Truss Tutorial

T4 – Floor Truss Example

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Topics Covered

- Floor and truss system/line superstructure definitions overview
- Floor truss description
- Analysis rating results and outputs

Floor and truss system/line superstructure definitions overview

BrDR supports the modeling of three types of floor system/line superstructure definitions and two types of truss system/line superstructure definitions.

Floor system/line superstructure definition supported configurations

- Girder-Floorbeam-Stringer
- Girder-Floorbeam
- Floorbeam-Stringer

Truss system/line superstructure definition supported configurations:

- Truss-Floorbeam-Stringer
- Truss-Floorbeam

Modeling capabilities in the system superstructure definition:

- Number of main members (girders or trusses) can be more than two.
- Continuous span main member are supported.
- Main members can directly support the deck. This enables entry of composite deck properties for the main members.
- Main member configuration type can be deck or through.
- Stringers can frame into the floor beam or rest on top of the floor beam.
- Support entry of deterioration profile information.

Modeling limitations in system superstructure definition:

- Main member spacings cannot vary along the length of the superstructure.
- Number of stringers and stringer spacings cannot vary in the superstructure.
- Deck width cannot vary along the length of the superstructure.
- Floor beams at support lines are assumed to have the same skew as the support line. All other floor beams are assumed to be perpendicular.
- Cantilevered floor beam spans are only supported for deck main member configuration type.
- Interior floor beams can only be supported by the main members.

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Floor trusses are supported in the system superstructure definition and implemented as a new type in the floorbeam definition. The truss members in floor truss can have rolled and built-up cross sections. The BrDR Truss LFR Engine is the analysis module for rating floor trusses.

Floor truss description

For this example, a new floor truss definition will be added in BID 13 and the floor beam definition assigned to Floorbeam1's Alt #1 floorbeam member alternative will be replaced with this newly added floor truss definition.

From the **Bridge Explorer** double click on **BID 13 FSys GFS TrainingBridge1** to open the **Bridge Workspace**. Expand the workspace tree until the FLOORBEAM DEFINITIONS and Floorbeam1's FLOORBEAM MEMBER ALTERNATIVES are visible. The partially expanded **Bridge Workspace** tree is shown below.
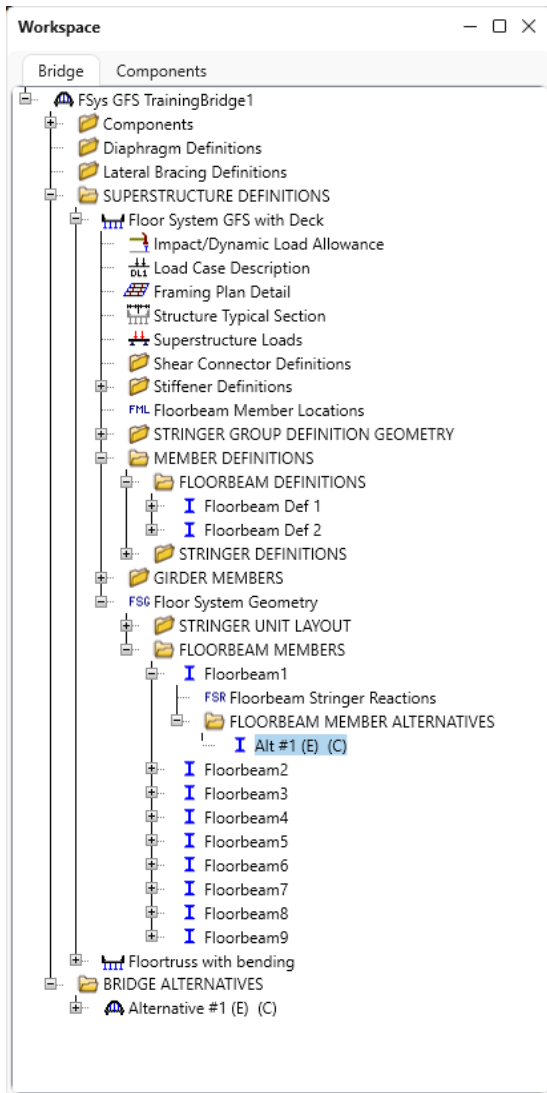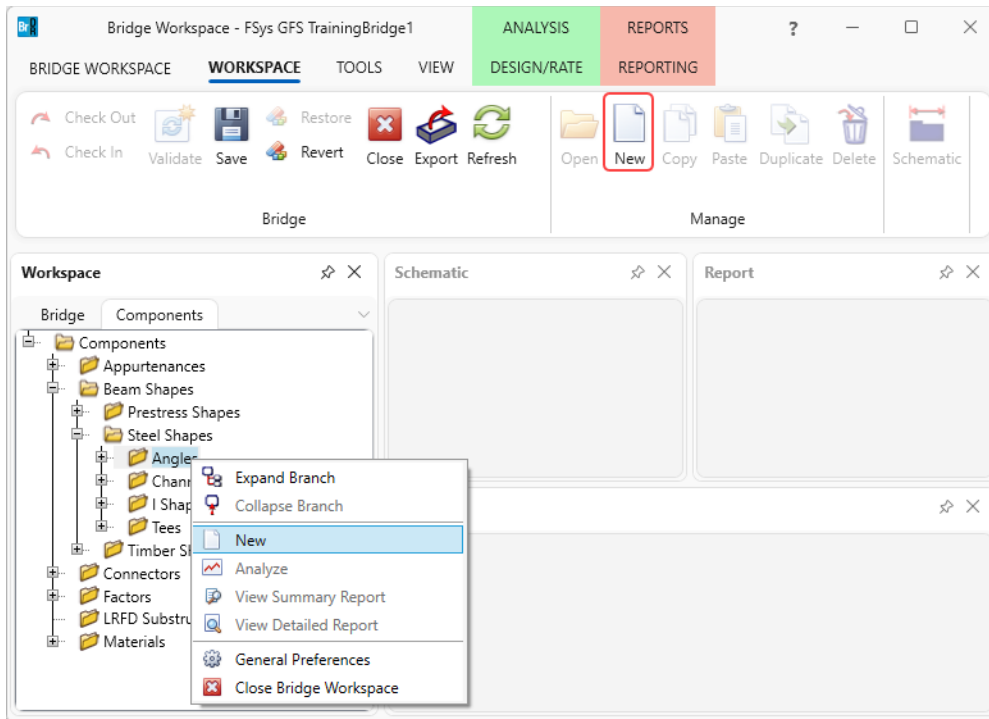
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Bridge Shapes

For this example, create a new steel angle as shown below. Navigate to the **Components** tab and expand the tree labelled **Beam Shapes** and **Steel Shapes** as shown below. The partially expanded **Components** tree with the **Steel Shapes** node is shown below.
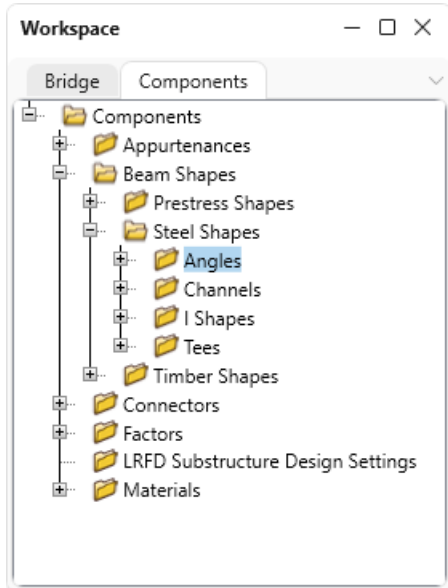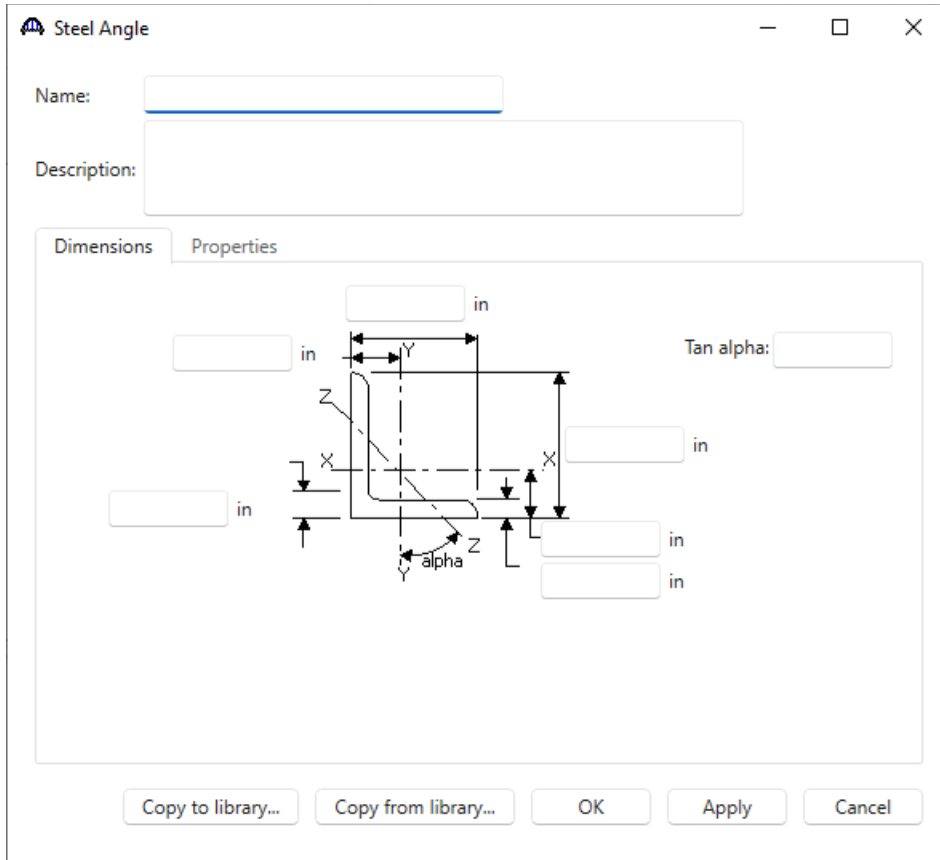

To add a new steel angle, click on the **Angles** node in the Components tree and select New from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Angles** and select **New** or double click on **Angles** in the **Components** tree). The window shown below will open.
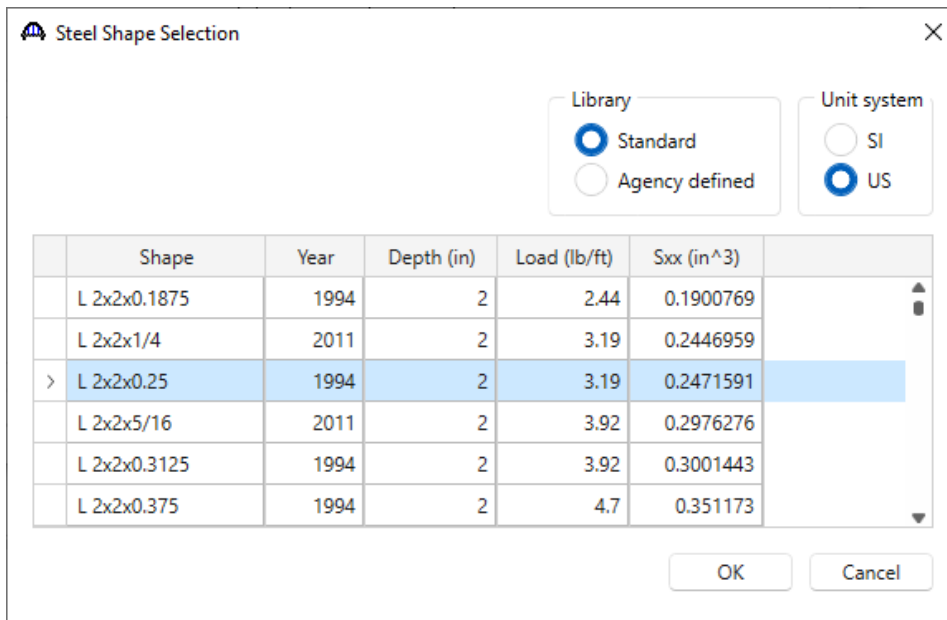
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Click the **Copy from library…** button. The **Steel Shape Selection** window will appear.

This window displays all the steel shapes available in the library. The list can be sorted by clicking on any of the column headers (e.g., **Shape**, **Year**, **Depth** etc.). Select **L 2x2x0.25** and click **OK**.

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The steel angle properties are copied to the **Steel Angle** window as shown below.
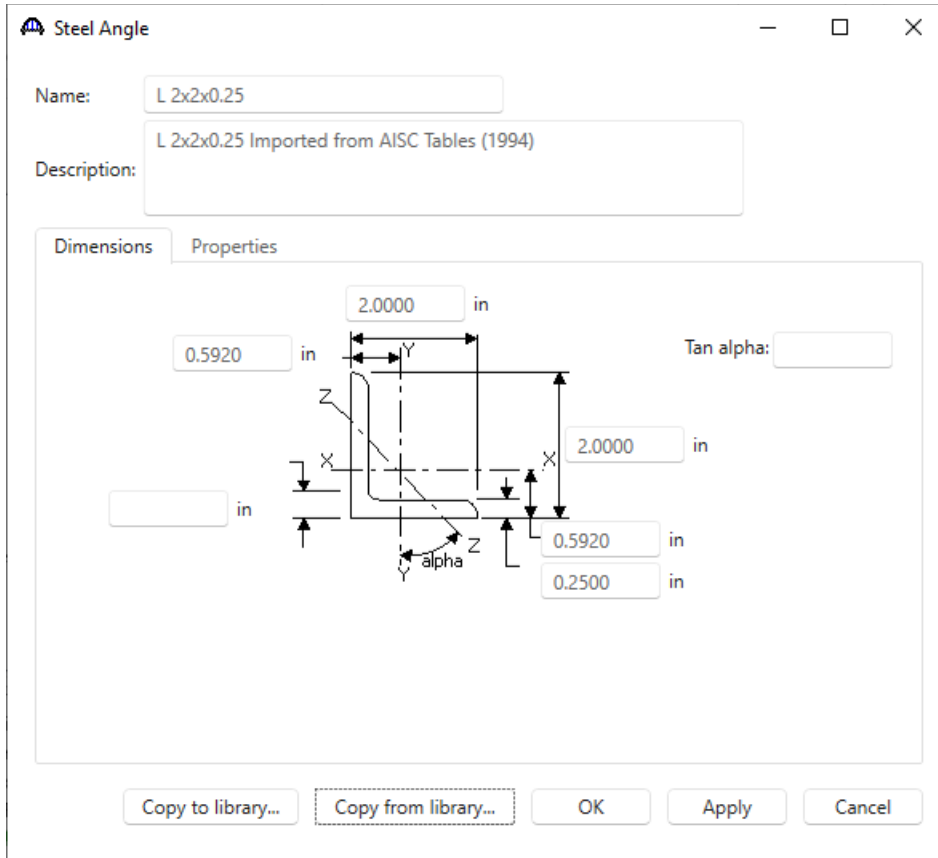
Click **OK** to apply the data and close the window.

Floorbeam Definition

Navigate back to the **Bridge** tab and double-click on the **FLOORBEAM DEFINITIONS** node in the Bridge Workspace tree to create a new floorbeam definition. The **New Floorbeam Definition** window appears as shown below.

Select **Steel** for the **Material type** and **Detailed Steel Truss** for the **Girder type**. Click **OK** to close this and create a new floorbeam definition.
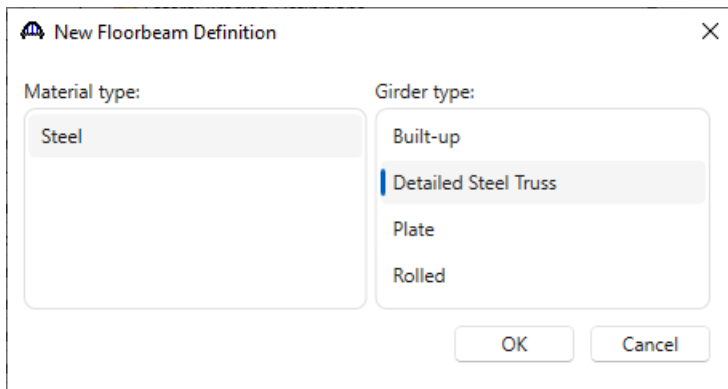
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The **Floorbeam Definition** window will open. Enter the data as shown below. **Cross-section based** property input method is the only input method for floor truss. The 0.005 kip/ft Additional self load will be applied for each truss member in the floor truss.

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Floorbeam Definition – Geometry

Select the **Geometry** tab of this window and enter the locations of the panel points as shown below. These panel points will be used to define the truss members.

Click **OK** to apply the data and close the **Floorbeam Definition** window.

In the **Floorbeam Definition** window **Geometry** tab, the **Symmetrical** option specifies that the entered panel point locations are symmetrical. The **Number of Panels** will be enabled when **Symmetrical** is selected. For even number of panels, enter the panel point locations from the left most panel to the central panel points. For odd number of panels, enter the panel point locations from the left most panel to the right end of the central panel. If **Symmetrical** is selected, symmetrical geometry, supports and user-defined truss member loads will be generated.
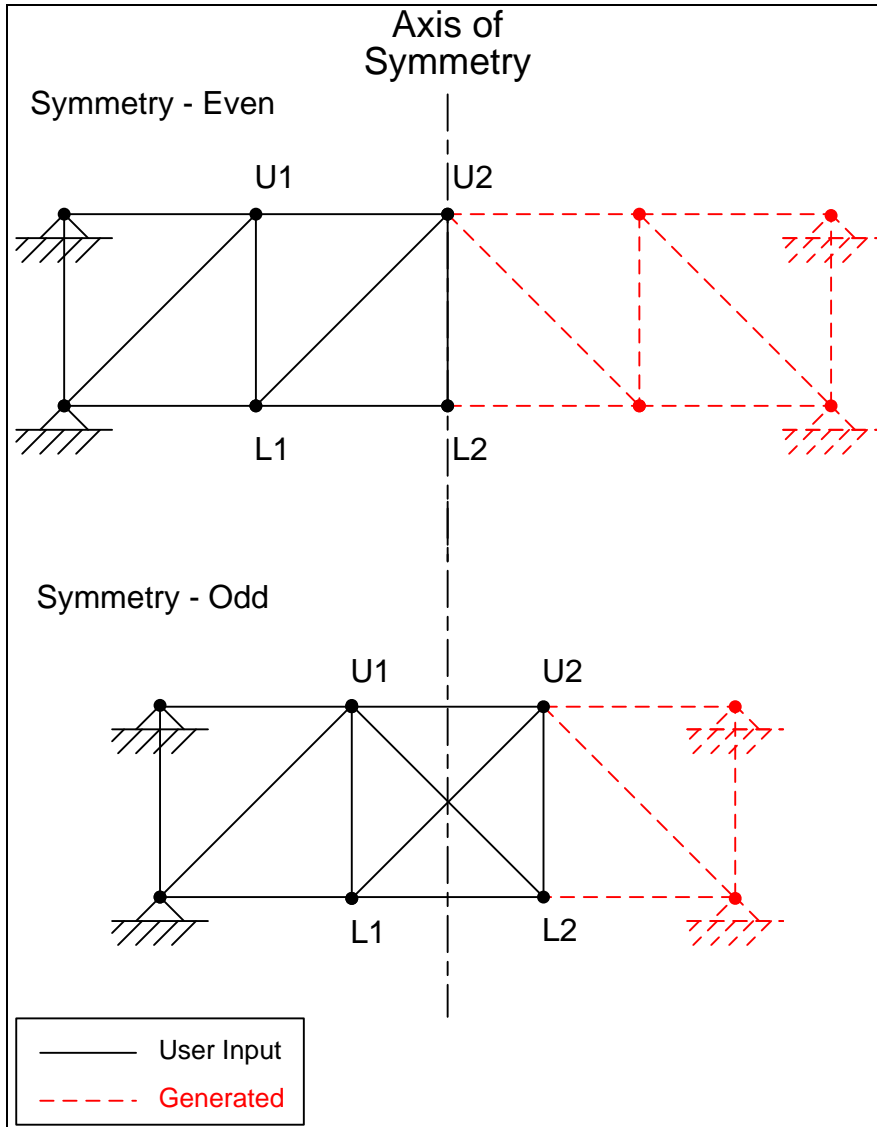
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The partially expanded Bridge Workspace tree with the new **Floortruss Def 1** is shown below.
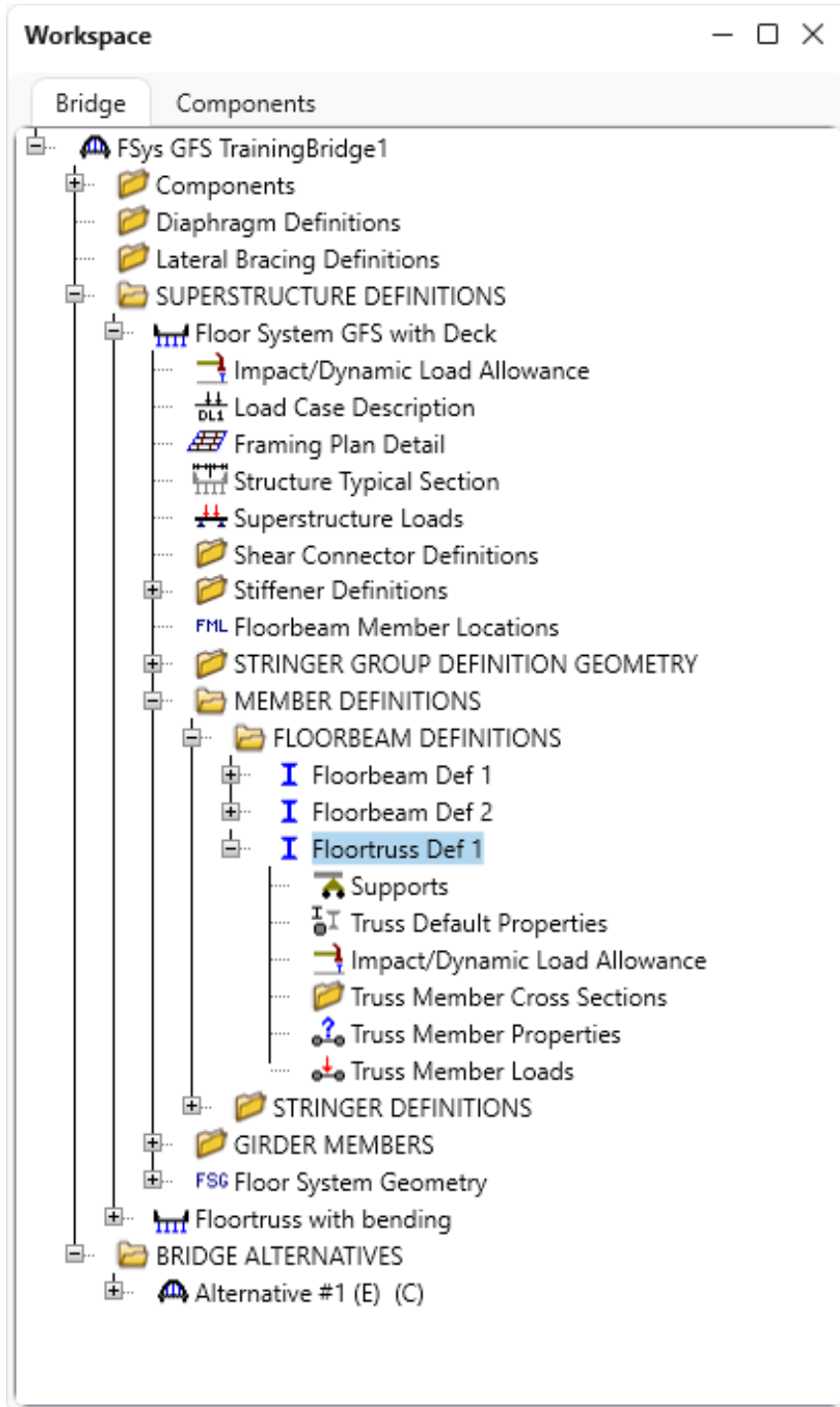
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Floorbeam Member Alternative

Double click on the **Floorbeam1**'s **Alt #1** floorbeam member alternative in the **Bridge Workspace** tree and change the assigned floorbeam definition to **Floortruss Def 1** as shown below.


Click **OK** to apply the data and close the window.

The **Floorbeam Member Alternative** window will be populated with truss members after **Floortruss Def 1** is completely defined. The **General** tab allows to override the computed capacities, the allowable stresses and the unbraced length defined in **Floortruss Def 1**.
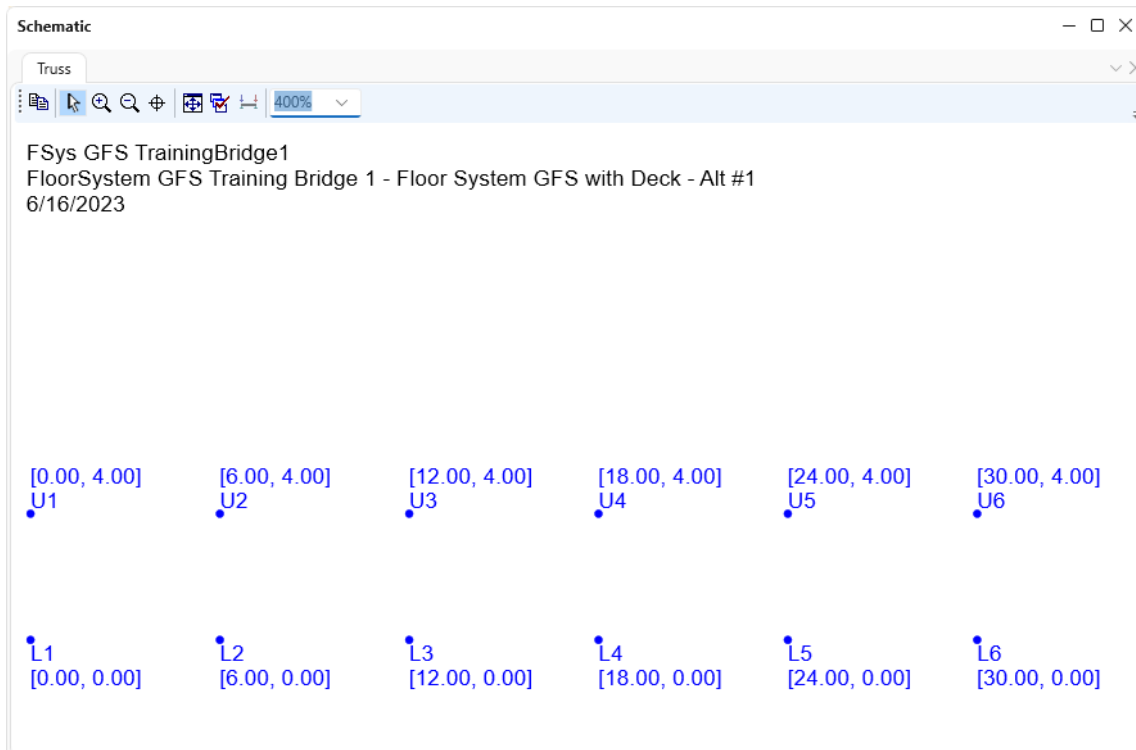
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Schematic – Floorbeam Member Alternative

While **Alt #1** is selected in the **Bridge Workspace** tree, open the schematic for the truss by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Alt #1** in the **Bridge Workspace** and select **Schematic** from the menu)
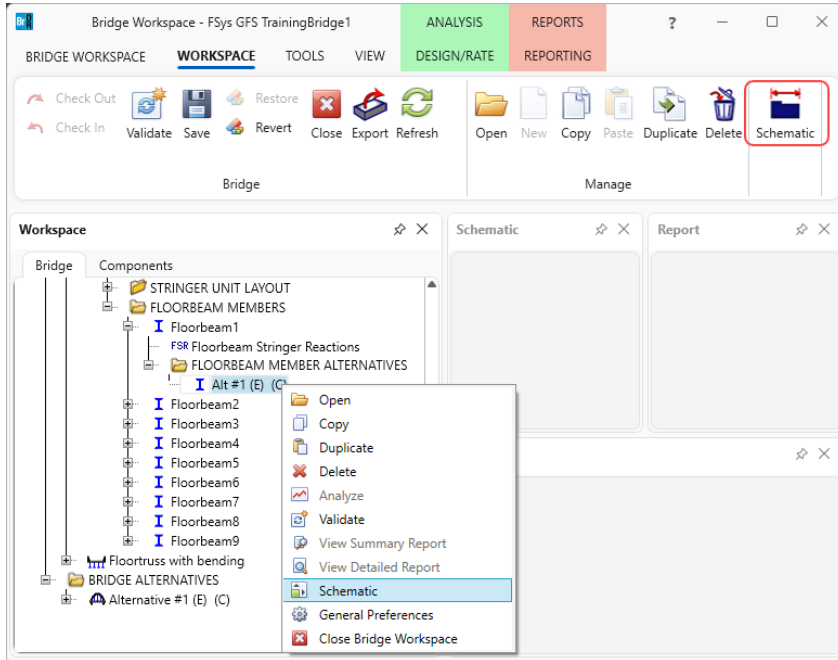

The following schematic will be displayed.

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Return to the **Floortruss Def 1** description. Expand the **Floortruss Def 1** node and double click **Truss Member Cross Sections** in the **Bridge Workspace** tree to create a new rolled section. The **New Cross Section** window shown below will open. Select **Rolled Section**, click **OK** to close this window and create a new rolled section.
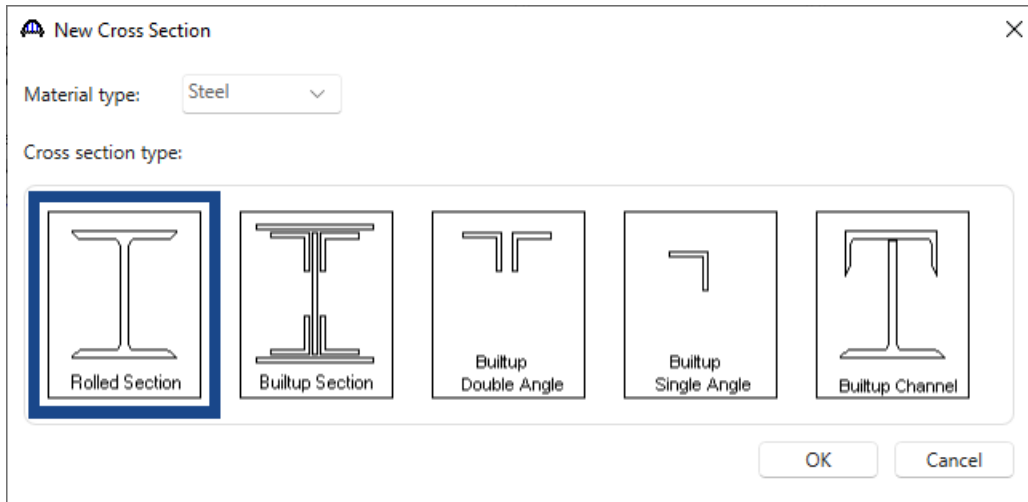
Enter the data as shown below for the rolled section. Click **OK** to apply the data and close the window.
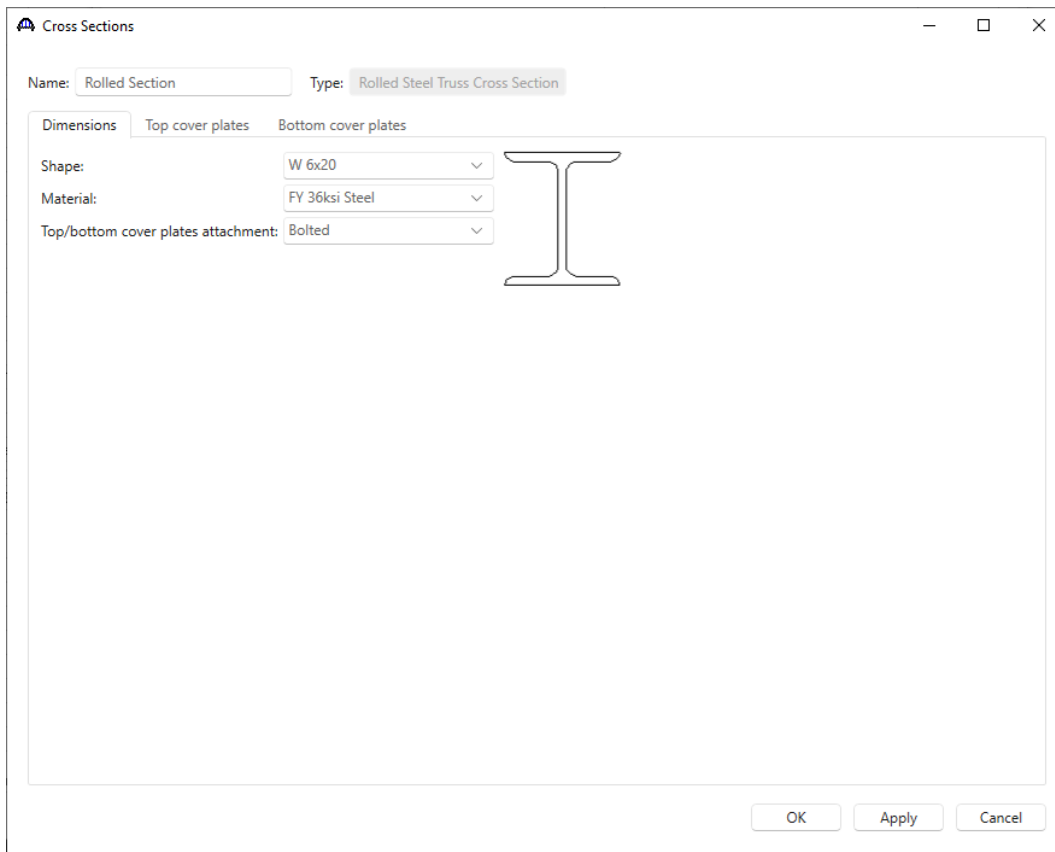
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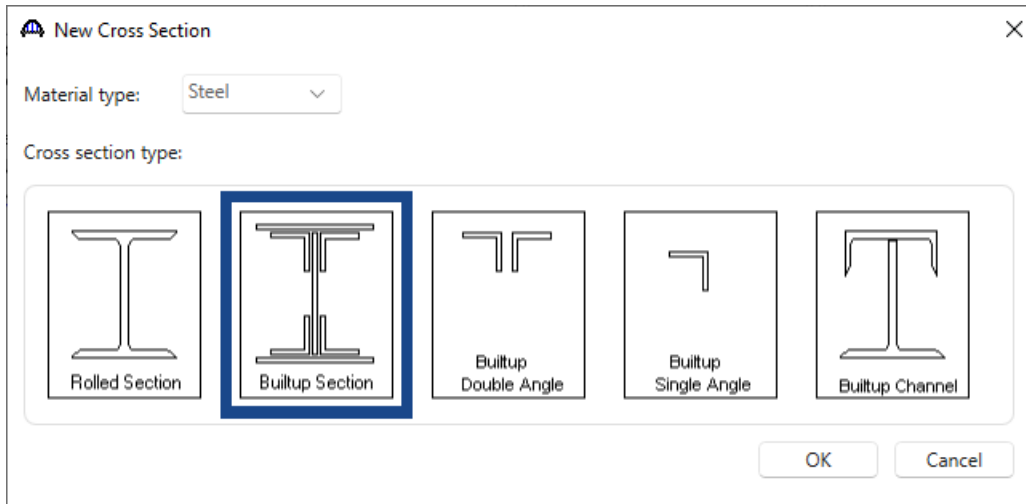
Similarly, double click the **Truss Member Cross Sections** in the **Bridge Workspace** tree to create another section. This will be a new **Builtup** Section.

Enter the data as shown below for the Builtup Section.

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Select the **Top cover plates** tab to enter the top cover plate as shown below. Click **Copy to bottom cover plates** to copy the cover plate to the **Bottom cover plates** tab.

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The partial **Bridge Workspace** tree with the new **Rolled Section** and **Builtup Section** is shown below.
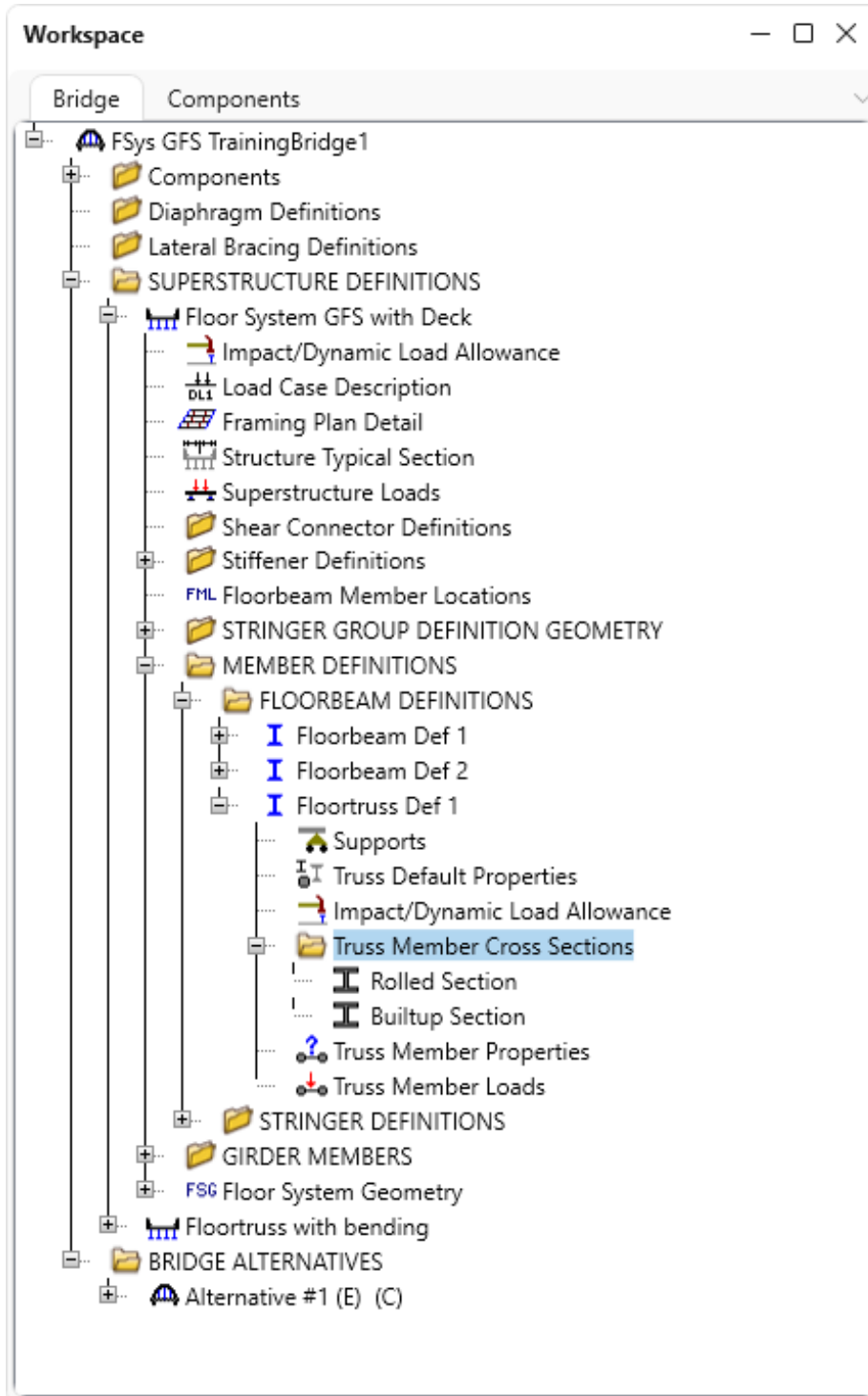
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The configurations of the supported rolled and built-up cross sections are shown below.

Supported Rolled Sections:

Rolled Section

Rolled Section
w/ Top Plate

Rolled Section
w/ Bot. Plate

Rolled Section w/
Top & Bot. Plates

Supported Builtup Sections:

Full I Section

I Section w/o
Top Plate

I Section w/o
Bot. Plate

I Section w/o Top
& Bot. Plates

I Section
w/o Angles

I Section w/o Web
Plate but w/ Lacing
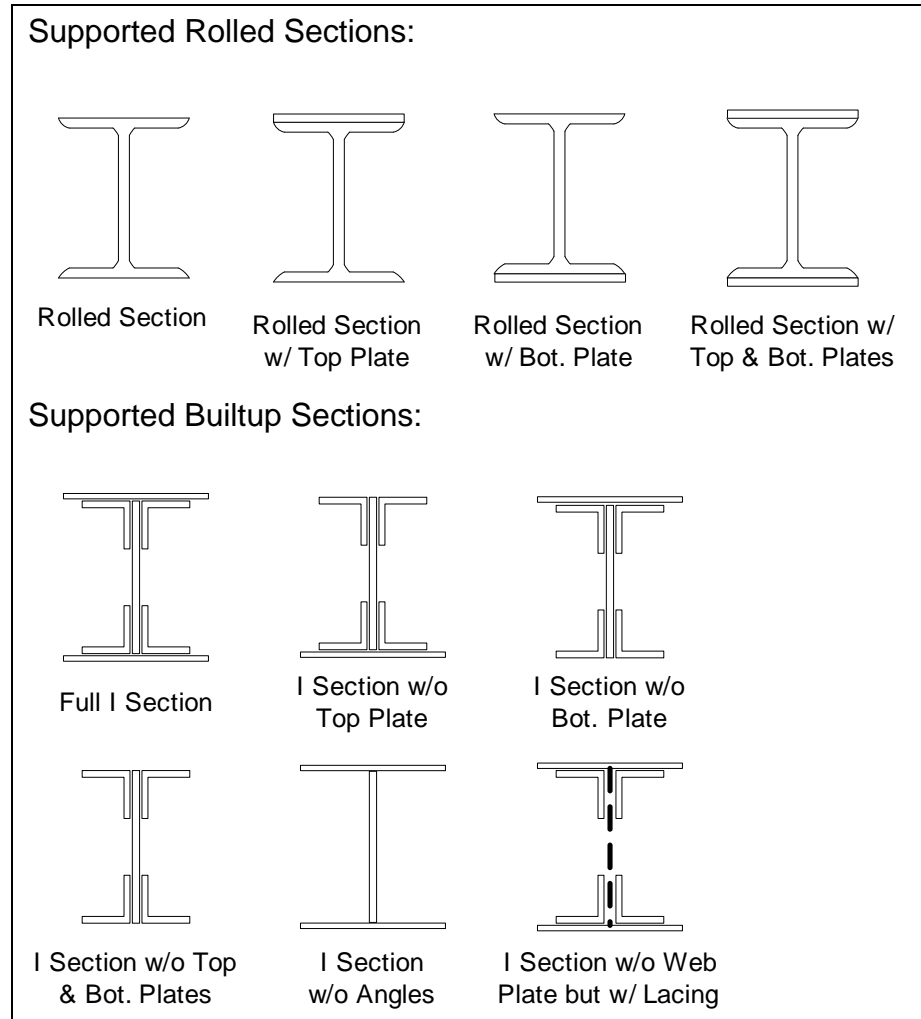
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Double-click **Truss Member Properties** in the **Bridge Workspace** tree to open the **Truss Member Properties** window. Click **New** to create a new row, select **Panel point from** and **Panel point to** and populate the **Member name**, the **Z axis** and **Y axis unbraced lengths**. Enter the data as shown below for the truss members. Click **OK** to apply the data and close the window.

	Member name	Panel point from	Panel point to	Length (ft)	Z axis unbraced length (ft)	Y axis unbraced length (ft)	Cross section	End connection	K
>	L1L2	L1	L2	6	6	6	Rolled Section	Pinned	0.875
	L2L3	L2	L3	6	6	6	Rolled Section	Pinned	0.875
	L3L4	L3	L4	6	6	6	Rolled Section	Pinned	0.875
	L4L5	L4	L5	6	6	6	Rolled Section	Pinned	0.875
	L5L6	L5	L6	6	6	6	Rolled Section	Pinned	0.875
	U1U2	U1	U2	6	6	6	Rolled Section	Pinned	0.875
	U2U3	U2	U3	6	6	6	Rolled Section	Pinned	0.875
	U3U4	U3	U4	6	6	6	Rolled Section	Pinned	0.875
	U4U5	U4	U5	6	6	6	Rolled Section	Pinned	0.875
	U5U6	U5	U6	6	6	6	Rolled Section	Pinned	0.875
	L1U1	L1	U1	4	4	4	Builtup Section	Pinned	0.875
	L2U2	L2	U2	4	4	4	Builtup Section	Pinned	0.875
	L3U3	L3	U3	4	4	4	Builtup Section	Pinned	0.875
	L4U4	L4	U4	4	4	4	Builtup Section	Pinned	0.875
	L5U5	L5	U5	4	4	4	Builtup Section	Pinned	0.875
	L6U6	L6	U6	4	4	4	Builtup Section	Pinned	0.875
	L2U1	L2	U1	7.211103	7.21	7.21	Builtup Section	Pinned	0.875
	L2U3	L2	U3	7.211103	7.21	7.21	Builtup Section	Pinned	0.875
	L3U4	L3	U4	7.211103	7.21	7.21	Builtup Section	Pinned	0.875
	L4U3	L4	U3	7.211103	7.21	7.21	Builtup Section	Pinned	0.875
	L5U4	L5	U4	7.211103	7.21	7.21	Builtup Section	Pinned	0.875
	L5U6	L5	U6	7.211103	7.21	7.21	Builtup Section	Pinned	0.875

☐ Model truss member as beam element

[New] [Duplicate] [Delete]

[OK] [Apply] [Cancel]
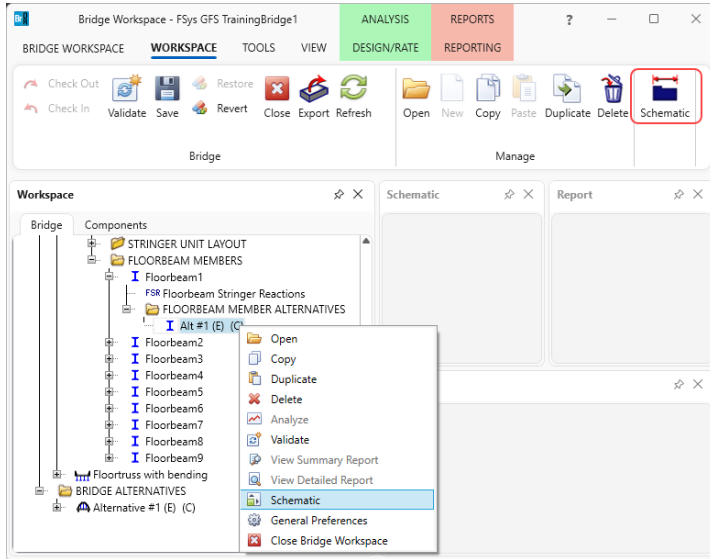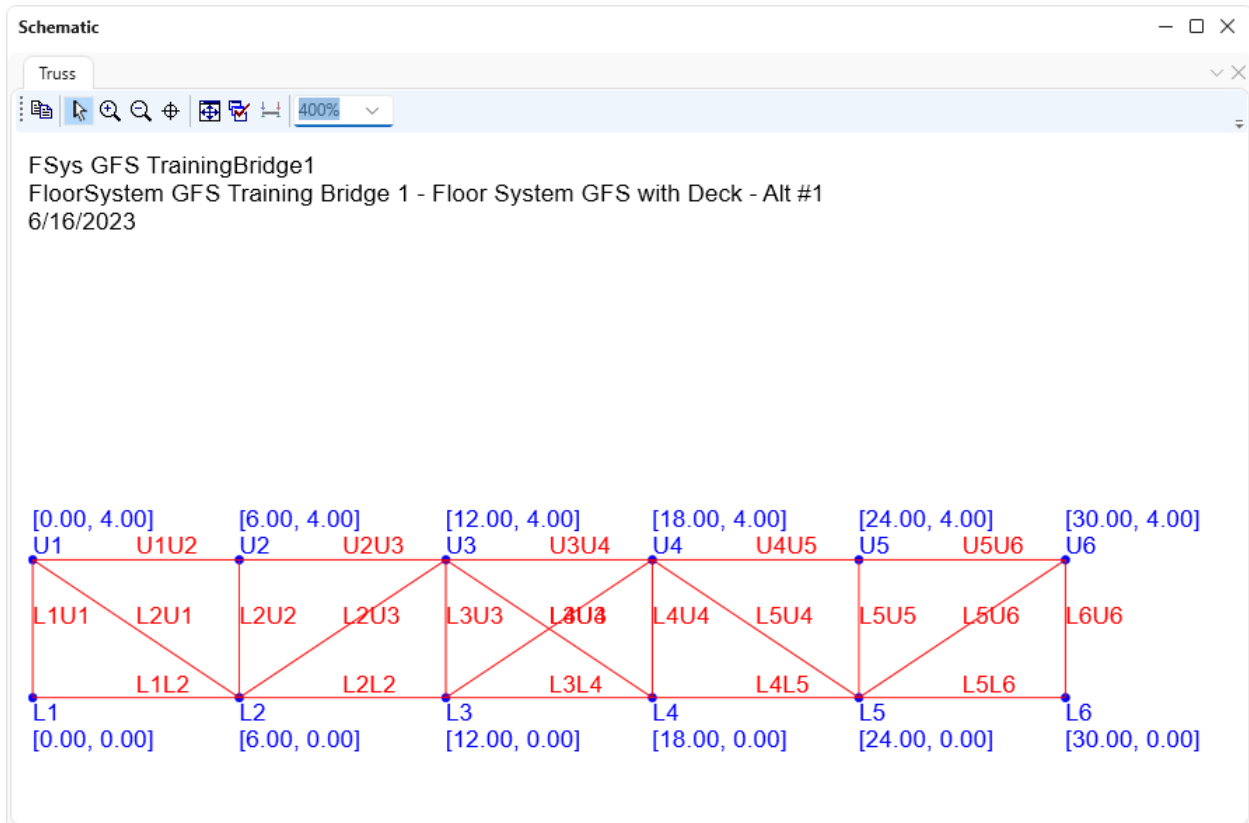
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Schematic – Floorbeam Member Alternative

While **Alt #1** is selected in the **Bridge Workspace** tree, open the schematic for the truss by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Alt #1** in the **Bridge Workspace** and select **Schematic** from the menu)

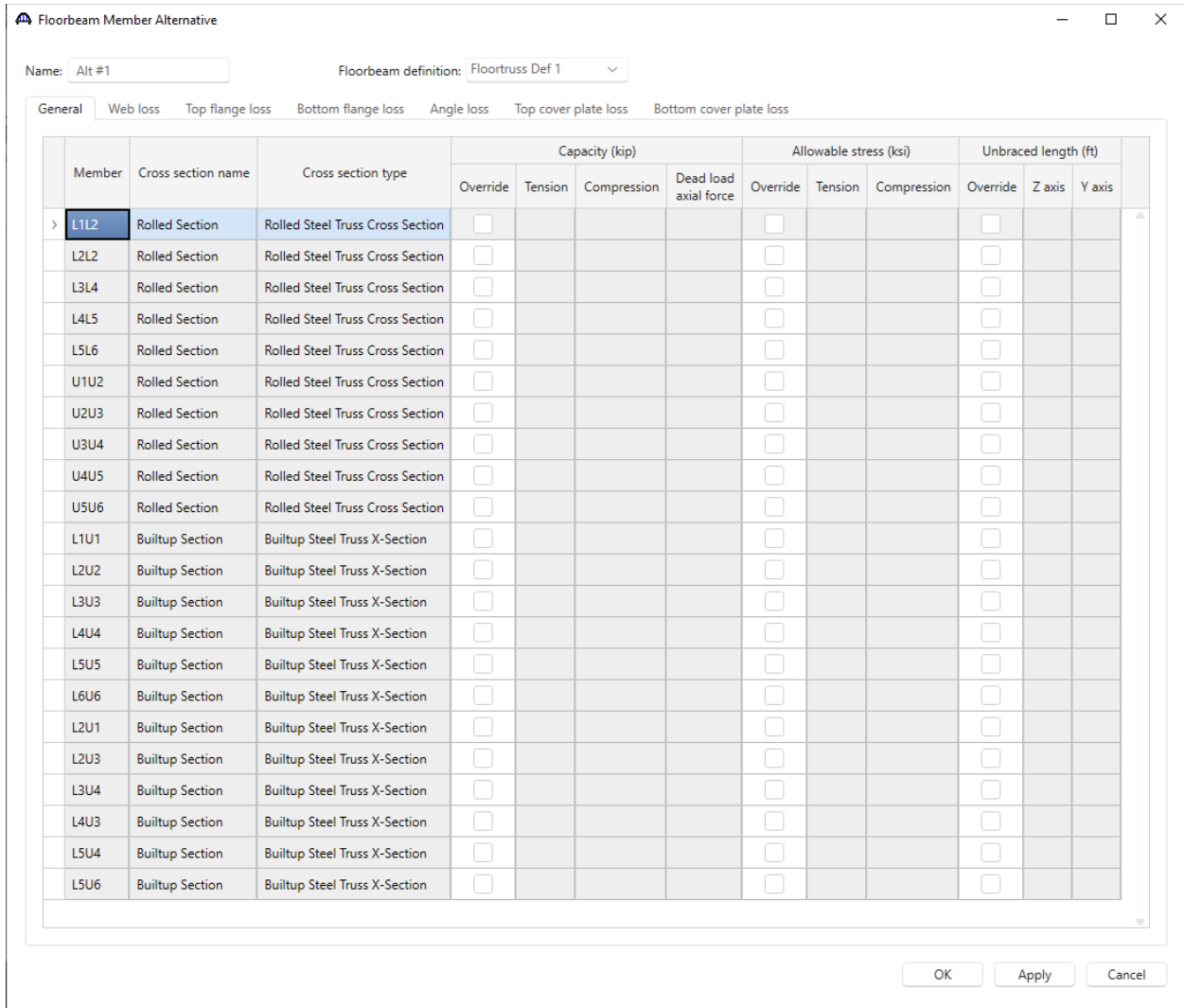The following schematic will be displayed.

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Double click Floorbeam1's Alt #1 floorbeam member alternative in the Bridge Workspace tree.

The **Loss** tabs allow to describe the deteriorations of the rolled and built-up cross sections. The deterioration is defined for a truss member and described over ranges, with each range being defined by a start distance and a length.

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LFR Analysis

To perform a rating on the newly added floorbeam member alternative **Alt #1**, select **Alt #1** in the **Bridge Workspace** tree and click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.
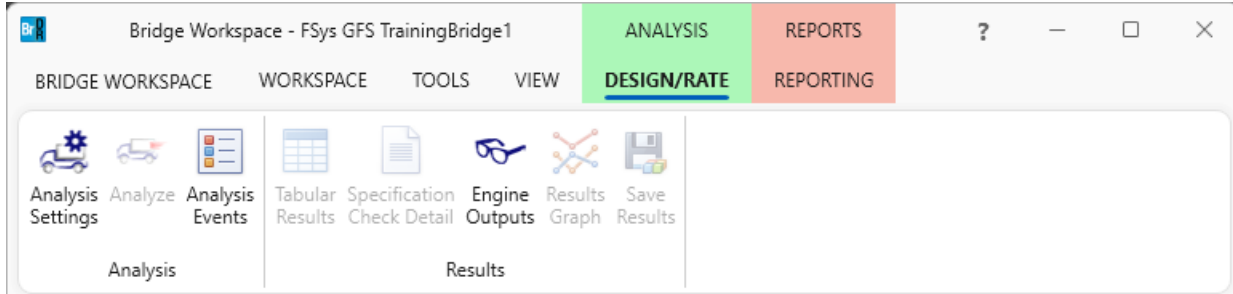
Select vehicle **HS 20-44** under **Inventory** and **Operating** as shown below.
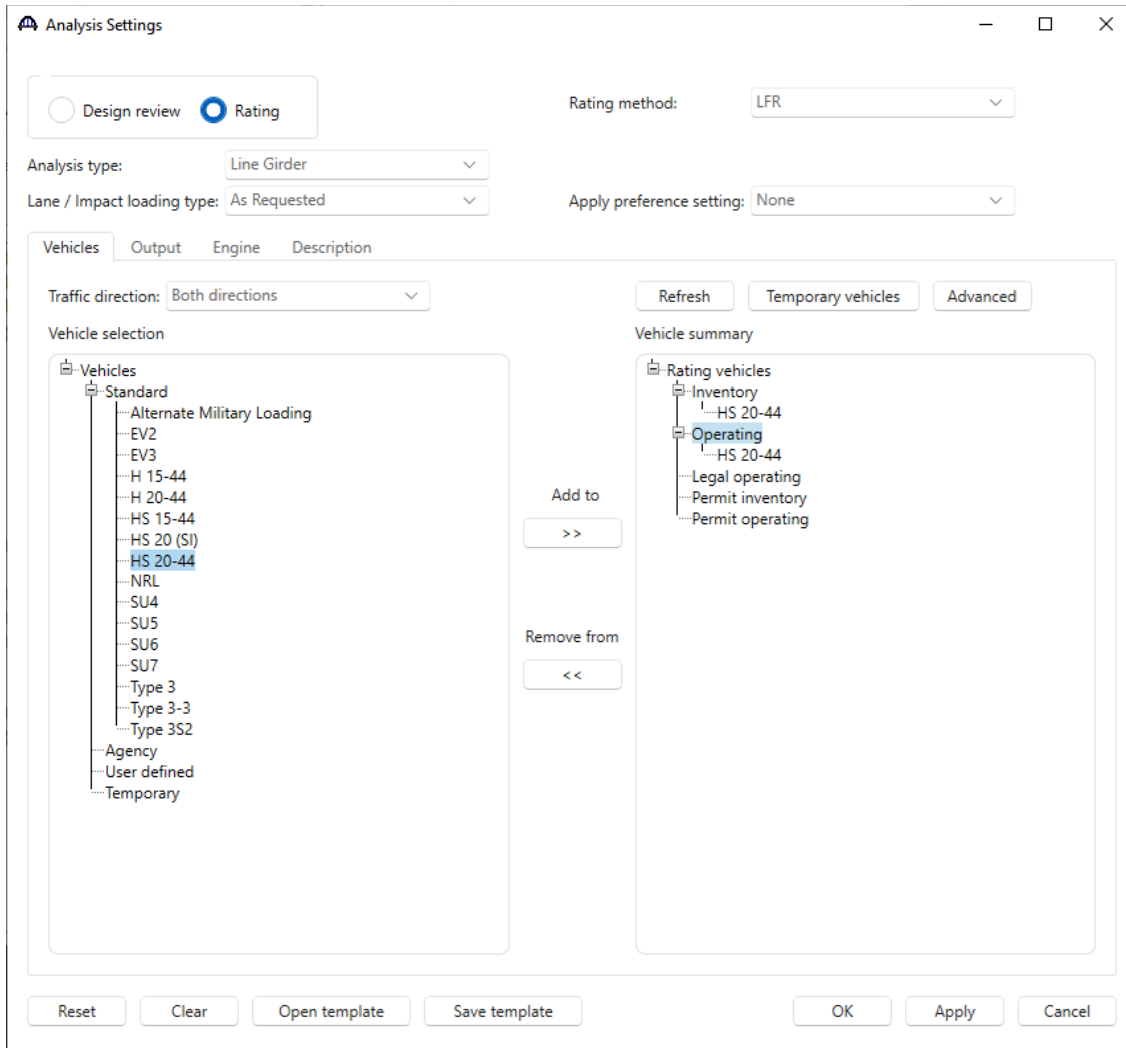
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Navigate to the **Output** tab and apply the settings as shown below.
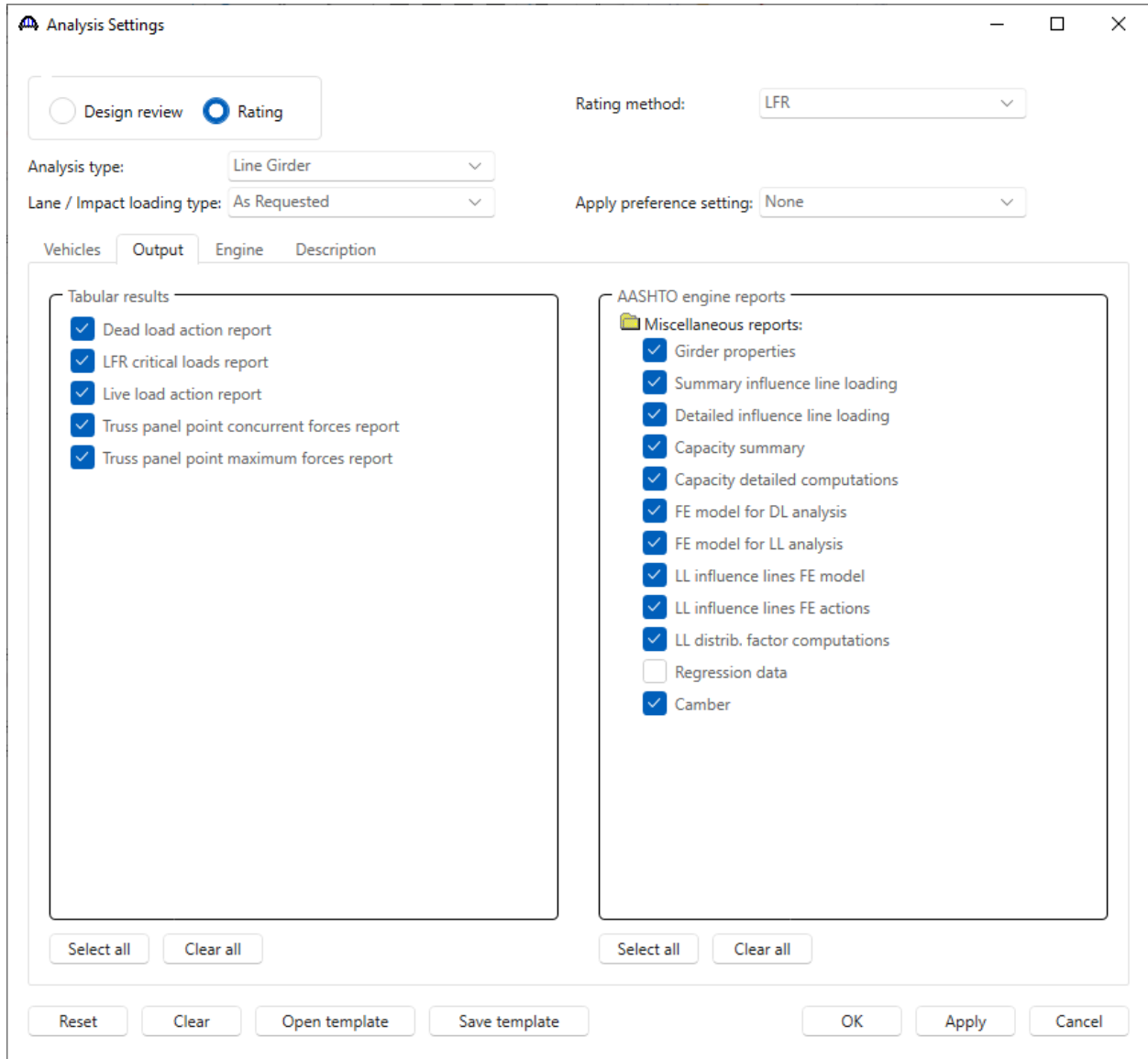
Click **OK** to apply the analysis settings and close the window.

Select **Alt #1** in the **Bridge Workspace** tree and click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.

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The **Analysis** window shows analysis progress messages during analysis. Messages in blue are information messages. Warning messages are in green and error messages are in red. The **Analysis** window indicates the analysis is successfully completed.
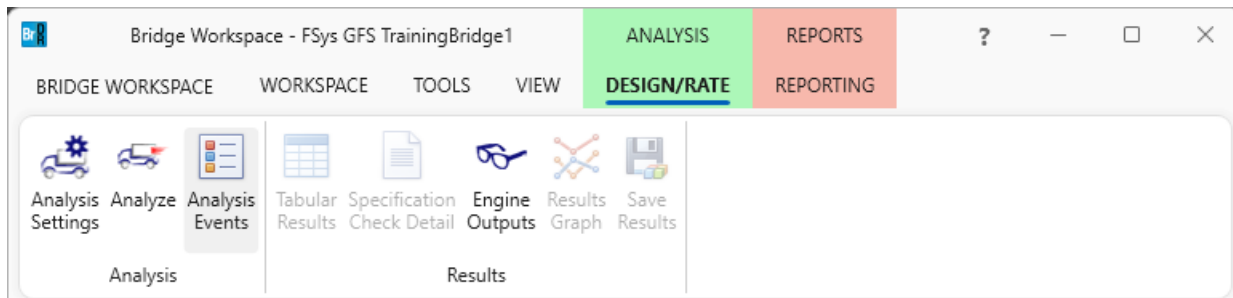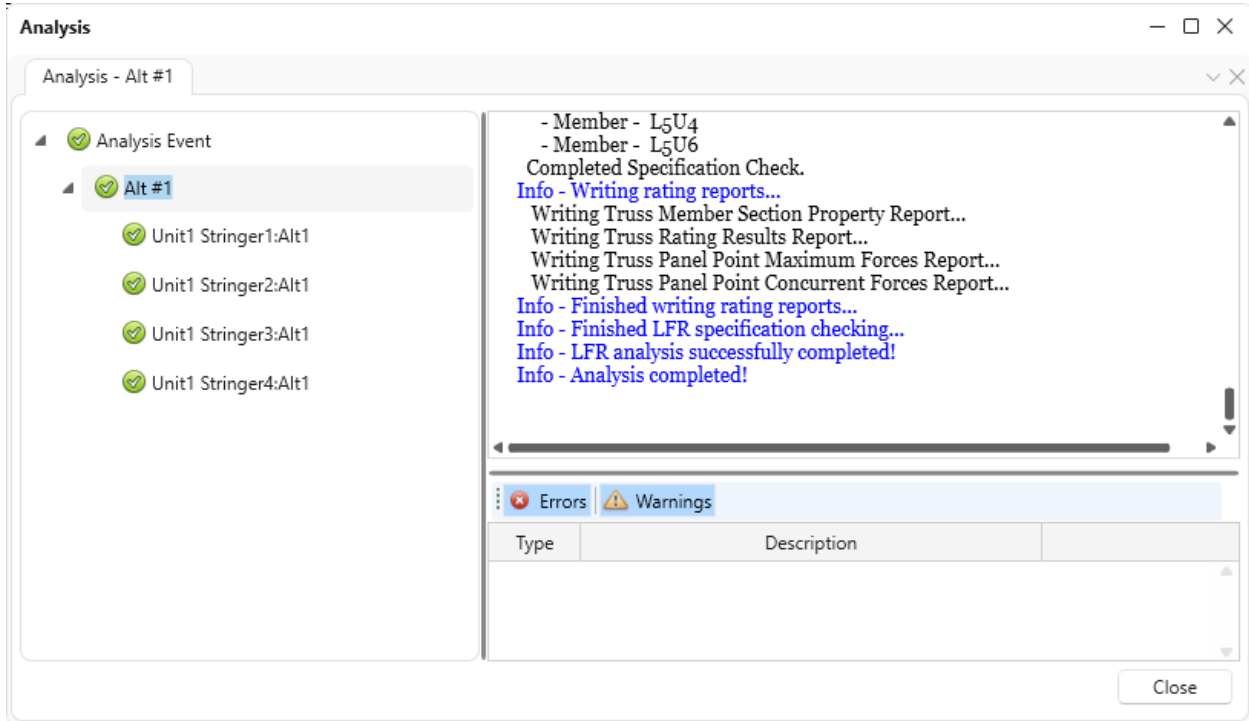
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Analysis results and outputs

Tabular Results

When the rating analysis is completed, results can be reviewed by selecting the **Alt #1** member in the **Bridge Workspace** tree and clicking the **Tabular Results** button on the **Results** group of the ribbon. The window shown below will open.
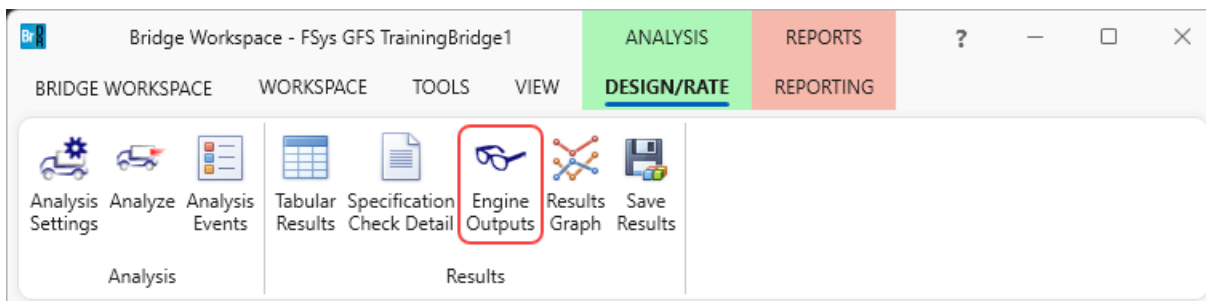

Engine Outputs

After the analysis, the output files can be viewed by clicking the **Engine Outputs** button on the **Results** group of the ribbon.

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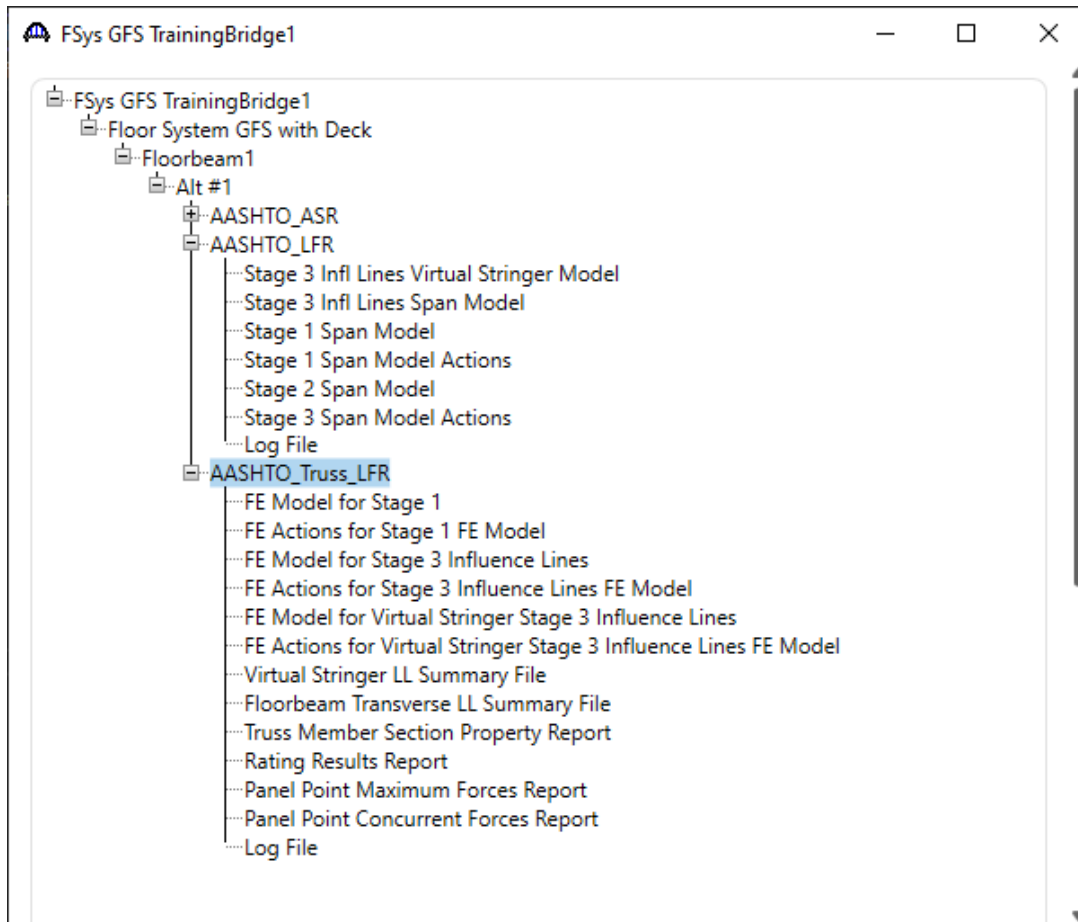
Description of the output files:

- **FE Model for Stage 1**

    The stage 1 finite element model presents the floor truss nodes, truss elements, element properties, support conditions and load cases for the dead load analysis.

- **FE Actions for Stage 1 FE Model**

    The stage 1 finite element result presents the support reactions, element actions and nodal displacements for each dead load case.

- **FE Model for Stage 3 Influence Lines**

    The stage 3 influence line finite element model presents the floor truss nodes, truss elements, element properties, support conditions and load cases for the influence line analysis. Each load case represents a unit load at a panel point.

- **FE Actions for Stage 3 Influence Lines FE Model**

The stage 3 influence line finite element result presents the support reactions, element actions and nodal displacements for each influence line load case. The results are used to generate the axial influence lines for the truss elements and the reaction influence lines for the support nodes.

- **FE Model for Virtual Stringer Stage 3 Influence Lines**

  The stage 3 virtual stringer influence line finite element model presents the virtual stringer nodes, beam elements, element properties, support conditions and load cases for the virtual stringer influence line analysis.

- **FE Actions for Virtual Stringer Stage 3 Influence Lines FE Model**

  The stage 3 virtual stringer influence line finite element result presents the support reactions for each influence line load case. The results are used to generate the reaction influence line for the support node located at the floor truss.

- **Virtual Stringer LL Summary File**

  The virtual stringer live load summary presents the reaction influence line for the support node located at the floor truss and the maximum and minimum vertical reactions for each live loading.

- **Floorbeam Transverse LL Summary File**

  The floorbeam transverse live load summary presents the stringer reactions for each vehicle position pattern and the resulting axial force for each truss member.

- **Truss Member Section Property Report**

  The section properties report presents the section properties for each truss member and for each component of a truss member.

- **Rating Results Report**

  The rating result report presents all information required to perform the rating computation.

- **Panel Point Maximum Forces Report**

  The maximum forces report presents the maximum member forces due to dead load and live load for each truss member at each panel point.

- **Panel Point Concurrent Forces Report**

  The concurrent forces report presents the concurrent member live load forces for each panel point's member under the critical live load condition.

- **Log File**

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The log file is the analysis log produced when the analysis is run. This file may contain errors and warnings that should be reviewed.

A portion of the **Truss Member Section Property Report** is shown below.

Truss Member Section Property Summary

Member	Gross Area Comp. (in²)	Gross Area Tens. (in²)	Effective Area Tens. (in²)	Izz (in⁴)	Cy (in)	Rz (in)	Iyy (in⁴)	Cz (in)	Ry (in)	Actual Length (ft)	Unbraced Length z (ft)	Unbraced Length y (ft)	Fy (ksi)
L1L2	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
L2L2	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
L3L4	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
L4L5	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
L5L6	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
U1U2	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
U2U3	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
U3U4	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
U4U5	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
U5U6	5.87	5.87	5.87	41.40	3.10	2.66	13.30	0.00	1.51	6.00	6.00	6.00	36.00
L1U1	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	4.00	4.00	4.00	36.00
L2U2	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	4.00	4.00	4.00	36.00
L3U3	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	4.00	4.00	4.00	36.00
L4U4	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	4.00	4.00	4.00	36.00
L5U5	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	4.00	4.00	4.00	36.00
L6U6	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	4.00	4.00	4.00	36.00
L2U1	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	7.21	7.21	7.21	36.00
L2U3	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	7.21	7.21	7.21	36.00
L3U4	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	7.21	7.21	7.21	36.00
L4U3	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	7.21	7.21	7.21	36.00
L5U4	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	7.21	7.21	7.21	36.00
L5U6	10.13	10.13	9.50	74.55	3.38	2.71	17.01	0.00	1.30	7.21	7.21	7.21	36.00

A portion of the **Rating Results Report** is shown below.

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A portion of the **Panel Point Maximum Forces Report** is shown below.