

CES324264

InfraWorks Bridges the Gap for Structural Modeling

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Learning Objectives

- Discover the workflow for modeling complex civil structures using Civil 3D, Inventor, and Revit
- Discover the steps your company can take to get started with this workflow
- Gain an understanding of the lessons learned by going through this process
- Learn the difference between this workflow and using Dynamo for Revit

Description

This class will cover the workflow for using Civil 3D, InfraWorks, with Inventor and Revit, for bridge modeling. It will cover what you can do with the software today, as well as what will be available in the near future. We'll discuss the steps you can take to move out of a 2D world, and the lessons learned from the pilot project, and we'll show how the project team can work together with an integrated model to manage change. Lastly, we'll compare the differences between using Dynamo for Revit and this workflow.

Speakers

Mike McKeon

Mike has worked in the civil engineering industry for over 30 years. His primary focus has been on the design and delivery of major highways and infrastructure projects. At Jacobs, Mike sits as a Digital Delivery Lead, focusing on design automation, information management and the development of innovative workflows. Mike has had the privilege of attending several Inside the Factory events with the Autodesk Civil team.

Ara Ashikian

Ara is the Senior Product Line Manager for the Autodesk Civil Structures product development teams. Prior to joining Autodesk in 2013, he had over 20 years of experience as a bridge engineer and a software developer, working on a large number of bridge projects, including preliminary, detailed and construction engineering design aspects for a wide range of bridge types. These projects included the detailed construction engineering of the EG LNG suspension bridge in Africa, as well as for the New Bay Bridge (self-anchored suspension bridge in California), the detailed engineering for the launching of the Kicking Horse Canyon in the Canadian Rockies as well as for the Coast Meridian bridges.

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Why Look at InfraWorks for Bridge Modeling

Our priority at Jacobs is to advance all disciplines within transportation and infrastructure to work in 3D, using BIM workflows. Bridge modeling has traditionally been slower to move to 3D.

Benefits:

- Ease of change management with alignment and corridors updating frequently
- Parametric models adapt to change easier
- Clients and contractors are starting to ask/require 3D
- Once the parts are created, similar bridges can be modelled rapidly
- Moves the industry closer to automated plan production and paperless delivery
- Can minimize risk of errors or emissions due to having more information in a comprehensive and immersive environment before construction.
- The ability to create quick visualizations with minimal effort
- Inventor shows promise with the ability to reuse parametric parts on multiple bridges and projects
- This workflow is very approachable and easier to learn and requires minimal funding to adopt.

In a step to move our bridge modeling to the next stage, we are evaluating the workflows available to project teams. The Civil 3D > Dynamo > Revit workflow is further along in terms of

acceptance and use. We are successfully using it on projects. Jim Crabtree of Jacobs delivered a presentation on this topic. To hear more about this workflow, see:

[CES321585 - Bridge Detailing 2.0: Computational modelling methods using Civil 3D, Revit & Dynamo](#)

The workflow that will be discussed in this session using InfraWorks, combined with Inventor and Revit to model bridges.

Steps to get started

- If you are not already part of the beta, request to get added to the InfraWorks Rolling Sandbox beta site. This will get you access to the latest (pre-release) build of InfraWorks. Ara and the InfraWorks team are rapidly releasing new, or enhancing existing tools in InfraWorks, especially when it relates to bridge modeling. You can request to be added here:
<https://feedback.autodesk.com/welcome/>
- Start with showing this workflow to your marketing team and PM's. At a minimum, this workflow can be extremely useful in project pursuits, public hearings and client meetings. You can rapidly create a model for presentation purposes.
- For presentation purposes, Inventor is often not needed. You can use the out of the box InfraWorks components. If you are interested in moving to final design, Inventor is most likely needed. Depending on your available resources, take an Inventor Fundamentals course. With approximately a four to six-hour investment, I was able to start creating parts that could be utilized in InfraWorks.
- Find a good team that is interested and realizes the need to move out of the 2D world. A team that is interested generally has a better attitude and tries to make it work, rather than trying to make it fail.
- Get access to the current version of Civil 3D and Inventor. Depending on how far you want to take the workflow, you will also want the current version of Revit. See the section on Prerequisites.
- Try this approach in parallel and setup a pilot or proof of concept

The Project

Pilot Project – Selection and Information

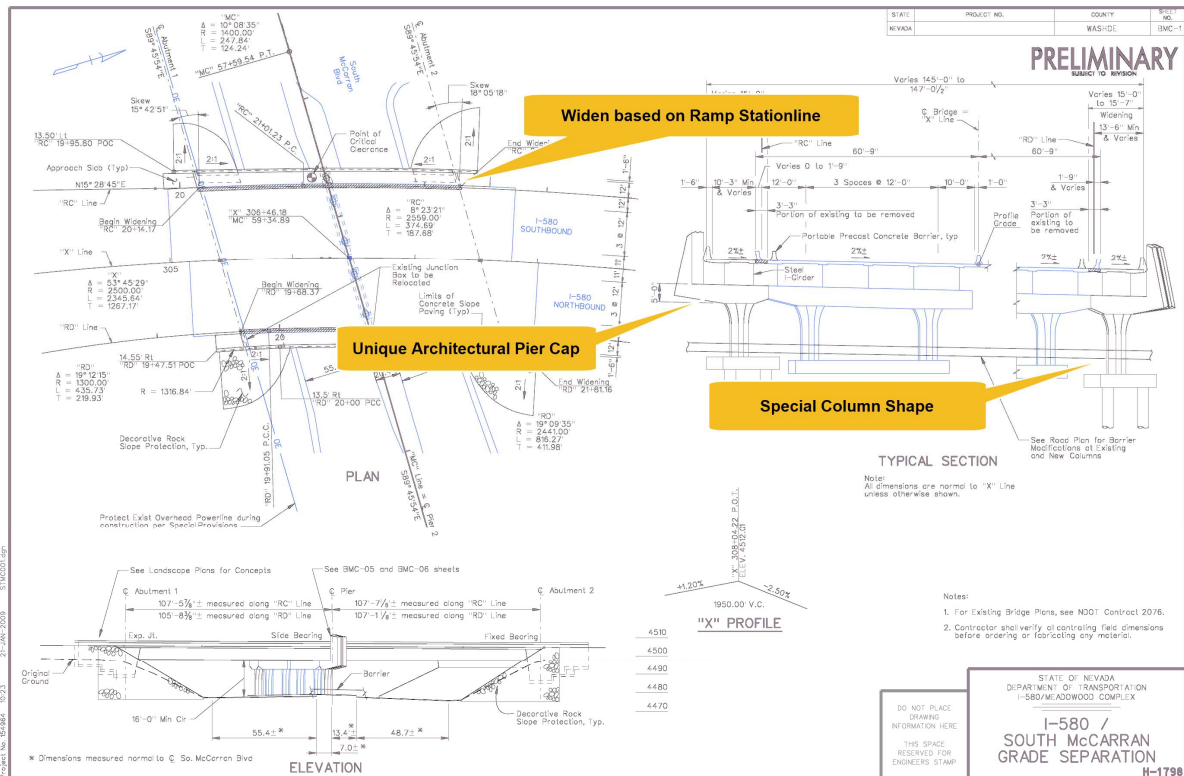
Our testing was done on the South McCarran bridge as a part of the I-580/Meadowood Complex project in Nevada. In selecting a project, we chose one that would challenge the workflow enough to allow us to learn Inventor and Revit, which were new to the roadway/structures staff.

Some of the challenging aspects were:

- Widening of an existing structure

- Unique deck, columns and pier cap
- Was not solely built off the highway centerline

When using new tools or a new workflow, it is as important to select the right team as it is to select the right project. With new tools and workflows, you can expect to run into some hurdles. I generally do not try to push new workflows on teams that are not interested. A team that is interested and eager to learn will generally try to make things work. Plans showing some of the challenges with modelling the projects

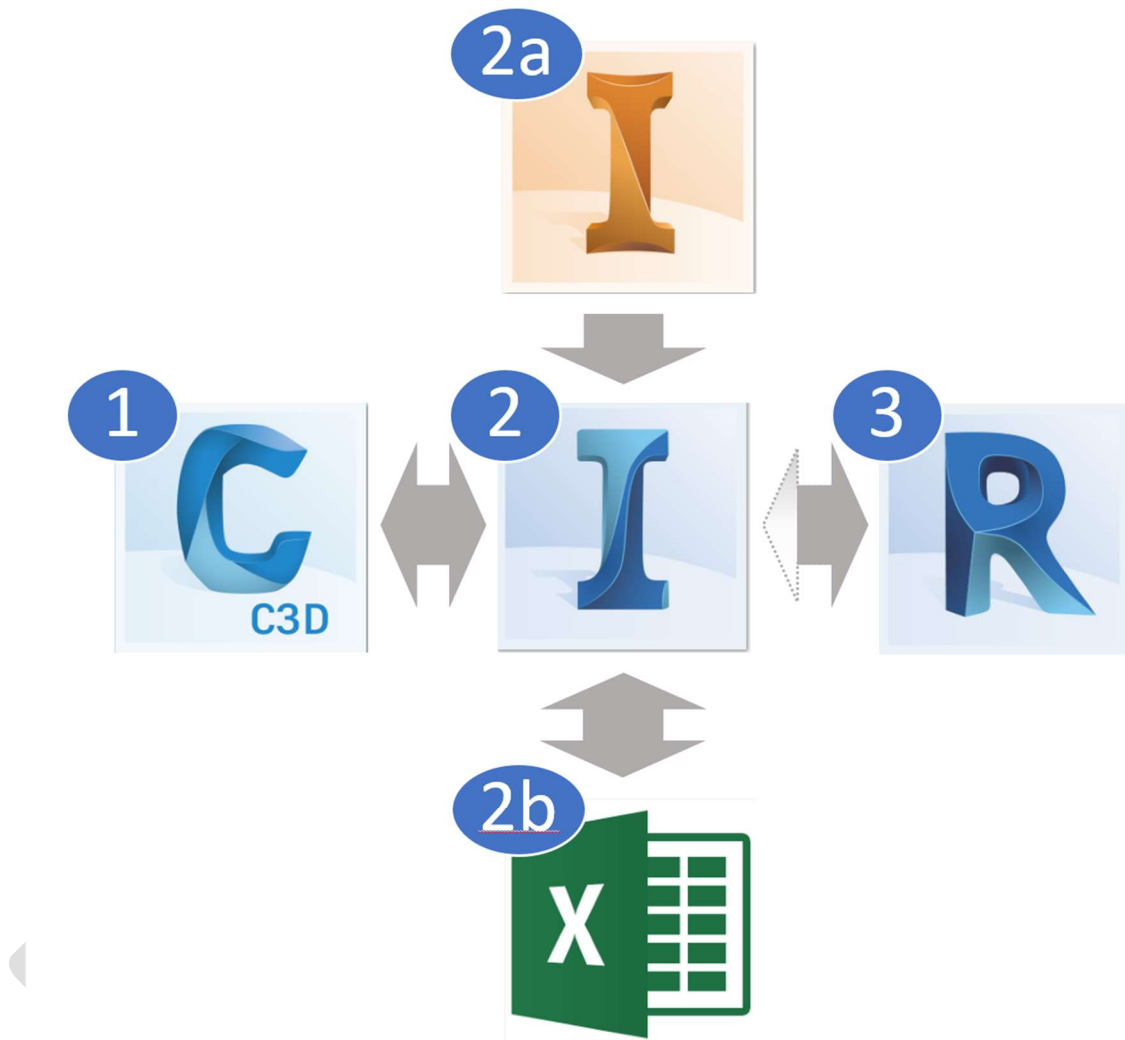


Images of the constructed bridge



The Workflow

Workflow Overview

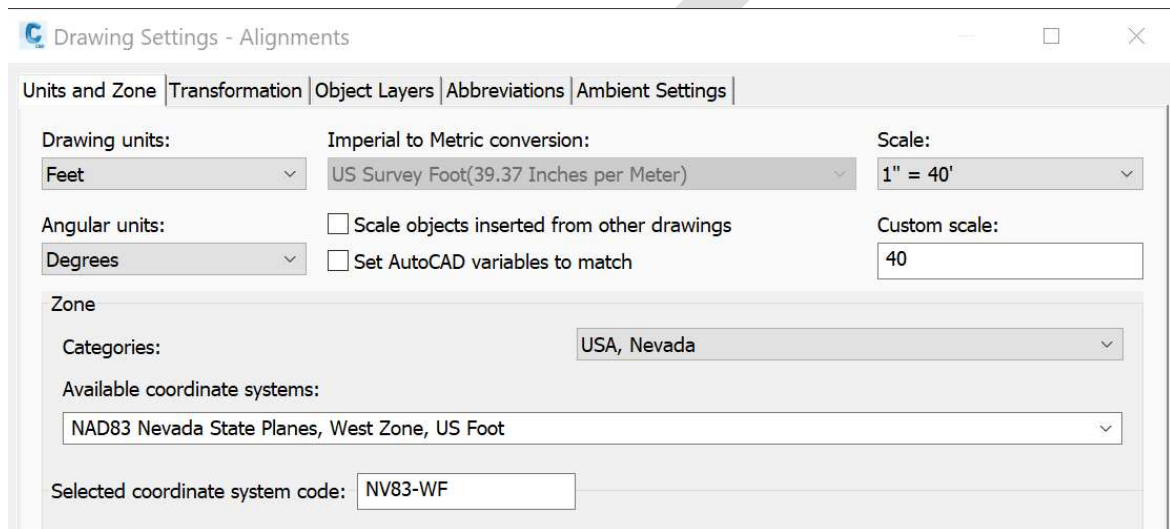


Prerequisites – Current versions at time of class

- Civil 3D 2020
- InfraWorks 2020.1 or above
- Inventor 2020
- Inventor Infrastructure Modeler Plugin 2020.1
 - The Autodesk Inventor Infrastructure Modeler Plugin adds Infrastructure Part Shape Utilities tools to Autodesk Inventor.
 - Used in Autodesk Inventor to create parametric content that can be used for civil infrastructure design in Autodesk Civil 3D and InfraWorks.
- Revit 2020
- Revit InfraWorks Updater 2020.2
 - Autodesk InfraWorks to Revit Interoperability Add-in

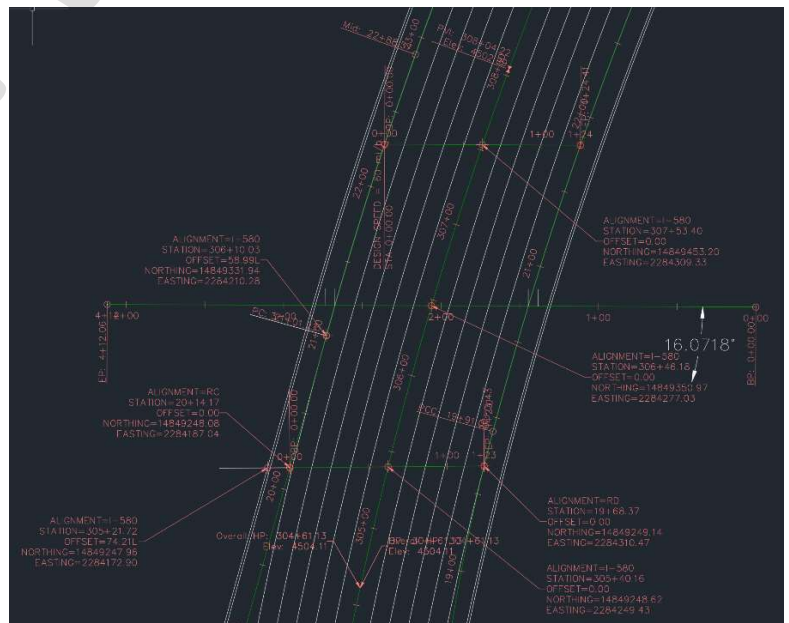
1. Define the coordinate system in DWG

Projects have different coordinate system requirements. Some work in a Grid system and some work in a Ground system. By default, InfraWorks does not include Ground or local coordinate systems but does share the Civil 3D coordinate system library. It is important to properly define the coordinate system in Civil 3D, in preparation for bringing the data into InfraWorks



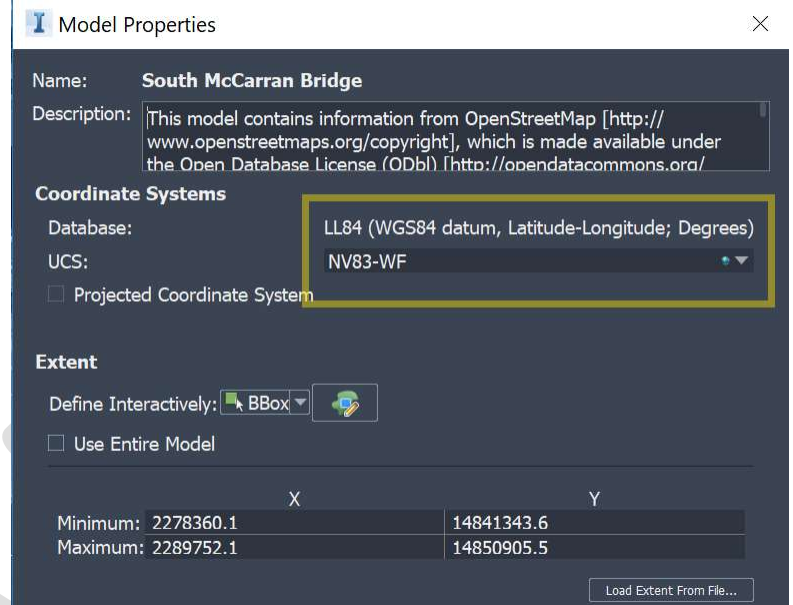
2. Create the Civil 3D objects, existing ground surface, alignments, profiles, and superelevation

The superelevation does not currently carry forward to InfraWorks but you will need it as a reference.



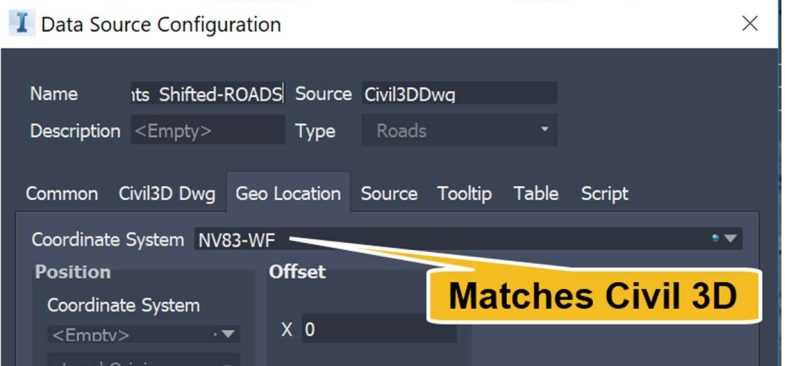
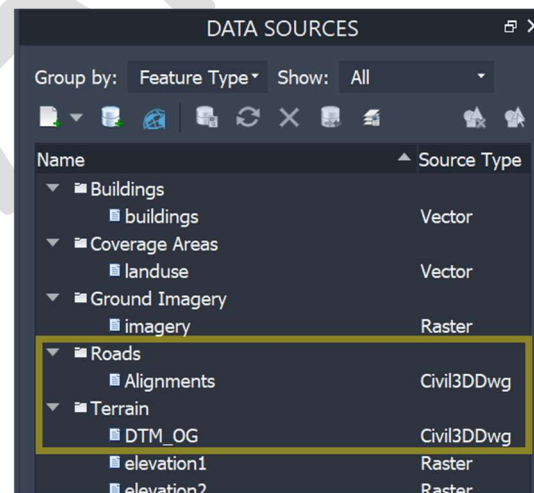
1. Create the InfraWorks model. *I generally use Model Builder*
2. Edit the Model Properties to assign proper coordinate system.

Ensure this is the same one as defined in Civil 3D



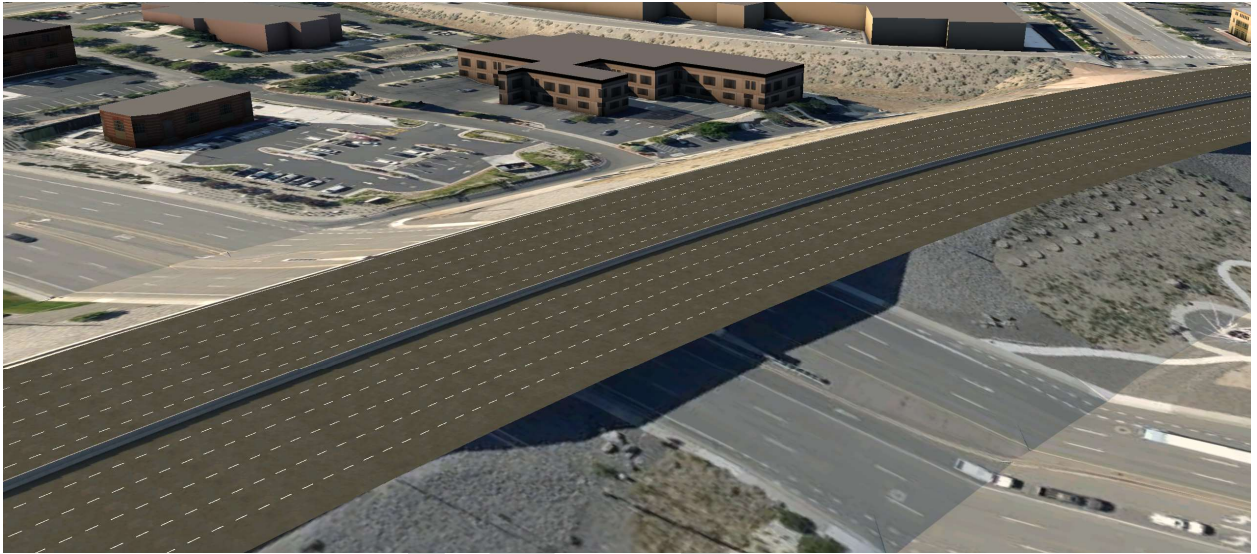
3. Attach the Civil 3D drawings as a data source and configure

If the Civil 3D DWG's coordinate system is the same as the InfraWorks model's, the Civil 3D data should line up automatically.

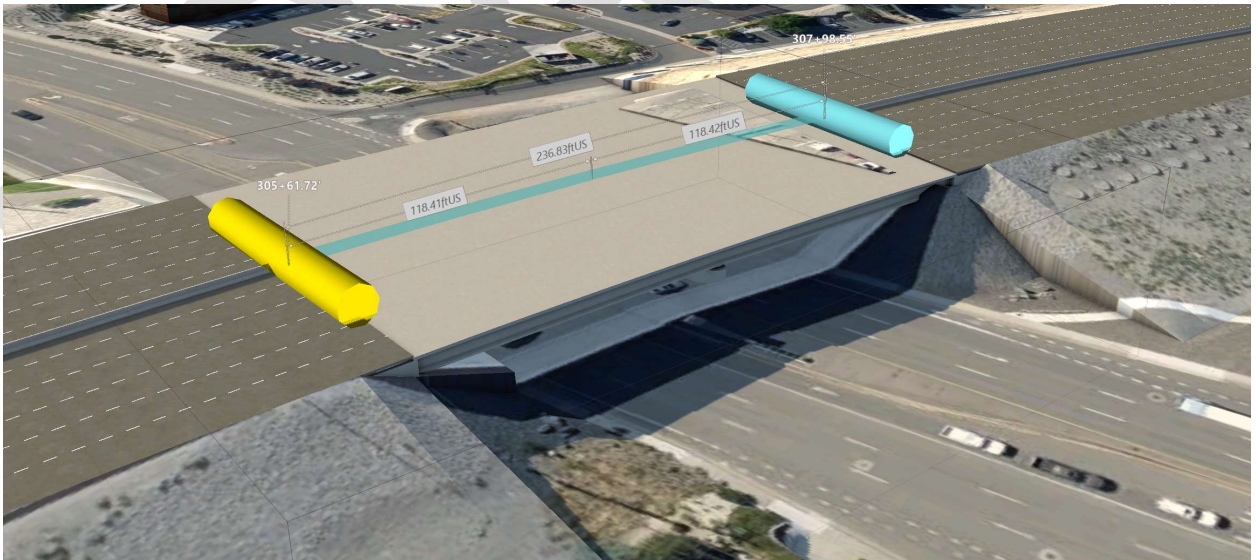


4. Build the component roads, enough to cover the location of the bridge

This workflow will be enhanced in the future so that the bridge deck will adapt to the Civil 3D corridor. You will not have to build the roadway components manually.

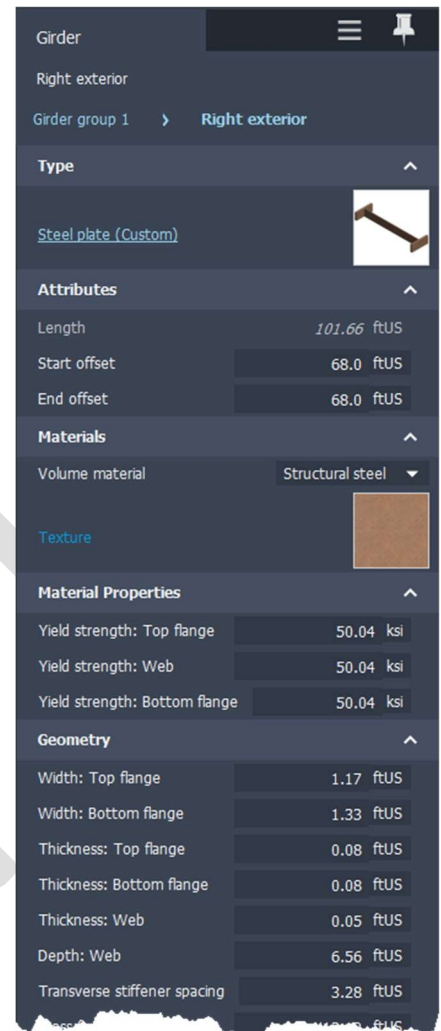


5. Place the bridge in your model

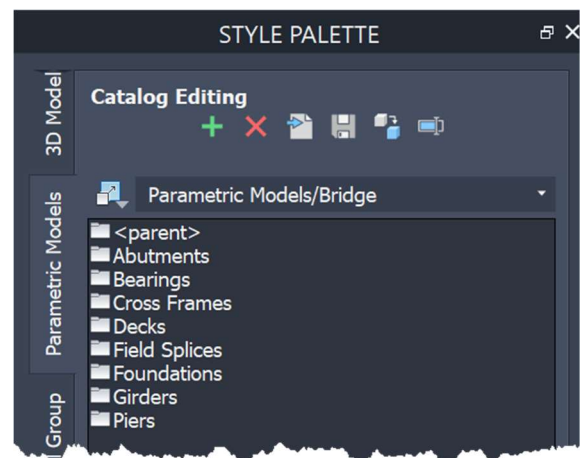


- Evaluate the bridge components that ship with InfraWorks to determine if they meet the project requirements. The parts that are available are seen to the right.

The standard InfraWorks components are flexible and the geometry can be applied to many projects. If they are not flexible enough, you can create custom parts or assemblies in Inventor.



- If the bridge components do not meet the project requirements, use Inventor to create ones that do. The available categories that can be imported from Inventor are shown to the right.



Workflow Overview

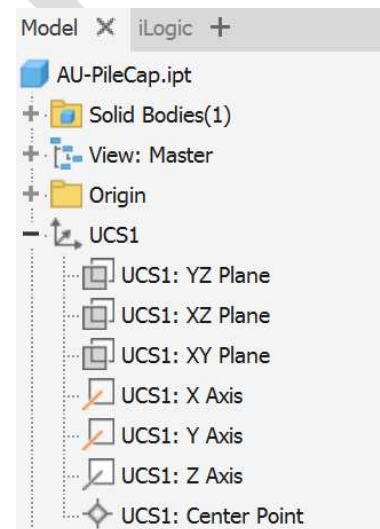
This section will not cover how to use Autodesk Inventor but will demonstrate the high-level steps to create a part and how to import and use the part in InfraWorks.

Autodesk Inventor can be used to create parametric parts or assemblies, which can be used in InfraWorks. These parts can be used by InfraWorks for modeling bridges, tunnels and generic components.

To start off, I suggest creating a template(s), which contains pre-configured settings. This template will reduce the time it takes to create future parts in Inventor. The settings that I recommend adding to a template are:

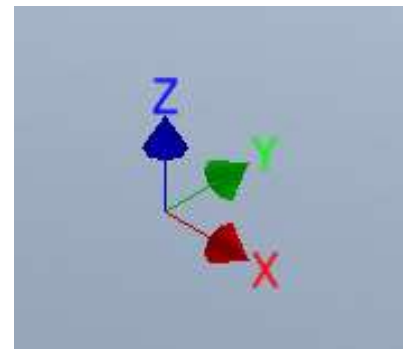
- Create a UCS

Creating a UCS is recommended to avoid any issues with items being constrained to the origin. Doing this allows for more flexibility when placing items in InfraWorks. Once the UCS is created, constrain all your elements to it.

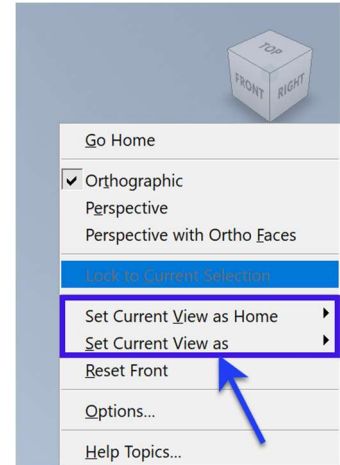


- Orient the view to your preferred orientation.

In Inventor you can set your Home view. I generally set the Home view to the orientation shown in the image to the right. You can also set your Top view. I set my top view to be oriented to the XY Plane.



Set your Home and Top views by right-clicking on the view cube as seen to the right.



- You can create a template for each bridge component. One which includes standard parameters that you typically use for that component type. This promotes consistency in Parameter naming and saves time. Sample Image to the right

It is important to note that InfraWorks expects and will utilize certain parameters for specific parts. Here is a list of required parameters:

Piers

- PierHeight
- PiercapRightWidth
- PiercapLeftWidth

Abutments

- CLBearingToBBW
- LeftWidth
- SeatDepth
- SeatOffset
- SeatWidth

Bearings

- BearingAssemblyHeight
- ExtraHeight
- GirderSoffitLongiSlope
- GirderSoffitTransSlope
- PiercapLongiSlope
- PiercapTransSlope

Decks

- LeftWidth
- RightWidth

Parameters

Parameter Name

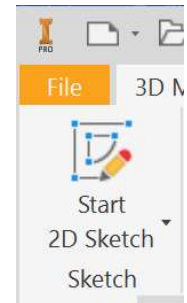
Model Parameters

UCS1X
UCS1Y
UCS1Z

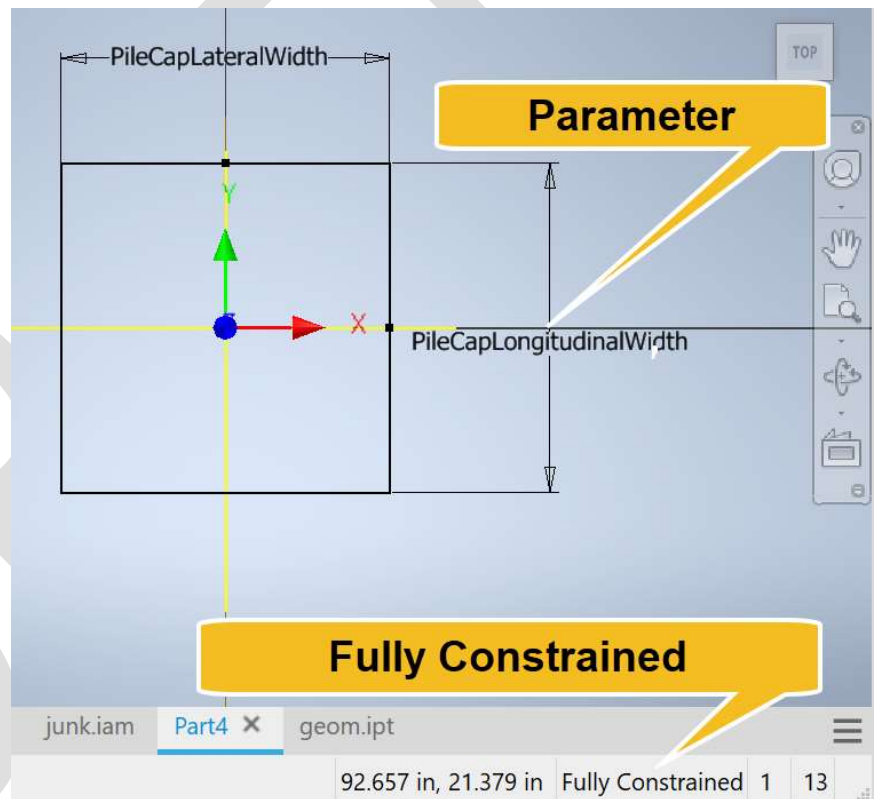
User Parameters

PierHeight
PierCapTopLeftSlope
PierCapTopRightSlope
PierCapDepth
PierColumnWidth
HasRoundColumns
StepHeight
PierColumnSpacing
PierCapTransEndLength

Once your template is created and saved, you can begin to create your bridge components. The next step is typically to create a new 2D Sketch.

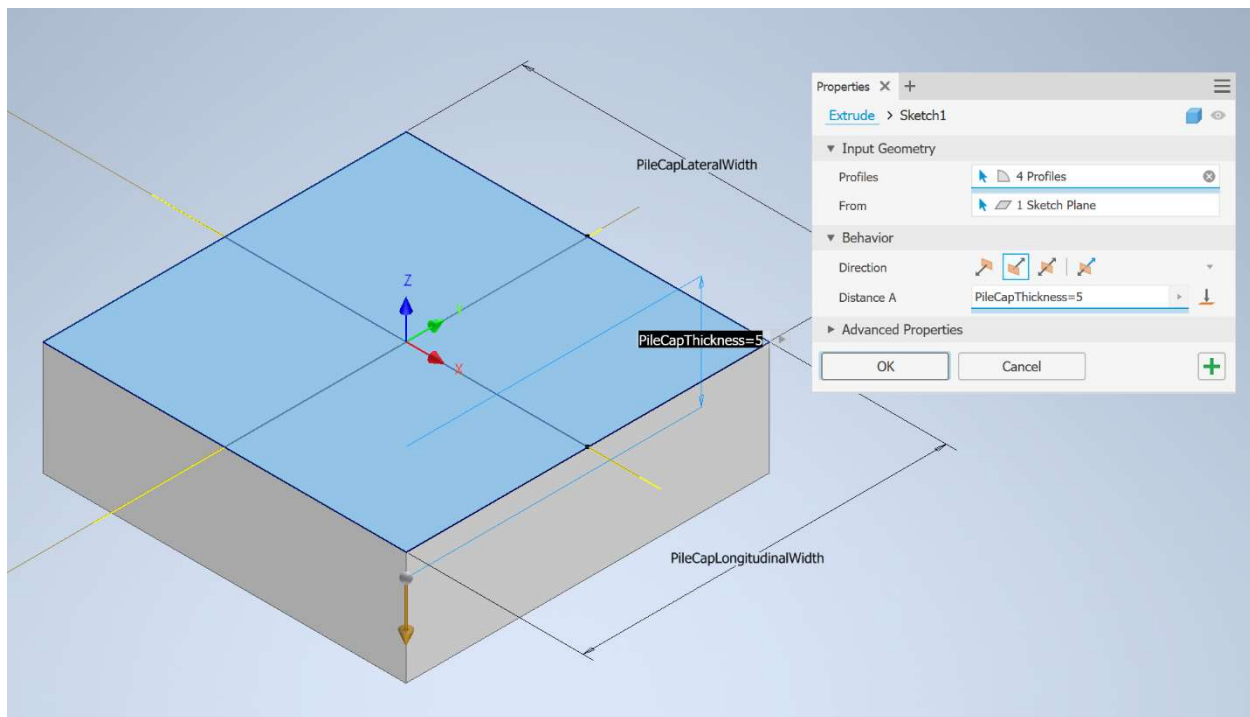


When sketching the geometry for the part, you generally want to use Parameters to define a value or equation. This is what enables you to “flex” or adjust the part size in InfraWorks. Also, most of the time, you want to make sure that your sketch is fully constrained. If a part is not fully constrained, the chances of the part having issues are greater.

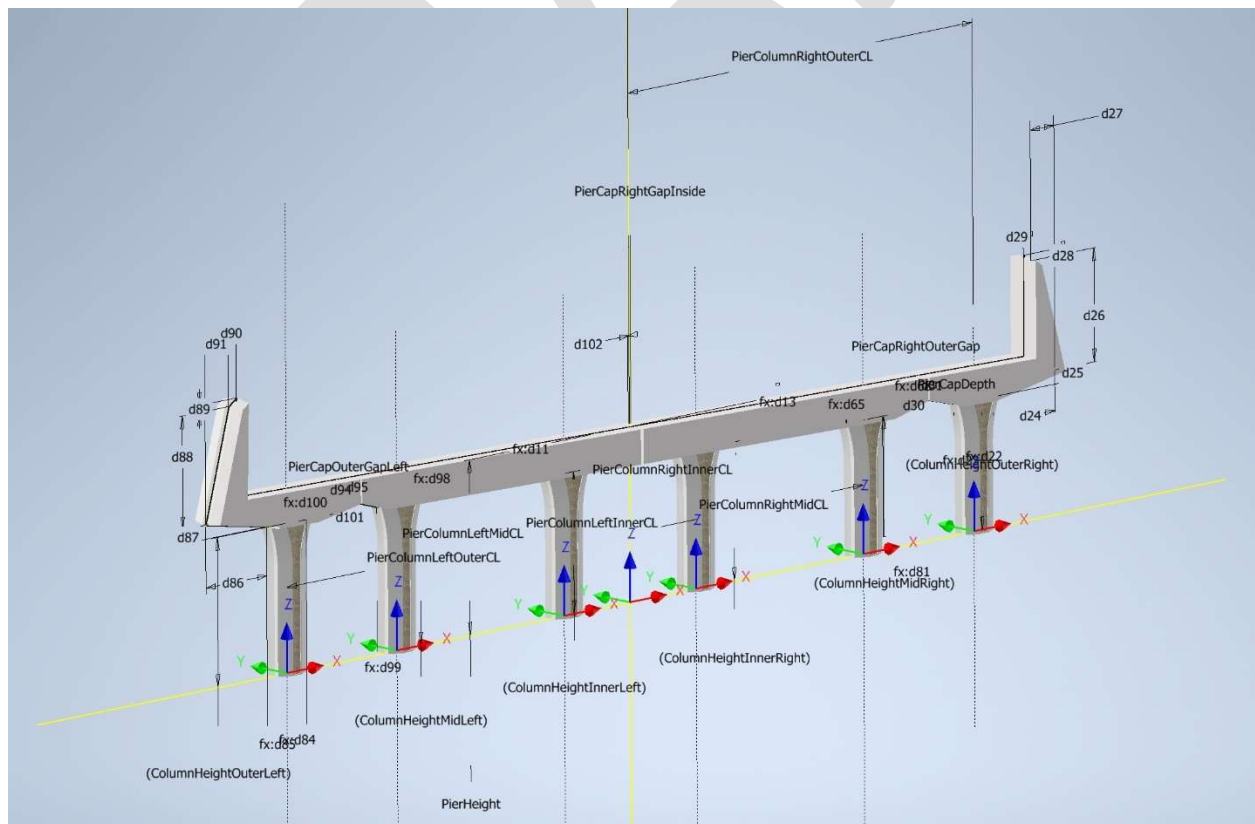


The sketch is used as a profile to create the 3D solids that you will bring into InfraWorks. Once it's complete, you can use tools like Extrude, Loft and Sweep to create the 3D solid.

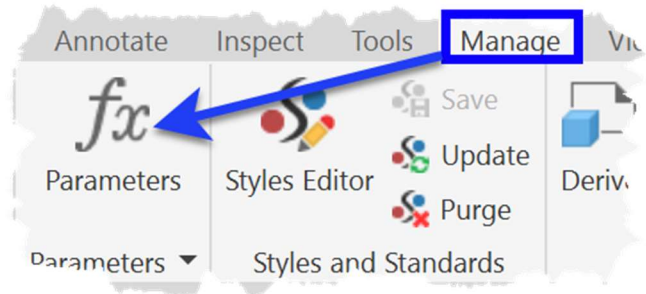
Extruding a sketch into a 3D solid:



A completed Pier, with columns and cap:



When you are finished with your part, the next step is to prepare it to be exported for use within InfraWorks. One critical step is to select the parameters that you want to be available in InfraWorks. To do this, you select the Parameters icon on the Manage tab of the ribbon



Once in the Parameters dialog, select the Key parameters that you want the ability to adjust in InfraWorks. Each parameter that is toggled will be available to be edited when the part is added to InfraWorks.

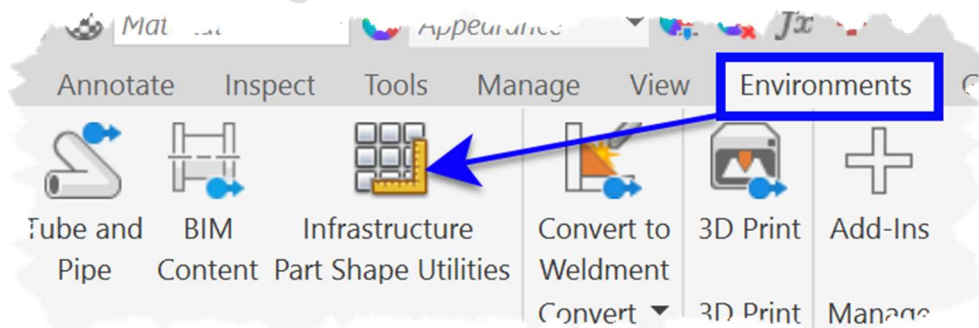
Parameters

Parameter Name	Consumption	Unit/Type	Equation	Nominal Value	Driving Rule	Tol.	Model Value	Key
Model Parameters								
User Parameters								
UCS1X		ft	12 in	1.000000		●	1.000000	<input type="checkbox"/>
UCS1Y		ft	12 in	1.000000		●	1.000000	<input type="checkbox"/>
UCS1Z		ft	12 in	1.000000		●	1.000000	<input type="checkbox"/>
PierColumnRightOuterCL							67.850000	<input checked="" type="checkbox"/>
PierCapTopRightSlopeInPer						●	2.000000	<input checked="" type="checkbox"/>
PierCapTopLeftSlopeInPer						●	-2.000000	<input checked="" type="checkbox"/>
PierCapTopRightSlope		deg	SlopeInPercentage / 100	1.145763		●	1.145763	<input checked="" type="checkbox"/>
PierCapTopLeftSlope		deg	atan(PierCapTopLeftSlopeInPercentage / 100)	-1.145763		●	-1.145763	<input checked="" type="checkbox"/>
PierCapRightGapInside		ft	0.25 ft	0.250000		●	0.250000	<input checked="" type="checkbox"/>
ColumnTopLer	dg	ft	7'-10"	7.833333		●	7.833333	<input checked="" type="checkbox"/>

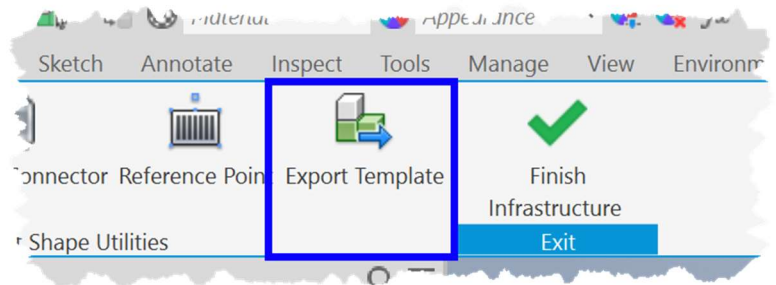
Select the parameters that you want the ability to adjust in InfraWorks

Next, on the Environments tab of the ribbon, select the **Infrastructure Parts Shape Utilities** tool.

Note: this is only available if you have installed the Inventor Infrastructure Modeler Plugin

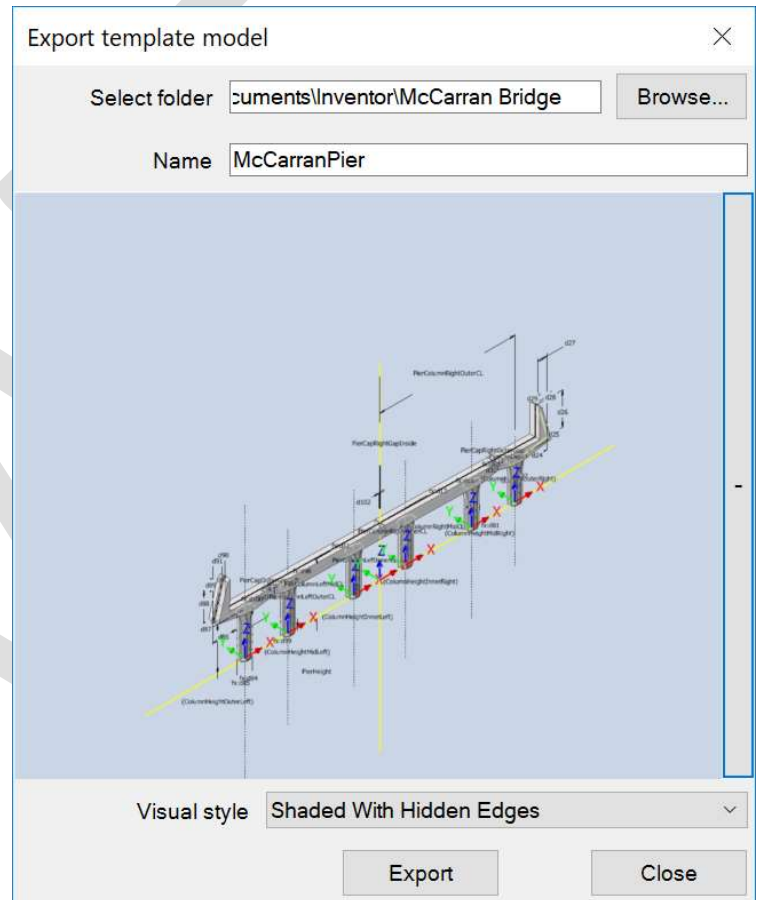


From the new ribbon, select Export Template



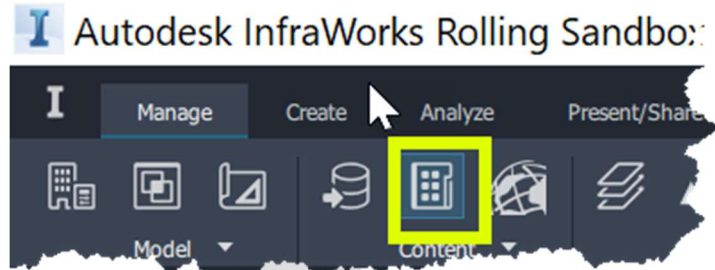
From the Export template model dialog, specify the name, and location where you want to export the part. Once exported, you are ready to import the part into InfraWorks.

When you export a part, the tool is creating the supporting files needed by InfraWorks to use the part. If you export to the same location as your original part, it will overwrite the original IPT in addition to the, IPT file, it will create an XML file and a couple of JPG files.



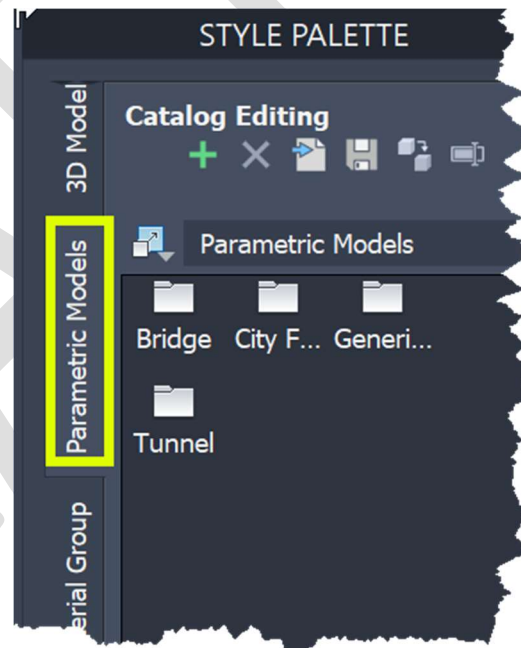
The steps to import an Inventor part to InfraWorks for bridge modeling are as follows:

1. Open the Style Palette

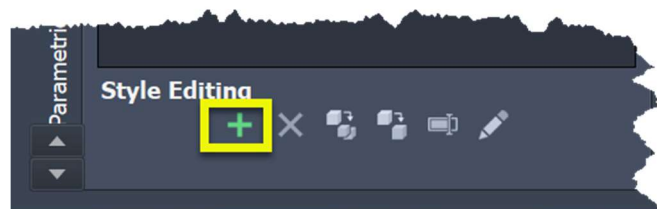


2. Switch to the Parametric Model tab and navigate to the Bridge folder

The Bridge folder is subdivided out into a few subfolders. Navigate to the folder for the part type that you are importing. In my case, I am importing a pier, so I have navigated to the Bridge > Pier folder.



3. At the bottom of the Style Palette dialog, select the Add New Style tool, designated by the "+"

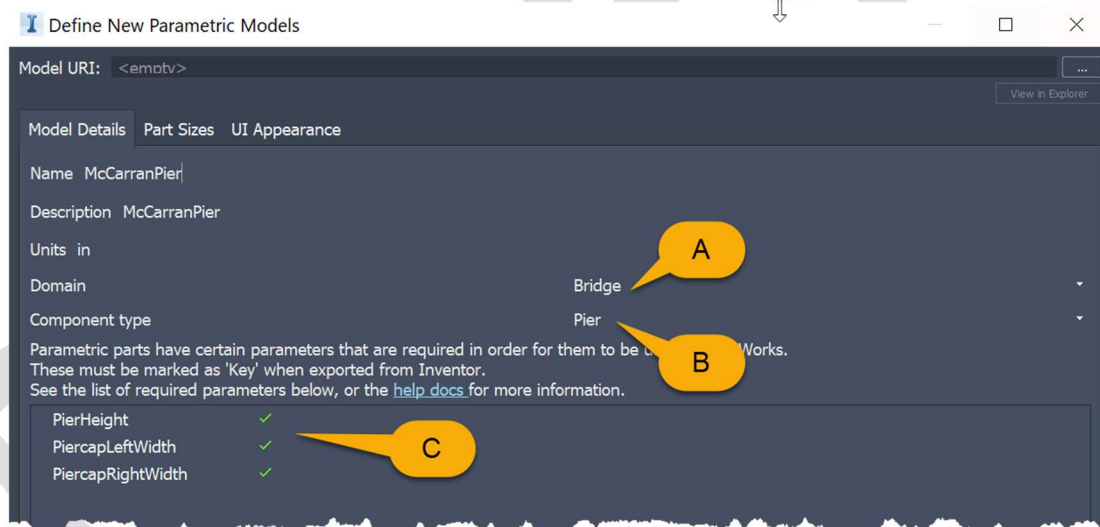


4. In the Define New Parametric Model dialog, select the “...” icon. Then navigate to the location of the Inventor part or assembly that you exported and select it, then select Open.

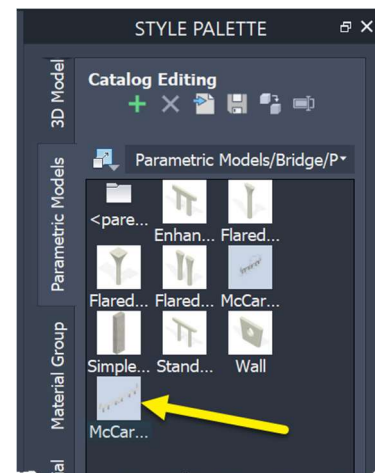


Next, you must configure the part properly;

- A. Select Bridge as the Domain
- B. Select the component type, in this case Pier
- C. Verify that the Inventor part has the expected Parameters. If the parameters are not set in the part, you will see a red “X”. This does not mean that the part will not work properly, it just means that InfraWorks will not control that parameter when used.



5. Once you select the part or assembly, select open. This will create the style and make it available for use.




6. Now that the part is available for use, assign it to your bridge by swapping out stock parts with the Inventor part.

The next step is to properly assign the parameters to your bridge. This includes, but is not limited to:

- Begin and end bridge locations
- Pier locations and skew
- Abutment locations and skew
- Girder type and size
- Deck dimensions
- Anything else needed

You can do that manually in InfraWorks by selecting the individual bridge components and revising the values in InfraWorks, or you can export to Excel to make bulk or mass edits.

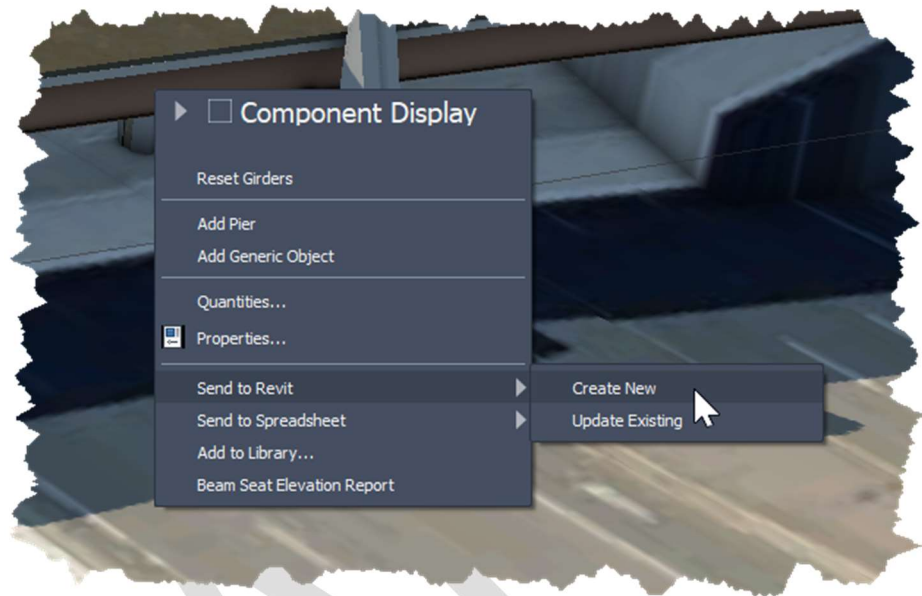
► ☐ Component Display

- Reset Girders
- Add Pier
- Add Generic Object
- Quantities...
-  Properties...
- Send to Revit
- Send to Spreadsheet
 - Open Existing
 - Create New
 - Update Existing
- Add to Library...
- Beam Seat Elevation Report

- Sample Spreadsheet exported from InfraWorks

[illegible]

Once you have finalized the bridge in InfraWorks, the next step is to send it to Revit. To accomplish this, select the bridge, right-click and select Send to Revit > Create New. This will prompt you to save an IMX file. Generally, it is a good idea to place this file in the same folder with your Revit model.



Revit

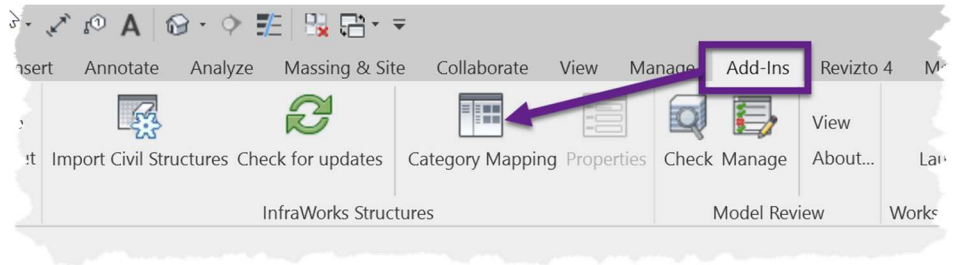
3

During our test, we wanted to see how far into the workflow we could get with Revit. Initially we were very pleased by the information that InfraWorks sends Revit but soon realized that Revit did not handle the InfraWorks data properly in all cases. When importing the bridge into Revit, Revit does not fully understand the parts since they do not come in as Revit families. During the import process, you do have the option to select a category for each part type. Doing this does extend what you can do with the parts but there are still limitations. I will explain these limitations in this section.

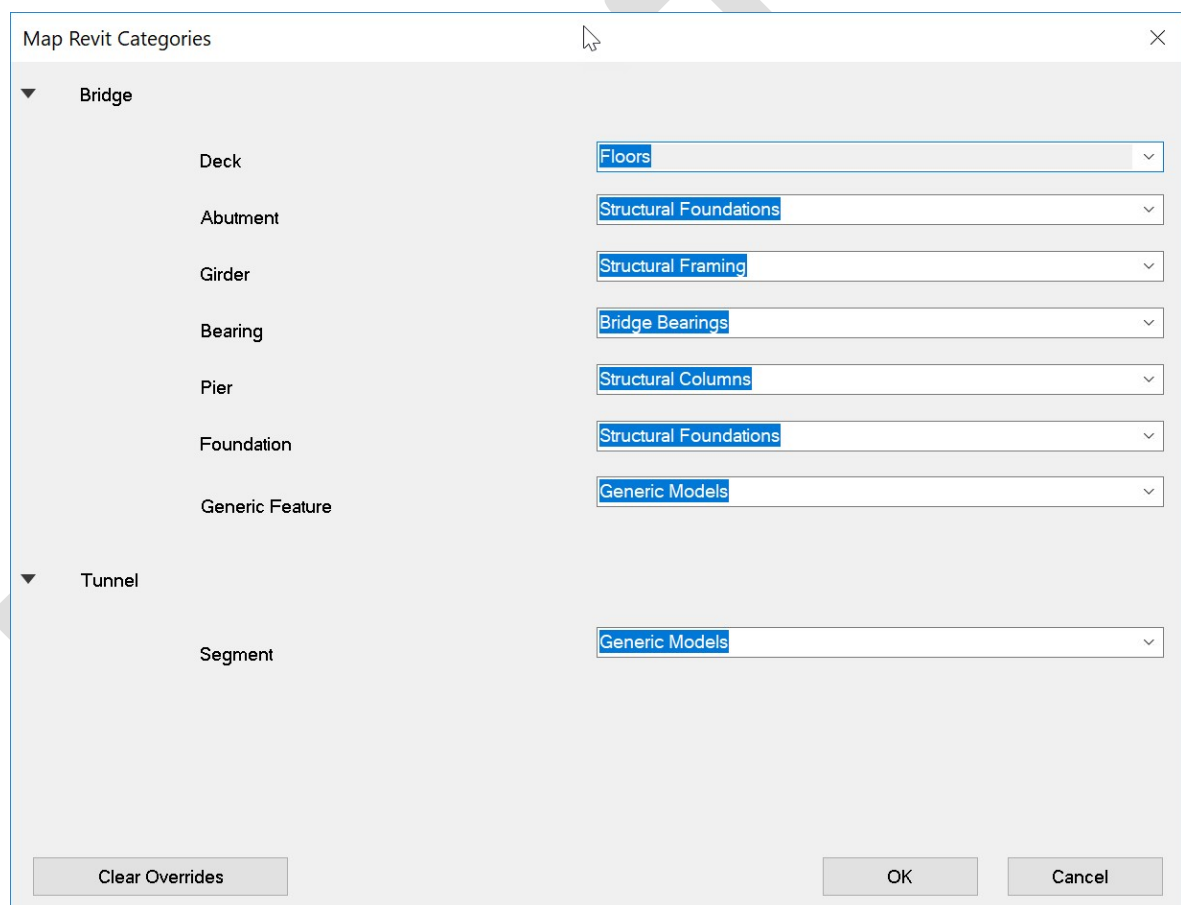
The steps to import the bridge into Revit are as follows:

1. Create a new Revit model from a Structural template (preferably your project/client specific template)

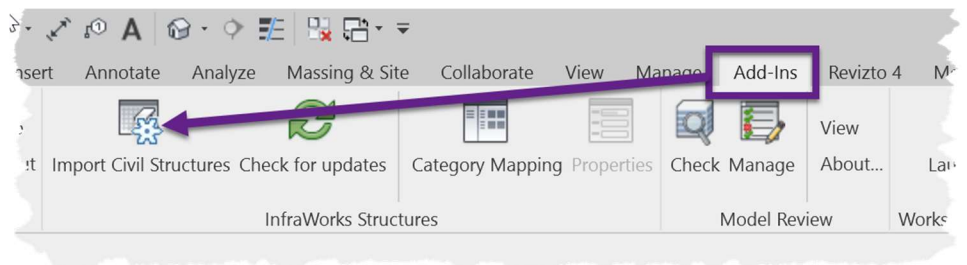
2. On the ribbon, select the Add-Ins tab and in the InfraWorks Structures panel, select Category Mapping.



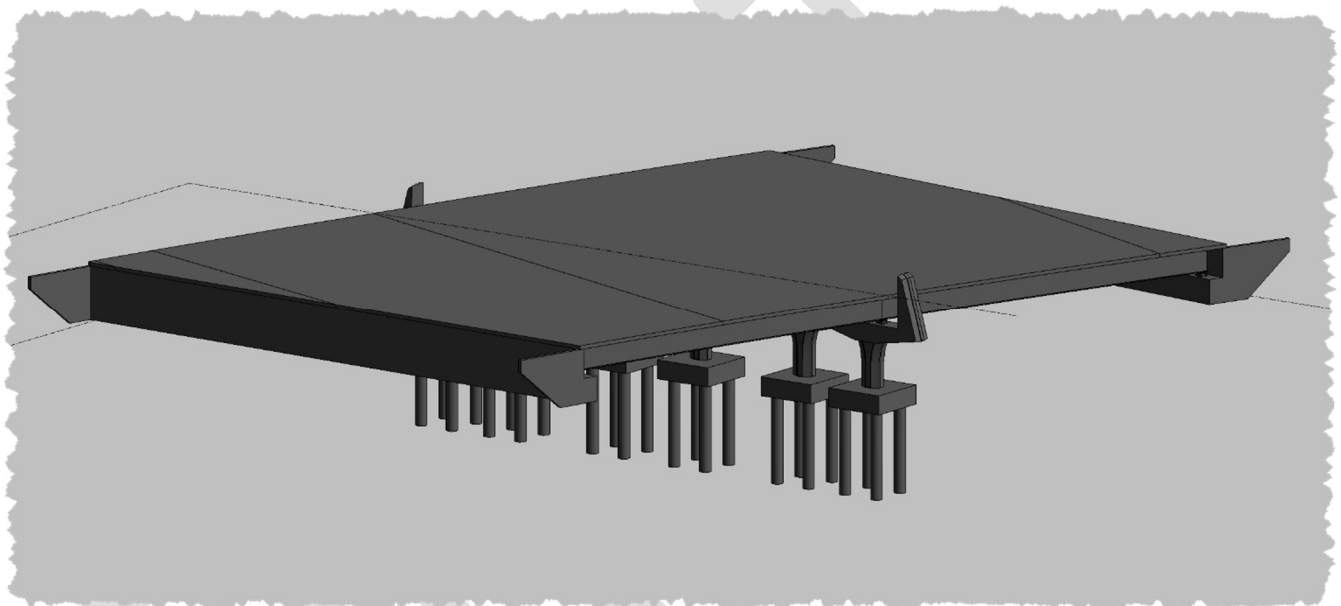
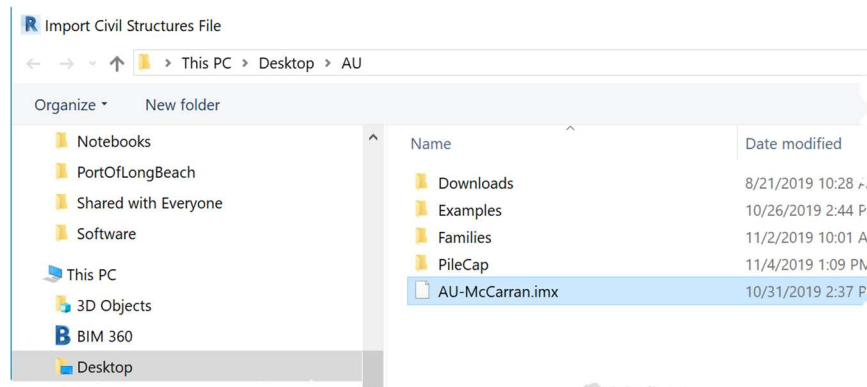
Doing this allows you to map the InfraWorks structure parts to Revit categories. The category that is mapped directly affects what you can do to the part after the import. An example is; not all Revit categories allow you to place rebar, so it is important to select a category which does allow for rebar if needed. The recommended category mapping is:



3. On the ribbon, select the Add-Ins tab and in the InfraWorks Structures panel, select Import Civil Structures.



4. Select the IMX file that was exported from InfraWorks. Doing this will import the bridge



As mentioned prior, there are limitations to what Revit can do with the parts that are imported from InfraWorks. Some of the current challenges are:

- While you can dimension some elements, others are more difficult. In the case where there are difficulties, I trace (and lock) the elements with Detail Lines.
- Most of the time, you can add rebar, but not as easily as if the parts were true Revit families
- Due to the parts not being true Revit families, it is more difficult to control the display of sub elements of the part.
- The ability to tag elements properly

These challenges are hopefully short lived. In the near (don't quote me on the time-frame) future, you will be able to import the InfraWorks model into Revit as true families. Once this happens, it will extend what can be done with Revit.

In the meantime, you can create sections, callouts, dimension, add rebar and schedule items. You just have to be a bit creative.

[illegible]

- InfraWorks led workflow is much more approachable to more staff
- Can be used very effectively in design pursuit and refined towards detailed design
- Inventor allows for the parametric modeling of very complex components
- For most users, an understanding of bridge layouts is all that is required to use the workflow and consume custom components
- Workflow focuses on coordination between the project's road design efforts, bridge design and construction drawings
- Supports effective iterative design with intelligent change management
- InfraWorks allows teams to tackle large projects with many bridges and not just one bridge in isolation
- Allows for easy visualization and real time modeling
- Will soon have fully integrated advanced structural analysis for bridge superstructures

Note – some of these are based upon future functionality being added to InfraWorks and Revit