



# ***Bentleyuser.dk Årsmøde 2012***

## ***Nordic Civil 2012***

### ***Bentley Civil Workshop***

**X09 Power Railtrack**

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## Preface

The bulk of this workshop will be on turnouts and turnout advanced topics. You will learn how to create new turnouts in the turnout library. In addition, you will learn the differences between the *Swiss* and *German* rules for turnout bending. What are standard sleeper sets and how are they used. You will learn how to create a vertical alignment through a crossover. Also, we will investigate several obscure project options related to turnouts and how to use them. In addition, since regression analysis is such an important topic, we will learn how to use single element regression to create multiple alignments simultaneously.

In this workshop, we will use Power Rail Track V8i 08.11.07.594 or later.

In order for all participants to design the same layout and to stay on course and on time, we request that all participants utilize the files as listed in the workshop materials. At the beginning of each chapter, we will start with a fresh set of data. This ensures that everyone is using the same data. Plus, we have added data to avoid redundant work.

The workshop guide is yours to take with you. If you don't finish all the exercises, or just want to work with the dataset upon return to your office, the datasets (both initial and completed files) are provided on the Conference DVD. Many workshops will also have videos of all exercises on the DVD.

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**Note** Prerequisite Knowledge Level: Participant should have a basic understanding of rail design and has used Bentley Rail Track or Bentley Power Rail Track.

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# Chapter 1: Multi-Alignment Single Element Regression

## OVERVIEW

All users of **Power Rail Track** should be well versed in the functionality for the creation of horizontal alignments from regression points. A typical workflow is as follows:

- Use **File > Text Import Wizard** and import regression points as cogo points
- Use **Horizontal Regression > Add Horizontal Regression Point** and create a horizontal regression buffer from the cogo points by applying selection and sorting criteria
- Use **Horizontal Regression > Curvature Diagram** and review the regression points and remove questionable data
- Use **Horizontal Regression > Edit / Review Horizontal Regression Points** and the *Select & Regress* option to single element regress the obvious lines and circular arcs
- Use **Horizontal Elements > Define Spiral** and fill in the gaps with spirals
- Finally, use **Horizontal Regression > Multiple Element Regression Analysis** and fine tune the geometry

The result is a horizontal alignment, but sometimes the user has more than one track and wishes to create parallel tracks. In this lesson, we will use regression data from two tracks and create both tracks simultaneously. We will have the following results:

- Tangents will be parallel
- Circular arcs will be parallel
- Transition spirals will be in filled
- The offset will not be constant from one element to another

## PROJECT DESCRIPTION

In this workshop, we will simultaneously construct two parallel horizontal alignments using single element regression.

## GETTING STARTED

In this lesson, we load the data, view the regression points and then create the two tracks using single element regression. But first, create a **Project Default** and load the .xin and the turnout.txt that is included in the workshop's data/ folder.

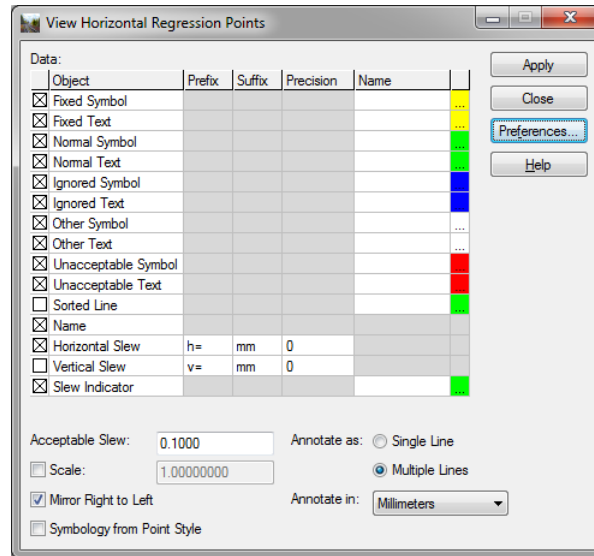


### *Exercise: Using Horizontal Regression Analysis*

**Exercise Objective:** Simultaneously create multiple horizontal alignments from regression points

**Procedure:**

1. Open the file *Chapter 1.dgn*.
2. Open the file *Regression.alg*.
3. Use **Horizontal Regression > View Horizontal Regression Points** and display each track's regression points



4. Use **Horizontal Regression > Curvature Diagram** and display a curvature diagram for the active alignment *Track 1*
5. Invoke the **Horizontal Regression > Edit / Review Horizontal Regression Points**.

Name	Northing	Easting	Include in An...	Status
T1-1743	118494.3840	265973.4170	No	Normal
T1-1742	118505.2170	265987.9850	No	Normal
T1-1741	118517.2220	266004.1400	No	Normal
T1-1740	118528.6940	266019.5840	No	Normal
T1-1739	118540.1320	266034.9790	No	Normal
T1-1738	118551.0070	266049.6070	No	Normal
T1-1737	118562.3430	266064.8660	No	Normal
T1-1736	118568.1980	266072.7490	No	Normal
T1-1735	118577.0420	266084.6430	No	Normal
T1-1734	118588.3010	266099.7930	No	Normal
T1-1733	118599.9410	266115.4700	No	Normal

In the Regression Points list view, do a right click and you will see the typical popup menu with *Insert*, *Edit* and *Delete*. Dismiss the pop-up. Now, hold down <Ctrl> and again do a right click. The menu is now different! You now have the following:

- Select All
- Select None
- Delete Last Element(s)
- Add Transition Spirals
- A list of all horizontal alignments that have horizontal regression points

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**Note** The software will use the active horizontal alignment and any other related alignments that you select from the pop-up. Remember we will only use two in this exercise, but the software will use as many as you wish.

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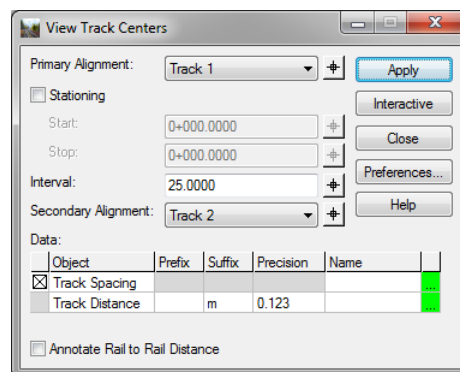
6. From the pop-up, right click *Track 2*
7. We will now use *Select & Regress* and select the tangents and circular arcs from the curvature diagram. As always, follow the prompts
  - i. *Identify first point*
  - ii. *Identify second point*
  - iii. *Accept / Reject*
8. Before exiting the command, let's again do a <Ctrl> right click and select the *Add Transition Spirals*. Now we have two alignments that have regressed tangents / circular arcs and we have filled in the gaps with spirals.

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**Note** The software will use the default spiral type as defined in **File > Project Options**.

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9. To review the results, go to **Horizontal Regression > Slew Diagram** and display a slew diagram for the active alignment
10. Let's use a tool that you may not be familiar with and review the track centers. Go to **Drafting > ProRail Extensions > View Track Centers** command. From the dialog
  - Set *Track 1* as the Primary Alignment
  - Set *Track 2* as the Secondary Alignment
  - Define an interval of 25 meters




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**Note** If the **Drafting > ProRail Extensions** commands do not show up then go to **Rail Track Tools > Application Addins** and select it.

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11. Click *Apply* and review the results.

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**Note** The tracks are parallel, but the element's offset vary from element to element.

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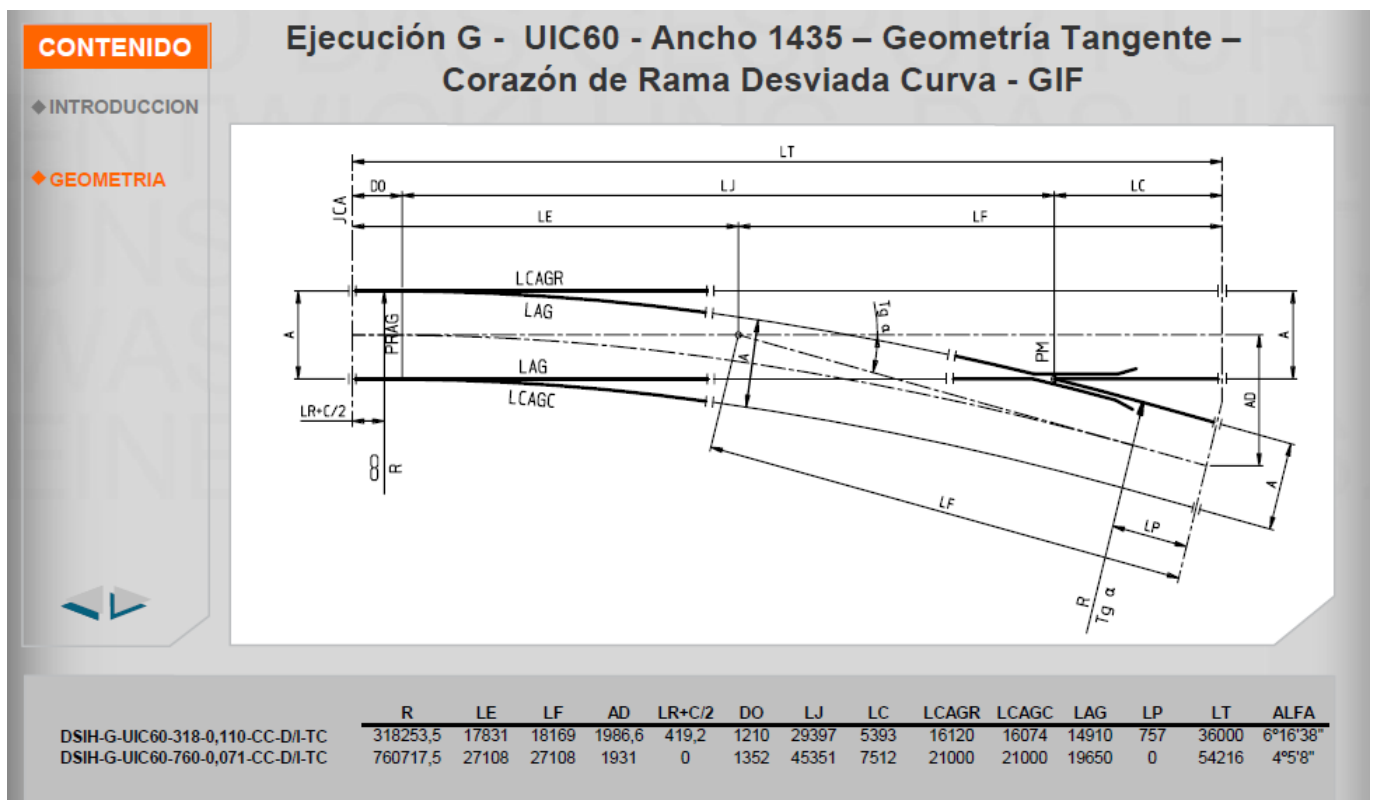
## CHAPTER SUMMARY

In this chapter, we have learned how to use single element regression analysis to simultaneously create multiple horizontal alignments with lines, circular arcs and transition spirals.

# Chapter 2: Creating the Turnout Library

## OVERVIEW

All users of **Power Rail Track** should be well versed in the functionality for the creation of horizontal alignments with turnouts. You may have used a turnout library that was provided by a client or another organization. But what if you need to add a new turnout? How do you go about defining a new turnout? Where do you start? Well the first place to start is from a set of drawings. Most of the time, you will find a schematic that provides the required information.



An example from a Spanish vendor

The standards are generally used by fabricators and constructors. As such they are sufficient, but the standards are not in a form that is easily digested by **Power Rail Track**. In this lesson, we will learn how to transform various unrelated standards and to create a turnout library within **Power Rail Track**.

## PROJECT DESCRIPTION

In this lesson, we will create a simple single branch turnout.



## GETTING STARTED

In this lesson, we will create a new single branch turnout in the current turnout library.



### *Exercise: Creating a new single branch turnout in the turnout library*

**Exercise Objective:** Understand how to create a new single branch turnout in the turnout library

#### Procedure:

1. Open the file *Chapter 2.dgn*.
2. Go to **Turnouts > Turnout Library**

Turnout Library

Name: e541200185 [Apply]

Description: EW 54 - 1200 - 1:18,5 [Close]

Type: Single [New...]

Theoretical .1 to .1 Length: 0.000000 0.000000 [Copy...]

Length Along Mainline: 64.817600 0.000000 [Delete]

Triangle Length: 32.408800 0.000000 [Rename...]

Define By:  Ratio  Angle [Verify]

Ratio at .0: 18.500000 0.000000 [Schematic]

Angle at .0: 03°05'38.6" 00°00'00.0" [Help]

Ratio at .1: 0.000000 0.000000

Angle at .1: 00°00'00.0" 00°00'00.0"

Linear Sleeper Set: 0.000000 0.000000

Circular Sleeper Set: 9.900000 0.000000

Distance to Last Long Sleeper: 9.900000 0.000000

Minimum Bending Radius: 440.000000

Bending Method:  Default  German

Maintain Length Along Inner Rail (from .1 to IP)

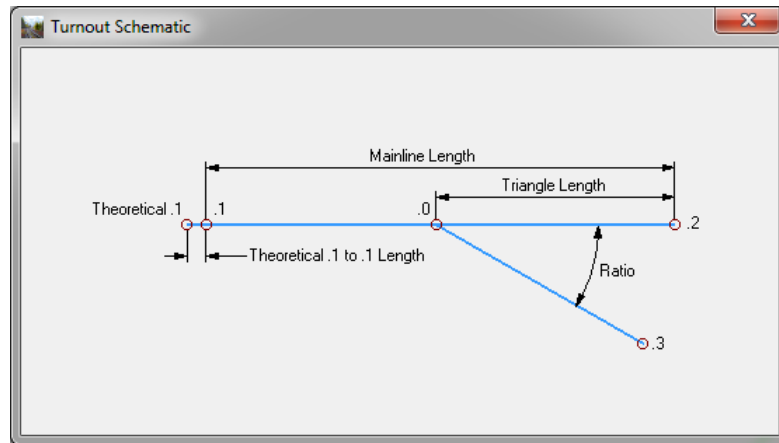
Maintain Length Along Outer Rail  Last Branch Element Always Unbent

Branch Geometry

Show:  1st Branch  2nd Branch

Element Type	Length	Starting Radius	Stopping Radius
Circular	64.801800	1200.000000	1200.000000

3. Click the *Schematic* button



Let's understand what is displayed and what it all means.

Obviously the *Name* and *Description* allows the user to provide textual information about a turnout. The name will ultimately be assigned to a turnout's style when an instance of the turnout is created in a **Power Rail Track** geometry project. The description will be assigned as the turnout's description.

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**Note** Once a turnout name has been defined and used within a geometry project, you should not rename or delete that turnout.

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The type of turnout is whether the turnout is a *single branch*, a *double branch*, a *single or double slip* or a *diamond crossing*. The most common type is single.

Note that we start to see various numeric data, such as *Length Along Mainline*, *Triangle Length* and *Ratio*. Refer to the Schematic for how these numeric values relate to .1, .0, .2 and .3

Let's skip down to the Branch Geometry group box. We see a list-view with element type, length and starting and ending radii. This allows the user to define each branch element as a linear, a circular arc or a spiral.

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**Note** **Power Rail Track** supports various types of spirals. However, in the creation of turnouts the software will place with either clothoids or cubic parabolas. Cubic parabolas will be used only if the default spiral type is such in **Project Options**.

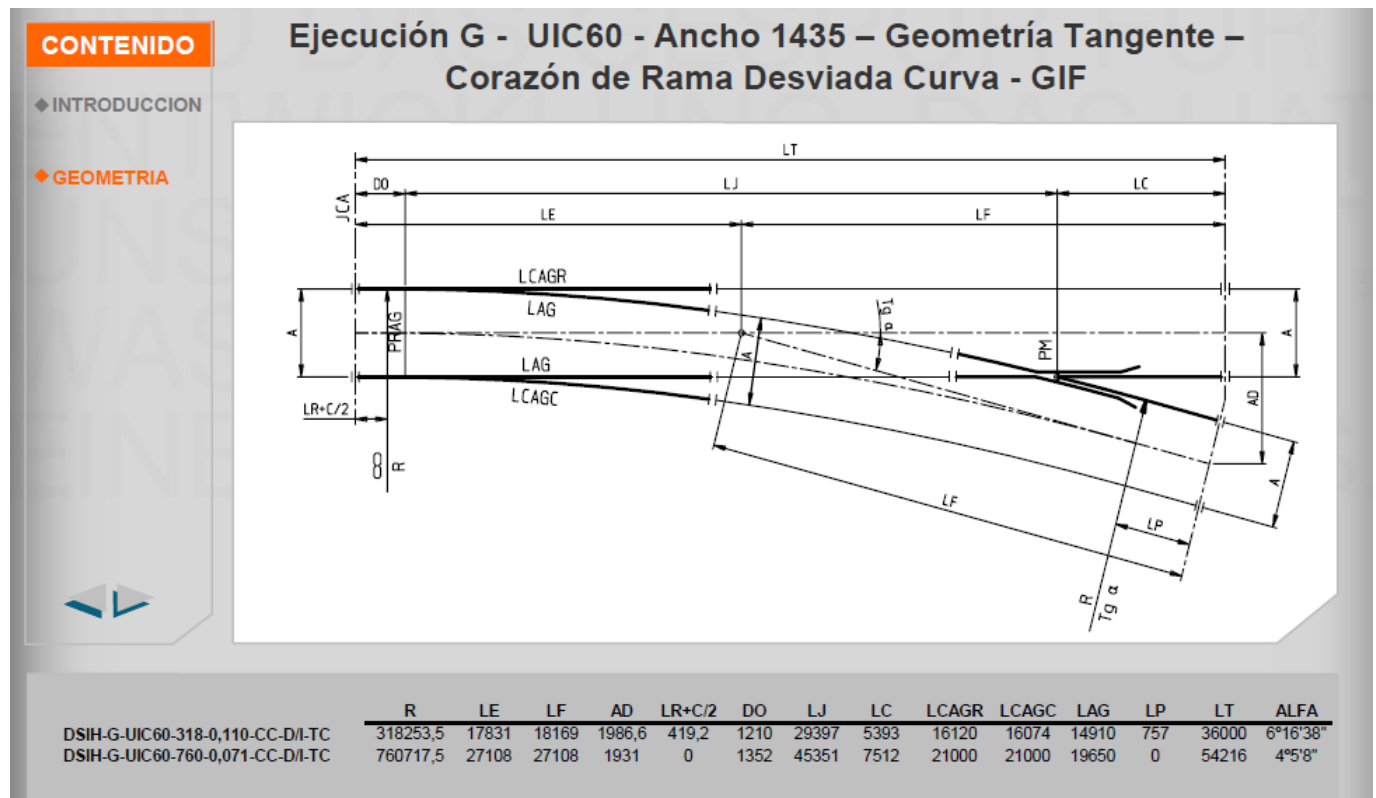
---

So when you start to collect the data for a new turnout, you need to look for the numeric data that is required on the dialog.

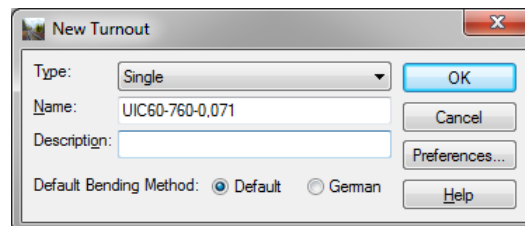
Let's look at various turnout standards. Open the Windows Explorer and navigate to the various .pdf's that are in the Chapter 2 folder.

It should be clear that various vendors / organizations provide the required numeric data in various forms. So let's try to use it and create a new turnout.

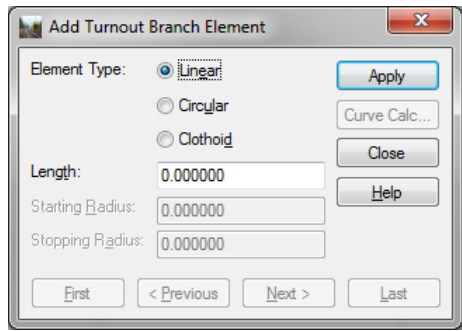
Using the following let's create a new turnout:



- Click the *New* button and define the following in the dialog and then click *OK*



- On the **Turnout Library** dialog select the turnout that we just created and enter the following information
  - Theoretical .1 Length is *0.0*
  - Mainline Length as *54.216*
  - Triangle Length as *27.108*
  - Ratio is *4 05 08* (switch from ratio to angle)
- Now the branch elements. Right click in the branch geometry list-view and select *Add* to invoke the **Add Turnout Branch Elements** dialog.



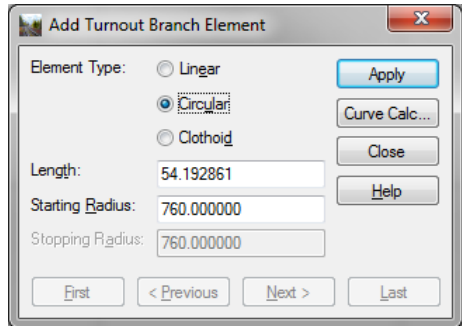
7. We know we have a circular arc and we know the radius, but we don't know the circular arc length. But we do know the delta. So click the **Curve Calc** and define the radius as 760.0 and the delta as 4 05 08 and *Compute* and click *OK*.

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**Note** The radius on the drawings is 760.7175 meters, which is measured to the outside rail. We want the centerline, so we need to adjust for half gauge.

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8. On the **Add Turnout Branch Element** dialog we should have



12. Click *Apply* to add the element
13. Click *Close* on the **Add Turnout Branch Element** dialog
14. On the **Turnout Library** dialog, you should see the following:

Turnout Library

Name: UIC60-760-0.071 Apply

Description: Close

Type: Single New...

Theoretical .1 to .1 Length: 1.352000 0.000000 Copy...

Length Along Mainline: 52.864000 0.000000 Delete

Triangle Length: 27.108000 0.000000 Rename...

Define By:  Ratio  Angle Verify

Ratio at .0: 14.000211 0.000000 Schematic

Angle at .0: 04°05'08.00" 00°00'00.00" Help

Ratio at .1: 0.000000 0.000000

Angle at .1: 00°00'00.00" 00°00'00.00"

Linear Sleeper Set: 0.000000 0.000000

Circular Sleeper Set: 0.000000 0.000000

Distance to Last Long Sleeper: 0.000000 0.000000

Minimum Bending Radius: 0.000000

Bending Method:  Default  German

Maintain Length Along Inner Rail (from .1 to IP)

Maintain Length Along Outer Rail  Last Branch Element Always Unbent

Branch Geometry

Show:  1st Branch  2nd Branch

Element Type	Length	Starting Radius	Stopping Radius
Circular	54.192861	760.000000	760.000000

15. Click *Apply* to accept this turnout and to add it to the turnout library.
16. Click *Close* to exit the command.

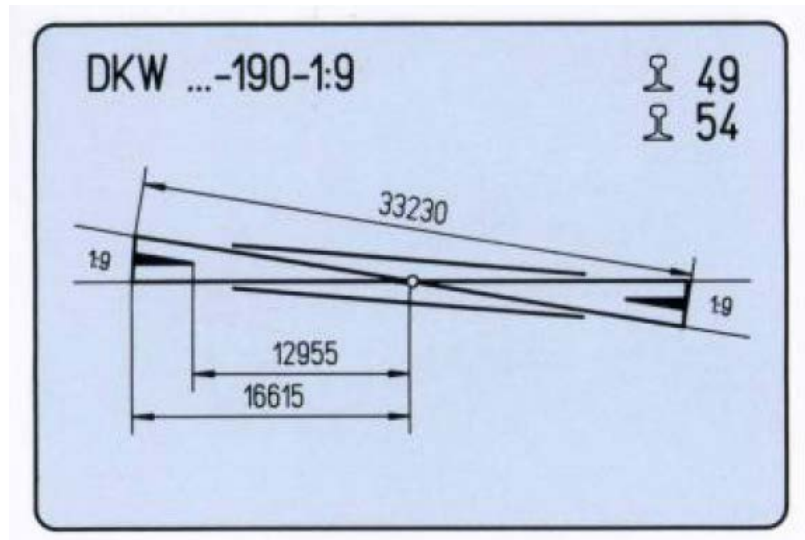
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**Hint** Sometimes, when you click *Apply*, you will get a warning “*Turnout definition is inaccurate!*” You will need to adjust the data to resolve the inaccurate warning. This is where you will need to make an engineering decision. What data is the most important and what data can be changed?

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## GETTING STARTED

In this lesson, we will create a new double slip turnout in the current turnout library. We will use the DKW54 -190-1:9 defined in *Chapter 2/db\_weichen\_100dpi.pdf*



As you can see we have the length along mainline, triangle length, ratio and we know radius from the turnout's name.

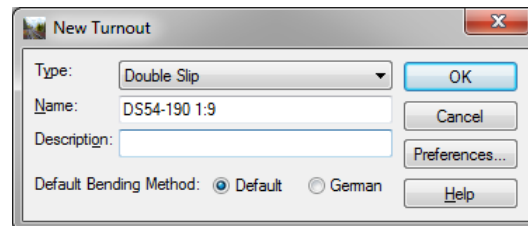


**Exercise:** Create a new double slip turnout in the turnout library

**Exercise Objective:** Understand how to create a new double slip turnout in the turnout library

### Procedure:

1. We will remain in the same .dgn and .alg for this lesson
2. Go to **Turnouts > Turnout Library**
3. Click the *New* button to invoke the **New Turnout** dialog



4. Change the type to *Double Slip*, enter a name and click *OK*
5. On the **Turnout Library** dialog select the double slip that you just created. Enter the length along mainline, triangle length and ratio for each side of the slip and click *Apply*. You should see the following on the dialog:

Turnout Library

Name: DS54-190 1:9 [Apply]

Description: [ ] [Close]

Type: Double Slip [New...]

Theoretical .1 to .1 Length: 0.000000 0.000000 [Copy...]

Length Along Mainline: 33.230000 33.230000 [Delete]

Triangle Length: 16.615000 16.615000 [Rename...]

Define By:  Ratio  Angle [Verify]

Ratio at .0: 9.000000 9.000000 [Schematic]

Angle at .0: 06°20'24.69" 06°20'24.69" [Help]

Ratio at .1: 0.000000 0.000000

Angle at .1: 00°00'00.00" 00°00'00.00"

Linear Sleeper Set: 0.000000 0.000000

Circular Sleeper Set: 0.000000 0.000000

Distance to Last Long Sleeper: 0.000000 0.000000

Minimum Bending Radius: 0.000000

Bending Method:  Default  German

Maintain Length Along Inner Rail (from .1 to IP)

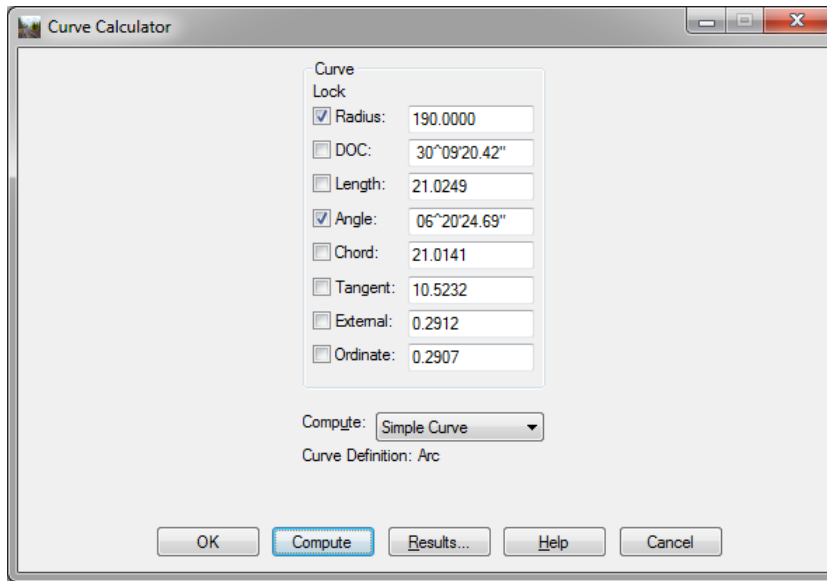
Maintain Length Along Outer Rail  Last Branch Element Always Unbent

Branch Geometry

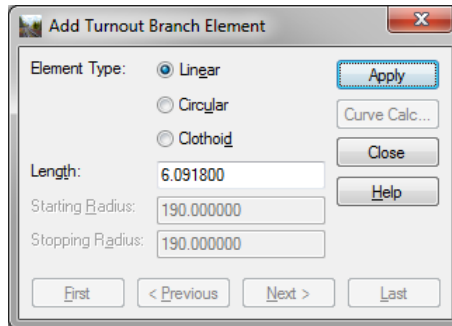
Show:  1st Branch  2nd Branch

Element Type	Length	Starting Radius	Stopping Radius

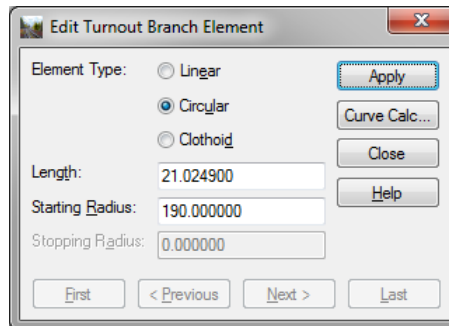
6. Okay, now we need to define the branch elements for each branch. Make sure that the *1st Branch* is selected and in the list-view click *Add* to invoke the **Add Turnout Branch Element**.
7. Again, we need to define element type, length and radii, but in this case we don't really know the element lengths. So let's use the curve calculator and compute what is needed. So click on *Circular* and then click the *Curve Calc.* to invoke the **Curve Calculator dialog**. The following:
  8. Enter a radius of 190
  9. Enter a delta of 6 20 24.69, now you see why I clicked *Apply* in step 5 above. We know the ratio, but the curve calculator does not understand ratio. The curve calculator wants delta as an angle!
  10. Click *Compute*



11. We want the tangent length 10.5232 meters and we want the circular arc's length of 21.0249 meters click *Cancel*
12. On the **Add Turnout Branch Element** dialog, click the *Linear* radio button and enter a length of 6.09180 meters, which is the triangle length minus the circular arc's tangent (i.e.  $16.615 - 10.5232$ )

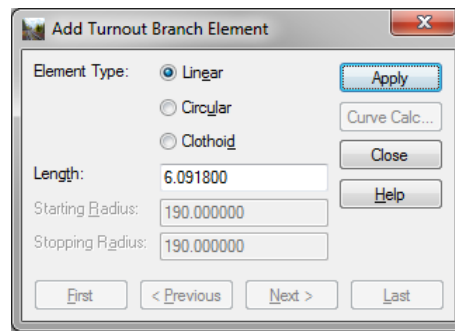


13. Click *Apply* to add the linear
14. Now click the *Circular* radio button and enter a length of 21.0249 meters (i.e. computed by the **Curve Calculator**) and a radius of 190 meters.

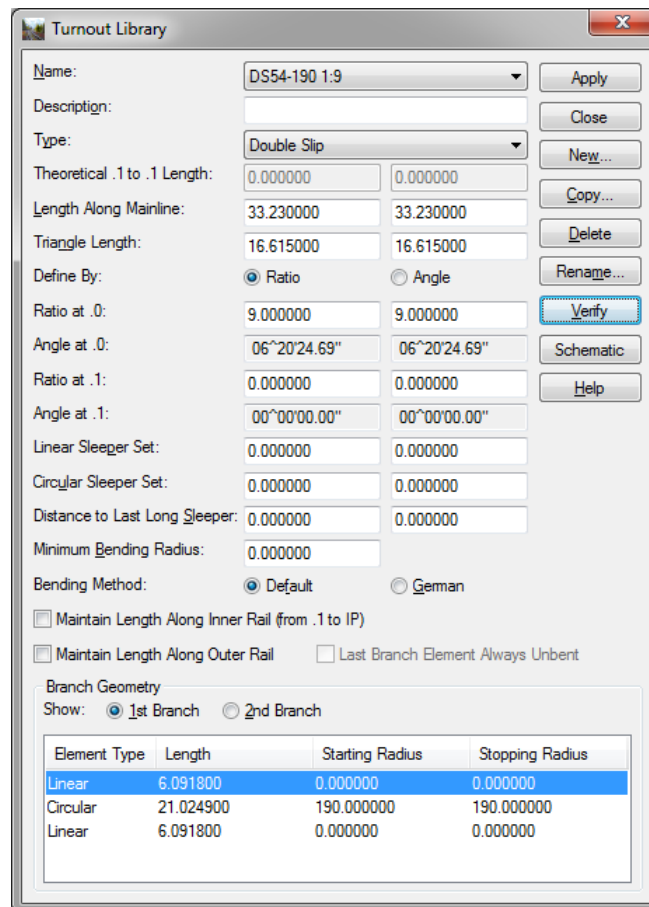


15. Click *Apply* to add the circular arc
16. And finally add the last linear by clicking *Linear* and defining the length as 6.0918 meters





17. Click *Apply* and *Close* to exit the dialog
18. Click the *2nd branch* and defined the exact same data for the second branch. When you have finished, the **Turnout Library** dialog should look like the following:



19. Click *Apply* to save the double slip turnout into the turnout library
20. Click *Close* to exit the dialog.

## CHAPTER SUMMARY

In this chapter, we have learned how to create single and double slip turnouts in the turnout library.

# Chapter 3: Turnout Bending Methods

## OVERVIEW

In the previous lesson, we created a single branch turnout from standard drawings. That turnout can now be used and the resultant geometry will be a circular arc with a length of 54.193 meters and a radius of 760 meters, provided it is placed onto a linear element. What happens if that turnout is placed onto a circular arc? The resultant geometry will be bent or flexed based upon rules. The software uses two different sets of rules for bending. They are the *Swiss* and *German* rules.

The *Swiss* rule (i.e. it is called *Default* on the user interface) is simply:

$$R_f = ( R_m \times R_b ) / ( R_m +/- R_b )$$

Where;

$R_f$  is the resultant flexed radius

$R_m$  is the mainline radius

$R_b$  is the branch radius as defined in the turnout library

The *Swiss* rule also states that the length along mainline is measured along the mainline alignment's centerline. Also the rule allows the user to set that the mainline length is applied to the *centerline*, the *outside rail* or the *inside rail*. The default is centerline, but some organizations clearly state that the length is along one of the rails.

The *Swiss* rule results in the following:

- Length along mainline held
  - Can be applied to inner or outer rail
- Coordinate Positions
  - .1, .2, .0 and .3 held
- Tangential Directions
  - .1 tangential compromised
  - .2 tangential held
  - .3 tangential held
  - Multi-element branch geometry is not always collinear

The *German* rule is simply:

$$R_f = ( R_m \times R_b - T^2 ) / ( R_m +/- R_b )$$

Where

$R_f$  is the resultant flexed radius

$R_m$  is the mainline radius

$R_b$  is the branch radius as defined in the turnout library

T is the sub-tangent length, which is the triangle length in a simple one element turnout, placed wholly within a circular element.

The *German* rule also states that the length along the mainline is measured along the mainline alignment's sub-tangents. Yes, that means that the length along the centerline will be shortened!

Maintains

- Length along mainline held, but it is interpreted as the sub-tangent length not the centerline length!
- Coordinate Positions
  - .1, .2, .0 and .3 held
- Tangential Directions
  - .1 tangential held
  - .2 tangential held
  - .3 tangential held
  - Multi-element branch geometry is usually collinear

## PROJECT DESCRIPTION

In this lesson, we will investigate the *Swiss* and *German* rules for turnout bending.

## GETTING STARTED

In this lesson, we will investigate the *Swiss* and *German* rules for turnout bending.

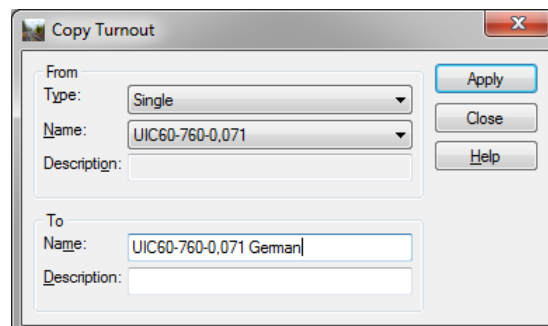


**Exercise:** *Investigating the Swiss and German rules for turnout bending.*

**Exercise Objective:** Understand the differences between the *Swiss* and *German* turnout bending rules.

**Procedure:**

1. Open the file *Chapter 3.dgn*
2. Open the file *Turnout Bending.alg*
3. Go to **Turnouts > Turnout Library** and select the turnout that was previously created.
4. Click the *Copy* option and copy this turnout and give it a name of *UIC60-760-0,071 German* and then *Close*.



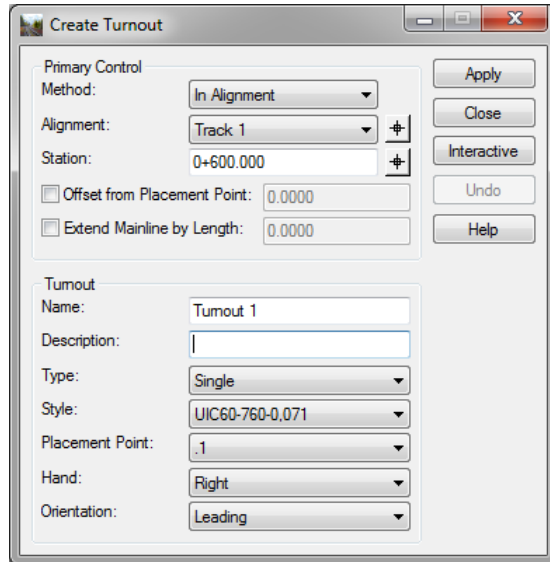
- Now select the *UIC60-760-0,071 German* turnout and change it from *Default* to *German*

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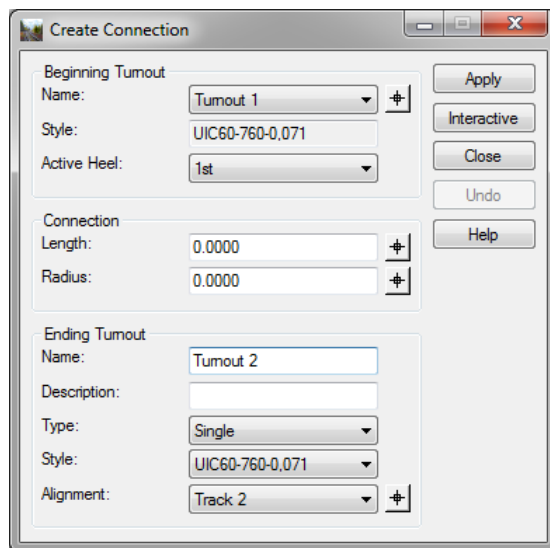
**Note** The bending method is on each turnout, which means that you can mix *Swiss* and *German* bending into the same turnout library

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- Click *Apply* and click *Close* to exit the dialog
- Let's used the defined turnouts to create several crossovers and then review the results.
- Go to **Turnouts > Create Turnout**



- We will create a *UIC60-760-0,071* on *Track 1* at station *0+600*. Set all values as shown and click *Apply* to create the new turnout.
- Click *Close* to exit the dialog
- Go to **Turnouts > Create Connection** to create the crossover



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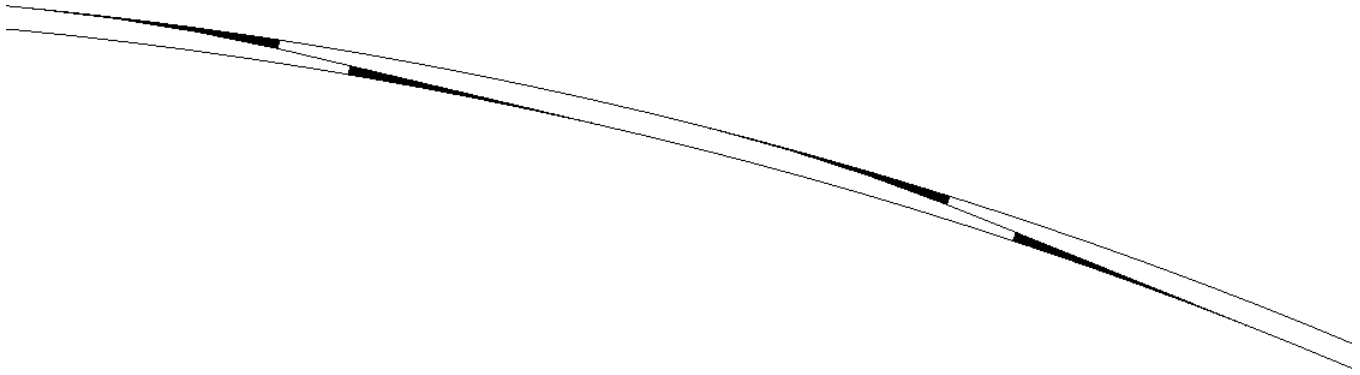
**Note** We are going to create a simple crossover from *Track 1* to *Track 2* from the previously created turnout *UIC60-760-0,071*

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12. Click *Interactive*, we could create the crossovers from the dialog, but this method is quicker. At the prompts:
  1. *Identify turnout* and select *Turnout 1*
  2. *Identify mainline alignment* and select *Track 2*
  3. *Accept / Reject* and accept the solution
13. We will repeat the steps 9 through 13 and create crossover using the *UIC60-760-0,071* German turnout.
14. Go to **Turnouts > Create Turnout** and define the following:

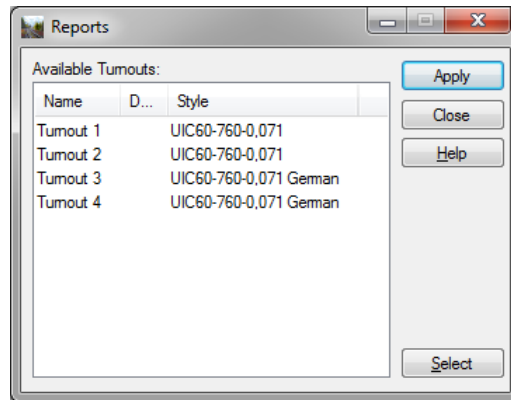
15. Click *Apply* and *Close* to exit the dialog
16. Go to **Turnouts > Create Connection** and define the following:

17. Click *Interactive* and select *Turnout 3* and *Track 2* to create the new crossover



Swiss ruled turnouts on the left and German ruled turnouts on the right

18. Now let's review the results. Go to **Turnouts > Reports**



19. Select all of the turnouts by right clicking in the list-view and selecting *Select All*

20. Click *Apply*

21. In the **Civil Report Browser** select the *turnouts.xml* and let's review the results.

Method	Turnout	Length along Mainline	Mainline Radius (R <sub>m</sub> )	T	Branch Length	Bend Radius (R <sub>r</sub> )	Equation
Swiss	1	54.216	1000.000	n/a	54.158	431.818	$R_f = ( R_m \times R_b ) / ( R_m + R_b )$
Swiss	2	54.216	995	n/a	54.228	3217.872	$R_f = ( R_m \times R_b ) / ( R_m - R_b )$
German	3	54.203	1000.000	27.108	54.114	431.401	$R_f = ( R_m \times R_b - T^2 ) / ( R_m + R_b )$
German	4	54.203	995	27.108	54.215	3220.999	$R_f = ( R_m \times R_b - T^2 ) / ( R_m - R_b )$

Gathered from several reports

## CHAPTER SUMMARY

In this chapter, we have learned the differences between the *Swiss* and *German* bending rules.



# Chapter 4: Standard Sleeper Sets

## OVERVIEW

Now that we have defined the Swiss and German bending methods, we can now look at sleeper sets. A sleeper set is a standard set of sleepers that will be placed at the end of the turnout geometry (i.e. at .2 and .3). All that we know about a standard sleeper set is a length and whether the sleeper set is linear or circular.

So what is the difference between a linear and circular sleeper set? Primarily it has to do how the geometry is constructed.

A linear sleeper set will match the mainline geometry. So if we place a 10 meter linear sleeper set onto a mainline radius of 1000 meter then the sleeper set will have a 1000 meter radius.

A circular sleeper set will bent the geometry using the *Swiss* or *German* rules. So the resultant radius will be less than or greater than 1000 meters, depending upon whether it is bent to the *inside* or *outside*.

## PROJECT DESCRIPTION

In this lesson, we will learn about standard sleeper sets

## GETTING STARTED

In this lesson, we will modify the *UIC60-760-0,071* in the turnout library and define a circular sleeper set. We will then place that turnout and let the software create the standard sleeper set geometry.



**Exercise:** *Modifying a turnout to include a circular sleeper set.*

**Exercise Objective:** Modifying a turnout to include a circular sleeper set.

### Procedure:

1. Open the file *Chapter 4.dgn*
2. Open the file *Standard Sleeper Set.alg*
3. Go to **Turnouts > Turnout Library**
4. Select the *UIC60-760-0,071* turnout
5. Set *Circular Sleeper Set* as 5 meters
6. Set *Distance to Last Long Sleeper* to 5 meters

---

**Note** A standard sleeper set and distance to last long sleeper are both optional. You can have neither, one without the other, or both.

---



Turnout Library

Name: UIC60-760-0,071 [Apply]

Description: [ ] [Close]

Type: Single [New...]

Theoretical .1 to .1 Length: 0.000000 0.000000 [Copy...]

Length Along Mainline: 54.216000 0.000000 [Delete]

Triangle Length: 27.108000 0.000000 [Rename...]

Define By:  Ratio  Angle [Verify]

Ratio at .0: 14.000211 0.000000 [Schematic]

Angle at .0: 04°05'08.00" 00°00'00.00" [Help]

Ratio at .1: 0.000000 0.000000

Angle at .1: 00°00'00.00" 00°00'00.00"

Linear Sleeper Set: 0.000000 0.000000

Circular Sleeper Set: 5.000000 0.000000

Distance to Last Long Sleeper: 5.000000 0.000000

Minimum Bending Radius: 0.000000

Bending Method:  Default  German

Maintain Length Along Inner Rail (from .1 to IP)

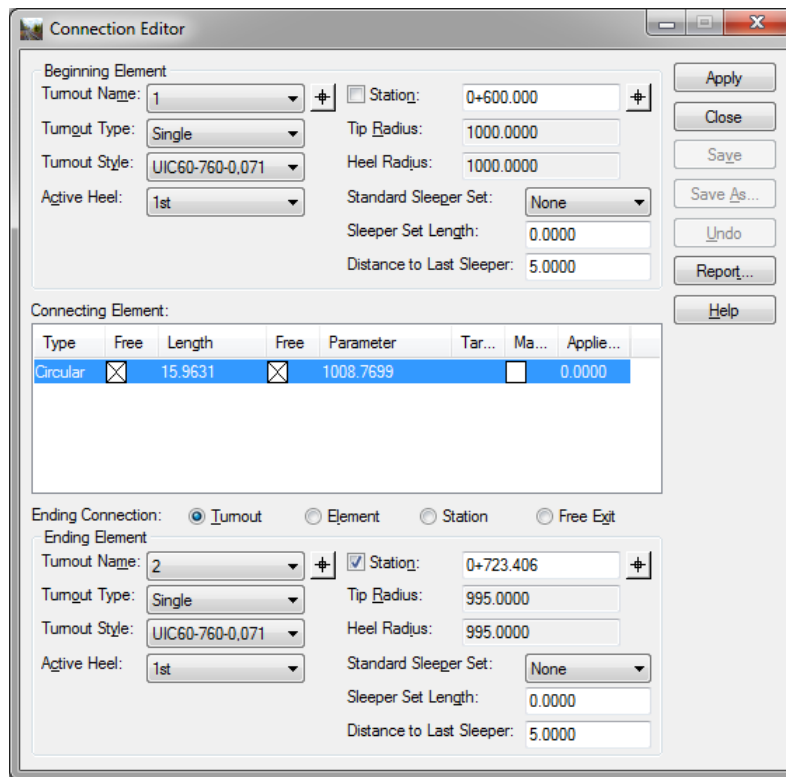
Maintain Length Along Outer Rail  Last Branch Element Always Unbent

Branch Geometry

Show:  1st Branch  2nd Branch

Element Type	Length	Starting Radius	Stopping Radius
Circular	54.192861	760.000000	760.000000

7. Click *Apply* and then *Close* to exit the dialog.
8. Create two new turnouts using the *UIC60-760-0,071* turnout. You can refer back to the **Chapter 3** for how to create a simple crossover. Once you have created the crossover invoke the **Turnouts > Connection Editor** command.



Let's take a look at what appears on the dialog and specific the standard sleeper set and last long sleeper. The *Standard Sleeper Set* is set to *None* and the *Sleeper Set Length* is *0.0* meters. Let's proceed to create the standard sleeper set elements.

9. Set the *Standard Sleeper Set* for each turnout to *Circular* and the software will set the *Sleeper Set Length* to *5.0* meters (remember that is what we added in the turnout library). You will notice as we added the standard sleeper set elements that the connection has lengthened!
10. Click *Apply* to recompute the connection. You will notice that the original connection element had a length of *15.963* meters and a radius of *1008.800* meters has been recomputed.
11. Click *Report...* and let's look at the results

The first element after the first turnout is defined as a circular arc with a length of *5.0* meters and a radius of *431.818* meters. The length of *5.0* meters is the standard sleeper length and since we defined it as a circular sleeper set then we would expect the radius to match the *.3* radius. And it does!

The next element is also a circular arc of length *5.040* meters and a radius of *1034.641* meters.

The third element is the trailing turnout's sleeper set. Again it is *5.0* meters in length and the radius is *3217.872* meters

## CHAPTER SUMMARY

In this chapter, we have learned about standard sleeper sets.

# Chapter 5: Project Options and Turnouts

## OVERVIEW

In this lesson we will look at several ways to override and affect the crossover geometry. In Chapter 3, we read that the turnout geometry may not always be collinear. But, we can attempt to force the geometry to be collinear.

It should be noted that when we are talking about a turnout's colinearity, we are talking about the branch elements. The software will always force the first element outside the branch (i.e. the element after .3) to be collinear. How? The software will use the direction from .0 to .3 as the first element's entrance tangential direction.

Another issue is related to what happens when the mainline is canted. The turnout will be canted based upon the mainline. But the crossing is generally a fixed angle, so should the crossing angle be adjusted to account for cant?

The software provides options for accomplishing both of these. Whether you need to do is up to you!

## PROJECT DESCRIPTION

In this workshop, we will learn about options that affect the turnout's geometry.

## GETTING STARTED

In this lesson, we will learn how to attempt to force a turnout to be collinear.

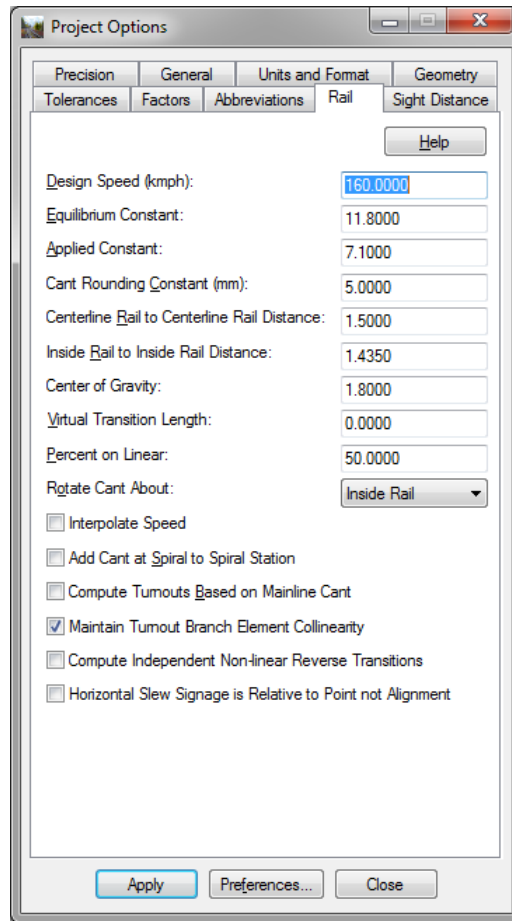


*Exercise: Forcing turnout colinearity.*

**Exercise Objective:** How to attempt to force a turnout to be collinear.

### Procedure:

1. Open the file *Chapter 5.dgn*
2. Open the file *Forced Collinearity.alg*
3. Go to **File > Project Options** and the **Rail** tab



4. Check on *Maintain Turnout Branch Element Colinearity*
5. Click *Apply* and then click *Close* to exit the dialog
6. Go to **Turnouts > Connection Editor**
7. Select the crossover for alignment 1-2, by selecting turnout 1
8. Keep the dialog up and go to **Geometry > Review Horizontal** and select the same crossover. You will see between the first and second elements, we have a non-collinear warning.

---

**Note** We have a 15 second difference in the directions, which equates to an offset of 2 millimeters over the length of the tangent of the turnout!

---

9. On the **Connection Editor** don't change anything, just click *Apply*. Since we have checked on *Maintain Turnout Branch Element Colinearity*, the software will re-compute the geometry.
10. Click *Save* to save the recomputed geometry
11. Now look at the **Review Horizontal** alignment dialog.
12. The first element's radius has changed from 431.818 meters to 431.401 meters and the non-collinear warning has gone away. The software will adjust the branch radius to force colinearity at .3.
13. If we take a look at a second example, select the crossover 3-4 by selecting turnout 3. Essentially repeat steps 8 through 12. In this case, the first element's radius has changed from 3217.872 meters to 3221.042 meters and the non-collinear warning has gone away.

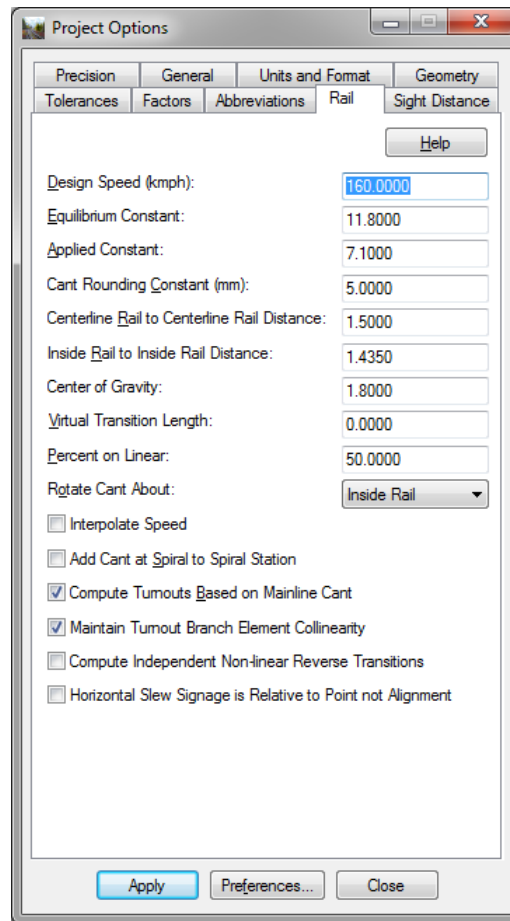


**Exercise: Should I consider cant when computing turnouts?**

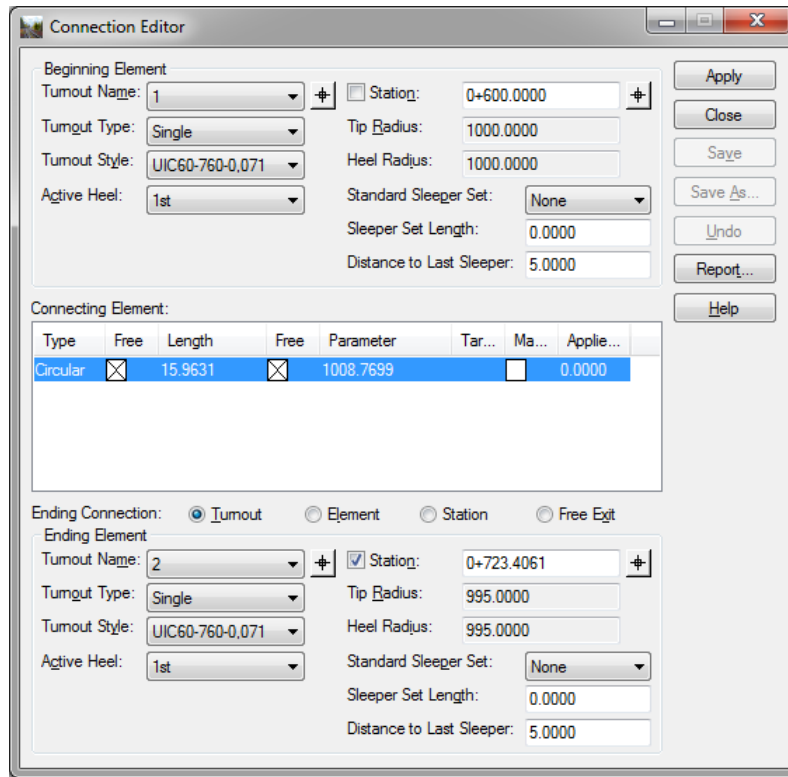
**Exercise Objective:** Investigate the affects of computing a turnout based upon the mainline's cant

**Procedure:**

14. We will remain in the same .dgn and .alg for this lesson
15. Go to **File > Project Options** and the **Rail** tab



16. Check on *Compute Turnouts Based on Mainline Cant*
17. Click *Apply* and then click *Close* to exit the dialog.
18. Go to the **Turnout > Connection Editor**
19. Select the crossover for alignment 1-2, by selecting turnout 1



20. Note that the existing connecting element, which was computed without adjusting for cant, has a length of 15.963 meters and a radius of 1008.770 meters.
21. Click *Apply*, so that the crossover is recomputed and adjusts for cant. The software has recomputed the connecting element with a length of 16.039 meters and a radius of 1008.734 meters. More importantly, the software has maintained the turnout's cross angle along the track plane, thus flattening the angle on the horizontal plane.

---

**Note** It should be clear that in the case of enforce colinearity; the software did not change the .1, .0, .2 or .3. The software held those critical points. However, when the software adjusted for cant the coordinates and tangential direction at .3 changed.

---

## CHAPTER SUMMARY

In this chapter, we have learned how to force a turnout's to have collinear branch geometry. As well as, how to take into consideration the mainline alignment's cant in computing turnout horizontal position.



# Chapter 6: Connection Editor

## OVERVIEW

In a previous lesson, we created a crossover by using the **Create Connection** command. While this command is quick and easy, sometimes that is not enough. Or sometimes the design needs to be changed and you need a more robust tool. The **Connection Editor** is that tool.

The **Connection Editor** will allow the user to edit an existing connection. The following:

Selecting a turnout will invoke an existing crossover. So making a simple edit like moving a turnout up station by 10 meters is simply changing the starting station and clicking *Apply* to re-compute.

Selecting a turnout and changing it from one turnout style to another turnout style. Again just selecting the turnout invokes the previous connection and you simply change the turnout's style and re-compute.

## PROJECT DESCRIPTION

In this workshop, we will learn about the **Turnout Connection Editor**.



## GETTING STARTED

In this lesson, we will learn how to edit a previously computed crossover.

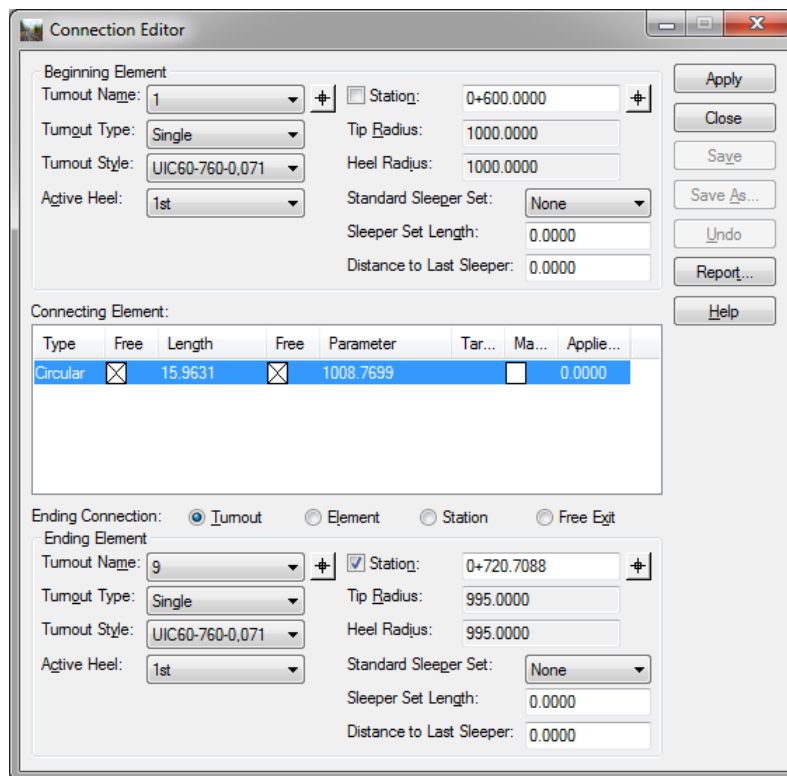


### *Exercise: Editing a previously computed crossover*

**Exercise Objective:** Edit a previously computed crossover's starting station

#### **Procedure:**

1. Open the file *Chapter 6.dgn*
2. Open the file *Connection Editor.alg*
3. Go to the **Turnout > Connection Editor**



4. In this case we have selected turnout 1 and the software recalls the previous connection (as well as recalling the previous fixities).
5. Change the start station from 0+600 to 0+575, you will see that turnout 1 plus the connecting elements have moved.
6. Now click *Apply* and the software recomputes the entire crossover.
7. Now let's see everything move in a more dynamic fashion. Again, we will be changing the first turnout's start station. But this time we will use the data point button, but when we select the data point click <Ctrl> at the same time. Now the entire crossover is placed in dynamics and everything is recomputed.

8. Accept or reject the dynamics.
9. Click *Save* to save the results and click *Close* to exit the dialog.

---

**Hint** If a turnout is defined with a theoretical .1 the station on the user interface is the .1 station. The geometry will start at the theoretical .1 and when it is created as a horizontal alignment it will start at the theoretical .1

---

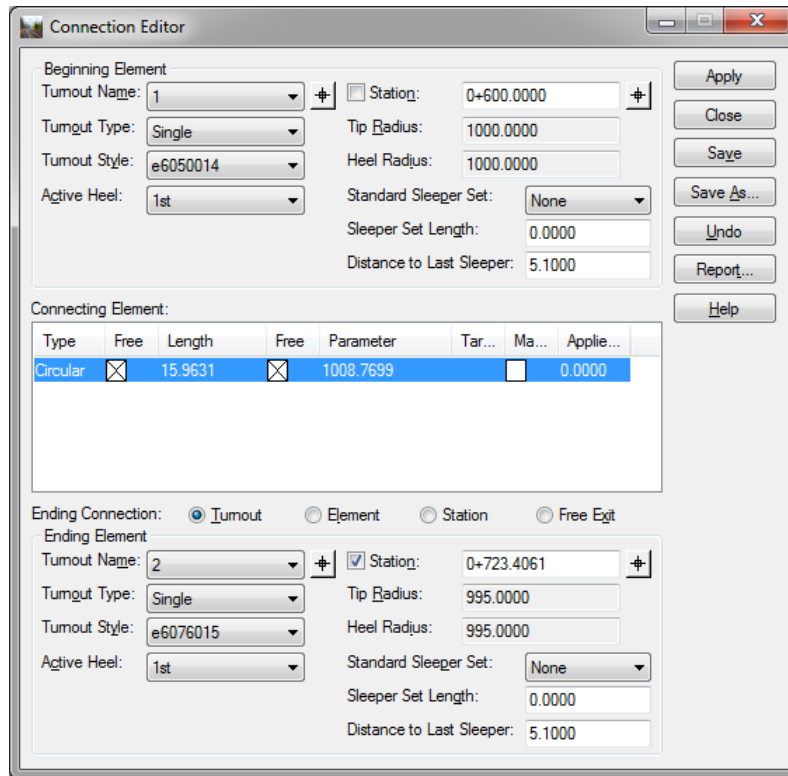


**Exercise: Editing a previous computed crossover**

**Exercise Objective:** Edit a previously computed crossover’s by changing the turnout’s style

**Procedure:**

10. Continuing with the same data, go to the **Turnout > Connection Editor**
11. Change the beginning turnout’s style to *e6050014*
12. Change the ending turnout’s style to *e6076014*
13. Click *Apply* to re-compute the solution



14. Click *Save* to save the solution
15. Based upon previous lessons, what other edits could we make in the **Turnout > Connection Editor**?

---

**Hint** If we refer back to **Chapter 4**, we discussed standard sleeper sets and last long sleepers. While we originally defined these within the

turnout library, you could define a non-standard length sleeper set within the **Turnout > Connection Editor**. Just change the Standard Sleeper Set to *Linear* or *Circular* and define the Sleeper Set Length.

---

## CHAPTER SUMMARY

In this chapter, we have learned how to modify a previous defined crossover.

# Chapter 7: Creating Verticals through Turnouts

## OVERVIEW

In this lesson, we will learn how to create a vertical alignment through a crossover. The software will use the turnout's mainline alignment's vertical alignment and cant alignments plus the offset from the mainline to the branch geometry (at an interval) to compute the turnout's vertical. The intent is to project the mainline's plane through to the plane of the turnout. We are also trying to ensure that there is a smooth transition from one turnout to the next.

## PROJECT DESCRIPTION

In this lesson, we will learn how to create a vertical alignment through a crossover.

## GETTING STARTED

In this lesson, we will learn how to create a vertical alignment through a crossover.

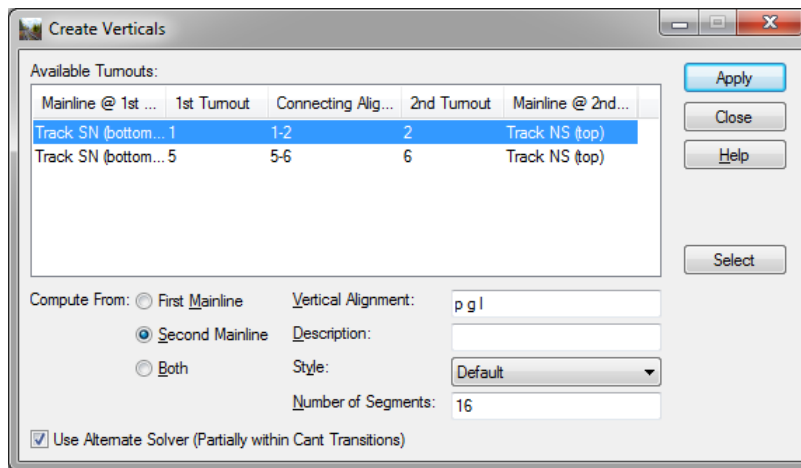


*Exercise: Creating a vertical alignment through a crossover*

**Exercise Objective:** Creating a vertical alignment through a crossover.

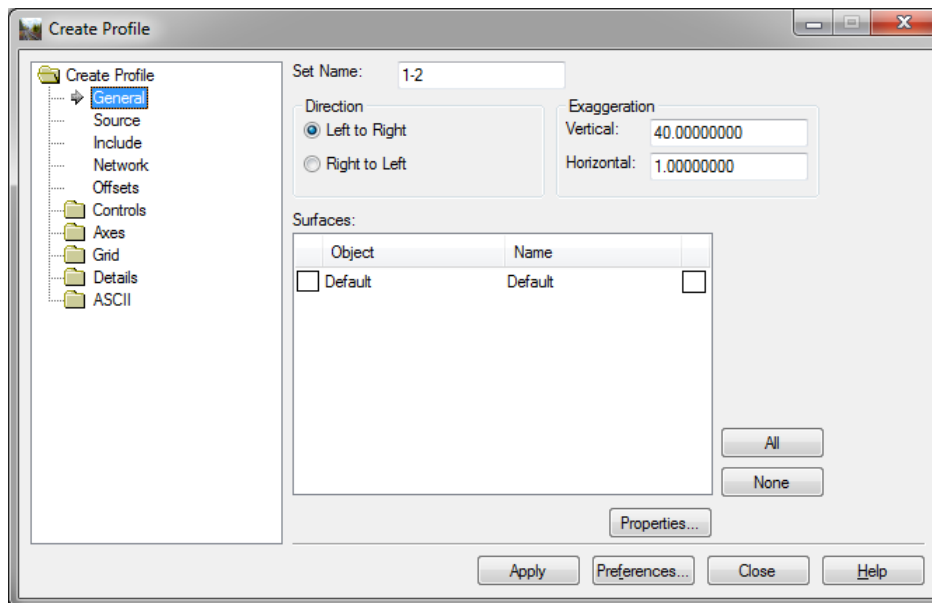
### Procedure:

1. Open the file *Chapter 7.dgn*
2. Open the file *Create Verticals.alg*
3. Go to **Turnouts > Create Verticals**
4. Set the vertical name, description and style as shown. Set the number of segments to 16. Also, toggle on compute from *Second Mainline* and check on *Use Alternate Solver (Partially with Cant Transition)*
5. Click *Apply*

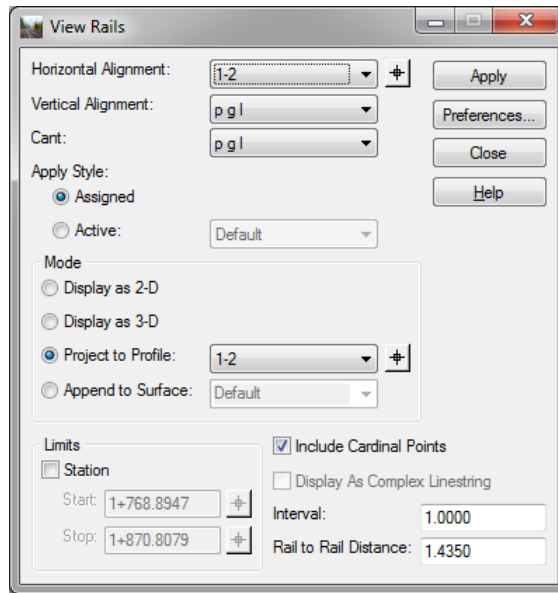


**Note** *Track NS (top)* has a defined vertical alignment and a cant alignment. *Track SN (bottom)* has a cant alignment. Its vertical will be created from *Track NS (top)* and the crossover *1-2*. Also, note that crossover *1-2* is wholly within a horizontal circular arc and crossover *5-6* is partially within a spiral / cant transition!

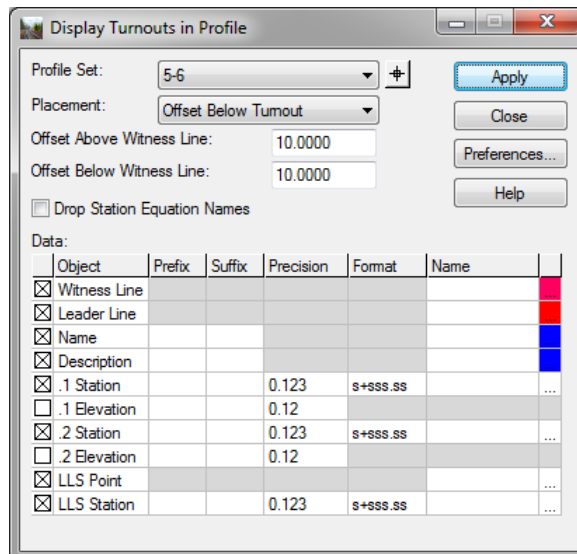
6. Click on the crossover 5-6 and create the vertical and cant alignment by clicking *Apply*
7. Click *Close* to exit the dialog
8. To review the results go to **Evaluation > Create Profile**. Create a profile for crossover *1-2* and *5-6* using an elevation range with a maximum elevation of 255 and a minimum elevation of 250. Also set the vertical exaggeration to 40

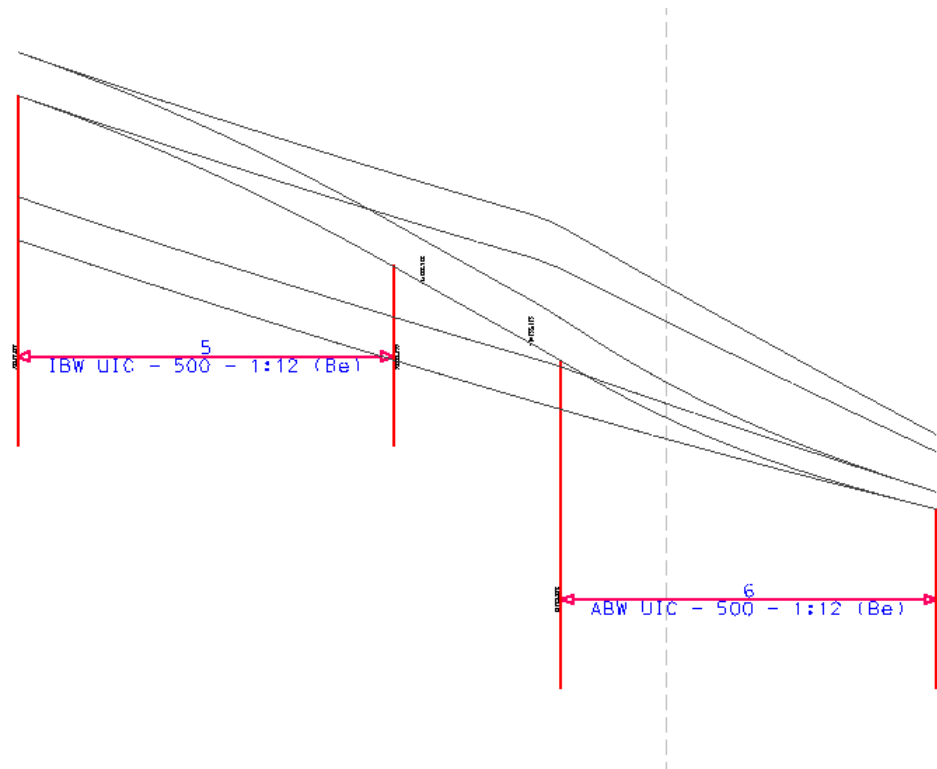


9. Go to **Geometry > View Rails** and select *Project to Profile* and select profile *1-2*. Set the settings as shown below.



10. Click *Apply*
11. Select horizontal alignment *Track NS (top)* and click *Apply* to project it onto the same profile.
12. Likewise select horizontal alignment *Track SN (bottom)* and project it onto the same profile.
13. Since that crossover was placed wholly within a circular arc and cant was constant, you will see that all rails are at a constant height above each other.
14. Now select the profile for 5-6 and project alignments 5-6, *Track NS (top)* and *Track SN (bottom)* into the profile window.
15. Before reviewing the results, go to **Turnouts > Display Turnouts in Profile**. Select the profile window for crossover 5-6, set the settings as shown below and click *Apply*





You can clearly see that turnout 6 is within a horizontal spiral and a corresponding cant transition. We have used **Geometry > View Rails** to project the rails onto a profile window. We could also have displayed the rails in plan (either as 2d or 3d) or appended them into a terrain model. In the case of the later, these could then be used as features within **Roadway Designer**.

## CHAPTER SUMMARY

In this chapter, we have learned how to create a vertical alignment through a crossover.