2009 Roads and Bridges Conference

IW 9

Working with Rail Geometry

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2. *LESSON NAME: REGRESSION ANALYSIS ON EXISTING TRACKS*

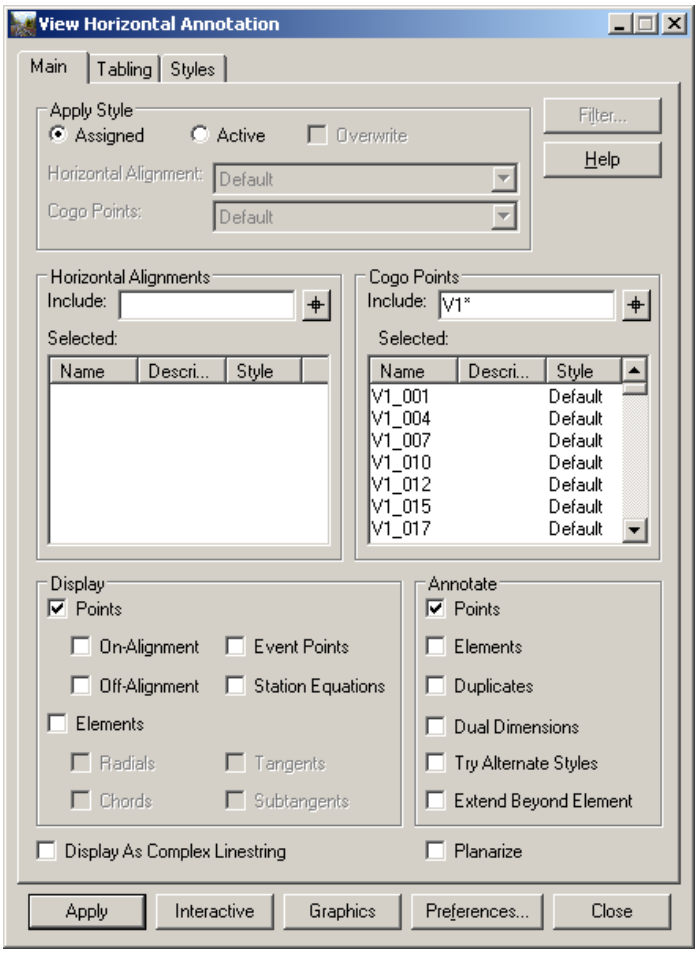
LESSON OBJECTIVE:

This lesson will show how to use the regression analysis for existing tracks

2.1 EXERCISE: REGRESSION ANALYSIS

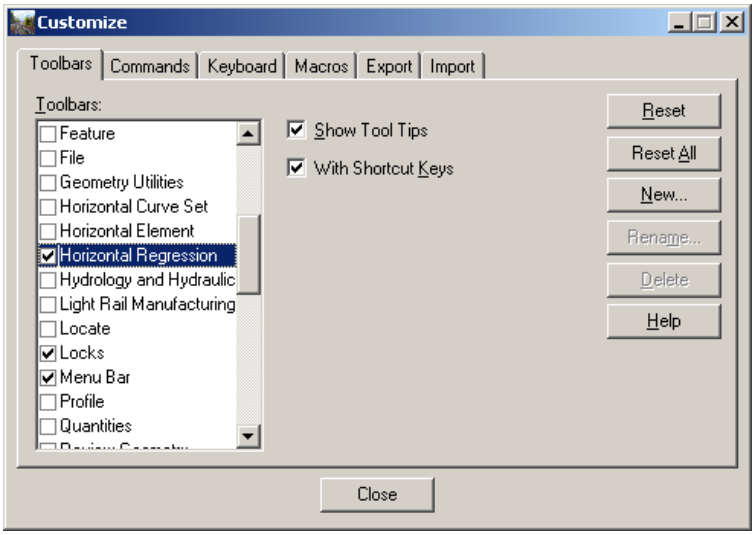
This exercise will guide you through the steps to get a new alignment on survey points. The regression analysis allows you to find the best fit alignment based on survey points.

1. Load the file _work.dgn
2. Load the file Regression.alg
3. View the cogo points V1* Geometry > View Geometry > Horizontal Annotation …

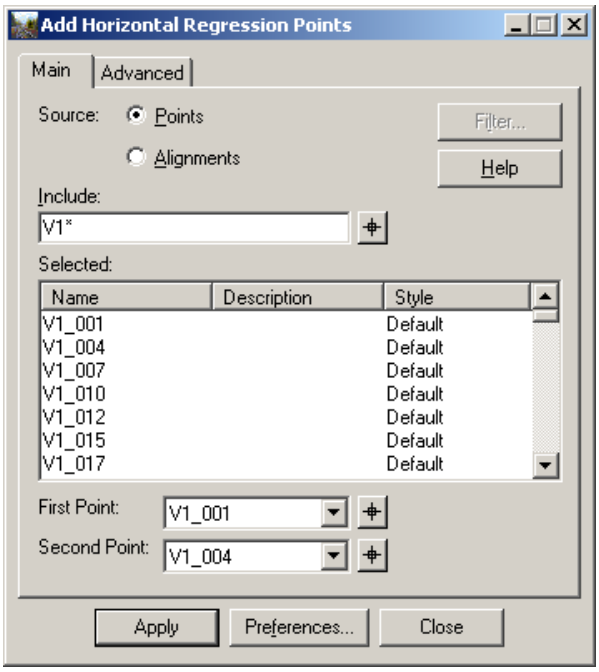


4. Customize BRT with the palette for Horizontal Regression

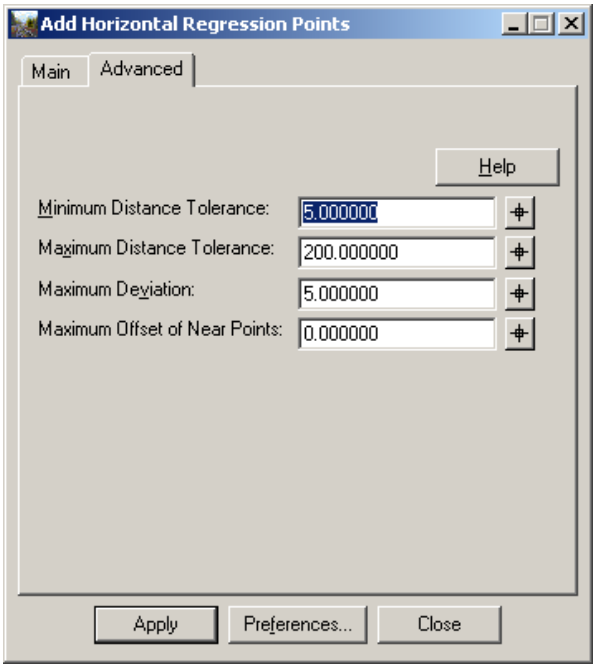
   Tools > Customize …



5. Load survey points V1* into the regression buffer

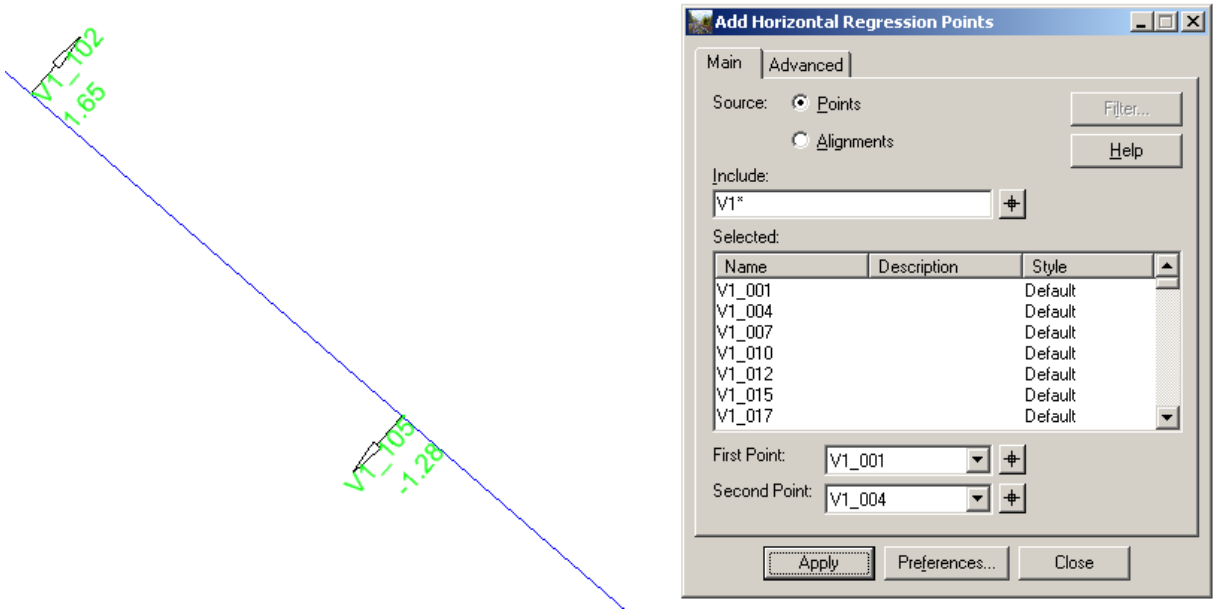


Under the Advanced tab you can define i.e. the regression band width or distance tolerances.



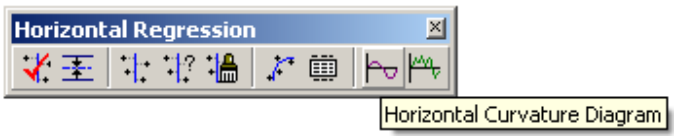
Go back to the Main tab and hit Apply.

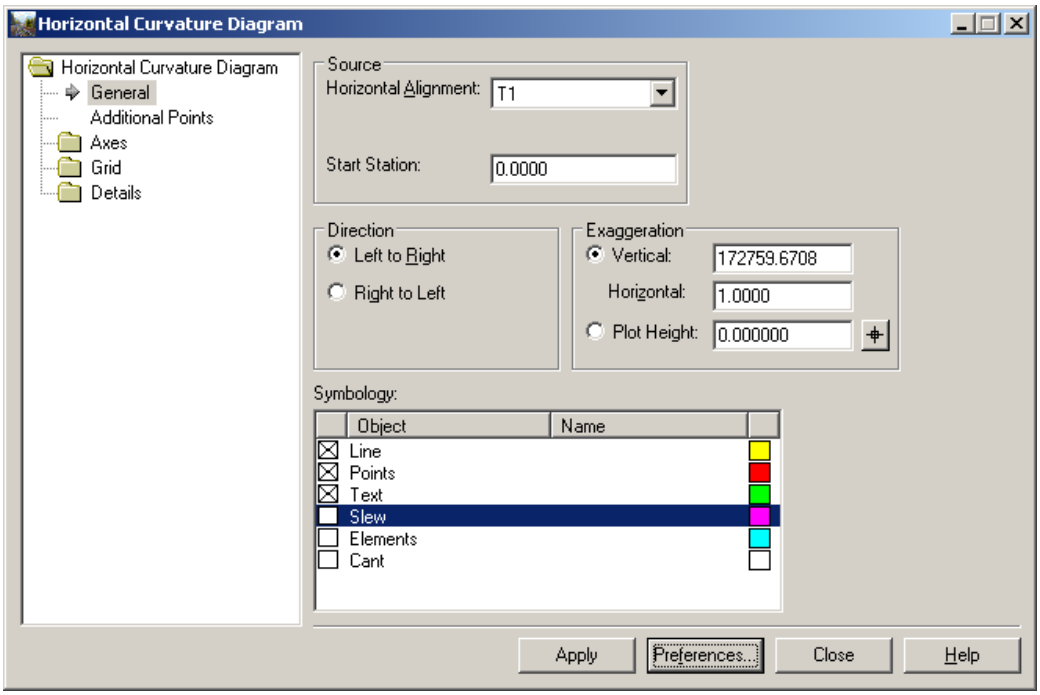
The result should be look like this:



The blue line is the control line which gives you a graphical feedback that all points are now in the regression buffer.

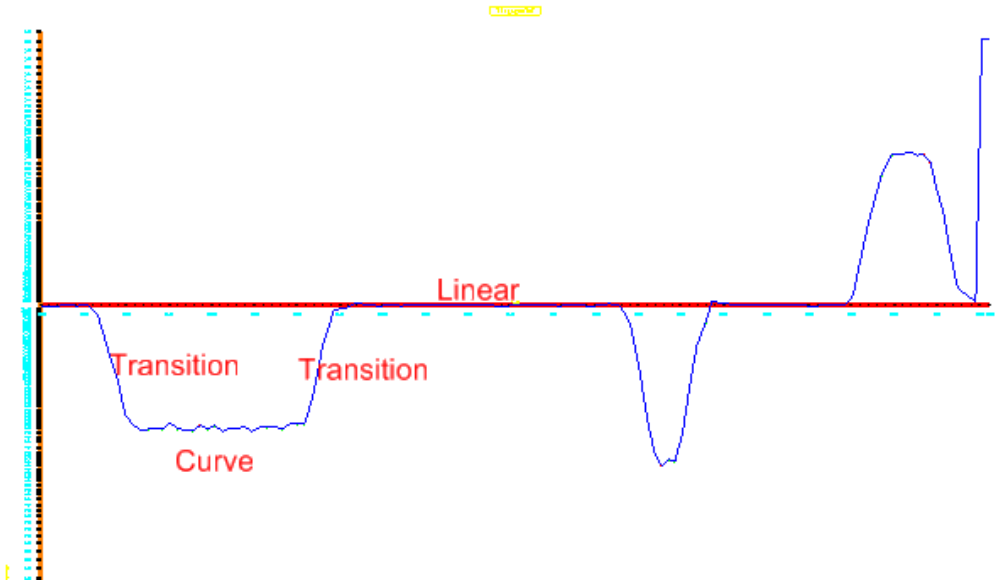
6. Create a curvature diagram





Hit Apply and place the diagram into the drawing.

Note: Do not place the curvature diagram across the survey points in the plan

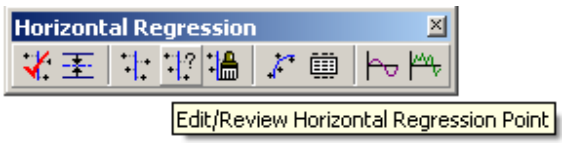


The diagram can be interpreted as shown above.

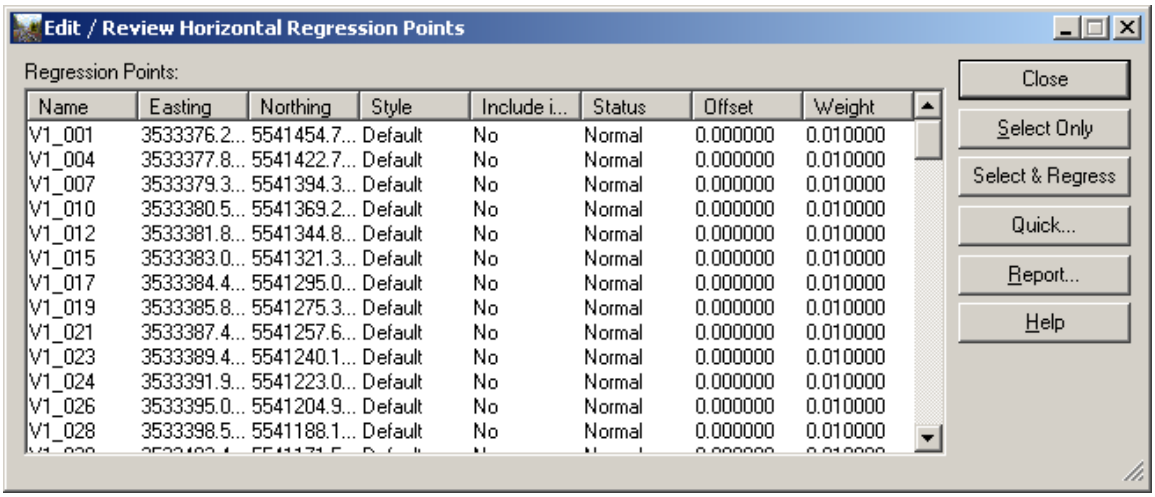
2.2 EXERCISE: ALIGNMENT CREATION

1.1.1 USE DIFFERENT REGRESSION METHODS FOR ALIGNMENT CREATION

Use the Edit/Review regression points command

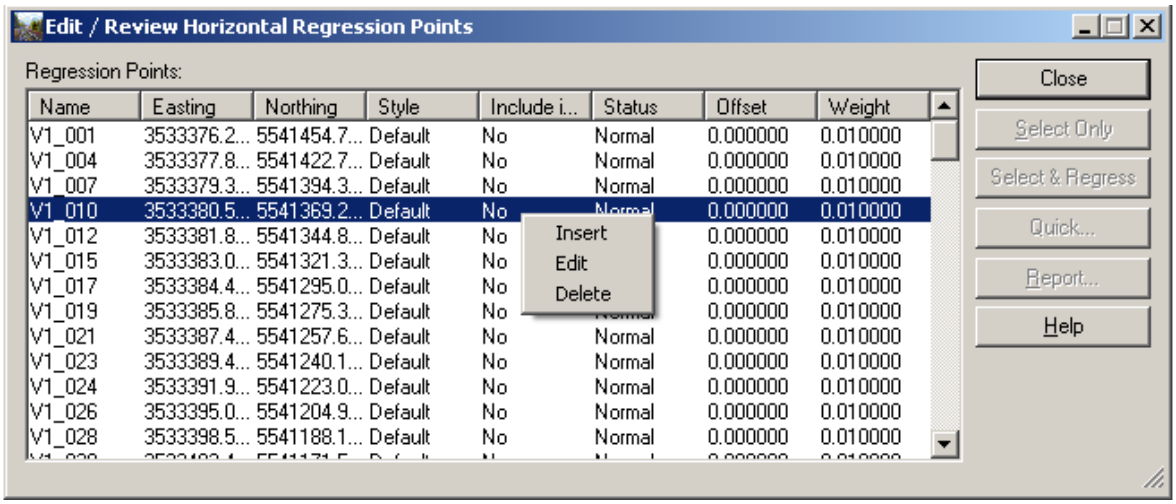


This command calls a dialog box which gives you the regression points.



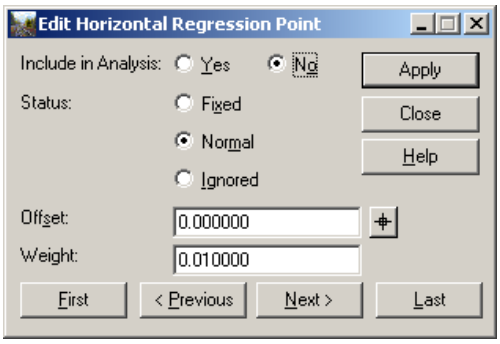
Name	Easting	Northing	Style	Include i...	Status	Offset	Weight
V1_001	3533376.2...	5541454.7...	Default	No	Normal	0.000000	0.010000
V1_004	3533377.8...	5541422.7...	Default	No	Normal	0.000000	0.010000
V1_007	3533379.3...	5541394.3...	Default	No	Normal	0.000000	0.010000
V1_010	3533380.5...	5541369.2...	Default	No	Normal	0.000000	0.010000
V1_012	3533381.8...	5541344.8...	Default	No	Normal	0.000000	0.010000
V1_015	3533383.0...	5541321.3...	Default	No	Normal	0.000000	0.010000
V1_017	3533384.4...	5541295.0...	Default	No	Normal	0.000000	0.010000
V1_019	3533385.8...	5541275.3...	Default	No	Normal	0.000000	0.010000
V1_021	3533387.4...	5541257.6...	Default	No	Normal	0.000000	0.010000
V1_023	3533389.4...	5541240.1...	Default	No	Normal	0.000000	0.010000
V1_024	3533391.9...	5541223.0...	Default	No	Normal	0.000000	0.010000
V1_026	3533395.0...	5541204.9...	Default	No	Normal	0.000000	0.010000
V1_028	3533398.5...	5541188.1...	Default	No	Normal	0.000000	0.010000

If you select a point by using the right mouse click you can add the point to the regression analysis or change the point state.



Name	Easting	Northing	Style	Include i...	Status	Offset	Weight
V1_001	3533376.2...	5541454.7...	Default	No	Normal	0.000000	0.010000
V1_004	3533377.8...	5541422.7...	Default	No	Normal	0.000000	0.010000
V1_007	3533379.3...	5541394.3...	Default	No	Normal	0.000000	0.010000
V1_010	3533380.5...	5541369.2...	Default	No	Normal	0.000000	0.010000
V1_012	3533381.8...	5541344.8...	Default	No		0.000000	0.010000
V1_015	3533383.0...	5541321.3...	Default	No		0.000000	0.010000
V1_017	3533384.4...	5541295.0...	Default	No		0.000000	0.010000
V1_019	3533385.8...	5541275.3...	Default	No		0.000000	0.010000
V1_021	3533387.4...	5541257.6...	Default	No	Normal	0.000000	0.010000
V1_023	3533389.4...	5541240.1...	Default	No	Normal	0.000000	0.010000
V1_024	3533391.9...	5541223.0...	Default	No	Normal	0.000000	0.010000
V1_026	3533395.0...	5541204.9...	Default	No	Normal	0.000000	0.010000
V1_028	3533398.5...	5541188.1...	Default	No	Normal	0.000000	0.010000

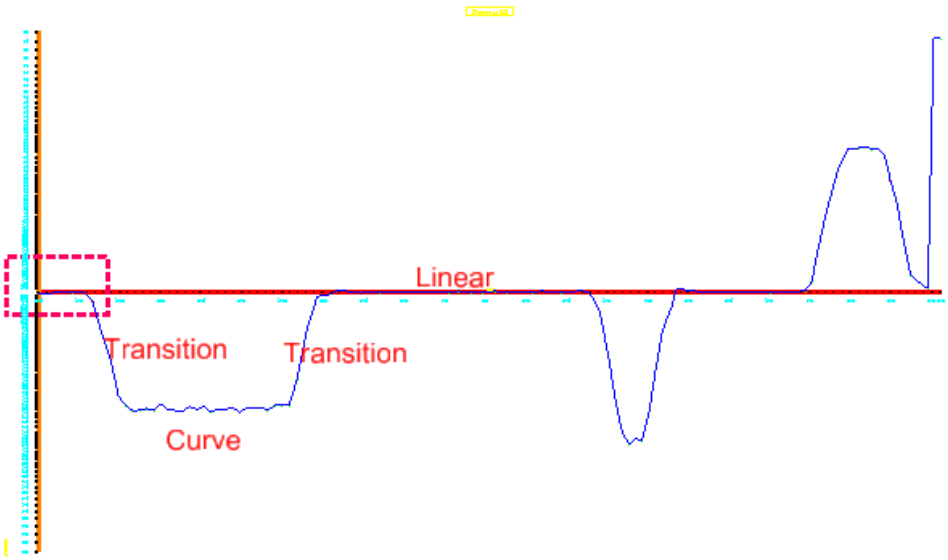
You can select multiple regression points in the list before you click Edit; your edits will apply to all selected points.



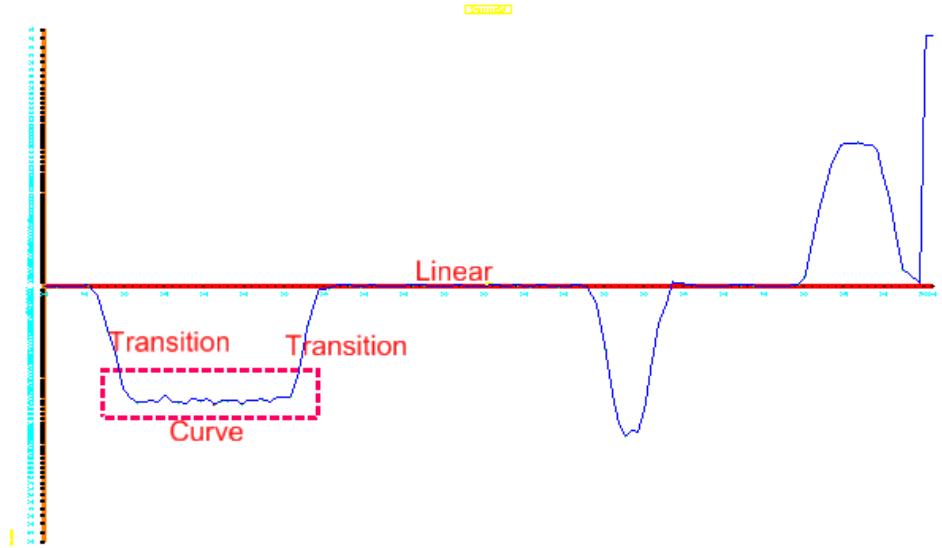
Close the dialog box.

1.1.2 Use Select & Regress

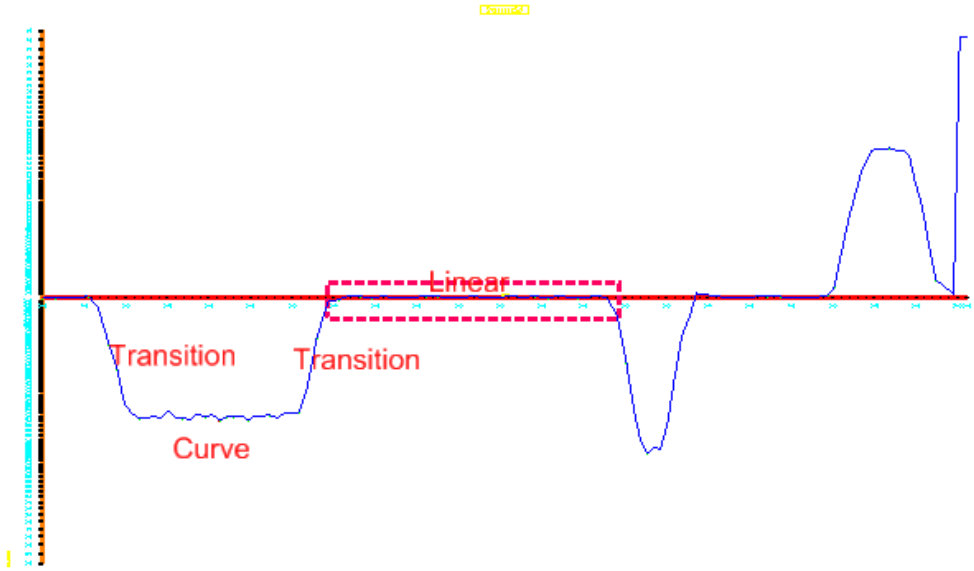
Select & Regress lets you select points from graphics (plan, curvature, slew), then automatically regress an element using the selected points. The element created is added to the end of the horizontal element list.
Place a selection fence along the points. Watch for the command on left lower side of MicroStation



Accept this solution and move on the next circular element.



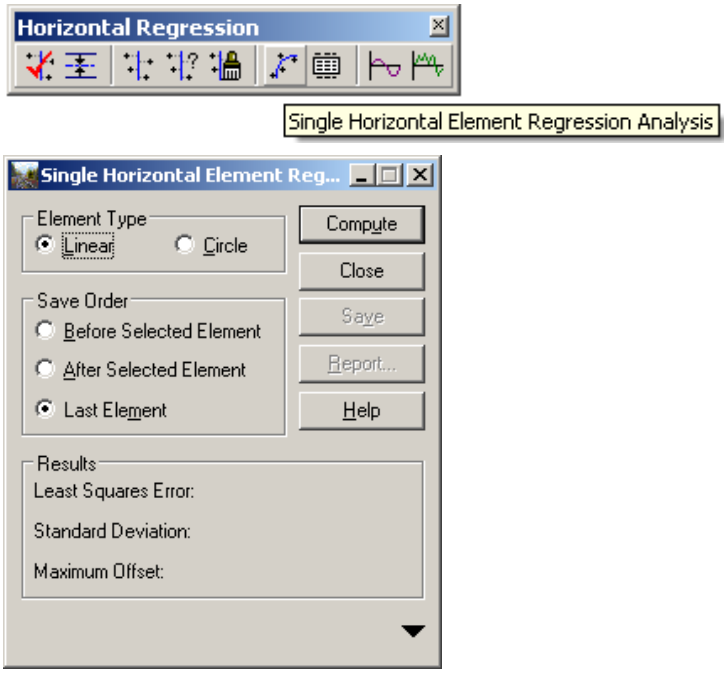
Accept this solution and move on the next linear elements.



Accept this solution

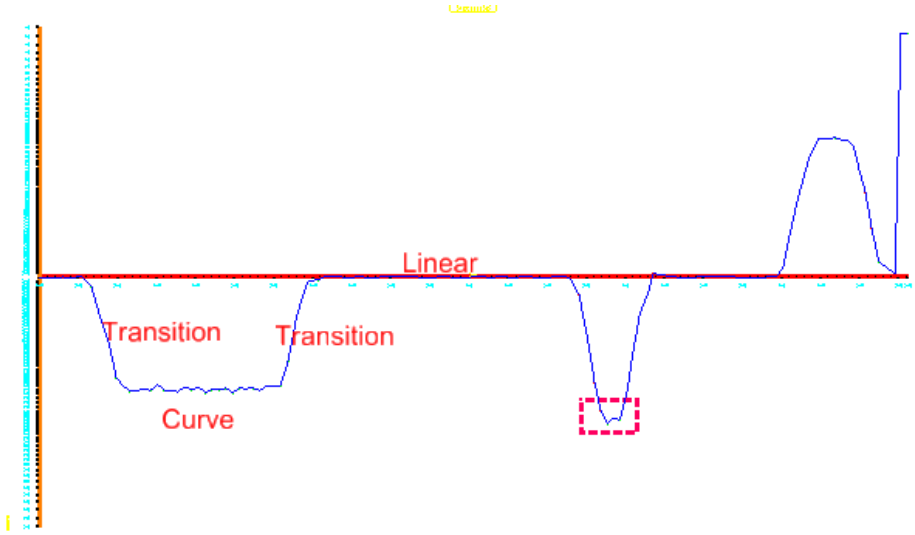
1.1.3 USE REGRESS ONLY

The Edit/Review regression point box must be open and you must call the Single Element Regression dialog box.

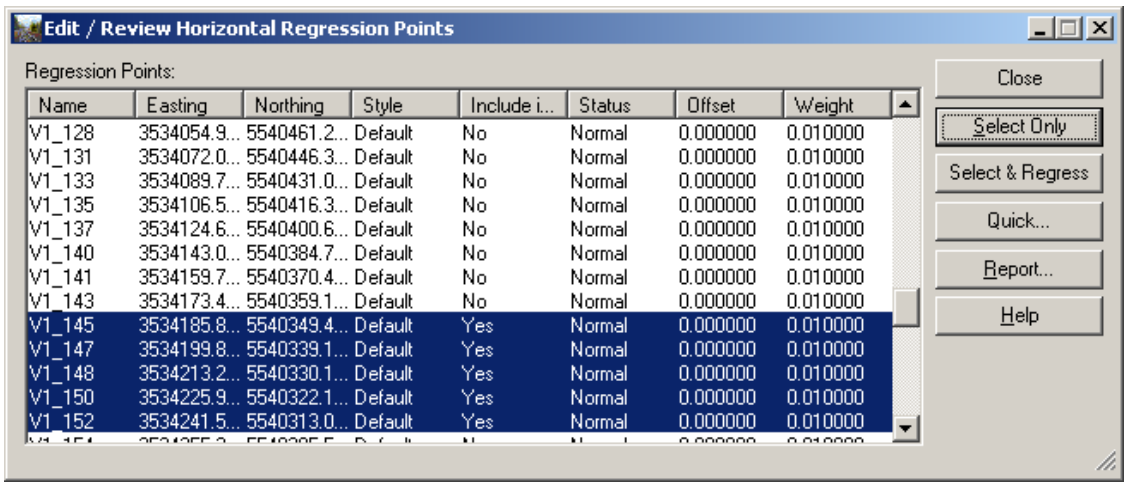


The box let you decide which type of element you want to regress.

Select in the curvature diagram the next curve.

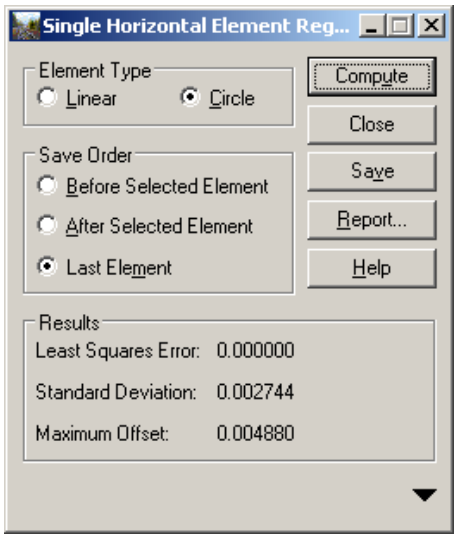


The point are selected in the dialog box as well



Name	Easting	Northing	Style	Include i...	Status	Offset	Weight
V1_128	3534054.9...	5540461.2...	Default	No	Normal	0.000000	0.010000
V1_131	3534072.0...	5540446.3...	Default	No	Normal	0.000000	0.010000
V1_133	3534089.7...	5540431.0...	Default	No	Normal	0.000000	0.010000
V1_135	3534106.5...	5540416.3...	Default	No	Normal	0.000000	0.010000
V1_137	3534124.6...	5540400.6...	Default	No	Normal	0.000000	0.010000
V1_140	3534143.0...	5540384.7...	Default	No	Normal	0.000000	0.010000
V1_141	3534159.7...	5540370.4...	Default	No	Normal	0.000000	0.010000
V1_143	3534173.4...	5540359.1...	Default	No	Normal	0.000000	0.010000
V1_145	3534185.8...	5540349.4...	Default	Yes	Normal	0.000000	0.010000
V1_147	3534199.8...	5540339.1...	Default	Yes	Normal	0.000000	0.010000
V1_148	3534213.2...	5540330.1...	Default	Yes	Normal	0.000000	0.010000
V1_150	3534225.9...	5540322.1...	Default	Yes	Normal	0.000000	0.010000
V1_152	3534241.5...	5540313.0...	Default	Yes	Normal	0.000000	0.010000

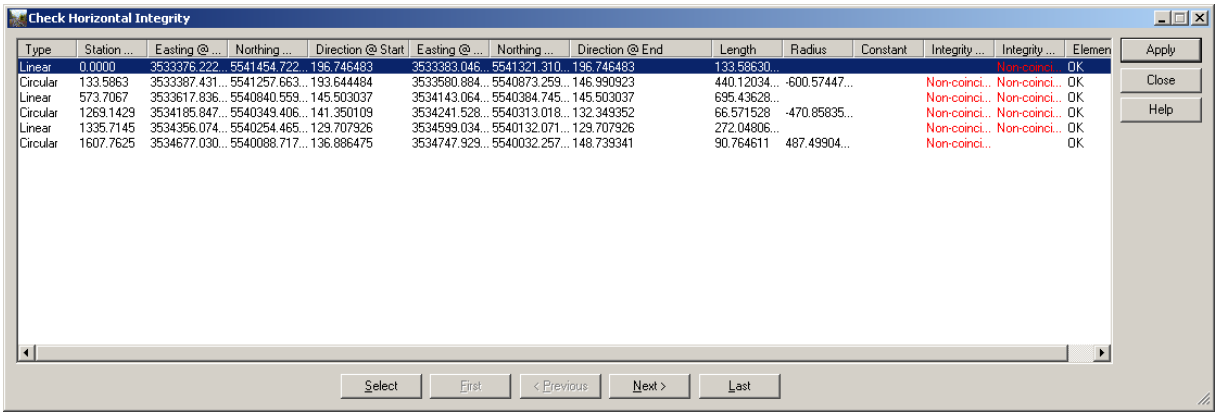
Select in the dialog box Curve and hit Compute.



Save the solution. If you click on Report te software gives you the slew values along the calculated element.

Move on with the next linear and circular element.

Check the Integrity.



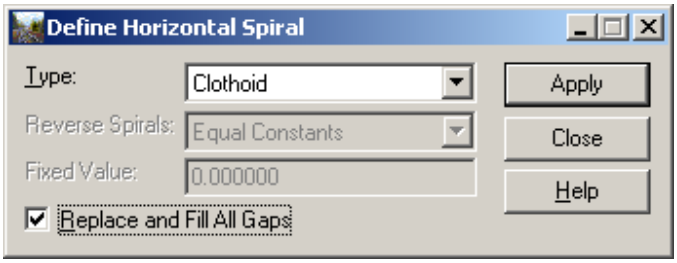
Type	Station ...	Easting @ ...	Northing ...	Direction @ Start	Easting @ ...	Northing ...	Direction @ End	Length	Radius	Constant	Integrity ...	Integrity ...	Elemen
Linear	0.0000	3533376.222...	5541454.722...	196.746483	3533383.046...	5541321.310...	196.746483	133.58630...				Non-coinci...	OK
Circular	133.5863	3533387.431...	5541257.663...	193.644484	3533580.884...	5540873.259...	146.990923	440.12034...	-600.57447...		Non-coinci...	Non-coinci...	OK
Linear	573.7067	3533617.836...	5540840.559...	145.503037	3534143.064...	5540384.745...	145.503037	695.43628...			Non-coinci...	Non-coinci...	OK
Circular	1269.1429	3534185.847...	5540349.406...	141.350109	3534241.528...	5540313.018...	132.349352	66.571528	-470.85835...		Non-coinci...	Non-coinci...	OK
Linear	1335.7145	3534356.074...	5540254.465...	129.707926	3534599.034...	5540132.071...	129.707926	272.04806...			Non-coinci...	Non-coinci...	OK
Circular	1607.7625	3534677.030...	5540088.717...	136.886475	3534747.929...	5540032.257...	148.739341	90.764611	487.49904...		Non-coinci...		OK

The elements are not connected but in the right order.

1.1.4 CLOSE THE TRACK WITH SPIRALS

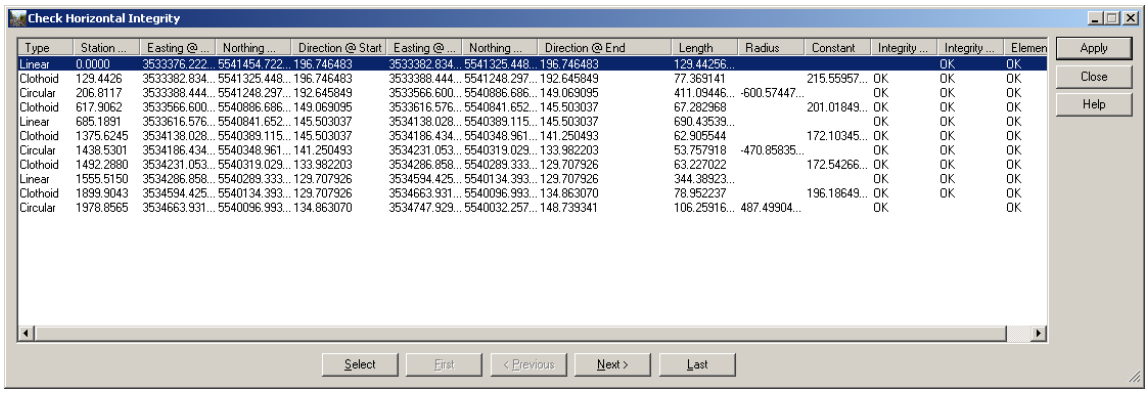
Call the Horizontal Element palette

To make life easier turn the check box for Replace and Fill Gaps on.



Hit apply and identify the 1st and then the last (2nd) element in the alignment.

Check the Integrity again.



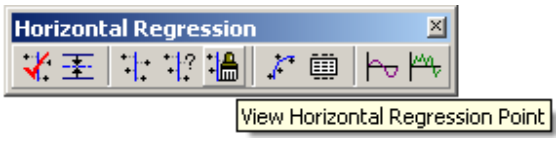
Type	Station ...	Easting @ ...	Northing ...	Direction @ Start	Easting @ ...	Northing ...	Direction @ End	Length	Radius	Constant	Integrity ...	Integrity ...	Elemen
Linear	0.0000	3533376.222...	5541454.722...	196.746483	3533382.834...	5541325.448...	196.746483	129.44256...				OK	OK
Clothoid	129.4426	3533382.834...	5541325.448...	196.746483	3533388.444...	5541248.297...	192.645849	77.369141		215.55957...	OK	OK	OK
Circular	206.8117	3533388.444...	5541248.297...	192.645849	3533566.600...	5540886.686...	149.069095	411.09446...	-600.57447...		OK	OK	OK
Clothoid	617.9062	3533566.600...	5540886.686...	149.069095	3533616.576...	5540841.652...	145.503037	67.282968		201.01849...	OK	OK	OK
Linear	685.1891	3533616.576...	5540841.652...	145.503037	3534138.028...	5540389.115...	145.503037	690.43539...			OK	OK	OK
Clothoid	1375.6245	3534138.028...	5540389.115...	145.503037	3534186.434...	5540348.961...	141.250493	62.905544		172.10345...	OK	OK	OK
Circular	1438.5301	3534186.434...	5540348.961...	141.250493	3534231.053...	5540319.029...	133.982203	53.757918	-470.85835...		OK	OK	OK
Clothoid	1492.2880	3534231.053...	5540319.029...	133.982203	3534286.858...	5540289.333...	129.707926	63.227022		172.54266...	OK	OK	OK
Linear	1555.5150	3534286.858...	5540289.333...	129.707926	3534594.425...	5540134.393...	129.707926	344.38923...			OK	OK	OK
Clothoid	1899.9043	3534594.425...	5540134.393...	129.707926	3534663.931...	5540096.993...	134.863070	78.952237		196.18649...	OK	OK	OK
Circular	1978.8565	3534663.931...	5540096.993...	134.863070	3534747.929...	5540032.257...	148.739341	106.25916...	487.49904...		OK		OK

All gaps are close with transitions.

Save your work.

3. *VIEW REGRESSION POINTS*

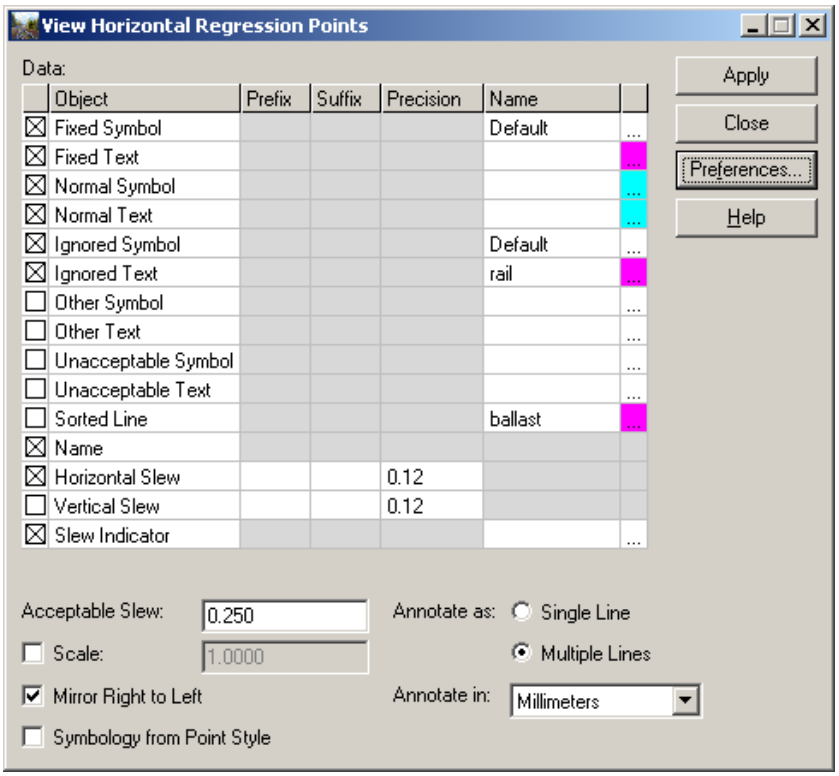
Geometry > View Geometry > Horizontal Regression > View Horizontal Regression …



Used to display regression points for the active horizontal or vertical alignment. You can define different symbologies for different types of regression points: *fixed*, *normal*, and *ignored*. The status of a regression point is determined on the Edit Horizontal Regression Point dialog box.

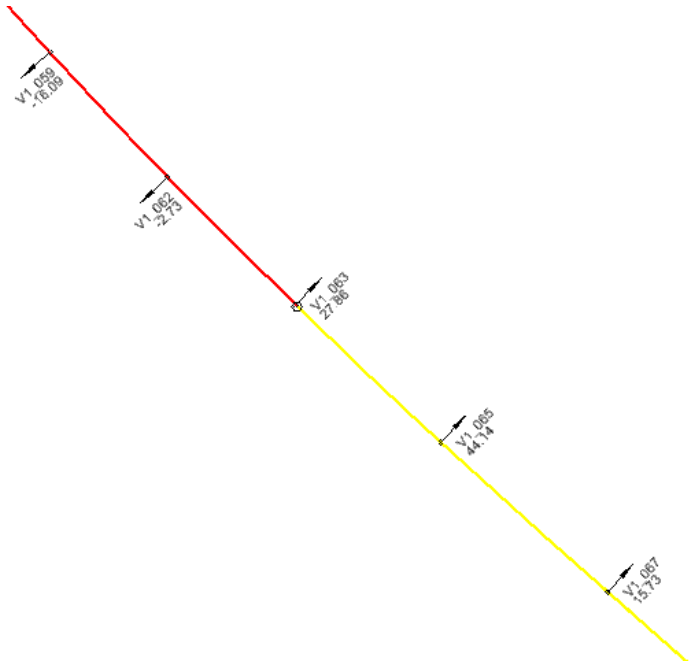
Other functions for this command:

- Annotate point name and slew value on multiple rows
- Display a directional indicator to indicate the slew direction
- Display other points of interest (platform edges, overhead line poles and other track furniture)
- Horizontal regression points are updated as the horizontal alignment is edited.


View Horizontal Regression Points
Data:
Object
Prefix
Suffix
Precision
Name
Fixed Symbol
Default
Fixed Text
Normal Symbol
Normal Text
Ignored Symbol
Default
Ignored Text
rail
Other Symbol
Other Text
Unacceptable Symbol
Unacceptable Text
Sorted Line
ballast
Name
Horizontal Slew
0.12
Vertical Slew
0.12
Slew Indicator
Apply
Close
Preferences...
Help
Acceptable Slew:
0.250
Scale:
1.0000
Mirror Right to Left
Symbology from Point Style
Annotate as:
Single Line
Multiple Lines
Annotate in:
Millimeters

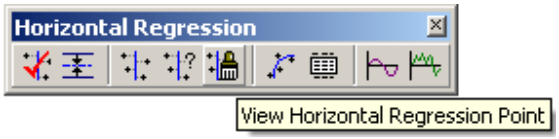
Hit Apply.

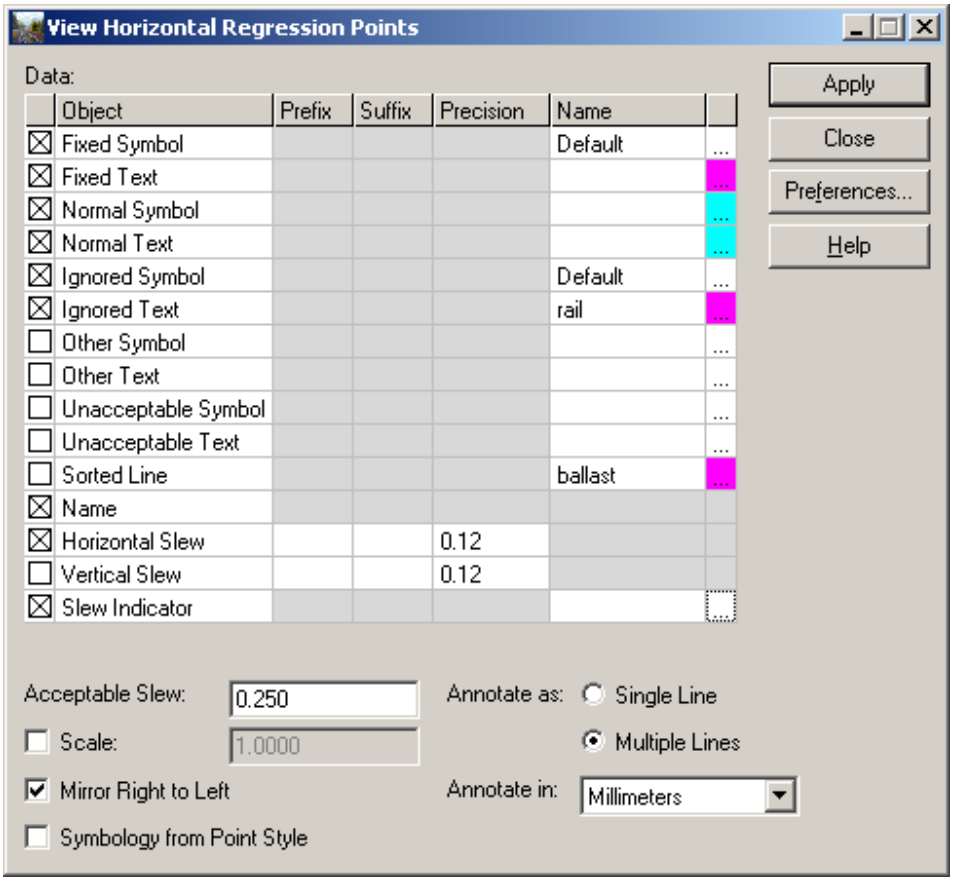
The result should look like this:



4. *LOAD THE FILE IDEAL WORLD.ALG*

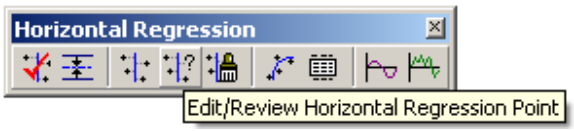
4.1 DISPLAY THE REGRESSION POINTS

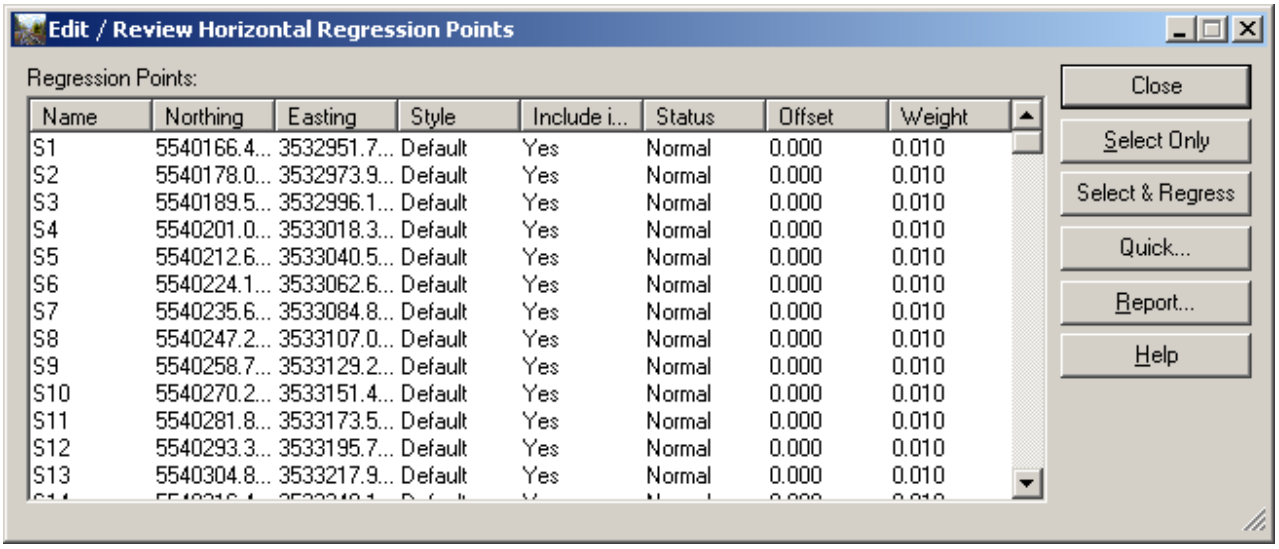




4.2 USE THE QUICK REGRESSION

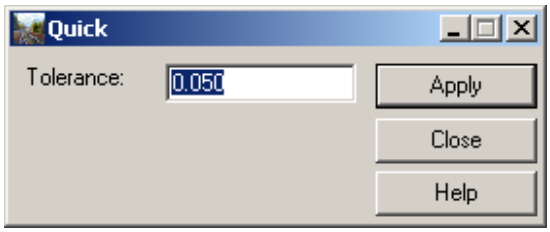
Go to Edit/Review Horizontal Regression Points …





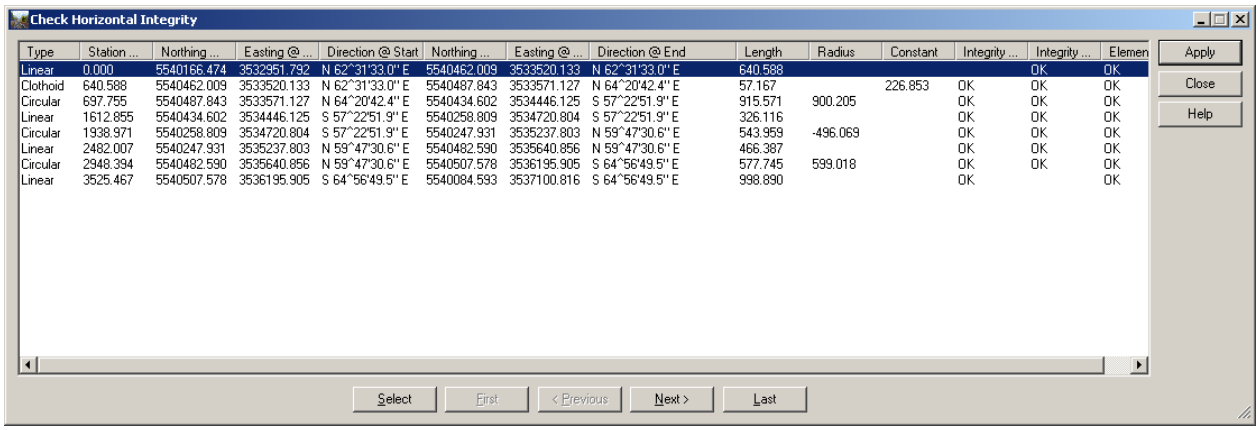
Name	Northing	Easting	Style	Include i...	Status	Offset	Weight
S1	5540166.4...	3532951.7...	Default	Yes	Normal	0.000	0.010
S2	5540178.0...	3532973.9...	Default	Yes	Normal	0.000	0.010
S3	5540189.5...	3532996.1...	Default	Yes	Normal	0.000	0.010
S4	5540201.0...	3533018.3...	Default	Yes	Normal	0.000	0.010
S5	5540212.6...	3533040.5...	Default	Yes	Normal	0.000	0.010
S6	5540224.1...	3533062.6...	Default	Yes	Normal	0.000	0.010
S7	5540235.6...	3533084.8...	Default	Yes	Normal	0.000	0.010
S8	5540247.2...	3533107.0...	Default	Yes	Normal	0.000	0.010
S9	5540258.7...	3533129.2...	Default	Yes	Normal	0.000	0.010
S10	5540270.2...	3533151.4...	Default	Yes	Normal	0.000	0.010
S11	5540281.8...	3533173.5...	Default	Yes	Normal	0.000	0.010
S12	5540293.3...	3533195.7...	Default	Yes	Normal	0.000	0.010
S13	5540304.8...	3533217.9...	Default	Yes	Normal	0.000	0.010

Select Quick …



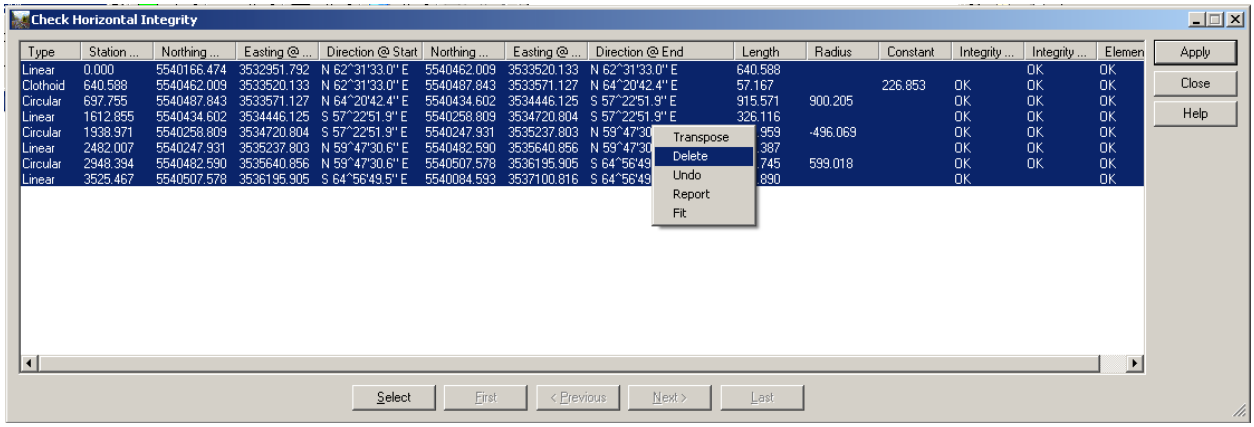
Apply this tolerance.

The software creates a best fit alignment based on the regression points. Check the integrity.

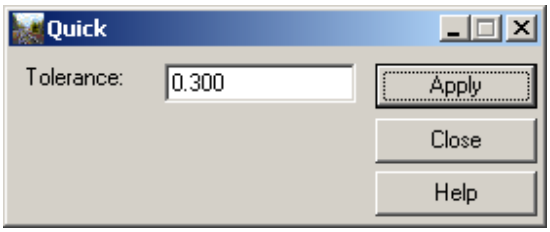


Type	Station ...	Northing ...	Easting @ ...	Direction @ Start	Northing ...	Easting @ ...	Direction @ End	Length	Radius	Constant	Integrity ...	Integrity ...	Elemen
Linear	0.000	5540166.474	3532951.792	N 62^31'33.0" E	5540462.009	3533520.133	N 62^31'33.0" E	640.588				OK	OK
Clothoid	640.588	5540462.009	3533520.133	N 62^31'33.0" E	5540487.843	3533571.127	N 64^20'42.4" E	57.167		226.853	OK	OK	OK
Circular	697.755	5540487.843	3533571.127	N 64^20'42.4" E	5540434.602	3534446.125	S 57^22'51.9" E	915.571	900.205		OK	OK	OK
Linear	1612.855	5540434.602	3534446.125	S 57^22'51.9" E	5540258.809	3534720.804	S 57^22'51.9" E	326.116			OK	OK	OK
Circular	1938.971	5540258.809	3534720.804	S 57^22'51.9" E	5540247.931	3535237.803	N 59^47'30.6" E	543.959	-496.069		OK	OK	OK
Linear	2482.007	5540247.931	3535237.803	N 59^47'30.6" E	5540482.590	3535640.856	N 59^47'30.6" E	466.387			OK	OK	OK
Circular	2948.394	5540482.590	3535640.856	N 59^47'30.6" E	5540507.578	3536195.905	S 64^56'49.5" E	577.745	599.018		OK	OK	OK
Linear	3525.467	5540507.578	3536195.905	S 64^56'49.5" E	5540084.593	3537100.816	S 64^56'49.5" E	998.890			OK		OK

Select all elements and delete them.



Repeat the Quick regression by changing the tolerance. Tolerance defines the tolerance within all points shall fit.



View the result.

Attempt to replace circular arcs (that should be transition spirals) with transition spirals. In this context the software looks for three adjacent circular arcs with the middle arc's radius less than the adjacent circular arcs' radii.

5. *Lesson Name: Cant Alignment Creation*

Lesson Objective:

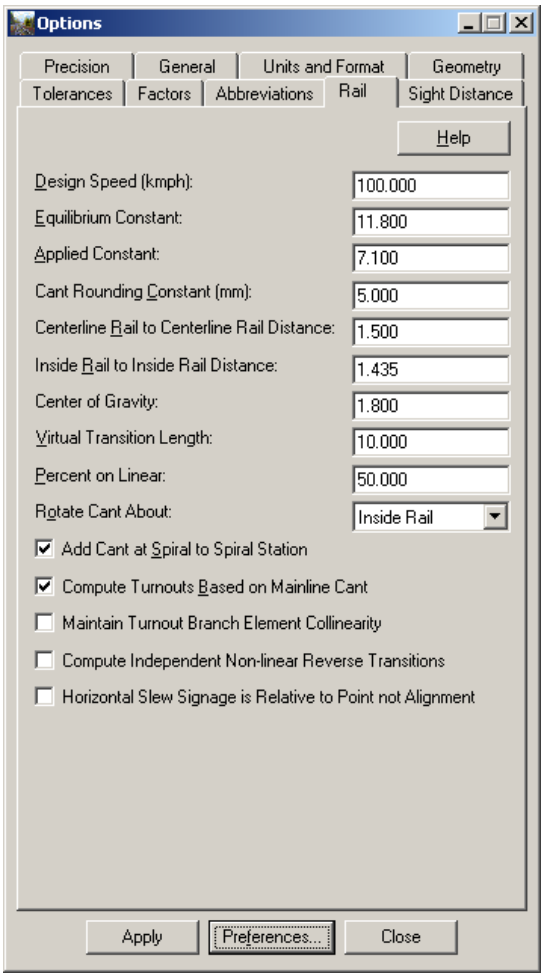
This lesson will show how use the Cant Alignment Creation

5.1 Exercise: Cant Alignment creation

This exercise will guide you through the Cant Alignment Creation

5.1.2 Setup Rail & Geometry Defaults

Go to Tools > Options > Rail …



The Rail Tab specifies cant parameters for the Cant Editor and the Maglev Superelevation Editor commands located on the Geometry > Superelevation menu. Use this tab to set default cant values used by the Cant Editor and Maglev Superelevation Editor commands

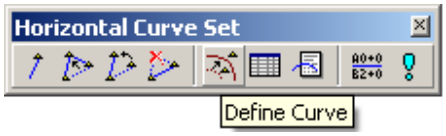
The Equilibrium Constant specifies the equilibrium constant used to calculate the equilibrium cant. This value can differ in various countries.

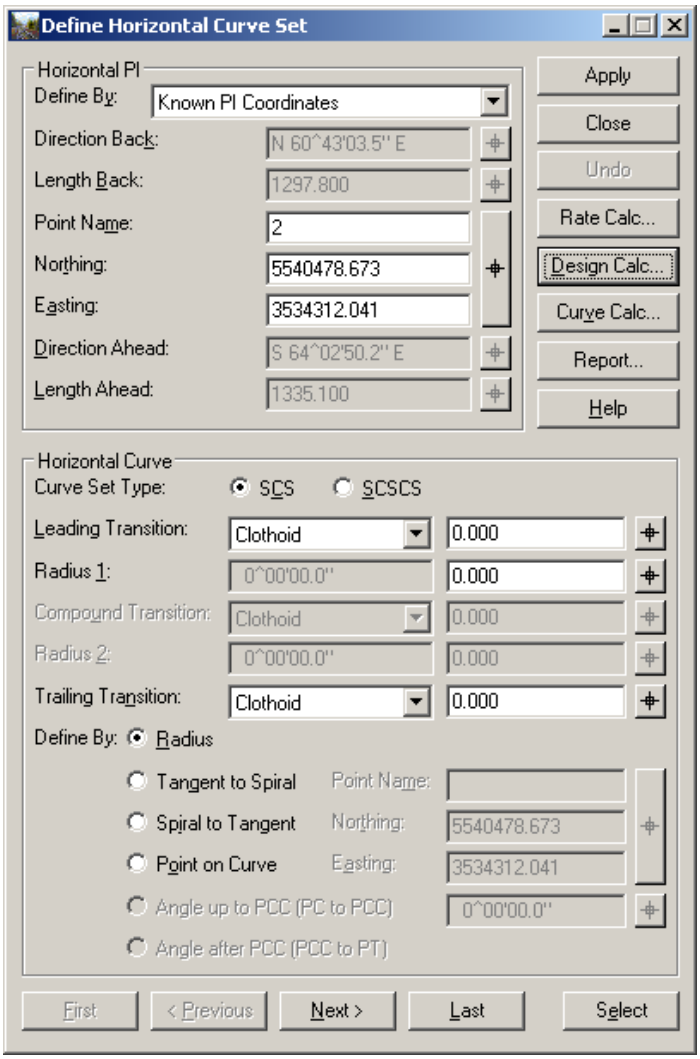
The cant equation: D= 11.8 * v**/ R

1. Load the geometry file called Cant.alg
2. Use the empty alignment A1
3. Create a simple horizontal alignment by using the PI-method. Insert into the horizontal alignment some spirals.

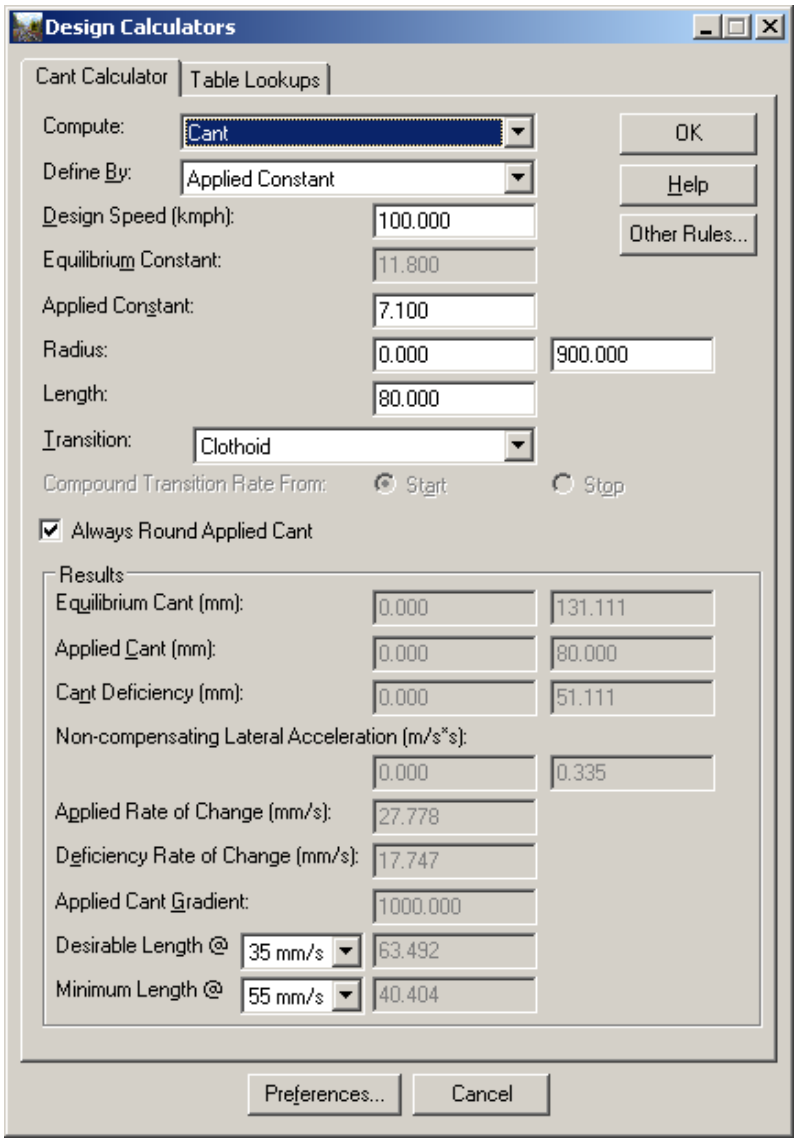
Create 3 PI's

Insert curves and spirals



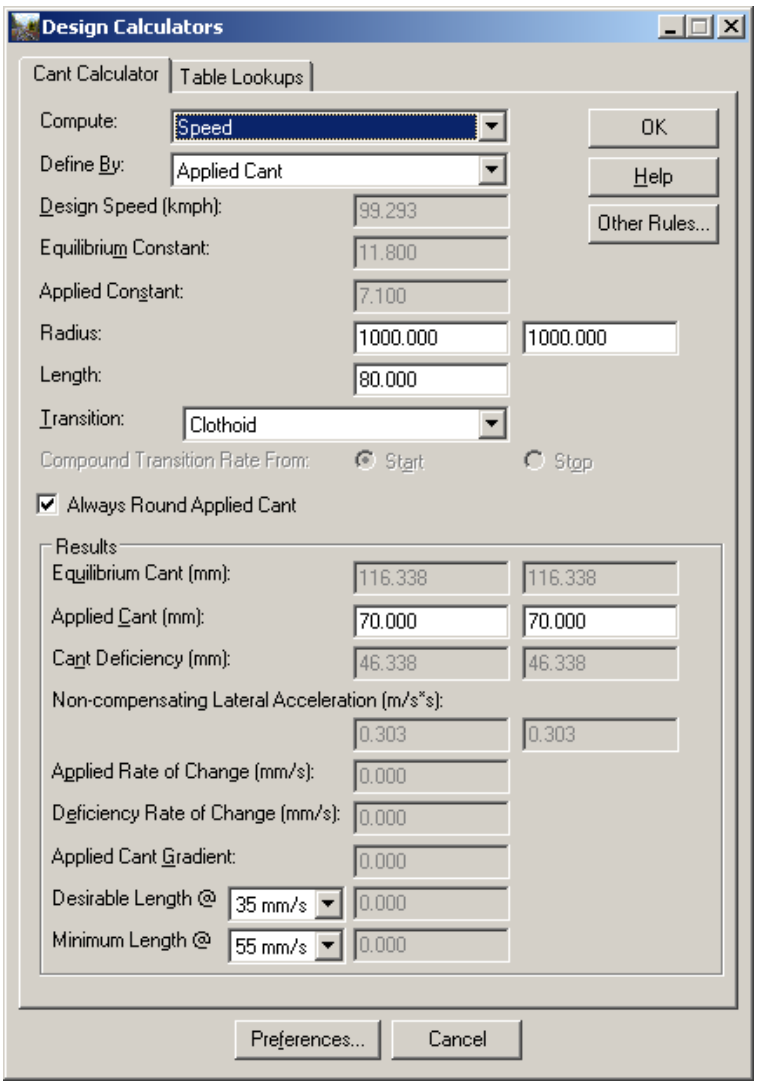


Use the Design Calculator to calculate the cant based on radius & speed

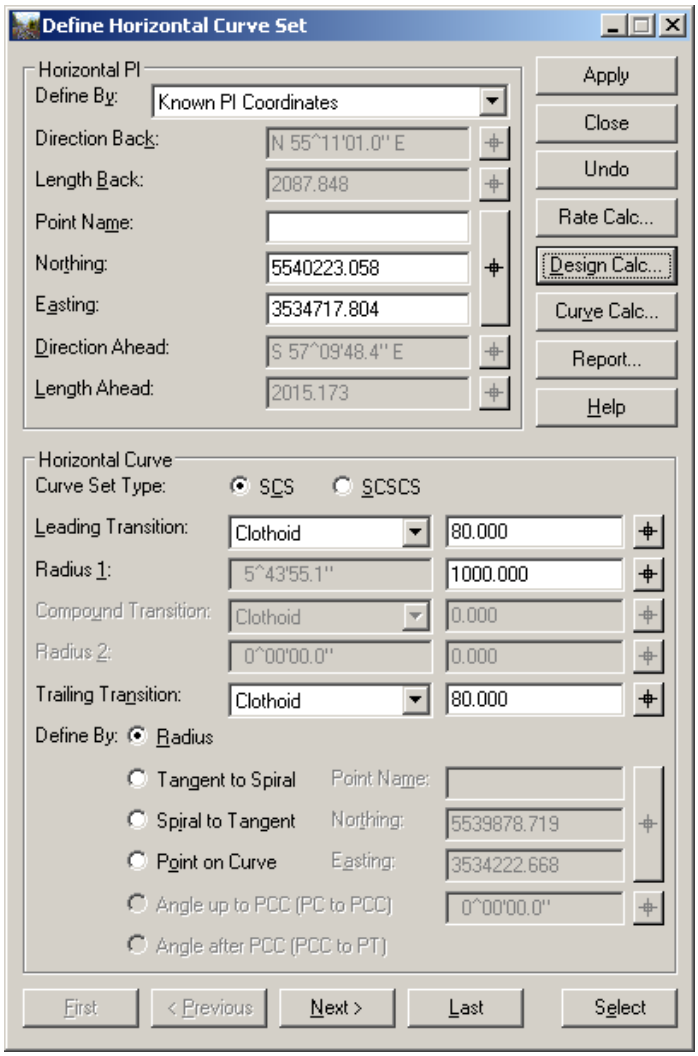


In this dialog box the user can create various scenarios to get the best geometric values for improving speed on a new or existing alignment. This Design Calculator can also use for existing alignment to improve speed on tracks.

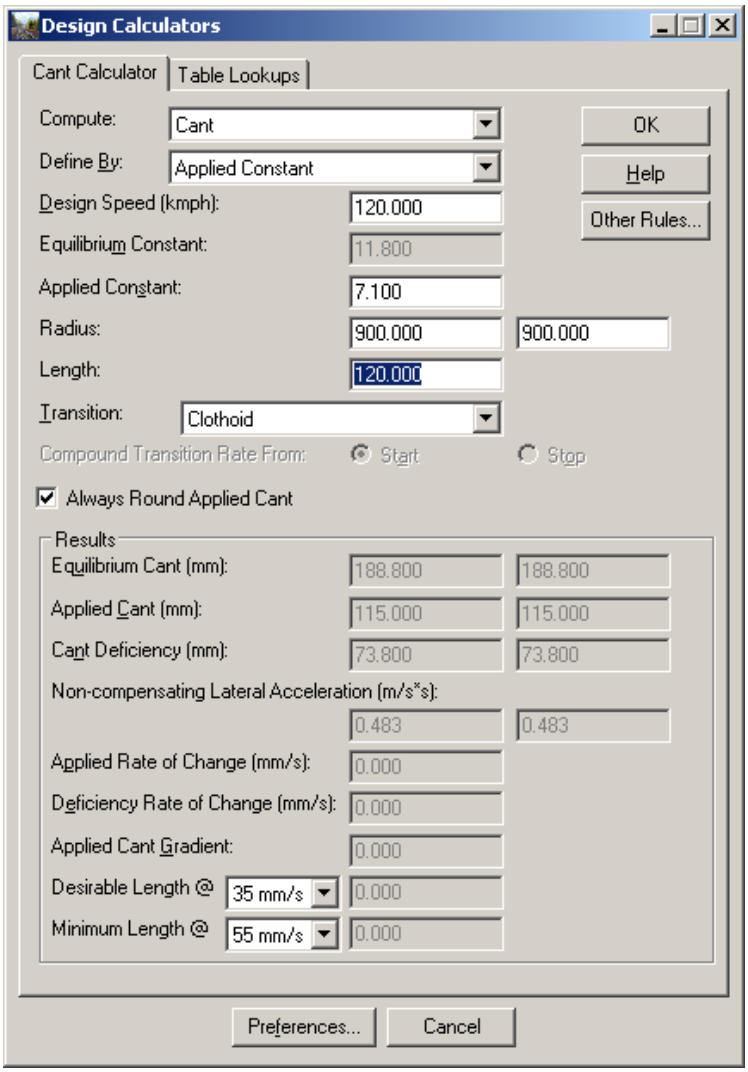
Based on given values the software can compute the applied cant based on speed:



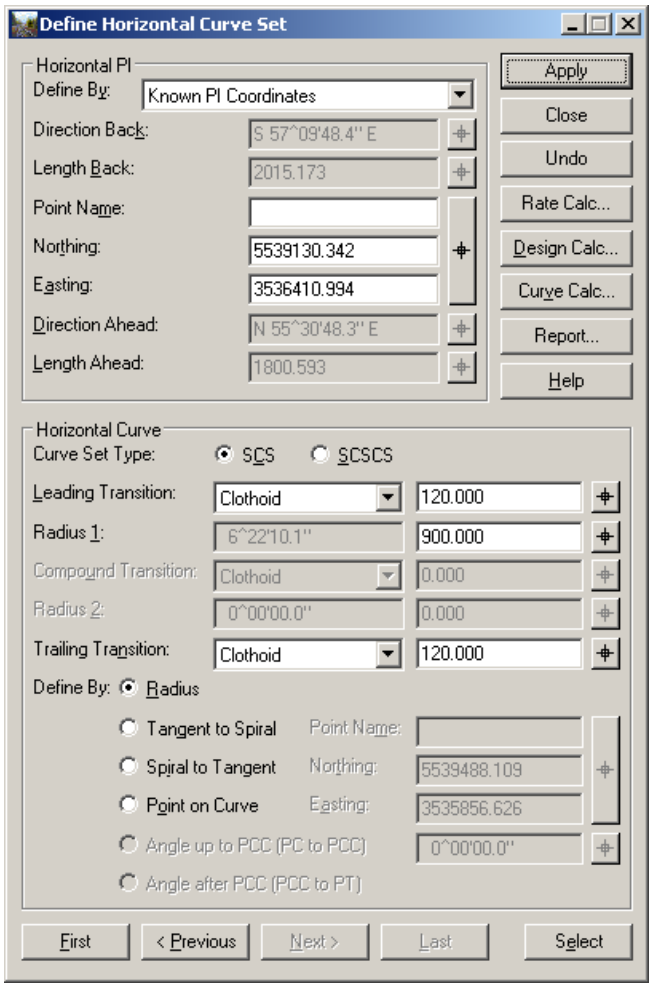
Toggle back to cant and click OK.



The dialog box takes the defined values based on the design calculator. Hit apply and move on to the next PI.

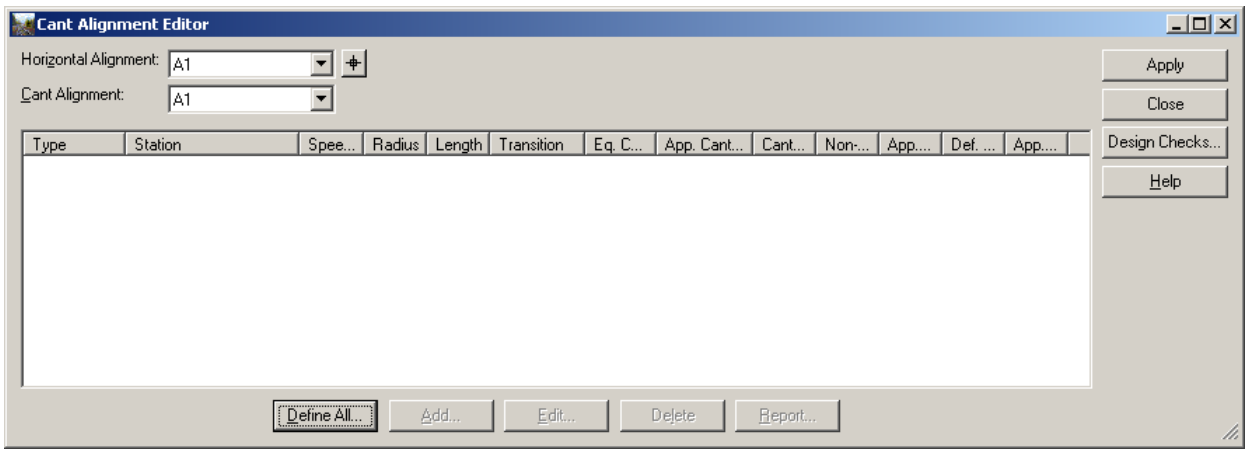

Design Calculators
Cant Calculator
Table Lookups
Compute:
Cant
Define By:
Applied Constant
Design Speed (kmph):
120.000
Equilibrium Constant:
11.800
Applied Constant:
7.100
Radius:
900.000
900.000
Length:
120.000
Transition:
Clothoid
Compound Transition Rate From:
Start
Stop
Always Round Applied Cant
OK
Help
Other Rules...
Results
Equilibrium Cant (mm):
188.800
188.800
Applied Cant (mm):
115.000
115.000
Cant Deficiency (mm):
73.800
73.800
Non-compensating Lateral Acceleration (m/s*s):
0.483
0.483
Applied Rate of Change (mm/s):
0.000
Deficiency Rate of Change (mm/s):
0.000
Applied Cant Gradient:
0.000
Desirable Length @
35 mm/s
0.000
Minimum Length @
55 mm/s
0.000
Preferences...
Cancel

Hit OK.


Define Horizontal Curve Set
Horizontal PI
Define By:
Known PI Coordinates
Direction Back:
S 57^09'48.4" E
Length Back:
2015.173
Point Name:
Northing:
5539130.342
Easting:
3536410.994
Direction Ahead:
N 55^30'48.3" E
Length Ahead:
1800.593
Apply
Close
Undo
Rate Calc...
Design Calc...
Curve Calc...
Report...
Help
Horizontal Curve
Curve Set Type:
SCS
SCSCS
Leading Transition:
Clothoid
120.000
Radius 1:
6^22'10.1"
900.000
Compound Transition:
Clothoid
0.000
Radius 2:
0^00'00.0"
0.000
Trailing Transition:
Clothoid
120.000
Define By:
Radius
Tangent to Spiral
Point Name:
Spiral to Tangent
Northing:
5539488.109
Point on Curve
Easting:
3535856.626
Angle up to PCC (PC to PCC)
0^00'00.0"
Angle after PCC (PCC to PT)
First
< Previous
Next >
Last
Select

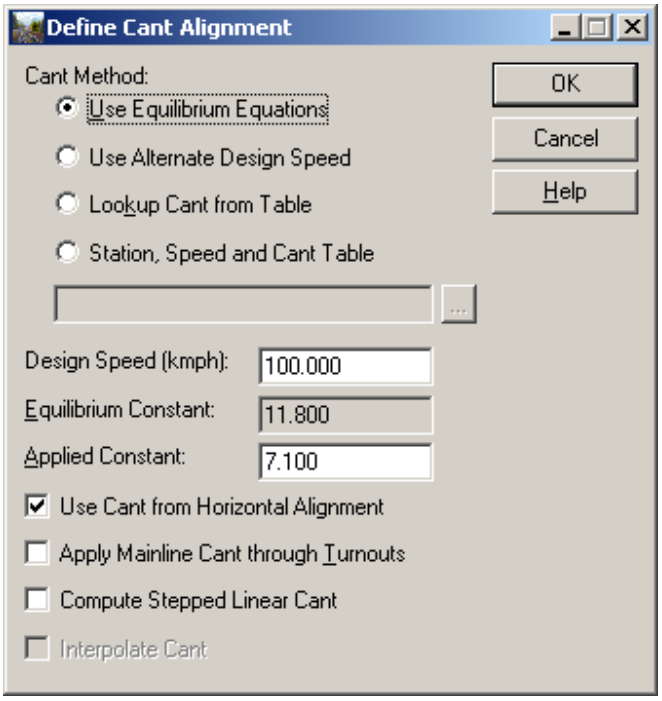
Hit Apply.

5.1.3 EDIT CANT



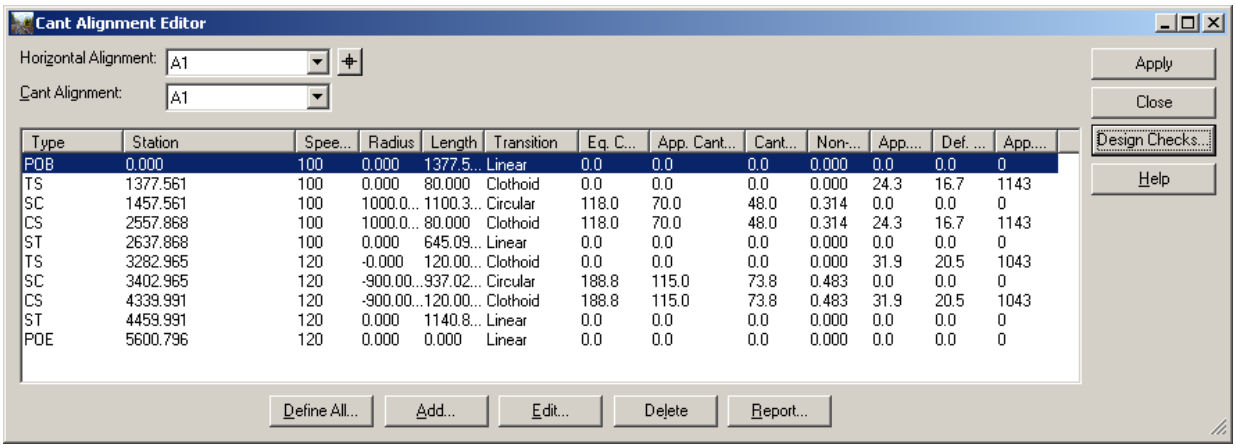
Click on Define All …

The following dialog box appears:



We have already created cant on elements since we used the Design Calculator. Use Cant from Horizontal Alignment.

Hit OK.

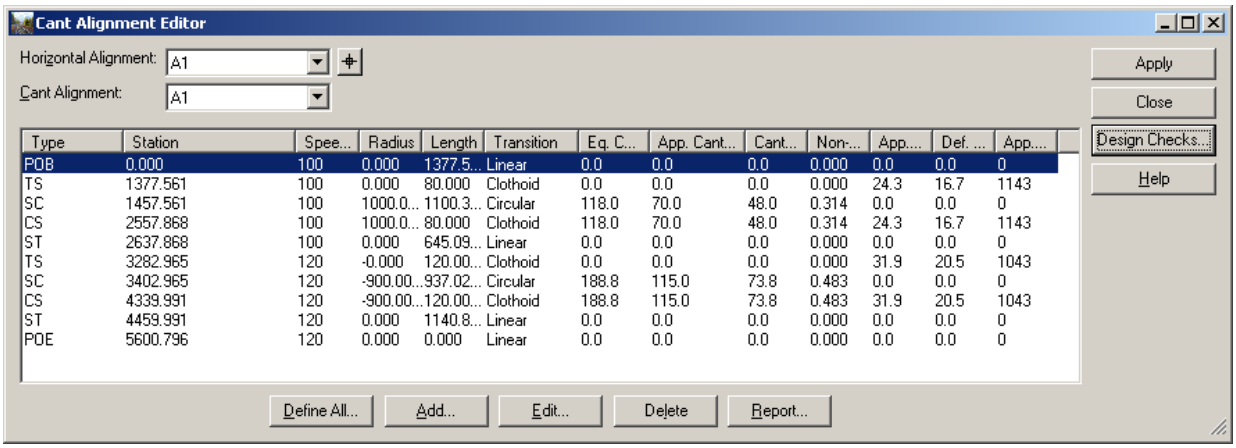


Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	120	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	31.9	20.5	1043
SC	3402.965	120	-900.00...	937.02...	Circular	188.8	115.0	73.8	0.483	0.0	0.0	0
CS	4339.991	120	-900.00...	120.00...	Clothoid	188.8	115.0	73.8	0.483	31.9	20.5	1043
ST	4459.991	120	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	120	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0

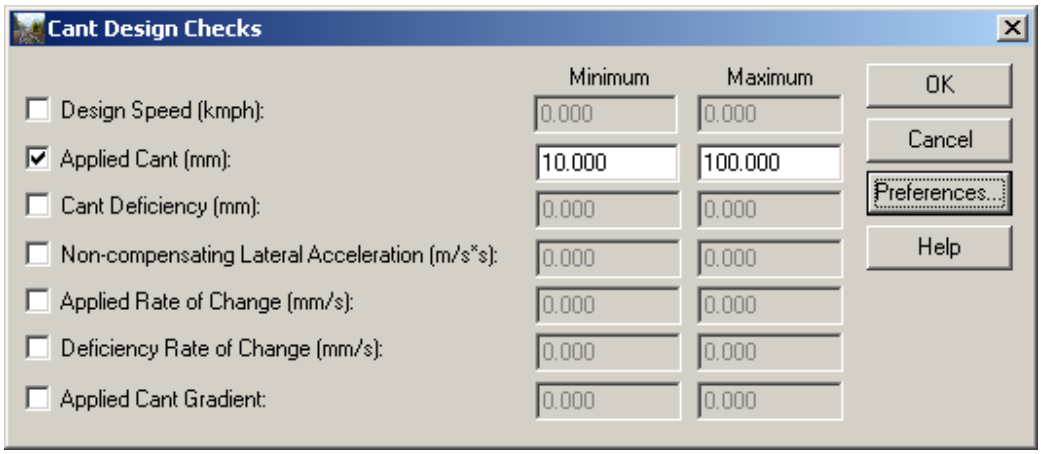
Apply ads the cant values to the alignment.

Note: Cant is defined by coordinate at the circular elements. Any changes in the horizontal alignment changes the cant! The changed values are shown in **RED**.

You also can setup the Design Check for cant related values. Click on Design Checks …

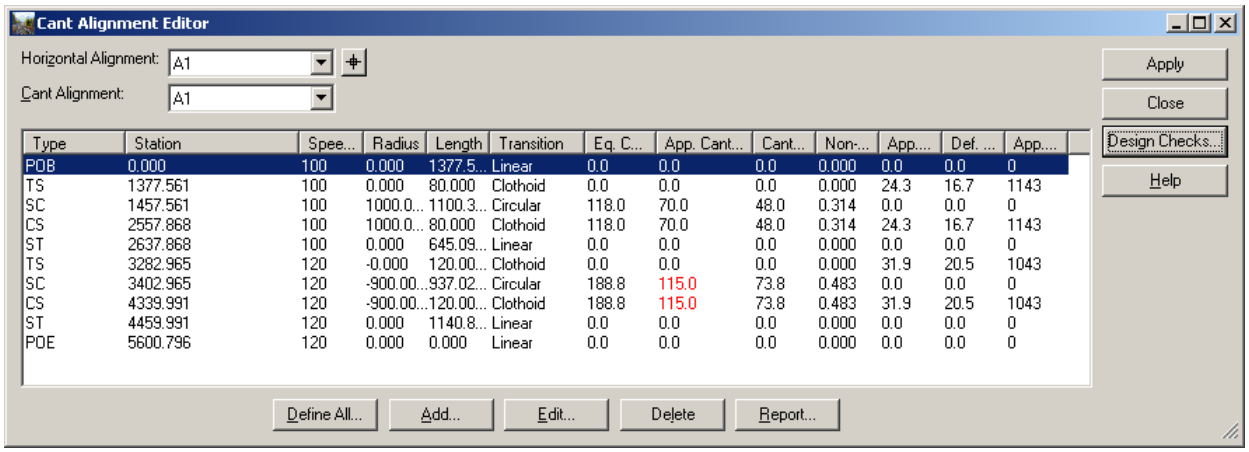


Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	120	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	31.9	20.5	1043
SC	3402.965	120	-900.00...	937.02...	Circular	188.8	115.0	73.8	0.483	0.0	0.0	0
CS	4339.991	120	-900.00...	120.00...	Clothoid	188.8	115.0	73.8	0.483	31.9	20.5	1043
ST	4459.991	120	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	120	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0



The Design Checks can be saved as Preferences …

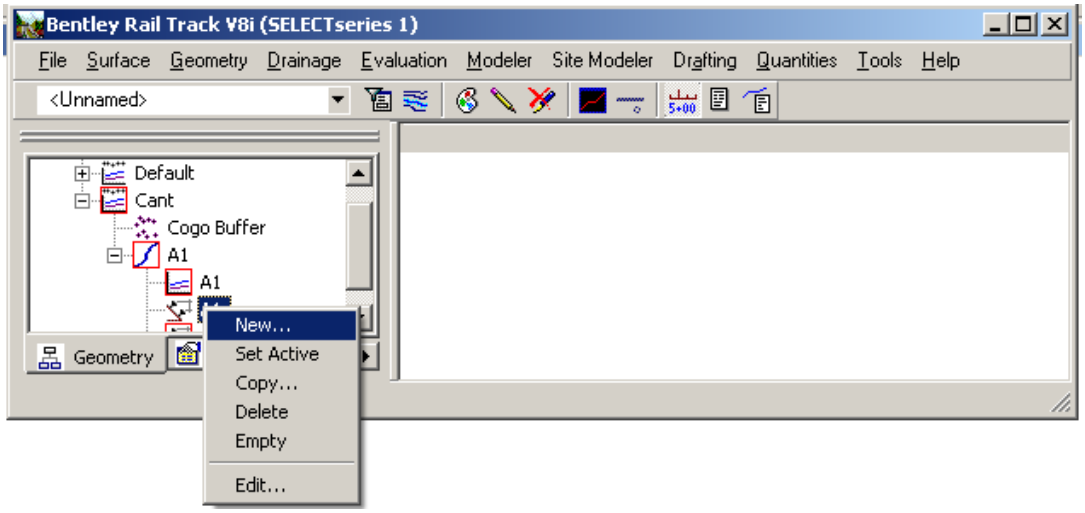
Hit OK.

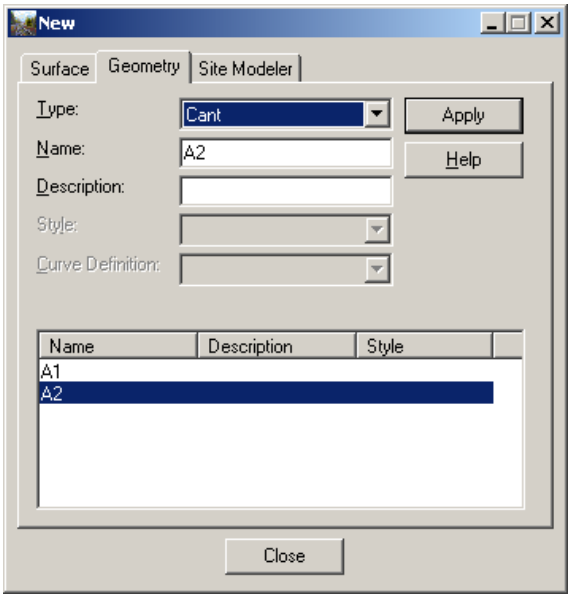


Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	120	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	31.9	20.5	1043
SC	3402.965	120	-900.00...	937.02...	Circular	188.8	115.0	73.8	0.483	0.0	0.0	0
CS	4339.991	120	-900.00...	120.00...	Clothoid	188.8	115.0	73.8	0.483	31.9	20.5	1043
ST	4459.991	120	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	120	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0

Hit Apply.

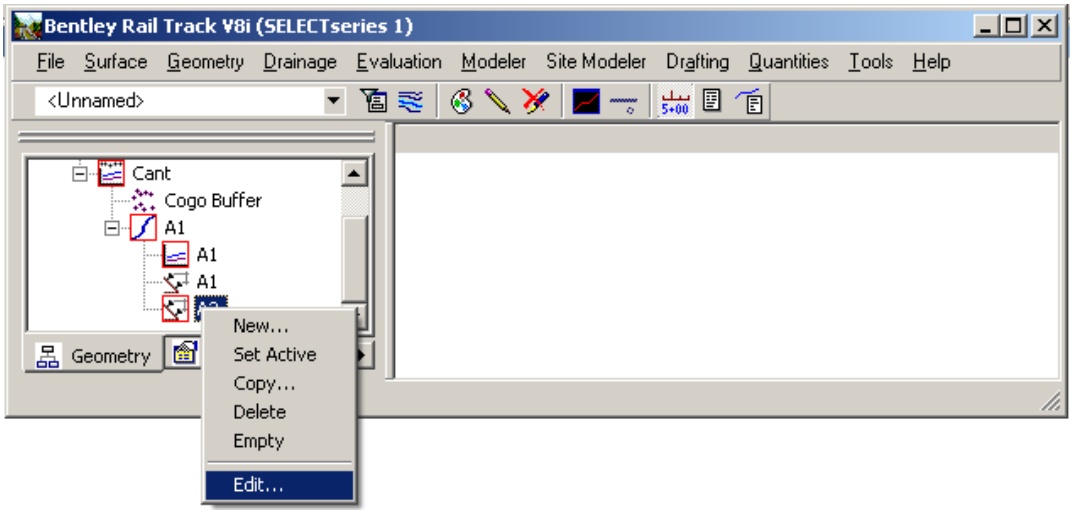
5.1.4 CREATE A NEW CANT ALIGNMENT USING THE EQUILIBRIUM EQUATION

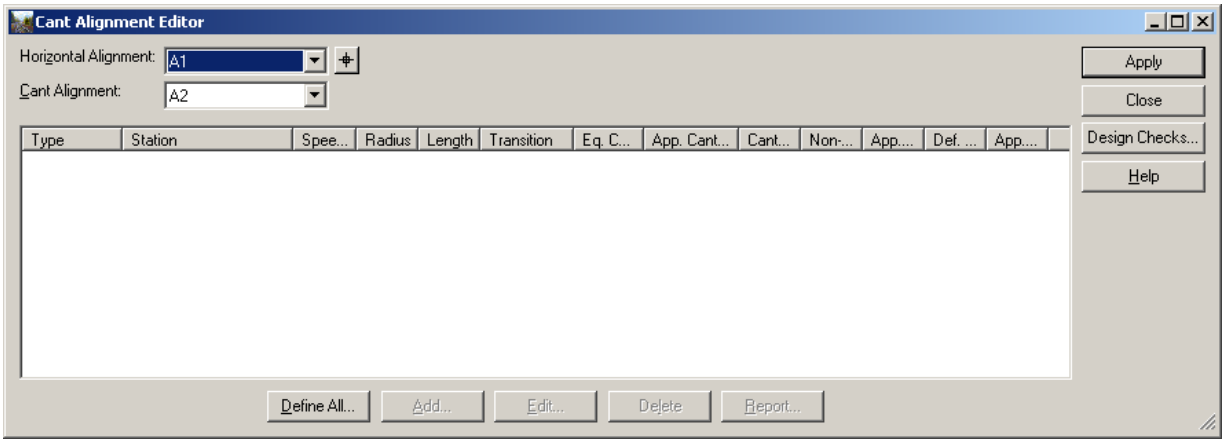




Hit Apply.

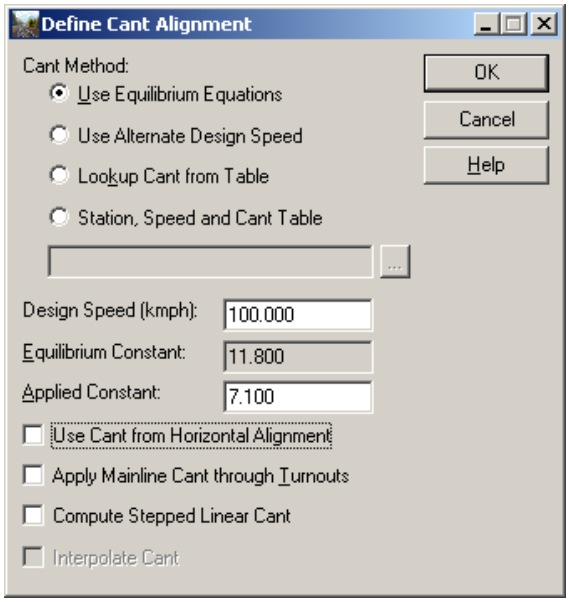
5.1.5 EDIT CANT



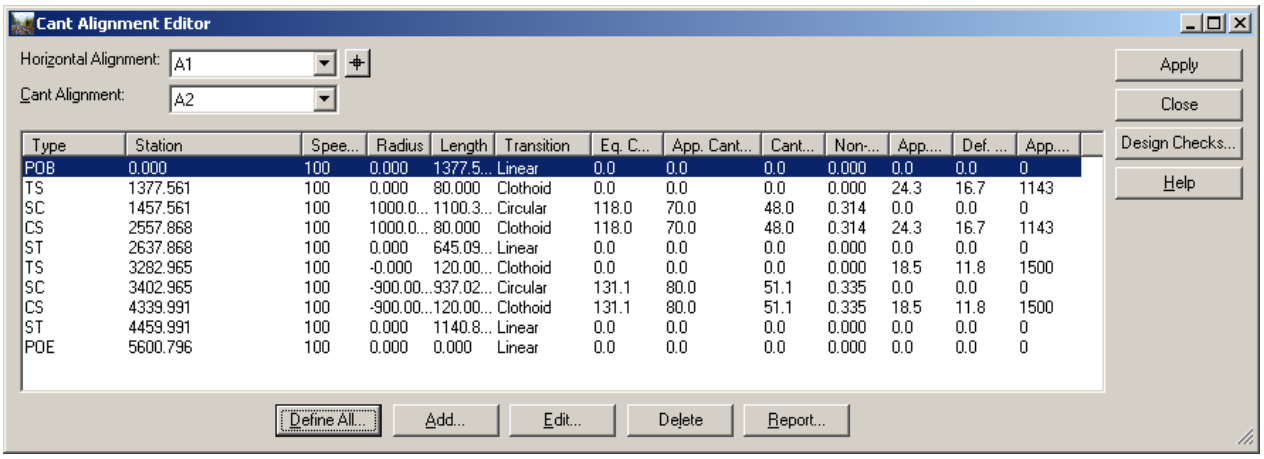


Click on Define All …

The following dialog box appears:



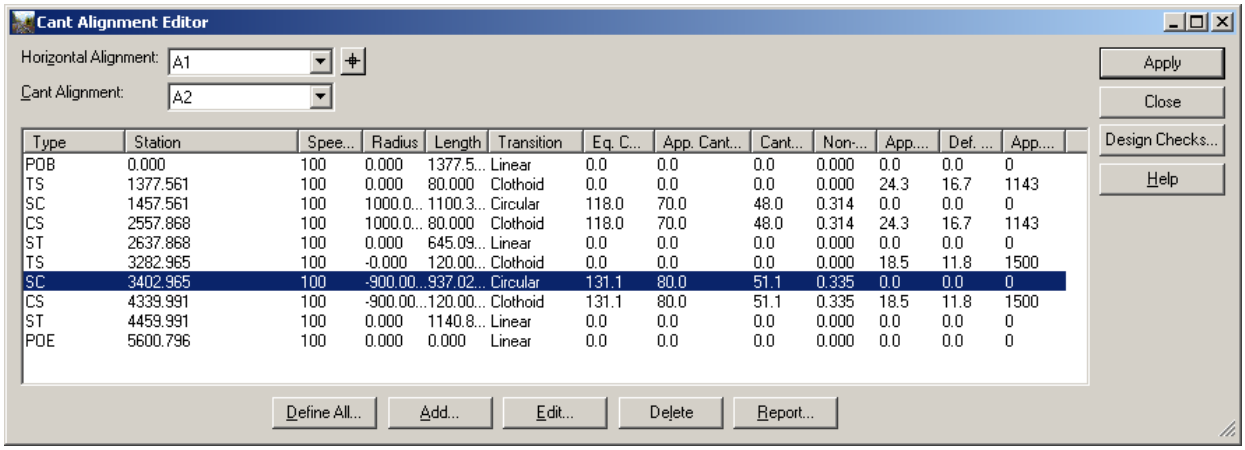
Turn OFF Use Cant from Horizontal Alignment. Hit OK.



Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	18.5	11.8	1500
SC	3402.965	100	-900.00...	937.02...	Circular	131.1	80.0	51.1	0.335	0.0	0.0	0
CS	4339.991	100	-900.00...	120.00...	Clothoid	131.1	80.0	51.1	0.335	18.5	11.8	1500
ST	4459.991	100	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	100	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0

Hit Apply.

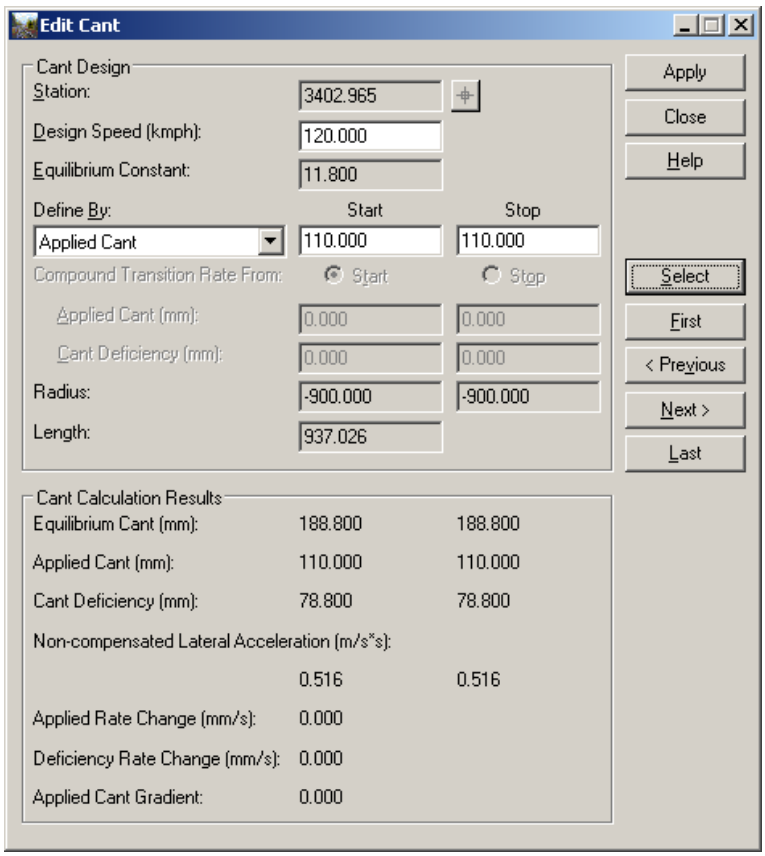
Select a cant



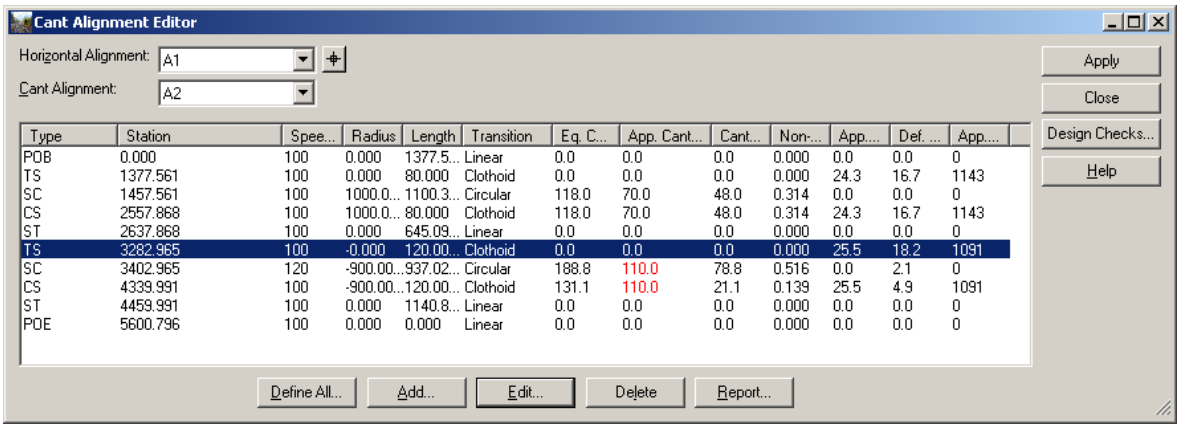
Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	18.5	11.8	1500
SC	3402.965	100	-900.00...	937.02...	Circular	131.1	80.0	51.1	0.335	0.0	0.0	0
CS	4339.991	100	-900.00...	120.00...	Clothoid	131.1	80.0	51.1	0.335	18.5	11.8	1500
ST	4459.991	100	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	100	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0

If you want to edit cant go to Edit …

Change some values and take a look at the results.



Hit Apply.

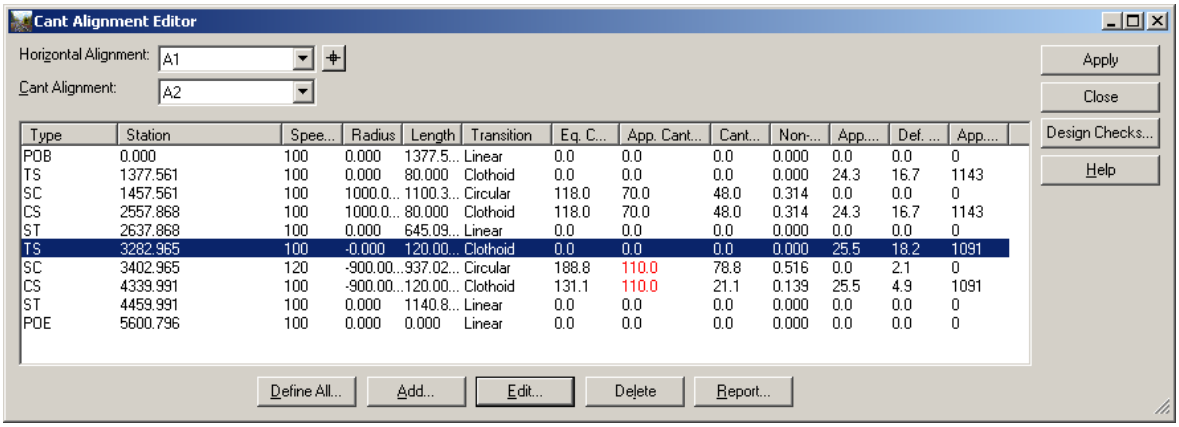


Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	25.5	18.2	1091
SC	3402.965	120	-900.00...	937.02...	Circular	188.8	110.0	78.8	0.516	0.0	2.1	0
CS	4339.991	100	-900.00...	120.00...	Clothoid	131.1	110.0	21.1	0.139	25.5	4.9	1091
ST	4459.991	100	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	100	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0

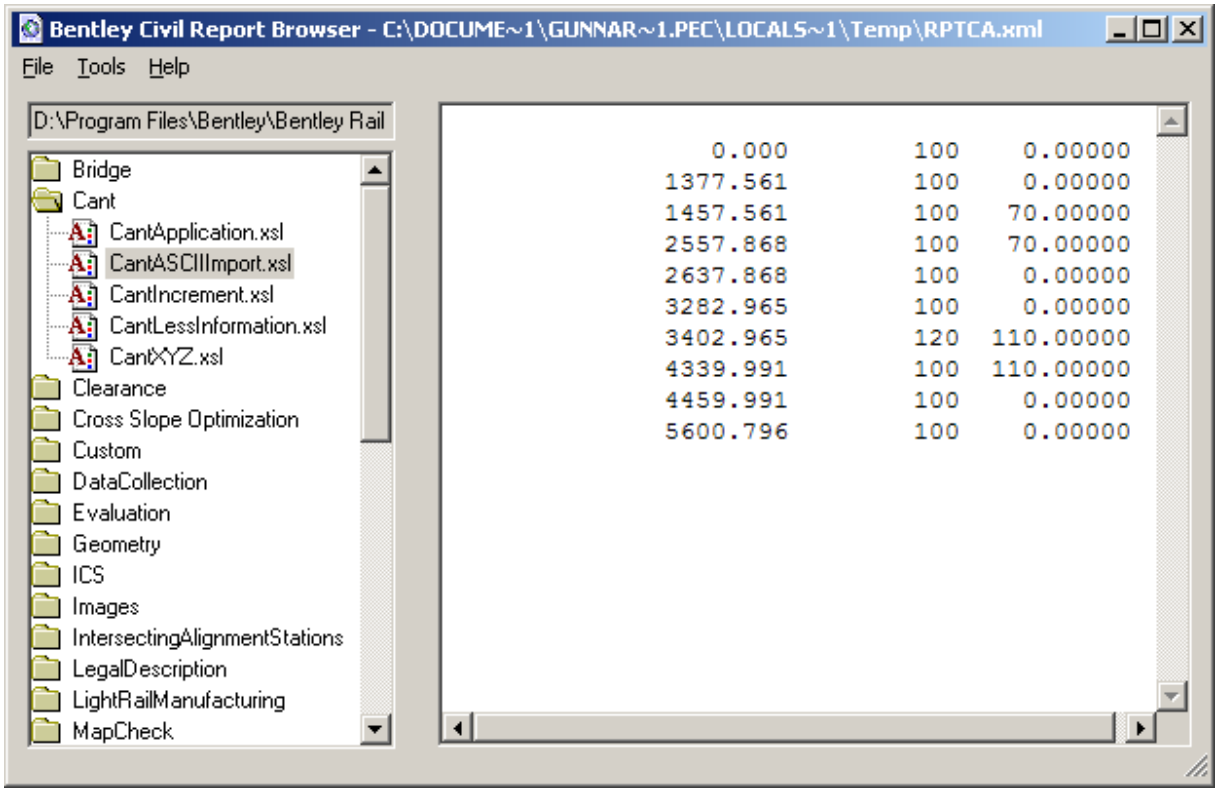
The user defined values are added to the alignment.

5.1.6 CREATE A REPORT (ASCII)

Click on Report …



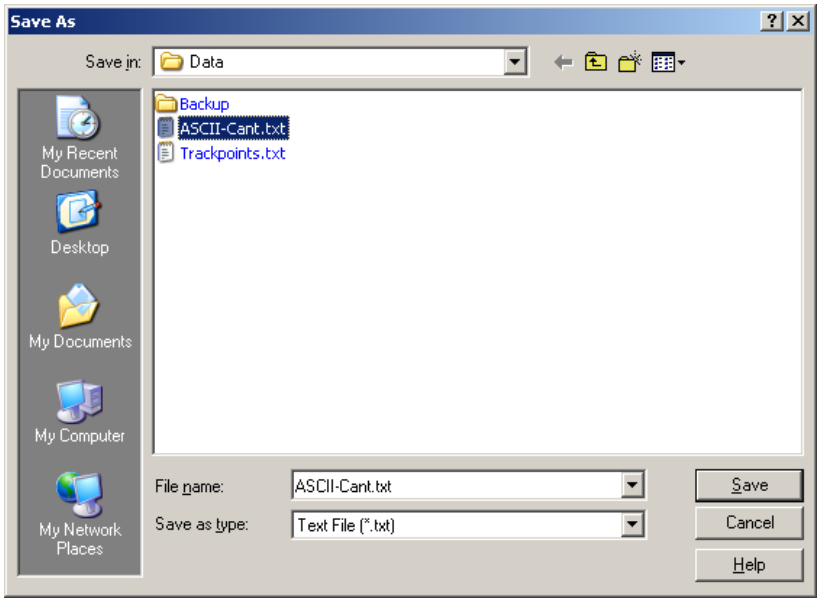
Type	Station	Spee...	Radius	Length	Transition	Eq. C...	App. Cant...	Cant...	Non-...	App....	Def. ...	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	80.000	Clothoid	0.0	0.0	0.0	0.000	24.3	16.7	1143
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	70.0	48.0	0.314	0.0	0.0	0
CS	2557.868	100	1000.0...	80.000	Clothoid	118.0	70.0	48.0	0.314	24.3	16.7	1143
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	25.5	18.2	1091
SC	3402.965	120	-900.00...	937.02...	Circular	188.8	110.0	78.8	0.516	0.0	2.1	0
CS	4339.991	100	-900.00...	120.00...	Clothoid	131.1	110.0	21.1	0.139	25.5	4.9	1091
ST	4459.991	100	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5600.796	100	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0



0.000	100	0.00000
1377.561	100	0.00000
1457.561	100	70.00000
2557.868	100	70.00000
2637.868	100	0.00000
3282.965	100	0.00000
3402.965	120	110.00000
4339.991	100	110.00000
4459.991	100	0.00000
5600.796	100	0.00000

File > Save As …

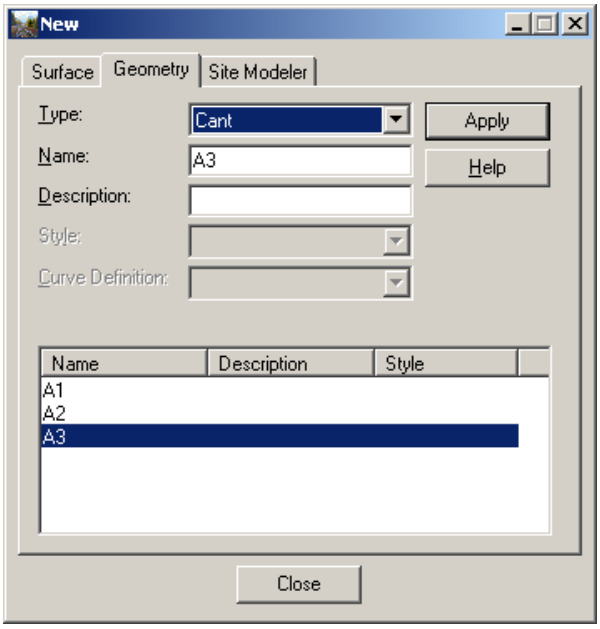
Save the report as *.txt file.



The user can change the cant values by editing the ASCII-file.

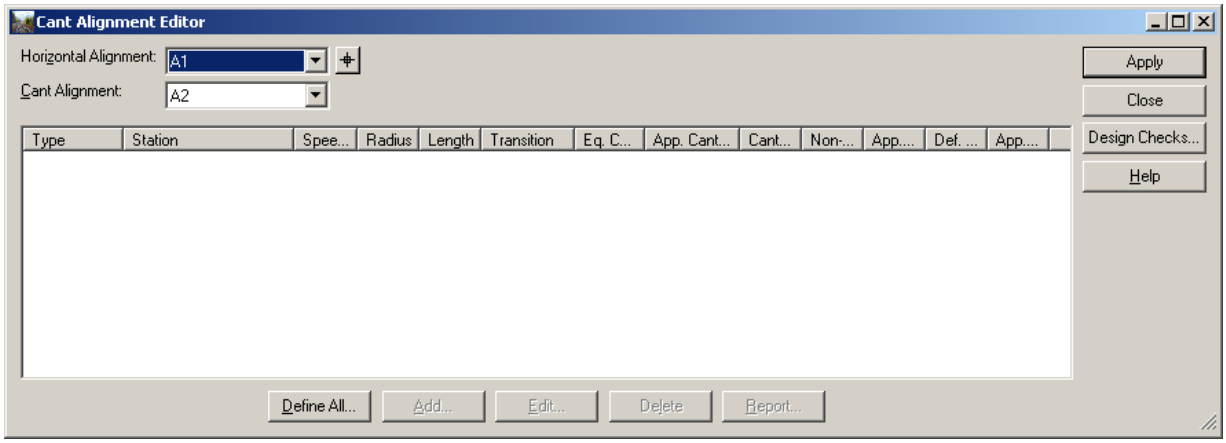
5.1.7 CANT FROM ASCII

Create a new cant alignment

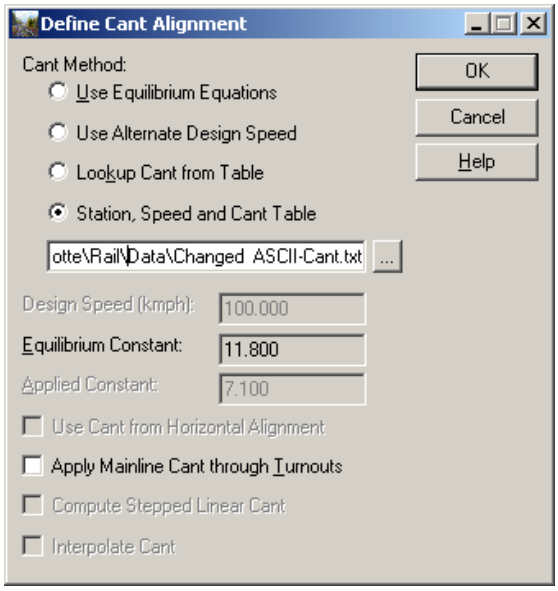


Click on Edit ….

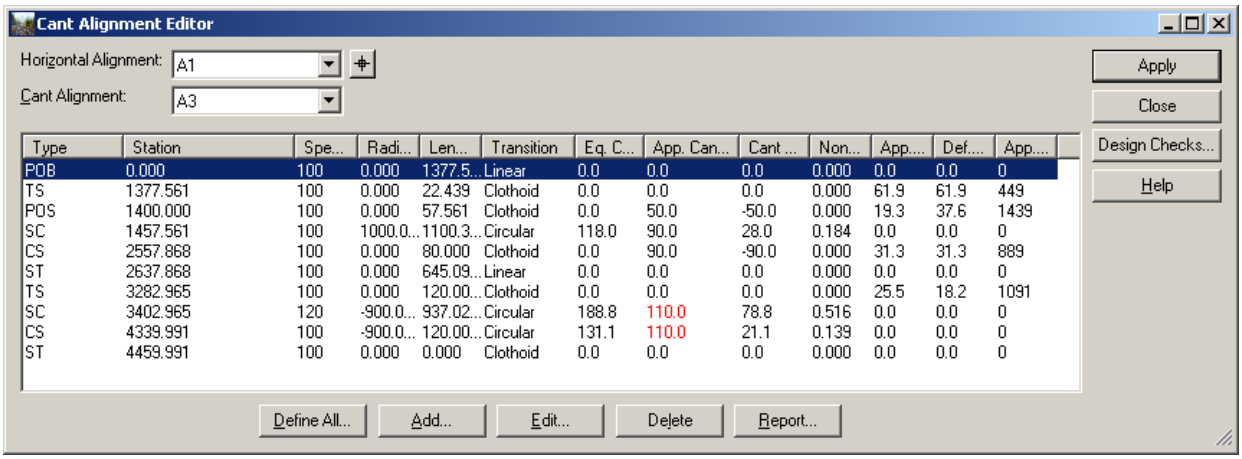
Define all …



Use Cant from Table



Select the file Changed ASCII-Cant.txt and hit OK.

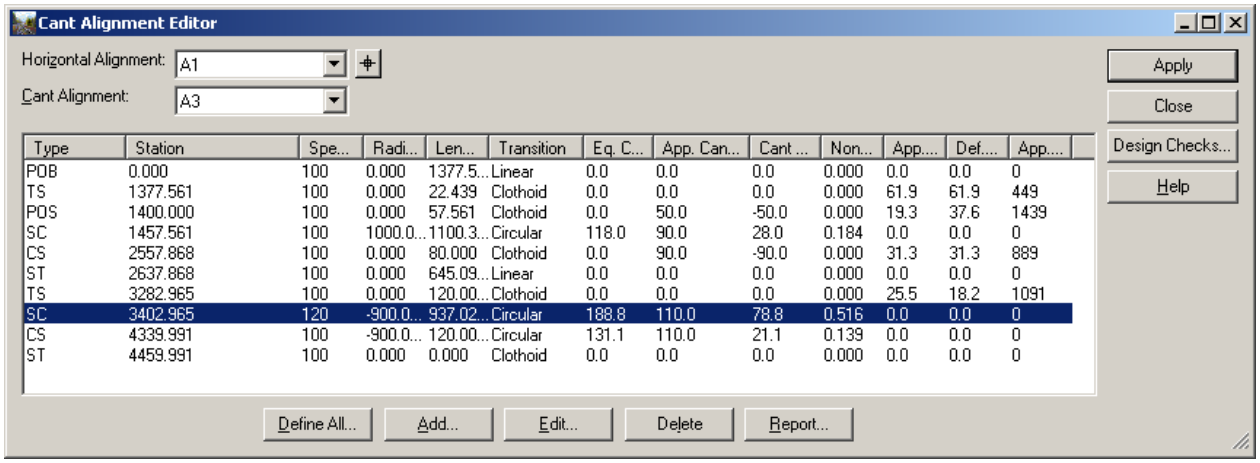


Type	Station	Spe...	Radi...	Len...	Transition	Eq. C...	App. Can...	Cant ...	Non...	App....	Def....	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	22.439	Clothoid	0.0	0.0	0.0	0.000	61.9	61.9	449
POS	1400.000	100	0.000	57.561	Clothoid	0.0	50.0	-50.0	0.000	19.3	37.6	1439
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	90.0	28.0	0.184	0.0	0.0	0
CS	2557.868	100	0.000	80.000	Clothoid	0.0	90.0	-90.0	0.000	31.3	31.3	889
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	25.5	18.2	1091
SC	3402.965	120	-900.0...	937.02...	Circular	188.8	110.0	78.8	0.516	0.0	0.0	0
CS	4339.991	100	-900.0...	120.00...	Circular	131.1	110.0	21.1	0.139	0.0	0.0	0
ST	4459.991	100	0.000	0.000	Clothoid	0.0	0.0	0.0	0.000	0.0	0.0	0

The user defined ASCII-values are applied. Hit Apply.

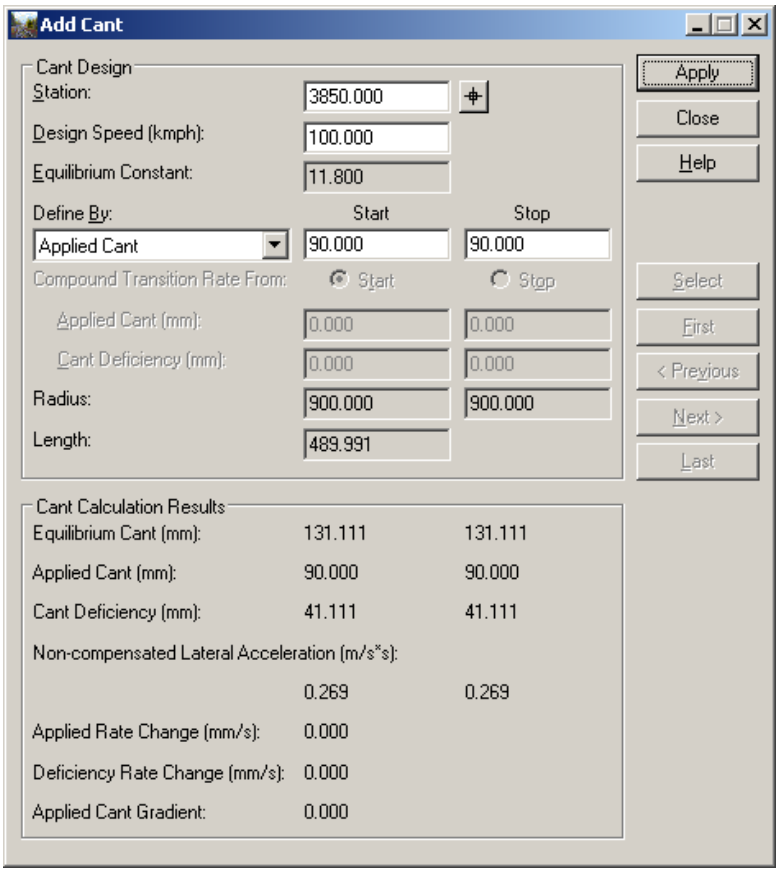
5.1.8 ADD CANT

Another way to change cant values is the ADD … command



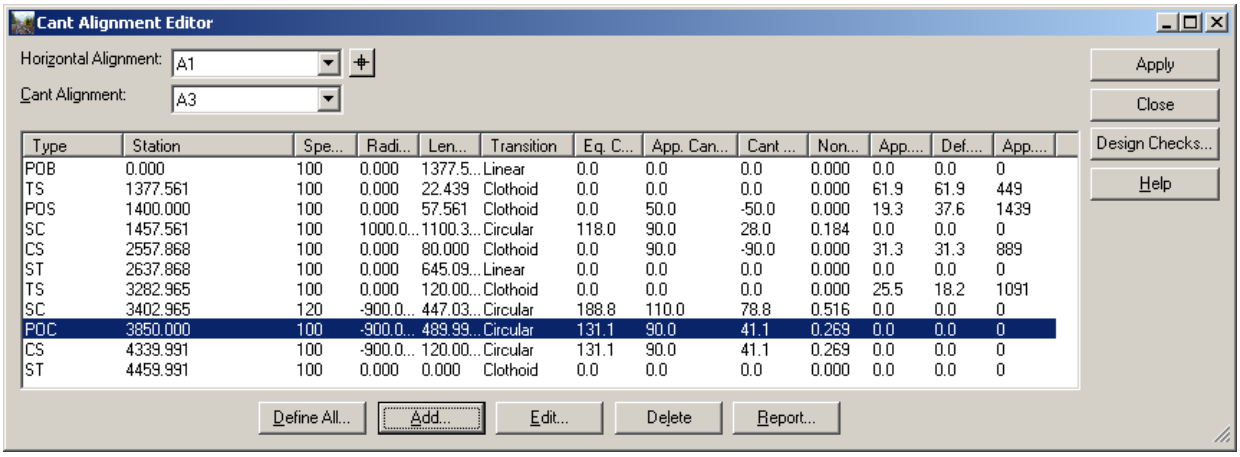
Type	Station	Spe...	Radi...	Len...	Transition	Eq. C...	App. Can...	Cant ...	Non...	App....	Def....	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	22.439	Clothoid	0.0	0.0	0.0	0.000	61.9	61.9	449
POS	1400.000	100	0.000	57.561	Clothoid	0.0	50.0	-50.0	0.000	19.3	37.6	1439
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	90.0	28.0	0.184	0.0	0.0	0
CS	2557.868	100	0.000	80.000	Clothoid	0.0	90.0	-90.0	0.000	31.3	31.3	889
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	25.5	18.2	1091
SC	3402.965	120	-900.0...	937.02...	Circular	188.8	110.0	78.8	0.516	0.0	0.0	0
CS	4339.991	100	-900.0...	120.00...	Circular	131.1	110.0	21.1	0.139	0.0	0.0	0
ST	4459.991	100	0.000	0.000	Clothoid	0.0	0.0	0.0	0.000	0.0	0.0	0

Click on ADD …



This dialog allows the user to add cant values at any station. The user can select the station using the radio button.

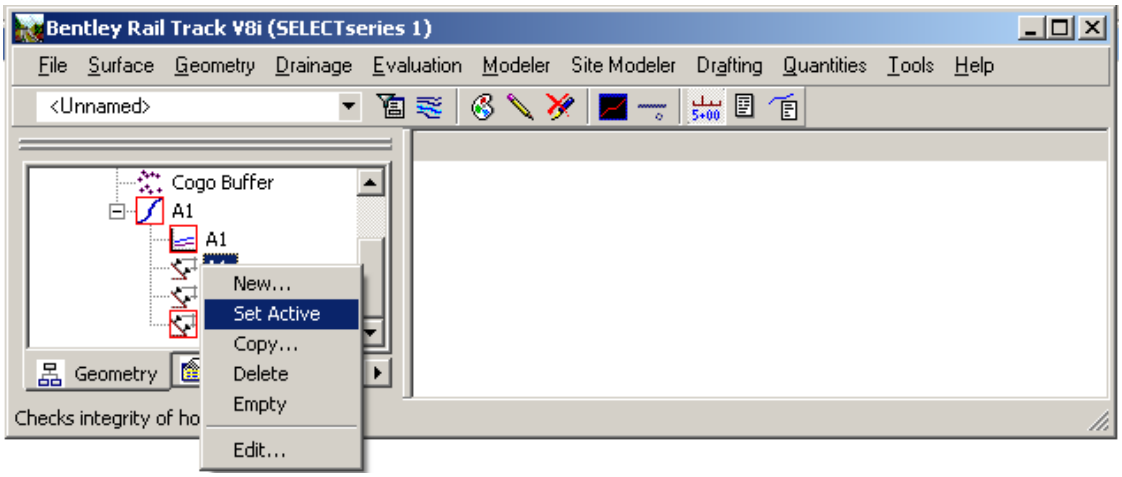
Apply ads the cant value at the selected station.



Type	Station	Spe...	Radi...	Len...	Transition	Eq. C...	App. Can...	Cant ...	Non...	App....	Def....	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	22.439	Clothoid	0.0	0.0	0.0	0.000	61.9	61.9	449
POS	1400.000	100	0.000	57.561	Clothoid	0.0	50.0	-50.0	0.000	19.3	37.6	1439
SC	1457.561	100	1000.0...	1100.3...	Circular	118.0	90.0	28.0	0.184	0.0	0.0	0
CS	2557.868	100	0.000	80.000	Clothoid	0.0	90.0	-90.0	0.000	31.3	31.3	889
ST	2637.868	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3282.965	100	0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	25.5	18.2	1091
SC	3402.965	120	-900.0...	447.03...	Circular	188.8	110.0	78.8	0.516	0.0	0.0	0
POC	3850.000	100	-900.0...	489.99...	Circular	131.1	90.0	41.1	0.269	0.0	0.0	0
CS	4339.991	100	-900.0...	120.00...	Circular	131.1	90.0	41.1	0.269	0.0	0.0	0
ST	4459.991	100	0.000	0.000	Clothoid	0.0	0.0	0.0	0.000	0.0	0.0	0

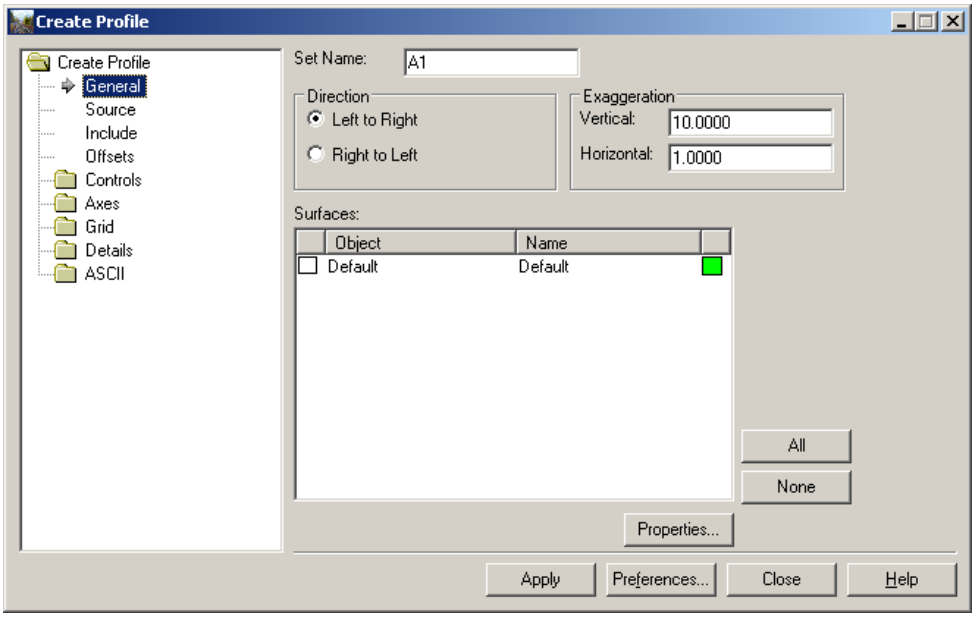
Apply stores the values at the alignment.

5.1.9 ACTIVATE CANT A1



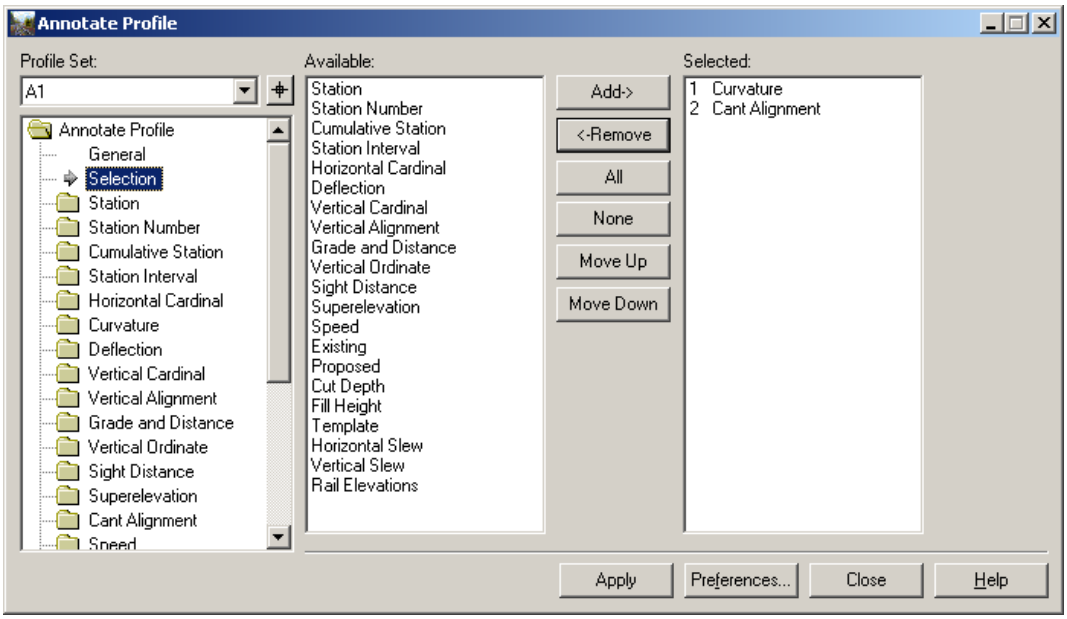
5.1.10 CREATE A PROFILE ALONG ALIGNMENT

Evaluation > Profile > Profile > Create Profile …



Hit Apply and place the profile in the drawing.

Annotate profile (Select Curvature, Cant Only & Rail Elevation)



Hit Apply.

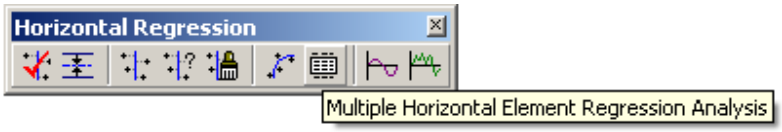
You can activate the different cant alignment and view the results.

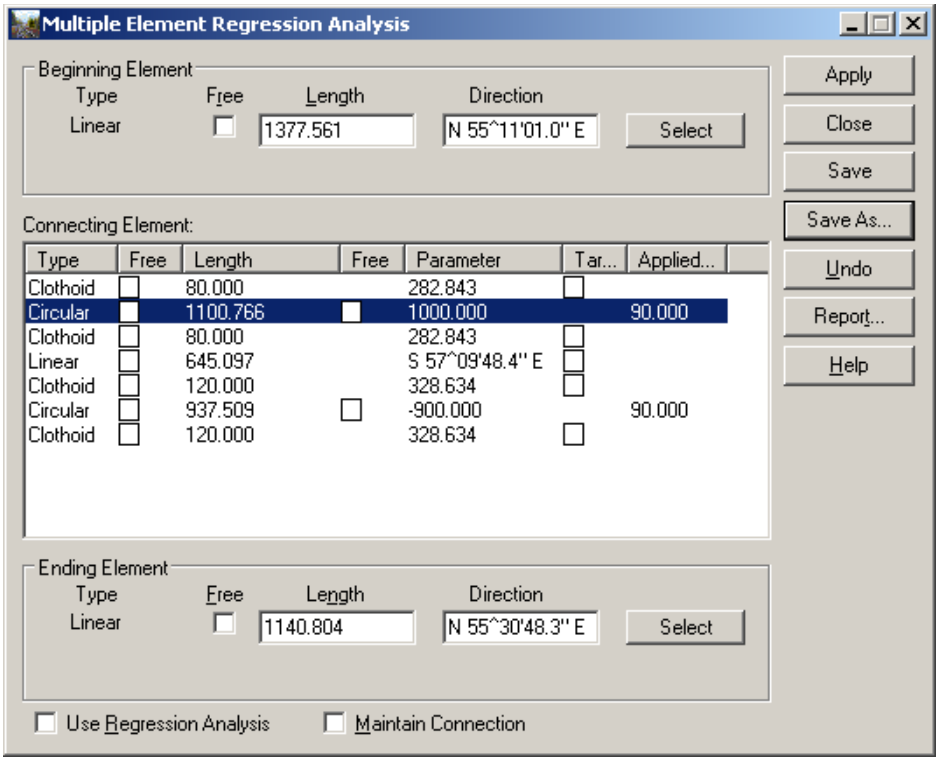
5.2 Exercise: Change horizontal Geometry with Multiple Horizontal element Regression and recomputing cant

This exercise will guide you through the cant recomputing if the horiz. alignment has been changed

5.2.1 Use the Horizontal Multiple Element Regression Analysis

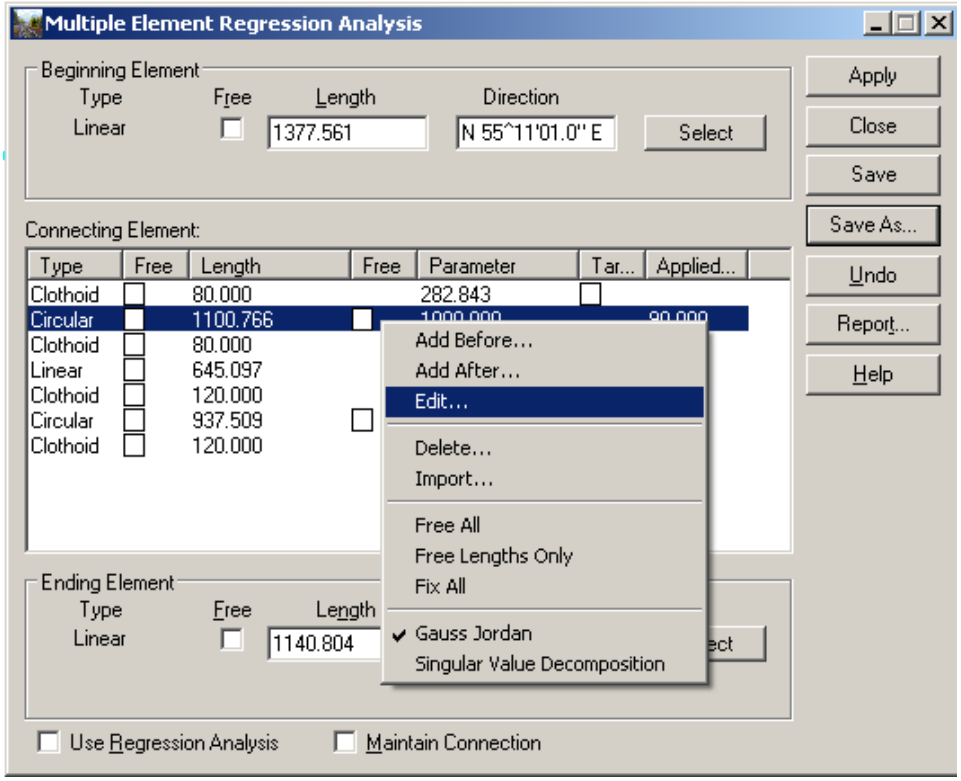
Geometry > Horizontal Regression > Horizontal Multiple Element Regression Analysis …

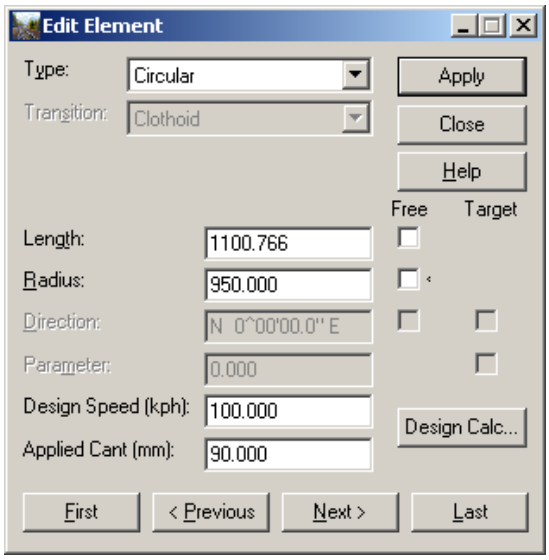




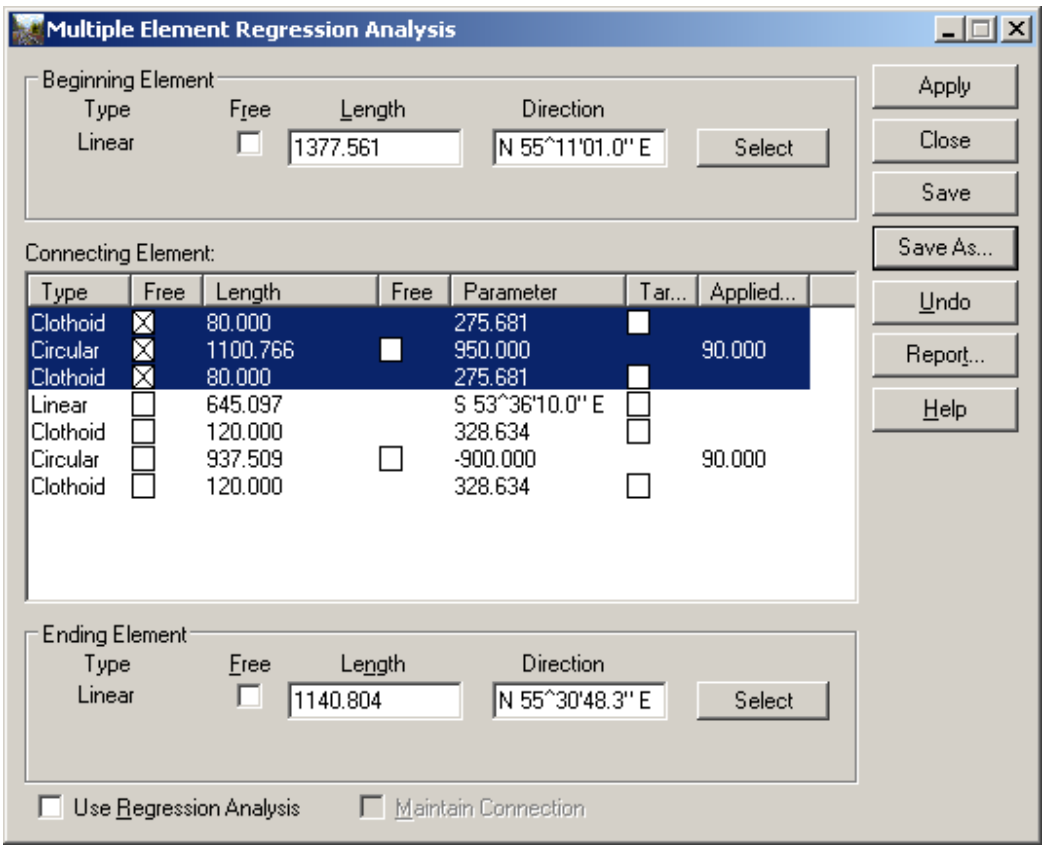
5.2.2 CHANGE A RADIUS

User the right mouse click to Edit …



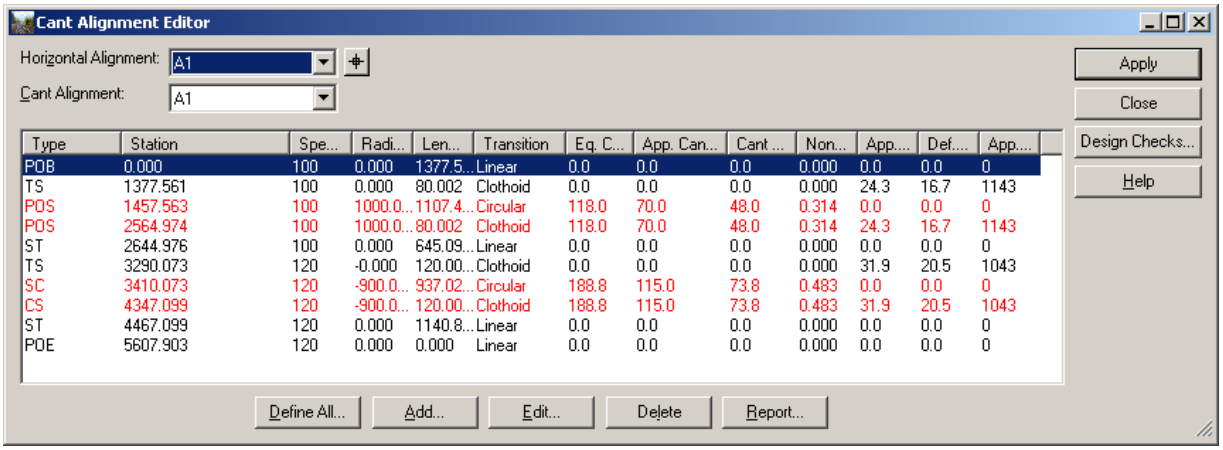


Free up the length from clothoids & radius



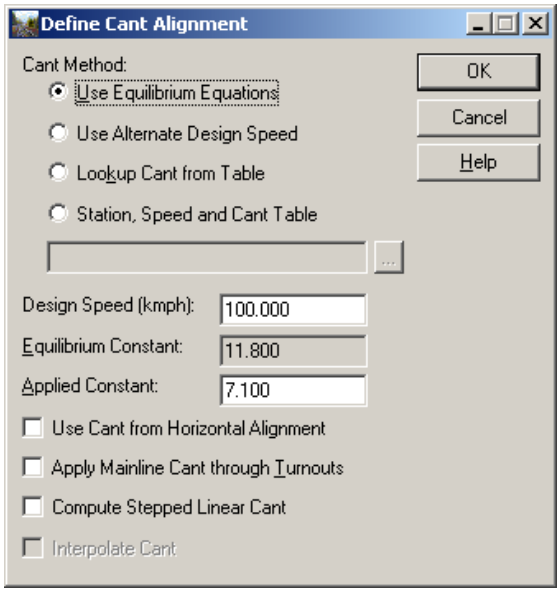
Hit Apply and save the solution.

5.2.3 EDIT CANT

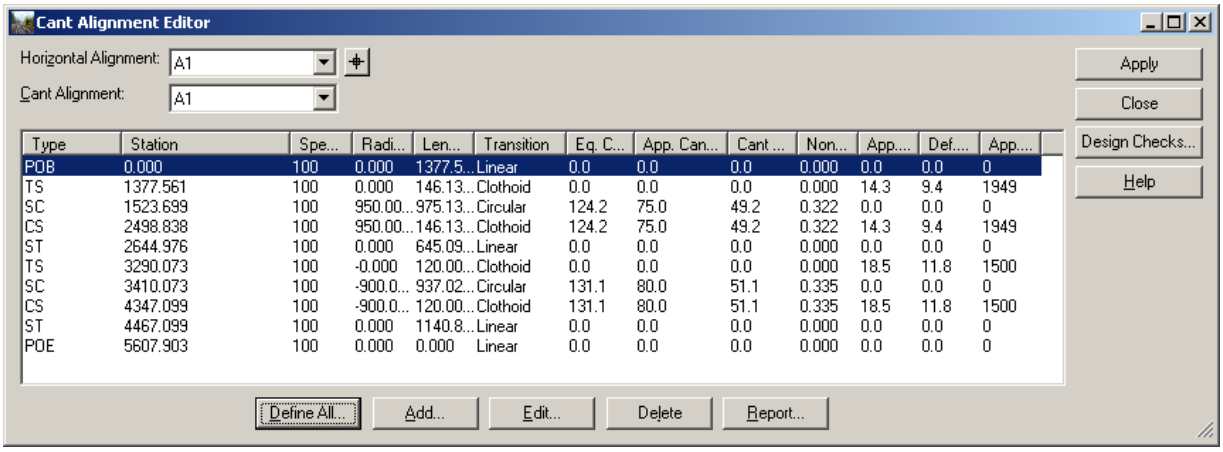


The geometry has been changed and the cant values as well since they are coordinative applied to the circular elements.

To optimize the cant based on the equilibrium equation you can click on Define All …



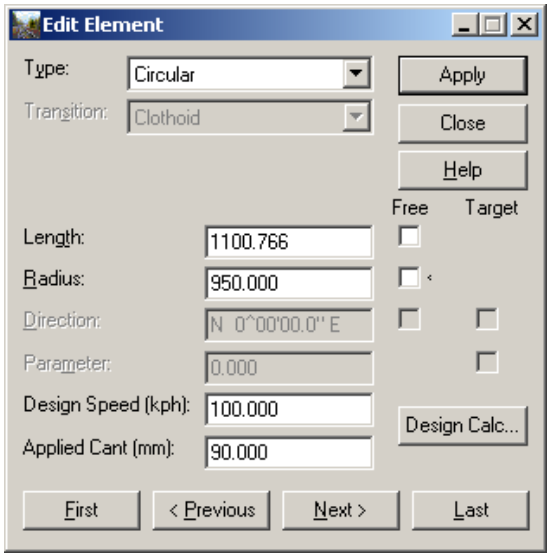
Apply.



Type	Station	Spe...	Radi...	Len...	Transition	Eq. C...	App. Can...	Cant ...	Non...	App....	Def....	App....
POB	0.000	100	0.000	1377.5...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	1377.561	100	0.000	146.13...	Clothoid	0.0	0.0	0.0	0.000	14.3	9.4	1949
SC	1523.699	100	950.00...	975.13...	Circular	124.2	75.0	49.2	0.322	0.0	0.0	0
CS	2498.838	100	950.00...	146.13...	Clothoid	124.2	75.0	49.2	0.322	14.3	9.4	1949
ST	2644.976	100	0.000	645.09...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
TS	3290.073	100	-0.000	120.00...	Clothoid	0.0	0.0	0.0	0.000	18.5	11.8	1500
SC	3410.073	100	-900.0...	937.02...	Circular	131.1	80.0	51.1	0.335	0.0	0.0	0
CS	4347.099	100	-900.0...	120.00...	Clothoid	131.1	80.0	51.1	0.335	18.5	11.8	1500
ST	4467.099	100	0.000	1140.8...	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0
POE	5607.903	100	0.000	0.000	Linear	0.0	0.0	0.0	0.000	0.0	0.0	0

The cant is now optimized for a given speed of 100 km/h.

During the design process the user can use various scenarios to Add, Change & Delete cant.



The Design Calculator helps to find the best solution.

6. LESSON NAME: TURNOUT CREATION

LESSON OBJECTIVE:

This lesson will show how to use the turnout commands.

You will find the turnout libraries in the Bentley Rail Track product under:

…\Program Files\Bentley\Bentley Rail Track V8.11\data\imperial\... for imperial units

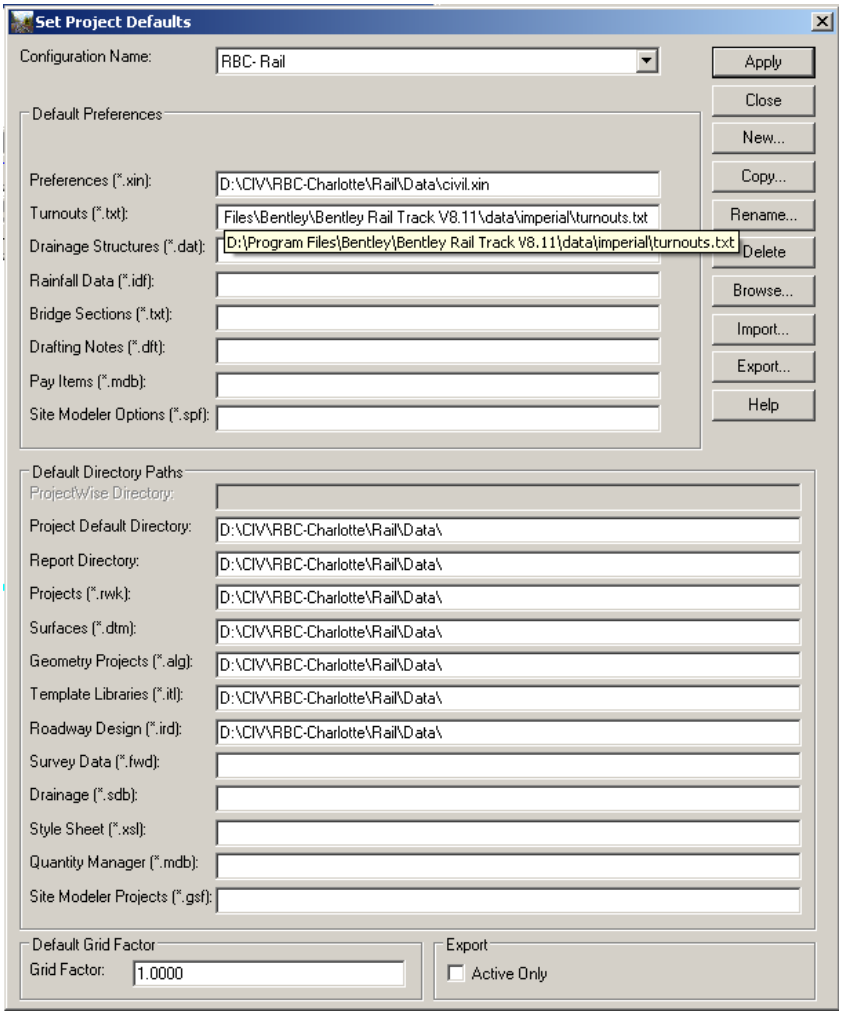
…\Program Files\Bentley\Bentley Rail Track V8.11\data\metric\... for metric units

6.1 EXERCISE: TURNOUT CREATION [IMPERIAL]

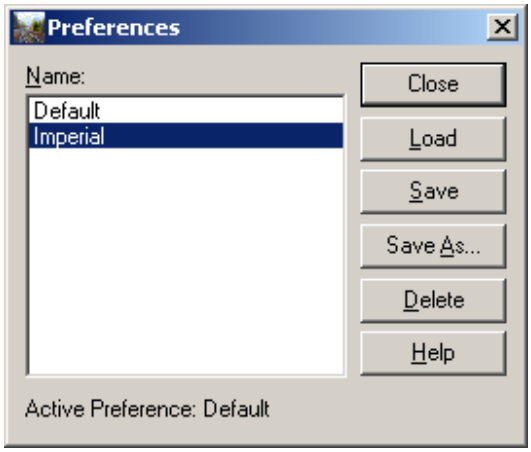
This exercise will guide you use the turnout commands

6.1.1 SETUP THE TURNOUT LIBRARY

To access the right turnout library you need to setup the library in the Project Defaults.



Under Tools > Options > Preference … load the Imperial preference.

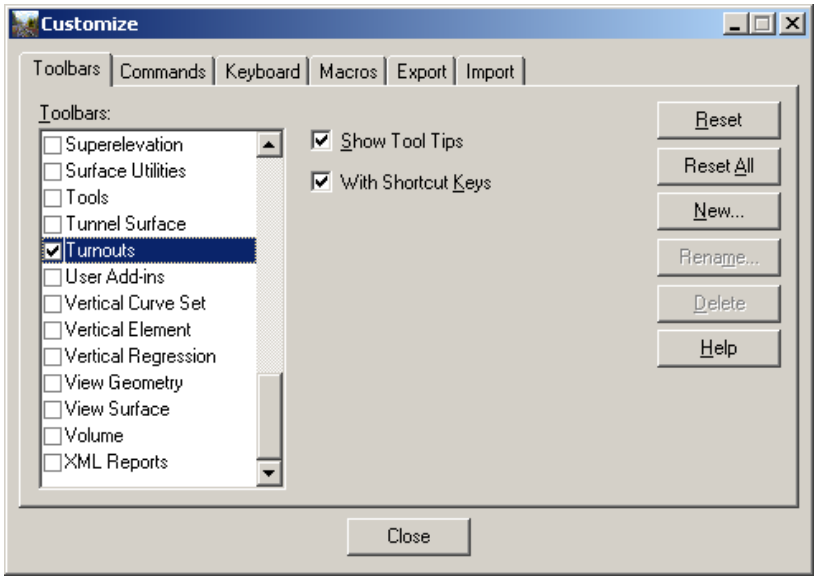


Close the dialog box.

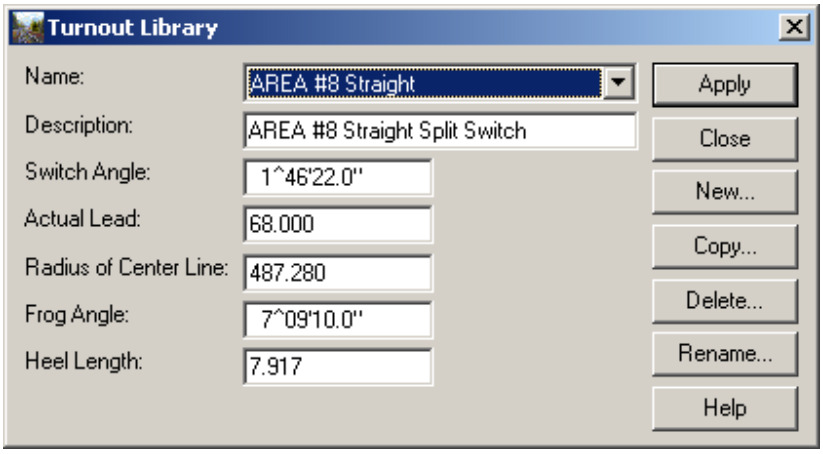
6.1.2 DESIGNING TURNOUTS

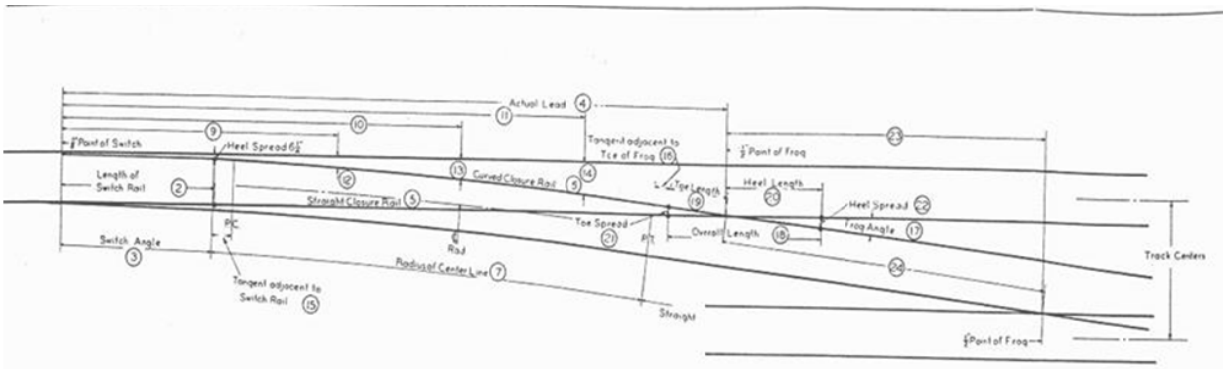
a. Imperial (AREMA)

Under Tools > Customize > Turnouts …



For Imperial unit you should use the Alternate Turnout Library.





TURNOUT AND CROSSOVER DATA

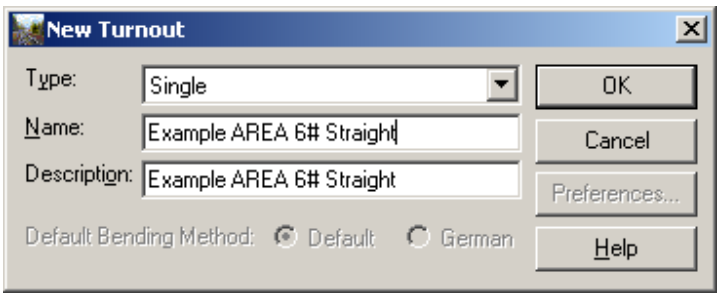
	Properties of Switches			Closure Distance		Lead Curve		Gage Line Offsets								Properties of Frogs							Data for Crossovers: 13'-0" Track Centers		For change of 1'-0" in Track Centers	
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 14	Col. 15	Col. 16	Col. 1	Col. 17	Col. 18	Col. 19	Col. 20	Col. 21	Col. 22	Col. 23	Col. 24		
Frog Number	Length of Switch Rail	Switch Angle	Actual Lead	Straight Closure Rail	Curved Closure Rail	Radius of Center Line	Degree of Curve							Tangent adjacent to Switch Rail	Tangent adjacent to toe of Frog	Frog Number	Frog Angle	Overall Length	Toe Length	Heel Length	Toe Spread	Heel Spread	Straight Track	Crossover Track	Straight Track	Crossover Track
	Ft In	Deg Min Sec	Ft In	Ft In	Ft In	Feet	Deg Min Sec	Ft In	Ft In	Ft In	Inches	Inches	Ft In	Feet	Feet		Deg Min Sec	Ft In	Ft In	Ft In	Inches	Inches	Ft In	Ft In	Ft In	Ft In
5	11-0	2-39-34	42-6 1/4	28-0	28-4	177.80	32-39-56	18-0	25-0	32-0	11 13/16	20 3/4	2-8 1/2	0.00	0.78	5	11-25-16	9-0	3-6 1/2	5-5 1/2	7 15/16	13 3/8	16-10 3/8	18-1 1/8	4-11 7/16	5-0 5/8
6	11-0	2-39-34	47-6	32-9	33-0	258.57	22-17-58	19-2 1/2	27-4 1/2	35-6 1/2	12 1/2	21 1/2	2-10	0.00	1.75	6	9-31-38	10-0	3-9	6-3	7	13	20-5 1/4	21-8 1/4	5-11 1/4	6-0 1/4
7	15-6	1-46-22	62-1	40-10 1/2	41-1 1/2	365.59	15-43-16	26-2 1/2	35-10 1/2	45-6 1/2	11 1/2	19 1/2	2-6 1/2	0.01	0.00	7	8-10-16	12-0	4-8 1/2	7-3 1/2	7 7/16	13	24-0 1/4	24-11 1/4	6-11 1/4	7-0 1/4
8	15-6	1-46-22	68-0	46-5	46-7 1/2	487.28	11-46-44	27-7 1/2	38-8 1/2	49-9 1/2	11 1/2	20 1/2	2-6 1/2	0.64	0.00	8	7-09-10	13-0	5-1	7-11	7 1/4	12 1/2	27-7 1/2	28-4 1/2	7-11 1/2	8-0 1/2
9	15-6	1-46-22	72-3 1/4	49-5	49-7 1/2	615.12	9-19-30	28-10 1/2	41-2 1/2	53-6 1/2	12 1/4	21 1/2	2-9 1/2	0.00	0.17	9	6-21-35	16-0	6-4 1/2	9-7 1/2	8	13 1/2	31-1 1/2	31-10 1/2	8-11 1/2	9-0 1/2
10	15-6	1-46-22	78-9	55-10	56-0	779.39	7-21-24	29-11 1/2	43-5 1/2	56-11 1/2	12 1/2	21	2-8 1/2	2.08	0.00	10	5-43-29	16-6	6-5	10-1	7 1/4	12 1/2	34-8 1/2	35-3 1/2	9-11 1/2	10-0 1/2
11	22-0	1-19-45	91-10 1/2	62-10 1/2	63-0	927.27	6-10-56	37-8 1/2	53-5	69-1 1/2	12 1/2	21 1/2	2-9 1/2	0.00	0.13	11	5-12-18	18-8 1/2	7-0	11-8 1/2	7 1/4	13 1/2	38-2 1/2	38-9 1/2	10-11 1/2	11-0 1/2
12	22-0	1-19-46	96-8	66-10 1/2	67-0	1104.63	5-11-20	38-8 1/2	55-5	72-1 1/2	12 1/2	21 1/2	2-9 1/2	0.00	0.50	12	4-46-19	20-4	7-9 1/2	12-6 1/2	7 1/4	13 1/2	41-8 1/2	42-3 1/2	11-11 1/2	12-0 1/2
14	22-0	1-19-45	107-0 1/4	76-5 1/2	76-8 1/2	1581.20	3-37-28	41-1 1/2	60-2 1/2	79-3 1/2	12 1/2	22 1/2	2-10 1/2	0.24	0.00	14	4-05-27	23-7	8-7 1/2	14-1 1/2	6 1/2	13 1/2	48-9 1/2	49-2 1/2	13-11 1/2	14-0 1/2
15	30-0	0-58-30	126-4 1/4	86-11 1/2	87-0 1/2	1720.77	3-19-48	51-9	73-6	95-3	12 1/2	21 1/2	2-9 1/2	1.56	0.00	15	3-49-06	24-4 1/2	9-5	14-1 1/2	7	12 1/2	52-3 1/2	52-8 1/2	14-11 1/2	15-0 1/2
16	30-0	0-58-30	131-4	91-11	92-0	2007.12	2-51-18	53-0	76-0	99-0	12 1/2	21 1/2	2-0 1/2	0.66	0.00	16	3-34-43	26-0	9-5	16-7	6 7/16	12 7/8	55-9 1/2	56-2 1/2	15-11 1/2	16-0 1/2
18	30-0	0-58-30	140-11 1/2	99-11	100-0	2578.79	2-13-20	55-0	80-0	105-0	12 3/4	22 1/2	2-0 1/2	0.57	0.00	18	3-10-56	29-3	11-0 1/2	18-2 1/2	6 1/2	12 1/2	62-9 1/2	63-2 1/2	17-11 1/2	18-0 1/2
20	30-0	0-58-30	151-11 1/2	110-11	111-0	3289.29	1-44-32	57-9	85-6	113-3	13 1/8	22 3/8	2-11 3/8	2.47	0.00	20	2-51-51	30-10 1/2	11-0 1/2	19-10	6 1/2	12 1/2	69-10	70-2	19-11 1/2	20-0 1/2

We want to create the following turnout AREMA #6 Straight with the following parameters:

This is an example how to create a turnout.

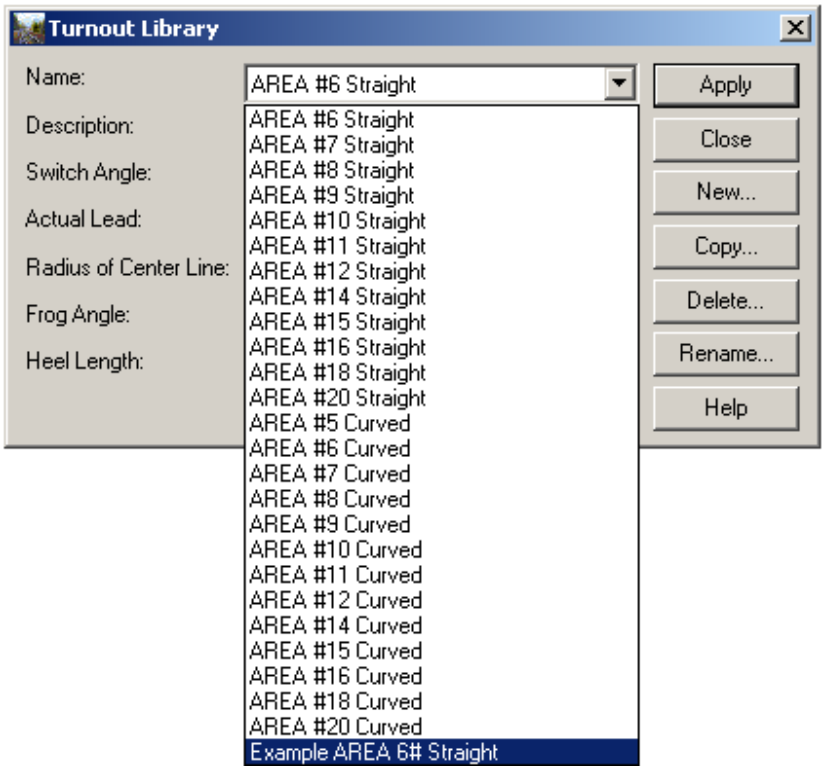
Switch Angle:	2^39’34.0”
Actual Lead:	47.500
Radius Of Centerline:	258.57
Frog Angle:	9^31’38.0”
Heel Length:	6.250

Click on New …

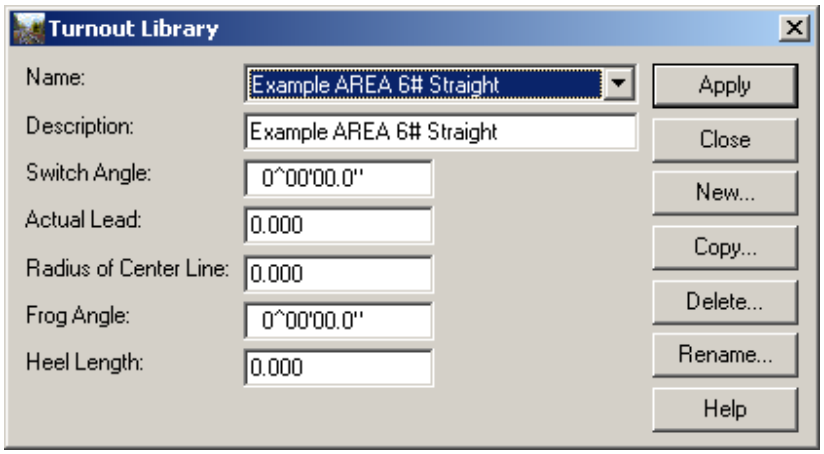


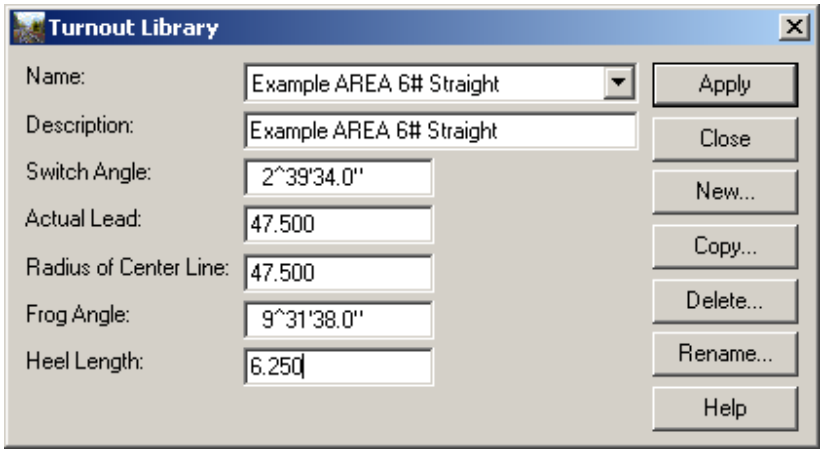
Under Type you can select different turnout type such a s Single, Single Slips etc.

Select the New turnout from the library.



Fill in the values:

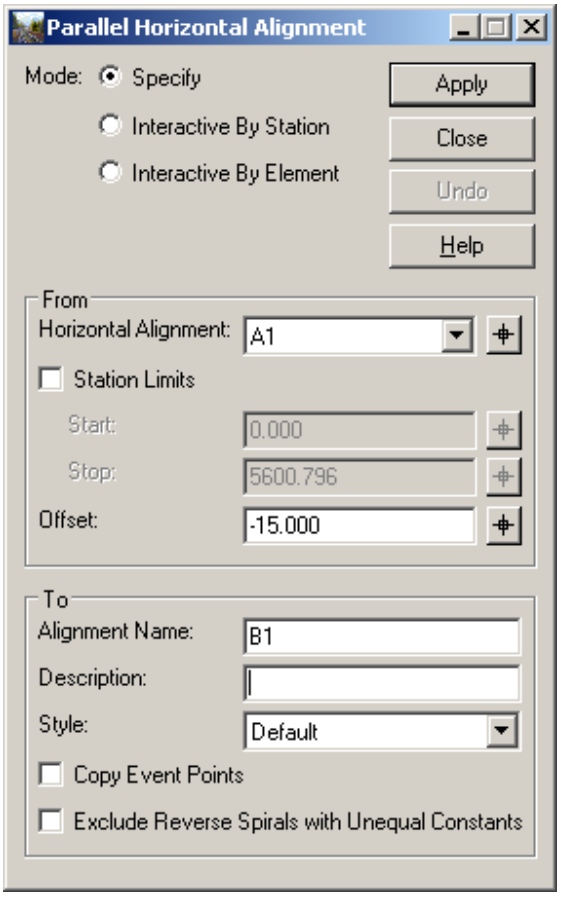




Hit Apply. The turnout is now stored in the library.

6.1.3 TURNOUT DESIGN

To create a simple turnout connection between two tracks goes to Geometry > Utilities > Parallel Horizontal Alignment …

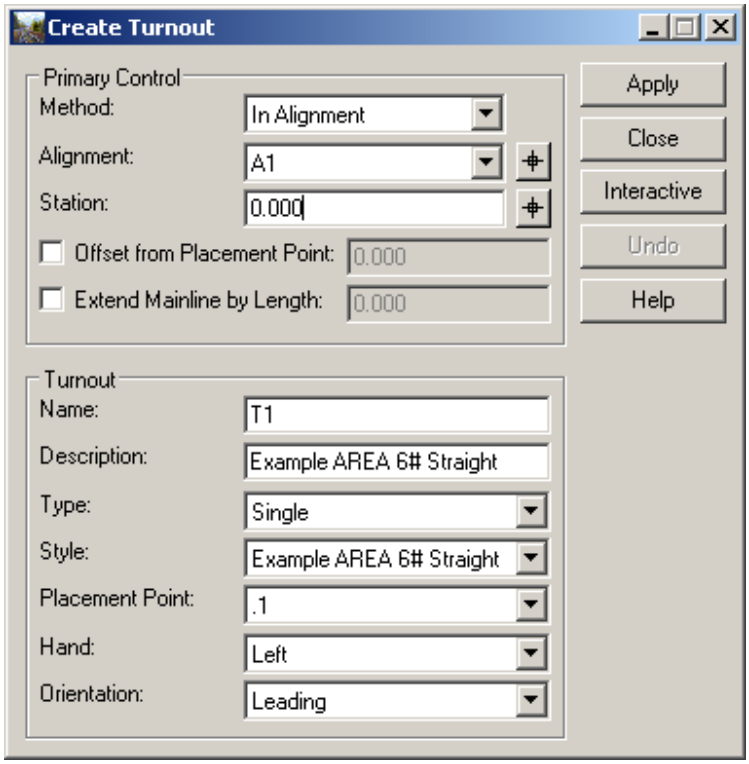


Apply.

You will now have an alignment 15 ft to the left from alignment A1.

6.2 CREATE TURNOUT

Interactive

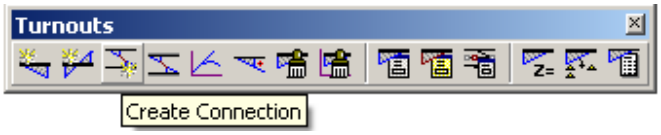


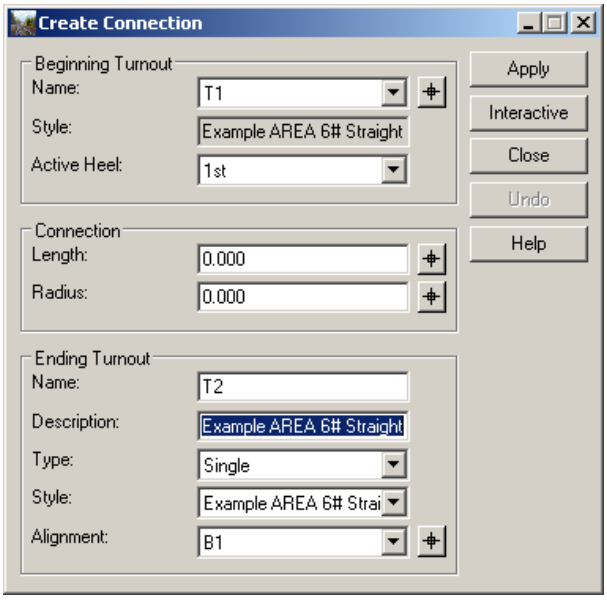
If you use Interactive you must follow the steps:

- Identify mainline alignment
- Identify point (turnout .1 as placement point)
- Identify orientation point (the direction for the branch)
- Accept.

6.3 Create Quick Connection

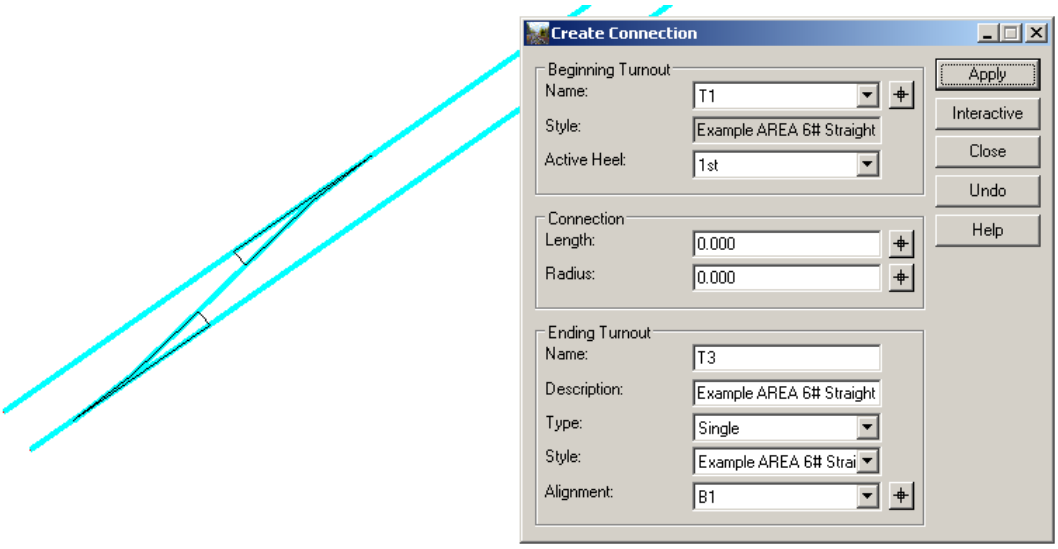
An easy way to make a connection is the Quick Connection Command.





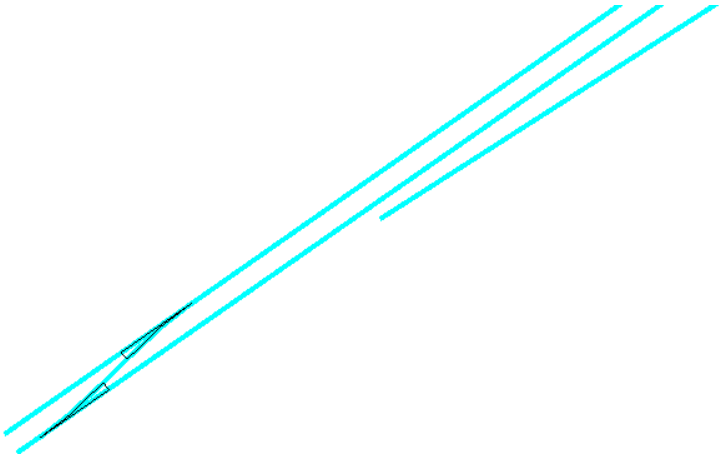
The software is using the same turnout which was place on alignment A1. To fill in a length is not needed in case you have a straight turnout connection.

Hit Apply.

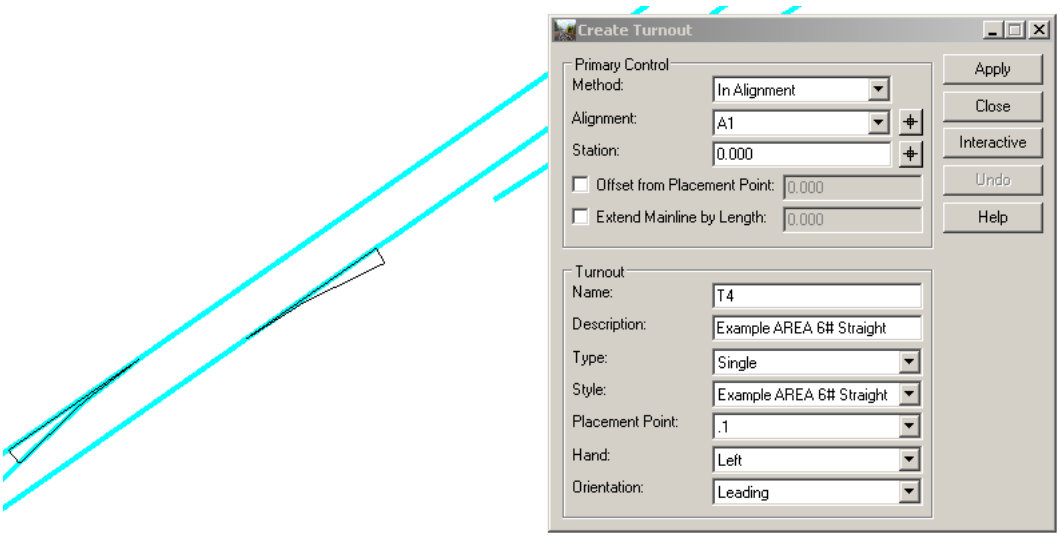


If you close the dialog box the turnout will store to the geometry.

Create a new horizontal alignment. Place a single fixed line close to the track A1.

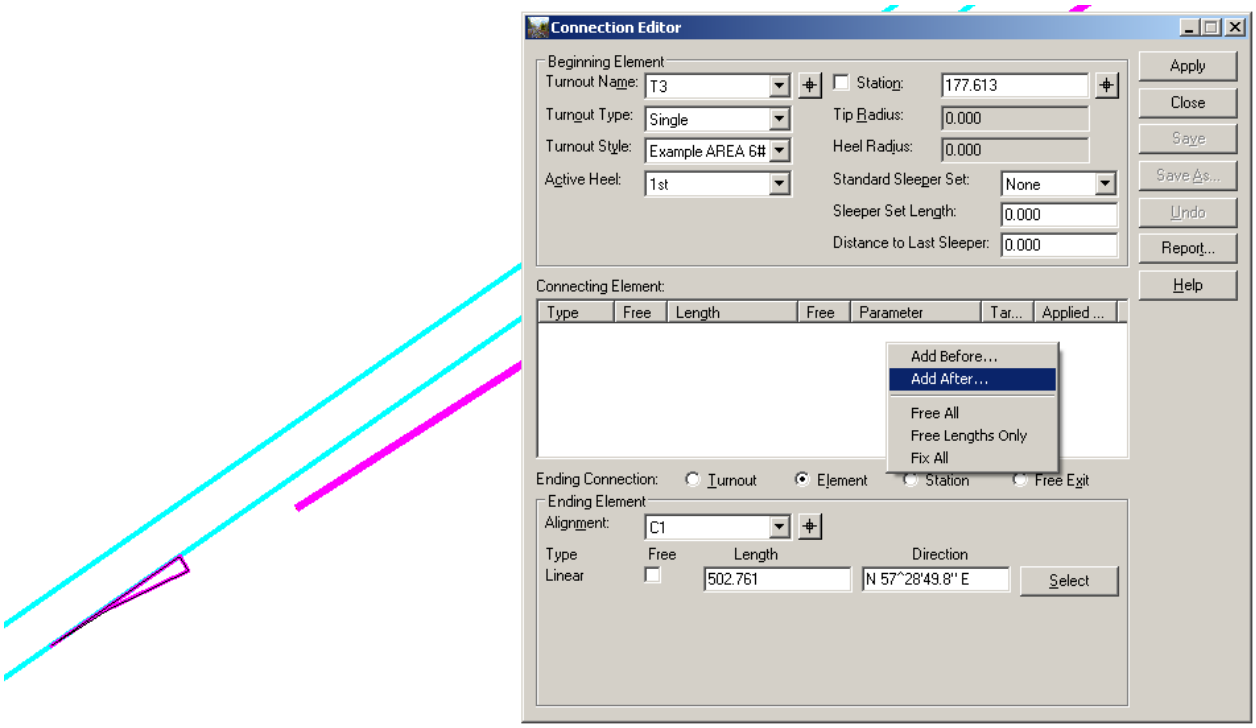


Place a new turnout in A1

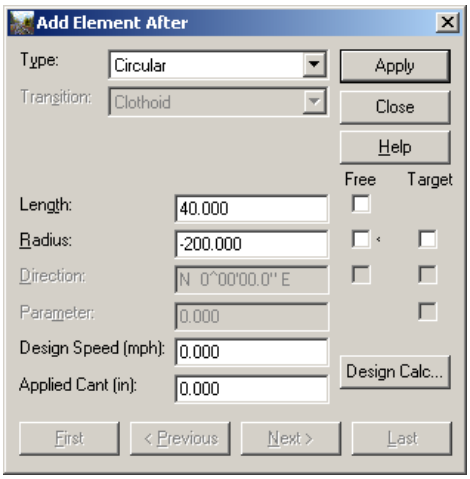


6.4 CREATE CONNECTION TURNOUT TO ELEMENT

Select the turnout an check on Element, Identify the alignment

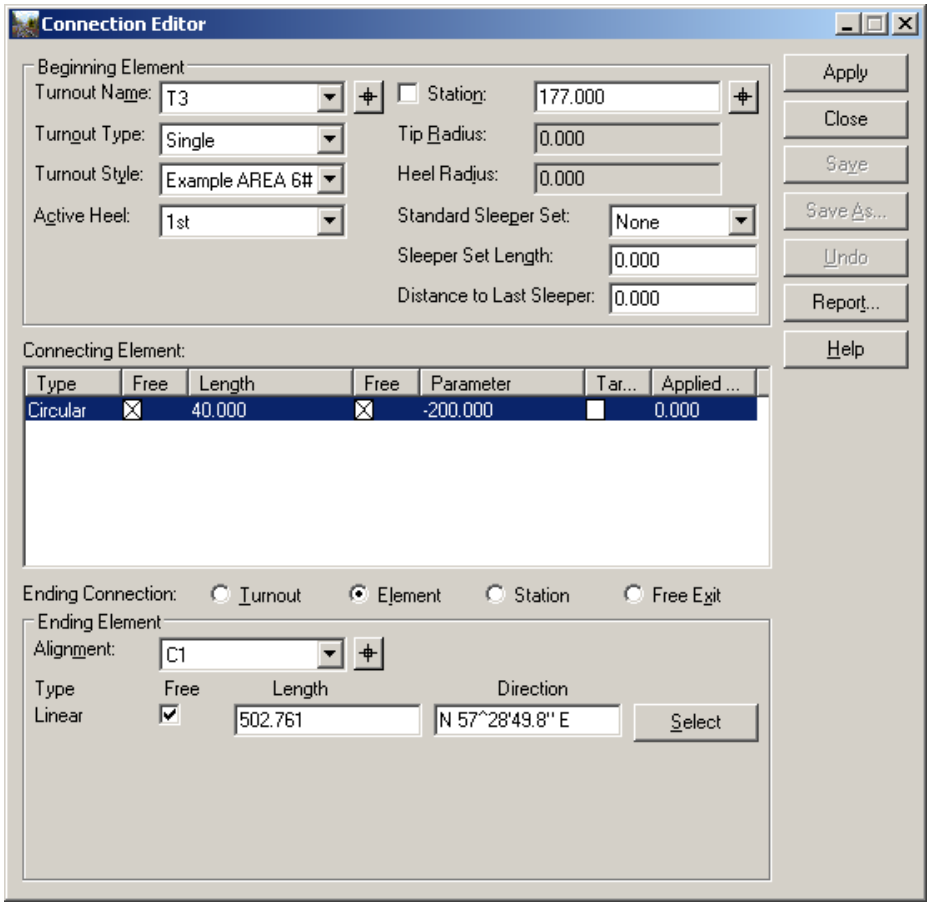


By using the right mouse click select Add After …



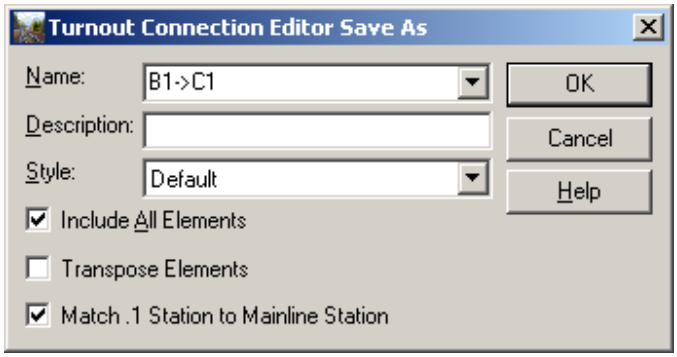
Select as connecting type a Circular element. Hit Apply.

If you want to set the turnout to a given station then key in the station and do not free the turnout.



Free up the length & radius of the connecting element and the ending element.

Hit Apply and Save the solution with Save As …



Save As .. saves the whole connection including the alignment C1.

Other options for turnout connections:

- Free Exit

  connects a turnout to nothing. For example, adds elements of known length and radii to the end of a turnout

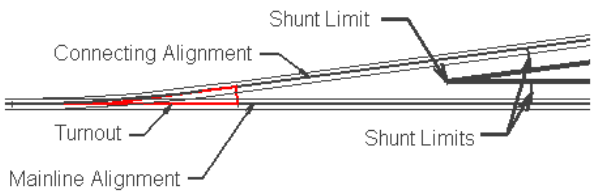
- Station

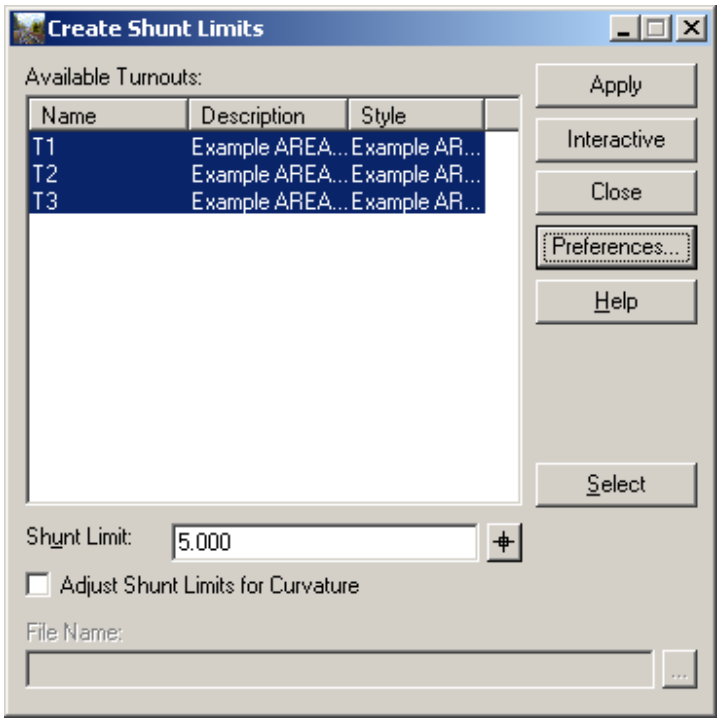
  defines the ending turnout's tip station. If on then the value is free to change during computations. If off then this value is fixed during computations. This freedom is persisted with the geometry

7. Create Shunt Limits

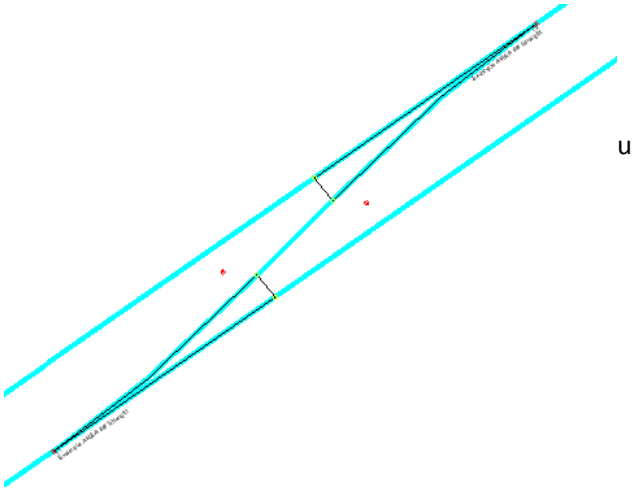
The Create Shunt Limits command computes a shunt point. A shunt point is a physical point at which a train must stop to avoid colliding with another train if two trains occupy a turnout and mainline track.

This picture explains how a shunt limit will be created.





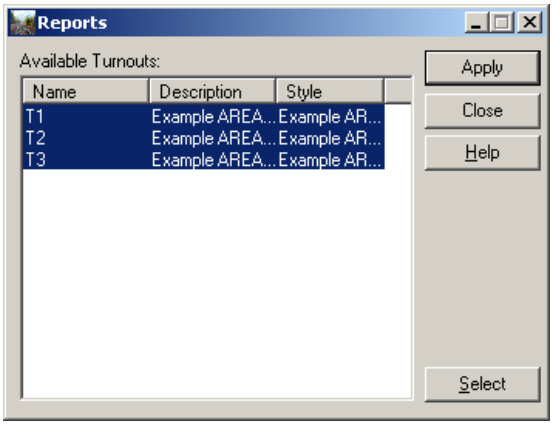
Hit Apply.



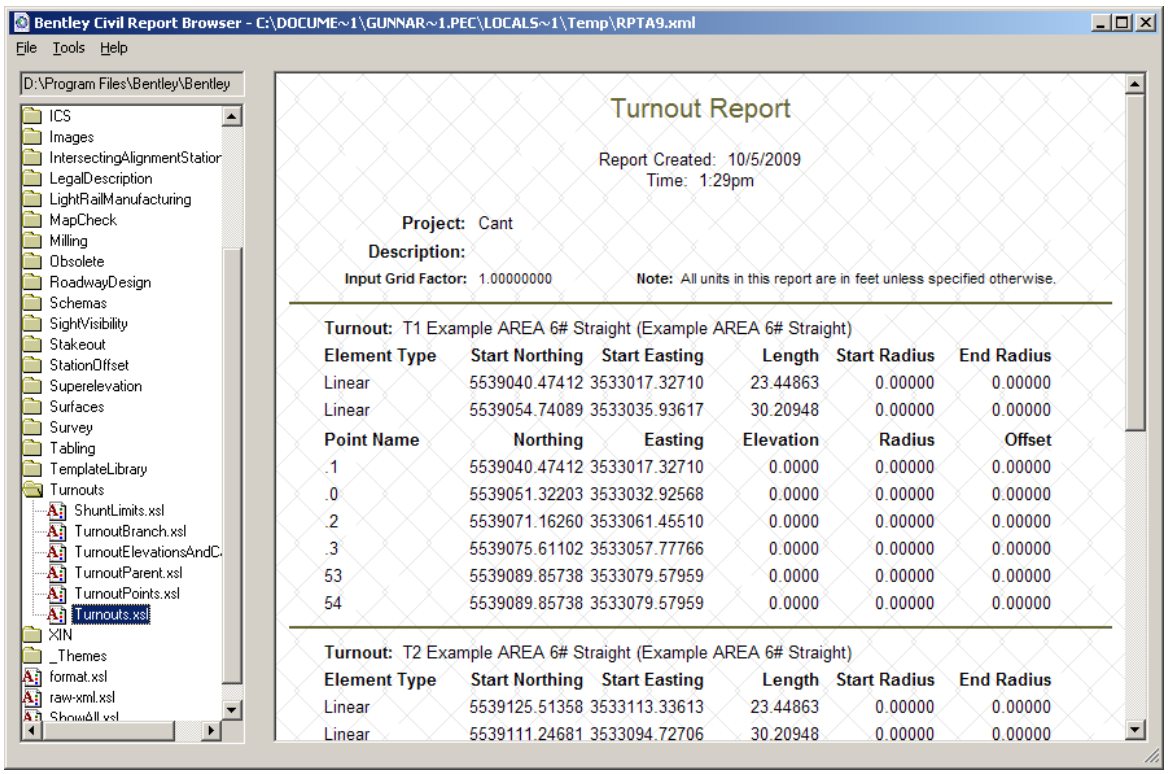
unt limits

7.1 REPORTING

If you want to create reports on turnout connections the use the report command



There several report templates available.

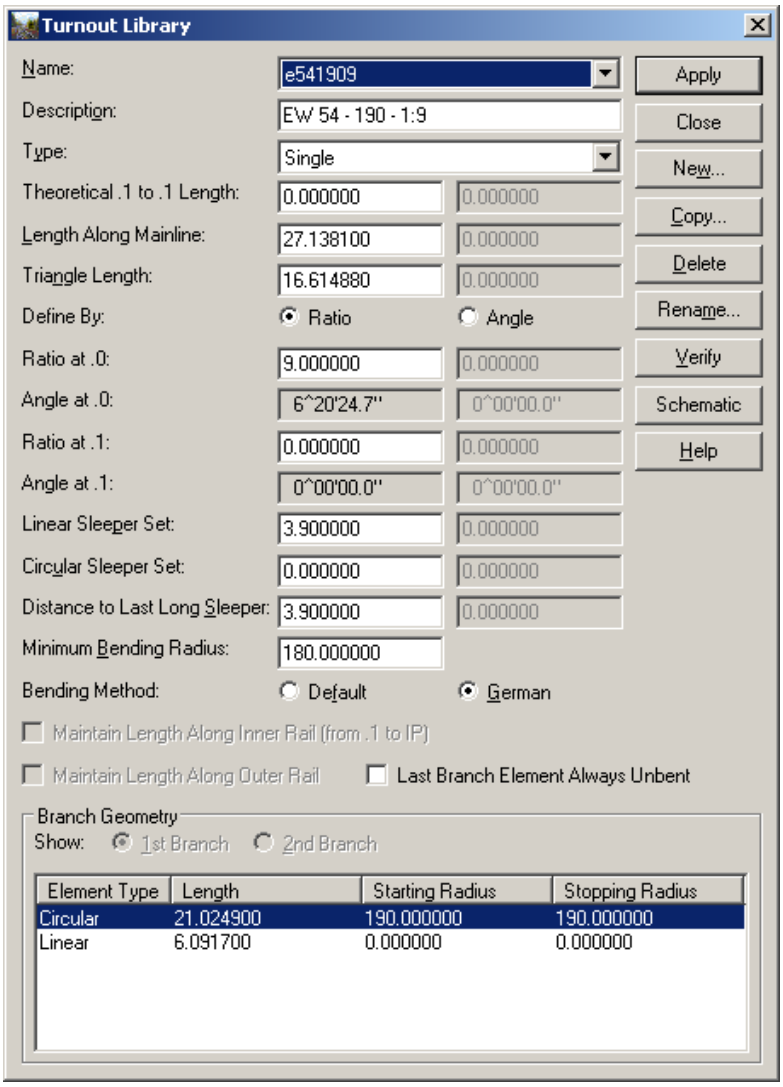


7.2 EXERCISE: TURNOUT CREATION [METRIC]

If the user wants to create metric turnouts then metric units needs to be setup in Tools > Options …

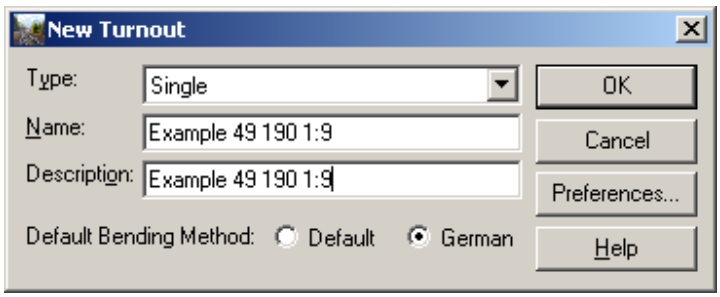
If metric unit applied then the Alternate Turnout Library cannot be used.

The user must use the Turnout Library.



If the user wants to create turnouts he has to follow a similar workflow like in the previous exercise.

Click on New …

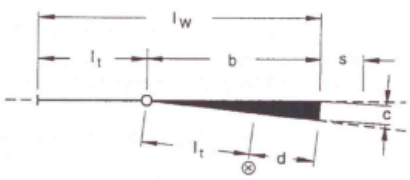


The bending method is German

A typical turnout schematic drawing with a straight frog

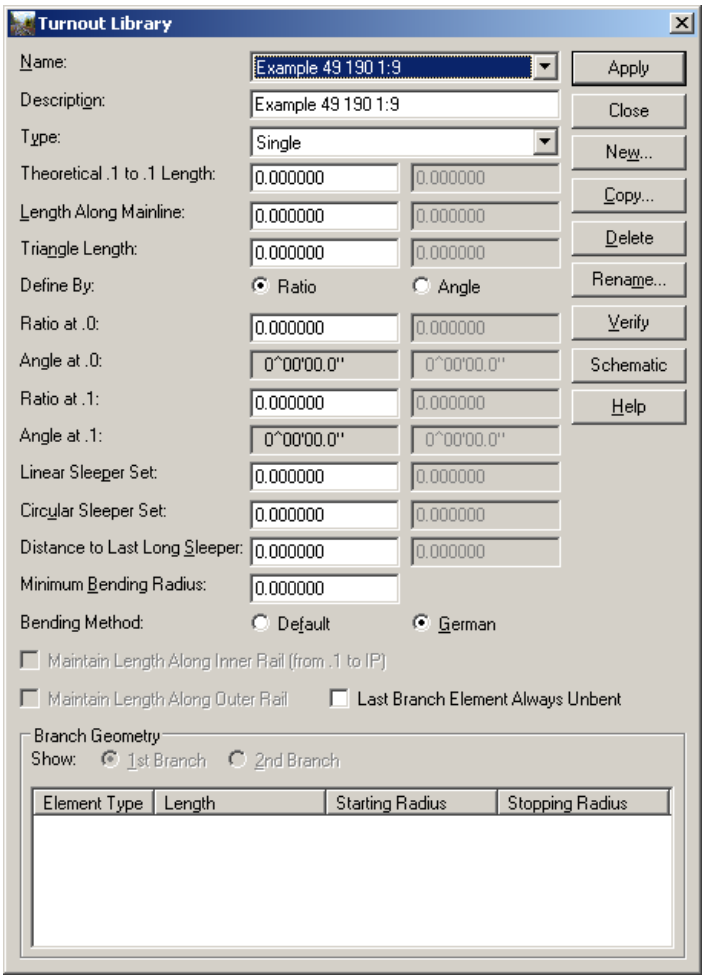
Einfache Weichen mit geradem Herzstück

Bild 1 Einfache Weichen mit geradem Herzstück

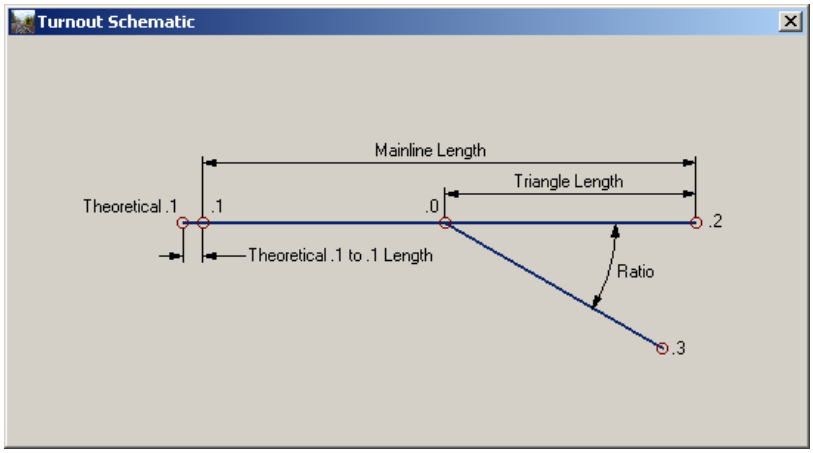


⊗ = Ende des Zweiggleisbogens
s = Abstand der letzten durchgehenden Schwelle (IdS) vom Weichenende

Weiche EW	l_t [m]	b [m]	d [m]	l_w [m]	c [m]	s [m]	zul. v [km/h] Zweig-gleis	Stamm gleis
49-Pa-190-1:9	10,5232	16,6149	6,0917	27,1381	1,8376	4,051	40	100
49-	10,7007	24,5374	13,8367	35,2381	1,7493	6,573		120
54-300-1:14	10,7007	27,1084	16,4077	37,8090	1,9326	5,125	50	160
60-								200 (230)
49-500-1:14 49-Pa-500-1:14	17,8344	24,5366	6,7022	42,3710	1,7491	6,573	60	120
54-500-1:14	17,8344	27,1080	9,2736	44,9424	1,9326	5,125	60	160
60-								200 (230)
60-500-1:14 -fb	17,8344	27,1080	9,2736	44,9424	1,9326	5,125	60	> 200
54-760-1:18,5	20,5256	32,4087	11,8831	52,9343	1,7499	9,920	80	160
60-						9,920		200 (230)


Turnout Library
Name:
Example 49 190 1:9
Description:
Example 49 190 1:9
Type:
Single
Theoretical .1 to .1 Length:
0.000000
0.000000
Length Along Mainline:
0.000000
0.000000
Triangle Length:
0.000000
0.000000
Define By:
Ratio
Angle
Ratio at .0:
0.000000
0.000000
Angle at .0:
0^00'00.0"
0^00'00.0"
Ratio at .1:
0.000000
0.000000
Angle at .1:
0^00'00.0"
0^00'00.0"
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
Apply
Close
New...
Copy...
Delete
Rename...
Verify
Schematic
Help

The Schematic shows the user the required values.

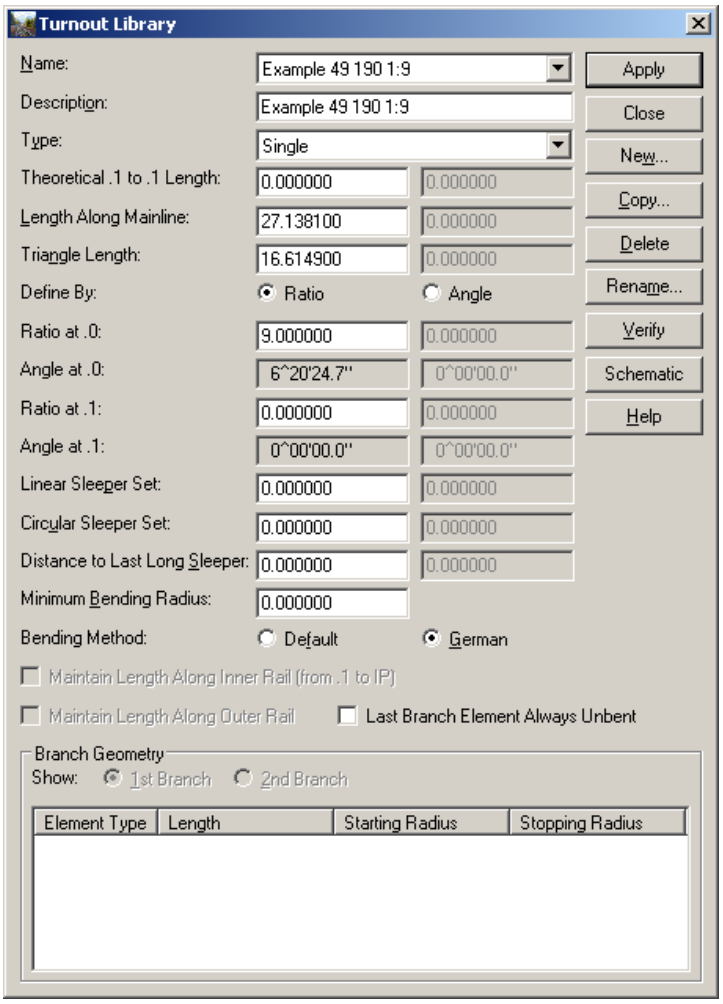


Fill out the turnout values:

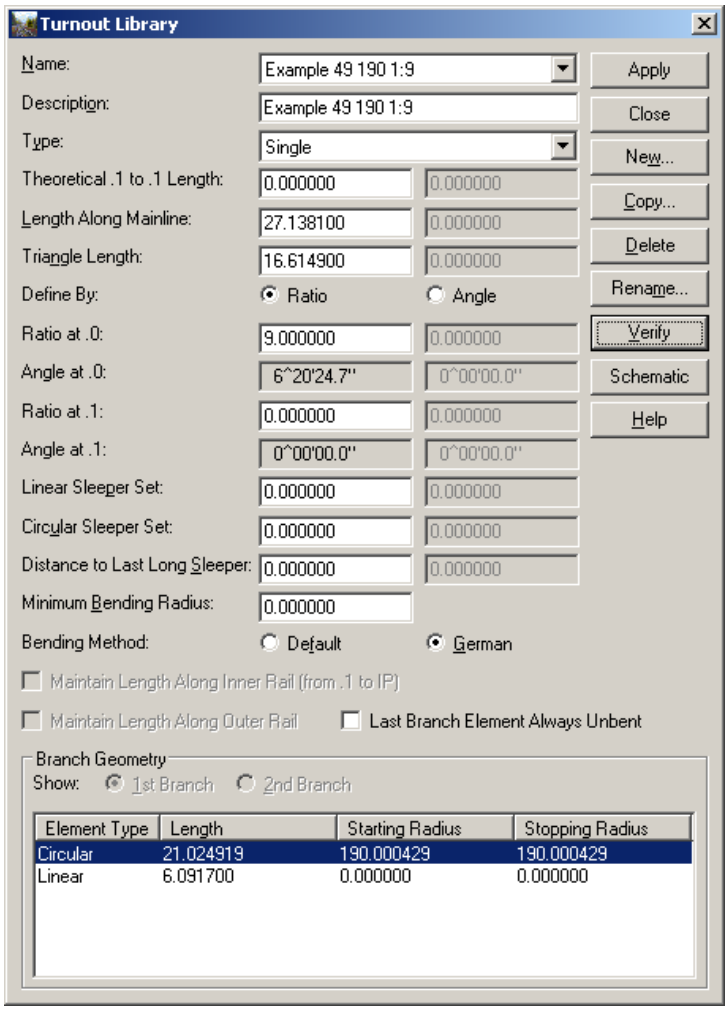
Length Along Mainline: 27.1281

Triangle Length: 16.6149

Ratio: 9.000



Click on Verify.



Apply. The New turnout has been stored in the library and can now used for design.