

Module

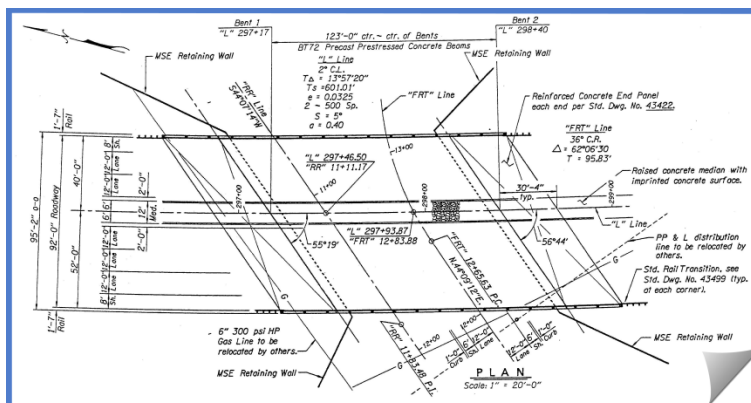
08

ABUTMENTS

Using InRoads

Introduction

This module will work through the process of modeling around abutments; however, because of the uniqueness of each design, this modeling will be approached from a simplistic perspective, and then later discuss other specific items relative to the tools, techniques and user focus.



When considering detailed abutment modeling, it can be found to be more of a ‘tool box’ activity versus being able to be executed along a rigid ‘workflow’. Therefore, due to the unique nature of this work from both design variations and software interaction, the main intent of this module will be to present the basic tools and concepts that *may* be used to execute this type of work on your project.

Ultimately, you will need to understand the basic modeling concepts, tools and techniques presented so that they can then be applied to the specifics of your project, determining the methodology that you will take, as well as how much of the abutment modeling detail will be done.

Purpose of this Module

The purpose of this module is to show a basic method to modeling abutments with InRoads, utilizing techniques that involve MicroStation, the surface design tools as well as templates, and to be able to use these techniques to model the abutments of your specific design project.

Objectives of this Module

At the end of this module, you will be able to create an accurate InRoads model of the abutment area using the InRoads surface design tools and InRoads modeling with templates as appropriate to your project design requirements.

Definition of Audience for future Modules

Please note that this module assumes that you have a certain level of competency with the software tools and will be asking you to execute some commands with very little instruction. This module was designed with a certain technical audience in mind, so ensure that you have the proper prerequisites.

Skill Level / Prerequisites:

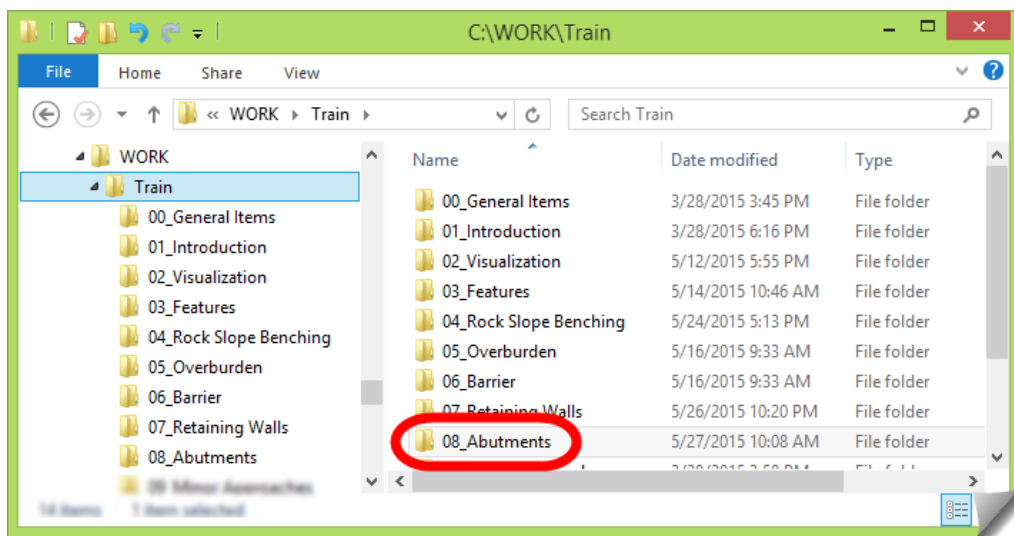
The prerequisites for this module are the following:

- Module 1 – Introduction to the Training Modules
- Module 2 – Visualization
- MicroStation Basics
- InRoads Level 1

Module Files and Folders

Training Folders

You will be working on your own hard drive during this training. The module instructions will expect the training files and folders to be set up as shown here in order to align with the module directions. You should have the **08_Abutments** training folder and files on your local drive. The module folder and related files should be placed under the **C:\WORK\Train** folder, and look like this:



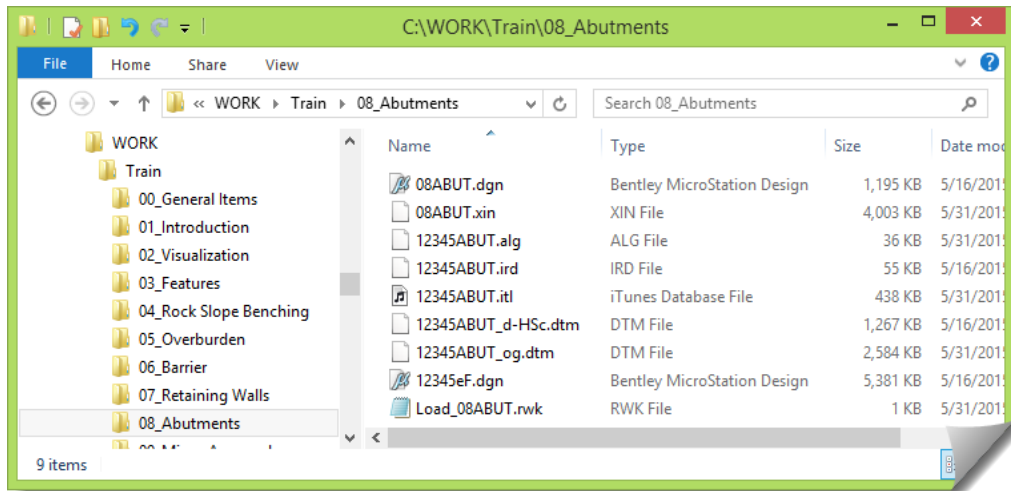
Training Files

The module folder contains all the files that will be used in these exercises including:

- **08ABUT.dgn**, the initial MicroStation file used at the start of the exercises
- **08ABUT.xin**, the InRoads configuration file for this work

There is an **RWK** file included in the module folder to assist in opening the InRoads files.

In this module folder, you should have these files:

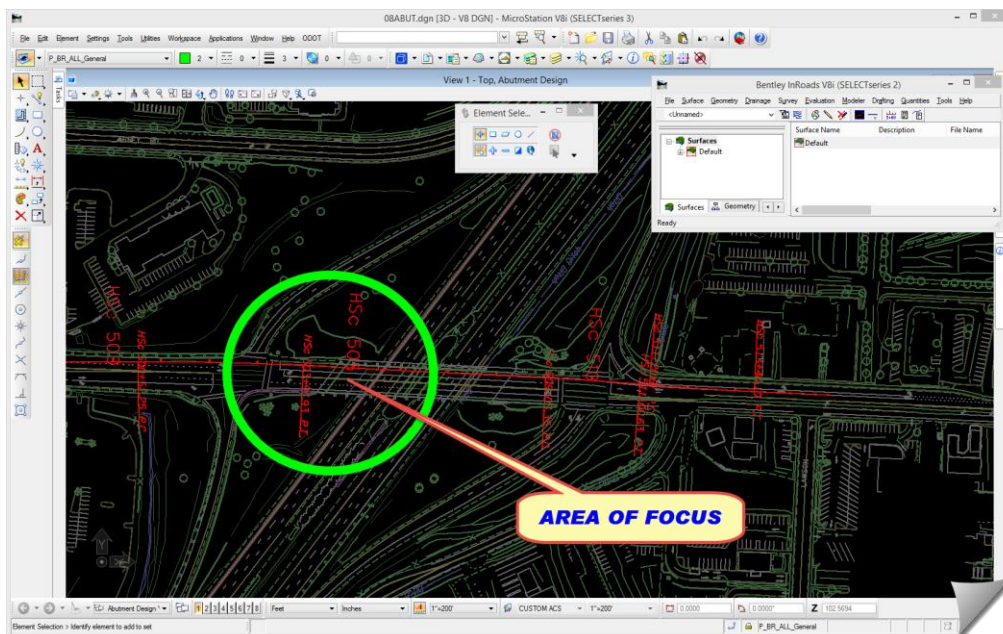


Technical Content of Training:

Project Orientation

REVIEW WORK AREA

The OG surface and **HSc** alignment are already created and will not be modified in this module. The focus of the work will be the west abutment around the bridge overpass shown below.



PREPARE MICROSTATION / INROADS DATA & FILES

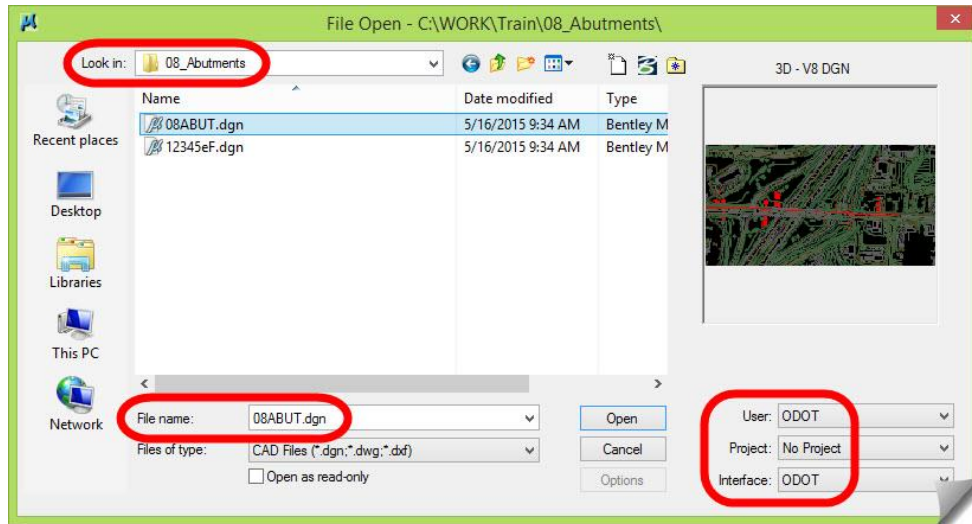
This section will get you into the DGN, load the module-specific XIN and other data files.

1) Launch InRoads

Use whatever mechanism you are familiar with to get the software started.

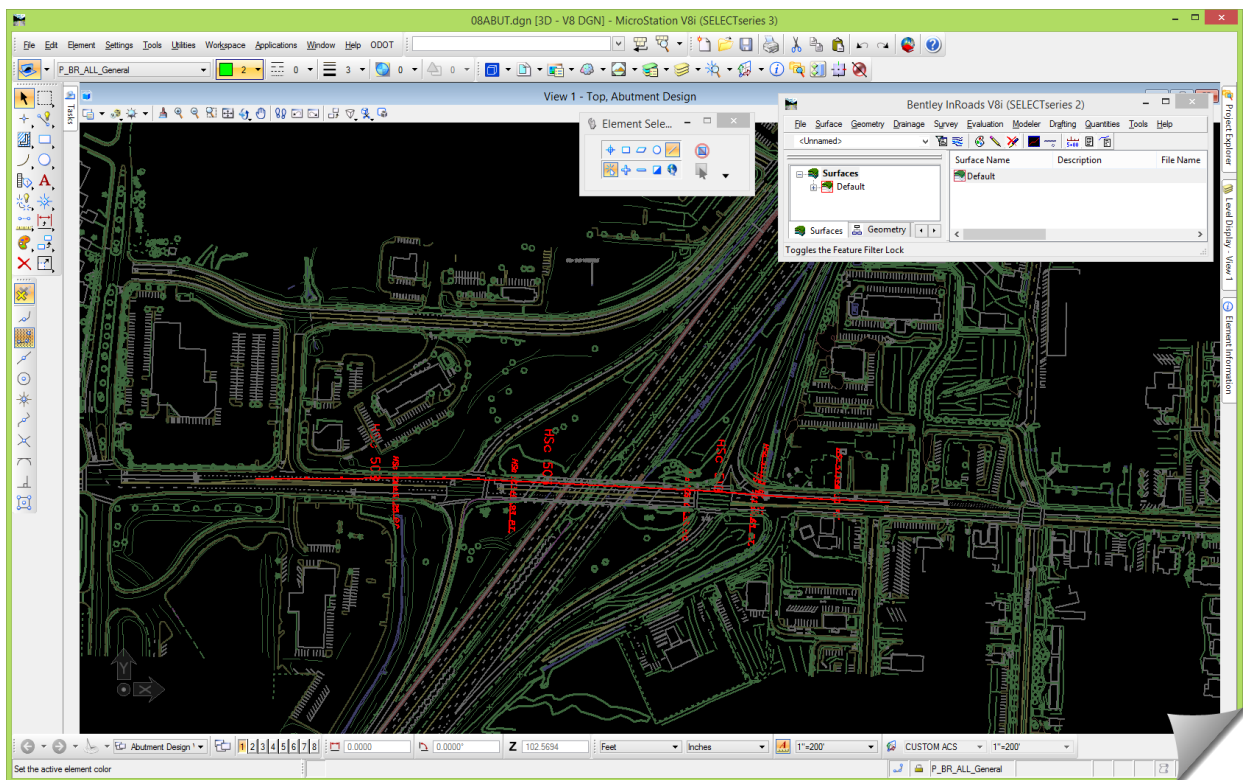
2) When the **MICROSTATION MANAGER** opens, set the **User** and **Interface** to **ODOT**.

3) Browse to **C:\WORK\Train\08_Abutments** and select the **08ABUT.dgn** file and [**Open**].



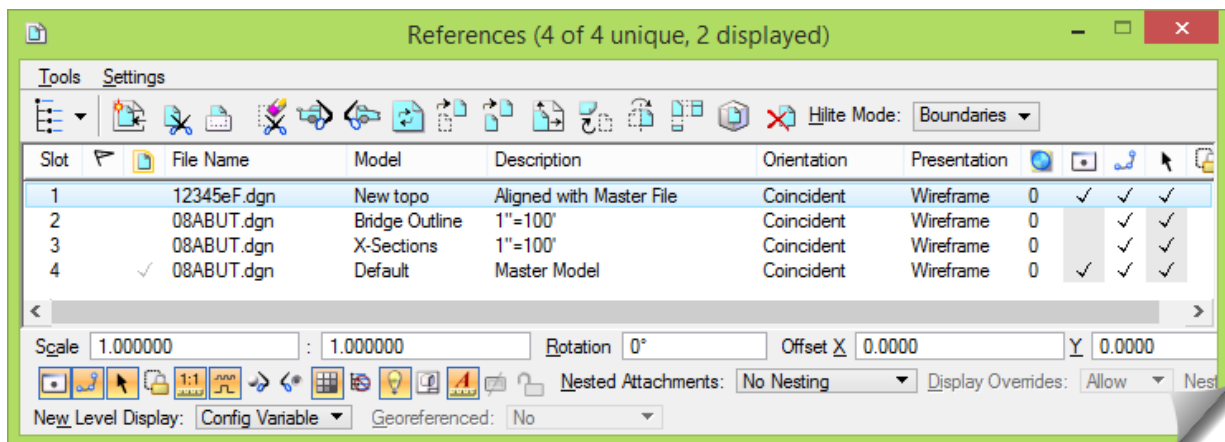
Eventually, MicroStation and then InRoads will open.

4) When the drawing opens you'll see that it has some content.



- 5) Open Windows **File Explorer** and browse to the **08_Abutments** folder.
- 6) Drag & drop **Load_08ABUT.rwk** into the InRoads interface to open the InRoads files.
- 7) Verify inside InRoads that the following files have been opened:
 - **08ABUT.xin**
 - **12345ABUT_og.dtm**
 - **12345ABUT_d-HSc.dtm**
 - **12345ABUT.alg**
 - **12345ABUT.itl**
 - **12345ABUT.ird**
- 8) Feel free to review the project data just opened by doing any or all of the following tasks:
 - a. View the **PERIMETER, FEATURES, CONTOURS** or **TRIANGLES** of the surfaces
 - b. View the **HORIZONTAL ALIGNMENT HSc**
 - c. View the **STATIONING** of the **HORIZONTAL ALIGNMENT HSc**
 - d. Create a **PROFILE** and view the **VERTICAL ALIGNMENT** called **HScvdr**

At this stage, it's not necessary to review the ITL or the IRD in the **CREATE TEMPLATE** or the **ROADWAY DESIGNER**. You will be guided into these files later in this module as needed.
- 9) Review the MicroStation models and reference files that are attached to this drawing so that you are oriented to the DGN file that is open.



- 10) Move forward into the study portion of this module. Feel free to interact with the software as needed during your study in order to solidify any of the items under discussion.

Theory - Study

There are two broad categories of design work when it comes to learning to apply InRoads.

- a. *Procedure* variety – those topics that are geared more to a specific workflow process, like how to get ROW **Features** on your Cross Sections, or executing the **GENERATE SLOPED SURFACE** command, or how to create a new **Corridor** in the **ROADWAY DESIGNER**. The execution of this variety of work is mostly mechanical, requiring an understanding of the various settings and prompts during execution.
- b. *Toolbox* variety – those topics that require *thought, evaluation* and *decision*, like ‘when’ should I use the **GENERATE LONGITUDINAL FEATURE** command, or should I use a **PARAMETRIC CONSTRAINT** or **POINT CONTROL**? InRoads becomes a mechanic’s toolbox in these cases.

One is obviously more challenging than the other is, and requires a deeper understanding of the software tools and design goals. With the *toolbox* variety, the more tools and techniques that you know the better off you will be, and the subject of abutment design is clearly of the *toolbox* variety.

This topic will be broken down this way:

- Discuss the generalized types of abutments that will be encountered
- Identify the software tools that are related to this work
- Sketch out the software techniques that can be used
- Move into the hands-on and continue to develop this topic

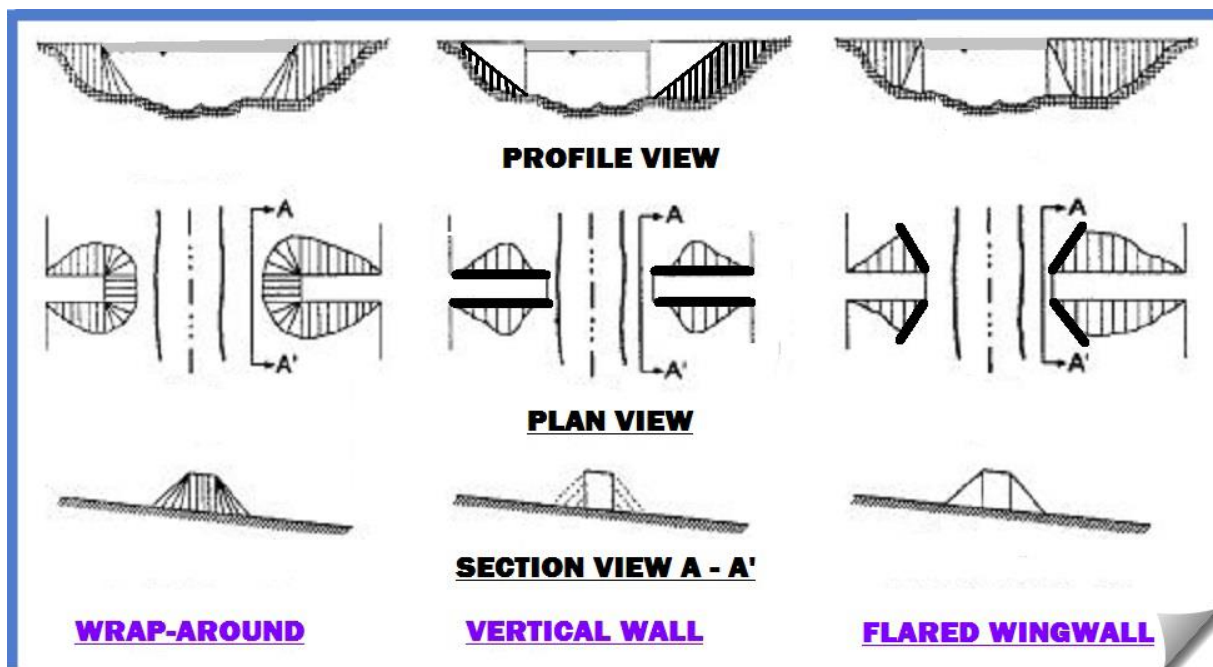
PROCESS OVERVIEW

Things to Consider

Categorizing Bridge Abutments

In an attempt to narrow and define the possible abutment variations in this subject, it might be said that there are three different types of abutments, which we'll call:

- Wrap-around** – where the grading slope starts and matches the roadway fill slope and continues to wrap around the abutment, transitioning from the roadway side slope to a slope under the bridge itself, and back around to the other side.
- Vertical Wall** – this type of grading slopes downward along a wingwall that is perpendicular to the vertical face of the abutment that parallels the roadway edge. This style minimizes the span length required.
- Flared Wingwall** – this design contains walls that angle outward from the abutment, extending until they intercept the normal roadway side slope.



Think back to abutments that you have encountered and place them within these three broad categories if you can.

Of course, many variants exist which contain elements of several of these types combined in one manner or another. A few example photos are provided here:



WRAP-AROUND



VERTICAL WALL



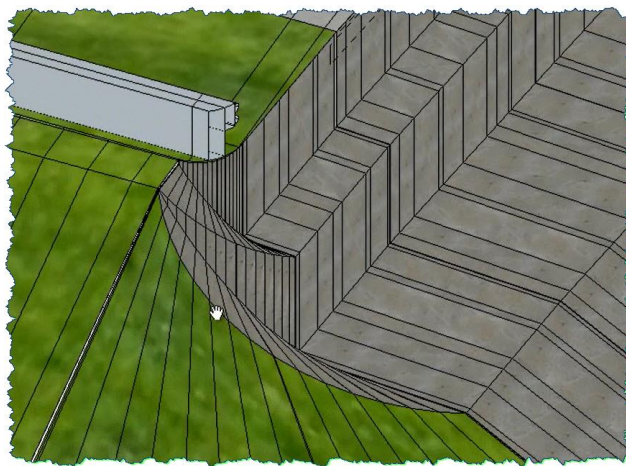
FLARED WINGWALL

Modeling Level of Detail

A question that must be answered by the Roadway designer is how detailed should the InRoads modeling be? The answer will define the tools and techniques that are used, as well as the length of time it will take. Of course, in general, the more detail required the longer the modeling time will be.

Why model? Modeling can be used for:

- Verification and validation of general design guidelines and project-specific integration
- Developing quantity take-offs
- Improved plan, profile and cross section display
- Constructability reviews
- Visualization



If detailed InRoads modeling is desired, or required, it will be vital that the Roadway designer work very closely with the Bridge designers and others involved to ensure that the model is an accurate representation of the design intent and meets the goals that motivated the modeling.



ALERT: It is sometimes found that the modeling of a design condition provides insight into areas of the project that might otherwise not be considered or directly observed, as well as revealing design details that may be inaccurate. Be alert for this and coordinate with the Bridge designer on any dimensional or layout issues that might be found.

High Level Modeling Overview

From a very high altitude viewpoint, abutment modeling can take on this general framework:

- a. Model the main roadway and bridge in a continuous corridor as usually done
- b. Identify the abutment locations and as many details about its construction as are available
- c. Create separate surfaces of the road on both ends of the bridge (removing bridge modeling)
- d. Define the level of detail for the abutment modeling and the InRoads techniques to be used
- e. Using either the **DESIGN SURFACE** tools, or the **ROADWAY DESIGNER**, model the abutments
- f. If desired, combine the abutment modeling and roadway model for each end of the bridge

This general workflow is the approach taken in this module.

Modeling Variables

This will be reiterated throughout this module as reinforcement – there are so many potential variables to abutment modeling that some of the actions offered here may not apply precisely to your specific project. In order to be successful with this type of modeling, the direction, tools and techniques found in this module have to be understood conceptually so that you will know how and when they apply to your specific modeling situation.

Here are a few project-specific variables that will occur:

- What your roadway section looks like
- The horizontal location of your abutment control
- The elevation or vertical grade of your abutment control
- The way that you want to transition from the full road section to the abutment grading
- What your abutment modeling templates look like
- What transitions look like (if you have them), exactly where they start, and for how long
- Where your abutment control elevations and location are (either along the roadway at the top, or on top as well as the bottom of the abutment grading)
- Whether you integrate it into your roadway model or keep as separate surfaces

These are all questions that will have to be asked, and answered, when doing this type of modeling with InRoads.

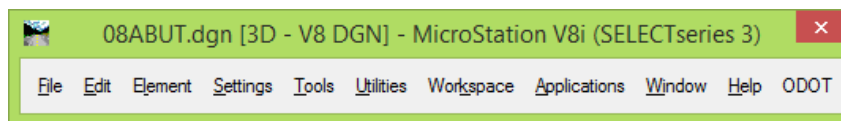
Understand that for this particular module, the answers to these questions, as integrated into these exercises, should be given some leeway and ‘artistic license’. The purpose here is to show how this type of work can be accomplished, and the tools that can be used to accomplish it. The exact project details, precise dimensions, and design criteria will not be given a significant amount of emphasis. That is for you to do on your project.

Techniques and Tools

Remember, this type of work is very tool-centric, so the more tools that you understand and can use the better off you will be. Moreover, this covers the tools in both InRoads and MicroStation.

MicroStation Tools

Although the focus of this module will be the InRoads tools and techniques, your MicroStation skills will go a long way with this type of work.



A few specific MicroStation-related tasks that may be done include:

- Drawing Lines / Placing Shapes / constructing Fillets
- Modify / Break / Extend / Trim / Inserting vertices / Deleting vertices
- Chaining line work together
- Copy / Move up and down
- Snapping to InRoads displayed graphics
- Placing Fences
- 3D View Rotation

Using drawn or manipulated MicroStation graphics can be very useful with abutment modeling.

InRoads–Specific Tools

Since modeling is an InRoads-based activity, the key tools are naturally those found in InRoads. Beyond that, with abutment modeling, the tools and their application can begin to move out of a Roadway designer’s comfort zone depending on the modeling technique chosen.

There are two basic modeling techniques in InRoads, which will then define the tools used.

- a. **Area** grading – this technique focuses mainly on the **DESIGN SURFACE** tools, with sporadic requirements to use some of the **EDIT SURFACE** tools. The possible challenge here is that these tools tend to be seldom used in a heavy roadway-driven design environment.
 - Place Feature
 - Drape Surface
 - Generate Sloped Surface
 - Apply Template
 - Set Elevation
 - Project Line to Surface
- b. **Corridor** grading – this technique utilizes tools and processes familiar to the Roadway designer and encompasses template creation and corridor construction.
 - Create Template
 - Roadway Designer

These tools will be discussed in more detail as they are used later.

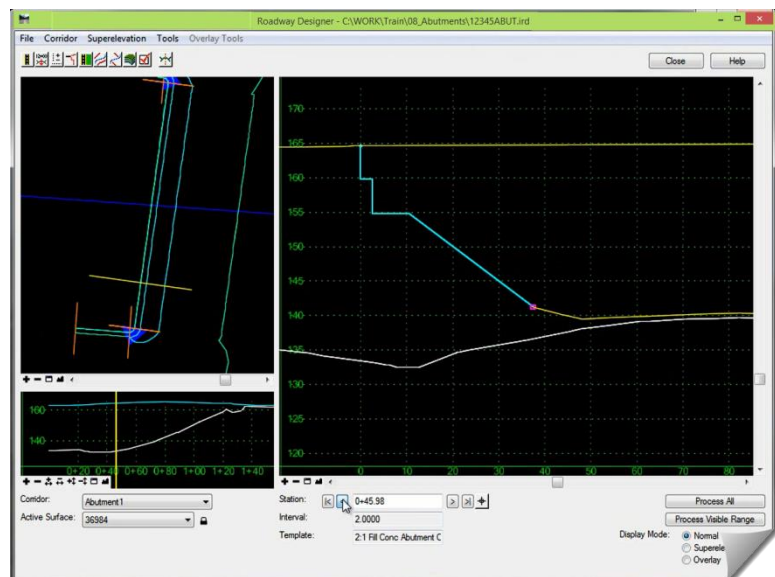
Apply Template Tool

Roadway designers should be comfortable with construction and application of templates. However, most of this experience is likely connected to the **ROADWAY DESIGNER**. Abutment work can leverage the capability to apply templates without the **ROADWAY DESIGNER** along either a **Feature** or graphic using the **APPLY TEMPLATE** tool under the **DESIGN SURFACE** tools.

Roadway Designer

Civil work encompasses two broad areas – *Roadway* design and *Site* design, and InRoads contains tools that address both classifications of modeling. Because of the nature of road design, Roadway designers have become intimately familiar with the application of templates and the creation of corridors. Site designers, on the other hand, tended not to consider the **ROADWAY DESIGNER**, if only because of its formal name – the **ROADWAY DESIGNER**.

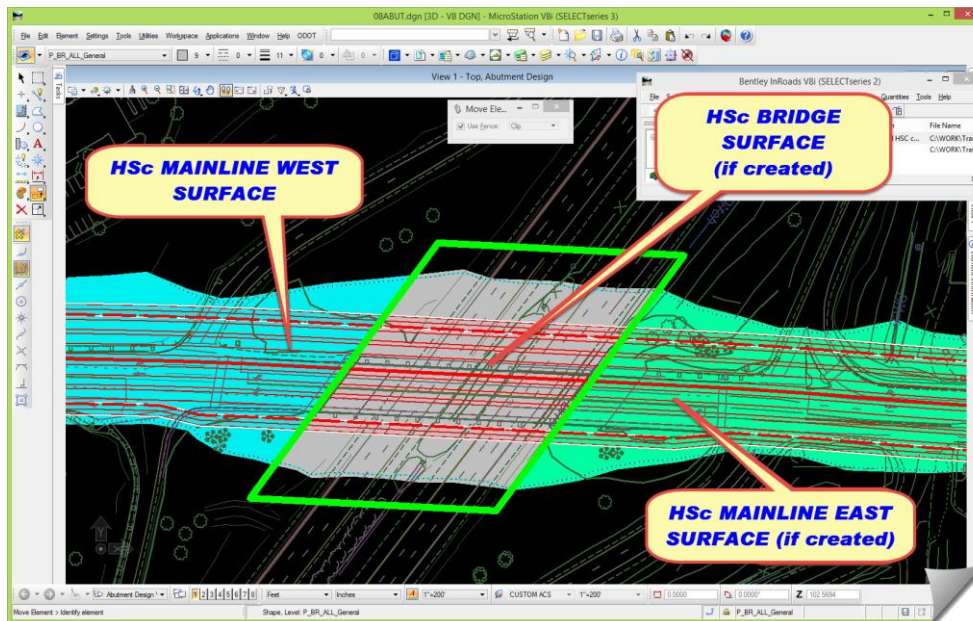
Abutment modeling is most commonly associated with *Site* design, and hence the **ROADWAY DESIGNER** tool tends to be overlooked. Using this tool for abutment modeling will be the approach used in this module, and can be a powerful method of doing this type of modeling. After this module, you should begin to consider the **ROADWAY DESIGNER** for applications beyond just the road itself.



The Overall Abutment Modeling Process

Earlier, an abutment-modeling framework was presented; this section will embellish that, adding some meat onto those bones along with some module-specific clarifications.

- a. Model the roadway and bridge in the traditional way with strategic template drops.
 - This module will not show the initial modeling construction.
 - A bridge template can be dropped at the abutment location if it's desired.
- b. Identify the abutment location and as many details about its construction as are available.
 - This will require some detailed coordination with the Bridge designer, as well as understanding how the abutment will be constructed. This includes how it will transition from the typical roadway section to the grading adjacent to, and under the bridge. The greater the level of understanding of the abutment, the easier the InRoads modeling will be. If it can't be explained or sketched on paper, it can't be modeled.
- c. After the corridor design surface is created, the bridge shape can be used (from abutment to abutment) to cut out and remove the bridge features, forming separate DTMs for the roadway on either end of the bridge. This can also be done, as in this module, using the **ROADWAY DESIGNER** to create a corridor ending at the abutment, or thereabouts as needed.
 - The goal here is to have a surface model on one end of the bridge, and another on the other end of the bridge. A third surface containing the bridge can also be created.
 - The roadway pieces on either end of the bridge can be used at the end of the abutment modeling process to integrate with the final abutment model.
 - An overall surface of the design of the roadway and the bridge may be needed and used in addition to the other 'pieces' for visualization.



TIP: The two sides of the bridge can be separated by copying the corridor and changing the station limits. However, it will still need to be clipped, or modified if there is any bridge skew. However it is accomplished, the roadway will have to be separated at the bridge.

- d. Define the level of detail for the abutment modeling and the InRoads technique to be used.
- This step is a planning stage where the details and process map is created and defined. Here are a few details about what's to come in the hands-on for this module:
 - The roadway fill slope is 1:2, so the abutment modeling will start at 1:2 to match.
 - Other sections used for abutment modeling in this module will not be based on any specific project, but on a general schematic layout. Once the modeling process is understood, it's expected that you will be able to integrate your specific project criteria into the workflows presented here to accomplish your abutment modeling.
 - MicroStation tools will be used to develop some of the initial abutment line work.
 - MicroStation graphics will be imported into InRoads to develop **Horizontal** and **Vertical** geometry to be used with the **ROADWAY DESIGNER**.
 - During the simple modeling scenario, the **GENERATE SLOPED SURFACE** tool can be used.
 - The MicroStation or InRoads tools used will be presented and discussed in varying levels of detail within each of the abutment modeling scenarios.
- e. Techniques to model the abutment using a combination of the **DESIGN SURFACE** tools and the **ROADWAY DESIGNER** will be shown.
- f. Combining the abutment modeling and roadway model can be accomplished once both surfaces or both corridors exist.
- This is just a matter of merging surfaces, either using the **COPY PORTION OF SURFACE** tool, or creating a composite surface from the **ROADWAY DESIGNER**.

This module will expand this process in the upcoming hands-on. For now, you should be getting a sense of where you will be going.

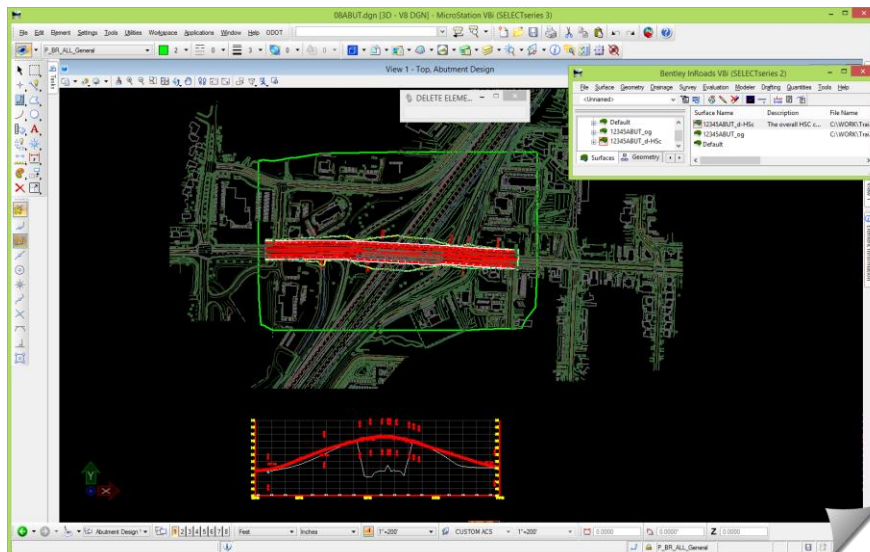
Practical Application - Hands On Lab Exercises

UNDERSTANDING THE DETAILS

Review any relevant project data

At this point, you should be in the **08ABUT.dgn** file and have loaded the InRoads RWK data.

- 1) If you reviewed the project data earlier, you should be looking at something like this:

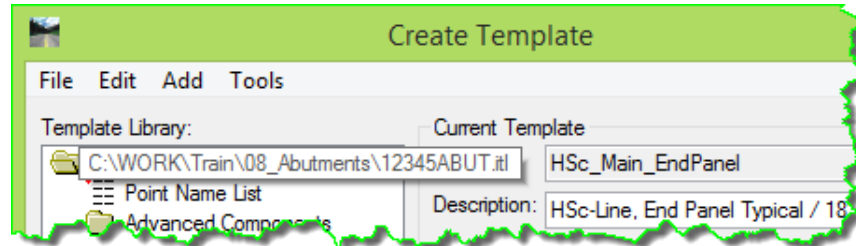


Review relevant InRoads ITL information

One technique of abutment modeling, the strongest technique, uses templates. However, since these templates have a high probability of being unique, combined with the fact that they are usually very simplistic, makes them less suited for inclusion in the standard ODOT template library. Roadway designers will more often than not find themselves just constructing the component and templates that they need for their project.

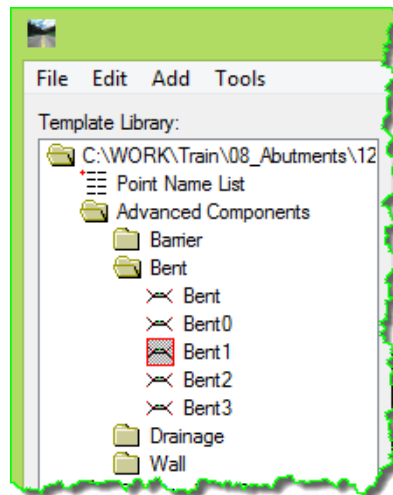
Regardless, let's take a quick look at the **TEMPLATE LIBRARY**.

- 1) Go to the InRoads main menu, open the **CREATE TEMPLATE** tool, and verify that the correct **ITL** is opened by checking the path at the top of the Library window.



- 2) Now browse and open the **Bent** folder under **Advanced Components**.

You will see a couple of components that can be used as a starting point for your abutment modeling.

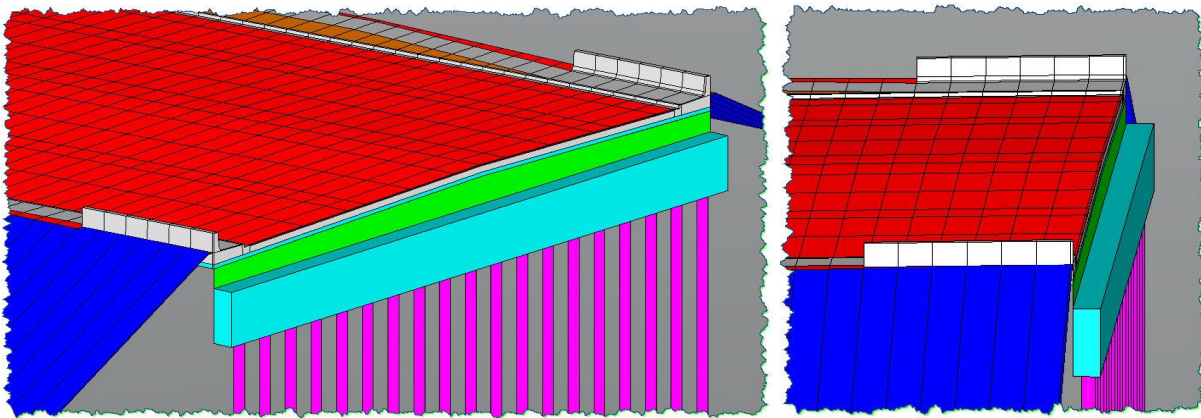


- 3) Feel free to review and [**Test...**] those components.
- 4) [**Close**] this dialog box when you are done.

SCENARIO - ABUTMENT MODELING

This module is not going to focus on the modeling details for the roadway corridor, and will be simply looking at how the grading around the bridge abutment will be accomplished. With that said, the **ROADWAY DESIGNER** has already been set up with two corridors.

- **HSc Mainline over Bridge_Full** – this corridor models the roadway from a starting point on one side of the bridge and carries the normal roadway section over the bridge to an ending point on the other side of the bridge.
- **HSc Mainline West** – this corridor is a copy of the one above with a few modifications as noted here:
 - The corridor has a **Stop Station** of **504+80.333**, which has been determined to be the location where the modeling first encounters the bridge bent.



- The corridor modeling details have been enhanced to incorporate a section with the bridge's associated end panel. Adjustments were also made to the planter strip, sidewalk and berm to match the bridge section.

This section will be covering:

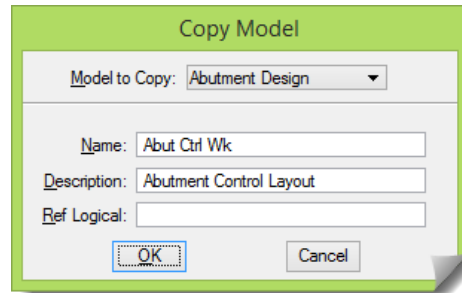
- Creating a surface for the west end of the bridge in the Roadway Designer
- Defining the 'base' abutment control line where the modeling will be originating from
- Determining the 'wings' of the abutment control line where the base control ties into the roadway modeling
- Import that graphic as either a surface Feature in **12345ABUT_control.dtm** or as an alignment in the main geometry project
- Creating the abutment corridor in the **ROADWAY DESIGNER**
- Creating a composite roadway and abutment surface model

Create the West Design Surface

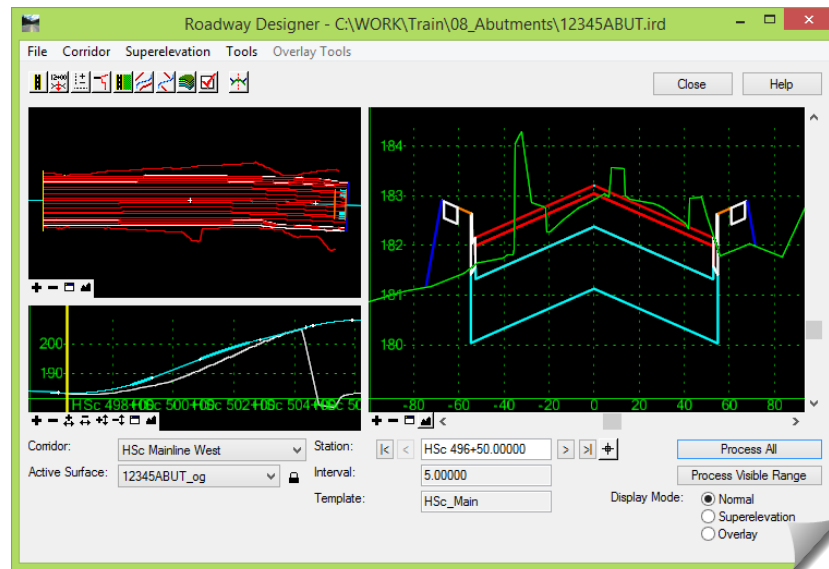
This section will use the pre-created corridor in the Roadway Designer for the west side of the roadway and generate a design surface. Once this design surface is created, the abutment control path will be developed in MicroStation.

- 1) Copy the **Abutment Design** MicroStation model and call it **Abut Ctrl Wk**.

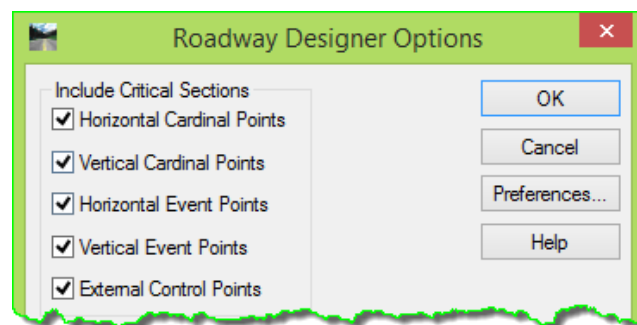
After this is created, it should become the active MicroStation model.



- 2) Open the **ROADWAY DESIGNER** and set the **HSc Mainline West** corridor active.

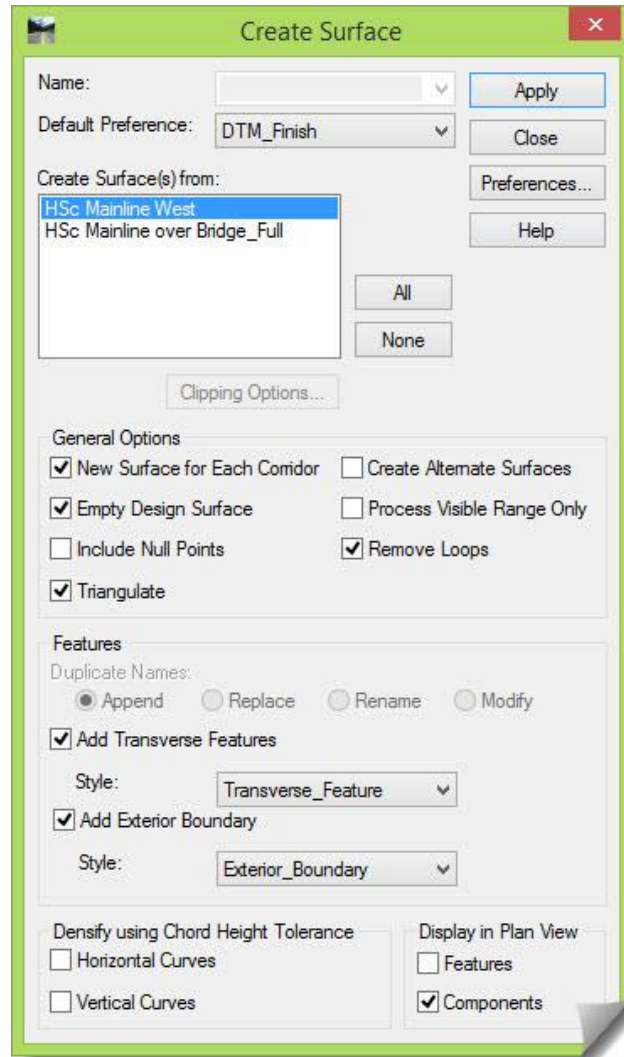


- 3) Make sure the **ROADWAY DESIGNER OPTIONS** are toggled *on* as shown here:

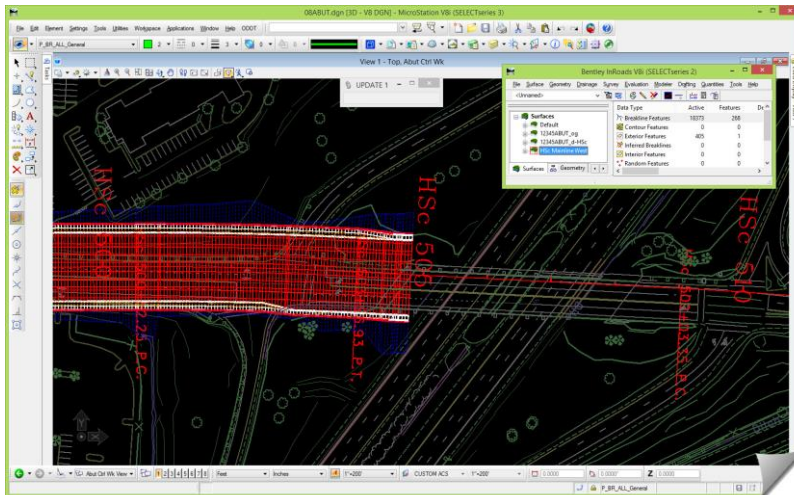


This is to make sure that any unique station locations are modeled relative to any **POINT CONTROLS** defined, and certain other station-related influences. These settings are discussed in more detail in later modules where they have a greater impact on the modeling.

- 4) Go to **CREATE SURFACE** and define the settings as shown here:

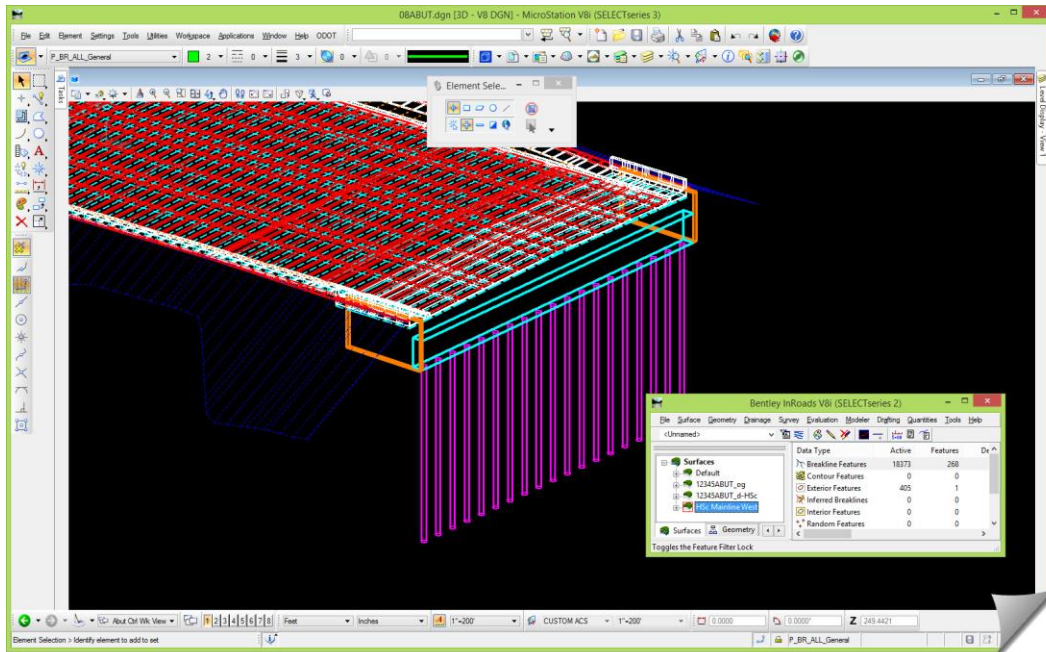


- 5) **[Close]** this command and then the **ROADWAY DESIGNER** once the surface is created.
- 6) **[Save]** the new design surface.

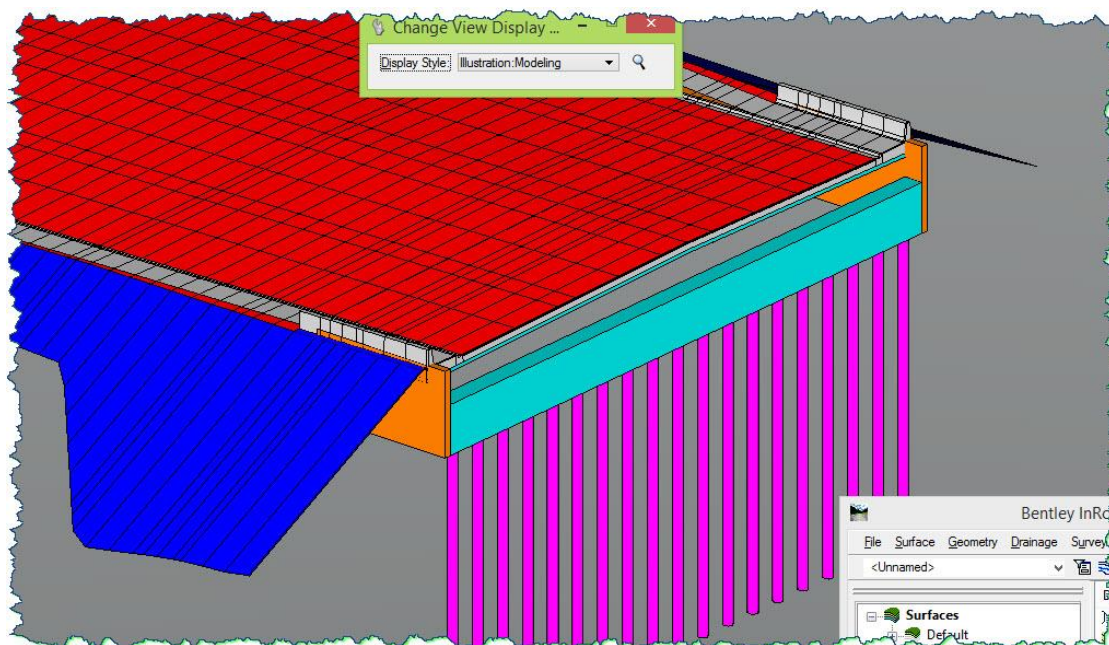


- 7) Toggle *off* all of the **Reference** files in the drawing.
- 8) Turn on the **LEVEL DISPLAY** for the **P_BR** levels.

These levels contain some rough bridgework representing the bridge piles, bent cap, and retaining walls. This information isn't required, but it provides a good visual orientation to laying out the abutment control. (If available, an accurate 3D bridge model should be obtained from the Bridge designer.)



A rendered view presents an improved visual perspective of the work, so use the **Display Styles** to your advantage when working with InRoads.



- 9) Take a few moments to review these MicroStation graphics.

Creating the Abutment Grading Control

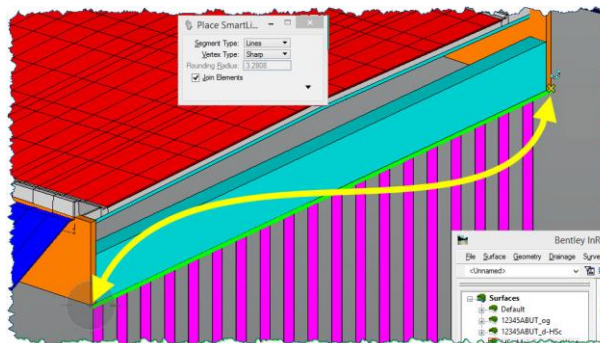
Next will be the creation of a very simple control line that will be used to develop the abutment grading. A slope will be projected from this line to the OG surface.



ALERT: The goal of the upcoming steps is to create a 3D line that represents the location from where the abutment grading will project. The exact path of this control line is completely dependent upon the specifics of your project, the bridge design details, and how precise the grading results have to be for the abutment modeling.

- 1) Draw a MicroStation **Smartline** that traces along the bottom of the bridge bent cap, from the outside of the one retaining wall to the outside of the other.

(It actually doesn't matter where it's drawn vertically because the elevation will be defined in a separate step.)



The next step will be to define the elevation of that line. This elevation will be developed between the Bridge designer and Roadway designer and may require some back and forth collaboration and analysis of the physical characteristics of the bridge itself as well as the surrounding terrain.

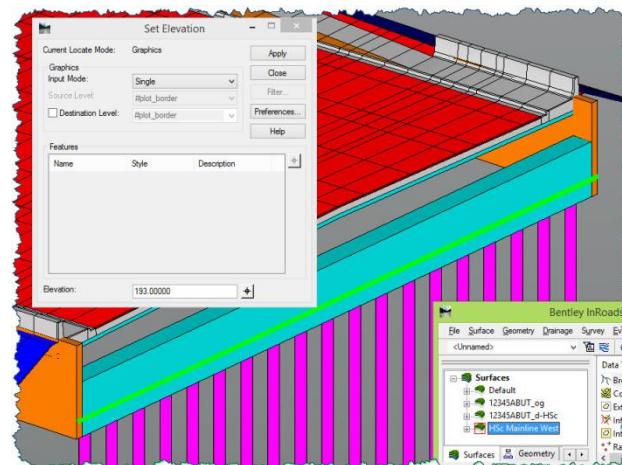
In this instance, the elevation at the face of the bent was found to be 193.00.



TIP: The control line location is initially developed by projecting the chosen design slope from the critical feature at the bottom (e.g. back of berm, sidewalk, or ditch). After reviewing where the projected slope catches on the face of the abutment, the location of the control line can be established.

- 2) Using a method you are familiar with, move the line just created to elevation 193.00.

From an InRoads perspective, the **SET ELEVATION** command under the **Design Surface** tools can be used with the InRoads **Locate Lock** set to **Locate Graphics**.



Now the control will be defined from the end of the line along the face of the bent cap, and up the face of the retaining wall to the roadway side slope.

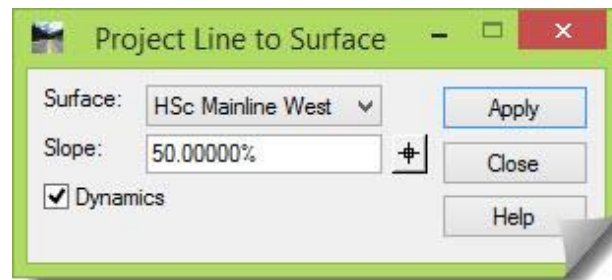
In this instance, a 50% slope will be used along the face of the retaining wall as it makes its way from the bent to the roadway berm.

Just for clarity, the side slope component has been deleted from the MicroStation view.

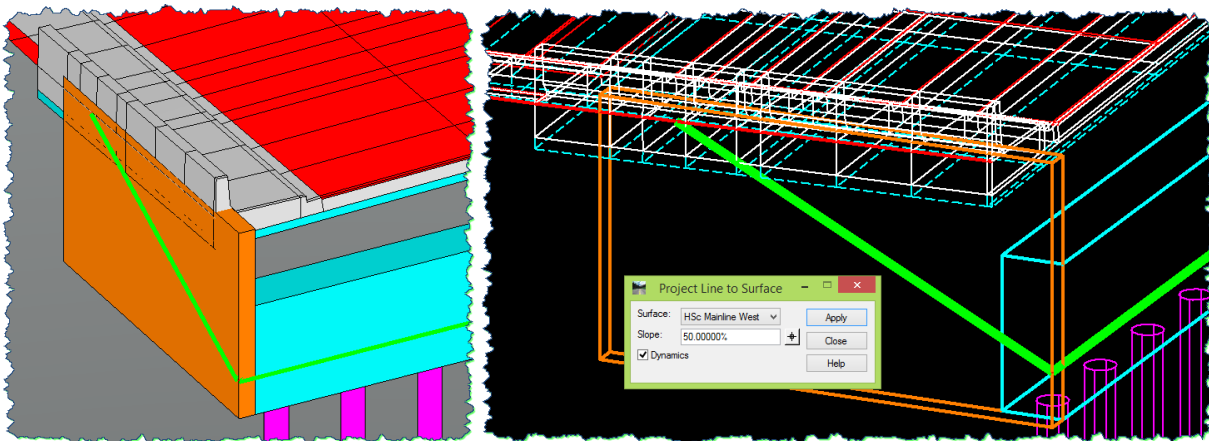
- 3) Open the **PROJECT LINE TO SURFACE** command under the **Design Surface** tools.

This simple tool is explained at the end of this module in the section titled - *Other Details – Miscellaneous Topics*. The settings only require the **Surface** to intercept, the **Slope** of the desired projection, and whether or not you want to see the projected line in **Dynamic** mode.

- 4) Set this command up for a 50% **Slope** to project to the roadway surface.



The intention here is to project the slope from the control line at the bent, upwards along the face of the retaining wall to determine the intercept with the roadway surface. This will help define the length of the required retaining wall.



Note that the graphics above show this tool projecting a line in a rotated view. This is only for added clarity to show the line that it is projecting from.



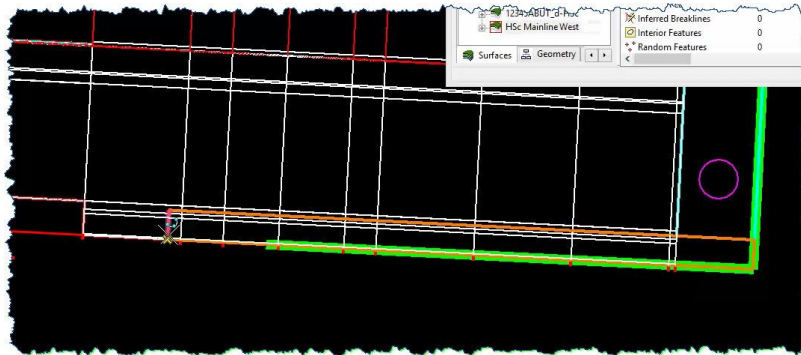
ALERT: This tool is very difficult to work with in a rotated view. It is strongly recommended, for accuracy-sake, that a top view be defined when using this tool.

- 5) Set the MicroStation view to **Top**.

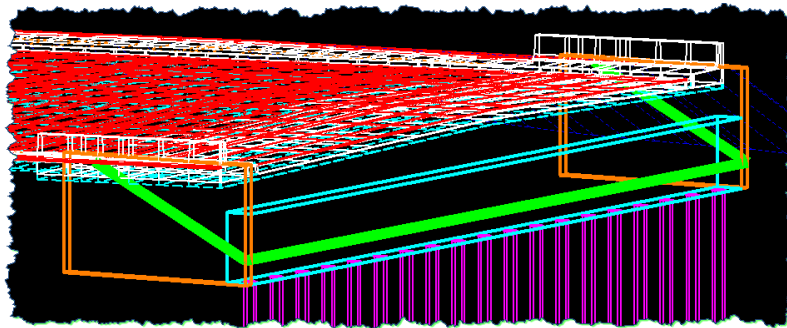
- 6) **[Apply]** the command and you will be prompted to *<Identify first endpoint>*.
- 7) Select the end of the 'control' line that was placed and moved to elevation 193.00 along the face of the bent.

As you move your cursor, you will see the line dynamically changing its length as it finds the intercept with the design surface in the direction of your cursor.

- 8) When prompted to *<Identify direction>* select the end of the retaining wall shape to define the direction.

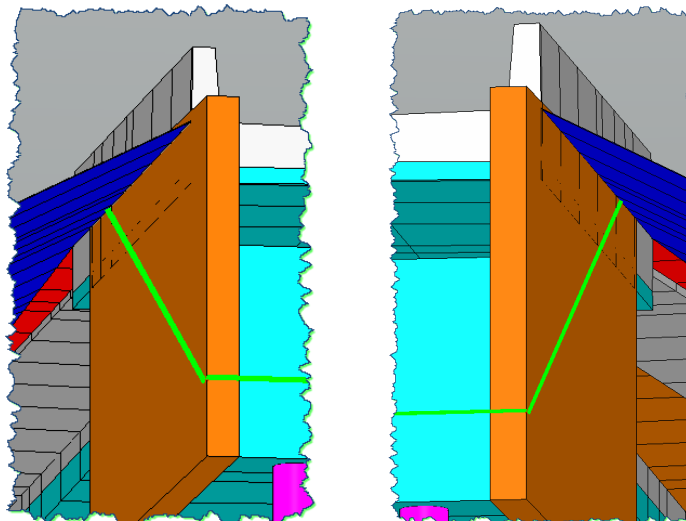


- 9) Repeat the last few steps with the other side of the abutment.



- 10) Verify that both of the 50% slope lines intercept the design surface properly.

These are just MicroStation lines. The next step is to get all of these control lines into InRoads so they can be used in the **ROADWAY DESIGNER**.



This modeling could be done with the **GENERATE SLOPE SURFACE** tool as well as the **APPLY TEMPLATE** tool. In this module however, it will be constructed using the **ROADWAY DESIGNER**.

First, this control will be brought into a **Geometry Project** as a horizontal and vertical alignment. From there it will be used for a corridor in the **ROADWAY DESIGNER** to produce the abutment slope.

Right now, three separate lines form the abutment grading control. These lines can either be chained together to form a single line, or selected and brought into InRoads as one alignment.

11) Using any technique you are comfortable with, prepare these three lines for import.

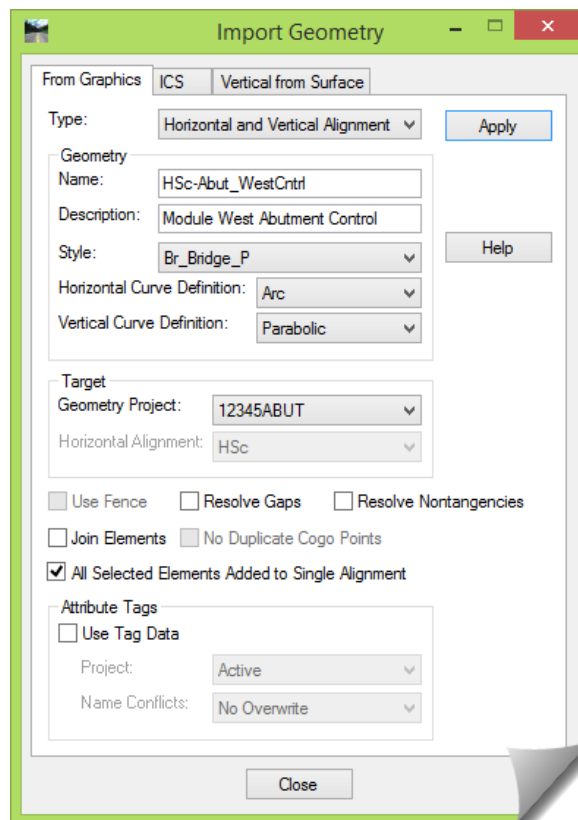


ALERT: Make sure that the MicroStation lines representing the abutment grading control are all going in the same direction before importing them into InRoads. When creating both **Horizontal** and **Vertical** geometry **FROM GRAPHICS**, extra InRoads cleanup work will be required if there are any issues with their **Integrity**.

After your MicroStation control line is prepared, an alignment can be created using the **FROM GRAPHICS** tab on the **IMPORT GEOMETRY** dialog box.

12) Go to **FILE > IMPORT > GEOMETRY** and to the **FROM GRAPHICS** tab.

13) Set it up to import both a **Horizontal and Vertical Alignment**, placing them in the module **Geometry Project**.



14) **[Apply]** the command and follow the prompts to complete the import, and then **[Close]**.

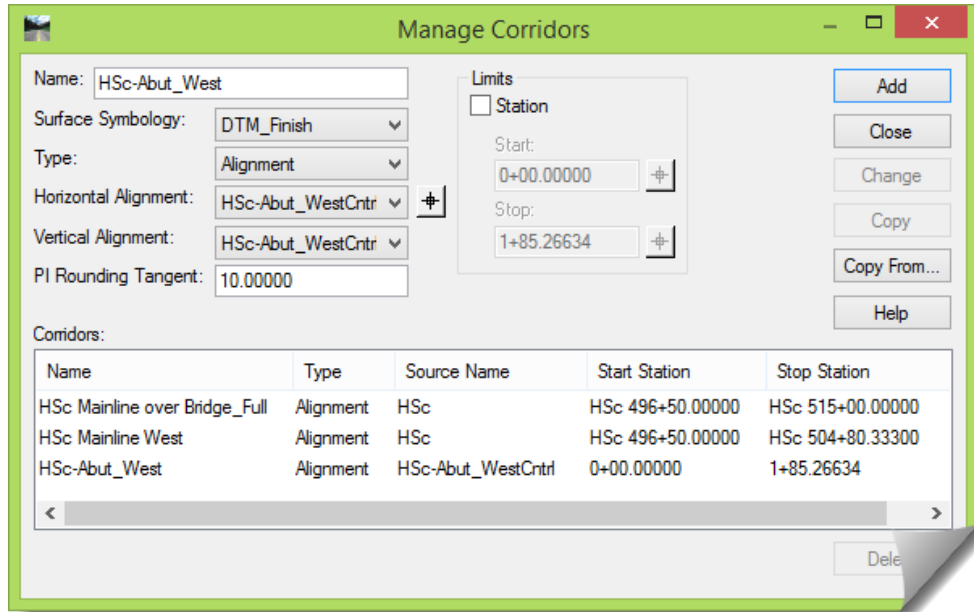
15) Verify the import with any confirmation routines that you might typically do including checking the alignment **Integrity** for both the **Horizontal** and **Vertical**.

16) **[Save]** the **Geometry Project**.

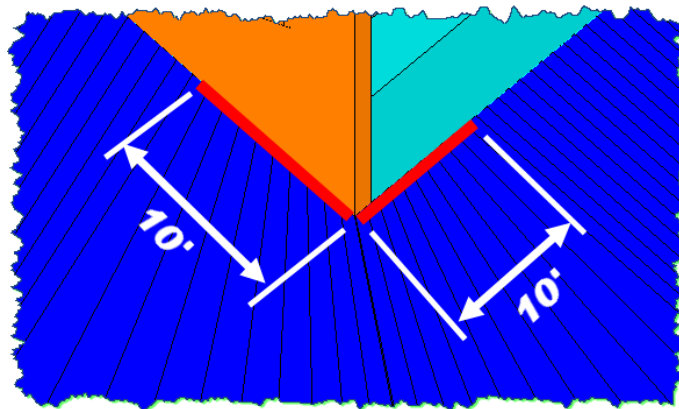
Creating the Abutment Corridor

- 1) Open the **ROADWAY DESIGNER** and set the **Active Surface** to **12345ABUT_og**.
- 2) Create a new **Corridor** for the abutment modeling using the alignment just created.

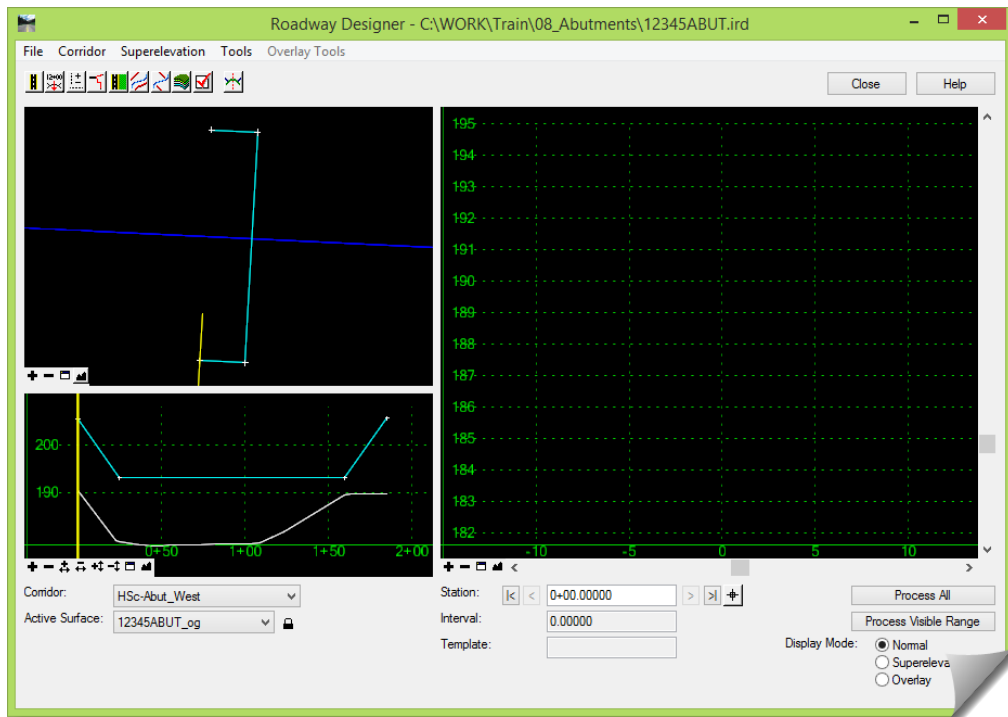
On this corridor, make sure you define the **PI Rounding Tangent**. Typically, this is set to **0.00** on most corridor models. Most models however, also have curves at the PI locations. This one does not, which is why this option is defined.



TIP: The setting for **PI Rounding Tangent** is useful when your alignment has angle points at the PIs versus curves. The value represents a 'simulated' tangent length on a curve (the distance from the PC to the PI, or PI to the PT). Modeling will begin to run orthogonal to the path at that distance from the PI. The modeling 'centerline' doesn't change, and the template origin still runs along the defined path.



- 3) [Close] the **MANAGE CORRIDORS** dialog and note the feedback in the **ROADWAY DESIGNER**.

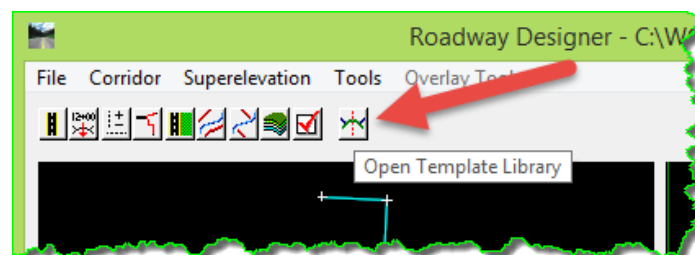


- 4) Notice the direction of the alignment modeling.

In the case shown here, it will be modeling from the south to the north. Your modeling may be the other direction. This is completely dependent on the sequence that you created the graphics followed by the subsequent import into the **Geometry Project**.

This should be noted because the template chosen next will have to be set to model on the correct side of the alignment. In this case, the modeling will occur on the right side. Also note that for the purposes of this modeling, there won't be a **_R** or **_L** designator on the template points since that suffix generally relates to the side of the roadway. If desired, a directional suffix can be added such as **_W**(est) and **_E**(ast), related to the position of the abutment relative to the bridge.

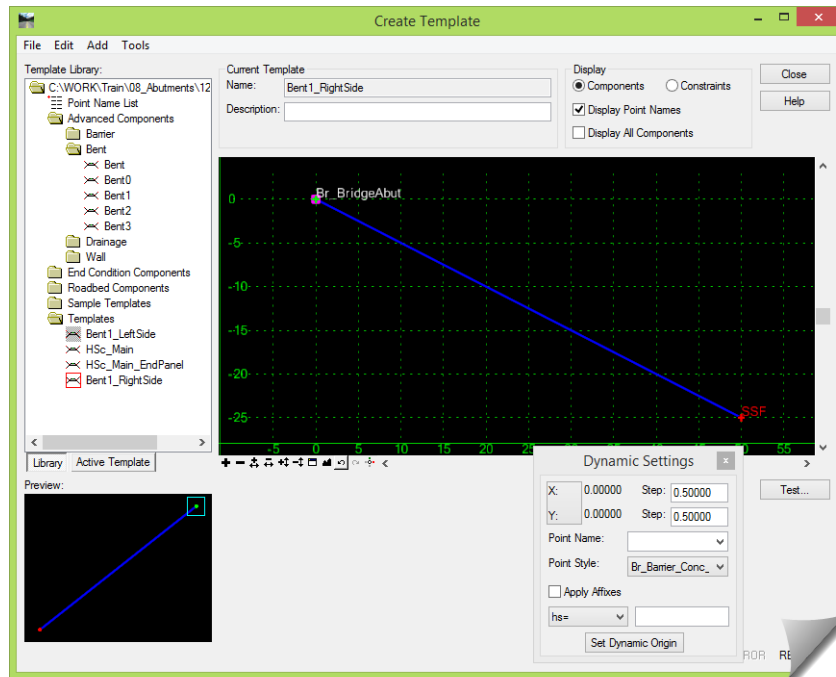
- 5) Determine on which side your modeling will occur.
6) Select the **Open Template Library** icon to open the **CREATE TEMPLATE** dialog box.



- 7) Browse to the **Bent** folder under the **Advanced Components** folder.
This module will be using the **Bent1** template.
8) [Copy] this template into the **Templates** folder for use in this module.
9) Determine if the template is correctly oriented for your modeling.
In this case, it is not, and will need to be reversed.

10) If needed for your modeling, use whatever skills you have to leverage this template and produce the one that you need with the correct orientation.

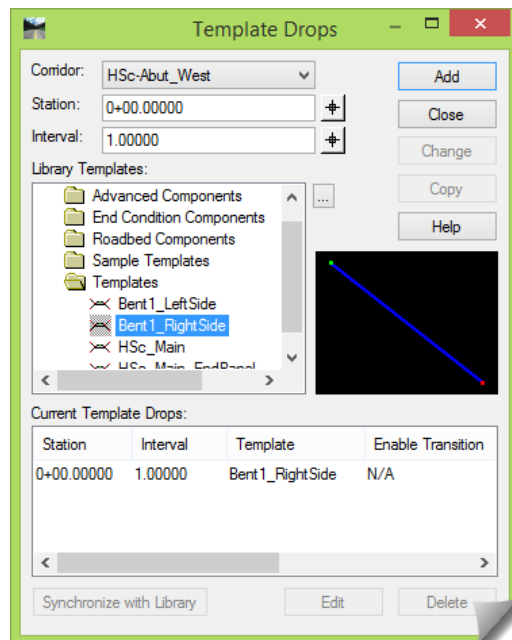
If desirable, you could rename the template points and component name to fit any naming convention standards for 'direction' that you may want to use.



11) [Save] and then [Close] the **CREATE TEMPLATE** dialog when you have completed that work.

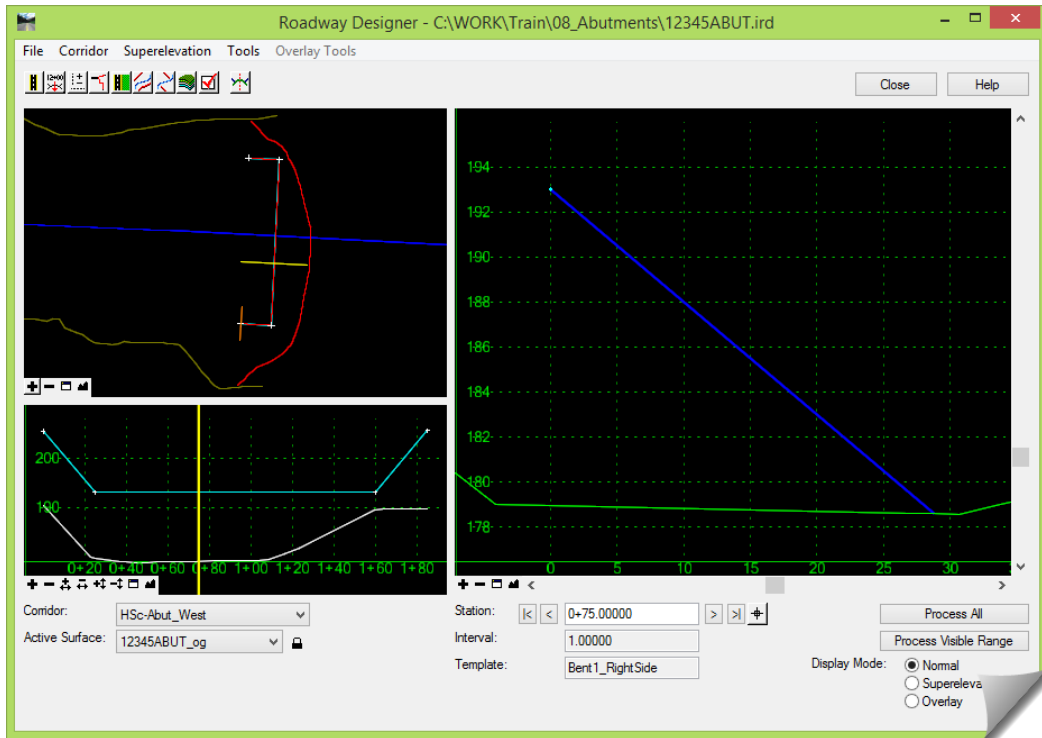
12) Open the **TEMPLATE DROPS** dialog box and add the appropriate abutment template.

This one template will run from the start until the end. The **Interval** should be something appropriate for the modeling accuracy you are trying to achieve. Don't be too concerned with this value since it can always be revisited and changed after you've reviewed your results.



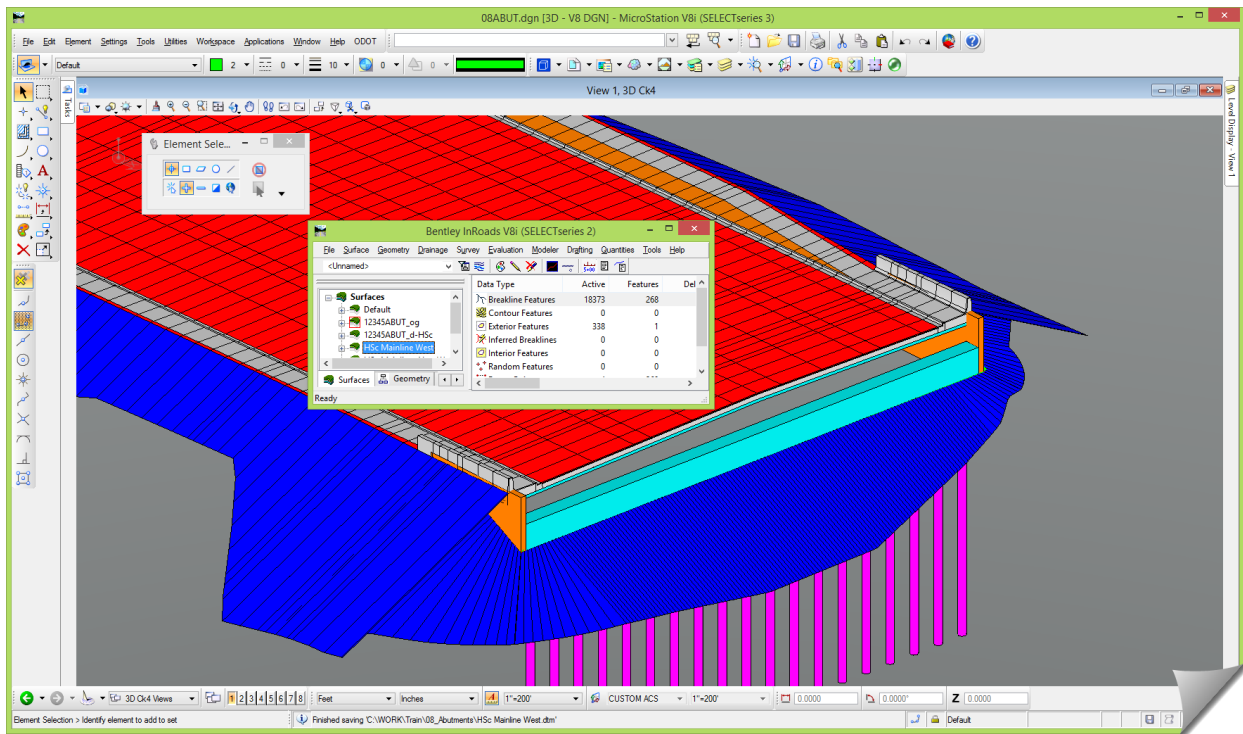
13) [Process All] and review the results in the ROADWAY DESIGNER.

Even though this is a very simple model, don't skip reviewing it before creating the surface.



14) Make sure the MicroStation model is set to **Abut Ctrl Wk**.

15) Create a surface for the abutment model and review the results in MicroStation.



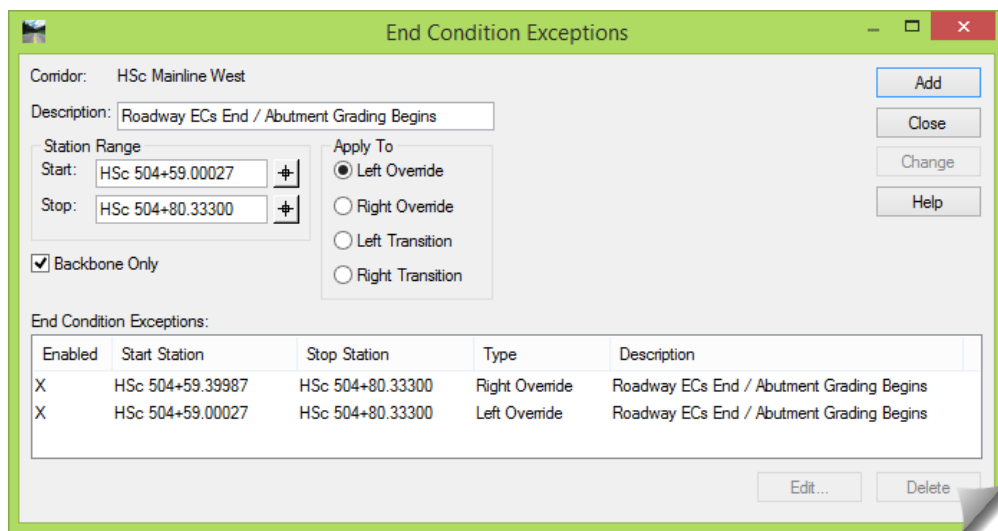
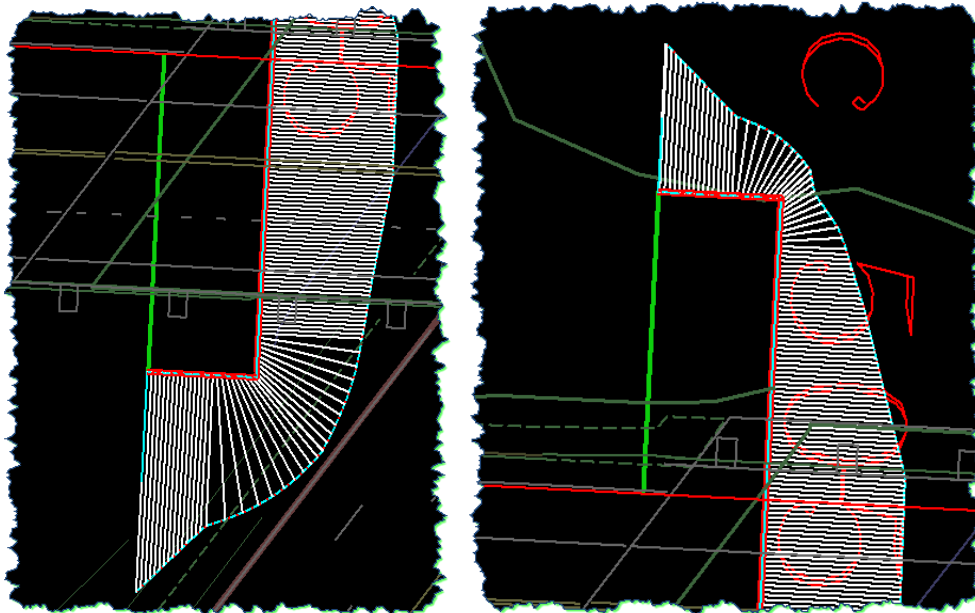
End Condition Adjustments

Next, the overlapping side slopes from the roadway model and abutment will be addressed.

In this instance, addressing the side slopes is simplified since they are both matching slope values. If the side slopes are not matching, then the slopes can either be controlled using **PARAMETRIC CONSTRAINTS** or by a **Transition-type END CONDITION EXCEPTION**.

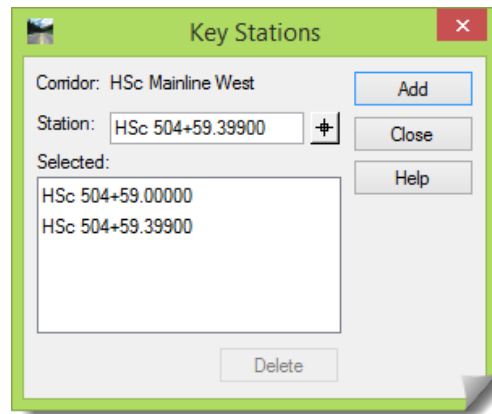
- 1) Go to the **ROADWAY DESIGNER** and set **HSc Mainline West** as the active **Corridor**.
- 2) Establish two **END CONDITION EXCEPTIONS** set to **Backbone Only** for the right and left sides of the roadway.

This is intended to turn off the roadway ECs at the exact point where the abutment modeling will take over. Make sure you locate the **Start** station from the MicroStation drawing.



These **EC EXCEPTIONS** tell the model when to turn off the ECs; however, they don't address what occurs the instant before they are turned off. This is one of those instances where **KEY STATIONS** have to be used.

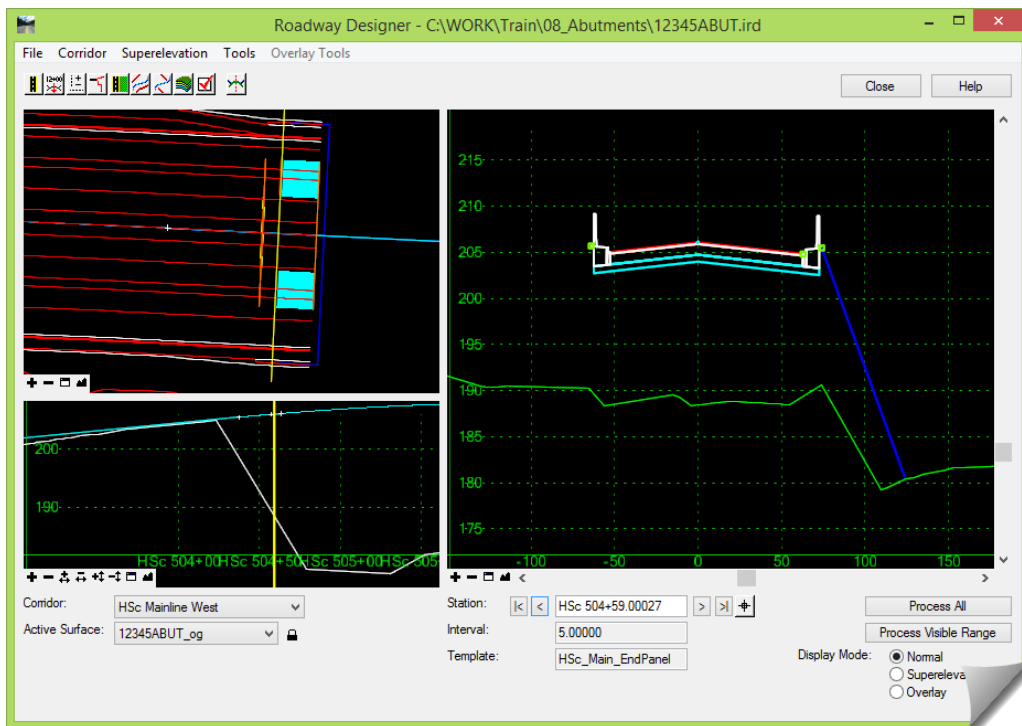
- 3) [Add] two KEY STATIONS just before the location where the ECs were turned off.
- Station 504+59.399
 - Station 504+59.000



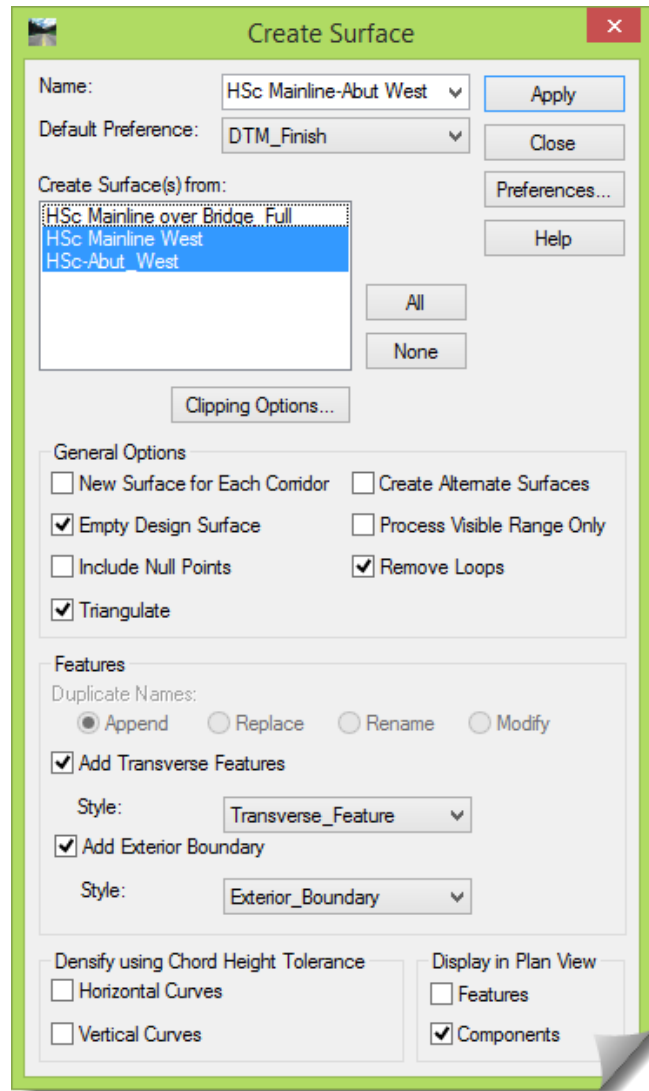
NOTE: Keep in mind that the exact berm transition lengths, berm widths, side slope and other details shown here may or may not be exactly the same as used on your project. Regardless, the techniques will still apply.

Depending on the design, a bench may extend beyond the berm and continue behind the barrier and be carried down the abutment slope, tapering out at the lower corner. If this were needed on your project, it would require some added modeling considerations. This is briefly discussed at the end of this module.

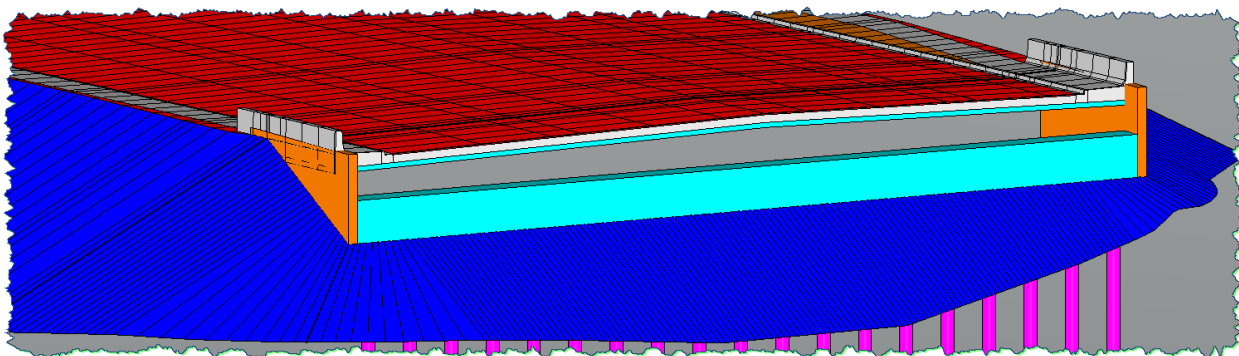
- 4) Verify the results.

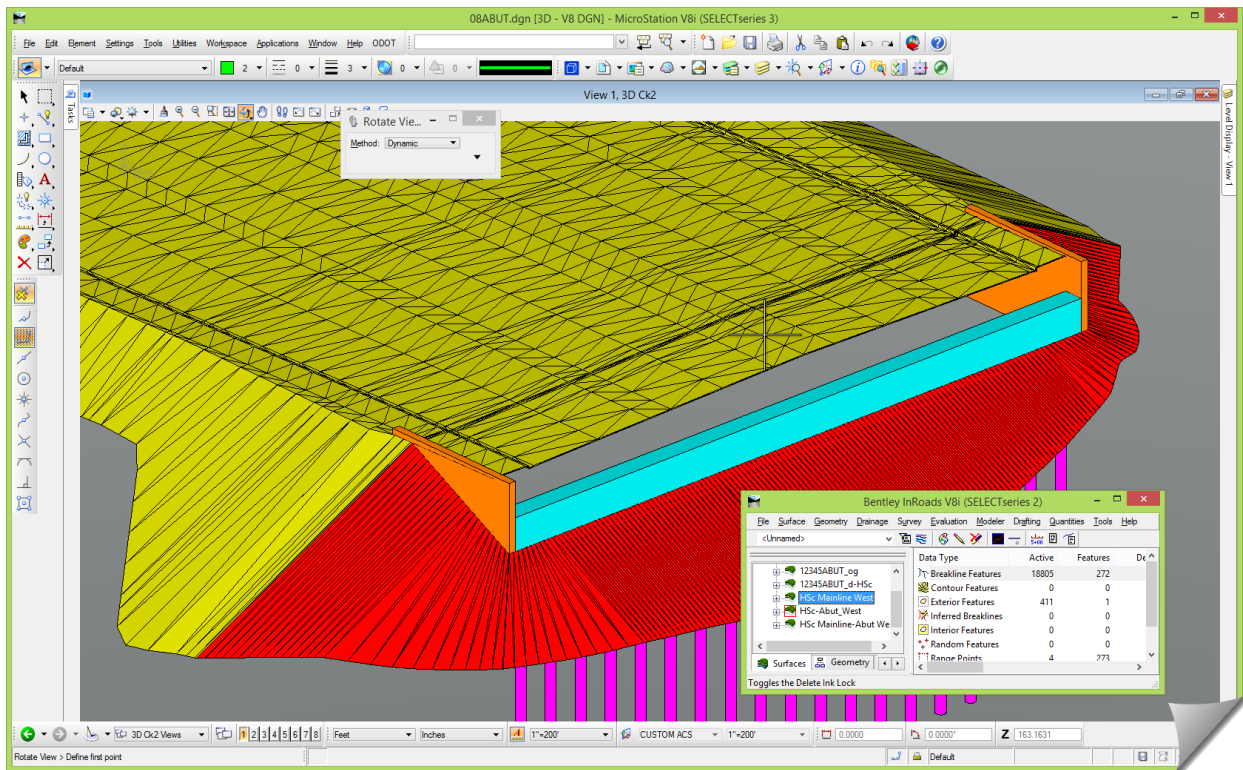
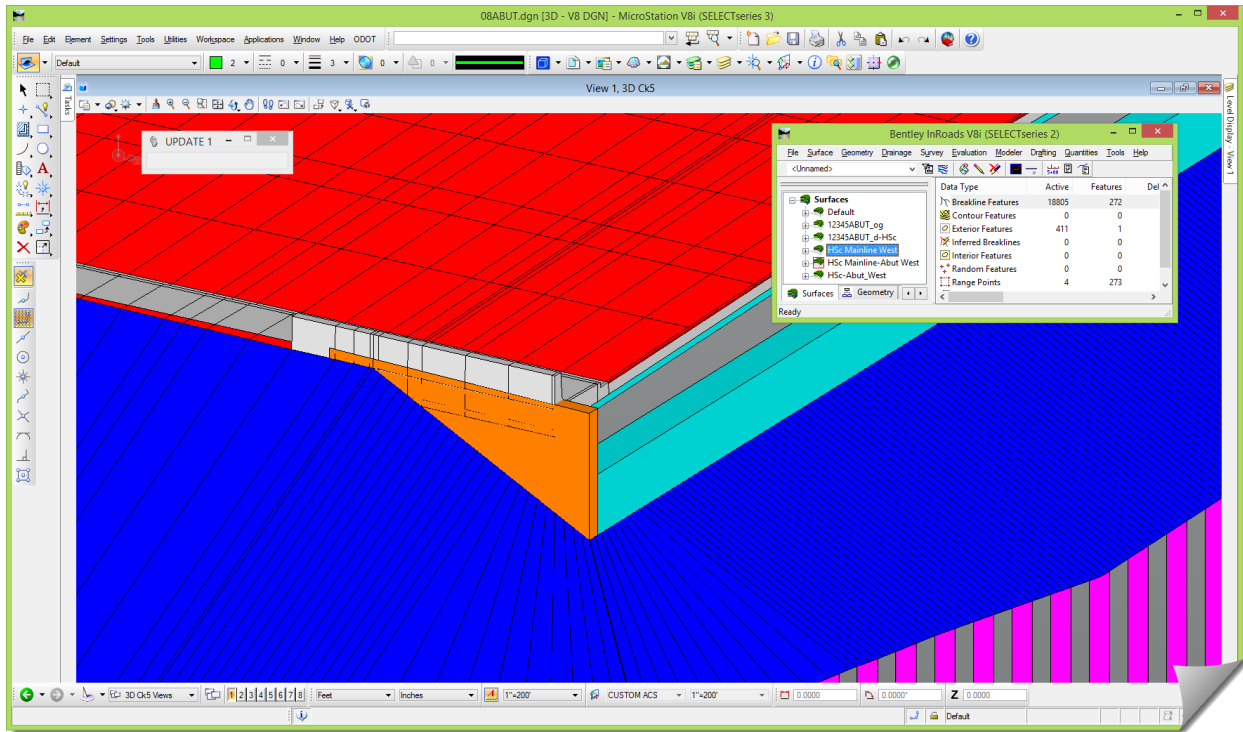


- 5) Create either a combined surface, or separate surfaces for each corridor and view the results.



- 6) **[Close]** the ROADWAY DESIGNER.
7) **[Save]** the newly created surface(s).

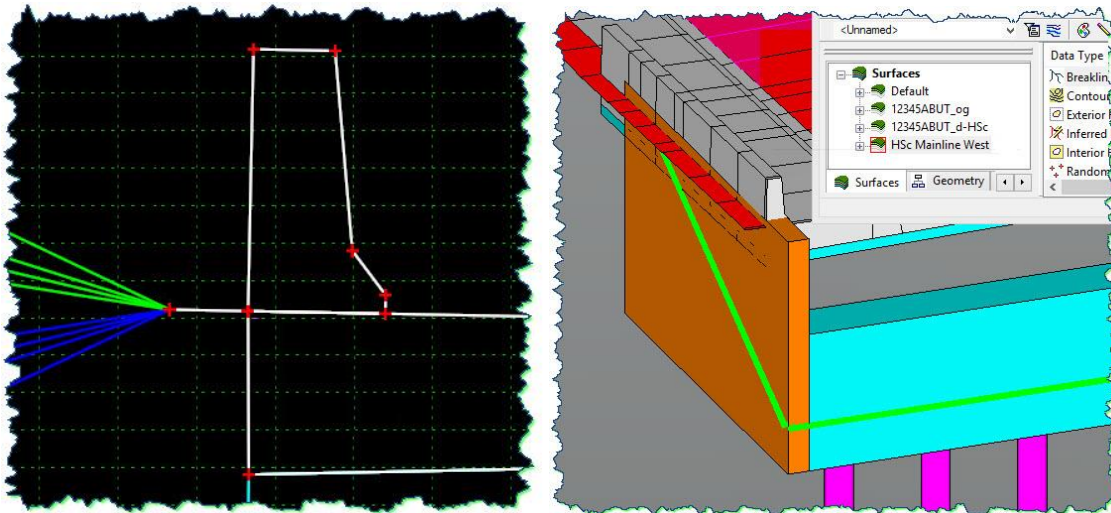




OTHER DETAILS - MISCELLANEOUS TOPICS

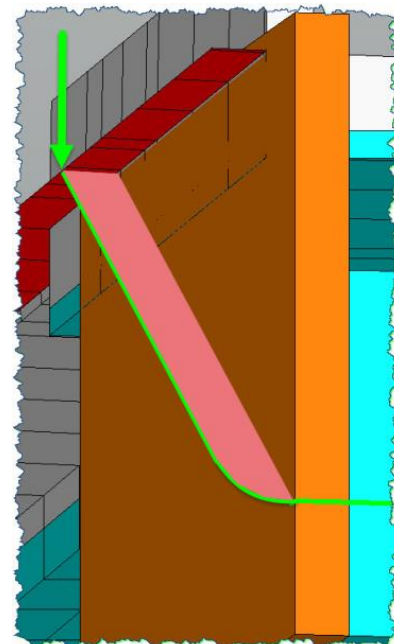
Bench Adjustment

The subject of the bench, and modeling variations, was briefly mentioned earlier. This modeling deserves another mention, and needs to be addressed when modeling around the bridge and abutment where a bench is desired.



A few items to consider are:

- Benches and berms are often controlled by **PARAMETRIC CONSTRAINTS**
- The bench behind the barrier will be part of the roadway template as well as the abutment template
- There are **Constraint Labels** called **BenchLt** or **BenchRt** assigned to the **Horizontal** constraint on the **Bench** point
- The **Bench** point is constrained horizontally from the **BermB** location on the road template
- A **Bench** segment will have to be added to the abutment template to coincide with the bench segment in the roadway template
- The bench segment of the abutment template will match the width of the roadway bench where the two tie together, and then continue down the face of the wingwall
- The control line along the wingwall face will move outward a distance equal to the width of the bench
- A horizontal and vertical curve radius equal to the width of the bench is used to transition out the bench as it meets the bent face instead of squared-off and using **PI Rounding** as illustrated in this module

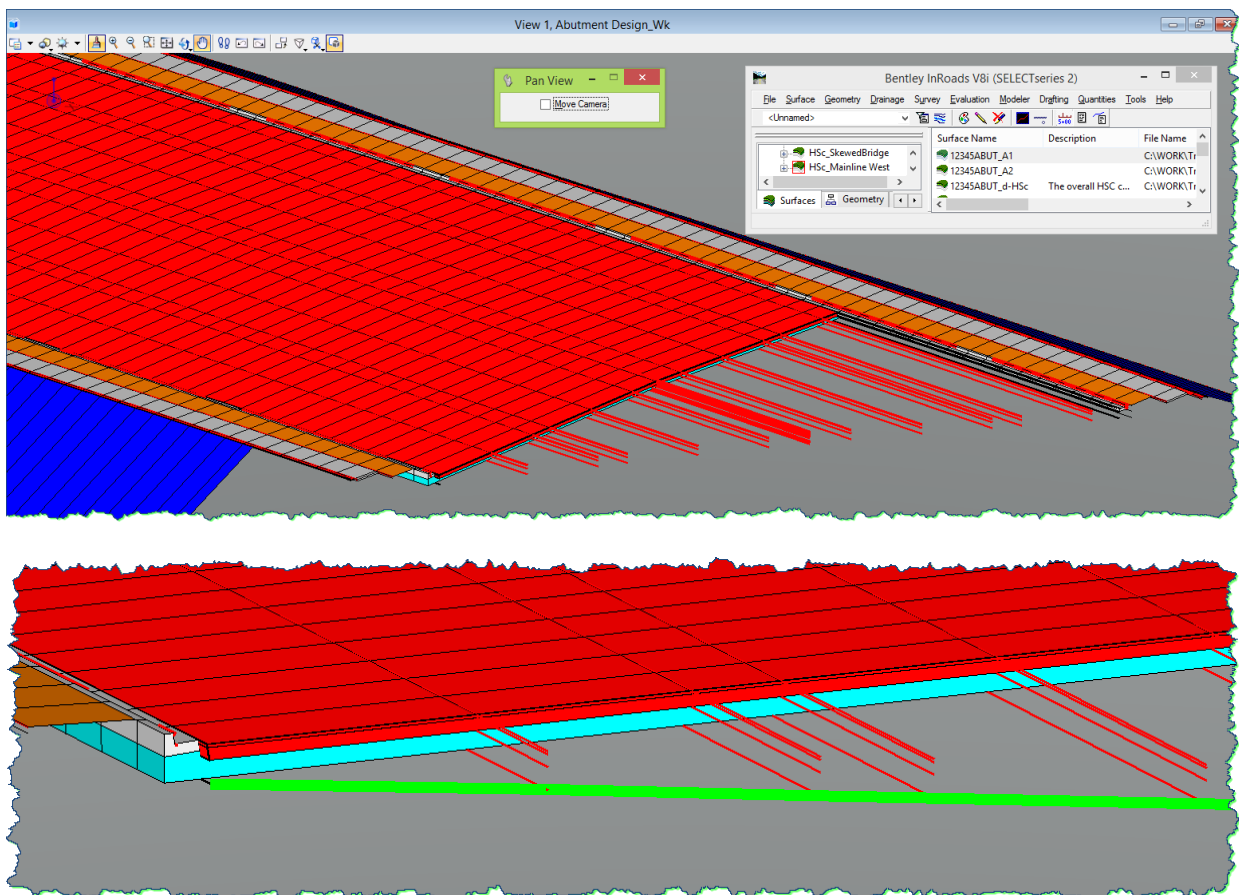


Skewed Bridges

What's the difference between working with a squared-off bridge end and a skewed bridge end? Not a lot, but some.

One thing that will be different occurs if you choose the option to clip out the features to form a partial surface for either end of the bridge. This subject was mentioned earlier in this module, but it is worth mentioning again. When you clip a **Feature** that belongs to a **Component**, that **Component** will not be able to be drawn. Even though it might have all of the other **Features** that comprise its shape, if one of those surface **Features** is missing, you get nothing in the way of the **Component**. This goes for both the plan view display as well as the cross sectional display. For this reason, it may be worth the added effort to construct your **Corridor** in the **ROADWAY DESIGNER** in such a way that it actually models at a skew so that the integrity of the **Components** is maintained.

The implications are that when you are working with a clipped surface, you will have to work with either the triangle display or the **Feature** display instead of the components.



Besides that, there aren't any other significant differences. That's because the abutment modeling is all about developing its own path for the modeling. Once that path is defined, any technique mentioned earlier would apply in the same way.

Abutments & Wingwalls

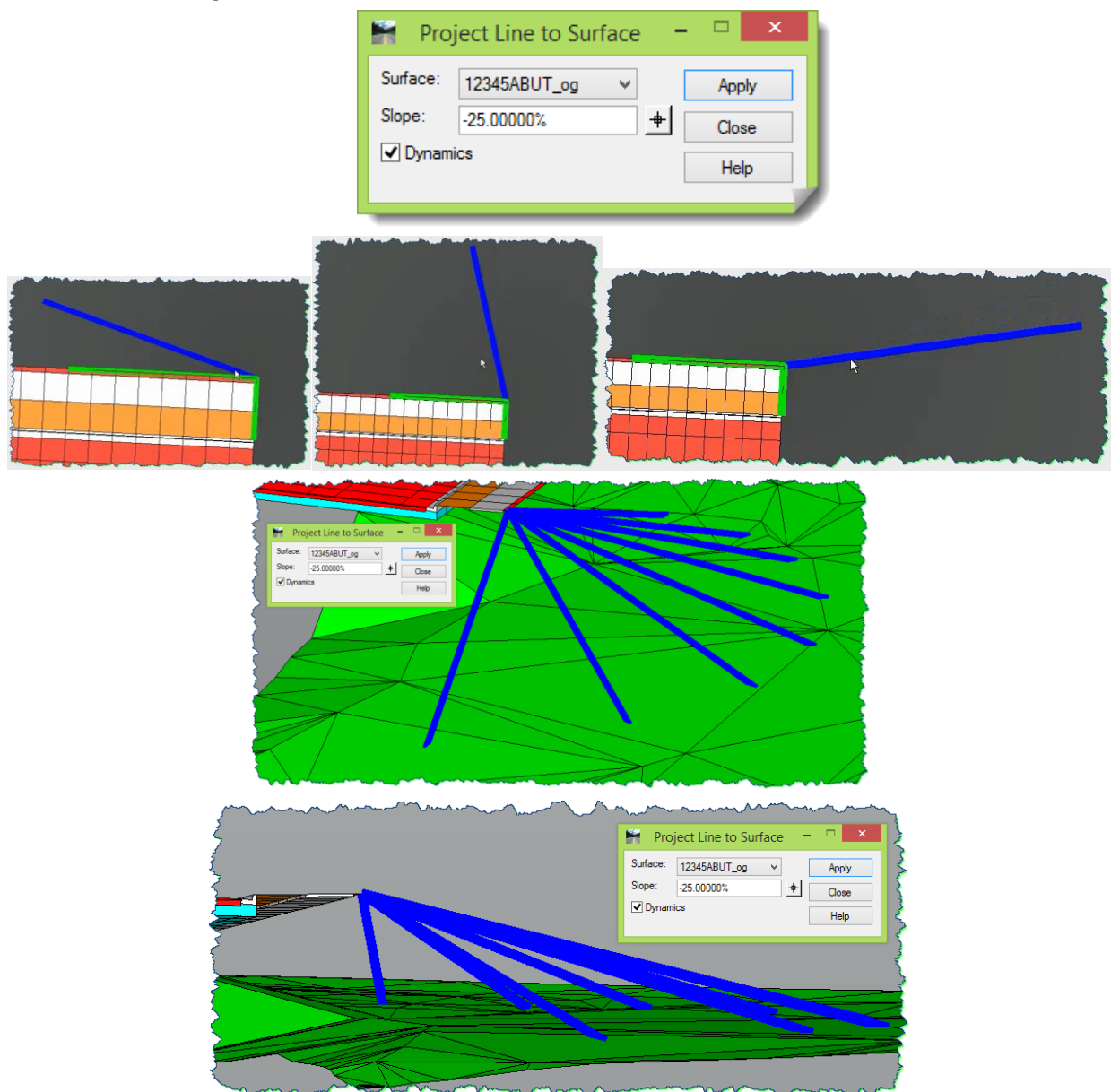
Modeling where walls are concerned is just a matter of defining the path of the grading, and sometimes checking and / or assisting with the wall layout. A couple of InRoads tools have some valuable functionality related to these activities. They can also be helpful during the early stages of project development to estimate wall heights and potential grading impacts.

Project Line to Surface

The **PROJECT LINE TO SURFACE** tool found under the **DESIGN SURFACE** tool set is very simple, yet very effective. It projects a defined **Slope** either up or down across the **Surface** triangles, searching for a route that complies with the **Slope** value that is entered in the dialog box.

The **Dynamics** provide instant visual feedback on the path that it has found.

Placing a data point with the mouse draws a MicroStation graphic that conforms to the settings of the dialog box.

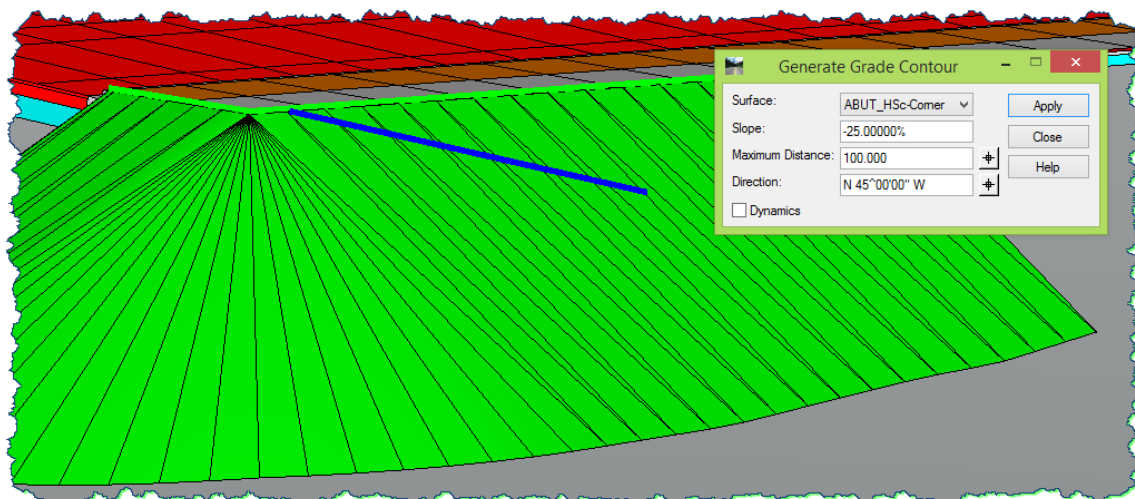
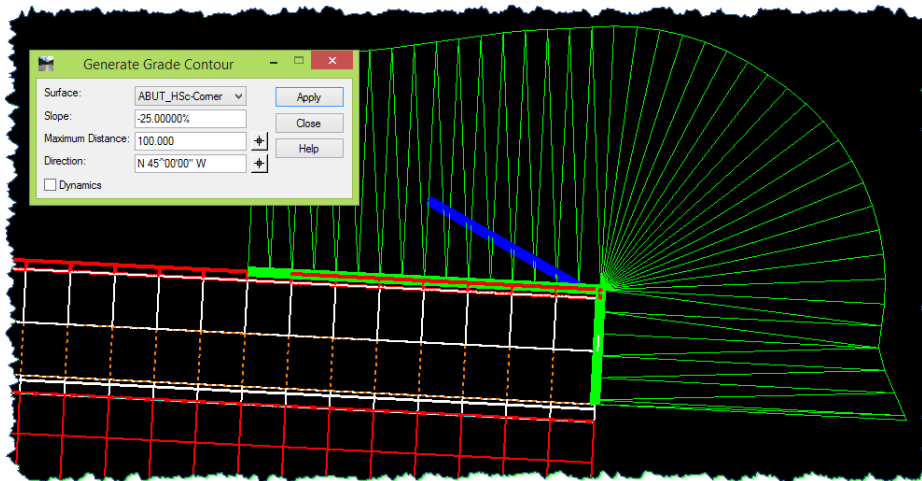
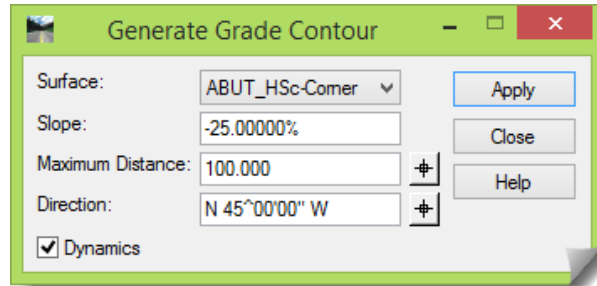


Generate Grade Contour

The **GENERATE GRADE CONTOUR** tool is an **APPLICATION ADD-IN** that must be turned *on* in order to make this command available. When turned *on*, it can be found under the **Surface** main menu category, under **Utilities**.

This tool has a strange name that seems to reference something relative to a contour. What is a contour? A contour is a line where every point (or vertex) on it is at the same elevation. Well, a **Grade Contour** is where every point on it is at a uniformly projected grade, or slope.

This tool traces a grade across a **Surface** at a particular **Slope** for a **Maximum Distance** at a given **Direction**, and offers the same **Dynamics** as the earlier command.



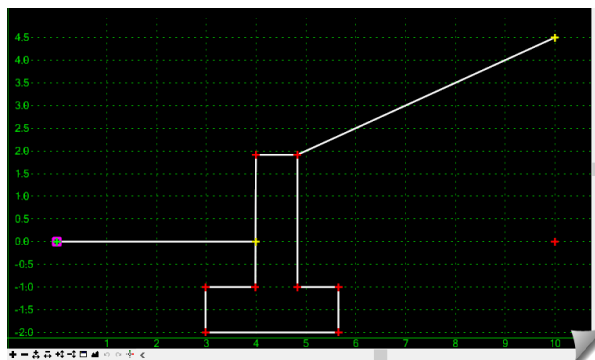
Food for Thought

Consider these additional thoughts about abutment modeling:

- The horizontal path of modeling can come from MicroStation, a surface **Feature**, or a **Horizontal** alignment.
- The vertical path can be developed in MicroStation, with the **DESIGN SURFACE** and **EDIT SURFACE** tools, or by creating a profile and laying out the elevation control using the **Vertical** layout tools.
- While normal roadway modeling typically uses **Intervals** like 5', 10' or larger, consider smaller **Intervals** like 5', 2' or 1' for longer straight areas; and even 0.5', 0.25' and 0.2' for tighter bends when doing abutment modeling. Look at the results and don't hesitate to return to the **ROADWAY DESIGNER** and change the modeling **Interval**.
- Make diagrams, sketches, and even draw on photos to map out what path your abutment modeling will take. Sketch out your thoughts on how grading slopes might form. Looking at bridge details and sections can be extremely helpful.



- Advanced components can be constructed that could be specifically used for abutment grading containing wing walls.



- As you are developing the corridor model for the abutment, go back to the main roadway model and add **END CONDITION EXCEPTIONS** to run **Backbone Only** so that the roadway model and abutment models tie together and do not overlap.
- If you need to tie your abutment grading into a specific point under the bridge or side road (like an existing wall, new back of walk or edge of pavement), use different **EC Targets** or **POINT CONTROLS** to lock the modeling onto other surfaces, features, geometry or corridors.
- If the decision is made to combine roadway models and abutment models, the **Exterior Boundary** will have to be addressed either automatically through the **ROADWAY DESIGNER** or manually after the individual surfaces were created and possibly combined using the **SURFACE EDITING** tools.

Combining corridor models from both sides of the bridge may or may not be done in the **ROADWAY DESIGNER**. It can be done if the corridors do not form a ‘gap’ between the roadway on either side of the bridge. This situation would likely only occur if you were also modeling the roadway underneath the bridge. In this case, the composite model would consist of the roadway on either side of the bridge, the two abutment corridors and the corridor of the roadway passing underneath the bridge.

If the area between the abutment corridors were not being modeled, then each side of the bridge and its companion abutment corridor would have to be created individually. This would result in a surface model of one side of the bridge, and another for the other side of the bridge.

- **Target Aliasing** can be used to target nearest (**Use Closest**), as well as sequencing and prioritizing EC targets if there are several. For instance, the side slope may target the design grade, the existing grade, or a side road or ramp corridor / surface.
- By constructing the abutment grading in the **ROADWAY DESIGNER**, the capability to use **Corridor Clipping** becomes available to automate the integration of the abutment model with the roadway and surrounding models all in one pass.

Visualization

Earlier in the module, there was a mention about the pieces of the model that are created by modeling the abutments. In the case of the bridge going over an already improved roadway, the design could result in three different surfaces – the one side of the bridge (with abutment modeling), the other side of the bridge (with abutment modeling) and the bridge itself.

The two models representing the opposite sides of the bridge could be combined into a single model if they were merged with the original ground, filling the non-designed gap in between them. If the roadway under the bridge was a new road, then that could be merged with the models of the two sides of the bridge forming one complete design surface. That larger model could further be merged with the original ground to form a ‘completed project’ model.

Then there is the bridge itself. This model cannot ever be merged with the other grading models due to the creation of conflicting breaklines, unless the bridge data were set to Do Not Triangulate. As any “bridge” model created through the Roadway Designer is only an approximation, creating elements for visualization of the bridge is best performed using MicroStation 3D tools or better yet, a 3D model generated through bridge design software.

For visualization purposes, it’s just a matter of either viewing the components or triangles from the separate corridors like pieces of a puzzle. The nature of the design models should allow them to fit closely together to form an overall complete picture of the result.

Conclusion

Congratulations, you have completed the Abutments module and should be another step closer to building a more complete design model with InRoads.

We leave you with our encouraging final thought – Do these modules with an attitude of application. Study them with the viewpoint that you are going to apply these new skills on your current or future project. Look into and beyond the exercise steps and motivate yourself to momentarily pause and consider past, present and future projects and how this information could be put into practice.

Glossary:

<http://www.iowadot.gov/subcommittee/bridgeterms.aspx> (Bridge Terms Definitions)

Abutment - A retaining wall supporting the ends of a bridge. That part of a pier from which an arch springs. A structure sustaining one end of a bridge span and at the same time supporting the embankment that carries the road.

Beam - A horizontal structure member supporting vertical loads by resisting bending. A girder is a larger beam, especially when made of multiple plates. Deeper, longer members are created by using trusses.

Beam Bridge - A bridge built of beams whose ends rest on piers or abutments.

Bearing - A device at the ends of beams that is placed on top of a pier or abutment. The ends of the beam rest on the bearing.

Bent - Part of a bridge substructure. A rigid frame commonly made of reinforced concrete or steel that supports a vertical load and is placed transverse to the length of a structure. Bents are commonly used to support beams and girders. An end bent is the supporting frame forming part of an abutment. Each vertical member of a bent may be called a column, pier or pile. The horizontal member resting on top of the columns is a bent cap. The columns stand on top of some type of foundation or footer that is usually hidden below grade. A bent commonly has at least two or more vertical supports. Another term used to describe a bent is capped pile pier. A support having a single column with bent cap is sometimes called a "hammerhead" pier.

Camber - A positive, upward curve built into a beam that compensates for some of the vertical load and anticipated deflection.

Column - A vertical, structural element, strong in compression.

Girder - A horizontal structure member supporting vertical loads by resisting bending. A girder is a larger beam, especially when made of multiple metal plates. The plates are usually riveted or welded together.

Parapet - A low wall along the outside edge of a bridge deck used to protect vehicles and pedestrians.

Pier - A vertical structure that supports the ends of a multi-span superstructure at a location between abutments. Also see column and pile.

Pile Bent - A row of driven or placed piles with a pile cap to hold them in their correct positions.

Skew - When the superstructure is not perpendicular to the substructure, a skew is created. The skew angle is the acute angle between the alignment of the superstructure and that of the substructure.

Substructure - The substructure consists of all parts that support the superstructure. The main components are the **Abutments** or end-**bents** / **Piers** or interior **bents** / **Footings** / **Piling**

Superstructure - The superstructure consists of the components that actually span the obstacle the bridge is intended to cross. It includes Bridge **deck**, **Structural members**, **Parapets**, **handrails**, **sidewalk**, lighting and **drainage** features.