

Working *Smarter*, Together

MAY 15 - 17, 2012 | PHILADELPHIA, PA., USA



Bentleyuser.dk Årsmøde 2012 Nordic Civil 2012

5.-7. November 2012, Munkebjerg Hotel, Vejle

Workshop – X13

Advanced Geometrical Layout for Compound and Reversed Curves

Team Leader: Richard Bradshaw

Bentley Systems, Incorporated 685 Stockton Drive Exton, PA 19341 www.bentley.com This page left intentionally blank.



MAY 15 - 17, 2012 | PHILADELPHIA, PA., USA

Bentley

Table of Contents

Commar	nd Index	1
Preface		3
Chapter	1: Fitting a Curve into an Existing Geometry	5
	Starting Power InRoads	5
	Open a CAD File	5
	Open Files in Power InRoads	5
	Turn on the Primary Toolbar	5
	Open Model	5
	Import Alignment	6
	Application Add-In	7
	Edit Alignment	7
Chapter	2: Best Fit from Survey Centerline	11
	Open Model	
	Create a New Alignment	12
	Import Horizontal Regression Points	13
	View the Horizontal Regression Points	
	Report Lock	
	Working with Regress Points	17
Chapter	3: Compound Curves	27
	Open Model	
	View and Review Horizontal Alignment	
	Edit Alignment	
	Review Alignment	40
Chapter	4: Solve for an Unknown Geometry	43
	Open Model	
	Create a New Alignment	
	View Cogo Points	
	Create Alignment	45
Optional	I Chapter: Continuation of Solving Geometry	
	Edit Alignment	
Chapter	5: Create a Continuous Tangential Alignment	52
•	Open Model	ED
	Create a New Alignment	

Edit Alignment	
Review Alignment	
Edit Alignment	



Working Smarter, Together

MAY 15 - 17, 2012 | PHILADELPHIA, PA., USA

😤 Bentley

Command Index

Active Horizontal	
Add Fixed Line	
Add Floating Curve	29, 38, 40
Add Floating Line	
Add Free Curve	8, 22, 30, 46
Check Integrity	7, 11, 34, 47
Delete Element	7, 8, 19, 20, 28, 29
Edit Element	47
Edit/Review Regression Points	17, 19, 21
Horizontal Annotation	10, 32, 34, 36
Power InRoads File	5, 12, 35, 44
Review Horizontal	27, 28, 34
Slew Diagram	25, 26
Text Import Wizard	13, 14, 15
View Regression Points	16

This page left intentionally blank.



MAY 15-17, 2012 | PHILADELPHIA, PA., USA

🚰 Bentley

Preface

In this workshop, you will construct horizontal alignments utilizing the V8*i* SELECTseries 2 Horizontal Element tools. We have structured the contents of the exercises herein to allow your interaction with a broad range of available tools, however, we will not use every tool. Also, it is impossible to engineer a complete interchange in the time frame of this workshop, but we will use the tools in their real-life context, so you can see how to utilize them in your own engineering projects.

This workshop is applicable for InRoads family of products. In this workshop, we will use Power InRoads V8*i* 08.11.07.566

There are more exercises in this manual than we will have time to cover today. We will all complete the basic set of exercises, and for those veteran users in the group who complete them and still have time left in the exercise session, you are welcome to work on the optional exercises.

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.

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.

Note Prerequisite Knowledge Level: Participant should have a basic understanding of road design principles and be fluent in use of MicroStation and the native application (InRoads) or of the Power product.

This page left intentionally blank.



MAY 15 - 17, 2012 | PHILADELPHIA, PA., USA

😤 Bentley

Chapter 1: Fitting a Curve into an Existing Geometry

CHAPTER OBJECTIVE:

In this scenario, there has been an error in construction which will be corrected by laying out new geometry, holding portions of the alignment constant while changing a defined portion of the alignment. There is a non-collinear tangent element that is causing a discontinuity in the alignment. It is necessary to place another curve in the alignment between the first and last curve. Requirement is to maintain the PC and PT of the entire curve set.

STARTING POWER INROADS

1. Double-click the Power InRoads icon.

Note The MicroStation Manager appears.

2. An alternate path for launching Power InRoads is Start > All Programs > Bentley > Bentley Power InRoads (SELECTseries 2) > Bentley Power InRoads (SELECTseries 2).

OPEN A CAD FILE

- Set the directory to C:\2012_BT_Civil\BC2WK2 Advanced Geometrical Layout\Data\BC2WK2 Advanced Geometrical Layout
- 2. Open the CAD file horiz_elem.dgn

OPEN FILES IN POWER INROADS

- 1. Select File > Power InRoads File > Open.
- 2. Go to the following directory: C:\2012_BT_Civil\BC2WK2 Advanced Geometrical Layout\Data\BC2WK2 Advanced Geometrical Layout
- 3. Open the following files: *alignments.xin* and *HorizElem.alg*

TURN ON THE PRIMARY TOOLBAR

1. Select Tools > Primary / Primary

OPEN MODEL

- 1. Select Models
- 2. Verify that Model 1. Fit Curve is active

a Ad	tive File	<u>- 1 % 87 ×</u>	. 📂 💷 🕨			
Гуре	2D/3D	Name ^	Description	*	Design File	Sheet Name
٦	1	1.Fit Curve			C:\Users\and\horiz_elem.dgn	
٥	Ĩ	2.Best Fit			C:\Users\and\horiz_elem.dgn	
٥	Ĩ	3.Compound-Reverse			C:\Users\and\horiz_elem.dgn	
٥	Ĩ	4.Solving Geometry			C:\Users\and\horiz_elem.dgn	
٥		5.Tangential			C:\Users\and\horiz_elem.dgn	
٥		Default	Master Model	\checkmark	C:\Users\and\horiz_elem.dgn	
٥		ref			C:\Users\and\horiz_elem.dgn	
٥	Ĩ	ref2			C:\Users\and\horiz_elem.dgn	

3. Close Models

IMPORT ALIGNMENT

1. Select File > Power InRoads Import > Geometry > ICS

Import Geometry		
From Graphics ICS	Vertical from Surface	
File Name:		Apply
		Browse
		Preview
		Help
	Close	

- 2. Browse to the following directory: C:\2012_BT_Civil\BC2WK2 Advanced Geometrical Layout \Data\BC2WK2 Advanced Geometrical Layout \Fit Curve
 - a. Select *Survey300.ics* > Open
 - b. Apply
 - c. Close

APPLICATION ADD-IN

- 1. Select Power InRoads Tools > Application Add-ins
- a. Select Horizontal And Vertical Elements Add-in and Multiple Horizontal Element Regression Analysis Add-in

Application Add-ins			x
Available: Generate Grade Contour Add-In GENIO Translator Add-In Giobal Scale Factors Add-In Graphics Translator Add-In Horizontal and Vertical Elements Add-In Hydrology and Hydraulics Add-In Hydrology and Hydraulics Add-In Import LAS Add-In Import SRV Add-In Import SRV Add-In Inport SRV Add-In Multiple Horizontal Element Regression Analysis Add-In Multiple Vertical Element Regression Analysis Add-In SDMS Translator Add-In Ste Modeler Add-In Description The Multiple Horizontal Element Regression Analysis Add-In Description The Multiple Horizontal Element Regression Analysis Add-In Remove User Data Add-In Description The Multiple Horizontal Element Regression Analysis Add-In Description	E egressio	OI Can He rommands for n by least	<pre>cel p </pre>
Command Geometry>Horizontal Regression>Add Regression Point Geometry>Horizontal Regression>Edit/Review Regression Point Geometry>Horizontal Regression>View Regression Point Geometry>Horizontal Regression>Single Element Regression A Geometry>Horizontal Regression>Multiple Element Regression III	int Analysis. 1 Analysi	 S	• •

- b. Apply
- c. Close

EDIT ALIGNMENT

- 1. Select Geometry > Horizontal Element > Check Integrity
 - a. Review the alignment and note that the linear element causes non-collinear issues in the alignment
 - b. Close
 - 2. Select Geometry > Horizontal Element > Add Free Curve
 - a. Set the radius to be 1^15'00" (d1.25) > Tab

b. Check on Delete Existing Elements Between First and Last



- c. Apply
- d. Select the first element



First Element

e. Select the second element



Second Element

- f. Data point to Accept the solution
- g. Reset and Close to exit the Add Free Horizontal Curve command

3. Select Geometry > View Geometry > Horizontal Annotation

- a. Load Preference: Fit Curve
 - i. Select Display: Elements, Radials, and Subtangents
- b. Include the *300* horizontal alignment
 - i. Place cursor in the Include field for Horizontal Alignments
 - ii. Select Filter
 - iii. Select 300 under Available
 - iv. Select Add

deometry	Selection Filter	-		June 3		X
Name:	Ignore	•				ОК
Description:	Ignore	•				Cancel
Style:	Ignore	•				Preferences
Fence Mode:	Ignore	-				Help
Available:				Selected:		Нер
Name	Description	Style	Add ->	Name	Description	Style
Mainline		1Blue	<- Remove <- Swap -> All	300	(101 110 C111R	2 1Blue

v. OK

ain Tabling Sty	les	
Apply Style		Filter
Horizontal Alignmer		Help
Cogo Pointo:	Default	
Cogo Points.	Default	*
Horizontal Alignmer	nts C	ogo Points
Include:	+ Ir	-e
Selected:		Selected:
Name 300	Descri Sty (101 11 1Blu	Name Description Styl
Name 300	Descri Sty (101 11 1Blu	Name Description Styl
Name 300 < Display Points	Descri Sty (101 11 1Blu	Name Description Styl
Name 300 <	t Event Points	Name Description Styl
Name 300 < III Display Points On-Alignment Off-Alignment	t Styerstein Sty	Name Description Styl
Name 300 < III Display Points Ø On-Alignmeni Off-Alignmeni Ø Elements	t Station Equations	Name Description Styl
Name 300 300 Isplay Points On-Alignment Off-Alignment Elements Radials	t Event Points Tangents	Name Description Styl
Name 300 Very Second Secon	Descri Sty (101 11 1Blu) t Event Points t Station Equations Tangents V Subtangents	Name Description Style <

- c. Apply
- d. Observe the 3 center curve in the plan view
- e. Close

4. Select Geometry > Horizontal Element > Check Integrity

a. Review the alignment and note that the curve resolves the issue

This page left intentionally blank.

Chapter 2: Best Fit from Survey Centerline

CHAPTER OBJECTIVE:

1.

In this unusual situation, x,y coordinates of a centerline have been given. However, only 24 points have been provided for a 4 mile stretch of roadway. It is required to create a best fit alignment with the points provided using the Geometry commands in Power InRoads. This is not a typical Regression workflow, but Regression tools will be used to solve for some of the Geometry.

OPEN MODEL



2. Double-click on 2.Best Fit to activate that model



3. Close Models

CREATE A NEW ALIGNMENT

- 1. Select File > Power InRoads File > New > Geometry
 - a. Set Type to Horizontal Alignment
 - b. Key in *Best Fit* for the alignment name
 - c. Apply

🗧 New		_ D X
Surface Geometry	Drainage Survey Data	
Туре:	Horizontal Alignment 👻	Apply
Name:	Best Fit	Help
Description:		
Style:	Default 🗸	
Curve Definition:	Arc 🔻	Ĵ

d. Close

IMPORT HORIZONTAL REGRESSION POINTS

- 1. Select File > Text Import Wizard
 - a. Select Data Type to be Horizontal Regression Points
 - b. Navigate to the directory C:\2012_BT_Civil\BC2WK2 Advanced Geometrical Layout

\Data\BC2WK2 Advanced Geometrical Layout \Best Fit

it
it
ete
elp

- c. Select the *NE.txt* file and click Open
- d. OK
- 2. Text Import Wizard Step 1 of 4
 - a. Keep the default settings in this first step (It will import lines 1 through the end of file)

Define Import Lines withir	Range n Range							Help)
Start Import	at Line:	1							
End Import	at Line:	EOF	×						
C Lines within	n Relative Range								
Start Impor	t at Start of File +	0							
			in the second se						
End Import	at End of File -	0	× 						
End Import	at End of File -	0	V A V						
End Import	at End of File - presto\Desktop\BE	0 Conference	e\Geomet	ny∖Kevin Te	st Run\NE.	bd			
End Import	at End of File - presto\Desktop\BE 2042292.518	0 Conference	e\Geomet	ny∖Kevin Te	st Run\NE:	txt			-
End Import	at End of File - presto\Desktop\BE 2042292.518 2044888.439	0 Conference	e\Geomet	ny∖Kevin Te	st Run\NE:	txt			-
End Import	at End of File - presto \Desktop \BE 2042292.518 2044888.439 2048782.26	Conference	e\Geomet	ny∖Kevin Te	st Run\NE:	txt			× III
End Import	at End of File - presto\Desktop\BE 2042292.518 2044888.439 2048782.26 2050419.531	Conference	e\Geomet	ry∖Kevin Te	st Run\NE:	txt			^ III
End Import	at End of File - presto\Desktop\BE 2042292.518 2044888.439 2048782.26 2050419.531 2051179.106	Conference	e Geomet	ny∖Kevin Te	st Run\NE:	txt			1
End Import	at End of File - presto\Desktop\BE 2042292.518 204888.439 2048782.26 2050419.531 2051179.106 2051891.058	Conference	e Geomet	ny∖Kevin Te	st Run\NE:	bđ			1
End Import	at End of File - presto\Desktop\BE 2042292.518 204888.4299 2048782.26 2050419.531 2051179.106 2051891.058 2052092.395	Conference	v Ave \Geomet	ry∖Kevin Te	st Run\NE.	bđ			

- b. Next
- 3. Text Import Wizard Step 2 of 4
 - a. Again, keep the default settings in the second step. It will import all the lines to the file

🐂 Text Import Wizard - Step 2 of 4		
Apply Filter to All Lines Lines that Start With: Lines that Include: 	Original Data Type Fixed Width - Fields are aligned in columns Delimited - Characters separate each field Defined Filters:	Help
Start: Include Start in Import End: Include Filtered Lines From Import	Name Description	Add Delete Update
C:\Users\andrea.presto\Desktop\BE Conference\Geom 2022722.411 2042292.518 2022868.309 2044888.439 2023086.846 2048782.26 2023201.344 2050419.531 2023501.392 2051179.106 2024197.304 2051891.058 2024580.061 2052092.395	netry∖Kevin Test Run∖NE.txt	× III
		•
Open Save Save As	< Back Next > Finish C	Cancel

- b. Next
- 4. Text Import Wizard Step 3 of 4
 - a. Select the Tab option as the delimiter for this specific file

🐂 Text Impor	t Wizard - Step 3	of 4					
Delimiters Tab Space Other:	Comma	Text Qualifier: Start of Line Column: Start of Field Column:	1 A 1 A V			Help	
Ignore Con	secutive Delimiters						
C:\Users\andr	ea.presto\Desktop	\BE Conference \Geom	try∖Kevin Test Run∖NE	i.txt		<u>^</u>	
2022722.411			2042292.518			E	
2022868.309)		2044888.439				
2023086.846	5		2048782.26				
2023201.344			2050419.531				
						*	
			III			•	
Open	Save	Save As	< Back Ne	ext > Fi	nish 🚺	Cancel	_

- b. Next
- 5. Text Import Wizard Step 4 of 4
 - a. Define the columns as Northing / Easting as shown in the picture below

Note Right-click on the column header and select the correct value

Text Import Wizard - Step 4 of 4		_ D _ X
Column Data Format: Skip 🔹		Help
Add to Cogo Buffer		
C:\Users\andrea.presto\Desktop X BE Conference\Geometry\	Kevin Test Run\NE.txt	
Northing	Easting	
2022722.411	2042292.518	E
2022868.309	2044888.439	
2023086.846	2048782.26	
2023201.344	2050419.531	
2023501.392	2051179.106	
		· · ·
		4
Open Save Save As	< Back Next > Finish	Cancel

- b. Finish
- 6. Select Yes to the dialog with the following message: "Changes have not been saved to the XIN file. Continue?"



7. Select OK on the dialog that states the 21 points have been imported successfully



Note Importing regression points by this method assumes that points are in order and that all points are valid. The typical regression sorting and ordering is not used in this context.

VIEW THE HORIZONTAL REGRESSION POINTS

- 1. Select Geometry > Horizontal Regression > View Regression Points
 - a. Load Preference Best Fit

📉 View Horizontal Regr	ession	Points				- 🗆 X
Data:						Apply
Object	Prefix	Suffix	Precision	Name		
Fixed Symbol						Close
Fixed Text						Preferences
Normal Symbol						Thereferences
Normal Text						Help
Ignored Symbol						
Ignored Text						
Other Symbol						
Other Text						
Unacceptable Symbol						
Unacceptable Text						
Sorted Line						
Name						
Horizontal Slew			0.12			
Vertical Slew			0.12			
Slew Indicator						
Acceptable Slew: 0.2	50		Annotate a	as: @ Single Li	ine	
	JU		/ inotato a		ile.	
Scale: 1.0	000			Multiple	Lines	
Mirror Right to Left			Annotate ir	n: Feet		•
Symbology from Point S	ityle					

- b. Apply
- c. Close
- 2. Fit View

REPORT LOCK

- 1. Ensure Report Lock is turned on
 - a. Select Tools > Locks > Report



Note Regress the 3 curves only to get their radii. Then delete the curve elements and add the curves back in after tangents have been defined.

WORKING WITH REGRESS POINTS

- 1. Select Geometry > Horizontal Regression > Edit/Review Regression Points
 - a. Select the Select & Regress button
 - b. Select the group of four points for the first curve starting from the left (See Screenshot)



First group of selected points for first curve

- c. For each Results dialog, write down the radius for each curve
- d. Repeat for each curve as illustrated in the screenshots below



Second group of selected points for second curve



Third group of selected points for third curve

- 2. Select Geometry > Horizontal Element > Delete Element
 - a. Use Selected Element Only
 - b. Apply
 - c. Delete the elements that were just created with the regression tool
 - d. Data point to Accept the solution
 - e. Reset and Close to exit the Delete Element command
- 3. Select Geometry > Horizontal Regression > Edit/Review Regression Points
 - a. Select the Select & Regress button
 - b. Select the group of three points for the first tangent from the left. (See Screenshot)



First group of selected points for first tangent

- c. For each Results dialog, make note of the offsets used during Regression to verify that the elements are valid.
- d. Repeat for each tangent as illustrated in screenshots below



Second group of selected points for second tangent



Third group of selected points for third tangent

Note Note the large offset of points. Delete this element and recreate with two points.

- 4. Delete any element that is not valid
 - a. Select Geometry > Horizontal Element > Delete Element



Select tangent to delete

5. Recreate the third tangent by selecting two points instead of three



Group of selected points for third tangent

- 6. Continue with the last tangent
 - a. Select Geometry > Horizontal Regression > Edit/Review Regression Points



Forth group of selected points for forth tangent

- 7. Select Geometry > Horizontal Elements > Add Free Curve
 - a. Use the radii from previous workflow above to add in curves (Left curves will require a negative sign)

Add Fr Transitio Leading: Radius:	ee Horizontal Curve ns and Parameters Clothoid	0.000	+ +	Apply Close					
Trailing:	Clothoid	0.000	+	Design Calc Help					
Delete	Alternate Solution Delete Existing Elements Between First and Second								

- i. Apply
- ii. Add first curve by selecting first and second tangents



First Tangent



Second Tangent

- b. Reset to bring up the dialog to change the radius
- c. Repeat for next two curves

Add Free Horizontal Curve			
Transitions and Parameters Leading: Clothoid	0.000	+	Apply
Radius:	2865.000	+	Close
Trailing: Clothoid 👻	0.000	+	Design Calc
Alternate Solution			Help
Delete Existing Elements Betwee	en First and Second		



Second Tangent



Third Tangent





Third Tangent



Forth Tangent

- 8. Select Geometry > Horizontal Regression > Slew Diagram
 - a. Load Best Fit preference
 - b. Apply
 - c. Data point to select a location in the design file to place the slew diagram



Slew Diagram

d. To view slew information in an XML report, click Report

Note The maximum offset from the surveyed points to the alignment is about 1.3

This page left intentionally blank.

Chapter 2 Alternate: Horizontal **Regression from Survey** Centerline

CHAPTER OBJECTIVES

Many times a user is provided a survey consisting of coordinates that represent the centerline of an existing road or rail. The user is required to quickly create a curvilinear alignment consisting of lines, circular arcs and transition spirals. In this chapter we will discuss functionality that will aid the user in creating the curvilinear geometry.

PROCEDURE

- 1. Create a new .dgn
- 1. Open the file shortened.alg
- 2. Open the file regression.xin
- 3. Go to Horizontal Regression > View Regression Points and click Apply



It appears that we have four circular arcs and two maybe three tangents. The leftmost circular arcs can be readily picked out from the data, the third is a bit more difficult and the fourth circular arc is detectable. But, does the data indicate whether or not there are any transition spirals? Or can the user determine if there is any questionable data? When the answer is obviously, no! You can't detect transition spirals or bad data. And if you really thought about it, you would have difficulty detecting the start and end of circular arcs. Let's see what can be done to resolve this.

- 5. Go to Horizontal Regression > Horizontal Curvature Diagram and click Apply
- 6. At the prompt Identify Location, data point slightly above the points.



What does this diagram tell use? The curvature diagram allows the user to display 1 / R in the y-axis and the length along in the x-axis. The following:

- If the point data runs close to the x-axis then those points will represent a line.
- If the point data runs nearly parallel but offset from the x-axis then those points will be represent a circular arc
- If the point data is neither of the above then those points will be a transition spiral.

What else can be seen from the diagram? If you see a spike in the curvature line then that point may be a bad point and you may wish to ignore it. In our case all of the points are reasonable.

Let's discuss the workflow to regress these points. We will do the following:

- From the diagram, we will work from left to right and select and regression the obvious lines and circular arcs. We will use *Horizontal Regression > Edit Review Regression Points*
- In fill transition spirals between the lines and circular arcs. We will use *Horizontal Element > Define Spiral*

But first a discussion on selecting points for the individual lines and circular arcs. It should be clear that at a minimum, we need two points for a line and three points for a circular arc. And when we select points, we only want to select points that are within the extents of the line or circular arc. You may ask, should I try to include the points that represent the exact start or end of an element? No, you should not! Why not? Well in doing so, you may actually be selecting points that are within the extents of another element. So when we regress the points, we may artificially skew the results. So it is best practice to not attempt to include the start and end points of an element.

Regressior	n Points:					Close
Name	Northing	Easting	Include in Analysis	Status	-	Coloct Only
901UE	31759.2950	311453.7680	No	Normal		Select Only
904	31756.9550	311462.0570	No	Normal		Select & Regress
905	31754.8200	311470.1870	No	Normal		
908	31752.6750	311479.0380	No	Normal		Quick
909	31750.8860	311487.1120	No	Normal		Report
912	31749.0500	311496.2580	No	Normal		
913	31747.4500	311505.1750	No	Normal		<u>H</u> elp
916	31746.1740	311513.0940	No	Normal		
917	31745.0660	311520.8170	No	Normal		
920	31744.0260	311529.0510	No	Normal		
1108	31743.1020	311537.6330	No	Normal	-	

7. Go to Horizontal Regression > Edit Review Regression Points and click Select & Regress

- 8. For each line and circular arc, we will repeat the following steps
 - Identify first point
 - Identify second point
 - Accept / reject

Note We will be using the curvature diagram to select the lines and circular arcs. Also, if you check on *Tools > Locks > Report*, you will get textual data, which will provide details on the results of the regression analysis.

When you have completed this step you should have the following:

With the above results, how close are we to our original guesses? We did not detect the first line between the first two circular arcs. The two short arc circulars we detected, but it would have been difficult to find them without the curvature diagram.

Also, if you had checked on report lock, you would have the following:

Results		x
Horizontal Regression Report	Close	-
PI () 0+060,0000 31739,2491 311 PI () 0+065,2647 31741.1713 311 CC () 32215.8557 311 PT () 0+129.7177 31740.6696 311 Delta: 15^38'25.1" Left Degree of Curvature(Arc): 12003'25.9" Length: 129.7177 Tangent: 65.2646 Chord: 129.3153 Middle Ordinate: 4.4193 External: 4.4608 Tangent Direction: 5.73^55'09.4" E Radial Direction: 5.73^55'09.4" E	1403.7347 1516.4657 1585.3811 1581.7285 <u>Display</u> <u>Help</u>	
Chord Direction: S 81^44'21.9" E Radial Direction: S 00^26'25.5" W Tangent Direction: S 89^33'34.5" E		
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		
920 0+076.9052 -0.0198 < 1108 0+085.5375 -0.0413 < 1111 0+093.6006 -0.0403 < 1112 0+102.9315 -0.0329 < 1115 0+112.0635 -0.0158 < 1116 0+120.8842 0.0106 > 1119 0+129.7178 0.0556>		
Least Squares Error: 0.0000 Standard Deviation: 0.0313 Maximum Offset: 0.0556	•	

9. Okay, now let's add the transition spirals. Go to *Horizontal Elements > Define Spiral*. Check on *Replace and Fill All Gaps* and click *Apply*



- At the Identify first element, select the leftmost circular arc
- At the Identify last element, select the rightmost line
- Accept / reject the solution
- 10. We now have an alignment with regressed lines and circular arcs and in filled transition spiral. Go to *Horizontal Elements > Check Integrity* to review the results

Check Ho	orizontal Integrity							
Туре	Northing Easting @ Start	Direction @ St	Length	Radius	Integri	Integr	Eleme	Apply
Circular	31759.249 311453.7547	S 73^55'09.4" E	118.9879	-475.2001		OK	ОК	Close
Clothoid	31740.873 311571.0007	S 88^15'57.1" E	81.4545		OK	ОК	OK	
Linear	31743.061 311652.3992	N 86^49'24.9" E	28.1888		OK	ОК	OK	Move Back
Clothoid	31744.623 311680.5447	N 86^49'24.9" E	51.8649		OK	ОК	OK	Marrie Conservat
Circular	31746.006 311732.3739	S 88^14'06.4" E	153.1742	300.6938	OK	ОК	OK	Move Forward
Clothoid	31703.331 311877.7637	S 59^02'54.6" E	63.2921		OK	ОК	OK	Help
Clothoid	31667.072 311929.6019	S 53^01'06.6" E	56.0030		OK	ОК	OK	
Circular	31634.634 311975.2332	S 57^44'22.5" E	16.6682	-339.8307	OK	ОК	OK	
Clothoid	31626.086 311989.5409	S 60^32'59.5" E	50.4029		OK	OK	OK	
Linear	31603.510 312034.5910	S 64^47'55.9" E	416.9116		OK	ОК	OK	
Clothoid	31425.990 312411.8203	S 64^47'55.9'' E	84.6288		OK	ОК	OK	
Circular	31392.825 312489.6301	S 71^08'55.8" E	27.1259	-381.8020	OK	ОК	OK	
Clothoid	31384.980 312515.5906	S 75^13'10.3" E	89.0620		OK	ОК	OK	
Linear	31369.026 312603.1574	S 81^54'07.7" E	224.1084		OK		OK	
	Select	rst < <u>P</u> revio		lext >	Last]		

Note If you want to control the content of the Check Integrity list-view, right click in the header and select / de-select what you want to see. You can also resize the columns and dialog so that it does not consume the entire monitor!

11. Go to *Horizontal Regression > Edit Review Regression Points* and click *Select Only* and place a rectangular around all of the points. This will include all points in the analysis.

Name Northing Easting Include in Analysis Status 901UE 31759.2950 311453.7680 Yes Normal 904 31756.9550 311462.0570 Yes Normal 905 31754.8200 311470.1870 Yes Normal 908 31752.6750 311479.0380 Yes Normal 909 31750.8860 311487.1120 Yes Normal 912 31749.0500 311496.2580 Yes Normal 913 31747.4500 311505.1750 Yes Normal 916 31746.1740 311513.0940 Yes Normal	elect Only xt & Regress
901UE 31759.2950 311453.7680 Yes Normal 904 31756.9550 311462.0570 Yes Normal 905 31754.8200 311470.1870 Yes Normal 908 31752.6750 311479.0380 Yes Normal 909 31750.8860 311487.1120 Yes Normal 912 31749.0500 311496.2580 Yes Normal 913 31747.4500 311505.1750 Yes Normal 916 31746.1740 311513.0940 Yes Normal	nt & Regress
904 31756.9550 311462.0570 Yes Normal Sele 905 31754.8200 311470.1870 Yes Normal 908 909 31752.6750 311479.0380 Yes Normal 909 909 31750.8860 311487.1120 Yes Normal 912 31749.0500 311496.2580 Yes Normal 913 913747.4500 311505.1750 Yes Normal 913 916 31746.1740 311513.0940 Yes Normal 916 91746.1740 311513.0940 Yes Normal 916 917 916 917.49 915 916 916 917 916 917.49 915 916 917 916 917 916 917 916 917 916 917 916 917 916 917 916 917 917 916 917 916 917 917 916 917 916 917 916 916 916 916 916 916 916 916<	ct & Regress
905 31754.8200 311470.1870 Yes Normal 908 31752.6750 311479.0380 Yes Normal 909 31750.8860 311487.1120 Yes Normal 912 31749.0500 311496.2580 Yes Normal 913 31747.4500 311505.1750 Yes Normal 916 31746.1740 31151.0940 Yes Normal	
908 31752.6750 311479.0380 Yes Normal 909 31750.8860 311487.1120 Yes Normal 912 31749.0500 311496.2580 Yes Normal 913 31747.4500 311505.1750 Yes Normal 916 31746.1740 31151.0940 Yes Normal	
909 31750.8860 311487.1120 Yes Normal 912 31749.0500 311496.2580 Yes Normal 913 31747.4500 311505.1750 Yes Normal 916 31746.1740 31151.0940 Yes Normal	Juick
912 31749.0500 311496.2580 Yes Normal 913 31747.4500 311505.1750 Yes Normal 916 31746.1740 311513.0940 Yes Normal	Report
913 31747.4500 311505.1750 Yes Normal 916 31746.1740 311513.0940 Yes Normal	
916 31746.1740 311513.0940 Yes Normal	<u>H</u> elp
917 31745.0660 311520.8170 Yes Normal	
920 31744.0260 311529.0510 Yes Normal 🔻	
۰ III ۲	

12. Go to *Horizontal Regression > Multi-element Regression Analysis* and lets fine tune the results

- Beginning Type Circul	g Eleme ar	nt Free	<u>L</u> eng 118.9879 Applied (jth Cant (m	m)	Radius -475.2001 0.0000		Select		Apply Close Save
Connecting	Elemer	nt:								Save As
Туре	Free	Length		Free	Pa	rameter	Tar	Applied	*	Undo
Clothoid Linear Clothoid Circular Clothoid Circular Clothoid Linear		81.4545 28.1888 51.8649 153.1742 119.2950 16.6682 50.4029 416.9116	2		196 N 8 124 300 137 -339 130 S 6	.7414 6^49'24.9" E .8817 .6938 .9548 9.8307 .8757 4^47'55.9" E		0.0000 0.0000	4	Repor <u>t</u>
Type Linea	r	Free	Le <u>no</u> 224.1084	jth Məint:	ain (Direction S 81^54'07.7	" E	Select		

Select each element in the *Connecting Elements* list-view and for each transition spiral, round its length up or down to the nearest 5 meter interval.

Also, set each linear element's length as free

Also, set each circular arcs element's length as free

As well as the Beginning Element and Ending Element

Beginning Type Circul	g Eleme ar	nt F <u>r</u> ee ▼	<u>L</u> eng 119.4185 Applied (gth ; Cant (m	m)	Radius -475.2001 0.0000		Select		Apply Close Save
Connecting	Elemer	nt:								Save As
Туре	Free	Length		Free	Pa	arameter	Tar	Applied		Undo
Clothoid Linear Clothoid Circular Clothoid Circular Clothoid Linear		80.0000 30.4073 50.0000 153.6816 120.0000 16.6423 50.0000 416.5490			194 N 8 122 300 138 -33 130 S 6	4.9769 36^51'33.6" E 2.6160 0.6938 3.3618 9.8307 0.3516 3.4^47'52.8" E		0.0000	4	Report
Ending E Type Linea	lement - ; r	<u>F</u> ree ▼	Le <u>n</u> 223.6991	gth		Direction S 81^54'07.7	" E	Select		

- 13. Check on Use Regression Analysis
- 14. Click Apply
- 15. Now edit each circular arc's radius so that it is rounded to the nearest 1 meter.
- 16. Once again click Apply
- 17. To review the results, click Report...
- 18. Go to Horizontal Regression > Slew Diagram



We want the green line as close as possible to the x-axis. Obviously, real world data will never hit flat on the axis, so some amount of offset is acceptable.

What is the secret to getting a reasonable display? It has to do with the settings for the *Left Axes*. The *Major Spacing* should be something like 0.1 meters. And the *Elevation Label Precision* should be something like 0.123

Horizontal Slew Diagram					
Horizontal Slew Diagram General Axes Left General Symbology	Major Ticks Length: Position: Spacing:	0.0600 Both Sides	Minor Ticks Length: Position: Minors/Major:	0.0300 Inside • 4	
Bottom Bottom Bight Top Vertical Center Grid Grid	Elevation La Prefix: Suffix: Precision:	0.123 •			
Details	Title Text: Placement:	1/R Automatic Manual			
		Mirro	Left to Right		
		Apply Report	Preference	es Close	<u>H</u> elp

CHAPTER SUMMARY

We have used **Regression Analysis** on survey points and have created a curvilinear alignment consisting of lines, circular arcs and transition spirals.

Chapter 3: Compound Curves

CHAPTER OBJECTIVE:

In this lesson, the radius of the centerline does not fall between the existing edges of pavement. The alignment appears to need a flatter curve at the top of the arc while having a tighter curve at the lower end of the arc. This alignment requires a compound curve instead of the one single curve that was initially created with the PI tools.

OPEN MODEL



2. Double-click on 3. Compound-Reverse to activate that model

	Mod	dels		•			
6	En Act	tive File	- 🗅 🔓 🚰 ≻	< 🚰 🗔 🕞			
	Туре	2D/3D	Name 🔷	Description	*	Design File	Sheet Name
	٥	Ĩ	1.Fit Curve			C:\Users\and\horiz_elem.dgn	
	٥	Ĩ	2.Best Fit			C:\Users\and\horiz_elem.dgn	
	٦	Û	3.Compound-Reverse			C:\Users\and\horiz_elem.dgn	
	٥		4.Solving Geometry			C:\Users\and\horiz_elem.dgn	
	٥		5.Tangential			C:\Users\and\horiz_elem.dgn	
	٥		Default	Master Model	\checkmark	C:\Users\and\horiz_elem.dgn	
	٥		ref			C:\Users\and\horiz_elem.dgn	
	٥		ref2			C:\Users\and\horiz_elem.dgn	
	C						4

3. Close Models

VIEW AND REVIEW HORIZONTAL ALIGNMENT

- 1. Set Mainline alignment active
 - a. Right click on Mainline in InRoads and select Set Active

Bentley InRoads	Suite V8i (SELECTseries
File Surface Ge	ometry <u>B</u> ridge <u>D</u> rainage
<unnamed></unnamed>	- 🚡 👳
	/ Projects
🗄 🛗 Default	t
📋 📄 🧮 Hwy12	Ex
🗄 🔆 Co	go Buffer
300	
🚊 🗌 🗄 📈 Ma	inline
	New
Surfaces 🚊	Set Active
Active horizontal al	Сору

- 2. Select Geometry > View Geometry > Active Horizontal
- 3. Select Geometry > Review Horizontal
 - a. Set mode to Element
 - b. Select "Next" to view first curve
 - c. Make note of the radius of the alignment's first curve

EDIT ALIGNMENT

- 1. Select Geometry > Horizontal Element > Delete Element
 - a. Select option Selected Element Only
 - b. Apply
 - c. Select the first curve of the alignment





- d. Reset and Close to exit the Delete Element command
- 2. Select Geometry > Horizontal Element > Add Floating Curve
 - a. Set the radius to 700

lode:	By Poi	int and Radius	;	-	Apply	/
Point		r			Close	
E Na	ime:					
No	orthing:	0.000		-	Design C	alc
Ea	sting:	0.000		ī I	Help	
				_		
		d Parameters -				
Transiti	ons and					
Transiti Leading	ons and Cloth	noid	▼ 0.0	000		+
Transiti Leading Radius:	ons and I [:] Cloth	noid	▼ 0.0 70	000 0.000		+ +
Transiti Leading Radius: Trailing:	ons and I: Cloth	noid	 ▼ 0.0 70 ▼ 0.0 	000 0.000 000		+ + +

- b. Apply
- c. Select second tangent and float the curve out so that it is between the two edges of pavement (See Screenshot)



Float Curve out to center of EOPs

- d. Data point to Accept the solution
- e. Reset and Close to exit the Add Floating Horizontal Curve command
- 3. Select Geometry Horizontal Element > Add Free Curve
 - a. Set the radius to 350

Kan Add Free Horizontal Curve	
Transitions and Parameters Leading: Clothoid • 0.000	+ Apply
Radius: 350.000	+ Close
Trailing: Clothoid O.000	Design Calc
Alternate Solution	Help
Delete Existing Elements Between First and	d Second

- b. Apply
- c. Select first tangent and then first curve



Select Tangent



d. Data point to Accept the solution

e. Reset and Close to exit the Add Free Horizontal Curve command.

REVIEW ALIGNMENT

- 1. Select Geometry > View Geometry > Horizontal Annotation
 - a. Load Preference Compound Curve
 - b. Include the *Mainline* horizontal alignment
 - i. Place cursor in the *Include* field for Horizontal Alignments
 - ii. Select Filter
 - iii. Select *Mainline* under Available and select *Add*

Geometry	Selection Filter			<u>Eila Curfaca</u>	Goometry Bridge	
Name:	Ignore	•				ОК
Description:	Ignore	•				Cancel
Style:	Ignore	•				Preferences
Fence Mode:	Ignore	-				Holo
Available:				Selected:		nep
Name	Description	Style	Add ->	Name	Description	Style
			<- Remove	Mainline		1Blue
			<- Swap ->			
			All	1		
			Nee			
			INDIE	J		

iv. OK

ain Tabling St	yles	
 Assigned 	Active Over	rwrite
Horizontal Alignme	nt: 1Blue	
Cogo Points:	Default	•
Horizontal Alignme	nts	Cogo Points
nclude:	-	Include:
Selected:		Selected:
Name Mainline	Descri Sty 1Blu	Name Description Sty
Name Mainline	Descri Sty 1Blu	Name Description Sty
Name Mainline	Descri Sty 1Blu	Name Description Sty Annotate Points
Name Mainline	Descri Sty 1Blu IBlu	Annotate Points Elements
Name Mainline	Tescri Sty 1Blu t Event Points t Station Equation	Annotate Points Elements Duplicates
Name Mainline Visplay Points V On-Alignmer Off-Alignmer Bements	t Station Equation	Annotate Points Elements Duplicates Dual Dimensions
Name Mainline Mainline Display Points V On-Alignmer Off-Alignmer Elements Radials	Descri Sty 1Blu t Event Points t Station Equation Tangents	Name Description Sty Image: Annotate Points Points Elements Duplicates Duplicates Try Altemate Styles
Name Mainline Mainline Visplay Points V On-Alignmer Off-Alignmer Bements Radials Chords	Descri Sty 1Blu t Event Points t Station Equation Tangents V Subtangents	Name Description Sty III) Annotate Points Points Elements Duplicates Duplicates Dual Dimensions Try Altemate Styles V Extend Beyond Element

- c. Apply
- d. Close



Outcome of Horizontal Annotation

- 2. Select Geometry > Review Horizontal
- 3. Select Geometry > Horizontal Element > Check Integrity

Chapter 4: Solve for an Unknown Geometry

CHAPTER OBJECTIVE:

Similar to the best fit issue in Lesson 2, in this lesson we will be using point data to create an alignment. The given data are three points and a radius for an unknown geometry. Use the Horizontal Element tools to construct the geometry for the data given.

OPEN MODEL



2. Double-click on *4.Solving Geometry* to activate that model.

(🖸 Mod	dels	•••• 🗸 🔽 🔪 ••••					
1	E Ac	tive File	- 🗅 占 🚰 🗙	🍰 🗌 🍃				
1	Туре	2D/3D	Name ^	Description	*	Desig	n File	Sheet Name
	٥		1.Fit Curve 2.Best Fit			C:\Us C:\Us	ers\and\horiz_elem.dgn ers\and\horiz_elem.dgn	
	٥	Ĩ	3.Compound-Reverse			C:\Us	ers\and\horiz_elem.dgn	
		1	4.Solving Geometry			C:\Us	ers\and\horiz_elem.dgn	
1.7 5.1.5	0 0 0		5.Tangential Default ref	Master Model	V	C:\Us C:\Us C:\Us	ers\and\horiz_elem.dgn ers\and\horiz_elem.dgn ers\and\horiz_elem.dgn	
			ref2			C:\Us	ers\and\horiz_elem.dgn	
2								
		_		_	III			4

3. Close Models

CREATE A NEW ALIGNMENT

- 1. Select File > Power InRoads File > New > Geometry
 - a. Select Type to be Horizontal Alignment
 - b. Key in *Solving Geometry* for the alignment name
 - c. Apply

New		
Surface Geometr	y Drainage Survey Data	
Туре:	Horizontal Alignment -	Apply
Name:	Solving Geometry	Help
Description:		
Style:	Default -	
Curve Definition:	Arc 🗸	Ĩ

d. Close

VIEW COGO POINTS

- 1. Select Geometry > View Geometry > Horizontal Annotation
 - a. Load preference Solving Geometry
 - b. Remove Mainline from the Horizontal Alignments
 - i. Place cursor in the *Include* field for Horizontal Alignments
 - ii. Select Filter
 - iii. Select *Mainline* under Selected
 - iv. Remove
 - c. Include Cogo points 65, 66, and 69
 - i. Place cursor in the *Include* field for Cogo Points
 - ii. Select Filter
 - iii. Select cogo points 65, 66, and 69 under Available and select Add

Geometry	Selection Filter	5.05.0	-	-		×
Name:	Ignore	•				ОК
Description:	Ignore	•				Cancel
Style:	Ignore	•				Preferences
Fence Mode:	Ignore	-				
Available:	·			Selected:		Help
Name	Description	Style	Add ->	Name	Description	Style
101		1Blue	<- Remove	65		1Blue
110		1Blue		66		1Blue
111		1Blue	<- Swap ->	69		1Blue
200		1Blue	All			
210		1Blue				
211		1Blue	None			
212		1Blue				
203		1Blue				
43		Default				
44		Default				
45		Default				

iv. OK

d. Apply the Horizontal Annotation command (This will display the cogo points selected in the design file.)

View Horizontal Annotation	
Main Tabling Styles	Filter
Assigned Active Overwrite Horizontal Alignment: 18	te Help
Cogo Points: Default	-
Horizontal Alignments Co	go Points lude:
Selected: S	elected: lame Description Style
65	1Blue 1Blue 1Blue
• III • III • I	4 III
Display Points	Annotate V Points
On-Alignment Event Points Off-Alignment Station Equations	Duplicates
Elements Radials Tangents	 Dual Dimensions Try Alternate Styles
Chords 🕢 Subtangents	Extend Beyond Element
Display As Complex Linestring	Planarize
Apply Interactive Graphics	Preferences Close

CREATE ALIGNMENT

1. Select Geometry > Horizontal Element > Add Fixed Line

a. The two points used are known (65 and 66)

H Add F	ixed H	orizontal Line		_ 🗆 <mark>_ X</mark>
Mode: Point 1	By Two	o Points	•	Apply
V Na	me:	65		
No	thing:	-221289.071	+	Help
Eas	sting:	338453.513		
Point 2	me:	22		
Nor	thing:	-221020.004	÷	
Eas	sting:	338404.633		
Select	Insertio	on Element 🍥 Insert Bef	fore	🔘 Insert After

- b. Apply
- c. Data point to Accept the solution

- d. Reset and Close to exit the Add Fixed Horizontal Line command
- 2. Select Geometry > Horizontal Element > Add Floating Curve
 - a. Key in the known radius

lode: By Poi	int and Radius	•	Apply
Point Name:			Close
Northing:	-221020.004	-+-	Design Calc
Easting:	338404.633		Help
Transitions and	d Parameters		
Leading: Cloth	noid	• 0.000	+
Radius:		-480.000	+
T + (hin	0.000	+
Trailing: Cloth	iona -		

- b. Select the first tangent that was just created
- c. Float the curve out so that it is between the edges of pavements (See Screenshot)



Float Curve between EOPs

- d. Data point to Accept the solution
- e. Close

3. Select Geometry > Horizontal Element > Add Floating Line

1	Add Floatir	ng Horizontal Line		
Mo	ode: By Poi	nt	-	Apply
	Name:			Close
	Northing:	0.000	+	Help
	Easting:	0.000		
Dir	rection:	N 0^00'00.000" E	+	

- a. Apply
- b. Select the floating curve that was just placed



Select Curve

- c. Tentative snap to the cogo point 69
- d. Data point to Accept the solution
- e. Reset and Close to exit the Add Floating Horizontal Line command

This page left intentionally blank.

Optional Chapter: Continuation of Solving Geometry

CHAPTER OBJECTIVE:

This section is optional if time is allotted. The Solve for an Unknown Geometry (Chapter 4) can be continued with the following workflow. In the following steps, the Floating Line and Curve commands will be used to place a centerline along the remainder of the roadway.

EDIT ALIGNMENT

- 1. Select Geometry > Horizontal Element > Add Floating Curve
 - a. Key in a radius of 480

lode: By Poi	int and Radius	•	Apply
Point Name:			Close
Northing:	-221020.004	-ф-	Design Calc.
Easting:	338404.633		Help
Transitions and Leading: Cloth	d Parameters loid	.000	<u>+</u>
		480.000	+
Radius:			
Radius: Trailing: Cloth	oid 🔹	• 0.000	<u>+</u>

- b. Apply
- c. Select the floating tangent placed in the last section
- d. Float curve out through the intersection



Float Curve

- e. Data point to Accept the solution
- f. Reset and Close to exit the Add Floating Horizontal Curve command
- 2. Select Geometry > Horizontal Element > Add Floating Line

Add Floatin	ng Horizontal Line		
Mode: By Poi	nt	•	Apply
🔲 Name:			Close
Northing:	0.000	-	Help
Easting:	0.000		
Direction:	N 0^00'00.000" E	-	

- a. Apply
- b. Select floating curve just created
- c. Float tangent out to the PC of the next curve



Float Tangent

- d. Data point to Accept the solution
- e. Reset and Close to exit the Add Floating Horizontal Line command

Chapter 5: Create a Continuous Tangential Alignment

CHAPTER OBJECTIVE:

Displayed in the CAD drawing are elements representing a driveway component. However, these elements are non-tangential. The goal is to recreate the curve while maintaining the tangency of the linear elements.

OPEN MODEL

- 1. Click Models
- 2. Double-click on *5.Tangential* to activate that model



3. Close Models

MEASURE RADIUS

- 1. Select the *Measure Radius* tool in the *Drawing* tools.
- 2. Select the curve in plan view

52



3. Read and record the radius given in the Measure Radius dialog

🖇 Measure Radius	
Primary Radius:	43.1280m
Primary Diameter:	86.2560m
Secondary Radius:	
Secondary Diameter:	

CREATE A NEW ALIGNMENT

- 1. Select File > Power InRoads File > New > Geometry
 - a. Select Type to be Horizontal Alignment
 - b. Key in *Tangential* for the alignment name
 - c. Apply

New New		
Surface Geometry	Drainage Survey Data	
Type:	Horizontal Alignment 🔹	Apply
Name:	Tangential	Help
Description:		
Style:	Default 🔹	
Curve Definition:	Arc 🔻	

d. Close

EDIT ALIGNMENT

- 1. Select Geometry > Horizontal Element > Add Fixed Line
 - a. Select Point 1 to be at the bottom of the first tangent line
 - i. Use the target button to tentative snap to Point 1
 - b. Select Point 2 to be at the beginning of the arc
 - i. Use the target button to tentative snap to Point 2

🗧 Add Fixed H	orizontal Line		- 🗆 X
Mode: By Tw	o Points	•	Apply
Point 1 Name:			Close
Northing:	1064644.818	+	Help
Easting:	157328.070		
Point 2			
Northing:	1064684 281	-	
Easting:	157293.052		
Select Insertion	on Element (@) Insert B	Before	🔵 Insert After



c. Apply

- d. Data point to Accept the solution
- e. Reset to return to the Add Fixed Horizontal Line command
- 2. While working in the Add Fixed Line command, define the second tangent
 - a. Select Point 1 to be at the end of the arc
 - i. Use the target button to Tentative snap to Point 1
 - b. Select Point 2 to be at the end of the second tangent element
 - i. Use the target button to Tentative snap to Point 2



- c. Apply
- d. Data point to Accept the solution
- e. Reset and Close to exit the Add Fixed Horizontal Line command
- 3. Select Geometry > Horizontal Element > Add Free Curve
 - a. Key in a radius of 43
 - b. Apply

Add Free Horizontal Curve	
Transitions and Parameters Leading: Clothoid Radius: 43.000 Trailing: Clothoid ✓ 0.000 Matemate 0.000 ✓ O.000 ✓ Delete Existing Elements Øuldet First Øuldet Output Øul	+ Apply + Close + Design Calc + Help

- c. Select the first tangent
- d. Select the second tangent



Curve placed between tangents

- e. Data point to Accept the solution
- f. Reset and Close to exit the Add Free Horizontal Curve command

REVIEW ALIGNMENT

1. Select Geometry > Horizontal Element > Check Integrity

EDIT ALIGNMENT

1. Adjust radius of curve to "flatten" it

a. Select Geometry > Horizontal Element > Edit Element

- i. Select *Next* to step through the alignment to the curve element
- ii. Key in a radius of 50
- iii. Select Maintain Element Connectivity

Chapter 5:	Create a Continuous	Tangential	Alianment
•			

)efine From:	Start Stop C	Both	Apply
ype:	Circular Arc	-	Close
ransition:	Clothoid	-	Transnose
Start		_	
Station:	65+09.152		Delete
Point Name:			Undo
Northing:	1064685.322	+	Nudge
Easting:	157292.128		Design Calc.
Direction:	N 41^35'06.329" W	+	Curve Calc
Radius:	50.000	+	
			кероп
Stop	[_	Help
Station:	65+71.078		
Point Name:			
Northing:	1064743.037	-	Select
Easting:	157285.956		First
Direction:	N 29^22'39.319" E	-	< Previous
Radius:	50.000	-	Net
			Next >
ength:	61.927	+	Last
Maintain Ele	ement Connectivity		

iv. Apply



Notice the edits made to the alignment



- v. Select Undo
- vi. Select Maintain Element Connectivity with Minimum Movement

Define From:	Start O Stop O	Both	Apply
уре:	Circular Arc	-	Close
ransition:	Clothoid	-	Transpo
Start		_	Tanapo
Station:	0+54.152		Delete
Point Name:			Undo
Northing:	1064685.322	+	Nudge
Easting:	157292.128		Design Ca
Direction:	N 41^35'06.329" W	+	Curve Ca
Radius:	50.000	+	Report.
Stop			Help
Station:	1+16.079		
Point Name:			
Northing:	1064742.033	-+-	Select
Easting:	157291.803		First
Direction:	N 40^55'46.750'' E	+	< Previo
Radius:	43.000	-#-	Next >
ength:	61.927	+	Last

vii. Select Apply

Note Notice the edits made to the alignment



Minimum movement shown here