Working with Superelevations

TRIMBLE BUSINESS CENTER TUTORIAL

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About this tutorial

"Superelevation" is the banking of a road along a horizontal curve so motorists can safely and comfortably maneuver the curve at design speed. As speeds increase and horizontal curves become tighter, a steeper superelevation rate is required.

In this tutorial, you will define a superelevation for an alignment used for a curved road. You will then apply the superelevation properties to the road as corridor template instructions. Finally, you will define rollover parameters for the road to ensure that slope differences between segments (for example, a driving lane and a shoulder in a superelevated curve) are kept to a minimum for safety and comfort at design speed.

Notes:

- To create a superelevation as described in this tutorial, you must be running **Trimble Business Center** software with the ***Survey Advanced*** product license. To verify the product license for your installation, select **Help > About Trimble Business Center** and click the **License** button. Licensed features are displayed in the **Features** list.
- If you do not already know how to work with corridors and specify corridor template instructions, it is recommended that you complete the tutorial ***Working with Corridors*** before proceeding with this tutorial.
- If you need additional help at any time you are using the software, press **F1** to display the online help.

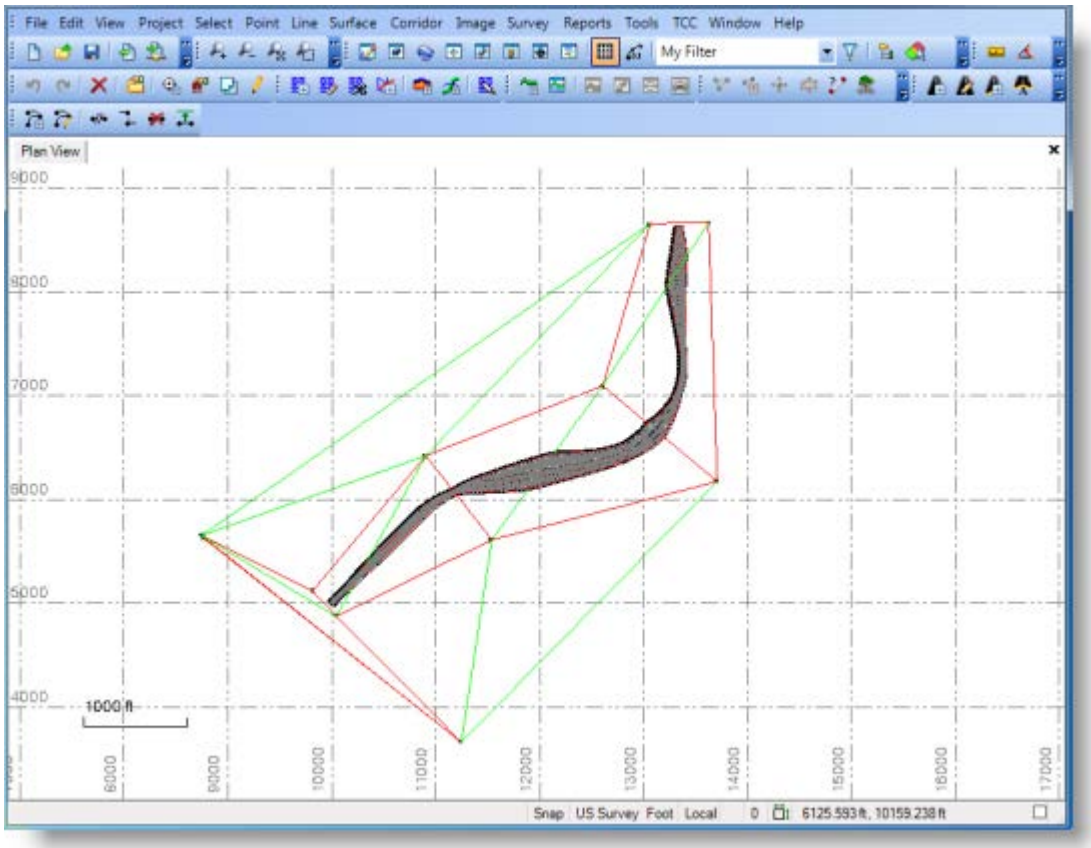
Step 1. Open the project

For this tutorial, you will use the project file *Working with Superelevations.vce*. This project contains a surface, a horizontal and vertical alignment, and a corridor.

1. On the **Trimble Business Center** menu bar, select **File > Open Project**. Or, click the **Open Project** icon on the toolbar.
2. In the **Open File** dialog, browse to ***C:\Trimble Tutorials\TBC\Projects\Working with Superelevations.vce*** and click **Open**.

   If you installed the tutorial to a location other than the default location shown here, browse to that location.

The project opens in the **Trimble Business Center** window.



Note: This figure shows the **Plan View** with a white background. Your background may be black. If you want to change it to white, select **Tools > Options** and select **Background color: White** in the **Options** dialog.

The project file is read-only. You can perform the tutorial steps without saving the project file. However, if you are interrupted while performing the tutorial, you can save it by selecting **File > Save Project As** and saving it to ***..\My Documents\Trimble Business Center***, which is the typical location for storing project files on your computer. Then, you can re-open the project to continue the tutorial at a later time.

Step 2. Apply superelevation to the alignment

The horizontal alignment in this project includes two arc curves, one of which includes a spiral in and a spiral out. For this tutorial, you will start by applying a superelevation to the two curves to define slope changes (banking) through the curve. Later, you will add superelevation instructions to a corridor template.

Note: For a more detailed description of superelevations, see the "Understanding Superelevations" topic in the online help.

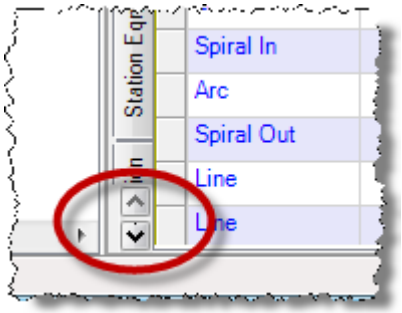
1. Select **View > Project Explorer**.

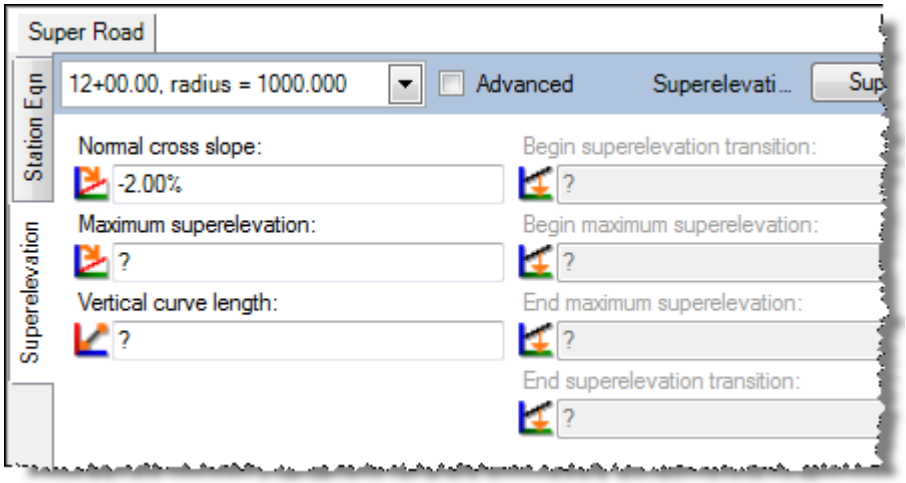
2. In the **Project Explorer**, expand the **Alignments** node . Then right-click *Super Road* and select **Edit**.

   The **Alignment Editor** pane displays in the lower area of the window.

3. Select the **Superelevation** tab in the left side of the **Alignment Editor** pane.

   If necessary, use the tab scroll control to display the **Superelevation** tab for selection.





The drop down list located at the top of the tab allows you to select each curve in the horizontal alignment so that you can define superelevation parameters for it. For each curve, the start station and radius for the curve are displayed.

You will start by defining superelevation parameters for the first curve in the alignment, which is a simple arc curve.

4. In the drop-down list, select the first curve: *12+00.00, radius = 1000.000.* Then enter the following parameters:

   a. In the **Normal cross slope** field, ensure the value is *-2.00%*.

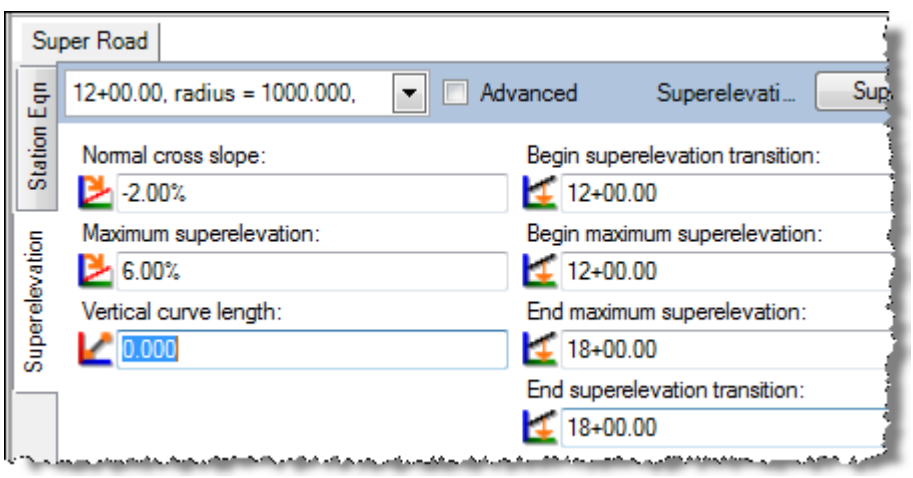
      This value represents the normal cross slope of the road when not in superelevation and is referenced by all of the superelevated curves in the alignment. Any changes you make to this field affect all of the superelevated curves. If you delete the normal cross slope, the superelevation is removed from the alignment.

Note: The normal cross slope value you enter is used in the **Superelevation Diagram** view. It does not replace the slope value specified in the corridor template instructions.

   b. In the **Maximum superelevation** field, enter *6*.

      When you move the cursor to another field or press the **Tab** key, the value *6* changes to *6.00%*. This is the maximum rate of superelevation for the curve in terms of percent slope.

      The program automatically enters values for the fields on the right side of the tab based on a maximum superelevation of 6.00% and the fact that this is a simple arc curve. Because the arc has no spiral in and spiral out, the program uses the arc parameters for the superelevation transitions. This means that there is no transitioning from the normal crown to full superelevation, and back to the normal crown. The change is abrupt. You will correct this later.



   c. In the **Vertical curve length** field, enter *100*.

      This value specifies the length of the parabolic vertical curve that will be applied at each beginning or ending station transition point in the superelevated curve to smooth the transition. The transition point is the PVI (point of vertical intersection) for the vertical curve. The software also draws these vertical curves in the superelevation diagram at these transition points.

You are now ready to define parameters for the second curve in the horizontal alignment, which is an arc curve with a spiral in and a spiral out.

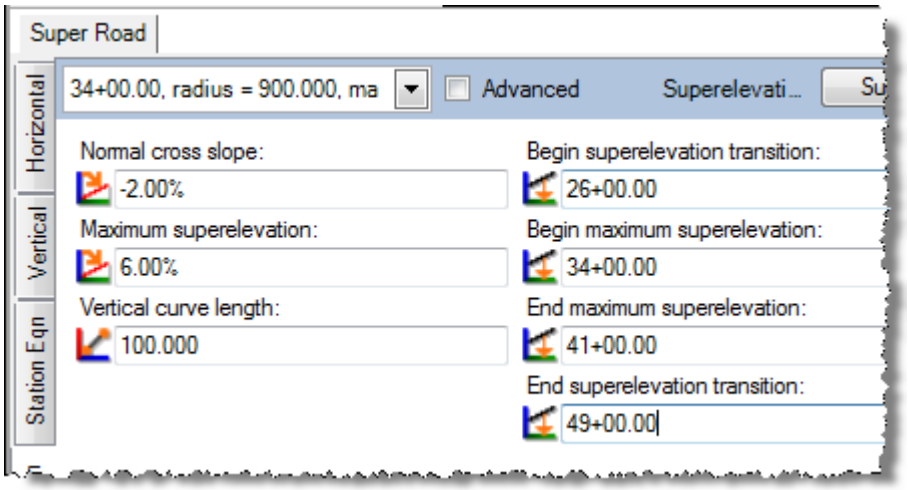
5. In the drop-down list, select the second curve: *34+00.00, radius = 900.000.* Then, enter the following parameters:

   a. In the **Normal cross slope** field, ensure the value is *-2.00%*.

   b. In the **Maximum superelevation** field, enter *6*.

   c. In the **Vertical curve length** field, enter *100*.

   The values automatically entered in the fields on the right side of the tab are based on a maximum superelevation of 6.00% and the fact that this is an arc curve with a spiral in and spiral out. The program uses the spiral in, arc, and spiral out values to fill-in the superelevation transition station values.



- **Begin superelevation transition** specifies the station at which the transition from the normal crown to the maximum superelevation of 6% slope begins.
- **Begin maximum superelevation** specifies the station at which the maximum superelevation of 6% slope begins.
- **End maximum superelevation** specifies the station at which the maximum superelevation of 6% slope ends and the transition back to the normal crown begins.
- **End superelevation transition** specifies the end of the transition from maximum superelevation of 6% slope back to the normal crown.

The following figures show the transition from the normal crown to the maximum superelevation, and back to the normal crown through a superelevated curve.

On approach:

Start with normal crown.

Transition to where the outside lane has zero (flat) cross slope.

Transition to where the crown has been removed.

Maximum superelevation.

On departure:

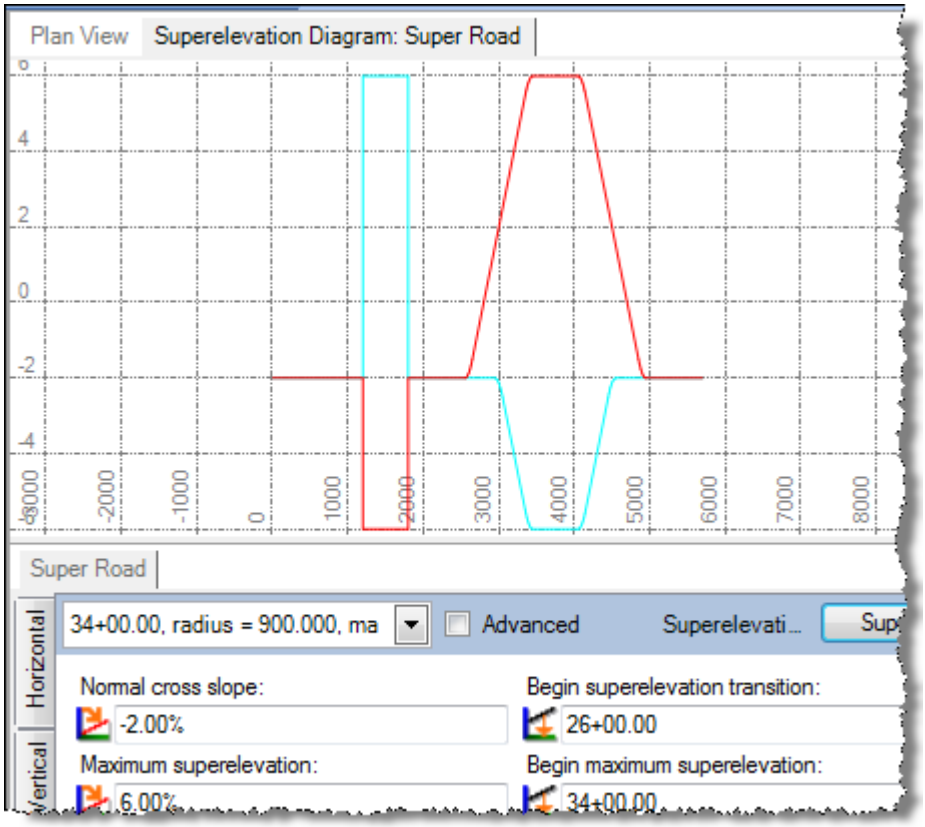
Transition back to where crown has been removed.

Transition back to where the outside lane has zero (flat) cross slope.

Back to normal crown.

You will now take a look at the superelevation you have defined in the **Superelevation Diagram** view.

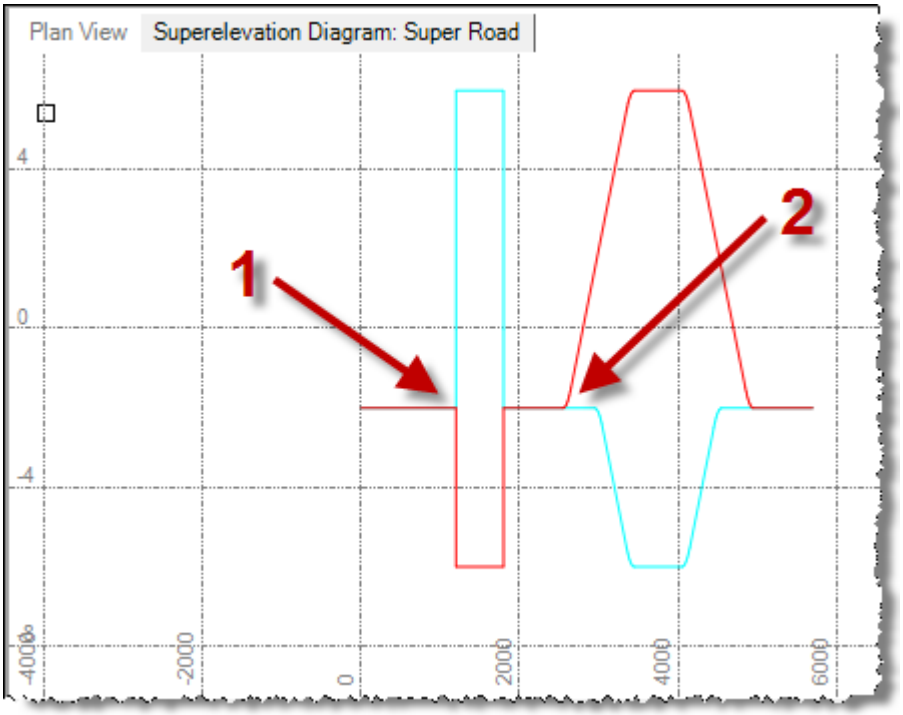
6. Click the **Superelevation Diagram** button located at the top of the **Superelevation** tab. Then, right-click the **Superelevation Diagram** tab and select **Move to Previous Tab Group**.



The diagram includes grid lines against which the superelevation profile is displayed. Vertical grid lines represent stations in the alignment. Horizontal grid lines represent degrees of slope. The two colored lines, which make up the superelevation profile, represent the inside and outside edges of the road. The diagram is updated automatically as you make changes on the **Superelevation** tab.

Note: You can change the plot scale and vertical exaggeration for the diagram in the **Project Settings** dialog.

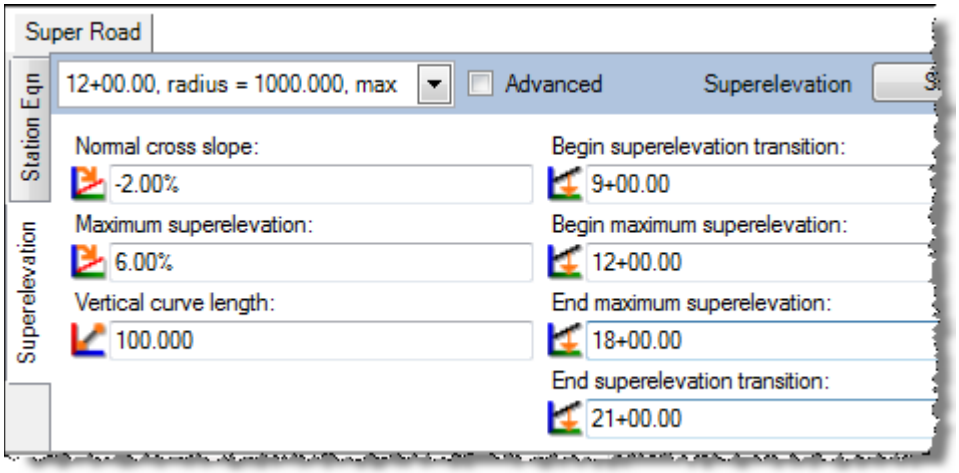
You can see in the diagram that the second curve (2 in the following figure), which is an arc with a spiral in and spiral out, includes a transition from the normal crown to the maximum superelevation, and back to the normal crown. The first curve (1 in the following figure) does not include spirals, so the program did not specify transitions for it. Instead, the curve changes abruptly from normal crown to maximum superelevation. You will correct this in the next step.



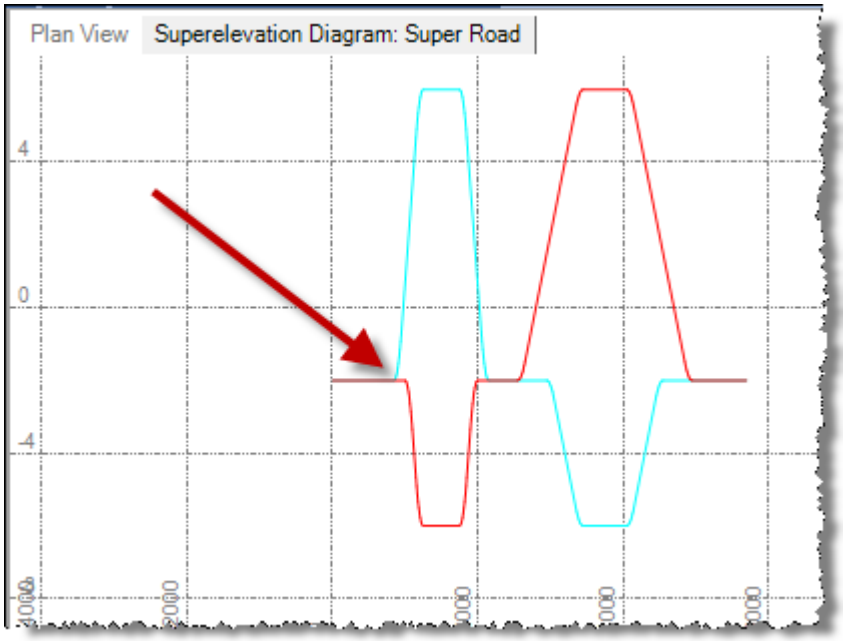
7. In the drop-down list on the **Superelevation** tab, select the first curve: *12+00.00, radius = 1000.000.* Then enter the following parameters:

   a. In the **Begin superelevation transition** field, enter *900*.

   b. In the **End superelevation transition** field, enter *2100*.



The first curve now shows a transition from the normal crown to maximum superelevation, and back to the normal crown.

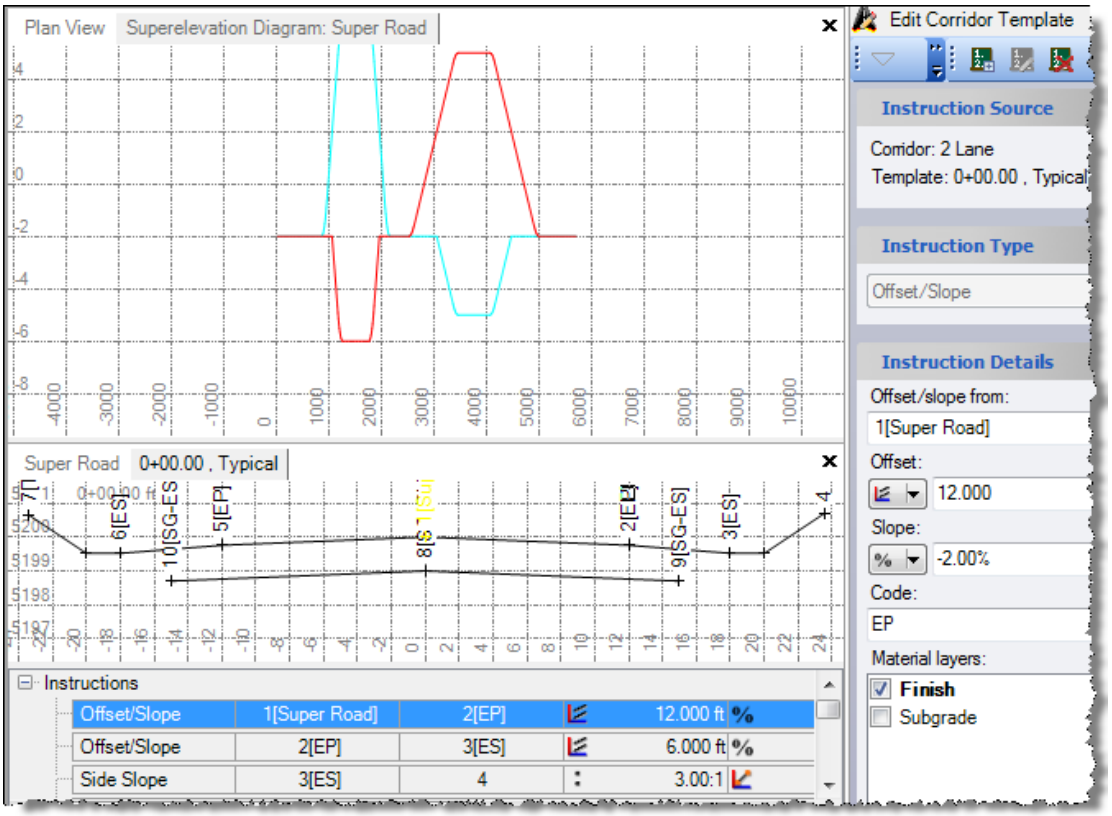


You are done applying superelevation to the horizontal alignment. Next, you will add superelevation instructions to a corridor template.

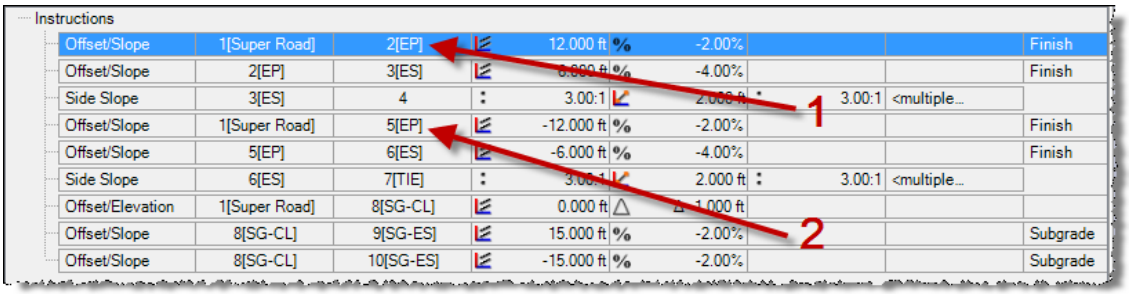
Step 3. Add superelevation instructions to a corridor template

1. In the **Project Explorer**, expand the **Corridors** node and the *2 Lane* node. Then, right-click *0+000, Typical* and select **Edit**.

The **Edit Corridor Template** pane displays.



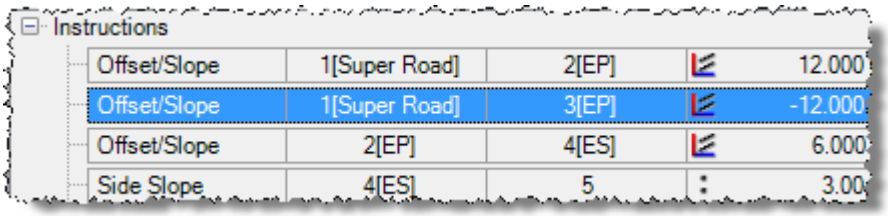
The template includes nine instructions that define nodes for Finish and Subgrade material layers.



Nodes *2[EP]* (1 above) and *5[EP]* (2 above), which are the right and left edge-of-pavement nodes for the Finish layer, need to be superelevated. Therefore, a Superelevation instruction must be inserted in the **Instructions** list immediately following the two instruction(s) that define these nodes. So, to start, you will move the instruction that defines node *5[EP]* to directly beneath the instruction that defines node *2[EP]*.

2. In the **Instructions** list, click and drag the instruction that defines node *5[EP]* to directly beneath the instruction that defines node *2[EP].*

Note that the node name changes from *5[EP]* to *3[EP]*.

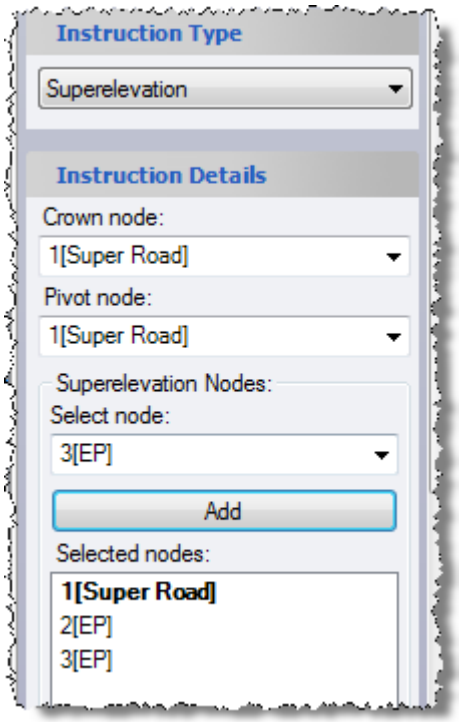


Now you can insert a new Superelevation instruction immediately following the instruction that defines node 3*[EP].*

3. To insert a Superelevation instruction for the Finish layer, do the following:
   a. Select the instruction that defines node *3[EP]* in the **Instructions** list.
   b. Click the **Add instruction** icon located at the top of the **Edit Corridor Template** pane.
   c. In the **Instruction Type** drop-down list, select **Superelevation**.
   d. In the **Crown node** list, select *1[Super Road]*.
   e. In the **Pivot node** list, select *1[Super Road]*.

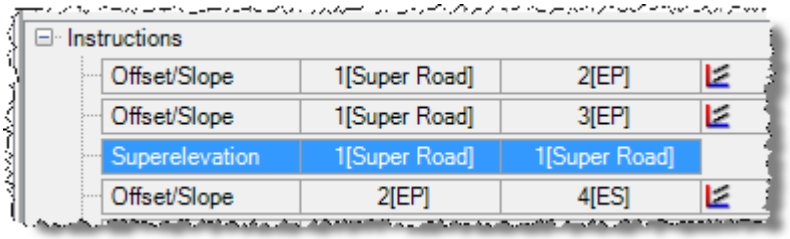
      This is the node about which the superelevated slope will pivot. This node is automatically added to the **Selected nodes** list.
   f. In the **Select node** drop down list, select *2[EP]* and click the **Add** button to add it to the **Selected** nodes list.

      Optionally, click in the **Select node** field and then select the *2[EP]* node in the template graphic view.
   g. In the **Select node** drop-down list, select *3[EP]* and click the **Add** button located directly beneath the list.



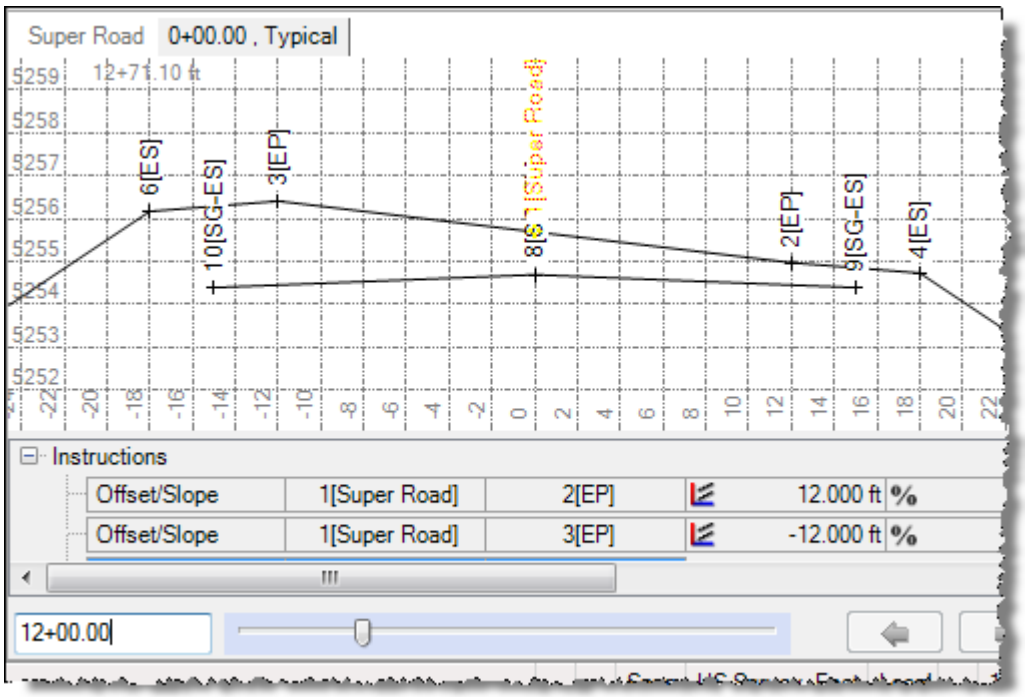
h. In the bottom of the **Edit Corridor Template** pane, click the **Add** button.

The new Superelevation instruction is added to the **Instructions** list.

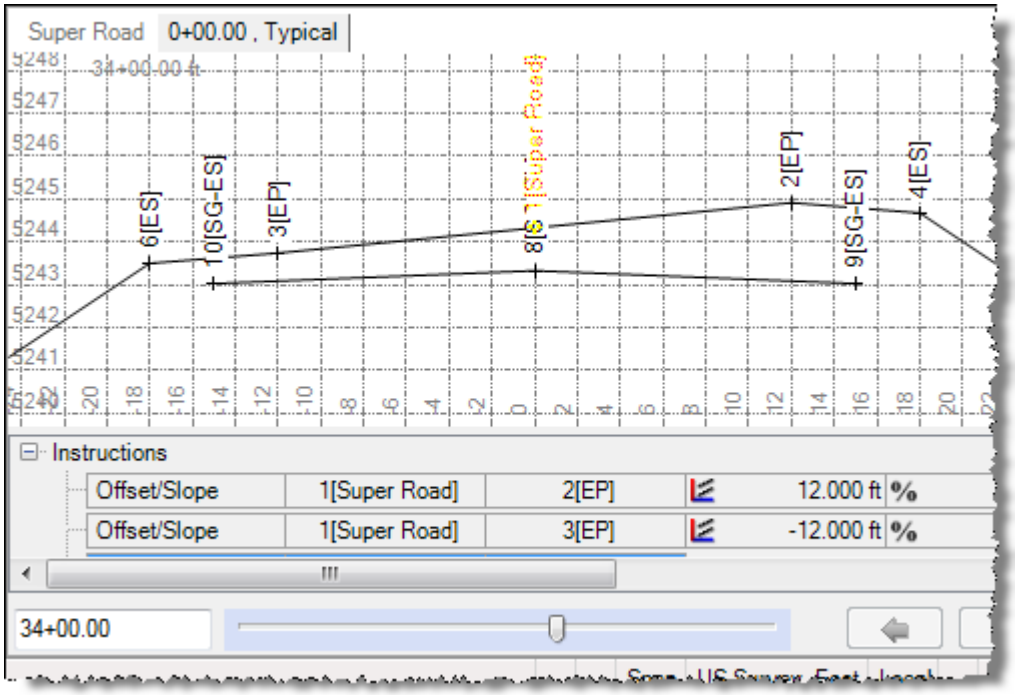


4. Use the slide control located beneath the **Instructions** list to view the template along the length of the alignment.

At station 9+00.00 the transition toward maximum superelevation for the first curve begins. Maximum superelevation is reached at station 12+00.00.



At station 21+00.00, the template returns to the normal crown. At station 25+60.00, the transition toward maximum superelevation for the second curve begins. Maximum superelevation for the second curve is reached at station 34+00.00.



The Finish grade of the template has been successfully superelevated. Next, you will apply superelevation to the Subgrade layer.

5. To insert a Superelevation instruction for the Subgrade layer, do the following:

   a. In the **Instructions** list, double-click the last instruction in the list (the instruction that defines node *10[SG-ES]*).

   b. Click the **Add instruction** icon located at the top of the **Edit Corridor Template** pane.

   c. In the **Instruction Type** drop-down list, select **Superelevation**.

   d. In the **Crown node** list, select *8[SG-CL]*.

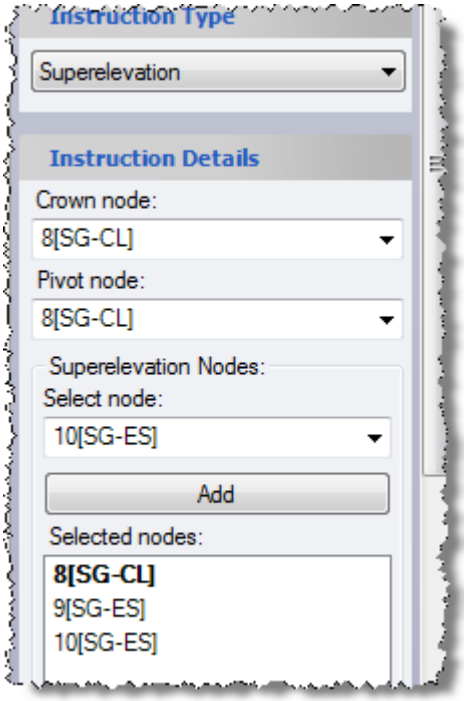
   e. In the **Pivot node** list, select *8[SG-CL]*.

      This node is automatically added to the **Selected nodes** list.

   f. In the **Select node** drop down list, select 9*[SG-ES]* and click the **Add** button to add it to the **Selected** nodes list.

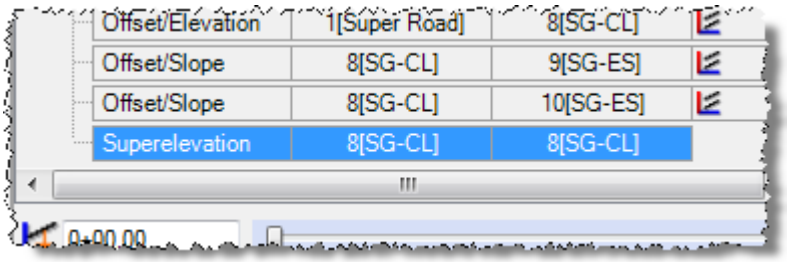
   g. In the **Select node** drop down list, select 10*[SG-ES]* and click the **Add** button.

h. In the **Selected nodes** list, right-click *1[Super Road]* and select **Delete** to remove it from the list.



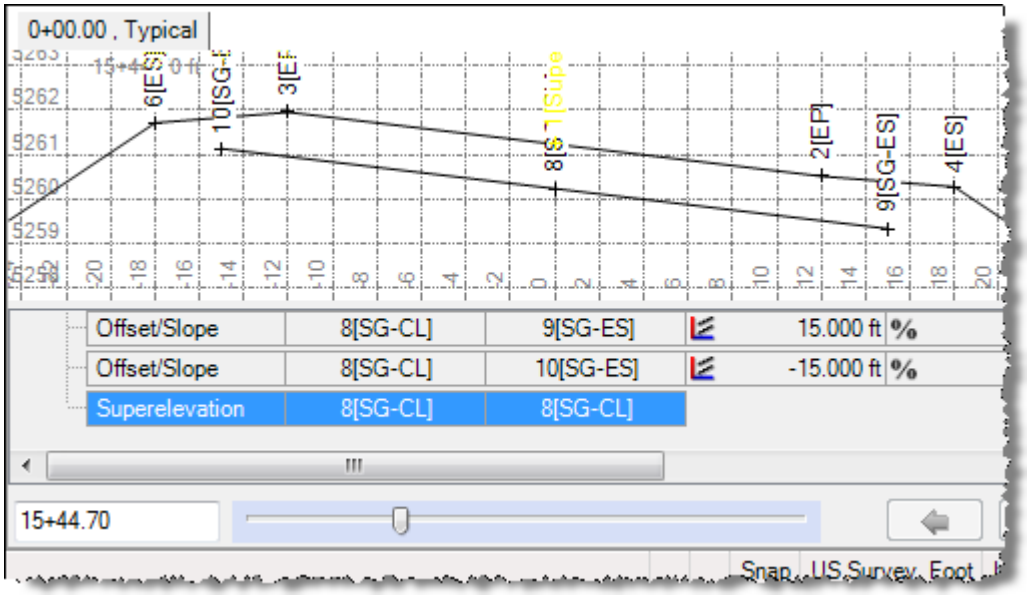
i. In the bottom of the **Edit Corridor Template** pane, click the **Add** button.

The new Superelevation instruction is added to the **Instructions** list.



6. Use the slide control located beneath the **Instructions** list to view the template along the length of the alignment.

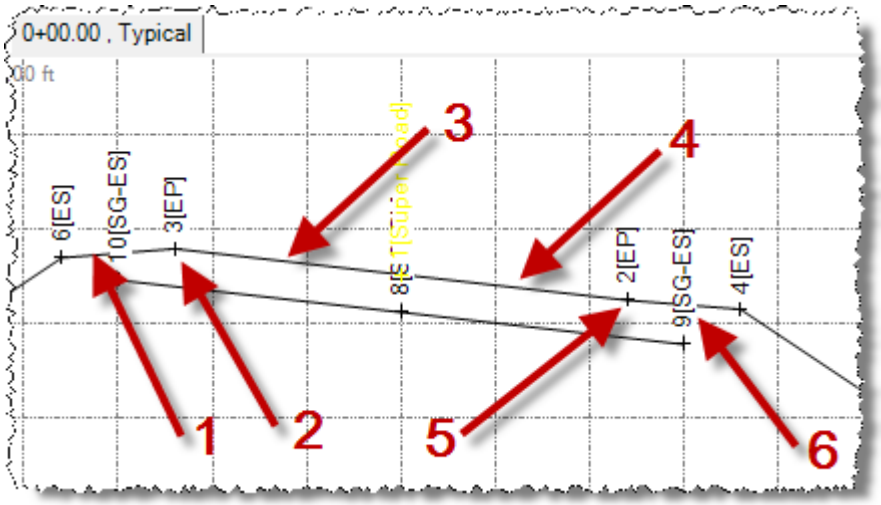
Note that the superelevated slope of the Subgrade layer now matches that of the Finish layer.



You are now ready to define rollover parameters for the road to ensure that slope differences between the driving lanes and shoulders in the superelevated curves are kept to a minimum for safety and comfort at design speed. For more information on rollover parameters, see "Rollover Parameter Examples" in the online help.

Step 4. Define rollover parameters

As shown in the following figure, when the road is at maximum superelevation in the first curve, there is a 10% slope difference between the left lane (the outside lane in the curve) and the left shoulder. There is a 2% slope difference between the right lane (the inside lane in the curve) and the right shoulder.

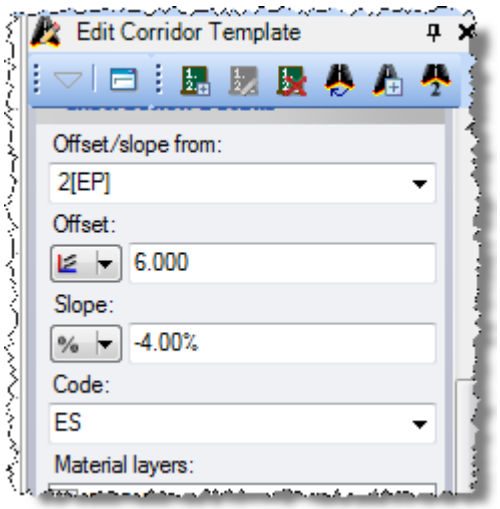


Key:
1. -4% shoulder
2. 10% delta
3. 6% super left lane
4. -6% super right lane
5. 2% delta
6. -4% shoulder

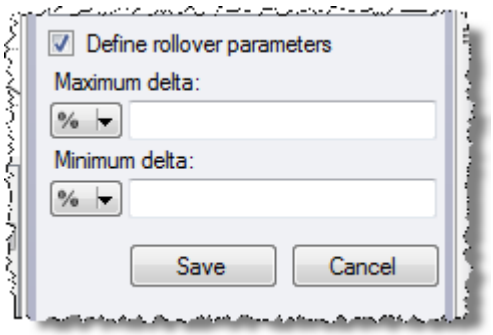
Both of these slope differences are too extreme for the design speed. So, you will specify a maximum and minimum delta that applies to the corridor that will change these slope differences. You will start by defining the maximum and minimum allowable slope differences for the right drive lane and shoulder.

1. In the **Instructions** list, double-click the instruction that defines the node *4[ES]*. Or, right-click the instruction and select **Edit**.

   This node defines the right shoulder. The properties for the instruction are displayed in edit mode.



2. Click the **Define rollover parameters** checkbox.

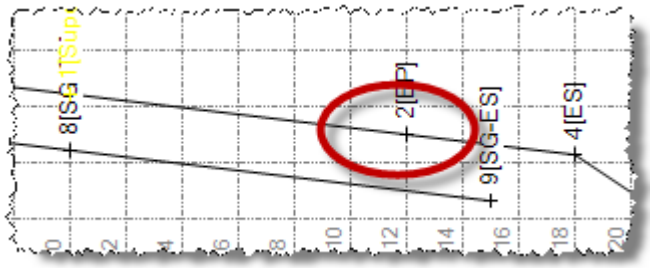


   The **Maximum delta** value specifies the allowable maximum slope difference between the driving lane and the shoulder on the outside of a curve. The **Minimum delta** value specifies the minimum slope difference between the driving lane and the shoulder on the inside of the curve. Note that for this road, the right lane is the inside lane in the first curve, and the outside lane in the second curve. So the **Maximum delta** value will apply to the right lane and shoulder in the second curve. The **Minimum delta** value will apply to the right lane and shoulder in the first curve.

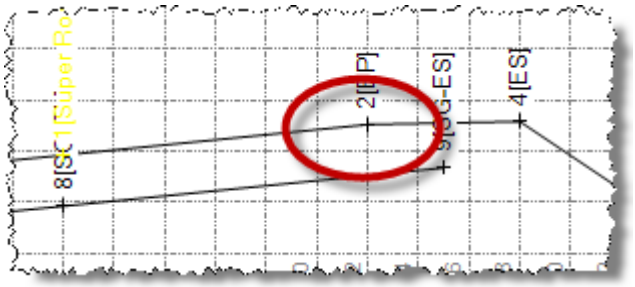
3. In the **Maximum delta** field enter *4%*. In the **Minimum delta** field, enter *0%*. Then click the **Save** button.

4. Use the slide control located beneath the **Instructions** list to view the template along the length of the alignment.

   Note that when you reach maximum superelevation for the first curve, the difference between the right (inside) lane and the right shoulder is now *0%*, based on the *0%* **Minimum delta** you specified.

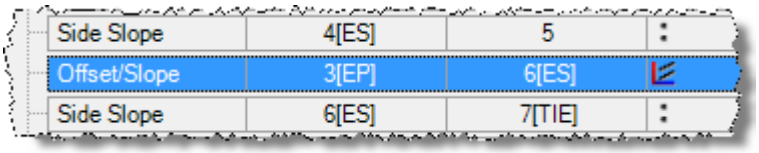


   When you reach maximum superelevation for the second curve, the difference between the right (outside) lane and the right shoulder is now *4%*, based on the *4%* **Maximum delta** you specified.



   You are now ready to define the rollover parameters for the left lane and shoulder. For this road, the left lane is the outside lane in the first curve, and the inside lane in the second curve.

5. In the **Instructions** list, double-click the instruction that defines the node 6*[ES]*. Or, right-click the instruction and select **Edit**.



Side Slope	4[ES]	5	:
Offset/Slope	3[EP]	6[ES]	
Side Slope	6[ES]	7[TIE]	:

6. Click the **Define rollover parameters** checkbox.

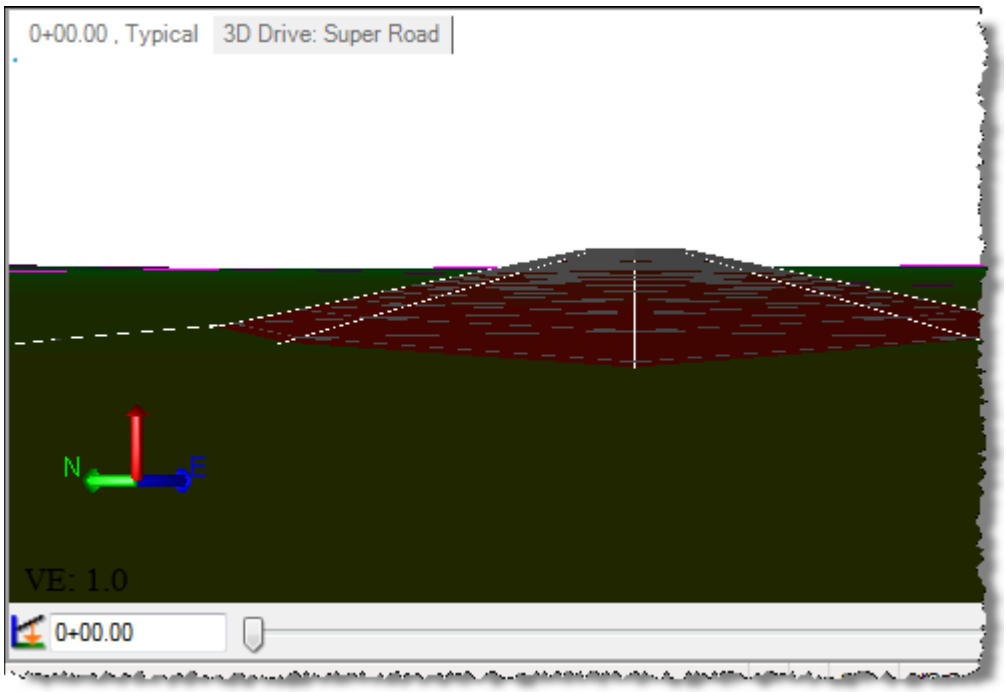
7. In the **Maximum delta** field enter 4%. In the **Minimum delta** field, enter 0%. Then, click the **Save** button.

8. Use the slide control located beneath the **Instructions** list to view the template along the length of the alignment to view the rollover parameters.

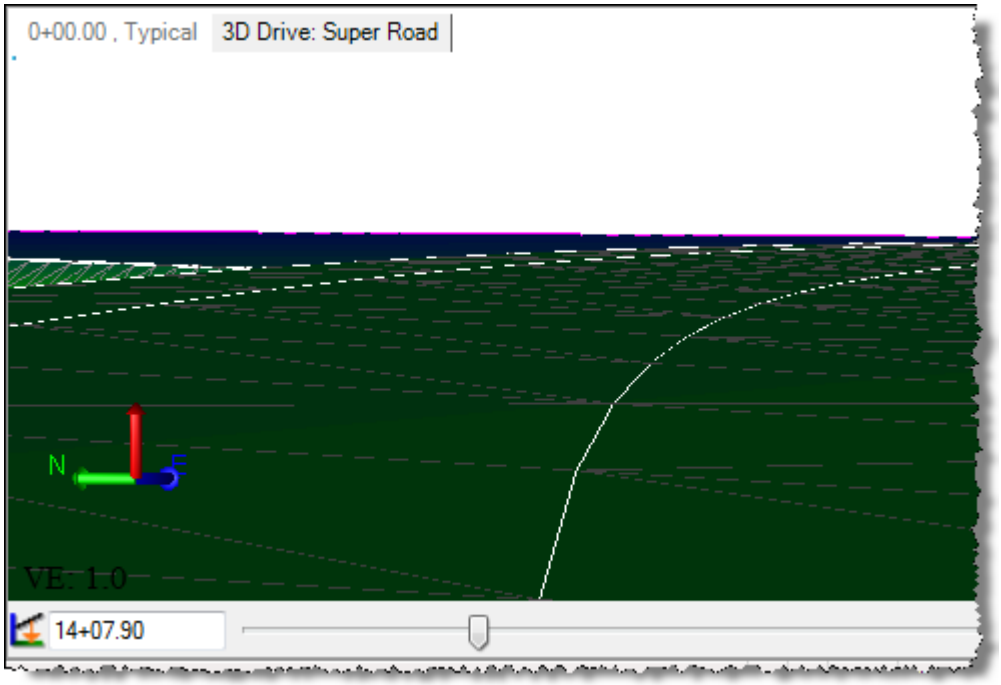
Step 5. View the alignment in 3D Drive View

To see a simulation of a drive along the newly superelevated roadway, follow these steps:

1. In the **Trimble Business Center** window, select **View > Alignment > New 3D Drive View**.



2. Use the slide control located along the bottom of the tab to view the roadway along the length of the alignment.



You are done working with the superelevations, so you can now close the project.

3. Select **File > Close Project**.

   The **Save Changes** dialog displays. If you saved the project to a new location or with a new name, you can click **Yes**. Otherwise, click **No**.