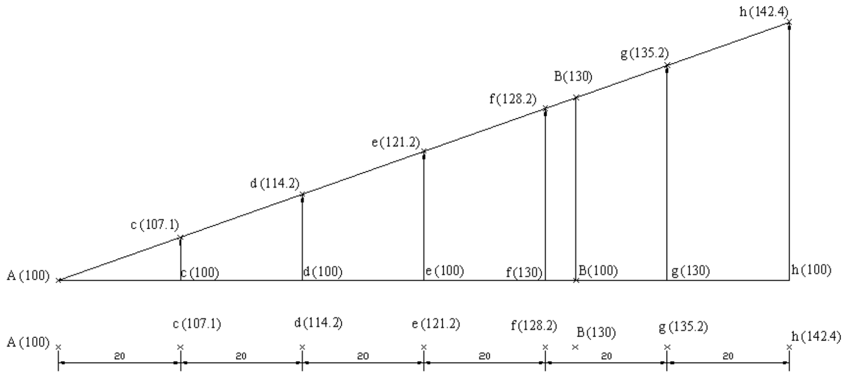
New points are inserted having interpolated heights between them from the two points selected, going from the first reference point to the second point, and according to the distance specified.



In the figure above, points are interpolated every 20 meters between the A and B reference points.

Interpolation by Distance Increment

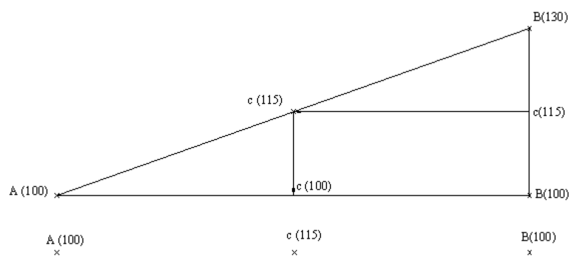
It is similar to the Interpolation by Distance method, but with the difference that in this case one also indicates the final distance up to which one wishes to draw. One can therefore insert points after the second reference point.



In the figure above, points are interpolated every 20 meters between the initial reference point and the final distance specified, which in this case is 120 meters.

Interpolation by Height

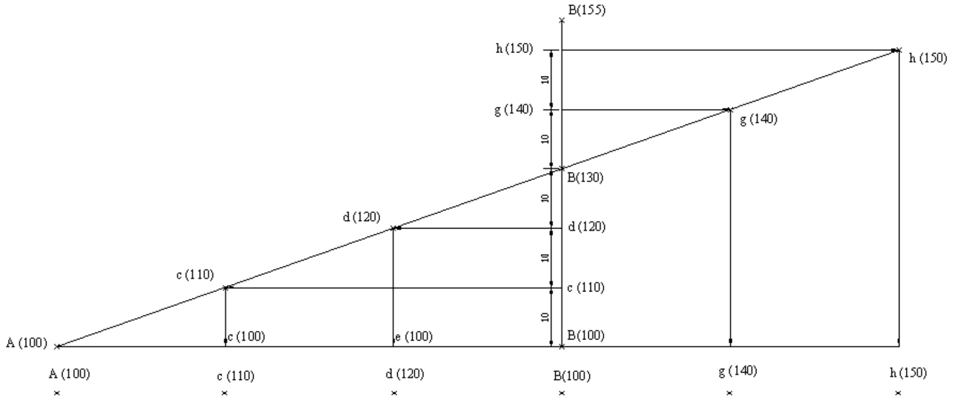
A point is inserted having the height entered between two points to be interpolated.



In the figure above, point C is interpolated between the A and B reference points by specifying its height, which in this case is 115 meters.

Interpolation by Height Increment

Allows one to interpolate a series of points, so that the points interpolated from the first reference point and according to the increment specified are inserted until the final height set is reached. This option allows one to include points after the second reference point.



In the figure above, points are interpolated every 10 meters of height between the first reference point and the final height specified , which in this case is 155 meters.

Interpolation by Number

This option allows one to insert the number of points specified between the two points to be interpolated, so that they remain equidistant between them and the two interpolation reference points.

Should a defined triangulation exist, it cannot be modified. It is therefore necessary to triangulate again.

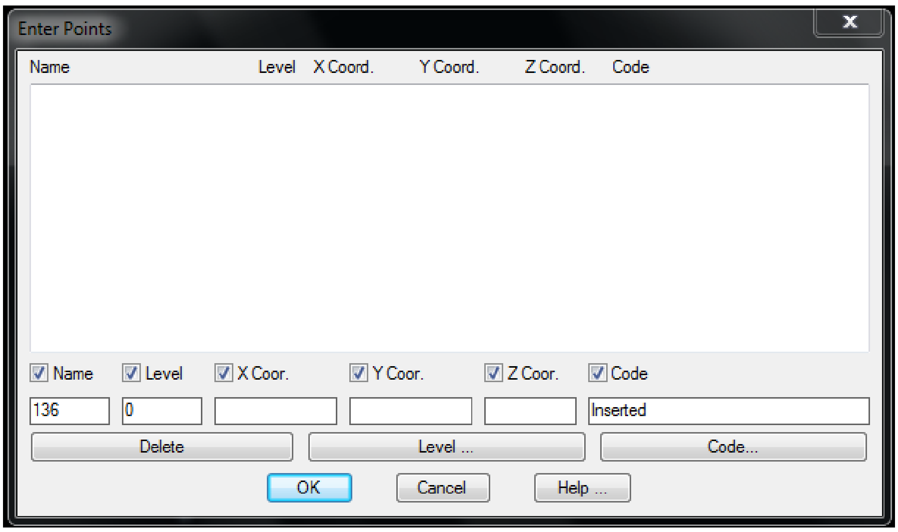
Interpolation by Designating Coordinates

This option allows one to select the coordinates of the point to be interpolated and the program assigns the corresponding height to the lineal interpolation between the two points designated. Additionally, if the ***Project onto Straight Line*** check box is activated, the program also ensures that the new point's X and Y coordinates are projected on the straight line between the points chosen.

Points Input

This command allows one to insert points manually in a successive and continuous fashion using a points list, so that one can view them in the window. It also allows users to check the list.

The ***Enter Points*** window is displayed by using this command. Firstly, it is advisable to activate the fields one intends to fill in: ***Number***, ***Level***, ***X Coordinate***, ***Y Coordinate***, ***Z Coordinate*** or ***Code***, so that it is not necessary to fill in the set boxes, such as the code, level etc…. If the number option is deactivated, one automatically increases each point inserted by one unit, starting from the last point existing in the job.

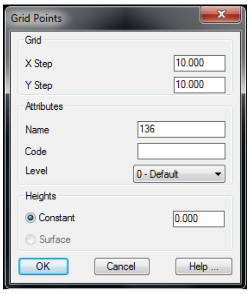


One can delete the point selected by using the ***Delete*** button. To edit point that has already been entered, the point in question should be double clicked.

The ***Level*** and ***Code*** buttons allow one to know the job’s existing levels and codes, so that they can be selected in the appropriate windows.

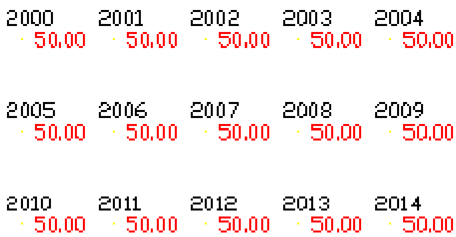
Grid Points

This command is used to quickly create a group of points. The initial window is for specifying the X and Y intervals of separation between the points, as well as the **Name**, **Code** and **Level** of the points being created. There are two possibilities for the elevation: a **Constant** elevation, or using the current surface to give the points their elevation. In the latter case, the grid points that do not project vertically over the surface are not created.



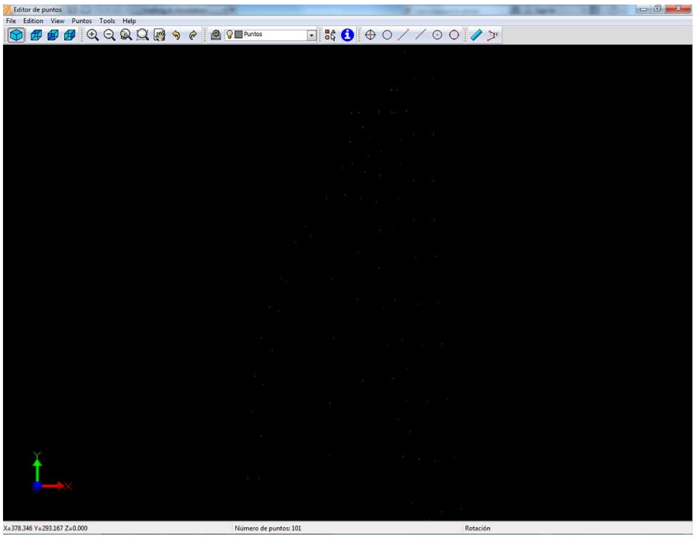
Once the parameters are validated the program requests the coordinates for a corner of the grid. Next, the second coordinate can be introduced, or, by typing “X” the direction of the X axis can be indicated, to create non-orthogonal grids. When the size of the grid is designated, the calculations of the number of points that are going to be created are displayed in the CAD status bar.

The points created are numbered successively, beginning in the first corner designated, and following the direction of the X axis.



Check Points

This command is used to visualize a points file in a window independently of CAD. The file format must be <Name> <X Coordinate> <Coordinate and> <Z Coordinate> and <Code> optional.

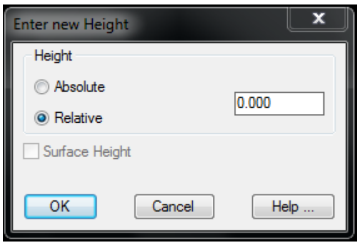


The window includes options for top, front and side views, zoom, layer control, etc.

Change Point Features

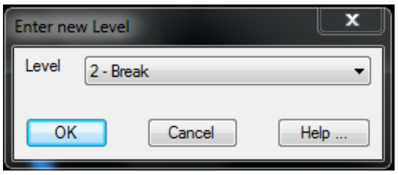
Change Heights

This command allows one to change the heights of a set of points. After selecting the points desired, one can either set an ***Absolute*** height for all the points or adjust them vertically using the ***Relative*** option by entering a value with a sign. Should the drawing have an active surface, the possibility of assigning the each of the points with the surface height also exists. When a point is modified in this way, neither an absolute or a relative height is assigned.



Change Levels

Simultaneously changes the level of a point selection. Firstly the program requests one to select a set of points. The level to which one wishes to change is then selected.

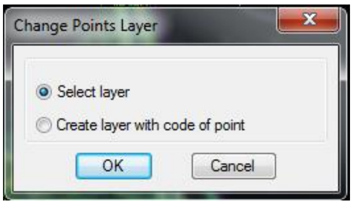


Change Codes

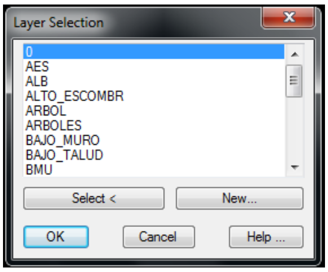
This command allows one to change the codes of a group of points at the same time. In order to do so, the points are selected first and then the code is specified in the ***Select Code*** window.

Change Layers

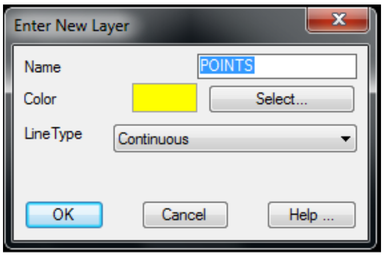
Initially, the program draws all the surveying points on the same layer. A group of points can be selected with this command. They can also be placed in a different layer. Belonging to a specific layer is independent of its influence on the digital model that is controlled by levels.



This command has two operating modes. The first is used to select a layer, to which the points selected will be copied.



Should one wish to generate a new layer, the ***New*** button should be clicked and then the following window is displayed. The layer's ***Name***, ***Colour*** and ***Line Type*** are set in this window.



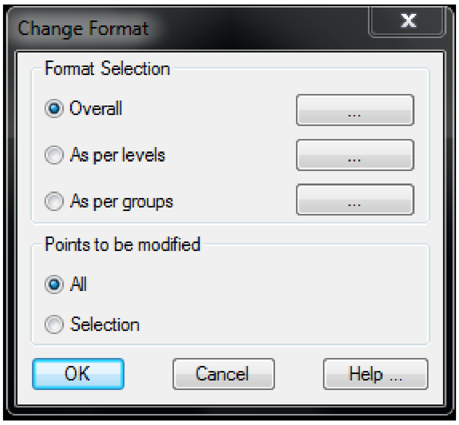
In the second mode, with the list of points selected the program uses the point code as the name for the layer. Layers that do not exist are automatically created.

Apart from using this command, the layer of a point can also be changed using AutoCAD's own tools.

Change Format

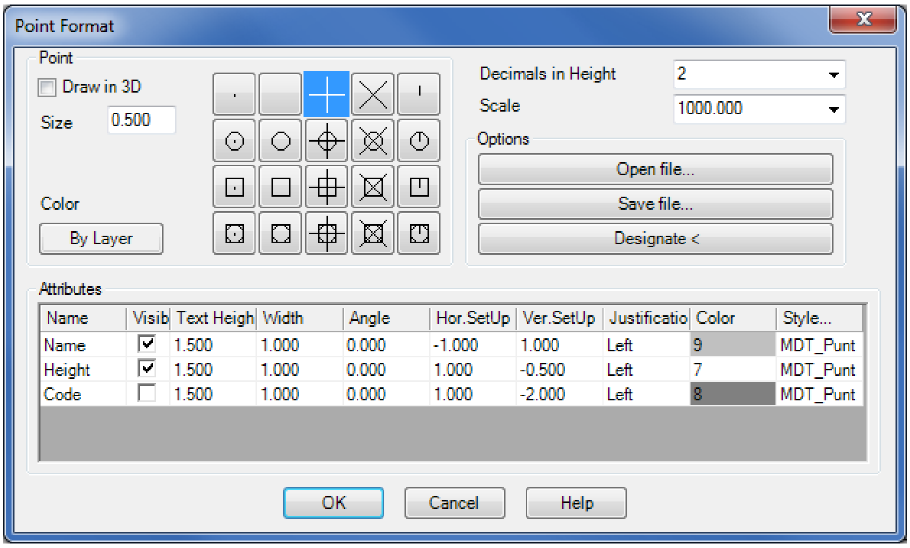
This command allows one to the change the appearance (format) of a drawing's points. There a three ways of doing so:

- Globally, in other words, with the same format for all the points.
- On the basis of the points' levels, so that each level can have a different format.
- By the point groups defined in the drawing.



It is also possible to change the way a selection of points is represented by any of the application criteria (by number, code, etc.). These changes are saved in the drawing.

The … button displays the following dialog box, which allows the way the points are represented to be controlled.



The ***Draw in 3D*** option allows one to control whether the points are to be shown in 3D or 2D. The ***Size*** box controls the point's dimensions. The view of which can be chosen by using one of the icons in the tool bar located on the top of the dialog box. The ***Colour*** button allows one to choose the colour with which points will be represented. There may be a value BY LAYER, so as to take the point layer's colour.

The ***Attributes*** box allows one to define point attribute characteristics, in other words: name, height and code. Each of these will have the following properties:

- Visibility (on or off)
- Text height in drawing units
- Text width factor (1.0 by default)
- Text inclination angle (horizontal by default)
- Attributes horizontal position measured by the number of characters from the point itself (negative to the left and positive to the right)
- Attribute's vertical position measured by the number of characters from the point itself (negative downwards and positive upwards)
- Text justification (left, centre or right)
- Attribute's colour

The number of decimals can additionally to be specified for height.

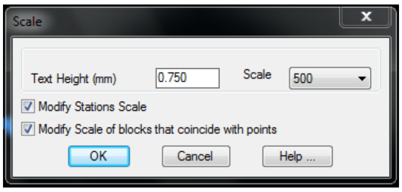
Lastly, other of the dialog box's options include

- ***Save File*** Saves representation properties in an external file with the `.SIM` extension
- ***Open File.*** Recovery of a newly created file with the previous option.
- ***Designate.*** Allows one to obtain a point's representation properties by selecting it graphically.

Change Scale

As is known, objects are drawn in their real dimensions in CAD, that is to say at a scale of 1:1. However, text sizes must correspond with the scale in which the planes are going to be traced.

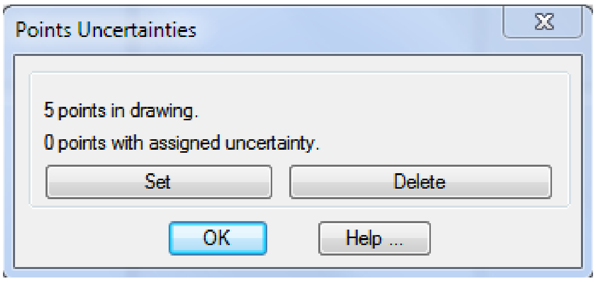
This command allows one to modify attribute sizes: number, height, code, so that they are represented according to the characteristics of the drawing. A specific text height can be entered directly or, if the program's scale is modified, it is calculated automatically.



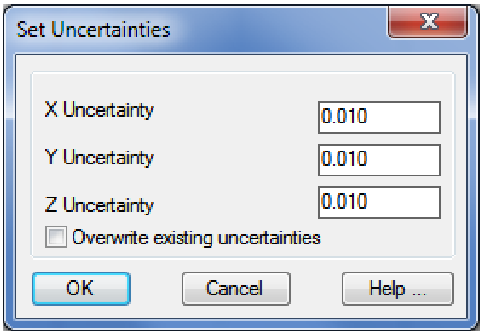
The ***Modify Stations Scale*** box also changes the drawing's bases. One can also manage to modify the scale of the blocks whose insertion point coincide with the point's coordinates.

Changing Uncertainties

This command enables us to edit or delete the uncertainties associated with the points in a drawing. A window appears with the total number of points in the drawing, stating how many of them have been assigned uncertainties.



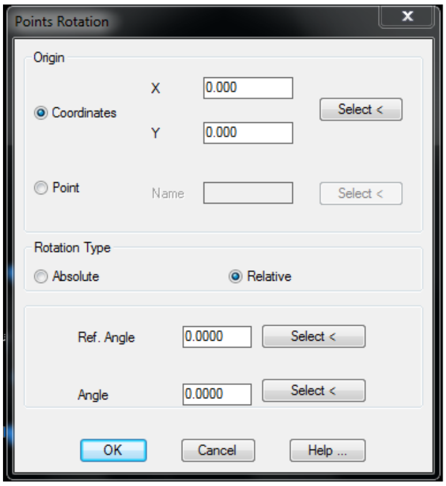
The **Assign** tab enables us to associate uncertainties with a selection of points, with the option of preventing them from overwriting existing uncertainties. A window appears requesting the new uncertainties and a selection of points on which to operate.



The **Delete** tab requests confirmation, enabling us to remove the uncertainties from a series of points.

Rotate Points

If this command is selected, the orientation of the coordinates system of the selected points' coordinate system can be changed.

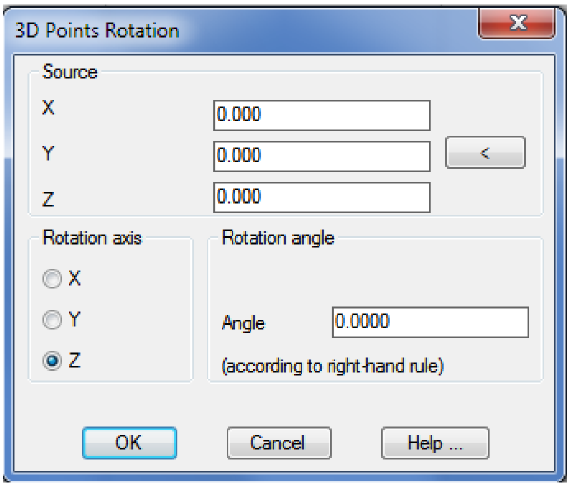


After invoking the command, one is requested the origin or number of the ***Point*** from which one wishes to rotate. The former case, one selects a point (by entering its coordinates, numerically, graphically or by selecting a point in the job) and by entering the point's **Name** in the latter case.

The rotation ***Angle*** is then entered, which can be done either graphically or numerically, and the scatter plot is redrawn and centred on screen.

3D Points Rotation

This command is similar to the previous command except that the rotation is conducted in 3D. The following window will appear on executing the command:

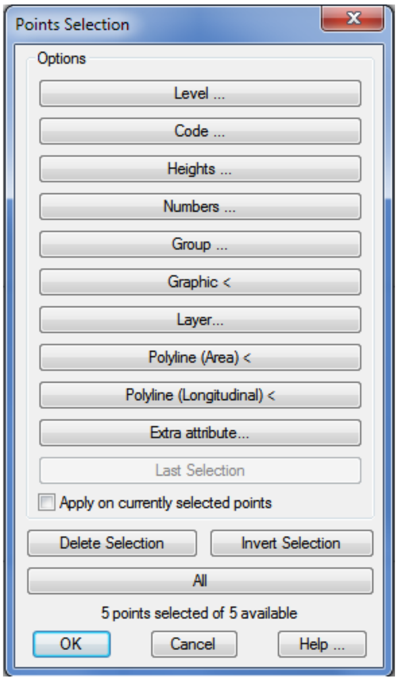


Source: Coordinates from which the rotation is to be conducted.

Rotation axis: We specify if the roation axis is the X, Y or Z axis.

Rotation angle: We specify the rotation to be used in gradians.

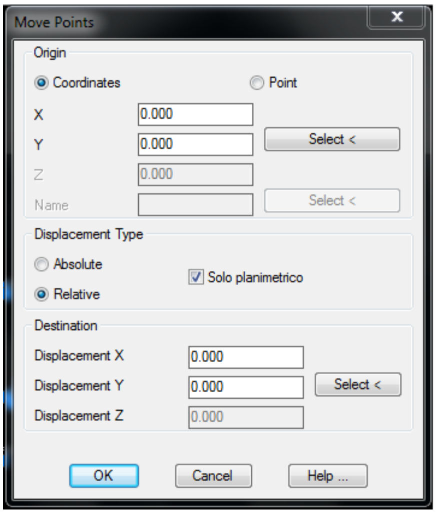
Once the different parameters have been inserted the command will request the points to be rotated using the usual point selection window. After validating this window the selected points will be rotated.



Move Points

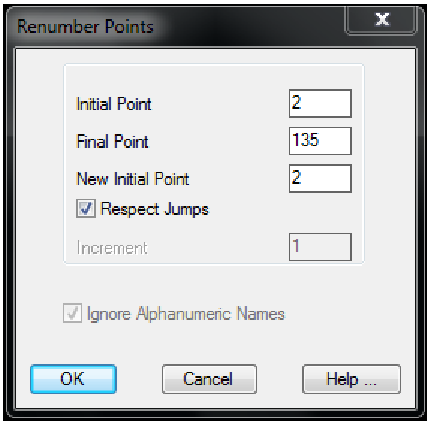
This command enables one to move a scatter plot or a specific selection of its points to a specific position. In order to do so, the base point's coordinates are entered after the points are selected. This can be done manually, selecting them graphically or specifying a specific scatter plot point by indicating its number or marking it in the drawing.

The movement is indicated in either Absolute or Relative terms by activating one or other option and graphically selecting the new base point's coordinates or its relative movement. To prevent modification of the point elevations, check the option P**lanimetrics only.**



Renumber Points

This command allows one to modify totally or partially the numeric order of the points represented in the drawing.



The program displays a dialog box containing the following elements:

Initial Point: Name of the first point one wishes to renumber. This point should be defined, otherwise the program will issue the warning “ERROR: Initial point not found”.

Final Point**:** Name of the final point up o which one wishes to perform the increment.

New Initial Point**:** Point number one wishes the first point requested will acquire. It should be equal to or greater than 1.

Respect Jumps**:** Allows one to indicate whether the numbering should be done respecting any possible jumps or increments of more than one point among various or if, on the contrary, all the points from the initial point should be numbered sequentially.

Increment: When the respect jumps option is deactivated, an increment can be entered that will be successively applied to each point. The points therefore can be renumbered, for instance, ten at a time.

Ignore Alphanumeric Names This possibility is enabled when there are point having a name that is not numerical. By activating it, those points will not be modified.

Along with Import Points and Export Points, this command is very useful to combine various jobs into a single job.

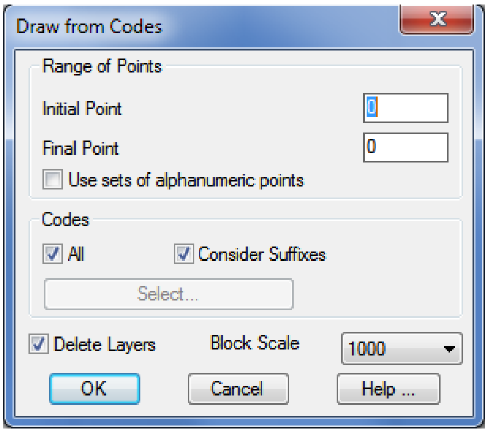
Draw from Codes

This tool is used to draw a set of graphical elements (blocks, lines and areas) from the drawing’s point codes and the shared Codes Database for all the projects.

When this command is executed, one can select the range of points one wishes to work with and if all or just one of the database’s codes are used by clicking on the ***Select*** button. The option **Consider Suffixes** is used when drawing lines to define whether the program will account for the suffixes at the beginning, end, line close, etc.

Moreover, the **Use sets of alphanumeric points** option enables us to use the command for sets of points shared by the same prefix in its name. Hence, the program covers the points with a numeric name from the initial to the final point, and then covers these points separately for each existing prefix.

One can also choose if the program should delete the objects drawn on the corresponding layer before drawing, in addition to specifying the scale with which blocks will be inserted.



One must take into account that if a point has various codes separated by commas, each of them will be processed independently.

Drawing Blocks

Blocks are inserted at any points whose code has been defined in the Codes Database as point type and when the block has been specified on the associated ground plan.

The blocks must be saved as independent drawings (DWG format) in the **Plant** subdirectory, within one of these two directories:

- ***User block*** directory, which can be specified in the parameter with the same name with the command **Tools > Configuration > General.**
- The program installation block directory. By default "C:\Archivos de Programa\Aplitop\MDT6\Bloques\es" in a Spanish installation, if no other installation directory is specified.

These blocks are inserted in the layer specified in the database. Each block's insertion point will coincide with the associated point's coordinates.

Drawing Lines

Polylines are drawn with the coordinates of points whose codes are defined in the Codes Database and line-type points. Additionally, the layer, colour and polyline line type are specified in the database.

The program runs through the points in numerical order and begins to draw a polyline when it discovers a point with a code that is included in the database. Depending on whether the suffixes are accounted for, it checks that the code has the indicative polyline starting text " I" (a space followed by the letter I). Then it continues to draw vertices as it discovers points with the same code (consecutive or not, but respecting its order). If the suffixes are accounted for, there are three possibilities for finishing the polyline:

- Code followed by the end of polyline identifier, "F" (space followed by the letter "F").
- Code indicating the start of a polyline. The current polyline is ended in the previous point and a new polyline is commenced.
- Code followed by the close polyline identifier, "C" (space followed by the letter "C"). In this case, a closed polyline is drawn that links the last point with the first.

Polylines can additionally contain arch segments. For this, "CI" suffixes should be used for the start point, "CC" for the intermediate points and "CF" for the final point. See **Surface Configuration**, ***Break Line Coding*** button.

Example: `TEST.PUN` file

```
1996        5045.832     1061.510    501.879 PT     I
1997        5044.845     1071.420    501.732 PT
1998        5043.683     1081.993    501.461 PT
1999        5043.091     1088.787    501.167 PT
```

2000	5041.971	1093.391	500.915	PT	
2001	5030.666	1108.028	501.395	PT	
2002	5024.684	1110.593	501.910	PT	
2003	5031.066	1101.000	504.437	PT	I
2004	5034.107	1099.849	504.126	PT	
2005	5035.346	1098.567	503.982	OF	
2006	5036.670	1097.461	503.671	PT	
2007	5038.556	1092.508	503.063	PT	
2008	5039.016	1088.253	503.584	PT	
2009	5038.387	1082.490	504.113	PT	F
2010	5037.174	1080.777	504.417	CP	I
2011	5038.500	1080.918	504.286	CP	
2012	5037.571	1073.691	504.841	CP	
2013	5038.561	1073.683	504.699	CP	
2014	5037.641	1066.026	505.287	CP	
2015	5039.541	1066.738	505.105	CP	
2016	5037.979	1056.046	505.906	CP	
2017	5039.174	1056.121	505.826	CP	
2018	5037.459	1052.331	506.239	CP	
2019	5038.846	1052.464	506.155	CP	C

Supposing the PT and CP codes were defined in the Codes Database line-type points and assigned to a layer with the same name, this file would have been drawn as follows:

New Polyline in PT layer, joining points 1996-1997-1998-1999-2000-2001-2002.

Polyline having the same characteristics joining points 2003-2004-2006-2007-2008-2009.

Polyline in CP layer, joining points 2010-2011-2012-2013-2014-2015-2016-2017-2018-2019 and closing with 2010.

Drawing Areas

This option is similar to the previous one, as the program draws a set of polylines with the same criteria as in the case of the lines. The difference lies in the fact that if ***Type*** code in the Codes Database is ***Area***, the program always automatically closes all polylines and then fills them in using a hatched pattern.

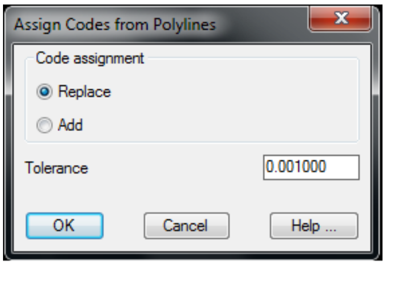
Classify Points by Levels

When a points file is imported or a set of points is created using a conversion command, all the points are initially assigned the same level, normally level 0 (Default Level). This command allows one to classify the points by levels by using their codes. In order to do so, the program analyses each point to see its code is in the Codes Database. Should this be the case, it substitutes the point's level for the level set in the database. The number of points modified is indicated in the command line.

Assign Codes from Polylines

One can assign codes to the points through the points a polyline goes through with this command. The code assigned is the name of the layer where the polyline is to be found.

The option to ***Replace*** or ***Add*** the code to the rest of the codes assigned to the point is offered in the dialog box. Likewise, one can set the minimum distance between the polyline's vertices and the points to which the code will be assigned in the ***Tolerance*** field.



Remove Codes

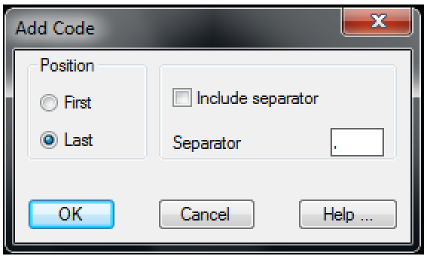
This tool allows one to delete codes assigned to points. In order to do so, one has to select the points whose codes one wishes to delete then specify the code to be deleted. As a result, the code disappears from the point's assignation, and it may even remain blank.

Separators are processed appropriately, so that if they are unnecessary are deleted from the beginning or the end of a code. For instance, if one wishes to delete the PT code from point 1 having the PT,AB code and from point 2 having a CD,PT code, the results will be AB for point 1 and CD for point 2.

This command is complementary to the **Points > Codes > Add Codes** command.

Add Codes

This command allows one to assign one or several codes to a specified set of points. In order to do so, once the set of points chosen has been selected, the code to be specified is selected. After validating it, the following dialog box is displayed.



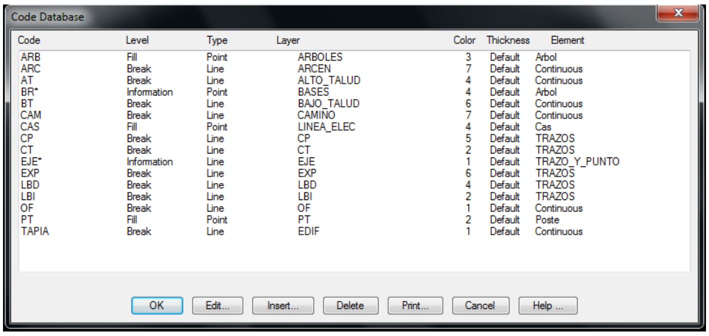
One specifies the new code's position in the point –either at the beginning or at the end of point set codes– in this window. One additionally, determines the possible inclusion of a separator between individual codes, allowing one to enter the most suitable separator.

For instance, if a point has the PK510 code assigned to it and one has selected it in order to add the PT code at the end with a comma separator, the new code will be PK510,PT.

These codes can be deleted using the **Points** > **Codes** > **Remove Codes** command.

Codes Database

This command displays a window allowing one to view and interactively edit the Codes Database's contents.



The list's parameters are as follows:

***Code*:** Text which should coincide with a point's code. Wildcard characters such as "?" (coincides with any character) and "*" (coincides with any group of characters) can be entered. These increase the versatility of drawing from codes, avoiding the need to define more codes than is necessary.

Level: Level assigned to the points when the Classify by Levels command is executed.

Type*:** Type of object the Draw from Codes command draws. Can be ***Point, ***Line*** or ***Area***.

***Layer* :** AutoCAD layer used to draw polylines or insert blocks.

Colour: Sets the colour used to draw polylines.

Element: Depending on the ***Type*** field, can be the name of the block to be inserted if it is Point, the type of line if it is a Line, or the hatch pattern if it is an Area.

The dialog box is equipped with the following buttons:

Edit: Modifies the parameters of the code selected by displaying the dialog box called ***Codes Database Element***.

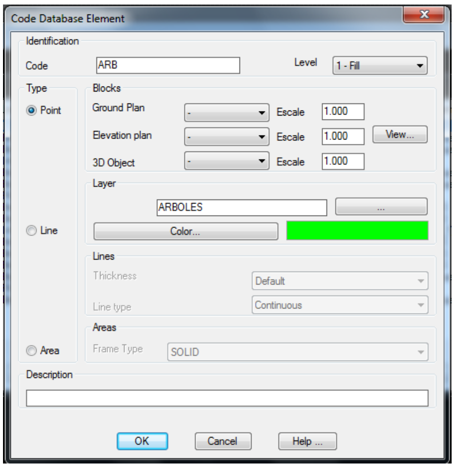
Insert : Enters a new code into the Database. It displays the dialog box called ***Codes Database Element***.

Delete : Deletes the code selected from the list.

Print: Generates a list of codes for the printer or stores it in a text file with a .PRN extension. It displays the ***List for Printer*** dialog box.

Codes Database Element

The parameters of the code selected can be modified by clicking the ***Edit*** button, whereupon the following dialog box is displayed:



For ***Point***-type elements, three different blocks can be set. The ***Ground Plan*** blocks are inserted with the Draw from Codes command. When longitudinal profiles and cross-sections are drawn, ***Elevation Drawing*** blocks are used at the vertices having the relevant code. **3D Object** blocks are used for the Terrain Tour Simulation and Road Tour Simulation commands. Each block has an associated scale factor that is multiplied by the specific scale used by the command.

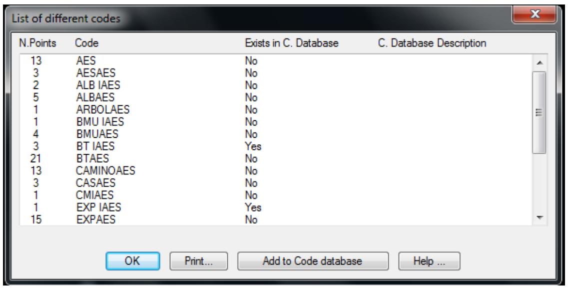
Each element in the database includes a field description where once can enter a more detailed description of what the code represents. This description can be included in points lists (see List Points command).

List of Different Codes

This function has a two-fold purpose: obtaining detailed information about the different codes in the job and the number of points that use them, and to help one create a template from the Codes Database that can subsequently be edited.

Initially, the program displays the ***List of Different Codes*** dialog box with the information above. One can ***Print*** it by clicking on the relevant button.

The ***Exists in C.Database*** column in the window indicates whether or not the code is already present in the codes database. All codes that do not exist in the database are added when the ***Add to Code Database*** button is clicked. Default properties are assigned to these codes, which can be edited using the **Points > Codes > Codes Database** command.



Locate Point

If one wishes to locate a point in a scatter plot that is dense enough to execute any of the existing functions, the **Points** > **Utilities** > **Locate Point** command can be used. The program then request the following information:

Point Number: The number of the point one wishes to locate is entered. If it does not exist, the warning message "ERROR: Point not found" will be displayed.

***Margin*:** Surroundings of the point selected in the viewing window. This value can be changed in points configuration.

The screen will immediately zoom in using the following end coordinates:

$$Xmin = xp - margin \qquad Ymin = yp - margin$$

$$Xmax = xp + margin \qquad Ymax = yp + margin$$

This operation can likewise be performed using the **Points** > **List Points** command, by clicking on the ***Locate*** button.

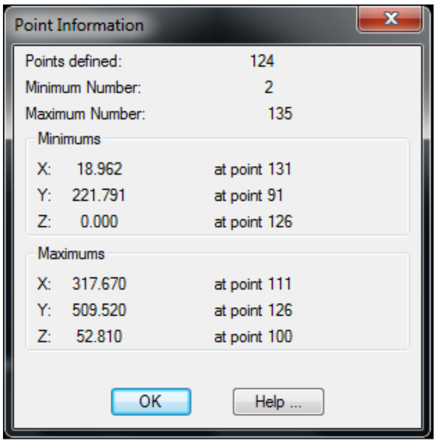
Open Hyperlink

This command is used to open a hyperlink linked to a point. The program continually requests selection of a point, and then if the point does have a hyperlink, it tries to open it with the relevant application. The command Edit Points initiates the same sequence.

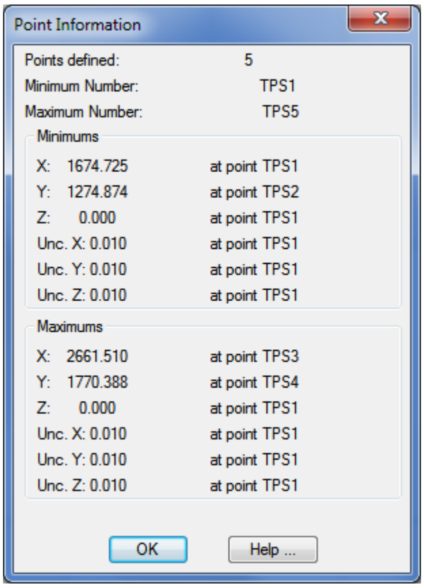
Information

Executing this command provides general information about the points contained in the current drawing through the corresponding dialog box. In it one can view the maximum and minimum values of the X, Y, Z coordinates, the point number that identifies them, total number of points, etc.

It is very useful to locate points having invalid heights or out-of-range coordinates.

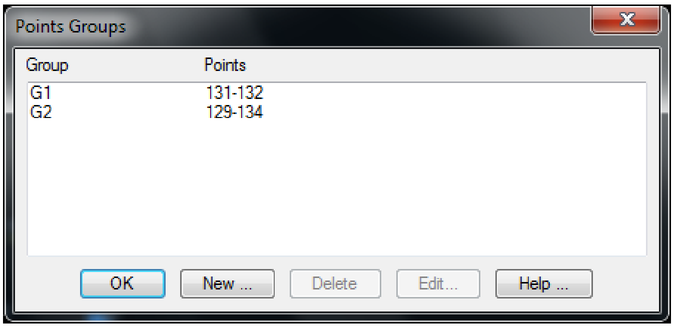


Moreover, if the points have assigned uncertainties, the minimum and maximum values of each of the uncertainties on the X, Y and Z axes are displayed.



Point Groups

This command allows one to create point groups, making if faster to select such points for different sessions within the same drawing. A point may belong to several groups.



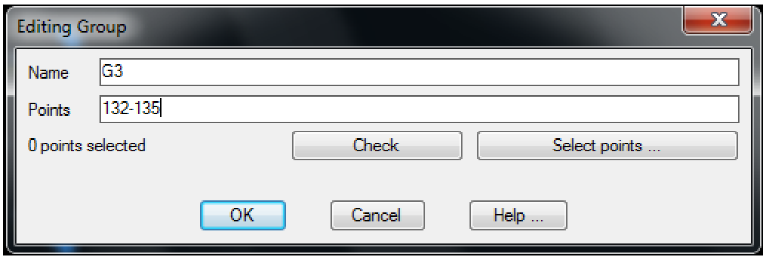
Should this window be opened once a specific selection has been made, it is displayed in the list of groups as ***Last Selection***. It is therefore possible to undo the last operation and perform another operation on the same set of points.

In this window the **New** button is used to create new groups, with the **Editing Group** dialog box.

The ***Edit*** button displays an Edit Points window containing the data of the group selected, thereby allowing one to modify it. One can also delete groups using the ***Delete*** button.

Edit Point Group

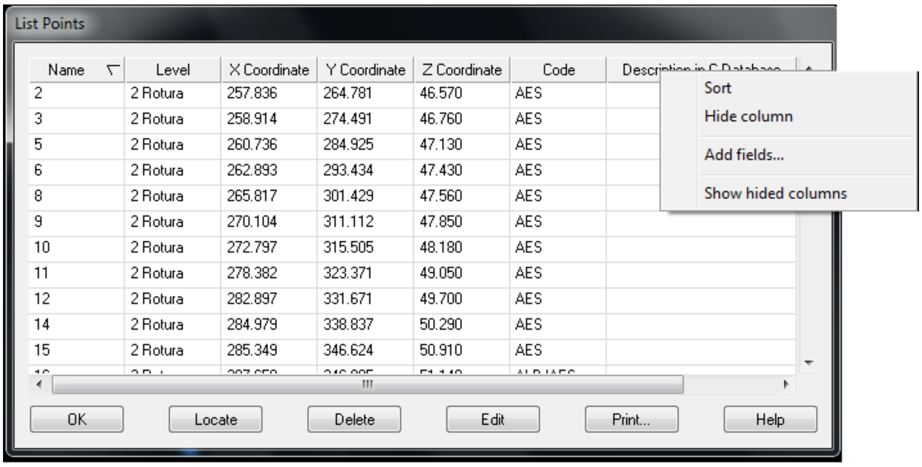
A group is defined and a name assigned to it in this window by entering the point numbers separated by commas and point intervals indicating ends by a dash. The ***Check*** button checks the specified syntax and shows the points found. The ***Select Points*** button allows one to access the normal point selection options and displays the Point Selection window.



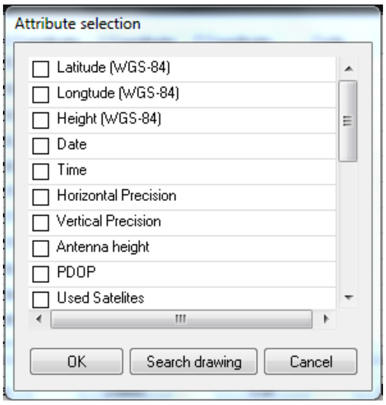
List Points

This command displays a list containing the points selected. It has a vertical scroll bar, that enables one to select a point from the list with the cursor, which can be located on screen by clicking on the ***Locate*** button.

Initially the list appears ordered according to the name of the points, in ascending order. Clicking on the first cell of this column inverts the order. Right clicking on the line that contains the headings displays a menu used to change the field used for ordering, as well as hide and/or add fields to the list. A line of the list can also be hidden by right clicking on it.



When adding a field, a window is displayed with a list of all the predefined attributes that the program recognizes. Pressing the button **Search Drawing**, it runs through it, and in the list displays only the attributes for which a point has a defined value.



It also allows one to edit these points. In order to do so, a point within the list is selected and the ***Edit*** button clicked. The ***Edit Points*** window is then displayed, which allows one to modify any field it contains.

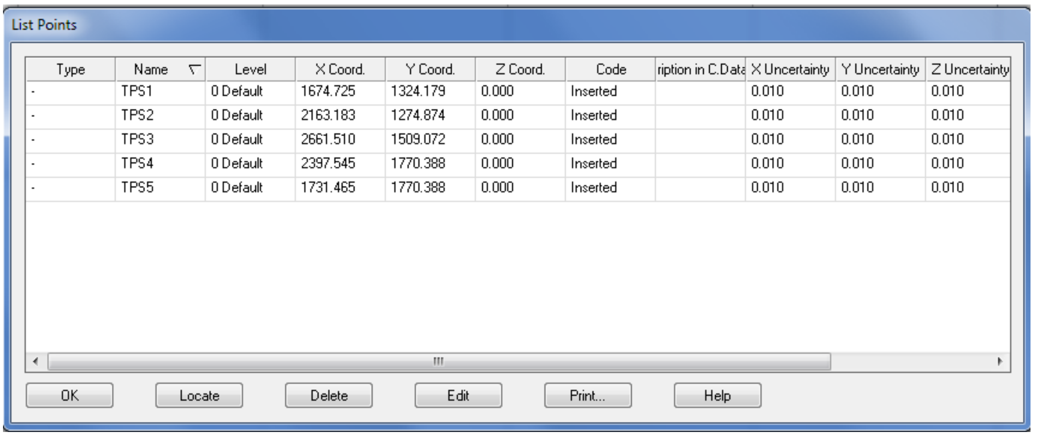
One can choose to ***Print*** in this window. The relevant window is then displayed. The list format in text mode is as follows:

```
POINT LIST
```

Name	X Coord.	Y Coord.	Z Coord.	Code
1	422367.355	4068639.079	70.840	
2	422378.326	4068642.938	71.300	
3	422387.818	4068652.044	71.840	
4	422386.678	4068654.075	71.860	
5	422411.167	4068693.520	73.830	
6	422429.688	4068723.361	75.390	
7	422451.340	4068758.349	77.150	
8	422455.229	4068766.271	77.550	
9	422458.130	4068778.227	78.100	
10	422463.956	4068811.373	79.590	

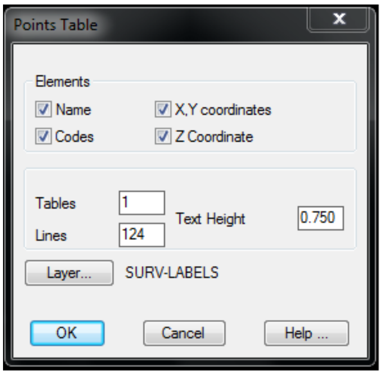
If the title and reference have been defined in the drawing or the project, they will appear centred on the top of the first page of the list See the **Project** command for further details on how to assign such data.

Furthermore, if uncertainties have been assigned to these points, the columns of uncertainties in the X, Y and Z coordinates appear on the list automatically.



Label Points

This command allows one to create a list of the points selected and insert it in the current drawing. In order to do so, the ***Label Points*** window appearing below should be completed.



The elements that will be shown on the table are set in this window, including: Point ***Name***, ***Codes*** and planimetric and Z coordinates. One can also indicate whether the list will be shared out among various ***Tables***. When this parameter is changed, the number of ***Lines*** each table will contain is automatically calculated. Lastly, a ***Text Height*** value is entered, and the layer and style to be used are set.

POINTS LIST				
Name	X Coord.	Y Coord.	Z Coord.	Code
1	348225.751	4070109.638	158.657	AT I
2	348226.490	4070112.474	158.901	AT
3	348230.226	4070115.564	159.334	AT
4	348231.472	4070116.552	159.390	AT
5	348233.667	4070120.183	159.455	AT
6	348234.417	4070122.292	159.407	AT
7	348234.945	4070124.387	159.776	AT
8	348236.073	4070126.483	160.154	AT
9	348235.165	4070130.128	160.105	AT
10	348233.157	4070132.163	160.086	AT
11	348232.458	4070133.380	159.944	AT
12	348233.193	4070135.527	160.743	AT
1090	348201.854	4070132.642	147.095	BT
1091	348204.017	4070132.685	147.678	BT F
1092	348202.430	4070134.497	147.765	AT I
1216	348196.853	4070152.941	148.954	AT
1238	348215.274	4070135.394	151.061	BT
1239	348215.059	4070133.065	150.950	BT

In AutoCAD version 2005 and later, a single AutoCAD table-type object is created if the list is not divided into various tables. The table's appearance is affected by the table's default style assigned in the drawing. In other versions, the table is made up of traditional texts and lines.

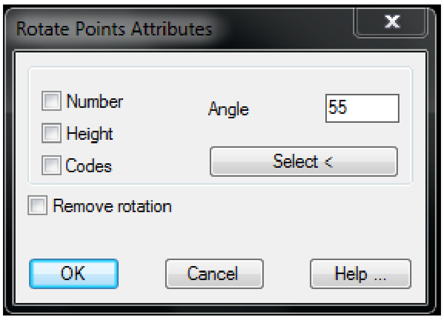
Move Attributes

This command allows one to move an attribute from a point to any other position. It is very useful when text height and number texts get confused because the points are very close. This command allows one to move these attributes, thereby enhancing a job's presentation.

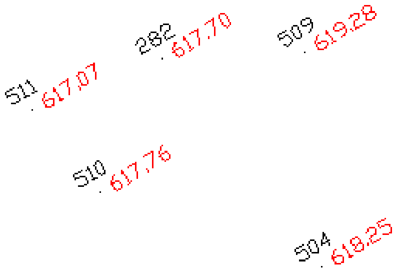
It works very simply. The attribute one wishes to move is selected (by point name, height or code) and then the cursor is situated in the new position.

Rotate Attributes

This command works in a similar way to the command explained in **Move Attributes.** Its functionality is based on aesthetic presentation, especially when it is impossible to frame a job within a specific format using the general coordinates system. It can be rotated until it fits into the format.



Using the **Rotate Attributes** command, one can represent the attribute texts in a different way to the default rotation defined by the drawing and additionally choose the attributes one may wish to modify. In order to do so, one can set the ***Angle*** numerically or graphically with the ***Designate*** button. If one wishes to restore the angle of each attribute to its original value, the ***Remove Rotation*** check box should be activated.



Restore Attributes

Executing this command places point attributes in their original location, thereby deleting any modifications made using the **Move Attributes** or **Rotate Attributes** commands.

Delete Additional Attributes

This command is used to delete the additional attributes associated with the points (observation data, hyperlinks, etc.). First, whether the drawing points have this type of information or not is checked. If they do, it requests confirmation before deleting these attributes.

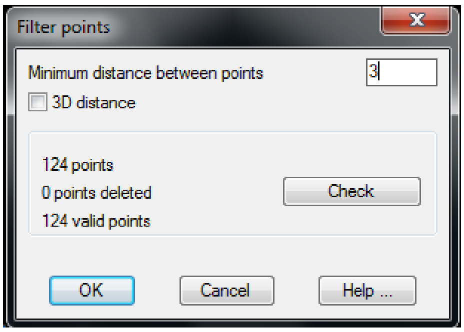
This command does not change the coordinates, names, and codes of the points.

Redraw Points

When a drawing is received from another user, it may happen that the points are drawn in different layers, styles, colours, etc. to the ones defined in the application. By executing this command, the program redraws all a drawing's points in accordance with the configuration defined for the program.

Filter Points

This utility allows one to delete points that are close to each other. The program requests the ***Minimum Distance*** that should exist between the points. Hence, any points that are at a lower distance than the one specified to another point are deleted. With the option **3D distance** the user can select whether to include the point elevation in the calculation, and the **Check** button is used to check the result of applying the filter.



Insert Points on Slope

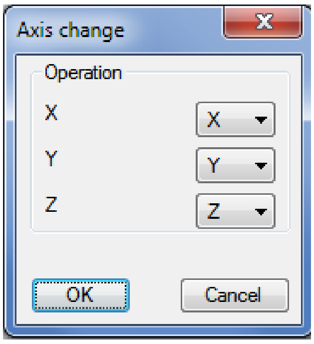
This option allows one to insert a set of points belonging to the same three-dimensional plane into a drawing. The program initially requests one to select an existing point and then requests the slope of the plan to be entered. The program then enters into a loop requesting the X and Y coordinates of the points to be inserted and assigns their corresponding heights, so that all the points inserted allowing with the one initially set share the same plane.

Axis Change

This command enables us to change the coordinates of the points or polylines selected. This is particularly useful for altering projects it is normally not possible to execute using MDT, for example, very steep slopes, tunnels, etc.

There are two ways of executing the command: selecting the polylines or a points file.

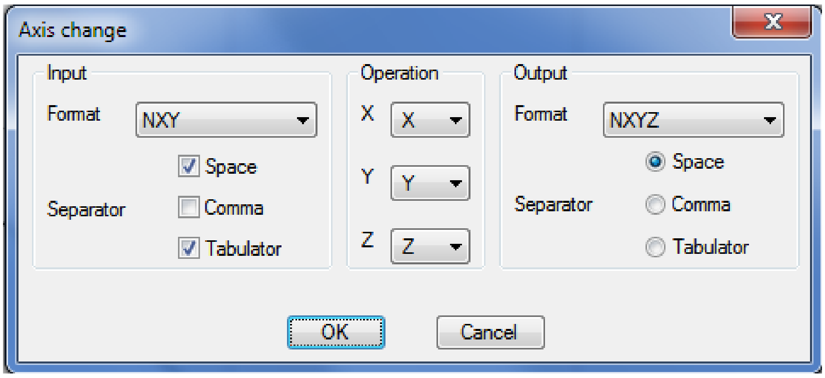
Selecting Polylines: The default option, whereby executing the command enables us to draw a graph of all the polylines whose coordinates we are going to change. Once concluded the following window appears in which the changes to be executed are inserted:



In this case, for example, the X column becomes the Y column, Y becomes X multiplied by (-1) and the Z coordinate remains the same.

The polylines selected will be redrawn on validating the window.

Selecting a file: In this case the change applies to a points file. The following window will appear on selecting this option:



Input: We specify the format of the file used to change the coordinates.

Operation: as in the previous case, we specify the correspondence between the current coordinate and the coordenate to be inserted.

Output: Format of the output file.

On validating this window the command will first ask for the points file in which we are going to change the axes, and then a new file to store the new coordinates once the changes have been made.

Available Points

This command lists the ordinal numbers that are not associated to a specific surveying point. Consequently, when a new point is about to be inserted, one can give it one of these numbers. This command automatically detects the existing jumps in the points list.

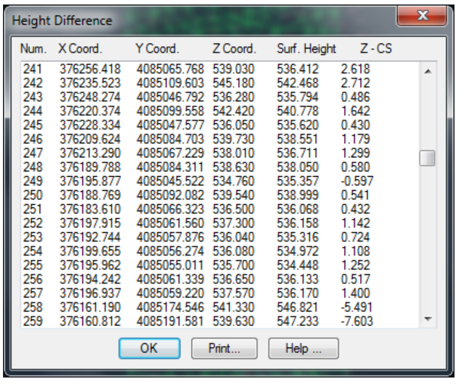
```
Available Points: 53,71,78,746-800,802-805,807+
```

Zoom in on Point Cloud

This tool allows on one to adjust the point cloud to the existing graphics window. This command is similar to CAD's Zoom Extension command, except that this command only takes into account the surveying points selected.

Compare with Surface

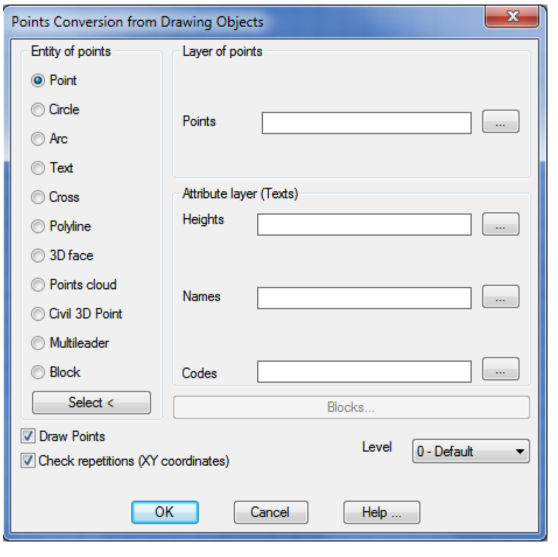
This command allows one to compare the heights of the drawing's points with the current surface. One must firstly select the points (Select Points) and then a list is displayed on screen containing the parameters of the points selected, surface heights at the same coordinates and the difference between both.



Convert Points

Convert Drawing Objects

This tool allows on to easily convert drawing objects created in other programs that define points in space and that contain defined layers into TCP-MDT surveying points,



First, the **Entity of points** type in the drawing must be specified. If unsure, the **Select** < button can be used to select the entity directly, keeping in mind that only the entities that appear in the window are recognized. For each type of entity, the program will create an MDT point in the following coordinates:

- Point: its own coordinates.
- Circle: Centre.
- Arc: Centre.
- Text: Point of insertion.
- Cross: Intersection of the two lines.
- First Polyline: Initial vertex.
- Block: Point of insertion.
- 3D face: each one of the vertices.
- Points cloud: each of the points contained in the cloud. This option is only available for AutoCAD 2013 onwards.

As well as the entity type, the ***Layer of points*** that the program should analyse must be specified, except when converted into blocks.

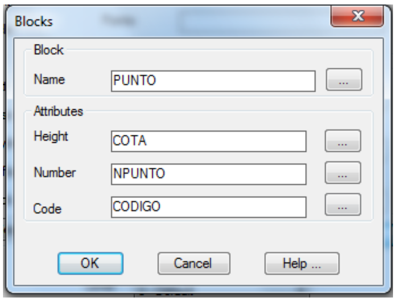
As an option the program can search additional attributes of the point in text type entities. To do this the layers corresponding to each attribute must be specified.

Elevation layer: The layer where the texts of the elevations are located. If they are not specified, each point is assigned its entity elevation, if it is in 3D.

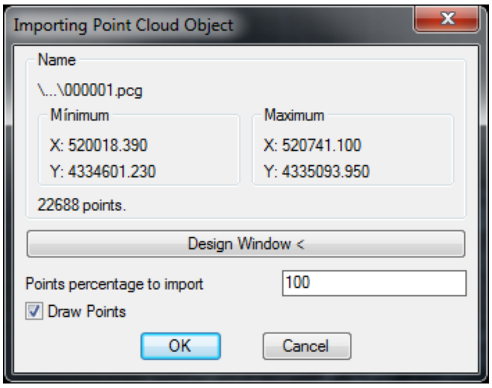
Numbers Layer: Layer with the point names texts. If they are not specified, the points are automatically numbered.

Code Layer: The layer where the assigned codes are located. If these are not specified, no code is assigned.

When the type of entity to be converted is a block, the ***Blocks*** button displays an additional window where the block attributes to be accounted for in the conversion are specified. If attributes are not specified, the program will do the same as with the other entities, and search for texts in the layers previously described.



If converting points cloud type entities, a window appears providing information about the dimensions of the cloud and the number of points it contains. A smaller window may be selected or a percentage of the points to be imported. There is also the possibility of not drawing the converted points so as not to load excessively the drawing.



Draw Points: This box will be activated by default and will draw the points automatically. If it is deactivated, the points will not be drawn but will be stored in the memory.

Check Repetitions: Provides a report with the points which have not been converted due to the fact their coordinates have been repeated at another point.

Once the process has finalized, the program indicates the number of points created with the criteria above. The drawing's original objects are kept unchanged.

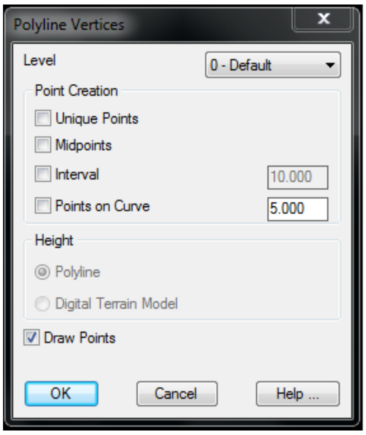
Convert Polyline Vertices

This command makes it possible to convert each of the vertices making up a polyline into surveying points, in addition to other options. The dialog box allows one to specify the ***Level*** of the new points to be created.

If the ***Unique Points*** check box is activated, the program inserts a point at each of the vertices (if it is not already inserted).

If the polyline is elevated (3D or 2D and elevation), the points take the height of the corresponding vertex. On the contrary, if the polyline is on the plane, the program will attempt to interpolate the vertices' heights from points whose height is known. If this it is not possible, a height of zero will be assigned to all of them. Additionally, if the ***Digital Model*** is defined in the drawing, one can obtain the heights from it by marking the option carrying the same name.

If the ***Midpoints*** option is marked, a point will be inserted at each of the midpoints of the vectors making up the polylines. Independently, if the ***Interval*** option is selected, a point will be inserted every certain distance beginning from the polyline's starting point.



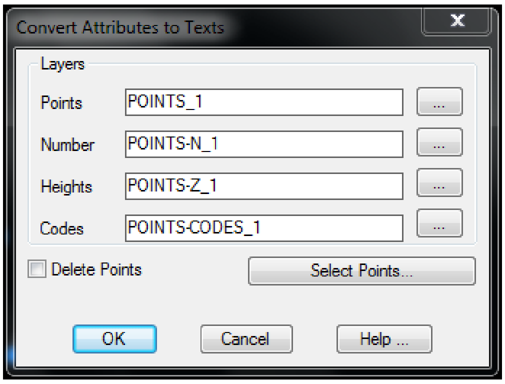
If the ***Points on Curve*** box is marked, the polyline's curved sections are also converted by the command. Points are inserted at the distance specified in the box to the right.

The ***Draw Points*** option controls whether or not the points to be generated with the command are to be drawn. It may sometimes be useful to deactivate it when a large number of points will be generated. Nevertheless, if one wishes to make a digital model from contour lines, it is more convenient to use the powerful model creation options offered in the ***Surfaces*** > ***Create Surface*** command.

Once the process has finalized, the program displays the number of points successfully created.

Convert Attributes to Texts

This tool allows one to convert the points' attributes into conventional texts, so that they can be handled as such making it easier and more flexible to work with them than with the normal attributes.



The dialog box allows one to specify the layers where the ***Points*** and the ***Number***, ***Height*** and ***Code*** attributes will be drawn. The original point can be deleted from the drawing after the texts are created by activating the ***Delete Points*** check box.

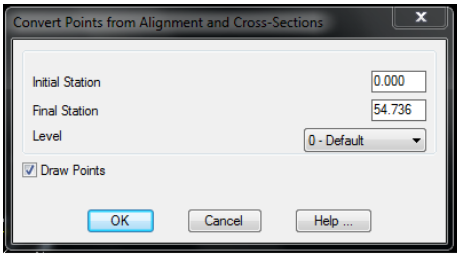
If not indicated otherwise, this command works with all the drawing's points. By clicking on the ***Select Points*** button, one can enter a set of arbitrary points to convert their attributes.

Convert Surface Vertices

This command allows one to obtain points from an already defined triangulation obtained from a mapping a contouring, etc. Each of the current surface's vertices are converted into surveying points, and information is provided on the number of vertices created.

Convert Alignment and Cross Sections

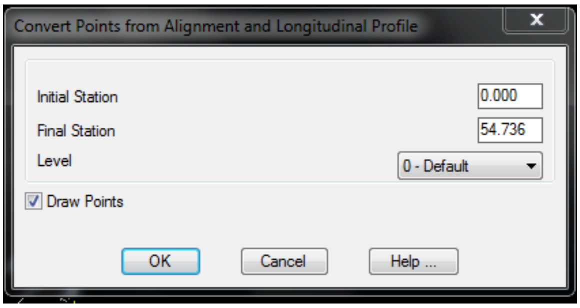
This command creates a point for each of the profile's vertices from a horizontal alignment defined graphically or from a file and a cross-sections file. The X and Y coordinates are calculated by projecting the distance of the profile's vertex with regard to the horizontal alignment, while height is equivalent to the profile's height. Each point's code will be the code of each vertex should they be defined.



The dialog box allows one to perform this operation with a subset of profiles by entering the ***Initial station*** and the ***Final station,*** choosing the ***Level*** to which the points will belong and controlling whether or not they will be drawn with ***Draw Points*** check box.

Convert Alignment and Profile

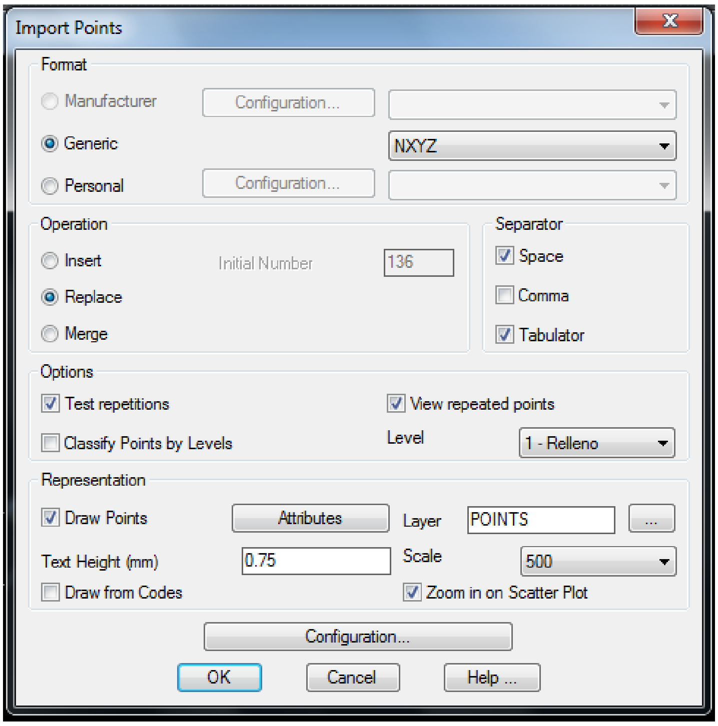
This command creates a point for each of the profile's vertices from a graphically defined horizontal alignment or from either a horizontal alignment or segment file. The X and Y coordinates are calculated by interpolating the position on the horizontal alignment at each vertex's station, while height is equivalent to the profile's height. Each point's code will be the code of each vertex should they be defined.



The dialog box allows one to perform this operation with a subset of profiles by entering the ***Initial station*** and the ***Final station,*** choosing the ***Level*** to which the points will belong and controlling whether or not they will be drawn with ***Draw Points*** check box.

Import Points

This command allows one to convert an ASCII coordinates file into points that can be read by MDT. The ***Import Points*** window dialog box requesting the parameters to be entered appears when this command is executed.



Format

The structure of the initial file is defined in the ***Format*** section, in which three alternatives are available:

Manufacturer: The format established by different programs, electronic data recorders, etc. Some of these allow various formats. Hence, the possibility exists of the configuring the structure through the ***Configuration*** button.

Generic: This option allows one to choose one of the following options from a drop-down list: XYZ, YXZ, ZXY, ZYX, XY, NXYZ, NYXZ, NZXY, NZYX, NXY and Ms Access, where N= Point number, X=X Coordinate, Y=Y Coordinate, Z=Z Coordinate. The default format is NXYZ. The former options are variations in the ASCII file’s field order.

Personal: A format that can be defined by the user with the configuration file (see **Customization Manual**).

The character used as a field separator (***Space***, ***Comma*** or ***Tab***) should be specified from Generic formats. If the ***Comma*** separator is not used, the program can import files whose decimal separator is a comma in addition to those using points as a decimal separator.

Operation

There are three ways of performing import operations:

Insert is used to add points to exiting points. The ordinal number of the points in the file to be imported is ignored and the new points are imported from the initial number entered in the dialog box.

It is the default option. ***Replace*** deletes all the drawing's points and replaces them with the points imported.

Lastly, the ***Merge*** option takes into account point names and only adds points to the new file whose number no longer exists in the scatter plot.

Options

One can define different processes that are executed once the points have been imported in the Options section.

Check Repetitions, the program runs different checks to identify repeated points, by name and by coordinates. Activating the option ***See Repeated Points*** displays the corresponding list.

Classify points by levels: for each point, whether its code is specified in Code Database is checked, and if so the corresponding level is assigned. If not, the points are included in the specified ***Level***.

Representation

For the points representation, it must be kept in mind that it is possible not to draw the imported points. This substantially increases the importation process for large files, and also the size of the drawing is not increased. The points that are not drawn behave exactly the same as those that are represented, they can be listed, triangulated, exported, etc., but they are not saved in the file. Therefore, when closing the drawing in CAD the points are lost.

Drawing from Codes: represents graphic elements associated with the codes in the Code Database.

Zoom in on Points Cloud: changes the CAD view so that all the points are visible on the screen.

Finally, the ***Configuration*** button gives access to the points configuration, for which it is recommended to view the **Points Configuration section**.

After validating the import the points file selection is accessed, the extension of which will accord with the format selected. The name of the file by default will be the same as the name of the drawing. The extension of the format by default NXYZ can be changed in the points configuration.

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Points File Format

The contents of a points data file consists of a series of lines, each of which contains a series of fields separated by a separator. It is not necessary for the points to be in order. A code of up to 255 characters can optionally be included at the end of each line. A file fragment having the program's default format is shown below

Example: `DEMO.PUN` file

```
156     20329.982       10794.929       341.850  FILLING
157     20340.044       10788.699       345.510  FILLING
158     20348.481       10783.943       348.200  FILLING
159     20362.966       10773.674       357.160  EDGE
160     20374.059       10759.334       358.600  EDGE
161     20382.959       10746.893       358.260  EDGE
162     20389.362       10732.626       355.190  EDGE
```

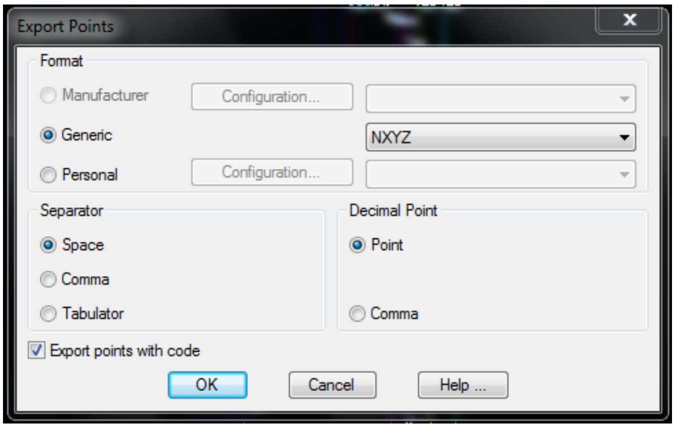
163	20382.768	10719.012	355.970	EDGE
164	20374.287	10706.949	356.080	EDGE
165	20349.239	10716.461	352.050	FILLING
166	20335.434	10720.082	350.390	FILLING
167	20311.123	10726.424	347.120	FILLING
168	20291.163	10730.610	344.910	FILLING
169	20363.322	10785.258	355.040	EDGE
170	20350.357	10790.070	347.270	FILLING
171	20340.376	10794.961	343.950	FILLING

Importing raw GPS data

If the points have been taken using the TcpGPS application and the raw data file is in the same folder as the coordinates file, other attributes will be imported such as the date and time, type of position, latitude and longitude, antenna height, number of satellites, etc. Moreover, the horizontal and vertical positions estimated by the receiver are assigned to the coordinates as uncertainties. See the Geodesic Calculations chapter in the User Manual for further details.

Export Points

The modifications or operations made with the functions specifically belonging to the **Points** menu only update the drawing. Imported files are not changed. This command exists in order to be able to create or update a points file. Initially, the window to select the points to be exported is displayed. Then the following dialog box is displayed.



Three alternatives are offered in the ***Format*** section:

Manufacturer: The format established by different programs, electronic data recorders, etc. Some of these allow various formats. Hence, the possibility exists of the configuring the structure through the ***Configuration*** button.

Generic: This option allows one to choose one of the following options from a drop-down list: XYZ, YXZ, ZXY, ZYX, XY, NXYZ, NYXZ, NZXY, NZYX, and NXY, where N=Point name, X=Coordinate X, Y= Coordinate Y, Z= Coordinate Z. The default format is NXYZ.

Personal: A format the can be defined by the user using the configuration file. See the **Customization Manual** for further details.

One can additionally indicate which character will be used to separate the file's fields (***Space, Comma*** or ***Tab***) for generic files, as well as set the ***Decimal Point*** for the points' coordinates (default option is ***Point***).

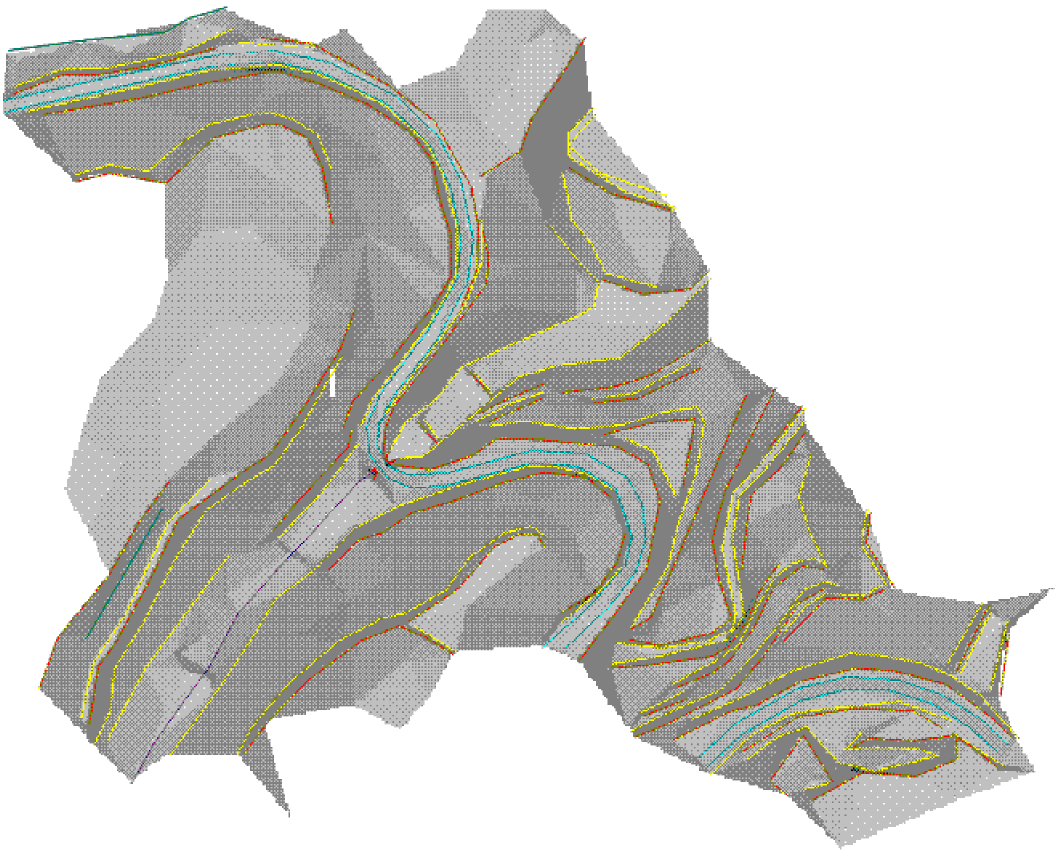
The option **Export points with code** establishes whether the information defined in the format includes a separator and a point code.

3. Break Lines

Break Line Definition

The options of this group of commands allow break lines to be defined if the tools available for exploiting code possibilities have not been used, which is generally advisable.

These comprise different tools to manually, automatically and semi-automatically define break lines, which will *a priori* generally have to form part of the obligatory lines used to form part of the digital terrain model either due to either the terrain's characteristics or the specific way of viewing it. Defining them is not obligatory. However, it is highly advisable to ensure the work is valid and accurate, given that these lines define the relief marked by existing slope changes.



In this example, we can see how the surface adapts itself to the slope changes represented by the break lines, troughs, slope crowns or feet, construction lines, white road lines, etc.

Break lines are conventional CAD polylines that are defined on specific layers. These polylines' vertices may or not coincide with surveying points. If they coincide on the ground plan, the triangulation considers the point's height Obviously, if they do not coincide, the height of the polyline's own vertex is taken.

These polylines can be drawn on the plan or the space, depending on whether the ***3D Break Lines*** parameter is activated in the program's configuration of the program, **Utilities > Configuration >**

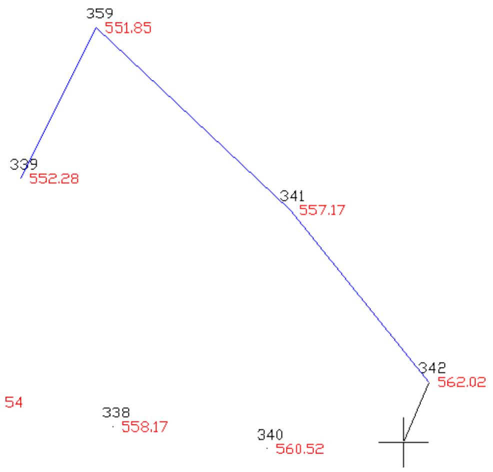
Surfaces. It is normally advisable to draw them in 2D, since all kinds of editing operations can be performed with the CAD commands, which would be more difficult in three dimensions. Additionally, these objects contain no additional information associated to them, so they can be treated by users as they wish. If the triangulation is defined and one wishes to include new break lines, the triangulation has to be repeated by selecting the layers where the break lines are found.

The application does not check if there are cuts in the break lines when it draws, so the user has to do so. In any case, triangulation cleanup commands have been implemented and they should be used to detect these cases. One example is the **Check Break Lines** command.

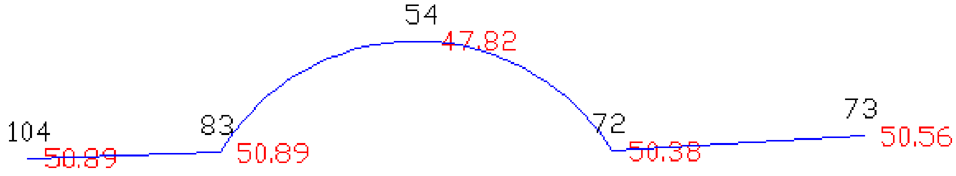
Break Lines by Closest Point

This command allows one to draw break lines between surveying points by taking the points closest to the coordinates selected as vertices. When this command is run, the ***Layer Selection*** window is displayed, where the layer in which the new break line will be is selected.

The polyline vertices should then be successively selected with the mouse. It is not necessary to use the reference to CAD objects mode to select the points, since it is sufficient to determine a coordinate close to a point because the program searches for the closest point. The polyline is drawn section by section and the last point can be undone by typing in **R** or **U** on the keyboard. By entering **C**, the polyline is closed with the first point and by right clicking the mouse, the polyline is terminated. As many lines as ones wishes may be drawn until one responds with the *<Enter>* key to the **First point** question:



It is possible to draw arcs. By pressing **A** on the keyboard, the program first requests a crossing point for the arc, initially drawing a straight line. Then it requests an end point for the arc, and it substitutes the previous straight line with an arc. In the following example the points 104, 83, 54, 72, 73 are selected with the mouse, pressing **A [Intro]** before selecting 54.



Points whose visibility from the point has been deactivated by the **Points > Visibility** command are not considered in this command, as well as in all other break line commands requiring a search for the nearest point.

Break Lines by Point Numbers

If the number of the points configuring the break lines is known as a result of generating field sketches or notes, this option allows one to draw by merely typing in the point numbers in question instead of selecting them with the mouse. Entering **C** closes the polyline with the first point entered. The polyline is then terminated with a blank line.

Break Lines by Interval

This option is aimed at making it easier (whenever possible) to draw break lines. After selecting the layer on which the polyline is to be drawn, the program requests the following information:

Initial Point: Number of the first point to be processed, which must be defined.

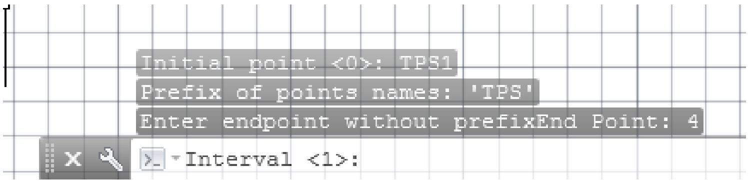
Final Point: Number of the final point to be processed, which must also be defined.

Interval: Whole number increment (positive or negative) in the numbering.

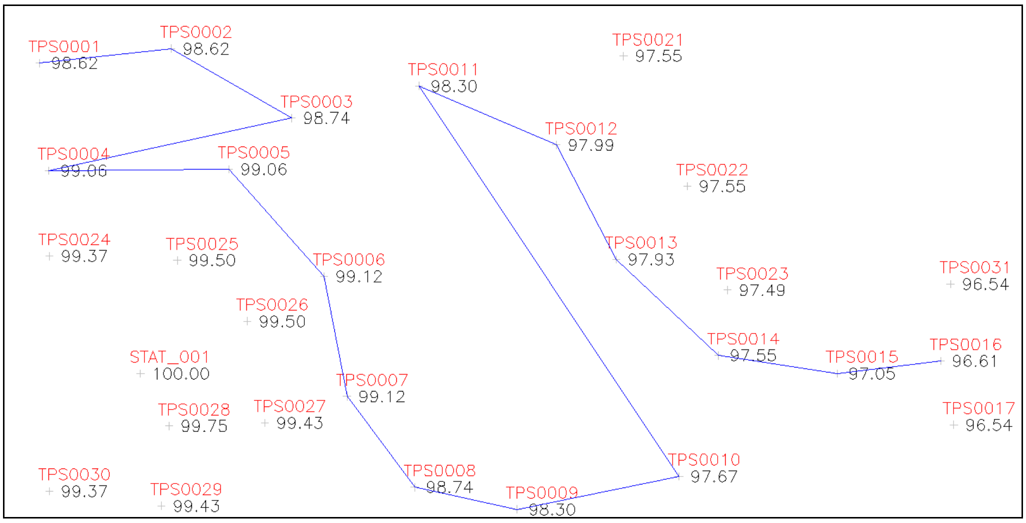
For example, if one wishes to join points 1, 3, 5, 7 and 9 in that order, we will reply with 1, 9 and 2 to the above questions.

Additionally, the command features the option of using the suffixes in the names of the points, in other words, joining all the points in accordance with the interval indicated and with the suffix specified in the initial point.

The shot below shows the command being executed by inserting "TPS1" as the initial point, "16" as the final point (without a suffix) and "1" as the interval;



The final result can be seen in the following image:

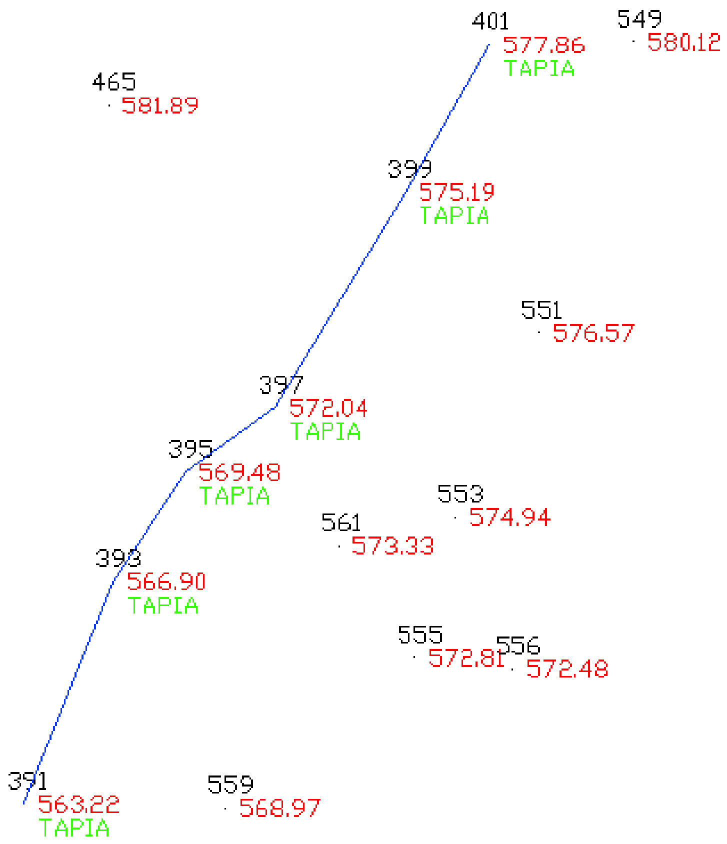


All the points in the sequence do not have to exist although the first and the last must be defined.

Break Lines by Code

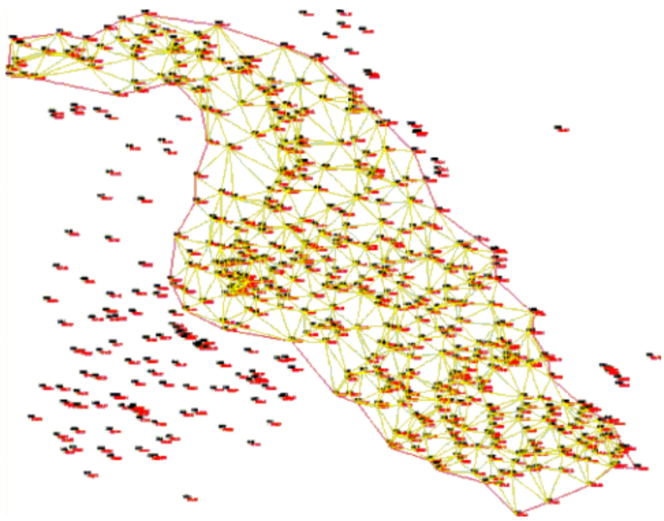
Automatic point coding capture with field data recorders or doing so manually on an ASCII point file not only facilitate drawing break lines but also the planimetry.

This command creates a break line joining all the points having a certain code, following the order of the points' numbers. It first requests a code and then a layer where the polyline is to be drawn.



Boundary Line

A boundary line is defined as the geometrical demarcation performed on the scatter plot delimiting the digital model area. In other words, triangles are not formed with the points that are not within the boundary. This tool facilitates editing a great deal, avoiding having to delete external lines created during triangulation and within its parameters.



This command allows a closed polyline to be drawn with assistance. The process is like the one offered in **Break Lines by Closest Point,** and the layer used by default in BOUNDARY.

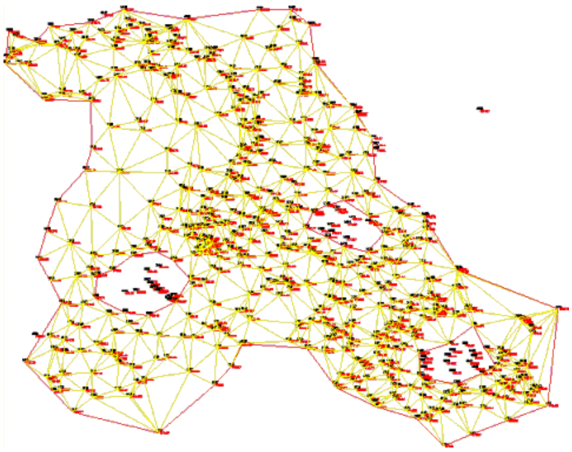
Although the boundary line is drawn, it does not necessarily have to be respected. It can be enabled or disabled in the triangulation process dialog box.

Find Boundary

The boundary of the current surface, if it is defined, can be found with this command. The polyline obtained will be drawn on the BOUNDARY layer and can be used to define the boundary when creating other surfaces related to the drawing.

Islands

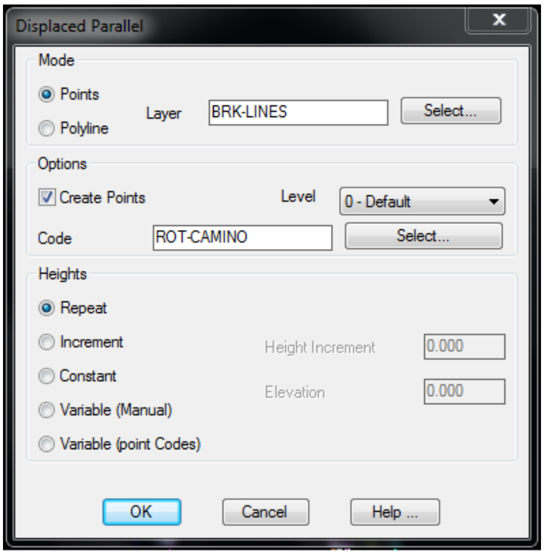
An island is an area defined within the scatter plot in which triangulation is not intended. This area acts as a space in which the digital model is not defined, and one therefore cannot work inside it. There can be several islands within the same scatter plot.



The command allows one to draw polylines delimiting islands. The ISLANDS layer is used by default and the process is identical to the one in the **Break Lines by Closest Point** command, with the peculiarity that the polylines are always closed.

Displaced Parallel

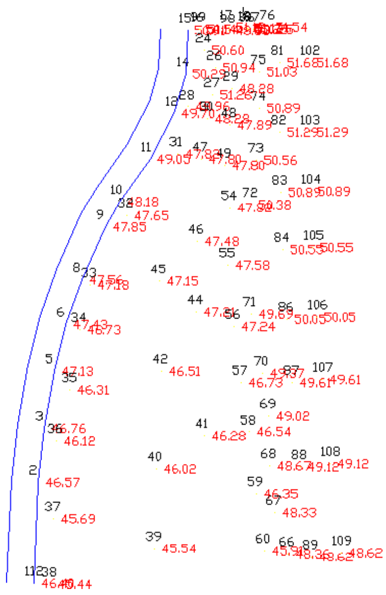
This command allows one to create break lines that are parallel to other break lines. It is very useful to define roads, pathways, streets, walls, etc., where only one edge has been measured and the parallel distance to another or others is known, in addition to the other edge's relative or absolute height.



There are two ways of executing this command. In the ***Points*** mode, a polyline is drawn as with the **Break Lines by Closest Point** command and then a line parallel to it is created. In the ***Polyline*** mode, a polyline that has already been drawn is selected as a reference to create the parallel line.

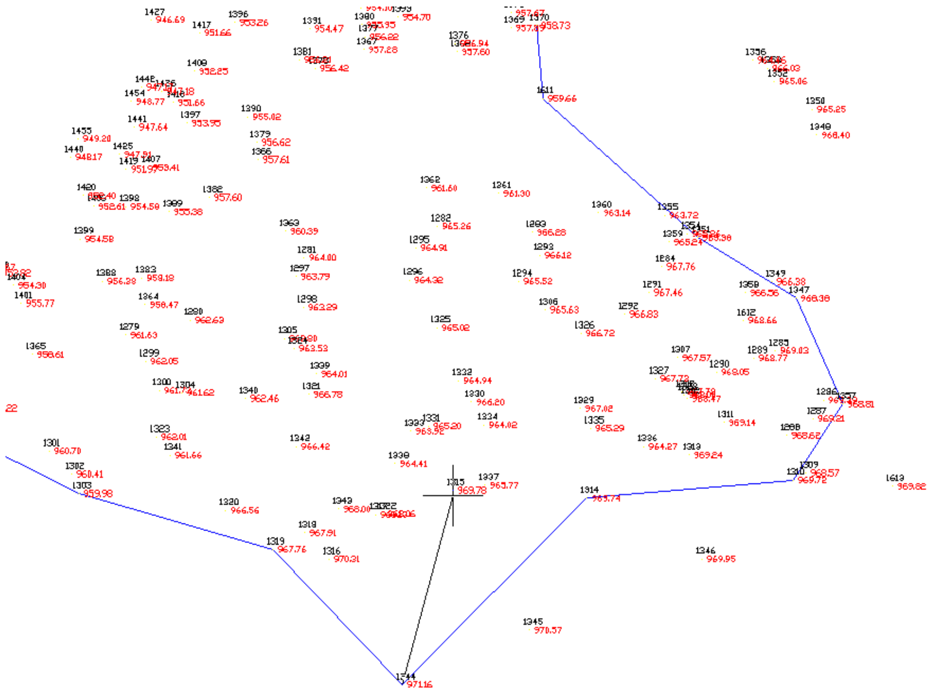
In order to create the parallel polyline, the program first requests an orientation indicating a point to the left or to the right of the original polyline and then a distance to the reference polyline. Concerning height, one choose among ***Repeat*** the original polylines heights, apply an ***Increment*** to them, use a ***Constant*** height, enter the height at each vertex in a ***Manual*** manner, or use the ***Point Codes*** as an increment for the original height in centimeters.

If the ***Create Points*** option has been activated, surveying points will be created at each of its vertices with the code selected in addition to the polyline being drawn.



Modify Break Lines

This command allows one to edit polylines that define break lines, boundary, islands, etc., thereby facilitating and improving the process of moving, inserting or deleting polyline vertices.



Firstly, the program request the polyline to be modified, and then displays three types of modifications on the command line:

Move: Displaces the vertex selected to the closest surveying point.

Insert : Adds a new vertex on the section of the polyline selected.

Delete : Deletes the vertex selected.

Check Break Lines

Break lines are very useful to define relief effects. However, it is essential to have a tool available to check such lines. This command has therefore been implemented, which enables errors to be detected by drawing a series of marks on specific layers. The different error detection possibilities that can be activated in the dialog box designed for this purpose are described below:

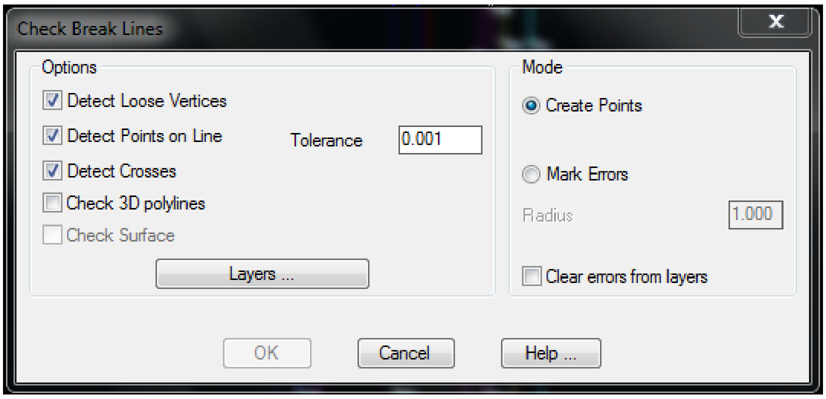
Detect Loose Vertices: Determines polyline vertices in which there are no surveying points. The marks are represented on the ERROR_VERTICES layer.

Detect Points on Line: Finds the surveying points closest to polylines considered as break lines, and which should possibly be its vertex. They are drawn on the ERROR_POINTS layer.

Detect Crosses: Examines the crossings between break lines, which could possibly be due to an interpretation fault. The errors are drawn on the ERROR_CROSSES layer.

Check 3D Polylines: Checks whether there is a height difference between surveying points and polyline vertices.

Check Surfaces: Determines whether the break lines are included on the current surface. If there is an error, it is represented on the ERROR_SUP layer.



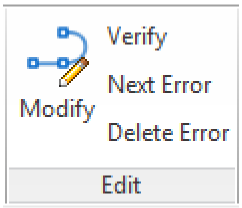
The ***Radius*** parameter defines the circumference used to mark possible errors on the drawing. ***Clean Error From Layers*** deletes all objects from the layers used to mark the errors.

The ***Layers*** button allows one to select the layers to be checked for possible errors.

Once the faults in the break lines that could considerably distort the digital terrain model have been detected, they can be checked either manually by creating a layer on which the errors are displayed or automatically by generating points where the error has been detected, activating error marks or creating points, respectively.

Check Break Lines

Possible faults are checked manually using the following toolbar:



These buttons allow one to zoom in on the area surrounding the errors. Once the error has been corrected, the circle marking it has to be deleted to enable the next one to be found when the toolbar button is clicked again. If there are no further errors, the toolbar disappears. The location margin can be modified by clicking the fifth button, and similarly the last button allows the ***Check Break Lines*** window to be displayed once again.

Next Error

This command enlarges the next error on the current layer with the predefined location margin. This command displays the ***Break Line Error*** toolbar again.

Delete Errors

This command deletes all the marks indicating the error found through the **Check Break Lines** command. The command should be executed once again to recover them.

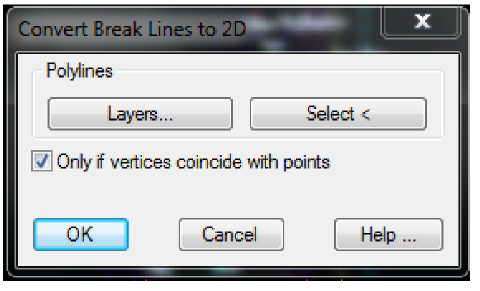
Location Margin

This command allows one to configure the size of the zoom used to locate break line errors.

Convert Break Lines to 2D

At times it may be useful to place the break lines on a plan upon which it is easier to perform certain operations. This command has therefore been implemented, which converts break lines to 2D on the zero height reference plan.

As shown in the following dialog box, the break lines to be converted can be selected either from the layers on which they are drawn or by identifying them graphically.



Activating the ***Only if Vertices Coincide with Points*** option allows one to only convert to 2D any break lines whose vertices coincide with surveying points. It is then possible to convert them to 3D, ignoring the 3D polylines that could have previously been represented on the drawing.

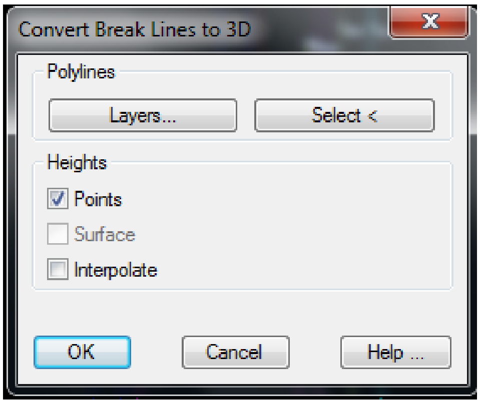
Convert Break Lines to 3D

This command enables break lines to be converted to 3D. Once the polylines to be converted have been selected either by layers or by manually selecting them, the Z coordinate of origin of each of the vertices should be specified. Three options are available for this operation:

Points: The height values assigned to the polylines' vertices are the height values of the corresponding surveying points.

Surface: The Z coordinate assigned to the vertices is obtained from the current surface through planimetric coordinates.

Interpolate: The height assigned is calculated by interpolating or extrapolating the closest vertices' height values.



The command has an order of preference when it comes to assigning heights. Firstly, it assigns the values corresponding to any surveying points coinciding with the polyline's vertices. If this is not the case, the heights are obtained from the current surface. Finally, if this is not possible either, the height is calculated by interpolating or extrapolating the closest vertices.

Assign Surface Heights to Break Lines

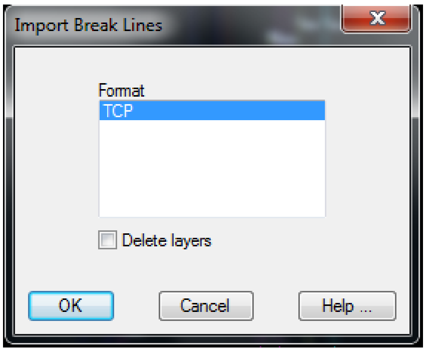
By means of this command, the height of the elements specified is assigned from the current surface. In order to do so, the command determines the height from the planimetric coordinates of each vertex by orthogonally projecting each of the selected objects' vertices on the current surface.

The command request objects to be selected and then modifies the polylines in the following way:

- It assigns the height corresponding to each vertex according to the current surface.
- Along each polyline segment, a vertex is inserted at each intersection of the polyline with the edge of a triangle on the current surface.

Import Break Lines

This utility allows one to draw the break lines defined in files having different formats. The following window allows one to select the file format types from different programs.



Files with a `.ROT` extension are DTM break line files. These files are easy to edit text files having the following structure.

The first line must contain a valid layer name, a color and an optional type of line, each separated by a space. This data will be used to create a layer on which to draw the break lines specified from now on, until a line of this type is found.

There are two ways of defining break lines. When one wishes to join a series of consecutive points, the first and last numbers and the numbering interval separated by one or several spaces simply have to be entered. For instance, when line "35 41 1" is read, the program will draw a line joining the points 35,36,37,38,39,40 and 41 in increasing order. The final point should be greater than the initial point, or otherwise the program will abort and show the following message "ERROR: Point invalid point interval on line X". It is not necessary to define all the points within the interval, but at least two of them have to be specified.

The other possibility consists of specifying a sequence that does not follow an arithmetical progression or respect the order of point numbers. Point numbers separated by commas must simply be written. All these points have to be defined on the scatter plot. Otherwise, the program issues a warning by displaying the following message: "ERROR: Point X does not exist on line Y".

The polylines end with a line that is either blank or has “C” as its first character, in which case it will close with the first point.

Example: `DEMO.ROT` file

```
BROOK 5 BROKEN
45
19 12 -1
STATION 7 DASHDOT
48
11 1 -1
43
68 72 1
51
BOUNDARY 4
42 45 1
73 79 1
12,46
48 51 1
41
C
```

This file would be interpreted as follows:

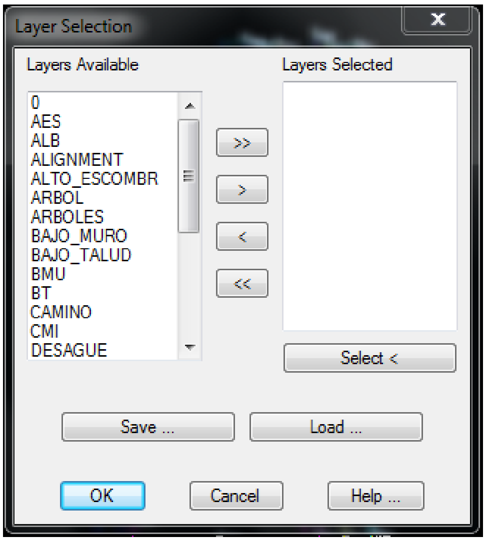
Creation of a layer called BROOK with color 5 (blue) and BROKEN line type; and line 45-19-18-17-16-15-14-13-12 will be drawn inside it.

Creation of the STATION layer with color 7 (white) and DASHDOT line type, in which the 48-11-10-9-8-7-6-5-4-3-2-1-43 and 68-69-70-71-72-51 lines are traced.

Creation of the BOUNDARY layer with color 4 (cyan), drawing line 42-43-44-45-73-74-75-76-77-78-79-12-46-48-49-50-51-41 and closure with point 42.

Export Break Lines

It is possible to generate break line files with this command. Firstly, the command asks for the name of the file to be created, and then asks for the list of layers containing the polylines to be processed. It then saves the information on all the lines and polylines drawn on these layers in a file with the `.ROT` extension.



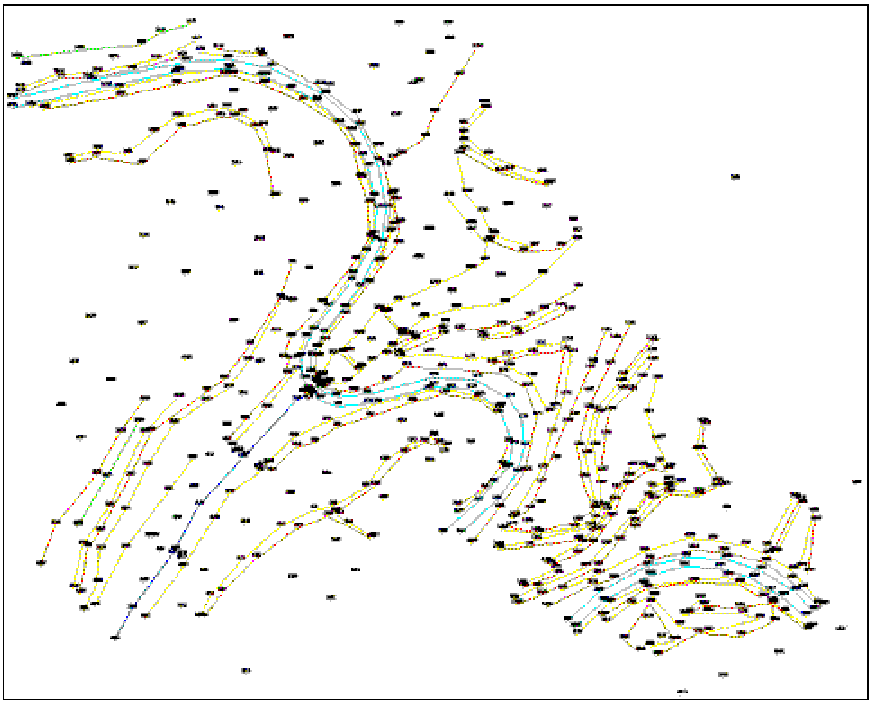
4. Surfaces

Surfaces

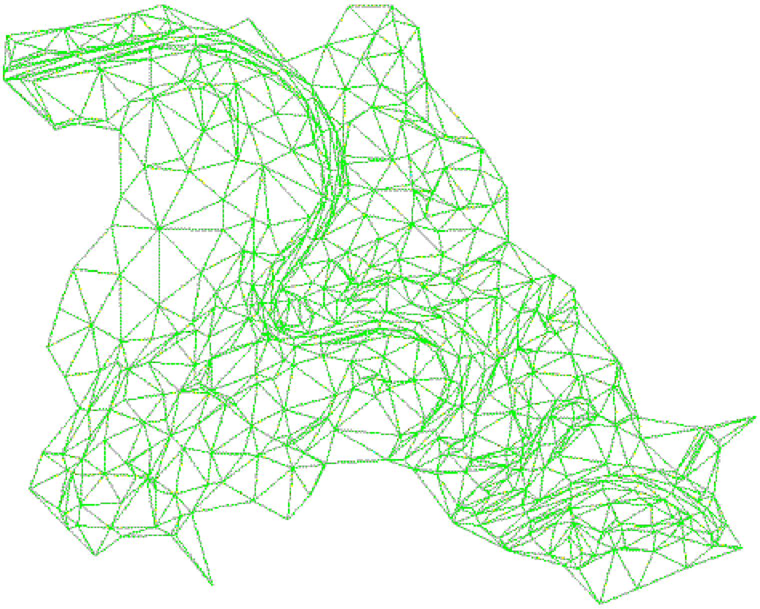
Obtaining a digital model requires a prior process called triangulation. During this process, the surface is divided into a grid by a series of triangular planes which adapt to the relief and simulate the slope changes occurring on the terrain, which are defined by what are called break lines.

Triangulation can be done with different methods, the most usual of which is based on a scatter plot. A plane is generated with every three points. These triangles have a series of properties which allow a triangular irregular network (TIN) to be formed within the scatter plot that respects the shape of the terrain.

Triangulation can also be performed from contour lines. This method consists of discretizing each contour line and the subsequent triangulation of the points thus generated. Contour lines are considered as break lines.



Points with break lines



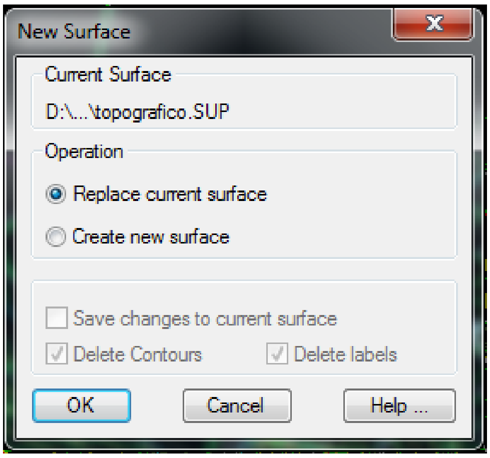
Resulting surface

In MDT, surfaces do not require the existence of surveying points. For instance, in order to create a surface from contour lines, it is sufficient to mark the relevant check box in the **Create Surface** command. Additionally, one can add, modify or delete vertices from surfaces using the commands included in the **Surfaces > Utilities** menu.

Create Surface

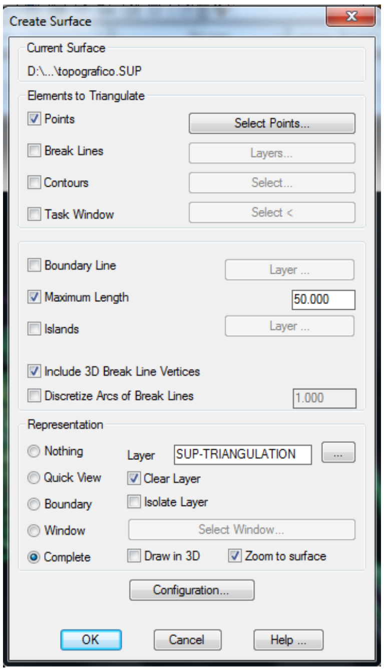
Creating a surface is equivalent to generating the digital terrain model. That is why this command performs the triangulation process in order to obtain the triangular irregular network. Each of the changes made to the original digital model can be saved as a different surface.

First, if a surface is associated with the drawing, a window is displayed for selecting whether to replace the current surface or create a new one. In the latter case, activate the option ***Save changes to current surface***.



If the program recognizes that a contour is drawn, it enables the option ***Delete Contours***. When it is activated, it deletes the polylines of the layers configured as contour layers at the end of the triangulation process.

If no current surface exists, or the option ***Create new surface*** was selected in the previous window, the program will request a file location for saving the surface. Next, the Create Surface window is displayed:

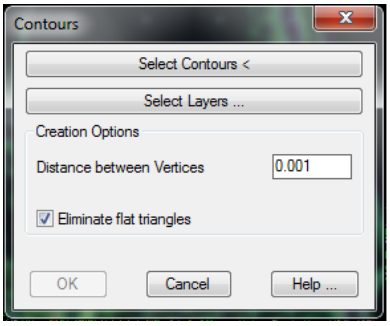


The ***Elements to Triangulate*** options box allows one to specify the different elements to be used to create the surface. One can triangulate ***Points, Break lines*** and ***Contours*** at the same time. Depending on whether each of the options is enabled or disabled, the relevant button on the right is enabled to allow one to specify the drawing elements that will be used.

Points: This option should be activated if one wishes to triangulate surveying points. The program triangulates all the points on the drawing by default, except those whose level cannot be triangulated. One can specify a different set of points by clicking on ***Select Points*** in the ***Point Selection*** window.

Break Lines: This option allows one to decide on the use of break lines. By clicking the ***Layers*** button, one can select the layers where the break lines are drawn through the ***Layer Selection*** window.

Contours: Should the drawing contain contour lines, one can use the polylines to create vertices on the surface. These polylines behave like break lines. The following window appears when the ***Select*** button is clicked.



The ***Select Contours*** button allows one to graphically select the contour lines one wishes to use to perform the triangulation. The option also exists of using the ***Select layers*** button to specify the contour lines to be triangulated by selecting the layers containing them.

Due to the fact that sometimes the polylines defining a contour line may have too many vertices, the program can filter them to discard vertices that are very close together. By doing this one can manage to reduce the number of vertices included in the surface and therefore processing time. The ***Distance between Vertices*** parameter controls the distance below which vertices are ignored. The ***Eliminate Flat Triangles*** box decides whether or not to use a subsequent process that avoids forming flat areas where contour lines are very tight, on crests, steep depressions, etc.

Once a decision has been made on which elements to triangulate, one can specify if the contours surrounding the scatter plot is to be used, or if ***Islands*** will be taken into account in the triangulation. Simply activating the corresponding options and specifying the layer where the polylines representing these objects is enough for both cases. If a boundary is not specified, it is important to specify the

Maximum Length of the external triangles' sides, so that one can prevent areas being formed whose vertices are very distant.

In addition, the ***Include 3D break line vertices*** option is possible. This option takes into account the coordinates of the vertices belonging to the 3D polylines in the layers selected as if they were triangulation vertices. If the break lines contain arcs, the parameter **Discretize Arcs of Break Lines** allows for specifying the separation between the vertices that the program will add to the surface along them.

Lastly, the way in which the surface is represented is controlled at the bottom of the dialog box. There are different possibilities, which are the same as for the **Draw Surface** command.

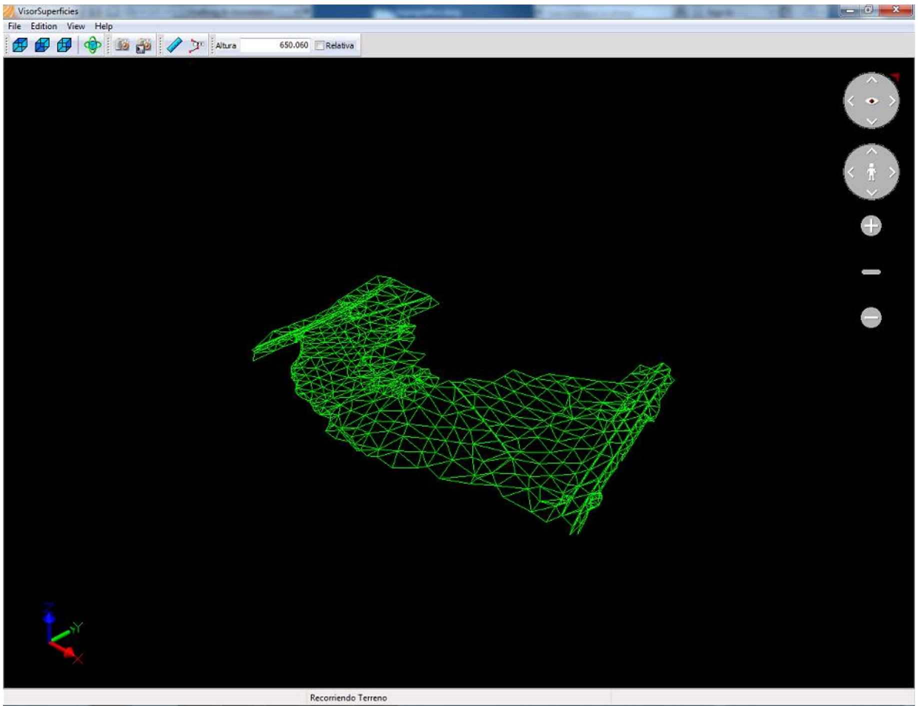
Current Surface

One can select the surface file to be considered as the current surface using this command. This will be the default surface taken by the commands used to contour, obtain profiles, etc. Once the file has been selected, the **Draw Surface** command is automatically executed.

As regards previous versions of MDT, there is the possibility of setting as the current surface a binary grid file. Its benefit is that for very dense models a binary mesh file take up significantly less memory than the equivalent surface file and its handling is more efficient. This benefit is offset by the fact that the binary grid has a regular cell interval, by contrast to a surface made from triangles in which any coordinate can be used as the vertex of a triangle. Using a binary grid would be suitable for bathymetry models, LIDAR flights etc.

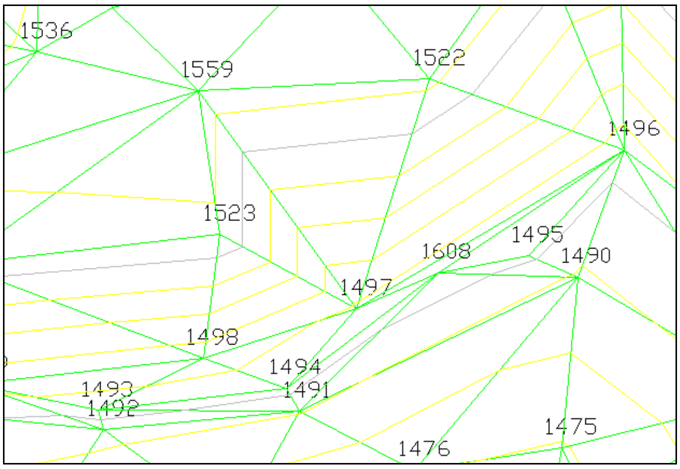
View Surface

This command represents a surface file in an independent CAD window. First, the command requests a surface file, then a program is launched to visualize the file. This same result can also be obtained by double clicking in the Windows explorer on a surface file.

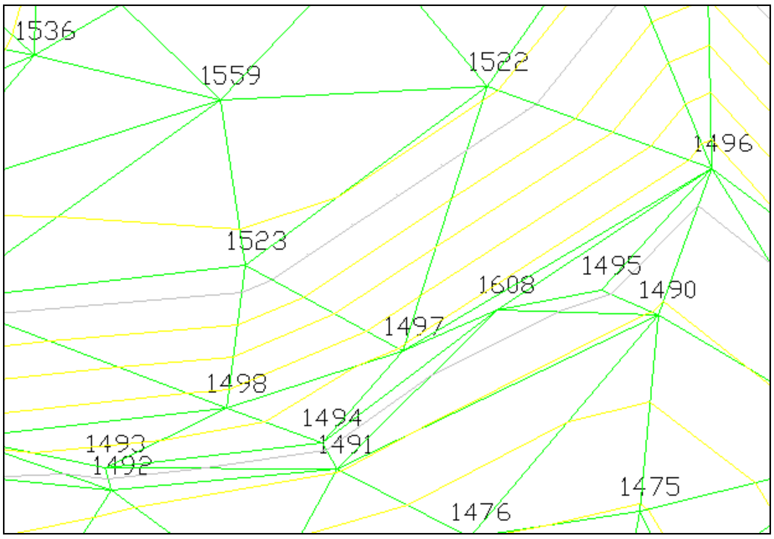


Invert Surface Line Direction

The process of creating a triangulation is based on the algorithm known as Delaunay's Triangulation. In this process, the triangles are oriented on the basis of some set technical requirements that cannot really be the best solution or that do not correctly represent the terrain. In order to define how the triangles are oriented, break lines can be used. In any event, once a surface is created, the orientation of two adjacent triangles can be changed manually by changing the common side for the side obtained by joining the vertices opposite it.



Line 1559-1497 generates a break in the contours



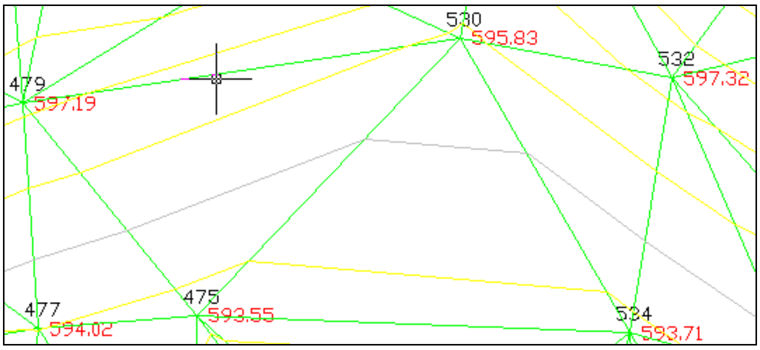
Once the above line is inverted, line 1523-1522 is generated and the resulting contour is more correct.

The command has two operating modes for selecting the line to be inverted. The entity can be selected, or coordinates near the line can be introduced. These modes can be altered entering the suitable option in the command line.

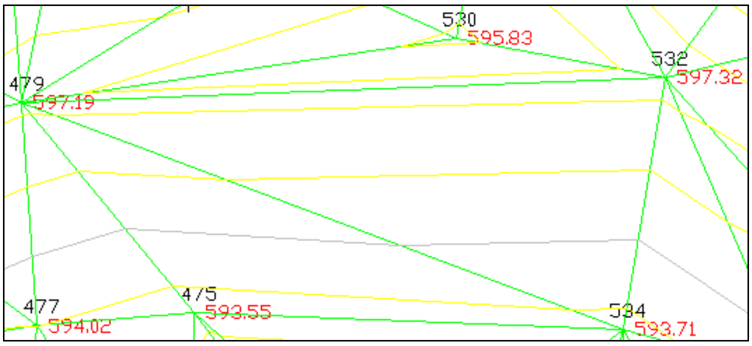
When the surface is edited, the new lines can appear in a different colour, according to the program configuration. If it is not possible to alter the triangulation, the corresponding message in the command line is printed.

Insert Line on Surface

As well as inverting the direction of a surface line, a surface can be modified by inserting a line between two random points. Once the points have been selected with the mouse, the program removes the triangulation lines that intersect the new line, and triangulates the surrounding area once again.



Before inserting a line from 479 to 532



After inserting the line, the surrounding area is automatically triangulated again

Delete Surface Lines

When boundary lines have not been defined, it is normal for triangles to be generated beyond the scatter plot's perimeter. On other occasions, one may wish to leave areas inside the group of points without contouring. This command can be used to delete undesired triangles. One simply has to select the sides of the triangles one wishes to delete graphically. The program then automatically updates any changes made to the triangulation.

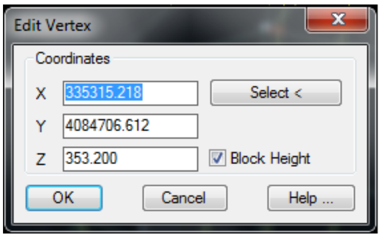
Should an AutoCAD command have been used to delete undesired lines from the surface, the program continues to consider them to all intents and purposes. In order to update these changes and delete lines from the surface, one can use the **Read Drawing Surface** command.

Delete Surface Triangle

This command is used to delete a surface triangle, by selecting an interior coordinate. Confirmation of the delete will appear in the command line. When deleting a triangle, depending on whether or not there are neighbouring triangles, its corresponding lines will be deleted.

Edit Surface Vertex

This command can be used if any surface vertex coordinates have to be manually changed. After selecting a point on the screen, the program searches for the closest vertex and displays the following window, where its coordinates can be viewed:



Two types of modifications are possible. If only the vertex's height is modified, one can change the slope of the triangles that share it. Additionally, the X and Y coordinates can be modified by clicking on the ***Designate*** button or by typing them in. This deletes the original vertex and a new vertex is created at the new position. The ***Block Height*** check box ensures that the Z coordinate is not changes when new coordinates are designated. Otherwise, the height will be calculated from the current surface.

A vertex belonging to the surface can also be edited by editing a surveying point having the same coordinates.

Delete Surface Vertex

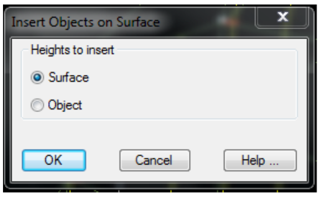
This command allows one to manually delete vertices from the current surface and automatically triangulates the area. In order to select the vertex, one merely has to enter some approximate coordinates with the mouse. The program then searches for the surface's closest vertex.

There is a second mode in which a surface line can be specified. The program deletes both vertices and re-triangulates the area.

A vertex can also be deleted by deleting a surveying point having the same coordinates with **Points > Delete**. If the point is deleted using an AutoCAD command, the surface is not modified.

Add Points to Surface

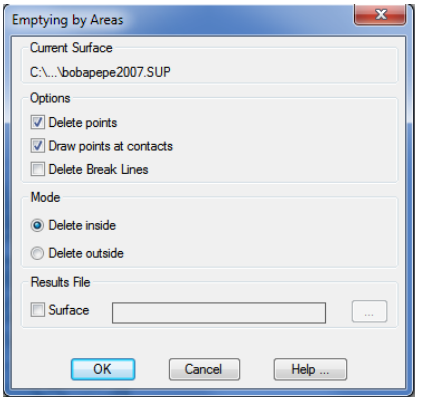
This command allows one to add surveying points to the current surface. Firstly, a dialog box is displayed where the program requests the origin of the vertex heights to be inserted.



The options available are ***Surface***, by means of which the new vertices will have the current surface's height, and ***Object***, which inserts a point having its own height. Once the appropriate option has been chosen, a ***Points Selection*** dialog box is displayed, where one has to select the points to be added.

Delete Area

This tool serves to create a gap in the current surface. In addition to changing the triangulation, the program can perform the following operations:

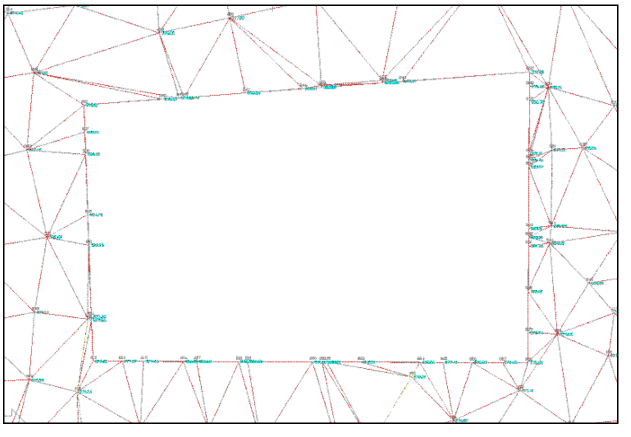


Delete points: Surveying points within the area concerned are deleted.

Draw Points at Contacts: When the surface is changed, the surface's triangles in contact with the perimeter of the area concerned are cut. This process creates new vertices on the surface. Activating this option also creates the corresponding surveying points.

Delete Break Lines: The break lines within the area concerned are cut and/or deleted. Should there be contour lines, they are also taken into account in this process.

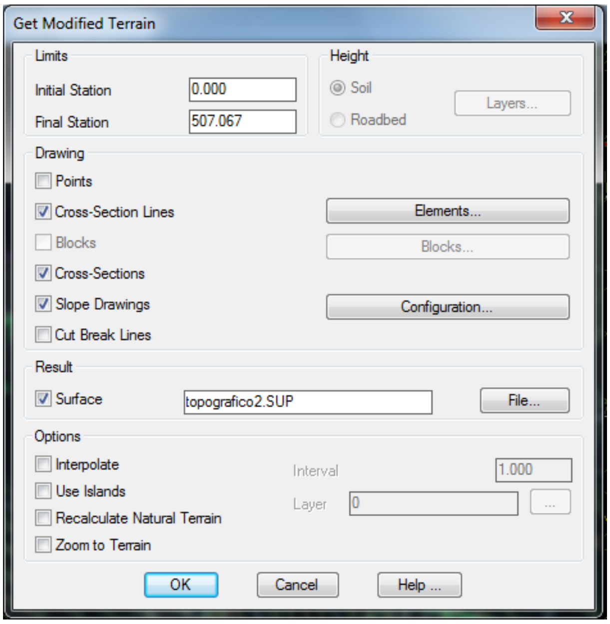
The **Mode** box allows one to choose whether the area concerned is within or outside the polyline. Once the options to be used have been chosen, the program requests the closed polyline that defines the area upon which one wishes to act.



Example of the result of emptying by areas

Get Modified Terrain

This command allows one to obtain the final status of the project's surface after earthworks. First one must select a segment file, or a horizontal alignment and a cross-section file, usually generated using the **Cross-Sections > Generate Modified Terrain** command. The following dialog box is then displayed:



The ***Initial station*** and ***Final station*** fields allow one to select the area of action along the horizontal alignment's length. Initially, it takes the minimum and maximum possible values, subtracted from the horizontal alignment and the cross-section profiles.

The cross-section template to be taken into account is specified in the ***Height*** box. Should the roadbed have multiple layers, a specific layer may be selected using the ***Layers*** button.

The program's different possibilities are individually controlled in the ***Drawing*** section.

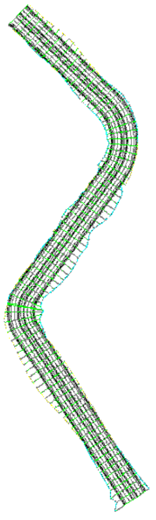
- ***Points***: The program creates a surveying point at each of the cross-section's vertices. Each point is assigned the vertex as a code.
- ***Cross-Section Lines:*** Polylines are drawn on the ground plan representing the different components of the cross-section template. Once can decide whether each of them will be drawn by clicking on the ***Elements*** button.
- ***Blocks*** : Represents the blocks on the ground plan in accordance with the block assignment performed for the segment.
- ***Cross-Sections:*** A polyline is drawn with each of the natural terrain cuts.
- ***Slope Drawings:*** Additional representations of the slopes.
- ***Cut Break Lines:*** Deletes polylines drawn within the occupation environment on the layers used for break lines to create the current surface.

The modification of the current surface can be enabled in the ***Result*** section. By default the program proposes a name for the surface file, so that it does not coincide with any existing files.

A drawing of the polylines on the ground plan having greater definition is obtained using the ***Interpolate*** option. The program will not only consider the modified cross-section's vertices but also create new vertices between the cuts according to the distance specified in ***Interval***.

By enabling the ***Use Islands*** option, one can define areas with closed polylines where the command will not make any modifications. This could be useful for road intersections, branches, etc.

Recalculate Natural Terrain makes the program internally recalculate the cross-section profile from the current surface. Thus, if various modifications have been made to the surface, the area of cutting and fill slopes could be affected by the surface's status without having to generate and include a cross-section profile in the segment that reflects such changes.

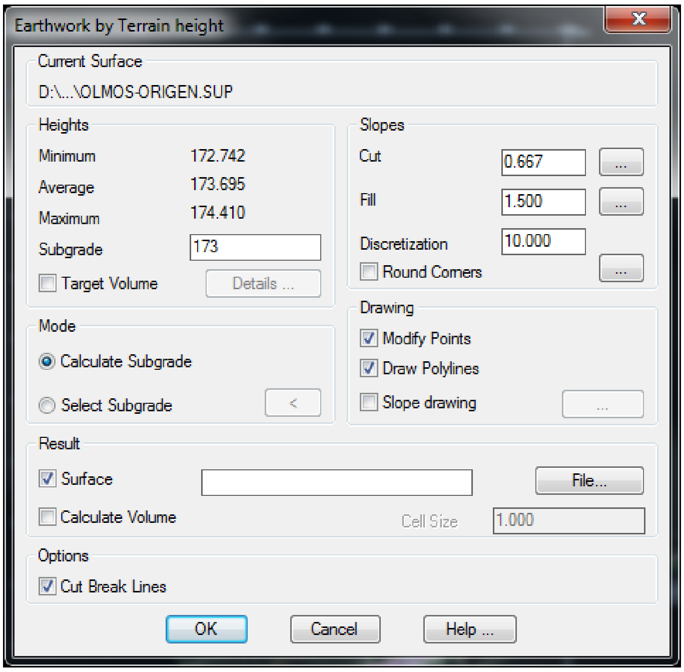


Example of a modified terrain

Earthworks by Terrain Height

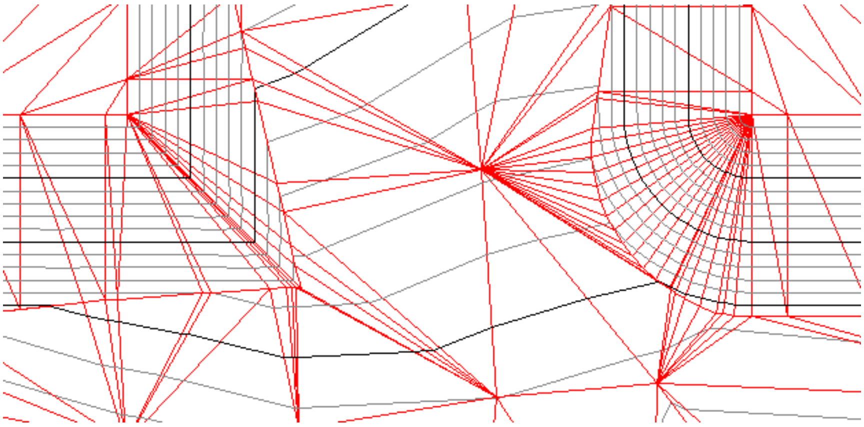
Along with **Earthworks by Subgrade Height, t**his tool allows one to change the current surface by creating a subgrade. It is supposed that either the external slope area, the height one wishes to reach or the resulting volume after the subgrade is created is known.

Firstly, one has to designate the closed polyline defining the contact area's boundary. The following dialog box is then displayed:



The upper part displays the name of the current surface and its heights along the polyline selected are displayed on the left. One then has to specify the following parameters depending on the option chosen in the ***Mode*** box.

- *Calculate Subgrade*: The crowning height of the subgrade to be created has to be entered in the ***Subgrade*** box. Additionally, the percentage gradients of the cutting and fill slopes also have to be entered. The ***Discretization*** parameter controls the interval between each slope projection. The lower this parameter is, the longer the command will take. The option **Round corners** is used to decide on the behaviour of the slope in convex vertices.

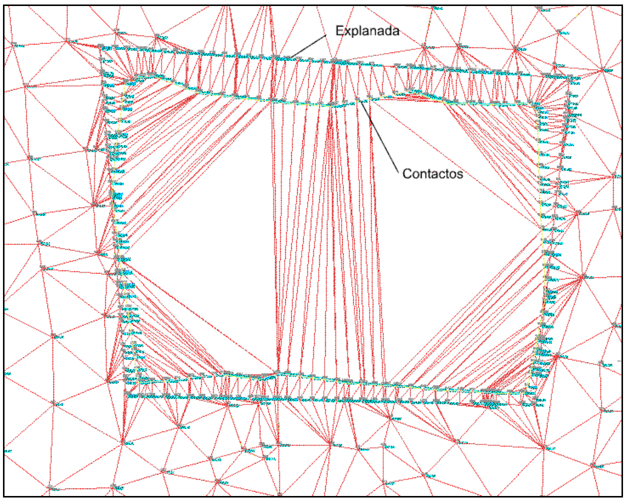


- **_Select Subgrade_**: By clicking on the associated button, one has to choose one of the drawing's closed polylines, which the program will take as the subgrade's crown without taking into account the slopes' gradient. Its height will be displayed in the dialogue box, so it can be edited if necessary unless the polyline has a variable height, in which case it cannot be changed.

Should **_Target Volume_** be activated, the program will search for a subgrade height around the one proposed by the user at the beginning of the earthworks calculation. By clicking on the **_Details_** button, one can specify the parameters used to search for the height.

One indicates in the **_Drawing_** box if the program should delete internal points and draw new points at the vertices making up the subgrade when creating the subgrade. The drawing of polylines defining the subgrade calculated can also be activated.

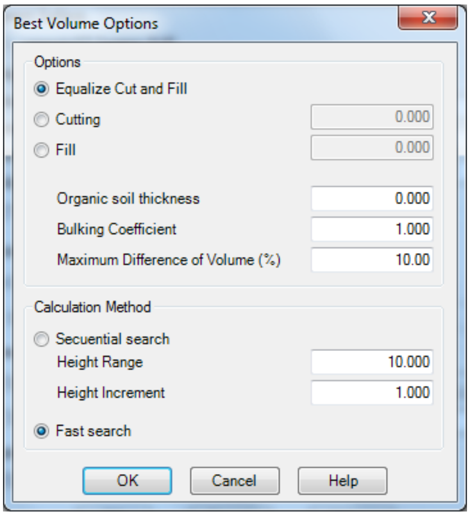
Result specifies whether the current surface should be modified and applies the changes resulting from earthworks. By default the program proposes a name for the surface file, so that it does not coincide with any existing files. By activating the **_Calculate Volume_** check box and specifying the **_Cell Size_**, the earthworks calculation volume resulting from the grid comparison method is included at the end of the process.



Example of a subgrade by terrain height

Target Volume

The **Earthworks along Subgrade Height** and **Earthworks along Terrain Height** commands allow one to either enter a subgrade height or make the program search for the subgrade height to achieve a specific volume of earthworks.



The most common option is to activate the **Equalize Cutting with Fill** option to get the earthworks to equalize the volumes in the cutting and fill areas within a margin. The other two options allow one to search for a specific volume, so that the volume difference between both volumes is a specific ***Cutting*** or ***Fill***.

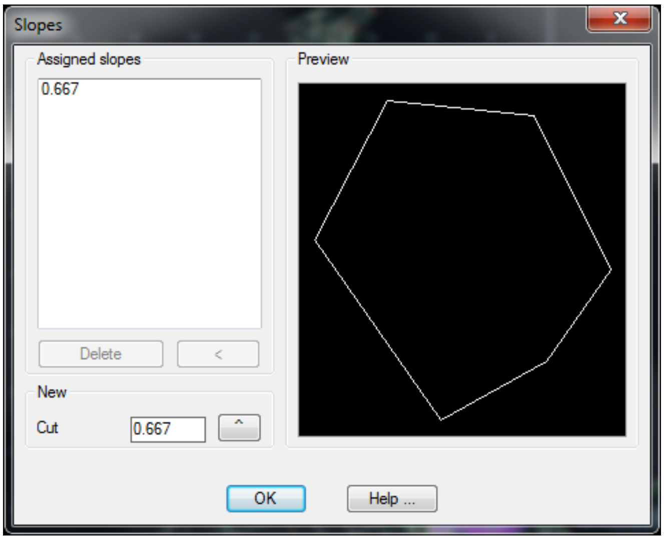
The ***Bulking Coefficient*** is multiplied by the cutting volume before comparing it with the fill volume. The default value is 1.0 and ensures that this parameter is not taken into account.

Maximum Volume Difference sets the tolerance margin to compare volumes. If the percentage represented by the difference between the cutting and fill volumes with regard to the total volume is less than this parameter, the program concludes the search and assumes both volumes are equal.

In the section ***Method of Calculation*** a choice between a ***Sequential Search*** around the subgrade height entered by the user and ***Fast Search*** to try and shorten the searching process is given.

Slopes

The earthworks commands allow different slopes to be used along the polyline that delimits the esplanade. The **Slopes** section introduces the cut and fill slope value which will be used throughout the grading. By pressing the corresponding button "**...**" a window like the following is accessed:



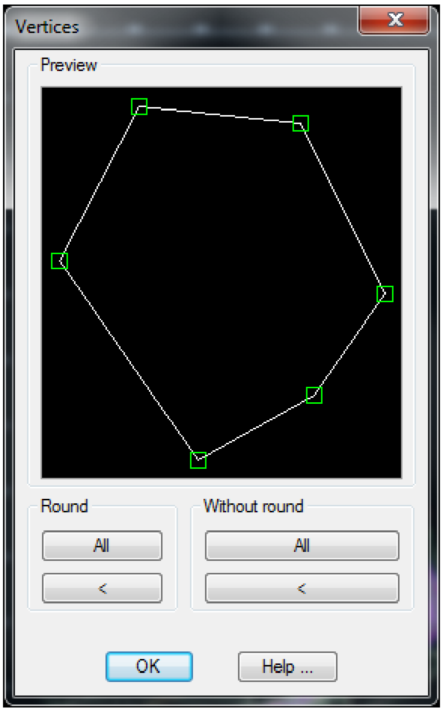
Under **New** a new slope value van be entered and by pressing the "**^**"button, the value is added to the list. The window disappears and by pressing the CAD window, points near the polyline of the esplanade, its programs the slope to the polyline segment where the points entered are projected.

On the **Assigned Slopes** list each of the values can be selected and under **Preview** the a polyline drawing can be viewed and the segments which have a value assigned are in blue whilst the rest is in white. By pressing the mouse over the preview, the slope of each segment can be changed. Using the **Delete**button, the value selected from the list is eliminated.

By pressing the "<" button the slope of each segment can also be changed, but by graphically selecting a nearby point on the CAD window. This option may prove more convenient in the event that the preview is confusing. On the command line there is the possibility of designating a continuous interval for polyline segments, entering three points.

Rounding off corners

The earthworks' commands it can be generally specified for all convex vertices whether the slope of the equipment rounds off or not using the option **Round Corners**. On the right of this option, by pressing the "**...**" button a window is accessed where each of the polyline vertices of the esplanade can be configured individually.



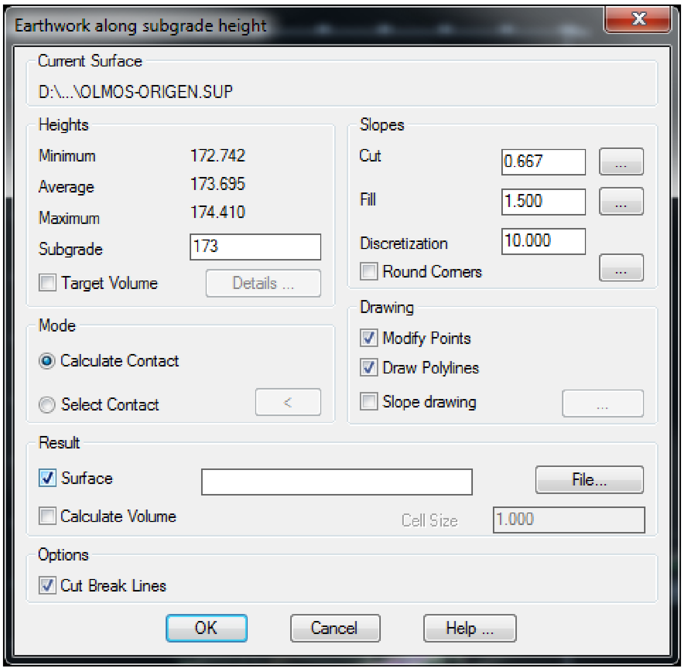
In the preview a circle or a square appears at each vertex depending on whether the slope is rounded off or not at this vertex. By pressing the mouse near a vertex, its behaviour is switched. In each **Round** and **Without Round** box, **All** button allow all the vertices to be changed at the same time and using the graphic designation button "<" the vertices can be selected at the CAD window in the event that the preview is confused. On the command line the latter option affords the possibility of designating a continuous interval for polyline vertices, entering three points.

Irrespective of the way in which the program is configured, if the segments before and after a convex vertex have a different slope, the slope is not rounded off.

Earthworks by Esplanade Height PRO

This tool, along with that of **Earthwork by Terrain Height** allows the current surface to be modified by creating an esplanade. On this occasion only the contour and elevation of the esplanade are known and nothing is known about the situation regarding contacts with the terrain. The slopes generated by the program start at the esplanade going in an el exterior direction and they end when the slope intersects with the current surface.

The first data requested by the program is the closed polyline that defines the contour of the esplanade to be carried out. The slopes will be generated towards the exterior of this polyline and then the following dialogue appears:



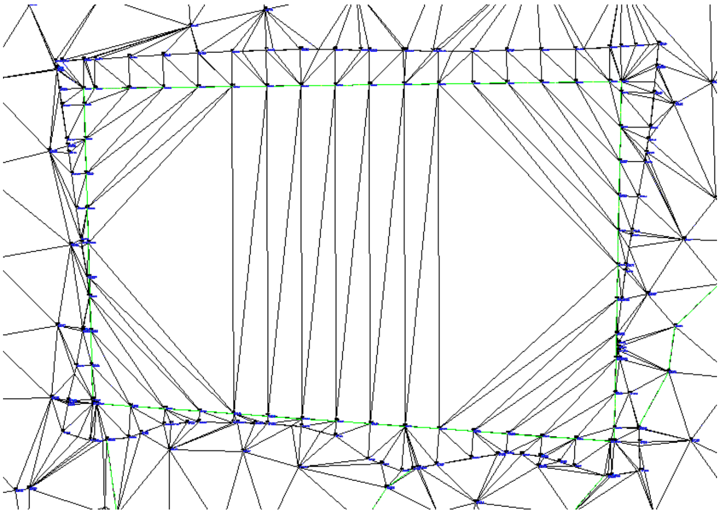
In the upper left-hand part the elevations of the current surface appear along the designated polyline, irrespective of the elevation of the polyline itself. In the ***Esplanade*** field the elevation is entered at which the esplanade is going to be carried out. If a 3D polyline is selected with different elevations, the text ***Variable*** appears in this field and if it is not modified, the esplanade takes on the elevations of the polyline itself.

Depending on the option chosen in the ***Mode*** box, the following parameters must be specified:

Calculate Contact: in this mode the elevation of the esplanade must be entered if it is not variable. In addition, the gradients are required, of however many to one, of the cut and fill slopes. The ***Discretization*** parameter controls the interval between each slope projection and with the parameter ***Rounding off Corners*** the convex vertices can be made to look rounded off.

Designate Contact: by pressing the associated button, a closed polyline of the drawing must be chosen which the program will assume as the foot of the slopes of the esplanade without taking into account their gradient. The program will assume as the vertex elevations those obtained from the current surface.

As regards the rest of the options, they are the same as those of the command **Earthworks by Terrain Height**.

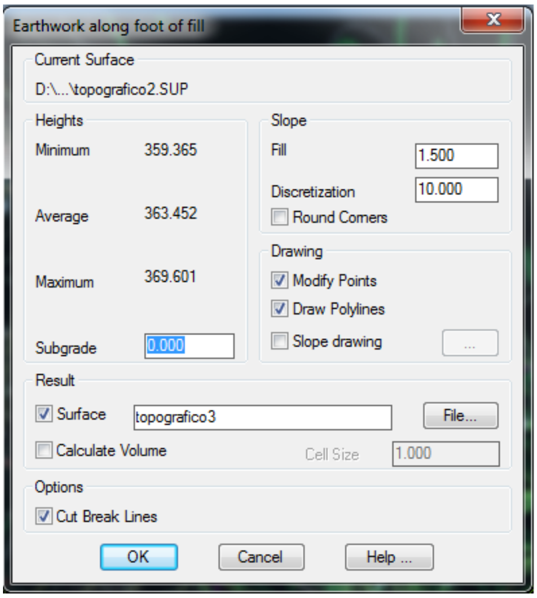


Example of an earthwork by esplanade elevation

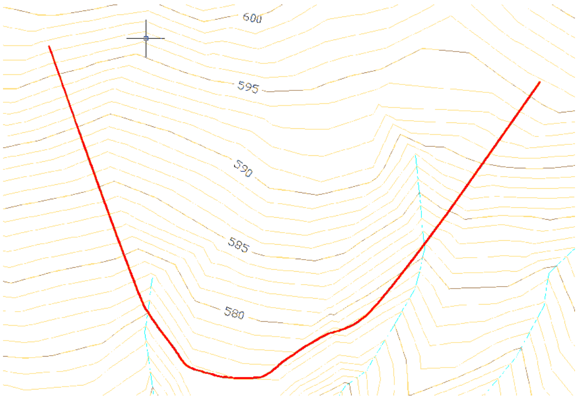
Earthworks along Fill Foot

This command is equivalent to **Earthworks by Terrain Height**, with the peculiarity that only the subgrade and its slopes are generated where there is a fill volume. No cutting area is generated in the current surface.

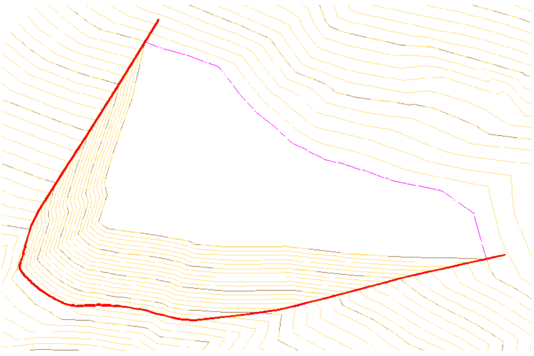
The first item of data requested by the program is a polyline that delimits the foot of the fill slopes. If the polyline is not closed, the direction toward which the slopes are projected is requested. The following dialog box is then displayed, which is similar to the **Earthworks by Terrain Height** command.



An image of the original terrain is shown in the illustration below. It contains a highlighted polyline that defines the fill foot boundary desired.



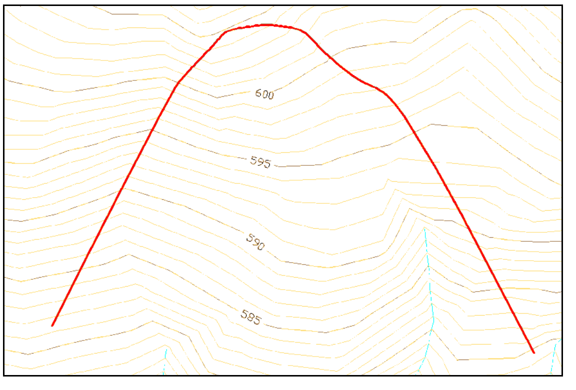
If the inside of the area defined by the polyline is defined as the slopes’ direction with a height of 595, the following result is obtained. That is to say, from the polyline, a fill is generated that rises up to a height of 595, and later a platform horizontal to this height is created.



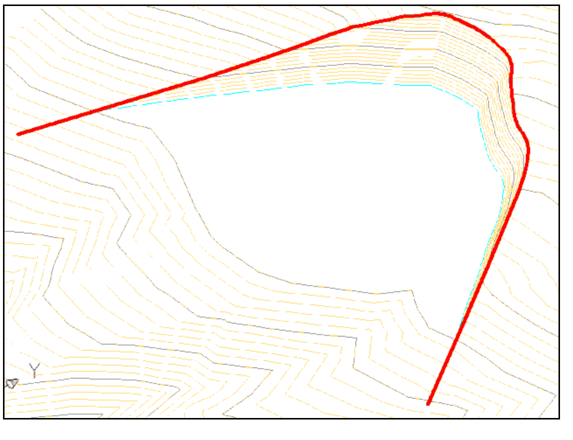
Earthworks by Cut Crown

This command is equivalent to **Earthworks by Terrain Height**, with the peculiarity that only the subgrade and its slopes are generated where there is a cutting volume. No cutting area is generated in the current surface.

An image of the original terrain is shown in the illustration below. It contains a highlighted polyline that defines the boundary of the cutting crown to be achieved.



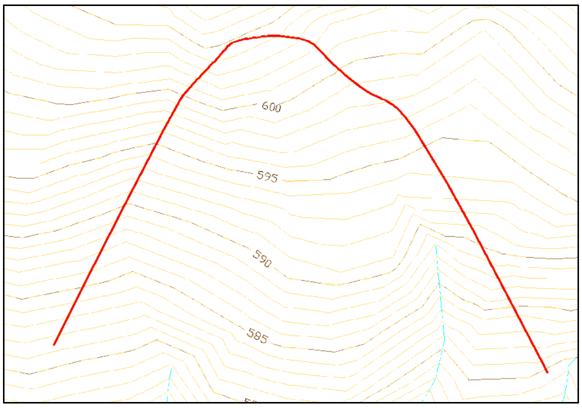
If the inside of the area defined by the polyline is defined as the slopes' direction with a height of 585, the following result is obtained: A cutting slope is created from the polyline that descends to a height of 585, and then it creates a platform horizontal to this height.



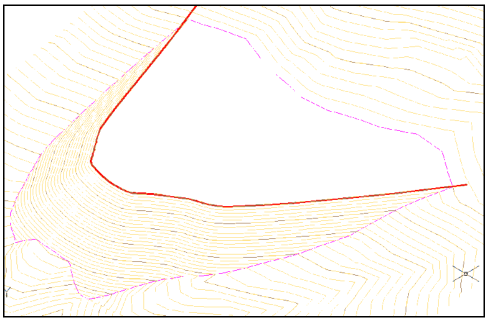
Earthworks by Fill Crown

This command is equivalent to **Earthworks by Terrain Height**, with the peculiarity that only the subgrade and its slopes are generated where there is a fill volume. No cutting area is generated in the current surface.

An image of the original terrain is shown in the illustration below. It contains a highlighted polyline that defines the fill crown boundary desired.



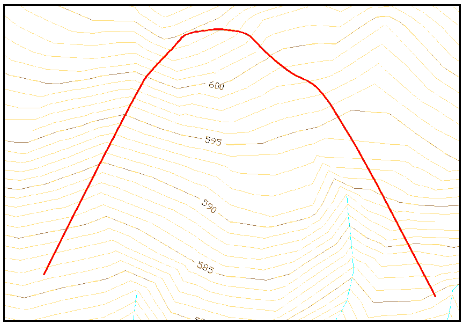
If the outside of the area defined by the polyline is defined as the slopes' direction with a height of 595, the following result is obtained: From the polyline and starting from the height of 595, on one side a fill slope has been created and towards the other side a horizontal platform.



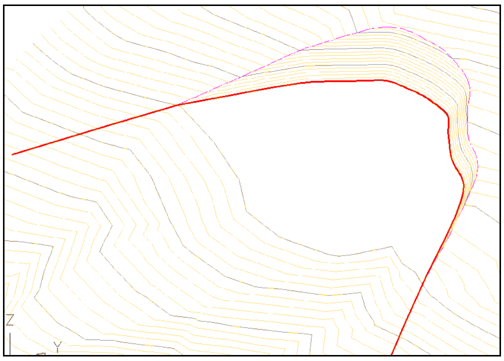
Earthworks along Cut Foot

This command is equivalent to **Earthworks by Subgrade Height**, with the peculiarity that only the subgrade and its slopes are generated where there is a cutting volume. No cutting area is generated in the current surface.

An image of the original terrain is shown in the illustration below. It contains a highlighted polyline that defines the cutting foot boundary desired.

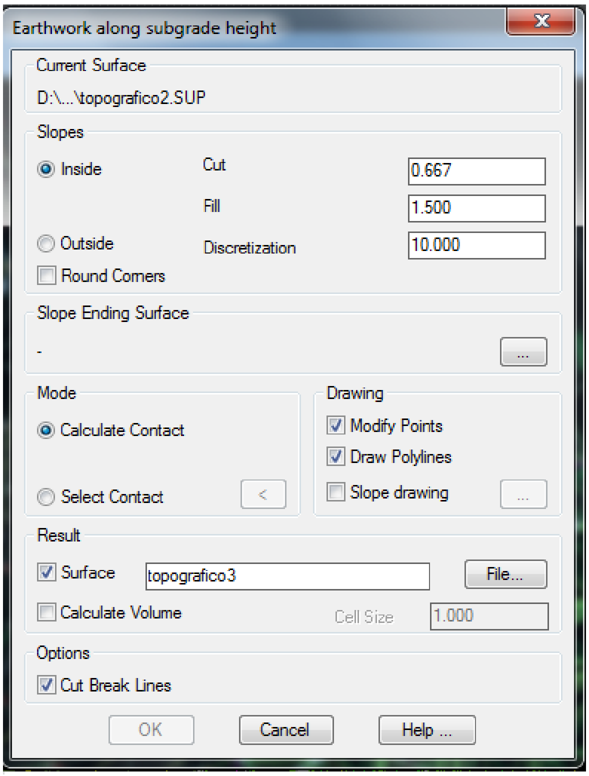


If one defines as the direction the direction of the slopes towards the outside of the area defined by the polyline, the following result is obtained: From the polyline and starting from the height of 595, on one side a cutting slope has been created and towards the other side a horizontal platform.



Earthworks by slope between surfaces

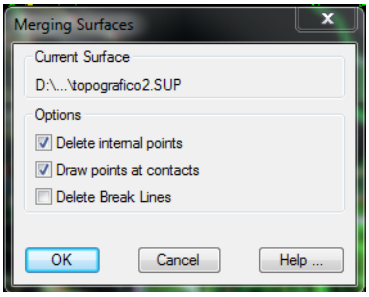
This command is similar to the **Earthworks along Terrain Height** tool, except that instead of specifying a height to create the subgrade, a second surface is designated, which limits the slopes. The command also allows for deciding whether the slopes go towards the interior or exterior of the polyline.



Merge Surfaces

The merging process allows one to include another surface within the current surface. It is equivalent **Delete Area** with the boundary of the surface included and then copies its triangles onto the current surface. In order to ensure the result is correct, heights at the perimeter of the surface to be included should coincide or be very close to the heights at the current surface's the corresponding coordinates, otherwise inconsistencies will be produced in the digital model.

The program requests the file of the surface to be included and displays the following options:



- ***Delete Internal Points***: Deletes the surveying points inside the area defined by the boundary of the surface to be included.
- ***Draw Points at Contacts***: Creates surveying points corresponding to the vertices of the surface to be merged, as well as on the contact area between the two surfaces.
- ***Delete Break Lines***: Cuts and/or deletes break lines within the boundary of the surface to be included. Should there be contour lines, they are also taken into account in this process.

There is the possibility of saving the result in a surface file other than the current one, enabling the **Surface** option and designating a file name.

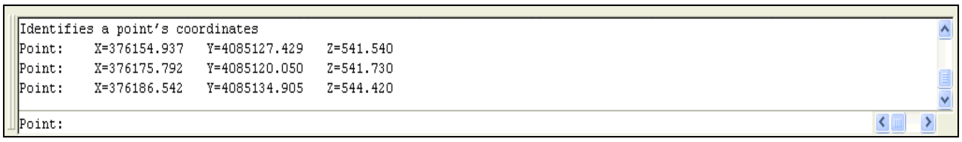
Identify Heights

This function enables us to calculate and display, using the commands of the CAD environment, the height of any predetermined flat coordinate point (2D) on a given surface represented by a triangular grid. Hence, each time we click on a point within the horizontal projection of a grid corresponding to a surface, its corresponding point coordinates are shown: the predetermined abscissa and ordinate, predetermined, and the height calculated for this position on the surface.

In addition, if the uncertainties in relation to the point coordinates of the vertices of the corresponding grid are ascertained using the laws of propagation of variances and covariances, the uncertainty associated with the height of this flat position on the surface is estimated and displayed.

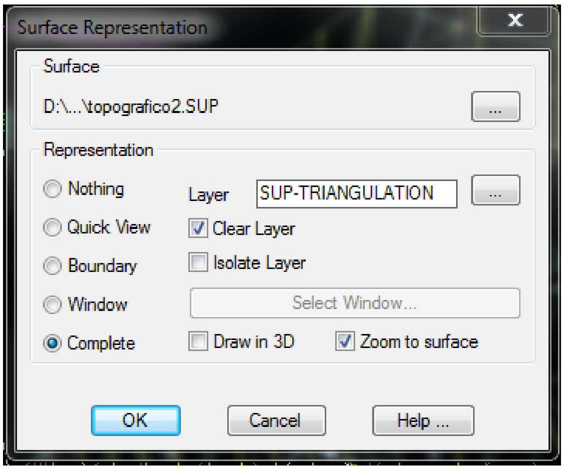
The method used to determine the height of points on a triangular grid consists of an algorithm which calculates the height of the point in question as a weighted average of the heights corresponding to the three vertices of the triangle in the grid containing the planimetric position predetermined by the user and the said weighting is based on criteria of a geometric nature. This relational model for calculating the height is subject to the law of propagation of variances and covariances to estimate the uncertainty or error in relation to the height.

Each time the screen is clicked with the mouse, the AutoCAD command line shows the coordinates (X, Y and Z) of the point. Should the area outside the area defined by the surface be clicked, the X coordinate appears as ***Indeterminate.***.



Draw Surface

This command allows one to draw the current surface. The following dialog box is displayed:



With the ***Surface*** button, one can change the file to be represented. The file chosen by default is of the current surface. However, a different file can be drawn.

The different representation possibilities include:

***Nothing*: **The surface is not drawn.

***Quick View*: **Displays the surface on the screen, but without creating objects. The next time AutoCAD refreshes the drawing, the elements thus drawn will disappear. It has the advantage that the drawing file does not increase in size.

***Boundary*: **Only displays the surface's boundary. It is useful if the surface does not have too many vertices and/or when a computer that is not very powerful is used.

***Window*: **Allows one to designate a rectangular area in order to draw only the part of the surface inside it.

***Complete*: **Draws all the lines comprising the surface. Should a surface with a very large number of vertices be created, the number of lines drawn is very large. This may lead to the drawing file's size increasing so much that AutoCAD is not able to deal with it efficiently. Should this be the case, it is advisable to use another representation option.

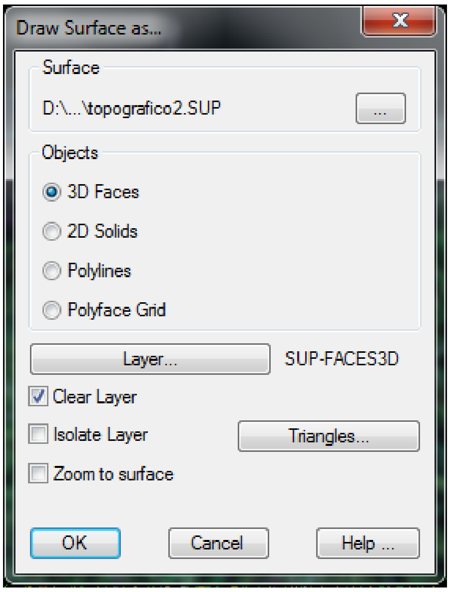
Additionally, one can also select the layer on which the surface is to be drawn by clicking ***Layer.*** It is usually advisable to activate the ***Clear Layer*** check box so that the program deletes any objects existing on the layer before drawing the surface. ***Zoom in on Surface*** can also be activated, so that the screen is centered on the drawing area containing the surface.

If the option Draw in 3D is checked, the program will draw the lines with their current heights, or a height of zero. In any case, the representation selected does not affect the calculation of profiles, volumes, etc.

Represent Surface

MDT represents a surface by drawing the lines of its triangles' edges without repetitions. This is an efficient way regarding the number and size of the objects created, while at the same time allowing one to perform editing and modification operations easily.

With a view to its use by other programs, this command allows one to represent the surface with different AutoCAD objects:



3D Faces: Generates a drawing made up by 3D Faces objects. Useful to generate images, shadows, etc.

2D Solids: Each triangle is drawn in a colour, depending on its type. It is geared towards allowing one to easily check the assignment of materials to a surface.

Polylines: A closed polyline for each triangle. It has disadvantage that edges are repeated when compared to line representation.

Polyface Grid: Draws the triangulation using an AutoCAD polyface grid. Once this object is created, it cannot me modified. It can only deleted.

In addition to specifying the type of object, the layer where it will be drawn can also be chosen and a series of operations can be performed with it:

Clear Layer: Deletes all objects from the layer before proceeding to draw.

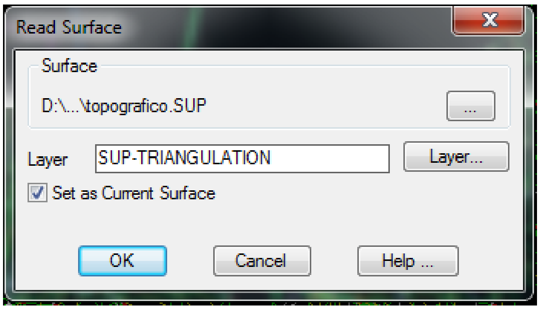
Isolate Layer: Deactivates other of the drawing's layers and only leaves the indicated layer active after drawing.

Zoom to Surface: Centres the screen on the area of the drawing containing the surface.

Convert Drawing

This command allows one to create a surface file from a triangulation drawn with line-type objects. This command can be used if one wishes to import a triangulation whose associated surface file has been lost or if the drawing has been manually modified and one wishes to accept the changes made to it. It can also be used to import a triangulation created using another program.

Firstly, the program requests a file in which to store the surface. It then shows displays dialog box where one specifies the ***Layer*** where the objects are drawn. If one wishes the program to assume them as the current surface, the ***Set as Current Surface*** check box should be activated.



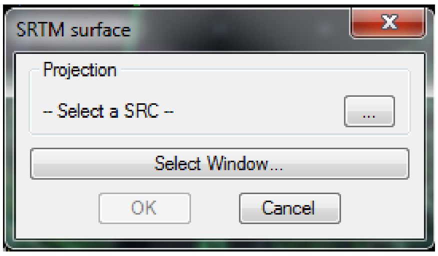
Read 3D Faces

This command allows one to create a surface file from a triangulation drawn with 3D Face-type objects. Its main use is to import a triangulation created with another program. It works similarly to the **Zoom to *Surface*:** Centres the screen on the area of the drawing containing the surface.

command.

Create Surface through SRTM

With this command a digital model of any part of the world can be created. Use the data available on the Internet from NASA's SRTM mission (http://www2.jpl.nasa.gov/srtm/). First, a window is displayed for specifying the system of reference coordinate for the drawing, and a window with the areas to triangulate.

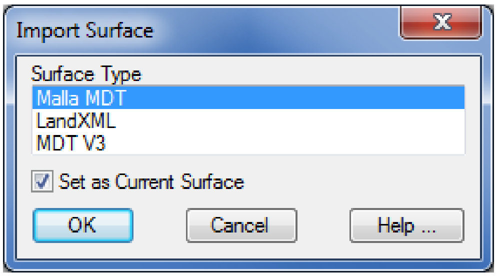


Once the data is introduced, the program downloads the necessary data via the Internet, triangulates it, and last a **Draw Surface** window is displayed.

The precision of the heights obtained is approximate to the meter, and the separation between each element of the grid is around 90 meters.

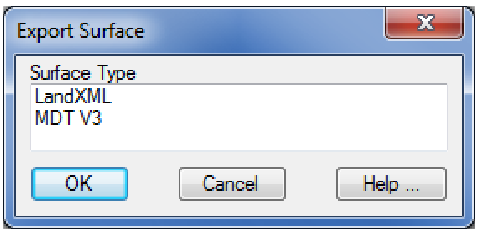
Import Surface

This command enables file conversion with a surface (triangulation) created with other programs. First a dialog box appears for selecting the file type to import, and then it requests the destination file. The option **Set as Current Surface** loads the resulting surface in the memory automatically.



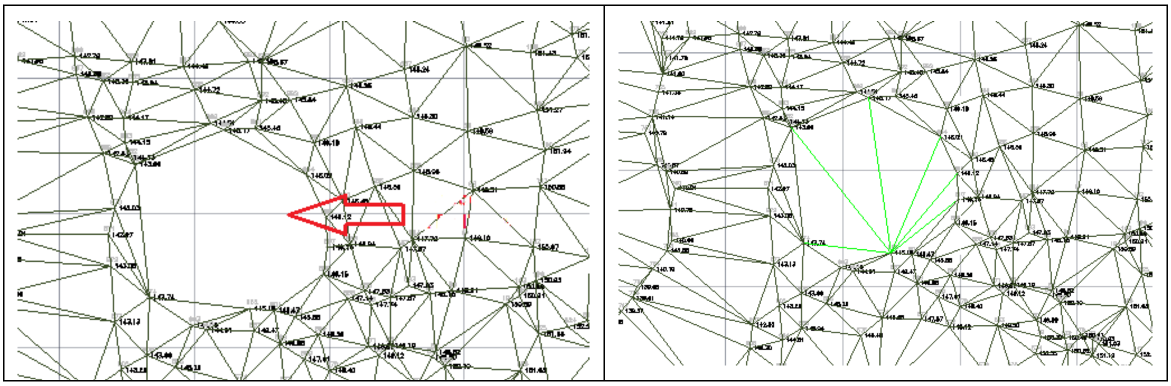
Export Surface

This command is used to export a current surface to a file that can be used by other programs. First a dialog box appears for selecting the type of file to create, then it requests the destination file.



Fill holes

This tool was created with a view to solving the triangulation problems to be found on the current surface. The program will ask the user to graphically designate the region he wishes to update and this area will be triangulated automatically in line with the existing elevations at the nearby vertices.



Save Surface

Allows one to save the current surface on a file and assign it a name. Different files than therefore be created with this option. Each will represent different stages of the actions performed on the terrain.

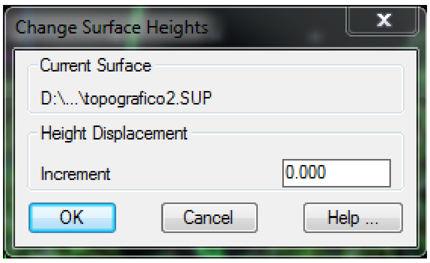
Independently from the use of this command, each time the drawing is saved, the state of the current surface is saved in the relevant file. It is therefore not necessary to regularly save the changes after performing an operation on the surface.

Delete Surface

With this command, the program eliminates the relation with the current surface, removing it from the drawing. From the moment it is executed, the drawing has no surface associated to it. Therefore, if one wishes to execute any command requiring the current surface, an error message will be issued.

Change Surface Heights

When this command is executed, a dialog box is displayed where the height adjustment to be applied to all the current surface's vertices can be entered.

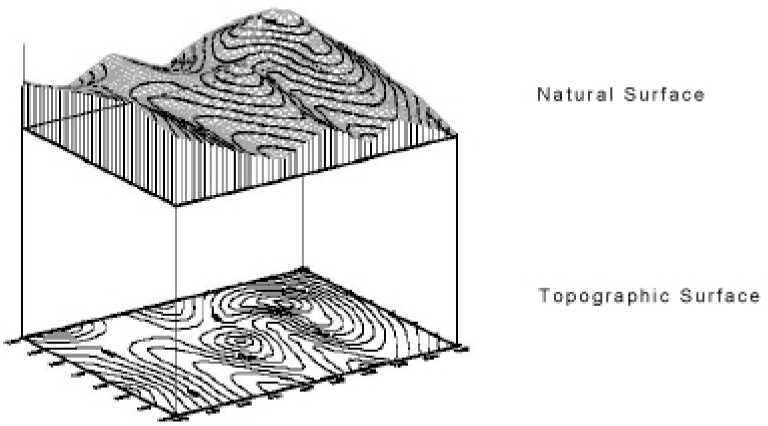


Add Polylines to Surface

This command makes it possible to add break lines to the current drawing, without the need of reconstructing it. When it is executed, a dialog box similar to **Add Points to Surface** is displayed where one has to specify if the break lines will take on the surface's height or the lines' heights will be taken into consideration. One then uses the mouse to select the polylines to be added.

Surface Information

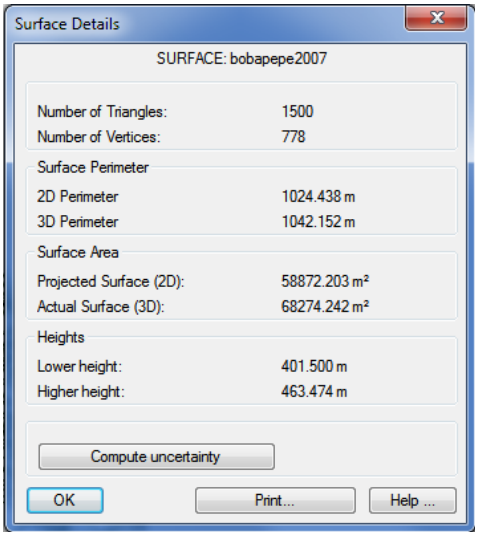
In Topography **natural surface** means the surface the shape of which coincides with the physical reality we intend to represent. However, the very nature of the graphic representation systems, as occurs in the bounded plane system, among others, obliges us to use its orthogonal projection on a horizontal reference plane as the most common surface, assigning it the name **topographic, agrarian or reduced surface** (see the figure). The topographic surface is always smaller or equal to the natural surface as the former is flat and the latter may be curved. Moreover, we need to take into account that two real different surfaces may correspond to the same horizontal surface. It is normally the topographic surface we are interested in – that represented in plans and maps -, although circumstances may exist where the natural surface is the target measurand, such as, for example, in cases of quantifying surface treatment. Therefore, both surfaces need to be taken into account.



Source: Franco, J. (2002). "Nociones de Topografía". CARTESIA
http://www.cartesia.org/download.php?op=viewsdownload&sid=7

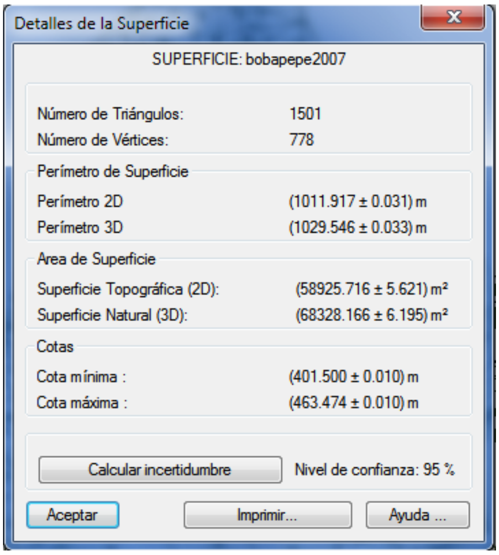
The representation of the terrain cannot entail the projection of all its points, and as such features only a number of characteristic points which enable us to determine the shape and dimensions of the same. These points may comprise a contour — obtained by projecting the points of a given altitude or height — or characteristic isolated points.

The execution of this command opens an informative window in which we specify the basic surface data. This window provides, first and foremost, the name of the surface, the number of vertices and triangles comprising the grid pertaining to the surface in question, the grid perimeters (3D perimeter), the horizontal projection of the same (2D perimeter) and the areas both of its natural (3D) and topographic surface (2D). Moreover the maximum and minimum heights of the surface in question are also displayed.



In the event the points used when creating the surface contained data on uncertainties, clicking on the ***Calculate Uncertainties*** tab will execute the calculation process and once it has been concluded a new dialog box will appear featuring all the data and the corresponding uncertainties.

It should be taken into account that the confidence level for calculating uncertainty (by default, 95%) is established in the Topography settings. See the Customisation Manual for further details.



In the event the calculation of the topographic surface (2D) is conducted using the Gauss formula, the method consists of:

1. Determining the position coordinates of each target point — points cloud — based on the corresponding tachymetric observations or, when the observations are conducted by satellite (GNSS), having such coordinates at hand, as these are the coordinates which have been calculated beforehand by the GNSS systems involved in each task.

2. Generating, with or without restrictions due to the predetermination of perimeter points, break lines — lines with sudden changes in slope — and/or other characteristic points; the triangular grid associated with each assignment. This task will involve assigning to each triangle three points from the cloud of known coordinates, as well as determining the points regarded as perimetral, which are the only ones to be taken into account for the subsequent calculation.

3. Applying the Gauss formula which associates the flat surface of a polygon with the position coordinates of its successive vertices, the result of which will be the topographic surface (2D).

The calculation of natural surfaces (3D) using Heron's method consists of:

1. Determining the position coordinates of each target point — points cloud — based on the corresponding tachymetric observations or, when the observations are conducted by satellite (GNSS), having such coordinates at hand, as these are the coordinates which have been calculated beforehand by the GNSS systems involved in each task.

2. Generating, with or without restrictions due to the predetermination of perimeter points, break lines — lines with sudden changes in slope — and/or other characteristic points; the triangular grid associated with each assignment. This task will involve assigning to each triangle three points from the cloud of known coordinates.

3. Calculating the lengths of the sides of each triangle comprising the grid, taking into account its three-dimensional coordinates if the desired calculation is for natural surfaces (3D); or its flat coordinates if the desired calculation is for topographic surfaces (2D). In both cases this calculation will be based on that of the module of a vector specified by two points.

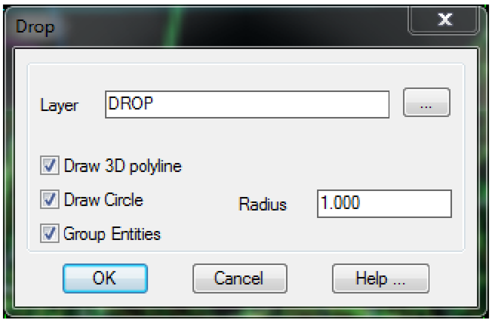
4. Determining the area of each triangle using Heron's formula, which associates the surface of a flat triangle with the length of each of its sides.

5. Adding up the surfaces of each of the triangles comprising the triangular grid associated with a specific task, the final result of which will be the natural surface (3D) if the calculation of the length of each side of each triangle has been conducted using its three-dimensional coordinates; or the topographic surface (2D) if the calculation was conducted using its flat coordinates only.

Finally, each of these mathematical models for the calculation of surfaces is subject to the laws of the propagation of variances and covariances to determine the uncertaintities of the topographic (2D) or natural surface (3D).

Drop

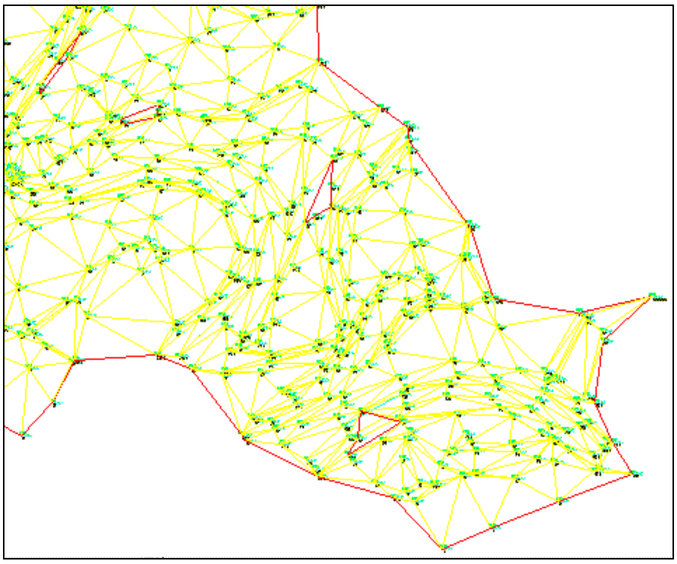
This command is used to draw a polyline with the approximate route of a drop of fluid on the surface. First, the following window is displayed



Next the program requests an initial point for the route, and draws a polyline to represent the drop. Checking the option **Draw Circle** makes it easier to distinguish the initial route point, because the program draws a circle around the position. With the option **Group Entities**, the polylines and the circles drawn are grouped, so that when one of the entities is selected, both are selected automatically. This way either can be easily deleted.

Check Surface

The program changes the colour of each triangulation line and assigns it the colour code corresponding to the number of times it is repeated. Hence, only the lines of the perimeter triangles (boundaries and islands) are drawn in colour 1 (red) and the interior lines should only appear in colour 2 (yellow). In this way, it is easy to detect gapped areas in the surface where one cannot calculate terrain heights and the program is therefore unable, for instance, to generate contour lines.



One can see that there are areas in this drawing where the surface is not defined

In order to go back to the surface drawn with normal colours, one can execute the **Draw Surface** command and mark the ***Complete*** and ***Clear Layer*** options.

5. Grids

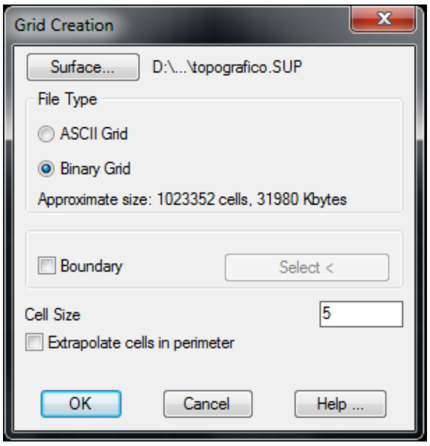
Grids

The tools described in this chapter allow one to generate attractive three dimensional representations from grids or height and slope surfaces, as well as to assign materials to apply quality rendering.

A grid file is a set of 3D coordinates that are planimetrically defined in a regular square grid. MDT works with two types of grid files: ASCII (.MLL extension) and binary (.MLB extension) files. The former have the advantage that the file’s contents can be viewed with a text editor, and they can easily be processed by other programs. Nevertheless, the large size of the files is a disadvantage. In order to avoid this, binary grid files can be used to provide quicker and more efficient access, although they do not have the aforementioned advantages.

Create Grid from Surface

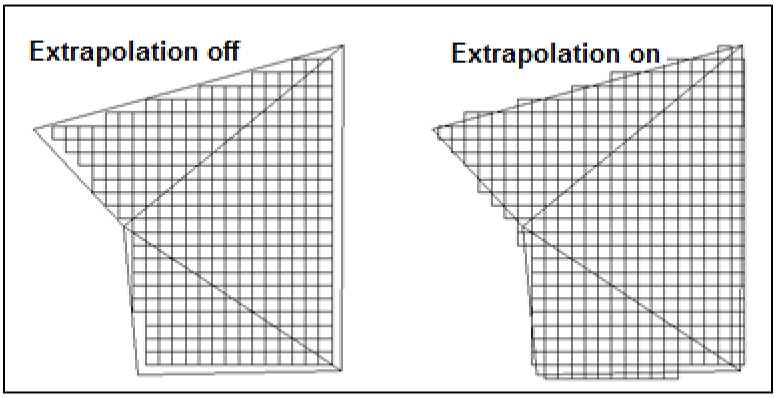
This tool allows us to create a grid file from a surface.



By clicking the ***Surface*** button, one can choose a surface other than the current drawing. In ***File type,*** one has to specify the type of grid to be created: either ***ASCII Grid*** or ***Binary Grid***. When one or other option is selected, the approximate size of the file to be created is displayed.

The possibility of specifying a ***Boundary*** exists by designating a closed polyline with the ***Select*** button. In this way, the grid would then be defined only within the boundary polyline. This check makes the grid creation process slower, and it is therefore not advisable for very dense grids.

The option **Extrapolate cells in perimeter** is used to obtain grids with a larger surface.

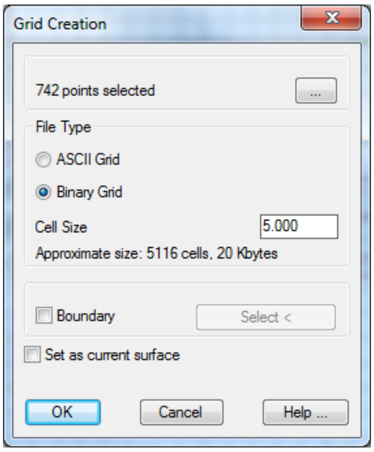


Lastly, the ***Cell Size*** parameter determines the separation between grid coordinates. The smaller this value is, the denser the grid, and the file will occupy more space. However, if the grid is used to calculate volumes, the result will be more accurate. See volume calculation by **Grid Difference** in the **Volumes** section.

This command ends with the creation of the relevant file. To view the results, use the **Maps > Draw Grid** command.

Create Grid from Points

This command allows the creation of a grid file from a set of points. The program initially selects all the points to be found in the drawing.



By pressing the corresponding button, a more precise selection of points can be carried out. The other options are the same as the command **Create Grid from Surface** in terms of the grid cell size and the possibility of using a **Boundary** polyline.

Finally, there is the option of establishing the grid created as the **current surface** provided that the grid file type is binary.

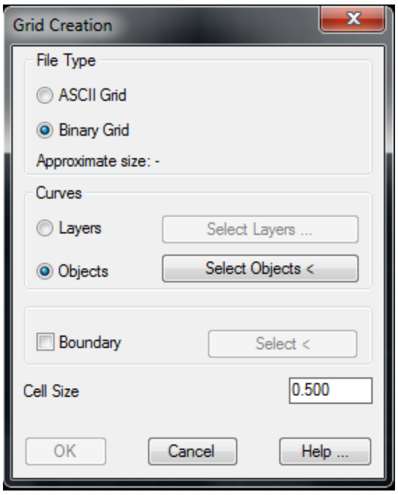
Create Grid from Contour Lines

This tool allows one to create a grid file from a set of contour lines.

The type of grid to be created is specified in ***File Type***: either ***ASCII Grid*** or ***Binary Grid***. When one or other option is selected, the approximate size of the file to be created is displayed.

The possibility of specifying a ***Boundary*** exists by designating a closed polyline with the ***Select*** button. In this way, the grid would then be defined only within the boundary polyline. This check makes the grid creation process slower, and it is therefore not advisable for very dense grids.

Lastly, the ***Cell Size*** parameter determines the separation between grid coordinates. The smaller this value is, the denser the grid, and the file will occupy more space. However, if the grid is used to calculate volumes, the result will be more accurate. See volume calculation by **Grid Difference** in the **Volumes** section.

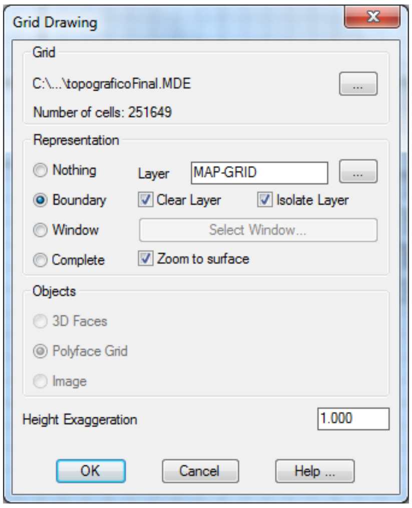


There are two possibilities of specifying the objects with which a grid will be generated: choosing a list of layers (***Layers*** option and ***Select Layers*** button) or directly entering the polylines of the drawing to be used (***Objects*** option and ***Select Objects*** button).

This command ends with the creation of the relevant file. To view the results, use the **Grids > Draw Grid** command.

Draw Grid

This command allows one to represent a grid file obtained by using the **Grids** > **Create Grid from Surface** or **Grids** > **Create Grid from Contour Lines** tools. First, the program requests a grid file (ASCII or binary). The following dialog box is then displayed:



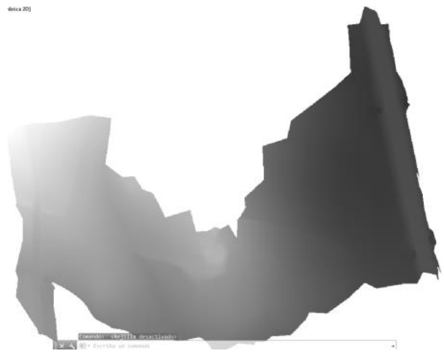
One can choose between two kinds of objects to draw a grid: The ***Polyface Grid*** option has the advantage of being quicker and the disadvantage that CAD sets a maximum limit on the number of vertices and faces. This is why the default option is ***3D Faces.***

In addition, there is the option of drawing the grid as an image and this method will allow us to create an **Image** from the grid file. To be precise, an image will be created in *TIFF* format.

By clicking the ***Select*** button, one can specify a layer other than the one proposed by the program. ***Clear Layer*** removes the objects from the layer before drawing the grid and ***Isolate Layer*** hides the drawing's other drawing layers.

The ***Height Exaggeration*** parameter is used to multiply the grid's height values in order to increase or decrease cell height differences and improve the viewing of relief. Lastly, once the representation is finished, the ***Zoom*** check box ensures the screen is framed on the grid area. In should be taken into account that the drawing is in three dimensions. It is therefore necessary to execute one of the CAD commands to change the viewpoint like, for example, VPOINT.

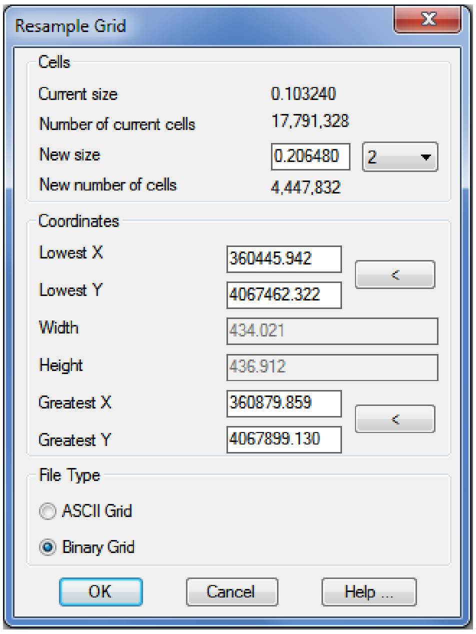
Drawing with 3D Faces



Drawing as an image

Resample Grid

Another file with a different cell size can be created from an existing grid file. Firstly, the program requests the original grid file. It then shows the following dialog box where ***New Cell Size*** and the ***File Type*** of the grid to be created are entered. It is also possible to select the coordinates of the resulting grid's corners to obtain a smaller surface.



Cells

Current size: The size of each current cell in the grid to be resampled.

Number of current cells: The number of existing cells in the grid to be resampled.

New size: The new cell size for the resulting grid. The value of the size of the cell may be inserted manually or in the dropdown menu selecting the multiplying factor.

Number of new cells: The total number of cells for the new grid based on the new size established.

Coordinates: This option enables us not to convert the complete grid but just a part of the same, for which we need to graphically define the window which defines the part of the grid to be converted. The complete grid will be resampled by default.

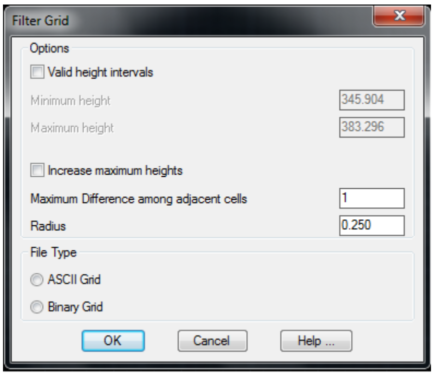
Type of File: Enables us to create an ASCII or binary grid on creating the resulting grid.

In reality, if one has the surface file used to create a grid file in addition to the grid file, it is much more accurate to create another grid file with the cell size desired than to resample the grid. This option should solely be used if one only has the grid file.

Filter Grid

This command is used to filter or generalize a grid in order to reduce its size. This is useful when a grid is too large to be represented with CAD.

When this command is executed, the window below appears to configure the filtering.



Valid height intervals: Indicate the heights for the new grid, meaning any cell with a lesser or greater height will be eliminated from the grid.

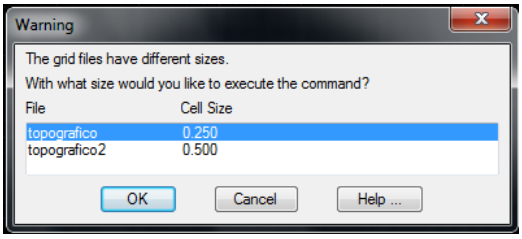
Increase maximum heights: this filter is to eliminate contiguous cells between which the height disparity is greater than the parameter given.

- **Maximum difference among adjacent cells:** Indicates the maximum difference that can exist between two adjacent cells.
- **Radius**: Radius in which the analysis is conducted, meaning that from each one of the cells all the cells that are contained in the indicated radius are analysed.

File Type: We indicate the type of file to work with, meaning with binary or ASCII grids.

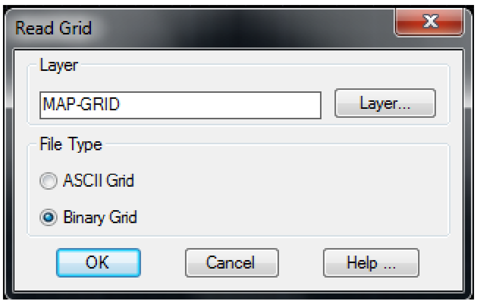
Merge Grids

This command allows one to modify an existing grid file by including the cells belonging to another grid file. The program requests the two grid files involved in the process and checks to see if they have the same cell size. Should they not have the same cell size, a dialog box is displayed where one can choose the cell size. This is equivalent to executing the ***Resample Grid*** command on one of the files.



Convert Grid from Drawing

A grid file can be created from a drawing's ***3D Face*** objects by means of this command. The ***Layer*** where the objects are drawn has to be specified, as does the ***File Type*** to be created.



Layer: The layer containing the entities from which the grid is created.

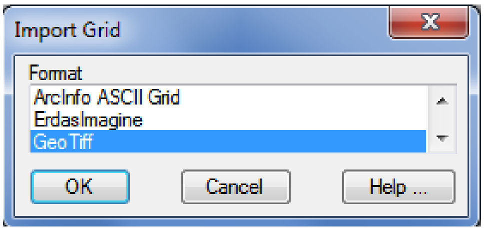
Type of file: We state the type of grid file to be generated.

1. ASCII Grid
2. Binary Grid

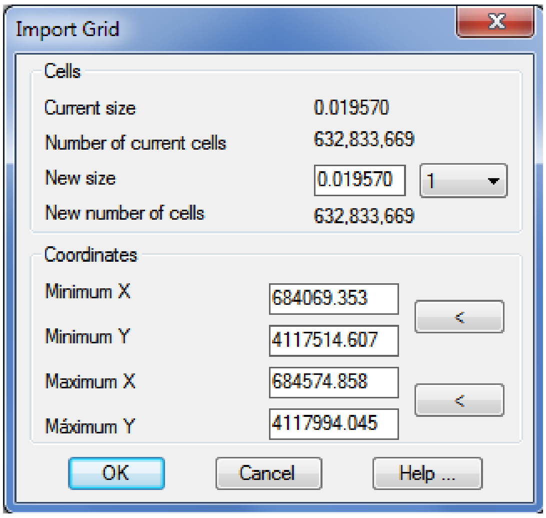
To ensure the command works properly, all objects should form squares with the same side length. In addition, adjacent squares should share the same height at common vertices.

Import Grid

This command allows the importing to MDT format grid files in other formats A dialogue appears with the list of formats supported and, after selecting one of them, the program asks for two files: firstly, the one existing in the format selected and then the file to be created in MDT format.



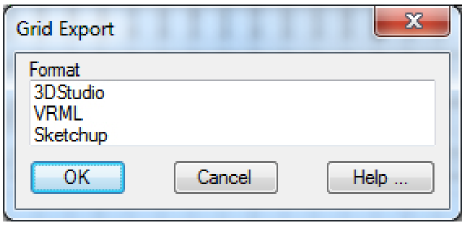
In the specific case of the GeoTiff format, the following text box appears in which we may select an area to convert only the region which is of interest to us.



Moreover, once the grid has been converted, if the size of the same is excessively large we may execute the "Resample Grid" command and change the size in accordance with our needs.

Export Grid

This command, by contrast, will allow us to export MDT grids to other formats external to MDT. A dialogue appears with the list of formats supported and, after selecting one of them, the program asks for two files: firstly, the MDT mesh file and finally the mesh file to be created with the selected format.



Information

On executing this command MDT will show the information associated with an MDT grid:

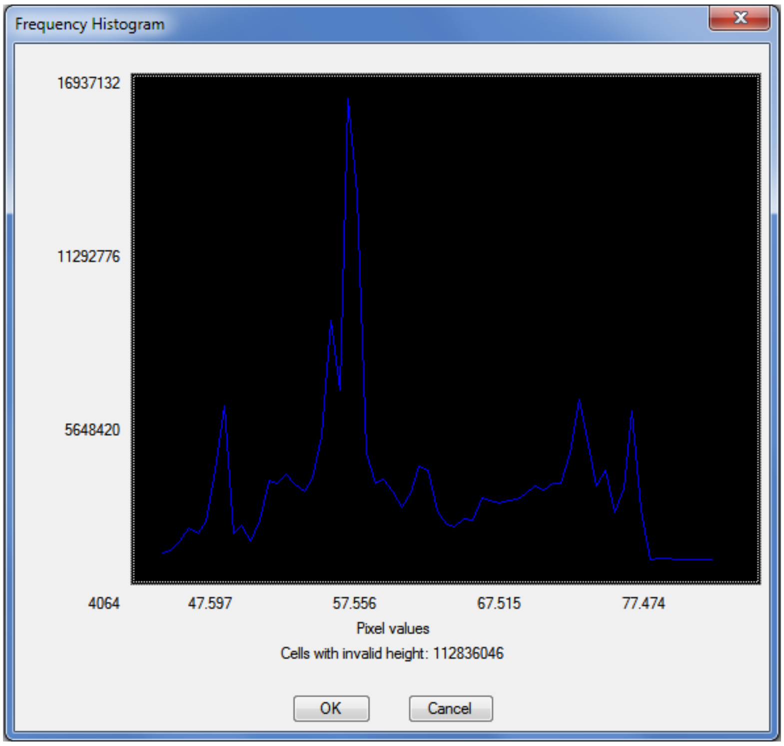
Coordinates: The minimum and maximum coordinates of the grid and the size of the same in metres.

Areas: Shows us the Topographic Surface (2D) and the Natural Surface (3D).

In Topography **natural surface** means the curve surface the shape of which coincides with the physical reality we intend to represent. However, the very nature of the graphic representation systems, as occurs in the bounded plane system, among others, obliges us to use its orthogonal projection on a horizontal reference plane as the most common surface, assigning it the name **topographic, agrarian or reduced surface**. The topographic surface is always smaller or equal to the natural surface as the former is flat and the latter may be curved. Moreover, we need to take into account that two real different surfaces may correspond to the same horizontal surface. It is normally the topographic surface we are interested in – that represented in plans and maps -, although circumstances may exist where the natural surface is the target measurand, such as, for example, in cases of surface treatment. See the ***Surfaces*** chapter.

Furthermore, information is also shown on the size of the cell, number of cells, columns and rows.

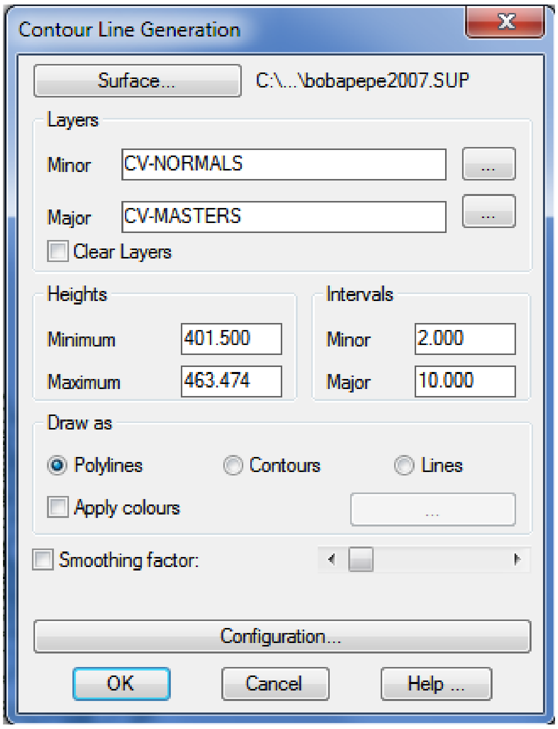
Clicking on the ***Histogram*** tab will show the distribution of the grid values. The X axis on the graph shows values of the heights, while the Y axis shows the absolute frequency (number of pixels with this height value). Hence, the distribution of heights in the grid is shown in an intuitive manner. The number of cells with no defined height is also shown.



6. Contours/Cartography

Create Contour Lines

It is necessary to have a defined surface in order to execute this process. Firstly, the command displays the following window:

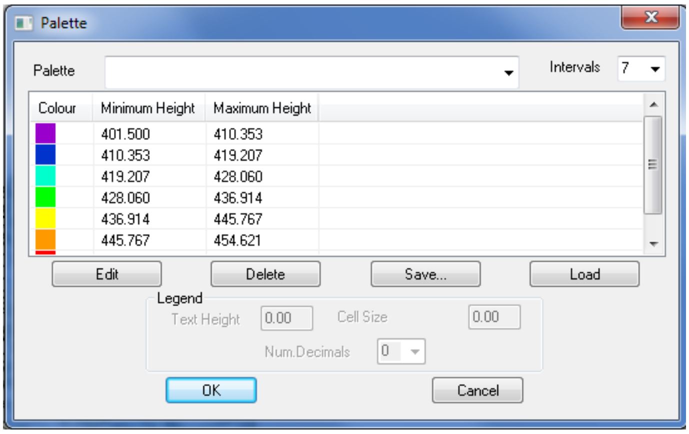


The ***Surface*** button allows one to select a surfaces file other than the current file. The options relating to layers are set out below. The layers where minor contour lines will be drawn can be specified. The ***Clean Layers*** box eliminates all objects from the layers selected to contain the contours

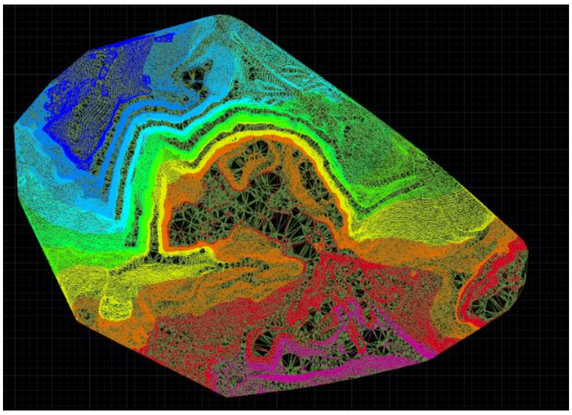
The dialog box also allows one to change the ***Minimum*** to ***Maximum*** height range to be contoured (by default this is set as the whole surface), in addition to the height intervals for ***Minor*** and ***Major*** contours to be applied when the contouring performed.

The contours may be drawn with three kinds of different objects: **CAD *Polylines***, a proprietary MDT object **(Contours)** or **CAD lines**. This first is the most common option. The second option allows the contour lines to be labeled without splitting the polylines and it is also possible to move the labels along the polylines. One drawback is that edit operations with CAD commands are not possible. Lastly, drawing the contours solely with lines has the advantage that the process of automatically editing the contours is quicker using the point and/or surface editing operations.

Apply Colours will enable us to assign a range of colours to the contour lines in accordance with the height of the contour line. We can choose from different palettes of colours.



The ***Smoothing Factor*** option ensures that the polylines generated include arch segments in order to look better. The greater the parameter value, the greater the arch introduced. Initially, it is not advisable to smooth contours since the number of vertices is quadrupled as is the amount of information that the computer has to process, thus slowing down subsequent processes. It is therefore recommended that smoothing should only be performed for the purposes of final presentation and not while working.

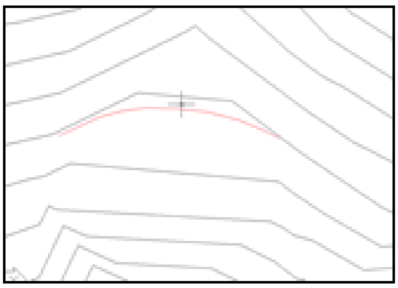


Modify Contour Lines

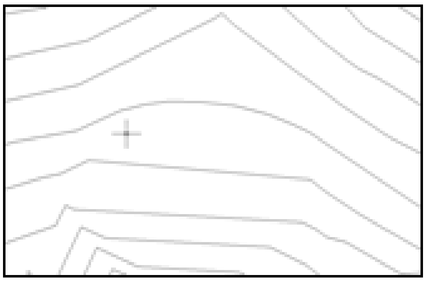
This tool is of great use to manually modify a polyline's vertices. The program requests the polyline to be modified and one then has to choose between two methods. How each method works is explained below:

Polyline: If this method is chosen, the program will additionally request a polyline to be used as the reference to modify the original. The end vertices of the second polyline will be joined to the vertices nearest to the original polyline, while all the intermediate vertices are removed. The result of applying this method can be seen below:

Before executing the command:

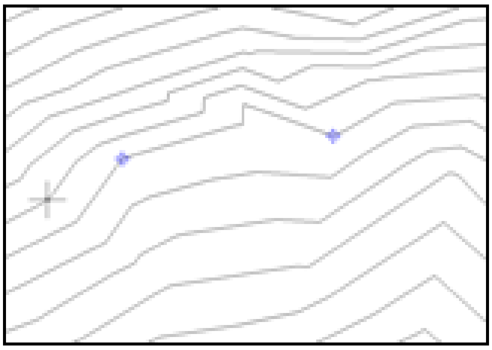


After executing the command:

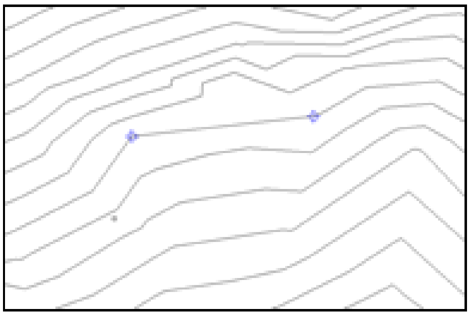


Points: If this method is chosen, the program will additionally request two points on the polyline. From these points, the program eliminates all the polyline's intermediate vertices. The result of applying this method can be seen below:

Before executing the command:



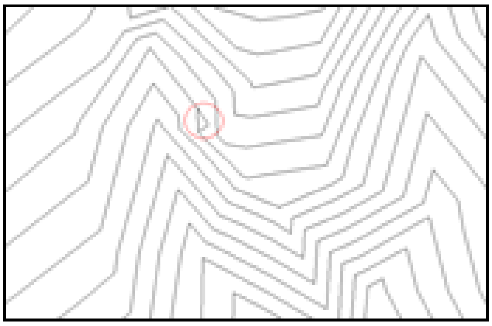
After executing the command:



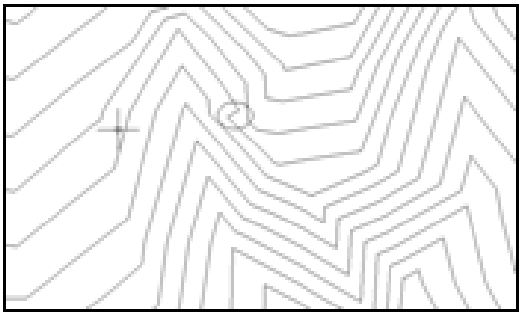
Add Vertices

This command allows one to insert intermediate vertices on a polyline. To begin with, the program requests the polyline to be modified. MDT will search for the vertices nearest to the point selected and then, if the mouse is moved, two elastic lines will appear emerging from the two nearest points in order to situate the new point at the desired coordinates.

An example of this command in operation is shown below. Before adding the vertex:

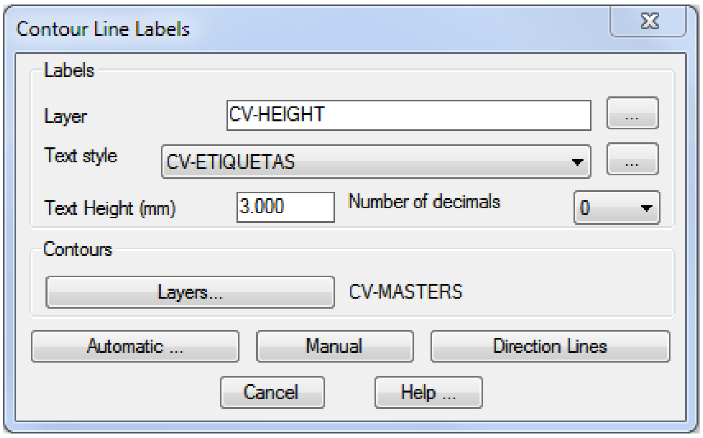


After adding the vertex:



Labeling Contour Lines

This command allows contours to be labeled, regardless of whether they have been generated as polylines or contour objects. All the parameters that take part in the process may be edited in the window shown below:

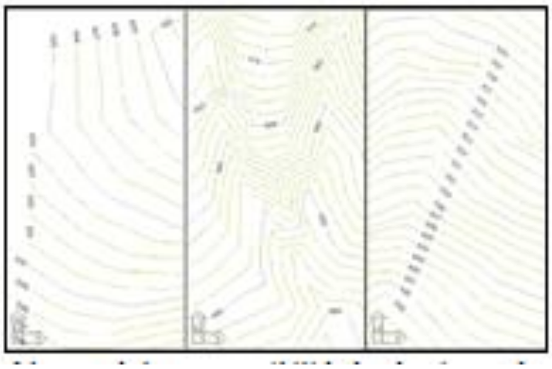


There are three options available once the ***Number of Decimals***, ***Text Height***, ***Layer*** and ***Text Style*** parameters have been configured.

Automatic: Positions the labels at the end and at the start of the contours drawn on any of the layers included in the list using the ***Layers*** button.

- **Manual:** Allows the contour line to be labeled to be entered and positioned manually.
- **Direction Lines:** By selecting two points on screen, all contours which cut across the line thus defined are labeled. This option is normally used in relatively empty areas, with gentle divides. As with the ***Automatic*** mode, the contours contained in the layers list available are analyzed with the ***Layers*** button.

All the labeling options draw the texts with an orientation which enables them to be read easily, in compliance with the labeling standards of conventional plans.



Sample of the three labeling options.

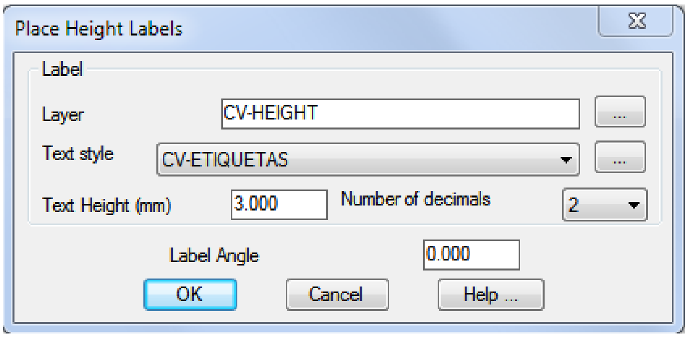
If a polyline is labeled, it is split in order to enhance the legibility of the height. But if the contour has been drawn using Contour Line objects, the same effect is achieved without altering the object. This difference means that if the labels are deleted with the **Delete Labels** command, the contours drawn with polylines will have gaps where the labels were to be found.

Delete Labels

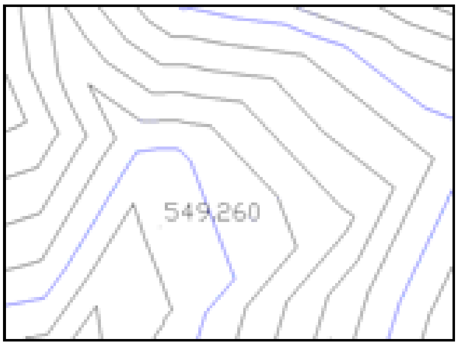
This operation deletes all contour labels, after asking first for confirmation. Should labels have been drawn in different layers, only those in the last layer selected will be deleted.

Place Label Heights

This command enables characteristics heights such as mountain passes, hills or depressions, etc. to be labeled. To do so, the following dialog is displayed:

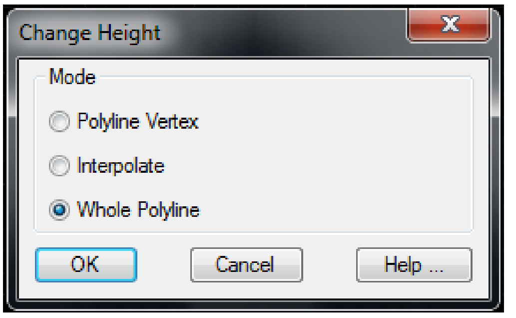


Once the parameters controlling the label's appearance have been set, the point to be labeled is clicked with the mouse. The current surface's height at the point appears in the command line as the height proposed for the label. This height may be substituted by another value.



Change Height

This tools allows one to change the height of any vertex on the polyline or of the whole polyline. The command has three different operating modes:



Polyline Vertex: The program requests the polyline’s vertex and then its height may be entered directly or by interpolating between the previous and the next vertices.

Interpolate: The program requests two of the polyline’s vertices and then the program automatically interpolates the height of all the vertices to be found between the two vertices selected.

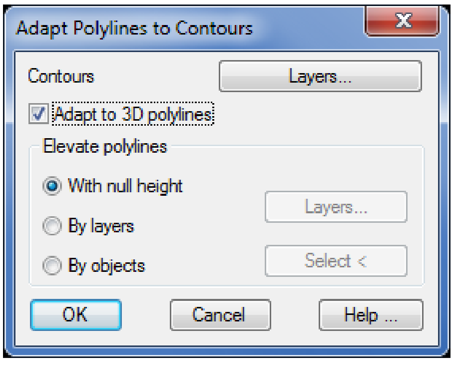
Whole Polyline: The program requests a polyline and a height and then all the polyline’s vertices are raised to the height entered.

Elevate Polyline to Contour Lines

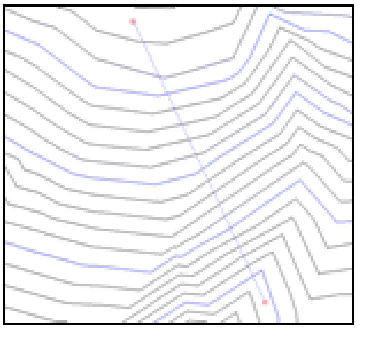
This command allows a polyline to be “pasted” on some contour lines, thus creating intermediate vertices with a height equal to that of the surface at these coordinates.

It is first necessary to specify which layers define the contours (normally CMinor and CMajor) by clicking on the ***Layers*** button. One must then decide which polylines have to be adapted:

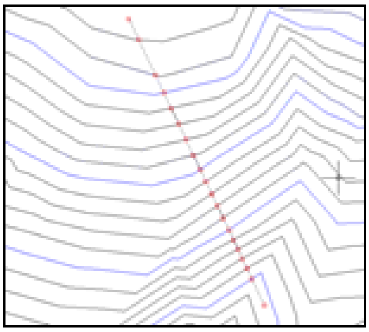
- Null height: All polylines assigned a height of zero.
- By layers: Allows one to specify the layers whose polylines will be adapted.
- By objects: Allows one to use the standard object designation mode in AutoCAD to elevate them. This method should be used to elevate one or various polylines selected manually.



The vertices of a polyline before applying the command:



The vertices of a polyline after applying the command:



Generalization

This command allows one to group together a series of known algorithms whose aim is to delete or keep the vertices of the polylines selected.

The program will execute the algorithm previously set in the program configuration. Consult the Contour Line section in the **Customization Manual**.

Two algorithms (the Douglas-Peucker and the Visvalingam algorithms) are described below.

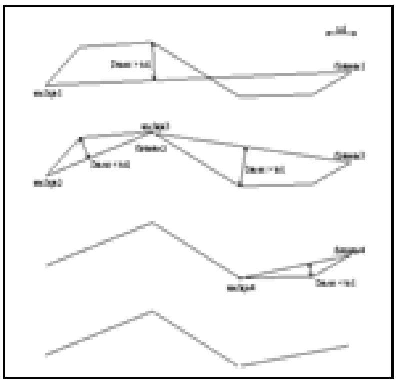
Douglas-Peucker Algorithm

This is a simplification algorithm, in other words, it seeks to reduce the number of points existing on a polyline.

It is based on the search for critical points starting off from a linear tolerance. The critical points, which will form the simplified line, will be those which progressively attain a greater perpendicular distance with respect to the base line considered that is always greater than the tolerance imposed.

The first base line will be formed between the first (anchoring) and last (floating) points of the original line. Then the perpendicular distances from all intermediate points will be calculated:

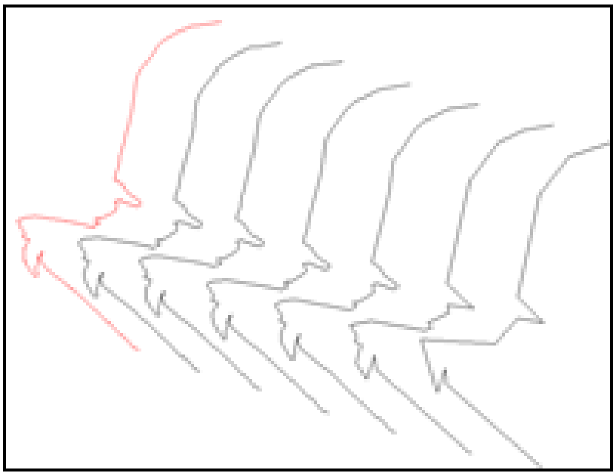
- If none of these distances is greater than tolerance, the simplification will have come to an end with only the line's initial and final points being retained.
- Should tolerance be exceeded, the point furthest away will be retained as the critical point that will subdivide the original line into two sections. In each of those sections, the process will be repeated as if they were two independent lines and the process will continue thus until there is no need to further subdivide the line.



Scheme of operation of the Douglas- Peucker algorithm.

Once the command has been run, MDT will request the polylines that are to be modified. It will then request the scale of the drawing. In accordance with this scale, it will propose a value for tolerance, which users may later modify.

How the algorithm works by applying different tolerance values can be seen below.



Parameter	Number of Vertices
Original Line	481
0.1	104
0.2	88
0.4	62
1	38
2	21
5	12

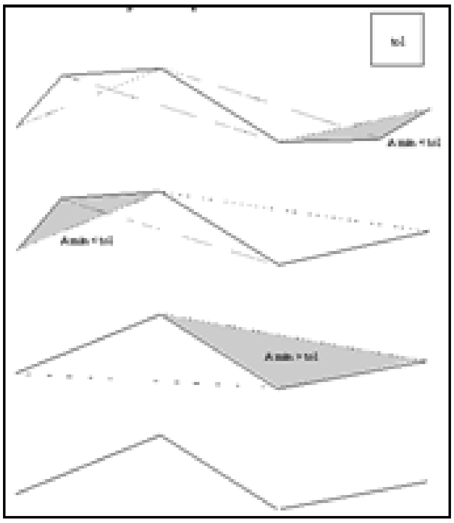
Visvalingam Algorithm

The Visvalingam algorithm is a polyline simplification operator used in the process of generalization. In said process, it will progressively eliminate any points that are less significant for the shape of the line's definition.

It is therefore a very useful tool when the aim is to diminish the drawing's volume or to represent a specific linear object on a smaller scale than the one for which it was originally conceived.

The Visvalingam algorithm is based on *effective area* concept, defined as the triangle area formed by each the line's points and its two immediately neighboring points. The concept effectively signifies the adjustment the line suffers should that point be eliminated.

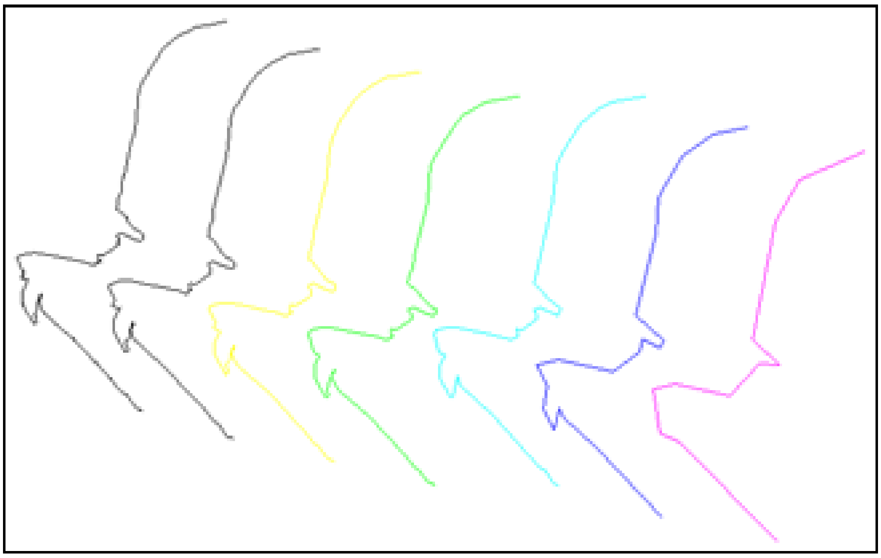
The algorithm's simplification process consists of establishing a specific tolerance which will correspond to the effective area parameter, below which any points will be eliminated whose corresponding triangles are smaller in area than said tolerance. Firstly, the areas of all the triangles are calculated and the point with least effective area is eliminated. Once this point has been eliminated, all the areas are calculated once more and the point with least effective area is eliminated once again. And so on until all areas are greater than the tolerance value set.



Scheme of operation of Visvalingam algorithm.

Once the command has been executed, MDT will request the polylines that are to be modified and the tolerance value. The program will then apply the entire calculation process.

How the algorithm works by applying different tolerance values can be seen below.



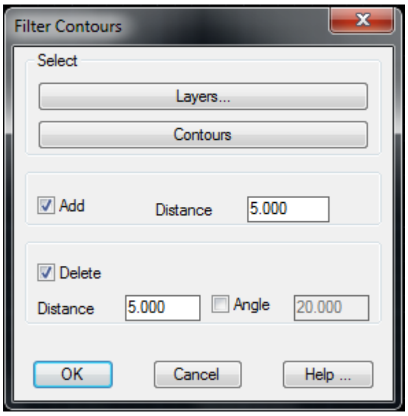
Filtering

This command groups together a series of algorithms whose aim is to eliminate certain vertices on the polylines selected. It is thus possible to correct the various errors which may exist in the contour line.

The program will execute the algorithm previously set in the program configuration (see **Contours Lines** section in the **Customization Manual**).

Tunnel Algorithm

When this command is run, the following dialog box will appear. A more detailed description is given below.



Select: The contour line that are going to intervene in the filtering are selected in this section. These contour lines may be selected by two methods.

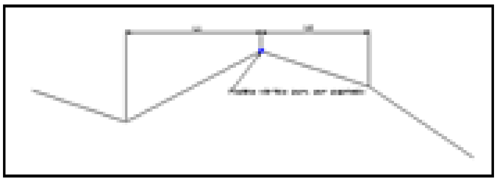
- **Contours**: We graphically name the contours to be filtered, via the standard AutoCAD modes of object selection.
- **Layers**: The layers where the contour lines or polylines to be filtered are to be found are selected.

Add: If this option is marked, MDT will enter vertices in the polyline in any segments whose length is greater than the value entered in the ***Distance*** control. It will therefore be impossible for there to be polyline segments whose length is greater than that distance.

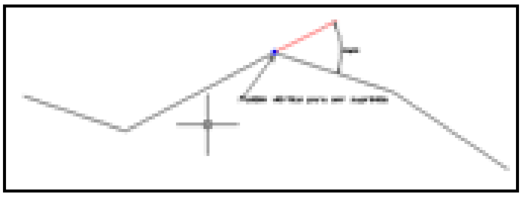
Delete: If this option is marked, MDT will use the following algorithm to eliminate vertices:

For a vertex on a polyline to be eliminated, two conditions must be satisfied:

The distance from the previous and next points cannot be greater than the distance specified in the ***Distance*** control.



The angles formed by the previous and next points with respect to the vertex cannot be greater than the value entered in the ***Angle*** control.



Midpoint Algorithm

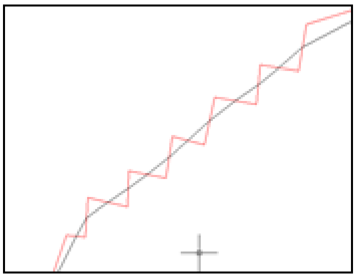
The aim of this algorithm is to seek a filter for polyline vertices while seeking the polyline's smoothing at the same time. The process consists of creating a new polyline from the original polyline by using its segments' midpoints. When this algorithm is selected, the program requests two parameters:

Minimum Segment Length: Any segment of the polyline whose length is greater than the value entered will be processed by the algorithm.

Maximum Length Accepted: If there is any segment whose length is greater than this distance, the segment will be subdivided into as many minimum segment lengths as possible.

MDT will start by processing all polylines with the second parameter and will then apply the first in order to extract all the intermediate points.

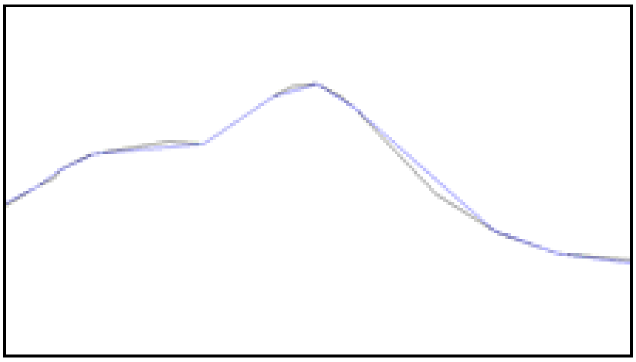
The effect of applying the algorithm to a polyline may be seen below.



Inner Segment Algorithm

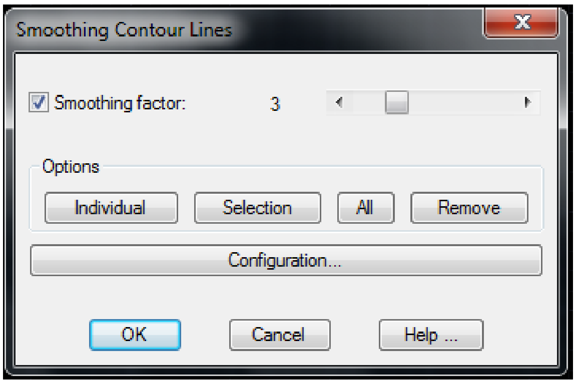
The application of this method consists of the fact that there can be no polylines among those selected whose length is less than that of a given length.

When the algorithm is executed, the program starts by requesting the contour lines or polylines that are to intervene in the algorithm and then the size of the segment. MDT then will progressively eliminate any of the polyline's vertices that do not comply with the aforementioned requirement.



Smoothing Contour Lines

The smoothing of contour lines may be applied when they are generated. However, in the case of very large and/or dense drawings, it is better not to work with smoothed contours since the size of the drawing increases. Performing this operation is more appropriate for the job's final presentation.



This operation may be configured by users through a variable factor ranging from 1 to 10. The options available are as follows:

- **Individual**: Allows contour lines to be smoothed one by one. The result is shown at the moment they are selected graphically. This option allows the result of the different factors to be observed.
- **Selection**: Allows a group of contour lines to be selected, so that smoothing factor chosen may be applied on them.
- **All**: Smoothes all the contours in a single action.
- **Remove**: Removes the smoothing of contour line.

By clicking on the ***Configuration*** button, the smoothing algorithm parameters may be specified (see **Customization Manual**).

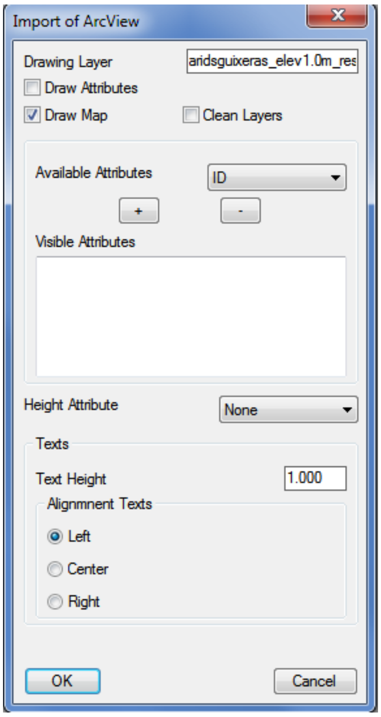
Import GIS

Using this command we will be able to directly import n ArcView file and the program will ask us for the ArcView file which must have an SHP extension.

In addition, as well as the file selected with an SHP extension, there must be other files with the same name and other extensions which contain the necessary information associated with the file to be imported.

The image below shows the set of files associated with an SHP file to be imported.

Once the file has been selected, the following window will appear in which we can manage and represent the attributes associated with the file to be imported.



Drawing Layer: Layer on which the elements resultig from the import of the selected file will be drawn.

Draw Map: This option will be enabled by default and it allows us to indicate that the lines or polylines resulting from the file import are drawn.

Clean Layer: On enabling this option we eliminate all those elements to be found in the layer we have designated to draw the elements.

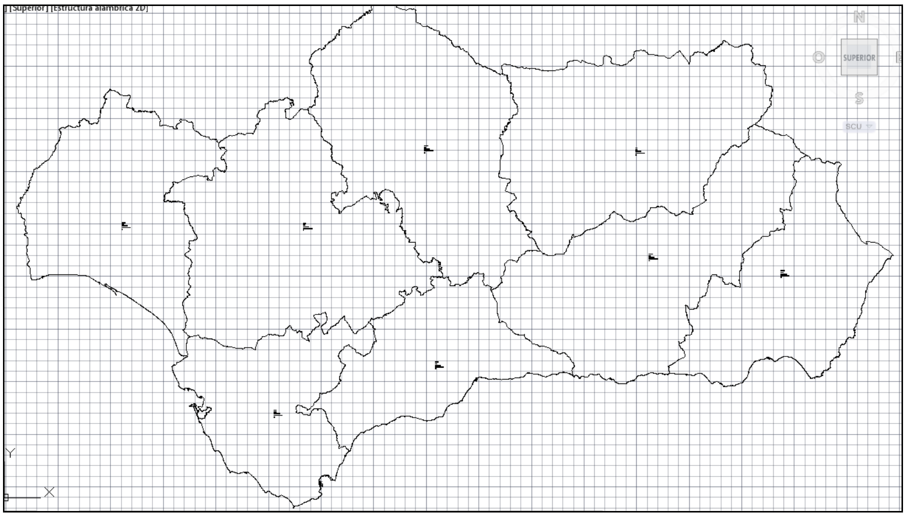
Draw Attributes: Furthermore, if this option is enabled, the attributes associated with the ArcView field and which we have selected previously will be drawn.

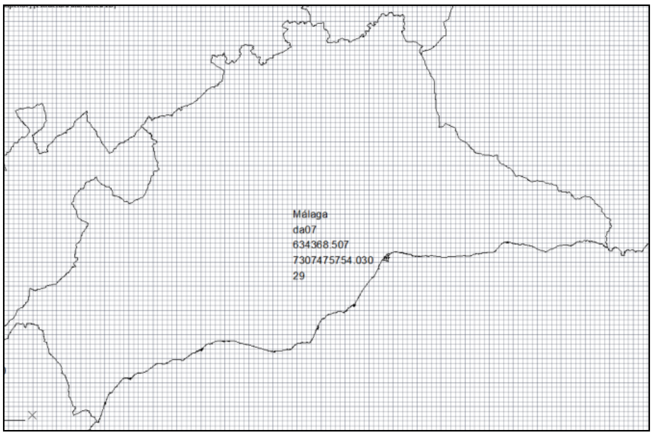
Available Attributes: These are all the attributes to be found in the ArcView fiel selected.

Visible Attributes: Set of attributes selected and which we wish to draw when importing the ArcView file.

Texts: In this section, in the event there is any attribute to be drawn, we configure their representation from the text height to their alignment.

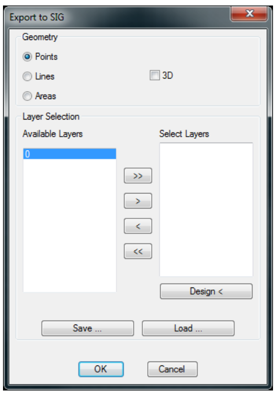
The result of importing an ArcView file with its corresponding attributes is then shown.





Export GIS

This command will allow us to export a drawing in ArcView format. It will initially ask us for the SHP file in which the information is to be stored and the following window will then appear where all the information to be imported will be managed.



Geometry: In this section we indicate how we wish to import the selected elements. We could export them as **Points**, **Lines or Areas**.

In addition, we have the possibility of exporting them in **3D** or 2D depending on whether we enable the corresponding box.

Layer Selection: We indicate the layers on which the elements are situated which we wish to export. We have the possibility of moving to the right the layer of layers selected or designatng them graphically.

Save: By pressing this button we will save the layer configuration selected in a file.

Load: By pressing this button we will be able to recover the configuration of layers selected.

Interpolate Contour Lines

This option has been implemented in order to interpolate a certain number of contour lines between two given contours without needing the digital model..

The program will execute the algorithm previously set in the program configuration (see **Contours Lines** section in the **Customization Manual**).

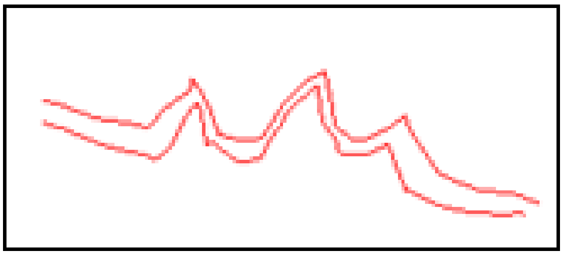
The command has the possibility of interpolating between complete contour lines or by selecting the initial and final points of each of the original contour lines in order to interpolate partially. The following message is shown:

Select <Polyline>/Vertices:

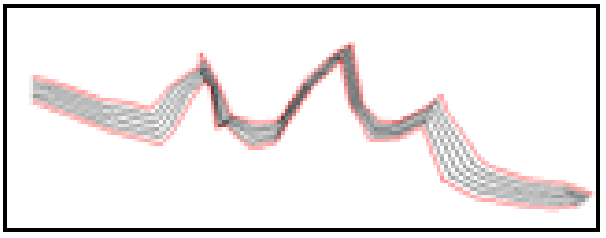
If a polyline is selected directly, it is understood that one wishes to interpolate complete contours. If the second option is chosen, four control points are requested.

The graphic below shows an example of this command in use:

Before executing the command:



After interpolation:



A brief description of the two algorithms employed is given below.

Vertex Matching Algorithm

This algorithm is relatively simple and consists of the following steps:

1. Select the first vertex of every two contours.

2. Calculate the distance that joins them and create a point belonging to the initial contour line(s) (linear interpolation).

3. Determine the least distance from a vertex on a contour line to another contour line. The following step are used to do this:

a) Start from the current points on both contour lines.

b) The distance from the next point on contour line 1 to the same point on contour line 2 is calculated. Then the distance from the next point on contour line 2 to the same point on contour line 1 is calculated. Finally, distance between the next points on contour line 1 and contour line 2 are calculated. In other words, three distances are calculated.

c) A decision is made on which of the three distances is smallest. This distance will determine whether the advance occurs on the vertices of contour line 1, contour line 2 or both in this step.

4. After determining the advance, the process is repeated from point 2 with the two new vertices selected until the last vertex of both polylines is reached.

Triangulation Algorithm

This algorithm consists of the following steps:

1. Extract from the initial and final contour lines all vertices.

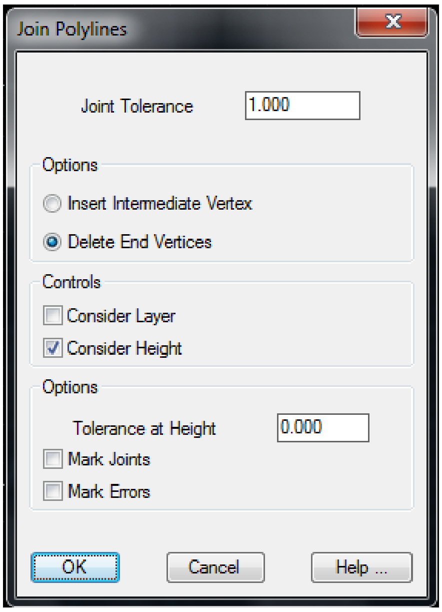
2. Generate a triangulation with all the vertices, considering as break lines all segments which form the contour lines and the polygon formed by these and the lines that join their ends as the boundary.

3. Contour line generation corresponding to this triangulation with the equidistance desired.

Join Contours Lines

The utility of this command lies in its ability to join any polylines whose end vertices coincide in a single polyline. This avoids having many broken polylines in the cartography, as well as making it possible to join sheets of digitalized cartography together.

When the command is executed, the program request one to select polylines on which the algorithm to be applied. The following dialog box is then displayed, which is described further below.



Joint Tolerance: Represents the maximum distance that may exist between the end vertices of the polylines selected.

Consider Layer: If this control is activated, only polylines in the same layer will be joined.

Consider Height: If this control is activated, only polylines having the same height will be joined.

Insert Intermediate Vertices: When the polylines are joined, a new vertex will be created at the joints.

Delete End Vertices: The end vertices on the new polyline corresponding to the polylines to be joined are deleted in the new polyline.

At Height Tolerance: Represents the maximum height difference that may exist between two polylines which are to be joined. This option is available for the case of **Consider Layer**.

Mark Joints (only in the case of **Consider Height**)**:** Any polylines which have been joined will be marked with a circle at the joint.

Mark Errors (only in the case of **Consider Height**)**:** Any polylines which have not been joined due to height tolerance will be marked with a circle at the joint.

Split Contour Lines

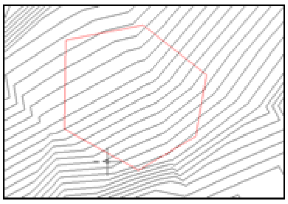
This tool is very useful for splitting a contouring or polyline group taking another as reference. It can be very useful if one wishes to divide the cartography into sheet formats to be printed subsequently.

The program will start by requesting the polylines one wishes to split and then the polyline that will be taken as a reference before executing the process.

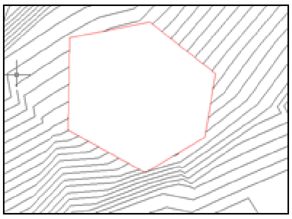
Cut Out Contour Lines

A gap within contour lines can be created by means of this command. The program requests a polyline to act as border of the cut and then the it eliminates all polyline segments to be found within the border. An example of this command in use can be seen in the image below.

Before executing the command:



After execution:



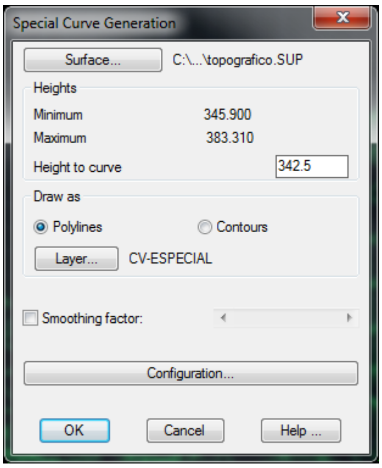
Delete Contour Lines

This command simply deletes contour lines and their corresponding labels after first asking for confirmation.

When one is working with a very large drawing, it is possible that the editing of surveying points is too slow due to automatic contouring. In such cases it is a god idea to delete the contouring and probably to destroy the current surface in order to generate the contours again later once the editing has been completed.

Contour Special Heights

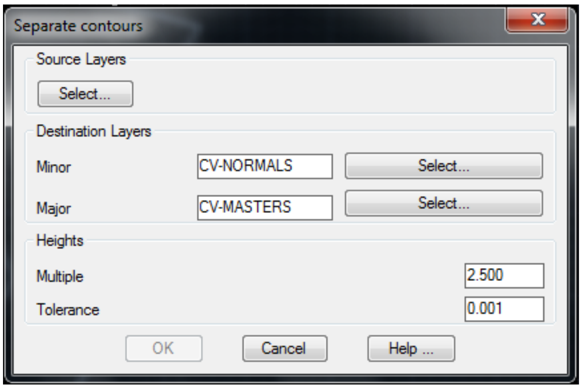
This command allows contours passing through specific heights to be obtained. In order do so, the following window is displayed:



The options are identical to those of the Contour command, except in this case only one Contour elevation to create is specified, instead of an interval. The command functions in an iterative manner. In other words, once the special contour has been generated, the command is executed again in order to indicate another special contour. This process is repeated until the ***Cancel*** button is clicked.

Separate Contour Lines

On many occasions, contour maps are imported in which no graphic difference exists between the minor and major contour lines. This command may be used in order to be able to distinguish one kind from the other.



As can be seen in the dialog box, the layers containing contour lines have to be specified. The program will move the objects to the ***Minor*** or ***Major*** layers. One will be distinguished from the other according to whether the contour line is a multiple of the number entered in the ***Multiple Factor*** parameter. Additionally, the ***Tolerance*** parameter allows any contour lines to be selected lying above or below the indicated height multiple tolerance.

For instance, in the case of a contour line map whose equidistance is one meter and height interval is between 100 and 150 meters above sea level and one wishes that the major contours be at 100, 110, 120, 130, 140 and 150 meters, a multiple factor of 10 has to be specified. If one additionally wishes to extract any contours that are one meter above or below, a tolerance of one meter has to be specified.

Detect Errors

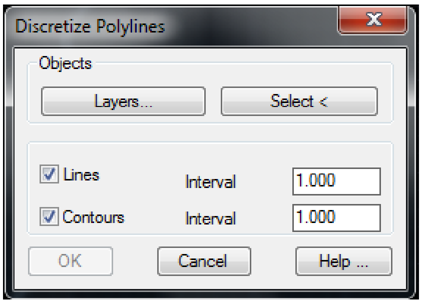
This tool is of great use to detect errors in contour line heights. The program requests one to define a line which crosses the contour lines to be checked by means of the ***Initial Point*** and ***Final Point,*** and the ***Height Interval*** between the existing contour lines.

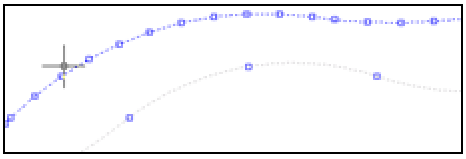
The color of any contour lines whose height does not correspond with the interval chosen will be changed to red, and information concerning the number of errors found is provided.

Discretize Polylines

The aim of this utility is to generate a series of intermediate vertices in the polylines selected. The entities to be processed may be specified by clicking on the ***Layers*** button, or by clicking ***Select*** and then selecting them using the standard selection methods.

Discretizing intervals may be controlled separately for ***Lines*** and ***Contours***.

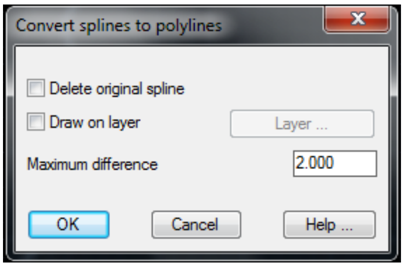


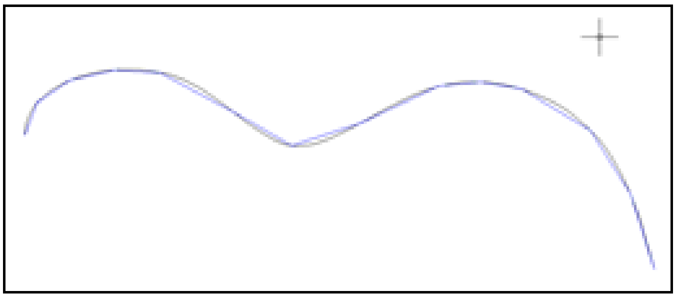


Convert Splines to a Polyline

This tool converts spline-type objects into conventional AutoCAD polylines. The ***Maximum Difference*** box is the maximum difference that will be found between the original layout of the spline and the polyline to be created.

The ***Delete Original Spline*** box when activated indicates that the original object will be deleted from the drawing. Additionally, if ***Draw on Layer*** is enabled the new polylines will be drawn in the layer specified by the corresponding button.





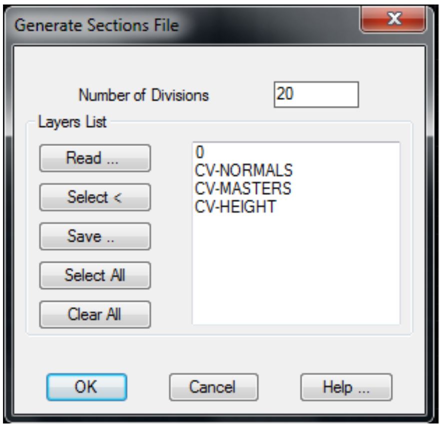
Create Sections File

This option has been put into place in order to speed up the process of obtaining longitudinal profiles and cross-sections from digitized cartography. By means of this tool, the program will create a file having same name as the drawing and with the extension `.TRM`, containing the same objects as the drawing. The will however be a special binary format conceived, so as optimize cutting times. The curved sections discretized using this format. There may therefore be some differences with respect to directly cutting the drawing's objects.

The program displays a dialog window containing a list of existing layers. The layers one wishes to store must be marked, as explained for previous commands.

By clicking on the ***OK*** button, the file will be created and ready to be used later use.

It should be pointed out that this format is designed to optimize calculation speed at the cost of size. The size may therefore sometimes be even greater than the corresponding DWG file. The size is affected by the value of the ***Number of Divisions*** parameter, which will determine the maximum number of quadrants which will divide a drawing for conversion into sections.



The remainder of the dialog buttons enables the selection of layers to be controlled, as with other commands.

Draw Sections File

The aim of this command is to permit the rapid and simple visualisation of the features of the cartography being worked on. To begin with, the file for the cartography's sections must be created (see Create Sections File Command).

). Then, in a new CAD drawing, we execute this command. It will ask us for a sections file, whereupon MDT will draw a preview of the cartography, offering a series of options in the command line, as described below:

Center: Allows one to center the cartography in accordance with the point selected on screen.

Window: This is the equivalent of CAD's **Zoom Window** command. The program will request the window's two end vertices.

Height: Request the height of the point designated in the cartography to be specified.

Enlarge: A zoom is automatically performed to enlarge the area centered in the drawing.

Reduce: As above, except that in this case the drawing's central area reduced.

Dynamic: Initially, two screen coordinates are requested and then an adjustment in the drawing is produced equivalent to the distance between the two points selected.

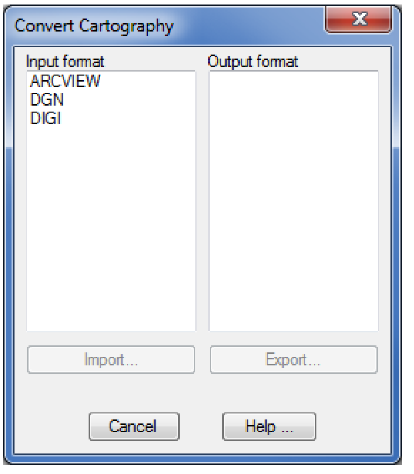
Profile: Allows one to preview a profile of the cartography. To do so, two points are requested and then a new window is automatically displayed containing the profile of the terrain selected (see definition for **Quick Profile**). The program will repeatedly ask for points in pairs until the process is cancelled by right clicking the mouse.

Longitudinal Profile: This is the same as the previous option, except N points will be requested until the process is canceled by right clicking the mouse. After entering the points, a view of the profile will be seen in a window. The program will repeatedly execute the command until it is canceled by right clicking the mouse.

In order to maximize speed, all the above commands do not really add new objects to the drawing. Rather they draw directly on screen, which is why they disappear when the command is terminated.

Convert Cartography

This tool converts a digitized cartography file into one of the various formats supported and directly represents it in the current drawing. Points, polylines and texts will be drawn, creating the necessary layers.



7. Elements

Introduction

MDT incorporates new functionalities for the Road Layout, especially in terms of alignment integration and design. The programme encompasses the concepts of fixed, coupled, revolving, mobile and link alignments.

Fixed Alignment

A fixed alignment includes all the parameters required to determine its position. It is defined by means of two points and a radius (0 for straight segments). Furthermore, it may include a setback distance and two clothoids (for output and output at the fixed segment).

Three points may also be used to define a fixed circular. The programme deducts the radius and thereafter assumes that two points and a radius have been used.

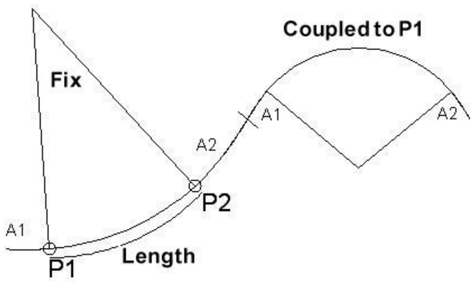
Coupled Alignment

A coupled alignment is supported on an alignment already calculated to determine its position. At the final or initial point of the already calculated alignment, and with the corresponding azimuth, the layout elements of the coupled alignment concatenate.

It is defined by its radius, its length and the parameters of the input and output clothoids. Furthermore, it has a final item of data pertaining to the length (or an increase in length) of the alignment on which it is supported. In view of this latter data, and bearing in mind whether the alignment calculated is the previous or subsequent one, four subtypes can be distinguished between

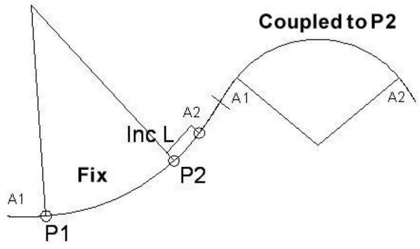
Coupled to P1

The coupled alignment replaces the length calculated on the previous alignment. For the new final point the coupled alignment is concatenated.



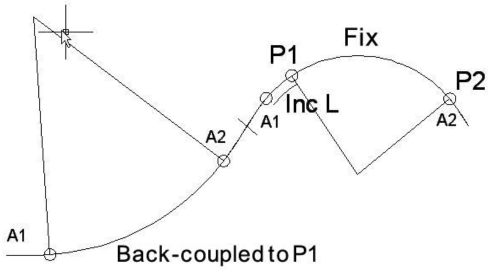
Coupled to P2

The coupled alignment extends the length calculated on the previous alignment. For the new final point the coupled alignment is concatenated.



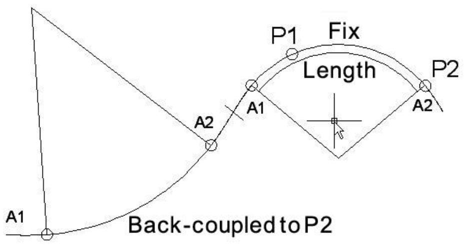
Back-coupled to P1

The coupled alignment extends the length calculated on the subsequent alignment. Before the next alignment, the layout elements of the coupled alignment are inserted.



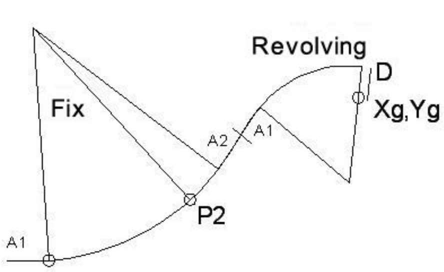
Back-coupled to P2

The coupled alignment replaces the length calculated on the subsequent alignment. Before the next alignment, the layout elements of the coupled alignment are inserted.



Revolving Alignment

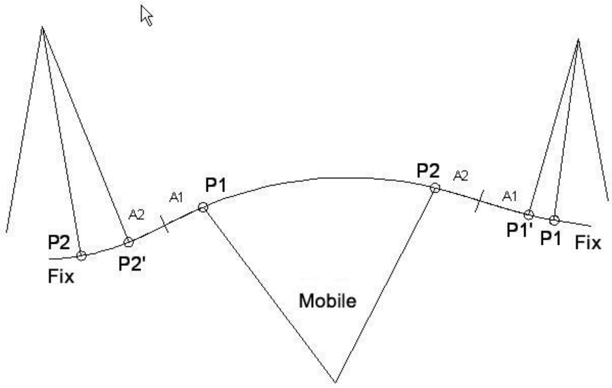
A revolving alignment is also supported on a calculated alignment and it meets the condition that it passes via a fixed point of known coordinates or at a distance from the latter. To achieve this, it modifies the length of the fixed alignment and calculates the length of the revolving alignment.



Two types are distinguished between, Revolving and Back-revolving, depending on whether it is supported on the previous or subsequent alignment. The data it includes are the radius, the clothoid parameters, the crossing point, and optionally a distance to the crossing point.

Mobile Alignment

A mobile alignment is defined by its radius and the parameters of the input and output clothoids. In order to calculate it, the previous and subsequent alignment are calculated.

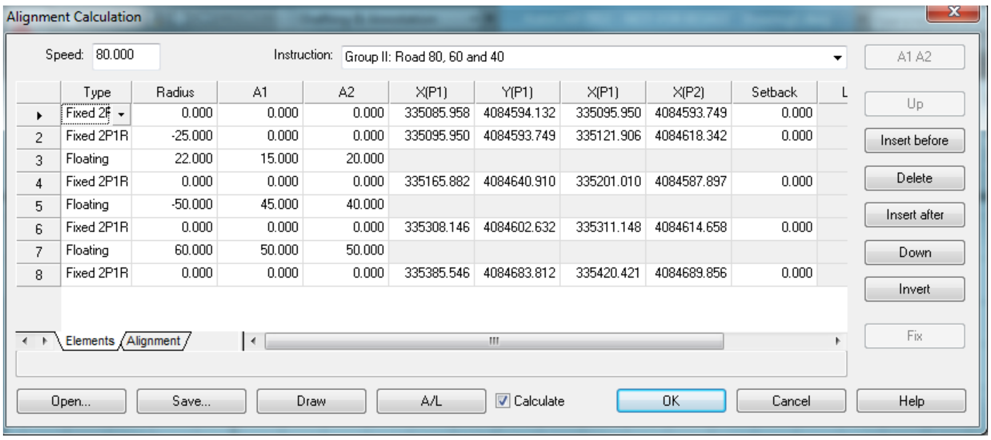


During the calculation process the lengths of the previous and subsequent alignments are modified in such a way that that the elements are tangential to each other.

There are cases in which two mobile alignment solutions are possible. In this case, the programme opts for the shortest development solution. To use the other solution, the type has to be changed to **Special Mobile**.

Calculate Alignments

This command allows an axis to be edited based on the alignments that define it. Upon executing the command, an axis can be selected on the screen or the command line options can be used to load a file or create a new axis. A window then appears with the list of alignments, ordered according to the direction of travel of the axis.



Firstly, the axis project speed appears and road instruction file. The "**A1 A2"** button assigns to the alignment of the list which has the cursor the clothoid parameters in accordance with the instruction.

Under the list there are two tabs labelled **Alignments** and **Axis**. The first allows the editing of the alignments and the second shows the axis resulting from the calculation.

On the right of the window there is an operations' column which operates on the alignment selected on the list. The **Raise** and **Lower** buttons allow an alignment to be moved within the list. The **Delete** button eliminates it and the **Invert** button exchanges the initial and final points of the alignment as well as the radius sign, resulting in the inversion of the direction of travel of the axis at this alignment. For an alignment which is not fixed and which has been calculated, the **Fix**button converts it into a fixed alignment, taking its initial and final points from the calculation. Finally, the **Insert before** and **Insert afterwards**buttons allow the graphic designation of a layout element and its addition to the list, being inserted at the position before or after that of the cursor.

On the list itself in the first column (**Type**) the alignment type can be changed, selecting it from a drop-down menu. When changing the type, the other cells on the row can be enabled or disabled in line with the option chosen.

The **Radius**columns, **A1**and **A2** allow the radius and the input (A1) and output (A2) clothoid parameters of the corresponding alignment to be edited. By pressing the lower button "**A/L**", you can switch between the parameter or length when editing the clothoids.

The columns **X(P1)**, **Y(P1)**, **X(P2)**and **Y(P2)** show the coordinates defined by the fixed alignments. In the rest of the alignments they are disabled, except at the revolving (or back-revolving) alignments in which the crossing point is shown at **X(P1)**, **Y(P1)**. These coordinates can be coordinated by keying in a value or pressing the "**...**" button to designate the point graphically.

The **Setback**column shows the displacement that fixed alignments may have.

The **Length** and **Inclength** are involved in the coupled alignments. The former is the length of the coupled alignment and the latter is the modification to the length of the alignment to which it is coupled.

In the event that on the lower part the **Calculate**option is enabled, each edition of the list brings about a recalculation of the alignments affected. In the event that the programme is unable to calculate any alignment, in the first column the cell with the ordinal of the alignment will appear in red. Upon placing the cursor on this line, under the list the error that has occurred appears on the status line.

The **Open**button allows an axis, segment or alignment file to be loaded. The **Save** button allows the list of alignments to be saved on a file. In the event that it is not possible to calculate the axis, the file to be save will be of the alignment type (with the extension ALI). When the axis can be calculated, the file to be saved will be of the axis type (with the extension AXIS), but including the information pertaining to the alignments. Hence, in a future sessions the same set of alignments can continue to be edited.

MDT6 type alignments

In addition to the Calculate Alignments command, MDT7 includes the alignment commands from the previous version. These commands can be used to edit an alignment or an axis, but it must be borne in mind that upon doing so, the information about the alignment type (Fixed, Mobile etc.) is eliminated.

Layout Elements

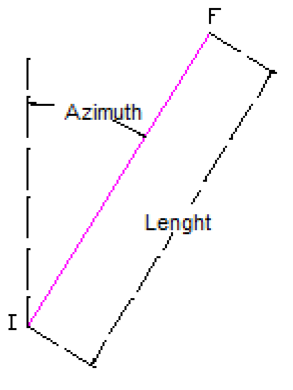
Layout elements are elementary geometric principles with which more complex alignments are formed. The programme distinguishes between three types of layout elements: straight lines, circular curves and clothoids.

The layout elements are defined by a point of origin, an initial azimuth and a length calculated by the system.

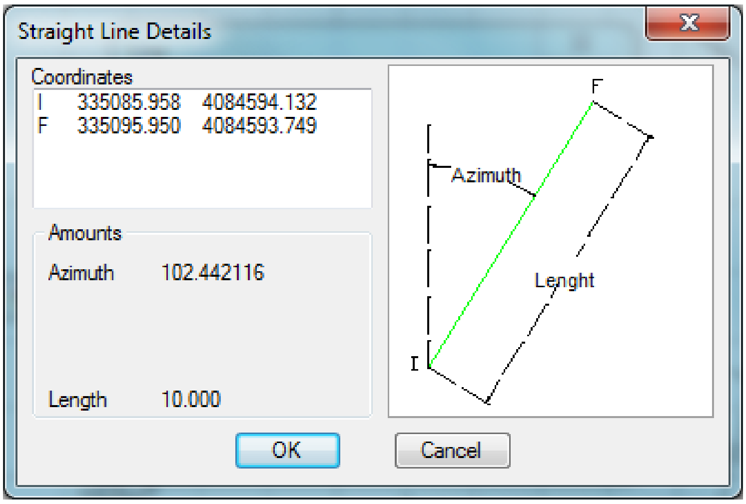
Straight lines

The straight line is defined by its initial (I) and final (F) points. The initial azimuth and the length are calculated automatically and they are indicated in the dialogue which is shown by pressing the ***Details***button in the command **Edit Alignment**

.



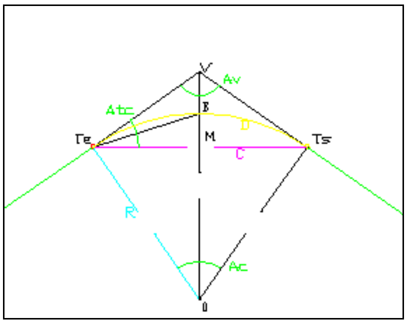
The straight lines are drawn as line type entities or as a polyline with two vertices.



Any kind of modification can be made to these elements using the CAD commands: copy, rotate, move, lengthen, shorten etc.

Curves

The curve type layout elements are defined by their centre, initial and final angles and their radius. The latter will bear a positive sign if it moves forward in a clockwise direction or negative otherwise.



The coordinates sow in the ***Details*** dialogue of the command **Edit Alignment**

are:

Te. Input tangent of the curve.

Ts. Output tangent of the curve.

O. Centre.

V. Vertex.

B. Bisector. Arc midpoint.

M. Chord midpoint.

On the other hand, the magnitudes indicated are as follows:

R. Radius.

T. Tangent

VB. Distance to the vertex: VB.

D. Development.

C. Curve length.

Sc. Semi-chord.

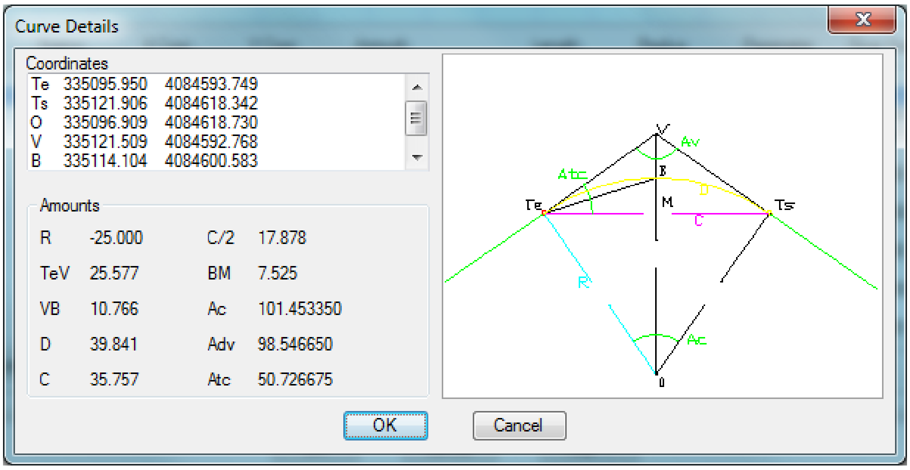
Fl. Arrow

Ac. Angle in the centre: TeOTs

Av. Angle at the vertex: TeVTs

Atc. Angle between tangent and chord: VTeTs

The circular curves are drawn as arc type entities or polylines with two vertices and curvature.



As with the straight lines, any kind of modification can be made to these elements using the CAD commands: copy, rotate, move, lengthen, shorten etc.

Clothoids

The clothoid type layout elements are defined not just by their origin and initial azimuth, but also by their input and output radio and their parameter. Provided that the following is complied with:

$$L = \frac{A^2}{R}$$

where L is the length of the clothoid, A is the parameter and R is the radius. The clothoids may be defined between a straight line and a curve (Re= ∞ y Rs=R), between a curve and a straight line (Re=R y Rs= ∞) or between two curves ($Re=R_1$ and $Rs=R_2$).

The coordinates sow in the ***Details*** dialogue of the command Edit Alignment

are:

O. Link circle centre.

Te. Input tangent of the curve.

Ts. Output tangent of the curve.

PI. Tangent intersection point.

On the other hand, the magnitudes indicated are as follows:

X. X-axis of the final point.

Y. Final point ordinate.

X0. X-axis of the centre.

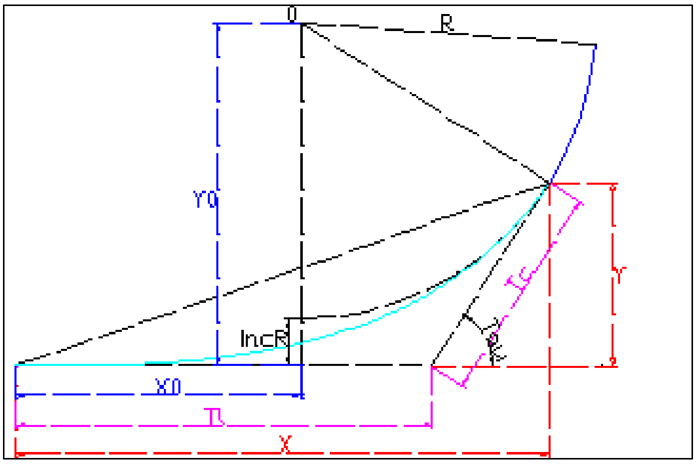
Y0. Ordinate of the centre.

Tc. Short tangent.

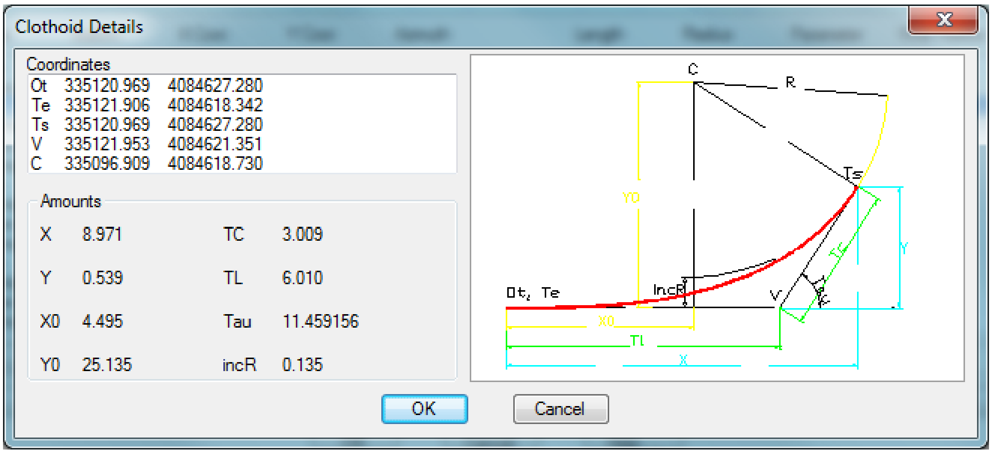
Tl. Long tangent.

Tau. Angle formed by the two tangents at the vertex.

IncR. Setback.



For the clothoids a discretisation is drawn of the theoretical curve by means of a polyline. The drawing interval may be specified on the configuration. This parameter only affects the representation as the results are always calculated analytically.



The polyline representing a clothoid can be copied, revolved and moved using the CAD commands. The modifications to individual vertices are not taken into account. To modify the length of a clothoid the command Edit Clothoid

must be used.

Elements

Once a set of layout elements has been drawn, they can be grouped with a view ensuring that a modification to any one of them modifies certain parameters of the adjoining elements in such a way that the alignment they form maintains its coherence. These modifications must be carried out with the commands provided by the programme. If they are carried out with CAD commands, the risk is run of breaking up the grouping or failing to comply with the azimuth continuity conditions imposed by an alignment.

Through the elements library we can create sequences of connected layout elements which can be inserted as part of a more complex alignment.

Alignments

Although the elements contain all the information required to analytically define the layout, the element needs to be converted into an alignment in order to be able to use it in profile calculation and setting out operations using the command **Convert Alignment**.

Isolated Line

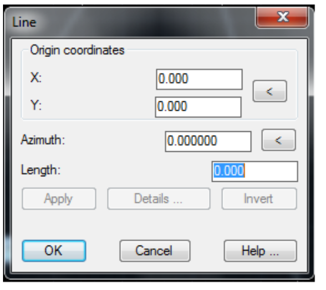
This command enables a line to be drawn independently. In other words, without it belonging to any alignment or being related to any road design element. Although the same result can be obtained by drawing a straight line directly on AutoCAD, with this command the element is drawn automatically in the alignments layer with the colour assigned for straight lines in accordance with the values specified in the program's configuration.

A dialog box appears with the following data:

X,Y Coordinates. Coordinates at beginning of straight line. They may be entered numerically or graphically by clicking on the < button.

Azimuth. Straight line's azimuth, in hundredths of a degree. Its value may be typed into the relevant box or it may be designated graphically with the < button situated to its right.

Length. Distance to the straight line's end point.



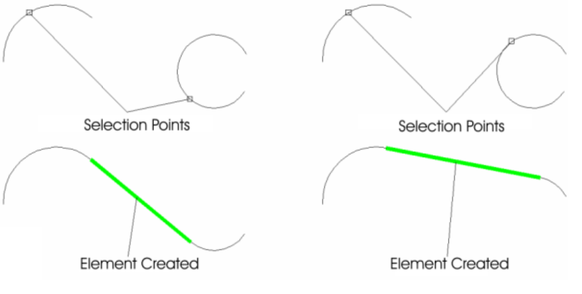
The **Apply** button uses the current values to draw the straight line desired without having to exit the dialog box. Once the **OK** button is clicked, the straight line is added to the current drawing.

The **Details** button shows detailed information about all the straight line's geometrical parameters, as explained in this chapter's introduction.

The **Invert** button interchanges the straight line's initial and final points.

Line between Curves

This command allows one to draw a straight section that joins together two circular curves, so that the straight line is tangential to both. Should there be various possible straight lines, the program searches for the one having the end points closest to the curves' selection points.



Isolated Curve

This command enables a circular curve to be drawn independently. In other words, a curve which does not belong to any alignment and is not related to any road design element. The same result can be obtained by drawing an arch directly on AutoCAD.

The following data may be entered in the dialog box:

X,Y Coordinates. Coordinates of the beginning of the curve. They may be entered numerically or graphically by clicking on the < button.

Azimuth. Initial azimuth of the circular curve, in hundredths of a degree. Its value may be typed into the relevant box or it may be designated graphically with the < button situated to its right.

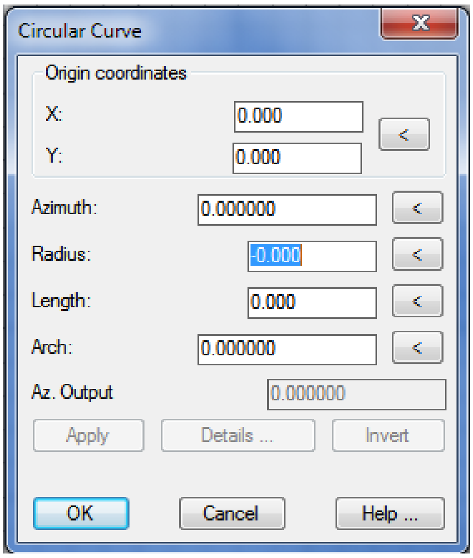
Radius. Radius of the arch, with its sign (positive if it rotates clockwise, negative if it rotates counterclockwise).

Length. Length developed by the arch in drawing units.

Arch. Azimuth travelled by the circular arch in hundredths of a degree.

Az. Output Azimuth at end of arch in hundredths of a degree.

If the **Radius, Length** or **Arch** fields are modified, the rest are recalculated automatically with the relevant error controls.



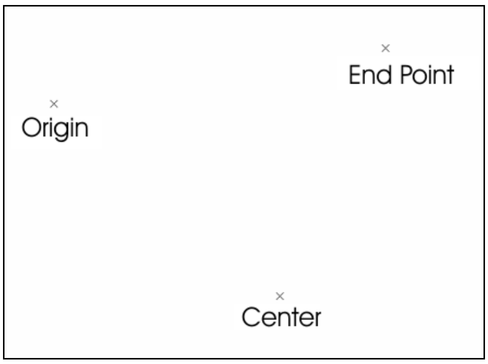
The **Apply** button draws the desired curve with the current values without having to exit the dialog box. Once the **OK** button is clicked, the curve will be incorporated into the current drawing.

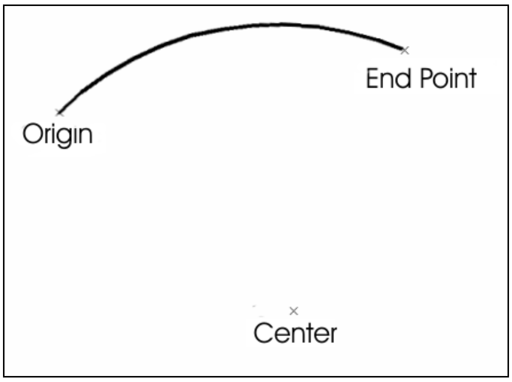
The **Details** button shows detailed information about all the curve's geometrical parameters, as explained in this chapter's introduction.

The **Invert** button changes the origin and sign of the curve, so that the final point becomes the origin, the final azimuth the initial azimuth, and vice versa.

Curve by Origin and Centre

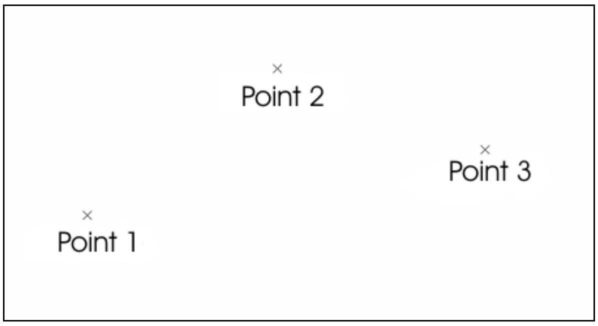
This option draws a circular curve on the basis of three points. The first is the curve's initial point, the second its centre and the third is an approximation to the final point.

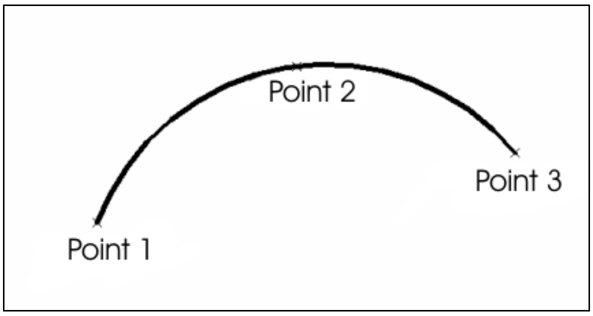




Curve by Three Points

This command draws a circular curve which passes through three points. Although the same result may be obtained by drawing an arch directly on AutoCAD, the element is drawn automatically in the alignment layer if this command is used with the colour assigned for circular curves in accordance with the values specified in the program's configuration.



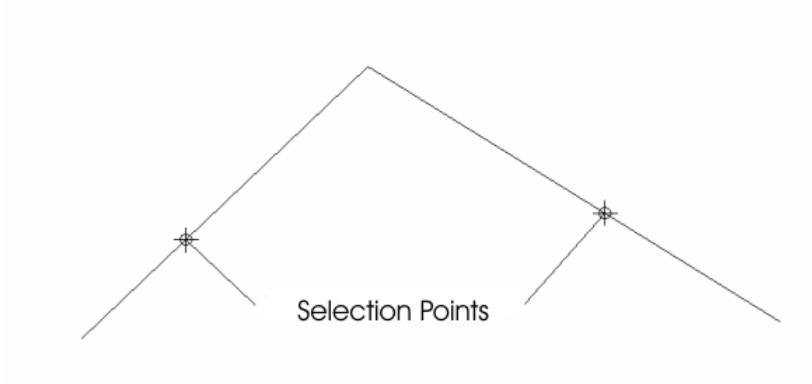


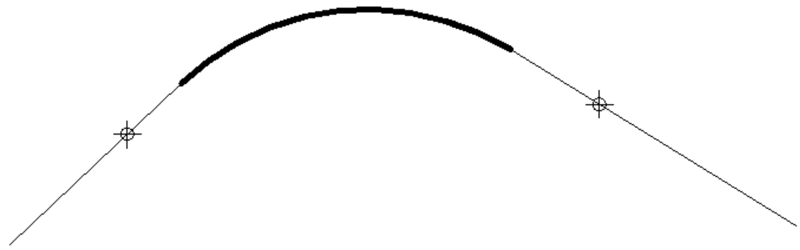
Curve Tangential to Two Lines or Curves

This command enables a circular curve to be inserted between two straight line or curve-type elements, so that the initial and final points of the curve are tangential to each of the elements selected. In addition to the most common tangent options to two straight lines or curves, a curve tangential to one straight line or curve may also be calculated.

Curve Tangential to Two Lines

When straight lines are not grouped together, the points used to select them determine which of the possible arches will be chosen as the solution. Starting from the straight lines' intersection point or from their extension should they be cut, the program divides the plane into four areas and calculates the circular arch situated in the area delimited by the curve selection points.





Once the straight lines have been selected, the program needs one more parameter in order to determine the arch. The available options include:

Radius: The circular curve's radius is entered.

Length: The circular curve's length is entered.

Chord: The straight line distance between the ends of the arch is entered.

Tangent: The distance from the end of the arc to the straight lines' intersection point.

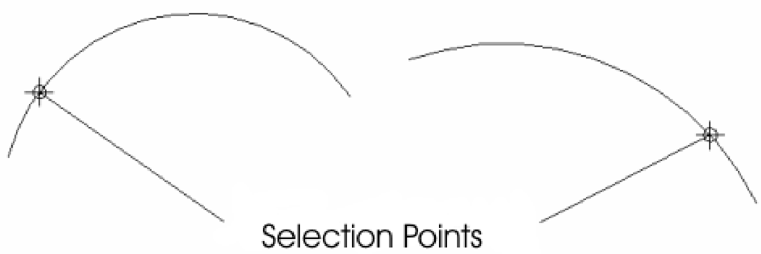
Arrow: Minimum distance from the straight lines' intersection point to the arch.

Pass-Through Point: This option asks for one of the arch's pass through points.

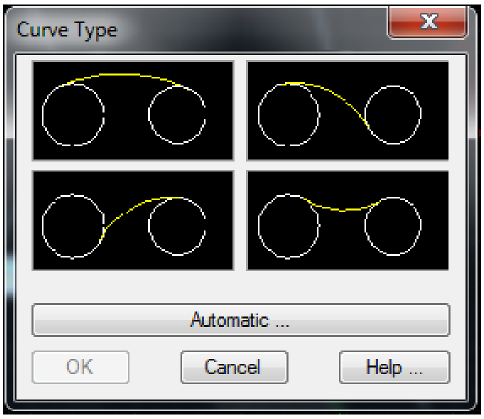
Depending on the fit options configured, it will not always be possible to calculate the solution. If the **Strict Fit** option is activated, it may therefore be the case that due to the lengths of the straight lines used it is not possible to fit an arch having the parameter specified between them, so that it will be tangential to both straight lines.

Curve Tangential to Two Curves

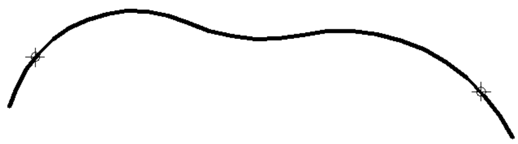
If the aim is to calculate a curve tangential to two other curves, it may only be calculated if the radius of the curve desired is specified.



Once the objects have been selected and the radius has been indicated, the program displays a dialog box asking users to specify the solution desired from among the possible alternatives:



If the **Automatic** button is clicked, the program will calculate the solution that is best adapted on the basis to the points selected. Should this solution not be the correct one, the changes can be undone and the process repeated.



Curve Tangential to a Line and a Curve

If the aim is to calculate a curve tangential to another curve and a straight line, it may only be calculated by specifying the radius of the curve desired.

Isolated Clothoid

This command enables a clothoid to be drawn independently. In other words, a clothoid which does not belong to any alignment and is not related to any road design element.

The following data may be entered in the dialog box:

X,Y Coordinates. Coordinates of the beginning of the curve. They may be entered numerically or graphically by clicking the < button.

Azimuth. Initial azimuth of the clothoid in hundredths of a degree. Its value may be typed into the relevant box or it may be designated graphically with the < button situated to its right.

Entry Radius: Radius at the beginning of the curve (positive if it rotates clockwise, negative if it rotates counterclockwise). The value zero corresponds to an infinite radius.

Exit Radius: Radius at the end of the curve. The sign should be the same as that of the entry radius. The value zero corresponds to an infinite radius.

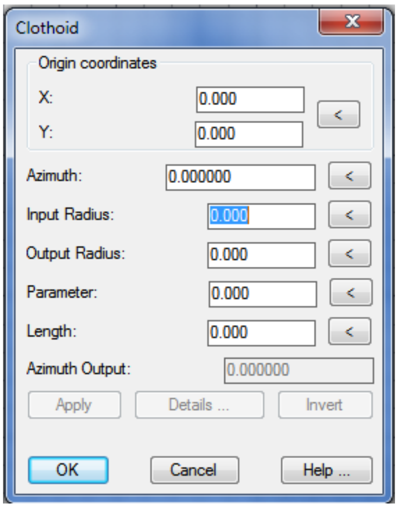
Parameter: Value of the parameter A in the formula which defines the clothoid:

$$L = \frac{A^2}{R}$$

Length. Length developed by the clothoid in drawing units.

Az. Oput:. Azimuth at the end of the clothoid, in hundredths of a degree.

If the **Input Radius, Output Radius, Parameter or Length** fields are modified, the rest are recalculated automatically with the corresponding error controls.



The **Apply** button draws the desired curve with the current values without having to exit the dialog box. Once the **OK** button is clicked, the curve will be incorporated into the current drawing.

The **Details** button shows detailed information about all the curve's geometrical parameters, as explained in this chapter's introduction.

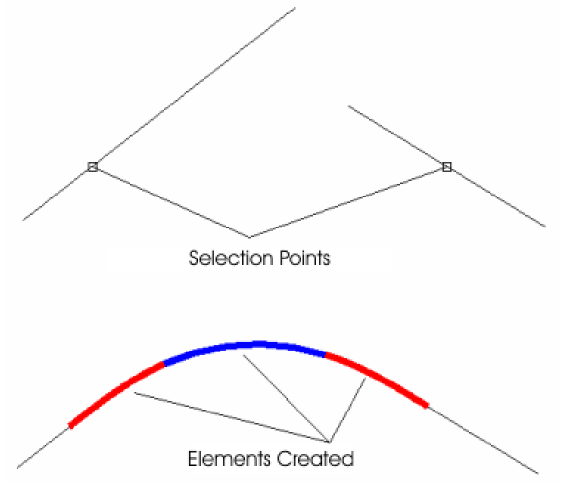
The **Invert** button changes the origin and the sign of the curve, so that the final point is interchanged with the initial point.

The **Instruction Parameters** button changes the clothoid's parameter and length, assigning the minimum corresponding to the clothoid's radius according to the highway instructions.

Clothoid - Curve – Clothoid between Lines

This command enables a clothoid, circular curve and clothoid sequence to be inserted between straight lines, so that the initial and final points of the set are tangential to each of the straight lines, and that the circular curve's radius coincides with the clothoids' radius.

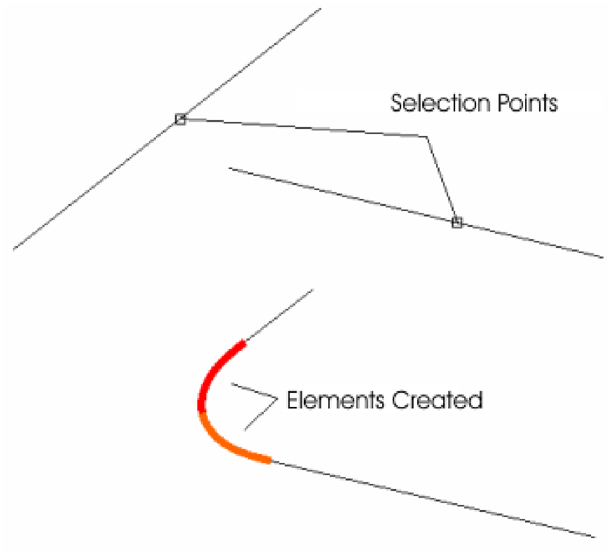
In the same way as the **Curve Tangential to two Lines**, the straight line's selection points determine the solution to be calculated. In addition to the straight lines, it is also necessary to enter the circular curve's **Radius** and both clothoid's circular curve **Lengths** (or **Parameters**).



Clothoid – Clothoid between Lines

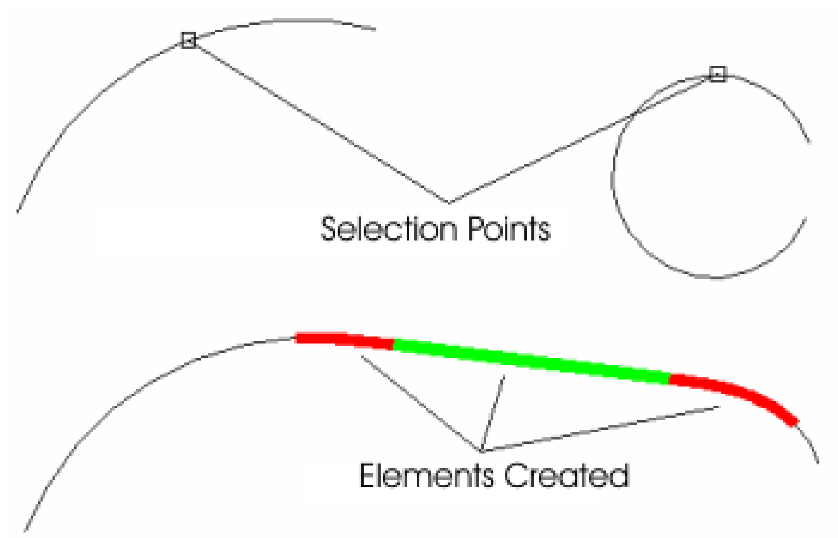
This command allows a sequence of two clothoids (also known as a vertex clothoid) to be inserted between two straight lines, so that the initial and final points of the set are tangential to each of the straight lines.

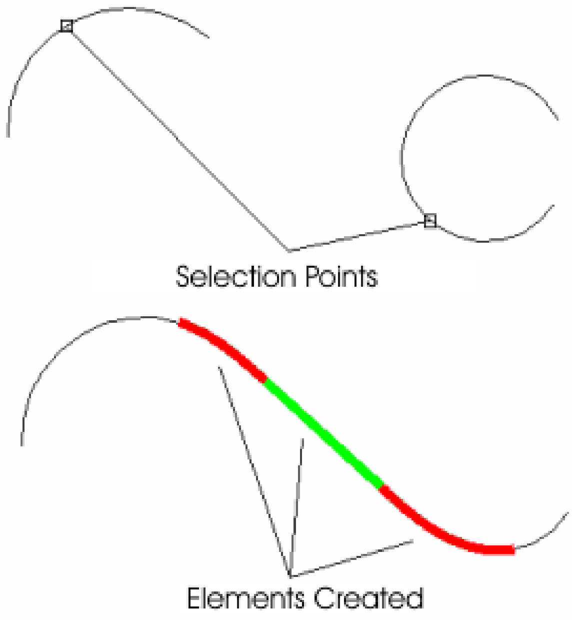
In the same way as the **Curve Tangential to two Lines**, the straight lines' selection points determine the solution to be calculated. In addition to the straight lines, it is necessary to enter the **Radius** of the clothoids in the vertices between them.



Clothoid – Line – Clothoid between Curves

This command enables a clothoid, straight line and clothoid sequence to be inserted between two circular curves, so that the initial and final points of the set are tangential to each of the curves. The points used for the curves' selection determine the type of solution to be calculated. It is possible to differentiate between solutions with clothoids whose radii are of the same sign or of different signs.



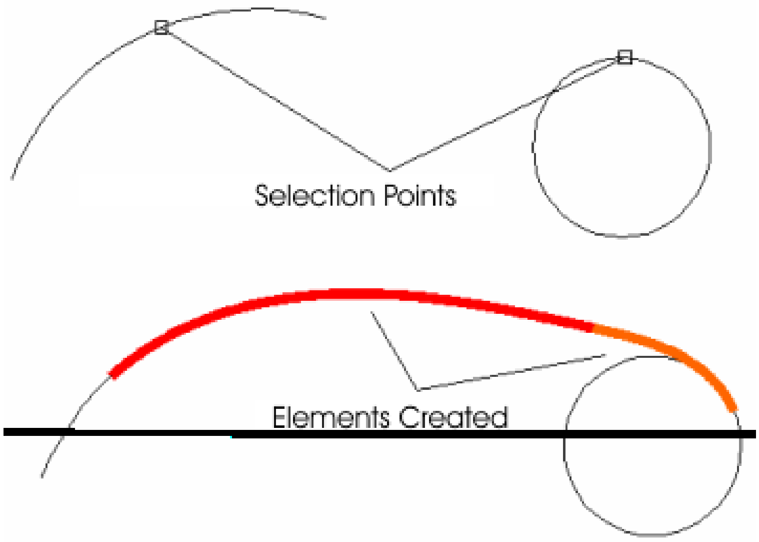


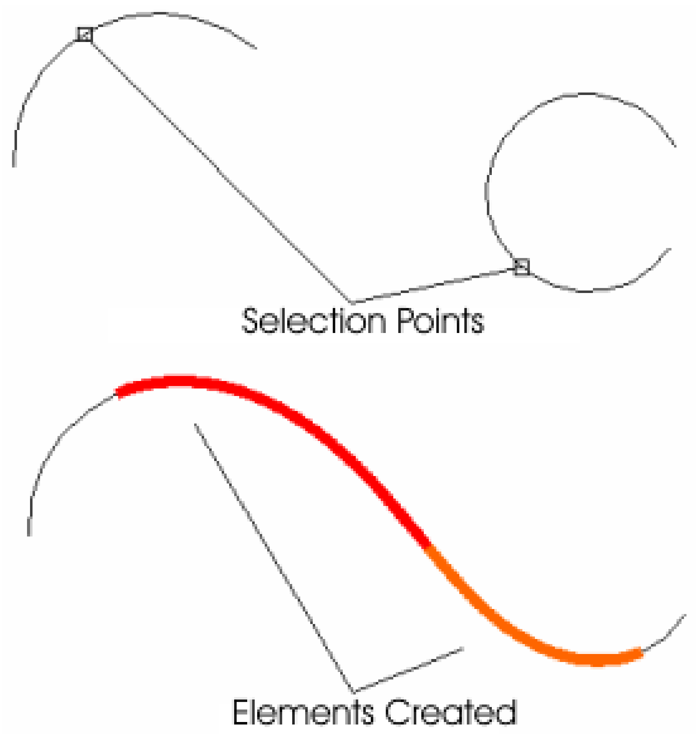
In addition to the curves, the program requests the lengths (or parameters) of the clothoids to be calculated.

In the specific case where the curves chosen are circles, the command does not cut the curve at the tangent point with the clothoid.

Clothoid – Clothoid between Curves

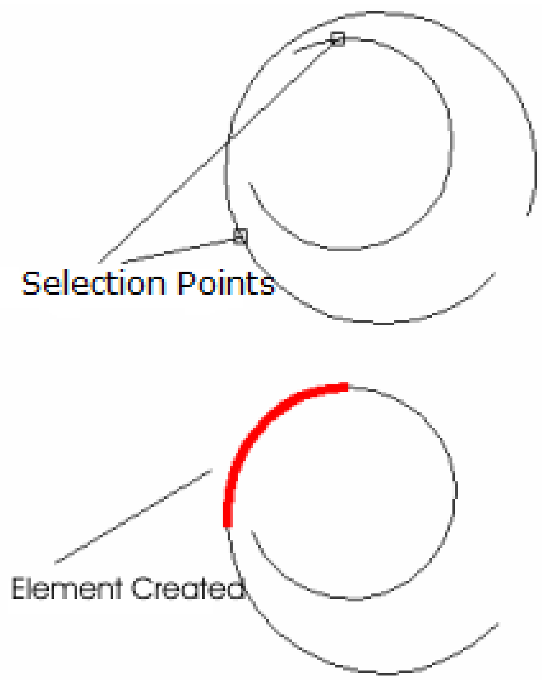
This command enables a sequence of two clothoids to be inserted between two circular curves, so that the set's initial and final points are tangential to each of the curves. The points used for the curves' selection determine the type of solution to be calculated with a distinction being made between clothoids whose radii are of the same sign and those having different signs.





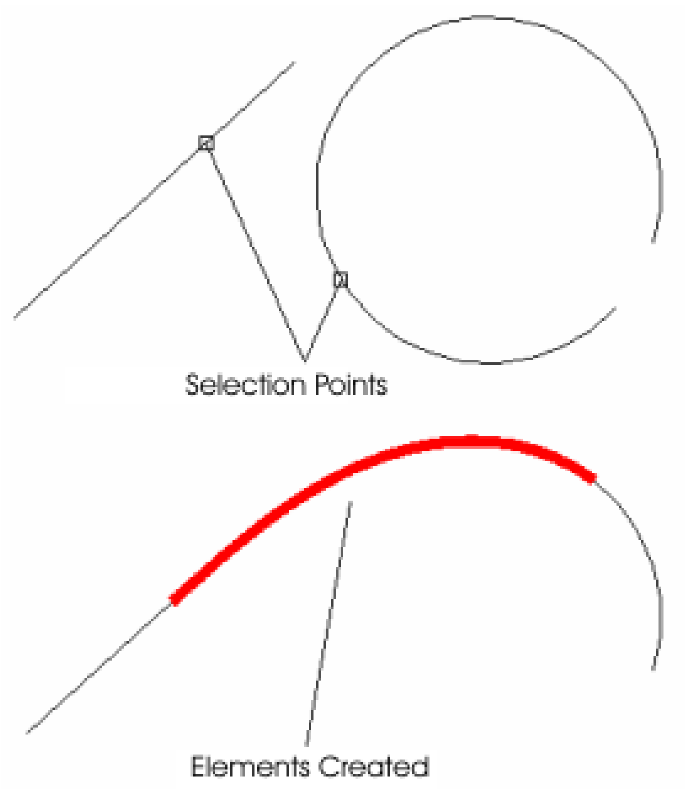
Clothoid between Two Curves

This command enables the transition clothoid to be inserted between two circular curves. For this clothoid to exist, the curve having the smaller radius must be defined within the curve having a greater radius.



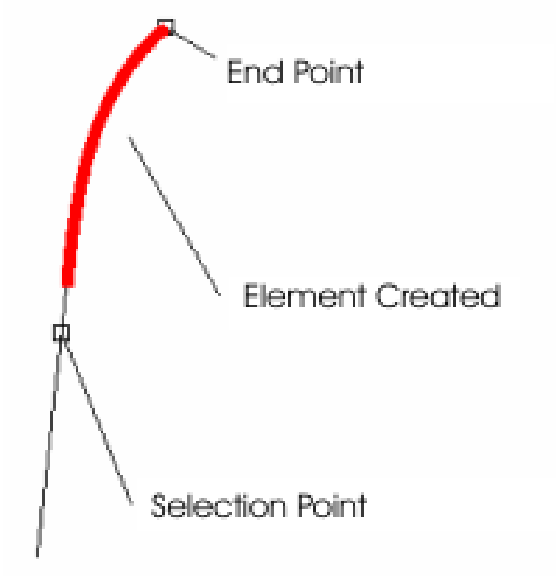
Clothoid Tangential to Line and Curve

This command enables a clothoid to be inserted between a straight line and a circular curve.



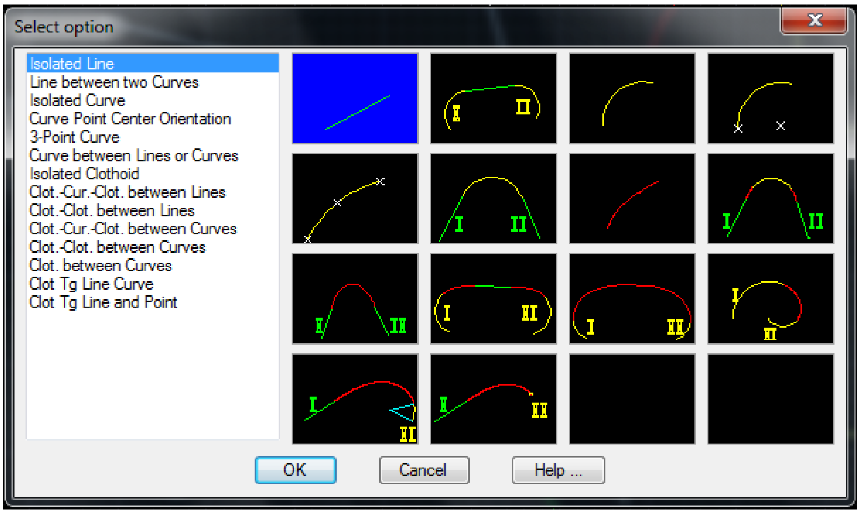
Clothoid Tangential to Line and End Point

This command enables a clothoid to be inserted after a straight line. Although the clothoid maintains the same azimuth, it ends at an arbitrary point. The program chooses the end of the straight line closest to the point used to select the clothoid as the clothoid's starting point. The clothoid's end point must then be selected.



Draw Alignments

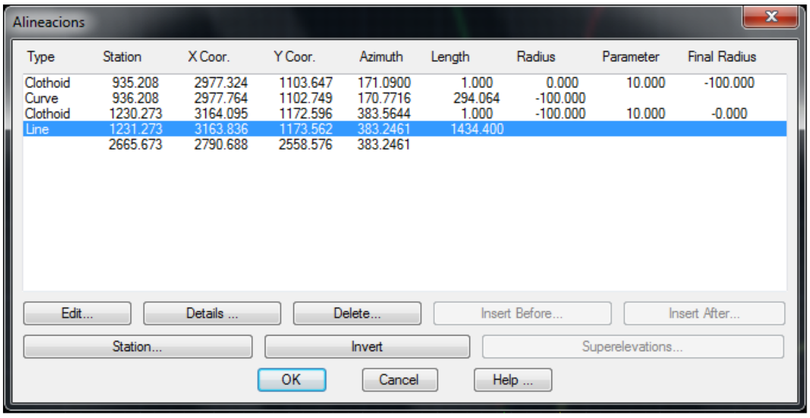
This command enables users to choose the most suitable calculation method to draw the alignments desired. By clicking on the desired icon, the relevant command will be called.



Edit Alignment

This command permits road element parameters to be modified, whether or not they belong to an alignment. In the cases of straight lines and circular curves, modifications may also be made directly with AutoCAD commands. However, it should be remembered that if the road design element is grouped together with others, AutoCAD will not modify the position of the group's other elements. To modify clothoid values (radii, length or parameter), it is obligatory to use this command. AutoCAD may, however, be used to change origin or orientation.

The program requests the element to be edited to be selected. Once selected, a dialog box appears giving a list of the whole group if it is grouped together with other elements. The line corresponding to the element selected is highlighted. It is also possible to select a horizontal alignment.



Edit: Displays a window where the road design element selected can be modified. The dialog box depends on whether it is a straight line, a curve or a clothoid.

Details: Displays a screen with additional parameters that can be obtained from the road design element.

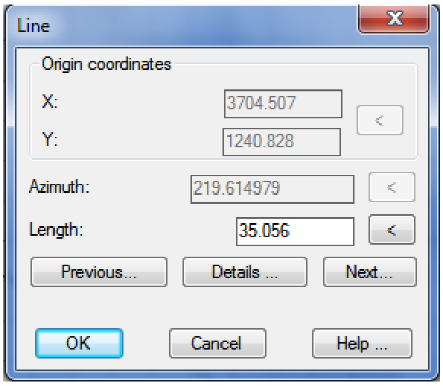
Delete: Deletes the elements selected and adjusts the subsequent alignments, so that the whole group maintains its continuity.

Station: This is used to change the selected element's Station. The corresponding Stations of the other group elements will be automatically modified.

Should the selected element not be grouped, the edit element window is automatically opened.

Edit Line

The program displays a dialog box containing the following information, which can be edited.



Apply : Temporarily hides the dialog box and redraws the element, showing any changes made. By clicking the screen with the mouse, the dialog box is displayed again.

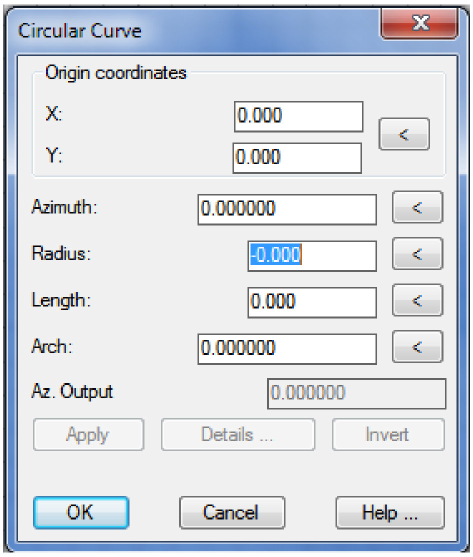
Details: Shows a screen containing additional data about the element.

Invert: Takes the other end of the element as the origin. The origin and azimuth coordinates are changed.

If the element being edited is grouped, the window will display two additional buttons: **Previous** and **Next**, to edit the other elements. Additionally, some of the edit fields may appear as disabled and the **Invert** button may not be shown, depending on location within the alignment.

Edit Circular Curve

The program displays a dialog box containing the following information, which can be edited.



Azimuth: Orientation of the curve at its initial point. If modified, the remaining parameters will not be altered except for **Exit Az**.

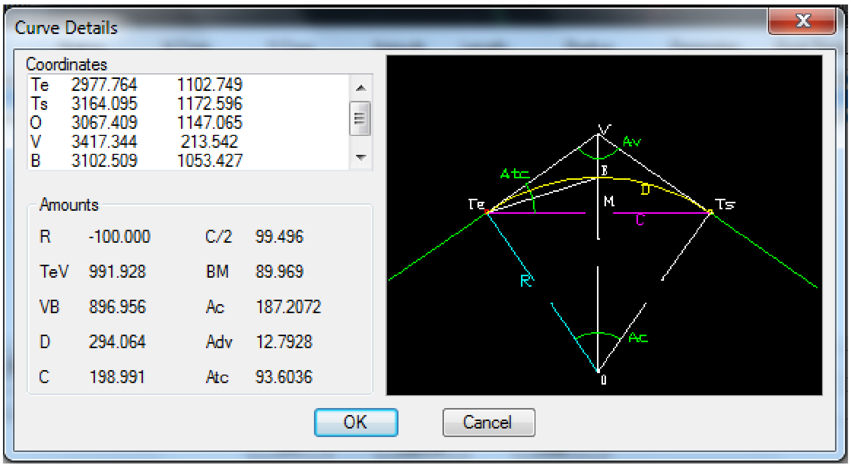
Radius: The sign indicates whether it is a curve rotating towards the left (negative sign) or the right (positive sign). When the value of the radius is edited, length is automatically modified, while the arch is maintained.

Length: Distance travelled by the curve's development. When edited, the arch is automatically modified, while the radius is maintained.

Arch: Angle described by the curve's development. When edited, length is automatically modified, while the radius is maintained.

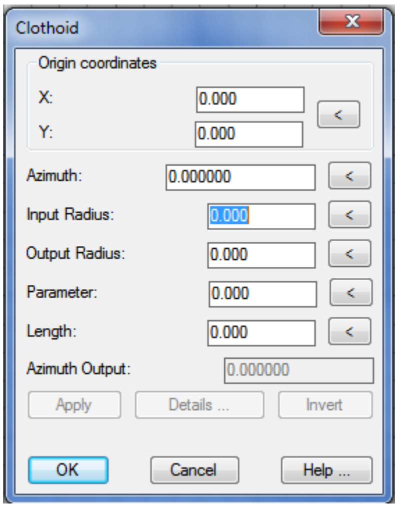
Azimuth Output: Orientation of the curve at the end point.

The **Apply**, **Details**, and **Invert** buttons behave as in **Edit Line**.



Edit Clothoid

The program displays a dialog box containing the following information, which can be edited.



Azimuth: Orientation of the clothoid at its initial point. If modified, the remaining parameters will not be altered, except for **Exit Azimuth**.

Input Radius: Radius of the clothoid at its initial point. The sign indicates whether it is a clothoid rotating towards the left (negative sign) or the right (positive sign). When the value of the radius is edited, length is automatically modified while the parameter is maintained

Output Radius: Radius of the clothoid at its end point. The sign will be the same as the entry radius. When the value of the radius is edited, length is automatically modified while the parameter is maintained

Length: Distance travelled by the clothoid's development. When edited, the parameter is automatically modified, while the entry and exit radii are maintained.

Parameter: Value which controls the clothoid's curvature. When edited, length is automatically modified, while the entry and exit radii are maintained.

Exit Azimuth: Orientation of the clothoid at the end point.

The **Apply**, **Details**, and **Invert** buttons behave as in **Edit Line**.

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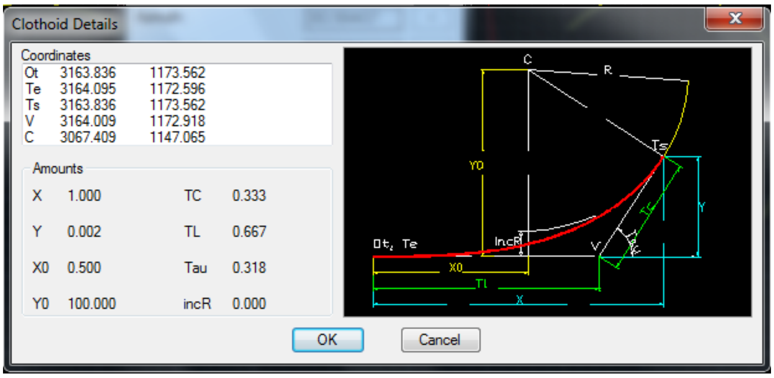


Delete Alignment

Although a road design element may be directly deleted in AutoCAD, this command is included to make it easier to delete a grouping of alignments.

The program request an alignment element to be selected and then proceeds to delete it. Should the element be grouped, it also deletes the group's other elements.

If an element belonging to a group is deleted in AutoCAD, the end result is that the group is divided into two.

Split Alignment

An alignment element (straight line, curve or clothoid) may be split into two parts through this command. Once the element has been selected, two options or operating modes are available:

Point: An element point is selected with the mouse, which will be used to make the division. This is the default option.

Length or Station: depending on whether the element is grouped or not the program will display its length or the initial and final stations of the element. Introducing a length or a station, the program will divide the element at the desired point.

If the element is grouped, the program requests if the resulting elements are to be separated once it has been divided. Should the answer be affirmative, the result will be two separate alignments. Should the answer be negative, the two elements created will be maintained in the same alignment.

The Join Alignments command is used to rejoin alignments.

Join Alignments

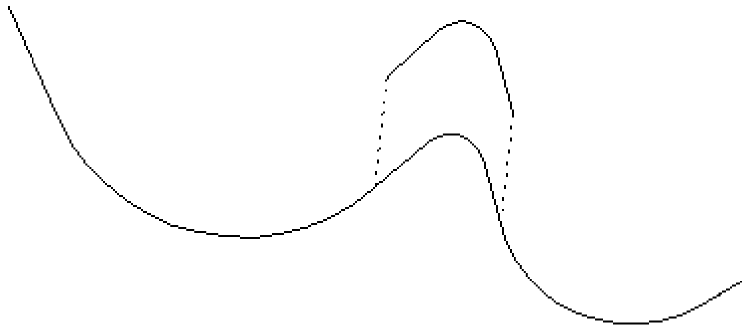
This command is the opposite of **Split Alignment.** Two consecutive road design elements of the same type (straight lines, curves or clothoids) must be selected in order for the program to convert them into a single one. The azimuths of the elements must maintain continuity for it to be possible to join them.

Copy Alignment

Although AutoCAD may be used directly to copy a road design element, information on its grouping with other elements is not recorded in this operation. This command should therefore be used to copy grouped elements.

One simply has to select an element and select a position for the copy with the mouse. Should the element be grouped, the program asks if the copy is **Total** or **Partial**.

The former option copies all the elements, while the second only permits a section to be copied by selecting its initial and final points. Two lines are drawn to clearly indicate the initial and final points chosen. This latter option allows modifications to be made to the section copied and then to incorporate the changes in the original group using the **Replace Alignment** command.



Move Alignment

Although AutoCAD commands can be used to adjust a road design element, this command makes it possible to move complete groups much more easily.

One simply has to select an element belonging to the alignment and designate a new position with the mouse.

Rotate Alignment

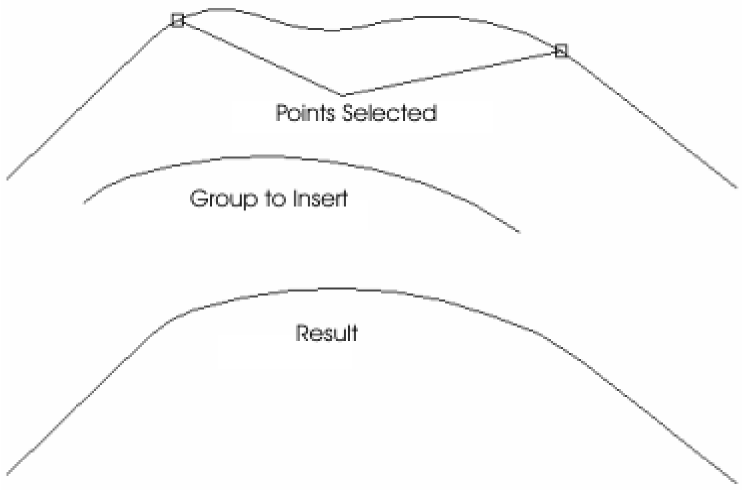
Although AutoCAD commands can be used to rotate a road design element, this command enables whole groups to be rotated.

One simply has to select an element and designate a new orientation for it with the mouse.

Replace Alignment

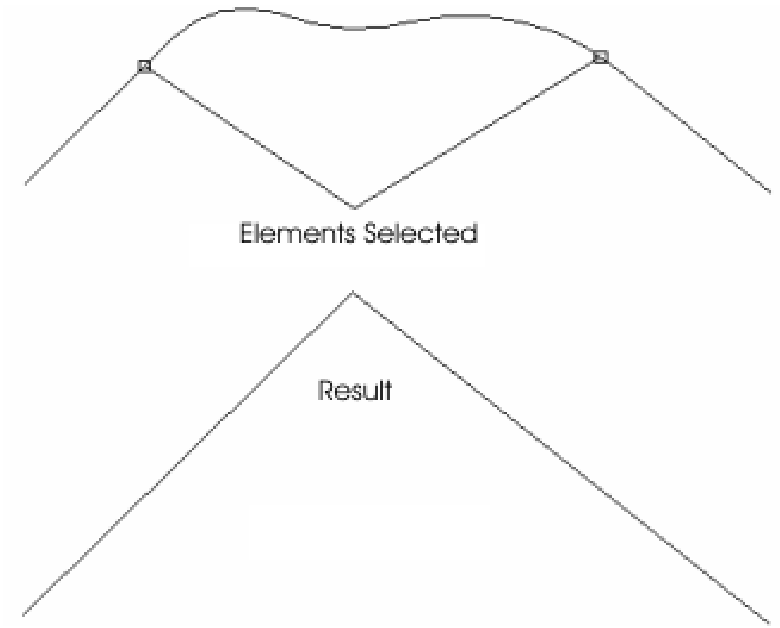
This command enables a group of road design elements to be included within another group, thereby replacing elements of the section affected.

First, the program requests the group to be inserted. Then an end element (initial or final) of the section to be replaced in the destination alignment must be specified. The program then checks whether the initial and final points and the azimuths coincide at those points if the group is moved to the section to be substituted. If this is the case, the section is substituted.



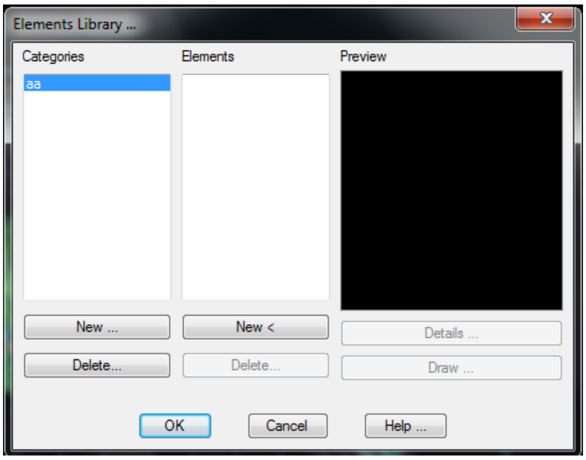
Adapt to Lines

This command extends two straight lines up to their intersection, deleting any intermediate elements. It may be applied to a horizontal alignment or to a road design element group.



Alignment Library

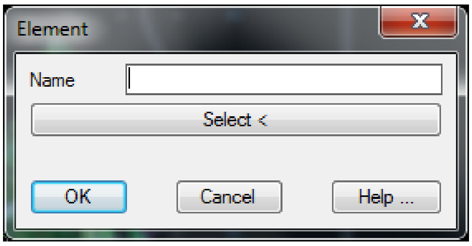
The option exists of creating an alignment library where the different groups of road design elements may be stored. These elements may be easily retrieved in new drawings.



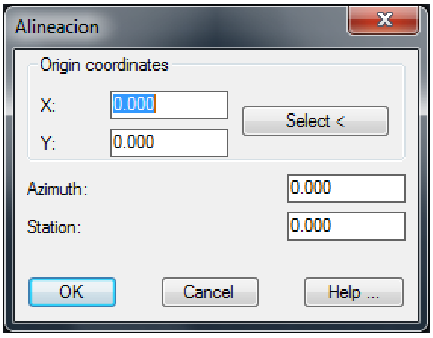
The library is organized by categories. Any number of alignments can be included within each category by assigning each element group a name.

The **New** button allows a new category to be created. Once it is clicked, a dialog box is displayed requesting the category's name. Additionally, the **Delete** button serves to delete categories.

Once a category has been selected from the list, elements may be included in it by clicking on the **New** button. In the dialog box below, the name which will be given to the category's element should be entered. By clicking on the **Select** button, the road design elements to be included in the library and the alignment's end of origin can be selected.



By clicking on the list of elements included in the category, a preview may be seen on the right-hand side of the dialog box. The element may be eliminated from the library by clicking on the **Delete** button, or it may be included in the drawing by clicking on **Draw**, in which case a dialogue box appears requesting the azimuth and Station coordinates for the point of origin.



Connect Elements

This command enables one road design element to be situated at the end of another element, so that the final point of the former coincides with the initial point of the latter. The orientation of the element adjusted is also modified, so that azimuth continuity with the previous element is maintained.

To begin with, the element to be adjusted is selected, bearing in mind that the closest end to the point of selection will be considered as the beginning of the alignment. Should the element be grouped, the program will look for the end of the closest group. This will be the end coinciding with the other element's end point.

Then the element marking the destination has to be selected. The end closest to the point of selection will be considered as the element's end, which will coincide with the other element's initial point.

After performing the adjustment and rotating the element, the command starts again in order to repeat the process with other elements. Once this command has been used to ensure that the elements have continuity, a group may be created with them using the **Alignments > Group Elements** command. Alternatively, they may be converted into a horizontal alignment using the **Alignments > Convert to Alignment** command.

Group Elements

The possibility exists of grouping road design elements. With this command it is possible, for instance, to edit the length of one of them. The subsequent elements are adjusted, so that the end and initial points of consecutive elements continue to be the same.

For a group to be successful, it is necessary for the end point of an element to coincide with the initial point of the next element. One way of ensuring that this is so is to execute the **Connect Elements** command. It should also be taken into account that an element can only belong to one group.

The command requests the selection of a group of elements, the order of which is not important, and it may be selected via a window. In the case that any of the selected elements is already grouped, it will required confirmation before continuing. Finally it requests the initial Station value.

Starting from the initial end, the program will link one element with the next, as long as there is continuity between them. Otherwise, a list containing any errors found will be shown and with the possibility of drawing them on screen.

Ungroup Elements

As its name indicates, this command enables alignment elements to be isolated. It may be performed on a group of alignments or on a horizontal alignment.

If an element belonging to a group is selected, the program asks whether all the elements are to be separated or whether each is to be selected individually.

Should a horizontal alignment be selected, the program draws in its place the road elements making it up and lastly gives users the possibility of ungrouping all or some of the elements.

Convert to Alignment

This command enables a horizontal alignment to be created from a group of road design elements. There are two operating modes:

Designating an element that forms part of an alignment, the program automatically includes the rest of the group elements, establishes the origin of the horizontal alignment at the appropriate extreme and proposes by default as a Station the origin of the horizontal alignment of the first element of the group.

When an element forming part of an alignment is selected, the program automatically includes the group's remaining road design elements, sets the horizontal alignment's origin at the correct end and proposes the horizontal alignment's station of origin and the group's first element by default.

When various elements are selected irrespective of how they are grouped, the program will only create a horizontal alignment with the elements selected. In addition, it is necessary to choose the end where the origin of the horizontal alignment is to be situated. Should the different elements not be at a tangent to each other, the dialog box below appears, where the station, the theoretical and real azimuths, and the difference between both are entered. By clicking on a specific line and clicking on the ***Draw*** button, the location of errors on the drawing will be represented.

8. Alignments

Introduction

The Alignments menu commands make it easier to process horizontal alignments defined by unique points and obtained from files generated by other programs or from polylines in a drawing.

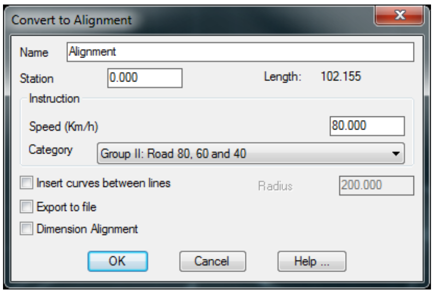
Horizontal alignments are composed of vertices (unique points), which have the following information: station, X coordinate, Y coordinate, azimuth, radius, parameter and length.

The polyline with which the program represents a horizontal alignment can be moved, deleted and/or rotated as a whole with CAD tools. Nevertheless, other commands such as cut, extend, stretch, scale or modify vertex coordinates with regard to the others should not be used with them. These operations lead the program into showing a warning indicating that there are inconsistencies among the polyline’s vertices and the alignment’s vertices when a drawing’s polyline is selected. Although the command continues to work after the warning, one has to check closely if the alignment information corresponds with what has been drawn.

Convert Polyline to Alignment

This command allows one to convert a drawing’s polyline into a horizontal alignment with all its analytical information. The result may have straight sections and circular curves, but may never have clothoids.

The program initially launches following dialog box, whose features are described in detail below.



Name : Identifier the alignment to be created.

Station: Alignment’s initial station.

Length: This control provides information on the total length of the polyline selected.

Speed: The average speed of the road to be defined is entered. This value will later influence the superelevation’s generation. Depending on the road’s speed, one or other superelevation table will be used.

Category: The category best adapted to the road to be created according to the Road Instructions is entered. Depending on this value and the **Speed**, the program will use one or other superelevation table to generate the superelevation.

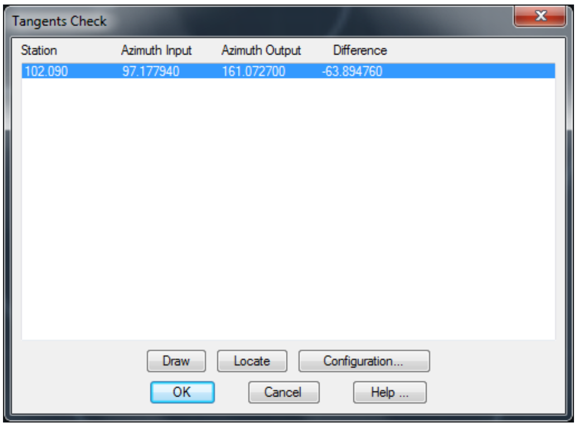
Insert curves between lines : The program can be made to automatically include circular curves between two consecutive lines. In the event that the radius specified is too large, the program uses a smaller radius.

Dimension Alignment: Finally, this option allows the command to be executed Dimension Alignment command.

Export to File: If this option is enabled, the program will request the file in which the horizontal alignment is to be saved once the dialog box has been validated.

MDT then draws the horizontal alignment in the ALIGNMENT layer, deleting the original polyline. The horizontal alignment can be checked by using the **Segments > Superelevations> List Superelevations** command. If an attempt is made to convert an already converted polyline, MDT will inform the user that the polyline is already a horizontal alignment.

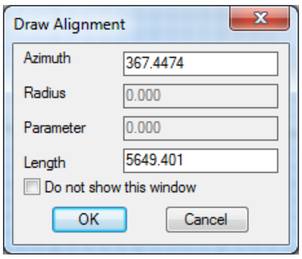
When designing the polyline with CAD and arches are entered, care must be taken to respect the tangents between the straight line and curved sections. Otherwise, the program will indicate the poorly defined tangents and the angular error of each of them in the following list.



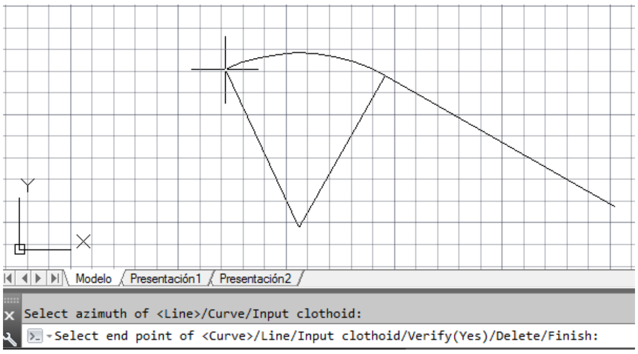
Draw Alignment

This command allows an alignment to be drawn interactively on the CAD screen. Firstly, the program asks for the initial point of the line to be designated with which the alignment starts. On the command line options appear to change the first element for a circular curve or a clothoid. Once the initial point has been entered, an initial azimuth is requested by means of a second point. In the event that the alignment starts with a line, the distance between both points will be assumed as the length of the segment. For circular curves or clothoids, once the azimuth has been entered the program requests the final point of the segment, calculating the radii and parameters automatically.

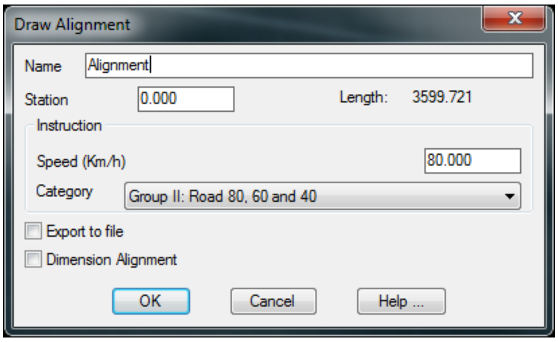
Once the first section of the alignment has been defined, a window appears in which the data entered can be checked. This window will be shown every time an alignment section is entered, unless they **Do not show this window** box is enabled.



For the following elements the program starts with the final azimuth of the previous element and only the final point of the section has to be entered. By default, after a line the program proposes a circular element and after a circular section a line one. A clothoid can be entered with the option **Input clothoid** of the command line which interactively calculates the parameter and the final radius of the clothoid as the cursor is moved. After a curve, an **Output clothoid** can also be entered in which, maintaining the initial radius, the parameter is calculated interactively.



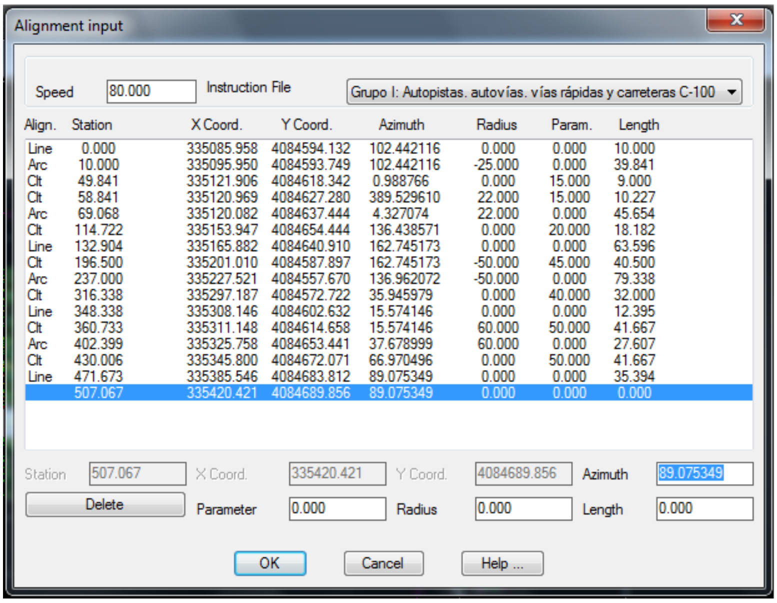
The **Verify** option monitors whether when entering an element, the data checking window appears and the **Delete** option eliminates the final section of the alignment, affording the possibility of re-entering it. **Finish** this completes the section input loop and shows a final window in which the initial Station can be specified, the instruction parameters etc. as well as in the command **¡Error! No se encuentra el origen de la referencia.**Polyline to Alignment



Input Alignment

This command constitutes an extremely useful tool to enter a horizontal alignment from a list.

MDT will initially request the horizontal alignment to be edited or created (either graphically or by selecting a file) and then display the following dialog box whose features and functions are described below.



The horizontal alignment's configuration appears in the upper part, that is to say, the **Speed** of the road to be defined and the type of road it will be associated with (**Instruction File**). These values will be essential for the subsequent superelevation calculation.

A list then appears showing the alignment's unique points should they have existed previously. In the lower part, a there is a control for each of the alignment's components , including: **station**, **X Coordinate**, **Y Coordinate**, **Azimuth**, **Parameter**, **Radius** and **Length**.

As each of these fields is filled in, the rest will be calculated automatically although all values must be entered for the first point.

For instance, if entry clothoid with its radius and parameter is entered, the length of the next point will be calculated automatically together with the new vertex's coordinates.

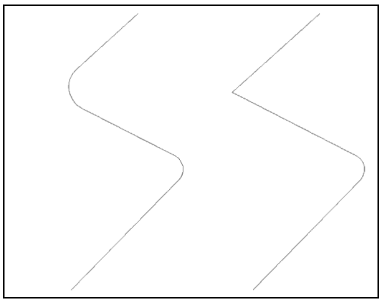
Delete : If this button is activated, the unique point of the horizontal alignment selected on the list will be deleted and the horizontal alignment will be recalculated automatically from the remaining vertices.

Once the dialog box has been validated, the changes will be saved in the file selected. If a horizontal alignment has been designated graphically, the changes will be reflected in the drawing.

Adapt to Line

This command converts a curved or clothoid-type alignment into the original state of straight alignments. It is therefore complementary to the commands described below.

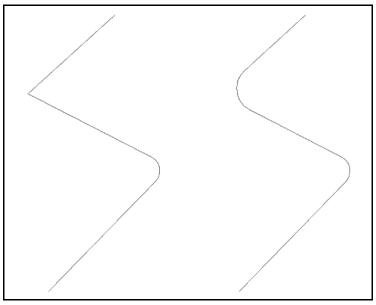
In order to execute the conversion, one only has to select a point belonging to the curve or the clothoid to be deleted.



Adapt to Curve

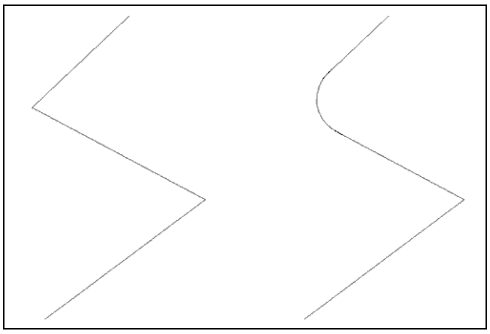
A curve can be fitted between two straight alignments by this option. In order to do so, one must select a point close to the vertex and then enter the radius desired. The program will then automatically draw the new alignment.

If an overlap between alignments is produced, the message **"**ERROR: Cannot be adapted to curve" will be displayed and a new vertex requested.



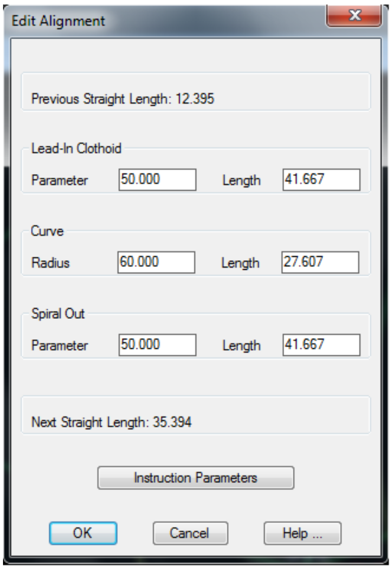
Adapt to Clothoid

This command is similar to the previous command. In this case, however, a clothoid can be fitted between two straight alignments. The data that should be entered are as follows: **Input Parameter, Radius** and **Output Parameter**. Possible overlaps are also checked.



Edit Vertex

This utility allows curved or clothoid-type alignments to be modified. In order to do so, the alignment to be modified must be selected and the program displays the following dialog box:

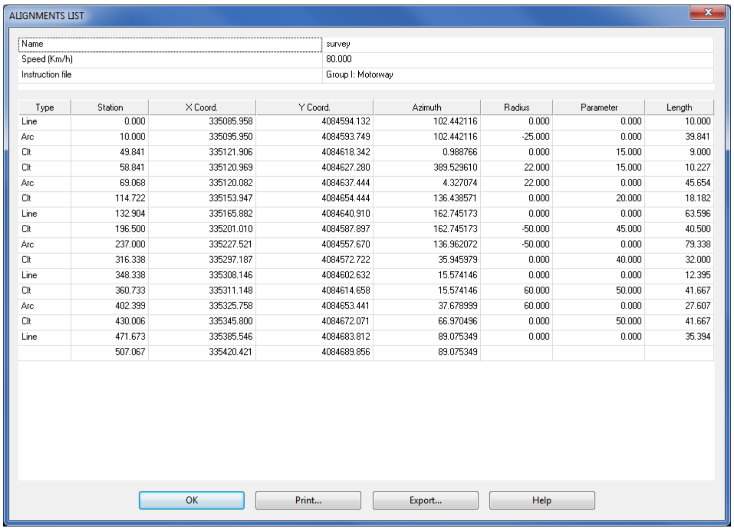


If any of the values are changed, the program automatically recalculates the rest. Possible overlaps are also checked.

The **Instruction Parameters** button attempts to assign the **Parameter** suggested by the Highway Instructions with regard to the alignment's **Radius** and depending on the kind of road and the project's speed, which were specified when the alignment was created (see **Alignments> Superelevations > Superelevation Table** command). This standard considers safety and aesthetic criteria. Should it not be possible to assign the parameters laid down, the program indicates it and leaves the previous values unchanged.

List Horizontal Alignment

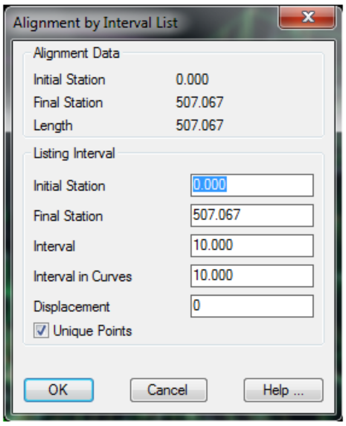
This tool enables an on-screen list to be obtained containing the contents of a horizontal alignment through a dialog box. The alignment's basic characteristics appear in the upper part, including the alignment's identifier, maximum speed allowed on the road and classification according to the Highway Instructions. This can be transferred onto a sheet of paper or to a text file by clicking on **Print**.



Type	Station	X Coord.	Y Coord.	Azimuth	Radius	Parameter	Length
Line	0.000	335085.958	4084594.132	102.442116	0.000	0.000	10.000
Arc	10.000	335095.950	4084593.749	102.442116	-25.000	0.000	39.841
Clt	49.841	335121.906	4084618.342	0.988766	0.000	15.000	9.000
Clt	58.841	335120.969	4084627.280	389.529610	22.000	15.000	10.227
Arc	69.068	335120.082	4084637.444	4.327074	22.000	0.000	45.654
Clt	114.722	335153.947	4084654.444	136.438571	0.000	20.000	18.182
Line	132.904	335165.882	4084640.910	162.745173	0.000	0.000	63.596
Clt	196.500	335201.010	4084587.897	162.745173	-50.000	45.000	40.500
Arc	237.000	335227.521	4084557.670	136.962072	-50.000	0.000	79.338
Clt	316.338	335297.187	4084572.722	35.945979	0.000	40.000	32.000
Line	348.338	335308.146	4084602.632	15.574146	0.000	0.000	12.395
Clt	360.733	335311.148	4084614.658	15.574146	60.000	50.000	41.667
Arc	402.399	335325.758	4084653.441	37.678999	60.000	0.000	27.607
Clt	430.006	335345.800	4084672.071	66.970496	0.000	50.000	41.667
Line	471.673	335385.546	4084683.812	89.075349	0.000	0.000	35.394
	507.067	335420.421	4084689.856	89.075349			

List Horizontal Alignment by Interval

This tool allows the coordinates and azimuths of specific points along a horizontal alignment to be obtained. It may be used for setting out on the horizontal alignment selected. Once the command is executed, the following dialog box appears where the results to be obtained are specified.



Initial Station: Initial station from which the list is to start.

Final Station: Station up to which the alignment list is to be performed.

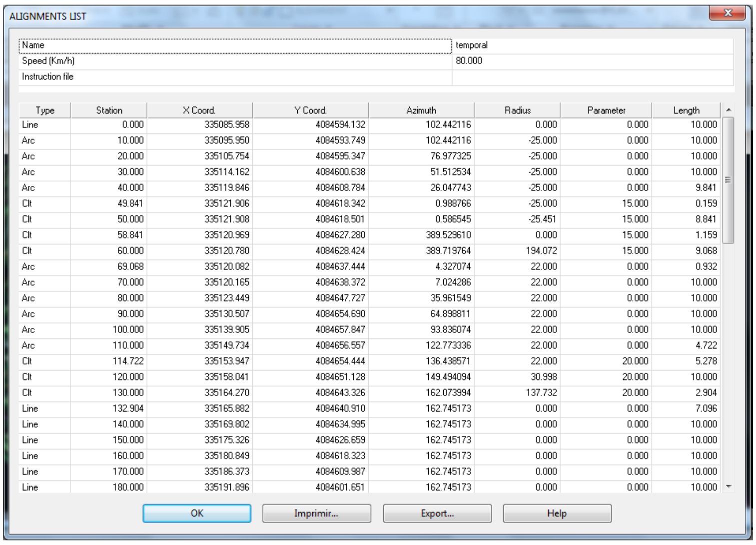
Interval: Interval with which one wishes to list the alignment for straight sections.

Interval in Curves: Interval with which one wishes to list the alignment for curved sections.

Displacement: Adjustment to be applied with respect to the horizontal alignment. If one wishes points to the left, it will be a negative value; and if to the right, it will be a positive value.

Unique Points: This box is activated, MDT will open the dialog box with the alignment's unique points.

Once the dialog box has been validated, a list will appear containing the features specified in the previous window.

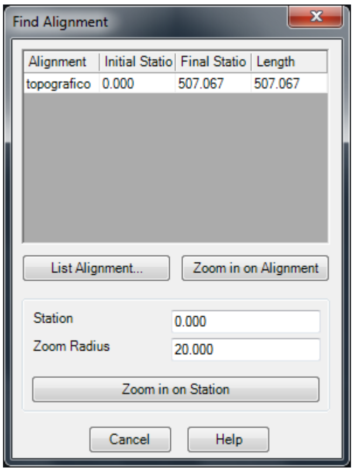


Type	Station	X Coord.	Y Coord.	Azimuth	Radius	Parameter	Length
Line	0.000	335085.958	4084594.132	102.442116	0.000	0.000	10.000
Arc	10.000	335095.950	4084593.749	102.442116	-25.000	0.000	10.000
Arc	20.000	335105.754	4084595.347	76.977325	-25.000	0.000	10.000
Arc	30.000	335114.162	4084600.638	51.512534	-25.000	0.000	10.000
Arc	40.000	335119.846	4084608.784	26.047743	-25.000	0.000	9.841
Clt	49.841	335121.906	4084618.342	0.988766	-25.000	15.000	0.159
Clt	50.000	335121.908	4084618.501	0.586545	-25.451	15.000	8.841
Clt	58.841	335120.969	4084627.280	389.529610	0.000	15.000	1.159
Clt	60.000	335120.780	4084628.424	389.719764	194.072	15.000	9.068
Arc	69.068	335120.082	4084637.444	4.327074	22.000	0.000	0.932
Arc	70.000	335120.165	4084638.372	7.024286	22.000	0.000	10.000
Arc	80.000	335123.449	4084647.727	35.961549	22.000	0.000	10.000
Arc	90.000	335130.507	4084654.690	64.898811	22.000	0.000	10.000
Arc	100.000	335139.905	4084657.847	93.836074	22.000	0.000	10.000
Arc	110.000	335149.734	4084656.557	122.773336	22.000	0.000	4.722
Clt	114.722	335153.947	4084654.444	136.438571	22.000	20.000	5.278
Clt	120.000	335158.041	4084651.128	149.494094	30.998	20.000	10.000
Clt	130.000	335164.270	4084643.326	162.073994	137.732	20.000	2.904
Line	132.904	335165.882	4084640.910	162.745173	0.000	0.000	7.096
Line	140.000	335169.802	4084634.995	162.745173	0.000	0.000	10.000
Line	150.000	335175.326	4084626.659	162.745173	0.000	0.000	10.000
Line	160.000	335180.849	4084618.323	162.745173	0.000	0.000	10.000
Line	170.000	335186.373	4084609.987	162.745173	0.000	0.000	10.000
Line	180.000	335191.896	4084601.651	162.745173	0.000	0.000	10.000

The information may be transferred to a printer or exported to a points file. Alternatively its content can also be transferred to an Excel worksheet. In order do so, either the **Print** or **Export** buttons should respectively be clicked.

Locate Alignment

When there are various horizontal alignments on a drawing, this command can be used to identify a specific alignment. First a dialog box appears containing the names of the horizontal alignments on the drawing, along with their initial and final stations, and their length.



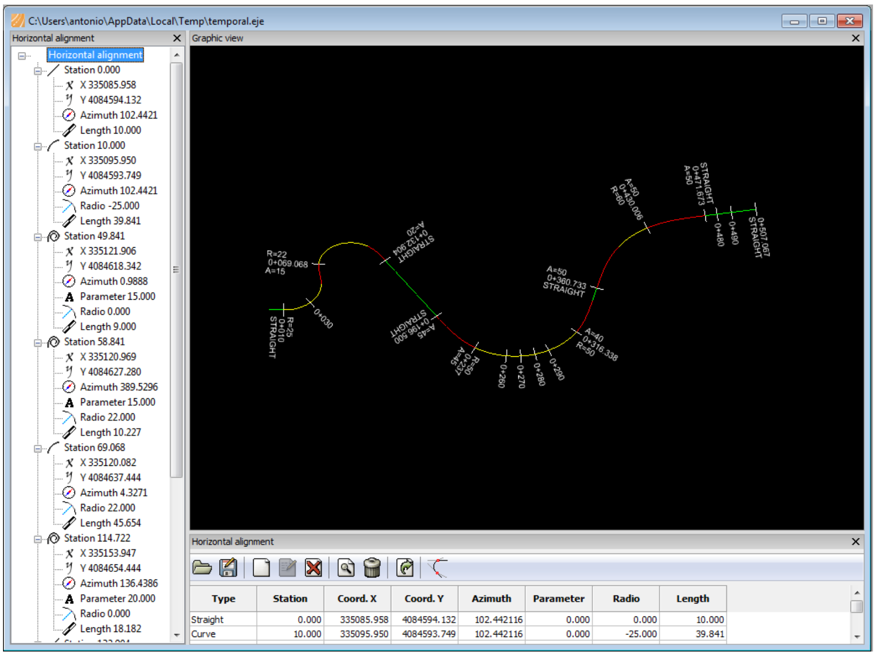
When an alignment on the list is selected, the buttons used to localize the alignment are enabled. **Zoom in on Alignment** resizes the AutoCAD window so that the polyline representing the alignment selected is wholly visible and selects it automatically. **Zoom in on Station** resizes the window and centres on the **Station** specified. **Zoom Radius** sets the drawing area visible around the point The **List Alignment** button allows a list of the alignment selected to be obtained.

View Alignment

This command can be used to view a horizontal alignment's geometry and characteristics.

Its most important feature is that it can be viewed by double clicking on the alignment file from the Windows Explorer without the need of running AutoCAD.

Additionally, information is provided in real-time in the status line on the point's information depending on the position the mouse is located at with regard to the horizontal alignment, including: stations, adjustment to alignment, azimuth, parameter and alignment radius.



It features a series of menu options with the most typical commands for processing horizontal alignments and images. Some of the most common include:

Files > **Properties**: This displays the properties of the horizontal alignment currently being edited, indicating the group it belongs to.

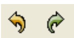
Files > **Import:** This option is used to import the horizontal alignment from other different formats. It enables conversion from the following formats: InRoads, MxRoads and LandXML.

Files > Export to DXF: Used to export the horizontal alignment to a DXF file.

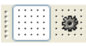
Tools > **Check Tangents:** This shows a report with the possible tangent errors of the current alignment being edited.

The following toolbar with the following options is located at the top of the window:

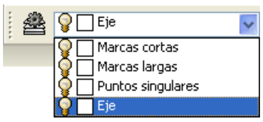
 A zoom with the options to zoom in and out, zoom extent, zoom window and pan.



Options to undo and redo any edits made to the horizontal alignment.

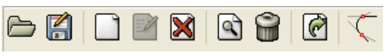
 Options to activate and deactivate the grid and assign it properties such as text colour and the colour of the grid itself.

 Two options for taking screen shots. The first of these records the image to the clipboard and the second saves the image to the clipboard.



An option to manage the drawing layers, used to hide and show the layers.

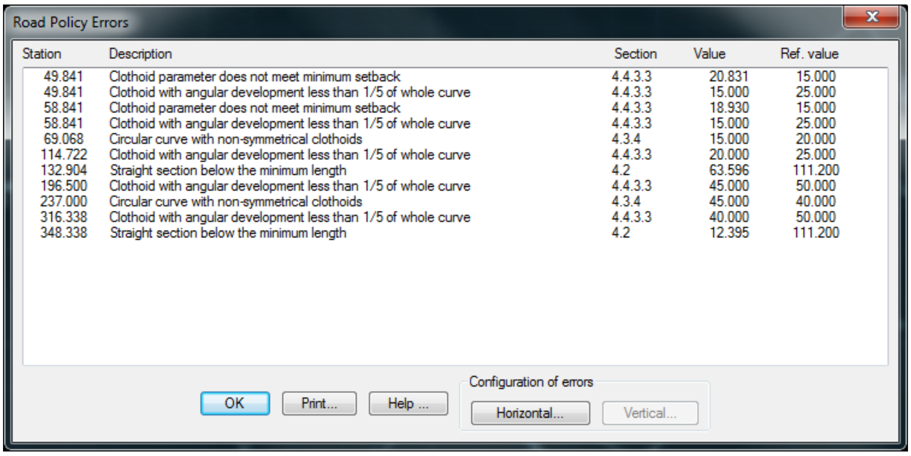
The horizontal alignment information toolbar is at the bottom of the window, used to modify each property. In addition the following toolbar is available for editing it.



Check Rules

This command checks the geometric characteristics of an horizontal alignment in accordance with the road standards configured in the program.

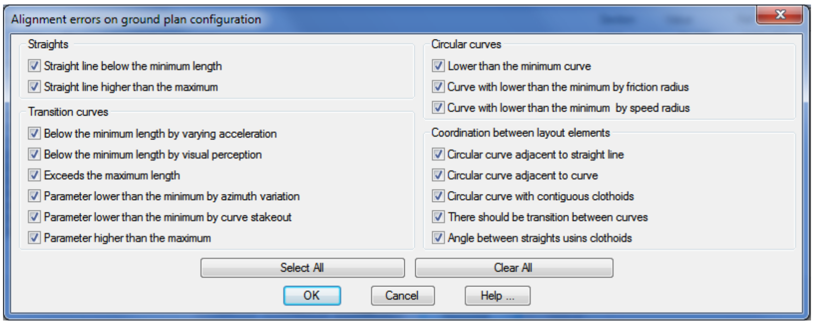
To do this the program requests a file from the horizontal alignment or segment, and then presents an error report. For each error it gives the station of the alignment that caused it, a description of the error and the relevant section of the regulation. It also displays the current numerical value of the parameter where the error originated and the reference value it should have. For example, the first line of the image below reports that for this alignment the radius (100) is less than the minimum established in the regulation (250).



The dialog box gives the option to Print the error report, as well as configure the errors to be detected, whether on **Horizontal** or **Vertical** if a segment has been selected.

Alignment Errors on Ground Plan Configuration

This dialog box enables the user to control the types of error detected by this command in different categories. All are activated by default. The ***Select All*** and ***Clear All*** tabs can also be used.



Below we explain the meaning of the different error messages and the reference to the same in the Road Instructions.

Import Alignment

This command draws a horizontal alignment in MDT format that is stored in a file generated by the **Alignments > Export Alignment** command. In order to import horizontal alignments in other formats, it is first necessary to convert them with the **Convert Alignment** command.

Although the horizontal alignments are drawn as polylines, all their analytical information is associated. Straight line or curved sections of the horizontal alignment are drawn with a single vertex, but clothoids are discretized by inserting a vertex at each distance specified by the **Clothoid Distance** parameter of the configuration menu's **Alignments** section.

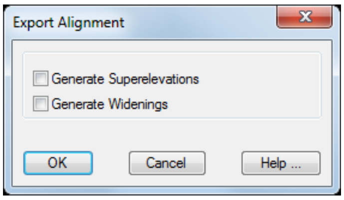
If one observes that curved sections are drawn as a traverse instead of as arches, the drawing should be regenerated with the CAD REGEN command.

If a horizontal alignment file is imported from an previous version of MDT, the program requests data on **Category** and **Project Speed**, as is done in the **Alignments > Convert Polyline to Alignment** command.

Export Alignment

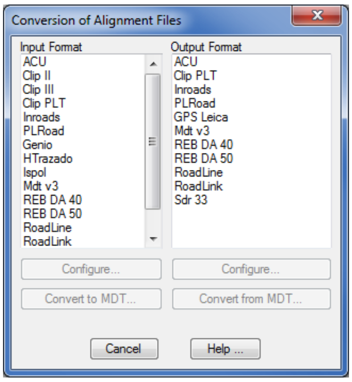
This command is complementary to **Alignments > Import Alignment.** In other words, it generates a file from a horizontal alignment drawn on screen which will subsequently be used for other commands such as, for instance, defining segments, obtaining profiles, setting out, etc.

When the command is run, the program requests the horizontal alignment to be selected. It then opens the next dialog box where one can simultaneously **Generate Superelevation** and **Generate Widenings** associated to the horizontal alignment, depending on the type of road and the project speed specified when it was created. These will be generated with the same name as the horizontal alignment file, but with their respective extensions (`.PER` for superelevations and `.SOB` for additional widths).



Convert Alignment

This command allows alignment files from other programs or with different formats to be converted, so that they can be imported into MDT or be exported to other programs. Once the command is run, the following dialog box appears, which is described below:

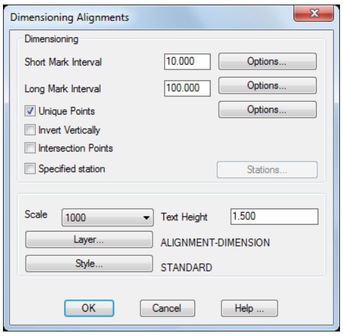


If a format is selected from the **Input Format** list, the **Convert to MDT** button will automatically be enabled. Once this button is clicked, the source file containing the horizontal alignment in the original format will be requested. Then the output file will be requested to where the information about the alignment will be transferred in MDT format. Optionally, the **Configure** button may be activated, where any special characteristics the format selected has can be specified.

Likewise, if any format on the **Output Format** list is selected, the **Convert from MDT** button will automatically be enabled. Once this button is clicked, the source file containing the MDT alignment will be requested. Then the output file to where the alignment information will be transferred with the format previously selected. Optionally, the **Configure** button may be activated, where any special characteristics the format selected has can be specified.

Dimension Alignment

This tool is used to dimension an alignment following standard criteria. The program requests the horizontal alignment drawn on screen and then activates a dialog box. where the characteristics of the marks to be drawn should be entered.



Invert Vertically: Allows the texts' labelling direction to be changed in the alignment's dimensioning.

Intersection Points**:** Activating this option the program draws two straight lines tangent to the entrances and exits of the curves.

Scale: Sets the scale value for the marks and texts to be drawn.

Text Height: Value of the height of the texts to be labelled. This value will be proportional to the preceding scale value.

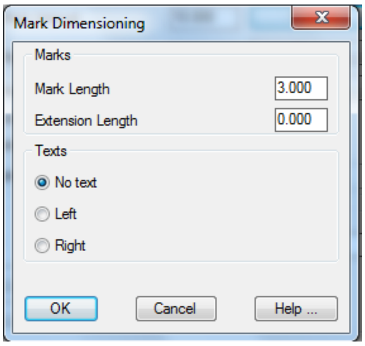
Layer : The layer in which marks and texts are to be drawn is designated.

Style: The style of the texts to be labelled. If the button is clicked, a list will be displayed containing the different styles available for the current drawing.

Specific Stations: This option is used to mark stations of particular interest.

Short Mark Interval

Sets the interval between each short mark to be drawn. If the **Options** button is activated, the interval's configuration can be modified.



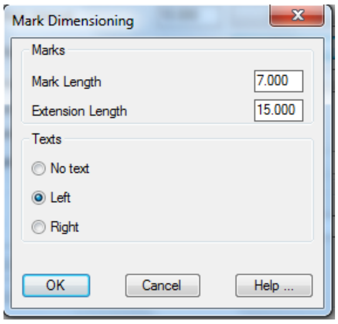
Mark Length: Length of short mark.

Extension Length: If texts are drawn, this value sets the mark's extension in the direction of the text attached.

Texts: It is possible either to draw the text to the **Left** or to the **Right**, or not draw the text (**No text**).

Long Mark Interval

Sets the interval between each long mark to be drawn. If the **Options** button is activated, the interval's configuration can be modified.



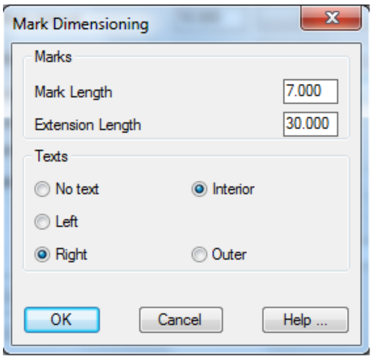
Mark Length: Length of long mark.

Extension Length: If texts are drawn, this value sets the mark's extension in the direction of the text attached.

Texts: It is possible either to draw the text to the **Left** or to the **Right**, or not draw the text (**No text**).

Unique Points

If this control is activated, MDT will mark the alignment's unique points. Similarly, the alignment's drawing may be configured.



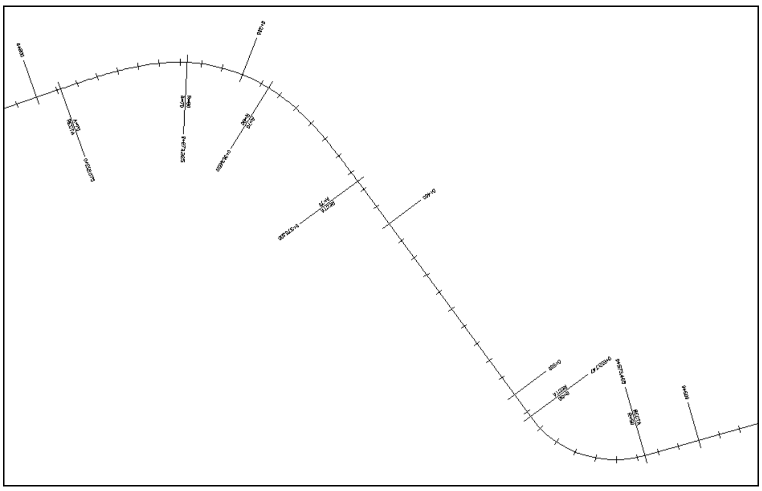
Mark Length: Length of the mark situated at unique points.

Extension Length: If texts are drawn, this value sets the mark's extension in the direction of the text attached.

Texts: It is possible either to draw the text to the **Left** or to the **Right**, or not draw the text (**No text**). To dimension curve or clothoid-type sections, dimensioning may be performed either in their **Exterior** or its **Interior**.

Final result

Once the dialog box has been validated, MDT will proceed to dimension the alignment selected. An example of the command in use can be seen below.



Delete Dimensioning

This command makes it easier to delete all the lines and texts that were labelled when the alignment was dimensioned.

MDT requests the horizontal alignment and then deletes all the objects associated to the alignment's dimensioning.

Displace Station

All the stations of an alignment drawn on screen can be changed by means of this command. The horizontal alignment to be processed should be selected and the program requests the **Initial Station,** showing the one currently set as the default value. If it is changed, the horizontal alignment is redrawn. One can check with the List command that the displacement desired has been produced.

Invert Alignment

This tool changes the direction of the beginning of an alignment drawn on screen, inverting the distances to origin, as well as changing azimuth and radius signs.

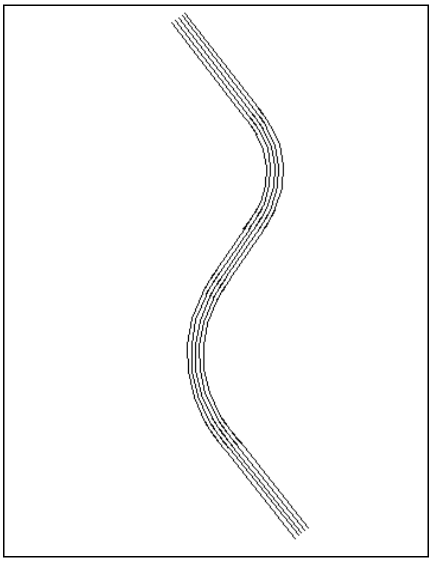
Example: Horizontal alignment before and after inversion

0.000	376382.670	4085076.190	355.5097	0.000	0.000	315.532
315.532	376179.676	4085317.755	355.5097	20.000	0.000	26.978
342.510	376179.068	4085342.728	41.3826	0.000	0.000	224.095
566.605	376314.694	4085521.122	41.3826	-80.000	40.000	20.000
586.605	376326.114	4085537.520	33.4249	-80.000	0.000	87.612
674.217	376324.235	4085620.799	363.7055	0.000	40.000	20.000
694.217	376312.087	4085636.670	355.7477	0.000	0.000	198.585
892.802	376184.899	4085789.180	355.7477	0.000	0.000	0.000

0.000	376184.899	4085789.180	155.7477	0.000	0.000	198.585
198.585	376312.087	4085636.670	155.7477	80.000	40.000	20.000
218.585	376324.235	4085620.799	163.7055	80.000	0.000	87.612
306.197	376326.112	4085537.521	233.4249	0.000	40.000	20.000
326.197	376314.694	4085521.122	241.3826	0.000	0.000	224.095
550.292	376179.068	4085342.728	241.3826	-20.000	0.000	26.978
577.270	376179.678	4085317.757	155.5097	0.000	0.000	315.532
892.802	376382.670	4085076.190	155.5097	0.000	0.000	0.000

Parallel to Alignment

This utility enables parallels to an alignment drawn on screen to be constructed. In order to do so, the horizontal alignment in question is selected and the **Offset** to be applied entered with its corresponding sign (negative to the left, positive to the right). The program will then draw the new alignment as a polyline. Parallels having other adjustments to the same horizontal alignment may be calculated without exiting from the command.

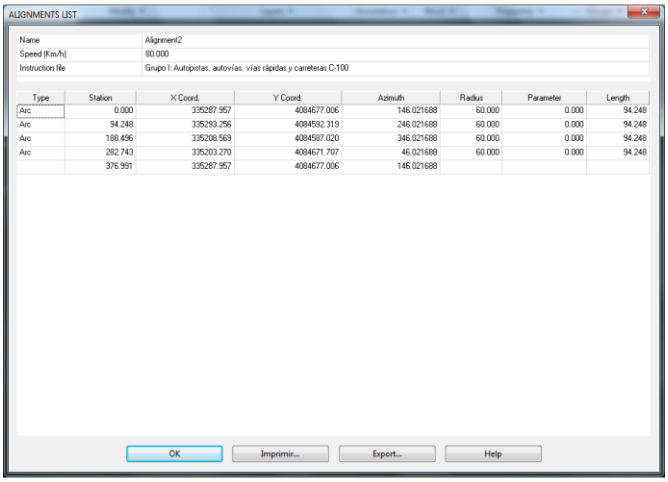


It should be noted that in order to calculate parallels to clothoids, the program respects their entry and exit parameters. This is why they are not really parallel along the whole of their path. This limitation cannot be overcome, since the geometrical figure parallel to a clothoid is not a clothoid.

Circular Alignment

This tool enables circular horizontal alignments to be created. It is extremely useful for creating traffic circles.

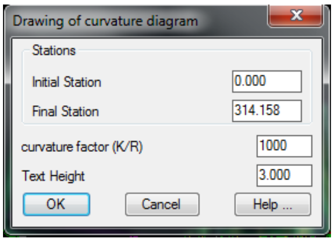
MDT initially requests the horizontal alignment's **Centre**, then its **Radius** and finally its **Origin** or the position of the initial station, temporarily changing the selection to the closest AutoCAD point.



Type	Station	X Coord.	Y Coord.	Azimuth	Radius	Parameter	Length
Arc	0.000	335287.957	4084677.006	146.021688	60.000	0.000	94.248
Arc	94.248	335293.256	4084592.319	246.021688	60.000	0.000	94.248
Arc	188.496	335208.569	4084587.020	346.021688	60.000	0.000	94.248
Arc	282.743	335203.270	4084671.707	46.021688	60.000	0.000	94.248
	376.991	335287.957	4084677.006	146.021688			

Drawing of Curvature Diagram

This command is used to draw the curvature diagram associated with an alignment. For this purpose it will initially request the alignment properly designated on screen or from a file. Next, the below window will appear which is used to configure the drawing parameters.



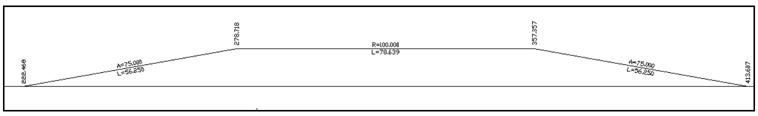
Initial Station: Initial station of the drawing.

Final Station: Final station of the drawing.

Curvature Factor: Exaggeration factor in the representation of the curvature diagram.

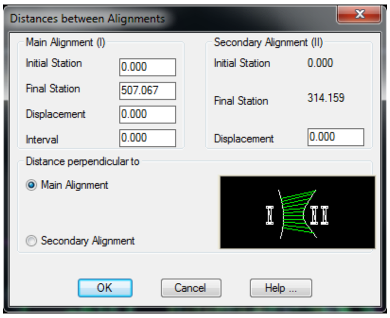
Text Height: Height of the texts that are marked next to the curvature diagram.

See this type of diagram below.



Distances Between Alignments

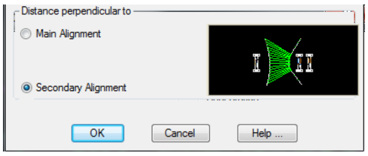
This tool provides users with information regarding distances equivalent stations existing on two different horizontal alignments. Firstly, the two horizontal alignments must be selected. Then the following dialog box is displayed:



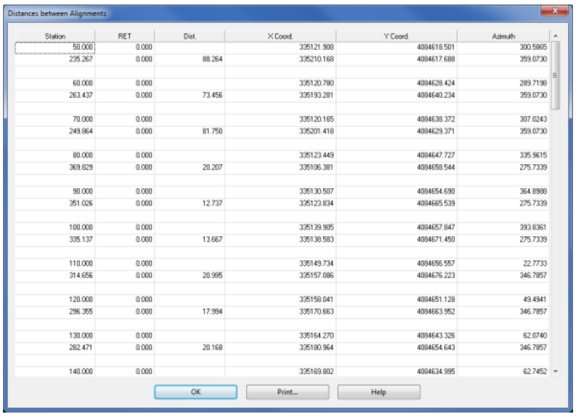
There are two ways of working or making the calculation, depending on whether **Main Alignment** or **Secondary Alignment** is selected.

Main Alignment: In this case the distances to horizontal alignments are calculated normally with regard to the first horizontal alignment selected and until the intersection with the second horizontal alignment.

Secondary Alignment: If this option is selected the distances will be perpendicular to the second horizontal alignment selected.



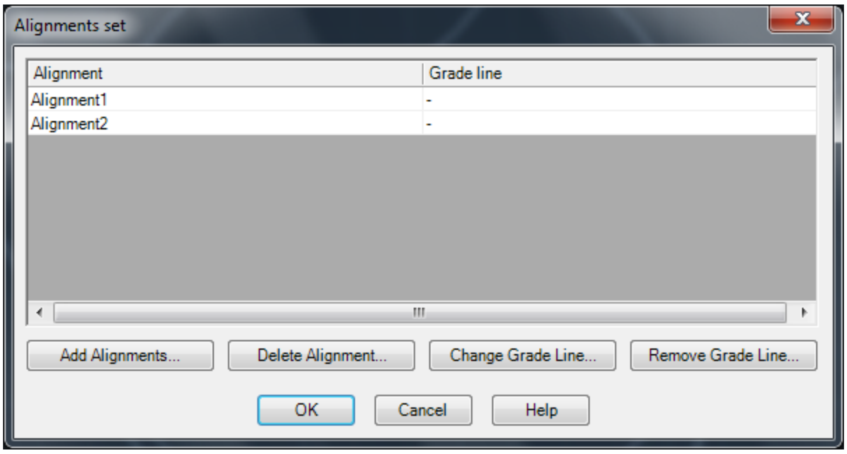
The **Initial Station** and the **Final Station** should be indicated for the main horizontal alignment (the first one selected), along with its **Offset** with respect to the alignment and the calculation **Interval**. In addition, the **Offset** with regard to the horizontal alignment is entered for the secondary alignment.



The results are grouped two by two in lines: one for the first alignment and the other for the second. In the first, the station, the X and Y coordinates, and the azimuth are indicated. In the second, the station, the distance between the horizontal alignments at that station, the X and Y coordinates, and the azimuth at that point are indicated.

Intersections between Alignments

This utility generates a list containing the coordinates, stations and height differences of the intersections of a set of coordinates or segments. If the drawing is associated to a project, the program deduces which set of horizontal alignment to check. Otherwise, the program requests a set of alignment and/or segment files. The following dialog box is then displayed:

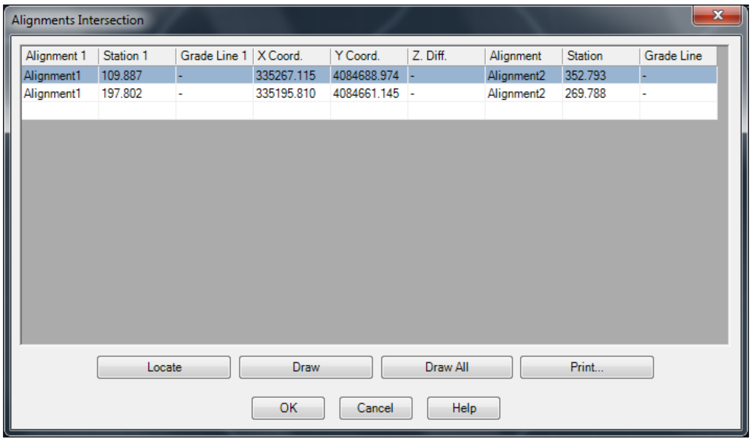


The **Add Alignments** button allows one to include more files to the current horizontal alignment set. If a horizontal alignment file is included, the program cannot know which is the grade line file. It is therefore not recommended. If a segment file is included, the program includes the alignment and the grade line belonging to it.

An alignment (and its associated grade line) can be removed from the set by the **Delete Alignment** button, so that it is not used in the calculation. **Delete Grade Line** works in a similar way. It leaves the alignment but deletes the grade line. In both cases, the files are not deleted. The command simply stops using them.

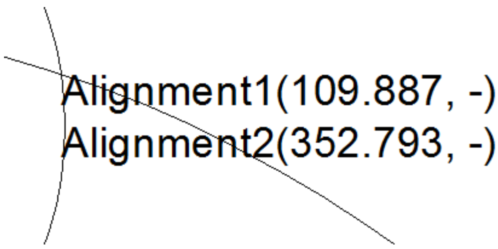
Should one wish to modify a grade line associated to a horizontal alignment, a horizontal can be selected from the list, **Change Grade Line** clicked and the appropriate file selected.

Once the set of alignments to be taken into account is modified, the intersections dialog box is displayed.



Locate centres the AutoCAD work window at the intersection selected from the list.

Draw creates an annotation on the intersection selected from the list on the drawing. The names of both horizontal alignments are shown, as are the intersection's stations and heights between parenthesis.



Draw All draws the annotations corresponding to all the intersections calculated.

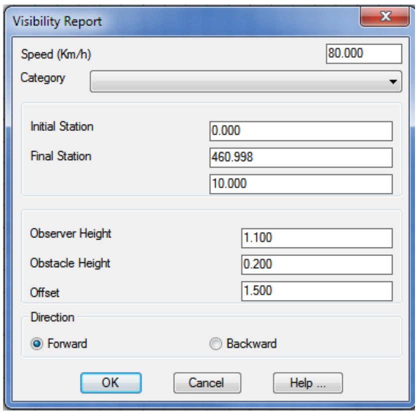
Print launches the list's printing.

When a horizontal alignment is associated to a grade line, the cell containing grade line height can be modified. When it is changed, the program modifies the relevant grade line.

Visibility Report

This command generates a list with the maximum visibility reached in each station along a horizontal alignment, using the digital model. This involves selecting a segment as an entry file.

This visibility list is calculated in accordance with visibility tables defined for the regulations of each country. In the event this table does not exist in the country selected, the calculation is conducted in accordance with the speed of the vehicle, the friction coefficient and the perception / reaction time. Consult the ***Customisation Manual*** to locate the visibility table files.



Speed: The speed of the project.

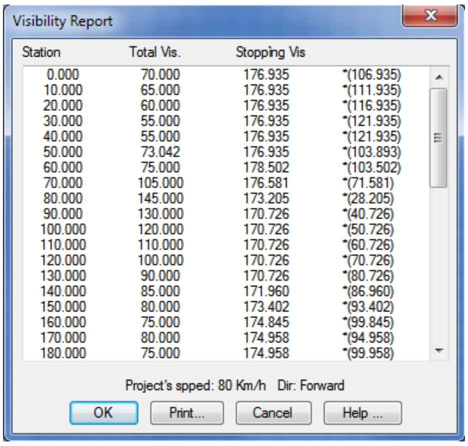
Category: The regulation of the country for which the calculation is to be conducted.

Initial Station: The initial station for which the calculation is conducted.

Final Station: The final station for which the calculation is conducted.

Interval: The calculation interval.

In addition to the initial and final stations and the **Interval** for the list, the **Height** of the observer and the adjustment with respect to the horizontal alignment must be indicated. The default values are those established in the Road Policy. The user may also select whether to calculate the direction of the horizontal alignment's advance as forward or **Backward**.


Visibility Report

Station	Total Vis.	Stopping Vis	
0.000	70.000	176.935	*(106.935)
10.000	65.000	176.935	*(111.935)
20.000	60.000	176.935	*(116.935)
30.000	55.000	176.935	*(121.935)
40.000	55.000	176.935	*(121.935)
50.000	73.042	176.935	*(103.893)
60.000	75.000	178.502	*(103.502)
70.000	105.000	176.581	*(71.581)
80.000	145.000	173.205	*(28.205)
90.000	130.000	170.726	*(40.726)
100.000	120.000	170.726	*(50.726)
110.000	110.000	170.726	*(60.726)
120.000	100.000	170.726	*(70.726)
130.000	90.000	170.726	*(80.726)
140.000	85.000	171.960	*(86.960)
150.000	80.000	173.402	*(93.402)
160.000	75.000	174.845	*(99.845)
170.000	80.000	174.958	*(94.958)
180.000	75.000	174.958	*(99.958)

Project's spped: 80 Km/h Dir: Forward

OK Print... Cancel Help ...

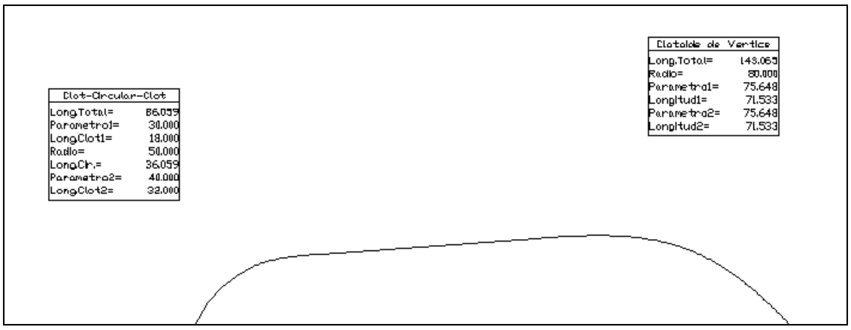
Once the dialog box options are validated a report is displayed on-screen, showing the current visibility for each Station, calculated from the intersections with the digital terrain model and the stopping visibility. Stopping Visibility is considered the distance along the length of a lane road that exists between an obstacle on the roadway and the position of a vehicle circulating toward said obstacle, in the absence of intermediate vehicles, at the moment at which the obstacle can be discerned and does not disappear from sight until reaching it.

At the bottom of the report the Takeover distance is displayed, defined as the distance necessary for a vehicle to overtake another driving at a lower speed, in the presence of a third vehicle coming from the opposite direction.

It also displays the light crossing distance for light, heavy and articulated vehicles. Light crossing distance is considered the crossing distance a driver needs to see to be able to cross another road with an intersecting trajectory, measured along the horizontal alignment of the lane road.

Labelling alignments

The purpose of this command is to represent boxes containing the information on singular and representative elements of each vertex of a horizontal alignment in ground plan view. The program asks the user to select a horizontal alignment for the drawing, then labels the tables located outside of the curves.



Convert Alignment to Polyline

This command is the inverse operation of the **Alignments > Convert Polyline to Alignment** command. Its usefulness lies in the possibility of working with the polyline than defines the horizontal alignment with CAD tools.

MDT initially requests the horizontal alignment to be selected and then the clothoids' discretizing **Interval**. Then the current horizontal alignment is deleted and the polyline drawn with the characteristics specified. All the analytical information inserted into the drawing will also be deleted.

9. Longitudinal Profiles

Introduction

In MDT, longitudinal profiles are stored in ASCII files with a `.LON` extension and the following information:

- Distance to the origin
- Height of the terrain
- Code (optional)

Quick Profile

This command is very useful for quickly obtaining an idea of the terrain. This command allows one to indicate the profile desired and represents it in a window. This representation can be scaled in order to view the slope changes clearly through the use of the **Vertical Factor** box. Additionally, information on the distance and height of each of the vertices is labelled when the mouse's cursor is situated over them. When the dialog box is validated, the process is automatically repeated until it is cancelled.

The profile to calculate can be comprised of as many sections as desired. Once satisfied with the number of sections click the right mouse button and the profile view will appear automatically.

The profile to be generated will be marked with a polyline which will be deleted automatically once it is visualized on screen.

The window shows the following information about each cut calculated:

- Length and average slope.
- Initial height, final height, maximum height, minimum height and average height.

Save Profile: This option allows one to record the information of the longitudinal profile generated. When the button is clicked, the program requests the longitudinal profile file name in which the information will be saved.

If we select the option ***Save*** and activate the ***Draw Horizontal Alignment*** box, once the longitudinal has been generated, the drawing will display the corresponding alignment.

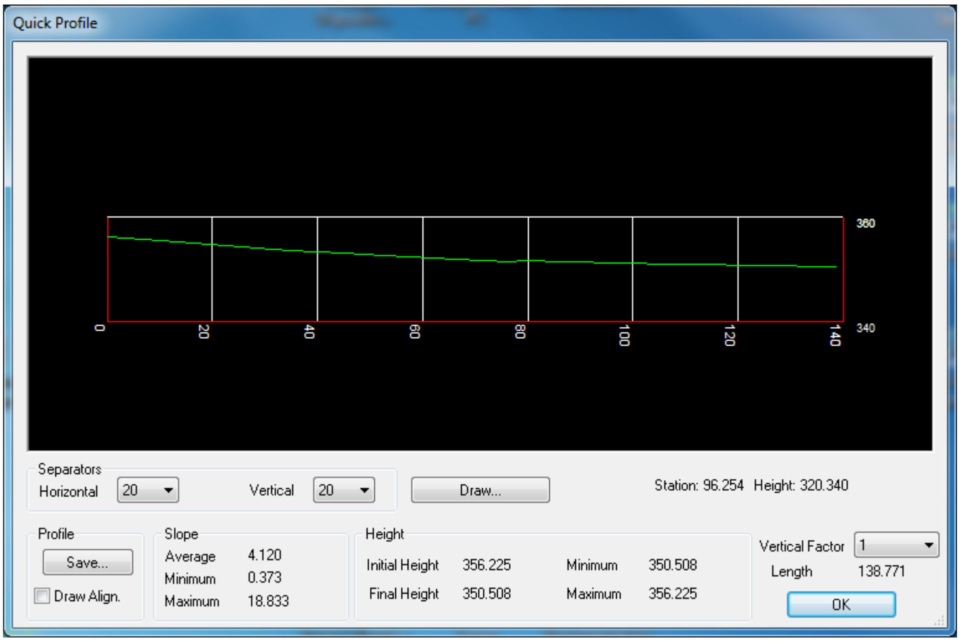
Draw : this option will allow us to draw the quick profile created as if it was a longitudinal profile. The command "***Draw Simple Profile***" will be executed directly.

It is only possible to obtain instant profiles when the surface is defined. Otherwise, the program will issue the following message: "ERROR: There are no surfaces defined". If no intersection is found with the lines making up the digital model, the program issues the following message: "There are no intersections with the surface".

If the profile to be drawn has an area with no surface information (islands for instance), it will be represented in the drawing with a blue outline.

The ends of the horizontal alignment line specified by the user are obtained from the digital model.

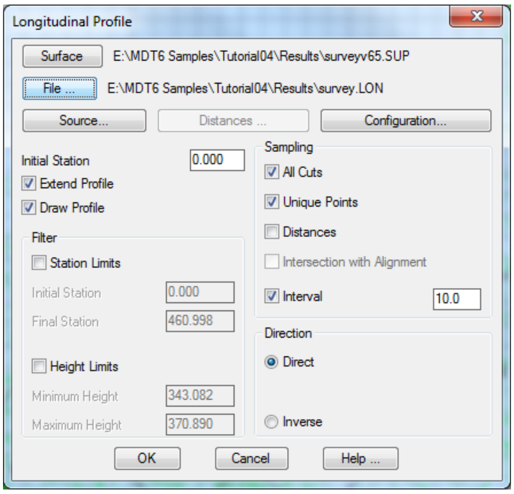
An example of a quick profile is shown below.



Get Profile

When this option is selected, the program requests a horizontal alignment file or that a polyline be selected that constitutes the trace the profile desired. Lines and polylines are admitted as horizontal alignments. In turn, the polylines can have straight and curved sections. To process clothoid sections, it necessarily has to be an horizontal alignment. If the profile is obtained from an object other than an horizontal alignment, it does not matter in which direction it was drawn, because the program chooses the closest end to the point selected as the origin.

Executing this command displays a dialog box to define the profile requested. An overview of the process and the elements in the window are described below.



.

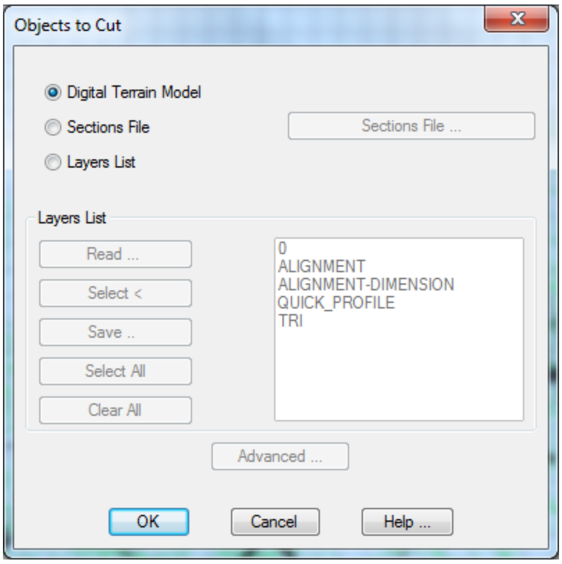
Firstly the digital model is specified based on which it is wished to obtain the longitudinal profile. With this in mind, the ***Surfaces*** button is pressed and surfaces or mesh file is selected based on which we wish to generate the profile if it is different from the one proposed. This option is only required in the event that we use as the data source a digital model or mesh file; otherwise, in the ***Source*** section we will select the mode or entities from which it is wished to generate the profile.

The **File** button shows a default directory (the current directory) in a overlaid window, together with a proposed longitudinal profile file name with a `.LON` extension. It is the drawing's default name. When the file name is validated or modified, the program goes back to the previous window.

The configuration of parameters involved in obtaining the profile can be accessed by clicking on **Configuration**.

Definition of Source

One can specify where the height information can be taken from to generate the longitudinal profile by clicking on **Source** button. This source can be:



Digital Model: Indicates the current surface of the drawing. This is where the object selected to obtain the profile will be projected. This option is advisable when the model has been correctly generated, since it includes all the height and break line orientation information, enabling a precise intersection with all the elements. The file model must be selected in the **Surface** option of the main dialog box.

Sections file: As in the digital height model, one can indicate a previously recorded Section file (.TRM extension) using the **Section File** button.

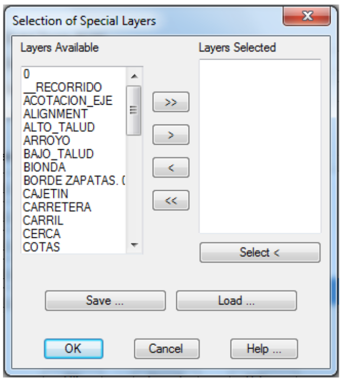
Layers List: This option can be used to cut any drawing element having a height. It is very useful when working with digital mapping without the need to create large surface files. In order to do so, the cursor is pointed at the layers containing 3D elements. The digital model can also be included in the selection by marking the MDT layer. This option enables the **Layers List** box, from which the layers containing the 3D information can be selected.

In this latter option, if the name of the layer of an element to be considered is unknown and its position in the drawing area is known, the **Select** button is simply clicked. Then it goes back to the drawing mode and the program requests the corresponding objects to be selected. This operation is executed for all the objects selected.

The **Save** option is used when one wishes the set of layers to be saved in an ASCII file with the `.CAP` extension. The program displays a window entitled **Save Layers List** with the project directory and a proposed name for the current drawing, which can be either validated or modified. When validated, one goes back to the previous window. Once this operation has been completed, the **Load** button is used, as layers can be selected by simply clicking this button by choosing the layers file for jobs in any subsequent longitudinal profile or cross-section operation.

When this option is selected, the **Advanced** button is enabled, so that information on the objects associated to the layers is included when profiles are obtained from the layers selected in the dialog box shown below. Object heights are interpolated.

By activating the corresponding option in configuration, one can decide whether or not polylines with a height of zero are to be cut.



Longitudinal Profile Parameters

Initial Station: The initial station assigned to the horizontal alignment's initial position is entered in this box. The default value is either zero or the origin of the horizontal alignment.

Extend Profile: If the horizontal alignment or polyline from which one wishes to obtain the profile exceeds the area covered by the digital model, height is interpolated using the last two vertices found before the first or last intersection with the model at the ends of the digital model.

Draw profile: If we enable this box, once the profile has been generated correctly, the command corresponding to the profile drawing will be executed automatically.

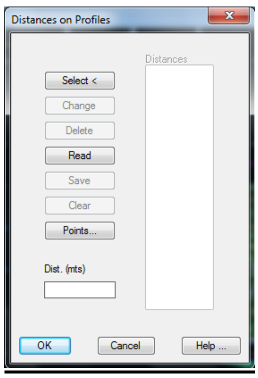
Sampling

This text box offers a series of options to be taken into consideration, depending on the longitudinal profile to be obtained.

All Cuts. This option informs the program to obtain cuts of all the vertices contained in the layers selected, digital model triangles or grid faces along the whole horizontal alignment.

Unique Points. When this option is selected, the program takes into consideration the initial and final stations and all the vertices found on the horizontal alignment, in addition to all the interval distances determined prior to the constant interval: changes of orientation, vertices forming straight lines, tangents, etc.

Distance. This option allows one to include specific stations on the longitudinal profile. Activating this option enables the **Distances** button. A new window called **Distances in Profiles** is then activated.



As can be observed in the window, it includes a series of buttons used for editing the stations to be included.

Select: Allows one to select the station graphically. In order to do so, either a point on the horizontal alignment is selected or a point close to the horizontal alignment indicated. The point is then projected on to itself, returning the station of the point indicated.

Change : This command changes the station selected from the list for the one indicated in the **Distances** text box.

Delete : Deletes the station selected from the list.

Read and **Save**: These commands allow one to load or generate a .DST file or a profile distance file, respectively. Each line indicates a station.

Clear: Deletes the entire list from the window.

Points: Provides access to the **Point Selection** window to determine the set of points whose stations one intends to project onto the horizontal alignment. See **Point Selection** in the **Surveying Points** section.

Interval: This option allows one to include a series of stations spaced out with the value indicated.

Horizontal Alignment Intersections: To use this option it is necessary to be working with a project. Once it is activated, the program will calculate the current horizontal alignment station intersections with the rest of the project's horizontal alignments.

It will include these stations in profile generation.

Filter

In this option box, one can select the part of the information about the longitudinal profile that is most relevant for the job. It offers two possibilities: Setting limits between stations or heights.

The first option allows one to indicate the initial and final station from which one intends to obtain the longitudinal profile.

Height limits indicate the maximum and minimum heights permitted on the profile. If these limits are exceeded, the profile represents a flat surface at the maximum or minimum height shown.

Direction

In this text box, the direction in which the profile is to be obtained is specified. **Direct** is the direction of the horizontal alignment from the initial station to the end. **Inverse**, on the other hand, means that the longitudinal profile starts with the final station and goes toward to the initial station.

Results

During the calculation process, heights are obtained from drawing objects and interpolating when necessary. There is also the possibility of cutting break lines even though they have been drawn on the plan. If the **Draw in 3D** option is activated, the program assigns the height value to each vertex of the point that coincides with it.

The only compulsory operation when entering longitudinal profile data is horizontal alignment selection. If this is not done, the program issues the following message: "ERROR: Horizontal alignment not selected". Additionally, if the digital model is not defined and a layer to cut has not been selected, the “Layers not selected” error occurs. Another possible error consists of not having found objects cutting the horizontal alignment. In this case, the “No intersections found” error message will be displayed.

Once the generation has finalized, the following window will be displayed should it have been impossible to obtain some of the cuts specified. It provides information on any stations whose height information has not been obtained.

Additionally, in the case of generating profiles from a surface, the program will automatically detect the existence of islands or zones with an undefined surface inside the model and that affect the horizontal alignment outline. In such a case, the program will suitably list or draw the profile so as to clearly identify the location of areas with these undefined surfaces.

The file format consists of a line for each longitudinal cut found. The distance to origin (considering the initial station), the height of the terrain at this point, and a remark –which can be “Unique Point”, “Constant Distance”, “Specified Distance”– or the name of the cut's layer will appear on each line.

Example: DEMO.LON

```
  0.000     152.888     Unique Point
 12.049     152.446     10050000
 25.232     151.963     10050000
 34.837     150.000     20010000
108.468     140.000     20010000
124.500     137.735     Distance Specified
144.079     135.000     20010000
151.677     134.451     11120000
153.921     135.000     20010000
156.594     136.093     Unique Point
166.144     140.000     20010000!
199.857     154.437     10050000!
204.713     154.729     10050000
211.550     160.000     20010000
221.007     164.758     Unique Point
221.487     165.000     20010000
293.591     175.000     20010000
301.020     172.628     10050000
314.621     175.000     20010000
327.384     175.606     Unique Point
```

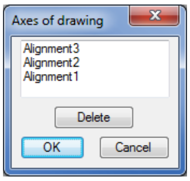
On this fragment of a longitudinal profile generated from a digital map drawing, cuts with contour lines (heights with integer values) and with 3D lines (heights with decimals) can be seen, in addition to their layer coding. Unique horizontal alignment points and a distance specified by the user have also been included.

It is also possible to see in this longitudinal profile that the station codes 166.144 and 199.857 have the character “!” added to them, which marks the zones for which no surface information exists for the program.

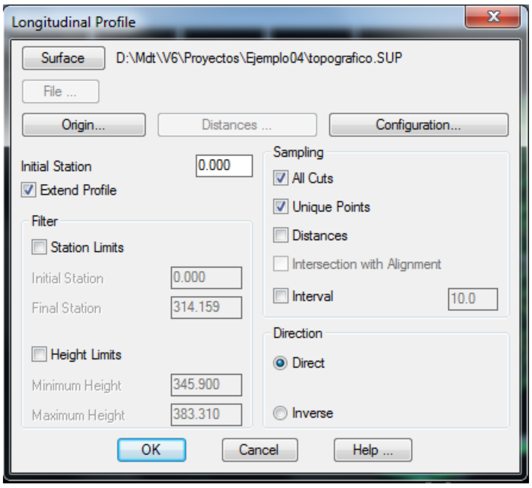
Get Multiple Profiles

This command is used to generate multiple longitudinal profiles simultaneously.

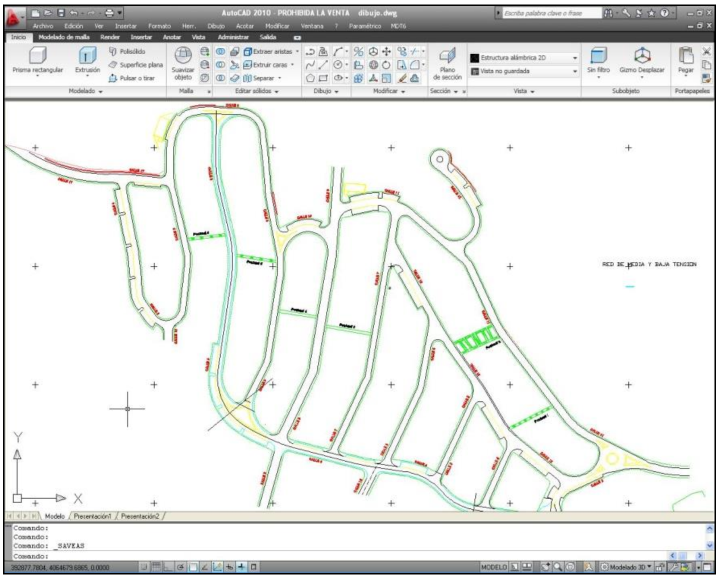
By executing the command, the program will read all the horizontal profiles existing in the drawing, for which it is necessary to previously import or draw all the horizontal alignments from which we wish to generate the profiles. Then it will display the following window with the name of each drawing’s horizontal alignment, allowing for the possibility to eliminate horizontal alignments with which we do not wish to generate the longitudinal profile.



Once this window is validated the program will display the following window whose details are described in the command **Generate Profiles**.



In this case the option **File** will appear disabled as the longitudinal profiles to generate will take the name of the horizontal alignment they are obtained from, and be saved in the current work folder.

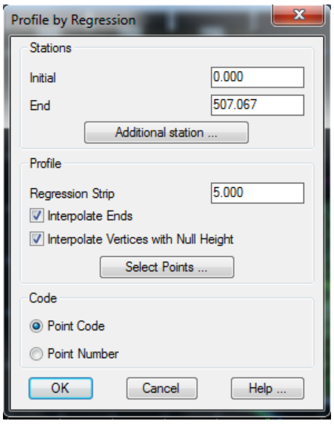


Get Profile by Regression

For some linear works, power lines, road alignments, etc. for which one does not have a surface of the area available but isolated surveying points near the horizontal alignment, the option enables one to obtain it without the need to triangulate. A longitudinal profile is thus obtained, whose heights are directly assigned from the points close to the horizontal alignment and within the margin set in the command.

Any points that are found at a level that cannot be triangulated will not be taken into account. For further details, consult the **Points** section in the **Customization Manual.**

When the command is executed, MDT initially request the horizontal alignment from which the profile will be generated. The following dialog box is then displayed, which is described below.



Initial station: Allows the longitudinal profile's initial point to be specified.

Final station: The station up to which the longitudinal profile will be obtained is likewise specified.

Additional stations*:* Used to select any additional stations that we wish to include in generating the longitudinal profile. The heights of these stations will be interpolated between the previous and following points with known heights.

Regression Strip: Sets the interval to the left and the right of the horizontal alignment where the points projected onto the alignment will be found.

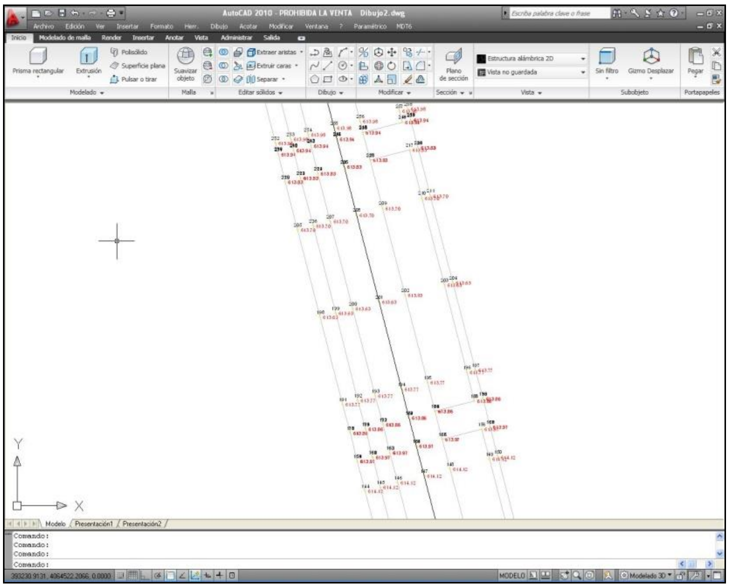
Interpolate Ends: Indicates whether the ends of the longitudinal profile are to be interpolated should no points be found at the ends. If they are found, the program will interpolate in a linear fashion with regard to the two distances before and after the initial and final point respectively.

Interpolate Vertices with Null Heights*:* This option is useful when there are points that project onto the horizontal alignment with null or zero height. If this option is activated, the program will automatically interpolate these points. In the case that vertices with null height exist and this option is not activated, the vertices in question will be eliminated from the profile generated.

Select Points: Allows one to select the points that will take part in the profile's generation. Point selection may be performed in many ways: by numbers, codes, etc. For further details, consult the section on Points.

Codes: Sets the representation of codes on the longitudinal profile. It may be configured in two ways:

- **Point Code** The code of the projected point appears in the code of the longitudinal profile's vertex.
- **Point Number:** The number of the projected point appears in the code of the longitudinal profile's vertex.



Finally, a file with `.LON` extension is generated. Its codes will include the point which has been used as a reference to generate the longitudinal profile. An example of a longitudinal file obtained by regression is shown below.

0.000	98.530	74
6.840	98.560	75
20.427	98.620	76
33.399	98.620	77
46.306	98.650	78
60.333	98.610	79
65.539	98.570	80
78.661	98.500	81
83.795	98.490	82
94.576	98.510	83
112.160	98.530	84
127.585	98.530	85
137.197	98.540	86
152.073	98.530	88
163.356	98.520	89
171.644	98.520	90
180.727	98.510	91
191.929	98.520	92
198.614	98.510	93
204.439	98.510	94

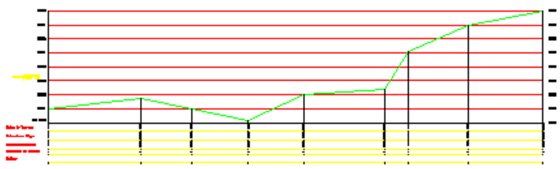
Convert from 3D polyline

A longitudinal profile is extracted from a 3D polyline using this command, taking the polyline's origin as the longitudinal profile's origin. The command requests the file name (by default, the file name corresponding to the drawing). When it is entered, it requests one to select the horizontal alignment on the command line. It then makes the relevant conversion, which may later be drawn.

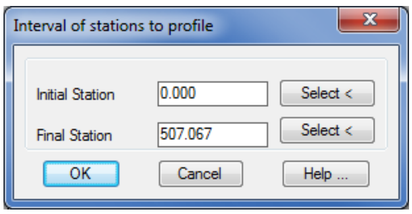
As many lines are generated in the file as the polyline's vertices. In each of these lines, distance corresponds to the length from the polyline's origin to the vertex, and height coincides with the vertex's height.

Convert Profile from Drawing

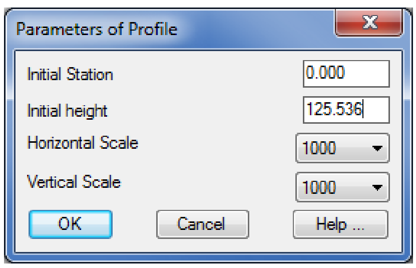
This command is particularly useful to obtain longitudinal profiles in ASCII format from a longitudinal profile represented on the drawing or from a polyline representing the profile.



If a longitudinal profile drawn with MDT is selected, the program will automatically detect it. It will then request the file in which one wishes to save the data, though previously it will request the initial and final stations of the new profile to be generated for the possibility of selecting it on the same drawing.



On the contrary if we select a polyline, MDT will need some additional data to generate the longitudinal profile from it. In a data window it will request the ***Horizontal Scale, Vertical Scale, Initial Station*** and ***Final Station*** Height, and then the same process as in the case of selecting a profile drawn with MDT.



In both cases, the file generated will have the `.LON` extension.

Convert from Cross-Sections

This utility is used to obtain a longitudinal profile file from cross-sections. The process transforms the cross-sections' stations into distances, which are then assigned the height of each profile's horizontal alignment, either directly or by interpolation. The program simply requests the cross-section file one wishes to use as a reference and the name of the longitudinal profile file which will contain the results. It then makes the conversion.

Example: Cross-sections and longitudinal profile obtained from them

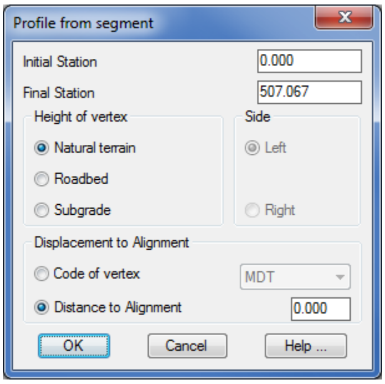
```
0.000      -18.520      43.887  TRI
0.000      -12.750      44.291  TRI
0.000      -8.769       44.612  TRI
0.000      0.000        45.318  Axle
20.000     -17.105      44.611  TRI
20.000     -16.140      44.670  TRI
20.000     -11.339      44.055  TRI
20.000     -3.832       45.434  TRI
20.000     9.316        46.121  TRI
40.000     -12.750      44.291  TRI
40.000     -11.047      43.949  TRI
40.000     -9.458       44.159  TRI
40.000     -5.009       47.678  TRI
40.000     0.000        48.201  Axle
40.000     3.462        47.503  TRI
40.000     11.611       48.129  TRI
40.000     17.226       48.435  TRI
40.000     19.677       49.094  TRI
```

```
0.000        45.318  Horizontal alignment
20.000       45.634  Interpolated
40.000       48.201  Horizontal alignment
```

Convert Segment

These tools are used to generate a longitudinal profile from a previously-defined segment or road. Thus we can select the displacement of the desired horizontal alignment and from which source of information we wish to obtain the height of the different profile vertices.

On executing this command the following dialog box will appear, which is described below:



Initial Station: Initial station of the new profile to be generated.

Final Station: Final station of the new profile to be generated.

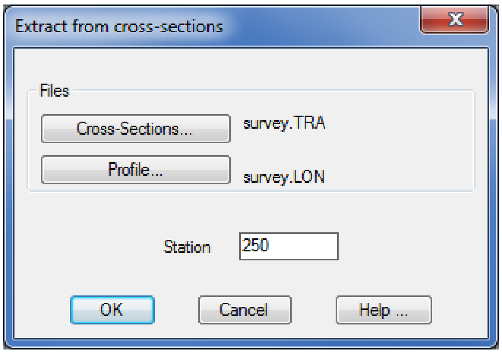
Height of Vertex: We indicate the source of information from which we wish to generate the heights of the new profile to be generated. A choice can be made between the heights of natural terrain, roadbed or subgrade in the case that roadbed exists in the defined segment.

Displacement to Alignment: The setback to horizontal alignment for the profile generation. This can be indicated with a code, which should coincide with one of the vertex codes of the cross-section profiles existing in the segment, or it can be indicated as a displacement value.

Side: This indicates whether we want the longitudinal to generate to the left or right of the horizontal alignment.

Convert a Cross-Section Station

This tool serves to obtain a longitudinal profile file from some cross-section profiles and a specified station. The process transforms the cut of the selected station into a longitudinal profile, taking 0.000 as the distance of the furthest vertex of the cut. The program simply asks for the file of cross-section profiles to use as a reference, the station of the cut to extract, and the name of the longitudinal profiles file to contain the results, making the conversions.



Example: Cross-section profile and longitudinal profiles obtained after extracting the Station 20.

0.000	-18.520	43.887	TRI
0.000	-12.750	44.291	TRI
0.000	-8.769	44.612	TRI
0.000	0.000	45.318	Axl
20.000	-17.105	44.611	TRI
20.000	-16.140	44.670	TRI
20.000	-11.339	44.055	TRI
20.000	-3.832	45.434	TRI
20.000	9.316	46.121	TRI
40.000	-14.961	43.283	TRI
40.000	-11.047	43.949	TRI
40.000	-9.458	44.159	TRI
40.000	-5.009	47.678	TRI
40.000	0.000	48.201	Axl
40.000	3.462	47.503	TRI
40.000	11.611	48.129	TRI
40.000	17.226	48.435	TRI
40.000	19.677	49.094	TRI

0.000	44.611	TRI
0.965	44.670	TRI
5.766	44.055	TRI
13.273	45.434	TRI
26.421	46.121	TRI

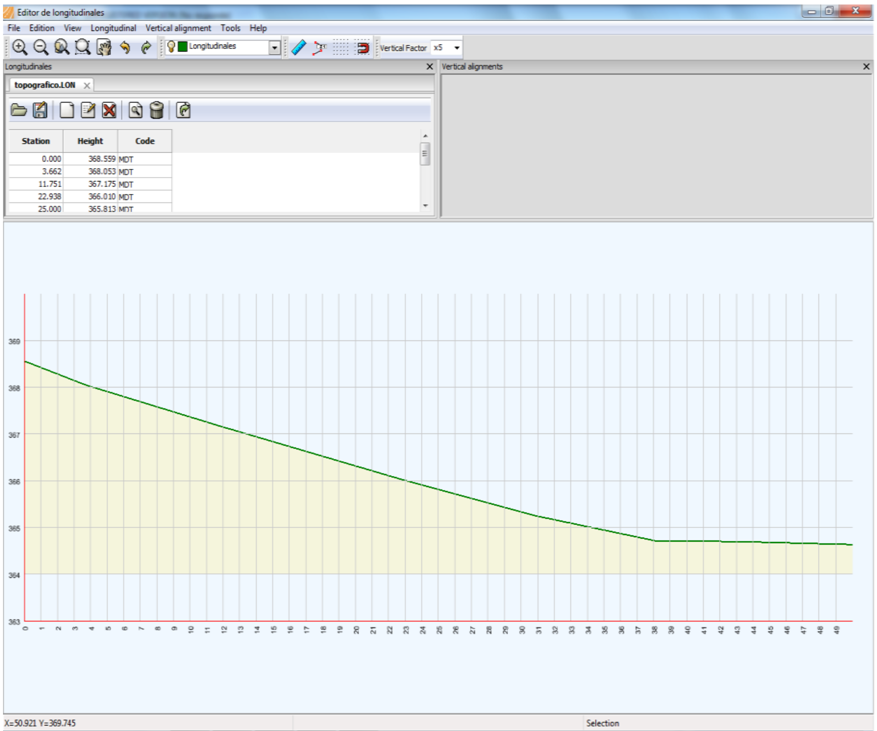
Edit Profile

This command is executed to visualize and quickly modify a longitudinal profile without needing to draw it on screen.

The command **Profiles > Edit Profile** first presents a window with the patterns `.LON` and `.SEG`.

Depending on whether we select a longitudinal or a segment it will display only information on the longitudinal or of the longitudinal and the vertical alignment together.

In either case modifications can be made to them so that once we validate the option we have the possibility to save the data in the longitudinal or vertical alignment file depending on our initial selection.



In the work window 4 sections can be distinguished:

- At the top there is menu bar with different options and commands for processing the information.
- On the upper left we have a list of profiles with its own editing options.
- In the upper right section there is the vertical alignment list, also with its editing options.
- In the centre is the drawing of the same.

Menus and commands

The different menu options include:

File: With the options to open, save and close files.

View: It is possible to view or eliminate the visibility of each one of the panels we find, whether of the longitudinal or the vertical alignment, as well as personalize the different toolbars that form part of the command.

Longitudinal: Under this option there are three options or tools to apply to the longitudinal of the work.

1. Displace height.
2. Displace station.
3. Invert

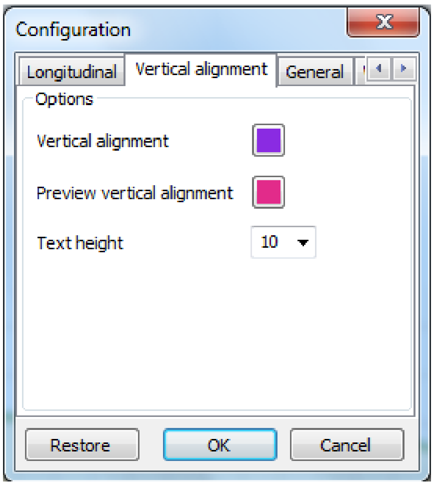
Vertical Alignment: In this menu option, in the case of editing a vertical alignment we find the following options:

1. Displace station.
2. Displace height.
3. Invert
4. Define by polyline: If we activate this option, next we graphically draw a polyline over the area of the drawing so that it automatically converts to a vertical alignment.

5. Insert Vertex: Used to insert a vertex in the vertical alignment in the position indicated on screen.

6. Crossing point: This option is used to define the curves graphically, so that the curve will pass through the point we select for it on screen. In the case that construction of the curve is not possible, for example because it overlaps with a previous or following vertex, a notice of this incidence will appear.

Tools – Configuration: From this option it is basically possible to personalize the representation of the profiles in the drawing area.



Toolbar

Zoom options: zoom in, zoom out, extents...

Tools for viewing the layers and to increase or reduce the drawing's scale factor.

 In this case the first three options will enable us to mark the pinch point by moving any vertex of the longitudinal profile, giving us three possibilities:

1. Tangent to an arc.
2. Final point of a straight line.
3. Mid point of a straight line.

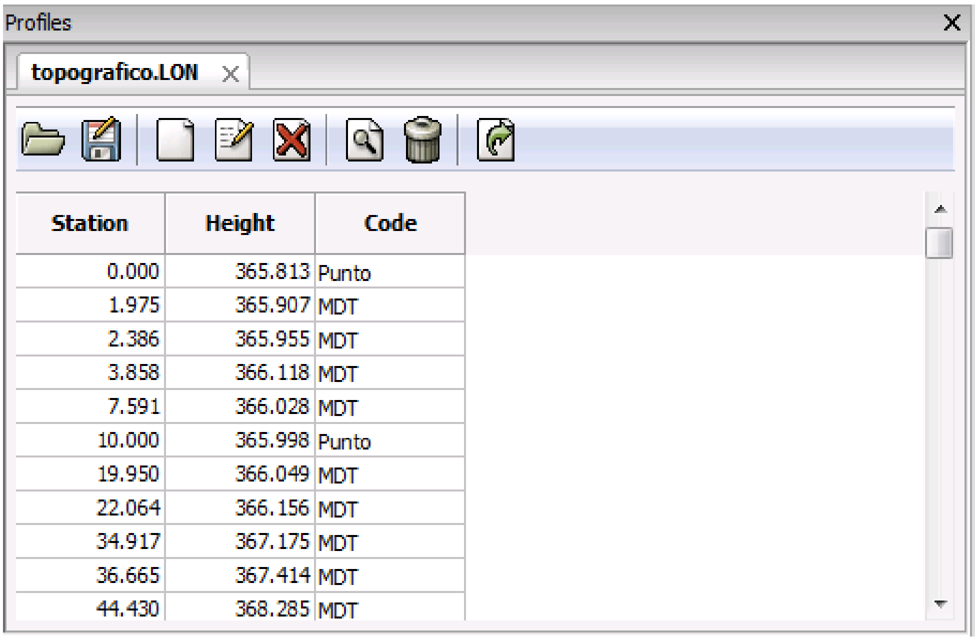
The second two options will enable us to measure the distance between two given points and to identify the real coordinates of a point on the screen.

 The first option will enable us to define a vertical alignment in graph format, the second the graphic insertion of a vertex on the vertical alignment and the third to edit a curve per crossing point.

 These commands will enable us to fix the different elements of the vertical alignment by moving any of the vertices of the same.

Profile

List for the profiles with the different editing options:



Vertical alignment

Vertical alignment with different options for editing vertexes.

Station	Height	Kv	Tangent	Arrow	Slope
0.000	365.800	0.000	0.000	0.000000	0.08275261
79.212	372.355	845.000	63.052	2.352000	-0.06648373
466.961	346.576	260.000	22.143	0.943000	0.10384980
507.067	350.741	0.000	0.000	0.000000	

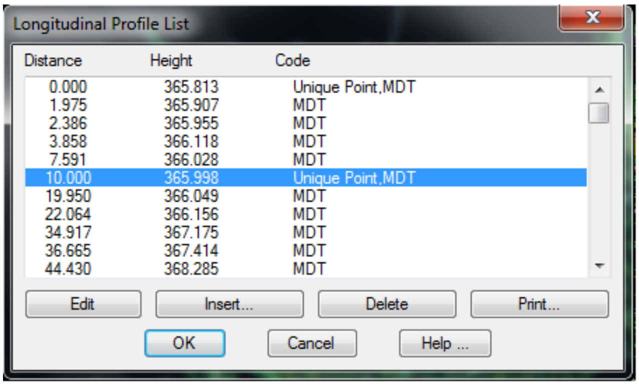
If we modify any of the curve values, whether the Kv, tangent or arrow, the other parameters will automatically be recalculated.

List Profile

When this command is executed, MDT asks requests a file with the `.LON` and `.SEG` extensions. Initially, a previously drawn longitudinal profile can be selected graphically. The result of the list will depend on the type of file selected. Both types are described below.

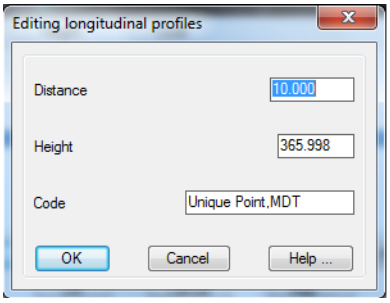
Longitudinal Profile List

Once the file has been selected or the longitudinal graphically selected, the following list divided into three columns is displayed: **Distance, Height and Code**. A description of their characteristics is given below.

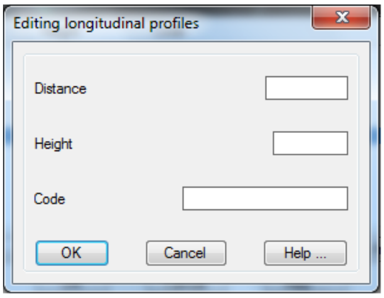


This window contains a series of buttons which allow one to modify the longitudinal profile's data.

Edit: Allows the height or code of the station selected to be modified. The following window is displayed in order to do so. In it the values of the vertex selected will appear by default. Once this dialog box has been validated, MDT will update the list, sorting the cuts by their distance from the origin.



Insert : Allows one to insert new characteristic points on the longitudinal profile. When the button is clicked, the following window is displayed, where the information on the new node desired can be entered. When the dialog box is validated, MDT will automatically sort the list.



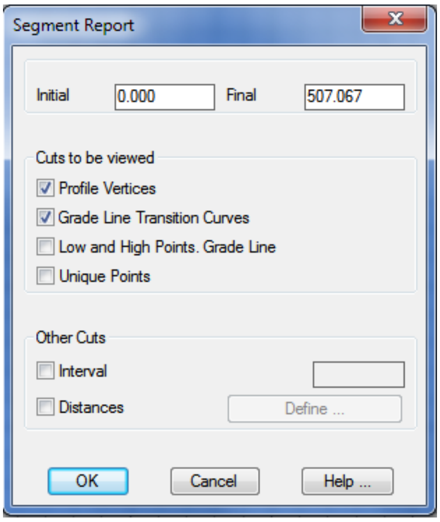
Delete : Deletes the vertex selected.

Print: Allows the list to be printed on hard copy or sent to a text file.

Once the dialog box has been validated, the changes are saved in the file selected previously. If a profile has been graphically designated, its drawing will be updated.

Segment List

Once a segment file has been selected, the program displays the following window:



This dialog box configures the type of list one wishes to obtain. Each of the controls making it up are described below.

Initial and Final Station: The station interval one wishes to obtain is set here. First the initial and final stations of the longitudinal profile comprising the segment are assigned (see definition of **Segment** in the **Horizontal Alignments** section).

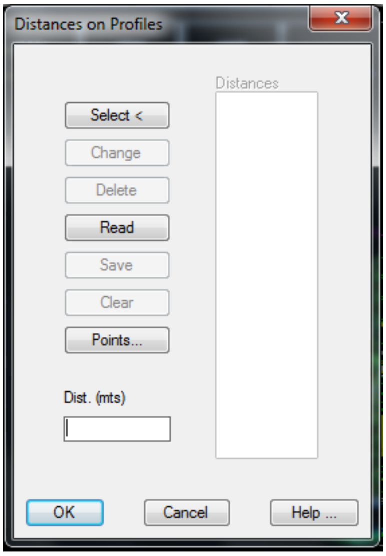
Cuts to be Viewed: The characteristic points of the longitudinal profile, the grade line or the horizontal alignment one wishes to list are selected.

- **Longitudinal Vertices**: All the vertices comprising the profile are listed.
- **Grade Line Transition Curves**: The grade line's transition curves are listed, in other words, the entry and exit tangents, as well as the vertex.
- **Low and High points. Grade Line**: A list is provided of the stations featuring the maximum and minimum heights on the vertical alignment curves.
- **Unique Points**: The characteristic points of the horizontal alignment the segment selected contains are listed.

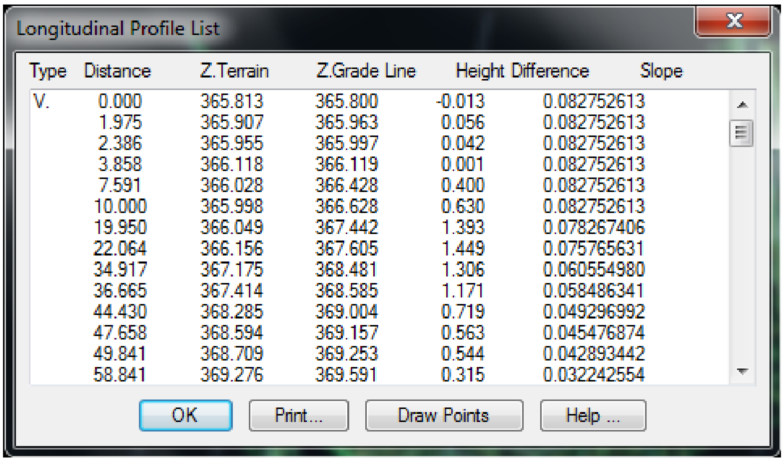
Other Cuts: In this section, other cuts are entered that the user may be interested in seeing on the list.

Interval: Depending on the value entered, MDT will represent the longitudinal profile's cuts using this value as an interval. The cut height will be interpolated between the previous and next vertices.

Distances: If the **Distances** button is activated, a dialog box will be displayed, where the specific distances one wishes to list are entered. They can either be typed in with the keyboard or selected graphically. The dialog box displayed when this button is clicked appears below.



Once the main dialog box has been validated, the following list appears. It shows the characteristics listed below for each cut.



Type: Indicates the characteristics of the cut or interval's :

U.P.: Horizontal alignment's unique point.

V.: Grade line transition curve's vertex.

I.T.: Grade line's input tangent.

O.T.: Grade line's output tangent.

Distance: Indicates the longitudinal profile's distance to origin.

Terrain Z.: Represents the terrain's height.

Grade line Z.: Represents the grade line's height.

Height Diff.: Represents the height difference between the terrain and the grade line, with a sign.

Slope: Represents the grade line's slope.

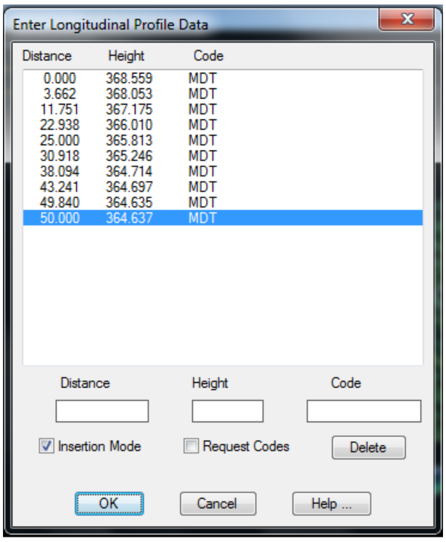
The following additional buttons also exist:

Print: Sends the list to the Windows default printer.

Excel: Sends the information to an Excel spreadsheet.

Input Profile

Possibility of entering or modifying a longitudinal profile, element by element. Once this command has been executed, .LON file will be requested. Then a dialog box will be displayed containing the profile's data should it exist or empty if no data has yet been entered.



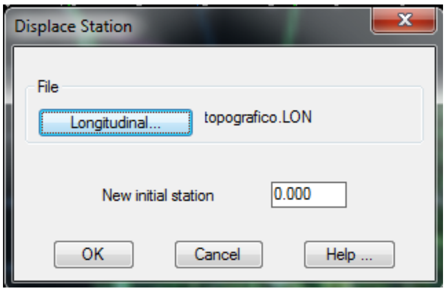
Insertion Mode: If this is not activated, the cut selected will be changed for the one entered using the keyboard. If it is selected, a new cut will be entered with the data entered using the keyboard.

Request Codes: If it is not activated, it will not request the code, so it has to be typed in, and the code of the previously selected cut will automatically be assigned. If, on the other hand, it is selected, the code has to be typed in using the keyboard.

Delete : Deletes the element marked on the list

Move Stations

This option allows us to change the stations or distances to origin of a longitudinal profile file. After selecting the file to be altered, the program displays its initial station. If a different number is entered, the program takes it as the origin and changes all the values in the file's first column.



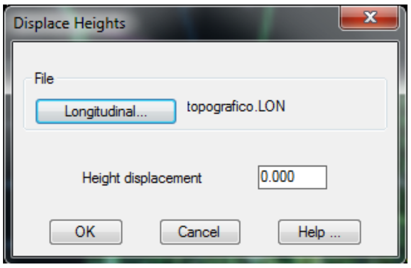
Example: Longitudinal profile before and after applying a station adjustment of +125.5 m

0.000	42.559	125.500	42.559
10.000	42.637	135.500	42.637
20.000	42.145	145.500	42.145
30.000	42.232	155.500	42.232
40.000	42.749	165.500	42.749
50.000	45.237	175.500	45.237
60.000	47.655	185.500	47.655
70.000	49.836	195.500	49.836
80.000	51.061	205.500	51.061
90.000	52.716	215.500	52.716
94.279	52.400	219.779	52.400

This utility creates a backup file of the original profile, to which it assigns the same name and .BAK extension. Therefore, if a mistake is made when this command is used, the modified profile file can be changed and the copy renamed.

Move Heights

This option works in the same way. After selecting the longitudinal profile file, a value to be added or subtracted from all the heights in the file is entered.



Example: Longitudinal profile before and after applying a height adjustment of +50.0 m

0.000	42.559	0.000	92.559
10.000	42.637	10.000	92.637
20.000	42.145	20.000	92.145
30.000	42.232	30.000	92.232
40.000	42.749	40.000	92.749
50.000	45.237	50.000	95.237
60.000	47.655	60.000	97.655
70.000	49.836	70.000	99.836
80.000	51.061	80.000	101.061
90.000	52.716	90.000	102.716
94.279	52.400	94.279	102.400

Invert Profile

There are often circumstances in which one needs to change the direction of a longitudinal profile. In order to do this, this utility has been added to the program. By simply selecting the file, it automatically inverts it and the original is renamed with the .BAK extension.

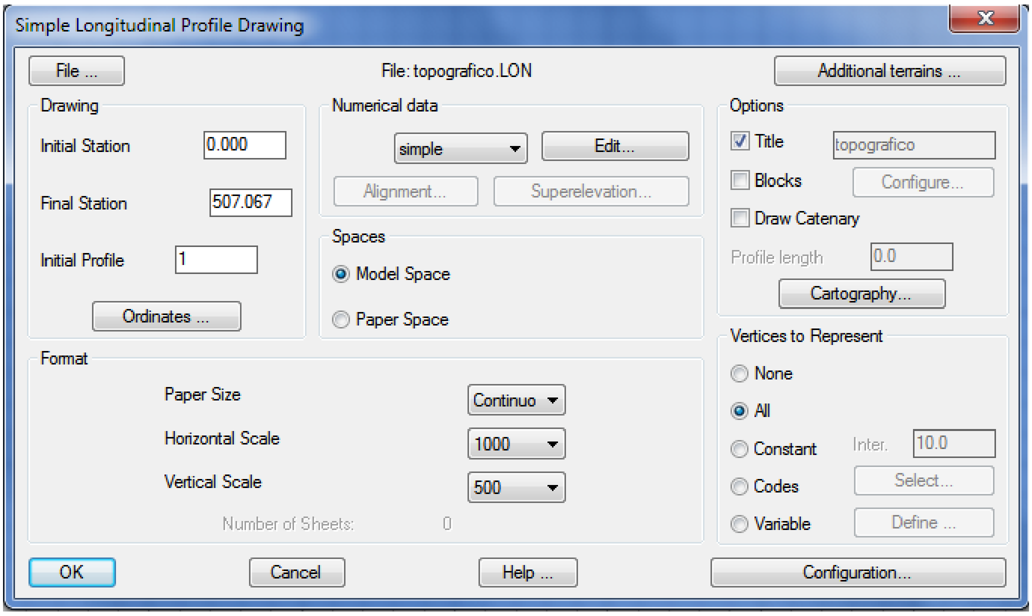
Example: Longitudinal profile before and after being inverted:

0.000	42.559	0.000	52.400
10.000	42.637	4.279	52.716
20.000	42.145	14.279	51.061
30.000	42.232	24.279	49.836
40.000	42.749	34.279	47.655
50.000	45.237	44.279	45.237
60.000	47.655	54.279	42.749
70.000	49.836	64.279	42.232
80.000	51.061	74.279	42.145
90.000	52.716	84.279	42.637
94.279	52.400	94.279	42.559

Draw Simple Profile

This option allows one to draw on screen a longitudinal profile of the terrain obtained previously by any of the procedures permitted by MDT. It should not be confused with the **Profiles** > **Draw Composite Profile** command, which can also draw the grade line, along with the curve and superelevation diagrams.

Once the command is executed, it will request a `.LON` or `.SEG` file, and the following dialog box will be displayed. If a segment file is selected, MDT will only extract the information concerning the longitudinal profile.



The window is comprised of the controls described below:

Drawing

Initial station : Initial station from which one wishes the drawing to be made. It has the default initial value of the longitudinal profile selected.

Final station: Station up to which one wishes to draw the profile on screen. By default, it is the profile's maximum station.

Initial profile: Represents the initial profile to be represented in the **Profile Numbering** element defined previously in the numerical data (see **Longitudinal > Definition of Numerical Data**).

Numerical Data

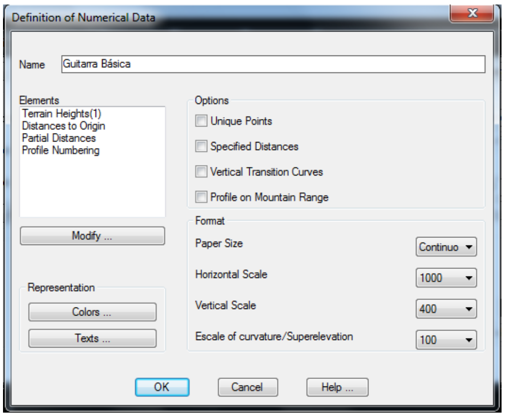
We select the numerical data associated with the profile that is to be represented; the different numerical data defined by the user is available in the drop-down menu.

Edit: To edit the active numerical data with the possibility of making modifications to it.

Horizontal alignment: In the case of adding the element "Curvature Diagram" to the numerical data, this button is used to select the horizontal alignment from which the corresponding diagram will be generated.

Superelevation: In this case, if we add the element "Superelevation", the superelevation will be taken as a reference in its drawing.

Next we can see the dialogue box that appears when editing the numerical data. In the section **Definition of Numerical data** its function and characteristics are described.



Spaces

If **Model Space** is selected, the profile's drawing will be drawn normally, that is to day from the initial point selected on screen.

Should **Paper Space** be selected, it will be drawn using the pre-set paper space option in AutoCAD. This option is not available in AutoCAD 14 and compatibles.

The program will assign a **Title** to each of the presentations it creates preceded by the "LON_" prefix and ending with an index corresponding to the number of sheets. For instance, LON_ROAD1.

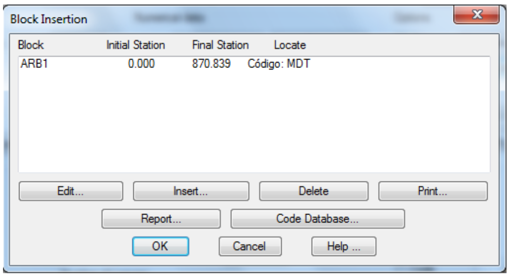
Additionally, should a representation already exist with the same name, the program will issue a warning that it already exists and ask whether the user wishes to delete it or create it again.

Options

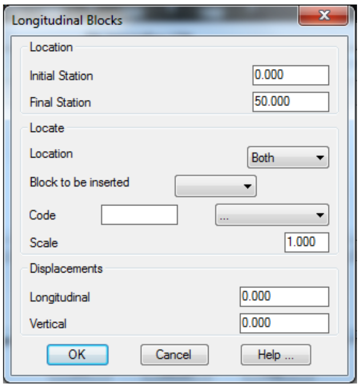
Title: Once the profile is drawn, the title entered will appear on the top of the drawing.

Blocks : This option allows one to select the blocks one wishes to draw on the longitudinal profile. At the same time, the **Blocks** numerical data element should be defined in the numerical data definition to be used

If the **Configure** button is clicked, the following window is displayed where the insertion point of each of the blocks one wishes to insert along with the longitudinal profile should be specified.



The following dialog box is displayed to insert or modify blocks for the longitudinal profile drawing.



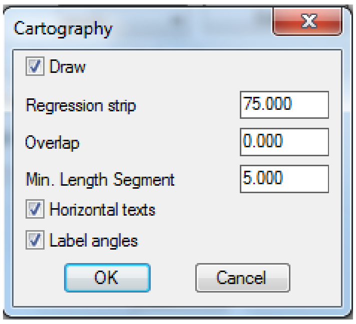
Everything concerning the definition and management of blocks is explained in greater detail in the **Blocks Definition** section.

Cartography**:** This option allows one to view the sections of mapping adjacent to the alignment selected as numerical data elements.

In order to do so, only those layers corresponding to the objects one wishes to project should be active when the profile is drawn.

Concerning the objects supported, it is advisable to previously convert splines (should they exist) into polylines to ensure they are correctly represented.

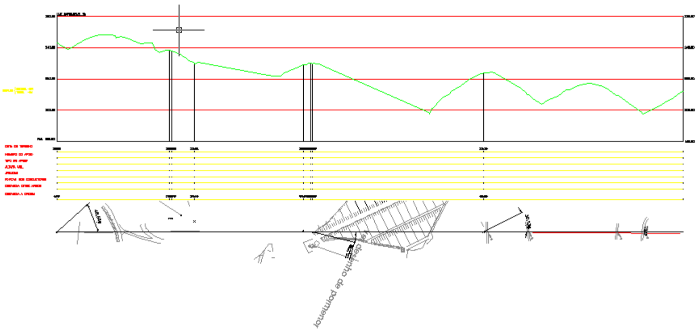
It has the following configuration parameters:



- **Draw:** If this box is activated, the mapping will be represented in the lower part of the profile.
- **Regression Strip**: Strip to the left and to the right of the area to be drawn, in meters.
- **Label Angles:** When this option is activated, the program indicates on the numerical data element the existing angle between each of the alignment sections selected.

If map drawing is selected, the program requests the alignment one wishes to project when the main screen for drawing longitudinal profiles is validated.

An example of the outcome of applying this drawing option is shown below.



Group Elements: If this control is activated, all the drawing objects can be grouped together as if they were an AutoCAD block in order make them easier to handle in the drawing. The drawing process may be considerably slower.

Profile length: This control will only be activated if the drawing is made on hard copy, in which case MDT will calculate the maximum length that can be drawn on each sheet depending on its format. The possibility exists of modifying this distance to adjust or give more margin to the representation.

Format

Paper Size: This check box is used to select the size of the paper. One can choose among the different formats contemplated for sheet distribution (defined in the `HOJAS.DAT` file). If one does not wish to split the drawing, the **Continuous** option (default value) should be selected.

The option exists of modifying the formats proposed regarding their names, size and contents. In order to do so, the blocks in the `BLOQUES\FORMATOS` folder of the program's root directory should be modified.

Concerning scale fields, it is necessary to take into account that the drawing's scale is determined by text size in AutoCAD, as the drawing is only generated in a scale of 1:1 and proportionally to the horizontal / vertical relation.

Horizontal Scale: This drop-down list displays all the scales defined in the `ESCALAS.DAT` file in the MDT configuration directory. It is possible to complete the list with other usual values.

Vertical Scale: Same as the previous paragraph. The possibility of defining a vertical scale on the cross-section drawings has been thought up to make it possible to observe height differences in very long profiles having very small height differences without having the need to continuously enlarge the drawing on screen.

If a sheet format is selected by the scale command, the number of sheets needed for the longitudinal profile drawing can be viewed.

Vertex to Represent

When a longitudinal profile is represented, a series of vertices are represented. In this section one selects the vertices to be represented and the interval with which they are to be represented. Different options exist, which are described below.

None: No cut is represented on the profile's horizontal alignment. Only the longitudinal profile will appear with the numerical data lines, without any text lettering.

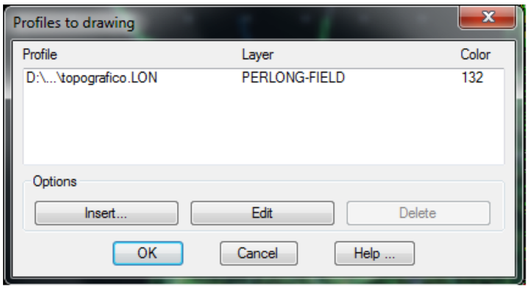
All: Represents all the cuts in the longitudinal profile.

Interval: Represents the longitudinal cuts at constant intervals.

Codes : Only represents those cuts where the codes selected are present. These codes are configured by activating the **Select** button.

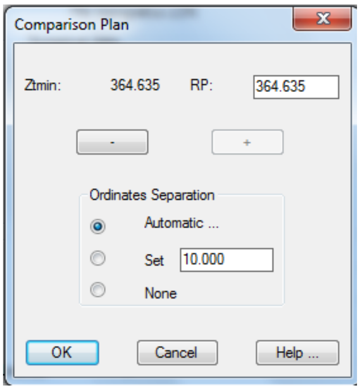
Terrain

It is possible to draw several longitudinal profiles at the same time on a same comparison plan with this option. In order to do so, the longitudinal profile initially selected will appear by default. Then one can insert as many longitudinal profiles as one wishes to add to the representation. The window shown below is then displayed when this command is activated:



Ordinates

This option controls the representation of both the comparison plan and separation in ordinates. When this button is clicked, the following window is displayed, which is described below:



Comparison Plan: MDT proposes the comparison plan's height (it can be seen with the text **Ztmin**) by default. Its height can be changed by using the + or - buttons. The height increases or decreases when these buttons are clicked are directly related to the vertical scale selected on the numerical data.

Ordinate Separation: This control sets the separation of ordinates or, in other words, terrain height marks. Three different options exist:

Automatic: Depending on the drawing's scale, the program sets a suitable separation.

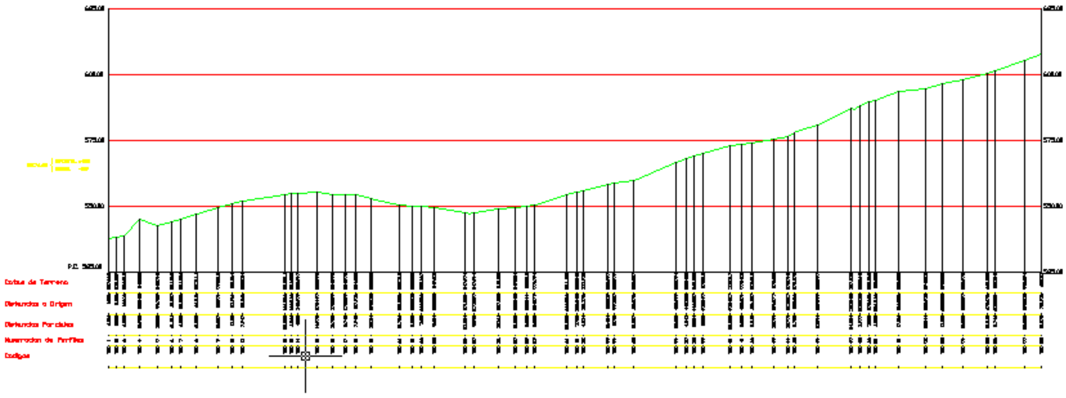
Fixed: The interval with which the terrain heights should be represented is set.

None: No information is displayed on terrain height ordinates.

Final Result

Once the dialog box has been validated, MDT requests a point on screen from which the longitudinal profile will be represented. This points can be selected with either the mouse or by entering data in the command line. The final result of a longitudinal drawing can be seen below.

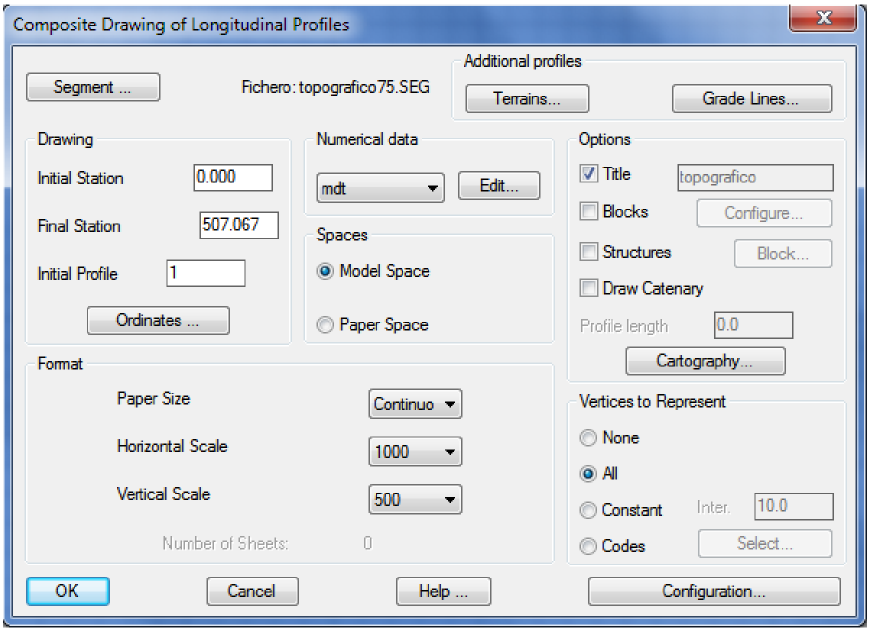
Furthermore, if we select "Automatic" as a drawing option the program will draw the profile in the first free area to the right of the current drawing.



Draw Compound Profile

Presents a segment on screen (see **Segments** commands), that is to say, the possibility of drawing a complete profile containing all the information on grade line, superelevations, longitudinal profiles, curvatures, etc. If one only wishes to draw the terrain, the **Profiles > Draw Simple Profile** command should be used.

Once the command has been executed, the following dialog box is displayed, whose characteristics are described below:



Drawing

Initial station : Initial station from which one wishes the drawing to be made. By default, it has the lowest station value of the profile selected.

Final station: Station up to which one wishes to draw the profile on screen. By default, it is the profile's maximum station.

Title: Once the profile is drawn, the title entered will appear on the top of the drawing.

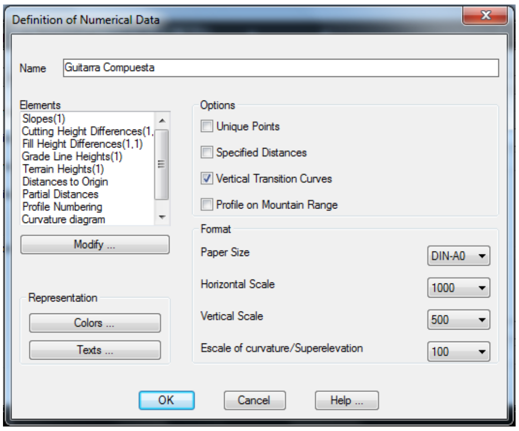
Initial profile: Represents the initial profile to be represented in the **Profile Numbering** element previously defined in the numerical data (see **Definition of Numerical Data**).

Numerical Data

We select the numerical data associated with the profile that is to be represented; the dropdown menu offers the different numerical data defined by the user:

Edit: To edit the active numerical data with the possibility to make any modifications.

Next we can see the dialogue box that appears when editing the numerical data. Its function and characteristics are described in the **Definition of Numerical data** section.



Spaces

If **Space Model** is selected, the profile drawing will be drawn normally, that is to day from the initial point selected on screen.

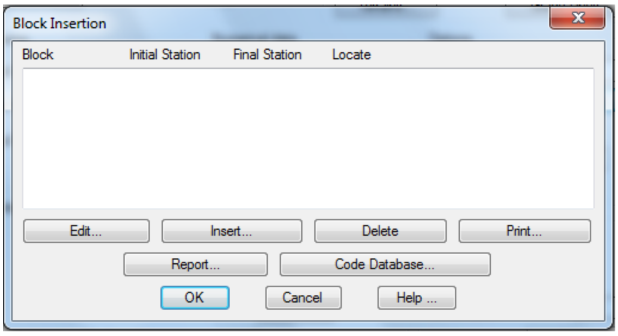
Should **Paper Space** be selected, it will be drawn using the paper space presentations available in AutoCAD. This option is not available in some CAD engines.

Options

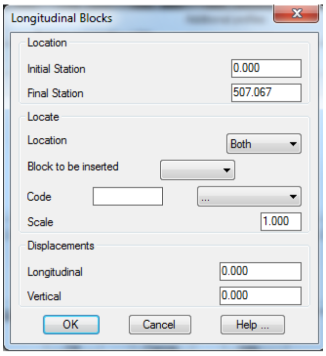
Title: Once the profile is drawn, the title entered will appear on the top of the drawing.

Blocks : This option allows one to select the blocks one wishes to draw on the longitudinal profile. At the same time, the **Blocks** numerical data element should be defined in the numerical data definition to be used

If the **Configure** button is clicked, the following window is displayed where the insertion point of each of the blocks one wishes to insert along with the longitudinal profile should be specified.



The following dialog box is displayed to insert or modify blocks for the longitudinal profile drawing.



Everything concerning the definition and management of blocks is explained in greater detail in the **Blocks Definition** section.

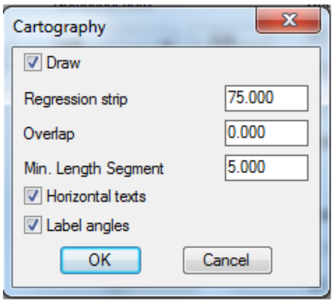
Blocks: This option only serves a purpose in the event a series of structures has been assigned to the template type. As such, if we activate this option a block will be drawn in the initial and final station of each structure. The block to be inserted may be selected.

***Cartography*:** This option allows one to view the sections of mapping adjacent to the alignment selected as numerical data elements.

In order to do so, only those layers corresponding to the objects one wishes to project should be active when the profile is drawn.

Concerning the objects supported, it is advisable to previously convert splines (should they exist) into polylines to ensure they are correctly represented.

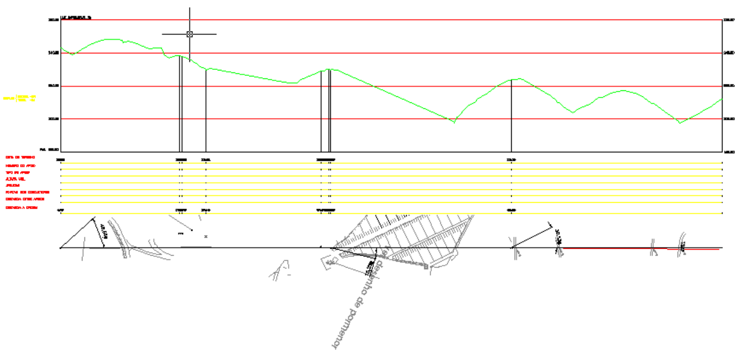
It has the following configuration parameters:



- **Draw:** If this box is activated, the mapping will be represented in the lower part of the profile.
- **Regression Strip**: Strip to the left and to the right of the area to be drawn, in meters.
- **Label Angles:** When this option is activated, the program indicates on the numerical data element the existing angle between each of the alignment sections selected..

If map drawing is selected, the program requests the alignment one wishes to project when the main screen for drawing longitudinal profiles is validated.

An example of the outcome of applying this drawing option is shown below.



Structures: Activating this option will provide us with the possibility of drawing a block in the stations featuring an initial or final structure. Consult the template type section for information on the definition of structures.

Draw Catenary: Activating this box will draw the power cables associated with the longitudinal profile. The numerical data on the "electricity lines" will be configured by default. On validating the dialog box the command will ask the user for the file containing the information on the power lines.

Profile length: This control will only be activated if the drawing is made on hard copy, in which case MDT will calculate the maximum length that can be drawn on each sheet depending on its format. The possibility exists of modifying this distance to adjust or give more margin to the representation.

Format

Paper Size: This check box is used to select the size of the paper. One can choose among the different formats contemplated for sheet distribution (defined in the `ESCALAS.DAT` file). If one does not wish to split the drawing, the **Continuous** option (default value) should be selected.

The option exists of modifying the formats proposed regarding their names, size and contents. In order to do so, the blocks in the `BLOQUES/FORMATOS` folder of the program's root directory should be modified.

Concerning scale fields, it is necessary to take into account that the drawing's scale is determined by text size in AutoCAD, as the drawing is only generated in a scale of 1:1 and proportionally to the horizontal / vertical relation.

Horizontal Scale: This drop-down list displays all the scales defined in the `ESCALAS.DAT` file in the MDT configuration directory. It is possible to complete the list with other usual values.

Vertical Scale: Same as the previous paragraph. The possibility of defining a vertical scale on the cross-section drawings has been thought up to make it possible to observe height differences in very long profiles having very small height differences without having the need to continuously enlarge the drawing on screen.

If a sheet format is selected by the scale command, the number of sheets needed for the longitudinal profile drawing can be viewed.

Vertices to be represented

When a longitudinal profile is represented, a series of vertices are represented. In this section one selects the vertices to be represented and the interval with which they are to be represented. Different options exist, which are described below.

None: No cut is represented on the profile's horizontal alignment. Only the longitudinal profile will appear with the numerical data lines, without any text lettering.

All: Represents all the cuts in the longitudinal profile.

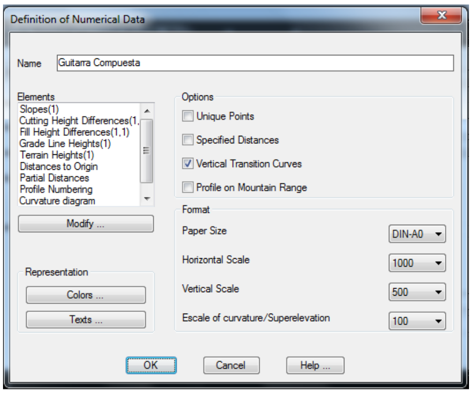
Interval: Represents the longitudinal cuts at constant intervals.

Codes : Only represents those cuts where the codes selected are present. These are selected by clicking on the **Select** button.

Numerical Data

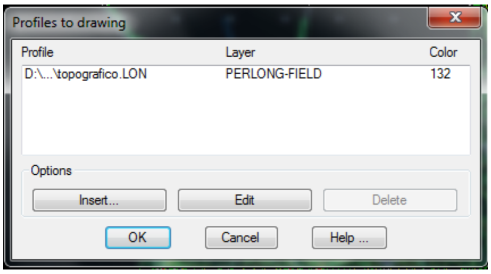
The type of numerical data to be represented on the longitudinal profile drawing is edited here. The SIMLE.GTR numerical data file is selected by default. To change the default numerical data file, one must access configuration (see **Customization Manual**).

The dialog box that is displayed when numerical data is edited can be seen below. Its characteristics and the way it works are described in the **Numerical Data Definition** section.



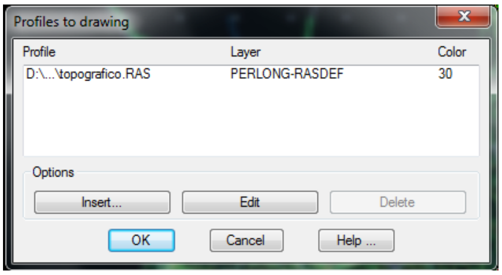
Terrain

It is possible to draw several longitudinal profiles at the same time on a same comparison plan with this option. If this button is selected, the longitudinal profile initially selected will appear by default. As many longitudinal profiles as one wishes to add to the representation can then be inserted. The window shown below is then displayed when this command is activated:



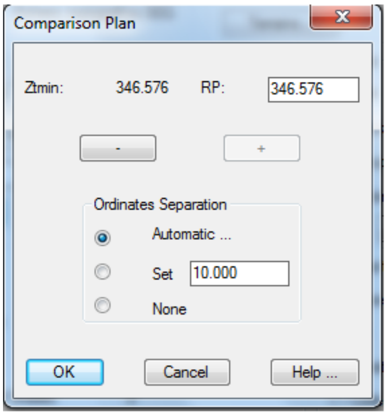
Grade Lines

Several grade lines can be drawn simultaneously on the same comparison plan using this option. If this button is clicked, the grade line initially selected will appear by default. As many grade lines as one wishes to add to the representation may then be inserted. The window shown below is then displayed when this command is activated:



Ordinates

This option controls the representation of both the comparison plan and separation in ordinates. When this button is clicked, the following window is displayed, which is described below:



Comparison Plan: MDT proposes the comparison plan's height (it can be seen with the text **Ztmin**) by default. Its height can be changed by using the + or - buttons. The height increases or decreases when these buttons are clicked are directly related to the vertical scale selected on the numerical data.

Ordinate Separation: This control sets the separation of ordinates or, in other words, terrain height marks. Three different options exist:

Automatic: Depending on the drawing's scale, the program sets a suitable separation.

Fixed: The interval with which the terrain heights should be represented is set.

None: No information is displayed on terrain height ordinates.

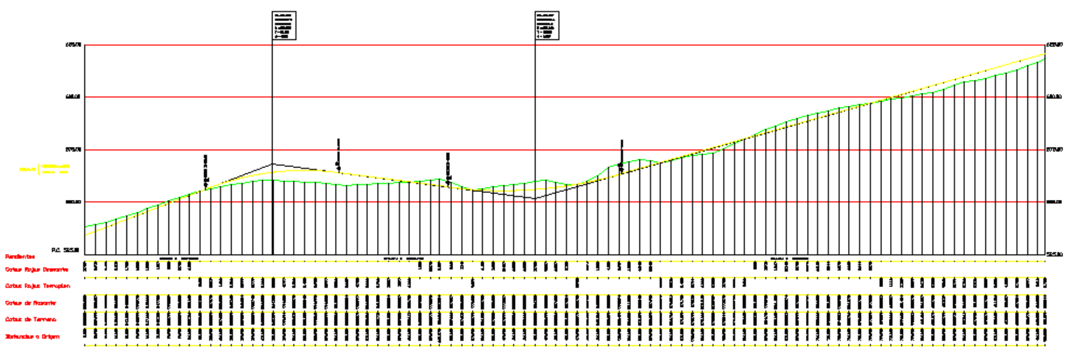
Settings

Clicking on this tab accesses the settings for the longitudinal profile, where, among other parameters, we can change the style of the presentation of the numerical data from among the different styles available. Consult the Customisation Manual for further details.

Final Result

Once the dialog box has been validated, MDT asks for a point on the screen from which the segment will be represented. These points can be selected with either the mouse or by entering data in the command line. The final result of a segment drawing can be seen below.

Furthermore, if we select "Automatic" as a drawing option the program will draw the profile in the first free area to the right of the current drawing.



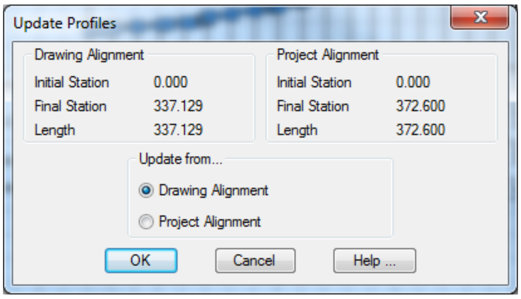
Update Profile

Using this command we can automatically update the drawing of a longitudinal profile prior to modification of the alignment or the surface from which it has been generated.

With this in mind, it is vital for there to be an active project in such a way that MDT is able to automatically detect the dependences between the profile drawn and the other project components.

Upon executing the command the program will request the longitudinal profile to be updated; once designated, if the program detects that any modification has been made either to the alignment or to the surface from which it was generated, the longitudinal profile will be generated and drawn automatically.

The circumstance may arise that the alignment or surface in the drawing has been modified and the corresponding file has not been modified or vice versa; in this case, the command will show a window in which the user must select from which information it wishes to automatically update the profile.



Drawing Alignment: We establish the alignment from which the longitudinal profile will be regenerated.

Project Alignment: In the event that modifications have been made to the surface from which the profile was originally generated, in this section we will be able to designate from which of them we wish to update its information.

Delete Profile

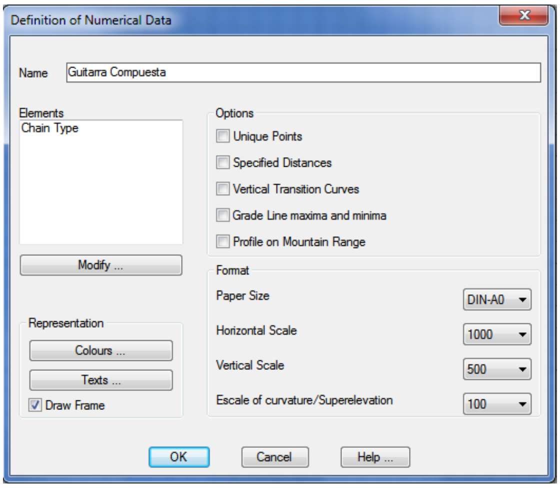
This command will allow us to delete a drawn longitudinal profile simply be selecting the polyline corresponding to the longitudinal terrain.

The terrain will be deleted automatically and all the elements associated with the drawing thereof, in other words, elements of guitars, elevations, ordinated, gradient (s) ….

This command will not be available for the profile drawing in ***paper space***.

Numerical Data Definition

Users may interactively define the composition of any numerical data file by executing this command The numerical data for both longitudinal profiles and cross-sections are defined by this command. Once **Profiles > Definition of Numerical Data** is accessed, the following dialog box is displayed:



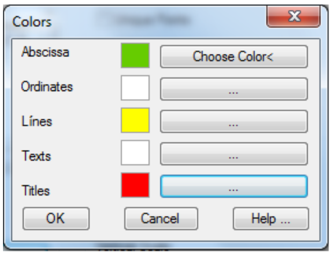
This window's characteristics are described below:

Representation

The different sizes for letters, spaces and colours of each of the elements of the numerical data that will be drawn next to the longitudinal are personalized.

Colours

When we this button is clicked, a dialog box is displayed to configure the colours of the different objects drawn on the numerical data. An example of the window is shown below and its characteristics are described.



Abscissa: Establishes the colour of the different horizontal lines that define the profile Drawing.

Coordinates: Establishes the colour of the system of coordinates on which the profile is drawn.

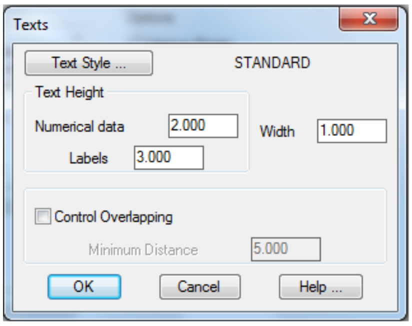
Numerical data lines: Establishes the colour of the different lines that comprise the numerical data.

Texts: Establishes the colour of the texts marked in each of the numerical data elements.

Titles: Establishes the colour of the titles of each of the elements of the numerical data.

Texts

When this button is activated, the characteristics with which the numerical data texts are to be drawn can be configured. The dialog box and a description of its characteristics appear below.



Text Style: Allows one to select the text style for the numerical data texts. MDT will display a list of the styles available in AutoCAD.

Numerical Data Text Height: Sets the numerical data element texts' heights.

Text Height Labels: This value represents the height of the labels associated with each of the numerical data elements.

Control Overlapping: If this box is marked, the overlap of any texts labelled will be controlled. Depending on the **Minimum Distance** entered, MDT will not draw any text at less than the specified distance from the previous text.

Options

Unique Points: If this control is activated, unique horizontal alignment points will be labelled when the longitudinal profile or segment are represented.

Specified Distances: When this control is activated, the distances specified that are generated when the longitudinal profile is obtained will be labelled on the profile drawing (see **Obtain Longitudinal Profile** command).

Vertical Transition Curves: Represents the distances corresponding to the vertical transition curves – grade line entry tangents and exit tangents– to be represented.

Grade Line maxima and minima: If we activate this box, the data corresponding to the stations featuring a maximum or minimum height on the vertical alignment curves will be labeled in the profile.

Saw Profile: If this option is activated, the profile may be drawn on any format, irrespective of the vertical scale selected. When the profile does not fit vertically on to the sheet, the comparison plan will automatically change and start drawing again from the bottom.

Format

Paper Size: This check box is used to select the size of the paper. One can choose among the different formats contemplated for sheet distribution (defined in the `ESCALAS.DAT` file). If one does not wish to split the drawing, the **Continuous** option (default value) should be selected.

The option exists of modifying the formats proposed regarding their names, size and contents. In order to do so, the blocks in the `BLOQUES\FORMATOS` folder of the program's root directory should be modified.

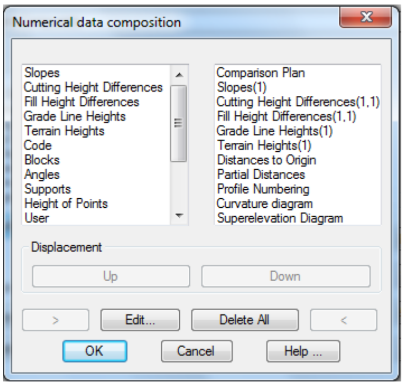
Concerning scale fields, it is necessary to take into account that the drawing's scale is determined by text size in AutoCAD, as the drawing is only generated in a scale of 1:1 and proportionally to the horizontal / vertical relation.

Horizontal Scale: This drop-down list displays all the scales defined in the `ESCALAS.DAT` file in the MDT configuration directory. It is possible to complete the list with other usual values.

Vertical Scale: Same as the previous paragraph. The possibility of defining a vertical scale on the cross-section drawings has been thought up to make it possible to observe height differences in very long profiles having very small height differences without having the need to continuously enlarge the drawing on screen.

Modify

When this button is clicked, the configuration of the different elements comprising the numerical data is activated. The dialog box and a description of its functions and characteristics appear below.



The dialog box consists of two lists. The one on the left displays the elements available and the one on the right displays the current status of the numerical data. The order latter is the order which will appear on the drawing. There are a series of controls on the bottom which help one to configure the numerical data.

Up: Any element selected on the list can be moved to higher position than its previous position.

Down : Any element selected on the left-hand list can be moved down from its previous position.

>: allows one to move an element selected on the right-hand list to the left-hand list.

<: allows one to delete an element from the left-hand or definitive list, so that it is not represented on the final drawing.

Delete All: All the elements from the left-hand list are deleted when this button is clicked, so that the numerical data will have no elements assigned to it.

Edit: Edits the characteristics of the element selected on the left-hand list.

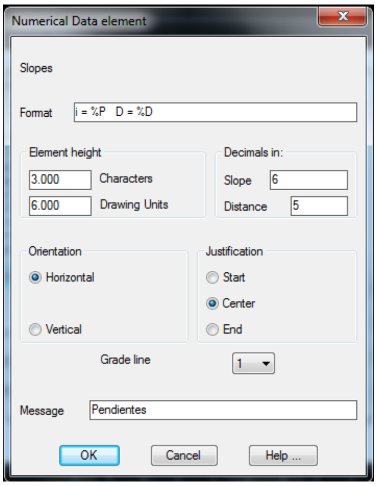
A description of the characteristics of each of the elements available for configuring the profile numerical data appears below.

Slopes

This numerical data element will only be drawn if the segment contains a defined grade line. It represents the slope and the length of each section of the grade line.

It is possible to display various numerical data elements on the type of Slope, with reference to each of the project’s vertical alignments.

The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Num. Decimals: Number of decimals with which the different slopes of the longitudinal are to be represented.

Orientation: Sets the texts' orientation. If **Horizontal** is selected, it will automatically be represented in a vertical manner should there not be enough space due to the text's length.

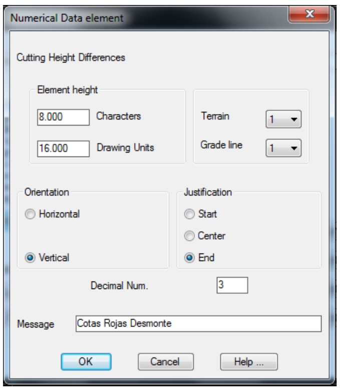
Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Terrain: The longitudinal profile to which the element refers should be selected. By default, 1 is equivalent to the profile contained in the segment. If any another number is selected, it will be related to the profile entered in the **Terrain** option.

Message: Text that will appear as the element's title on the numerical data drawing.

Cutting Height Differences

This numerical data element will only be drawn if the segment contains a defined grade line. It represents the grade line's negative height difference with regard to the longitudinal profile contained in the segment selected. The dialog box shown below is then displayed a description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element. This value can be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimal points with which the values representing cutting height differences will be represented

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

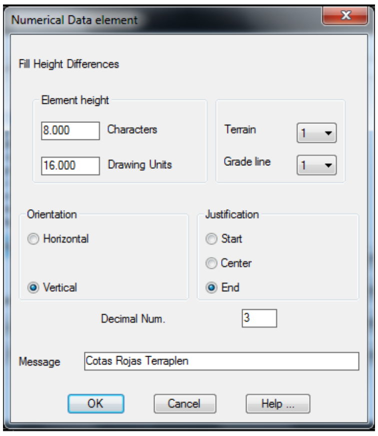
Grade Line: The grade line to which the element refers should be selected. By default, 1 is equivalent to the grade line contained in the segment. If another number is selected, it will be related to the grade line entered in the **Grade Lines** option.

Terrain: The longitudinal profile to which the element refers should be selected. By default, 1 is equivalent to the profile contained in the segment. If any another number is selected, it will be related to the profile entered in the **Terrain** option.

Message: Text that will appear as the element's title on the numerical data drawing.

Fill Height Differences

This numerical data element will only be drawn if the segment contains a defined grade line. It represents the height differences of the grade line's fill with regard to the longitudinal profile contained in the segment selected. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimals with which the values representing fill height differences will be represented.

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

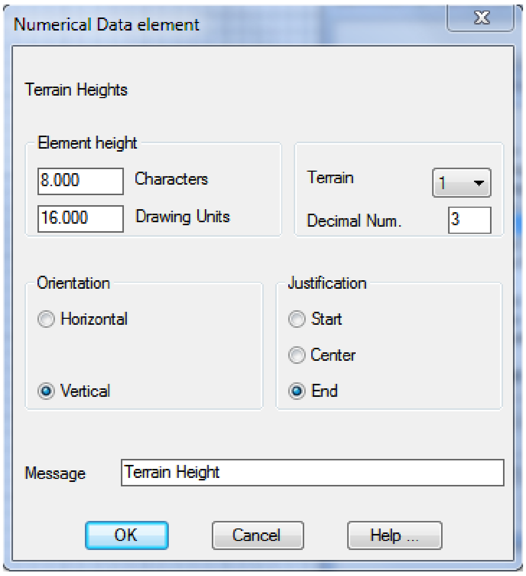
Grade Line: The grade line to which the element refers should be selected. By default, 1 is equivalent to the grade line contained in the segment. If another number is selected, it will be related to the grade line entered in the **Grade Lines** option.

Terrain: The longitudinal profile to which the element refers should be selected. By default, 1 is equivalent to the profile contained in the segment. If another number is selected, it will be related to the profile entered in the **Terrain** option.

Message: Text that will appear as the element's title on the numerical data drawing.

Terrain Heights

This numerical data element represents the terrain heights of the longitudinal profile contained in the segment selected. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimals with which the values representing terrain heights are to be represented.

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

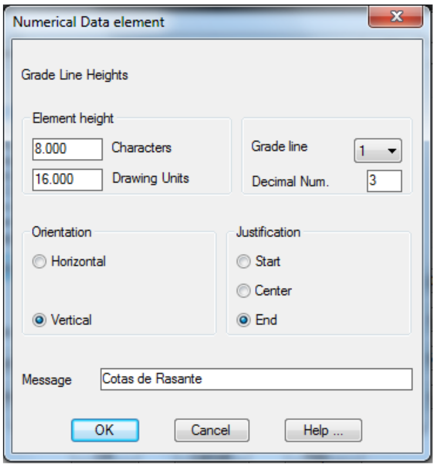
Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Terrain: The longitudinal profile to which the element refers should be selected. By default, 1 is equivalent to the profile contained in the segment. If another number is selected, it will be related to the profile entered in the **Terrain** option.

Message: Text that will appear as the element's title on the numerical data drawing.

Grade Line Heights

This numerical data element will only be drawn if the segment contains a defined grade line. It represents the grade line heights of the grade line contained in the segment selected. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimals with which the values representing grade line heights are to be represented.

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

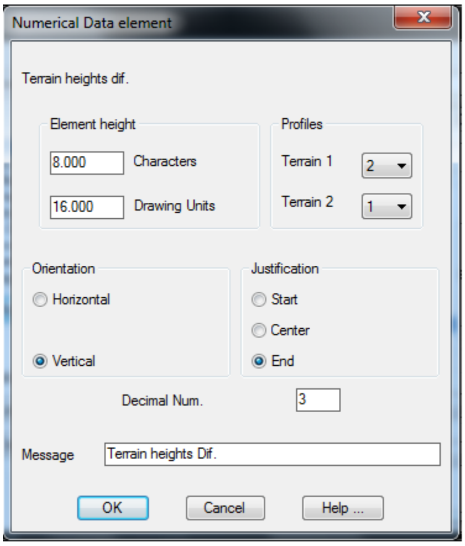
Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Grade Line: The grade line to which the element refers should be selected. By default, 1 is equivalent to the grade line contained in the segment. If another number is selected, it will be related to the grade line entered in the **Grade Lines** option.

Message: Text that will appear as the element's title on the numerical data drawing.

Terrain Heights Difference

This element is of enormous use for comparing the heights between two simultaneously-drawn terrains. Immediately afterward the dialog box is displayed and the characteristics are given.



Element height: Represents the immediately preceding numerical data's distance to the element. This value can be expressed in two different ways:

- In number of characters.
- In Drawing Units.

When validating either of these, the other value will automatically recalculate.

Decimal num.: Number of decimals that will be displayed in the values representing the cut/fill.

Direction: Establishes the text direction. There are two possibilities - ***Horizontal*** and ***Vertical***.

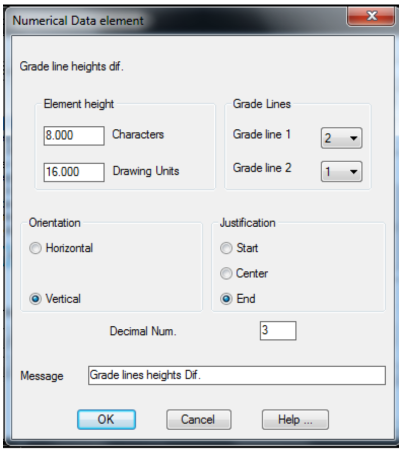
Justification: Establishes the text position in respect to the point of insertion. There are three possibilities: ***Start***, ***Centre*** and ***End***.

Terrain 1/ 2: We select the terrains between which a height comparison will be made. Previously, in the Draw Longitudinal window, in the option ***Terrain,*** the profiles we wish to compare should have been included. The order in which the profiles have been selected is the order in which they appear in the dropdown menu.

Message*:* Text that will appear as the element's title on the numerical data drawing.

Grade Line Heights Difference

This is the same as the previous numerical data element but in this case with the grade lines. This element will only be available in the option **Draw compound profile**. The dialog box is displayed below with a description of its characteristics.



Element height: Represents the immediately preceding numerical data's distance to the element. This value can be expressed in two different ways:

- In number of characters.
- In Drawing Units.

When validating either of these, the other value will automatically recalculate.

Decimal num.: Number of decimals that will be displayed in the values representing the cut/fill.

Orientation: Sets the text direction. There are two possibilities - ***Horizontal*** and ***Vertical***.

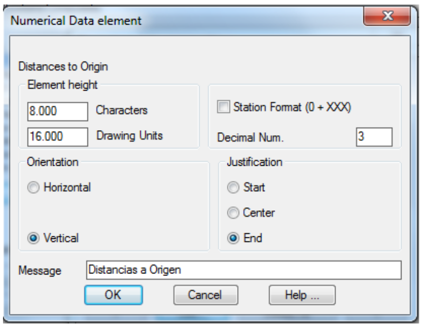
Justification: Sets the text position in respect to the point of insertion. There are three possibilities: ***Start***, ***Centre*** and ***End***.

Grade line 1/ 2: We select the terrains between which a height comparison will be made. Previously, in the Grade line option, the grade lines we wish to compare should have been included. The order in which the profiles have been selected is the order in which they appear in the dropdown menu.

Message: Text that will appear as the element's title on the numerical data drawing.

Distances to Origin

This numerical data element represents the distances to the initial station of the longitudinal profile to be represented. The dialog box shown below is then displayed A description of its characteristics follows.



Station Format (0+XXX): If this option is enabled, one can represent the station in 0+xxx format.

Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of decimals: Number of decimals with which distances to origin are to be represented.

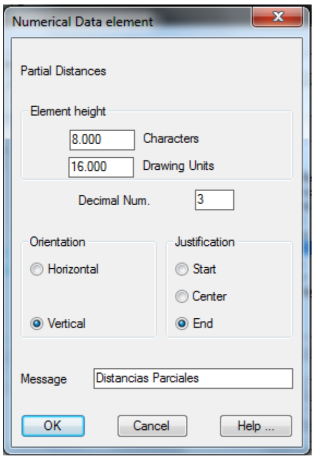
Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Message: Text that will appear as the element's title on the numerical data drawing.

Partial Distances

This numerical data element represents the partial distances from the longitudinal profile included in the previously selected segment. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimals with which distances to origin are to be represented.

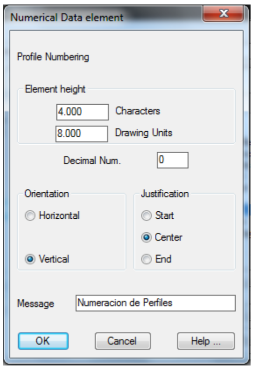
Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Message: Text that will appear as the element's title on the numerical data drawing.

Profile Numbering

This numerical data element numbers each of the cuts that MDT represents on the profile drawing. The number of the initial cut in the case of longitudinal profiles is set in the main dialog box. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimals to be represented. It should always be zero.

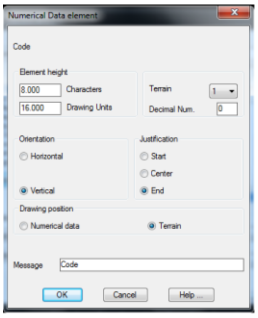
Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Message: Text that will appear as the element's title on the numerical data drawing.

Codes

This numerical data element labels the codes of the longitudinal profile corresponding to the cut on which it is to be found. If a cut is represented that does not exist on the longitudinal profile (representation by intervals, for instance), MDT will assign the immediately preceding code. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Terrain: The longitudinal profile to which the element refers should be selected. By default, 1 is equivalent to the profile contained in the segment. If another number is selected, it will be related to the profile entered in the **Terrain** option.

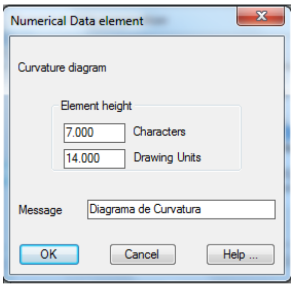
Decimals Num.: In the case that the code is a numerical value, the number of decimals displayed as applicable.

Drawing Position: This indicates whether the codes are to be labelled as another numerical data element or over the line of the profile drawn.

Message: Text that will appear as the element's title on the numerical data drawing.

Curvature Diagram

This numerical data element can only be represented if a segment has been selected. It calculates the curvature diagram of the horizontal alignment associated to the segment and then draws it. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

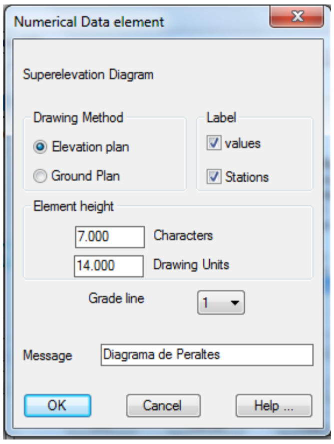
- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Message: Text that will appear as the element's title on the numerical data drawing.

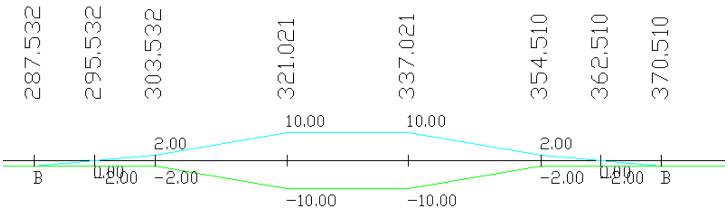
Superelevations Diagram

This numerical data element can only be represented if a segment has been selected. It calculates the superelevation diagram of the horizontal alignment associated to the segment and then draws it. The dialog box shown below is then displayed A description of its characteristics follows.



Drawing method: Represent the two ways MDT can use to draw the superelevations. An example of each of them follows.

Front View:



Top View:

Label: Indicates whether one wishes to label both the stations and the superelevation values. These controls are only valid should the superelevation be in the elevation drawing.

Element Height: Represents the distance to the immediately preceding numerical data element. This value can be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Message: Text that will appear as the element's title on the numerical data drawing.

Gradient Angles

This element will allow us to label the angle at an elevation view of each of the gradient vertices. It may be particularly useful for working with pipes.

MDT will draw a new numerical data element in such a way that at each of the vertices of the gradient, the corresponding vertex will be constrained in angular terms.

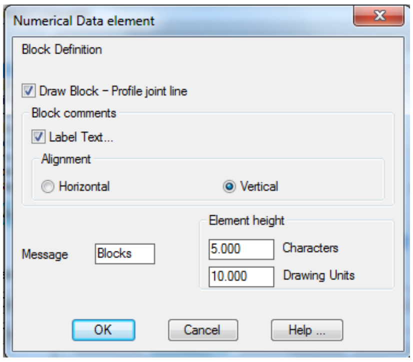
This numerical data element, as with previous ones, allows the customisation of the size of the text, separation of the guitar, number of decimals…

A screenshot has been shown below in which the delimitation of one of the gradient vertices can be seen.

Blocks

This numerical data element is used to insert drawing blocks along the profile. In order to do so, the insertion of blocks should have been configured in the main longitudinal drawing window. For further details on configuring the representation of these, see the **Alignment** > **Block Definition** command.

Depending on how the blocks are configured, they are either inserted as another numerical data element (**Numerical Data** mode) or on the profile drawn (**Terrain** mode). The dialog box shown below is then displayed A description of its characteristics follows.



Draw Block – Profile joint line: This option only makes sense in the case of drawing blocks over the terrain and will draw a line from the insertion point to the profile projection point.

Label Text: If we check this option, as well as drawing the block it will label the comment associated with the code corresponding to the code data base.

Alignment: Offers the choice of vertical or horizontal when labelling text.

Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

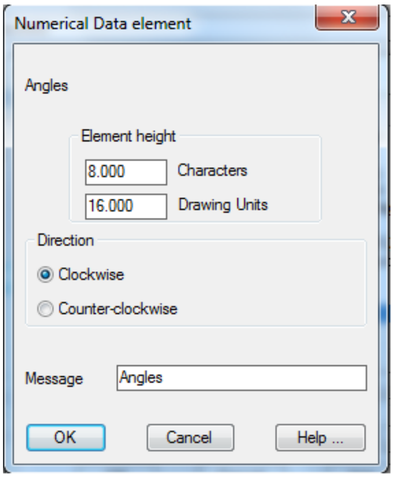
- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Message: Text that will appear as the element's title on the numerical data drawing.

Angles

This numerical data element represents the angles formed by each of the horizontal alignment's intermediate vertices. It is only valid when a segment is selected containing horizontal alignment information. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

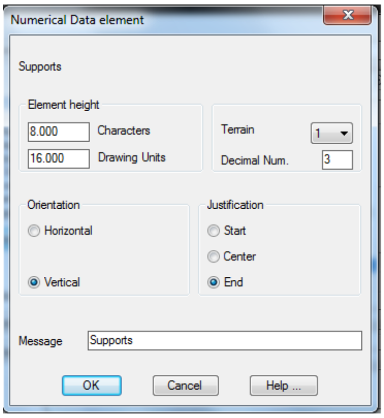
When either of them is validated, the other value is automatically recalculated.

Direction: It represents the direction in which the angle is to be taken.

Message: Text that will appear as the element's title on the numerical data drawing.

Supports

This numerical data element is aimed at representing power lines, although it can be used more generally. It represents the partial distance between two SUPPORT codes on the longitudinal profile to be represented. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Number of Decimals: Number of decimals with which the lengths of the partial distances between the supports are to be represented.

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

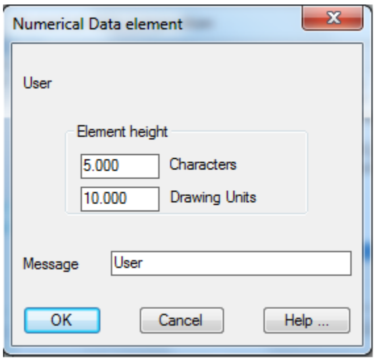
Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Terrain: The longitudinal profile to which the element refers should be selected. By default, 1 is equivalent to the profile contained in the segment. If another number is selected, it will be related to the profile entered in the **Terrain** option.

Message: Text that will appear as the element's title on the numerical data drawing.

Empty Element (User)

This numerical data element represents an single horizontal line without text of any kind. It is useful to manually complete the line after generating the drawing. The dialog box shown below is then displayed A description of its characteristics follows.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

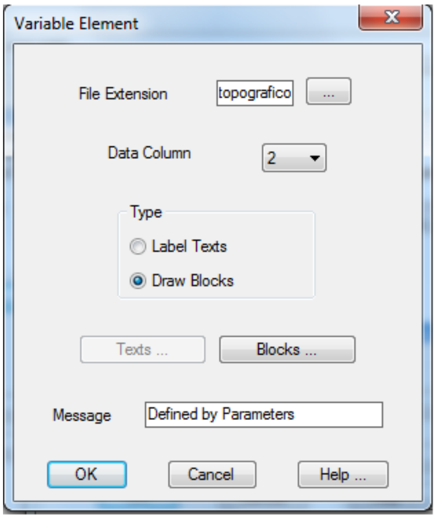
- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Message: Text that will appear as the element's title on the numerical data drawing.

Defined by Parameters

The aim of this element is to allow users to label a data series concerning a numerical data element whose data is not stored in the segment but in an external file. MDT reads a file containing columns. Stations to be used as a reference should be in first column. This column is then followed by a series of columns containing the information one wishes to label. The dialog box shown below is then displayed A description of its characteristics follows.



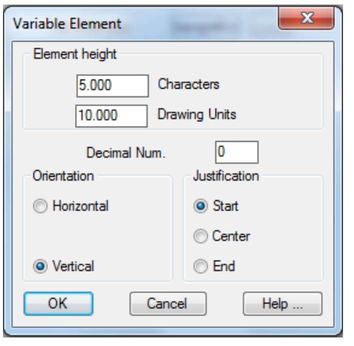
File Extension: Select the file to be used as a reference for the creation of this numerical data element.

Data Column: It is compulsory for the initial column to contain the stations used as a reference. In this command one selects the column in which the data one wishes to label is to be contained.

Type: Optionally, the possibility exists of either labelling the character chain of the column selected or drawing the block referred to by the character chain in the column selected. A different configuration for both cases. In the latter case, MDT searches for the block in the program's `BLOCKS` folder (see **Customization Manual)**.

Texts

When this button is activated, the following window appears, whose characteristics are described below.



Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

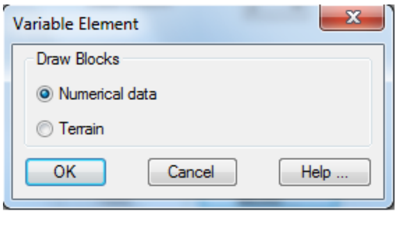
Number of Decimals: If there are numbers in the texts of the selected column, they will be represented with the specified decimals.

Orientation: Sets the texts' orientation. There are two possibilities, either **Horizontal** or **Vertical**.

Justification: Sets the position of the text in relation to the insertion point. There are three possibilities: **Start, Centre** and **End**.

Block

If the Blocks option is selected, the position in which one wishes to draw the blocks can be set. In other words: on a numerical data element (**Numerical Data**) or on the profile to be drawn (**Terrain**).

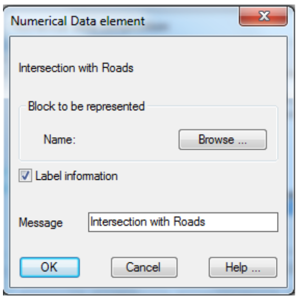


Road Intersection

This numerical data element allows one to view the intersection points of the segment drawn compared to the segments in the same folder or project.

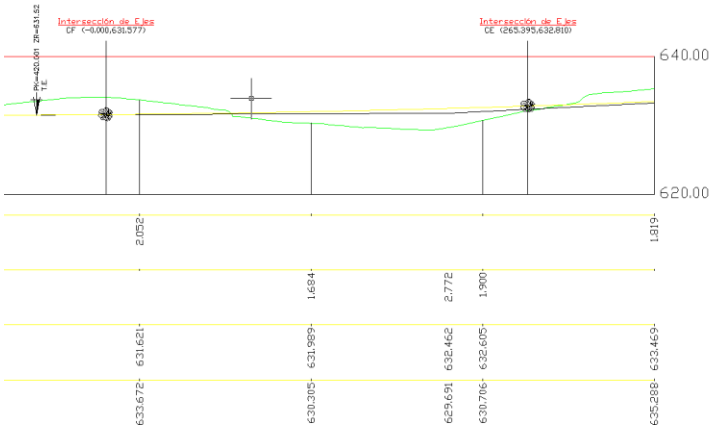
This option is only available for the **Draw Composite Profile** option.

The configuration options are as follows:



Block to be Represented Block that will be represented on the longitudinal profile drawing. It will be inserted at the height of the segment with which the intersection is produced.

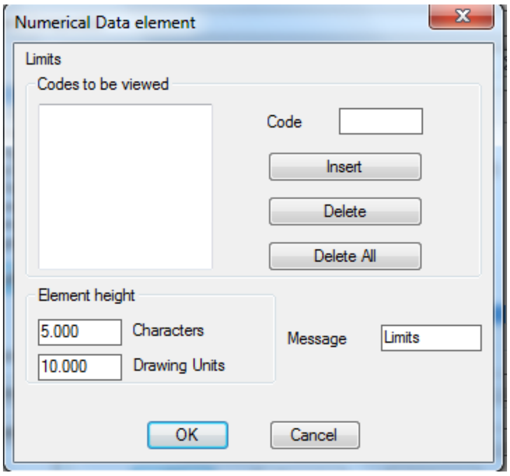
Label Information: Allows one to label information concerning the intersection with other segments. It shows the name, station and height of the intersection with another segment. A drawing where one can see how this information is labelled then displayed.



Limits

This numerical data element allows one to set limits and boundaries corresponding to the profile being drawn.

When it is edited, the following window is displayed, which is described below:



Codes to be Viewed: The longitudinal profile's codes that will set the limits or boundaries.

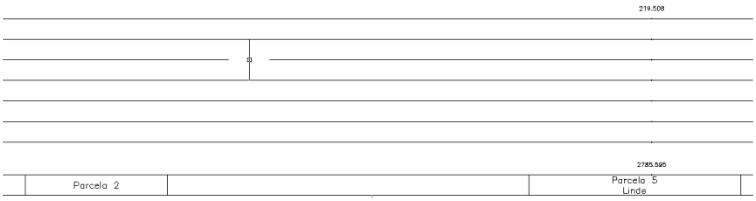
Element Height: Represents the distance to the immediately preceding numerical data element, expressed in number of characters. This value may be expressed in two different ways:

- In number of characters
- In drawing units

When either of them is validated, the other value is automatically recalculated.

Message: Attached text that appears in this numerical data element's definition.

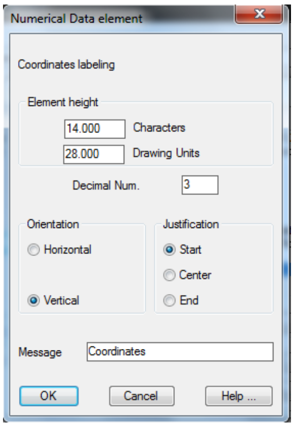
An example of the use of this element can be seen below:



Coordinates

This numerical data element is used to label the coordinates of each vertex represented in the profile.

Evidently this element can only be labelled in the case of selecting the segment as it has the horizontal alignment information for calculating the coordinates.



Element height: Represents the immediately preceding numerical data's distance to the element. This value can be expressed in two different ways:

- In number of characters.
- In Drawing Units.

When validating either of these, the other value will automatically recalculate.

Decimal Num.: Number of decimals of the values representing the partial distances between supports.

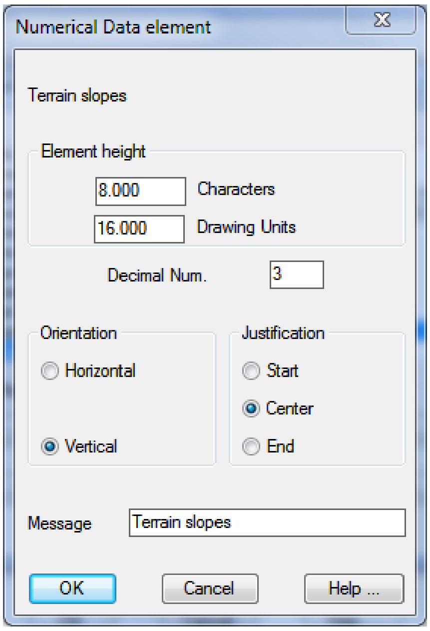
Orientation: Sets the text direction. There are two possibilities - ***Horizontal*** and ***Vertical***.

Justification: Sets the text position in respect to the point of insertion. There are three possibilities: ***Start***, ***Centre*** and ***End***.

Message: Text that will appear as the element's title on the numerical data drawing.

Terrain Slopes

This numerical data element will label the slope of each of the sections or vectors of the longitudinal profile.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

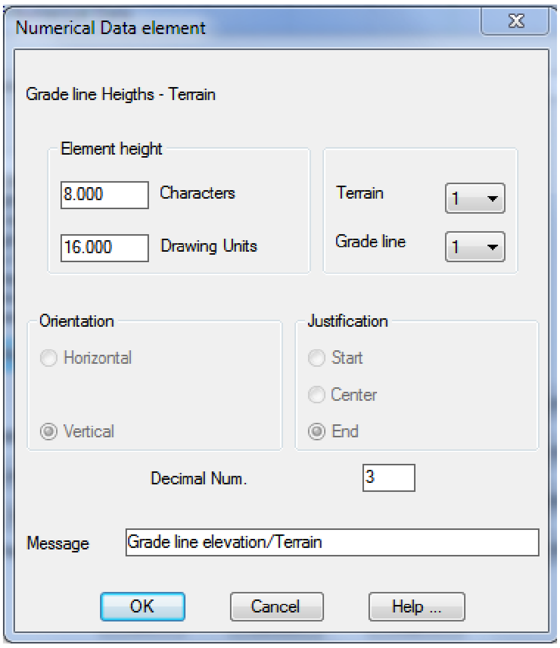
Num. Decimals: Any numbers in the text in the column selected will be represented with the decimals indicated.

Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.

Grade Line Heights / Terrain

This numerical data element will display the height of the terrain and the height of the vertical alignment for each of the dimensionings together.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

Num. Decimals: Any numbers in the text in the column selected will be represented with the decimals indicated.

Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.

Terrain: We select the terrain for which the heights are to be labeled.

Vertical alignment: We select the vertical alignment for which the heights are to be labeled.

Message: Text which appears as the title of the element in the numerical data drawing.

Mileage

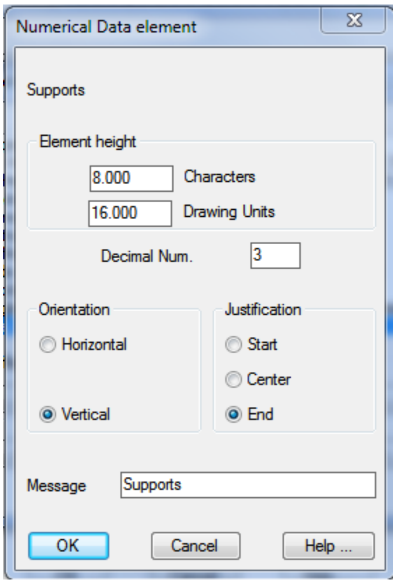
Shows the distance to the origin in accordance with the interval configured in the element itself.

Electricity Line Elements

Supports

This numerical data element shows us the names or labels of the power line supports to be drawn.

These will only be drawn in the event the "Draw Power Lines" option has been activated and the file corresponding to the power lines has been selected.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

Decimals: Any numbers in the text in the column selected will be represented with the decimals indicated.

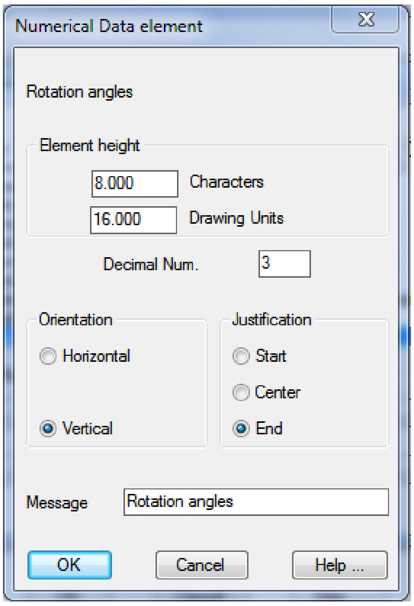
Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.

Rotation Angles

This numerical data element will label the rotation angle of each of the power line supports or poles.

These will only be drawn in the event the “Draw Power Lines” option has been activated and the file corresponding to the power lines has been selected.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

Num. Decimals: Any numbers in the text in the column selected will be represented with the decimals indicated.

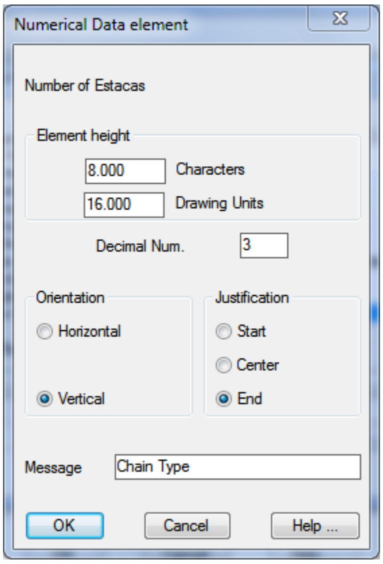
Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.

Chain Type

This numerical data element labels the chain type of each of the power line supports or posts. There are two types of chain: Moorage and Suspension.

These will only be drawn in the event the “Draw Power Lines” option has been activated and the file corresponding to the power lines has been selected.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

Num. Decimals: Any numbers in the text in the column selected will be represented with the decimals indicated.

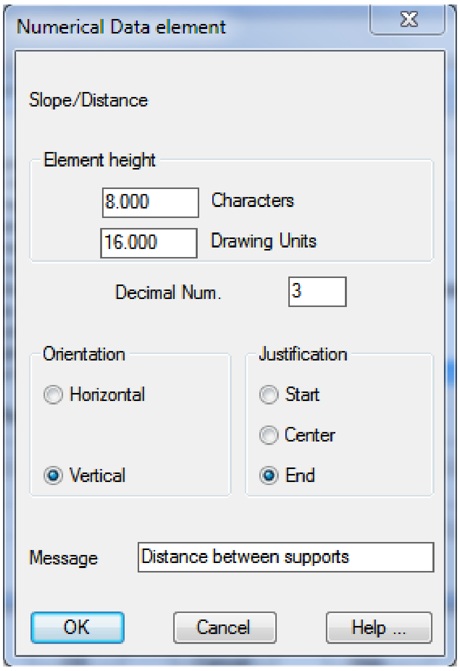
Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.

Distance between supports

This numerical data element labels the distance between each of the power line supports or poles.

These will only be drawn in the event the “Draw Power Lines” option has been activated and the file corresponding to the power lines has been selected.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

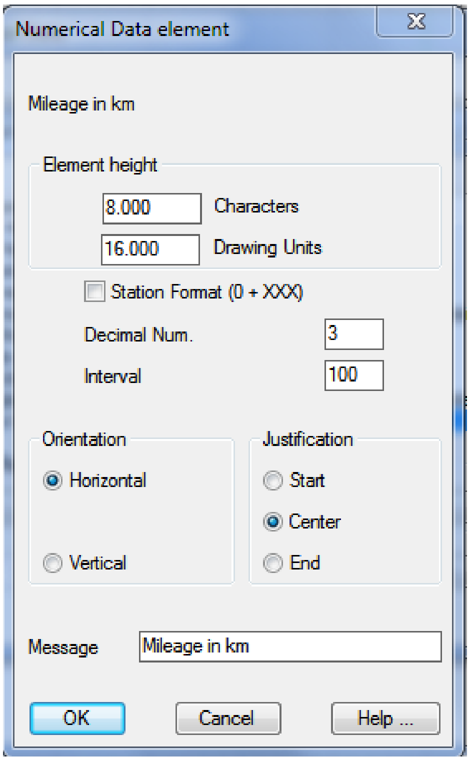
- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

Num. Decimals: Any numbers in the text in the column selected will be represented with the decimals indicated.

Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.



Element height: Represents the distance to the immediately previous numerical data element. This value may be expressed in two different formats:

- Expressed in number of characters.
- Expressed in drawing units.

On validating either of these formats, the other value will be recalculated automatically.

Num. Decimals: Number of decimals to be represented in the values representing the red ground fill heights.

Interval: Interval representing the marks of the distance to the origin in the numerical data.

Station format: Possibility of labeling the station with the extended format (contains the symbol +).

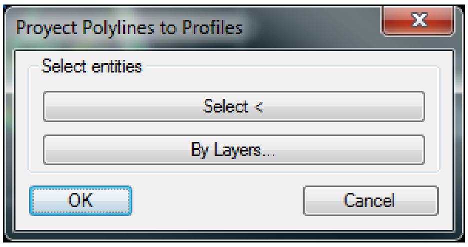
Orientation: Establishes the orientation of the texts. There are two possibilities, ***Horizontal*** or ***Vertical***.

Justification: Establishes the position of the text in relation to the point of insertion. There are three possibilities: ***Start***, ***Center*** and ***End***.

Project Polyline to Profile

This option will allow us to project a 3D polyline situated in our work with regard to a longitudinal profile obtained in the same work or model. With this in mind, the longitudinal must first be drawn on which it is wished to project the polyline.

Upon executing the command, the following window will appear to facilitate the selection of the polyline (s) to be projected.



Select: We will graphically select all the 3D polylines we wish to project.

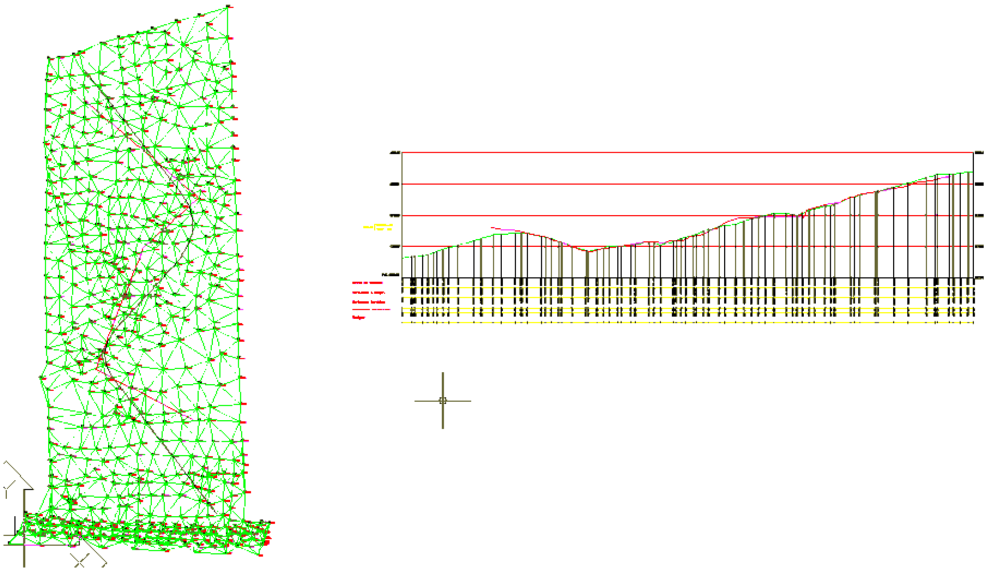
By Layers: We will select the layers on which the polylines to be projected are situated. In this case, it is important that the selected layer only contains the polylines to be projected and no other element.

The command will then request the following information:

Horizontal alignment: Horizontal alignment the longitudinal is generated from over which the 3D polylines will be projected.

Longitudinal Profile: Graphic selection of the longitudinal profile over which the designated polylines will be projected.

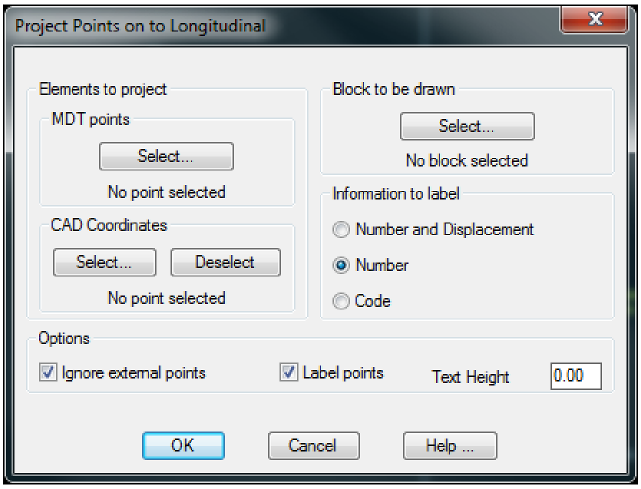
The following is an example of this command's use.



Project Points to Profile

This option allows us to project a set of points on a longitudinal profile obtained in the same work or model. In order to do so, it is necessary to have previously drawn the longitudinal profile on which one wishes to project the polyline.

When the command is executed, the program requests the horizontal alignment used to generate the longitudinal profile and then requests the profile. Once the two objects have been selected, the following dialog box is displayed.



Elements to project:

MDT points: The points that one wishes to project on the longitudinal profile are selected. For further details on the point selection command, see the Points section.

CAD coordinates: Graphic selection of the coordinates we wish to label on the drawing; these need not coincide with the MDT points:

Block to be Drawn: The block that one wishes to represent on the longitudinal profile is selected. By default, the program reads all the blocks in the program's `BLOCKS` folder.

Information to label: In addition to the block, there is the possibility of drawing the following information contiguously:

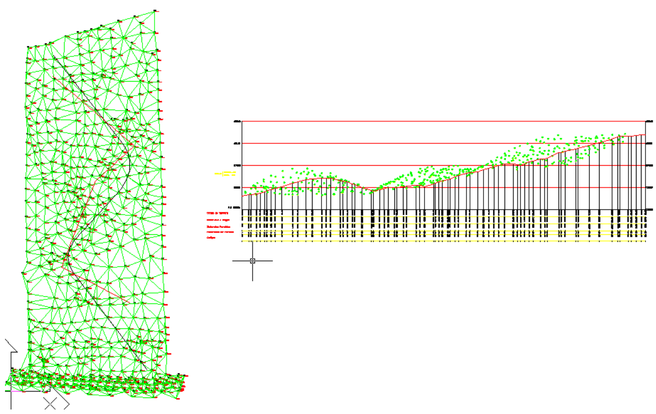
1. ***Number and Displacement***: Number of the point and displacement to the horizontal alignment.
2. ***Number***: Number of the point.
3. ***Code***: Code of the planned point.

Ignore External Points: If any of the points projected on the profile are not within it environment, they will not be drawn if this box is marked.

Label Points: Activating /deactivating this box indicates whether to label the MDT point information.

Text height: Height of the texts for the label information.

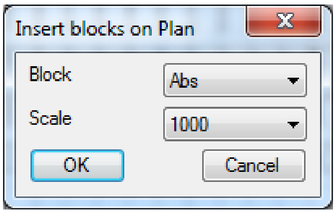
The command is run when the dialog box is validated. It inserts a block corresponding to the projection of each vertex of the 3D polyline on the profile. The following is an example of this:



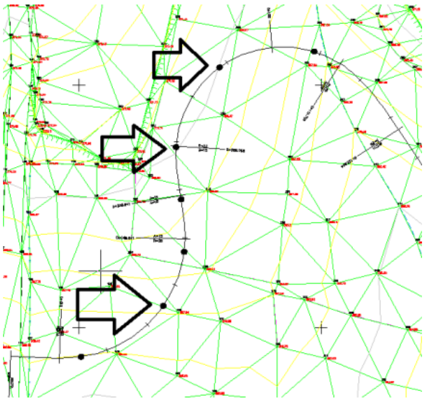
Project Points on Plan

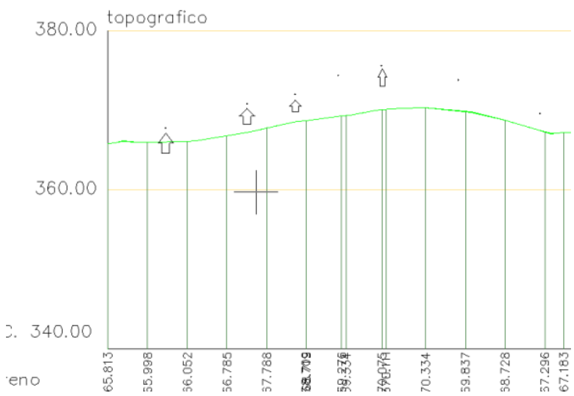
This command will enable us to ascertain the situation of given points with regard to the alignment on the ground plan of a series of designated points on the longitudinal profile. The purpose of this option is to have the possibility of marking on the mapping from which the longitudinal profile has been generated a series of designated points on the longitudinal profile drawn beforehand.

With this in mind, the command will initially ask us to designate the longitudinal profile drawn and the alignment from which it was generated. The following window will then appear in which we will select the block to be inserted as well as the drawing scale.

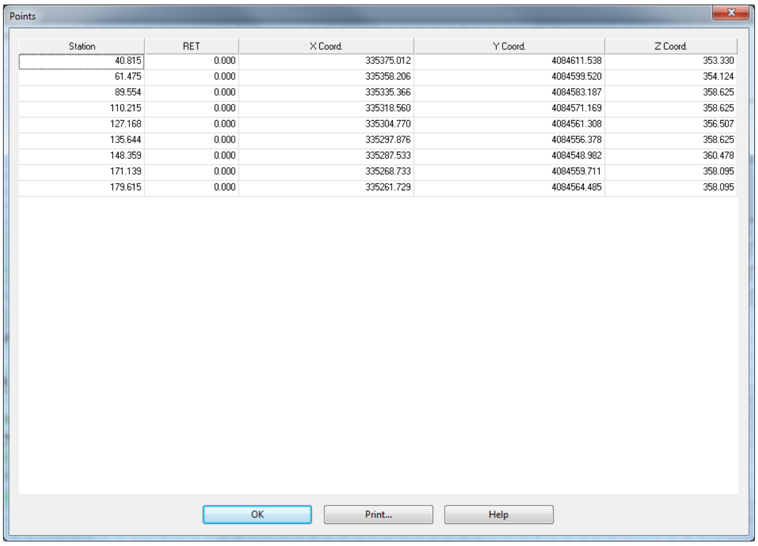


Once the window has been validated, we will designate the points on the profile and simultaneously the selected block will be drawn in its position in accordance with the designated alignment. In addition, a circle will be drawn on the profile at each of the designated points on it.





Once the points designation is complete, a list will appear with information from all the points calculated with the possibility of printing them.



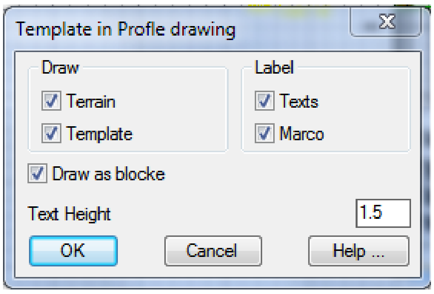
Station	RET	X Coord.	Y Coord.	Z Coord.
40.815	0.000	335375.012	4084611.538	353.330
61.475	0.000	335358.206	4084599.520	354.124
89.554	0.000	335335.366	4084583.187	358.625
110.215	0.000	335318.560	4084571.169	358.625
127.168	0.000	335304.770	4084561.308	356.507
135.644	0.000	335297.876	4084556.378	358.625
148.359	0.000	335287.533	4084548.982	360.478
171.139	0.000	335268.733	4084559.711	358.095
179.615	0.000	335261.729	4084564.485	358.095

Template in Profile Drawing

This command enables us to include in the previously drawn longitudinal the finished template in the stations designed graphically by the user. The profile or template of the station nearest to that selected on which information exists will be drawn.

To do so, we first need to draw the profile with the vertical alignment by executing the "***Draw Compound Profile***" command.

Once the profile has been drawn, we execute the command, firstly we will be asked to select the longitudinal profile and the following window will appear for the configuration of the elements to be drawn.



Draw Terrain: Activating this box will draw the natural terrain of the station selected.

Draw Template: Activating this box will draw the template of the station selected.

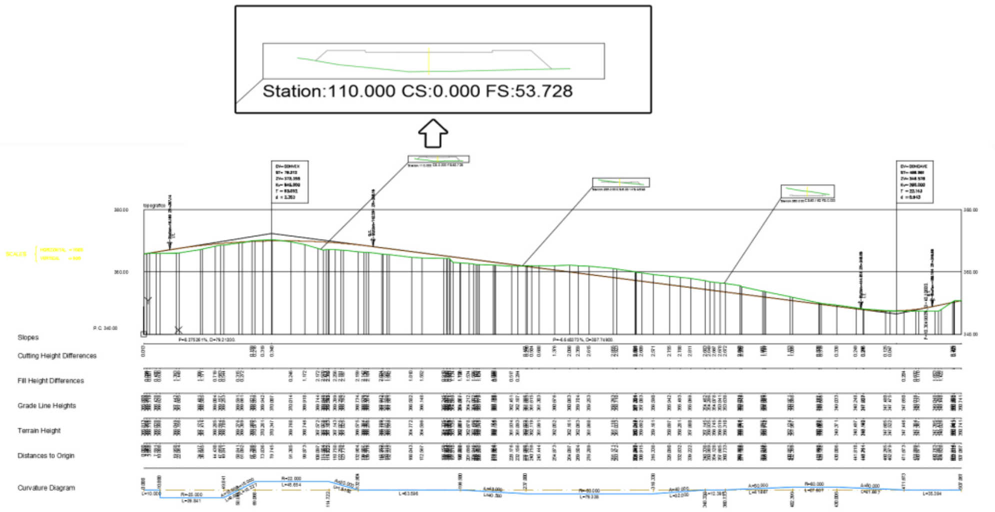
Label Texts: Will label the station and the surfaces of the station.

Framework: A framework will be created in the profile drawing.

Draw as block: Activating this box will insert the drawing as a block, which will facilitate changing the insertion point of the same.

Text height: The height of the texts when activating the Label Texts box.

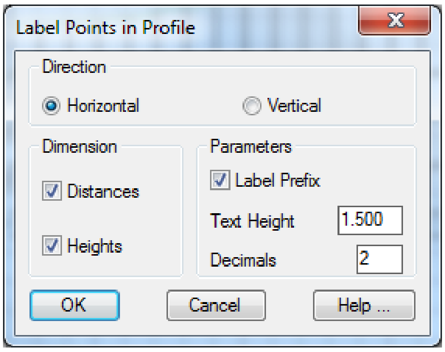
Once the dialogue has been validated, the command will ask us repeatedly for the vertices on the longitudinal on which we wish to calculate and draw the template type.



Draw Station and Elevation in Profile

Using this option we can label the station and the elevation of the designated point on the longitudinal profile drawn beforehand.

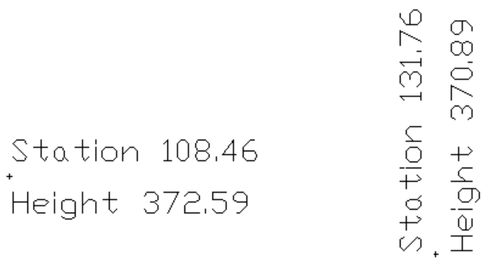
With this in mind, upon executing the command, the following window will appear which is described below.



Direction: This allows us to indicate whether we wish to label the aligned texts horizontally or vertically.

Dimension: We indicate whether we wish to label the station, the elevation or both.

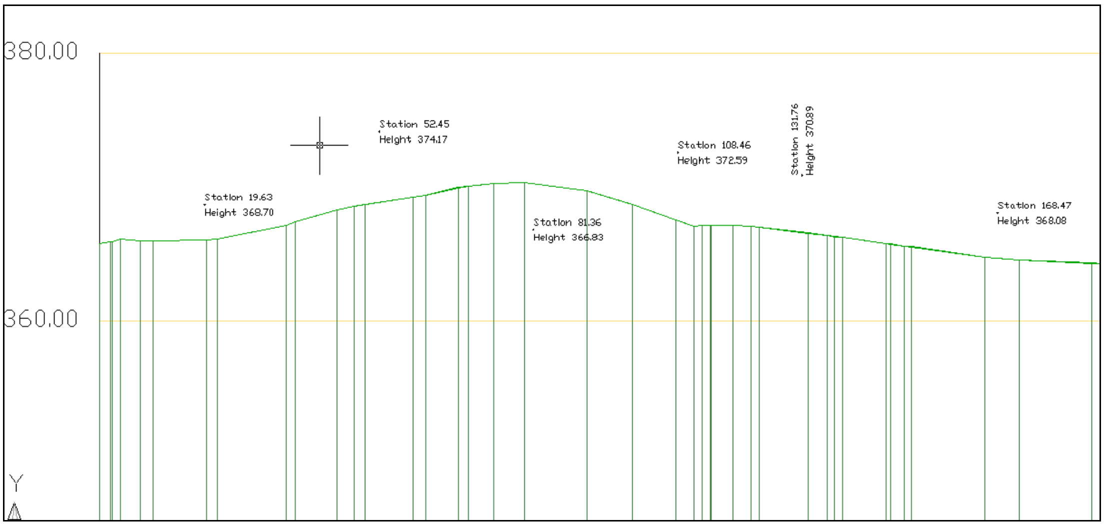
Label Prefix: If we enable this box, in the case of the station, the text "Station:" will be labelled before the numerical value. and in the case of the elevation the text "Elevation:".



Text Height: We set the height to the texts to be drawn.

Decimals: We establish the number of decimal points both for the station and for the height.

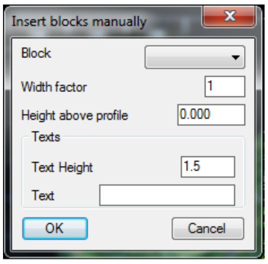
A screenshot can then be seen of a profile drawing showing the station and the elevation labelled at different points.



Insert Blocks

This command allows one to insert the block selected on a previously drawn longitudinal profile by selecting the insertion station and height.

When this option is activated, the following window is displayed, which is described below:



Block: Block to be inserted. The program reads these block in the blocks folder. So, if one wishes to insert one's own block, it should have previously been copied to that folder.

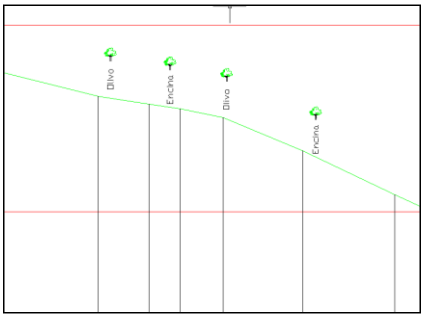
Width factor: Multiplication factor for insertion of the block width into the CAD drawing.

Height above Profile: The block will be inserted by default at the longitudinal profile's height at the station selected. Additionally, a height increment equivalent to the height selected will be applied to it.

Text Height: Optionally, the command allows one to label a text on the lower part of the block in a vertical position. This option enables one to configure its height.

Text: Text one wishes to label next to the block.

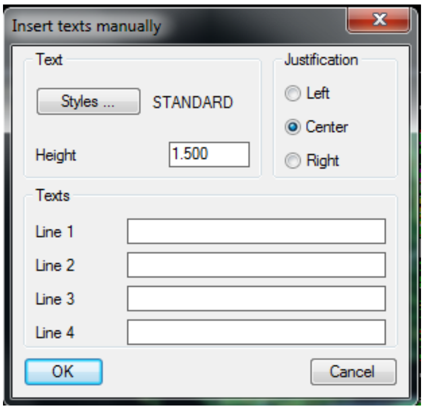
Once the dialog box is validated, the program firstly requests the longitudinal profile. It then requests the points at which one wishes to insert the block selected.



Insert Texts

This option allows one to insert multiple CAD texts rapidly and easily between two previously selected points. It is particularly useful for the insertion of points associated to the **Limits** numerical data element (see its description in the **Numerical Data** command).

When this command is activated, the following window is displayed, which is described below:



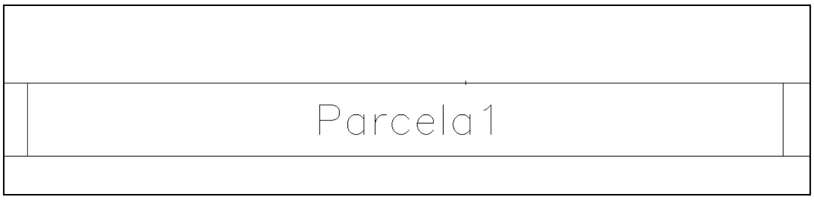
Text Style: The AutoCAD text style one wishes to assign to the texts to be inserted is selected.

Height: Text's height.

Justification: Justification of the texts to be inserted.

Texts: The texts one wishes to insert are written on each of these lines. A maximum of 4 lines can be inserted.

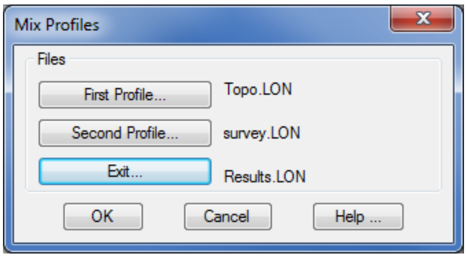
The result is as follows:



Merge Profiles

This command facilitates merging two longitudinal profiles for which the program requests, via the below window, the two profiles to merge and the profiles file where the resulting profile will be saved.

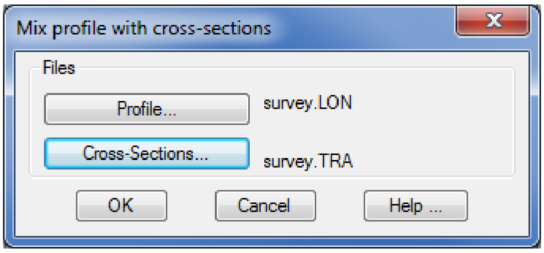
As a result the two files will be merged and ordered and saved in the selected output file.



Merge with Cross-sections

The purpose of this command is to create a longitudinal profile file with the extension `.LON` that has not been obtained from the Digital Terrain Model, with the cross-section profile horizontal alignment position corresponding to the same horizontal alignment or polyline, given that the interpolation of this point gives unequal or incomplete interpolation values.

With the following window select the longitudinal file and cross-section to merge.

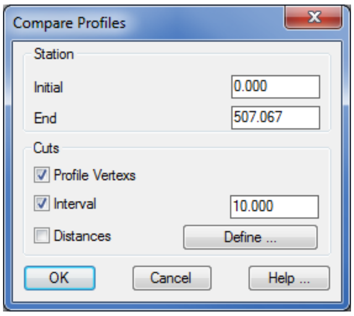


Last, the two files are merged, completing the horizontal alignment vertexes for each cross-section profile for the stations at which the height information is not defined, first modifying the selection then renaming the original with the extension `.BAK`.

Compare Profiles

This command generates a list with height comparisons of two previously-selected profiles.

Initially it asks for the two longitudinal profiles to compare then the below window appears:



Stations: The stations the user wishes to compare.

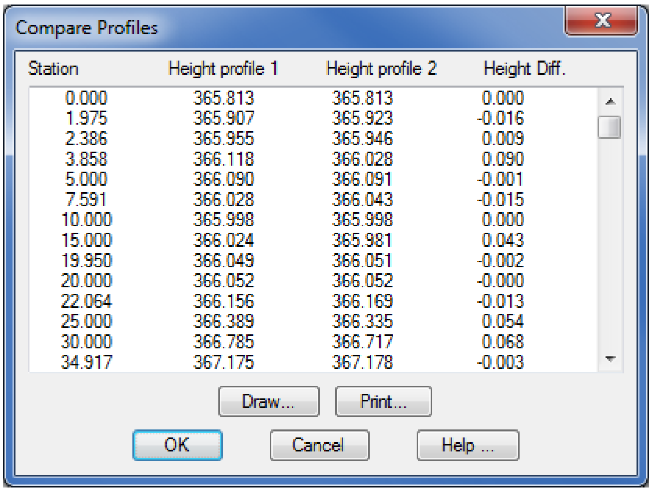
Cuts: Indicate the cuts to be represented in the list:

Profile Vertices: displays all the stations of each longitudinal.

Interval: Indicates the representation interval.

Distances: Manual selection to represent specific stations, they may be manually introduced or designated in the drawing on the horizontal alignment.

Once the window is validated, the following list will appear with the Station information and the heights of the two profiles.

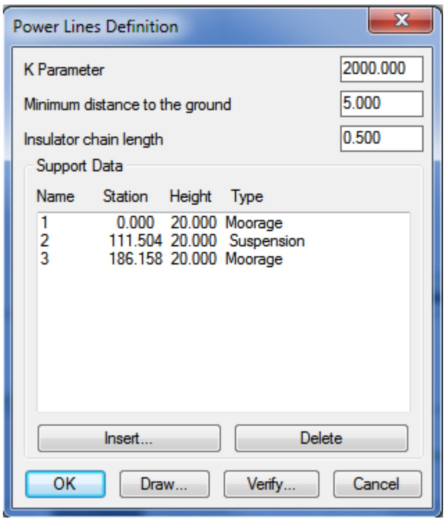


Draw: This button automatically draws the profiles, so that we may simultaneously draw the two profiles with the correctly-configured numerical data.

Power Lines Definition

This command enables us to both define and draw a power line. Once the different parameters have been inserted both the electricity poles and the power lines themselves are drawn automatically.

We first need to have drawn the longitudinal profile on which the power lines are to be drawn; we then execute this command and we will be asked for the drawn profile and the file in which the power line parameters are to be stored. The following window will then appear into which we insert the different parameters.



Parameter (K): The power lines parameter; the parabola of the same is defined in accordance with this data.

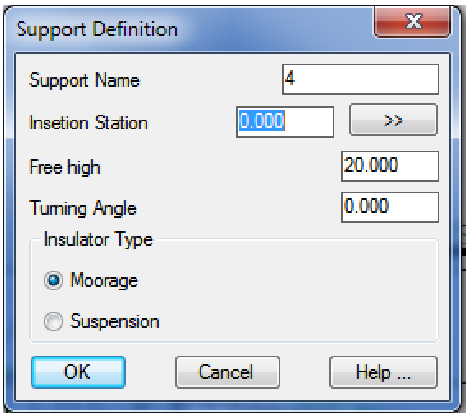
Minimum distance to the terrain: Indicates the minimum distance allowed between the nearest points between the ground and the power lines vertically.

Insulator chain length: We define the length of the insulator chain. This parameter currently has no influence on the calculation or the drawing, and will only appear in the corresponding list.

Verify: Clicking on this tab will cause the command to inform us if the power lines comply with the "*Minimum distance to the ground*" requirement.

Draw: The power lines will be drawn automatically whenever the "*Minimum distance to the ground*" requirement has been complied with.

Support data: This section enables us to define the different power line supports and posts. The "*Insert*" and "*Delete*" tabs will enable us to manage the definition of the same.



Support Name: Identification of the support.

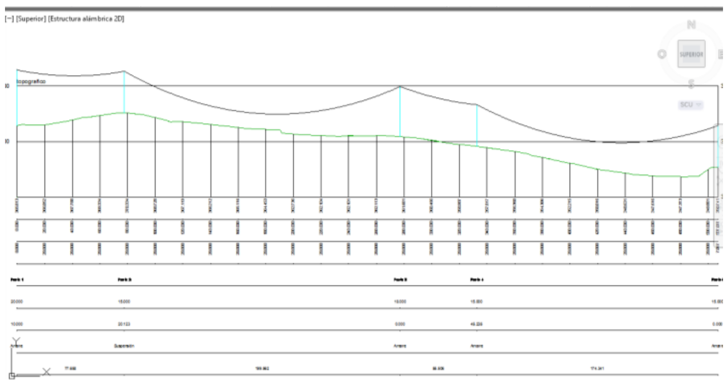
Insertion Station: Support insertion station.

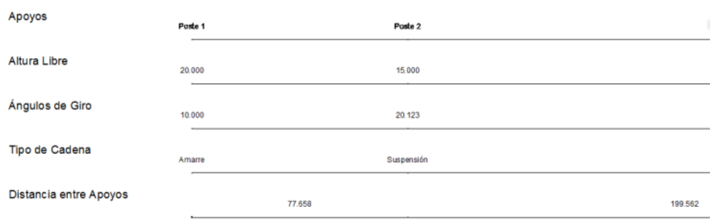
Free height: Support height.

Rotation angle: Support rotation angle.

Insulator type: Type of chain or coupling of the power line support, either of the Moorage or Suspension type.

Once the power line file has been defined with the "Draw Longitudinal Profile" commands from the longitudinal profile itself and the segment we will be able to draw the power lines and the associated numerical data elements.



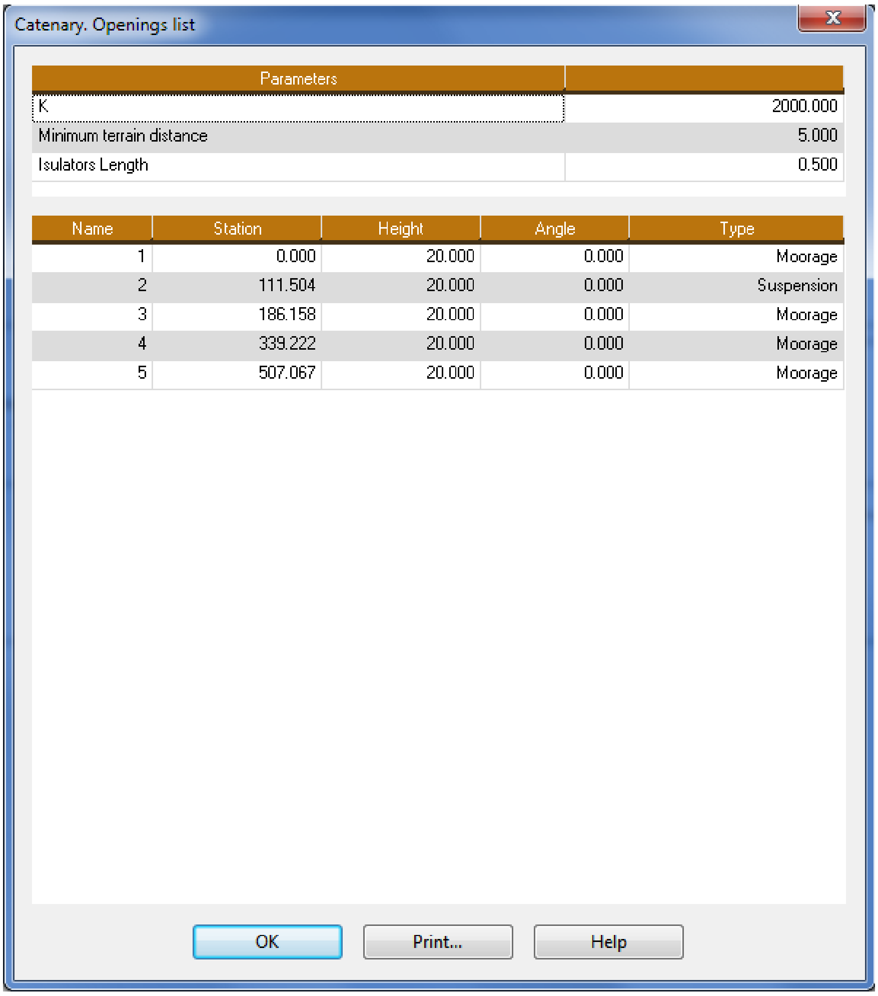


Delete Power Lines

This command enables us to delete all the entities associated with the power lines. It will request the longitudinal profile on which the power lines have been drawn.

List Power Lines

This command provides us with a detailed list of the power lines selected. The command will request the file containing the same.

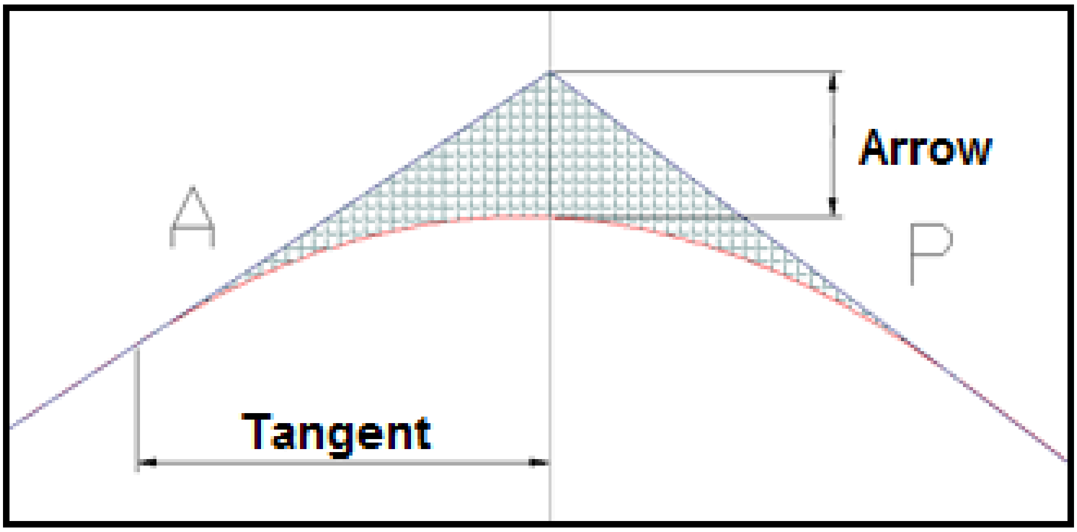


10. Grade Line

Introduction

Grade lines are vertical alignments comprising the final status of a longitudinal profile.

They involve certain distances to origin and their absolute heights, with the possibility of linking the vertices by means of parabolic or circular sections (vertical transition curves) which will be defined by any of their components: Kv (parameter of the parabola) or R (radius of the circle), Tangent (length in an orthogonal projection on each of the alignments involved) or Arrow (maximum ordinate at the vertex).



Parabolic or circular curves

MDT may work both with parabolic and circular type curves; with this in mind, at the time of defining the grade line, the program asks what type of grade line is going to be worked on.

The necessary formulation is then shown to calculate each of the parabola or circular parameters of each of the vertices.

Types of vertical curves

MDT works indistinctly with parabolic or circular curves. When defining the grade line the program ask for the type of vertical curves to be created.

The equations for the parabolic or circular curves are the following:

	KV / Radius	Tangent	Arrow
Parabolic	$\frac{2*tangent}{\theta}$	$\frac{4*\text{Arrow}}{\theta}$	$\frac{tangent*\theta}{4}$
Circular	$\frac{tangent}{\tan\beta}$	$\text{Radius}*\beta$	$\sqrt{kv^2+tangent^2}-\text{kv}$

where:

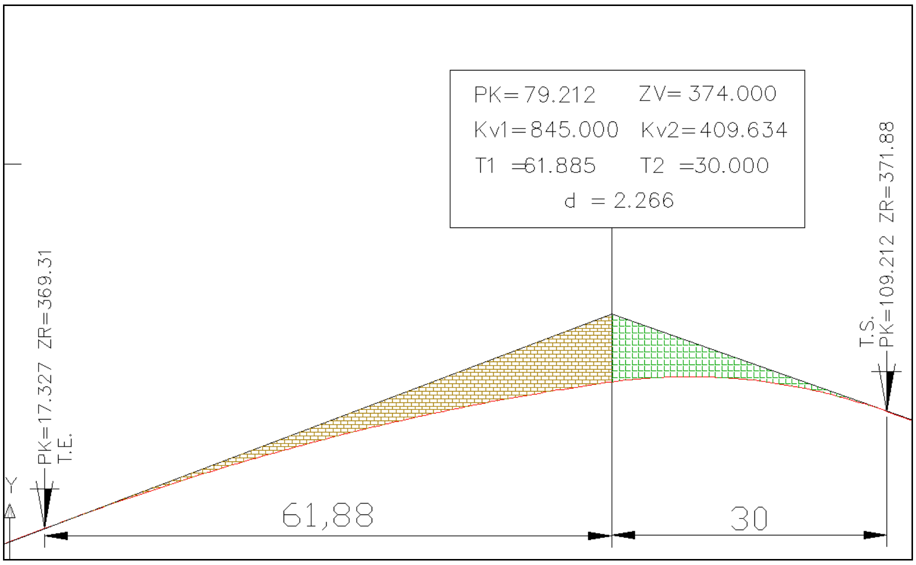
$$\theta = \text{Slope } P - \text{Slope } A$$

$$\beta = \frac{\text{atan}(\text{Slope } P) - \text{atan}(\text{Slope } A)}{2}$$

Symmetric and asymmetric vertices

Additionally, MDT can work with grade lines in which some of its vertices are asymmetric. In this type of vertical curve the input tangent is different to the output tangent, as shown in the next figure.

The image shows an example of an asymmetric curve with two different parabolas. The parameter of first one is 845 and the second one is 409.634.



In MDT it's possible to design a grade line in which symmetric and asymmetric vertical curves exist simultaneously.

Asymmetric vertices will be drawn with all information of vertical curve, including data about input tangent and output tangent.

Creation of a Grade Line

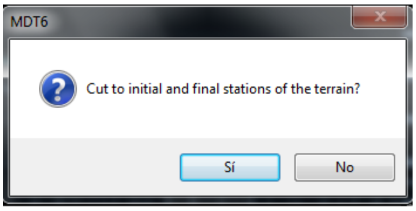
A grade line can be created by either converting it from a polyline or defining it using different methods.

Convert Grade Line from Polyline

Before selecting this command, the current drawing has to have the reference longitudinal profile represented continuously without it being divided into sheets.

By executing the command initially MDT will request the terrain of the longitudinal profile over which the grade line is defined. Last we select the polyline that defines the grade line. When this command is executed, the grade line information is saved in the polyline entity, which can be used with any of the commands in this chapter.

Additionally, if the polyline defined for the grade line exceeds the longitudinal profile limits either at the start or end of it, the following message will appear for indicating whether we wish the grade line to cut to the longitude of the defined longitudinal.



Once the polyline has been converted into a grade line, it is convenient to save the alignments' status in a separate file using the **Export Grade Line** option described below although one may later proceed to match the vertices.

Define Grade Line

Before selecting this command, the current drawing has to have the reference longitudinal profile represented continuously, that is to say without it being divided into sheets.

First of all the program will request what type of grade line we are going to work with, or in other words, if the grade line is of the parabolic or circular type.

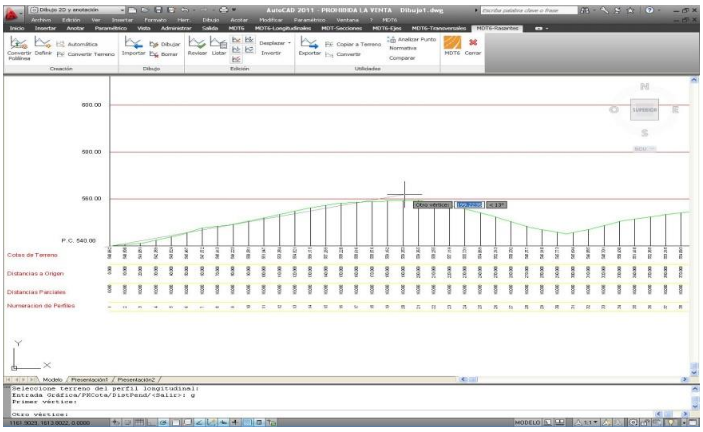
The program requests the longitudinal profile's terrain from which the grade line is designed.

The command line then indicates the different ways of defining the grade line:

Graphic

Allows one to define the vertices of the alignments graphically by marking them as if they were the representation of a polyline within or outside the orthogonal projection of the longitudinal profile's terrain. The definition is completed by pressing <*Enter*> twice, so that the program associates the graphic created on the terrain.

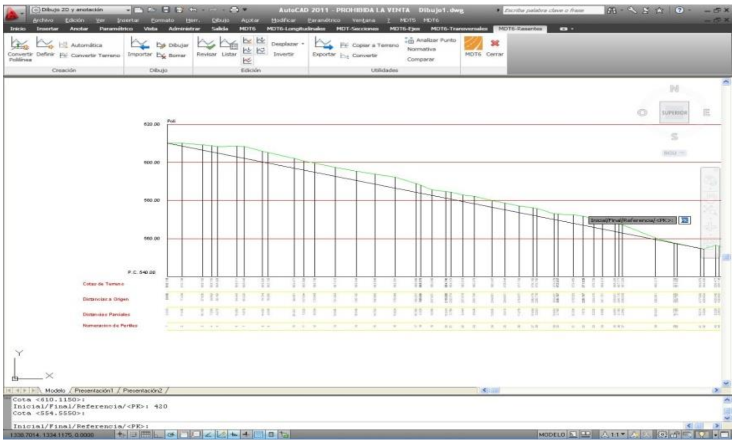
Only the areas between the origin and the end of the profile will be drawn. Intersections are calculated and the horizontal alignment outside the area is eliminated, automatically modifying the alignments to leave only the resulting alignment. One can then proceed to export the grade line to a file, so that it can subsequently be used in other processes.



Station and Height

This procedure is similar, but in this case the data is entered in response to the ***Initial/Final/Reference/<station>*** sub-menu. After entering a distance or station, the program requests the height and displays the height of the terrain interpolated at said position by default.

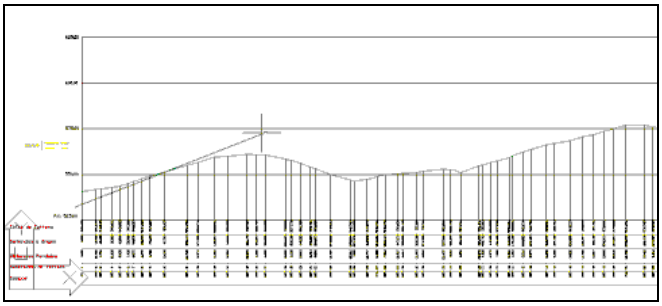
The ***Initial*** and ***Final*** options can be used to define the ends of the terrain. Additionally, the ***Reference*** option provides facilitates designating a specific point graphically. As explained in the ***Graphic*** option, this process may be continuous or partial.



Distance and Slope

This other kind of definition initially displays the same sub-menu as the ***Station and Height*** option. Once the first item of data (station) is entered, the program requests the height and then displays the terrain's data at the point desired by default. After the first point is thus specified, it requests the ***Distance*** from the alignment from the first to the current vertex. When this distance is entered, the program requests its ***Slope.*** It then creates the new alignment vector based on the previous one and with the distance set. The program will continue to request distance and slope until it is given a null response. Once the grade line has been defined, the program assumes the alignments and matches them to the parameters of the profile's orthogonal projection.

It should be remembered that for a distance of less than zero, the slope to be set in the opposite direction to the left and right, implies a change of sign after the slopes (+ Ramp, - Slope). In other words, for distances of less than zero, both a ramp seen from the final point as well as a slope seen from the final point will have to be considered.

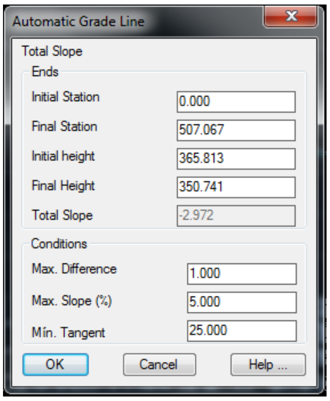


Having described the three procedures for defining straight grade line alignments, we should mention that they can be alternatively defined using the three methods, accessing each of them without finally completing the process. Lastly, it is convenient to save the alignments' status in a separate file using the Export Grade Line option although one may later proceed to the process of matching the vertices.

Automatic Grade Line PRO

With this process, with parameters previously configured, the program will automatically create the grade line.

To do this, the same as for previous options, initially the program requests the drawing longitudinal, then the following window will be displayed for introducing the parameters from which the grade line will be generated.



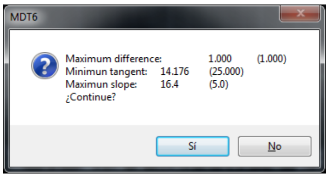
Ends:

- **Initial station**: From which we wish to generate the grade line.
- **Final station**: Up to which the grade line is to be generated.
- **Initial height**: Starting point height for the grade line in the initial station.
- **Final Height**: Final height for the grade line in its last station.

Conditions: We establish the conditions for the generation of the grade line.

- **Maximum difference**: Maximum difference of elevation that can exist in any station between the longitudinal and the new grade line. This approximation is carried out using least squares.
- **Maximum slope (%)**: We indicate the maximum slope that any section of the new grade line can have.
- **Minimum Tangent**: Minimum longitude that any section of the grade line can have.

Once the dialog box is validated, the program displays the following window showing the values obtained and the values introduced by the user in parentheses. If in agreement with the calculation, on accepting the window the program will draw the calculation.

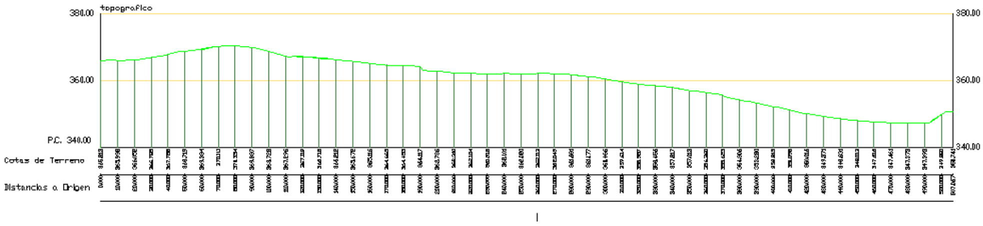


Import Grade Line PRO

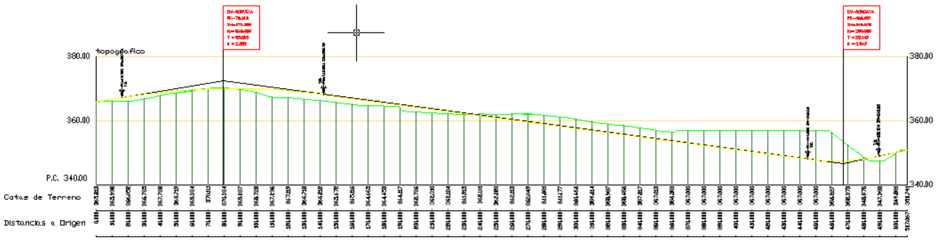
To execute this command there must be a representation of the longitudinal profile on the drawing. The program asks for the graphic selection of the longitudinal profile terrain. It then asks us to select the gradient file extension `.RAS`. Once selected, it will be graphically incorporated into the longitudinal profile into its corresponding elevation.

If the grade line has any curve defined, both the information associated with the curves as well as the input and output tangents will be drawn automatically.

Longitudinal profile before importing the gradient:



Longitudinal profile with the imported gradient:

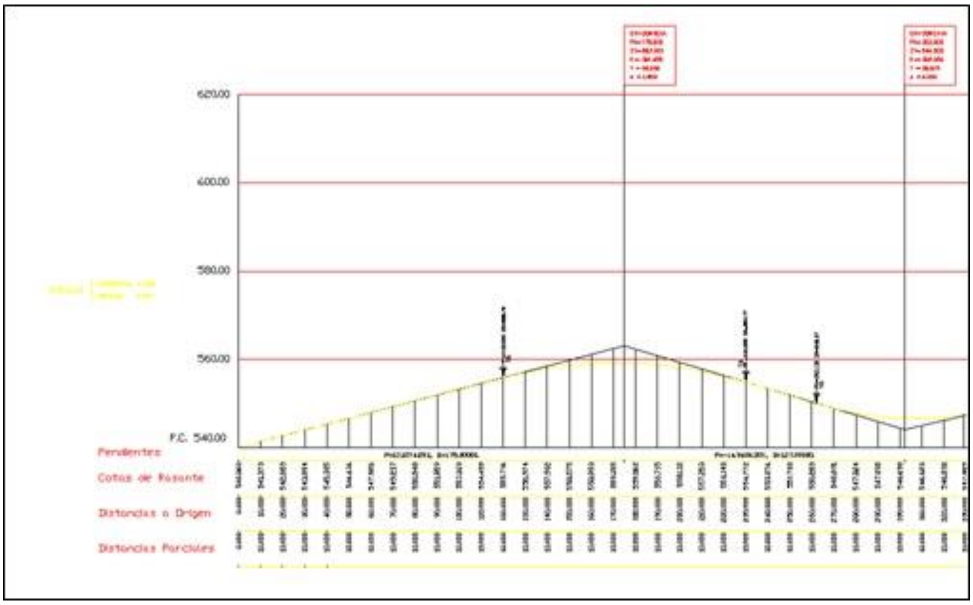


Draw Grade line PRO

This option is used to draw a grade line without the need for the longitudinal or the corresponding segment.

The functioning of the command is similar to the **Draw Simple Profile** and **Draw Compound Profile** commands in the Longitudinal options and allows us, from the grade line file selection, to draw it with the associated numerical data elements.

By default, the compound numerical data is associated (**see configuration** > **Profiles**) and only those elements that are related to the grade line to be represented are drawn.



Draw Grade Line on Ground Plan

This command will allow us to draw a gradient as a 3D polyline. With this in mind, the program will initial request the grade line, the alignment and the discretization interval for the vertices of the polyline to be created.

MDT will draw the corresponding 3D polyline at its location in accordance with the alignment coordinates and the grade line elevations.

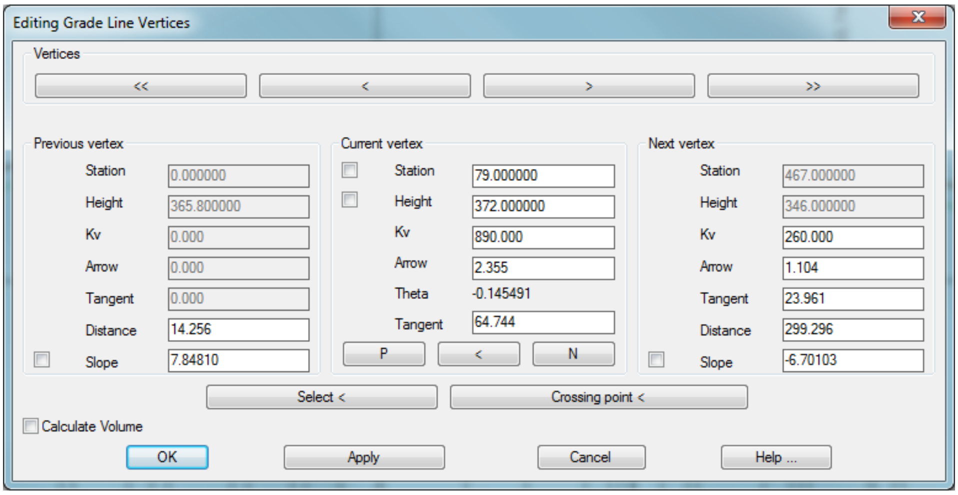
Delete Grade Line

This command allows one to delete grade lines from the current drawing. The advantage of this command is when selecting either of the polylines comprising a grade line both are simultaneously deleted, be it the previous grade line or the definitive one.

This operation can also be performed with the usual AutoCAD commands, but taking care to delete both polylines.

Vertical Transition Curve

This command allows us to modify a grade line's transition curves. Once the command has been executed, MDT requests the vertex to be edited and the vertex's characters are displayed, as are those of the previous and next vertex. A description of the dialogue box's characteristics appears below.



Firstly, one can distinguish three different sections: Previous Vertex, Current Vertex and Next Vertex. Any element of any of the vertices can be modified. The characteristics shared by the three vertices are described below.

Station: Station of the vertex. If it is changed, an adjustment in X will be produced on the grade line.

Height: Grade line's height at the vertex. If this value is changed, the vertex of the edited grade line will be adjusted in Y.

KV or **Radius**: Represents the parabola constant in the case of parabolic curves, or alternatively the arch radius in the case of circular curves. Modifying this information will lead to a modification of the grade line's transition curve at the vertex edited.

Tangent: Represents orthogonal projection length on each alignment being modified.

Arrow: It represents the maximum ordinate at the vertex.

In addition, the following information is also displayed for the previous and next vertex.

Distance: Distance between the vertex or vertex's tangent (should it exist) and the current vertex's tangent or the vertex itself.

Slope: Slope of the grade line section.

Element to Set: When the aforementioned values are entered, the possibility exists of setting the **Station,** the **Height** or the **Slope**, so that one is obliged to make modifications at the vertex while the element set is maintained.

The functions of each the dialog box's buttons is described below.

Select: This button allows us to move the transition curve of the grade line being edited. It in turn has three different options:

Set Slopes

Set Previous Slope: The previous alignment to the vertex edited is set using this option. Hence, it will only be possible to move the vertex in the direction marked by the next alignment to the vertex.

Set Next Slope: This is a similar case, except that the alignment set is the one following the vertex, which can only be moved in the direction marked by the following alignment.

Set No Slope: This option allows one to arbitrarily move the vertex with no restrictions of any kind.

Tangents

These commands allow one to change the tangent points (entry and exit) of the transition curve defined at the current vertex. There are three different options.

“A”: If a transition curve has been defined at the previous vertex, MDT will change the tangents of the previous and current vertices so that the exit and entry tangents of both vertices coincide.

“P”: If a transition curve has been defined at the next vertex, MDT will change the tangents of the next and current vertices so that the exit and entry tangents of both vertices coincide.

“<”: When this button is clicked, MDT will graphically request the distance to the tangent to be set from the current vertex. In this case, the entry and exit tangents will be equalled.

<: Establishes as the current vertex previous vertex to the one currently being edited.

>: Establishes as the current vertex the following vertex to the one currently being edited.

Apply : Updates all the changes made on the drawing.

Once the dialogue box has been validated, all the changes made at each of the vertices will be applied to the drawing.

Pass through point

This option is explained in detail in the following section.

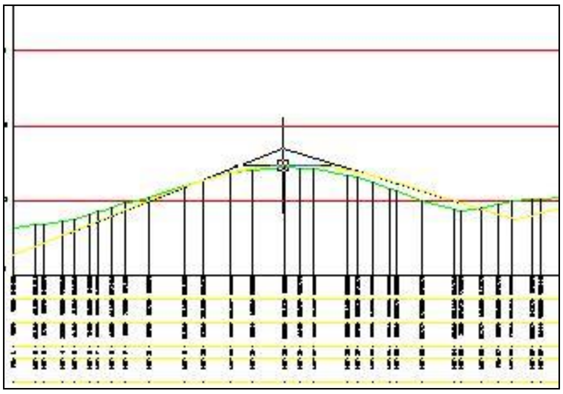
Calculate Volume

If we check this box, it will automatically calculate the total volume of cut and fill for the defined road. When any of the vertices is modified, if this box is checked, at this moment we will be able to see the result of the volume calculation of the change made in the active vertex.

Pass-Through Point Transition Curve

Using this command makes it easier for one to enter vertical transition curves at the different vertices of the grade line selected.

MDT will first request the vertex of the grade line to be edited, followed by the point through which one wishes the vertex’s curve to pass. The program will then automatically draw the definitive grade line with the characteristics entered.



Move Vertex

This command makes it easier for one to adjust the vertex of the grade line selected. Once it has been adjusted, the Kv value will not change (grade line radius in the case of a circular transition curve). However, the values of the tangent and the arrow will change in relation to the movement made.

Insert Vertex PRO

MDT initially requests the vertex one wishes to use as a reference to insert the new vertex. Once it has been selected, it requests the position of the new vertex. The grade line is automatically drawn and the transition curve characteristics of the vertex selected initially will be modified.

Delete Vertex PRO

This command deletes the vertex of the grade line selected. MDT initially requests the vertex to be deleted and then redraws the grade line, deleting that vertex and modifying the characteristics of both the previous and following vertices.

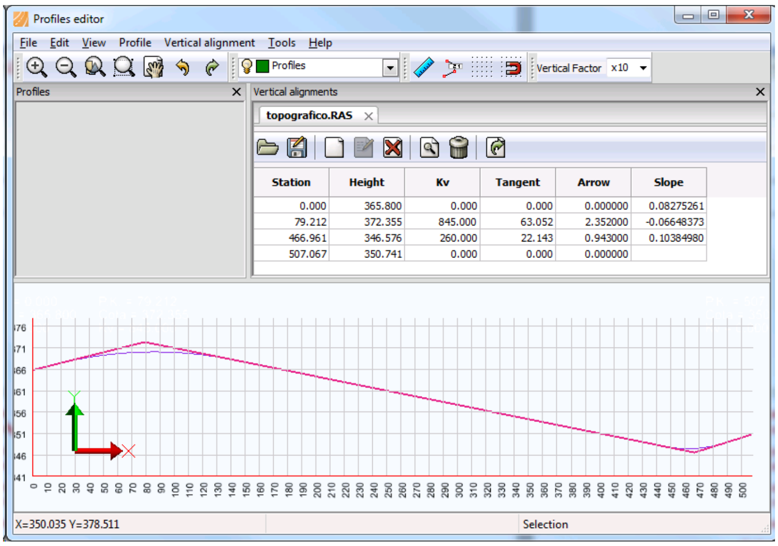
Edit Grade line PRO

This command is executed to visualize and quickly modify a grade line without the need to draw it on the screen.

The **Grade Lines > Review Profiles** command provides us with a window with the `.RAS` y `.SEG`. patterns.

Depending on whether we select a grade line or a segment it will display information on the grade line only or on the longitudinal profile and the grade line together.

In either case this information may be amended and once the option has been validated we are given the option of storing the data in the longitudinal profile or grade line file in accordance with what we selected initially.



There are four well-differentiated areas:

- The central area: Where the grade line drawing is visualized.
- The top area: Here we find the options menu together with the toolbar.
- The left area: A description of the characteristics of each grade line.
- Lower area: Here we can edit, insert and delete the different grade line vertices.

Menus and commands

The different menu options feature:

File: Features the options for opening, saving and closing files.

View: Enables or disables the visibility of each of the panels illustrated, either of the longitudinal profile or of the grade line, in addition to customising the different toolbars comprising the command.

Longitudinal profile: This option features three utilities in relation to the longitudinal profile.

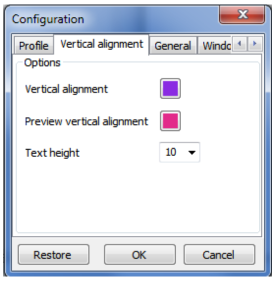
4. Displace height
5. Displace station
6. Invert

Grade line: In the event we are editing a grade line this option on the menu provides the following features:

1. Displace height
2. Displace station
3. Invert

7. Define by polyline: Activating this option will enable us to draw a polyline in the drawing area which will automatically turn into a grade line.
8. Insert Vertex: Enables us to insert a vertex on the grade line in the position shown on the screen.
9. Crossing point: This option will help us define the curves in graph format, whereby the curve will pass through the point we mark on the screen. In the event it proves impossible to create the curve, such as, for example, if it overlaps the front or rear vertex, a warning to this end will appear.

Tools – Settings: This option basically enables us to customise the profiles in the drawing area.



Toolbar

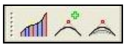
 Options of zoom: increase, reduce, extend ...

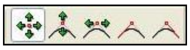
Tools to make the layers visible and to increase or reduce the scale factor of the drawing.

 In this case the first three options will enable us to mark the pinch point by moving any vertex of the longitudinal profile, giving us three possibilities:

4. Tangent to an arc.
5. Final point of a straight line.
6. Mid point of a straight line.

The second two options will enable us to measure the distance between two given points and to identify the real coordinates of a point on the screen.

 The first option will enable us to define a vertical alignment in graph format, the second the graphic insertion of a vertex on the vertical alignment and the third to edit a curve per crossing point.

 These commands will enable us to fix the different elements of the vertical alignment by moving any of the vertices of the same.

List of the longitudinal profiles with the different editing options:

topografico.LON

Station	Height	Code
0.000	365.813	Punto Singular,
1.975	365.907	MDT
2.386	365.955	MDT
3.858	366.118	MDT
7.591	366.028	MDT
18.994	365.888	Punto Singular,
19.818	365.879	MDT
21.226	365.830	MDT
22.497	365.855	MDT
24.330	365.901	MDT
35.051	366.374	MDT
43.608	366.851	MDT
45.495	367.007	MDT
53.413	367.532	MDT
54.605	367.444	MDT
61.443	367.476	Punto Singular,
62.984	367.492	MDT
67.703	367.569	MDT
74.045	367.414	MDT
74.407	367.395	MDT
78.417	367.067	MDT
88.303	366.111	MDT
93.733	365.468	MDT
95.139	365.542	MDT
101.508	365.815	MDT

Grade line

Grade line with the different vertex editing options.

topografico.RAS

Station	Height	Kv1	Kv2	Tangent1	Tangent2	Arrow
0.000	366.049	0.000	0.000	0.000	0.000	0.00000
69.203	367.569	536.000	0.000	18.138	0.000	0.30689
146.115	364.053	1255.000	0.000	14.674	0.000	0.08578
240.606	361.943	533.000	0.000	14.444	0.000	0.19570
430.028	347.447	51.000	0.000	4.592	0.000	0.20673
460.998	350.654	0.000	0.000	0.000	0.000	0.00000

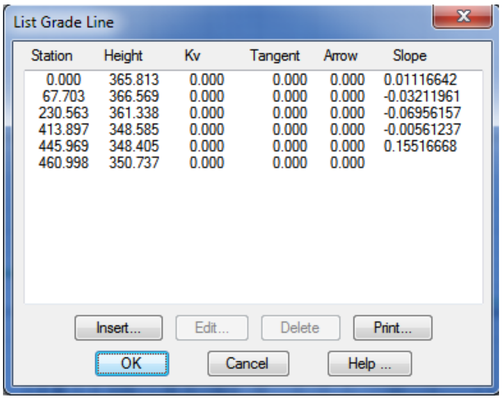
If we change any value of the curve, such as the kv, tangent or arrow, the remaining parameters will be recalculated automatically.

Likewise, as explained in the introduction, asymmetric vertices may be inserted in which the input and output tangents have a different value.

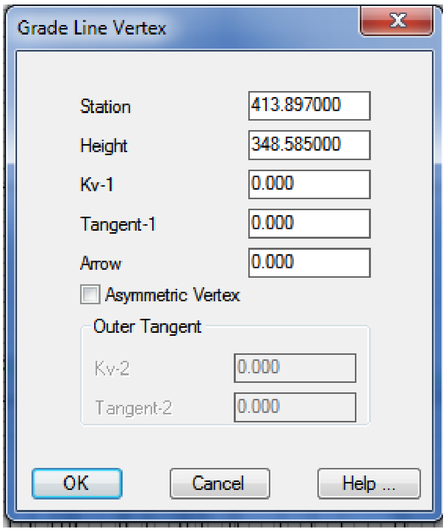
List Grade Line PRO

This command allows for total or partial modification of a grade line, by selecting or from a completely empty one.

After selecting a grade line either graphically or by selecting the file containing the grade line in question, the screen will display a list of its vertices. A description of the dialogue box's characteristics and functionalities appears below.



Edit/Insert: When this button is clicked, the characteristics of the transition curve selected on the list will automatically be edited. On clicking on the "Insert" tab an empty window will appear for the user to insert the data. This new window enables us to change the characteristics of the edited vertex curve, as well as defining the curve as asymmetric, achieved by activating the "**asymmetric vertex**" box.



Delete: Deletes the vertex of the grade line selected on the list and maintains the characteristics of the previous and next vertices.

Print: Sends the content of the list to the system's printer.

Excel: Exports the data listed to an Excel worksheet.

Move Station PRO

When this command is executed, MDT requests the file of the grade line to be adjusted and then requests a new ***Initial Station.*** Once it has been entered, the program will generate an adjustment of the grade line in X on the basis of the initial station entered.

Move Height PRO

When this command is executed, MDT will first request the file of the grade line to be adjusted. It then requests the ***Height Adjustment*** (for a negative adjustments, the negative sign must first be entered). Once it has been entered, the program will generate an height adjustment and modify the selected file.

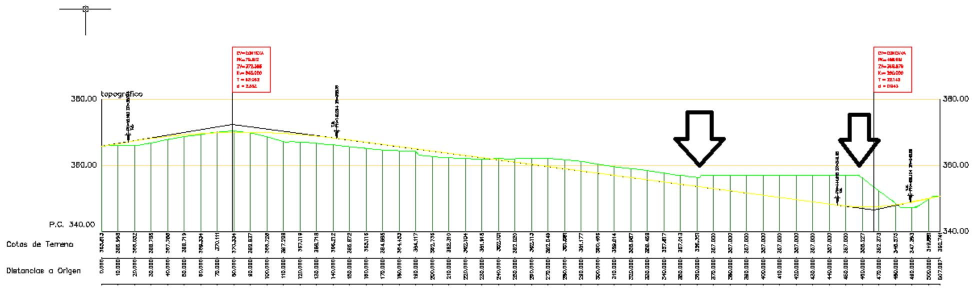
Fit to Profile

The purpose of this command is to copy the longitudinal profile on the gradient between given stations. This tool may be very useful for automatically adapting the gradient al to the terrain between given stations; for example, in the case of intersections.

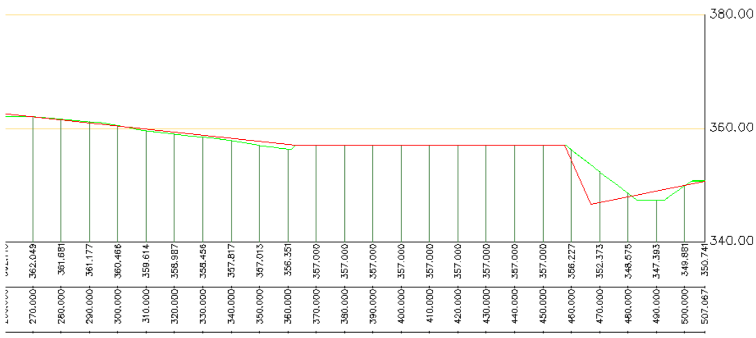
With this in mind, we must initially have drawn the longitudinal profile with the associated grade line, then we execute the command and MDT will ask us to designate the profile and the grade line. Once the elements have been designated, we enter or designate the initial and final station between which we wish to adapt the grade line.

An example is then shown of the adaptation of the grade line between to specific stations.

Before executing the command:



After execution of the command and marking the designated stations with the arrows:



Invert Grade Line

This command is used to invert a grade line file. The process is performed by inverting the vertex stations, maintaining the same distance between them and leaving the transition's curves values unchanged. An example of running this command is shown below.

Original grade line:

0.000	540.062	0.000	0.000	0.000
177.763	563.330	55.000	7.901	0.567
302.571	543.810	300.000	40.962	2.796
870.839	610.115	0.000	0.000	0.000

Inverted grade line:

0.000	610.115	0.000	0.000	0.000
568.268	543.810	300.000	40.962	2.796
693.076	563.330	55.000	7.901	0.567
870.839	540.062	0.000	0.000	0.000

Export Grade Line PRO

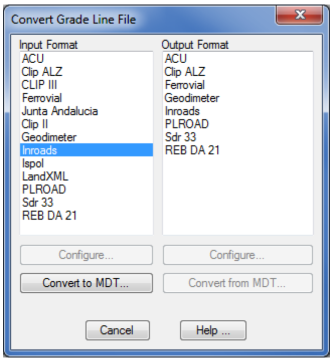
This option allows one to convert a grade line previously defined on screen into an ASCII file with a `.RAS` extension. It is advisable to use this command immediately after defining the grade line on the drawing.

Example: `TEST.RAS` file

0.000	237.952	0.000	0.000	0.000
20.000	237.700	455.685	20.000	0.439
420.000	197.548	4041.270	40.000	0.198
750.000	157.890	1085.509	60.000	1.658
1100.000	154.520	1249.117	40.000	0.640
1220.000	161.050	1198.941	80.000	2.669
1510.000	138.130	2211.592	50.000	0.565
1620.000	134.410	2911.879	60.000	0.618
1750.750	124.600	597.846	20.000	0.335
1800.000	124.200	197.420	10.000	0.253
2115.000	89.730	1334.648	60.000	1.349
2260.000	86.900	1650.658	20.000	0.121
2300.000	85.150	3047.619	20.000	0.066
2380.000	80.600	1939.394	20.000	0.103
2420.000	77.500	3999.980	20.000	0.050
2460.000	74.000	2000.000	20.000	0.100
2500.000	71.300	2452.208	20.000	0.082
2528.405	69.846	0.000	0.000	0.000

Convert Grade Line PRO

This command allows one to convert other program's grade line files or grade line files having different formats. When the command is run, the following dialog box is displayed, which is described further below:

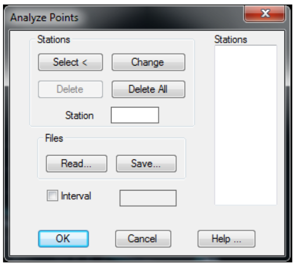


If a format is selected from the ***Input Format*** list, the ***Convert to MDT*** button will automatically be enabled. When it is clicked, the program requests the source file containing the grade line in the original format and then requests the output file where the grade line information will be sent in MDT format. Optionally, the ***Configure*** button can be enabled, where one can specify any special characteristics of the format selected.

Likewise, if any format on the ***Output Format*** list is selected, the ***Convert from MDT*** button will automatically be enabled. If it is clicked, the program will request the source file containing the MDT grade line and then for the output file where the grade line information will be sent with the format selected. Optionally, the ***Configure*** button

Analyse Points in Profile PRO

It is necessary to have a longitudinal terrain profile with an associated grade line on screen to use this command. The program requests a grade line to be selected in **Graphic** or **File** fashion. The following dialog box is then displayed, whose characteristics are described below.



Select: One graphically selects on the profile the stations from which information is to be obtained.

Change : Changes the station selected from the list for the one entered in the **Station** box.

Delete : Deletes the station from the list.

Delete All: Reinitiates the list, which then becomes completely empty.

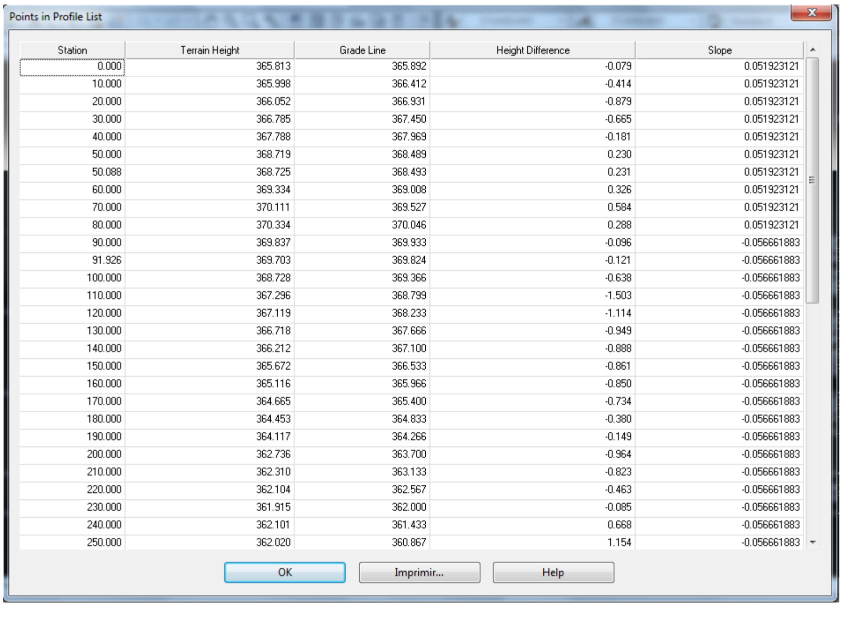
Read: It is possible to read any file containing a station in its first column, so that the list is filled in automatically.

Record: Once all the stations are entered, the information on the stations can be saved on a file using this option.

Interval: Additionally, it is possible to set a specific interval to obtain the list. This option does not exclude the aforementioned options.

Lastly, the program displays a dialog box containing the information about the corresponding grade line projected orthogonally on the terrain, its corresponding height on the terrain (**Terrain Height**), the height of the grade line used for the calculation (**Grade Line Height**), as well as the difference between both along with its sign (**Height Difference**), depending on whether it is a fill (+) or a cutting (-).

These results can be printed or exported to an ASCII file or to a Microsoft Excel worksheet.



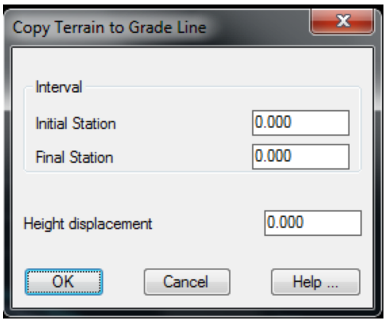
Points in Profile List

Station	Terrain Height	Grade Line	Height Difference	Slope
0.000	365.813	365.892	-0.079	0.051923121
10.000	365.998	366.412	-0.414	0.051923121
20.000	366.052	366.931	-0.879	0.051923121
30.000	366.785	367.450	-0.665	0.051923121
40.000	367.788	367.969	-0.181	0.051923121
50.000	368.719	368.489	0.230	0.051923121
50.088	368.725	368.493	0.231	0.051923121
60.000	369.334	369.008	0.326	0.051923121
70.000	370.111	369.527	0.584	0.051923121
80.000	370.334	370.046	0.288	0.051923121
90.000	369.837	369.933	-0.096	-0.056661883
91.926	369.703	369.824	-0.121	-0.056661883
100.000	368.728	369.366	-0.638	-0.056661883
110.000	367.296	368.799	-1.503	-0.056661883
120.000	367.119	368.233	-1.114	-0.056661883
130.000	366.718	367.666	-0.949	-0.056661883
140.000	366.212	367.100	-0.888	-0.056661883
150.000	365.672	366.533	-0.861	-0.056661883
160.000	365.116	365.966	-0.850	-0.056661883
170.000	364.665	365.400	-0.734	-0.056661883
180.000	364.453	364.833	-0.380	-0.056661883
190.000	364.117	364.266	-0.149	-0.056661883
200.000	362.736	363.700	-0.964	-0.056661883
210.000	362.310	363.133	-0.823	-0.056661883
220.000	362.104	362.567	-0.463	-0.056661883
230.000	361.915	362.000	-0.085	-0.056661883
240.000	362.101	361.433	0.668	-0.056661883
250.000	362.020	360.867	1.154	-0.056661883

OK | Imprimir... | Help

Copy Terrain to Grade Line

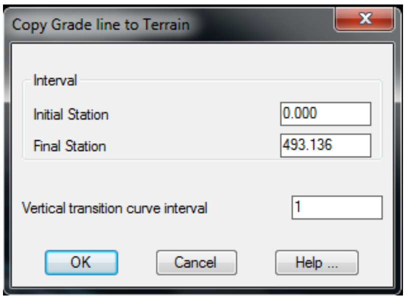
This command allows one to create a grade line parallel to the terrain represented by a longitudinal profile that already exists on the drawing. One is initially requested to select the terrain (by default the green polyline on the PERLONG-TERRAIN layer). The program then requests the **Initial Station** and **Final Station** (by default, 0 and the length of the profile respectively). Lastly it requests the **Height Displacement,** where one can enter values lower than zero in the case of a downward interval, or greater than zero in the case of an upward interval.



The opposite option is Copy Grade Line to Terrain.

Copy Grade Line to Terrain

Initially, one is requested to graphically select a grade line. The longitudinal profile file to be created is then selected. The dialog box then requests the **Initial Station** and **Final Station** (with the default values being the values at the ends of the grade line), in addition to the **Interval** to discretize the vertical transition curves.



Both this option and its opposite are particularly useful for partially or totally processing the theoretical grade lines designed, which can be used as future current conditions to design underground conduits.

List of Grade Line lengths

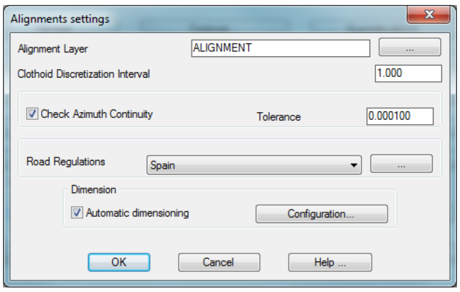
This command enables us to obtain a list of both the horizontal and inclined lengths of the grade line sections which surpass a previously inserted slope value.

At first, on executing the command, the user will be asked for the grade line or segment files with which the calculation is to be conducted; the selection may be conducted in a multiple fashion in the same folder.

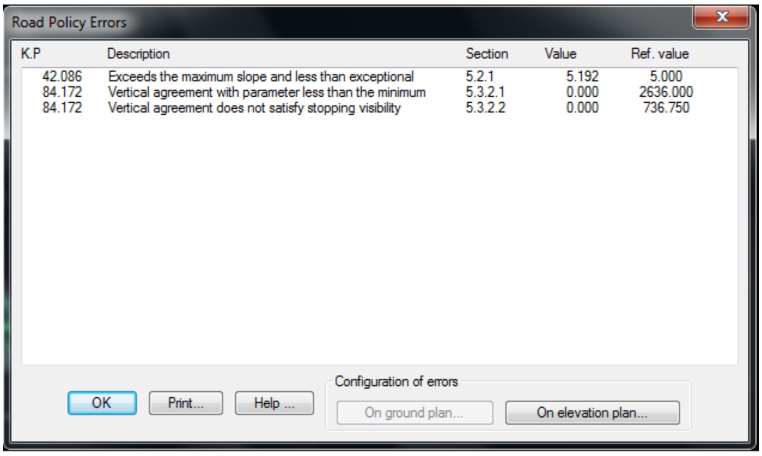
Then, the user will be asked for the minimum slope value to be calculated and a list will appear with the name of the grade line or segment and the lengths which surpass the specified value of the slope.

Check Rules

This command checks the geometric characteristics of a grade line in such a way that it is verified whether it strictly complies with the standards according to that specified in the configuration. It is important that to define in each alignment the road type (highway, road etc.) and the project speed have been correctly defined.



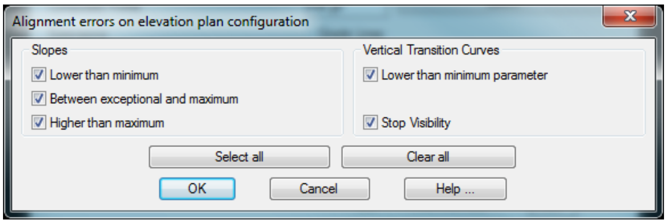
To do so the program requests a grade line or segment file, and then presents an error report. The station of the alignment where the error is located is indicated, with a description of the error and the section of the regulation referenced. It also displays the current numerical value of the parameter that caused the error and the reference value it should have. For example, the first line of the image below reports that a section of the current slope (13.107) is higher than the maximum established by the regulation (6.000).



The dialog box allows the user to ***Print*** the error report, and configure the errors to be detected ***on ground plan*** or ***elevation plan***.

Alignment errors on elevation plan configuration

This dialog box allows the user to control the type of errors for this command to detect in different categories. By default all of them are checked. The options ***Select all*** and ***Clear all*** are also available.



Next is a description of the meaning of the different error messages and references to them in the Road Policy.

Slopes

The errors refer to section 5.2 of the regulation.

- **Lower than the minimum.** The slope in the section is lower than the minimum specified in the regulation.
- **Between exceptional and maximum.** The slope in the section is higher than that recommended, and is only allowed in exceptional cases.
- **Higher than the minimum.** The slope in the section is higher than the minimum specified in the regulation.

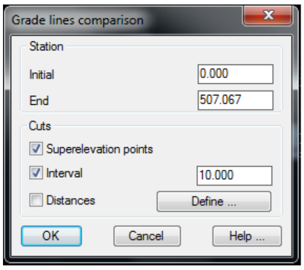
Vertical Transition Curves

The errors refer to section 5.3 of the regulation.

- **Parameter lower than the minimum.** The vertical curve parameter is lower than the minimum recommended by the regulation, in accordance with the conditions of visibility or aesthetic factors (section 5.3.2).
- **Stopping visibility.** The curve parameter is lower than that required to comply with the stopping visibility (Table 5.1).

Grade lines comparison PRO

This command is used to obtain a list comparing two previously-selected grade lines. Executing the option displays the following window for establishing the criteria for creating the list:



Initial: Initial station from which the comparison list is to be made.

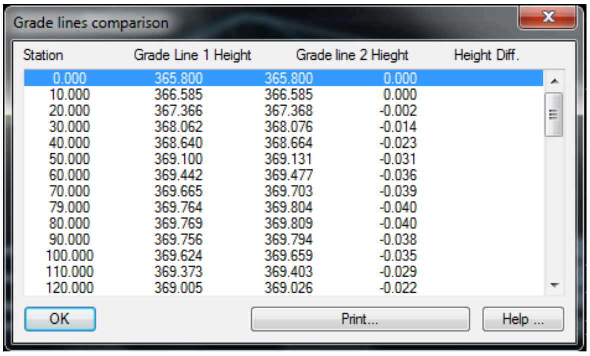
End: Station up to which we want the list.

Superelevation points: If this option is checked, the comparison list includes the vertices of each grade line selected.

Interval: Interval at which the list is executed.

Distances: Additionally, to compare stations determined from the grade line, the desired stations can be inserted in this option with the **"Define …"** button.

After pressing okay on the dialogue box, the corresponding list appears in which we have the additional possibility of printing the list with the different printing options the application provides.



Grade lines comparison

Station	Grade Line 1 Height	Grade line 2 Hieght	Height Diff.
0.000	365.800	365.800	0.000
10.000	366.585	366.585	0.000
20.000	367.366	367.368	-0.002
30.000	368.062	368.076	-0.014
40.000	368.640	368.664	-0.023
50.000	369.100	369.131	-0.031
60.000	369.442	369.477	-0.036
70.000	369.665	369.703	-0.039
79.000	369.764	369.804	-0.040
80.000	369.769	369.809	-0.040
90.000	369.756	369.794	-0.038
100.000	369.624	369.659	-0.035
110.000	369.373	369.403	-0.029
120.000	369.005	369.026	-0.022

OK Print... Help ...

can be enabled to specify any special characteristics of the format to which one wishes to export.

11. Cross-Sections

Introduction

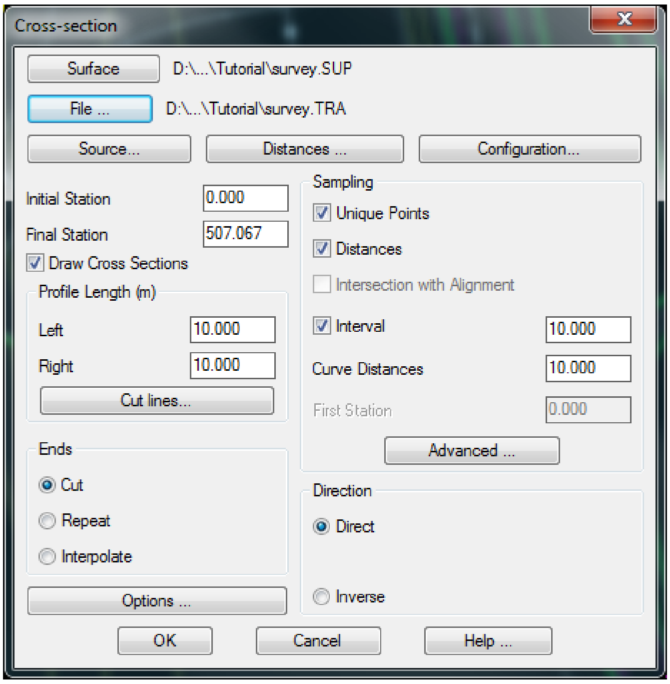
In order to obtain cross-section profiles, it is necessary to have 2D drawing objects and height or 3D drawing objects, or alternatively the digital terrain model, in addition to the horizontal alignment's geometric definition. Furthermore, the process' parameterization is very similar to that of longitudinal profiles. Repetitive definitions will therefore be avoided to focus on the differences.

In the case of surfaces, the existence of islands should be taken into account to enable the cut of cross-sections to contain information on both sides and no information in the central area.

Get Cross Sections

When this command is executed, cross-sections are obtained from 3D objects or MDT surfaces. There are different methods to obtain them. Initially, the program requests the horizontal alignment from which to obtain the profiles, which can be designated on the screen or by selecting the relevant file. The following dialog box then appears:

Surface: By clicking on this button, one selects the surface from which one wishes to obtain the profiles. Initially, the name of the current surface will be displayed. If a surface will not be used, this option is not necessary.

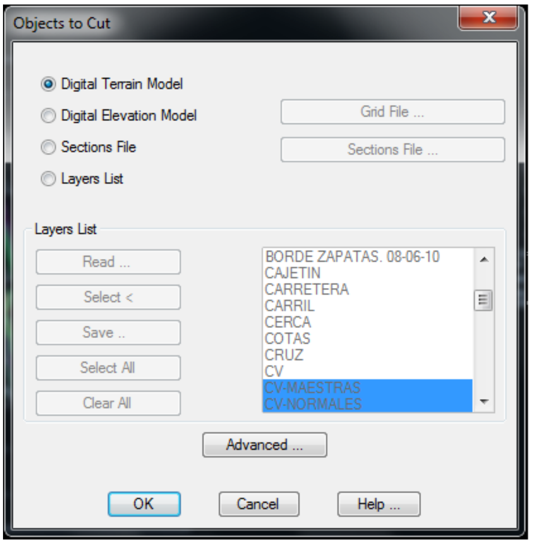


File: The cross-section information will be saved by default in a file with the name of the drawing and a `.TRA` extension. This name can be changed by clicking on the relevant button and selecting the file desired.

Source

By activating this button, one selects the data source from which one wishes to obtain the profiles – in other words, from an MDT surface, a set of contour lines, a three-dimensional grid, a road section file, etc.

The dialog box that is displayed when this option is executed appears below. It is commented on further below.



There are different options for obtaining cross-sections, depending on the data source one wishes to use in order to generate them. The different methods are described below.

Digital Terrain Model: Uses the surface generated by MDT as a data source. It should have been previously selected in the main dialog box. This option is advisable when the model has been correctly obtained, since it includes height and orientation towards break line information, making it possible to obtain an accurate intersection with all the elements.

Sections File: In this case, the profiles are generated from a section file. When this option is selected, one has to select the section file with one will work. The sections definition and generation are detailed in the **Contour Lines** section.

Digital Height Model: In this case, the profiles are generated from a **Grid File** or a **Digital Height Model.** Their definition and how they are handled are described in the **Maps** section of this manual.

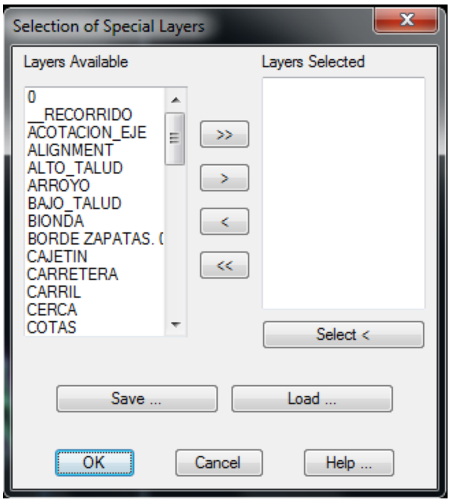
Layers List: This option allows one to cut any drawing element with elevation. In order to do so, the relevant layers whose elements are represented in 3D are selected using the cursor. The digital model can also be included in the selection by marking the TRI layer. Activating this option enables the **Layers List** box, from which the layers containing the 3D information can be selected.

In this latter option, if the name of an element's layer to be considered is unknown and its position in the drawing area is known, the **Select** button is simply clicked. At that moment, the program goes to drawing mode and the program requests objects to be selected. This operation should be executed for all of the elements selected.

The **Save** option is used when one wishes the set of layers to be saved in an ASCII file with the `.CAP` extension. The program superimposes a window called **Save Layers List** containing the project's directory and proposes the current drawing as a name, which can either be validated or changed. When validated, one goes back to the previous window. Once this operation has ended, one can understand the utility of the **Read** button, seeing as in all subsequent operations involving longitudinal or cross-section cuts the layers can be selected by clicking this button and selecting the name of the relevant layers file.

When this option is selected, the **Advanced** button is enabled, so that information on the objects associated to the layers is included when profiles are obtained from the layers selected in the dialog box shown below. Object heights are interpolated.

By activating the corresponding option in configuration, one can decide whether or not polylines with a height of zero are to be cut.



Initial Station: The initial station assigned to the horizontal alignment's initial position is entered in this box. The default value is either zero or the start of the horizontal alignment.

Final Station: The final station up to which one wishes to obtain the cross-sections is entered. Its default value will be the last station on the horizontal alignment selected.

Draw cross sections : If we enable this option, after successfully generating the cross sections the drawing thereof will be executed automatically.

Profile Length: The cross-sections' length is entered in this control by indicating the meters to the left and the right of the horizontal alignment.

Should the horizontal alignment or polyline from which one wishes to obtain the profile go beyond the area included in the digital model, its ends are interpolated from the last two vertices found before the first and last intersection in the model.

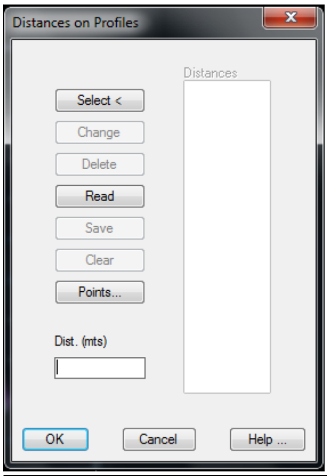
Cut Lines: This option allows one to set a series of polylines that will serve as a reference to calculate the ends of the cross-sections. The program will extend the cross-section until it finds an intersection with any of the polylines entered. The maximum extension length is as set in the **Profile Length** field.

Sampling

This text box displays a series of options to be considered depending on the cross-sections to be obtained.

Unique Points: When this option is selected, in addition to the previously determined constant interval distances, the program takes into account the initial and final stations and all the vertices found on the horizontal alignment, including: changes of orientation, vertices when forming straight lines, tangents, etc.

Distance: This option allows one to include the cross-sections corresponding to specific stations. Activating this option enables the **Distances** button. A new window called **Distances in Profiles** is then displayed.



As can be seen, the window contains a series of buttons allowing one to edit the list of stations to be included.

Select: Allows one to graphically select the station. In order to do so, a point on screen is specified. The point thus chosen will be projected on the horizontal alignment and its distance with regard to the alignment's initial station will be found. If there is no projection, it will not be added to the list.

Change : This command changes the station selected from the list for the one indicated in the **Distances** text box.

Delete : Deletes the station selected from the list.

Read and **Save**: These commands load or generate a .DST file respectively, or a distance in profiles file where which each line indicates a station.

Clear: Deletes the entire list from the window.

Points: Provides access to the **Point Selection** window to determine the set of points whose stations one intends to project onto the horizontal alignment. (see **Point Selection** in the **Points** section).

Interval: This option allows one to extract cross-sections having the interval entered using this control.

Distance on Curve: The on-curve interval value with which one wishes to obtain the profiles is entered in this field

First station: This value indicates the horizontal alignment's first station from which the profiles will be obtained.

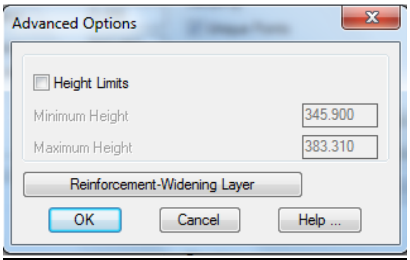
Advanced Options

The following parameters are configured in this group of options:

Height Limits: The maximum and minimum height values to generate cross-sections are set. It is really a filter to avoid the existence of any heights above or less than the ones entered.

Skewing: The cross-sections' angle of inclination with regard to the horizontal alignment in hundredths of a degree. A negative value indicates skewing to the left, while a positive value indicates skewing to the right. The default value is 0.

Reinforcement-Widening Layer: Should there be the possibility of taking advantage of additional spaces in the road's definition, this command optionally allows one to select the layer where the polylines will be drawn to delimit the reinforcement or additional width areas.



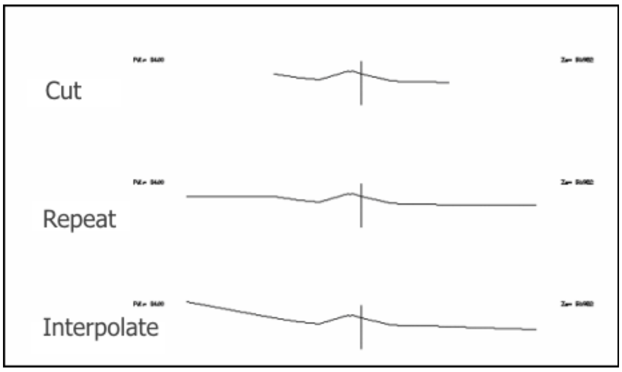
Ends

The program's behaviour concerning cut ends of the cross-sections is set in this box when there is no terrain. Each of the options is described below:

Cut. Selected by default. It proposes the cross-sections to be cut should their strip width exceed the digital model's definition or the objects selected, in which case the profiles take on a width equivalent to the width entered or up the point the model is defined.

Repeat. Using this option is recommended when there is excess strip width compared to the digital model and the surroundings are substantially similar to the last height obtained from the digital model. This is usually the case in terrain having large flat surfaces, or when curves in are cut a parallel fashion.

Interpolate. This option is used in order to complete the strip proposed when there is insufficient terrain in the strip width specified, the slope outside the working area is known and has similar gradients as those at the end of the profile. The program will interpolate using the slope of the last vectors cut until the height is raised to the profile's final length at the right-hand and left-hand sides.



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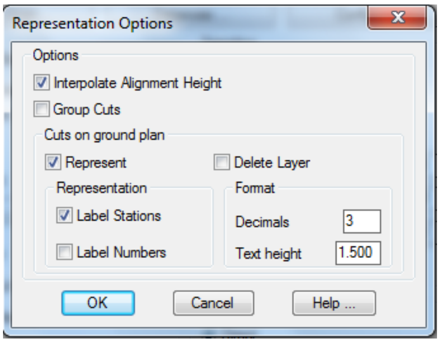
Direction

This control allows one to specify the direction in which the profiles are to be obtained. **Direct** means in the direction of the horizontal alignment's definition, whereas **Inverse** means opposite to the forward direction defined.

Rendering options

These options allow one to configure how the cross-sections that will be obtained are to be represented.



Interpolate Alignment Height: If this option is activated, the program will automatically generate a height on the horizontal alignment of each cross-section. If the source of the data is not a MDT surface, this height will be interpolated between the adjacent vertices.

Group Cuts: This allows one to group all the cross-sections drawn in a single block so that they can be more easily deleted or handled with AutoCAD.

Represent Cuts: When this option is activated and the cross-sections are obtained, it will draw the profiles obtained on the ground plan.

Some options to configure the representation of ground plan cuts are additionally available:

Label Stations: One indicates whether ones wishes to label the stations corresponding to each cut.

Label Numbers: One indicates whether one wishes to show the number corresponding to each of the profiles generated.

Decimals: Number of decimals to use to label the stations.

Text Height: Height of texts to be displayed.

Results

There are various compulsory operations when entering cross-section data. One of them is to select the horizontal alignment. If it is not selected, the cross-sections cannot be obtained.

Additionally, if the digital model is not defined and no layer to cut or section or grid file has been selected, the "Layers not selected" error is displayed. Another possible error consists of not having found objects cutting the horizontal alignment. In this case, the error warning “No intersections found" is displayed

After all the data is entered in the dialog box, the program proceeds to draw all the cuts proposed (if the relevant option is activated) and information about the operation’s progress is provided as a percentage. It then reminds one of the name of the file generated with a .TRA extension, in the project directory.

All the layers selected that are not visible will be reused and activated before this process begins, which is why it may be necessary to regenerate the drawing. If only the digital model is going to be cut, this is not necessary.

During the calculation process, heights are obtained from drawing objects and interpolating when necessary. There is also the possibility of cutting break lines even though they have been drawn on the plan. If the **Draw Break Lines in 3D** option of the **Surface Configuration** command in is not activated, the program assigns to each vertex the value of the point height coinciding with it.

Example: DEMO.TRA

```
0.000       8.161  353.710   EDGE
20.000    -20.000  349.645   End
20.000      0.000  349.740   Horiz.Alignment
20.000      4.523  349.761   EDGE
20.000      6.617  349.793   FILL
20.000     20.000  355.187   End
40.000    -20.000  348.534   End
40.000    -12.554  348.554   EDGE
40.000      0.000  347.363   Horiz.Alignment
40.000     16.932  345.757   EDGE
40.000     20.000  346.132   End
58.555    -20.000  341.677   End
58.555     -6.587  332.850   STREAM
58.555      0.000  336.672   Horiz.Alignment
58.555     11.363  343.267   EDGE
58.555     20.000  345.536   End
60.000    -20.000  339.701   End
60.000     -7.366  332.476   STREAM
60.000      0.000  336.680   Horiz.Alignment
60.000     11.480  343.232   EDGE
60.000     20.000  345.496   End
80.000      4.402  342.500   EDGE
```

The file format consists of one line for each intersection found. The following appear on each line: station (taking the initial station into account), distance to the horizontal alignment (negative or positive, depending on whether it is to the left or the right of the horizontal alignment), the height of the terrain at that point and the name of the layer cut. This file can be drawn directly with the Draw Cross-Sections option.

In the aforementioned fragment of cross-sections made from a digitized cartography drawing, cuts with objects situated on different layers (fourth column) can be seen. Analysing the stations, one can deduce that a distance of 20 m between profiles has been used and that the unique points have been included (station 58.555).

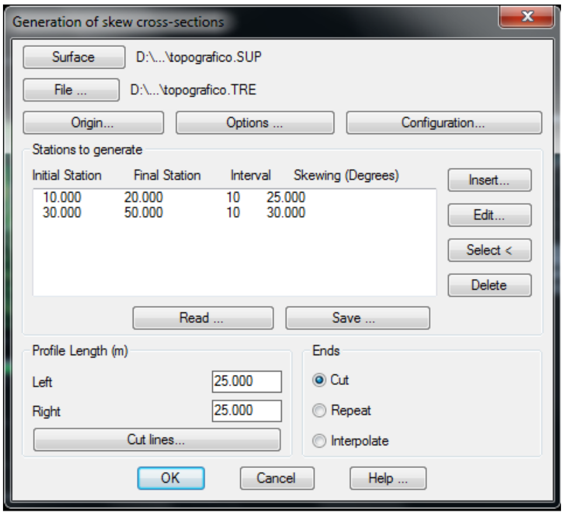
One can likewise observe that the **Interpolate** option has been used for the cuts. This can be seen because the observation “End” appears at the ends of each cut and because their heights are interpolated from the closest intersections. If the digital model had been defined, these height would have been obtained from it whenever possible. When a profile is incomplete (there are only cuts on one side of the horizontal alignment), it is shown by an asterisk located in the first column of the line, so that the user can easily detect and correct such situations by editing the file or modifying the digital model. It can also be seen that the program always includes a line having the horizontal alignment’s height for each cut, which is interpolated from the adjacent heights.

Get Skewed Cross Sections

This command is useful to generate profiles that are not normal to the horizontal alignment. It is possible to indicate the angle of inclination with regard to the horizontal alignment of each cut or group of cuts. This angle is specified in grads with a margin of +- 100 degrees, in which the value of zero is considered normal to the horizontal alignment.

The information is saved in the file selected with the extension “TRE”, differentiating it from the traditional cross-section profiles as a completely new and independent element.

When the command is executed the following window is displayed. Its parameters are described below.



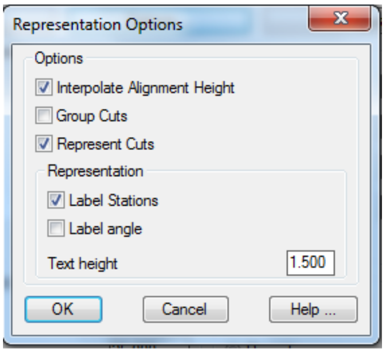
Surface: Select the surface from which to generate the profiles, in the case that it exists.

File: Name of the skew cross-sections file to be generated.

Origin: This option is exactly the same as the same button that exists under the command “Obtain Profiles”.

Options

This option, in general, is used to personalize the representation of the profiles in ground plan view.



Interpolate Alignment Height: If no information exists in the alignment position, the position height is interpolated.

Group Cuts: This creates a block with all the cuts represented in ground plan view, to enable the option after all the cuts are deleted.

Represent Cuts: Check this box to represent the cuts in ground plan view.

Label Stations: Used to label the station corresponding to each cut.

Label angle: When this option is checked, the angle corresponding to each cut is labelled.

Text height: To personalize the text height for both the station and the angle.

Stations to generate

In this section we indicate which cuts to generate, at which stations and what the angles of these will be. There are several groups of cuts or individual cuts, each one with its own angle. There are several ways to input this data:

Insert: A window is displayed to establish the initial station, final station, the interval between the cuts and the angle of this group of profiles.

Edit: Edit the element selected making any modifications to its parameters.

Select: With this option there must be previously-drawn lines indicating from where to obtain the cuts in the drawing in ground plan view. By clicking this button we select each one of these lines and the command to automatically calculate the station and the angle of each one. It is necessary in all cases that the lines cut the horizontal alignment.

Delete: Delete the entry selected in the list.

Read: This option is used to read the information previously recorded with all the information on the cuts to generate.

Save: Click this button to save the information on the defined cuts in a file to be read later in another situation.

Length of profile. Left: Length of the cut to the left of the horizontal alignment.

Length of profile. Right: Length of the cut to the right of the horizontal alignment.

Cut lines: This option is used to set a limit to the generation of cross-sections. To do this, when clicking this button it will request a series of polylines that will serve as a reference for generating the cuts.

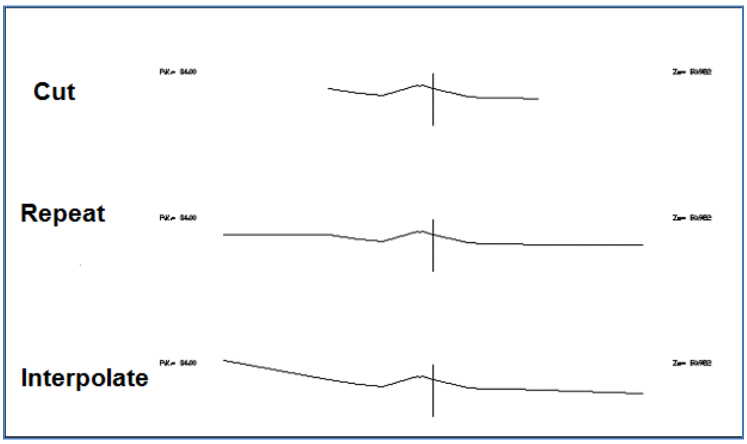
Ends

In this box the performance of the program at the ends of the cross-sections cuts is defined when no terrain is available in them. A description of each option follows:

Cut. Selected by default. This proposes the cross-section profiles be cut should their strip width exceed the digital model definition or objects selected, in which case the profiles take on a width equivalent to the width entered or up to the point it is defined in the model.

Repeat. Using this option is recommended when there is excess strip width compared to the digital model and the surroundings are substantially similar to the last height obtained from the digital model. This is usually the case in terraced terrain or terrain having large flat surfaces, or when curved areas are cut in parallel fashion.

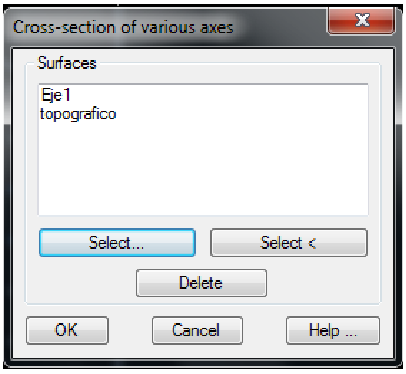
Interpolate. This option is used in order to complete the strip proposed when there is insufficient terrain in the strip width specified, the slope outside the working area is known and has similar gradients as those at the end of the profile. The program will interpolate using the slope of the last vectors cut until the height is raised to the profile's final length at the right and left sides.



Get from several alignments

This command works similarly to the command **Get Cross Sections** with the difference that it generates several cross-sections with the same characteristics (interval, width ...) from the different horizontal alignments existing in the drawing.

Initially, after executing the command, the following window is displayed for managing the horizontal alignments from which we wish to obtain the profiles. The window is automatically filled in with the active project horizontal alignments and if there is no active project, it is filled in with the horizontal alignments existing in the drawing.



Select: The possibility to select a new horizontal alignment from a file

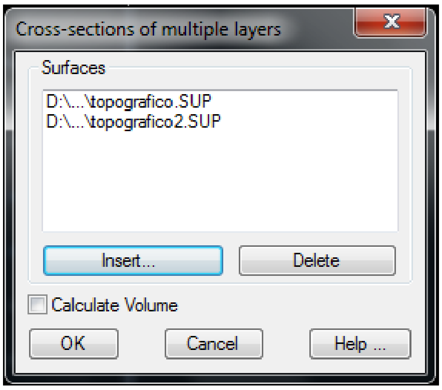
Select <: Select a new horizontal alignment designating it on the current drawing.

Delete: Deletes the horizontal alignment that is currently selected in the list.

Once the window is validated, a cross-section is created for each horizontal alignment with the name specified in the window and using the name of the horizontal alignment from it has been generated from as a suffix.

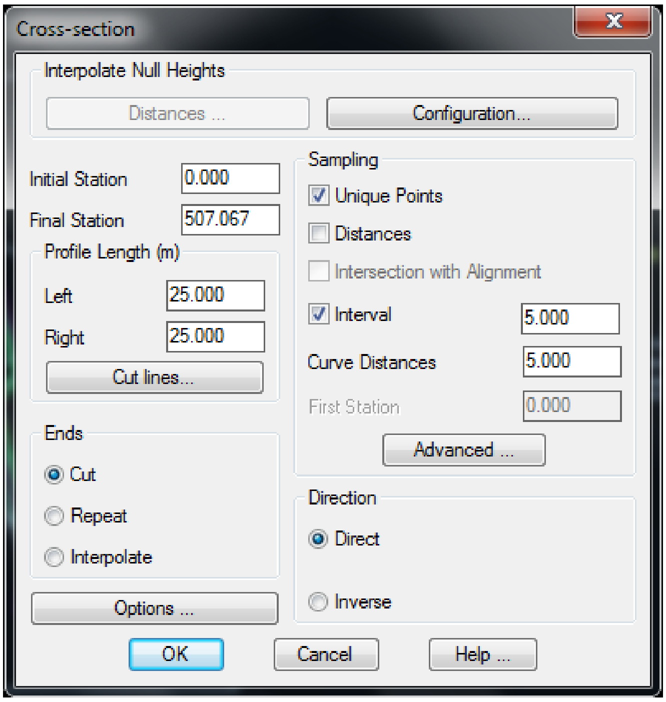
Get from several surfaces

With this option we can generate several groups of cross-section profiles from several surfaces. When the command is executed the program displays the following window to select the surfaces from which to generate the cross-sections.



If we select two surfaces, the option “Calculate Volume” is also enabled, and if it is activated, the program will automatically execute the calculation as a difference of the cross-sections from the profiles generated.

Once the surfaces are selected, the following window will appear for setting the generation parameters.



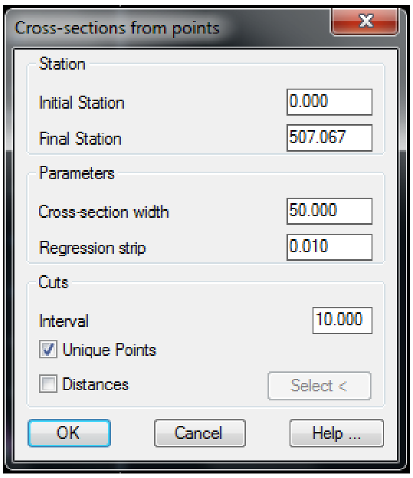
The operating parameters of this window are similar to the command "**Obtain Profiles**" with the only difference being that we do not select the surfaces or the name of the cross-section file.

Once this window is validated it generates a cross-section for each surface, using as a name for the cross-section the name of the surface from which it has been generated. If two surfaces have been selected, the option cubic measurement by profiles will automatically appear.

Convert from Points

This utility allows one to obtain cross-section profiles from a horizontal alignment and a scatter plot. It is extremely useful to convert a series of surveying points without the need of applying any kind of codes.

When the command is executed, MDT requests following information on the command line.



It initially asks requests horizontal alignment from which the profiles are to be generated.

Initial station: The initial station from which one wishes to obtain the cross-sections is entered.

Final station: Station corresponding to the last cross-section cut one wishes to obtain.

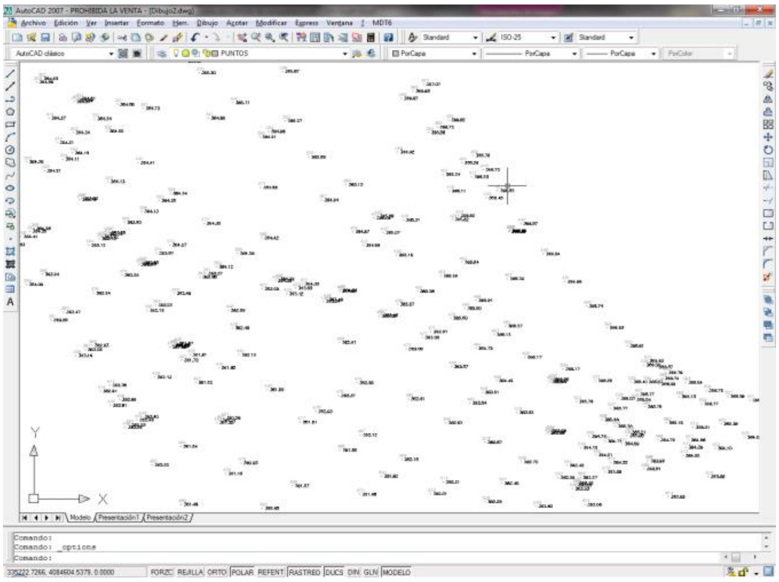
Cross-section width: Indicates the cross-section widths of both sides to generate each of the cuts.

Regression strip: Defines the interval according to which MDT will project the points found to the left and right of the horizontal alignment that will comprise the cross-section profiles.

Interval: Interval with which one wishes to obtain the profiles.

Unique Points: If this option is checked, cross-section cuts are created in the unique points of the horizontal alignment.

Distances: Indicates the exact distances with which to generate the cross-section.



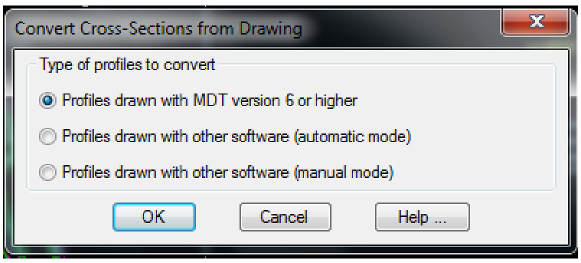
Convert Cross-Sections from Cuts

This command complements **Draw Cuts Manually**, so that one can generate the information about the previously defined profiles on a file with a .TRA extension. In order to do so, it is enough to select all the cuts one intends to use. Then the name the new cross-section file thus generated should be entered.

Convert Cross-Sections from Drawings

This command is particularly useful to obtain the cross-section file in ASCII format from cross-sections represented on the drawing by polylines representing the profiles. There are three alternatives depending on how the drawing was made.

When the command is executed, the following window is displayed to select the operating mode:



Profiles drawn with MDT version 6 or higher

This option is very useful if the profile drawing has been done with MDT version 6.0 or higher and later on the drawing modifications have been made.

In the case that the drawing is a segment drawing, the command will request the corresponding segment as an output file, saving the changes made to the drawing in the natural terrain cross-sections file. If on the contrary, a cross-section has been modified, it will request the corresponding natural terrain file.

Profiles drawn with alternative software (manual mode)

In this case the program will request the following data in the command line:

Terrain: Graphically select the terrain we wish to convert.

Station: Introduce the station corresponding to the terrain selected.

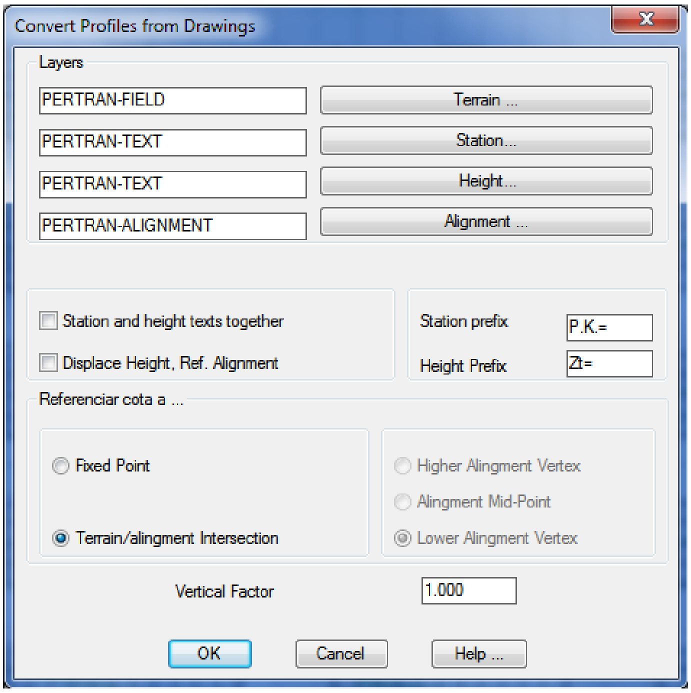
Height: Introduce the height of the terrain selected.

Horizontal alignment position: Graphically select on-screen the vertex corresponding to the position of the horizontal alignment in the cross-section.

When we finish entering the data, MDT will request the file in which we wish to save the profiles obtained.

Profiles drawn with alternative software (automatic mode)

If we select this option the following dialog box will be displayed. A description follows.



Layers: Select the layers where all the cross-section elements are located, meaning: the natural ***Terrain***, the text of the ***Station***, the text of the ***Height*** and the line or polyline that represents the ***Alignment***.

Station and heights texts together: This option must be selected if the station text appears in the same text entity.

Displace Height Ref. Alignment: If this option is activated the height that is to be associated to the cross-section will be the labelled height minus the length of the vertical alignment that corresponds to the cut of the cross-section to convert.

Station prefix.: The text that precedes the number indicating the station of the cross-section cut must be specified. By default "P.K.=".

Height Prefix.: The text to precede the number that indicates the cross-section cut height. By default "Zt=".

Reference height to: These options indicate how to associate the text of the height of each cross-section cut with the position of the horizontal alignment of the same.

1. ***Terrain / alignment intersection***: The height assigned to the position of the cross-section alignment is the height of the corresponding text.

2. ***Fixed point***: In this case the position of the cross-section alignment is assigned the height of the text selected but with a displacement, the behavior of this displacement shall be in accordance with one of the following options.

    a. ***Higher Alignmen Vertext***: In this case the height read in the drawing corresponds to the highest point of the line representing the horizontal alignment.

    b. ***Alignment Mid-Point***: In this case the height read in the drawing corresponds to the mid point of the line representing the horizontal alignment.

    c. ***Lower Alignment Vertex***: In this case the height read in the drawing corresponds to the lowest point of the line representing the horizontal alignment.

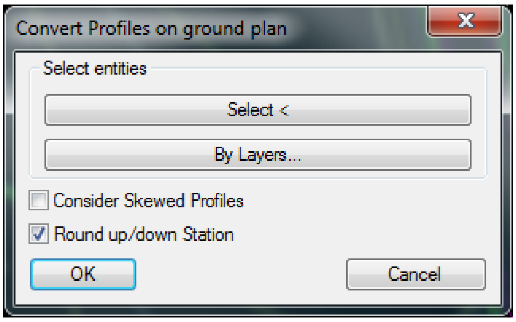
Vertical Factor: By default this is 1, this is the multiplication factor of the height difference of the vertices that comprise the cross-section.

Once the dialog box is validated, MDT will request a cross-section file to transfer the data resulting from the conversion.

Convert Profiles on Plan

This command will allow us to convert to cross sections a series of lines on the ground plan drawn in the mapping. With this in mind, we will initially designate the working alignment and then the cross sections file in which the read drawing profiles will be stored.

Once the alignment and the file have been selected, the following window will appear in which we will establish all the settings required for profile generation.



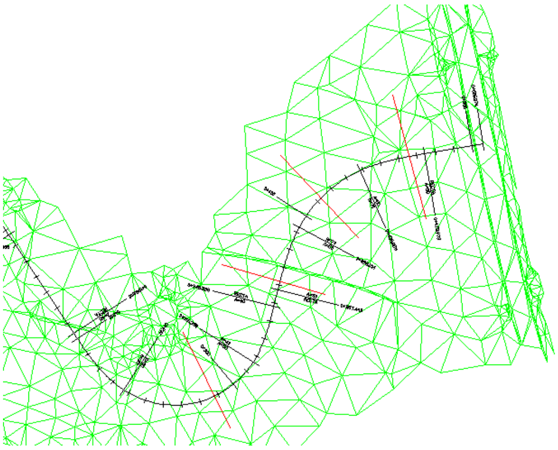
Select elements: We will be able to select the lines or polylines that represent the profiles on the ground plan either graphically or by indicating the layer or layers on which they are situated.

Consider Skewed Profiles: In the event that the lines drawn on the ground plan which represent the cross sections are not normal for the alignment, if this option is enabled these profiles will be generated, otherwise they won't.

If the cross sections are generated, they will be associated with the code “Skewed” to distinguish it from the other profiles. A cross sections will be regarded as skewed when the angular difference from the axis norm is greater than one degree.

Round up/down Station: If we enable this box, the stations associated with the drawing cross sections read will be rounded up/down in multiples of 0.5.

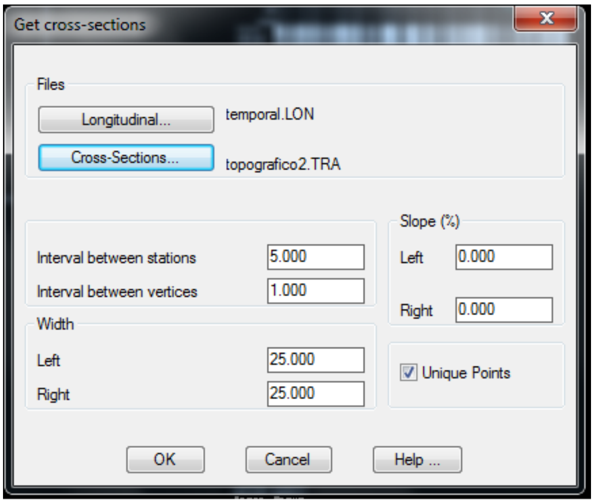
An example has been shown below of an application in which the drawing profiles have been read (red lines), having enabled by default the option “Consider Skewed Profiles” and disabled the “Round up/down stations” option.



288.226	-35.136	364.802	MDT
288.226	-34.509	364.661	MDT
288.226	8.983	360.509	MDT
288.226	13.997	359.911	MDT
288.226	18.852	359.130	MDT
362.073	-32.383	362.042	Esviado
362.073	-26.084	360.825	Esviado
362.073	-18.234	359.275	Esviado
362.073	23.466	353.039	Esviado
362.073	25.053	352.877	Esviado
412.551	-31.391	353.506	Esviado
412.551	-3.493	350.934	Esviado
412.551	5.609	350.306	Esviado
412.551	13.613	350.039	Esviado
412.551	18.765	349.778	Esviado
412.551	27.305	349.512	Esviado
412.551	29.192	349.446	Esviado
465.804	-34.145	348.125	MDT
465.804	-26.171	348.001	MDT
465.804	-24.417	347.887	MDT
465.804	-17.820	347.736	MDT
465.804	-9.207	347.536	MDT
465.804	16.799	347.530	MDT
465.804	28.843	347.671	MDT
465.804	33.049	347.663	MDT

Convert from Profile

From this command we can generate a cross-section file from a profile. When this option is executed the following window will appear.



Longitudinal: File from which the conversion is carried out.

Cross-sections: Name of the new file to generate the cross-sections.

Interval between Stations: Interval of separation of stations that will exist in the new cross-section.

Interval between vertices: Distance and separation that will exist between each one of the vertices of each cross-section cut.

Left width: Left width of the cross-sections from the horizontal alignment.

Right width: Right width of the cross-sections from the horizontal alignment.

Left Slope: Slope percentage from the horizontal alignment to be applied to the left cut. It is understood that 0% equals a totally horizontal cut.

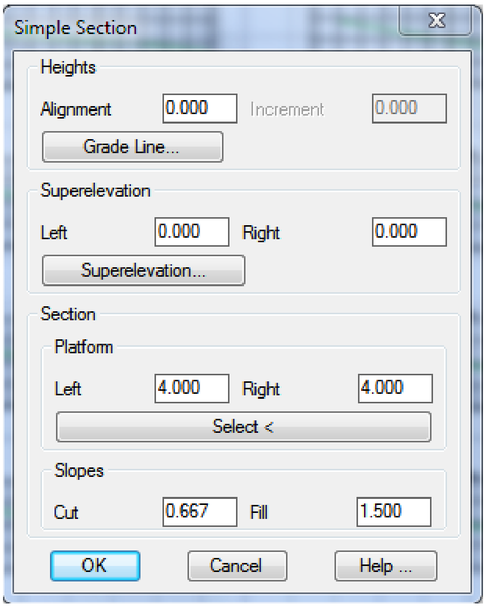
Right Slope: Slope percentage from the horizontal alignment to be applied to the right cut. It is understood that 0% equals a totally horizontal cut.

Unique points: Indicate whether we wish to create cuts equivalent to the unique cross-section cuts.

Convert Simple template

This command is very useful for generating a cross-section file with a cross-section template that can be quickly associated without the need to carry out the entire template definition process.

To do this, at first the program requests the natural terrain cross-section to serve as a pattern for generating the profiles, then the following window is displayed, the characteristics of which are described below.



Height: We can opt to set the horizontal alignment height or on the contrary select a grade line from which we wish to obtain each station height. In the box “Step” we can set a positive or negative variation of the height in regard to that calculated from the grade line.

Superelevation: The possibility to introduce a fixed superelevation along the horizontal alignment or have the information on the superelevations read from the file corresponding to superelevations.

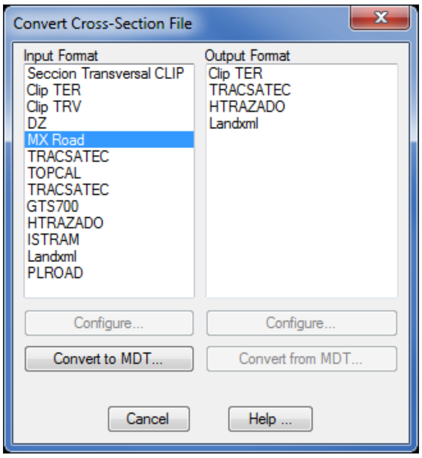
Section: To indicate the basic characteristics of our section.

- **Platform**: We have two options to define the platform:
  - Indicating the width on either side of the platform.
  - Selecting a polyline which represents the platform; this polyline may feature as many vertices as necessary. There should be one vertex in the position of the horizontal alignment.
- **Slopes**: Corresponding cutting and fill slopes.

Last, the program requests a cross-section file to transfer the information generated from the previous data.

Import and Export

This command is used to convert cross-section files from other programs or from other different formats. When the command is executed the following dialog box appears. It is explained below:



If we select any format from the list **Input format** it will automatically enable the lower button **Convert to MDT**. Clicking on this button, it will request the source file that contains the stations in the original format, then the output file to transfer the station information, in MDT format. Optionally, it is possible to enable the ***Configure*** button where some special characteristics may be specified for the selected format.

If we select any format from the list ***Output format*** it will automatically enable the bottom button ***Convert from MDT***. Clicking on this button, it will request the source file that contains the MDT stations, then the output file to transfer the station information, in the format selected. Optionally, it is possible to enable the ***Configure*** button where some special characteristics may be specified for the format we wish to specify.

Edit Cross Sections

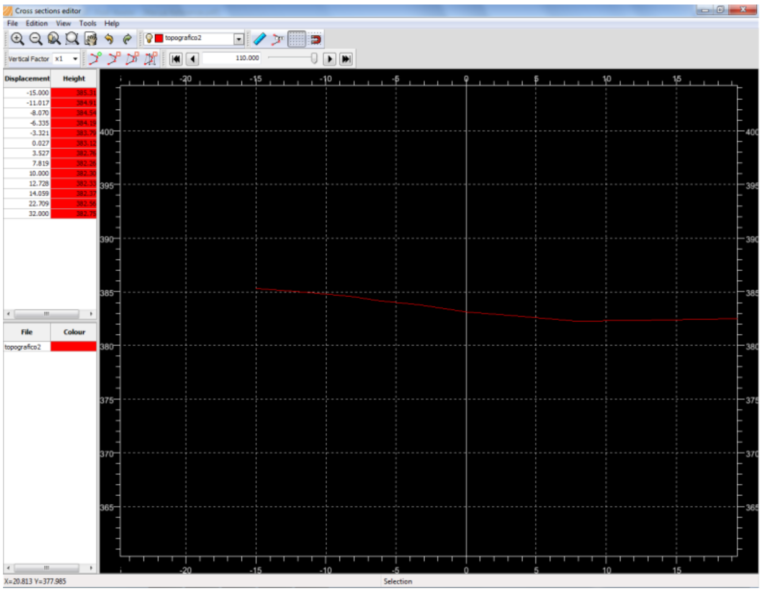
This command allows editing, visualization and modification of cross-section profiles, both for natural terrain (extension `.TRA`) and for roads generated with the segment files. (extension `.SEG`).

After invoking this command, the program will show the window for selecting files, with the two cited valid extensions. Then it describes the characteristics of the windows that appear when executing the command in both modes.

Cross-section Profile Files

After selecting the file the window described below is displayed.

Initially the first cut corresponding to the cross-section group that has been obtained is visualized. If we mouse over the graphic window that appears, we can view the information associated with each one of the cross-section vertices.



The window is divided into two parts; the left shows the information on the open files, and the cross-section data. The right hand part corresponds to the graphic representation of the cross-section.

Several files can be open in the editor at the same time. For a particular station it will show all the cross-sections that we have defined in this station.

The left side of the status bar that appears at the bottom of the window displays the cursor coordinates. The right displays information on the mode we are in (displaying a figure, deleting vertices). It always displays information on the graphic editing of the cross-sections.

Cross-section panel

To the left of the window is a panel giving the station, file, vertices and loaded files.

Then it details the different parts of the panel from top to bottom:

Current station

It is possible to change the station we are viewing by typing a value, or using the displacement bar. By typing a value we go to the station closest to it.

If there are several files, we will move through the ordered list of all the cross-section stations.

To the sides of these controls are buttons for changing the station. From left to right these are:

First: Goes to the initial station of all the cross-sections loaded.

Previous: Goes to the station before the current one.

Next: Goes to the station after the current one.

Last: Goes to the last station of the cross-sections loaded.

Current file

A drop-down window indicates the current file, in the case there are more than one file loaded. This window is displayed for the entire route.

If for a given station cross-sections exist in more than one file, by changing this control we can change the data to be shown.

Cross-section vertices

The current cross-section vertices appear in a table so that they can be modified numerically.

If no cross-section exists for the current station in the file selected, this panel will be disabled, and we will not be able to modify the values.

If we modify the cross-section graphically moving or deleting vertices, this table is automatically updated.

When selecting a specific file, if we view the graphic representation, the vertex corresponding to the marked file will appear. .

File - Colour

In this table we can view the cross-sections that we have loaded. We can also change this to show them in the graphic window, and change their colour.

Graphic representation panel.

A graphic representation of the cross-sections defined in the current stations appears in the right hand section of the main window.

In this window we can adjust, delete, or insert vertices. The toolbars provide assistance to do this.

Tools

The following options are available to modify the cross-sections. They operate with the file that we have selected.

Displace horizontal alignment

Displace the cross-section horizontally, a negative value displaces it left, a positive displaces it right.

We can choose to apply the current cross-section or all the cross-sections. in the file.

It is accessed from ***"Tools->Displace alignment …"***

Displace height

Displaces the cross-section vertically, a negative value displaces it towards the bottom, a positive towards the top.

We can choose to apply the current cross-section or all the cross-sections in the file.

It is accessed from ***"Tools->Displace height…"***

Invert all

Reverses the direction of all the cross-sections of the file we have selected.

It is accessed from ***"Tools->Invert all…"***

The cross-sections generated by MDT generate the vertices towards the right or following the hands of the clock, we can use the invert commands to change the direction and be able to use them in applications in which it is necessary to have points in different directions.

Graphic tools

Toolbars appear in the different editors to access a series of commands, depending on the type of editor, some of them may not be available. In any case, their functioning is common to all editors.

Standard

The most common options appear in this toolbar for moving around the drawing and enlarging an area of interest.

From left to right the buttons are:

Enlarge: Enlarge the drawing with the centre as the point of origin. The mouse wheel can also be used, spinning it forwards, but in this case the point of origin will be the location of the cursor.

Reduce: Reduce the drawing with the centre as the point of origin. The mouse wheel can also be used, spinning it backwards, but in this case the point of origin will be the location of the cursor.

Zoom Extension: Enlarge or reduce the view to be able to see all the elements the drawing contains. It only accounts for the visible layers.

Zoom Window: To enlarge an area of the drawing, the first click of the mouse marks a corner of the window, the second marks the opposite corner.

Displacement: We can move the drawing by clicking on the window and without letting go and moving the mouse.

Layers

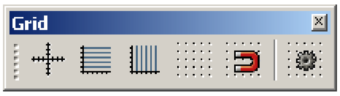
With this toolbar we can show or hide the different layers of the drawing.

By clicking on the drop-down control, it displays a list with all the layers. Each row contains the following fields.

- A visible layer, indicated with a bulb. If it is in grey, the layer is not visible.
- Colour of the layer by default
- Name of the layer

Grid

Contains buttons for activating or deactivating the references on the drawing that we are viewing; they will only be active when the drawing is in 2D.



From left to right the buttons are:

Alignments: Draws the XY alignments on the drawing.

Horizontal Lines: Draws horizontal lines on the drawing to obtain their Y coordinates.

Vertical Lines: Draws vertical lines on the drawing to obtain their X coordinates.

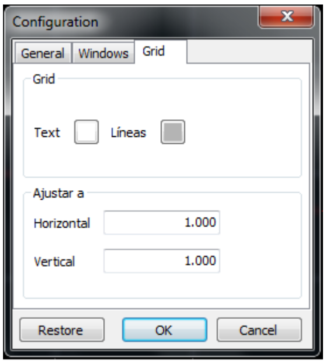
Grid: Activates or deactivates the visualization of the points grid on-screen to have a visual reference.

Adjust the grid: Restricts the coordinates of the cursor to specific coordinates.

Grid properties: This displays a dialog box where we can change the different values of the grid, such as size and colours.

Grid Configuration

The colour of the grid, lines and the drawing's support texts can be changed.



This dialog box appears when we click on the grid configuration button. Although this button appears in the main window and in the editors, the configuration values are all the same.

Horizontal Grid: Separation of the grid points in the X alignment.

Vertical Grid: Separation of the grid points in the Y alignment.

The colour of the text and the points can also be changed by clicking on the corresponding squares.

Adjust to horizontal: Values to which the cursor’s X coordinate will adjust.

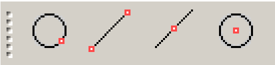
Adjust to vertical: Value to which the cursor’s Y coordinate will adjust.

These two values only apply if the option "Adjust to grid" is activated.

References to figures

References to figures or objects allows for quick selection of precise geometric points in existing figures, without the need to know the exact coordinates of these points. With references to object select the final point of a line or arc, the central point of a circle, or any other significant geometric position.

When we have more than one active reference, it will show the closest one.



From left to right the buttons are:

Point: Mark the point nearest to the position of the cursor. It only applies to point-type figures.

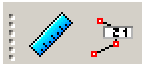
Near: Marks the point nearest to the position of the cursor, applicable to any figure.

Final point: Marks the end of the figure, or of one of its parts that is nearest the position of the mouse. It is not applicable to circles.

Middle Point: Marks the middle point of the figure.

Centre: Marks the centre of the arc or circumference nearest the mouse.

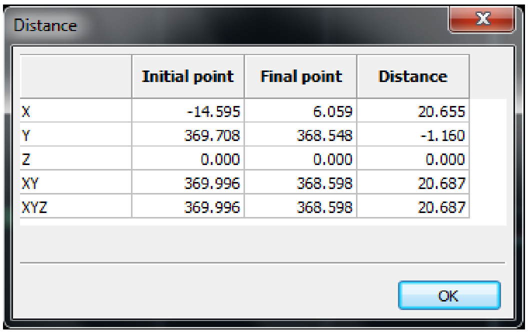
Help



From left to right the buttons are:

Measure: This command measures the distance between two points, first we select the initial point of the measurement, then the end point. The distance measured will appear in the status bar. It is recommended to activate the most suitable reference to figures, otherwise the application can give erroneous data by not using the point coordinates that we think have been selected.

After selecting the second point the following window will appear.



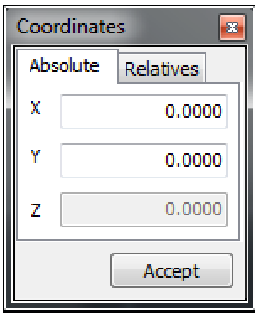
Distance

	Initial point	Final point	Distance
X	-14.595	6.059	20.655
Y	369.708	368.548	-1.160
Z	0.000	0.000	0.000
XY	369.996	368.598	20.687
XYZ	369.996	368.598	20.687

OK

The values of the initial and final point in the XY and XYZ rows correspond to the distance from origin of the points on the XY and XYZ plane, respectively.

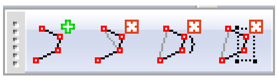
Numerical Editing: Displays the following window in which the coordinates can be measured manually. If the drawing is in two dimensions the control corresponding to the Z coordinate will appear disabled.



After entering the coordinates click the accept button. If in the absolute coordinates tab, the coordinates marked will be added; if in the relative mode tab the coordinates are considered increments from the last point measured.

Modify

Commands to modify the polylines that form a cross-section.



From left to right the buttons are:

Insert vertex: Insert a vertex at the point selected. It must near an arrow.

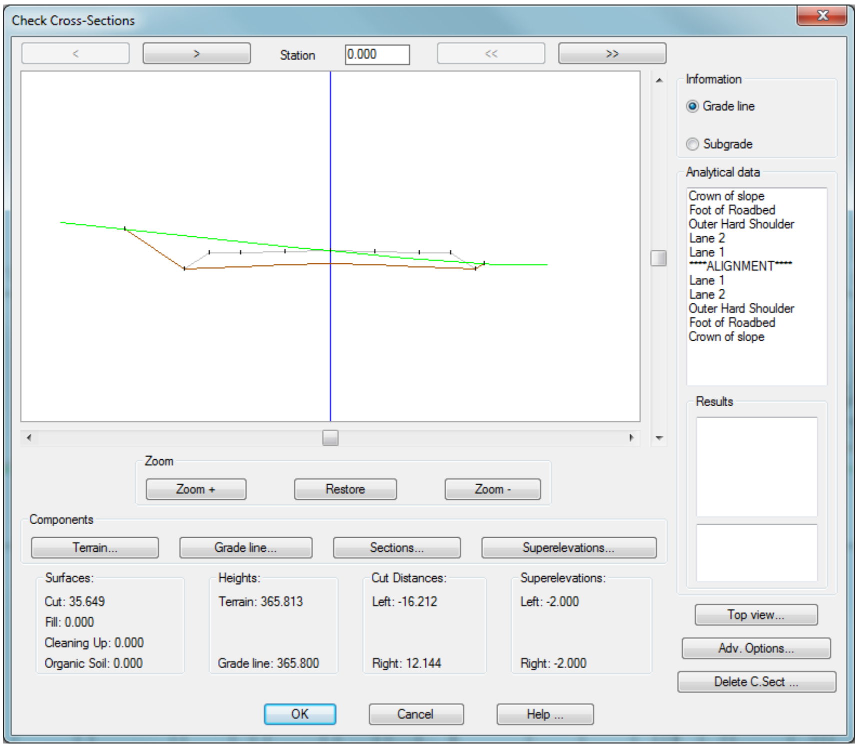
Delete vertex: Delete the vertex selected. It is recommended to have the polyline selected to see where the vertices are.

Delete range of vertices: Two vertices are marked and all vertices between these two are deleted.

Delete vertices window: A square is selected with the mouse and the vertices within it are deleted.

SegmentFile

If we select a segment, a file in which all the road information is contained, in other words, a definition of the longitudinal profile, the horizontal and vertical alignment, the templates etc., we will be able to view and modify its characteristics. At the start the ***Initial Station*** is shown, corresponding to the first cross section of the cross sections contained in the segment. In this window we can distinguish between three well-differentiated sections: a graphic section where the cross section characteristics can be viewed; a data section where the road characteristics can be modified and finally an area in which detailed information about it can be viewed as well as any possible error messages regarding the cross sections construction.



Below we have described each of these sections in detail:

Graphic Window

In this window all the graphic information of the current station of the selected segment can be viewed.

The components thereof can be distinguished between using colours:

- In cyan we can see the definition of the road surface.
- In yellow the composition of the template is defined, in other words, platforms, ditches, slopes etc.
- In green we can see the definition of the existing terrain.
- In white, optionally if defined, the section of the slope will appear.
- For each of the vertices of our template, a mark will appear indicating its position.
- If we mark any of the vertices, the vector type will be enabled in the lists on the right as well as their coordinates, distance from the alignment, elevation ...

Component Editing

Terrain: Upon selecting this button a new window will appear with a definition of the existing terrain. Here we can make modifications both to the graphic window and to the attached numerical list (see the command **Check Cross Sections**). Once the dialogue has been validated, the current dialogue will change in line with the modifications made.

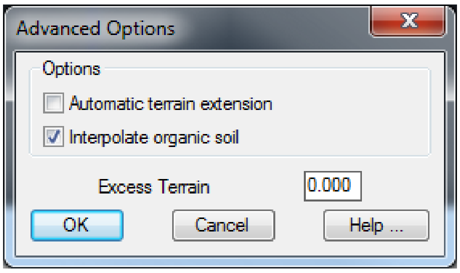
Grade line: Upon selecting this button a list will appear with the gradient associated with the segment we are revising. Any kind of modification can be made to the list which, on validating the dialogue, will be shown in our main window (see **List Grade Line** in the **Grade Line** section).

Sections: Upon selecting this button access is gained to modify any of the templates characteristics associated with the segment being revised. For further detail about the composition of sections consult **Templates Definition** in the chapter **Templates**.

Superelevations: Upon executing this option the characteristics of the cant will automatically appear associated with the segment we are revising. Any changes made to this list will be shown in the current window. For further detail about the characteristics of this list consult **List of Superelevation** command.

Advanced Options

Upon enabling this option we are given three new road configuration options.



Automatic Terrain Extension: This option allows one to automatically extend the terrain until the slope cut of the section defined.

Interpolate Organic Soil: In the case of defining the different thicknesses of organic soil along the horizontal alignment, this option enables interpolation at the transitions.

Excess Terrain: This option is used to specify an extension of the natural terrain from a cut with the crown and foot of the slope.

Top View

When this button is clicked it displays a window independent of the ground plan view drawing of the segment under revision. This command is explained in more detail in the section on “Segments”.

Delete cut

This option enables directly deleting a cut that for some reason is of no interest. In this case the command deletes the cut of the station selected in the segment cross-section file.

Choice of station

<: Goes back to the previous station.

>: Goes forward to the next station.

<<: Goes back to the initial cut of the cross-sections in the segment being checked.

>>**:** Goes forward to the final cut of the cross-sections contained in the segment being checked.

Station: The station entered in this check box will be automatically displayed. If the station entered does not exist in the cross-sections, the program will calculate the template applied to the station entered. The natural terrain will be calculated by interpolating the previous and next profiles.

Image Control

Zoom +: It zooms in on the image so that the central area is enlarged. If one repeatedly clicks this button, the zoom will continue to grow, diminishing the cross-section's field of vision.

Zoom -: On the other hand, this zoom broadens the cross-section's field of vision . In this way, the cross-section's field of vision is broadened.

Restore: Restores the original zoom values.

Information

These controls are divided into three groups.

Surfaces: The cutting, fill and organic soil surface areas of the current cut are displayed.

Heights: The natural terrain and grade line heights are labelled on the horizontal alignment.

Cut Distances: Distances in X from the horizontal alignment to the natural terrain's contact points are displayed.

Superelevations: The superelevation value at the station being viewed is displayed, as long as the superelevation has been previously entered in the segment.

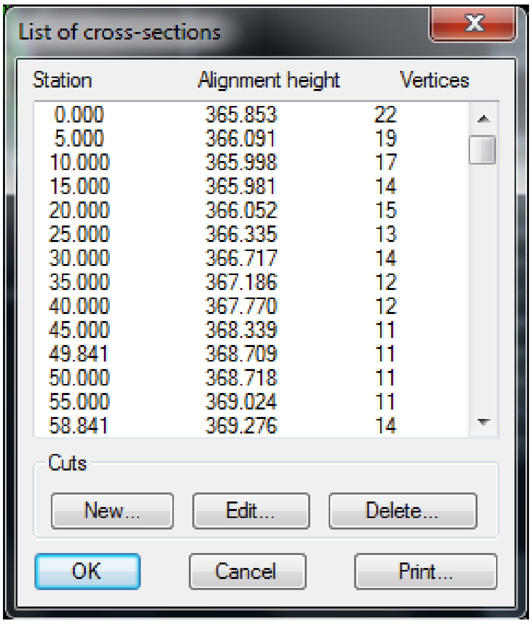
Information: Offers the possibility of extracting information about either the grade line or subgrade vertices, should one so wish.

Analytical Data: All the vertices making up the current cross-section template are displayed on this list. If any of them is activated, its characteristics will be displayed in the lists at the bottom. Additionally, a red point will be drawn on the image at the corresponding vertex.

When the dialog box is validated, all the changes will automatically be reflected in the segment file. Before then, a dialog box will be displayed to confirm the updating of the files linked to the segment.

List Cross-Sections

When this option is selected, the usual file selection window appears containing `.TRA` extension files and the working directory of the last file selected. Once the file desired has been selected, the program will display an on-screen list through the dialog box shown below.

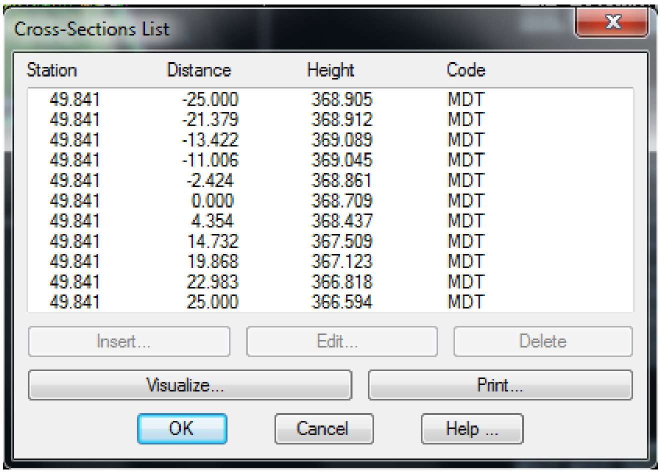


This window displays all the cross-section cuts with the alignment height and the number of vertices of each. All these cuts can be deleted completely, or edited.

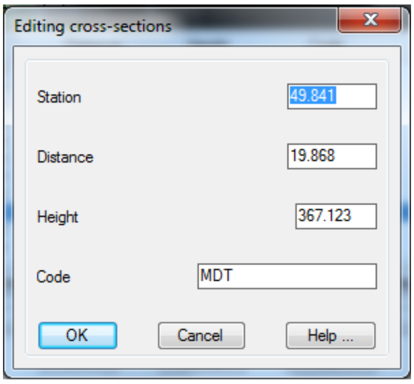
New: To create a new cut.

Edit: Editing of all the cuts of the element selected.

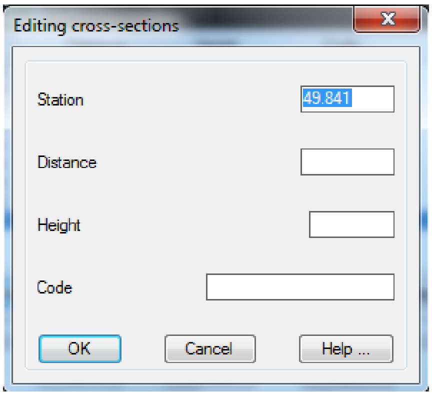
Delete: To completely delete the cut selected. It will delete all the vertices corresponding to the selected code.



Edit: Allows one to change the station, distance, height or code of the station selected. In order to do so, the following window is displayed.



Insert : Allows one to insert new characteristic points in a specific cross-section profile. Subsequently, MDT will update the list and sort the cross-section cuts. The window displayed when the element is inserted is shown below.



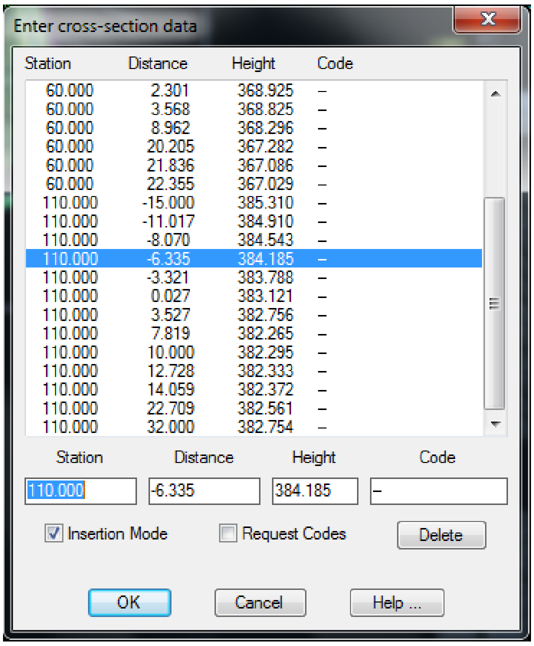
Delete : This deletes the data corresponding to vertex of the cut belonging to the cross-section selected.

Print: Allows the list to be printed on hard copy or sent to a text file.

View: This enables viewing the edited cut with the possibility to make modifications to each of its vertices. Consult the command ***Check Cross-Sections***.

Enter Cross Sections

This command aims to make the manual input of a series of cross-section profiles easier, in addition to their possible modification. When the command is executed, a file is requested, which can either be new (the window will be empty) or an existing file (a list will appear), and then the following dialog box is displayed.



Insertion Mode: If command is not activated, the cut selected will be changed for the one entered using the keyboard. Should it be selected, a new cut will be entered with the data keyed in.

Delete : Deletes the element marked on the list.

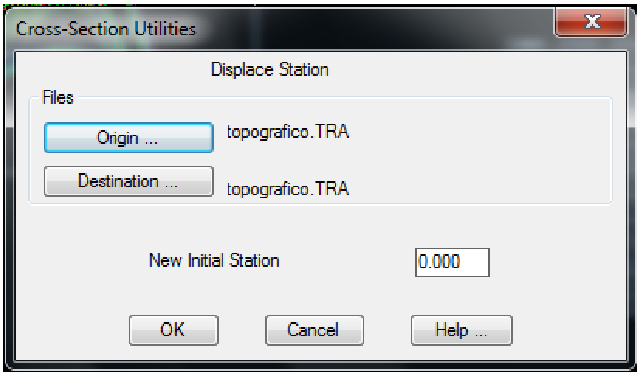
Insertion Mode: If command is not activated, the cut selected will be changed for the one entered using the keyboard. Should it be selected, a new cut will be entered with the data keyed in.

Request Codes: If this command is not activated, the code to be entered through the keyboard will not be requested and the code of the cut selected previously will be automatically assigned. If, on the contrary, the command is selected, one should enter the code using the keyboard.

Move Stations

This option allows one to modify the stations or distances to the origin of a cross-section file. After selecting the file to be modified, the program requests a new **Initial Station.** If one enters a number other than the one proposed, the program takes it as the origin and changes all the values in the file's first column.

When the command is executed, the following dialog box is displayed. One enters the **Source** and **Destination** files, together with the **New Initial Station** to be applied.



MDT automatically creates a backup file of the original file, with the same name and a .BAK extension.

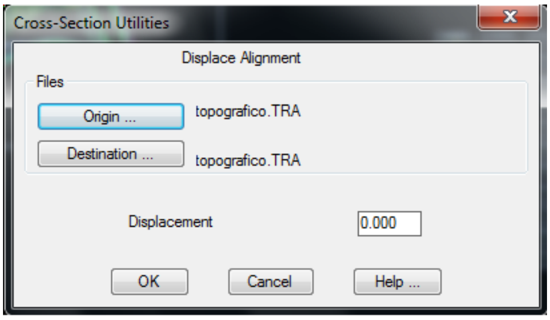
Example: Cross-sections before and after applying a station adjustment of +250.0 m

0.000	-18.520	43.887	TRI	250.000	-18.520	43.887	TRI
0.000	-12.750	44.291	TRI	250.000	-12.750	44.291	TRI
0.000	-8.769	44.612	TRI	250.000	-8.769	44.612	TRI
0.000	0.000	45.318	Alig	250.000	0.000	45.318	Alig
20.000	-17.105	44.611	TRI	270.000	-17.105	44.611	TRI
20.000	-16.140	44.670	TRI	270.000	-16.140	44.670	TRI
20.000	-11.339	44.055	TRI	270.000	-11.339	44.055	TRI
20.000	-3.832	45.434	TRI	270.000	-3.832	45.434	TRI
20.000	9.316	46.121	TRI	270.000	9.316	46.121	TRI
40.000	-14.961	43.283	TRI	290.000	-14.961	43.283	TRI
40.000	-9.458	44.159	TRI	290.000	-9.458	44.159	TRI
40.000	-5.009	47.678	TRI	290.000	-5.009	47.678	TRI
40.000	0.000	48.201	Alig	290.000	3.462	47.503	TRI
40.000	3.462	47.503	TRI	290.000	11.611	48.129	TRI
40.000	11.611	48.129	TRI	290.000	19.677	49.094	TRI

Move Alignment

This utility enables one to modify the entire contents of the profiles' horizontal alignment position using adjustments to the left (negative value) or the right (positive value).

When the command is executed, the following dialog box is displayed, where one enters the **Source** and **Destination** files, together with the **Adjustment** to be applied in relation to the horizontal alignment.



MDT automatically creates a backup file of the original file, with the same name and a .BAK extension.

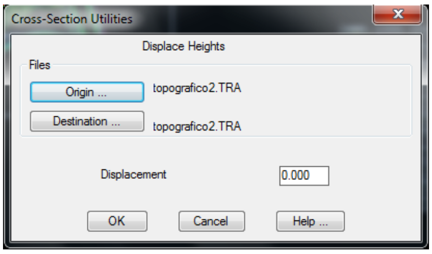
Example: Cross-sections before and after applying a horizontal alignment adjustment of -15.0 m

0.000	-18.520	43.887	TRI	0.000	-33.520	43.887	TRI
0.000	-12.750	44.291	TRI	0.000	-27.750	44.291	TRI
0.000	-8.769	44.612	TRI	0.000	-23.769	44.612	TRI
0.000	0.000	45.318	Alig	0.000	-15.000	45.318	Alig
20.000	-17.105	44.611	TRI	0.000	-15.000	45.318	Alig
20.000	-16.140	44.670	TRI	20.000	-32.105	44.611	TRI
20.000	-11.339	44.055	TRI	20.000	-31.140	44.670	TRI
20.000	-3.832	45.434	TRI	20.000	-26.339	44.055	TRI
20.000	9.316	46.121	TRI	20.000	-18.832	45.434	TRI
40.000	-14.961	43.283	TRI	20.000	-5.684	46.121	TRI
40.000	-9.458	44.159	TRI	40.000	-29.961	43.283	TRI
40.000	-5.009	47.678	TRI	40.000	-24.458	44.159	TRI
40.000	0.000	48.201	Alig	40.000	-20.009	47.678	TRI
40.000	3.462	47.503	TRI	40.000	-15.000	48.201	Alig
40.000	11.611	48.129	TRI	40.000	-11.538	47.503	TRI
40.000	19.677	49.094	TRI	40.000	-3.389	48.129	TRI

Move Heights

This option allows one to modify all the heights in a cross-section file. By marking a the name of the file to be processed on the selection window, one then enters the relative height adjustment (negative or positive).

When the command is executed, the following dialog box appears and one enters the **Source** and **Destination** files, as well as the height **Adjustment** to be applied.



MDT automatically creates a backup file of the original file, with the same name and a .BAK extension.

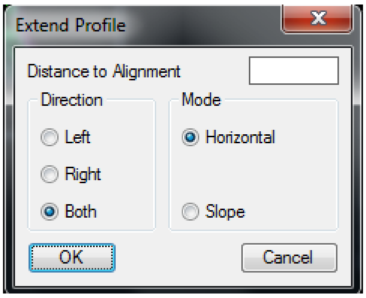
Example: Cross-sections before and after applying a height displacement of +85.0 m

0.000	-18.520	43.887	TRI	0.000	-18.520	128.887	TRI
0.000	-12.750	44.291	TRI	0.000	-12.750	129.291	TRI
0.000	-8.769	44.612	TRI	0.000	-8.769	129.612	TRI
0.000	0.000	45.318	Alig	0.000	0.000	130.318	Alig
20.000	-17.105	44.611	TRI	20.000	-17.105	129.611	TRI
20.000	-16.140	44.670	TRI	20.000	-16.140	129.670	TRI
20.000	-11.339	44.055	TRI	20.000	-11.339	129.055	TRI
20.000	-3.832	45.434	TRI	20.000	-3.832	130.434	TRI
20.000	9.316	46.121	TRI	20.000	9.316	131.121	TRI
40.000	-14.961	43.283	TRI	40.000	-14.961	128.283	TRI
40.000	-9.458	44.159	TRI	40.000	-9.458	129.159	TRI
40.000	-5.009	47.678	TRI	40.000	-5.009	132.678	TRI
40.000	0.000	48.201	Alig	40.000	0.000	133.201	Alig
40.000	3.462	47.503	TRI	40.000	3.462	132.503	TRI
40.000	11.611	48.129	TRI	40.000	11.611	133.129	TRI
40.000	19.677	49.094	TRI	40.000	19.677	134.094	TRI

Extend Cuts

This tool allows one to extend the ends of the cross-section's cuts from the horizontal alignment to the distance desired.

When the command is executed, the program requests the cross-section file in addition to the initial and final stations affected by the changes to be made. The following window is then displayed, where one configures the method that will be used to extend the cuts.



Direction: One selects the side towards which one intends to extend the profile. Either to the left, right or both sides.

Mode: Method to be used to extend the cuts.

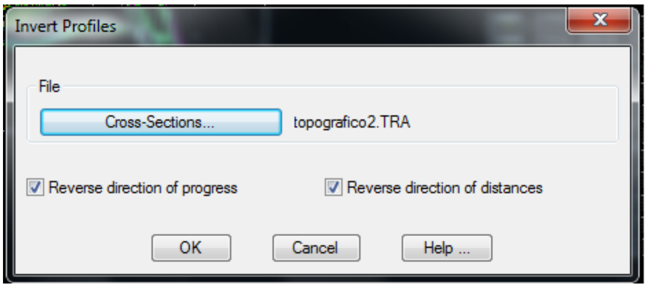
- Horizontal: Assigns the previous or next vertex height.
- Slope: Assigns the height extrapolated from the two previous or next vertices.

Lastly, the program requests a new cross-section file in which the changes made will be saved.

Invert Cross-Sections

This option allows one to entirely transform a cross-section profile regarding its direction and sign, so that the initial station becomes the final station and the positions on the left go to the right and those to the right go to the left.

The program's command line first requests the types of change to be made.



Reverse direction of progress: If this option is activated we reverse the rest of cross-section profiles so that the first cross-section cut will become the last, and the last the first, the second the penultimate, and so on consecutively.

Reverse direction of distances: In this case, if this box is checked, all the cuts are reversed so that what was on the left is now on the right of the alignment and vice versa.

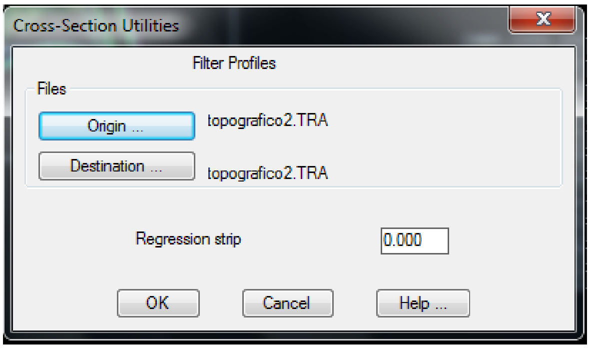
Example: Cross-sections before and after being inverted

0.000	-18.520	43.887	TRI	0.000	-19.677	49.094	TRI
0.000	-12.750	44.291	TRI	0.000	-11.611	48.129	TRI
0.000	-8.769	44.612	TRI	0.000	-3.462	47.503	TRI
0.000	0.000	45.318	EJE	0.000	0.000	48.201	EJE
20.000	-17.105	44.611	TRI	0.000	5.009	47.678	TRI
20.000	-16.140	44.670	TRI	0.000	9.458	44.159	TRI
20.000	-11.339	44.055	TRI	0.000	14.961	43.283	TRI
20.000	-3.832	45.434	TRI	20.000	-9.316	46.121	TRI
20.000	9.316	46.121	TRI	20.000	3.832	45.434	TRI
40.000	-14.961	43.283	TRI	20.000	11.339	44.055	TRI
40.000	-9.458	44.159	TRI	20.000	16.140	44.670	TRI
40.000	-5.009	47.678	TRI	20.000	17.105	44.611	TRI
40.000	0.000	48.201	EJE	40.000	0.000	45.318	EJE
40.000	3.462	47.503	TRI	40.000	8.769	44.612	TRI
40.000	11.611	48.129	TRI	40.000	12.750	44.291	TRI
40.000	19.677	49.094	TRI	40.000	18.520	43.887	TRI

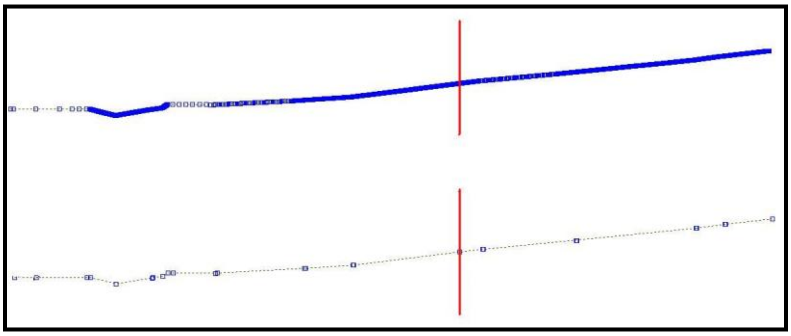
Filter Cross-Sections

This tool is used to reduce the number of vertices in a cross-section file.

The program requests the file to be processed and the size of the **Regression Strip.** It then deletes all the vertices beyond that strip.



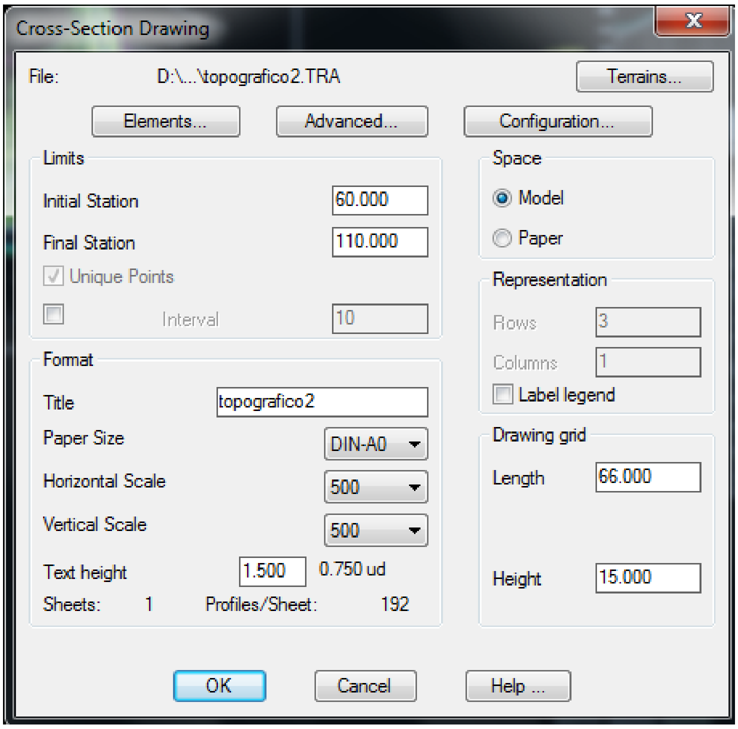
. The below image displays an example of the application of this command, with a regression strip of 0.5.



Draw Cross-Sections PRO

When this command is executed, either the natural terrain cross-sections (.TRA extension), skew profiles (extension .TRE) or the segment containing all the information on the road generated (see **Definition of Segment** in the **Alignments** section) is drawn.

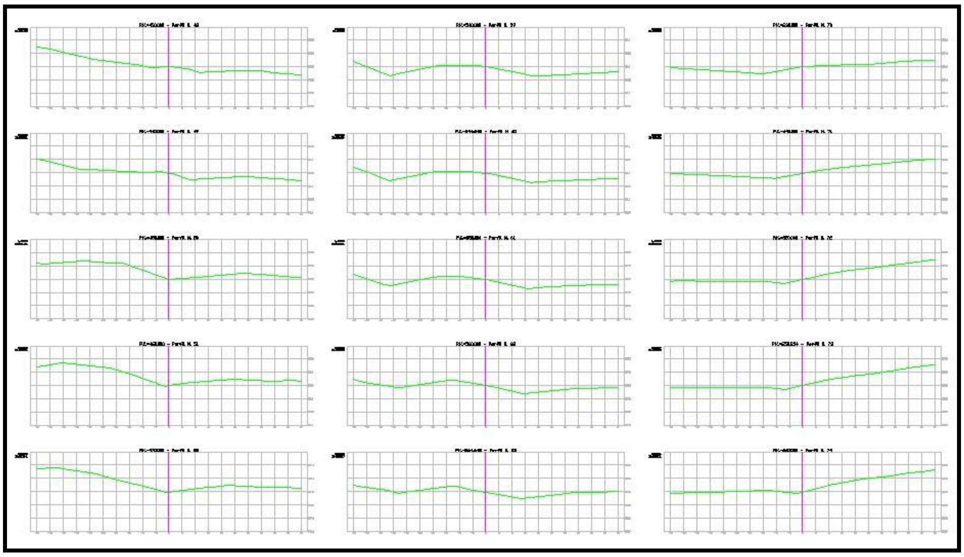
When this command is executed, the program initially displays the .TRA and .SEG file templates and goes to the last folder used. By selecting or keying in a name, one goes to the parameter definition window, where the different options applied to drawing cross-sections can be configured.



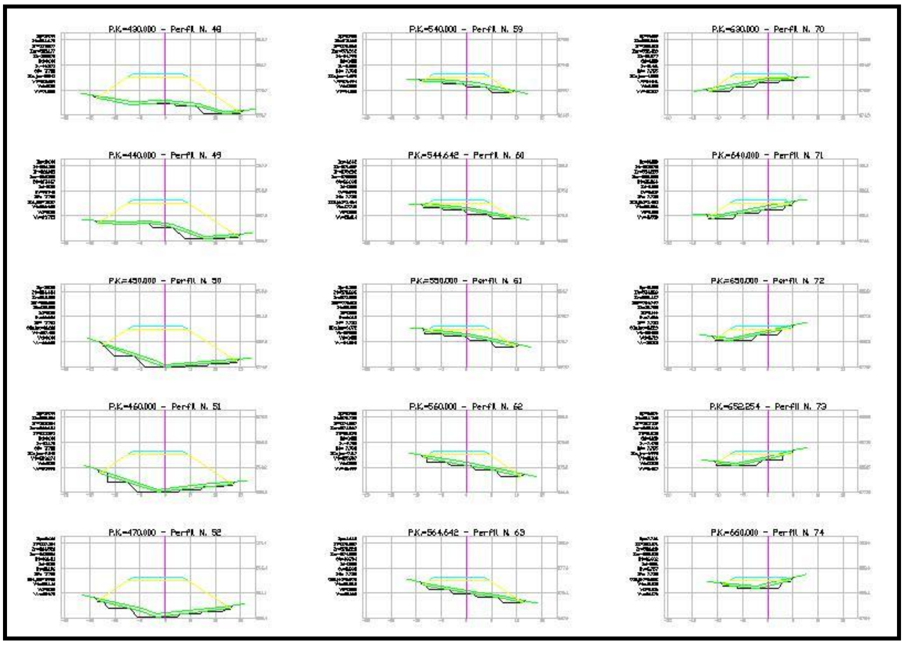
Once all the window's parameters have been set, the source of the top left corner where one wishes to commence their representation is requested. The profile matrixes are then drawn from left to right and top down depending on the drawing direction set.

For continuous format drawings, the project's title and reference are displayed on top left-hand corner. If any of the formats available is selected, the profiles will be distributed on the sheet selected, and as many sheets as may be necessary will be inserted. Each of the sheets contains a series of attributes detailing the drawing's characteristics: horizontal and vertical scales, title, reference, sheet number, total number of sheets and date. To change or create new sheets or attributes, see the **Customization Manual**.

The following image shows an example of cross-sections drawn:



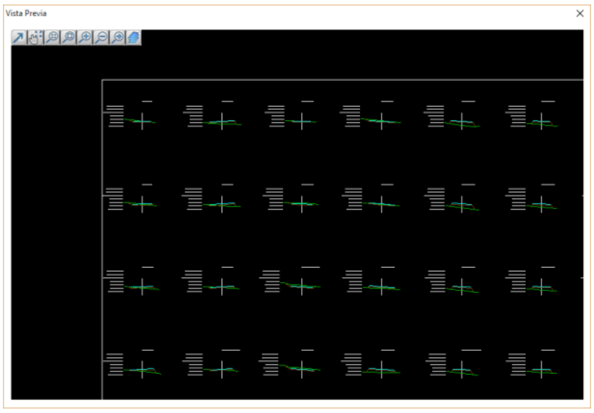
And this image shows an example of a segment drawn:



The controls in this dialog box are described below.

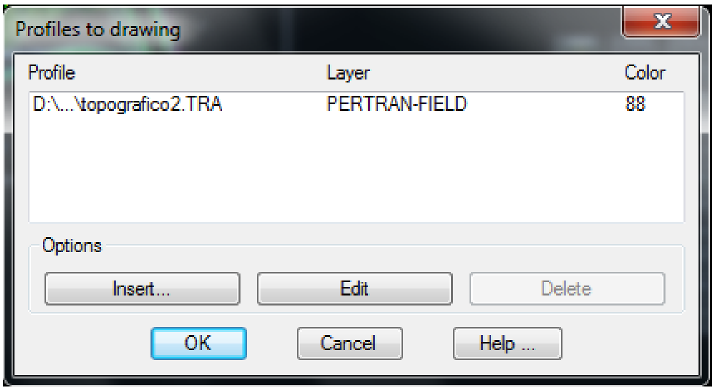
Preview

Prior to drawing the profiles pressing this tab gives us the option of viewing the distribution of the profiles. For example, this option is interesting when drawing on sheets as it enables us to view the distribution of the same and to change the "Height" and "Length" parameters with the aim of removing one of the sheets.



Terrains

This option is used to manage the different terrains to be drawn. It is possible to simultaneously draw all the cross-sections that are necessary, personalizing the colour and the name of each cross-section file.



Limits

Initial Station: The field shows the station from which the profiles are to be represented. It can be changed if one requires the drawing of profiles to start at a later station.

Final Station: This field, on the other hand, shows the last profile of the file selected. This value can likewise be changed if one wishes to end the list at station before the last one.

Unique Points: Only available for the segment drawing and offers one the chance of choosing whether or not to draw the horizontal alignment's unique points.

Interval: This option allows one to set the representation interval desired, as long as the cross-section stations to be drawn exist.

Spaces

If **Model Space** is selected, the profile's drawing will be drawn normally, that is to say from the initial point selected on screen.

Should **Paper Space** be selected, it will be drawn using the pre-set paper space option in AutoCAD. This option is not available for AutoCAD 14 and compatibles.

In the latter option, the program will assign a **Title** to each of the presentations it creates preceded by the "LON_" prefix and ending with an index corresponding to the number of sheets. For instance, LON_ROAD1.

Additionally, should a "Paper Space" already exist with the same name, the program will issue a warning that it already exists and ask whether the user wishes to delete it or create it again.

Format

Title: Once the profile is drawn, the title entered will appear on the top of the drawing.

Paper Size: This check box is used to select the size of the paper. One can choose among the different formats contemplated for distribution on sheets (defined in the `HOJAS.DAT` file). If one does not wish to split the drawing, the **Continuous** option (default value) should be selected.

It is possible to modify the name, size and contents of the formats proposed. In order to do so, the blocks in the `BLOCKS` folder of the program's root directory should be modified.

Concerning scale fields, it is necessary to take into account that the drawing's scale is determined by text size in AutoCAD, as the drawing is only generated on a scale of 1:1 and proportionally to the horizontal / vertical relation. The default value of both fields will be 1:200.

Horizontal Scale: This drop-down list displays all the scales defined in the `ESCALAS.DAT` file in the MDT configuration directory. It is possible to complete the list with other usual values.

Vertical Scale: Same as the previous paragraph. The possibility of defining a vertical scale on the cross-section drawing has been thought up to make it possible to observe height differences in very long profiles having very small height differences without having the need to continuously enlarge the drawing on screen.

Text Height: The value for the height of the texts that will be labelled on the cross-section drawing is entered.

If one selects a sheet format using scale control, the number of sheets and profiles per sheet to be represented on the drawing will be displayed.

Presentation

Rows and **Columns**: Both boxes are interrelated, depending on the number of profiles to be drawn. The initial values are calculated so that there is approximately the same number of rows and columns. If one figure is changed, the other will automatically be recalculated, so that the rows multiplied by the columns provides the approximate number of profiles. Both boxes are enabled with the continuous drawing option, because these values are automatically calculated when a sheet size is selected.

Label legend: If this option is activated an additional text will be labelled in the point selected by the user meaning that all the legends are labelled in the cross-section drawing.

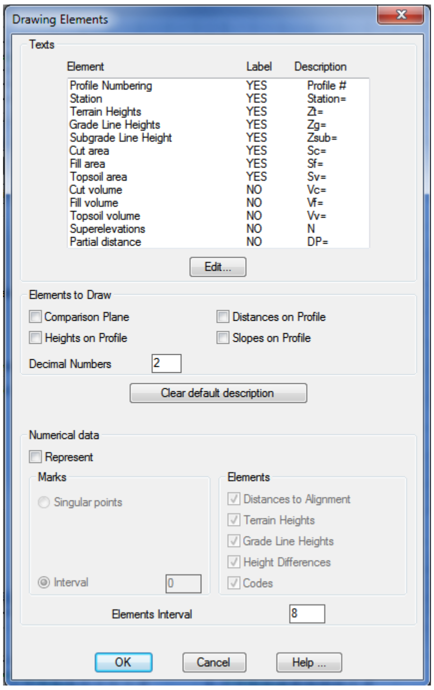
Drawing Elements

***Length and Height*:** The command will automatically calculate these values from the file selected. It represents the width and height of the element in which each of the cross-sections is drawn. It also displays minimum and maximum values that serve as orientation for the user when it comes to deciding the values of these parameters.

If these margins are considered excessive, (as they measure the module of each element of the drawing grid matrix), both values can be reduced, so that a higher number of profiles can be entered in the selected format.

Elements

When this button is clicked, one accesses a new window where a series of profile characteristics the program can label on the drawing is displayed. The window in which these appear is shown below and a description of its characteristics appears further below.



Element

For each of the elements associated with the cross-section we have the option of indicating if we wish to draw it, in addition to the text as a prefix which will appear in the drawing of the profile.

Profile Numbering: When this box is activated, an increasing ordinal starting from the number one is displayed for each profile drawn.

Station: The box is enabled by default and it shows the station or distance to origin.

Partial Distances: Indicates the distance with respect to the previous cut.

Terrain Height: Also enabled by default, because it is of great help to configure the comparison plan at the intersection of the terrain with the horizontal alignment's position. This height is displayed with the "Zt=" prefix beneath the above-mentioned text. If the **Numerical data** option is activated, it appears as another element included in this data.

Grade Line Height: This box is only active when the profile file to be drawn comes from a segment file, in which case there is grade line information. It is displayed with the "Zr=" prefix. Similarly, if the **Numerical Data** option is activated, it appears as an element included in this data.

Subgrade line height: This option is only available in the case of selecting a segment and the subgrade is to be labelled at each cut, whenever the corresponding cut has an assigned roadbed.

Surfaces: Like the previous option, it is only active under the same conditions. Its text is positioned to the right of the horizontal alignment, symmetrical to the above-mentioned texts.

We can choose from the following drawings:

- Cut Surface
- Fill Surface
- Plant Surface

The representation format is "Sd=" for the cutting surface and "St=" for the fill surface.

Volumes: Displays the calculation of the volume between the current station and the immediately previous one.

We can choose from the following drawings:

- Cut Volume
- Fill Volume

- Plant Volume

The drawing format default is “Vd =” for the cut surface, “Vt =” for the fill surface and “Vv =” for the plant surface.

Superelevations: Labels the superelevation to be applied both to the left as well as to the right of the station belonging to the segment to be drawn.

Elements to be labeled

Comparison plan: Features a horizontal line for each cut with a reference height.

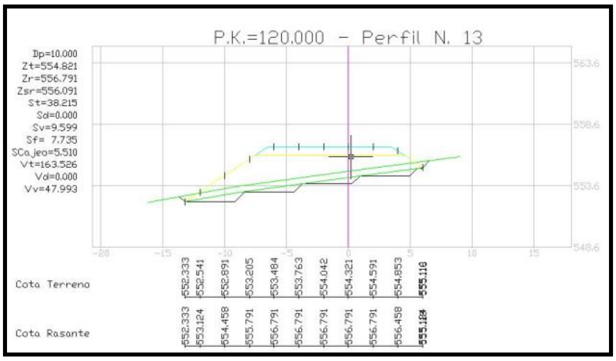
Heights on Profile: Displays heights on the terrain line at each of the points defining the cross-section.

Distances on Profile: Indicates the distances to the horizontal alignment beneath the terrain line at each of the points defining the cross-section.

Slopes in Profile: Shows the slopes of each of the vectors. Illustrated in each of the sections of the polyline. The value of the same is labeled per hundred.

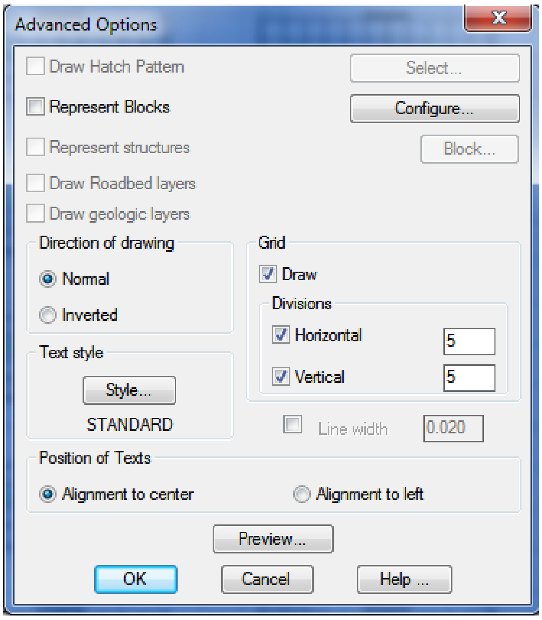
Numerical data: In this section the numerical data associated with the cross-section profiles is activated and configured: Terrain heights, Grade line heights, cut/fill, and codes, depending on whether a segment or a cross-section is selected.

The following image displays a representation of a profile with associated numerical data:



Advanced

One can configure other profile drawing options using this command.

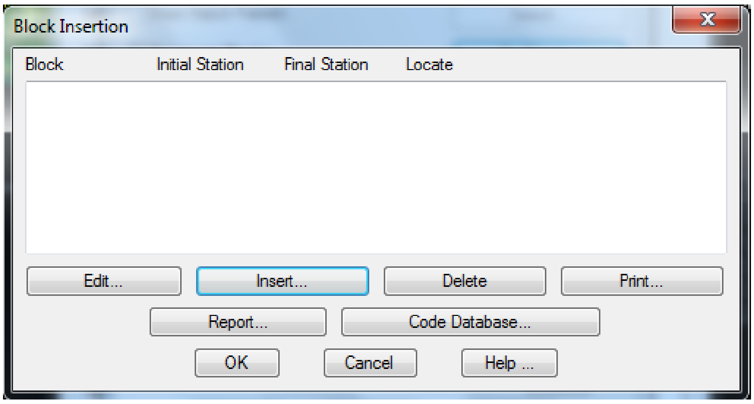


Draw Hatch Pattern: This option is only available for segment drawings. Should it be activated, it will draw a hatched pattern in the surface area to be measured cubically.

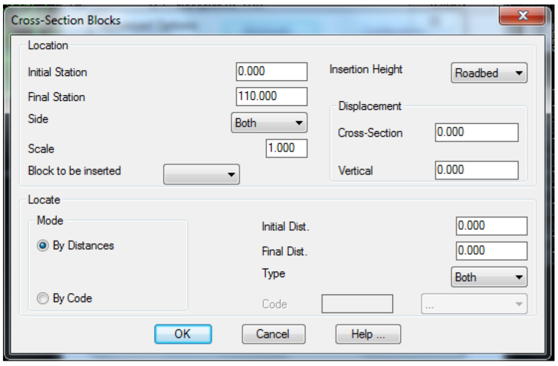
The hatch pattern can be selected by clicking on the **Select** button.

Represent Blocks: This option allows one to select the blocks one wishes to draw along with the cross-section.

If the **Configure** button is clicked, the following window is displayed where the insertion point of each of the blocks one wishes to insert along the different cross-section cuts is specified.



The following dialog box is displayed to insert or modify blocks in cross-section drawings.



Everything concerning the definition and management of blocks is explained in greater detail in the **Alignments >Blocks Definition** section.

Represent Structures: If this option is checked, if there are structures in the segment definition, it will represent the block selected in the stations where the structure exists.

Group Elements: This option allows one to represent the set of cross-sections as if it were an AutoCAD block. This enables one to treat all the profiles as if they were a single object.

Draw Roadbed Layers: This option is only available for segment drawings. Should it be activated, the program will draw the roadbed layers associated to the cross-section defined if roadbed layers have been defined for it.

Direction of Drawing: The possibility exists of specifying the way in which the cross-sections will be drawn.

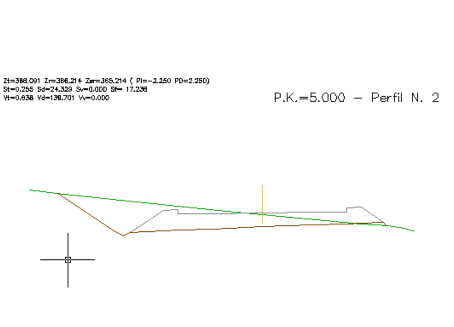
- **Normal**: The drawing is first made in columns and then in rows. The upper left-hand cut is the first station. (Direction of drawing top – down).
- **Inverted:** Likewise, columns are drawn first and then files are drawn. However, in this case, the initial station corresponds to the lower left-hand corner. (Direction of drawing bottom – up).

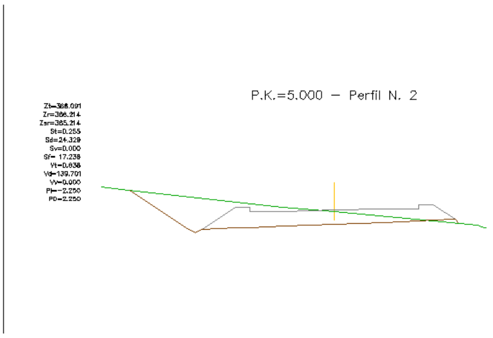
Text Style: Select the text style to be associated with the texts labelling the cross-section drawing. By clicking on “Styles” any of the styles previously configured in AutoCAD may be selected.

Grid: This option allows drawing a grid associated with each cut to be drawn, the intervals between the long marks and short marks can be personalized.

Line Thickness: Indicates the thickness with which the cross-section lines will be drawn.

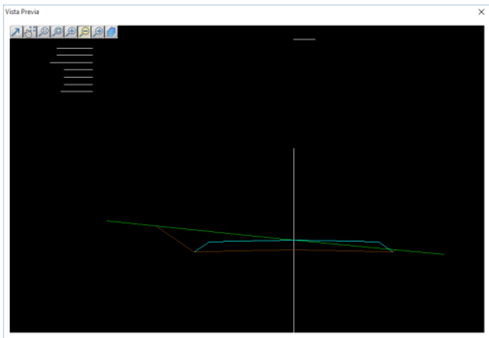
Position of the Texts: We may choose the position in which the texts associated with each cross-section are to be labeled. The text can be inserted horizontally in the upper left part of each profile or vertically on the left of each cut.





Horizontal alignment **Vertical alignment**

Preview: Selecting this tab will enable us to view the drawing of one of the profiles and the position of the texts.

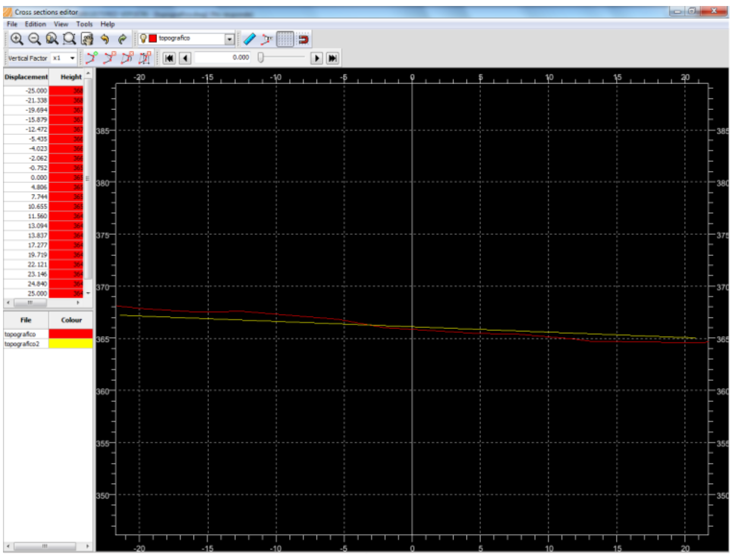


Insert Cross-Sections in Phases

This command allows one to view the evolution of earthworks on screen by graphically comparing different cross-section files corresponding to different phases or stages of the work.

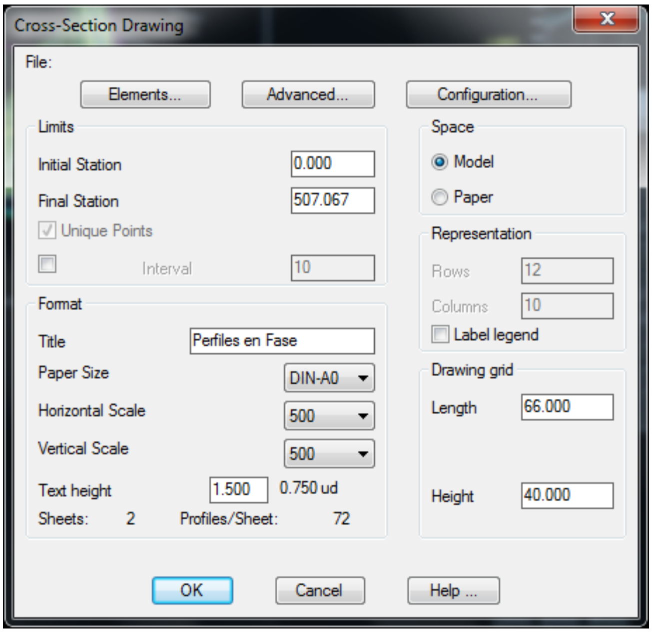
The program successively requests each of the cross-sections one wishes to view. Once all the files are selected, the **Cancel** button should be clicked to prevent the input of more files.

Lastly, the program displays the window shown below:



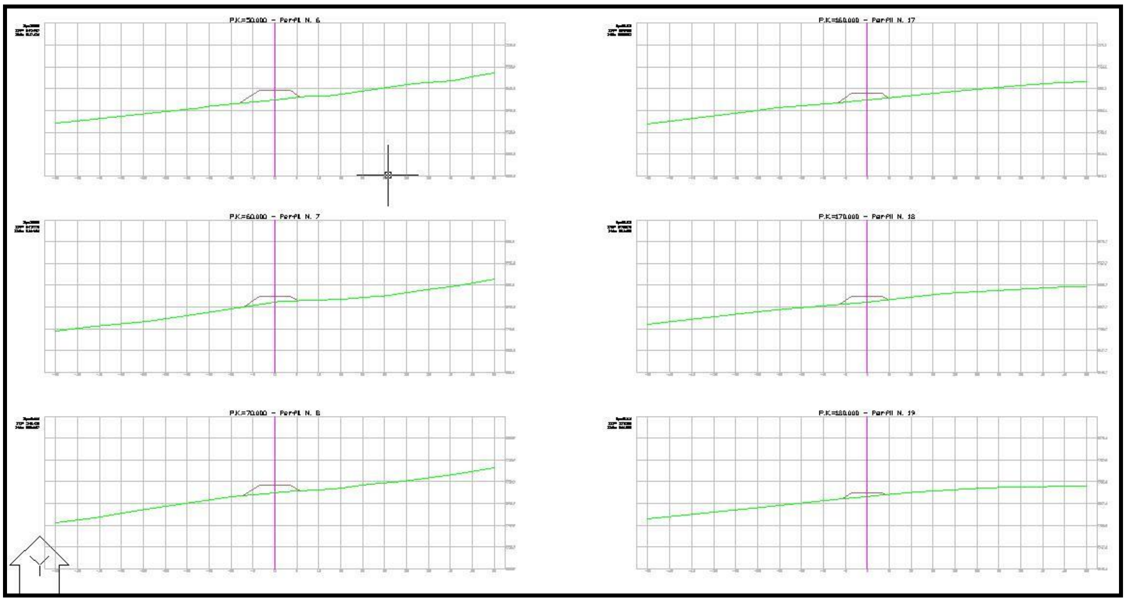
This dialog box's characteristics are described in detail in the **Edit Cross-Sections** section.

In addition, the **Draw** button is displayed, which takes one to the cross-section profile drawing window.



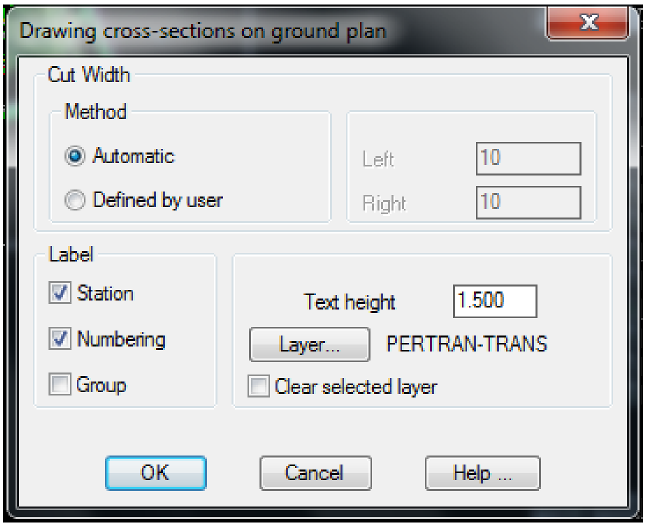
A detailed description of this dialog box can be found in the **Cross-Sections > Draw Cross-Sections** section.

Finally, an example of this command is shown below.



Draw Cross Sections on Plan

Using this command allows one to draw the cross-sections obtained. The dialog box that is displayed when the command is executed is shown below.



Method: Select the drawing type for the cuts in ground plan view.

- **Automatic:** In this case the width of the cross-section drawing in ground plan will be the one that corresponds in the selected cross-section file. So that depending on the width of each cut, there may be cuts with different right and left lengths.
- ***Defined by user:*** For this case, on the contrary, we specify in the "Left" and "Right" fields the width that we want the cross-sections to have in ground plan, which is the same for all cuts.

Label Station and **Numbering**: When the cross-section is drawn on the ground plan, these options will be labelled next to the cross-sections if either of them is activated

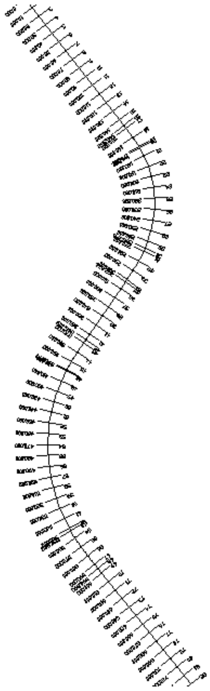
Group: This allows one to group all the lines representing the cross-sections to be drawn in a single block. It makes it easier to adjust or delete them subsequently.

Text Height: One specifies the height of the texts used to label in this box, if the relevant check boxes have been marked.

Layers: One selects the layer on which the cross-sections will be drawn on the ground plan. The program proposes the TRANS layer by default.

Clear selected layer: If this box is checked, all the entities found in the layer selected for the cuts drawing will be deleted.

Once the dialog box has been validated, MDT will draw them with the options selected.



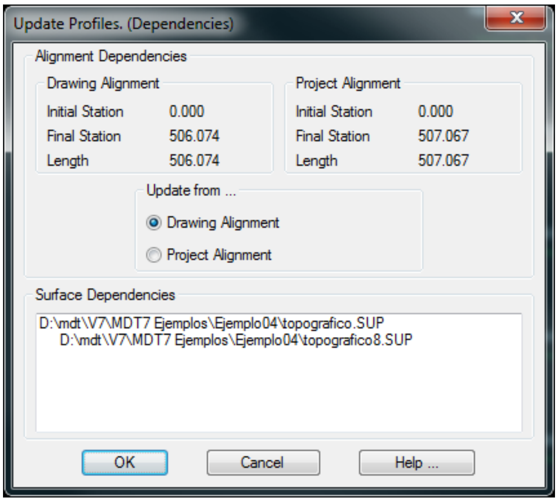
Update Cross Sections

Using this command we can automatically update the drawing of a group of cross sections prior to modification of the alignment or the surface from which it has been generated.

With this in mind, it is vital for there to be an active project in such a way that MDT is able to automatically detect the dependences between the cross sections drawn and the other project components.

Upon executing the command the program will request the cross section to be updated; once designated (we will select the title associated therewith), if the program detects that any modification has been made either to the alignment or to the surface from which it was generated, the profiles will be generated and drawn again automatically.

The circumstance may arise that the alignment or surface in the drawing has been modified and the corresponding file has not been modified or vice versa; in this case, the command will show a window in which the user must select from which information it wishes to automatically update the profiles.



Alignment Dependencies: We establish the alignment from which the cross sections will be regenerated.

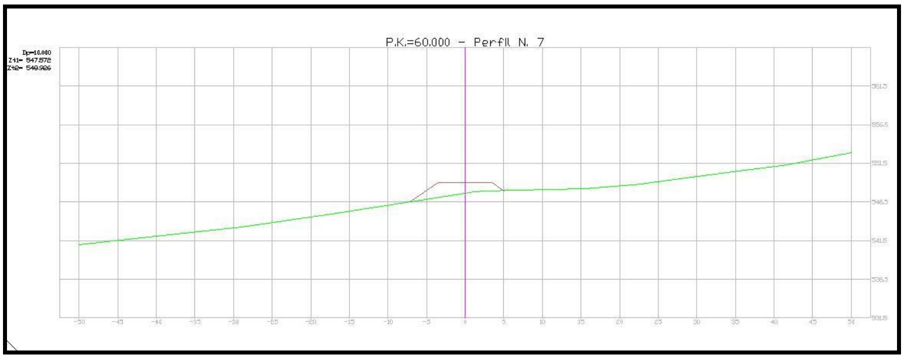
Surface Dependencies: In the event that modifications have been made to the surface from which the profile was originally generated, in this section we will be able to designate from which of them we wish to update its information.

Delete Cross Sections

This command will allow us to remove from the drawing a group of cross sections drawn beforehand. With this in mind, after executing the command, just select the title associated with the group of cross sections drawn. Once selected, all the cross sections will be deleted automatically along with the information associated with each of them (texts, alignment, grade line, top soil…).

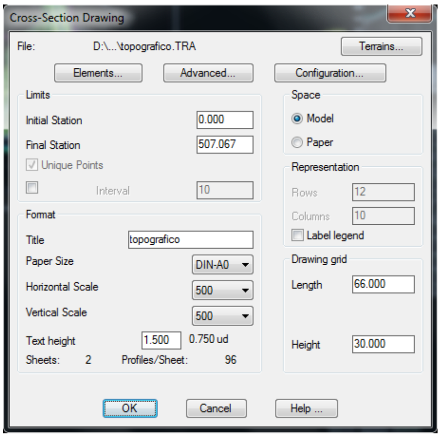
Locate Cross-Sections

Using this command, one can locate the cross-section corresponding to a certain station on a cross-section matrix by zooming around it. Should there be more than one cross-section profile matrix in the command line, a message is issued requesting one to select the horizontal alignment of the matrix in which one wishes to search



Draw Skewed Cross Sections

This option enables drawing the sections of the skew cross-sections that we have generated with the corresponding command. When the command is executed, it will request the segment file associated to the skew cross-sections file, then the following window will be displayed for configuring the profiles drawing. (There is a description of this window in **Draw Profiles**.)



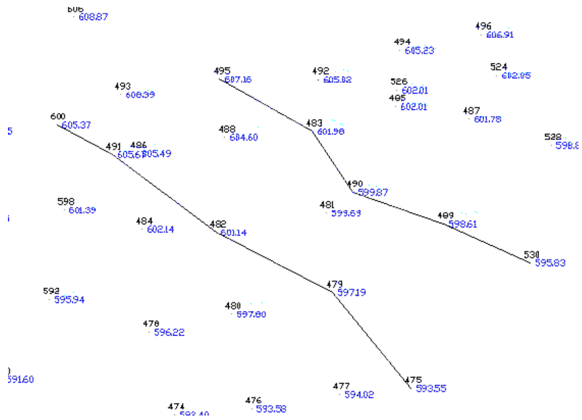
Once the drawing is done it is possible to check whether the dimensions of the section associated are variable in terms of the skew of each cut of the skewed cross-sections inserted in the segment.

Draw Cuts

The working of this command is linked to **Convert Cross-Sections from Cuts**. Its aim is to put together cross-sections by selecting surveying points from left to right and determining the station (either manually or automatically using a constant interval), in addition to positioning the horizontal alignment's point. The selection of these profile components as well as of the horizontal alignment is done by the positioning of the closest point.

The command area of the program requests the **Initial Station** and the **Interval** (constant distance between profiles). If the latter is constant, its value is indicated. It is zero if one wishes the program to request it for each station. The selection of points on the same profile is displayed by the creation of a 3D polyline joining the points selected on the XSECTIONS layer.

After joining all the points defining the profiles one by one, the **Convert Cross-Sections from Cuts** command should be executed, which reads what is represented in the formation.



Project Polyline to Cross-Sections

This tool allows one to represent a section of a 3D polyline on the cross-sections. It is used a lot in jobs containing pipelines, power lines, etc. when one wishes to show the position of the piping on the cross-section.

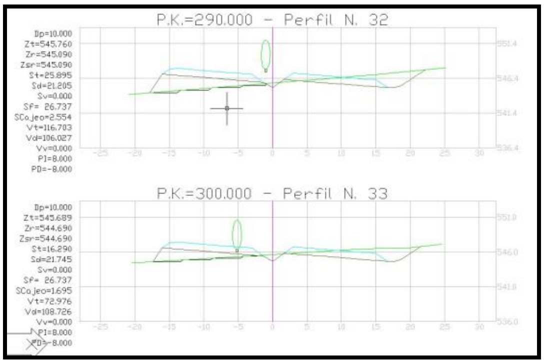
To do this it will request the following parameters:

3D Polylines: Select the 3D polylines that we wish to Project, which will be within the band width of the cross-section profiles. If they are not, they are not represented in cuts in which the distance to the alignment is greater than the cross-section width.

Alignment: Alignment on which the polyline will be projected.

Profile Matrix: Select any of the horizontal alignments of any of the profile matrix cuts in which we want to Project the polylines.

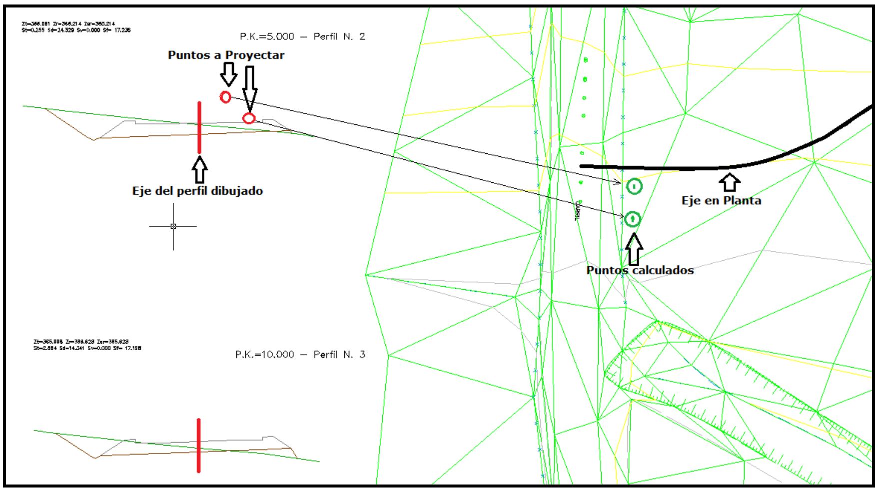
Last, the **Drawing Blocks** window appears for selecting the block to be used to represent the section.



The command is accessed from the "***Elevation***" folder in the blocks folder in the configuration. For this, if we wish to draw a specific block, it is enough to include it in this folder and it will appear automatically when the command is executed.

Project Points in Plan View

This tool is designed to calculate points over the survey from points selected in the drawing of cross sections. It would be really the opposite of the previous command, so that we would calculate the projection of the designated points on the cross sections drawn.



The program will ask for the following data:

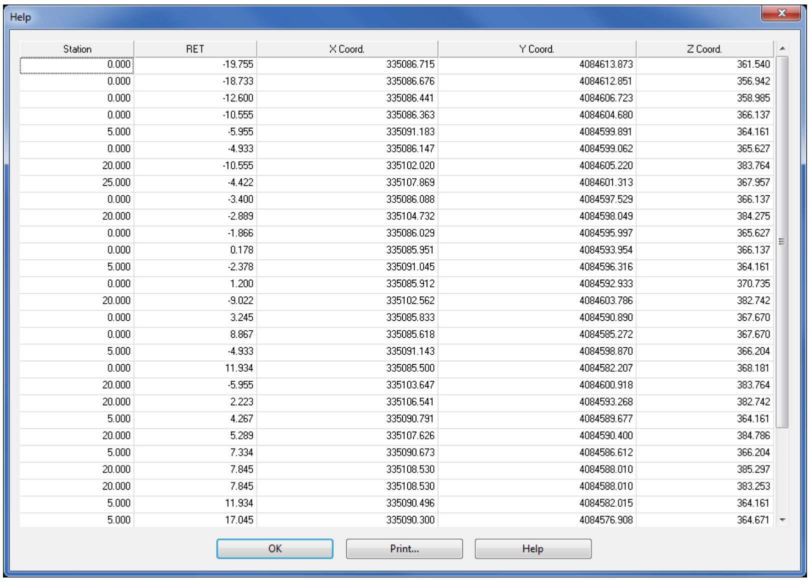
1. Horizontal alignment in order to project points
2. Axis of the cross section drawn
3. Points to project, selected on the drawing of cross section, that would be automatically drawn on the survey.

After entering these parameters the program will ask for the block we want to draw on the survey.

This block can be selected from a list.

This process could be repeated as often as cross sections have then drawn.

After finishing the execution of the command a list of all points calculated will be shown.



Help

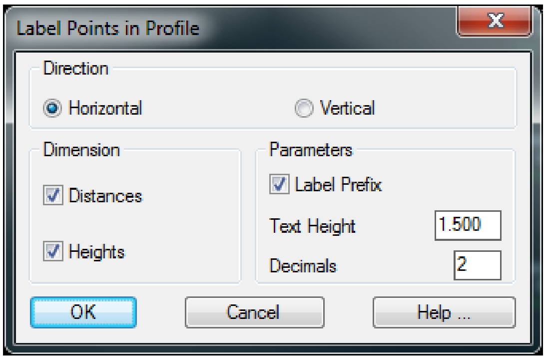
Station	RET	X Coord.	Y Coord.	Z Coord.
0.000	-19.755	335086.715	4084613.873	361.540
0.000	-18.733	335086.676	4084612.851	356.942
0.000	-12.600	335086.441	4084606.723	358.985
0.000	-10.555	335086.363	4084604.680	366.137
5.000	-5.955	335091.183	4084599.891	364.161
0.000	-4.933	335086.147	4084599.062	365.627
20.000	-10.555	335102.020	4084605.220	383.764
25.000	-4.422	335107.869	4084601.313	367.957
0.000	-3.400	335086.088	4084597.529	366.137
20.000	-2.889	335104.732	4084598.049	384.275
0.000	-1.866	335086.029	4084595.997	365.627
0.000	0.178	335085.951	4084593.954	366.137
5.000	-2.378	335091.045	4084596.316	364.161
0.000	1.200	335085.912	4084592.933	370.735
20.000	-9.022	335102.562	4084603.786	382.742
0.000	3.245	335085.833	4084590.890	367.670
0.000	8.867	335085.618	4084585.272	367.670
5.000	-4.933	335091.143	4084598.870	366.204
0.000	11.934	335085.500	4084582.207	368.181
20.000	-5.955	335103.647	4084600.918	383.764
20.000	2.223	335106.541	4084593.268	382.742
5.000	4.267	335090.791	4084589.677	364.161
20.000	5.289	335107.626	4084590.400	384.786
5.000	7.334	335090.673	4084586.612	366.204
20.000	7.845	335108.530	4084588.010	385.297
20.000	7.845	335108.530	4084588.010	383.253
5.000	11.934	335090.496	4084582.015	364.161
5.000	17.045	335090.300	4084576.908	364.671

OK Print... Help

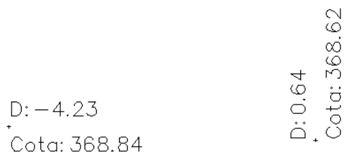
Label distances and elevations in Profile

Using this option we can label the distance from the alignment and the elevation of the designated point on the cross section drawn beforehand.

With this in mind, upon executing the command, the following window will appear which is described below.



Direction: This allows us to indicate whether we wish to label the aligned texts horizontally or vertically.



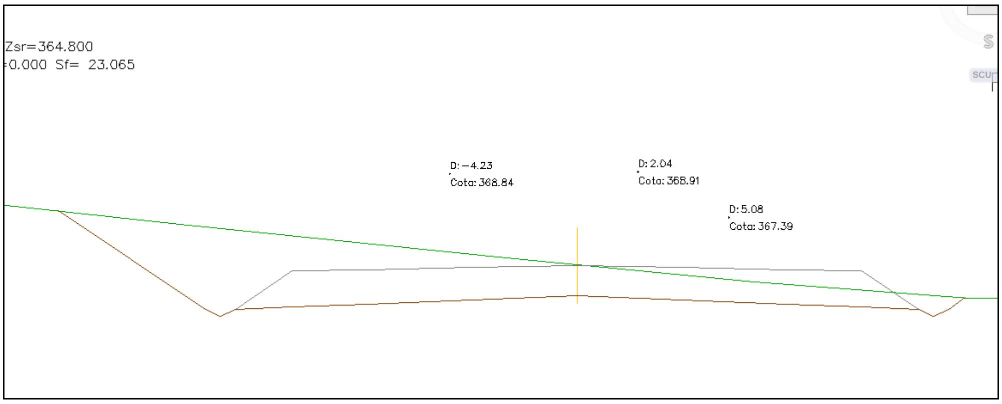
Dimension: We indicate whether we wish to label the station, the elevation or both.

Label Prefix: If we enable this box, in the case of the distance from the axis, the text "D:" will be labelled before the numerical value. and in the case of the elevation the text "Elevation:".

Text Height: We set the height to the texts to be drawn.

Decimals: We establish the number of decimal points both for the station and for the elevation.

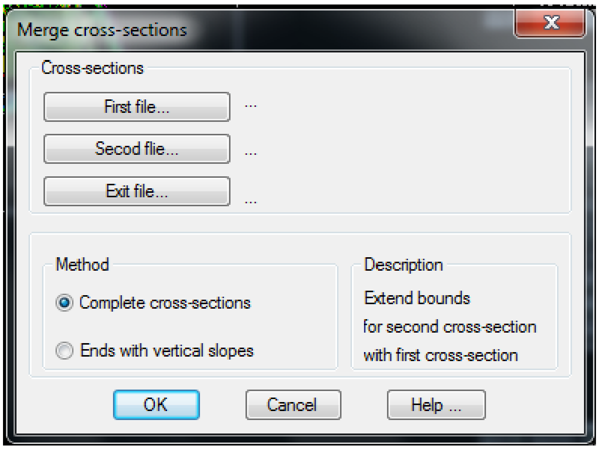
A screenshot can then be seen of a drawing of a given part of the cross section in which the distance from the axis and the elevation at different points appear labelled.



Merge Cross-sections

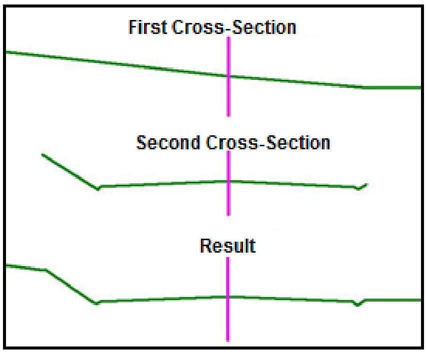
This command is used to merge two cross-sections of different methods. The program will display the following window for specifying the files we wish to merge and the output file for saving the result.

Last, we select the type of merging we wish to carry out between the cross-sections selected:



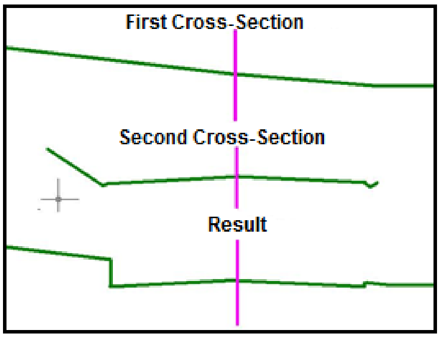
Complete Profiles

In this case, the second cross-section is inserted in the first cross-section, for which in the first cross-section the vertices common to the second profile are deleted and the second cross-section is inserted.



Ends with vertical slopes

This option's merging process is similar to the previous option with the difference that the merging of the two cuts is done with the vertical slope. This merging is done from the ends of the platform, without having to find the existing ditches or slopes.



Merge Cross Sections

This program option enables merging a set of cross-section files into one only. It is ideal if we have a road divided into several groups of cross-section files and we want to join them in a single file.

First the command requests the cross-sections file folder and then the name of the new cross-section file to generate.

If there are station overlaps between some of the cross-section files, the overlap information in question will, in the final cross-section file, be the result of merging all the common stations.

File1

0.000	-25.000	367.959	MDT
0.000	-2.062	365.410	MDT
0.000	5.918	364.646	MDT
0.000	13.094	364.114	MDT
0.000	18.241	364.097	MDT
0.000	24.840	364.035	MDT
0.000	25.000	364.037	MDT
5.000	-25.000	368.967	MDT
5.000	-3.725	366.431	MDT
5.000	7.040	365.448	MDT
5.000	8.913	365.285	MDT
5.000	10.133	365.120	MDT
5.000	10.648	364.956	MDT
5.000	13.268	364.842	MDT
5.000	16.710	364.372	MDT
5.000	17.066	364.310	MDT

File 2

10.000	-25.000	368.905	MDT
10.000	-14.840	367.562	MDT
10.000	-14.156	367.477	MDT
10.000	-5.230	366.452	MDT
10.000	5.902	365.486	MDT
10.000	14.007	364.383	MDT
10.000	16.174	363.603	MDT
10.000	25.000	363.570	MDT
15.000	-25.000	368.928	MDT
15.000	-10.566	367.091	MDT
15.000	-3.540	366.244	MDT
15.000	2.891	365.686	MDT
15.000	11.546	364.509	MDT
15.000	14.857	364.151	MDT
15.000	24.898	363.570	MDT
15.000	25.000	363.541	MDT

Output File

0.000	-25.000	367.959	MDT
0.000	-2.062	365.410	MDT
0.000	5.918	364.646	MDT
0.000	13.094	364.114	MDT
0.000	18.241	364.097	MDT
0.000	24.840	364.035	MDT
0.000	25.000	364.037	MDT
5.000	-25.000	368.967	MDT
5.000	-3.725	366.431	MDT
5.000	7.040	365.448	MDT
5.000	8.913	365.285	MDT
5.000	10.133	365.120	MDT
5.000	10.648	364.956	MDT
5.000	13.268	364.842	MDT
5.000	16.710	364.372	MDT
5.000	17.066	364.310	MDT
10.000	-25.000	368.905	MDT
10.000	-14.840	367.562	MDT
10.000	-14.156	367.477	MDT
10.000	-5.230	366.452	MDT
10.000	5.902	365.486	MDT
10.000	14.007	364.383	MDT
10.000	16.174	363.603	MDT
10.000	25.000	363.570	MDT
15.000	-25.000	368.928	MDT
15.000	-10.566	367.091	MDT
15.000	-3.540	366.244	MDT
15.000	2.891	365.686	MDT
15.000	11.546	364.509	MDT
15.000	14.857	364.151	MDT
15.000	24.898	363.570	MDT
15.000	25.000	363.541	MDT

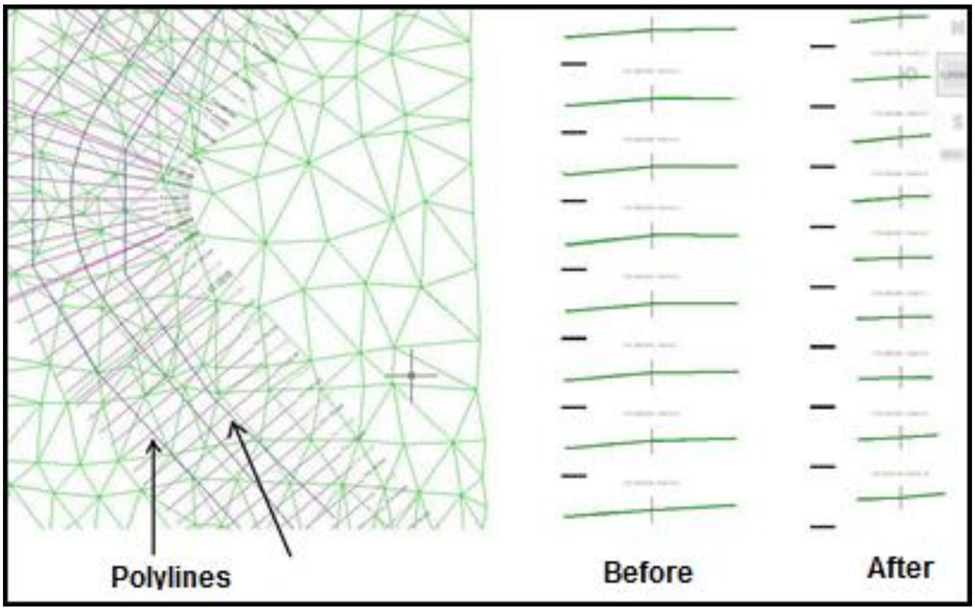
Trim Cross Sections

This command facilitates trimming each of the cuts of a cross-section file using the set of polylines in ground plan as a reference. It can be useful for areas in which the profiles overlap so that these may be trimmed without needing to regenerate them with the overlap accounted for.

In areas with no cut polyline the cross-sections are maintained intact as they were originally generated.

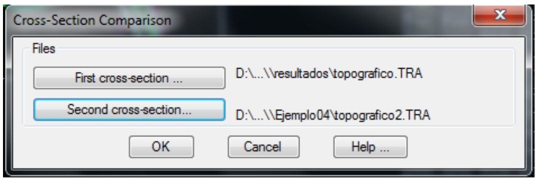
When initiated, first it will request the cross-section file we wish to modify, then the horizontal alignment and then the set of polylines.

Last, the program will request a new file for saving the trimmed profiles.

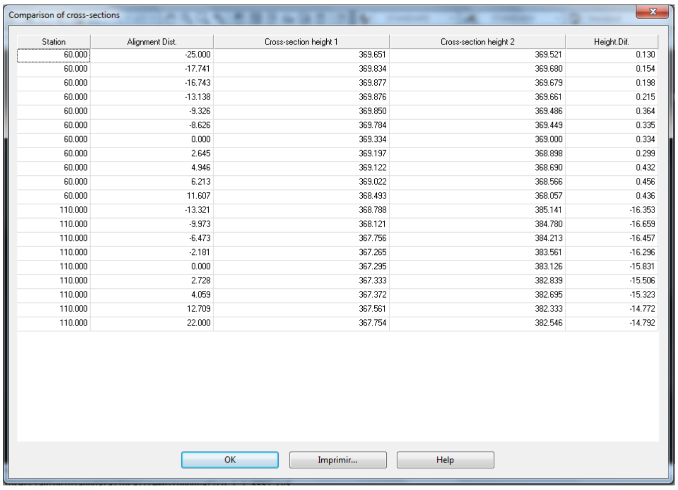

Polylines
Before
After

Compare Cross Sections

This command displays a list with the height differences for each station at the different cuts of each cross-section.



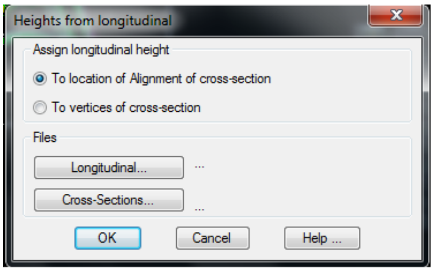
First it requests two profiles to compare and finally the following list is displayed with the information on each cross-section cut.



Station	Alignment Dist.	Cross-section height 1	Cross-section height 2	Height.Dif.
60.000	-25.000	369.651	369.521	0.130
60.000	-17.741	369.834	369.680	0.154
60.000	-16.743	369.877	369.679	0.198
60.000	-13.138	369.876	369.661	0.215
60.000	-9.326	369.850	369.486	0.364
60.000	-8.626	369.784	369.449	0.335
60.000	0.000	369.334	369.000	0.334
60.000	2.645	369.197	368.898	0.299
60.000	4.946	369.122	368.690	0.432
60.000	6.213	369.022	368.566	0.456
60.000	11.607	368.493	368.057	0.436
110.000	-13.321	368.788	385.141	-16.353
110.000	-9.973	368.121	384.780	-16.659
110.000	-6.473	367.756	384.213	-16.457
110.000	-2.181	367.265	383.561	-16.296
110.000	0.000	367.295	383.126	-15.831
110.000	2.728	367.333	382.839	-15.506
110.000	4.059	367.372	382.695	-15.323
110.000	12.709	367.561	382.333	-14.772
110.000	22.000	367.754	382.546	-14.792

Heights from Profile

This command enables changing the heights of the cross-section cuts in terms of the longitudinal. This option is particularly useful to equalize the cross-sections alignment height with that of the longitudinal.



There are two different ways to assign heights to the cross-section:

To location of Alignment of cross-section

This command is used to establish how the cross-section alignment height, the longitudinal height of the corresponding station, and that of the rest of the vertices, increases or decreases in terms of the height difference between the cross-section and the longitudinal.

Below is an example of this command executed.

Example: For the next longitudinal:

0	125.546	MDT
50	135.265	MDT
150.238	137.568	MDT

The cross-section cut for station 50 would be:

	BEFORE			AFTER	
50	-5.5	134.568	50	-5.5	135.633
50	0	134.200	50	0	135.265
50	6	133.954	50	6	135.019

To vertices of cross-section

This command is useful to equalize the heights of the longitudinal with the heights of the cross-section alignment. The program assigns to each alignment vertex the height corresponding to the longitudinal of each cross-section cut.

Example: For the following longitudinal:

0	125.546	MDT
50	135.265	MDT
150.238	137.568	MDT

The cross-section cut for station 50 would be:

	BEFORE			AFTER	
50	-5.5	134.568	50	-5.5	134.568
50	0	134.200	50	0	135.265
50	6	133.954	50	6	133.954

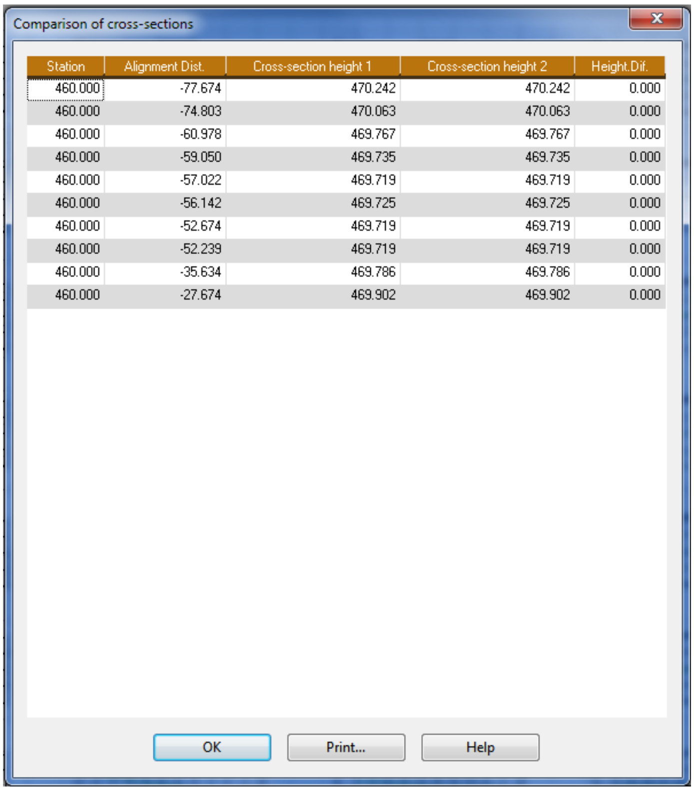
For cross-section vertices with no longitudinal profile height we insert the height of the longitudinal profile and assign it to the corresponding cross-section.

Insert Polylines in Cross-Sections

This utility allows one to insert the references of the polylines entered in the cross-section file selected. The **Definition of Blocks** command may subsequently be used to graphically represent this reference at its position with regard to the profiles.

The steps needed to execute the command are detailed below:

- The program requests the cross-section file on which the operation will be performed.
- The horizontal alignment from which the cross-sections have been obtained is entered.
- The polylines to be projected onto the profile are selected. These should be 3D polylines. They will be assigned the “POL” code when inserted in the profile. These should be within the area of occupation or the strip width of each profile.
- Lastly, the file in which the new cross-section file’s data will be stored is requested.



Station	Alignment Dist.	Cross-section height 1	Cross-section height 2	Height.Dif.
460.000	-77.674	470.242	470.242	0.000
460.000	-74.803	470.063	470.063	0.000
460.000	-60.978	469.767	469.767	0.000
460.000	-59.050	469.735	469.735	0.000
460.000	-57.022	469.719	469.719	0.000
460.000	-56.142	469.725	469.725	0.000
460.000	-52.674	469.719	469.719	0.000
460.000	-52.239	469.719	469.719	0.000
460.000	-35.634	469.786	469.786	0.000
460.000	-27.674	469.902	469.902	0.000

12. Templates

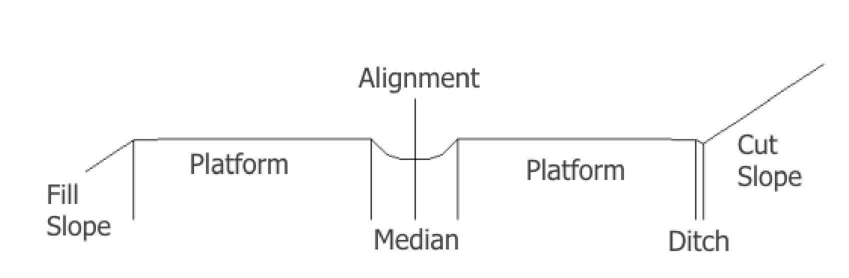
Introduction

MDT allows one to create an alignment's cross-sections using a series of components or elements that, along with the customized superelevation table and the assignment of materials for different roadbed layers, determine the cross-section template in. These components include:

- Platforms
- Ditches
- Median elements
- Cutting slopes
- Fill slopes
- Roadbeds
- Safeguard ditches
- Wall and structures

By assigning these sections to an alignment's different sections and margins, one can generate the terrain's construction cross-sections. One can subsequently proceed to check, list, draw, calculate volumes, etc.

A file with the `.SCC` extension that stores all the information needed to configure the project's roads is generated throughout this process.



MDT distinguishes two types of templates for the platform type assigned:

- Urban templates.
- Road templates.

The main difference between them is that in the road templates it is possible to define the central reservation (median) elements and two types of roadbed also exist, one for the left roadway and another for the right.

It is possible to work with the template file or with the segment, in the latter case the segment must already be comprised of all the road elements including the template type.

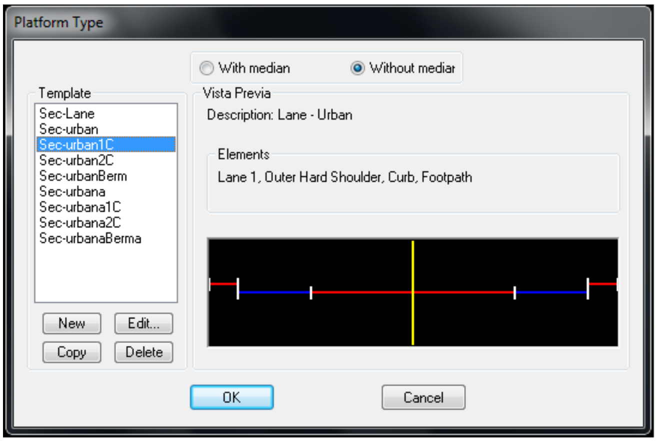
Define – Edit PRO

This is the main command for the complete definition of the template, when executing it the program requests a file which can be a template file or a segment file.

If a template file is selected it is possible to indicate a new file or an existing file to which modifications can be made.

If a new template file is selected, the following window will be displayed for indicating the template type to be defined, meaning, urban or road template (*With or without median*).

All the modifications made in this command in the first definition of the template type can be modified later in the template type definition.

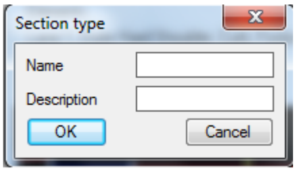


For each type distinct templates are available by default that serve as a base for the development of our section, even if one is selected, later in the definition of our section we can make modifications to it (adding or subtracting vectors, changing properties, etc.).

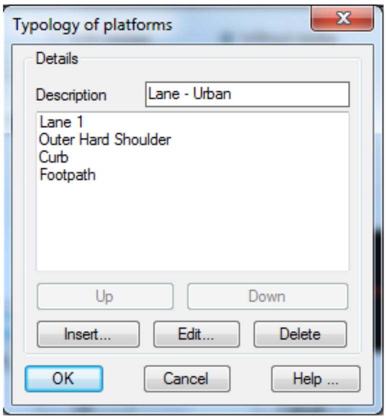
We can also define new templates, according to our needs, which we will have available for the definition of new sections.

The following buttons are used to customize the sections:

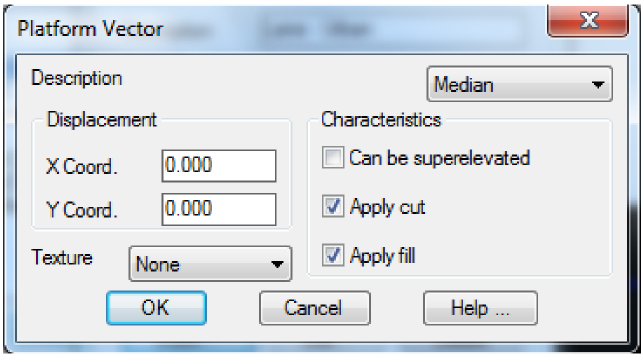
New: Create a new section. Indicate the name of the section and give a brief description (optional).



Edit: When editing the template selected in the list the following window will appear for defining each of its vectors. Only one of the sides is defined, so that in the definition it is necessary to keep in mind all the possible vectors that will be used in the platform. In a later definition not all the vectors have to be used on both sides.



Distinct properties may be assigned to each of the vectors, from the type of vector to whether it can be superelevated or not. All the characteristics can be modified in the definition of the template.



- **Description**: Type or name of the vector.
- **Displacement**: The dimension the vector will have by default.
- **Texture**: Type of texture to be applied to the vector for later visualization with textures.
- **Can be superelevated**: Indicates whether the vector can be superelevated by default.
- **Apply cut/fill**: The possibility to indicate at which part of the section to apply the vector, when it is cut, fill or both.

Copy: Copy an already-existing template by changing its name. This option is of enormous use in cases when the new section is very similar to one that already exists, and prevents having to give the definition for all the vectors.

Delete: Eliminates the selected section.

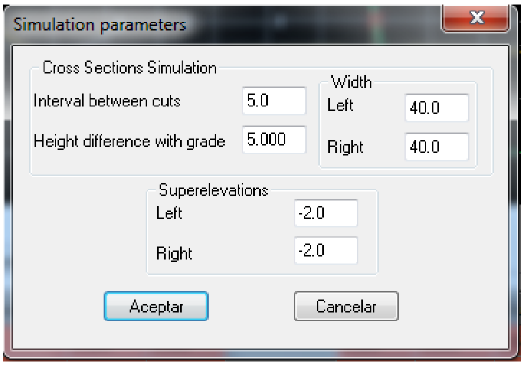
Once the template is defined or the file in which we will be developing our template is selected, the following window will be displayed for defining all the construction elements of the template section and the station where each one is located.

There are three different sections in this window:

Top

Buttons for displacement over the course of each of the stations, in the case of selecting a template file, if no information exists on the natural terrain the button is available which simulates the cross-sections in order to obtain a real simulation of the section.

Pressing the button displays the following window which is described below:



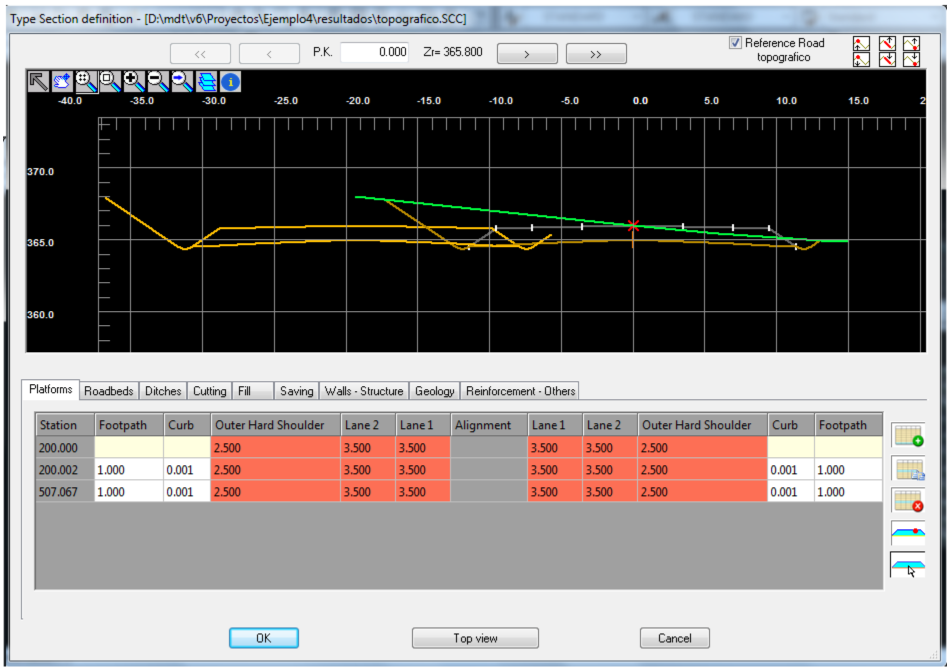
Cross Section Simulation: Here we establish the parameters for creating the virtual cross-section that will form part of the template.

- *Interval between cuts*: Interval with which the profiles are developed.
- *Height difference with grade*: To establish the height difference with the grade, basically for the simulation of slopes.
- *Left width*: Cut width of the left cross sections.
- *Right width*: Cut width of the right cross sections.

Superelevations: To simulate the superelevations, establish the values both to the left and the right.

Reference road: This option enables visualization of the current segment with respect to another segment, so that for example the intersections between the two can be analysed.

When this box is activated the program will request the segment with regard to which the comparison will be made and then the editing window below will be displayed.



It is also possible to modify the vertical alignment height of the edited segment in order to adjust the intersections. To do this the following buttons will be enabled, increase/decrease will always be 0.01, though it can be modified from the program configuration options:

Increase / decrease the vertex prior to the vertical alignment according to the station analysed.

Increase / decrease the section of the vertical alignment where the station analysed is.

Increase / decrease the vertex after the vertical alignment according to the station analysed.

The changes made to the vertical alignment height are saved automatically in the segment once we validate the section editing window.

Middle

The drawing of the section being defined is in this part of the widow. The drawing changes in real time according to the different modifications made.

On the top right of the drawing there is a series of zooming tools to visualize the section in more detail.

On the top toolbar, if we click the icon and graphically select one of the section's vectors, the program displays information on its definition.

Bottom

Each of the elements comprising the section is defined in this part of the window. It features a series of tabs for quicker access to their definitions.

The definition is done by station, indicating by lines up to which station each element is defined.

In turn, each element to define has a series of buttons for typical tasks such as inserting, editing, deleting, etc.

There is also the bottom middle button "**Top View**" which allows us to visualize a top view of the state of the section we are defining.

Below is a detailed description of the definition of each element:

Platform

A platform is defined as the set of vectors formed on both sides of the horizontal alignment, or from the median if there is one.

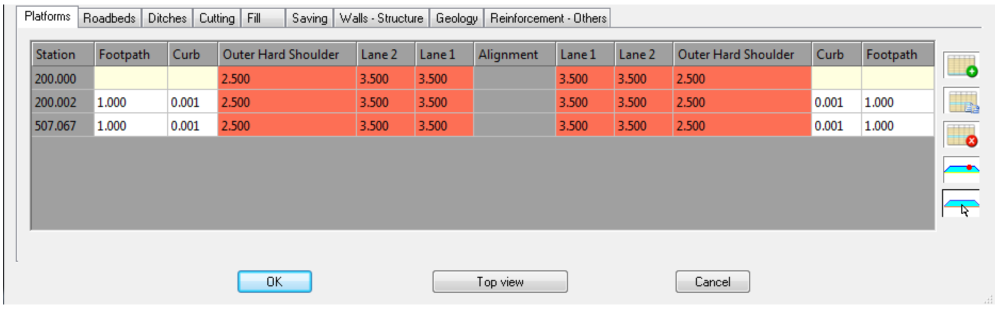
This set of vectors also configures the subgrade or surface supporting the roadbed. In other words, it will be used to calculate the excavation surface area. The ditch and/or the slopes will be situated at the ends of the platform should there be a cutting or fill surface.

If superelevations are considered, they will be applied to the vectors selected. For this purpose, they can be marked by double clicking on the graphic representation or changing the corresponding vertex's properties. They are clearly differentiated in the dialog box, because the vectors that can be superelevated are displayed in red, while the rest are displayed in white.

Additionally, defining the pivot element is essential, as it is at this vertex that grade line height will be applied and from where the superelevations are applied to both sides. The pivot vertex is represented in the image with a red arrow. For platforms with a median, two pivot points exist one for each roadway.

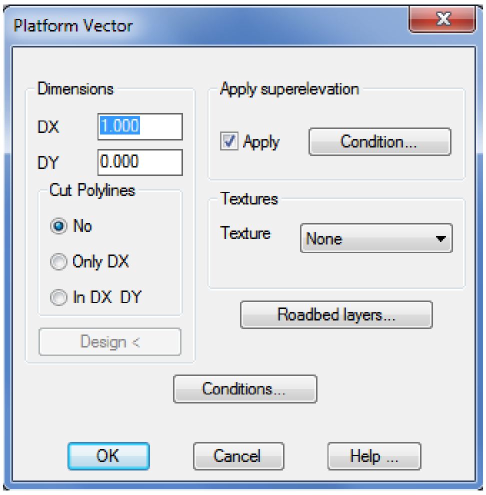
The data is introduced into a series of cells with the name of the vector in the top row, having previously been defined in the template. The first column is the station up to which the corresponding platform is applied.

The X displacement of the vector in question can be directly introduced in the cells. To apply a displacement in Y, double clicking on the desired cell a window appears for modifying this parameter as well as other characteristics.



If a cell is left blank, it is assumed that no vector exists for it, so that if in the previous or following definition one does exist, the vector will be automatically interpolated.

As previously mentioned, double clicking on any data cell displays a new window where the characteristics of the selected vector can be configured in more detail.

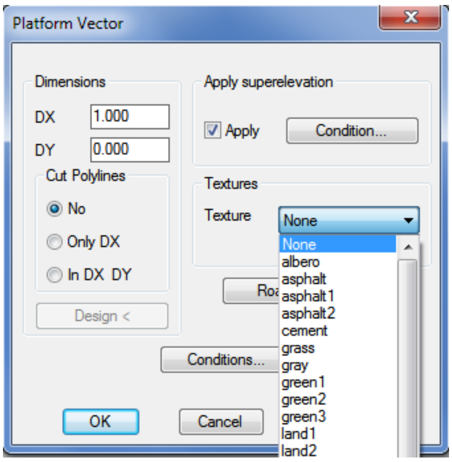


DX: Horizontal vector displacement.

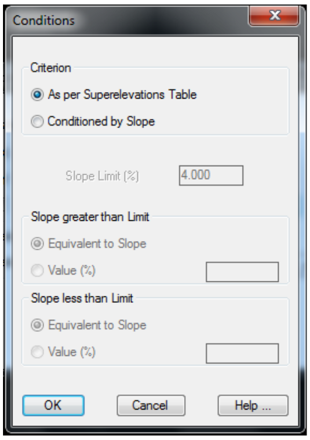
DY: Vertical vector displacement.

Cut polylines: The option to designate in top view a polyline up to which to stretch the edited vector.

Texture: Optionally set the texture associated to each of the vectors. This option is used to give a more realistic appearance to the 3D representation commands available in the ***Maps*** option. If textures are not assigned, the program will automatically assign a texture when the above-mentioned commands are executed.



Superelevate: Indicate whether the vector can be superelevated. Click on the "Condition…" button to customize the superelevation to apply.

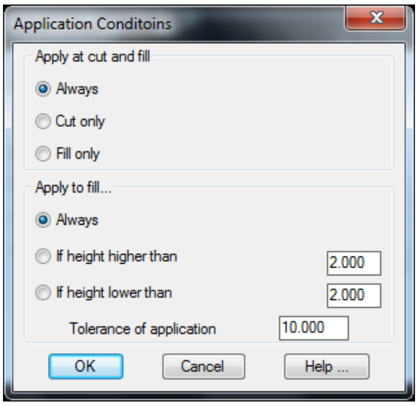


The superelevation will either be applied **As per Superelevations Table** or **Conditioned by Slope**. In the latter case, there are two criteria for the application of said slope: it can be either **greater than** or **less than** the limit set. There are two criteria for both alternatives:

Equivalent to Slope.

- A % value entered by the user (***Value*** box).

Application conditions: A series of conditions can also be applied to the vector according to which it will or will not be defined in the template.

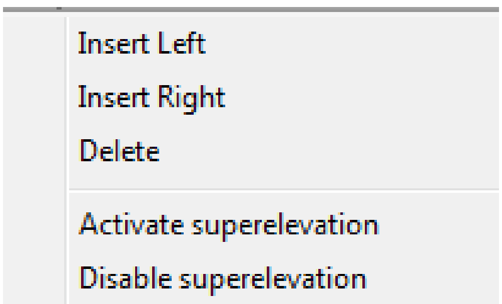


Apply at cut and fill: This is to indicate whether the vector is applied according to whether it is cut only or fill only. Deciding on the vector application is the point of connection for the vector in the corresponding platform.

Also, if deciding that the vector is only applied to fill, there are three options:

1. Apply always.
2. Apply if the height in regard to the previous vector is greater than a value introduced.
3. Apply if the height in regard to the previous vector is lower than a value introduced.

Selecting any of the names of the existing vectors and clicking the right mouse button displays a submenu with the following options:



Insert Left: Insert a new vector to the left of the selection, in this case a new window will appear with the vectors available to insert in this position.

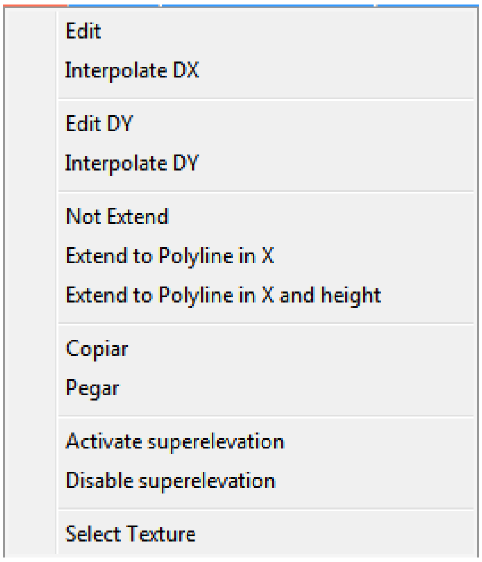
Insert Right: The same as for the previous case, only this time the right vector is selected.

Delete: Eliminates the vector selected, completely eliminating the column selected.

Enable superelevation: Activates the superelevation in the vector selected, for all definitions at every station.

Disable superelevation: Similar to the previous only in this case it disables the superelevation in all the stations of the vector in question.

If on the contrary we select a group of cells belonging to the same type of vector and click on the right tab, the following sub-menu will appear:



Edit: Edits the vector selected. The same as double clicking on the box to be changed.

Interpolate DX: The option of interpolating the vector or vectors selected between two values specified by the user.

Edit DY: Enables us to assign the same DY to all the vectors selected.

Interpolate DY: In this case, we assign a DY to the first vector selected and another DY to the last vector selected; the DY arising from the interpolation is assigned to the intermediate vectors selected.

NOT Extend: Deactivate the option for extending the vector specifying a pre-selected polyline.

Extend to Polyline in X: This option enables us to extend the vector selected to a polyline specified by the user; in this case it will only be extended in X.

Extend to Polyline in X and Height: This is similar to the previous option only in this case the extension also applies to the height. The selected polyline should be in 3D in this case.

Copy: Copies the cell selected to the memory.

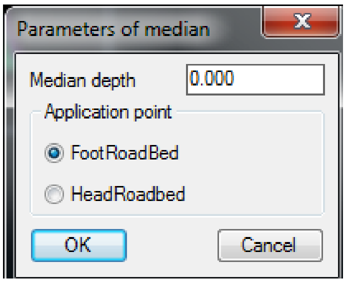
Paste: Enables us to copy the data from the cells selected from the copied cell using the previous command.

Activate Superelevation: Activates superelevation in the vectors selected.

Deactivate Superelevation: Deactivates superelevation in the vectors selected.

Select Texture: Enables us to assign a specific texture to the vectors selected.

For definitions of templates that have a median, the same properties of the median-type vector can be assigned to it. By double-clicking on the corresponding vector, the following window is displayed for setting up the configuration.



Median depth: Average depth of the median from the pivot point to both sides of the section.

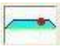
Application: Indicate here if the roadbed vectors connect at the crown or foot of the roadbed.

Additionally, there are four buttons for carrying out the following operations on the platform definition across the stations.

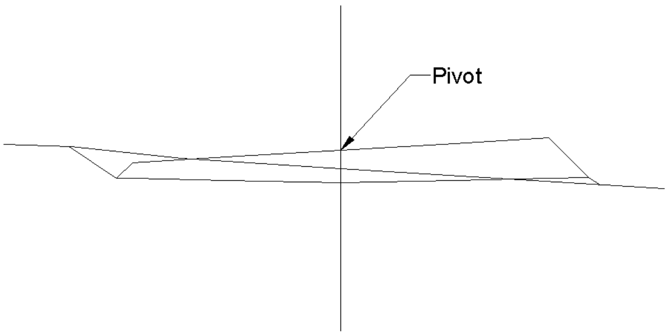
 This inserts a new platform assignment in a particular station. When the button is pressed it will request the station and once it is validated a line is inserted in the position where the vectors are assigned the values of the section with which the template was initially defined.

 With one of the platforms assigned to a specific selected station, this button makes a copy of the vectors at that station.

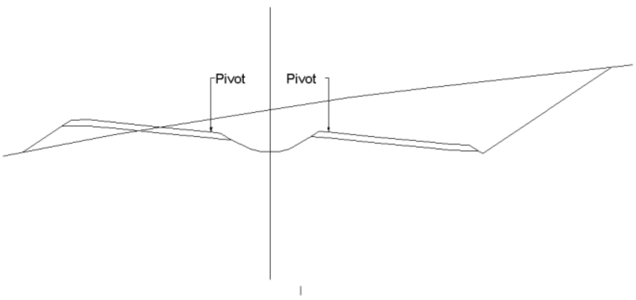
 Deletes the assignment of a particular station.

 This button defines the platform pivot point, meaning the point from which the vertical alignment height will be applied and from which the left and right superelevations are applied. In order to do this first select the name of the vector on which to situate the pivot, then click the button.

The application point is shown with a red arrow in the vertex in question.



Platform pivot without median



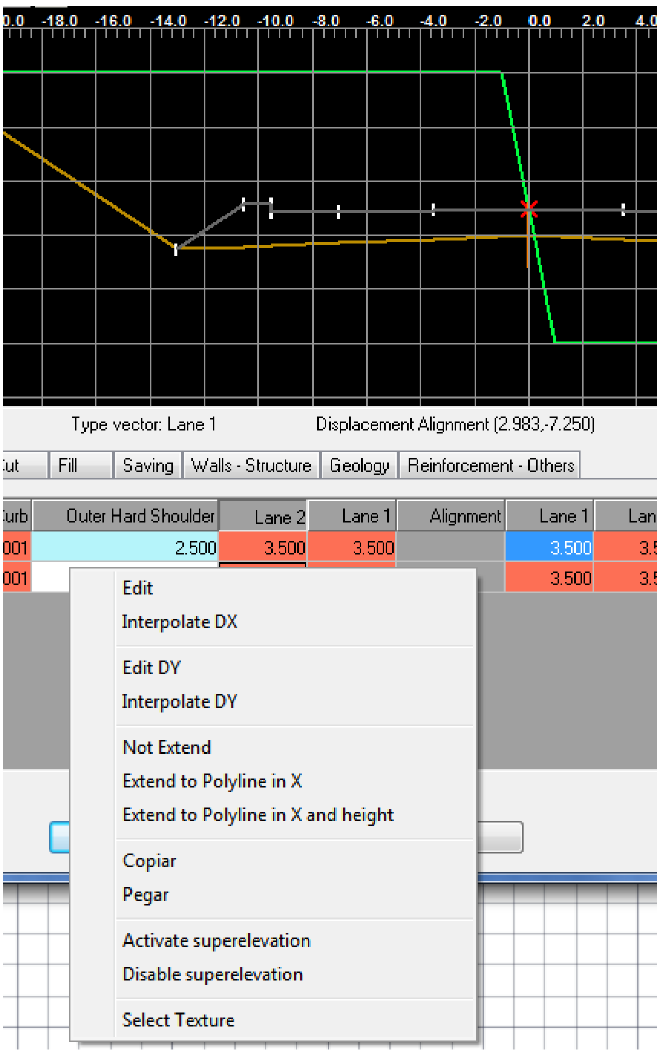
Platform pivot with median

 With this button the program allows all the vertices of any polyline to be read, creating a new platform with its vectors.

First, the platform definition window disappears momentarily, to request the designation of a ***Polyline*** by placing the cursor on it. Then the ***Vertex*** corresponding to the ***Horizontal Alignment*** is selected. This is also done with the cursor, on the vertex we want considered as the horizontal alignment of the polygon.

The program will calculate the increases of the vectors drawn in their values (X and Y), with (0, 0) as a horizontal alignment of reference and restoring the dialog box for platform definition.

In addition to the aforementioned tabs for editing the platforms, we have a contextual menu with a series of options described below for each of the vectors of each of the platform assignments.



Edit: Edits the properties of the vector selected, similar to double clicking on any of the vectors.

Interpolate DX: We select a series of cells of the same type beforehand. On selecting this option the program will request the initial DX and the final DX and interpolate the intermediate vectors.

Edit DY: Enables us to edit the displacement in Y of the vector or vectors selected.

Interpolate DY: The same function as the “Interpolate DX” option; but in this case for the displacement in Y.

NOT Extend: Deactivates the option for extending the vector to s polyline when activated.

Extend to Polyline in X: This option enables us to extend the vector to a polyline specified below. It will only be extended in X.

Extend to Polyline in X and Height: This is similar to the previous option only in this case the extension also applies to the height.

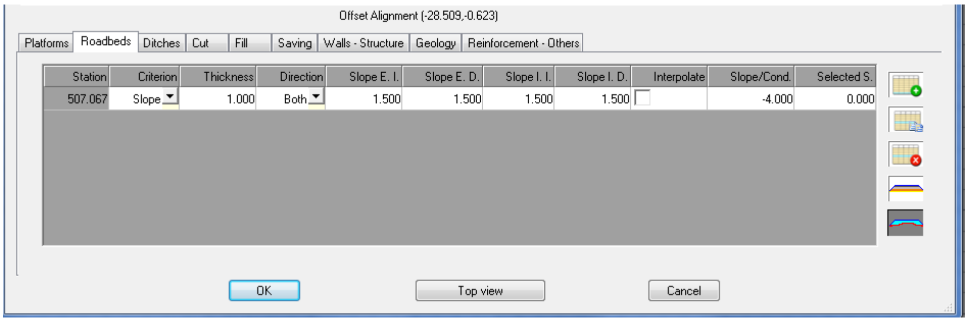
Activate Superelevation: Activates superelevation in the vectors selected.

Deactivate Superelevation: Deactivates superelevation in the vectors selected.

Select Texture: Enables us to assign a specific texture to the vectors selected.

Roadbeds

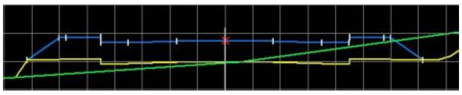
Roadbed thickness is defined as the existing thickness between the subgrade and the previously-defined vertical alignment. It has some internal and external slope values that will cut the platform defined for the template.



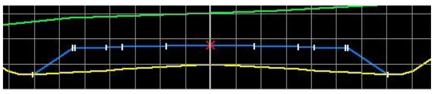
It is assigned by station and at the same time has a series of behavioural characteristics described below:

Criteria: Performance of the subgrade in the definition of roadbed. There are five performance types:

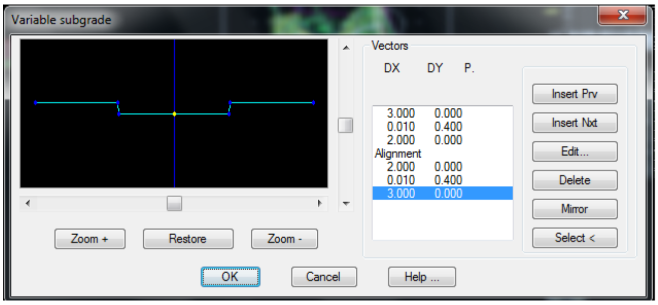
- **Parallel**: The subgrade is always parallel to the platform.



- **Conditioned**: The subgrade will take the maximum value from the value introduced in the box **Pend / Cond.**
- **Parallel-Conditioned**: The subgrade will be parallel except in other vector types such as lane vectors, to which a slope will be applied via the Pend/Cond. box.
- **Slope**: Subgrade has a slope value determined by the box **Pend./ Cond.**



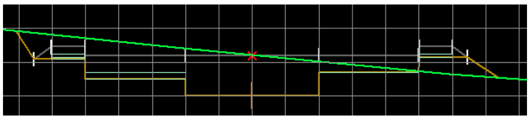
- **Variable**: This situation is for those cases in which the subgrade performs independently to the platform, without performing in any of the previously-defined ways. For this, once it is selected the following window is displayed to define subgrade platform vector.



On the left is a graphic representation and on the right is the vector definition with the corresponding buttons for editing. Among these buttons are the typical buttons to insert, edit, and delete, as well as the following buttons:

- **Mirror**: If the platform is the same on both sides of the horizontal alignment. Define only one of the sides and click this button.
- **Select**: If the platform is previously drawn in real dimensions in AutoCAD, this option can be used to graphically select it and in this way it will read it and automatically build a list of vectors.

- **Adapt layers:** On selecting this option the subgrade will be defined in accordance with the roadbed layers defined for each of the vectors in the platform. In the event a vector has no associated roadbed layers, the roadbed thickness shall be that defined in the respective definition of the same.



Thickness: Absolute value of measurement to apply under the definitive vertical alignment of the platform. Is must be higher or the same as the sum of the layer thicknesses. Any change to this box will immediately modify the graphic image above in proportion to the other data.

Direction: Indicate whether to always apply, whether the section is cut or fill. The decision point to indicate whether the section is cut or fill is the horizontal alignment position.

Slope E.L.: Value of exterior left roadbed slope.

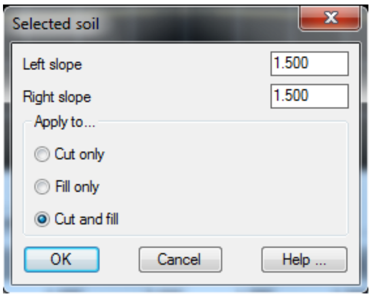
Slope E.R..: Value of exterior right roadbed slope

Slope I.L.: Value of interior left roadbed slope, this is only applicable in the case of templates with a median.

Slope I.R.: Value of interior right roadbed slope, similarly only applicable to templates with a median.

Interpolate: If this is activated it will interpolate the roadbed thickness between the station in question and the station assigned previously to intermediate stations.

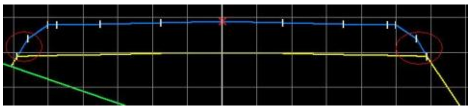
Selected soil: The thickness of the soil selected existing under the subgrade. If this value is edited the following window is displayed to configure the parameters of the soil selected.



- **Left Slope**: Left slope value of the soil selected.

- **Right Slope**: Right slope value of the soil selected.
- **Apply to**: Indicate whether to apply when the roadbed is cut, fill or in both circumstances.

Below is an example of the soil selected in which the slope is different to the roadbed.

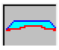


Functions of the different buttons on the roadbed definition panel:

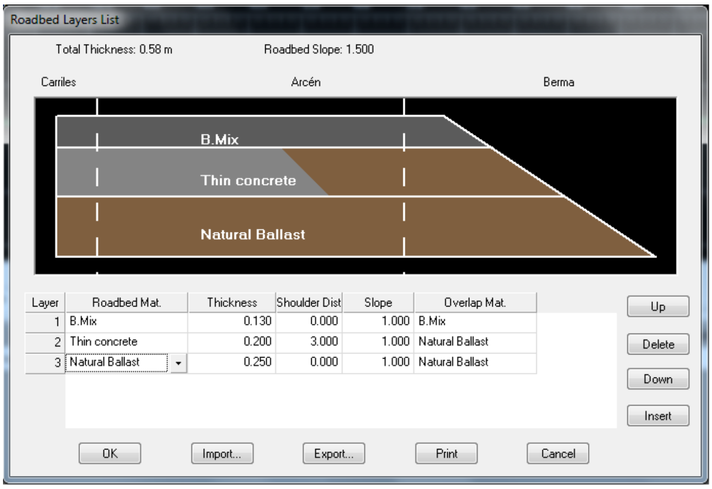
 **Insert** a new roadbed assignment in a particular station.

 Copies a roadbed to another station. Copies all the characteristics including the roadbed layers.

 **Delete** the roadbed selected.

 Edits the definition of the subgrade. This tab only works if the ***Variable*** criterion has been selected.

 This button is activated to define the **roadbed layers** associated with the selected roadbed. The definition of these layers only affects the vectors for lanes, hard shoulders and berms.



The Roadbed layers are defined from the surface to the contact point with the subgrade. There are different ways of handling and managing the dialog box. It is possible to **Import, Export** and **Print** the detailed characteristics of each of them.

The top of the dialog box shows the total **Roadbed Thickness** and the value of the **Exterior Slope**.

The list is entirely editable, so that the properties of each roadbed layer can be directly modified, and their order changed, any of them can be deleted and new ones created. The buttons: ***Up, Down, Delete*** and ***Insert*** are used for this.

Roadway Surface Material. Material assigned to the roadbed’s surface up to the external shoulder.

Thickness: Thickness of the roadbed layer. The sum of all the roadbed layer thicknesses can be no greater than total roadbed thickness.

Shoulder Dist.: Length of the overlap in the layer being defined. It is applied to the layer depending on the overlap selected.

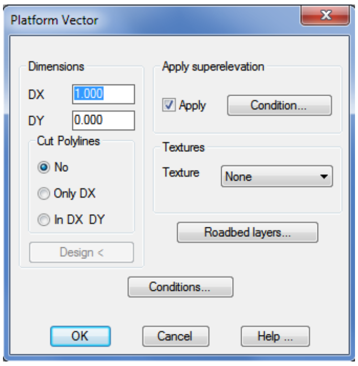
Slope: Slope of the existing overlap in the layer that is being defined**.**

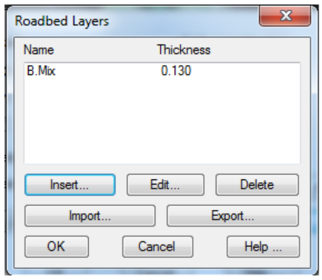
Overlap Material. Material assigned to the roadbed layer making up the previously defined overlap.

Define Materials: Definition of the materials comprising the roadbed layers.

Additionally, different roadbed layers can be assigned to the vectors that are not templates for lanes, hard shoulders or berms.

To carry out this definition when editing the vector properties, a window is displayed in which by pressing the button “**Roadbed Layers**” we can specify the characteristics of each of the roadbed layers for the vector in question.

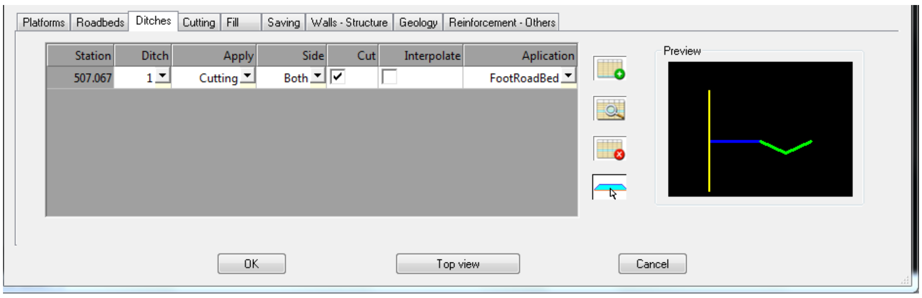




Ditches

A Ditch is defined as the element added to the external edge of the platform. It is configured by adding vectors formed in a positive X direction to vectors given by coordinates associated to the origin or previous point. They move forward if they are positive (x) values. Ordinate increments (y) will be positive upwards and negative downwards.

To the left the data for the ditch is introduced in the corresponding station and on the right is a preview of the ditch that is currently assigned.



Ditches: Number of the ditch assigned. All the available ditches are listed in the drop-down menu.

Apply: Indicate here whether the ditch is applied to cutting or fill.

Side: Side of the ditch’s application.

Cut: If this box is checked, and if the terrain cuts the ditch, it will be cut at this point.

Interpolate: If this box is checked the ditch will be interpolated between the current and the next one assigned.

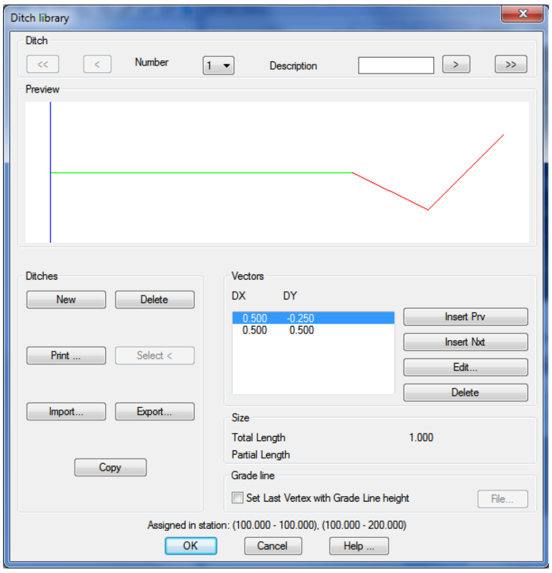
Application: The point of connection of the ditch, at the crown or foot of the roadbed. If we have defined the roadbed layers, this would give us the possibility of placing the ditch in a specific roadbed layer.

Control of Differences in Height: This parameter will enable us to monitor whether the ditch has been inserted in accordance with the difference in height in relation to the natural terrain at the point where the ditch is inserted.

The value will be set to “Always” by default, or in other words the insertion of the ditch will not depend on the difference in height between the vertical alignment and the terrain.

Additionally there are buttons with the functions described below.

 This inserts a new ditch assignment. When the button is pressed the window below will appear for defining the ditch with which we wish to work.



There are three areas:

Ditch: Buttons for moving forward and back over the course of the defined ditch library.

Ditches: Group of buttons for defining or deleting the existing ditches.

New: Creates a new ditch.

Delete: Deletes the current ditch.

Print: Prints the list of ditches with their vectors.

Select: This is used to graphically select a ditch which was previously drawn with an AutoCAD polyline.

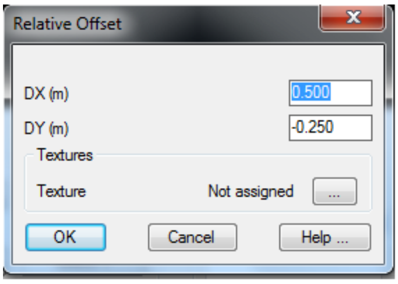
Import: Imports ditches from a file.

Export: Exports ditches to a file.

Copy: Copies the current ditch to create a new ditch.

Vectors: The group of vectors comprising the ditch, with the corresponding buttons to insert, edit, or delete them.

By selecting any of the editing buttons (***insert Prv., insert Next, Edit***) the following window is displayed to specify the X and Y displacement that the ditch vector being edited will have.



It is important to highlight that the value of the X increment cannot be zero or negative. In other words, vectors always have to travel away from the horizontal alignment. Should a vertical jump need to be entered, a small value can be entered (such as 0.01 or 0.001), which will have practically no effect on the calculations.

In the ***Textures*** section the texture associated to each of the vectors can optionally be set. This option is used to give a more realistic appearance to the 3D representation commands available in the

Maps option. If textures are not assigned, the program will automatically apply a texture when the above-mentioned commands are executed.

Once the dialog box has been validated, the list defining the current ditch will be updated.

When the ditch to be assigned is selected, a window appears for indicating the station up to which said ditch is to be assigned.

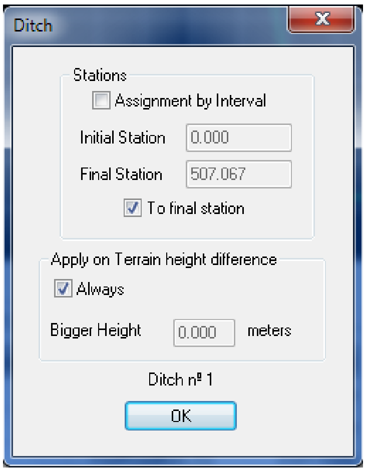
 Edit the ditch selected. The same window as in the "Insert" option will appear.

 Deletes the ditch assignment selected.

 Gives the option to graphically select a ditch that has been previously drawn with a polyline in real dimensions.

The last vertex at grade line height: the option of extending / removing the last vector of the ditch at the grade line height. The grade line should be selected beforehand using the "File" tab.

For the insertion or editing operation, as well as selecting the ditch, we must indicate the Station at which said ditch would be assigned and with this in mind, once the ditch has been selected the following window will appear.

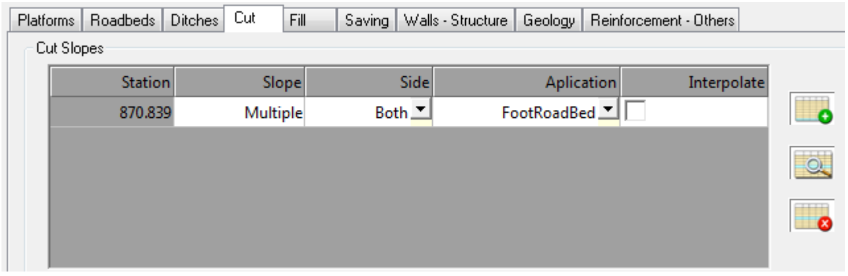


We can carry out the assignment up to a specific Station or between a certain Station interval. With this in mind, we disable or enable the "Assignment by Interval" box

In addition, we will use this window to indicate whether the ditch is always to be inserted or whether this will depend on the difference in height between the point of the ditch and the natural terrain.

Cut

Cutting slopes are defined as the vectors that set the closure of a cross-section template with the terrain. They are applied to the last vertex formed by the ditch or subgrade, providing this vertex has an elevation lower than that of the terrain in abscissa. It is likewise applied to the last subgrade vertex when its height is lower than that of the terrain compared to the same abscissa value.



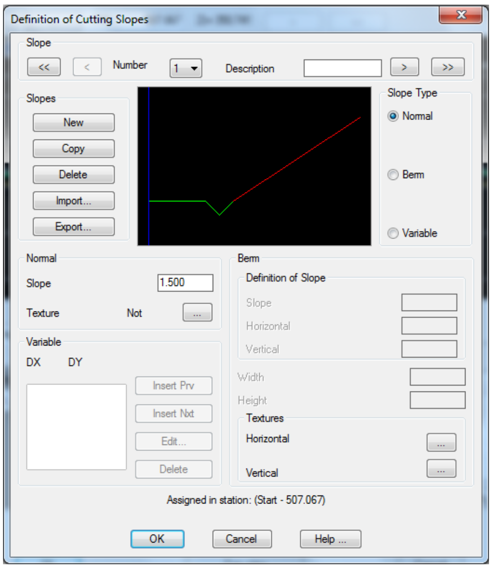
Slope: To select the slope to apply in the current station.

Side: Side of the slope application.

Application: To indicate whether the slope will be connected at the crown or foot of the roadbed.

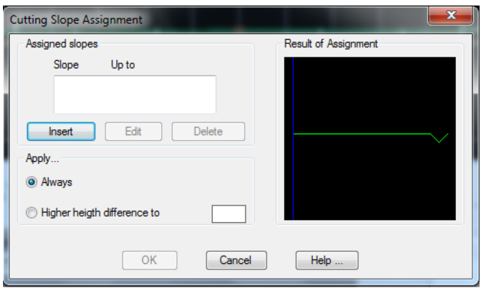
Interpolate: If this box is checked, in the previous stations where slope is not explicitly assigned it will be interpolated.

 This button is used to insert a new assignment for the cutting slopes. At first the following window will be displayed:



The slopes to be assigned are defined in this window. It is possible to assign up to a maximum of three at the same station, depending on the application point of each.

 We use this button to edit the assignment of the designated cutting slope. The following window will appear:



Apply: This parameter will enable us to monitor whether the ditch has been inserted in accordance with the difference in height in relation to the natural terrain at the point where the ditch is inserted.

The value will be set to “Always” by default, or in other words the insertion of the ditch will not depend on the difference in height between the vertical alignment and the terrain.

This option is used to define the slopes we are going to assign and there is the possibility of assigning up to a maximum of three in the same station, depending on the point of application of each one.

Assigned Slopes: The slopes are selected with the buttons "Insert", "Edit " and "Delete". When "Insert" or "Edit" is pressed the following window appears for defining the slope.

The functions for the buttons are described below:

Number: Drop-down list for selecting a slope from the section file.

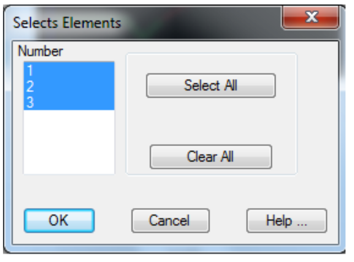
Description: For writing in text to identify the defined cutting slope. It is not a required parameter but is of enormous use in the assignment of templates as it enables easy identification of each of the assigned slopes.

Delete: Deletes the current slope and automatically goes to the next one, should one exist.

Print: Sends the slope content to the printer.

Copy: Creates a new slope identical to the current slope and assigns it the next number to the last one on the list.

Export: Displays a window containing all the activated slopes ready to be exported so that one of them may be selected.



Once validated, the marked slopes are exported to the file that is then requested. The output file is an ASCII file having a .TAL extension.

Import: Imports any .TAL file and adds it to the current slopes. All this information is stored in the section file selected.

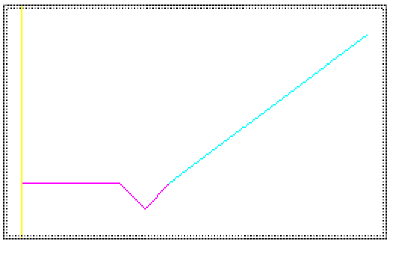
New: This creates a ***Normal*** type slope by default and assigns it the number following the last on the list. To define different types of slope, proceed as follows.

Under ***Slope Type*** there are three possibilities for defining the type of slope to be applied:

Normal Slope

A slope with a single vector. In this field, key in the value resulting from dividing the abscissa (x) and ordinate (y) values making up the slope gradient (tangent) as an absolute value.

A **Texture** can be applied to it with a view to the road's 3D representation.



Normal-type slope

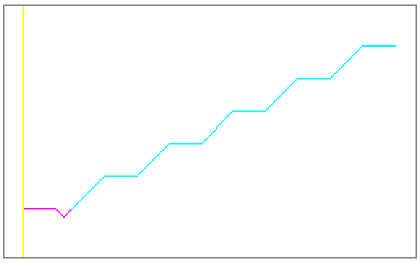
Slope with Berm

The slope with berm can be entered by either entering the **Slope's** numerical value or specifying its **Horizontal** and **Vertical** values. In any case, when the values of any of them are entered, the rest are recalculated. The following parameters may additionally be specified:

• **Height:** Height of each of the steps in the berm slope.

• **Width**: Width of each of the steps in the berm slope.

A different **Texture** may be applied to the vertical and horizontal vectors with a view to the road's 3D representation.

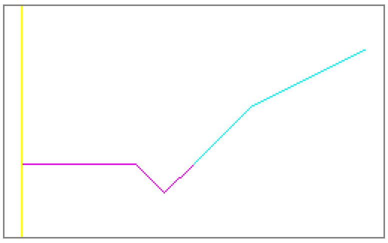


Berm-type slope

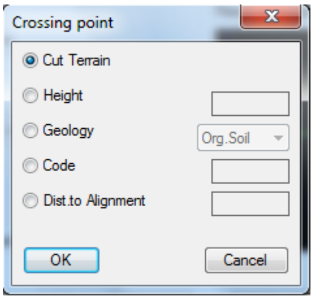
Variable Slope

The structure of the slope to be defined is defined by vectors (similar to **Definition of Ditch**) by entering the dimensions of its respective vectors.

The program indefinitely extends the last vector until it finds natural terrain.



Once the slope to be applied is selected, the following window is displayed to indicate where to apply the slope in question.



Cut Terrain: The last slope vertex extends until it intersects with natural terrain.

Height: The slope will be extended up to a specific height. This value is applied vertically from the slope's connection point.

Geology: In this case the slope will extend up to the specified geological layer.

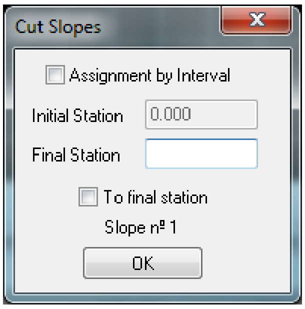
Code: For this case the cross-section must be coded, so the slope will stretch to the cross-section vertex with the code specified on the side indicated. In such a case the slope definition is irrelevant as the slope is obtained from the cross-section vertex with the code specified.

Dist. to Horizontal alignment: In this last case a distance to the horizontal alignment is specified and the slope is created from the section connection point up to the point on the natural terrain whose distance to the horizontal alignment is specified in this option. The same as the previous, it is independent of the defined slope as the slope is marked by the value of the distance to the horizontal alignment.

Grade line: In the latter case, a grade line is used as the reference for the extension of the slope, and on selecting this option the program will request the grade line file and will extend the slope in question to the height of the grade line in the corresponding station.

 Deletes the selected slope assignment.

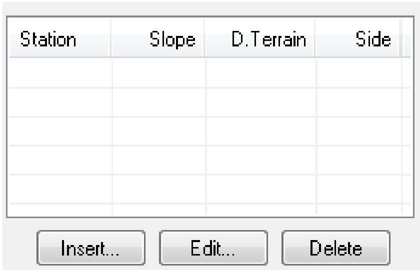
For the insertion or editing operation, as well as selecting the current slope, we must indicate the station at which said slope would be assigned and with this in mind, once the cut slope has been selected the following window will appear.



We can carry out the assignment up to a specific station or between a certain station interval. With this in mind, we disable or enable the “Assignment by Interval" box

Crowns

This option gives the possibility to establish a different value to the slope in the final section of contact with the natural terrain, in the case of cutting. Different parameters are available for defining the performance of the crown. The different configuration parameters are described below:



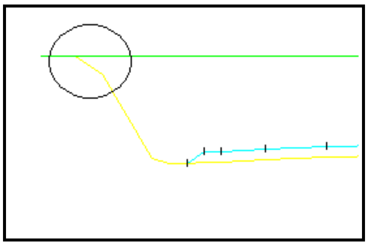
Station: Station up to which the specified crown is applied.

Slope: Slope value in the final section.

Distance to Terrain: Height difference between the terrain and the point of application of the new crown slope.

Side: Side on which the user wishes to apply it.

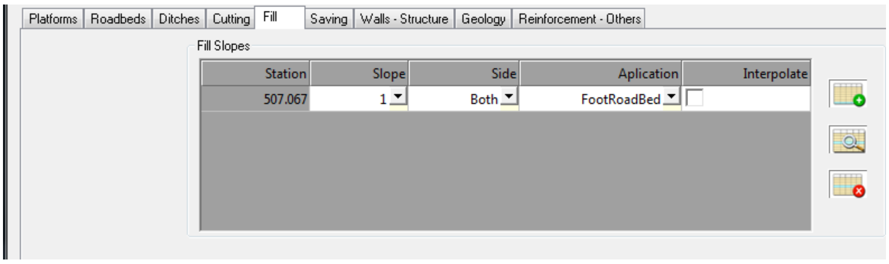
The defined cutting crown can be visualized in the image below.



This can also be defined with the definition of the cutting slopes assigned by geological layer, but this way is much more simple and direct and obtains the same result.

Fill

Fill slopes are defined as the closure of a cross-section template with the terrain. These are applied to the last vertex making up the ditch or the subgrade, as long as that vertex has a greater height than the terrain in abscissa. They are also applied to the last subgrade vertex when its height is greater than that of the terrain compared with the same abscissa value.



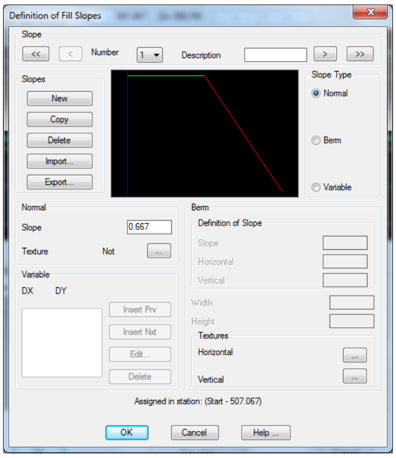
Slope: Selection of the slope to apply in the current station.

Side: Side of the slope application.

Application: Indicate whether the slope will connect at the crown or foot or the roadbed.

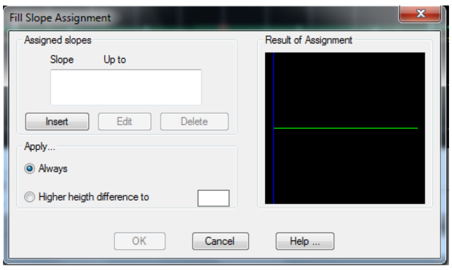
Interpolate: If this box is checked in the previous stations that are not explicitly assigned the slope will be interpolated.

 This button is used to insert a new fill slope assignment. Initially the following window will be displayed:



This window is used to define the slopes to be assigned; it is possible to assign up to a maximum of three at the same station, depending on the point of application of each.

 Clicking on this tab will enable us to edit the assignment selected in the list. The following window will appear:



Apply: Specify up to which station the slope or slopes selected are to be applied.

This option is used to define the slopes we are going to assign and there is the possibility of assigning up to a maximum of three in the same station, depending on the point of application of each one.

Assigned Slopes: The buttons “Insert”, “Edit” and “Delete” are used to define slopes. When any of them is clicked the following window will be displayed for defining the slope.

A description of the functions of each button follows:

Number: Drop-down list for selecting a slope from those existing in the section file.

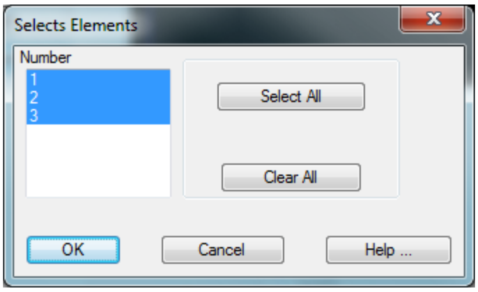
Description: Text for identifying the defined fill slope. It is not a necessary parameter but it will be of enormous use in the assignment of sections as it makes each slope assigned be easily identified.

Delete: Deletes the current slope and automatically moves to the next slope if one exists.

Print: Sends the slope content to the printer.

Copy: Creates a slope identical to the current one and assigns it the next number following the last on the list.

Export: Displays a window containing all the slopes ready to be exported, so that any of them may be selected.



Once validated, the slopes marked are exported to the file that is then requested. The output file is an ASCII file and has a `.TAL` extension.

Import: Imports any file with a `.TAL` extension and adds it to the current platforms. All this information is saved in the section file selected.

New: Creates, by default, a ***Normal***-type slope, assigning it the number following the last on the list. To identify different types of slopes proceed as follows.

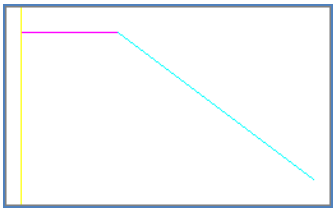
Select the ***Slope Type*** to define one of the three options for slopes that can be applied.

Normal Slope

Slope with a single vector. In this field, one keys in the value resulting from dividing the abscissa (x) and ordinate (y) values making up the slope gradient (tangent) as an absolute value.

A **Texture** can be applied to it with a view to the road's 3D

representation.



Normal-type Slope

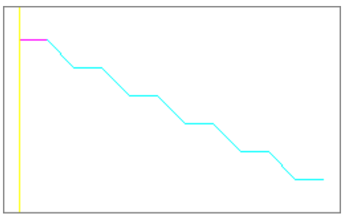
Slope with Berm

The slope with berm can be entered by either entering the **Slope's** numerical value or specifying its **Horizontal** and **Vertical** values. In any case, when the values of any of them are entered, the rest are recalculated. The following parameters may additionally be specified:

• **Height:** Height of each of the steps in the berm slope.

• **Width**: Width of each of the steps in the berm slope.

A different **Texture** may be applied to the vertical and horizontal vectors with a view to the road's 3D representation.

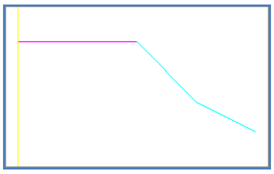


Berm-type slope

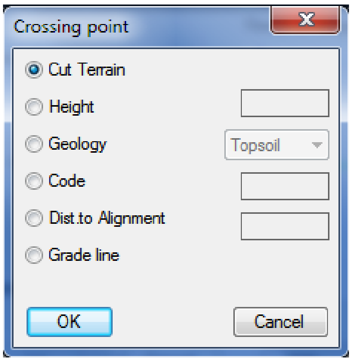
Variable Slope

The structure of the slope to be defined is defined by vectors (similar to **Definition of Ditch**) by entering the dimensions of its respective vectors.

The program indefinitely extends the last vector until it intersects natural terrain.



Once the slope to be applied is selected, the following window is displayed to indicate where to apply the slope in question.



Cut Terrain: The last slope vertex extends until it intersects with natural terrain.

Height: The slope will be extended up to a specific height. This value is applied vertically from the slope's connection point.

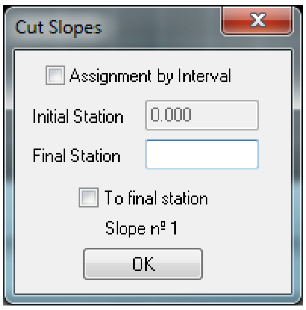
Code: For this case the cross-section must be coded, so the slope will stretch to the cross-section vertex with the code specified on the side indicated. In such a case the slope definition is irrelevant as the slope is obtained from the cross-section vertex with the code specified.

Dist. to Horizontal alignment: In this last case a distance to the horizontal alignment is specified and the slope is created from the section connection point up to the point on the natural terrain whose distance to the horizontal alignment is that specified in this option. The same as the previous, it is independent of the defined slope as the slope is marked by the value of the distance to the horizontal alignment.

Grade line: In the latter case, a grade line is used as the reference for the extension of the slope, and on selecting this option the program will request the grade line file and will extend the slope in question to the height of the grade line in the corresponding station.

 Deletes the selected cutting slope assignment.

For the insertion or editing operation, as well as selecting the current slope, we must indicate the station at which said slope would be assigned and with this in mind, once the fill slope has been selected the following window will appear.

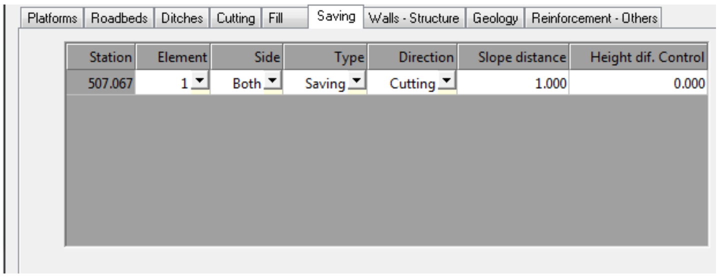


We can carry out the assignment up to a specific station or between a certain station interval. With this in mind, we disable or enable the “Assignment by Interval" box

Central reservation element

The term central reservation defines the ditches that are found at the end of the slope intersecting with natural terrain. Generally these are used to control the water falling down fill or cutting slopes, among other functions.

In this section the central reservation element is also defined referring to the ditch constructed in the median in the case of motorway templates.



Station: Station up to which the saving or median element is applied.

Side: Side of application.

Type: Indicate here whether the element will behave like a saving ditch or a median element.

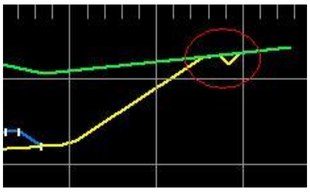
The following parameters are only applicable in the case of saving ditches:

Direction: If applied in cutting or fill.

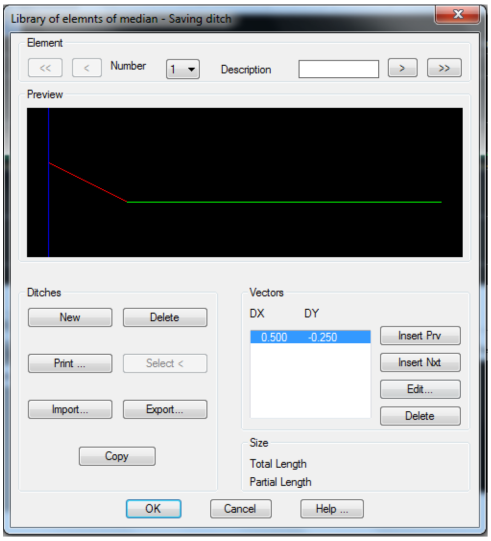
Slope Distance: Point of application of the ditch measured from the slope's contact with the terrain.

Height dif. Control: This parameter is used to control the ditch. If the height difference between the slope ends is greater than this parameter, the corresponding ditch is applied; if it is not, it is not applied. A "zero" value indicates that the saving ditch is always applied.

A red circle indicates the saving ditch.



 This button is used to insert a new saving ditch or median element assignment. It displays the following window for defining and selecting the ditch to apply.

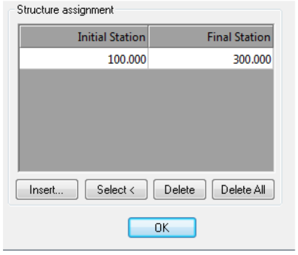


 For editing the ditch element. The same window will appear as that of the "insert" option.

 Deletes the saving ditch or median element selected.

Structure Assignment

Structures are understood to mean the road station intervals that will not have a cross-section template definition. This will be applicable for all later commands that work with this cross-section template, namely for drawing and checking cross-sections, volumes, surface area calculations, etc.



The image is of a defined structure from station 100 to 300 inclusive.

Insert: This introduces a new white line into the list where the initial and final stations are introduced, between which the structure is found.

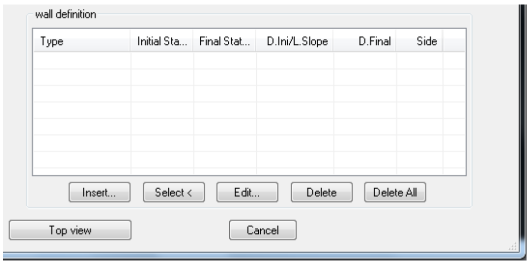
Select: This option enables the graphic selection on the drawing of the structure's initial and final stations. The station is calculated projecting the point selected onto the working horizontal alignment.

Delete: Deletes the selected structure.

Delete All: Deletes all the defined structures. A warning appears to notify that all assignments will be deleted and may not be recovered.

Assignment of Walls

This defines the vertical cuts in the section. These cuts are totally vertical, starting at the last vector of the section and according to the distance entered. They cut into the natural terrain.

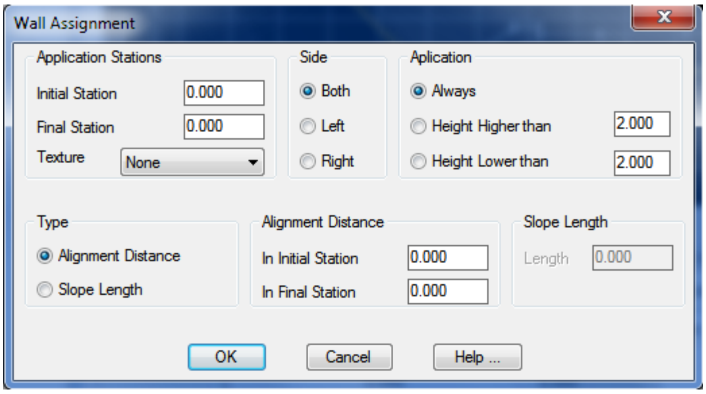


There are two **types** of Walls:

Alignment distance: This wall is defined with a set of stations and the horizontal alignment distance between the initial station and final station, interpolating the stations in between.

Slope Length: This wall is also defined by initial and final stations and is applied if the horizontal slope distance exceeds the **Slope Length** parameter.

When clicking on the **Insert** or **Edit** buttons the following window is displayed, to manage the creation or editing of a wall, the definition of which we then describe.



Initial station: Station from which the wall is to be applied.

Final station: Station up to which the wall is to be applied.

In the case of the *alignment distance* wall, for every station a ***Distance*** must be specified. This value is the relative distance from the horizontal alignment. The program will interpolate between the distance entered at the initial station and the final station for the intermediate stations.

Application: We can specify that the walls are used always or only when the height of the same is greater or less than a value specified by the user.

Length: For the *Slope Length* wall, this value indicates the maximum horizontal displacement the slope can have before applying the vertical cut.

Texture: Type of texture applied to the wall for its 3D representation.

It is possible to specify whether the wall is applied to the ***Left, Right,*** or ***both*** sides simultaneously.

Additionally, the following buttons are used for managing and assigning walls.

Select: This option is quite useful as it enables the automatic creation of a wall assignment from the selection of a line or polyline in top view. The program will request all the lines or polylines representing the walls and analysing them with regard to the project horizontal alignment it will automatically calculate the walls.

Delete: Deletes the assignment of the wall selected.

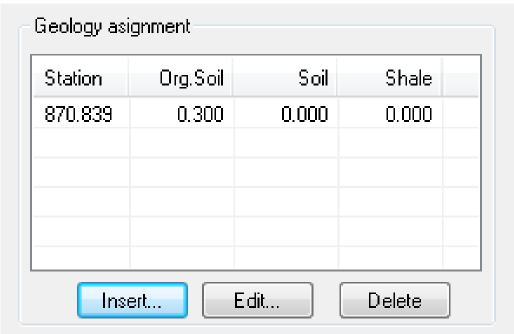
Delete All: Deletes all existing wall assignments.

Geology

The different thicknesses of the geology of the natural terrain are defined in this section. Currently, up to four different strata types are supported:

1. Org.Soil
2. Soil
3. Shale
4. Rock

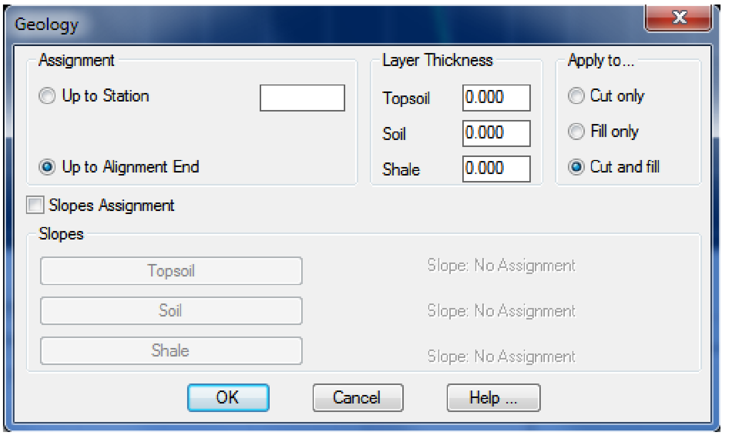
For each of them it is necessary to introduce the particular thickness except for Rock, as it is it is considered excess terrain.



To the right of the panel is a drawing representing the distribution of each strata of terrain.

On the left is the definition of these by station, indicating up to which station it is defined and the thickness of each one:

Insert – Edit : In both these options, the one for inserting a new element and the other to edit an existing one, the following dialog box appears to specify the terrain characteristics up to a particular station.



Assignment: This is to specify up to which station we are going to apply the defined geology type.

Layer Thickness: The thickness of the different types of terrain comprising the section are set. This value will be used in the assignment of cutting slopes to specify the type of slope assignment.

Assign Slopes: This option enables us to conduct a rapid assignment of the slope for each of the types of geology defined.

Clicking on the corresponding tab will assign the slope to this layer of terrain. Once the assignment of geology has been completed and the dialog box validated, the corresponding cutting slope will be assigned automatically.

Delete: Deletes the selected assignment.

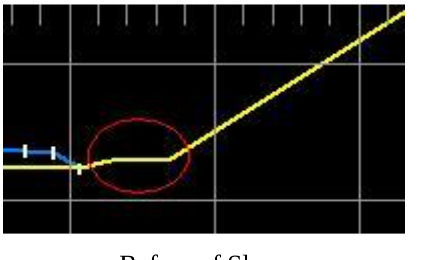
Geology exclusion region: This option enables us to specify a given area of the cartography affecting our road, at which we do not wish any geology calculation to be conducted.

As such, we need to draw one or more closed polylines in the areas we wish to exclude from the calculation, and once we have drawn these polylines we click on this button and draw the said polylines. The program will automatically consider these regions as areas in which the specified vegetal soil thickness will not be applied.

Clearing Berm

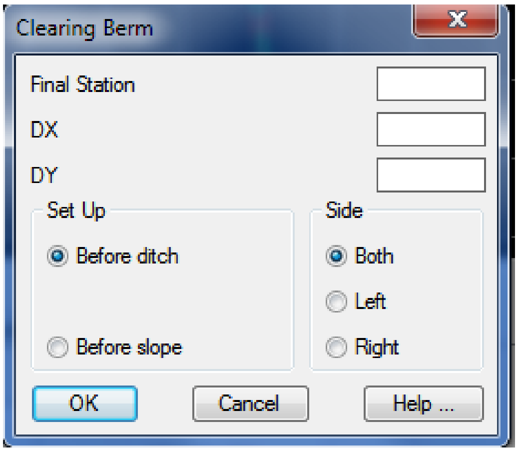
A Clearing Berm is a vector with a determined slope found before a ditch, meaning after the platform, or before the slope inclination. The two types are illustrated in the images below within the red circles.

Before the Ditch



Before of Slope

Below is the window that uses the command to assign the berms to the template.



Station: Station up to which the clearing berm is assigned.

DX: X displacement of the vector that represents the clearing berm.

DY: Y displacement of the vector that represents the clearing berm.

Set Up: As indicated previously in the two images, the clearing berm's point of application, whether this is before the ditch or before the slope.

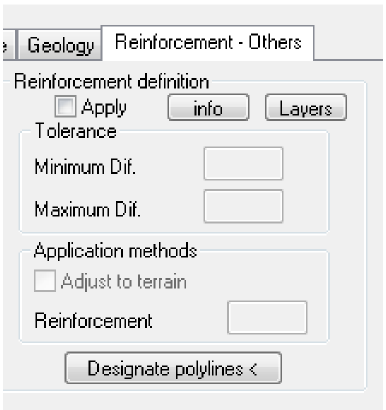
Side: Indicate the side on which to apply the Clearing Berm.

The buttons "**Insert**", "**Edit**" and "**Delete**" are used to edit the data.

Definition of Reinforcements

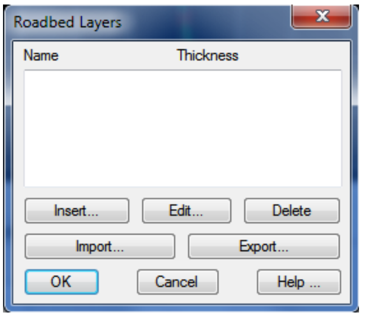
In order to calculate surfaces and volumes, MDT can consider roadbed reinforcements. It is necessary that the initial and final vertices of the sections of the cross-section file to be reinforced are coded as **Pavement**, so that the program can automatically differentiate the part of each profile that should be reinforced. See the **Cross-Section Configuration** section for further details or the **Obtain Cross-Section Profiles** command.

Below is a description of each parameter that defines the reinforcement application.



Apply: If this box is checked it indicates that we wish to apply reinforcement.

Layers: This option enables us to assign different roadbed layers to the reinforcement area. If this assignment exists when calculating the volume of roadbed layers, the calculation of the corresponding materials will appear. If there is no assignment of layers, the item "Reinforcement" will appear as material in the calculation.



Tolerances: To apply reinforcement in a particular station the following condition must be met. The height difference in the vertices where the reinforcement is to be applied between the vertical alignment height and the terrain height must be between the "**Minimum Dif.**" and "**Maximum Dif.**" values.

The objective of these tolerances is to control the application of reinforcement only when the terrain is very near the vertical alignment height.

Mode of application: Once it is decided to apply reinforcement to the template, in the area to be reinforced there are two options for the construction of the reinforcement base:

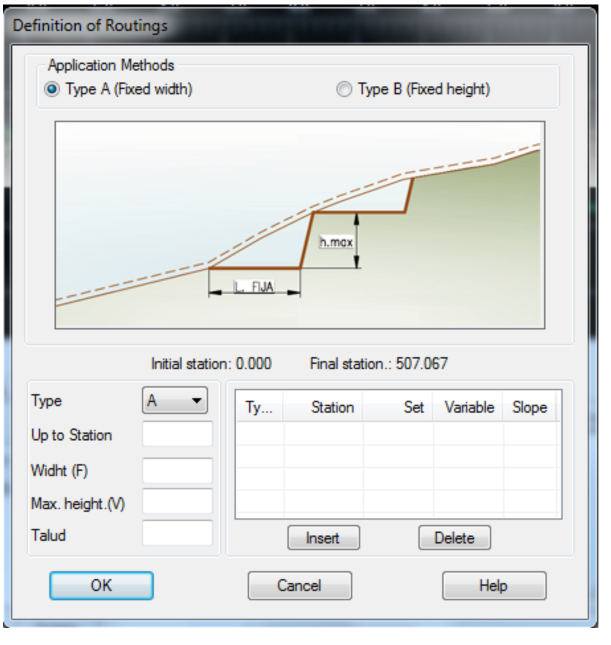
Thickness: Indicate here the thickness of the terrain in the area to be reinforced.

Adapt to Terrain: In this case a particular thickness is not applied to the reinforcement area, the subgrade is automatically adapted to the natural terrain of the area to be reinforced.

Designate Polylines: For the case that in top view the polylines indicate the reinforcement areas, selecting this button then said polylines, will automatically insert the reinforcement in the corresponding stations according to the definition specified.

Definition of Routings

In this section we define the slope existing beneath the natural terrain in the case of fill, also called routings.



Method of application: It is possible to apply two different types of routing:

- **Type A**: In this case the width of the routing, that is the horizontal section is fixed, but the step height is variable.
- **Type B**: In this case on the other hand, the height of the step is fixed and the width of the flat surface is variable.

Up to Station: Station up to which the routing is defined.

Width: Width of the step of the berm or routing. This will be fixed or variable depending on the type of routing selected.

Height: Height of step. This value will likely depend on the routing type applied.

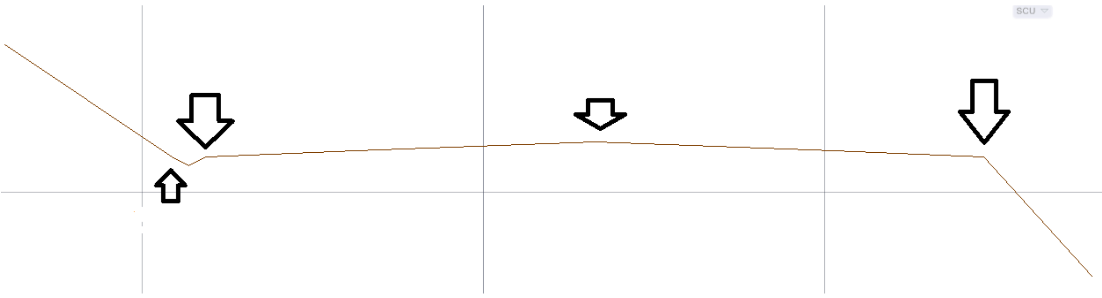
The “**Insert**” and “**Delete**” buttons are used to control the different routing types to introduce in a particular road.

Define from polyline in elevation view

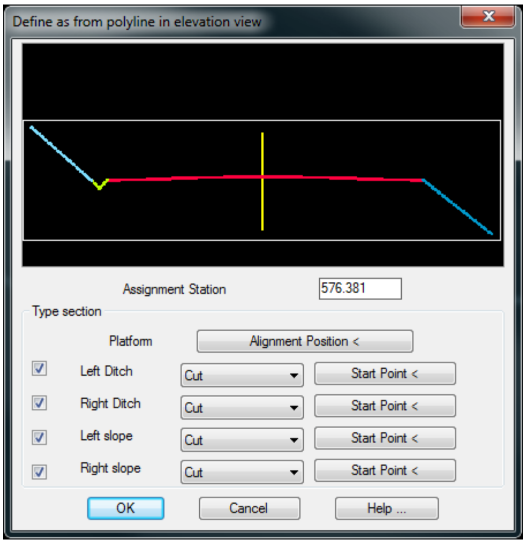
This command will allow us to define a standard section at a given station as from a drawn polyline which represents section in question.

This polyline must contain at least the information corresponding to the platform with a vertex in the alignment position and in addition, optionally, the information from the ditches or slopes may be incorporated.

One example of a polyline to be converted could be the image which appears below.



Upon executing the command, it will initially ask us for the new file for sections to be created and the project alignment; once these elements have been selected, the following window will appear where the whole process will be managed.



Assignment Station: We indicate the Station at which the section in question will be assigned.

Alignment Position:: We designate the platform alignment position.

The other elements, in other words, the ditch and the slope we will be able to enable it or not depending on the available information.

Left Ditch: We indicate whether it is being cut or filled and the starting point at the polyline of the ditch.

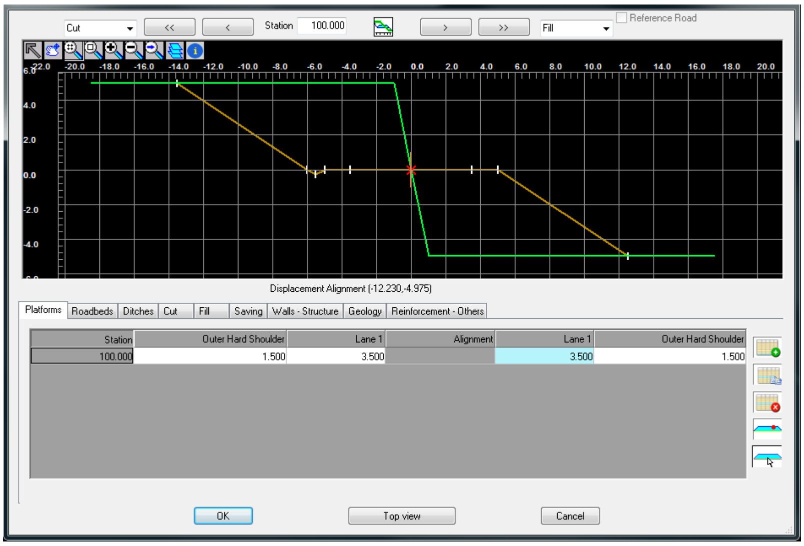
Right Ditch: We indicate whether it is being cut or filled and the starting point at the polyline of the ditch.

Left Slope: We indicate whether it is being cut or filled and the starting point thereof.

Right Slope: As in the previous cases above, we indicate whether it is being cut or filled and the starting point thereof.

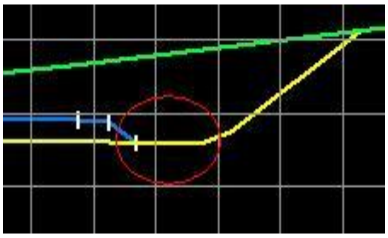
One of the elements comprising the section have been designated, the command "***Definition of Templates***" will be automatically designated where we will be able to see the polyline drawing and the creation of each of the elements.

The image below shows us the result of executing the command with the previous polyline.

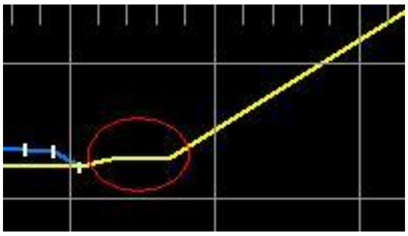


Definition of Clearing Berm PRO

Clearing Berm is the vector with a determined slope which can be found before a ditch, meaning after a platform or before the inclination of the slope. The two types are illustrated in the images below inside the red circles.



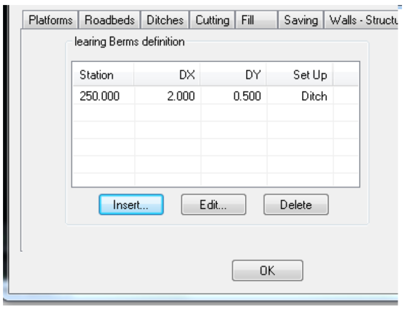
Before the Ditch



Before the Slope

This command will first request an existing template file on which the clearing berms to be applied are defined.

Once the file is selected the following window is displayed for defining the parameters of the clearing berm. Clearing Berm is understood to be the vector existing in our template which is found before the definition of the ditch or before the definition of the slope.



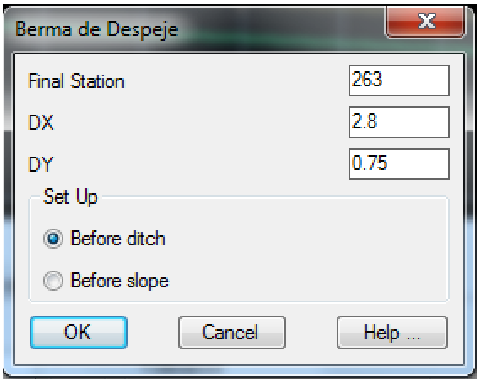
Up to Station: Station up to which the clearing berm is to be defined.

DX: X displacement of the vector that defines the berm.

DY: Y displacement of the vector that defines the berm.

Position: Indicates whether the berm is placed before the ditch or before the slope.

The buttons "**Insert**", "**Edit** " and "**Delete**" are used to manage the different clearing berm assignments.

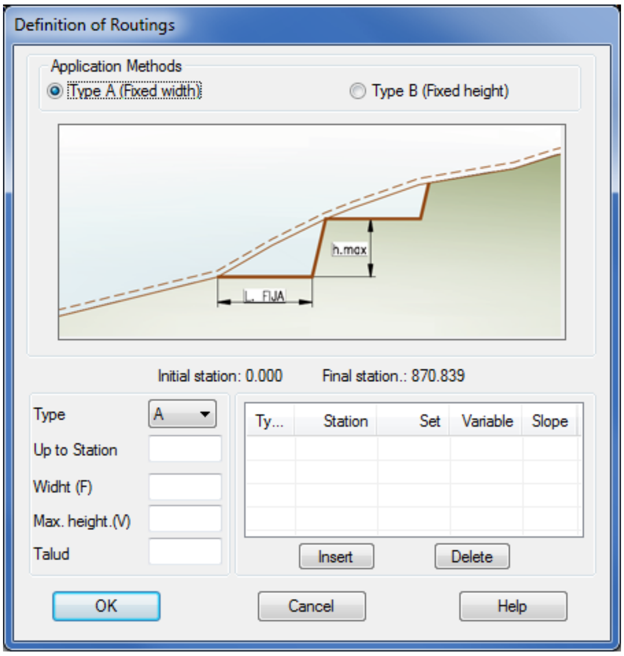


Definition of Routings PRO

With this command we define the slope existing beneath the natural terrain in the case of fill, also called routings.

The program will first request an existing template file on which to define the routing to apply.

Once the file is selected, the following window is displayed to define the routing parameters.



Method of application: It is possible to apply two different types of routing:

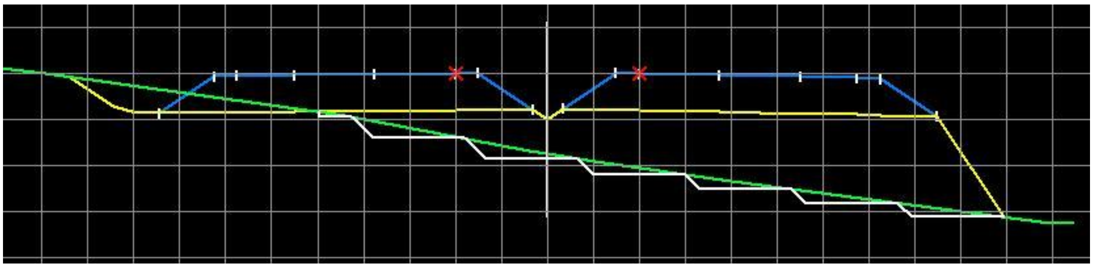
- **Type A**: In this case the width of the routing, that is the horizontal section is fixed, but the step height is variable.
- **Type B**: In this case on the other hand, the height of the step is fixed and the width of the flat surface is variable.

Up to Station: Station up to which the routing is defined.

Width: Width of the step of the berm or routing. This will be fixed or variable depending on the type of routing selected.

Height: Height of the step. Its value will likely depend on the routing type applied.

The “**Insert**” and “**Delete**” buttons are used to control the different routing types to introduce in a particular road.



Conversion of Platforms from Drawing

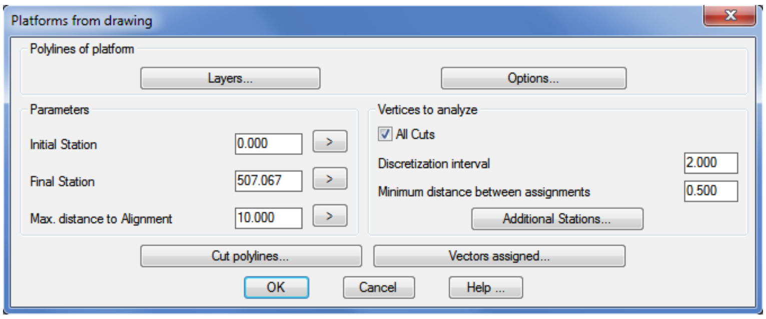
This command is used to build a complete platform assignment of a particular road from a drawing in top view.

The program will build the template file, where it will include all the platforms necessary to build the road. It works well in 2D or 3D.

This drawing in top view must be built from AutoCAD polylines or lines.

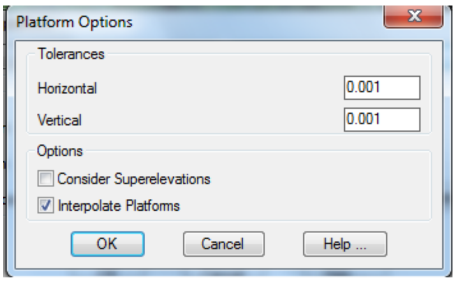
Additionally, the command “**Assign properties to platform vectors**” can be used to associate properties with polylines to simulate curbs for instance, and through which two or more vectors may be associated with the polylines of interest. This command is explained in more detail further on. To use it, if we select polylines "with properties", the command will automatically create the corresponding vectors in the construction of the platform.

When the command is executed the program will first request the horizontal alignment to work with. Then the following dialog box is displayed with the elements described below.



Layers: For selecting the layer or list of layers where the entities are located that will be forming part of the element in question.

Options: Particular configuration characteristics.



Horizontal Tolerance: Minimum horizontal distance that can exist between two platform vertices.

Vertical Tolerance: Minimum vertical distance that can exist between two consecutive platform vectors.

Consider Superelevations: When this option is checked the platform vectors are configured as superelevations.

Interpolate Platforms: If this option is checked the program will apply the option to interpolate the platform, deleting all unnecessary intermediary platforms.

Initial station: Station from which the template is to be generated.

Final station: Station up to which the template is to be generated.

Max. distance. to Alignment : In this parameter we indicate the maximum distance to the horizontal alignment in which the program will find the entities for building the template. In this case, it will analyse 10 meters to the left and right of the horizontal alignment .

Vertices to be Represented

All Cuts: Activating this box orders the program to analyse all the vertices of the designated polylines.

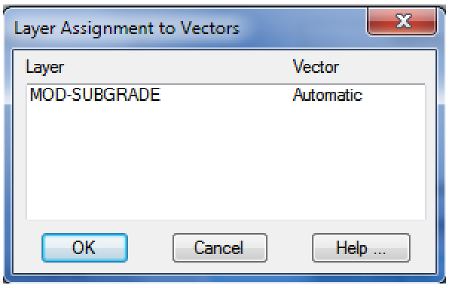
Discretization Interval: The program will analyse the drawing with the interval on the axis specified in this option.

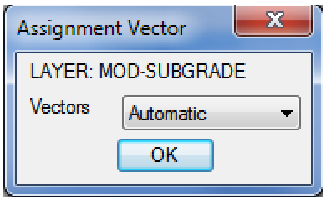
Minimum distance between assignments: Once all the intersections have been processed the program will optimise the set of platform assignments conducted in such a way that there are never two consecutive assignments with a distance between them less than that specified in this box.

Cut Polylines: Clicking on this tab will enable us to select a set of polylines which will delimit the end of the polyline. The purpose of this option is for the case of circular regions in which platforms from different stations can be overlapped.

Assign Vectors:

This window is used to inform the program what type of platform vector is to be used for each of the layers selected. In the event of selecting the default option (Automatic) the program will assign a code automatically.



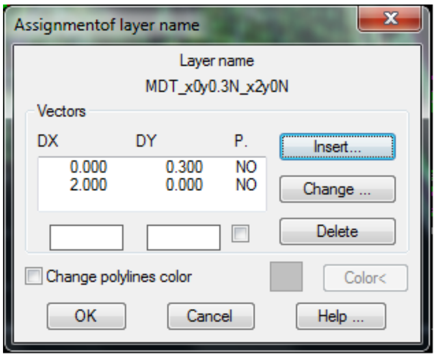


Assign properties to platform vectors PRO

This command is complementary to the previous command "Convert Platforms from drawing" and will be of enormous use for assigning properties to polylines in top view that define the road and that will comprise platform structures.

The basic function is that once the vectors are assigned to the polyline, the name of the layer in which said polyline is located changes such that, in the later execution of the command "Convert platforms from a drawing" it interprets the name of the layer in which the polyline is found and the corresponding vectors are associated.

When the command is executed, the program will first request selection of all the polylines we wish to associate the same properties to, once this is done the following window will be displayed:



Layer name: Name of the layer to be associated with the selected polylines according to the properties it has been attributed.

Vectors: These are the vectors assigned to the polylines or selected polylines, and with the buttons "Insert", "Change" and "Delete" we can manage data input.

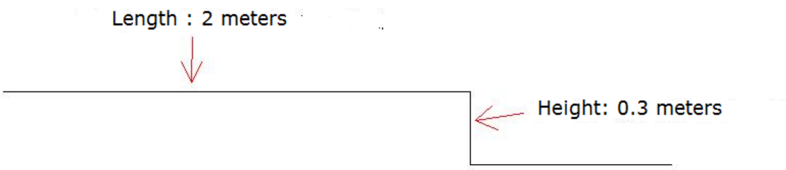
DX: X displacement of the vector.

DY: Y displacement of the vector.

P.: Indicates whether the vector to create in the platform can be superelevated or not.

In the case that it presents in the image captured, we attribute a first vector to the polyline selected which would be a 0.3 m-high step and then a straight vector, to simulate a 2-meter long pathway.

Drawn in elevation plan it would be:



Change polyline colour: If this option is activated, the colour of the selected polylines would change. This option is useful to distinguish those polylines to which we have already attributed properties.

Once the command is finalized, the polylines selected will change to a new layer whose name is given according to the assigned vectors. In the case that it does not present it is associated with the name of the layer MDT_x0y0.3N_x2y0N.

To interpret the name of the layer, with each sequence existing between two characters "_" we have a new vector, in this case the first vector would be:

x0y0.3N where x has an increase of the value of 0.000, and has an increment of the value of 0.3 and the character "N" at the end indicates that it cannot be superelevated.   If it can be superelevated the character "S" must appear at the end.

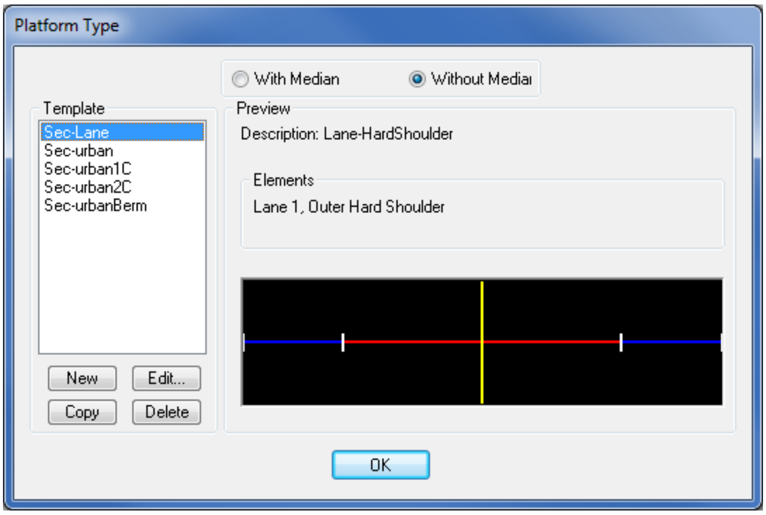
Following the assignment of properties to polylines, it is time to execute the command "Convert Platforms from Drawing" to automatically create the platform assignment.

Platform Library

This command is used to define the set of platforms with which we will be working normally, the platform selected in this section will serve as a reference when it is time to carry out the platform assignment, although in the command "**Definition of Templates**" modifications can be made that are considered suitable to the type of platform selected.

In the case of selecting a template file we can indicate either a new file or an existing file on which modifications will be made.

When the command is executed the following window is displayed for managing the different platforms we will be working with.



First we distinguish the main property of the platform and whether or not it has a median. This aspect is important as only in the case of platforms with medians is there a median-type element and a distinct roadbed for each roadway and each side of the median.

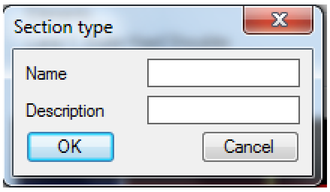
Various templates are available by default for each type to serve as a base for developing our section.

"Preview" displays an image of how the platform selected will be.

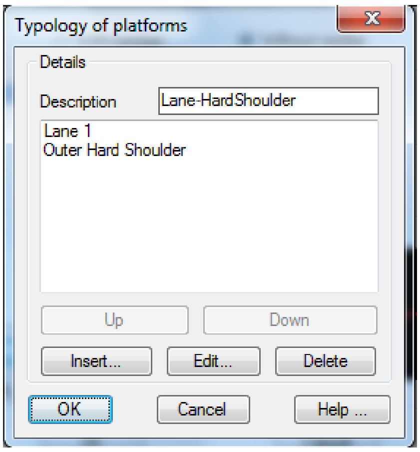
Also, we can define new templates, according to our needs that are available for defining new sections

The sections can be personalized with the following buttons:

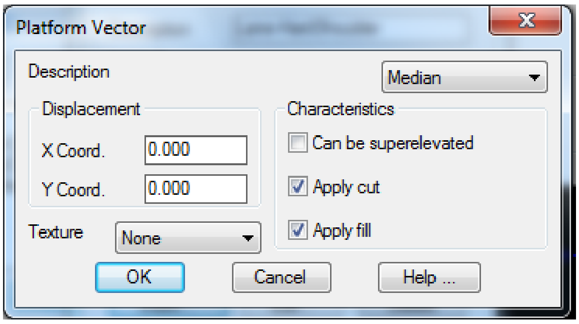
New: Creates a new section. Indicate here the name of the section and a give a brief description (optional).



Edit: Edits the section selected in the list and the following window is displayed for defining each of the vectors comprising it. Only one of the sides is defined, so that in the definition we have to keep in mind all the possible vectors we will use in our platform. In a later definition not all the vectors need to be used on both sides.



Distinct properties can be assigned to each of the vectors, from the vector type to whether it can be superelevated or not. All these characteristics can be modified in the definition of the template.



- **Description**: Type or name of the vector.
- **Displacement**: The dimension the vector will have by default.
- **Texture**: Type of texture to be applied to the vector for later visualization with textures.
- **Can be superelevated**: Indicate here whether the vector is superelevated by default.
- **Apply cut/fill**: It is possible to indicate in which section of the template to apply the vector, whether in cutting or fill, or both.

Copy: This is used to copy an already-existing template and change its name. This option is of enormous use in cases when the new section is very similar to an already-existing one, which prevents us having to define all the vectors.

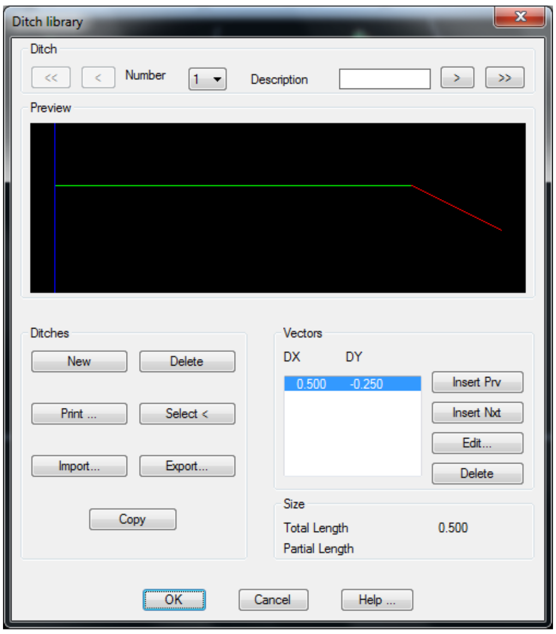
Delete: Deletes the template selected.

For each section created a new file is created in the folder "***mdt5\config\secciones***" where the information associated with each one is saved. This way, if these files are copied in another MDT installation the templates will be ready to use. If the file extension is "**vpc**" it refers to a highway platform, meaning the type "**With median**"; if the extension is "**vpu**" it refers to a platform "**Without median** ".

Ditch Library

This command is used to define the ditches we will be working with. Any number of ditches may be defined, though it is not necessary to define them from this option as the "Template Definitions" command gives the option to create a new ditch if it is required.

When the command is executed, a window is displayed to create, modify, or delete the different ditches the program is working with by default. The ditches defined in these libraries will be added by default in the creation of the template file.



There are three sections:

Ditch: Buttons for moving forward and backward across the entire library of defined ditches.

Ditches: Set of buttons for defining or deleting the existing ditches.

New: Creates a new ditch.

Delete: Eliminates the current ditch.

Print: Prints the list of ditches with their vectors.

Select: Used to graphically select a ditch which has been previously drawn with an AutoCAD polyline.

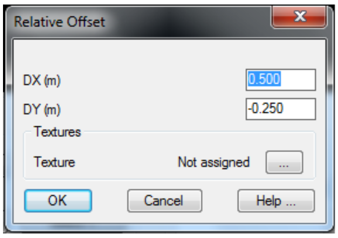
Import: Imports the ditches from a file.

Export: Exports the ditches from a file.

Copy: Copies the current ditch to a new file.

Vectors: Set of vectors comprising the ditch, with the corresponding buttons for inserting, editing and deleting them.

When any of these vector-editing buttons is selected (***Insert Prv., Insert Nxt., Edit***) the following window is displayed for specifying the X and Y displacement that the vector the ditch being edited will have.



It is important to highlight that the value of the X increment cannot be zero or negative. In other words, vectors always have to travel away from the horizontal alignment. Should a vertical jump need to be entered, a small value can be entered (such as 0.01 or 0.001), which will have practically no effect on the calculations.

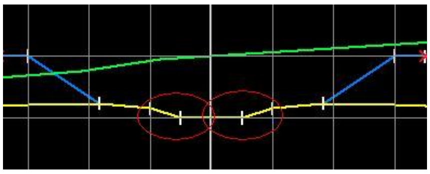
In the ***Textures***, the texture associated to each of the vectors can optionally be set This option is used to give a more realistic appearance to the 3D representation commands available in the ***Maps*** option. If textures are not assigned, the program will automatically apply a texture when the above-mentioned commands are executed.

Elements Library – Saving Ditches PRO

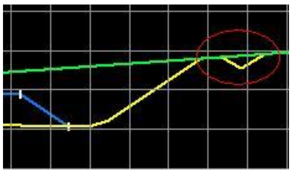
In this option we define two types of elements we will be working with in the templates:

Elements of Median: Available for templates with medians, these are the interior median ditches, connected at the platform's interior vertex on both sides. The image shows the position.

Saving Ditches: These are ditches existing either at the crown or foot of the slope, generally used to channel water. The image demonstrates its application.

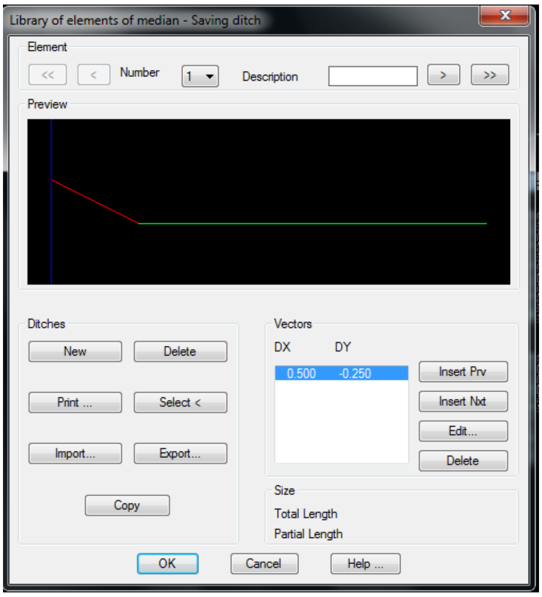


Element of Median



Saving Ditch

When the command is executed, a window is displayed to create, modify or delete the different ditches the program is working with by default. The elements defined in these libraries will be added by default when the template file is created.



There are three sections:

Element: Buttons for moving forward and backward across the entire library of defined ditches.

Elements: Set of buttons for defining or deleting the existing ditches.

New: Creates a new ditch.

Delete: Eliminates the current ditch.

Print: Prints the list of ditches with their vectors.

Select: Enables graphically selecting a ditch which has been previously drawn with an AutoCAD polyline.

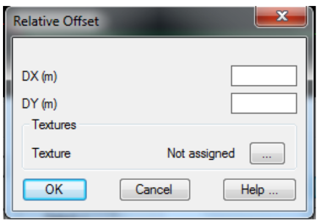
Import: Imports the ditches from a file.

Export: Exports the ditches from a file.

Copy: Copies the current ditch to a new file.

Vectors: Set of vectors comprising the ditch, with the corresponding buttons for inserting, editing and deleting them.

When any of these vector-editing buttons is selected (***Insert Prv., Insert Nxt., Edit***) the following window is displayed for specifying the X and Y displacement that the vector the ditch being edited will have.



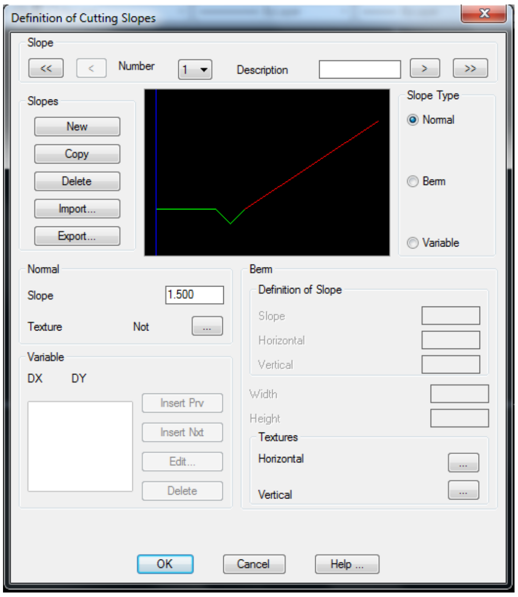
It is important to highlight that the value of the X increment cannot be zero or negative. In other words, vectors always have to travel away from the horizontal alignment. Should a vertical jump need to be entered, a small value can be entered (such as 0.01 or 0.001), which will have practically no effect on the calculations.

In the ***Textures***, the texture associated to each of the vectors can optionally be set This option is used to give a more realistic appearance to the 3D representation commands available in the ***Maps*** option. If textures are not assigned, the program will automatically apply a texture when the above-mentioned commands are executed.

Library of Cut Slopes PRO

In this option we define the cutting slopes with which we will usually be working in the definition of the template type. The same as before, in the template definition it is possible to define new slopes without needing to execution this command.

The following window will appear for defining the slopes according to their needs.



A description of the button functions follows:

Number: Drop-down list for selecting a slope from those existing in the section file.

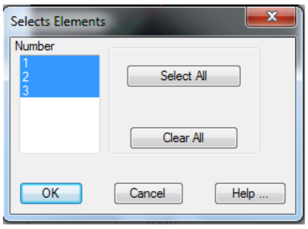
Description: Text for identifying the defined fill slope. It is not a necessary parameter but it will be of enormous use in the assignment of sections as it makes each slope assigned be easily identified.

Delete: Deletes the current slope and automatically moves to the next slope if one exists.

Print: Sends the slope content to the printer.

Copy: Creates a slope identical to the current one and assigns it the next number following the last on the list.

Export: Displays a window containing all the slopes ready to be exported, so that any of them may be selected.



Once validated, the slopes selected are exported to the file then specified. The output file is an ASCII file and has a `.TAL` extension.

Import: Imports any file with a `.TAL` extension and adds it to the current platforms. All this information is saved in the template file selected.

New: Creates, by default, a ***Normal***-type slope, assigning it the number following the last on the list. To identify different types of slopes proceed as follows.

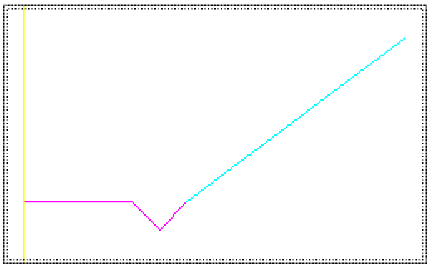
Select the ***Slope Type*** to define one of the three options for slopes that can be applied.

:

Normal Slope

Slope with a single vector. In this field, key in the value resulting from dividing the abscissa (x) and ordinate (y) values making up the slope gradient (tangent) as an absolute value.

A ***texture*** can be applied to it with a view to the road's 3D representation.



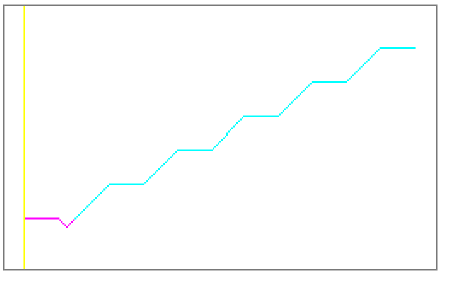
Normal-type slope.

Slope with Berm

The slope with berm can be entered by either entering the ***Slope*** numerical value or specifying its ***Horizontal*** and ***Vertical*** values. In any case, when the values of any of them are entered, the rest are recalculated. The following parameters may additionally be specified:

- ***Height***: Height of each of the steps in the berm slope.
- ***Width***: Width of each of the steps in the berm slope.

A different ***texture*** may be applied to the vertical and horizontal vectors with a view to the road's 3D representation.

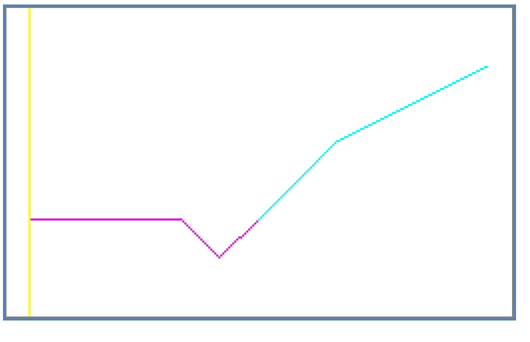


Berm-type slope

Variable Slope

The structure of the slope to be defined is defined by vectors (similar to the definition of Ditch) by entering the dimensions of its respective vectors.

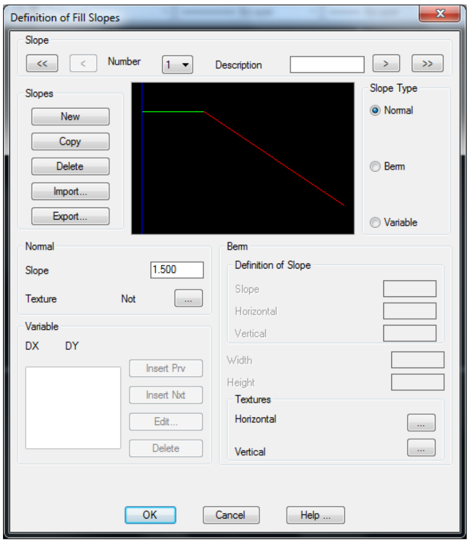
The program indefinitely extends the last vector until it intersects natural terrain.



Library of Fill Slopes

In this option we define fill slopes, the same as in the previous case of cutting, with those that we will usually be working with in cross-section definitions. The same as before, in the template definition it is possible to define new slopes without needing to use this command.

The following window will appear for defining the slopes according to their needs.



A description of the button functions follows:

Number: Drop-down list for selecting a slope from those existing in the section file.

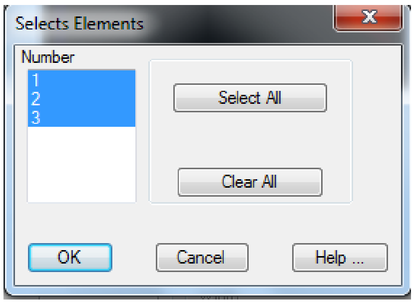
Description: Text for identifying the defined fill slope. It is not a necessary parameter but it will be of enormous use in the assignment of sections as it makes each slope assigned be easily identified.

Delete: Deletes the current slope and automatically moves to the next slope if one exists.

Print: Sends the slope content to the printer.

Copy: Creates a slope identical to the current one and assigns it the next number following the last on the list.

Export: Displays a window containing all the slopes ready to be exported, so that any of them may be selected.



Once validated, the slopes selected are exported to the file then specified. The output file is an ASCII file and has a `.TAL` extension.

Import: Imports any file with a `.TAL` extension and adds it to the current platforms. All this information is saved in the template file selected.

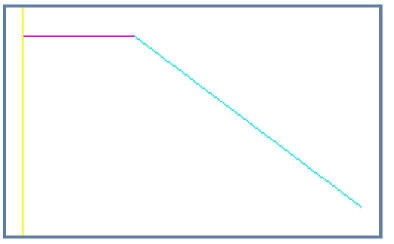
New: Creates, by default, a ***Normal***-type slope, assigning it the number following the last on the list. To identify different types of slopes proceed as follows.

Select the ***Slope Type*** to define one of the three options for slopes that can be applied.

Normal Slope

Slope with a single vector. In this field, key in the value resulting from dividing the abscissa (x) and ordinate (y) values making up the slope gradient (tangent) as an absolute value.

A ***texture*** can be applied to it with a view to the road's 3D representation.



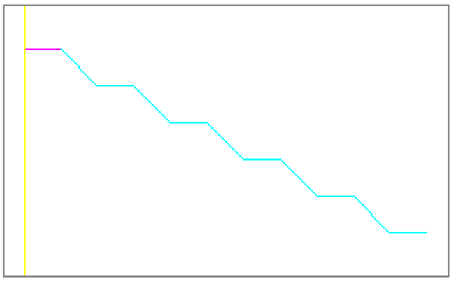
Normal-type slope.

Slope with Berm

The slope with berm can be entered by either entering the ***Slope*** numerical value or specifying its ***Horizontal*** and ***Vertical*** values. In any case, when the values of any of them are entered, the rest are recalculated. The following parameters may additionally be specified:

- ***Height***: Height of each of the steps in the berm slope.
- ***Width***: Width of each of the steps in the berm slope.

A different ***texture*** may be applied to the vertical and horizontal vectors with a view to the road's 3D representation.

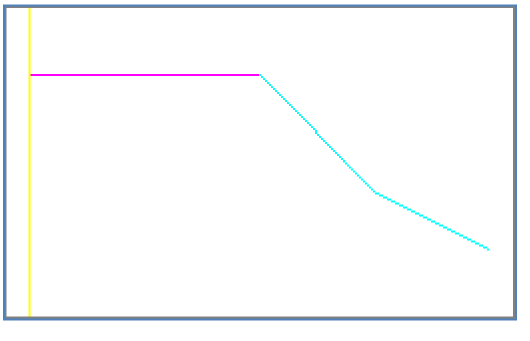


Berm-type slope

Variable Slope

The structure of the slope to be defined is defined by vectors (similar to the definition of Ditch) by entering the dimensions of its respective vectors.

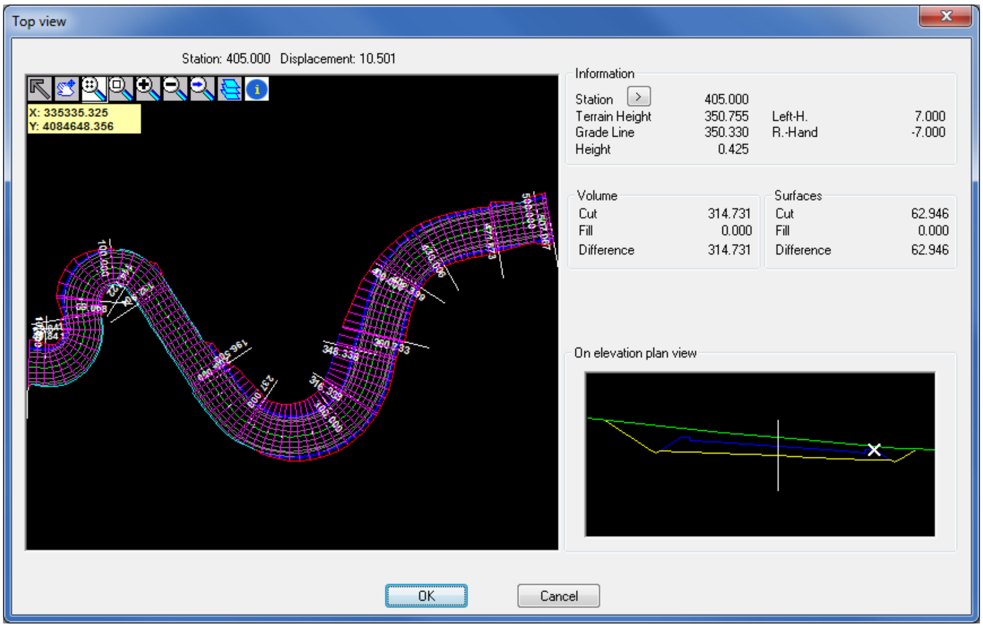
The program indefinitely extends the last vector until it intersects natural terrain.



Top View

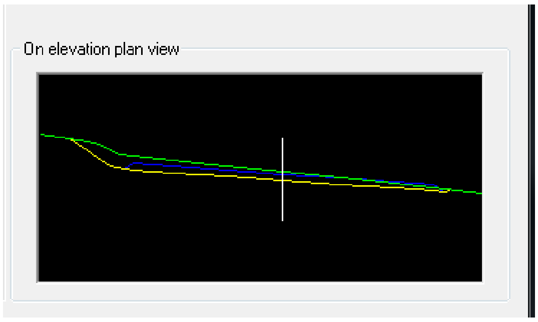
This command is used to interactively see the road that has just been defined, as well as make any kind of change to the design of the cross section.

Initially, the program will request the segment we wish to visualize, then the following window will be displayed for visualization.



In the left hand region of the window the full road is displayed in top view, and basic zoom tools allow for moving along it.

As we pass the mouse over the road, the section of the road in top view appears in the lower right hand region by way of the cut in the current station.



Also, at all times the program displays the following data in the top right hand area:

Information:

- Station: Current station.
- “>” : Clicking this button takes us directly to a particular station.
- Terrain Height: Height of the natural terrain of the vertex selected on-screen.
- Grade line height: Height of the grade line of the vertex selected on-screen.
- Cut/fill: Difference between the height of the terrain and the grade line.
- Left superelevation: superelevation to the left of the current station.
- Right superelevation: superelevation to the right of the current station.

Surfaces: In this section it displays the cut and fill surface of the current station. Additionally, it shows the difference between them.

Volume: Shows the volume of the current station with regard to the next one.

Current Template: This part of the dialog box displays the template we have defined in the station currently selected. The element we are currently positioned appears in black.

There are also buttons with which to define the cross-section or the assignment we have made. These modifications are made in real time.

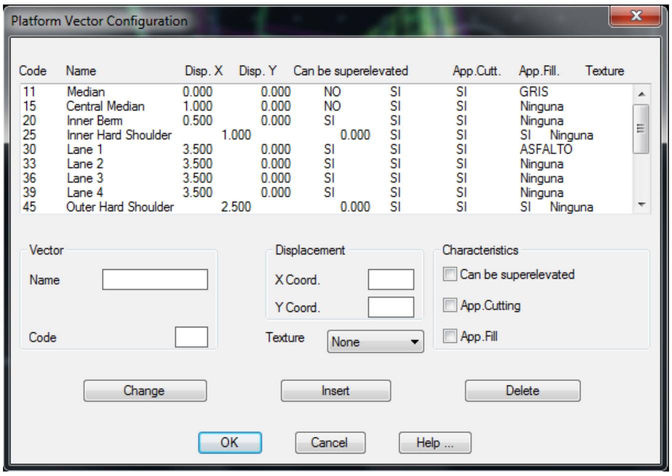
Definition: Directly accesses the cross-sections definition.

Assignment: Accesses the current assignment of the road.

Definition of Platform Vectors

The purpose of this option is to define the default codes and dimensions of the different vectors that can constitute the platform. Each one of these has a numeric ***Code***, a ***Name***, relative **X** and **Y** ***Displacements*** , and a value to indicate whether it ***can be superelevated*** or not.

The codes must increase from the horizontal alignment (value 0) up to the ends of the profile, both for the left and the right. The buttons ***Change, Insert*** and ***Delete*** can be used to modify the configuration, which will be saved in the file `Secciones\VecPlat.dat` in the directory `Config`.



Additionally, three properties have been added to each one of the vectors:

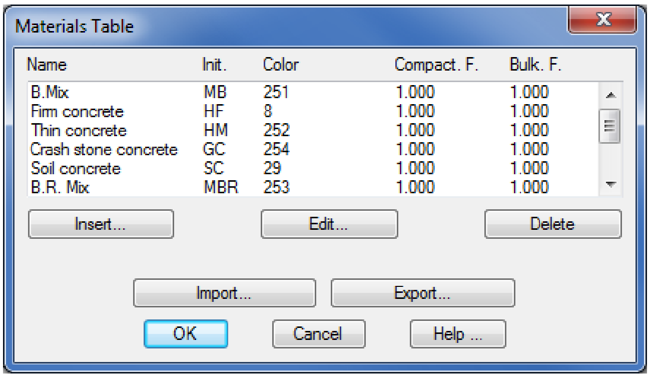
App.Cut: If this is checked the vector will be applied to the platform in the case that the vector's point of application is cutting.

App.Fill: If this is checked the vector will be applied to the platform in the case that the vector's point of application is in fill.

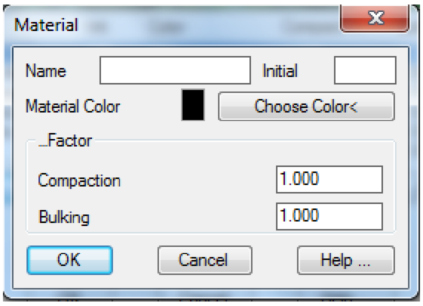
Texture: Texture to apply to the vector in question for later 3D visualization of the road with the commands “Maps/Realism”.

Definition of Materials

The materials that will make up the roadbed layers of a previously defined roadbed are set in this option. A list containing all the materials that will comprise or form part of the layers is entered in the following dialog box. The information is stored in a file with a `.MAT` extension, and it can be used in any other subsequent project. The materials defined can be **Imported** and **Exported**.



When either the **Insert** or **Edit** are clicked, the following window is displayed, where one can enter the material’s characteristics:



Name : Description of the material to be defined.

Colour: Colour of the material in the representation.

Init.: Initials representing the materials.

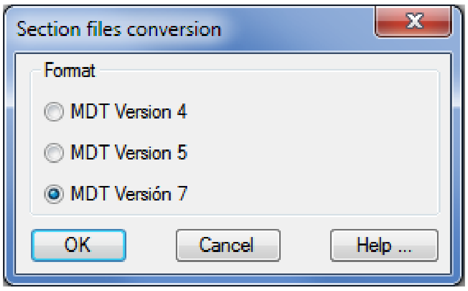
Compacting and Absorption Factor: Material factors that have an influence on the calculations performed using **Roadbed Layers List** option.

Convert to MDT Version 6 Cross-Sections

This command allows one to convert an MDT Version 7.5 cross-section file into a Version 7, 6, 5 or 4.x file.

The new Version 4, 5, 6 or 7 file created will not have Version 7.5's new features.

First of all the program will request the file to be converted, then a window will appear in which we select the version we wish to convert and finally the file in which to save the changes.



13. Segment

Introduction

The segment commands are directly related to the road definitions.

By segment, we understand a file that represents the roadway and which will contain all the elements necessary for defining it, meaning, horizontal alignments, slopes, grade lines, cross-sections, sections, superelevations, etc.

Additionally, a series of tools is available to facilitate editing, revision and visualization.

All the commands in this menu group correspond to the professional MDT model.

Define - Edit PRO

This command is used to define a segment file (extension `.SEG`). This file will include all files generated over the course of our project associated with each horizontal alignment, in order to integrate all the information and avoid having to request each part individually in all the commands required. It is comprised of the following elements:

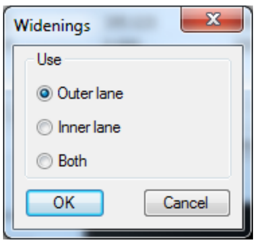
Horizontal alignment (extension `.horizontal alignment`): the most important file, as all the other files are associated with this one. Obligatory.

Longitudinal (extension `.LON`): contains the longitudinal profile associated with the horizontal alignment. Obligatory.

Cross-sections (extension `.TRA`): contains the cross-section profiles associated with the horizontal alignment. It is not essential to draw complete longitudinal profiles, although it is to draw cross-section profiles and cubic measurement lists.

Grade line (extension `.RAS`): contains the vertical alignment associated with the horizontal alignment and the longitudinal profile. It is necessary both for the complete longitudinal profile drawing and for the calculation and drawing of the cross-section profiles.

Widenings (extension `.SOB`): contains the shoulders associated with a horizontal alignment, if they exist. Optional.



Sections (extension `.SCC`): contains the section definition and assignment across the horizontal alignment. These are necessary to calculate and draw the cross-section profiles.

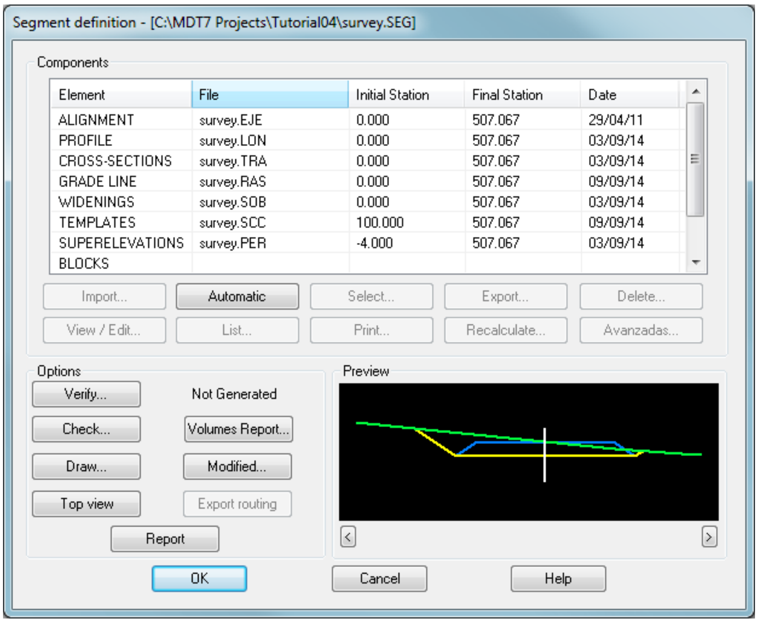
Superelevations (extension `.PER`): contains the superelevations associated with a horizontal alignment, if they exist. Optional.

Blocks (extension `.BLK`): contains the block assignment definitions to represent in the drawing, of the roads or the profiles. Optional.

Skewed Cross-sections (extension `.TRE`): contains the skewed cross-sections definitions that could be generated from the horizontal alignment. Optional.

In order to facilitate its use, the content of each of these files is copied to the segment file in binary format, meaning, they are not linked to the original files but are embedded in them. Therefore, if any changes are made to one of these files using the different options the command provides, the original file will not change, though once we validate this dialogue box, the command will notify us of said circumstances and we can update the files that were originally imported with the current information.

After activating it the MDT command requests a segment file, which can be a new file or an already-existing file. Once it is selected a dialog box like the one below will appear, which details the characteristics of the segment, meaning, the elements or files it contains. The following is a description of the characteristics of each of the controls in the dialog box.



Three differentiated sections can be distinguished.

Components: Makes reference to each one of the linked files.

Options: Different options for the segment for once the different segment elements have been imported.

Preview: Drawing representing the element selected in the section *Components*.

Components

This section features the different elements the segment contains, as well as the different buttons for interacting with them. Their functions are described below.

The date field is filled in whenever the file that it refers to is found on the computer, showing its date.

Import: Depending on the element selected, by pressing this button MDT requests the respective file and once selected this becomes a part of the segment. For example, if the ***Longitudinal*** option is activated by pressing this button the program will request a file with the file ending `*.LON`.

Automatic: Pressing this button automatically imports all the files found in the same folder as the segment and with its same name.

Select: This option is only accessible for the horizontal alignment, the longitudinal and the vertical alignment. It allows us to graphically select the element instead of importing it necessarily from a file.

Export: Similar to the previous button, by pressing this one MDT will export the selected element to a file. This option is very useful for updating information if the segment content has been modified in a command later executed.

Delete: Deletes the information the segment of the element has associated with the element selected.

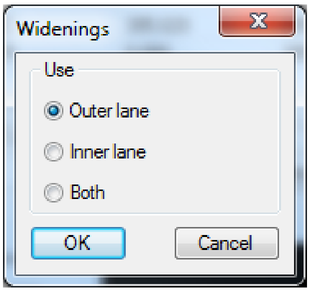
View/edit: Enables visualization of the element selected. Editing is carried out on an external editor and changes can be made on the majority of the elements, but these changes will only be kept for the segments and not the files they depend on. To update the files use the ***Export*** option mentioned previously.

List: This enables listing the elements selected. Changes can be made to the lists, but these changes will only be maintained in the segments and not in the files they depend on. To update the files use the option ***Export*** mentioned previously.

Recalculate: This option is another alternative to importing. For superelevations and shoulders it is only necessary to define the horizontal alignment. To make it possible to use these with longitudinal profiles and cross-sections, it is necessary to have a surface and its respective files defined. MDT analyses them to extract the interval between profiles and then recalculates them, updating the information.

Print: Use this option to extract the object selected in a selected output file (printer, pdf, excel, etc.).

Advanced: This option has been designed for those components that require additional configuration and it can now only be used for the configuration of the additional width application point. Upon selecting the Additional widths option and pressing this button the following window will appear in which we will indicate the application vector.



Options

This section has a series of options that directly affect the segment and each of its components. For each and every one of them it is necessary that in the segment at least the horizontal alignment, cross-sections, vertical alignments and sections have been imported, meaning, the road can be made up. Below is a description of each option:

Verify: This option analyses the segment and displays an error report indicating the possible defects existing in the section definition. For more details see the section “***Generate Modified Terrain***” in the section on “***cross-sections***”.

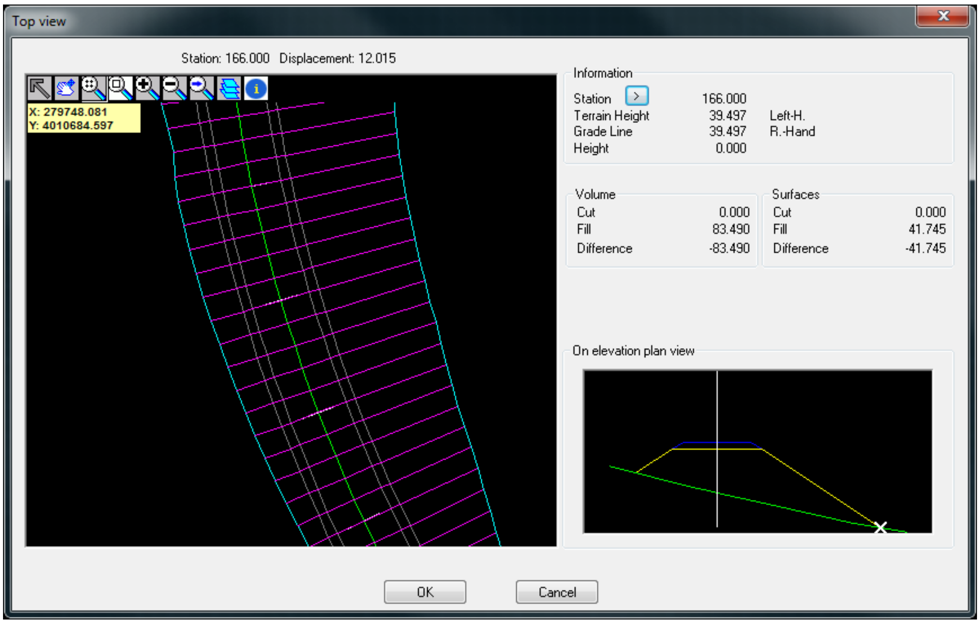
Check: Use this button to view the final state of our road in elevation plan view in a new window.   For more detail see the section “***Check cross-sections***” in the section on “***cross-sections***”.

Cubic measurement: This will display the cubic measurement of the segment in question. This option is described in more detail in the subsection “***list of cubic measurements***” in the section on “***Volumes***”.

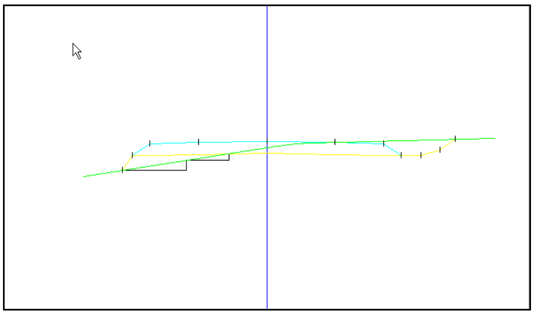
Draw: When this option is selected it will draw the cross-sections. For more detail see the section “***Draw cross-sections***” in the section on “***cross-sections***”.

Modified: This option is used to generate the final modified terrain of the road defined by the segment, and if roadbed layers exist, a modification associated with any of the existing roadbed layers can be generated. For more detail, see the subsection "Generate Modified Terrain" within the section “Cross-Sections”.

Top view: Use this button to visualize the top view of the complete road that we have defined with the working segment.



Export Routing: If a routing is defined in the section associated with the segment, this enables exporting the routing section as cross-sections file, which will appear as a black line in the drawing.

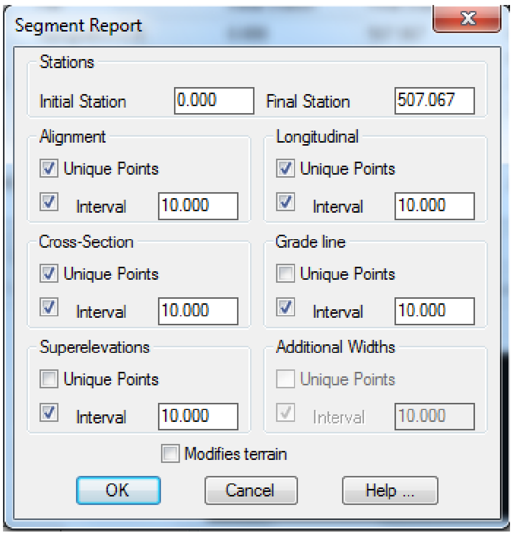


Preview

Graphic representation of the element of the selected segment. Depending on the object selected there are several visualization options. For example, each one of the cuts that comprise a cross-section can be viewed.

Report

Activating this button generates a complete report of the elements linked to the segment. The following window will appear for the purpose of customizing the type of list to be generated.



It is possible to indicate the stations for generating the list and for each segment element if we wish to send the information on the unique points or if we want the report with a determined interval.

In the case of “Modified Terrain” it will generate a report on the vertical alignment and subgrade cross-sections if roadbed has been assigned to the section.

Segment report
06/07/011

Alignment: topografico.EJE

Type	Station	X Coord.	Y Coord.	Azimuth	Radius	Parameter	Length
Line	0.000	335085.958	4084594.132	102.442116	0.000	0.000	10.000
Arc	10.000	335095.950	4084593.749	102.442116	-25.000	0.000	39.841
Clt	49.841	335121.906	4084618.342	0.988766	0.000	15.000	9.000
Clt	58.841	335120.969	4084627.280	389.529610	22.000	15.000	10.227
Arc	69.068	335120.082	4084637.444	4.327074	22.000	0.000	45.654
Clt	114.722	335153.947	4084654.444	136.438571	0.000	20.000	18.182
Line	132.904	335165.882	4084640.910	162.745173	0.000	0.000	63.596
Clt	196.500	335201.010	4084587.897	162.745173	-50.000	45.000	40.500
Arc	237.000	335227.521	4084557.670	136.962072	-50.000	0.000	79.338
Clt	316.338	335297.187	4084572.722	35.945979	0.000	40.000	32.000
Line	348.338	335308.146	4084602.632	15.574146	0.000	0.000	12.395
Clt	360.733	335311.148	4084614.658	15.574146	60.000	50.000	41.667
Arc	402.399	335325.758	4084653.441	37.678999	60.000	0.000	27.607
Clt	430.006	335345.800	4084672.071	66.970496	0.000	50.000	41.667
Line	471.673	335385.546	4084683.812	89.075349	0.000	0.000	35.394
	507.067	335420.421	4084689.856	89.075349			

Road Intersection PRO

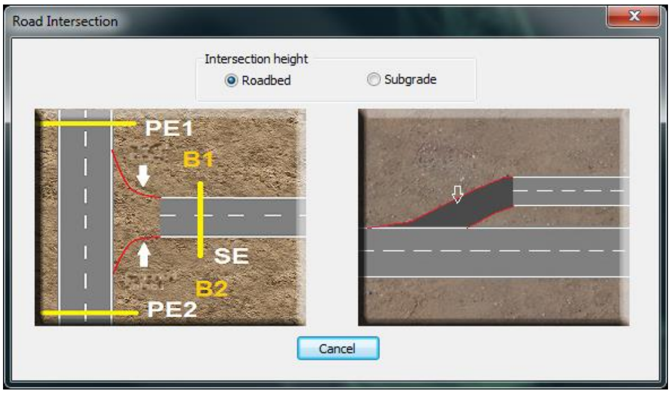
This tool will make it easier for us to create intersections between two roads. With this in mind, before executing the command the roads must be properly connected in the intersection area between both,

MDT has a series of tools which allow the user to adapt a gradient to the profile of another road in a very dynamic manner. He can consult the command **MDT7 > Gradients > Modify > Adapt to Longitudinal**, inter alia.

For the execution of the intersection, this command will assume two different segments or roads, on the one hand the so-called **Main Road**and this road will be the one which will run completely in accordance with its definition and the **Secondary Road** which will be the road that meets the Main Road and where we will undertake the intersection.

MDT distinguishes between two types of intersection**, Intersection** and **Link intersection** which we will describe below.

Upon executing it, it will initially ask us for the Main Road segment and the Secondary Road segment and then the following window will appear.



intersection Elevation : In the event that the secondary road has a road surface, we indicate whether the elevation at which the intersection will be built is going to be the road surface elevation or that of the subgradient.

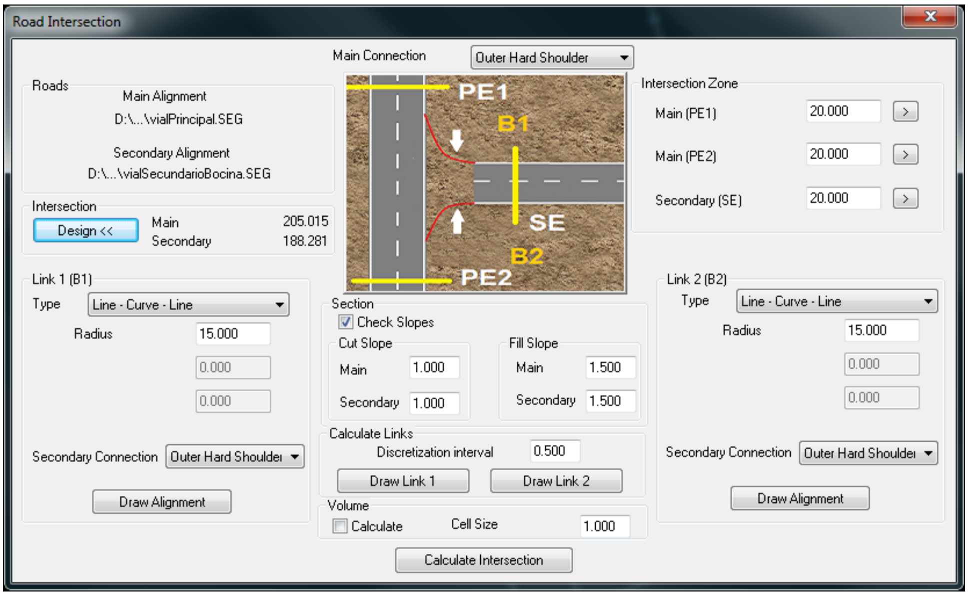
 **Intersection**: At this type of intersection the meeting with the Main Road is carried out in the form of two fans and MDT will treat each fan as it was a separate link.

 **Link type intersection**: In this case, the meeting with the Main Road is achieved automatically by prolonging the Secondary Road, adapting to the Main Road.

Intersection

At this type of intersection the meeting of the Secondary Road with the Main Road is carried out by constructing two fans with their own axes, gradients and standard sections and which behave totally independently. The section of each of the links will inherit the characteristics of the section of the Secondary Road depending on which side it is on.

Upon selecting this option, MDT will initially ask us to designate a point near the intersection to be built and the following window will then appear at which we will enter the parameters required to carry it out.

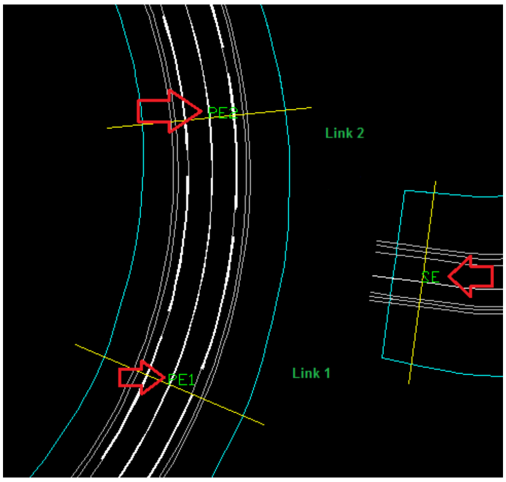


Main Connection: This dropdown menu will show us the different types of vectors to be found on the Main Road and we must choose the vector as far as which the intersection or expansion will be built. Generally speaking, this vector usually coincides with the *Outer Hard Shoulder*where there is one.

Intersection Surroundings: In this section we will define the extension which the intersection to be carried out is to occupy.

- **Main (PE1)** : This distance is measured from the centre of the intersection on the right of the Main Road.
- **Main (PE2) :** This distance is measured from the centre of the intersection on the left of the Main Road.
- **Secondary (SE)**.: In this case the distance is measured from the centre of the intersection to the point on the Secondary Road as far as which the intersection is to be built.

MDT draws some lines on the drawing indicating the surroundings of the intersection in accordance with the parameters stated previously.



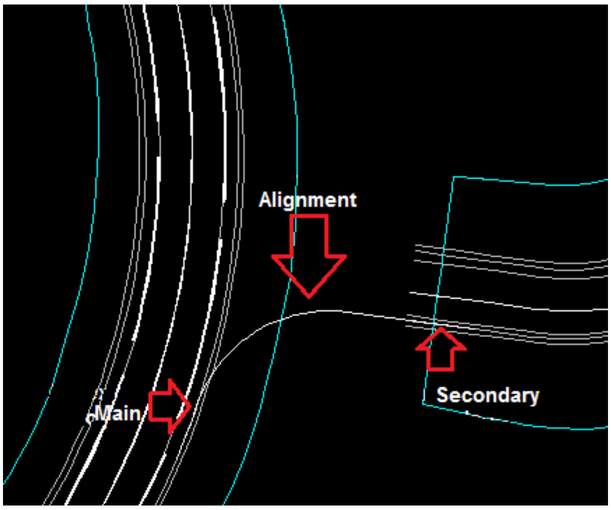
Link 1 (B1): Parameters required for the development of ***Link 1***; this link will be situated on the left depending on the direction of travel of the Secondary Road.

Type: We define the alignment which is to connect the Secondary Road to the Main Road in line with the type selected and we will enter the values corresponding to the alignment designated on the lower controls.

There is also the possibility of "***designating***" an alignment or axis which we have pre-defined.

Secondary Connection: This dropdown menu will show us the platform vectors of the Secondary Road and we will designate the one on which we wish to start the aforementioned alignment.

Draw Alignment: Preview of the alignment in line with the parameters specified.



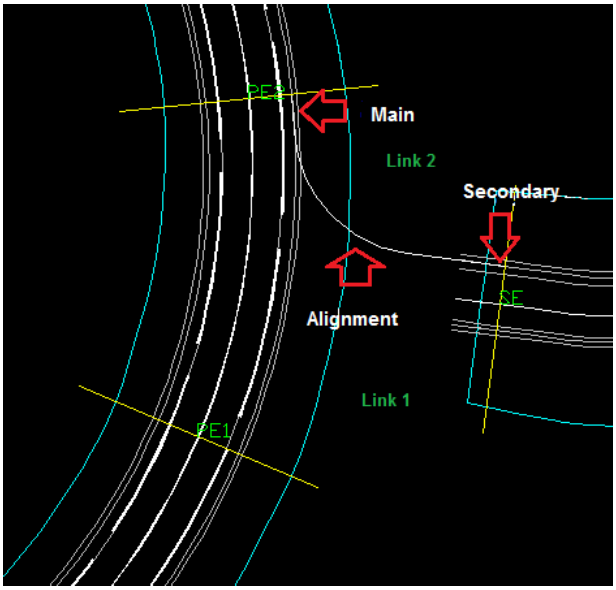
Link 2 (B2): Parameters required for the development of ***Link 2***; this link will be situated on the right depending on the direction of travel of the Secondary Road.

Type: We define the alignment which is to connect the Secondary Road to the Main Road in line with the type selected and we will enter the values corresponding to the alignment designated on the lower controls.

There is also the possibility of "**designating**" an alignment or axis which we have pre-defined.

Secondary Connection: This dropdown menu will show us the platform vectors of the Secondary Road and we will designate the one on which we wish to start the aforementioned alignment.

Draw Alignment: Preview of the alignment in line with the parameters specified.



Section: This part show us the values of the cut and fill slopes of the Main Road and the Secondary Road in line with the intersection point with the corresponding link.

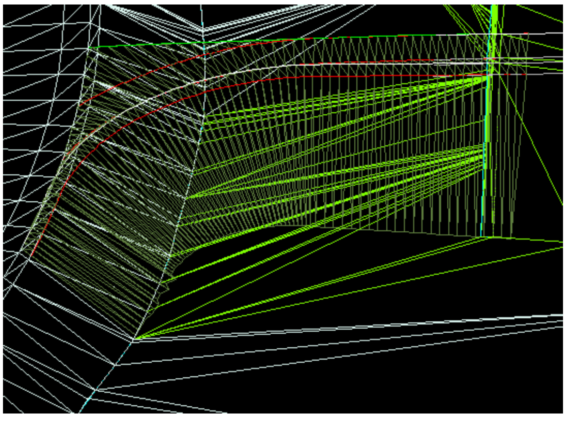
The user has the possibility of changing the values of the slopes in line with the characteristics of the intersection.

Discretization Interval: Separation between the vertices for drawing the links,

Draw Link 1: Preview of the final condition of Link 1 in line with the parameters specified.

Draw Link 2: Preview of the final condition of Link 2 in line with the parameters specified.

The image below shows the preview of one of the links before its fusion with the current surface.



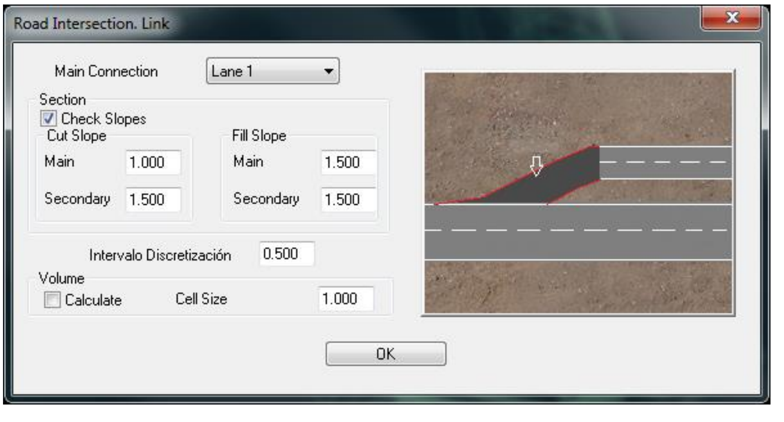
Volume: Possibility of showing, once the intersection has been carried out, the cut volume and total fill it affects in line with the earthworks carried out. The volume will be calculated in line with the specified cell size.

Calculate intersection: By pressing this button the two links will be calculated automatically and the new intersection surface will be merged with the current surface, resulting in a new surface.

Link type intersection

At this type of intersection the meeting of the Secondary Road with the Main Road is carried out by lengthening the Secondary Road until contacting the Main Road, adapting to the characteristics thereof.

Upon selecting this option, MDT will initially request us to designate the point on the Secondary Road where we wish to start building the intersection. Once the point has been designated, the following window will appear which we have described below.



Main Connection: This dropdown menu will show us the different types of vectors to be found on the Main Road and we must choose the vector as far as which the intersection will be built.

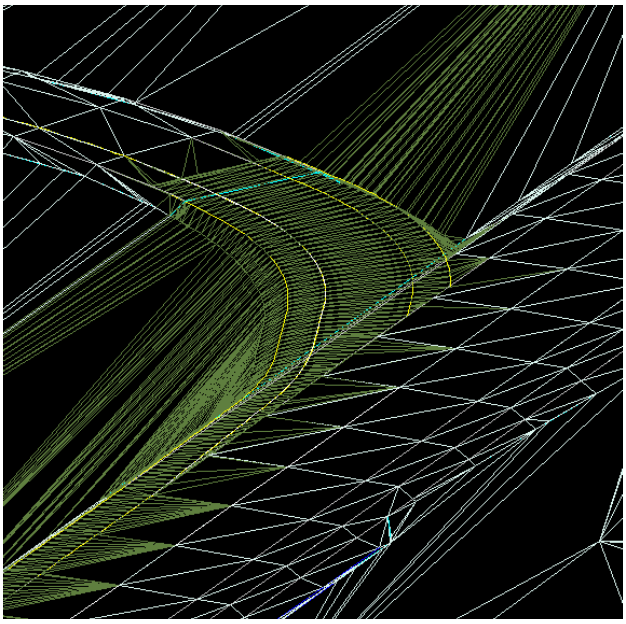
Section: This part show us the values of the cut and fill slopes of the Main Road and the Secondary Road in line with the intersection point with the corresponding link.

The user has the possibility of changing the values of the slopes in line with the characteristics of the intersection.

Discretization Interval: Separation between the vertices for drawing the links,

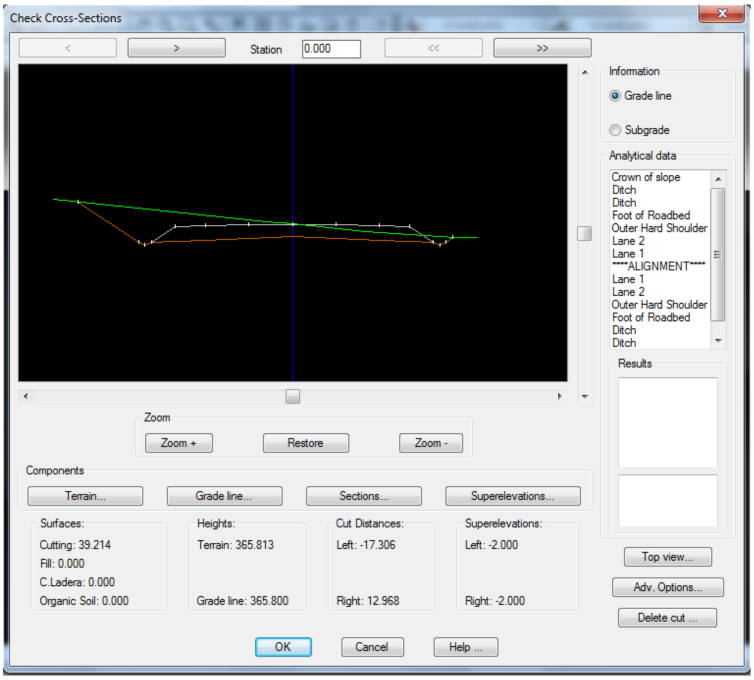
Volume: Possibility of showing, once the intersection has been carried out, the cut volume and total fill it affects in line with the earthworks carried out. The volume will be calculated in line with the specified cell size.

Accept: By pressing this button the link intersection will be calculated automatically and the new intersection surface will be merged with the current surface.



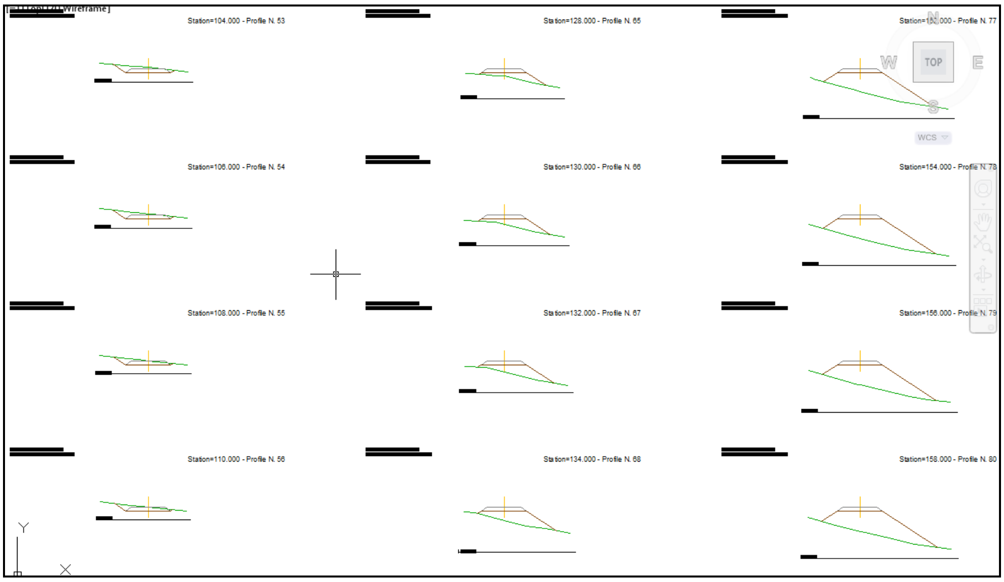
Check

When this command is executed the program will request a segment and the section will be viewed in a graphic window on elevation plan view. For more details see the section "**Check cross-sections**" in the section on "***cross-sections***".



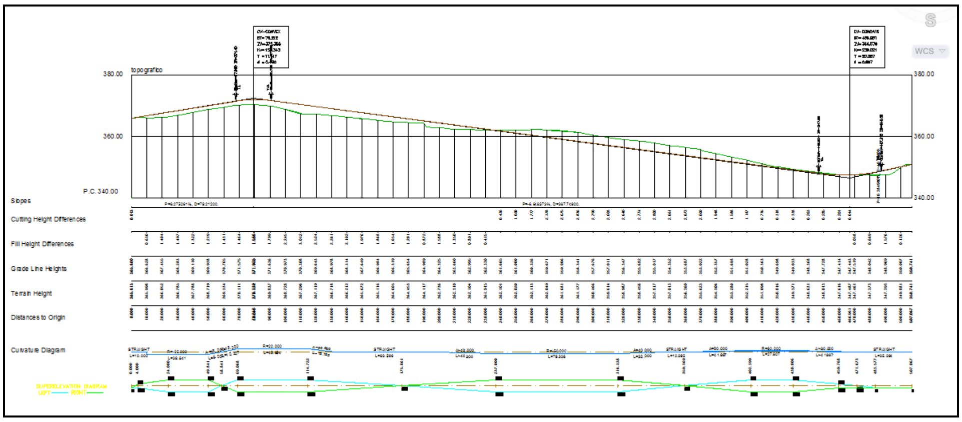
Draw cross-sections

This command is used to create a drawing of the sections on elevation plan view. Initially it will request the segment and then it will display a window in which all the drawing options are managed. This option is explained in more detail in the subsection “***Draw cross-sections***” in the section on “***cross-sections***”.



Draw Longitudinal Profile

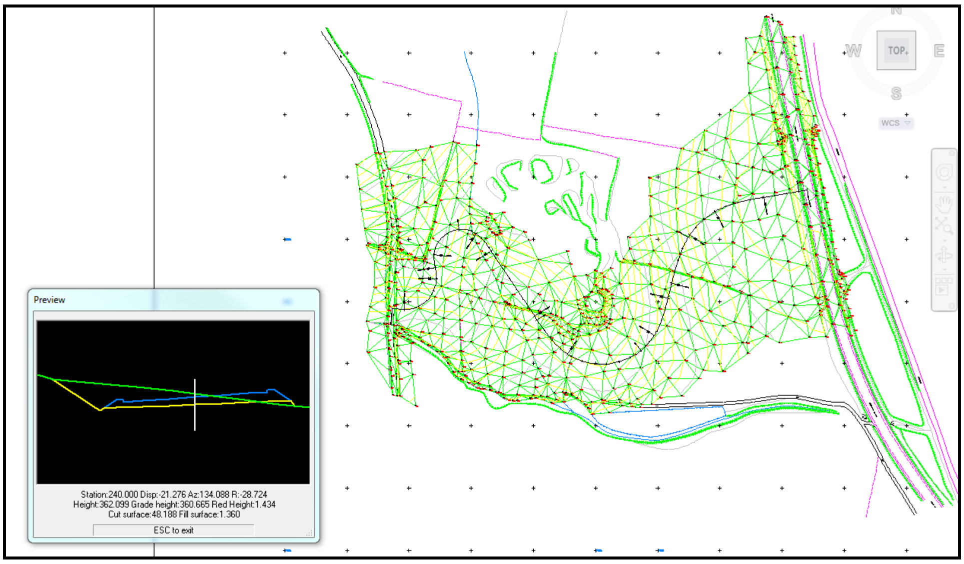
This command is used to draw the longitudinal profile with the associated vertical alignment, for which initially it will request the segment and then a window is displayed for customizing aspects of the drawing. For more detail on the command see the subsection “**Draw Compound Profile**” in the section on “***Longitudinals***”.



Quick view from alignment

With this command, with the drawing of the road or surface in top view, we can interactively visualize the cross-section according to the station where the cursor is located.

The user can work in two different ways, either from a segment or from a horizontal alignment and a surface; in both cases it is necessary to have the corresponding information previously drawn in top view. Once the corresponding file is selected a floating window appears displaying the cut in elevation plan view according to the point selected on the horizontal alignment.



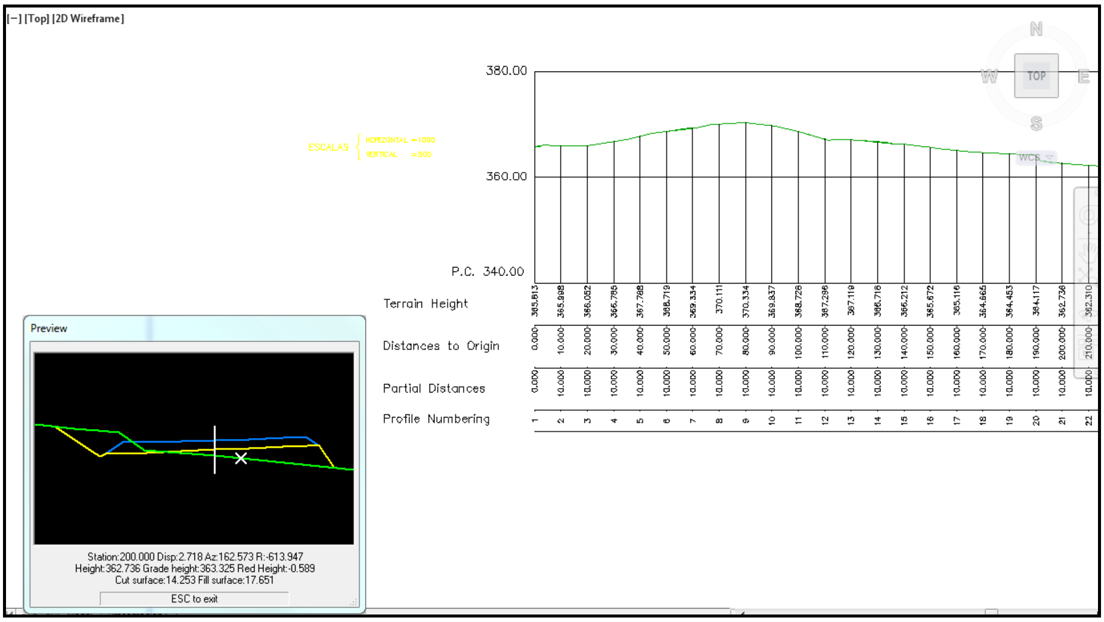
As well as this floating window with the profile in elevation plan view, it provides important information such as the horizontal alignment elevations, surfaces, volumes, etc., according to the work mode selected in the command.

Quick view from profile PRO

This command is very similar to the previous one, except that it works with a previously-drawn longitudinal profile. With the command **Draw compound profile** first draw the longitudinal with the associated vertical alignment and then execute the command.

It will request the segment and on-screen designation of the drawn profile. Once it is designated a floating window will appear showing a cut of the section in elevation plan view according to the station where the point on the longitudinal is selected.

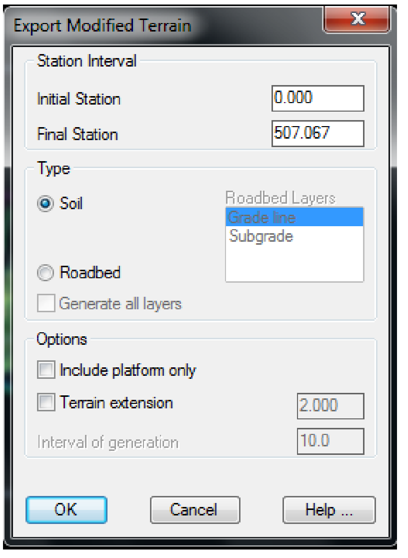
Moving the cursor along the profile checks how the section automatically changes in elevation plan view according to the station at which it is projected.



Generate Modified Terrain PRO

This command generates the modified terrain associated with a previously-defined segment (see **Define/Edit Segment** command).

First the program requests the segment file from which to generate the profile, and then the following window appears to manage the type of modification to generate and last, the name of the cross-section file to generate.



Station Intervals

Initial station: This facilitates selection of the initial station from which to calculate the modified cross-section.

Final station: Final station up to which the modified terrain will be generated.

Type

Soil: The modified terrain will be generated taking only the subgrade into account if roadbed is defined. If it is not defined it will directly generate on the vertical alignment.

Roadbed: It only makes sense to select this option if the section of our road has roadbed assigned, in which case if there are roadbed layers associated with it the layer that we wish to account for in generating the terrain must be selected.

Roadbed layers: This lists the data on the roadbed layers associated with the road. Select the one that must be accounted for when generating the modified road.

Generate all layers: If several layers are associated with the roadbed, if this option is activated, the program will automatically generate a cross-section for each of the layers of associated roadbed. The cross-section will take the name of the cross-section output file selected, giving it the name of the corresponding roadbed layer as a suffix.

Options

Include Platforms only: If this option is activated, when generating the modified terrain or any of the roadbed layers, in the final cross-section it will only create the vertices corresponding to the platform, omitting those that correspond to other section elements, whether ditches, slopes, walls, etc.

Terrain extension: If this box is checked, it will indicate the amount of terrain to exceed the profile. If, on the contrary it is not checked, it will represent the entire profile. This option only affects the graphic representation, not the surface calculation.

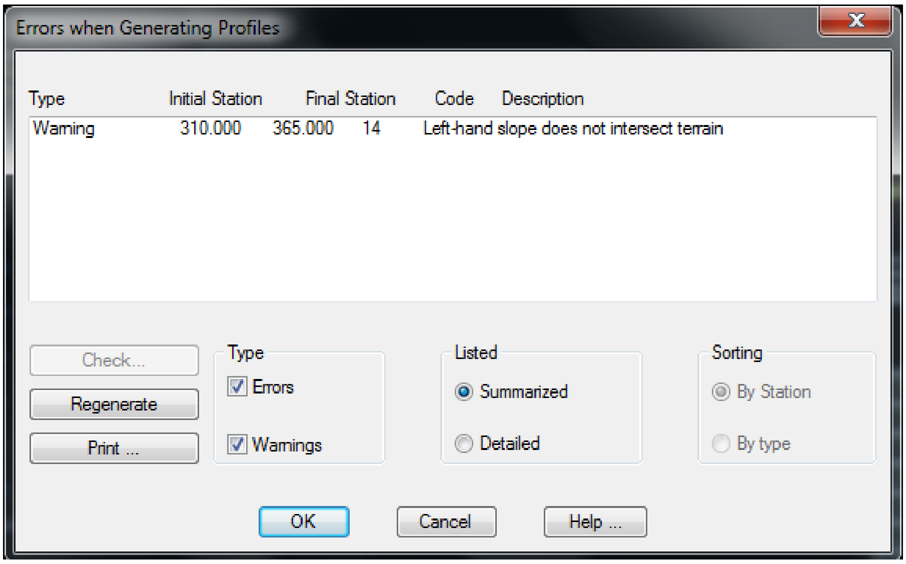
Interval of Generation: If the segment selected has no natural terrain associated, in this field we define the interval of generation of the modified terrain. In this case, the information on each of the cross-section cuts generated will only include those corresponding to the platform.

Once the dialogue box is validated the modified terrain is generated. This file is processed as if it were another cross-section file, with commands to check, draw, etc. -- the list given previously.

Generation Errors

After generating the modified terrain the following window will appear detailing the different errors found. These errors are classified as "Warnings" or "Errors" depending on their degree of influence on the road definition. In the former the road has been generated and in the latter its composition is impossible in the station specified.

The following displays the error window that appears after the generation process.



The list displays the error report and at the bottom are the different classifications.

Errors: The list only displays the errors found during the generation process.

Warnings: In this case it only shows the warnings.

Summarized: Displays the list grouped by stations with the same type of incident.

Detailed: A station-by-station list of the errors found at each station.

By clicking on the ***Check*** button (only if **Detailed** is checked), the command corresponding to the error found is activated and any changes necessary can be made. If the Regenerate button is then clicked, MDT will calculate the new segment.

It will then display a list of different possible errors and their error category.

Station not generated. No intersection with terrain

Cause: When generating the cross-sections the corresponding cut was not created as the objects selected are not cut.

Solution: Check whether the drawing or horizontal alignment is correctly defined.

Left/right-hand slope does not intersect terrain

Cause: When assigning the slope that cuts the natural terrain with a code, the code entered is not found in the terrain.

Solution: Check slope assignment to see if the code entered is correct.

Too many vertices on slope

Cause: The slope's definition contains too many vertices.

Solution: An erroneous height difference may exist between the grade line and the natural terrain, thereby creating an excessive number of berms on the slope.

Too many vertices in ditch

Cause: The ditch's definition contains too many vertices.

Solution: There may be an erroneous height difference between the grade line and the natural terrain.

Slope assigned does not exist

Cause: A slope has been assigned which has not been previously defined.

Solution: Execute the **Sections > Definition of Slopes** command and define the appropriate slope.

Platform assigned does not exist

Cause: A platform has been assigned which has not been previously defined.

Solution: Execute the **Sections > Definition of Platforms** command and define the appropriate platform.

Left/right roadbed creation error

Cause: MDT has detected an error when generating the roadbed associated to the section type at the specified station.

Solution: Check in **Sections > Definition of Roadbeds** the roadbed assigned to the station in question and the criterion defined.

Cross-section definition does not exist

Cause: The natural terrain associated to the segment contains no information or is corrupt.

Solution: It would be advisable to obtain the profiles associated to the work again. In order do so, execute the command **Cross-Sections > Obtain Profiles**.

Geology assignment not found on left/right slope

Cause: The definition of the terrain's geology associated to the definition of the section's slope does not exist or is incomplete.

Solution: Execute the **Templates > Assignment of Templates to Horizontal Alignment** command, activate the **Geology** option and configure it properly.

There is no left/right slope assignment

Cause: No slope assignment has been defined.

Solution: Execute the command **Templates Type > Assignment of Templates to horizontal alignment** and configure slope assignment at the stations where the problem appears.

Vertical alignment does not exist

Cause: The segment has no grade line information associated to it.

Solution: Execute the **Vertical Alignment > Define Vertical Alignment** command and insert it in the segment.

Platform assignment does not exist

Cause: The platform has not been assigned to the section template.

Solution: Execute the **Section Template > Assignment of Templates to Alignment** command and assign the relevant platform to the station concerned.

Platform not found

Cause: MDT is attempting to assign a platform to a station, which has not been defined or has been deleted.

Solution: Execute the command **Templates > Definition of Platforms** and define the appropriate platform for the station.

Station does not exist on alignment

Cause: The station it is trying to process is not defined on the horizontal alignment.

Solution: The horizontal alignment associated to the segment may contain corrupt information or the segment may have a horizontal alignment assigned that does not correspond to it.

Generation Warnings

The ditch assigned does not exist

Cause: A ditch that has not been previously defined has been assigned.

Solution: Execute the **Template Types > Definition of Ditches** command and define the appropriate ditch.

Station does not exist on the vertical alignment

Cause: The station interval defined on the grade line is less than the one defined in the natural terrain.

Solution: Execute the **Vertical Alignment > Define Vertical Alignment** command or the **Vertical Alignment > Edit Vertical Alignment** commands and check the grade line.

Left/right-hand slope does not intersect terrain

Cause: One or several slopes have been assigned which do not cut the terrain. The problem may lie in the fact that the natural terrain is narrower that the cross-section template defined.

Solution: Obtain the cross-sections again with a left/right-hand width greater than before, or modify the slopes' gradient.

Terrain to the left/right shorter than platform

Cause: A platform has been assigned which is wider than the natural terrain in the segment.

Solution: Obtain the cross-sections again with a left/right-hand width greater than before.

Left/right-hand ditch assignment does not exist

Cause: No ditch assignment has been defined for the station specified.

Solution: Execute the command **Templates > Assignment of templates to horizontal alignment** and assign the appropriate ditch.

Roadbed assignment does not exist

Cause: No roadbed has been assigned for the station specified.

Solution: Execute the **Templates > Assignment of Templates to Horizontal Alignment** command and assign the appropriate roadbed.

The roadbed assigned does not exist

Cause: A roadbed that has not been previously defined has been assigned.

Solution: Execute the command **Templates** > **Definition of Roadbeds** and define the appropriate roadbed.

Median element assigned does not exist

Cause: A median element that has not been previously defined has been assigned.

Solution: Execute the **Template Types > Definition of Elements** command and define the appropriate median element.

Median element assigned does not exist

Cause: A median element that has not been previously defined has been assigned.

Solution: Execute the **Template Types > Definition of Elements** command and define the appropriate median element.

Insufficient median width

Cause: Either median width is incorrect or, on the contrary, the median element defined is too wide.

Solution: Check both the median's definition in definition of platform as well as the definition of the median element assigned.

There is no correlation in code assignation

Cause: The platform's vector codes may have possibly not been correctly assigned in the platform's definition.

Solution: Check that the vector codes of the platforms assigned have been correctly assigned.

There is no information on the left/right-hand side profile

Cause: The cross-section has not been generated on one of the horizontal assignment's sides.

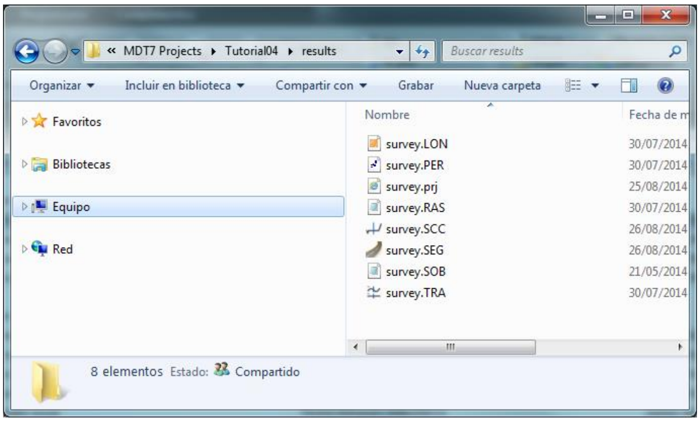
Solution: Check that information does not really exist about the objects to be

cut in the side affected.

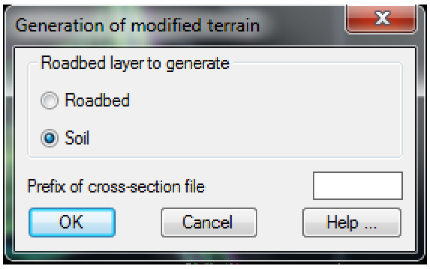
Generate Multiple Modified Terrains PRO

This option operates in the same way as the previous option, only in this case, a folder is selected and the command will automatically generate the modified terrain from all the segments it finds in the selected folder.

When executing the command the window below is displayed for selecting the folder location of the segments to generate:



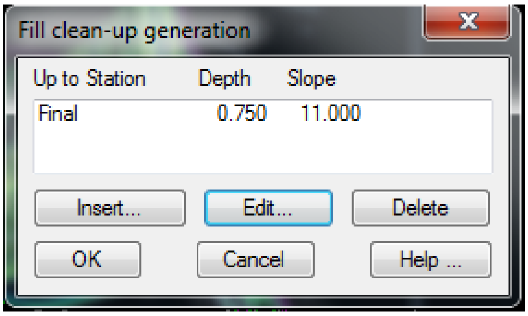
Once the working folder is selected, the window below is displayed to indicate the modified terrain to generate:



On one side the user selects whether to generate the roadbed or the soil and also the prefix of the cross-section file. The command will generate a cross-section file for each segment found in the folder. These files will take the name of the corresponding segment using the text introduced in the corresponding field as a prefix.

Calculate fill clean-up PRO

The purpose of this command is to clean up the natural land in the fill area according to a series of parameters. First, it will request the segment to be modified, then the following window is displayed to manage the type of clean-up to be carried out.



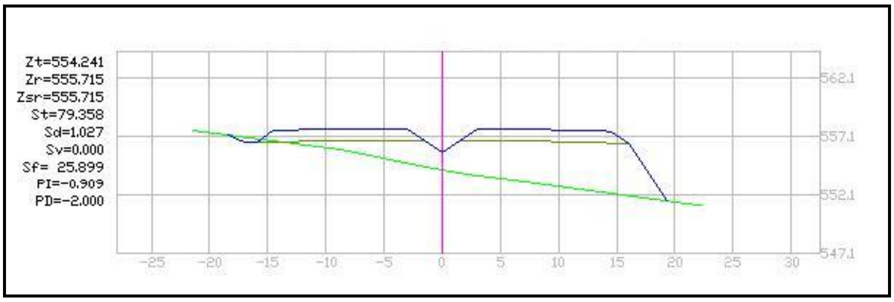
Introduce the information by intervals, where the following parameters must be specified:

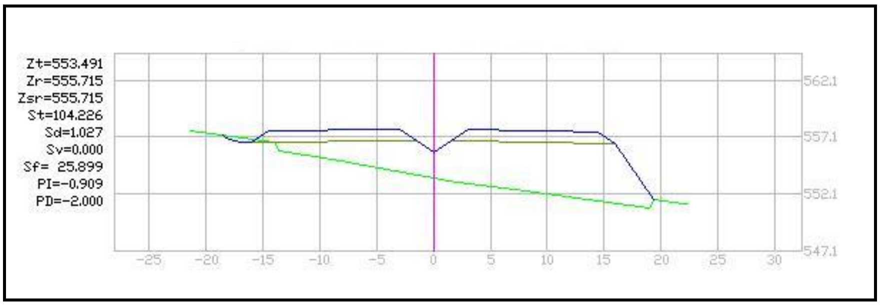
Up to Station: The station up to which the clean-up will be introduced.

Depth: Depth of the clean-up.

Slope: Slopes of contact between the bottom of the clean-up and the natural terrain.

When the window is validated the command requests a new segment to store the modifications. What is really modified is the information on the cross-section profile cuts.





Generate Widenings

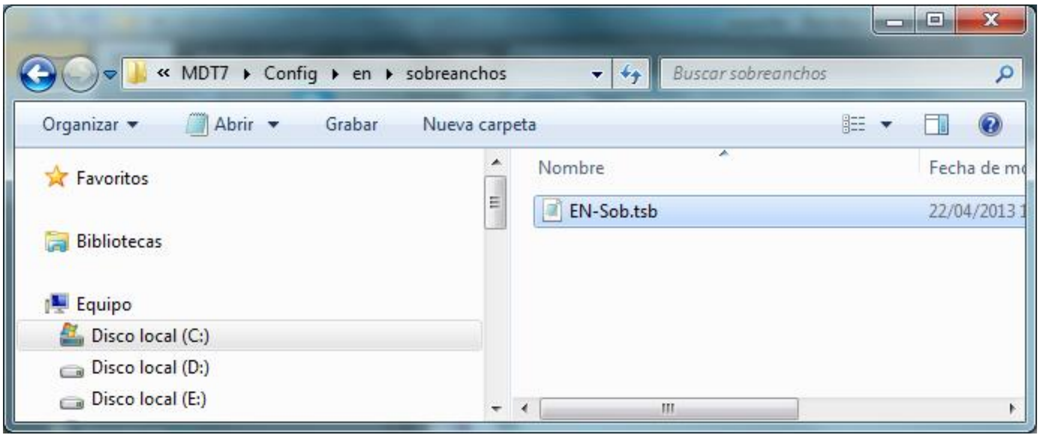
Using this command the Widenings associated with a pre-defined alignment are generated.

MDT initially asks for the file in which the axis defined is contain and then the file where it is wished to save the widenings (extension `.SOB`).

The widenings will be generated in line with the road standards for the selected country. At present MDT has the possibility of working with the standards of different countries (Spain, Brazil, Portugal, Andorra …) and the software is prepared for the user to modify or incorporate its own standards.

The software configuration folder contains the different tables deployed to generate them and a screenshot can then be viewed where their location can be seen.

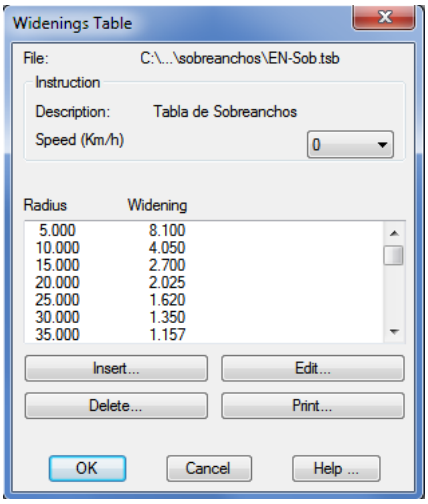
If the standards of a country are chosen which has several associated tables, the programme, before carrying out the conversion, will ask the user to indicate the widenings table he wishes to use to carry out the conversion.



Widenings Table

Executing this command will open a window containing the widenings table for the file in question. This window contains a list comprising the ***Radius*** and ***Widening*** columns in accordance with the speed selected.

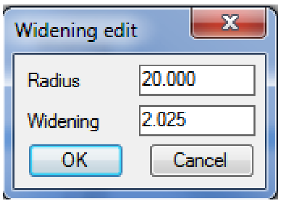
The table may be amended or personalised depending on the characteristics of the sketch and the speed assigned to the same. First of all the user is asked for the widenings file and then a text appears with the settings for the same. Each widenings table may feature different values in accordance with the speed of the sketch. The characteristics of the text are specified below.



Description: Provides a description of the widenings table in question.

Speed: the option of selecting one of the different speeds available in the widenings table in question.

Insert and ***Edit***: The entries in the widenings table can be edited by activating any of these tabs, whereby the following text will appear in which to conduct the changes.



Delete: Removes the entry in the table marked on the list.

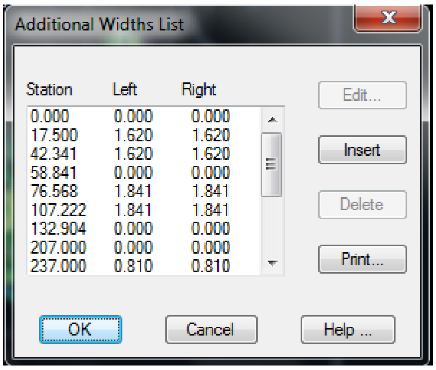
Print: Transfers the information from the widenings table to the system printer or a file.

List of Widenings

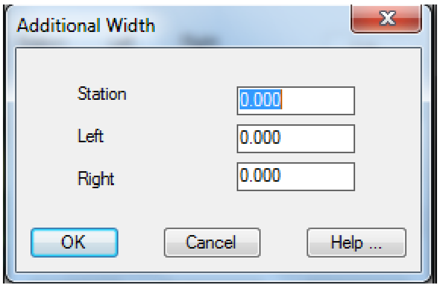
This command displays an on-screen listing of the list selected, with the option to modify the data.

MDT initially requests the widenings file and then the representation interval. If ***All*** is indicated, (equivalent to all vertices) it is possible to modify the data. On the contrary, if a particular interval is selected, a list will be displayed that cannot be modified.

The list window is displayed below with a description of its functions.



Insert* and *edit: These commands allow specific widenings data to be modified. When this button is activated, the following window is displayed, where the data desired may be entered.



Delete: Eliminates the interval marked on the list and updates the list.

Print: Transfers the list's contents to the system's printer or to a file.

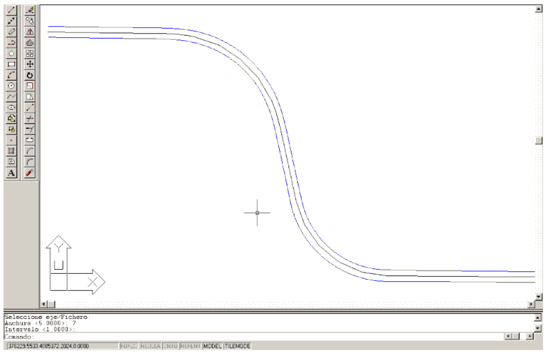
Once the dialog box has been validated, the changes made will be saved if all the vertices have been selected.

Draw Widenings PRO

Widenings are drawn from this command, using the specific parameters entered previously.

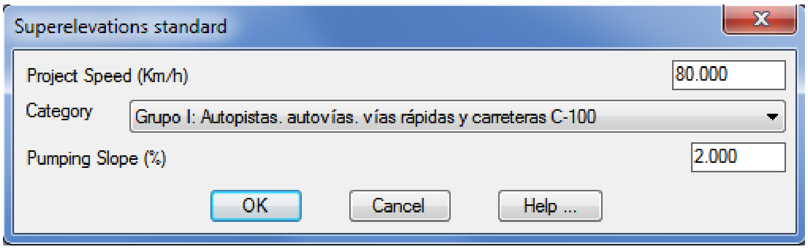
When the command is executed, the program first requests the widenings file, then the horizontal alignment from which the widenings were generated, the **Width** to left and right of the platform's horizontal alignment, and the discretization **Interval** of the polylines to be drawn.

The program will generate two discretized polylines with the interval specified on both sides of the alignment. The widenings parallel to the alignment can be seen in the image below.

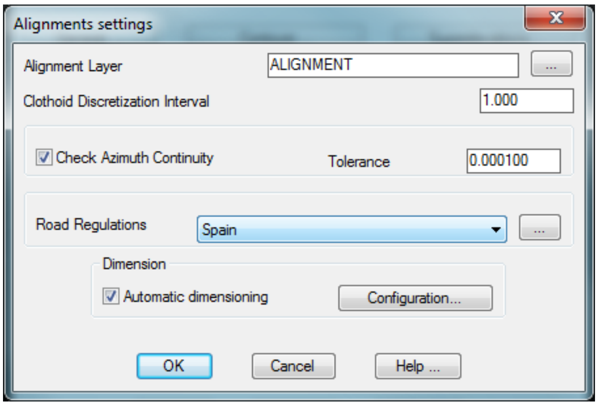


Generate superelevations from a horizontal alignment PRO

The superelevation associated with an alignment is generated using this command. The program initially requests the alignment from which the superelevation is meant to be generated. Then it displays the following dialog box to set its characteristics.



Category: We establish the category of the road to be defined and in line with this choice one or another cant table will be selected. These categories will be depend in the ***Roads Standards*** selected under Configuration.



Once the dialog box has been validated, the program will request the file name (with extension .PER) where the superelevation generated is to be saved.

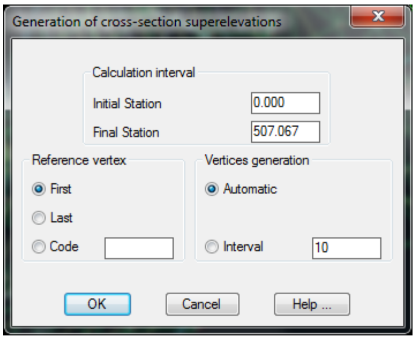
A series of vertices is generated for each section of the horizontal alignment with values for the station, superelevation to the left and superelevation to the right pursuant to the Road Policy regulations and taking into account the superelevations tables defined. See **Alignments > Superelevations Table** for further information.

Generate superelevations from cross-sections

The same as the previous command, this option generates a superelevation, but instead of the usual practice of using a horizontal alignment, this option enables generating the superelevation from the information existing of the cross-sections.

The command will analyse the vertices of each previously-indicated cut and from the slope in regard to the position of the horizontal alignment of each one of them it calculates the left and right superelevation.

The first thing it requests is the cross-section file from which to generate the superelevation, then the following window is displayed to manage how the new superelevation file will be built.



Calculation interval. Used to indicate between which stations the superelevation will be calculated.

Reference Vertex: Used to indicate the reference vertex of the cross-section to serve as a reference in generating the superelevation. There are three possibilities:

1. The first vertex on both sides from the position of the horizontal alignment.

2. The last vertex on both sides from the position of the horizontal alignment.
3. The first vertex on each side existing from the position of the horizontal alignment and in which its code coincides with the specified one in this option.

Vertices Generation: A superelevation vertex will be generated for each cross-section cut or according to the interval specified.

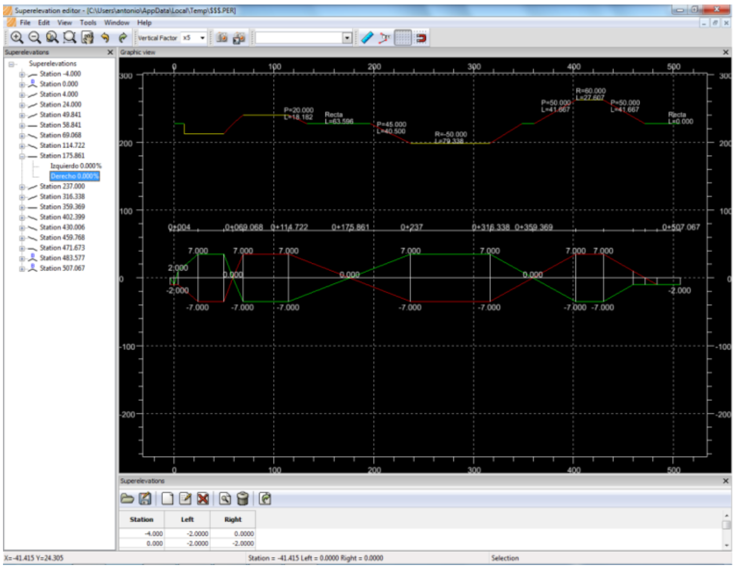
Once the window is validated it will request the superelevations file in which to save the information.

Check superelevations PRO

This command allows a specific superelevation to be viewed and modified. Initially, the superelevation or segment file to be edited is requested. Then a dialog box is displayed with the superelevation's elevation plan drawing and the corresponding list. If instead of selecting a superelevation file a segment is selected, the curvature diagram corresponding to the alignment contained in the segment will additionally be drawn in the upper part of the dialog box.

This option additionally allows the list values to be modified and enables interactive modification of the superelevation values to the right or to the left on the drawing.

The functions and features of the dialog box are described below.



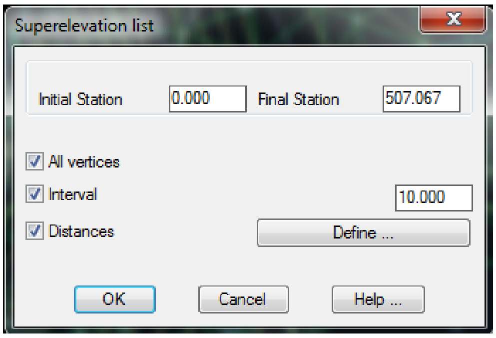
There are three different regions in the superelevation editing window. A complete list of vectors is displayed on the left; at the top-right is the definition with the option to make changes and in the centre is a representation of it on elevation plan view.

It also features a series of tools for visualizing and editing the superelevation.

Superelevations List PRO

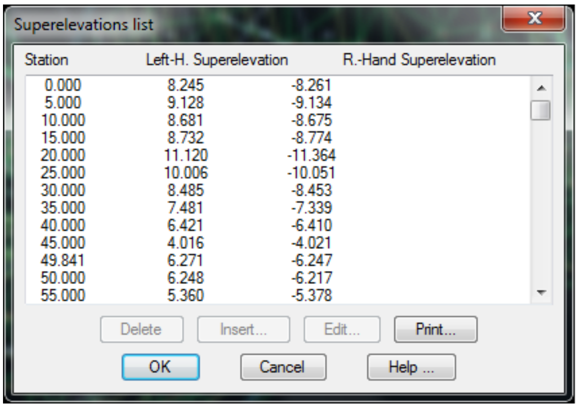
This option is fairly similar to the **Horizontal Alignments > Check Superelevation** option, except that in this case only a list containing information about the superelevation appears.

When the command is executed, MDT displays a window for configuring the type of list the user wishes to obtain. In this dialog box the initial and final stations may be specified, the interval, and individual stations.

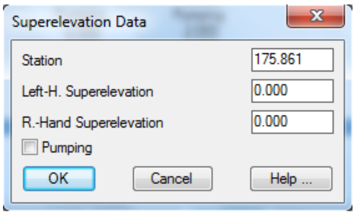


Once the window is validated the corresponding list is displayed. Only in the case that only the option “**All**” has been selected is it possible to modify each and every one of the superelevation vertices. On the contrary, if the list has been created from an interval, no modifications may be made to it.

Below is an example of such a list:



Insert and ***Edit***: Allows a specific record of the superelevation listed to be modified. When the button is activated, MDT launches the following dialog box giving details of the characteristics of the record to be inserted or modified.



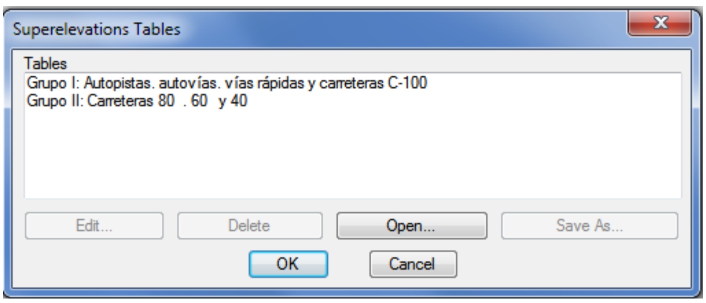
Delete: Removes the record currently selected on the list.

Print: Transfers the superelevation information to the system’s printer or to a text file.

Once the dialog box has been validated, all the information modified will be saved in the file selected.

Superelevations Table PRO

On executing this command the program will show a window with the existing superelevations tables in accordance with the country selected under settings.

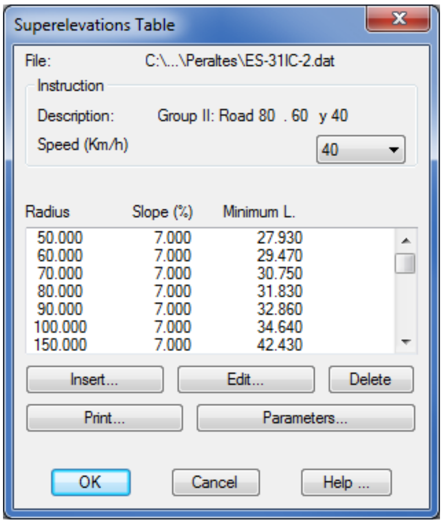


Delete: Removes the superelevations table selected.

Open: Enables us to select a new superelevations table to insert in the list. The “**Generate Superelevation from Horizontal Alignment**” command will activate all the tables we have configured in this section.

Edit: Enables us to edit the superelevations table selected. This window contains a list comprising the ***Radius***, ***Slope in %*** and ***Minimum Clothoid Length*** columns to be applied to the previous ones. The minimum length is used to calculate the recommended value of the parameter for each radius in accordance with the Road Instructions. See the Personalisation Manual for more details.

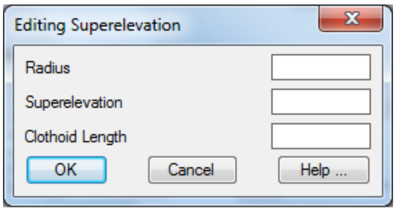
Optionally, the table may be modified or customized depending on the road design characteristics and the speed assigned to them. The superelevation file is initially requested. Then a dialog box is displayed showing the file’s configuration. Each of the superelevation tables may have different values according to the road design’s speed. The features of the dialog box are described below.



Description: Shows the description of the superelevations table selected.

Speed: Offers the possibility of selecting among the different speeds available in the superelevations table selected.

Insert and ***Edit***: Any of the records appearing in the superelevations table may be entered or modified. When any of these buttons is activated, the following dialog box is displayed, where the changes are made.

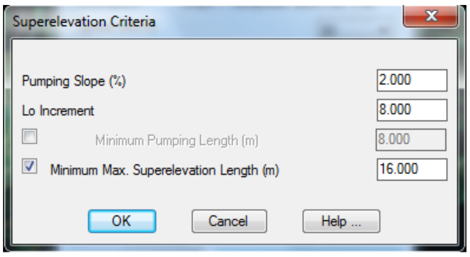


Delete : Deletes the record marked on the list from the table.

Print: Transfers the information on the superelevation table to the system’s printer or to a file..

Parameters

A series of values which are needed to generate and process superelevations are configured in this window. The dialog box and its parameters are shown below.



Pumping Slope (%): The pumping slope expressed as a percentage for straight sections which is proposed by default is entered here. It is normally 2 %.

Lo Increment: The camber transition length to 0% and from 0% to slope are set here, which is applied before and after the origin of L_0.

$$\Delta L_0 = \frac{2L_0}{P}$$

Minimum Pumping Length: When activated, this box will apply the criterion of setting at least one straight section length with camber. This is indicated by the values entered in the adjacent box. This parameter analyses the length that results between transition curves and, if the difference between the start of the cambered section and its end is below the established value, the camber is cancelled. In the case of curves having same sign, superelevation continuity is set at 2% (in the case of curves of the same sign), otherwise the devil effect is produced at the center of the straight section (in the case of curves having the opposite sign).

Minimum Length of Maximum Superelevation: As with the previous element, when this command is activated it will require that a section of maximum superelevation should remain (the maximum established by the radius and superelevation table) once the L_0 lengths have been applied towards the inside of the curve from its entry and exit tangents. The minimum length this section is equal to or greater than the length set in the relevant box. Should a lower value be produced, the program will modify the L_0 value until it is able to apply the criterion set out above.

Invert superelevations PRO

This command modifies the superelevations file selected changing the direction of the superelevation left and right maintaining the pump. The image below gives an example of the application.

0.000	Pumping	Pumping
208.406	Pumping	Pumping
222.468	0.000	-2.000
236.531	2.000	-2.000
278.718	8.000	-8.000
357.357	8.000	-8.000
399.545	2.000	-2.000
413.607	0.000	-2.000
427.670	Pumping	Pumping
539.642	Pumping	Pumping
544.642	-2.000	0.000
549.642	-2.000	2.000
564.642	-8.000	8.000

Original superelevations file

0.000	Pumping	Pumping
208.406	Pumping	Pumping
222.468	0.000	2.000
236.531	-2.000	2.000
278.718	-8.000	8.000
357.357	-8.000	8.000
399.545	-2.000	2.000
413.607	0.000	2.000
427.670	Pumping	Pumping
539.642	Pumping	Pumping
544.642	2.000	0.000
549.642	2.000	-2.000
564.642	8.000	-8.000

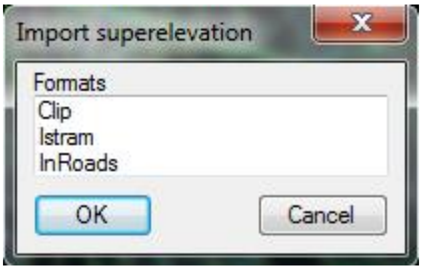
Superelevations file after executing the command

Import superelevations PRO

This command is used to convert superelevations files from other surveying software to MDT format.

When executing this command the following window is displayed showing the distinct conversions currently available. Once one of them has been selected it will request the original files and corresponding destination files.

New formats are continuously incorporated with this command according to the needs of our clients.



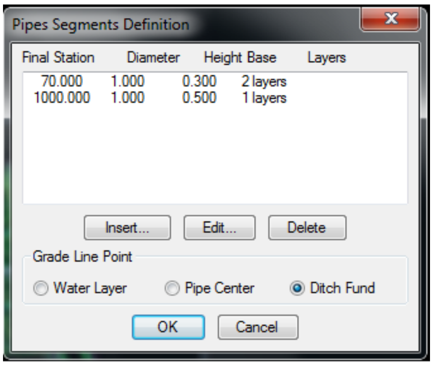
Pipe Segments

In this group of commands a series of basic tools is available for the drawing and cubic measurement of the pipe segments, calculating the volumes of the pipes and the roadbed layers that comprise it:

Definition of Segment (Pipes)

This option enables defining a ditch segment with the associated pipes, to be able to draw it and obtain its cubic measurement for the following commands.

On executing the command the program first requests the file where it should save the data related to the position of the pipes and the different materials to fill (extension .TUB).



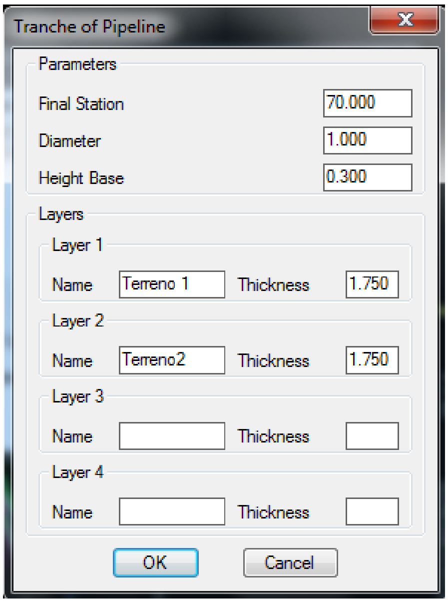
Grade line application point

There are three options for indicating the grade line point:

1. **Water Layer**: The vertical alignment elevation goes at the pipe support point on the terrain.
2. **Pipe Center**: The vertical alignment grade line point is applied on the geometrical center of the pipe.
3. **Ditch Fund**: The vertical alignment grade line point is applied to the ditch bottom.

Lists

The configuration of the pipe by station and the different materials between each interval will be introduced. When inserting or editing the following window will appear to configure these parameters.



Final Station: station up to which the pip segment is defined.

Diameter: Diameter of the pipe.

Height Base: Vertical distance existing between the ditch **fund** and the pipe support point (water layer).

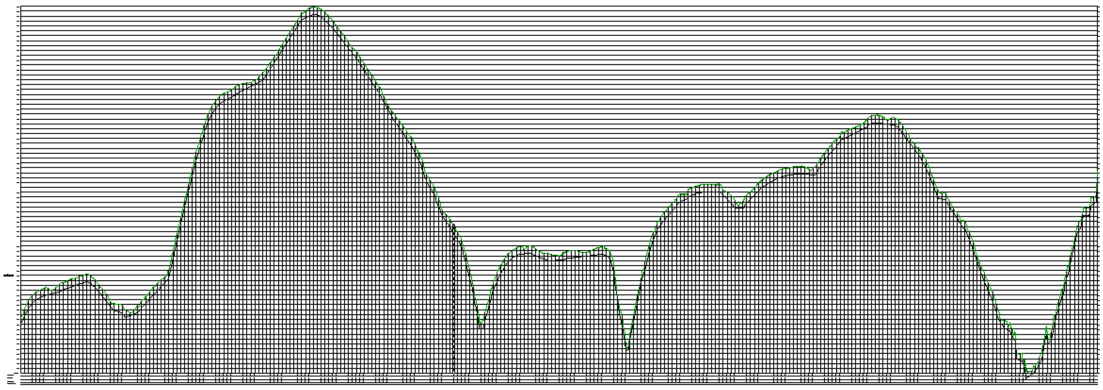
Soil Layers: The different soil strata with which the ditch is to be filled are defined. A maximum of 4 types of soil can be introduced, specifying the name and the thickness. The soil thicknesses are accounted for from the height base.

Define Grade Line (Pipelines)

This command enables us to define a grade line with a specific depth determined in accordance with the longitudinal profile.

This command will request the longitudinal profile from which the grade line is generated and the difference in minimum and maximum height with regard to the same.

A grade line will be calculated which complies with the requirements in relation to height difference and the minimum number of vertices.

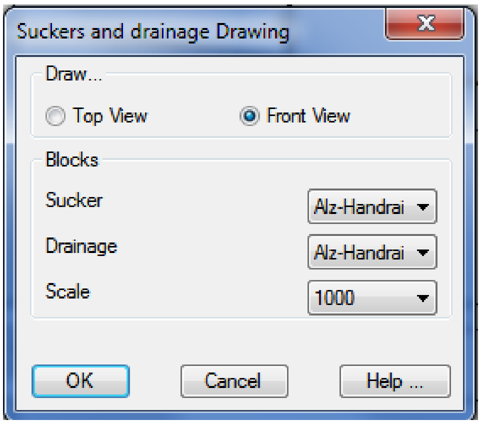


Calculation of suckers and drains (Pipelines)

This tool enables us to calculate the points on our pipeline grade line at which the suckers and drains need to be placed.

The program will assign a sucker for each maximum on the grade line and for the drains, which are the minimums in this case.

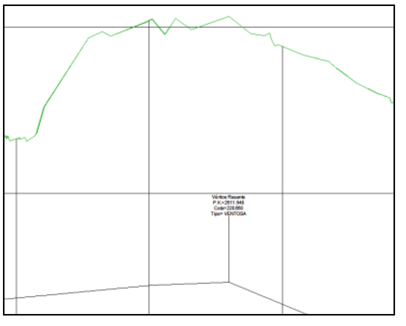
The following window will appear on executing the command:



Initial Station: Initial station from which the list is generated.

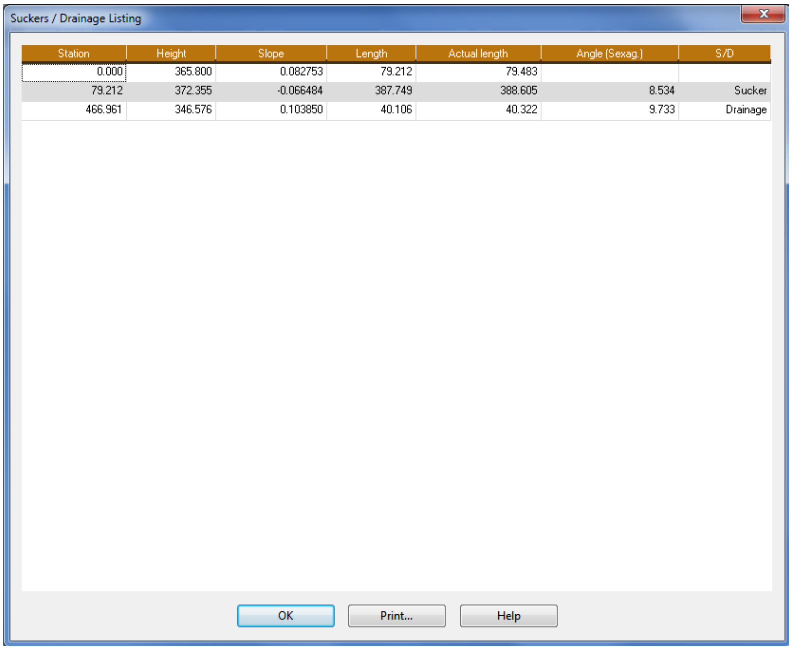
Final Station: Final station up to which the list is generated.

Label information in the drawing: Activating this box will label the vertices where the suckers and drains are to be placed in the grade line drawing.



Draw Blocks: The option of drawing a block both in the ground plan and inserted at the location featuring the characteristic point.

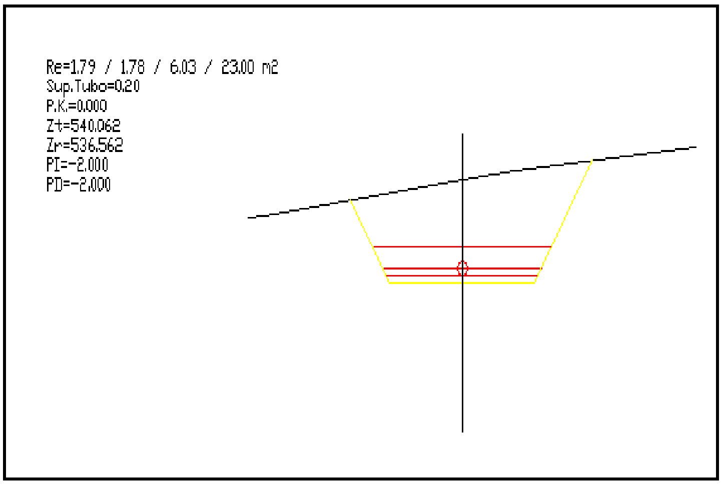
The following list with all the information will appear on validating the input data.



Draw cuttings (Pipes) PRO

When selecting this command, it consecutively requests the configuration files for the pipe section (TUB) and segment to be drawn. Next the usual cross-section drawing window appears and when it is validated it draws the section of road with the pipes and layers of soil defined.

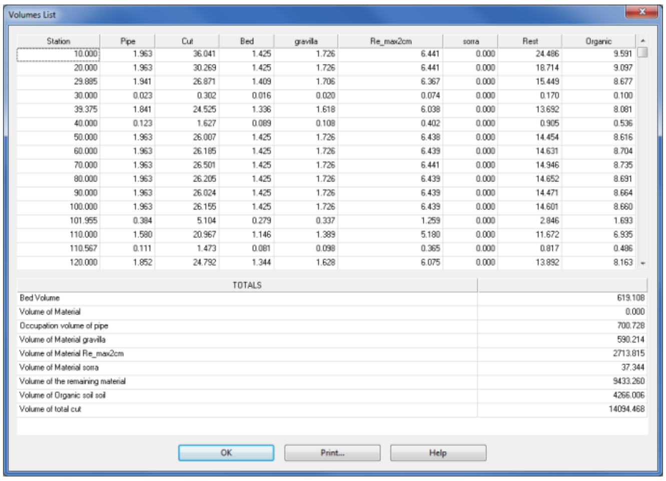
It will additionally display the surfaces of the pipe section along with those of each defined layer.



List of Volumes (Pipes) PRO

This command, like the previous, will request the definition file of the pipe and the segment and then display a complete list of surfaces and volumes of the different objects that comprise the defined pipe section.

Once the segment is selected, it will request the initial and final station between which we wish to make the calculation, to finally display the list that is shown below.


Volumes List

Station	Pipe	Cut	Bed	gravilla	Re_max2cm	sorra	Rest	Organic
10.000	1.963	36.041	1.425	1.726	6.441	0.000	24.486	9.591
20.000	1.963	30.269	1.425	1.726	6.441	0.000	18.714	9.097
29.885	1.941	26.871	1.409	1.706	6.367	0.000	15.449	8.677
30.000	0.023	0.302	0.016	0.020	0.074	0.000	0.170	0.100
39.375	1.841	24.525	1.336	1.618	6.038	0.000	13.692	8.081
40.000	0.123	1.627	0.089	0.108	0.402	0.000	0.905	0.536
50.000	1.963	26.007	1.425	1.726	6.438	0.000	14.454	8.616
60.000	1.963	26.185	1.425	1.726	6.439	0.000	14.631	8.704
70.000	1.963	26.501	1.425	1.726	6.441	0.000	14.946	8.735
80.000	1.963	26.205	1.425	1.726	6.439	0.000	14.652	8.691
90.000	1.963	26.024	1.425	1.726	6.439	0.000	14.471	8.664
100.000	1.963	26.155	1.425	1.726	6.439	0.000	14.601	8.660
101.955	0.384	5.104	0.279	0.337	1.259	0.000	2.846	1.693
110.000	1.580	20.967	1.146	1.389	5.180	0.000	11.672	6.935
110.567	0.111	1.473	0.081	0.098	0.365	0.000	0.817	0.486
120.000	1.852	24.792	1.344	1.628	6.075	0.000	13.892	8.163

TOTALS	
Bed Volume	619.108
Volume of Material	0.000
Occupation volume of pipe	700.728
Volume of Material gravilla	590.214
Volume of Material Re_max2cm	2713.815
Volume of Material sorra	37.344
Volume of the remaining material	9433.260
Volume of Organic soil soil	4266.006
Volume of total cut	14094.468

OK Print... Help

Convert 3D Polyline to Segment PRO

This command generates a segment file from a 3D polyline. First the polyline is requested. Then the file to be created is requested. The horizontal alignment on ground plan and elevation drawing, as well as the longitudinal profile are automatically entered.

The complementary command to this is **Convert Segment to 3D Polyline.**

Convert Segment to 3D Polyline PRO

This command draws a 3D polyline from a segment's information, taking into account the horizontal alignment on ground plan and elevation plan. The program requests the segment file and the discretization interval. It then draws the polyline with these characteristics.

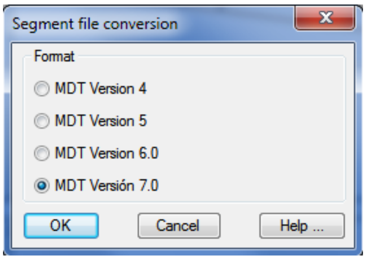
The complementary command to this is **Convert 3D Polyline to Segment.**

Convert to MDT version 6 Segment

This command enables conversion of a segment from MDT version 6.x to version 5.x.

The new file created for Version 5 will not have the new features of version 6.

First the program will request the file the user wishes to convert and then the file to save the changes.

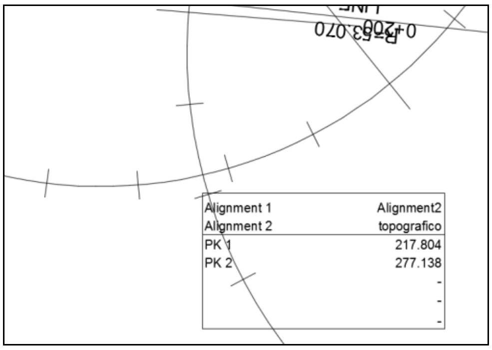


Gauge Control

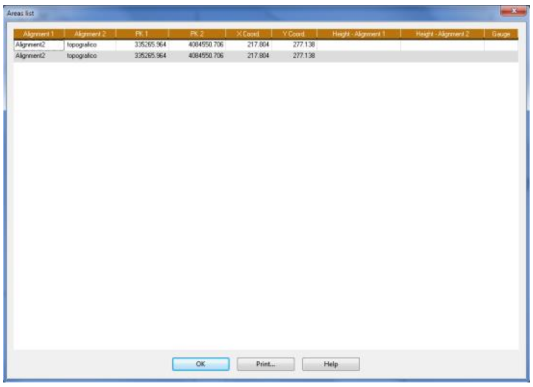
This command enables us to calculate the difference in height between two segments or roads at intersection points.

First of all the drawing needs to feature the horizontal alignments corresponding to the roads we wish to analyse, then, on executing the command it will ask us to draw the intersection between the two roads on the screen.

Once selected a block with all the information in relation to the same will appear next to the intersection. The image below illustrates this operation.



Once all the intersections between the different horizontal alignments in the drawing have been selected, the command will give us the option of showing all the information on a list with the option of printing the same.

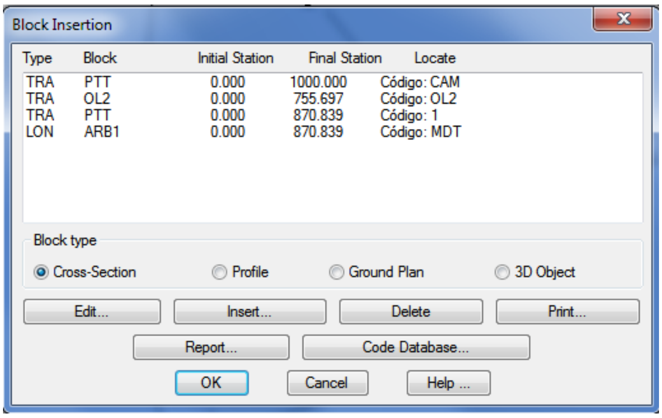


Definition of Blocks PRO

This option enables us to establish the representation of the drawing blocks in both the cross-section and longitudinal profile drawings.

You may consult “Draw Cross-Sections” in the “Cross-Section Profile” and “Draw Longitudinal Profiles” in the “Longitudinal Profile” sections for a more detailed explanation of all the functions.

The screenshot below illustrates the assignment of different blocks to different sections of the horizontal alignment.

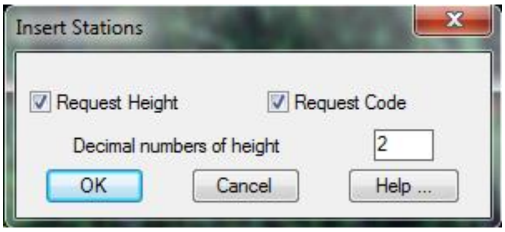


14. Stations

Insert Stations

The program initially displays a dialog box where one must specify the data one wishes it to request in the command line.

Additionally the decimal number that will be used to mark the station in the drawing can be configured.



Once the dialog box has been validated, the program will first request the ***Name*** of the station. This may be any combination of a maximum of 8 alphanumeric characters. Spaces and special characters are not accepted. If an invalid name is entered, the program will indicate it with the following message: “ERROR: Invalid name”.

The program will then request the station’s ***Position*** on the ground plan, which may be entered using any of AutoCAD’s coordinate entry methods, mainly graphically with the mouse or by typing in its X and Y values separated by a comma. The program then requests Station’s ***Height*** if this option has been selected previously in the dialog box. This information is entered numerically.

Lastly, an informative ***Code*** made up of a string of up to 14 alphanumeric characters may be assigned . This will be requested should it have been selected in the previous dialog box.

Before drawing the new station, the program checks if it is repeated in the drawing. Two stations are considered to be repeated if they have the same X,Y coordinates or if they have the same name. In either case, the following message is shown: “ERROR: Station already exists”, and the forgoing data will be requested once again.

The station entry process will continue until a null reply is given when station name is requested. In this case, control will revert to AutoCAD.

Create from Points

By means of the possibilities offered by point selection (by level, code, number, height, etc.), this option allows one to convert surveying points into setting out stations.

Once the points have been selected, a setting out station will be created for each of them. The station will be given the point’s number preceded by the letter “P” as a name for purposes of identification (for example, the station created from point 1607 will be named P1607) and assigned the same code as the point.

As with the manual insertion of stations, a check is run to avoid repetition of stations and duplicates are ignored.

Create from Alignment

. With this option we have the possibility to create Setting out Stations from the station coordinates of a particular alignment, with or without displacement.

First of all the program requests the name of the horizontal alignment file or we select it on the screen, followed by the Initial Station Number from which we begin to name the new stations. From this point the displacement from the horizontal alignment (negative to the left and positive to the right) is requested for each station, in addition to the station and the height of the new station.

The new station will be created at the position calculated from the horizontal alignment. If the station entered does not belong to it, the following error message is displayed "*ERROR: Station does not belong to alignment*". The name consists of the characters "BR" followed by an index that starts with the number of the initial station specified previously (for example, if we enter 1 as the initial station, the stations will be named BR1, BR2...). The code will be the prefix "PK" plus the value of the station rounded to a whole number and separated by a comma (for example PK180,-5).

The application will continue to request data for the creation of new stations until a null reply is given to the adjustment request.

Create Points from Stations

This command copies all the drawing's stations to MDT points. The only data requested are the new points' levels.

The command will automatically assign as the name for the new point being created the name of the station from which it is created.

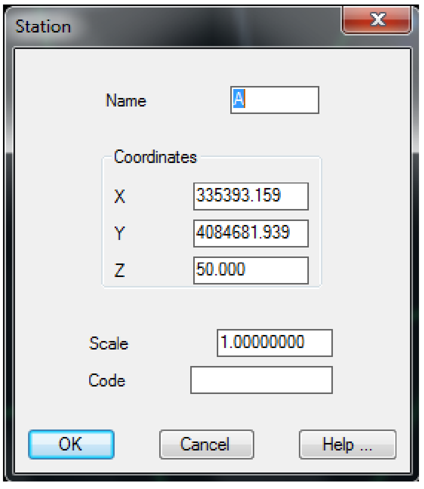
Bases that already have points with the same coordinates will be automatically discarded, meaning it will not create two points with the same X and Y coordinates.

Edit Station

This option allows us to modify the features of any setting out station drawn in the current file. In order to execute it, it is necessary for defined stations to exist on the drawing. Otherwise the message "ERROR: There are no defined stations" is displayed.

MDT requests the station to be selected by designating any element belonging to the block or its attributes. If another object is selected, the message "ERROR: Not a station" is displayed.

Once selected, a dialog box appears on screen which is described below:



Name : Name of the station selected.

Coordinates: Coordinates of the selected station's location.

Scale: The anamorphosis of the station.

Code: The station's descriptive code.

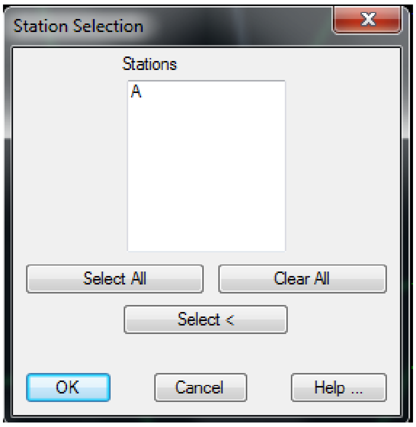
Once any of these fields has been modified, the changes are updated when the dialog box is validated, and the station is redrawn. If the station's name is changed to that of another already existing station, the program will prevent the operation from being confirmed, showing the message "ERROR: Existing station".

Move Stations

This utility allows one to modify the X,Y coordinates corresponding to station locations. Once these are designated as in the previous command, the program requests a new location for the setting out station selected, using its original position as a point of reference. Likewise, coincidence between stations will be prevented.

Delete Stations

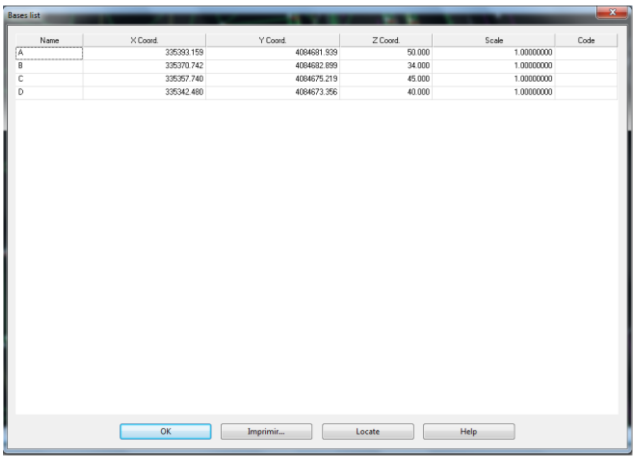
This tool enables one to delete setting out stations inserted in the drawing. To do so, the following dialog box appears once the command has been run, where the stations one wishes to delete should be marked.



The way this dialog box works is basic, that is to say, one can either select all the stations (***Select All*** button) or choose them manually (***Select*** button). Once the dialog box has been validated, the stations selected will be deleted.

List Stations

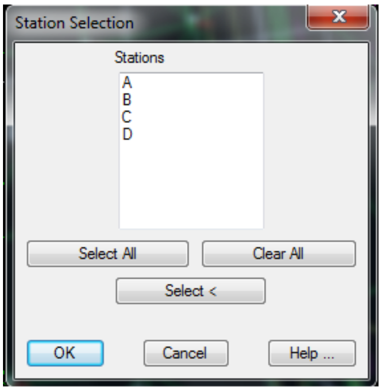
A new list containing all the characteristics of the stations selected will be displayed once this command is run. The dialog box is described below.



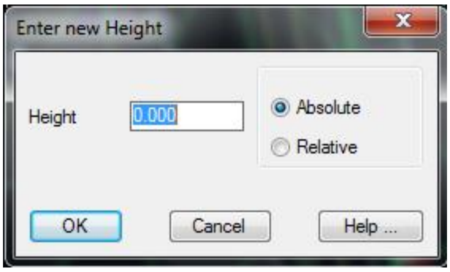
Once on screen, an element on the list can be selected and the ***Locate*** button clicked. The program will then enlarge the area surrounding that station in order to perform subsequent operations (edit, delete, etc.) easier. Additionally, if one clicks on ***Print***, a printed list of the information shown on screen will be obtained.

Change Heights

When this command is run, a dialog box will appear requesting the stations whose heights one wishes to change.



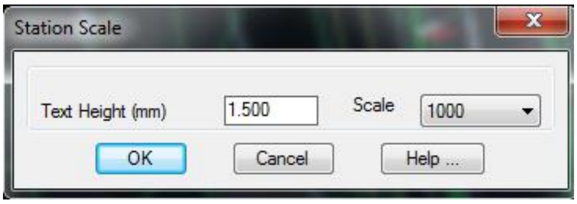
Either all the stations may be selected or they may be selected graphically. Once the dialog box has been validated, a new window will appear where one has to specify how one wishes to change the height. The new dialog box together with its features is shown below.



The value of the new height desired is entered in ***Height*** and whether the height adjustement is to be ***Absolute*** or ***Relative,*** that is to say, whether it is to be changed to the height actually entered or to be increased with respect to the existing height.

Change Scale

This command allows one to change the representation size on the drawing of the stations. Apart from this, the ***Points*** > ***Change*** > ***Change Scale*** command also allows one to set the stations' scale along with the points' scale.



Attribute height can be changed in the dialog box using the ***Text Height*** box. When the drop-down list is modified using ***Scale***, the program recalculates text size.

Import Stations

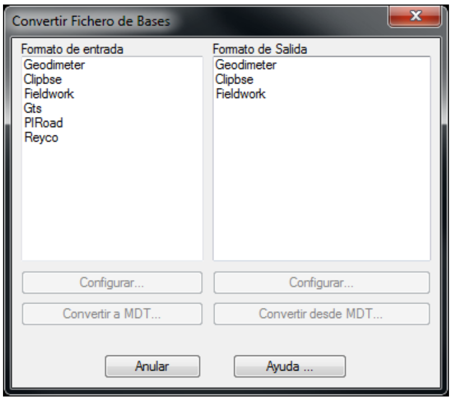
This option draws setting out stations that have previously been recorded with the **Export** option. To do so, the program requests the file name (by default the name of the drawing with extension `.BSE`). It will then draw all setting out stations contained in the same file, provided that they do not already exist.

Export Stations

From the setting out stations of the current job, one can create an ASCII file (extension `.BSE`) containing information about these stations. This file can be subsequently used in other jobs by using the analogous **Import Stations** command.

Convert Stations

This command allows one to convert setting out station files from other programs or in different formats. When the command is run, the following dialog box appears:



If a format is selected from the ***Input Format*** list, the ***Convert to MDT*** button will automatically be enabled. When this button is clicked, the source file containing the stations in the original format will be requested and then the output file will be requested to where the station information will be sent in MDT format. Optionally, the ***Configure*** button can be enabled where some of the special characteristics of the format selected can be set.

Similarly, if any format from the ***Output Format*** list is selected, the lower button ***Convert from MDT*** will be activated. If this button is clicked, the source file containing the MDT stations will be requested and then the output file will be requested, where the information about the stations will be sent in the selected format. Optionally, the ***Configure*** button can be enabled to specify some special characteristics of the format to which one wishes to export.

15. Setting Out

Introduction

A set of commands is described in this section that allow one to solve most setting out needs that may arise from the viewpoint of ground plan alignments.

Setting Out Methods

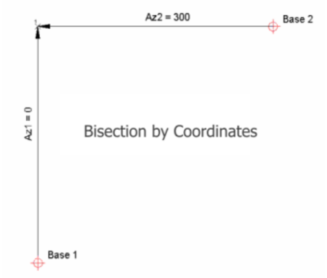
The program allows one to set out using two different methods, depending on the results supplied:

Polar

This method simply consists of calculating the azimuth and the distance between the base station and the point to be set out.

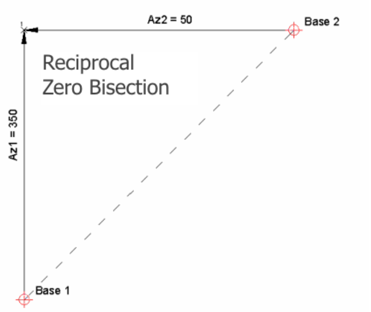
Bisection According to Coordinates

This method uses both the base and the reference stations for the calculation. The azimuth and the distance are shown for both of them.



Reciprocal Zero Bisection

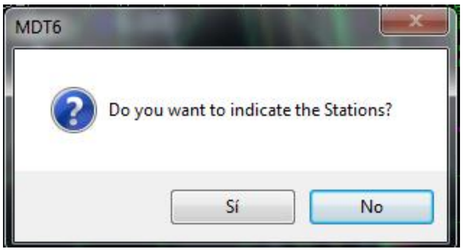
This method uses both the base and the reference stations for the calculation. The azimuth shown for each of them is calculated after having previously oriented one station in relation to the other.



Setting Out Points

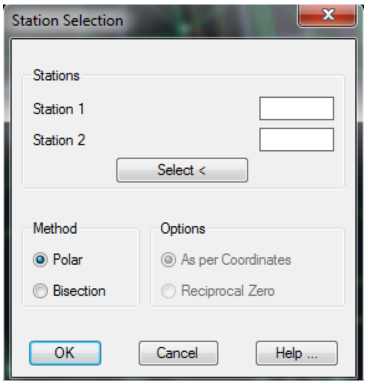
This command allows one to obtain on-screen and printed lists containing the polar or bisection setting out data of a set of points belonging to the current drawing.

Initially, the program requests if one is going to perform the setting out by indicating a base and reference station.



Should this not be the case, the program then displays a dialog box where the points one wishes to list are requested. For further details, consult the **Points > Points List** section.

On the contrary, if one wishes to indicate a base and reference station, the following window is displayed where the configuration to generate the setting out list is set.



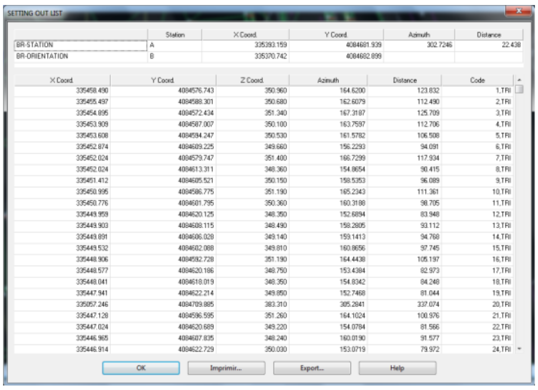
Stations: The station names may be entered manually or they may be entered by clicking on the **Select** button to graphically select each of the stations, both the initial and the reference station.

Method: There are two different calculation methods: either **Polars** or **Bisection**. In the latter case, there are also two options:

- According to coordinates.
- Reciprocal zero.

Once the options desired have been selected and validated, the program requests one to select a points list to set out in the usual manner.

If one wishes to perform a **Setting Out by Polars,** a list with the following characteristics will be displayed:



SETTING OUT LIST

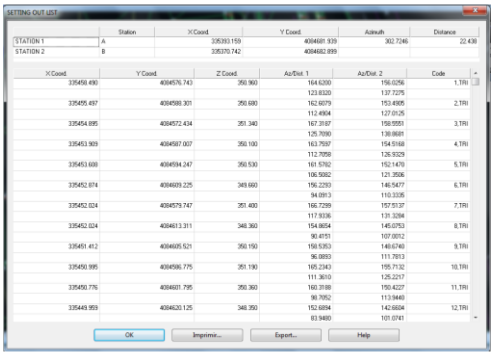
	Station	X Coord.	Y Coord.	Azimuth	Distance
BR-STATION	A	335393.159	4084681.939	302.7246	22.438
BR-ORIENTATION	B	335370.742	4084682.899		

X Coord.	Y Coord.	Z Coord.	Azimuth	Distance	Code
335458.490	4084576.743	350.960	164.6200	123.832	1,TRI
335455.497	4084588.301	350.680	162.6079	112.490	2,TRI
335454.895	4084572.434	351.340	167.3187	125.709	3,TRI
335453.909	4084587.007	350.100	163.7597	112.706	4,TRI
335453.608	4084594.247	350.530	161.5782	106.508	5,TRI
335452.874	4084609.225	349.660	156.2293	94.091	6,TRI
335452.024	4084579.747	351.400	166.7299	117.934	7,TRI
335452.024	4084613.311	348.360	154.8654	90.415	8,TRI
335451.412	4084605.521	350.150	158.5353	96.089	9,TRI
335450.995	4084586.775	351.190	165.2343	111.361	10,TRI
335450.776	4084601.795	350.360	160.3188	98.705	11,TRI
335449.959	4084620.125	348.350	152.6894	83.948	12,TRI
335449.903	4084608.115	348.490	158.2805	93.112	13,TRI
335449.891	4084606.028	349.140	159.1413	94.768	14,TRI
335449.532	4084602.088	349.810	160.8656	97.745	15,TRI
335448.906	4084592.728	351.190	164.4438	105.197	16,TRI
335448.577	4084620.186	348.750	153.4384	82.973	17,TRI
335448.041	4084618.019	348.350	154.8342	84.248	18,TRI
335447.941	4084622.214	349.850	152.7468	81.044	19,TRI
335057.246	4084709.885	383.310	305.2841	337.074	20,TRI
335447.128	4084596.595	351.260	164.1024	100.976	21,TRI
335447.024	4084620.689	349.220	154.0784	81.566	22,TRI
335446.965	4084607.835	348.240	160.0190	91.577	23,TRI
335446.914	4084622.729	350.030	153.0719	79.972	24,TRI

OK | Imprimir... | Export... | Help

The coordinates, distance and azimuth to the base station, as well as the point number are displayed for each point selected.

Setting Out by Bisection:

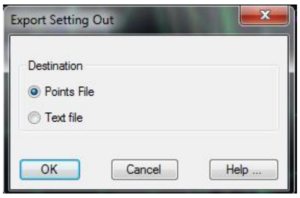


For each point selected, its coordinates, the distance and azimuth to the base station, as well as the reference are displayed.

The possibility of exporting and printing the data thus obtained exists for all lists. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box with different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section in this manual.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

Print

When this option is selected, the data on the list are sent to the printer selected. Information about the stations used is also shown. An example of a printed list in high resolution mode can be seen below.

SETTING OUT LIST
07/07/011

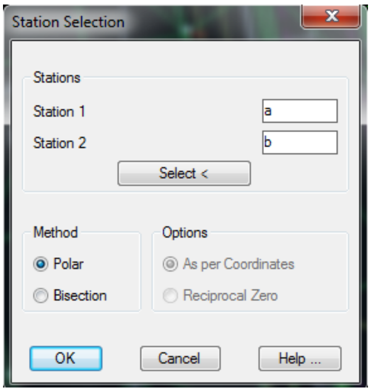
	Station	X Coord.	Y Coord.	Azimuth	Distance
STATION 1	A	335393.159	4084681.939	302.7246	22.438
STATION 2	B	335370.742	4084682.899		

X Coord.	Y Coord.	Z Coord.	Az/Dist. 1	Az/Dist. 2	Code
335458.490	4084576.743	350.960	164.6200 123.8320	156.0256 137.7275	1,TRI
335455.497	4084588.301	350.680	162.6079 112.4904	153.4905 127.0125	2,TRI
335454.895	4084572.434	351.340	167.3187 125.7090	158.5551 138.8681	3,TRI
335453.909	4084587.007	350.100	163.7597 112.7058	154.5168 126.9329	4,TRI
335453.608	4084594.247	350.530	161.5782 106.5082	152.1470 121.3506	5,TRI
335452.874	4084609.225	349.660	156.2293 94.0913	146.5477 110.3335	6,TRI
335452.024	4084579.747	351.400	166.7299 117.9336	157.5137 131.3284	7,TRI
335452.024	4084613.311	348.360	154.8654 90.4151	145.0753 107.0012	8,TRI
335451.412	4084605.521	350.150	158.5353 96.0893	148.6740 111.7813	9,TRI
335450.995	4084586.775	351.190	165.2343 111.3610	155.7132 125.2217	10,TRI

Setting out Polyline Vertices

The objective of this command is to set out the vertices of a polyline with respect to a horizontal alignment using two stations, one for reference.

Initially the program requests the horizontal alignment with respect to which the setting out will be conducted and the below window is displayed to establish the configuration for generating the setting out list.



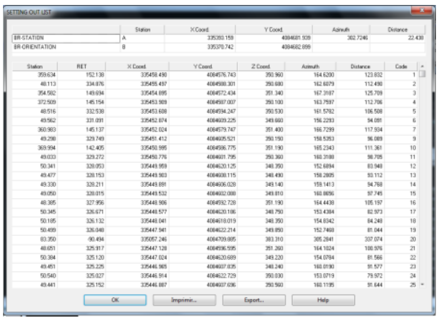
Stations: The names of the stations can be manually introduced or, by pressing the ***Select*** button we can graphically select each of the stations, both the one of origin and the reference station.

Method: There are two different methods of calculation: ***Polar*** and ***Bisection***. For the latter case we are presented with two other options, these are:

- As per coordinates.
- Reciprocal Zero

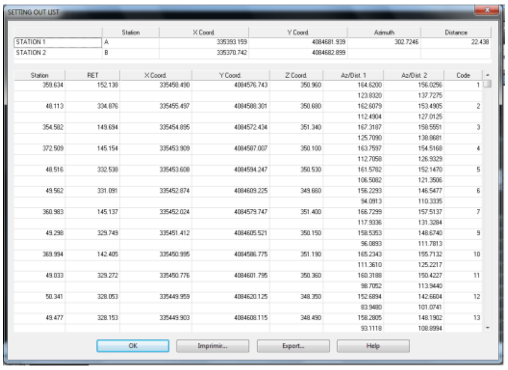
Once the desired options are selected in the dialogue box, and the user presses OK, the program requests selection of a polyline for setting out, then it will automatically create MDT points at each of the polyline vertices, then the corresponding setting out list will appear.

When performing ***Setting out by Polar*** a list with the following characteristics will be displayed:



For each point selected its coordinates, the distance and azimuth to the station and its point number are given.

Setting out by Bisection:

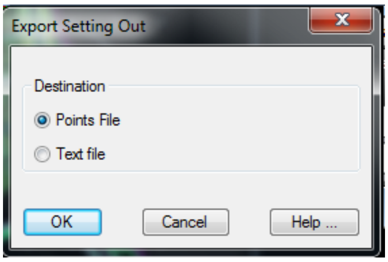


For each point selected its coordinates, the distance and azimuth to the base station and reference are given.

It is possible to export and print all the data obtained in all the lists. Each option is described below.

Export

When the **Export** option is selected, the program displays a new dialog box with different ways to export the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

Print

When this option is selected, the data on the list are sent to the printer selected. Information about the stations used is also shown. An example of a printed list can be seen below:

SETTING OUT LIST
07/07/011

	Station	X Coord.	Y Coord.	Azimuth	Distance
STATION 1	A	335393.159	4084681.939	302.7246	22.438
STATION 2	B	335370.742	4084682.899		

Station	RET	X Coord.	Y Coord.	Z Coord.	Az/Dist. 1	Az/Dist. 2	Code
359.634	152.138	335458.490	4084576.743	350.960	164.6200	156.0256	1
					123.8320	137.7275	
48.113	334.876	335455.497	4084588.301	350.680	162.6079	153.4905	2
					112.4904	127.0125	
354.582	149.694	335454.895	4084572.434	351.340	167.3187	158.5551	3
					125.7090	138.8681	
372.509	145.154	335453.909	4084587.007	350.100	163.7597	154.5168	4
					112.7058	126.9329	
48.516	332.538	335453.608	4084594.247	350.530	161.5782	152.1470	5
					106.5082	121.3506	
49.562	331.091	335452.874	4084609.225	349.660	156.2293	146.5477	6
					94.0913	110.3335	
360.983	145.137	335452.024	4084579.747	351.400	166.7299	157.5137	7
					117.9336	131.3284	
49.298	329.749	335451.412	4084605.521	350.150	158.5353	148.6740	9
					96.0893	111.7813	
369.994	142.405	335450.995	4084586.775	351.190	165.2343	155.7132	10
					111.3610	125.2217	
49.033	329.272	335450.776	4084601.795	350.360	160.3188	150.4227	11
					98.7052	113.9440	

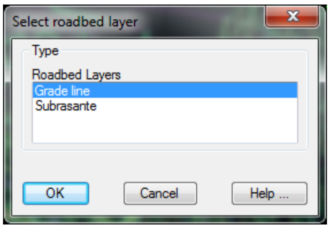
Analyse Points

This command will allow us to ascertain the correspondence of a point, entered using a cursor in the surroundings of an horizontal alignment or by entering the coordinates in x, y format.

Firstly, the program asks whether we are going to designate the points graphically, the MDT points to be found on the drawing or they are going to be read from a file and secondly the alignment is requested and a segment may be selected. The user then enters a series of points in the manner stated. After each of these operations, in the commands area it will present us with the relationship characteristics with regard to the alignment with station and offset,as well as their coordinates, azimuth and radius. In the event that any point cannot be projected onto the alignment, this will produce the corresponding error message.

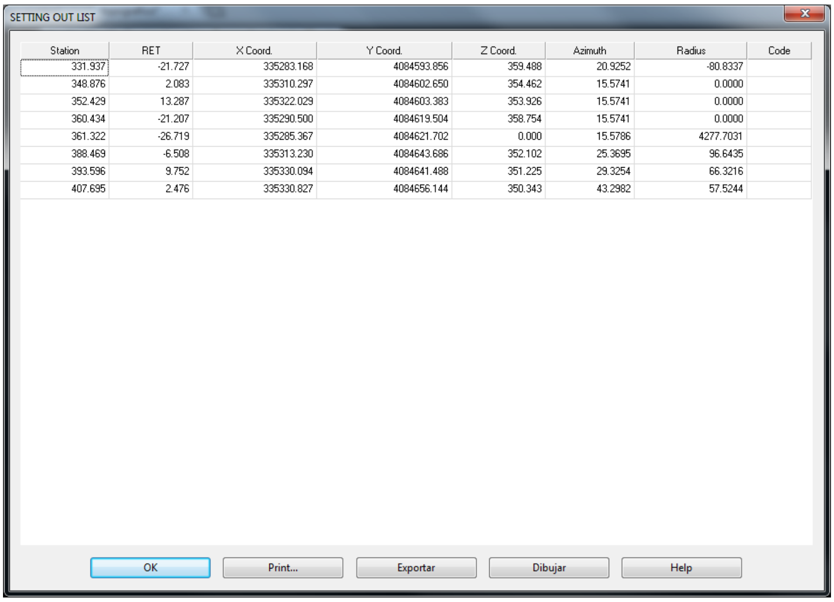
At Z-coordinate the elevation of the model at this point will be shown if we have selected an alignment.

If a segment has been selected, it will be shown in line with the standard section associated with the road and if there is no associated section, it will be calculated in line with the grade line elevation.



In addition there is the possibility of entering a ***Layer Thickness*** and this will ensure that the grade line elevation to be shown is that calculated minus the layer thickness.

Once the points entering process is complete, we press <*Enter*> and the points calculation window will appear in the ground plan with the previous data listed.

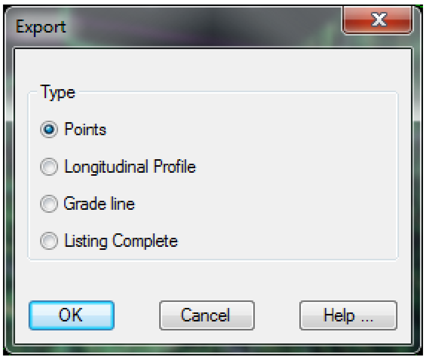


Station	RET	X Coord.	Y Coord.	Z Coord.	Azimuth	Radius	Code
331.937	-21.727	335283.168	4084593.856	359.488	20.9252	-80.8337	
348.876	2.083	335310.297	4084602.650	354.462	15.5741	0.0000	
352.429	13.287	335322.029	4084603.383	353.926	15.5741	0.0000	
360.434	-21.207	335290.500	4084619.504	358.754	15.5741	0.0000	
361.322	-26.719	335285.367	4084621.702	0.000	15.5786	4277.7031	
388.469	-6.508	335313.230	4084643.686	352.102	25.3695	96.6435	
393.596	9.752	335330.094	4084641.488	351.225	29.3254	66.3216	
407.695	2.476	335330.827	4084656.144	350.343	43.2982	57.5244	

On the final list there is the possibility of exporting and printing the data obtained. Below we have described each of the options:

Export

When selecting the ***Export*** option, the program presents us with a new dialogue in which different forms of exporting data are presented. The dialogue is shown below and its characteristics:



Points File : The coordinates of all the points on the list are exported to a points file. When validating the dialogue, the command **Export Points** will be executed automatically**.** For further detail consult the **Topographical Points** section.

Longitudinal Profile: Possibility of creating a longitudinal profile from the information obtained in the points' analysis.

Grade line: The same as in the previous case above, in this case a grade line would be generated.

Complete List: Dumps all the content of the list in an ASCII file in such a way that it can be edited or handled with any word processor.

Print

When selecting this option, the data on the list is dumped into the selected printer.

Analyse Points over Alignment and Terrain

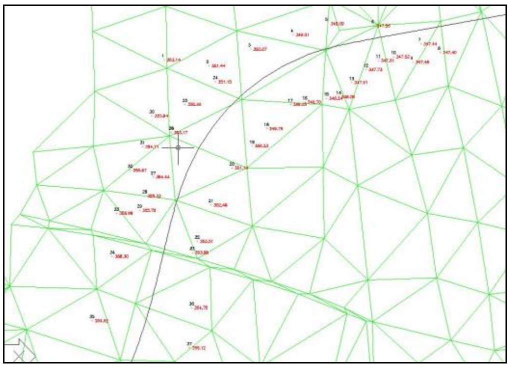
This option is very much geared towards controlling a linear work that is in progress. The command enables one to conduct analyses and control a surveying conducted on MDT done from cross-section templates with horizontal alignments on the ground plan and elevation drawing obtained from the theoretical status of the terrain in a linear work. These files can either have come from being fully completed with TCP applications or from files imported from other applications.

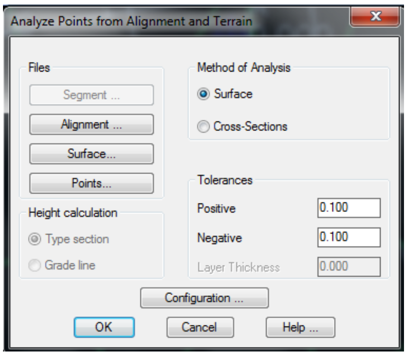
There are two calculation methods: using a **Surface**, or using **Cross-Sections**.

In both cases, the **Points file** to be analysed should be selected. Likewise, the maximum **Positive** and **Negative** admissible tolerance values are entered. If the difference between the actual height and the theoretical heights exceeds these limits, the point is considered to be unacceptable and marked with an asterisk (*).

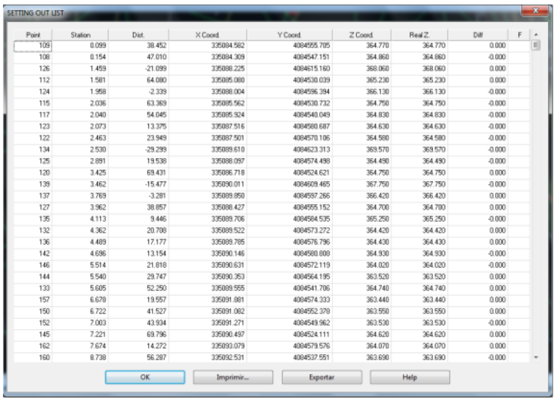
Calculation Method for Surfaces

In this case we must select the surface file for which the calculation is to be made, with the corresponding horizontal alignment and the points we wish to analyse.





Once the dialog box has been validated, MDT performs a calculation with the aforementioned data and displays a list with the following information on each line: point set out, station, adjustment in relation to the horizontal alignment, X and Y coordinates, theoretical height, actual height, and the difference between the two.



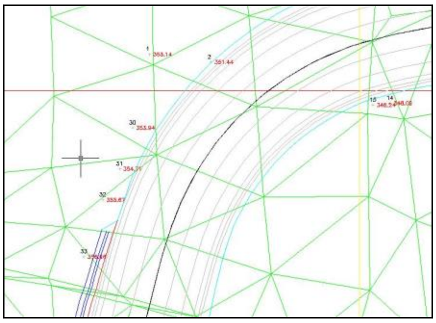
SETTING OUT LIST

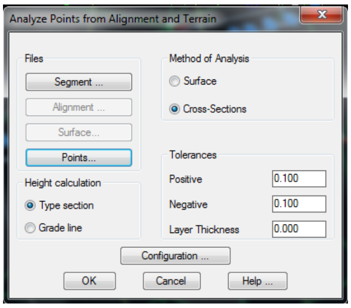
Point	Station	Dist.	X Coord.	Y Coord.	Z Coord.	Real Z.	Diff	F
109	0.099	38.452	335084.582	4084555.705	364.770	364.770	0.000	
108	0.154	47.010	335084.309	4084547.151	364.860	364.860	-0.000	
126	1.459	-21.099	335088.225	4084615.160	368.060	368.060	0.000	
112	1.581	64.080	335085.080	4084530.039	365.230	365.230	0.000	
124	1.958	-2.339	335088.004	4084596.394	366.130	366.130	-0.000	
115	2.036	63.369	335085.562	4084530.732	364.750	364.750	-0.000	
117	2.040	54.045	335085.924	4084540.049	364.830	364.830	-0.000	
123	2.073	13.375	335087.516	4084580.687	364.630	364.630	-0.000	
122	2.463	23.949	335087.501	4084570.106	364.580	364.580	-0.000	
134	2.530	-29.299	335089.610	4084623.313	369.570	369.570	-0.000	
125	2.891	19.538	335088.097	4084574.498	364.490	364.490	-0.000	
120	3.425	69.431	335086.718	4084524.621	364.750	364.750	0.000	
139	3.462	-15.477	335090.011	4084609.465	367.750	367.750	-0.000	
137	3.769	-3.281	335089.850	4084597.266	366.420	366.420	0.000	
127	3.962	38.857	335088.427	4084555.152	364.700	364.700	0.000	
135	4.113	9.446	335089.706	4084584.535	365.250	365.250	-0.000	
132	4.362	20.708	335089.522	4084573.272	364.420	364.420	0.000	
136	4.489	17.177	335089.785	4084576.796	364.430	364.430	0.000	
142	4.696	13.154	335090.146	4084580.808	364.930	364.930	-0.000	
146	5.514	21.818	335090.631	4084572.119	364.020	364.020	-0.000	
144	5.540	29.747	335090.353	4084564.195	363.520	363.520	0.000	
133	5.605	52.250	335089.555	4084541.706	364.740	364.740	0.000	
157	6.678	19.557	335091.881	4084574.333	363.440	363.440	0.000	
150	6.722	41.527	335091.082	4084552.378	363.550	363.550	0.000	
152	7.003	43.934	335091.271	4084549.962	363.530	363.530	-0.000	
145	7.221	69.796	335090.497	4084524.111	364.620	364.620	0.000	
162	7.674	14.272	335093.079	4084579.576	364.070	364.070	0.000	
160	8.738	56.287	335092.531	4084537.551	363.690	363.690	-0.000	

OK Imprimir... Exportar Help

Calculation method for Cross sections

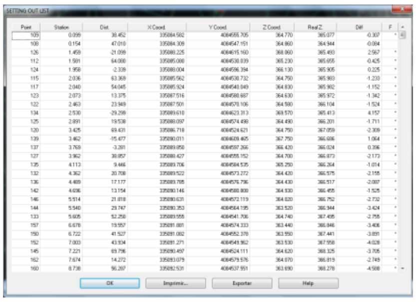
In this case we select the segment for which we will make the calculation and the points to be analysed.





In this case we have two options for calculating the elevation, either from the selection type or on the contrary from the slope with the corresponding superelevation.

Once the MDT dialog box is validated it performs the calculation process with the previous data and presents on-screen a list with the following information on each line: setting out point, Station, and Displacement with regard to the horizontal X and Y coordinates, the theoretical elevation, real elevation and difference between the two.



SETTING OUT LIST

Point	Station	Dist.	X Coord.	Y Coord.	Z Coord.	Real Z.	Diff	F
109	0.099	38.452	335084.582	4084555.705	364.770	365.077	-0.307	*
108	0.154	47.010	335084.309	4084547.151	364.860	364.944	-0.084	
126	1.459	-21.099	335088.225	4084615.160	368.060	365.493	2.567	*
112	1.581	64.080	335085.080	4084530.039	365.230	365.655	-0.425	*
124	1.958	-2.339	335088.004	4084596.394	366.130	365.905	0.225	*
115	2.036	63.369	335085.562	4084530.732	364.750	365.983	-1.233	*
117	2.040	54.045	335085.924	4084540.049	364.830	365.982	-1.152	*
123	2.073	13.375	335087.516	4084580.687	364.630	365.972	-1.342	*
122	2.463	23.949	335087.501	4084570.106	364.580	366.104	-1.524	*
134	2.530	-29.299	335089.610	4084623.313	369.570	365.413	4.157	*
125	2.891	19.538	335088.097	4084574.498	364.490	366.201	-1.711	*
120	3.425	69.431	335086.718	4084524.621	364.750	367.059	-2.309	*
139	3.462	-15.477	335090.011	4084609.465	367.750	366.686	1.064	*
137	3.769	-3.281	335089.850	4084597.266	366.420	366.024	0.396	*
127	3.962	38.857	335088.427	4084555.152	364.700	366.873	-2.173	*
135	4.113	9.446	335089.706	4084584.535	365.250	366.264	-1.014	*
132	4.362	20.708	335089.522	4084573.272	364.420	366.575	-2.155	*
136	4.489	17.177	335089.785	4084576.796	364.430	366.517	-2.087	*
142	4.696	13.154	335090.146	4084580.808	364.930	366.455	-1.525	*
146	5.514	21.818	335090.631	4084572.119	364.020	366.752	-2.732	*
144	5.540	29.747	335090.353	4084564.195	363.520	366.944	-3.424	*
133	5.605	52.250	335089.555	4084541.706	364.740	367.495	-2.755	*
157	6.678	19.557	335091.881	4084574.333	363.440	366.846	-3.406	*
150	6.722	41.527	335091.082	4084552.378	363.550	367.441	-3.891	*
152	7.003	43.934	335091.271	4084549.962	363.530	367.558	-4.028	*
145	7.221	69.796	335090.497	4084524.111	364.620	368.325	-3.705	*
162	7.674	14.272	335093.079	4084579.576	364.070	366.815	-2.745	*
160	8.738	56.287	335092.531	4084537.551	363.690	368.278	-4.588	*

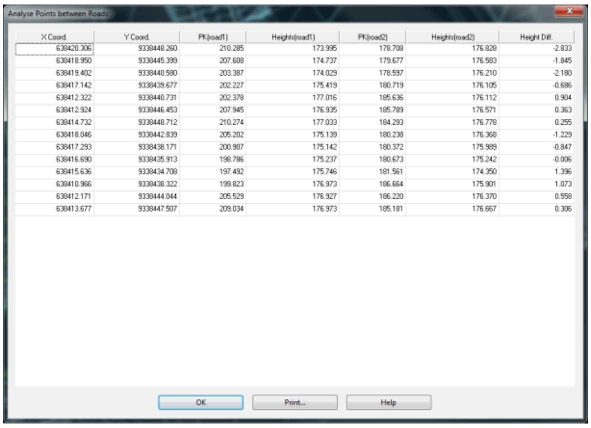
OK Imprimir... Exportar Help

Analyse Points between Roads

This command will make it easier for us to calculate the elevation difference between two roads at certain points that the user will designate graphically.

The command will initially ask for the two roads or segment files and it will then designate the different points to be analysed on the drawing.

Once all the points to be analysed have been designated, all the information resulting from the calculation on both roads will appear.



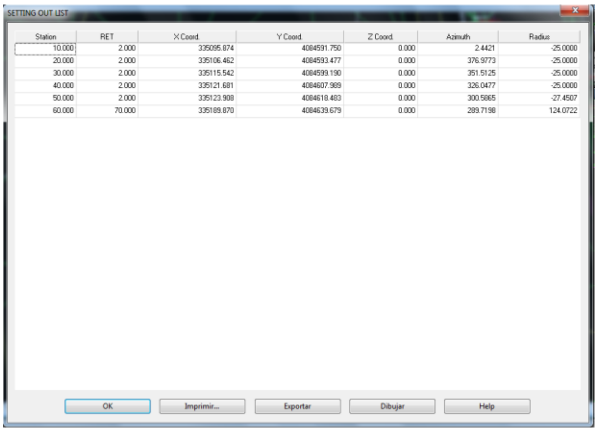
Calculate Points by Station and Displacement

This command helps one to calculate a point related to a horizontal alignment. The command initially requests if the values are to be keyed in or read from a **File**. In the latter case, it requests a file (with `.PKD` extension) having a two-column format: the first column contains the stations and the second contains the adjustments, separated by one or more spaces. The file does not have to be in column format.

The horizontal alignment is the selected either graphically or through a file, with the possibility of selecting a segment. Once the file is requested, the program then requests **Station** and **Offset** continuously until the user presses <Enter>. The last adjustment is repeated by default.

Additionally, if a segment has been selected, the program will request **Layer Thickness.** This value will be subtracted from the height resulting from the setting out and is always positive.

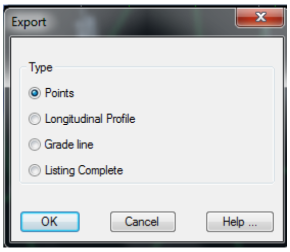
MDT performs a calculation process with the above-mentioned data and displays a list containing the following information on each line: station and adjustment (input data), X,Y and Z coordinates, as well as the azimuth and radius corresponding to the horizontal alignment at that station. Any station outside the horizontal alignment's limits will be ignored. The Z coordinate is obtained from the digital model, should it be defined. If a segment is selected, the Z coordinate will correspond to the grade line having the layer thickness applied.



It is possible to export and print the data obtained from the final list. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box with different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

Longitudinal profile: Creates a longitudinal profile from the information in the list generated.

Slope: Similar to the previous option, only in this case it creates a slope without curves.

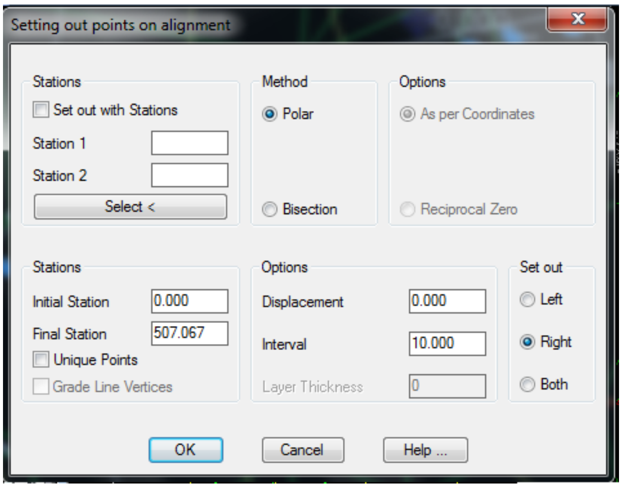
Complete List: This option transfers the complete list to a text file.

Print

When this option is selected, the data listed is sent to the printer selected.

Setting out Alignment Points

This tool facilitates the task of obtaining the coordinates of points belonging to the horizontal alignment. It also has an optional adjustment. The program first requests the horizontal alignment file (by default, the name of the current drawing with an .EJE extension) to be selected. Alternatively, one can also select a segment, in which the height of the grade line in the segment (see **Definition of Segment**) must also be entered. The dialog box and a description of its characteristics appear below.



Stations: Setting out stations that will be used to perform the calculation. **Station 1** represents the base station and **Station 2** represents the reference station. Their names can either be keyed in or selected on screen.

Method: Types of setting out methods that can be used, either **Polars** or **Bisection**. The bisection method has different options: **Reciprocal Zero** and **According to Coordinates**.

Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Unique Points: If it is enabled, the horizontal alignment's unique points will also be set out.

Grade Line Vertices: If it is enabled, the grade line vertices will also be set out.

Options

Displacement: Offset to the horizontal alignment of the points to be set out, also called setting back. If it is negative, it is to the left of the horizontal alignment; and if it is positive, it is to the right of the horizontal alignment.

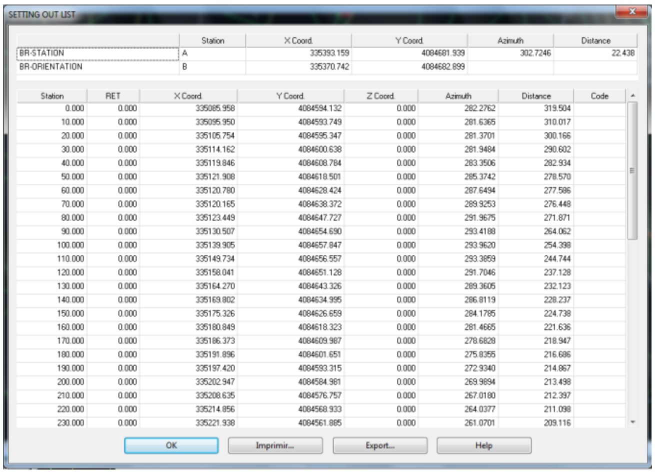
Interval: Station intervals at which the setting out is to be performed.

Thickness: This value will be taken into account if a segment is selected, in which case the value entered in this box will be subtracted from the resulting grade line height. The value should always be positive.

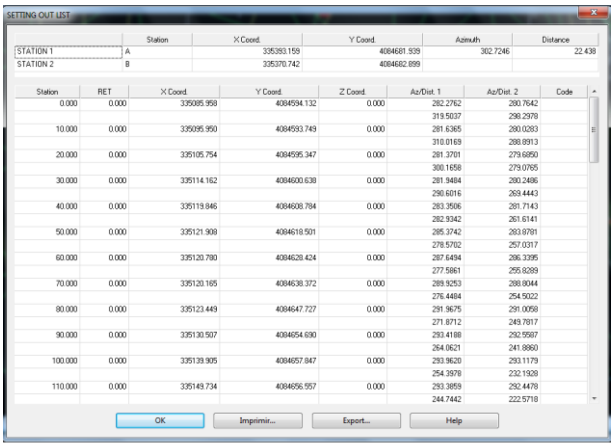
Set Out: The horizontal alignment side one wishes to set out is entered in this box. **Left, Right** or **Both**.

Once the dialog box has been validated, the different lists, depending on the method selected, will appear as follows.

Setting Out by Polars Method: For each interval from the initial station to the final station, it displays the station, adjustment, X,Y and Z coordinates, azimuth and distance from the base station, and code. The latter will be an asterisk (*) for unique points. The Z Coordinate is obtained from the segment, should it be defined.



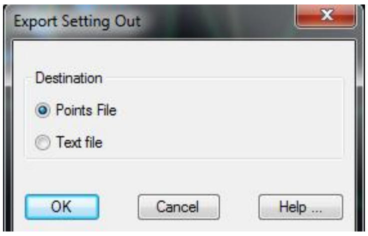
Setting out by Bisection Method: For each interval from the initial station to the final station, it displays the station, adjustment, X,Y and Z coordinates, azimuth and distance from the base and reference stations, and code. The latter will be an asterisk (*) for unique points. The Z Coordinate is obtained from the segment, should it be defined.



The possibility exists for all the different lists of exporting and printing the data obtained. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box with different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

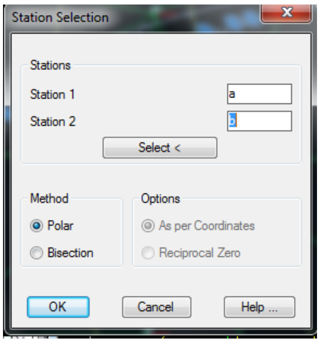
Print

When this option is selected, the data on the list are sent to the printer selected. Information about the stations used is also shown. An example of a printed list can be seen below:

```
                          SETTING OUT LIST
                             07/07/011

                Station    X Coord.      Y Coord.       Azimuth     Distance
                -------    ----------    -----------    --------    --------
   STATION 1    A          335393.159    4084681.939    302.7246      22.438
   STATION 2    B          335370.742    4084682.899

Station RET       X Coord.   Y Coord.      Z Coord. Az/Dist. 1 Az/Dist. 2 Code
------- -------- ---------- ----------- -------- ---------- ---------- ----
359.634  152.138 335458.490 4084576.743  350.960   164.6200   156.0256    1
                                                   123.8320   137.7275
 48.113  334.876 335455.497 4084588.301  350.680   162.6079   153.4905    2
                                                   112.4904   127.0125
354.582  149.694 335454.895 4084572.434  351.340   167.3187   158.5551    3
                                                   125.7090   138.8681
372.509  145.154 335453.909 4084587.007  350.100   163.7597   154.5168    4
                                                   112.7058   126.9329
 48.516  332.538 335453.608 4084594.247  350.530   161.5782   152.1470    5
                                                   106.5082   121.3506
 49.562  331.091 335452.874 4084609.225  349.660   156.2293   146.5477    6
                                                    94.0913   110.3335
360.983  145.137 335452.024 4084579.747  351.400   166.7299   157.5137    7
                                                   117.9336   131.3284
 49.298  329.749 335451.412 4084605.521  350.150   158.5353   148.6740    9
                                                    96.0893   111.7813
369.994  142.405 335450.995 4084586.775  351.190   165.2343   155.7132   10
                                                   111.3610   125.2217
 49.033  329.272 335450.776 4084601.795  350.360   160.3188   150.4227   11
                                                    98.7052   113.9440
```

Setting Out Points Regarding to Alignment

When this command is selected, the program requests the horizontal alignment, which can be selected on screen or its file selected. If a segment is selected, the program will take the information from the segment's horizontal alignment. The following dialog box is then displayed, which is described further below:

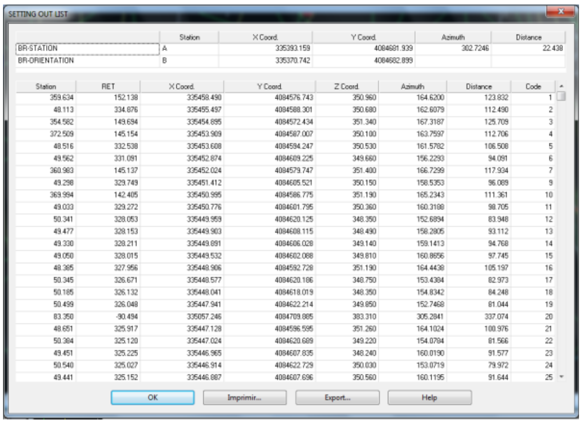


Stations: Setting out stations that will be used to perform the calculation. **Station 1** represents the base station and **Station 2** represents the reference station. Their names can either be keyed in or selected on screen.

Method: Types of setting out methods that can be used, either **Polars** or **Bisection**. The bisection method has different options: **Reciprocal Zero** and **According to Coordinates**.

Once the dialog box has been validated, the points to be set out (see **Select Point**) are selected. When these are selected, the different lists appearing below are displayed depending on the method selected.

Setting out by Polars Method: The station and the point's adjustment in relation to the horizontal alignment, its coordinates, the distance and azimuth to the base station, and the point number are displayed for each point selected. If any of the points cannot be projected on the horizontal alignment, it will not be included in the list.

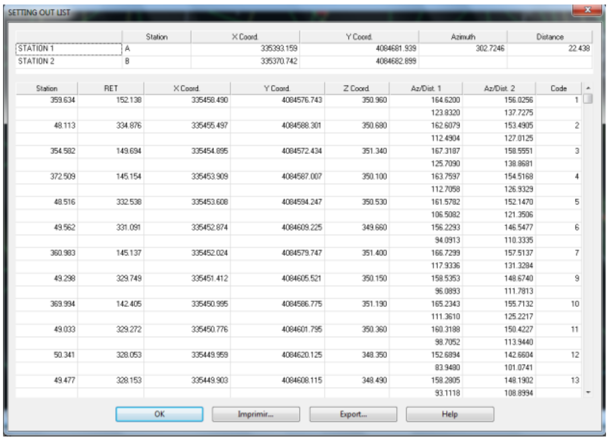

SETTING OUT LIST

	Station	X Coord.	Y Coord.	Azimuth	Distance
BR-STATION	A	335393.159	4084681.939	302.7246	22.438
BR-ORIENTATION	B	335370.742	4084682.899		

Station	RET	X Coord.	Y Coord.	Z Coord.	Azimuth	Distance	Code
359.634	152.138	335458.490	4084576.743	350.960	164.6200	123.832	1
48.113	334.876	335455.497	4084588.301	350.680	162.6079	112.490	2
354.582	149.694	335454.895	4084572.434	351.340	167.3187	125.709	3
372.509	145.154	335453.909	4084587.007	350.100	163.7597	112.706	4
48.516	332.538	335453.608	4084594.247	350.530	161.5782	106.508	5
49.562	331.091	335452.874	4084609.225	349.660	156.2293	94.091	6
360.983	145.137	335452.024	4084579.747	351.400	166.7299	117.934	7
49.298	329.749	335451.412	4084605.521	350.150	158.5353	96.089	9
369.994	142.405	335450.995	4084586.775	351.190	165.2343	111.361	10
49.033	329.272	335450.776	4084601.795	350.360	160.3188	98.705	11
50.341	328.053	335449.959	4084620.125	348.350	152.6894	83.948	12
49.477	328.153	335449.903	4084608.115	348.490	158.2805	93.112	13
49.330	328.211	335449.891	4084606.028	349.140	159.1413	94.768	14
49.050	328.015	335449.532	4084602.088	349.810	160.8656	97.745	15
48.385	327.956	335448.906	4084592.728	351.190	164.4438	105.197	16
50.345	326.671	335448.577	4084620.186	348.750	153.4384	82.973	17
50.185	326.132	335448.041	4084618.019	348.350	154.8342	84.248	18
50.499	326.048	335447.941	4084622.214	349.850	152.7468	81.044	19
83.350	-90.494	335057.246	4084709.865	383.310	305.2841	337.074	20
48.651	325.917	335447.128	4084596.595	351.260	164.1024	100.976	21
50.384	325.120	335447.024	4084620.689	349.220	154.0784	81.566	22
49.451	325.225	335446.965	4084607.835	348.240	160.0190	91.577	23
50.540	325.027	335446.914	4084622.729	350.030	153.0719	79.972	24
49.441	325.152	335446.887	4084607.696	350.560	160.1195	91.644	25

OK Imprimir... Export... Help

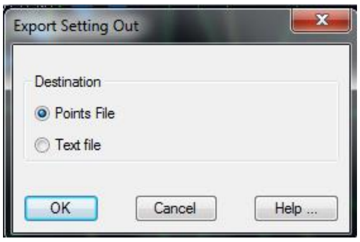
Setting out by Bisection Method: For each point selected, the station and the point's adjustment in relation to the horizontal alignment, its coordinates, the distance and azimuth to the base and reference stations, and the point number are displayed. If any of the points cannot be projected on the horizontal alignment, it will not be included in the list.



The possibility exists for all the different lists of exporting and printing the data obtained. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box containing the different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

Print

When this option is selected, the data on the list are sent to the printer selected. Information about the stations used is also shown. An example of a printed list in high resolution mode can be seen below.

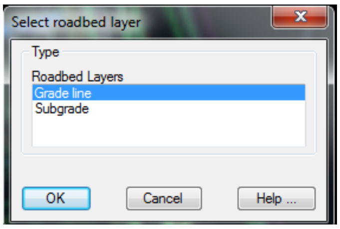
```
                              SETTING OUT LIST
                                 07/07/011

                 Station   X Coord.     Y Coord.      Azimuth    Distance
                 -------   ----------   -----------   --------   --------
    STATION 1    A         335393.159   4084681.939   302.7246     22.438
    STATION 2    B         335370.742   4084682.899

Station RET       X Coord.   Y Coord.     Z Coord. Az/Dist. 1 Az/Dist. 2 Code
------- -------- ---------- ----------- -------- ---------- ---------- ----
359.634  152.138 335458.490 4084576.743  350.960   164.6200   156.0256    1
                                                  123.8320   137.7275
 48.113  334.876 335455.497 4084588.301  350.680   162.6079   153.4905    2
                                                  112.4904   127.0125
354.582  149.694 335454.895 4084572.434  351.340   167.3187   158.5551    3
                                                  125.7090   138.8681
372.509  145.154 335453.909 4084587.007  350.100   163.7597   154.5168    4
                                                  112.7058   126.9329
 48.516  332.538 335453.608 4084594.247  350.530   161.5782   152.1470    5
                                                  106.5082   121.3506
 49.562  331.091 335452.874 4084609.225  349.660   156.2293   146.5477    6
                                                   94.0913   110.3335
360.983  145.137 335452.024 4084579.747  351.400   166.7299   157.5137    7
                                                  117.9336   131.3284
 49.298  329.749 335451.412 4084605.521  350.150   158.5353   148.6740    9
                                                   96.0893   111.7813
369.994  142.405 335450.995 4084586.775  351.190   165.2343   155.7132   10
                                                  111.3610   125.2217
 49.033  329.272 335450.776 4084601.795  350.360   160.3188   150.4227   11
                                                   98.7052   113.9440
```

Setting out Polylines Regarding to Alignment

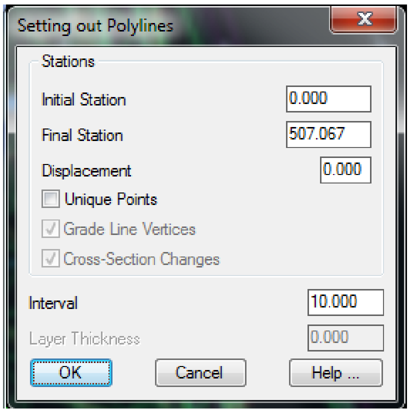
This tool will be of great use if one wishes to set out a set of polylines with regard to a horizontal alignment or segment without the need of creating points on such polylines.

Once the command is executed, the program requests the horizontal alignment or segment. Should a segment be selected, the program provides information on the height of the point set out on the definitive road in the setting out list.

If the segment is selected and it has an associated section, the command asks for which layer of roadbed the elevation must be analysed.



Once the horizontal alignment or segment is selected select the polyline for setting out. Lastly, the following dialog box is displayed, where the kind of setting out one wishes to perform is configured.



Initial station: Initial station from which the setting out will be calculated.

Final station: Last station up to which the setting out list will be created.

Displacement: Additionally, a displacement may be specified with regard to the designated polylines, meaning, it is as if it were really analysing parallels to the selected polylines keeping the sign in mind (negative > Left – Positive > Right).

alignment's unique points are displayed on the list.

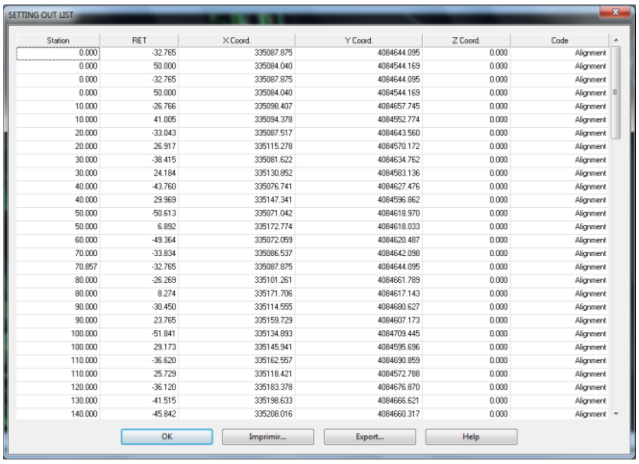
Grade Line Vertices: In this case, the grade line's transition curves vertices are also added.

Template Changes: All the stations at which some assignment change regarding the template associated to the segment has been done are added to the list. This option is only valid should one be working with Segments.

Interval: Value indicating the interval with which the setting out is to be performed.

Layer Thickness: In the event of setting out a segment, the program can apply a layer thickness to the final height calculated. This value is always positive and is subtracted from the definitive height.

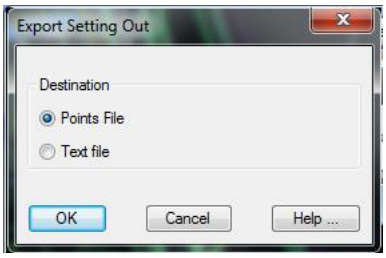
Once the dialog box has been validated, MDT performs a calculation with the aforementioned data and displays a list with the following information on each line: station and adjustment from vertex selected with regard to horizontal alignment, X, Y and Z coordinates, and the code corresponding to the vertex set out.



The possibility of exporting, printing or drawing points from the data obtained exist in the final list. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box with different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

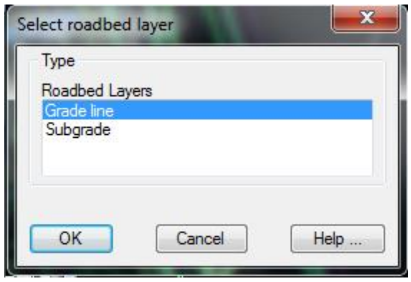
Print

When this option is selected, the data listed is sent to the printer selected.

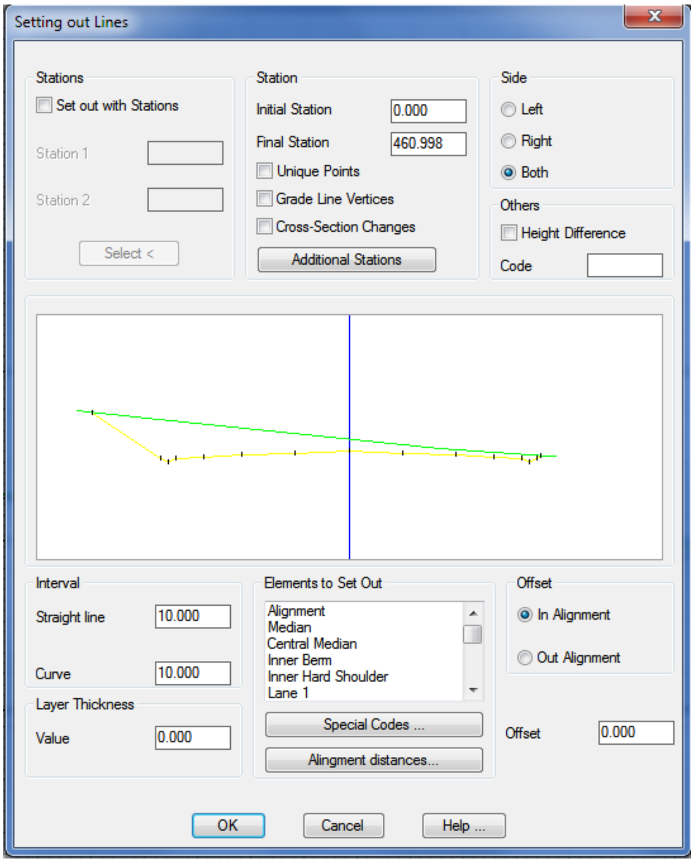
Setting Out Lines

A list containing the X, Y and Z coordinates of the cross-section's characteristic points is displayed with this option. Optionally, one can obtain a setting out list from the stations of these points.

When this command is executed, a segment is requested, which must contain information on the horizontal alignment, natural terrain, grade line and cross-section template (see **Definition of Segment**). Next, in the case that roadbed is assigned, a window is displayed to select the layer of roadbed for setting out:



Once the layer of roadbed is selected, a message appears with the possible errors found in the segment and then after accepting this, the following window appears for establishing the setting out lines.



Stations: The possibility of indicating the setting out stations exists, where **Station 1** is the base station and **Station 2** is the reference station. They can either be selected or their names entered in the respective boxes.

Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Unique Points: If the check box is enabled, the horizontal alignment's unique points will be added to the list.

Grade Line Vertices: If the check box is enabled, the segment's grade line vertices will be added to the list.

Template Changes: If the check box is enabled, all the stations where any **Alignment Template Assignment** changes have been made will be added.

Additional Stations: The possibility exists of indicating the command to calculate some additional stations.

Side: Indicates the side of the cross-section to be set out: **Left, Right** or **Both**.

Others: If this program option is activated, a list showing slope crown and feet height differences with regard to the vertex whose code coincides with the value entered in the **Code** box will be displayed.

If no value is entered in the Code field, the program displays the height difference with regard to the previous or next vertex, depending on whether the cursor is to the right or the left of the horizontal alignment.

Interval: Value indicating the interval with which the setting out is to be performed. The possibility of indicating a different interval for **Curves** also exists.

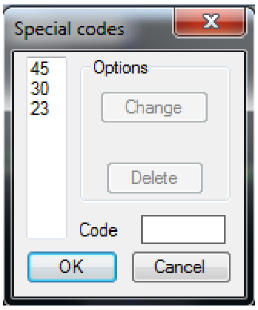
Elements to Set Out: List of the characteristic cross-section points which can be set out. If any of them are selected graphically, it will appear marked on the image above. This image is a preview of the initial station of the cross-section selected. It is possible to make a multiple selection.

Layer Thickness: this value will be taken away from the height resulting from the setting out. As such, in the event it is positive the result of the height will be lower and in the event it is negative the result of the height will be greater.

Roadbed Thickness: this value is subtracted from the setting out result. If it is positive the elevation result will be lower and if it is negative the elevation result will be higher.

Special Codes

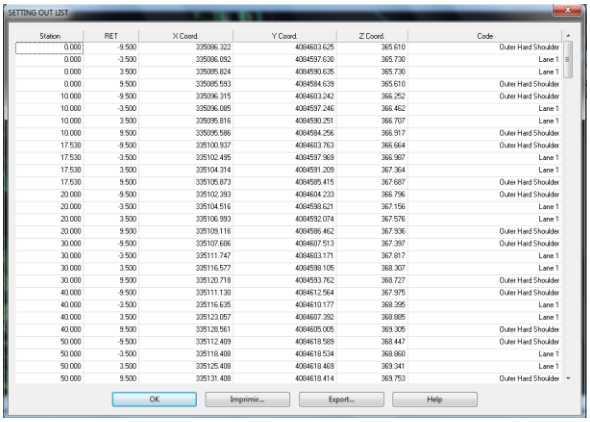
In addition to the elements to be set out, one can enter one or more specific codes on which one wishes to obtain information. The dialog box used to manage this type of codes is shown below.



Distances to the Horizontal Alignment

Additionally, as well as indicating the setting out element, for example the horizontal alignment, road shoulder, etc., we can indicate to the command additional distances to the horizontal alignment we wish to set out and that do not coincide with any of the elements in the list.

Once the dialog box has been validated, MDT performs a calculation with the aforementioned data and displays a list with the following information on each line: station and adjustment of the vertex selected in relation to the horizontal alignment, X, Y and Z coordinates, azimuth and distance (if setting out stations have been used) and the code corresponding to the vertex set out.


SETTING OUT LIST

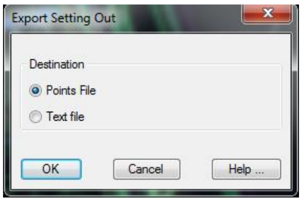
Station	RET	X Coord.	Y Coord.	Z Coord.	Code
0.000	-9.500	335086.322	4084603.625	365.610	Outer Hard Shoulder
0.000	-3.500	335086.092	4084597.630	365.730	Lane 1
0.000	3.500	335085.824	4084590.635	365.730	Lane 1
0.000	9.500	335085.593	4084584.639	365.610	Outer Hard Shoulder
10.000	-9.500	335096.315	4084603.242	366.252	Outer Hard Shoulder
10.000	-3.500	335096.085	4084597.246	366.462	Lane 1
10.000	3.500	335095.816	4084590.251	366.707	Lane 1
10.000	9.500	335095.586	4084584.256	366.917	Outer Hard Shoulder
17.530	-9.500	335100.937	4084603.763	366.664	Outer Hard Shoulder
17.530	-3.500	335102.495	4084597.969	366.987	Lane 1
17.530	3.500	335104.314	4084591.209	367.364	Lane 1
17.530	9.500	335105.873	4084585.415	367.687	Outer Hard Shoulder
20.000	-9.500	335102.393	4084604.233	366.796	Outer Hard Shoulder
20.000	-3.500	335104.516	4084598.621	367.156	Lane 1
20.000	3.500	335106.993	4084592.074	367.576	Lane 1
20.000	9.500	335109.116	4084586.462	367.936	Outer Hard Shoulder
30.000	-9.500	335107.606	4084607.513	367.397	Outer Hard Shoulder
30.000	-3.500	335111.747	4084603.171	367.817	Lane 1
30.000	3.500	335116.577	4084598.105	368.307	Lane 1
30.000	9.500	335120.718	4084593.762	368.727	Outer Hard Shoulder
40.000	-9.500	335111.130	4084612.564	367.975	Outer Hard Shoulder
40.000	-3.500	335116.635	4084610.177	368.395	Lane 1
40.000	3.500	335123.057	4084607.392	368.885	Lane 1
40.000	9.500	335128.561	4084605.005	369.305	Outer Hard Shoulder
50.000	-9.500	335112.409	4084618.589	368.447	Outer Hard Shoulder
50.000	-3.500	335118.408	4084618.534	368.860	Lane 1
50.000	3.500	335125.408	4084618.469	369.341	Lane 1
50.000	9.500	335131.408	4084618.414	369.753	Outer Hard Shoulder

OK Imprimir... Export... Help

It is possible to export and print the data obtained from the final list, or to Draw Points. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box with different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

Print

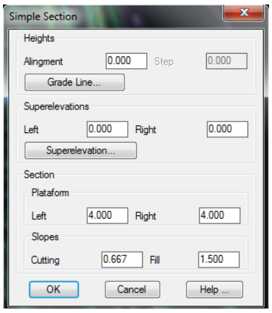
When this option is selected, the data listed is sent to the printer selected.

Setting Out Simple Section

This command is used to easily set out a roadway without the need to define the segment fully. It would be ideal for setting out a section with the platform and a few simple cut and fill slopes.

At first it requests the terrain cross-section profiles file and then the horizontal alignment, either graphically or by selecting it from the file.

After selecting the files, the following window is displayed for defining the characteristics of our section type.



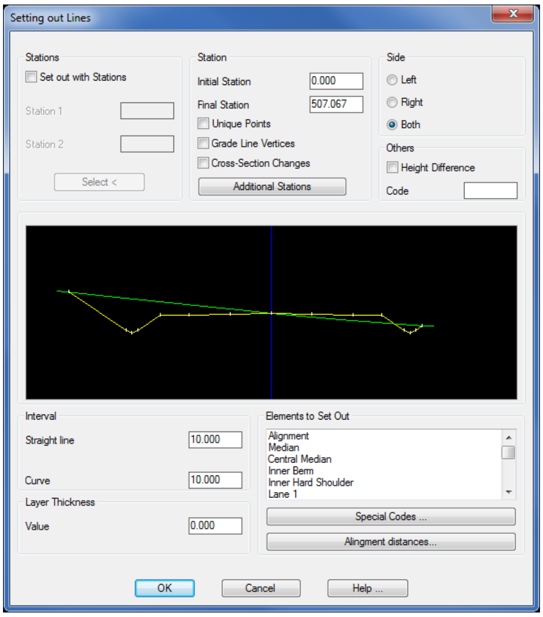
Heights: Indicate the height of our road or extract the height from the vertical alignment selected. Also, if the vertical alignment file is selected, a positive or negative increment may be applied to the height calculated in the station to be set out.

Superelevation: Indicate the superelevation to apply to both sides of the horizontal alignment, similarly it can be established according to the selected superelevation file.

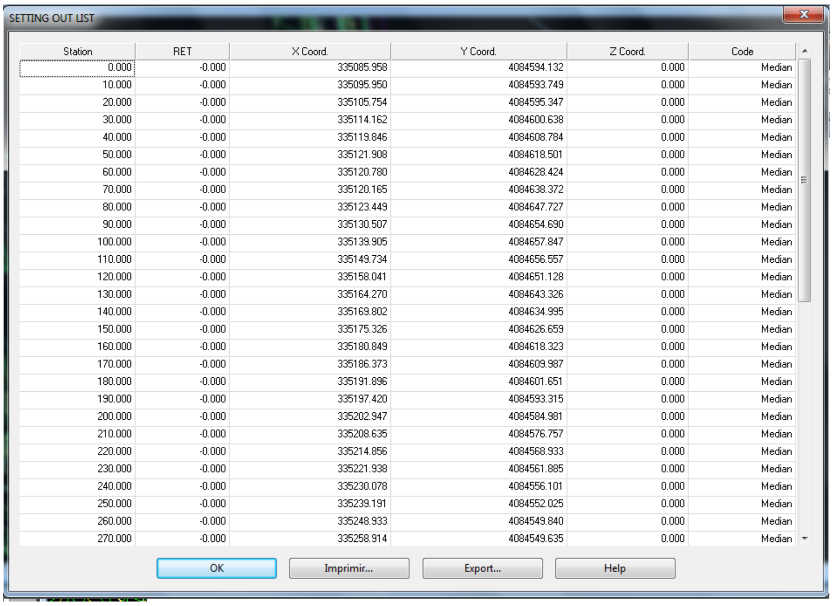
Section: Defines the basic parameters of our section type.

- **Platform**: Left and right platform length.
- **Slopes**: Slopes to apply in the case of cut and fill.

Once all the setting out values are established the following window will be displayed to specify the elements we wish to set out in the section type created, this option will be similar to that explained in the list of lines.



Once the dialog box is validated the final setting out result is displayed.



SETTING OUT LIST

Station	RET	X Coord.	Y Coord.	Z Coord.	Code
0.000	-0.000	335085.958	4084594.132	0.000	Median
10.000	-0.000	335095.950	4084593.749	0.000	Median
20.000	-0.000	335105.754	4084595.347	0.000	Median
30.000	-0.000	335114.162	4084600.638	0.000	Median
40.000	-0.000	335119.846	4084608.784	0.000	Median
50.000	-0.000	335121.908	4084618.501	0.000	Median
60.000	-0.000	335120.780	4084628.424	0.000	Median
70.000	-0.000	335120.165	4084638.372	0.000	Median
80.000	-0.000	335123.449	4084647.727	0.000	Median
90.000	-0.000	335130.507	4084654.690	0.000	Median
100.000	-0.000	335139.905	4084657.847	0.000	Median
110.000	-0.000	335149.734	4084656.557	0.000	Median
120.000	-0.000	335158.041	4084651.128	0.000	Median
130.000	-0.000	335164.270	4084643.326	0.000	Median
140.000	-0.000	335169.802	4084634.995	0.000	Median
150.000	-0.000	335175.326	4084626.659	0.000	Median
160.000	-0.000	335180.849	4084618.323	0.000	Median
170.000	-0.000	335186.373	4084609.987	0.000	Median
180.000	-0.000	335191.896	4084601.651	0.000	Median
190.000	-0.000	335197.420	4084593.315	0.000	Median
200.000	-0.000	335202.947	4084584.981	0.000	Median
210.000	-0.000	335208.635	4084576.757	0.000	Median
220.000	-0.000	335214.856	4084568.933	0.000	Median
230.000	-0.000	335221.938	4084561.885	0.000	Median
240.000	-0.000	335230.078	4084556.101	0.000	Median
250.000	-0.000	335239.191	4084552.025	0.000	Median
260.000	-0.000	335248.933	4084549.840	0.000	Median
270.000	-0.000	335258.914	4084549.635	0.000	Median

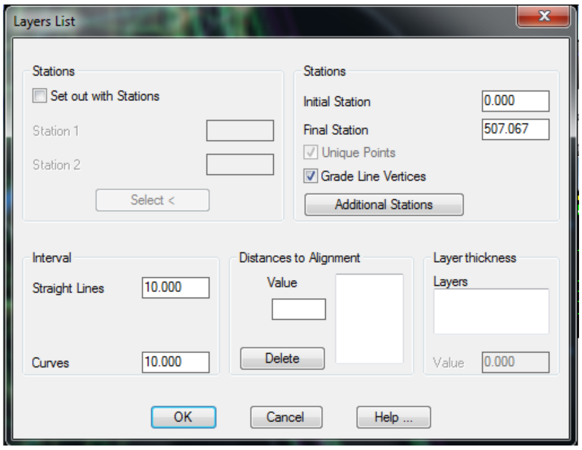
OK | Imprimir... | Export... | Help

Setting Out Layers

This option is used to create a list of points analysed in regard to the horizontal alignment or segment from an unlimited number of distances from the horizontal alignment in question.

When the command is executed, the program first asks for the horizontal alignment or segment to be used in the setting out. It then displays the following dialog box:

The elevation of the point analysed is always calculated from the height of the vertical alignment of the segment with the corresponding superelevation, according to the displacement selected.



Stations: The possibility of indicating the setting out stations exists, where **Station 1** is the base station and **Station 2** is the reference station. They can either be selected or their names entered in the respective boxes.

Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Unique Points: If it is enabled, the horizontal alignment's unique points will be added to the list.

Grade Line Vertices: If it is enabled, the grade line vertices in the segment will be added to the list.

Additional Stations: The possibility exists of indicating the command to calculate some additional stations.

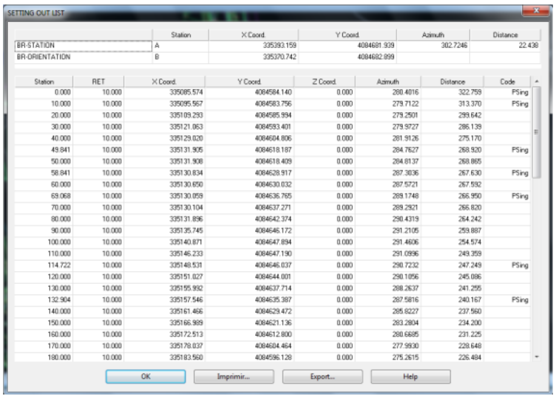
Roadbed Thickness: All the layers that have been associated to the roadbed assigned will be displayed on this list, should there be a roadbed assigned. If no roadbed layers are assigned, the **Grade Line** and **Subgrade** will be displayed, offering one the possibility of setting out either of the two options.

In addition, the possibility of assigning a specific roadbed thickness exists. In order to do so, the relevant thickness should be entered in the **Value** box, so that the value will be subtracted from the setting out's resulting height. Thickness should always be positive.

Interval: Value indicating the interval with which the setting out is to be performed. A different interval may be entered for **Curves**.

Distances to Horizontal Alignment: Introduce the distances with their sign to analyse with regard to the horizontal alignment or segment selected.

Once the dialog box has been validated, MDT performs a calculation with the aforementioned data and displays a list with the following information on each line: station and adjustment entered, in addition to the X,Y and Z coordinates. The Z coordinate will take values if a segment has been selected. The grade line height with the superelevation, if it exists, will be applied to it.


SETTING OUT LIST

	Station	X Coord.	Y Coord.	Azimuth	Distance
BR-STATION	A	335393.159	4084681.939	302.7246	22.438
BR-ORIENTATION	B	335370.742	4084682.899		

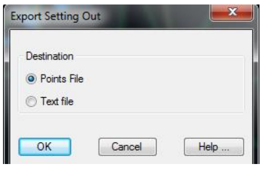
Station	RET	X Coord.	Y Coord.	Z Coord.	Azimuth	Distance	Code
0.000	10.000	335085.574	4084584.140	0.000	280.4016	322.759	PSing
10.000	10.000	335095.567	4084583.756	0.000	279.7122	313.370	PSing
20.000	10.000	335109.293	4084585.994	0.000	279.2501	299.642	
30.000	10.000	335121.063	4084593.401	0.000	279.9727	286.139	
40.000	10.000	335129.020	4084604.806	0.000	281.9126	275.170	
49.841	10.000	335131.905	4084618.187	0.000	284.7627	268.920	PSing
50.000	10.000	335131.908	4084618.409	0.000	284.8137	268.865	
58.841	10.000	335130.834	4084628.917	0.000	287.3036	267.630	PSing
60.000	10.000	335130.650	4084630.032	0.000	287.5721	267.592	
69.068	10.000	335130.059	4084636.765	0.000	289.1748	266.950	PSing
70.000	10.000	335130.104	4084637.271	0.000	289.2921	266.820	
80.000	10.000	335131.896	4084642.374	0.000	290.4319	264.242	
90.000	10.000	335135.745	4084646.172	0.000	291.2105	259.887	
100.000	10.000	335140.871	4084647.894	0.000	291.4606	254.574	
110.000	10.000	335146.233	4084647.190	0.000	291.0996	249.359	
114.722	10.000	335148.531	4084646.037	0.000	290.7232	247.249	PSing
120.000	10.000	335151.027	4084644.001	0.000	290.1056	245.086	
130.000	10.000	335155.992	4084637.714	0.000	288.2637	241.255	
132.904	10.000	335157.546	4084635.387	0.000	287.5816	240.167	PSing
140.000	10.000	335161.466	4084629.472	0.000	285.8227	237.560	
150.000	10.000	335166.989	4084621.136	0.000	283.2804	234.200	
160.000	10.000	335172.513	4084612.800	0.000	280.6685	231.225	
170.000	10.000	335178.037	4084604.464	0.000	277.9930	228.648	
180.000	10.000	335183.560	4084596.128	0.000	275.2615	226.484	

OK Imprimir... Export... Help

It is possible to export and print the data obtained from the final list, or to Draw Points. A description of each of the options follows:

Export

When the **Export** option is selected, the program displays a new dialog box with different ways of exporting the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

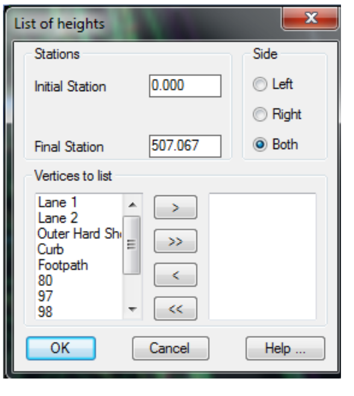
Print

When this s option is selected, the data listed is sent to the printer selected.

List of Heights

This command generates a list of heights of the vertices selected from the working segment.

To do this the command initially requests the segment file and then the roadbed layer (if this exists) from which to calculate the heights. Once selected the following window is displayed for establishing the type of list to generate:



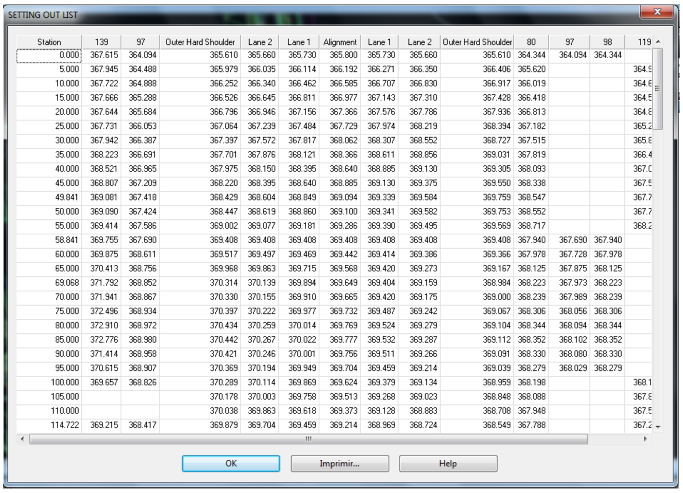
Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Side: Side of the horizontal alignment we wish to analyse.

Vertices to list: It is necessary to send the left list of vertices for which we wish to calculate the elevation to the right list of vertices. In the right list only the vertices existing in the roadway or segment selected will appear.

Once this dialog box is validated the following list will appear with all the information on the elevation requested. The list is given by stations with the analysed vertex appearing at the top of each column.



SETTING OUT LIST

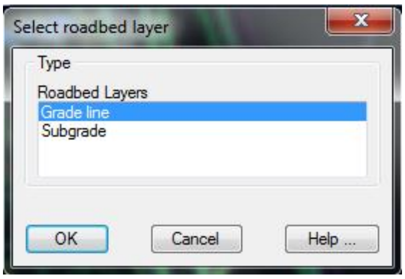
Station	139	97	Outer Hard Shoulder	Lane 2	Lane 1	Alignment	Lane 1	Lane 2	Outer Hard Shoulder	80	97	98	119
0.000	367.615	364.094	365.610	365.660	365.730	365.800	365.730	365.660	365.610	364.344	364.094	364.344	
5.000	367.945	364.488	365.979	366.035	366.114	366.192	366.271	366.350	366.406	365.620			364.9
10.000	367.722	364.888	366.252	366.340	366.462	366.585	366.707	366.830	366.917	366.019			364.6
15.000	367.666	365.288	366.526	366.645	366.811	366.977	367.143	367.310	367.428	366.418			364.5
20.000	367.644	365.684	366.796	366.946	367.156	367.366	367.576	367.786	367.936	366.813			364.8
25.000	367.731	366.053	367.064	367.239	367.484	367.729	367.974	368.219	368.394	367.182			365.2
30.000	367.942	366.387	367.397	367.572	367.817	368.062	368.307	368.552	368.727	367.515			365.8
35.000	368.223	366.691	367.701	367.876	368.121	368.366	368.611	368.856	369.031	367.819			366.4
40.000	368.521	366.965	367.975	368.150	368.395	368.640	368.885	369.130	369.305	368.093			367.0
45.000	368.807	367.209	368.220	368.395	368.640	368.885	369.130	369.375	369.550	368.338			367.5
49.841	369.081	367.418	368.429	368.604	368.849	369.094	369.339	369.584	369.759	368.547			367.7
50.000	369.090	367.424	368.447	368.619	368.860	369.100	369.341	369.582	369.753	368.552			367.7
55.000	369.414	367.586	369.002	369.077	369.181	369.286	369.390	369.495	369.569	368.717			368.2
58.841	369.755	367.690	369.408	369.408	369.408	369.408	369.408	369.408	369.408	367.940	367.690	367.940	
60.000	369.875	368.611	369.517	369.497	369.469	369.442	369.414	369.386	369.366	367.978	367.728	367.978	
65.000	370.413	368.756	369.968	369.863	369.715	369.568	369.420	369.273	369.167	368.125	367.875	368.125	
69.068	371.792	368.852	370.314	370.139	369.894	369.649	369.404	369.159	368.984	368.223	367.973	368.223	
70.000	371.941	368.867	370.330	370.155	369.910	369.665	369.420	369.175	369.000	368.239	367.989	368.239	
75.000	372.496	368.934	370.397	370.222	369.977	369.732	369.487	369.242	369.067	368.306	368.056	368.306	
80.000	372.910	368.972	370.434	370.259	370.014	369.769	369.524	369.279	369.104	368.344	368.094	368.344	
85.000	372.776	368.980	370.442	370.267	370.022	369.777	369.532	369.287	369.112	368.352	368.102	368.352	
90.000	371.414	368.958	370.421	370.246	370.001	369.756	369.511	369.266	369.091	368.330	368.080	368.330	
95.000	370.615	368.907	370.369	370.194	369.949	369.704	369.459	369.214	369.039	368.279	368.029	368.279	
100.000	369.657	368.826	370.289	370.114	369.869	369.624	369.379	369.134	368.959	368.198			368.1
105.000			370.178	370.003	369.758	369.513	369.268	369.023	368.848	368.088			367.8
110.000			370.038	369.863	369.618	369.373	369.128	368.883	368.708	367.948			367.5
114.722	369.215	368.417	369.879	369.704	369.459	369.214	368.969	368.724	368.549	367.788			367.2

As in all lists, it has the option to send it to "Print" according to the different options the program offers.

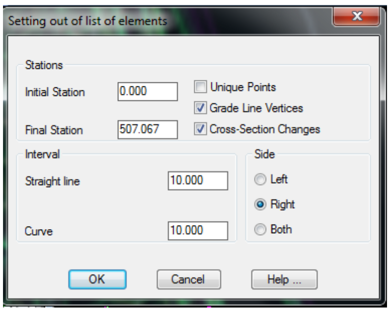
List of Platform Vertices

This command is similar to the List of Lines the only difference being that it only analyses the platform vertices of the selected segment.

To do this, like previous commands, initially the work segment is selected then the roadbed layer with which to work is indicated, in the case that there are defined roadbeds:



Once the segment is selected the following window appears in which we specify the type of list we wish to obtain:



Stations:

Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Unique Points: Activating this box adds the horizontal alignment's unique points to the list.

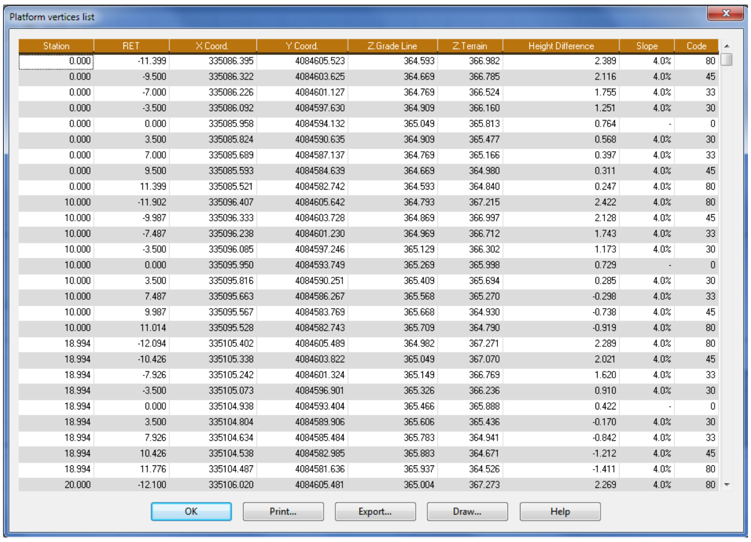
Grade line Vertices: Activating this box adds to the list of grade line vertices found in the segment.

Cross-Section Changes: Activating this box adds to the list all the stations where any assignation has existed within the Assignment of **Horizontal Alignment Sections.**

Interval – Straight line: Interval of analysis for the horizontal alignment on its straight segments.

Interval –Curve: Interval of analysis of the horizontal alignment for curved or clothoid sections. **Side**: To indicate the side of the horizontal alignment to analyse.

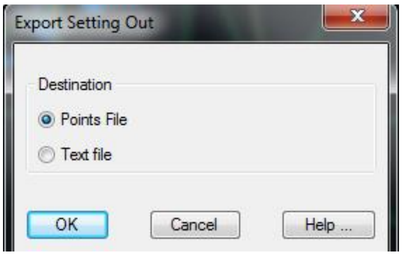
Side: Indicate the side of the horizontal alignment to analyse.



Station	RET	X Coord.	Y Coord.	Z.Grade Line	Z.Terrain	Height Difference	Slope	Code
0.000	-11.399	335086.395	4084605.523	364.593	366.982	2.389	4.0%	80
0.000	-9.500	335086.322	4084603.625	364.669	366.785	2.116	4.0%	45
0.000	-7.000	335086.226	4084601.127	364.769	366.524	1.755	4.0%	33
0.000	-3.500	335086.092	4084597.630	364.909	366.160	1.251	4.0%	30
0.000	0.000	335085.958	4084594.132	365.049	365.813	0.764	-	0
0.000	3.500	335085.824	4084590.635	364.909	365.477	0.568	4.0%	30
0.000	7.000	335085.689	4084587.137	364.769	365.166	0.397	4.0%	33
0.000	9.500	335085.593	4084584.639	364.669	364.980	0.311	4.0%	45
0.000	11.399	335085.521	4084582.742	364.593	364.840	0.247	4.0%	80
10.000	-11.902	335096.407	4084605.642	364.793	367.215	2.422	4.0%	80
10.000	-9.987	335096.333	4084603.728	364.869	366.997	2.128	4.0%	45
10.000	-7.487	335096.238	4084601.230	364.969	366.712	1.743	4.0%	33
10.000	-3.500	335096.085	4084597.246	365.129	366.302	1.173	4.0%	30
10.000	0.000	335095.950	4084593.749	365.269	365.998	0.729	-	0
10.000	3.500	335095.816	4084590.251	365.409	365.694	0.285	4.0%	30
10.000	7.487	335095.663	4084586.267	365.568	365.270	-0.298	4.0%	33
10.000	9.987	335095.567	4084583.769	365.668	364.930	-0.738	4.0%	45
10.000	11.014	335095.528	4084582.743	365.709	364.790	-0.919	4.0%	80
18.994	-12.094	335105.402	4084605.489	364.982	367.271	2.289	4.0%	80
18.994	-10.426	335105.338	4084603.822	365.049	367.070	2.021	4.0%	45
18.994	-7.926	335105.242	4084601.324	365.149	366.769	1.620	4.0%	33
18.994	-3.500	335105.073	4084596.901	365.326	366.236	0.910	4.0%	30
18.994	0.000	335104.938	4084593.404	365.466	365.888	0.422	-	0
18.994	3.500	335104.804	4084589.906	365.606	365.436	-0.170	4.0%	30
18.994	7.926	335104.634	4084585.484	365.783	364.941	-0.842	4.0%	33
18.994	10.426	335104.538	4084582.985	365.883	364.671	-1.212	4.0%	45
18.994	11.776	335104.487	4084581.636	365.937	364.526	-1.411	4.0%	80
20.000	-12.100	335106.020	4084605.481	365.004	367.273	2.269	4.0%	80

Export

When the **Export** option is selected, the program displays a new dialog box with different ways to export the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

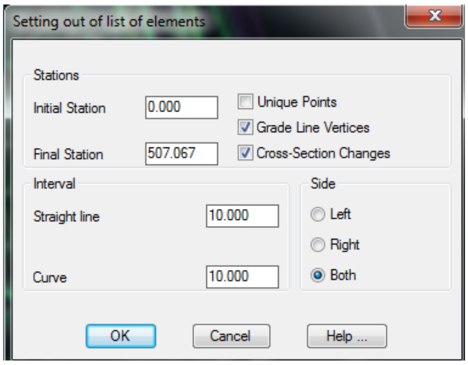
ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

Print

When selecting this option the list data is sent to the printer selected.

List of Ditch Vertices

This command displays a list with all the ditch vertices existing in the roadway or segment defined. Initially the file for the segment is requested and then it displays the following window to select the type of list to generate:



Stations:

Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Unique Points: Activating this box adds the horizontal alignment's unique points to the list.

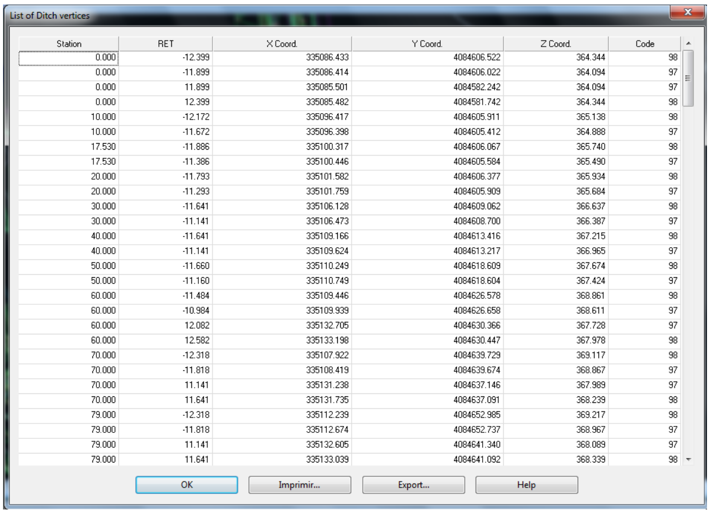
Grade line Vertices: Activating this box adds to the list the grade line vertices found in the segment.

Cross-Section Changes: Activating this box adds to the list all the stations where any assignation has existed within the Assignment of **Horizontal Alignment Sections.**

Interval – Straight line: Interval of analysis for the horizontal alignment on its straight segments.

Interval –Curve: Interval of analysis of the horizontal alignment for curved or clothoid sections.

Side: Indicate the side of the horizontal alignment to analyse.

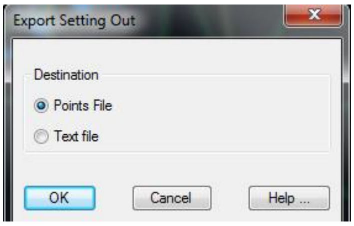

List of Ditch vertices

Station	RET	X Coord.	Y Coord.	Z Coord.	Code
0.000	-12.399	335086.433	4084606.522	364.344	98
0.000	-11.899	335086.414	4084606.022	364.094	97
0.000	11.899	335085.501	4084582.242	364.094	97
0.000	12.399	335085.482	4084581.742	364.344	98
10.000	-12.172	335096.417	4084605.911	365.138	98
10.000	-11.672	335096.398	4084605.412	364.888	97
17.530	-11.886	335100.317	4084606.067	365.740	98
17.530	-11.386	335100.446	4084605.584	365.490	97
20.000	-11.793	335101.582	4084606.377	365.934	98
20.000	-11.293	335101.759	4084605.909	365.684	97
30.000	-11.641	335106.128	4084609.062	366.637	98
30.000	-11.141	335106.473	4084608.700	366.387	97
40.000	-11.641	335109.166	4084613.416	367.215	98
40.000	-11.141	335109.624	4084613.217	366.965	97
50.000	-11.660	335110.249	4084618.609	367.674	98
50.000	-11.160	335110.749	4084618.604	367.424	97
60.000	-11.484	335109.446	4084626.578	368.861	98
60.000	-10.984	335109.939	4084626.658	368.611	97
60.000	12.082	335132.705	4084630.366	367.728	97
60.000	12.582	335133.198	4084630.447	367.978	98
70.000	-12.318	335107.922	4084639.729	369.117	98
70.000	-11.818	335108.419	4084639.674	368.867	97
70.000	11.141	335131.238	4084637.146	367.989	97
70.000	11.641	335131.735	4084637.091	368.239	98
79.000	-12.318	335112.239	4084652.985	369.217	98
79.000	-11.818	335112.674	4084652.737	368.967	97
79.000	11.141	335132.605	4084641.340	368.089	97
79.000	11.641	335133.039	4084641.092	368.339	98

OK Imprimir... Export... Help

Export

When the **Export** option is selected, the program displays a new dialog box with different ways to export the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

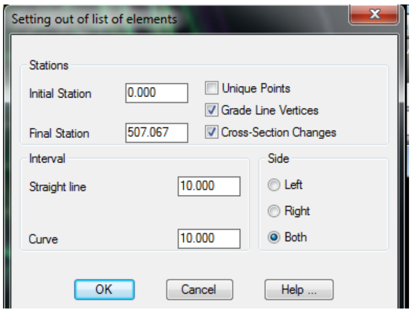
Print

When selecting this option the list data is sent to the printer selected.

List of Slope Vertices

Executing this command creates a list of all the vertices corresponding to the distinct slope vectors that comprise the section in each station.

The same as for previous commands, initially it will request the segment, then the following dialog box will be displayed to customize they list type to generate.



Stations:

Initial station: Initial station from which the setting out will be performed.

Final station: Final station up to which the setting out will be performed.

Unique Points: Activating this box adds the horizontal alignment's unique points to the list.

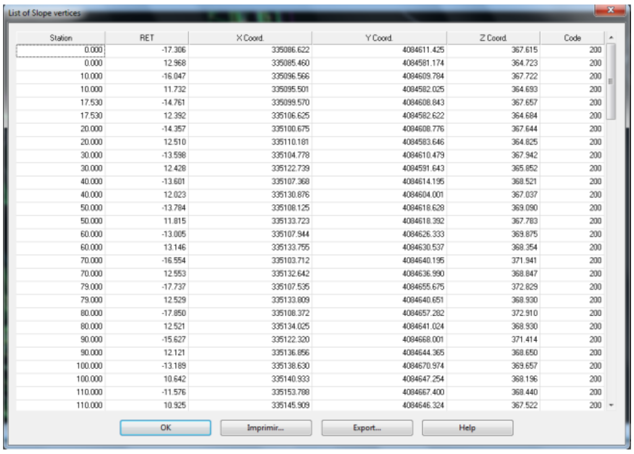
Grade line Vertices: Activating this box adds to the list the grade line vertices found in the segment.

Cross-Section Changes: Activating this box adds to the list all the stations where any assignation has existed within the Assignment of **Horizontal Alignment Sections.**

Interval – Straight: Interval of analysis for the horizontal alignment on its straight segments.

Interval –Curve: Interval of analysis of the horizontal alignment for curved or clothoid sections.

Side: Indicate the side of the horizontal alignment to analyse.

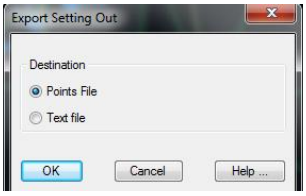

List of Slope vertices

Station	RET	X Coord.	Y Coord.	Z Coord.	Code
0.000	-17.306	335086.622	4084611.425	367.615	200
0.000	12.968	335085.460	4084581.174	364.723	200
10.000	-16.047	335096.566	4084609.784	367.722	200
10.000	11.732	335095.501	4084582.025	364.693	200
17.530	-14.761	335099.570	4084608.843	367.657	200
17.530	12.392	335106.625	4084582.622	364.684	200
20.000	-14.357	335100.675	4084608.776	367.644	200
20.000	12.510	335110.181	4084583.646	364.825	200
30.000	-13.598	335104.778	4084610.479	367.942	200
30.000	12.428	335122.739	4084591.643	365.852	200
40.000	-13.601	335107.368	4084614.195	368.521	200
40.000	12.023	335130.876	4084604.001	367.037	200
50.000	-13.784	335108.125	4084618.628	369.090	200
50.000	11.815	335133.723	4084618.392	367.783	200
60.000	-13.005	335107.944	4084626.333	369.875	200
60.000	13.146	335133.755	4084630.537	368.354	200
70.000	-16.554	335103.712	4084640.195	371.941	200
70.000	12.553	335132.642	4084636.990	368.847	200
79.000	-17.737	335107.535	4084655.675	372.829	200
79.000	12.529	335133.809	4084640.651	368.930	200
80.000	-17.850	335108.372	4084657.282	372.910	200
80.000	12.521	335134.025	4084641.024	368.930	200
90.000	-15.627	335122.320	4084668.001	371.414	200
90.000	12.121	335136.856	4084644.365	368.650	200
100.000	-13.189	335138.630	4084670.974	369.657	200
100.000	10.642	335140.933	4084647.254	368.196	200
110.000	-11.576	335153.788	4084667.400	368.440	200
110.000	10.925	335145.909	4084646.324	367.522	200

OK Imprimir... Export... Help

Export

When the **Export** option is selected, the program displays a new dialog box with different ways to export the data. The dialog box and a description of its characteristics appear below:



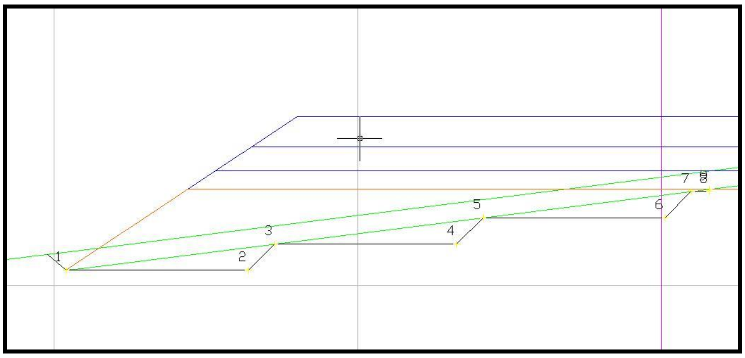
Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

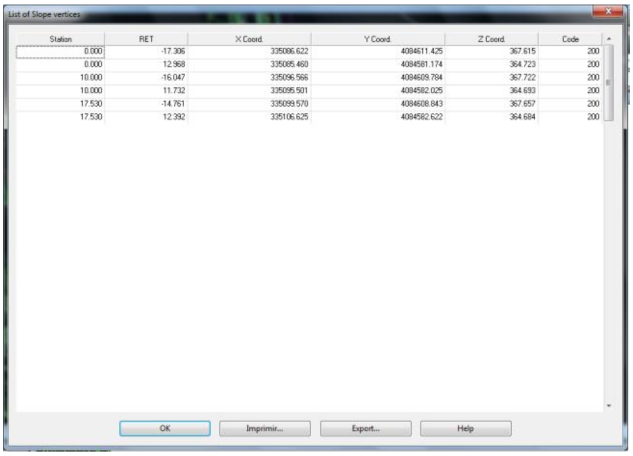
When selecting this option the list data is sent to the printer selected.

List of Routing Vertices

This command is used to generate a list of all the routing vertices that have been defined in our roadway or segment. The image displays the numbered vertices that would appear in the final list.

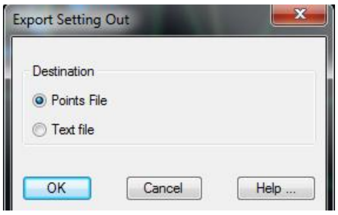


Initially it requests the working segment and then the initial and final stations from which to generate the list, then it provides a list of the vertices corresponding to station 0.000 of a determined segment.



Export

When the **Export** option is selected, the program displays a new dialog box with different ways to export the data. The dialog box and a description of its characteristics appear below:



Points File: All the coordinates of all the points on the list are exported to a points file. When the dialog box is validated, the **Export Points** command is automatically executed. For further details, see the **Surveying Points** section.

ASCII List: Sends the contents of the list to an ASCII file, so that it can be edited or handled with a word processor.

Print

When selecting this option the list data is sent to the printer selected.

16. Volumes

Grid Difference

This command calculates the cutting and fill volumes from two grid files obtained using the **Maps > Create Grid from Surface** and **Maps > Create Grid from Contour Lines** commands. Both files should be generated with the same cell size. The smaller this value is, more precise is the calculation. However, grid files are larger and processing is therefore slower.

The calculation process is as follows: The average height is measured for every two cells whose 2D coordinates coincide from their four vertices. Then the heights are compared. If the difference is above the tolerance set, the volume between both cells is calculated and the cutting or fill volume is added in accordance with its sign. The formula used to calculate the volume is as follows:

$$V_i = D^2 (z_1 - z_2)$$

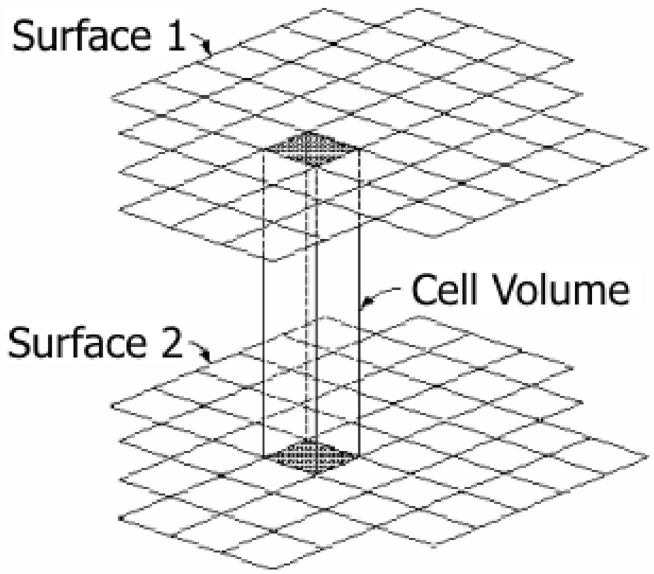
where:

V_i = Volume of cell i

D = Size of the cell

Z_1 = Average height of the cell in surface 1

Z_2 = Average height of the cell in surface 2

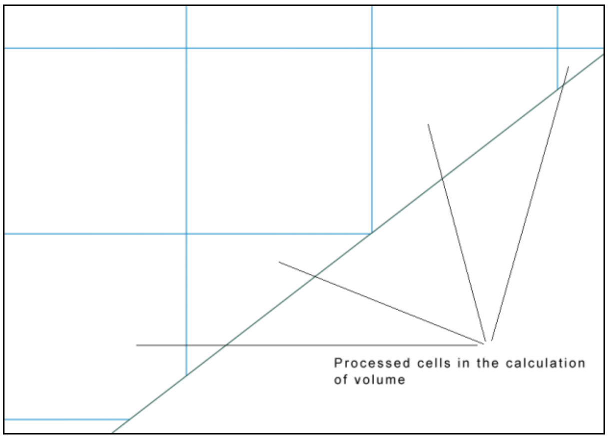


If the **partial cells on the boundary**" option is activated in "**Settings > Volumes**", in the event the cells on the calculation perimeter are only partially affected by the calculation of volume, only the affected region of the cell in question will be processed.

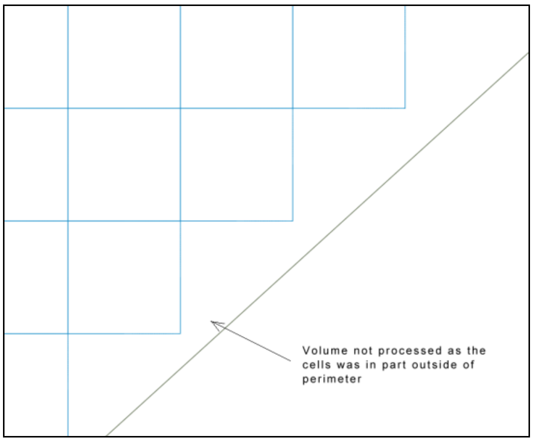
.

If the option is not activated, the cell which is partially beyond the boundary will not be processed.

Use partial cells on the boundary

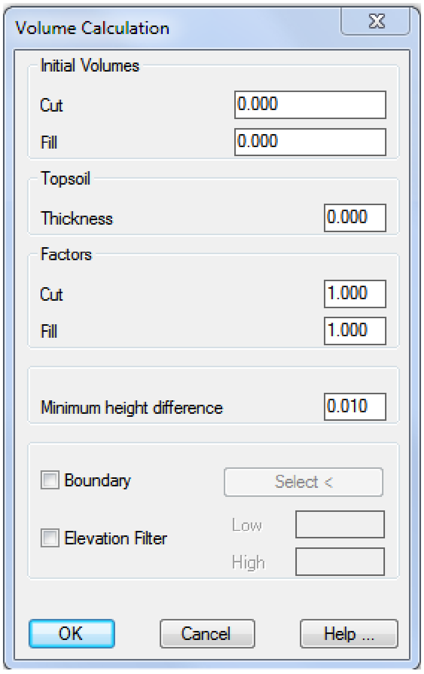


ACTIVATED



DEACTIVATED

When the command is executed, the program first displays a dialog box where one can enter ***Initial Volumes*** for the cutting and the fill, which the program adds to the calculation's final result. If a ***Thickness*** is added for ***Organic Soil***, the program internally lowers the height of the first grid by the meters entered before proceeding to calculate. Factors that multiply the volumes obtained can also be entered.

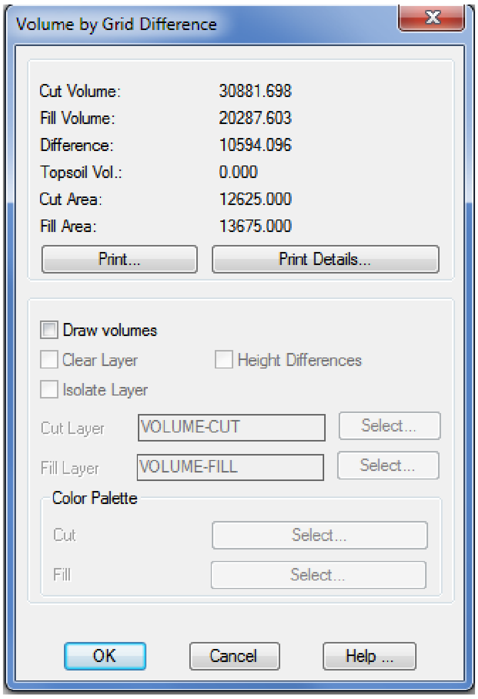


Minimum height difference. The minimum difference in metres at which the volume is calculated.

Boundary: We can select a polyline which delimits the surface we wish to analyse.

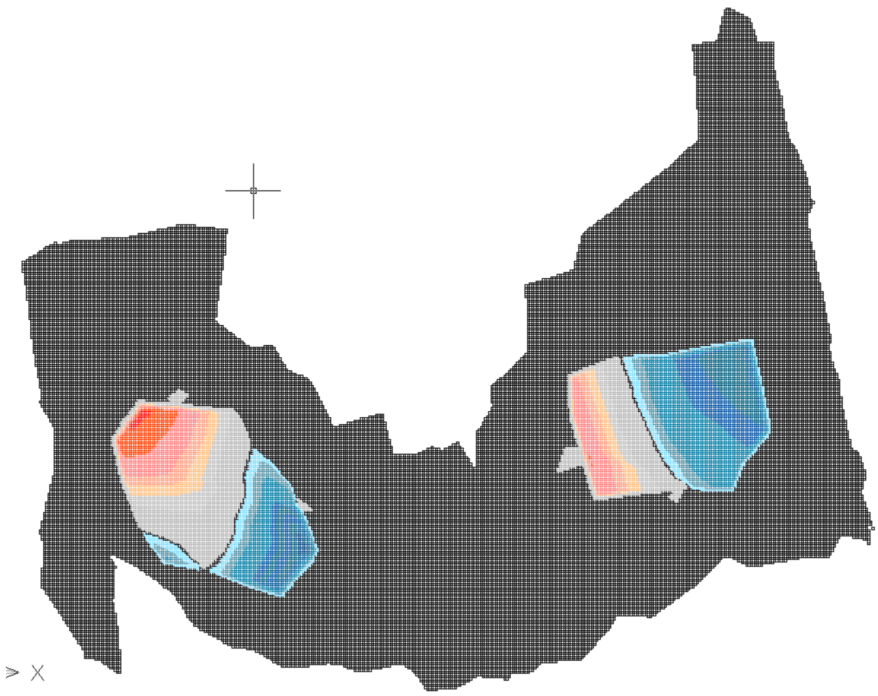
Elevation Filter: By enabling this box we will be able to set the minimum elevation and maximum elevation values between which it is wished to make the calculation.

Once the two grid files to be used have been selected, the program calculates the volume by superimposing the two grids and provides information on the results obtained.



The ***Print*** button creates a list where the names of the grid files and the results obtained are displayed. Additionally, the ***Print Details*** button adds a detailed breakdown of each of the cells to the above-mentioned list.

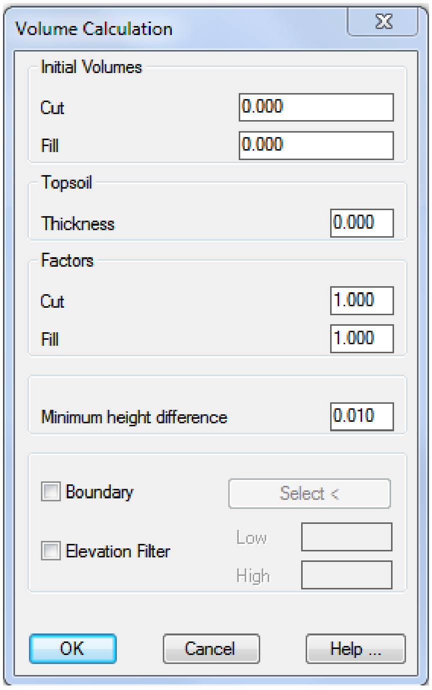
One can obtain a graphic representation of the results by activating the ***Draw Volumes*** check box. This consists of a grid that is only defined in the area defined by both grid files. Each cell will have a colour indicating if the area is in a cutting, fill or whether it does not contribute to volume within tolerance set in the configuration. There is the possibility of assigning at the drawing a range of colours both for the cut and fill; with this in mind, we have the option of selecting the corresponding colour palette.



In addition, if one activates the ***Height Differences*** check box, a text containing the height differences between the both grids will be drawn within each cutting or fill cell.

Surface Difference

This command is identical to **Grid Differences,** except that it uses surface files as data input instead of grid files. When the initial parameters are requested, a new additional element is displayed where one must enter ***Cell Size***, which will be used to create the grids used to calculate volumes.



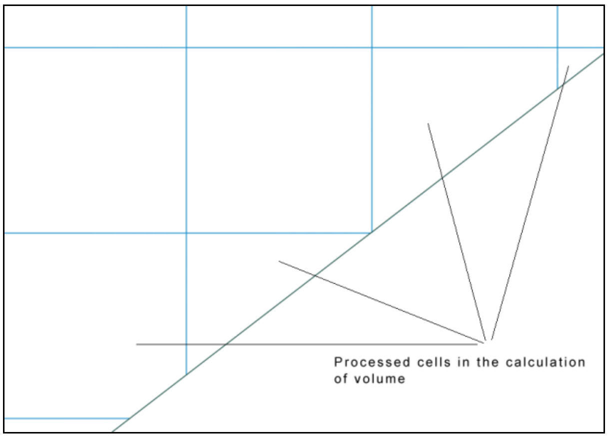
Once the two surface files to be used have been specified, the program calculates the volume, superimposing the meshes generated from the surfaces and informing the results obtained.

If the **partial cells on the boundary**” option is activated in “**Settings > Volumes**”, in the event the cells on the calculation perimeter are only partially affected by the calculation of volume, only the affected region of the cell in question will be processed.

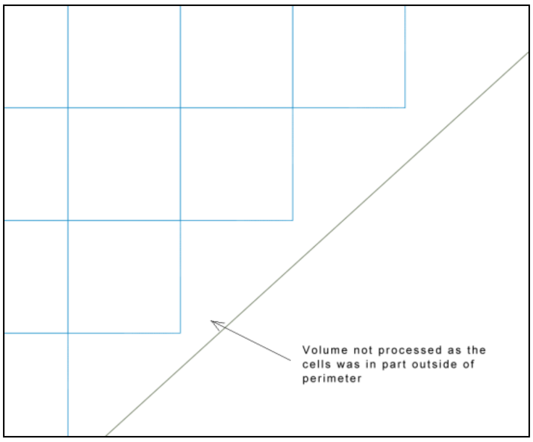
.

If the option is not activated, the cell which is partially beyond the boundary will not be processed.

Use partial cells on the boundary



ACTIVATED

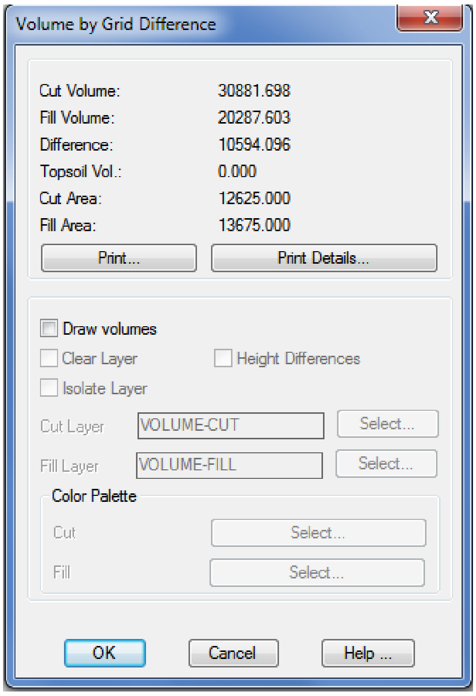


DEACTIVATED

Diferencia Mínima de Cotas. Diferencia mínima, en metros, para que se calcule el volume.

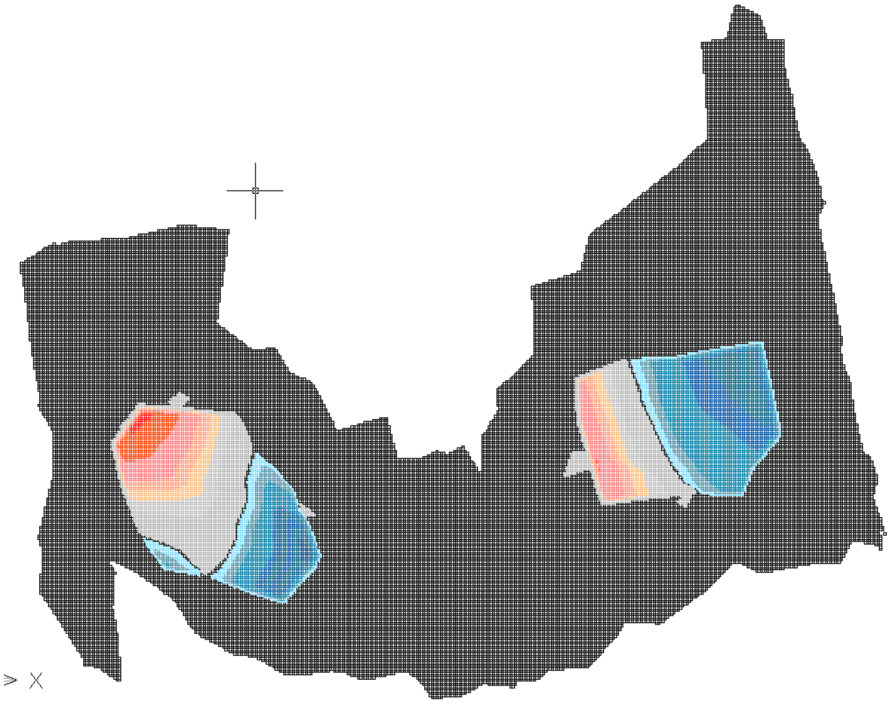
Boundary: We can select a polyline which delimits the surface we wish to analyse.

Elevation Filter: By enabling this box we will be able to set the minimum elevation and maximum elevation values between which it is wished to make the calculation.



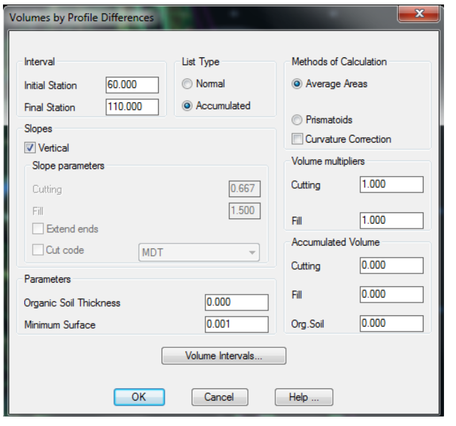
The ***Print*** button creates a list where the names of the surfaces files appear and the results obtained. Furthermore, the ***Detailed Print*** button adds to the previous list a detailed breakdown of each of the grid cells generated.

By enabling the box ***Draw Volumes*** a graphic representation can be obtained of the results which consists of a grid defined solely in the area where both grid files are defined. Each cell will have a colour indicating whether the area is being cut, filled or does not have a volume which falls within the tolerance defined in the configuration. There is the possibility of assigning in the drawing a range of colours both for the cut and fill; with this in mind, we have the option of selecting the corresponding colour palette.



Cross-Section Difference

This option obtains the volume between two terrains from two cross-section profiles. These should have the same stations defined along the horizontal alignment. The program requests the files and displays the following dialog box, where the list is configured. A description of all its characteristics follows.



Initial Station: Station from which the volume measurement will be calculated.

Final Station. Station up to which the volume measurement will be calculated.

Slopes

Verticals: This option is activated by default. To calculate the surface at each station, make a **vertical** cut on one side and another in the shortest profile, so that the calculation is made as if it were defining a slope.

If the option is deactivated, instead of all slopes being vertical, one slope can be specified a slope for **cutting** and another for **fill**.

Extend ends: If when forming the slope indicated the terrain in the first cross-section is not wide enough for the cut, it is automatically extended, interpolating with the two last vertices of each side as a reference.

Cut code: This option is the alternative to introducing specific cutting and fill slopes. The cut code is indicated for it, meaning from the ends of the second selected cross-section, the cut is completed by seeking contact with the vertex of the first cross-section with the code indicated in the list. If there is no code, the cut will be vertical.

Parameters

Organic Soil Thickness: Sets the organic soil value for the volume measurement calculation.

Minimum surface: Sets the minimum surface admissible on the list. Any values that are lower are considered as zero.

Calculation Methods

There are two different methods to calculate the volume associated to a cutting, fill or organic soil. If the ***Correction for Curvature*** check box is activated, the program will request a horizontal alignment file to perform the relevant calculations.

Average Area Method

In this case, the volume is calculated using the following formula:

$$V = \frac{H}{2}(A_1 + A_2)$$

where:

V = Volume between the current and the previous station.

H = Interval between the previous and the current station.

A_1 = Surface of the previous station.

A_2 = Surface of the current station.

Prismatoid Method

In this case, the formula is as follows:

$$V = \frac{H}{3}(A_1 + \sqrt{A_1 \cdot A_2} + A_2)$$

where:

V = Volume between the current and the previous station.

H = Interval between the previous and the current station.

A_1 = Surface of the previous station.

A_2 = Surface of the current station.

Accumulated Volume

These values are assigned to the respective volumes, so that they already have this value at the initial station on the list.

Cutting: Accumulated cutting value. MDT will start off with the value entered in this field as the cutting value.

Fill: As above, but for fills.

Organic Soil: Same as above, but for organic soil.

Factors

These values are factors which multiply the values calculated for the respective surfaces. They can be used to consider the bulking or compacting of earth when making volume measurement calculations.

Cutting: Multiplying factor for the cutting surface.

Fill: Multiplying factor for the fill surface.

Types of List

Normal: In this case, a list containing each profile's surface and volume calculations is displayed.

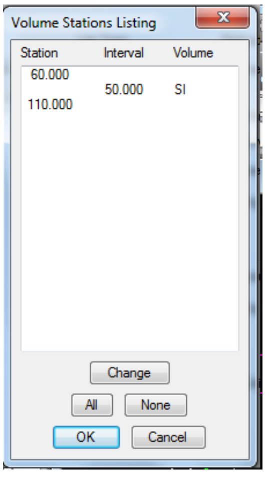
Accumulated: In this case, the accumulated surfaces and volumes for every two stations up to the current station are displayed on the list.

Once the dialog box is validated, the following list is displayed showing the final volume measurement (net difference).

Cubic measurement intervals

This option is used to exclude the calculation of particular areas that are not of interest to calculate, because, for example, they correspond with an intermediate area where there is really no terrain to apply cubic measurements.

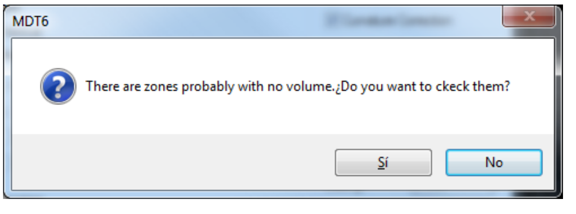
When this option is activated the following window is displayed:



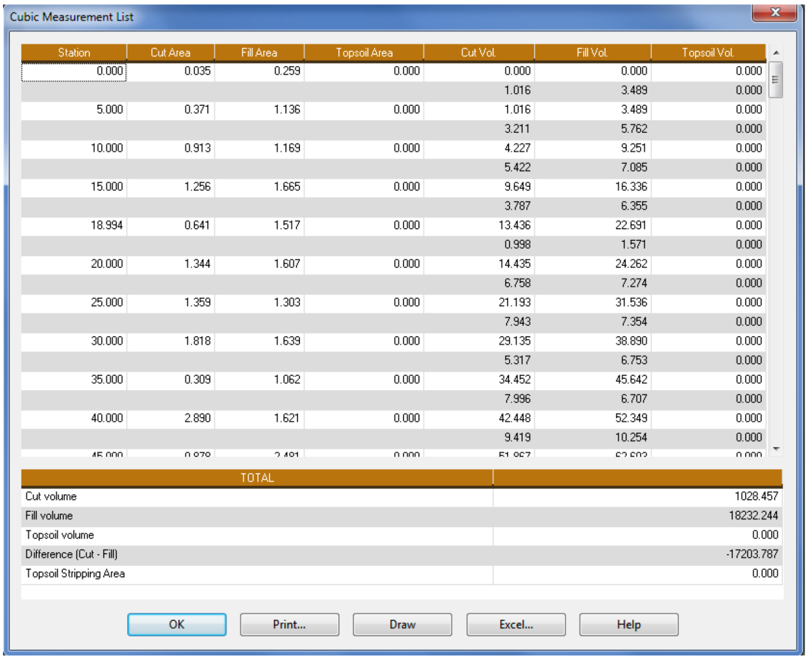
Double click on the interval, or select and click the ***Change*** button to include or exclude the cubic measurement.

The options ***All*** and ***None*** are used to include and exclude, respectively, all the cubic measurement intervals.

Also, if there are areas that should not be included for cubic measurements, for example the interval between station 189.4 and 960 and this option is not accessed, when the cubic measurement window is validated, the program will display the following message to give notification of the incident.



Once the dialog box is validated, the following list is displayed showing the final volume measurement.



Station	Cut Area	Fill Area	Topsoil Area	Cut Vol.	Fill Vol.	Topsoil Vol.
0.000	0.035	0.259	0.000	0.000	0.000	0.000
				1.016	3.489	0.000
5.000	0.371	1.136	0.000	1.016	3.489	0.000
				3.211	5.762	0.000
10.000	0.913	1.169	0.000	4.227	9.251	0.000
				5.422	7.085	0.000
15.000	1.256	1.665	0.000	9.649	16.336	0.000
				3.787	6.355	0.000
18.994	0.641	1.517	0.000	13.436	22.691	0.000
				0.998	1.571	0.000
20.000	1.344	1.607	0.000	14.435	24.262	0.000
				6.758	7.274	0.000
25.000	1.359	1.303	0.000	21.193	31.536	0.000
				7.943	7.354	0.000
30.000	1.818	1.639	0.000	29.135	38.890	0.000
				5.317	6.753	0.000
35.000	0.309	1.062	0.000	34.452	45.642	0.000
				7.996	6.707	0.000
40.000	2.890	1.621	0.000	42.448	52.349	0.000
				9.419	10.254	0.000

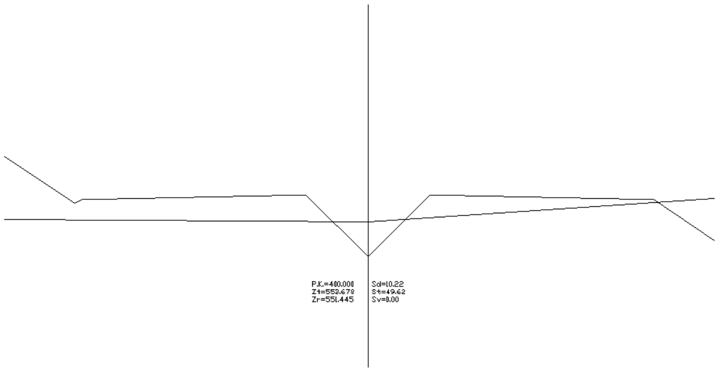
TOTAL	
Cut volume	1028.457
Fill volume	18232.244
Topsoil volume	0.000
Difference (Cut - Fill)	-17203.787
Topsoil Stripping Area	0.000

For each station, the report contains the cutting and fill surfaces, the distances between profiles, as well as the partial and accumulated volumes

The totals appear in the last line, along with the cutting and fill surface difference.

This list can be modified manually by changing the surfaces result and displaying the final result on subsequent lists.

The dialog box offers the possibility of selecting ***Draw*** and, if the button is clicked, the segment will be drawn (see **Draw Cross-Sections** in the **Cross-Sections** section).



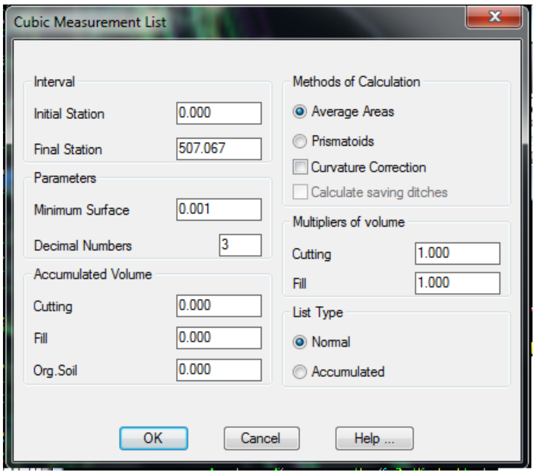
In addition, clicking on the ***Excel*** button sends all the list information to an Excel spreadsheet. The totals are introduced on the spreadsheet with a formula that modifies the end result if any of the values are modified.

Cubic Measurement Report

This command generates a complete list of the surface areas and volumes in a segment. It displays the cutting, fill and organic soil surface areas and volumes by station, as well as their accumulated values.

MDT initially requests the segment file containing all the project's information (see **Definition of Segment** in the **Alignments** section), in other words, information on the grade line, the natural terrain, cross-section template, etc. Once it is selected, the following dialog box is displayed where the parameters of the list one wishes to obtain are set.

The dialog box's characteristics and functionalities are described below.



Initial Station: Station from which the volume measurement will be calculated.

Final Station. Station up to which the volume measurement will be calculated.

Minimum Surface: Sets the minimum surface area admissible on the list. Any values that are lower are considered as zero. It is used to prevent accuracy or rounding off errors that could lead to confusing results.

Number of Decimals: Sets the number of decimals with which one wishes the volume measurement calculations to be displayed.

Accumulated volume

These values are assigned to the respective volumes, so the initial station on the list has this initial value.

Cutting: Accumulated cutting value. MDT will start off with the value entered in this field as the cutting value.

Fill: As above, but for fills.

Organic Soil: Same as above, but for organic soil.

Calculation Methods

There are two different methods to calculate the volume associated to a cutting, fill or organic soil.

Average Area Method

In this case, the volume is calculated using the following formula:

$$V = \frac{H}{2}(A_1 + A_2)$$

where:

V = Volume between the current and the previous station.

H = Interval between the previous and the current station.

A_1 = Surface of the previous station.

A_2 = Surface of the current station.

Prismatoid Method

In this case, the formula is as follows:

$$V = \frac{H}{3}(A_1 + \sqrt{A_1 \cdot A_2} + A_2)$$

where:

V = Volume between the current and the previous station.

H = Interval between the previous and the current station.

A_1 = Surface of the previous station.

A_2 = Surface of the current station.

Curvature Correction

If this box is marked, the impact of curvature when calculating the volumes is taken into account. The formula employed is as follows:

$$C_c = \frac{H}{2 \cdot R}(A_1 \cdot E_1 + A_2 \cdot E_2)$$

where:

C_C = Curvature correction to be added to the total volume

H = Interval between the previous and the current station.

R = Radius of the curve.

A_1 = Surface of the previous station.

A_2 = Surface of the current station.

E_1 = Distance from the previous profile's centre of gravity to the horizontal alignment

E_2 = Distance from the current profile's centre of gravity to the horizontal alignment

In order to calculate a profile's centre of gravity, a traverse containing all the vectors of the natural terrain and the profile generated is constructed. Then the following formula is applied:

$$C_x = \frac{\sum_{i=1}^{n} d_i}{n} \qquad C_y = \frac{\sum_{i=1}^{n} z_i}{n}$$

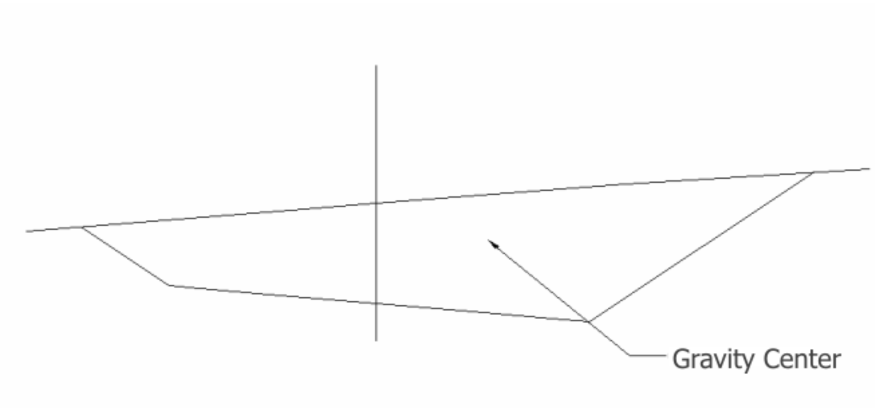
where:

C_x, C_y = X and Y coordinates of the centre of gravity

d_i = Distance from vertex i to the horizontal alignment

z_i = Surface of the previous station.

From this calculation, E is assigned the value of C_x, with its corresponding sign.



Saving ditch

If there are saving ditches defined in the segment, by activating this option the program will automatically calculate the total volume of this element definition.

Factors

These values are factors which multiply the values calculated for the respective surfaces. They can be used to consider the bulking or compacting of earth when making volume measurement calculations.

Cutting: Multiplying factor for the cutting surface.

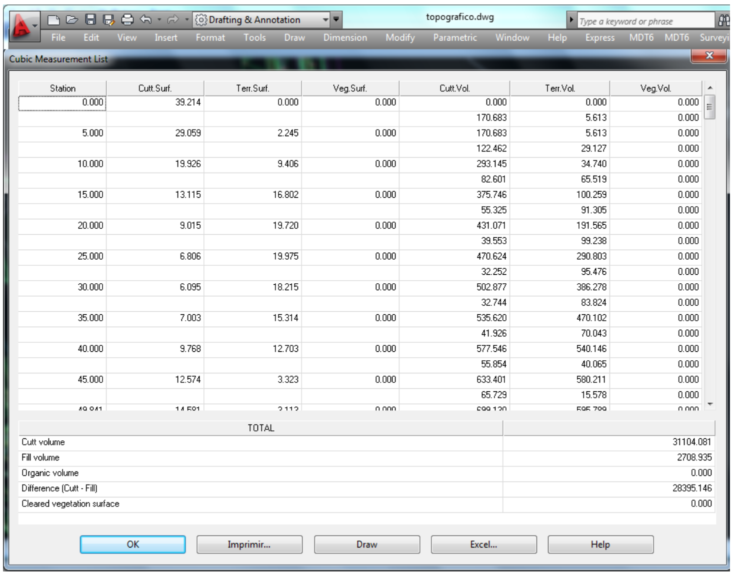
Fill: Multiplying factor for the fill surface.

Types of List

Normal: In this case, a list containing each profile's surface and volume calculations is displayed.

Accumulated: In this case, the accumulated surfaces and volumes for every two stations up to the current station are displayed on the list.

Once the dialog box is validated, the following list is displayed showing the final volume measurement (net difference).



When the dialog box is finalized, totals along with the difference between cutting and fill will be displayed.

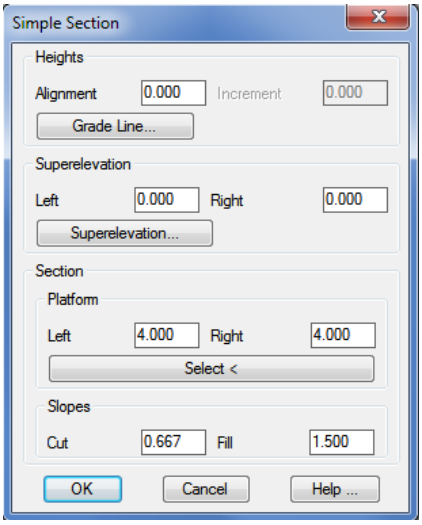
The dialog box offers one the possibility of using the ***Draw*** button. If this button is clicked, the segment will be drawn (see **Draw Cross-Sections** in the **Cross-Sections** section).

In addition, clicking on the ***Excel*** button sends all the list information to an Excel spreadsheet. The totals are introduced on the spreadsheet with a formula that modifies the end result if any of the values are modified.

Volume by Simple Selection

This command is of enormous use for generating a cross-section file with a cross-section template that can be quickly associated without the need to carry out the entire template definition process.

To do this, at first the program requests the natural terrain cross-section to serve as a pattern for generating profiles, then the following window is displayed for specifying the characteristics of the final terrain.



Height: We can opt to set the horizontal alignment height or extract the height from the selected grade line. Also, if we select the grade line file, we can apply a positive or negative height increase for the station to be set out.

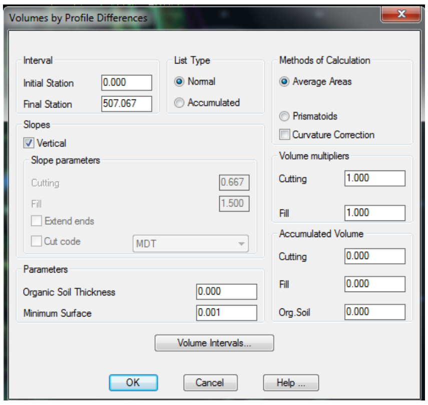
Superelevation: This is to indicate the superelevations to apply to both sides of the horizontal alignment.

Section: To indicate the basic characteristics of our section.

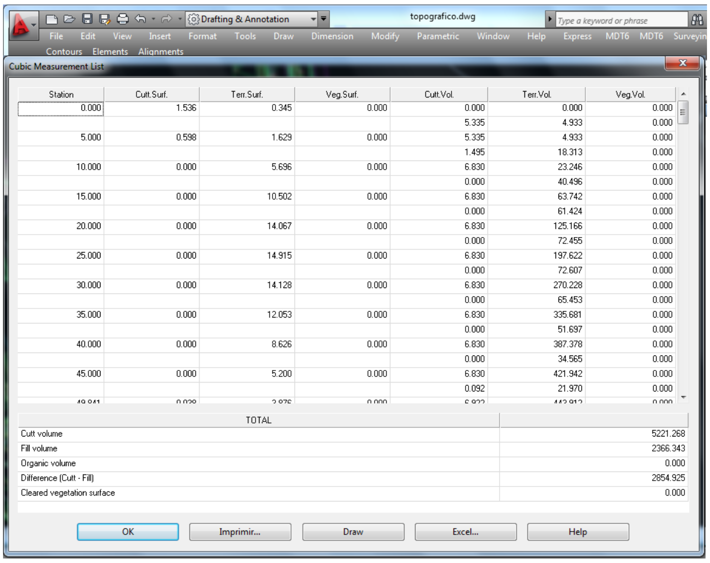
- **Platform**: There are two options for defining the platform:
  - Indicating the width on each side of the platform.
  - Designating a polyline which represents the platform; this polyline may feature as many vertices as necessary. There should be one vertex in the horizontal alignment position.

- **Slopes**: Slopes to apply in the case of cutting or fill.

Once the values of what will be a simulation of our road with its section have been introduced, the program will request the type of list to be made, as well as a series of parameters that are necessary for the calculation. These parameters are described in the section **Volume by Profile difference.**



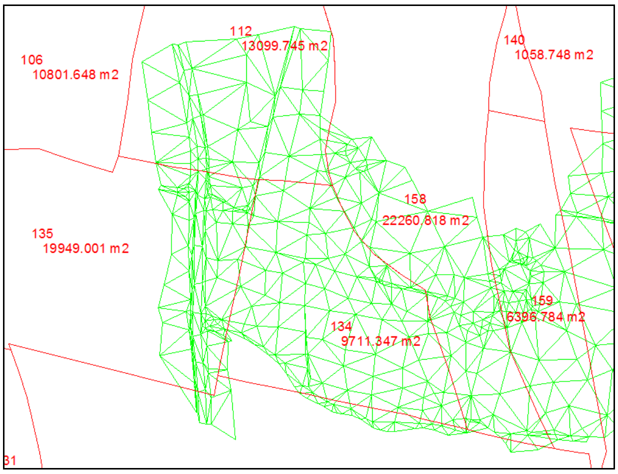
Once this window is validated, it displays a list similar to the cubic measurement list showing all the information on the surfaces and volumes calculated, with the option to send the list to a printer or draw the profiles.



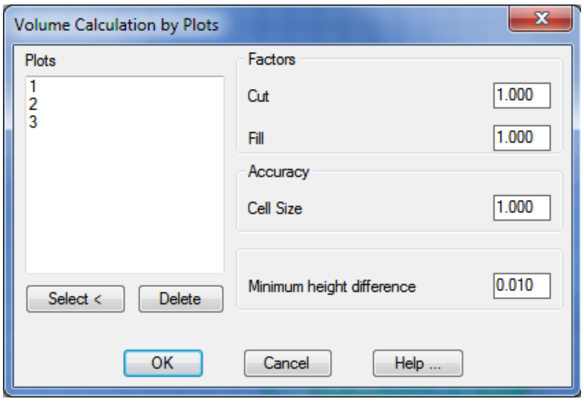
Volume by Plots PRO

This command enables us to calculate the volume of a group of plots from two surfaces.

On executing the command, MDT automatically reads all the plots featured in the drawing (to define plots, go to the Plots section in the reference manual), in the event there are no plots in the drawing the command will end, reason for which the plots to be analysed need to be defined before executing this command.



Once the plots featured in the drawing have been detected, the following window will appear, and which we will describe below:



Plots: Name of the plots detected in the drawing the volume of which is to be calculated. Plots may be "**Selected**" or "**Deleted**" with the aim of customising the list.

Factors: These values are factors which multiply the calculated values of the respective surfaces. They may be used to take into account the fluffing or compacting of earth in the calculation of the volume.

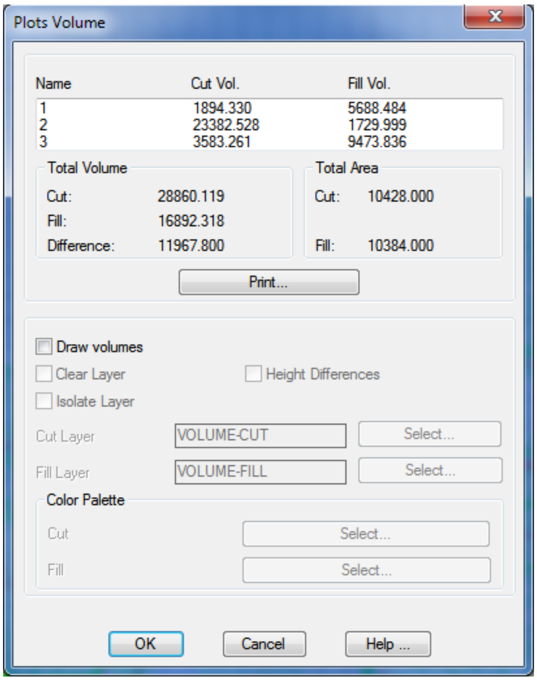
Cut: Multiplying factor of the cut surface.

Fill: Multiplying factor of the fill surface.

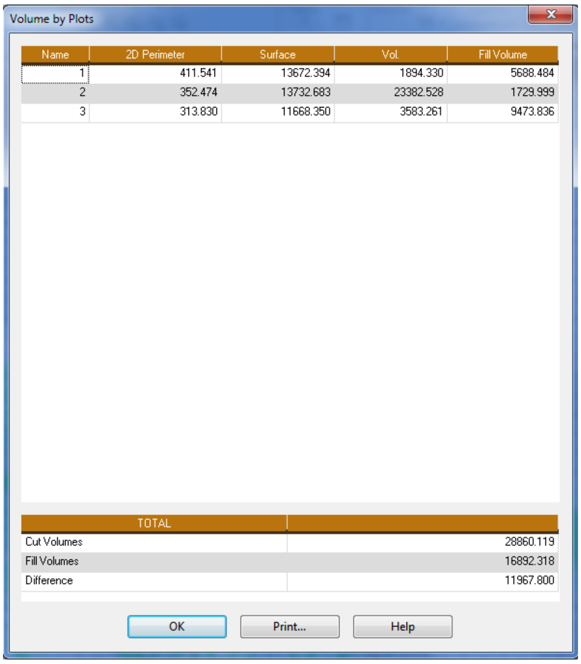
Size of the cell: To calculate the volume, MDT generates internally a mesh for each surface; this value refers to the size of the cell with which the mesh is to be created.

Minimum height difference. The minimum difference, in metres, at which the volume is calculated. In other words, in areas in which the difference in height between the two surfaces is less than this parameter, the volume of the surface will not be calculated and this area will be regarded as void or zero.

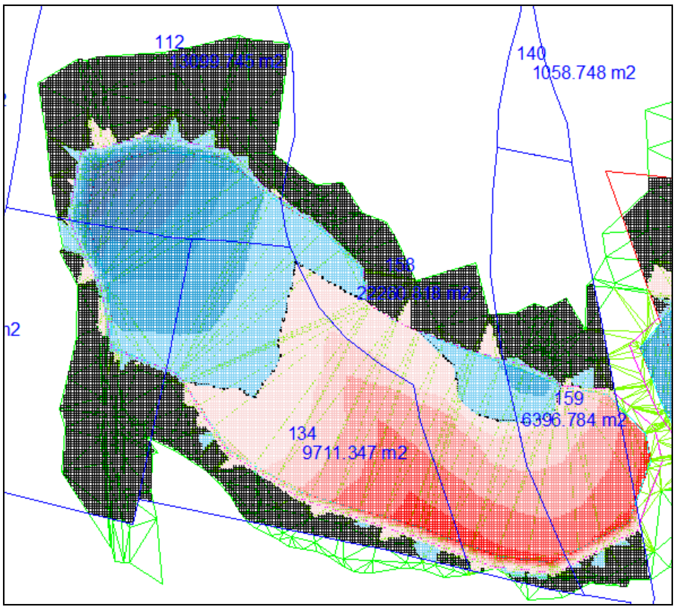
Clicking on this window will display all the information on the calculation of the volume of each of the plots.



The ***Print*** button creates a list featuring the names of the plots and the information on the cubic measurement of each one:



Activating the ***Draw Volumes*** box will provide a graphic representation of the results, consisting of a mesh located only in the area in which both mesh files are defined. Each cell will have a colour indicating if the area is in cut, fill, or does not possess a volume within the limits defined in the settings. A range of colours may be assigned to both the cut and the fill; for this we have the option of selecting the corresponding colour palette.

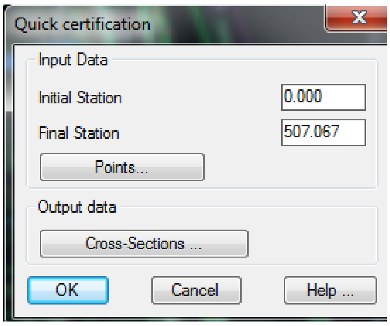


Moreover, if we activate the ***Differences in Heights*** box in each cut or fill cell, a text will appear with the difference in height between the meshes.

Quick Certification PRO

This command is of great use, since it allows one to rapidly calculate the quantity and percentage of the work executed from a file of points taken from the platform. These points do not have to coincide with stations, since the program interpolates the rest of the information. For each profile, it estimates the percentage executed from the cutting and fill heights.

The program initially requests the ***Segment*** containing the complete road information, requesting the roadbed layer for which to make the calculation whenever a roadbed layer definition exists in the selected segment. Next the following dialog box is displayed for entering the rest of the parameters for the calculation:

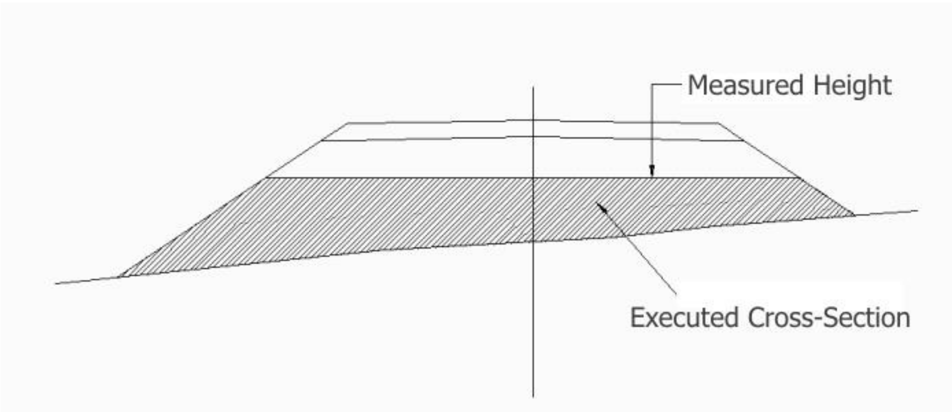


Initial Station: Initial station from which the calculation is made.

Final station: Station up to which the calculation is made.

Points: Points file taken from the current state of the works.

Cross-sections: Cross-sections file where the program will save the current state of the works. MDT will analyse the points of the segment introduced and make a by-station estimate of the works executed.



The following is an example of the list. A description of the characteristics of each of the columns appears below:

Station: Station analysed.

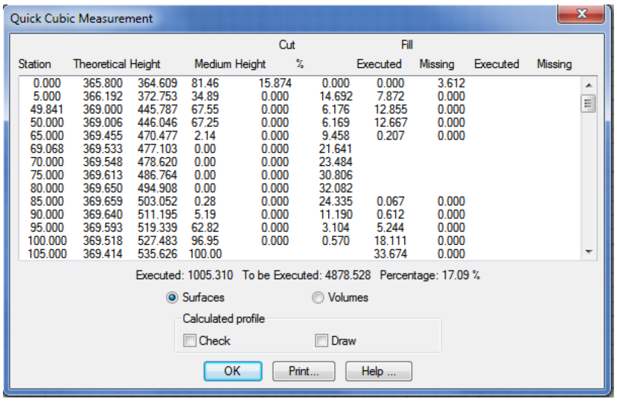
Theoretical Height: Height that should be reached when executing the works at the previous station.

Height: Height of the current terrain.

Executed: Surface or volume executed according to the previous height.

Pending: Surface or volume pending execution.

All these values are indicated for cutting and fills. The end of the list displays the amount of square or cubic (volume) meters executed and pending, along with the survey percentage completed.



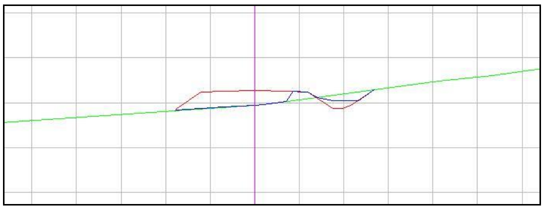
Station	Theoretical Height	Medium Height	%	Executed	Missing	Executed	Missing
0.000	365.800	364.609	81.46	15.874	0.000	0.000	3.612
5.000	366.192	372.753	34.89	0.000	14.692	7.872	0.000
49.841	369.000	445.787	67.55	0.000	6.176	12.855	0.000
50.000	369.006	446.046	67.25	0.000	6.169	12.667	0.000
65.000	369.455	470.477	2.14	0.000	9.458	0.207	0.000
69.068	369.533	477.103	0.00	0.000	21.641		
70.000	369.548	478.620	0.00	0.000	23.484		
75.000	369.613	486.764	0.00	0.000	30.806		
80.000	369.650	494.908	0.00	0.000	32.082		
85.000	369.659	503.052	0.28	0.000	24.335	0.067	0.000
90.000	369.640	511.195	5.19	0.000	11.190	0.612	0.000
95.000	369.593	519.339	62.82	0.000	3.104	5.244	0.000
100.000	369.518	527.483	96.95	0.000	0.570	18.111	0.000
105.000	369.414	535.626	100.00			33.674	0.000

One can specify that the results displayed on the list should be expressed in surface or volume units.

Additionally, the list also contains a series of controls whose features are described below:

Print: It sends the list to the system printer or a text file.

After validating the list, it is possible to draw the segment selected with the cross-sections of the current state of the terrain created from the selected points.



Executed Work

This command operates exactly the same way as **Quick Certification**_only that instead of requesting a points file to verify the current state of the terrain, it requests a cross-section file.

The command first requests the segment from which to make the calculation, then the cross-section file of the current state of the terrain and finally the roadbed layer (if defined in the segment) for which the comparison will be made.

Last it displays the list and describes the characteristics with a description of each column:

Station: Station analysed.

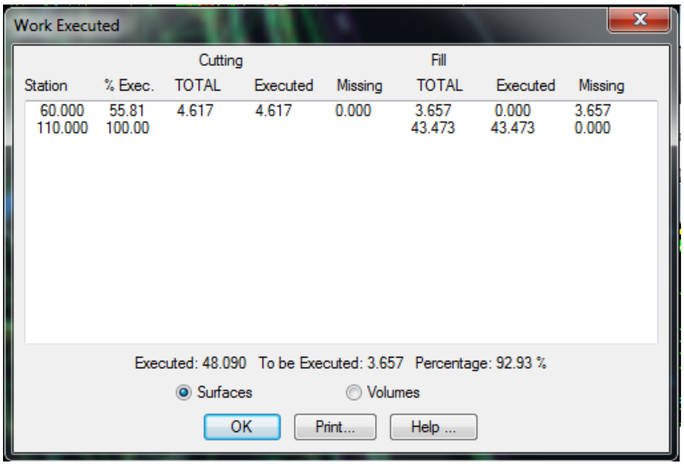
Theoretical Height: Height that should be reached when executing the works at the previous station.

Height: Height of the current terrain.

Executed: Surface or volume executed according to the previous height.

Missing: Surface or volume pending execution.

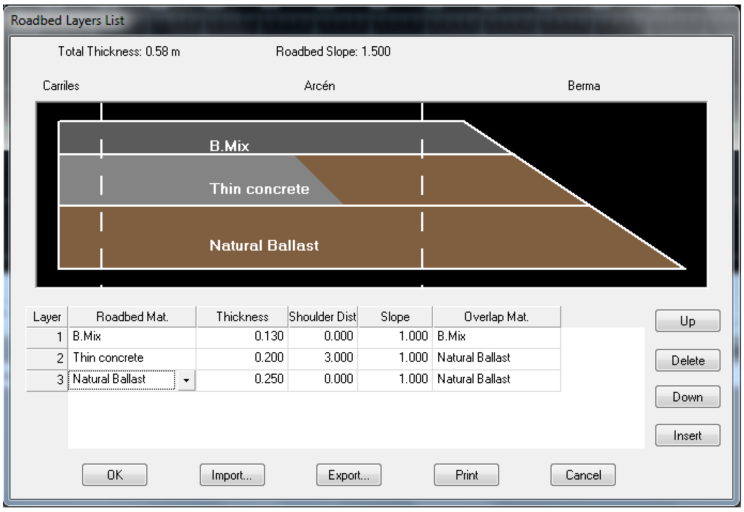
All these values are indicated for cutting and fills. The end of the list displays the amount of square or cubic (volume) meters executed and pending, along with the survey percentage completed.



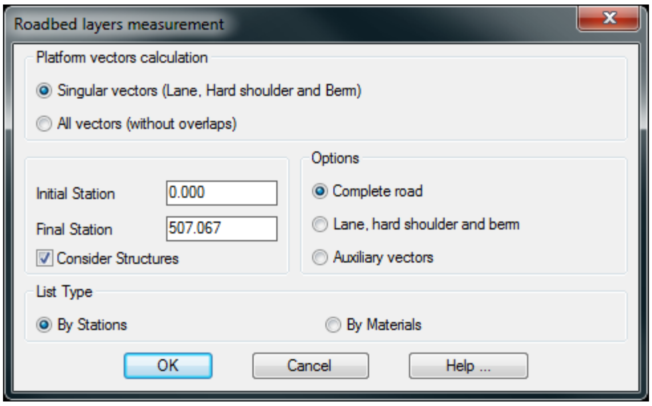
Roadbed Layer Measurements Report

This command calculates the volume of each roadbed layer, as well as of the remaining volume of the cross-sections defined in the segment.

To achieve this, the roadbed layers definition should have been included in the roadbeds assigned to the segment when it was previously defined. Consult the **Roadbed Layers** option in the **Cross-Section Templates** section. The following image shows an example of roadbed layers defined in the section.



Once the segment is selected, MDT displays the following dialog box to configure the type of list to generate.



Platform vectors calculation:

Two options are available:

Singular Vectors: If this option is activated, cubic measurements can be taken separately according to the instructions in the section "Calculate" as given below.

All vectors: Cubic measurements for all vectors as a set in terms of the defined roadbed layers, independently of the types of vectors defined in the platform.

Options:

Complete road: Cubic measurements for all vectors, singular (lane, hard shoulder and berm) and the other platform vectors for which roadbed layers have been defined.

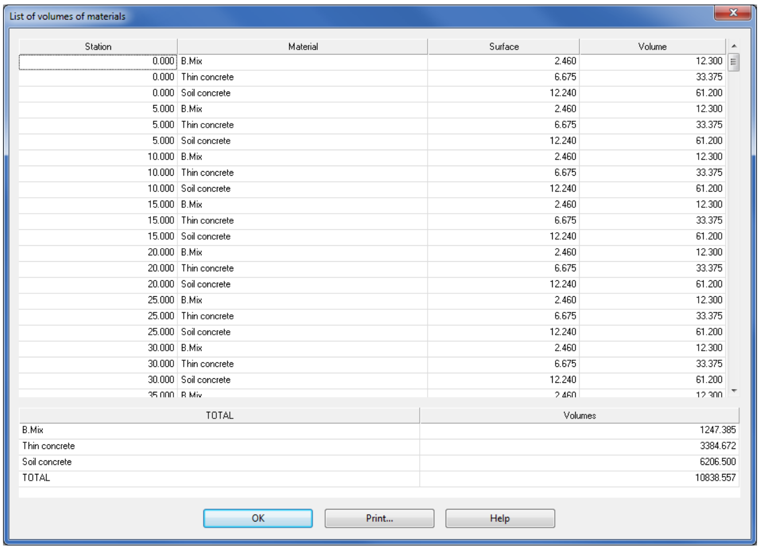
Lane, hard shoulder and berm: Cubic measurements of only singular vectors ignoring the definitions that auxiliary vectors may have.

Auxiliary vectors: Cubic measurement of only auxiliary vectors defined for layers of roadbed.

Consider Structures: Only applicable in the event that there are structures defined in the template. In this case and this option is enabled, the stations to be found within a structure the volume will be determined in the same way. If it is not enabled, the volume of these stations will not be determined.

List Type: The lists can be shown well organised by stations or materials

Once the previous dialog box has been validated the following list is displayed, showing the calculations by stations and the name of the roadbed layer.



Station	Material	Surface	Volume
0.000	B.Mix	2.460	12.300
0.000	Thin concrete	6.675	33.375
0.000	Soil concrete	12.240	61.200
5.000	B.Mix	2.460	12.300
5.000	Thin concrete	6.675	33.375
5.000	Soil concrete	12.240	61.200
10.000	B.Mix	2.460	12.300
10.000	Thin concrete	6.675	33.375
10.000	Soil concrete	12.240	61.200
15.000	B.Mix	2.460	12.300
15.000	Thin concrete	6.675	33.375
15.000	Soil concrete	12.240	61.200
20.000	B.Mix	2.460	12.300
20.000	Thin concrete	6.675	33.375
20.000	Soil concrete	12.240	61.200
25.000	B.Mix	2.460	12.300
25.000	Thin concrete	6.675	33.375
25.000	Soil concrete	12.240	61.200
30.000	B.Mix	2.460	12.300
30.000	Thin concrete	6.675	33.375
30.000	Soil concrete	12.240	61.200
35.000	B.Mix	2.460	12.300

TOTAL	Volumes
B.Mix	1247.385
Thin concrete	3384.672
Soil concrete	6206.500
TOTAL	10838.557

Optionally this window allows for different operations:

Print: Sends the list content to the system printer or to a text file.

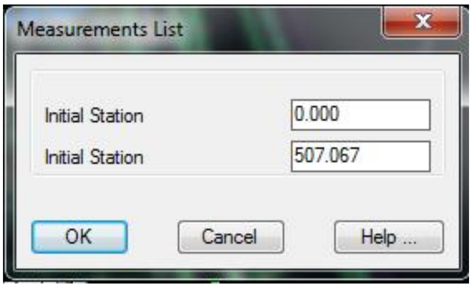
If the command is executed with a segment that has no defined roadbed layers, it will not display the list indicated.

Additionally, the swelling factor of each of the materials is accounted for as a calculation multiplier for calculating the corresponding volume.

By default all the materials are configured with a swell factor of 1.

Roadbed Measurements Report PRO

With this option, the program generates a list of measurements of the selected segment. Initially it requests the segment or road previously defined then with the below window we indicate the stations between which the calculation will be made.



It includes the stations in each cross-section together with the following measurements:

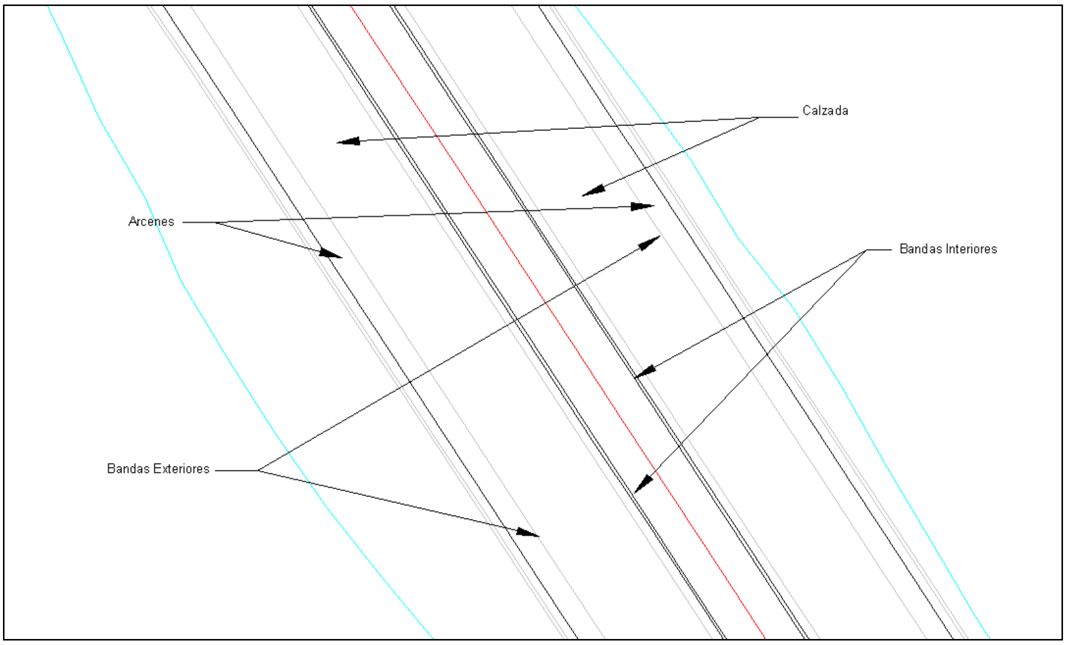
Length of the Internal Bands (LIB): This is the sum of the lengths of the lines defining the median ends between two consecutive stations.

Length of the Left and Right-Hand External Bands (LBEI, LBED): It is the length of the line separating the road and the hard shoulder on the left or right of the horizontal alignment between two consecutive stations.

Road Surfaces (Rd.Surf.): It is the sum of the surfaces of the road to the left and right of the horizontal alignment and the surface of the internal hard shoulders between two consecutive stations.

Surface of Left and Right-Hand Shoulders. (Surf.R.Shld. L.Shld) It is the surface of the external hard shoulder to the left or right of the horizontal alignment between two consecutive stations on the list.

Roadbed volume (Rd.Bd.Vol.): It is the volume of the roadbed between two consecutive stations on the list.



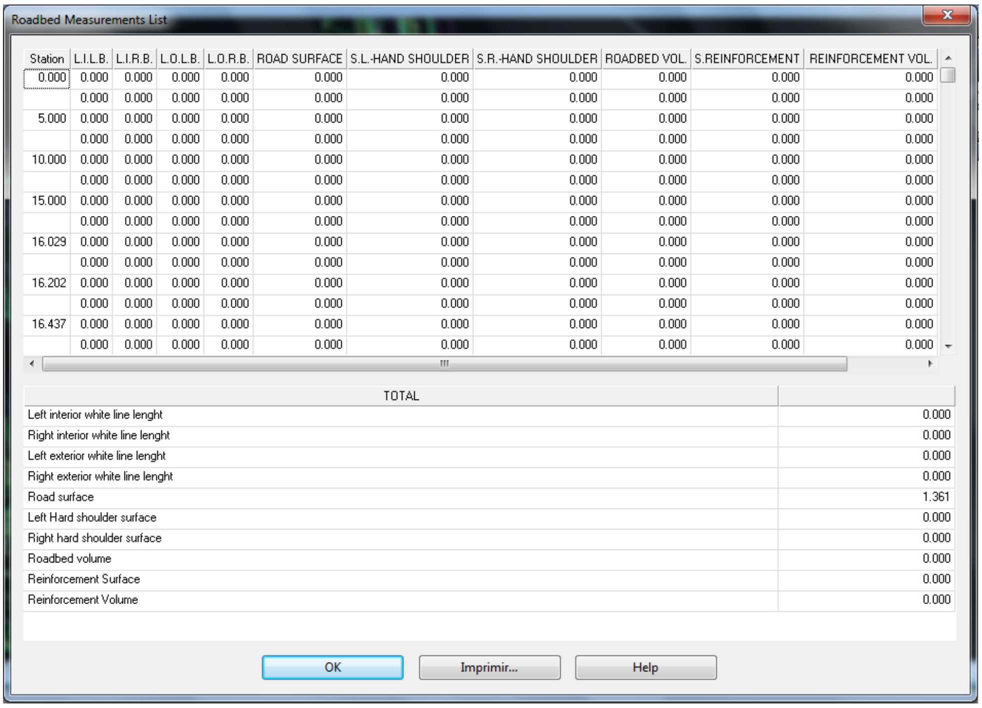
Reinforcements

If the existing roadbed is used, the program also calculates the volume measurement of the reinforcement layers. In order to do so, the reinforcement layers should have been previously defined to the segment selected (see **Definition of Roadbeds** in the **Cross-Section Templates** section) Should this be the case, the following parameters are displayed:

Surface of Reinforcements (S.Ref.): It is the surface between the reinforcement marks and two consecutive stations.

Volume of Reinforcement (Vol.Ref.): It is the volume of the reinforcement between two consecutive stations.

The program initially requests the segment containing the cross-section defined. One then has to enter the station interval, as well as choose whether ***Normal*** or ***Accumulated*** list is desired. Lastly, the resulting list is displayed.


Roadbed Measurements List

Station	L.I.L.B.	L.I.R.B.	L.O.L.B.	L.O.R.B.	ROAD SURFACE	S.L.-HAND SHOULDER	S.R.-HAND SHOULDER	ROADBED VOL.	S.REINFORCEMENT	REINFORCEMENT VOL.
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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.029	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.202	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16.437	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	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TOTAL	
Left interior white line lenght	0.000
Right interior white line lenght	0.000
Left exterior white line lenght	0.000
Right exterior white line lenght	0.000
Road surface	1.361
Left Hard shoulder surface	0.000
Right hard shoulder surface	0.000
Roadbed volume	0.000
Reinforcement Surface	0.000
Reinforcement Volume	0.000

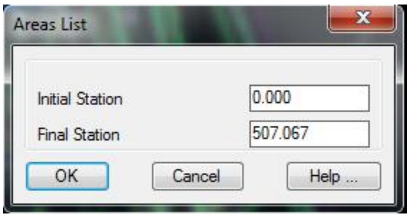
OK Imprimir... Help

The information can be sent to the system printer or exported to an Excel spreadsheet from this window.

Areas Report PRO

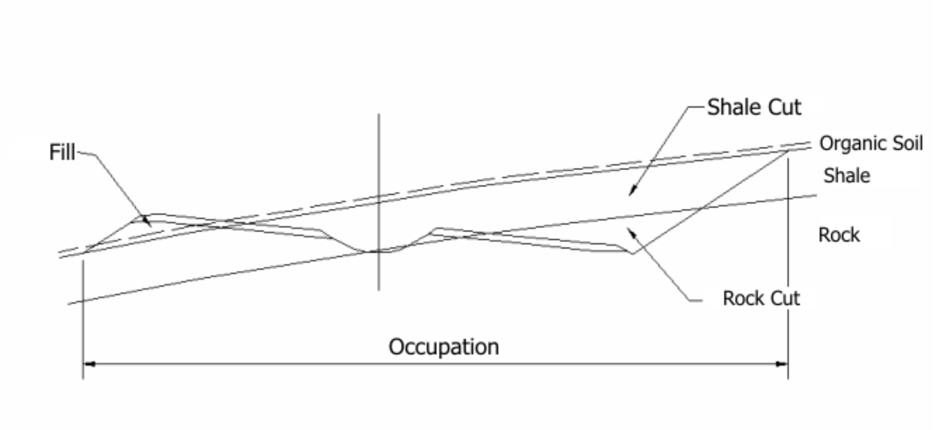
When this command is executed, a complete report of the areas contained in a specific segment is displayed.

MDT initially requests a segment (see **Definition of Segments** in the **Horizontal Alignments** section) and then requests the initial and final stations that will delimit the list.



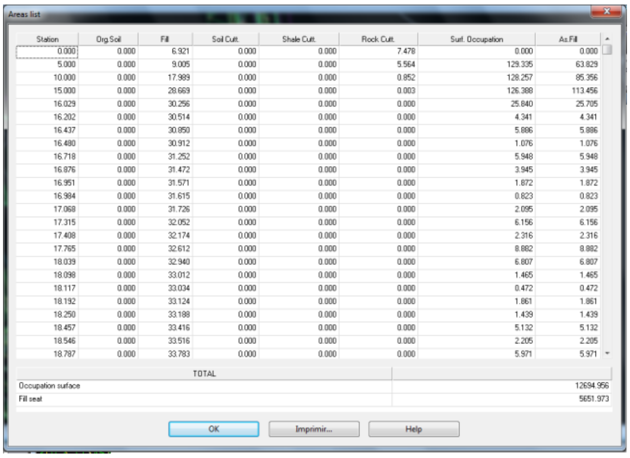
Finally, a dialog box is displayed containing a report for organic soil, cutting, fill and occupation surfaces for each station. The cutting is in turn divided into soil, transit and rock. The sum of these latter three surfaces will be equal to the total cutting surface.

The definition of the soil, transit and rock thickness values is done through the **Assignment of Templates to Alignment** command**,** more specifically using the **Assignment of Geology** section, where the thickness of each is set. The sum of the three will be equal to the total cutting surface.



Occupation surface is the width of the section developed multiplied by the difference between the current and the previous section.

The window where the list is displayed appears below.



Areas list

Station	Org.Soil	Fill	Soil Cutt.	Shale Cutt.	Rock Cutt.	Surf. Occupation	As.Fill
0.000	0.000	6.921	0.000	0.000	7.478	0.000	0.000
5.000	0.000	9.005	0.000	0.000	5.564	129.335	63.829
10.000	0.000	17.989	0.000	0.000	0.852	128.257	85.356
15.000	0.000	28.669	0.000	0.000	0.003	126.388	113.456
16.029	0.000	30.256	0.000	0.000	0.000	25.840	25.705
16.202	0.000	30.514	0.000	0.000	0.000	4.341	4.341
16.437	0.000	30.850	0.000	0.000	0.000	5.886	5.886
16.480	0.000	30.912	0.000	0.000	0.000	1.076	1.076
16.718	0.000	31.252	0.000	0.000	0.000	5.948	5.948
16.876	0.000	31.472	0.000	0.000	0.000	3.945	3.945
16.951	0.000	31.571	0.000	0.000	0.000	1.872	1.872
16.984	0.000	31.615	0.000	0.000	0.000	0.823	0.823
17.068	0.000	31.726	0.000	0.000	0.000	2.095	2.095
17.315	0.000	32.052	0.000	0.000	0.000	6.156	6.156
17.408	0.000	32.174	0.000	0.000	0.000	2.316	2.316
17.765	0.000	32.612	0.000	0.000	0.000	8.882	8.882
18.039	0.000	32.940	0.000	0.000	0.000	6.807	6.807
18.098	0.000	33.012	0.000	0.000	0.000	1.465	1.465
18.117	0.000	33.034	0.000	0.000	0.000	0.472	0.472
18.192	0.000	33.124	0.000	0.000	0.000	1.861	1.861
18.250	0.000	33.188	0.000	0.000	0.000	1.439	1.439
18.457	0.000	33.416	0.000	0.000	0.000	5.132	5.132
18.546	0.000	33.516	0.000	0.000	0.000	2.205	2.205
18.787	0.000	33.783	0.000	0.000	0.000	5.971	5.971

TOTAL	
Occupation surface	12694.956
Fill seat	5651.973

OK Imprimir... Help

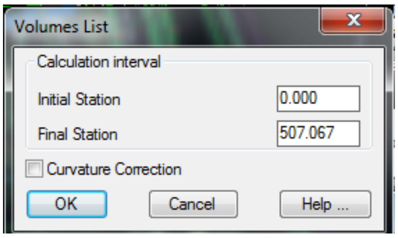
At the end of the list it shows the **Occupation surface** and the **Fill seat**.

Print: Sends the list's contents to the system printer. It can also be sent to an ASCII file.

Volumes Report PRO

In this case, MDT will provide a complete volumes list from a segment.

The program initially requests the segment, as well as the initial and final stations on the list and gives the option to apply the curvature correction, in this last case.



Next it will display a list with the following characteristics:

Station: station analysed.

Fill: Volume of fill.

Soil. Cut: Cut volume of geological Soil layer.

Shale. Cut: Cut volume of geological Shale layer.

Rock. Cut: Cut volume of geological Rock layer.

Org. Soil: Volume of Organic Soil.

Veg. Cut.: Volume of Organic Soil in cutting.

Veg. Fill.: Volume of Organic Soil in fill.

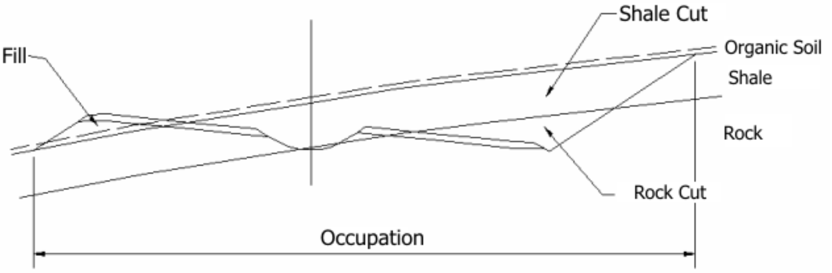
Routing: Volume of routing defined in the section.

The following is a list resulting from executing the command.

Volumes List
07/07/011

Station	Fill	Soil Cutt.	Shale Cutt.	Rock Cutt.	Org.Soil	Veg.Cut	Veg.Fill	Routing
5.000	43.996	0.000	0.000	32.431	0.000	0.000	0.000	0.000
10.000	76.718	0.000	0.000	15.924	0.000	0.000	0.000	0.000
15.000	132.236	0.000	0.000	2.101	0.000	0.000	0.000	0.000
20.000	177.419	0.000	0.000	0.005	0.000	0.000	0.000	0.000
25.000	197.588	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30.000	197.551	0.000	0.000	0.000	0.000	0.000	0.000	0.000
35.000	182.877	0.000	0.000	0.000	0.000	0.000	0.000	0.000
40.000	154.329	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45.000	120.160	0.000	0.000	0.000	0.000	0.000	0.000	0.000
49.841	95.286	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50.000	2.949	0.000	0.000	0.000	0.000	0.000	0.000	0.000
55.000	81.937	0.000	0.000	0.000	0.000	0.000	0.000	0.000
58.841	48.598	0.000	0.000	0.038	0.000	0.000	0.000	0.000
60.000	12.379	0.000	0.000	0.073	0.000	0.000	0.000	0.000
65.000	42.480	0.000	0.000	6.951	0.000	0.000	0.000	0.000
69.068	25.090	0.000	0.000	26.743	0.000	0.000	0.000	0.000
70.000	5.247	0.000	0.000	10.313	0.000	0.000	0.000	0.000
75.000	27.178	0.000	0.000	68.786	0.000	0.000	0.000	0.000
80.000	27.162	0.000	0.000	78.844	0.000	0.000	0.000	0.000
85.000	32.842	0.000	0.000	64.367	0.000	0.000	0.000	0.000
90.000	46.573	0.000	0.000	34.925	0.000	0.000	0.000	0.000
95.000	72.617	0.000	0.000	10.177	0.000	0.000	0.000	0.000
100.000	122.993	0.000	0.000	0.420	0.000	0.000	0.000	0.000
105.000	196.087	0.000	0.000	0.000	0.000	0.000	0.000	0.000
110.000	256.613	0.000	0.000	0.000	0.000	0.000	0.000	0.000
114.722	257.808	0.000	0.000	0.000	0.000	0.000	0.000	0.000

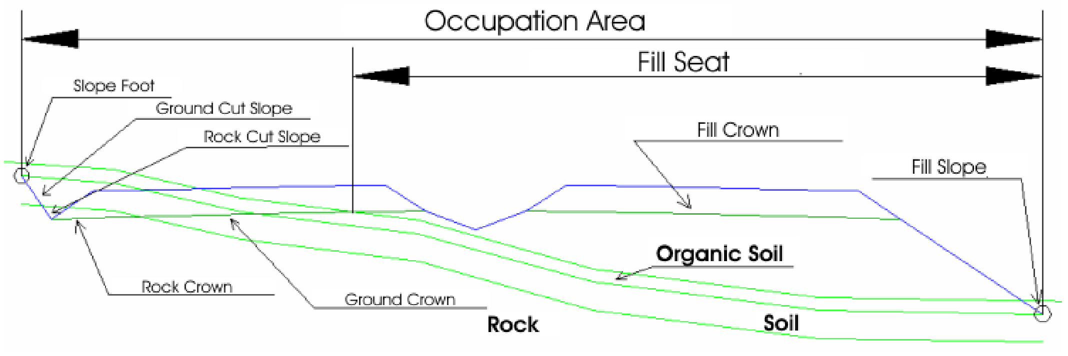
Lastly, the totals obtained from the volume calculations are displayed. The possibility also exists of printing its contents or exporting them to an Excel spreadsheet.



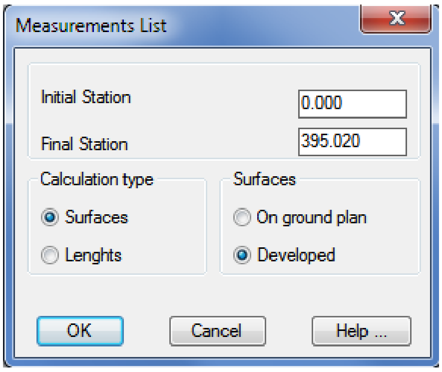
Cross-Section Measurements Report

This command enables us to obtain two different types of list, of the length of the elements of the completed road or of the surfaces developed or in the cut and fill crown plan. Furthermore, it shows the surfaces developed in the fill, soil, rock and transit slope plan.

The following diagram illustrates the meaning of the measurement data.



MDT initially requests the segment where the cross-section is defined. The following dialog box is displayed, where one sets the list desired.



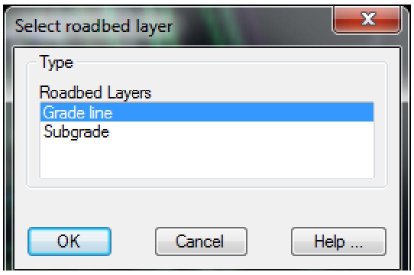
Initial station: Station from which one wishes to create the list.

Final station: Station up to which we wish to create the list.

Type: The type of list to be created is set. It can be either with ***Accumulated*** values or not (***Reduced*** check box).

Surfaces: Selecting "Surfaces" enables us to see if the list to be generated features ground plan or raised surfaces, in other words, a developed surface or a ground plan surface.

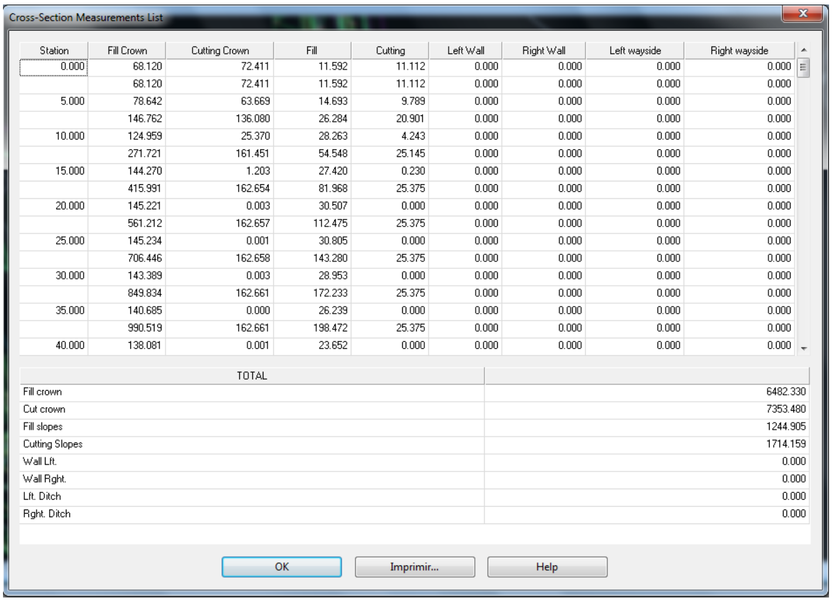
Once the dialog box has been validated a segment must be selected with roadbed or layers of associated roadbed. A window will appear in which we select the roadbed layer from which we wish to obtain the measurements.



Once the dialog box has been validated, the following window is displayed showing all surface values described above.

The totals of each of the measurements are displayed at the bottom of the window.

Additionally, the possibility also exists of either sending the contents to a printer or exporting the data to an Excel spreadsheet.



Cross-Section Measurements List

Station	Fill Crown	Cutting Crown	Fill	Cutting	Left Wall	Right Wall	Left wayside	Right wayside
0.000	68.120	72.411	11.592	11.112	0.000	0.000	0.000	0.000
	68.120	72.411	11.592	11.112	0.000	0.000	0.000	0.000
5.000	78.642	63.669	14.693	9.789	0.000	0.000	0.000	0.000
	146.762	136.080	26.284	20.901	0.000	0.000	0.000	0.000
10.000	124.959	25.370	28.263	4.243	0.000	0.000	0.000	0.000
	271.721	161.451	54.548	25.145	0.000	0.000	0.000	0.000
15.000	144.270	1.203	27.420	0.230	0.000	0.000	0.000	0.000
	415.991	162.654	81.968	25.375	0.000	0.000	0.000	0.000
20.000	145.221	0.003	30.507	0.000	0.000	0.000	0.000	0.000
	561.212	162.657	112.475	25.375	0.000	0.000	0.000	0.000
25.000	145.234	0.001	30.805	0.000	0.000	0.000	0.000	0.000
	706.446	162.658	143.280	25.375	0.000	0.000	0.000	0.000
30.000	143.389	0.003	28.953	0.000	0.000	0.000	0.000	0.000
	849.834	162.661	172.233	25.375	0.000	0.000	0.000	0.000
35.000	140.685	0.000	26.239	0.000	0.000	0.000	0.000	0.000
	990.519	162.661	198.472	25.375	0.000	0.000	0.000	0.000
40.000	138.081	0.001	23.652	0.000	0.000	0.000	0.000	0.000

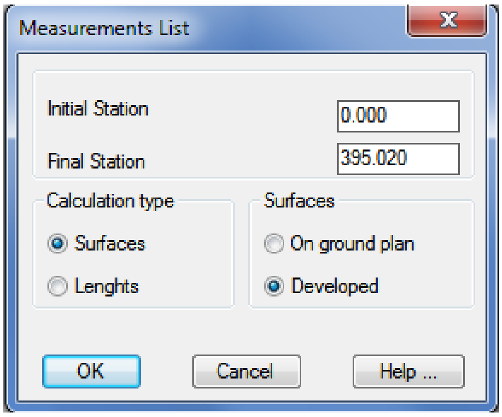
TOTAL	
Fill crown	6482.330
Cut crown	7353.480
Fill slopes	1244.905
Cutting Slopes	1714.159
Wall Lft.	0.000
Wall Rght.	0.000
Lft. Ditch	0.000
Rght. Ditch	0.000

OK Imprimir... Help

Slope Measurements Report PRO

As with the previous command, in these cases we can generate a list of the length of the slopes or the surface of the same. When selecting surfaces, the list may consist of developed or ground plan surfaces in the cut and fill slopes of the road of the segment selected.

When this command is executed the following window is displayed:



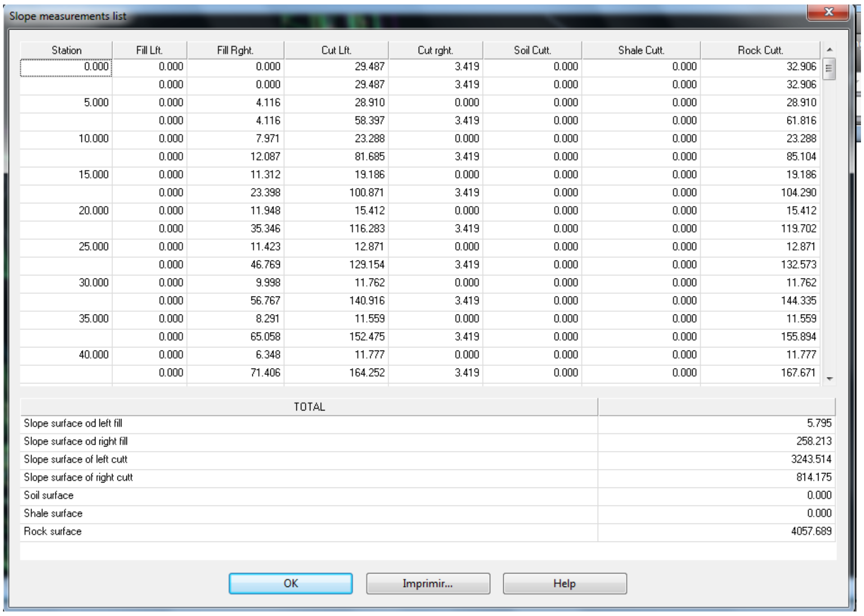
Initial station: Station from which the list is made.

Final station: Station up to which the user wishes to make the list.

Type of calculation: We specify whether the measurement we wish to make is in elevation view, meaning a developed surface or a surface on ground plan.

Surfaces: Selecting “Surfaces” enables us to see if the list to be generated features ground plan or raised surfaces, in other words, a developed surface or a ground plan surface.

In the case of cutting, it also lists the three types of terrains that MDT analyses: Soil, Shale and Rock.



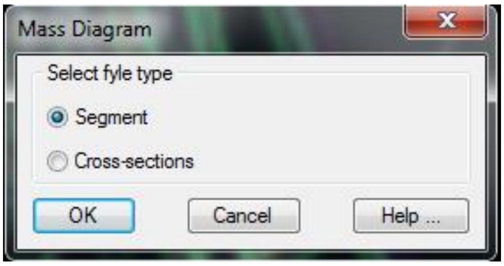
Station	Fill Lft.	Fill Rght.	Cut Lft.	Cut rght.	Soil Cutt.	Shale Cutt.	Rock Cutt.
0.000	0.000	0.000	29.487	3.419	0.000	0.000	32.906
	0.000	0.000	29.487	3.419	0.000	0.000	32.906
5.000	0.000	4.116	28.910	0.000	0.000	0.000	28.910
	0.000	4.116	58.397	3.419	0.000	0.000	61.816
10.000	0.000	7.971	23.288	0.000	0.000	0.000	23.288
	0.000	12.087	81.685	3.419	0.000	0.000	85.104
15.000	0.000	11.312	19.186	0.000	0.000	0.000	19.186
	0.000	23.398	100.871	3.419	0.000	0.000	104.290
20.000	0.000	11.948	15.412	0.000	0.000	0.000	15.412
	0.000	35.346	116.283	3.419	0.000	0.000	119.702
25.000	0.000	11.423	12.871	0.000	0.000	0.000	12.871
	0.000	46.769	129.154	3.419	0.000	0.000	132.573
30.000	0.000	9.998	11.762	0.000	0.000	0.000	11.762
	0.000	56.767	140.916	3.419	0.000	0.000	144.335
35.000	0.000	8.291	11.559	0.000	0.000	0.000	11.559
	0.000	65.058	152.475	3.419	0.000	0.000	155.894
40.000	0.000	6.348	11.777	0.000	0.000	0.000	11.777
	0.000	71.406	164.252	3.419	0.000	0.000	167.671

TOTAL	
Slope surface od left fill	5.795
Slope surface od right fill	258.213
Slope surface of left cutt	3243.514
Slope surface of right cutt	814.175
Soil surface	0.000
Shale surface	0.000
Rock surface	4057.689

Mass Diagram - Calculation PRO

The distribution of earthworks throughout the road's route can be analysed using this option. Also, with a series of tools, the user can carry out different types of movements of materials to find minimum heights and obtain a list with all earthworks carried out and the cost of each one.

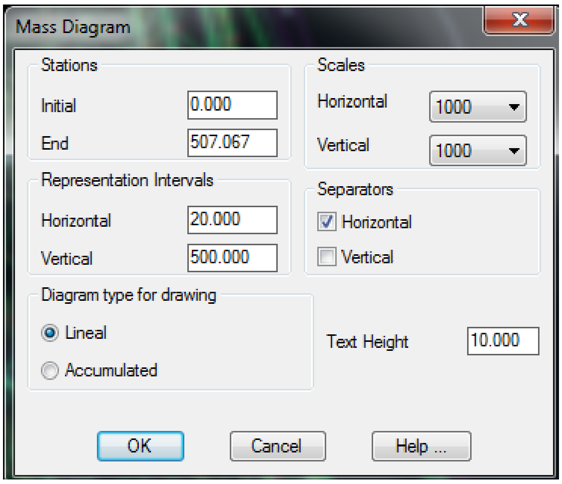
When this command is executed it gives the option to work in two ways, from a segment or from two cross-section files (two different states of the same terrain).



At the end of the process, the command will request that the information be saved in a file with a "**DMS**" extension. The rest of the commands related to the Mass Diagram work with this file type.

Mass Diagram – Drawing PRO

Next it will optionally request a file to save any type of earthworks that we have been able to make in the road and finally the following dialog box will appear for configuring the characteristics of the different diagrams to be drawn.



Initial Station: Initial station where the analysis begins.

Final Station: Final station where the analysis ends.

Vertical Scale: Vertical scale of the drawing, which affects both the diagram and the text labelling.

Horizontal Scale: Horizontal scale of the drawing, which affects both the diagram and the text labelling.

Horizontal Representation Interval: Spacing of the stations on the horizontal alignment in the representation.

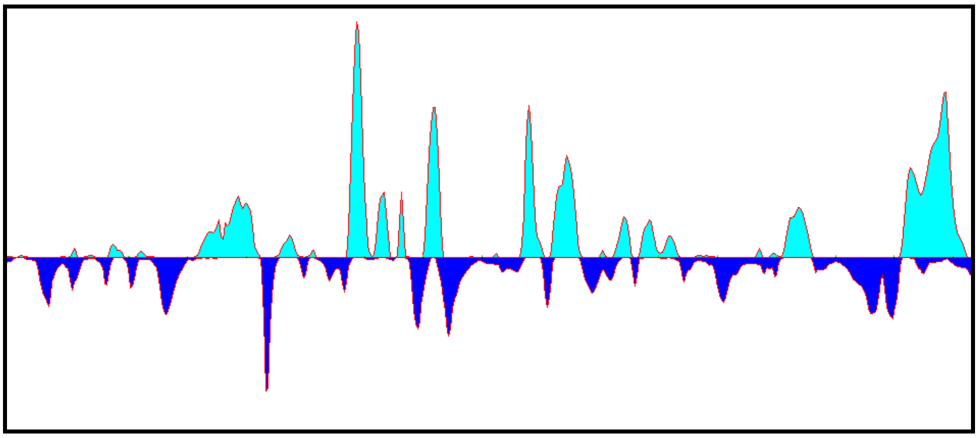
Vertical Representation Interval: Spacing of the volume markings on the vertical alignment in the representation.

Text Height: Height of the texts labelled

- ***Mass Diagram Accumulated at Origin:***

This diagram shows areas with a predominance of cutting or fill. Positive slopes indicate a predominance of cutting and the negative ones fill.

A flatter diagram indicates greater compensation between cutting and fill. Below is a screenshot of this type of diagram.

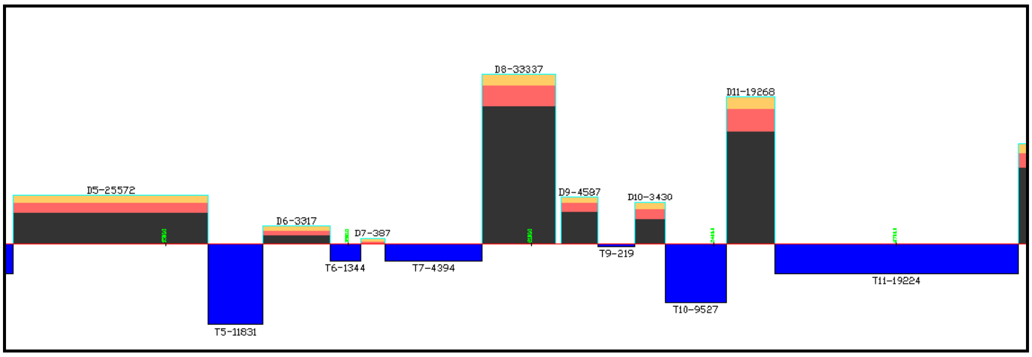


- **Rectangle graphs of cut and fill**

This diagram is used to represent the different cutting and fill compensations of the terrain.

The cutting appears broken down in different areas, depending on the different geological types.

- **Soil** is represented in yellow.
- **Shale** is represented in magenta.
- **Rock** is represented in brown.



When the dialog box is validated, the program will save the data processed in the corresponding mass diagram file.

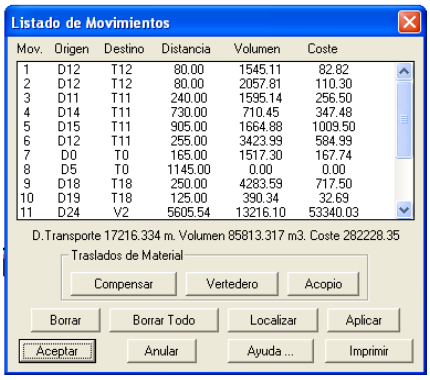
This file is important because in successive applications of the command with the same segment, selecting it considerably speeds up the process, and saves important information on the earthworks that have been carried out.

Mass Diagram- Earthworks PRO

This command is used to carry out movements of materials between cutting and fill, as well as account for the different dumps and stockpile sites available.

All earthworks are shown in a list that displays the material moved, the distance transported and the estimated cost of transport.

First the command requests the mass diagram file we will be working with, and then some on-screen coordinates to draw the rectangle graph on which different earthworks will be defined.



The following information is given in the list:

Mov: Identifies movement.

Origin: Accumulation of cutting from which the terrain is to be moved. Also in this case Stockpile can appear from which material is taken.

Destination: Accumulation of fill to which the material will be taken. It can also be a dump which is filled with the excess material.

Distance: Distance of transport.

Volume: Volume of the material moved.

Cost: Estimated cost in Euros of the earth movement, according to the costs table of the materials configured with the corresponding command.

Material Transport

Compensate: Compensation between a block of cutting and one of fill. The command first requests the cutting block from which to extract the material, then the fill block where it should be taken.

Dump: In this case the cutting material is taken to a dump. First the cutting block to be moved is indicated then the corresponding dump is selected from the list.

Stockpile: This option is the opposite of the dump option. First we select the stockpile from which to bring the material, then the fill where it is to be taken.

Delete: To delete any of the earth movements carried out.

Delete All: To delete all movements carried out, leaving earthworks as they were at the start.

Locate: A zoom window over the elements that formed part of the movement selected.

Apply: Re-draws the block diagram in terms of the earth movements carried out.

Print: Shows a detailed list by printer, with the different movements and the totals for each concept.

Earthworks List
13/07/011

EarthW	Origin	Destination	Distance	Volume	Cost (euros)
1	D1	T1	70.00	745.63	37.58
2	D0	T0	15.00	33.48	0.36
3	D3	T1	362.50	0.00	0.00

Transport distance 447.500 m
Transport distance to dump 0.000 m

Transported volume 779.106 m3
Transported volume to dump 0.000 m3

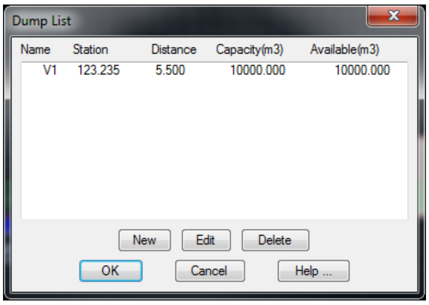
Total cost (euros) 779.11
Total cost (euros) in dump 0.000

Mass Diagram – Dumps

In this mass diagram option the different dumps that are available for the road works are listed.

When inserting a new one it will request the station location for the dump with regard to the project alignment, the alignment displacement and the dump's capacity in cubic meters.

As the dumps are used for the various earthworks, the program will automatically provide updated information on the space remaining at the dumps.

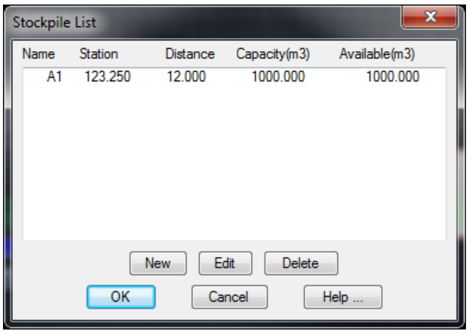


Mass Diagram - Stockpiles

In this mass diagram option the different material stockpile areas available for the road works are introduced.

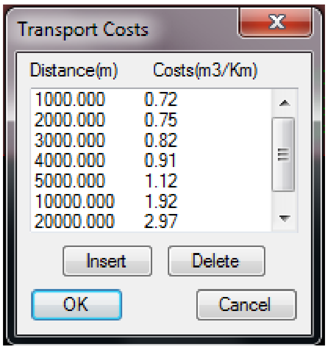
When inserting a new one it will request the station location for the stockpile with regard to the project horizontal alignment, the alignment displacement and the availability in cubic meters.

As the stockpiles are used for the various earthworks, the program will automatically provide updated information on the remaining available material.



Mass Diagram - Transport Costs PRO

The price of moving material in terms of its displacement in cubic meters, per linear kilometer is introduced in this table.



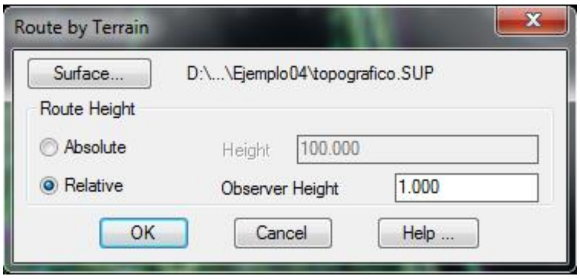
The cost of moving 1m3 of material the distance covered with it.

17. Maps/Render

The tools described in this chapter allow one to generate attractive 3D representations from grid or surface files.

Route by Terrain

This tool allows one to take an interactive tour simulation on a surface file. The following dialog box is displayed:



By clicking the ***Surface*** button, one can choose a surface other than the current drawing. Concerning the observer's height, one can choose between ***Absolute*** height throughout the tour or ***Relative*** height with regard to the surface height in each position.

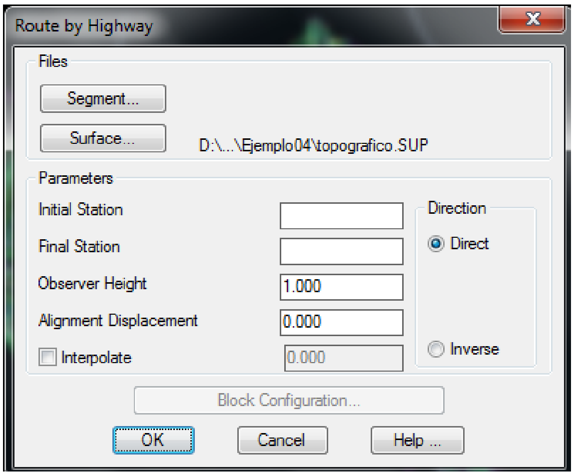
To generate the route by terrain, the program employs a predefined texture configuration. A more realistic result can be obtained by inserting a georeference image with the **Insert Image** command.

Click on OK to display the view screen.

See detailed description of viewer later.

Route by Highway

This command is similar to the **Route by Terrain**, except that movement is now restricted to along the horizontal alignment definition.



The program requests the following input data:

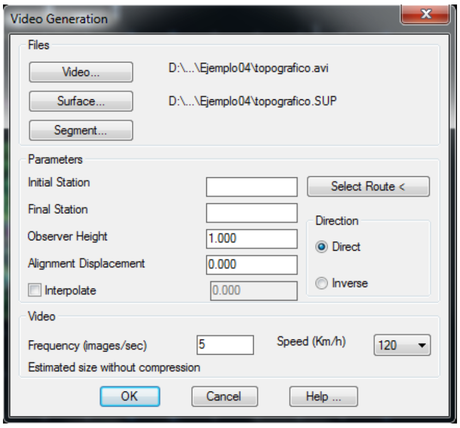
- ***Segment:*** Segment file containing the road's geometric definition, including at least the ground plan alignment and elevation drawing, the cross-section profiles and the cross-section template used.
- ***Surface***: Optional file used to generate the terrain upon which the road will be drawn.
- ***Initial station:*** Point at which the tour starts.
- ***Final station:*** Point at which the tour ends.
- ***Observer Height:*** Height in meters above the road's grade line.
- ***Alignment Displacement:*** Transversal offset on the alignment (negative to the left and positive to the right).
- ***Direction:*** Direction of movement along the road (***Direct*** from initial station and ***Inverse*** from final station).

Click on OK to display the view screen.

See detailed description of viewer later.

Generate Video

This command is used to save the representation obtained from the command **Route by Highway** in a video file.



A destination file name can be specified by clicking on ***Video***. The ***Surface*** and ***Segment*** buttons allow one to choose the model used to generate the terrain.

The tour parameters are as follows:

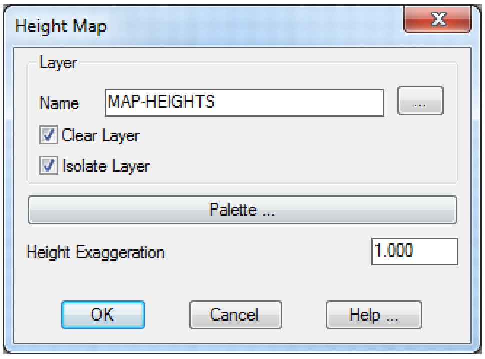
- ***Initial station:*** Point at which the tour starts.
- ***Final station:*** Point at which the tour ends.
- ***Observer Height:*** Height in meters above the road's grade line.
- ***Alignment Displacement:*** Transversal offset on the alignment (negative to the left and positive to the right).
- ***Direction:*** Direction of movement along the road (***Direct*** from initial station and ***Inverse*** from final station).

When no segment has been selected, a polyline and a viewpoint must be selected using ***Select Route***.

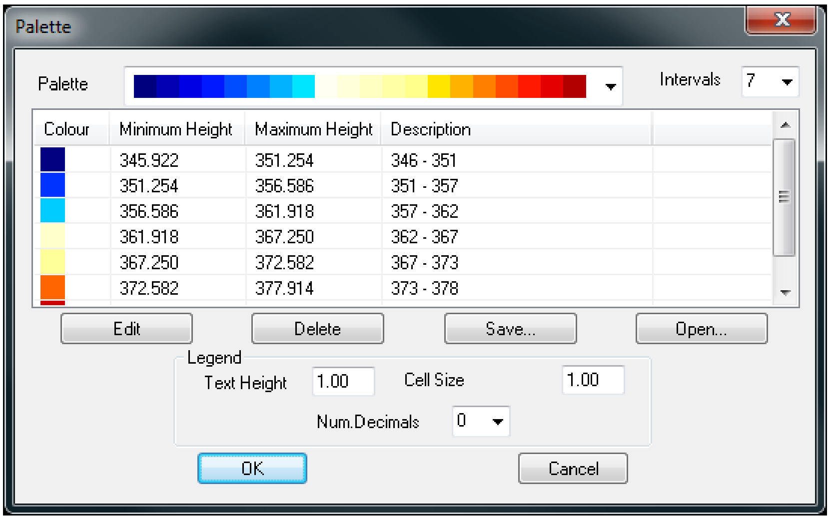
Click on OK to display the view screen. The video will be displayed on screen while it is generating and the animation bar and camera controls will refresh.

Draw Height Map

This command shows a grid file and assigns different colours according the cell heights.

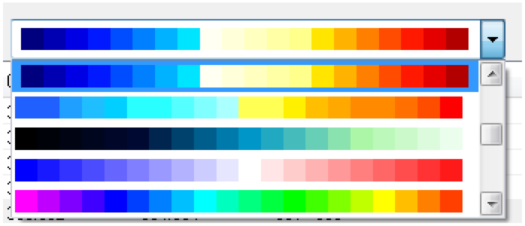


The ***Colour Palette*** button shows the following dialogue which shows the elevation ranges, the colour assigned and the different palettes available for assignment. The default configuration for intervals and the colour palette may be edited in **Map Configuration**.



On the list we will be able to see the different colours assigned to each of the elevation ranges. In addition to each interval, there is an associated description which the user may customise.

Palette: Colour Palette to be assigned. Some of the palettes available can be seen below:



Intervals: Colour interval to be created, as many colours can be created as are available on the palette.

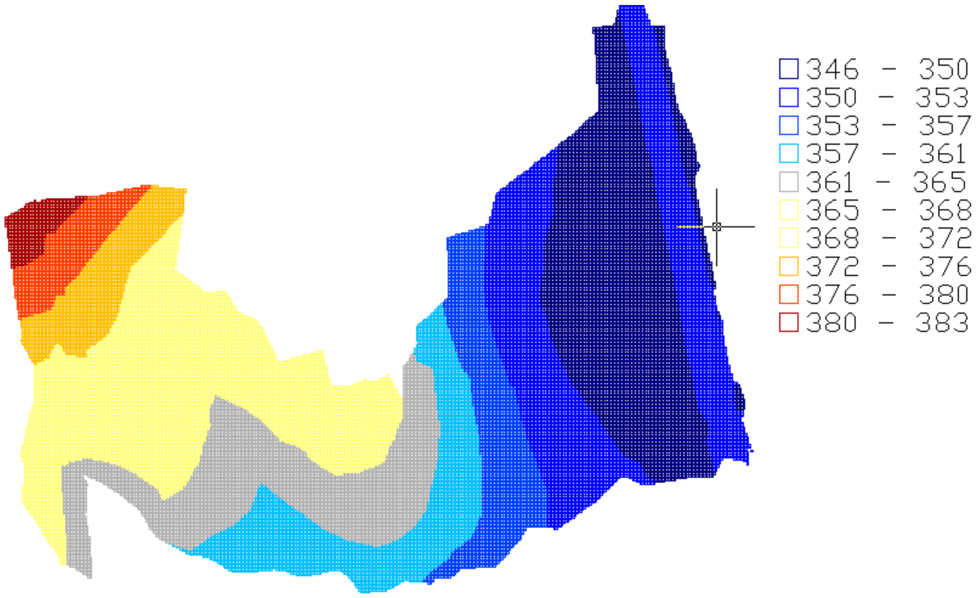
Edit: Editing of a given interval with the possibility of changing the minimum and maximum values and the description thereof.

Delete: Possibility of deleting one of the intervals.

Both when editing and deleting any interval, the rest of the intervals will be recalculated in line with the minimum and maximum values specified.

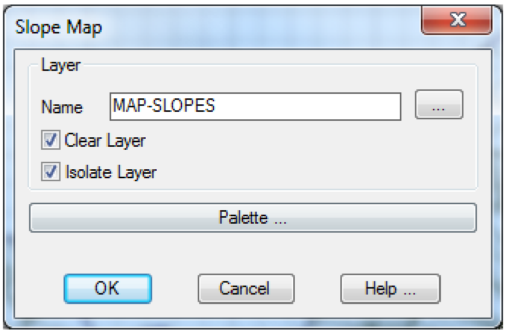
Save: Possibility of saving in a file the whole configuration of intervals, colours, description… in such a way that it can be recovered at any time.

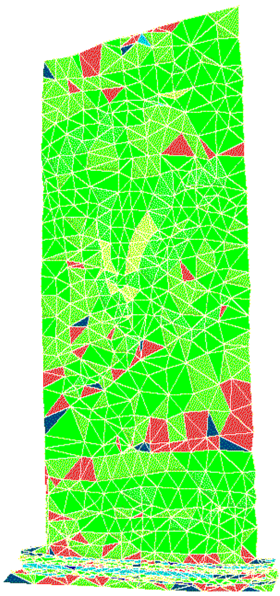
Load: By using this option we will recover a configuration that has been previously saved with the previous option.



Draw Slope Map

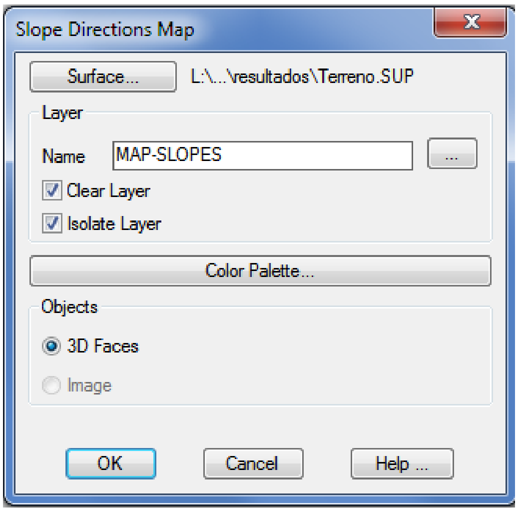
This command draws a map based on the current surface, assigning a different colour to each triangle according to its slope. The options are the same as the ones available in the **Maps/Render** > **Draw Height Map** command. The default interval and colour configurations can be edited using the **Map Configuration,** ***Slopes*** button.





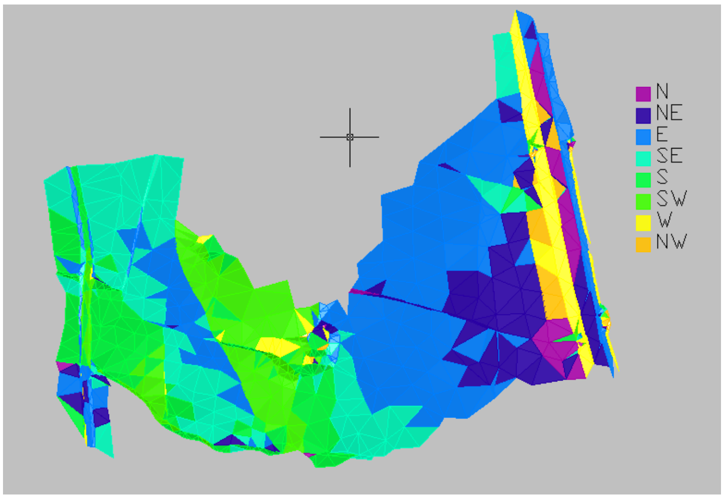
Draw Slope Direction Map

This command draws a map based on the current surface, assigning a different colour to each triangle according to the orientation of its slope with regard to the cardinal points. The options available the same as the ones available in the **Maps/Render** > **Draw Height Map** command. The default interval and colour configurations can be edited using the **Map Configuration,** ***Slope Dir.*** button.



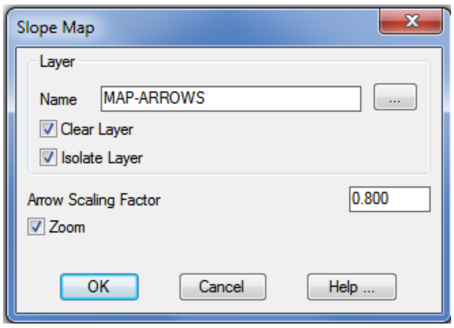
Objects: The drawing of the directions map can be executed as AutoCAD 3D Faces entities or as an image.

With this command, by contrast to the previous ones, the number of interval cannot be customised and the intervals will always be 8, coinciding with the 8 subdivisions of the cardinal points.



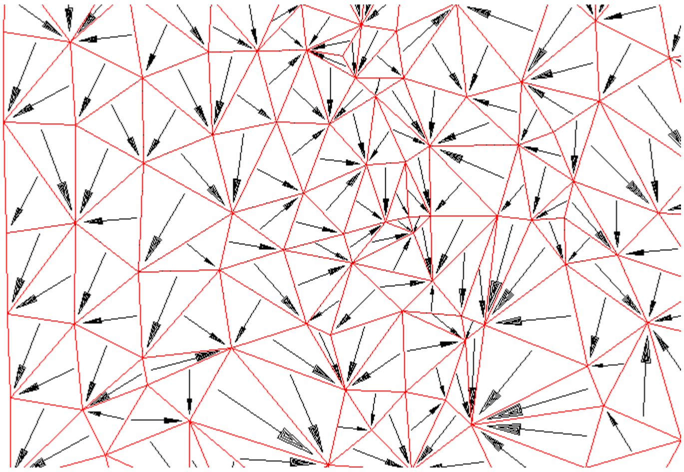
Draw Slope Arrow Map

This command draws an arrow for each triangle of the current surface. An arrow's direction indicates the triangles lowest vertex.



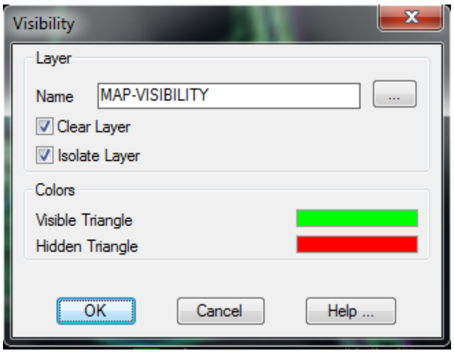
As can be seen, the options available are the same as for any other mapping command. The ***Arrow Scale Factor*** parameter multiplies by the triangle's size before serving as a scale to insert the arrow. The value 1 indicates that the arrows would fill the entire height of the triangle.

The arrows drawn correspond to insertions of the `bloques\flecha.dwg` block located in the program installation directory. This block can be edited or replaced by another, taking into account that its size must be equal to one for the scaling to work correctly.

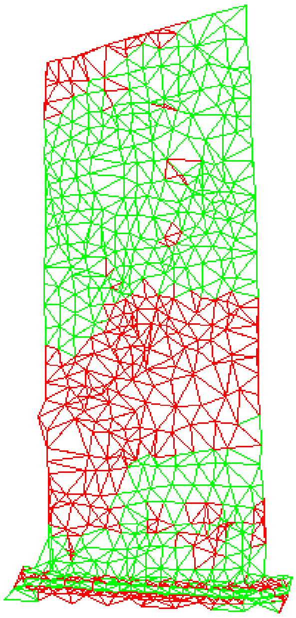


Draw Visibility Map

This command allows one to identify the areas of a surface which are visible from a specific point. Firstly, the program requests a point from which to perform the process, along with the observer's height. Then a dialog box is displayed allowing one to configure the layer and the colours to be used.



By clicking on the coloured rectangles, one can change the colour that will be used for the triangles that the observer can see and cannot see.



Draw Anaglyphs

The word anaglyph means carved in relief. This is one of the most commonly used techniques in 3D viewing because its rendering and viewing is inexpensive.

The wavelengths corresponding to red in the visible light spectrum are eliminated by using a red filter, so that green or blue are seen as black. Similarly, using a green, blue or cyan filter, wavelengths of the filter's colours are eliminated, thereby making it possible to view red as black.

Using these two filters allows one to merge two images –a red image and a blue image– on the same sheet of paper, so that when they are observed through the filters, they are separated and each is seen by one eye. Given that there is a small displacement between the two images, a stereoscopic effect is generated enabling one to view relief features. The image is seen in black and white.

The image of the left eye is drawn in red and the image of the right eye in cyan or green. The glasses should be equipped with red filters for the left eye, and cyan or green filters for the right eye. This same configuration is valid for projected images or images on a computer screen.

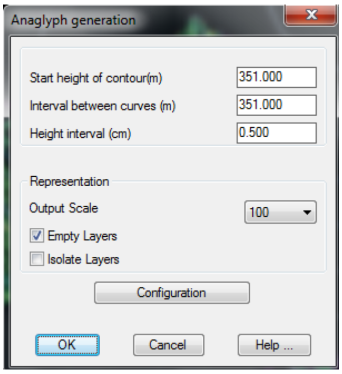
The dialog box requests the following data:

Start of Contouring. The minimum height from which the displacement will be applied.

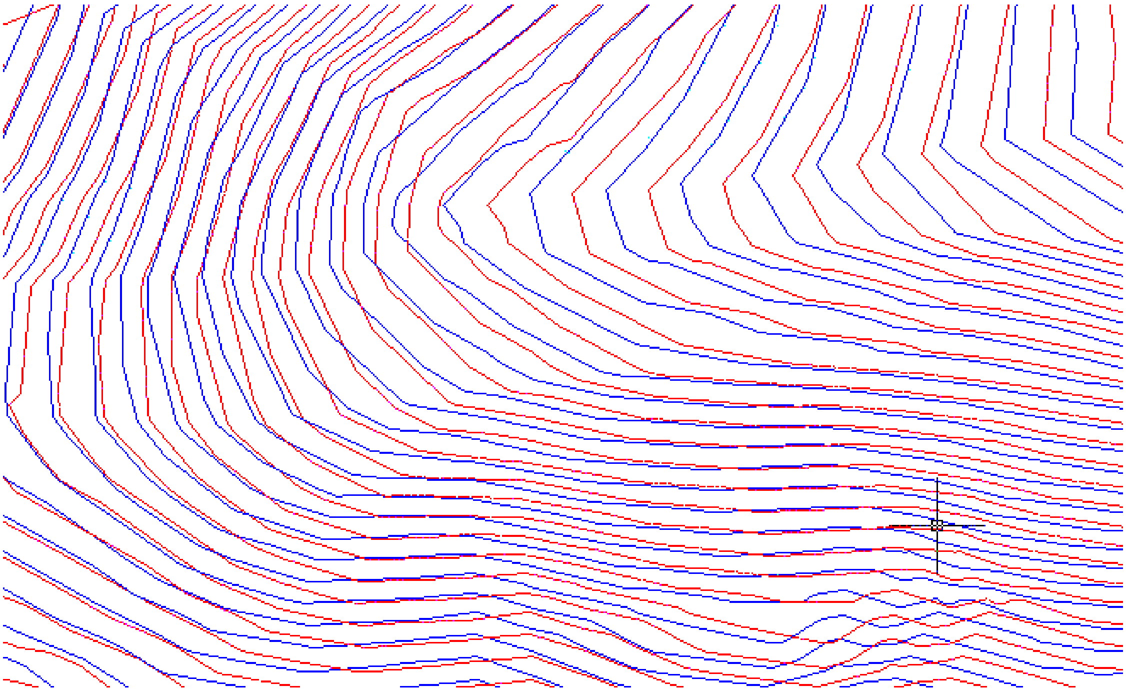
Contour Interval. Interval between the contour lines represented on the drawing.

Height Interval. Height displacement difference. It controls the perception of relief.

Output Scale. Scale in which the plan will be drawn.



Once the dialog box has been validated, the program requests a series of objects to which the algorithm will be applied. The result is generated on the ANAGLYPH_LEFT layer for the left eye and on the ANAGLYPH_RIGHT layer for the right eye. In order to obtain the best results, trials should be done with the colours.

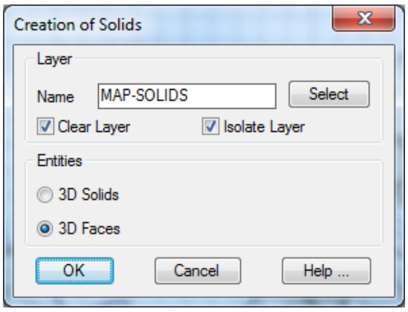


Draw Solids

Drawing solids allows the creation from the current surface of a representation thereof in such a way that it is possible to be used with the CAD's RENDER command. There are two representation possibilities in line with the type of entity to be used:

- 3D Solid
- 3 D Faces

The drawing of 3D faces is quicker and the drawing file increases to a lesser extent compared with the 3D solids drawing.



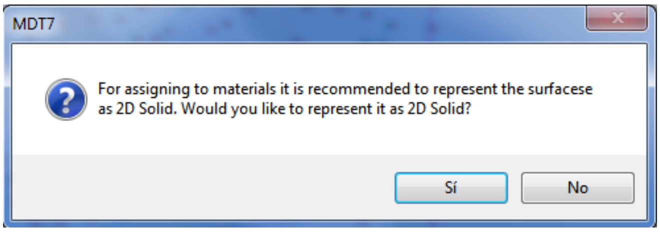
Assign Materials

A material may be assigned to specific triangle of the current area by using this command. Its aim is to improve its presentation in the **This command** allows one to open a MDT project file that is displayed in the Project Window. Once the project is open, the successive MDT commands will update its information.

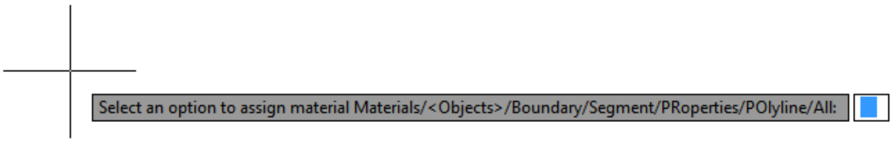
, **¡Error! No se encuentra el origen de la referencia.** and **Generate Video** commands.

Each triangle in the MDT surfaces file is associated to a triangle type indicator. When the program creates a surface, all the triangles or of ***Normal*** type. However, when the Earthworks or Obtain Modified Terrain commands are executed, they are assigned with another triangle type corresponding to the new triangles generated if the current surface is modified. Additionally, when one inserts a geo-referenced image using the **Insert Image** command, the program creates a new triangle type associated to the image and assigns it to all normal-type triangles on which the image is projected.

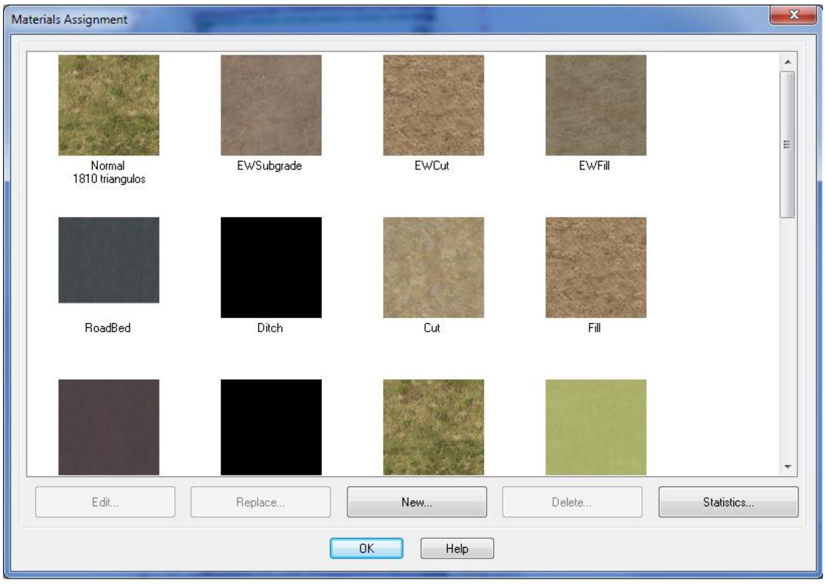
This command allows one to consult or modify the information about a surface's triangle types. Firstly a message appears enabling us to select the type of surface representation, 2D SOLIDS or POLYLINES; we recommend working with 2D SOLIDS in order to take full advantage of the different colours of the materials.



The image below illustrates a line of command with the different options for the assignment of materials:



Materials: Shows a text box enabling the user to select different materials and conduct different operations. The ***Edit*** tab enables us to change the colour and / or texture of a type of triangle. The ***Replace*** tab enables us to change material for another. The ***New*** tab enables us to create a new type of triangle for use with one of the assignment options. The ***Delete*** tab removes the types of triangle which have not been predefined. The ***Statistics*** tab covers the current surface and shows a list of the types of triangles assigned.



Objects: enables us to select the triangles to be modified by selecting entities of the 3D FACE, 2D SOLID or POLYLINE type.

Boundary: we need to select a closed polyline which delimits the triangles to be modified.

Segment: requests a segment file used to generate an internally modified terrain and copies the types of triangles (***Median***, ***Platform***, etc.) to the current surface.

Properties: enables us to select one or more triangles and features a text with the name of the material in a dropdown list on which we can select another material and replace the triangles selected with the new one.

Polyline: we need to select a polyline and apply the material to all the triangles whose edges cut that line.

All: applies the material selected to all the triangles.

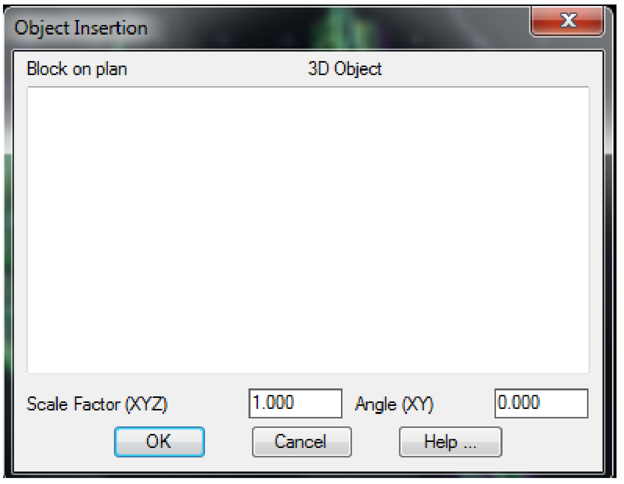
The **Surfaces > Represent As** command is used to change the way of representing the surface.

Insert 3D Objects

This command allows blocks to be inserted in the drawing at the current surface's terrain height and according to the point designated. Initially, a dialog box is displayed showing blocks that have been defined in the **Codes Database** that have been associated to specific points and that have at least one block associated to00 the ground plan.

In addition, if a 3D object is associated to the block, the associated 3D object will be shown in the Terrain Tour Simulation, Road Tour Simulation and Generate Video commands.

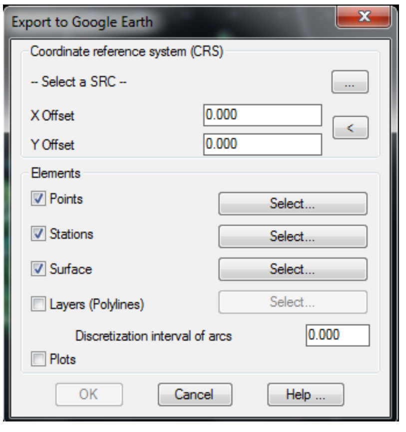
The program allows one to specify the ***Scale Factor*** or multiplying factor of the block selected in the three dimensions (X, Y, and Z), as well as the ***Angle*** with regard to the X, Y plan.



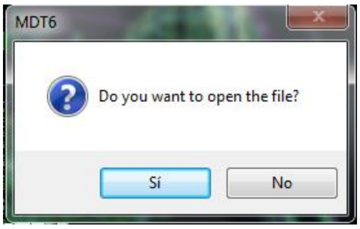
Export to Google Earth

This MDT command is used to generate a KML file to be visualized later on Google Earth. The export coordinates must be UTM coordinates, and the UTM zone specified must be correct. If these requirements are not met, the file will appear in an incorrect location on the planet. A ground displacement may also be specified which will be applied to all the coordinates included in the file.

Initially a dialogue box appears for selecting which elements to include in the export.



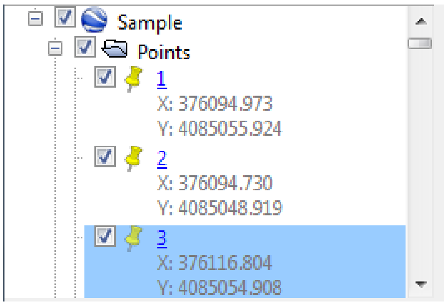
Once the export elements are selected the program requests a file location to save the information. It must be taken into account that a KML file is less efficient in size and speed in relation to its equivalent DWG file. Due to this, depending on the computer's characteristics, it is possible that if many elements are exported, Google Earth will not be able to open the resulting file.



Finally, if the user answer's yes to opening the file, Google Earth will execute if it is installed on the computer. Further details of the different exportable elements follow.

Points

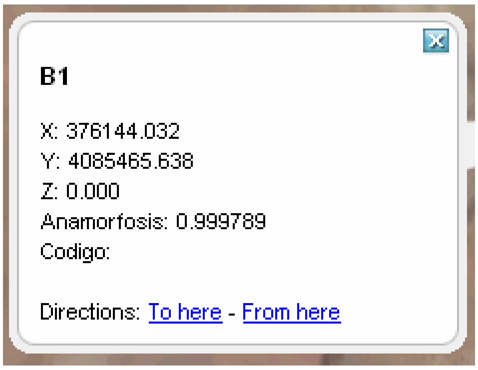
Activating the **Points** option selects all the points of the drawing by default and the corresponding **Select** button is used to make a smaller selection. The left panel of Google Earth will display inside a **Points** folder. Activating or deactivating the folder box controls the visibility of the elements it contains. Unfolding the content, it is possible to activate the visibility individually for each point.



By clicking on the name of the point, a floating window appears with the details, and by double clicking the image is centered on these coordinates.

Stations

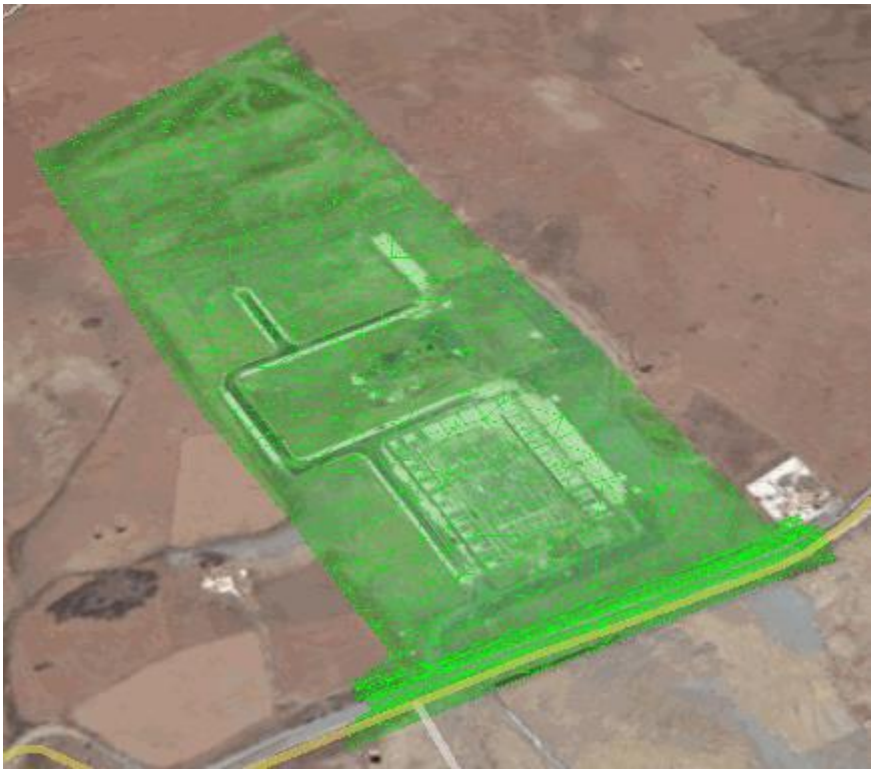
Exporting stations is similar to exporting points, with the difference that it includes the station anamorphosis in its details.



Surface

When a surface is exported it creates an object that includes all its triangles. If earthworks commands are executed, or obtaining terrain has been modified, the surface is divided into several objects that reflect subgrade, cut and fill, etc.

Under the list of elements, when selecting a surface a control appears that enables adjustment of the transparency of the graphic representation.



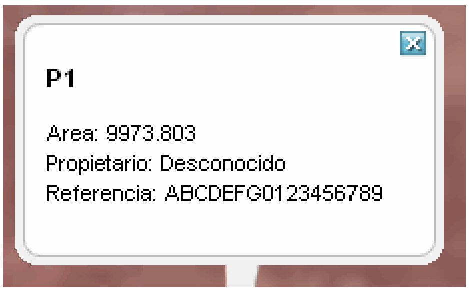
Layers (Polylines)

Every one of the layers selected appears as an element on the left panel in Google Earth. Only layers that have polylines are included, And all of them are represented in the same colour, that of the layer.

Plots

The elements created with the commands **Utilities** > **Plots** are exported individually. Each one of these is individually listed on the left hand panel of Google Earth, in the folder **Plot**, including associated details on the **Area**, and whether an **Owner** or **Reference** exist.

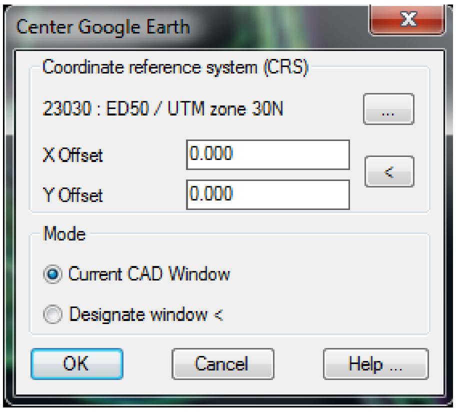
In exactly same way as for points, clicking on the name of the plot a floating window is displayed with its details.



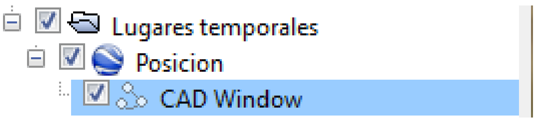
In regard to the graphic representation, the plots are shown as a closed polyline and coloured, similar to the way that surfaces are visualized.

Centre Google Earth

This command opens Google Earth and makes it “fly” to the terrain area that our drawing represents. Also, a specific window can be selected.

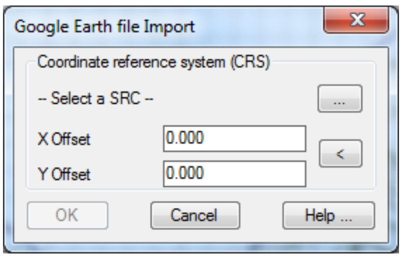


Click **OK** to open Google Earth and it will move to the location selected, which will appear marked with a polyline referenced as the **CAD Window** in the list of locations. Deactivating the corresponding box hides the polyline.

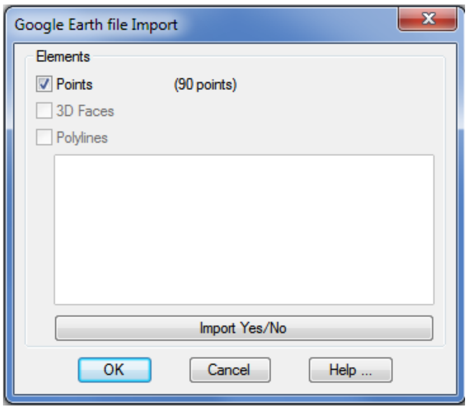


Import Google Earth file

This command carries out the contrary step to that of Export Entities to Google Earth, drawing in CAD the content of a Google Earth KML file. Firstly, a window appears in which the coordinates system of the drawing must be specified.



The program will then ask for the file with a KML or KMZ extension to be imported, after which the following window will appear with the option of selecting the layers to import:



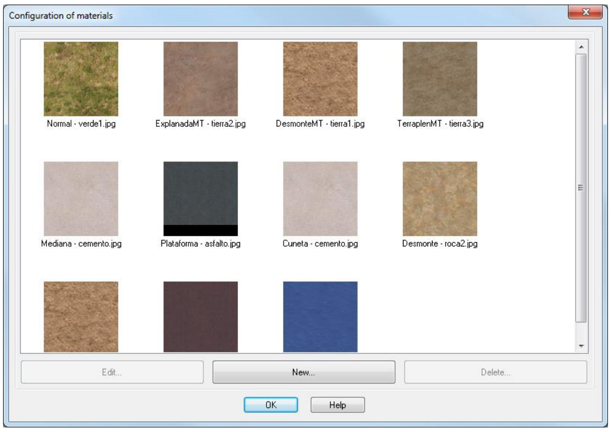
Recognised elements: This command enables us to import “Points”, “3D Faces” and “Polylines”, and once the file has been specified the number of entities of each one will appear with the option of activating or deactivating the import.

Furthermore, the list features all the layers contained in the file selected to enable the user to select the layer he wishes to import.

Once the dialog box has been validated the entities selected are imported automatically.

Materials Library

The different materials the program offers can be defined with this command.



The ***Description*** of materials is merely informative. It describes the triangle type which will be applied to the material. The following kinds of triangles are differentiated according to the command with which they are generated.

Type	**MDT Command**
Normal	Create Surface
MTSubgrade	Earthworks
MTCutting	Earthworks
MTFill	Earthworks
Median	Modified Terrain
Platform	Modified Terrain
Ditch	Modified Terrain
Cutting	Modified Terrain
Fill	Modified Terrain

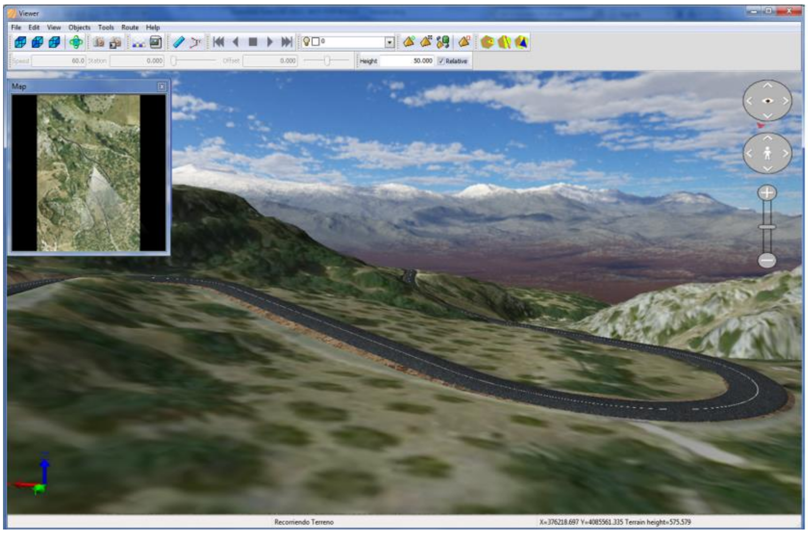
The material ***Colour*** option is used should the Assign Materials option not be used within the **Draw Solids** command. In this case, the command is executed more quickly.

Texture indicates the kind of texture that will be applied to the material when its modelling is represented.

The ***Edit*** button allows one to change any element. The ***New*** button allows one to create new materials, which can be manually assigned using the **Maps > Assign Materials** command.

Terrain Viewer

After applying textures or other photos of the surface we can position ourselves over it with a more realistic visualization, or follow paths along a horizontal alignment.



Surface with a segment applied

The view screen distinguishes between two types of movement, route by terrain or fly mode.

In route by terrain mode, by moving the mouse with the left mouse button pressed we move over the surface; the right button changes the viewing direction. The mouse wheel is used to change the height, relatively or absolutely.

If fly mode activated when we move the mouse with the left button pressed we spin around the surface, by default the pivot point is the centre of the surface, with the right button pressed we move the pivot point. Spinning the mouse wheel varies the turning radius.

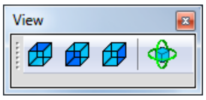
In the ***View*** menu there are several options for displaying the image more or less realistically, which are activated or deactivated using the corresponding menu item.

- ***Lighting*** This illuminates the surface depending on the position of the light. If it is activated all the triangles are displayed with the same level of lighting making it more difficult to differentiate the relief.
- **Shading:** If this is activated the lighting on each triangle is graduated across its surface depending on the amount of light that each vertex receives. It makes the surface appear more rounded.
- **Textures:** We can view the surface with or without textures applied.
- **Grid:** Draws the sides of each triangle that forms the surface.
- **DXF:** Activates or deactivates all the layers corresponding to the imported DXF files.
- **Flooding:** Displays or hides the surface generated through flooding.

The view screen features a series of tools.

View

The following buttons change the perspective and the navigation mode. By changing the perspective we move in one direction depending on the view mode selected to see the entire surface.



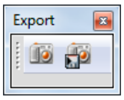
From left to right:

- **Top view:** Places the camera over the centre of the surface looking downwards.
- **Frontal view:** Places the camera at the south of the surface looking north.
- **Right view:** Places the camera east of the surface pointing west.
- **Orbit mode:** This button activates and deactivates the orbit mode.

The movement of observation will depend on whether the orbit mode is activated or deactivated.

Image capture

The image can be stored in the clipboard or saved to disk. The image capture will cover the movement controls.

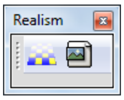


From left to right:

- Capture the image and save it to the clipboard.
- Capture the image and save it in a file. Any of these file formats may be selected: BMP, JPG, PNM, PNG, TIFF

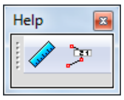
Realism

With this toolbar we access the panels used to configure fog and background.



Help

We can measure distances between two points on the surface, or specify coordinates manually.



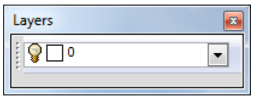
From left to right:

- **Measure distance:** Measures the distance between two points. Although the points selected are assigned the height of the surface, the distance does not account for terrain irregularities.

- **Manual coordinates:** Allows entering the coordinates manually if the current command allows.

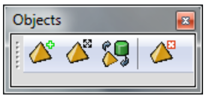
Layers

This control is used to display or hide the different layers that make up the drawing, the layers available will depend on the commands that we have executed.



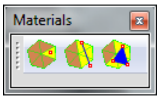
Objects

This toolbar is used to Access the commands to add, move, change or delete objects from the scene.



Materials

Permits modification of the material of one or several triangles selecting them (from left to right) by point, polyline or polygon.



The material is changed for the entire triangle if a vertex is inside the polygon or if any point of the polyline is inside the triangle, depending on the selection type chosen.

To select the material to change use the context menu when we are in one of these commands.

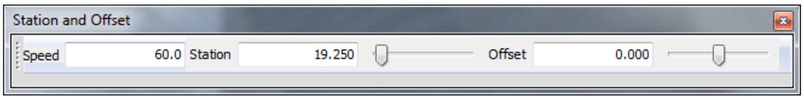
Route and position over horizontal alignment

These two toolbars only appear activated if we have a horizontal alignment associated with the surface.

The buttons from left to right are:

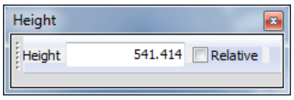
- Go to the initial station of the horizontal alignment.
- Return via the horizontal alignment
- Stop the current route, you can also stop by pressing the *Escape* button
- Move forward along horizontal alignment.
- Go to the final station of the horizontal alignment.

With the following controls we can move to a specific position of the horizontal alignment using a **Station** and a **Route**. Both values can be written manually or using the corresponding route bar.



Height

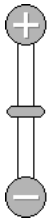
When we travel along a route (orbit mode deactivated) we can choose whether we want to move to an absolute/specific or relative height above the surface, for which we would check the box ***Relative*** as applicable.



Movement controls

The controls to facilitate movement are located superimposed on the right hand side of the window. These operate in route by terrain mode.

When we use the left button inside a control, the movement becomes faster the further away from the centre we press.

	Changes the direction of observation, the red frame indicates the position of north. The red frame indicates north.
	Movement over a surface, pressing at the top or bottom takes us forwards or backwards. Pressing on the sides takes us sideways.
	We move to the centre point of the scene if we press above the central frame, and move backwards pressing beneath it.

Map

Using the menu option **View > Map** opens a window and shows a representation of the surface. It will always appear in its entirety, over it a viewing cone appears, its vertex is the position of observation, and the direction is represented by the light beam.

Surface with viewing cone

We can use this window to quickly move to or look at a point on the surface.

Pressing the left mouse button on a point in the window, we place ourselves over this position without changing the orientation. The height will depend on the mode we are in.

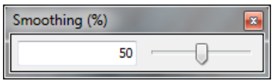
Using the right button we look towards the point selected.

Effects

To improve the representation of the surface two effects are available: softening and the application of fog.

Smoothing

With the smoothing tool we can more or less make the undulations of the surface noticeable. The greater the value the more rounded the surface will appear (shading must be activated).



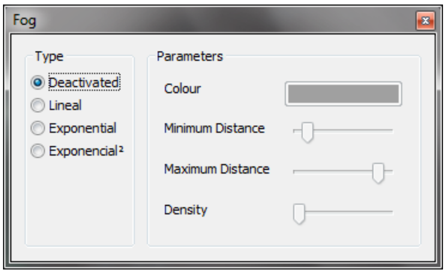
The value of 0% indicates that the vertex normal will be those of the plane to which they belong.

A value of 100% indicates that the vertex normal correspond to the result of all normal of the maps that contain this vertex.

With the intermediate value the lineal interpolation is used between the normal corresponding to 0 and 100.

Fog

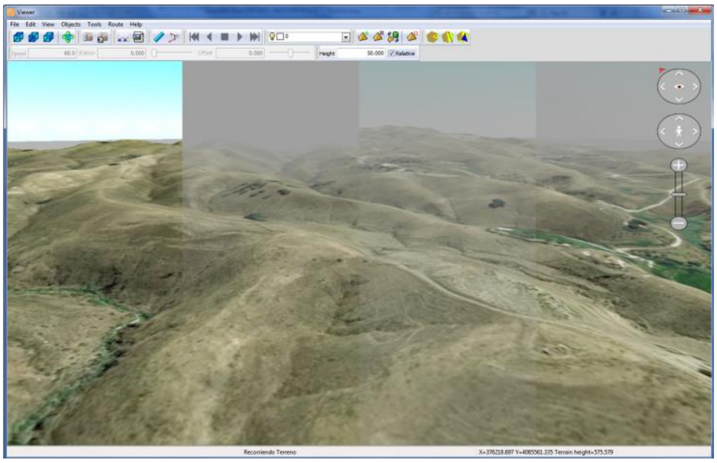
Fog can be applied to the scene to give it a more realistic look and its colour be changed clicking the corresponding button.



Three types of fog are available.

Linear. We can specify the minimum and maximum distance, the areas that are closer than the minimum distance will not appear to alter. Those that are further than the maximum distance will appear with the colour of the fog. For intermediate values a linear interpolation is given between the colour of the surface and that of the fog.

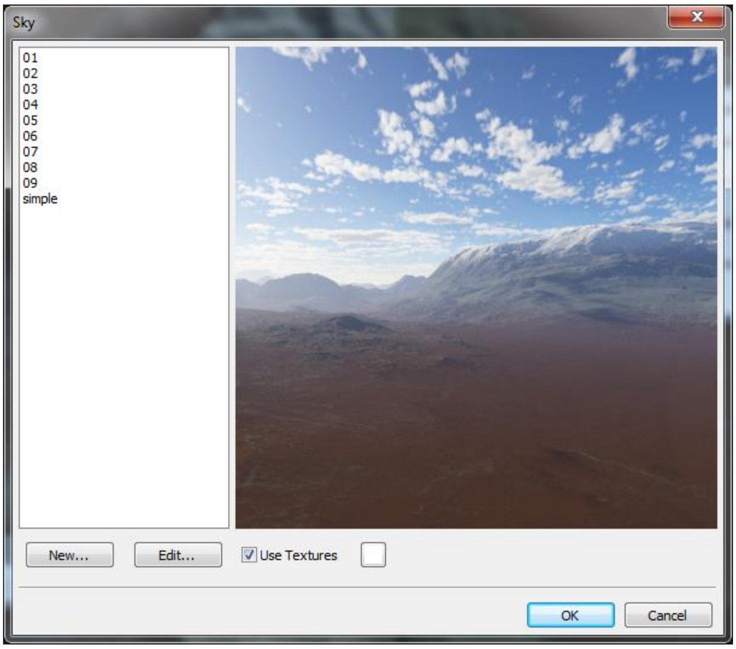
Exponential and Exponential². For these two types of fog only the density is specified. If we are distanced from the surface—like in the image—we must put in a very small value to be able to see distances further away.



From left to right: without fog, linear, exponential, exponential squared

Background

The application has several screen backgrounds available for heightened realism. If we do not wish to use a screen background we can deactivate the option by unchecking the box **Use Textures**, if we do not use a background texture we can change the background colour.

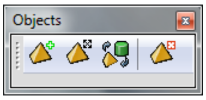


Objects

To improve it, we can add objects to the scene. These must be in 3D Studio format, and the objects cannot include textures as these are ignored for the moment.

It is important that the object is defined with the origin of the coordinates in its station as this point is used as the object's point of insertion.

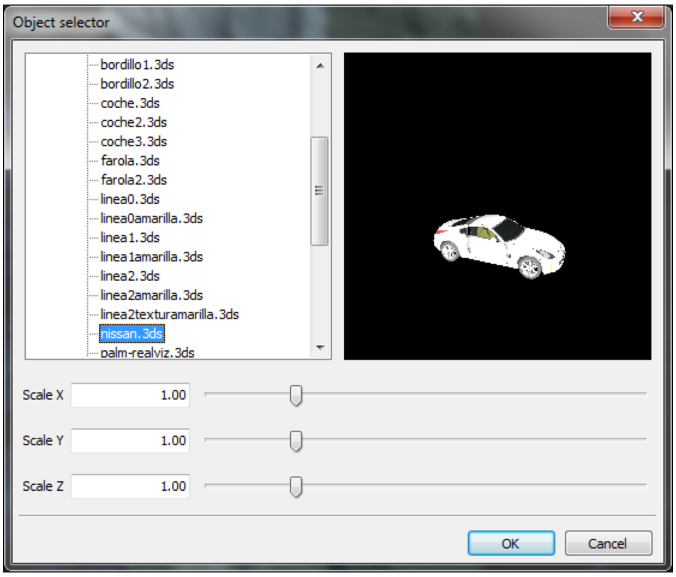
We will use the corresponding toolbar or the **Objects** menu of the main window.



From left to right:

- Add new objects
- Move an object.
- Change the object to display without modifying its position.
- Delete an object

To select an object to add we use the object selection dialogue box that is automatically displayed when adding a new object.



Object selection and scale change

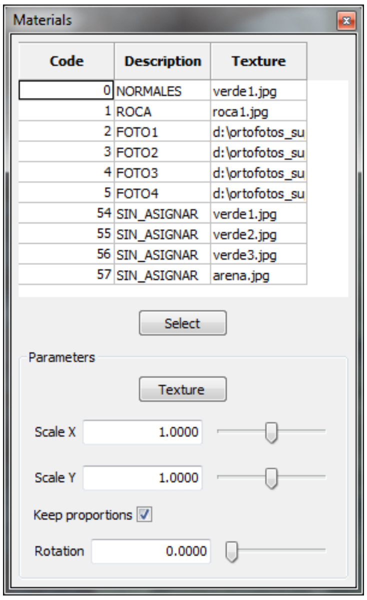
Tools

Materials

The **Materials** command is used to change the texture of each material to be used, as well as the scale and rotation parameters of each material.

The textures and the parameters of scale and rotation of the orthophotos materials cannot be modified.

The **Select** button is used to click on a triangle on the surface and it will display the material that it has assigned.



Water flow

This command draws the direction of the flow of water on the surface by selecting points on the surface.

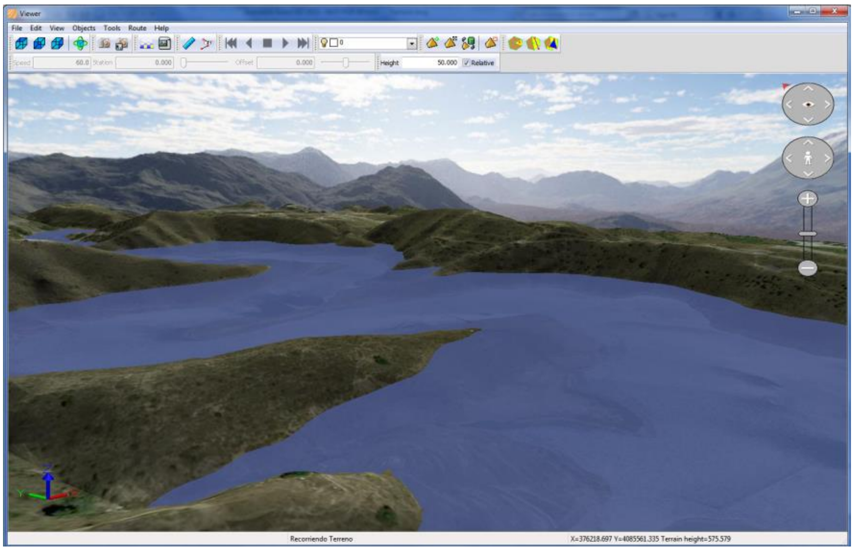
These flow lines are created on a separate layer that so that it can be hidden.

Flooding

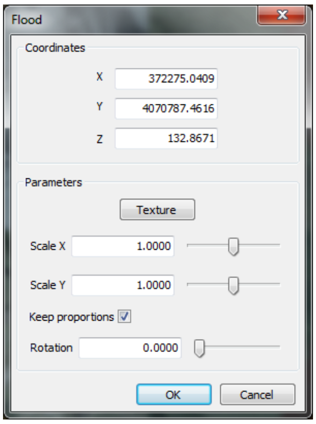
It is possible to simulate a flood by providing a starting point. The application will apply the surface flooding only to those areas with the lowest elevations and that are accessible from the initial flood point.

Once finished the command will display the approximate volume of the flood.

The surface showing the flood is created on a separate layer so that it may be hidden, and the program will only allow one flood on the surface, if we select another flood point the previous flood will be deleted before the new one is generated.

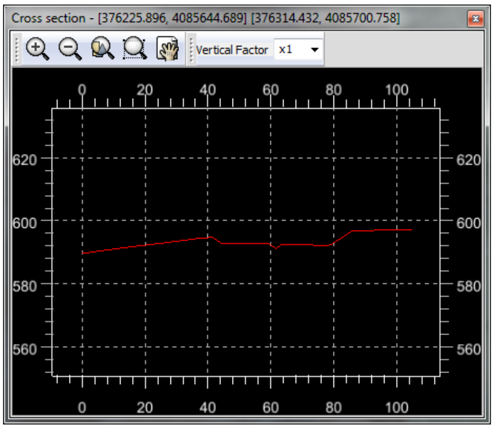


The specific position of the flood starting point, the texture to be used and the scale and rotation parameters can be specified.



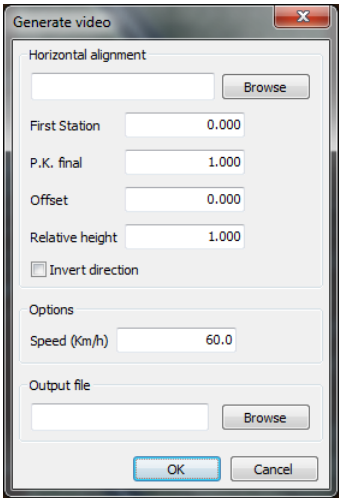
Calculate Profile

It is possible to calculate the longitudinal profiles between any two points on a surface. It is helpful to visualize the ground plan view to make sure that the points between which the profile will be calculated are properly selected.



Route

It is possible to create a route along the surface following a horizontal alignment, it only requires a horizontal alignment and specification of the parameters for the route such as the station displacement interval, height above the surface, etc.



In order to make a video the output file must be selected. When clicking on Accept the dialog box will request the video output format; depending on the CODECs that are installed the format list may vary. Significantly, it is possible that a particular format is installed that will only visualize videos but not record them.

18. Plots

Introduction

This module includes a set of basic commands for plot division processes. The functions it offers can be summed up as:

- Creating land plots from CAD objects such as lines, polylines, etc.
- Viewing, editing and exporting land plot information (name, owner, limits, etc.).
- Viewing and editing all the information about each vertex making up a plot.
- Splitting plots according to various criteria, as well as merging them.

All these operations are carried out on an independent CAD layer, allowing it to be isolated from the rest of the drawing.

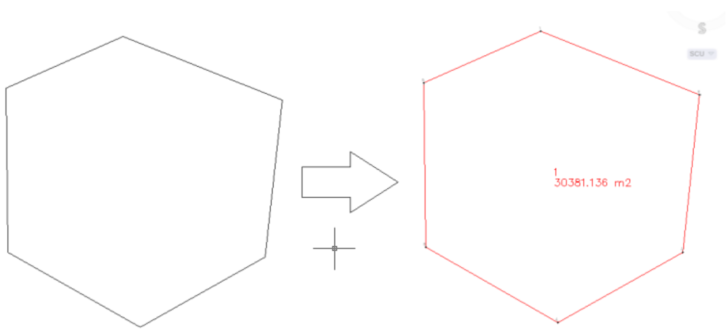
Plot selection in the commands that require it can be done by clicking on the plot name or on the polyline making up the plot.

Define by Polylines

Allows one to create a plot either from a closed polyline or from various open polylines forming an enclosure.

If the first polyline to be selected is closed, the plot is automatically created. Otherwise, open polylines are requested until the enclosure is completed. Once all the polylines have been selected, the <Esc> button should be pressed or the mouse should be right clicked.

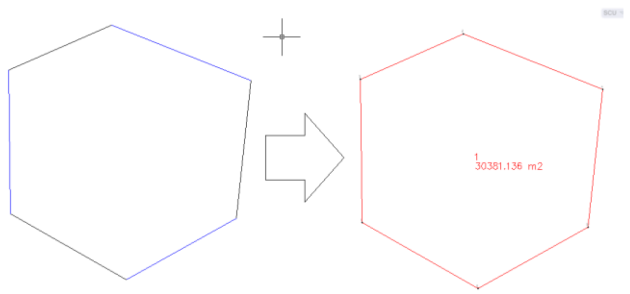
The plots are named with a numerical identifier equivalent to the number of the last plot defined in the drawing plus 1.



Define by Lines

Allows one to define a plot from the lines making up a closed polyline. The lines should be selected in the order they make up the polyline. Once all the lines have been selected, the <Esc> button should be pressed or the mouse's right button clicked to create the plot.

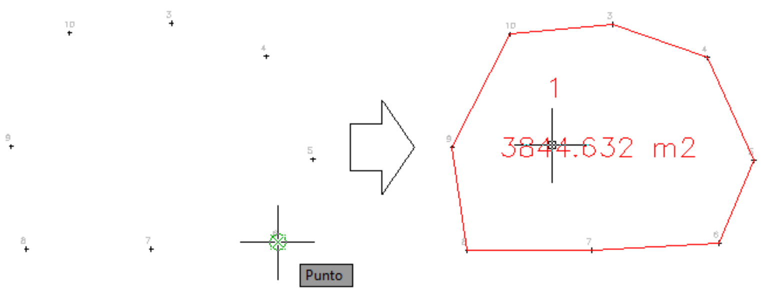
The plots are named with a numerical identifier equivalent to the number of the last plot defined in the drawing plus 1.



Define by Points

Allows one to create a plot from a series of points that will be taken as the vertices of the plot. Once all the lines have been selected, the <Esc> button should be pressed or the mouse’s right button clicked to create the plot.

The plots are named with a numerical identifier equivalent to the number of the last plot defined in the drawing plus 1.

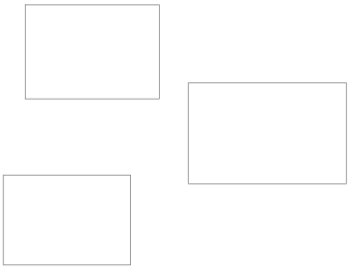


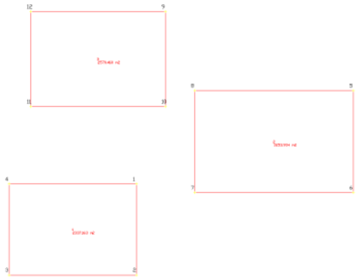
Define by Interior Point

This command will allow us to automatically define a plot based on the designation of an interior point of a closed polyline.

Create from drawing

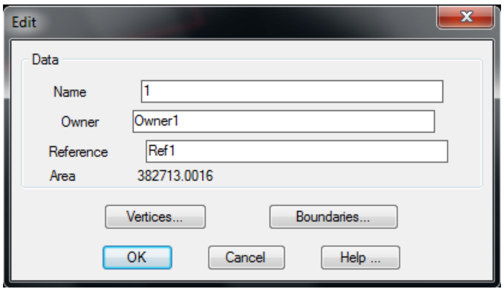
This command will read all the closed polylines to be found in the current drawing and it will automatically convert them into plots.





Edit

Allows one to change a plot’s **Name**, **Owner** and **Reference** after having selected it in the drawing. It also displays information about its **Area.**



Vertices: Provides information about the plot’s vertices (see **Plots > Vertices** command).

Boundaries: Provides information about a plot’s boundaries with the rest of the drawing’s plots (see **Plots > Boundaries**).

After having clicked **OK** or **Cancel,** a new plot can be requested. In order to exit the command, one must press <Esc> or right click the mouse once the dialogue box has been closed

Delete

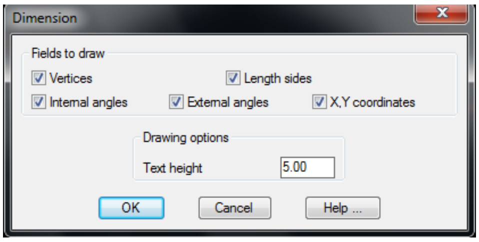
Allows one to delete plots individually by selecting its name graphically or selecting the polyline that makes it up.

Define Height

Draws a table containing detailed information about the plot selected. Once the plot has been selected, this information is shown in a window where one can choose the information that will be drawn.

- **Vertex**: Number of the vertex, beginning from 1.
- **Side Length**: Side length between the current vertex and the next one. The length of the last vertex is the distance between the current vertex and the first one.
- **Angle:** Internal and external angles of each vertex.
- **X,Y Coordinates**

Height of the Text to be used is also specified (set by default in the **Parameters** option).



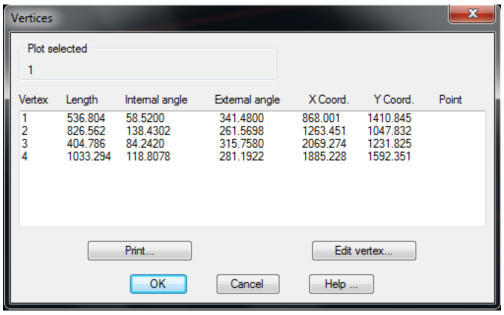
An insertion point for the table that will be created is then requested. This point coincides with the top left-hand corner of the table.

The command is repeated until the plot selection process is cancelled. The results' appearance for each of the plots are is displayed as follows:

Vertex	Lenght	Internal Angle	External Angle	X Coordinate	Y Coordinate
1	292.479	121.380	278.620	993.450	1880.655
2	420.194	105.661	294.339	843.592	1629.485
3	319.926	115.168	284.832	1183.894	1382.995
4	201.248	144.925	255.075	1427.413	1590.484
5	442.980	112.867	287.133	1427.413	1791.732

Vertices

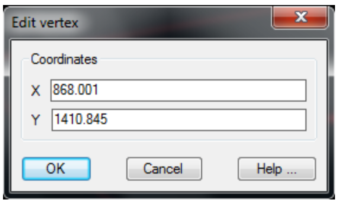
Provides information about the vertices of the plot selected. The following is shown for each vertex: vertex number, side length from the current vertex to the next one, internal and external angles, and X and Y coordinates.



Print: Sends the information about the plot's vertices to the printer.

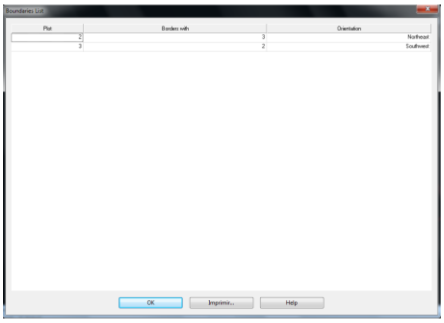
Vertex	Lenght	Internal Angle	External Angle	X Coord	Y Coord
1	89.982	96.8869	303.1131	362.509	119.421
2	61.072	117.2841	282.7159	383.417	206.940
3	105.612	99.0078	300.9922	444.447	209.199
4	85.671	86.8213	313.1787	446.708	103.611

Edit Vertex: Allows one to modify a vertex's coordinate values. Once accepted, the new values are updated in the drawing.



Boundaries

Shows information on each plot's orientation with regard to all plots bordering it at the four cardinal points.

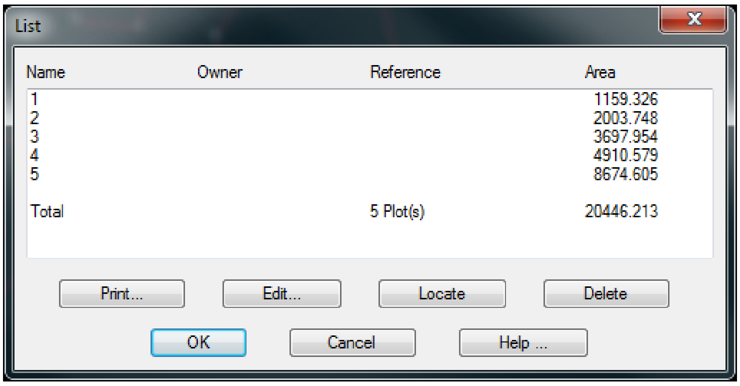


Print: Sends a list containing each plot’s boundaries to the printer.

Plot	Borders with	Orientation
2	3	East
3	2	West
	4	East
4	3	West

List

Shows information about a the name, owner, reference and area of all the drawing’s plots.



Print: Sends a report containing the on-screen plot information to the printer.

Name	Owner	Reference	Area
Parcela1	Prop1	Ref1	10562.331
Parcela2	Prop2	Ref2	7074.366

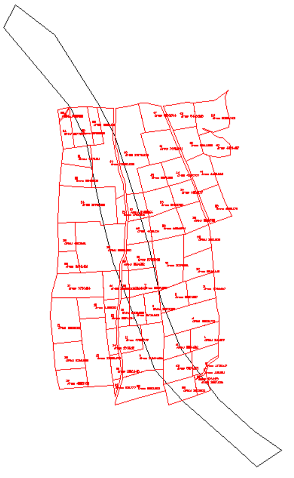
Locate: Shows the plot selected from the list on screen (see **Plots > Locate**).

Locate

By entering the plot’s **Name**, the corresponding plot will appear on screen. This command is useful when the plot is not within the area being viewed or when the zoom level is very low.

Occupation Area

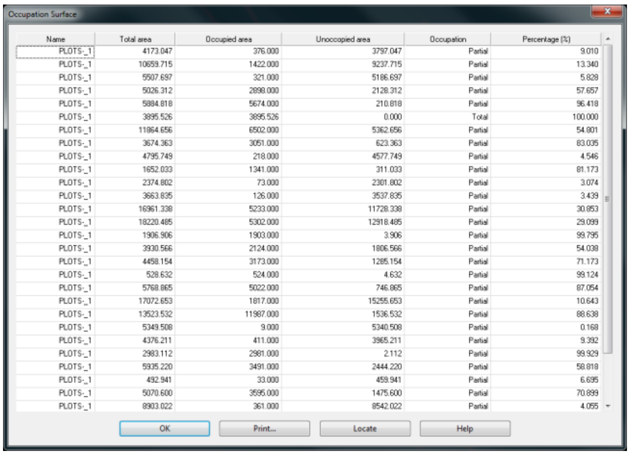
This command allows the calculation of the area concerned of one or several plots based on a closed polyline.



Initially the cell size is requested which will be used to calculate the surfaces. By default it is set at 1 metre. The smaller the cell, the larger the calculation accuracy.

Subsequently, the polyline must be designated which it encroaches on, which must be closed, and the plots for which it is wished to know the area occupied.

Once the calculation has been carried out, a list is presented with the plots concerned:



Occupation Surface

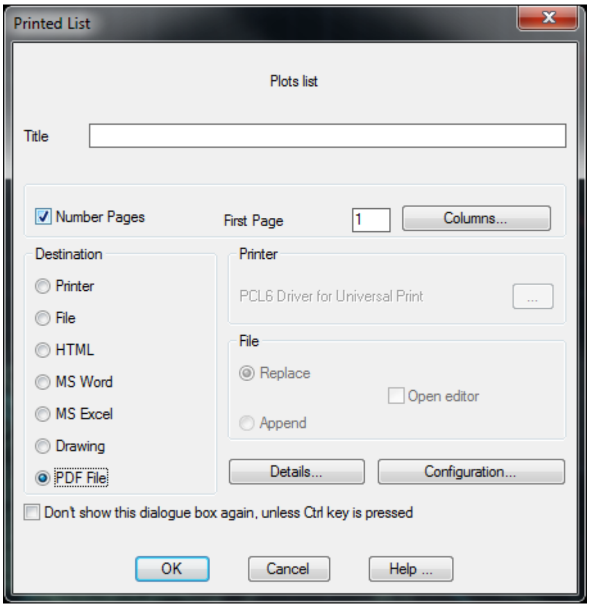
Name	Total area	Occupied area	Unoccupied area	Occupation	Percentage (%)
PLOTS-_1	4173.047	376.000	3797.047	Partial	9.010
PLOTS-_1	10659.715	1422.000	9237.715	Partial	13.340
PLOTS-_1	5507.697	321.000	5186.697	Partial	5.828
PLOTS-_1	5026.312	2898.000	2128.312	Partial	57.657
PLOTS-_1	5884.818	5674.000	210.818	Partial	96.418
PLOTS-_1	3895.526	3895.526	0.000	Total	100.000
PLOTS-_1	11864.656	6502.000	5362.656	Partial	54.801
PLOTS-_1	3674.363	3051.000	623.363	Partial	83.035
PLOTS-_1	4795.749	218.000	4577.749	Partial	4.546
PLOTS-_1	1652.033	1341.000	311.033	Partial	81.173
PLOTS-_1	2374.802	73.000	2301.802	Partial	3.074
PLOTS-_1	3663.835	126.000	3537.835	Partial	3.439
PLOTS-_1	16961.338	5233.000	11728.338	Partial	30.853
PLOTS-_1	18220.485	5302.000	12918.485	Partial	29.099
PLOTS-_1	1906.906	1903.000	3.906	Partial	99.795
PLOTS-_1	3930.566	2124.000	1806.566	Partial	54.038
PLOTS-_1	4458.154	3173.000	1285.154	Partial	71.173
PLOTS-_1	528.632	524.000	4.632	Partial	99.124
PLOTS-_1	5768.865	5022.000	746.865	Partial	87.054
PLOTS-_1	17072.653	1817.000	15255.653	Partial	10.643
PLOTS-_1	13523.532	11987.000	1536.532	Partial	88.638
PLOTS-_1	5349.508	9.000	5340.508	Partial	0.168
PLOTS-_1	4376.211	411.000	3965.211	Partial	9.392
PLOTS-_1	2983.112	2981.000	2.112	Partial	99.929
PLOTS-_1	5935.220	3491.000	2444.220	Partial	58.818
PLOTS-_1	492.941	33.000	459.941	Partial	6.695
PLOTS-_1	5070.600	3595.000	1475.600	Partial	70.899
PLOTS-_1	8903.022	361.000	8542.022	Partial	4.055

OK Print... Locate Help

For each plot the following data is shown:

- **Name**
- **Total area**
- **Occupied area**
- **Unoccupied area**
- **Occupation** which may be total or partial.
- **Percentage** occupation.

There is the possibility of printing the list in different formats.



If there is a large number of plots involved and it is wished to view a specific one, it can be selected from the list, pressing the ***Locate*** button. The program will allow zoom into the area where said plot is located.

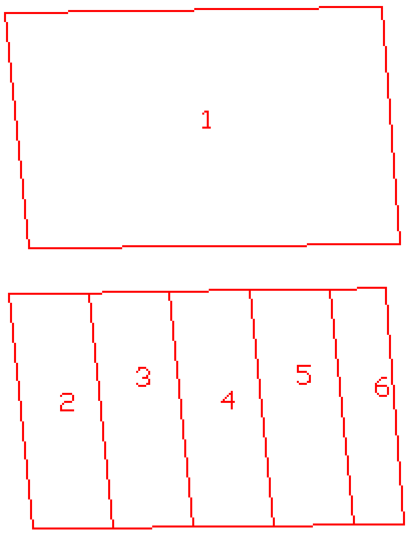
Divide

Offers the possibility of splitting up a plot into plots adjacent to a specific area by various criteria. These criteria are described below.

Divide by Parallel

Splits the plot into parallel plots on the side indicated. The steps to follow are as follows:

- Select the plot desired.
- Select the side parallel to which the plots will be created.
- Enter the area that should contain the plots which will be created. It should be smaller than the area of the plot that will be split. This area is shown in the command line split area is requested.



Divide by Parallel and Distance

Divides up the plot according to a parallel line on one side of the plot and at a distance from the latter. The steps to be taken would be the following:

- Select the desired plot.
- Select the side to which it will be parallel.
- Enter the distance.

Divide by Azimuth

Divides the plot according to a reference azimuth; once the azimuth has been entered, a reference line will appear to carry out the division. The steps to be taken would be the following:

- Select the desired plot.
- Enter the azimuth. The zero angle would be in the north.
- Move ye floating line to the desired position to establish the plot division.

Divide by Point

Divides the plot using as its reference a vertex of the latter; once the point has been selected, a floating line will appear in accordance with which the division will be carried out. Interactively on the CAD "command line" the calculation of the division area will appear in accordance with the position of the line.

Divide by Point and Azimuth

This command will create a division on the plot from a vertex thereof and a given azimuth. To enter the angle, MDT determines that the zero angle is in the north.

Divide by Perpendicular

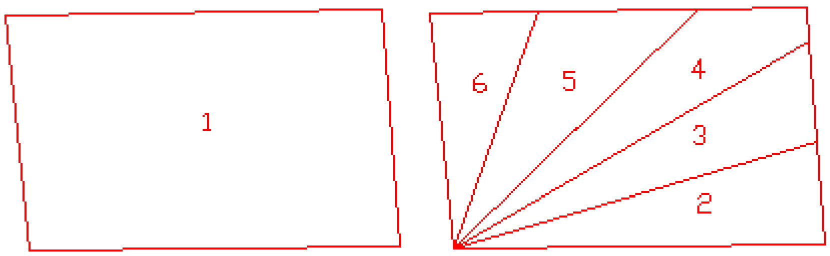
Splits the plot into plots perpendicular to the side indicated. The steps to follow are as follows:

- Select the plot desired.
- Select the side parallel to which the plots will be created.
- Enter the area that should contain the plots which will be created. It should be smaller than the area of the plot that will be split. This area is shown in the command line split area is requested.

Divide by Angle

Splits a plot by scanning it from the side indicated. The steps to follow are as follows:

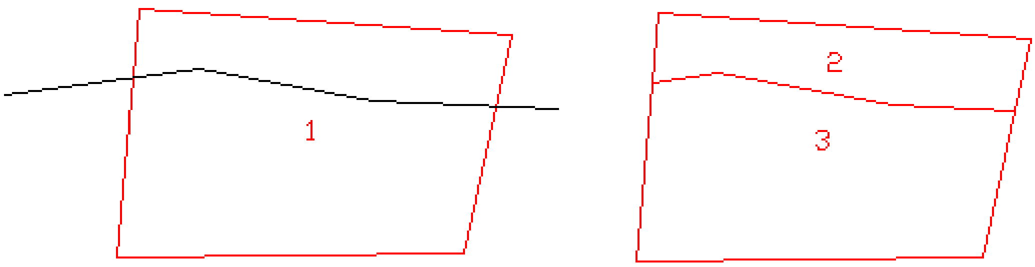
- Select the plot desired.
- Select the first vertex of the side from which the plot's angular scanning will begin.
- Enter the area that should contain the plots which will be created. This area should be smaller than the area of the plot that will be split. This area appears in the command line before asking for the split area.



Divide by Polyline

Splits one or several plots by a polyline that cuts them. The steps to follow are as follows:

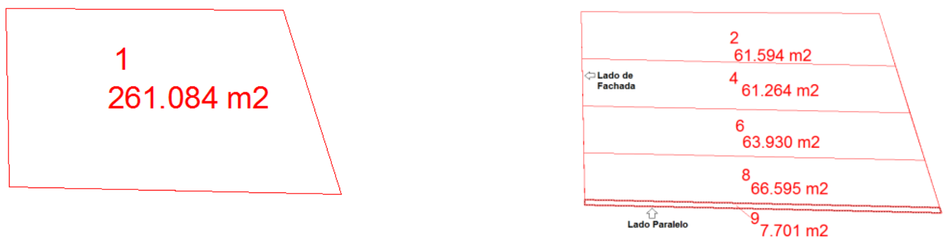
- Select the plots desired The selection can be multiple or single. Once the plot(s) have been selected, press the **Esc** button or right click the mouse.
- Select the polyline that cuts the plots.
-



Divide by parallel and façade length

Using this division method we will be able to divide up a plot parallel to a given side thereof and at given distances from the other side of the plot. The steps to be taken would be the following:

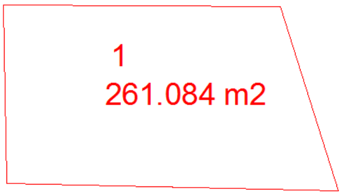
- Plot selection.
- Selection of the side from which the plot will be built in parallel fashion
- Selection of that side of the plot on which the distances will be calculated. Façade.
- Length of the side of the new plots

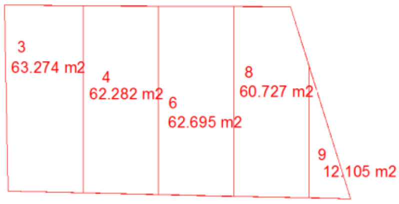


Divide by azimuth and façade length

In this case, the division of the plot is carried out in line with an azimuth, one side of the plot and a length which will mark the side of the new plots to be created. The command will request the following data:

- Plot selection.
- Azimuth.
- Side on which the new plots will be calculated. Façade.
- Length of the side of each of the plots to be created.

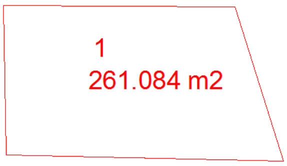


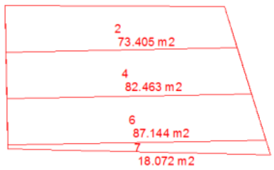


Divide by perpendicular and façade length

This division method is similar to the two previous ones, except that in this case the sides of the new plots will be perpendicular to the plot side selected. The data would be as follows:

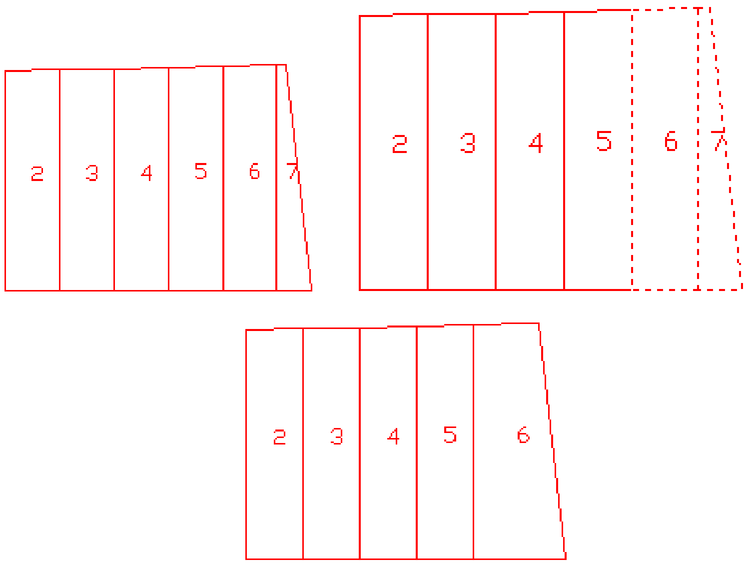
- Plot selection.
- Side on which the new plots will be created.
- Separation between the plots.





Merge

Allows one to merge several adjacent plots. In order to do so, the plots must be selected individually and in the order one will border with another.



Import

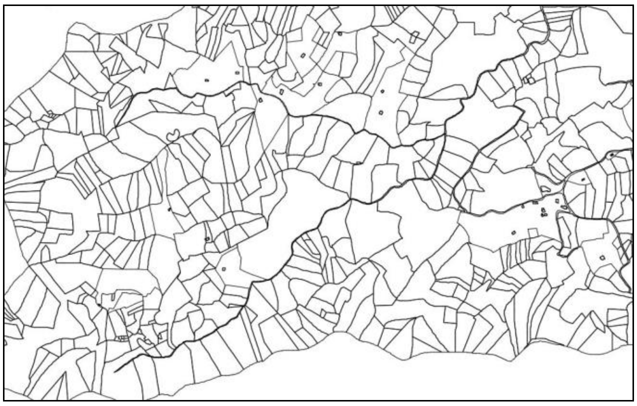
This command will enable us to import plots from known formats, and in this case we will be able to import from LandXML and shape.

LandXML

This program will request a file in LandXML format (XML extension). The plots will be drawn automatically, featuring straight lines or curves on the perimeter of the plots.

Shape

This option enables us to directly import a shape file (.SHP extension) with polygon type entities. The plots will be converted automatically. The image below illustrates the result of importing a specific file.



Geography Markup Language (GML)

The user will be asked for a file in GML format (.GML extension) featuring polygon type entities.

Export LandXML

This option enables us to export all the plots featured in the drawing to a file in LandXML format.

If the export is successful, the XML file will open automatically.

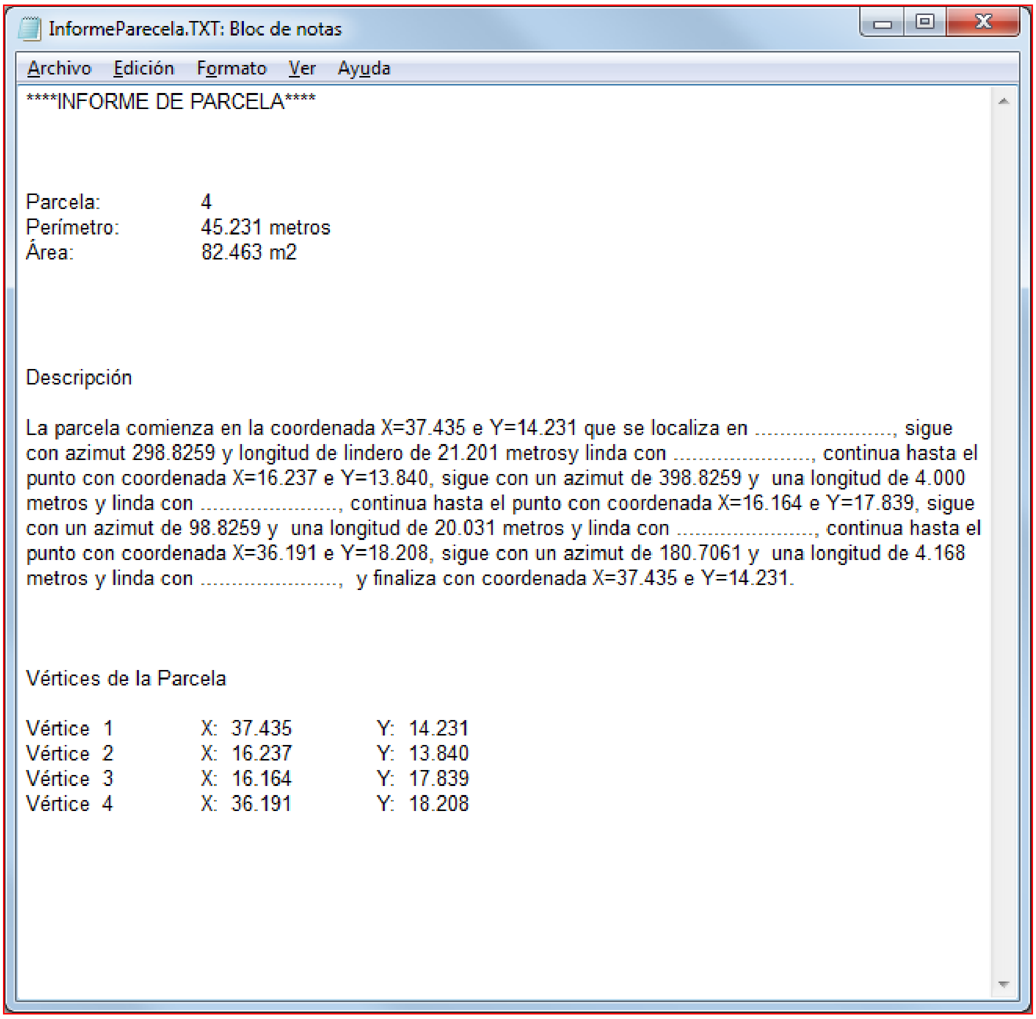
MDT Export

Stores information about the current drawing's plots in an ASCII file with the `.PAR` extension. The following is stored for each plot: name, owner, reference, area and centroid coordinates.

Report

This command will allow us to generate a complete report on the boundaries of a given plot as well as of its coordinates.

The program will asks us for the plot for which we wish to generate the report and a file will be created automatically in TXT format containing the information indicated.



InformeParecela.TXT: Bloc de notas

Archivo Edición Formato Ver Ayuda

****INFORME DE PARCELA****

Parcela: 4
Perímetro: 45.231 metros
Área: 82.463 m2

Descripción

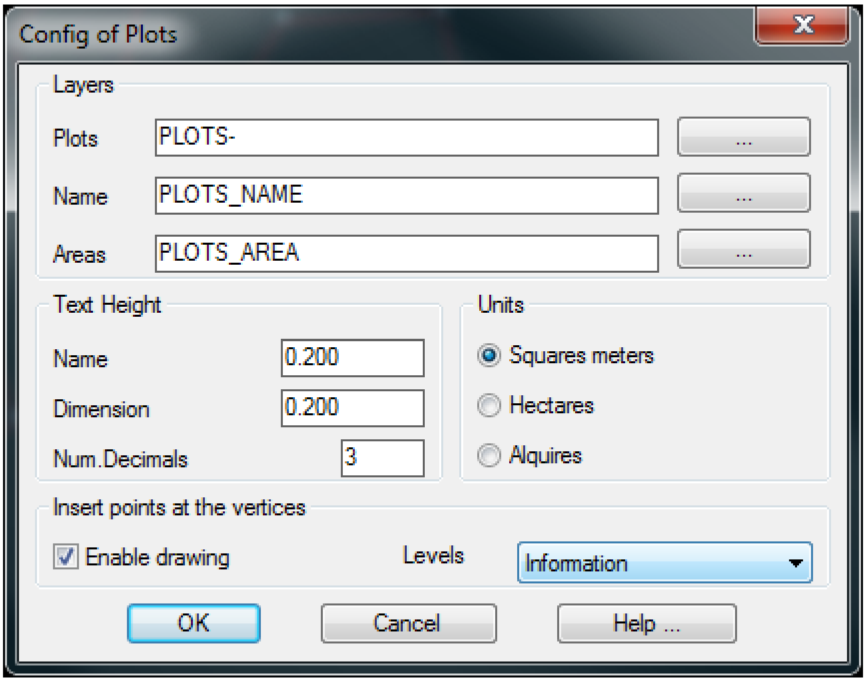
La parcela comienza en la coordenada X=37.435 e Y=14.231 que se localiza en ...., sigue con azimut 298.8259 y longitud de lindero de 21.201 metrosy linda con ...., continua hasta el punto con coordenada X=16.237 e Y=13.840, sigue con un azimut de 398.8259 y una longitud de 4.000 metros y linda con ...., continua hasta el punto con coordenada X=16.164 e Y=17.839, sigue con un azimut de 98.8259 y una longitud de 20.031 metros y linda con ...., continua hasta el punto con coordenada X=36.191 e Y=18.208, sigue con un azimut de 180.7061 y una longitud de 4.168 metros y linda con ...., y finaliza con coordenada X=37.435 e Y=14.231.

Vértices de la Parcela

Vértice 1	X: 37.435	Y: 14.231
Vértice 2	X: 16.237	Y: 13.840
Vértice 3	X: 16.164	Y: 17.839
Vértice 4	X: 36.191	Y: 18.208

Parameters

In this section we will be able to configure the different plot drawing parameters:



Plots: Name of the layer on which the plot will be created.

Name: Name of the layer on which the plot name will be labelled.

Area: Name of the layer on which the plot area will be labelled.

Text Height

> ***Name***: Text height of the plot name.
>
> ***Dimension***: Text height of the texts associated with the elevation mark of the plot vertices.
>
> ***Num. Decimals***: Decimal numbers when labelling the areas and coordinates of the plot vertices.

Units: Three units may be used to work on the labelling of the area.

- Square metres
- Hectares
- Alquires (used in Brazil)

Insert Points at the Vertices: If we enable this option, an MDT point will be drawn at the selected level for each of the plot vertices. This operation is carried out automatically when creating the plot.

19. Images

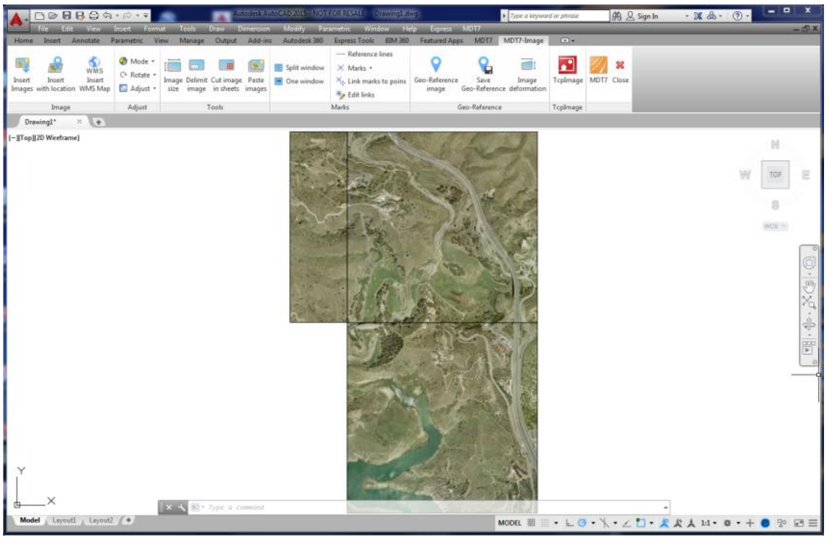
The tools described in this chapter allow the management of images with and without georeference.

Insert Images

This command allows us to insert into its coordinates one or several georeferenced images in TIF, JPEG, ECW, JPEG2000 or MrSID format (in AutoCAD, BricsCAD does not support JPEG2000 and ZWCAD does not support MrSID nor JPEG2000 images).

Once the command has been executed, it asks us for the images to be inserted. Then the program will search in the same folder and with the name of the respective images its georeference files where it will locate the insertion coordinates of the drawing and its scales, automatically inserting the images at said coordinates.

In the event that there is no georeferenced file, the program will request in the command line the coordinates in which it is wished to introduce the image and the drawing scale, inserting the image in the position indicated.



In order to be able to view ECW, JPEG2000 and MrSID images in AutoCAD, it will be necessary to install a plug-in which can be obtained at any of the following links:

- AutoCAD Raster Design at

  http://knowledge.autodesk.com/support/autocad,

  en la pestaña *Download*, buscar la palabra “raster” en la casilla de *Keywords* y en *Type* elegir *Object Enablers.*

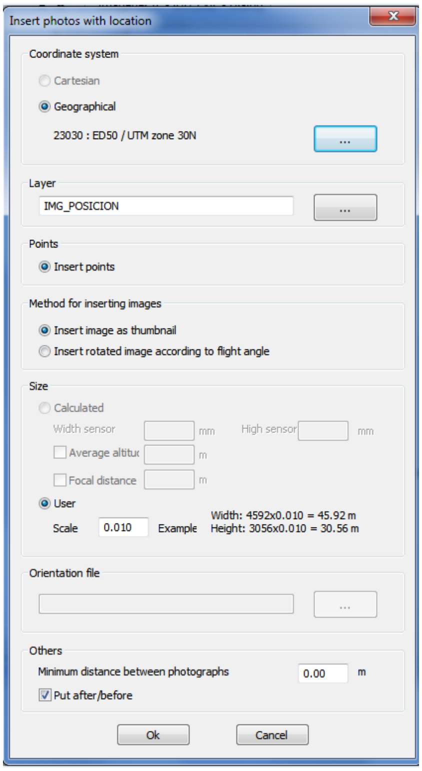
- ECW and JPEG 2000 Support for CAD, GIS, and Office Software at http://download.intergraph.com/

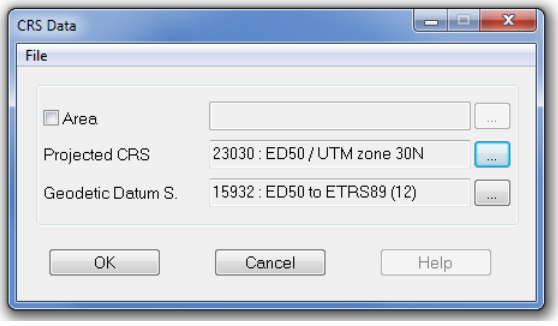
  En *Product Family* seleccionar *ECW Products* y en *Products* seleccionar *ECW Plugin.*

- These pages may have changed since the editing of this document.
- For BricsCAD and ZWCAD it is not necessary to install any complement.

Insert Pictures with Position

This command allows a group of images with EXIF(1) information about their location to be selected and shows a dialogue in which a choice can be made between inserting a point with a hyperlink to the image or inserting the image in miniature on the scale chosen by the user at said location.



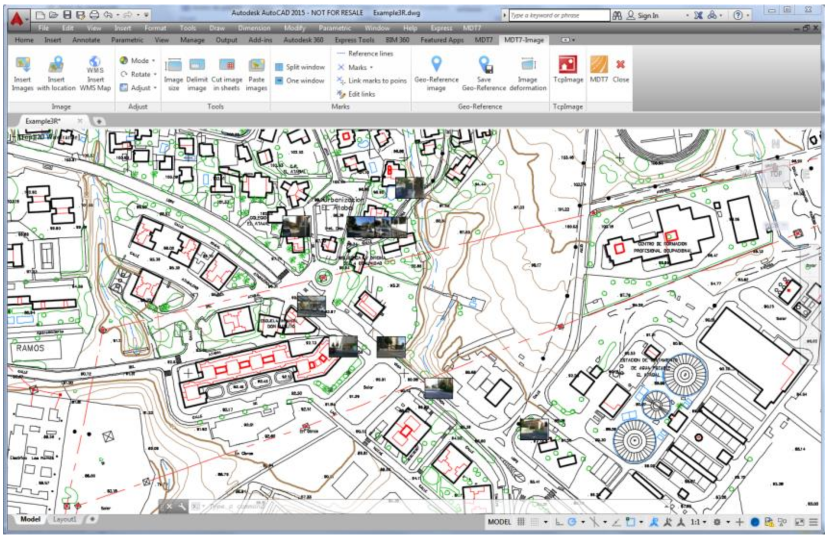


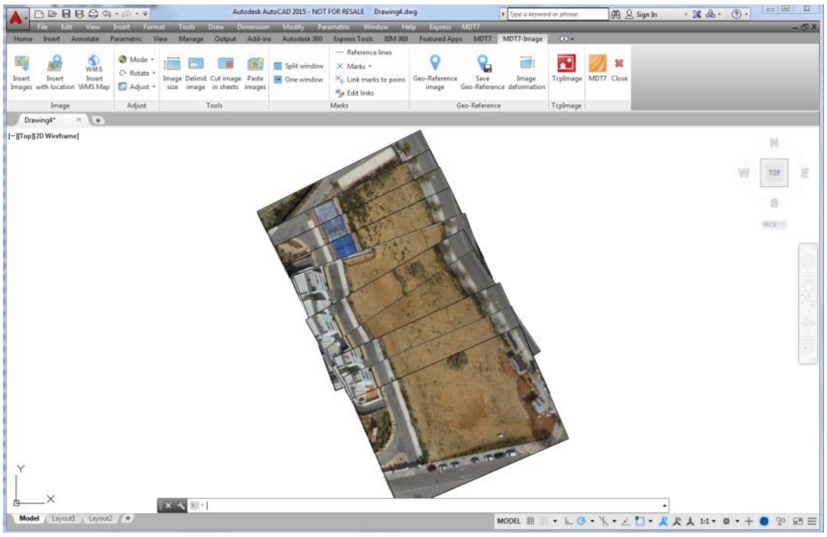
Those options which are common to both insertion methods are: insert points with a hyperlink, only images or both, select the appropriate coordinates reference system for converting the information taken from the EXIF labels for geographic coordinates (latitude, longitude, altitude) into projected coordinates (X, Y, Z) by pressing the browse button, choose the minimum distance between photos, their placement with regard to the drawing, in other words, in front of or behind the latter and the choice of layer. In order to able to open the hyperlink of the points inserted, go to **Points >Open hyperlink**, select the point and the image will be shown in the application predetermined in the system for opening images.

The specific options for the method to insert an image as thumbnail are: in the **Size** section, we can only choose the manual option and enter a scale value for which an example is shown with the height and width of one of the images selected so we can get some idea of the size of the image inserted.

The specific options for the method to insert an image turned according to the angle of flight are: the orientation information for these images may be shown on the EXIF labels or in a text file which can be selected in the section **Orientations file** which may come under Cartesian coordinates (x, y,z) or under Geographic coordinates (latitude, longitude and altitude), information which the user must be familiar with and select the corresponding option in the section **Coordinates system** in the event that the orientation information cones in a file, the user must also provide the focal distance of the camera. In the **Size** section a choice can be made between **Calculated**, whereby the scale is calculated based on the side of the sensor an the focal distance or **Manual** whereby it is the user who enters the desired scale value; this section also contains the **Average Altitude** field and it is used so that the user can insert a mean altitude value and so that the real altitude values of the images are not taken into account.

(1) EXIF *"Exchangeable Image File Format*" is a standardisation of the information about the image format. The EXIF information is in the same file: structure, size, encoding, date of creation, position, focal, amongst many other attributes. This standardisation allows the different digital cameras and smartphones to record this information in the images so that it can subsequently be read and interpreted numerous software and scripts for image handling. In the specific case of information about location, this can only be added by those devices with GPS integrated.

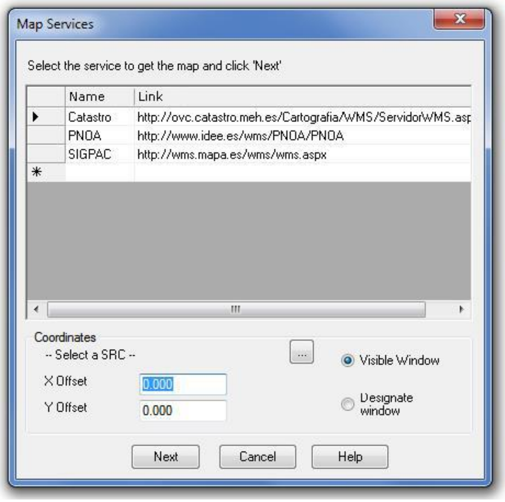




Insert WMS Map

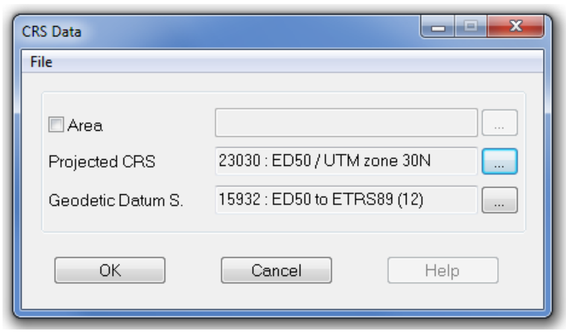
The OpenGis consortium http://www.opengis.org has developed a protocol to obtain geographic information by means of the Internet and a multitude of public and private organisations have services of this type. This command allows connection to one of these services, downloading an image and inserting it in the current CAD drawing at the appropriate coordinates.

Firstly, a window appears with a list containing the different maps' services configured in the program. This list includes a **Name** to identify the service and a website **Address** where the map request can be made. Elements can be added to the list, typing on the line marked *****. Furthermore, the drawing projection must be specified and whether it is wished to obtain an image which takes up the whole visible drawing area or designate a smaller window.



WMS-T Services: Some of the map services now provide the possibility of specifying the desired reference date for importing the map. This type of parameter is specific to each provider. The user may specify this parameter at the corresponding address. There follows an example in which the user accesses the Spanish Cadastre website for a specific date.

To select the drawing projected, the examine button must be pressed and it will show us the following dialogue:



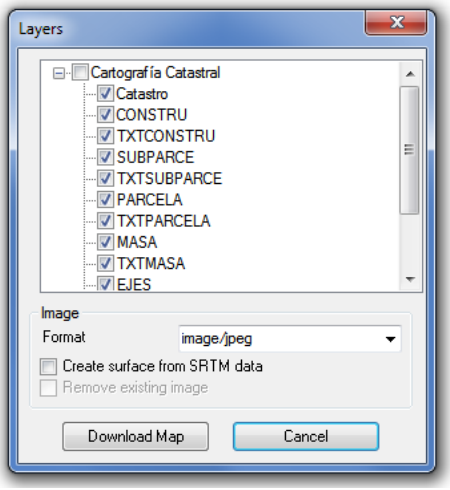
By pressing the **Next** button the program connects to the service selected on the list and another window appears to select the layers to be included in the image as well as the format of the latter. These options depend on the service selected.

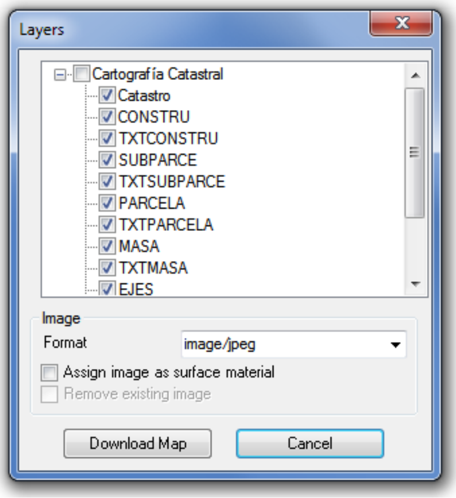
If there is a surface on the drawing, the possible dialogue options will be: **Assign Image as surface material**, if we activate this option the program is enabled to show this image in the commands Field Route, Road Route and **¡Error! No se encuentra el origen de la referencia.**. The option **Remove Existing Image** is enabled in the event that the drawing has already inserted an image. By activating it, a previous image may be easily replaced by another in the event of executing the command more than once.

In the event that there is no surface in the drawing, the option **Assign Image surface material** is replaced by **Create surface with SRTM data** (2) and upon activating this option, the Internet will be connected to obtain the information required to create the surface of NASA's SRTM mission (http://www2.jpl.nasa.gov/srtm/). The option **Remove Existing Image** will appear deactivated.

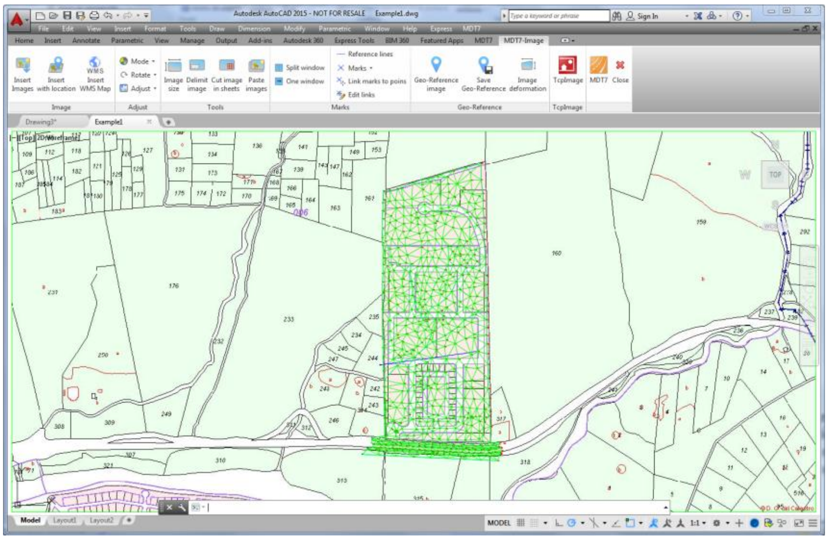
By pressing the **Download Map** button, the image requests starts and finally the program will request a file where to save it. A second file will be created automatically with the georeferencing data of the image and the image will be inserted in the drawing.

To consult the list of WMS services available in Spain, consult the following web page: http://www.idee.es. In other countries refer to mapping authorities.





When downloading an image from the cadastre where some layers have been selected, such as that of the cadastre, alignments, parcels, … the result could be as follows:



It may sometimes be impossible to download the map as there is no Internet connection for foreign countries; this may occur on local or corporate networks where the Internet connection is controlled by a username and password system. As such, if the command is unable to download the map because there is no Internet connection, it will request the username and password in a new window, so, in the event it exists, the user can insert the corresponding data.

(2) The SRTM "*Shuttle Radar Topography Mission*" consists of an especially modified radar system which was flown on board the space shuttle Endeavour to acquire stereoscopic topographic elevation data. Elevation models deriving from SRTM data is used with GIS (Geographic Information System) software

which may be accessed free-of-charge online and whose extension (.hgt) is supported by many software programs.

Colour

In all subsequent commands it is requested to select an image and the selection of the name and the location of the resulting image is allowed. When the command completes, in the drawing the original image is replaced by the resulting image.

Grayscale

This converts the selected image into a grayscale image.

Colour Resolution

This shows a dialogue in which it is allowed to change the number of pixels per colour which the selected image has.

In the dialogue the image is shown before and after applying the changes, in these image controls, the images can be viewed on a scale of 1:1 or a complete image.

The fields shown in the dialogue are:

Bits per pixel: this allows the number of bits per pixel of the image to be changed from 1 bit to 32 bits.

Dither method: this allows the selection of the squaring method to be applied to the image. This option will be activated when 8bits or less is selected in the **Bits per pixel** field and this is when one of these methods must be selected: None, Floyd Stein, Stucki, Burkes, Sierra, Stevenson Arce, Jarvis, Ordered and Cluster. The Ordered and Cluster method are the speediest and the most effective for reducing an image at 256 colours or less. The rest of the methods deploy error-diffusion algorithms with which greater quality is obtained; amongst these methods it would be worth highlighting the Floyd method which is the one that has the greatest quality and is the speediest and, generally speaking, the quality of these methods will depend on the size of the image or on what it is wished to do with the resulting image, viewing or printing it.

Palette: this allows the selection of the colour palette which will be used for the image and the different options are: fixed Palette, Optimised Palette, Netscape Fixed Palette, Windows Identity Palette, SVGA Palette, Uniform Palette and MSIE Palette. This option is also activated when selecting 8bits or less in the **Bits per pixel** field.

Colour order: this allows the selection of the order of the three colour components, Blue-Green-Red (BGR), Red-Green-Blue (RGB).

Open palette file: to select a palette which is different from the **Palette** options.

Turn

In all the following commands it is requested to select an image and the selection of the name and the location of the resulting image is allowed. When the command ends, the original image is replaced by the resulting image in the drawing.

Flip

This command allows the selected image to be flipped horizontally without altering its position.

Reverse

This command allows the selected image to be reversed horizontally without altering its position.

Rotate

The georeference will be affected by all the operations involving any kind of rotation; in these cases, it will changes the terms dependent on rotation and the scale on X and Y. The original image will not be affected and hence only the name and destination directory will be requested where the new georeference will be saved.

The left upper point of the image will be assumed as the point of reference for rotation.

Rotate 90º Left

Rotates the image 90º clockwise.

Rotate 180

Rotates the image 180º clockwise.

Rotate 270

Rotates the image 270º clockwise.

Any Angle

This allows an image to be rotated at an angle selected by the user.

Adjust

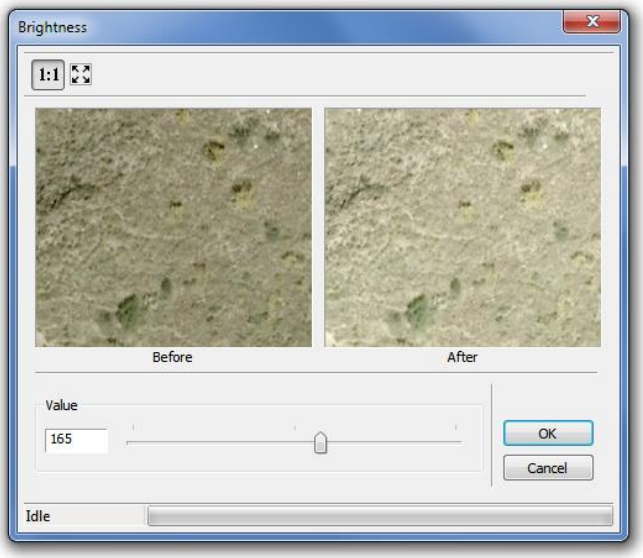
In the dialogues described below the image is shown before and after applying the changes; in these image controls the images can be viewed on the scale 1:1 or the complete image.

In all the following commands it is requested to select an image and the selection of the name and location of the resulting image is allowed. When the command ends, the original image is replaced by the resulting image in the drawing.

The difference of this command group from the specific AutoCAD ones lies in whether the original image is affected or not. Any adjustments made by this command group will be saved in an image file, whereas with AutoCAD, in which said adjustments are only saved in the drawing, the image file is not modified.

Brightness

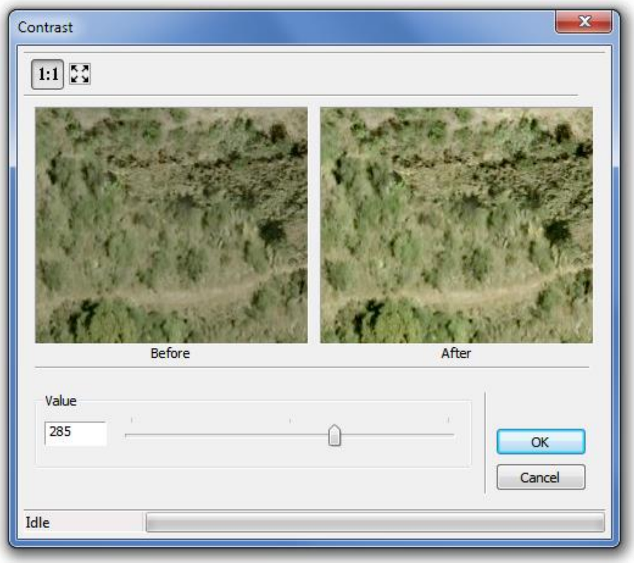
This allows the brightness of the selected image to be modified. Brightness is assumed to mean the total amount of light in an image.



Value: to modify the image brightness level and it may fluctuate between -1000 and 1000.

Contrast

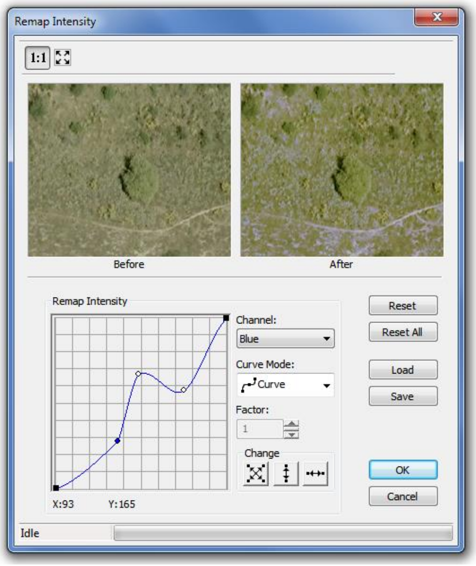
This allows the contrast of the selected image to be changed. Contrast is taken to mean the degree of difference between the darkest and brightest components in an image.



Value: to modify the image contrast level and it may fluctuate between -1000 and 1000.

Hue

This allows the hue of the selected image to be changed. The hue of a polychromatic image is taken to mean the level of each of the colour components (RGB) and, in the case of monochromatic images, the grayscale is referred to. This is why in the dialogue the levels of each component can be changed separately or jointly.



The dialogue has the following fields:

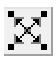
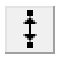
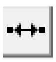
Channel: this allows the channel to be selected where the changes will be applied and it has four options: **RGB** (applied on all channels), **Red** (only applies to the red channel), **Green** (only applies to the green channel), **Blue** (only applies to the blue channel).

Curve mode: this allows the curve mode to be selected which is used in the graphic to modify the hue level. There are four options:

-  curve
-  lineal
-  exponential
-  logarithmic

Factor: this allows a factor to be given to the logarithmic or exponential curve.

Change: these modes can only be used for curves of the **Curve** or **Linear** type and they serve for moving the graphic curve.

-  movement of the curve vertically and horizontally.
-  vertical movement of the curve.
-  horizontal movement of the curve

Restore: puts the defect values on the current channel.

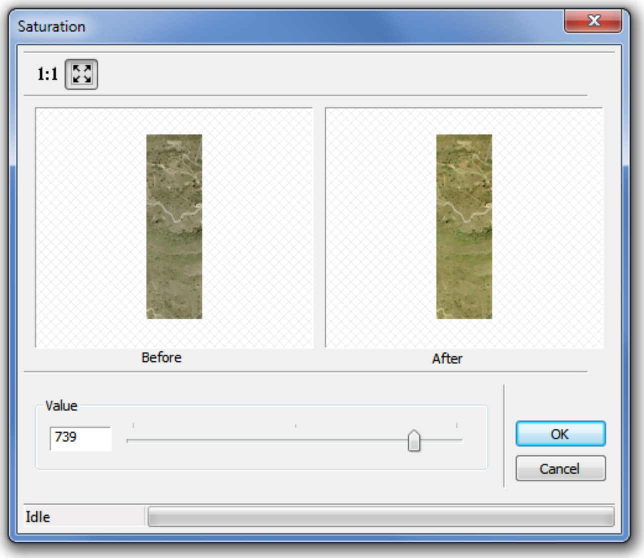
Restore all: puts the defect values on all the channels.

Load: this allows the loading of a file with an extension *.lri which contains the characteristics of the hue curve for application to the image.

Save: this allows the characteristics of the current hue curve to be saved in a file with the extension *.lri for use on a future occasion.

Saturation

This allows the saturation of the selected image to be changed. Saturation is taken to mean the relative purity or amount of white light mixed with a tone (represents the dominant colour), and this is why the pure colours of the spectrum are wholly saturated and they do not have any amount of white light.



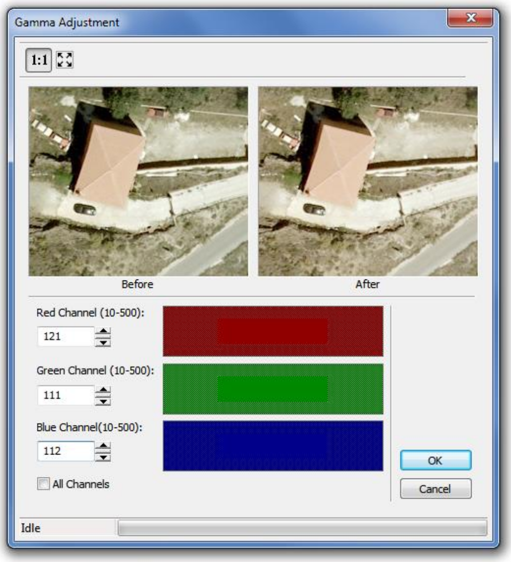
Value: to modify the amount of white light which is added to the colour of the image and may vary between -1000 and 1000.

Gamma

This allows the gamma values of each of the three colour channels of the selected image to be changed. The gamma correction is a special way of increasing contrast designed to improve the contrast in very light or very dark areas. This is achieved by modifying the mean values, particularly the medium-low ones, without affecting either the white (255) or the black (0). It may be used to improve the appearance of an image or to compensate the performance of different devices in the case of an image.

As in previous commands, the correction can be made on the three channels at the same time or on a given colour channel (RGB).

A gamma value of 150 is equivalent to the original hue curve. An increase in this value brightens the image and increases the contrast in the darkest areas. A value of under 150 darkens it and emphasises the contrast in the brighter areas.



The dialogue has the following fields:

Red Channel: to indicate the gamma value for the red channel, it may fluctuate between 10 and 500 and the value 150 is equivalent to the original gamma level of the image.

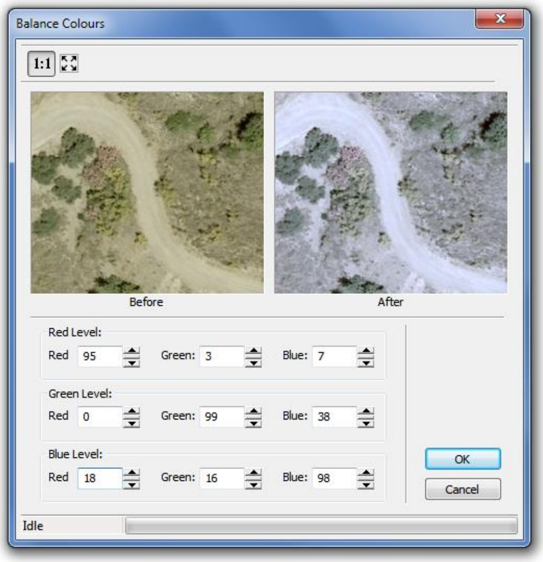
Green Channel: to indicate the gamma value for the green channel, it may fluctuate between 10 and 500 and the value 150 is equivalent to the original gamma level of the image.

Blue Channel: to indicate the gamma value for the blue channel, it may fluctuate between 10 and 500 and the value 150 is equivalent to the original gamma level of the image

All channels: when changing the value for one of the channels it is reflected for all the others.

Balance Colours

This allows a change in the total mix of colours in the selected image. Reference is made to the adjustment of the relative amounts of red, green and blue (primary colours) in an image in such a way that the neutral colours are reproduced correctly. The colour balance changes the total mix of colours in an image.



The dialogue has the following fields:

Red Level: this allows an adjustment to the red level, changing the different contributions of Red, Green and Blue. The ideal value in this case is Red = 100, Green = 0 and Blue = 0.

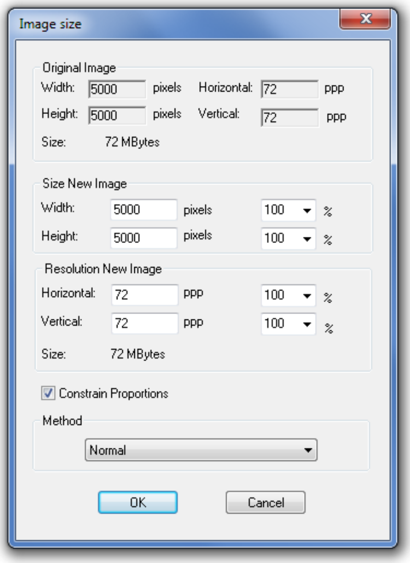
Green Level: this allows an adjustment to the green level, changing the different contributions of Red, Green and Blue. The ideal value in this case is Red = 0, Green = 100 and Blue = 0.

Blue Level: this allows an adjustment to the blue level, changing the different contributions of Red, Green and Blue. The ideal value in this case is Red = 0, Green = 0 and Blue = 100.

Resize Image

This shows information about the selected image such as the width and height in pixels, the horizontal and vertical resolution in pixels per inch, the memory size in bytes and this allows the editing of the size and of the resolution with or without restriction of proportions and with the possibility of choosing the interpolation method which will be applied to the image when resizing it.

The three possible interpolation methods will be: **Normal**, **Bilinear and Bicubic**.



The dialogue has the following fields:

Original Image

Width: indicates the width of the image in pixels.

Height: indicates the height of the image in pixels.

Horizontal: indicates the horizontal resolution of the image in pixels per inch.

Vertical: indicates the vertical resolution of the image in pixels per inch.

Size of New Image

Width: this allows a new value to be entered or X per cent to be applied to the width of the image if we modify the value on the drop-down list. This list will also allow the entering of a new value of X per cent as well as those values which are default.

Height: this allows a new value to be entered or X per cent to be applied to the height of the image if we modify the value on the drop-down list. This list will also allow the entering of a new value of X per cent as well as those values which are default.

New Image Resolution

Horizontal: this allows a new value to be entered or X per cent to be applied to the value of the horizontal resolution of the image if we modify the value on the drop-down list. This list will also allow the entering of a new value of X per cent as well as those values which are default. When modifying this value, the image width is automatically modified too.

Vertical Resolution: this allows a new value to be entered or X per cent to be applied to the value of the vertical resolution of the image if we modify the value on the drop-down list. This list will also allow the entering of a new value of X per cent as well as those values which are default. When modifying this value, the image height is automatically modified too.

Restrict Proportions: if this box is activated when modifying the width value, the height will also be modified and also vice versa as it is endeavoured to maintain the image appearance relationship. The same occurs with the horizontal and vertical resolution values.

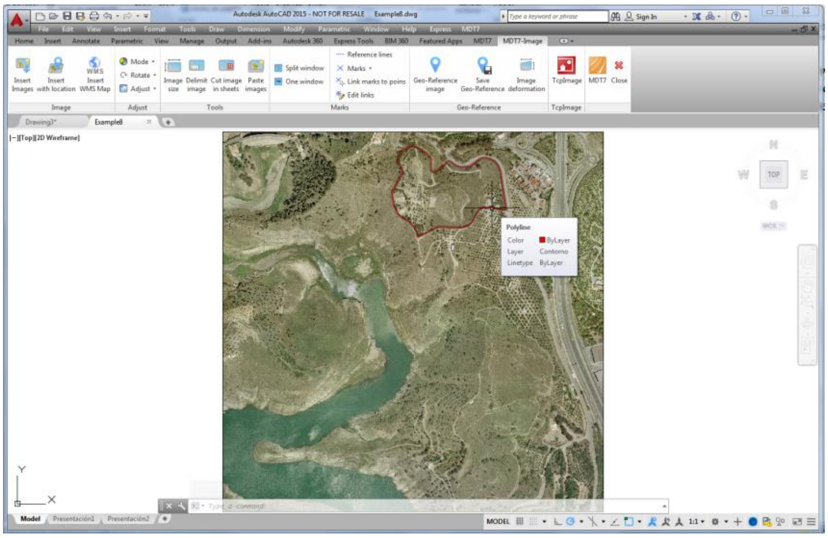
Method: when changing the image size, a new image must be created and hence a pixel interpolation method must be used and the options are Normal, Resampling and Bicubic in order from lesser to greater quality in the resulting image.

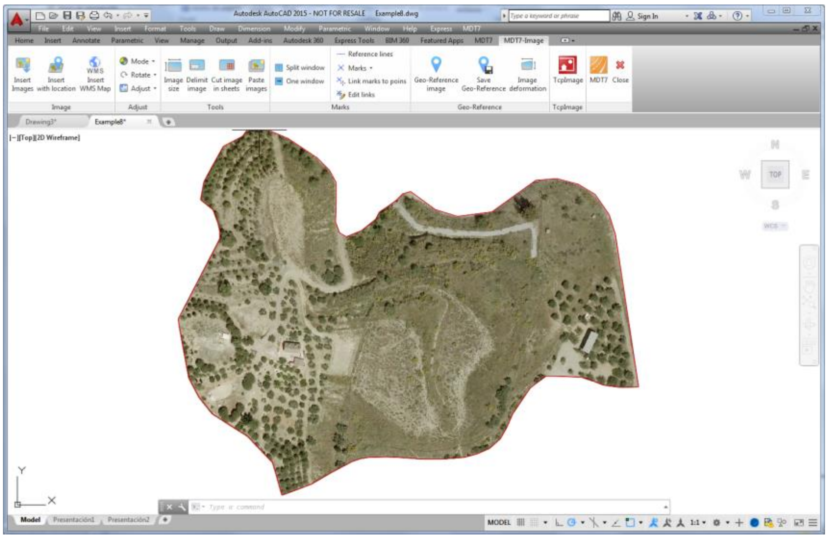
When changing the size of a georeference image, it will also be modified with regard to the scale in X and Y. When pressing the **Accept** button, it will request the destination directory for the new image which will be generated and its corresponding georeference.

Delimit Image

This command allows the selection of an image and a contour (closed polyline) and the creation of a new image with the area which encompasses said contour. The command will request the destination directory of the resulting image. The original image will be undone from the drawing and replaced by the new image.

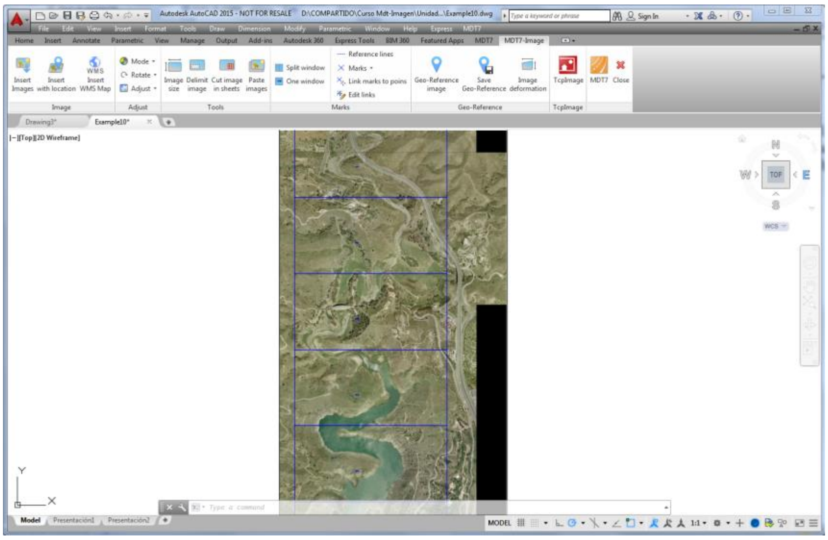
On AutoCAD there is a similar command called Delimit > Image, but the difference with this other one is that in AutoCAD it conceals the image area which is situated on the exterior of the contour, the modification is only saved in the drawing and this command cuts away the image and creates a new one with the result.





Divide on Sheets

This command allows the division of a georeferenced image on sheets, following as a standard a sheet scheme created with MDT using tools from the **Utilities >Sheets** menu. The command asks for an image to be selected and then the images corresponding to the sheets are gradually generated and will be stored in the image origin directory.



Paste Images

This command allows a group of georeferenced images to be pasted in a single final image whose georeference will be calculated in line with the images selected. The command asks for the selection of a group of images and of a directory in which to save the final image and its georeference. The image group will be replaced by the resulting image.

Marks

To use the following commands it is important to ascertain the following concepts:

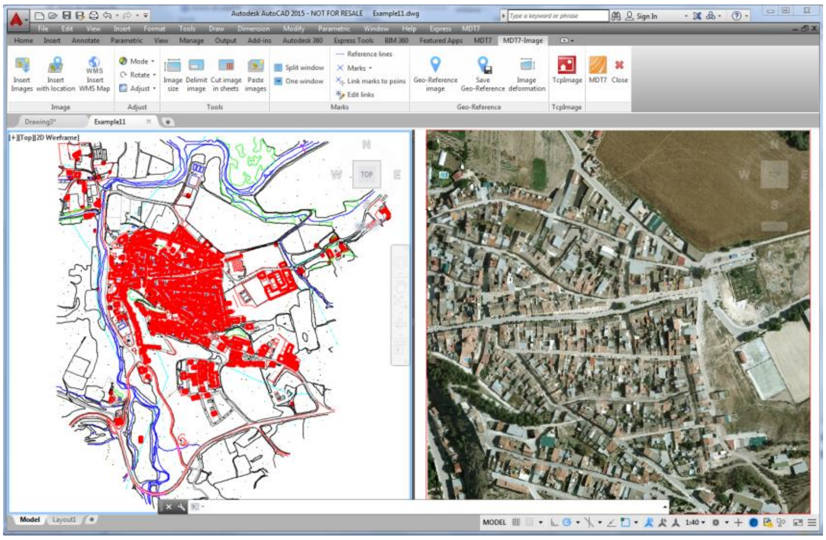
- **Marks**: this is the name given to those blocks inserted with the command **Create Marks** and they are used to indicate the support points in an image.

- **Links**: this is the name given to the line which joins a **Mark** to an **MDT Point** by means of the command **Create links of marks to points** and they will be used to pair the support points of the images with the field points when Georeferencing or Deforming an image.
- **Reference lines:** the concept is similar to that of the **Link**, but simpler as it does not require **Marks** or **MDT Points**, only designating on the screen an origin and a destination. They are created with the command **Create reference lines**.

Using **Links** or **Reference lines** will depend on the user's likes and requirements, but both may be used either together or separately to calculate the Georeference or Deformation of an image.

Split Window

This command allows the division of the work space into two windows to delimit the first window will request the selection of an image and for the second window two points and in this way on the first window we will have a zoom extension over the image and in the second window a zoom extension over the selected area. This command will facilitate the drawing of **Reference lines** for us and the creation of **Marks** and **Links**.



Restore to single Window

This command allows the work space to be restored to a single window.

Create Reference Lines

This command allows the creation of **Reference lines** which will be used for the **Georeferencing** or **Deformation** of images. All the **Reference lines** will be drawn on the same "IMG-REFERENCE" layer and in one colour by defect, both the name of the layer as well as the colour of the line may be modified under **Utilities** > **Configuration** > **Images**. The command will request an origin which will be the points on the image and a destination corresponding to field points.

Create Marks

This command allows the creation of **Marks** to indicate support points on an image and which will subsequently be used as an origin in the creation of **Links** for the **Georeferencing** or **Deformation** of images. All the **Marks** will be drawn on the same "IMG-MARKS" layer and in a default colour and both the name of the layer as well as the colour of the line can be changed under **Utilities** > **Configuration** > **Images**.

Move Marks

This command allows the selected **Mark** to change position.

Delete Marks

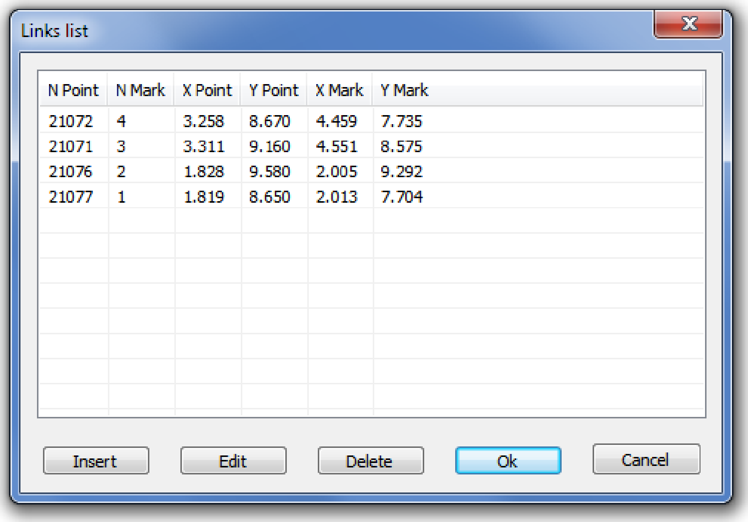
This command allows the selected **Mark** to be deleted.

Link from Marks to Points

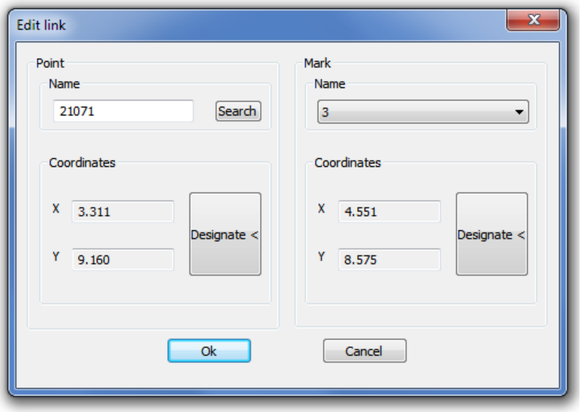
This command allows a **Link** to be created, selecting a **Mark** as an origin and an **MDT Point** as a destination, thereby identifying a pair of points which will subsequently be used for the **Georeferencing** or **Deformation** of an image.

Edit Links

This command shows a dialogue in which the links created can be inserted, edited and deleted.

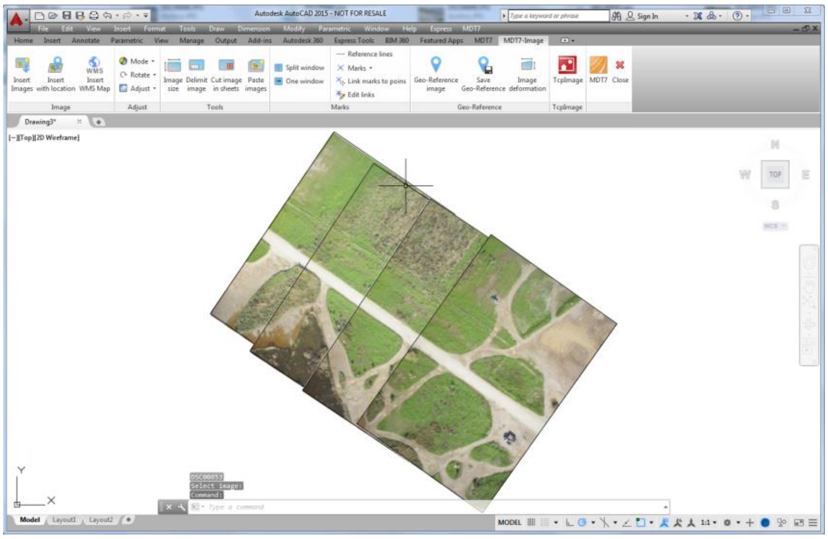


When selecting an element from the list and pressing **Insert** or **Edit**, the following dialogue is shown in which a certain **MDT Point** can be **Searched** amongst all those to be found in the drawing or designating the point on the screen and furthermore a **Mark** can be selected from the corresponding dropdown list or also designated on the screen.



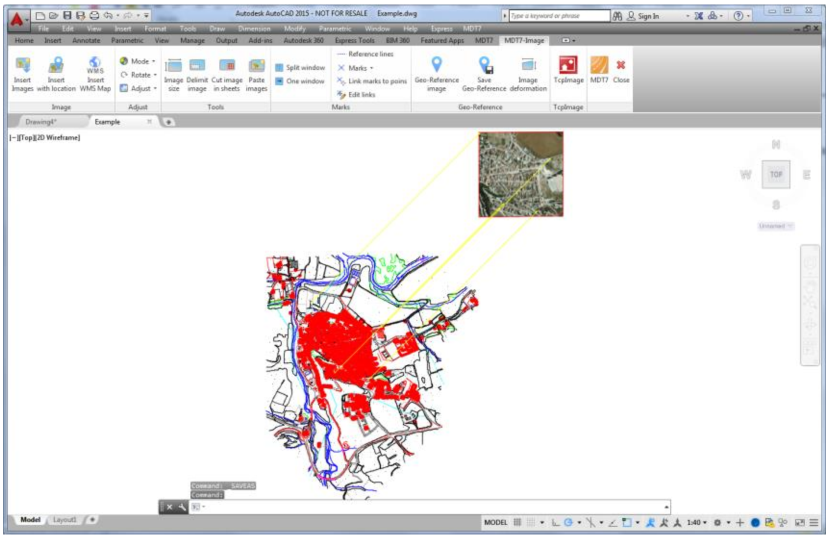
Identify Image

This command allows the selection of an image and shows the file name on the text window so as to be able to identify it speedily from amongst a group of images.

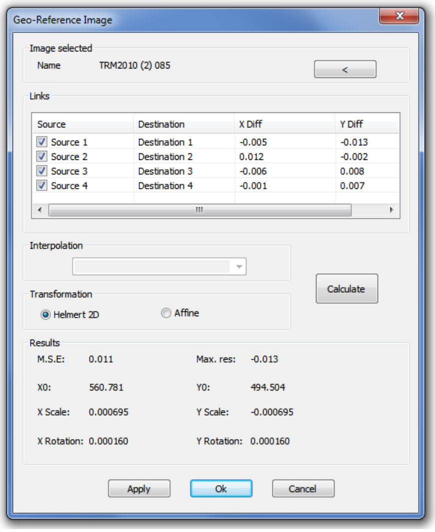


Geo-Reference Image

In order to be able to use this command it is necessary to insert an image and have defined at least two **Reference lines** or **Links**.



This command will request the selection of an image which will be georeferenced and it will show the following dialogue in which the name of the file of the selected image is revealed which may be changed, designating on the screen the list of all the **Reference lines** and **Links** to be found in the drawing which may be activated or deactivated to form part of the transformation calculations and said transformation may be **HELMERT 2D** based on two pairs of points, or **AFIN**, based on three pairs of points. As a result, the **MSE,** mean square error, will be shown as well as the **Max.Res.**, the maximum residue, **X0** and **Y0**, coordinates of the upper left-hand point of the image, **Scale on X** and **Y**, in m/pixel and **Rotation in X** and **Y**.



The **Apply** button allows the viewing of the result of the Georeferencing before endorsing the operation. By pressing **Accept** the Georeferencing is endorsed and the image is inserted in the coordinates resulting from the transformation, the destination directory will be requested for the georeference file which has been created and the **Reference lines**, **Links** and **Marks** will be deleted which have been involved in the transformation. By pressing the **Cancel** button, the operation cancelled and all the elements are restored.

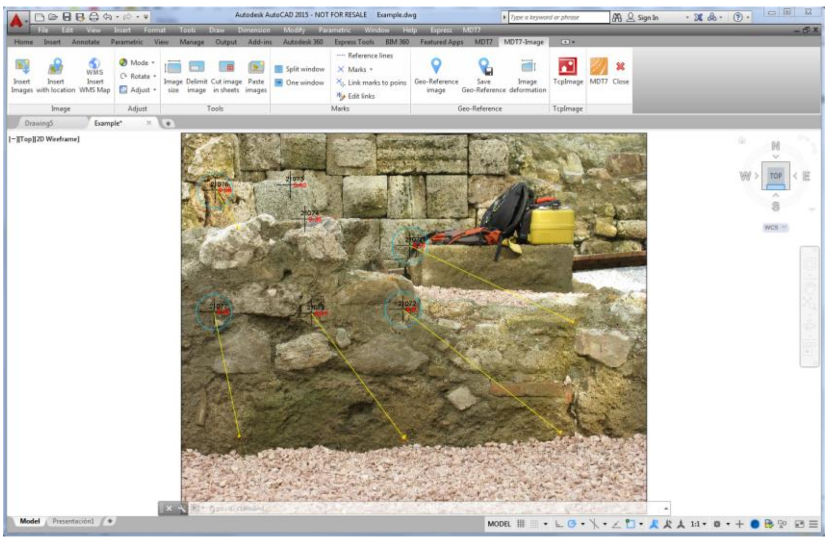
Update Geo-Reference

This command allows the creation of a Georeferencing file based on an image inserted in a drawing, already correctly situated in its coordinates. Just select the inserted image and the program asks for the file name where the information will be saved relating to the Georeferencing of the image which, by default, will be the same as the image file and a different extension (for example, if the original is called IMAGE.JPG, an IMAGE.JPGW file will be created).

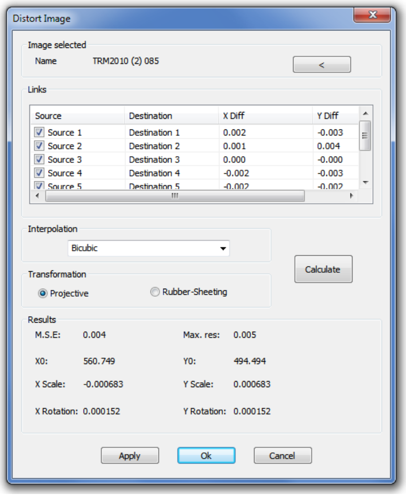
If the image is in the drawing but is not situated at its original coordinates, it is recommended to fit it in using the **Georeference** command, assigning real field coordinates to points of the image by means of **Reference lines** or **Links from Marks to Points**.

Distort Image

In order to be able to use this command it is necessary to insert and image and have defined at least four **Reference lines** or **Links**.



This command will ask for the selection of the image which is going to be deformed and will show the following dialogue where the file name of the selected image is shown which may be changed by designating on the screen, the list of all the **Reference lines** and **Links** related to the selected image which may be activated or deactivated to form part of the calculation, the interpolation method used to generate the final image may be selected and it may be, **Next neighbours**, **Bilinear**, **Bicubic** or **Lagrange**, the method of transformation may be selected and it may be, **Projective** or **Rubber-Sheeting** in both cases at least four pairs of points will be required. As a result, the **MSE**, mean square error will be shown as well as **Max.Res.**, maximum residue, **X0** and **Y0**, coordinates of the upper left-hand point of the image, **Scale in X** and **Y** in m/pixel and **X** and **Y Rotation**.

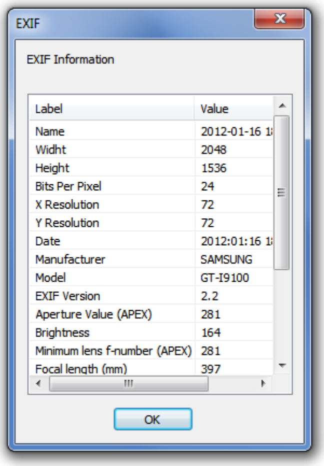


The **Apply** button allows the viewing of the result of the Deformation before endorsing the operation. By pressing **Accept** the adjustment is endorsed and the image is inserted at the coordinates resulting from the transformation, the destination directory will be requested for the generated image and its corresponding georeference file and the **Reference lines**, **Links** and **Marks** which have been involved in the transformation will be deleted. When pressing the **Cancel** button, the operation is cancelled and all the elements are restored.

The main difference between the Projective transformation and Rubber-Sheeting method is the numbers of points that may be adjusted, in the case of projective, four points may be adjusted as maximum, in the case of Rubber-Sheeting, all points involved of the calculation may be adjusted.

View EXIF information

This command shows whether the EXIF information which contains the selected image exists.



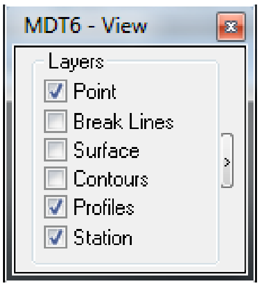
Run TcpImage

This command allows the TcpImage application to be opened if it is installed in the system.

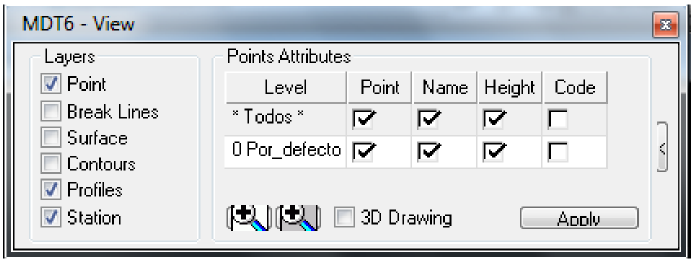
20. Utilities

View

This tool allows one to easily hide or display information grouped in layers. When it is selected, a window containing a set of options will be displayed. These hide or display (i.e. they change the state) the relevant layer groups.



Clicking the right mouse button displays a drop-down menu of information on the points. The visibility of each level of points can be changed separately, or that of all points at the same time. The information disappears with another click on the right mouse button, leaving the window a smaller size.

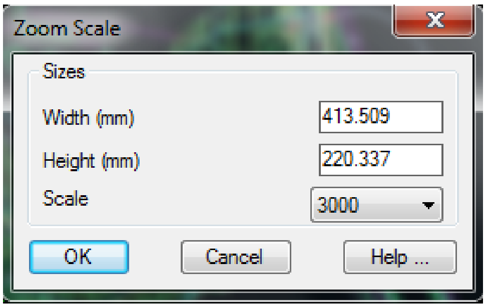


Additionally, one can customize the way points are viewed. This can be by attributes, point types, levels, etc. In order to do so, the ***MDT5 > Points > Change > Change Format*** command should be executed.

Zoom to Scale

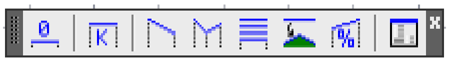
This tool allows one to modify the current drawing's zoom level, allowing it to be measured on screen at a specific scale. It is very useful for tasks like editing cartography and checking if certain details will be visible or not when printed.

The ***Width*** and ***Height*** fields specify the screen dimensions in millimeters, which are automatically calculated by the program. The ***Scale*** box indicates the value of the scale denominator desired.



Elevation of Objects

This command allows one to convert a flat cartography containing 2D entities into 3D cartography, in order to prepare it to obtain profiles or a surface. The objects processed by this command include lines, polylines and arches. The program displays the following toolbar from which one can select the different methods available, which are described below.



The icons from left to right are described below:

Zero Height: One simply has to select the objects to be assigned a height of zero.

Constant Height: The program first requests the height. Then one has to select the objects to be elevated.

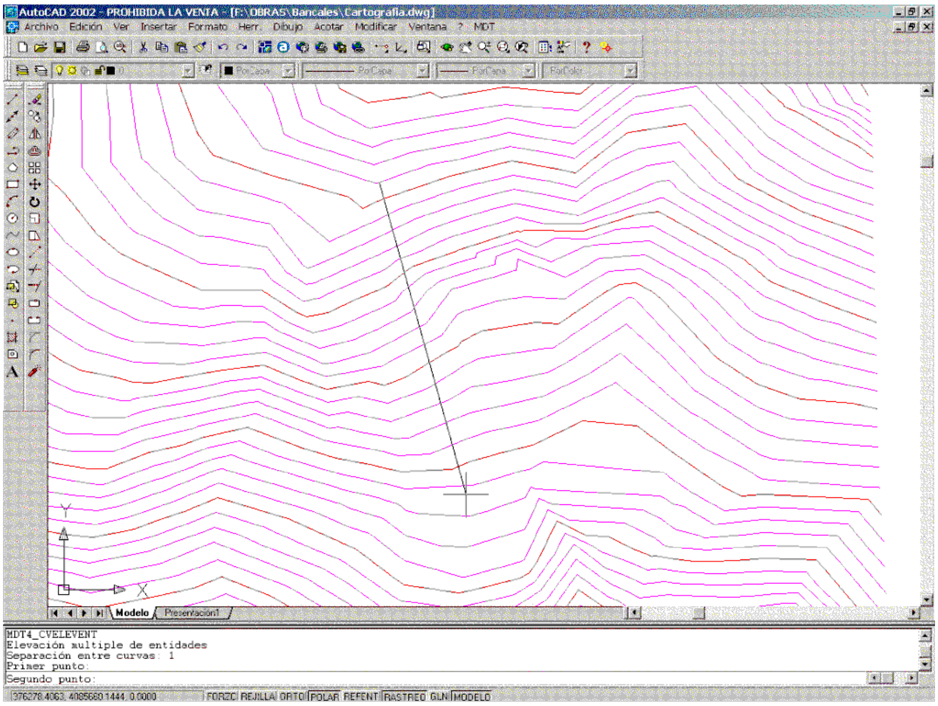
Ends: Once an object has been selected, the program requests the initial and final heights. The program takes the end closest to the point selected as the start of the object. Should the object be a polyline, the height is interpolated at intermediate vertices. Should the object be an arch, it is discretized and converted into a polyline before the heights are assigned.

Variable: This option allows one to assign different heights to an object's vertices. If the object selected is a line or an arch, this option behaves like the ***Ends*** command and requests the initial and final heights. Should a polyline be selected, the program situates itself at the first vertex and displays the following sub-menu in the command line:

Height/Reference/Back/Move/Exit <Interpolated>:

If a ***Height*** is entered, it is assigned to the corresponding vertex. If ***Reference*** is chosen, the program will request one to select a point. It will then take the same height as the point selected. The ***Back*** option allows one to go back in order to edit the last vertex. If ***Move*** is chosen, the vertex's X and Y coordinates can be moved. ***Exit*** takes one back to the tool's main menu. If *<Enter>* is keyed in directly, height will be interpolated from the other vertices' heights.

Multiple: This option allows one to raise several contour lines at the same time. The program initially requests the separation in height between successive contours and its sign. Then two points are entered, so that the line between them intersects several contour lines. Finally, the initial height is entered. With these data, the program assigns the first height to the first curve. It then successively increases the height using the separation entered and assigns it to the next contour line.

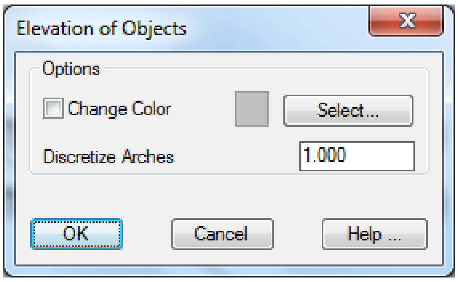


Surface: Once a set of objects has been selected, the program assigns each of their vertices the height corresponding to them in the current surface.. It also requests one to specify if one wishes to process the polylines that are already in 3D or just the 2D polylines. Should the surface not be defined, the program attempts to assign heights to each vertex on the basis of the drawing's points.

Inclined: One can assign heights of an inclined plane to a polyline's vertices using this option. Once the polyline has been selected, the program requests a point, its height, the direction of the slope on the plan, and for the slope (in percentage terms).

Options: A dialog box is displayed allowing one to specify the parameters affecting all the above-mentioned modes. If the ***Change Color*** option is activated, the color each object modified by this command will change color and assigned the one appearing on the right-hand side of the box. This is useful to modify large drawings, so that already processed objects can be differentiated. Additionally, the ***Arch Discretization*** box indicates the discretization value of arches and polyline arch segments that are elevated.

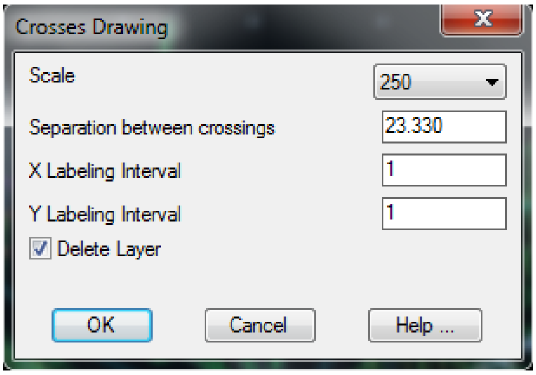
Tool Bar: Displays this command's tool bar on the AutoCAD user interface, allowing it to be subsequently used.



Draw Crosses

This option draws a set of crosses at coordinates with a set interval by specifying the distance between them and the distance between of X and Y coordinate labels. The CROSS and COORD blocks are respectively inserted. These blocks are in the `Blocks` folder located in the directory where the program has been installed.

Once the command is executed, MDT requests the coordinates that will set the limits of the crosses' drawing. Firstly one should choose the bottom left-hand corner and then the top right-hand corner. The program will then display the following dialog box, where the different parameters for drawing crosses are set.



Scale: Sets the scale of the drawing. The text sizes will be calculated on the basis of this value.

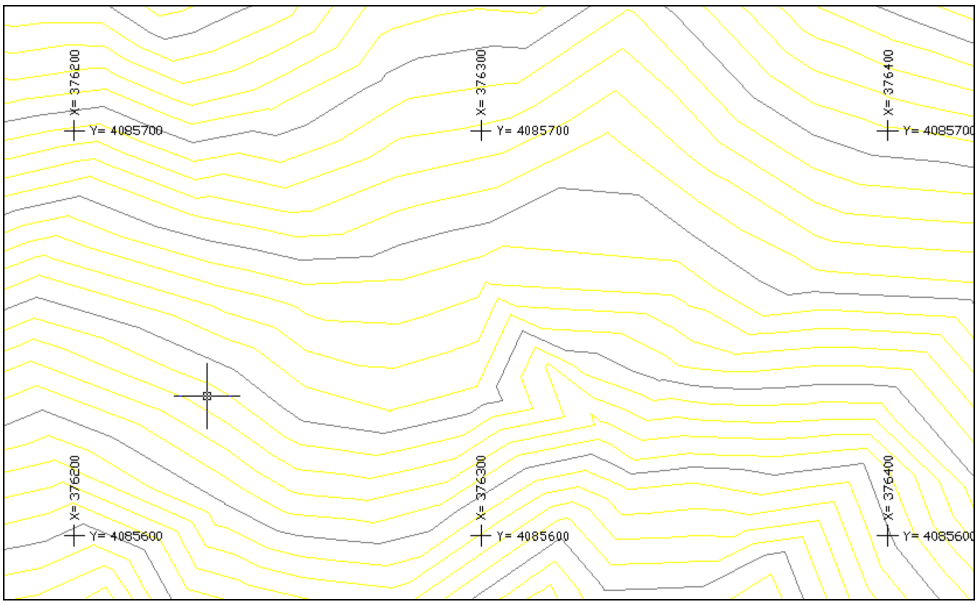
Separation between Crosses: MDT will label the crosses with the interval specified in this box.

X Labeling Interval: Sets the interval on the abscissa's axis with which one wishes to label the X values.

Y Labeling Interval: Sets the interval on the ordinate axis with which one wishes to label the Y values.

Delete Layer: If this option is activated, MDT will automatically delete any objects which happens to be in the same layer while drawing the crosses.

Once the dialog box is validated, it proceeds to draw the crosses.



Draw Slopes

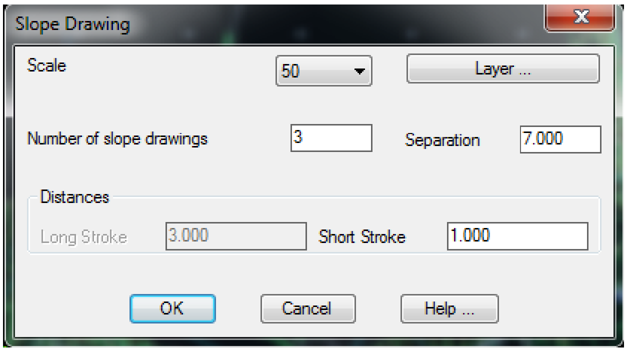
This command allows one to represent the cutting or fill slopes in the drawing.

The program initially requests the polyline from which the lines marking the slopes will start. Then the mode in which the tool will be executed in the command line is selected:

Partial: A polyline of origin is selected.

Total: The polylines of origin and reference are designated.

Once the polyline(s) are selected, MDT will display the following dialog box, where the way polylines are drawn is configured.



Scale: Sets the scale of the slope drawings.

Layer : The layer in which one wants to draw the slope drawings is selected.

Number of Slope Drawings: Number of short slopes to be represented between two long slopes.

Separation: Separation interval between two long marks.

Long Mark Distances: Length of long mark. This value is only valid should the ***Partial*** method be chosen, as the ***Total*** method uses the second polyline as a reference for the long mark's length.

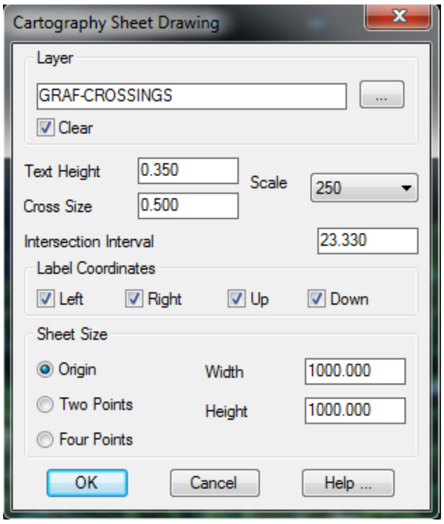
Short Mark Distances: Length of the short marks to be drawn.

Once the dialog box is validated, MDT proceeds to draw them.

Label Frame

This tool is similar to the **Crosses Drawing** command, except that in addition it also labels the frame according to the dimensions specified.

When the command is executed, the program displays a dialog box where a set of parameters to configure is displayed before the frame is drawn.



Layer : Layer in which the frame and crosses configured are drawn.

Clear: If this check box is activated, the program previously deletes any objects on the layer selected when it draws the frame.

Text Height: Height of the texts that are going to be labeled.

Cross Size: Value that defines the crosses' size.

Scale: Scale of the drawing.

Cross Interval: Interval of representation for the crosses. It is common for both the X and Y axes.

Width: Dimension of the frame along the abscissa.

Height: Dimension of the frame along the ordinate axis.

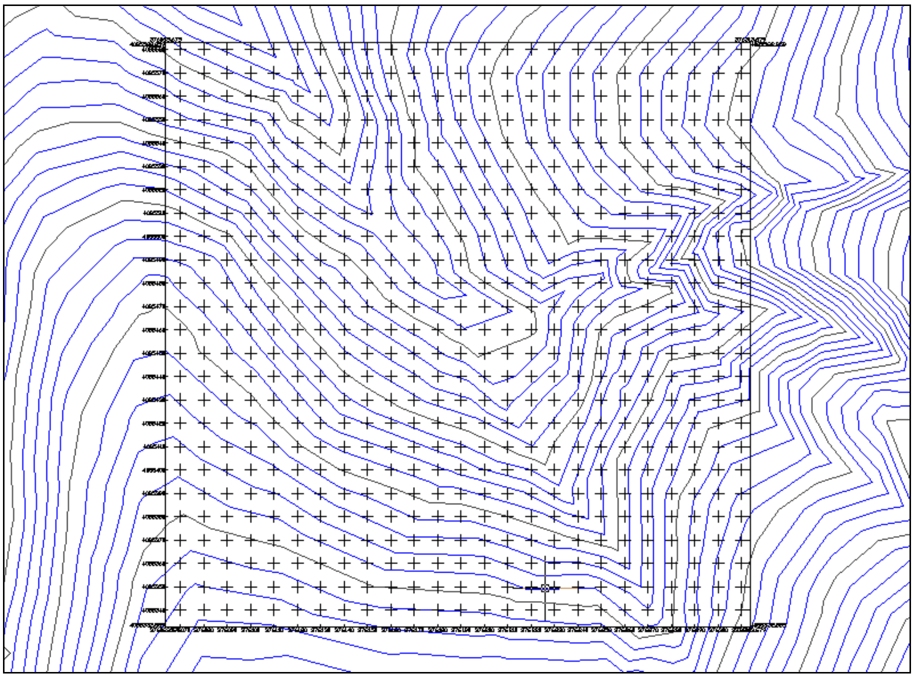
Label Coordinates: One activates the side of the grid in which one wishes to label the frame's coordinates.

Sheet Size: There are three possibilities when defining the frame's size.

- ***Origin:*** From a point selected on screen and with the ***Width*** and ***Height*** values set.
- ***Two Points:*** Sets the frame's dimensions from two points selected on screen.
- ***Four Points:*** The frame's dimensions are set by selecting four points that establish the frame's size.

Once the dialog box is validated, the program requests the origin from which the frame will be drawn. One can choose this point either graphically or by entering its coordinates in the command line.

An example of this tool's use is shown below:

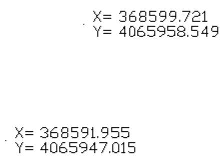


Identify Coordinates

This command allows one to identify and label the coordinates of the points selected in the drawing. Initially the following message is displayed in the command line:

```
Enter Height/<Coordinates>:
```

One can enter the height of the texts to be labeled by clicking on the ***Height*** option. Then one has to simply select the points to be labeled with the cursor.



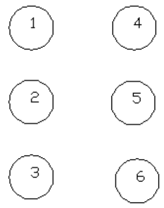
Number

This command allows one to quickly label a numbering sequence. Initially the following are requested in the command line:

```
Initial Number <1>:
```

Enter Height/<Coordinates>:

One can enter the height of the texts to be labeled by clicking on the ***Height*** option. Then one has to simply select the points to be labeled with the cursor.



Label Slope

This command is used to label the slope between two particular points. The slope is calculated in terms of the variation in the heights of the two selected points.

The selection can be made from a polyline or line with variable heights of its vertices or from two points with a height that is different to zero.

Once the entities from which the height will be calculated are selected, the program will request the parameters necessary to label the corresponding text, meaning, position, angle and height of the text.

Get vertices of polylines

This option generates a text file with the coordinates of the vertices of a selected polyline. The program will initially select the polyline in question and then the file in which it to save the polyline coordinates. This file will have a VRT extension. The user can specify number of decimals to save the coordinates of the vertices with.

The file format follows.

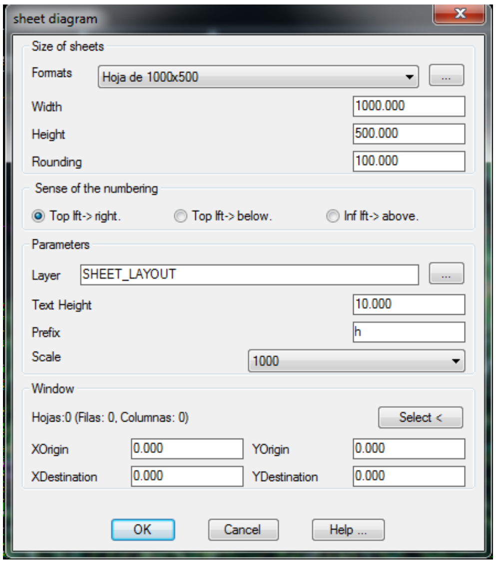
```
376673.987  4085499.905       0.000
376673.987  4085621.860       0.000
376794.479  4085563.199       0.000
376746.592  4085487.556       0.000
376723.420  4085628.035       0.000
376826.919  4085649.647       0.000
376879.441  4085462.856       0.000
376879.441  4085439.700       0.000
376933.509  4085419.631       0.000
376982.940  4085439.700       0.000
376927.329  4085566.286       0.000
376867.083  4085481.380       0.000
376908.792  4085455.137       0.000
376962.859  4085436.612       0.000
376896.433  4085347.075       0.000
376830.008  4085394.931       0.000
376830.008  4085448.962       0.000
376859.359  4085482.924       0.000
376859.359  4085510.712       0.000
376707.972  4085649.647       0.000
376707.972  4085705.222       0.000
```

Sheets

A series of commands allowing one to divide an CAD drawing into different sheets is to be found in this option. The aim of these commands is to separate them into different drawings and print them.

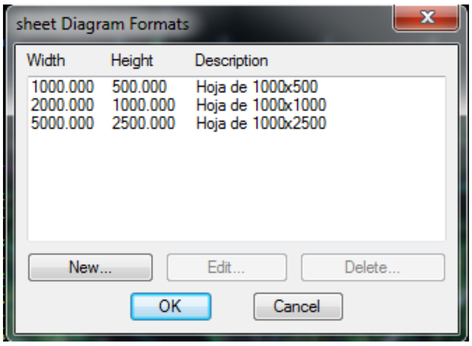
Draw Diagram

When this command is executed, the following window is displayed where the characteristics of the sheets where the drawing will be inserted are set.



Formats: One can choose among the different predefined formats available. However, the dimensions of the sheet selected can subsequently be changed in the ***Width*** and ***Height*** fields.

Also, if we press the **"..."** button we access a screen used to personalize the different sheet formats.



Direction of the numbering: This is to indicate the direction in of the numbering of the sheets to insert. There are three possibilities given in the dialog box.

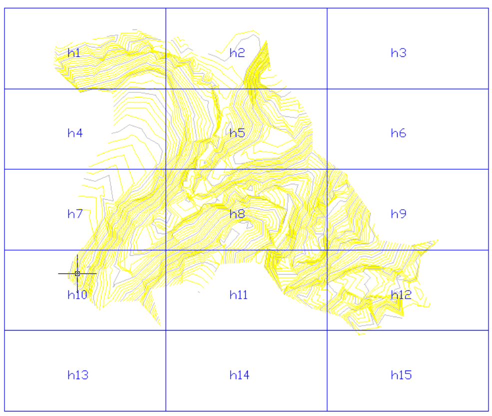
Layer: Layer in which the sheets are represented by default.

Text Height: This value refers to the height of the texts that will be labeled on each of the sheets.

Prefix: Each of the sheets will be identified with a prefix entered through this option and a sequential number from the first sheet inserted.

Once the dialog box has been validated, the program will request the lower left-hand point and the upper right-hand point to delimit the area where one wishes to insert the sheets.

Scale: Text insertion scale.



Window: In this section we indicate the initial and final coordinates between which the sheets will be. They can also be selected graphically by clicking on the button "Select <" or by introducing the coordinates manually in the corresponding boxes.

Once the coordinates are introduced the command displays an estimate of the number of sheets to be inserted, the number of Rows and number of Columns.

Draw diagram from entities

The function of this command is similar to the previous one, draw sheets diagram, only that in this case, when the command is executed the program will request selection of the entities on which the sheet diagram should be drawn.

Once these are selected, the previous command window will be displayed and the section "Window" is filled in automatically from the information obtained from the entities selected.

Delete sheets

This option is useful for deleting unneeded sheets, for which we select all the sheets in question and they are automatically deleted.

Add sheets

This option is opposite to the previous; when it is executed, the program requests that we select the corner of any of the already-existing sheets and it will automatically insert a sheet with the selected corner as the lower left corner of the new sheet being created.

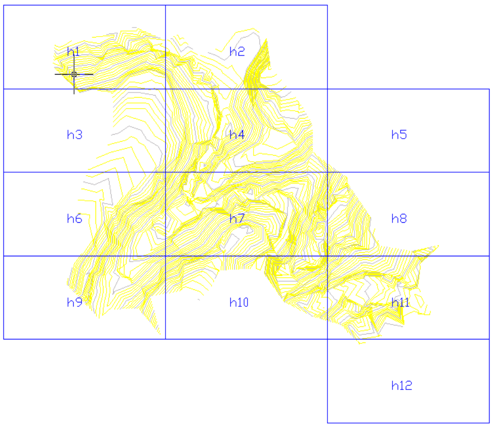
Move sheets

In this case we move a sheet's position. First we request the sheet to move and then the new position in which to insert the sheet selected.

Number Diagram

This command allows one to number all the previously inserted sheets.

This option should be executed once any sheets that are not of interest have been deleted to ensure the new numbering is sequential.



Split Drawing

Once the drawing has been configured with the sheets one wishes to separate, this command is executed. It allows one to split the objects individually on each of the sheets.

Save Sheets

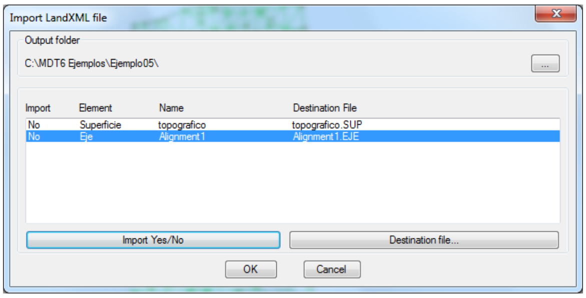
This command saves each of the previously drawn sheets in separate drawings. In order to do so, the program requests a drawing name. The sheets will then be saved with this same and a suffix of the number associated with each of them.

For instance, if the new drawing file is called topo.dwg, each sheet will be saved with the names topoh1.dwg, topoh2.dwg, etc.

Import from LandXML

This command allows one to convert a file in LandXML format into different MDT files.

The program initially requests the LandXML file we wish to convert. Then the following window is displayed, where the information associated to the file is shown.

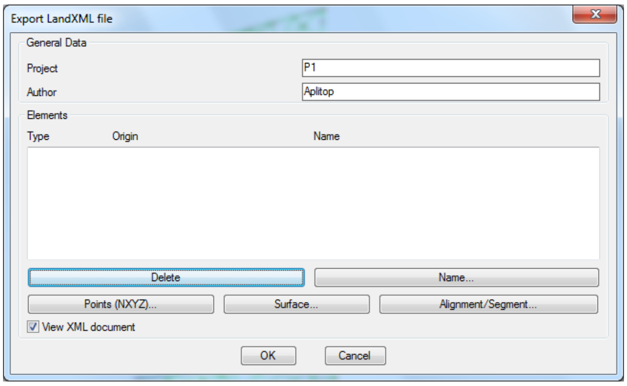


Output Folder: Directory to where the converted files will be sent. These will be created with the name of the element to be converted and its corresponding extension.

Export to LandXML

This command allows one to convert the different kinds of existing MDT files to LandXML format.

The following window is initially displayed, where one can manage the different files to be converted. A detailed description of this window appears below.



Points: Allows one to select the different points files one wishes to convert.

Surfaces: Likewise, the different surface files to convert are selected.

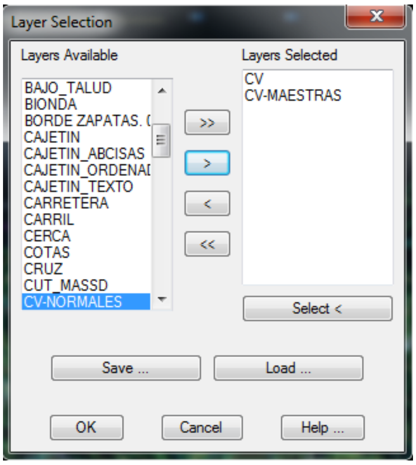
H. Alignment/Segment: In this case, either a horizontal alignment or a segment may be selected. Should a segment be selected, the program will automatically enter the horizontal alignment, cross-sections and grade lines it may contain.

Delete: If this button is clicked, the element selected will be deleted from list to convert.

View XML Document: If this option is activated, the XML file generated will be opened in the operating system's default browser.

Isolate Layers

This command allows one to keep visible only the layers that are of interest. Initially MDT shows the following dialog box in which one can select the layers one wishes to view.



One can either graphically select the layers one wishes to view or use the displacement buttons to set the configuration of the layers desired.

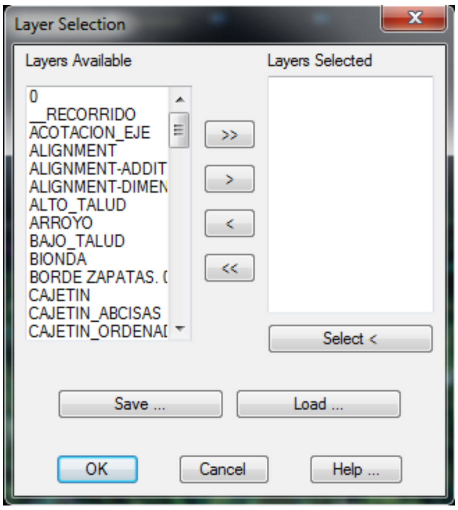
In addition, the possibility exists of saving the layers configuration in a file (***Save*** button) or loading it from a previously defined file (***Load*** button).

Once the dialog box is validated, the command will be executed.

Clear Layers

This command allows one to delete all the objects associated to previously selected layers.

Once the command is executed, MDT displays the following dialog box where one can select the layers to be cleared.



On the right-hand side all the available layers in the drawing are displayed. All the layers one wishes to clear should be entered in the list appearing on the left-hand side

The characteristics of all the window’s controls are described below.

< **and** >: Moves the layer selected from the list from one side to another.

<< **and** >>: It moves all the layers from one side to another.

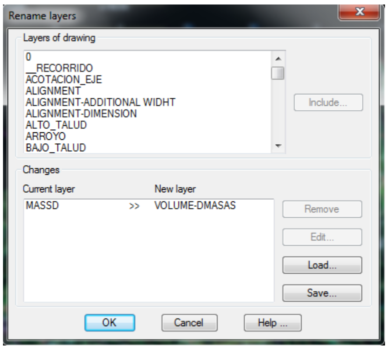
Select: By clicking on this button, all the objects on the layers one wishes to clear will be selected graphically.

Save: Once the layers to be cleared have been set, their configuration can be saved with this option.

Load: This is the reverse the previous process. In this case, a file containing the information saved by the previous button is read.

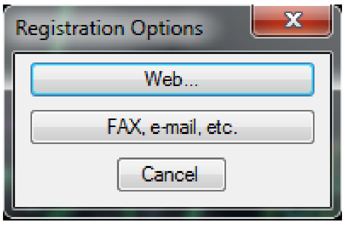
Once the dialog box is validated, the command will be executed and the objects will be deleted without deleting the drawing's layer.

Rename Layers

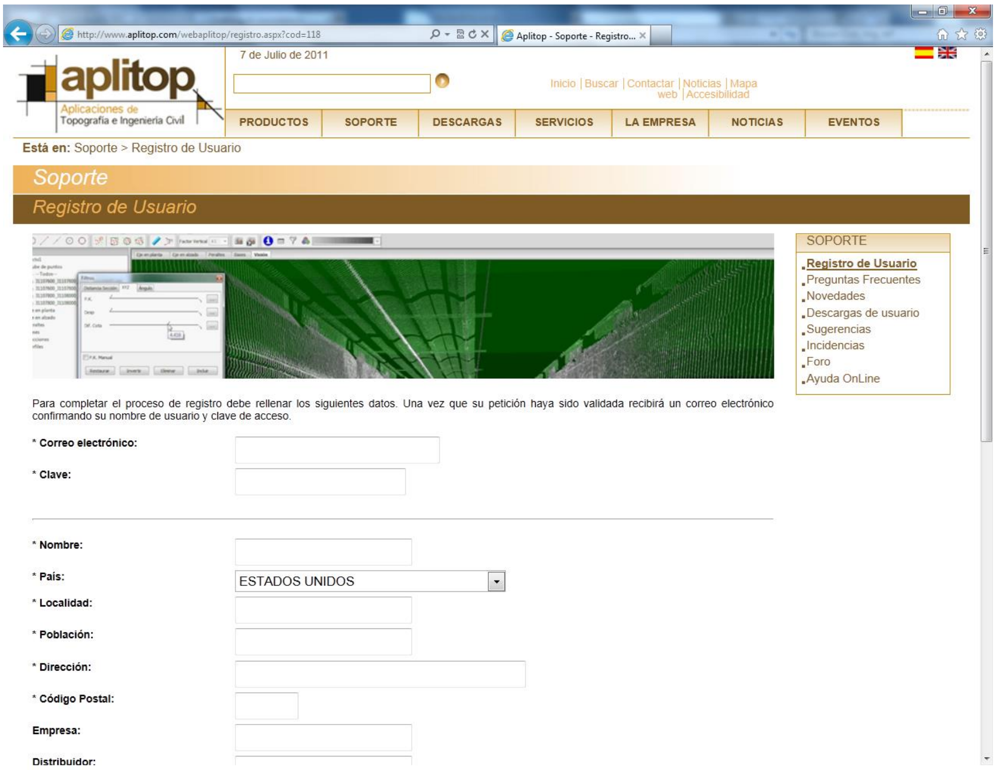


User Registration

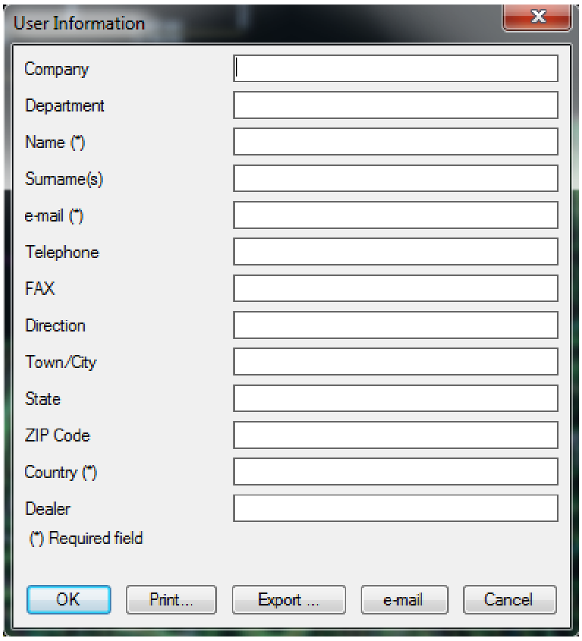
This command makes registering the software easier. When this command is executed, a window offering two product registration options is displayed.



Website: This option can be used should an Internet connection be available. Should this be the case, Aplitop's website's registration area will be displayed directly when this button is clicked.



Fax, E-mail, etc. Should an Internet connection not be available, one can fill in the following form if this option is activated. It can subsequently be either sent by Fax (after clicking on the relevant print button) or by e-mail by clicking on the ***e-mail*** button. In the latter case, the e-mail message will automatically be filled in.



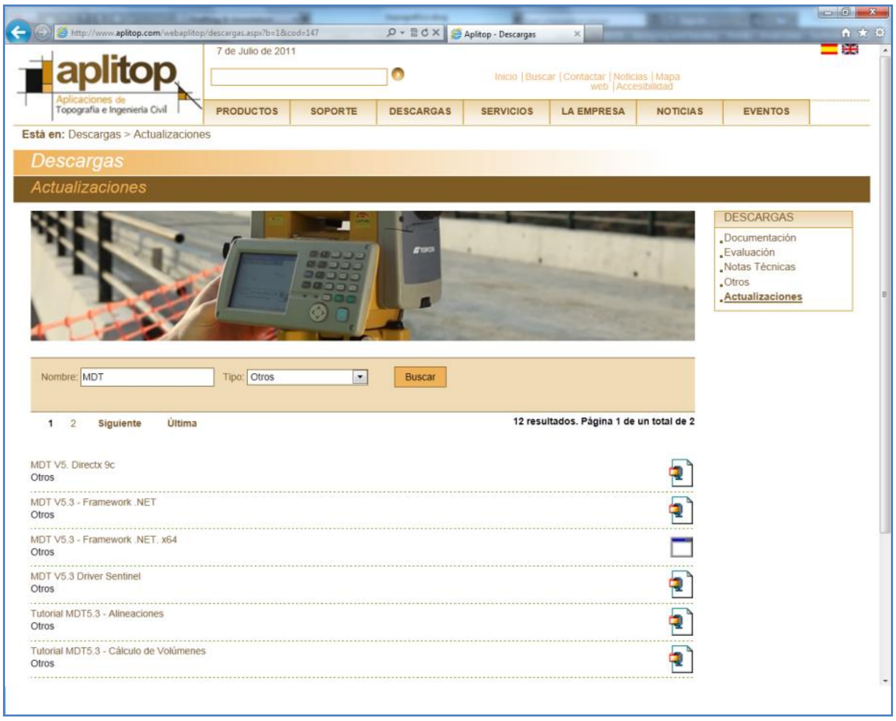
It is advisable to register the program, as it allows users to keep updated with the latest modifications, updates, new products and different resources available on our website (www.aplitop.com).

Available Updates

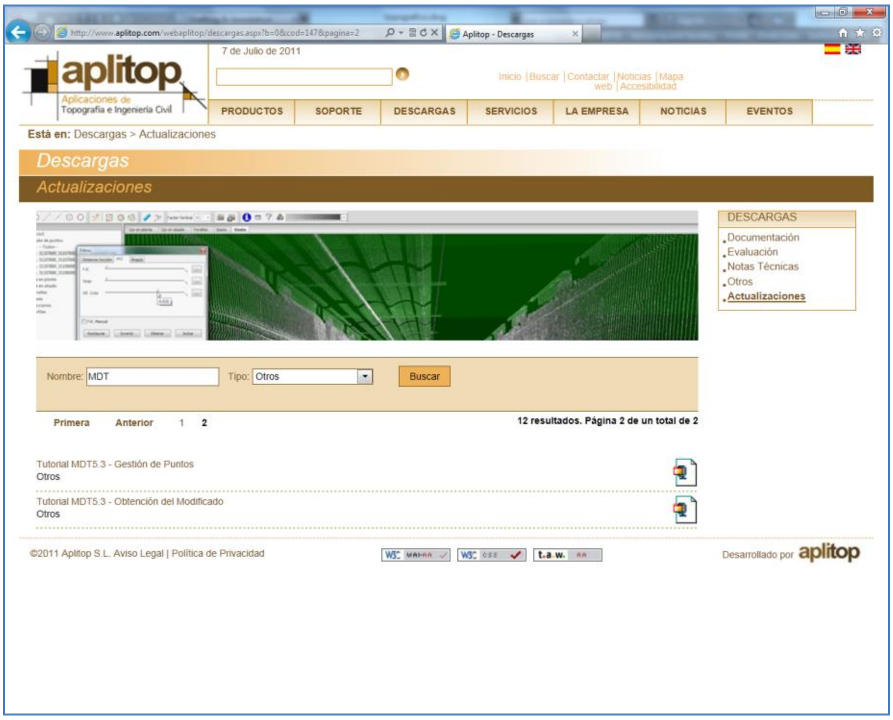
This command is used to access the latest updates available for the products contracted.

Access is only give to registered **Aplitop S.L.** product users. See the section “**User Registration**”.

Once registered, when this command is executed a Webpage will automatically open and the different serial numbers the user has registered will be displayed.



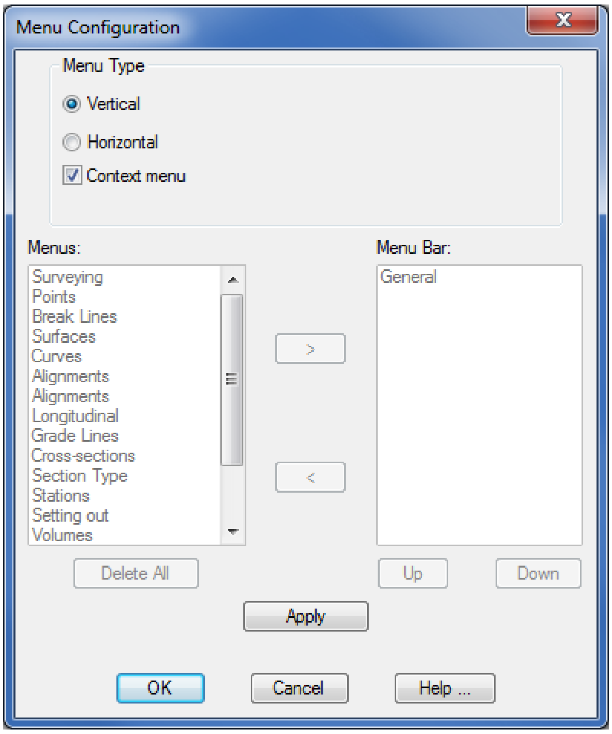
If we click on any of the serial numbers registered the following window will be displayed showing the different downloads available depending on the license selected.



The existence of updates for each acquired product depends in part on the license having a current "**Maintenance Contract**".

Customize Menus

Offers one the possibility of configuring the way the program's menu layouts are shown in AutoCAD.



The **Vertical** option is active by default, which indicates that just one **MDT** menu appears on the AutoCAD toolbar, from which the other system menus drop down.

If the **Horizontal** option is selected, individual system menus can be chosen to appear on the AutoCAD toolbar. Thus, the main **MDT** menu is hidden and only the ones selected are shown.

Enable Context Menus: If this option is enabled, the context menus for MDT objects that are available will automatically be activated.

> Adds the menu selected from the ***Menus*** box to the **Menu Bar** box.

< Deletes the menu selected from the **Menu Bar** box.

Delete All: Deletes all menus from the **Menu Bar** box.

Up: Moves up one position in the **Menu Bar** box.

Down: Moves down one position in the **Menu Bar** box.

Apply: Updates the AutoCAD menu bar with the changes made.

Ribbon Menu

This option is only available for AutoCAD versions the same as or higher than AutoCAD 2010. Executing it activates the tape menus, also called **Ribbons**.

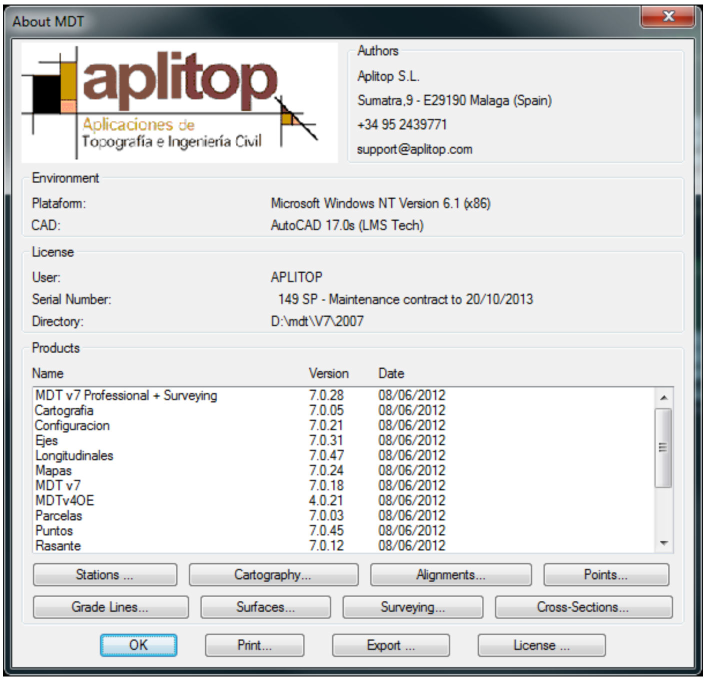
About MDT

This command shows the versions and dates of all the applications that comprise MDT.

In addition, if the ***Stations, Cartography, Horizontal Alignments, Points, Grade Lines, Surfaces, Surveying*** or ***Cross Sections*** buttons are clicked, details about the file formats installed and their respective versions are displayed.

Lastly, the ***License*** button allows one to read the terms and conditions of the license agreement.

It also indicates el path of the application’s installation.


About MDT
Authors
Aplitop S.L.
Sumatra,9 - E29190 Malaga (Spain)
+34 95 2439771
support@aplitop.com
aplitop
Aplicaciones de
Topografía e Ingeniería Civil
Environment
Plataform: Microsoft Windows NT Version 6.1 (x86)
CAD: AutoCAD 17.0s (LMS Tech)
License
User: APLITOP
Serial Number: 149 SP - Maintenance contract to 20/10/2013
Directory: D:\mdt\V7\2007
Products
Name Version Date
MDT v7 Professional + Surveying 7.0.28 08/06/2012
Cartografia 7.0.05 08/06/2012
Configuracion 7.0.21 08/06/2012
Ejes 7.0.31 08/06/2012
Longitudinales 7.0.47 08/06/2012
Mapas 7.0.24 08/06/2012
MDT v7 7.0.18 08/06/2012
MDTv4OE 4.0.21 08/06/2012
Parcelas 7.0.03 08/06/2012
Puntos 7.0.45 08/06/2012
Rasante 7.0.12 08/06/2012
Stations ...
Cartography...
Alignments...
Points...
Grade Lines...
Surfaces...
Surveying...
Cross-Sections...
OK
Print...
Export ...
License ...

Estimation of Uncertainties

Acknowledgments

The new features of MDT 7.5 in relation to the estimation of uncertainties are the result of a research agreement between the University of Oviedo (UO) and the company APLITOP, S.L. The ensuing work has been conducted by Enrique Covián Regales, Víctor Puente García and Miguel Casero Flórez, as members of the UO AssIST research group.

Concepts on Metrology

The inclusion of the estimation of uncertainties - error propagation - in the calculation conducted by MDT of different magnitudes of topographic interest requires the analysis and comprehension of certain concepts, set forth below in the form of theoretical fundaments.

Measurement procedures are intrinsic to the practice of topography, the exercise of which will require the comprehension and application of knowledge in relation to metrology. First of all, this will require being familiar with the definition of the same as a science and its specific terminology:

<u>Metrology</u>

A science the purpose of which is the study of units and measurements of magnitudes and which also defines the technical requirements of the measuring methods and tools.

<u>Magnitude</u>

The attribution of a phenomenon, body or substance capable of being distinguished qualitatively and determined quantitatively (measurable).

<u>Measurands and observables</u>

A measurand is any particular magnitude capable of being measured. When dealing with measurands susceptible of direct measurement they are called “observables”.

<u>Value</u>

The size of a measurand expressed as a measurement unit multiplied by a number.

<u>Unit</u>

A quantity selected as a comparison standard for expressing each magnitude.

<u>Measurement and observation</u>

Measurement is understood as the series of operations aimed at determining the value of a measurand - a particular magnitude - by comparison with the yardstick. When the measurement of the measurand is direct it can be called an “observation”. This is a unique event due to the fact the circumstances involved vary and this variability may imply different results for each measurement.

<u>Measure and observation</u>

A value attributed to a specific measurand, obtained as a result of the measurement. When this result is obtained via direct measurement it may also be called an “observation”, having to distinguish between the polysemy of the term featured in the meanings of the measurement process and the result of the measurement, when this is direct.

<u>Error</u>

Measurement error is the difference between value measured and the true value of a particular magnitude. All measurements are inevitably affected by error and the value of the same is always unknown.

Conventional true value

Due to the fact it is impossible to obtain an error-free measurement, the real value of any measurand is always unknown. The value generally adopted as true is the conventional true value, which is that attributed to a particular magnitude and accepted, at times by agreement, as possessing an appropriate uncertainty for the given purpose.

Measurement residue

As it is not possible to determine neither the true value nor, as such, the measurement error, the term “measurement residue” is used to refer to the difference between the value measured and the conventional true value.

Estimation

Estimation is understood as the best possible value determined for a measurand using the measures available; this is the main result from the observation adjustment process.

Tolerance

The maximum error admitted for each particular magnitude, basically determined in accordance with the purpose of the work and the resources available.

Basic legislation on Metrology

The text set forth below refers exclusively to Spain, although most regulations applicable to the practice of metrology are in force on an international basis. For other countries their respective laws on the issue need to be consulted.

The Spanish Constitution grants the State the exclusive power to legislate within the scope of Metrology. Pursuant to the use of such powers *Law 32/2014 of 22 December on Metrology* (published in the Official Gazette dated 23 December 2014) determinines, among other things, the legal system for measurement units and metrological control, in accordance with the agreements of the General Conference on Weights and Measures (CGPM), of which Spain is a founding member, and the regulatory decisions of the European Union. This law is the result of the amendment of former *Law 3/1985 of 18 March, on Metrolology*; *Legislative Royal Decree 1296/1986 of 28 June, amending Law 3/1985 of 18 March, on Metrology, and establishes EEC metrological control*; and chapter IV of *Royal Decree 889/2006 of 21 July, regulating on the metrological control of the State over measuring tools*; and which are hereby repealed:

Law 32/2014 comprises 26 articles grouped in six chapters, in addition to temporary, repealing and final provisions. Chapter I sets forth the purpose of the law – to establish and implement the legal system for measuring units and the establishment of the principles and general standards to which the organisation and legal sceheme of metrological activity in Spain need to be adapted. Chapter II deals with the system and legal measurement units: their names and symbols and the rules in relation to the written form and expression of their values and the multiples and sub-multiples of the same; domestic standards and the disclosure of the measurement units; and the mandatory nature of the use of the legal measurement unit system. Chapter III covers the metrological control of the State, specifying its scope, the elements subjected to this control and the phase it comprises, surveillance and inspection, the responsable declaration of repairers and the processing of the modifications and repairs executed throughout the service life of the tools. Chapters IV and V refer to, respectively, the protection of artistic historic heritage in the form of due restrictions on the export of instruments and other metrological objects and the administrative organisation and structure dedicated to metrological control within the scope of the General State Administration. Finally, Chapter VI establishes the infractions and penalties scheme, taking into account the distribution of powers between the State and the Autonomous Communities.

To sum up, this law, together with the remaining part of *Royal Decree 889/2006* and *Royal Decree 2032/2009 of 30 December, establishing the legal measurement units* (published in the Official Gazette dated 21 January 2010) and the almost immediate correction of errors of the same (published in the Official Gazette dated 18 February 2010)

a) Governs on the definition and implementation of the legal measurement system and the principles and general standards to which metrological activity in Spain needs to be adapted.

b) Classifies as legal measurement units the basic units and those derived from the International System (SI) adopted by the CGPM and in force in the EU.

c) Establishes the written rules for the names and symbols of the units, the formation of multiples and sub-multiples of the same and for expressing the values of the magnitudes.

d) Decrees the power of the Government to declare the use of new units adopted by the CGPM as legal, as well as authorising the use of other units not featured in the IS if regarded as essential.

e) Establishes the mandatory nature of the use of the legal measurement units throughout Spanish territory, prohibiting the use of other units and ensuring the inclusion of the same in the educational system.

f) Regulates the metrological control of the measurement units in the defence of safety, the protection of health and the economic interests of citizens. This metrological control comprises the approval of models, preliminary verification and that subsequent to monitoring and inspection and is mandatory for indivuduals and entities intending to manufacture, import, market, repair or lease measurement instruments.

g) Establishes that the expression of a magnitude requires both the indication of its value and the magnitude measured, whereby this rule is applicable to measurement instruments, among other contexts.

h) Prohibits metrological ítems with historic significance or which are over fifty years of age from leaving Spanish territory, except when due authorisation is provided.

Error concepts, causes and components of error. Types and causes and components of error

Any measure – a value attributed to a particular magnitude obtained through measurement – is affected by a series of factors known as causes or sources of error implying the existence of a difference between the true value and the value obtained. Some of these causes are permanent and affect each measurement in the same manner, while others are variable and affect the measurement in a different manner on each occasion.

Hence, the measure should be regarded as a variable and the true value of a measurand - a particular magnitude — unknown. However, by agreement, a value is generally used which is given a real nature to refer to the real value. This is known as the “conventional true value”, “best estimated value” or “reference value” (x_e) and is defined as a value attributed to a particular magnitude and accepted, at times by convention, as possessing an appropriate uncertainty for a given purpose.

The error (ε) in relation to each measure is the difference between the true value (τ) and the value of the measurand arising from the measurement (l). Dimensionally it is analog to the magnitude being measured and the absolute value and mathematic expression of the same:

$$\varepsilon = \left|\tau - l\right|$$

While, due to the fact the true value is unknown, the term “measurement residue” (ν) is used to refer to the error, taking into account the conventional true value (x_e):

$$v = \left|x_e - l\right|$$

The analysis of the causes of error and the influence of the same on measures is known as “observation theory” or “error theory” and basically serves to reduce the amount of error, and, consequently, to obtain more accurate measurements.

It should be pointed out that the term “types of error”, frequently used and found in a number of literary references, is normally used to refer to types of causes which affect measurements in the form of error and / or the influence these causes have on the measurement, reason for which – in the author´s opinion - it would be more appropriate to talk about “types of causes of error” and “error components”. These two terms best match the error concept – the difference between the true value and the measure value – and, consequently, the residue, as the error all measurements are subject to is the result of the effect giving rise to several causes which act simultaneously. Referring to different error components means determining the extent of repercussion of each type of cause or each specific cause in the total error.

Error causes are grouped in three types for the purpose of analysis: gross, accidental and systematic:

Gross causes and the components of the same

Associated with a lack of attention or concentration on the part of the worker at the time of conducting or registering the measurement. This involves more or less significant random variations of the value measured and / or registered in relation to other measurements in relation to the same measurand. This often gives rise to illogical measurements whose order of value bears no relation to the magnitude to be measured. The influence of the same would be, where applicable, the gross component of the error, which needs to be identified and eliminated. It is normally avoided by conducting measurements with due care and attention. However, repetition and contrast techniques can be used to enable us to identify these error components and eliminate them.

Systematic causes and the components of the same

These are physical phenomena of a permanent nature the influence of which can be determined due to the fact mathematical models exist to determine such phenomena. They affect each measurement in the same manner - constant or variable, but in accordance with a well-known physical law. When referring to permanent physical phenomena we may be dealing with maladjustments or imperfections of measuring instruments, changes in the environmental conditions with regard to those regarded as standard for the calibration of instruments, or the use of simplified models of reality. Their influence on the measurement would be the systematic component of the error and would be of an accumulative nature, as each time a measurement is conducted this cause of error would be present increasing this component, and a significant value order in relation to the value of the measurement, The elimination of the systematic component is mandatory, achieved by correcting, generally by adjusting the instrument, the cause in question; quantifying the influence and conducting the consequent corrections to the measurement; or by implementing methods to offset the influence of the same (for example: the Bessel and average point methods).

Accidental causes and the components of the same

Those related to the intrinsic limitations of the measuring instruments – technical characteristics – and of the operators – skills – and the influence of the same on the measurement is random – their value and meanings are variable. The influence of these causes on the measurement is the accidental component of the error and the value order small in relation to the result of the measurement. The specific value of the same will always be unknown, although it is possible to determine the maximum amount of the same, and, consequently, the range of variation. Different to what occurs with the gross and systematic error components, the accidental component cannot be eliminated, but minimised. As such it is important to use measurement instruments the accuracy of which - meaning that of their measurements - is appropriate for each operation and series of measurements to ensure an accurate analysis (typical deviation) / probability.

Measurement reliability

The different parameters related to measurement reliability are:

a) The accuracy of a series of measurements, representing the degree of proximity between those obtained for the same measurand and usually expressed as the standard deviation of the probability distribution of the series. This depends on the technical characteristics of the measuring instruments used and the skills of the worker.

b) The accuracy of a measurement, which is the degree of concordance between the value obtained from a measurement and the true value in question. This depends on the influence of the accidental causes of error and the systematic errors which have not been eliminated or the corresponding component of which has not been offset.

c) Measurement uncertainty is a parameter associated with the result of a measurement which characterises the dispersion of values which can be reasonably attributed to the measurand (CEM, 2005). It specifically refers to the value interval within which the measurement is expected to figure and which is associated with a degree of probability. It is a quantitative measure of the quality of the result of a measurement. It is generally determined in accordance with the document entitled *GUM* (*Guide to the Expression of Uncertainty in Measurement*). This document requires the measurement to be expressed stating its respective uncertainty and probability, in accordance with the following equation:

$$x = \mu_x \pm k \cdot \sigma_x = \mu_x \pm U_x ,$$

where x is the result of the measurement or measure, μ_x y σ_x are the average and standard deviation of the values of the series of measurements, k is the multiplication factor of the standard deviation and U_x is the expanded uncertainty, the last two being associated with a specific level of confidence; and, moreover, the expanded uncertainty (U_x) is expressed with no more than two significant figures and the average (μ_x) is rounded off to the corresponding number of digits. The expanded uncertainty used is often that calculated multiplying the standard uncertainty – standard deviation – by the numerical factor ($k = 2$) which corresponds to a level of confidence of approximately 95%

Obtaining a reliable measurement will depend on the use of measures to eliminate the gross and systematic error components, in addition to others geared to minimising the accidental component. The latter, besides implying the selection of appropriate instruments and techniques for each situation, requires repeated observations to enable us to conduct an adjustment the result of which will be the estimation of the measurement of the measurand in question.

Indirect measurement and error propagation

The determination of the value of a measurand based on the acquisition of others – observations – is an extremely frequent task in technical disciplines and, more specifically, in topography. This is what is known as “indirect measurement”. Hence, the values of the magnitudes to be determined – dependent variables – are expressed using mathematical functions or relational models the independent variables of which are the observations.

Consequently, the observables are affected by errors, which spread to the magnitudes to be determined. Al analysis of the evaluation of the errors transmitted is known as “error propagation” and will depend on the relational model used to calculate the desired magnitude, even though the error propagated may be determined anyway using the general Law on the propagation of variances and covariances:

$$\Sigma_{yy} = J \cdot \Sigma_{xx} \cdot J^t ,$$

where Σ_{yy} is the matriz of variances and covariances of the dependent variables, range $(p \times p)$; J is the Jacobian matrix, range $(p \times m)$ and Σ_{xx} is the matrix of variances and covariances of the independent variables, range $(m \times m)$.