AASHTOWare BrDR 7.5.0

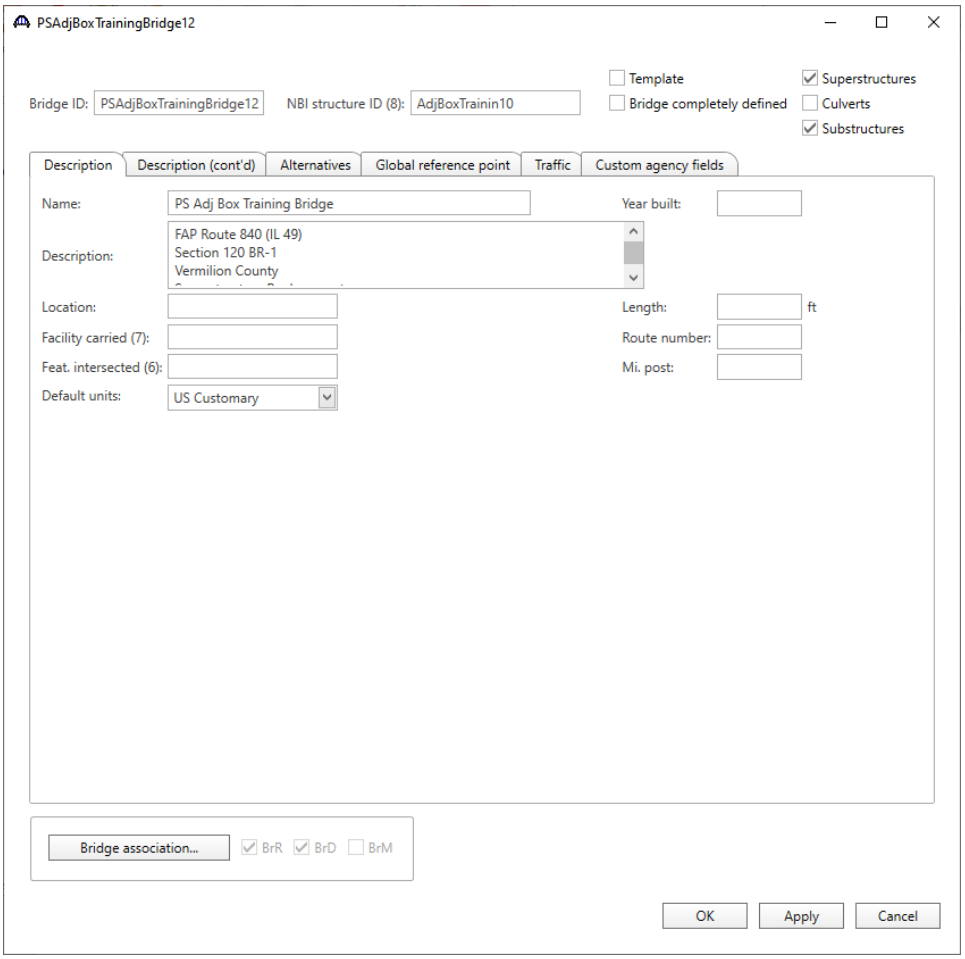
Prestressed Concrete Structure Tutorial

PS15 – Two Span PS adjacent Box With Straight Strands

BrDR Training

PS15 - Two Span PS Adjacent Box With Straight Strands Example

From the **Bridge Explorer** create a **new bridge** and enter the following description data:

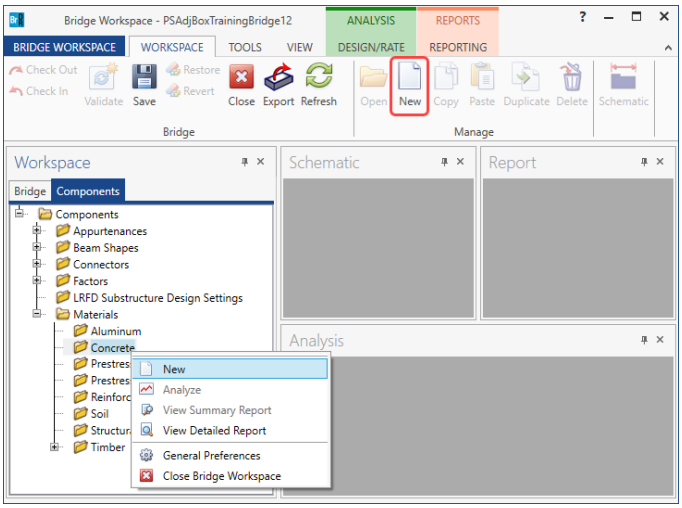


Click **OK** to apply the data and close the window.

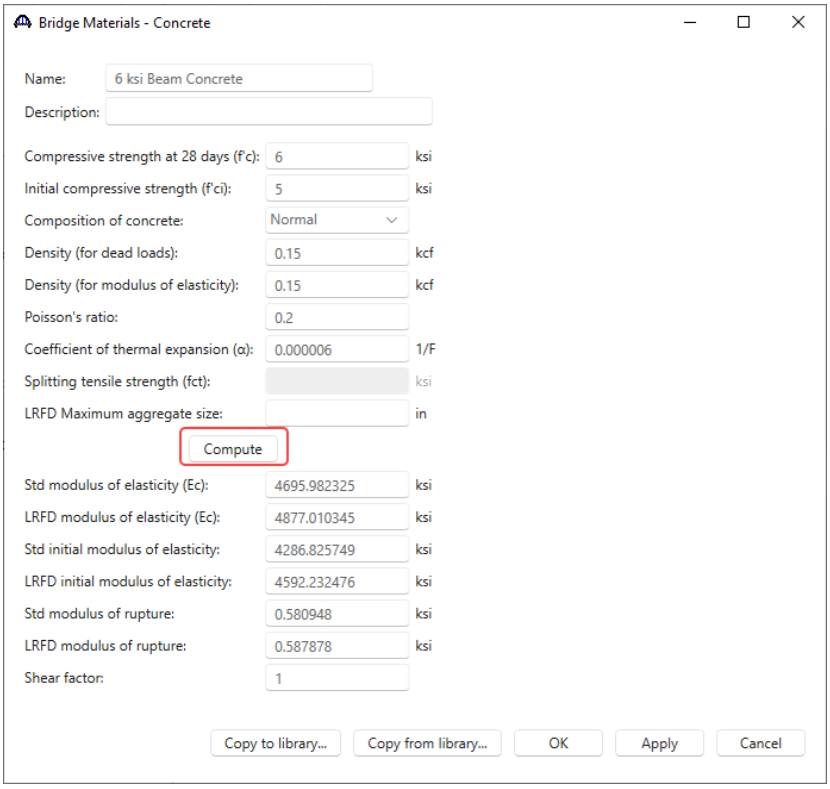
Bridge Components

Bridge Materials - Concrete

To add a new concrete material, in the **Components** tab of the **Bridge Workspace**, expand the **Materials** node by clicking the ⊞ button, select **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 as shown above the **Compute** button and click the **Compute** button to compute the remaining values below them.

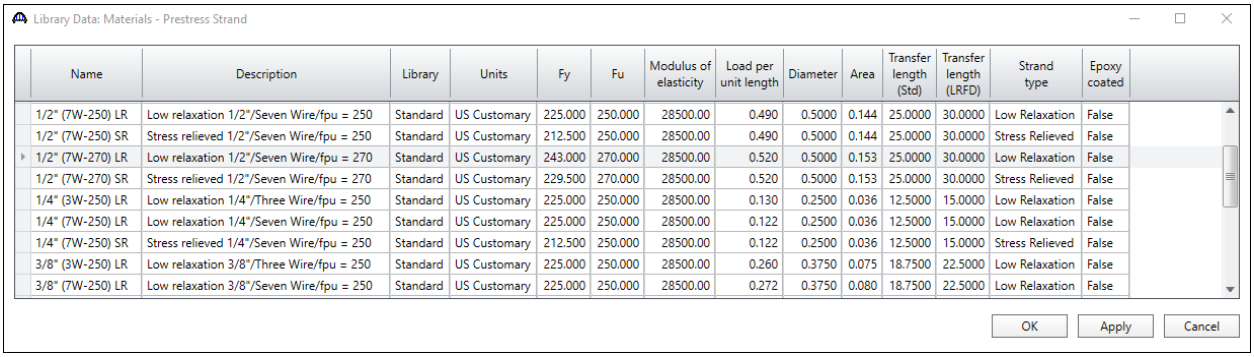


Click **OK** to apply the data and close the window.

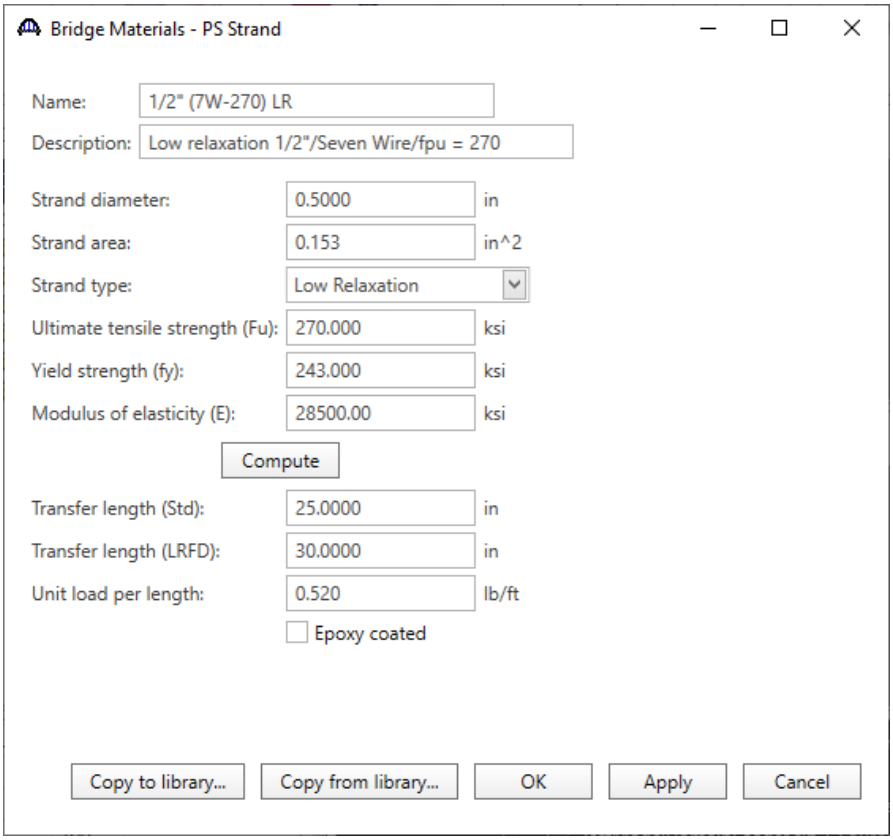
Bridge Materials – Prestress strand

To add a new prestress strand material, select **Prestress Strand** in the **Components** tree**,** and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Prestress Strand** and select **New**).

Click on the **Copy from library…** button in this window and select **½" (7W-270) LR** from the library and click **OK.**

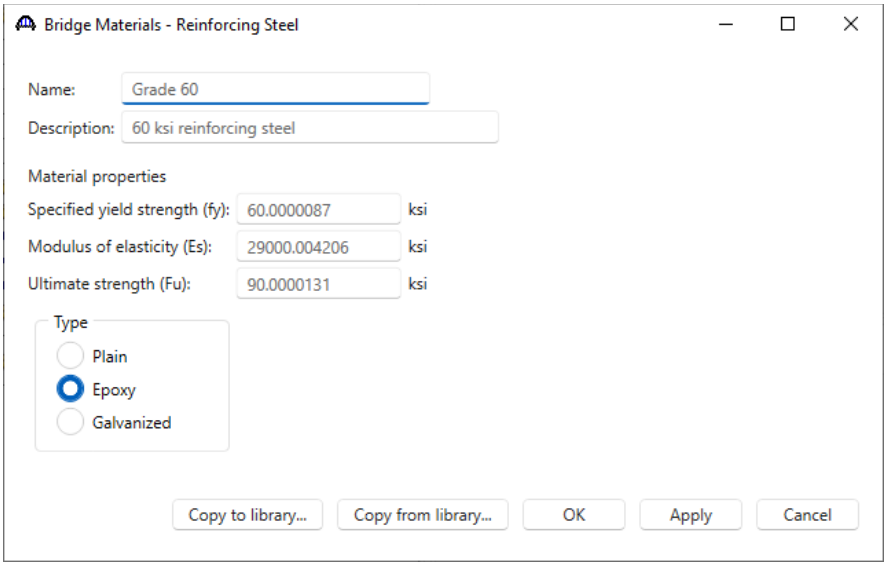


The selected material properties are copied to the **Bridge Materials – PS Strand** window as shown below.



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

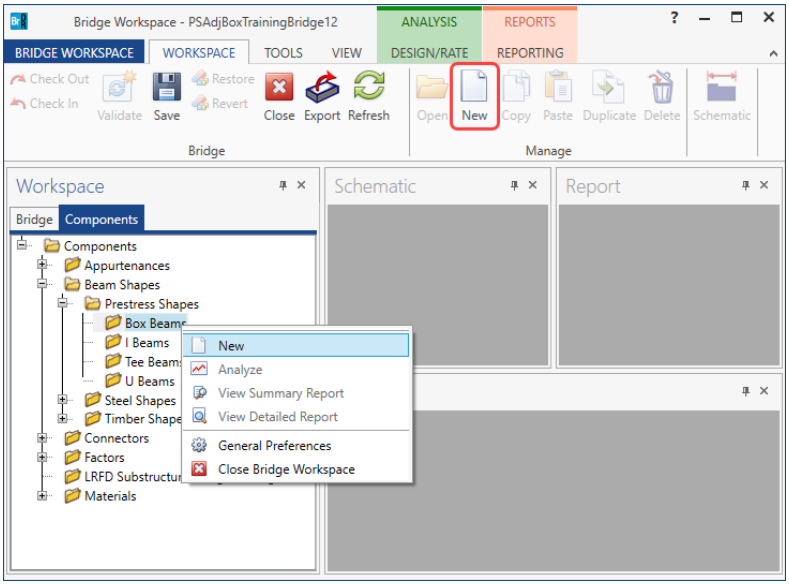
Add the following reinforcement steel in the same manner.



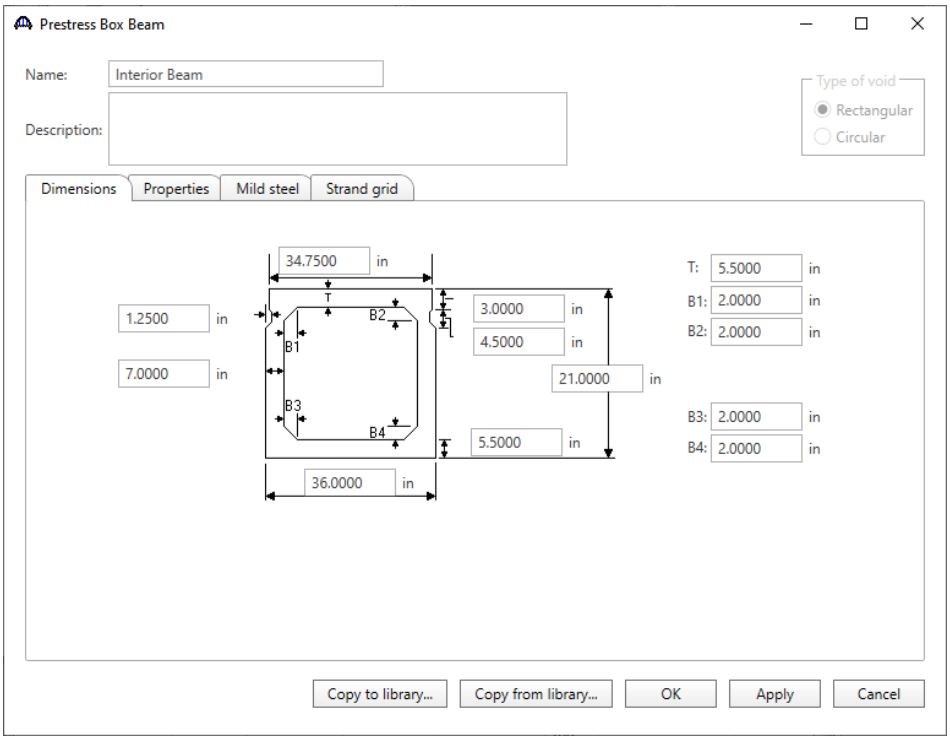
Click **OK** to apply the data and close the window.

Beam Shape

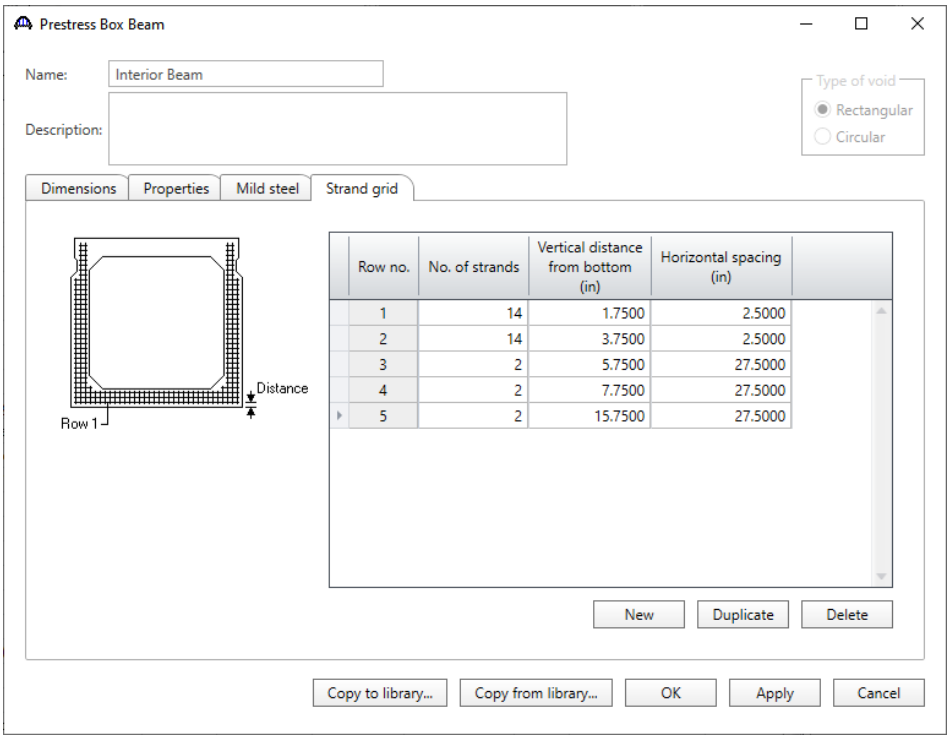
To enter a prestress beam shape to be used in this bridge expand the tree labelled **Beam Shapes** and **Prestress Shapes** as shown below and click on the **Box Beams** node in the **Components** tree, select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Box Beams** and select **New** or double click on **Box Beams** in the **Components** tree).



The **Prestress Box Beam** window shown below will open. Select the **Type of Void** as **Rectangular** and enter the data for the interior beam as shown below.



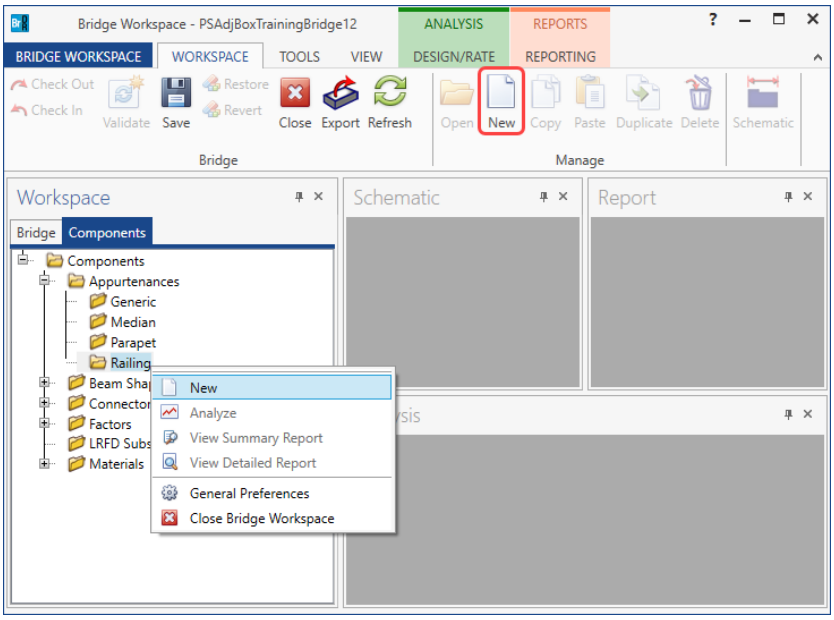
Navigate to the **Strand grid** tab and enter the data as shown below.



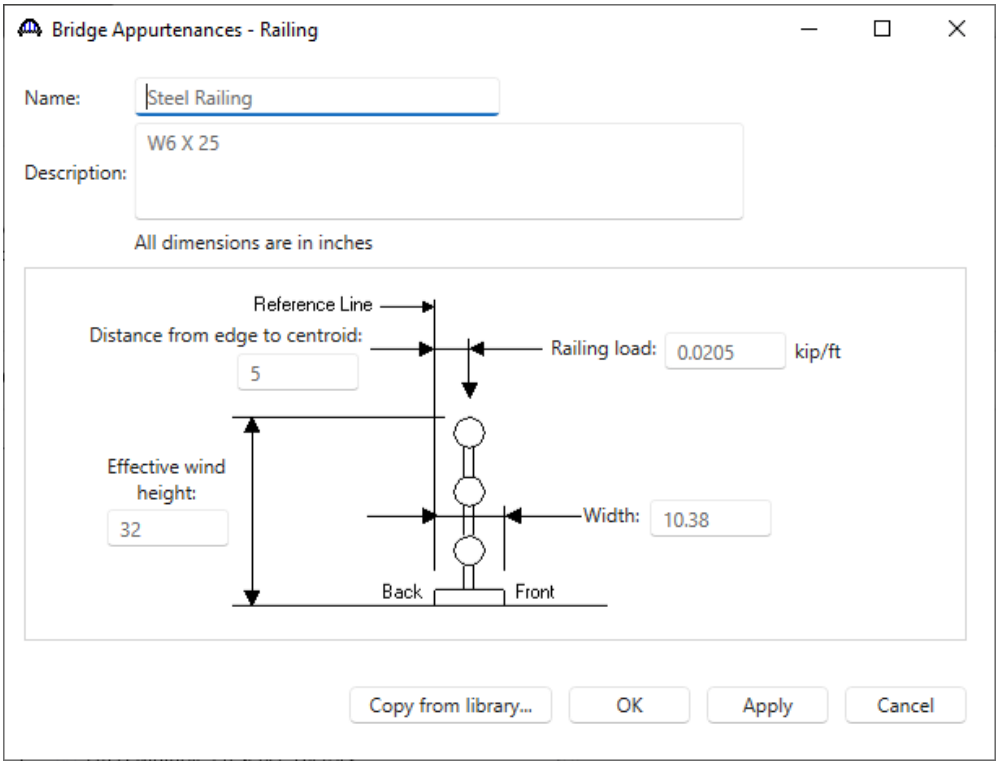
Click **OK** to apply the data and close the window.

Bridge - Appurtenances

To enter the appurtenances to be used within the bridge expand the tree branch labeled **Appurtenances**. To define a steel railing, select **Railing** and click on **New** from the **Manage** button on the **WORKSPACE** ribbon (or right click on **Railing** in the **Components** tree and select **New**).



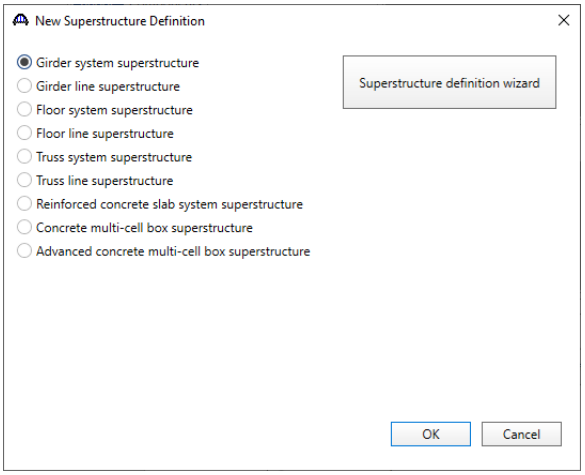
Enter the data as shown below.



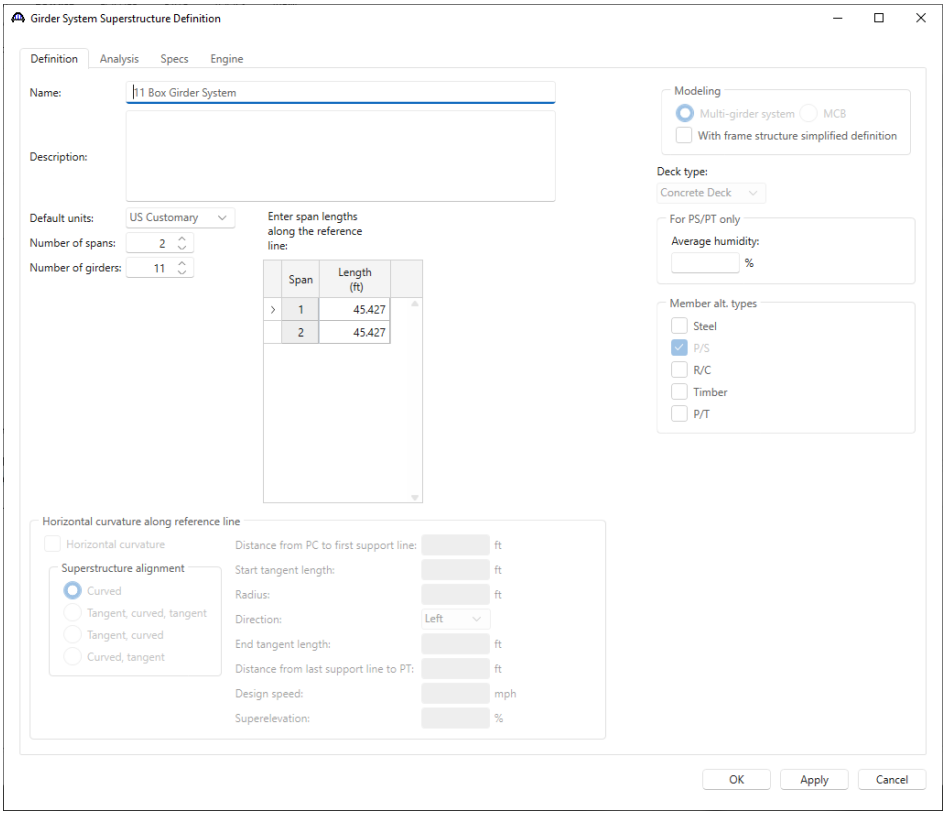
Click **OK** to apply the data and close the window.

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.

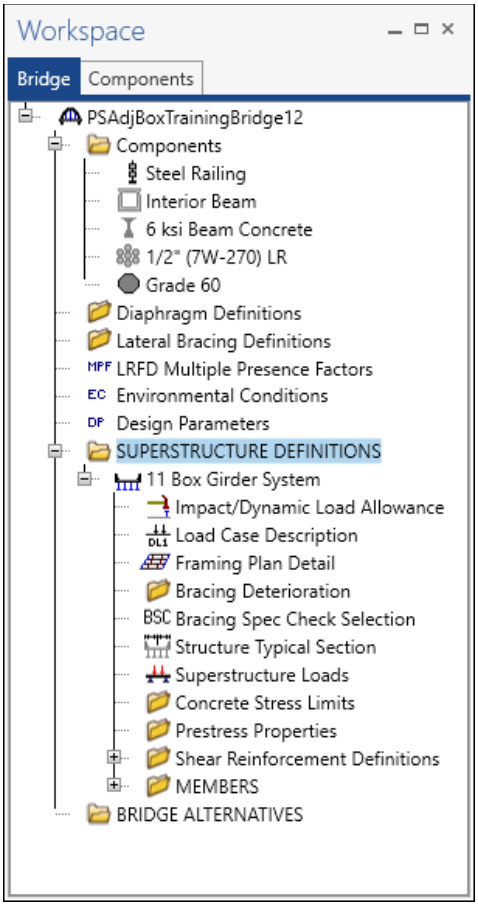


Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open. Enter the data as shown below.



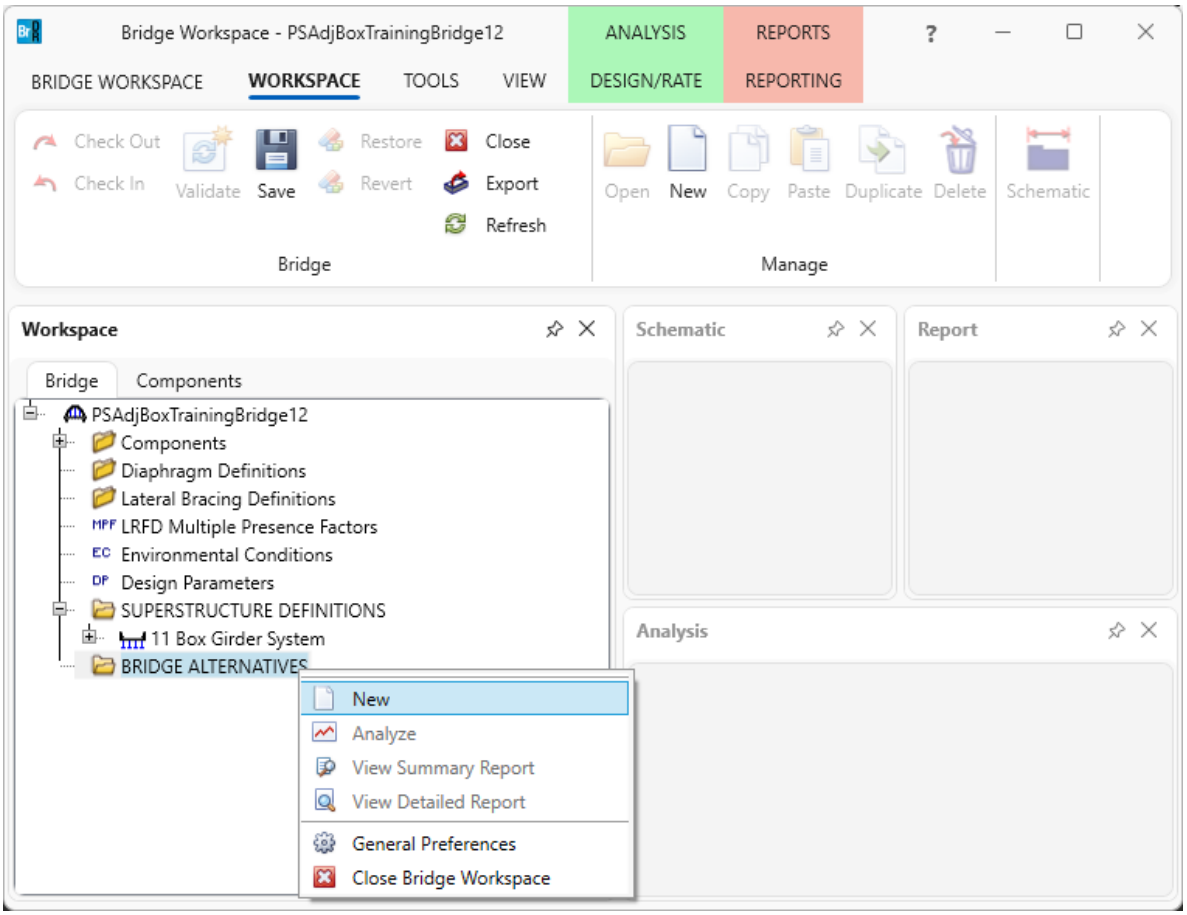
Click **OK** to apply the data and close the window.

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

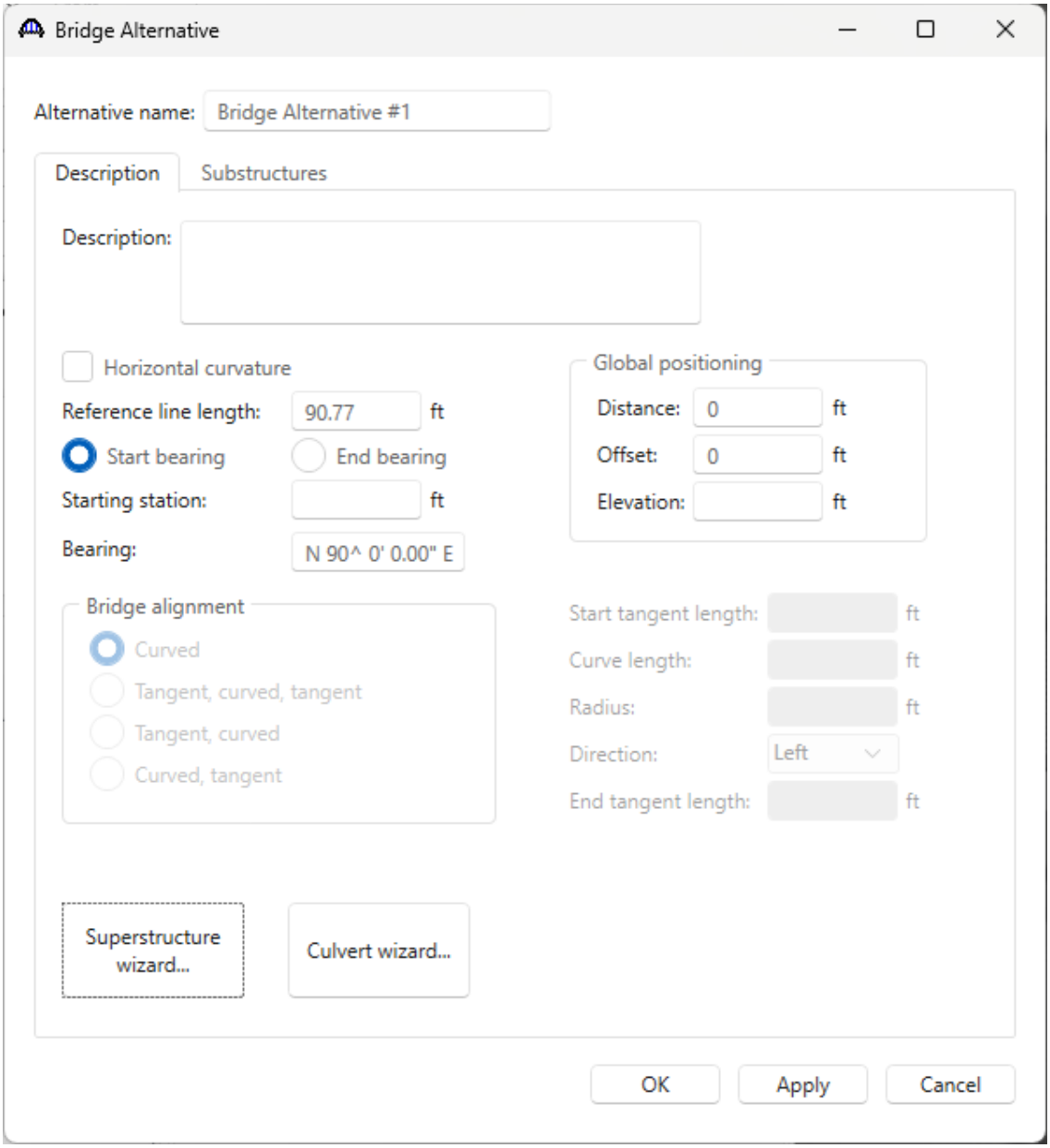


BRIDGE ALTERNATIVES

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).

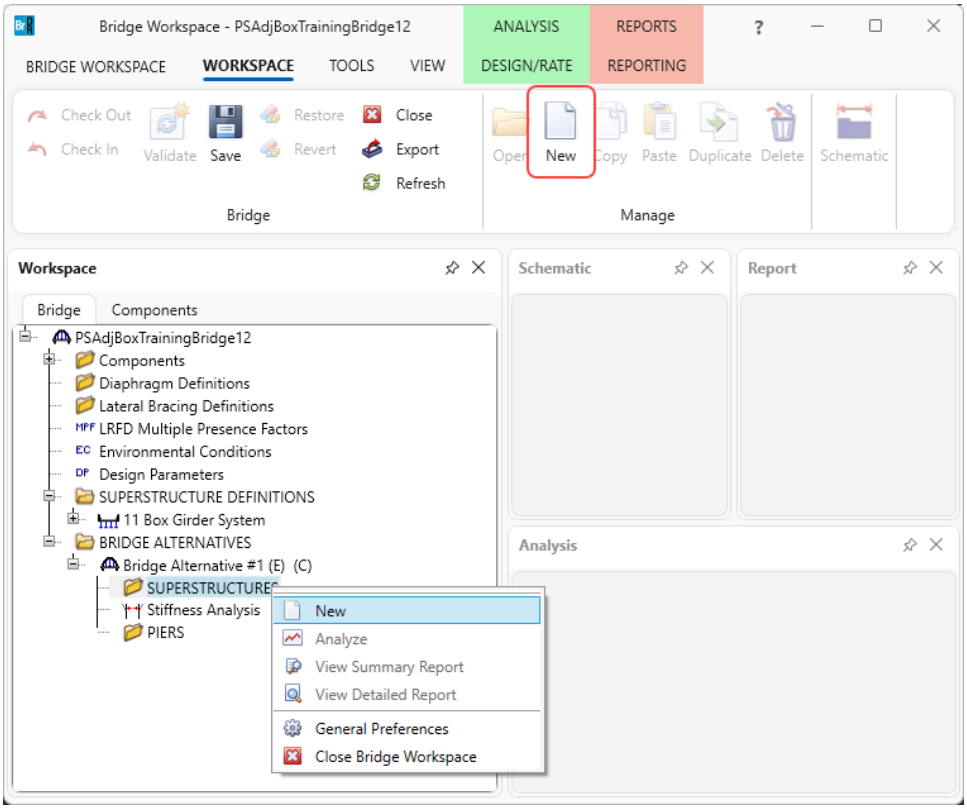


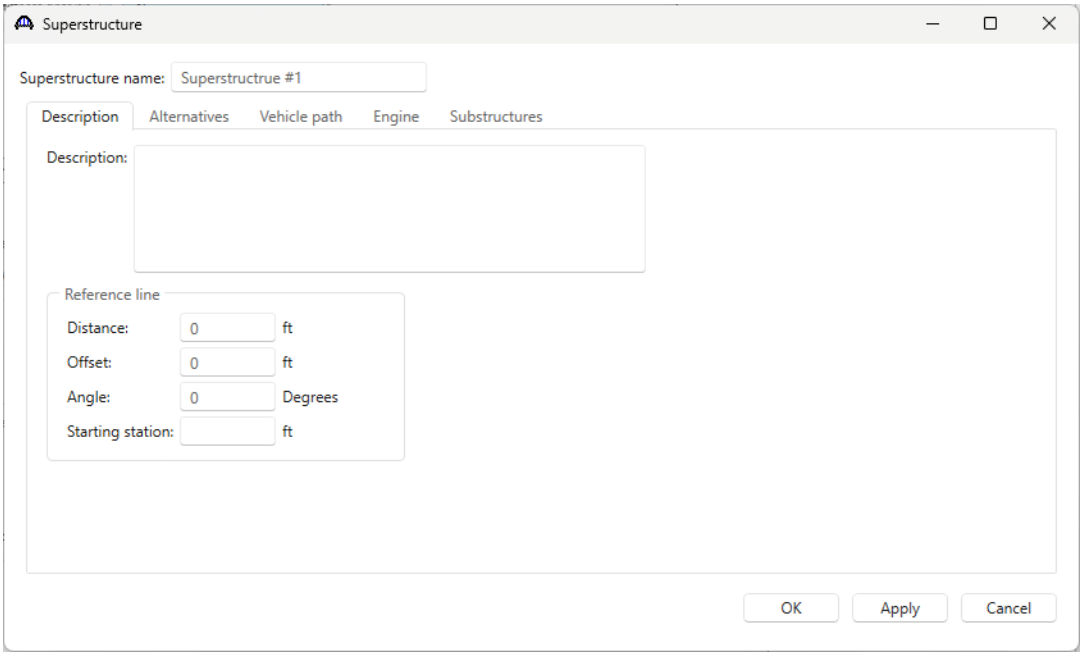
Enter the following data.



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

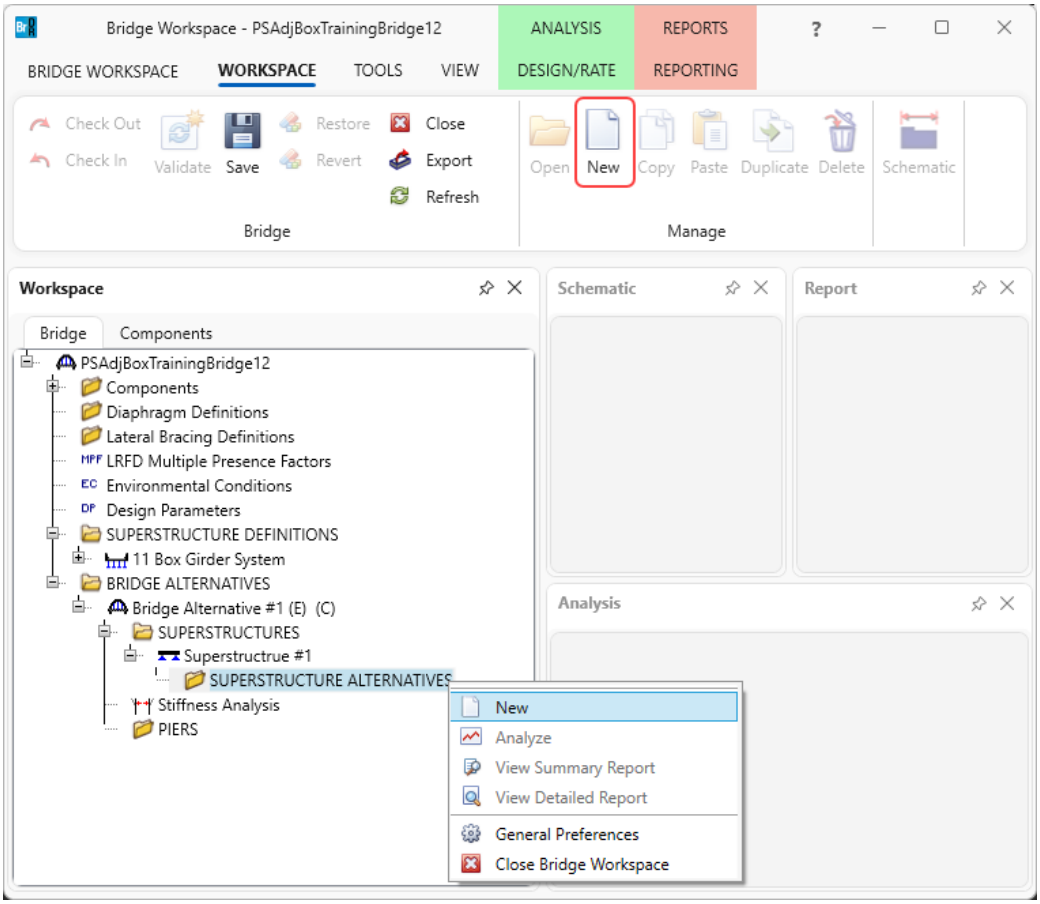
Expand the **Bridge Alternative #1** node in the **Bridge Workspace** tree by clicking the ⊞ button. Double-click on the **SUPERSTRUCTURES** node (or select **SUPERSTRUCTURES**, click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure.



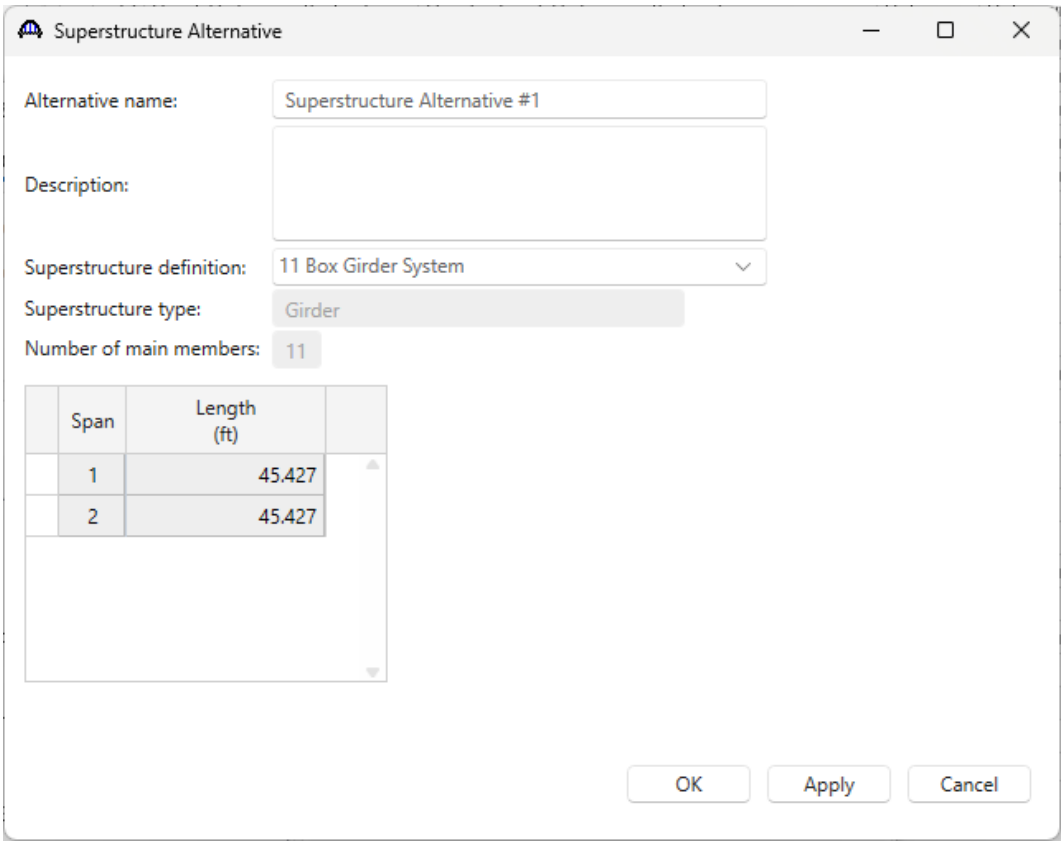


Click **OK** to apply the data and close the window.

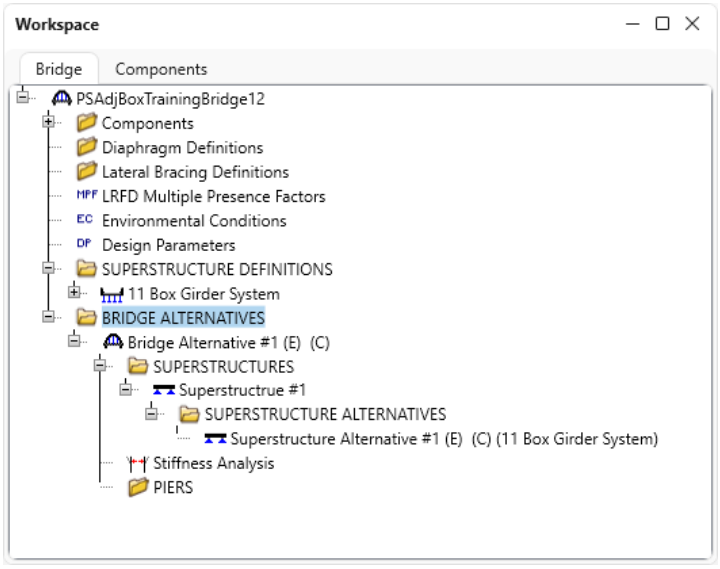
Expand the **Superstructure #1** node in the **Bridge Workspace** tree by clicking the ⊞ button. Double-click on the **SUPERSTRUCTURE ALTERNATIVES** node (or select **SUPERSTRUCTURE ALTERNATIVES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure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



Select the **Superstructure definition 11 Box Girder System** as the current superstructure definition for this Superstructure Alternative.



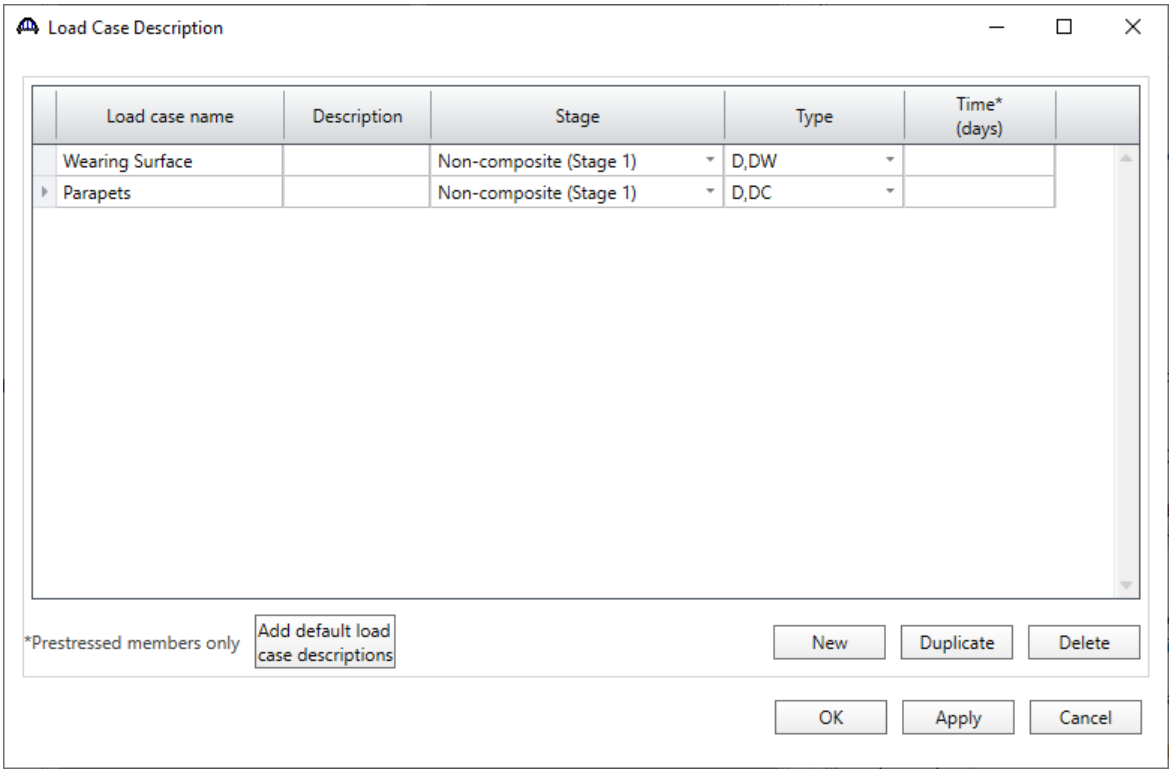
The partially expanded **Bridge Workspace tree** is shown below.



The default impact factors, standard LRFD and LFR factors will be used.

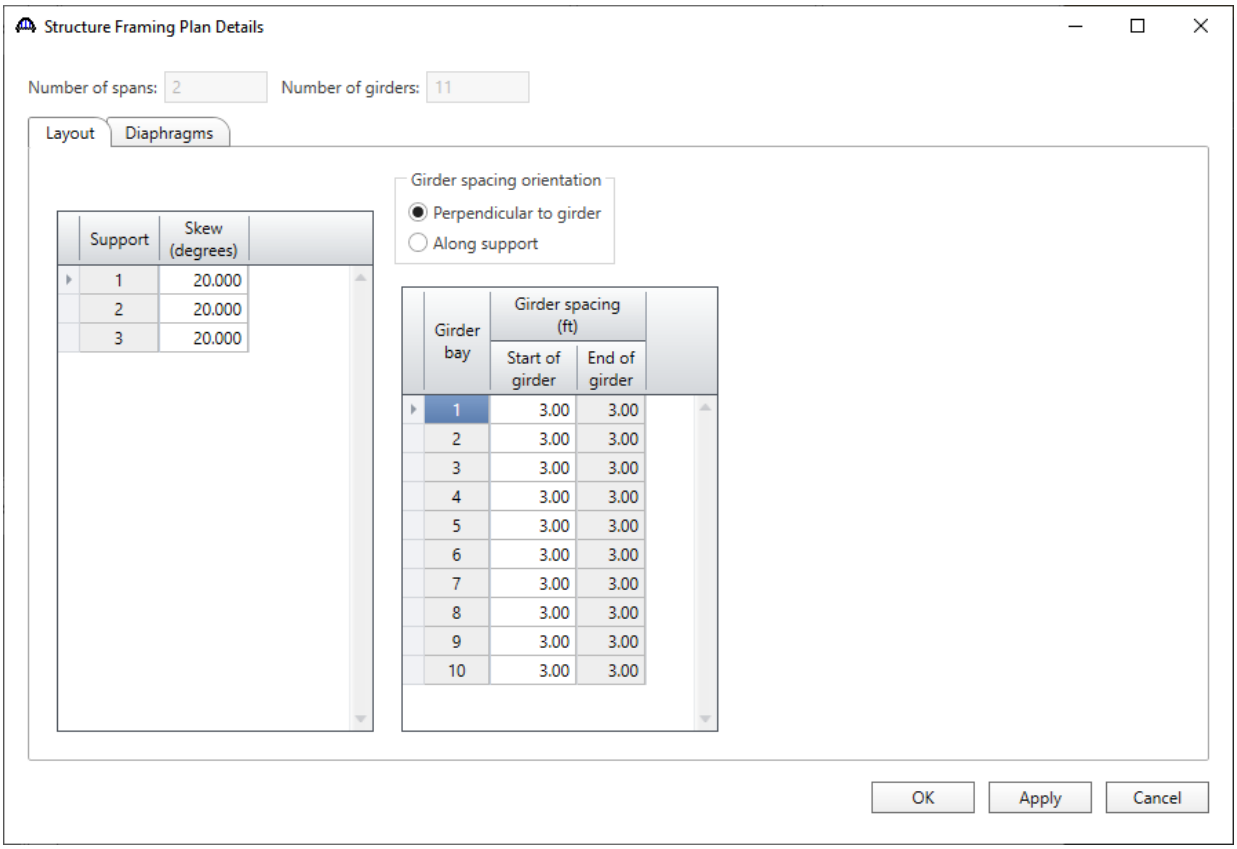
Load Case Description

Navigate back to the superstructure definition **11 Box Girder System**. Double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window** and define the dead load cases as shown below. The completed **Load Case Description** window is shown below.



Structure Framing Plan Detail – Layout

Double-click on **Framing Plan Detail** node in the **Bridge Workspace** tree to describe the framing plan in the **Structure Framing Plan Details** window. Enter the data as shown below.



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

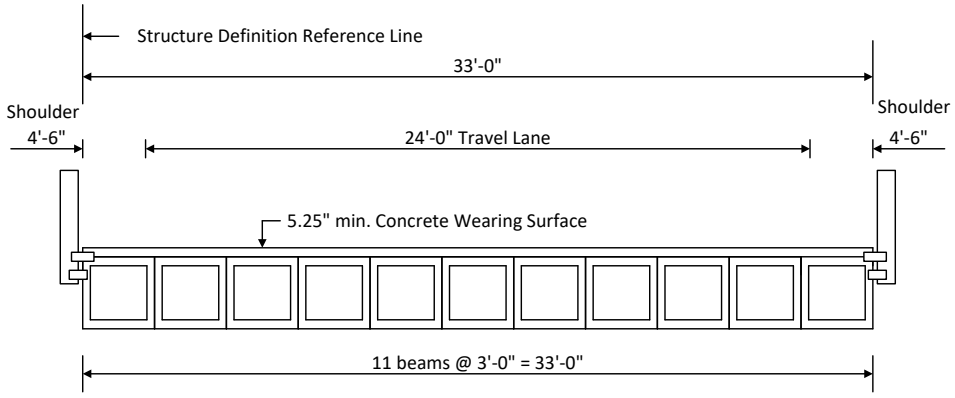
Structure Framing Plan Detail – Diaphragms

The **Diaphragms** tab of this window is used to enter data for exterior diaphragms, in other words diaphragms located between girders. Since an adjacent box beam structure does not have exterior diaphragms, no data will be entered in the **Diaphragms** tab.

Structure Typical Section - Deck

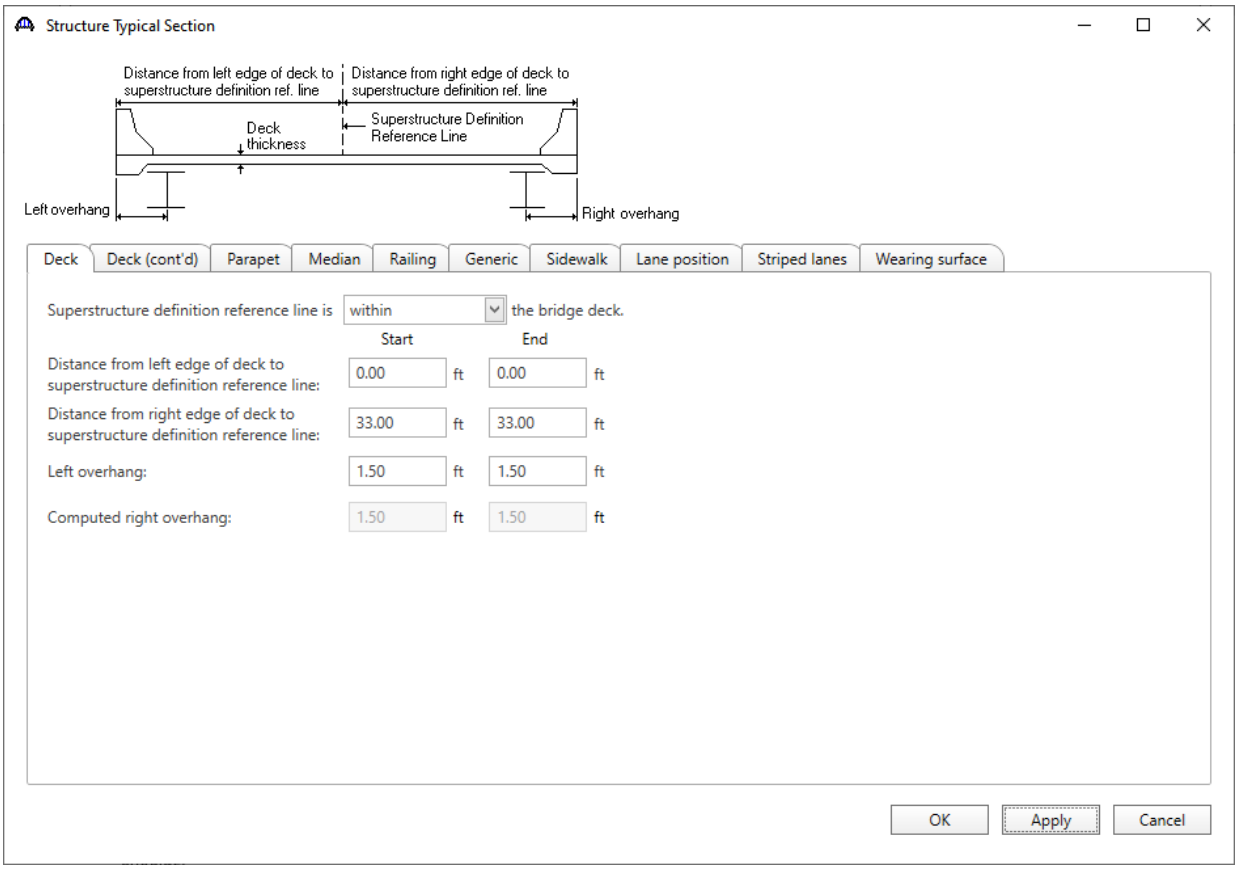
Next, define the structure typical section by double-clicking on the **Structure Typical Section** node in the **Bridge Workspace** tree. Input the data describing the typical section as shown below.

The basic deck geometry is shown below.



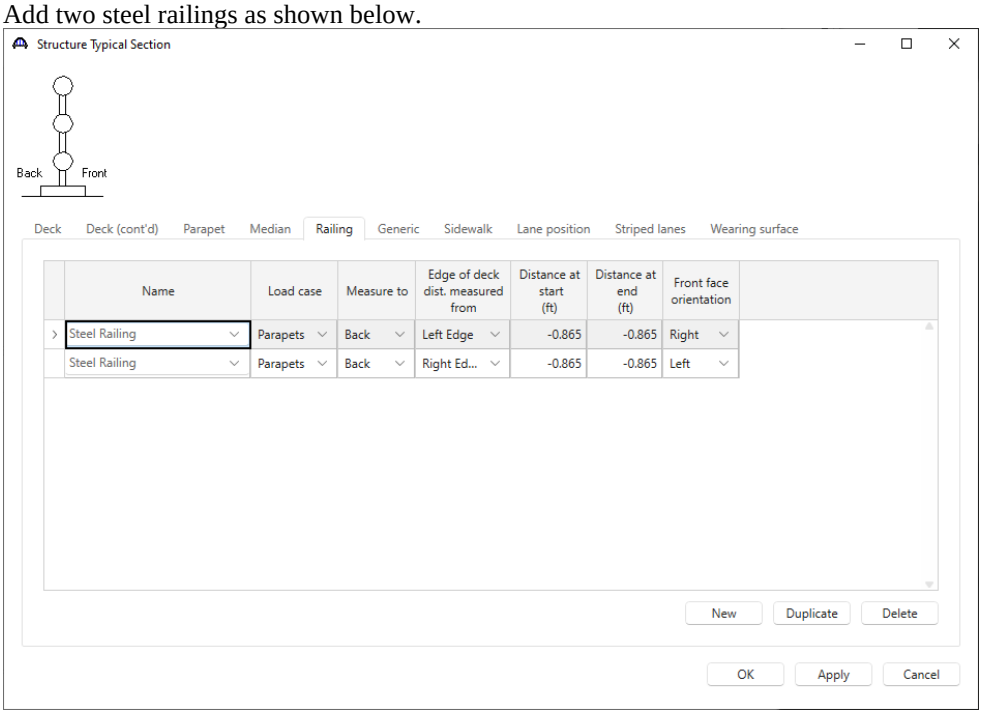
Typical Section

Input the data describing the typical section as shown below.



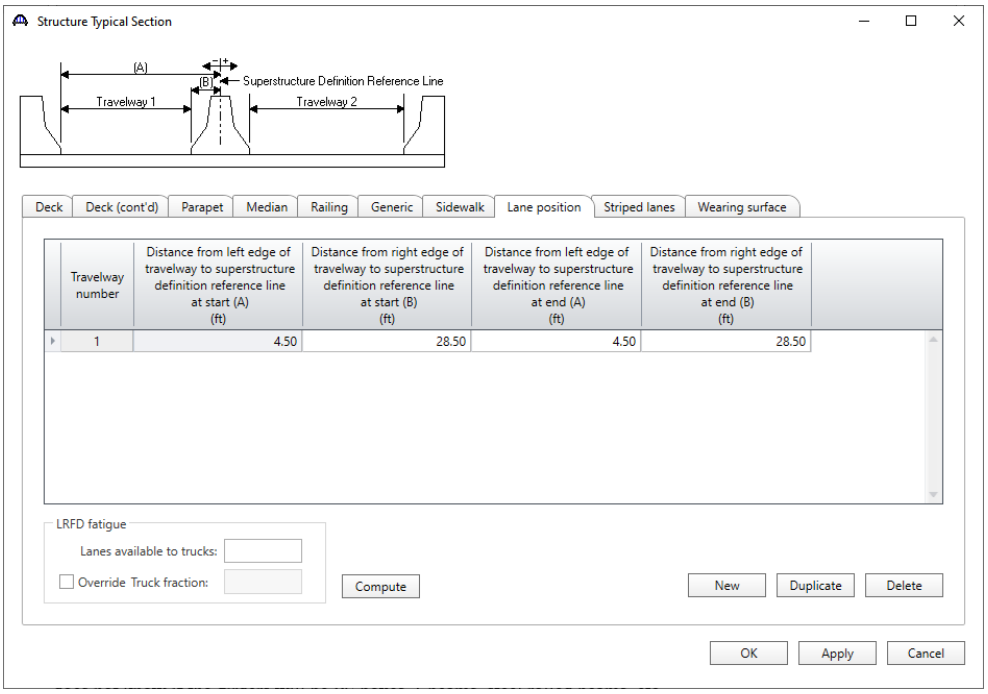
Structure Typical Section – Railing

Add two steel railings as shown below.



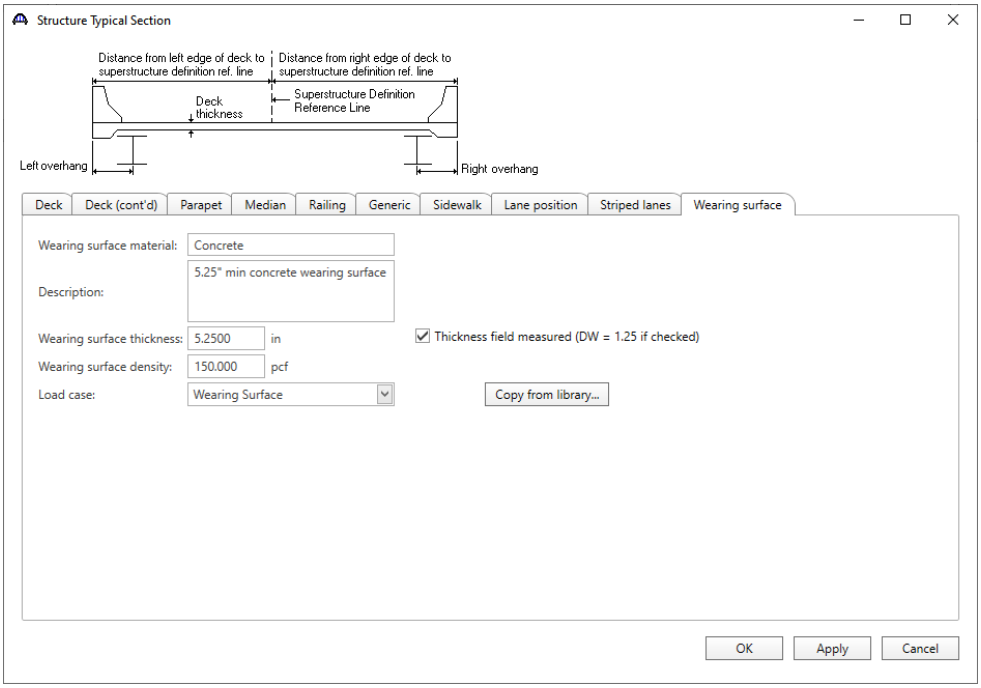
Structure Typical Section – Lane Positions

Select the **Lane position** tab and add the travel lanes as shown below as per the typical section schematic.



Structure Typical Section – Wearing surface

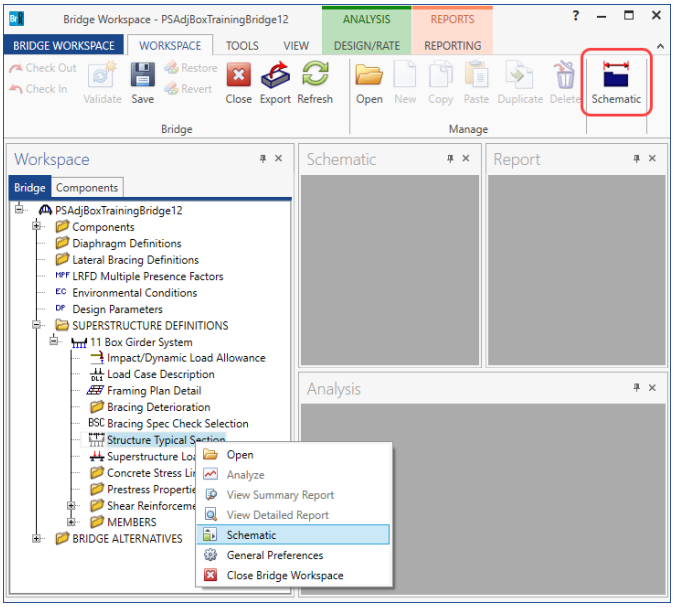
Enter the data shown below.

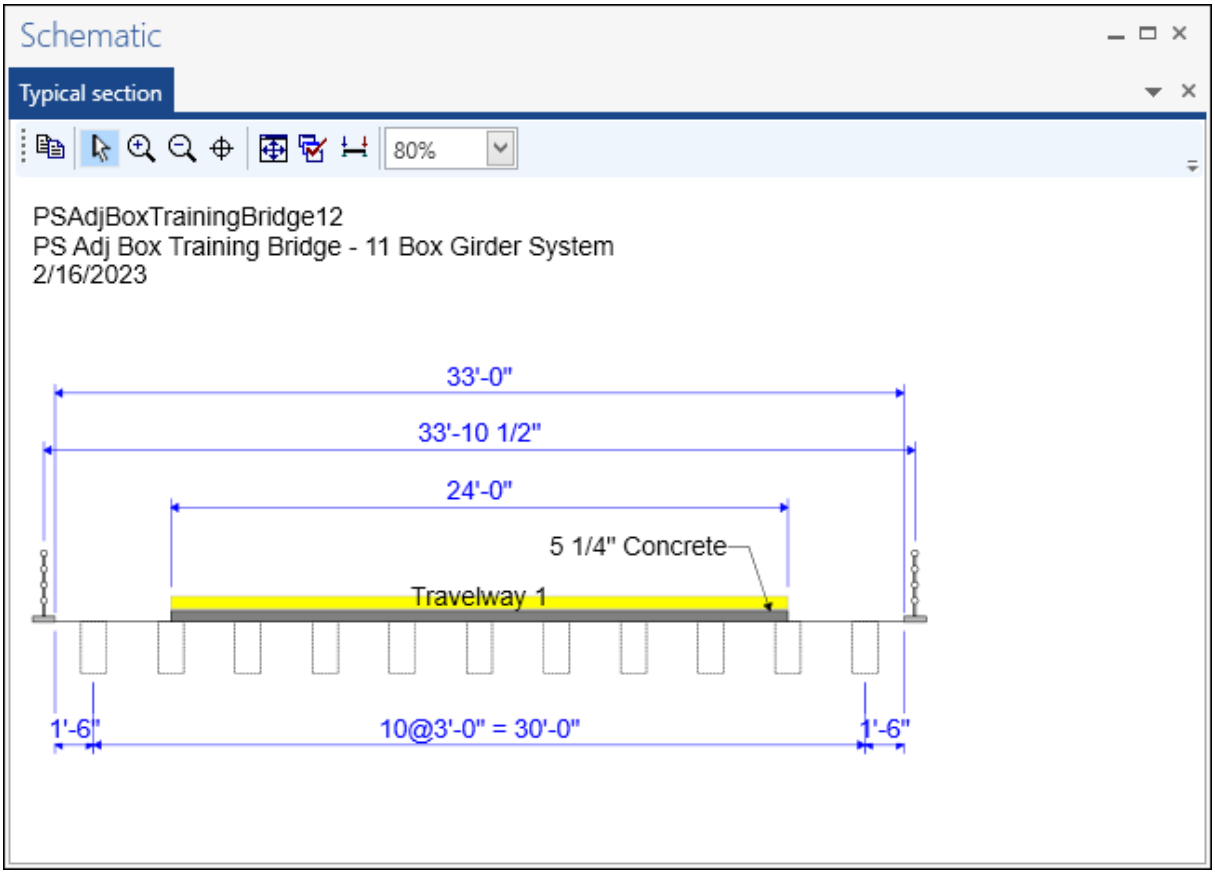


Click **OK** to apply the data and close the window.

Schematic – Structure Typical Section

While the **Structure Typical Section** node is selected in the **Bridge Workspace** tree, open the schematic for the typical section by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Structure Typical Section** in the **Bridge Workspace** and select **Schematic** from the menu).

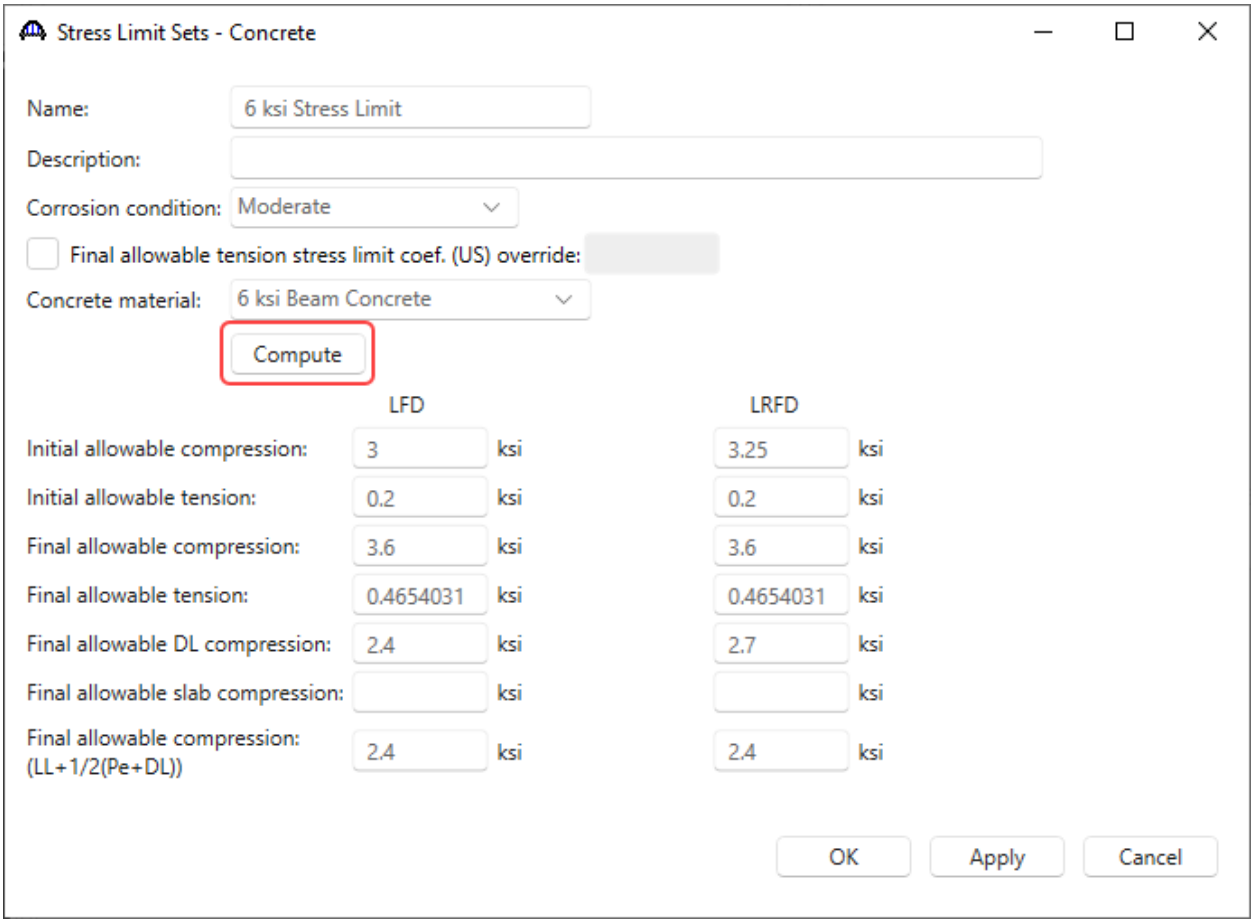




Since the member alternatives are not defined yet, the girders are displayed as dashed boxes. At this point BrDR does not know if the girders will be PS boxes, I-beams, steel rolled beams, etc.

Concrete Stress Limits

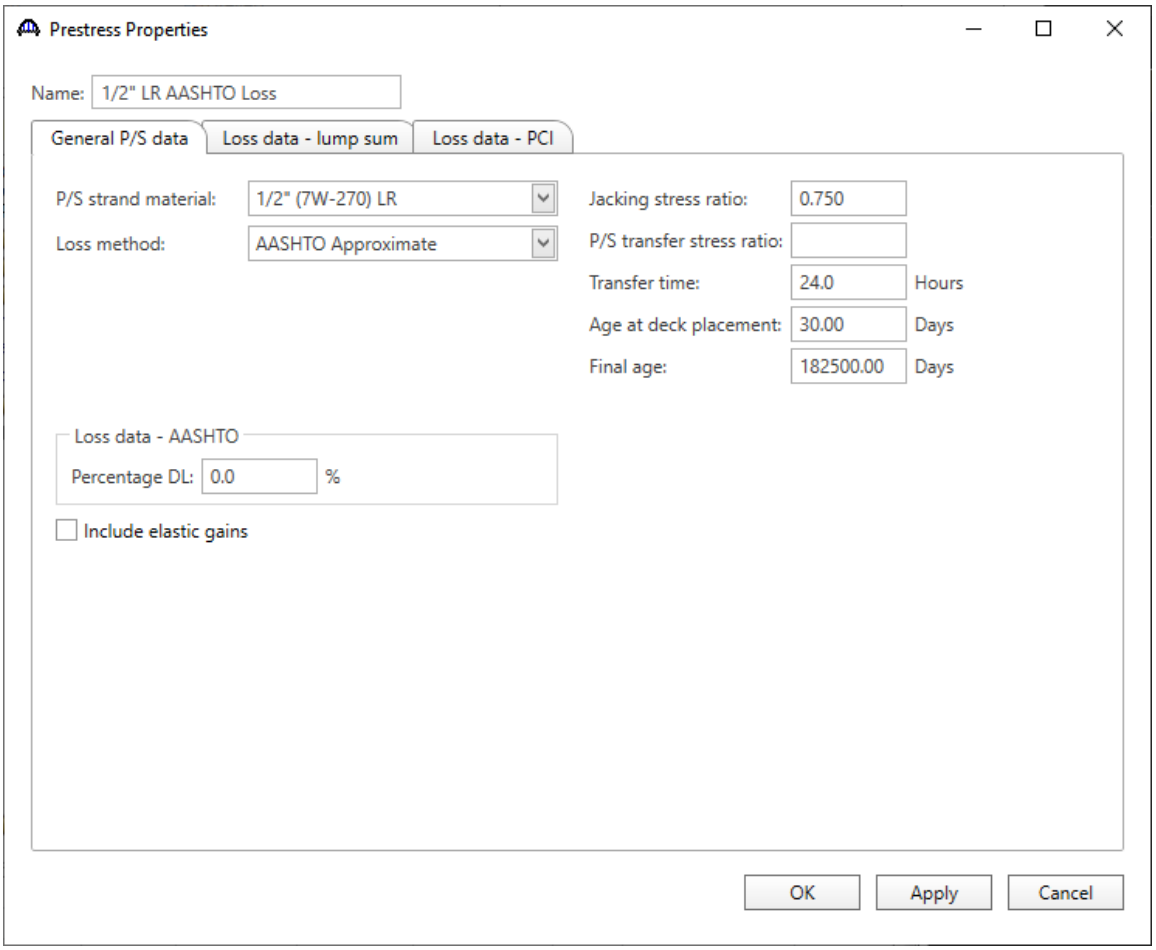
A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the **Concrete Stress Limits** node in the **Bridge Workspace** tree to open the **Stress Limit Sets – Concrete** window. Enter data shown above the **Compute** button, select **Moderate** for the **Corrosion condition** and select the **6.0 ksi Beam Concrete** material from the drop-down menu of the **Concrete material**. Click the **Compute** button. Default values for the allowable stresses will be computed based on the **Concrete material** selected and the AASHTO Specifications. The default value for the **Final allowable slab compression** is not computed since the deck concrete is typically different from the concrete used in the beam. This value will be left blank since this example does not have a concrete deck.



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

Prestress Properties

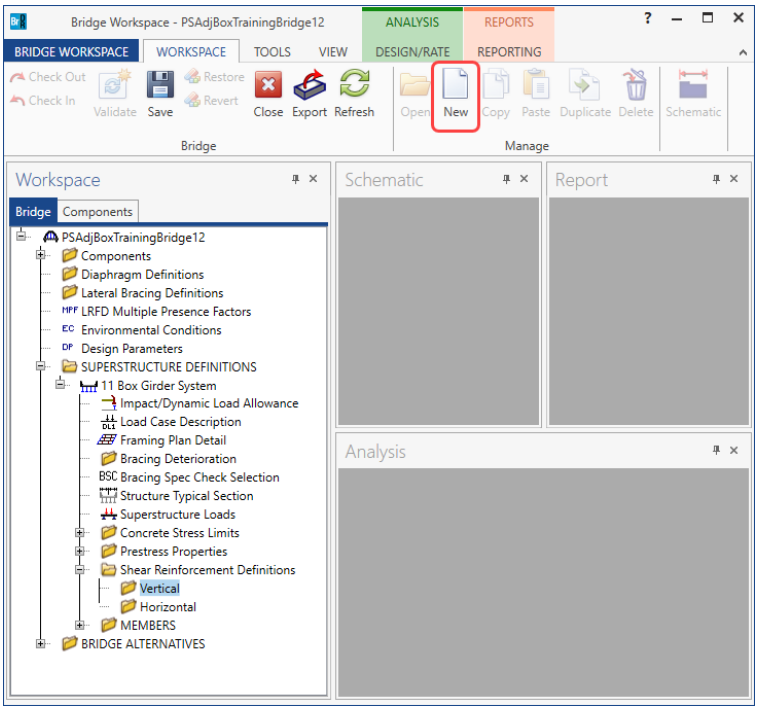
Double click on the **Prestress Properties** node in the **Bridge Workspace** tree to open the **Prestress Properties** window. Define the prestress properties as shown below. Since the **AASHTO Approximate** method is used to compute the losses, only the information on the **General P/S data** tab is required.



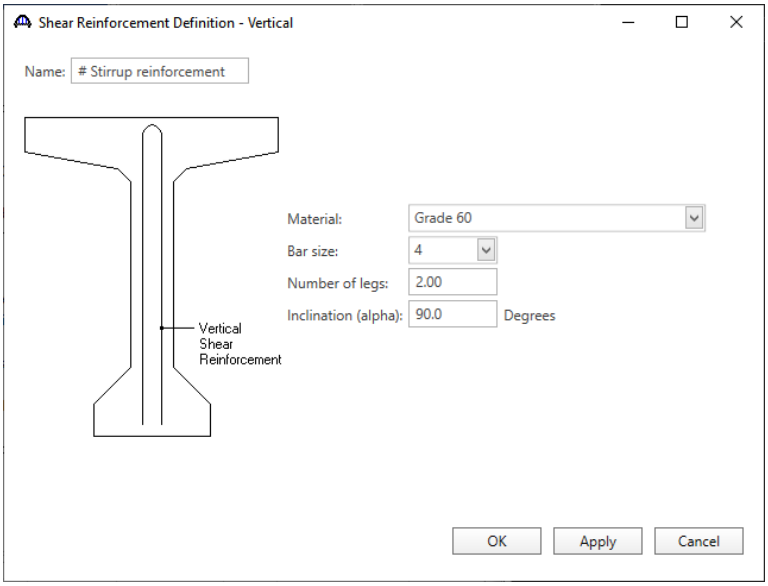
Click **OK** to apply the data and close the window.

Shear Reinforcement

Define the vertical shear reinforcement to be used by the girders. Expand the **Shear Reinforcement Definitions** node in the **Bridge Workspace** tree, select the **Vertical** node and click on **New** from the **Manage** group of the **WORKSPACE** ribbon (or double click on **Vertical)**.

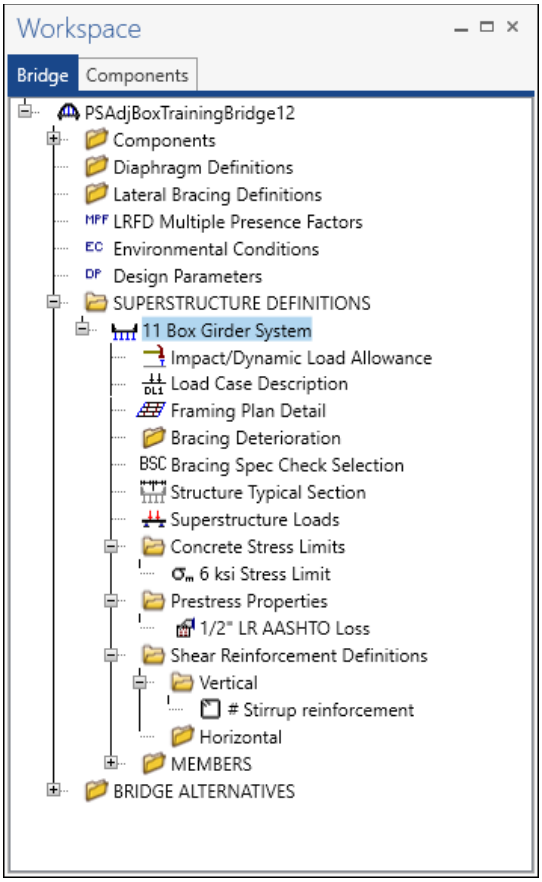


The I shape shown is for illustrative purposes only, it is not meant to display the actual beam shape. Enter the data as shown below.



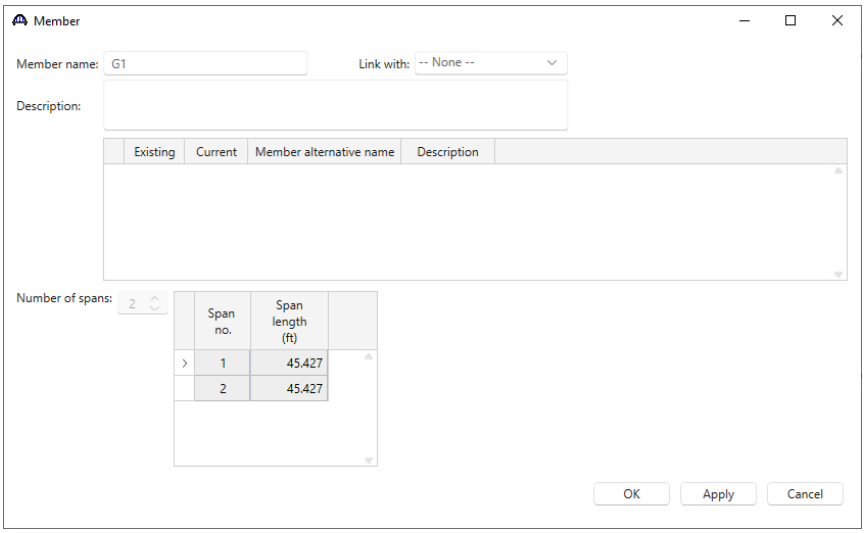
Click **OK** to apply the data and close the window.

A partially expanded **Bridge Workspace** is shown below.



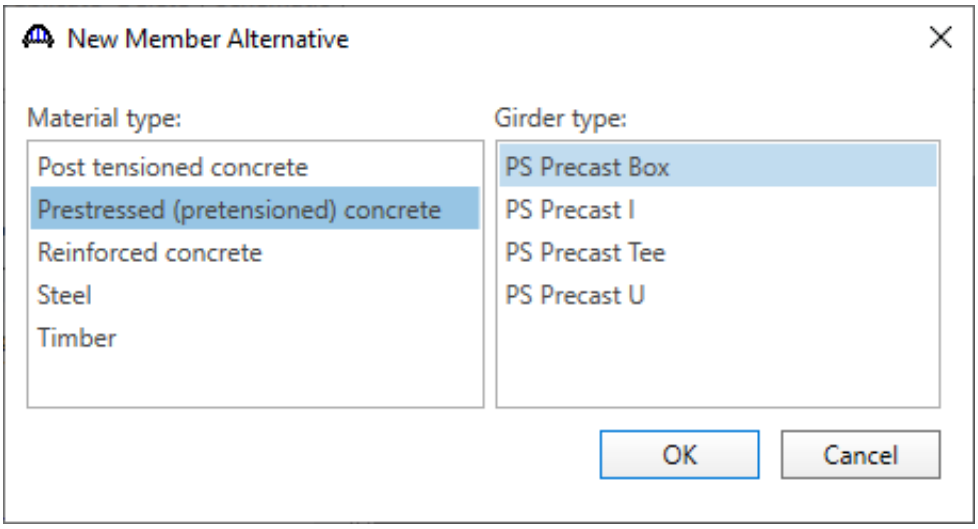
Describing a member

The **Member** window shows the data that was generated when the structure definition was created. No changes are required in this window. The first member alternative created will automatically be assigned as the **Existing** and **Current member alternative** for this Member.



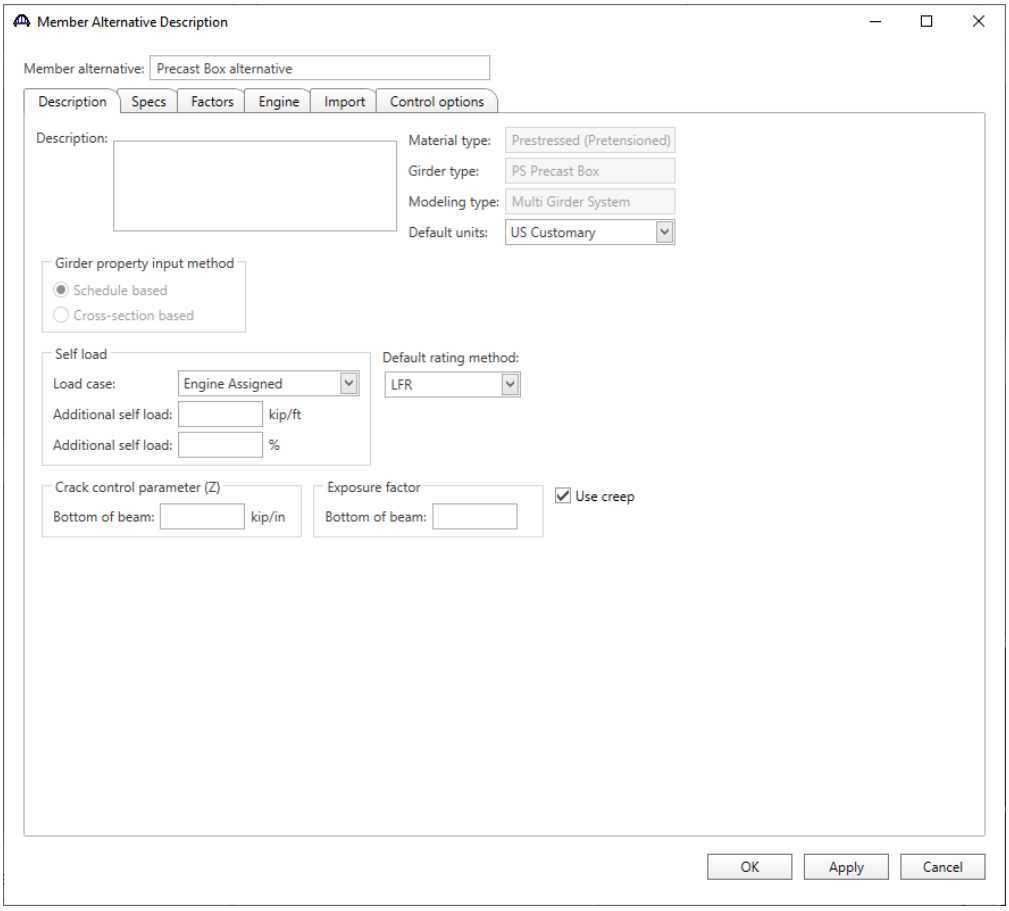
Defining a Member Alternative

Expand node **G2**. Double-click on **MEMBER ALTERNATIVES** in the **Bridge Workspace** tree for member **G2** to create a new member alternative. The **New Member Alternative** window shown below will open. Select **Prestressed (pretensioned) concrete** for the **Material type** and **PS Precast Box** for the **Girder Type**.



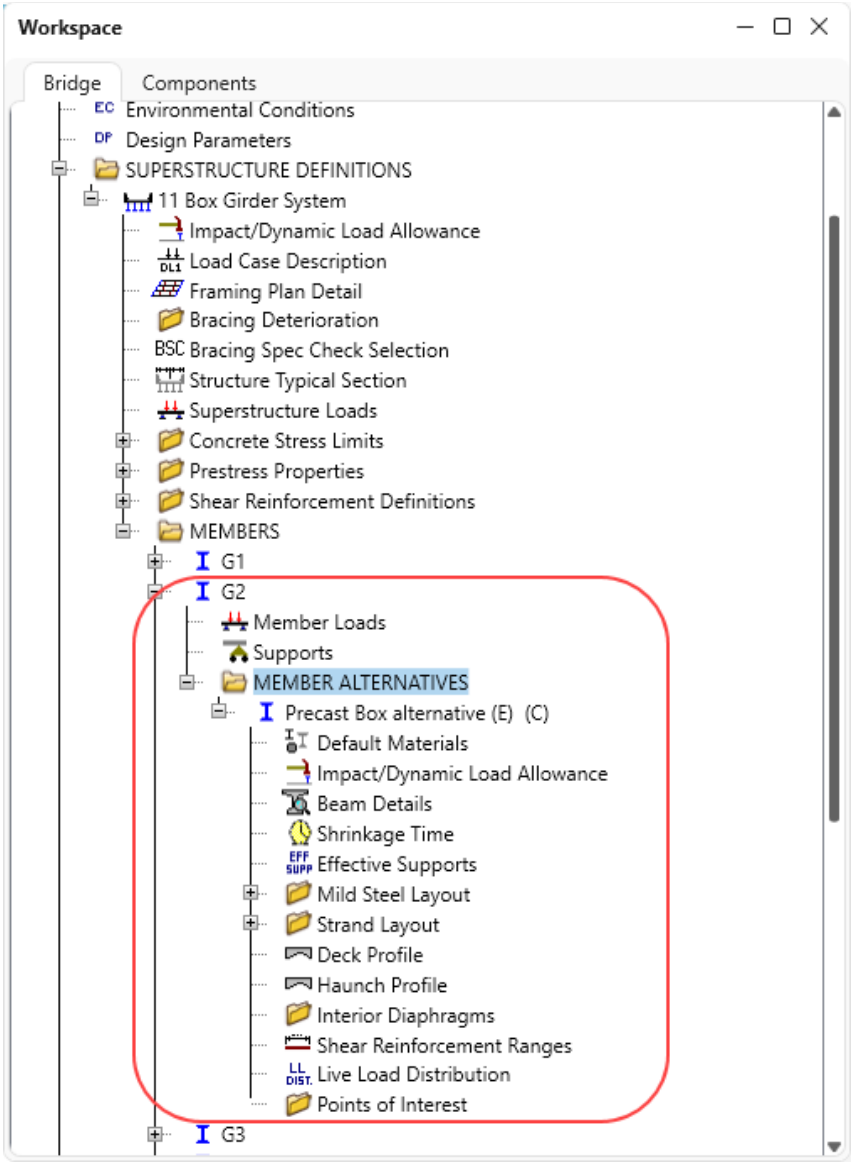
Click **OK** to close the window and create a new member alternative.

The **Member Alternative Description** window will open. Enter the data as shown below. The **Schedule based Girder property input method** is the only input method available for a prestressed concrete beam. Enter data as shown below.



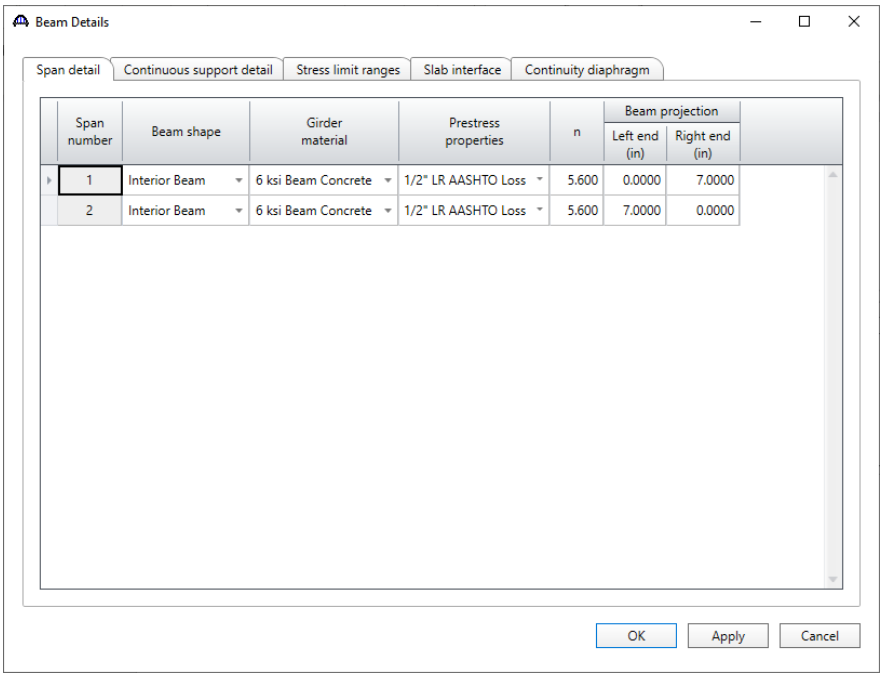
Click **OK** to apply the data and close the window.

Expand the newly added member alternative. The partially expanded **Bridge Workspace** tree is shown below.



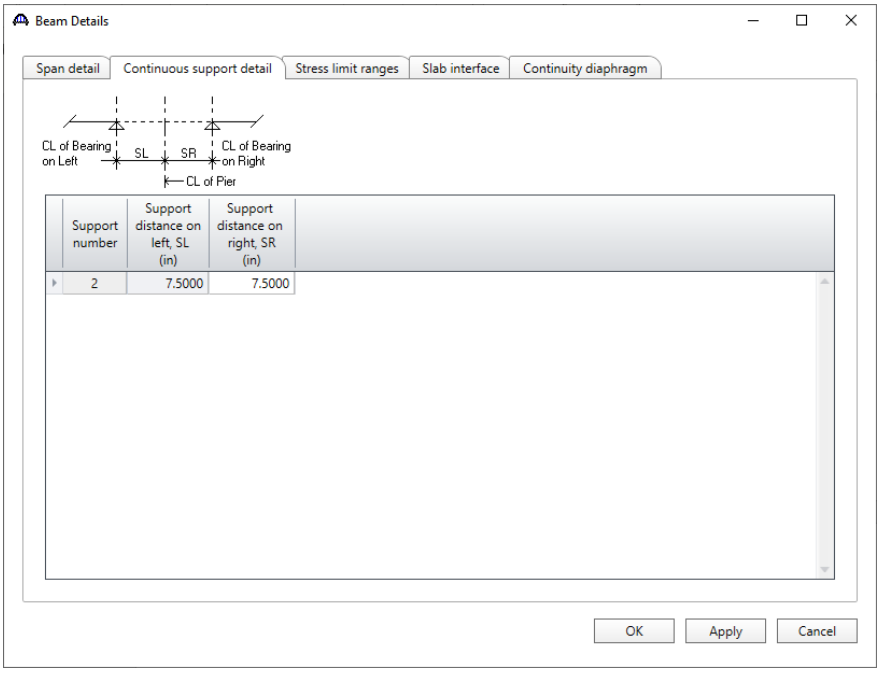
Beam Details – Span detail

Next describe the beam by double clicking on the **Beam Details** node in the **Bridge Workspace** tree. Enter the data in each tab of the **Beam Details** window as shown below.



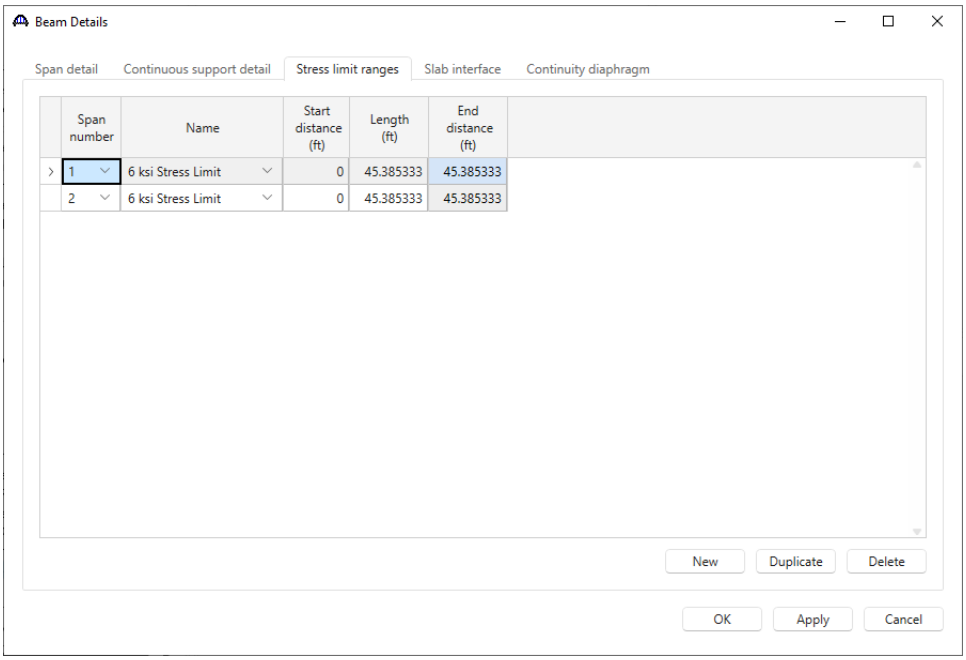
Beam Details – Continuous support detail

Define the continuous support detail as shown below.



Beam Details – Stress limit ranges

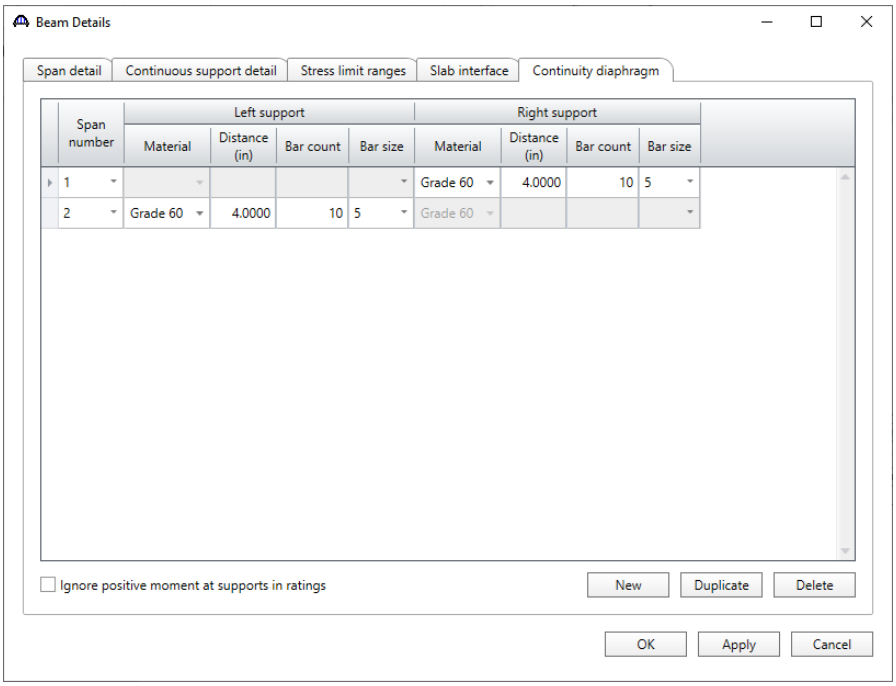
Note that the stress limit ranges are defined over the entire length of the precast beam as shown below for span 1 and span 2.



Since this example does not have a concrete deck, the **Slab interface** tab does not require input.

Beam Details – Continuity diaphragm

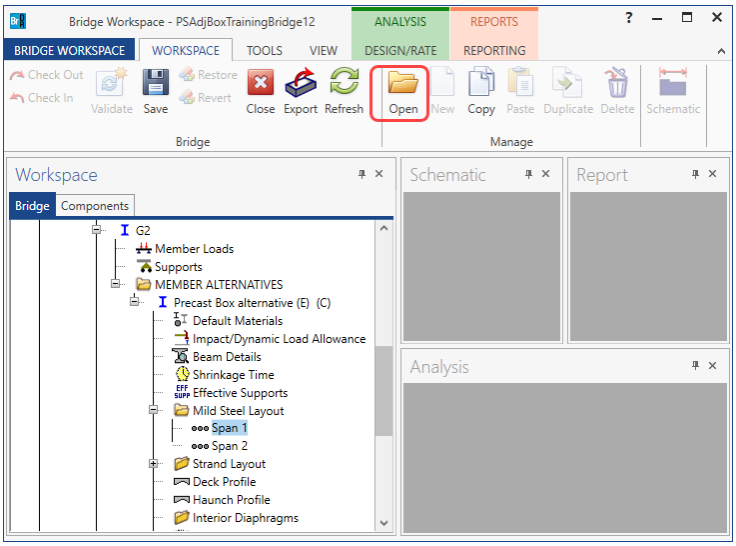
Enter the Continuity diaphragm detail as shown below.



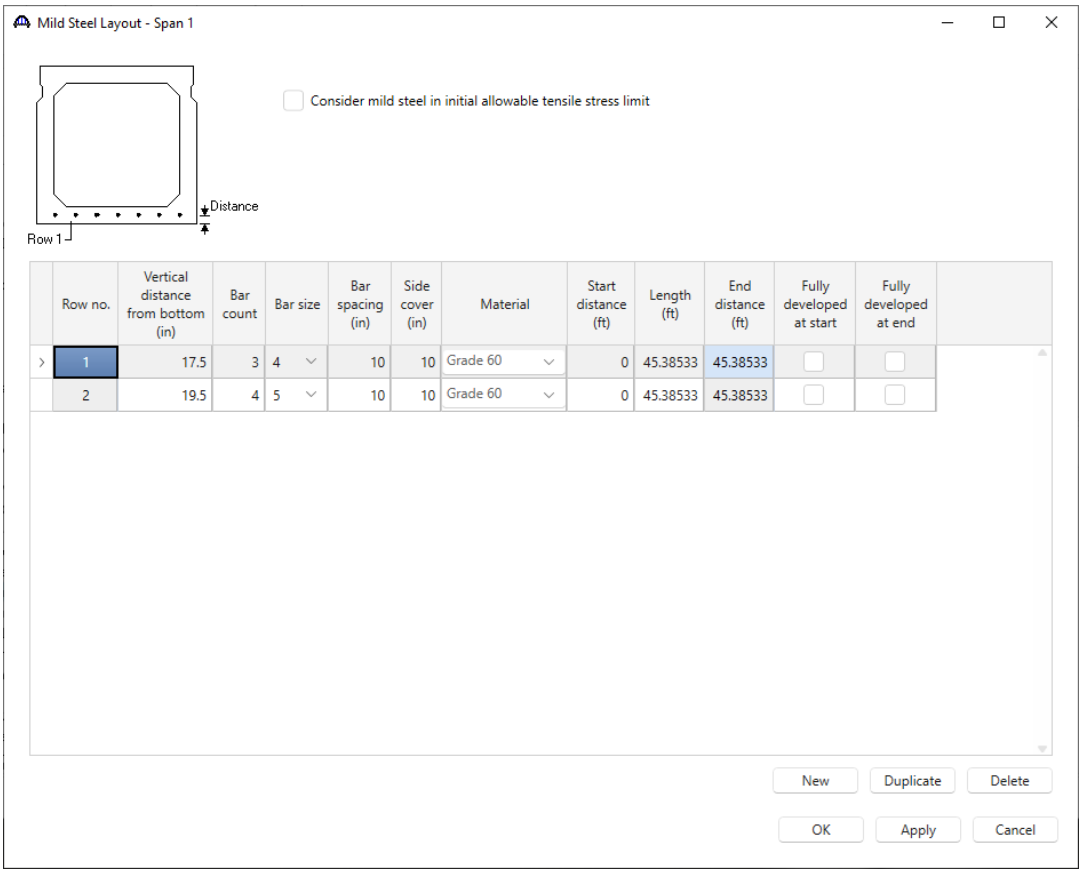
Click **OK** to apply the beam details and close the window.

Mild Steel Layout – Span 1

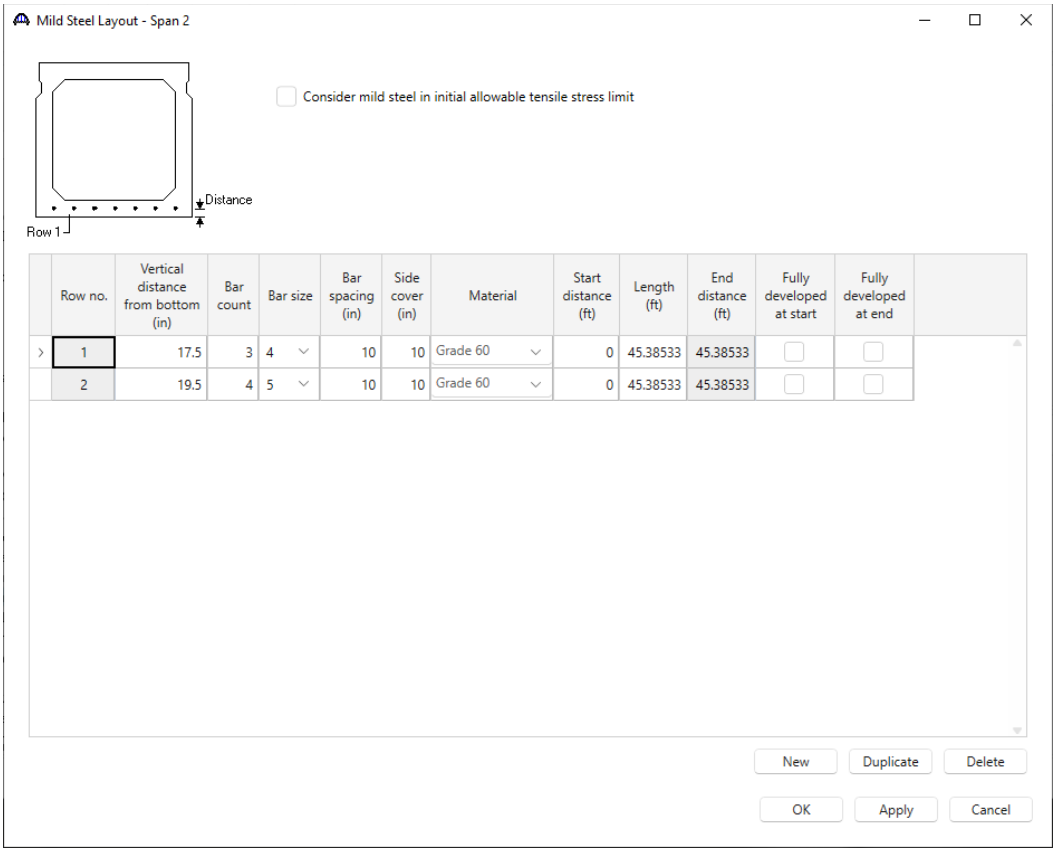
Expand the **Mild Steel Layout** in the **Bridge Workspace** tree and double-click on **Span 1** (or select **Span 1** and click the **Open** button from the **Manage** group of the **WORKSPACE** ribbon) to open the **Mild Steel Layout – Span 1** window.



Enter the Span 1 details as shown below.



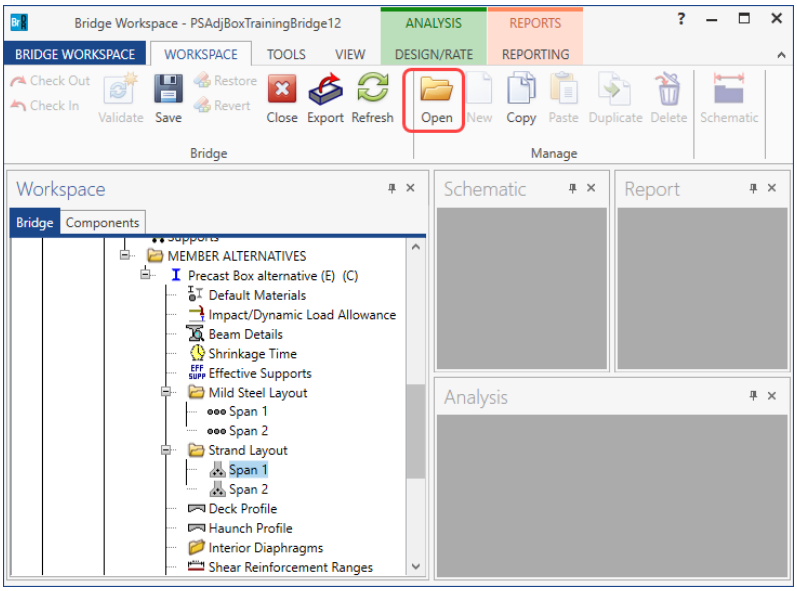
Similarly, enter the **Mild Steel Layout – Span 2** as shown below.



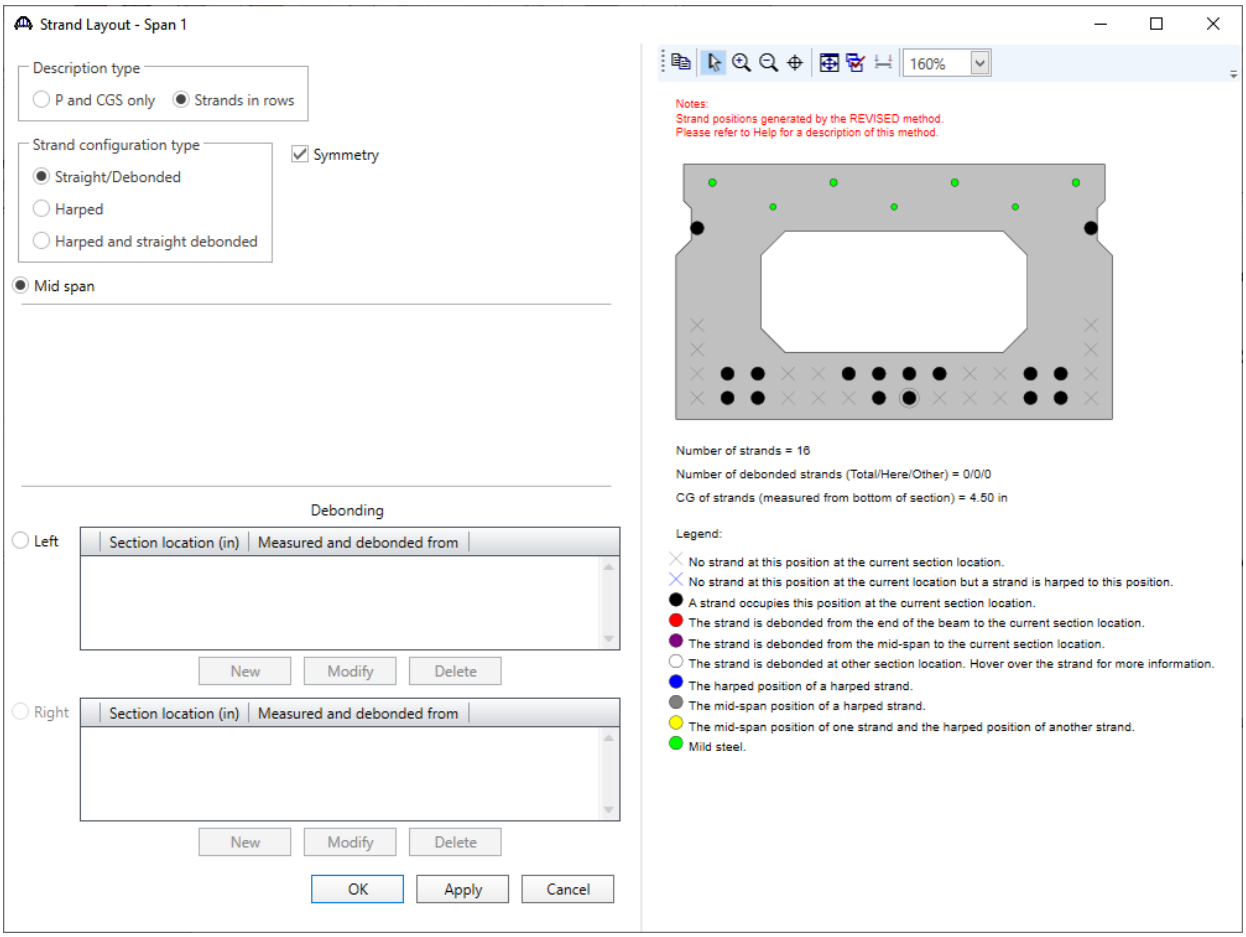
Click **OK** to apply the beam details and close the window.

Strand Layout – Span 1

Expand the **Strand Layout** in the **Bridge Workspace** tree and double-click on **Span 1** (or select **Span 1** and click the **Open** button from the **Manage** group of the **WORKSPACE** ribbon) to open the **Stand Layout – Span 1** window.

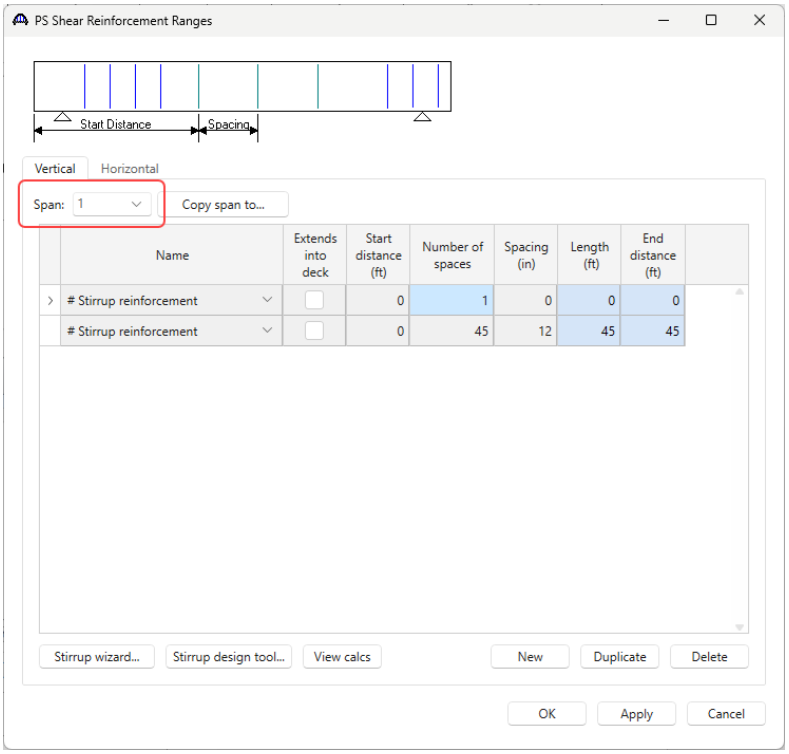


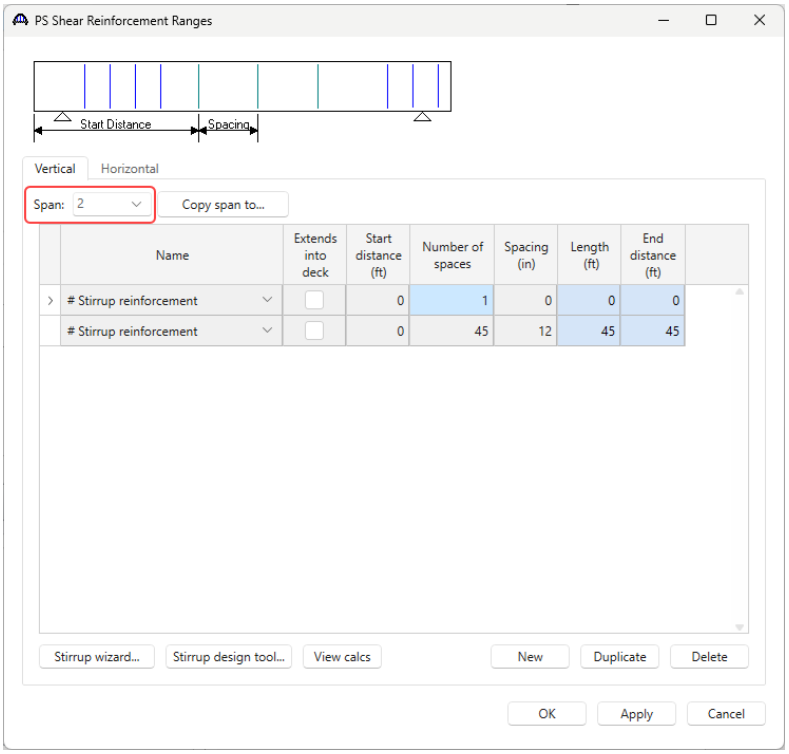
Use the **Zoom** buttons to shrink/expand the schematic of the beam shape on the right side of the screen so that the entire beam is visible. Select the **Description type** as **Strands in rows** and the **Strand configuration type** as **Straight/Debonded**. The **Mid span** radio button will now become active. Strands can now be defined at the middle of the span by selecting strands on the right hand schematic. Select the following strands in the schematic so that the CG of the strands is 4.5 inches. Click the **Apply** button and then **OK** to apply this data. Repeat these steps for **Span 2.**



Shear Reinforcement Ranges

Double-click on the **Shear Reinforcement Ranges** node in the **Bridge Workspace** tree to open the **PS Shear Reinforcement Ranges** window. The shear reinforcement ranges for each span are entered as described below.



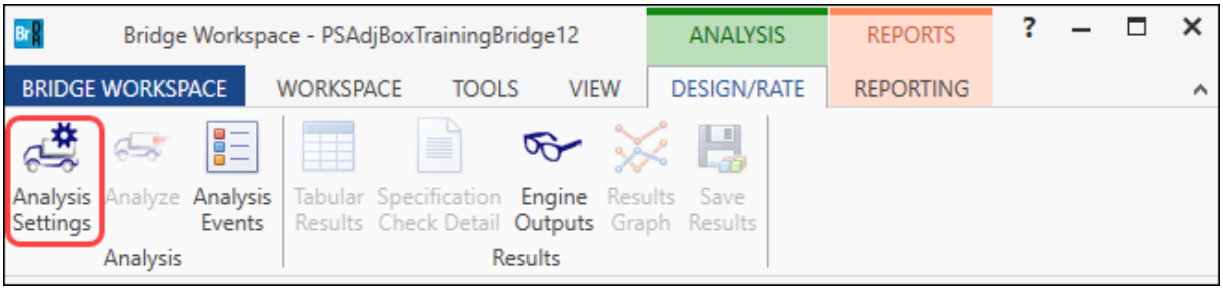


Click **OK** to apply the data and close the window.

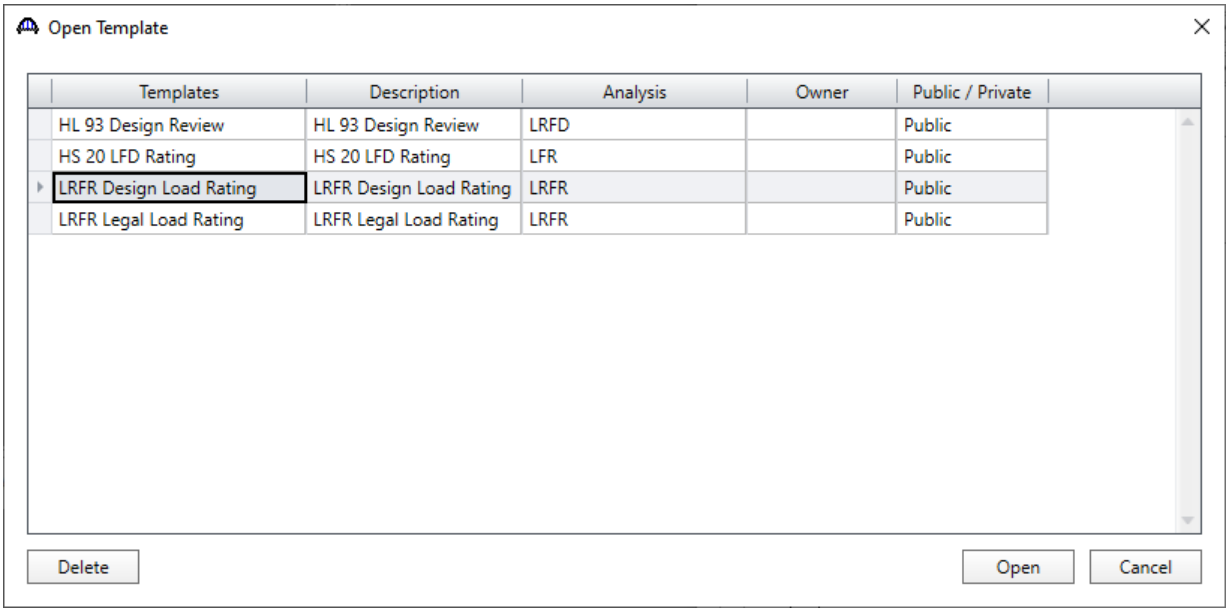
The description of an interior beam for this structure definition is complete. The member alternative can now be analyzed.

LRFR Rating

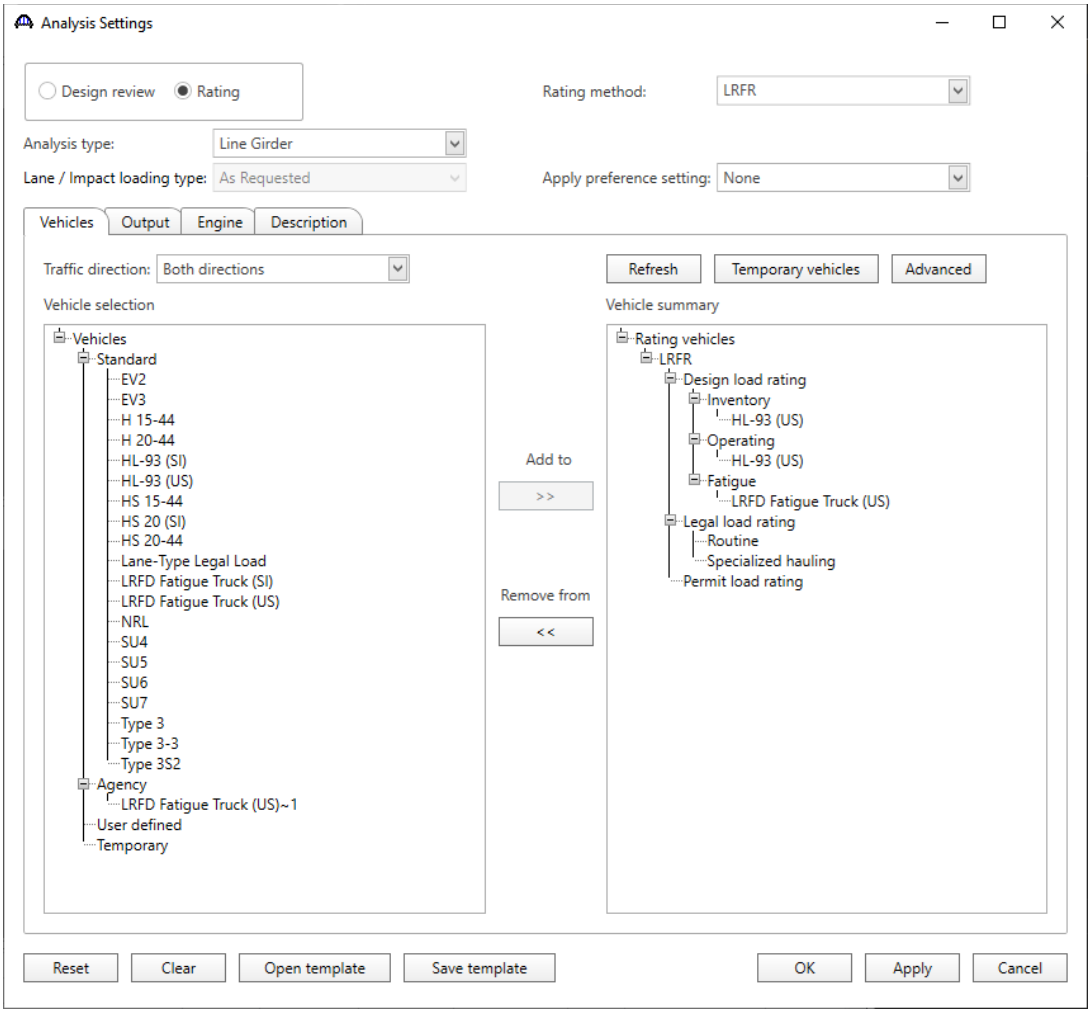
To perform an **LRFR** rating on **G2**, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon to open the window shown below.



Click the **Open Template** button and select the **LRFR Design Load Rating** to be used in the rating and click **OK**.



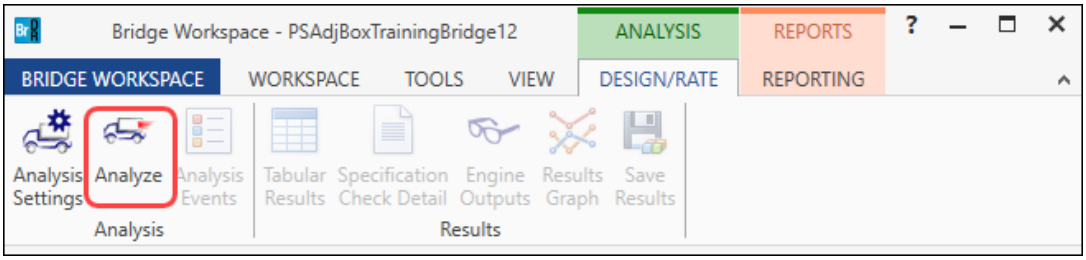
The **Analysis Settings** window will be updated as shown below.



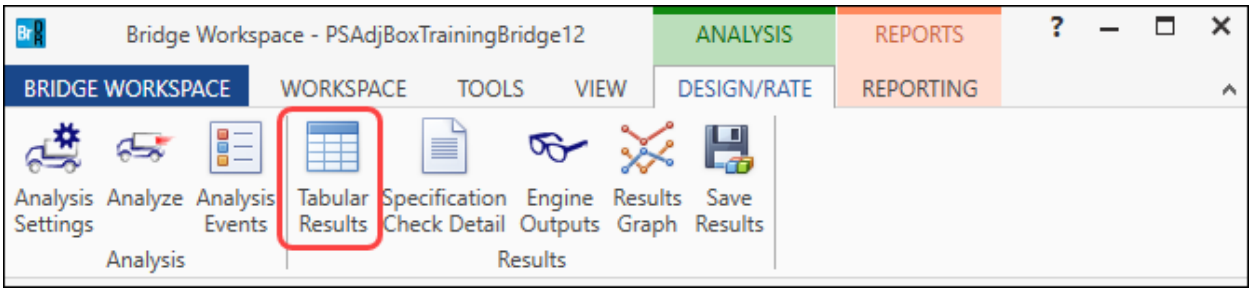
Click **OK** to apply the data and close the window.

Tabular Results

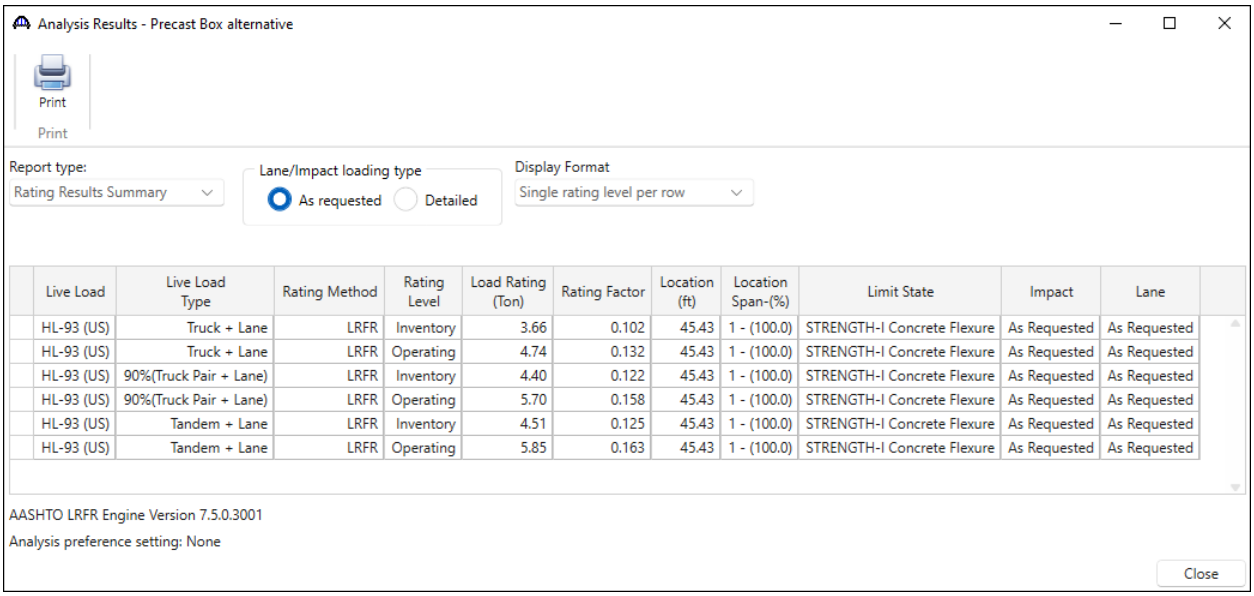
With **G2** member alternative **Precast Box alternative** selected, click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



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



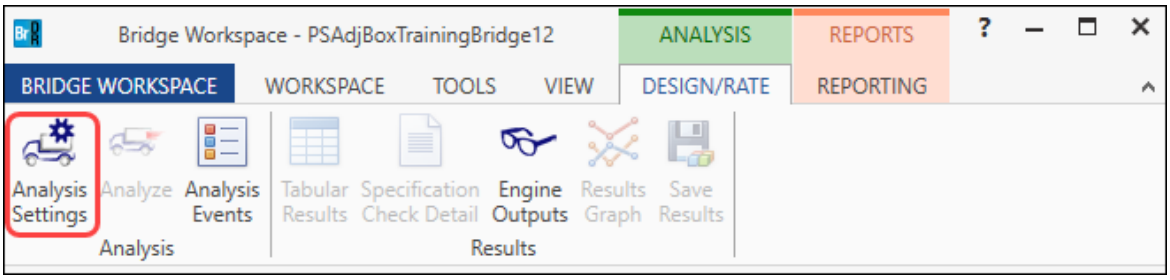
The window shown below will open.



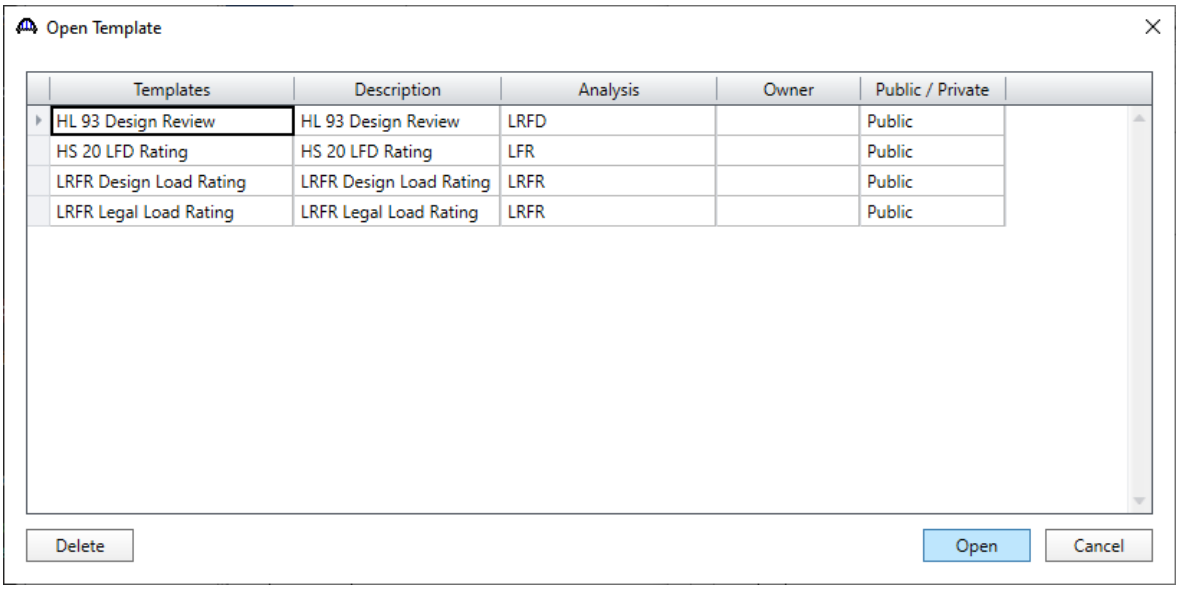
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HL-93 (US)	Truck + Lane	LRFR	Inventory	3.66	0.102	45.43	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	4.74	0.132	45.43	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	4.40	0.122	45.43	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	5.70	0.158	45.43	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	4.51	0.125	45.43	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	5.85	0.163	45.43	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested

LRFD Design review

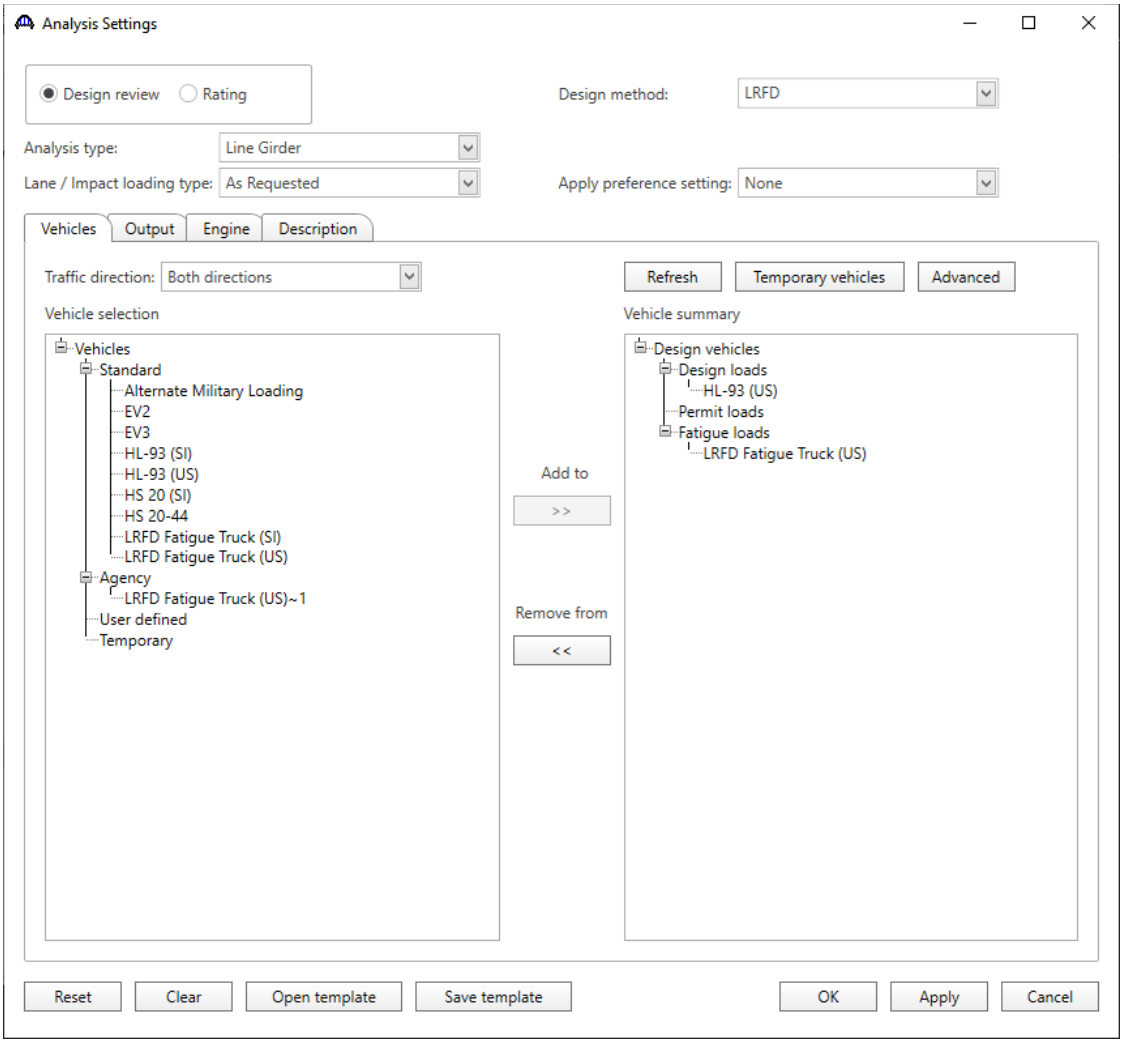
To perform an **LRFD design review of G2** of this girder for HL93 loading, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon to open the window shown below.



Click the **Open Template** button and select the **HL 93 Design Review** to be used in the rating and click **OK**.



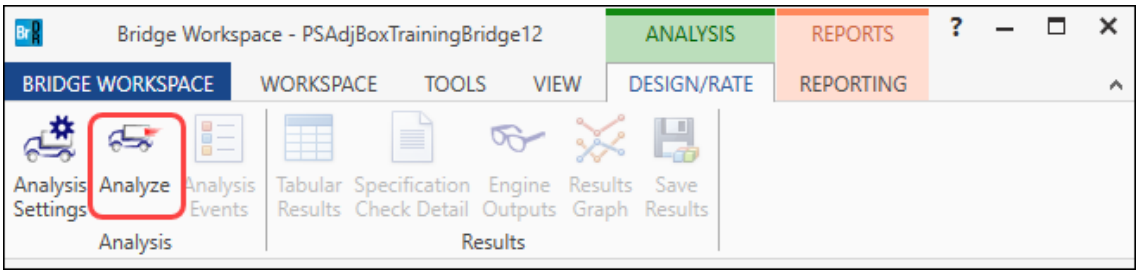
The **Analysis Settings** window will be updated as shown below.



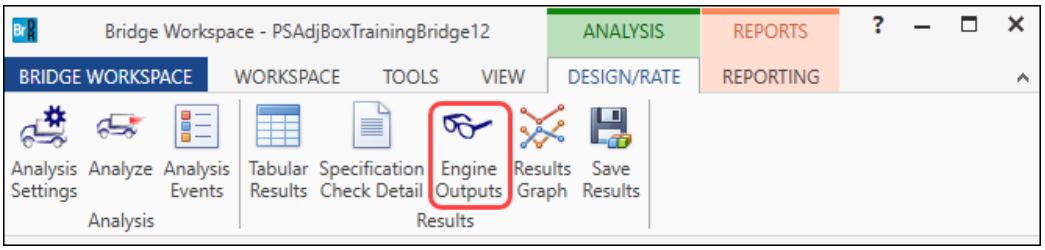
Click **OK** to apply the data and close the window.

Engine Outputs

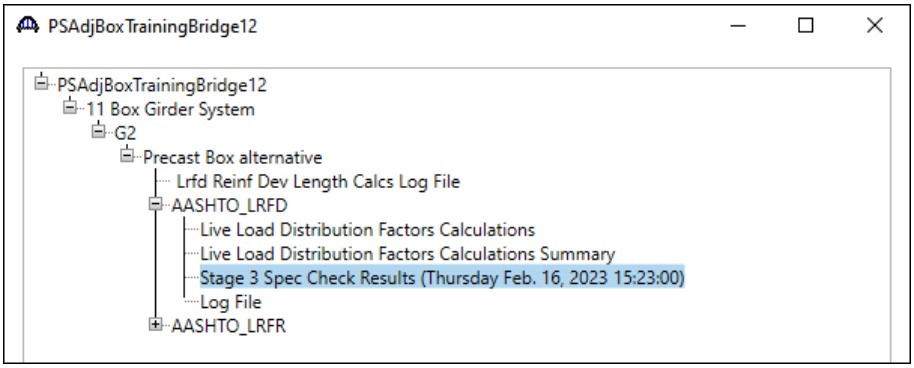
Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review.



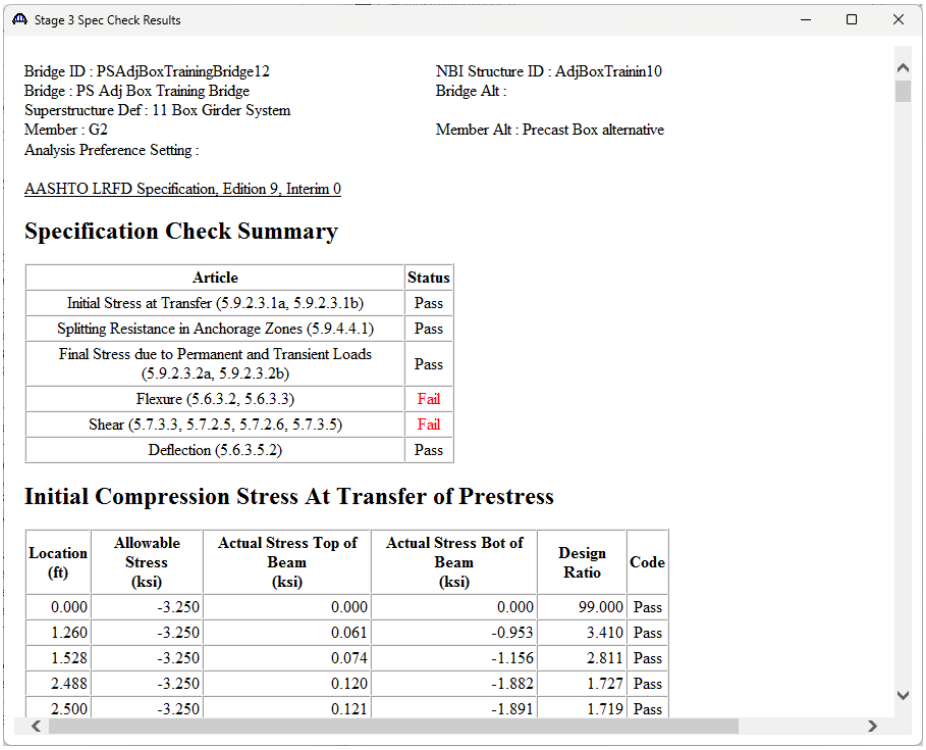
AASHTO LRFD analysis will generate a **Spec Check Results** file. When the design review is finished, results can be reviewed by clicking the **Engine outputs** button on the **Results** group of the ribbon.



The following window opens.



To view the spec check results, double click the **Stage 3 Spec Check Results** file in this window.



Stage 3 Spec Check Results

Bridge ID : PSAdjBoxTrainingBridge12
Bridge : PS Adj Box Training Bridge
Superstructure Def : 11 Box Girder System
Member : G2
Analysis Preference Setting :

NBI Structure ID : AdjBoxTrainin10
Bridge Alt :

Member Alt : Precast Box alternative

AASHTO LRFD Specification, Edition 9, Interim 0

Specification Check Summary

Article	Status
Initial Stress at Transfer (5.9.2.3.1a, 5.9.2.3.1b)	Pass
Splitting Resistance in Anchorage Zones (5.9.4.4.1)	Pass
Final Stress due to Permanent and Transient Loads (5.9.2.3.2a, 5.9.2.3.2b)	Pass
Flexure (5.6.3.2, 5.6.3.3)	Fail
Shear (5.7.3.3, 5.7.2.5, 5.7.2.6, 5.7.3.5)	Fail
Deflection (5.6.3.5.2)	Pass

Initial Compression Stress At Transfer of Prestress

Location (ft)	Allowable Stress (ksi)	Actual Stress Top of Beam (ksi)	Actual Stress Bot of Beam (ksi)	Design Ratio	Code
0.000	-3.250	0.000	0.000	99.000	Pass
1.260	-3.250	0.061	-0.953	3.410	Pass
1.528	-3.250	0.074	-1.156	2.811	Pass
2.488	-3.250	0.120	-1.882	1.727	Pass
2.500	-3.250	0.121	-1.891	1.719	Pass