2009 Roads and Bridges Conference

GW-5

Intersection Design with Roadway Designer

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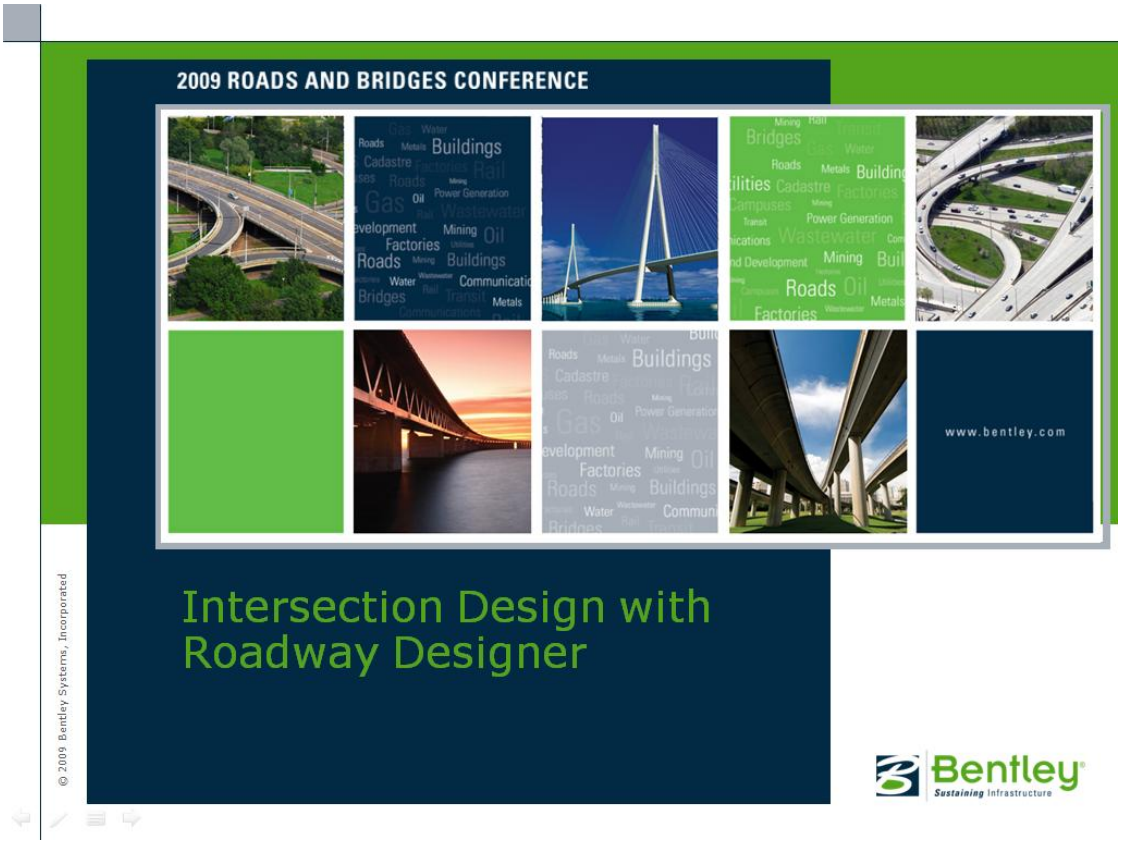
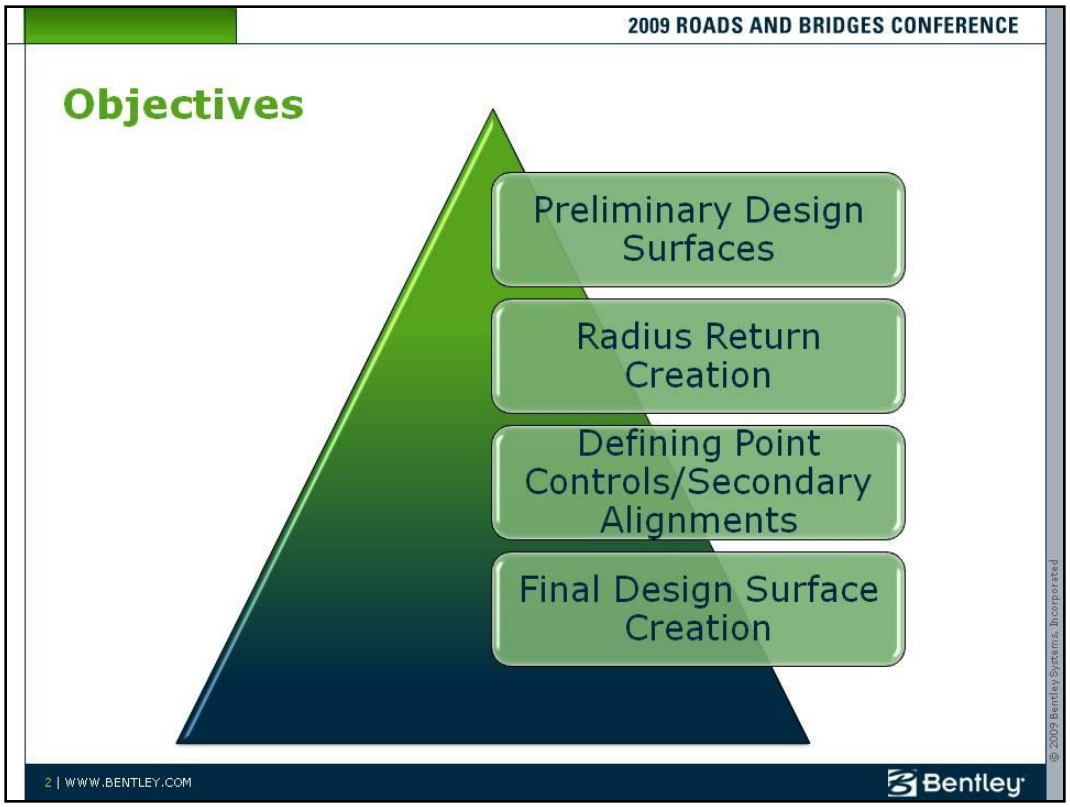


Welcome to Intersection Design with Roadway Designer. This workshop introduces some techniques that can be utilized in the Roadway Designer to model at-grade intersections. There are many techniques that can be used to model intersections in InRoads and GEOPAK, and this workshop just covers a few of them. You will also look at some examples of how different tools in the roadway designer can be used to handle different challenges when designing an intersection.



In this lesson we will…

- Create Preliminary Design Surfaces
- Create Geometry for Radius Returns
- Define Point Controls/Secondary Alignments
- Create The Final Design Surface

Lesson Name: Opening a Project (InRoads User)

LESSON OBJECTIVE:

In this lesson the student will learn to access an InRoads project in preparation for creating an intersection in Roadway Designer. Note, this lesson is for InRoads users only. For GEOPAK users, please proceed to the next lesson.

EXERCISE: GETTING STARTED (INROADS USER)

This exercise will guide you through the steps to get started

1. Double-click the InRoads or InRoads Suite icon
   The MicroStation Manager appears
   If there is no icon, then an alternate path for launching InRoads is
   Start > Programs > Bentley > InRoads Group V8i (SELECTseries 1) > InRoads
2. The instructor will provide the appropriate path location for this project. Open the CAD file **Model.dgn** located in the training folder for this workshop
3. Once InRoads has started, open the file **Project.rwk** located in the same folder as the design file.

Lesson Name: Opening a Project (GEOPAK User)

LESSON OBJECTIVE:

In this lesson the student will learn to access a GEOPAK Corridor Modeler project in preparation for creating an intersection in Roadway Designer. Note: This lesson is for GEOPAK users only.

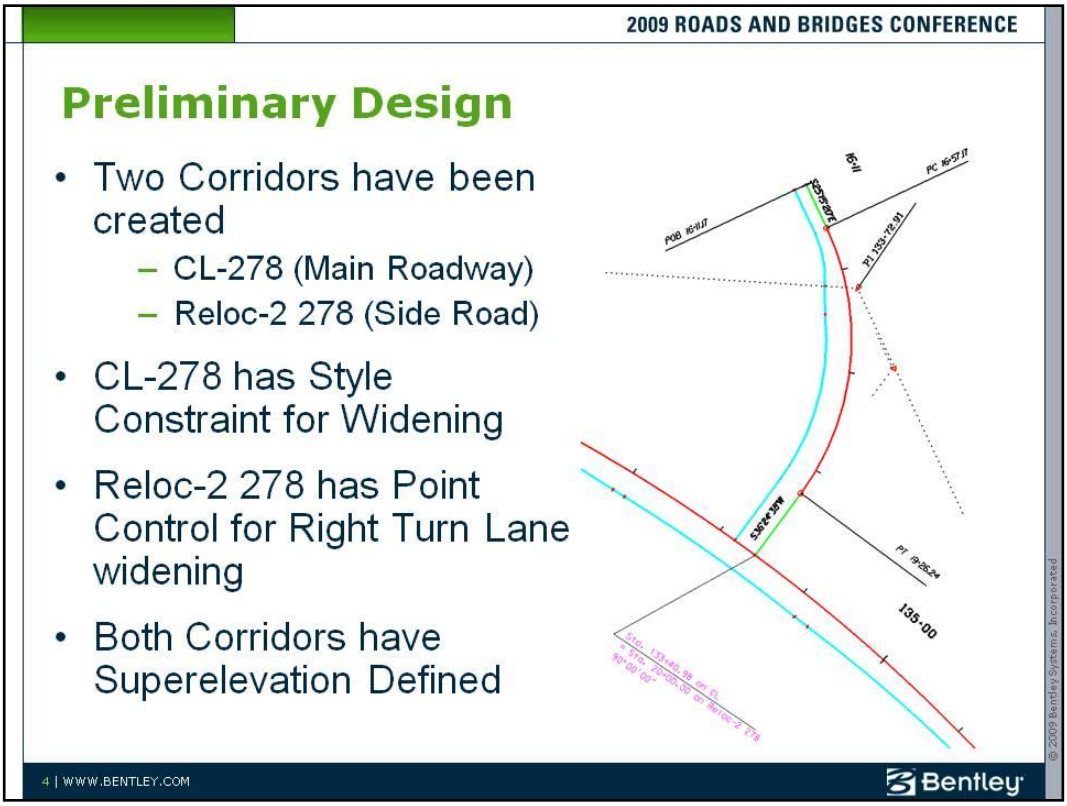
EXERCISE: GETTING STARTED (GEOPAK USER)

This exercise will guide you through the steps to get started

1. Go to **Start > Programs > Bentley > MicroStation V8i > Bentley MicroStation V8i (SELECTseries 1)**
2. The instructor will provide the appropriate path location for this project. When the MicroStation Manager appears select the file:
   Model.dgn and press **OK**.
3. Activate GEOPAK then go to **Applications > GEOPAK > Road > Corridor Modeling**.

   IMPORTANT: If a prompt appears asking to re-import the DDB file, make sure to select **Cancel**.

4. Select the GPK job number **001**
5. Choose **File > Load** from the Corridor Modeling dialogue.
6. Load the Corridor Modeler project file entitled **My_Project.rdp**.
7. Choose the Roadway Designer icon and open **Geopak_46480.ird**



Lesson Name: Analyze the Corridor

LESSON OBJECTIVE:

In this lesson the student will review two corridors that have already been created, one for the mainline and one for the side road.

EXERCISE: ANALYZE THE MAIN LINE CORRIDOR

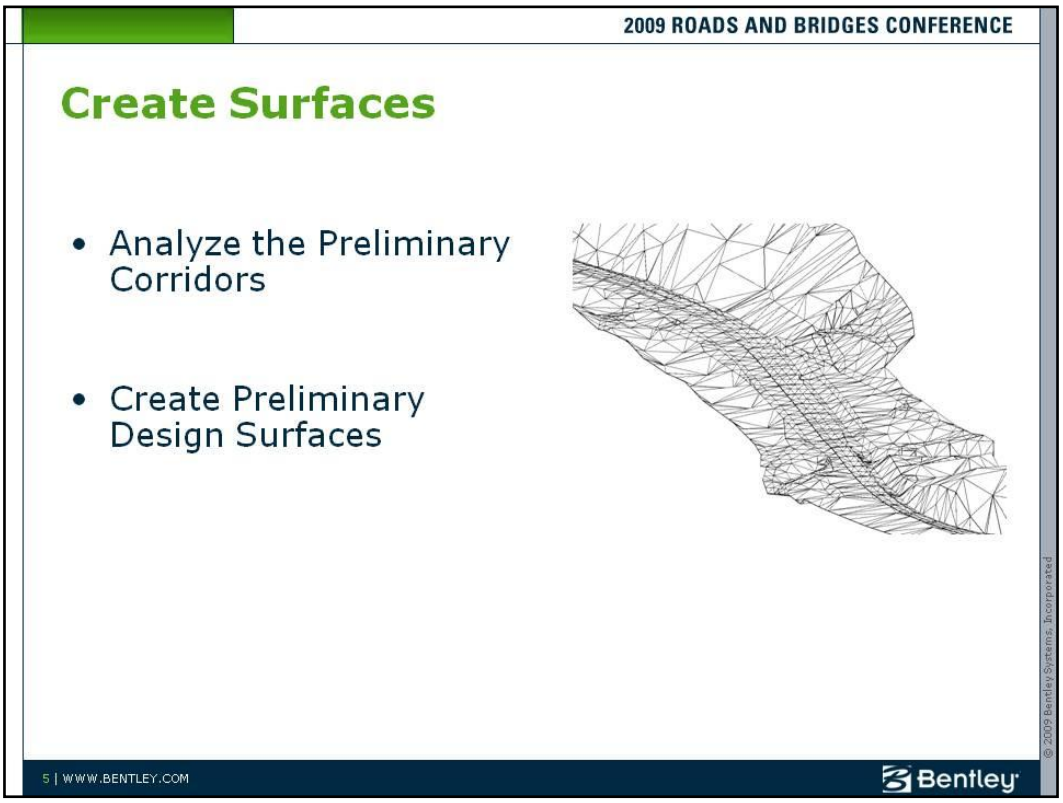
There are currently two corridors already established. CL-278 is the main line and Reloc-2 278 is the side road. (There is an additional corridor in the roadway designer file, but that will be addressed at a later time.)

1. Open the **Roadway Designer**.
2. Set the active corridor to **CL-278** and review the design.
3. On the bottom right of the Roadway Designer, set the *Display Mode* to **Superelevation** and review the design.

4. After reviewing the superelevation, select **Corridor > Point Controls** and review the point controls for CL-278. When finished, close the Point Controls dialog.
5. Select **Corridor > Template Drops**
6. Highlight the **Two-Lane Rural** template, then click the **Edit** button.
7. Edit the **Point REP**. Notice there is a Style Constraint which targets the style ROEP. The horizontal alignment 278 REP has a style ROEP and is used for widening

EXERCISE: ANALYZE THE RELOC-2 278 CORRIDOR

1. Set the active corridor to **Reloc-2 278**
2. Select the Display Superelevation toggle and review the design
3. Select **Corridor > Point Controls** and review the point controls for Reloc-2 278. When finished, close the Point Controls dialog.
4. Notice that other than superelevation, there is an additional point control. This is a horizontal control used for the right turn lane widening for the side road Reloc-2 278



Lesson Name: Create Surfaces

LESSON OBJECTIVE:

In this lesson the student will create preliminary design surfaces for the two corridors

EXERCISE: CREATE THE CL-278 SURFACE

1. Select **Corridor > Create Surface**
2. Key in **CL-278** for the Surface name, or you can simply select the corridor CL-278 if *New Surface for Each Corridor* is enabled.
3. Select the corridor **CL-278**
4. Make sure *Features in Plan View* is disabled, then click **Apply**.

EXERCISE: CREATE THE RELOC-2 278 SURFACE

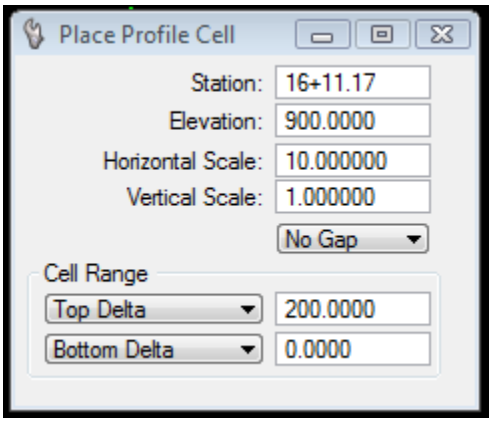
1. Make sure the active surface is set to **Existing**
2. Key in **Reloc-2 278** for the Surface name
3. Select the corridor **Reloc-2 278**
4. Click **Apply**.
5. (InRoads User) When finished, save both surfaces.

EXERCISE: REVIEW THE DESIGNED PROFILE GRADE LINE FOR THE SIDE ROAD (INROADS USER)

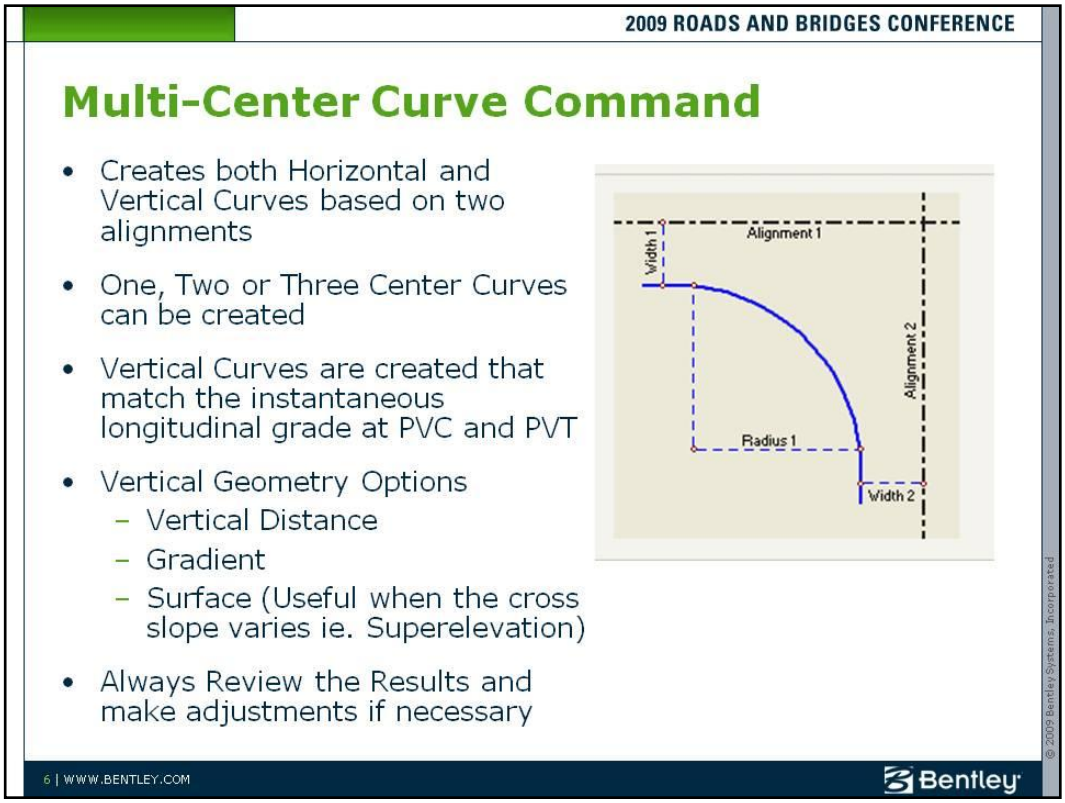
1. Set the active alignment to **Reloc-2 278**
2. Select **Evaluation > Profile > Create Profile**
3. Enable both the Existing Surface and the surface CL-278
4. Click **Apply**, then place the profile to the far right of the plan graphics.
5. Select **Geometry > View Geometry > Vertical Annotation** then click Apply.
   Notice the profile grade line ties into the cross slope of the CL-278 design surface.

EXERCISE: REVIEW THE DESIGNED PROFILE GRADE LINE FOR THE SIDE ROAD (GEOPAK USER)

1. Select **Applications > GEOPAK > Road > Plans Preparation > Draw Profiles**
2. Set the Job Number **001** and the Chain to **Reloc-2_278**.
3. From the Draw Profile dialog, select the icon Dialog Profile Cell Control.
4. From the Profile Cell Control dialog, select the icon Place Profile Cell.
5. Fill out the dialog as shown.

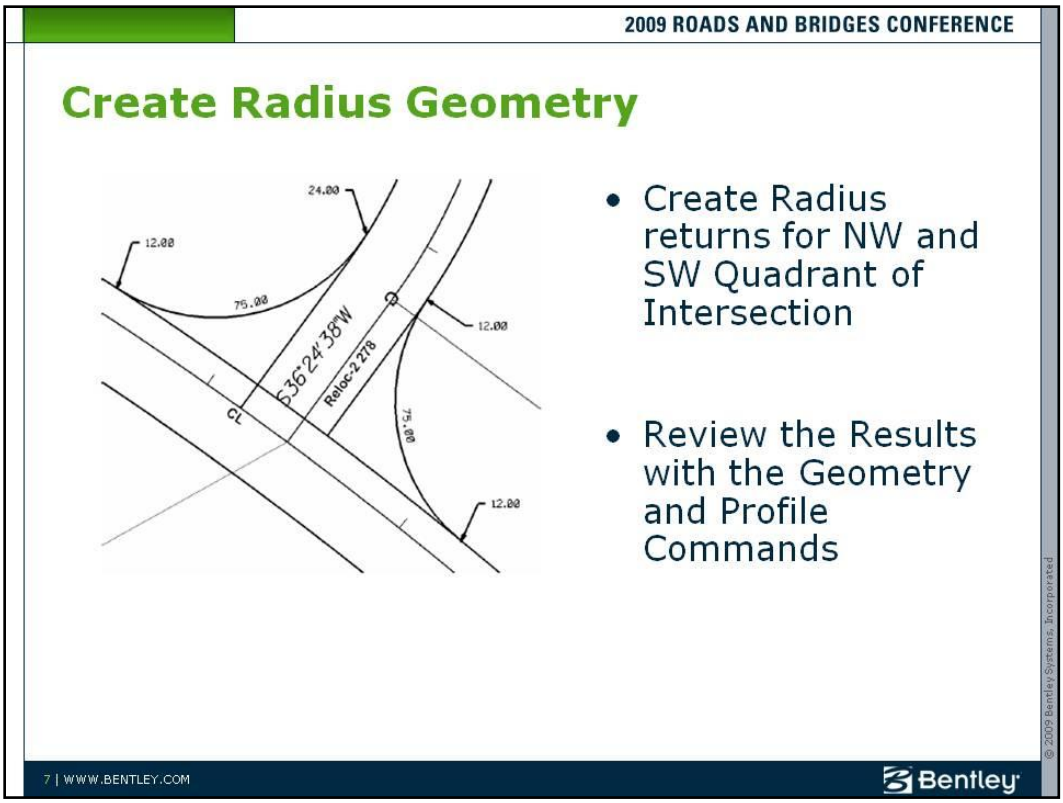


6. Place the Profile Cell.
7. Dismiss the Place Profile Cell dialog.
8. From the *Surfaces* tab, select **Existing.tin** and add to the list box.
9. From the *Surfaces* tab, select **CL-278.tin** and add to the list box.
10. From the COGO tab, select profile **RL2-PG** and add to the list box.



Multi-Center Curve Command

The Multi-Center Curve command places one-center, two-center, and three-center compound curves at the intersection of two alignments. The command creates a new horizontal alignment in the active geometry project/geometry database and, if desired a vertical alignment as well. When creating a vertical alignment, you can choose to define the elevations of the vertical alignment by either vertical distance, from transverse gradient (cross slope) or by surface.



Lesson Name: Create the Geometry for the NW and SW Radius Return

LESSON OBJECTIVE:

In this lesson the student will create Radius returns for the NW and SW quadrant of the intersection.

EXERCISE: CREATE THE RADIUS RETURN GEOMETRY (INROADS USER)

1. Select **Geometry > Utilities > Multi-Center Curve**
2. Adjust the settings as follows:
   Curve Type: **One Center**
   Radius 1: **75**
   Width 1: **12**
   Width 2: **24**
3. Click the Advanced tab and adjust the settings as follows:
   Name: **NW Quadrant**
   Style: **ROEP**
   Create Vertical Alignment: **Enabled**
   First Selected Alignment: Surface: **CL-278**
   Second Selected Alignment: Surface: **Reloc-2 278**
4. Click **Apply**.

5. Follow the prompts in the MicroStation Status bar. Select **CL-278** for the first alignment then select **Reloc-2 278** for the second alignment.
6. Click in the NW quadrant of the intersection to specify the location, and Left mouse click to accept. Right click to bring up the dialog box. (you may need to right click more than once.)
7. In the Advanced tab, adjust the settings as follows:
   Name: **SW Quadrant**
   Style: **LEOP**
8. Click the main tab and change the settings as follows:
   Width 1: **12**
   Width 2: **12**
9. Click **Apply.**
10. Follow the prompts in the MicroStation Status bar. Select **CL-278** for the first alignment and select **Reloc-2 278** for the second alignment.
11. Click in the SW quadrant of the intersection to specify the location, and Left mouse click to accept.
12. When finished, Right Click to bring up the dialog box.
13. There should now be two additional alignments in the active geometry project, One called **NW Quadrant** and one called **SW Quadrant**.

EXERCISE: REVIEW THE RESULTS (INROADS USER)

1. Change the Active Alignment to NW Quadrant
2. Select **Evaluation > Profile > Create Profile**
3. Enable all three surface, then click **Apply**
4. Place the profile to the right of the view.
5. Use the View Vertical Annotation command to display the vertical alignment and the labeling.
6. The vertical curve set and the Vertical PI commands can be used to modify the vertical alignment of the radius return. i.e. adjusting the low point for inlet locations.

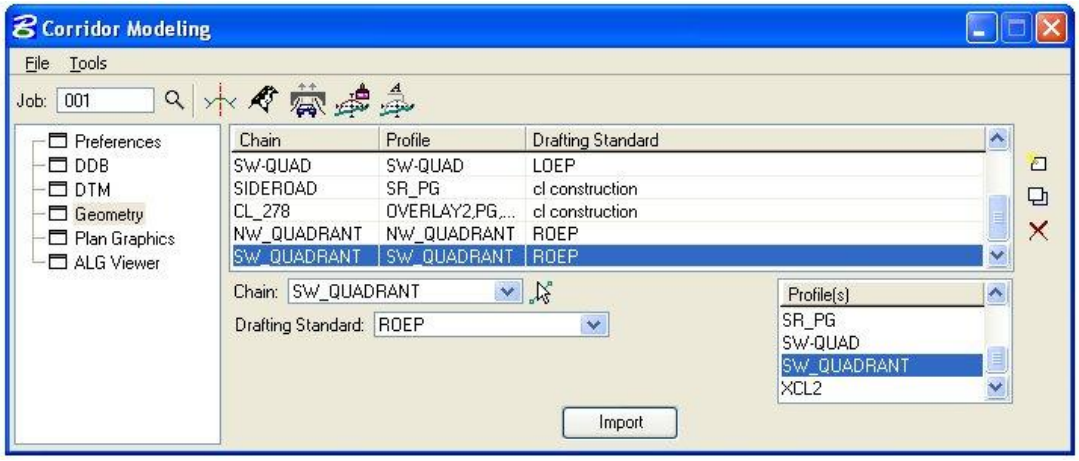
EXERCISE: CREATE THE RADIUS RETURN GEOMETRY (GEOPAK USER)

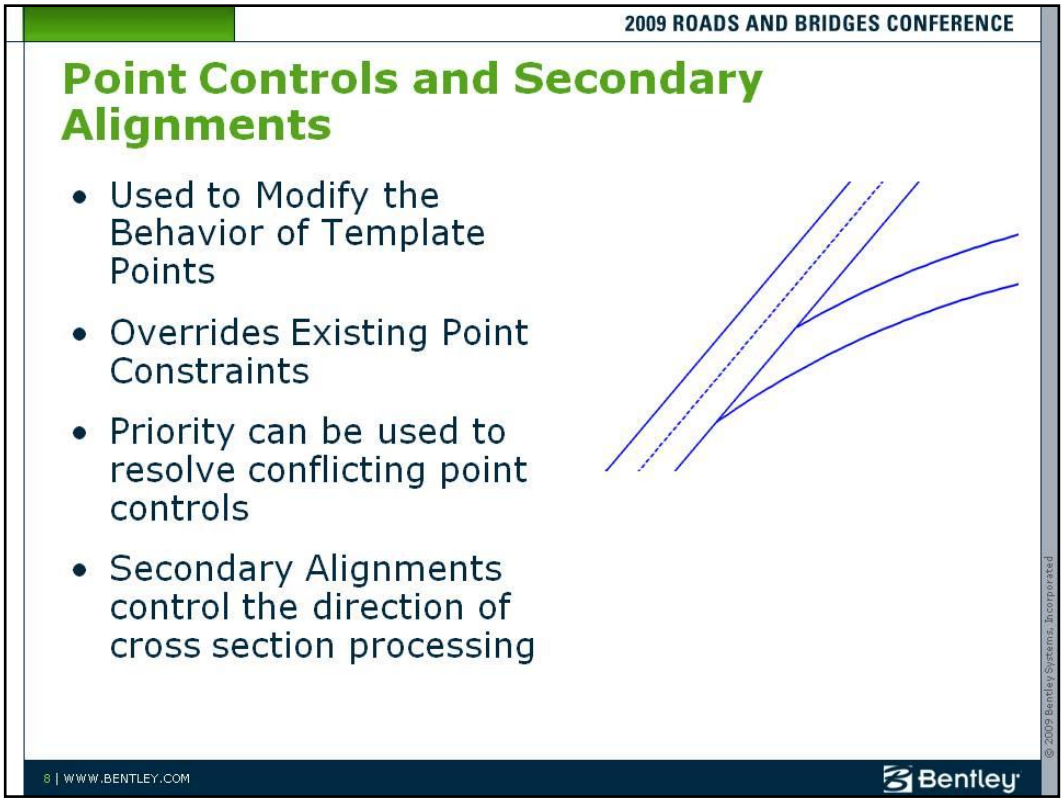
1. Select **Road Tools > Geometry > Design Multicenter Curve**
2. Select the Horizontal Tab and adjust the settings as follows:
   Curve Type: **One Center**
   Store to GPK File: **Enabled**
   Select By: **GPK Alignment**
   Job: **001**
   Design Vertical Profile**: Enabled**
   New Chain: (Key-In) **NW_Quadrant**
   Start Sta: **0+00**
   New Profile: **NW_Quadrant**
   Entry
   Chain: **CL_278**
   Profile: **PG**
   Exit
   Chain: **RELOC-2_278**
   Profile: **RL2_PG**
   One Center
   Entry Width: **12**
   Radius: **75**
   Exit Width: **24**
3. Select the Vertical Tab
4. For the Entry Grade Definition, enable TIN File and select **CL-278**
5. For the Exit Grade Definition, enable TIN File and select **Reloc-2 278**
6. Select the Horizontal tab, then click **Apply**
7. Data Point in the NW Quadrant of the intersection to store the new alignment

8. In the Horizontal Tab, change the settings as follows
   Curve Type: **One Center**
   Select By: **GPK Alignment**
   Job: **001**
   New Chain: (Key-In) **SW_Quadrant**
   Start Sta: **0+00**
   New Profile: **SW_Quadrant**
   Entry
   Chain: **CL_278**
   Profile: **PG**
   Exit
   Chain: **RELOC-2_278**
   Profile: **RL2_PG**
   One Center
   Entry Width: **12**
   Radius: **75**
   Exit Width: **12**
9. Click **Apply**
10. Data Point in the SW Quadrant of the intersection to store the new alignment
    At this point the VPI based Vertical Alignment Design tools could be used to modify the profiles for the radius returns if necessary ie. Adjusting the low points.

EXERCISE: UPDATE THE GEOMETRY (GEOPAK USER)

1. Select **Applications > GEOPAK > Road > Corridor Modeling**
2. Select **Geometry** on the left hand side
3. Select the Chain **NW_Quadrant** from the drop down list
4. On the right, select the Profile **NW_Quadrant**
5. Select **ROEP** for the *Drafting Standard*
6. Select the Icon *Add Chain to List*
7. Repeat steps 2-6 for the SW_Quadrant. Be sure to select the Profile SW_Quadrant.
8. Select the **Import** button.
9. A message will appear stating that the Geometry has been Updated.
10. Click **OK**





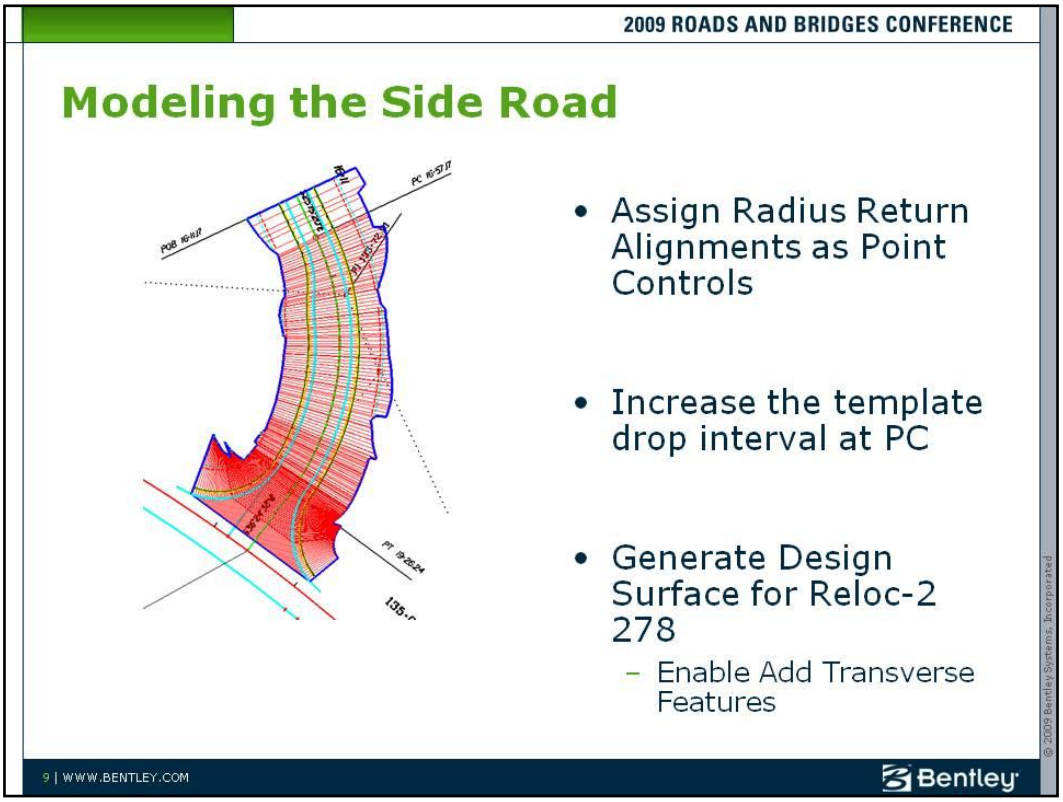
Point Controls and Secondary Alignments

Template point controls are used to override the normal horizontal and/or vertical locations of template points during the modeling process. Design examples include lane widening, ramp and intersection design, superelevation, and divided highways with separate grade lines. These overrides are accomplished by assigning template point names to alignments.

The assigned template points will follow the alignments using horizontal and/ or vertical controls within a specified station range. Surface features can also be used to control template points. When more than one point control of the same type exists for the same template point within the same station range, then a conflict will occur.

A point control conflict is visible as a tan color in the point controls dialog. Point control conflicts can be resolved by either adjusting the station range of the point controls or changing the priority. Point Controls can also be used as secondary alignments.

Secondary Alignments change the direction of cross section processing. This is especially useful for intersection modeling, when the cross section direction needs to be perpendicular to the radius return alignment.



Lesson Name: Model the Side Road with the Radius Return

LESSON OBJECTIVE:

In this lesson the student will assign the radius return alignments as point controls for the side road, then generate the design surface.

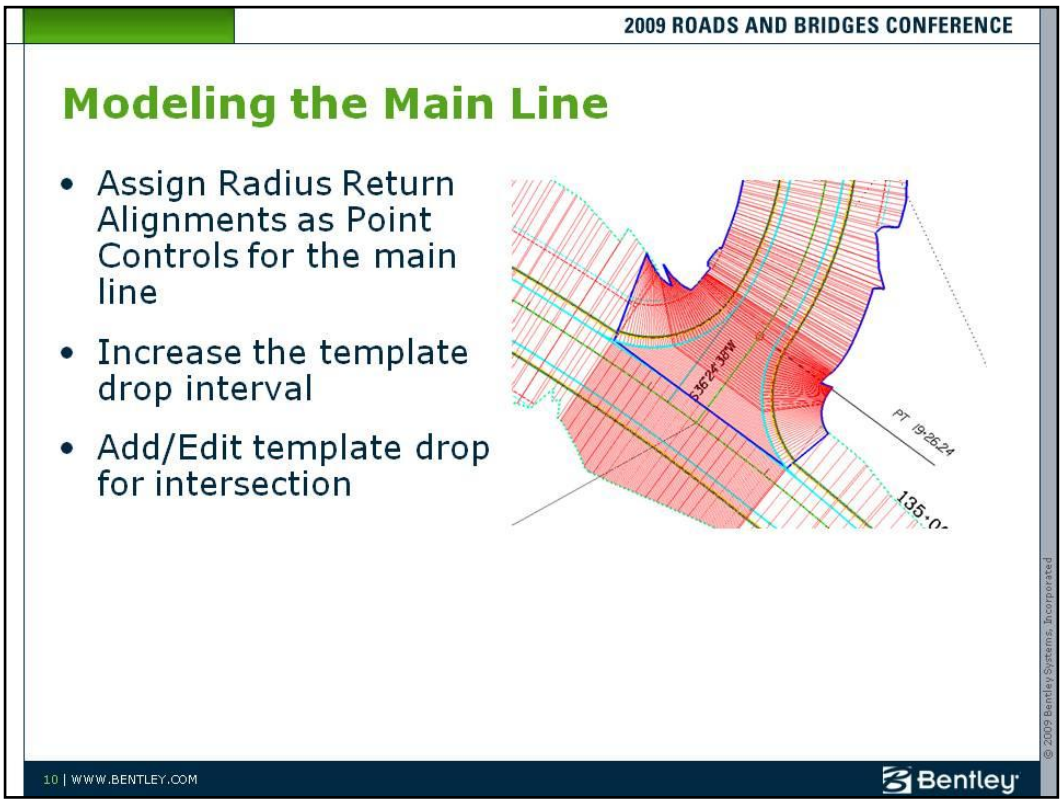
EXERCISE: ASSIGN POINT CONTROLS

1. Open the Roadway Designer
2. Set the *Active Corridor* to **Reloc-2 278,** and the *Active Surface* to **Existing**
3. Select **Corridor > Point Controls**
4. Use the target button to select point **REP**, or select the point from the list.
5. Set the *Mode* to **Both**
6. Set the *Control Type* to **Alignment**
7. Select the Alignment **NW Quadrant**
8. Set the *Start Station Limits* to **19+09.05**
9. Enable *Use as Secondary Alignment*. This will change the direction of the template when REP point encounters the NW Quadrant alignment.

10. Click **Add**.
11. Select the **Reloc-2 REP** Horizontal Point Control and set the *Stop Station* to **19+09.05.** Be sure to click the **Change** button.
12. Now assign the Point **LEP** to the alignment **SW Quadrant**. Make sure the *Mode* is still set to **both** and *Use as Secondary Alignment* is enabled.
13. Click **Add.**
14. Notice the point controls colors change. This is because there is a conflict. Adjusting the priorities will resolve this.
15. Change the priority of the Superelevation Point controls to **2**. The Point Controls for the NW and SW Quadrant should already be 1. Be sure to click the **Change** button.

EXERCISE: INCREASE THE TEMPLATE DROP INTERVAL

1. Select **Corridor > Template Drops**
2. Select the **Two Lane Rural** Template in the list
3. In the Template Drops dialog, enter **19+09.05** for the station
4. Change the *Interval* to **1**
5. Select **Copy**, then click **Close**
   Select Copy because corridor specific changes have been made to this template.
6. Select **Process All** and Review the Results
7. Re-Create the Surface for the Reloc-2 278 corridor. This time, enable Add Transverse features and Display Features in Plan View. Review the results.
8. (InRoads User) Save the surface when finished.



Lesson Name: Assign the Point Controls for the Main Line

LESSON OBJECTIVE:

In this lesson the student will assign the radius return alignments as point controls for the Main Line, then generate the design surface.

EXERCISE: ASSIGN POINT CONTROLS FOR THE MAIN LINE

1. Open the Roadway Designer
2. Set the active corridor to **CL-278**
3. Select **Corridor > Point Controls**
4. Change the priority of the Superelevation Point controls to 2. Be sure to click the **Change** button.
5. Use the target button to select point **LEP**, or select the point from the list.
6. Set the *Mode* to **Both**
7. Set the Control Type to **Alignment**
8. Select the Alignment **NW Quadrant**
9. Enable **Use as Secondary Alignment**. This will change the direction of the template when LEP point encounters the NW Quadrant alignment

10. Change the Priority to 1
11. Change the Start station limits to **132+46.59**
12. Change the End Station Limits to **132+62.83**
13. Click **Add**
14. Now assign the Point LEP to the alignment SW Quadrant. Make sure the Mode is still set to both and Use as Secondary Alignment is enabled.
15. Change the Start station limits to **134+09.23**
16. Change the End Station Limits to **134+23.46**
17. Make sure the Priority is set to **1**, then click **Add**.
18. Process All and Review the results. Note: The colors of the two point controls will still show orange because they occur within the same station range as the superelevation point controls. Remember however that we changed the priority so there should not be a conflict.

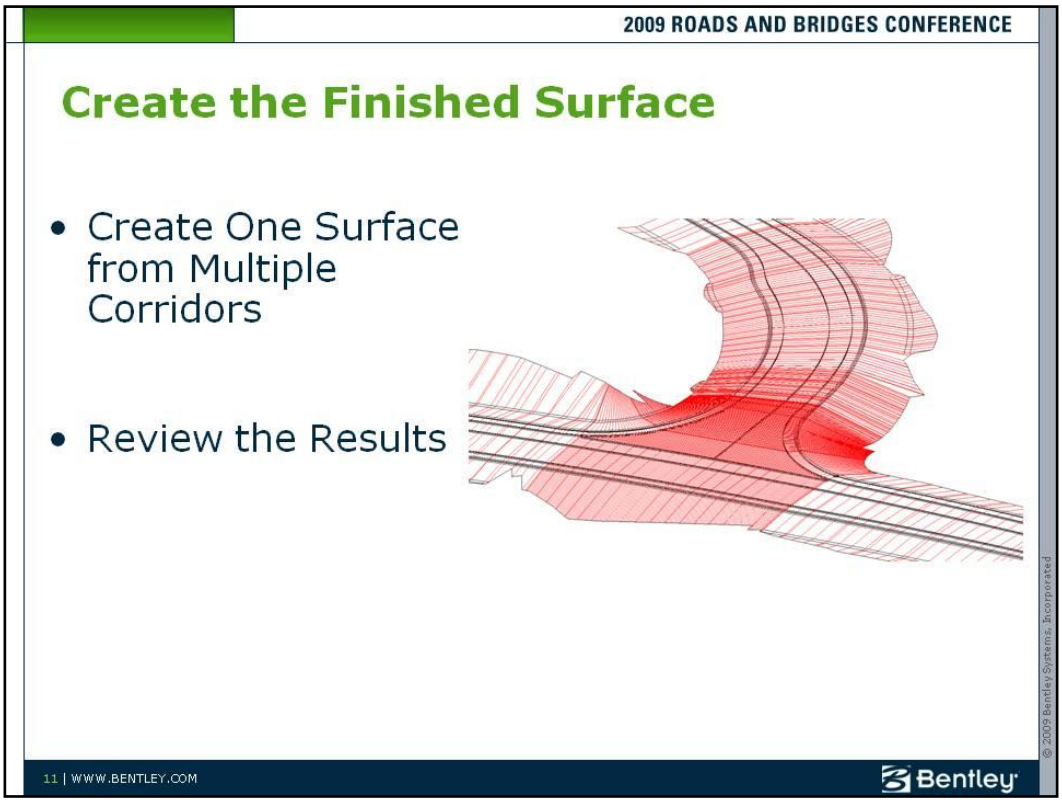
EXERCISE: ADD/EDIT TEMPLATE DROPS

1. In Roadway Designer, select **Corridor > Template Drops**
2. Select the Two Lane Rural Template in the template drop list.
3. Use the Copy button to add additional template drops at the following stations:

- 132+62.82 1 foot interval
- 132+62.83 1 foot interval
- 134+09.23 1 foot interval
- 134+09.24 10 foot interval

EXERCISE: REMOVE THE END CONDITIONS IN THE INTERSECTIONS

1. Select the template drop at 132+62.83 and click the **Edit** button
2. Delete the End Conditions and the Shoulder Components on the left side of the template
3. Delete the End Conditions and the Shoulder Components on the left side of the template at Station 134+09.23
4. **Process All** and review the design
5. Create the Surface for the CL-278 corridor using the Create Surface command.
6. Save the surface when finished. (InRoads User)
   You can also use end condition exceptions to remove the side slopes in the intersection. We will use this technique in a later part of the exercise.



Lesson Name: Create the Finished Surface

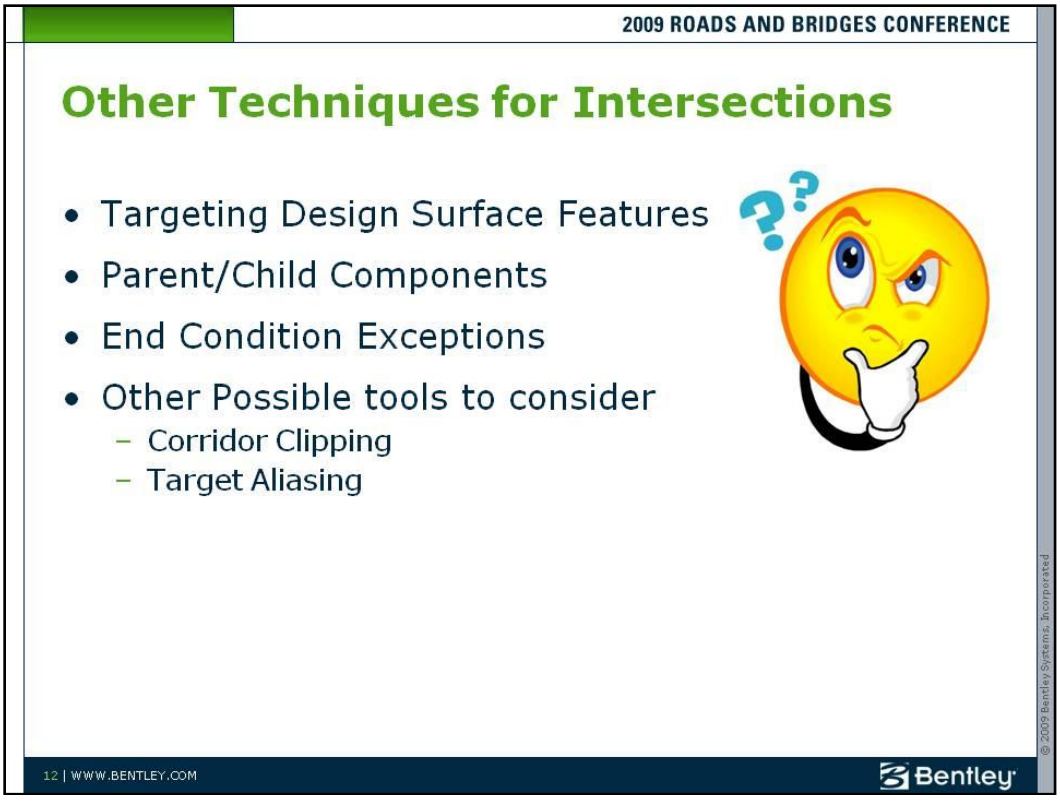
LESSON OBJECTIVE:

In this lesson the student will complete this intersection by creating one surface from the main line and the side road corridor

EXERCISE: CREATE THE FINISHED SURFACE

1. Use the Undo Command in MicroStation to remove the previous graphics
2. Set the active surface **Existing**
3. Select **Corridor > Create Surface**
4. Enter **Finished** for the Surface name. (New Surface for Each Corridor should be disabled.)
5. Select corridor **CL-278** and **Reloc-2 278** from the corridor list.

6. Enable *Add Transverse Features* and *Display Features in Plan View*, then click **Apply**.
7. Save the surface **Finished**. (InRoads User)
8. Use the MicroStation rotate view command to review at the results.



Other Techniques for Intersection Modeling

Designing an intersection in itself is a complex process. Like many design elements, there are an abundant things to consider, such as such as minimum maximum slope criteria, stopping sight distance and right-of-way encroachments just to name a few. InRoads provides many tools that can be used to model an intersection effectively.

End Condition Exceptions

In the previous exercise additional template drops were added and edited to handle the removal of side slopes and shoulder components in the intersection. End Condition Exceptions can also be used to remove the side slopes on either side of the alignment within a particular station range.

Parent/Child Components

Parent/Child components can also be used to determine the display of different components when certain end conditions exist. For example, the shoulder components can be made a “child” of an end condition, so that they will only display when the end condition displays.

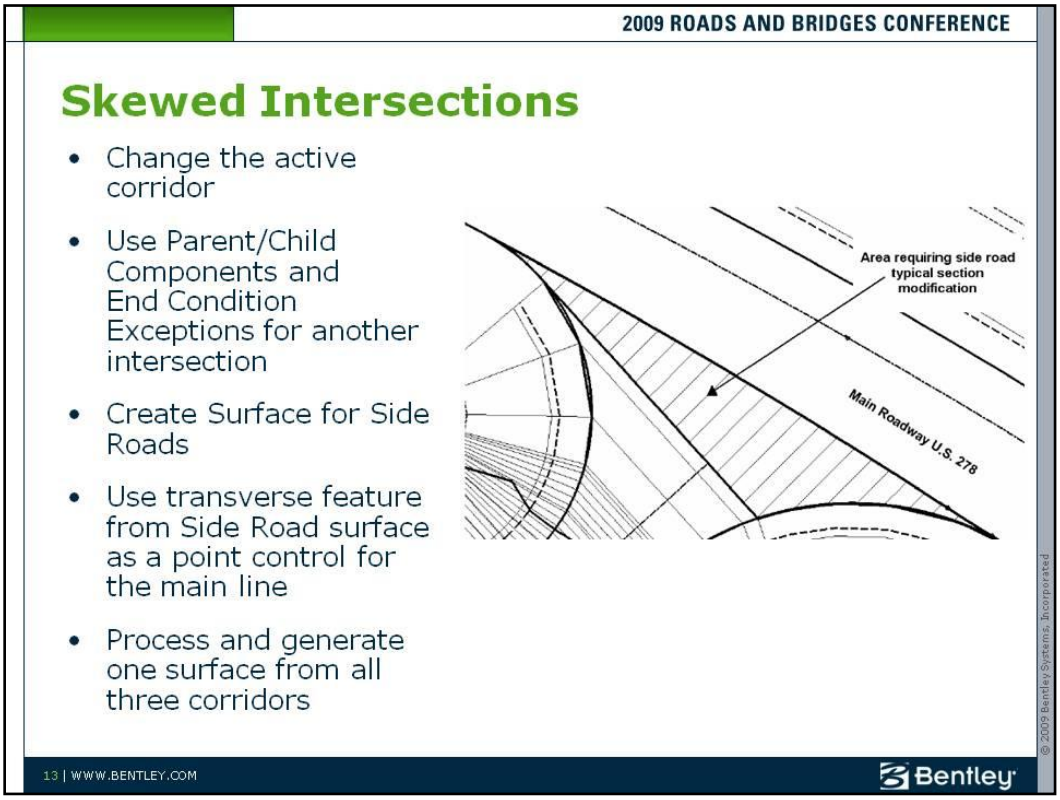
Corridor Clipping/Target Aliasing

Target Aliasing can be used to set the Active or Named Surface to the surface resulting from another corridor within the same Roadway Designer file. For example, a ramp needs to target first the Mainline Corridor and the Existing Ground, both targets would be added to the Alias list.

Clipping Options are set as part of the Roadway Designer Create Surface command. The options are determined from the Corridors defining other Corridors in the Target Aliasing. In the ramp example, you could use the Clipping options to effectively trim back the limits of ramp where it abuts the main corridor.

Targeting Design Surface Features

In certain cases, it may be necessary to create preliminary design surfaces first before continuing with the design in the Roadway Designer as shown at the beginning of this lesson. Creating the surface after key steps along the way allow you to target design surface features. For example, in a skewed intersection you may want to use design surface edge of the side road as a horizontal and vertical point control along the mainline. This can be accomplished by first creating a surface, then using the surface feature in the point controls command of the roadway designer, or by specifying the target feature for and end condition point in the point properties dialog.



Skewed Intersections

Skewed intersections provide a challenge in generating an accurate surface. Although similar, the exact technique demonstrated in the prior exercise for the "T" intersection will not work for a skewed intersection, therefore some additional tools will be used to create the model.

Lesson Name: Create Model for the Side Road of a Skewed Intersection

LESSON OBJECTIVE:

In this lesson the student will create a model for the side road of the skewed intersection

EXERCISE: INCREASE THE TEMPLATE DROP INTERVAL FOR THE SIDE ROAD

1. Use the Undo command in MicroStation to remove the previous graphics
2. Open the Roadway Designer and change the active corridor to **Side Road**
3. Review the Side Road corridor
4. Select **Corridor > Point Controls** and review the point controls for the Side Road corridor.
5. Select **Corridor > Template Drops**

5. Select the **Two Lane Rural** template and use the **Copy** button to create another template drop at 9+03.62 with a 1' interval.
6. When finished, Process All and review the results
7. Create a surface called **Side Road** for the Side Road corridor. Be sure to enable *Add Transverse Features* and *Display Features in Plan View*.
8. You will get a message stating that the Exterior boundary is crossing itself, click **Close** to dismiss the Results box. Surface editing tools can be used to correct this if desired, or you can try the *Remove Loops* option in the Create Surface command. Another option could be to change the end conditions within the station range of the radius return so the catch limits do not overlap.
9. (InRoads User) When finished, save the surface.

EXERCISE: INCREASE THE TEMPLATE DROP INTERVAL FOR THE CL-278 CORRIDOR

1. Change the active Corridor to **CL-278**
2. Select **Corridor > Template Drops**
3. Select the Two Lane Rural template and use the Copy button to create two additional template drops at the following locations:
   - 130+57.00 1' interval
   - 132+11.02 10' interval

EXERCISE: EDIT THE TEMPLATE DROP FOR THE INTERSECTION

1. Edit the template drop at Station **130+57.00**
2. Edit the top most shoulder component on the right called **RAKG**
3. Assign the component **RDitch** as the parent component. Be sure click **Apply**.
4. When finished, Click **OK**, then close the Template drops dialog.

EXERCISE: ASSIGN THE POINT CONTROLS

1. Select **Corridor > Point Controls**
2. Use the target button to select point REP, or select the point from the list.
3. Set the *Mode* to Both
4. Set the Control Type to **Alignment**

5. Select the Alignment **SW Quad**
6. Enable **Use as Secondary Alignment**. This will change the direction of the template when REP point encounters the SW Quad alignment
7. Change the *Priority* to 1
8. Change the End station limits to **130+89.57**
9. Click **Add**
10. Change the Control Type to **Feature** and make sure the *Mode* is still set to **Both**
11. Select the surface **Side Road**
12. Use the target button to select, then accept the last transverse feature of the Side Road surface. This should be the feature called **Side Road-9+50.50**
13. Enable **Use as Secondary Alignment**
14. Change the *Priority* to 1
15. Change the Start station limits to **130+89.57** and the End Station limits to **131+49.41**, then click Add
16. Now assign the Point REP to the alignment SE Quad. Make sure the Mode is still set to both and *Use as Secondary Alignment* is enabled.
17. Change the Start station limits to **131+49.41** and the End Station limits to **132+11.02**
18. Make sure the Priority is set to 1, then click **Add**. **Process All** and review the results.

EXERCISE: DEFINE END CONDITION EXCEPTIONS

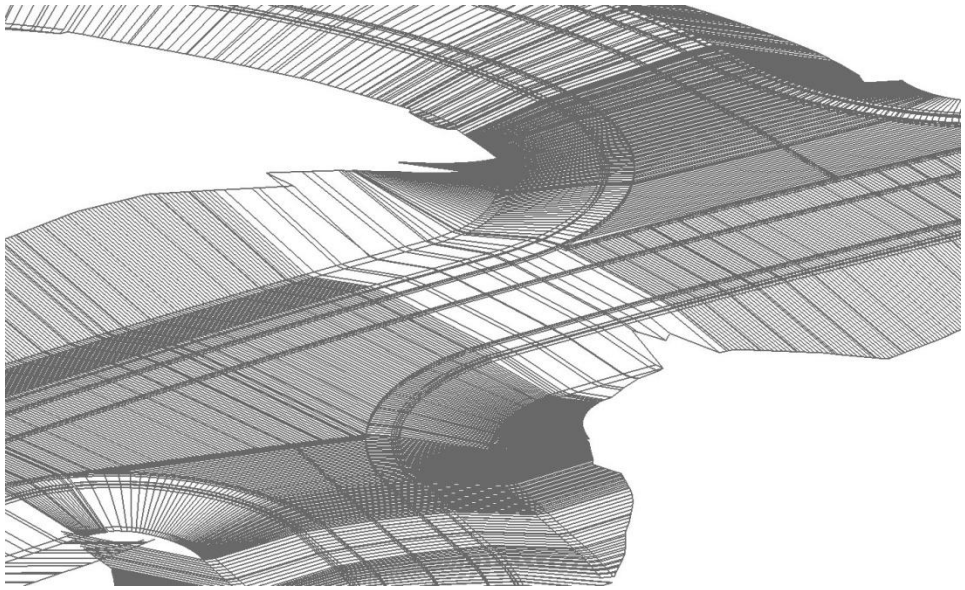
In the exercise where the "T" intersection was modeled, the template was edited to remove the end condition components in the intersection. Now, End Condition Exceptions will be used on the right side to remove the side slopes within the station limits of the Side Road.

1. Select **Corridor > End Condition Exceptions**
2. Key-In **130+89.57** for the Start Station
3. Key-In **131+49.41** for the Stop Station
4. Select Apply To: Right Override
5. Enable **Backbone Only**, then click **Add**
6. Process All and review the results

EXERCISE: GENERATE THE FINAL DESIGN SURFACE

Now that all of the corridors have been modeled, one design surface will be created from all three corridors

1. Remove any of the previous surface features from the CADD file.
2. Select **Corridor > Create Surface**
3. For the surface name enter **Final 3-Roads**
4. Select all three corridors from the list.
5. Enable Remove Loops and Display Features in Plan View, then click **Apply**
6. Use the MicroStation view commands to rotate the view and review the results.
   Your results should look similar to the illustration below



7. If desired, surface editing tools can be used to refine the final design surface after it has been created.