Chapter 4

Superelevation

4.1 Objectives

- Learn how GEOPAK defines a roadway slope.
- Learn to use GEOPAK **Auto Shape Maker** and **Graphics Shape Maker** to apply superelevation to a roadway.

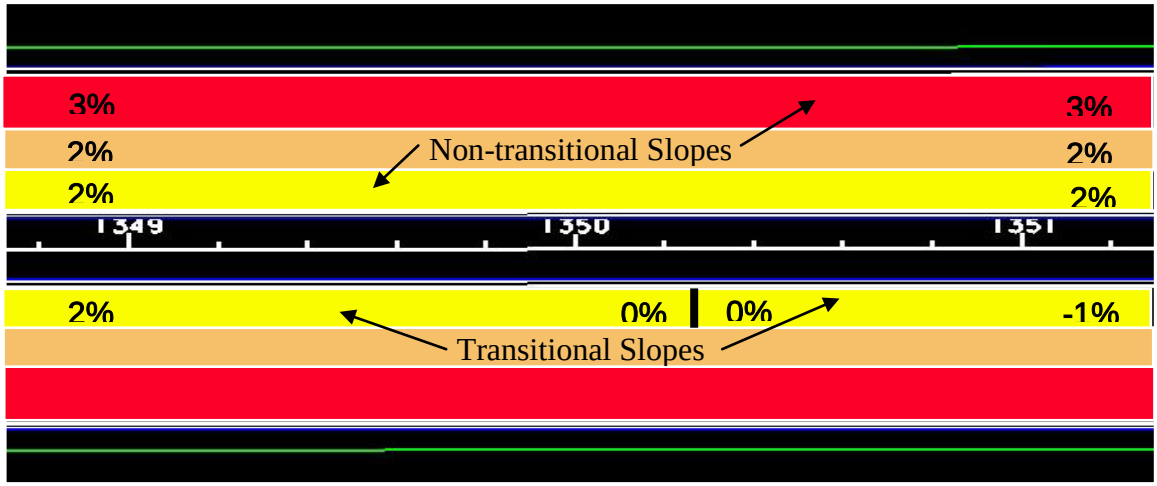
4.2 Definitions

GEOPAK uses two tools to calculate superelevation transition locations for any chain stored in the coordinate geometry database. One tool results in an ASCII file that lists the stations and slopes for each superelevation transition break. Microstation shapes represent the roadway crown and depict the superelevation transition breaks. GEOPAK Superelevation uses the following tools for shape creation.

- **Auto Shape Maker -** is a tool used to create an input file for applying superelevation transition locations along a specified alignment. Using this tool will result in an ASCII file that lists the stations and slopes for each superelevation transition break. This file is then processed to draw the shapes into the Microstation drawing.
- **Graphics Shape Maker** permits interactive creation of superelevation shapes defined by graphic elements drawn in a Microstation file.

4.2.1 Shapes

Shapes are Microstation complex shapes that are placed into a design file to represent an area of pavement slope. **Non-transitional** shapes have a constant slope for the entire length of the shape. **Transitional** shapes have a different slope at each end of the shape, and will either linearly or parabolically interpolate between the slopes.



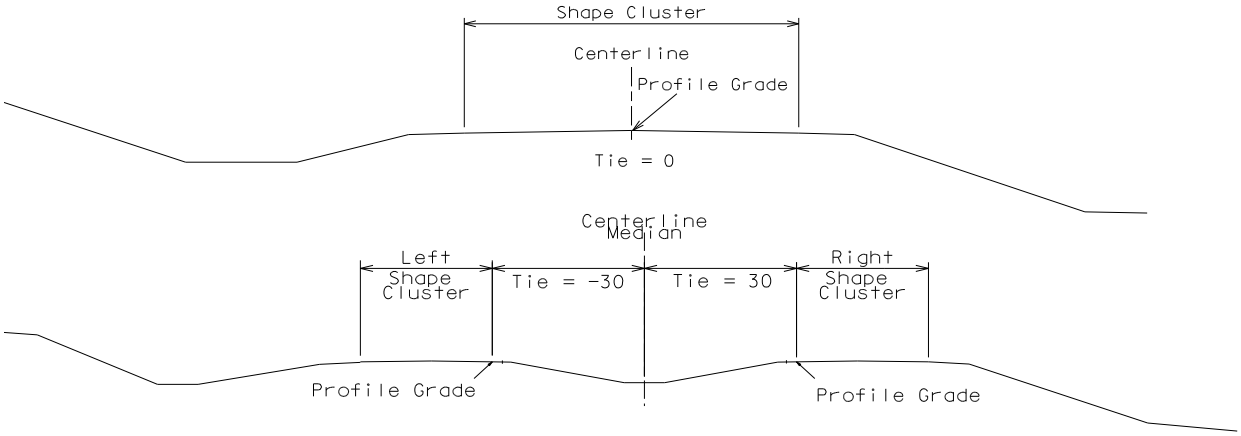
4.2.2 Shape Clusters

Four attributes are associated with each shape depending on the definition of the profile grade line.

Baseline – roadway baseline

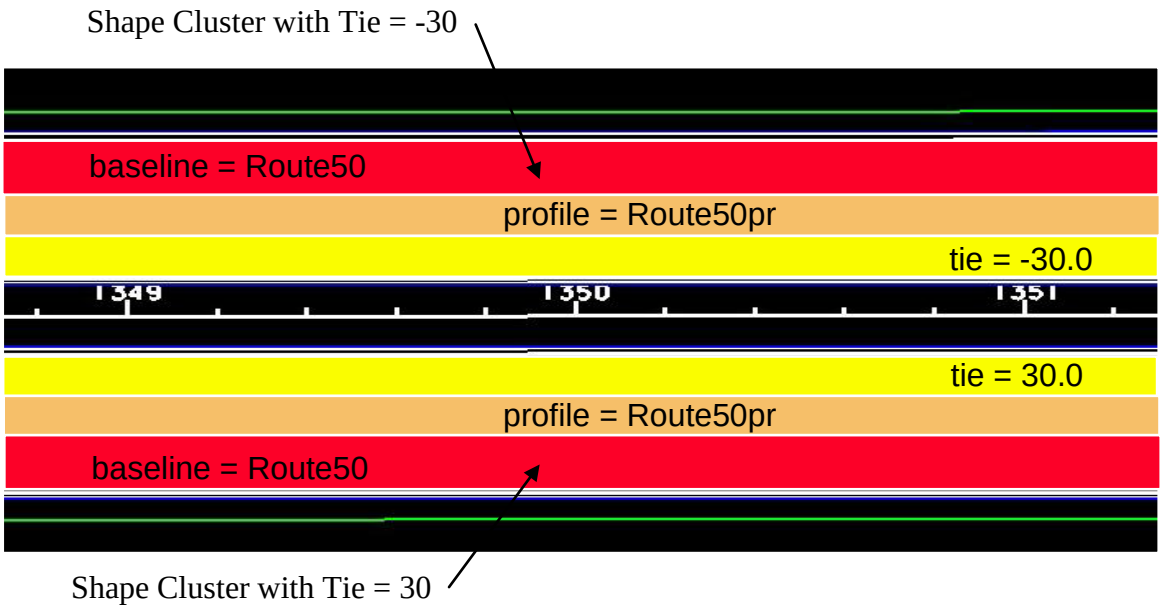
Profile – roadway profile

Tie – distance between the roadway baseline and roadway profile



PGL-Chain – (optional) defines the location of the profile if the distance between the baseline and profile is not constant. (If the distance is constant the tie distance can be used.)

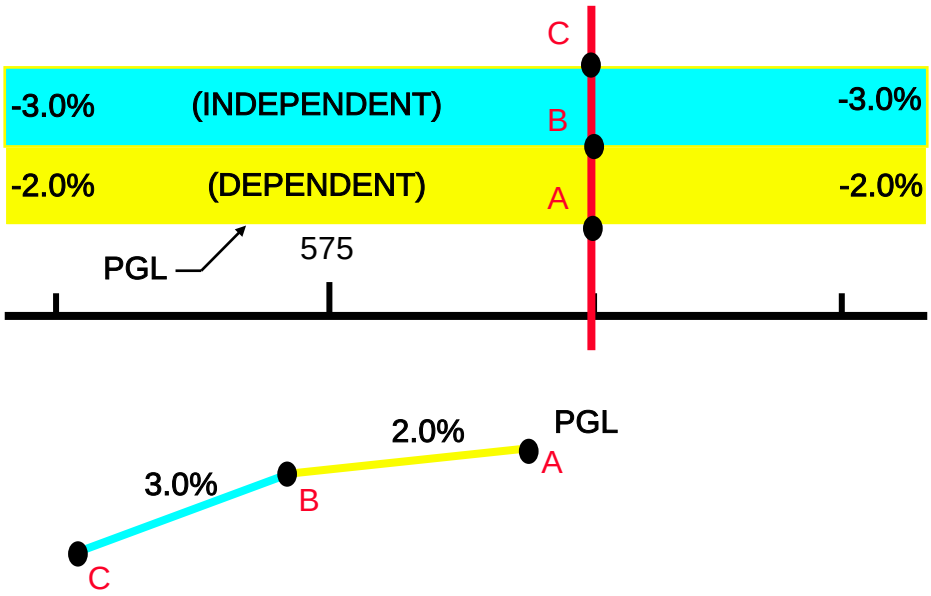
A group of shapes with the same shape attributes is called a "Shape Cluster".



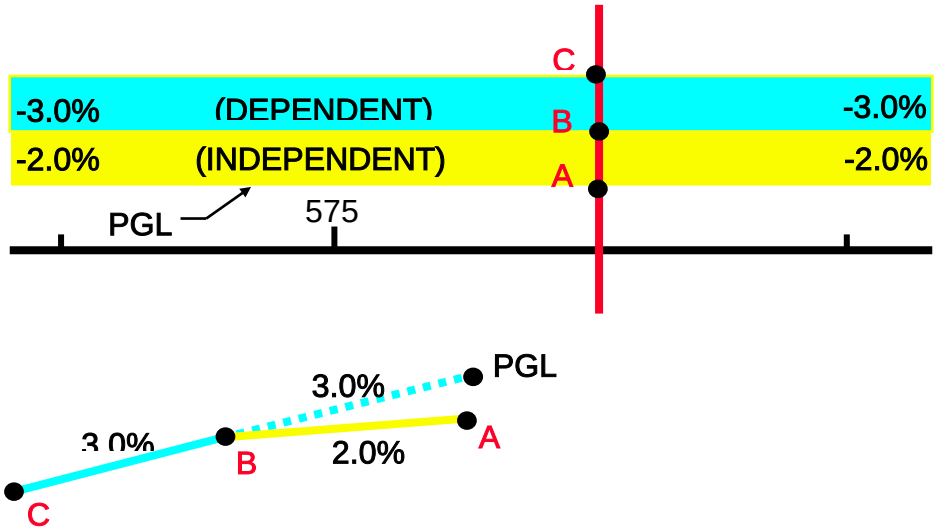
4.2.3 Shape Class

There are two classifications of shapes, **Dependent** and **Independent,** which determine how the pavement elevations are computed. **Dependent** shape pavement elevations are determined directly from the profile. **Independent** shape pavement elevations are determined from adjacent shapes.

The figure below shows the dependent shape adjacent to the profile grade line (PGL). Therefore, the elevation of the shape at point A will be the elevation of the profile at point A. The elevation of the shape at point B will be calculated based on the width and slope of the dependent shape. This will be the starting elevation for the independent shape. The elevation of point C will be calculated based on the width and slope of the independent shape.



The figure below shows the independent and dependent shape reversed from the figure above. In this case, the independent shape is located next to the PGL. The starting elevation of the dependent shape, point B, is calculated based on the slope of the dependent shape and the



distance between the dependent shape and the profile. The end of the dependent shape, point C, is calculated based on the width and slope of the dependent shape. The end point of the independent shape, point B, is at the same elevation as the dependent shape at that point, and the beginning of the independent shape, point A, is calculated based on the width and the slope of the independent shape.

It is good practice to use one dependent shape for each shape cluster.

4.2.4 Shape Elements

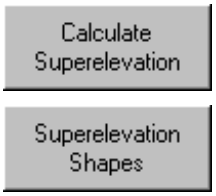
Shapes consist of a series of connected Microstation elements that form a closed surface. The types of elements can be classified into two types, **longitudinal edges**, and **filler lines**.

Longitudinal Edges - Typically, these consist of the roadway edges of pavement or lane lines. These lines do not represent slopes.

Filler Lines - These lines represent the beginning and ending slopes of a pavement shape. Each of these lines always represents a slope value.

4.3 Accessing

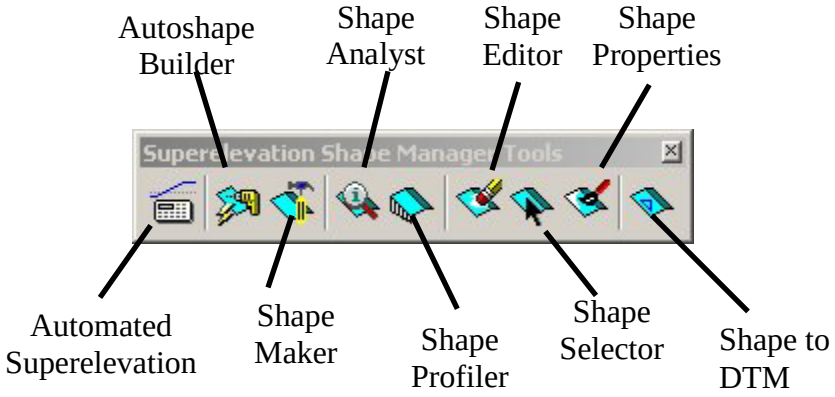
The superelevation tools can be accessed from the cross section toolbox by choosing the **Superelevation Shape Manager** tool. When selected, the superelevation toolbox will be displayed.



The Automated Superelevation can also be accessed from **Project Manager >> Calculate Superelevation**, and the **Shape Maker** can also be accessed from **Project Manager >> Superelevation Shapes**.

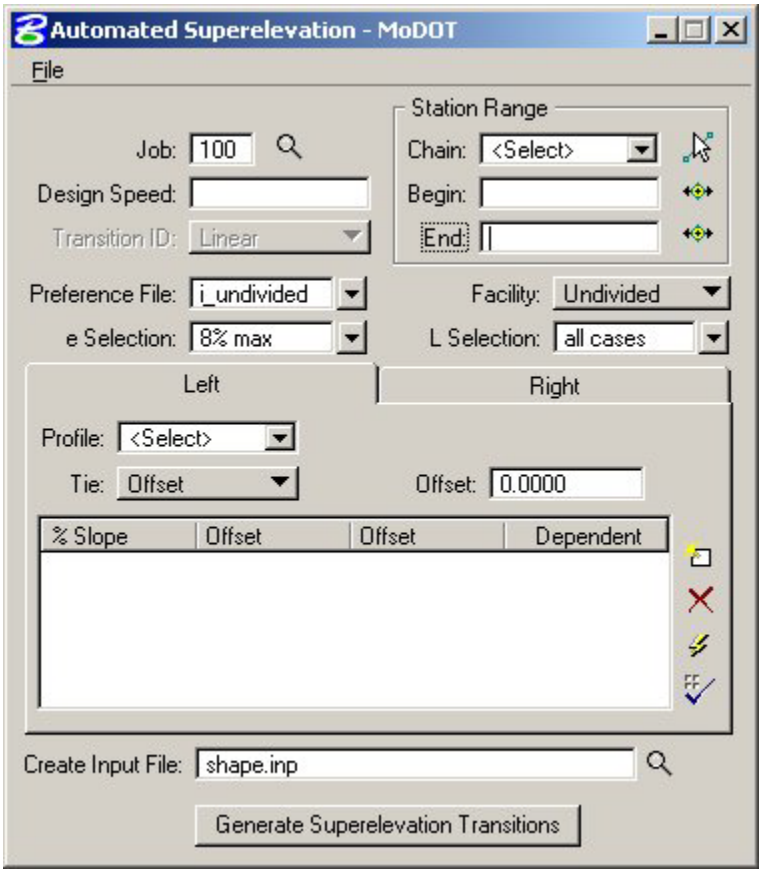
4.4 Dialog

The superelevation toolbox is shown below.



4.4.1 Automated Superelevation

The **Automated Superelevation** dialog is the dialog most commonly used to create superelevation. It allows the user to specify the parameters needed for superelevation, and then creates an input file the user can modify according to the specific design for the project. When the **Automated Superelevation** icon is chosen, the following dialog will appear.



If project manager is used, the **Job Number**, **Chain**, and **Begin** and **End** stations will be filled in using the current **Working Alignment**. The user can specify the design information as follows.

Job – Job number of the .gpk file for the project.

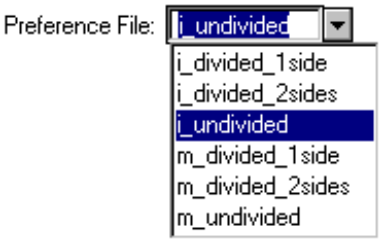
Chain – Baseline chain name for the project. This may be the centerline of roadway for an undivided roadway, the centerline of median for a divided roadway, or the edge of pavement for a ramp.

Begin – station to begin the shapes.

End – station to end shapes.

Design Speed - the design speed for the project that determines the rate of superelevation for curves.

Preference File – the file to use in calculating the superelevation rates and transition stations. The user should choose the preference file according to the standard plan being used for superelevation calculations.



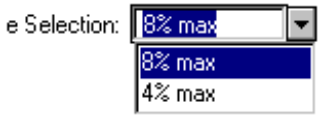
i_divided_1side – imperial, divided roadway, using standard 203.21G, when calculating only 1 side of the median.

i_undivided – imperial, undivided roadway, using standard 203.20E

m_divided_1side – metric, divided roadway, using standard M203.21G, when calculating only 1 side of the median

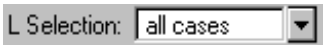
m_undivided – metric, undivided roadway, using standard M203.20E

e Selection – the maximum superelevation value to be used for the alignment. Select **8% max** for rural projects and **4% max** for urban projects.



Facilitiy – set according to if the roadway is Undivided or Divided

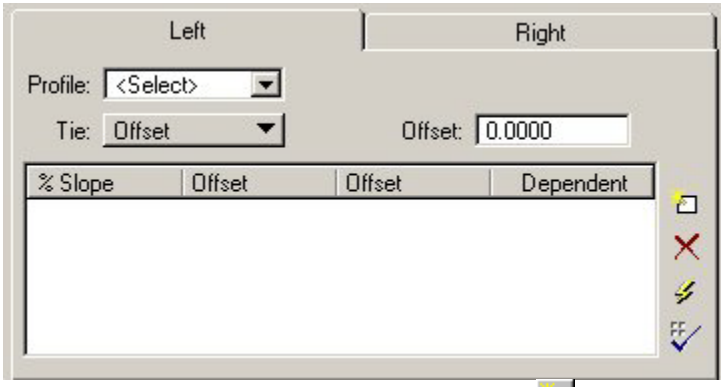
L Selection – this should be set to **All Cases** for all situations.



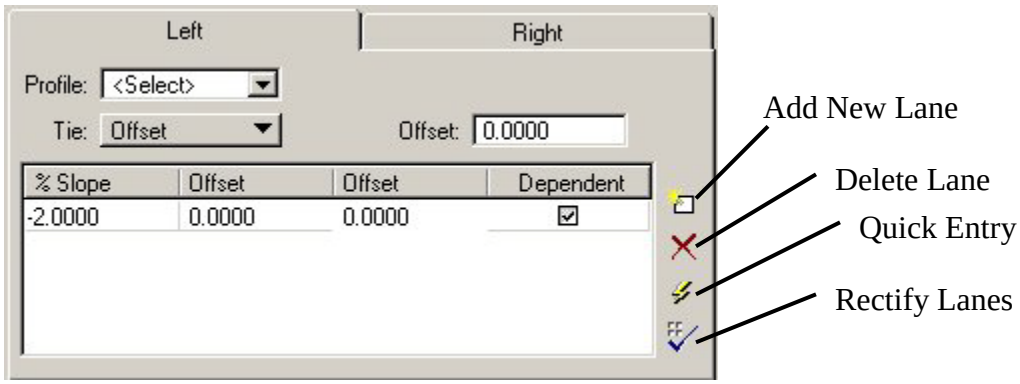
Profile – choose the profile for the left and right sides. For undivided roadways, the left and right profiles should be the same. For divided roadways, the left and right profiles may or may not be the same.

Tie/PGL Chain – set to either **Tie** or **PGL Chain**. The tie distance is the distance between the baseline and the profile. If this distance is variable, a PGL chain can be used to define the location of the profile.

The **% Slope**, **Offset**, and **Dependency** field define the shape characteristics.



Shapes can be added by selecting the **Add New Lane** button  . Once the add button has been selected the following dialog appears



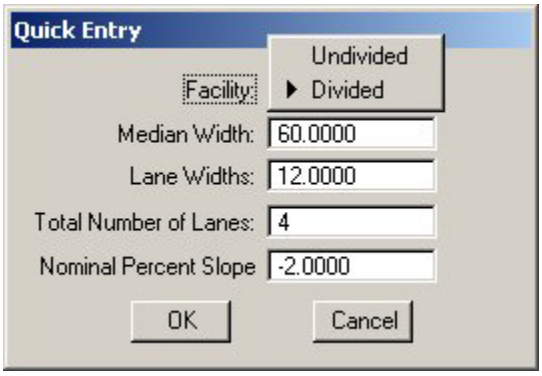
To specify the **% Slope, offsets, and dependency**, double click in the **% Slope, Offset and Dependent cells** for each row and type in the desired value. Once listed, the shapes can be deleted, or modified by re-entering the values in the cells.

% Slope – define as the normal slope for this section of roadway.

Offset – define one **Offset** as the distance between the baseline and the inside edge of the shape, and the other as the distance between the baseline and the outside edge of the shape.

Dependency – defines whether the shapes elevation is determined by the profile, or by the adjacent shapes. **Dependent** shapes obtain the elevation from the profile and the slope of the shape as discussed in section 14.2. **Independent** shapes obtain the elevation from adjacent shapes. Check the toggle to set a **Dependent** shape or leave unchecked for an **Independent** shape.

Create Input File – specifies the name o the shape input file to be created that creates the shape information. This file needs to be run to plot the shapes into the Microstation drawing.



The **Quick Entry** button will bring up the **Quick Entry** dialog. This dialog can be used to create shapes without calculating the required offsets for multiple lanes. The user chooses the type of **Facility** as divided or undivided. If divided is chosen, the **Median Width** can be specified. The **Lane Widths**, **Total Number of Lanes**, and the **Nominal Percent Slope** are specified. When the dialog has been completed, the **OK** button is pressed, and the number of lanes and their corresponding offsets are automatically entered into the shape cluster list boxes.

When the **Automated Superelevation** dialog has been completed, the user presses the **Generate Superelevation Transitions** button. This will create the input file specified in the **Create Input Field** dialog.

4.4.2 Superelevation Input File

A **Superelevation Input File** with an .inp extension is created and placed in the project directory. This input file shows where the location superelevation critical points by indicating the station and slope along the roadway. This is an ASCII file that may be reviewed and/or edited. A sample input file is provided below.

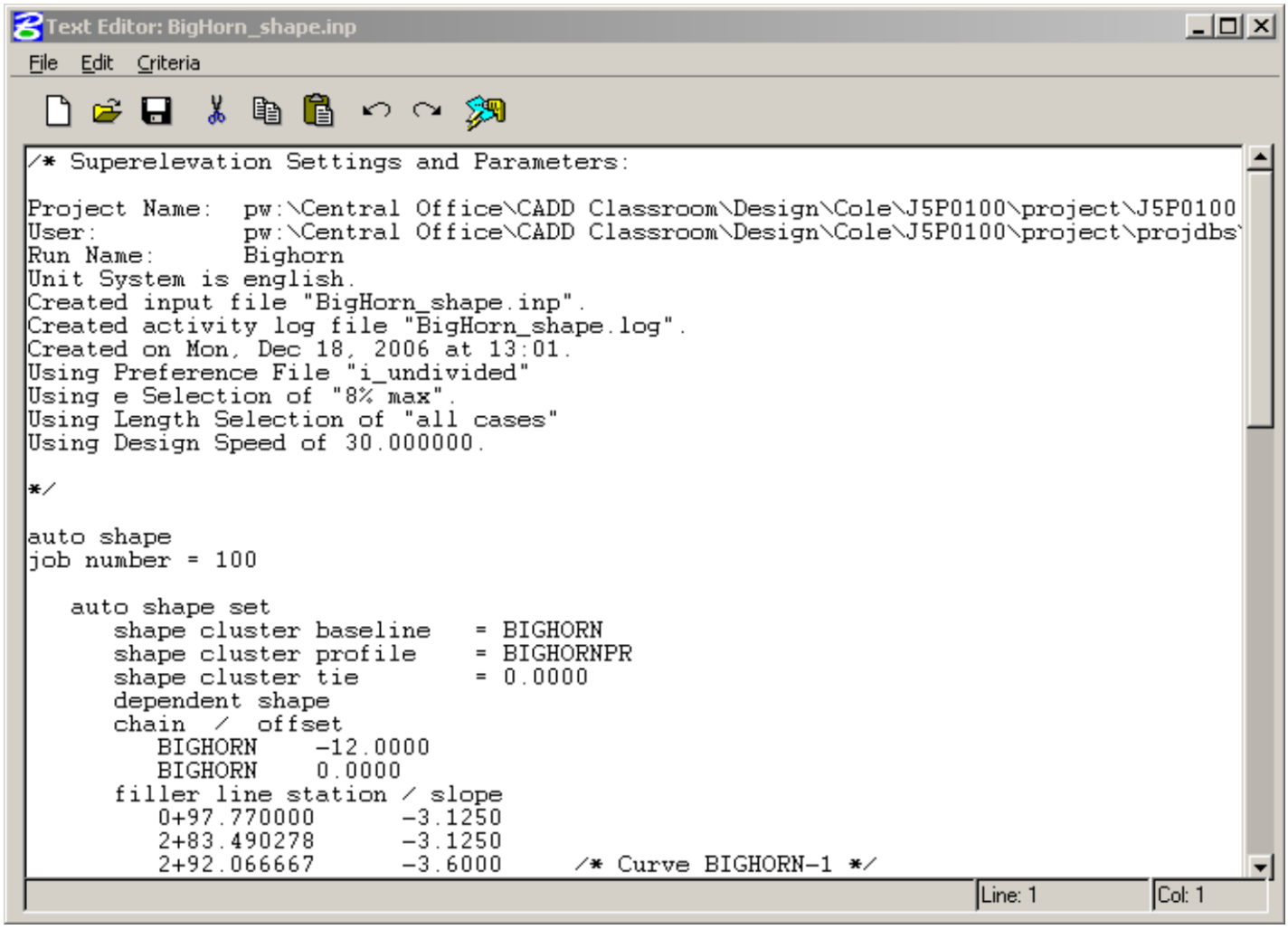
```
/* Superelevation Settings and Parameters:
Project Name:  PW:\Central Office\CADD
Classroom\Design\Randolph\J2P0200\project\J2P0200.prj
User:          PW:\Central Office\CADD
Classroom\Design\Randolph\J2P0200\project\projdbs\ClsUser
Run Name:      ROAD1
Unit System is english.
Created input file "shape_ROAD1.inp".
Created activity log file "shape_ROAD1.log".
Created on Tue, Oct 05, 2004 at 15:19.
Using Preference File "i_undivided"
Using e Selection of "8% max".
Using Length Selection of "all cases"
Using Design Speed of 30.000000.
*/

auto shape
job number = 100

  auto shape set
    shape cluster baseline   = ROAD1
    shape cluster profile    = ROAD1PR
    shape cluster tie        = 0.0000
    dependent shape
    chain  /  offset
      ROAD1    -12.0000
      ROAD1    0.0000
    filler line station / slope
         0+97.770000   -3.1250
        21+52.700000   -3.1250

  auto shape set
    shape cluster baseline   = ROAD1
```

shape cluster profile = ROAD1PR
shape cluster tie = 0.0000
independent shape
chain / offset
ROAD1 0.0000
ROAD1 12.0000
filler line station / slope
0+97.770000 -3.1250
21+52.700000 -3.1250
Plot Parameters
Dependent Shape
lvname = Geopak-Shapes 2
co = 2
lc = 0
wt = 2
Dependent Text
lvname = Geopak-Shapes 2
co = 2
Independent Shape
lvname = Geopak-Shapes 2
co = 7
lc = 0
wt = 2
Independent Text
lvname = Geopak-Shapes 2
co = 7

Write shapes into the following dgn:

PW:\Central Office\CADD Classroom\Design\Randolph\J2P0200\data\Pattern_shape_J2P0200.dgn

The input file is also opened into the Geopak text editor. The input file can be edited in the text editor. Once any changes have been made, and the input file has been saved, the text editor can be used to process the input file by clicking on the **Create Superelevation Shapes** button.



4.4.3 Superelevation Log File

When the **Superelevation Input File** is created, the **Superelevation Log File** is also created. The **Superelevation Log File** contains information pertaining to the creation of the input file. A sample log file is shown below.

Beginning calculation of superelevation for chain ROUTE63 in job 100.

Computing superelevation rates . . .
Curve ROUTE63-1, radius 2864.7890: Superelevation rate computes to be 3.8000.

Computing transition lengths . . .
Note: Because the roadway width consists of 4 lanes,
lengths are to be adjusted after initial calculation.
Curve ROUTE63-1: Super rate of 3.8000 yields
unadjusted runoff length of 150.0000.

Transition Length adjusted to 150.0000 for 4 lanes.

Checking for transition conflicts . . .
No transition conflicts were found.

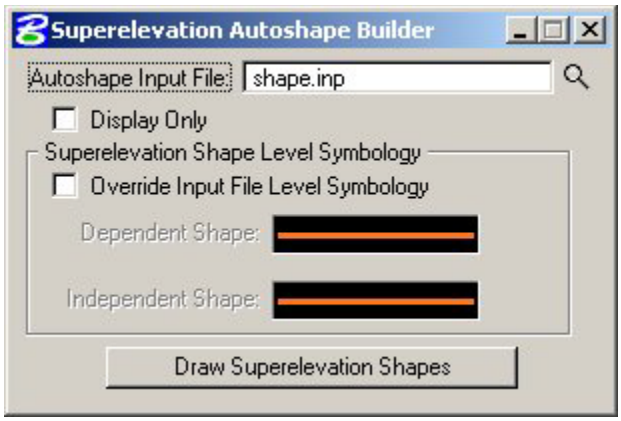
Superelevation Calculation Complete.
Output written to file "shape.inp"

The log file indicates the superelevation rate computed for each curve, the transition length for each curve, and any transition conflicts between curves.

The **Superelevation Log File** should be reviewed prior to the processing of the input file to check for errors, and verify any transition conflict resolutions.

4.4.4 Autoshape Builder

After the input file has been created and edited, it needs to be processed to plot the shapes into the Microstation design file. The input file can be processed by using the **Create Superelevation Shapes** button in the text editor, or by using the **Autoshape Builder**. The **Autoshape Builder** can be accessed from the Superelevation toolbox.  The following dialog will appear.



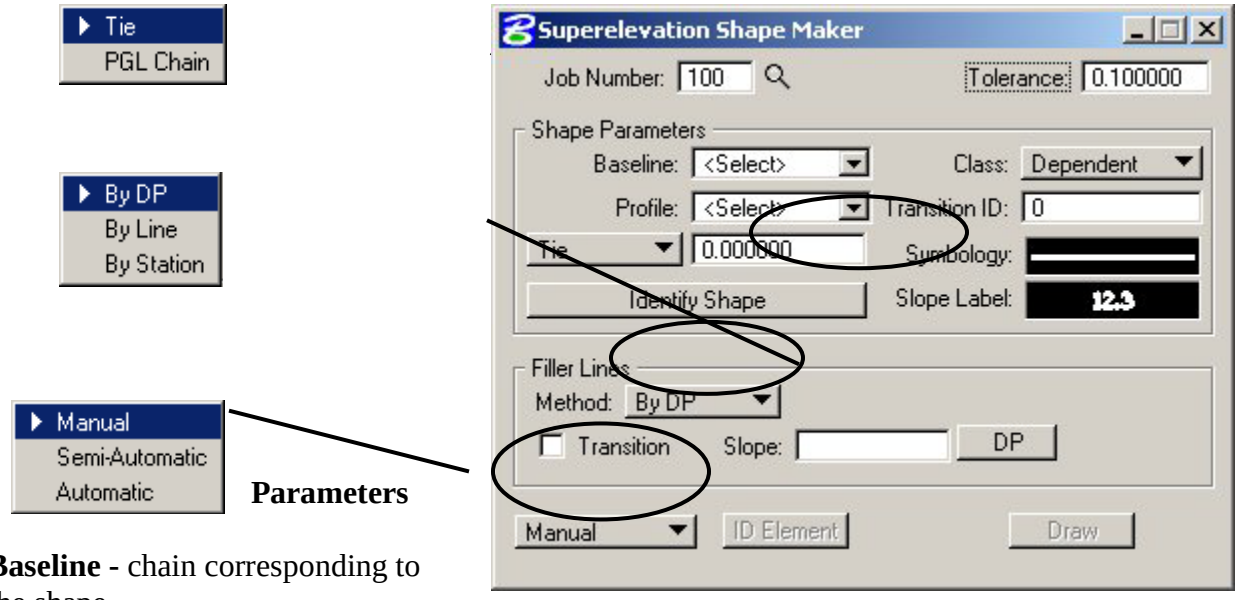
The user selects the **Autoshape Input File** to process and then press the **Draw Superelevation Shapes** button to process. The shapes will be placed with the level symbology that was specified in the input file. However, if the user desires to place the shapes with different level symbology**,** then the **Override Input File Level Symbology** to set the desired parameters. The **Display Only** toggle can be turned on to temporarily plot the shapes into the Microstation design file. When the view is updated, the temporary graphics will be deleted.

4.5 Shape Maker

Not all superelevation transitions can be defined by station and offset. GEOPAK provides the **Graphical Shape Maker** for situations that involve **left turn lanes**, **merging roadways** and in some cases, **widening**.

The user uses simple Microstation elements to depict the area to which superelevation is applied. Once the area is drawn, the **Graphical Shape Maker** dialog box allows the designer to define the roadway information to apply superelevation. The Microstation elements are then identified and a complex shape representing the superelevation is created.

Access Shape Maker from the GEOPAK Project Manager by selecting **Superelevation Shapes** or from the **Shape Maker** icon in the **Superelevation** toolbox. The following dialog is displayed.



Parameters

Baseline - chain corresponding to the shape.

Profile - profile controlling shape.

Tie - distance between the profile and the baseline.

PGL Chain - chain to define the profile location if the tie distance varies.

Class - dependent or independent, as previously discussed

Transition ID - determines linear or parabolic transition. Use 0 for linear transition.

Symbology - MicroStation level symbology used for placing the shape.

Slope Label – Sets level symbology to be used for plotting slope labels.

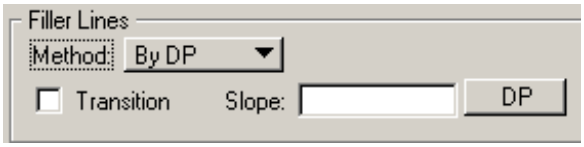
Identify Shape – Displays the parameters of the selected shape utilizing the sequence of operations listed below:

1. Click **Identify Shape**.
2. Identify and accept a previously defined shape with a data point cursor button.

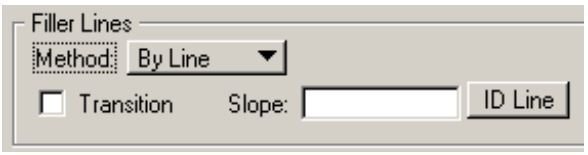
3. The **Baseline**, **Profile**, **PGL Chain**, **Trans ID**, and **Tie** parameters associated with the shape are displayed on the Shape Maker Window and become active parameters.

Filler Lines

Method: **By DP -** identify filler line by issuing a data point (DP) on each end of the line



By Line - identify filler line by selecting a Microstation line



By Station - identify filler line by keying in station limits

Transition: This option determines whether GEOPAK creates the shapes as transitional or non-transitional shapes. When the toggle is turned off, a non-transitional shape is drawn. When toggled on, a transitional shape is drawn using the slope specified in the **Slope** field.

Transitional - shape is in a superelevation transition
Non-Transition - shape is not in a superelevation transition (full super or normal crown).

Slope: Cross slope for the filler line at the beginning and end of the shape

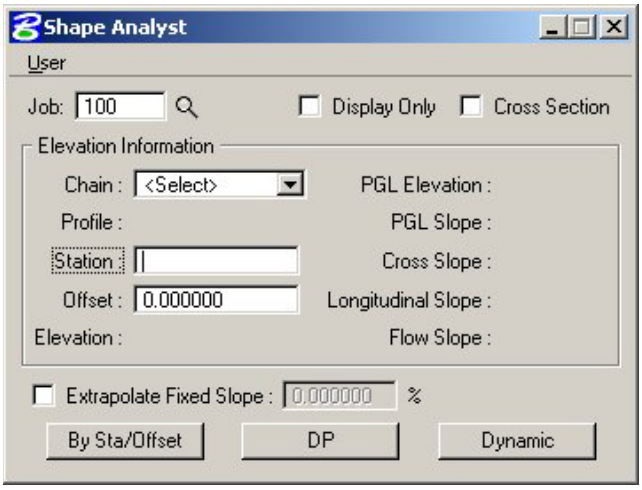
Complete Shape: **Manual -** user identifies each element that makes up the shape.
Semi-Automatic - user *accepts* or *rejects* elements that make up the shape.
Automatic - GEOPAK uses all contiguous elements to create the shape.

Tolerance: User specified acceptable maximum gap between the MicroStation elements that make up the shape.

4.6 Additional Superelevation Tools

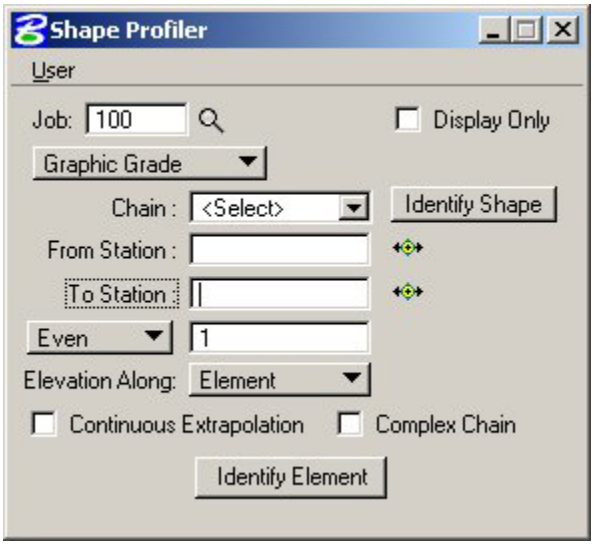
4.6.1 Shape Analyst

The **Shape Analyst** is used to determine the slope of a shape at a particular point. The elevation, profile elevation, and slope, cross slope, longitudinal slope, and flow slow are computed and displayed. The elevation can be computed off the shape by using an **Extrapolated Slope** from the edge of the shape. The **Cross Section** option will display the slope of each shape, and the elevation at the edge of each shape.



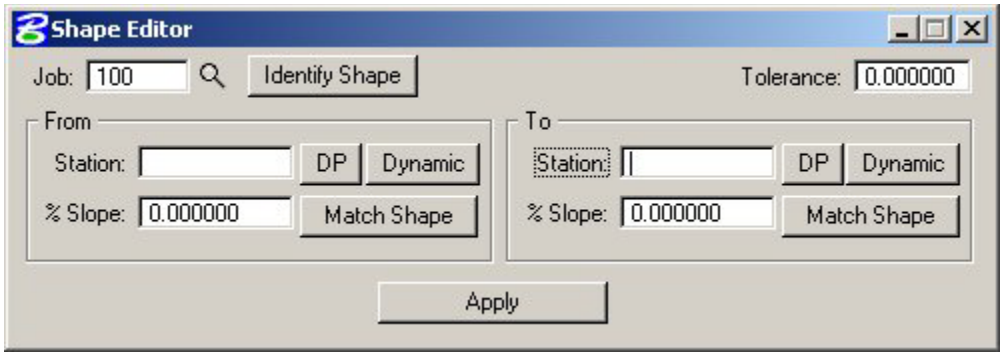
4.6.2 Shape Profiler

The **Shape Profiler** is used to graphically draw the elevations and/or slope arrows into the design file for a specified element or shape. COGO points can also be stored at the given locations.



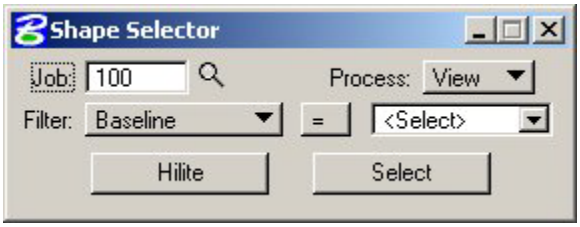
4.6.3 Shape Editor

The user can edit the plotted shapes by using the **Shape Editor**. The Shape Editor allows the user to adjust the slope of the filler lines, or change the location of the filler lines. The filler lines of the adjacent shapes are also adjusted as needed.



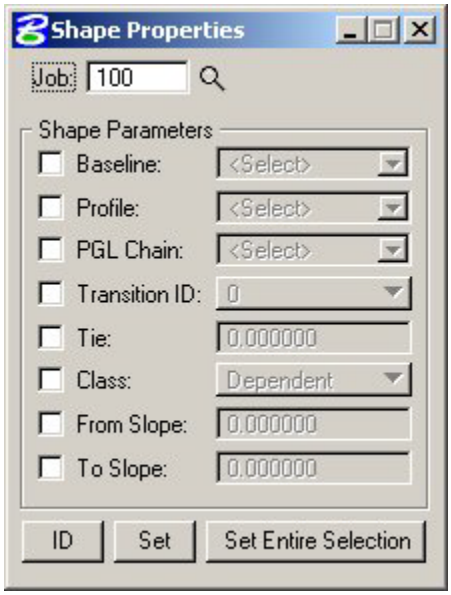
4.6.4 Shape Selector

The **Shape Selector** allows the user to select or highlight shapes based on various attributes of the shape. The attributes include baseline, profile, tie, transition type, class, slope, etc.



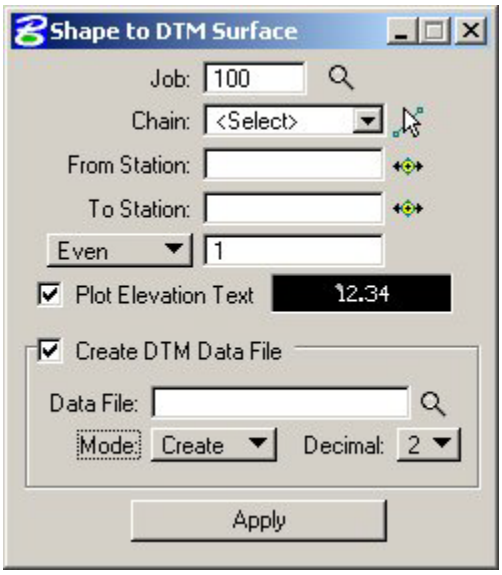
4.6.5 Shape Properties

The properties of a shape can be edited using the **Shape Properties** tool. With **Shape Properties**, a user can change the baseline, profile, tie, etc. of a shape.



4.6.6 Shape to DTM Surface

The **Shape to DTM Surface** tool allows the user to create a data file from the plotted shapes. This data file can then be used to create a TIN model based on the elevations calculated from the plotted shapes. The user has the option to calculate the Digital Terrrain Model (DTM) data file for the entire chain or for a specific station range.



4.7 Group Exercise – Road1

1. Using ProjectWise open the following MicroStation file:

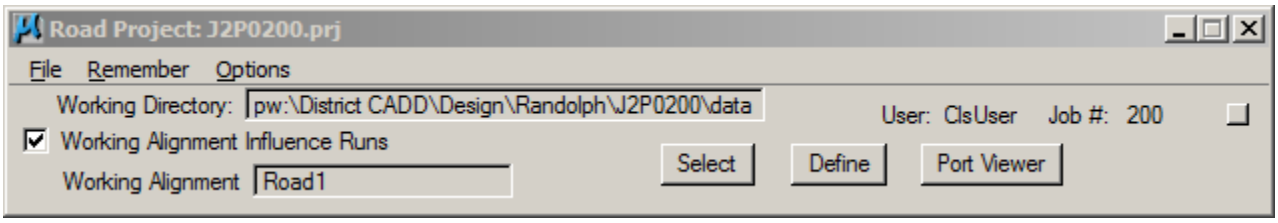
   pw:\\MoDOT\ District CADD\Design\Randolph\J2P0200\data \pattern_shape.dgn.

2. Open the following project:

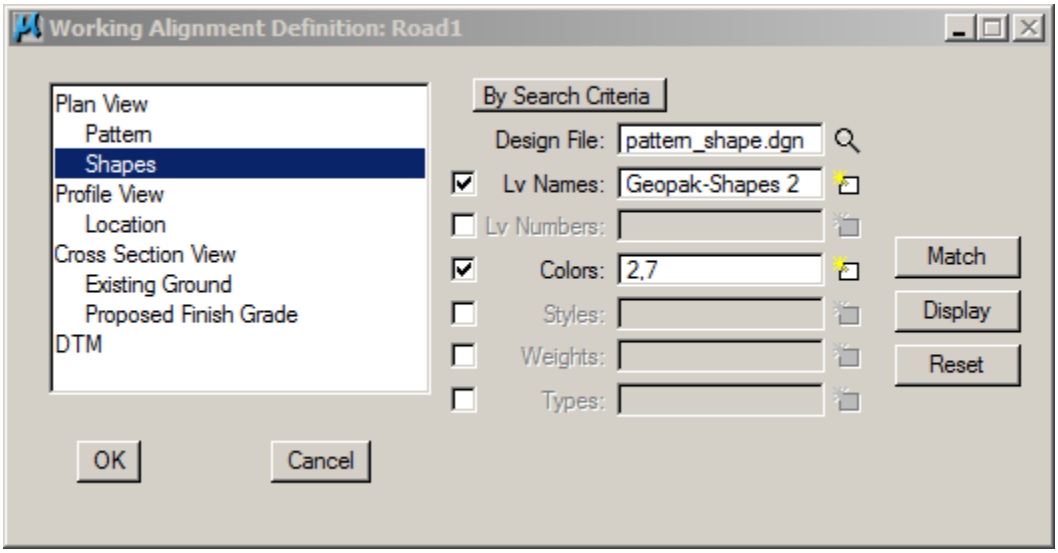
   pw:\\MoDOT\District CADD\Design\Randolph\J2P0200\project\J2P0200.prj.

   Select the user **ClsUser** and enter **Road**.

3. Select the **ROAD1** working alignment and click on Define to enter the Working Alignment Definition.

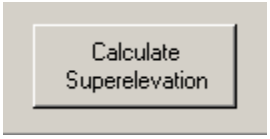


Switch to the Shapes section and notice that the design file is already set and that the symbology is set to GeoPak-Shapes 2 and Colors 2, 7, as shown below.



Close the Working Alignment Definition dialog by clicking on **OK**.

4. Choose Calculate Superelevation from the Road Project dialog.

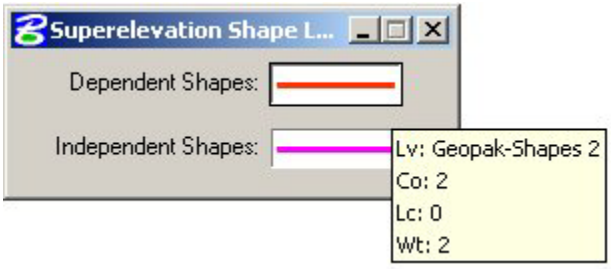


Copy the **MoDOT** run to **ROAD1**, and open the **ROAD1** run as demonstrated.

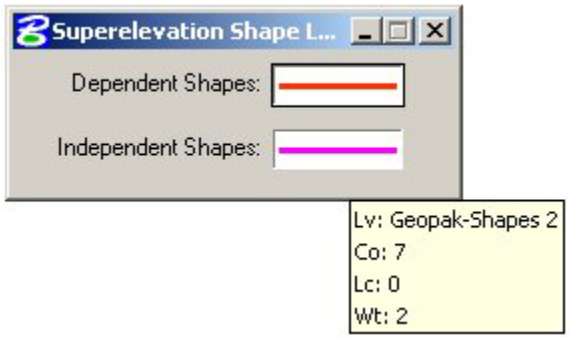
5. In the Automated Superelevation dialog, go to File > Level Symbology.

Make the following changes as shown in the picture of the dialog.

Dependent Shapes Level: **Geopak-Shapes 2** Color: **2**



Independent Shapes Level: **Geopak-Shapes 2** Color: **7**

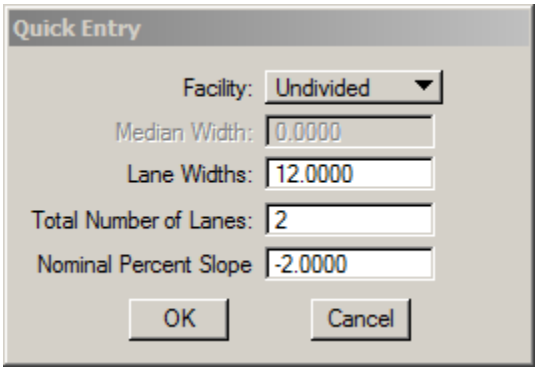


6. Setup the superelevation using the following parameters.

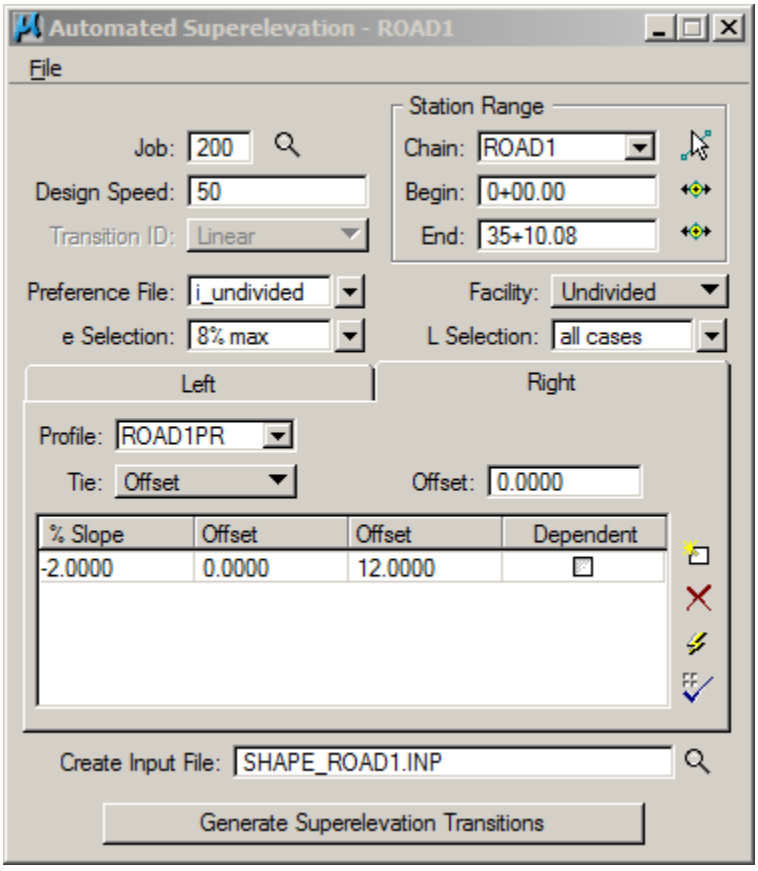
Station Range	
Job: **200**	Chain:**ROAD1**
Design Speed: **50**	Begin: ***Beginning of Chain***
Preference File: **i_undivided**	End: ***End of Chain***
e Selection: **8% max**	Facility: **Undivided**
	L Selection: **all cases**

Enter **ROAD1PR** as the profile for the **Left** tab. Because the facility is undivided, the same profile is automatically added to the Right tab. Select the **Quick Entry icon** shown to the right to bring up the Quick Entry dialog shown on the next page.

Enter the information in the **Quick Entry** dialog as shown below.



After entering the information in the dialog, click OK and edit the **Right** list box so that the **Dependent** toggle is unchecked as shown below.



Create the following Input File:

SHAPE_ROAD1.INP

7. Review the **SHAPE_ROAD1.log** for any errors.

8. To show that the Shape inp file can be editied, modify the Road1 inp file as listed below:

Original Road1 Shape File

```
auto shape set
  shape cluster baseline  = ROAD1
  shape cluster profile   = ROAD1PR
  shape cluster tie       = 0.0000
  dependent shape
  chain  /  offset
    ROAD1      -12.0000
    ROAD1      -0.0000
  filler line station / slope
    0+00.000000     -2.0000
    7+50.221017     -2.0000
    7+79.096017     -3.2000    /* Curve CURVE3 */
    23+37.286492    -3.2000    /* Curve CURVE3 */
    23+66.161492    -2.0000
    35+10.080000    -2.0000

auto shape set
  shape cluster baseline  = ROAD1
  shape cluster profile   = ROAD1PR
  shape cluster tie       = 0.0000
  independent shape
  chain  /  offset
    ROAD1      0.0000
    ROAD1      12.0000
  filler line station / slope
    0+00.000000     -2.0000
    6+53.966017     -2.0000
    7+02.096017     0.0000
    7+79.096017     3.2000    /* Curve CURVE3 */
    23+37.286492    3.2000    /* Curve CURVE3 */
    24+14.286492    0.0000
    24+62.416492    -2.0000
    35+10.080000    -2.0000
```

Modified Road1 Shape File

```
auto shape set
  shape cluster baseline  = ROAD1
  shape cluster profile   = ROAD1PR
  shape cluster tie       = 0.0000
  dependent shape
  chain  /  offset
    ROAD1      -12.0000
    ROAD1      -0.0000
  filler line station / slope
    0+00.00     -2.0000
    7+50.22     -2.0000
    7+79.10     -3.2000    /* Curve CURVE3 */
    25+37.29    -3.2000    /* Curve CURVE3 */
    25+66.16    -2.0000
    35+10.08    -2.0000

auto shape set
  shape cluster baseline  = ROAD1
  shape cluster profile   = ROAD1PR
  shape cluster tie       = 0.0000
  independent shape
  chain  /  offset
    ROAD1      0.0000
    ROAD1      12.0000
  filler line station / slope
    0+00.00     -2.0000
    6+53.97     -2.0000
    7+02.10     0.0000
    7+79.10     3.2000    /* Curve CURVE3 */
    25+37.29    3.2000    /* Curve CURVE3 */
    26+14.29    0.0000
    26+62.42    -2.0000
    35+10.08    -2.0000
```

Save the changes to the input file in the GEOPAK Text Editor, and choose the **Create Superelevation Shapes** button shown to the right to process the input file.

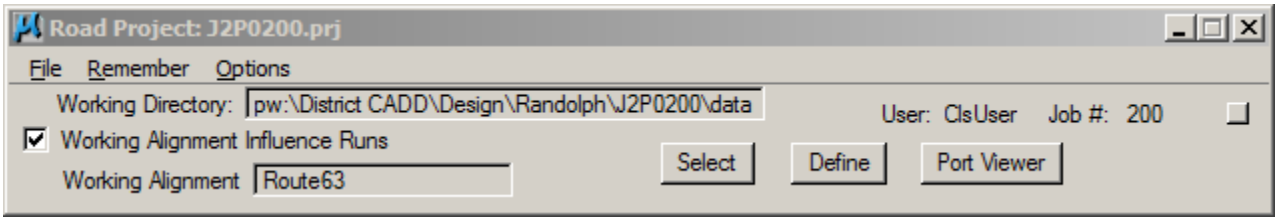
Save the changes to the MicroStation file and exit the superelevation dialogs.

4.8 Individual Exercise - Route 63

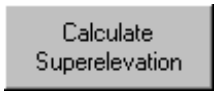
1. Using ProjectWise open the MicroStation file:

   pw:\District CADD\Design\Randolph\J2P0200\data\pattern_shape.dgn.

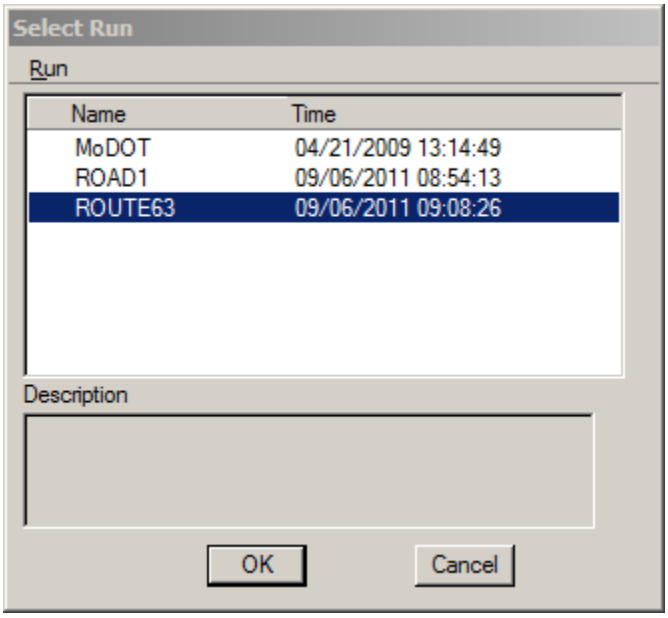
2. Select the **ROUTE63** working alignment.



3. Choose **Calculate Superelevation** from the **Road Project** dialog.



   Copy the **MoDOT** run to **ROUTE63**, and open the **ROUTE63** run.

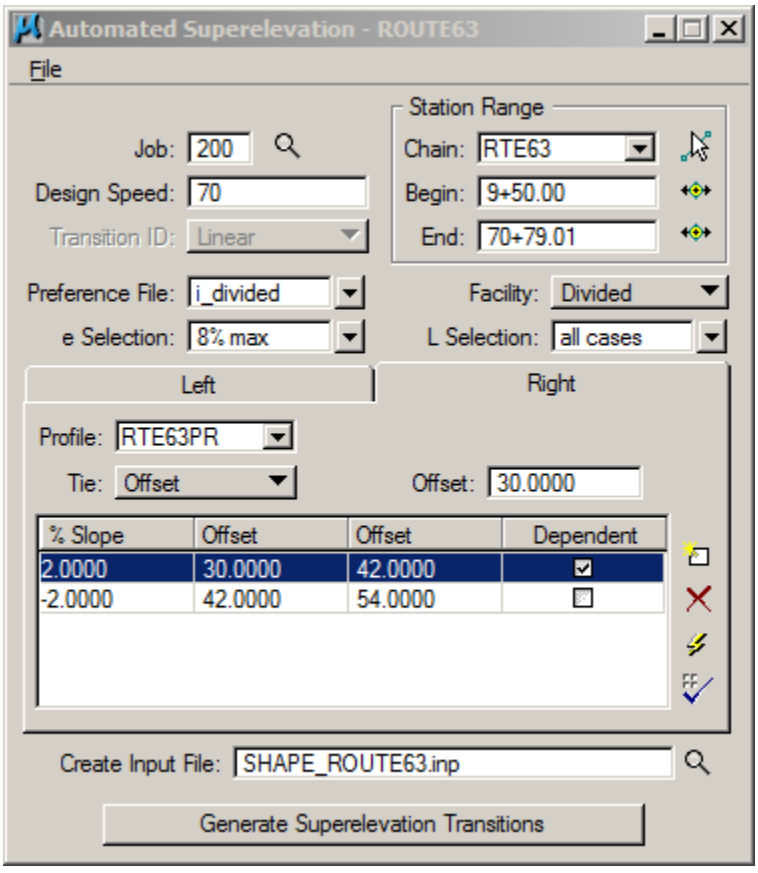


4. Setup the superelevation using the following parameters.

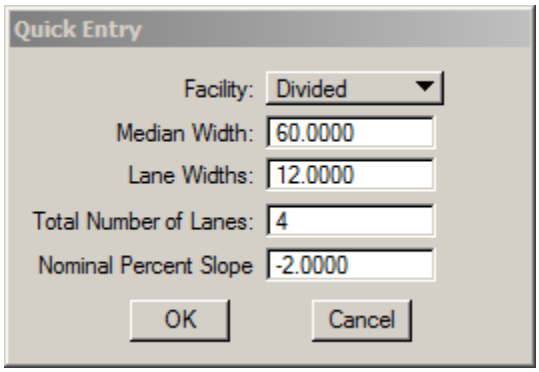
Station Range Job: **100**	Chain: **ROUTE63**
Design Speed: **70**	Begin: ***Beginning of Chain***
	End: ***End of Chain***
Preference File: **i_divided**	Facility: **divided**
e Selection: **8% max**	L Selection: **all cases**

Enter **ROUTE63PR** as the profile for the **Left** and **Right** tabs.

Select the **Quick Entry icon** shown to the right to bring up the Quick Entry dialog shown on the next page. This will populate the left and right tabs as shown in the picture below.



6 (Cont'd) Enter the information in the **Quick Entry** dialog as shown below.

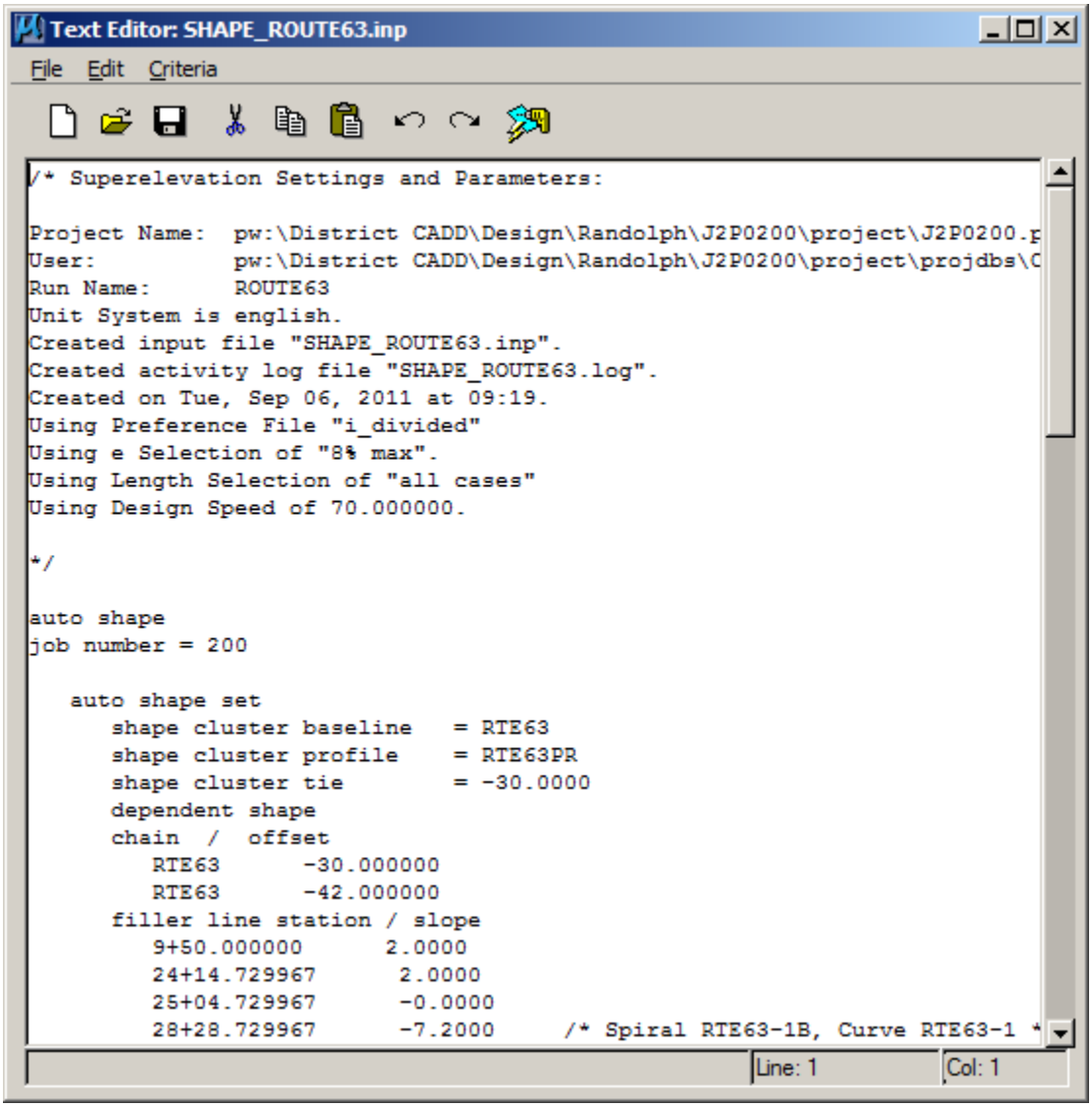


After entering the information in the dialog, click OK and edit Left and Right list box so that it agrees with the following information. Hint: All you should have to do is modify the slopes to the correct signs.

Left:				Right:			
% Slope	Offset	Offset	Dependent	% Slope	Offset	Offset	Dependent
2.0	**-30**	**-42**	**Checked On**	**2.0**	**30**	**42**	**Checked On**
-2.0	**-42**	**-54**	**Checked Off**	**-2.0**	**42**	**54**	**Checked Off**

Create Input File: **SHAPE_ROUTE63.inp**

7. Review the **SHAPE_ROUTE63.inp** and the **SHAPE_ROUTE63.log** for any errors.



8. Save any changes to the input file in the GEOPAK Text Editor, and choose the **Generate Superelevation Transitions** button shown to the right to process the input file.

Save the MicroStation file, exit the superelevation dialogs update the working alignment.