



TcpTUNNEL CAD

3

Reference Manual

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1. Features and Functionality

This document describes how the application runs to calculate and draw in CAD tunnel cross-sections taken from total stations. This program is complementary to the surveying and staking out application **TcpTunnel TS**, although files generated by other applications available in the market can also be used.

The application allows one to define a project made up of the ground plan and elevation alignment, optional superelevations and the theoretical cross-section whose parameters are specified. Such data may also be optionally copied to the mobile device for its use with the above-mentioned program.

Once the coordinate data of the points corresponding to the total station's survey are available, it is possible to draw the cross-sections obtained with different options, render the theoretical and measured tunnel with a 3D wire diagram, in addition to obtaining point and volume lists.

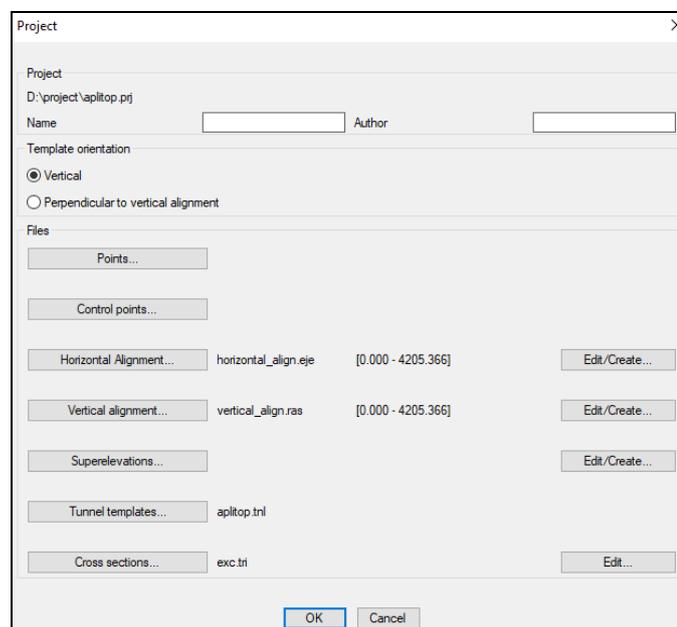
2. Projects

2.1. Create Project

In order to avoid having to remember each of the files making up a project, a type of file to store the links to each of its essential components has been created.

All these components should be kept in the same folder where the project is to be created.

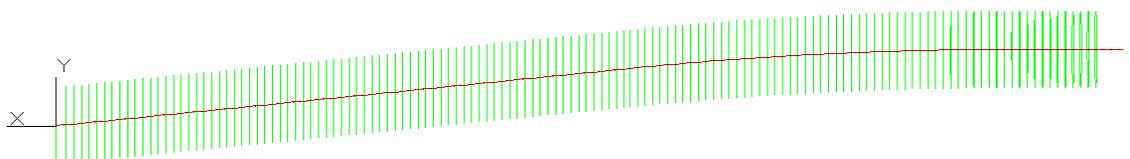
Once the name of the project to be created is entered, a screen is shown where the files making up the project should be selected:



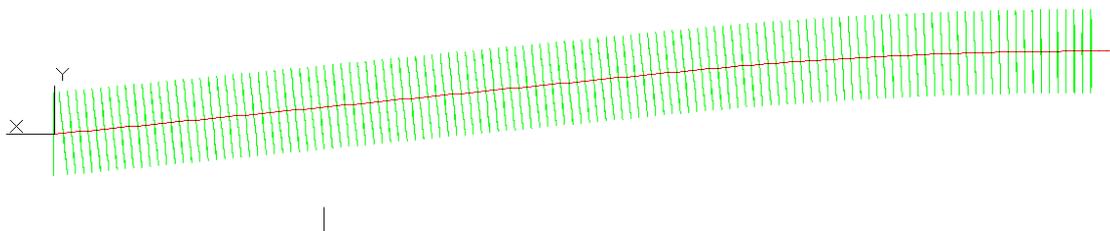
The *Points*, *Control Points*, *Horizontal Alignment*, etc. buttons allow one to select each of the components making up the project. Of all of these, stations and superelevations are not obligatory.

Within *Template Orientation*, it must be selected if the profiles are created vertical or perpendicular to horizontal alignment. The latest option should be used for tunnel with high slopes.

Vertical



Perpendicular to vertical alignment



Pressing the *Edit...* buttons open an editor to create or modify the selected item. With the **OK** button creates the project indicated containing the files selected.

The different kinds of files requested are described below.

2.1.1. Points

The surveying points of the current project are stored in these files in ASCII format. These files have the ***.PUN** extension (compatible with **TcpTunnel TS** and **TcpMDT**) and contain the following data for each point separated by spaces:

<Number> <X Coordinate> <Y Coordinate> <Z Coordinate> <Code>

Name	Type	Length	No of Decimals	Remarks
N	Alphanumeric	14	0	Point number
X	Numeric	11	3	
Y	Numeric	11	3	
Z	Numeric	8	3	
Code	Alphanumeric	14	-	

Files in GSI format may be selected directly. The application will automatically import such files and create the corresponding ***.PUN** file.

2.1.2. Stations

The surveying stations of the current project are stored in these files in ASCII format. These files have the ***.BSE** extension (compatible with **MDT**) and contain the following data for each station separated by spaces:

<Number> <X Coordinate> <Y Coordinate> <Z Coordinate> <Anamorhosis> <Code>

Name	Type	Length	No of Decimals	Remarks
Station	Alphanumeric	8	-	Station's name
X	Numeric	11	3	
Y	Numeric	11	3	
Z	Numeric	8	3	
Code	Alphanumeric	14	-	
Scala	Numeric	9	8	

2.1.3. Horizontal Alignments

These files have *.EJE extension and are compatible with TcpTunnel TS and TcpMDT.

The records have the following fields:

Name	Type	Length	No of Decimals	Remarks
Station	Numeric	11	3	Kilometre point
X	Numeric	11	3	
Y	Numeric	11	3	
Azimut	Numeric	8	4	
Parameter	Numeric	9	3	Clothoid section parameter
Radio	Numeric	9	3	

2.1.4. Vertical Alignments

These files have *.RAS extension and are compatible with TcpTunnel TS and TcpMDT.

The records have the following fields:

Name	Type	Length	No of ° Decimals	Remarks
Station	Numeric	11	3	Kilometre point
Height	Numeric	8	3	Vertex height
Kv / Radio	Numeric	9	3	
Tangent	Numeric	9	3	
Arrow	Numeric	9	3	

2.1.5. Superelevations

These files have *.PER extension and are compatible with TcpTunnel TS and TcpMDT.

The records have the following fields:

Name	Type	Length	No of Decimals	Remarks
Station	Numeric	11	3	Kilometer point
Pl	Numeric	6	3	Left hand superelevation
Pr	Numeric	6	3	Right hand superelevation

2.1.6. Tunnel Templates

These files have *.TNL extension and are compatible with TcpTunnel TS.

2.1.7. Cross-Sections

This kind of file stores the information about measured profiles. It is created from horizontal and vertical alignments, tunnel template and measured points. They have *.TRI extension.

The records have the following fields:

Name	Type	Lenght	No of Decimals	Remarks
Station	Numeric	11	3	Kilometer point
Offset	Numeric	8	3	Point's offsert relative to alignment
Height	Numeric	8	3	Point's height
Number	Alphanumeric	16		Number of the measured point

2.2. Open Project

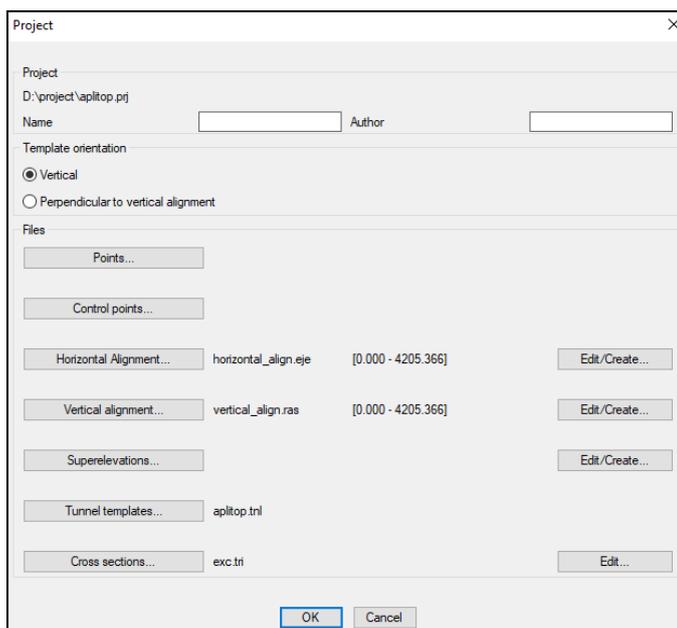
With this command one can change the current project. All the other commands will use the last project loaded. If one has not been opened, it will ask for a created project.

If one uses the option of creating a new drawing in CAD, it will forget the last project loaded, and any other subsequent command will ask for a project.

2.3. Edit Project

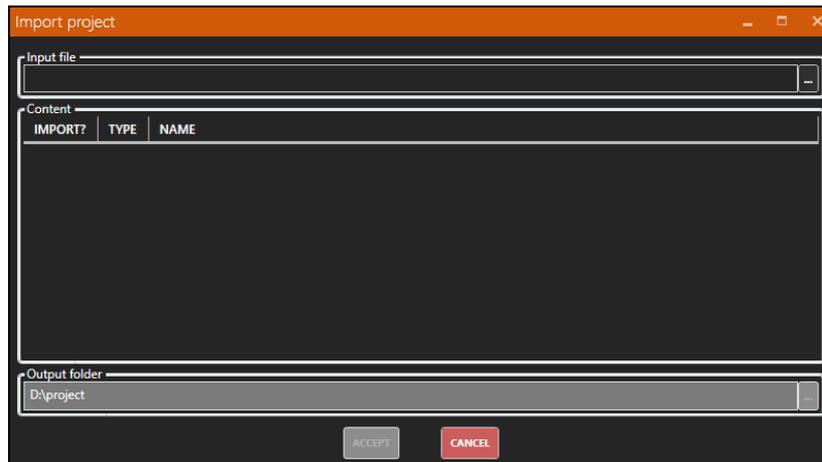
This command allows one to change the files to be used in an existing project.

The changes made to the project selected will be stored by clicking on the **OK** button.



2.4. Import Project

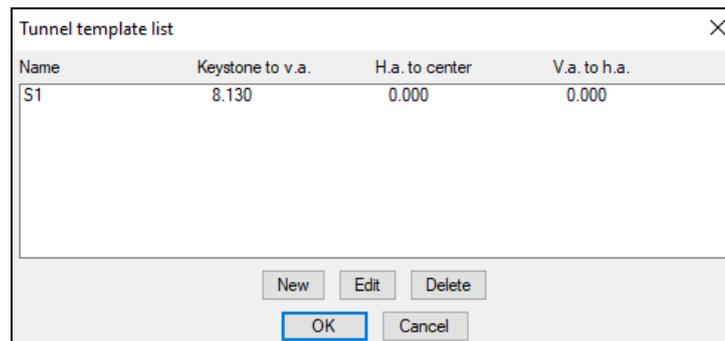
This command allows one to import a **Trimble *.TXL** file, selecting the components (horizontal alignment, vertical alignment, etc) to be imported.



3. Tunnel Templates

3.1. Edit Tunnel Templates

This command allows one to edit the tunnel template file (*.TNL) of the project.



New: This option creates a new template, which must be drawn before it can be assigned graphically.

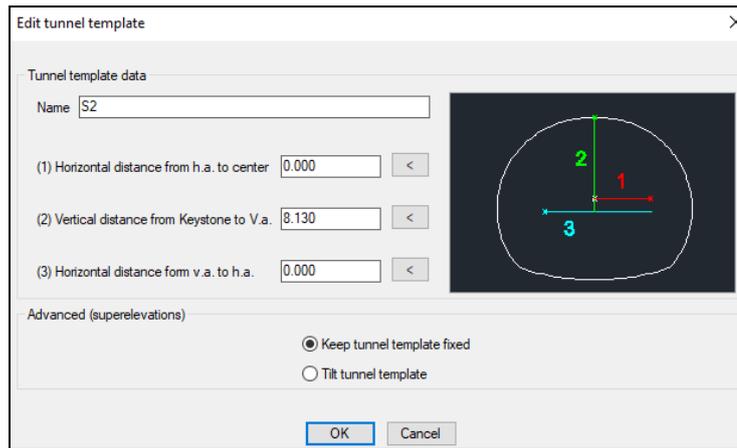
Edit: This allows one to edit an existing template.

Delete: Deletes selected tunnel template.

Any new templates that have been created or deleted will only be saved if one exits the dialog by using the **OK** button.

3.1.1. New Tunnel Template

The tunnel template is defined from a polyline. The polyline may be open or closed and, may be generated either clockwise or counter-clockwise. Once selected (you are asked to **Select Tunnel Template**) the following data is requested:



Name: Name of the cross-section. S1 is shown by default. If more than one cross-section is created, they will be named S2, S3, etc.

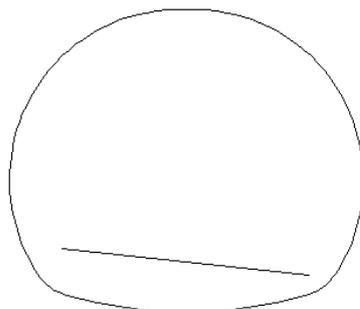
Horizontal distance form H.a. to Center: A positive value indicates that the ground plan alignment is to the right of the cross-section’s center and a negative value indicates it is to the left. Differently to the grade line and superelevation application point, the ground plan application point can be defined to be outside the tunnel template.

Vertical distance from Keystone to V.a.: A positive value should be indicated if the keystone point is above the grade line and superelevation application point and negative otherwise. Under normal conditions, this value should always be positive. The grade line and superelevation application point should be within the tunnel template.

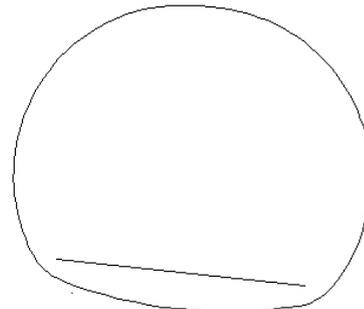
Horizontal distance from V.a. to H.a.: In this case the reference is the ground plan alignment’s application point. One will therefore have to indicate a positive value if the vertical alignment and superelevation application point is to the right of the alignment and a negative value if it is to the left.

Advanced (Superelevations): If a superelevation file has been selected, the program allows tilt the tunnel template depend on the superelevation values. If **Keep tunnel template fixed** is selected and the tunnel template is open, the superelevations will be applied, creating the roadbed and closing the tunnel template.

Keep tunnel template fixed



Tilt tunnel template



3.1.2. Edit Tunnel Template

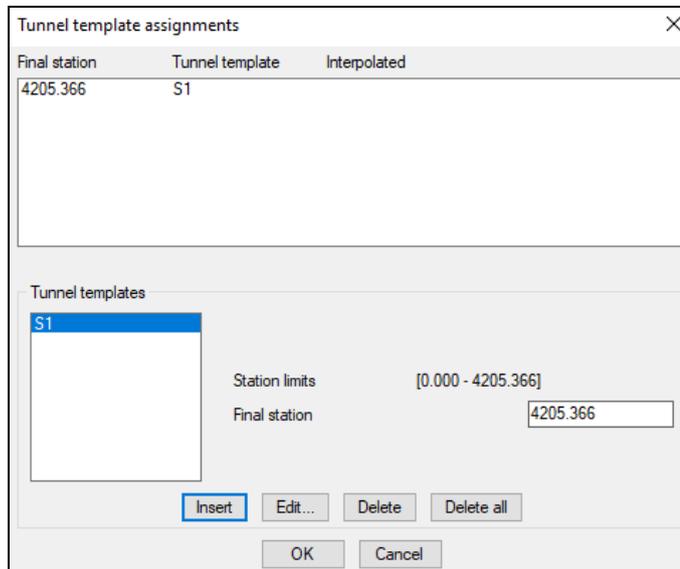
This command allows one to change the parameters of an existing tunnel template. First, one must indicate an insertion point inside the drawing. Then, the **Edit Tunnel Template** dialog is displayed (see **New Tunnel Template**).

3.2. Tunnel Template Assignments

After the tunnel templates have been defined, they must be assigned to the along the horizontal alignment.

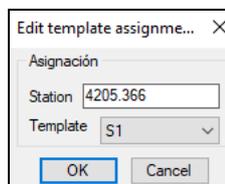
To create assignments, select one of the created tunnel templates listed in the box, on the left, and specify the *Final station*.

The program will interpolate the tunnel templates between each assignment if it is possible. To do that, the tunnel templates must have the same number of elements and they must be of the same type, line or arc. A copy of the previous assignment must be created if the interpolation is not necessary.



Insert : Insert a new assignment with the control values.

Edit: Opens a dialog for editing the values of the selected assignment.



Delete: Delete the selected assignment.

Delete All: Delete all the assignments.

Exit the dialog with the **OK** button to *save any changes made*.

3.3. Draw Tunnel Templates

This option allows one to draw the tunnel templates included in the *.TNL file of the project.

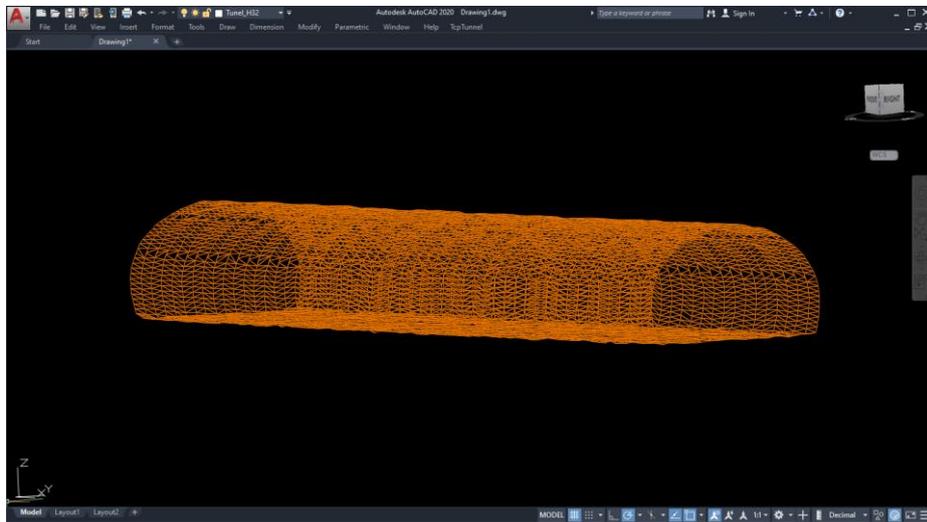
3.4. Import Tunnel Templates

This command can be used to import tunnel templates from a **Leica *.TPE** file.

3.5. Draw IFC

This option loads and draws an IFC file, allowing to save it as DWG or DXF file.

The main goal of this command is to create tunnel templates from the 3D faces contained in the model.



3.6. Create Tunnel Templates from 3D Faces

This command allows to create a tunnel template file from a 3D face drawing. This file will be created in the project folder, regardless of the folder that has been selected.

To run this command, the project must contain the horizontal and vertical alignments.

The program asks for the following data:

Stations

Station interval 1.000

Initial station 326.000

Final station 400.000

Add horizontal alignment points

Add vertical alignment points

Add extra stations ...

Maximum distances to horizontal alignment

Left 20.000

Right 20.000

Tunnel templates

Replace current tunnel templates

Generate tunnel templates for TcpScancyr

Horizontal distance to center 0.000

Vertical distance to center 0.000

OK Cancel

Station interval: The distance between two tunnel templates. If this option is unchecked, the stations by interval won't be added to the final list.

Initial station: The first station of the list by interval.

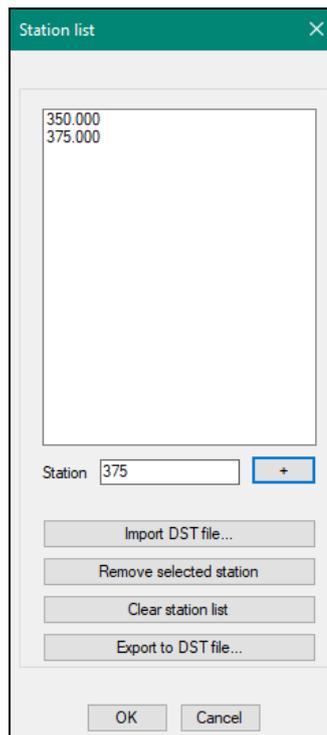
Final station: The last station of the list by interval.

Add horizontal alignment points: Allows user to add the stations of the singular points of the horizontal alignment.

Add vertical alignment points: Allows user to add the stations of the singular points of the vertical alignment.

Add extra stations: Allows user to add a station list manually or imported from a DST file. This file could be created in an easy way because it's an ASCII file with a station value per line.

The windows which manage the station list allows user to import and export DST files and, also, add and remove stations manually.



Left distance: The maximum distance, in meters, on the left of horizontal alignment which includes the elements to be analyzed.

Right distance: The maximum distance, in meters, on the right of horizontal alignment which includes the elements to be analyzed.

Replace current tunnel templates: If this option is checked, the program will replace the tunnel template file in the project and will overwrite the assignment file. Each tunnel template created will have an assignment on the station where has been calculated.

Generate tunnel templates for TcpScancyr: If this option is checked, the program will create a tunnel template file, with TRA extension, which can be imported in **TcpScancyr**, **TcpTunnel TS** and **TcpTunnel Scan**.

Horizontal distance to center: Negative or positive value which will be added to X component of the geometric center of each tunnel template, allowing to sort correctly the vertices generated when the tunnel template is not symmetrical.

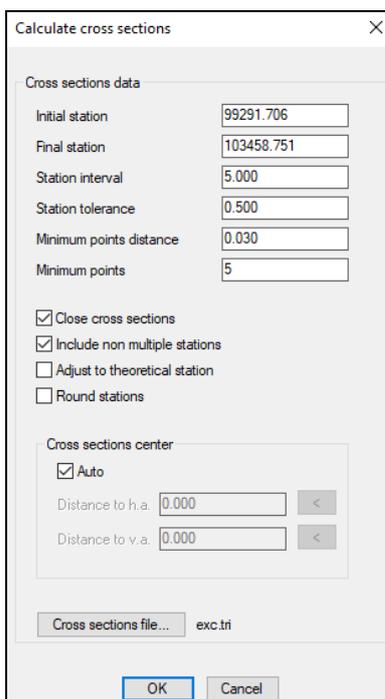
Vertical distance to center: The same as previous parameter but the value is added to Y component of the center.

4. Cross-sections

4.1. Calculate Cross-Sections

This option calculates the cross-sections with the project's points and horizontal and vertical alignments.

The cross-sections calculated are saved in the selected *.TRI file.



Initial station: Station from which measured points to be drawn are sought. The project’s alignment is indicated next to the initial station.

Final station: Station up to which measured points to be drawn are sought. The project’s alignment is indicated next to the final station.

Station interval: Value by which stations increase from the initial station indicated up to the final station.

Station tolerance: Station’s regression value. If the difference between a station analyzed for a point and a station on the theoretical list is less than this value, a point in the theoretical station profile is considered to which it is adjusted.

Minimum points distance: Minimum distance between two consecutive points of the profile.

Minimum points: Minimum number of points that a profile must contain.

Close cross-sections: After calculating each cross-sections, the program will join the final and the initial point to create a closed cross-section. If the cross-section is open, the join between the ends will not be taken into account when calculating the surfaces. If there is a closed theoretical cross-section, this option must be marked if one wants the surface area calculation to include the whole cross-section.

Include non-multiple stations: Initially, the file’s points are analyzed and grouped together by the closest station according to the tolerance indicated.

These stations are then adjusted in accordance with the tolerance to the stations appearing on the list created according to the *Station interval*. By marking this box, one indicates that one wishes to take into account stations that have not been adjusted to any multiple of the initial station indicated in accordance with the *Station interval*.

Adjust to theoretical station: Uses the stations calculated with the interval and the initial and final stations instead of the stations calculated automatically.

Round stations: Round cross-section stations to the closest integer number.

Cross-sections center: This option allows one to set up the point which is used to sort the points of the profiles. If **Auto** option is selected, the point calculated is the center of the rectangle that encloses the profile points. Otherwise, horizontal and vertical alignments application points will be use. The program allows one to change those points entering a horizontal and vertical distance.

Cross-sections file: Cross-Sections file output, by default it will show cross-sections file project.

4.2. Draw Cross-sections

It shows graphically the differences between the surveyed cross-sections and the tunnel templates.

The following data is requested:

Initial station: Station from which measured points to be drawn are sought.

Final station: Station up to which measured points to be drawn are sought.

Minimum Height: Height with respect to the grade line for cutting the cross-sections and theoretical cross-section, by a horizontal line.

The elements one wishes to show can be selected in the *Drawing* section, as can the *Scale*, *Text Height*, *Space (Model or Paper)* and *Drawing Format*. The latter has options for drawing Cross-Sections in *Continuous* mode or on several sheets of *DIN-A0*, *DIN-A1*, *DIN-A2*, *DIN-A3* o *DIN-A4* paper. The option of also drawing one profile per sheet (DIN-A4) is also offered in the *Individual* option.

The drawing option in paper model allows one to use the CAD command **Publish** to print the cross-sections in PDF.

The elements making up the drawing include:

Point Number: Number of the points taken in the field.

Point Height: Height of the points taken in the field.

Difference: Perpendicular distance to the tunnel cross-section from the point measured.

Dimensioning Lines: Lines that join the point taken and its projection on the tunnel's theoretical cross-section.

Station: Theoretical station calculated by regression.

Vertical Alignment Height: Vertical alignment height at the theoretical station.

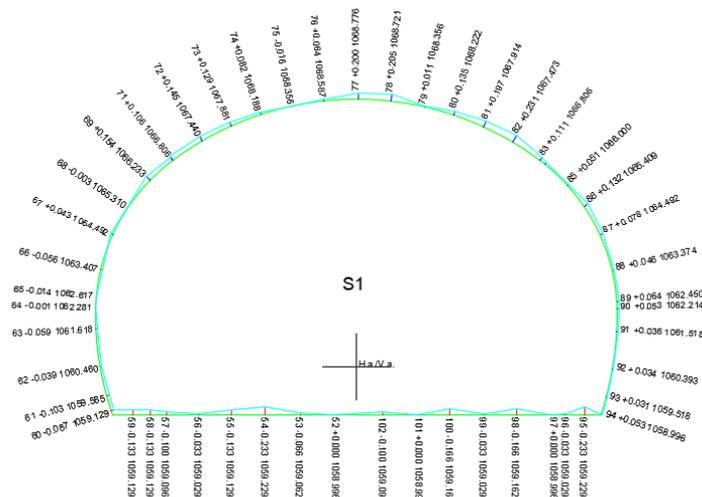
Superelevation: Left-hand superelevation at the theoretical station.

Horizontal Alignment Coordinates: X and Y coordinates of the ground plan alignment at the theoretical station.

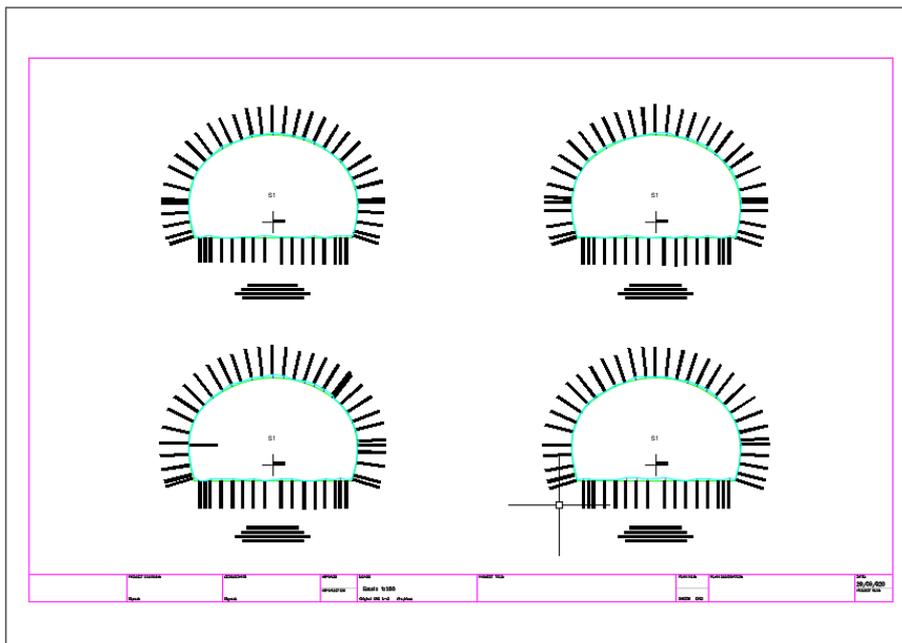
Area: Undercut and overcut areas and total areas of the theoretical and measured cross-sections at the theoretical station.

Grid: Is only activated when the *Individual* option is selected in *Drawing Format*. Shows a grid to mark distances and heights.

You are requested to select an insertion point for the drawing when **OK** is clicked. It should be taken into account that tunnel templates are only drawn when measured points have been found depending on the filters indicated. It could therefore happen that no drawing is generated.

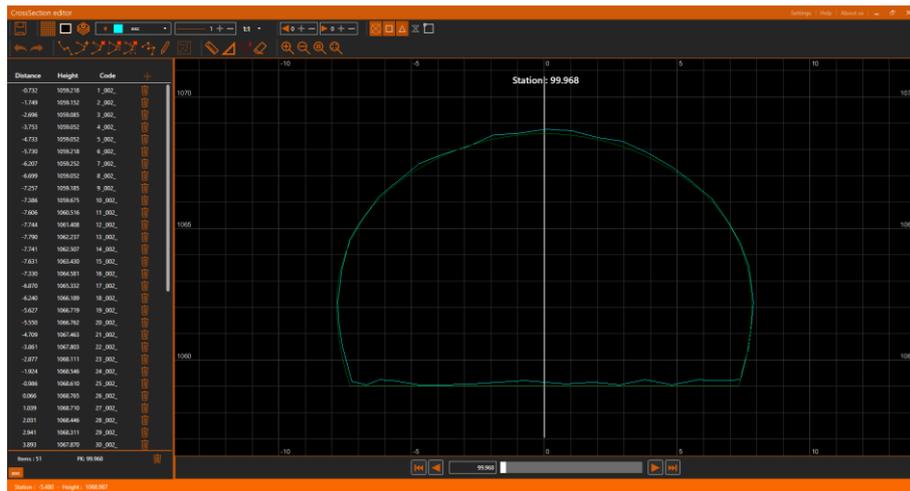


Station = 101.971 V.a.H. = 1080.446m
 X H.a. = 875494.096m Y H.a. = 4856313.086m
 Overbreak Area = 2.024m² Underbreak Area = 1.247m²
 Pr. Area = 127.308m² Exc. Area = 127.665m²



4.3. Edit Cross-sections

This tool allows one to edit the surveyed cross-sections to delete, mainly, the points which introduce noise in the profile, by example, the points surveyed on ventilation pipes. Read the **Cross-section Editor** chapter for more details.



4.4. Import Cross-sections

This command allows user to import a cross-section file with *.TRA extension, used in previous versions of TcpTunnel CAD.

After selecting the file to import, the program will create a file with the same name and TRI extension, it will be included in the current project and it will be showed in the cross-section editor.

4.5. Draw Tunnel

Shows a 3D graphic of the theoretical and measured tunnel. In both cases the initial and final stations delimiting drawing request. If no cross-section file exits in the project, or it's empty, the corresponding section will appear disabled.

Draw tunnel

Measured tunnel

Initial station:

Final station:

Drawing

Points Cross sections

Project tunnel

Initial station:

Final station:

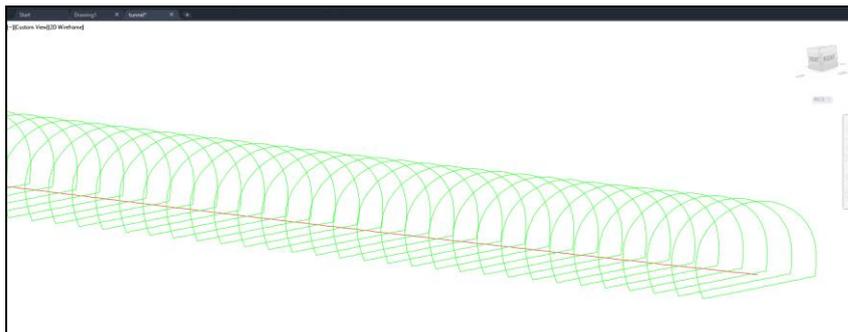
Station interval:

Drawing

Cross sections

Points Longitudinal lines

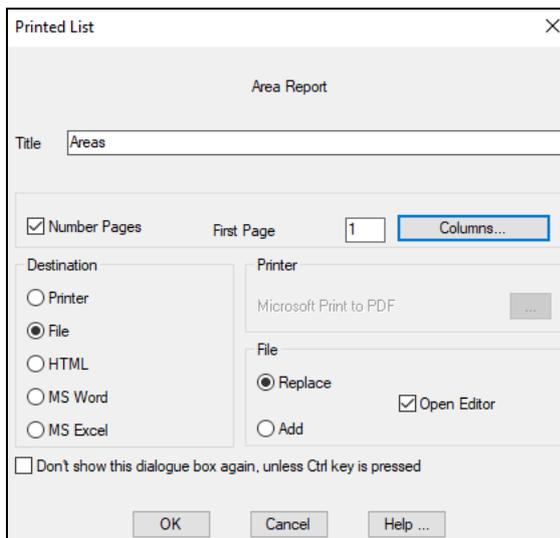
Discretization distance:



5. Reports

This chapter shows the different reports that can be created with TcpTunnel CAD.

The program allows one to print these reports in several formats. To do this, the following screen is shown when clicking **Print** button.



Title of document.

Number Pages: Indicates if one wishes to add page numbers to the **Printer** option.

First Page: First page of numbering.

Destination: Indicates where one wishes to transfer the information. If one selects the **Printer** option, one can select and configure the printer by clicking on the ... button appearing in the **Printer** box on the right-hand side of the screen. Should the **File** option be selected, the information is transferred onto a text file. One can also **Replace** or **Add** the information should the file already exist. The document can additionally be opened once printing is completed (**Open Editor**). The **HTML** option creates an HTML document that can be opened with an Internet browser. Lastly, the **MS Word**

and *MS Excel* options create Microsoft Word and Microsoft Excel documents.

Do not show this dialog box again unless...: Once the destination where one wishes to print the information is configured, the dialog box will not be shown again if this box is marked unless the Ctrl key is kept pressed.

5.1. Area and Volume Report

This kind of reports shows the same initial screen for requesting the entry data.

Initial station: Station where volume calculation starts.

Final station: Station where calculation ends.

Minimum height: Height with respect to the vertical alignment for cutting the cross-sections and theoretical cross-section, by a horizontal line.

Once the data requested has been entered, the following list is shown after clicking on **OK**.

5.1.1. Area Report

The area report shows the following information:

Station	Length	Perimeter	Area
99.968	2.003	43.498	87.541
101.971	1.999	43.925	87.493
103.969	2.000	43.634	87.458
105.969	2.002	43.835	87.881
107.971	2.001	43.947	87.948
109.973	1.997	43.946	87.502
111.970	1.999	43.692	87.478
113.968	1.999	43.840	87.506
115.967	2.007	43.722	87.571
117.974		43.562	

Total Perimeter: 2188.006 m
Total Area: 4376.012 m2

Station: Shows the stations where points have been observed.

Length: Difference between previous and next station.

Perimeter.: Cross-section perimeter.

Area.: Area formed by the cross-section of the previous and next station on the list. This is calculated by the Mean Areas method:

$$A = (\text{PerimeterFST} + \text{PerimeterIST}) * ((\text{FST} - \text{IST}) / 2)$$

where

FST = Final Station of the interval.

IST = Initial Station of the interval.

PerimeterIST = Perimeter of the initial cross-section of the interval.

PerimeterFST = Perimeter of the final cross-section of the interval.

5.1.2. Volume Report

The volume report shows the following information:

Station	Length	Overbreak area	Underbreak area	Exc. area	Overbreak vol	Underbreak vol	Exc. vol
99.968	2.003	1.507	2.198	126.598	3.535	3.850	254.607
101.971	1.999	2.024	1.647	127.665	4.010	3.604	254.792
103.969	2.000	1.989	1.959	127.319	3.574	4.307	253.813
105.969	2.002	1.585	2.348	126.526	3.396	3.719	254.540
107.971	2.001	1.807	1.366	127.730	3.519	3.491	254.763
109.973	1.997	1.709	2.122	126.876	3.234	4.321	253.095
111.970	1.999	1.530	2.206	126.613	2.818	4.296	252.944
113.968	1.999	1.290	2.093	126.485	3.226	4.166	253.477
115.967	2.007	1.938	2.075	127.152	3.361	4.199	254.578
117.974		1.412	2.110	126.591			

Total Overbreak Volume: 171.936 m3
 Total Underbreak Volume: 195.504 m3
 Total Excavation Volume: 12705.294 m3

Station: Shows the station where points have been taken.

Length: Difference between previous and next station.

Overbreak area: Excess excavation area at station indicated.

Underbreak area: Area to be excavated at station indicated.

Exc. area: Excavated area at station indicated.

Overbreak vol: Existing excess excavation volume between the previous and next station on the list. It is calculated by the Average Areas Method:

$$V = ((FSt - ISt) / 2) * (SurFSt + SurISt)$$

Where

FSt = Final station of interval.

ISt = Initial station of interval.

SurFSt = Excess excavation surface or surface to be excavated calculated at the final station of interval.

SurISt = Excess excavation surface or surface to be excavated calculated at the initial station of interval.

Underbreak vol. Existing volume to be excavated between the previous and next station on the list. Calculated using the same method as for overbreak volume.

Exc.vol.: Existing excavated volume between the previous and next station on the list. Calculated using the same method as for overbreak volume.

Total Overbreak Volume: Sum of over excavation volumes between the initial and final stations on the list.

Total Underbreak Volume: Sum of volumes to be excavated between the initial and final stations on the list.

Total Excavation Volume: Sum of excavated volumes on the list

5.2. Cross-section Report

This command shows the cross-section list of the current file.

For each point, **Station**, offset (**H. offset**) regarding with horizontal alignment, **Height** and **Point number** is showed.

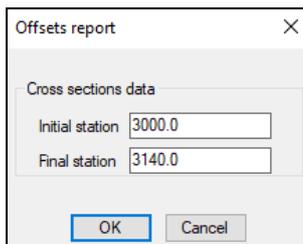
Station	H. offset	Height	Point number
99.968	-0.732	1059.218	1_002_
99.968	-1.749	1059.152	2_002_
99.968	-2.696	1059.085	3_002_
99.968	-3.753	1059.052	4_002_
99.968	-4.733	1059.052	5_002_
99.968	-5.730	1059.218	6_002_
99.968	-6.207	1059.252	7_002_
99.968	-6.699	1059.052	8_002_
99.968	-7.257	1059.185	9_002_
99.968	-7.386	1059.675	10_002_
99.968	-7.606	1060.516	11_002_
99.968	-7.744	1061.408	12_002_
99.968	-7.790	1062.237	13_002_
99.968	-7.741	1062.507	14_002_
99.968	-7.631	1063.430	15_002_
99.968	-7.330	1064.581	16_002_
99.968	-6.870	1065.332	17_002_
99.968	-6.240	1066.189	18_002_
99.968	-5.627	1066.719	19_002_

5.3. Offset Report

If the tunnel templates are circular, the offset at each station can be calculated by calculating the geometric center of each cross-section and measuring its adjustment.

Currently, this option must not be used unless use the tunnel templates are circular.

The following information is requested:



After pressing **OK** button, the program calculates the tunnel offsets as follow:

- It creates groups of points formed by three points.
- For each group, it calculates the middle of the circle (which is why the tunnel template must always be circular)
- It accumulates horizontal and vertical offset from the middle of the circle with respect to the middle of the tunnel template.
- It averages the offsets with the number of groups created.

Station	Horizontal	Vertical	X coord.	Y coord.	Z coord.	Radio
3000.000	0.891	-0.089	434970.615	589146.249	-10.174	5.439
3010.000	0.812	0.079	434970.948	589156.275	-9.999	5.461
3020.000	0.724	0.047	434970.901	589166.303	-10.003	5.432
3030.000	0.668	-0.011	434970.515	589176.321	-9.998	5.439
3040.000	0.526	-0.025	434969.671	589186.308	-9.915	5.449
3050.000	0.370	-0.057	434968.446	589196.250	-9.816	5.451
3060.000	0.302	-0.055	434966.941	589206.148	-9.648	5.451
3070.000	0.214	-0.002	434965.052	589215.977	-9.394	5.443
3080.000	0.054	0.060	434962.730	589225.710	-9.098	5.450
3090.000	0.048	0.231	434960.200	589235.386	-8.657	5.450
3100.000	0.053	0.028	434957.322	589244.964	-8.557	5.446
3110.000	0.042	0.032	434954.078	589254.425	-8.214	5.443
3120.000	0.071	0.049	434950.523	589263.773	-7.825	5.442
3130.000	0.098	0.031	434946.621	589272.984	-7.444	5.430
3140.000	0.135	0.035	434942.390	589282.048	-7.039	5.452

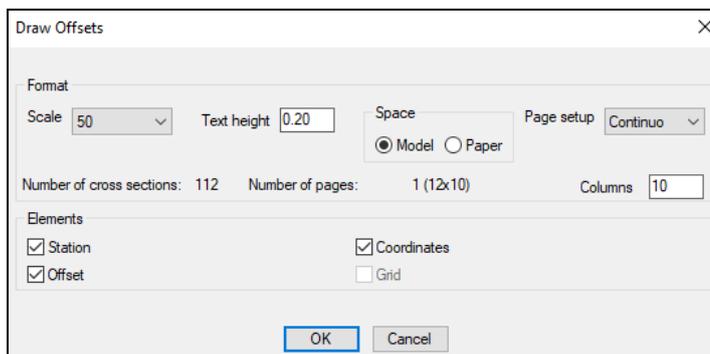
Station: Station of the cross-section used for calculating the offset.

Horizontal: Horizontal offset of the cross-sections with respect to the ground plan alignment.

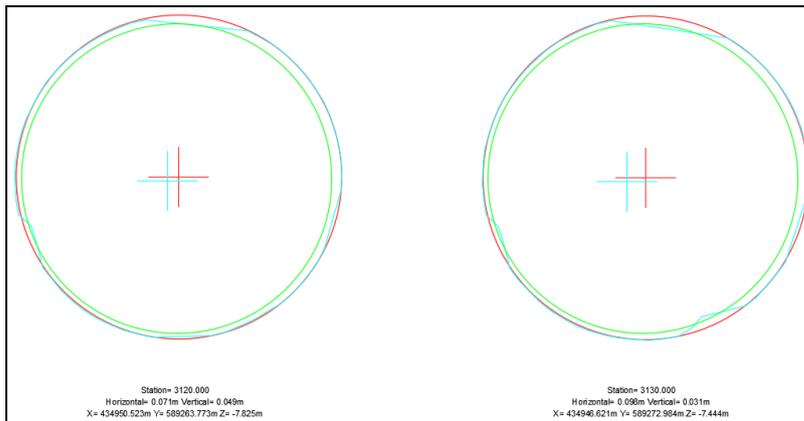
Vertical: Vertical offset of the cross-sections with respect to the elevation alignment.

X, Y, Z Coord.: 3D coordinates of the offset alignment at the station in question.

For a graphic representation of the calculations, select **Draw**, which will display the following dialog for configuring the input/output format. The options are the same as for drawing cross-sections.



The cross-section is light blue, and the tunnel template is green. The place where the tunnel template with the data of the offset applied would be placed is shown in red.



5.4. Point Report

Shows a report containing information about the points of the project.

Number	X.Coord	Y.Coord	Z.Coord	Station	Offset	Height diff	Difference	Code
1	434965.108	589146.606	-9.667	3000.029	-4.628	0.419	-0.547	
2	434965.175	589146.510	-9.225	2999.935	-4.555	0.861	-0.557	
3	434965.296	589146.659	-8.856	3000.094	-4.444	1.230	-0.583	
4	434965.418	589146.512	-8.416	2999.952	-4.313	1.670	-0.568	
5	434965.591	589146.572	-8.047	3000.024	-4.144	2.039	-0.575	
6	434965.785	589146.481	-7.649	2999.943	-3.945	2.437	-0.557	
7	434966.011	589146.482	-7.292	2999.958	-3.719	2.794	-0.542	
8	434966.268	589146.456	-6.947	2999.947	-3.461	3.139	-0.521	
9	434966.552	589146.424	-6.621	2999.932	-3.176	3.465	-0.493	
10	434966.863	589146.400	-6.319	2999.927	-2.864	3.767	-0.461	
11	434967.199	589146.371	-6.039	2999.918	-2.527	4.047	-0.423	
12	434967.539	589146.468	-5.786	3000.036	-2.193	4.300	-0.367	
13	434967.940	589146.318	-5.551	2999.909	-1.784	4.635	-0.320	
14	434968.330	589146.388	-5.342	3000.003	-1.399	4.744	-0.248	
15	434968.754	589146.364	-5.157	3000.004	-0.974	4.929	-0.169	
16	434969.667	589146.308	-4.895	3000.002	-0.059	5.191	-0.002	
17	434969.945	589146.325	-7.328	3000.036	0.217	2.758	-2.427	
18	434970.384	589146.275	-7.643	3000.012	0.658	2.443	-2.654	
19	434970.606	589146.239	-7.709	2999.990	0.882	2.377	-2.658	

The following data are displayed for each point:

Number of the point.

X, Y, Z Coord.: Point coordinates.

Station: Station of the point with respect to the project's horizontal alignment.

Offset.: Distance regarding to the project's horizontal alignment.

Height Dif.: Height difference with respect to the vertical alignment, which is the Z Coordinate – Height of the grade line at the point station.

Difference.: Distance of the point with respect to the tunnel template, a negative value indicates that the point is inside the tunnel template (undercut point). If no tunnel template has been assigned to the station of this point, this field will appear empty.

Code.: Code of the point that was included in the original file.

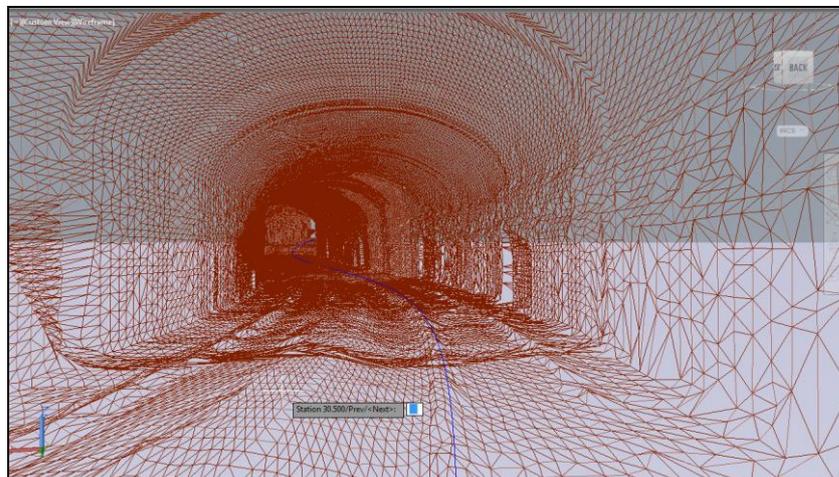
6. 3D Model

This group of options allows one to generate a 3D triangulation of the tunnel, take a tour inside it and export to several file formats of geometrical definition, are as OBJ (Wavefront Technologies) and OFF.

6.1. Draw

This option does the 3D triangulation and it shows a drawing of this one along with the horizontal alignment of the project.

For doing this, the program asks for the initial and final stations and the number of points that will be created for each profile.



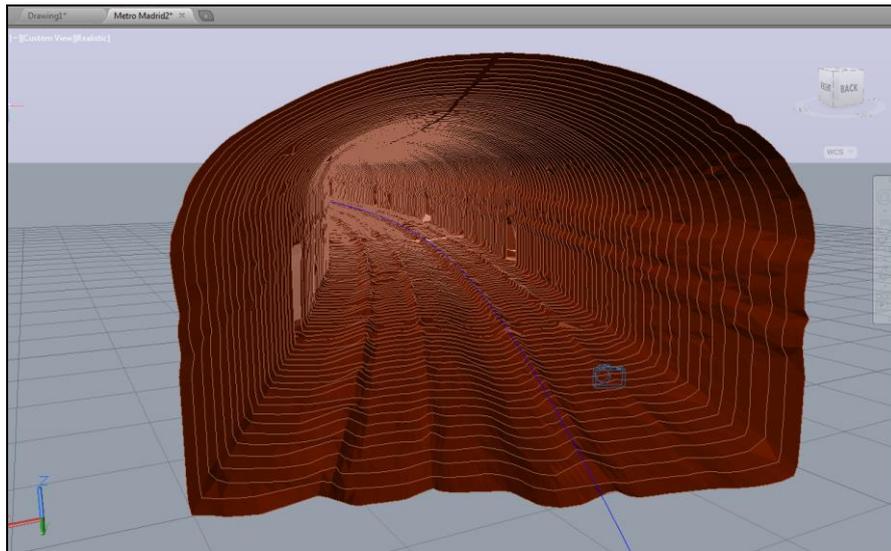
6.2. Tunnel Walkthrough

After 3D model of the tunnel is drawing, the program allows one to take a tour inside it. For doing this, the program asks for the following data:

Observer height: Height at which the camera is located, in meters.

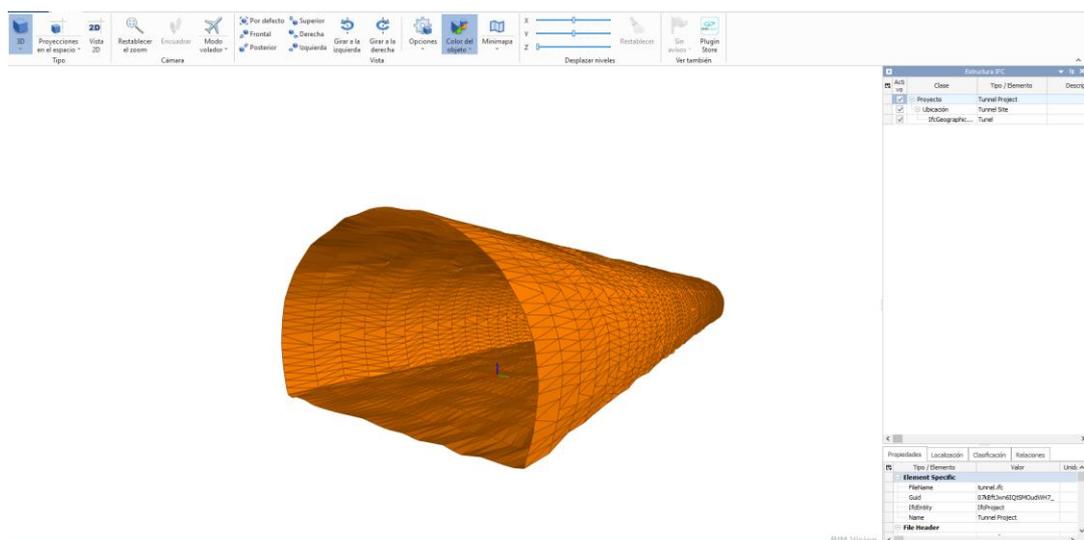
Movement: Forward direction in the tunnel, which can be Direct or Reverse.

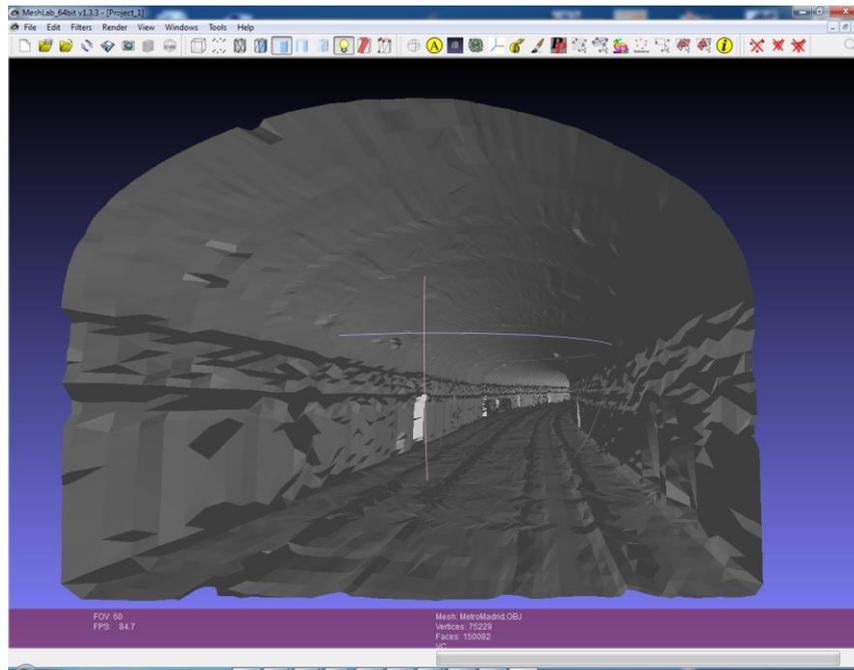
Interval: Increased progress at every step, in meters.



6.3. Export

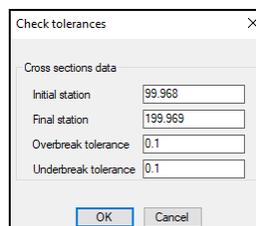
The program allows one to export the 3D model created to IFC (BIM), OBJ and OFF formats for later viewing in other applications.





7. Check Tolerances

This option allows one to check if the measured cross-sections are under tolerance. The program asks for a profile file, initial and final stations and overbreak and underbreak tolerances.



After enter the data, clicking on **OK** button, the program shows the tolerance report.

The 'Tolerances report' dialog box displays a table with the following data:

Station	Number	Difference	Out tolerance
99.968	1	-0.199	*
99.968	2	-0.133	*
99.968	3	-0.066	*
99.968	4	-0.033	*
99.968	5	-0.033	*
99.968	6	-0.199	*
99.968	7	-0.233	*
99.968	8	-0.033	*
99.968	9	-0.112	*
99.968	10	-0.123	*
99.968	11	-0.083	*
99.968	12	-0.052	*
99.968	13	-0.032	*
99.968	14	-0.070	*
99.968	15	-0.043	*
99.968	16	0.049	
99.968	17	0.017	
99.968	18	0.068	
99.968	19	0.056	

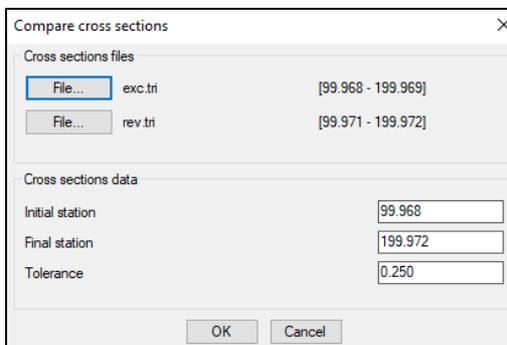
Buttons for 'OK' and 'Print...' are located at the bottom.

For each point of each cross-section, it shows the **Station**, the **Number**, the **Difference** regarding with the tunnel template and, with an asterisk, if the point is out of the tolerances entered.

8. Compare Cross-sections

This command allows to compare two cross-section files from different stages of a project.

The following data is requested:



The *.TRI files to be compared, the *Initial* and *Final station* and the station *Tolerance*.

The first of the two files selected will be used as a reference point when calculating.

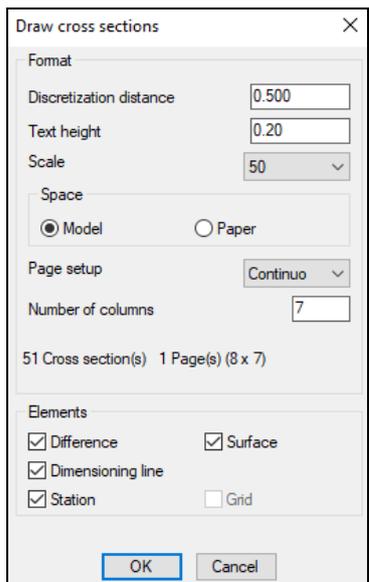
When **OK** button is pressed, the following area and volume report will be shown.

Station	Overbreak area	Underbreak area	Station diff.	Overbreak vol.	Underbreak vol.
99.970	0.253	10.846	1.999	0.332	22.335
101.969	0.079	11.476	2.003	0.241	22.816
103.972	0.162	11.335	1.996	0.570	21.941
105.968	0.409	10.633	2.002	0.600	22.208
107.970	0.190	11.536	2.002	0.484	22.615
109.972	0.293	11.045	1.998	0.674	21.677
111.971	0.382	10.660	1.998	0.532	21.215
113.968	0.151	10.578	2.001	0.353	21.682
115.970	0.202	11.116	2.001	0.644	21.728
117.971	0.441	10.566			

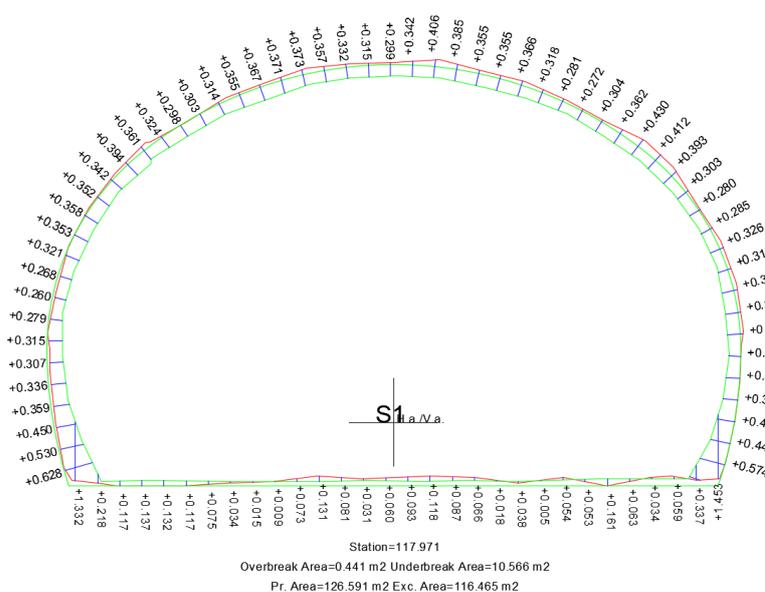
Total Overbreak Volume: 22.477 m3
Total Underbreak Volume: 1103.940 m3

The program will always close the two cross-sections to make calculations.

Draw button allows one to view graphically the comparison of cross-sections. The following screen will be shown to set up the drawing options. The *Discretization distance* allows to set the number of points used for drawing the cross-sections.



After clicking **OK** button, for each station, the program draws, in red, the cross-sections of the first file and, in green, the tunnel template and the points of the second file. As numeric information, the program shows the differences between both cross-sections, the **Station** and **Overbreak, Underbreak, Project** and **Excavation** areas.



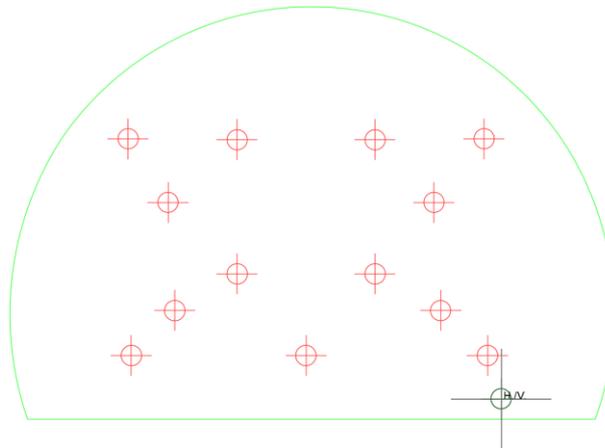
9. Export Stake out Front Face Pattern

This command allows one to create a grid file to stake out the front using TcpTunnel for total station.

Before running the command, the point grid must be drawn in a separated layer.

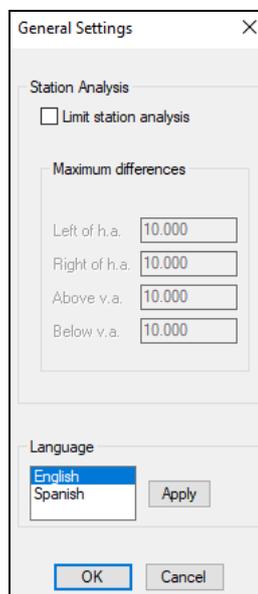
Then, the next steps must be followed:

- Select a point from the grid.
- Enter the offset of the point regarding the horizontal alignment.
- Enter the offset of the point regarding the vertical alignment.
- Enter the name of the grid file.
- After this, if a tunnel template file exists in the project, the tunnel templates will be drawn along with the point grid.



10. General Settings

This option allows one to change several parameters of the program settings.



Station Analysis

Allows one to activate/desactivate the limits for station analysis. This feature is useful for spiral horizontal alignment or horizontal alignments with crossed sections which have different heights. The program asks for maximum differences on the left and on the right of the horizontal alignment and maximum differences above and below of the vertical alignment heights.

For each point, the program will calculate several station solutions along the horizontal alignment and then, it will select the first station where the point is under the values of the previous four parameters.

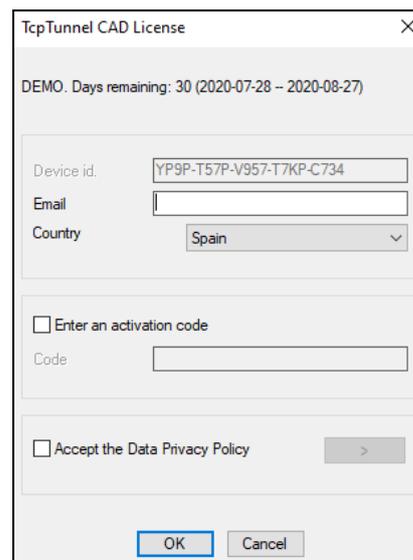
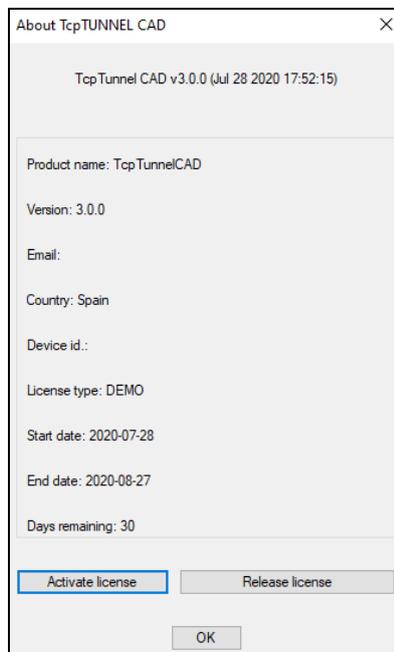
This feature is used within the options **Calculate Cross-sections** and **Point Report**.

Language

Allows one to change the program language. English or Spanish can be selected.

11. About

This option shows the license data of the program, such as *Product name*, *Version*, *Email*, *Country*, etc.



The *Release license* button allows one to remove the current license from the device. After doing this, the CAD program must be closed and it will be necessary to request a new activation the next time it is run.

The *Activate license* button manages the non-permanent licenses. It allows to change DEMO license to FINAL or 365, reactivate 365 license or change this to FINAL license.