



# Origin Software RXL Roads User Guide



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## Introduction to Roads

Origin Roads software is a specialized application for surveying roads. Use the Roads software to:

- Upload an existing road definition.
- Key in an RXL road definition including horizontal and vertical alignments, templates, and superelevation and widening records.
- Review the road definition.
- Stake out the road.
- Generate a report for the staked road data to check data in the field, or to transfer data from the field to your client or to the office for further processing with office software.

**TIP** – Use the **Cogo** menu to carry out coordinate geometry (cogo) functions without having to switch to General Survey. You can also access some of these cogo functions from the tap and hold menu in the map. For information on all available cogo functions, refer to the *Spectra Geospatial Origin General Survey User Guide*.

When starting a survey you are prompted to select the survey style you have configured for your equipment. To learn more about survey styles and related connection settings refer to the appropriate topics in the *Origin Help*.

To switch between applications, tap the application icon in the status bar and then select the application to switch to. Alternatively, tap  and tap the name of the app you are currently using, and then select the application to switch to.

To customize the terminology used in the software, tap  and select **Settings / Language**. Select:

- **Use railroad terminology** if you are surveying a railroad and wish to use railroad-specific terminology.
- **Use chainage distance terminology** to use the term **Chainage** instead of **Station** for the distance along the road.

## RXL roads

RXL road files can be created using:

- Origin Roads software.
- Survey Office software.
- A number of third party design packages including Autodesk AutoCAD Land Desktop, AutoCAD Civil 3D, Bentley InRoads, and Bentley GEOPAK.

**NOTE** – *The Roads software treats all road distances, including station and offset values, as grid distances. If a ground coordinate system is defined in the job, the grid coordinates are, in effect, also ground coordinates.*

### Viewing RXL roads in the map

In the map, an RXL road is shown shaded in gray with the horizontal alignment shown as a red line.

If the road is not shown in the map, tap  to open the **Layer manager** and select the **Map files** tab. Select the file and then make the appropriate layer(s) visible and selectable. The file must be in the current project folder.

In the map, tap a road to select it. The road is highlighted in yellow with the horizontal alignment shown as a blue line.

**TIP** – If the road is shown as a color gradient and you would prefer to view it in yellow, in the map toolbar tap  / **Settings** and clear the **Display color gradient** check box in the **Surface** group box.

When you select a road, the **Review**, **Edit**, and **Stakeout** softkeys appear, enabling you to review or edit the road definition, or to stake out the road.

To show or hide roads or other linked files in the map, tap  to open the **Layer manager** and select the **Map files** tab. Tap a file to make it visible or to hide it. This is useful for reviewing a road relative to related secondary roads, particularly at interchanges and intersections.

## Defining an RXL road

Use the **Define** menu to create or edit the road definition.

When defining a road, you create an RXL file and add elements to complete the road definition.

- The **horizontal alignment** defines a line that runs along the center of the road.
- The **vertical alignment** defines the changes in the elevation of the road.
- The **template** defines a cross section of the road at a point across the road to define how wide it is at different points.

Add a template for each change in width. The template may consist of any number of strings.

- Add **template positions** to assign the appropriate template at different points along the road.
- Add **superelevation and widening** to add extra slope (banking) and widening on curves in a road design to assist vehicles negotiating the curves.
- **Station equations** define station values for an alignment.
- **Additional strings** define features that are related to but separate from the road, such as sound barriers or storm water drains.
- **Additional points** define design features like key positions for a drainage system or road cross sections.

### To define an RXL road

To define a new road, you can key in the definition or select items in the map and then create the road from the selected items. When working from the map you can select points, lines, arcs, or polylines in the job or in DXF, SHP, or LandXML files.

Roads are stored as RXL files in the current project folder.

Once a road is defined, you can edit it as required.

### To define a road by keying in components

1. Tap  and select **Define**. Alternatively, with nothing selected in the map, tap **Define**.
2. Tap **RXL road**.
3. Tap **New**.
4. Enter a name for the road.
5. To define a new road from an existing road definition, enable the **Copy existing road** switch and then select the file to copy from. The file must be in the current project folder.
6. To define a new road, select the method you will use to key in each component.
  - a. To define the **horizontal alignment** you can use the:
    - [Length or coordinate entry method, page 9](#)
    - [End station entry method, page 11](#)
    - [Points of intersection \(PI\) entry method, page 12](#)
  - b. Select the transition type. See [Transition types, page 12](#).
  - c. To define the **vertical alignment** or the **vertical geometry of additional strings** you can use the:
    - [Vertical points of intersection \(VPI\) entry method, page 16](#)
    - [Start and end point entry method, page 16](#)
7. Tap **Accept**.

The list of components that can be defined for the road appears.

If the list of components shows only **Horizontal alignment**, **Vertical alignment**, and **Station equations**, tap **Options** and select the **Enable templates and additional points/strings** check box.

**TIP** – To change the entry method or the transition type for the road, tap **Options**. However, once you have entered two or more elements defining the horizontal or vertical alignment definition, the entry method and transition type cannot be changed.

8. Select each component and define it as required.

9. Once you have defined the components for the road, tap **Store**.

The road definition screen closes and the software shows the map.

**TIP** – To configure the software to display the road selection screen when you tap **Store** instead of the map, in the **Select a file** screen, tap **Options** and select the **Display the road selection screen on escape** check box.

#### To define the road from selected items in the map

1. If the items you want to select are not visible in the map, tap  in the map toolbar to open the **Layer manager** and select the **Map files** tab. Select the file and then make the appropriate layer(s) visible and selectable.

2. In the map, tap the items that will define the horizontal alignment.

The order in which items are selected and the direction of the lines, arcs, or polylines defines the direction of the horizontal alignment.

If the items have elevations, then the elevations are used to define the vertical alignment.

3. Tap and hold in the map and select **Store road**.
4. Enter the road name, start station, and station interval.
5. Tap **Accept**.

To add other components such as templates and superelevation to the new road, tap  and select **Define**. See [To define a road by keying in components, page 6](#).

#### Road scale factor

**NOTE** – *This functionality is a requirement for the Ministry of Transportation Quebec, Canada but may have application elsewhere.*

The default **Road scale factor** is set to **1.00000000**. If required, in the list of components for the road definition, tap **Options** and change the **Road scale factor**.

The specified scale factor scales the road's horizontal alignment definition but retains the original station values. When you define the road, all values are entered and appear as unadjusted values. The scale factor is applied to the length/radius values defining each element/curve when computing the coordinates for the road definition. When surveying and reporting the road, the station values are not adjusted by the scale factor.

- For a road defined by entering end coordinates or end points, Spectra Geospatial recommends you do not change the scale factor after initial entry. Otherwise the scale factor rescales the alignment elements, and since the end coordinates/end point coordinates are not changed, a change in station values must occur.
- For a road defined by PI (Points of Intersection), Spectra Geospatial recommends you do not change the scale factor after initial entry. Otherwise the scale factor rescales the curve components, and since the PI coordinates are not changed a change in station values must occur.

### To key in the horizontal alignment

Use the steps below to key in the horizontal alignment for the selected road. To define the horizontal alignment by selecting items from the map, see [To define the road from selected items in the map, page 7](#).

1. Tap **Horizontal alignment**.
2. Tap **Add**.

The **Element** field is set to **Start point**.

3. To define the start point:
  - a. Enter the **Start station**.
  - b. In the **Method** field, select either:
    - **Key in coordinates** and then enter values in the **Start north** and **Start east** fields.
    - **Select point** and then select a point in the **Point name** field.

The **Start north** and **Start east** fields will update with the values for the entered point.

To edit the **Start north** and **Start east** values when they have been derived from a point, change the method to **Key in coordinates**.

- c. Enter the **Station interval**.
- d. Tap **Store**.

4. To add elements to the alignment:

- a. Select the **Element** type and fill out the remaining fields.

For more information, refer to the topic for the selected entry method.

- b. Tap **Store**.

- c. Continue adding elements as required.

Each element is added after the previous element.

- d. When you are done, tap **Close**.

**TIP** – To edit an element or to insert an element further up the list, you must first tap **Close** to close the **Add element** screen. You can then select the element to edit in the list and then tap **Edit**. To insert an element, tap the element that will come after the new element and then tap **Insert**.

5. Tap **Accept**.

6. Enter the other road components, or tap **Store** to store the road definition.

### Length or coordinate entry method

As you add each element to the alignment, fill out the fields required for the selected element type.

#### Line elements

To add a line to the alignment, select **Line** in the **Element** field and then select the method to construct the line:

If you select...	Then...
<b>Azimuth and length</b>	Enter the <b>Azimuth</b> and <b>Length</b> to define the line. The <b>End north</b> and <b>End east</b> fields automatically update.
<b>End coordinates</b>	Enter the <b>End north</b> and <b>End east</b> values to define the line. The <b>Azimuth</b> and <b>Length</b> fields automatically update.
<b>Select end point</b>	Enter the <b>Point name</b> . The <b>Azimuth</b> , <b>Length</b> , <b>End north</b> and <b>End east</b> fields automatically update.

**NOTE** – If this line is not the first line to be defined, the **Azimuth** field displays an azimuth calculated from the previous element.

To edit the azimuth, tap ► next to the **Azimuth** field and select **Edit azimuth**. If the element is non tangential the icon at the start of the element is shown in red.

### Arc elements

To add an arc to the alignment, select **Arc** in the **Element** field and then select the method to construct the arc:

If you select...	Then...
<b>Radius and length</b>	Select the arc direction. Enter the <b>Radius</b> and <b>Length</b> to define the arc. The <b>End north</b> and <b>End east</b> fields automatically update.
<b>Delta angle and radius</b>	Select the arc direction. Enter the <b>Angle</b> and <b>Radius</b> to define the arc. The <b>End north</b> and <b>End east</b> fields automatically update.
<b>Deflection angle and length</b>	Select the arc direction. Enter the <b>Angle</b> and <b>Length</b> to define the arc. The <b>End north</b> and <b>End east</b> fields automatically update.
<b>End coordinates</b>	Enter the <b>End north</b> and <b>End east</b> values to define the arc. The <b>Arc direction</b> , <b>Radius</b> , and <b>Length</b> fields automatically update.
<b>Select end point</b>	Enter the <b>Point name</b> . The <b>Azimuth</b> , <b>Length</b> , <b>End north</b> and <b>End east</b> fields automatically update.
<b>End coordinates and center point</b>	Enter the <b>End north</b> , <b>End east</b> , <b>Center point north</b> and <b>Center point east</b> values to define the arc. If required, select <b>Large arc</b> . The <b>Azimuth</b> , <b>Arc direction</b> , <b>Radius</b> , and <b>Length</b> fields automatically update.
<b>Select end and center points</b>	Enter the <b>End point name</b> and <b>Center point name</b> values to define the arc. If required, select <b>Large arc</b> . The <b>Azimuth</b> , <b>Arc direction</b> , <b>Radius</b> , and <b>Length</b> , <b>End north</b> and <b>End east</b> fields update with the values entered.

**NOTE** – For an arc defined by **Radius and length**, **Delta angle and radius** or **Deflection angle and length**, the **Azimuth** field shows the azimuth as calculated from the previous element. If the element is non tangential the icon at the start of the element is shown in red. To reload the original azimuth, tap ► next to the **Azimuth** field and select **Restore tangency**.

### Entry transition/exit transition elements

To add a transition to the alignment:

1. Select **Entry transition** or **Exit transition** in the **Element** field.
2. Select the arc direction.
3. Enter the **Start radius**, **End radius** and **Length** to define the transition.

The **End North** and **End East** fields update automatically.

The **Azimuth** field displays the azimuth as calculated from the previous element. To edit the azimuth, tap ► next to the **Azimuth** field and select **Edit azimuth**. If the element is non tangential the icon at the start of the element is shown in red.

If the transition type is NSW cubic parabola the computed **Transistion Xc** value is displayed. If the transition is between two arcs the **Transistion Xc** displayed is the value computed for the common tangent point with the smaller of the two arcs.

### End station entry method

As you add each element to the alignment, fill out the fields required for the selected element type.

#### Line elements

To add a line to the alignment:

1. Select **Line** in the **Element** field.
2. Enter the **Azimuth** and **End station** to define the line.

The **End North** and **End East** fields update automatically.

**NOTE** – If this line is not the first line to be defined, the **Azimuth** field displays an azimuth calculated from the previous element.

To edit the azimuth, tap ► next to the **Azimuth** field and select **Edit azimuth**. A solid red circle is shown at the start of an element if adjoining elements are non tangential.

#### Arc elements

To add an arc to the alignment, select **Arc** in the **Element** field and then select the method to construct the arc:

If you select...	Then...
<b>Radius and end station</b>	Select the arc direction. Enter the <b>Radius</b> and <b>End station</b> to define the arc.
<b>Deflection angle and end station</b>	Select the arc direction. Enter the <b>Angle</b> and <b>End station</b> to define the arc.

The **End North** and **End East** fields automatically update.

**NOTE** – The **Azimuth** field displays the azimuth as calculated from the previous element.

To edit the azimuth, tap ► next to the **Azimuth** field and select **Edit azimuth**. The icon preceding the element name is shown red if adjoining elements are non tangential or if adjoining elements defining a curve have different radii.

### Entry transition/exit transition elements

To add a transition to the alignment:

1. Select **Entry transition** or **Exit transition** in the **Element** field.
2. Select the arc direction.
3. Enter the **Start radius**, **End radius** and **Length** to define the transition.

The **End North** and **End East** fields update automatically.

The **Azimuth** field displays the azimuth as calculated from the previous element. To edit the azimuth, tap ► next to the **Azimuth** field and select **Edit azimuth**. If the element is non tangential the icon at the start of the element is shown in red.

If the transition type is NSW cubic parabola the computed **Transition Xc** value is displayed. If the transition is between two arcs the **Transition Xc** displayed is the value computed for the common tangent point with the smaller of the two arcs.

### Points of intersection (PI) entry method

To add an element to the alignment:

1. Define the points of intersection.
2. Select the **Curve type**. If you select:
  - **Circular**, enter the **Radius** and **Arc length**.
  - **Transition|Arc|Transition**, enter the **Radius**, **Arc length**, **Transition length in** and **Transition length out**.
  - **Transition|Transition**, enter the **Radius**, **Transition length in** and **Transition length out**.
  - **None**, no further values are required.
3. Tap **Store**.

### Transition types

The software supports the following transition types.

Method	Length	End station	PI
Clothoid spiral	*	*	*
Egg-shaped clothoid spiral	*	*	–
Cubic spiral	*	*	*

Method	Length	End station	PI
Bloss spiral	*	*	*
Korean cubic parabola	*	*	*
NSW cubic parabola	*	*	-

#### Clothoid spiral

The clothoid spiral is defined by the length of the spiral and the radius of the adjoining arc. The formulae for the **x** and **y** parameters in terms of these two values are as follows:

Parameter **x**:

$$x = l \left[ 1 - \frac{l^4}{40R^2L^2} + \frac{l^8}{3456R^4L^4} - \dots \right]$$

Parameter **y**:

$$y = \frac{l^3}{6RL} \left[ 1 - \frac{l^4}{56R^2L^2} + \frac{l^8}{7040R^4L^4} - \dots \right]$$

#### Egg-shaped clothoid spiral

By editing the **Start / End radius** for an **Entry / Exit transition** from **Infinite** to a required radius it is possible to define an egg shaped clothoid. To return to an infinite radius, select **Infinite** from the pop-up menu.

#### Cubic spiral

The cubic spiral is defined by the length of the spiral and the radius of the adjoining arc. The formulae for the **x** and **y** parameters in terms of these two values are as follows:

Parameter **x**:

$$x = l \left[ 1 - \frac{l^4}{40R^2L^2} + \frac{l^8}{3456R^4L^4} - \dots \right]$$

Parameter **y**:

$$y = \frac{l^3}{6RL}$$

### Bloss spiral

Parameter **x**:

$$x = l \left[ 1 - \frac{l^6}{14R^2L^4} + \frac{l^7}{16R^2L^5} - \frac{l^8}{72R^2L^6} + \frac{l^{12}}{312R^4L^8} - \frac{l^{13}}{168R^4L^9} + \frac{l^{14}}{240R^4L^{10}} - \frac{l^{15}}{768R^4L^{11}} + \frac{l^{16}}{6528R^4L^{12}} \right]$$

Parameter **y**:

$$y = \left[ \frac{l^4}{4RL^2} - \frac{l^5}{10RL^3} - \frac{l^{10}}{60R^3L^6} + \frac{l^{11}}{44R^3L^7} - \frac{l^{12}}{96R^3L^8} - \frac{l^{13}}{624R^3L^9} \right]$$

**NOTE** - The Bloss spiral can only be fully developed, that is, for an entry transition the start radius is infinite and similarly for an exit transition the end radius is infinite.

### Korean cubic parabola

This cubic parabola is defined by the length of the parabola and the radius of the adjoining arc. The formulae for the **x** and **y** parameters in terms of these two values are as follows:

Parameter **x**:

$$x = l \left[ 1 - \frac{l^4}{40R^2L^2} \right]$$

Parameter **y**:

$$y = \frac{x^3}{6RX}$$

**NOTE** - The Korean cubic parabola can only be fully developed, that is, for an entry transition the start radius is infinite and similarly for an exit transition the end radius is infinite.

### NSW cubic parabola

The NSW cubic parabola is a special parabola used for rail projects in New South Wales, Australia. It is defined by the length of the parabola and an **m** value. Refer to [NSW Government Technical Note ESC 210 Track Geometry and Stability](#).

### To key in the vertical alignment

If you created the road definition by selecting items in the map, the elevations of those items are used to define the vertical alignment as a series of **Point** elements. The vertical alignment can be edited if required.

To key in the vertical alignment for the selected road definition:

1. Tap **Vertical alignment**.
2. Tap **Add**.

The **Element** field is set to **Start point**.

3. To define the start point:
  - a. Enter the **Station (VPI)** and the **Elevation (VPI)**.
  - b. To change the way a slope value is expressed, tap **Options** and change the **Grade** field as required.
  - c. Tap **Store**.

4. To add elements to the alignment:

- a. Select the **Element** type and fill out the remaining fields.

For more information, refer to the topic for the selected entry method.

- b. Tap **Store**.
- c. Continue adding elements as required.

Each element is added after the previous element.

- d. When you are done, tap **Close**.

**TIP** – To edit an element or to insert an element further up the list, you must first tap **Close** to close the **Add element** screen. You can then select the element to edit in the list and then tap **Edit**. To insert an element, tap the element that will come after the new element and then tap **Insert**.

5. Tap **Accept**.
6. Enter the other road components, or tap **Store** to store the road definition.

## Vertical points of intersection (VPI) entry method

To add an element to the alignment:

1. Select the **Element**. If you select:
  - **Point**, enter the **Station** and **Elevation** to define the VPI.
  - **Circular arc**, enter the **Station** and **Elevation** to define the VPI and enter the **Radius** of the circular arc.
  - **Symmetric parabola**, enter the **Station** and **Elevation** to define the VPI and enter the **Length** of the parabola.
  - **Asymmetric parabola**, enter the **Station** and **Elevation** to define the VPI and enter the **In length** and **Out length** of the parabola.

The **Slope in** field shows the calculated slope value.

The **Length**, **K factor** and **Slope out** fields update when the next element is added. The exact fields shown depend on the selected element.

2. Tap **Store**.

### **NOTE –**

- *A vertical alignment defined by VPIs must end with a point.*
- *When you edit an element, only the selected element is updated. All adjoining elements remain unchanged.*

## Start and end point entry method

1. Select the **Element**. If you select:
  - **Point**, enter the **Station** and **Elevation** to define the start point.
  - **Circular arc**, enter the **Start station**, **Start elevation**, **End station**, **End elevation** and **Radius** to define the circular arc.
  - **Symmetric parabola**, enter the **Start station**, **Start elevation**, **End station**, **End elevation** and **K factor** to define the parabola.

The other fields show calculated values. Depending on the selected element, these may include **Length, Slope in, Slope out, K factor** and **Sag / Summit** values.

2. Tap **Store**.

**NOTE** – *When you edit an element, only the selected element is updated. All adjoining elements remain unchanged.*

### To add templates

To define a template for the selected road definition:

1. Tap **Templates**.

2. To add a new template:

a. Tap **Add**.

b. Enter the template name.

c. In the **Copy from** field, select whether to copy an existing definition from a road or another template, into the template.

**TIP** – To create a template library, define a road that only contains templates.

d. Tap **Add**.

The graphical template view appears.

3. To add a string to the template:

a. Tap **New**.

b. Enter the **String name**.

c. To create a gap in the template, select the **Create gap** check box.

d. Select the **Method** and then define the string. See:

[Cross slope and offset](#)

[Delta elevation and offset](#)

[Side slope](#)

e. Tap **Store**.

4. Continue adding strings as required.

Each string is added after the selected string.

Use the **Start**, **Prev**, **Next** and **End** softkeys to view other strings in the template.

5. To save the template and return to the **Templates** screen, tap **Accept**.
6. Add or select a different template to edit, or tap **Accept** to return to the list of components for the selected road definition.
7. Enter the other road components, or tap **Store** to store the road definition.

#### Cross slope and offset

1. Enter the **Cross slope** and **Offset** values.

To change the way a cross slope value is expressed, tap **Options** and change the **Grade** field as required.

2. Select the **Apply superelevation** and **Apply widening** options as required.

**NOTE** – When the pivot position is set to **Pivot left** or **Pivot right**, the algebraic difference in cross slope between the first template string with superelevation applied and the superelevation value is used to calculate the superelevation for all other template strings with superelevation applied.

3. Select **Apply super rollover** and then specify a **Max value** to limit shoulder rollover. For more information, see [Understanding superelevation rollover, page 31](#).

#### Delta elevation and offset

1. Enter the **Delta elevation** and **Offset** values.

2. Select the **Apply superelevation** and **Apply widening** options as required.

**NOTE** – When the pivot position is set to **Pivot left** or **Pivot right**, the algebraic difference in cross slope between the first template string with superelevation applied and the superelevation value is used to calculate the superelevation for all other template strings with superelevation applied.

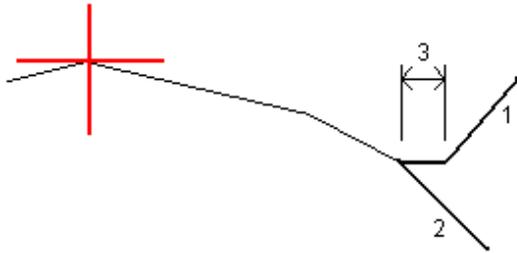
3. Select **Apply super rollover** and then specify a **Max value** to limit shoulder rollover. For more information, see [Understanding superelevation rollover, page 31](#).

#### Side slope

Enter the **Cut slope (1)**, **Fill slope (2)**, and **Cut ditch width (3)** values.

**NOTE** – Cut and fill slopes are expressed as positive values. You cannot add a string after a side slope.

To define a side slope with only a cut or fill slope, leave the other slope value field as '?'.



### To add template positions

After adding templates, you must specify the station at which the Roads software starts to apply each template. A template is applied at the start station and the values defining each string are then interpolated linearly (applied on a pro rata basis) from that point to the station where the next template is applied. See [Template positioning examples, page 27](#).

To add template positions to the selected road definition:

1. Tap **Template positioning**. The **Apply template** screen appears.
2. To specify a new position at which template(s) should be applied:
  - a. Tap **Add**.
  - b. Enter the **Start station**.
  - c. In the **Left template** and **Right template** fields, select the template to apply.

To interpolate the template for this station from the previous and next templates in the road definition, select **<Interpolate>**.

If you do not want to apply a template, for example to create a gap in the road definition, select **<None>**.

- d. Tap **Store**.
3. Continue adding positions where templates should be applied, as required.
4. When you are done, tap **Close**.
5. Tap **Accept**.

6. To select the interpolation method for calculating cross sections between template positions, select **Elevation** or **Cross slope**. Tap **Accept**.

**TIP** – The **Road cross section interpolation by** field is added to the road **Options** screen. To change the interpolation method for the road, tap **Options** in the road components screen.

7. The software returns to the **Apply template** screen. Tap **Accept**.
8. Enter the other road components, or tap **Store** to store the road definition.

### To add superelevation and widening

Superelevation and widening values are applied at the start station, and values are then interpolated linearly (applied on a pro rata basis) from that point to the station where the next superelevation and widening values are applied.

To add superelevation and widening values to the selected road definition:

1. Tap **Superelevation & widening**.
2. Tap **Add**.
3. Enter the **Start station**.
4. In the **Pivot** field, select the position about which the template rotates. If you select:
  - **Pivot left**, the pivot position is the maximum offset, left of the alignment, of the last template string with superelevation applied.
  - **Pivot crown**, the pivot position is at the alignment.
  - **Pivot right**, the pivot position is the maximum offset, right of the alignment, of the last template string with superelevation applied.

**NOTE** – When the pivot position is set to **Pivot left** or **Pivot right**, the algebraic difference in cross slope between the first template string with superelevation applied and the superelevation value is used to calculate the superelevation for all other template strings with superelevation applied.

5. In the **Left super** and **Right super** fields, enter superelevation values for the left and right sides of the horizontal alignment.

To change the way a superelevation value is expressed, tap **Options** and change the **Grade** field as required.

6. In the **Left widening** and **Right widening** fields, enter the widening values to be applied. Widening is expressed as a positive value.

These values are applied to each string in the template that has the **Widening** check box selected.

7. Tap **Store**.
8. Continue adding records as required.
9. When you are done, tap **Close**.
10. Tap **Accept**.
11. Enter the other road components or tap **Store** to store the road definition.

### To add station equations

Use **Station equations** when the horizontal alignment has changed but you wish to retain the original station values.

1. Tap **Station equations**.
2. Tap **Add**.
3. In the **Back station** field, enter a station value.
4. In the **Ahead station** field, enter a station value. The **True station** value is calculated.
5. Continue adding records as required.
6. Tap **Store**.

The values entered in the **Back station** and **Ahead station** fields are shown.

The zone is indicated by a number after the colon in each field. The zone up to the first station equation is zone 1.

The calculated **Progression** indicates whether the station value increases or decreases after the station equation. The default setting is **Increasing**. To change the **Progression** for the last station equation to **Decreasing**, define and store the last equation and then tap **Edit**.

7. When you are done, tap **Close**.
8. Tap **Accept**.
9. Enter the other road components, or tap **Store** to store the road definition.

### To define additional strings

Use **Additional strings** to define features that are related to but separate from the road, such as sound barriers or storm water drains. The additional string is defined by horizontal geometry comprising a series of lines that are defined relative to the horizontal alignment of the road and, if required, vertical geometry defined using all the options available when defining a vertical alignment for a road.

To add additional strings to the selected road definition:

1. Tap **Additional strings**.
2. Tap **Add**.
3. Enter the **String name**. Tap **Accept**.
4. To define the horizontal geometry of the string:
  - a. Tap **Horizontal geometry**. If required, tap **Edit**.
  - b. Tap **Add**.
  - c. Enter the **Station** and **Offset** to define the start point. Tap **Store**.
  - d. Enter the **End station** and **Offset** for the line. Tap **Store**.
  - e. Continue adding lines to define the string as required.
  - f. When you are done, tap **Close**.
5. Tap **Accept**.
6. To define the vertical geometry of the string:
  - a. Tap **Vertical geometry**.
  - b. Tap **Add**.
  - c. Enter the **Station (VPI)** and **Elevation (VPI)** to define the start point. Tap **Store**.
  - d. Add the required elements to the vertical geometry. See [To key in the vertical alignment, page 15](#).
  - e. When you are done, tap **Close**.
7. Tap **Accept**.
8. Add another string, or tap **Accept** to return to the list of components for the selected road

definition.

9. Enter the other road components or tap **Store** to store the road definition.

### To define additional points

Use **Additional points** to define design features like key positions for a drainage system or road cross sections.

You can key in points or import them from a CSV file or LandXML file.

**NOTE** – *When importing points from a CSV file, two formats are supported:*

- *Station and offset where each position in the file must be defined by a station and offset and, optionally, an elevation and code, in that order. See the following:*  
*1+000.000, 0.250, 20.345, ,*  
*1+000.000, -5.000, 25.345, End curb*  
*1+000.000, 4.500, , Lamp post*  
*1+000.000, 7.000, 25.294, Begin sound wall*
- *Northing and easting where each position in the file must be defined by a northing and easting and, optionally, an elevation and code, in that order. See the following:*

*5000.000, 2000.000, 20.345, ,*  
*5000.000, 2100.000, 25.345, End curb*  
*5000.000, 2200.000, , Lamp post*  
*5000.000, 2300.000, 25.294, Begin sound wall*

*For both file formats, where points have null elevations you can choose to use the elevation of the vertical alignment at the station value of the point.*

**TIP** – *On import northing and easting coordinates in the CSV or LandXML file are converted to station and offset values relative to the road.*

To add additional points to the selected road definition:

1. Tap **Additional points**.
2. To import points from a file:
  - a. Tap **Import**.
  - b. Select the file. Tap **Accept**.

The imported points are listed in the **Additional points** screen.

3. To key in points:
  - a. Tap **Add**.
  - b. Enter the **Station** and **Offset** for the point.
  - c. If required, enter the **Elevation** and **Code**.
  - d. Tap **Store**.
  - e. Continue adding points as required.
  - f. When you are done, tap **Close**.

**TIP** – To insert a point, tap the point you want the new point to follow and tap **Insert**.

4. Tap **Accept**.
5. Enter the other road components or tap **Store** to store the road definition.

## To review the definition of an RXL road

You can review the definition of a road at any time. View the road in 3D to visually confirm the road definition and to visualize the road relative to other road definitions, such as a complex interchange or urban intersection.

1. In the map, tap the road.
2. Tap **Review**.

Black hollow circles represent any portion of the horizontal alignment that has no elevations and so is drawn on the ground plane.

**TIP** – To move the ground plane closer to the road, tap  and select **Settings** and then edit the ground plane elevation.

Black solid circles represent the positions on the strings at each cross section.

Gray lines represent the strings and connect the cross sections.

To understand the rules for connecting cross sections in an RXL road, see [Template positioning examples, page 27](#) and [Non tangent horizontal alignment elements, page 30](#).

3. Tap a string or a station on a string.

Alternatively, tap the **String** softkey to select a string from the list. The list shows only the strings that are at the start station or, if you have a position, the strings at the cross section at your current position. When a string is selected, tap the **Station** softkey to select a station from the list. Information about the selected item is shown alongside the map.

4. To select a different station or string, you can:

- Tap the station on a string.
- Tap the **Station** or **String** softkey to select a station or string from a list.
- Press the up or down arrow key to select another station, or press the left or right arrow key to select another string.
- Tap the **Sta-** or **Sta+** softkey.

Use the map toolbar to navigate around the map and to change between views.

5. To view available cross sections, tap  or press the **Tab** key.

By default, each cross section is displayed so that it fills the screen, providing the best view of the cross section. To view cross sections relative to each other, tap the **Fixed scale** button  so that it changes to . Each cross section is displayed with the scale fixed so that the widest cross section fills the screen.

The alignment is shown as a red cross. The black circles represent the strings. The larger blue circle represents the currently selected string. The linework preceding the selected string is shown as a bold blue line. Information about the selected item is shown alongside the map.

To view the cross section at a different station, you can:

- Press the up or down arrow key.
- Tap **Station** to key in a station or to select a station from the list.

To select a different string, you can:

- Tap the string.
- Press the left or right arrow key.

- Tap **String** to select a string from the list.
6. To return to the plan of the road, tap  or press the **Tab** key.
  7. To view an automated 3D drive through of the road:
    - a. When viewing the plan or cross section in the map, tap **3D drive**.
    - b. Tap  to start the drive through.
    - c. To pause the drive through and inspect a particular part of the road, tap . To orbit the road while the drive through is paused, tap the screen and swipe in the direction to orbit.
    - d. To move forward and back along the road, press the up and down arrow keys.
    - e. To exit 3D drive, tap **Close**.
  8. To exit the road review, tap **Close**.

**TIP –**

- To review a position defined by a nominal station value, where the station does not have to coincide with a cross section, from the plan or cross section view tap **Station** and then key in a station value.
- To review a position in an RXL road that is defined by a nominal offset value, where the offset does not have to lie on a string, tap **String** and then key in an offset. The offset is computed from the alignment. The elevation for the resultant position is defined by interpolation of the cross section at the entered station and offset.

## To report the definition of an RXL road

To generate an HTM text report of the defined RXL road:

1. Select the road. In the map, tap the road to select it.

To select the road from the list:

  - a. Tap  and select **Define**.
  - b. Tap **RXL road**.
  - c. Select the road.
2. Tap **Edit**.

3. Tap **Report**.
4. To include only a part of the road definition in the report, select a different **Start station** and **End station**.
5. Tap **Accept**.

The report appears in your browser. It shows the offset, coordinates, elevation, and code for each position in the cross section for the selected stations. The values reported are for the resolved cross sections, that is, they include any superelevation and widening values that may have been applied, and any interpolation between different templates.

If the definition includes additional points these are included in the report in a separate section after the Road Cross-Section Points.

## Template positioning examples

A template defines a cross section of the road at a point across the road to define how wide it is at different points. Add a template for each change in width. The template may consist of any number of strings.

A string is the linework connecting adjoining templates. Strings typically define the shoulder, edge of the pavement, curb, and similar features that make up a road. The string name is displayed during stakeout. You can define the string when you add the template.

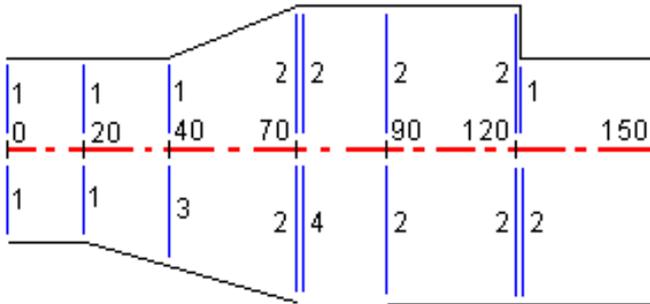
You can add gaps between strings where required. This is useful when the template does not start at the alignment. A gap is shown as a dashed line from the current string to the previous string. When measuring your position relative to the road, and if your position is in the gap, the **V.Dist** to the road value is null.

### **NOTE -**

- *If the design requires a gap in its definition, set the template field to **<None>**.*
- *No interpolation occurs between a null and a valid template.*
- *Templates are interpolated after superelevation and widening have been applied.*

### Template assignment

This example explains how positioning of templates and use of interpolation can be used to control an RXL road definition:



Assign the templates at the specified start stations as shown in the following table:

Start station	Left templates	Right templates
0.000	Template 1	Template 1
20.000	Template 1	Template 1
40.000	Template 1	<Interpolate> 3
70.000	Template 2	Template 2
70.005	Template 2	<None> 4
90.000	Template 2	Template 2
120.000	Template 2	Template 2
120.005	Template 1	Template 2

#### Right side of the road

On the right side, template 1 is assigned to stations 0 and 20. The road transitions from template 1 at station 20 to template 2 at station 70. Because a template must be assigned at station 40 on the left side, the system template <Interpolate> 3 must be assigned to the right side of the road to maintain correct interpolation.

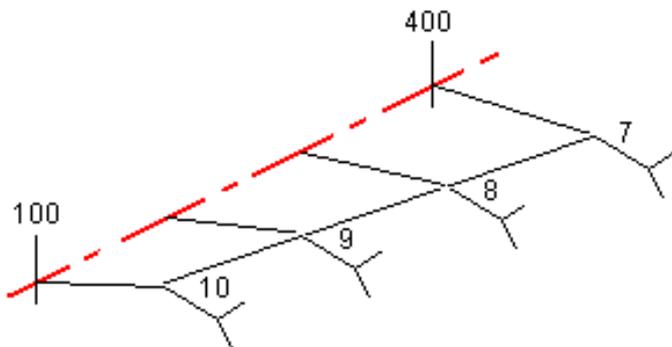
To correctly represent the gap between stations 70 and 90, the system template <None> 4 is assigned at a nominal distance after station 70 (5 mm). To complete the right side of the road, template 2 is assigned to stations 90, 120, and 120.005.

### Left side of the road

On the left side, template 1 is assigned to stations 0, 20, and 40. The road transitions from template 1 at station 40 to template 2 at station 70. To correctly represent the design, template 1 is assigned a nominal distance after station 120 (5 mm).

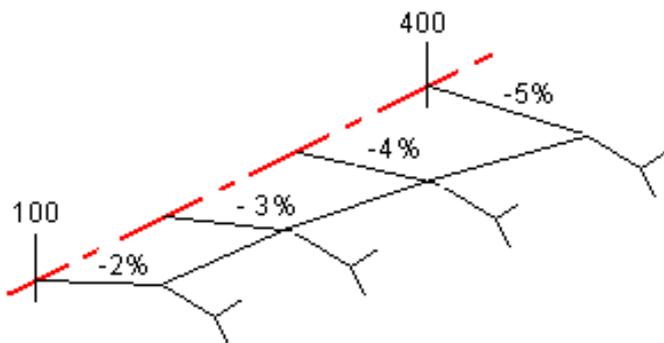
### Interpolation by elevation

See the following example where the template at station 100 has a string with an elevation of 10.0. The next template is assigned at station 400 and has a string with an elevation of 7.0. The cross section for stations 200 and 300 are interpolated as shown to provide even grading of elevation from station 100 to 400.



### Interpolation by cross slope

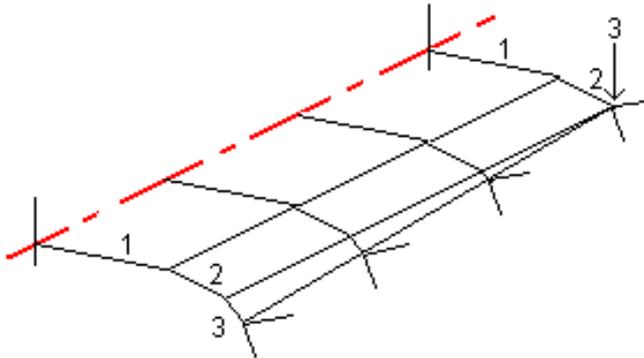
See the following example where the template at station 100 has a string defined by a crossfall of -2%. The next template is assigned at station 400 and has string defined by a crossfall of -5%. The cross section for stations 200 and 300 are interpolated as shown to provide even grading of cross slope from station 100 to 400.



### Interpolating between templates that have a different number of strings

For templates with an unequal number of strings, the template with the least strings has, in effect, a string defined with a zero offset added before the side slope string. The interpolation is then performed

given an equal number of strings exist. In the example below, an additional string (3) has automatically been inserted.



By adding strings defined with a zero offset, you can further control the interpolation process to best represent the road design.

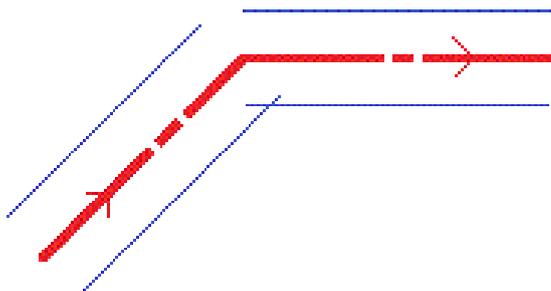
### Interpolation of side slopes

If consecutive templates contain side slopes of differing values intermediate stations have side slopes interpolated based on the slope value as a percentage.

For example, if the side slope value at station 600 is 50% (1:2) and at station 800 it is 16.67% (1:6) the side slope value at station 700 will be  $50\% + 16.7\% / 2 = 33.33\%$  (1:3).

### Non tangent horizontal alignment elements

The following diagram illustrates how, for an RXL road, cross sections connect when consecutive horizontal alignment elements are non tangential.



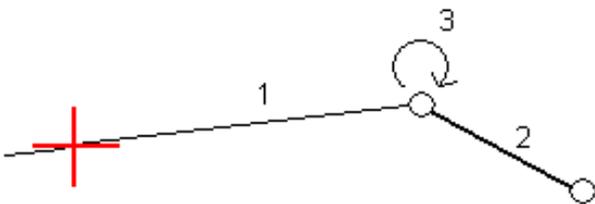
To understand how this affects the reported values when your current position is near the point of non tangency and you are measuring your position relative to a road or to a string, see [Plan and cross section view, page 42](#).

## Understanding superelevation rollover

You can add superelevation values when defining an RXL road.

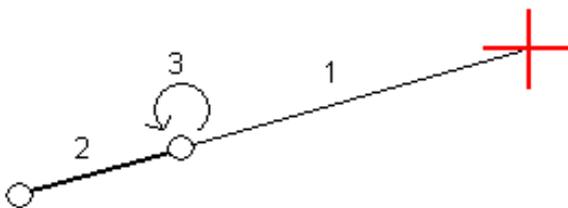
### Outside of curve (high side)

As shown below, the superelevation rollover value is the maximum algebraic difference in cross slope (3) between the carriageway or travel lane (1) where the carriageway is adjusted by superelevation and the shoulder (2) which is not adjusted by superelevation. If the station being staked includes superelevation that results in the difference in cross slope exceeding the specified maximum, the slope defining the shoulder is adjusted so that the algebraic difference in slope is not exceeded.



### Inside of curve (low side)

For the inside of a superelevated curve, the shoulder (2) uses its design value unless that value is less than the slope value of the superelevated carriageway (1). In that case, the superelevated value for the carriageway is used for the shoulder. This behavior happens only if you specified a maximum superelevation rollover value.



## Staking out an RXL road

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 **CAUTION** - Do not change the coordinate system or calibration after you have staked out points, or computed offset or intersection points. If you do, the previously staked out or computed points will be inconsistent with the new coordinate system and any points computed or staked out after the change.

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1. In the map, tap the road and then tap **Stakeout**. Alternatively, tap  and select **Stakeout**, tap **Stakeout roads** and select the road to stake then tap **Next**.

If the road you want to stake out is not shown in the map, tap  in the map toolbar to open the **Layer manager** and select the **Map files** tab. Select the file and then make the appropriate layer(s) visible and selectable. The file must be in the current project folder.

2. If you have not yet started a survey, the software prompts you through the steps to start the survey.
3. Enter a value in the **Antenna height** or **Target height** field and make sure that the **Measured to** field is set correctly.
4. Enter the **Station interval** or accept the default value set when the road was defined.

A **Station interval** value is required when staking out a station on a string. This value is optional for other survey methods.

5. Tap **Options** to:
  - Configure preferences for **Grade**, **As-staked point details**, **Display** and **Available stations**.
  - Enable [staking out relative to a digital terrain model \(DTM\)](#).

6. Tap **Next**.

The road is ready to stake, using your preferred stakeout method. For more information, refer to the topic for the selected method. See:

[To stake out positions relative to the road, page 33](#)

[To stake out positions relative to a string, page 34](#)

[To stake out a station on a string, page 35](#)

[To stake out additional strings, page 37](#)

[To stake out additional points, page 39](#)

## To stake out positions relative to the road

1. In the **Stake** field, select **To the road**, or tap an empty part of the map. This will clear any selected items in the map, leaving you ready to stake positions relative to the road.
2. To stake points offset from the road, leaving the roadway clear for construction, [define a construction offset](#).
3. To view the perpendicular cut/fill to the road, select **Options** and in the **Road** group box set the **Design cut/fill** field to **Perpendicular**.
4. Tap **Start**.
5. Use the [plan or cross section view](#) to see your position relative to the road.

If your current position is:

- Within 30 m of the horizontal alignment, the plan view shows a dashed green line drawn at a right angle from your current position to the alignment.
  - More than 30 meters from the horizontal alignment, the software navigates you to a position on the horizontal alignment. This is calculated by projecting your current position at right angles to the horizontal alignment.
6. When the point is within tolerance, tap **Measure** to measure the point.
  7. Tap **Store**.

The software returns to the navigation screen.

You can then:

- Continue measuring points along the road.
- Tap **Esc** to exit this stakeout method.
- Change stakeout methods. To stake:
  - **To the road**, tap an empty part of the map.
  - **To a string**, tap the string in the map.
  - A **Station on a string**, tap the station on a string in the map.

## To stake out positions relative to a string

1. Tap the string in the map or select **To the string** in the **Stake** field and then tap **String** and select a string from the list.

The strings in the list are determined by the templates assigned at your current position relative to the road.

To select a different string, press the left or right arrow key.

To stake out your position relative to the nearest string, select **To the nearest string** from the **Stake** field. Using this method means you don't have to select a string. Instead the software will navigate you to the string nearest to your current position, meaning that as you move across the road the string you are staking relative to will automatically change to reflect your new position.

2. If required, add the following features:
  - To stake points offset from the road, leaving the roadway clear for construction, [define a construction offset](#).
  - To confirm the construction of the road surface, [define a cross slope](#).
3. Tap **Start**.
4. Use the [plan or cross section view](#) to navigate relative to the string. See [Stakeout navigation, page 45](#).

- If required, you can [add or edit a side slope](#).
- To stake the hinge position for a cut slope when measuring relative to a side slope, tap and hold in the plan or cross section view and select **Stake cut slope hinge**. This option is useful when the side slope includes a cut ditch.
- If you are staking to a [catch point](#) with construction offsets, navigate to the catch point and then tap **Apply** to add the construction offsets. You are prompted to apply the offsets from your current position. If you are not on the catch position, select **No**, navigate to the catch position and then tap **Apply** again. To store the catch position and the construction offset, see [Construction offsets, page 50](#).

If your current position is within 5 m of the selected string, the plan view shows a dashed green line drawn at a right angle from your current position to the string.

5. When the point is within tolerance, tap **Measure** to measure the point.
6. Tap **Store**.

The software returns to the navigation screen.

You can then:

- Continue measuring points along the road.
- Tap **Esc** to exit this stakeout method.
- Change stakeout methods. To stake:
  - **To the road**, tap an empty part of the map.
  - **To a string**, tap the string in the map.
  - A **Station on a string**, tap the station on a string in the map.

## To stake out a station on a string

1. Tap the station on a string in the map, or select **Station on string** in the **Stake** field and then tap **Station** to select the station from the list or to enter a nominal offset value.

The strings in the list are determined by the templates assigned at your current position relative to the road.

To select a different string, press the left or right arrow key. To select a different station, press the up or down arrow key, or tap the **Sta-** or **Sta+** softkey.

**NOTE –**

- *If a road consists of a horizontal alignment only, you can stake it out in only two dimensions.*
  - *The horizontal and vertical alignments of a road may not start and end at the same station values. When they start and end at different station values, you can only stake out points in three dimensions if their stations lie within the horizontal alignment.*
2. To edit the elevation, tap and hold in the map and select **Edit elevation**. To reload an edited elevation, tap and hold in the map and select **Reload original elevation**.
  3. To stake out a position defined by a nominal offset, tap **Offset** and enter the offset value.  
To enter an offset to the left of the horizontal alignment, enter a negative value.
  4. If required, add the following features:
    - To stake points offset from the road, leaving the roadway clear for construction, [define a construction offset](#).
    - To confirm the construction of the road surface, [define a cross slope](#).
    - To stake points on surfaces other than the finished road surface, [define a subgrade](#).
  5. Tap **Start**.
  6. Use the [plan or cross section view](#) to navigate to the point. See [Stakeout navigation, page 45](#).  
If you are staking to a [catch point](#) with construction offsets, navigate to the catch point and then tap **Apply** to add the construction offsets. You are prompted to apply the offsets from your current position. If you are not on the catch position, select **No**, navigate to the catch position and then tap **Apply** again. To store the catch position and the construction offset, see [Construction offsets, page 50](#).
  7. If required, you can [add or edit a side slope](#).

8. To stake the hinge position for a cut slope when measuring relative to a side slope, tap and hold in the plan or cross section view and select **Stake cut slope hinge**. This option is useful when the side slope includes a cut ditch.
9. When the point is within tolerance, tap **Measure** to measure the point.
10. Tap **Store**.

The software returns to the navigation screen.

You can then:

- Continue measuring points along the road.
- Tap **Esc** to exit this stakeout method.
- Change stakeout methods. To stake:
  - **To the road**, tap an empty part of the map.
  - **To a string**, tap the string in the map.
  - A **Station on a string**, tap the station on a string in the map.

## To stake out additional strings

To stake your position relative to an additional string

1. Tap the additional string in the map, or select **To an additional string** in the **Stake** field and then tap **String** and select the string from the list.
2. To stake points offset from the road, leaving the roadway clear for construction, [define a construction offset](#).
3. Tap **Start**.
4. Use the [plan or cross section view](#) to navigate relative to the string. See [Stakeout navigation, page 45](#).
5. When the point is within tolerance, tap **Measure** to measure the point.
6. Tap **Store**.

The software returns to the navigation screen.

You can then:

- Continue measuring points along the road.
- Tap **Esc** to exit this stakeout method.
- Change stakeout methods. To stake:
  - **To the road**, tap an empty part of the map.
  - **To a string**, tap the string in the map.
  - A **Station on a string**, tap the station on a string in the map.

To stake a station on an additional string

1. Tap the station on the additional string in the map, or select **Station on additional string** in the **Stake** field, tap **String** to select the string from the list and then tap **Station** to select the station from the list. To select a different station, press the up or down arrow key, or tap the **Sta-** or **Sta+** softkey.
2. To stake points offset from the road, leaving the roadway clear for construction, [define a construction offset](#).
3. Tap **Start**.
4. Use the [plan or cross section view](#) to navigate to the point. See [Stakeout navigation, page 45](#).
5. When the point is within tolerance, tap **Measure** to measure the point.
6. Tap **Store**.

The software returns to the navigation screen.

You can then:

- Continue measuring points along the road.
- Tap **Esc** to exit this stakeout method.
- Change stakeout methods. To stake:
  - **To the road**, tap an empty part of the map.
  - **To a string**, tap the string in the map.

- A **Station on a string**, tap the station on a string in the map.

## To stake out additional points

1. Tap the additional point in the map, or select **Additional points** in the **Stake** field and then tap **Select** to select the additional point from the list.
2. If required, add the following features:
  - To edit the elevation, tap and hold in the map and select **Edit elevation**. To reload an edited elevation, select **Reload original elevation**.
  - To define a [construction offset](#), select **Define construction offsets** and then enter the required values.

***NOTE** – The **Vertical Offset** value specified here is not applied to a DTM surface.*

3. Tap **Start**.
4. Use the [plan or cross section view](#) to navigate to the point. See [Stakeout navigation, page 45](#).
5. When the point is within tolerance, tap **Measure** to measure the point.
6. Tap **Store**.

The software returns to the navigation screen.

You can then:

- Continue measuring points along the road.
- Tap **Esc** to exit this stakeout method.
- Change stakeout methods. To stake:
  - **To the road**, tap an empty part of the map.
  - **To a string**, tap the string in the map.
  - A **Station on a string**, tap the station on a string in the map.

## To show the station and offset relative to a reference alignment

For any stakeout method, you can select a reference alignment for which the software shows the station and offset values of your current position relative to the reference alignment. This information

is also saved in the job.

1. In the plan or cross section view, tap and hold in the screen and tap **Select reference alignment**.
2. Select the road format.
3. Select the file. The **Road name** field shows the selected road name.
4. Tap **Accept**.
5. During stakeout, a dashed line is drawn from your current position to the horizontal alignment of the reference alignment.
6. To stop using a reference alignment, tap and hold in the plan or cross section view and tap **Select reference alignment**. In the list of road formats, select **<None>**.

## To configure the available stations

To configure the stations available for stakeout in an RXL or LandXML road, select the appropriate **Available Stations** check boxes in the **Options** screen.

To view the **Options** screen, tap the **Options** softkey in the screen where you enter the **Antenna height** or **Target height** value.

Depending on the road type, you can select the following check boxes:

- **Regular Sections** (stations defined by the station interval)
- **Horiz. Curve** (key stations defined by the horizontal alignment)
- **Vert. Curve** (key stations defined by the vertical alignment)
- **Template** (stations where templates have been assigned)
- **Super/Widen** (stations where superelevation and widening has been assigned)

The station abbreviations used in the Roads software are:

Abbreviation	Meaning
CS	Curve to transition
CXS	Computed sections defined by the station interval
DXS	Design sections defined by the positions in the file
Hi	Vertical curve high point
Lo	Vertical curve low point

Abbreviation	Meaning
PC	Point of curvature (Tangent to curve)
PI	Point of intersection
PT	Point of tangent (Curve to tangent)
RE	Road end
RS	Road start
SC	Transition to curve
SEE	Superelevation end
SEM	Superelevation maximum
SES	Superelevation start
SS	Transition to transition
ST	Transition to tangent
STEQ	Station equation
T	Template assignment
TS	Tangent to transition
VCE	Vertical curve end
VCS	Vertical curve start
VPI	Vertical point of intersection
WE	Widening end
WM	Widening maximum
WS	Widening start

## Stakeout features for all road types

Depending on the selected stakeout method, you can add more features to the road or edit existing features when staking out the road.

### Plan and cross section view

To switch between the plan view and the cross section view, tap  or , or press the **Tab** key.

#### Plan view

The plan view shows:

- Horizontal alignment/master string as a red line
- Other strings as black lines
- Construction offsets as green lines
- Skew offsets as dashed black lines

#### Before stake out

Before stakeout the plan view shows:

- Construction offsets as green lines
- Skew offsets as dashed black lines

Alongside the plan view, before stakeout the software shows:

- Station (when staking a station on a string)
- String name (when staking a station on a string or measuring your position relative to a string)

For an RXL road, the software uses the string name from the template definition. When the offset is 0.000 m, the string name defaults to CL.

- Design elevation of the selected position (shown in red if edited)
- Construction offsets

- When staking a station on a string, the software also shows:
  - Type
  - Offset
  - Elevation (shown in red if edited)
- When staking a side slope, the software also shows the:
  - Design side slope values
  - Cut ditch width (RXL roads only)
- When staking a skew offset, the software also shows the:
  - Skew offset
  - Deflection angle/azimuth

#### During stakeout

During stakeout the plan view shows a dashed green line drawn from the current position to the:

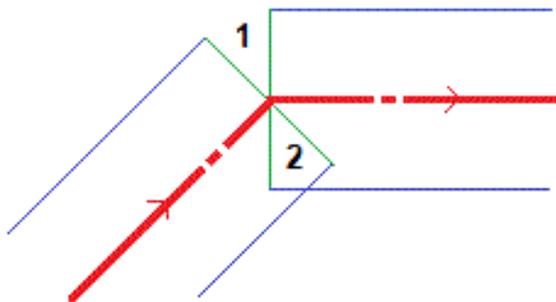
- horizontal alignment/master string when measuring your position relative to the road and you are within 30 m of the alignment/string
- selected string when measuring your position relative to a string and you are within 5 m of the string

Alongside the plan view, during stakeout the software shows:

- Elevation of your current position (shown in blue)
- When staking a side slope, the software also shows:
  - Side slope value defined by your current position (shown in blue)
  - Design side slope value (shown in red if edited)
- **Off road** appears if your current position is before the start of the road or beyond the end of the road.
- **Undefined** appears when consecutive horizontal alignment elements are non tangential and your current position is beyond the end tangent point of the incoming element but before the start

tangent point of the next element and you are on the outside of the road. See position 1 in the diagram below.

- When consecutive horizontal alignment elements are non tangential and your current position is before the end tangent point of the incoming element but after the start tangent point of the next element, and your position is on the inside of the road (see position 2 in the diagram below), the station, offset and vertical distance values are reported using the closest horizontal element to your position to determine which portion of the road to use.



### Cross section view

The cross section that appears is orientated in the direction of increasing station. Your current position and the target are shown. If the target has construction offsets specified, the smaller single circle indicates the selected position and the double circle indicates the selected position adjusted for the specified construction offset(s). The construction offset(s) appear as green lines.

When you view the cross section, the appropriate cut or fill side slope appears for the side of the road that you are currently on.

**NOTE** - If you have set the **Design cut/fill** field to **Perpendicular** in the **Stakeout options** screen, the perpendicular cut/fill position is drawn on the design in the cross section view only when measuring positions relative to the road. Because the cross section view is not drawn to scale, the perpendicular position may appear slightly incorrect (ie. not exactly perpendicular).

Tap and hold in the cross section view to define a [cross slope](#) or [subgrade](#).

### Current position information

The base of the plan view or cross section view reports your current position relative to the item being staked:

- To select the delta display, tap the arrow to the left of the navigation deltas.
- Tap **Options** for further delta display options.

### **NOTE -**

- *If you are using a conventional instrument, the road values only appear after you take a distance measurement.*
- *If the road consists of only a horizontal and vertical alignment the **V.Distance** value reports the vertical distance to the vertical alignment.*
- *If your position is in a gap, the V. Dist value is null. Gaps are shown as a dashed line in the cross section view. To see how to create a gap in a template, see [To add templates, page 17](#).*

### GNSS tilt sensor information

When using a GNSS receiver with a built-in tilt sensor, you can:

- Tap **eBubble** to display an electronic bubble
- Configure the survey style to prompt a warning when the pole is outside a specified **Tilt tolerance**
- To configure quality control, precision, and tilt settings, tap **Options**.

### Stakeout navigation

During stakeout the software helps you to navigate to the selected position on the road. The display orientation assumes you are moving forwards at all times.

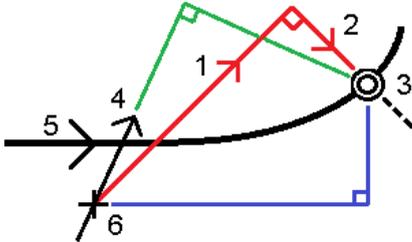
### Stakeout display orientation

Select the display orientation when defining your survey style or, when in a survey, from the **Options** softkey. The options are:

- Direction of travel – the screen will orientate so that the top of the screen points in the direction of travel.
- North – the screen will orientate so that the north arrow points up the screen.
- Reference azimuth – the screen will orientate to the azimuth of the road.

### Understanding the navigation directions

As shown in the diagram below, the values in the **Go Forward/Go Backward (1)** and **Go Right/Go Left (2)** fields are relative to the cross-section of the point that you are staking out **(3)**. They are *not* relative to the current direction of travel **(4)**, or to the direction of increasing station **(5)** at your current position **(6)**.

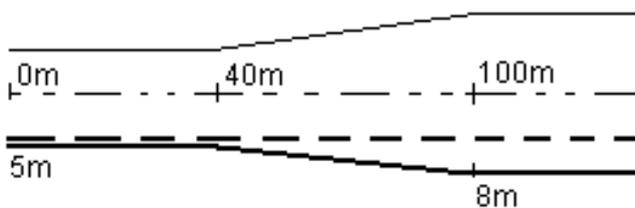


### Keyed in and selected offset/feature behavior

The behavior at stake out differs depending on whether the offset/string was selected graphically, selected from a list, or keyed in.

- If you graphically select a string or select a string from the list, the Go Right/Go Left value at stakeout updates to reflect any changes in geometry due to template changes or widening.
- If you key in a numeric offset value (effectively defining a string on the fly) that value is maintained for the entire length of the road.

Consider the following diagram:



If you select an offset/string that has an offset value of 5 m, the offset value updates to follow the solid line for subsequent stations. In this example, the offset changes from 5 m to 8 m between stations 40 m and 100 m and then is maintained at 8 m for subsequent stations.

If you key in 5 m for the offset, the offset follows the dashed line. That is, the offset of 5 m is maintained for subsequent stations.

## To navigate to the point in a conventional survey

If you are using the **Direction and distance** mode:

1. Hold the display screen in front of you as you walk forwards in the direction that the arrow is pointing. The arrow points in the direction of the point that you intend to measure (the "target").
2. When you get to within 3 meters (10 feet) of the point, the arrow disappears, and the in/out and left/right directions appear, with the instrument as a reference point. Follow the instructions below to navigate in this mode.

If you are using the **In/out and left/right** mode:

1. The first display shows which way the instrument should be turned, the angle that the instrument should display and the distance from the last point staked to the point currently being staked.
2. Turn the instrument (two outline arrows will appear when it is on line), and direct the person holding the pole on line.

If you are using a servo instrument, and the **Servo auto turn** field in the survey style is set to **HA & VA**, or **HA only** the instrument automatically turns to the point. If you are working robotically, or when the **Servo auto turn** field in the survey style is set to **Off**, the instrument does not turn automatically.

3. If the instrument is not in **TRK** mode, tap **Measure** to take a distance measurement.
4. The display shows how far the person holding the pole should move towards or away from the instrument.
5. Direct the person holding the pole, and take another distance measurement.
6. Repeat steps 2–5 until the point has been located (when four outline arrows are displayed), then mark the point.
7. If a measurement to the target is within the angular and distance tolerances, tap **Store** at any time to accept the current measurement. If the instrument is in **TRK** mode and you require a higher precision distance measurement, tap **Measure** to take an **STD** measurement and then tap **Store** to accept that measurement. To discard the **STD** measurement and return the instrument to **TRK** mode, tap **Esc**.

If you are operating a robotic instrument remotely from the target:

- the instrument automatically tracks the prism as it moves
- the instrument continuously updates the graphical display
- the graphical display is reversed and the arrows are shown from the target (prism) to the instrument

### To navigate to the point in a GNSS survey

1. Hold the display screen in front of you as you walk forwards in the direction that the arrow is pointing. The arrow points in the direction of the point that you intend to measure (the "target").
2. When you get to within 10 feet (3 meters) of the point, the arrow disappears and a bull's-eye target appears.

When the bull's-eye target is displayed, do not change your orientation. Keep facing in the same direction and only move forwards, backwards, left or right.

3. Continue moving forwards until the cross, representing your current position, covers the bull's-eye target, representing the point. Mark the point.

### To stake out relative to a DTM

You can display the cut/fill to a digital terrain model (DTM) during stakeout, where the horizontal navigation is relative to the road but the displayed cut/fill delta value is from your current position to a selected DTM.

1. At the stakeout screen, tap the **Options** softkey.
2. In the **Deltas** group box, tap **Edit** and, if required, select the **DTM elevation** delta. Tap **Accept**.
3. In the **DTM** group box, select the DTM.
4. If required, in the **Offset to DTM** field, specify an offset to the DTM. Tap **▸** and select whether the offset is to be applied vertical or perpendicular to the DTM. The **V.Dist DTM** value is to the offset position.
5. Stake out the road as usual.

**NOTE** – When a horizontal construction offset is applied, the cut/fill value reported is to the DTM at the position selected for stakeout and not to the DTM at your current position.

When viewing the cross section, the DTM is displayed at your current position as a green line. A circle on the DTM indicates your position projected vertically to the surface.

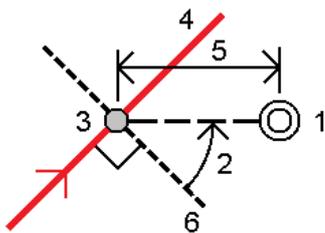
**TIP** - To check layer thickness when constructing a road, define a DTM for the previous layer and then when staking out the current layer, tap **Options** and in the **Deltas** group box, tap **Edit** and select the **V.Dist DTM** delta.

## To stake out a skew offset

Use this stakeout method to stake out a position that is not defined at a right angle to the horizontal alignment/master string, for example when staking culverts or bridge abutments.

### Example skew offset

The diagram below shows a point defined by skew forward and offset to the right. The point to stake (**1**) is defined from the station (**3**) by an offset (**5**) along the skew (**2**). The skew can be defined by a forward or backward delta angle to a line (**6**) at right angles to the road being staked (**4**) or, alternatively, the skew can be defined by an azimuth.



## To stake out a position at a skew offset

1. In the **Stake** field, select **Skew offset**. Tap **Station** to select the station on the horizontal alignment/master string that the skew offset will be applied from.

**TIP** - To stake out a skewed offset relative to a nominal station value (where the station does not have to coincide with a cross section), select any station on the horizontal alignment/master string and then tap and hold in the map and tap **Select station** and key in a station value.

2. To define the skew offset:
  - a. Tap **Skew offset**.
  - b. Enter the **Offset** and **Skew** values. Tap ► to change the offset or skew direction.

c. To define the elevation for the point, select:

- **Slope from string** to compute the elevation by a slope from the elevation on the string at the selected station
- **Delta from string** to compute the elevation by a delta from the elevation on the string at the selected station.
- **Key in** to key in the elevation.

If the road only has a horizontal alignment/master string, you must key in the elevation.

d. Tap **Accept**.

3. To stake points offset from the road, leaving the roadway clear for construction, [define a construction offset](#).
4. Tap **Start**.
5. Use the [plan view](#) to navigate to the point. See [Stakeout navigation, page 45](#).
6. When the point is within tolerance, tap **Measure** to measure the point.

## Construction offsets

To stake positions offset from the road, leaving the roadway clear for construction, define one or more construction offsets for the road. The construction offset is applied to all positions in the road.

In the plan or cross section view, a construction offset is indicated by a dashed green line, and a solid green circle indicates the selected position adjusted for the construction offsets.

When you define a construction offset for a road, the offset is:

- used for all roads of the same file format in the same job.
- used for all subsequent surveys of the road in the same job, until a different construction offset is defined.
- not used for the same road when it accessed from a different job.

To define a construction offset, tap and hold in the plan view or cross section view and select **Define construction offsets**.

## Horizontal construction offsets

When staking to a string or when staking stations on a string, you can define a horizontal construction offset where:

- A negative value offsets points to the left of the horizontal alignment/master string.
- A positive value offsets points to the right of the horizontal alignment/master string.

For all other strings, including side slope strings, you can define a horizontal construction offset where:

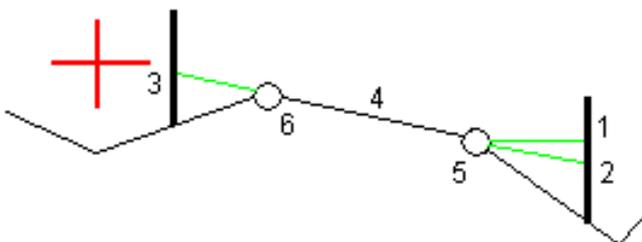
- A negative value offsets points toward the horizontal alignment/master string (in).
- A positive value offsets points away from the horizontal alignment/master string (out).

**NOTE** - When staking a side slope with construction offsets where you wish to store a position at the catch and the offset position, select the **Store both catch and construction offset** check box when defining the construction offset. See [Catch point](#).

Tap **▶** next to the **Horizontal offset** field to specify if the offset is to be applied:

- Horizontally
- At the slope of the line from the previous string to the current string in the cross section
- At the slope of the line from the current string to the next string in the cross section

The following diagram shows a **Horizontal offset (1)**, **Slope previous offset (2)** and **Slope next offset (3)** applied to a position. For the **Slope previous** option, the slope of the offset is defined by the slope of the line (4) before the position (5) selected to stake. For the **Slope next** option, the slope of the offset is defined by the slope of the line (4) after the position (6) selected to stake. The **Vertical offset** value in the diagram is 0.000.



**NOTE** - For points with zero offset, you cannot apply horizontal construction offsets at the slope value of the previous line.

When measuring positions relative to a string (except by the **Measure nearest string** option) or staking stations on a string, you can define a horizontal construction offset by your current position. To do this:

1. Tap ► next to the **Horizontal offset** field and select **Calculated**.
2. Navigate to the position you want to place the stake.

The **Go left / Go right** navigation delta is replaced by the distance to the horizontal alignment when the horizontal offset is **Calculated**.

3. Measure and store the point.

The calculated horizontal offset is reported in the **As staked deltas**.

### Vertical construction offsets

You can define a vertical construction offset where:

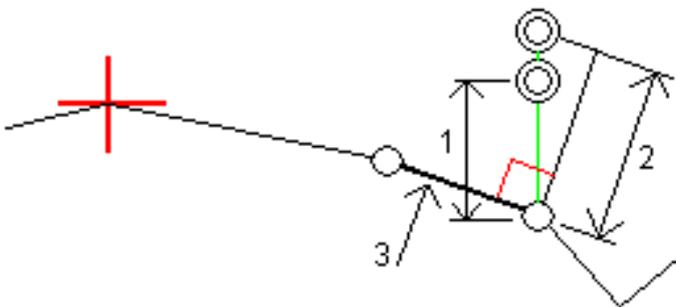
- A negative value offsets points vertically down.
- A positive value offsets points vertically up.

The **Vertical Offset** value is not applied to a DTM surface.

Tap ► next to the **Vertical offset** field to specify if the offset is to be applied:

- Vertically
- Perpendicular to the element in the cross section before the point being staked

The following diagram shows a **Vertical offset** applied vertically **(1)** and a **Vertical offset** applied perpendicular **(2)** to the previous cross section element **(3)**.



### Side slopes

In some situations, you may need to add or edit the side slope.

**NOTE** – The side slope, and any edits to the side slope, are discarded after a position is measured or when you exit the stakeout screen.

### Adding a side slope

You can add a side slope when staking a station on a string or measuring your position relative to a string. The current string is, by default, the hinge string but you can [select a different string as the hinge string](#) if required. You cannot add a side slope to the alignment.

1. At the stakeout screen, tap and hold in the [plan or cross section view](#) and select **Add side slope**.
2. Complete the details defining the side slope.

**NOTE** – Adding a side slope at stakeout is available only for an RXL road. However, when defining a GENIO road you can add a new string and then edit its type to be an **Interface 5D string**, which effectively adds a side slope.

### Editing a side slope

If the design cut or fill slope value or the cut ditch width value is not applicable, overwrite the value with a new one.

1. At the stakeout screen, tap and hold in the [plan or cross section view](#) and select **Edit side slope**.
2. Complete the details defining the side slope.

In some situations, it may be preferable to adjust the cut or fill slope value to the value defined by the slope from the current string to the next string or from the previous string to the current string. In either the **Cut slope** field or the **Fill slope** field, select **Slope to next string** or **Slope from previous string**. The **Slope** field updates with the appropriate slope value.

[The example below](#) shows where you might select the **Slope to next string** or **Slope from previous string** option for a cut slope. A similar approach can be used for a fill slope.

**NOTE** – The next or previous string slope options are available:

- Only if a next or previous string exists.
- In the **Cut slope** field, the options are available only if the next or previous slope values are positive, that is, if they define a cut slope.
- In the **Fill slope** field, the options are available only if the next or previous slope values are negative, that is, if they define a fill slope.

Sometimes, particularly for LandXML road files, the side slope may specify only one slope value, where the other is null (?). If, when staking a side slope, the design and calculated side slope values at the top of the navigation screen are null, this indicates that the undefined slope value is required to stake the catch. Use the **Edit side slope** option to specify the slope value to enable the catch to be staked.

You can also:

- change the string name.
- [select a different string as the hinge string](#), if required.

A side slope is shown in red if edited.

The [diagram](#) below shows a typical example of where you might use these options.

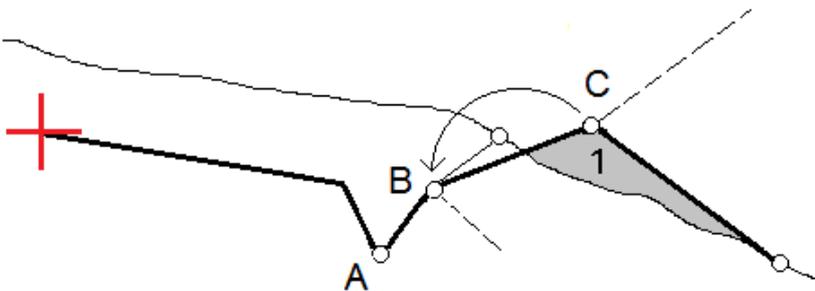
#### Selecting a different string as the hinge string

1. At the stakeout screen, tap and hold in the plan or cross section view and select **Edit Side Slope**.
2. From the **Hinge string** field tap the arrow and then select a string by one of these methods:
  - Tap a string on the screen
  - If appropriate for your controller, use the left/right arrow keys
  - Tap and hold on the screen and select the string from the list

The current hinge string is shown as a solid blue circle.

#### Example - select hinge string and edit side slope

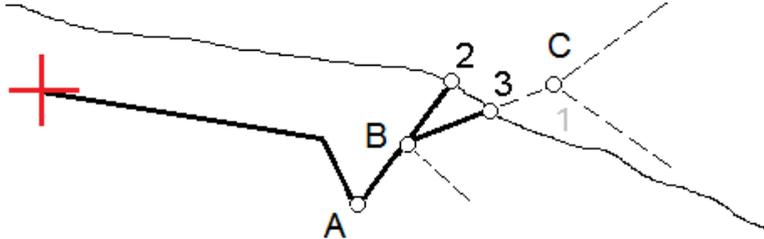
The diagram below shows a typical example of where you might select a different string as the hinge string. In this example, the original design with the hinge at string **C** is in fill, resulting in an unwanted fill zone **(1)**. By selecting string **B** as the hinge string, the new design is now in cut and the unwanted fill zone is avoided.



With string **B** selected as the hinge string, the cut slope can be defined by either retaining the design slope value or keying in another value. Alternatively, the cut slope can be defined by selecting one of the following:

- **Slope from previous string** option to define the cut slope as the slope from the previous string **A** to the new hinge string **B**, resulting in a catch position at **(2)**.

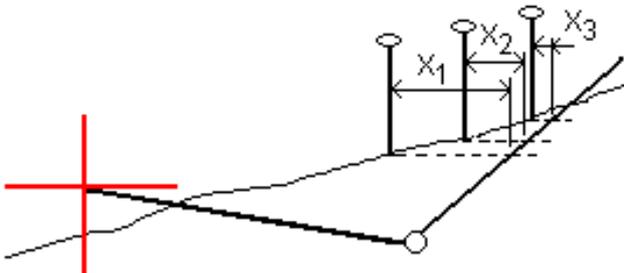
- **Slope to next string** option to define the cut slope as the slope from the new hinge string **B** to the next string **C**, resulting in a catch position at **(3)**.



## Catch point

The catch point is the point where the design side slope intersects with the ground.

The actual intersection position of the side slope with the existing ground surface – the catch point – is determined iteratively (by repetition). The software calculates the intersection of a horizontal plane passing through the current position, and either the cut or fill side slope, as shown in the following diagram, where  $x_n$  is the **Go Right/Left** value.



The plan view shows the calculated catch position. The calculated slope value (in blue) and the design slope value appears at the top of the screen.

The cross section is displayed looking in the direction of increasing station. Your current position and the calculated target are indicated. A line is drawn (in blue) from the hinge position to your current position to indicate the calculated slope.

Green lines indicate if the catch point has construction offsets specified. The smaller single circle indicates the calculated catch position and the double circle indicates the selected position adjusted for the specified construction offset(s). The construction offsets appear only after you have applied them.

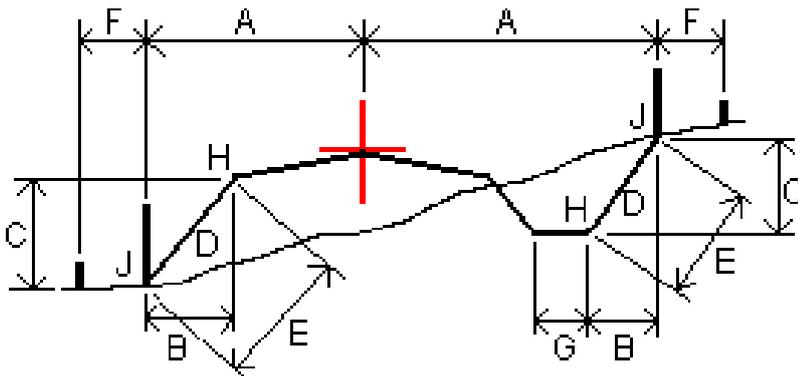
**NOTE** – For side slope offsets where the slope changes between templates, the software calculates the side slope for intermediate stations by interpolating the slope value.

### Catch point staked deltas

To view the **Catch point deltas report** screen, tap **Report** in the **Confirm staked deltas** screen or **Review job** screen.

The horizontal and vertical distances from the catch point to each string are shown, up to and including the horizontal alignment. If the template includes a cut ditch, the report includes the hinge position at the toe of the cut slope. The reported values exclude any construction offset specified.

See the diagram below:



Where:

A	=	Distance to horizontal alignment
B	=	Horizontal distance to hinge point
C	=	Vertical distance to hinge point
D	=	Slope
E	=	Slope distance to hinge point
F	=	Horizontal construction offset
G	=	Ditch offset
H	=	Hinge point
J	=	Catch point

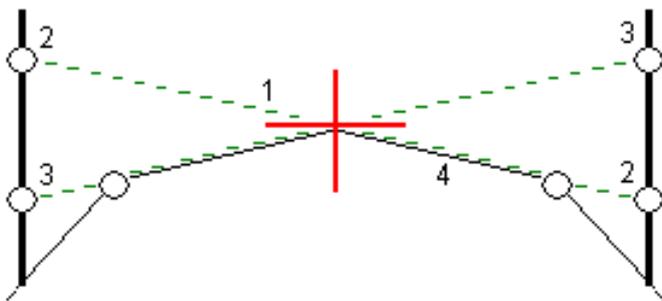
**NOTE -**

- When you stake a fill side slope with a subgrade, the as staked deltas include the distance from the catch to the intersection of the subgrade with the side slope.
- The value in the **S.Dist to hinge + Constr off** field includes any construction offset values specified and reports the slope distance from the hinge to the as-staked position. The value is null (?) if there is no horizontal construction offset specified or the horizontal construction offset is applied horizontally.

## Cross slopes

Define a cross slope when you need to confirm the construction of a road surface – typically the carriageway.

Refer to the following diagrams:



Typically a wire (1) is stretched from one side of the road to the other fixed at position (2) on each stake. The wire is then checked to see that it lies on the formed road surface (4). The process is then repeated for the other side of the road by fixing the wire to the stakes at position (3). The cross slope can be offset vertically so that the wire is above the surface making it easier to confirm the construction. If the cross slope is offset, the measured distance from the wire to the surface should be consistent. The cross slope option reports the deltas, enabling the stake to be marked up with positions (2) and (3).

**NOTE -**

- A cross slope must be defined in the cross section view.
- A cross slope cannot be defined when measuring your position relative to the road or when staking a side slope.

## To define a cross slope

1. From the cross section view, define a horizontal construction offset, typically at **Slope previous**, and enter a vertical offset if required.

The smaller single circle **(8)** indicates the selected position and the double circle **(6)** indicates the selected position adjusted for the specified construction offsets. The construction offset(s) appear as a green line **(7)**.

2. Tap the line **(1)** that will define the cross slope. The selected line appears as a bold green line.

**NOTE** - You cannot select a line that defines a side slope to define a cross slope.

3. From the pop-up menu, select **Define cross slope**, enter a **Cross slope offset** if required, and tap **OK**.

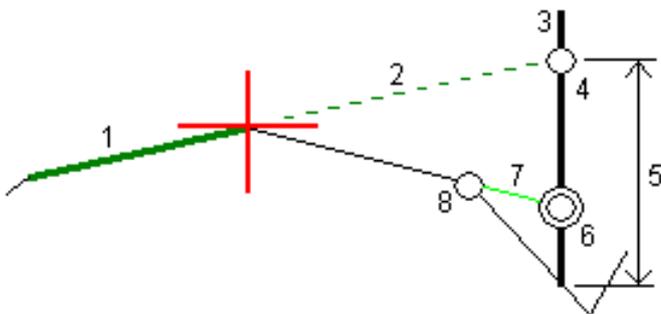
A dashed green line **(2)** extends from the selected line to intersect with a vertical line **(4)** at the target stake **(3)**.

4. Tap **Start**.

5. Navigate to the target and then stake the position.

6. Use the **V.Distance cross slope** value **(5)** to mark the stake with the second position.

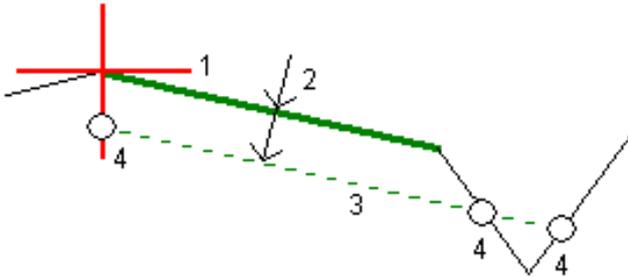
**NOTE** - To de-activate the cross slope function, tap the selected line **(1)**.



## Subgrades

Define a subgrade when the cross section represents the finished road surface and you need to stake the points defining other surfaces in the road – typically the subgrade.

Subgrade points are computed by creating a temporary line that is parallel to, and offset from, a line between two strings in the cross section. The points can then be selected for stakeout:



**NOTE** - You must be in the cross section view to define a subgrade. You cannot define a subgrade from the Stakeout method screen or when measuring your position relative to a road or a string.

### To define a subgrade

1. From the cross section view, tap the line **(1)** that will define the subgrade. The selected line appears as a bold green line.

**NOTE** - You cannot select a line that defines a side slope to define a subgrade.

2. From the pop-up menu, select **Define subgrade**, enter the depth to subgrade **(2)** where the depth is from the selected line to the subgrade surface, and tap **OK**.

A dashed green line **(3)** extends to intersect with all encountered lines in the cross section. If no intersection(s) are found, computed points are created at the same start and end offsets as that of the selected line. The single circles **(4)** indicate the computed positions.

3. Tap **Start**.
4. Tap the position that you want to stake.
5. Navigate to the target and then stake the position.
6. To exit the subgrade function, tap the selected line **(1)**.

## Reports

Use the **Reports** function in the software to generate reports from survey data. Use these reports to check data in the field, or to transfer data from the field to your client or to the office for further processing with office software.

### Roads stakeout reports

To display the **Confirm staked deltas** screen before you store a point, select the **View before storage** check box in the **Stakeout options** screen and then select the required format in the **Stakeout deltas format** field.

When staking out roads, in addition to the usual translated stakeout reports provided by Origin, the following stakeout reports are available:

#### Road – Catch + offsets

Provides details of all the standard road staked deltas plus a list of the horizontal and vertical distances to each of the cross-section positions from the staked offset position. The reported horizontal and vertical distances include the applied horizontal and vertical construction offsets.

Provides details of all the standard road staked deltas plus a list of the horizontal and vertical distances to each of the cross-section positions from the staked offset position. The reported horizontal and vertical distances include the applied horizontal and vertical construction offsets.

#### Road – Stake markup

Provides a simplified stakeout display that presents the vertical distance (cut/fill) to the road design position. Appropriate station and offset values and cross-section details (in the case of catch point staking) are reported, based on the road stakeout method.

#### Road – XS details

Provides all the standard road staked deltas details as well as a list of the cross-section elements (left and right) that define the design cross-section at the selected station.

### To generate a report

1. Open the job that contains the data to export.
2. Tap  and select **Report**.

3. In the **File format** field, specify the type of file to create.
4. Tap  to select an existing folder or create a new one.
5. Enter a filename.

By default, the **File name** field shows the name of the current job. The filename extension is defined in the XSLT style sheet. Change the file name and extension as required.

6. If more fields are displayed, complete them.

You can use the XSLT style sheets to generate files and reports based on parameters that you define. For example, when generating a Stakeout report, the **Stakeout horizontal tolerance** and the **Stakeout vertical tolerance** fields define acceptable stakeout tolerances. When generating the report you can stipulate the tolerances, then any stakeout delta greater than the defined tolerances appears in color in the generated report.

7. To automatically view the file after you create it, select the **View created file** check box.
8. To create the file, tap **Accept**.

Alternatively, export the job as a JobXML file and then use the ASCII File Generator utility to create the report from the exported JobXML file, using the required XSLT style sheet as the output format. To download the utility, go to [Spectra Geospatial Origin Downloads page](#) and click **Spectra Geospatial File and Report Generator Utility**.

# Legal information

[www.spectrageospatial.com](http://www.spectrageospatial.com)

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This product includes software developed by the OpenSSL Project for use in the OpenSSL Toolkit ([www.openssl.org/](http://www.openssl.org/)).

Spectra Geospatial Origin includes a number of open source libraries.

For more information, see [Open source libraries used by Spectra Geospatial Origin](#).