AASHTOWare BrDR 7.5.0

Floor System Tutorial

FS2 – Floorbeam Stringer Line Example

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BrDR Tutorial

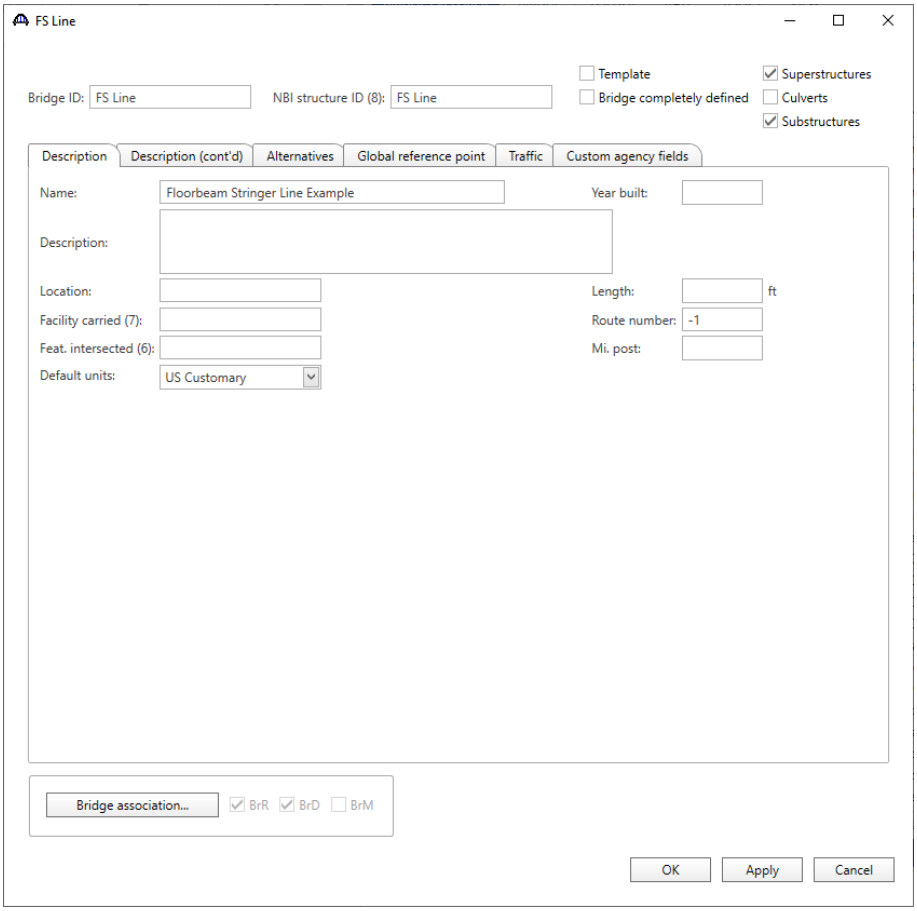
Topics Covered

- Superstructure composed of floorbeams and stringers.
- Line Superstructure Definition
- Plate girder floorbeams, linearly varying web.
- Rolled beam stringers.

This example demonstrates entering a Floorbeam-Stringer superstructure in BrDR using the Line superstructure definition approach. This example targets an advanced user familiar with the basics of BrDR.

Superstructure composed of girders, floorbeams and stringers.

From the **Bridge Explorer** create a **New** bridge and enter the following description data.

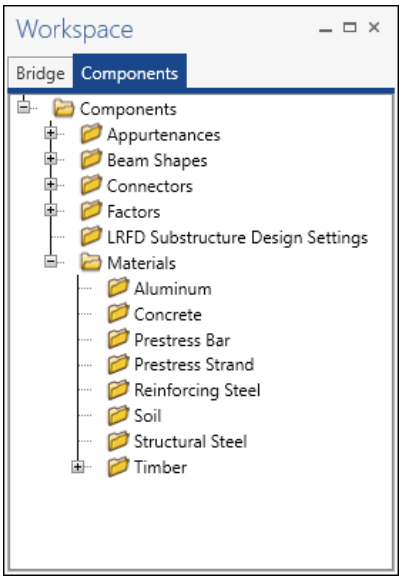


Close the window by clicking **OK**.

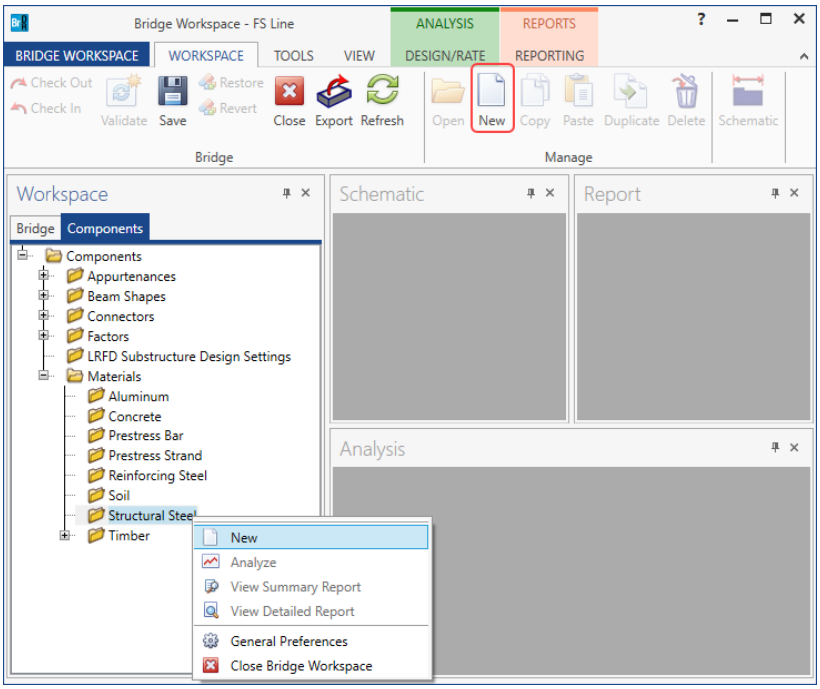
Bridge Materials

To enter the materials to be used by members of the bridge, in the **Components** tab of the **Bridge Workspace**, click on the ⊞ button to expand the tree for **Materials**.

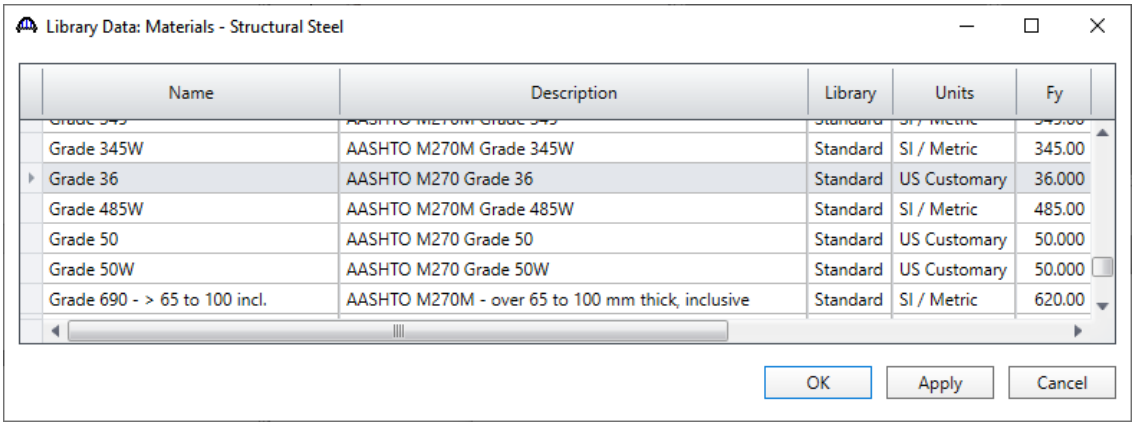
The tree with the expanded **Materials** branch is shown below.



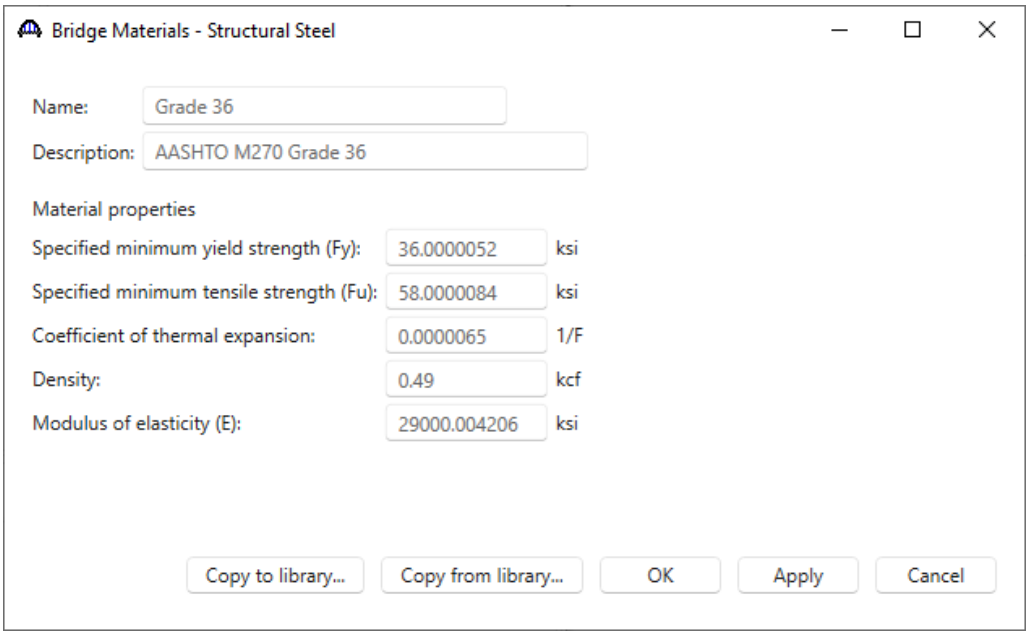
To add a new structural steel material, in the **Components** tab of the **Bridge Workspace**, click on **Materials**, **Structural Steel,** and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Structural Steel** and select **New**). The window shown below will open.



Add the structural steel material by clicking the **Copy from library…** button. The following window opens. Select **Grade 36** and click **OK.**

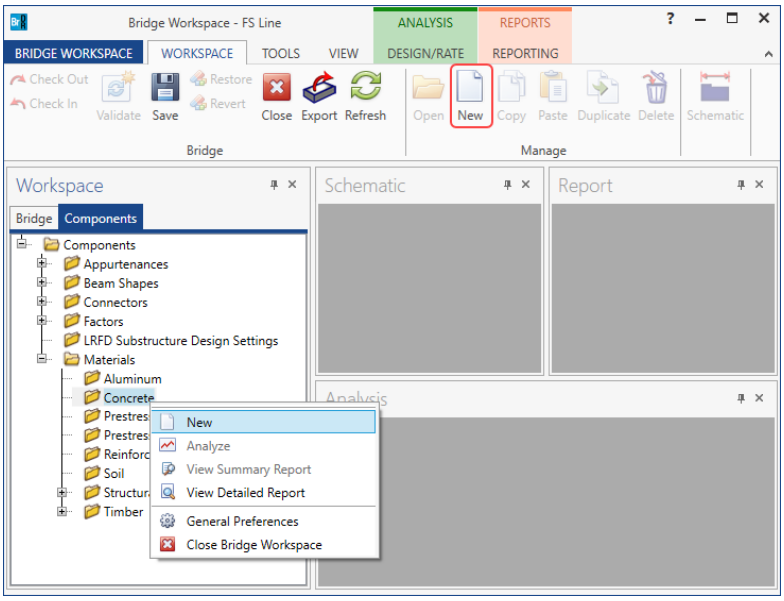


The selected material properties are copied to the **Bridge Materials – Structural Steel** window as shown below.

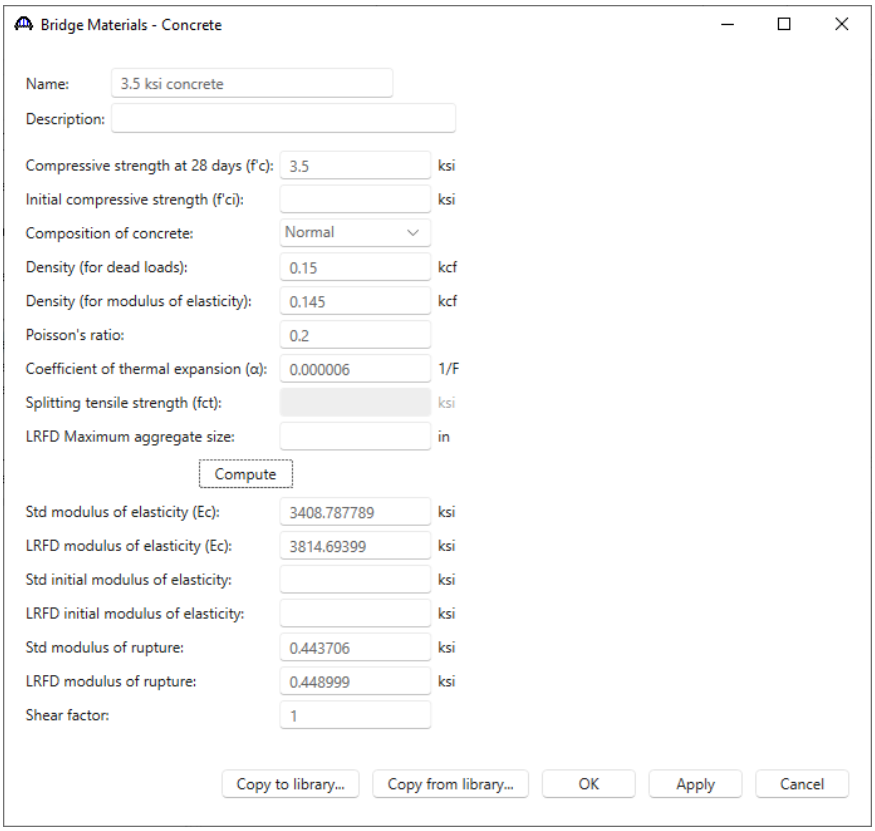


Click **OK** to apply the data and close the window.

Add a new concrete material, by clicking on **Materials**, **Concrete,** and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Concrete** and select **New**). The window shown below will open.



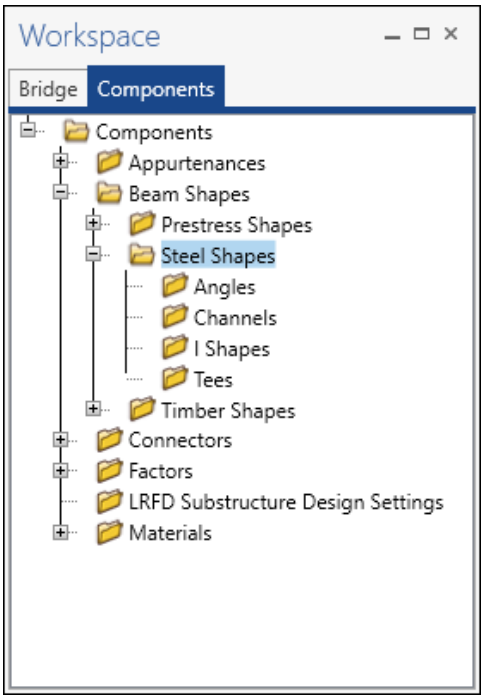
Enter the values shown above the **Compute** button and click the **Compute** button to compute the remaining values below them.



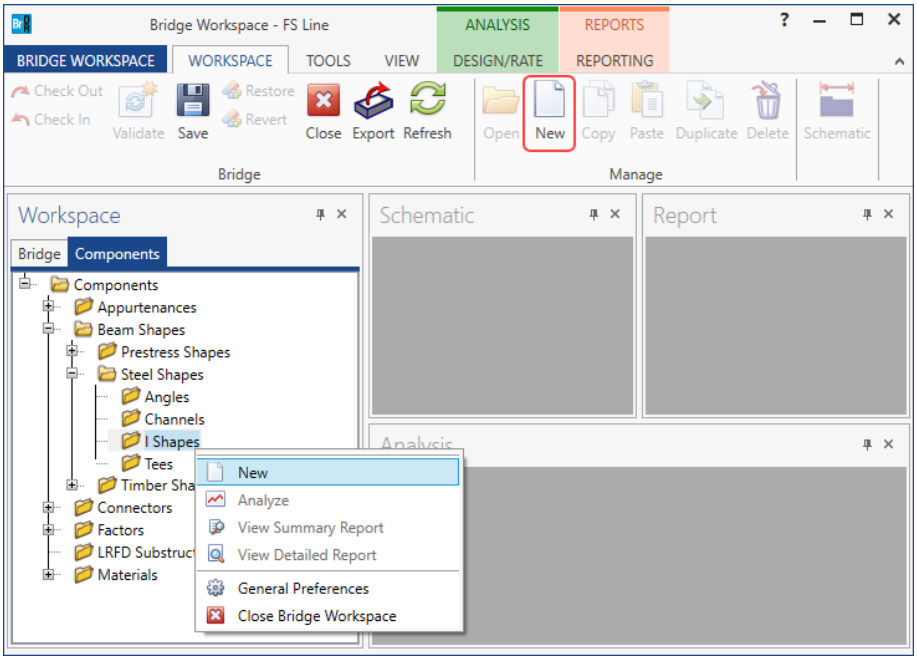
Click **OK** to apply the data and close the window.

Beam Shapes

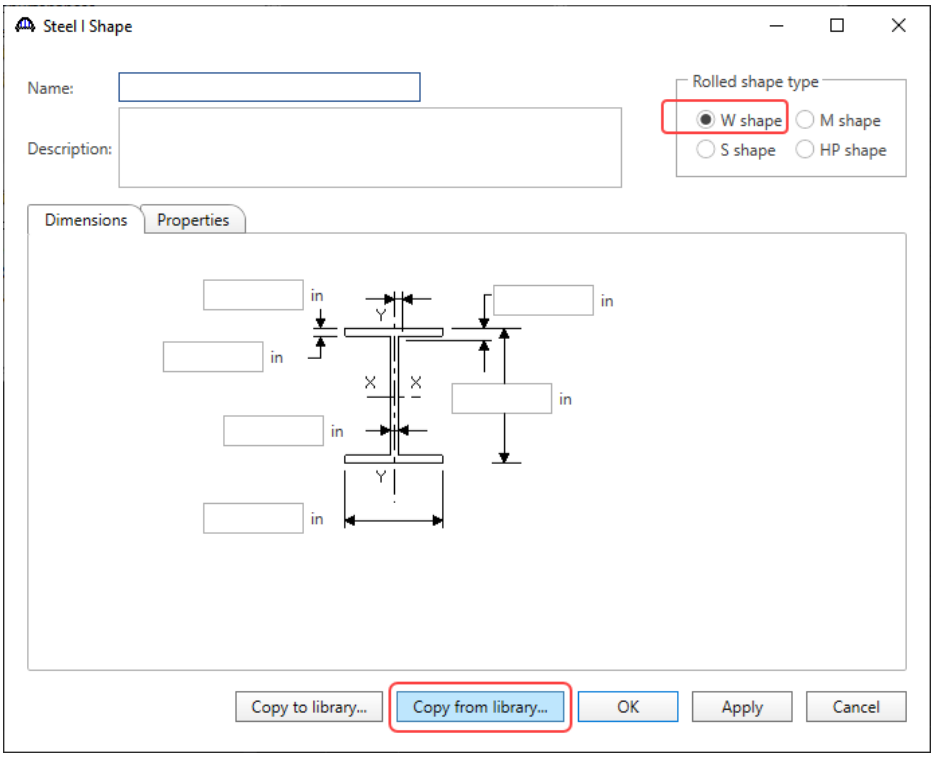
To enter a steel beam shape to be used in this bridge expand the tree labeled **Beam Shapes** and **Steel Shapes** as shown below. The partially expanded **Components** tree with the **Steel Shapes** node expanded is shown below.



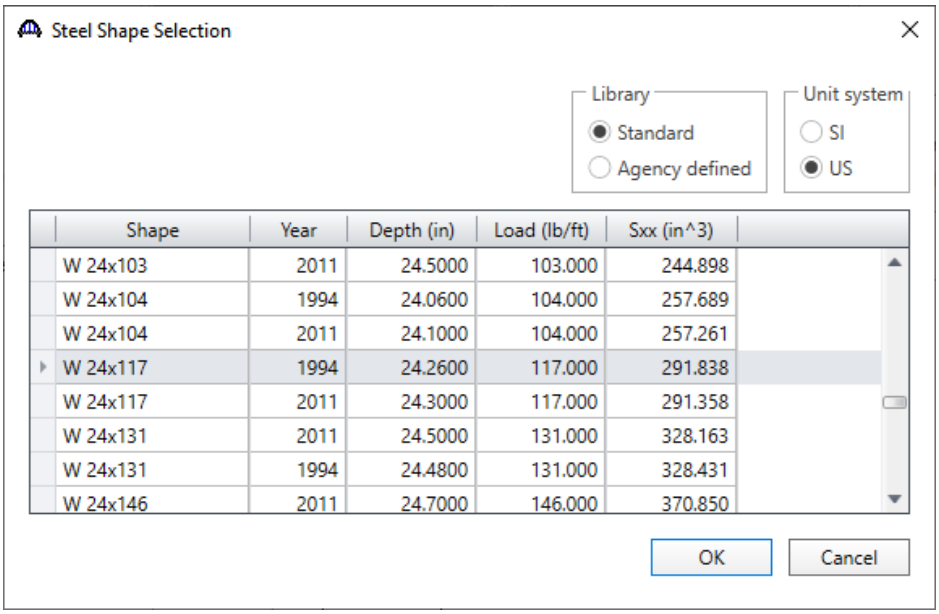
To add a new steel I shape, click on the **I Shapes** node in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **I Shapes** and select **New** or double click on **I Shapes** in the **Components** tree). The window shown below will open.



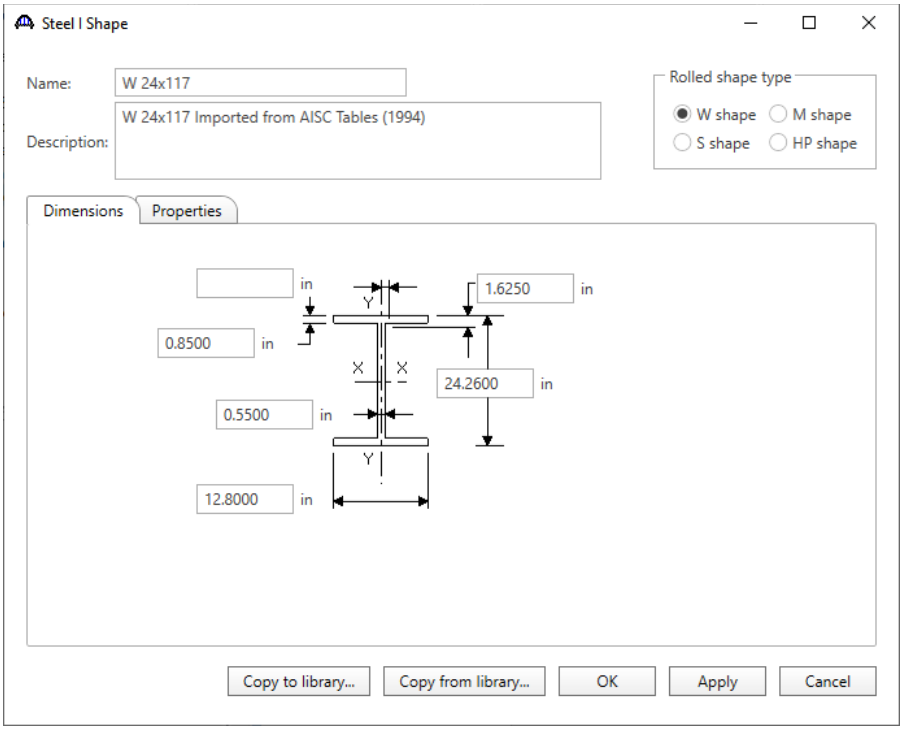
Select the **Rolled shape type** as **W shape** and click the **Copy from library…** button. The **Steel Shape Selection** window will appear.



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 **W24x117 (Year – 1994)** and click **OK**.

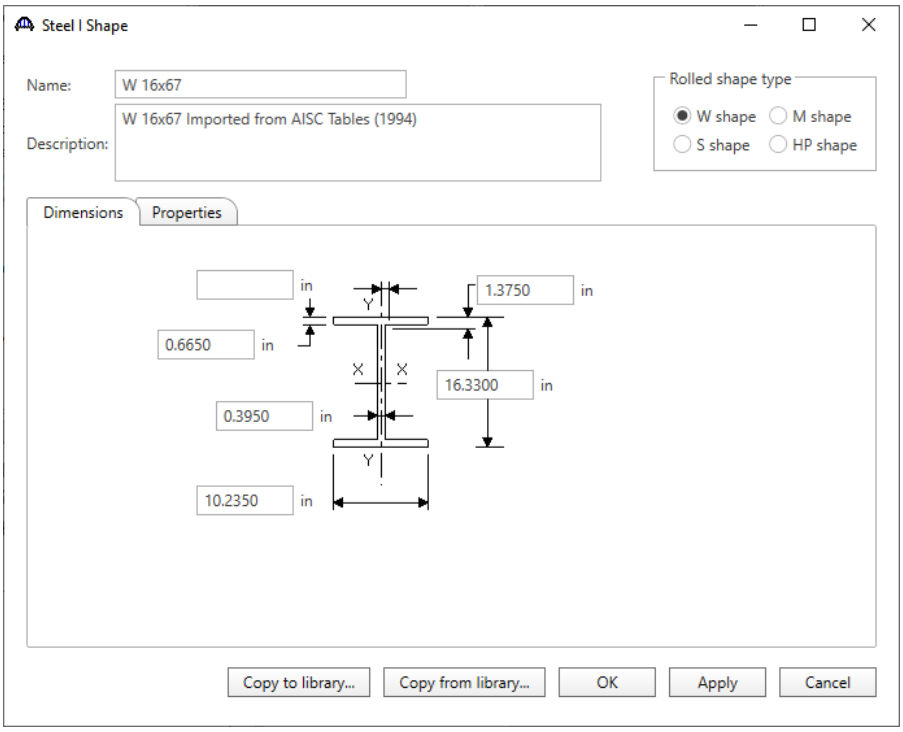


The beam properties are copied to the **Steel I Shape** window as shown below.



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

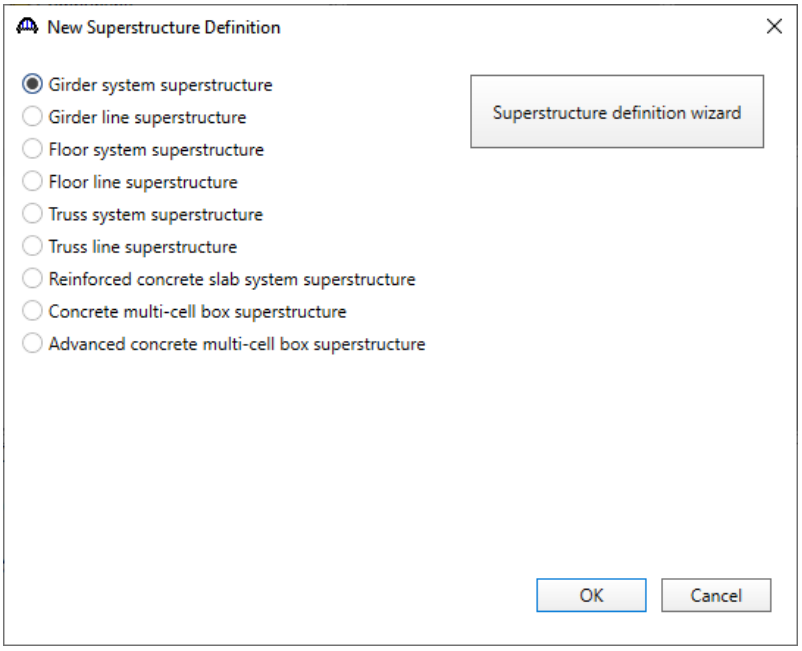
Similarly add a **W16x67 (Year – 1994)** steel I shape. The **Steel I Shape** window will be updated as shown below.



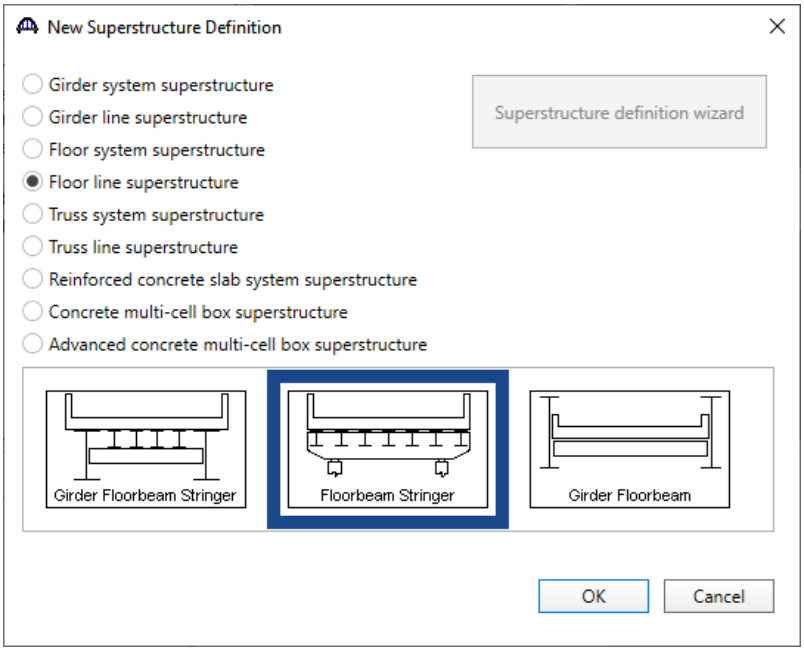
Click **OK** to apply the data and close the window.

Line Superstructure Definition

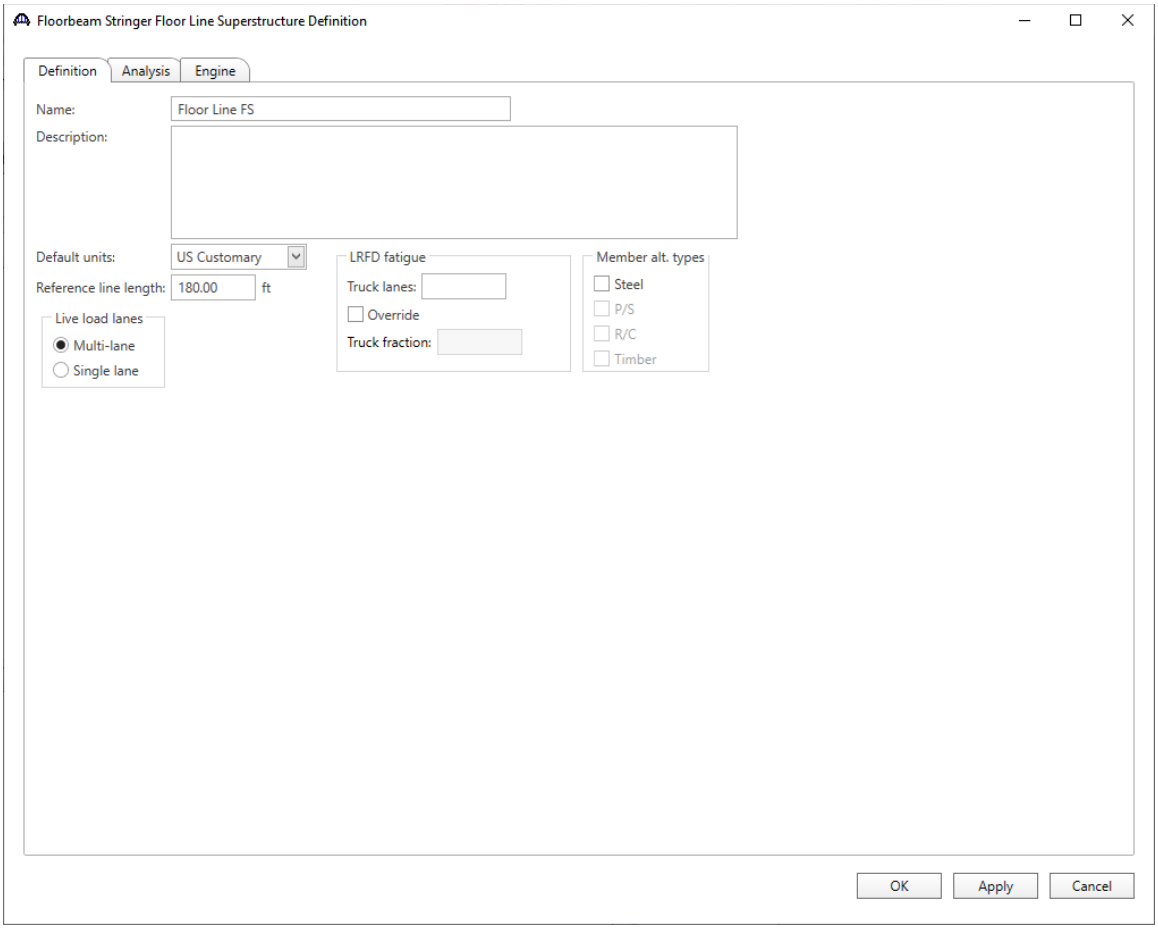
Returning to the **Bridge** tab of the **Bridge Workspace**, double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the **WORKSPACE** ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition. The window shown below will appear.



Selecting **Floor line superstructure** displays three types of floor line superstructure definitions. Select the **Floorbeam Stringer** and click **OK.**

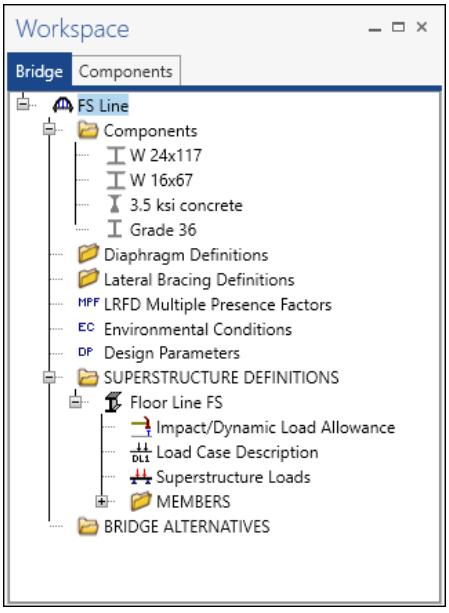


The **Floorbeam Stringer Floor Line Superstructure Definition** window will open. Enter the data as shown below.



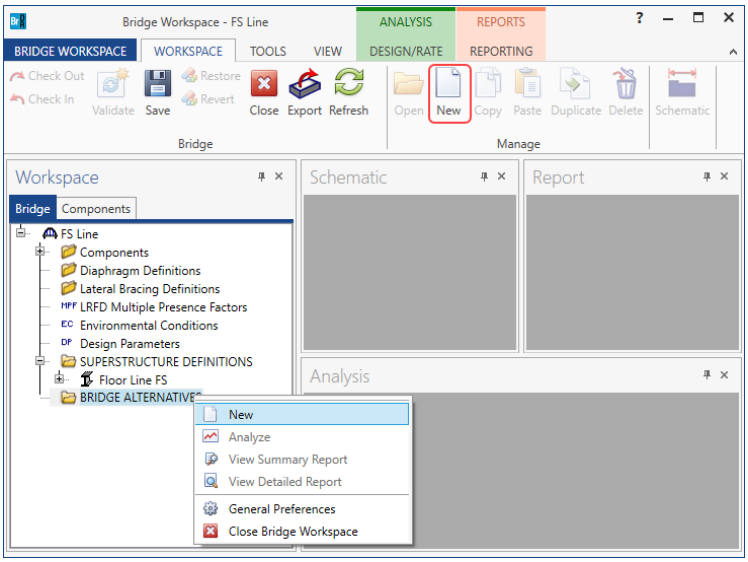
Click **OK** to apply the data and close the window.

The partially expanded **Bridge Workspace** tree is shown below.

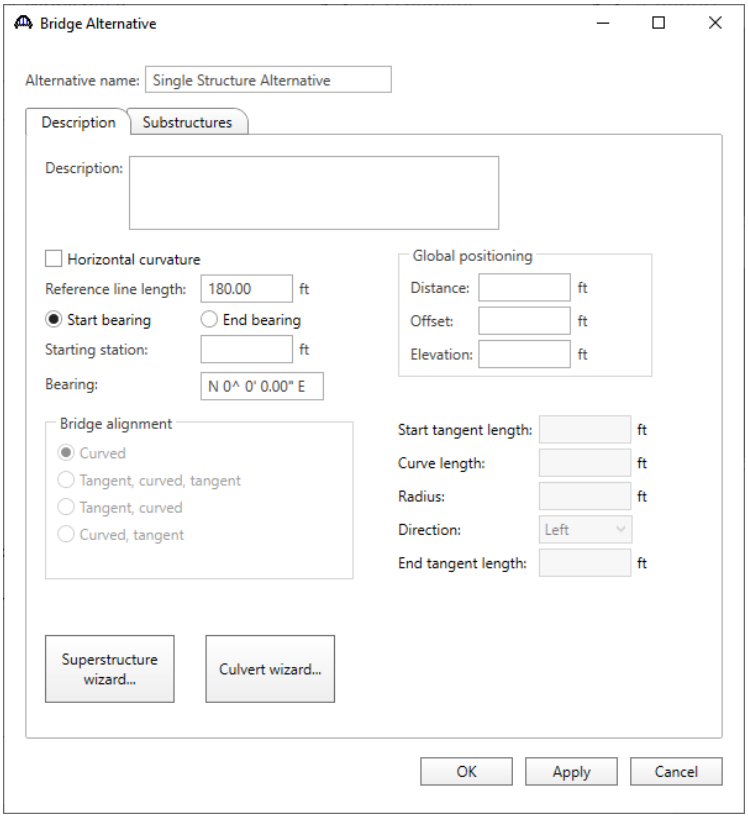


BRIDGE ALTERNATIVES

Navigate to the **BRIDGE ALTERNATIVES** node in the **Bridge Workspace** tree and create a new bridge alternative by double-clicking on **BRIDGE ALTERNATIVES** (or click on **BRIDGE ALTERNATIVES** and select **New** from the **Manage** group of the **WORKSPACE** ribbon).

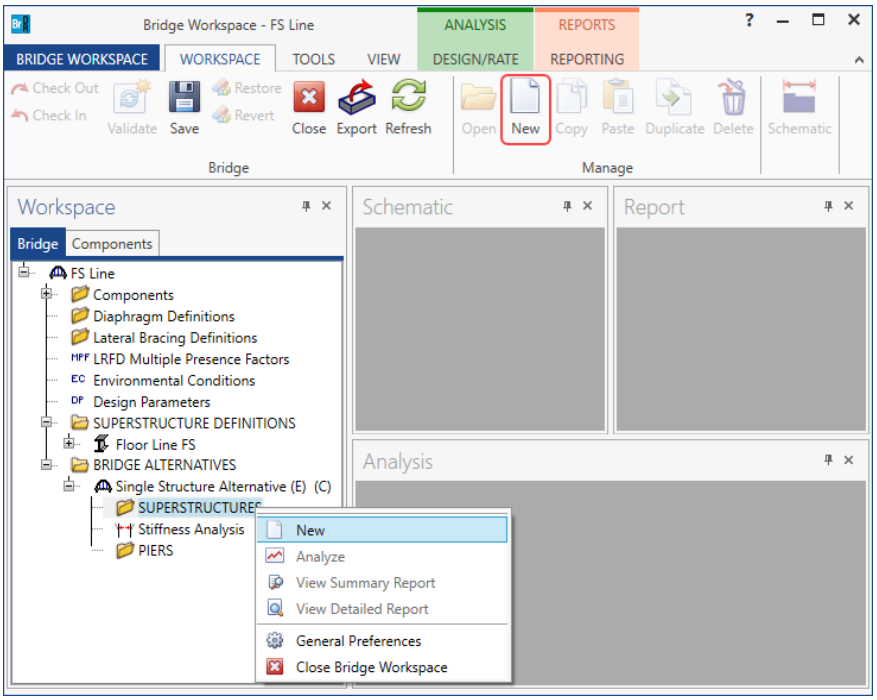


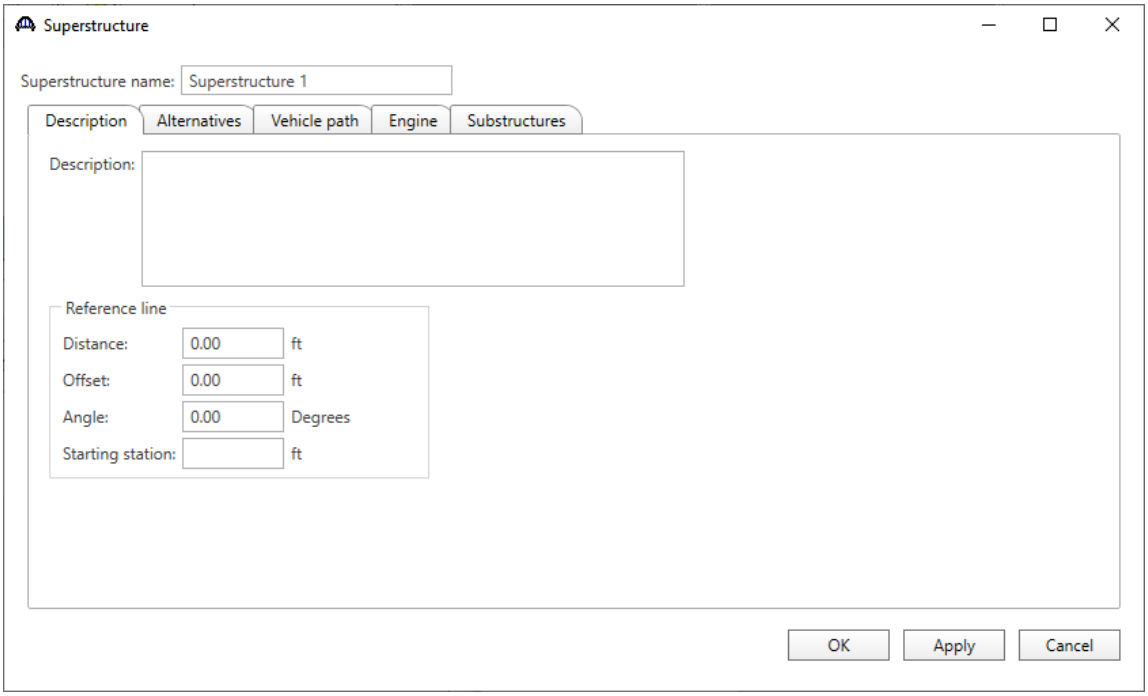
Enter the following data.



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

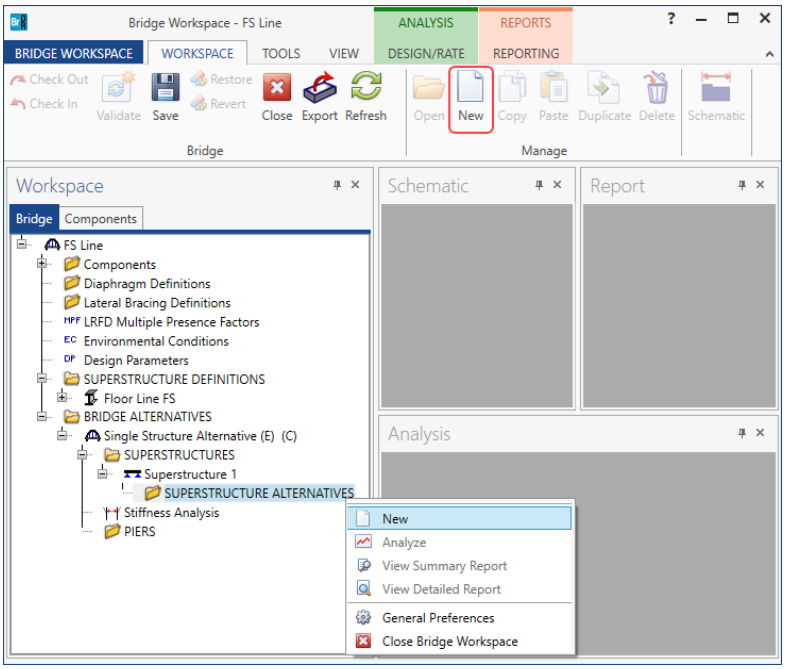
Expand the **Single Structure Alternative** node in the **Bridge Workspace** tree by clicking the ⊞ button. Double-click on the **SUPERSTRUCTURES** node (or select **SUPERSTRUCTURES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure.



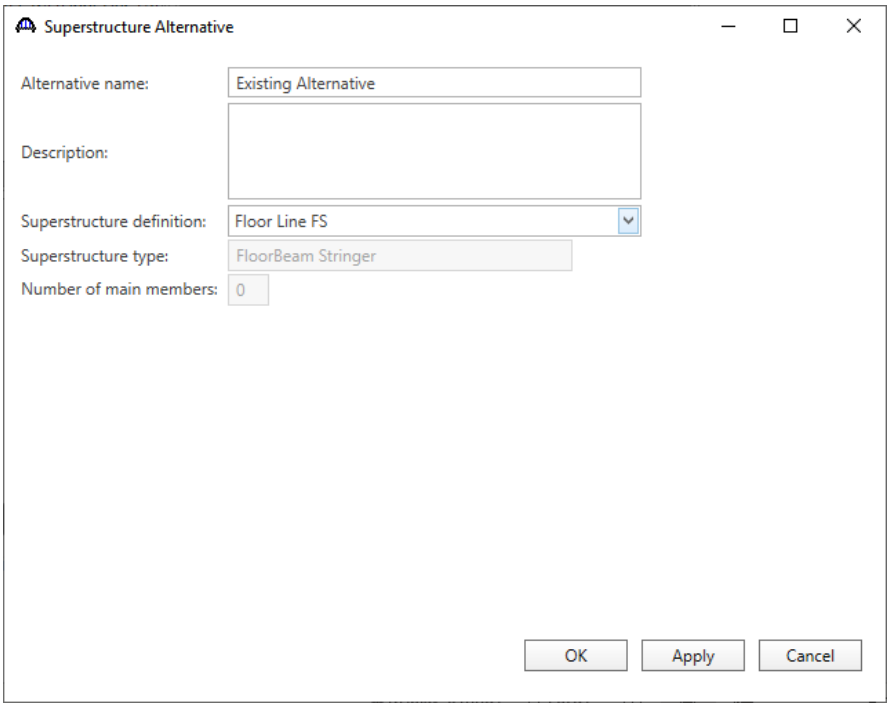


Click **OK** to apply the data and close the window.

Expand the **Superstructure 1** node in the **Bridge Workspace** tree by clicking the ⊞ button. Double-click on the **SUPERSTRUCTURE ALTERNATIVES** node (or select **SUPERSTRUCTURE ALTERNATIVES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure alternative.

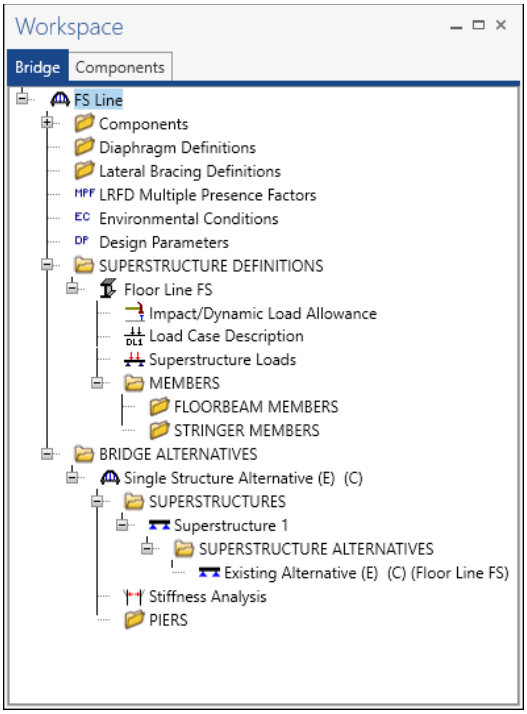


Select the **Superstructure definition Floor Line FS** as the current superstructure definition for this Superstructure Alternative.



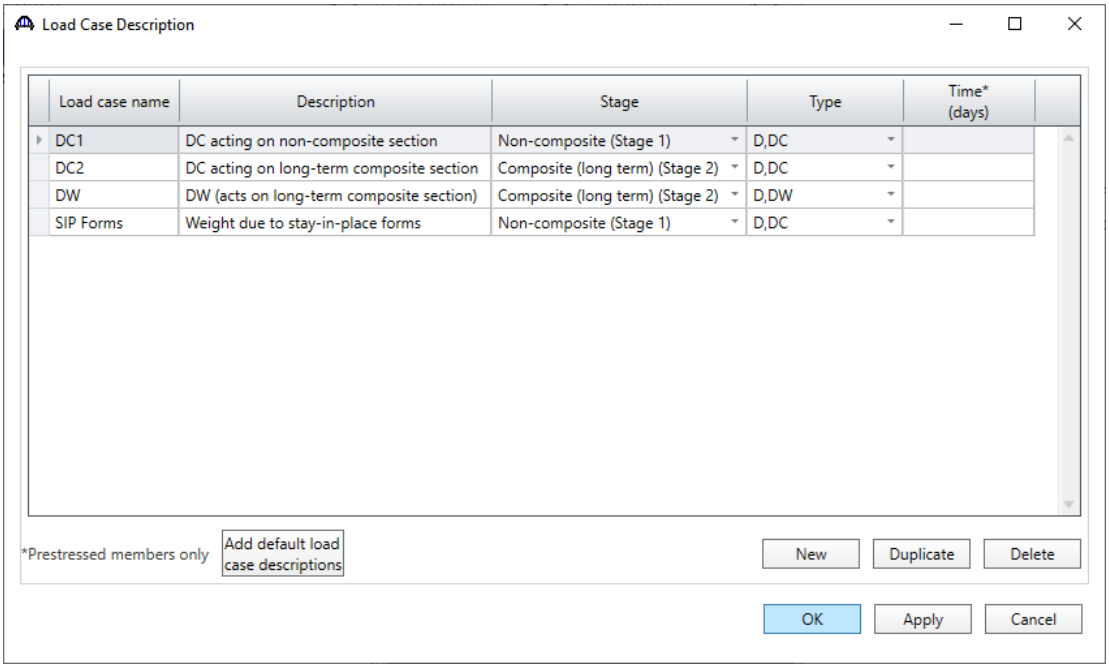
Click **OK** to apply the data and close the window.

The partially expanded **Bridge Workspace** tree is shown below.



Load Case Description

Navigate to the **Floor Line FS** superstructure definition and double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window.** Click on the **Add default load case description** button to create the following load cases.

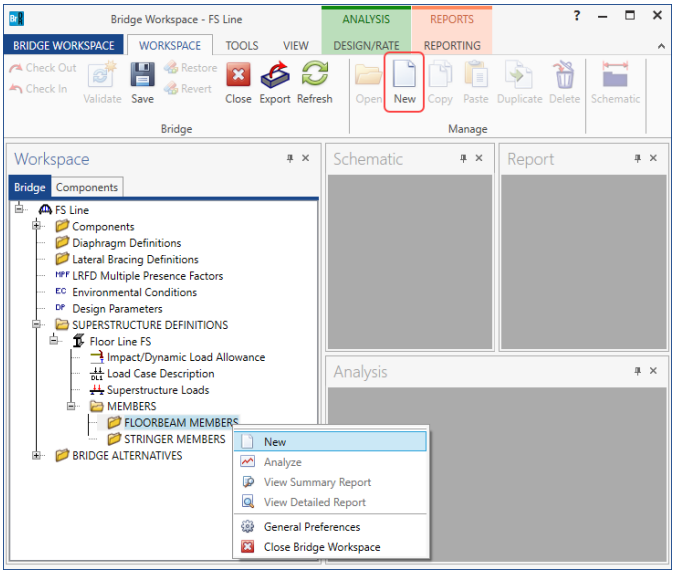


Click **OK** to apply the data and close the window.

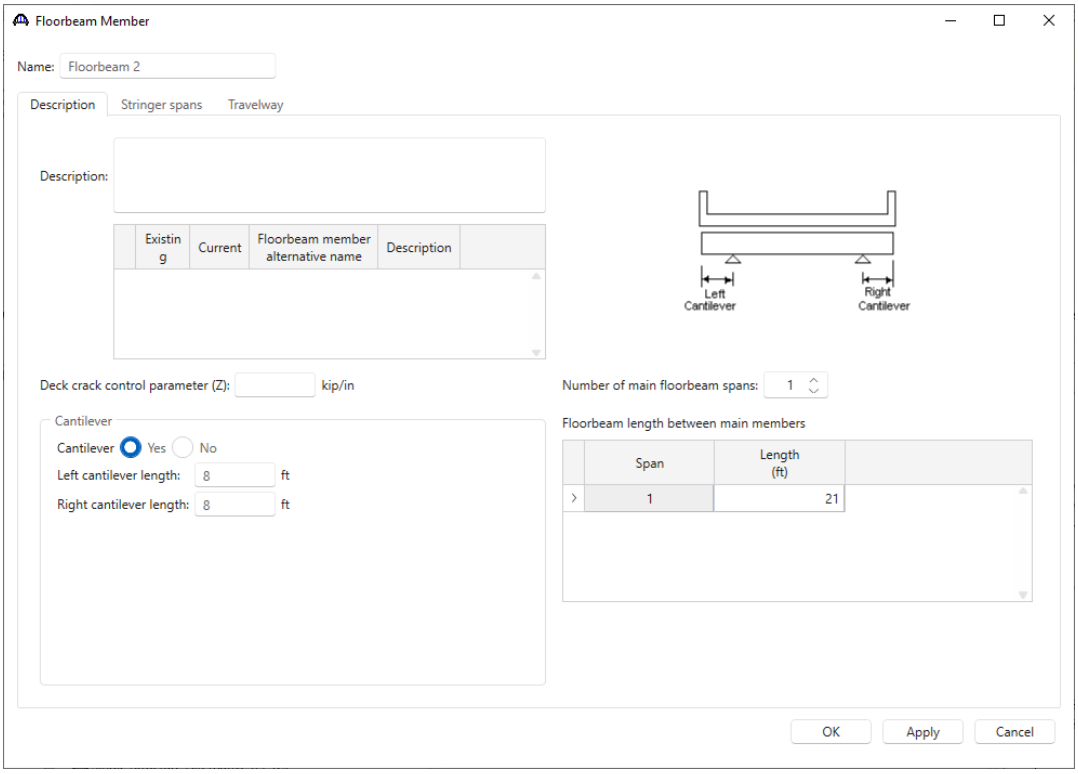
This superstructure does not contain any transverse or bearing stiffeners so they will not be created in this example.

Floorbeam Members - Description

Create a new floorbeam member by expanding **MEMBERS**, selecting **FLOORBEAM MEMBERS** in the **Bridge Workspace** tree and clicking the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**). The following **Floorbeam Members** window opens.



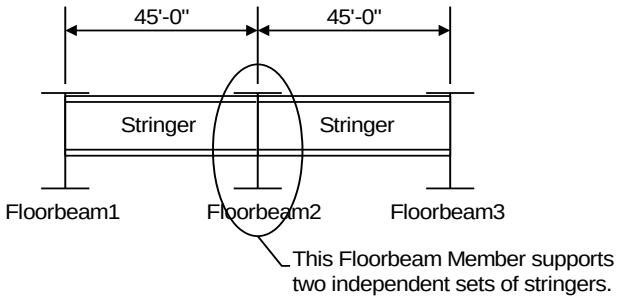
Enter the data in the Description tab as shown below.



Floorbeam Members – Stringer spans

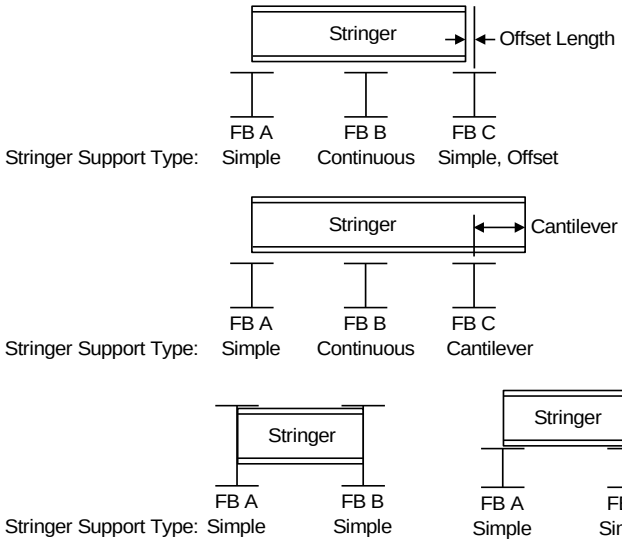
The **Stringer spans** tab on the **Floorbeam Member** window describes the stringer spans that the floorbeam member supports. The **Stringer spans** tab allows the user to describe the stringers that contribute live load to this floorbeam member. This tab allows the analysis engine to compute the stringer live load reaction on the floorbeam due to one wheel line of a vehicle. The analysis engine will then use data from the **Floorbeam Member: Travelway** to place the appropriate number of wheel lines on the floorbeam member and move the wheel lines across the floorbeam to produce the critical loading. The actual stringer spacing is not entered nor used to transfer the live load from the stringers to the floorbeam.

The first item on this tab is the question **Is this floorbeam shared by two independent sets of stringer spans?** Select **Yes** since this floorbeam is supporting two structurally independent sets of stringers as shown in the sketch below. The option to specify the span lengths for the stringer to the left of Floorbeam 2 and for the stringer to the right of Floorbeam 2 will now be available.

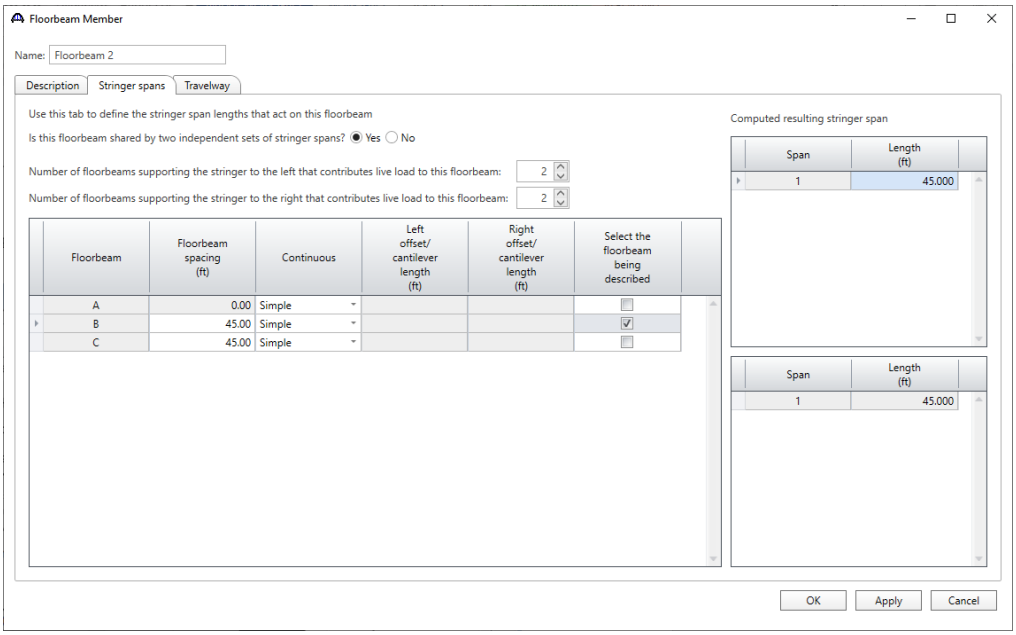


2 floorbeams support the stringer to the left in this example.
2 floorbeams support the stringer to the right in this example.

When entering the floorbeam spacing in the grid, the type of stringer support at each floorbeam can be specified. The following sketches illustrate the different types of stringer supports available.

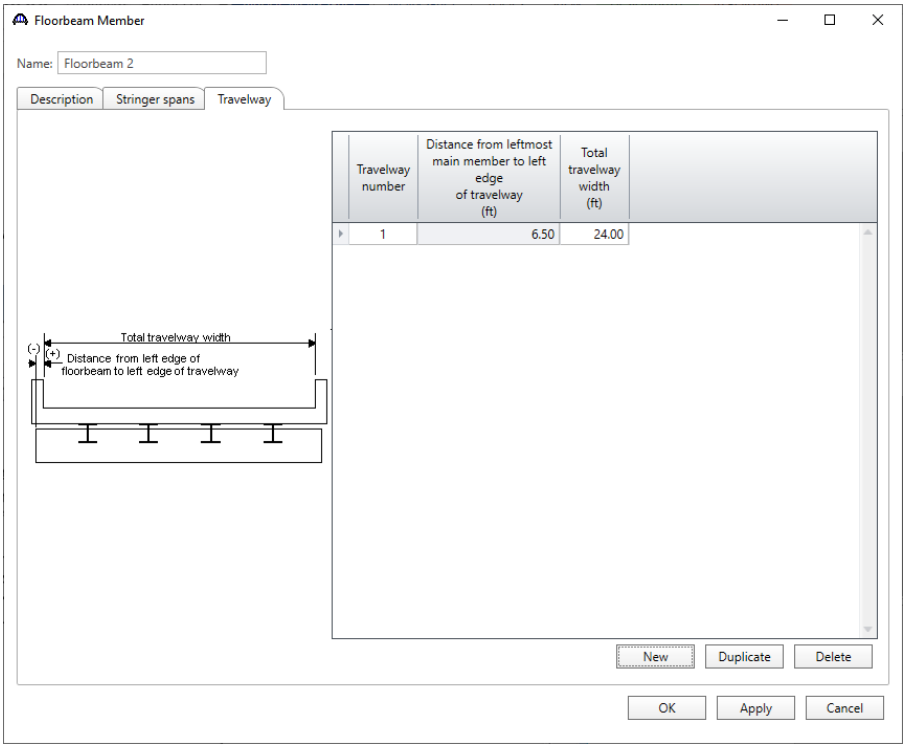


For this example, the stringer support types are all simple. Lastly check the floorbeam member being described in the grid. The completed **Stringer spans** tab is shown below.



Floorbeam Members – Travelway

The **Travelway** tab on the **Floorbeam Member** window describes the following lane positions for loading the floorbeam member.



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

Floorbeam Member Loads

Expand the **Floorbeam 2** floorbeam member and double click on **Floorbeam Member Loads** in the **Bridge Workspace** tree to open the **Floorbeam Member Loads** window. Since this floorbeam member is being described using the Line approach, the dead loads from the stringers acting on the floorbeam must be entered. The deck slab acting on the floorbeam will be described in the floorbeam member alternative so the dead load due to the deck slab will not be input as a load on the floorbeam. It will be computed by the system when the member alternative is exported to the analysis engine.

The stringer dead loads acting on the floorbeam can be input as either a uniform load acting over the length of the floorbeam or as concentrated loads acting at the stringer locations. In this example, these loads will be entered as concentrated loads at the stringer locations. The following shows how the interior stringer DC1 deadloads are computed.

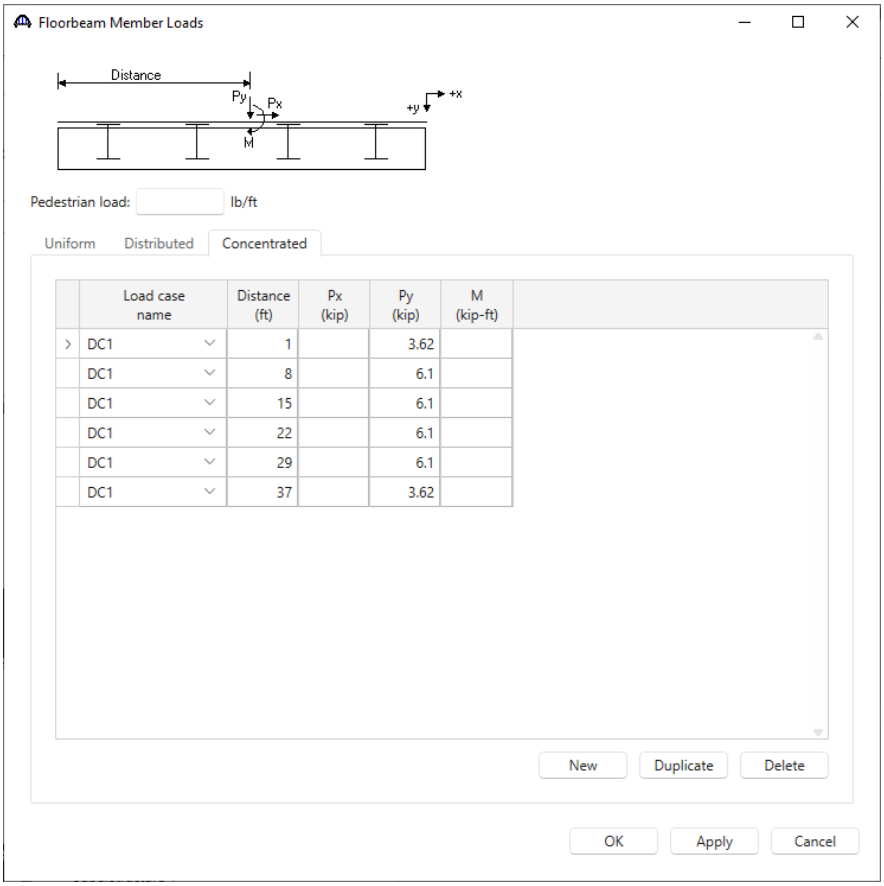
Interior Stringer DC1 Load on Floorbeam

Component	Load (lb/ft)
Selfweight	117
Haunch	13.3
Diaphragms	5.27
Total =	135.57

The reaction on the floorbeam due to the stringer load is computed as follows:

$$R = \frac{(135.57\ \text{lb/ft}) * 45'}{2} = 3050\ lb = 3.05\ kips$$

Since the floorbeam is supporting 2 sets of stringers, the total reaction on the floorbeam for an interior stringer is 6.10 kips. This load is applied as a concentrated load on the floorbeam at the stringer location. The same procedure is followed to determine the dead load reaction on the floorbeam for the exterior stringers.

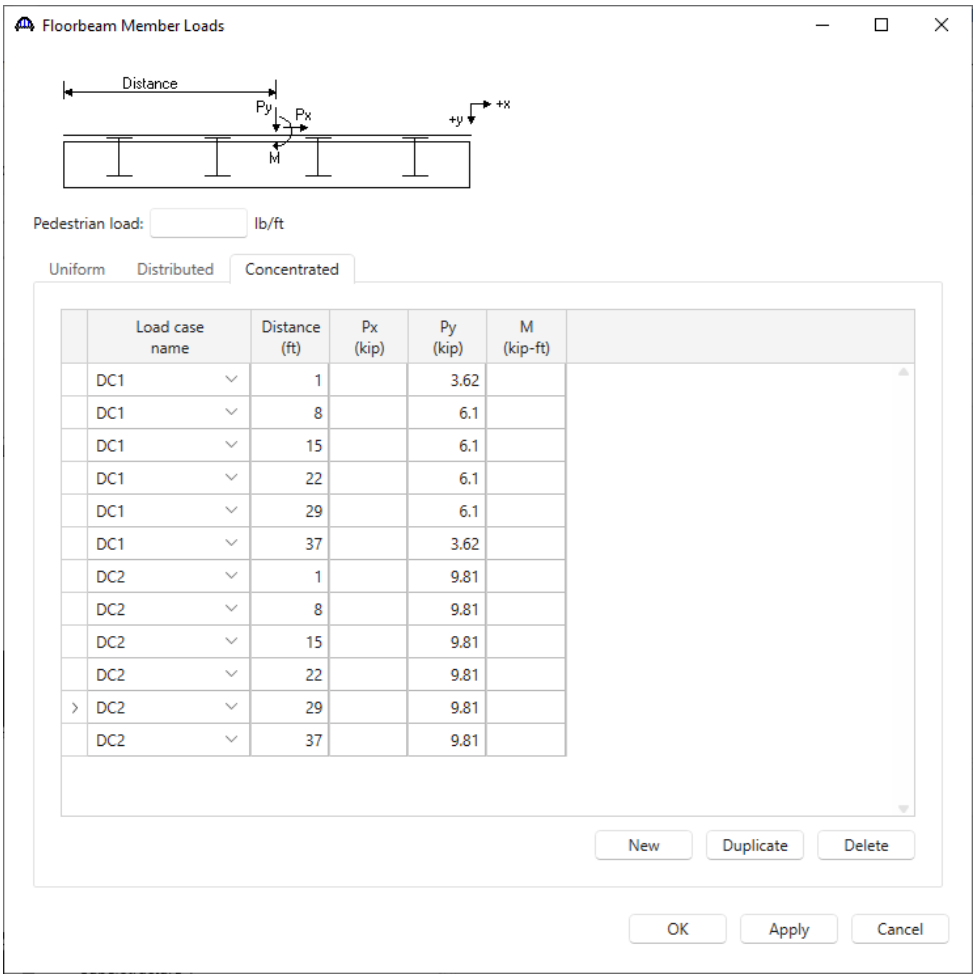


The DC2 dead load on the floorbeam is the load due to the appurtenances. This load is also applied to the floorbeam as concentrated loads at the stringer locations.

$$Uniform\ dead\ load\ on\ each\ stringer = \frac{2(150\ \text{lb/ft}) + 2(505\ \text{lb/ft})}{6\ stringers} = 218\ \text{lb/ft}$$

$$Concentrated\ load\ on\ the\ floorbeam = (218\ \text{lb/ft})\ \frac{45'}{2} = 4905\ lb = 4.905\ kips$$

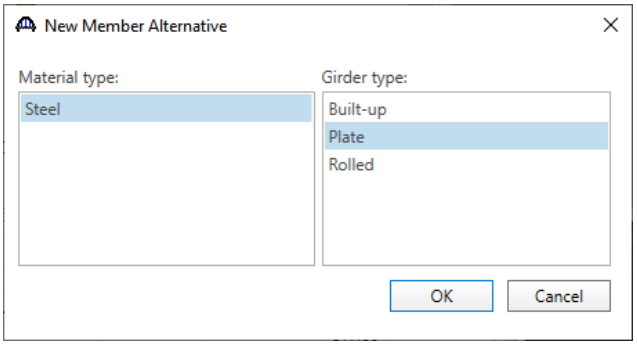
Since the floorbeam is supporting 2 sets of stringers, the total reaction due to the appurtenances on the floorbeam for a stringer is 9.81 kips.



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

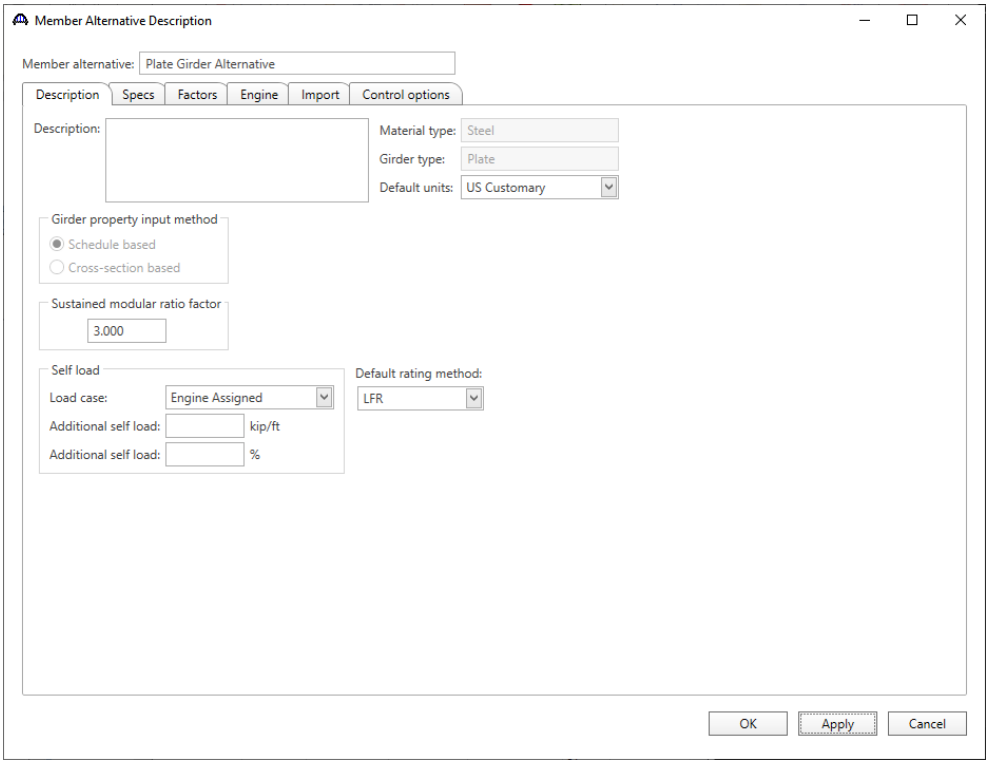
Floorbeam Member Alternative (Plate girder floorbeams, linearly varying web)

Now create a schedule based steel plate girder floorbeam member alternative by selecting the **FLOORBEAM MEMBER ALTERNATIVES** node in the **Bridge Workspace** tree and click **New** from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**). The following window opens.



Select **Steel** as the **Material type**, **Plate** as the **Girder type** and click **OK**.

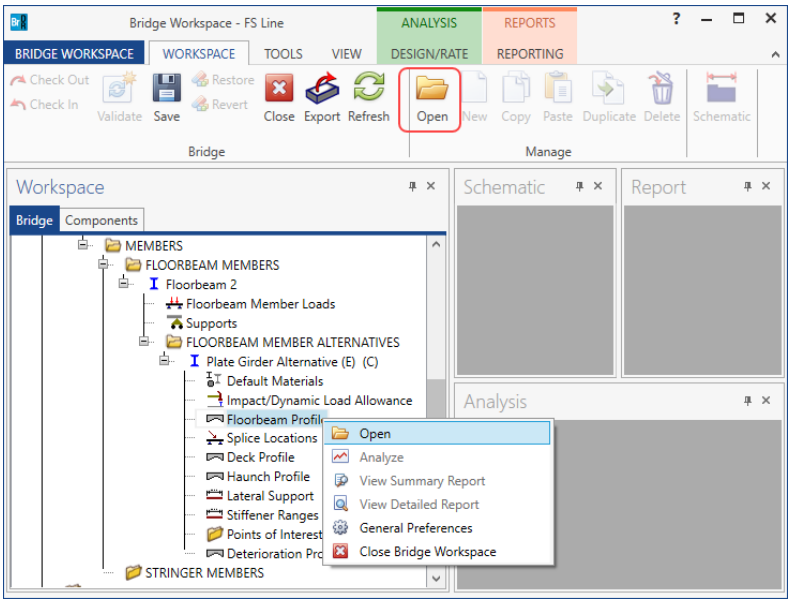
The **Member Alternative Description** window opens as shown below. Enter the following data.



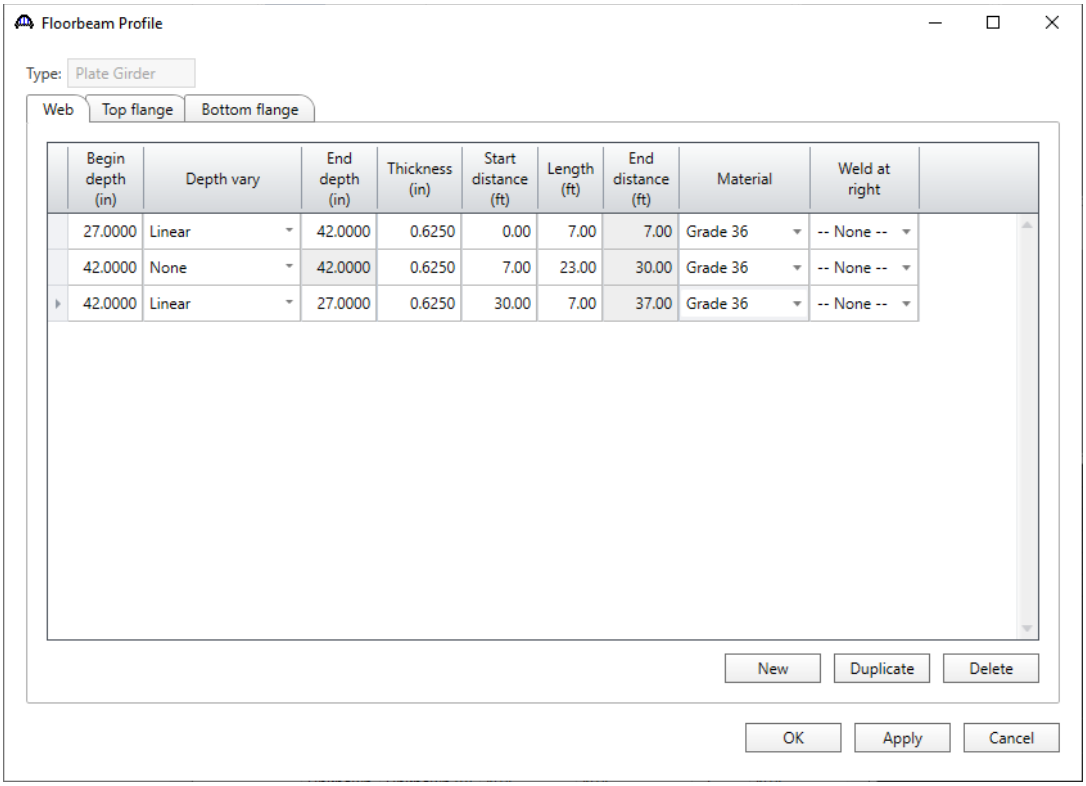
Click **OK** to apply the data and close the window.

Floorbeam Profile

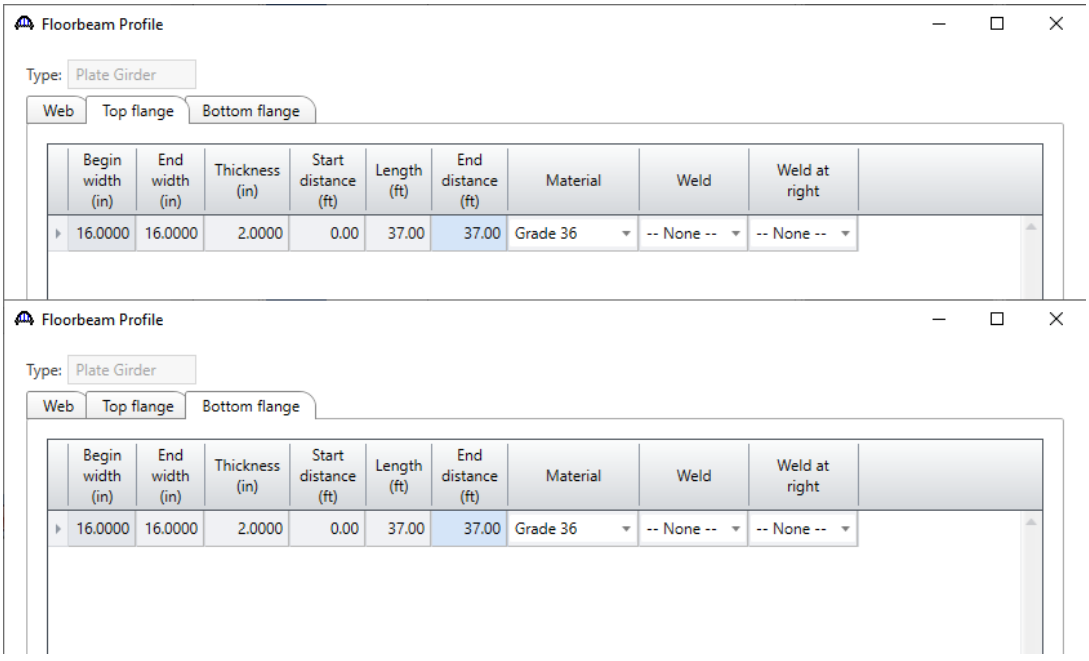
Expand the **Plate Girder Alternative** member alternative and double click on the **Floorbeam Profile** node in the **Bridge Workspace** tree (or right click and select **Open** or select **Open** from the **WORKSPACE** ribbon)to open the **Floorbeam Profile window** as shown below.



Describe the floorbeam profile as shown below.



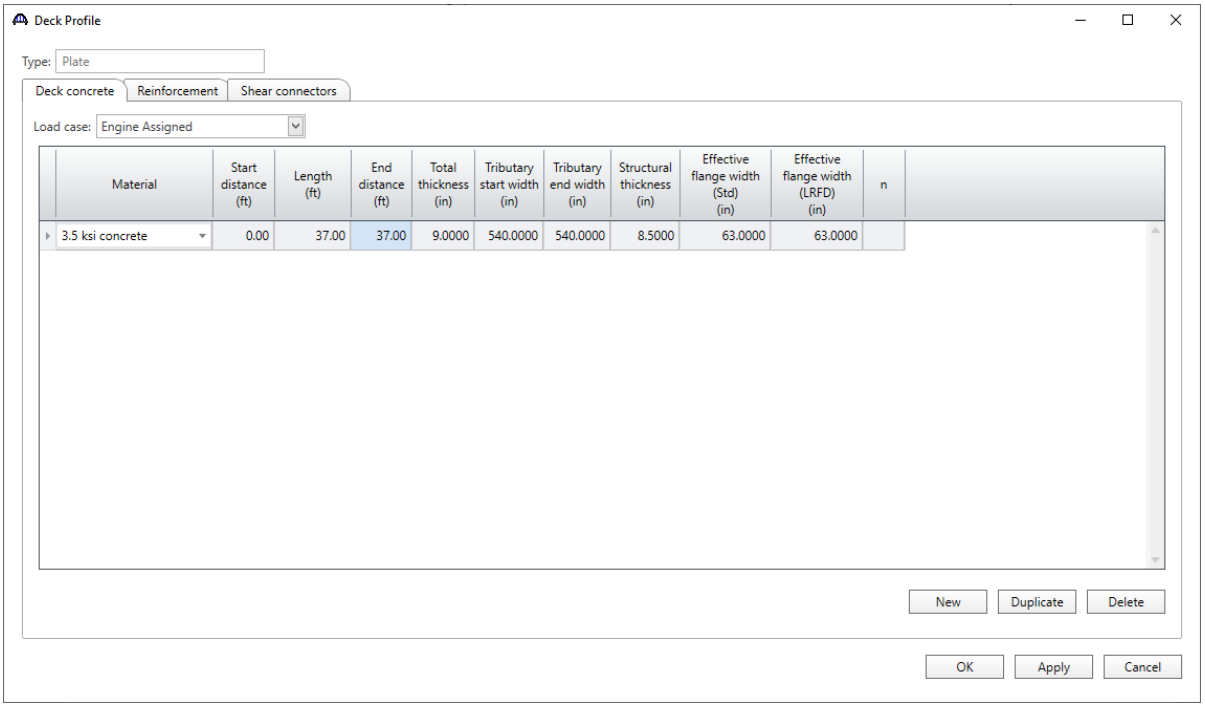
Describe the flanges as shown below.



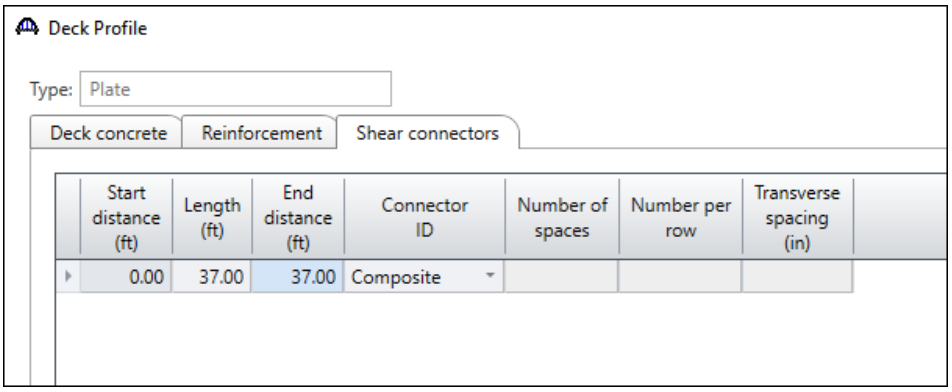
Click **OK** to apply the data and close the window.

Deck Profile

Next open the **Deck Profile** window by double clicking the **Deck Profile** node in the **Bridge Workspace** tree. Enter the data describing the structural properties of the deck. The floorbeam spacing is entered as the tributary width of the deck so the export can compute the dead load of the deck slab.



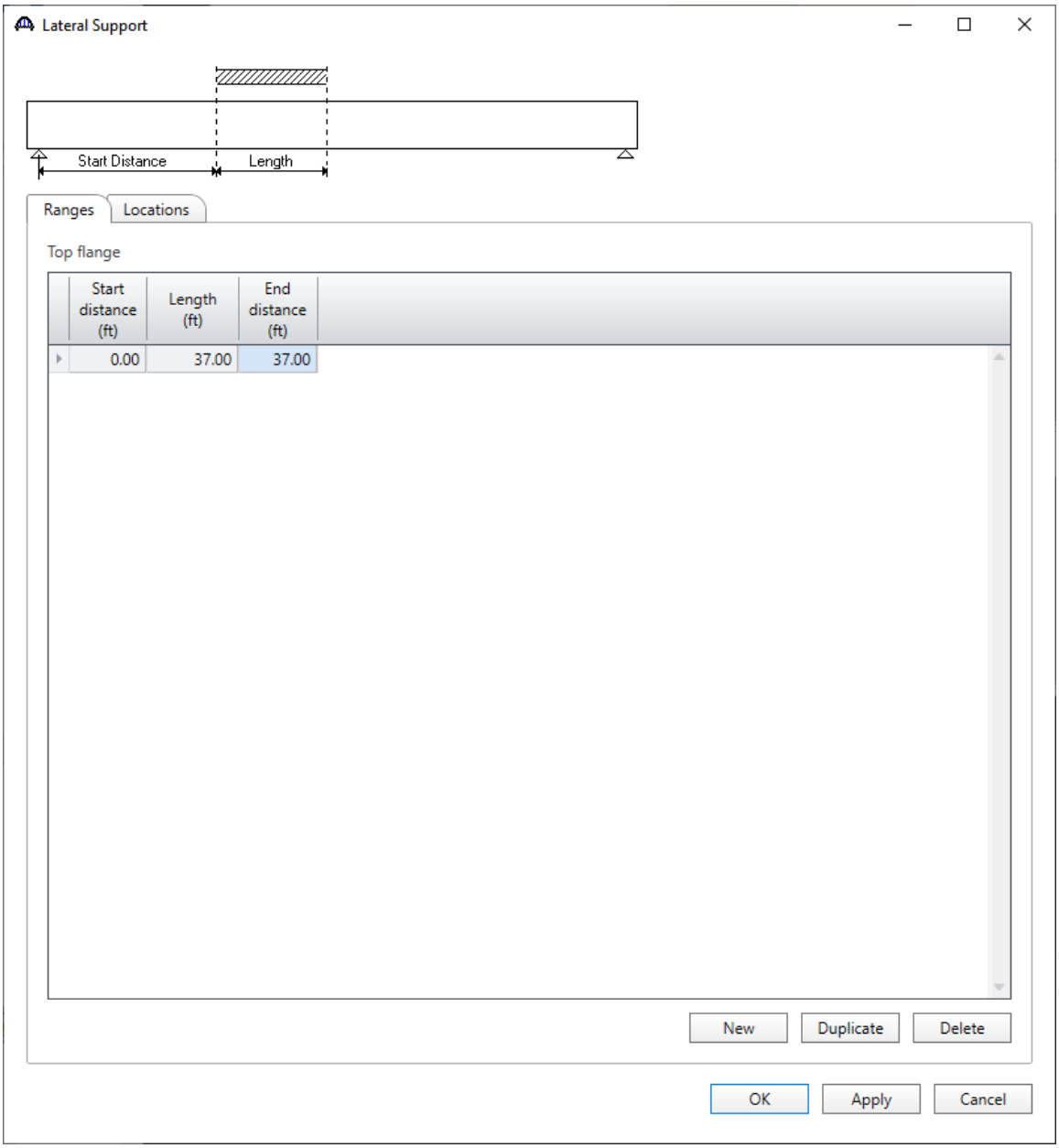
Navigate to the **Shear connectors** tab and enter the following data.



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

Lateral Support

Open the **Lateral Support** window by double clicking the **Lateral Support** node in the **Bridge Workspace** tree. Define the lateral support for the top flange of the floorbeam as follows.

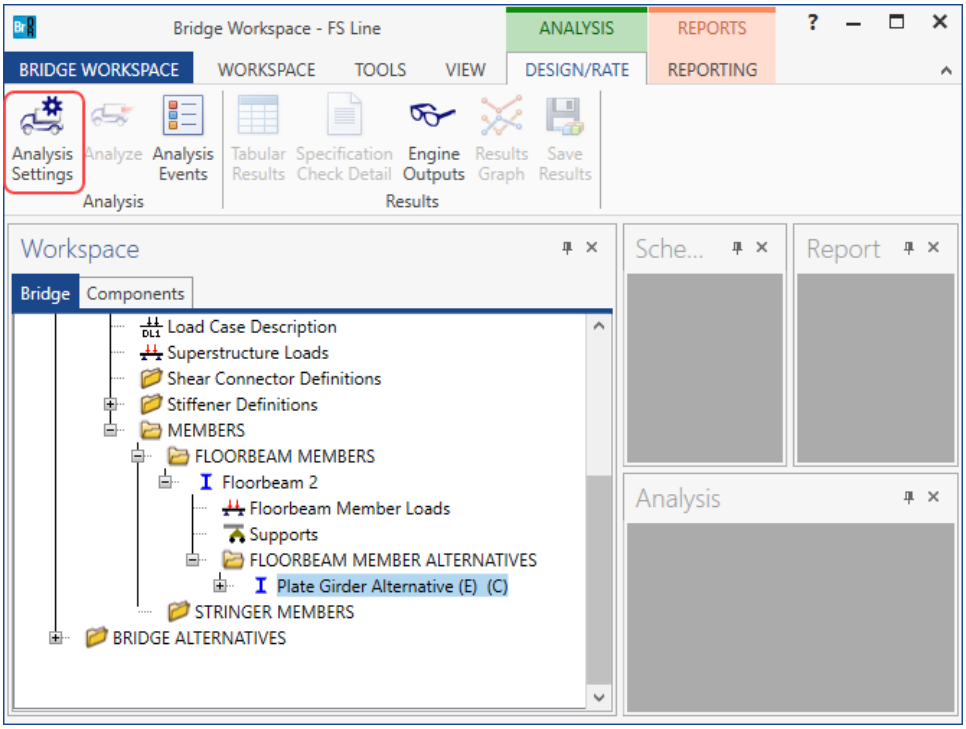


Click **OK** to apply the data and close the window.

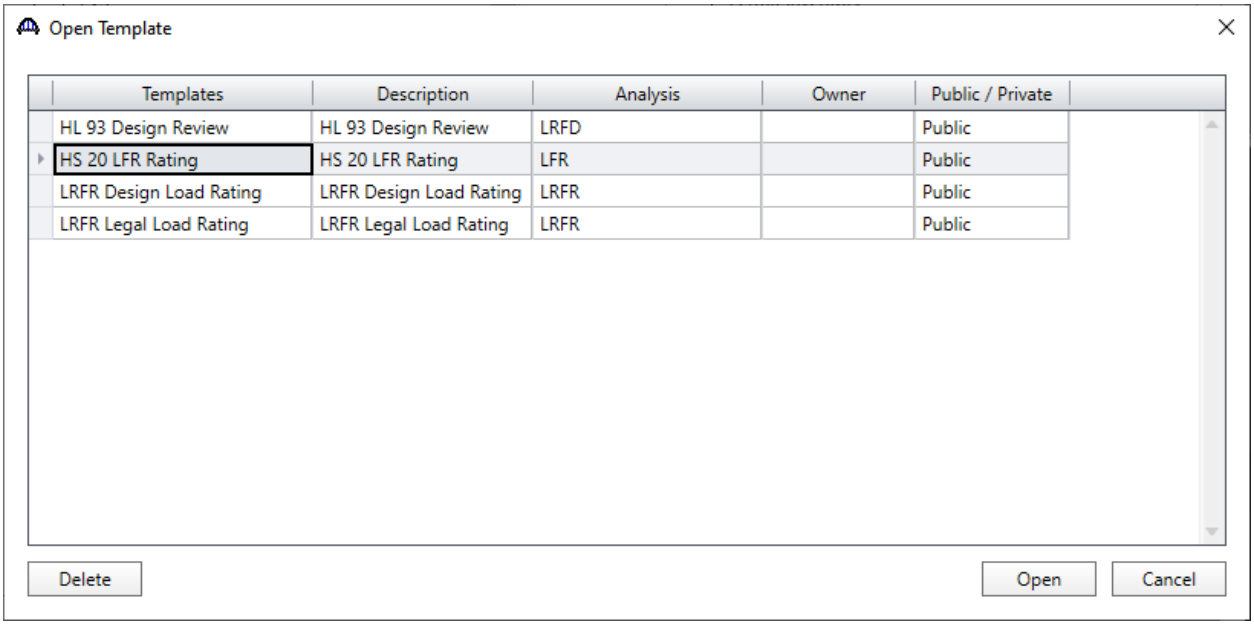
The description of the floorbeam member alternative is complete.

LFR Analysis – Floorbeam member alternative

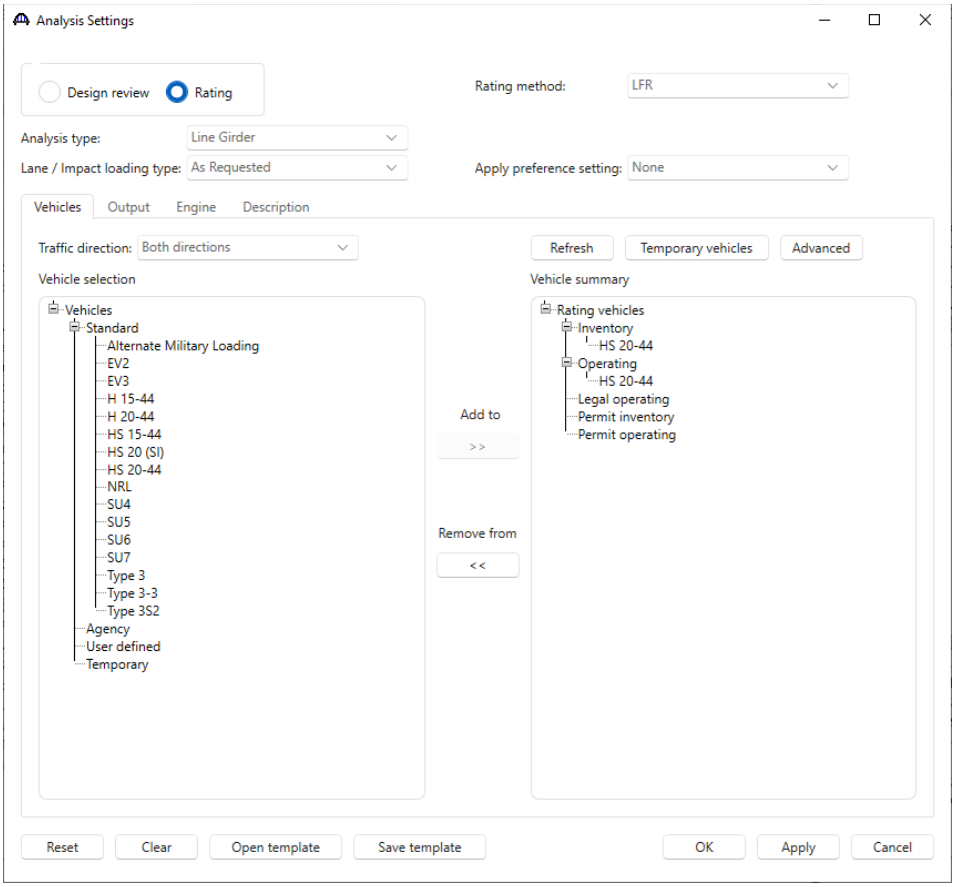
To perform an LFR rating of the floorbeam member alternatives, select **Plate Girder Alternative** in the **Bridge Workspace** tree and click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Click the **Open Template** button and select the **HS 20 LFR Rating** to be used in the rating and click **Open**.



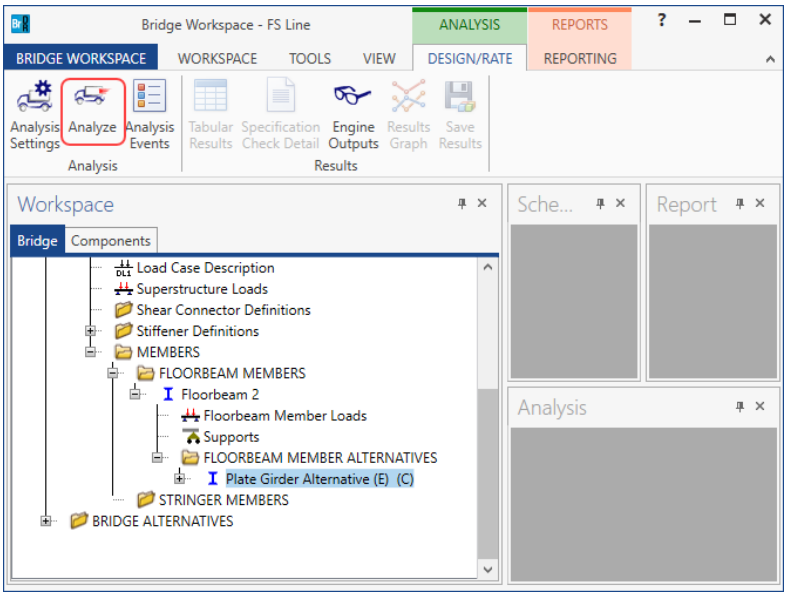
The **Analysis Settings** window will be populated as shown below.



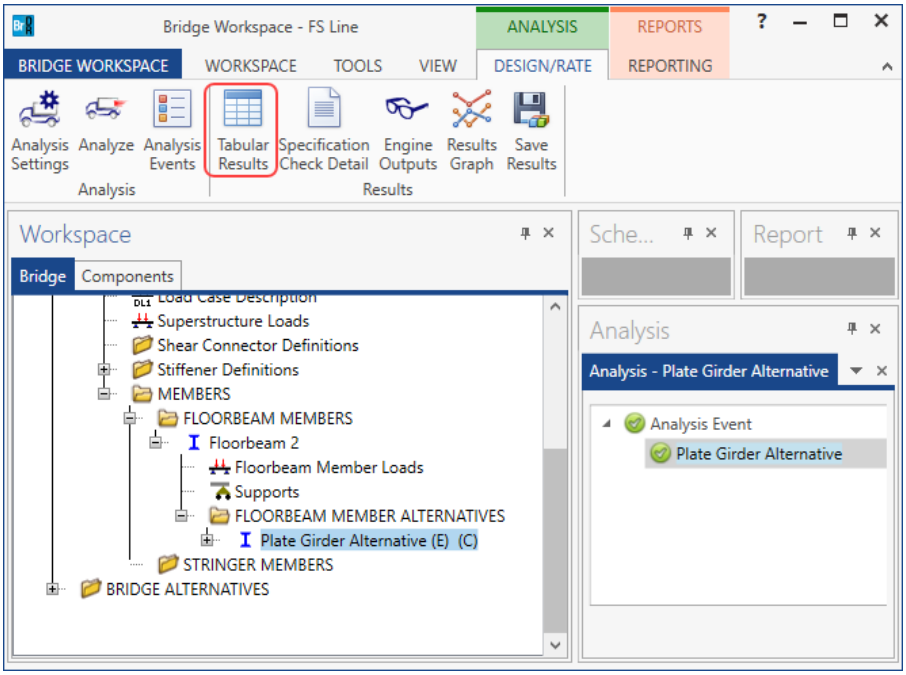
Click **OK** to save the analysis settings and close the window.

Tabular Results

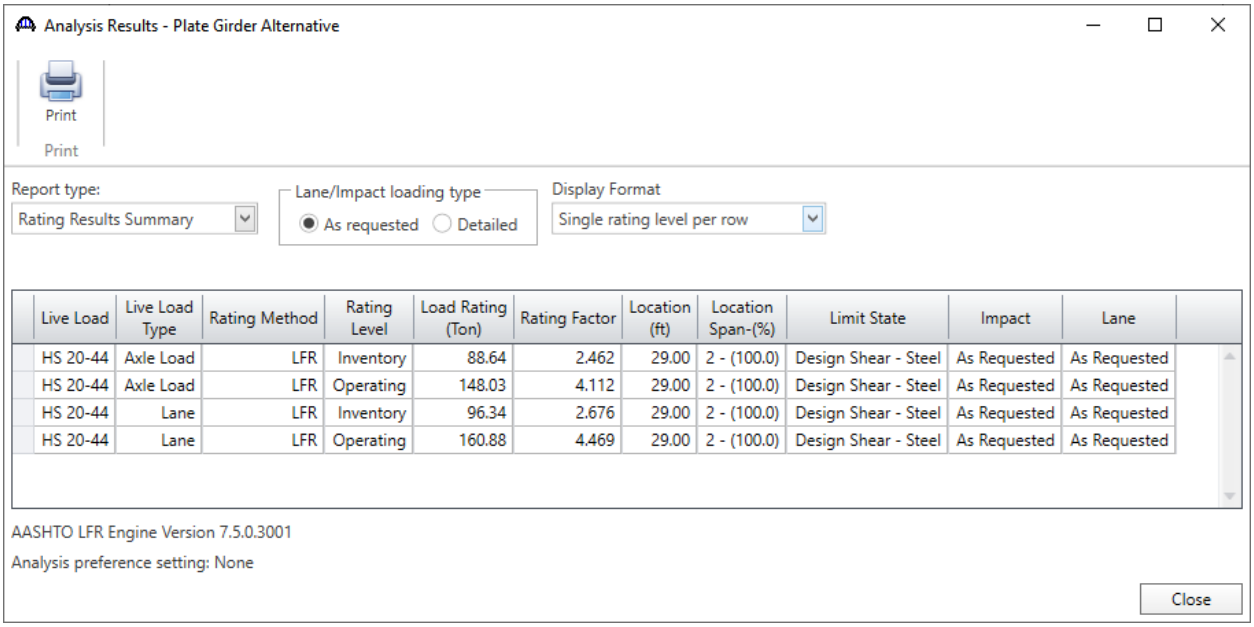
Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



When the rating is finished, results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the ribbon.

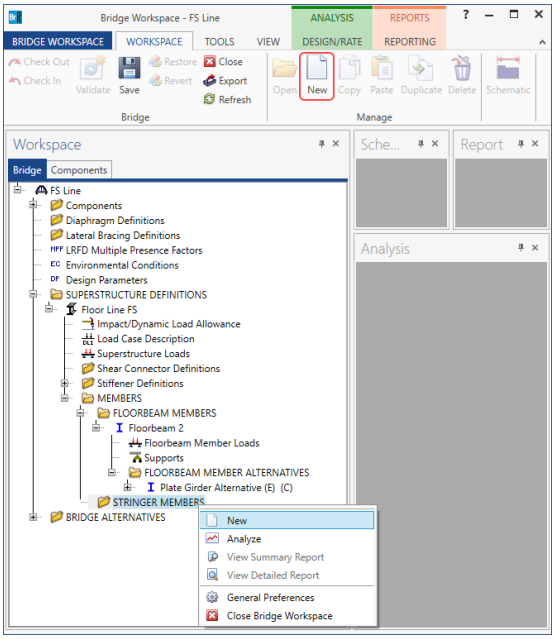


The window shown below will open.

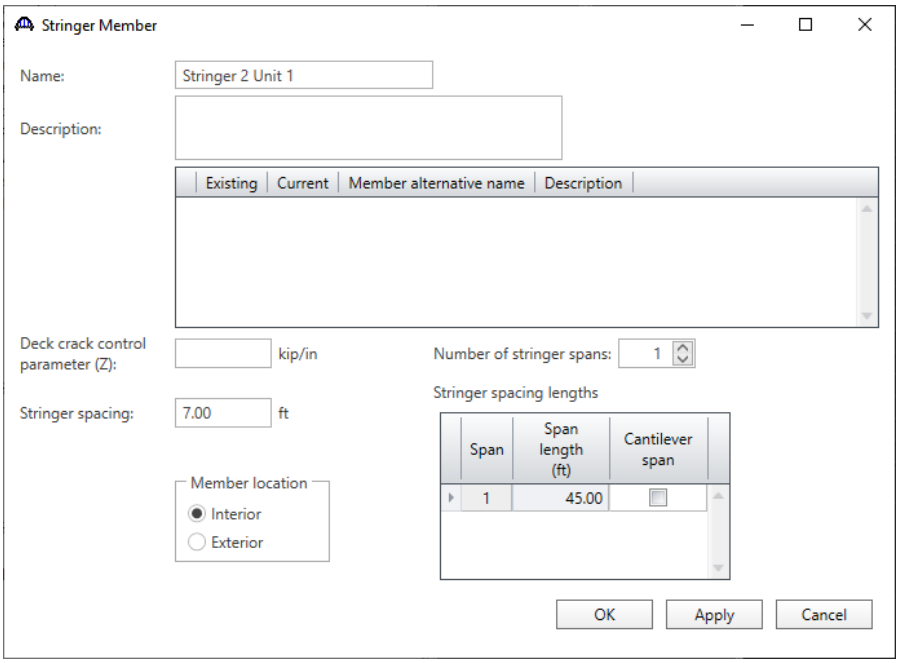


Stringer Members - Description

Now create one of the interior stringer members. To open the **Stringer Member** window, select **STRINGER MEMBERS** in the **Bridge Workspace** tree and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**, or double click on **STRINGER MEMBERS**) as shown below.



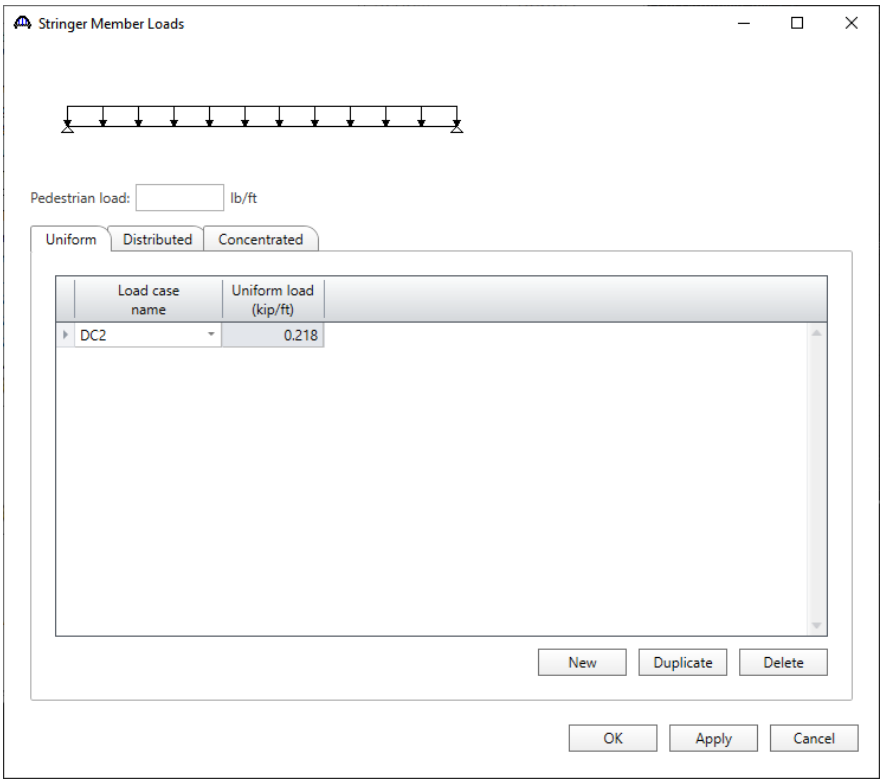
Enter the following data for the stringer member.



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

Stringer Member Loads

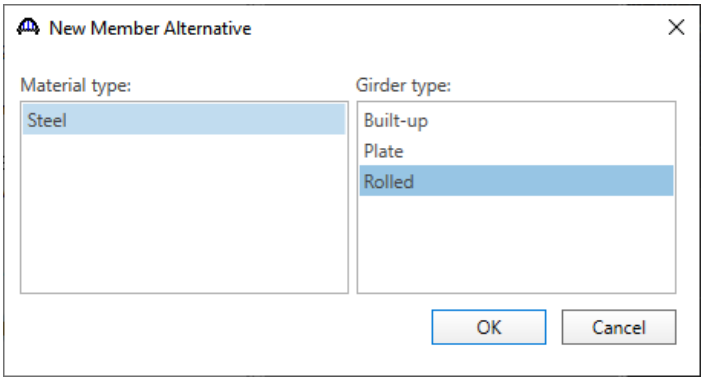
Double click on the **Stringer Member Loads** node in the **Bridge Workspace** tree and add the following member load to the stringer for the weight of the appurtenances as shown below.



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

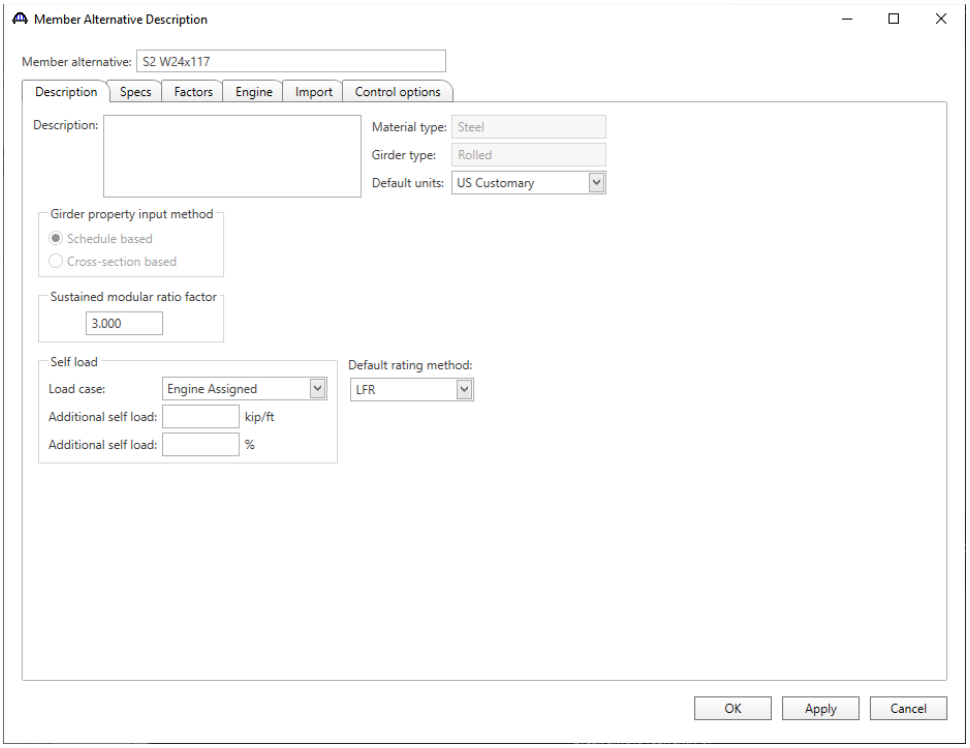
Stringer Member Alternative (Rolled beam stringers)

Now create a schedule based steel rolled beam member alternative by selecting the **STRINGER MEMBER ALTERNATIVES** node in the **Bridge Workspace** tree and click **New** from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New**). The following window opens.



Select **Steel** as the **Material type**, **Rolled** as the **Girder type** and click **OK**.

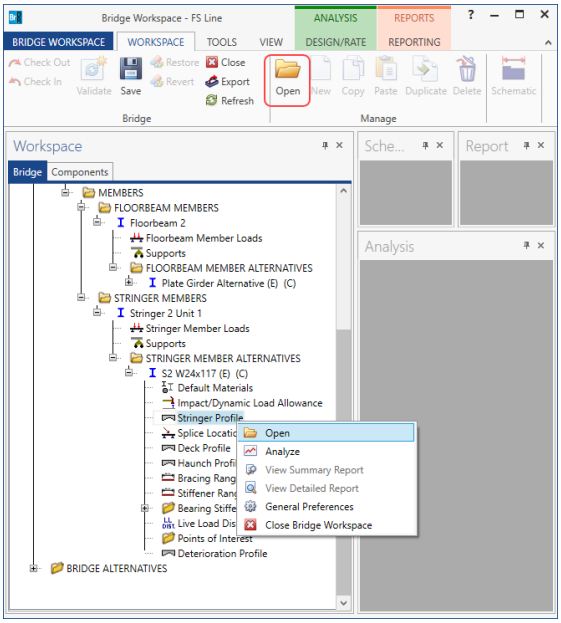
The **Member Alternative Description** window opens as shown below. Enter the following data.



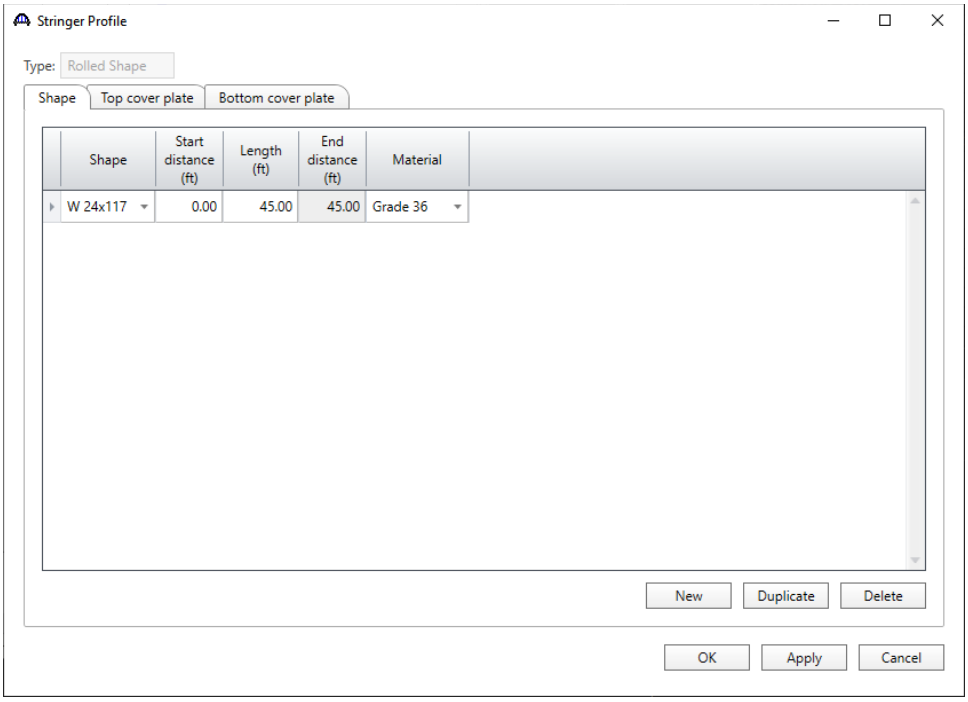
Click **OK** to apply the data and close the window.

Stringer Profile

Expand the **S2 W24x117** member alternative and double click on the **Stringer Profile** node in the **Bridge Workspace** tree (or right click and select **Open** or select **Open** from the **WORKSPACE** ribbon)to open the **Stringer Profile window** as shown below.



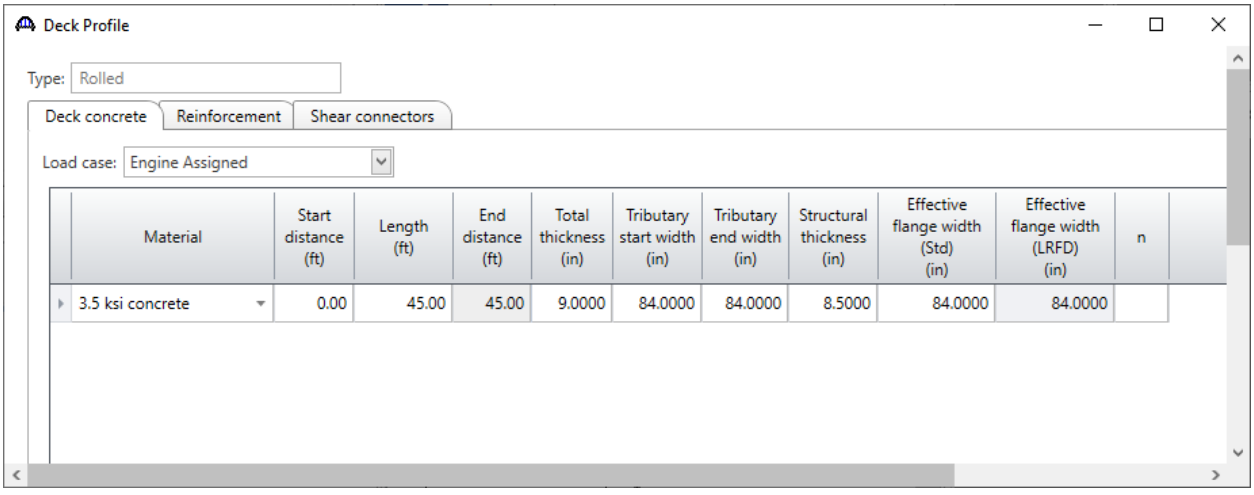
Describe the stringer profile as shown below.



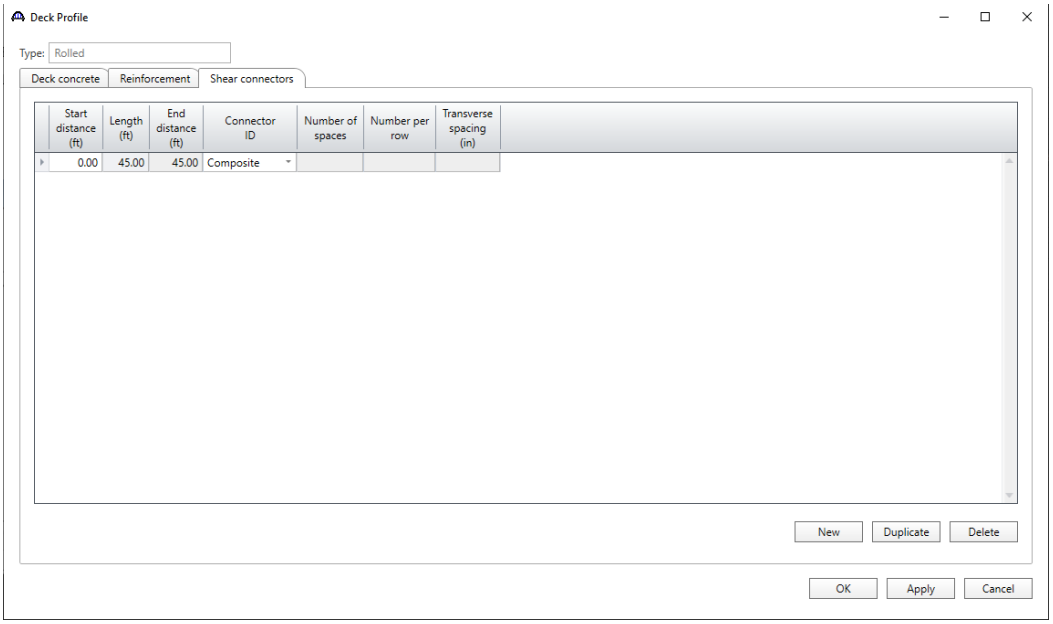
Click **OK** to apply the data and close the window.

Deck Profile

Next open the **Deck Profile** window by double clicking the **Deck Profile** node in the **Bridge Workspace** tree. Enter the data describing the structural properties of the deck.



Navigate to the **Shear connectors** tab and enter that data as shown below.

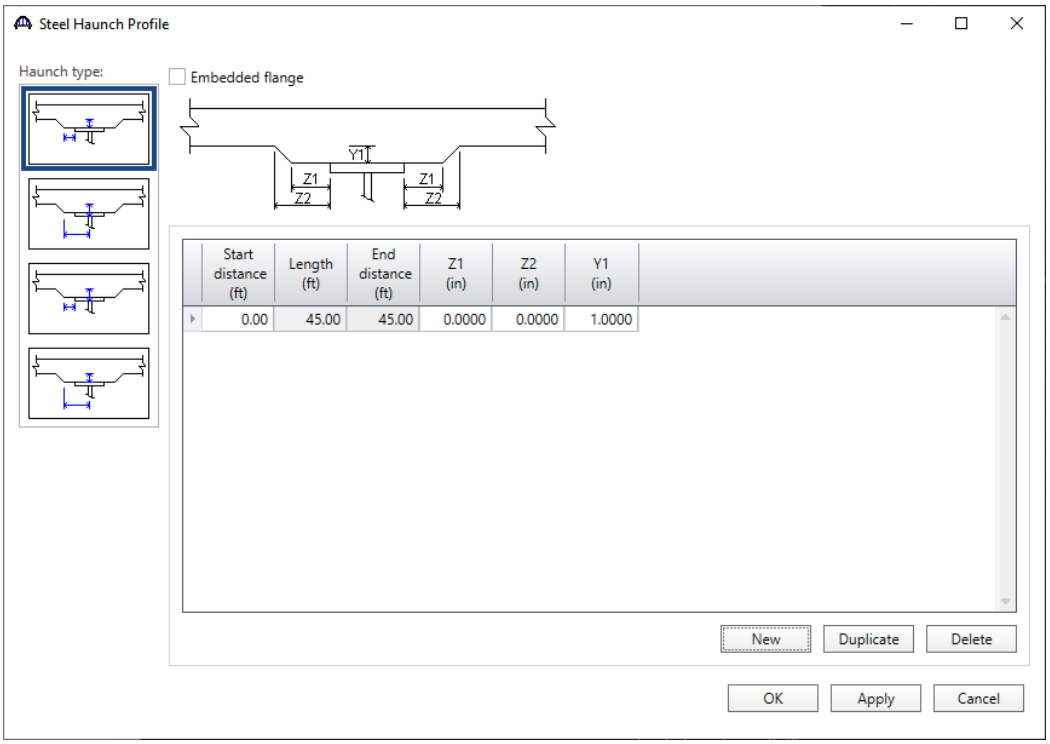


Click **OK** to apply the data and close the window.

Haunch Profile

Open the **Haunch Profile** window by double clicking the **Haunch Profile** node in the **Bridge Workspace** tree.

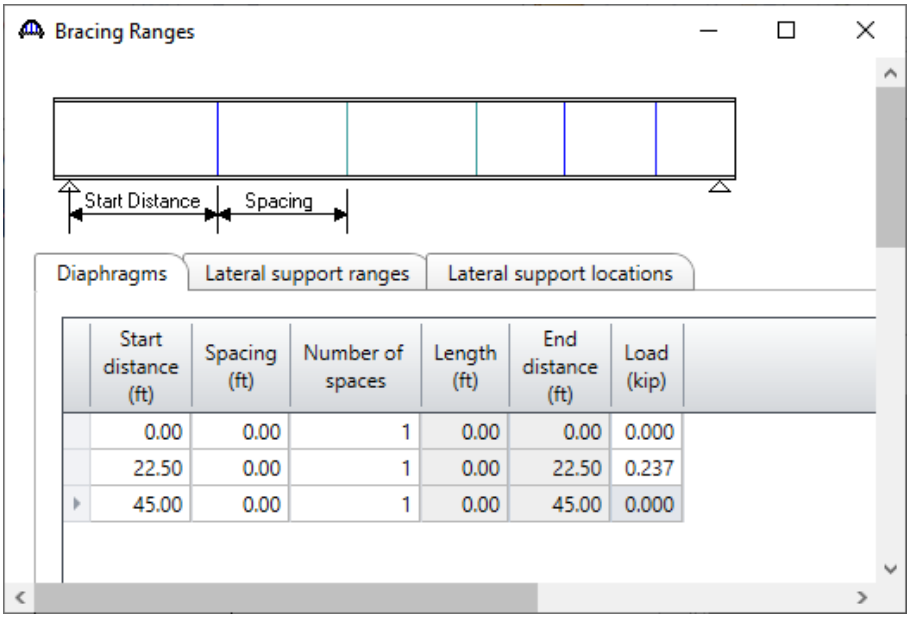
Define the haunch profile as follows.



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

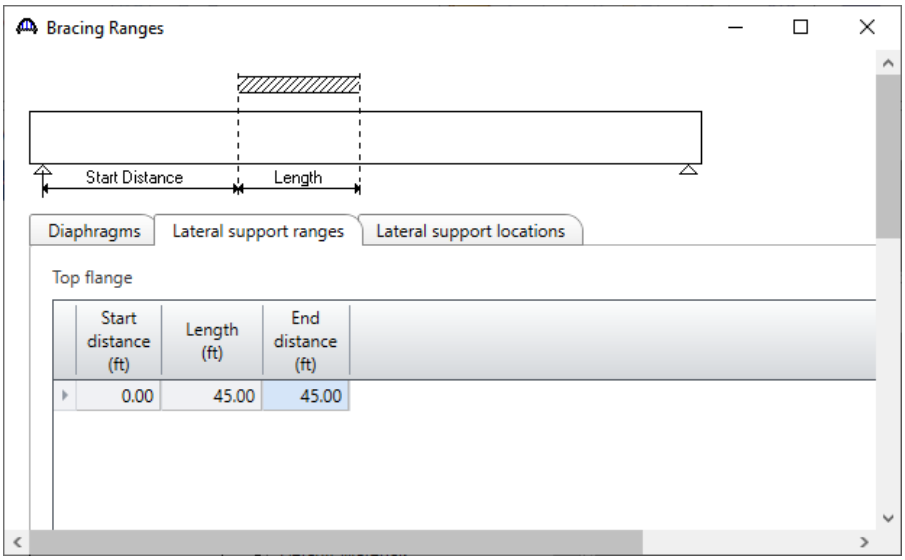
Bracing Ranges - Diaphragms

Open the **Bracing Ranges** window by double clicking the **Bracing Ranges** node in the **Bridge Workspace** tree. Specify the brace points for the stringer. Specify a brace point at the beginning and end of the stringer where the stringer frames into the floorbeam. Also specify the load as 0 kips since there really is not a diaphragms at those locations.



Bracing Ranges – Lateral support ranges

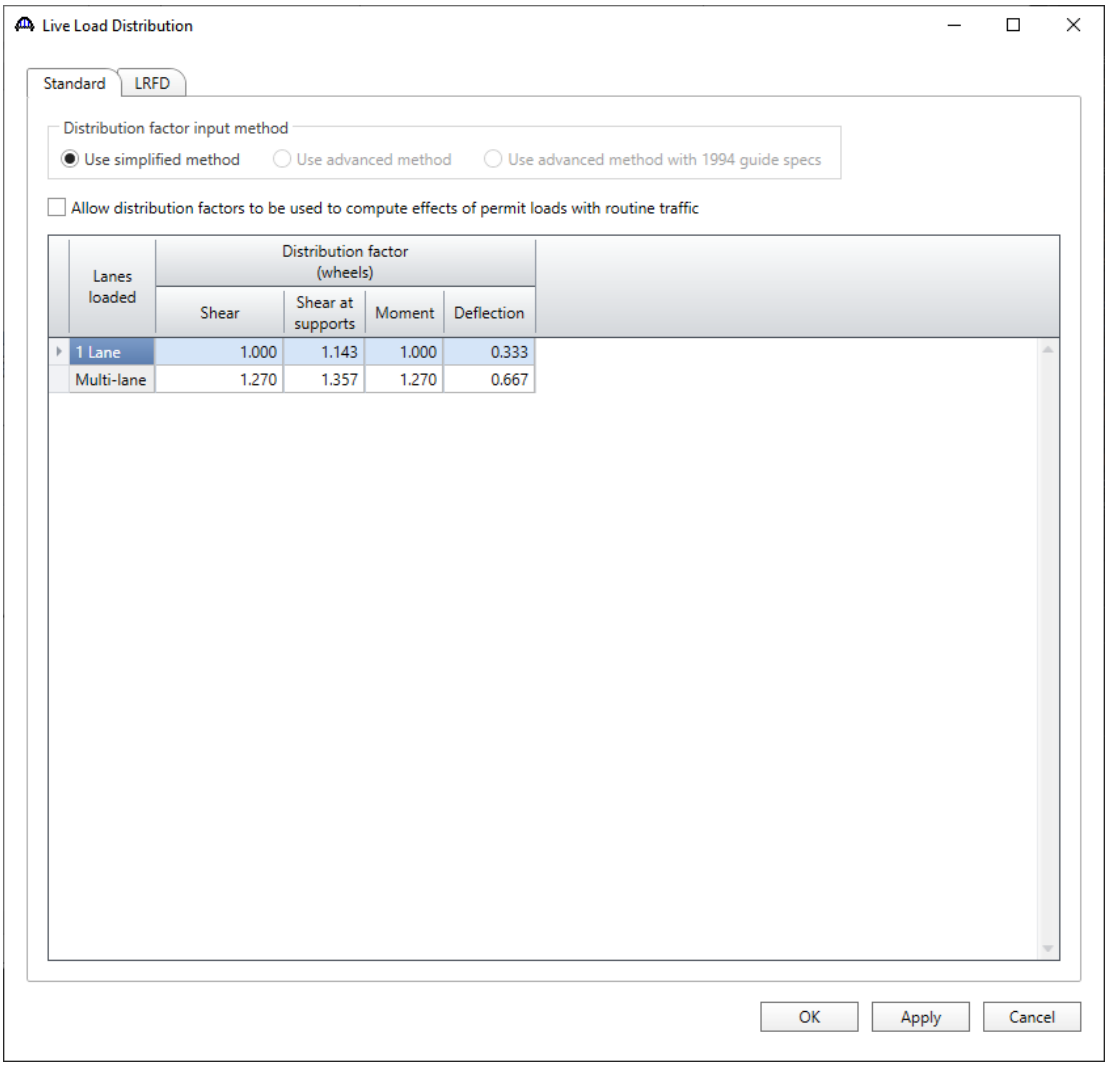
Navigate to the **Lateral support ranges** tab of this window and describe the lateral support for the top flange of the stringer as shown below.



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

Live Load Distribution

Open the **Live Load Distribution** window by double clicking the **Live Load Distribution** node in the **Bridge Workspace** tree. Enter the live load distribution factors as follows.

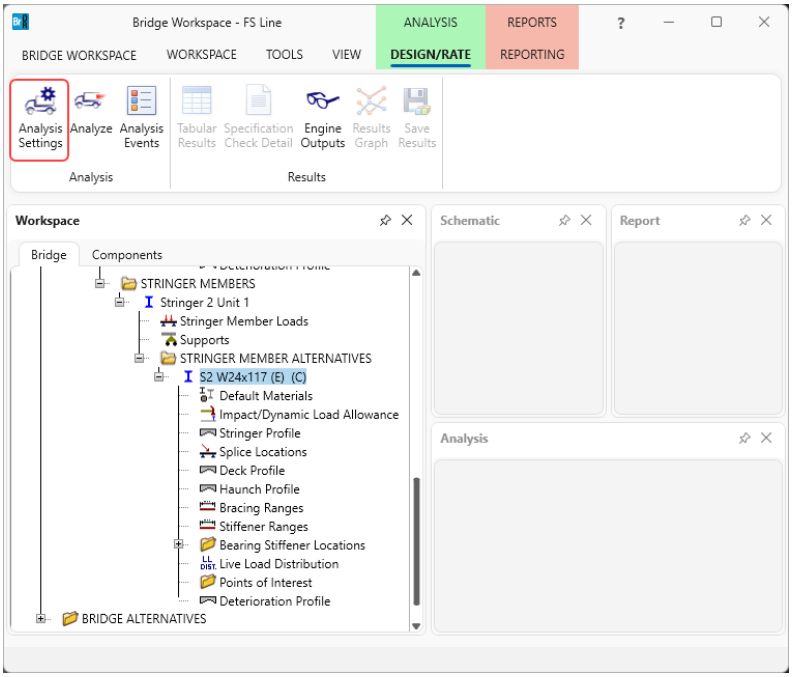


Click **OK** to apply the data and close the window.

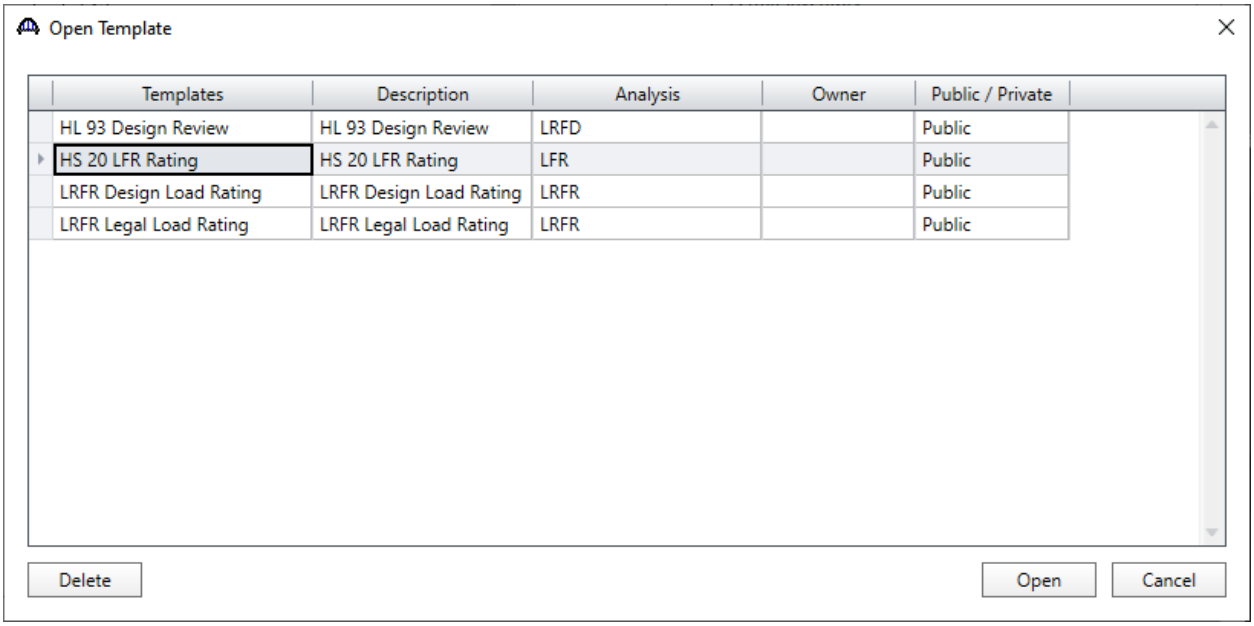
The description of an interior stringer member is now complete. The stringer member alternative can now be rated.

LFR Analysis – Stringer member alternative

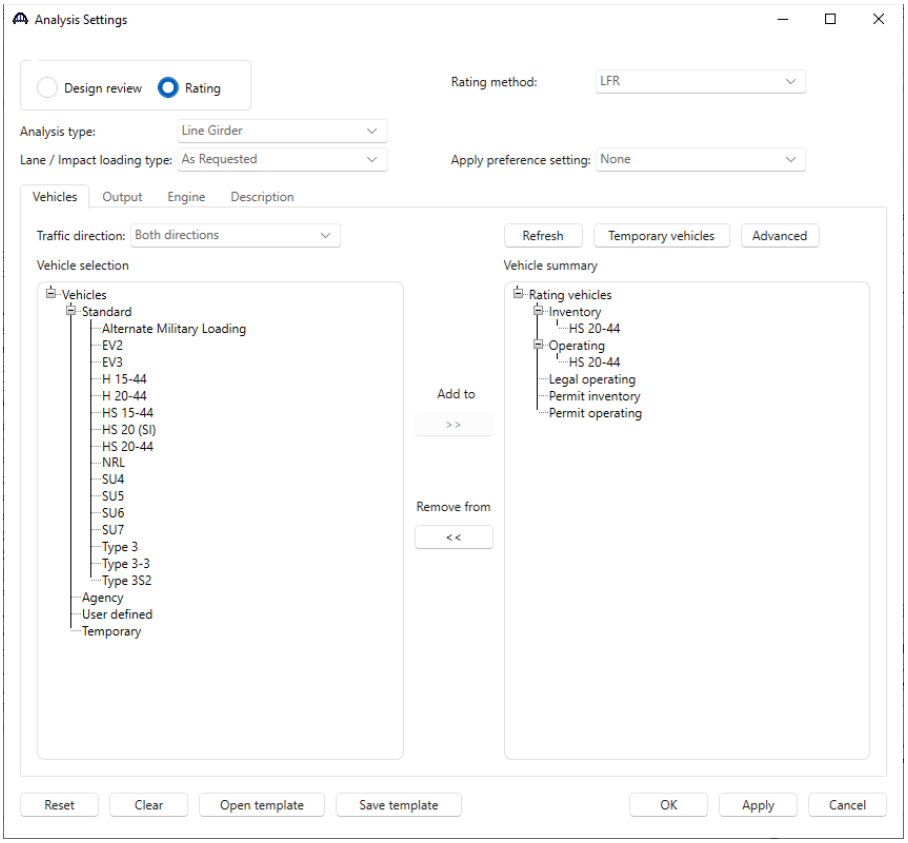
The perform an LFR rating of the stringer member alternatives, select **S2 W24x117** in the **Bridge Workspace** tree and click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Click the **Open Template** button and select the **HS 20 LFR Rating** to be used in the rating and click **Open**.



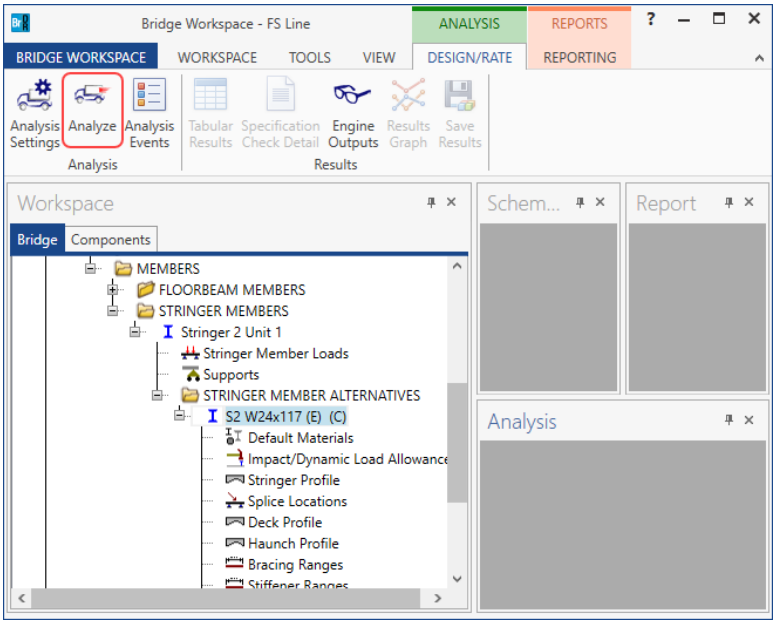
The **Analysis Settings** window will be populated as shown below.



Click **OK** to save the analysis settings and close the window.

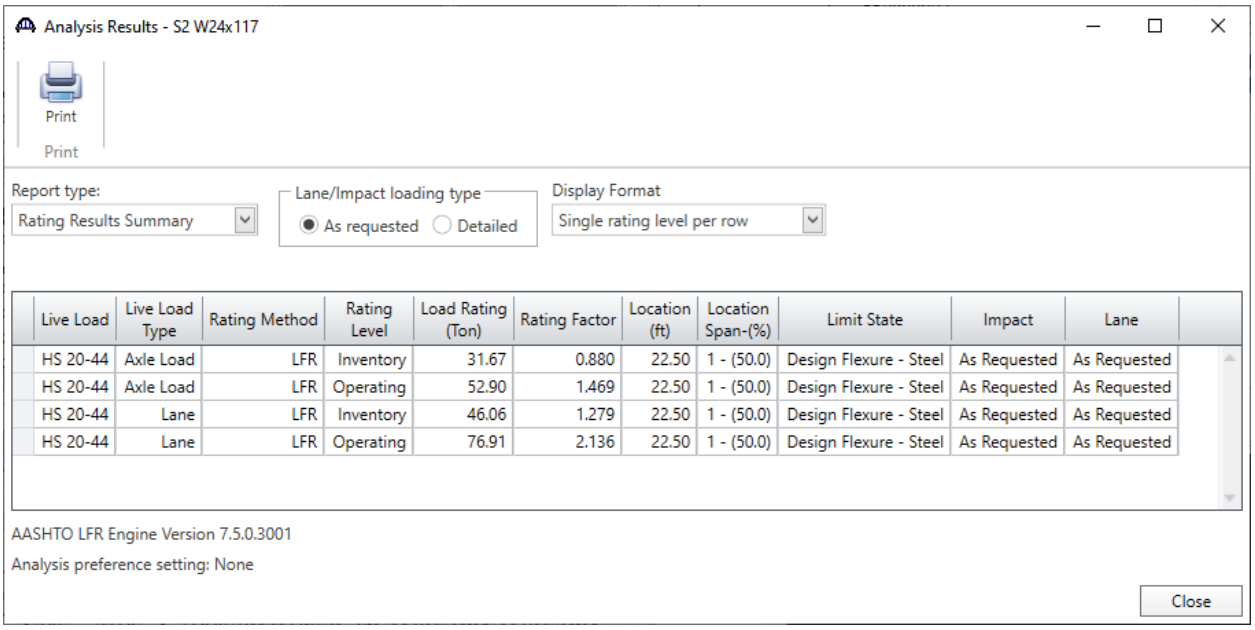
Tabular Results

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



When the rating is finished results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the ribbon.

The window shown below will open.



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Axle Load	LFR	Inventory	31.67	0.880	22.50	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	52.90	1.469	22.50	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Inventory	46.06	1.279	22.50	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	76.91	2.136	22.50	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested