Module 04

ROCK SLOPE BENCHING

Using InRoads

Introduction

This module, addressing a very specific design scenario, is another step toward learning how to complete various details of your project in 3D using the Bentley InRoads software.

One of the strengths of InRoads is roadway modeling. And when it comes to modeling roadways there are two basic areas of the design, the roadway or drivable portion, and the shoulders or cut / fill slopes.

In InRoads, the cut / fill slopes are modeled with what are called **END CONDITIONS**. These are unique design components that are created within the software in such a way as to be able to develop either the cut or fill slope based on the actual condition that it finds at any one particular station or section of the road. End Conditions can be very simple, or very complex, depending on how sophisticated the design decision-making process is for your project.

These **END CONDITIONS** are stored within the ITL file, or InRoads Template Library.

As a user of the InRoads software, it would be very valuable to be able to construct an **END CONDITION** to fit the needs of any project-related side slope. But as valuable as this skill is, it's not necessarily true that each user has to be able to build their own **END CONDITION** solutions. Part of the power of the software is to be able to reuse pre-created solutions that apply to 'typical' conditions that could potentially arise on any project. So, the fundamental skill level that is *really* required of a user is to be able to understand any pre-created solutions, and know when and how to apply them on their specific project.

Purpose of this Module

The purpose of this module is to demonstrate modeling rock slope benching.

Objectives of this Module

At the end of this module you will be able to use the InRoads **ROADWAY DESIGNER** to layout Rock Slope Benching utilizing the special **END CONDITION** from the ODOT Template Library.

Definition of Audience for future Modules

Before moving forward, it needs to be stated that this module has its own prerequisites and skill level requirements. Do not take these prerequisites lightly as this module assumes that you have achieved a certain level of competency with the software tools and you may be asked to execute a command with very little instruction. If you are unable, you will likely not be able to successfully complete this module and achieve its intended objectives.

Skill Level / Prerequisites:

The prerequisites for this module are the following:

- Module 1 – Introduction to the Training Modules
- Module 2 – Visualization (beneficial, but not mandatory)
- MicroStation Basics
- InRoads Level 1
- InRoads Level 2

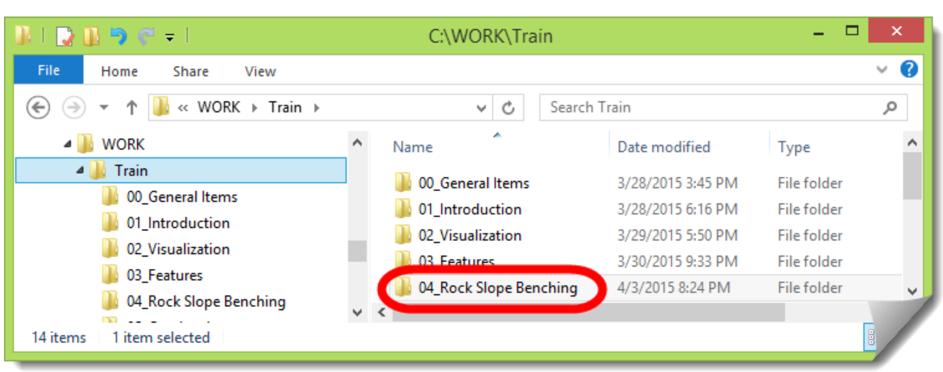
Module Files and Folders

The activities of this technical module will be a combination of study and hands-on. The hands-on will work you through the process so you see how it is accomplished by your own hand (with the guidance of the module material). The study portion is there to support the hands-on and explain what you are doing and why you are doing it. The study portion is there to strengthen the activities and ensure that you can apply it to your project, and not just the sample project.

Training Folders

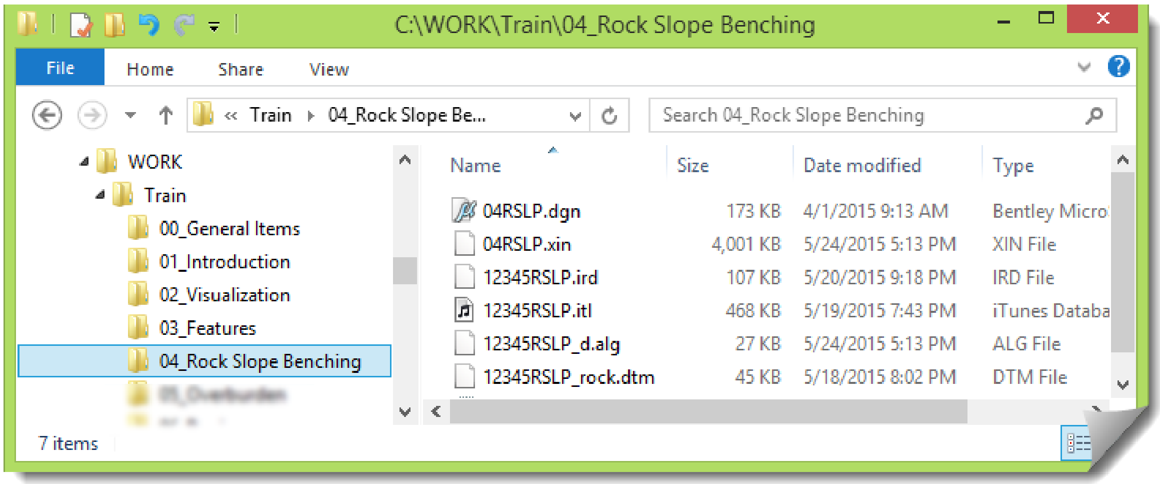
You will be working on your local hard drive during this training. The material within the modules will be expecting the training files and folders to be set up in a very specific way in order for them to align with the step by set module directions.

You should have a copy of the **`04_Rock Slope Benching`** 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 any training files (DGNs, DTMs, ALGs, ITLs, IRDs, XIN and so on) that might be used during the module exercises. In this module folder you should have these files:



Glancing at the files you should see familiar InRoads file types, as well as the DGN files for this module.

DGN files starting with **`12345`** are support files, or reference files. Likewise, InRoads files starting with **`12345RSLP`** are also support files that will be used within the hands-on exercises as directed.

Files starting with the module identifier, in this case **`04RSLP`**, are files that will typically be opened during the launch of the hands-on work and include:

- **`04RSLP.dgn`**, the initial MicroStation file used at the start of the exercises
- **`04RSLP.xin`**, the InRoads configuration file for this work

And there will be an **`RWK`** file included in the module folder to assist in opening the InRoads files using that **Project** file technique.

Technical Content of Training:

This module will be focusing on the application of a very specific **END CONDITION** (**EC**) built within InRoads to be used in a rock slope benching cut condition.

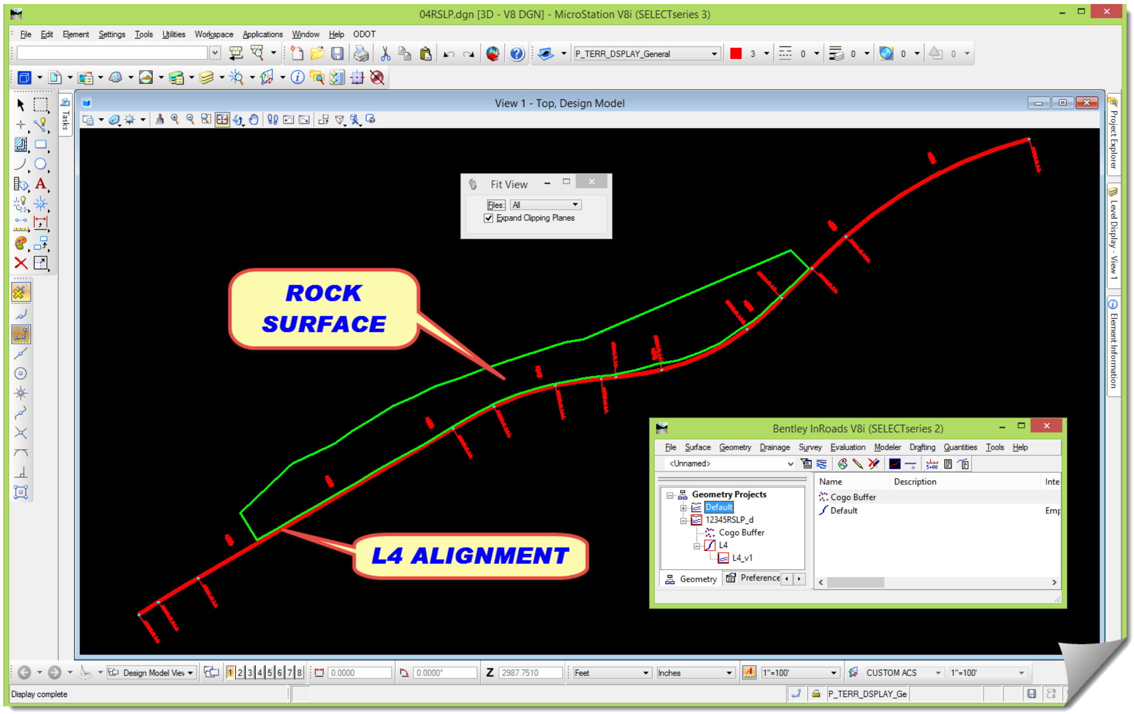
The focus in the upcoming material will contain two different aspects of this work. First, it will cover the application of this particular EC to a condition where rock exists. The intended result of this content is so that you can apply this EC on your project where it is applicable. A secondary aspect of this content will be to provide you with some basic insight into how this EC works. The information presented regarding the 'mechanics' of the EC construction will be at an InRoads Level 1 understanding, but will be enough for someone who has completed the InRoads Level 2 training to do further personal investigation regarding the 'inner workings' of this EC to gain greater insight into exactly how this EC works.

Project Orientation

REVIEW WORK AREA

This module will be using a rock surface (**`Rock`**), as well as a main centerline alignment called **`L4`**. The areas of coverage and locations for these are shown below. The main focus of the work in this module will be where the **`Rock`** surface exists and the modeling will be confined to the area within the extents of that surface.

This surface and alignment are already created and will just be used as is within this module, and no modification will be made to them.



PREPARE MICROSTATION / INROADS DATA & FILES

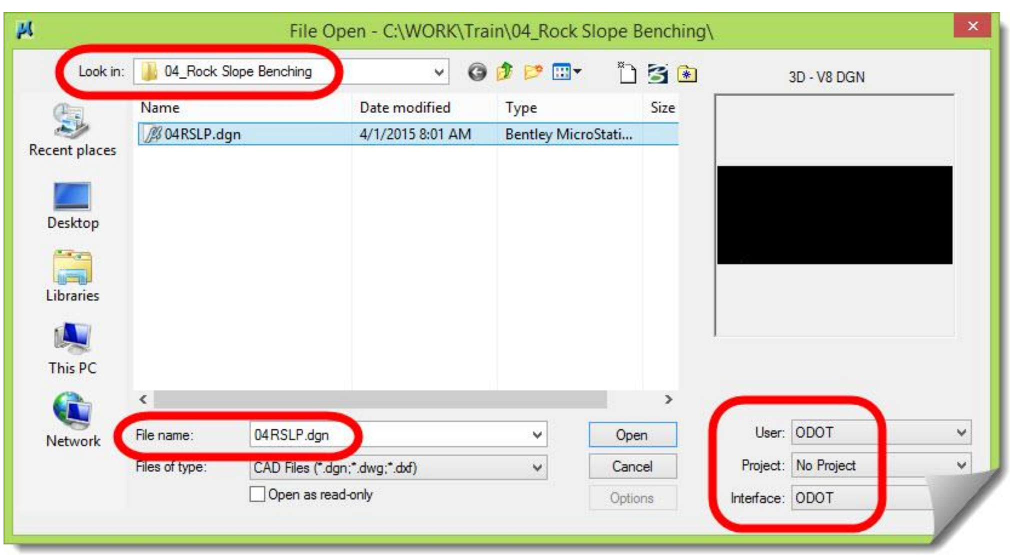
This section will get you into the correct DGN, load the module specific XIN and other data files.

1) Launch InRoads

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

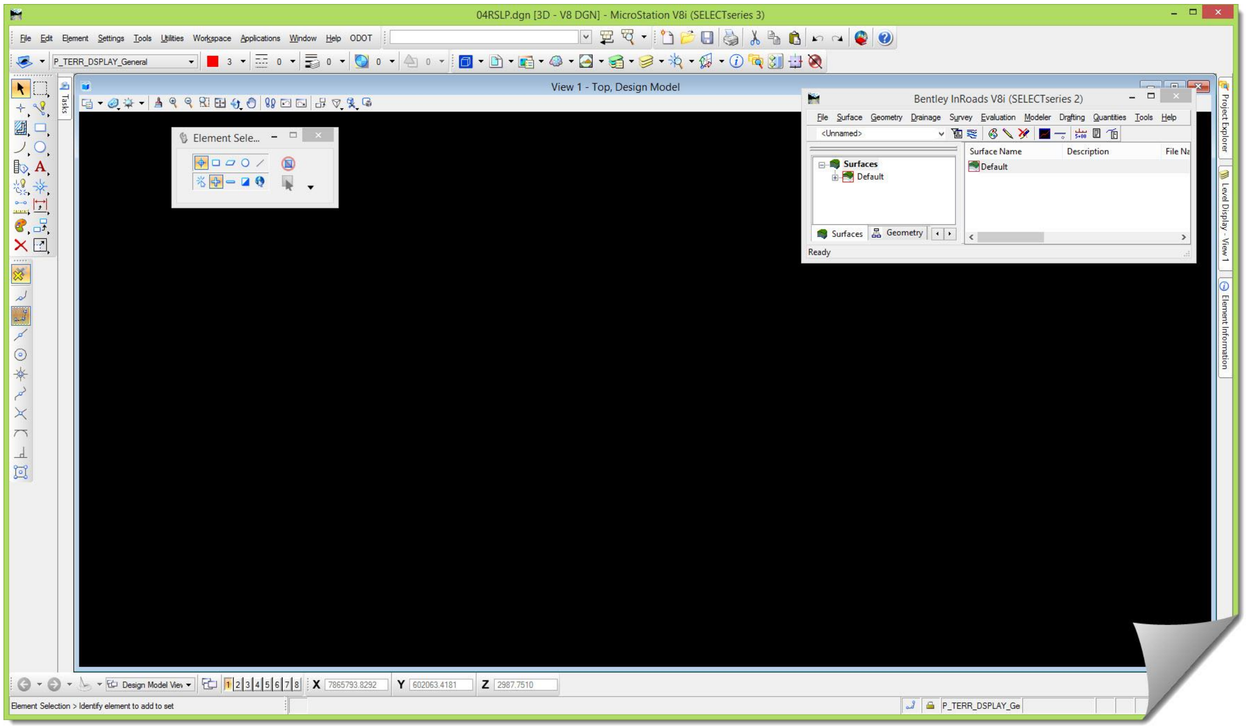
2) When the **MicroStation Manager** opens, set the **User** and **Interface** to **ODOT**.

3) Then browse to the ***C:\WORK\Train\04_Rock Slope Benching*** folder and select the **`04RSLP.dgn`** file and click [**Open**].



Eventually, MicroStation and then InRoads will open.

4) When the drawing opens you'll see that it is completely empty.



5) Open Windows **File Explorer** and browse to the `04_Rock Slope Benching` folder.
6) Drag & drop the `Load_04RSLP.rwk` file into the InRoads interface to load the data files.
7) Verify inside InRoads that the following files have been opened:
   - `04RSLP.xin`
   - `12345RSLP_rock.dtm` (internal name = `Rock`)
   - `12345RSLP.itl`
   - `12345RSLP.ird`
   - `12345RSLP_d.alg`
8) At this time, feel free to review the project data that was just opened by doing any or all of the following tasks:
   a. View the **PERIMETER** of the `Rock` surface
   b. View the **HORIZONTAL ALIGNMENT** `L4`
   c. View the **STATIONING** of the **HORIZONTAL ALIGNMENT** `L4`
   d. Create a **PROFILE** and view the **VERTICAL ALIGNMENT** `L4_v1`

At this stage in the module don't bother reviewing the ITL or the IRD in the **CREATE TEMPLATE** or the **ROADWAY DESIGNER**. You will be guided into these files later in this module.

9) 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.

Following this upcoming study section, there will be a guided hands-on that will walk you through the application of the important tools and work processes.

Theory - Study

This begins the section where you will do some background study on **END CONDITIONS** and the specifics of this module in preparation for what's to come in the practical hands-on section.

PROCESS OVERVIEW

This portion of the module will be focusing on two aspects of the work to be done. First are the items to consider going into this activity (which includes understanding what is needed by InRoads) and second, ensuring that the work process and technical tools are properly used.

Things to Consider

Surfaces required

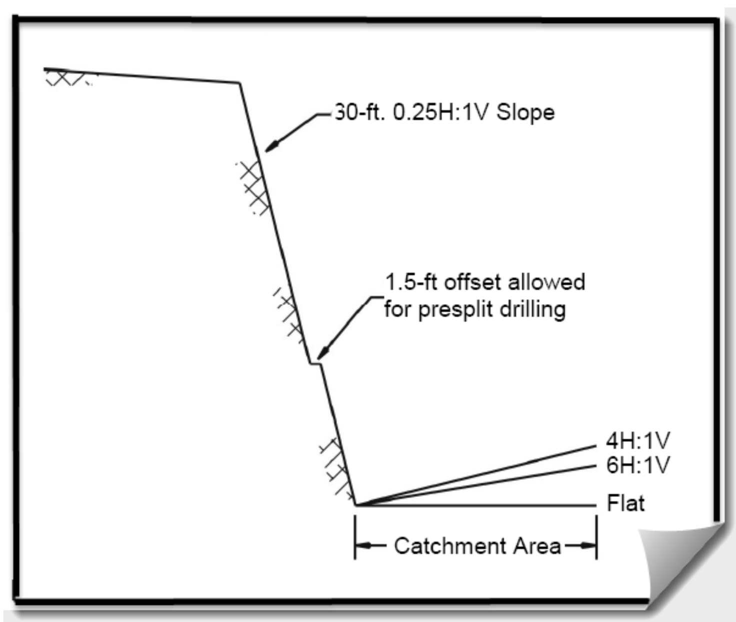
The subject matter of this module addresses a very specific design scenario where a rock cut will have to be done as part of the roadway design. This leads to the first critical prerequisite for this work, a rock surface. Prior to applying this **END CONDITION** solution a DTM surface has to be available that defines the rock surface. This is important as the cut slope **END CONDITION** within InRoads is designed to seek this rock surface. If InRoads cannot locate this rock surface, then the rock slope benching condition will not be produced.

In the case of this module, the surface called **`Rock`** will be the rock surface that will be used.

Geotechnical Information

Another prerequisite needed before the design model can be finalized is obtaining the specific design criteria from the Geotechnical designer regarding the design details for your project. These include three specific areas of the design:

- Catchment Area Slope
- Catchment Area Width
- Rock Cut Slope



This information will be needed when you get into the **ROADWAY DESIGNER** in order to integrate this site-specific information into your corridor layout.

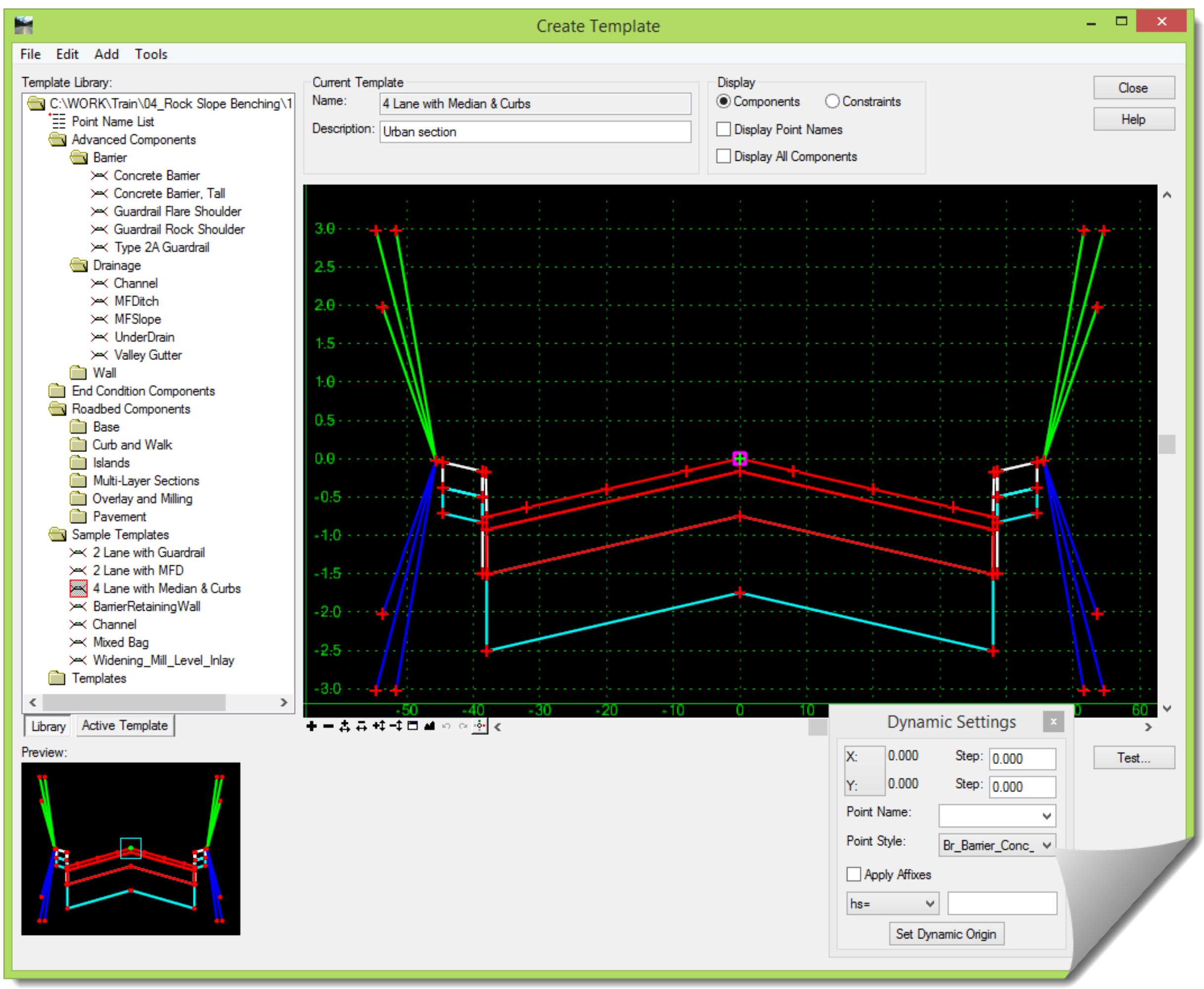
NOTE: If you don't have the specific design details from the Geotechnical designer you can still develop the **Corridor** in the **ROADWAY DESIGNER** using the default values built into the **Rock Slope Benching** component. This will allow you to establish the basic design and ensure that it produces an expected result. Then you can incorporate the project-specific Geotechnical information into the **Corridor** as soon as you get it to finalize the design.

End Conditions

This section will act as a slightly rapid refresher and capture the key fundamentals of templates as well as **END CONDITIONS** to lay the groundwork for the Rock Slope Benching component addressed later in this module. If additional information and details are needed please refer back to your *InRoads Level 1* material. If you already understand this material you can move through this section very rapidly.

It's the **ITL** file, containing the ODOT library of typical sections, which will be used as a base to design the project and develop the design surface. You *should* be familiar with this file.

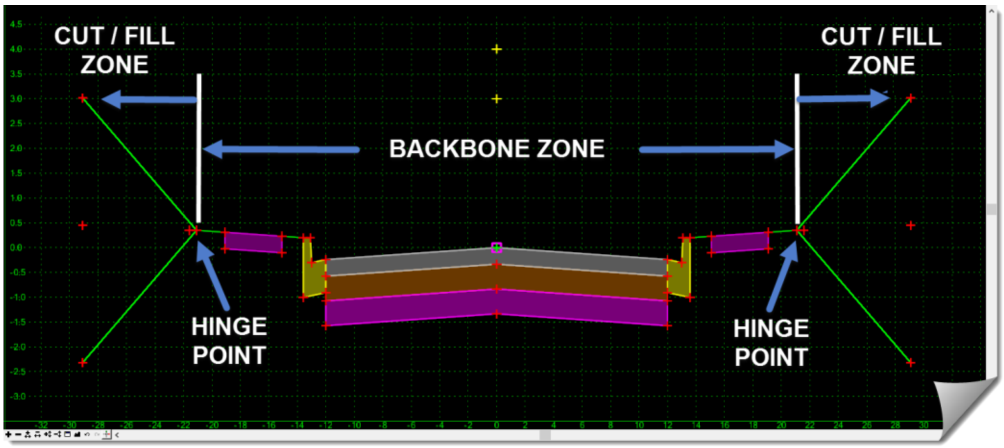
The **ITL** file, or **TEMPLATE LIBRARY**, contains all of the sections that have been pre-developed for use on ODOT projects. From here, the project-designers will use what is already stored in this file, and then develop any additional project-specific sections needed by their particular project requirements.



The ITL that is used in this module is a copy of the ODOT 'seed' ITL with an additional project-based template added specifically for the work that will be done later.

NOTE: The `ODOTseed.itl` contains the standard sections that have been developed by ODOT for use on State projects. If you create a new **Component** or **Template** and feel that it is valuable enough to incorporate into the 'seed' ITL, provide the information to someone in the CAD support team so that it can be reviewed for compliance to ODOT standards and potentially incorporated into the 'seed' ITL for everyone's benefit.

A basic template contains two main zones – the **Backbone** and the **Cut / Fill**.

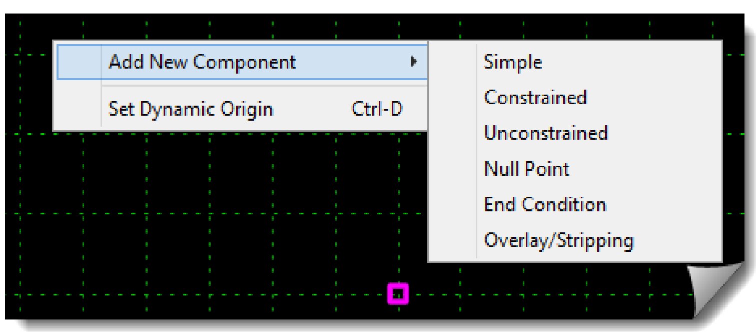


Generally speaking, the **Backbone** is that area of the template that is unconcerned about the location of the existing surface. The roadbed width and slopes are defined, the curbing is always there, as well as any other typical portions of the section.

The **Cut / Fill** zone is that area of the template where the location of the existing surface becomes a factor. It's in the Cut / Fill zone that the daylights are targeted and developed.

Regarding template construction, there are six different types of **Components** that can be used.

- Simple
- Constrained
- Unconstrained
- Null Point
- End Condition
- Overlay / Stripping

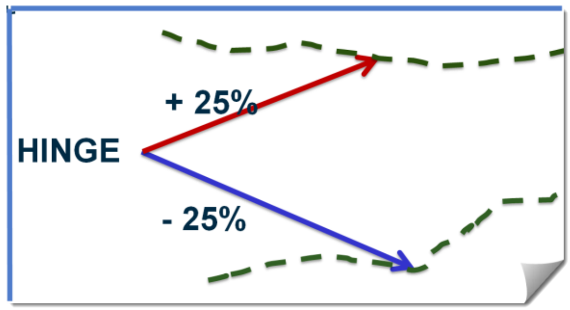


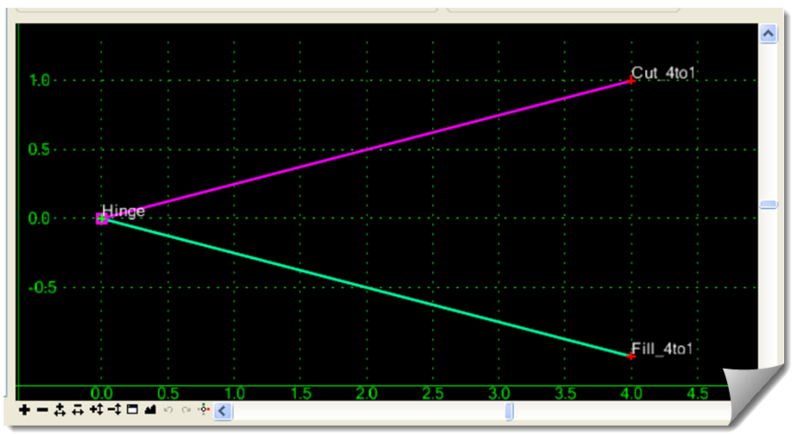
The first three are **Backbone** zone **Components**.

The **Null Point** and **Overlay / Stripping** components are a very specialized variety used in specific applications that are not part of this module, therefore will not be covered here.

The **End Condition** is the **Component** type used in the **Cut / Fill** zone.

End Conditions are a special type of **Component** because unlike other types, they have an enhanced capability to target InRoads information. This is how they are able to develop the daylight location and limits of construction.





End Conditions 'seek' **Targets**, of which there are 11 different types of targets that include **Surfaces**, **Elevations** and '*spatial*' targets.

TIP: **End Condition** *spatial* targets just means that they can locate items in 'space', either horizontally or vertically or both. An example of a spatial target is a horizontal alignment of the Right-of-Way. Another example could be flowline grade found in a surface DTM.

End Condition targets allow the template cut / fill slopes the capability to interact with other InRoads data stored in either the DTM or ALG files.

End Conditions can succeed or fail, and this is a strategic part of their design that is used within the logic of their construction, and can play heavily into the development of their eventual result.

The bottom line is that an **End Condition** defines a path from the **Backbone** of the template section toward some predefined target.

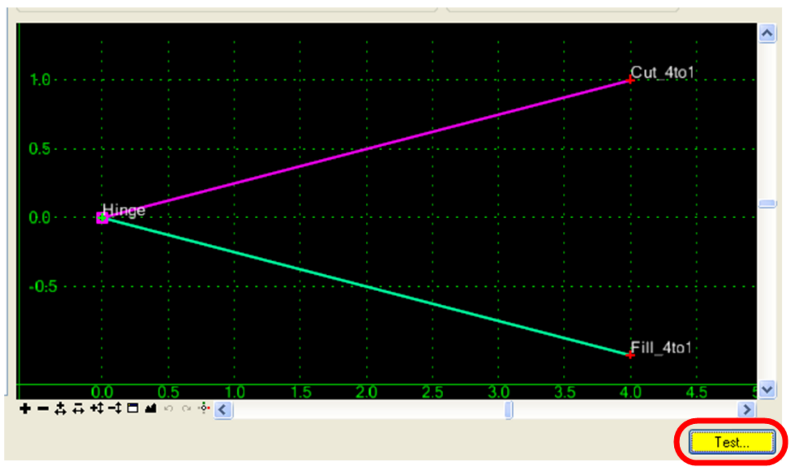
End Conditions can be very simple as shown earlier, with only a straight cut slope targeting the existing ground or a straight fill slope targeting the existing ground.

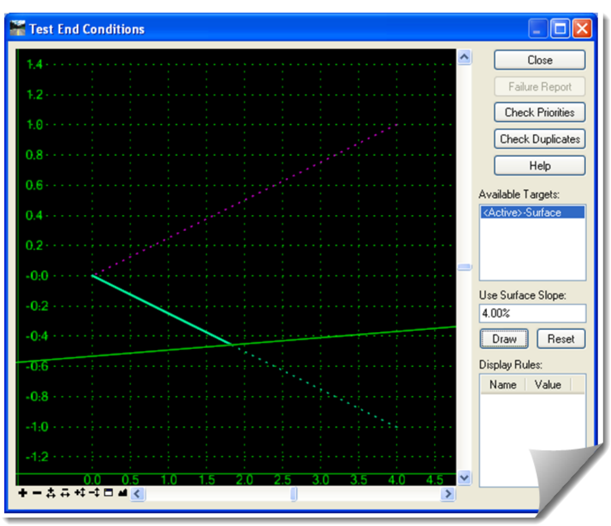
End Conditions can also be very complex. EC's can have branches that 'split' in order to introduce various options. EC's can be 'chained' together to form an EC 'series' that as a whole defines a complete solution. The complexity is sometimes only limited by one's understanding of the various target types and construction techniques.

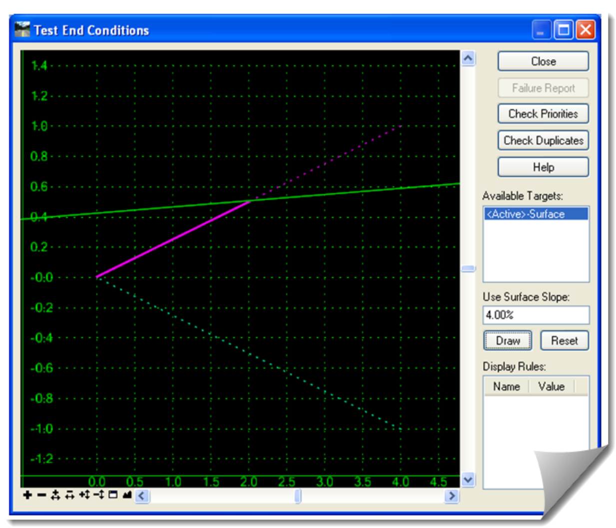
Within the **CREATE TEMPLATE** dialog box, where ECs are constructed, there is the capability to **Test** the reaction of an EC under a simulated condition.

TIP: The more complex the **End Condition** the more elaborate the **Test** can become. This is especially true when several ECs are in a chain, each having a different **Target** type. All **Targets** must be defined when in **Test** mode. This requires a good understanding of the EC.

Testing an EC is a first pass look at checking if it will function as expected. This is not a substitute for applying this EC in a real-world application, but it can provide insight into an area of the EC that may not be reacting as anticipated.





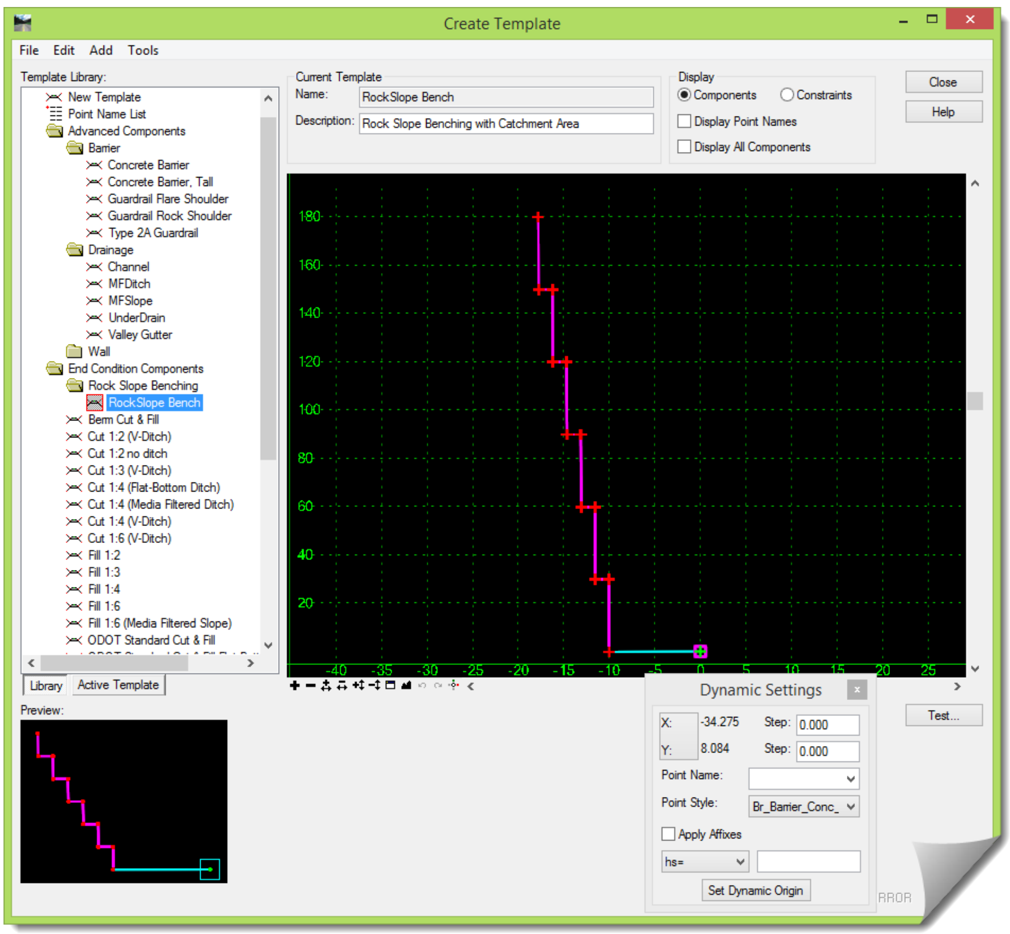


End Conditions is a key topic covered in the *InRoads Level 2* class. If this area interests you, or you feel you need to strengthen your understanding of **End Conditions**, it is highly recommended that you take the Level 2 class.

The specific details of the Rock Slope Benching component, the subject of this module, will be covered later in the hands-on portion. This is done so that you can be strategically guided to review certain aspects of the EC that will increase your understanding and ability to apply this component on a future project.

Techniques and Tools

The use of the Rock Slope Benching rests in the ability of the user to construct templates from individual **Components**, and then use those templates in the **ROADWAY DESIGNER** to develop the details of the **Corridor**. The majority of the skills to perform this work, aside from the actual construction of the EC, are covered in sufficient detail in the *InRoads Level 1* class. The *InRoads Level 2* class covers the information related to the actual construction details of the EC.



This module will take the stance that the EC has already been created and will primarily be teaching someone how to use it. Additionally, this module will glance at assembly of this EC so that you understand enough of its construction to be able to **Test** it and know that it is working.

TIP: The more complex the **End Condition** the more elaborate the **Test** can become. This is due to the fact that some ECs contain multiple **Targets**. When an EC that contains multiple targets is tested, those **Targets** have to be properly placed to accurately simulate a potential design condition. For example, if the ROW were one of the **Targets**, it would not be placed near the road center, since that would typically be an unrealistic design condition.

Practical Application - Hands On Lab Exercises

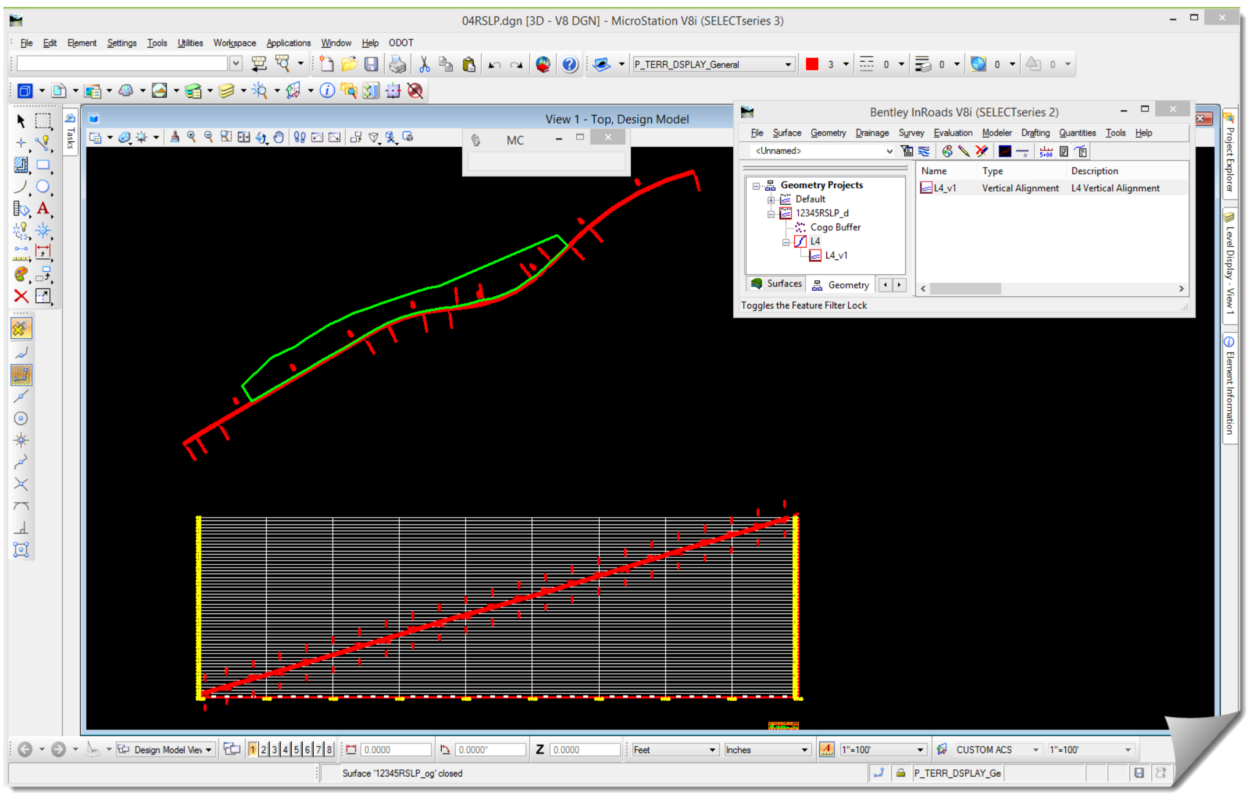
The following hands-on section will consist of reviewing the Rock Slope Benching EC and then using that EC in the **ROADWAY DESIGNER**, and eventually creating a design surface.

UNDERSTANDING THE DETAILS

Review any relevant project data

At this point you should be in MicroStation and have the **`04RSLP.dgn`** file open. You should also have InRoads open, and having loaded the RWK, should have the **`04RSLP.xin`** open, the **`12345RSLP_rock`** surface, the **`12345RSLP_d`** Geometry Project, and the **`12345RSLP`** template library ITL and **ROADWAY DESIGNER** IRD files.

1) If you did a review of the project data as suggested earlier, you should be looking at something like this:



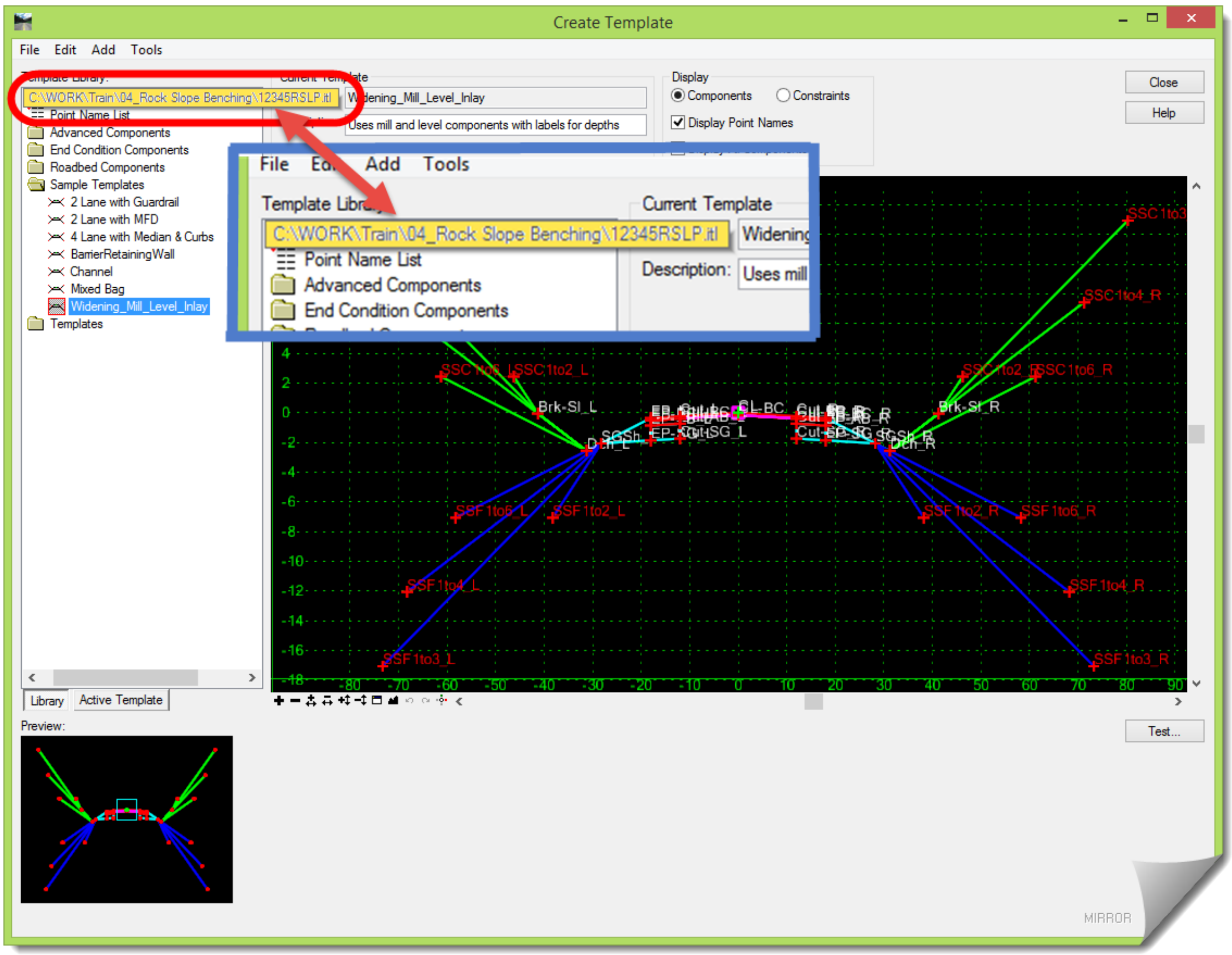
If you aren't seeing graphics as shown here, it won't make a difference moving forward. The important part is that you understand the surfaces and geometry data that are associated with this module.

The next section will be a review of the Rock Slope Benching EC. This review will be emphasizing the important aspects of this EC. This section will be followed by the workflow necessary to apply this EC to your project template as well as in the **ROADWAY DESIGNER**.

Review any relevant InRoads ITL information

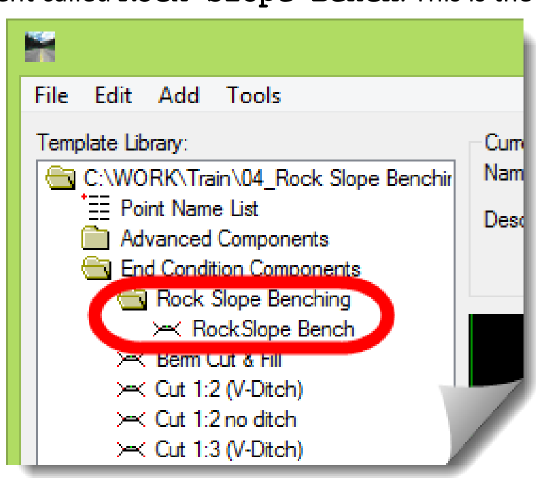
The main part of this module activity surrounds the use of the EC **Component** constructed to produce the required benching when encountering a rock surface. With that in mind, let's take a look at this **Component**.

1) Go to the InRoads main menu and open the **CREATE TEMPLATE** tool.
2) The first thing is to simply verify that the correct **`ITL`** is opened by checking the path at the top of the Library window.



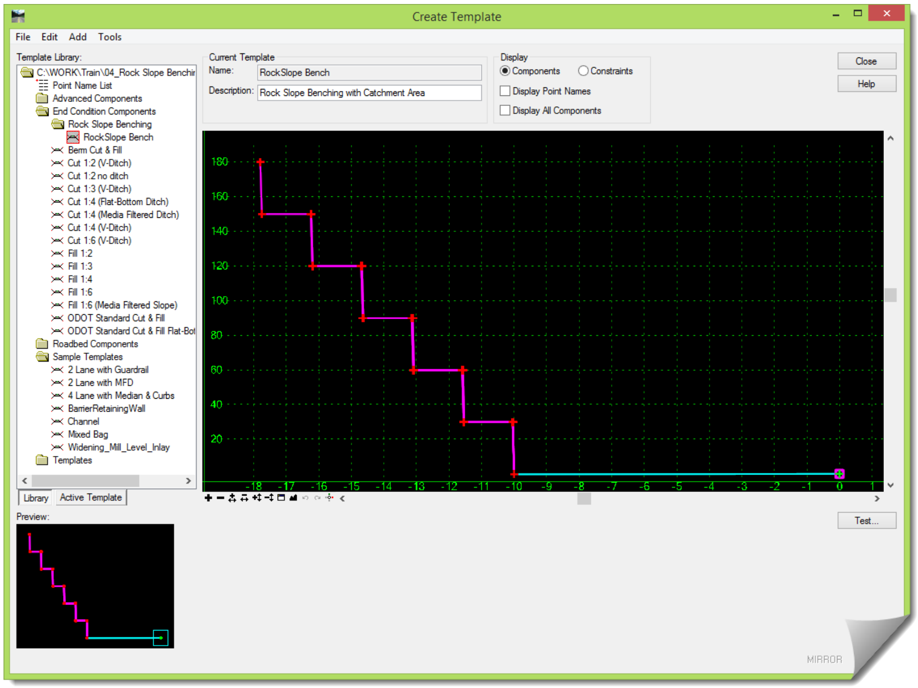
3) Now browse the Component folders and open the **`Rock Slope Benching`** folder under **`End Condition Components`**.

You should see a component called **`Rock Slope Bench`**. This is the heart of this module.



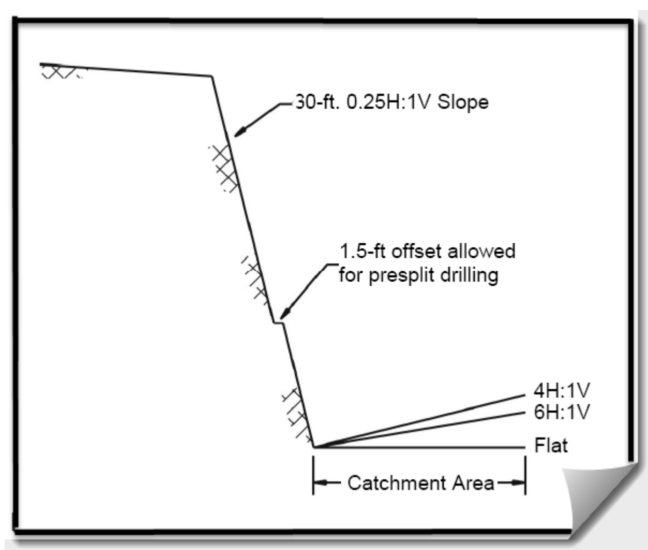
4) Double-click on that component to activate it and put it into editing / review mode.

For clarity, feel free to turn *off* the **Display Point Names** toggle.



This component will not be edited during the module as it was designed to require a very minimal amount of editing, and in most cases, to require no editing.

Let's redirect this review away from the actual component and take a moment to examine the criteria for benching in a rock condition such as this. Here is the slope benching layout concept:



a. Extend off of the aggregate shoulder wedge with a slope for the **Catchment Area**
   - **Catchment Slope** and **Width** to be determined by the geotechnical designer
b. Extend cut up vertically (30' typical) at a **Slope** determined by the geotechnical designer
c. Bench over 1.5' Horizontal and 0.00' Vertical
d. Repeat vertical cut and bench as needed until it intercepts the rock surface

These steps are only used to determine the intercept location on the rock surface at the top of the slope, and not the actual benching design. The criterion goes on with:

e. With the intercept point established on the rock surface, reverse the process by:
   - From the intercept point on the rock surface, extend a cut slope down vertically (30' typical) at **Slope** determined by geotechnical designer.
   - Bench over 1.5' Horizontal and 0.00' Vertical
   - Repeat vertical cut down and bench until it reaches the end of the catchment area.

There are three variables in this design condition that will have to be addressed:

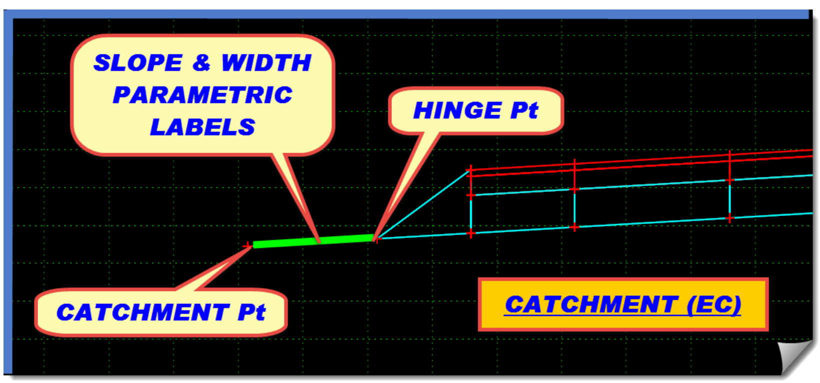
- The Catchment Area slope
- The Catchment Area width
- The Rock Cut slope

The other design condition that must be incorporated into the solution is that the slope cut is done in 30' increments from the top of the slope, not from the toe of the Catchment Area. That means that the location of the catch with the rock surface has to be located by benching upward without constructing those points, and then constructed in a reverse direction back downward to the Catchment Area, constructing those points.

Here are the components and diagrams that were created to meet these requirements:

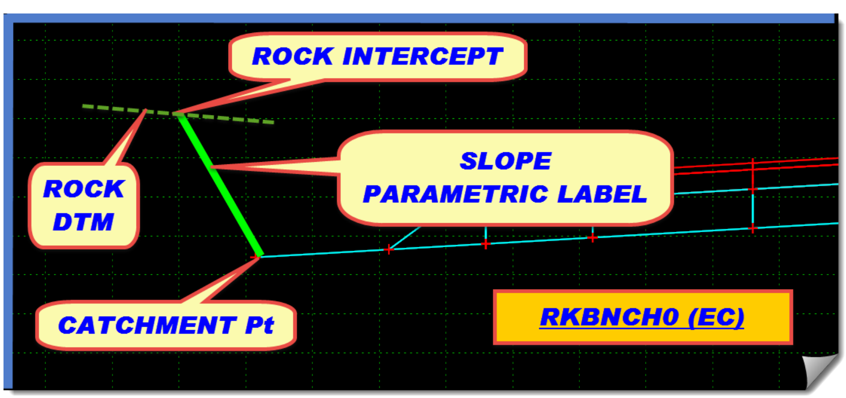
EC Component 1

Catchment - **Constrained** component with 2 pts (not closed). The component is initially laid out at 10' wide @ 2% slope. Both the **Slope** and **Width** will have **Parametric Constraints** (**Labels**).



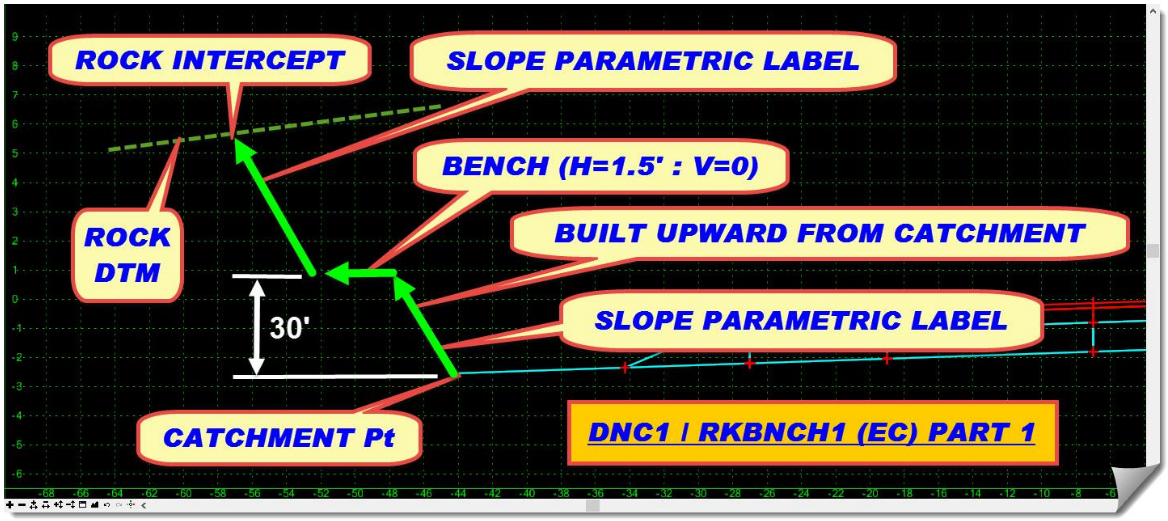
EC Component 2

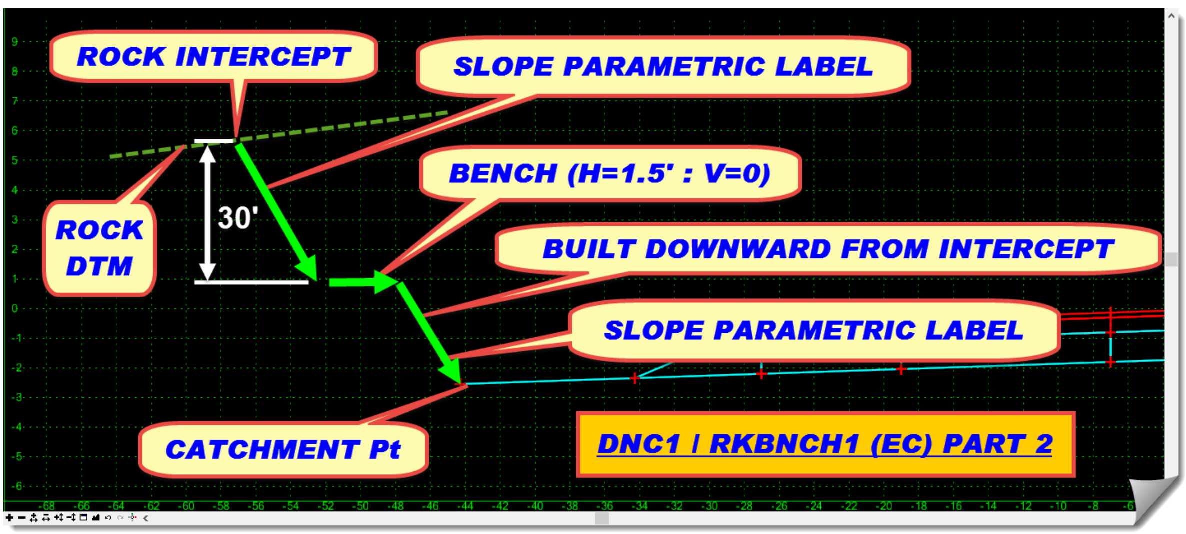
RkBnch0 - a single **End Condition** component with two pts constructed as shown here:



EC Component 3

DNC1 / RkBnch1 - a single **End Condition** component with 4 points, combined with a **Constrained** component overlaying the **EC**, also with 4 points. This pair defines a single bench.





EC Component 4 thru 7

These ECs follow the same pattern of construction as the previous one and only vary in the number of benches that the components have.

DNC2 / RkBnch2 - a single **End Condition** component with 2 benches + a **Constrained** component

DNC3 / RkBnch3 - a single **End Condition** component with 3 benches + a **Constrained** component

DNC4 / RkBnch4 - a single **End Condition** component with 4 benches + a **Constrained** component

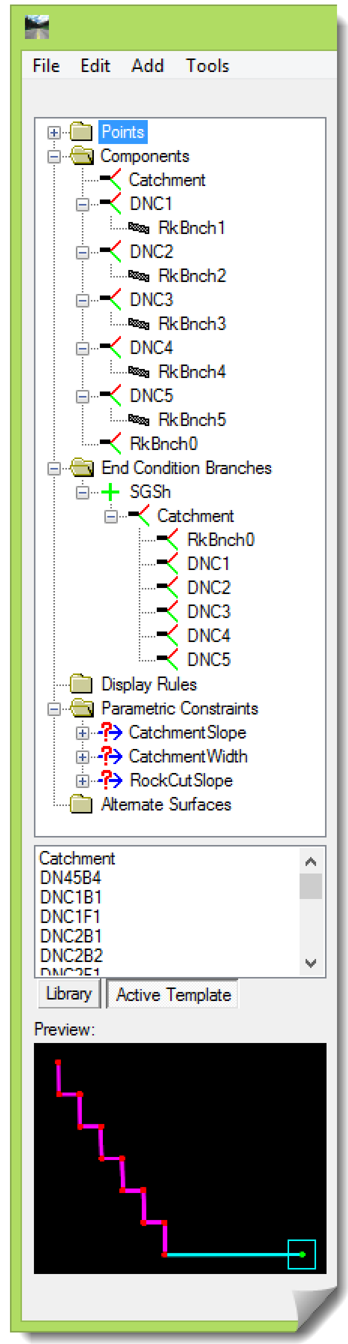
DNC5 / RkBnch5 - a single **End Condition** component with 5 benches + a **Constrained** component

One of the keys to this solution is using an End Condition going up from the Catchment Point with points that are not constructed by InRoads. This is only done in order to locate the daylight point. Then once that point is successfully found, turning on a 'Child' Component that then displays the required benching in a reverse direction.

Fully understanding the mechanics behind this End Condition requires knowledge of:

- **END CONDITION** chaining – stringing ECs together to form a complete solution
- **END CONDITION** branching – combining ECs at a common point to define different alternative solutions
- **PARAMETRIC CONSTRAINTS** – using Values to drive the component Point Constraints
- **Parent Components** – attaching a component to another with a display dependency
- **End Condition Point Properties** – controlling the ability of the points that are part of an EC to be a part of the final solution or not.

This is InRoads Level 2 knowledge and will not be covered in this module.



1) If you have this level of knowledge and wish to review the construction details, feel free to take some time to review the **`Rock Slope Benching`** component. As a suggestion, these are the areas that will provide insight into its structure.

   - Review the **ACTIVE TEMPLATE** tab for the following:
     - **Point Names**
     - **Feature Name Overrides**
     - **Components** used
     - **Parent / Child Components**
     - **End Condition** chaining
     - **End Condition** branching
     - **Parametric Constraints**

It should be noted that this EC component, although mildly complex, does not need to be reconstructed in order to use it on a project. Once the thought process has been worked out, and integrated into the construction of the completed component, then it's only a matter of understanding those facets of the component that require input by the user.

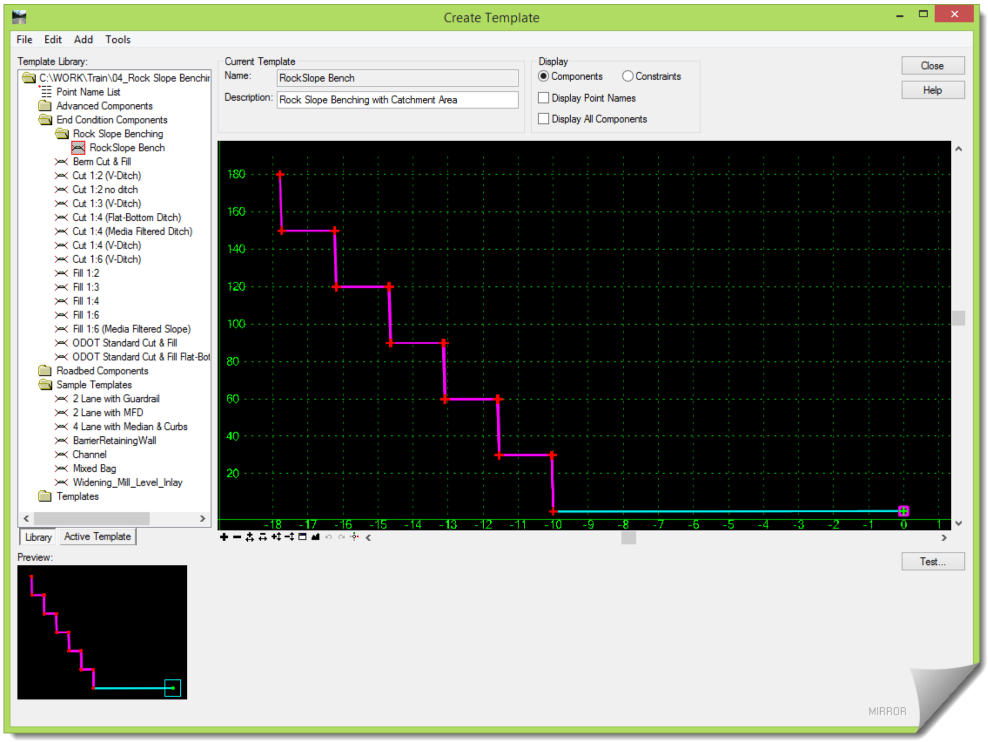
In this case, there is really only one area that is required by the user in order for this component to work correctly, and that is the **PARAMETRIC CONSTRAINT Values**.

These will have to be obtained from the Geotechnical designer for your specific project. And once obtained, they will need to be entered into the **ROADWAY DESIGNER** so that they can be applied to this component.

PARAMETRIC CONSTRAINTS is basically a textual method of changing the layout of a component by manually entering values for the components variable conditions. The way that this is done will be covered in a later section of this module.

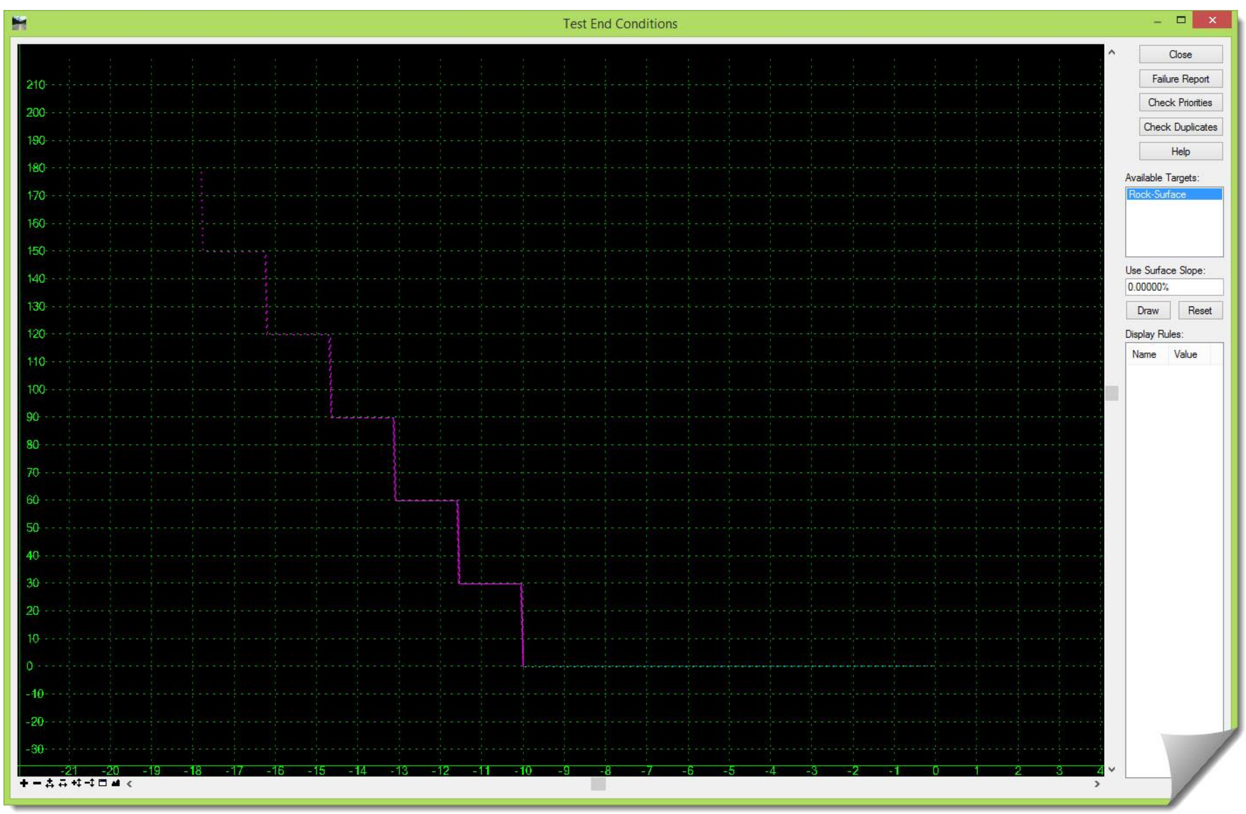
Before moving on, the one thing that will be done here is to run the standard **Test** of an EC.

2) Make sure that the **Rock Slope Bench** component is the active component.



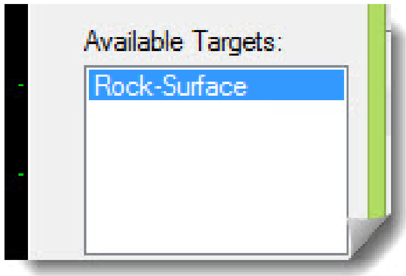
3) Click the [**Test…**] button in the lower right corner.

This will open the **TEST END CONDITION** window.



4) Notice the **Available Targets** area and the **Rock – Surface** in the list window.

There is only one **Target** listed here because this particular EC only targets that surface even though there are many components that make it up. In this case, all of the components within this EC are targeting the Rock surface.

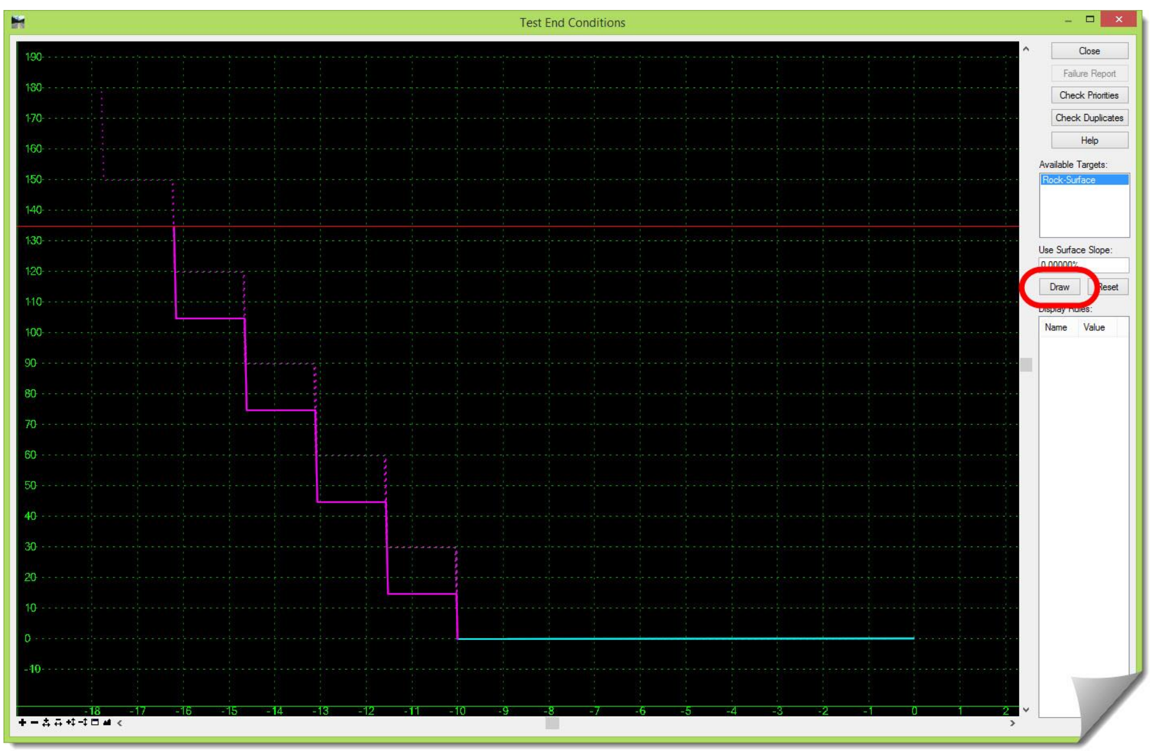


5) Click [**Draw**] on the middle right side, and then hover the mouse in the grid window.
6) As you move your mouse up and down, simulating the Rock surface, the EC will show the solution for the surface in that position. If you left-click the mouse in the view the simulated surface will anchor itself to that spot.
7) Place a left-click to anchor the surface so that a few benches are created.

Notice the dashed purple lines? Those represent the "**Do Not Construct**" EC making its way up from the Catchment Point (the end of the cyan line). The solid purple lines represent the **Child** component that is built downward from the Rock surface intercept location.

Eyeball the distance from the Rock surface intercept down to the first solid purple bench. It looks to be the 30' that it was designed as.

This testing shows that this component is reacting the way it is designed to react.

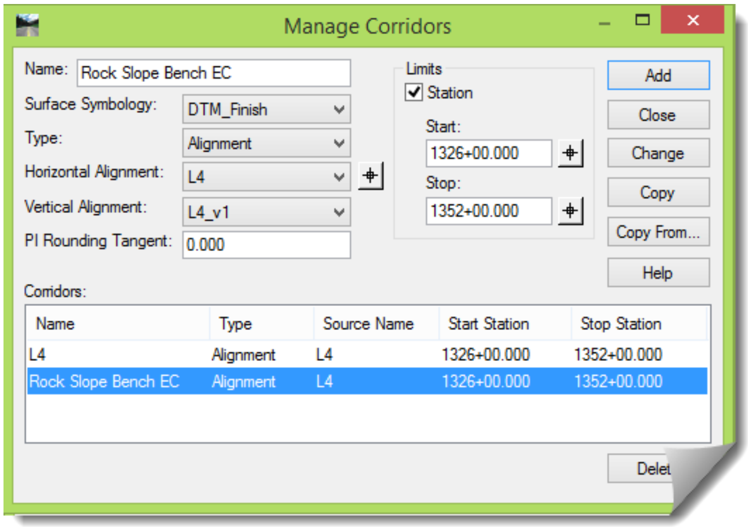


8) You can click [**Draw**] again and reposition the simulated surface if you have the interest.
9) [**Close**] this dialog box when you are done.

Let's create a **Corridor** in the **ROADWAY DESIGNER** that only uses this EC to see how it reacts.

10) Open the **ROADWAY DESIGNER** and create a new **Corridor** with the following settings:

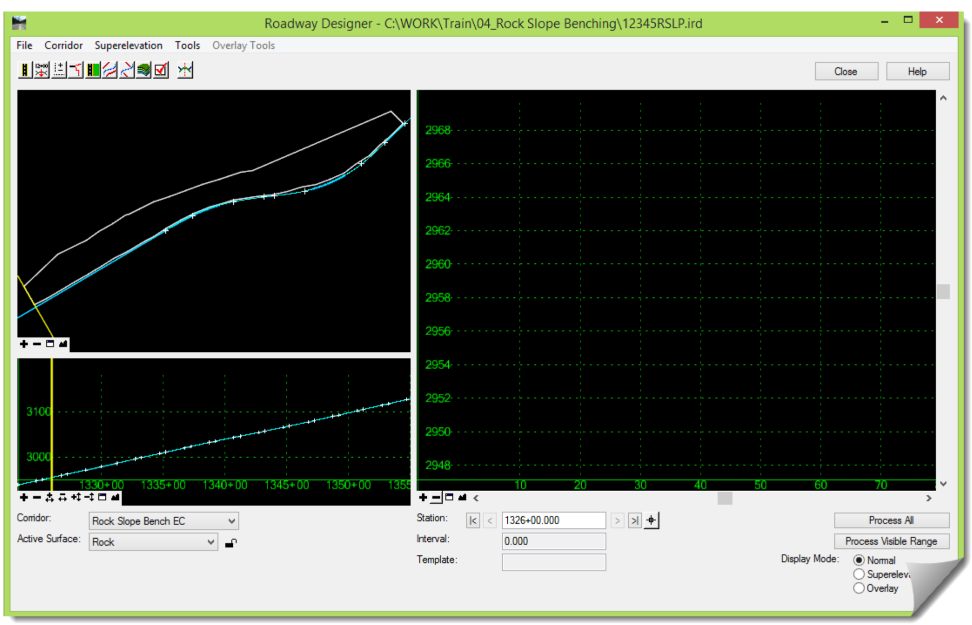
- Enter the **Name** as `Rock Slope Bench EC` or something similar
- Set the **Surface Symbology** to `DTM_Finish`
- Use `L4` and `L4_v1` as the **Horizontal** and **Vertical Alignment**
- Set the **Station Limits** to the area where the Rock surface exists
  - **Start** at `1326+00`
  - **Stop** at `1352+00`



11) [**Add**] this new **Corridor** to the IRD and then [**Close**] the **MANAGE CORRIDORS** dialog box.

The way that this **Corridor** is defined, the EC will be running directly along the centerline defined by the `L4` horizontal alignment. The only purpose this serves is as a test of this EC and obviously has no connection with the final design.

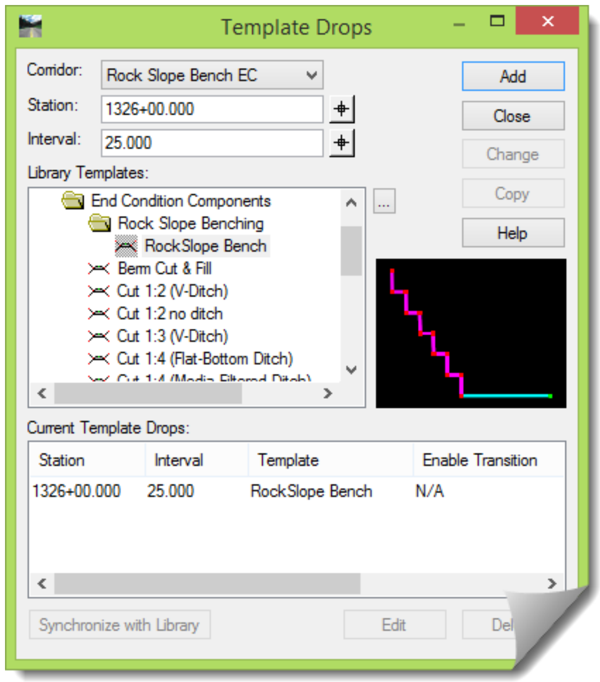
12) As expected, you should see some information in the both the Plan and Profile views.



Now the EC component will be added to this **Corridor**.

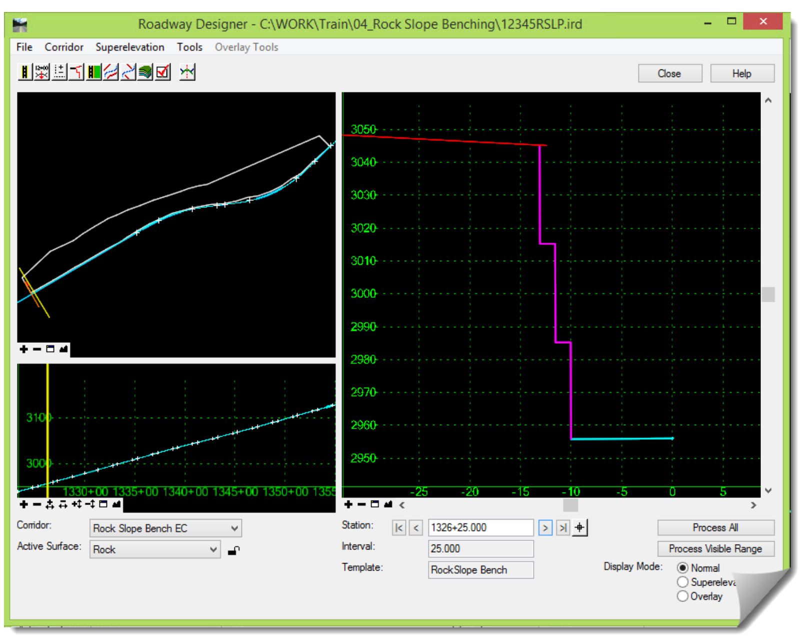
13) Go to the **Template Drops** dialog box and add the EC component per the following:

- Make sure the **Corridor** is set to the **`Rock Slope Bench EC`**, just created
- The **Station** should be the first station of this **Corridor, `1326+00`**
- Set the **Interval** to something like `25.00`
- Browse the **Library Templates** and select the **`Rock Slope Bench`**
- [**Add**] that entry so it appears in the **Current Template Drops** list window



14) [**Close**] the **Template Drops** dialog box

15) Now you should be seeing feedback in all three views.



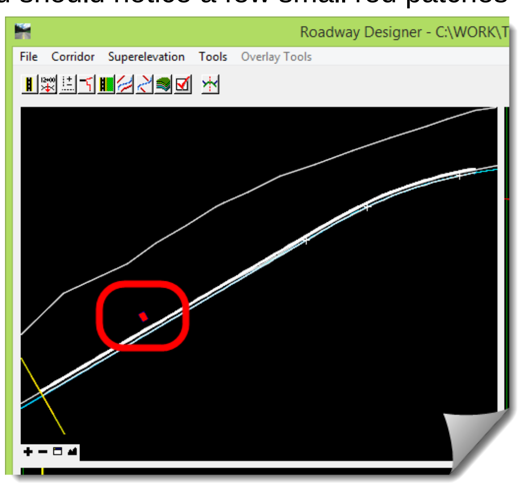
16) Look closely at some of the sections and verify that the benching is being determined from the rock intercept and establishing the benches `30'` downward from that intercept.

You can just 'eyeball' the elevation values on the section grid to confirm this.

17) Step further along the alignment and verify some of the other section views to make sure that they are reacting properly as well.

18) When you are done with that review, click [**Process All**] to temporarily develop the design model within the **Roadway Designer.**

19) After this is done you should notice a few small red patches in the plan view window.

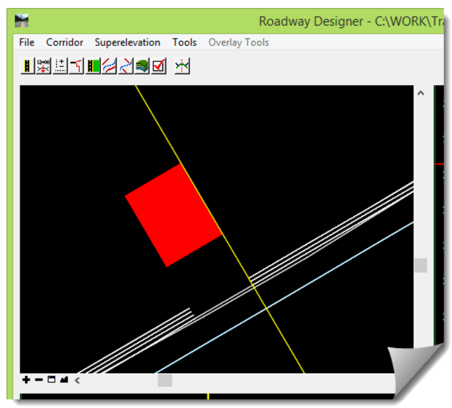


TIP: Color-coded bands in the Plan view of the **ROADWAY DESIGNER** along the corridor path indicate that a transition is taking place. These bands can be red (indicating total failure), dark blue (indicating full connectivity), yellow (indicating partial failure), or cyan (indicating an incomplete edit was made by a user).

This banding occurs in the **Backbone** portion of the model whenever two different templates are dropped; however, it can also be seen when two different side slope solutions are constructed. Like **Backbone** transitions, **End Condition** transitions can be edited also; however, the editing mechanism and presentation is slightly different.

The following is covered in the InRoads Level 2 class, but will be presented as refresher.

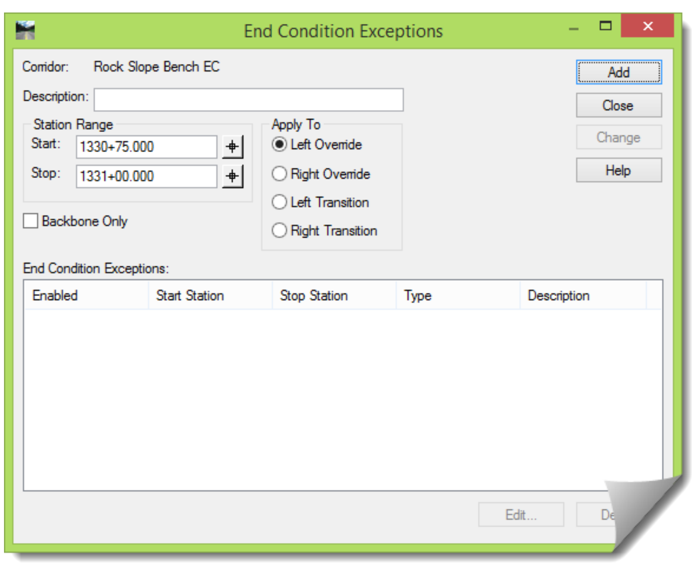
20) Window the Plan view of the **ROADWAY DESIGNER** to the area of the red EC transition failure (around cross section 1330+50).



EC transition failures are edited differently than **Backbone** transitions and require a unique workflow to be done. Also, in the view above, do you notice the gaps in the planimetric lines? That's a result of the transition failure between two different EC solutions containing differences.

21) Double-click on the red EC transition failure area.

When you do this, the **END CONDITION EXCEPTIONS** dialog box appears with certain information already populated, namely the **Start** and **Stop** fields under the **Station Range**. This is a start.



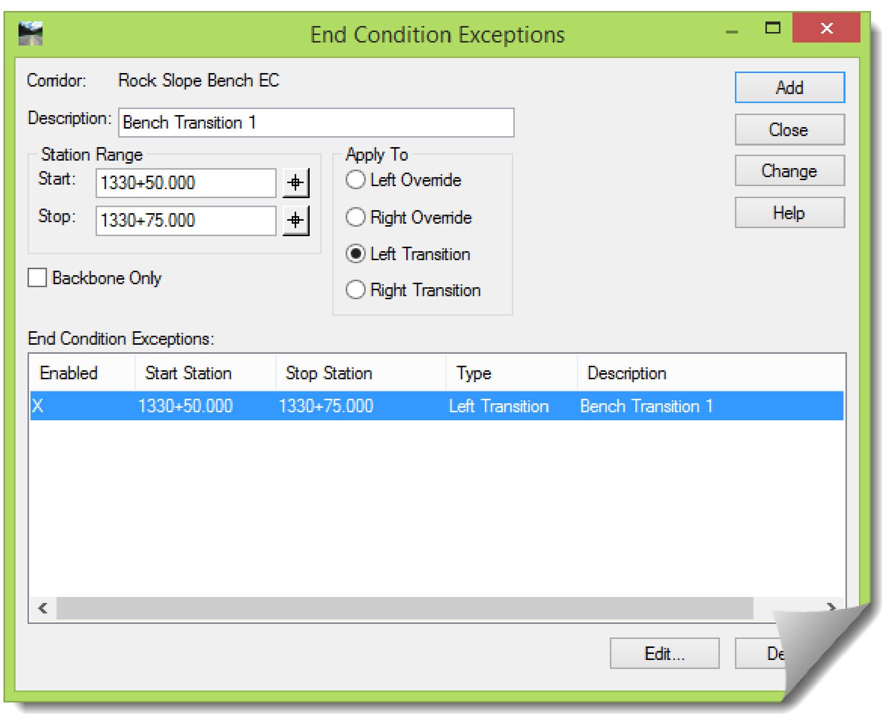
The way EC transitions are edited is to first create a **Transition** entry in the **END CONDITION EXCEPTIONS** dialog box.

TIP: There are three different types of **END CONDITION EXCEPTIONS**, each with its own purpose.

- **Override: Backbone Only** - used to turn off a template End Condition at a range of stations where it isn't needed or wanted.
- **Override: Edit** - used to replace or somehow modify the cut or fill slope that is being applied from the 'typical' section along some range of modeling stations.
- **Transition: Edit** - used when a transition exists from one **EC** solution to another **EC** solution. It is very similar to the transition edits that exist within the backbone.

22) Create an entry in the **END CONDITION EXCEPTION** tool for this EC failure.

- Add a good **Description** like `Bench Transition 1` (allowing for the potential of having to do this more than once).
- Set the **Station Range** to whatever **Start** and **Stop** makes sense for this area. You do not have to adhere to any particular station range. Whatever you enter will be the range that is affected by your upcoming edit.
  - Set the **Start** to `1330+50`
  - Set the **Stop** to `1330+75`
- Under the **Apply To** area, click the radio button next to **Left Transition** since this occurs on the left side of the alignment looking up station.

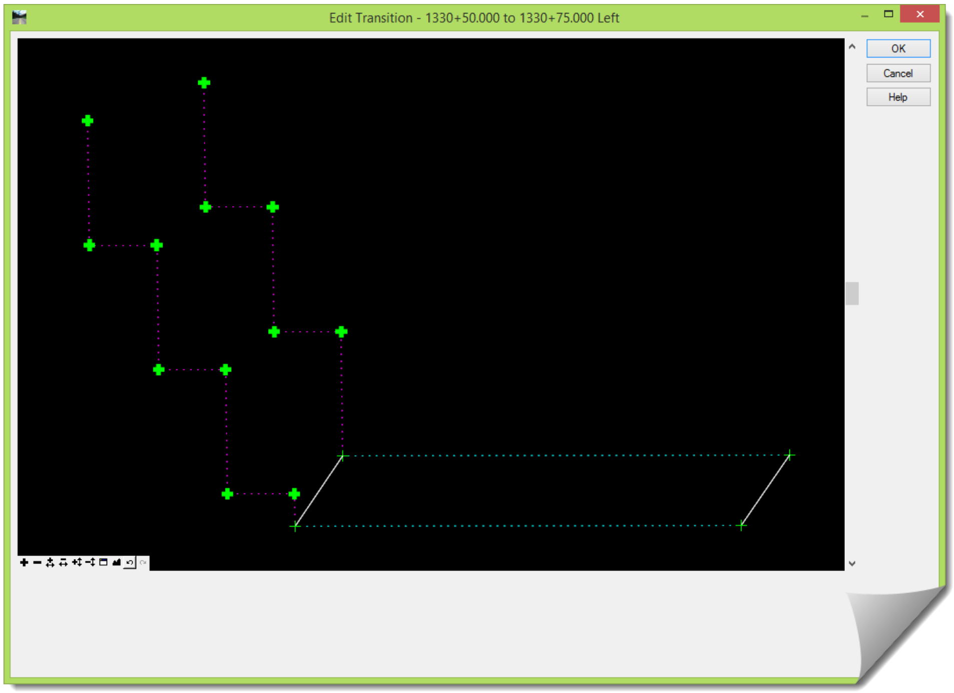


23) Click [**Add**] to create that entry.

Once a transition entry has been added, it can then be edited or reviewed.

24) Highlight that entry in the **End Condition Exceptions** list window and then click [**Edit…**]

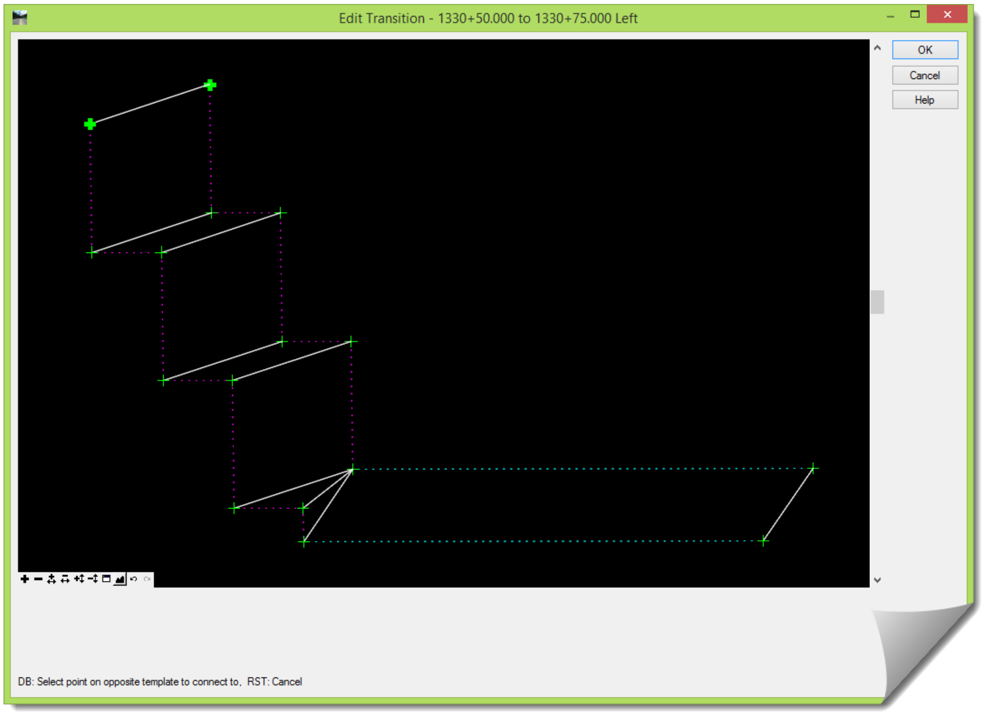
This will open what should be a familiar **EDIT TRANSITION** window. Right-click on any point as needed in order to **Move Template** and reposition the 3D view of the transition.



This editor acts the same way the **Backbone** transition editor works.

25) Using what you know of the roadway transition editor, connect up the template points from one EC solution to the next EC solution.

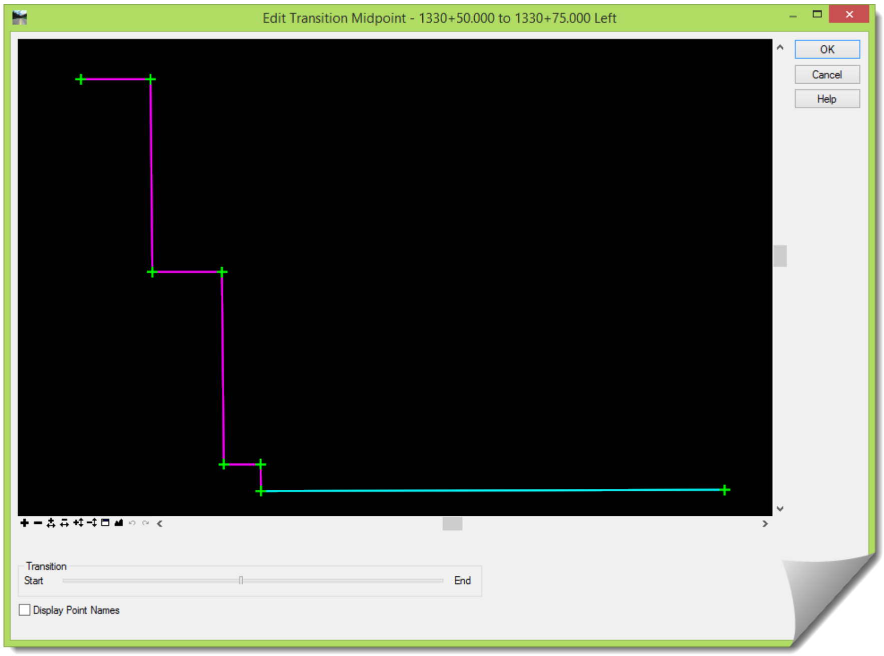
In this case, the transition is between an EC solution with three benches and a solution with two.



ALERT: For some reason the final catch point, where the **End Condition** hits its **Target** and daylights, may refuse to allow the user to connect a line. This is usually not a problem since in most cases the triangulation connects correctly between these end points. But you should be alert to this fact and make sure you check the triangulation and display in these EC transition areas. **FEATURE NAME OVERRIDES** will also address the final EC connection.

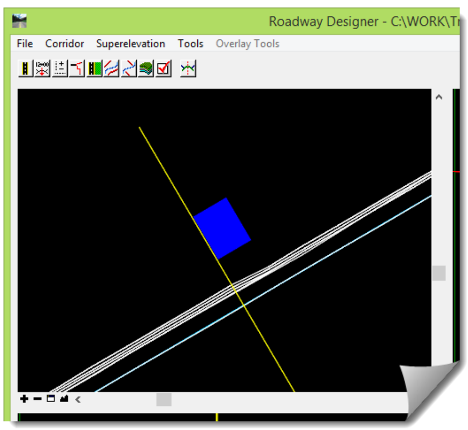
26) Click [**OK**] when you have finished connecting the two solutions.

Once you click [**OK**] you will see the familiar **EDIT TRANSITION MIDPOINT** dialog box.



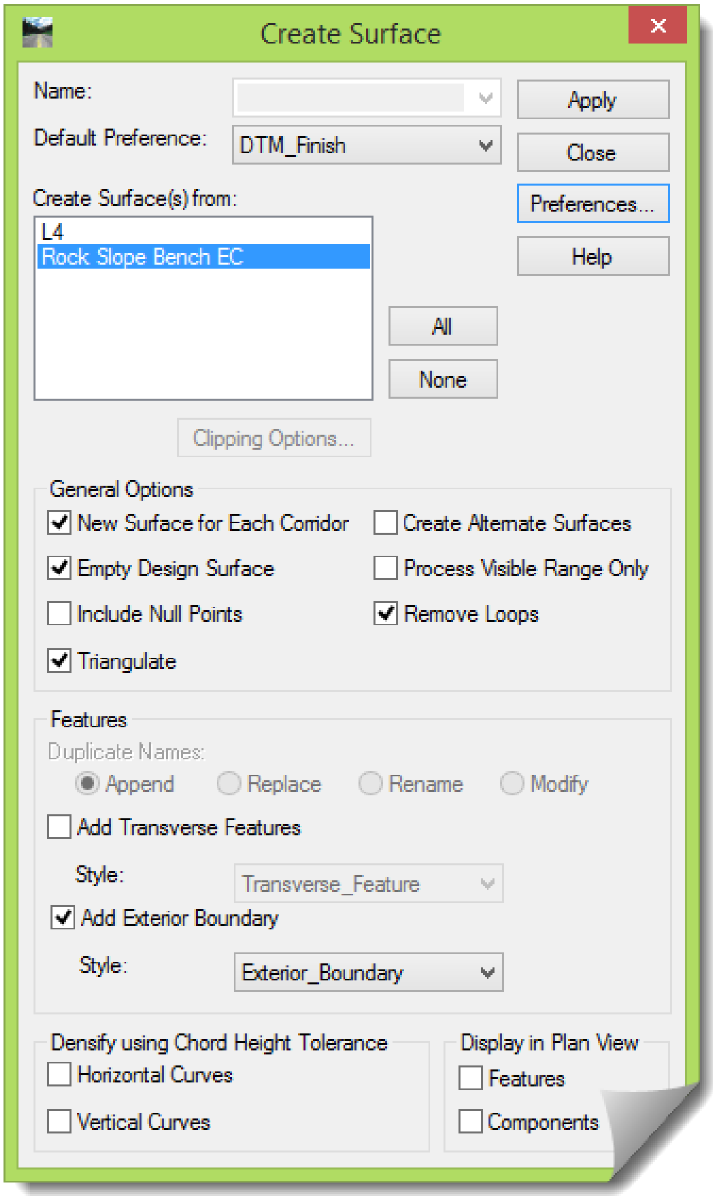
27) Feel free to test the **Transition** by sliding the slider bar from the **Start** to the **End** and checking to make sure that the components transition as expected.
28) Click [**OK**] when you are done here.
29) Take note of the previously red transition band. It should be dark blue indicating that it has appropriate connectivity.

There are additional transitions here that require editing, but they will not be done at this time.



The next step will create a surface of this corridor and view it outside of the **ROADWAY DESIGNER**.

30) Create a surface of this `Rock Slope Bench` **Corridor** by going to the **CREATE SURFACE** tool using the settings shown here:



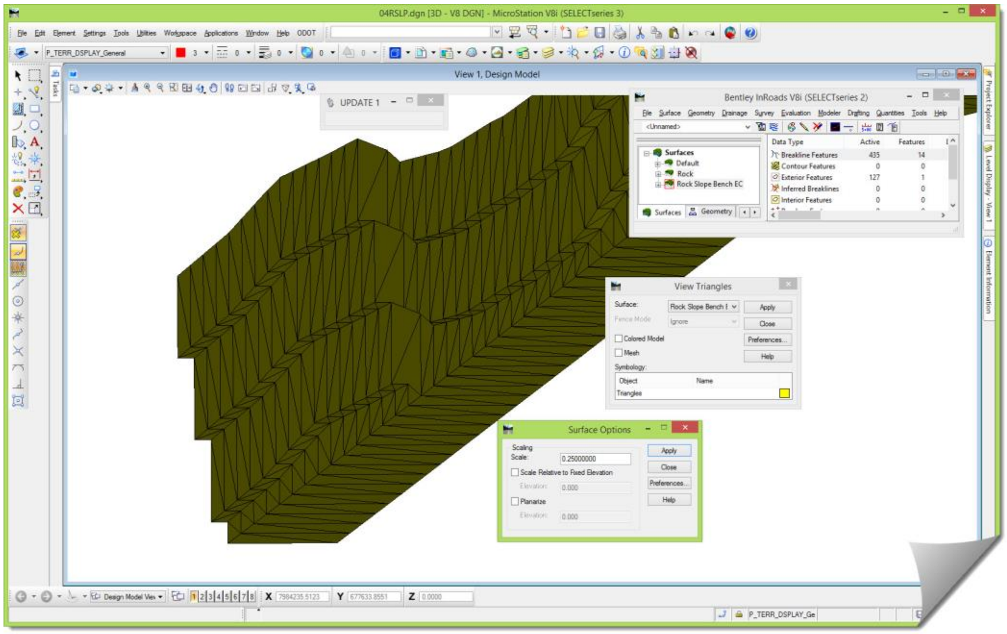
It should not be forgotten that this is just a test of the Rock Slope Bench EC, as it has not been associated with an actual roadway template yet.

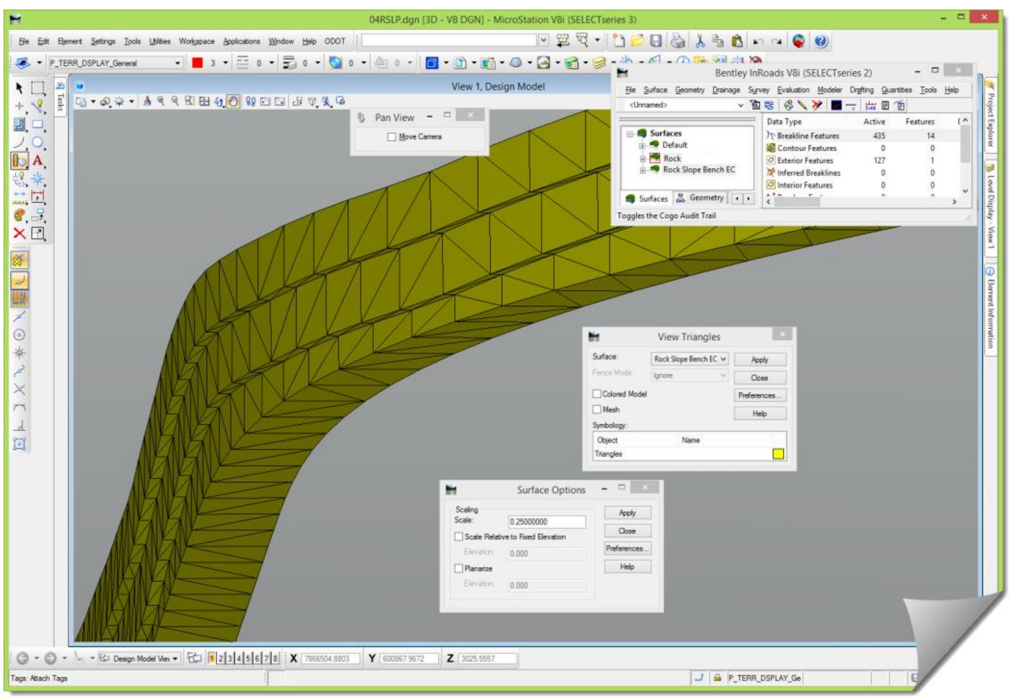
Regardless, the steps that are being done here will be no different when it is attached to the backbone area of a template.

TIP: When using the **CREATE SURFACE** tool, and creating a surface from a single corridor, there are two ways to control the resulting **Name** of the surface. When the option **New Surface for Each Corridor** is toggled *off*, the **Name** can be entered manually. When that option is toggled *on*, the **Name** is defaulted to the name given to the **Corridor** itself from the **MANAGE CORRIDOR** dialog box.

31) View the triangles of the resulting surface and take a look at the results.

The view shown below was created with the **Scaling** on the **SURFACE OPTIONS** set to `0.25`. Feel free to apply any scaling that you feel is appropriate or none at all.





Everything should look good at this point.

32) Feel free to **Save** this surface to the module folder for future reference.

That was more or less a complete run through of the Rock Slope Benching component.

Now that you have a fair understanding of this component, next up will be the actual project workflow that you would do on your job. After all of the work that you've already done, you'll see how simple it will be to apply this component to your project.

SCENARIO - ROCK SLOPE BENCHING

In this section the Rock Slope Benching EC will be applied to a project template, used in the **ROADWAY DESIGNER** with the addition of the Geotechnical details, and then a final design surface will be created.

Here is the overall project workflow (starting with the templates and the assumption that there is a need for rock slope benching):

Prerequisites:

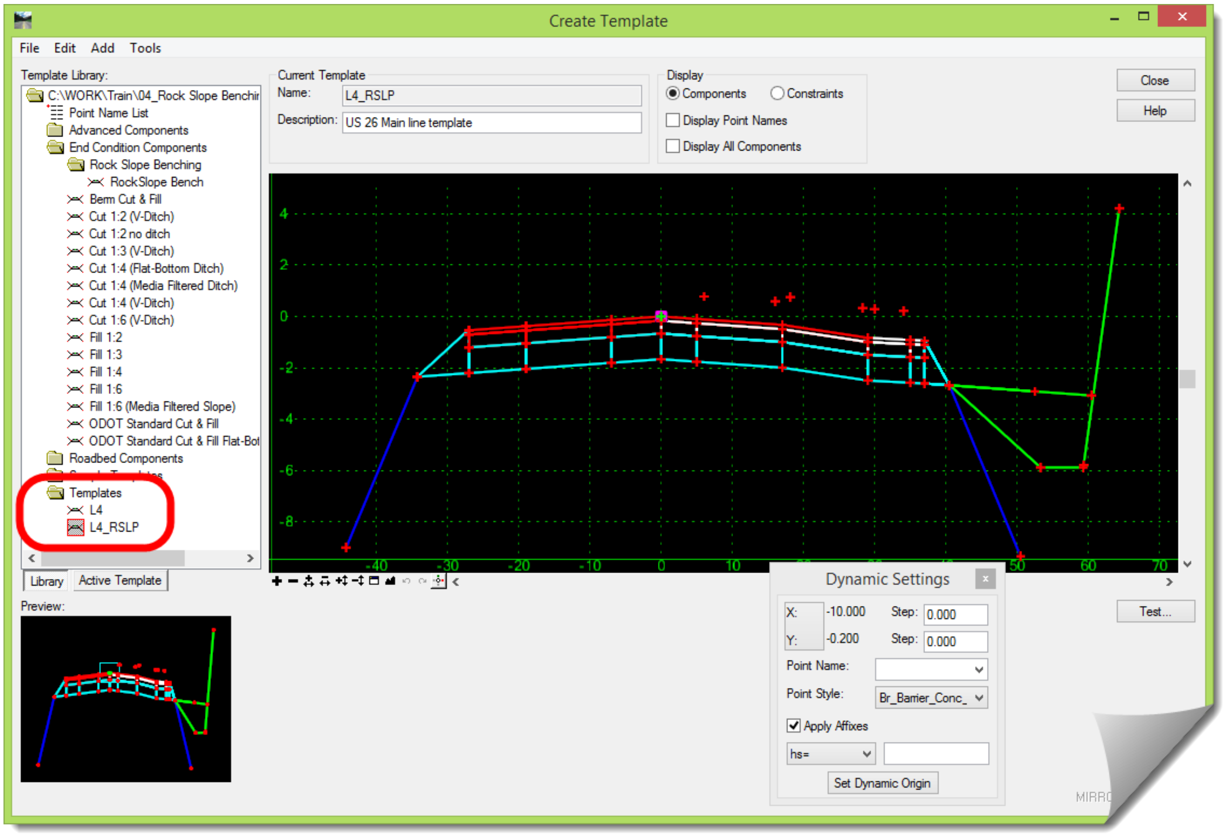
a. Rock Surface DTM
b. Geotechnical details for the Catchment width and slope, as well as the rock slope
  - The information that will be used here is:
    - ♦ Catchment Width = 12’
    - ♦ Catchment Slope = 1V : 4H
    - ♦ Rock Cut Slope = 1V : 0.25H
c. You are using the ODOT template seed file to start your project. This is required in order to have the necessary pre-created components available (such as the **`Rock Slope Bench`**).
d. Roadway Template backbones are created
  - A template called **`L4`** will be used as the base roadway section

Overall Project Workflow

a. Construct your template using the Rock Slope Bench as appropriate (make sure that the **APPLY AFFIXES** is appropriately defined before dragging and dropping any components during template construction)
b. [**Test…**] the template End Conditions in the **CREATE TEMPLATE** tool
c. Open the **ROADWAY DESIGNER** and create a **Corridor** for your roadway
d. Drop your templates based on your project requirements
e. Take the Geotechnical information and establish the **PARAMETRIC CONSTRAINTS** in the **ROADWAY DESIGNER** for each of the three different variables (Catchment width & slope, and Rock Cut Slope)
f. Do a [**Process All**] in the **ROADWAY DESIGNER**
g. Review the resulting **ROADWAY DESIGNER** sections
h. Pay special attention to any EC transitional issues and create **END CONDITION EXCEPTIONS** to address any EC transition failures
i. Create the design surface
j. Review the resulting design surface in MicroStation
k. Create Cross Sections for an additional review of the design surface

1) If you happen to have exited out, and are just now getting back into InRoads, make sure that you have opened the following InRoads project data at a minimum:
   - **`04RSLP.xin`**
   - **`12345RSLP_rock.dtm`**
   - **`12345RSLP.itl`**
   - **`12345RSLP.ird`**
   - **`12345RSLP_d.alg`**

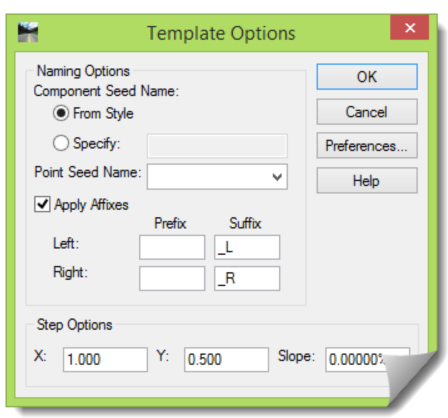
2) Open the **Create Template** tool and browse to the **Templates** folder and expose **L4**.
3) Right-click on **L4** and **Copy**. Then right-click on the **Templates** folder and **Paste**.
4) Right-click on **L41** and **Rename** it to **L4_RSLP** and then double-click on it to make it the active template.



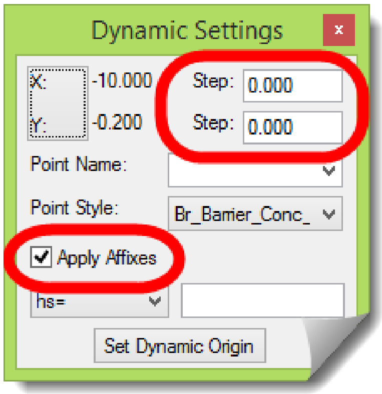
We are not going to concern ourselves with the construction details of source template **L4**. At this stage an assumption is being made that the base roadway component is constructed properly, and its details are beyond the scope of this module.

The next step will be to drag and drop the **Rock Slope Bench** component onto **L4_RSLP**, so let's make sure that everything is set for this to be properly accomplished.

5) On the **Create Template** tool, go to ***Tools > Options*** to open the **Template Options** dialog box.
6) Go to [**Preferences**] and [**Load**] the **Preference** called **ODOT**. Then [**Close**] that dialog.



7) Open the **DYNAMIC SETTINGS** dialog box and set the **X Step** and **Y Step** to 0.00, and make sure that **Apply Affixes** is toggled *on*. Don't worry about any other settings on that dialog.



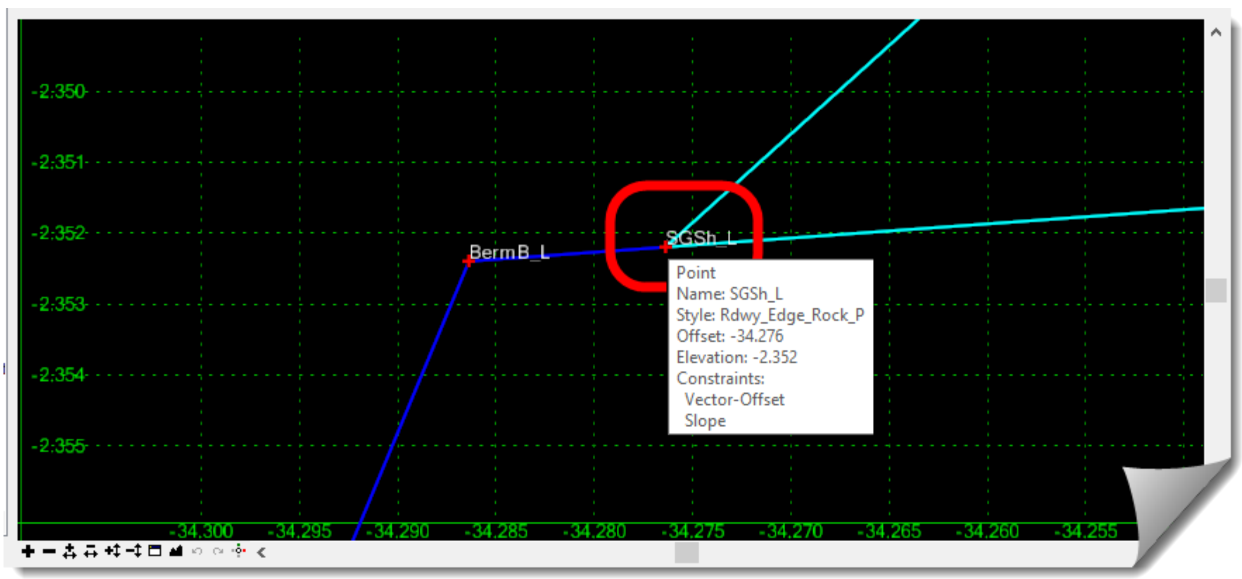
Toggling *on* the **Apply Affixes** will assign left and right designators, making the resulting surface DTM breaklines easier to locate and identify.

TIP: When constructing a new template using the drag and drop technique and pre-created **Components**, it's always a good idea to set the **Step** values to some number to ensure the first point is directly snapping onto the 0,0 template origin location. However, after that first **Component** is placed, changing the **Step** values to 0,0 will help tremendously with a smoother placement when locking subsequent **Components** onto **Component** points that are already in the construction window.

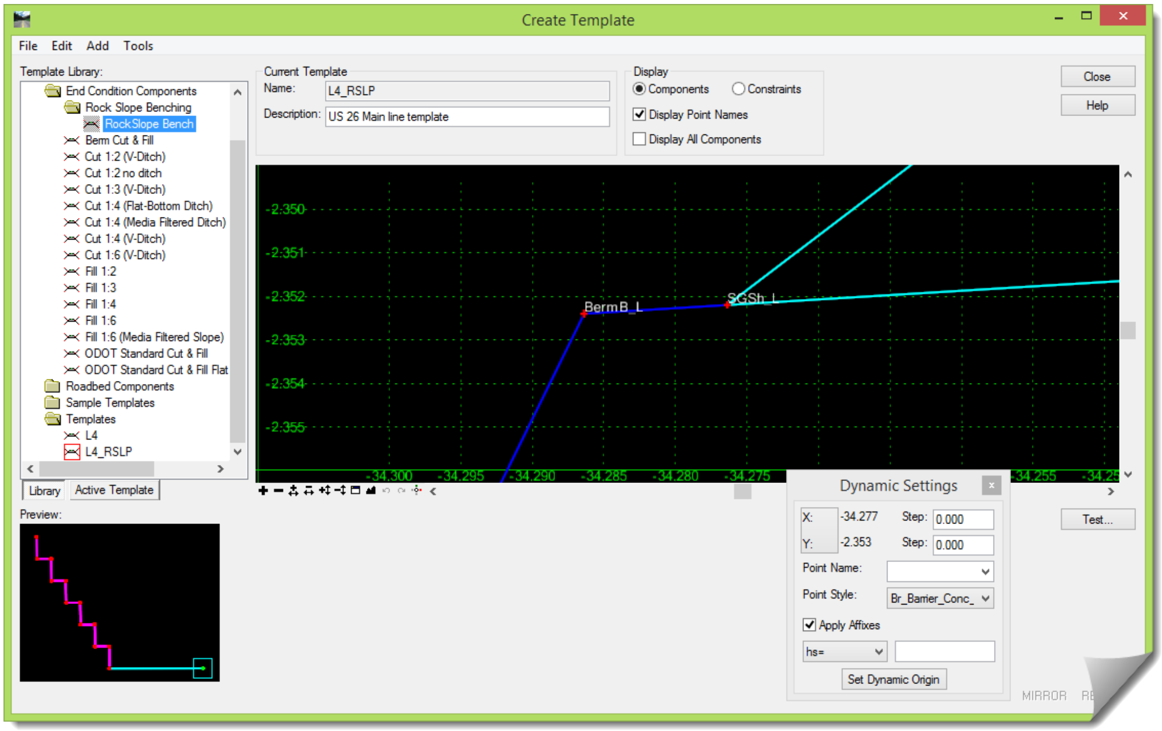
Let's identify exactly where the **Rock Slope Bench** component will be attached on the **L4_RSLP** template.

8) Zoom in very close on the left side of the shoulder wedge, where the dark blue line comes off the cyan triangle.

The placement point for the **Rock Slope Bench** component is on the **SGSh_L** point.

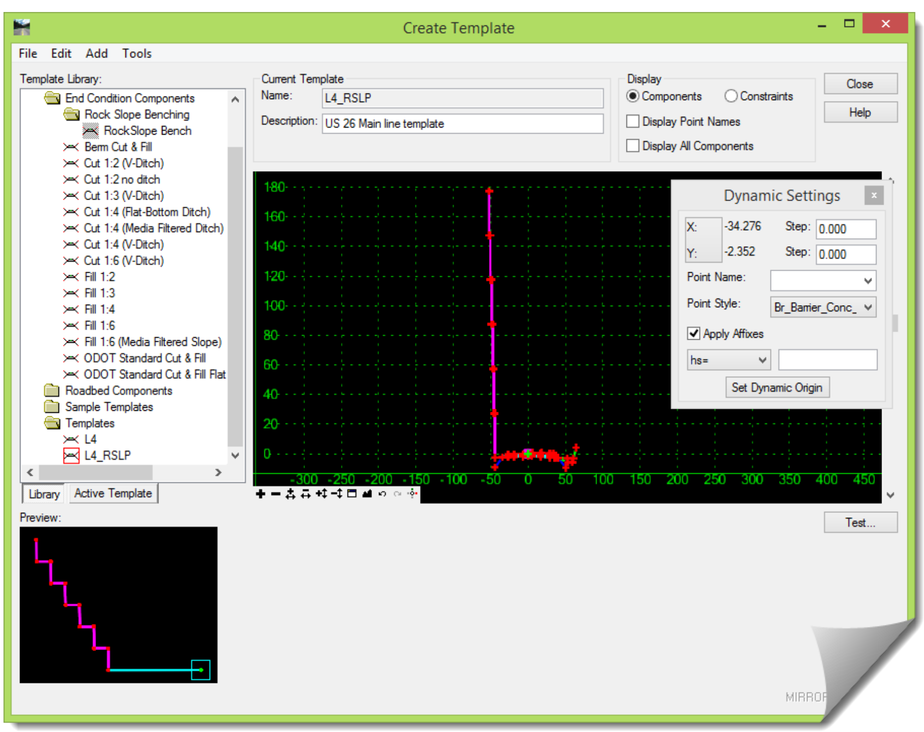


9) Single-click the `Rock Slope Bench` component so it shows up in the preview window and make sure that the `L4_RSLP` template is positioned to accept the new EC.



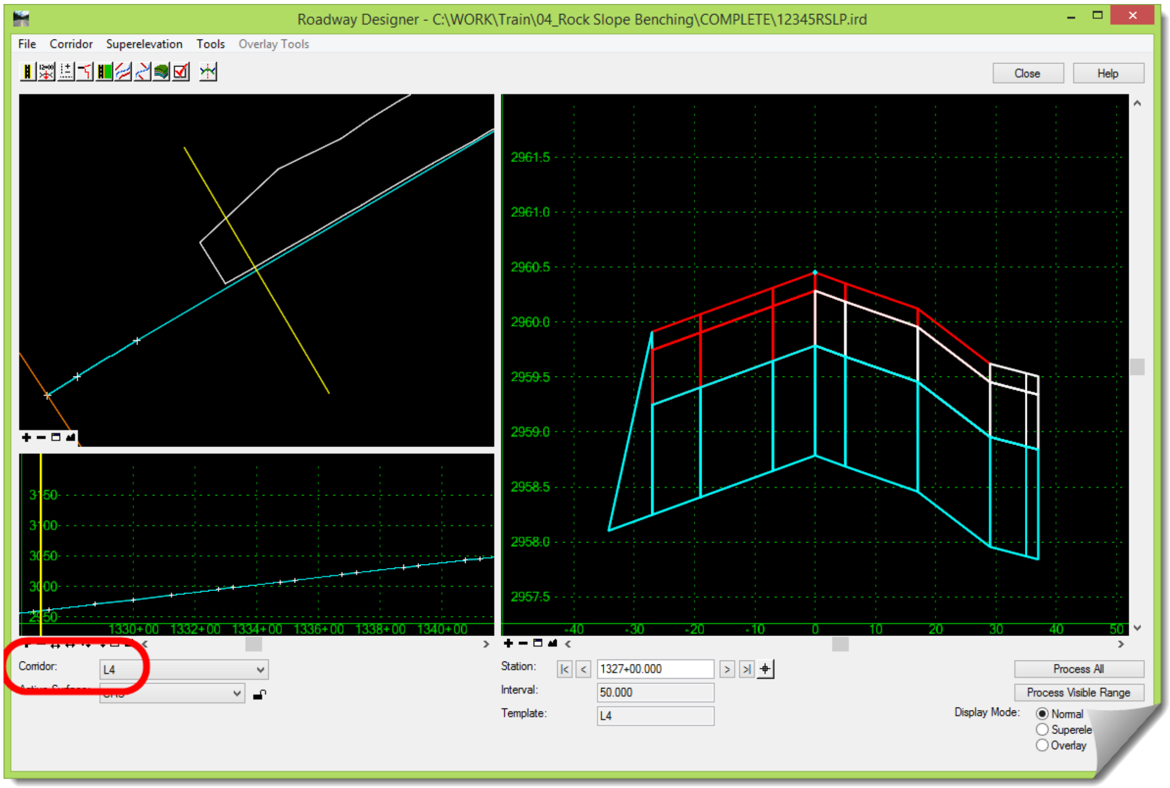
10) Drag and drop the `Rock Slope Bench` EC onto the left side of the `L4_RSLP` template onto point `SGSh_L`.

Because of the excessive height of the EC, when you **Fit** the template it is a bit difficult to read, but it should be constructed correctly if the EC was dragged and dropped onto the correct point.



11) **Save** the **Template Library** at this point if you haven't already and the [**Close**] it.

12) Open the **Roadway Designer** and set the **Corridor** to **`L4`** and make sure the **Active Surface** is set to **`Rock`**.



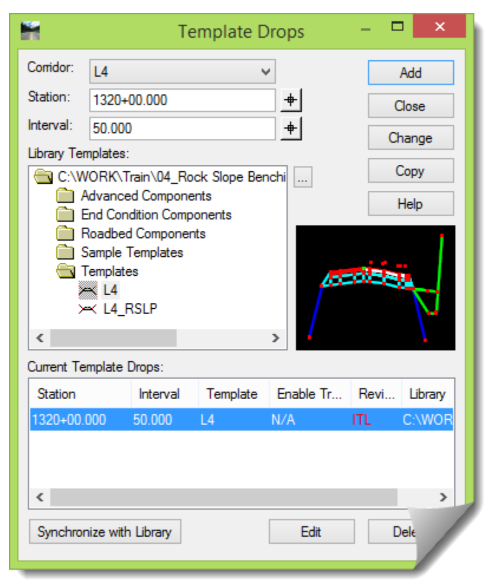
There is an existing **Corridor** in this IRD that was set up using the **`L4`** template. If you think back just a moment, you should recall that you copied the **`L4`** template and called it **`L4_RSLP`**. And it was the **`L4_RSLP`** template that the **`Rock Slope Bench`** EC was added onto.

Therefore, what can be done here is to go into the **Template Drops** for the **`L4`** **Corridor** and just change the template from the old **`L4`** template to the latest **`L4_RSLP`** template.

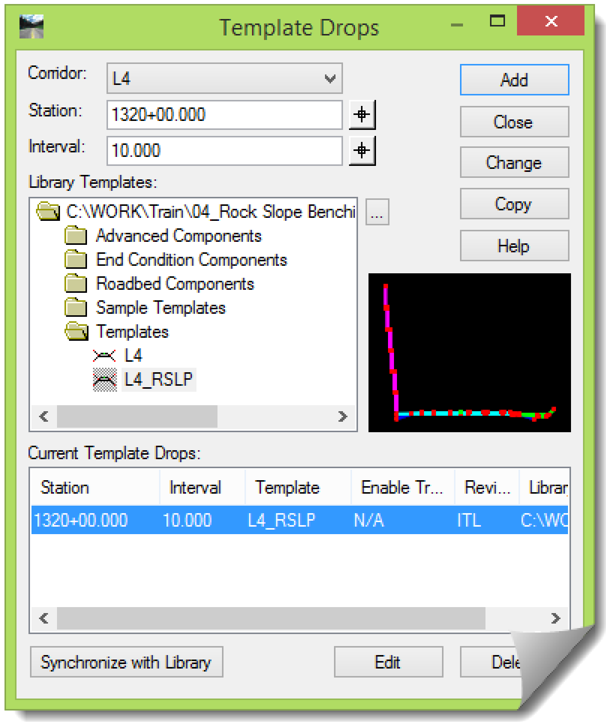
13) Go to the **Template Drops** dialog box and select the single entry listed in the **Current Template Drops** list window.

14) Browse into the **Library Templates** and locate the **Templates** folder.

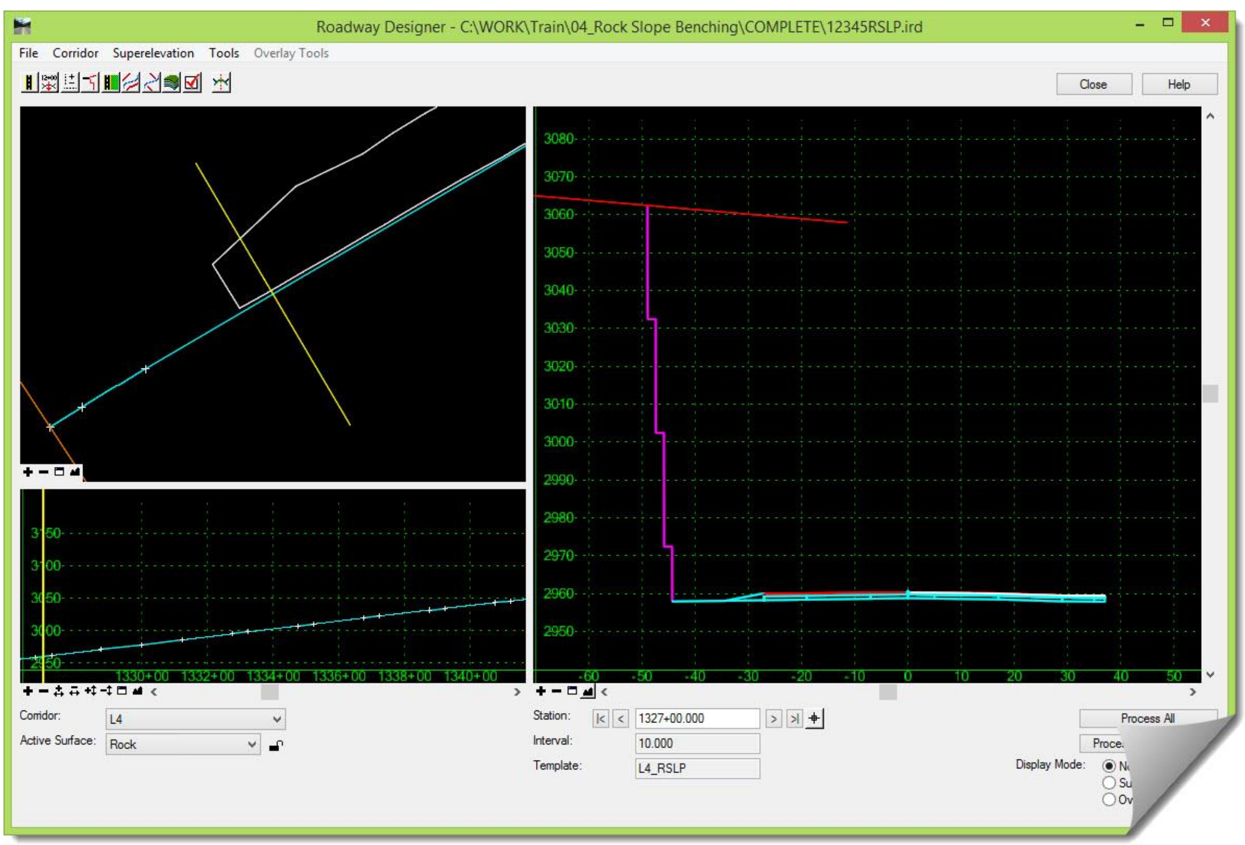
15) Select the **`L4_RSLP`** template and also change the **Interval** to <u>**`10.00`**</u>.



16) Select [**Change**] and verify the setting in the **Current Template Drops** list area.



17) [**Close**] the **Template Drops** dialog once it has been updated to reflect the new settings. You should now see the rock slope bench solution in the section window.

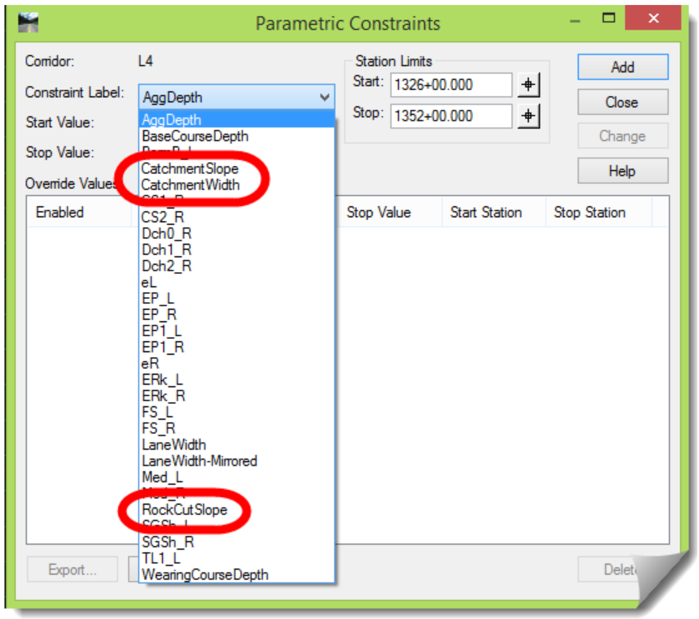


The last thing to do as far as entering the design details is to address the variable conditions that were specifically defined by the Geotechnical designer for this specific project.

18) On the **Roadway Designer**, go to ***Tools > Parametric Constraints***.

The **L4** template used in this module had a number of its own **Parametric Constraints** assigned to the road. When you combine those with the wall, there will be several dozen items in the **Constraint Label** list. Of course, the potential **Labels** shown here will vary on your projects.

19) Select the dropdown list next to **Constraint Label**.



The `Rock Slope Bench` EC uses three specific **Labels** to define its variable conditions:

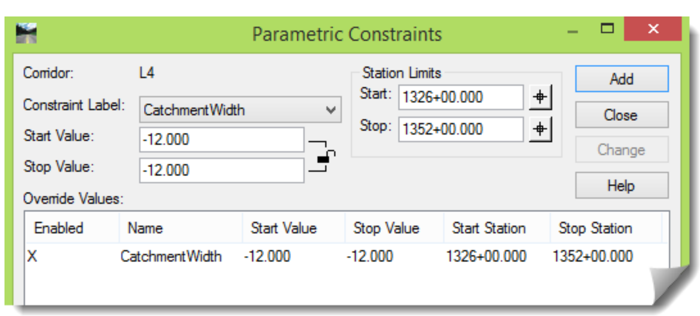
- **CatchmentSlope**
- **CatchmentWidth**
- **RockCutSlope**

As a reminder, the values provided by the Geotechnical designer were:

- Catchment Width = 12’
- Catchment Slope = 1V : 4H
- Rock Cut Slope = 1V : 0.25H

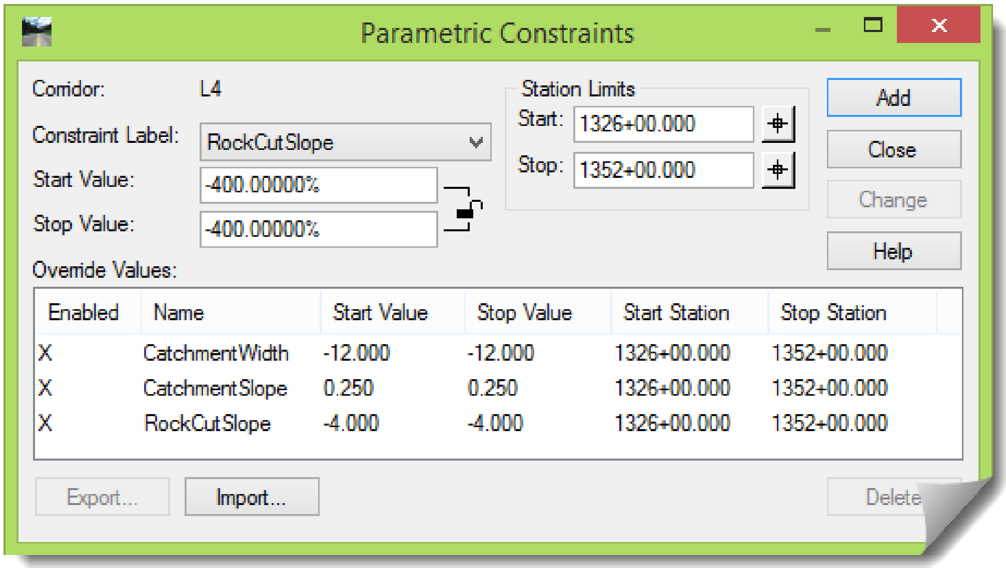
Since these values will be applied to the entire project for this rock slope condition, only a single entry needs to be created for each **Constraint**.

20) Set the **Constraint Label** to **CatchmentWidth** and define the **Start Value** and **Stop Value** as `-12.00` and then [**Add**].



21) Set the **Constraint Label** to **CatchmentSlope** and define the **Start Value** and **Stop Value** as `25%` and then [**Add**].

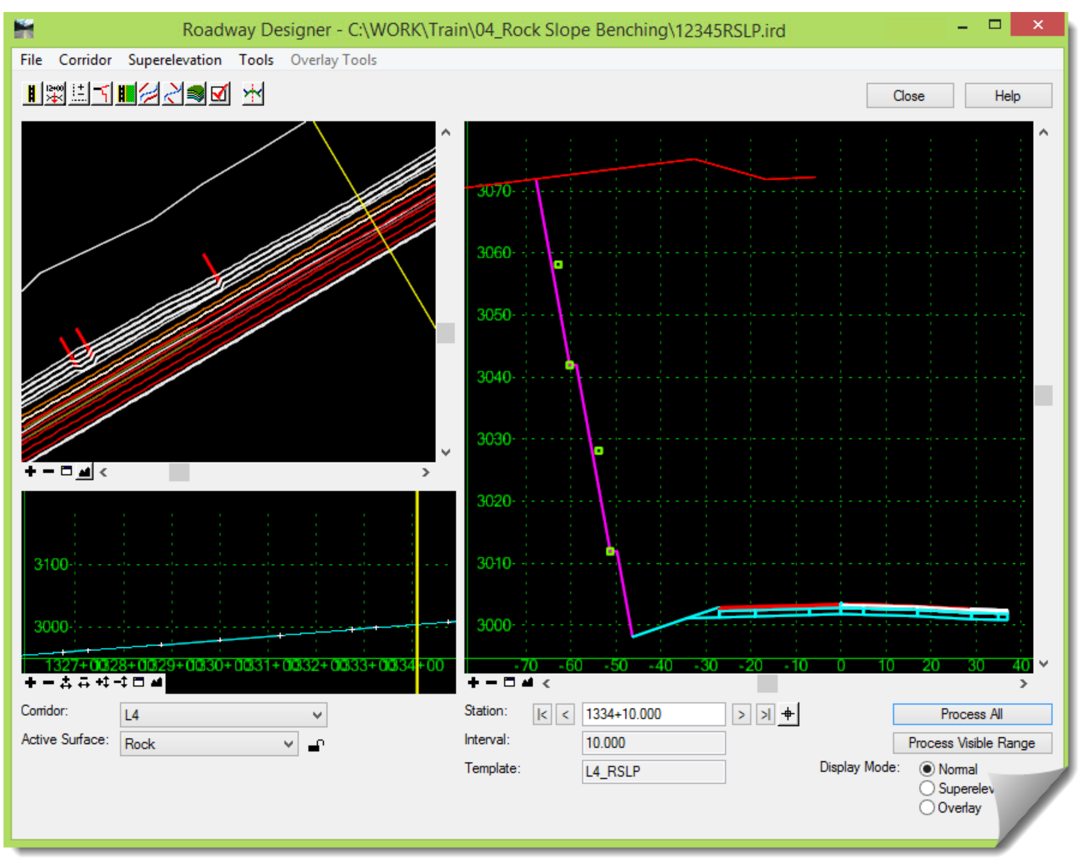
22) Set the **Constraint Label** to **RockCutSlope** and define the **Start Value** and **Stop Value** as `-400%` and then [**Add**].



23) [**Close**] the **PARAMETRIC CONSTRAINTS** dialog box when this is complete.

24) Select [**Process All**] to generate the corridor.

You should now see an accurate Geotechnical-driven rock benching in the **ROADWAY DESIGNER**.

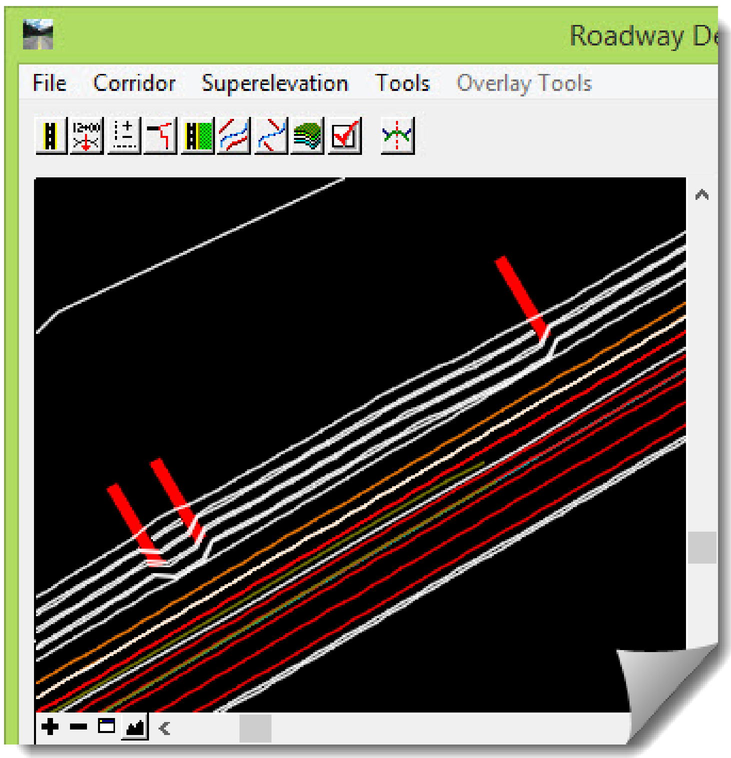


TIP: When **Parametric Constraints** are actively in use in the **ROADWAY DESIGNER**, the points being controlled appear with small green squares on them in the Cross Section window.

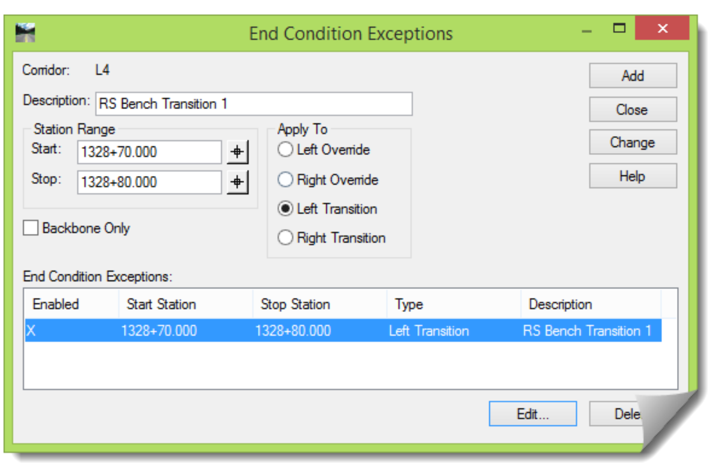
25) If you haven't already done so, **Save** the **ROADWAY DESIGNER**.

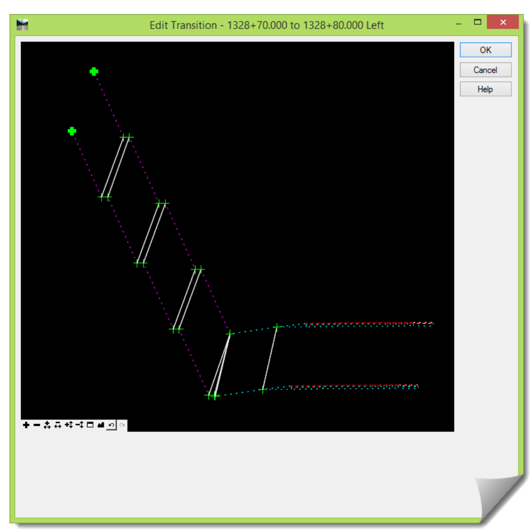
26) If you window into the Plan view window, you will see several areas where there were some EC transition connection failures.

These will need to be addressed per the procedure covered earlier.



27) [**Add**] **END CONDITION EXCEPTIONS** in any areas that require them until your confidence in working with these areas increases.





28) To conclude this module you can:

- Create the design surface
- Review the resulting design surface in MicroStation
- Create Cross Sections for an additional review of the design surface

Conclusion

Congratulations, you have completed the Rock Slope Benching 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.