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TR20425

Do You Cross the Bridge or Fade Away?

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ASCENT

Learning Objectives

- Learn how to create engineered roads of the proposed design.
- Learn how to add bridges to design roads using Bridge Design for InfraWorks 360
- Learn how to verify the structural strength of the bridge girders
- Learn how to incorporate design changes from AutoCAD Civil 3D

Description

This class will help you to explore preliminary bridge design options by using Bridge Design for InfraWorks 360 software to visualize realistic civil structures in the context of the surrounding proposed site. Then Structural Bridge Design software is used to analyze the bridge in the cloud. We run a line girder analysis to verify the structural strength of the bridge girders and ensure they meet design standard requirements. Next, we take the design into Navisworks software to uncover design problems and constructability issues more effectively and plan the construction sequencing. The Autodesk InfraWorks 360 model is taken into AutoCAD Civil 3D software for precise grading. Then we round-trip the model back into Autodesk InfraWorks 360 for better design communication. This session features Autodesk InfraWorks 360, AutoCAD Civil 3D, and Navisworks Manage.

Your AU Expert

Michelle Rasmussen has been using AutoCAD since release 9. Starting out in the Civil Engineering Unit of the U.S. Air Force, she has used Softdesk, Land Desktop, Civil 3D, and InfraWorks software on infrastructure projects for more than 20 years. She has worked for both consulting engineering firms and municipalities laying out subdivisions, designing roadways, and managing infrastructure projects. Her extensive experience also includes writing training guides and instructing users how to use the Autodesk Infrastructure software product line. As a Senior Instructional Designer at ASCENT, Michelle currently writes courseware for AutoCAD, AutoCAD Civil 3D, AutoCAD Map 3D, Autodesk Infrastructure Design Suite and Autodesk InfraWorks 360. The training guides she writes are used by Instructors, students, schools and ATC’s in over 67 countries.

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Learn how to create engineered roads of the proposed design.

The Autodesk Roadway Design for InfraWorks 360 module is a cloud-based add-on that enables you to add engineering parameters to road designs. The rule-based tool sets help you to quickly lay out a preliminary roadway design.

Road Types

Selecting the correct road type is a crucial part of setting the design parameters. There are multiple road types that are available in the Roadway Design for InfraWorks 360 Module; four of which automatically set the default design speed to be used for the roadway design.

Road Types Which Set the Design Speed

Icon	Road Type	Maximum Speed
	Highway Roads	70 mph or 110 km/h
	Arterial Roads	50 mph or 80 km/h
	Collector Roads	40 mph or 60 km/h
	Local Roads	30 mph or 45 km/h

If a road's design speed changes, you can change it during the creation process by typing the new speed in the Speed field that displays next to the cursor, as shown in Figure 1.

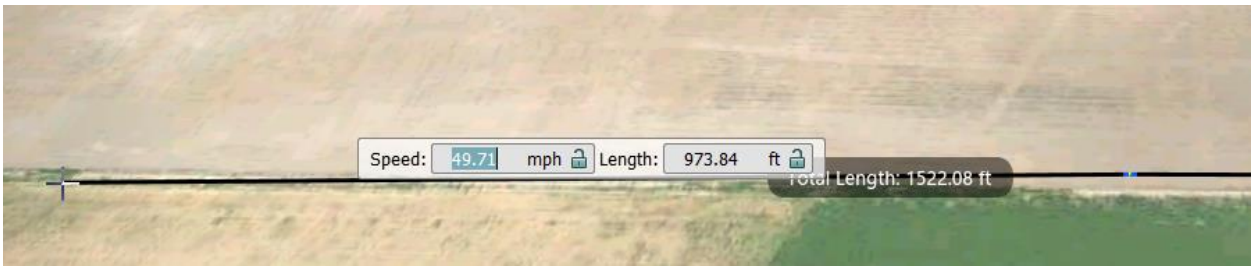


FIGURE 1

Horizontal Curves and Spirals

The design speed property of a roadway sets the minimum and maximum allowed curve radius and spiral lengths for a given point of intersection (PI) along a roadway. When you use the Highway Roads command, the default curve type is set to Spiral Curve Spiral. For all other design road commands (i.e., arterial, collector, or local), the default curve type is set to Curve. To change which curve type to use at a PI, right-click on the curve to display a fly-out menu, as shown in Figure 2. As you set the PI's, tangent lines (which project all of the way to the actual point of intersection) display in yellow, curves display in blue, and spirals display in orange, as shown in Figure 2.

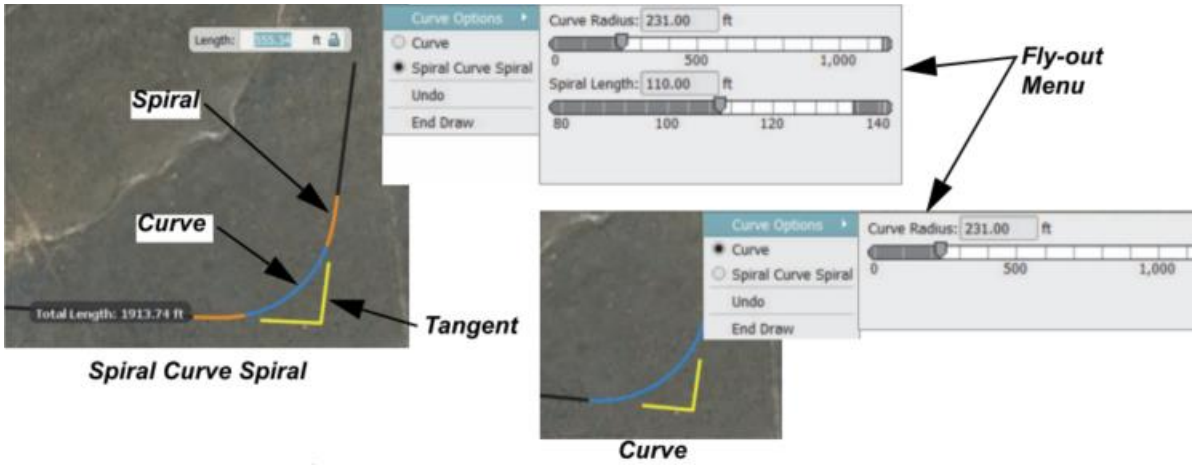


FIGURE 2

How To: Create Design Roads from Scratch

1. In the In Canvas Tools, expand  (Design, review and engineer roads) and click  (Design roadways).
2. Select one of the four road types from the expanded tool group, shown in Figure 3.

FIGURE 3

3. In the Select Draw Style asset card, select an appropriate road style according to the type of road being designed, as shown in Figure 4.

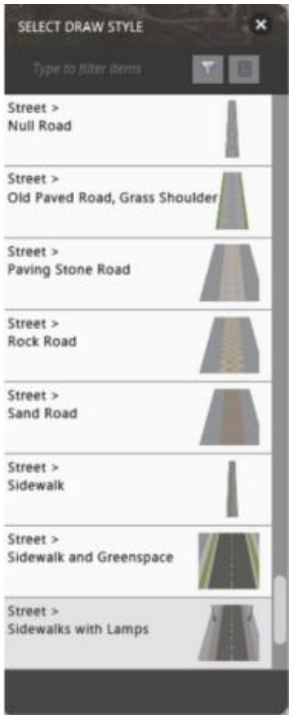


FIGURE 4

4. In the model, click to set the starting point of the new roadway.
5. In the model, move the cursor in the direction toward the next PI. Type a design speed and distance in their respective fields, and then press <Enter> to set the values.
6. Click to set the second PI when the angle looks correct.
7. In the model, move the cursor in the direction toward the next PI and then right-click to display the curve options.
8. Select Curve or Spiral Curve Spiral for the transition between tangents, according to the project requirements, as shown in Figure 5.

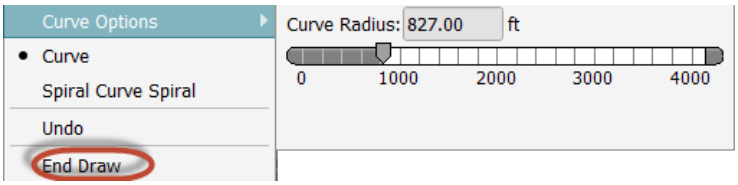


FIGURE 5

9. Use the slider to set the Curve or Spiral Curve Spiral parameters, or type the required values into the respective fields.
10. Type a design speed and distance in their respective fields and press <Enter> to set the values. Then click to set the next PI once the angle looks correct.
11. Repeat Steps 6 to 10 until all but the last horizontal PI' is set for the roadway design.
12. Double-click to set the last point or right-click and select **End Draw**, as shown in Figure 5.

Hint: Design Profile

I suggest adding the bridge and setting the clearance envelope before worrying about the vertical design of the road.

Objective 2: Add Bridges to Design Roads

Bridge Components

The Autodesk Bridge Design for InfraWorks 360 module enables you to add bridge structures to any design road. Bridges can be used where overpasses are required, where the road crosses a river or ravine, or where the road intersects a railway that you do not want interfering with traffic. Bridges are very complex structures that contain multiple sub-components. Figure 6 illustrates many of these components.

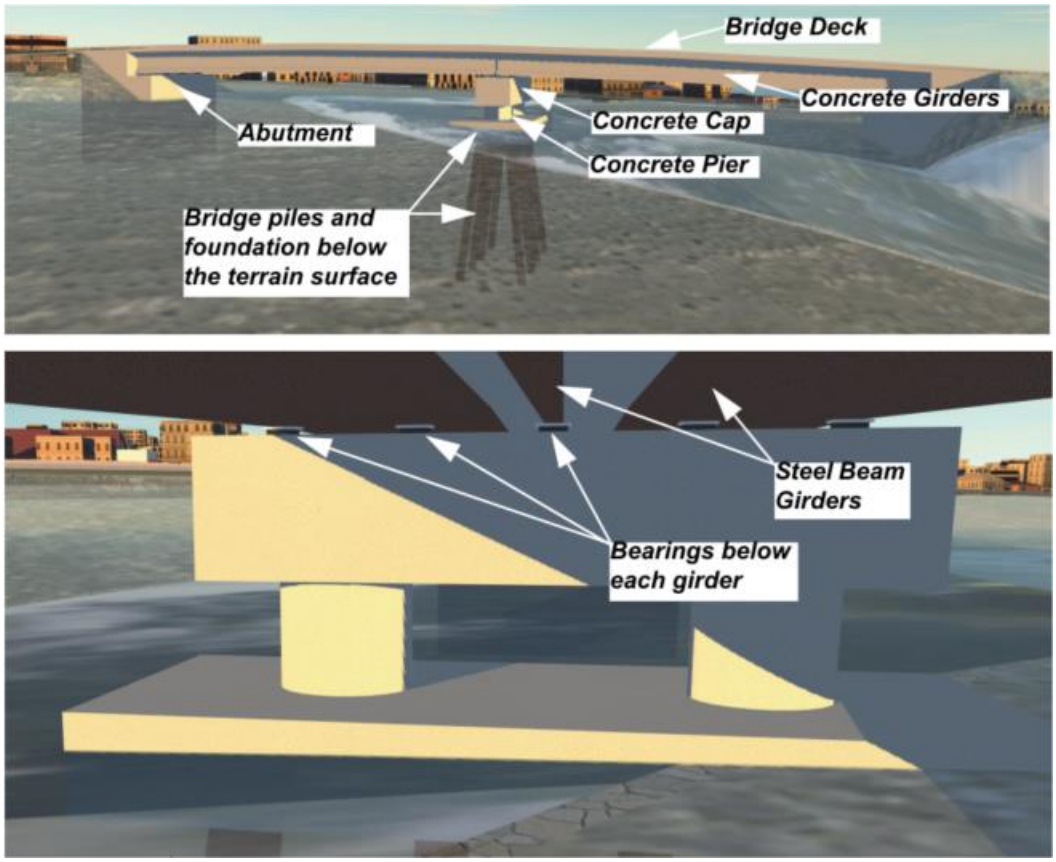


FIGURE 6

The most important component used to work with bridges is the bridge deck. The bridge deck is used to select the bridge in order to make changes to it. All other components are controlled using the bridge style, or specific component gizmos or stacks (asset cards). Before you can add a bridge to the model, you must have a design road.

Hint: Automatic Bridge Creation

If you have a license for the Bridge Design for InfraWorks 360 module, before you start creating design roadways, bridges are created automatically if the design road crosses a water feature.

How To: Add a Bridge to a Design Road

1. In the model, draw a design road.
2. In the In Canvas tools, click  (Design, review and engineer bridges)>  (Design bridges).
3. In the expanded tool group, click the  (Precast | Girder Bridge) or  (Steel Plate Girder Bridge) for the type of bridge you want to create.
4. In the model, click on the design road at the station where you want to start the bridge. Alternatively, you can type the starting station and press <Enter>.
5. In the model, click on the design road at the station where you want the bridge to end. Alternatively, you can press <Tab> and type the bridge length, or you can press <Tab> twice to type the ending station, then press <Enter>, as shown in Figure 7.

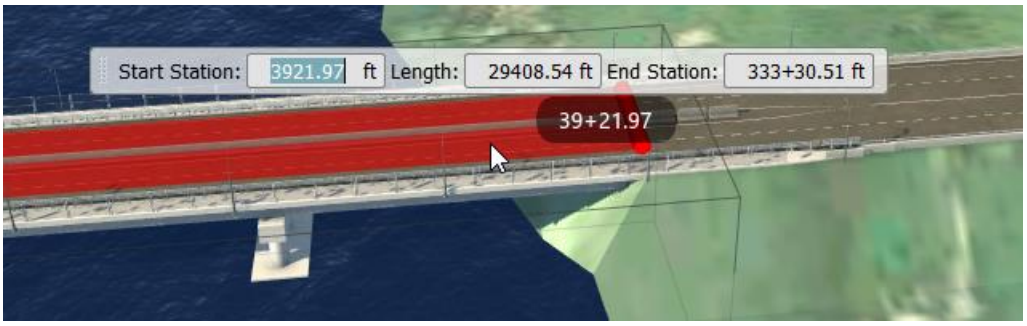


FIGURE 7

Modify Bridges

Once a bridge has been created, it can be modified using the Bridge asset card, gizmos, properties, and the Style palette.

Bridge Asset Card

The Bridge asset card enables you to change the type of bridge being modeled, the number of piers used to hold up the bridge, the clearance below the bridge, or Bearings and other attributes, as shown in Figure 8.

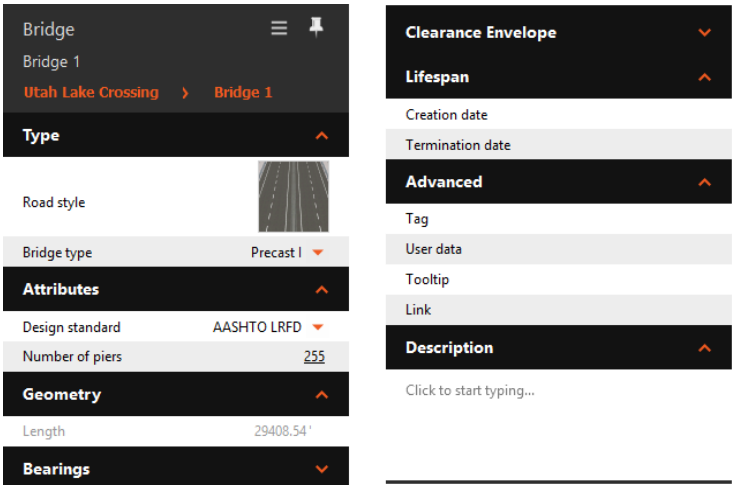


FIGURE 8

Bridge Clearance

To ensure that the bridge has the correct clearance for traffic below it, the clearance envelope can be displayed in the model. The clearance envelope is a purple box that indicates the clearance height required for the bridge. The Show clearance envelope option is found in the Bridge asset card, as shown in Figure 9.

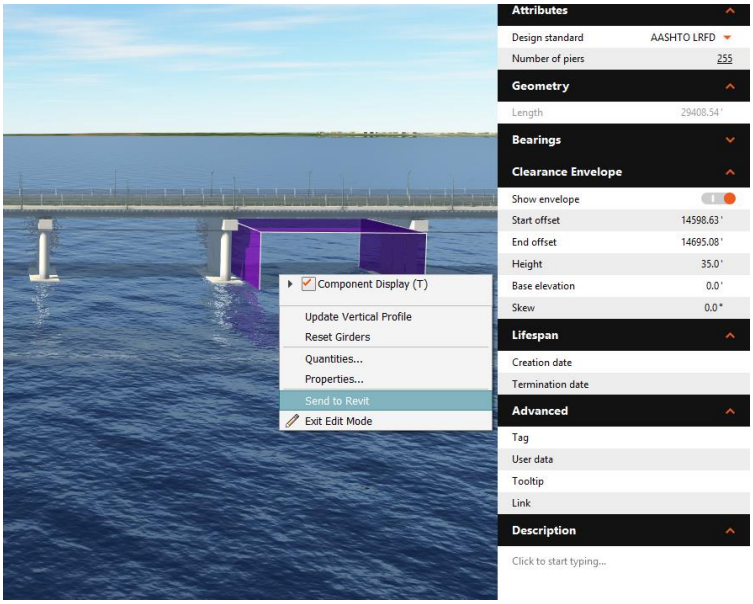


FIGURE 9

Once the Show clearance envelope option is turned on, all of the values in the Clearance area can be modified. Changing the Height value changes the height of the clearance envelope only. To change the height of the bridge, you must right-click on the bridge deck in the model and select Update Vertical Profile, as shown in Figure 9. This causes the profile of the road to adjust to accommodate the clearance envelope. After setting the bridge at the correct height according to the required clearance envelope, then you can design the profile for the rest of the road. For time's sake, we do not cover this in the class but you can check out my screencast which covers working with the design profile by going to: **http://autode.sk/2fjo1T1**

Bridge Gizmos

When the bridge deck is selected, gizmos display at the beginning and ending stations of the bridge. Selecting either gizmo enables you to change the station for that specific gizmo, as shown in Figure 10.

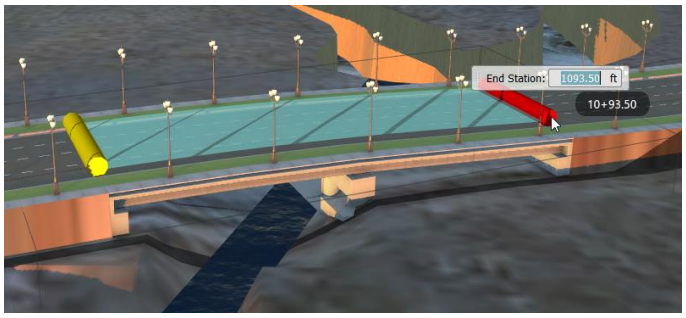


FIGURE 10

If both the beginning and ending stations require changing, the space between the two gizmos can be selected. This enables you to change both stations at the same time, as shown in Figure 11.

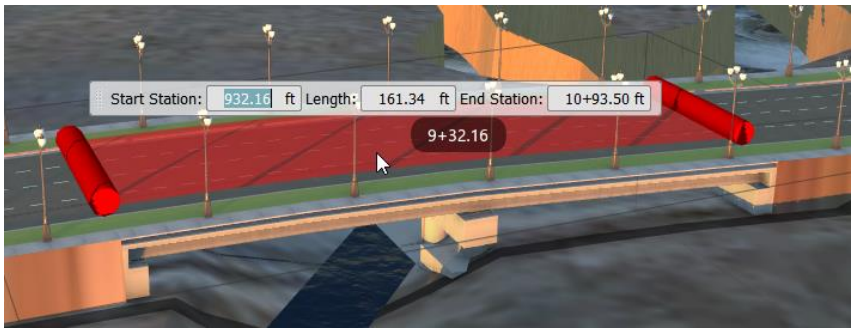


FIGURE 11

When the view is set closer to a plan view, selecting a pier causes a control gizmo to display. Clicking (Control Gizmo) for the pier enables you to change the location of the pier. Additionally, you can rotate each pier with the (Rotate Gizmo), as shown in Figure 12.

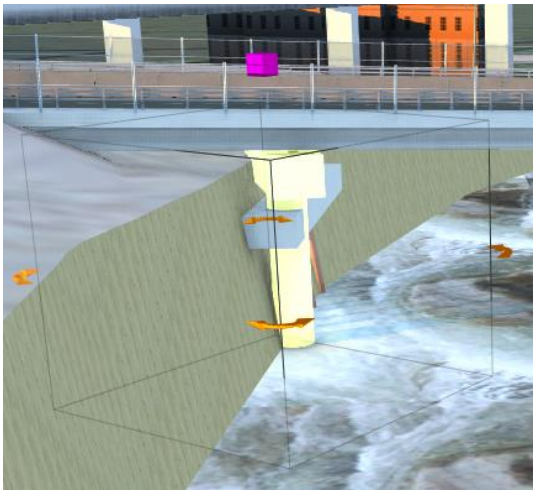


FIGURE 12

Bridge Properties

Each component of a bridge can be modified using the component's stack (asset card). Select the bridge component that needs to be modified to display its stack. Different properties are available depending upon which component of the bridge is selected in the model, as shown in Figure 13.

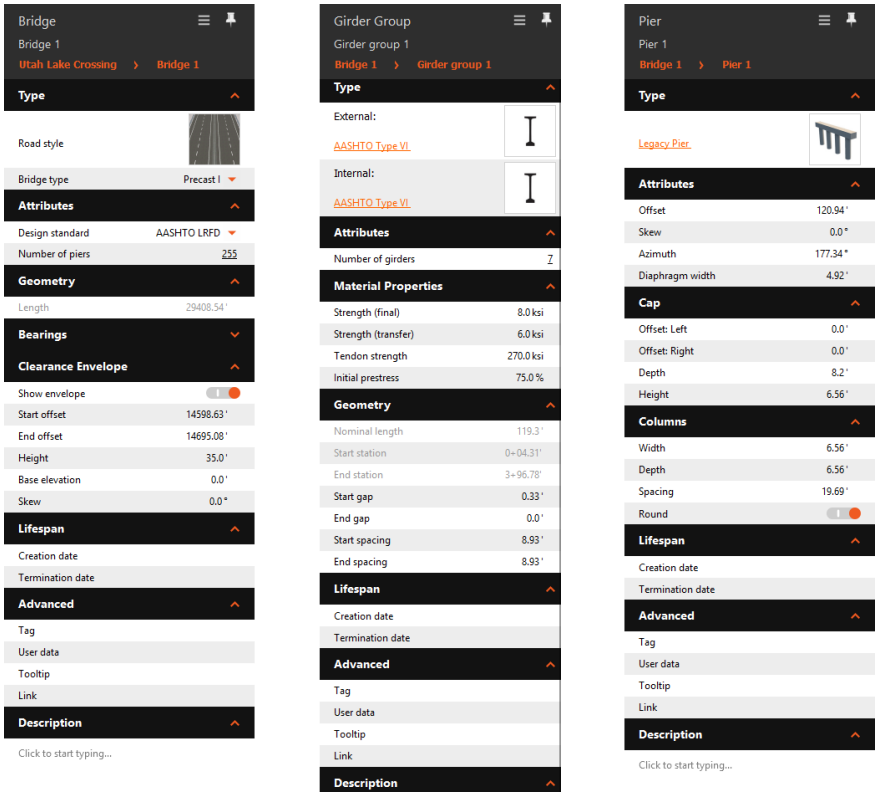


FIGURE 13

Style Palette

As with any other Autodesk InfraWorks 360 object, the style of a bridge can be modified by dragging a different style onto the object from the Style palette, as shown in Figure 14.

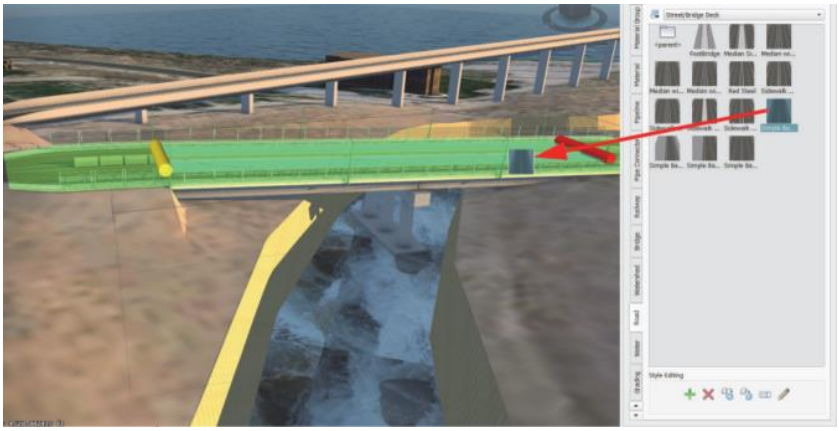


FIGURE 14

How To: Modify the Number of Bridge Piers Using the Bridge Asset Cards

1. In the model, select the design bridge deck. The Bridge asset card displays.
2. In the Bridge asset card, change Number of piers, as shown in Figure 15.

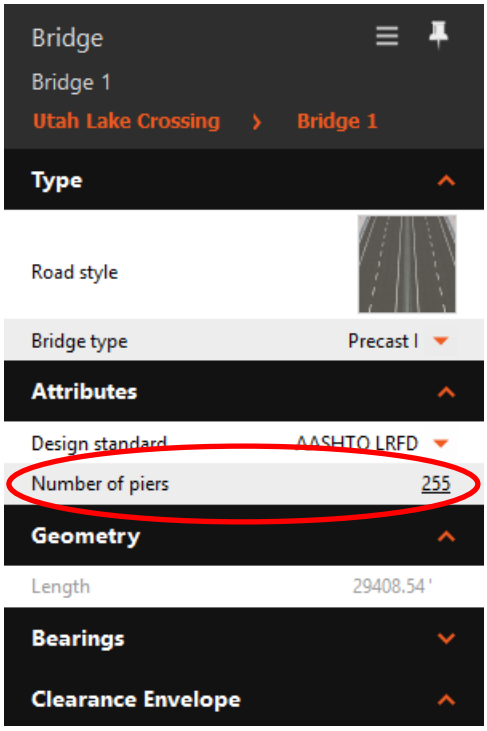


FIGURE 15

3. Press <Esc> to clear the bridge selection.

How To: Modify the Bridge Using Gizmos

1. In the model, select the design bridge deck, and then click on the bridge beginning or ending station gizmo.
2. Drag the bridge gizmo to a new location to change the length of the bridge. Alternatively, you can type a new station value for the beginning or ending station and press <Enter>, as shown in Figure 16.

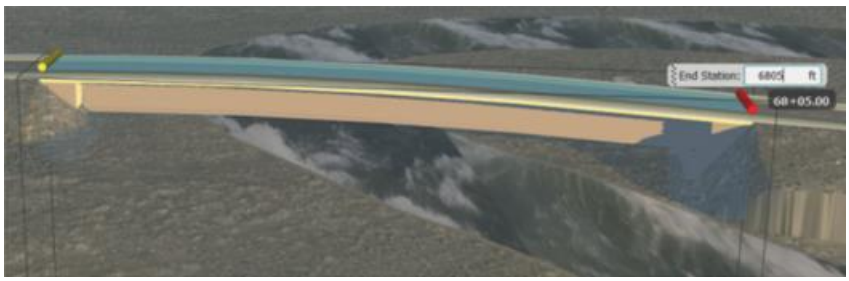


FIGURE 16

3. Press <Esc> to clear the bridge selection.

Objective 3: Verify the Structural Strength of the Bridge Girders

Girders

Girders can be edited individually or in groups (interior and exterior). Autodesk InfraWorks 360 contains multiple precast girder styles. You can assign different girder styles to each girder in a bridge, or assign styles to a group of girders. The Girder Group asset card and the Girder asset card are shown in Figure 17.

- Clicking on a bridge once selects the road and displays the Design Road asset card.
- Clicking on a bridge twice selects the bridge and displays the Bridge asset card.
- Clicking on a bridge a third time selects a bridge girder group and displays the Girder Group asset card.
- Clicking on a specific girder displays the Girder asset card.

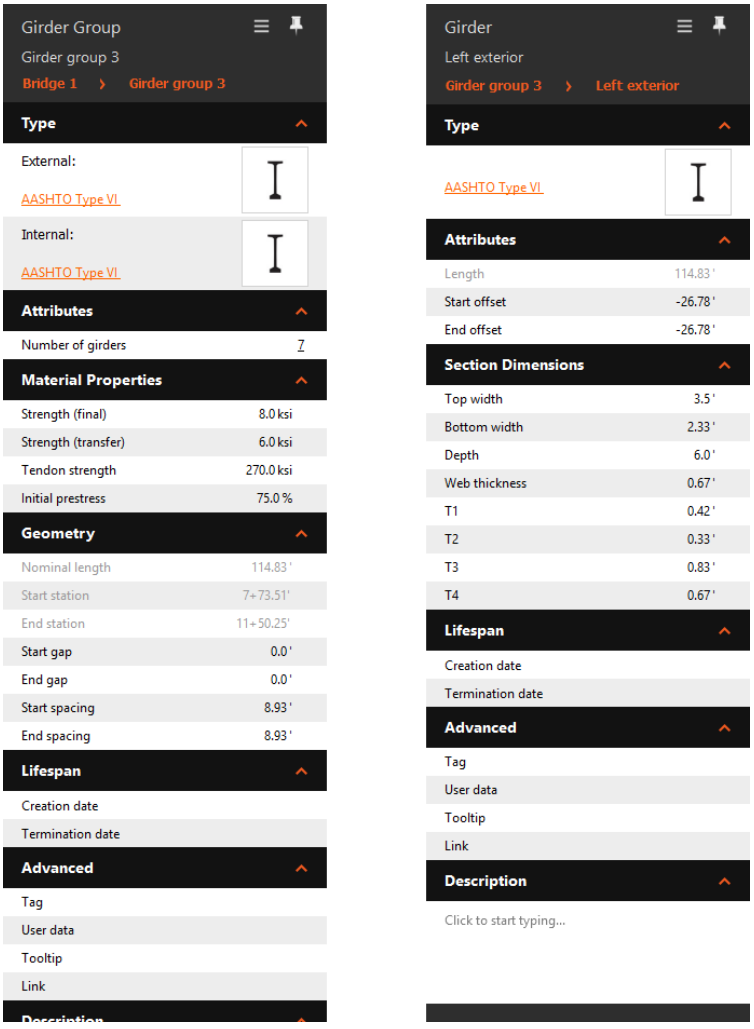


FIGURE 17

When the girder image is clicked inside the Girder asset card, a girder schematic displays, as shown in Figure 18.

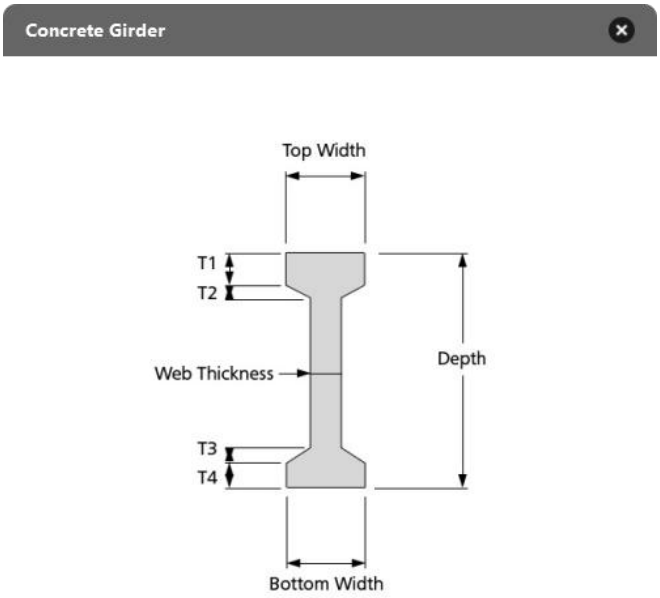


FIGURE 18

Girder Analysis

The structural strength of pre-stressed concrete bridge girders can be verified using the Autodesk InfraWorks 360 cloud service. Initial results can be viewed in the model. A full girder design document can be purchased using cloud credits. The design optimization is computed using the Autodesk Structural Bridge Design.

Project Information

Information provided during the analysis displays in the final *.PDF report. By completing as much information as possible, others reading the report can identify the project it belongs to and the company that created the report. The following information can be added to the report, as shown in Figure 19:

- Job name
- Job number
- Project name
- Company name
- Address
- Logo file
- User name
- User initials

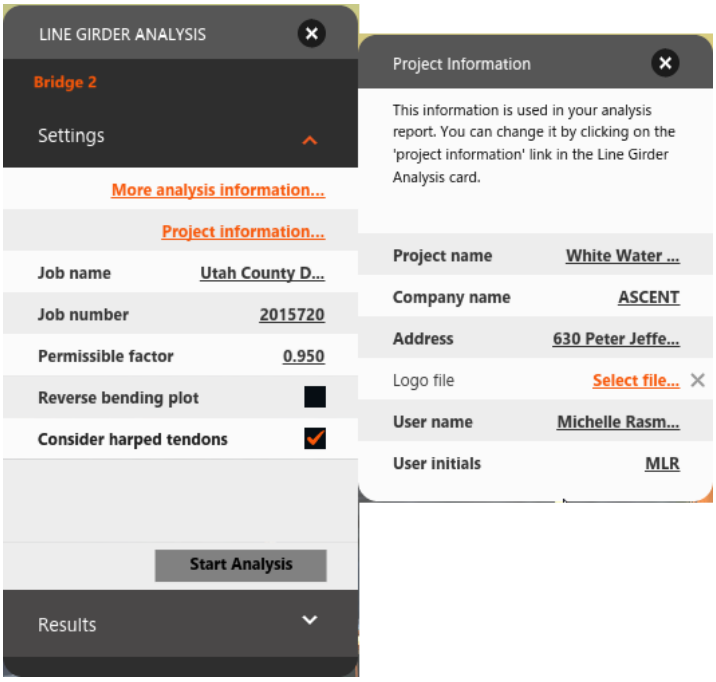


FIGURE 19

Once an analysis is complete, selecting any girder displays the results of the analysis in the Line Girder Analysis asset card, as shown in Figure 20. Clicking the flag at the bottom of the analysis causes the process log to open in Notepad. Hovering over the exclamation mark indicates problems that need to be addressed.

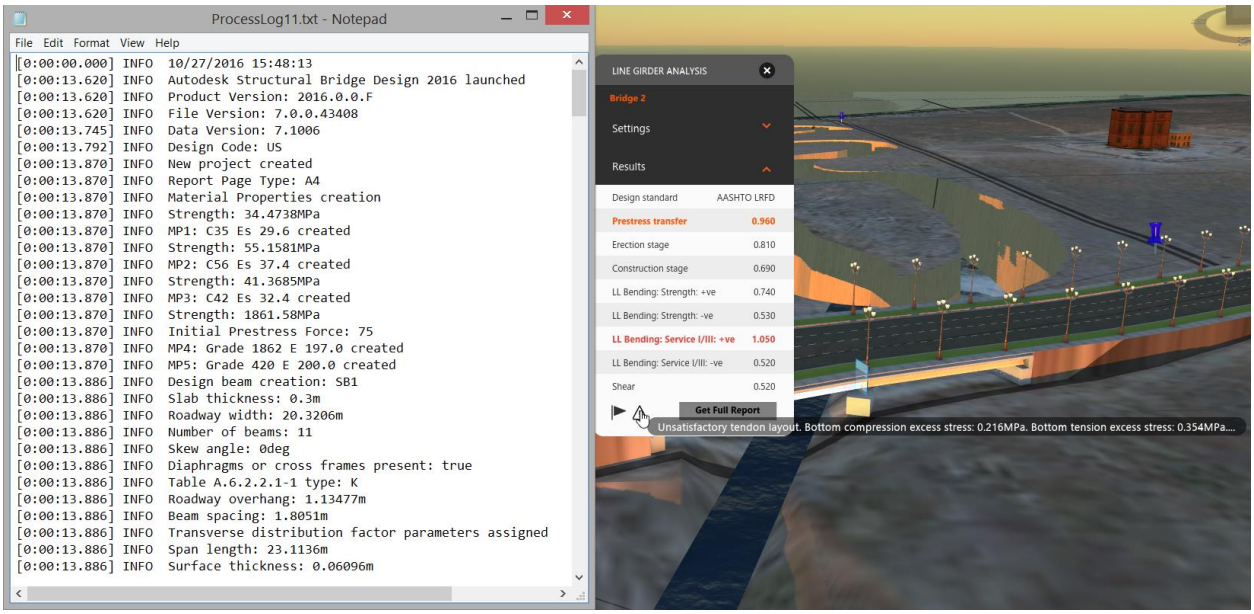
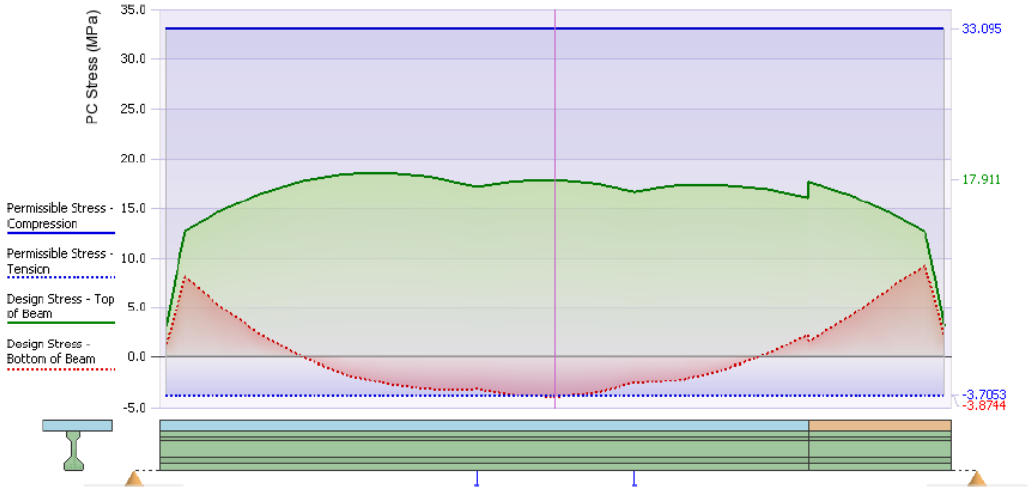


FIGURE 20

Additional analysis information can be viewed by clicking Get Full Report. A sample report is shown in Figure 21 as well as available in your class handouts.

Girder Design Calculations: Live Load Bending



Effects ignored within 0.2m from each beam end.

Performance ratio = -3.87 / -3.71 = 1.05

Section details:

Ref 1 "Section 1"
at 0.5 x span = 0.5 x 23.1136 = 11.5568 m from left end of beam

Design Code:

AASHTO LRFD Bridge Design Specifications
Sixth Edition with 2013 Interim Revisions

FIGURE 21

How To: Run a Bridge Line Girder Analysis

1. In the model, select the bridge you want to analyze.
2. In the in Canvas Tools, click (Design, review and engineer bridges) > (Perform analysis on your bridge design) > (Line Girder Analysis).
3. In the Line Girder Analysis asset card, enter the Job name and Job number.
4. In the Line Girder Analysis asset card, click **Project Information**.
5. In the Project Information asset card, enter all of the available project information. Close the card.
6. In the Line Girder Analysis asset card, enter a Permissible Factor. This factor is applied to the permissible values during the tendon design.
7. Check or clear **Reverse bending plot**.
8. This affects the graphic representations that are received in the detailed girder documentation (full report). It changes the direction of bending moments but not the direction of torsion moments.
9. Check or clear **Consider harped tendons**. This sets whether harping is considered in the tendon design.
10. Click **Start Analysis**.
11. Once complete, select a girder to view the results in the Line Girder Analysis asset card.
12. Click **Get Full Report** to view the full PDF report.

Objective 4: Incorporate Design Changes from AutoCAD Civil 3D

In most projects, multiple design professionals or departments work on different elements of the design. For the architectural elements, architects often use the Autodesk® Revit® structure software to model bridges, while civil engineers and surveyors work on the detailed design phase using the AutoCAD Civil 3D software. The Autodesk InfraWorks 360 software can communicate with other Autodesk software types, which enables you to take advantage of models created by other departments.

Exchange Data with AutoCAD Civil 3D Users

Autodesk InfraWorks 360 models can be opened in the AutoCAD Civil 3D software. Therefore, you do not have to recreate these design elements for the detailed design phase of the modeling process. Additionally, AutoCAD Civil 3D drawing files can be imported into an Autodesk InfraWorks 360 model to help communicate the final design to stakeholders by taking advantage of the high definition graphics inside Autodesk InfraWorks 360. When you add an AutoCAD Civil 3D DWG data source, the following AutoCAD Civil 3D data objects are imported:

- Corridors
- Surfaces
- Pipes
- Pipe Networks

  *This does not include pressure pipes at this time.

Import Line Work from AutoCAD Civil 3D Drawings

Although it is nice to be able to bring in AutoCAD Civil 3D objects into Autodesk InfraWorks 360 models, that is not all you need in order to communicate the design. You often need to show other line work from the drawings such as parking lot and road striping, vegetation, parcel lines, and more. That is why Autodesk also added the ability to import drawings as Overlays, as shown in Figure 22.

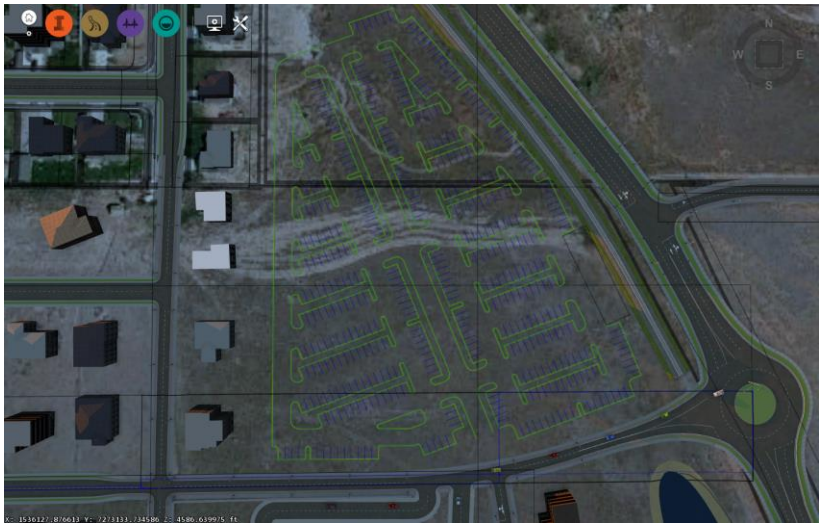


Figure 22

How To: Open an Autodesk InfraWorks 360 model in AutoCAD Civil 3D

For time's sake, we do not cover this in the class but you can check out my screencast which covers opening an Autodesk InfraWorks 360 model inside AutoCAD Civil 3D by going to: **http://autode.sk/2e1Pk23**

How To: Bring AutoCAD Civil 3D objects into Autodesk InfraWorks 360

1. Open the Autodesk InfraWorks 360 model you want the drawing added to.
2. Open windows explorer and locate the drawing file.
3. Drag the drawing file into the Autodesk InfraWorks 360 model and drop it in place, as shown in Figure 23.

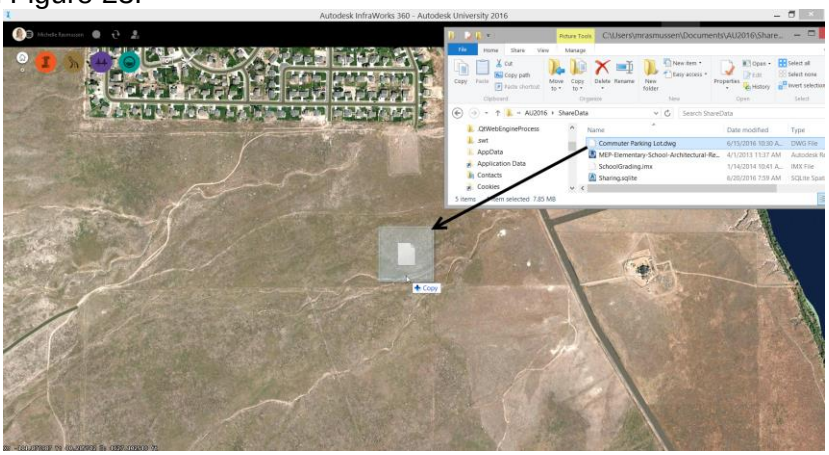


FIGURE 23

4. In the DWG File Import dialog box, select AutoCAD Civil 3D DWG to bring in the AEC objects, then remove the check from the option to "Do this for the next files", as shown in Figure 24. Click **OK**.

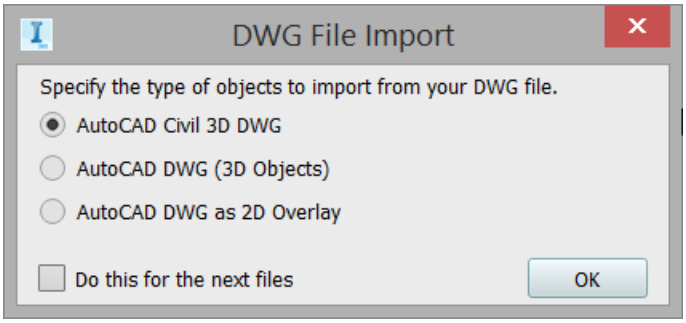


Figure 24

5. In the Data Sources Configuration dialog box, click on the *Geo Location* tab and verify that the Coordinate System field has the correct zone, then click **Close & Refresh**.
6. In the Data Sources palette, a list of all the AutoCAD Civil 3D objects imported should appear and be highlighted. You can click (Refresh) (as shown on the left in Figure 25) to have all of the items appear in the model using their default settings.
7. Double-click on any one of the imported data sources to configure it independent of the others. Different options appear for the various types of AutoCAD Civil 3D objects. For example, if you double-click on the imported roads, the *Civil3D Dwg* tab will list all the alignments from the AutoCAD Civil 3D drawing file. This allows you to select just the ones you need, as shown on the right in Figure 25.

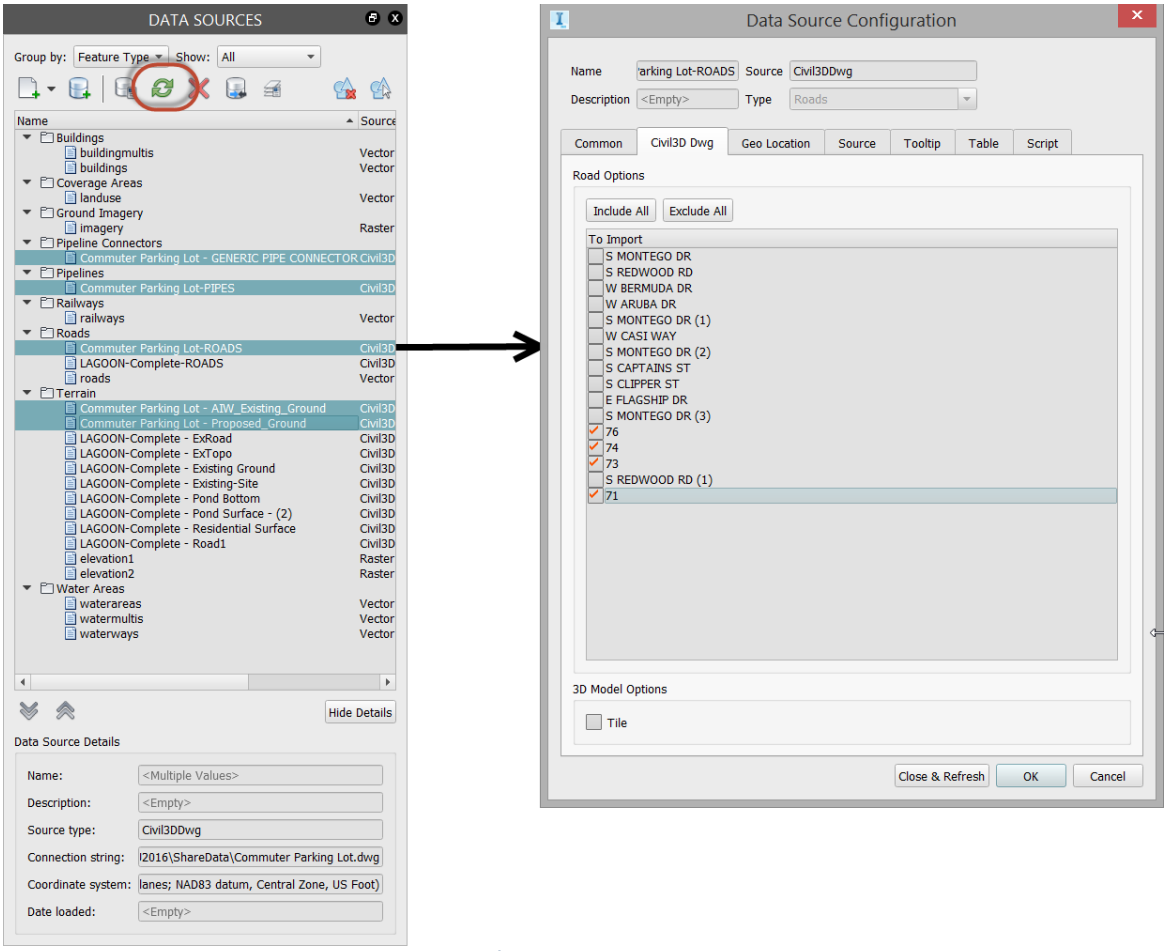


Figure 25

8. After making all the necessary changes in the Data Source Configuration dialog box, click **Close & Refresh**.

How To: Bring AutoCAD Civil 3D drawing line work into Autodesk InfraWorks 360

1. Open the Autodesk InfraWorks 360 model you want the drawing added to.
2. Open windows explorer and locate the drawing file.
3. Drag the drawing file into the Autodesk InfraWorks 360 model and drop it in place.
4. In the DWG File Import dialog box, select AutoCAD DWG as 2D Overlay, then remove the check from the option to “Do this for the next files”, as shown in Figure 26. Click **OK**.

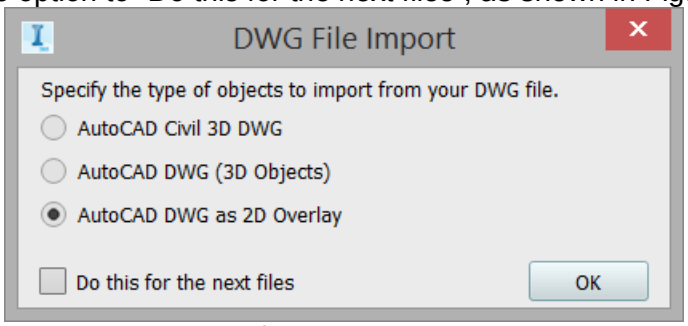


Figure 26

5. In the Data Import dialog box, click **Send**.

6. In the Data Sources palette, double-click the drawing file under Terrain Overlays to configure it.
7. In the Data Configuration dialog box, either select the Coordinate System or click **Interactive Placing** to manually place the drawing file where you want in the model, as shown in Figure 27.

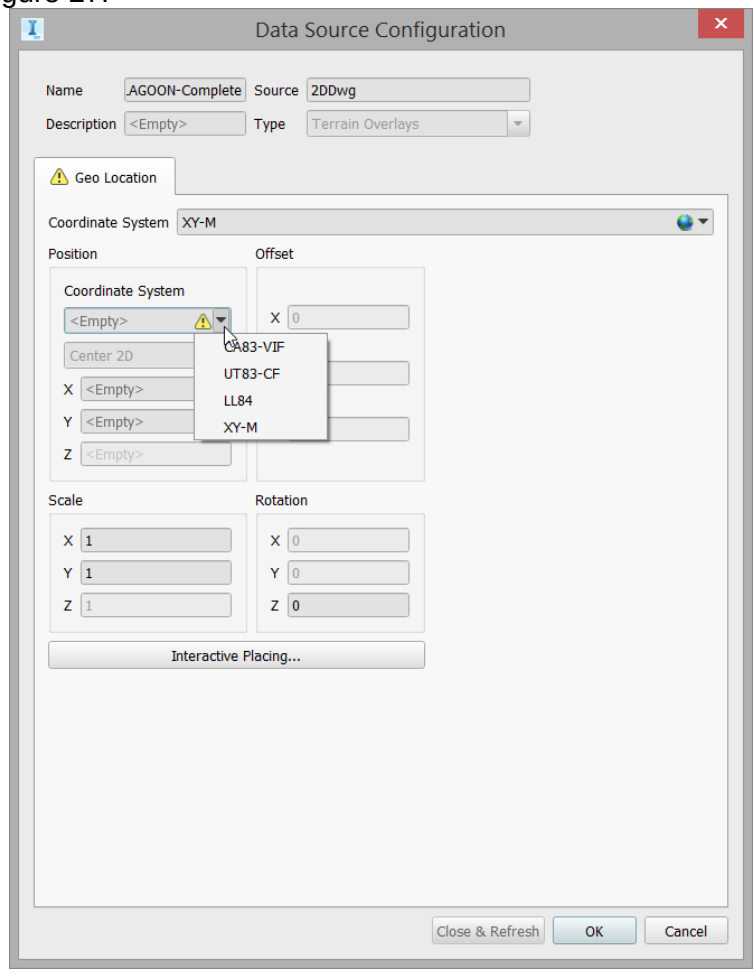


Figure 27

Bonus Material

Take the Bridge into Revit

Bridges created inside Autodesk InfraWorks 360 include a lot of detail. Unfortunately, when you take the design into AutoCAD Civil 3D, that detail is lost as the bridge is turned into AutoCAD 3D solids. In order to maintain the detail and take the bridge to the next step in the design process, it is better to take the design into Revit. When you do so, the following happens:

- The bridge opens up in Revit with predefined views and levels.
- Revit automatically names the file the same as the bridge name in the Autodesk InfraWorks 360 model (so make sure you give it a meaningful name).
- The northing and easting from the Autodesk InfraWorks 360 model is added to the Revit model as a Project Base Point for georeferencing the Revit model.
- Bridge components are converted to Inventor models, then Revit elements are created from these parts.

- Bridge girders are converted to Revit Structural Framing Families and Analytical Beams. (All other components are converted to generic models).

  Hint: Revit link does not exist

  Once the bridge is taken into Revit software, there is no link to connect it to the bridge inside the Autodesk InfraWorks 360 model. Therefore, if the bridge inside Autodesk InfraWorks 360 changes, it is necessary to send the bridge into Revit once again. When you do so, the new Revit file overwrites the original Revit file causing all your work on the bridge inside Revit to be lost. That is why it is recommended to save the Revit file something other than the name of the bridge from the Autodesk InfraWorks 360 software.

How To: Open a Bridge model in Revit software

1. Open the Autodesk InfraWorks 360 model containing the bridge.
2. Click on the bridge slowly twice to select the bridge deck (remember the first time selects the design road).
3. Right-click on the bridge and select **Send to Revit**, as shown in Figure 28.

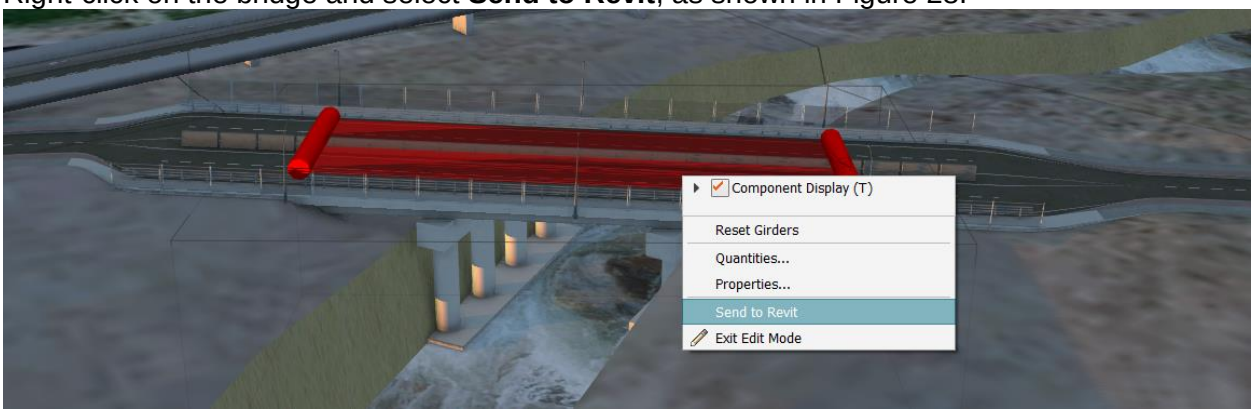


Figure 28

The bridge opens automatically in the Revit software once the conversion is complete. In Revit, do the following.

1. Add rebar to the Structural Framing.
2. Review the many levels created and remove any that do not reference anything.
3. Assign additional levels where needed such as the bridge deck or footings.
4. Save the model as a new name to avoid overwriting your work.

Take the Design into Navisworks

The design can be taken directly into the Navisworks software to uncover design problems and constructability issues more effectively and plan the construction sequencing. There are two options when porting your Autodesk InfraWorks 360 model to Navisworks software.

- First, take it into AutoCAD Civil 3D.
- Export a 3D Model which you can append to the Navisworks file.

If a 3D model is used to take the design into Navisworks, you can export it as a single file or multiple files. The benefit of using multiple files is that you can select which features in the model to export.

How To: Export the Autodesk InfraWorks 360 Model to Navisworks

1. In the In Canvas Tools, click  (Settings and Utilities)> (Export 3D Model).

2. In the Export to 3D Model File dialog box, do the following, as shown in Figure 29:
   - Define the area to export.
   - Set the Target Coordinate System
   - Determine if you want one file or many.
   - Click Export.

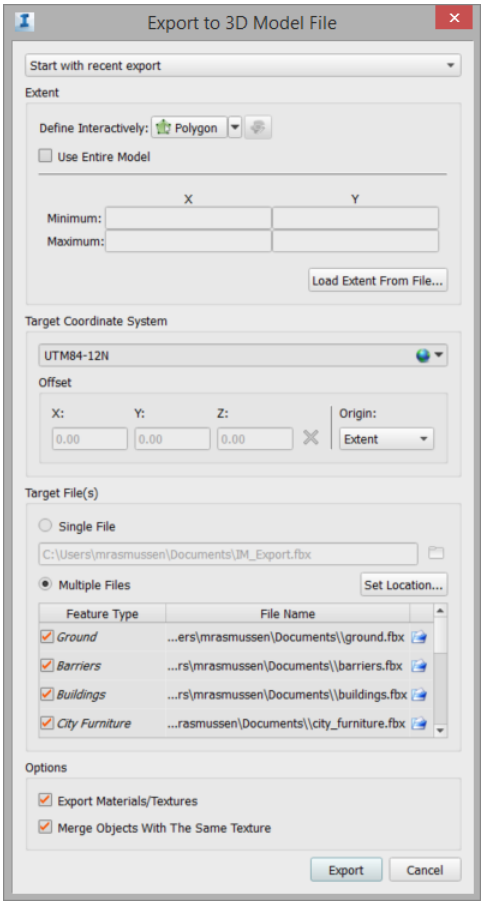


FIGURE 29