CI11133

Do You Cross the Bridge or Fade Away?

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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 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 InfraWorks software model is taken into AutoCAD Civil 3D software for precise grading. Then we round trip the model back into InfraWorks for better design communication.

Your AU Experts

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 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. The training guides she writes are used by Instructors, students, schools and ATC's in over 67 countries.

Objective 1: 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

The Design speed is the maximum speed that the road is designed for and should not be confused with the legally permitted travel speed. The default design speed for a roadway depends on the type of road being designed. A full list of the available options is shown in the table below.

Icon	Road Type	Maximum Design Speed
	Highway Roads	70 mph
	Arterial Roads	50 mph
	Collector Roads	40 mph
	Local Roads	30 mph

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.
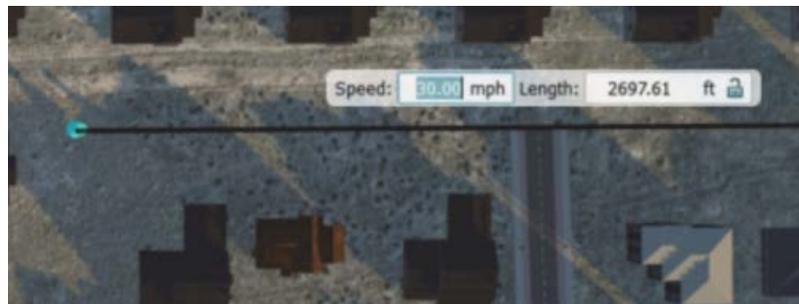

Figure 1

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.
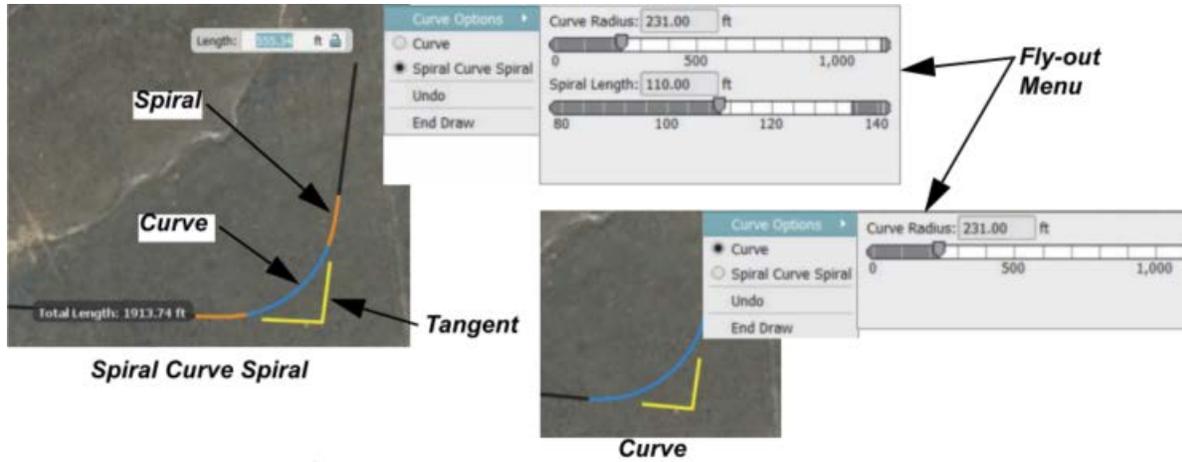

Figure 2

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.
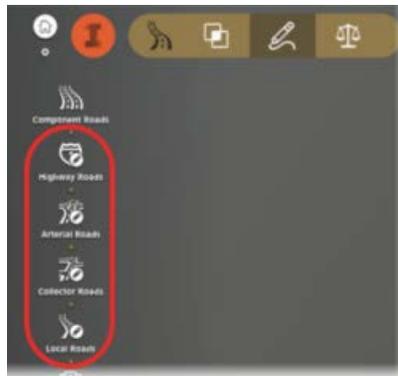

Figure 3

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.
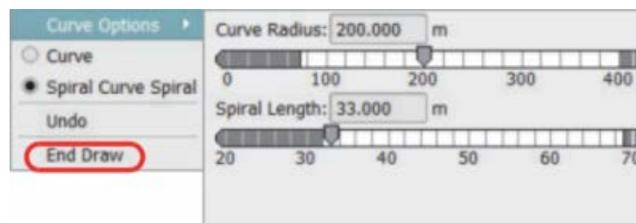

Figure 5

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.

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.
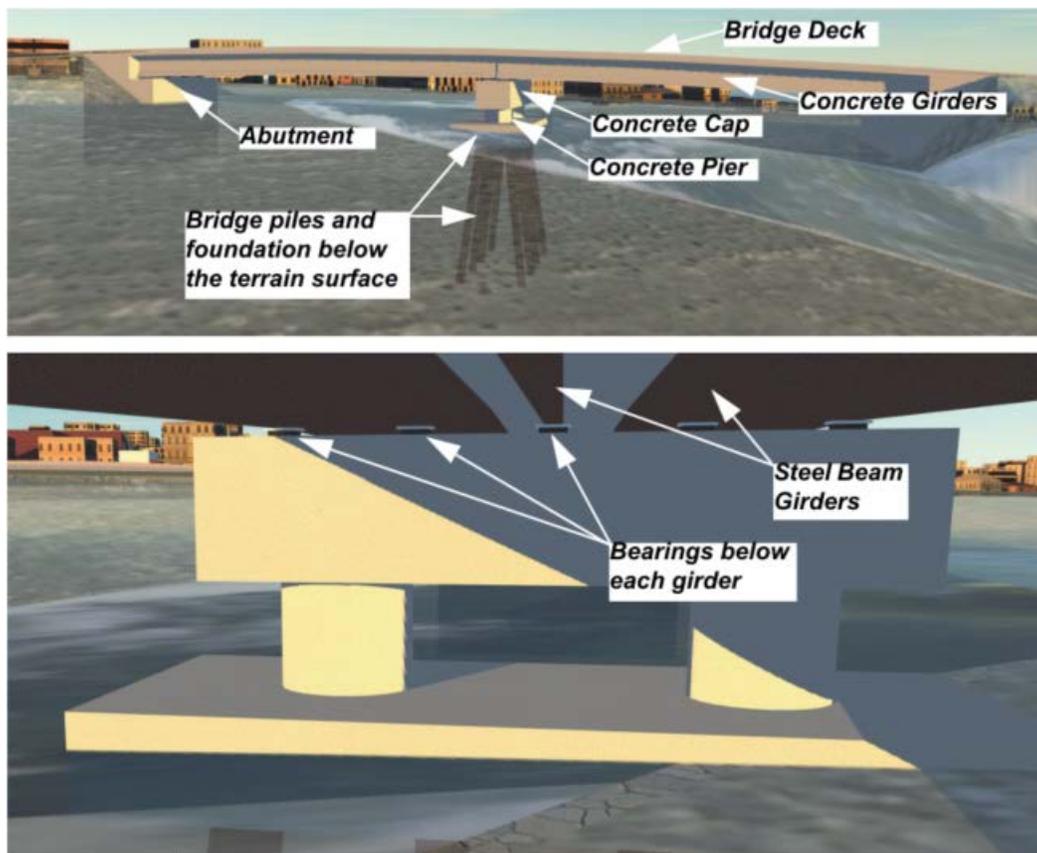

Figure 6

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. Before you can add a bridge to the model, you must have a design road.

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 the deck attributes, as shown in Figure 8.
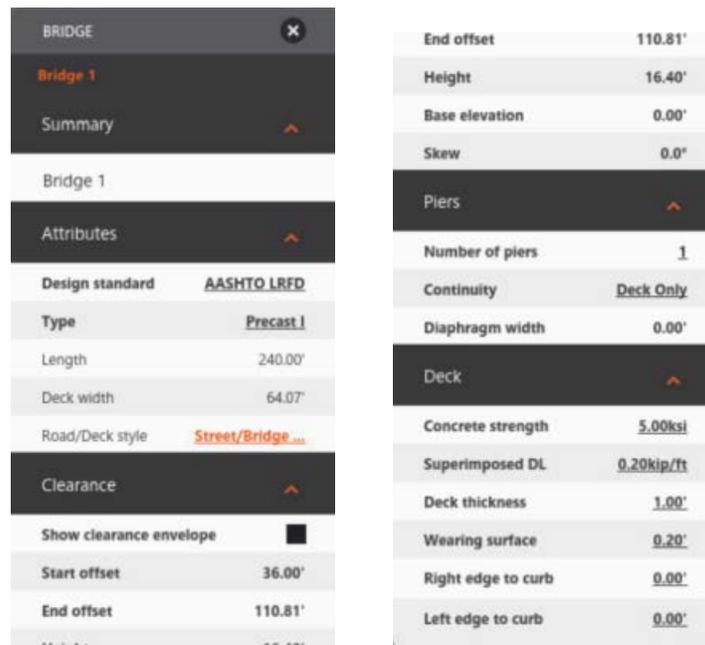

Figure 8

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 10. This causes the profile of the road to adjust to accommodate the clearance envelope.
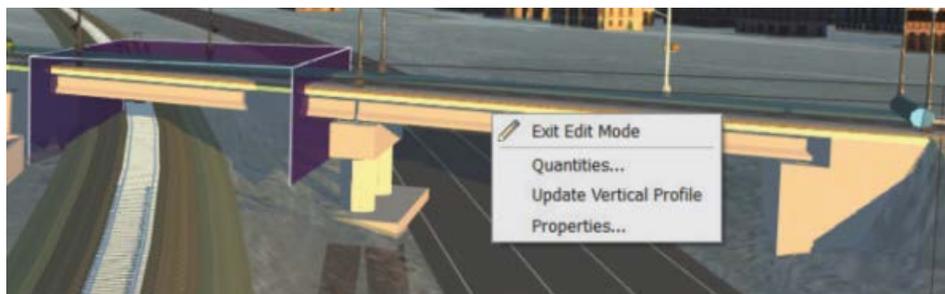

Figure 10

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 11.
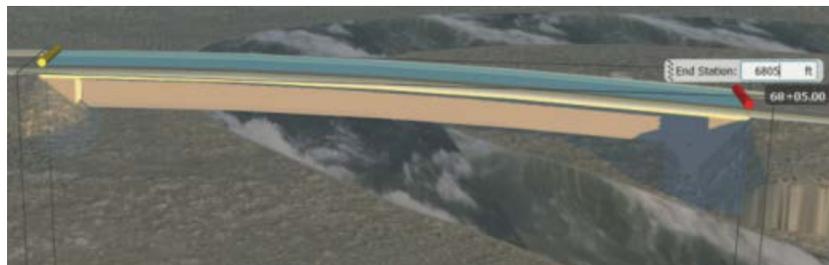

Figure 11

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 12.

Figure 12

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 13.

Figure 13

Bridge Properties

Each component of a bridge can be modified using the Properties panel. Right-click on the bridge component that needs to be modified and select Properties. Different properties are available depending upon which component of the bridge is selected in the model, as shown in Figure 14. The bridge style cannot be changed in the Properties panel.

Figure 14

Style Palette

As with any other Autodesk InfraWorks 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 15.
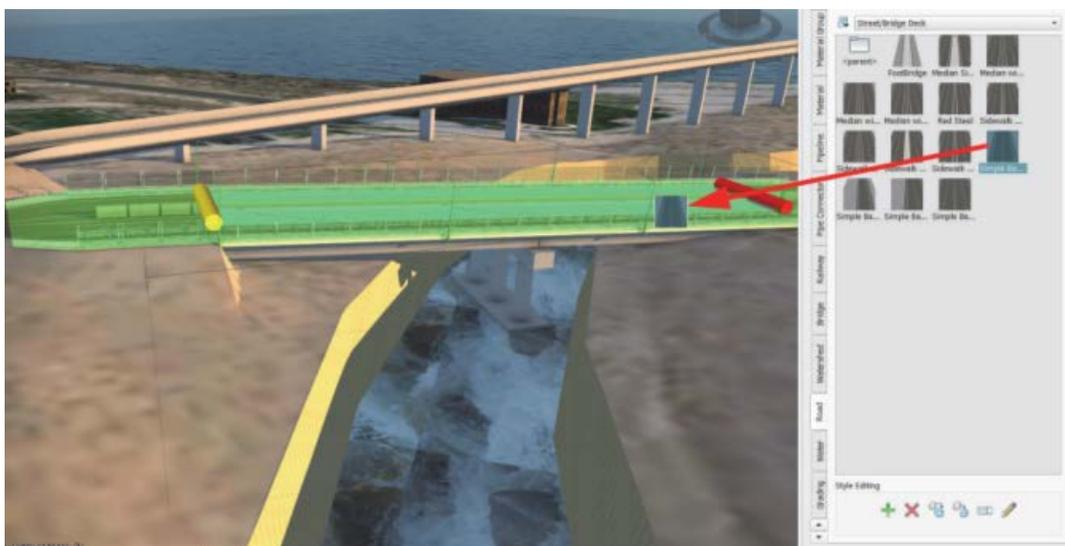

Figure 15

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.
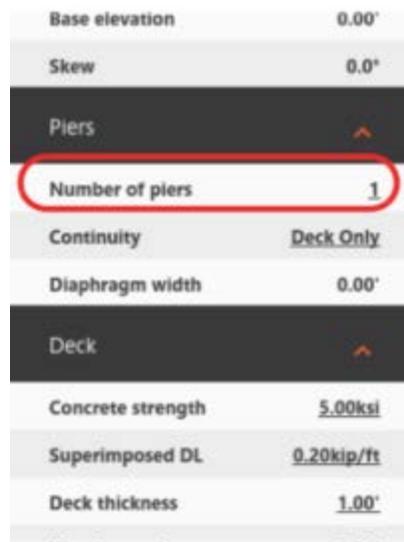2. In the Bridge asset card, change Number of piers, as shown in Figure 16.

Figure 16

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 17.
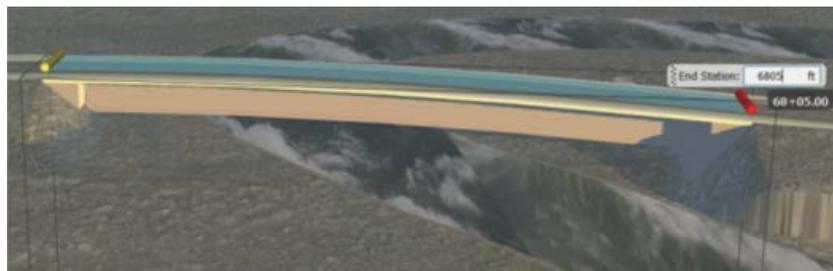

Figure 17

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 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 18.

- 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.
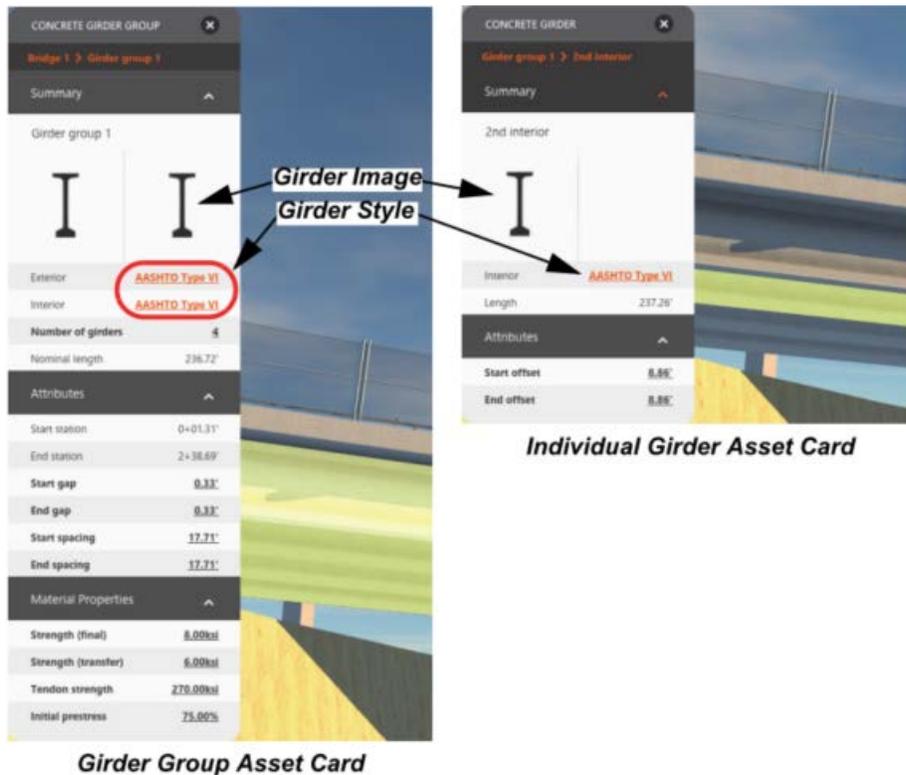

Figure 18

When the girder image is clicked inside the Girder asset card, a girder schematic and the Properties palette display, as shown in Figure 19.
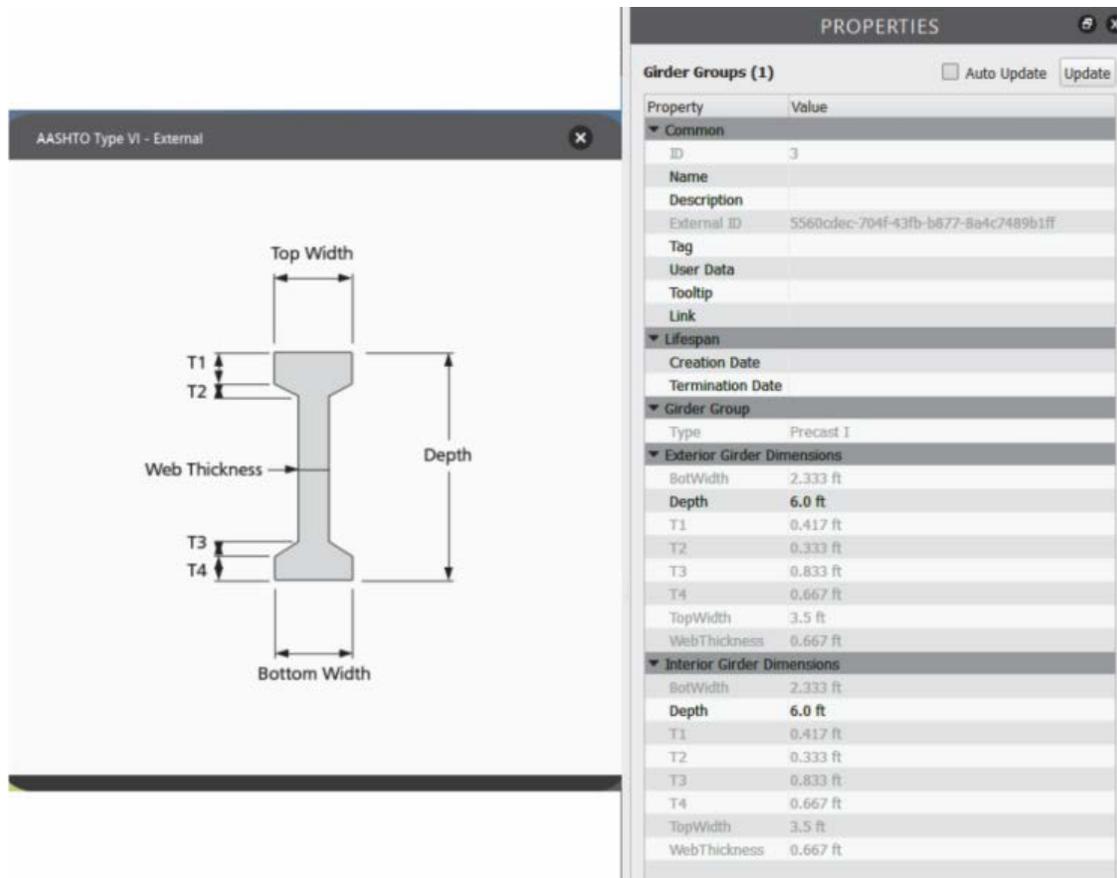

Figure 19

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 20:

- Job name
- Job number
- Project name
- Company name

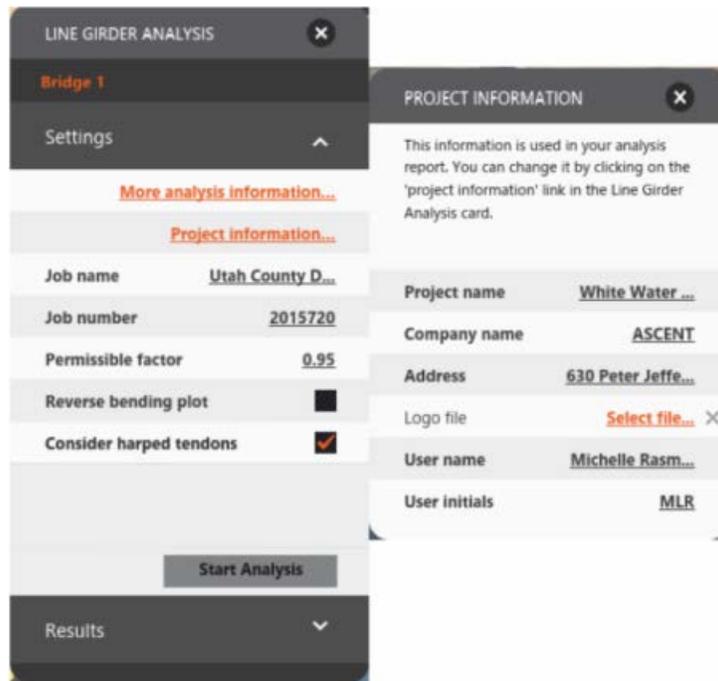- Address
- Logo file
- User name
- User initials

Figure 20

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 21.
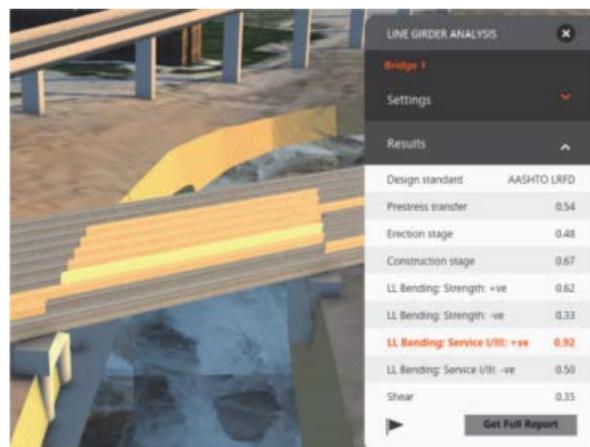

Figure 21

Additional analysis information can be viewed by clicking Get Full Report. A sample report is shown in Figure 22.
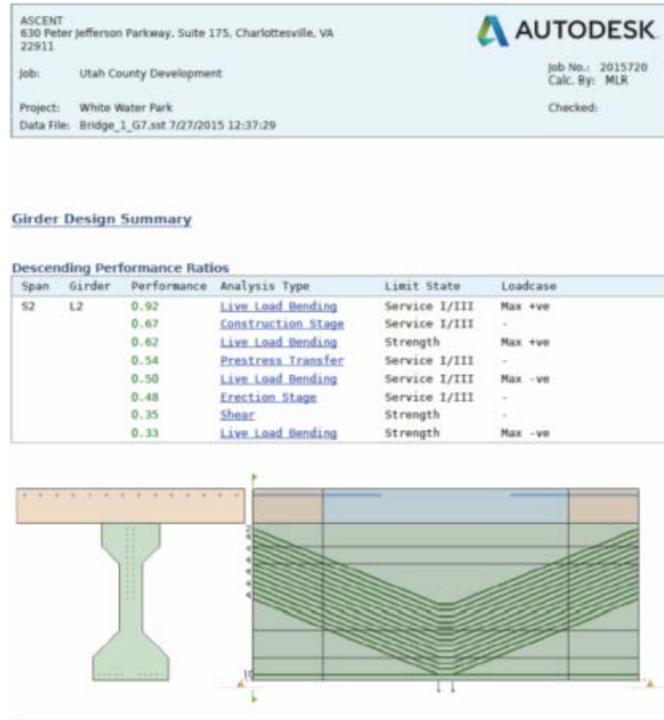

Figure 22

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

Autodesk InfraWorks features can be imported into 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 model to help communicate the final design to stakeholders by taking advantage of the high definition graphics. Files are transferred between the software using .IMX files.

Exporting .IMX Files

When exporting an .IMX file to be used in the AutoCAD Civil 3D software, you can export the entire Autodesk InfraWorks model, or a portion of the model. When you export an .IMX file, everything becomes part of the .IMX, including the existing conditions of features that were imported from other data sources. To reduce the file size and duplication of model elements in the AutoCAD Civil 3D software, it is recommended that you only export a portion of the model by using a bounding box or polyline. In addition to setting how much of the model to include in the .IMX file, you can also set the target coordinate system.

How To: Create an .IMX file in InfraWorks

1. In the In Canvas Tools, click ![icon] (Settings and Utilities)> ![icon] (Export IMX).
2. In the Export to IMX dialog box, set the model extents in the Defining Interactively drop-down list by selecting **BBox** or **Polygon** (as shown in Figure 23), or by selecting the **Use Entire Model** option.
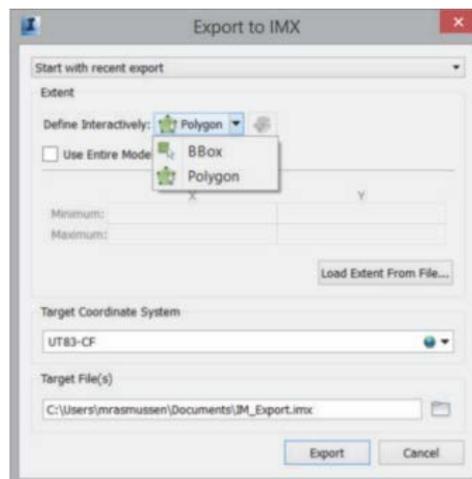

Figure 23

3. In the Export to IMX dialog box, set the target coordinate system and the target's directory and filename.
4. Click **Export**.

How To: Create an .IMX file in AutoCAD Civil 3D

1. Open the Civil 3D drawing file.
2. Save the drawing file (even if you just opened it, it requires a save just before exporting.)

3. On the Output tab>Export panel, click (Export IMX).
4. In the Command Line, select the IMX version required [2.1 or 2.0].

Importing .IMX Files

When importing .IMX files into an Autodesk InfraWorks model, you use the process that would be used to import any other data source. Importing files does not create a link to the file. Therefore, it is recommended that you create a new proposal before importing an .IMX file to ensure that you have a base model to revert to if anything changes. If the detailed design changes in the AutoCAD Civil 3D software, you have to create and import an updated .IMX file.

Only certain AutoCAD Civil 3D elements can be imported into the Autodesk InfraWorks software. These elements include surfaces, alignments and profiles, corridor models, and pipe networks. Each element must be configured separately. When you import an .IMX file with multiple objects, you must select which type of data to include. The Choose Data Sources dialog box enables you to select the data to import, as shown in Figure 24.
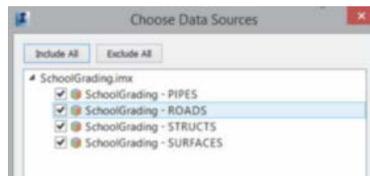

Figure 24

Once imported, each data type becomes its own data source in the Data Sources palette. Before they display in the model, the data source must be configured. The list below describes how each data source is handled and configured in the Autodesk InfraWorks software.

- **Surfaces:** Both existing ground and finish ground surfaces can be imported, becoming terrain surfaces. If a grid surface is imported, it is converted into a TIN surface. Only one surface can be displayed in the model at a time, so you must select which surface to import in the IMX tab in the Data Source Configuration dialog box, as shown in Figure 25.
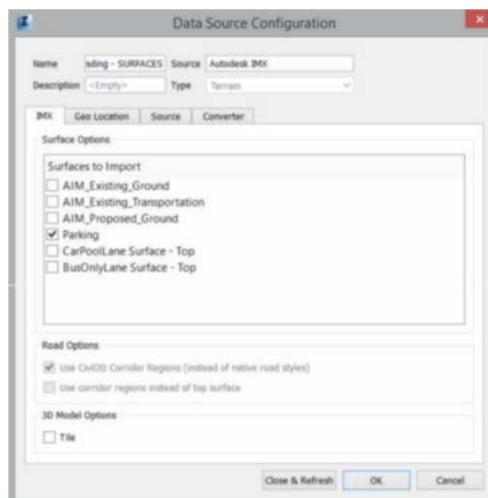

Figure 25

- **Alignments and Profiles:** Alignments and profiles are combined into one road feature. They are assigned a road style in the Data Source Configuration dialog box in the Common tab, in the Style area. Any alignments and profiles that are used to create a corridor model are imported separately. For any alignments that are not associated with a corridor model, you can set the style in the Common tab in the Data Source Configuration dialog box, as shown in Figure 26.
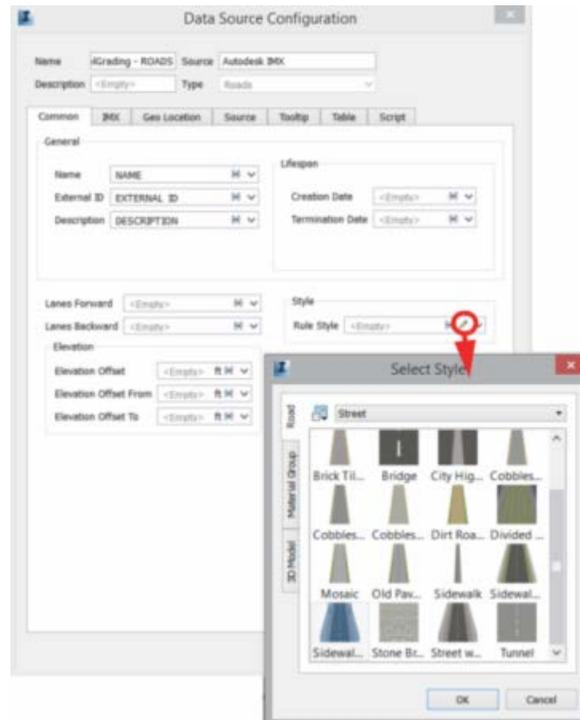

Figure 26

- **Corridors:** Alignments and profiles that have been assigned to a corridor model in the AutoCAD Civil 3D software can be imported into the model in a few different ways. You can use an Autodesk InfraWorks road style or you can use the AutoCAD Civil 3D corridor surface or regions to display the road design. If the Autodesk InfraWorks styles are used to display the corridor model, only one centerline alignment associated with the corridor is used to stylize the road. All of the other alignments associated with the corridor are ignored. When using the corridor surface or regions to stylize the road, two options are available in the IMX tab, in the Data Source Configuration Dialog Box, as shown in Figure 27.

Figure 27

The two Road Options are described as follows:

- o Use Civil 3D Corridor Regions (instead of native road styles): If the corridor surface is used to stylize the road, the surface becomes a coverage area rather than a road feature. In Figure 28, the road on the left uses the native road styles and on the right it shows the same road using the Civil3D Corridor Regions setting.
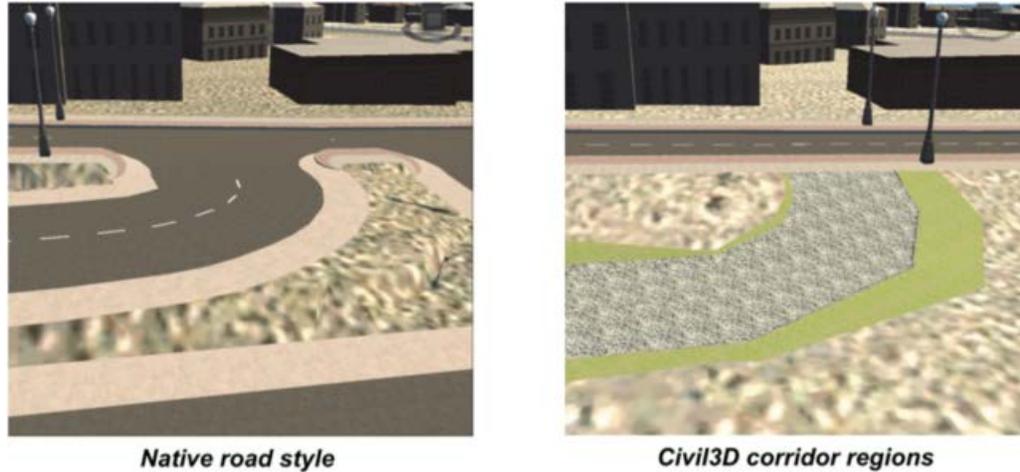

Figure 28

- o Use corridor regions instead of top surface: This option creates a more detailed display of the road surface. The detail is sharp enough to display curbs, medians and other raised or lowered areas more clearly. Figure 29 shows the road that is shown on the right in Figure 28, but with both Road Options selected.
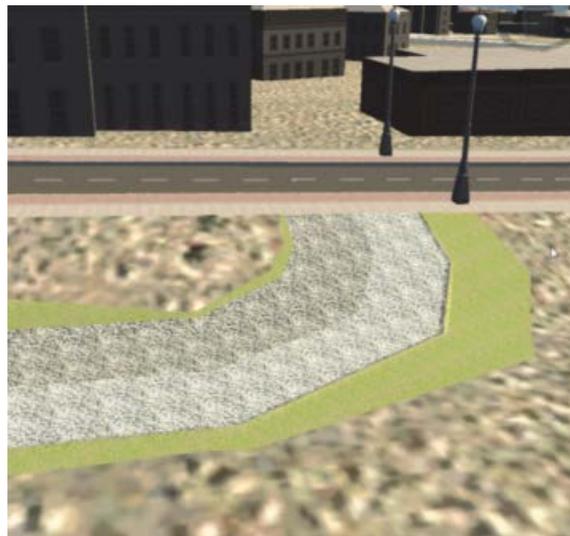

Figure 29

You can take advantage of both corridor regions and native road styles. By configuring the road twice, you can create a more realistic display. For the first time, use the corridor surface and regions. Then, configure it a second time to use a native road style.

This causes the road can display the cut/fill slopes from the AutoCAD Civil 3D corridor model, and display the pavement markings and other details that display when using a native road style, as shown in Figure 30.

Figure 30

- **Pipe Networks:** Pipes from the AutoCAD Civil 3D software become Pipes in the Autodesk InfraWorks software, while structures become Pipe Connectors. Pipes and Pipe Connectors display separately when a pipe network is imported from the AutoCAD Civil 3D software, as shown in Figure 31. When configuring the pipe networks, set the style in the Common tab, in the Data Configuration dialog box.
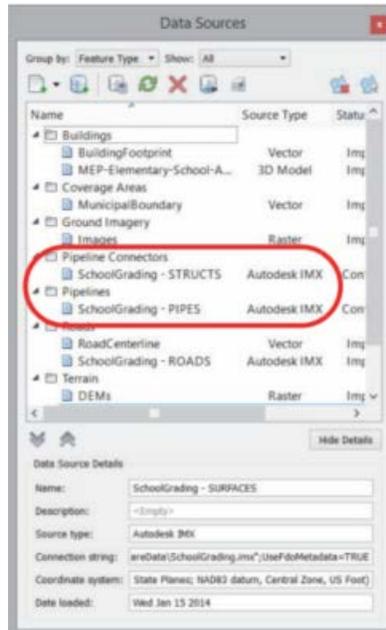

Figure 31

How To: Import an .IMX file

1. In the In Canvas Tools, click (Build, manage, and analyze your industry model)> (Create and manage your model)> (Data Sources).
2. In the Data Sources palette, expand (Add file data source) and select **Autodesk IMX**.
3. In the Select Files dialog box, browse to the location of the file, select it, and click **Open**.

4. In the Choose Data Source dialog box (shown in Figure 32), select the AutoCAD Civil 3D objects that you want to import. Click **OK**.
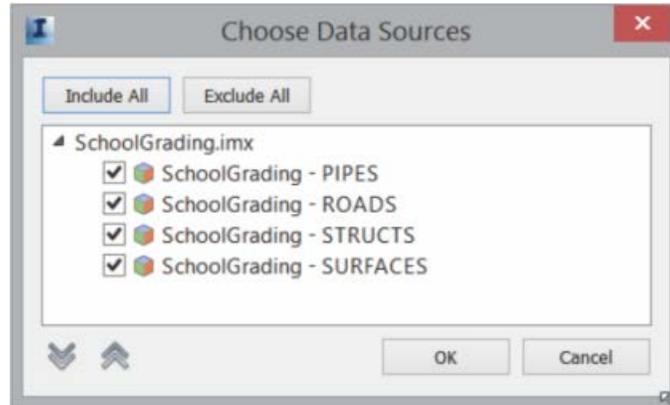
5. In the Data Sources palette, double-click on the .IMX files to configure them.
6. If it is a surface or corridor model, in the *IMX* tab, in the Data Source Configuration dialog box, select the required settings.
7. Click **Close & Refresh** to display the imported data in the model.

Bonus Material

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 InfraWorks model to NavisWorks.

- 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 InfraWorks 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 33:
    - Define the area to export.
    - Set the Target Coordinate System
    - Determine if you want one file or many.
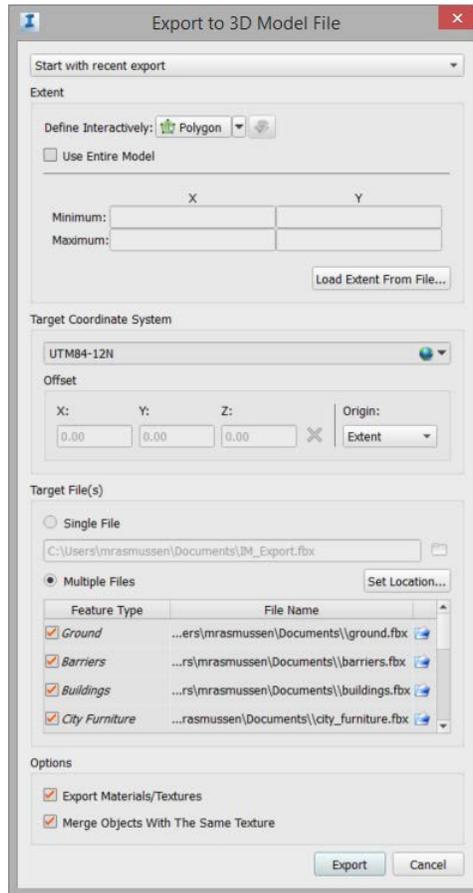   - Click Export.

Figure 33