TR21695 – A360 InfraWorks Bridge Design with Revit and Structural Detailing

Dzan Ta – Repro Products
Dave Young – Repro Products

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TR21695   In this class, you will learn the workflow and thinking behind how to use A360 Autodesk InfraWorks to create a bridge design and then transfer it to Revit to make a more parametric structural bridge. You will then use Revit to create structural rebar drawings based on the revised design. Finally, you will transfer this information back to InfraWorks A360 for continuing your site design.

Learning Objectives

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

- Learn the basics of Infraworks 360 Bridge Design

- Learn how to transfer the data to Revit

- Learn how to parameterize and enhance the bridge design within Revit

- Learn how to create reinforcement within the bridge design

- Learn how to transfer design back to Autodesk InfraWorks 360

Dataset Files:

https://www.dropbox.com/sh/qf9fogpmljifj3z/AADWjm0IDJHt7uHlgDJatG9sa?dl=0

About the Speaker

I graduated from FIU and am an Autodesk Expert Elite. I am an Autodesk Certified Instructor in Revit and AutoCAD. I hold certifications in Autodesk Revit Architecture, Structure and AutoCAD 2010-2016 as well as other Autodesk Certifications. I am also a Bluebeam Certified Instructor. I have been in the Architectural industry for 20+ years and worked as both an I.T. Network Administrator and CAD Manager for over 10 years. I am currently the Lead Application Engineer providing support, mentoring and training of Autodesk Products at Repro Products since 2008. In addition to Revit Architecture, I also provide expertise on AutoCAD, AutoCAD Architecture, Revit MEP and Structure, Navisworks, A360 Services, Buzzsaw, AutoCAD MEP, Showcase, 3ds Max Design, etc. Lastly, I am a Chief Head Instructor for Choi Kwang Do International Headquarters Martial Arts as well as a 2nd Degree Black Belt (EE Dan). Email: dta@reproproducts.com and dzanta@gmail.com

About the Co-Speaker

Dave began his search for CAD enlightenment in the civil engineering world, drawing up mortgage surveys about 25 years ago. From there, he switched over to a CAD manager position and then to IT manager, then started working with an Autodesk reseller about ten years ago. His computer science degree and IT background have helped him along the way with customizing and implementing unique solutions for over a dozen years.

Although his family still doesn't know how to explain what he does, Dave has been working at Repro Products (an Autodesk reseller) as a Infrastructure Solutions Specialist and Autodesk Certified Instructor to help companies with their Autodesk implementation and training.
Email: dyoung@reproducts.com

Contents

A360 Autodesk Infraworks for Bridge Design

"Bladeville Bridgeworks Inc." has been tasked to create a new concrete and steel bridge design for the City of Morgantown, WV. *Bladeville Bridgeworks* has asked us (**Autodesk/Repro Products**) to teach them how to use their existing Autodesk software to accomplish this goal easily. We will provide a workflow using *Autodesk InfraWorks 360* and *Autodesk Revit* to create a 3D parametric bridge design with detailing.

As a trusted advisor to our client, we understand there are several if not numerous paths to take when designing a bridge. Many architects and engineers will revert to using one if not more than one of the following methods:

1. Hand drawings/sketches
2. 2D AutoCAD or other CAD based software
3. Bridge Modeler Extension for Autodesk Civil 3D
4. Bridge Modeler Extension for Autodesk Revit
5. Revit
6. Dynamo/Revit
7. Autodesk InfraWorks 360
8. Point Cloud Scan data
9. Photos/SketchUp/Videos

Depending on which methods they choose there will be pros and cons to each one. Our job is to ensure they use a clean, simple, easy to learn method; one that most, if not all end users can adapt into their initial design phase of their projects. To accomplish our goal, we will teach them the following workflow:

Step 1: Use Autodesk InfraWorks 360 to quickly design a conceptual bridge within the context of the site

Step 2: Export the bridge design out of InfraWorks and import it into Revit

Step 3: Use Autodesk Revit to create/enhance the design and make it more parametric

Step 4: Use Revit's Extension features to create Reinforcement for the bridge design and produce the working drawings

Step 5: Import the revised design back into InfraWorks 360 for contextual understanding

By teaching our client this method of approach they gain the following:

- They become familiar with Autodesk InfraWorks 360
- They continue to use their extensive knowledge of Revit
- They become familiar with Revit Extensions
- They see their revised design quickly within Autodesk InfraWorks 360

Lastly, the client can further enhance their design using InfraWorks 360, Revit or any other Autodesk software in the future.

Let's begin….

1. A360 Autodesk InfraWorks for Bridge Design

Infraworks Basics

So what is InfraWorks/360?

InfraWorks® 360 preliminary design software helps improve your project outcomes. Combine and connect data to better create, view, analyze, share, and manage information to make decisions in context.

Improve public engagement, gather feedback, and help speed the approvals process by sharing near-realistic visualizations with a larger range of stakeholders in a more secure cloud environment.

Quickly generate and evaluate multiple design alternatives using data-rich models that more accurately present your design within the as-built environment.

Collaborate more effectively with project teams and stakeholders by sharing cloud-based models of design scenarios, to gather feedback and input in real time.

Manage larger-scale infrastructure models created from existing data sources, engineer in context from the start, and generate proposals at the appropriate level of detail.

Access and incorporate large amounts of data and quickly model the existing environment.

Create and sketch early design concepts.

Extend your design capabilities with access to specialized applications for roadway, bridge, and drainage.

With all the capabilities that Autodesk InfraWorks and Autodesk InfraWorks 360 gives you, creating preliminary designs within the context of your site is easy and adaptable into any design process.
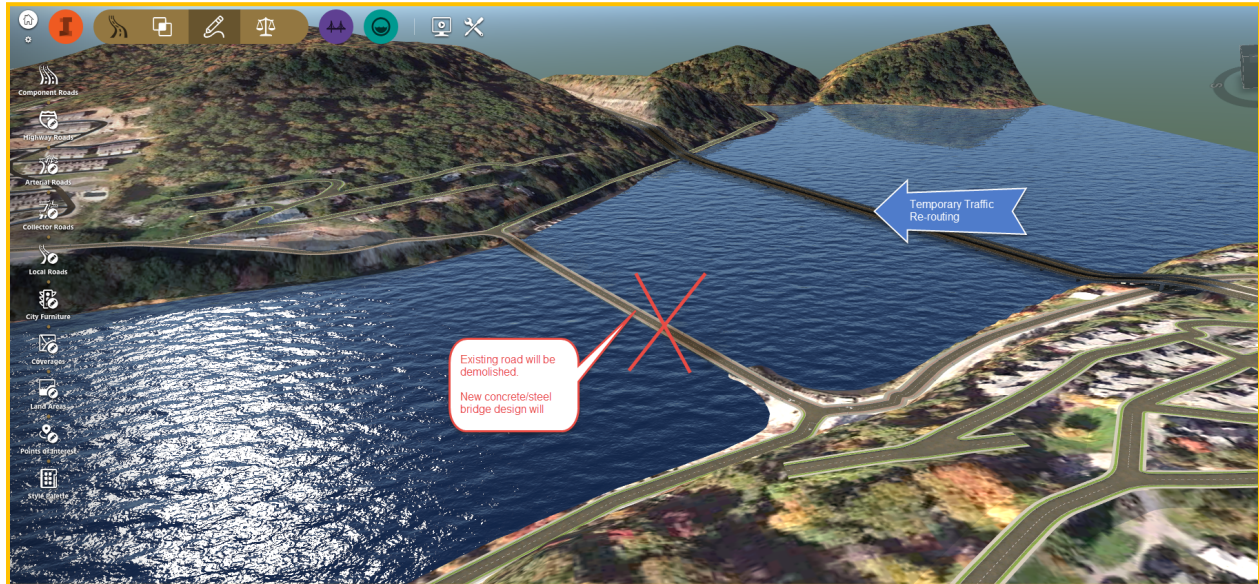
The basic process to work with and create an Autodesk Infraworks model is as follows:
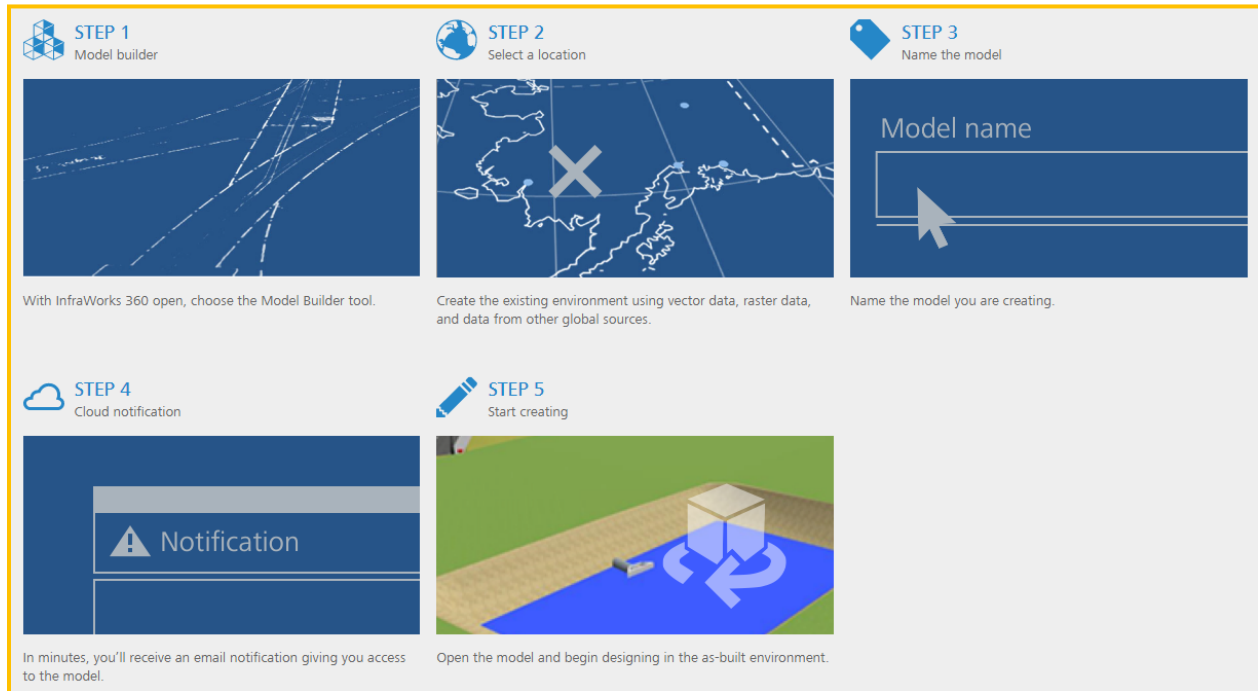
Here is our initial InfraWorks model for our client:

The client's design will involve redesigning the existing road as a concrete and steel bridge as follows:

Concrete and Steel Bridge Design Criteria:
- Design must follow typical technical policy guidelines set forth by AASHTO, WVDOT, State of West Virginia Standard Specifications for State Road and Bridge Construction and CRSI Manual of Standard Practice.
- System of Weights and Measurements: The bridge design, plans, and specifications are based upon the English (US) system of weights and measurements
- The bridge spans, horizontal and vertical alignment, and general arrangement of the structures are as shown on the preliminary drawings.
- All typical clearances are to be met within guidelines set forth above.
- All design loads and materials are to be met within guidelines set forth above.

A360 Autodesk InfraWorks Bridge Design

For those using Autodesk InfraWorks 360 (not InfraWorks), additional capabilities exist. In particular…Bridge Design Advanced Capability exists.

Explore preliminary design options more effectively by creating data-rich models and visualizing realistic civil structures in the context of the surrounding proposed site. Autodesk InfraWorks 360 software includes bridge design capabilities to help simplify, accelerate, and focus the layout of girder bridge design concepts, and maintain consistent data and context.

Features and benefits include:

- Comprehensive Catalog of Precast Girders
- Evaluate Design Options Faster
- Data Exchange with Civil 3D
- Data Exchange from Civil 3D

Here is our proposed new concrete bridge design:

Note: Portion of bridge support is underwater due to road/water elevation.

This is our initial bridge design. We will adjust the design via different aspects of the A360 Autodesk InfraWorks software.

Autodesk InfraWorks 360 Bridge Design Modification Tools

When working with the Bridge Design Extension within Autodesk InfraWorks 360, you have the ability to select each part of the bridge design to quickly adjust properties, placement, count, etc. to obtain a decent overall schematic design for the bridge.

Selecting an object gives you placement/rotation control
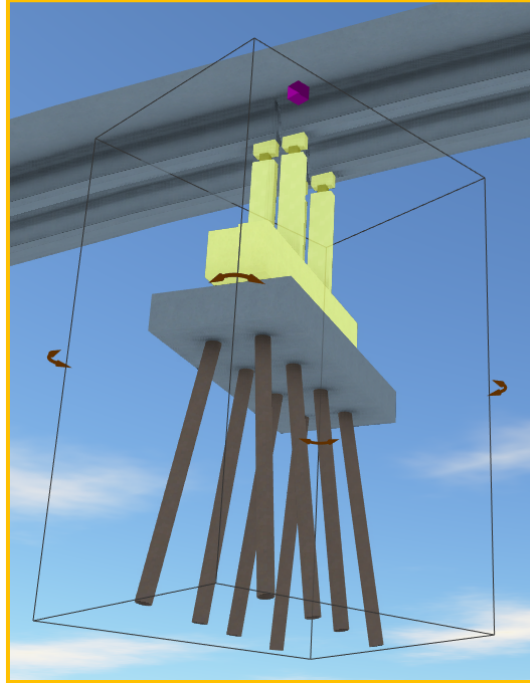
Left click once will select groups of objects
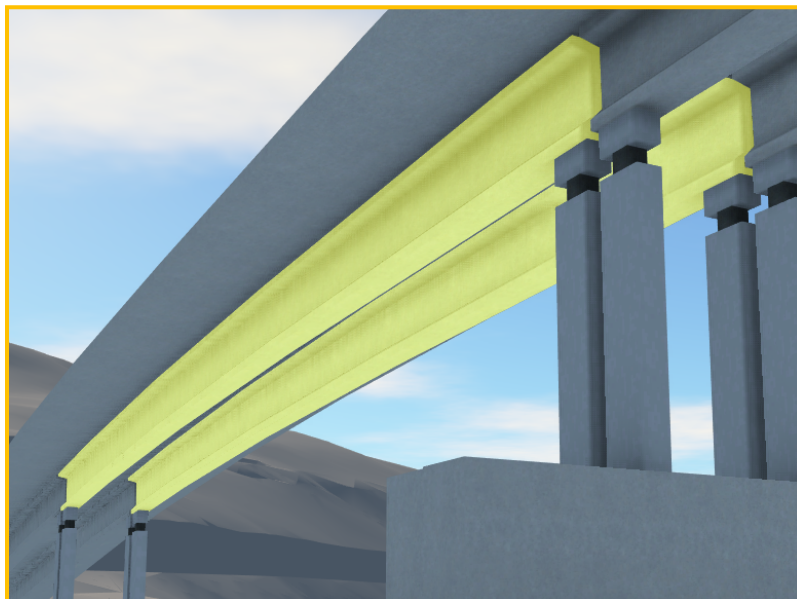
Left click again will select an individual element within the group
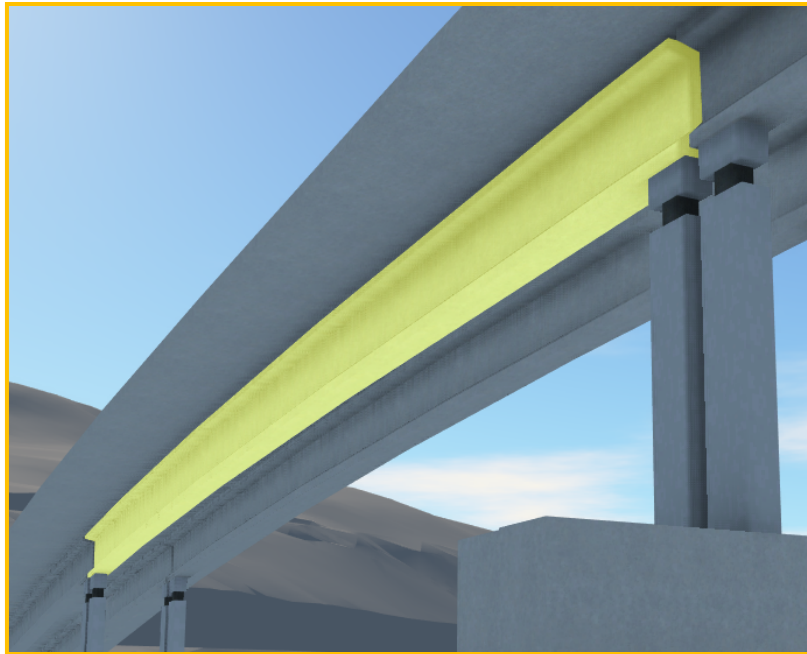
After making your selection, the properties palette will show you data that you can adjust
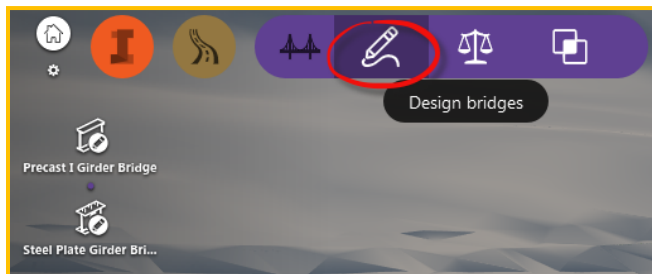
Road of Bridge Selected with Properties Palette
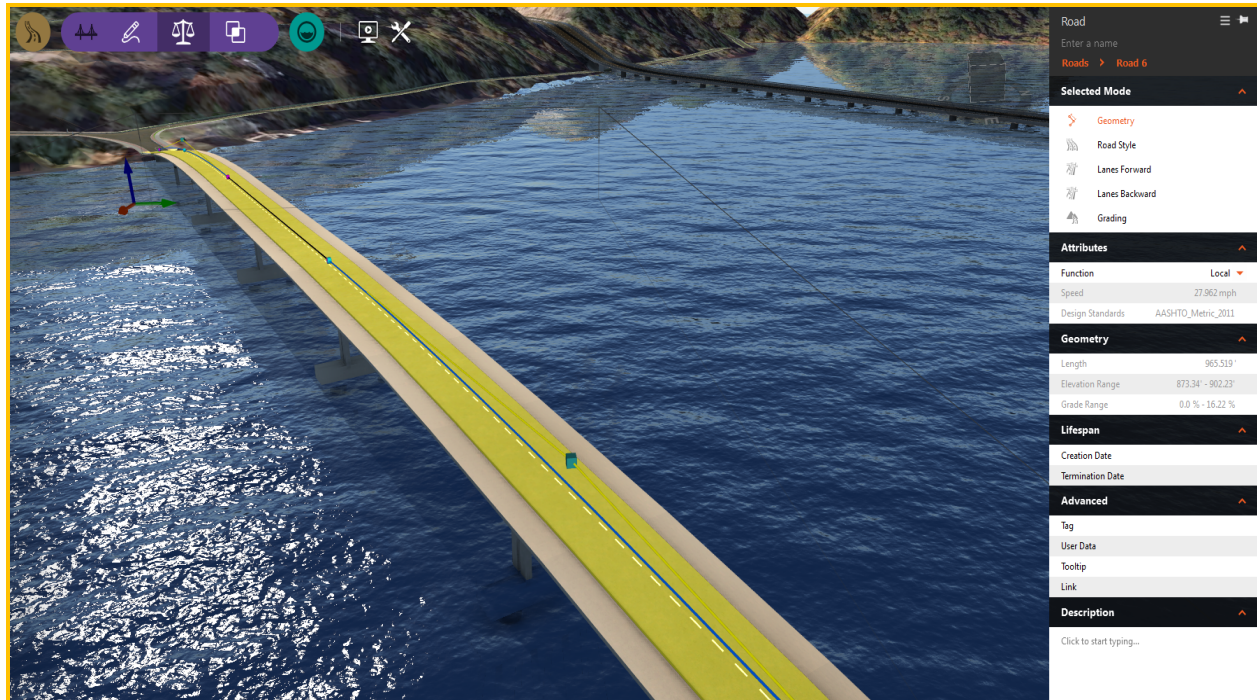
Bridge Design Command Tools
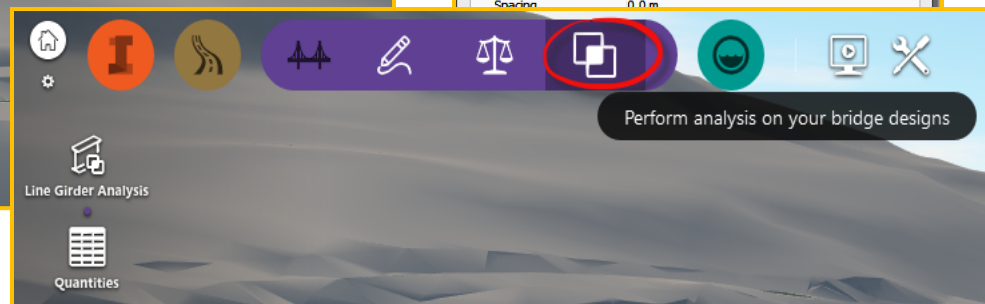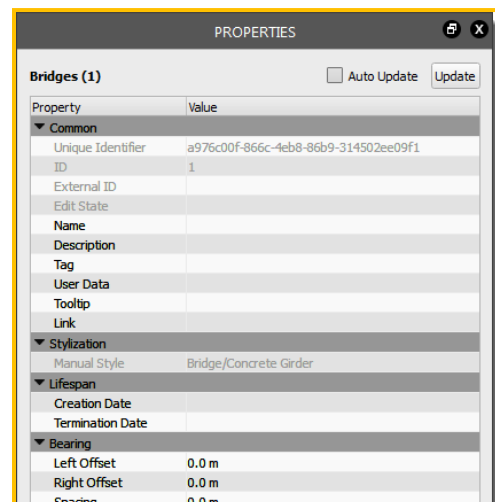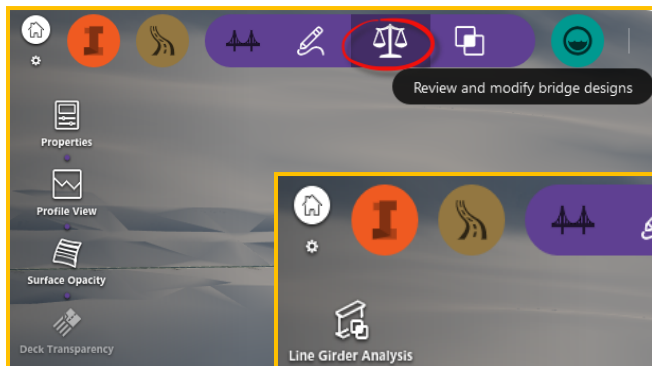
With our initial bridge design created, we have the ability to adjust many parameters within the bridge design using the Properties Palette.
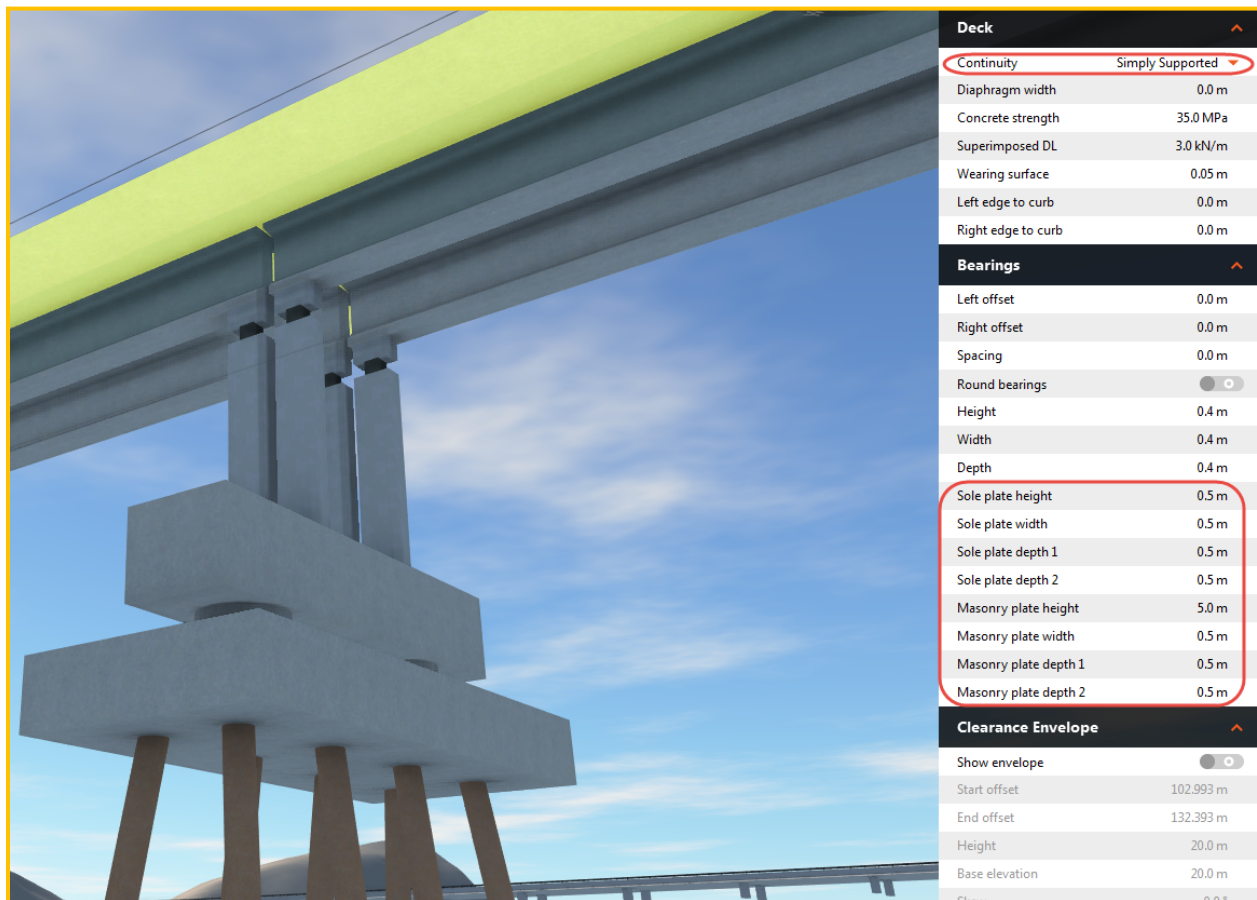
Within the Properties Palette, we can adjust many parameters such as (but not limited to):

- Bridge Type
- Attributes
- Geometry
- Deck
- Bearings
- Clearance Envelope
- Lifespan

Here is our bridge design showing different properties adjusted.

Once our bridge design is adjusted and finalized for exporting, our next step is to export the data out of A360 Autodesk InfraWorks and into Revit for further design exploration.

2. Export Design to Revit

Exporting Bridge Design to Revit

Before exporting the bridge design, understanding the BIM data that is exported is important. Quantities of Concrete and Steel properties are exported as shown:

	Concrete (m3)		Steel (tonnes)	
	Precast	CIP	Structural	Reinforcing
Bridge	372.27	1809.67	113.87	0.00
Superstructure	372.27	844.50	0.00	0.00
Substructure	0.00	965.17	113.87	0.00
Selected	0.00	844.50	0.00	0.00

Additionally, all property aspects of the bridge design within the Properties Palette will also be exported.
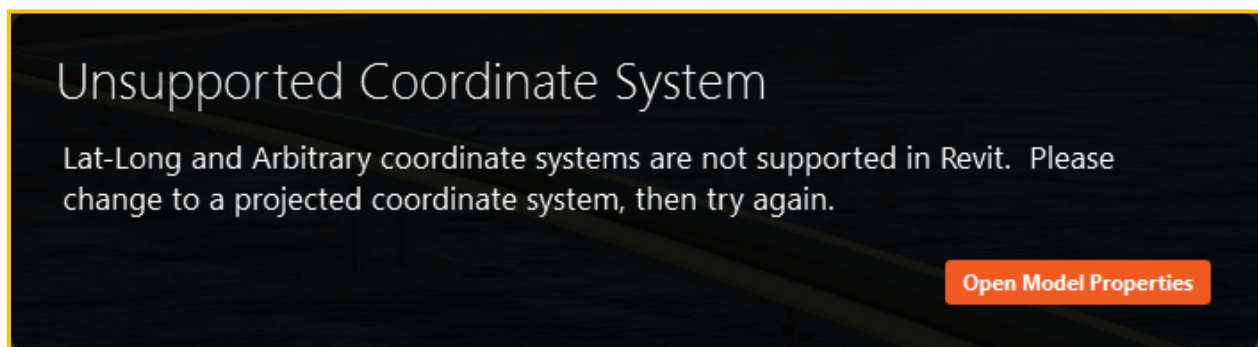
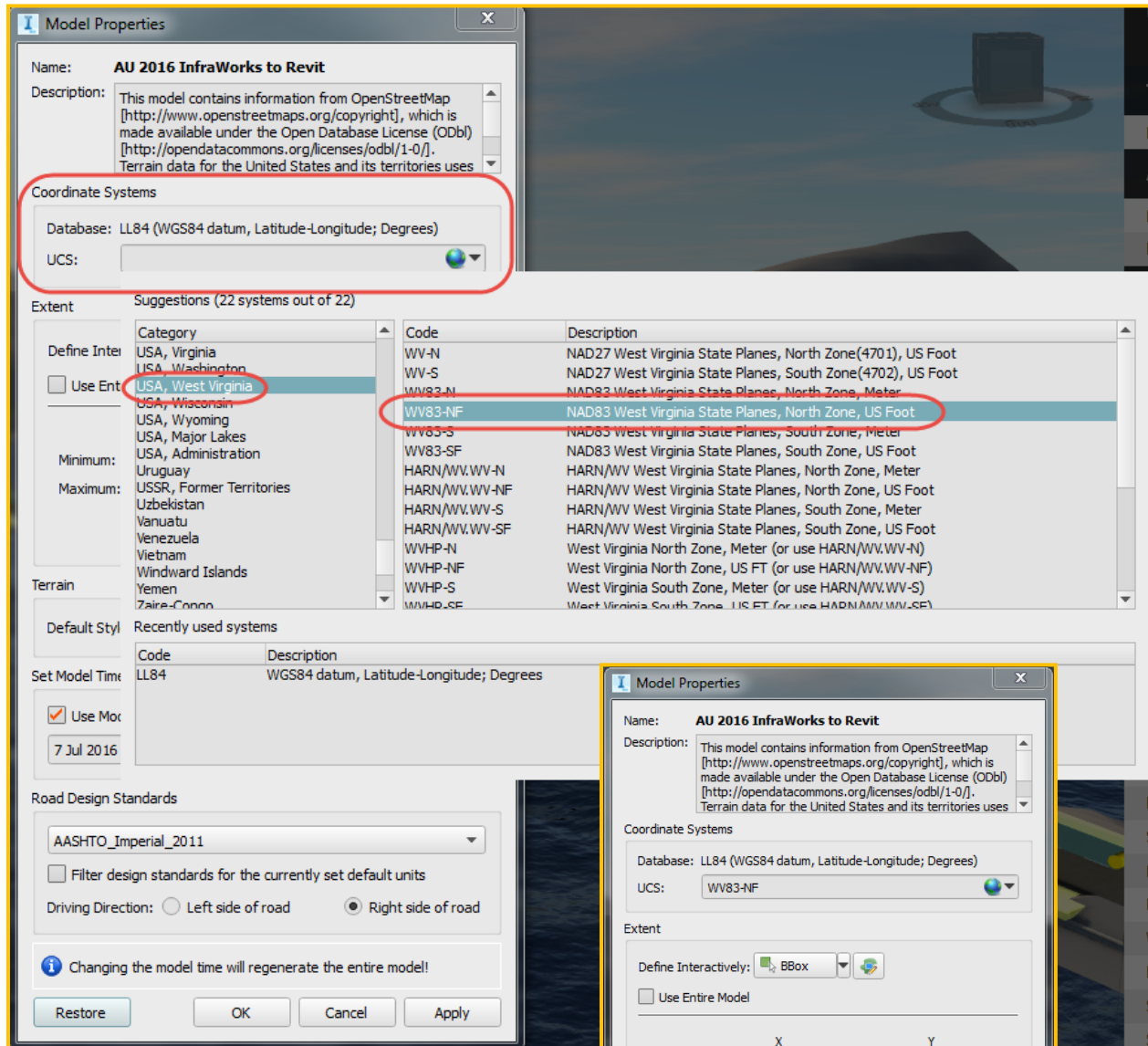| Bridge	
Bridge 1	
Road 6 > Bridge 1	
Type	
Bridge type	Precast I
Attributes	
Design standard	AASHTO LRFD
Number of piers	5
Geometry	
Length	270.386 m
Deck width	6.0 m
Deck thickness	0.3 m
Deck	
Continuity	Simply Supported
Diaphragm width	0.0 m
Concrete strength	35.0 MPa
Superimposed DL	3.0 kN/m
Wearing surface	0.05 m
Left edge to curb	0.0 m
Right edge to curb	0.0 m
Bearings	
Left offset	0.0 m
Right offset	0.0 m
Spacing	0.0 m

Right-Click Send to Revit

To export just the bridge design to Revit, select it and right-click. Then, choose ***Send to Revit*** command.
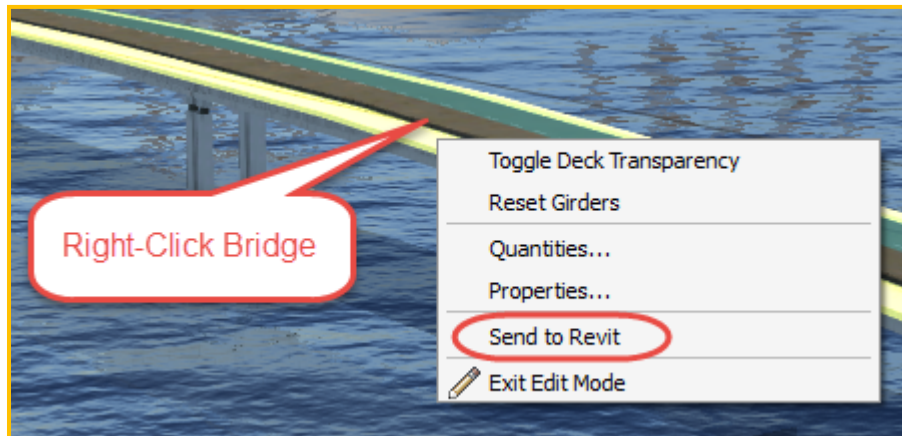
When the command is initiated, Autodesk InfraWorks 360 will check the coordinate system. It will state the following if not set up prior to the export command:
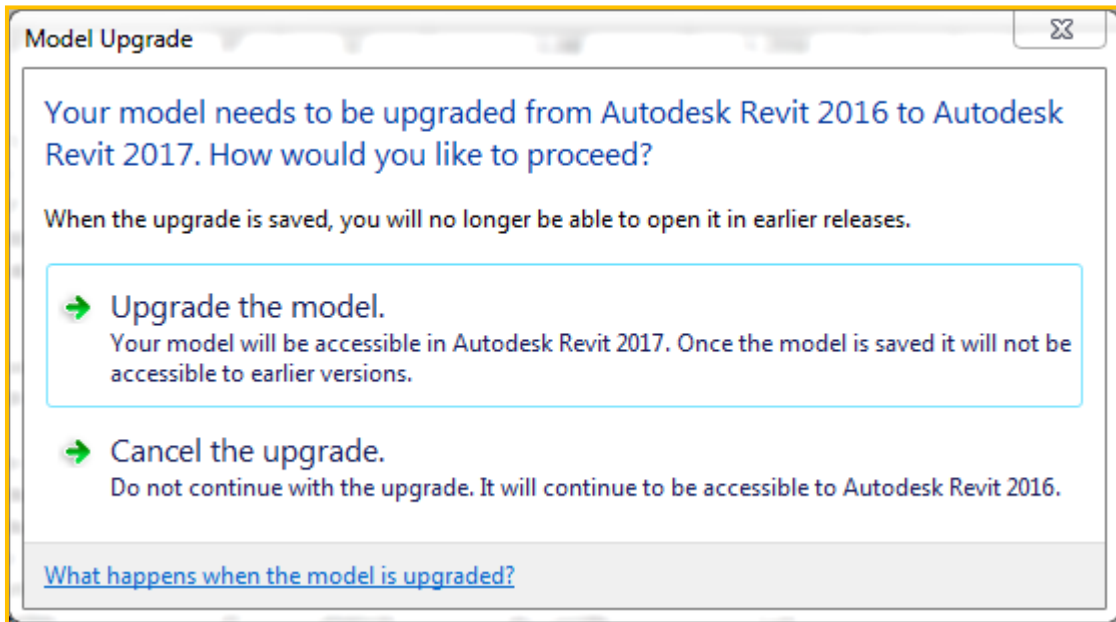

You will need to go into the Model Properties to adjust the coordinate system to a Project Coordinate System.

After the Coordinate System is defined properly, you will need to initiate the command again to export the bridge to Revit.

Depending on the data exported, when Revit opens the file it may request upgrading of the file.
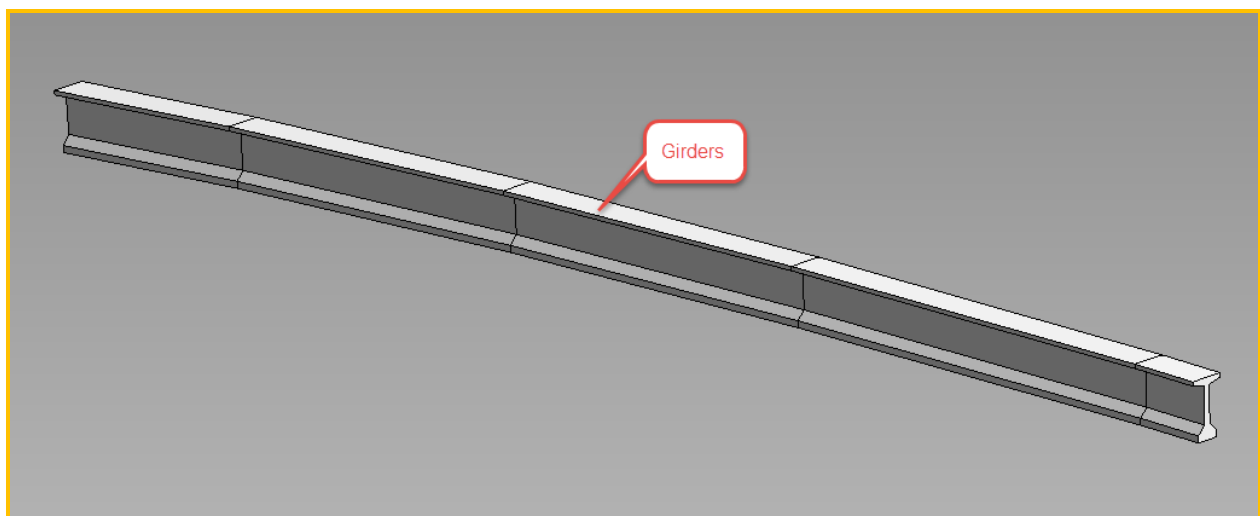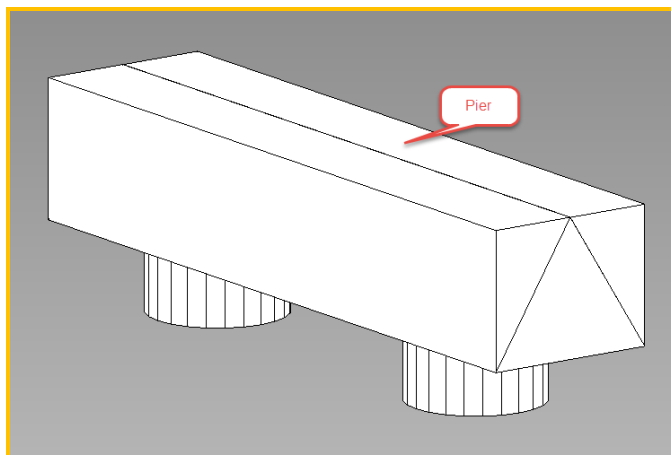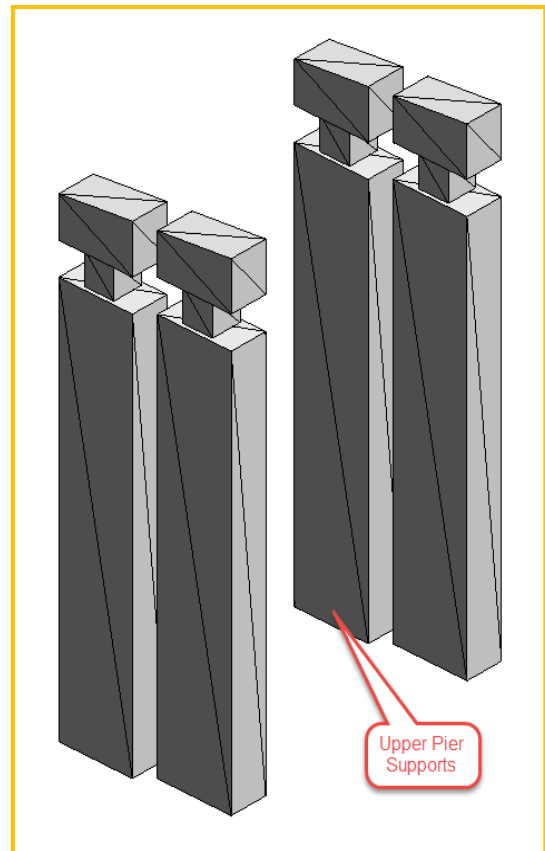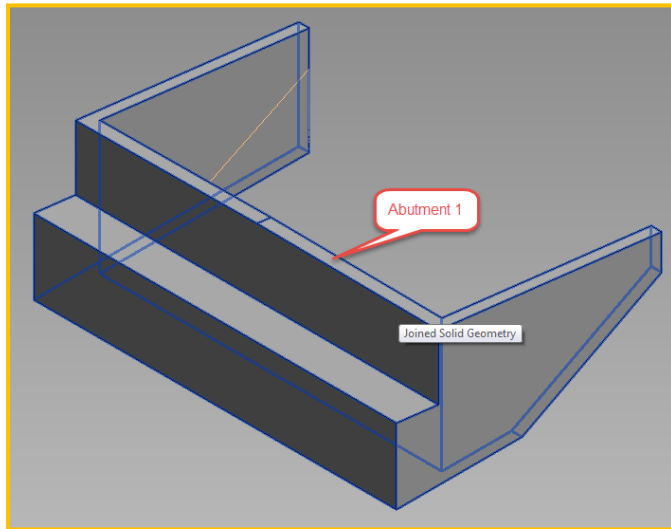

After the file is open, you can save it.

The bridge will come into Revit as a Project file. You will notice that each part of the bridge is a separate family. You can select any part and look deeper into each family.

Abutment 1

Joined Solid Geometry
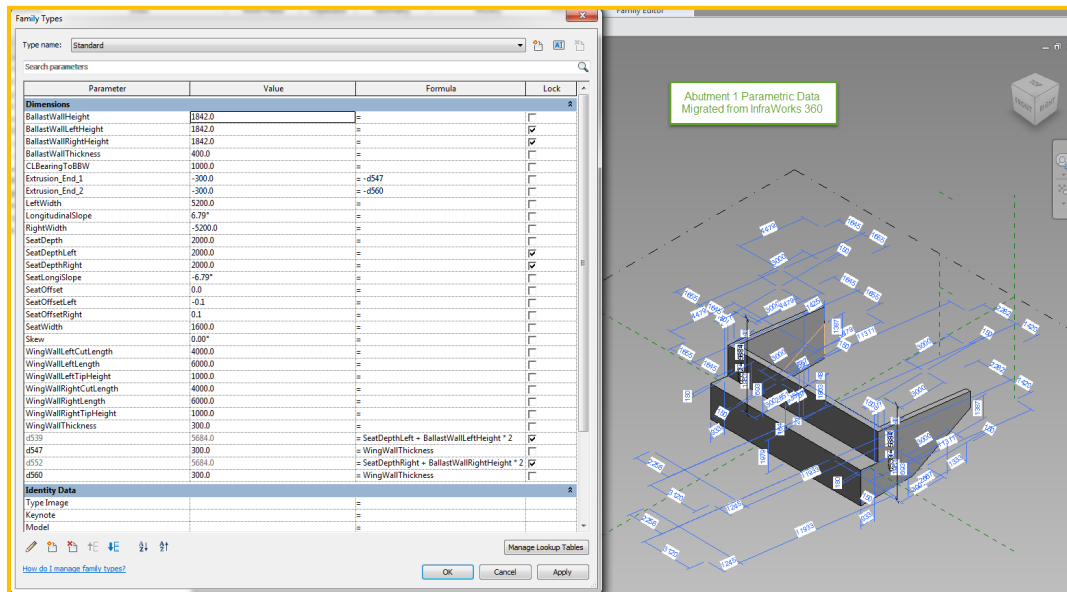
Upper Pier
Supports

Pier

Girders
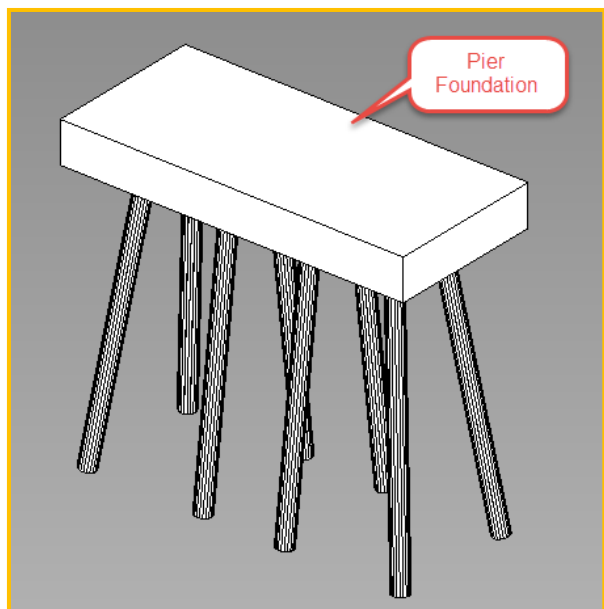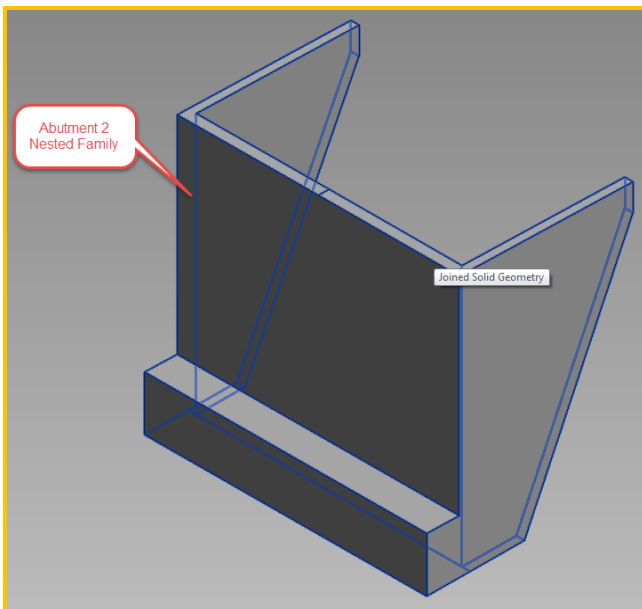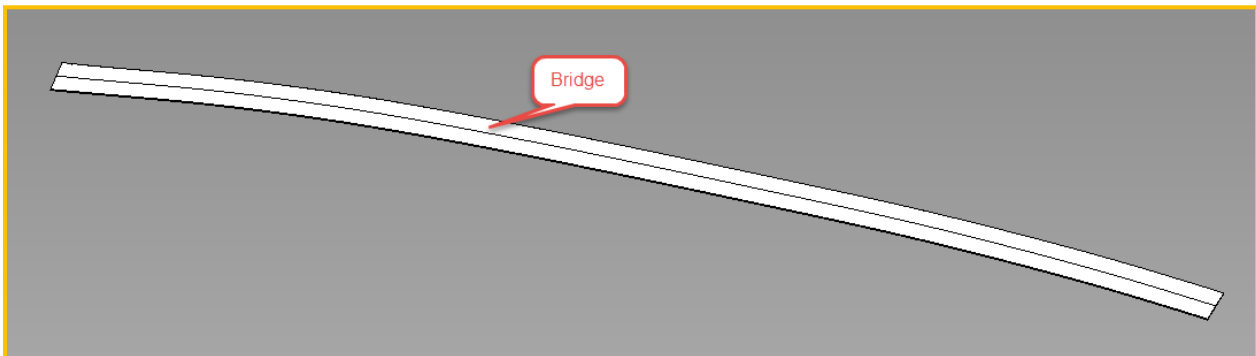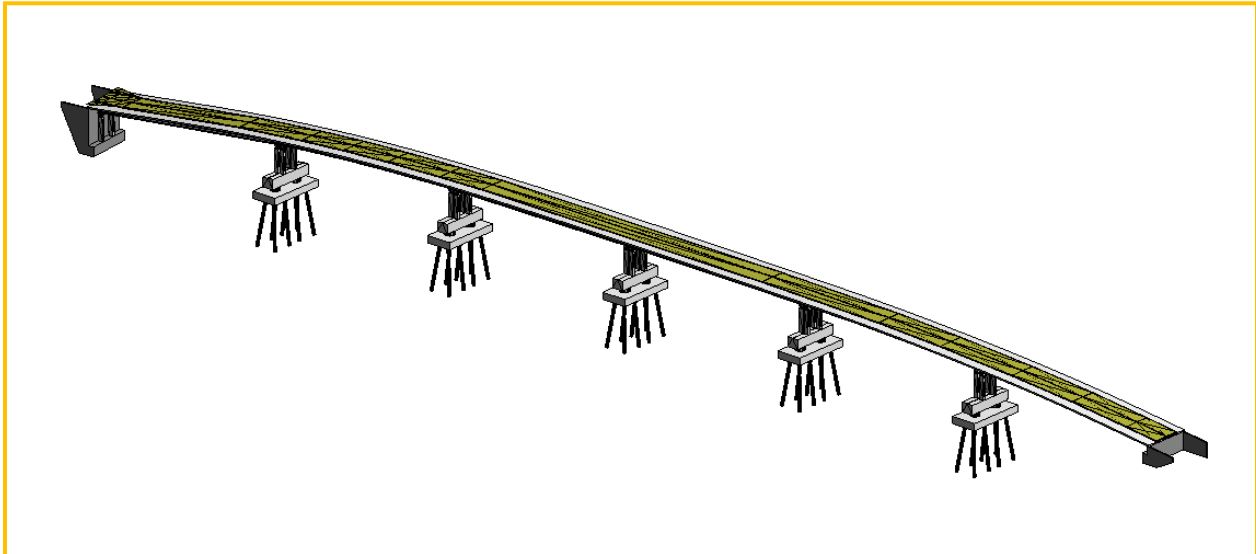
3. Revit Parametric Design

Enhance the Bridge Design with Revit Parametrics

Now that we have the data in Revit, we can use Revit's capabilities to enhance the components of the bridge design with parametric information.
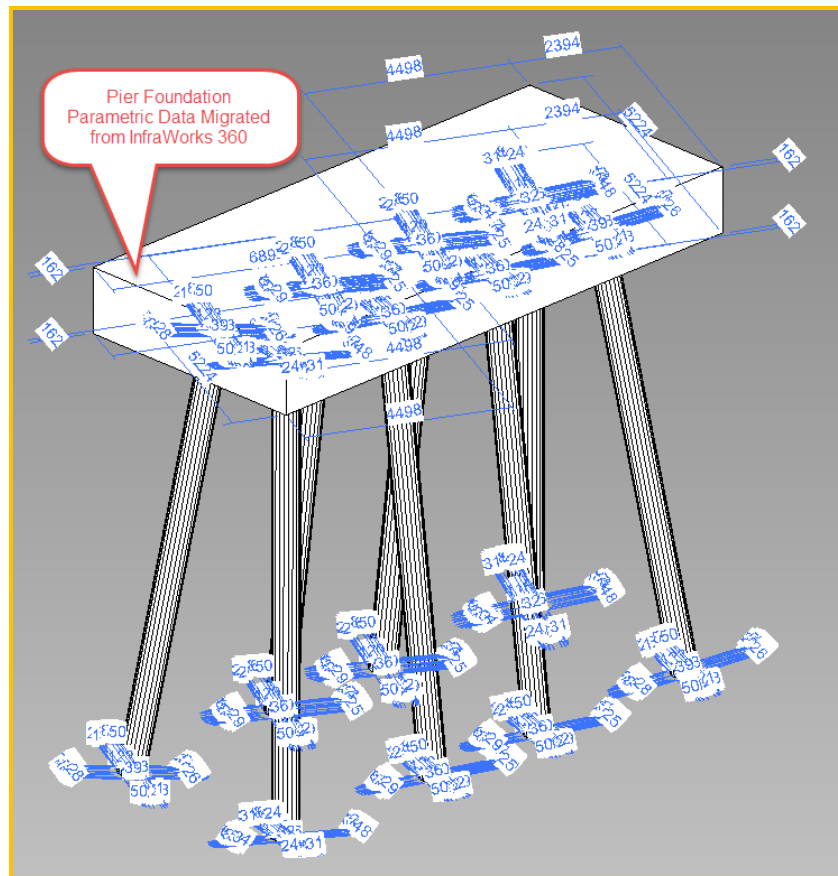
Abutment 1 Parametric Data Migrated from Autodesk InfraWorks 360

Bridge Parametric Data Migrated from Autodesk InfraWorks 360
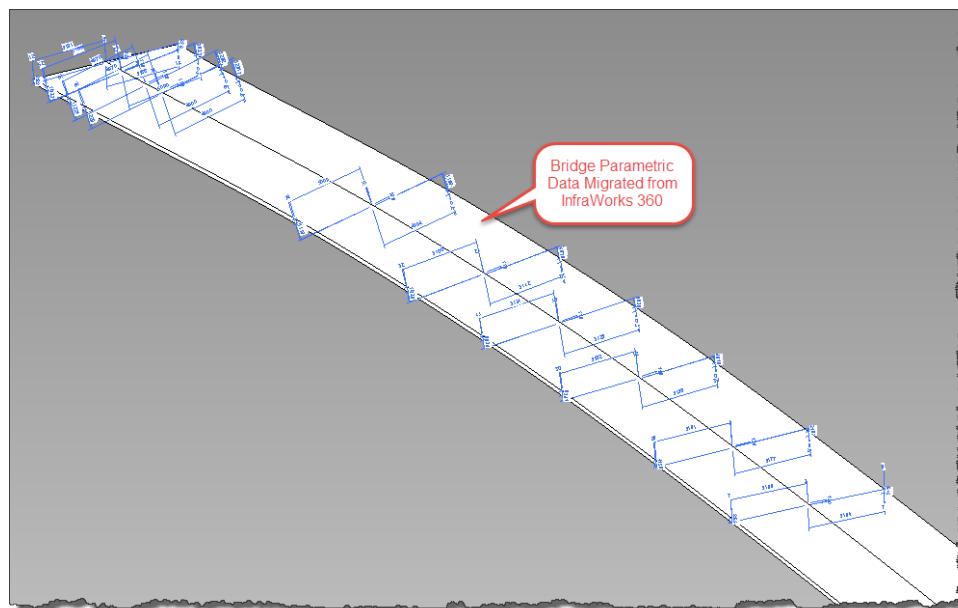
Pier Foundation Parametric Data Migrated from Autodesk InfraWorks 360

Depending on how the data is converted into Revit families (nested families, basic geometry, adaptive components, etc.), you will be able to add parametric data to certain aspects of the geometry. Things to keep in mind are:

1. You may need to nest basic family geometry into another family that has a specific category you desire (i.e. structural connections, structural framing, wall foundations, etc.)
2. You may need to assign the Material for Model Behavior to Concrete for rebar placement capability if not already assigned
3. Not all parametric data will come over…you will need to add more
4. After creating parameters, test to ensure proper flexing
5. Some imported geometry will not be able to be parameterized…you may need to draw those objects using Revit Boolean operations.
6. You may need to export the Revit families as DWG files for importing into a new Revit family to use as a visual guide to create your families.
7. In some cases, you will need to create the family from scratch using the converted Revit families as a visual guide.
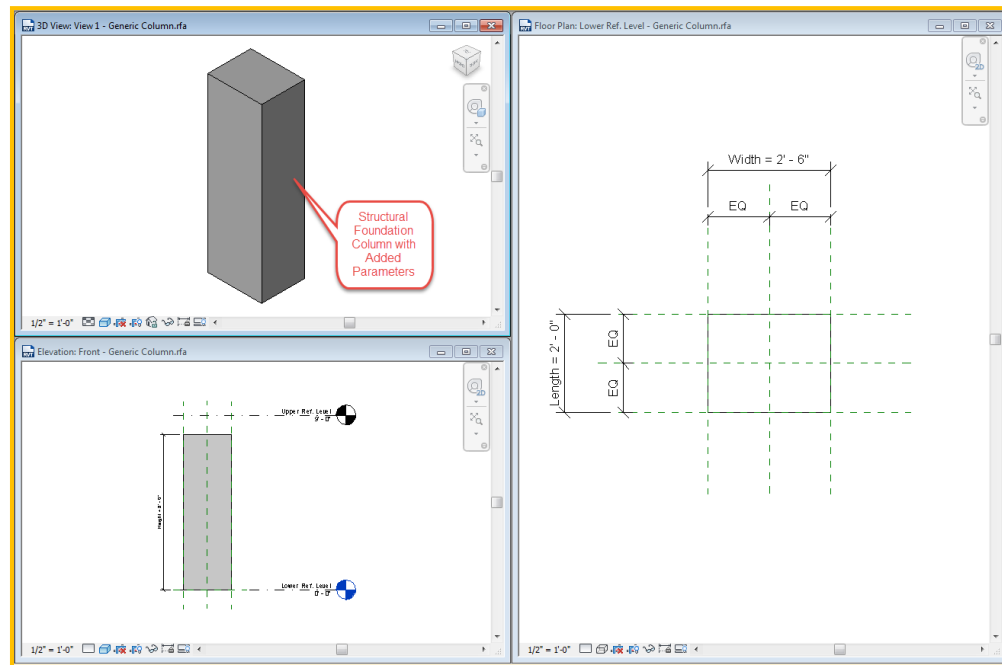
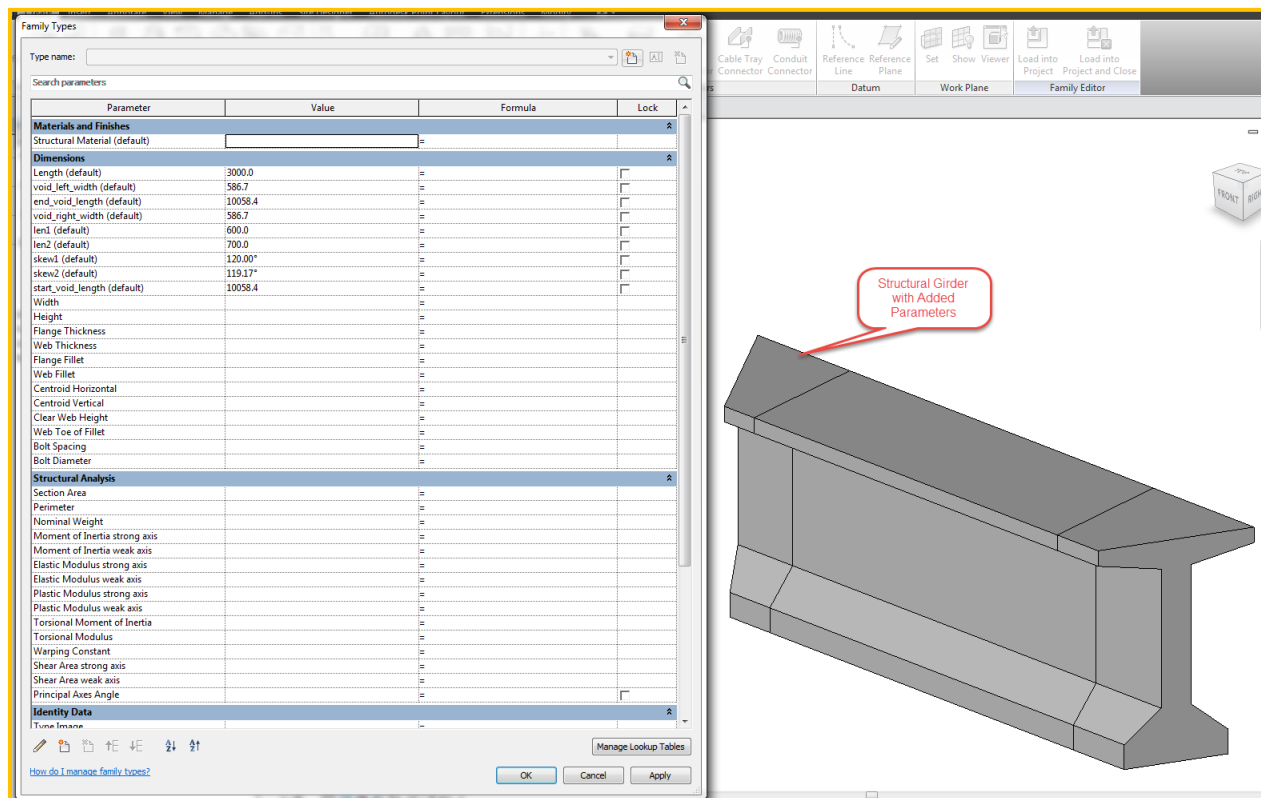Pier Foundation Revit Family with Additional Parameters
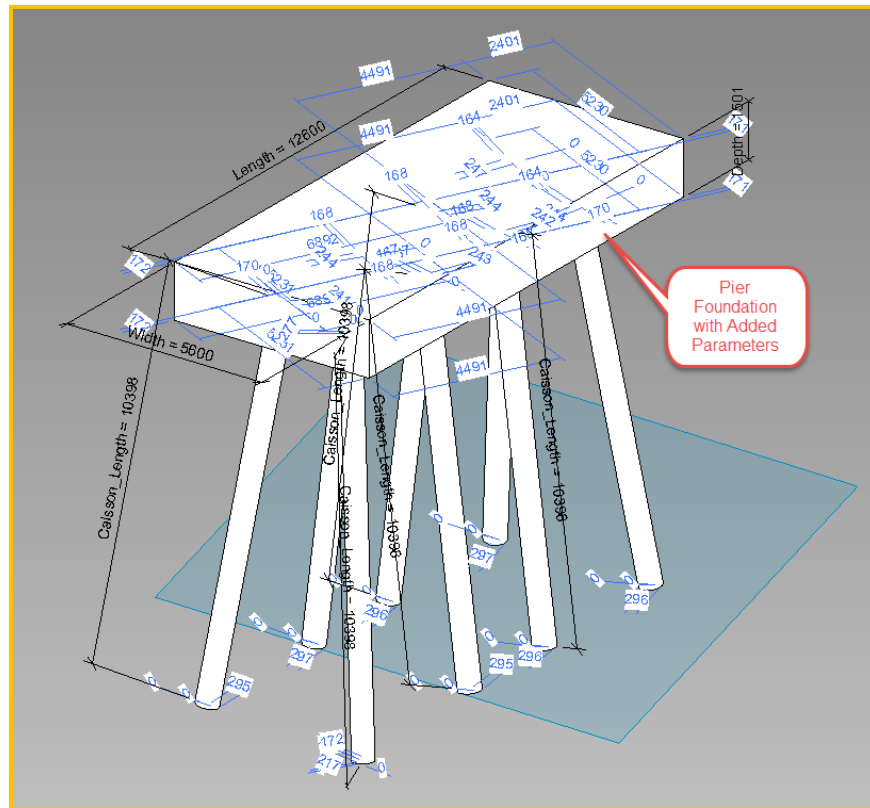
Pier Revit Family with Additional Parameters
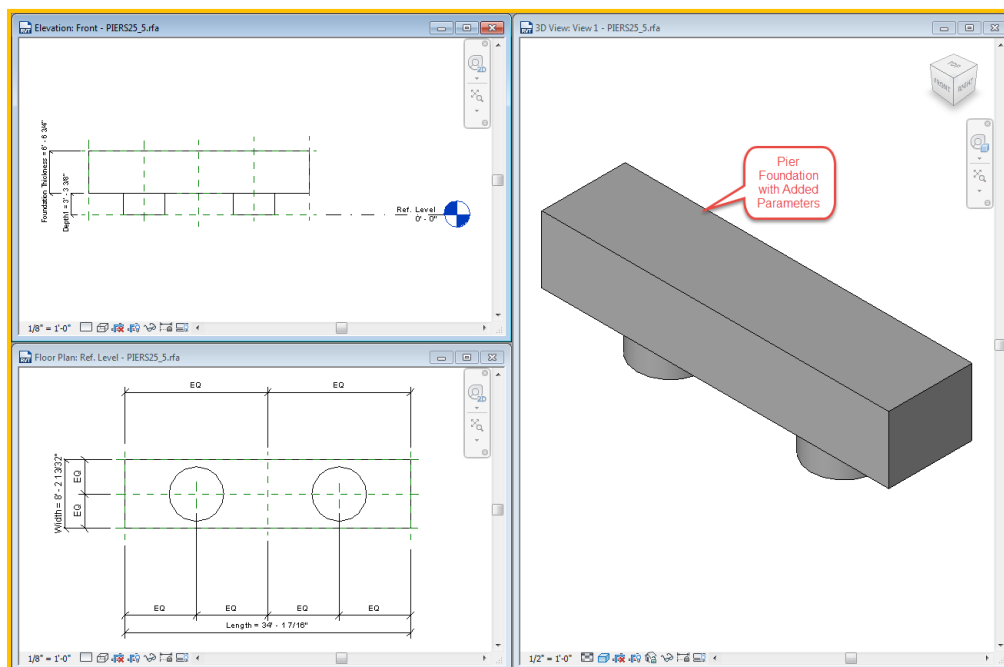
Structural Foundation Column Support Revit Family with Additional Parameters

Structural Girder Revit Family with Additional Parameters

Abutment 1 Revit Family with Additional Parameters
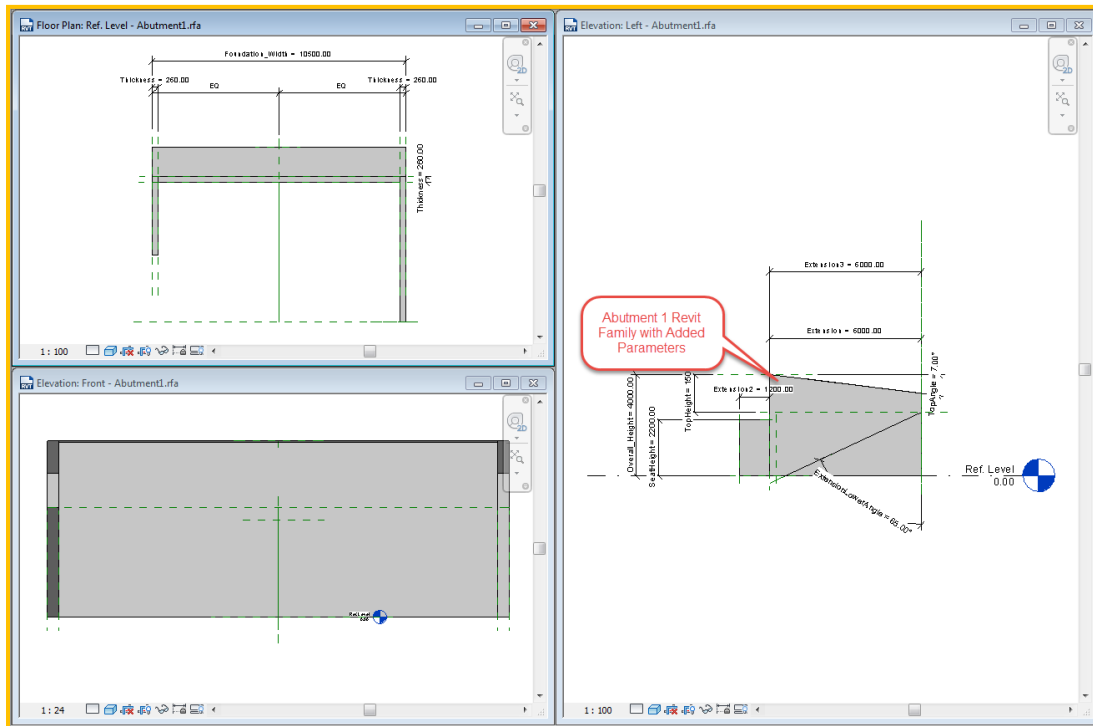
Abutment 2 Revit Family with Additional Parameters
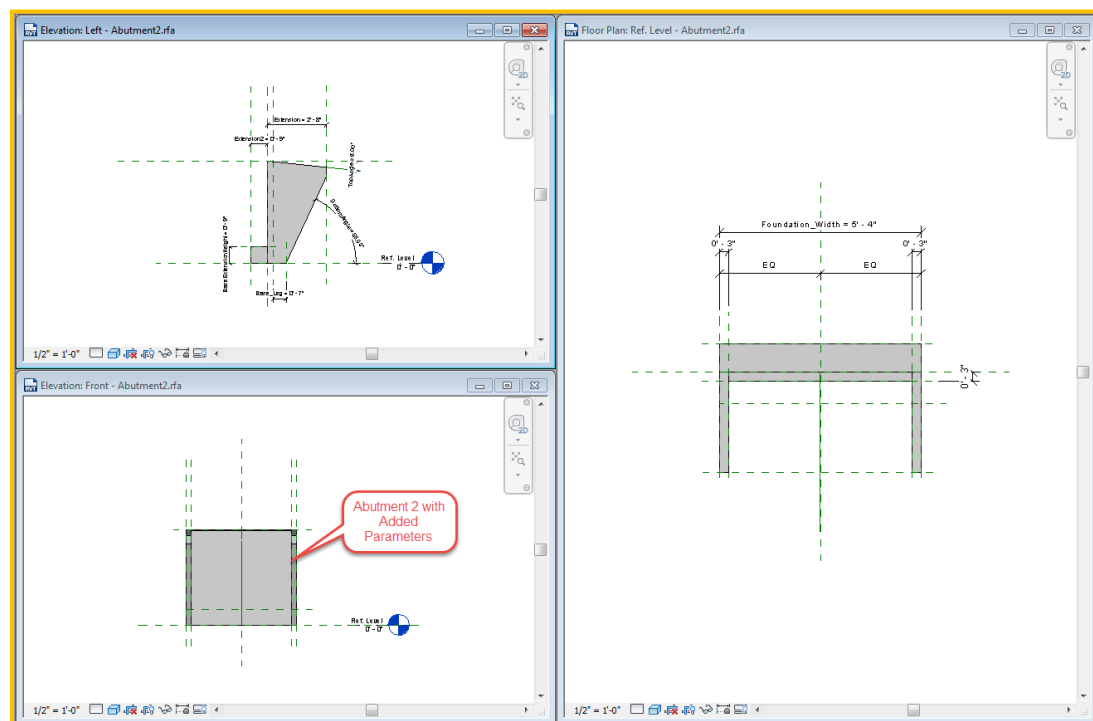
4. Revit Reinforcement Detailing with Extensions

Create reinforcement using Revit native commands and Extensions features

Now that we have enhanced our Revit families and bridge design with more parametric information, we can choose to start detailing our work by creating sections and including reinforcement elements (rebars, hooks, fabric sheets, etc.) within the design.

The typical approach to creating reinforcement within the Revit model is to use the default reinforcement tools within Revit.
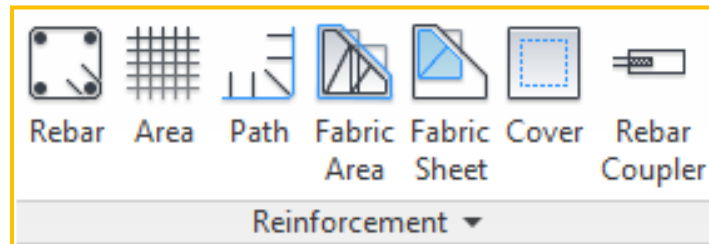
However, for this class we will explore not just those tools but Revit Extensions as well.
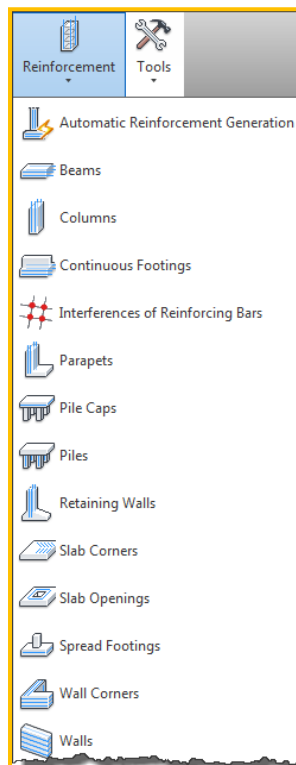
Revit Column Reinforcement via both methods

Revit
Reinforcement
Tools

Revit
Extensions
Tools

Revit Column Reinforcement via both methods

When detailing in Revit, using the native Reinforcement tools or using the Extensions to create reinforcement rebars will depend on the type of objects you have in Revit to work with. If the content is basic generic model data or non categorized families, you will not be able to use either tool unless you specify the correct category and material.
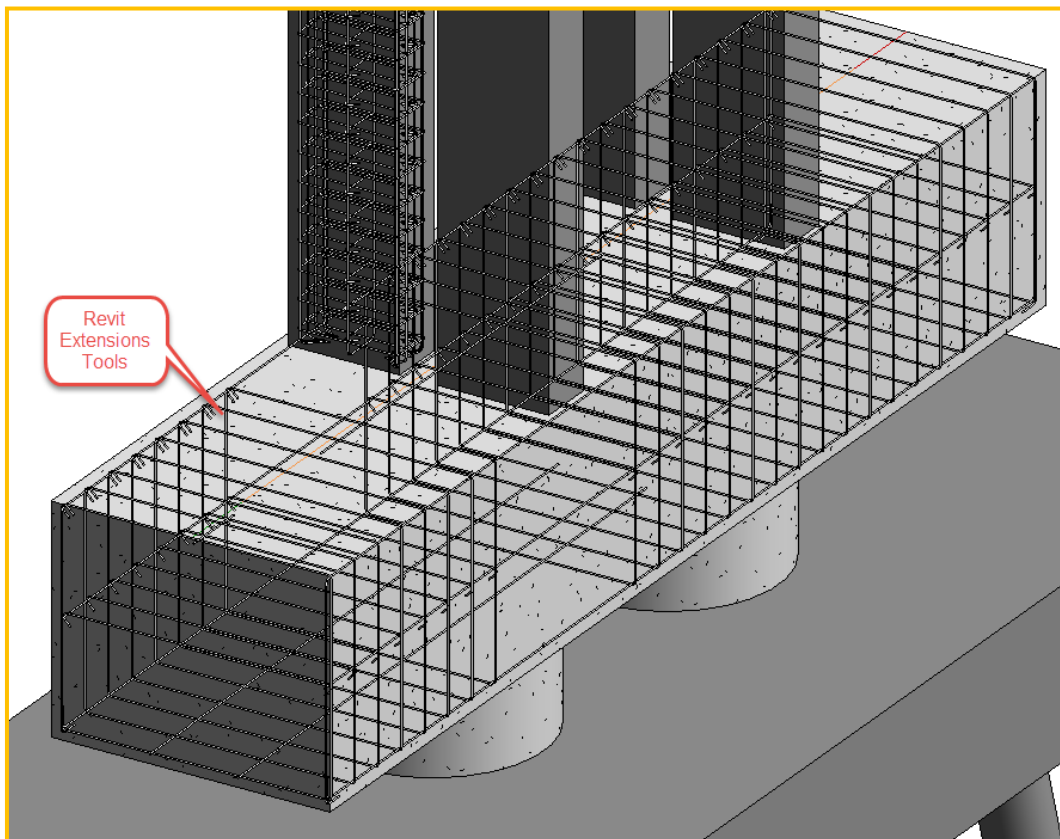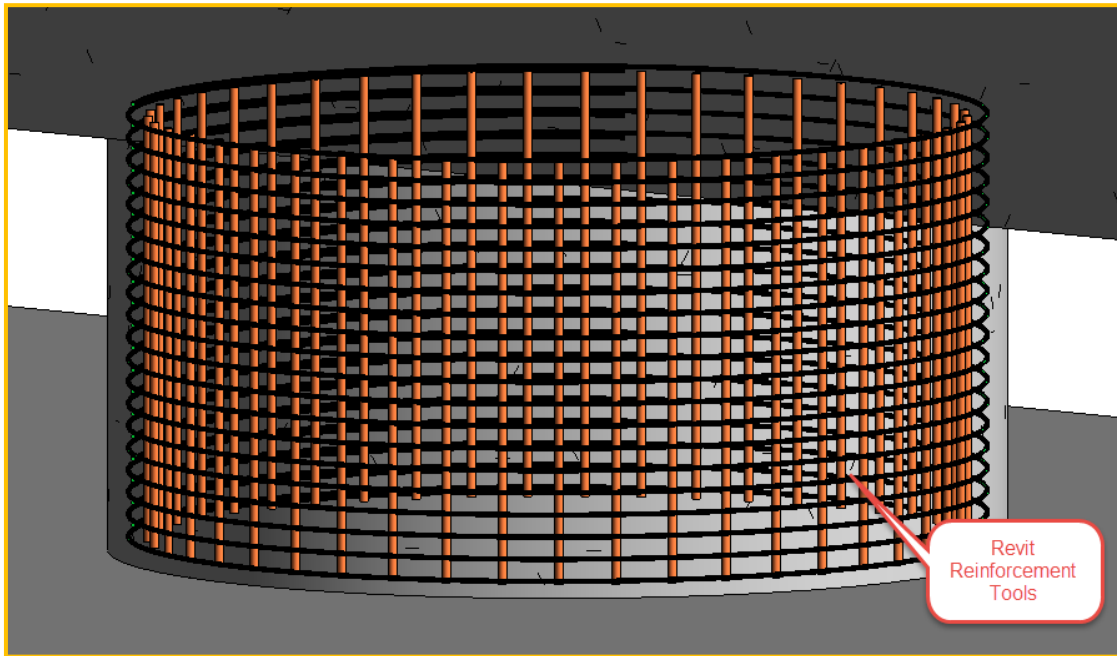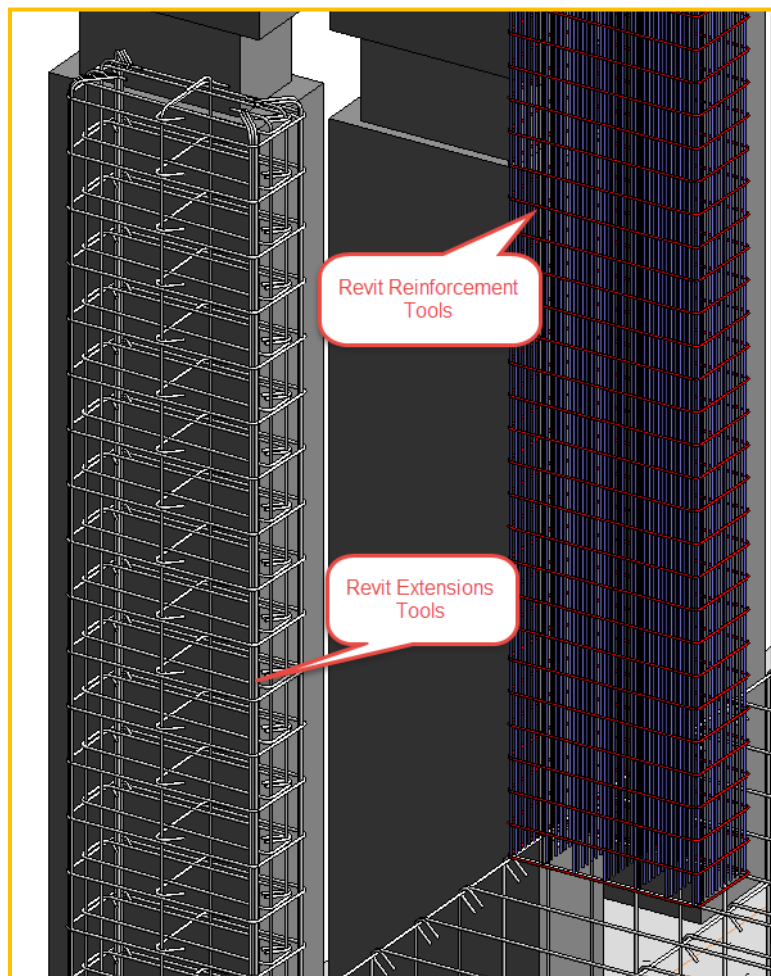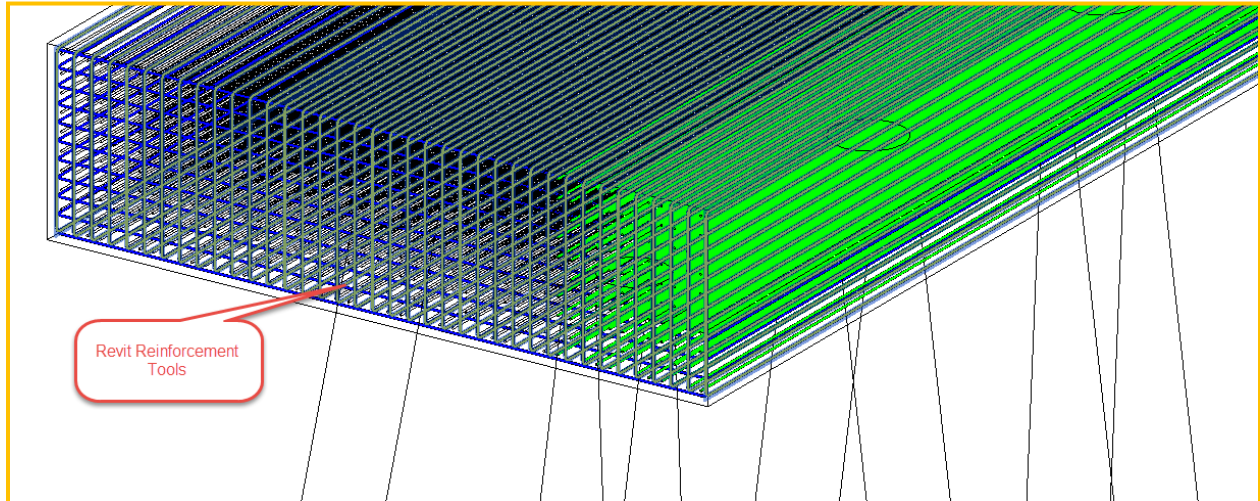
Once the schematic bridge reinforcement is created, you may want to import the bridge design back into A360 Autodesk InfraWorks to see the design in site context.

Alternatively, you may want to bring the design into Autodesk Civil 3D as well.

5. Roundtrip back to Autodesk InfraWorks 360

Import enhanced Revit Bridge Design Model back into Autodesk InfraWorks 360

As our design is now enhanced with Revit parametric data, reinforcement and other aspects such as materials, we can import the model back into InfraWorks 360 to see our results.

When importing our data back into Autodesk InfraWorks 360, we can import the data via several methods:

- Import via FBX file type
- Import via Internet Mapping
- Import via Project Base Point
- Import via Drag and Drop
- Import via Import Command with Geo Location within Infraworks

Our focus will be on the Import Command within Infraworks 360. Prior to importing any Navisworks or Revit content into InfraWorks, you will need to go into the Application Options to ensure the Data Import section is checked off.
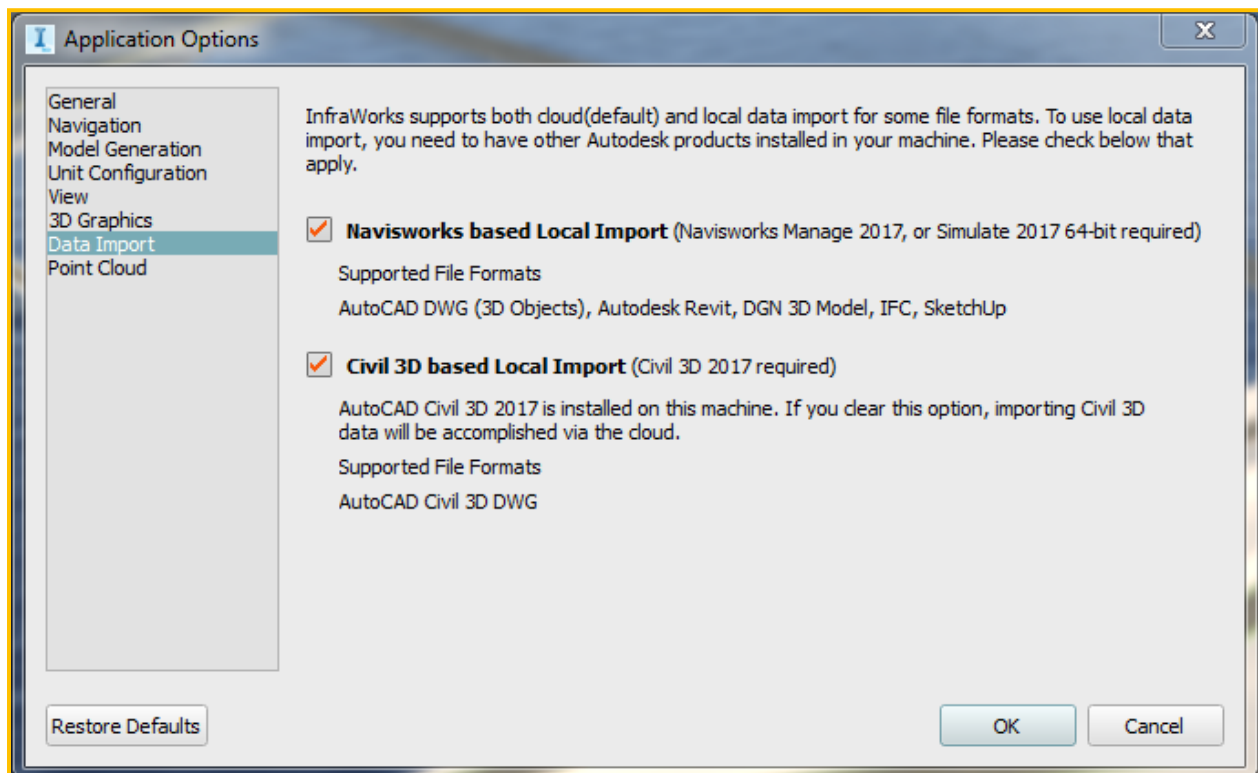
To import a Revit model into InfraWorks 360, the steps are as follows:

1. Select the InfraWorks Icon

2. Select Create and Manage your Model Icon

3. Select Data Source Icon

4. Select the Import Cloud Icon within the Data Source Palette
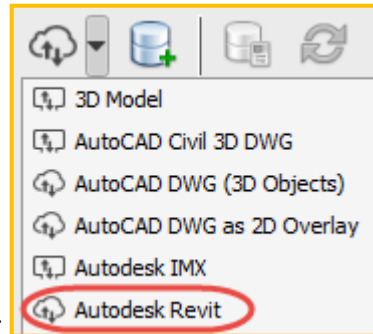
5. Choose Autodesk Revit
6. Internet connection and Autodesk 360 account is required
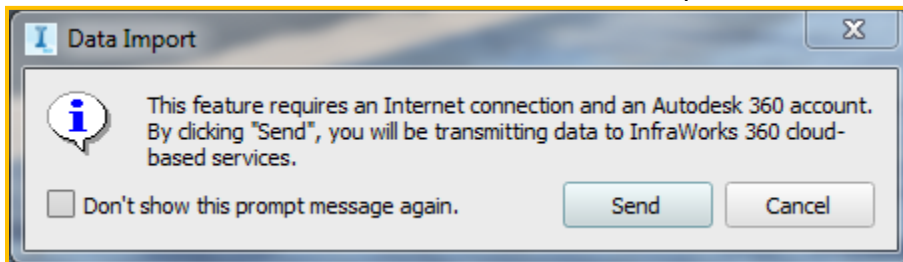
7. Linked files and custom textures may or may not import into InfraWorks at this time (FBX method will keep textures)
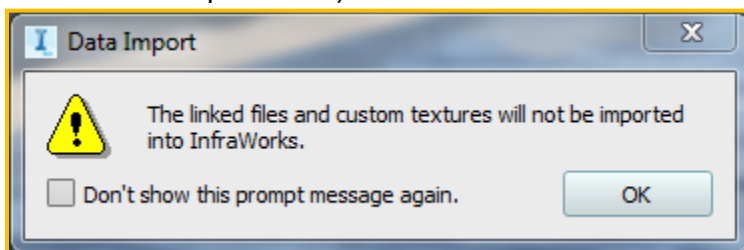
8. Connecting to Data Sources window will show progress
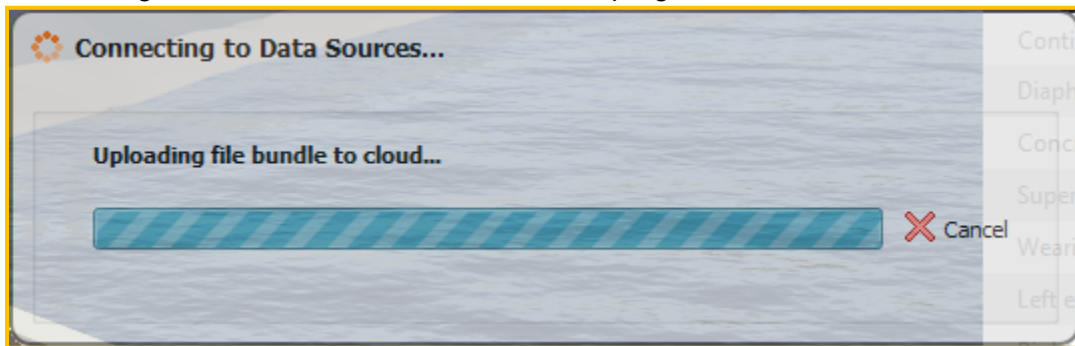
9. Once the process is complete, you will see the Data Source window show the Revit file is **Configured**….not imported yet. You will need to double click this data source to configure it for importing. Click Close & Refresh to apply your changes and see the results in the Model.
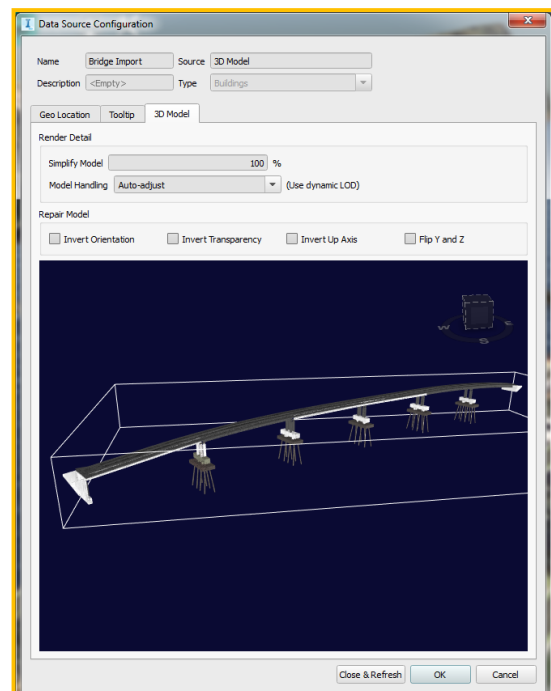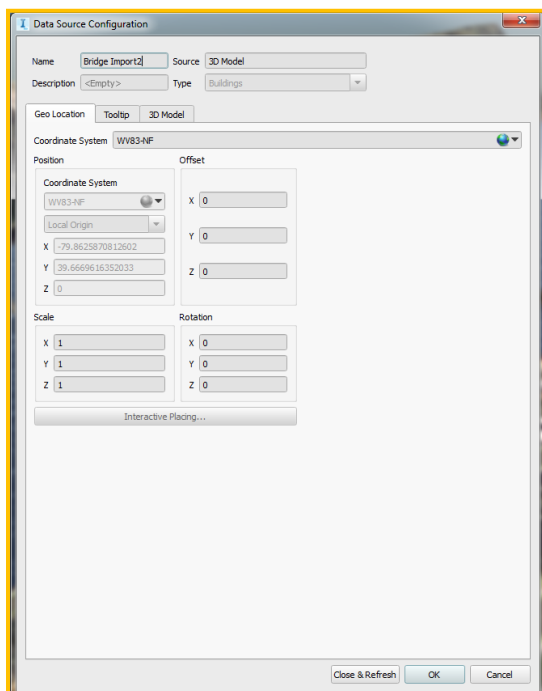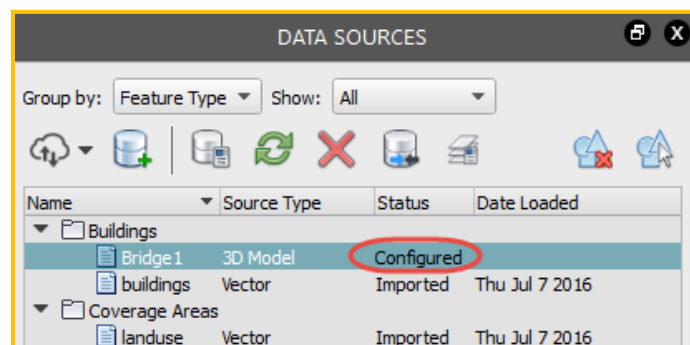
Advanced Tips

You can import a Revit file from your local computer or from a network.
Protein textures and user-defined texture materials are imported.
If you need to adjust the model handling, use these guidelines:

Auto-adjust	A360 Autodesk InfraWorks determines the settings for the 3D model.	If the automatic setting applies LOD, you can change the LOD Distance setting by selecting LOD explicitly and then adjusting the LOD Distance.
Direct Display	A360 Autodesk InfraWorks applies your settings for Simplify Model and the options under Repair Model, but does not adjust how the model is rendered.	Use this setting if the model uses a small number of triangles to define its shape, for example, a house with little detail.
Use LOD	A360 Autodesk InfraWorks uses LOD (Level of Detail) to generate a series of simplifications, assigning the best one based on viewing distance. If you select this option, specify the LOD Distance.	Use this setting if the model has a great deal of detail with many triangles defining its shape, for example, a detailed city furniture model. LOD reduces the complexity of a 3D model as it moves away from the camera. The number of triangles defining the model are reduced to one quarter their previous value at each transition distance. (The transition levels are determined by the

		application.)
		The LOD Distance setting represents the first transition distance. At distances smaller than this, the model appears with full detail. Note: If you reduced the value for Simplify Model, the level of detail starts with the reduced value.
Tile	The surface of a model is tiled to display graphics smoothly and efficiently. When a single object spans multiple tiles, its display can be erratic. If the object is on the periphery of the visible area of the model, it may not appear at all, or it may suddenly appear when the viewer pans closer to it. The Tile setting avoids these issues by permanently attaching the 3D model to multiple tiles. It does not affect your ability to view or manipulate the model.	Use this setting if the model has a large bounding box, and if much of the bounding box is empty. For example, a model of a bridge might span several kilometers, and the bounding box would contain a lot of empty space. The model will be imported in such a way that it can span multiple tiles in the model effectively.

Use the Repair Model settings to adjust the model when it does not appear as expected.

- Invert Orientation — Inverts the direction of the *face normals* that make up each surface of the model.
- Invert Transparency — Makes the transparent areas of the model solid and the solid areas transparent.
- Invert Up Axis — Flips the model upside-down.
- Flip Y and Z — Controls whether the 'up' axis runs along the Y or Z axis. Some applications use the Y axis as the 'up' direction while others use the Z axis.
- Texture Blend Mode — Controls how texture images are combined with surface colors and lighting. Modulate tends to darken images while Decal lightens them.

After you import Revit data, the screen refresh time will vary depending on the size of the imported file. For a building system that is smaller than 10 Mb, to import all exterior elements takes less than 40 seconds. If the size is closer to 200 Mb, refreshing can take as much as fifteen minutes.

If you change the coordinate system, make sure to specify the coordinate system of the incoming data (not the coordinate system of the model). If the imported data uses a different coordinate system than your model uses, A360 Autodesk InfraWorks will transform the data to the model's coordinate system, without changing the original data store.

10. The Data Source window will change to show you the Revit model is now ***Imported*** instead of Configured. You may need to *Refresh* this to process the data in the InfraWorks Model view.
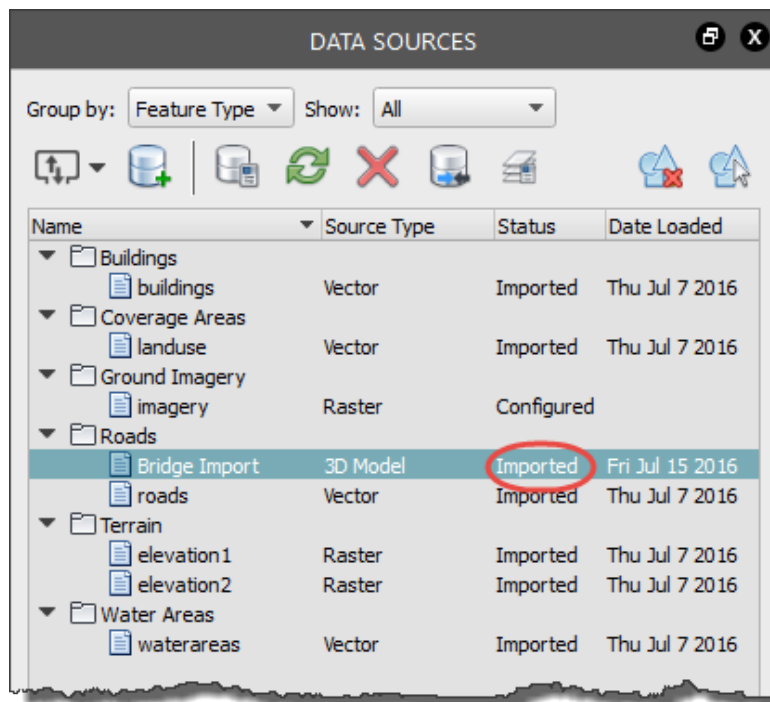
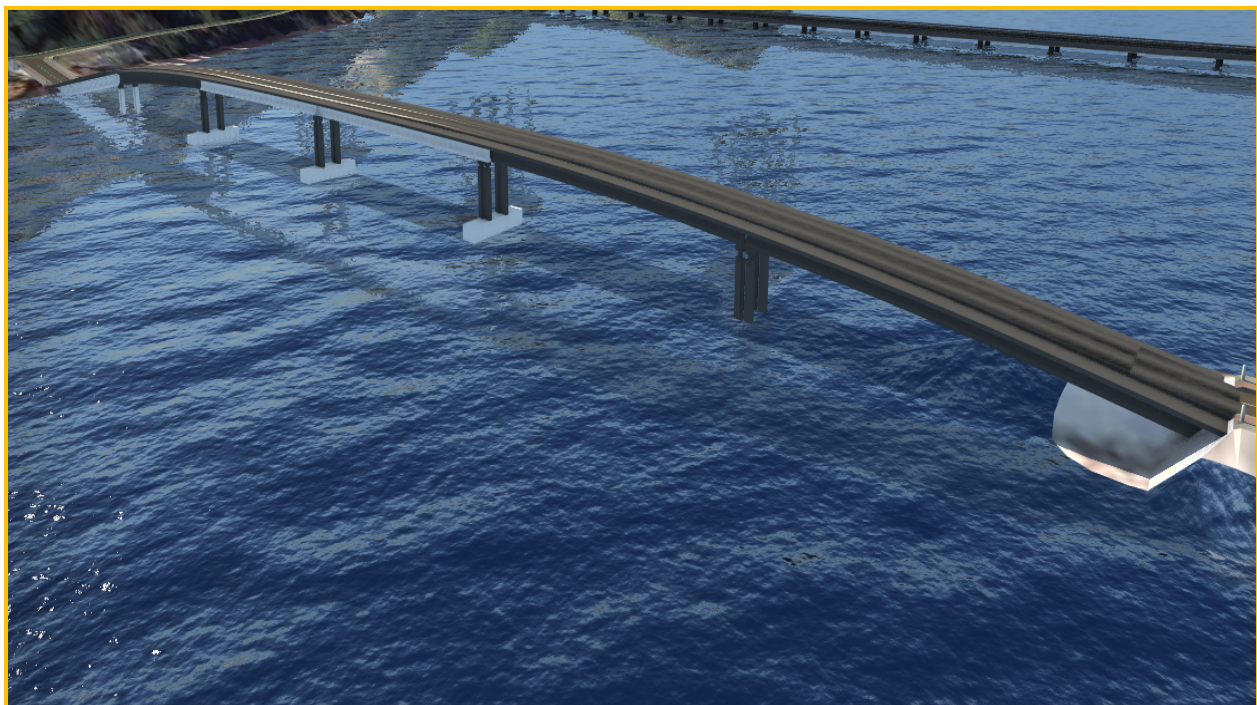11. Once the Revit model is displayed in the InfraWorks Model, you will need to manually move it to its exact location. The location accuracy of data import will not be 100%.
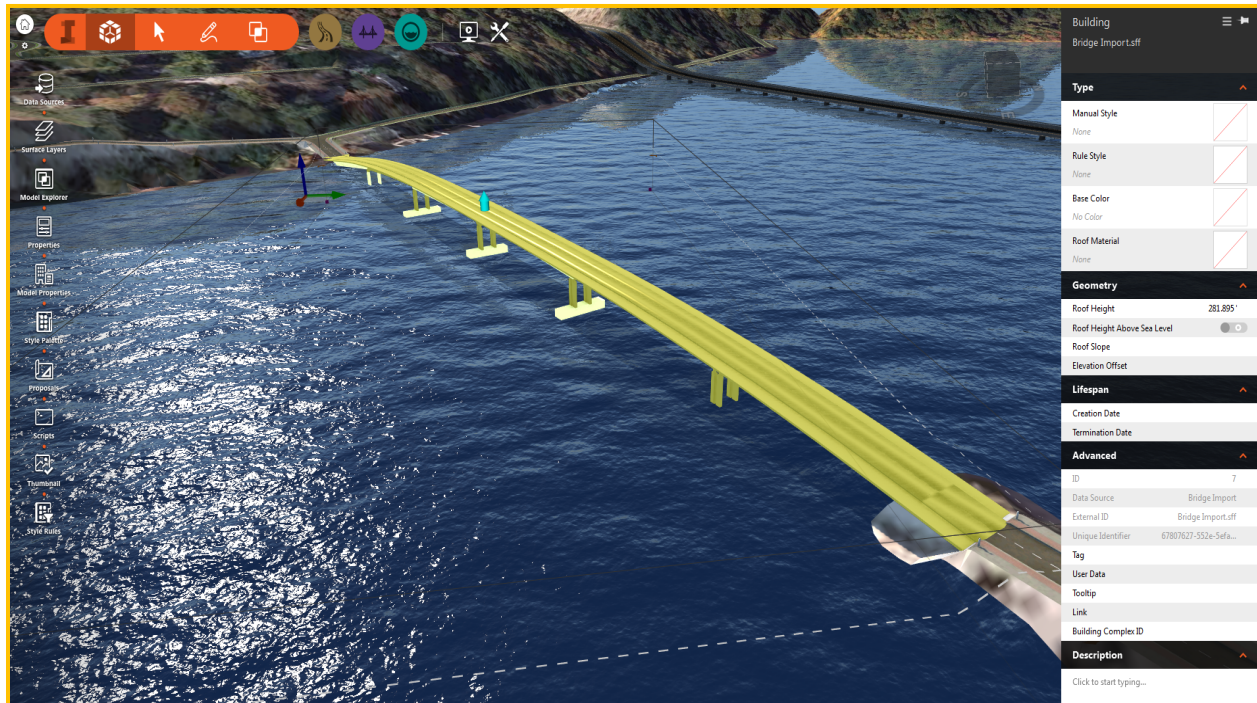
Revit Bridge Model within A360 Autodesk InfraWorks

Depending on your varying results and attempts, some things to keep in mind when importing the Revit model back into InfraWorks is as follows:

1. The Data Source Import Configuration will need to be attempted more than once
2. The Revit model will need to be simplified before the import process
3. You may need to create multiple InfraWorks proposals to show existing versus proposed
4. Cross reference the X, Y and Z location in Revit again the InfraWorks X, Y and Z designation of the Revit model…they should match
5. Refreshing the imported Revit model data source will need to be performed several times

Final Thoughts

As with any workflow process involving multiple software and multiple file formats, there are bound to be some hiccups. This workflow example illustrates how we can use Autodesk InfraWorks 360 and Revit together to obtain a desired result. What we learned from this workflow is that the ease of creating a bridge design in InfraWorks is good, better than expected but still lacking in content. The bridge export to Revit creates families that have strange long number names and inconsistent families/generic geometry. Recreation of the Revit families will need to be considered. Reinforcements with the tools given will give basic results. Detailed rebar design within Revit will be solely dependent on the structural experience and knowledge of the end user and how much he/she creates the rebar content within the Revit model. Final manipulation/change of the Revit model within InfraWorks (such as changing the design) is not possible. You can however, adjust the design to a degree within Revit and then from within Autodesk InfraWorks 360, Refresh/Reimport your data source for the bridge. Lastly, you may have to redesign from InfraWorks and start the process all over again. Autodesk is aware of the workflow process from InfraWorks to Revit and is working hard on making the collaboration between the two much easier to work with and allow for flexibility in design change.

Thank you very much for attending our class. We hope this class has been a great value to you.

Dzan Ta
Dave Young

Resources:

CV5777-P: Bridge Design for InfraWorks 360
CI11198: REVITalize Bridge Design
Bridge from Scratch in Dynamo