GPS System 500

General Guide to RoadPlus

Version 4.0
English

Leica Geosystems

Congratulations on your purchase of a new Leica System GPS500.

View of chapters

Contents

Introduction

This manual is an introduction to the application program RoadPlus for the Leica GPS Sytem 500. RoadPlus is a complete road package application primarily intended for staking out of roads. Furthermore, it is also applicable to railways, canals, damns, pipelines or any other project that is definable as curvilinear alignments with optional cross sectional information.
The program supports

- the staking out of individual points using horizontal and vertical alignments and cross sections.
- station equations.
- cross section assignment by station cross section definition.
- cross section.
- interpolation superelevation.
- widening.
- staking out of catch points.

Activation of the Application

The application is activated by an access code which is provided by Leica. If the application does not appear on your menu or you are otherwise unable to access it, please contact your Leica representative.

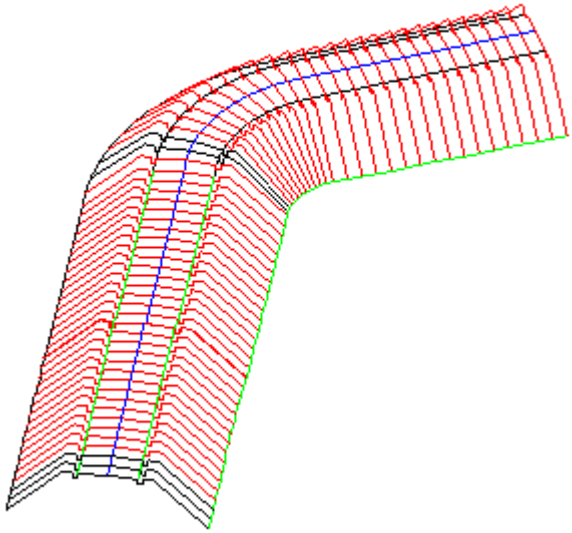
Requirements

You must be familiar with the principles and procedures that are outlined in the manual “Getting Started with Real-Time Surveys“ as well as the “Technical Reference Manual“.
If the material referenced is not thoroughly understood, it is strongly adviced that you review them prior to proceeding with this application program.
Within this manual, it is assumed that you are familiar with the operation of the system.

Design Elements

A road surface can be thought of three different types of design elements:

- the horizontal alignment
- the vertical alignment
- the cross section

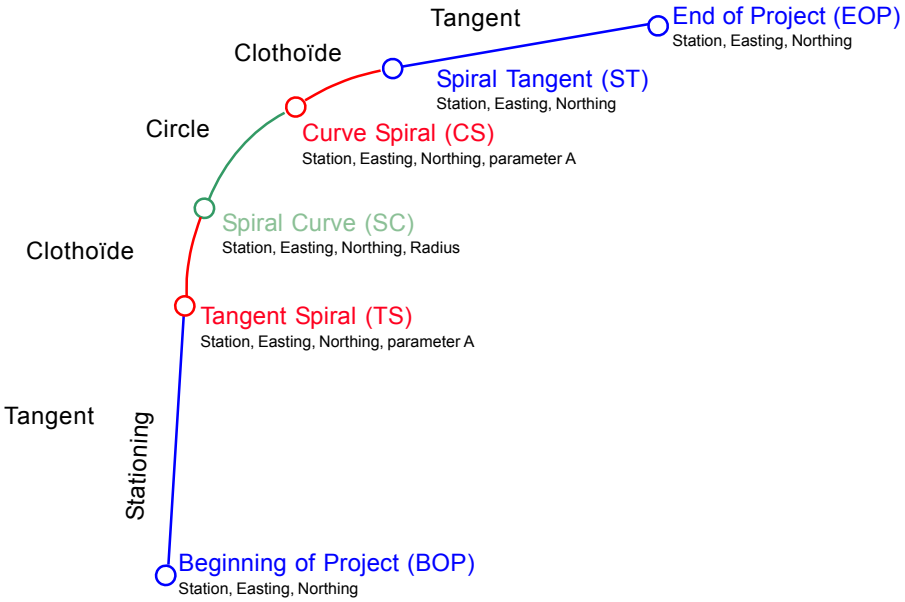


The horizontal alignment defines the road axis of a project.

The **constituting elements** of a horizontal alignment are

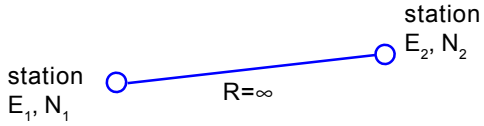
- tangents (straight segments)
- circles
- clothoïdes (spiral in/out, curve in/out).

Each constituting element is defined by individual **horizontal design elements** such as station, easting, northing, radius and parameter A.

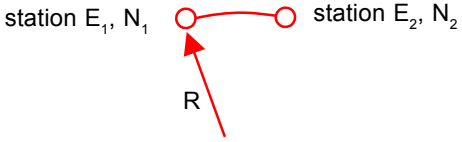


For the reason of completness, a short summary of the design elements for horizontal alignment is included in this chapter.

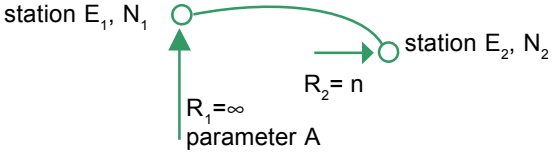
The Tangent - straight line between two points. It's end point is identical with the beginning of a curve or spiral. The tangent is perpendicular to the radius of the curve.



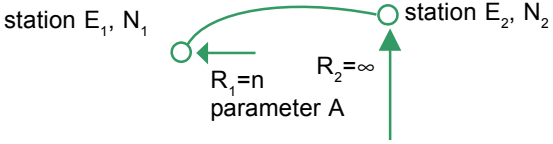
The Curve - circular curve with constant radius.



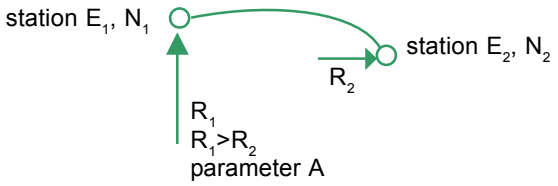
Sipral in - spiral transition from tangent to curve.



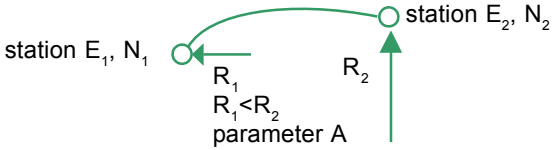
Sipral out - spiral transition from curve to tangent.



Curve in - spiral transition from larger to smaller radius curve.



Curve out - spiral transition from smaller to larger radius curve.



Curve in and out are used for combinations such as:

curve - curve in - curve out - curve
or
tangent - spiral in - curve in - curve

whereas spiral in/out always connect a tangent with a curve / curve in / curve out.

Parameter A

$$A^2 = R \times L$$

R radius of the connecting circular curve
L length of the spiral in/out or curve in/out

Sign convention for curves and spirals:

centre of curvature to left of centre line: R resp. A < 0
centre of curvature to right of centre line: R resp. A > 0

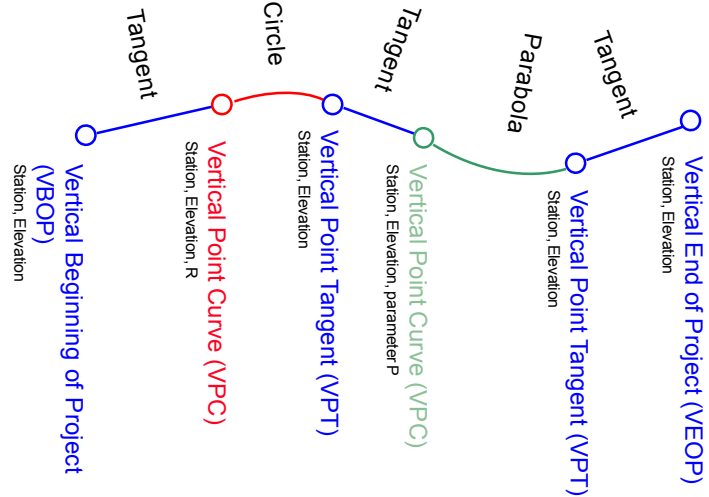
Or in words: Looking in the direction of increasing station, apply the "right hand positive rule".

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

The **constituting elements** of a vertical alignment are

- tangents (straight segments)
- circles
- parabolas.

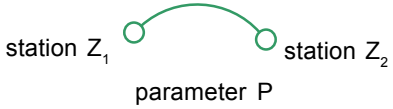
Each constituting element is defined by individual **vertical design elements** such as station, easting, northing, radius and parameter P.



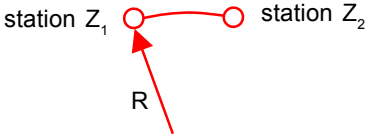
For the reason of completness, a short summary of the design elements for vertical alignment follows.

The Tangent - straight line between two points. It's end point is identical with the beginning of a curve or spiral. The tangent is perpendicular to the radius of the curve.

The Parabola - a parabolic vertical curve with constant rate of grade change.



The Curve - circular vertical curve with constant radius.



Sign convention for curves and parabolas:

centre of curvature below the alignment: R resp. P < 0
centre of curvature above the alignment: R resp. P > 0

Parameter P - is the reciprocal of the rate of change of grade in the vertical curve. Three formulas for the calculation of P exist:

1. $P = L / (G_{out} - G_{in})$

L length as horizontal distance from the beginning to the end of the vertical curve
G_{in} grade of the vertical alignment at the beginning of the vertical curve
G_{out} grade of the vertical alignment at the end of the curve

G_{in} and G_{out} in decimal units (not percent) negative for decreasing elevation with increasing station.

2. $P = (S - S_0)^2 / 2(H - H_0)$

S any station (chainage) on the parabola
S_0 station (chainage) of the high/low point of the parabola
H height at any station S of the parabola
H_0 height of the high / low point of the parabola

3. $P = 1 / 2a$

whereas a is a parameter in the general equation for a parabola in mathematics $Y = aX^2 + bX + c$.

Y elevation of vertical curve above datum
X horizontal distance from the beginning of the vertical curve
a one half of the rate of change of grade in the vertical curve
b Grade of the vertical alignment at the beginning of the vertical curve
c elevation above datum at the beginning of the vertical curve

The Cross Section

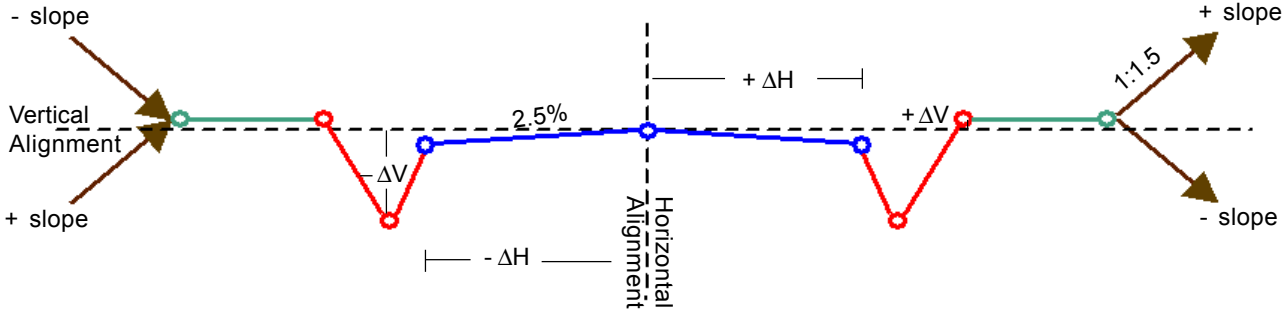
A cross section gives a profile view. It requires vertical alignment or actual elevation on each station.

The **constituting elements** are straight elements. The points are called vertices. You may optionally define slopes at the vertices most left and most right.

Points are definined by:

- ΔH and ΔV
- ΔH and slope in percentage
- ΔH and slope ratio

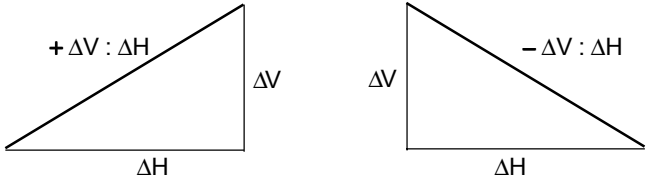
ΔH horizontal distance from the centre line
ΔV vertical distance from the centre line (vertical alignment or actual elevation mandatory)



Sign convention for cross sections:

Sign convention is based on horizontal and vertical alignments.
left or below centre line: -
right or above centre line: +

Slope ratio definition:



cut slope **fill slope**

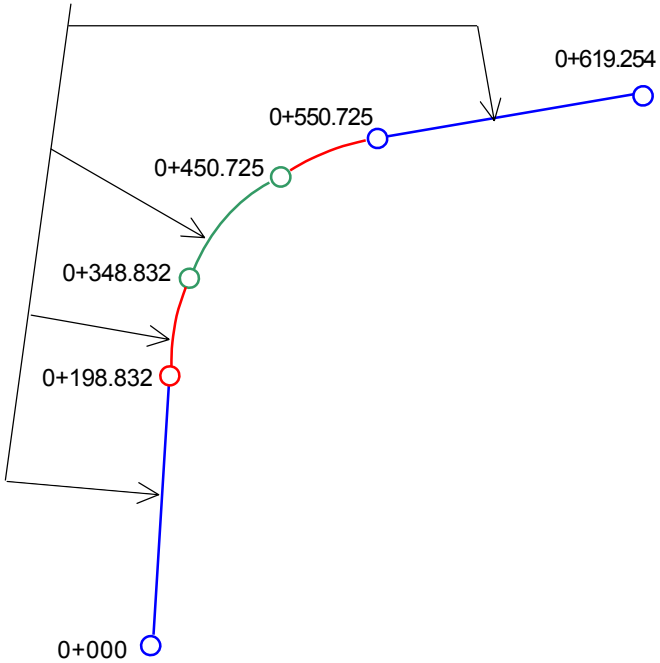
slope ratio = 1 : slope = ΔV : ΔH

positive for cut slopes
negative for fill slopes

The American style and road editor slope definition is
slope ratio = 1 : slope = ΔH : ΔV

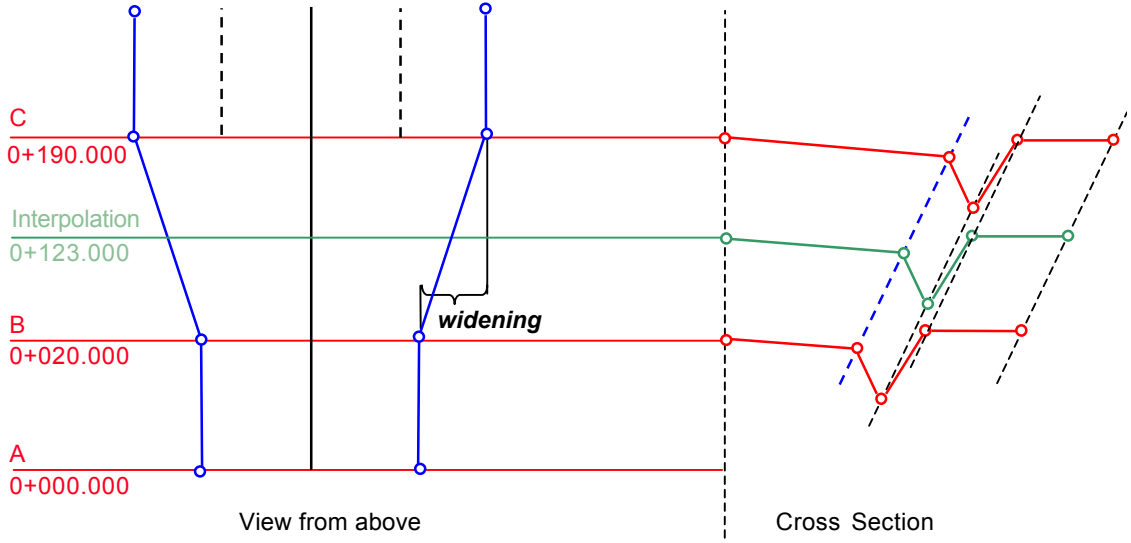
Cross sections are assigned to stations not to sections. One cross section is valid until a new one is defined at a station ahead.

Cross section definition can be at **any** station. The stations need not necessarily correspond to stations where a design element starts or ends.

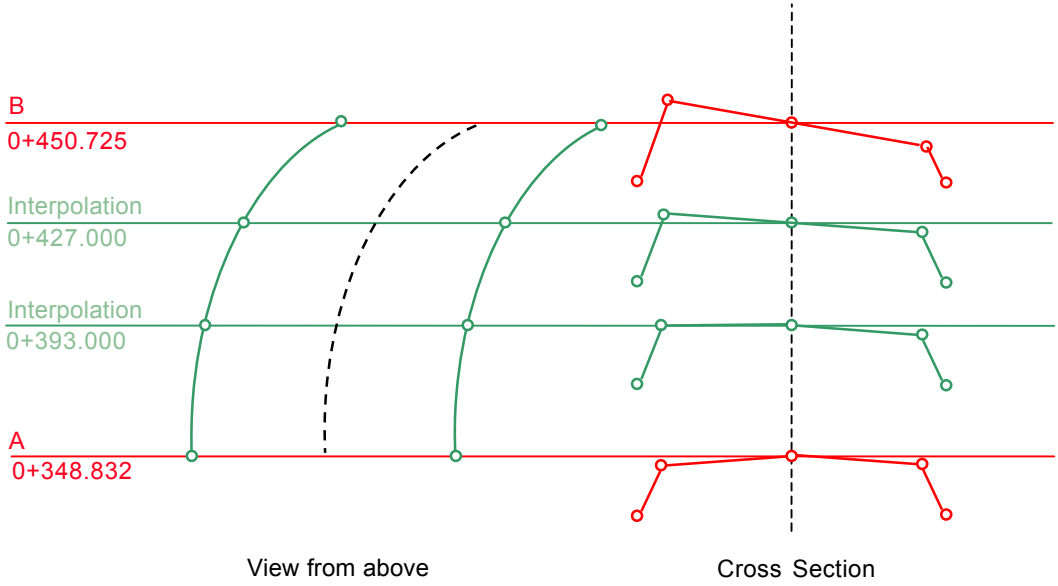


For the reason of completness, widening and superelevation as part of cross sections are mentioned here.

Widening - increase / decrease of road width with change in number of lanes.
Widening influences the shape of the cross sections. RoadPlus has the ability to interpolate cross sections between beginng and end of the widening.



Superelevation - modification of the normal pavement cross slope. Intended to increase comfort and safety at speed.

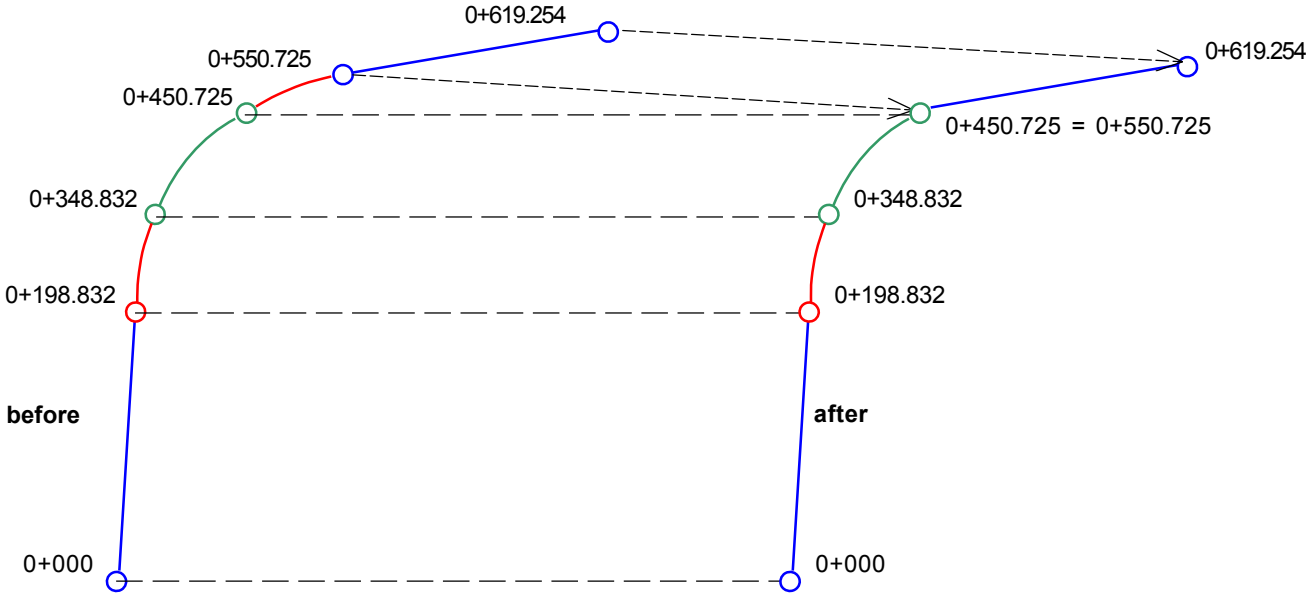


The Station Equation

Station Equations define adjustments for the stationing values in the Horizontal Alignment File. These adjustments may be necessary when the horizontal alignment has been modified by inserting or removing a constituing element and the stationings in the Horizontal Alignment File were not recomputed. This can be the case when editing manually or with a program which does no automatic recomputation. Simply speaking, station equations define leaving a gap or allow an overlap at certain stations.

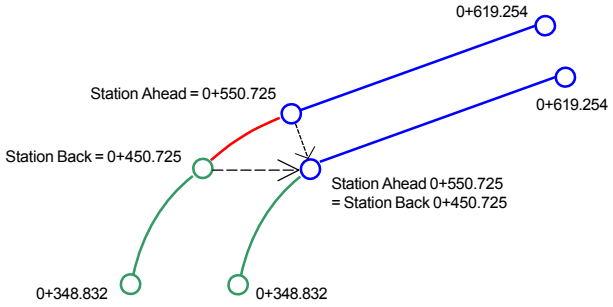
The **constituting elements** in the equations are

- station back
- station ahead.



Due to removing a constituing element, the sequence of stationing misses some values. If this is the case, a **gap equation** (forward station equation) is required. The station equation is of the form:

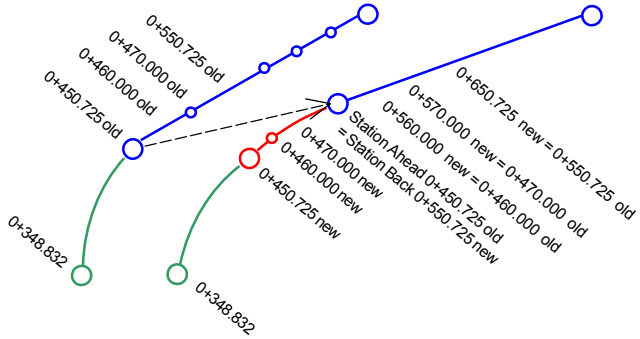
Station Ahead y+yyy = Station Back x+xxx



The stations between 0+450.725 and 0+550.725 will be ignored.

Where the sequence of stationing repeats some values after inserting a design element, we speak of an **overlap equation** (backward station equation). Then, the equation is of the form:

Station Ahead y+yyy = Station Back x+xxx



Stations between 0+450.725 and 0+550.725 exist twice and require re-organizing.

As mentioned in the chapter "Design Elements", a road surface is described by three different design elements - horizontal alignment, vertical alignment and cross section.

RoadPlus reads the elements of each of these components from individual data files that are in the Leica GSI file format. In addition, a file can be created for entering cross-section stations for specific locations such as points needed for staking of superelevation points. Furthermore, if station equations are needed, RoadPlus will read a file created for station equations and apply the appropriate corrections.

Since all RoadPlus project files are in GSI format, the common extensions is .gsi, however they are distinguished by three letter file name prefixes which define the file type and must be used when creating the files. The question marks in the example file names may be replaced with any DOS permitted file name character.

Horizontal Alignment File mandatory	**ALN?????.GSI**
Vertical Alignment File optional	**PRF?????.GSI**
Cross Section (Template) File optional	**CRS?????.GSI**
Cross Section Assignment File optional	**STA?????.GSI**
Station Equation File optional	**EQN?????.GSI**

Example for a Horizontal Alignment File in Leica GSI format

All parameters describing the constituting elements of a horizontal alignment build a so called Horizontal Alignment File. The following is an example of a Horizontal Alignment File in Leica GSI8 format. GSI16 is also supported.
A Horizontal Alignment File must contain at least a header and two elements. The last element must be EOP.

```
41....+0EXAMPLE 42....+HZALIGNM 43....+STACOORD
11....+00000000 71....+STRAIGHT 72....+00000NON 73....+QP000125 81..10+06000000 82..10+02000000
11....+00198832 71....+00SPIRIN 72....+00122474 73....+QP000123 81..10+06068005 82..10+02186841
11....+00348832 71....+000CURVE 72....+00100000 73....+QP000123 81..10+06150344 82..10+02307751
11....+00450724 71....+0SPIROUT 72....+00100000 73....+QP000123 81..10+06247816 82..10+02304071
11....+00550725 71....+STRAIGHT 72....+00000NON 73....+QP000125 81..10+06310759 82..10+02227794
11....+00619253 71....+00000EOP 72....+00000NON 73....+00000000 81..10+06345023 82..10+02168447
```

Note that each line must end with a space and that a CR/LF is required after the last data line.

Header of a Horizontal Alignment File in Leica GSI format

The header is the first line in the GSI file. There is only one header line per file.
The header line takes the following form:

41....+0EXAMPLE 42....+HZALIGNM 43....+STACOORD

WI 41	Job identification, maximum 8 ASCII characters, may be defined by user.
WI 42	Identification of Horizontal Alignment File, may not be changed by user. This entry must be +HZALIGNM.
WI 43	Identification of principal point type file, may not be changed by user. This entry must be +STACOORD.

11....+00198832 71....+00SPIRIN 72....+00122474 73....+QP000123 81..10+06068005 82..10+02186841

WI 11	Station (chainage) of principal point. Data units and decimal places are defined by WI 81 and WI 82.
WI 71	Type of the following geometric element.
WI 72	Radius 1 for compound curve resp. A parameter for spirals. If the radius point for a curve is to the right of the alignment (looking in the direction of increasing stations), the radius is positive, otherwise negative. Data units and decimal places are defined by WI 81 and WI 82. Default for tangents and End of Project is 00000NON.
WI 73	Number of cross section assigned to the next geometric element. Corresponds to WI 11 in Cross Section File. A cross section may be assigned to more than one location.
WI 74	Radius 2 for compound curves. If the radius point for a curve is to the right of the alignment (looking in the direction of increasing stations), the radius is positive, otherwise negative. Data units and decimal places are defined by WI 81 and WI 82.
WI 81	Easting of principle point.
WI 82	Northing of principle point.

The following table shows for all possible elements of a horizontal alignment, the variables and predefined names which are required for each WI in a Horizontal Alignment File.

Element	WI 11	WI 71	WI 72	WI 73	WI 74	WI 81	WI 82
Tangent	Station	STRAIGHT	00000NON	Cross Section Number		Easting	Northing
Circular Curve	Station	000CURVE	R	Cross Section Number		Easting	Northing
Spiral - Tangent to Curve	Station	00SPIRIN	A	Cross Section Number		Easting	Northing
Spiral - Curve to Tangent	Station	0SPIROUT	A	Cross Section Number		Easting	Northing
Spiral - Curve to Curve (R1>R2)	Station	0CURVEIN	R1	Cross Section Number	R2	Easting	Northing
Spiral - Curve to Curve (R1<R2)	Station	CURVEOUT	R1	Cross Section Number	R2	Easting	Northing
EOP	Station	00000EOP	00000NON			Easting	Northing

Example for a Vertical Alignment File in Leica GSI format

All parameters describing the constituting elements of a vertical alignment build a so called Vertical Alignment File. The following is an example of such file in Leica GSI8 format. GSI16 is also supported.
An Vertical Alignment File must contain at least a header and two elements. The last element must be EOP.

```
41....+0EXAMPLE 42....+0VALIGNM 43....+STACOORD
11....+00000000 71....+STRAIGHT 72....+00000NON 83..10+00400000
11....+00300000 71....+000CURVE 72....-01142932 83..10+00422500
11....+00500000 71....+STRAIGHT 72....+00000NON 83..10+00420000
11....+00550000 71....+PARABOLA 72....+02091126 83..10+00415000
11....+00850000 71....+STRAIGHT 72....+00000NON 83..10+00406522
11....+01127904 71....+00000EOP 72....+00000NON 83..10+00418605
```

Note that each line must end with a space and that a CR/LF is required after the last data line.

The header is the first line in the GSI file. There is only one header line per file.
The header line takes the following form:

41....+0EXAMPLE 42....+0VALIGNM 43....+STACOORD

WI 41	Job identification, maximum 8 ASCII characters, may be defined by user.
WI 42	Identification of Vertical Alignment File, may not be changed by user. This entry must be +0VALIGNM.
WI 43	Identification of principal point type file, may not be changed by user. This entry must be +STACOORD.

11....+00300000 71....+000CURVE 72....-01142932 83..10+00422500

WI 11	Station (chainage) of a vertical alignment point. The stationing is projected onto a horizontal plane. Data units and decimal places are defined by WI 83.
WI 71	Type of the following geometric element.
WI 72	Radius for following curve or P parameter for parabolas. If the radius point for a curve/parabola lies above the centre line, the radius or P is positive, otherwise negative. Data units and decimal places are defined by WI 83. Default for tangents and End of Project is 00000NON.
WI 83	Elevation of the point.

The following table shows for all possible elements of a vertical alignment, the variables and predefined names which are required for each WI in a Vertical Alignment File.

Element	WI 11	WI 71	WI 72	WI 83
Tangent	Station	STRAIGHT	00000NON	Ordinate
Circular Curve	Station	000CURVE	R	Ordinate
Parabola	Station	0PARABOL	P	Ordinate
EOP	Station	00000EOP	00000NON	Ordinate

Example for a Cross Section File in Leica GSI format

All parameters describing the constituting elements of a cross section build a so called Cross Section (or Template) File. The following is an example of such a file in Leica GSI8 format. GSI16 is also supported.
A Cross Section File must contain at least one cross section. 200 cross sections per file are allowed. One cross section may be described by up to 64 vertices (points).

```
41....+0EXAMPLE 42....+TEMPLATE
11....+QP000123 35..10-00013000 36..10-00003000
11....+QP000123 35..10-00010000 36..10-00005000
11....+QP000123 35..10-00004000 36..10-00000100
11....+QP000123 35..10+00004000 36..10+00000100
11....+QP000123 35..10+00010000 36..10-00006000
11....+QP000123 35..10+00013000 36..10-00003500
11....+QP000124 35..10-00012000 36..10-00002000
11....+QP000124 35..10-00011000 36..10-00004000
11....+QP000124 35..10-00004000 36..10-00000100
11....+QP000124 35..10+00004000 36..10-00000100
11....+QP000124 35..10+00011000 36..10-00005000
11....+QP000124 35..10+00012000 36..10-00002500
11....+TEMPLATE 35..10-00002000 36..10+00000000 71....+0000FILL 72....+00002000
11....+TEMPLATE 35..10-00000500 36..10+00000000 71....+0000FILL 72....+00002000
...
```

Note that each line must end with a space and that a CR/LF is required after the last data line.

The header is the first line in the GSI file. There is only one header line per file.
The header line takes the following form:

41....+0EXAMPLE 42....+TEMPLATE

WI 41	Job identification, maximum 8 ASCII characters, may be defined by user.
WI 42	Identification of Cross Section File, may not be changed by user. This entry must be +TEMPLATE.

```
11....+QP000124   35..10+00012000   36..10-00002500
11....+TEMPLATE   35..10-00002000   36..10+00000000   71....+0000FILL   72....+00002000
```

WI 11	Cross section number, corresponds to WI 73 in the Horizontal Alignment File. Cross section numbers need not be in as- or descending order. However, all data lines having the same cross section number belong together and should be kept together. The data lines for one cross section must be sorted from left to right across the section.
WI 35	Horizontal distance from centre line. A positive distance indicates a point to the right of the centre line. A negative distance indicates a point to the left of the centre line.
WI 36	Height difference from the centre line. A positive height difference indicates a point above the centre line. A negative height difference indicates a point below the centre line.
WI 71	Cross section type; optional.
WI 72	Slope ratio as dH/dV (definition see chapter Cross Section); optional. 0 allowed for all but leftmost and rightmost points in a cross section. Data units defined by WI 35 and WI 36.

The following table shows the two possibilities for defining vertices of a cross section and the predefined names which are required for each WI in a Cross Section File.

Element	WI 11	WI 35	WI 36	WI 71	WI 72
Vertex (using vertical alignment)	Cross Section Number	Horizontal Offset	Vertical Offset	00000CUT 0000FILL	Slope
Vertex (without vertical alignment)	Cross Section Number	Horizontal Offset	Elevation	00000CUT 0000FILL	Slope

Example for a Cross Section Assignment File in Leica GSI format

The Cross Section Assignment File defines the stations for the cross sections. Note that the stations given for the cross sections do not necessarily correspond to stations where design elements start or end. The following is an example of such a file in Leica GSI8 format. GSI16 is also supported.
A Cross Section Assignment File belongs to a corresponding Cross Section File. You must have a Cross Section Assignment File when using a Cross Section File. The number of assignments is restricted to 100 per file. A cross section remains valid until a new cross section is assigned. A given cross section may be assigned more than once. Automatic transitions such as width and superelevation are possible.

```
41....+OEXAMPLE 42....+ASSIGNMT 43....+CRSEXAMP
11....+QP000123 71....+00050000
11....+TEMPLATE 71....+00100000
11....+QP000124 71....+00250553
11....+QP000123 71....+00350000
11....+QP000124 71....+00500000
11....+TEMPLATE 71....+00600000
```

Note that each line must end with a space and that a CR/LF is required after the last data line.

The header is the first line in the GSI file. There is only one header line per file.
The header line takes the following form:

41....+0EXAMPLE 42....+ASSIGNMT 43....+CRSEXAMP

WI 41	Job identification, maximum 8 ASCII characters, may be defined by user.
WI 42	Identification of Cross Section Assignment File, may not be changed by user. This entry must be +ASSIGNMT.
WI 43	Name of the corresponding Cross Section File. The named file must exist in the active directory on the PC card to use an assignment file.

11....+QP000123 71....+00100000

WI 11	Cross section number, corresponds to WI 11 in the Cross Section File and WI 73 in the Horizontal Alignment File.
WI 71	Beginning chainage for the particular cross section.

For the matter of completion, the following table is added as in the previous chapters.

Element	WI 11	WI 71
Assignment	Cross Section Number	Station

Example for a Station Equation File in Leica GSI format

The Station Equation File re-defines horizontal alignments after adding / removing constituing elements. Station Equation Files are optional for RoadPlus and only required when stationings have not been recomputed after changes in the Horizontal Alignment File. The number of equations per file is limited to 100.
The following is an example of such a file in Leica GSI8 format. GSI16 is also supported.

```
41....+0EXAMPLE 42....+0STAEQTN
41....+00000000 42....+00550725 43....+00450725
41....+00000001 42....+00560000 43....+00460000
41....+00000002 42....+00570000 43....+00470000
...
```

Note that each line must end with a space and that a CR/LF is required after the last data line.

If you use the Leica program RoadEd for your editing, you really should not need to use a station equation file because it will always attempt to adjust the stationings for you as you make changes. You can also force it to re-calculate the stationing using the Recalc Stationings command from the menu. However, RoadEd does support the creation and editing of these files if they are needed. Be aware of the fact that RoadEd does not read the station equation file when it checks for errors in your alignment. You can ignore stationing errors which you have corrected using a station equation file.

The header is the first line in the GSI file. There is only one header line per file.
The header line takes the following form:

41....+0EXAMPLE 42....+0STAEQTN

WI 41	Job identification, maximum 8 ASCII characters, may be defined by user.
WI 42	Identification of Station Equation File, may not be changed by user. This entry must be +0STAEQTN.

41....+00000000 42....+00550725 43....+00450725

WI 41	Station equation number
WI 42	Station ahead
WI 43	Station back

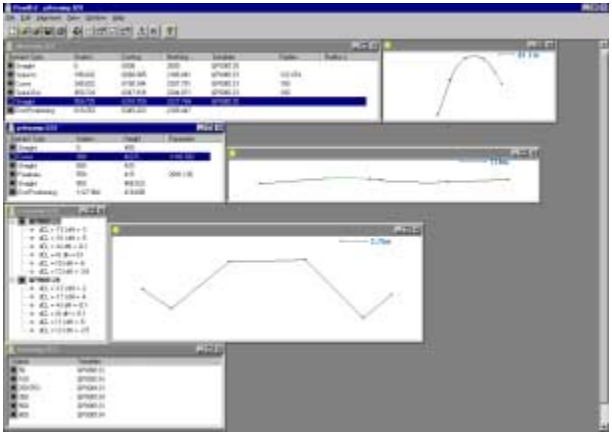
For the matter of completion, the following table is added as in the previous chapters.

Element	WI 41	WI 42	WI 43
Equation	Station Equation Number	Station Ahead	Station Back

Creating RoadPlus project files

The data files is GSI format can be created either by using the Leica program RoadEd or by converting files from different road packages.

RoadEd is a basic tool intended for quick and easy creation of new alignments or modification of existing ones. It also supports checking alignments for errors and plotting alignments on a graph.



Some commercial road packages such as

- TopoCAD (Sweden)
- Geo11 (Sweden)
- GEOSECMA NT (Sweden)

save the data directly in **GSI format**.

Other road packages have their own file format for which **conversion programs to GSI** exist, for example

- Microstation with Intergraph Inroads as add-on (worldwide)
- CARD1 (Germany)
- REB (Germany)
- MOSS (UK)
- NRG (UK).

Copy the data files to the PCMCIA card

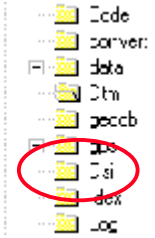
Once the data files have been created, they need to be copied to the PCMCIA card.
If your computer has a PC card reader, you can transfer the data files directly from the PC to the card. If no PC card reader is available on the PC being used, use the sensor transfer option in SKI-Pro.

Transferring the data files directly from the PC to the card

➢Format the PCMCIA card in the sensor.

➢Insert the card into the PC.

➢By using the Explorer, copy the data files from the hard drive of the PC into the directory GSI on the memory card.



➢Switch the **Sensor off**.

➢**Remove** the TR500 terminal from the sensor.

➢**Connect** the data transfer cable to the serial port of your computer and to the TERMINAL port on the Sensor.

➢Start SKI-Pro. Go to **Sensor Transfer** under Tools.

➢Right-click on **Sensor**, go to **Settings...** and check the serial port and the baud rate settings.

➢Right-click on **Sensor** and choose **Turn GPS Sensor on**.

➢Right-click on **Sensor** and select **Transfer Any File**.

➢Under **Look in:** select the directory where the data files are kept.

➢Under **Files of Type:** select **GSI**.

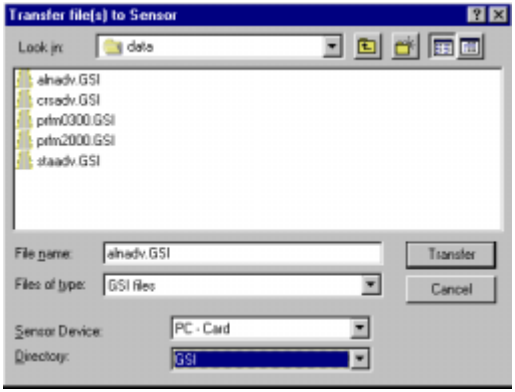
➢Under **Sensor device:** select **PC-card**.

➢Under **Directory:** select **GSI**.

➢Highlight one file to be transferred since only one file can be transferred at a time. Click the **Transfer** button.

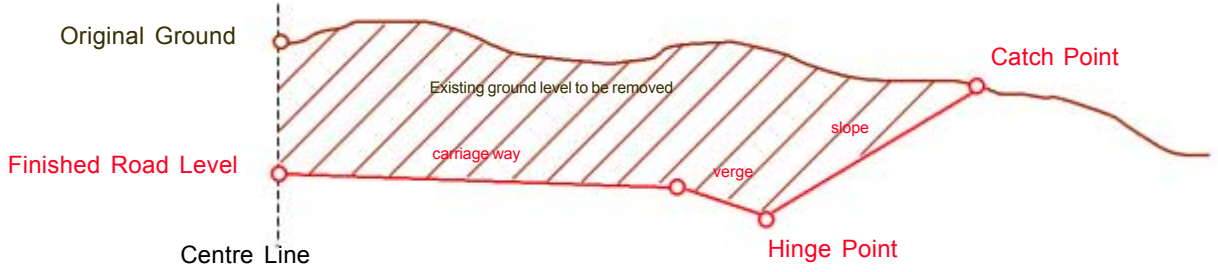
➢For transferring the next file, right-click on **Sensor** again and select **Transfer Any File**. Select as before. Repeat this until all necessary files are transferred.

➢Once the transfer for all files is finished, right-click on **Sensor** and choose **Turn GPS Sensor off**.



Terminology of Road Staking

Certain terminology is sometimes used for road staking. They may vary from country to country.
In order to make the chapter on staking a road alignment with the program RoadPlus easier to understand, the basic terminology of one common way of road staking is introduced in this chapter. The technical terms are indicated in the drawings and are also explained in words afterwards.


Original Ground
Finished Road Level
Centre Line
Existing ground level to be removed
carriage way
verge
slope
Catch Point
Hinge Point


Finished Road Level
carriage way
verge
Hinge Point
slope
Fill to be placed (rocks/earth)
Catch Point
Original Ground
Centre Line

The part of the road on which you drive once the road is finished is called **carriage way** (roadway, travel way).

Next to the carriage way may be the **verge** (shoulder) with usually a slightly higher slope ratio than the carriage way.

The **slope** is next to the verge and can be thought of as linking the road level with the original ground. Its slope ratio is even higher than the one of the verge. A slope starts at the **hinge point**.

The **original ground / surface** is the undisturbed surface before project construction.

The **Finished Road Level** describes the final road.

Since cuts / fills start from the original ground, there must be a physical point on each desired cross section station where the finished design shape of the roadway cut / fill intersects with the existing ground surface. This point is called **catch point**. If the catch point is marking the catch of a cut slope, it is called **top of bank (= top)**. **Toe of bank/slope (=toe)** is the catch point marking the catch of a fill slope.

Usually, the stake of the catch point is gone after the initial cut / fill. An **offset catch point** is often marked nearby as second point. This point is offset from the catch point.

Staking a Road Alignment

This chapter of this guide explains the operation of the RoadPlus application program covering the following steps:

- Starting the application
- Configuring road stakeout parameters
- Selecting the alignment file
- Staking uneven stations
- Staking cross sections

The Coordinate System

In order to get the correct result when working with RoadPlus, the GPS jobs must be orientated to the same local grid coordinate system as the alignment to be staked out. This is accomplished by attaching the current coordinate system to the job.

Depending on the coordinate system, you will either use pre-defined parameters or determine the required transformation parameters either on the sensor or in SKI-Pro.

On how to set up a coordinate system and on how to calculate transformation parameters please refer to "Getting Started with Real-Time Surveys“ as well as the "Technical Reference Manual" for assistance.

Receiver set-up

RoadPlus is a real-time application.

Therefore, a properly initialised real-time configuration set is required. This means, reference and rover must be set-up properly running a suitable configuration set and the data transfer from the reference to the rover must be working.

For detailed information please refer to „Getting Started with Real-Time Surveys“ and the "Technical Reference Manual".

Setting the units

The GPS sensors must be configured in the same coordinate units as those of the generated gsi files.

Check the sensor settings in **panel CONFIGURE \ Units**.

The units must not be changed while working with RoadPlus.

Switch the receiver **ON** > Main Menu
Select **3 Applications ...**
CONT (F1)

Remember to ensure that the icon for the accuracy status shows the symbol for high precision navigation.

Panel APPLICATION \ Menu

10 RoadPlus
CONT (F1)

Panel ROAD+ \ Begin.
CONF (F2) for defining the road stake parameters.

Panel ROAD+ \ Configuration

DFLT (F5)
This sets the default values for all input fields. It may be necessary to adapt them according to your needs.

Beg. Station - Beginning station (chainage) from which you want to start working.
End Station - End station (chainage) where you want to finish.
Sta. Incr. - Station increment. Type in the interval at which stations have to be staked.
Vert. Shift - Enter a vertical shift value if required. The value will then be applied to the entire alignment.
Defl. Tol. - Deflection Tolerance. Enter an angle tolerance for deflection angles. If this value is set to zero the deflection tolerance is ignored.

Sta. Tol. - Enter a value for station tolerance. This is the accepted tolerance for the difference between two stations as calculated from the stationing and the coordinates. If this value is set to zero the deflection tolerance is ignored.

Vert. Mode - Choose between **Profile/XSec**, **DTM** and **OFF**. **Profile/XSec** allows you to stakeout a vertical alignment and cross sections. **DTM** uses a pre-defined digital terrain model. Set to **OFF** when only a horizontal alignment has to be staked. The normal mode is **Profile/XSec**.

Crs. Intrpl. - The cross section interpolation can be switched **ON** or **OFF**. In the case of **OFF**, a cross section assigned to a station in a Cross Section Assignment File will remain effective to the next station where another cross section is assigned. The transition between the two cross sections will be abrupt. When set to **ON**, all cross sections must consist of the same number of points. A linear transition will be applied to two cross sections defined in the Cross Section Assignment File. If the project continues past the last station defined in the Cross Section Assignment File, the last given cross section will be applied. The interpolation between cross sections makes the staking out of sections of road with superelevation and widening possible.

Crs. Movemnt - There are three choices: **Left > Right**, **Right > Left** and **None**. The direction chosen is for automatic selection of the next station of a cross section. Points can still be staked out at any desired direction along the cross section. **None** is for no automatic pre-selection.

Hinge Mode - Method for the catch point determination. The options are **Normal** and **Not from End Pts**. When **Normal** is selected, the points to the most right or left from the centre line are used for calculating the catch point. Select **Not from End Pts**, when the catch point is already available in the cross section file and therefore the points to the most right or left from the centre line are not needed for its calculation.

Log File - If this is set to **ON**, stake out data can be stored in a file for printing later.

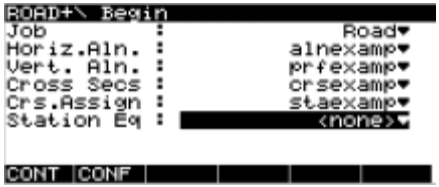
Log FIName - Enter a file name for the log file.

Edit Height - If you wish to edit the elevation of a design point before staking select **YES**. When changing heights before staking, the Log File will be updated accordingly. This is for example useful if someone would like to manually enter the elevation of the invert level of a manhole and then stakeout the manhole's horizontal location in relation to the horizontal alignment and the manhole's invert level without being tied to the vertical alignment. The default setting is **NO**.

When all input fields have been set correctly:
CONT (F1)

This will take you to the **panel Road+ \ Begin** where you can select the alignment files.

Panel ROAD+ \ Begin



Job - Press ENTER to open listbox (and if required create a new job) or use right and left arrow key to toggle between jobs.
Horiz.Aln. - A Horizontal Alignment File is displayed by default. If this is not the file required toggle between files by using the right and left arrow key.
Vert. Aln. - Select a Vertical Alignment File if you have one. The default is none since a Vertical Alignment File is optional.
Cross Secs - Select a Cross Section File if you have one. The default is none since a Cross Section File is optional.
Crs. Assign - Select a Cross Section Assignment File if you have one. The default is **<none>** since a Cross Section Assignment File is optional. In order to use a Cross Section Assignment File a Cross Section File must have been selected.
Station Eq - Select a Station Equation File if you have one. The default is **<none>** since a Station Equation File is optional.

CONT (F1)

The alignment checking routine starts.
This routine may detect errors in one of the files and promt an warning message.

Panel ROAD+ \ Checking Files

OK (F5) to continue checking the files
or
ABORT (F1) to continue with the next panel.

If the alignment files are error free you will be automatically taken to **panel ROAD+ \ Station & Offset**.

Follow the instructions in the chapters Starting the Application, Configuring Road Stakeout Parameters and Selecting the Files in order to get to the **panel ROAD+ \ Station & Offset.**

Initially, this panel appears as below:

If you wish to see the entire display, use the up arrow key to scroll up to the top.

Vert. Shift - Vertical shift applied to the whole alignment. Cannot be changed.
Sta. Incr. - The station increment as set in the configuration is displayed. If desired, a new value can be entered.
Station - Current station.
Element - Element for the chosen station such as Tangent, Spiral In, Curve, etc.
H Offset - Horizontal Offset to apply to the current chainage.
V Offset - Vertical Offset to apply to the current chainage.

NEXT (F2) displays the next station and its element according to the defined station incrementation.
PREV (F3) displays the previous station and its element according to the defined station incrementation.

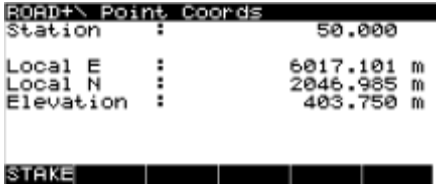
XSEC (F4) - Starts cross section staking. See chapter "Staking a Cross Section".

STA? (F5) - Station and offset calculation for a known point (select from point ID listbox) or for a new point (determine with **NEWOC (F5)**). You may then use the station of that measurement to stake out a cross section point.

SHIFT + StaEq (F4) - In **panel Road+ \ Station Equations**, you can scroll through the station equations.

CONT (F1)

Panel Road+ \ Point Coords

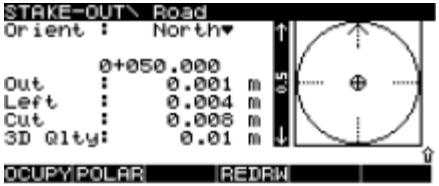


Here, the design coordinates for the current station are displayed. If in the **panel ROAD+ \ Configuration** Edit Height is set to YES, the focus will be on the Elevation and the value can be changed before staking.

STAKE (F1)

You will automatically be taken to the Stakeout graphics screen.

Panel STAKE-OUT \ xxx
whereas xxx is the name for the file stake point as defined in stake out setting.



Orient - Select a method of orientation as reference direction.

The next line shows the station to be staked.

Out / In and Right / Left - This is the range to the selected point and is updated as the antenna pole is moved.
Cut / Fill - Indicates the cut / fill to the surface. If the point elevation in the previous panel has been changed, the value for cut applies to this new elevation.

Navigate to the correct point. Place the antenna pole at the location. Be sure that the antenna is levelled. Once the desired point is located:
OCUPY (F1)

Panel STAKE-OUT \ Occupy Point

The current **Point ID** may be accepted or changed.

3D Quality - Observe the position quality indicator. Data should not be recorded until you are satisfied with this value. When you are satisfied:
STOP (F1)

DIFF (F2)

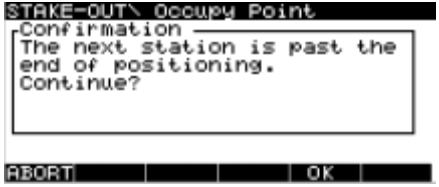
Pressing this key gives the difference between the designed coordinates and staked coordinates of the point. If the point elevation has been changed before staking, the value Diff Cut / Fill is calculated relative to this new elevation.

STORE (F1)

The system returns to **Panel ROAD+ \ Station & Offset** where the station has incremented by the station increment value.

Repeat the steps before to stake-out additional stations along the alignment.

Once the last point (EOP) in the Horizontal Alignment File has been staked and you continue anyway, this confirmation message will appear:



OK (F5) and then **CONT (F1)** to continue anyway
or
ABORT (F1) and ESC to exit the panel.

For complete information on how to use STAKE-OUT please refer to chapter "Real-Time Rover, Staking Out" in the "Technical Reference Manual".

Staking uneven stations of the Horizontal Alignment

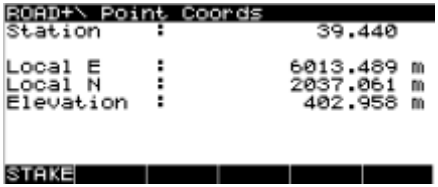
It is often required to stake stations that are not on the even station as defined by the station interval. The steps below describe how to stake a station at an uneven station.

Follow the instructions in the chapters Starting the Application, Configuring Road Stakeout Parameters and Selecting the Files in order to get to the **panel ROAD+ \ Station & Offset.**

Station - Manually enter the uneven station.
H Offset - Horizontal offset to be applied to current station. Looking in the direction of increasing station, apply the "right hand positive rule".
V Offset - Vertical offset to be applied to current station. A positive offset is above, a negative offset is below the normal height of the current station.

CONT (F1)

Panel ROAD+ \ Point Coords

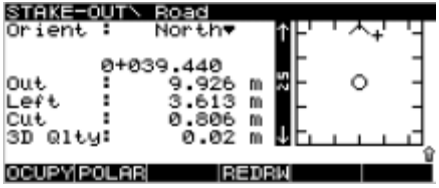


Here, the design coordinates for the current uneven station are displayed. If in the **panel ROAD+ \ Configuration** Edit Height is set to YES, the focus will be on the Elevation and the value can be changed before staking.

STAKE (F1)

You will automatically be taken to the Stakeout graphics screen.

Panel STAKE-OUT \ xxx
whereas xxx is the name for the file stake point as defined in stake out setting.



Once in the Stakeout graphics screen navigate to the correct point as normal.

Orient - Select a method of orientation as reference direction.

The next line shows the station to be staked.

Out / In and Right / Left - This is the range to the selected point and is updated as the antenna pole is moved.
Cut / Fill - Indicates the cut / fill to the surface. If the point elevation in the previous panel has been changed, the value for cut applies to this new elevation.

Navigate to the correct point. Place the antenna pole at the location. Be sure that the antenna is levelled. Once the desired point is located:
OCUPY (F1)

Panel STAKE-OUT \ Occupy Point

The current **Point ID** may be accepted or changed.

3D Quality - Observe the position quality indicator. Data should not be recorded until you are satisfied with this value. When you are satisfied:
STOP (F1)

DIFF (F2)

Pressing this key gives the difference between the designed coordinates and staked coordinates of the point. If the point elevation has been changed before staking, the value Diff Cut / Fill is calculated relative to this new elevation.

STORE (F1)

Panel ROAD+ \ Station & Offset

Here, the station has incremented to the next regular station according to the defined station increment value.

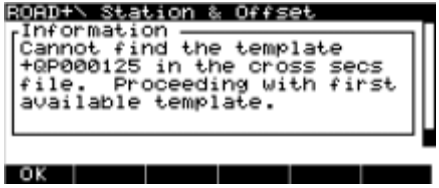
For complete information on how to use STAKE-OUT please refer to chapter "Real-Time Rover, Staking Out" in the "Technical Reference Manual".

Follow the instructions in the chapters Starting the Application, Configuring Road Stakeout Parameters and Selecting the Files in order to get to the **panel ROAD+ \ Station & Offset.**

Station - Select a station of the horizontal alignment for which you want to stake the cross section either by using **NEXT (F2)**, **PREV (F3)** or typing manually.

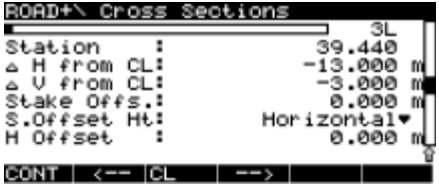
XSEC (F4)

If the assigned cross section for the selected station is not available in the cross section file, the following information message appears:

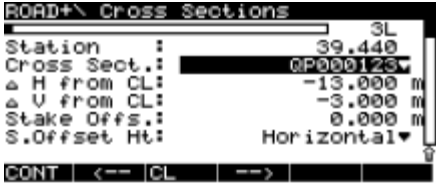


OK (F1)

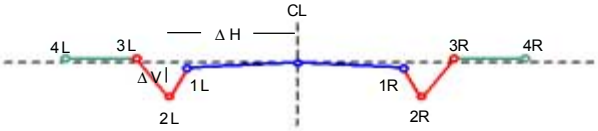
Panel ROAD+ \ Cross Sections



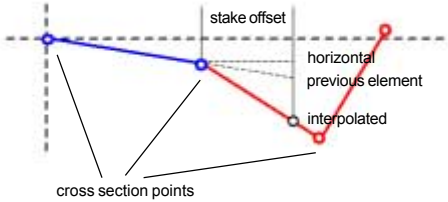
Initially, the panel looks as shown above.
From the Cross Section Assignment File, RoadPlus knows which cross section to use for the entered station. There may however be cases where you wish to apply another cross section. Press the upwards arrow key 5 times. An additional line **Cross Sect.** appears and will be highlighted.



Cross Sect. - Use the left / right arrow keys to toggle between cross sections.
Scroll bar - Indicator for the position along the cross section template. The number and letter right of the scroll bar express how many positions left (L) or right (R) of the centre line you are working or if you are on the centre (C). A * next to it indicates that this point has been staked already.



Stake Offs. - Stake offset for a cross section point (see graphic below).
S.Offset Ht - Height mode for the stake offset. The options are: **Prev. Elem.**, **Interpolated** and **Horizontal** (see graphic below). **Horizontal** is default.

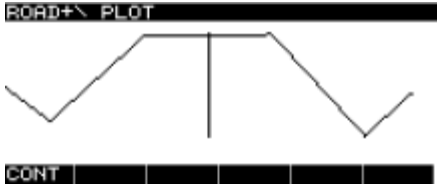


Station - The current station selected for stakeout.
Δ H from CL - The horizontal distance of the point from the centre line. To stake any point along the cross section which is not pre-defined in the cross section file, enter its horizontal distance from the centre line. RoadPlus interpolates within the cross section.
Δ V from CL - The vertical distance of the point from the centre line. To stake any point along the cross section which is not pre-defined in the cross section file, enter its vertical distance from the centre line.

H Offset - Horizontal offset to be applied to current station. Looking in the direction of increasing station, apply the "right hand positive rule".
V Offset - Vertical offset to apply to current station. A positive offset is above, a negative offset is below the normal height of the current station.

Further options in this panel are:

- **CL (F3) -** Select the point of the centre template.
- **←(F2) -** Select next template point to the left.
- **→(F4) -** Select next template point to the left.
- **SHIFT + ¦<-- (F2) -** Select extreme left template point.
- **SHIFT + CATCH (F3) -** See chapter "Staking a Catch Point".
- **SHIFT + PLOT (F4)**



Panel ROAD+ \ Plot
Here you will see a graphical view of the chosen cross section. **CONT (F1)**

- **SHIFT + -->¦ (F5) -** Select extreme right template point.

Select the point along the cross section which you want to stake.

CONT (F1)

Panel ROAD+ \ Point Coords

Here, the design coordinates for the selected station are displayed. If in the **panel ROAD+ \ Configuration** Edit Height is set to YES, the focus will be on the Elevation and the value can be changed before staking.

STAKE (F1)

You will be taken to the Stakeout graphics screen.

Panel STAKE-OUT \ xxx
whereas xxx is the name for the file stake point as defined in stake out setting.

Orient - Select a method of orientation as reference direction.

The next line shows the station of the horizontal alignment to which the cross section is assigned. The number and letter in brackets to the right express how many positions left (L) or right (R) of the cross section's centre line you are working or if you are on the centre (C). A * next to it indicates that this point has been staked already.

Out / In and Right / Left - This is the range to the selected point and is updated as the antenna pole is moved.
Cut / Fill - Indicates the cut / fill to the surface. If the point elevation in the previous panel has been changed, the value for cut applies to this new elevation.

Once in the Stakeout graphics screen navigate to the correct point as normal. Place the antenna pole at the location. Be sure that the antenna is levelled. Once the desired point is located:
OCUPY (F1)

Panel STAKE-OUT \ Occupy Point

The current **Point ID** may be accepted or changed.

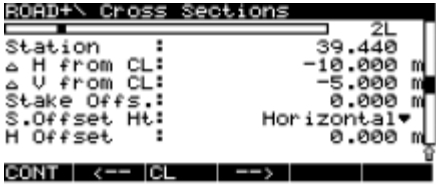
3D Quality - Observe the position quality indicator. Data should not be recorded until you are satisfied with this value. When you are satisfied:
STOP (F1)

DIFF (F2)

Pressing this key gives the difference between the designed coordinates and staked coordinates of the point. If the point elevation has been changed before staking, the value Diff Cut / Fill is calculated relative to this new elevation.

STORE (F1)

Panel ROAD+ \ Cross Sections



Here, the next point along the cross section is set for staking out.

After staking out the last point of a cross section, the program goes automatical to **panel ROAD+ \ Station & Offset** and displays the next following horizontal alignment station. Start staking its cross section with XSEC (F4).

For complete information on how to use STAKE-OUT please refer to chapter "Real-Time Rover, Staking Out" in the "Technical Reference Manual".

The stakeout functionallity for a catch point can be accessed from the **panel ROAD+ \ Cross Sections**.
On how to get there follow the instructions in chapter Staking a Cross Section.

Panel ROAD+ \ Cross Section

SHIFT + CATCH (F3)

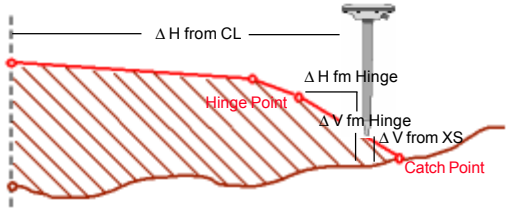
Panel ROAD+ \ Catch Point

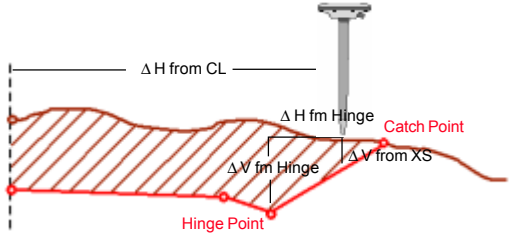
Station - The selected station of the horizontal alignment for which the cross section has to be staked.
Cross Sect. - Name of the cross section template currently in use.
XSection - Cross section type either **CUT** or **FILL**.
Δ H from CL - The horizontal distance of the actual pole. position from the centre line.
Δ V from XS - The vertical distance of the actual pole position from the cross section template.
Δ Station - The horizontal difference between the actual pole position and the selected station of the horizontal alignment

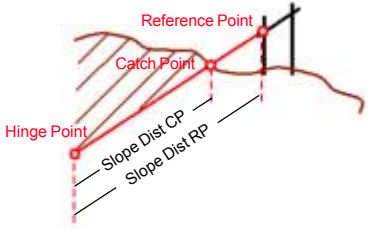
for which the cross section has to be staked.
Δ H fmHinge - The horizontal distance of the actual pole position from the hinge point.
Δ V fmHinge - The vertical distance of the actual pole position from the hinge point.
Slope Dist - The slope distance of the actual pole position from the hinge point. Once the catch point has been found, this is the slope distance between the catch point and the hinge point.
Elevation - Height of the actual pole position.

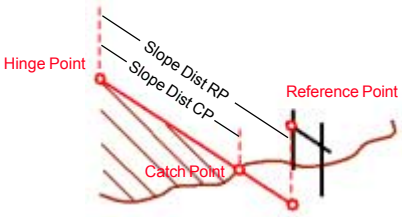
According to the update rate, the individual values are updated automatically. Note that the highest update rate in this panel is 1 second even though the general update rate might be set to a value < 1 second.

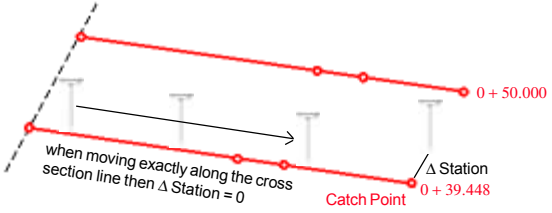
The catch point has been found when the **Δ V from XS** and **Δ Station** are zero. Navigate to the correct point. Place the antenna pole at the location. Be sure that the antenna is levelled.







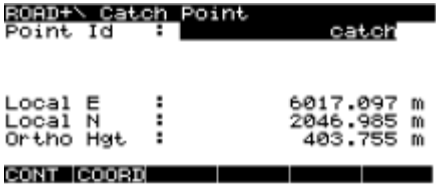




If the planned catch point cannot be accessed, use **SHIFT + Δ St=0 (F2).** Wherever you are RoadPlus, determines a new cross section such that Δ St=0.

Once the desired point is located:
STORE (F3)

Panel ROAD+ \ Catch Point



Point ID - Enter point ID under which the catch point will be stored.

CONT (F1)

Panel Road+ \ Catch Point

You may now wish to stake a reference point which marks the catch point.

SHIFT + REFPT (F5)

Panel Road+ \ Reference Point

Scroll bar - Indicator for the position along the cross section template for which you are about staking a reference point. The number and letter right of the scroll bar express how many positions left (L) or right (R) of the centre line you are working or if you are on the centre (C).
Station - The current station selected for stakeout.
Cross Sect. - Name of the cross section template currently in use.
Δ Station - Horizontal distance from displayed station.
Δ H fmCatch - The horizontal distance of the actual pole position from the catch point.
Δ V fmCatch - The vertical distance of the actual pole position from the height of the catch point.
Δ H fmHinge - The horizontal distance of the actual pole position from the hinge point.
Δ V fmHinge - The vertical distance of the actual pole position from the height of the hinge point.

Δ H from CL - The vertical distance of the actual pole position from the centre line.
Δ V from CL - The vertical distance of the actual pole position from the height of the centre line.
Δ V fmSlope - The vertical distance of the actual pole position above the slope. Only available once the reference point has been stored.
Slope - Slope value.
Slope Dist - The slope distance of the actual pole position from the hinge point. Once the reference point has been found, this is the slope distance between the reference point and the hinge point.
Elevation - Height of the actual pole position.

According to the update rate, the individual values are updated automatically. Note that the highest update rate in this panel is 1 second even though the general update rate might be set to a value < 1 second.

Either navigate to a point which is suitable as reference point or until Δ H and Δ V from catch / hinge / centre line / slope show required values. Place the antenna pole at the location. Be sure that the antenna is levelled. If you decide not to stake and store the reference point, press **CONT (F1).** It takes you back to the **panel ROAD+ \ Catch Point.**

Otherwise:

STORE (F3)

Panel Road+ \ Reference Point

Point ID - Enter name under which the catch point will be stored.

CONT (F1)

Panel Road+ \ Reference Point

CONT (F1)

Panel Road+ \ Catch Point

CONT (F1)

Panel Road+ \ Cross Sections

A

Parameter A of a clothoïde. Defined as $A^2 = R \times L$ (A - parameter, R - radius, L - length of portion of curve).

Alignment

A curvilinear line describing the plan or profile view of a project. Horizontal and Vertical Alignments exist.

Backward Station Equation

See overlap equation

Batter

Slope

Carriage Way

The final driving path. Also called roadway or travel way.

Catch Point

A point marking the intersection between the design surface and the original ground.

Centre Line

The plan view alignment, also called Horizontal Alignment.

Chainage

The cumultative distance along the horizontal alignment, frequently but not always starting at zero. Also called station.

Clothoïde

A horizontal curve with constantly linear increasing curving. Defined by $A^2 = R \times L$ (A - parameter, R - radius, L - length of portion of curve).

Cross Section

A profile view of a project at a particular station.

Curve

A horizontal curve of constant radius, e.g. a portion of a circle.

Curve In

A portion of a clothoïde. Spiral transition from larger to smaller radius curve ($R_1 > R_2$, parameter A).

Curve Out

A portion of a clothoïde. Spiral transition from smaller to larger radius curve ($R_1 < R_2$, parameter A).

Curvilinear

A line consisting of any combination of tangents, curves and / or spirals for the horizontal or for the vertical of tangents, curves and / or parabolas.

Cut Slope

The surface of the project in areas of excavation with the design surface below original ground.

Design Surface

The intended shape of the completed project.

Equation

Required for a point on the horizontal alignment where the stationing is discontinuous. Gap equations and overlap equations are distinguished.

Fill Slope

The surface of the project in areas of fill with the design surface above original ground.

Finished Road Level

The level to which the final road is build to.

Forward Station Equation

See gap equation

Gap Equation

A type of station equation handling gaps in the stationing after removing a constituing element and stationing has not been re-computed.

Grade

Rate of change in elevation of the vertical alignment.

Ground Surface

See original ground

Hinge Point

The point on the cross section marking the beginning of the cut or fill slope.

Horizontal Alignment

The plan view alignment, also called centreline.

Long Profile

The profile alignment, also called vertical alignment.

Offset

The horizontal or vertical distance from a point to an alignment or cross section.

Offset Point

See reference point

Original Ground

The undisturbed surface before project construction is started as well as the actual shape of the project at the current stage of construction; also called original surface or ground surface.

Original Surface

See original ground

Overlap Equation

A type of station equation handling overlaps in the stationing after inserting a constituing element and stationing has not been re-computed.

P

Parameter P. This is the reciprocal of the rate of change of grade in the vertical curve. Three formulas for the calculation of P exist (see chapter Vertical Alignment).

Parabola

A parabolic arc. Exists only on vertical alignments.

Profile

See cross section

Reference Point

A second point often marked nearby the catch point or other point of interest since the catch point is often gone after the first earth movements. The stake is typically marked with the information that allows the user to replace the point of interest and re-create the slope information. Also known as the offset point.

Roadway

See carriage way

Shoulder

See verge

Slope

The slope is next to the verge. It links the road level with the original ground. Its slope ratio is usually higher than the one of the verge. For a fill, the slope direction corresponds to the one of the verge. For a cut, it is the opposite direction.

Spiral

A gradual horizontal transition from a tangent to a curve or two curves of different radii; optional for roads, required for railroads.

Spiral In

A gradual horizontal spiral transition from a tangent to a curve ($R_1 = \infty$, $R_2 = n$, parameter A).

Spiral Out

A gradual horizontal spiral transition from a curve to a tangent ($R_1 = n$, $R_2 = \infty$, parameter A).

Station

The cumultative distance along the horizontal alignment, frequently but not always starting at zero. Also called chainage.

Station Ahead

The stationing to be applied going forward along the alignment from the equation.

Station Back

The stationing to be applied going backwards along the alignment from the equation.

Station Equation

It defines adjustments for the Horizontal Alignment File when consituing elements have been added / removed resulting in a gap or overlap in the stationing without re-computing stationing.

Superelevation

Modification of the normal pavement cross slope. Intended to increase comfort and safety at speed.

Verge

Next to the carriage way, the part of the road with usually a slightly higher slope ratio. Also called shoulder.

Tangent

A straight line connecting two position points (XY) or height points (Z). It touches a circle, curve or spiral in one point and is perpendicular to the radius of the circle, curve or spiral in this point.

Top (of Bank)

A catch point marking the catch of a cut slope.

Toe (of Bank/Slope)

A catch point marking the catch of a fill slope.

Travel Way

See carriage way

Vertical Alignment

The profile alignment, also called long profile.

Widening

Increase / decrease of road width with change in number of lanes.

Index

Leica Geosystems AG, Heerbrugg, Switzerland, has been certified as being equipped with a quality system which meets the International Standards of Quality Management and Quality Systems (ISO standard 9001) and Environmental Management Systems (ISO standard 14001).

Total Quality Management-
Our commitment to total customer satisfaction

Ask your local Leica agent for more information about our TQM program

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