

# Leica FlexLine plus

## Tunnel Application



Version 1.0  
English

- when it has to be **right**

**Leica**  
Geosystems

# Introduction



To use the product in a permitted manner, please refer to the detailed safety directions in the available User Manual.

## Trademarks

- Windows is a registered trademark of Microsoft Corporation.
  - Bluetooth® is a registered trademark of Bluetooth SIG, Inc.
- All other trademarks are the property of their respective owners.

## Validity of this manual

This manual applies to the Tunnel application of FlexField plus running on the TS06 plus/TS09 plus. The application allows measuring and staking of tunnels.

## Symbols

The symbols used in this manual have the following meanings:

Type	Description
	Important paragraphs which must be adhered to in practice as they enable the product to be used in a technically correct and efficient manner.



myWorld@Leica Geosystems (<https://myworld.leica-geosystems.com>) offers a wide range of services, information and training material. With direct access to myWorld, you are able to access all relevant services whenever it is convenient for you, 24 hours a day, 7 days per week. This increases your efficiency and keeps you and your equipment instantly updated with the latest information from Leica Geosystems.

Service	Description
myProducts	Add all products that you and your company own and explore your world of Leica Geosystems: View detailed information on your products and update your products with the latest software and keep up-to-date with the latest documentation.
myService	View the current service status and full service history of your products in Leica Geosystems service centres. Access detailed information on the services performed and download your latest calibration certificates and service reports.
mySupport	View the current service status and full service history of your products in Leica Geosystems service centres. Access detailed information on the services performed and download your latest calibration certificates and service reports.
myTraining	Enhance your product knowledge with Leica Geosystems Campus - Information, Knowledge, Training. Study the latest online training material on your products and register for seminars or courses in your country.
myTrusted-Services	Add your subscriptions and manage users for Leica Geosystems Trusted Services, the secure software services, that assist you to optimise your workflow and increase your efficiency.

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# 1

## Overview

### 1.1

### Functions

#### Description

The Tunnel application is an onboard software program for tunnel measurements on FlexLine plus TS06 plus/TS09 plus instruments.

#### Functions

- Data management  
Data are, for example, control points, horizontal alignment, vertical alignment and design sections. Data must be saved on the instrument. After inputting the data, they can be verified.
- Stake measurements  
Check cut and fill, stakeout cross sections, measure cross sections, stakeout
- Browse and delete the measurement results
- Data transfer  
Upload of original data and download of stakeout measurement results for the horizontal and vertical alignment

#### Features

- Data input on the instrument or data upload from PC software
- Input of all data of the horizontal alignment at once.
- Input of multiple design sections into one measurement
- Support of various data output formats



#### Data capacity

Type	Known points	Measurement points
TS06 plus/TS09 plus	≤ 100000	≤ 60000



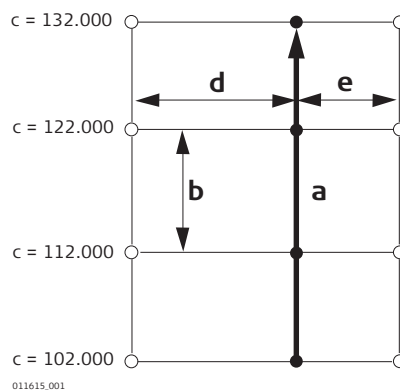
The program can be trialled 15 times. After 15 trials, it is necessary to enter the licence code.

## Common key functions

Key B&W	C&T	Description
		ESC key. Quits a screen or edit mode without saving changes. Returns to next higher level.  Pressing ESC short: Returns to next higher level. Quits a screen or edit mode without saving changes.  Pressing ESC long: Returns to the <b>Main Menu</b> . Quits a screen or edit mode without saving changes.
<b>Quit</b>		To exit the screen or program.
<b>OK or Yes</b>		To exit the screen or program.
<b>Quit or No</b>		To cancel the current operation.

## Common terms

Term	Description
Direction	Forward direction of the tunnel centreline. The chainage of the centreline increases in this forward direction.
Right	On the right side of the centreline when looking in the direction of increasing chainage. Values are positive.
Left	On the left side of the centreline when looking in the direction of increasing chainage. Values are negative.



- a) Centreline
- b) Increment
- c) Chainage
- d) Left of centreline
- e) Right of centreline

## Description

Leica Instrument Tools is used for the data exchange between the instrument and a computer. It contains several auxiliary programs in order to support the instrument.

Leica Instrument Tools are for free and can be downloaded from myWorld.



For more information about Instrument Tools refer to the comprehensive online help.

## 2 Defining the Road



### 2.1 Overview

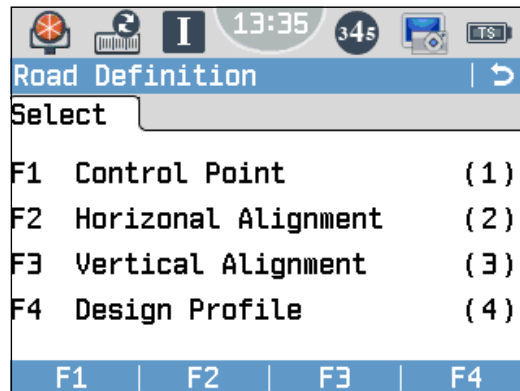
#### Description

**Road Definition** is used to browse and edit the known data, including the control point, horizontal alignment, vertical alignment and designed sections.

 Import horizontal alignments, vertical alignments or cross sections from the Office tunnel interface or an USB stick.

#### Access

1. Select  **Programs** from the **Main Menu**.
2. Select  **Tunnel** from the **Programs Menu**.
3. Complete program pre-settings.
4. In **Tunnel Measure-Main Menu**, select **Road Definition**.





It is recommended to upload control point data to the instrument using Leica Instrument Tools or the USB stick.

### Description

Control points including various levels of known plane points are used to set the station and the orientation.

### Access

1. Select **Control point** in **Road Definition**.

### View the Control Point

To browse and delete existing control point.

#### Add

To enter a new control point. The **Input Control Point** screen opens.

#### Delete

To delete the displayed control point.

### Input Control Point

#### Store

To store the data.



Check the data carefully in the **View the Control Point** screen.

Field	Description
<b>PtID</b>	Point ID of the point. Input is mandatory. * is not allowed as part of the point ID.
<b>East</b>	Easting coordinate of the point.
<b>North</b>	Northing coordinate of the point.
<b>Height</b>	Height coordinate of the point.

2.3

Horizontal Alignment



Is recommended to import horizontal alignments using the Tunnel Office interface or the USB stick.

Horizontal Alignment

The horizontal alignment defines the road axis of a project. Horizontal alignments are comprised of the elements:

- straights (tangents)
- curves (arcs)
- spirals (clothoid or cubic parabola)

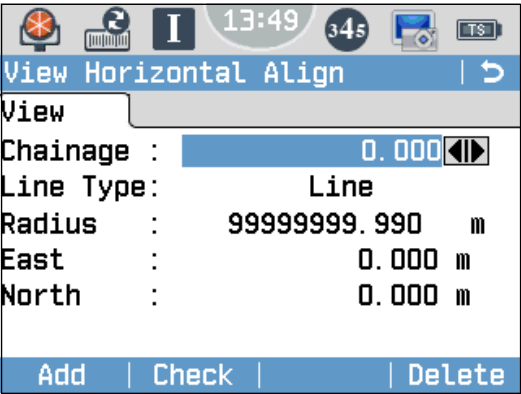
Each element involved is defined by individual horizontal design elements such as chainage, Easting, Northing, radius and parameter A.

Access

1. Select **F2 Horizontal Alignment** in **Road Definition**.

View Horizontal Align

To browse and delete existing elements of the horizontal alignments.



- Add**  
To add a new horizontal alignment. The **Input Horizontal Align** screen opens.
- Check**  
To check the horizontal alignment for smoothness or errors. The **Input Horizontal Align** screen opens. The duration of checking depends on the number of elements in the horizontal alignment. To correct an error, select the element, then press **Add** and correct the current data.
- Delete**  
To delete the selected element from the horizontal alignment.



## Input Horizontal Align

**Input Horizontal Align**

**Data**

Chainage : 0.000 m

Line Type: Line

Radius : 99999999.990 m

East : 0.000 m

North : 0.000 m

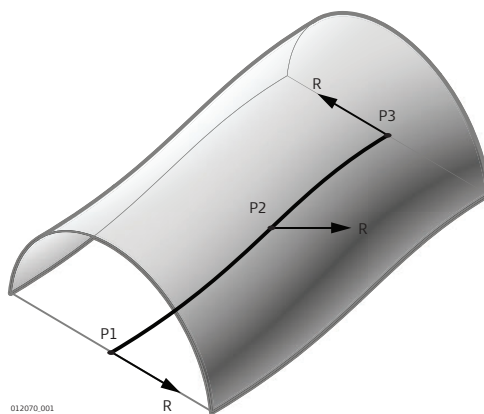
Save | Check | Quit

### Save

To save the displayed values.

### Check

To check the horizontal alignment for smoothness or errors.



P1 Start point  
P2 Point along the centreline  
P3 End point  
R Radius of the curve

Field	Description
<b>Chainage</b>	<p>The chainage along the centreline where the new element is added.</p> <ul style="list-style-type: none"> <li>Entering elements following the increasing chainage simplifies the checking procedure.</li> <li>Checking, measuring or staking require at least two valid elements.</li> <li>The maximum chainage is 4294000.000 m = K4294 +000.000 m.</li> </ul>
<b>Line Type</b>	The line style of the alignment before the new element. Available are: <b>Line</b> , <b>Sect. Name</b> , <b>Ele. Offset</b> and <b>CtrlLine Off.</b>
<b>Radius</b>	<p>The radius of the curve. When the radius of the curve is infinite, enter 99999999.999 or -99999999.999.</p> <ul style="list-style-type: none"> <li>Positive radius = Right-handed arcs</li> <li>Negative radius = Left-handed arcs</li> </ul>
<b>East</b>	The Easting coordinate of the element.
<b>North</b>	The Northing coordinate of the element.

Required radius entries depending on the selected line type:

Line Type	Radius
Start point	$\pm 99999999.999$ or $\pm R$
Curve	$\pm R$ (radius of curve)
Clothoid	$\pm R$ (radius of curve)
Line	99999999.999
End point	$\pm 99999999.999$ or $\pm R$

## 2.4

## Vertical Alignment



It is recommended to import vertical alignments using the Tunnel Office interface or the USB stick.

## Vertical alignment

The vertical alignment gives information about the pattern of heights of the road axis as it is defined in the horizontal alignment.

A vertical alignment is comprised of the elements:

- tangents (straight segments)
- curves
- parabolas.

Each element involved is defined by individual vertical design elements such as chainage, Easting, Northing, radius and parameter P.

## Access

1. Select **F3 Vertical Alignment** in **Road Definition**.

### View Vertical Align

To browse and delete existing elements of the vertical alignments.

**Add**

To add a new vertical alignment. The **Input Vertical Align** screen opens.

## Delete

To delete the selected element from the vertical alignment.

## Input Vertical Align

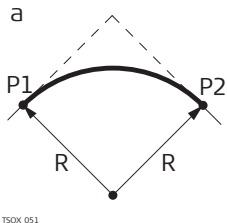
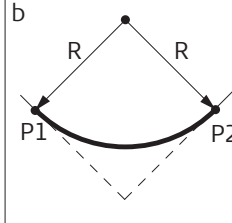
The vertical alignment is defined by **P**oints of **V**ertical **I**ntersection. PVIs are tangent or geometrical points.

- Vertical alignments with symmetrical curves are defined by the PVI chainage, the elevation of PVI and the total length of curve, where the tangent length is half the total length of the VC.
- Vertical Alignments with non-symmetrical curves are defined by the PVI chainage, the elevation of the PVI and both tangent lengths.

Input Vertical Align	
Chainage	10.000 m
Height :	11.000 m
Radius	0.000 m
Tangent Len. :	0.000 m
<div>Save       Quit</div>	

### Save

To save the displayed values.

Field	Description
<b>Chainage</b>	<p>The chainage along the centreline where the new element is added.</p> <ul style="list-style-type: none"> <li>☞ Entering PVIs following the increasing milage simplifies the checking procedure.</li> <li>☞ Start point and end point of the vertical alignment must be located at the straight slope segment of the vertical curve. The corresponding tangent length and radius is 0.000.</li> <li>☞ Checking, measuring or staking require at least two valid PVIs.</li> <li>☞ The maximum milage is 4294000.000 m = K4294 +000.000 m.</li> </ul>
<b>Height</b>	Elevation of the new PVI.
<b>Radius</b>	<p>The vertical curve radius of the PVI.</p> <ul style="list-style-type: none"> <li>• Positive radius = Convex curves</li> <li>• Negative radius = Concave curves</li> </ul> <div>   <div> <p>a Convex</p> <p>b Concave</p> <p>P1 Start point</p> <p>P2 End point</p> <p>R Radius</p> </div> </div>
<b>Tangent Len.</b>	Length of the straight element as slope distance.

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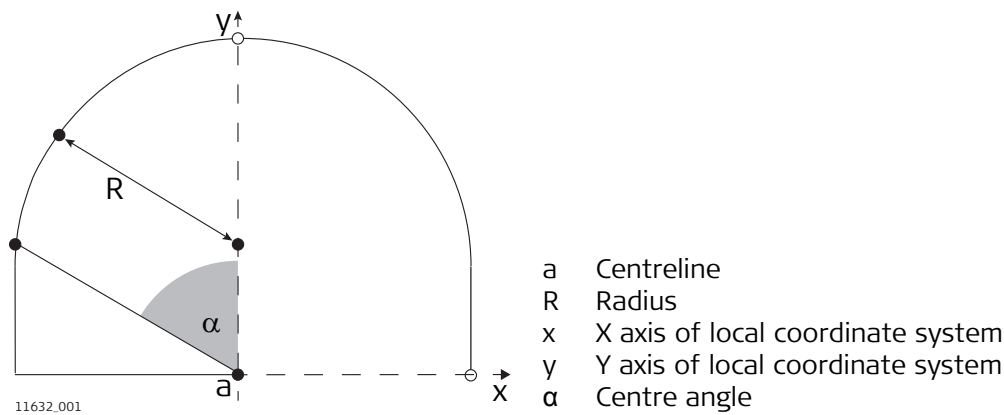
Design Profile



Is recommended to import design profiles using the Tunnel Office interface or the USB stick.

Design profile

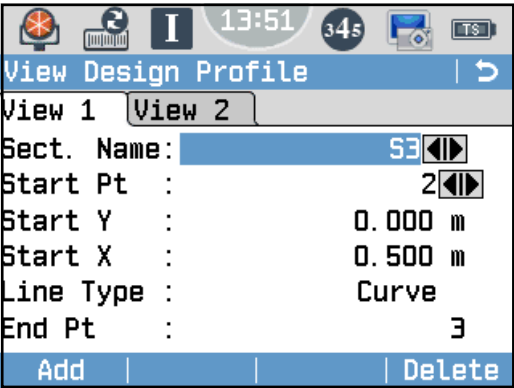
The design profile is a set of data describing and determining the contour of the tunnel.



Access

1. Select **F4 Design Profile** in **Road Definition**.

View Design Profile



- Add**  
To add a new design section. The **Input Design Profile** screen opens.
- Delete**  
To delete the selected design section.

## Input Design Profile

Enter lines and arcs in of clockwise direction.

**Input Design Profile**

Data | Data

Sect. Name: S3

Start Pt : 2

Start Y : 0.000 m

Start X : 0.500 m

Line Type : Line

End Pt : 3

Save | | | Quit

### Save



To save the displayed values.

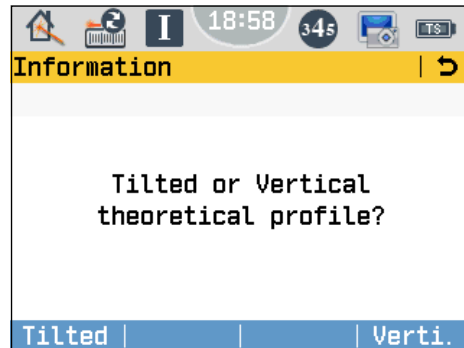
Field	Description
<b>Sect. Name</b>	The name of the design profile.
<b>Start Pt</b>	The point ID where the design profile starts.
<b>Start X</b>	The X coordinate of the start point in the local coordinate system.
<b>Start Y</b>	The Y coordinate of the start point in the local coordinate system.
<b>Line Type</b>	The line style of the profile. Available are: <b>Line</b> and <b>Sect. Name</b> .
<b>End Pt</b>	The point ID where the design profile ends.
<b>End X</b>	The X coordinate of the end point in the local coordinate system.
<b>End Y</b>	The Y coordinate of the end point in the local coordinate system.
<b>Cent.Angle</b>	Centre value of the arc section in radians
<b>Radius</b>	The radius of the tunnel design.

**Description**

**Stakeout Measure** is used to check cut/fill, stake cut outlines and to scan profiles.

**Access**

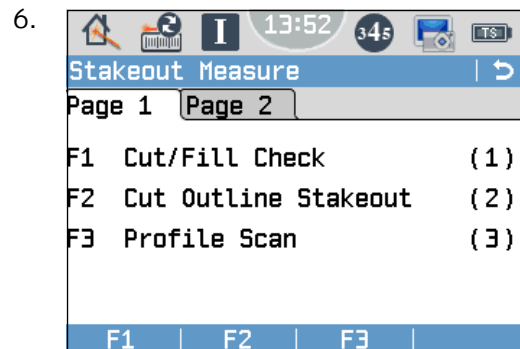
1. Select  **Programs** from the **Main Menu**.
2. Select  **Tunnel** from the **Programs Menu**.
3. Complete program pre-settings.
4. In **Tunnel Measure-Main Menu**, select **Stakeout Measure**.
- 5.



**Tilted**

**Verti.**

The mileage of cut/fill check will consider the influence of line longitudinal. Does not consider the influence of line longitudinal. Under normal circumstances. Select for standard applications.



**F1 Cut/Fill Check**

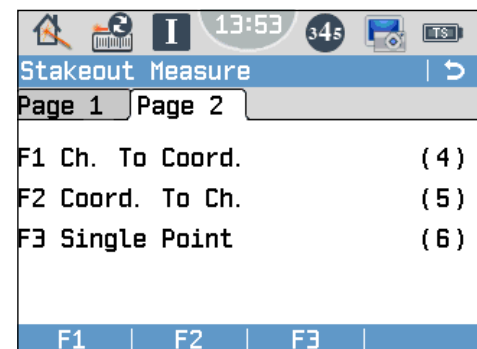
**F2 Cut Outline Stakeout**

**F3 Profile Scan**

**F1 Ch. To Coord.**

**F2 Coord. To Ch.**

**F3 Single Point**



To verify required cut and fill.

To define the outline of the stakeout.

To measure cross sections of stations and non-stations along the profile.

To convert the chainage, offset from the centreline and elevation from the centreline into coordinates.

To convert the coordinates of a point of the centreline into chainage, offset from the centreline and elevation from the centreline.

To stakeout individual points based on chainage, offset from the centreline and elevation from the centreline.

## Access

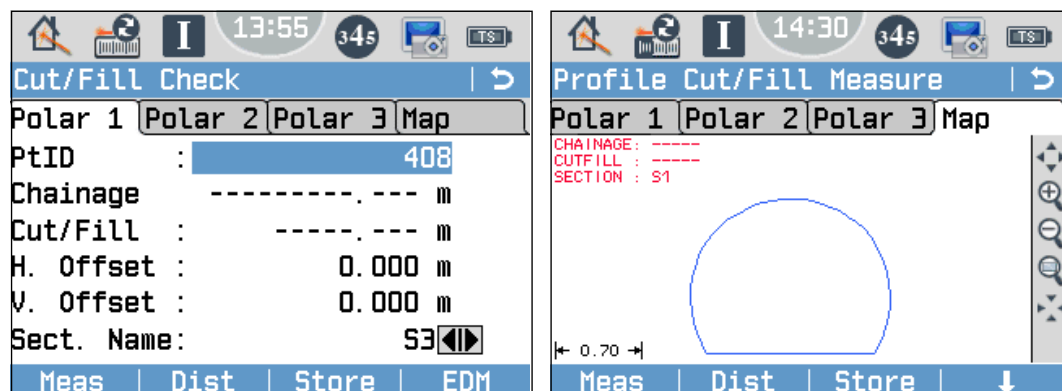
1. Select **F1 Cut/Fill Check** in **Stakeout Measure**.

## Cut/Fill Check

To verify required cut and fill.

 **EDM Mode: Non-Prism** must be used.

The map is an interactive display feature embedded in the firmware. The map provides a graphical display of the survey elements which allows for a better overall understanding of how the data being used and measured relates to each other. Refer to the Leica FlexLine plus User Manual for more information.



Field	Description
<b>PtID</b>	Point ID of the point.
<b>Chainage</b>	Selected chainage to measure.
<b>Cut/Fill</b>	The amount for cut or fill. <ul style="list-style-type: none"> <li>• Positive value = Fill/overbreak</li> <li>• Negative value = Cut/underbreak</li> </ul>
<b>H. Offset</b>	Perpendicular offset. <ul style="list-style-type: none"> <li>• Positive value = Cut/fill point is to the right</li> <li>• Negative value = Cut/fill point is to the left</li> </ul>
<b>V. Offset</b>	Height offset. <ul style="list-style-type: none"> <li>• Positive value = Cut/fill point is higher</li> <li>• Negative value = Cut/fill point is lower</li> </ul>
<b>Sect. Name</b>	Section name of corresponding measured position.
<b>Ele. Offset</b>	The difference in height between design elevation and measured elevation. <ul style="list-style-type: none"> <li>• Positive value = Measured point is higher than design</li> <li>• Negative value = Measured point is lower than design</li> </ul>
<b>CtrlLine Off.</b>	The offset value from the measured centerline and the design. <ul style="list-style-type: none"> <li>• Positive value = Point is located on the right side</li> <li>• Negative value = Point is located on the left side</li> </ul>


3.3

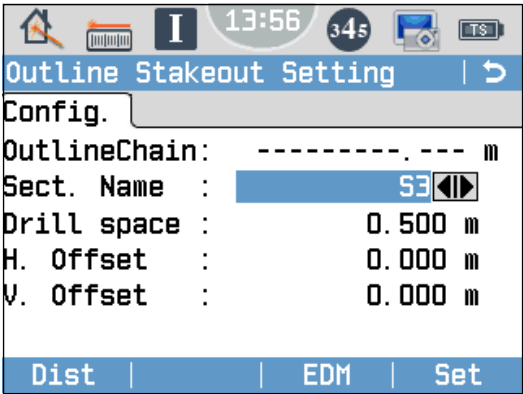
Cut Outline Stakeout

Access

1. Select **F2 Cut Outline Stakeout** in **Stakeout Measure**.

Outline Stakeout Setting

To define the outline of the stakeout.  
 Some settings must be defined before staking out cross section, including section name, drill hole spacing and tunnel heading mileage.



Set

To enter the **Outline Stakeout Setting** screen opens.

Field	Description
Outline-Chain	Current working face of the chainge. The value is calculated from the inverse computed distance. Target at the working face, press <b>Set</b> . The program automatically calculates this value.
Sect. Name	The name of the corresponding section of current working face.
Drill space	The distance between adjacent drill hole.

FlexLine plus Tunnel, Staking Out

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## Cut Outline Stakeout

Field	Description
PtNo.	The point to be staked. The point ID is a combination of section name and drill hole spacing defined in <b>Cut Outline Stakeout</b> . Example: AB 0 is the first point of the line AB of the design section, AB 1 is the second point of the line AB of the design section.
Cur Chainage	The chainage along the centreline where the point is staked.
Offset	Horizontal offset. The deviation in x-axis direction between the measured point and the stakeout point of the design section. <ul style="list-style-type: none"> <li>Positive value = Stake out point is to the right of the measured point</li> <li>Negative value = Stake out point is to the left of the measured point</li> </ul>
Line	Arc distance between the measured point and the stakeout point
ΔV	Height offset. The deviation in y-axis direction between the measured point and the stakeout point of the design section. <ul style="list-style-type: none"> <li>Positive value = Stake out point is higher than the measured point</li> <li>Negative value = Stake out point is lower than the measured point</li> </ul>
ΔHz	Angle offset. Horizontal angle difference between the measured point and the stakeout point of the design section. <ul style="list-style-type: none"> <li>Positive value = Stake out point is to the right of the measured point</li> <li>Negative value = Stake out point is to the left of the measured point</li> </ul>

Field	Description
PtNo.	The point to be staked. The point ID is a combination of section name and drill hole spacing defined in <b>Cut Outline Stakeout</b> . Example: AB 0 is the first point of the line AB of the design section, AB 1 is the second point of the line AB of the design section.
Cur Chainage	The chainage along the centreline where the point is staked.
Offset	Horizontal offset. The deviation in x-axis direction between the measured point and the stakeout point of the design section. <ul style="list-style-type: none"> <li>Positive value = Stake out point is to the right of the measured point</li> <li>Negative value = Stake out point is to the left of the measured point</li> </ul>
Line	Arc distance between the measured point and the stakeout point
ΔV	Height offset. The deviation in y-axis direction between the measured point and the stakeout point of the design section. <ul style="list-style-type: none"> <li>Positive value = Stake out point is higher than the measured point</li> <li>Negative value = Stake out point is lower than the measured point</li> </ul>
ΔHz	Angle offset. Horizontal angle difference between the measured point and the stakeout point of the design section. <ul style="list-style-type: none"> <li>Positive value = Stake out point is to the right of the measured point</li> <li>Negative value = Stake out point is to the left of the measured point</li> </ul>

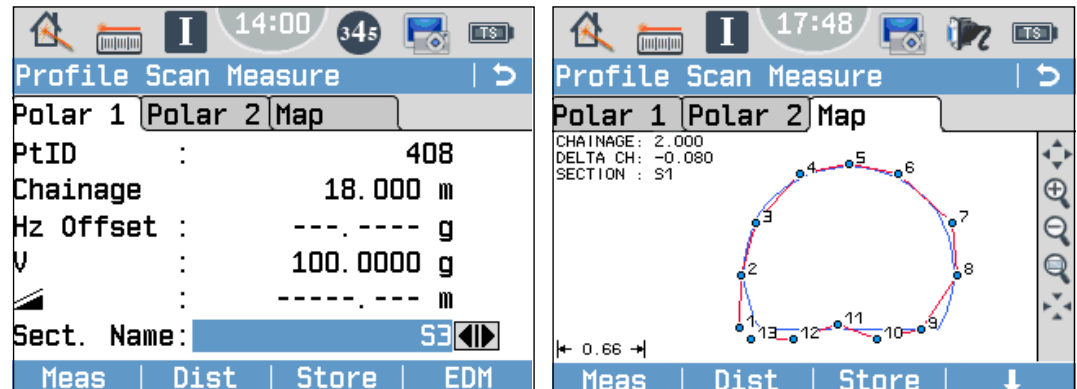
## Outline stakeout step-by-step


Step	Description
1.	Select the point to be staked.
2.	Rotate the telescope according to the horizontal and vertical angle deviation.
3.	Press <b>Meas Pt</b> to calculate the deviation of the current point.
4.	Repeat step 2. and 3. until the accuracy requirements are met.

## Access

1. Select **F3 Profile Scan** in **Stakeout Measure**.

**Profile Scan Measure** To measure cross sections on defined chainages along the tunnel alignment.



Field	Description
<b>PtID</b>	The point ID of the point.
<b>Chainage</b>	Selected chainage to measure.
<b>ΔChain.</b>	Longitudinal offset. <ul style="list-style-type: none"> <li>• Positive value = Design point is further away than the measured point.</li> <li>• Negative value = Design point is closer than the measured point.</li> </ul>
<b>Hz</b>	Horizontal direction to the station on the cross section.
<b>V</b>	Vertical angle to the station on the cross section.
	Slope distance to the point.
<b>North</b>	Northing coordinate of the point.
<b>East</b>	Easting coordinate of the point.
<b>Height</b>	Height coordinate of the point.

## Access

1. Select **F1 Ch. To Coord.** in **Stakeout Measure**.

## Ch. To Coord.

To convert the chainage, offset from the centreline and elevation from the centreline into coordinates.

Ch. To Coord.	
Result	
Chainage :	0.000 m
CtrLine Off. :	0.000 m
Ele. Offset :	0.000 m
North :	----- . --- m
East :	----- . --- m
Height :	----- . --- m
<div>Calc   Store   Back</div>	

**Calc**

To compute coordinates from the values entered.

**Store**

To save the results.

**Back**

To return to **Stakeout Measure**.

Field	Description
<b>Chainage</b>	The chainage at which the point of the centreline must be converted into coordinates.
<b>CtrLine Off.</b>	The offset of the centreline of which point coordinates must be computed. <ul style="list-style-type: none"> <li>• Positive value = Offset to the right</li> <li>• Negative value = Offset to the left</li> </ul>
<b>Ele. Offset</b>	The height offset of the centreline of which point coordinates must be computed. <ul style="list-style-type: none"> <li>• Positive value = Higher</li> <li>• Negative value = Lower</li> </ul>
<b>East</b>	Easting coordinate of the point in the local coordinate system.
<b>North</b>	Northing coordinate of the point in the local coordinate system.
<b>Height</b>	Height coordinate of the point in the local coordinate system.

**Access**

1. Select **F2 Coord. To Ch.** in **Stakeout Measure**.

**Cd. To Ch.**

To convert the coordinates of a point of the centreline into chainage, offset from the centreline and elevation from the centreline.

Cd. To Ch.	
Result	
North	: ----- m
East	: ----- m
Height	: ----- m
Chainage	: ----- m
CtrLine Off.	: ----- m
Ele. Offset	: ----- m
<div>Calc   Back</div>	

**Calc**

To compute a chainage from the values entered.

**Back**

To return to **Stakeout Measure**.

Field	Description
<b>East</b>	Easting coordinate of the point in the local coordinate system.
<b>North</b>	Northing coordinate of the point in the local coordinate system.
<b>Height</b>	Height coordinate of the point in the local coordinate system.
<b>Chainage</b>	The chainage at the centreline computed from the coordinates entered.
<b>CtrLine Off.</b>	The offset from the centreline computed from the coordinates entered. <ul style="list-style-type: none"> <li>• Positive value = Offset to the right</li> <li>• Negative value = Offset to the left</li> </ul>
<b>Ele. Offset</b>	The height offset from the centreline computed from the coordinates entered.. <ul style="list-style-type: none"> <li>• Positive value = Higher</li> <li>• Negative value = Lower</li> </ul>

## Access

1. Select **F3 Single Point** in **Stakeout Measure**.

## Single Point

To stakeout individual points based on chainage, offset from the centreline and elevation from the centreline.

**Calc**

To compute coordinates from the values entered.

**Back**

To return to **Stakeout Measure**.

**Meas Pt**

To stake the point.



Field	Description
<b>Chainage</b>	The chainage at which a point must be staked.
<b>CtrLine Off.</b>	The offset of the stakeout point from the centreline. <ul style="list-style-type: none"> <li>• Positive value = Offset to the right</li> <li>• Negative value = Offset to the left</li> </ul>
<b>Ele. Offset</b>	The height offset of the stakeout point from the centreline. <ul style="list-style-type: none"> <li>• Positive value = Higher</li> <li>• Negative value = Lower</li> </ul>
<b>East</b>	Easting coordinate of the point in the local coordinate system.
<b>North</b>	Northing coordinate of the point in the local coordinate system.
<b>Height</b>	Height coordinate of the point in the local coordinate system.
<b>PtID</b>	The point number of the stakeout point.
<b>hr</b>	Height of the reflector.
<b>H<sub>z</sub></b>	Angle offset. <ul style="list-style-type: none"> <li>• Positive value = Stake out point is to the right of the measured point</li> <li>• Negative value = Stake out point is to the left of the measured point</li> </ul>
<b>Back</b>	Distance offset between measured point and stakeout point seen in the direction of the telescope. <ul style="list-style-type: none"> <li>• Positive value = Stake out point is further away from the instrument</li> <li>• Negative value = Stake out point is closer to the instrument</li> </ul>
<b>Left</b>	Distance offset between measured point and stakeout point in the orthogonal direction to the telescope. <ul style="list-style-type: none"> <li>• Positive value = Stake out point is further left</li> <li>• Negative value = Stake out point is further right</li> </ul>
<b>Cut/Fill</b>	Height offset <ul style="list-style-type: none"> <li>• Positive value = Stake out point is higher than the measured point</li> <li>• Negative value = Stake out point is lower than the measured point</li> </ul>

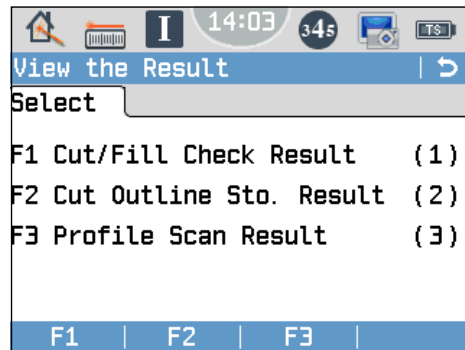
**Description**

**Result View** is used to browse the results of **F1 Cut/Fill Check**, **F2 Cut Outline Stakeout**, **F3 Profile Scan**.

The results can only be viewed and deleted. Editing is not allowed.

**Access**

1. Select  **Programs** from the **Main Menu**.
2. Select  **Tunnel** from the **Programs Menu**.
3. Complete program pre-settings.
4. In **Tunnel Measure-Main Menu**, select **Result View**.
- 5.



6. **F1 Cut/Fill Check Result**

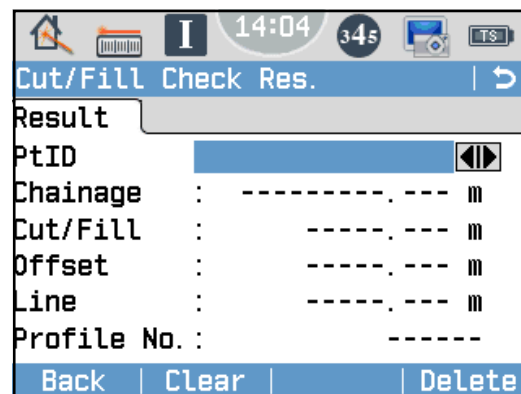
**F2 Cut Outline Sto. Result**

**F3 Profile Scan Result**

To view results from "3.2 Checking Cut and Fill".

To view results from "3.3 Cut Outline Stakeout".

To view results from "3.4 Profile Scan".

**Cut/Fill Check Res.****Back**

To return to **View the Result**.

**Clear**

To delete all results of **F1 Cut/Fill Check** from the selected job.

**Delete**

To delete the displayed result.

Field	Description
<b>PtID</b>	Point ID of the point.
<b>Chainage</b>	Chainage at which the measurements were taken.
<b>Cut/Fill</b>	The amount for cut or fill. <ul style="list-style-type: none"> <li>• Positive value = Fill/overbreak</li> <li>• Negative value = Cut/underbreak</li> </ul>
<b>Offset</b>	Perpendicular offset. <ul style="list-style-type: none"> <li>• Positive value = Cut/fill point is to the right</li> <li>• Negative value = Cut/fill point is to the left</li> </ul>
<b>Line</b>	The offset value from the measured centreline and the design. <ul style="list-style-type: none"> <li>• Positive value = Point is located on the right side</li> <li>• Negative value = Point is located on the left side</li> </ul>
<b>Profile No.</b>	The number of the measured profile.

## Outline Stakeout Res.

### Back

To return to **View the Result**.

### Clear

To delete all results of **F2 Cut Outline Stakeout** from the selected job.

### Delete

To delete the displayed result.

Field	Description
<b>PtID</b>	Point ID of the point.
<b>Chainage</b>	Chainage at which the measurements were taken.
<b>ΔOffset</b>	Total difference in East, North and Height between staked point and design coordinates.
<b>North</b>	Northing coordinate of the staked point.
<b>East</b>	Easting coordinate of the staked point.
<b>Height</b>	Height coordinate of the staked point.

## Profile Measure Res.

### Back

To return to **View the Result**.

### Clear

To delete all results of **F3 Profile Scan** from the selected job.

### Delete

To delete the displayed result.



Field	Description
<b>PtID</b>	Point ID of the point.
<b>Chainage</b>	Chainage at which the measurements were taken.
<b>ΔChain</b>	Total difference in East, North and Height between measured point and chainage coordinates.
<b>North</b>	Northing coordinate of the measured point.
<b>East</b>	Easting coordinate of the measured point.
<b>Height</b>	Height coordinate of the measured point.

## 5 Data Transfer

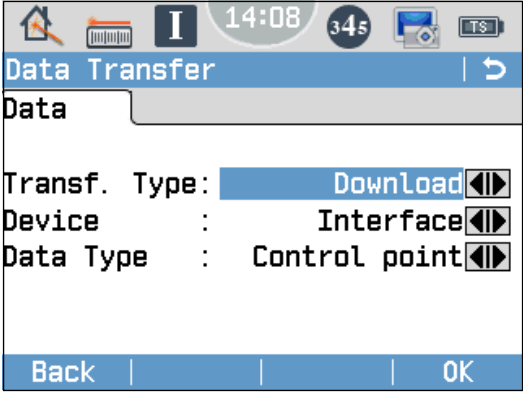
### Description

**Data Transfer** is used to upload or download the tunnel definition and stakeout results using the data cable or the USB stick.

### Access

1. Select  **Programs** from the **Main Menu**.
2. Select  **Tunnel** from the **Programs Menu**.
3. Complete program pre-settings.
4. In **Tunnel Measure-Main Menu**, select **Data Transfer**.

### Data Transfer




The screenshot shows the 'Data Transfer' menu. At the top, there's a status bar with icons for home, a printer, a person, the time 14:08, a battery level indicator, and a 'TS' icon. The menu title 'Data Transfer' is in a blue bar. Below it, the 'Data' tab is selected. The menu contains three settings: 'Transf. Type:' set to 'Download', 'Device' set to 'Interface', and 'Data Type' set to 'Control point'. Each setting has a double arrow icon to its right. At the bottom, there are two buttons: 'Back' and 'OK'.

#### Back

To return to **View the Result**.

#### OK

To transfer the data.

Field	Description
<b>Transf. Type</b>	Select between data download and upload.  For an upload from the USB stick: Create a folder called TUNNEL on the USB stick. All files must be called Tunnel. *. For example a flat curve file must be called Tunnel.HLN.
<b>Device</b>	USB memory stick or RS232 serial interface.
<b>Data Type</b>	Data type to be transferred. <b>Control point</b> For upload and download Control points of the tunnel <b>Horizon. align.</b> For upload and download Horizontal alignment for the tunnel <b>Vertical align.</b> For upload and download Vertical alignment for the tunnel <b>Design Profile</b> For upload and download Design profile of the tunnel
	<b>Cut/Fill</b> For download <b>ChkRes,</b> Cut or fill check results <b>Outline Stk</b> For download <b>Res</b> Stakeout results from the tunnel outline <b>Profile</b> For download <b>ScanRes</b> Measured cross sections of stations and non-stations along the profile.



## 6

## Post-Processing

### 6.1

### Working with Tunnel Office

#### Installation on a computer

Tunnel Office is available for download in myWorld for customers who have purchased the onboard Tunnel application.

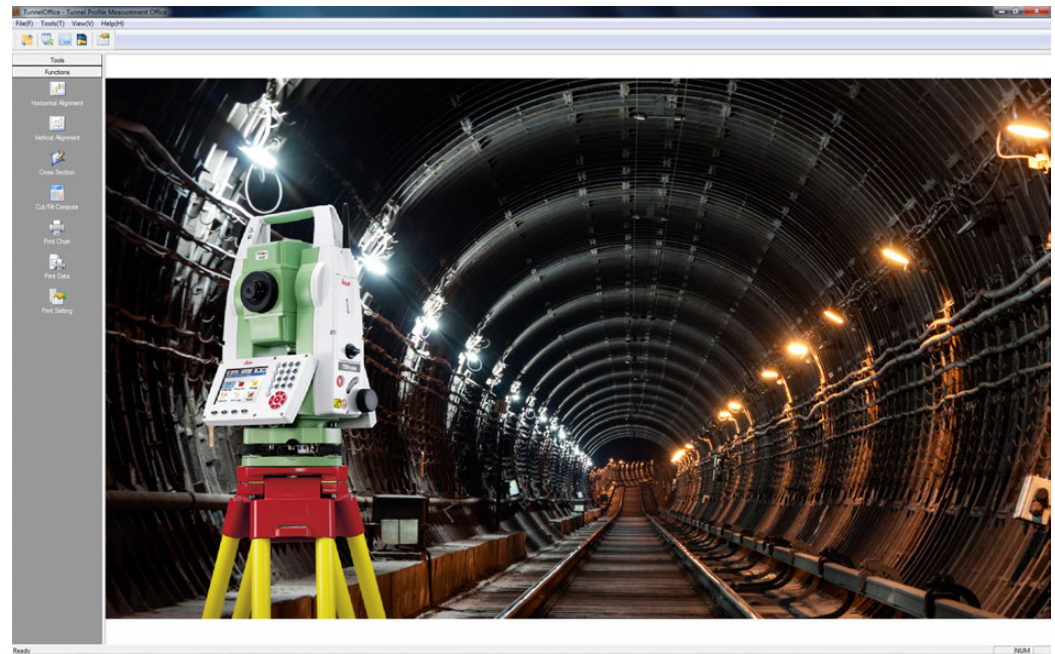
Tunnel Office can be installed on computers with MS Windows XP, Vista and Windows 7/8/10 operating systems.

Step	
1.	Double click the TunnelOffice.exe.
2.	Follow the on-screen instructions.

#### Description

Tunnel Office is used to:

- Upload data to the instrument
- Download data from the instrument
- Define and view a horizontal alignment design
- Define and view a vertical alignment design
- Define and view a cross section design
- Print out graphics and data



**File**

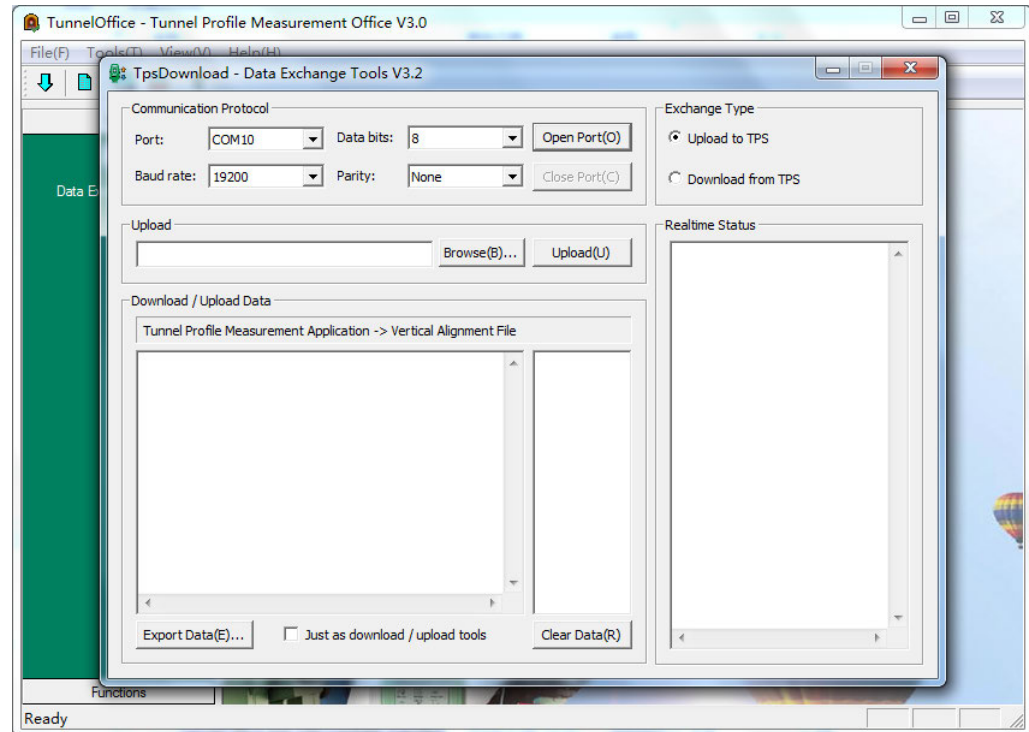
Options:

- Print the tunnel cross section chart and data.
- Export the tunnel cross section data as Excel file.
- Export the tunnel cross section chart as image.
- Export the tunnel cross section data as dxf file.

**Tools**

Starts the data exchange tool.

Upload design data from the PC to the instrument or download measured data from the instrument to the PC.

**Communication protocol**

Set the same COM port, baud rate, data bits and parity as on the instrument.

**Open port** To establish the communication between PC and instrument.

**Exchange type**

Select upload or download.

**Upload**

**Browse** To select the file you want to upload.

**Upload** To start the upload process.

**Download/Upload data**

Displays data available for download from the instrument or available for upload to the instrument.

**Export data** To save the data downloaded from the instrument to a file.

**Clear Data** To clear the data displayed in the window.



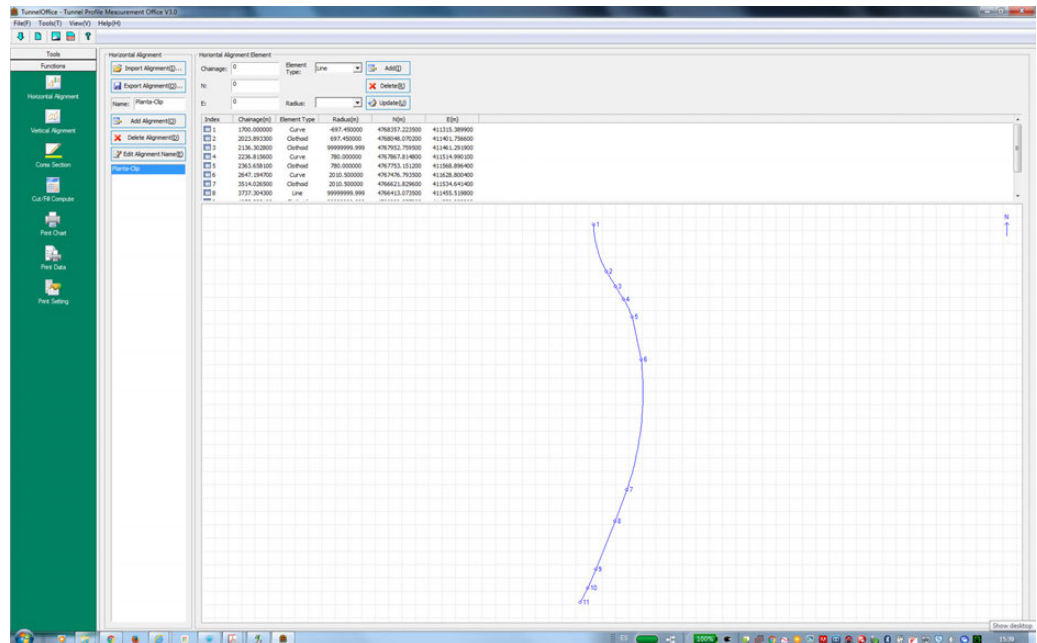
Click **Clear Data** each time before an upload or download.

**Realtime status**

Displays the progress of the data upload.

## Horizontal Alignment

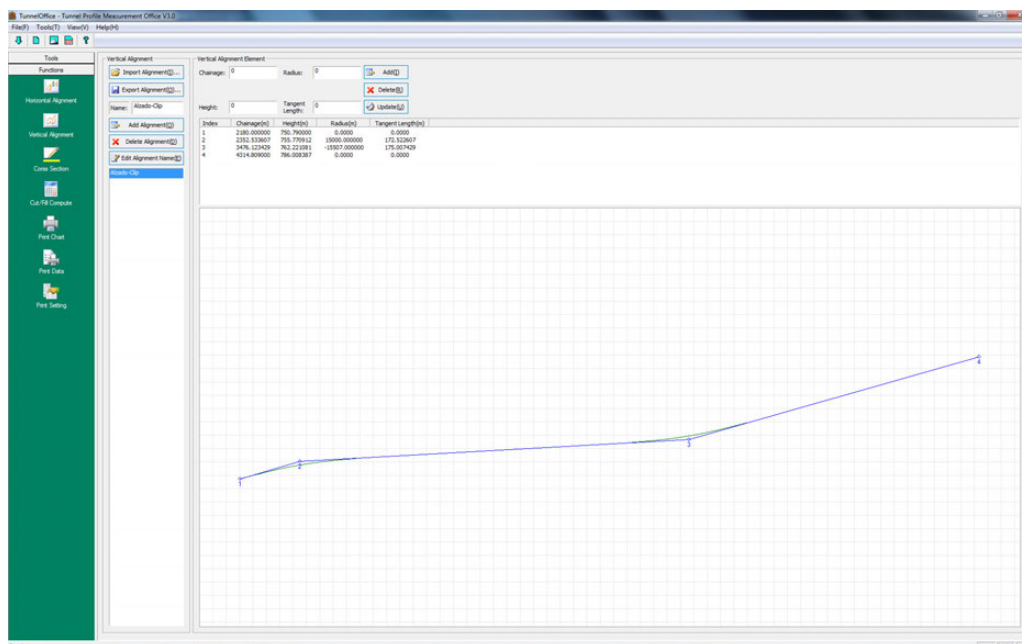
A horizontal alignment is a set of data defining the top view design of the centreline.



Button or field	Description
<b>Horizontal Alignment</b>	
<b>Import Alignment</b>	To open an existing alignment. LandXML format is supported.
<b>Export Alignment</b>	To save the alignment entered in Tunnel Office to a file.
<b>Name</b>	Name for the alignment <ul style="list-style-type: none"> <li>For add new alignment, enter a name and click <b>Add Alignment</b>.</li> <li>To edit the name of an alignment, click on the name in the name box and make the modifications. When finished, click the <b>Edit Alignment Name</b>.</li> </ul>
<b>Horizontal Alignment Element</b>	
<b>Chainage</b>	The chainage along the centreline where the new element is added.
<b>N</b>	North coordinate of the point at the defined chainage. Characters and spaces are not allowed.
<b>E</b>	East coordinate of the point at the defined chainage. Characters and spaces are not allowed.
<b>Element Type</b>	The line style of the alignment before the new element. Available are: <b>Line</b> , <b>Curve</b> , <b>Clothoid</b> and <b>End</b> .
<b>Radius</b>	The radius of the curve or clothoid. Characters and spaces are not allowed. The sign indicates the direction of the curve or clothoid looking in the direction of increasing chainage. <ul style="list-style-type: none"> <li>For right turn: Select + from the list.</li> <li>For left turn: Select - from the list.</li> <li>For a straight: Use no sign in this field.</li> </ul>

## Vertical Alignment

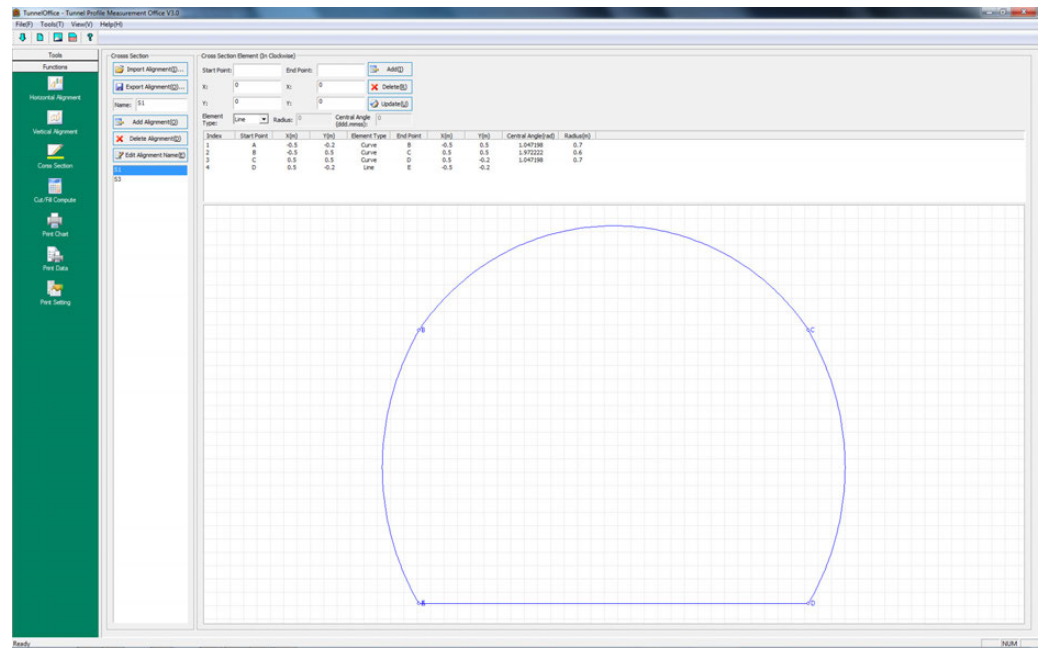
A vertical alignment is a set of data defining the elevation of the centreline.



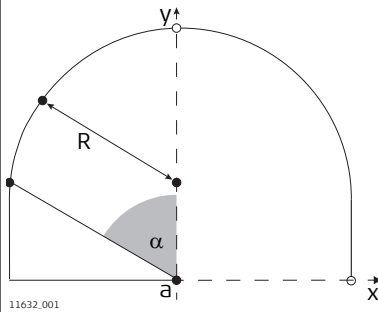
Button or field	Description
<b>Vertical Alignment</b>	
<b>Import Alignment</b>	To open an existing alignment. LandXML format is supported.
<b>Export Alignment</b>	To save the alignment entered in Tunnel Office to a file.
<b>Name</b>	Name for the alignment <ul style="list-style-type: none"> <li>For add new alignment, enter a name and click <b>Add Alignment</b>.</li> <li>To edit the name of an alignment, click on the name in the name box and make the modifications. When finished, click the <b>Edit Alignment Name</b>.</li> </ul>
<b>Vertical Alignment Element</b>	
<b>Chainage</b>	The chainage along the centreline where the new element is added.
<b>Height</b>	Elevation at the defined chainage
<b>Radius</b>	The vertical curve radius of the point. <ul style="list-style-type: none"> <li>Positive radius = Convex curves</li> <li>Negative radius = Concave curves</li> </ul> <div style="display: flex; align-items: center;"> <div style="margin-right: 20px;"> </div> <div> <p>a Convex</p> <p>b Concave</p> <p>P1 Start point</p> <p>P2 End point</p> <p>R Radius</p> </div> </div>
<b>Tangent</b>	Length of the straight element as slope distance.                      The end of the long straight and radius with tangential slope segment is 0.

## Cross Section

A cross section is a set of data describing and determining the contour of the tunnel. When editing cross section data, the plot is updated immediately.

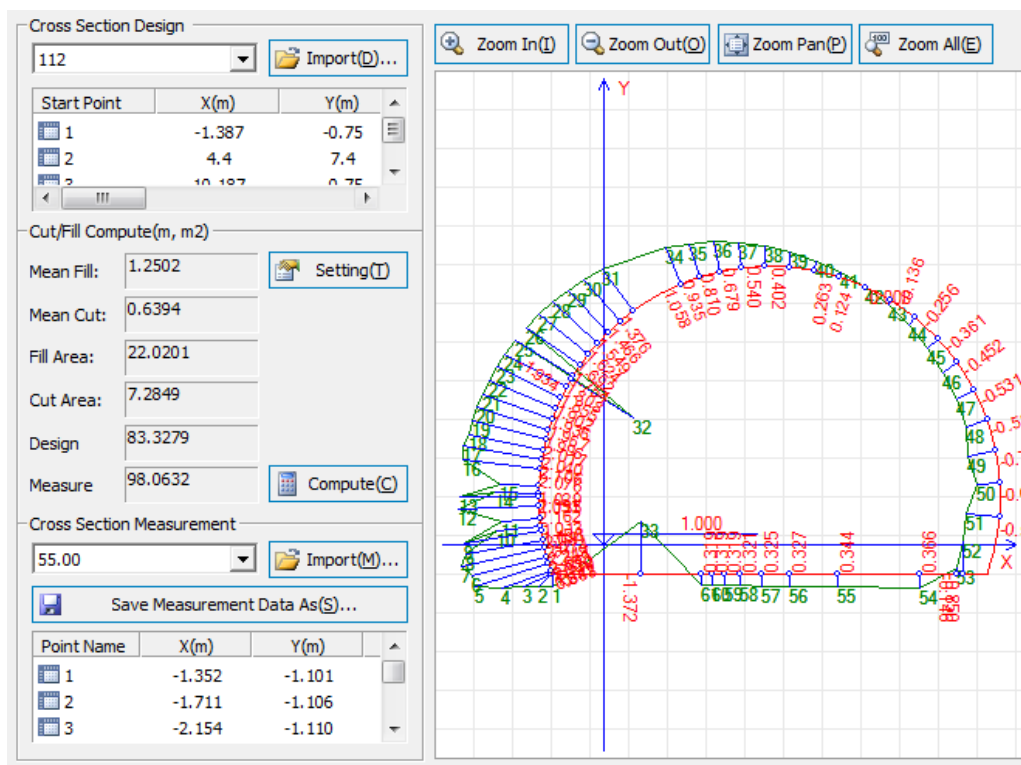


Button or field	Description
<b>Cross Section</b>	
<b>Import Alignment</b>	<p>To open an existing cross section from a LandXML, *.tln or *.dxf file.</p> <p>☞ The units in the *. dxf file must be meters. In the CAD program, draw from the CAD coordinate origin. Start with the line and arc segments at the closed section of tunnel design in clockwise direction. Save in AutoCAD R11/R12 DXF format, with the maximum decimal units precision. Delete all auxiliary lines and check that all the entities are perfectly closed before saving as DXF file.</p> <p>☞ Execute the command specific to your CAD program to remove unused items, for example block definitions and layers.</p>
<b>Export Alignment</b>	To save the cross section entered in Tunnel Office to a file.
<b>Name</b>	<p>Name for the cross section</p> <ul style="list-style-type: none"> <li>For add new cross section, enter a name and click <b>Add Alignment</b>.</li> <li>To edit the name of a cross section, click on the name in the name box and make the modifications. When finished, click the <b>Edit Alignment Name</b>.</li> </ul>
<b>Cross Section Element</b>	
	A local coordinate system must be used. Origin is the centerline point at the mileage.

Button or field	Description
	 <p> a Centreline  R Radius  x X axis of local coordinate system  y Y axis of local coordinate system  α Centre angle </p> <p>11632.001</p>
<b>Start point</b>	The point ID where the design profile starts.
<b>End point</b>	The point ID where the design profile ends.
<b>X</b>	The X coordinate of the start or end point in the local coordinate system.
<b>Y</b>	The Y coordinate of the start or end point in the local coordinate system.
<b>Element Type</b>	The line style of the profile. Available are: <b>Line</b> and <b>Curve</b> .
<b>Radius</b>	The radius of the tunnel design.
<b>Central angle (ddd.mmss)</b>	The centre angle $\alpha$ . Enter in degrees.minutessecond. For example: 12°25'36" = 12.2536 In the cross section plot, the angle is shown in radians.

## Cut/Fill Compute

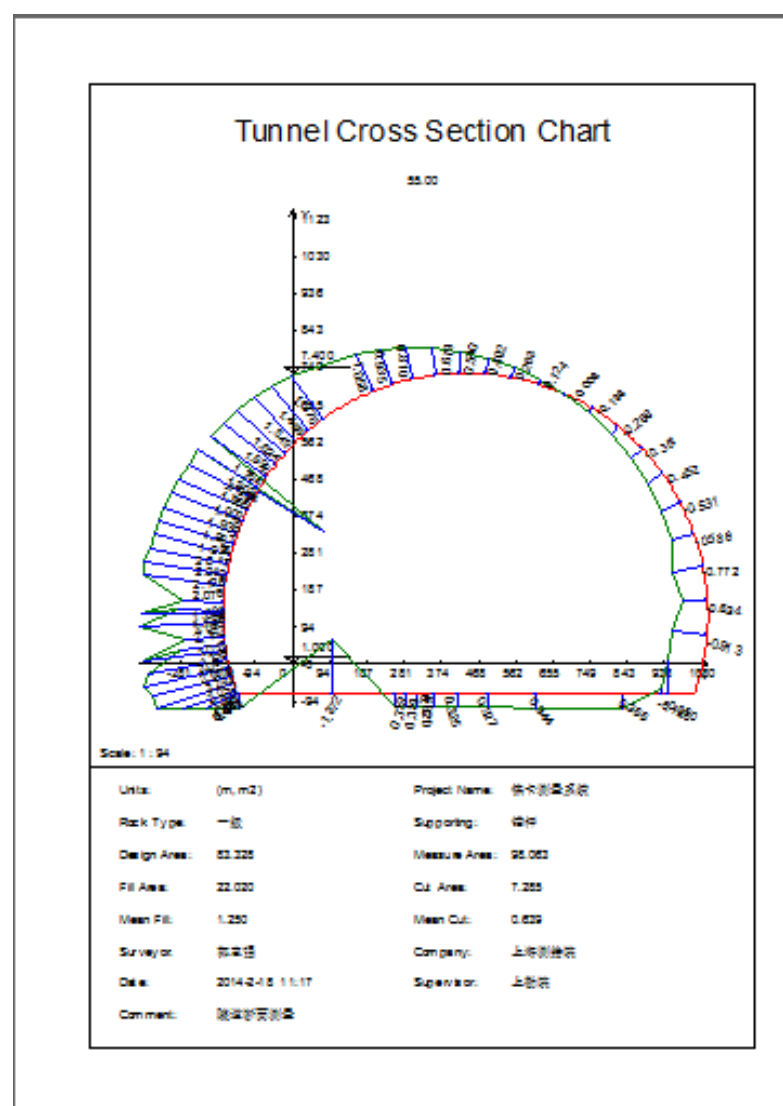
Calculate the cut and fill as difference between tunnel design and measured data.



Button or field	Description
<b>Cross Section Design</b>	
<b>Import</b>	To open a design cross section.
<b>Cross Section Measurement</b>	
<b>Import</b>	To import the *.obs file which includes the measured data downloaded from the instrument. In the drop-down list, select a chainage for the calculations.
<b>Cut/Fill Compute</b>	
<b>Settings</b>	Used to offset the measured cross section so that unexcavated part is excluded from the calculation. <div data-bbox="683 1352 1394 1772"> <p><b>Compute Setting</b></p> <p>Offset</p> <p>Horizontal Offset: <input type="text" value="6"/> m</p> <p>Vertical Offset: <input type="text" value="0"/> m</p> <p>Bottom Compute Height</p> <p>Bottom Height: <input type="text"/> m</p> <p>Point Name Mark</p> <p><input type="checkbox"/> Mark Every Two Point</p> <p><input checked="" type="button" value="OK(O)"/> <input type="button" value="Cancel(C)"/></p> </div>

Button or field	Description
	<p><b>Offset</b></p> <p>The offset effects the curve position. The tunnel section line has an offset relative to the center line. The tunnel section has a coordinate system relative to the center line.</p> <ul style="list-style-type: none"> <li>• Positive offset = Measured cross section right or up</li> <li>• Negative offset = Measured cross section left or down</li> </ul> <p><b>Point Name Mark</b></p> <p>Used for marking points in the graph. If the measured points are too close to each other, the points overlap in the graph and when printed. Select to mark only every second point.</p> <p><b>Bottom Compute Height</b></p> <p>To analyse the overbreak and to exclude unexcavated parts from the calculation. Enter the lowest elevation relative to the coordinates origin.</p> <p>After the excavation of up steps, enter the lowest elevation, so that excavation sections with lower elevation are not considered.</p>
<b>Save current measurement data</b>	To save measured data to a selected file.
<b>Compute</b>	To analyse and calculate the overbreak. Before a calculation can be done, import the data, select a section and define the calculation settings.





## Print Data

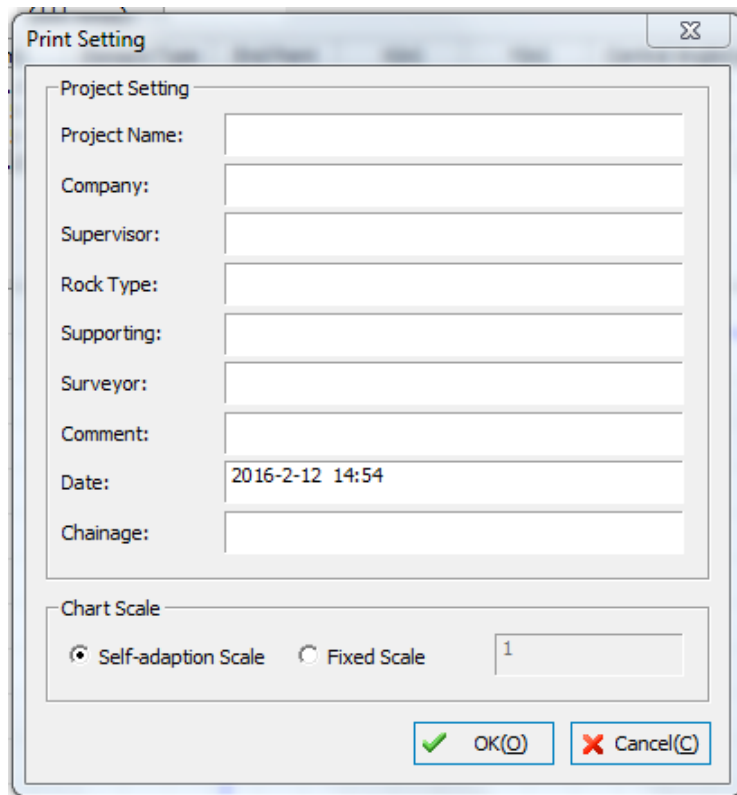
To print the data of the cross section as table. The data includes the index with the according local coordinates and the cut/fill.

Tunnel Cross Section Data							
Project Name:				Chainage: 55.00			
Company:				Date: 2014-2-18 11:17			
Supervisor:				Surveyor:			
Index	X(m)	Y(m)	Cut/Fill(m)	Index	X(m)	Y(m)	Cut/Fill(m)
1	-1.352	-1.101	0.351	34	-2.615	5.075	1.555
2	-1.711	-1.105	0.451	35	-2.355	5.434	1.505
3	-2.154	-1.110	0.547	36	0.755	3.299	-1.934
4	-2.725	-1.117	1.355	37	-2.054	5.753	1.754
5	-3.415	-1.095	2.039	38	-1.734	6.123	1.692
6	-3.512	-0.815	2.053	39	-1.355	6.451	1.624
7	-3.774	-0.570	2.249	40	-0.955	6.763	1.549
8	-3.653	-0.340	2.074	41	-0.523	7.054	1.455
9	-2.833	0.353	1.155	42	-0.043	7.320	1.376
10	-2.720	0.555	2.051	43	1.623	7.900	1.055
11	-2.713	0.623	1.013	44	2.345	7.995	0.925
12	-3.556	0.977	2.152	45	2.594	8.045	0.810
13	-2.553	1.390	1.125	46	3.554	8.025	0.679
14	-3.520	1.255	2.091	47	4.247	7.935	0.540
15	-2.750	1.625	1.029	48	4.925	7.750	0.402
16	-3.744	2.270	2.075	49	5.620	7.545	0.253
17	-3.723	2.627	2.105	50	6.255	7.232	0.124
18	-3.595	2.949	2.040	51	6.931	6.844	-0.005
19	-3.491	3.295	2.017	52	7.535	6.375	-0.135
20	-3.359	3.649	1.995	53	8.059	5.841	-0.255
21	-3.221	4.004	1.957	54	8.554	5.241	-0.351
22	-3.049	4.352	1.925	55	9.010	4.554	-0.452
23	-2.851	4.724	1.902	56	9.354	3.879	-0.531
Design Area: 51.325				Cut Area: 7.255			
Measure Area: 95.053				Fill Area: 22.020			
Mean Fill: 1.250				Units: (m, m2)			
Comment:							

## Print Settings

Enter project information, for example the project name and rock type. The information is added in the header of graphic prints.

☞ To print data or graph of a specific chainage, enter the chainage in the field **Chainage**.



The image shows a 'Print Setting' dialog box with a title bar and a close button. It contains two main sections: 'Project Setting' and 'Chart Scale'. The 'Project Setting' section has text labels for 'Project Name:', 'Company:', 'Supervisor:', 'Rock Type:', 'Supporting:', 'Surveyor:', 'Comment:', 'Date:', and 'Chainage:', each followed by a text input field. The 'Date' field is pre-filled with '2016-2-12 14:54'. The 'Chart Scale' section has two radio buttons: 'Self-adaption Scale' (which is selected) and 'Fixed Scale'. To the right of these radio buttons is a text input field containing the number '1'. At the bottom right of the dialog are two buttons: 'OK(O)' with a green checkmark icon and 'Cancel(C)' with a red X icon.

Project Setting	
Project Name:	
Company:	
Supervisor:	
Rock Type:	
Supporting:	
Surveyor:	
Comment:	
Date:	2016-2-12 14:54
Chainage:	

Chart Scale	
<input checked="" type="radio"/> Self-adaption Scale	<input type="radio"/> Fixed Scale
1	

OK(O) Cancel(C)

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**Leica Geosystems AG**

Heinrich-Wild-Strasse

CH-9435 Heerbrugg

Switzerland

Phone +41 71 727 31 31

[www.leica-geosystems.com](http://www.leica-geosystems.com)

- when it has to be **right**

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