# Tunneling Design in Autodesk® AutoCAD® Civil 3D® and Autodesk® Revit® Structure

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**CI1671**    The class will focus on how to create model solids for tunnels in Autodesk AutoCAD Civil 3D software. Users will learn how Civil 3D interacts with Autodesk Revit Structure software and how to manipulate tunnel solids, obtain drawings, and create reports, volumetrics, and visualization in Revit Structure.  The class will also address on how to Place Rebar on Tunnel Solids in Revit Structure . Finally, users will learn how to model a tunnel natively in Revit Structure and export it to Civil 3D.

## Learning Objectives

At the end of this class, you will be able to:

- Build tunnel solids in Civil3D

- Importing Civil3D solids into Revit

- Place Rebar on Tunnel Solids

- Compute  Volumes, Drawings and Reports into Revit

- Create a Tunnel in Revit and export to Civil3D

## About the Speaker

*Transportation Engineer for Autodesk's civil engineering and structural engineering applications, including Civil 3D, Infraworks and Revit Structural. Responsible for pre-sales presentations of Autodesk's civil engineering/structural products as well as development of techniques for improving and optimizing customer's daily workflows. Proven history of civil engineering software deployments at several DOT's, private and public companies in the US, Canada, Latin America, Europe and the Middle East for more than 18 years.*
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## Build Solids in Civil3D

1.  Using Civil3D, open the Tunnel.dwg file located under the class file directory.
    The file contains a horizontal alignment, a profile surface and a proposed profile.

2.  If the Tool Palettes Civil Metric Subassemblies is not displayed, press the Ctrl and 3 keys simultaneously from the keyboard to visualize it.

3.  Select any tab from the subassemblies, right click and then select New Palette.
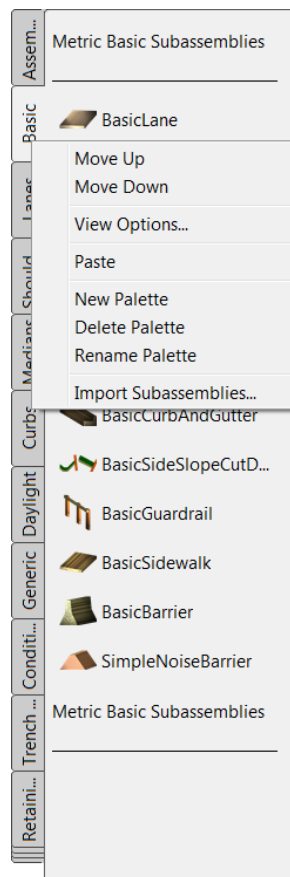


4.  Type in Tunnel. A new Tunnel tab should be part of the subassemblies.

5.  From the Tunnel tab, right click on the RIGHT gray column and select Import Subassemblies…
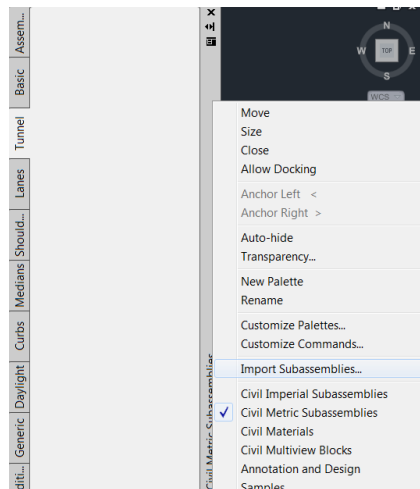
6. Select the Tunnel.pkt file from the working class directory. Import it to the Tunnel Palette.

7. From the Civil3D ribbon Home tab, select Assembly > Create Assembly.
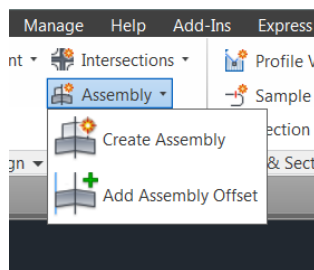


8. Keyin Tunnel on the Name field, and select OK. Place the marker anywhere on the file.
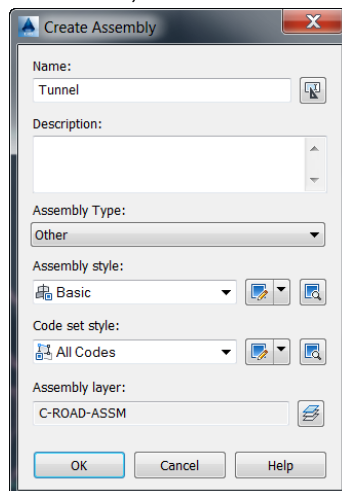
9. Click on the Tunnel name on the subassemblies menu, the properties dialog box will appear and click on the marker. The tunnel subassembly will appear on the drawing:
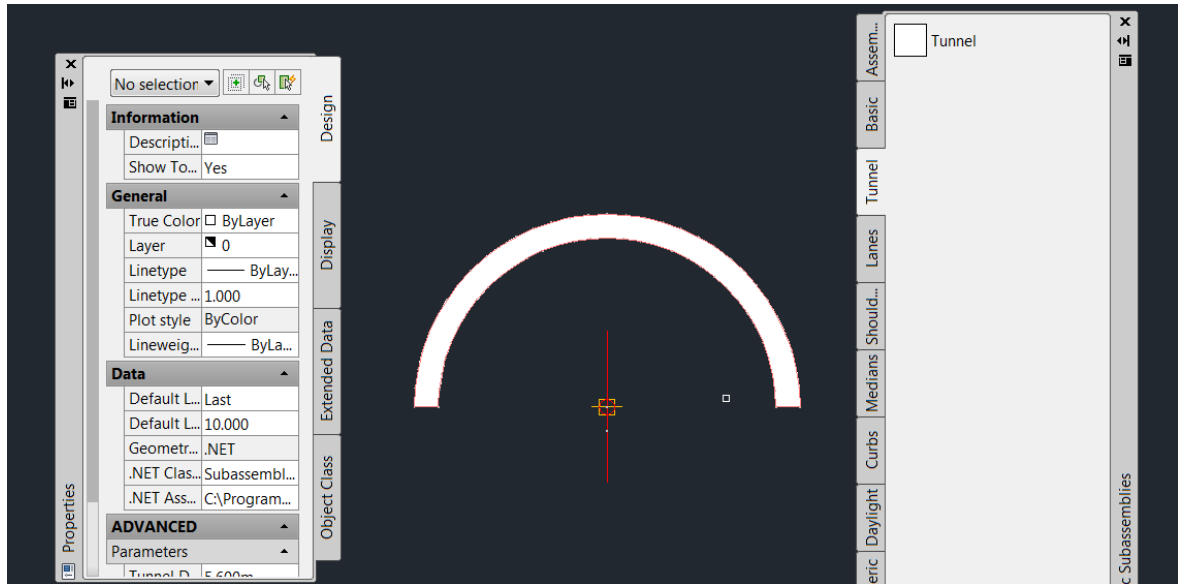


Close the properties dialog box.

10. From the Ribbon, select the Home tab > Corridor command. Type in Tunnel under Name, select bl for the Alignment and Profile and Tunnel for the Assembly. Do not mind about the Target Surface and turn on Set baseline and region parameters. Select OK.
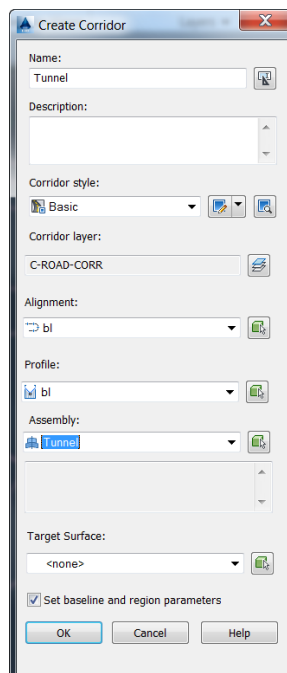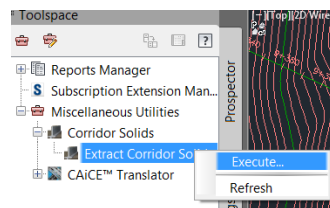
11. Set the Start Station to 8+500.00, End Station to 12+200.00 and the Frequency on tangents to 100.00. Select OK. The tunnel corridor is modeled.
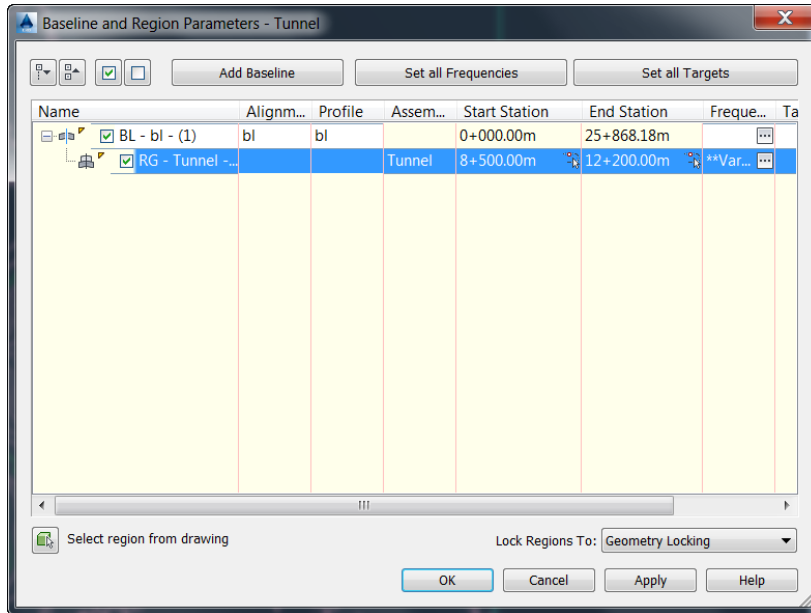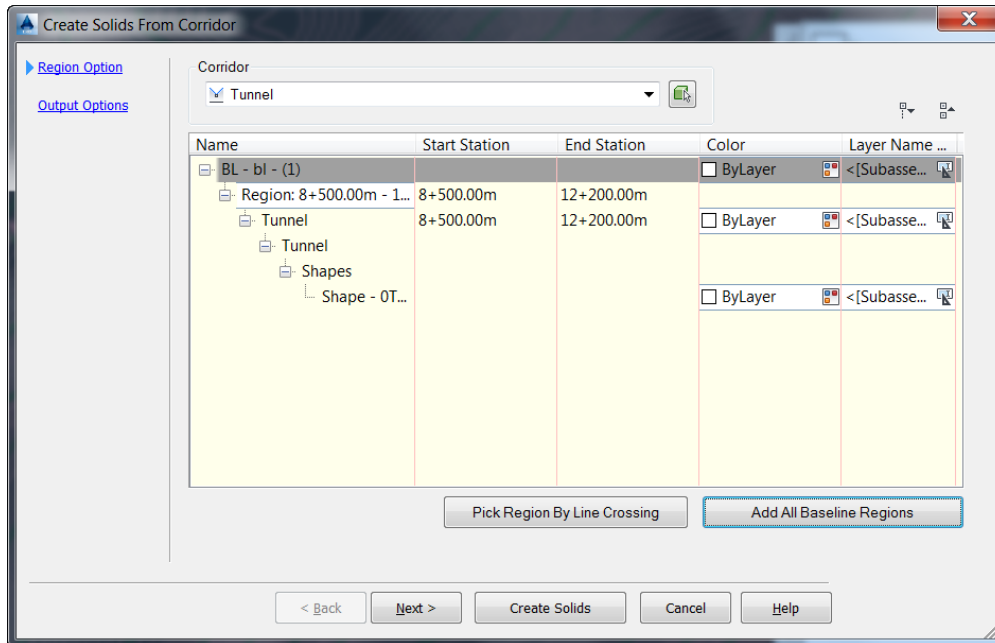


12. From the Toolspace menu, select the Toolbox tab. Expand the Miscellaneous Utilities > Corridor Solids menu.
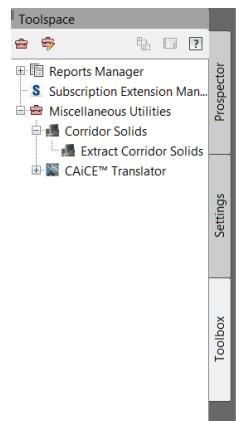


13. Right click on Extract Corridor Solids and select Execute.

14. Highlight the first row on the dialog box and select the Add All Baseline Regions option. The Regions, Start Station, End Station values are automatically computed.



15. From the left side of the window, select Output Options and select Add to a new drawing. Name the file Solids.dwg and place it under the working class directory:
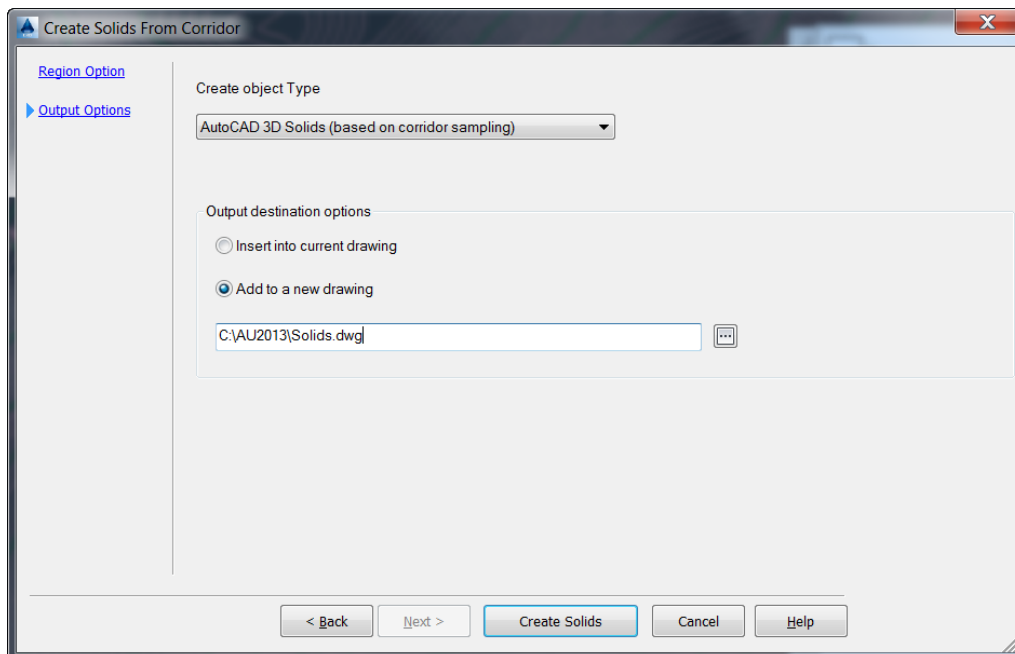


Select Create Solids from the bottom of the dialog box. The Solids file is created. Select Cancel at the bottom of the dialog box.

16. Open the Solids file recently created. Zoom Extents to visualize the content. The tunnel solids are displayed. Right click on the solid and select Object Viewer. The tunnel solid is visualized:
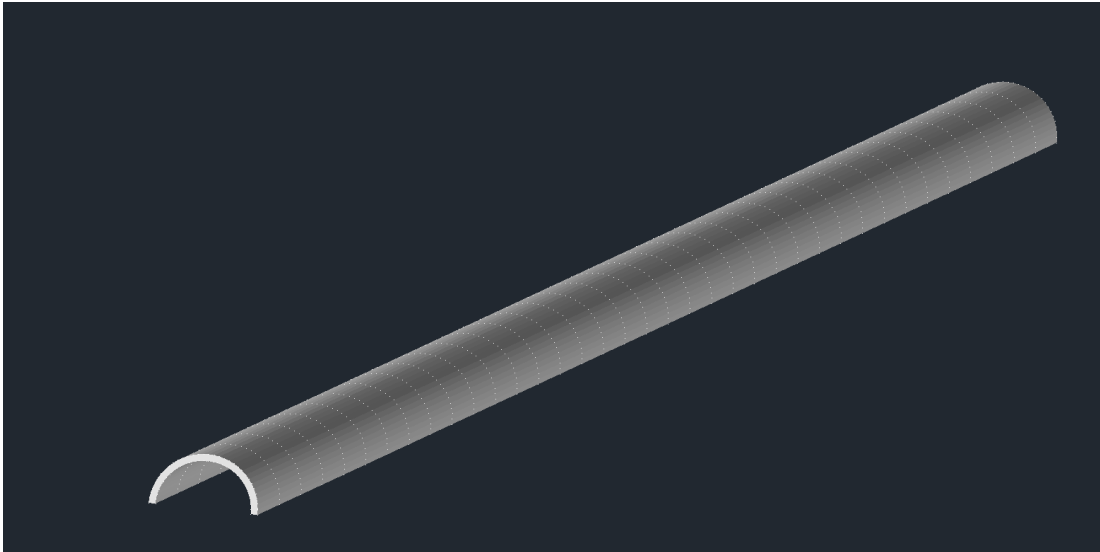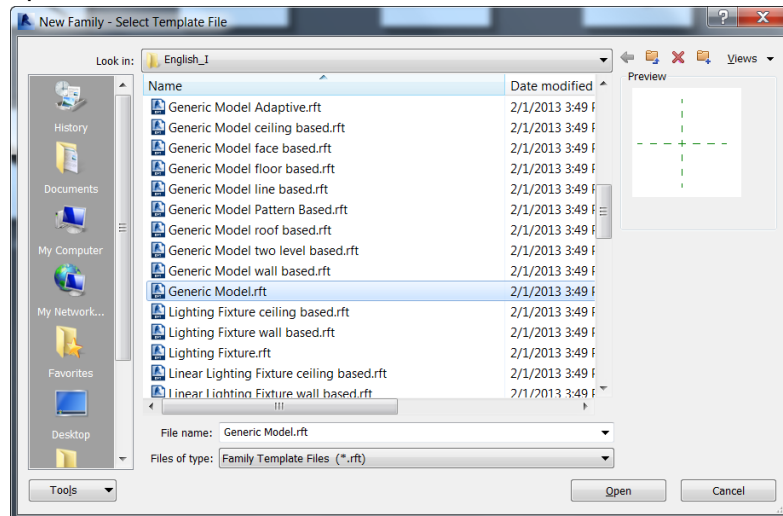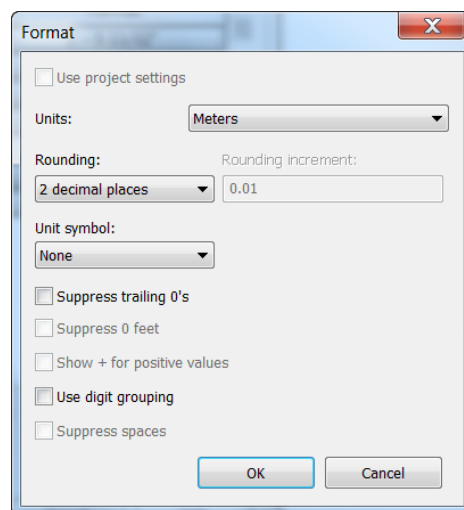


17. Close the Object Viewer window.

## Importing Civil3D Solids into Revit

**Creating Families in Revit from Solids.**

1. Startup Revit Structure.

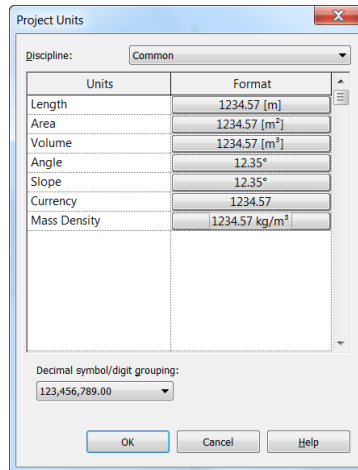2. On Revit's main menu, create a New **Family** using the Generic Model.rtf template file. Select Open.



3. Select the Manage Tab > Project Units Command. Change the Length Units to Meters, Rounding to 2 decimal places. Select OK.
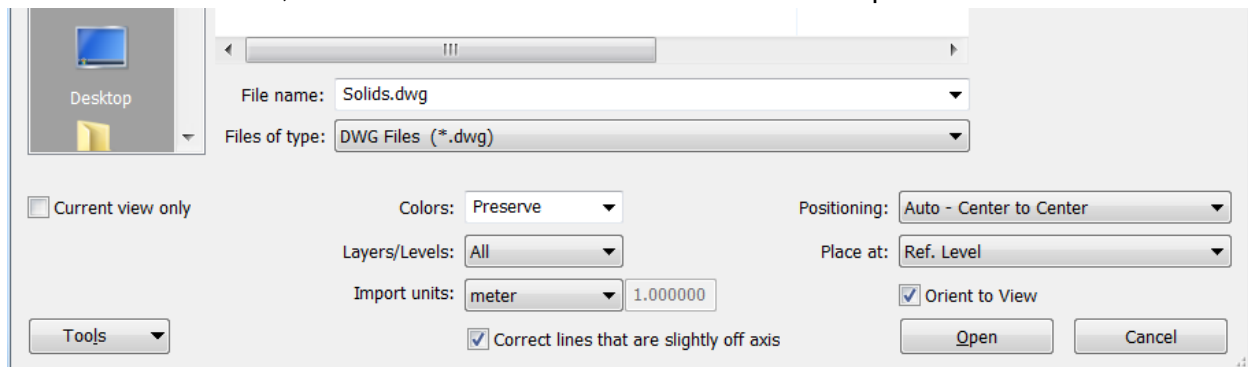
4.  Change the Area to m2, Select OK.



5.  Select the Insert Tab from the Ribbon, Import CAD command. Select the Solids.dwg file created on the previous exercise located on the working file directory. Select the Import units to meter, leave the rest of the default values. Select Open.



6.  Disregard the Import Geometry Not Visible message by selecting Close. Close as well the warning window that appears upon importing.

7.  From the Project browser on the left side of Revit, select under Floor Plans > Ref. Level. By doing so, the Properties window appears at the top. Scroll down until you find View Range Edit…
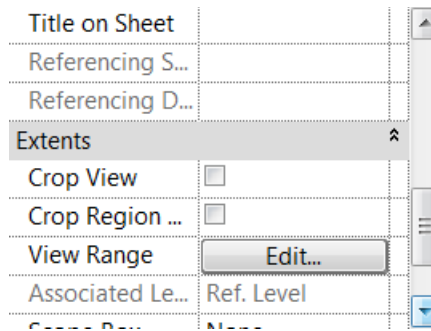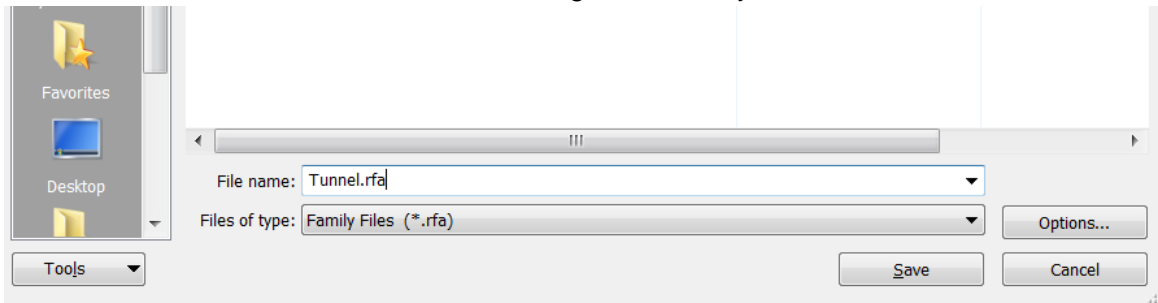
Select the Edit… button. Change the Top, Bottom and Level values to Unlimited. Select OK.
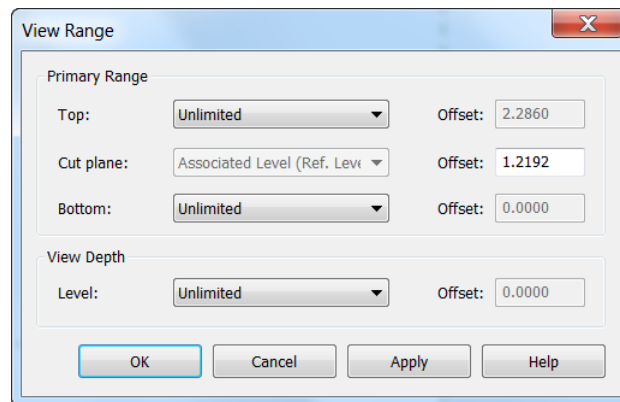


8. Click anywhere in the blank space on the screen. On the left side of the screen, in the Properties window, turn on Can host rebar.
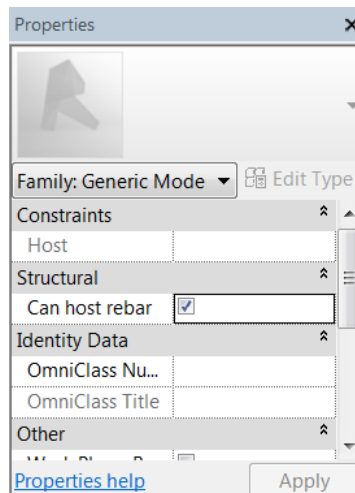
9. From the upper left corner of Revit, select the R icon > Save As> Family. Name the file Tunnel.rfa. Place it under the working file directory. Select Save.
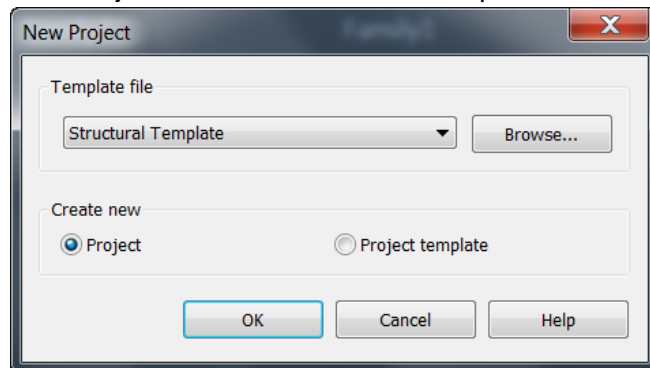


10. From Revit, select R icon > Close.


## Place Rebar on Tunnel Solids


**Transverse Rebar**


1. Select New Project. Use the Structural Template File. Select OK.



2. From the Screen, select with the mouse all the default symbols. Select the delete key on the keyboard to erase all existing symbols delivered with the template. Select OK to accept.

3. Select the Manage tab from the ribbon > Project Units. Change the Length and Area, values to the same settings as done in the families. Select OK.
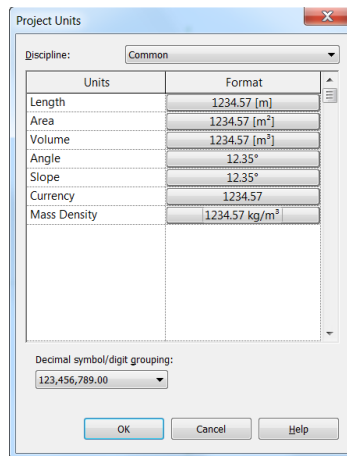
4. From the Structure tab, select Component > Place a Component. From the new created tab select, Modify | Place Component > Load Family. Load the Tunnel.rfa file created on the families section. Select Open. Click anywhere on the blank drawing Level 2 window. Close the warning window.

5. From the left side of Revit, under the Project Browser window, highlight the Level 2 Structural Plan view. By doing so, the Properties window appears at the top. Scroll down until you find View Range Edit…
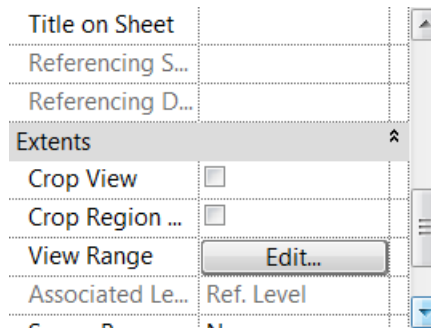
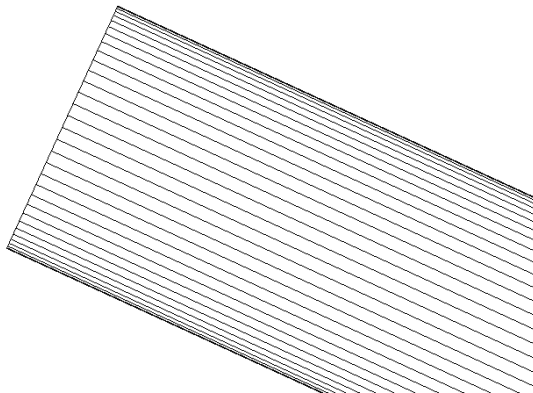6.  Select the Edit… button. Change the Top, Bottom and Level values to Unlimited. Select OK.
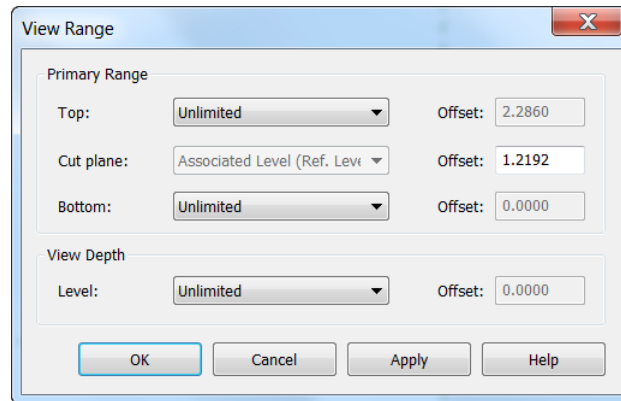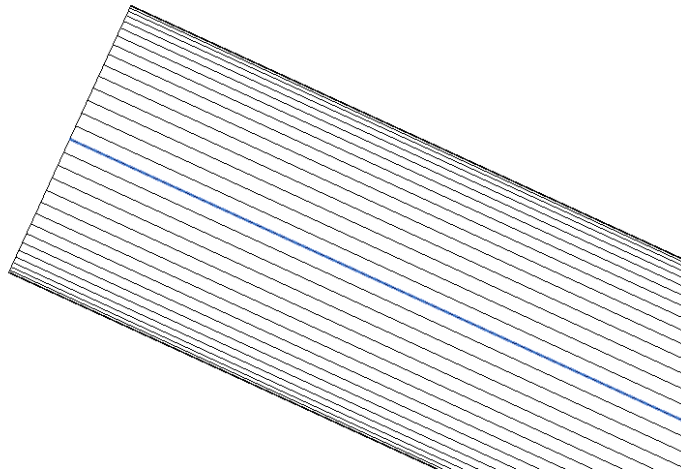


The tunnel solids are now visualized on the Level 2 window.

7.  Zoom to the upper left corner of the tunnel:



8.  From the Ribbon, select under Structure tab > Work Plane > Ref Plane

9.  From the Modify | Place Reference Plane command, select the green line with the arrow icon (Pick Lines), and select the middle longitudinal line to become a new reference plane.



10. From the  View tab, select the Section command. Place the Starting point at the top of the solid, drag the symbol down until the symbol locks visually perpendicular to the reference plane. A new section view is created.
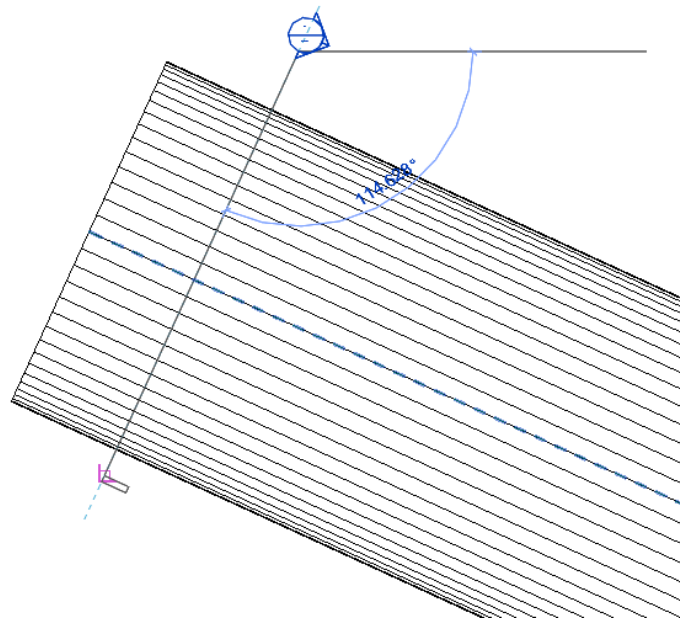
11. Double click on the section symbol. The section view is automatically opened:
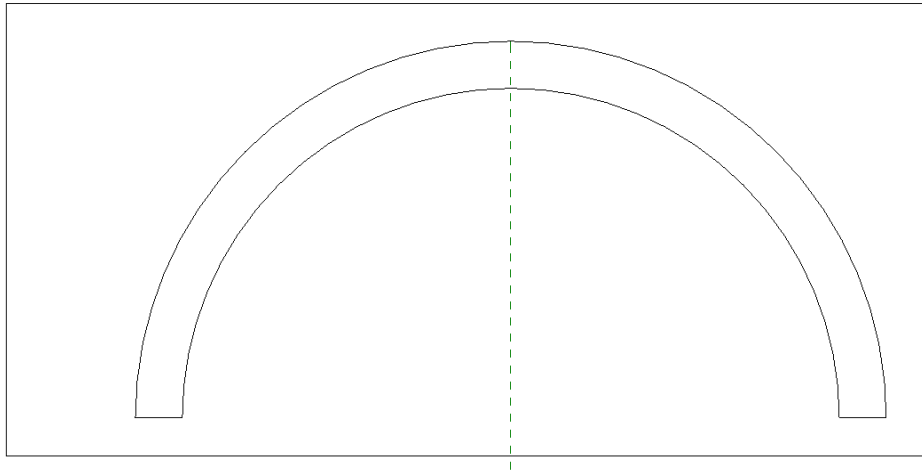


12. Select from the Structure tab > Work Plane > the Ref Plane command. From the Modify | Place Reference Plane command, under the Draw command, select Line
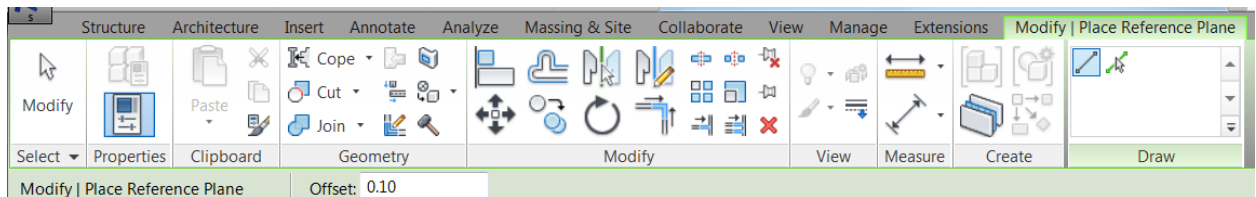


**Type 0.10** for the Offset located at the bottom left of the Modify |Place Reference Plane.

13. Draw a line representing the reference plane from the external bottom left corner of the tunnel to the external right corner of the tunnel. Notice that the reference plane will be offset 0.10 as desired (representing the cover):
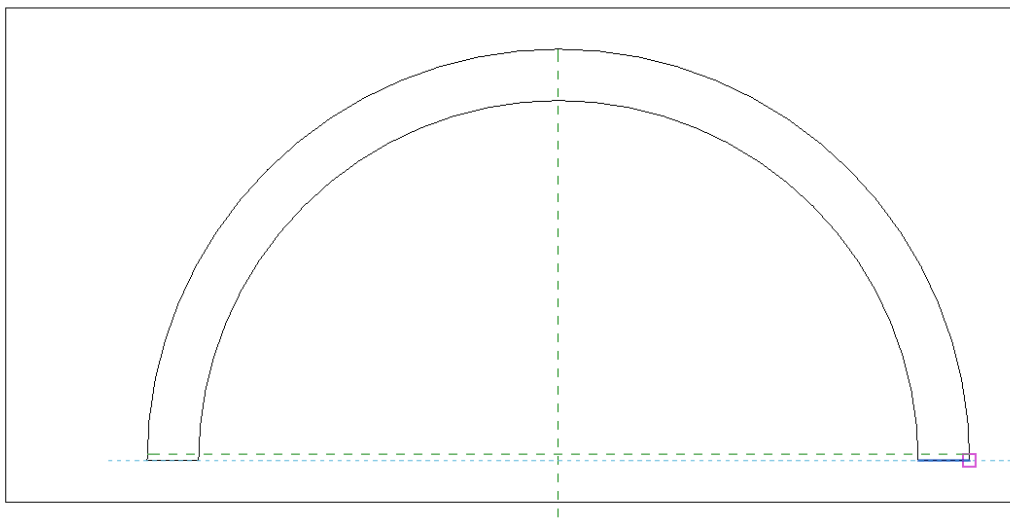
14. Select the tunnel. The tunnel is highlighted and the ribbon is updated. Notice under the Modify|Generic Models that the Rebar command is now available:
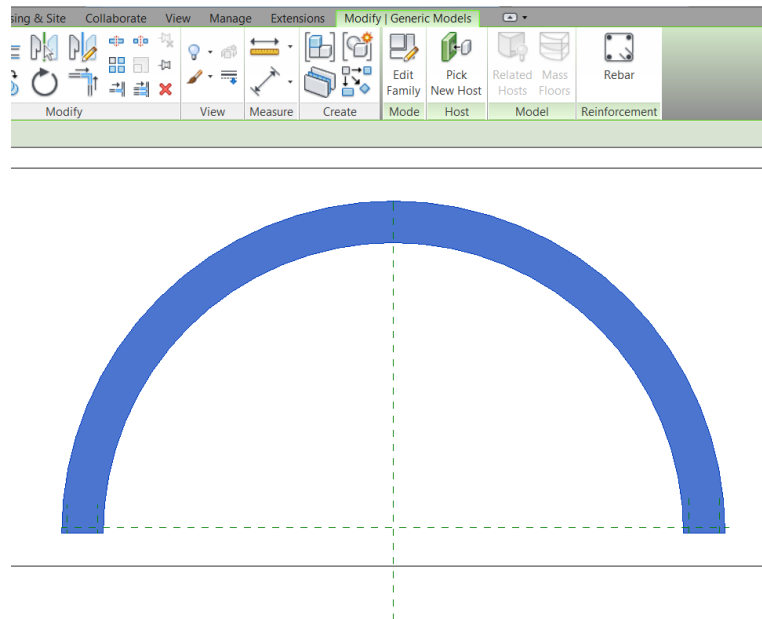




15. Select the Rebar command. Disregard the window by selecting OK. On the Modify| Place Rebar tab, select the Sketch Rebar command:
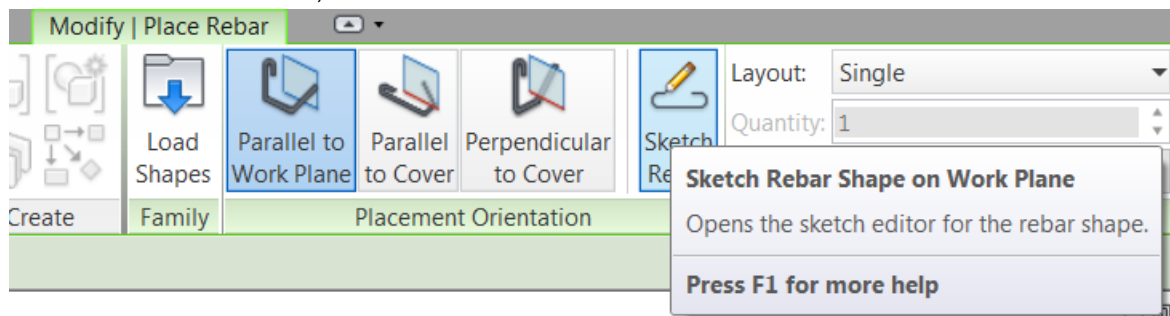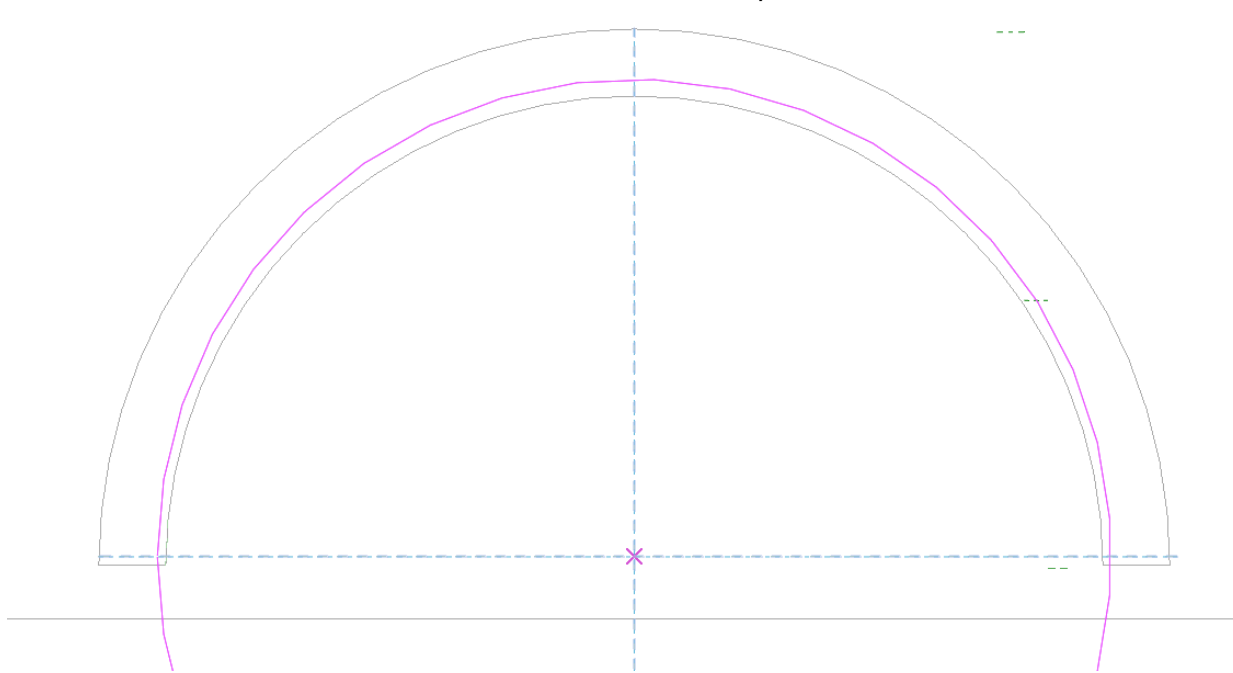


16. On the left bottom corner, Revit is prompting to Pick Host for Rebar. Select the tunnel. Disregard the window by selecting OK.

17. On the Modify| Create Rebar Sketch, under the Draw tab, select the first icon on the second row, Center – ends Arc . TURN ON Radius. Type 5.70
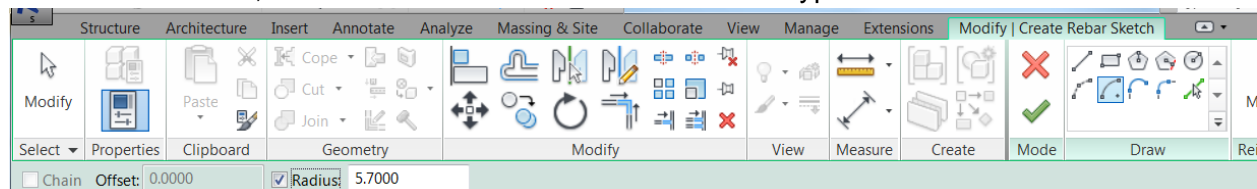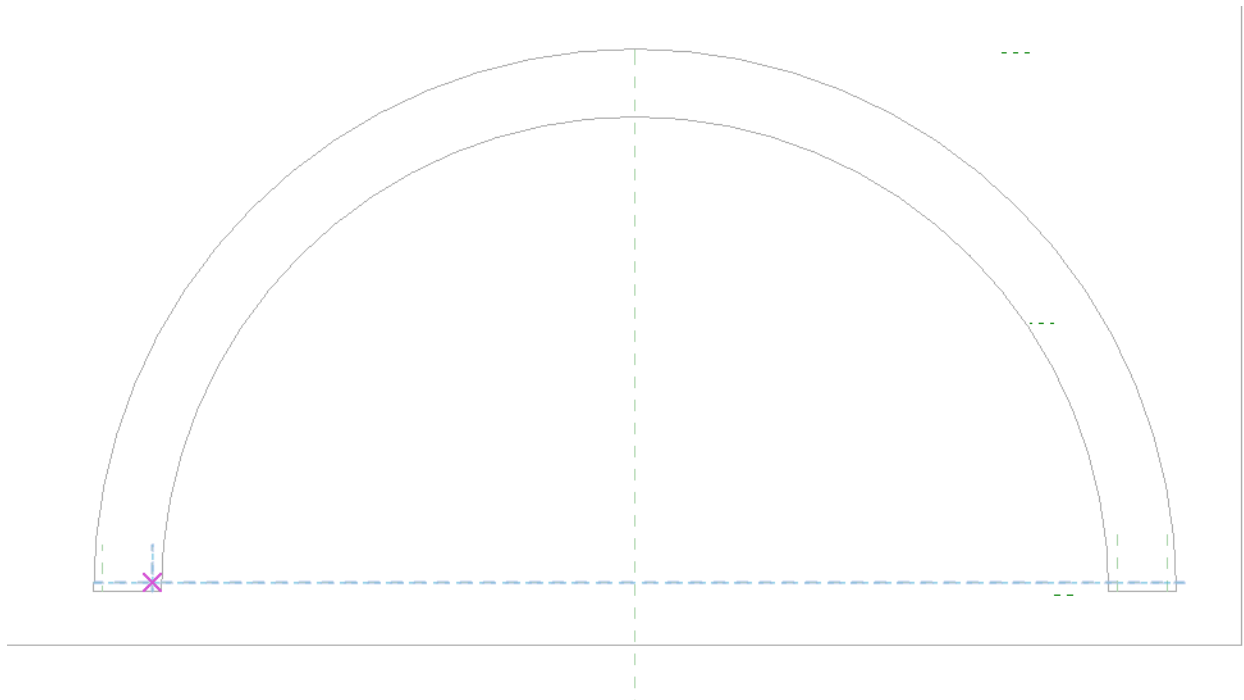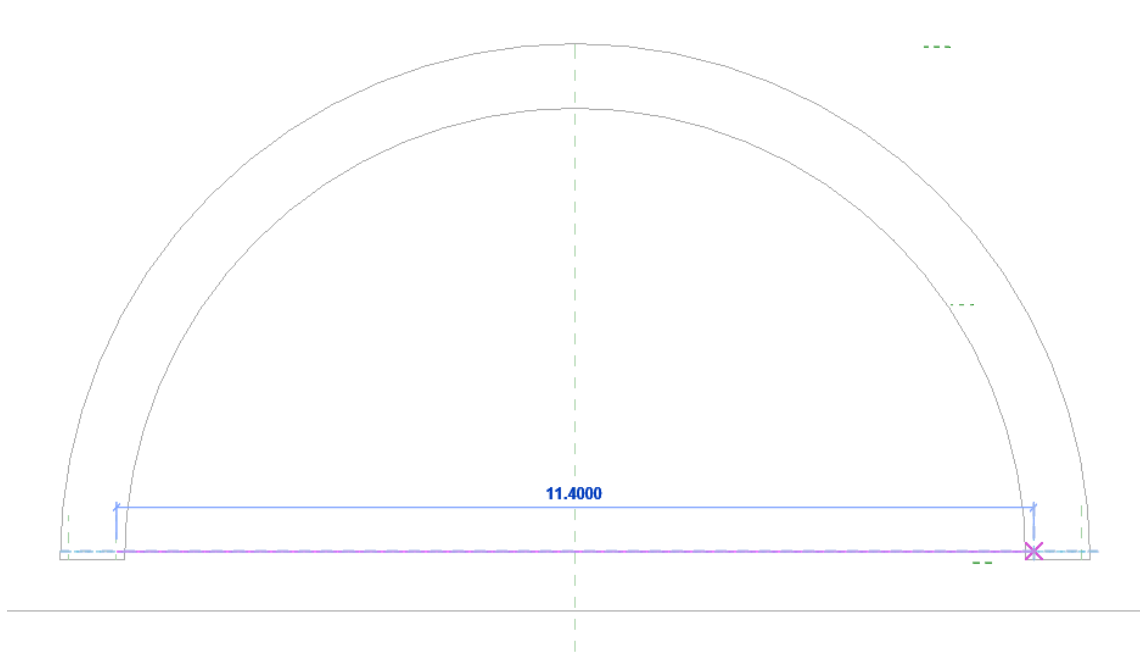
18. For the Center Point, select the intersection of the planes:



19. For the Arc Start Point, select the left side. Revit will automatically snap to the reference plane at the correct radius from the Center:
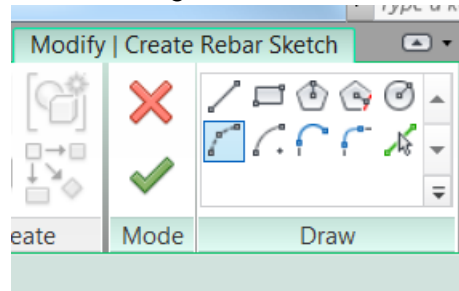
20. For the Arc End Point, select the right side. Revit will automatically snap to the reference plane at the correct radius from the Center:
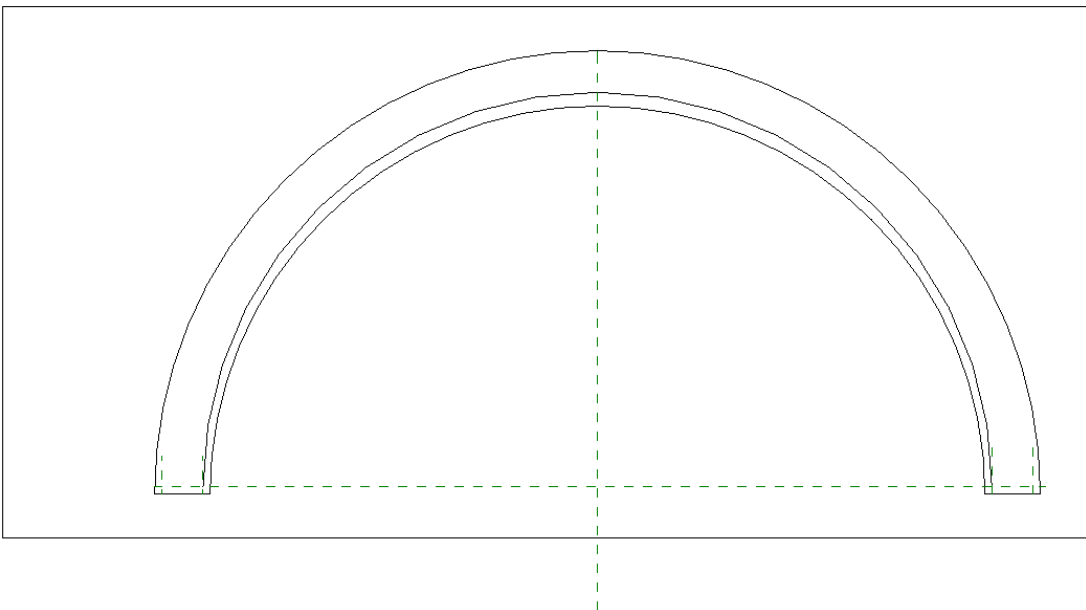


21. The rebar is placed at the desired radius on the inside of the tunnel. Press escape to finish laying out the rebar:
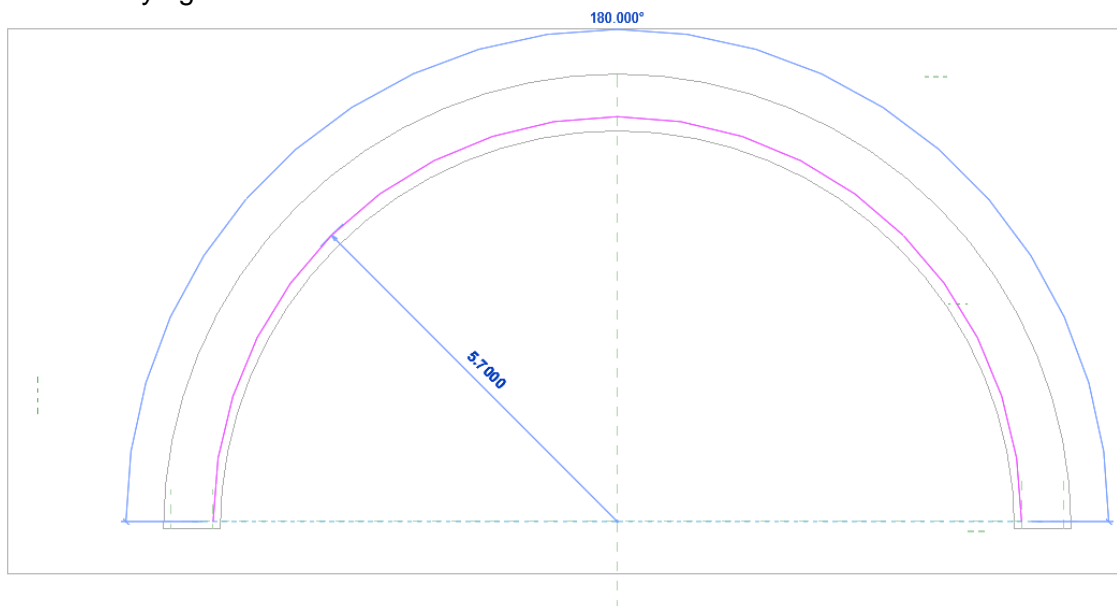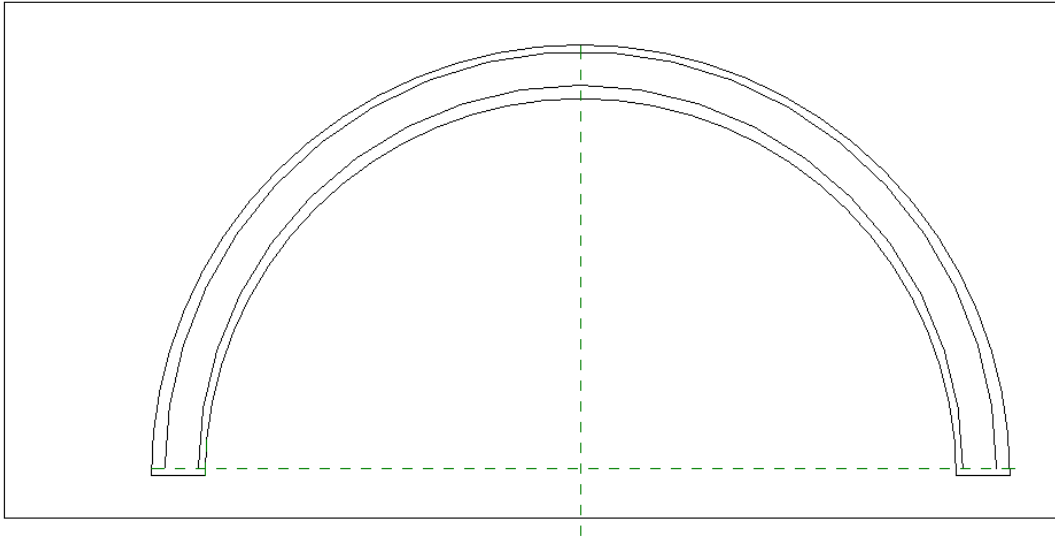
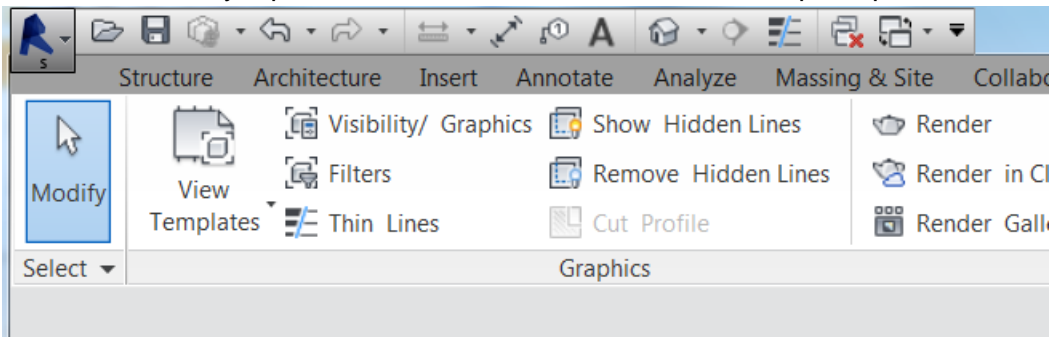22. To finish the command, select the green check mark on the Mode tab:



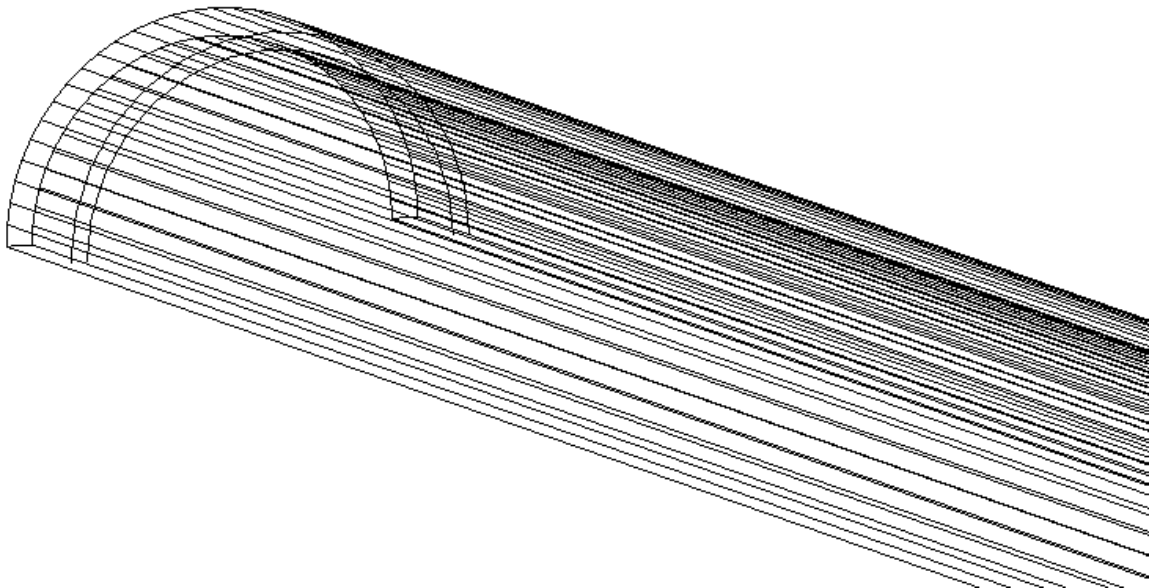23. The transverse rebar is created on the tunnel.

24. Repeat the same process for the external transverse rebar. Use a 6.20 Radius:
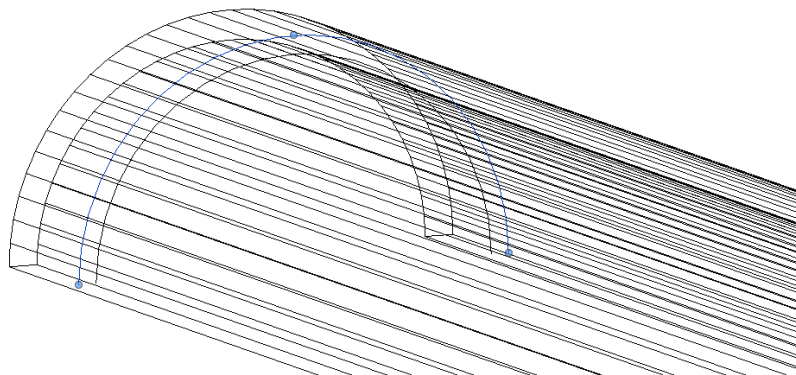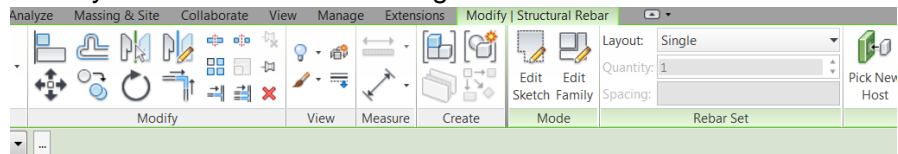


25. At the very top of the menu, select the house icon to open up a 3D view:
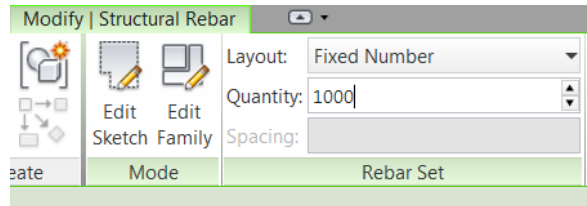
26. Navigate to the top left corner on the tunnel. Use the Cube to rotate the tunnel view to visualize the rebar in isometric:
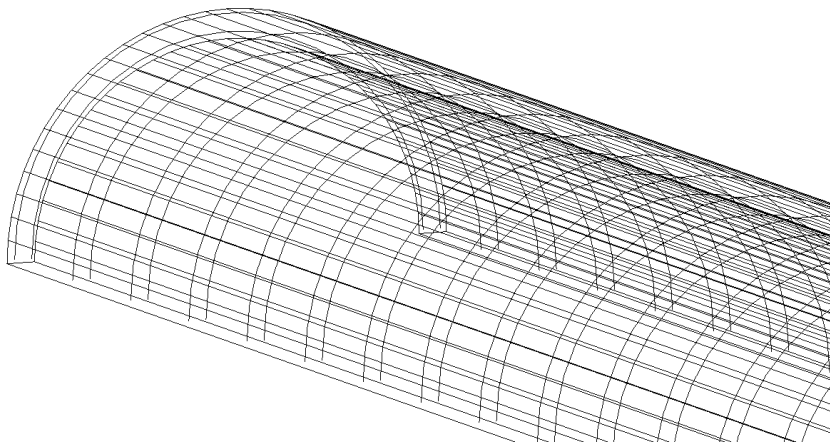
27. Click on any of the rebar elements. Notice the Ribbon changing to Modify | Structural Rebar. The layout for the moment is Single.
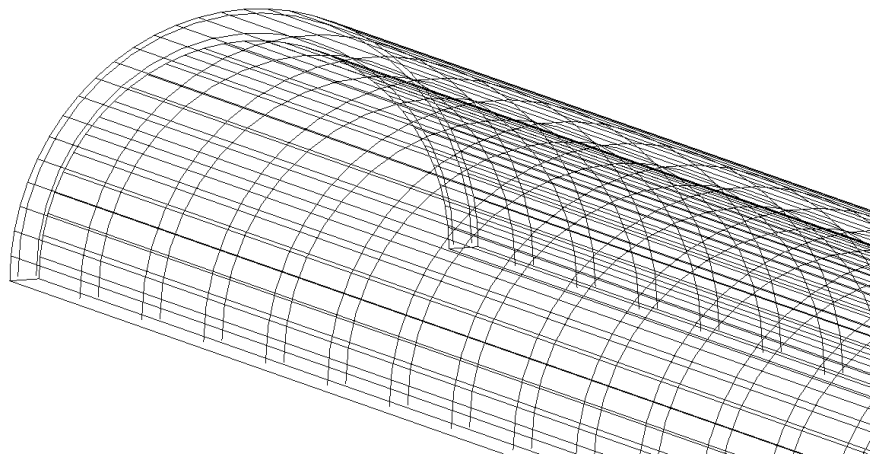
28. Change the Layout to Fixed Number. For the Quantity, type in 1000.00



One thousand rebar elements are placed along the tunnel.
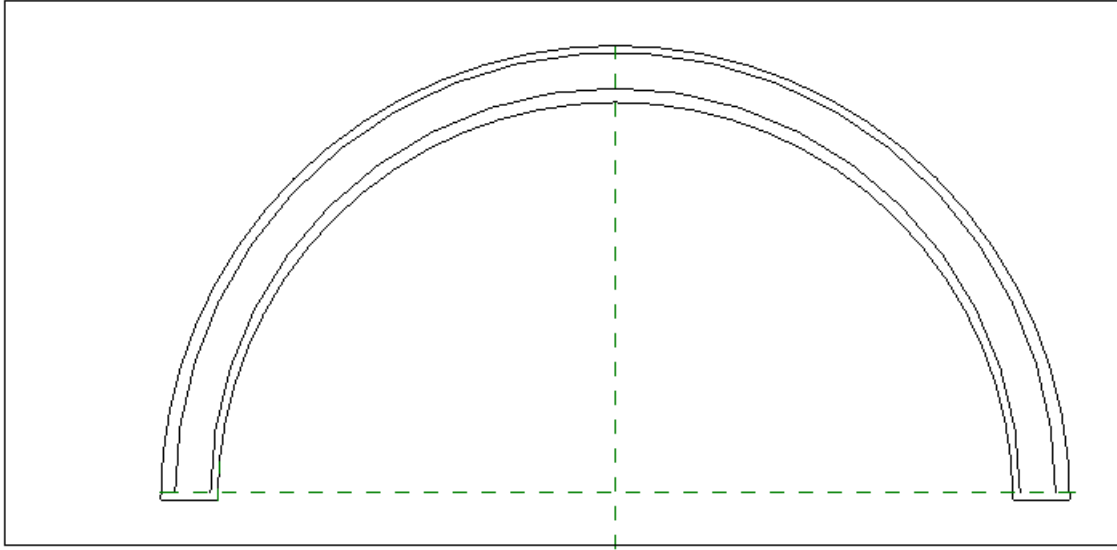


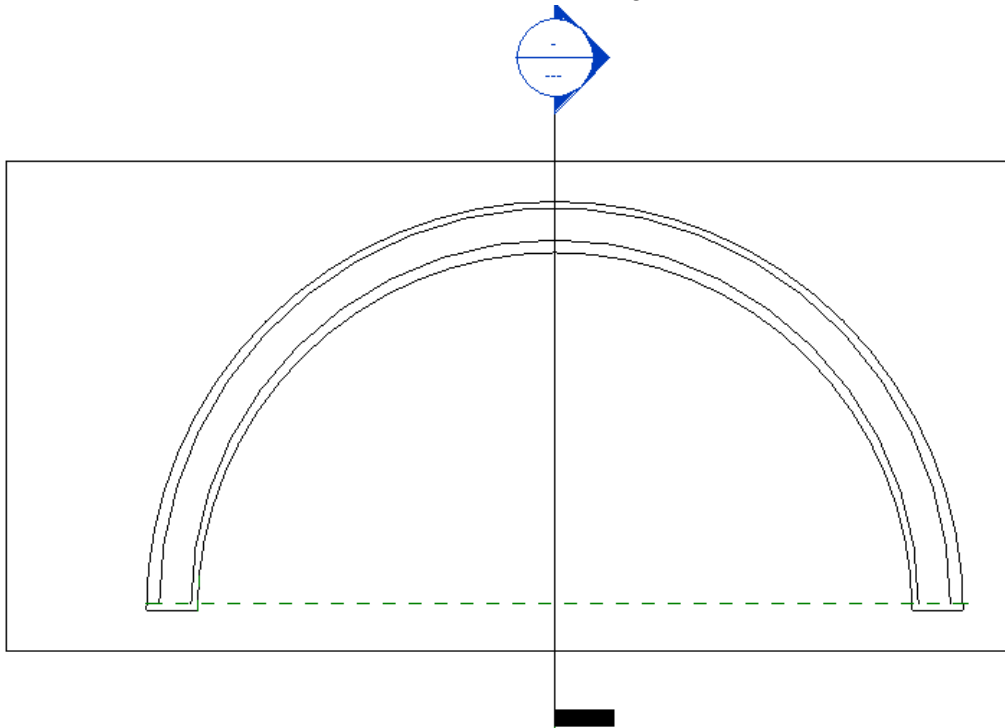29. Repeat the same process for the other transverse single rebar element:

**Longitudinal Rebar**

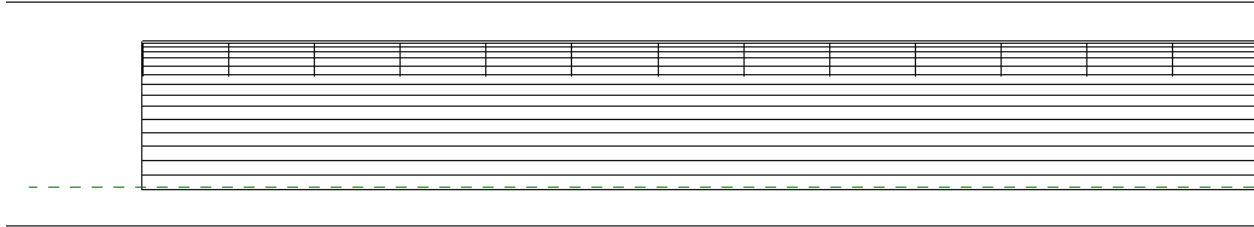1.  Switch to Section 1 (Project Browser in Revit > Sections > Double click on Section 1)
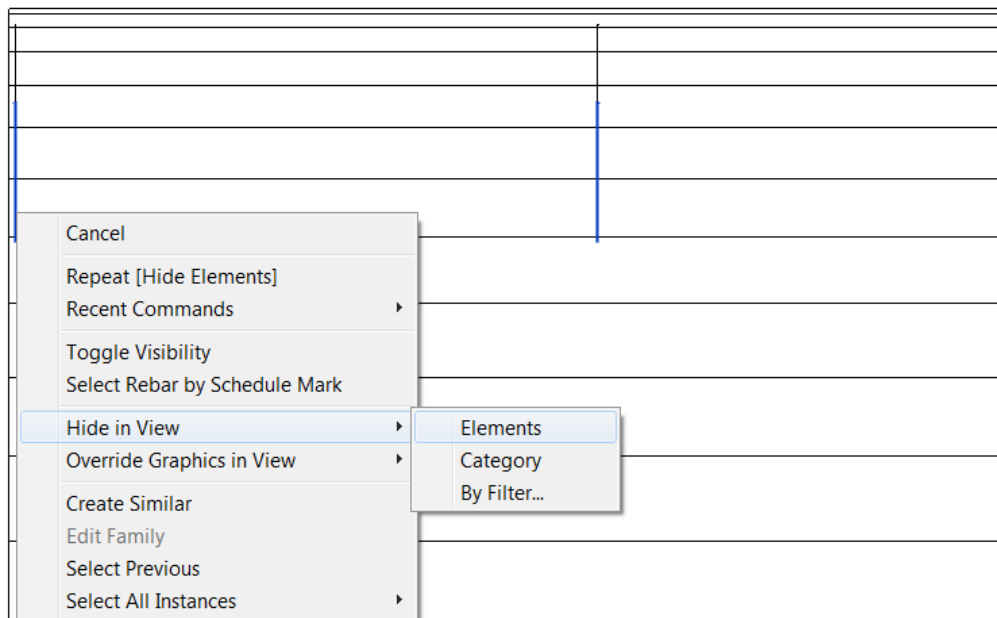


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2.  From the View tab, Create a Section View along the Vertical Reference Plane:

3.  Double click on the symbol to open up Section View 2. Zoom to the left side of the tunnel:
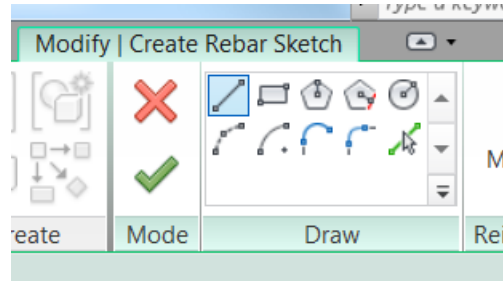


4.  Highlight the BOTTOM rebar set. Right click and select Hide in View > Elements. The bottom transverse rebar set is hidden from the section view.
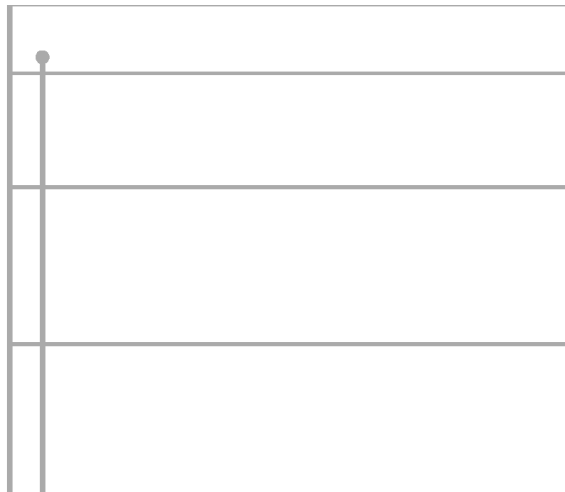
5. Highlight the Tunnel Solid. From the Modify | Generic Models tab, select the Rebar command. Select Sketch Rebar and select the Tunnel Solid again. Select the Line command from Modify | Create Rebar Sketch > Draw



6. To place the line start point, zoom closely to the left side of the tunnel visualizing the first top transverse rebar.



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7. Select the intersection of the transverse rebar with the longitudinal line of the solid.
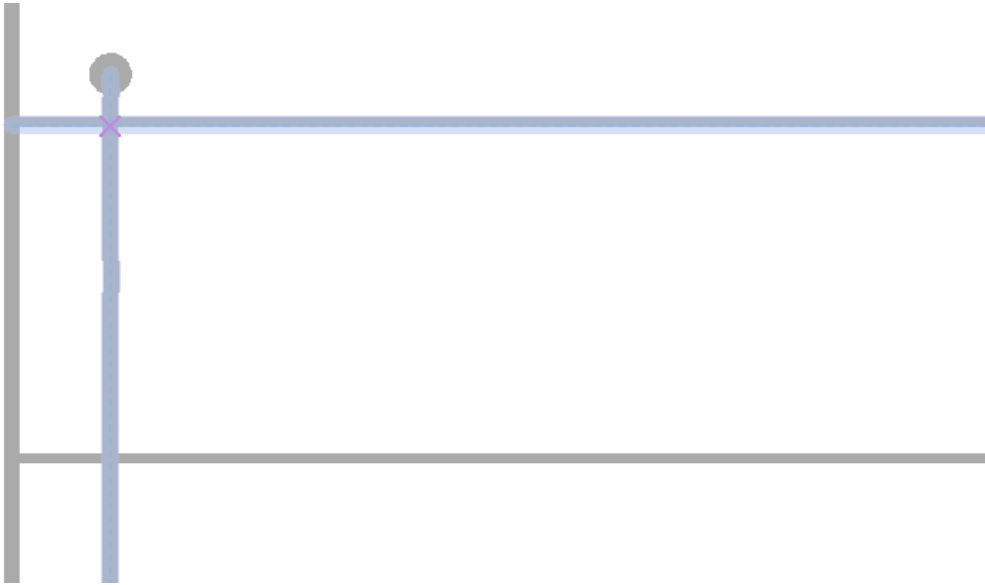
8. Drag the line to the right, zoom out and find the last transverse rebar on the right side of the tunnel to finish the first longitudinal rebar:
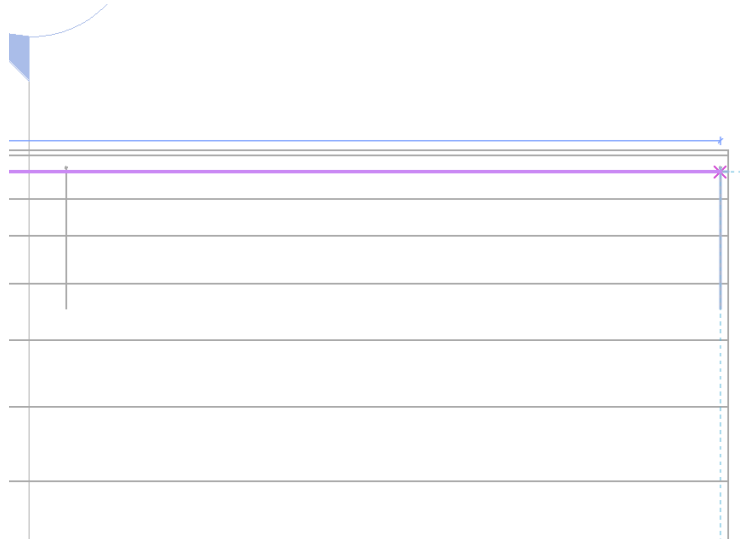
9. Press the escape key to exit out of the command. Select the green check mark under Modify | Create Rebar Sketch to finalize placing the rebar. The longitudinal rebar at the top layer of the tunnel is placed.

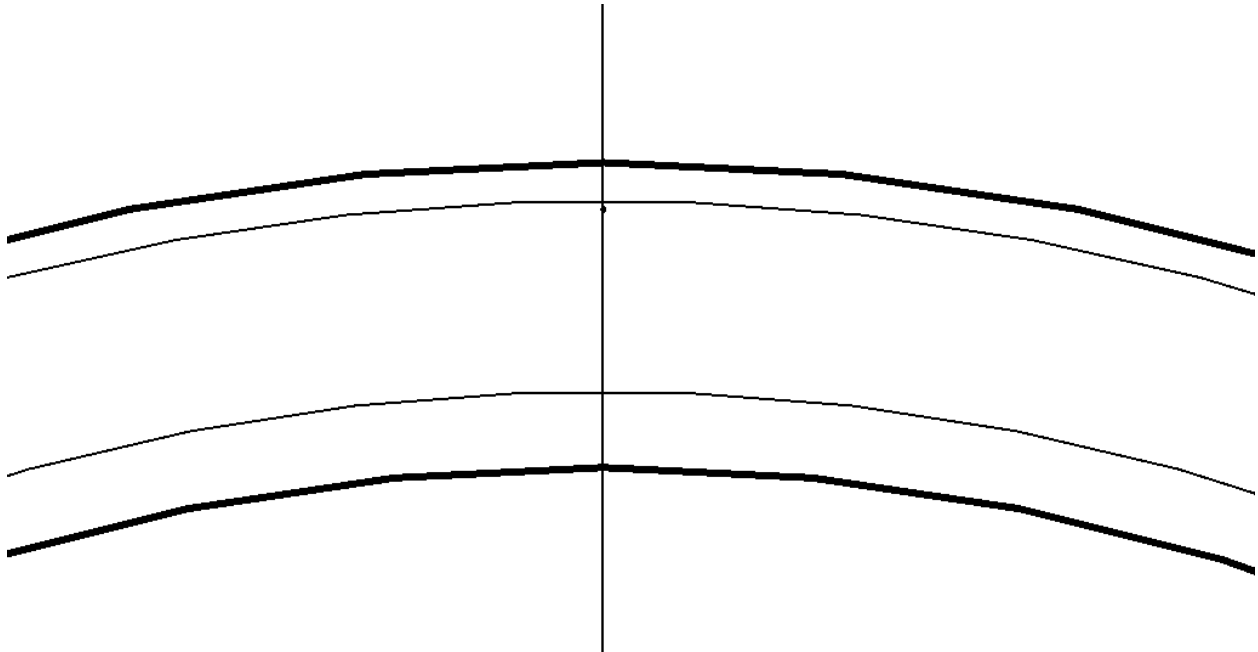10. Switch to Section 1 (Project Browser in Revit > Sections > Double click on Section 1).
    Zoom to the center at the top layer transverse rebar location. Notice the dot depicting the
    longitudinal recently placed rebar.



11. Select the Longitudinal bar (Data point from left to right to encompass the entire rebar).
    The ribbon changes. Select the Modify | Structural Rebar tab > Array icon (Four
    squares)
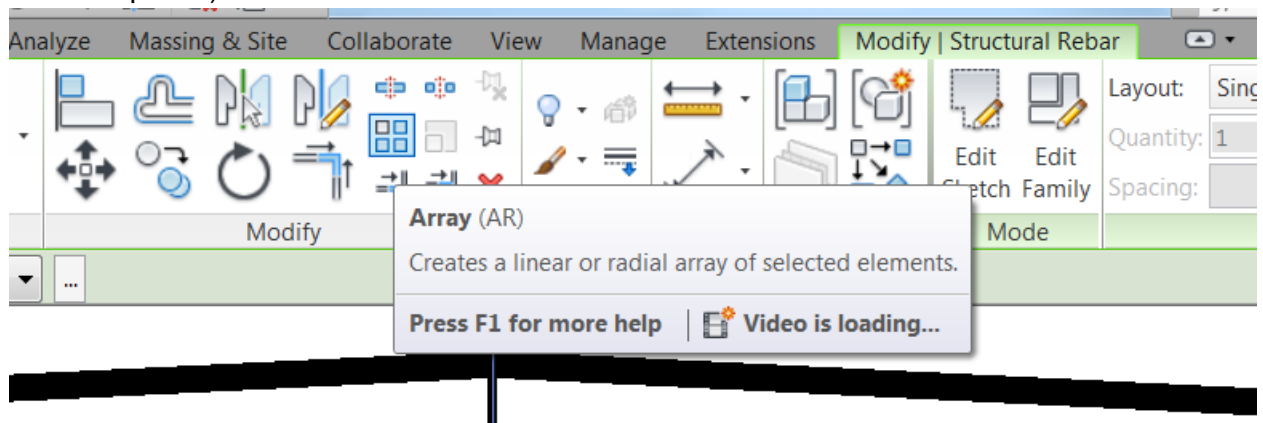
TURN ON THE RADIAL ICON on the top bar. Turn on Group and Associate. Type in 10 for the Number. Move To: Last and click on the PLACE button to establish the Center of Rotation.
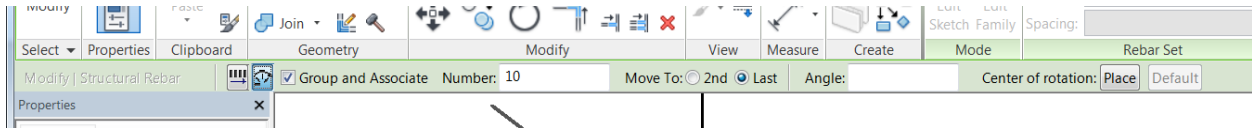


After clicking Place on the Center of Rotation, select the intersection of the two reference planes:
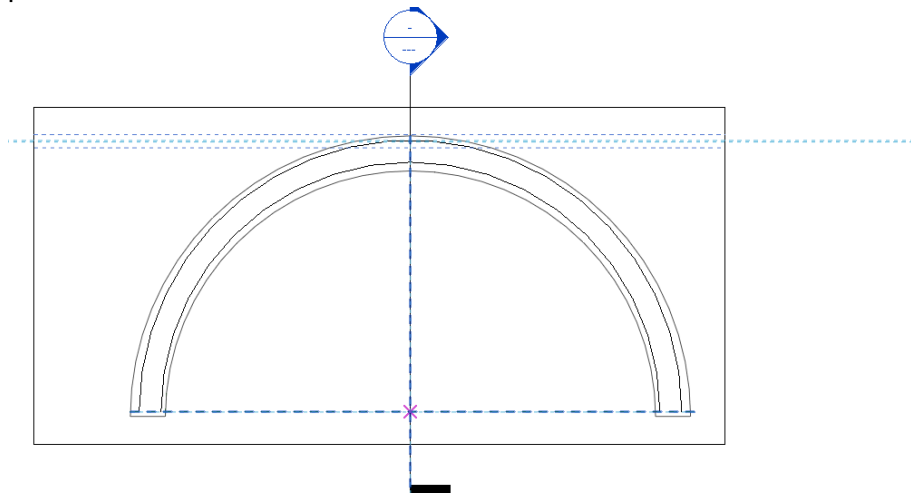


Immediately thereafter place a data point on the Vertical Reference Plane:
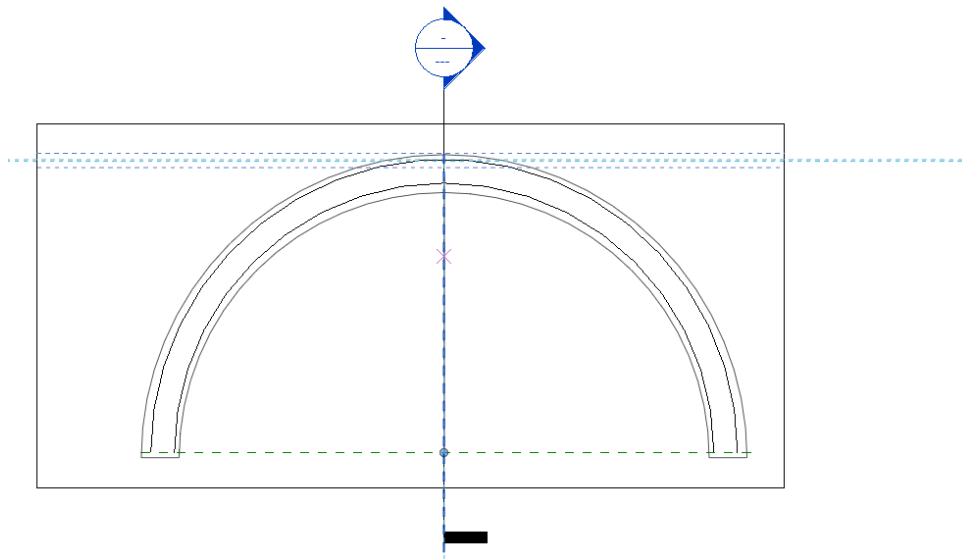
Immediately thereafter place a data point on the Horizontal Reference Plane to the Right of the Symbol:



Place a data point anywhere on the blank screen.

The rebar arrangement has been placed on the Tunnel Solid to the right of the symbol:

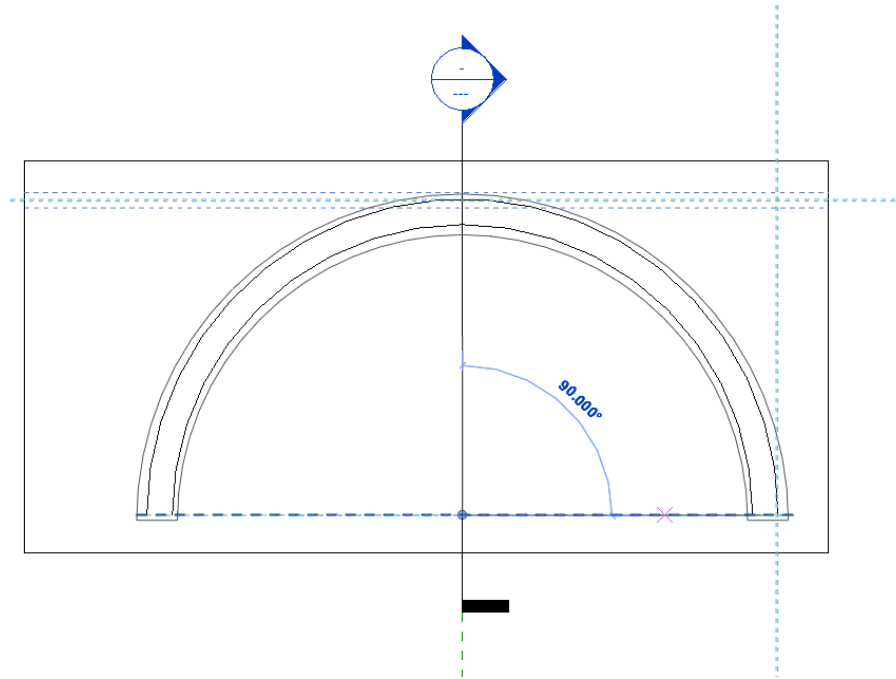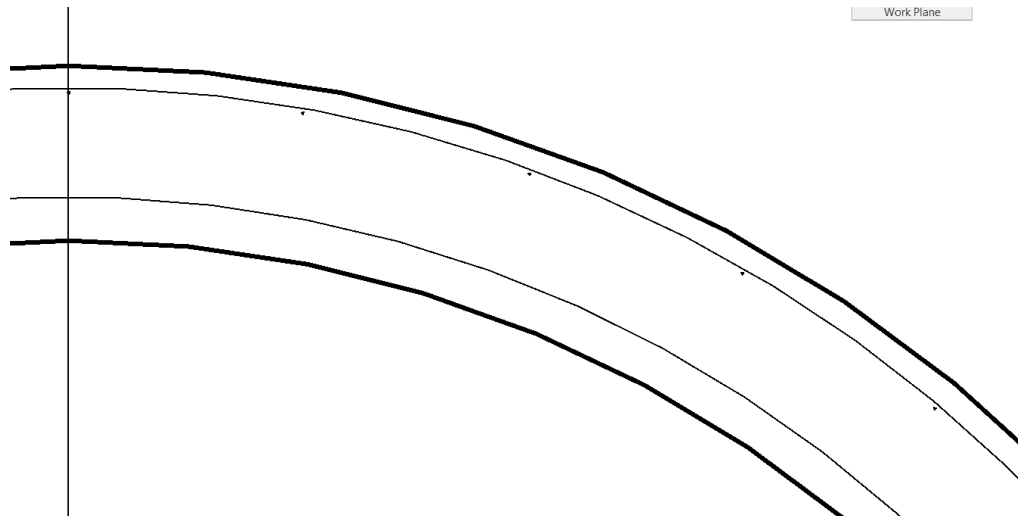12. Repeat the same process to create an array to the left of the symbol. Both sides should now be completed:

13. Switch to the Section 2 View. Zoom to the left top corner of the solid:

14. From the bottom of the Window, select the light bulb icon: Reveal Hidden Elements:

15. The bottom transverse element is revealed.

Reveal Hidden Elements

Highlight any of the transverse elements. Select Unhide in View > Elements.
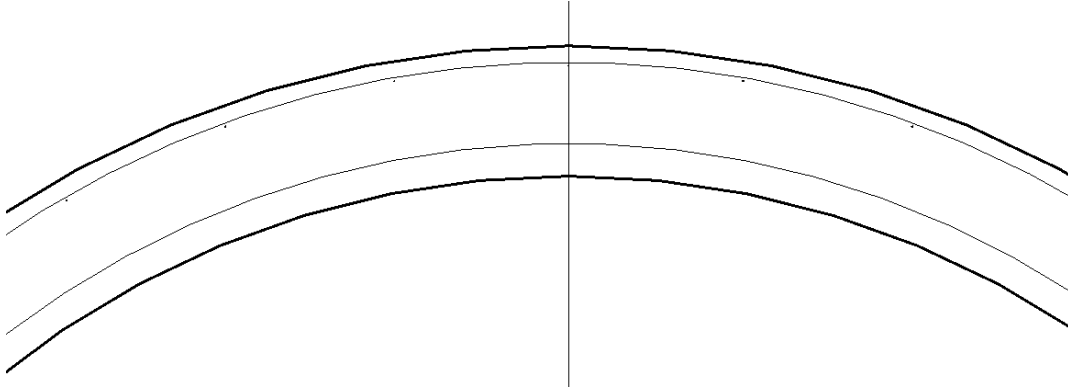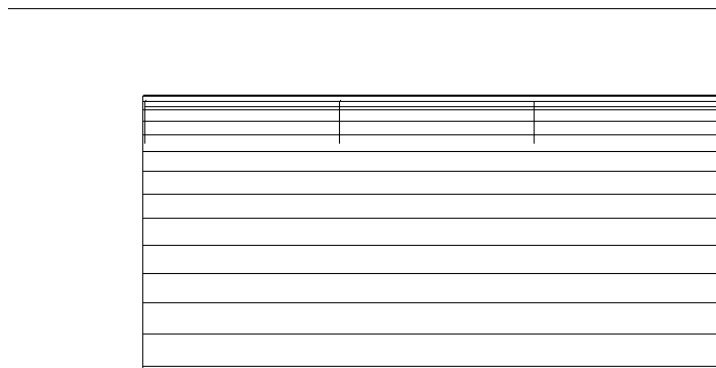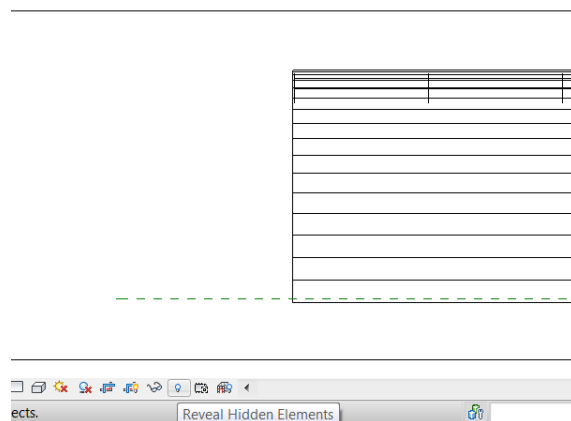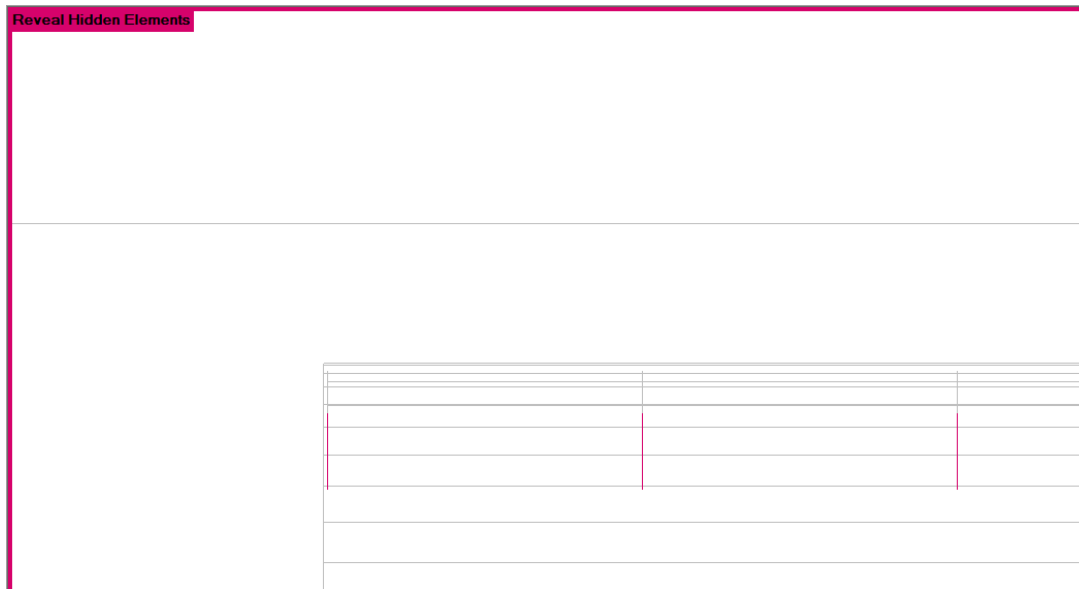
| | | |
|---|---|---|
| Hide in View | ▸ | |
| Unhide in View | ▸ | Elements |
| Override Graphics in View | ▸ | Category |
| | | By Filter... |
| Create Similar | | |
| Edit Family | | |
| Select Previous | | |
| Select All Instances | ▸ | |
| Delete | | |
| Find Referring Views | | |
| Zoom In Region | | |
| Zoom Out (2x) | | |
| Zoom To Fit | | |
| Previous Pan/Zoom | | |
| Next Pan/Zoom | | |
| ✓ Properties | | |
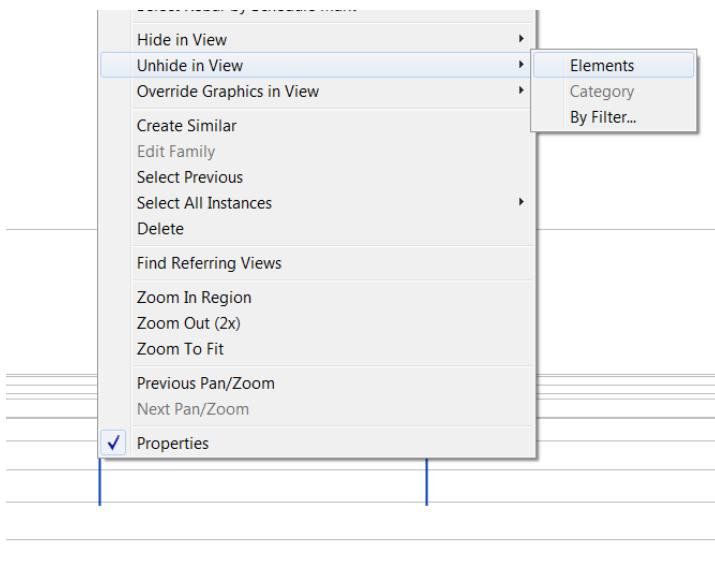
At the bottom of the window, click again on the light bulb icon Close Reveal Hidden Elements. The bottom rebar elements are now re-visualized on the Window.

16. Repeat steps 4-15 isolating the top Transverse rebars and placing the longitudinal rebar elements at the bottom layer of the tunnel to complete the model:
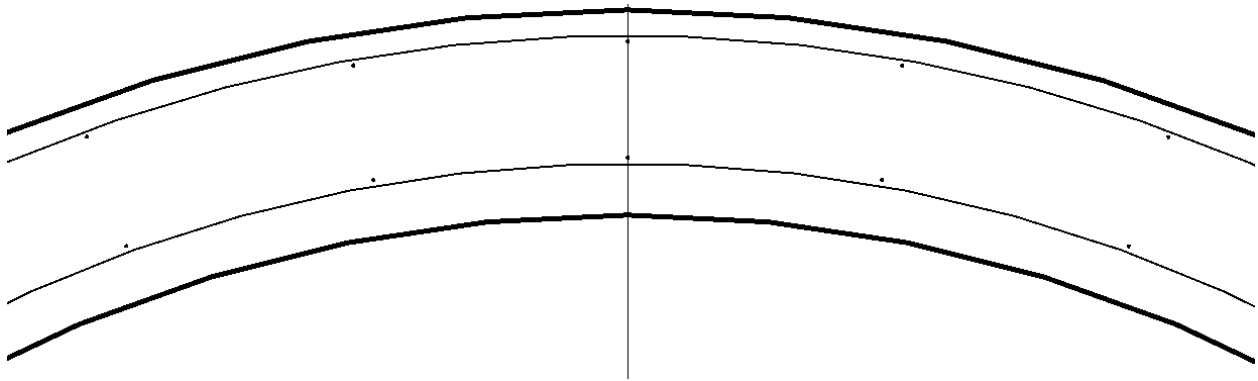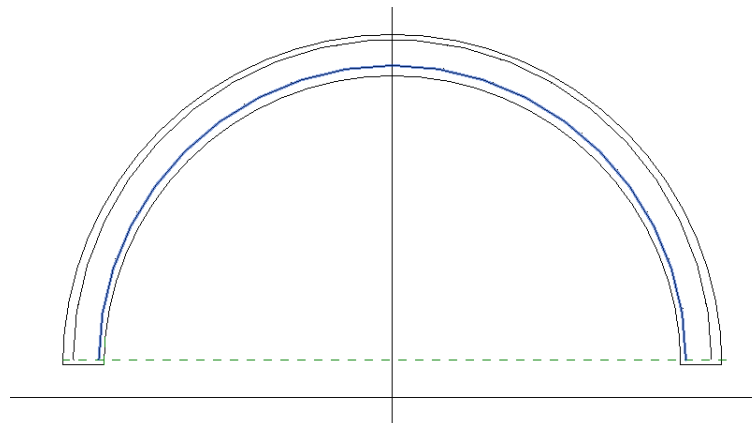


## Annotation in Revit

1. Switch to Section 1. From the Annotate tab, select Radial Dimension
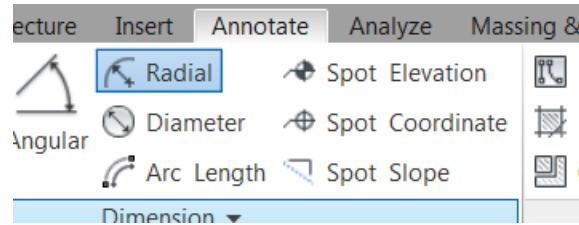


2. Select the inside Rebar arc:

Select the Center of the tunnel. The Radial dimension is placed:
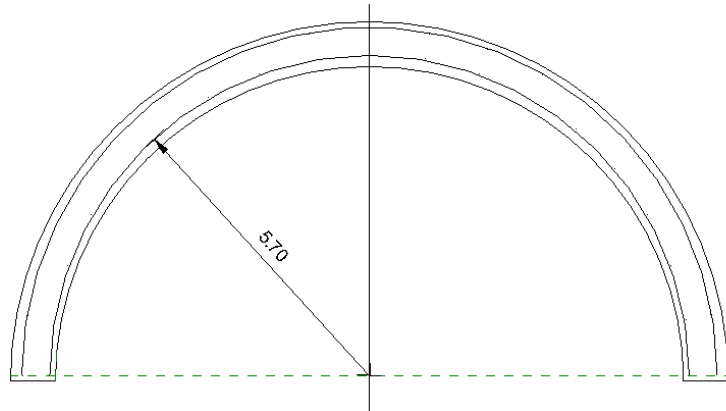


3. Repeat the dimension for the External Transverse rebar:

4. From the Annotate tab, select Spot Elevation. Place elevations at the bottom and top of the tunnel:
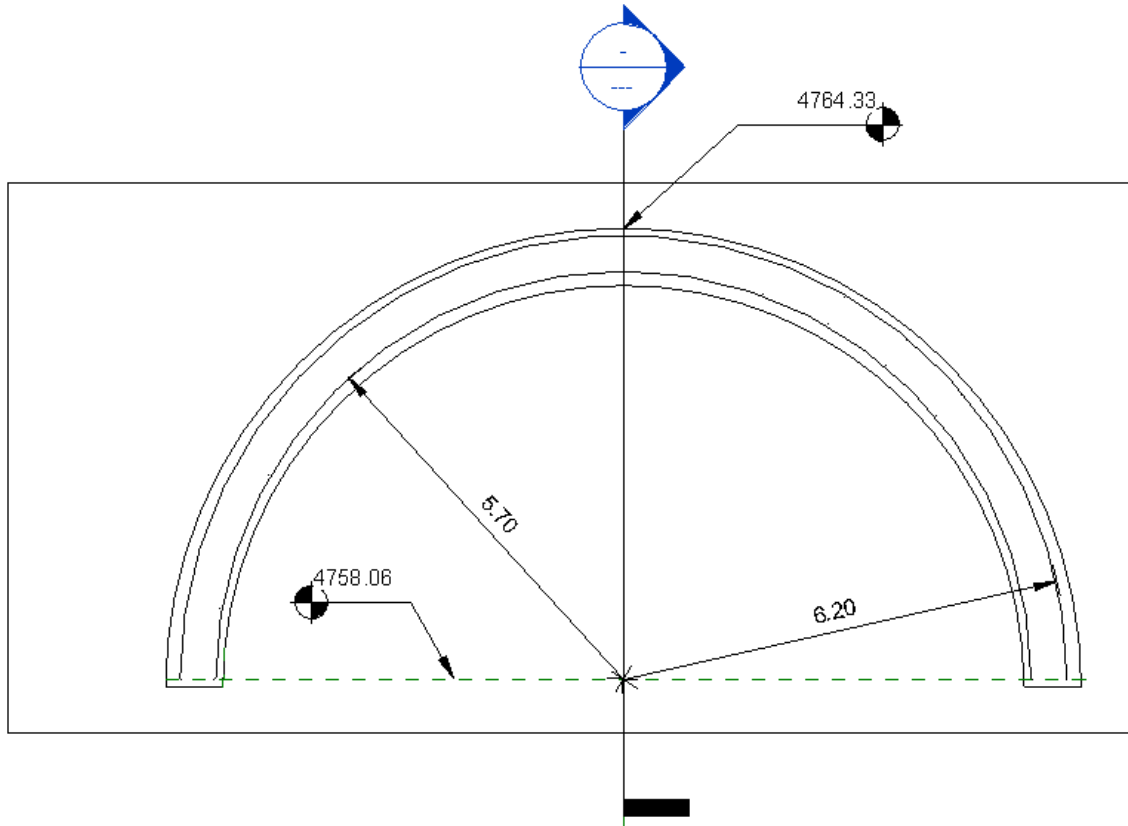


5. From the Annotate tab, select Tag by Category. Turn on Leader. Highlight any of the transverse rebars and place it outside of the tunnel. Escape to exit out of the command:
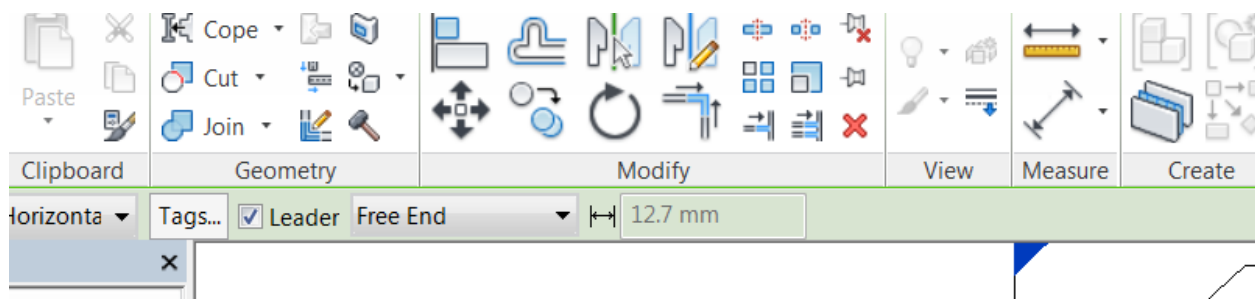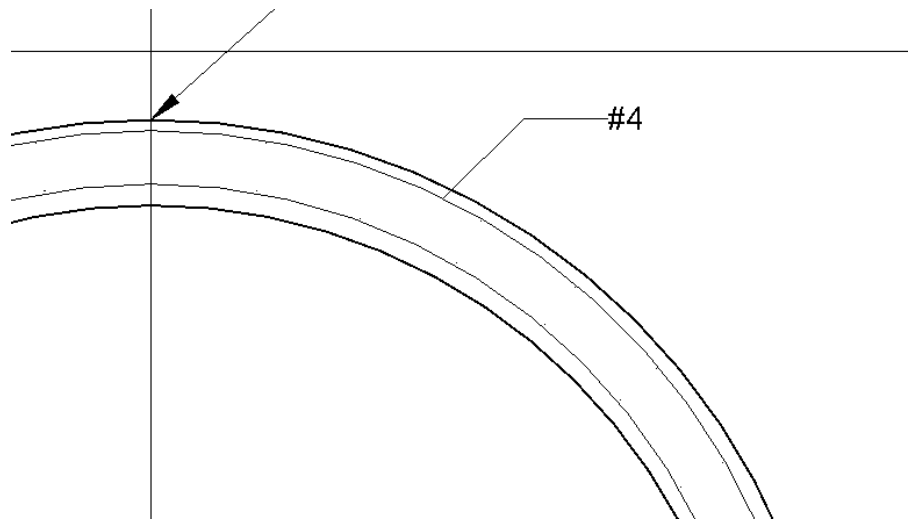
6.  Highlight the default rebar annotation. On the left side of Revit, under Properties, select Edit Type.



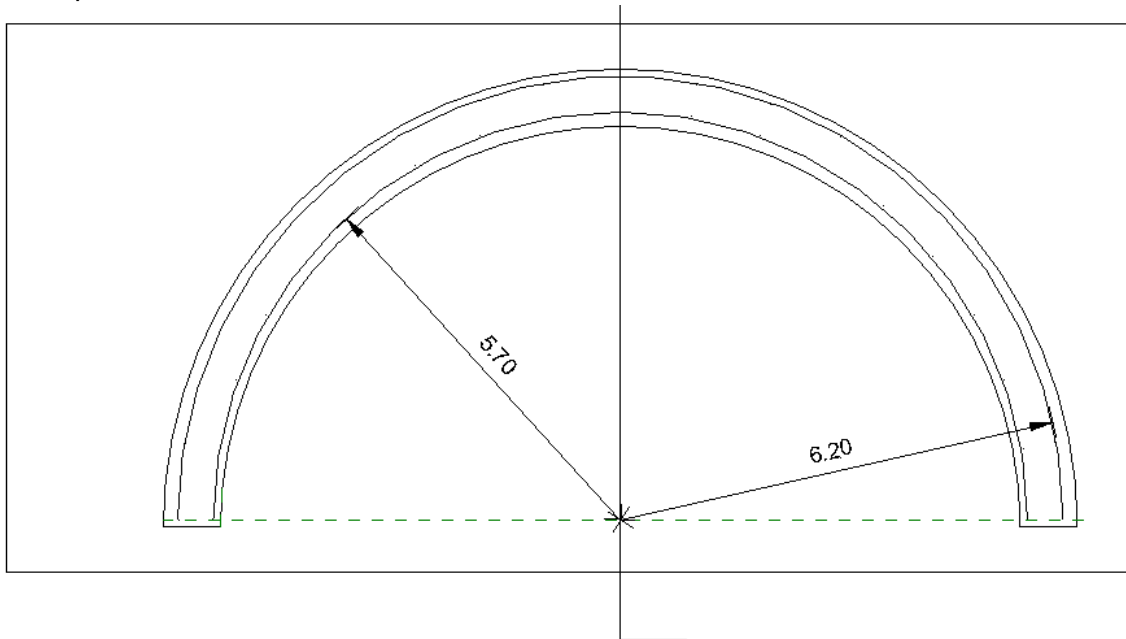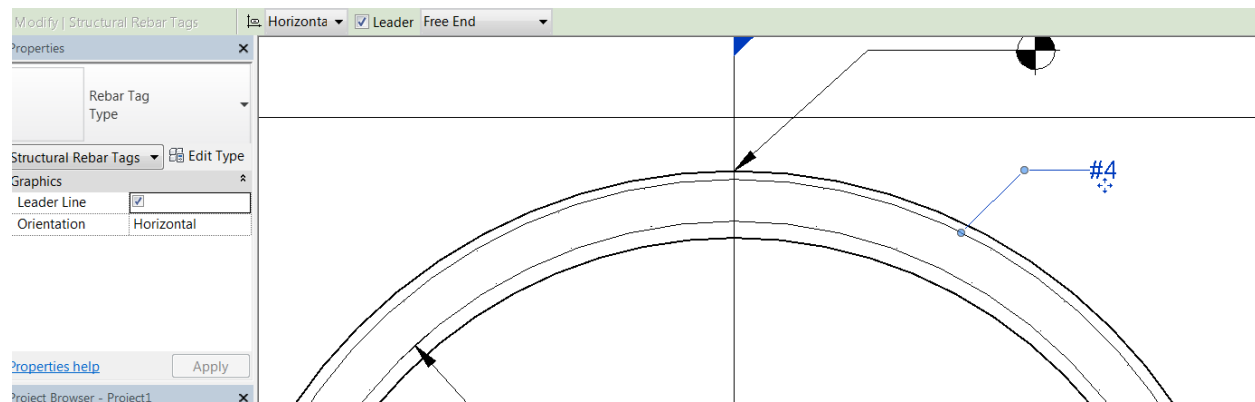Under Type Properties, turn off Type, Turn on Quantity Type & Spacing – 2 Line and for the Leader Arrowhead, select Arrow Filled 20 Degrees. Select OK.
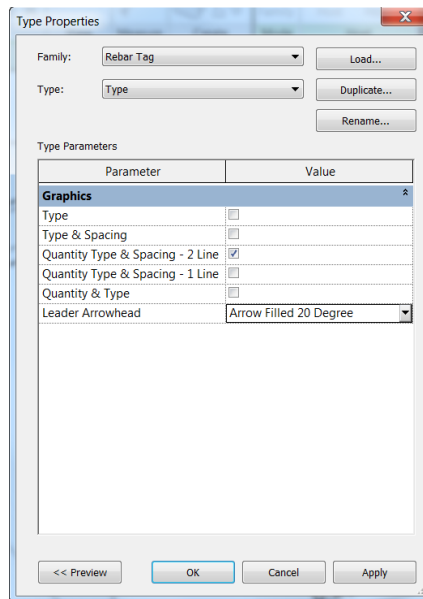
7. The rebar is now annotated with diameter, number of elements:
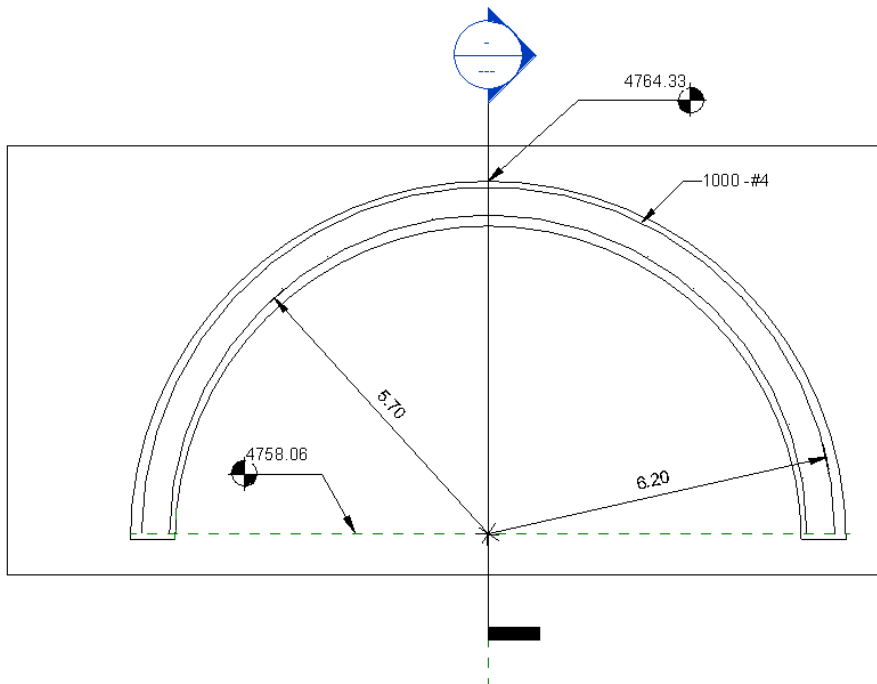
## Reporting in Revit

1. From the Project Browser on the left side of Revit, right click on Schedule/Quantities and select New Schedule/Quantities:
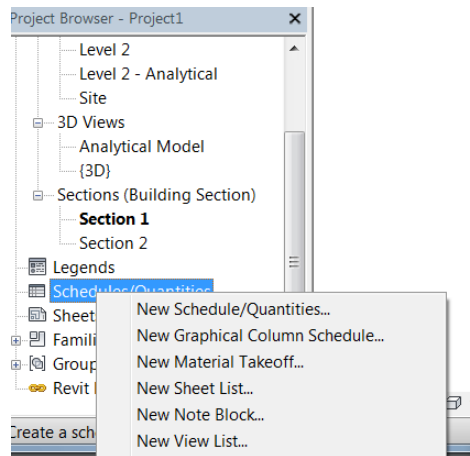


2. On the New Schedule window, select the Structural Rebar Category on the left side. Type Tunnel Rebar Schedule. Select OK:
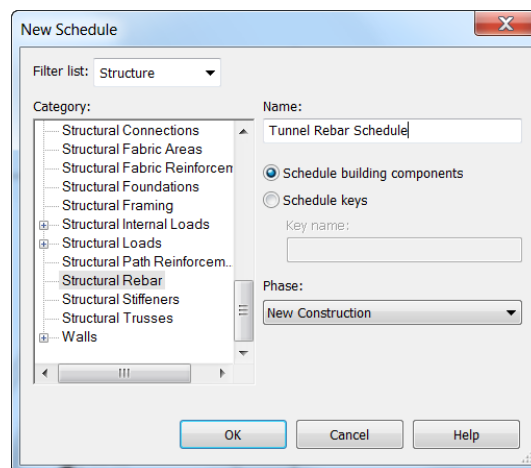
3. On the Schedule Properties Window, Add the Bar Diameter, Total Bar Length, Quantity and Reinforcement Volume
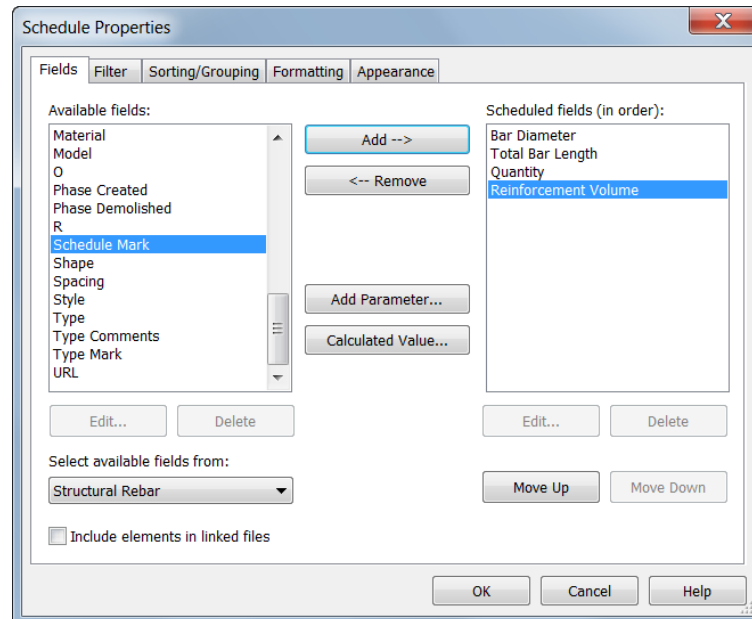


4. Select Calculated Value… Type Reinforcement Volume (LBS). For the formula, select with the three periods Reinforcement Volume. Place parenthesis around the Reinforcement Volume and complete as follows: (Reinforcement Volume * 0.000578704) * 490 / 1 CF. Select OK

5.  The report is created:

## \<Tunnel Rebar Schedule\>

| A | B | C | D | E |
|---|---|---|---|---|
| Bar Diameter | Total Bar Lengt | Quantity | Reinforcement | Reinforcement |
| 0.50" | 58750' - 0" | 1000 | 138426.43 in³ | 22.715789 |
| 0.50" | 63916' - 8" | 1000 | 150600.10 in³ | 24.71349 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
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| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
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| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |
| 0.50" | 12138' - 10" | 1 | 28601.45 in³ | 4.693501 |

6.  Right click again on Schedules/Quantities, select New Schedule/Quantities. Select Generic Models for the category. Type Concrete Volume for Name. Select OK



7.  Select Volume for the Available Fields. Select OK.

8. The concrete volume report is created:



## Drawing Composition in Revit

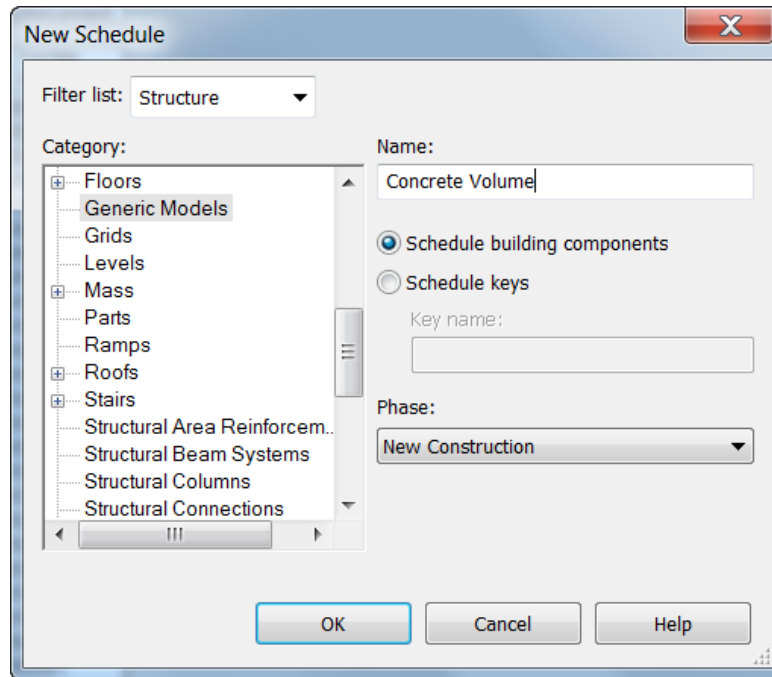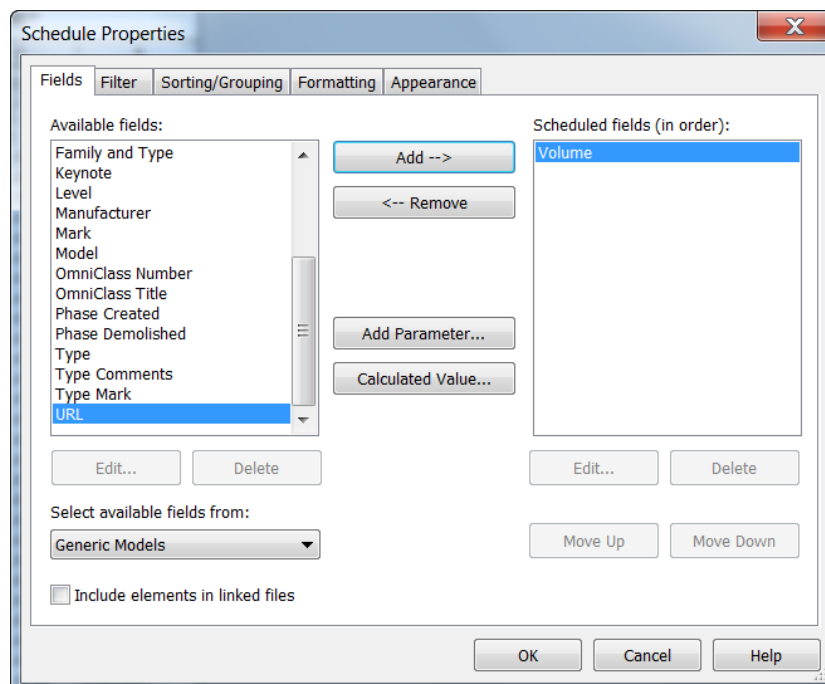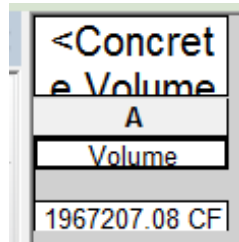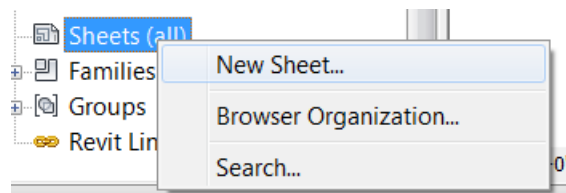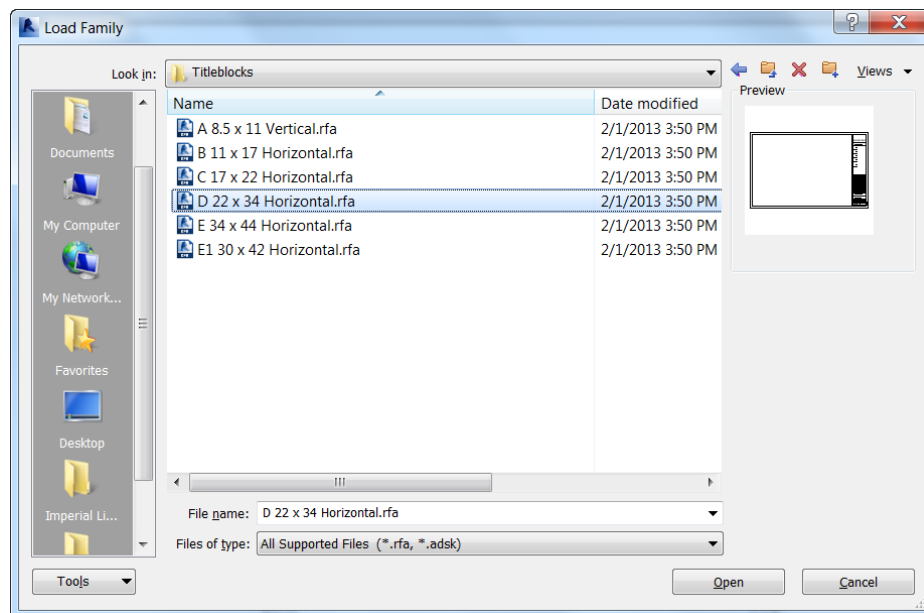1. From the Project Browser on the left side of Revit, right click on Sheets (all) and select New Sheet:



2. On the New Sheet dialog box, select Load…Scroll down to the bottom of the available directories list. Double click on Titleblocks. Select D 22 x 34 Horizontal.rfa. Select Open. Select OK.

3.  From the available Sections list, drag the Section 1 view to the drawing sheet.



4.  Drag the Tunnel Rebar Schedule to the current Sheet.



Note that if any of the rebar diameters change, the schedule will be automatically updated.

5.  From the R icon in Revit, select Save. Save the .rvt project on the class working directory.

## Creating  a Tunnel in Revit Native Format

### Creating a Typical Section inside a Revit Family

1. Close any families or projects currently open in Revit.

2. From Revit's main menu, create a new project using the Generic Model.rtf from the default English directory. Select Open
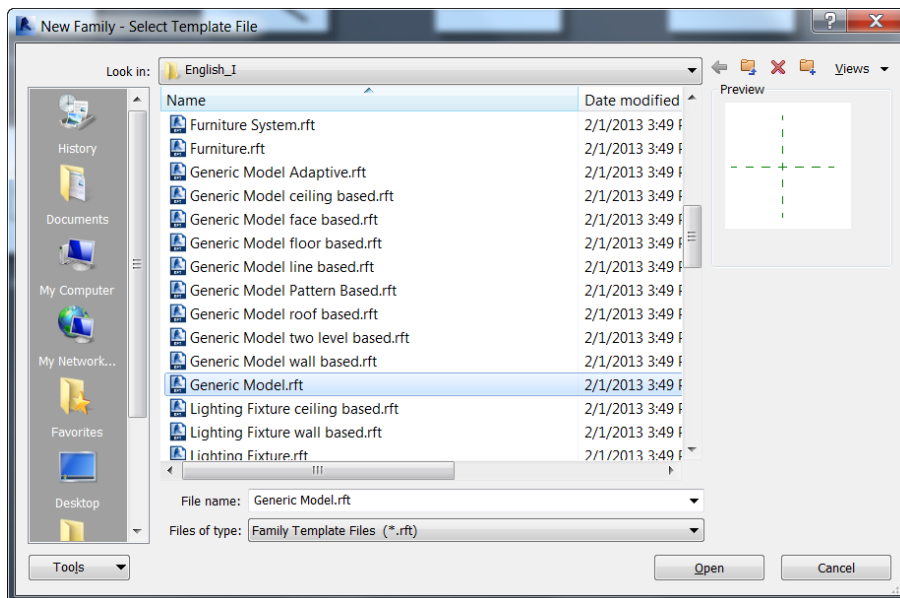


3. From the Create tab, select the Model Line command. From the Modify | Place Lines tab, select the second icon on the second row from the Draw menu. Turn on the Radius field and type in 15.00':
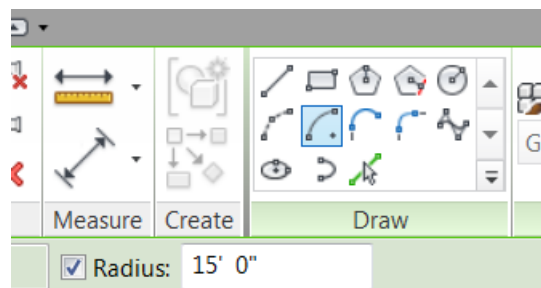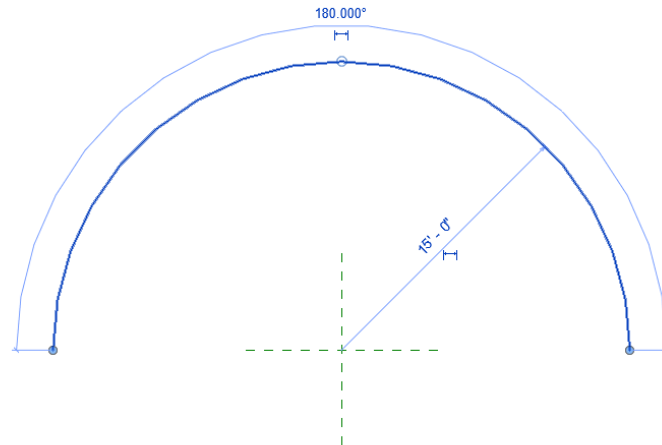
4.  Place the center at the intersection of the reference planes, place a data point to the right and sweep the arc to the left
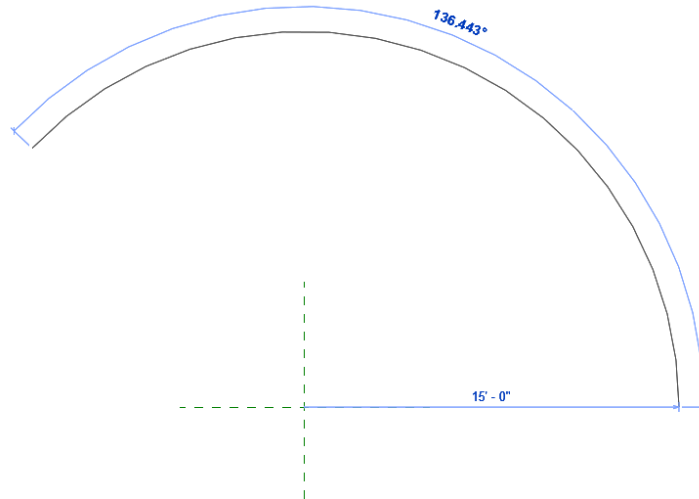


Until the arc is locked to 180 degrees. Press the Escape Key to exit the command:
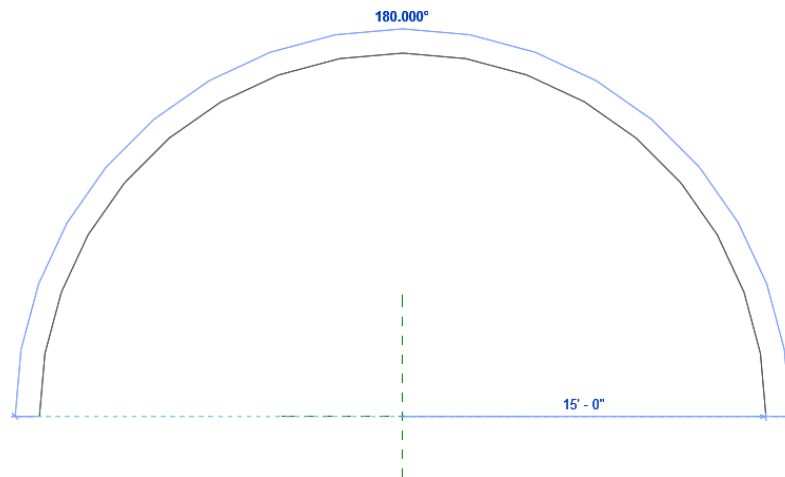
5. Click on the arc. The dimensions are visualized:



6. Click on the horizontal line dimension icon to make the temporary dimension, permanent. Press the Escape key.

7. Click the dimension line. The horizontal menu from the ribbon changes. Click on Label and select <Add parameter…>
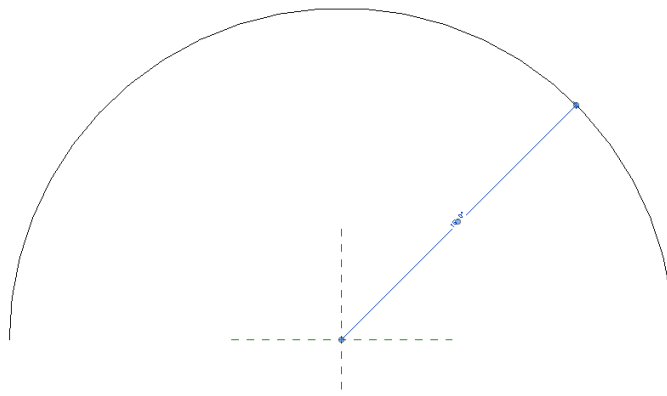
8. From the Parameter Properties, under Parameter Data, type in Inside Radius. Select OK.
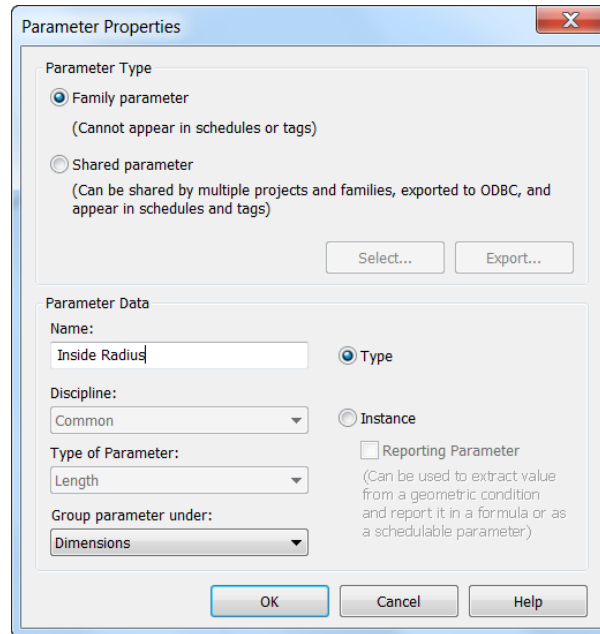


9. Repeat the complete process for the outside arc. Use a 16' 6" radius and name Outside Radius on the Parameter Data under Parameter Properties:

10. From the Create tab, select the  Model Line command. From the Modify | Places Lines tab, select the Line command from the Draw Menu. Place a line on the left side and right side of the bottom of the tunnel to close the tunnel solid:
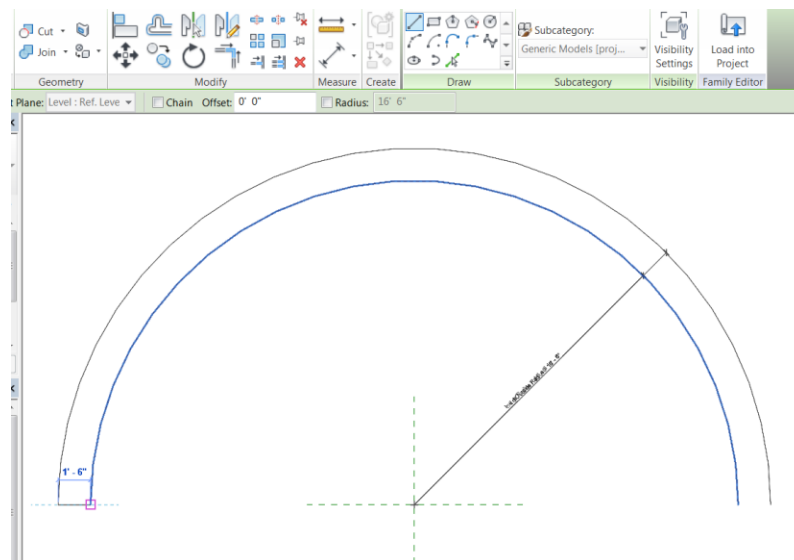
11. On the left side, under properties, scroll down. Under Other, turn off Always Vertical. Turn on Work Plane Based.
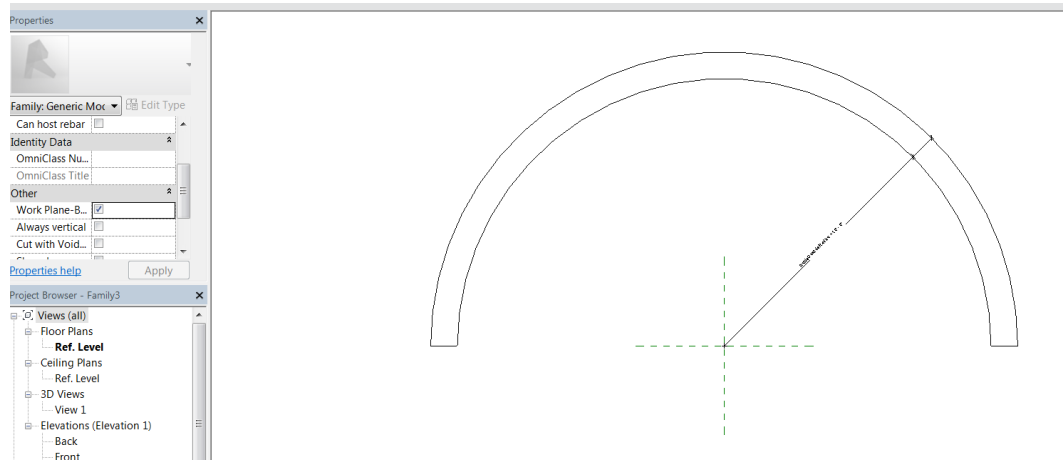


12. Save the family to the working directory as TunnelSection.rfa.
13. From the Revit icon at the top left, create a New Family. Select the Generic Model Adaptive.rtf Template File. Select Open.
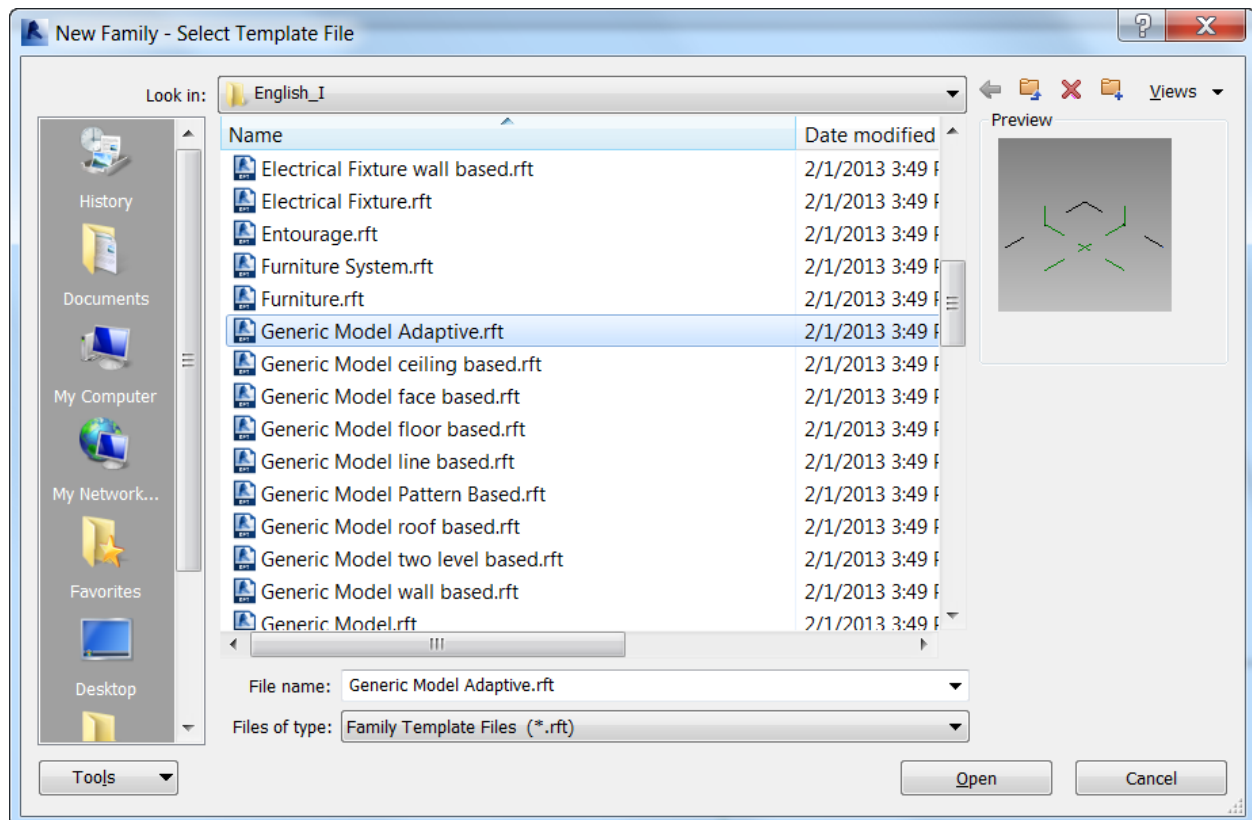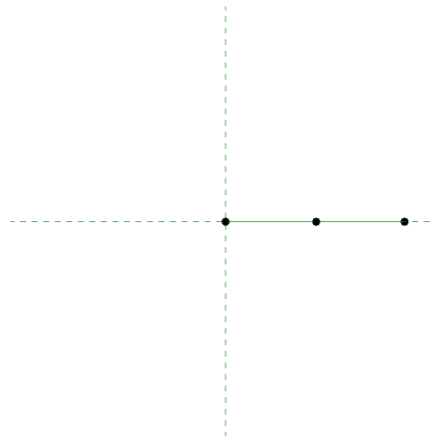
14. On the left side, under Project Browser > Floor Plans, double click on Ref. Level.

15. From the Create tab, on the Draw Menu, click on Reference lines on the Draw menu and then select Spline Through Points.
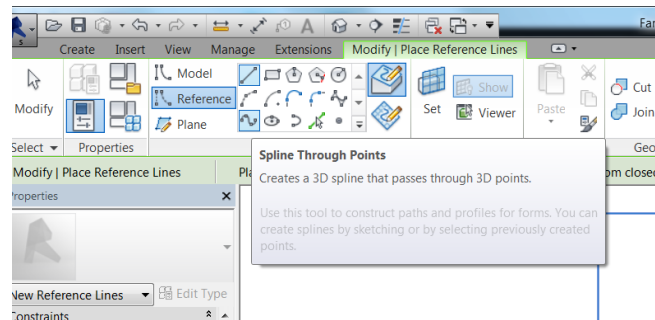


16. Place the first line at the intersection of planes, and then place two points to the right at any location along the reference horizontal plane.
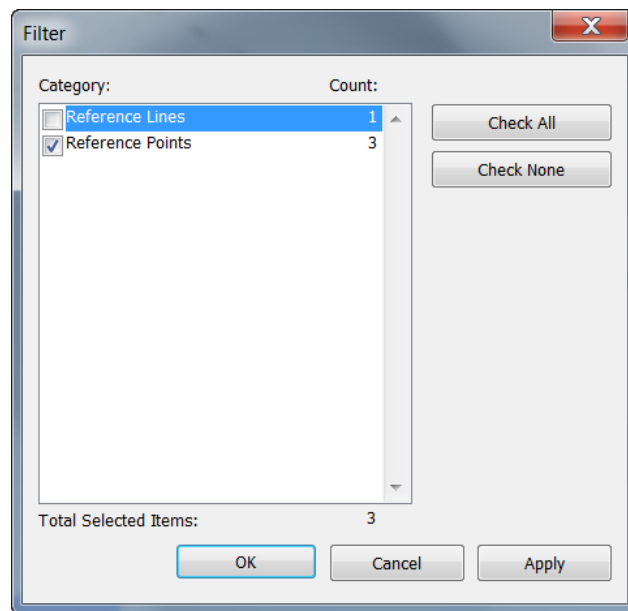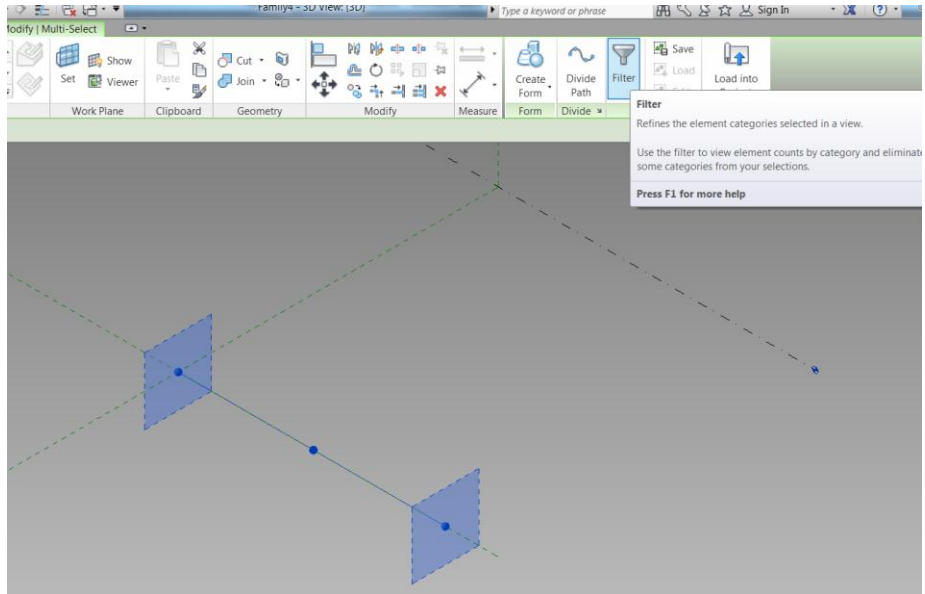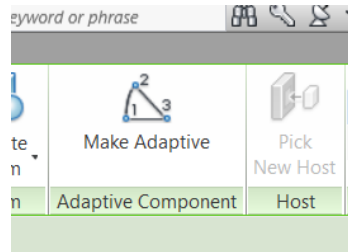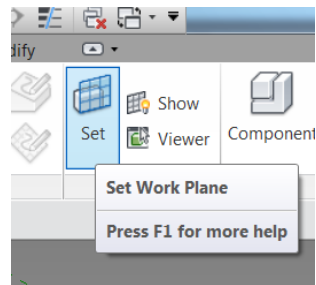


17. Switch to the {3D} View
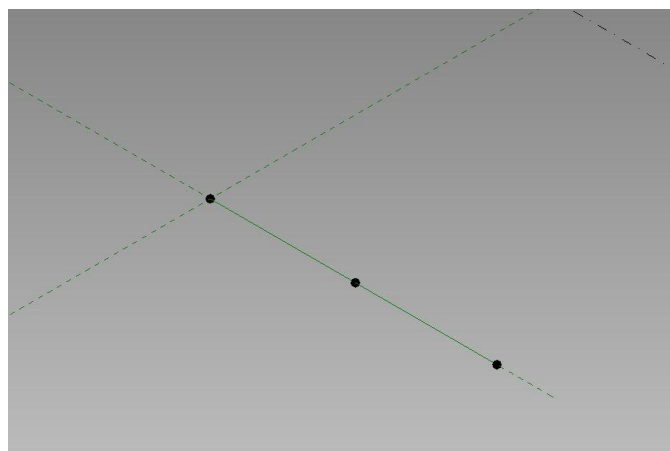
18. Select all elements. From the ribbon, select the Filter icon. Turn off Reference Lines and leave Reference Points on.
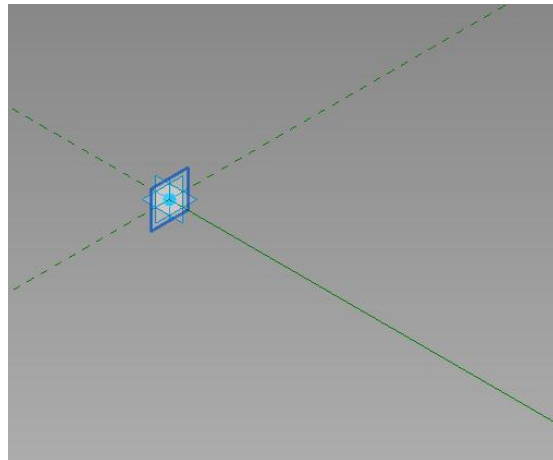
19. From the ribbon, select Make Adaptive from the Adaptive Component menu. The points are now adaptive.



20. On the Create tab, select the Set Work Plane Command from the Work Plane menu



21. Select the plane normal to the horizontal axis on the first point of the reference line.

22. From the Insert tab in Revit, select Import Family and load the TunnelSection family previously created.

23. From the left side of the Project, under the Project Browser window, select Families, expand the Generic Model family and find Tunnel Section. Right Click and select Create Instance.
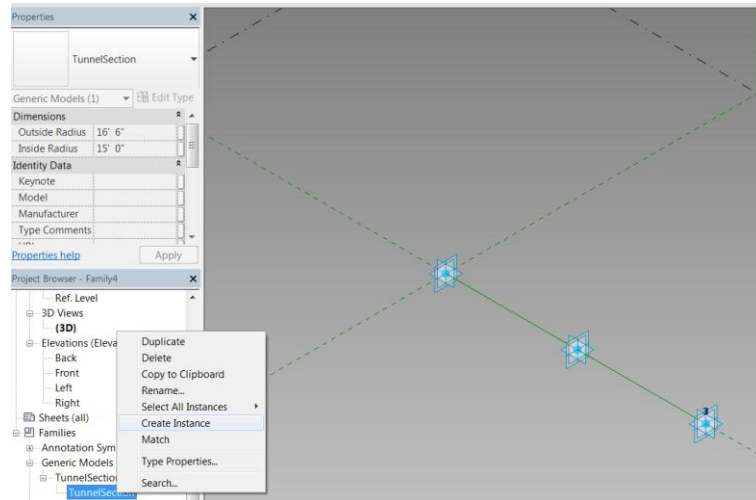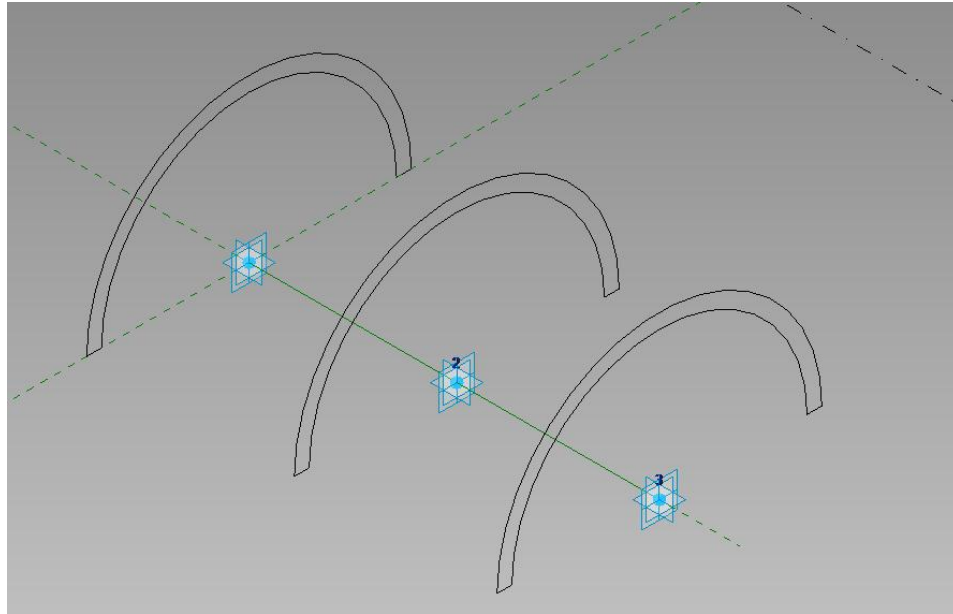


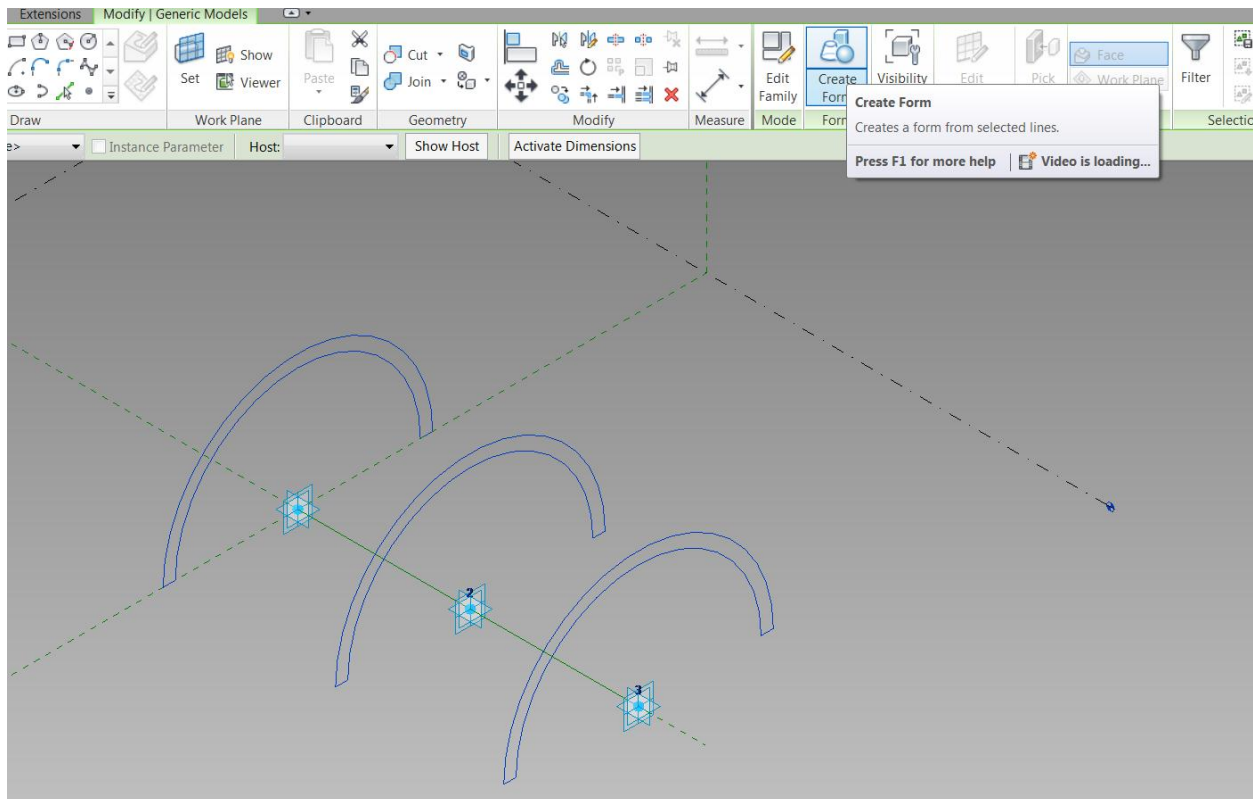24. From the Ribbon, select Place on Work Plane.
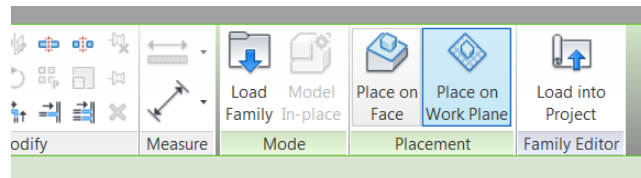

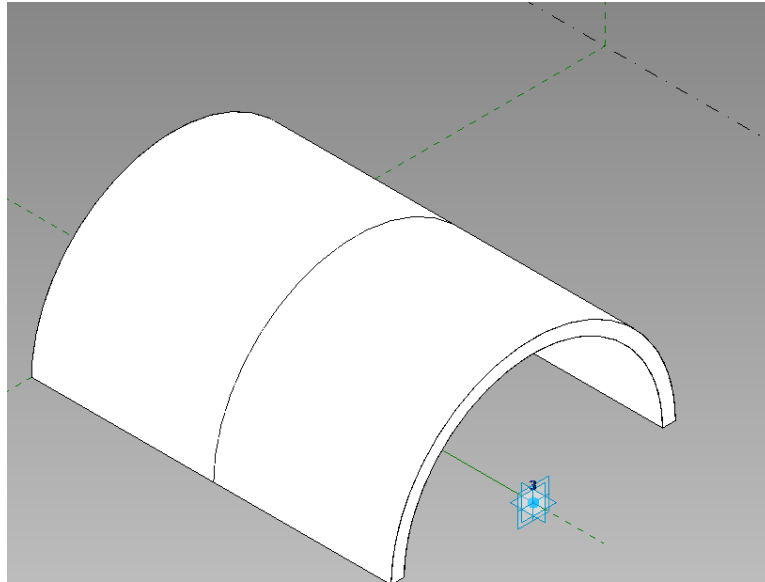
25. Place the section at the first point.
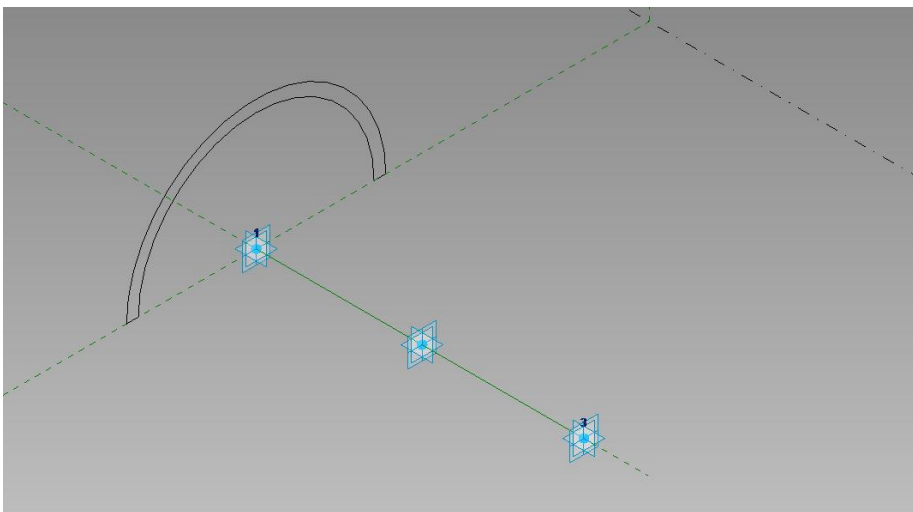
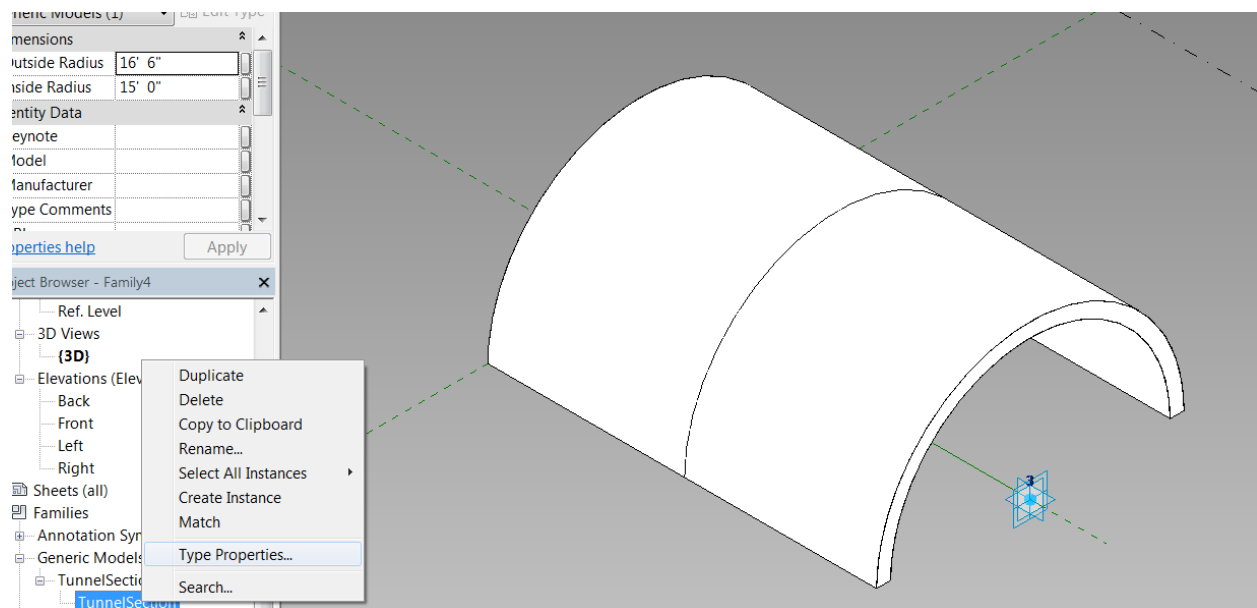26. Repeat steps 20 – 25 for the remaining two points.



27. Select the first section and using the control key, select all sections. From the ribbon, select the Create Form > Solid form command.
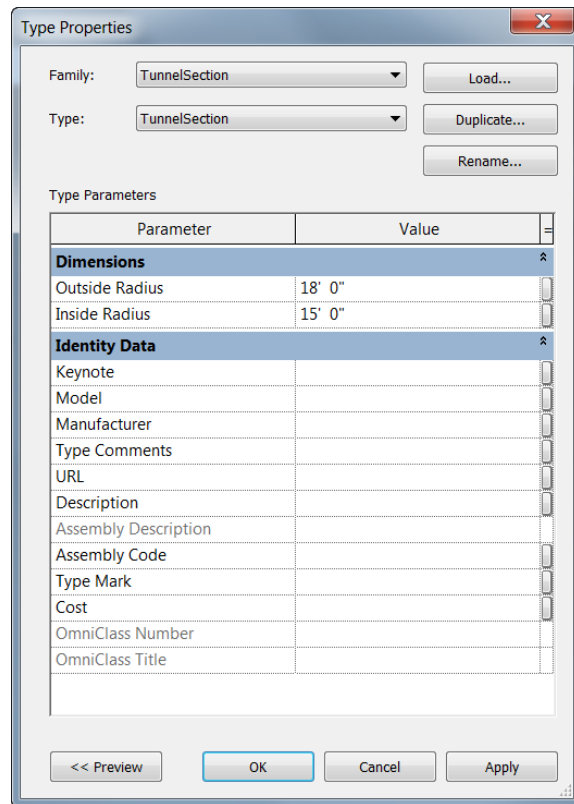
28. The solid is created:



29. From the Tunnel Section Generic Family , right click and select Type Properties.

30. Change the Outside Radius to 18'. Select OK. The solid automatically changes.
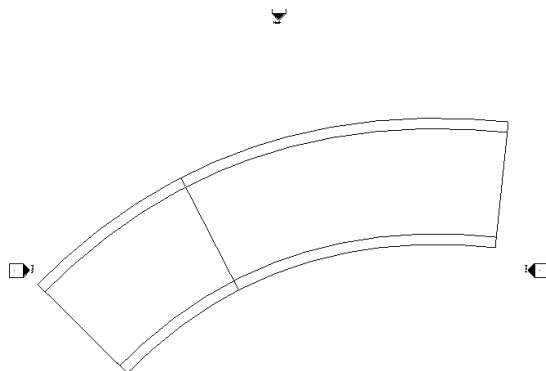


31. Save the family as Adaptive Tunnel
32. From the Revit R icon on the top left side, create a new project.
33. From the Structure tab, select Component. From the Modify | Place Component, select Load Family. Load the Adaptive Tunnel family.
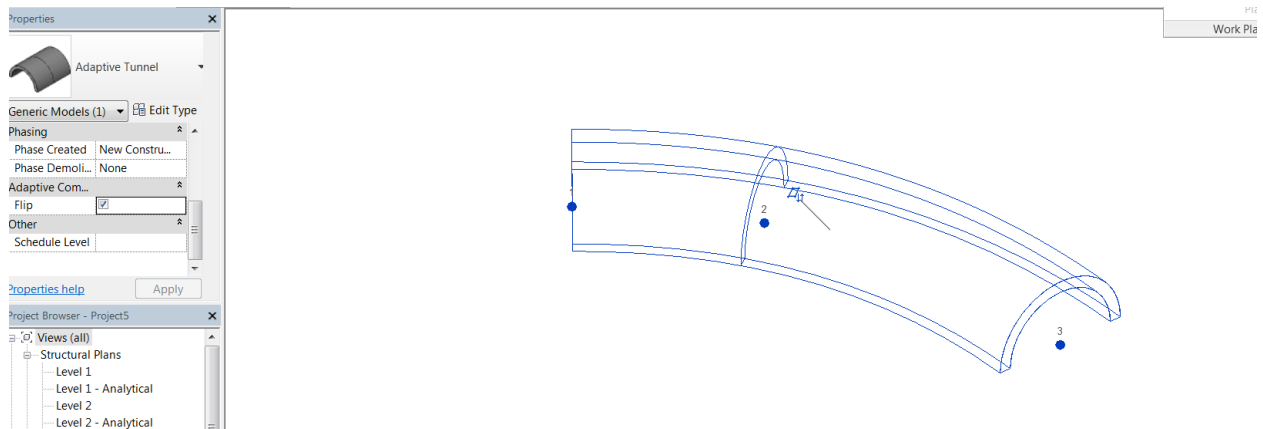34. Place the component on the top view by clicking three points for the tunnel geometry
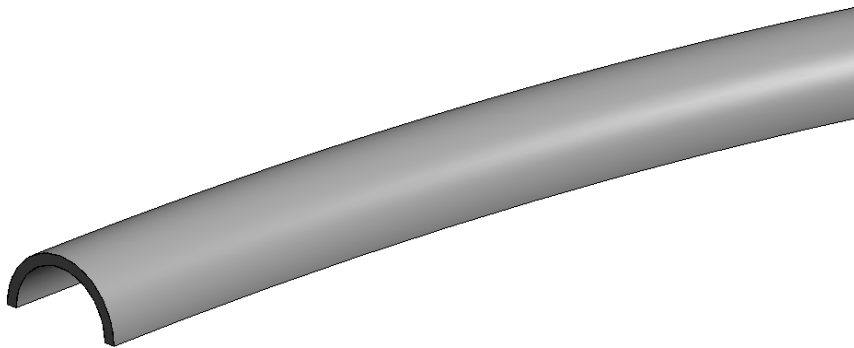
35. Open a 3D view. Since the  primitive section was constructed in the opposite order, the tunnel will be upside down:
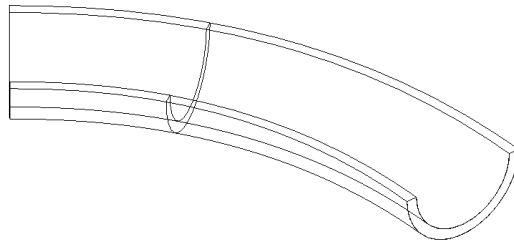
36. Highlight the solid. From the left side in Revit, under Properties, scroll down and turn on Flip on Adaptive Component. Select Apply.

37. The tunnel is correctly placed.

38. Save the project. If the solid wants to be exported to Civil 3D, select Export > CAD Formats. The solid can be exported to a dwg, dxf , dgn or a solid format (.sat).