

Road Rehabilitation Design Using AutoCAD® Civil 3D® Subassemblies

Presenter: Michael Bandich, P.E. – U.S. CAD

Lab Assistants: Danny Counts (C.E.O. U.S. CAD) & Melanie Santer (A.E. U.S. CAD)

CV214-1L Using a real-world example of a road rehabilitation project, we will unleash the "magic" of AutoCAD Civil 3D subassemblies to increase productivity and help reduce errors and omissions. We will create a Corridor model that will start with an existing road surface, and then learn how to improve that surface by holding to certain existing features and/or holding certain cross fall. We'll explore the (near) automatic creation of dynamically annotated cross-sectional views. And lastly, we'll learn to generate quantity takeoff reports.

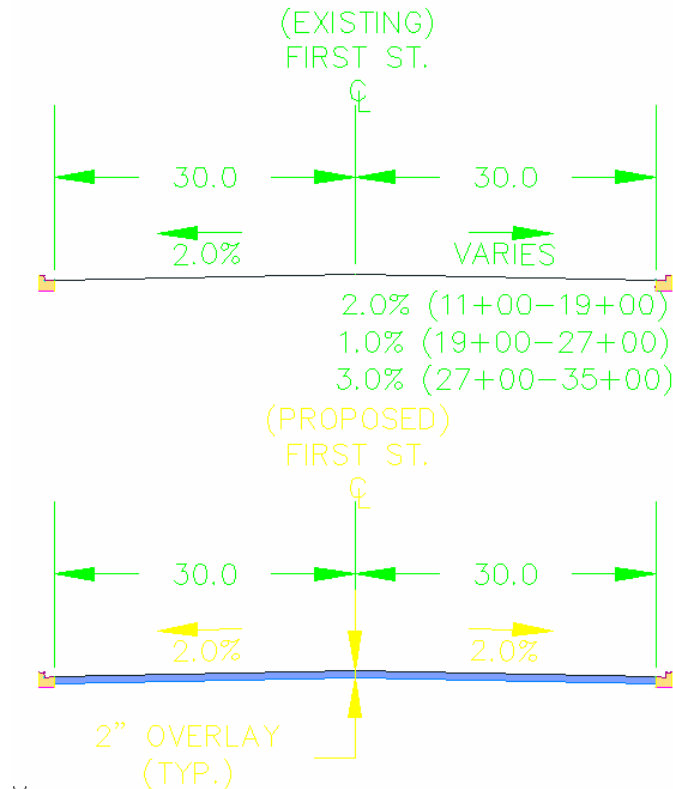
About the Speaker:

Mike has worked in the civil engineering field for the past 12 years. Currently, he is an applications engineer for U.S. CAD. His current duties include training on all Autodesk ISD (Infrastructure Solutions Division)-related products and project management of a variety of civil engineering projects. Prior to joining U.S. CAD, he worked with a variety of land- and civil-development projects as a designer and project manager. Mike has a solid understanding of the engineering process thanks to his experiences with large and small engineering firms and with a design/build contractor.

E-Mail: mbandich@uscad.com

Exercise 1: Simple Overlay

In this exercise, we will use a road rehabilitation subassembly, “OverlayCrownBetweenEdges”, to complete a simple road overlay project.



Givens: Existing ground (“EG”) surface; centerline horizontal and vertical alignments (“First St”)

A. Create Assembly

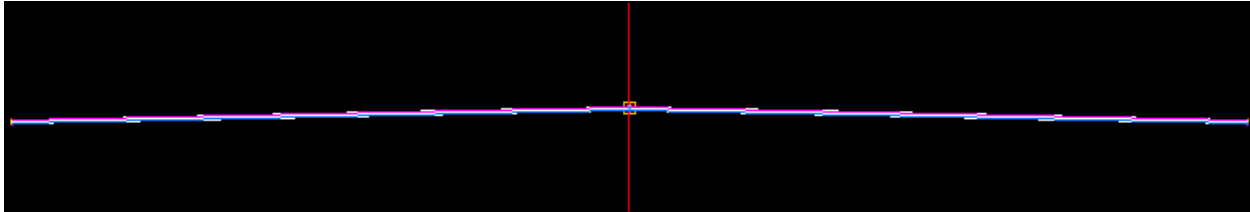
1. Open drawing “1-A”
2. If the Tool Palette containing the subassemblies is not visible, enter “Toolpalettes” at the command line. Click corridors menu → create assembly.
3. In the Create Assembly dialog box, Type “Case-1” for the assembly name. Accept the default settings for all other options. Click OK.
4. When the ‘Specify assembly baseline location’ prompt is displayed at the command line, click a point in the drawing to build the assembly (The view zooms to the assembly baseline).
5. In the Tool Palette, click the Rehab tab and select the “OverlayCrownBetweenEdges” subassembly.
6. In the ADVANCED Parameters section, set the value as displayed in image to the right.

ADVANCED	
Parameters	
Left Lane Slope	-2.00%
Right Lane Slope	-2.00%
Version	R2008
Left Edge Offset	-30.000'
Right Edge Of...	30.000'
Left Edge - M...	none
Right Edge - ...	none
Crown Height	0.600'
Min Slope	-1.00%
Max Slope	-3.00%
Overlay Depth	0.167



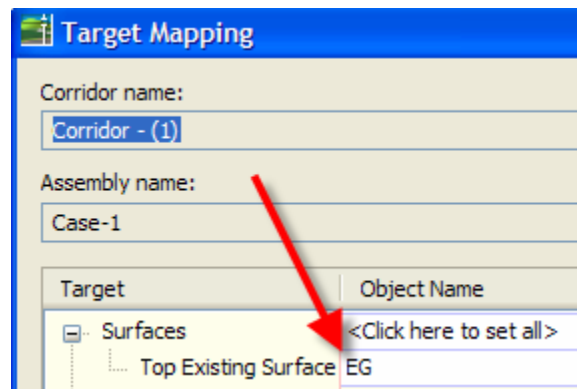
7. In the drawing, click the marker point on the assembly baseline. A lane is drawn. Press Esc to exit subassembly placement mode.

The finished assembly should look as follows:



B. Build Corridor

1. Open drawing "1-B"
2. Click Corridors menu → Create Corridor.
3. When the 'Select baseline alignment' prompt is displayed, press Enter. Select "First St." in the Select An Alignment box. Click OK.
4. When the 'Select a profile' prompt is displayed, press Enter. Select "EG – Surface (1)" in the Select A Profile box. Click OK.
5. When the 'Select an assembly' prompt is displayed, press Enter. Select "Case-1" in the Select An Assembly box. Click OK. The Create Corridor dialog box appears.
6. In the Create Corridor dialog box, in the Corridor Name field, enter an appropriate name (or leave default value).
7. Define your starting and ending stations for the Case-1 assembly as (start station = 11+00'; end station = 35+00').
8. Define your sampling frequency for Case-1 assembly (select as appropriate or leave default values).
9. Click "Set All Targets" button in the create corridor dialog box. The Target Mapping dialog box opens. Set the "Top Existing Surface" to "EG" and leave all other targets as default values. Click OK to close the Target Mapping dialog box.
10. Click OK to close the Corridor properties dialog box.



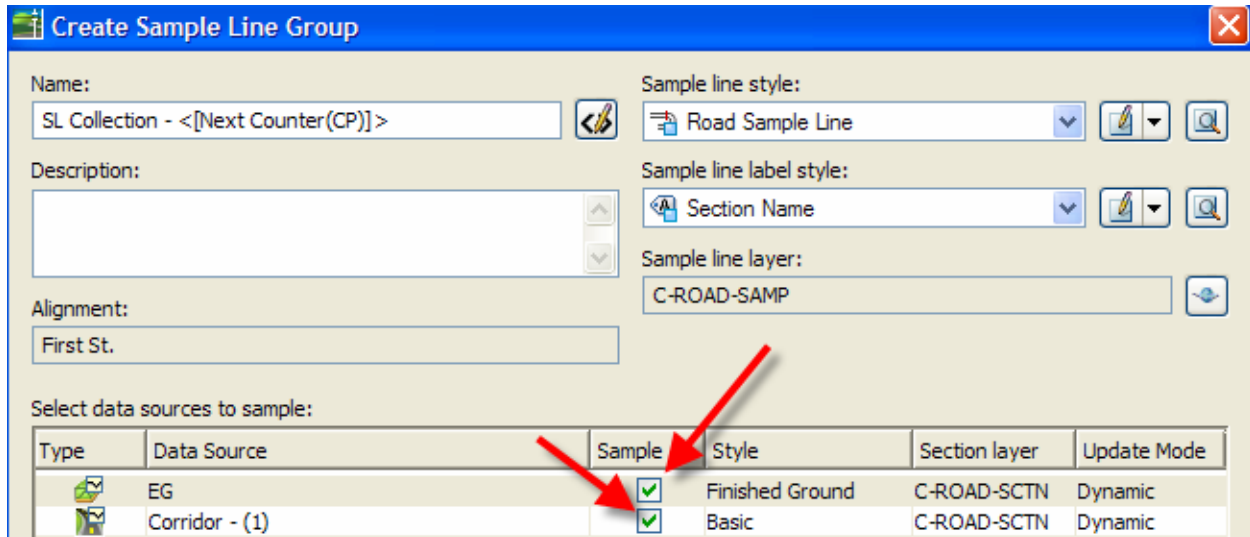
The corridor model is built and should look similar to the below image:



C. Create Cross-Section Views

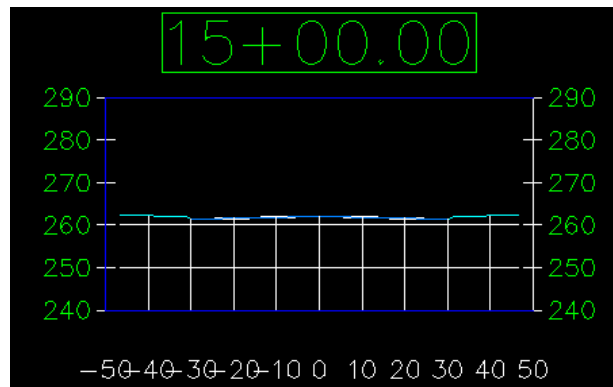
1. Open drawing "1-C"
2. Click Sections menu → Create Sample Lines.

- When the 'Select baseline alignment' prompt is displayed, press Enter. Select "First St." in the Select An Alignment box. Click OK. The "Create Sample Line Group" dialog box appears (the "create sample line group" dialog box appears only if this is the first sample line group created in the current drawing).
- In the "Create Sample Line" dialog box leave defaults or set all values as displayed below and Click OK.



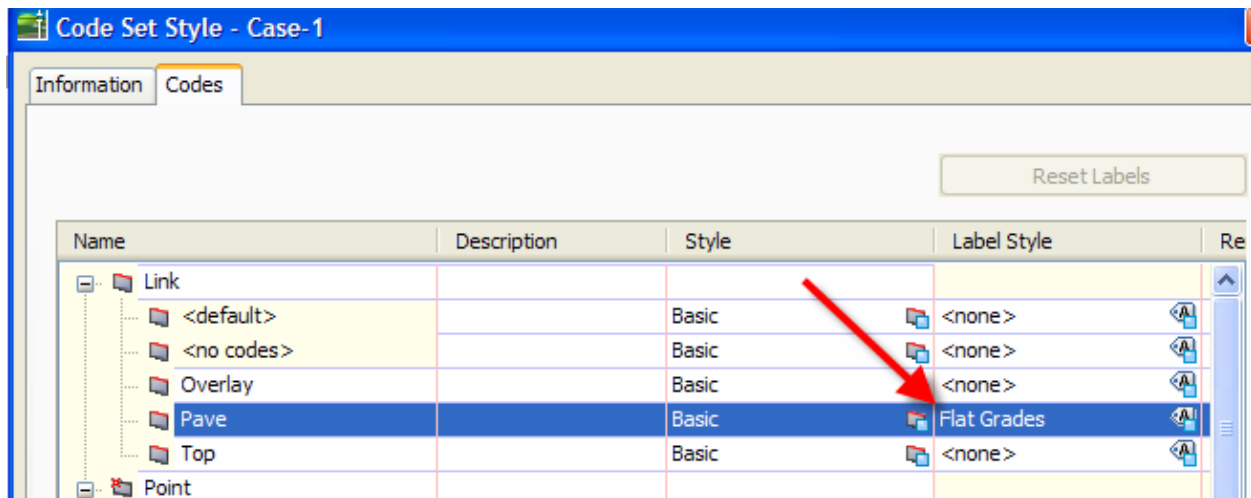
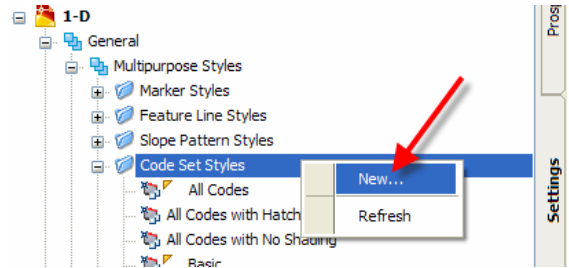
- At the "Specify Station" prompt, type 1500 [Enter]. When prompted for the left/right swath width, accept the default value of 50'. Repeat the previous step for station 2300 and 3100 (If you get a warning stating that the corridor model is out of date, be sure to "rebuild" your corridor before the next step).
- Click Sections menu → Create Multiple Section Views.
- When the "Create Multiple Section Views" dialog appears, un-check the "data bands" box and accept all other values as default and Click OK.
- When prompted to 'Identify Section View Origin', find a suitable location for the section view, for example, outside the surface boundary for ease of viewing. Click that location to define the origin.

The section view at station 15+00 should like very similar to the below image:

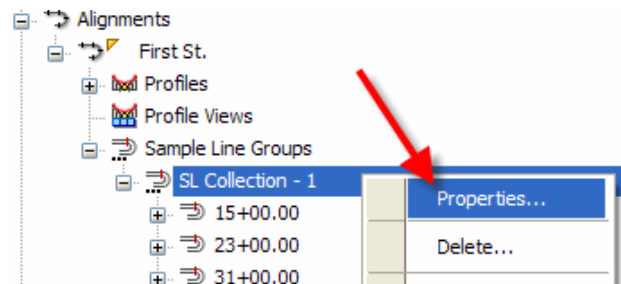


D. Create Cross-Section Annotation

1. Open drawing “1-D”
2. On your Toolspace Settings tab, expand your General collection, Multipurpose Styles collection, and Code Set Style collection. Right click on the top level of the Code Set Style collection and select “New”.
3. The “Code Set Style” dialog box appears. On the Information tab, in the name field, type “Case-1”.
4. Switch to the “Codes” tab. Select the “Import Codes...” button (bottom right).
5. When prompted to “Select subassemblies, assemblies, and/or corridors to import codes from”, graphically select the corridor model from the drawing area and [Enter]. The codes are automatically displayed in the Codes tab list.
6. Assign appropriate object and label styles to the point, link or shape you wish to annotate in section view (i.e. add slope labels to the Pave link in order to display the design slopes). Click OK.



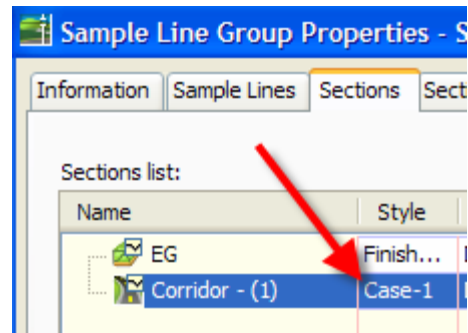
7. Apply the newly created Code Set Style to the section views. On your Toolspace Prospector tab, expand your Alignments collection, First St collection, and Sample Line Group collection. Right click on the “SL Collection - 1” and select the “Properties” option.



8. In the resulting dialog box, select the “Sections” tab. Find the “Style” column and click in the cell next to the “Corridor – (1)” and set the Style to “Case-1”.

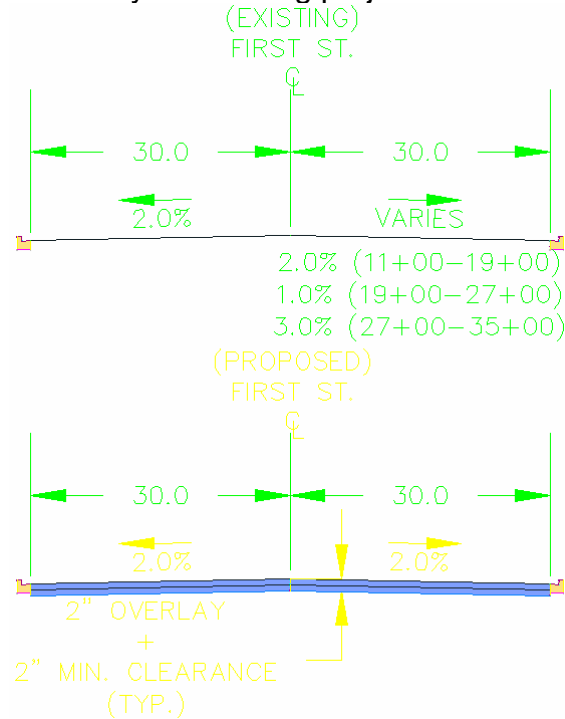
E. Extra Practice with
“OverlayCrownBetweenEdges” Sub-Assembly

1. Open drawing “1-E”
2. Set the following sub-assembly parameters: crown height = 0'; min slope = +1%; max slope = -1%.
3. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00. (*note that crown height and min/max slopes...*)
4. Set the following sub-assembly parameters: crown height = 0'; min slope = 0%; max slope = -1%.
5. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00. (*note that crown height and min/max slopes*
6. Set the following sub-assembly parameters: crown height = 0'; min slope = -0.5%; max slope = -1%.
7. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00. (*note that crown height and min/max slope*
8. Set the following sub-assembly parameters: crown height = 0'; min slope = -10%; max slope = -30%.
9. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00. (*note that crown height and min/max slope.*



Exercise 2: Overlay and Mill

In this exercise, we will use a road rehabilitation subassembly, “OverlayMillAndLevel2”, to complete a simple road overlay with milling project.



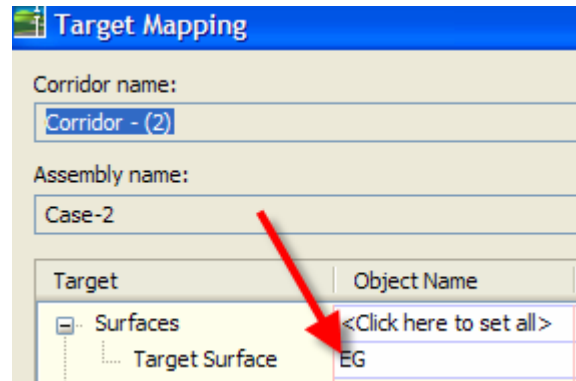
Givens: Existing ground (“EG”) surface; centerline horizontal and vertical alignments (“First St”)

A. Build Corridor

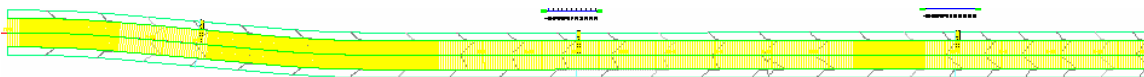
1. Open drawing “2-A”.
2. Review the input parameter for the “Case-2” assembly by right clicking on the “OverlayMillAnd Level2” sub-assembly and selecting “Properties” (not sub-assembly properties) and verify the match the below image:

ADVANCED	
Parameters	
Left Overlay Slope	-2.00%
Right Overlay Slope	-2.00%
Version	R2008
Crown Point Offset	0.000'
Left Sample Point Offset	-30.000'
Right Sample Point Offset	30.000'
Left Trim Point Offset	-30.000'
Right Trim Point Offset	30.000'
Left Overlay Slope Options	Match slope
Default Left Overlay Slope	-2.00%
Right Overlay Slope Options	Match slope
Default Right Overlay Slope	-2.00%
Slope Tolerance	1.00%
Use Profile	Use minimum clearance
Minimum Clearance	-0.167
Overlay Depth	0.167

3. Click Corridors menu → Create Corridor.
4. When the 'Select baseline alignment' prompt is displayed, press Enter. Select "First St." in the Select An Alignment box. Click OK.
5. When the 'Select a profile' prompt is displayed, press Enter. Select "EG – Surface (1)" in the Select A Profile box. Click OK.
6. When the 'Select an assembly' prompt is displayed, press Enter. Select "Case-2" in the Select An Assembly box. Click OK. The Create Corridor dialog box appears.
7. In the Create Corridor dialog box, in the Corridor Name field, enter an appropriate name (or leave default value).
8. Define your starting and ending stations for the Case-2 assembly as (start station = 11+00'; end station = 35+00').
9. Define your sampling frequency for Case-2 assembly (select as appropriate or leave default values).
10. Click "Set All Targets" button in the create corridor dialog box. The Target Mapping dialog box opens. Set the "Top Existing Surface" to "EG" and leave all other targets as default values. Click OK to close the Target Mapping dialog box.
11. Click OK to close the Corridor properties dialog box.

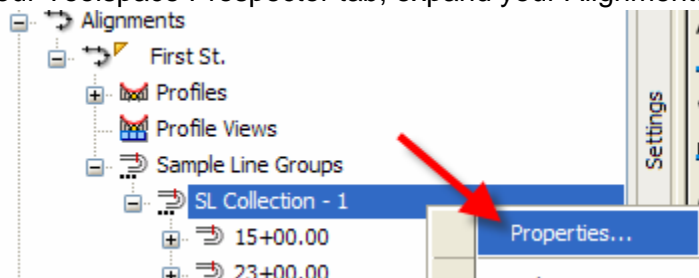


The corridor model is built and should look similar to the below image:

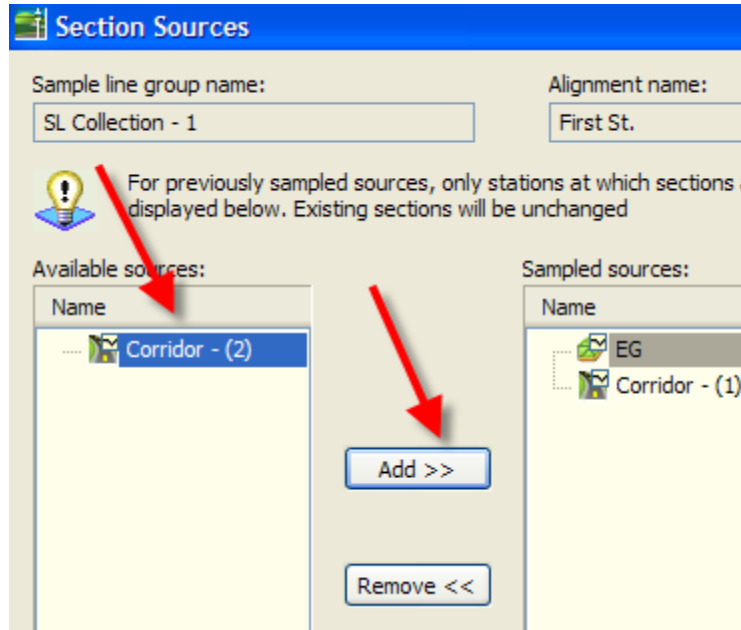


B. Create Cross-Section Views

1. Open drawing "2-B"
2. Add the newly created corridor model (Corridor – (2)) to the existing sample line group ("SL Collection - 1"). On your Toolspace Prospector tab, expand your Alignments collection, First St collection, and Sample Line Group collection. Right click on the "SL Collection - 1" and select the "Properties option".
3. In the resulting dialog box, select the "Sections" tab. Click the "Sample More Sources" button (Upper right corner).

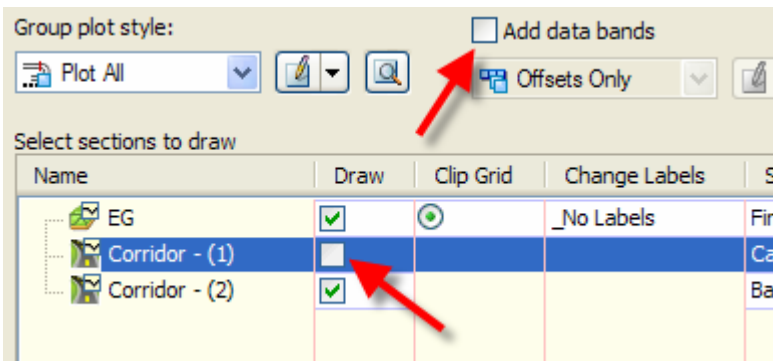


- In the resulting Section Source dialog box, Highlight “Corridor – (2)” and click the Add button:



- Click OK in the Section Sources dialog box and OK again in the Sample Line Group Properties dialog box to exit.
- Create three new section views, using the same procedure as discussed above (being sure to un-check the “Corridor – (1) as a data source to draw).
- Click Sections menu → Create Multiple Section Views.

- When the “Create Multiple Section Views” dialog appears, un-check the “data bands” box and the draw “Corridor – (1)” box. Accept all other values as default and Click OK.

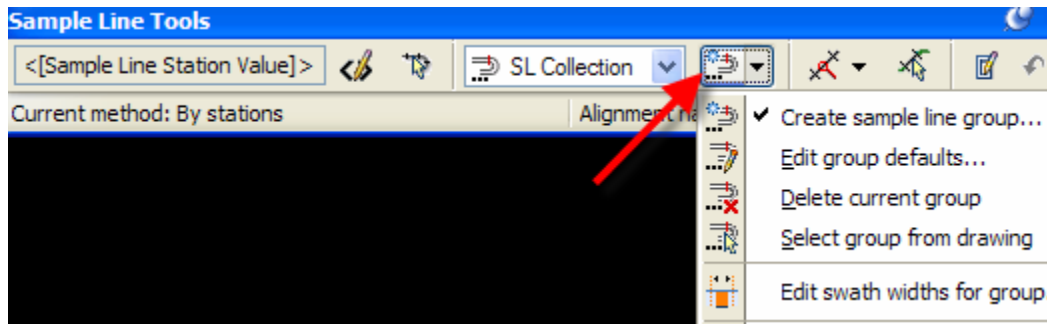


- When prompted to ‘Identify Section View Origin’, find a suitable location for the section view, for example, outside the surface boundary for ease of viewing. Click that location to define the origin.
- Three new section views are added to the drawing. If time permits, build a custom Code Set Style for Corridor – (2), using the procedure discussed in Exercise 1, Step D.

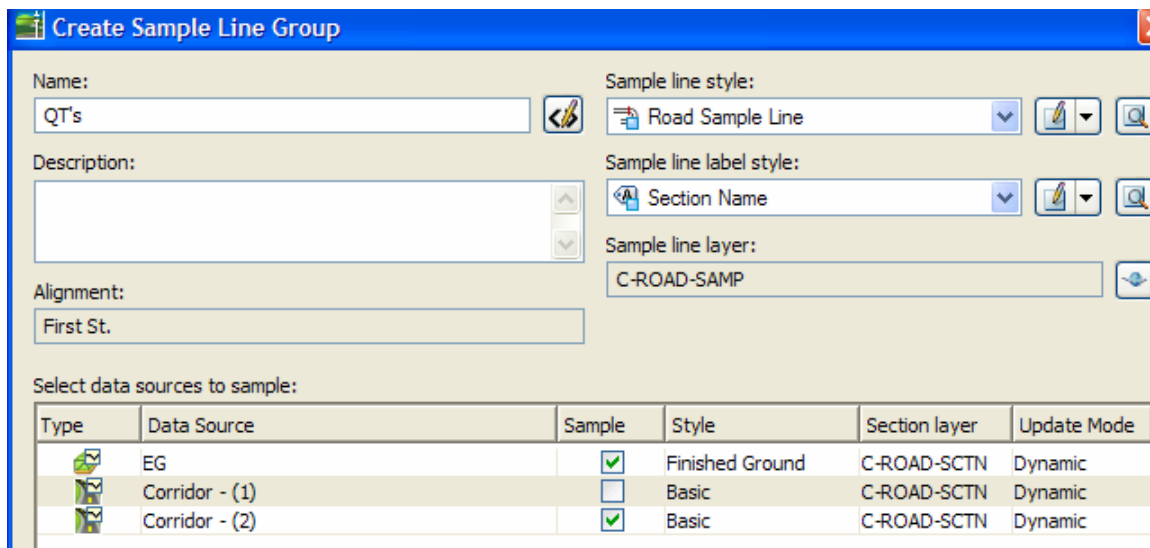
C. Generate Quantity Takeoff (“QT”) for Required Milling

- Open drawing “2-D”
- Create a new Sample Line Group for QT purposes. Click Sections menu → Create Sample Lines.

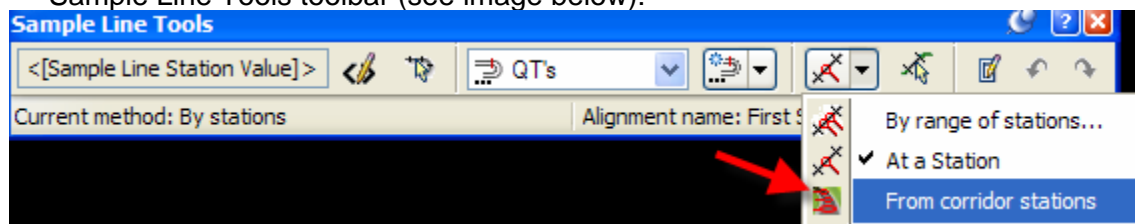
- At the Select An Alignment prompt, press Enter to display the Select Alignment dialog box and Select "First St". Click OK.
- The Sample Line Toolbar appears. Click the Create Sample Line Group button (see image below):



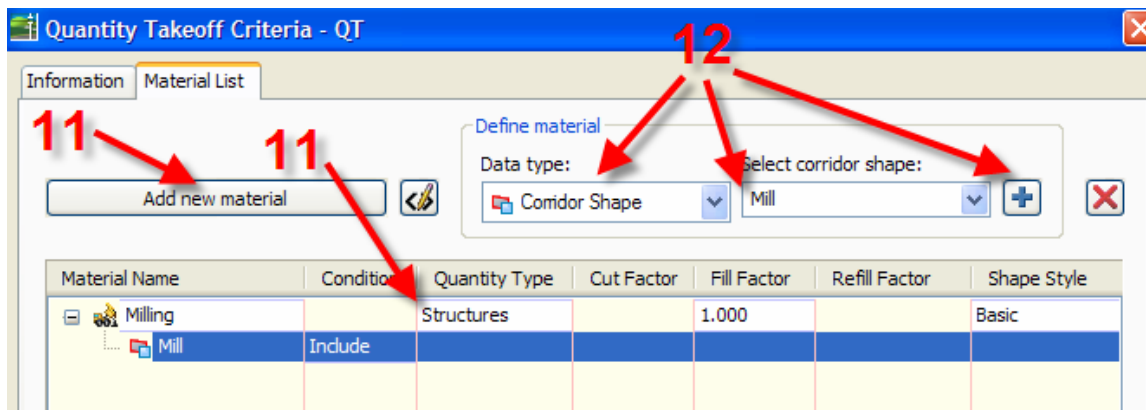
- The Create Sample Line dialog box appears. Set all values as displayed below then click OK.



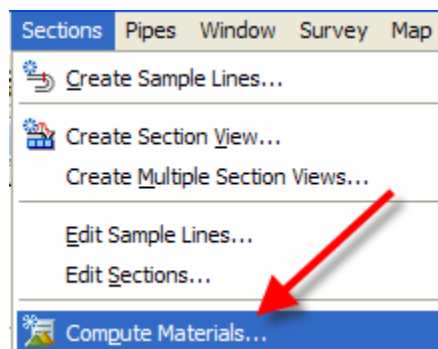
- When prompted to Specify Station, select the "From corridor stations" option on the Sample Line Tools toolbar (see image below):



7. The Create Sample Lines - From Corridor Sections dialog box is displayed. Set the Width values for both the Left Swath Width and Right Swath Width to 50. Click OK. The sample lines are created and drawn on the screen.
8. Close the Sample Lines Tools toolbar by clicking on the red "X" (upper right corner). If you get a warning that the corridor is out of date, be sure to "rebuild" "Corridor - (2)".
9. Define a "generic" quantity take-off criteria for the required Milling. On the settings tab of the Toolspace toolbar, expand the "Quantity Takeoff" tree, right-click on the "Quantity Takeoff criteria" option, and select "new".
10. The Quantity Takeoff dialog box appears. On the information Tab give the newly created criteria an appropriate name ("QT").
11. From the Materials List tab, select the "Add New Material" button. A new material is populated in the dialog box below. Change the name to "Milling". Change the Quantity type (in the spreadsheet below) to "Structures" (see image below step 12).
12. In the Data Type box, select "Corridor Shape". In the Select Corridor Shape box, click inside the box and type "Mill". Now click on the "+" symbol next to the Select Surface box. A corridor shape with the name "Mill" is populated below the Material for "Milling".

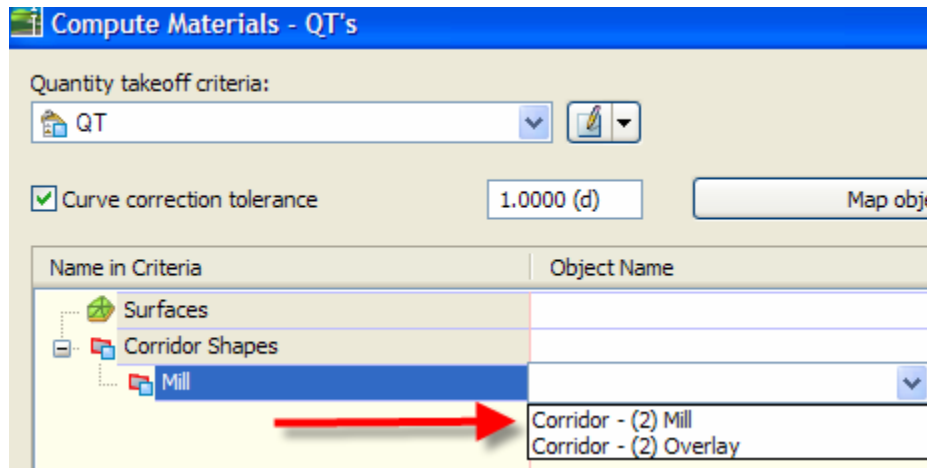


13. Click OK to exit Quantity Takeoff Criteria dialog box. This generic quantity take-off criterion will be used later when we map the corridor shape found in our drawing.
14. Create a material list for the sample line group using the "generic" quantity takeoff criteria (both having been created above). Here we will now map all generic materials, set up in the quantity takeoff criteria, to actual surface and/or corridor shapes. Click Sections → Define Materials.
15. In the Select a Sample Line Group dialog box, click the Select Alignment field and select "First St".
16. Click the Select Sample Line Group field, and select "QT's". Click OK.





17. The Compute Materials dialog box is displayed. Set the Quantity Takeoff Criteria to “QT”.
18. In the Compute Materials dialog box, Click in the individual cells under the column for Object name to map the actual surface/shape to the generic.




19. Click OK (The quantity takeoff calculation is performed and the material list is added to the sample line group properties).
 20. Generate a quantity takeoff table to display the Earthwork volume information using a standard Autodesk Civil 3D table format. Click Sections → Add Tables → Material Volume.
 21. In the Create Material Volume Table dialog box, select a table style and layer.
 22. Click the Select Alignment field, and select “First St”.
 23. Click the Select Sample Line Group field, and select “QT’s”.
 24. Click OK. The top-center portion of the new table is attached to your cursor. Click in the drawing to set the location of the table.
 25. Review your results.
- D. Extra Practice with “OverlayMillAndLevel2” Sub-Assembly
1. Open drawing “2-D”
 2. Set the following sub-assembly parameters as depicted below:

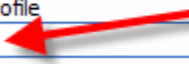
Left Overlay Slope Options	User Defined
Default Left Overlay Slope	-2.00%
Right Overlay Slope Options	User Defined
Default Right Overlay Slope	-2.00%
Slope Tolerance	0.10%
Use Profile	Use minimum clearance
Minimum Clearance	-0.167
Overlay Depth	0.167



3. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00.
4. Set the following sub-assembly parameters as depicted below:

Left Overlay Slope Options	User Defined
Default Left Overlay Slope	-2.00%
Right Overlay Slope Options	User Defined
Default Right Overlay Slope	-2.00%
Slope Tolerance	0.10%
Use Profile	Use profile 
Minimum Clearance	-0.167'
Overlay Depth	0.167'

5. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00.
6. Set the following sub-assembly parameters as depicted below:

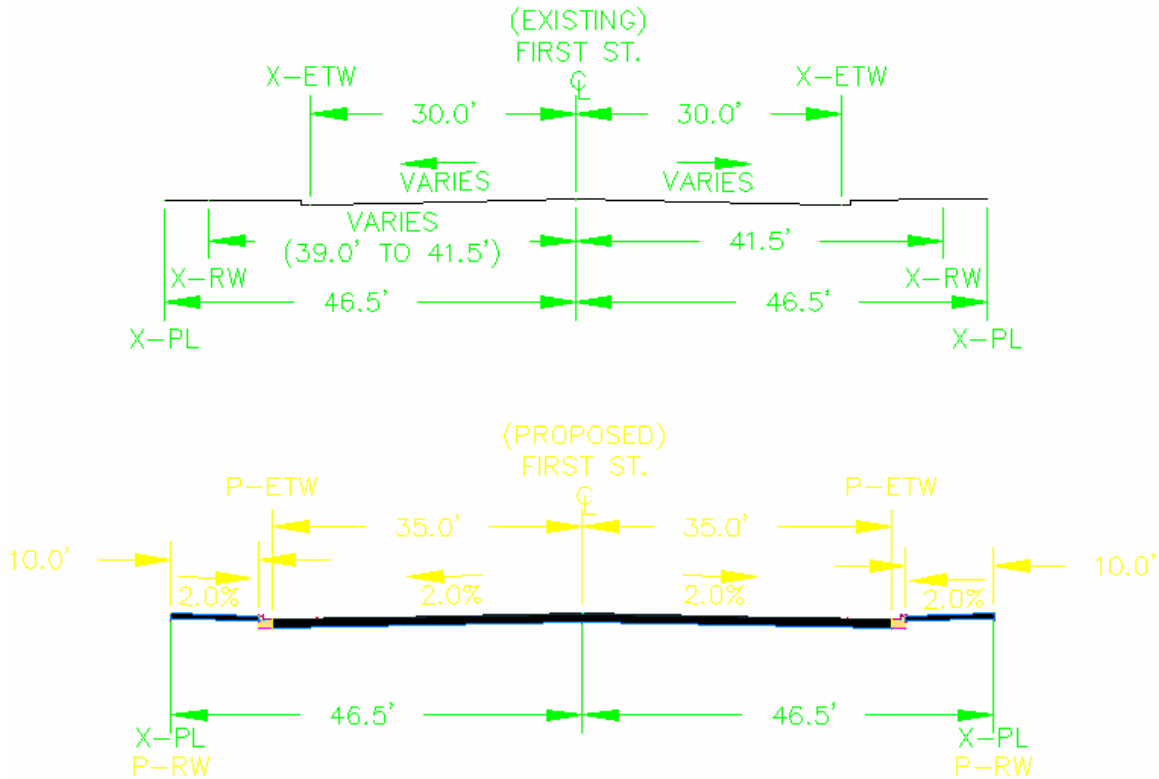
Left Overlay Slope Options	User Defined
Default Left Overlay Slope	-2.00%
Right Overlay Slope Options	User Defined
Default Right Overlay Slope	-2.00%
Slope Tolerance	0.10%
Use Profile	Use profile
Minimum Clearance	0.167' 
Overlay Depth	0.167'

7. Rebuild your corridor and note the resulting Left/Right proposed slopes at stations 15+00, 23+00 & 35+00.



Exercise 3: “Real World” Rehabilitation with Widening Project

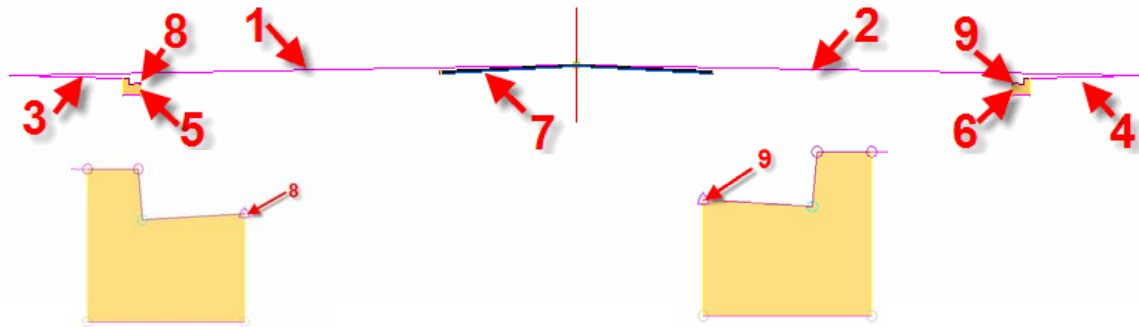
In this exercise, we will use techniques learned above, as well as a few new ones, to complete a “real world” urban road rehabilitation with widening project.



Givens: Existing ground (“EG”) surface; horizontal alignments (First St., Lt/Rt Property Line, Lt/Rt Proposed Back of Curb); Existing Ground vertical alignments (First St. and Lt/Rt Property Line)

A. Build Assembly

1. Open drawing “3-A”
2. Click corridors menu → create assembly.
3. In the Create Assembly dialog box, accept the default settings for all options. Click OK.
4. When the ‘Specify assembly baseline location’ prompt is displayed at the command line, click a point in the drawing to build the assembly (The view zooms to the assembly baseline).
5. Build the following assembly, in the order indicated (advanced parameters will be noted below):



Imperial - Generic
LinkWidthAndSlope

Side	Left
Width	1 50.000
Slope	-2.00%
Point Codes	P2
Link Codes	Top,Datum
Omit Link	No

Imperial - Generic
LinkWidthAndSlope

Side	Right
Width	2 50.000
Slope	-2.00%
Point Codes	P2
Link Codes	Top,Datum
Omit Link	No

Imperial - Generic
LinkWidthAndSlope

Side	Right
Width	3 10.000
Slope	-2.00%
Point Codes	P2
Link Codes	Top,Datum
Omit Link	No

Imperial - Generic

LinkWidthAndSlope

Side	Left
Width	4 10.000
Slope	-2.00%
Point Codes	P2
Link Codes	Top,Datum
Omit Link	No

Imperial - Basic
BasicCurbAndGutter

Side	Right
Insertion Point	Curb Back
Gutter Width	5 1.000'
Gutter Slope	-6.00%
Curb Height	0.500'
Curb Width	0.500'
Curb Depth	1.500'

Imperial - Basic
BasicCurbAndGutter

Side	Left
Insertion Point	Curb Back
Gutter Width	6 1.000'
Gutter Slope	-6.00%
Curb Height	0.500'
Curb Width	0.500'
Curb Depth	1.500'

C3D Imperial Rehab ...

OverlayCrownBetweenEdges

Left Edge Offset	-12.000'
Right Edge Offset	12.000'
Left Edge - Marked Point	left
Right Edge - Marked Point	right
Crown Height	7 0.600'
Min Slope	-1.00%
Max Slope	-3.00%
Overlay Depth	0.167'

Imperial - Generic

MarkPoint

Version	8 R2008
Point Name	left
Point Codes	MarkedPoint

Imperial - Generic

MarkPoint

Version	9 R2008
Point Name	right
Point Codes	MarkedPoint

B. Build Corridor

1. Open drawing “3-B”
2. Locate the assembly. Pick the sub-assemblies numbered “1” & “2” (created above in step “A”) and right-click and select the properties option.
3. In the Advanced Parameters, set the “omit link” option to “yes” .
4. Next, build your corridor with the following parameters (see image below):

Width	50.000
Slope	-2.00%
Point Codes	P2
Link Codes	Top,Datum
Omit Link	Yes

Name	Alignment	Profile	Assembly	Start Stat...	End Station	Freque...
Baseline (1)	First St.	EG - Surface (4)		10+00.00'	37+74.67'	
Region (1)			Assembly - (1)	11+00.00'	35+00.00'	25.000'

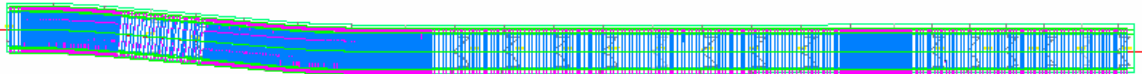
5. Click the “Set all Targets” button and map all required targets (see image below):

Target	Object Name	Subassembly	Assembly G
Surfaces	<Click here to set all>		
Top Existing Surface	EG	OverlayCrownBetweenEdge...	Group - (3)
Alignments			
Target Alignment	RT-PL	Rt-PL-LinkWidthAndSlope - (3)	Group - (1)
Target Alignment	Rt-BOC-P	Rt-BOC-P-LinkWidthAndSlop...	Group - (1)
Target Alignment	Lt-PL	Lt-PL-LinkWidthAndSlope - (4)	Group - (2)
Target Alignment	Lt-BOC-P	Lt-BOC-P-LinkWidthAndSlop...	Group - (2)
Left Edge Alignment	<None>	OverlayCrownBetweenEdge...	Group - (3)
Right Edge Alignm...	<None>	OverlayCrownBetweenEdge...	Group - (3)
Profiles			
Target Profile	EG - Surface (6)	Rt-PL-LinkWidthAndSlope - (3)	Group - (1)
Target Profile	<None>	Rt-BOC-P-LinkWidthAndSlop...	Group - (1)
Target Profile	EG - Surface (5)	Lt-PL-LinkWidthAndSlope - (4)	Group - (2)
Target Profile	<None>	Lt-BOC-P-LinkWidthAndSlop...	Group - (2)
Left Edge Profile	<None>	OverlayCrownBetweenEdge...	Group - (3)
Right Edge Profile	<None>	OverlayCrownBetweenEdge...	Group - (3)



6. Click OK to exit the Target Mapping dialog box and click OK again to exit the Create Corridor dialog box.

The corridor model is built and should look similar to the below image:



C. Extra Practice with “Real World” Corridor

1. Open drawing “3-C”
2. Generate Cross-Sections and a custom Code Set Style that annotates all pavement slopes (Refer to Exercise 1, steps C & D if necessary).
3. Generate pavement quantity take-offs (refer to Exercise 2, step C if necessary).
4. Replace the sub-assembly

