TR20178

Working with InfraWorks 360 – Workflows for Concrete Bridge Design

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Learning Objectives

- Identify workable bridge design at early project stage
- Produce structural calculations for concrete bridge beams
- Quickly model bridge structures in the context of a project landscape
- Connect bridge models to Civil 3D and Revit to enable further detailing an documentation

Description

This class will cover the use of InfraWorks 360 as a bridge modelling and design tool in the context of a wider transportation project and explore a workflow to each of Civil 3D, Revit and Autodesk Structural Bridge Design.

You will learn how to create concrete bridges in InfraWorks 360 and use the Line Girder Analysis cloud service to quickly validate the girders against different design standards and to establish the required pre-stressing. You will learn how you can then simply open up the corresponding analytical model directly in Autodesk Structural Bridge Design for further refinement as well as to carry out more detailed analysis and design checks.

You will learn how to open up the InfraWorks 360 model in Civil 3D and Revit to enable further design and documentation.

About the speaker

Andrew Manze is Autodesk's InfraWorks 360 Business Development Manager in EMEA. He has worked in the civil and structural engineering industry for over 30 years functioning both in industry and in the specialist construction software sector. After training as a structural engineer in the UK in the late 80's and working on a variety of unusual and novel international projects Andrew moved on to business development in the 3D modelling and structural analysis software field spending many years bringing innovative technology to the European and CIS regions. In later years Andrew has concentrated on the bridge analysis and design market getting involved with the rollout of the Eurocodes within engineering consultants in Europe.

Hands-on Tutorial for Bridge Design in InfraWorks 360

In this tutorial we will be utilizing an existing InfraWorks 360 model and modelling from scratch a new bridge proposal. The input for generating most of the bridge will be conceptual in style and so some flexibility in modelling is to be expected and encouraged.

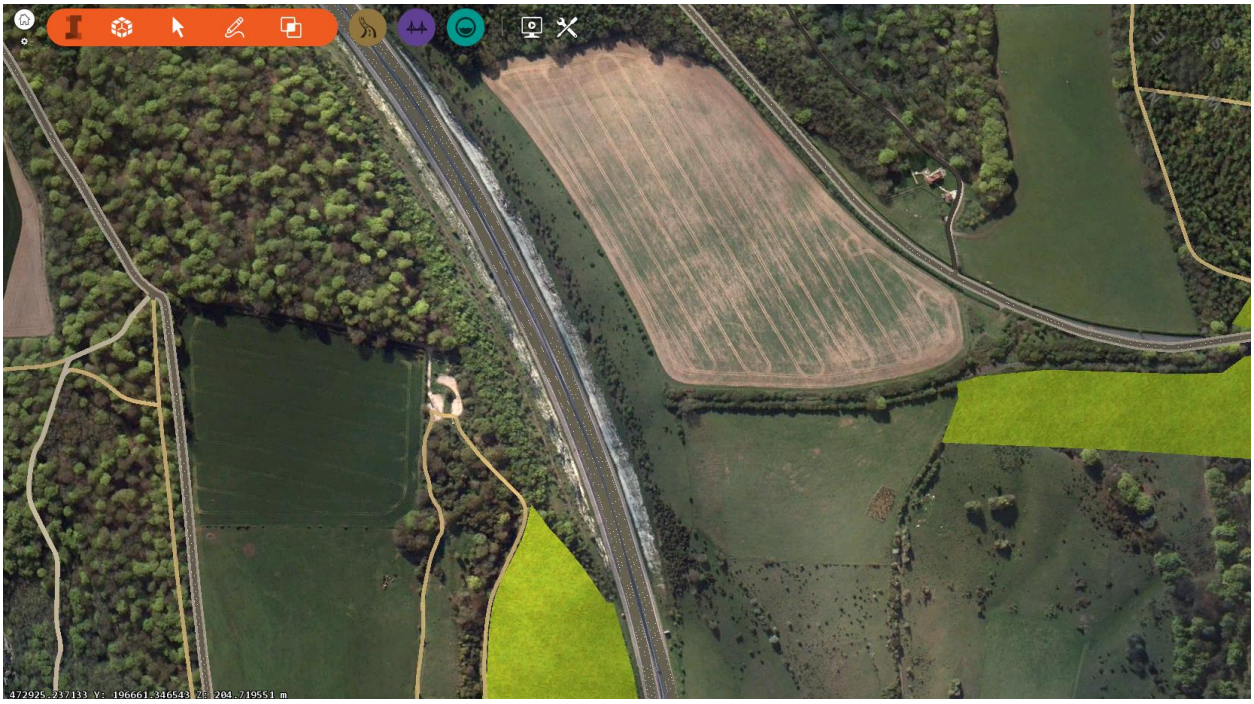
The bridge that we will be modelling is to cross a dual carriageway linking the existing road networks on either side.

Once the initial bridge has been modelled we will explore ways of analyzing and designing the prestressed concrete bridge girders.

Once we have examined the structural calculations we will link the bridge model and surrounding topography to Civil 3D and finally export the bridge model to Revit.

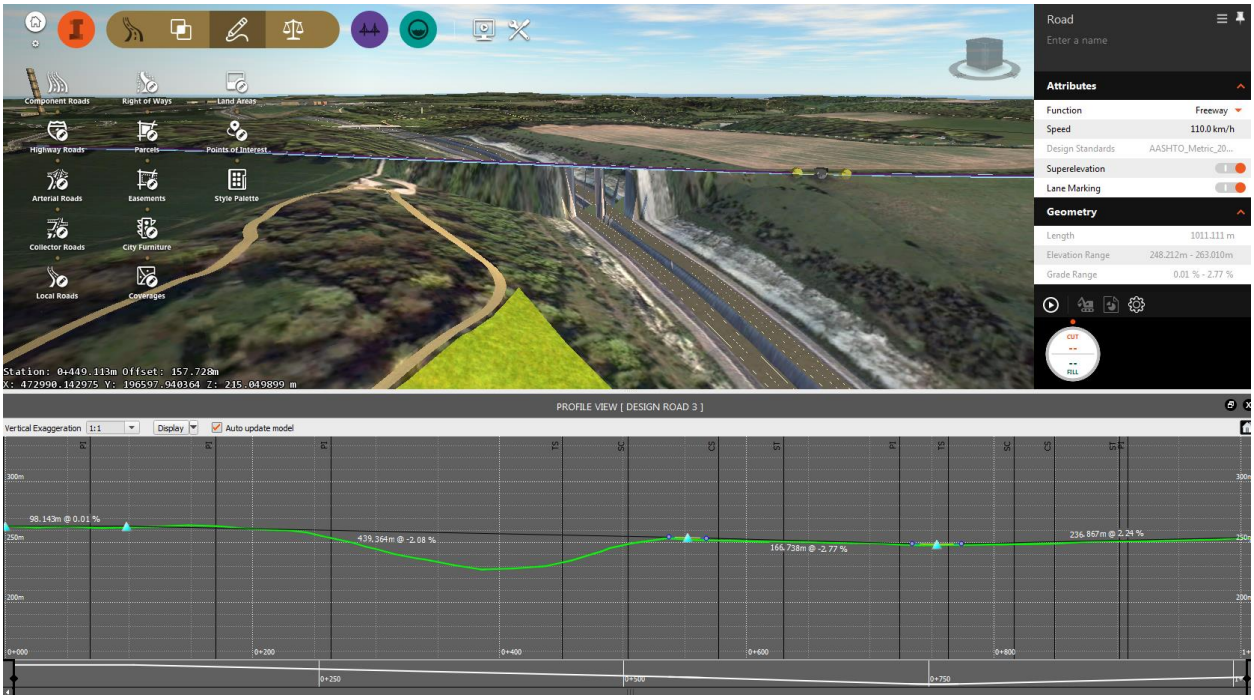
1. Once logged in to InfraWorks 360, from the Home Screen **OPEN** the model **AU Bridge Modeling Lab**
2. From the utility bar at the top of the screen click on **master** and **add** a new proposal called **NewBridge**
3. Again from the utility bar click on the bookmarks icon and use the **Bridge** bookmark
4. Your model should look like this;

5. Rotate the view so that we are looking on plan and zoom out as shown below. We will be tying into the road network on each side of the cutting.



6. From the **Design Roads** menu select **Component Roads** and then **Two Lane Road gutter and pavement** from the assembly list.
7. Create a road alignment as shown below tying in the two road networks across the cutting.

8. Rotate the model to a side view and right click on the road then select **Show profile view**.
9. Use the profile view to achieve a vertical alignment similar to that shown below. Use the right click menu to add and remove PVIs as necessary. Close the profile view when complete.



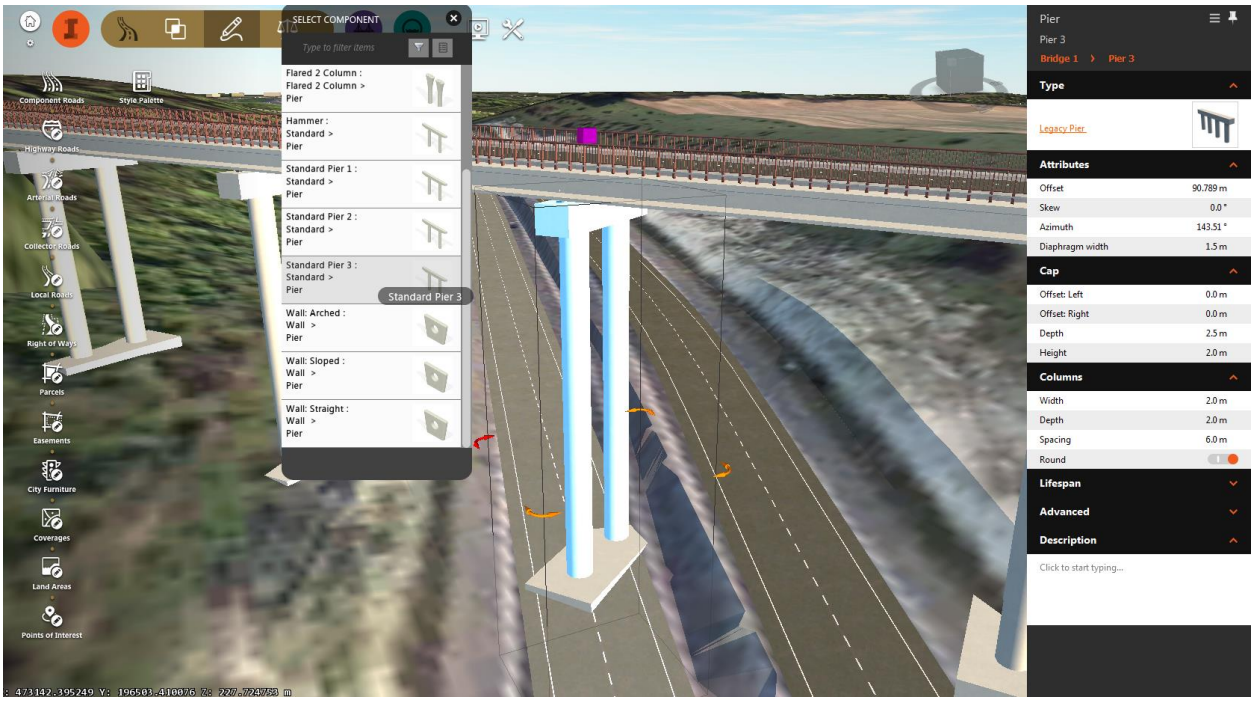
10. Right click on the road and select Add Bridge, click on the road on the left side of the cutting and then the right to specify the extent of the bridge.

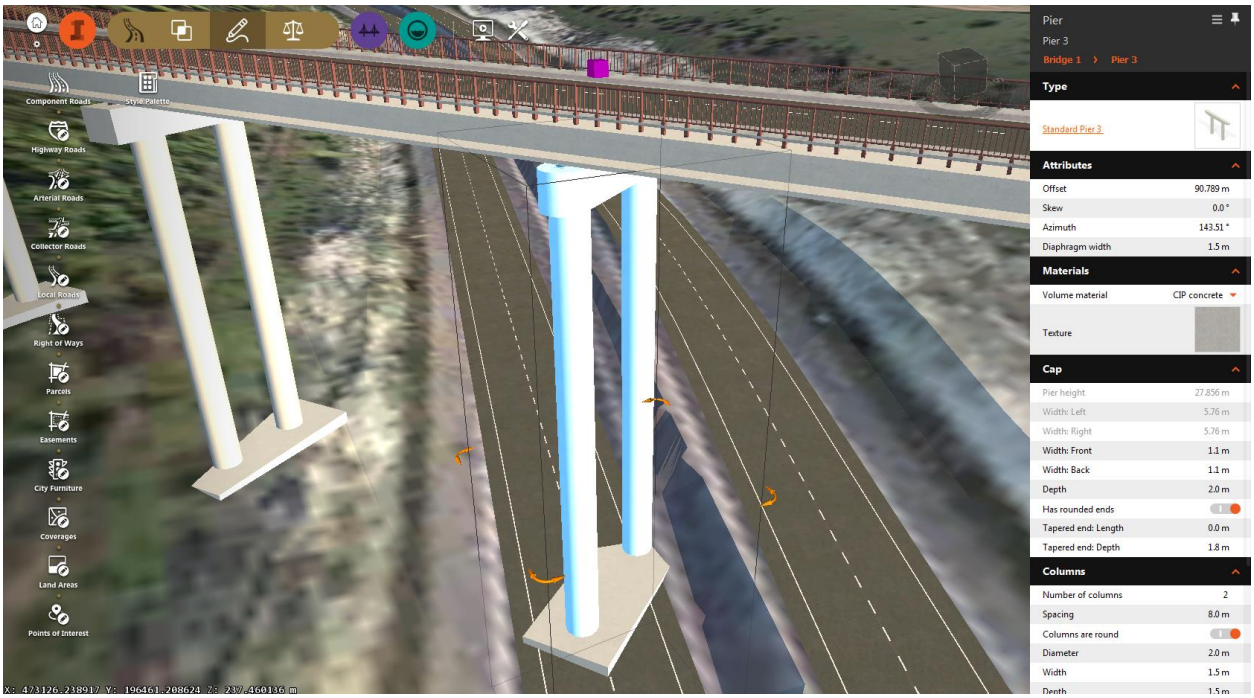
11. The bridge modelled should look similar to that below. Ensure that the bridge has at least 4 or 5 piers.

12. **BREAK**.
13. Click on the main carriageway so that the full width of the carriageway is selected, then right click and select **Replace Assembly** from the menu.
14. Select a starting position for the bridge road profile and then click on the **black grip** to extend the profile to the other end of the bridge and release.

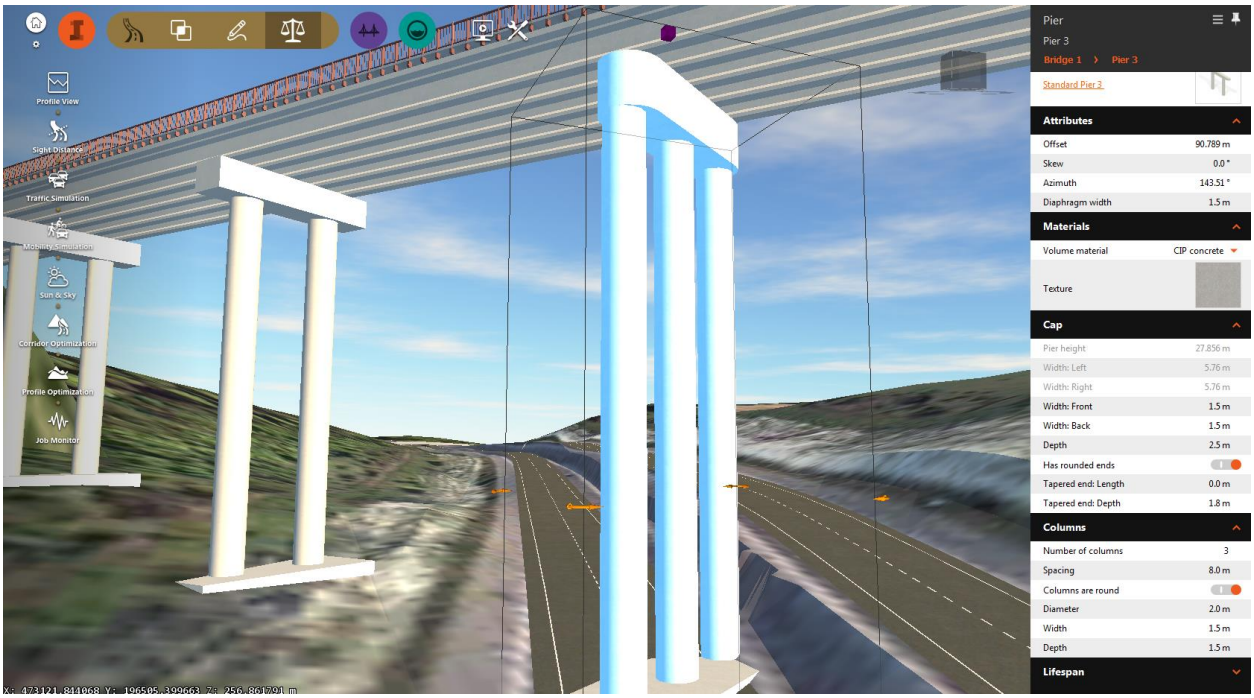
15. Select from the Component menu **Lane Bridge with Red Rail Pavement** and press return.
16. The bridge should then be modelled as below;

17. Select the main central pier and then click **Legacy Pier** in the contextual stack on the right
18. Double click **Standard Pier 3** in the list to change the pier type as below;



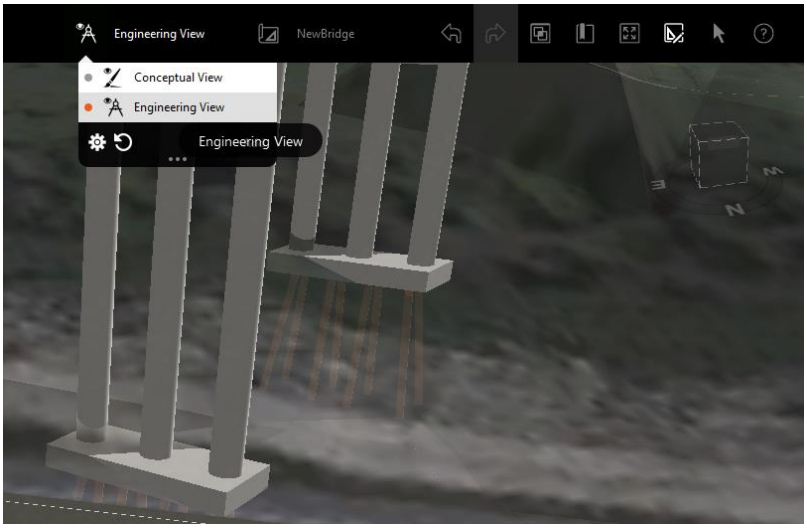


19. With the pier selected make the following changes to the pier geometry in the contextual stack on the right.
    a. **Columns = 3**
    b. **Width: Front = 1.5m**
    c. **Width: Back = 1.5m**
    d. **Depth 2m**



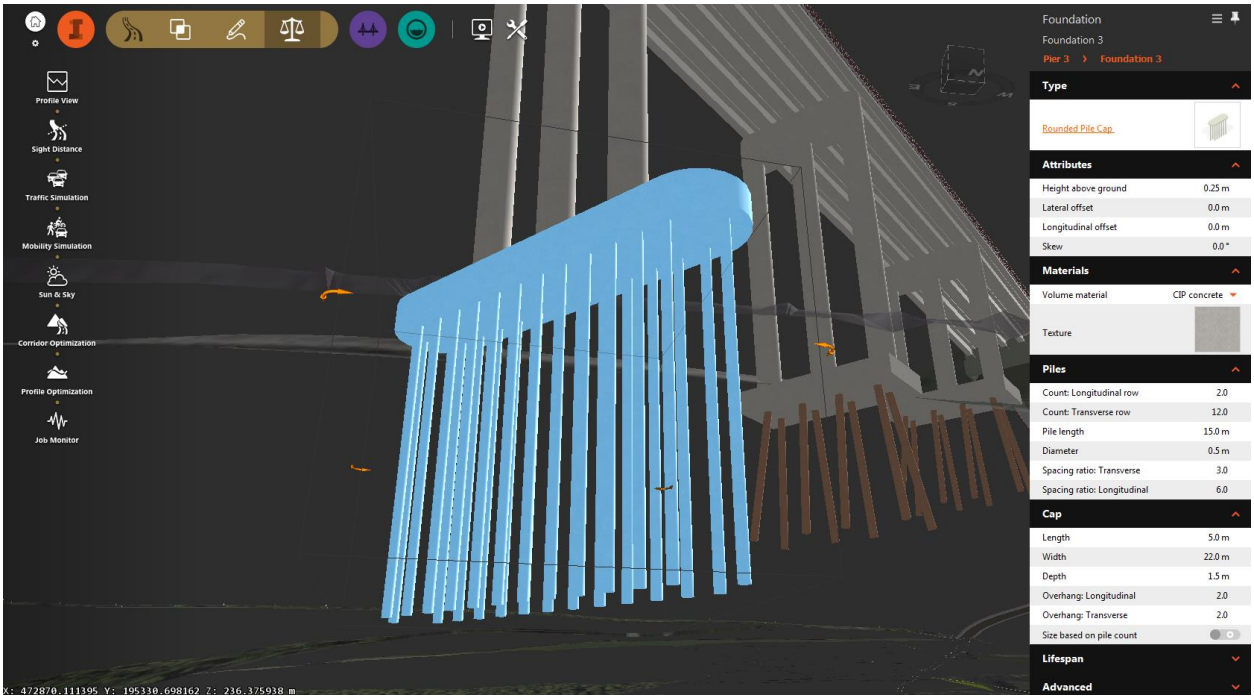
20. Right click on the selected pier and pick **Apply to…All Piers**

21. Select from the utility bar **Engineering View**

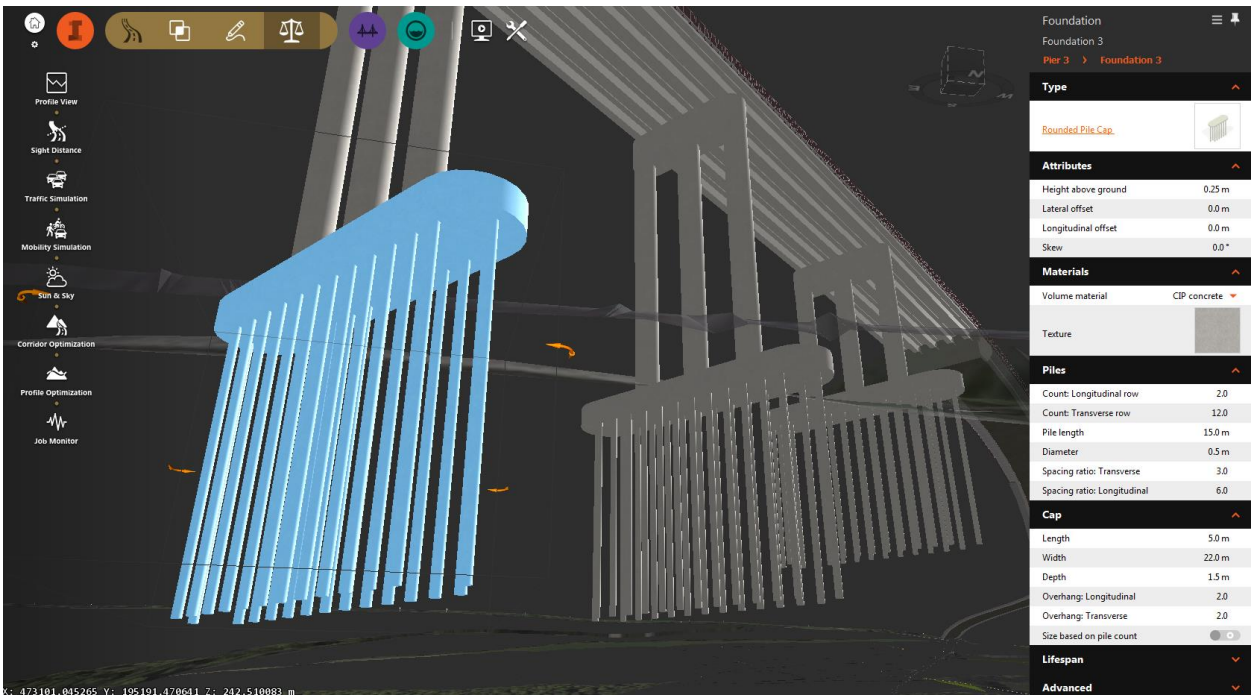


22. Select the pier foundation and make the following changes to the foundation geometry in the contextual stack.

a. Type = Rounded Pile Cap
b. Count: Longitudinal row = 2
c. Spacing ratio: Longitudinal = 6.0



23. Right click on the selected foundation and choose **Apply To…All Pier Foundations**



24. Now reposition the central pier between the two carriageways. Click on the pier, ensure it is selected, then use the **purple grip** over the pier to move it. Then use the **orange rotation grips** to rotate the pier into position. Make note of the skew angle in the contextual stack.
25. Click on each pier in turn and apply the same skew angle.

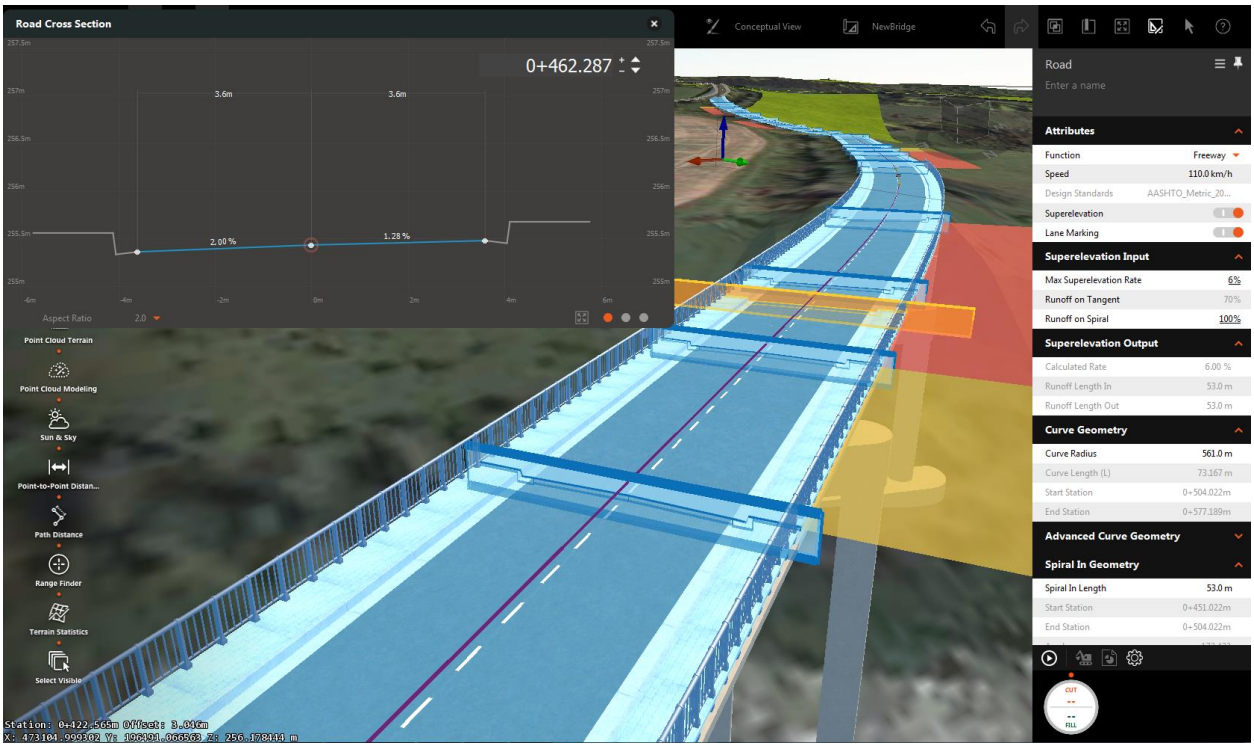
26. Move each pier in turn to achieve an even distribution across the bridge

27. Select the abutment for the left hand side of the bridge. Make the following changes in the contextual stack.

a. Type = Wing Walls 1
b. Offset = 8m
c. Depth: Left = 12
d. Depth: Middle = 12
e. Depth: Right = 12
f. Legnth: Left = 9
g. Length: Right = 9

Results may vary with this numbers, try adjusting the values to create an abutment that ‘looks right’. If necessary move the extent of the bridge deck by selecting the bridge deck and redefining the bridge length/station.

28. Repeat for the other abutment.
29. **BREAK**
30. Click on the bridge deck, right click and tick **Show Superelevation**, repeat and tick **Show Cross Section View**. Drag the **Yellow section marker** to examine the Superelevation, then repeat and untick Superelevation and close the cross section window.



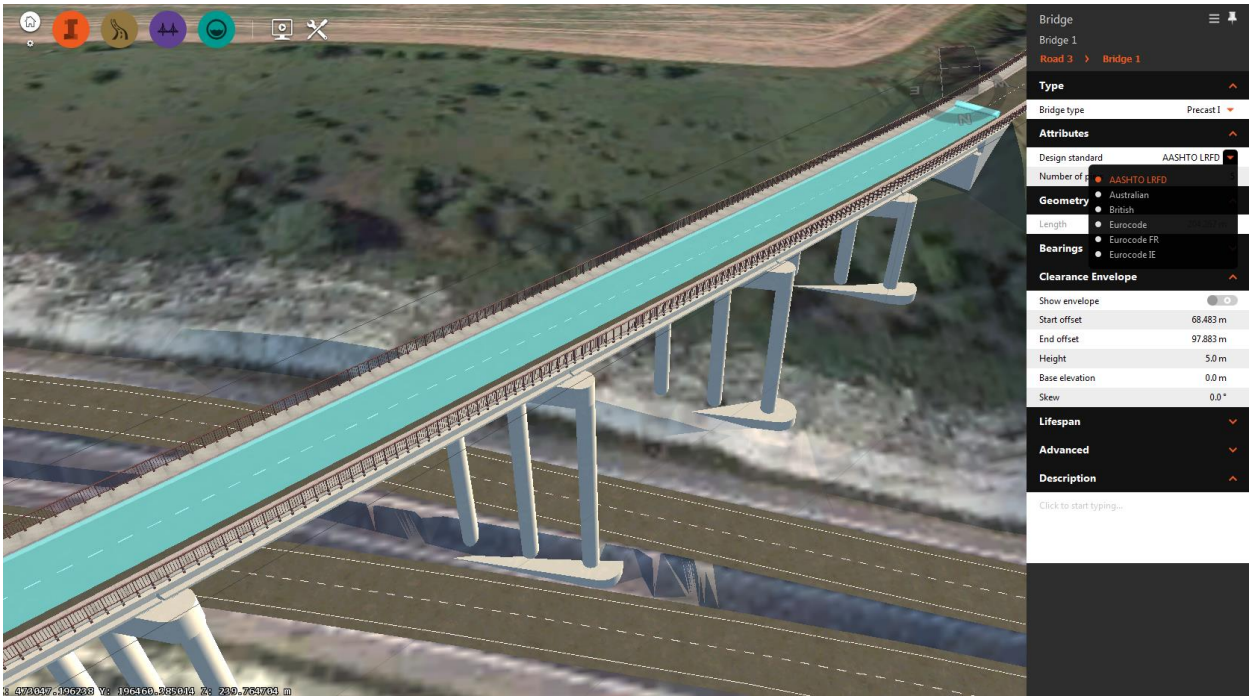
31. Select the bridge deck, change these values;

a. Left edge to curb = 1.5m
b. Right edge to curb = 1.5m
c. Continuity = Deck Only

The bridge girders should now be ‘discontinuous’.

Notice the values in the contextual stack relating to **Concrete strength** and **Superimposed loading**, these will be used shortly with the structural analysis and design functions.

32. By selecting the bridge and looking to the contextual stack, click on the Design Standard dropdown menu to reveal the available design standards for bridge analysis and design, leave as **AASHTO LRFD**.



33. Select and then right click on a bridge girder. Expand the Component Display menu and untick **Road** and **Deck**.

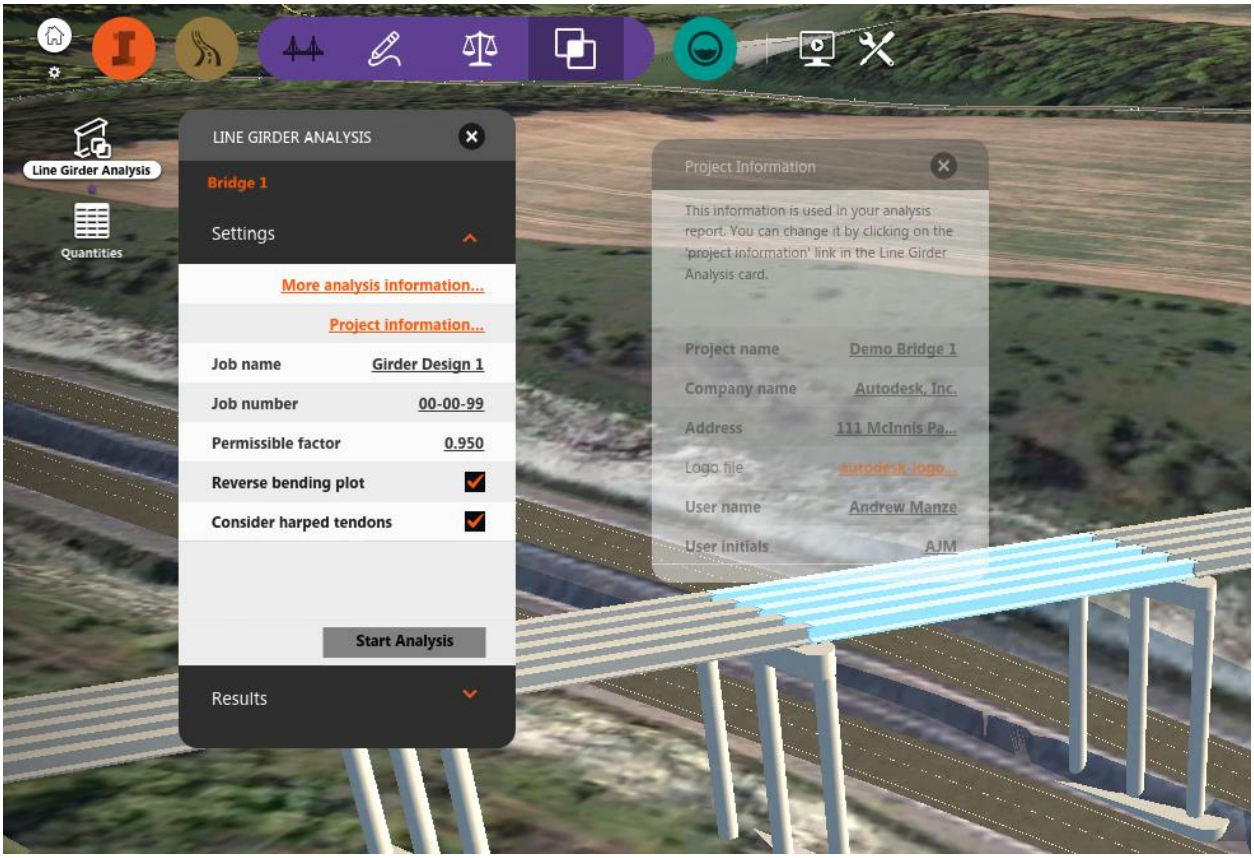
34. Click on the Section Type **External** to reveal the bridge girder **Select Component** list, double click **AASHTO Type VI** to change section type.
35. Repeat for **Internal** girders.
36. Right click on the selected group and select **Apply To…All Girder Groups**.

37. Examine the values in the contextual stack for **Material Properties**, these will be used next in the girder design.

38. BREAK

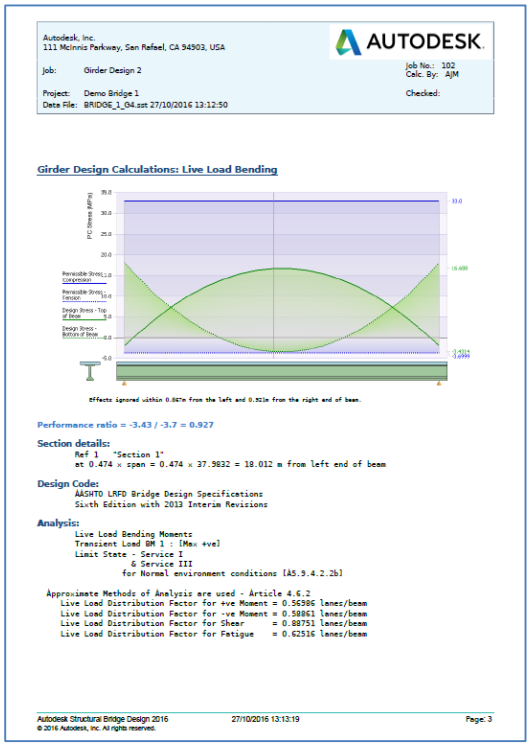
39. From the Bridge menu, select **Line Girder Analysis**.

40. Click the **Project information…**link and change some of the data and close.

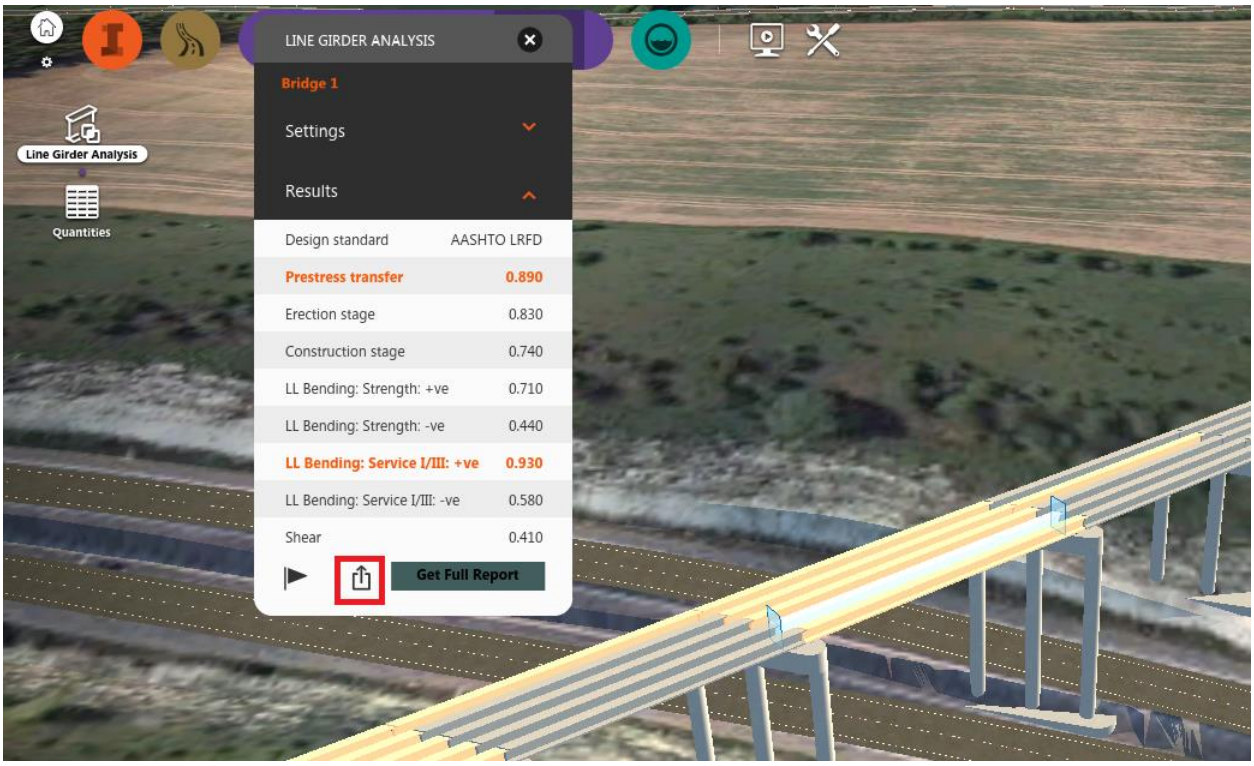


41. Change the **Job number** to **100** and untick **Consider harped tendons**.
42. Click **Start** Analysis (if time is short **do not start the analysis** but switch to the proposal **LineGirderAnalysis_1** where the results for a similar bridge are already stored and activate the line girder analysis function)
43. Once the analysis and design are complete hover over the color coded girders to inspect the unity factors.
44. Select one of the girders to reveal more unity factors in the Line Girder Analysis panel with the leading design case highlighted in orange.

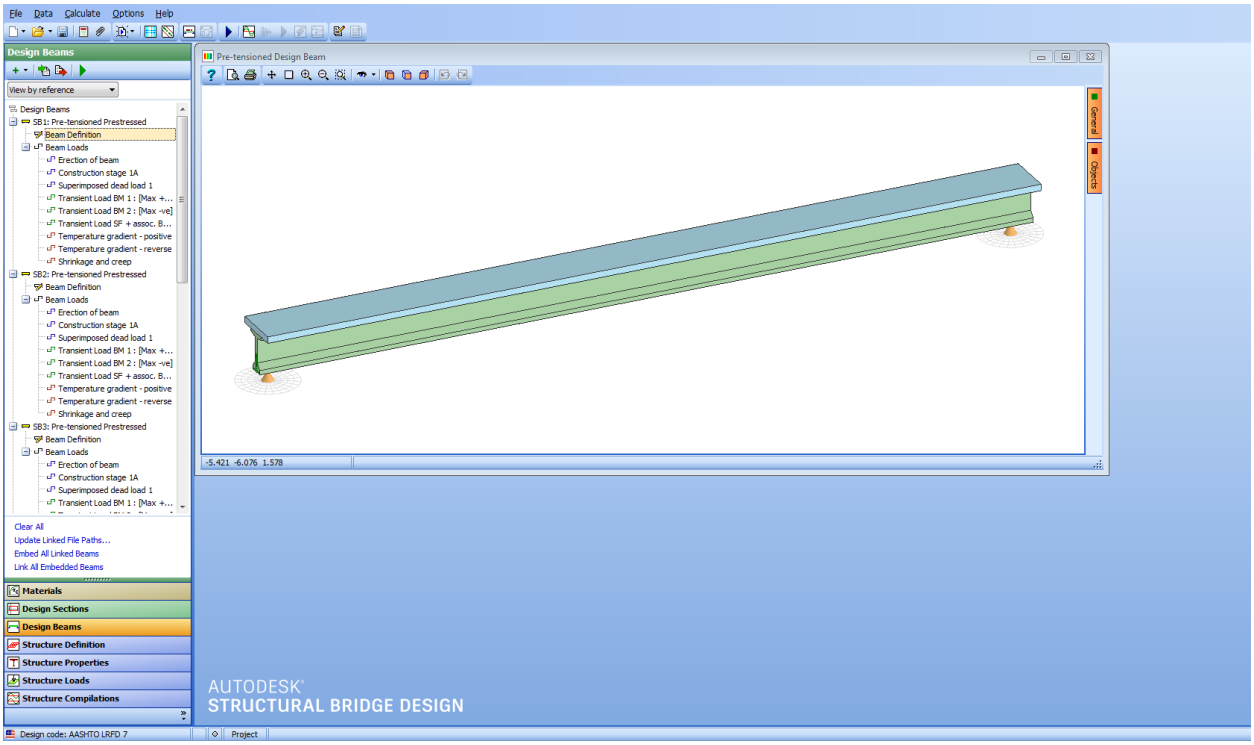
45. Click **Get Full Report**, **Complete Purchase** and examine results.



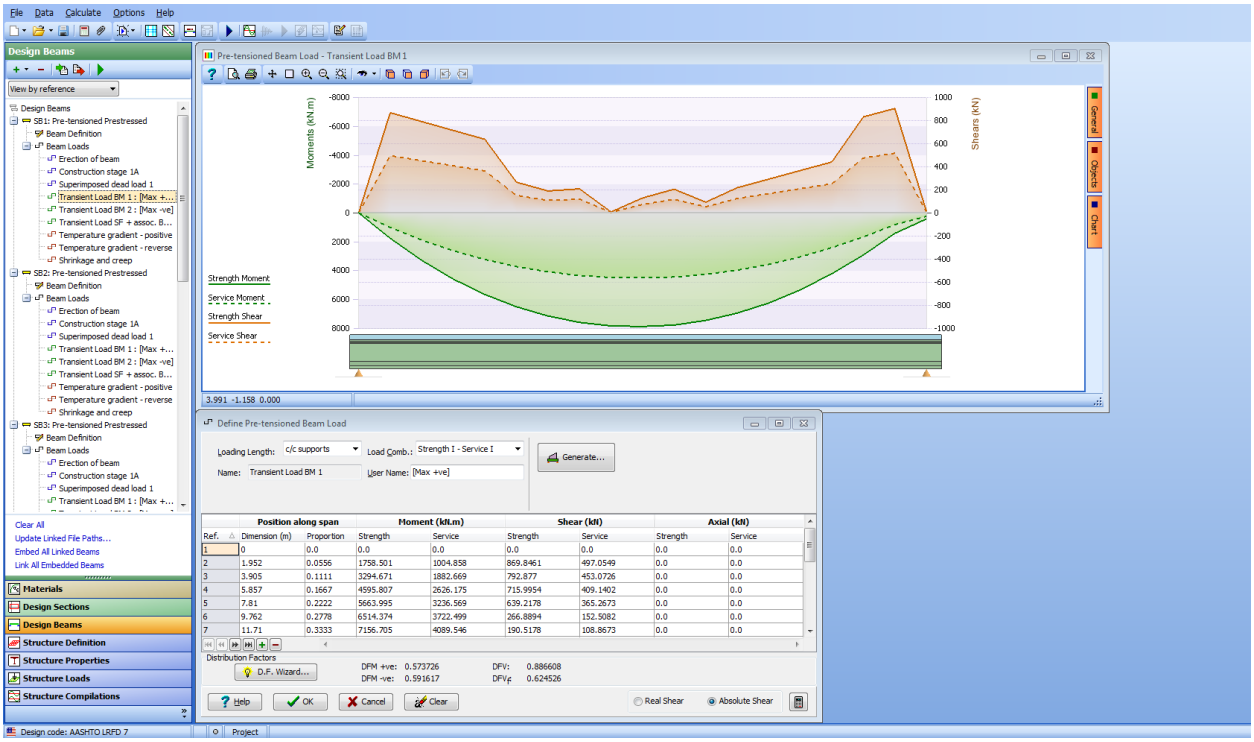
46. To open the structure **in Autodesk Structural Bridge Design 2017** click the **open icon**.



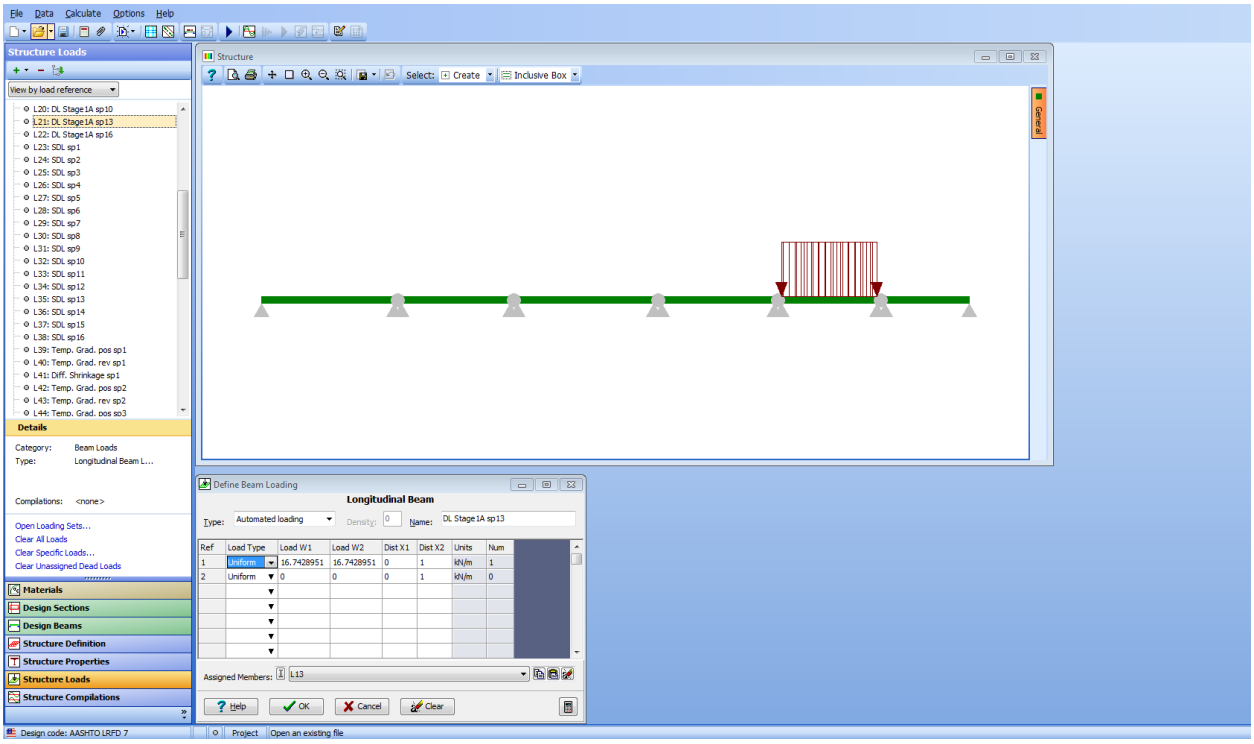
47. Click **Done** is the main ASBD screen. Then select **Design Beams** from the side menu and then click **SB1: Pre-tensioned Prestressed**.



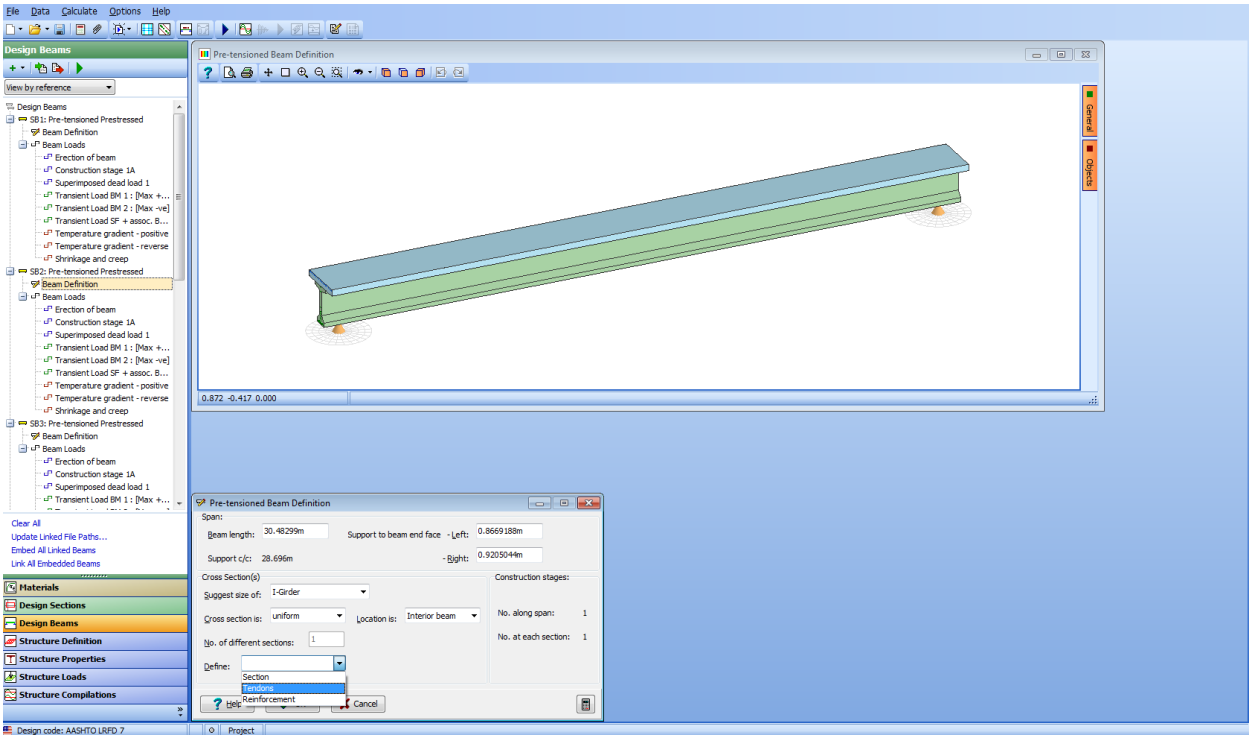
48. By selecting different items with in the tree we can examine different analysis results for beams within the selected structure in both graphical and numerical form.

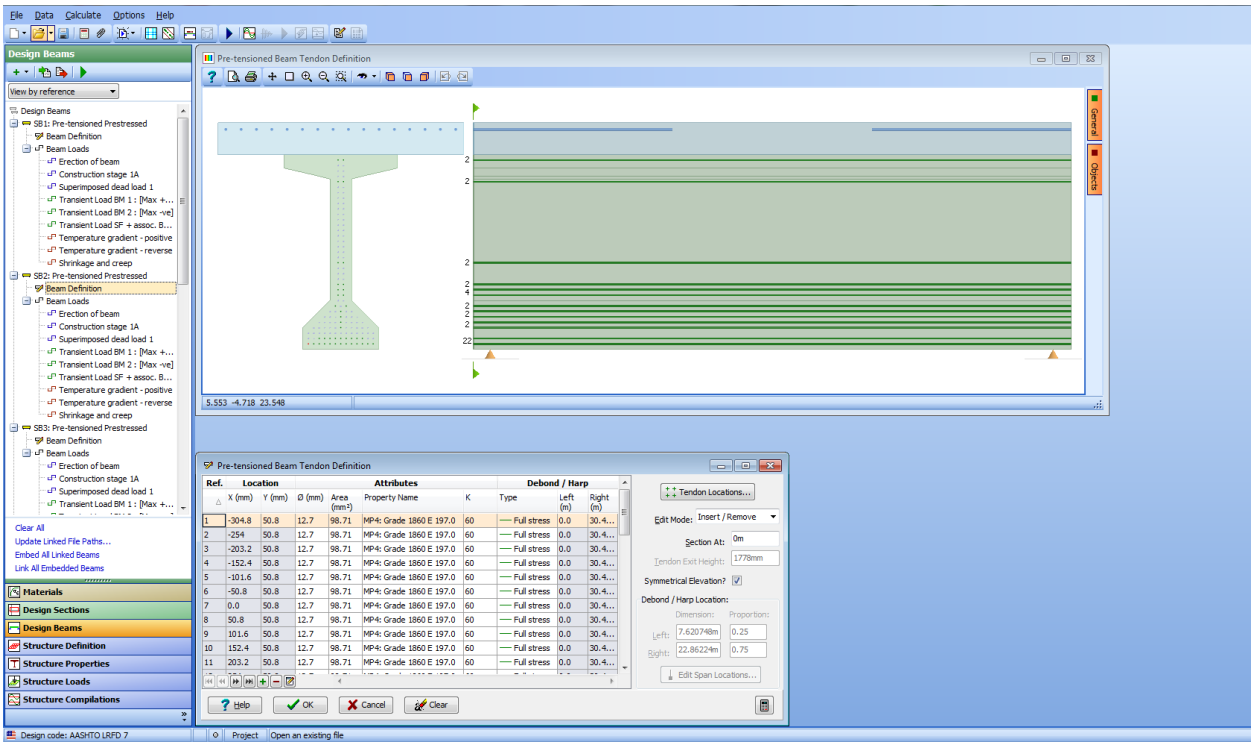


49. Moving down to **Structure Loads** Menu item we can examine the various loadings that were generated by InfraWorks 360.

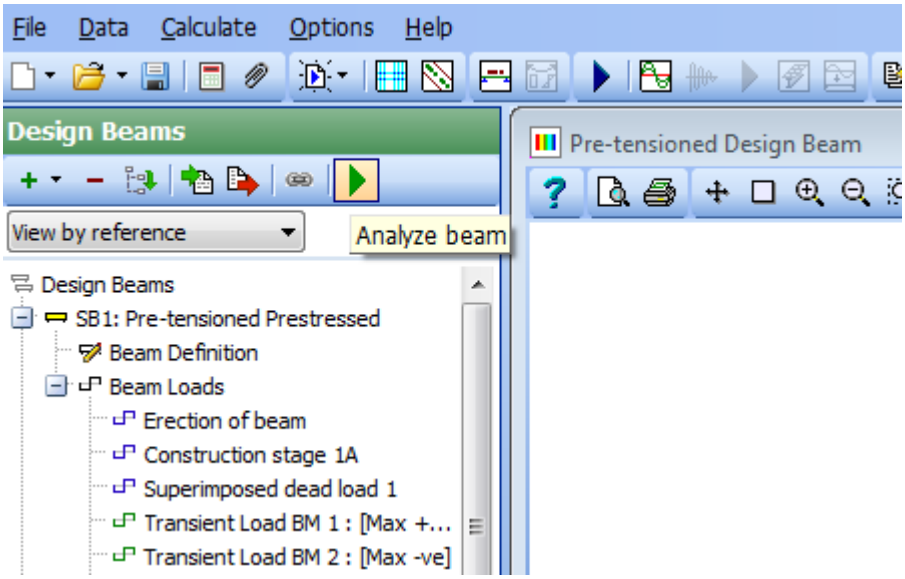


50. By selecting **Beam Definition** and then **Tendons** from the **Pre-tensioned Beam Definition dialogue** we can interact with the tendon design and make changes where necessary.

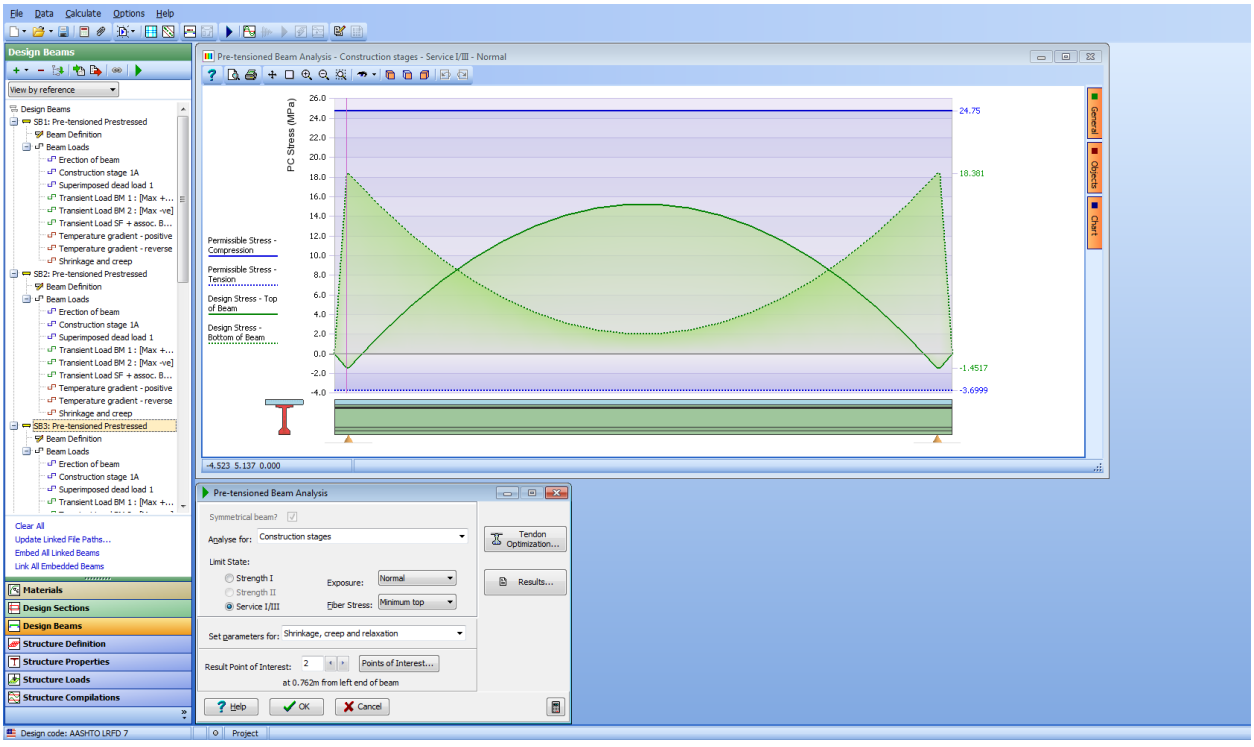




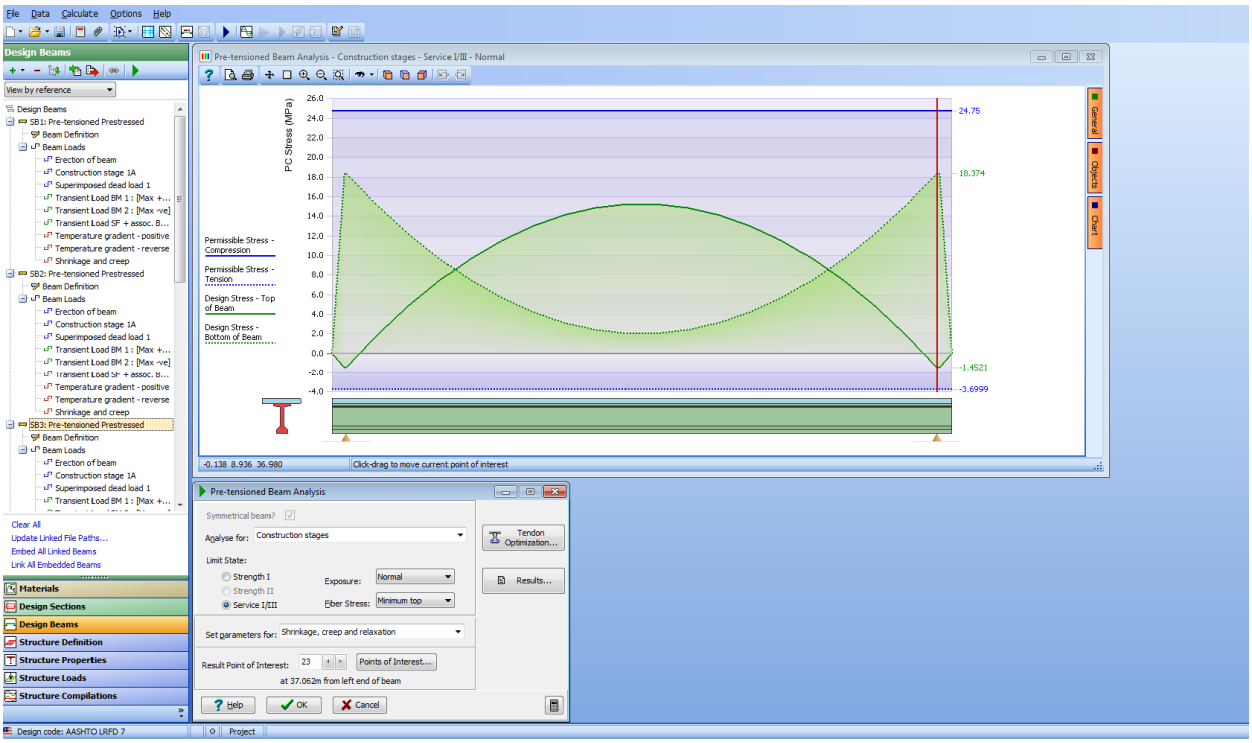
51. To test any changes or to examine the existing results we can click the **Analyze beam** play button.



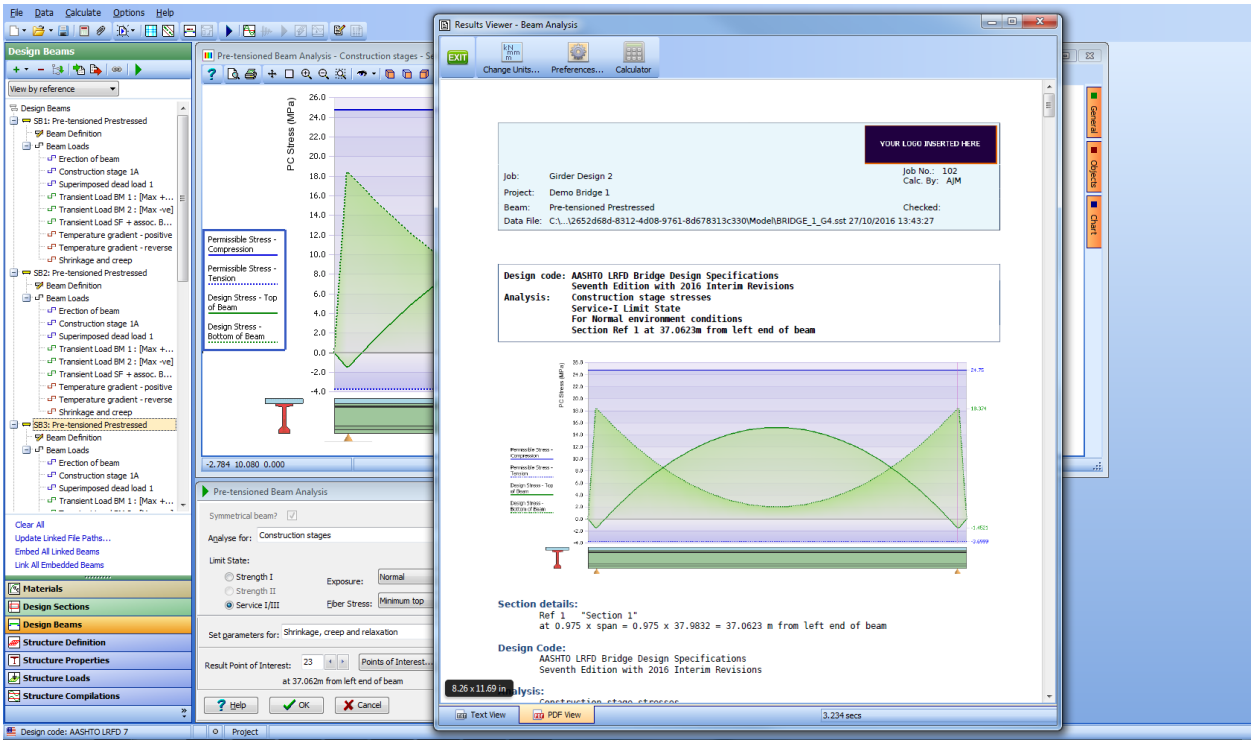
52. You will then be presented with the Analysis screen, where we can interact with the girder design, below is a stress plot of the compressive stresses in the concrete girder for permissible and design stresses in the top and bottom of the beam.



53. Click and hold the **pink section line** and drag to a point of interest anywhere along the beam. Then hit **Results…** and then **PDF View** on the bottom tab.

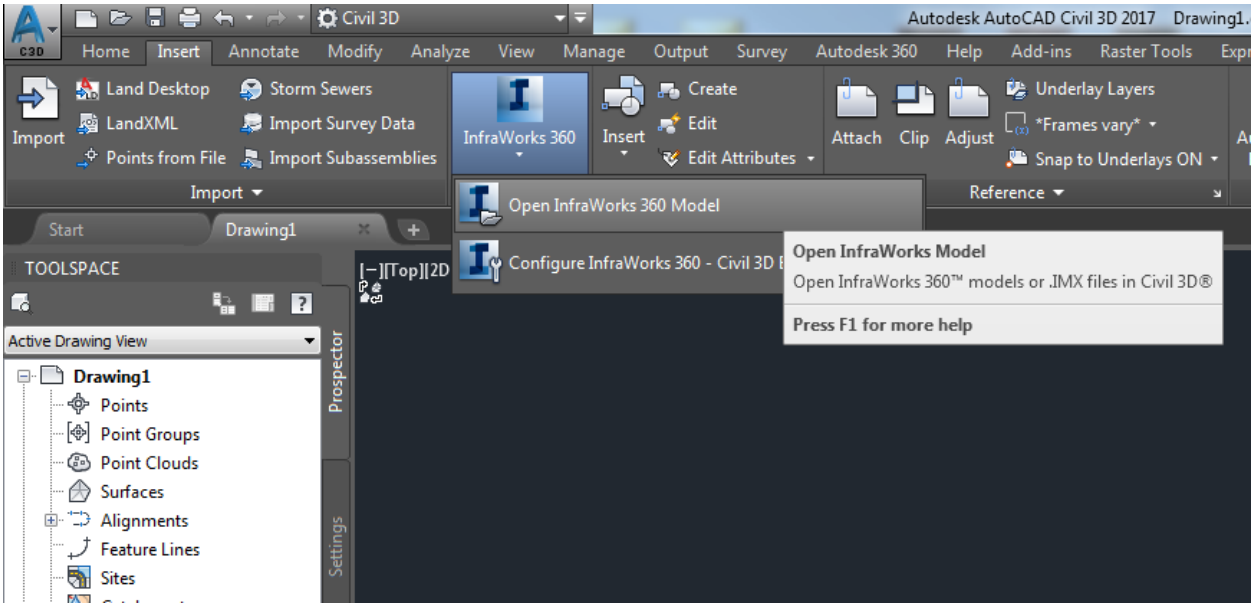


54. You will see that we are presented with similar results to that obtained from with InfraWorks 360, but reflecting any changes made.

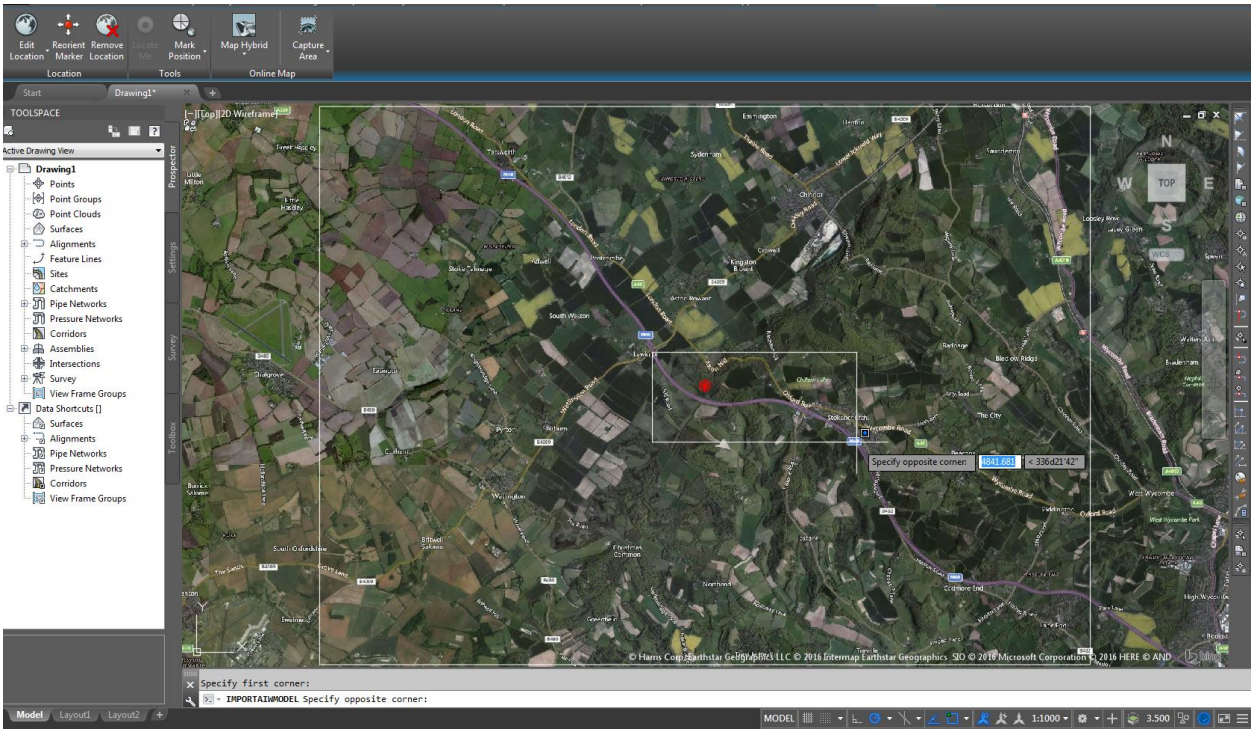


55. Close down Autodesk Structural Bridge Design clicking **Yes** to **Okay to lose edits?**
56. Back in InfraWorks 360 click **Line Girder Analysis** from the menu to close that function.

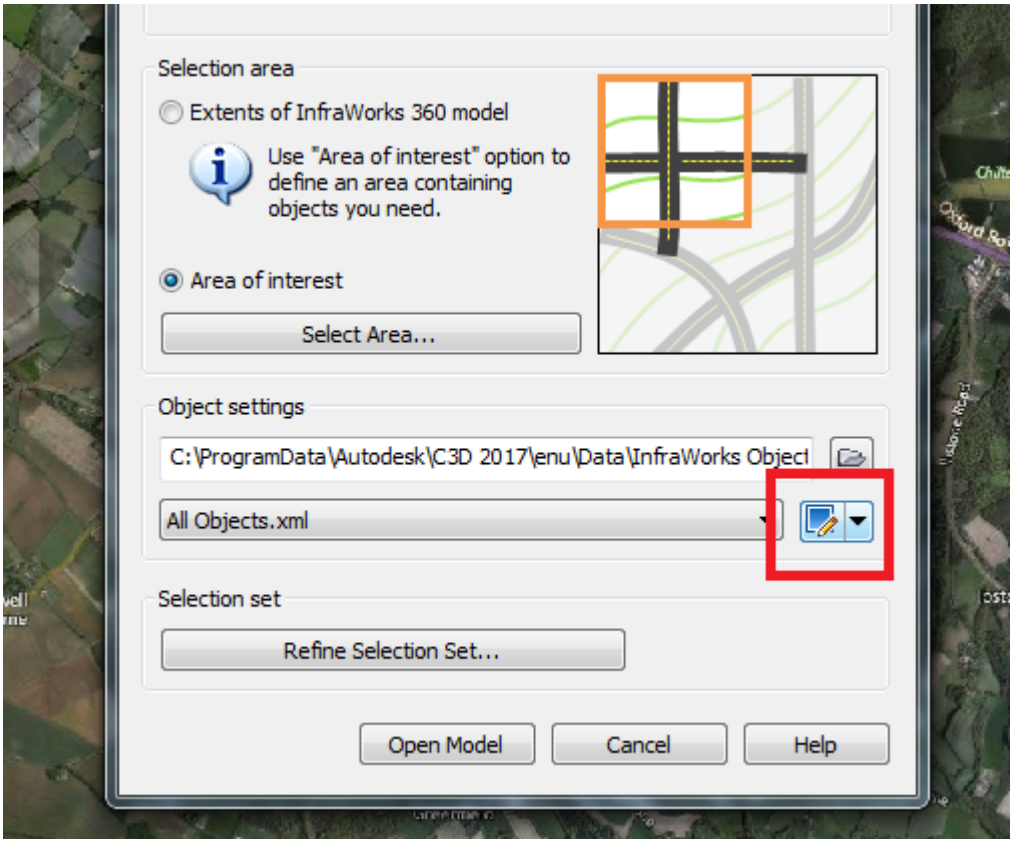
57. Close InfraWorks 360.
58. Start Autodesk Civil 3D Metric.
59. Ensure that you are working in the Civil 3D Workspace and select Open InfraWorks 360 Model from the Insert tab.



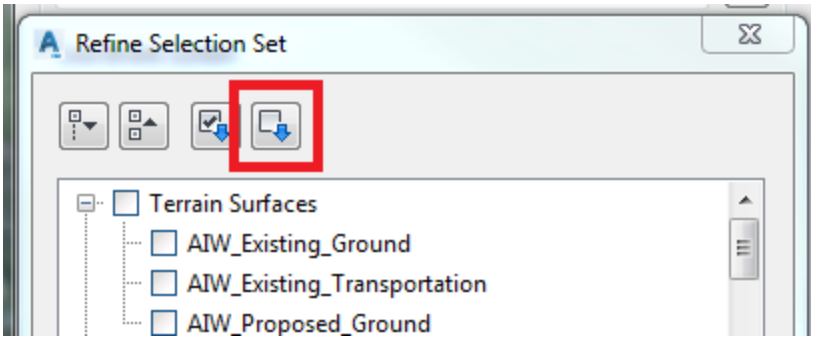
60. Navigate to the InfraWorks 360 model folder and select **AU Bridge Modeling Lab.sqlite**
61. Select **Set a Coordinate System** and choose Use the **InfraWorks 360 model coordinate system [BritishNatGrid]**.
62. Then under Selection Area choose **Area of Interest** and then **Select Area…**
63. Civil 3D will then load the InfraWorks model extents with a map overlay. **Select a window** similar to the one shown to encompass the bridge project.



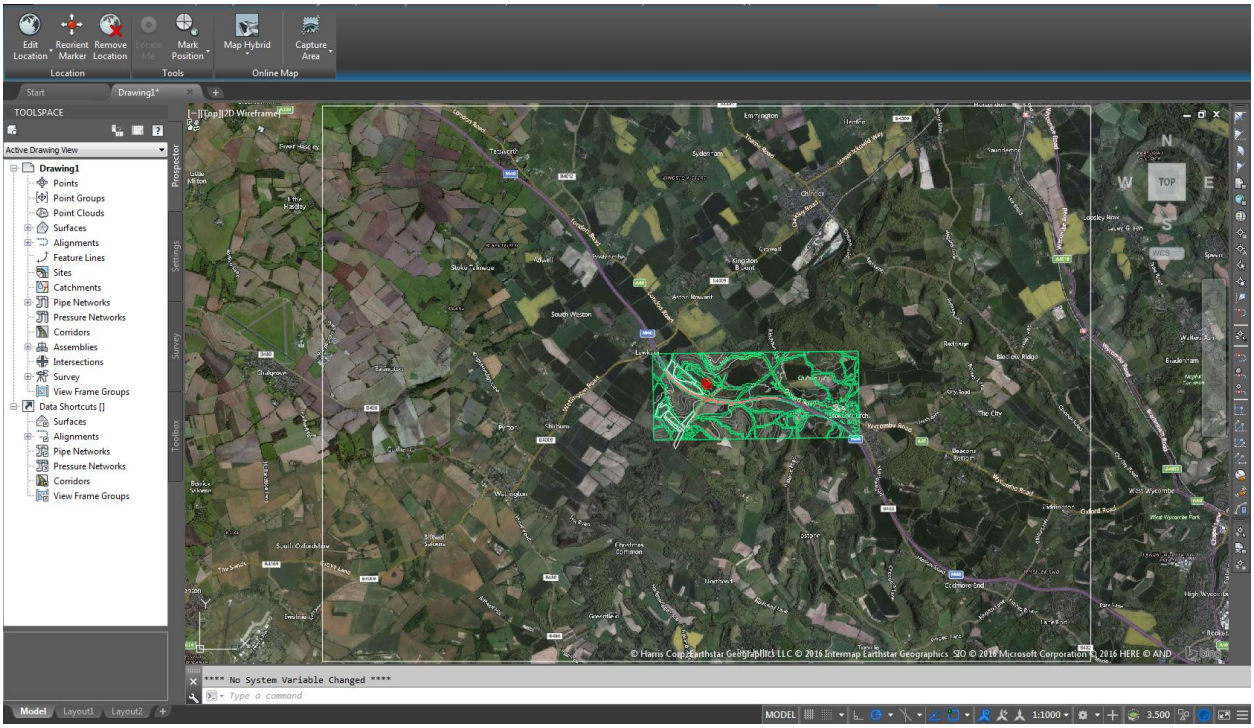
64. In the Open InfraWorks 360 Model dialogue Open the **Object setting configuration**.



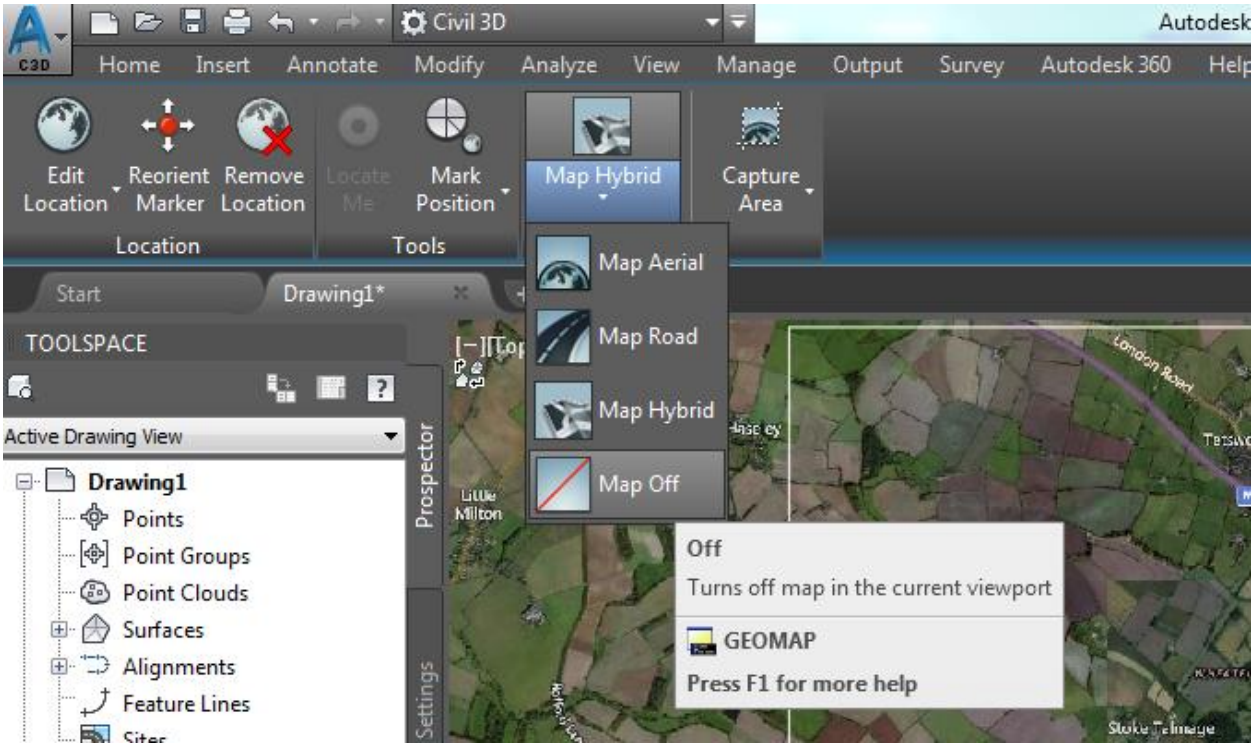
65. Examine the exchange settings, no changes necessary.
66. Click **Refine Selection Set…**
67. Use the controls at the top of the dialogue to **deselect all items** in the tree.



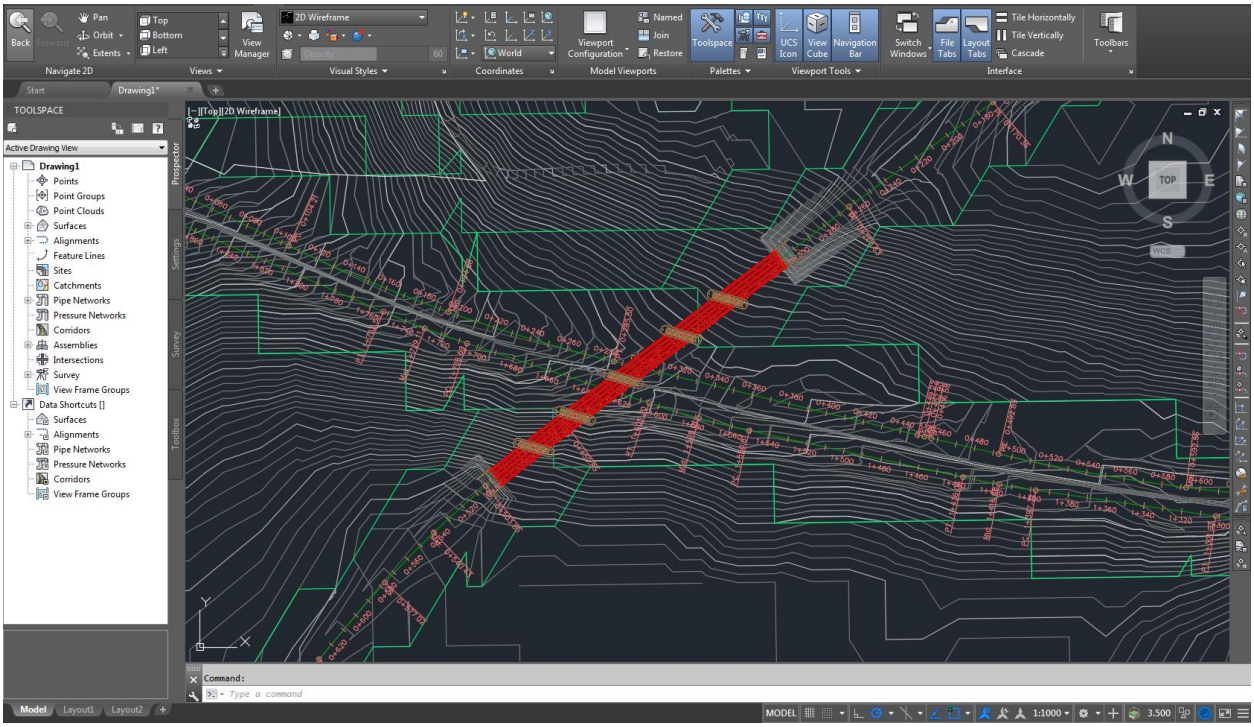
68. Then click to add
a. All Terrain Surfaces
b. All Design Roads
c. All Coverages (Terrain Modifying)
d. All Bridges
69. Then click **OK.**
70. Then click **Open Model**.
71. The selected InfraWorks 360 model entities will then be opened in Civil 3D.



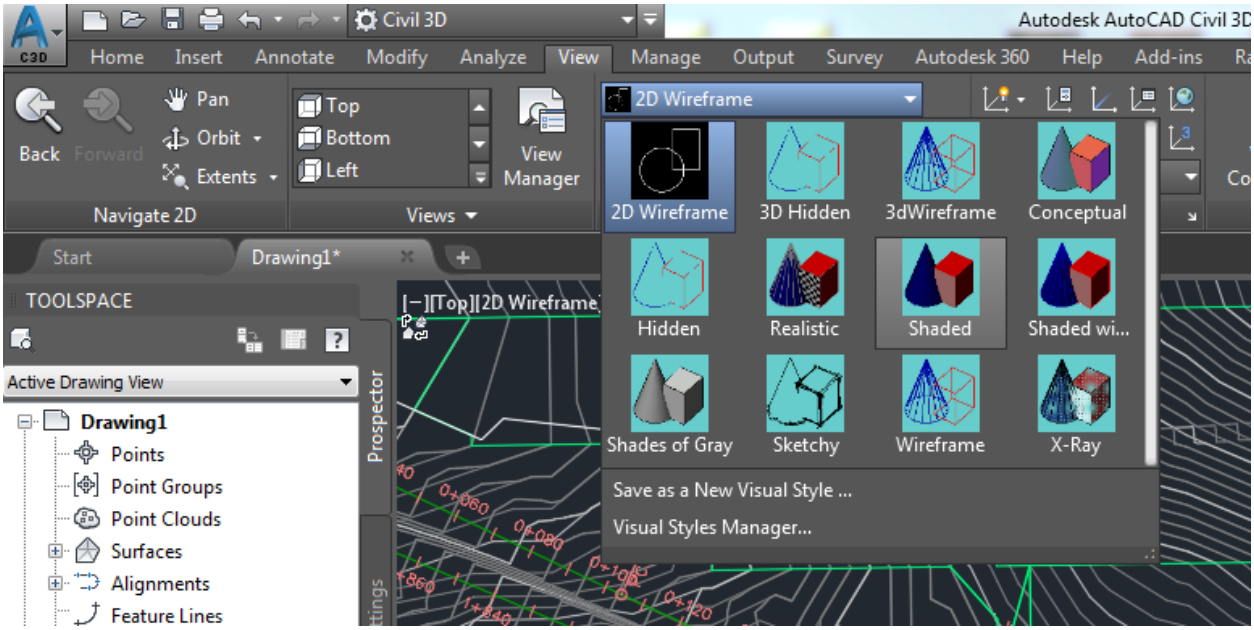
72. Click Map Hybrid from the ribbon and select Map Off.



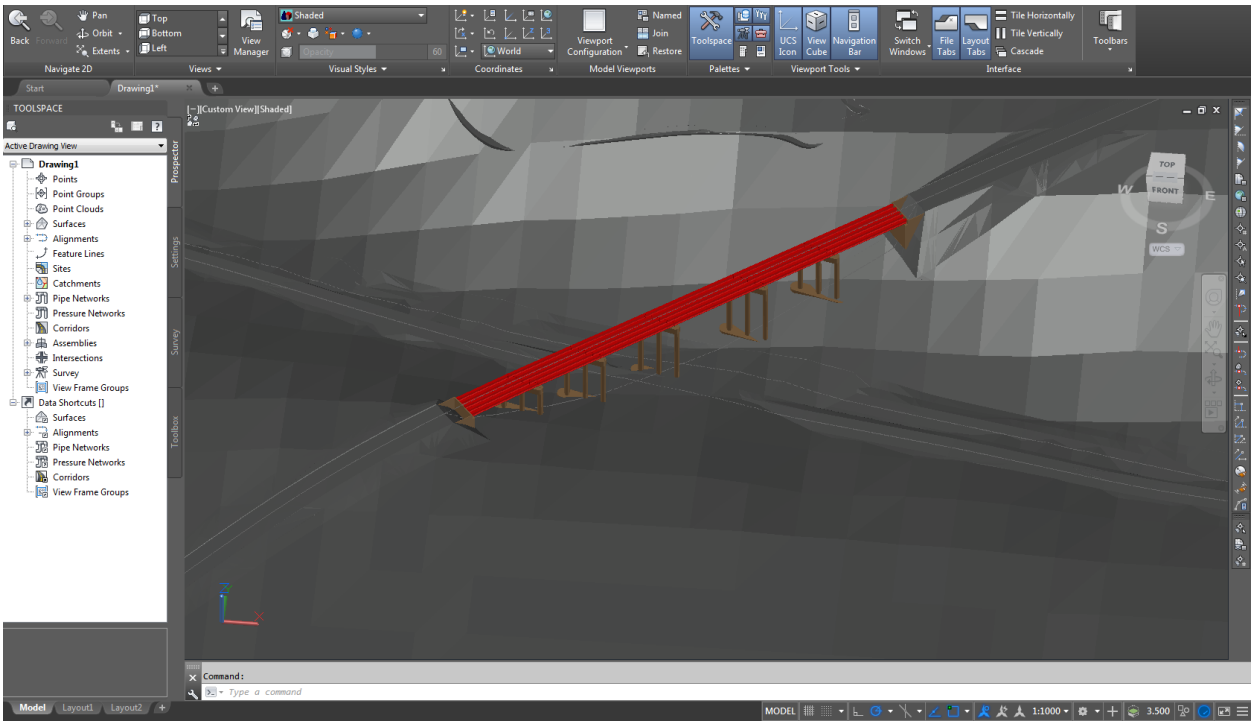
73. **Zoom in** with the mouse to examine the imported bridge and surfaces.



74. From the View tab select **Shaded view**.



75. Use **shift – middle mouse** button to rotate the view, examine the model.



76. Close Civil 3D.
77. **Restart** InfraWorks 360 and load our **AU Bridge Modeling Lab** model.
78. Choose the **Bridge bookmark** from earlier.
79. Ensure that the **NewBridge** proposal is current in the utility bar.
80. The previously modelled bridge should now be visible, rotate it to a convenient view.

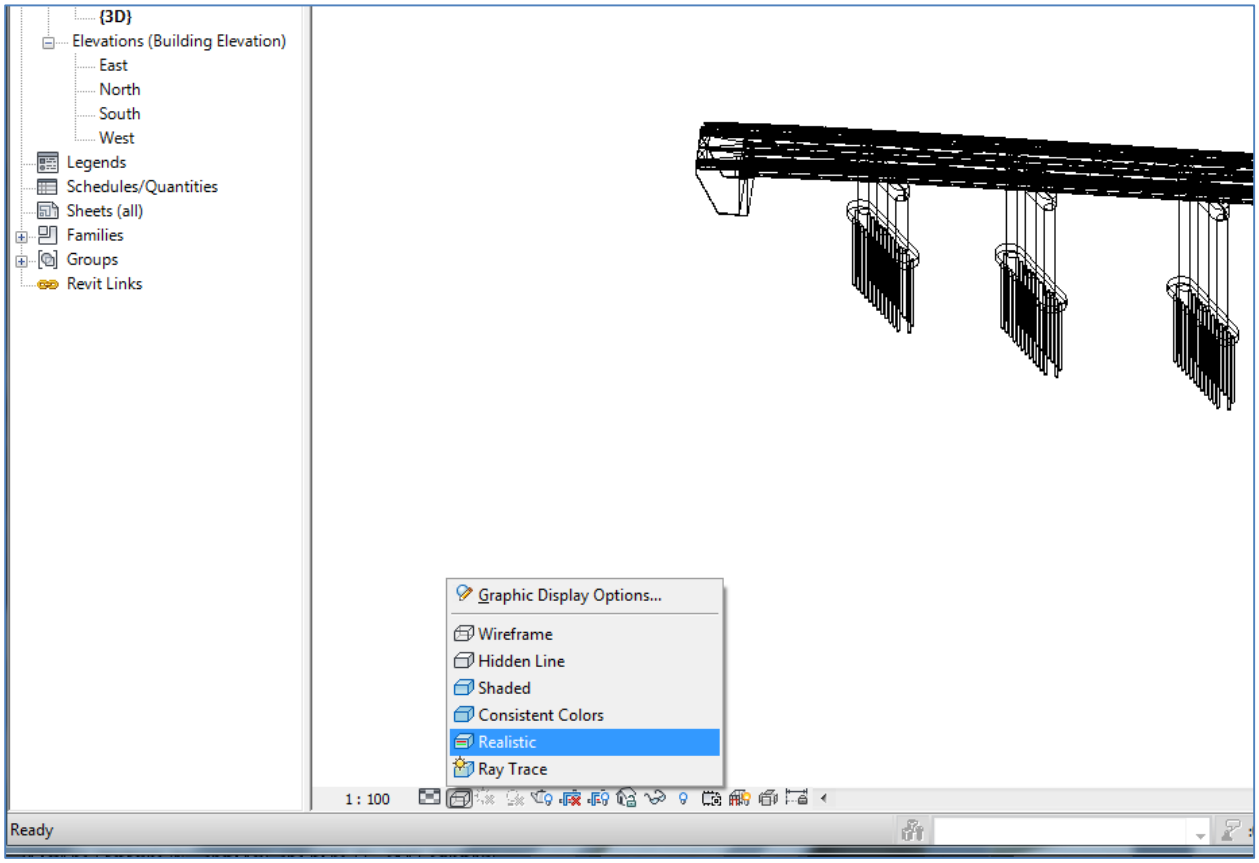
81. **Select** the bridge and then right click and select **Quantities…**

82. Once the Quantities panel has opened click around the model selecting different parts, the **Selected** row in the Quantities panel will change accordingly.

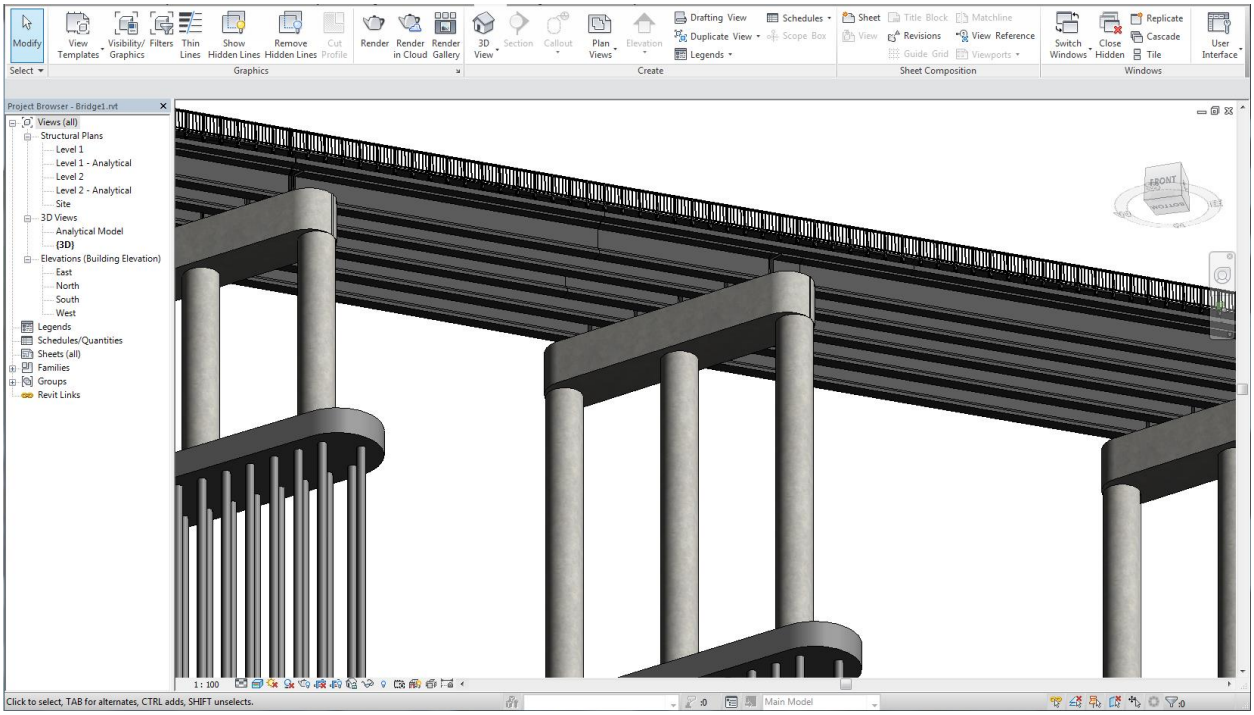
83. Close the Quantities panel.
84. Deselect the bridge by clicking somewhere in the terrain.
85. Reselect the bridge and right click.
86. From the right click menu choose **Send to Revit**.

87. The Revit entities will be created and the Revit window will open.
88. Once the Revit window has opened, from the **View tab** select **3D view**. The wireframe bridge model should appear.

89. From the bottom of the screen **select a display option**.



90. Zoom in (mouse wheel) and rotate the view (shift-middle button) to examine the Revit bridge model.



91. This ends the tutorial.

Summary

The InfraWorks 360 bridge modelling tools can be used to rapidly model realistic conceptual concrete bridge structures in the context of the project environment. Bridge components automatically sized by the heuristic rules can be adjusted.

The integrated Line Girder Analysis and Design can produce designs for the modelled girders and allow the designer to quickly arrive at a workable girder solution that can be modified and verified with the Autodesk structural Bridge Design workflow.

Representative quantities can be obtained which can be used to assist in early budgeting.

Workflows to both Civil 3D and Revit allows for the use of InfraWorks 360 modeling data further down the design journey of the bridge structure allowing changes to the surrounding grading, production of sheet sets, structural drawings and rebar detailing.