

AASHTOWare BrDR 7.5.0

Prestressed Concrete Structure Tutorial
PS2 – Three Span Spread PS Box Beam Example

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BrDR Training

PS2 - Three Span Spread PS Box Beam Example

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

The screenshot shows a software window titled "3SpanSprdBoxTrainingBridge" with the following fields and options:

- Bridge ID: 3SpanSprdBoxTrainingBrid
- NBI structure ID (8): 3SpanSprdBoxTra
- Template:
- Bridge completely defined:
- Superstructures:
- Culverts:
- Substructures:

Tabbed interface with the following fields:

- Name: 3Span Sprd Box Trn Bridge
- Year built: []
- Description: 3 span spread PS box beam bridge made continuous for live load through continuity
- Location: []
- Length: [] ft
- Facility carried (7): []
- Route number: -1
- Feat. intersected (6): []
- Mi. post: []
- Default units: US Customary

Bridge association... BrR BrD BrM Sync with BrM

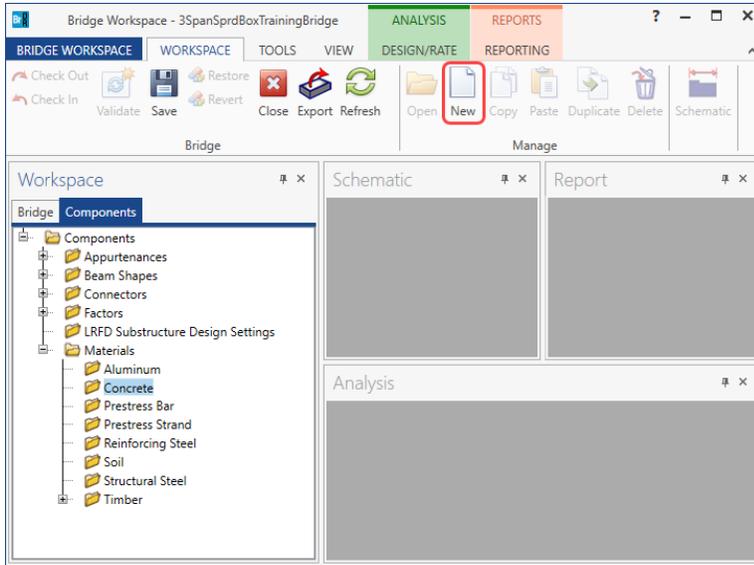
Buttons: OK, Apply, Cancel

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

PS2 – Three Span Spread PS Box Beam Example

Bridge Materials

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 above the **Compute** button and click on the **Compute** button to compute the remaining values as shown below.

Name:	6 ksi Beam Concrete
Description:	
Compressive strength at 28 days (f'c):	6 ksi
Initial compressive strength (f'ci):	5.1 ksi
Composition of concrete:	Normal
Density (for dead loads):	0.15 kcf
Density (for modulus of elasticity):	0.15 kcf
Poisson's ratio:	0.2
Coefficient of thermal expansion (alpha):	0.000006 1/F
Splitting tensile strength (fct):	
LRFD Maximum aggregate size:	
Compute	
Std modulus of elasticity (Ec):	4695.982325 ksi
LRFD modulus of elasticity (Ec):	4877.010345 ksi
Std initial modulus of elasticity:	4329.481782 ksi
LRFD initial modulus of elasticity:	4622.340373 ksi
Std modulus of rupture:	0.580948 ksi
LRFD modulus of rupture:	0.587878 ksi
Shear factor:	1

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

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Create another new concrete material to be used for the deck concrete. Add the concrete material by selecting from the Concrete Materials Library by clicking the **Copy from Library** button. The following window opens:

Library Data: Materials - Concrete

Name	Description	Library	Units	f _c	f _{ci}	alpha	DL density	Modulus density	Std modulus of elasticity	LRFD modulus of elasticity	Poisson's ratio	Modulus of rupture
Class A	Class A cement concrete	Standard	SI / Metric	28.00		0.0000108000	2400.00	2320.00	25426.08	27730.36	0.200	3.33
Class A (US)	Class A cement concrete	Standard	US Customary	4.000		0.0000060000	0.150	0.145	3644.15	3986.55	0.200	0.480
Class B	Class B cement concrete	Standard	SI / Metric	17.00		0.0000108000	2400.00	2320.00	19811.84	23520.23	0.200	2.60
Class B (US)	Class B cement concrete	Standard	US Customary	2.400		0.0000060000	0.150	0.145	2822.75	3368.12	0.200	0.372
Class C	Class C cement concrete	Standard	SI / Metric	28.00		0.0000108000	2400.00	2320.00	25426.08	27730.36	0.200	3.33
Class C (US)	Class C cement concrete	Standard	US Customary	4.000		0.0000060000	0.150	0.145	3644.15	3986.55	0.200	0.480

OK Apply Cancel

Select the **Class A (US)** material and click **OK**. The selected material properties are copied to the **Bridge Materials – Concrete** window as shown below.

Bridge Materials - Concrete

Name:

Description:

Compressive strength at 28 days (f_c): ksi

Initial compressive strength (f_{ci}):

Composition of concrete: ▼

Density (for dead loads): kcf

Density (for modulus of elasticity): kcf

Poisson's ratio:

Coefficient of thermal expansion (α): 1/F

Splitting tensile strength (f_{ct}):

LRFD Maximum aggregate size: in

Std modulus of elasticity (E_c): ksi

LRFD modulus of elasticity (E_c): ksi

Std initial modulus of elasticity:

LRFD initial modulus of elasticity:

Std modulus of rupture:

LRFD modulus of rupture: ksi

Shear factor:

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

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Add the following reinforcement steel in the same manner.

Bridge Materials - Reinforcing Steel

Name:

Description:

Material properties

Specified yield strength (fy): ksi

Modulus of elasticity (Es): ksi

Ultimate strength (Fu): ksi

Type

Plain

Epoxy

Galvanized

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

Add the following prestress strand in the same manner.

Bridge Materials - PS Strand

Name:

Description:

Strand diameter: in

Strand area: in²

Strand type:

Ultimate tensile strength (Fu): ksi

Yield strength (fy): ksi

Modulus of elasticity (E): ksi

Transfer length (Std): in

Transfer length (LRFD): in

Unit load per length: lb/ft

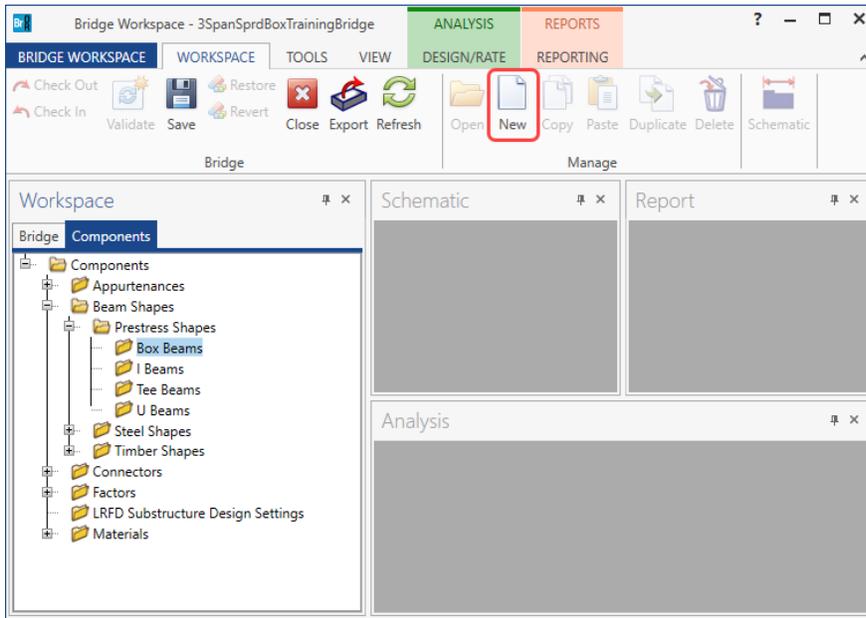
Epoxy coated

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

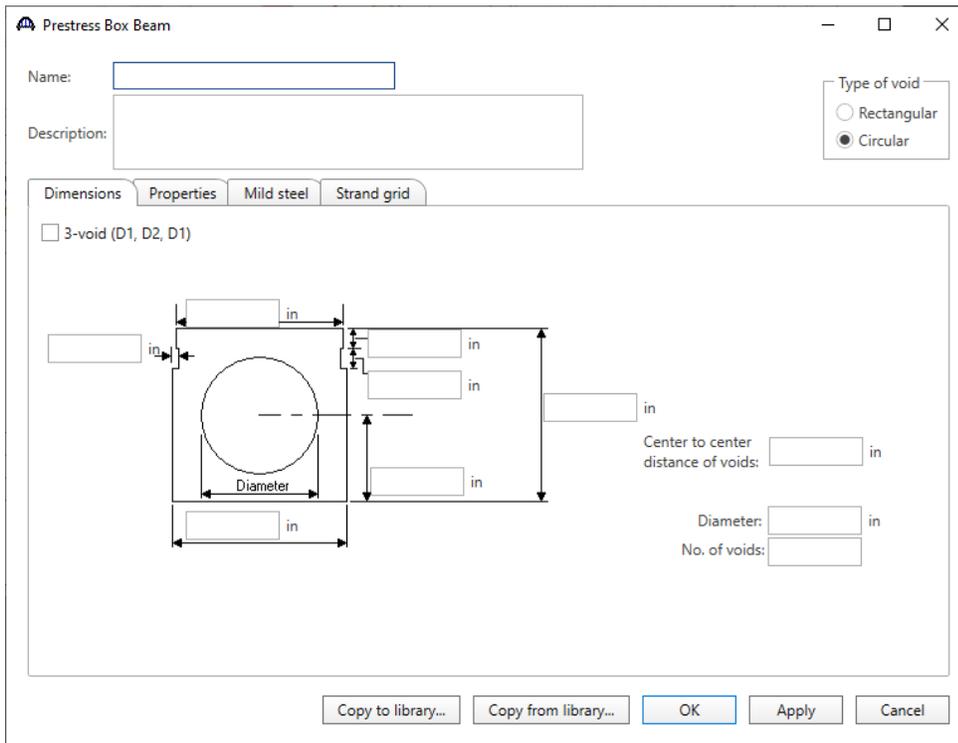
PS2 – Three Span Spread PS Box Beam Example

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.



PS2 – Three Span Spread PS Box Beam Example

Select the **Type of Void** as **Rectangular** and click on the **Copy from Library** button. The window shown below appears.

Name	Description	Library	Units	Depth	Top width	Bottom width	Top slab thickness	Bottom slab thickness	Top haunch width	Top haunch height	Bottom haunch width	Bottom haunch height	Shear key height	Shear key depth
BI-36	AASHTO-PCI BI-36	Standard	US Customary	27.0000	35.2500	36.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BI-48	AASHTO-PCI BI-48	Standard	US Customary	27.0000	47.2500	48.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BII-36	AASHTO-PCI BII-36	Standard	US Customary	33.0000	35.2500	36.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BII-48	AASHTO-PCI BII-48	Standard	US Customary	33.0000	47.2500	48.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BIII-36	AASHTO-PCI BIII-36	Standard	US Customary	39.0000	35.2500	36.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BIII-48	AASHTO-PCI BIII-48	Standard	US Customary	39.0000	47.2500	48.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BIV-36	AASHTO-PCI BIV-36	Standard	US Customary	42.0000	35.2500	36.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500
BIV-48	AASHTO-PCI BIV-48	Standard	US Customary	42.0000	47.2500	48.0000	5.5000	5.5000	3.0000	3.0000	3.0000	3.0000	6.0000	0.7500

Select **BII-48 (AASHTO-PCI BII-48)** and click **OK**. The beam properties are copied to the **PS Box Beam** window as shown below.

Prestress Box Beam

Name:

Description:

Type of void: Rectangular Circular

Dimensions Properties Mild steel Strand grid

T: in

B1: in

B2: in

B3: in

B4: in

0.75 in

5 in

47.25 in

48 in

6 in

6 in

33 in

5.5 in

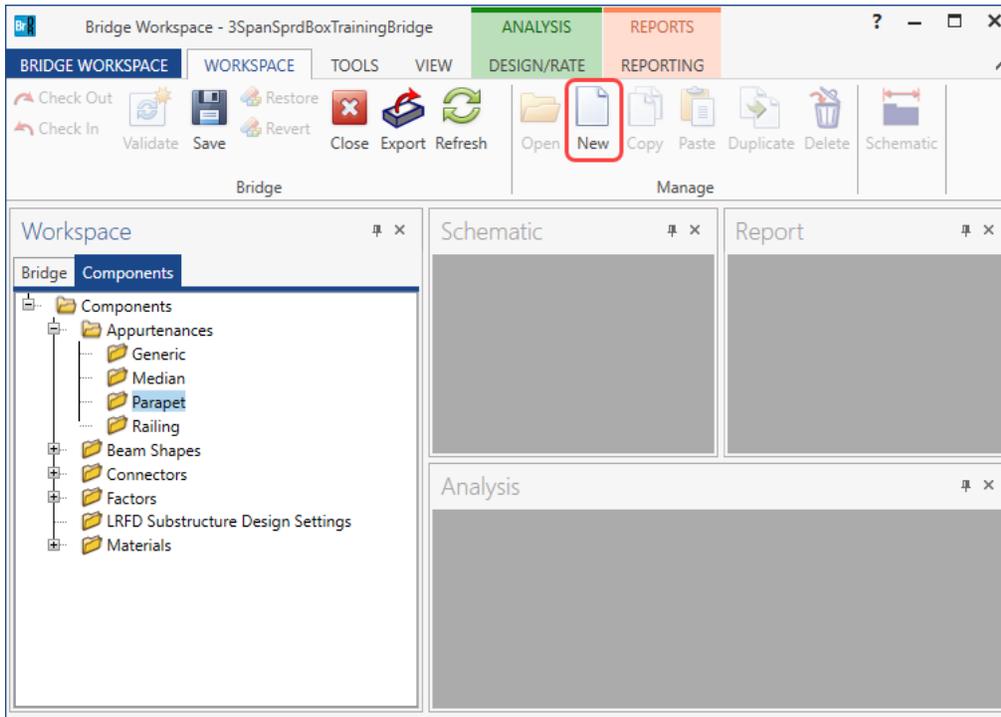
Copy to library... Copy from library... OK Apply Cancel

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

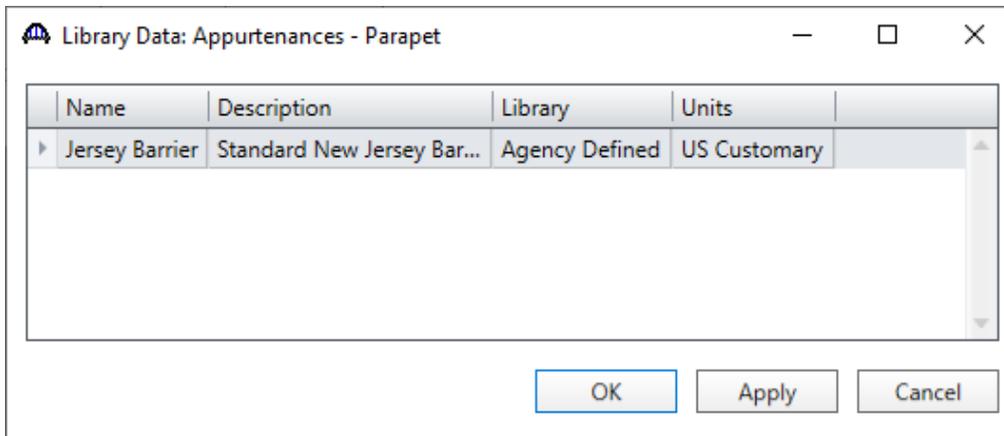
PS2 – Three Span Spread PS Box Beam Example

Bridge - Appurtenances

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



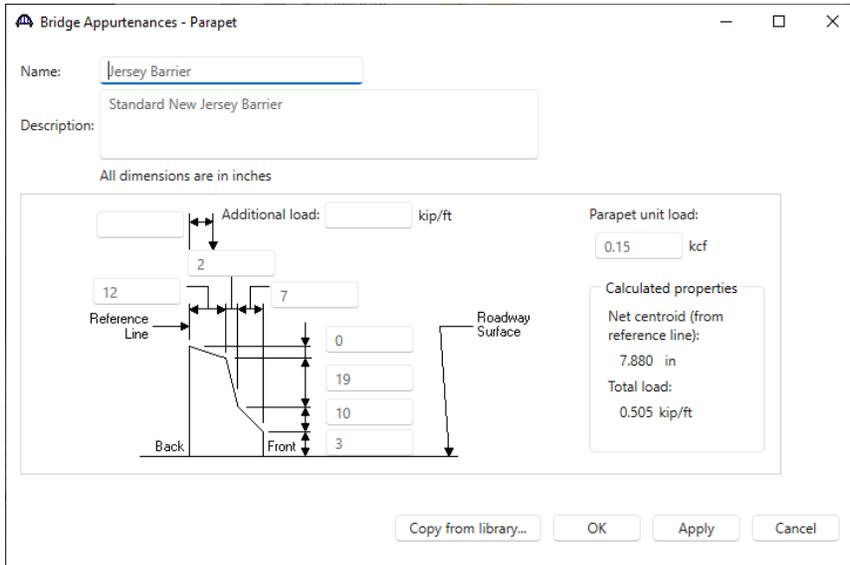
Add the parapet by clicking the **Copy from Library** button. The following window opens:



Select **Jersey Barrier** and click **OK**.

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The parapet properties are copied to the **Bridge Appurtenances - Parapet** window as shown below.



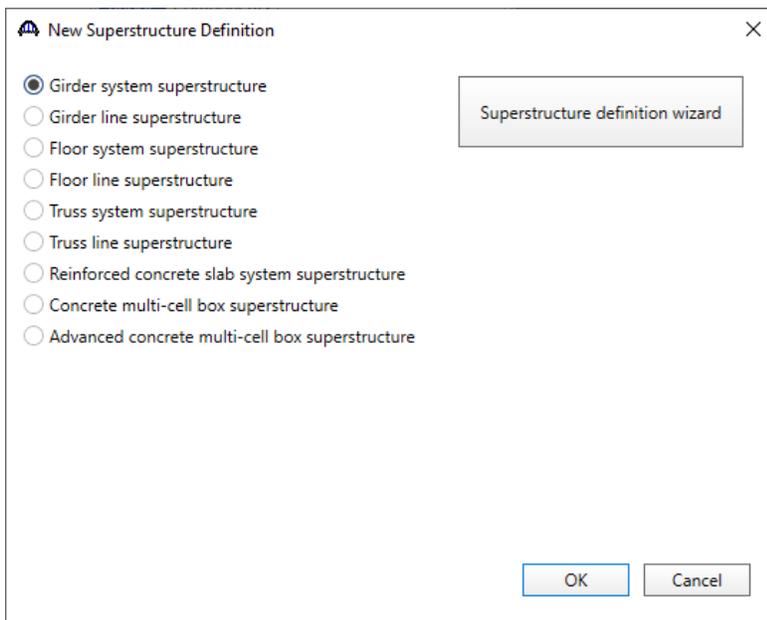
Click **OK** to apply the data and close the window

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

Bridge Alternatives will be added after entering the Structure Definition.

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.



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

Girder System Superstructure Definition

Definition Analysis Specs Engine

Name: 5 Girder System

Description:

Default units: US Customary

Number of spans: 3

Number of girders: 5

Enter span lengths along the reference line:

Span	Length (ft)
1	75.00
2	60.00
3	60.00

Modeling

Multi-girder system MCB

With frame structure simplified definition

Deck type: Concrete Deck

For PS/PT only

Average humidity: %

Member alt. types

Steel

P/S

R/C

Timber

P/T

Horizontal curvature along reference line

Horizontal curvature

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: Left

End tangent length: ft

Distance from last support line to PT: ft

Design speed: mph

Superelevation: %

Superstructure alignment

Curved

Tangent, curved, tangent

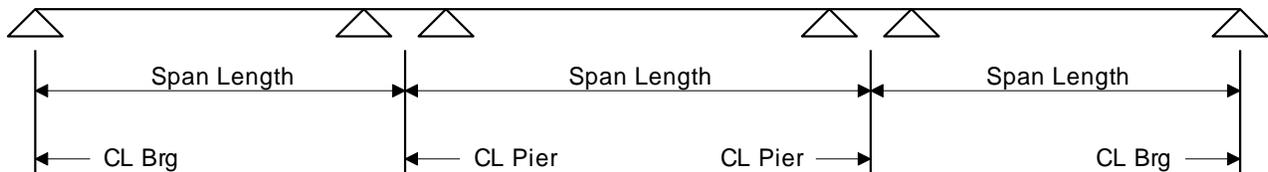
Tangent, curved

Curved, tangent

OK Apply Cancel

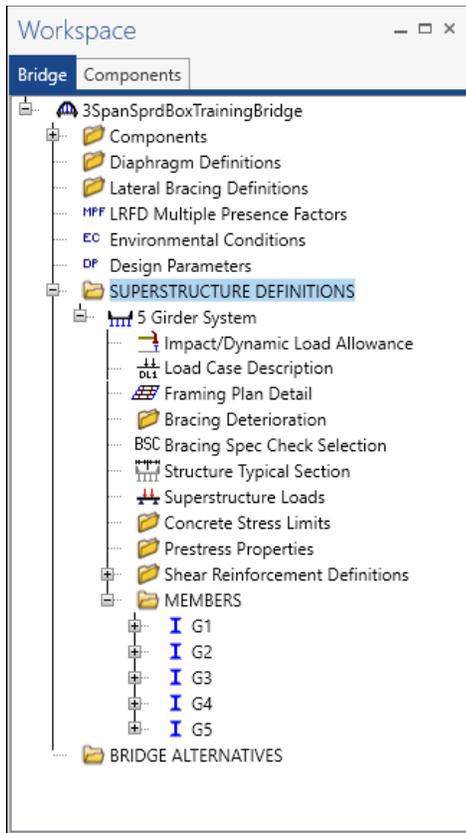
Click **OK** to apply the data and close the window

Note: Span lengths for a prestressed beam structure made continuous for live load should be entered as follows:



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



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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.

Bridge Alternative

Alternative name:

Description:

Horizontal curvature

Reference line length: ft

Start bearing End bearing

Starting station: ft

Bearing:

Global positioning

Distance: ft

Offset: ft

Elevation: ft

Bridge alignment

Curved

Tangent, curved, tangent

Tangent, curved

Curved, tangent

Start tangent length: ft

Curve length: ft

Radius: ft

Direction:

End tangent length: ft

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

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Expand the **Bridge Alternative 1** node in the **Bridge Workspace** tree. 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.

Superstructure

Superstructure name:

Description Alternatives Vehicle path Engine Substructures

Description:

Reference line

Distance: ft

Offset: ft

Angle: Degrees

Starting station: ft

OK Apply Cancel

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

PS2 – Three Span Spread PS Box Beam Example

Expand the **Superstructure #1** node in the **Bridge Workspace** tree. 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 **5 Girder System** as the current superstructure definition for this Superstructure Alternative.

Superstructure Alternative

Alternative name:

Description:

Superstructure definition:

Superstructure type:

Number of main members:

	Span	Length (ft)	
>	1	75	
	2	60	
	3	60	

OK Apply Cancel

Re-open the **Superstructure #1** window and navigate to the **Alternatives** tab. The **Superstructure Alternative #1** will be shown as the **Existing** and **Current** alternative for **Superstructure #1**.

Superstructure

Superstructure name:

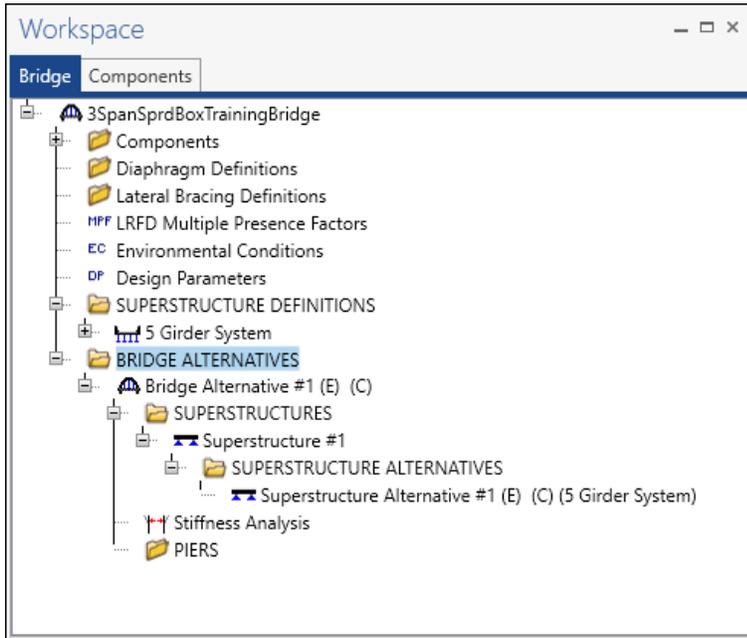
Description Alternatives Vehicle path Engine Substructures

	Existing	Current	Superstructure alternative name	Description
>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Superstructure Alternative #1	

OK Apply Cancel

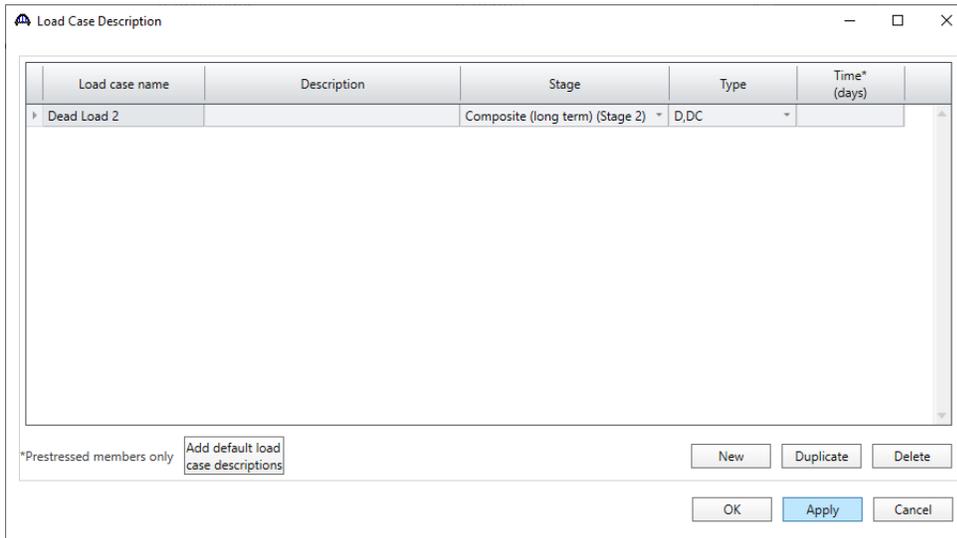
PS2 – Three Span Spread PS Box Beam Example

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



Load Case Description

Navigate back to the Superstructure definition **5 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 case as shown below. The completed **Load Case Description** window is shown below.



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

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Structure Framing Plan Detail – Layout

Double-click on the **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.

The screenshot shows the 'Structure Framing Plan Details' window with the 'Layout' tab selected. At the top, 'Number of spans' is set to 3 and 'Number of girders' is set to 5. Below this, there are two tabs: 'Layout' and 'Diaphragms'. The 'Layout' tab contains two tables and a radio button group.

Girder spacing orientation:

- Perpendicular to girder
- Along support

Support	Skew (degrees)
1	0.000
2	0.000
3	0.000
4	0.000

Girder bay	Girder spacing (ft)	
	Start of girder	End of girder
1	7.50	7.50
2	7.50	7.50
3	7.50	7.50
4	7.50	7.50

Buttons at the bottom: OK, Apply, Cancel.

Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab to enter the diaphragm spacing. Click the **Diaphragm wizard...** button to add diaphragms for the entire structure. **Select the desired framing plan system** and click the **Next** button. Enter the following data on the window shown below.

The screenshot shows the 'Diaphragm Wizard' window. It has a title bar with a close button (X). The main area contains the text 'Select the desired framing plan system:' followed by a grid icon. The grid icon is a 5x5 grid of squares, with a blue border around it. At the bottom, there are three buttons: '< Back', 'Next >', and 'Cancel'.

PS2 – Three Span Spread PS Box Beam Example

Diaphragm Wizard

Diaphragm spacing

Enter number of equal spaces per span
 Enter equal spacing per span
 Enter groups of equal spacing

Support diaphragm load: 1.0000 kip
 Interior diaphragm load: 1.0000 kip

Span	Length (ft)	Number of equal spaces
1	75.00	2
2	60.00	2
3	60.00	2

< Back Finish Cancel

Click the **Finish** button to add the diaphragms. The **Diaphragm Wizard** will create diaphragms and loads for all the girder bays in the structure. The diaphragms created for **Girder bay 1** are shown below.

Structure Framing Plan Details

Number of spans: 3 Number of girders: 5

Layout Diaphragms

Girder bay: 1 Copy bay to... Diaphragm wizard...

Support number	Start distance (ft)		Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft)		Load (kip)	Diaphragm
	Left girder	Right girder				Left girder	Right girder		
1	0.00	0.00	0.00	1	0.00	0.00	0.00	1.0000	--Not Assigned--
1	0.00	0.00	37.50	1	37.50	37.50	37.50	1.0000	--Not Assigned--
2	0.00	0.00	0.00	1	0.00	0.00	0.00	1.0000	--Not Assigned--
2	0.00	0.00	30.00	1	30.00	30.00	30.00	1.0000	--Not Assigned--
3	0.00	0.00	0.00	1	0.00	0.00	0.00	1.0000	--Not Assigned--
3	0.00	0.00	30.00	1	30.00	30.00	30.00	1.0000	--Not Assigned--
3	60.00	60.00	0.00	1	0.00	60.00	60.00	1.0000	--Not Assigned--

New Duplicate Delete

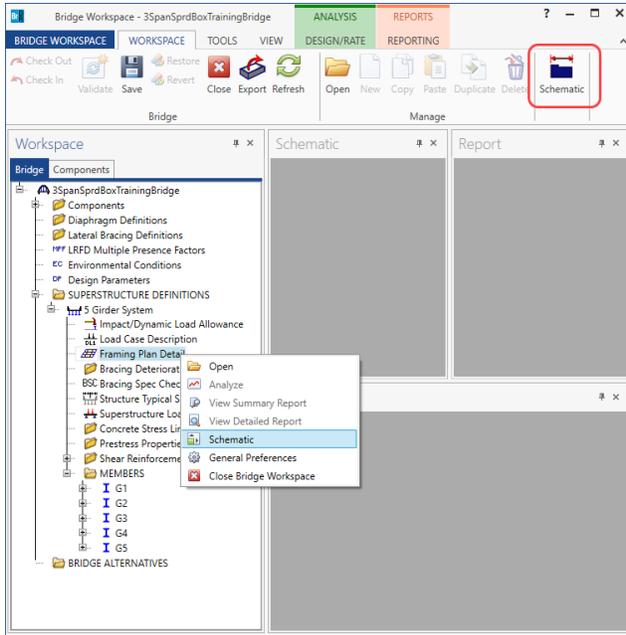
OK Apply Cancel

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

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Schematic - Framing Plan Detail

While **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu).



The following schematic will be displayed.



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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.

Structure Typical Section

Distance from left edge of deck to superstructure definition ref. line: 18.75 ft

Distance from right edge of deck to superstructure definition ref. line: 18.75 ft

Left overhang: 3.75 ft

Computed right overhang: 3.75 ft

Superstructure definition reference line is within the bridge deck.

Start: 18.75 ft, End: 18.75 ft

OK Apply Cancel

Structure Typical Section – Deck (cont'd)

The **Deck (cont'd)** tab is used to enter information about the **Deck concrete** and the **Total deck thickness**. The material to be used for the deck concrete is selected from the list of bridge materials. Enter the data as shown below.

Structure Typical Section

Distance from left edge of deck to superstructure definition ref. line: 18.75 ft

Distance from right edge of deck to superstructure definition ref. line: 18.75 ft

Left overhang: 3.75 ft

Computed right overhang: 3.75 ft

Deck concrete: Class A (US)

Total deck thickness: 8.0000 in

Load case: Engine Assigned

Deck crack control parameter: kip/in

Sustained modular ratio factor: 2.000

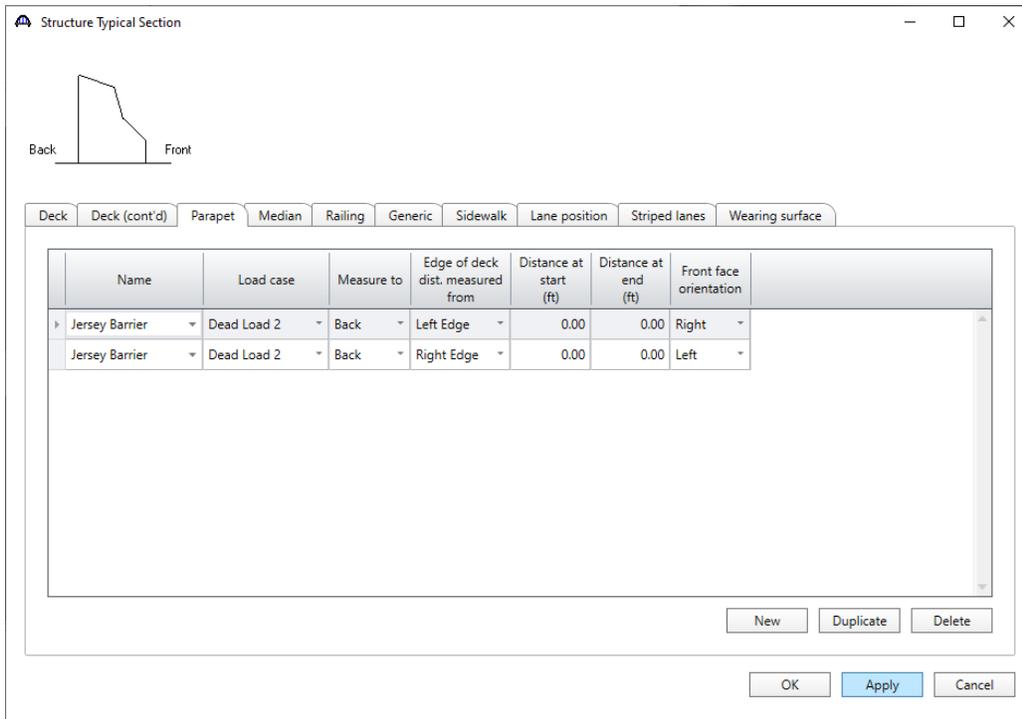
Deck exposure factor:

OK Apply Cancel

PS2 – Three Span Spread PS Box Beam Example

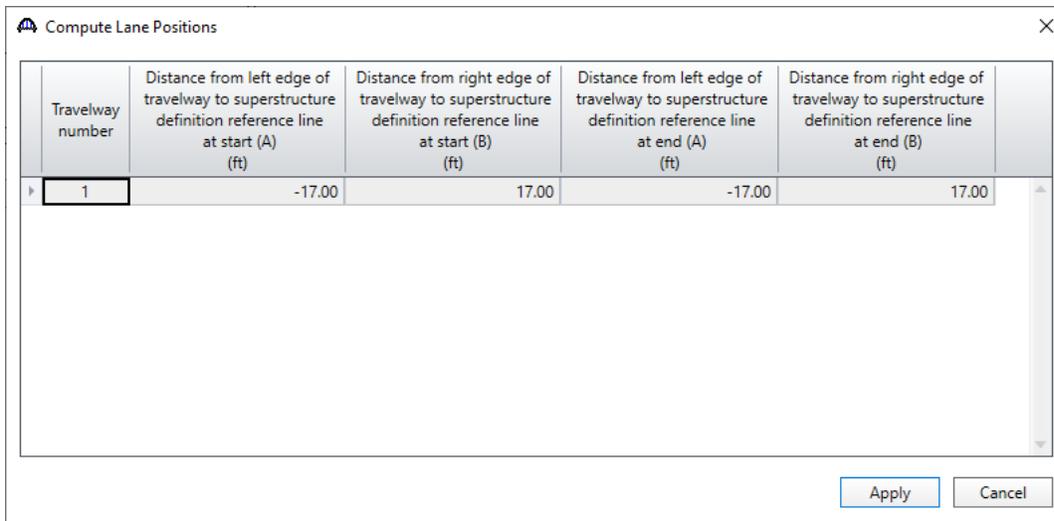
Structure Typical Section – Parapets

Select the **New** button on the **Parapets** tab of this window. Add two parapets as shown below.



Structure Typical Section – Lane Positions

Select the **Lane position** tab and use the **Compute...** button to compute the lane positions. A window showing the results of the computation opens. Click **Apply** to apply the computed values.



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The **Lane Position** tab is populated as shown below.

Travelway number	Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)	Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)
1	-17.00	17.00	-17.00	17.00

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

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 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 **Final allowable slab compression** is not computed since the deck concrete is typically different from the concrete used in the beam. Enter this value manually as shown below.

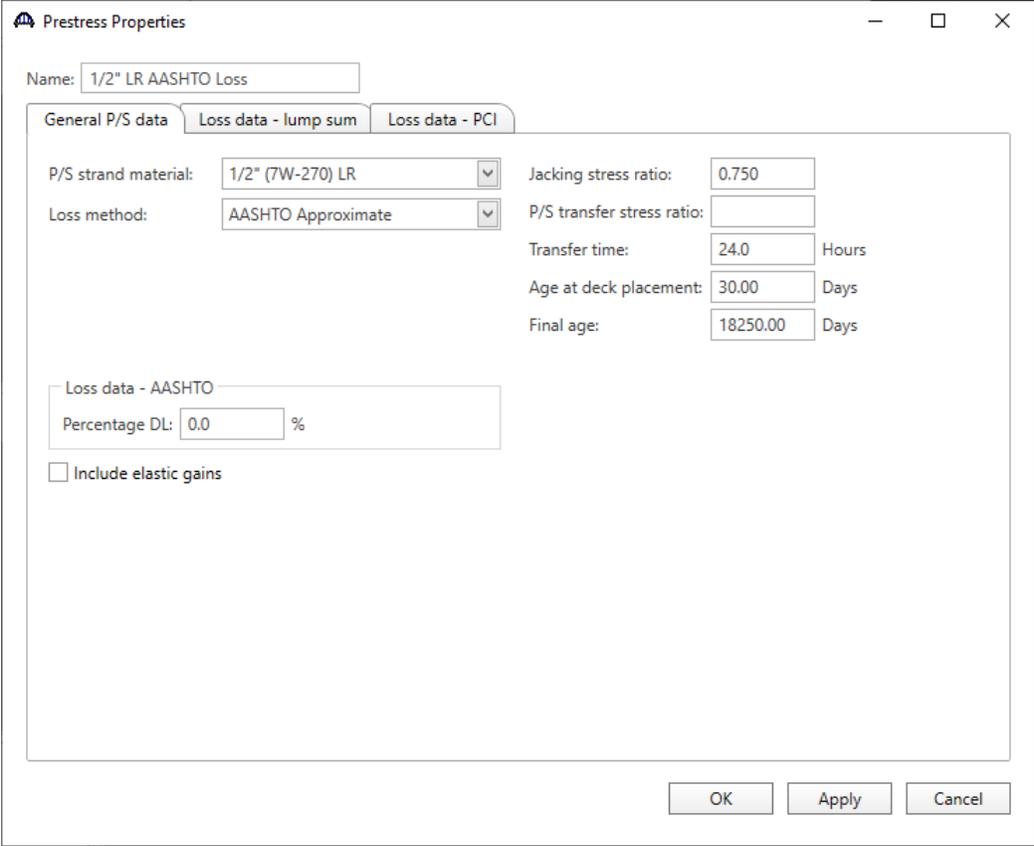
	LFD	LRFD
Initial allowable compression:	3.06 ksi	3.315 ksi
Initial allowable tension:	0.2 ksi	0.2 ksi
Final allowable compression:	3.6 ksi	3.6 ksi
Final allowable tension:	0.4654031 ksi	0.4654031 ksi
Final allowable DL compression:	2.4 ksi	2.7 ksi
Final allowable slab compression:	2.4 ksi	2.4 ksi
Final allowable compression: (LL+1/2(Pe+DL))	2.4 ksi	2.4 ksi

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

PS2 – Three Span Spread PS Box Beam Example

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.



The screenshot shows a software dialog box titled "Prestress Properties". At the top, there is a "Name:" field with the text "1/2\" LR AASHTO Loss". Below this are three tabs: "General P/S data", "Loss data - lump sum", and "Loss data - PCI". The "General P/S data" tab is active and contains several input fields:

- "P/S strand material:" dropdown menu set to "1/2\" (7W-270) LR".
- "Loss method:" dropdown menu set to "AASHTO Approximate".
- "Jacking stress ratio:" text box with "0.750".
- "P/S transfer stress ratio:" empty text box.
- "Transfer time:" text box with "24.0" and "Hours" label.
- "Age at deck placement:" text box with "30.00" and "Days" label.
- "Final age:" text box with "18250.00" and "Days" label.

Below these fields is a section titled "Loss data - AASHTO" containing a "Percentage DL:" text box with "0.0" and a "%" symbol. At the bottom left of this section is a checkbox labeled "Include elastic gains" which is currently unchecked. At the bottom right of the dialog box are three buttons: "OK", "Apply", and "Cancel".

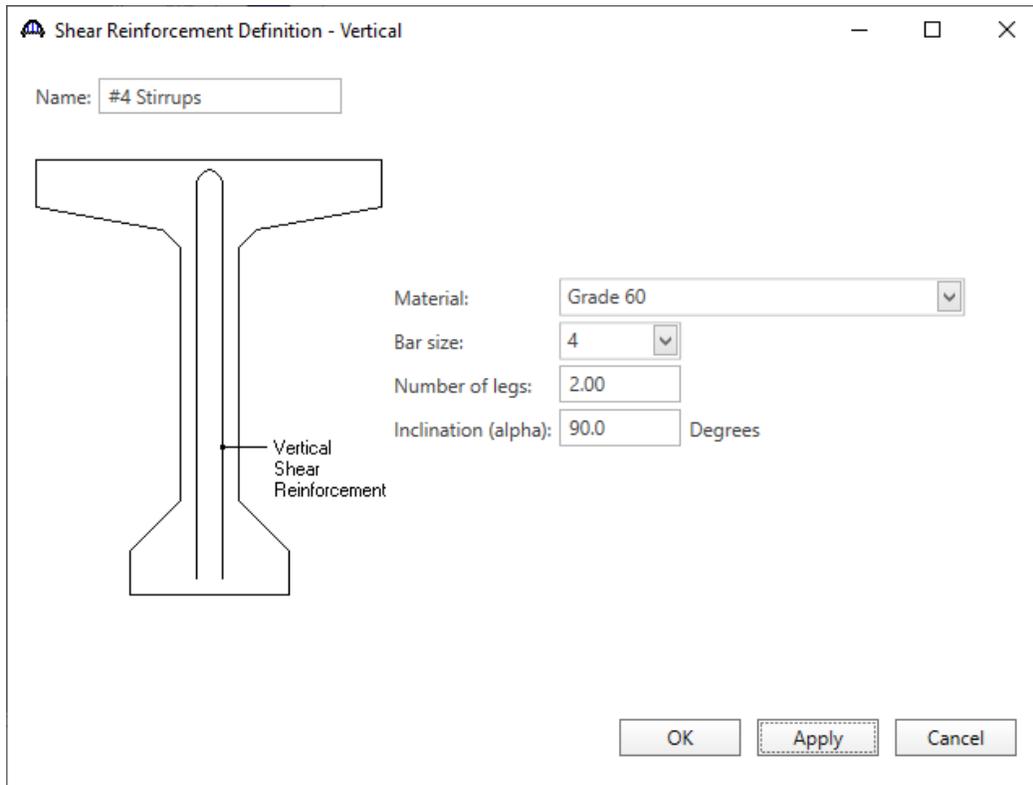
Click **OK** to apply the data and close the window.

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Shear Reinforcement

Define the vertical shear reinforcement to be used by the girders. Expand the **Shear Reinforcement Definitions** on 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.



The dialog box is titled "Shear Reinforcement Definition - Vertical". It contains the following fields and controls:

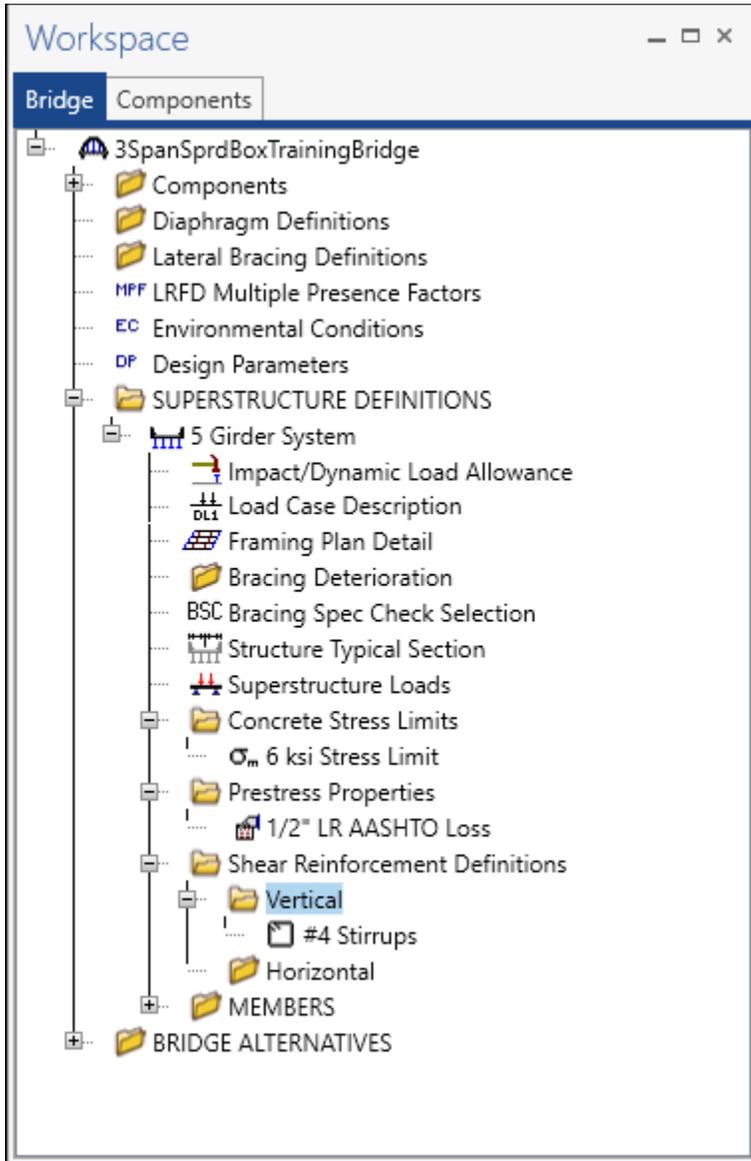
- Name: #4 Stirrups
- Material: Grade 60 (dropdown menu)
- Bar size: 4 (dropdown menu)
- Number of legs: 2.00
- Inclination (alpha): 90.0 Degrees
- Buttons: OK, Apply, Cancel

A diagram of an I-beam is shown on the left, with a vertical line through the web labeled "Vertical Shear Reinforcement".

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

PS2 – Three Span Spread PS Box Beam Example

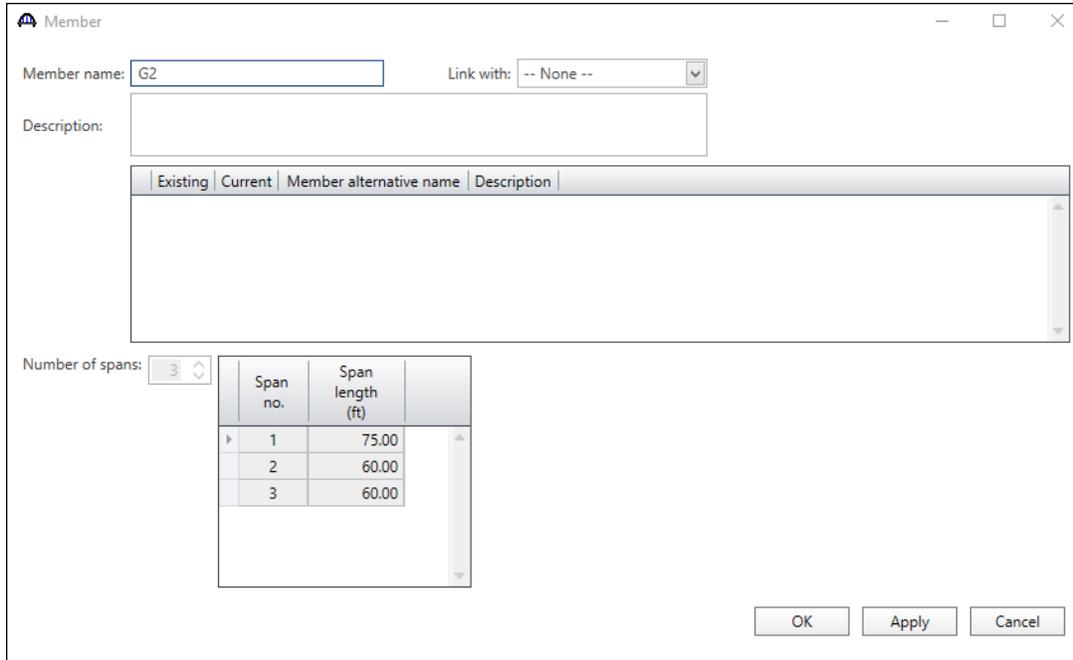
A partially expanded **Bridge Workspace** tree is shown below.



PS2 – Three Span Spread PS Box Beam Example

Describing a member

Expand the **MEMBERS** node in the **BWS** tree and double click on **G2**. 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.



The screenshot shows the 'Member' window with the following details:

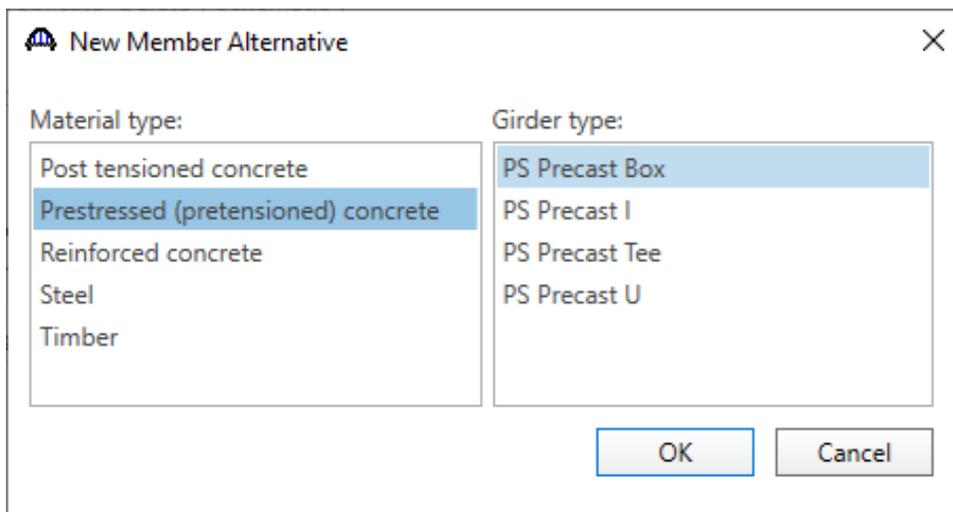
- Member name: G2
- Link with: -- None --
- Description: (empty text box)
- Number of spans: 3
- Table of spans:

Span no.	Span length (ft)
1	75.00
2	60.00
3	60.00

Buttons: OK, Apply, Cancel

Defining a Member Alternative

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**.



The screenshot shows the 'New Member Alternative' window with the following details:

- Material type: Prestressed (pretensioned) concrete
- Girder type: PS Precast Box

Buttons: OK, Cancel

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

PS2 – Three Span Spread PS Box Beam Example

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.

The screenshot shows a software window titled "Member Alternative Description" with a standard Windows interface (minimize, maximize, close buttons). The window contains several tabs: "Description", "Specs", "Factors", "Engine", "Import", and "Control options". The "Description" tab is active. At the top, there is a text field labeled "Member alternative:" containing the text "48\" PS Box". Below this are several input fields and controls:

- A large empty text box labeled "Description:".
- Material type: "Prestressed (Pretensioned)" (dropdown menu).
- Girder type: "PS Precast Box" (dropdown menu).
- Modeling type: "Multi Girder System" (dropdown menu).
- Default units: "US Customary" (dropdown menu).
- Girder property input method: Two radio buttons, "Schedule based" (selected) and "Cross-section based".
- Self load: A dropdown menu set to "Engine Assigned", and two text input fields for "Additional self load:" with units "kip/ft" and "%".
- Default rating method: A dropdown menu set to "LFR".
- Crack control parameter (Z): A text input field for "Bottom of beam:" with unit "kip/in".
- Exposure factor: A text input field for "Bottom of beam:".
- A checkbox labeled "Use creep" which is currently unchecked.

At the bottom right of the window are three buttons: "OK", "Apply", and "Cancel".

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

PS2 – Three Span Spread PS Box Beam Example

Beam Details

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.

Span number	Beam shape	Girder material	Prestress properties	n	Beam projection	
					Left end (in)	Right end (in)
1	B11-48	6 ksi Beam Concrete	1/2" LR AASHTO Loss		9.0000	6.0000
2	B11-48	6 ksi Beam Concrete	1/2" LR AASHTO Loss		6.0000	6.0000
3	B11-48	6 ksi Beam Concrete	1/2" LR AASHTO Loss		6.0000	9.0000

Buttons: OK, Apply, Cancel

The **Continuous Support Detail** tab is only available for a multi-span structure. The following data describes the distances from the centerlines of bearing to the centerlines of the piers.

Diagram labels: CL of Bearing on Left, SL, SR, CL of Bearing on Right, CL of Pier

Support number	Support distance on left, SL (in)	Support distance on right, SR (in)
2	9.0000	9.0000
3	9.0000	9.0000

Buttons: OK, Apply, Cancel

PS2 – Three Span Spread PS Box Beam Example

Note that the **Stress Limit Ranges** are defined over the entire length of the precast beam, including the projections of the beam past the centerline of bearing which were entered on the **Span Detail** tab. The stress limit names appearing in the drop down menu of the **Name** column correspond to the stress limits associated with the concrete material specified for that span on the **Span Detail** tab.

Span number	Name	Start distance (ft)	Length (ft)	End distance (ft)
1	6 ksi Stress Limit	0.00	75.50	75.50
2	6 ksi Stress Limit	0.00	59.50	59.50
3	6 ksi Stress Limit	0.00	60.50	60.50

Buttons: New, Duplicate, Delete, OK, Apply, Cancel

The defaults on the **Slab interface** tab are shown below and are acceptable.

Interface type: Intentionally Roughened

Default interface width to beam widths:

Interface width: in

Cohesion factor: ksi

Friction factor:

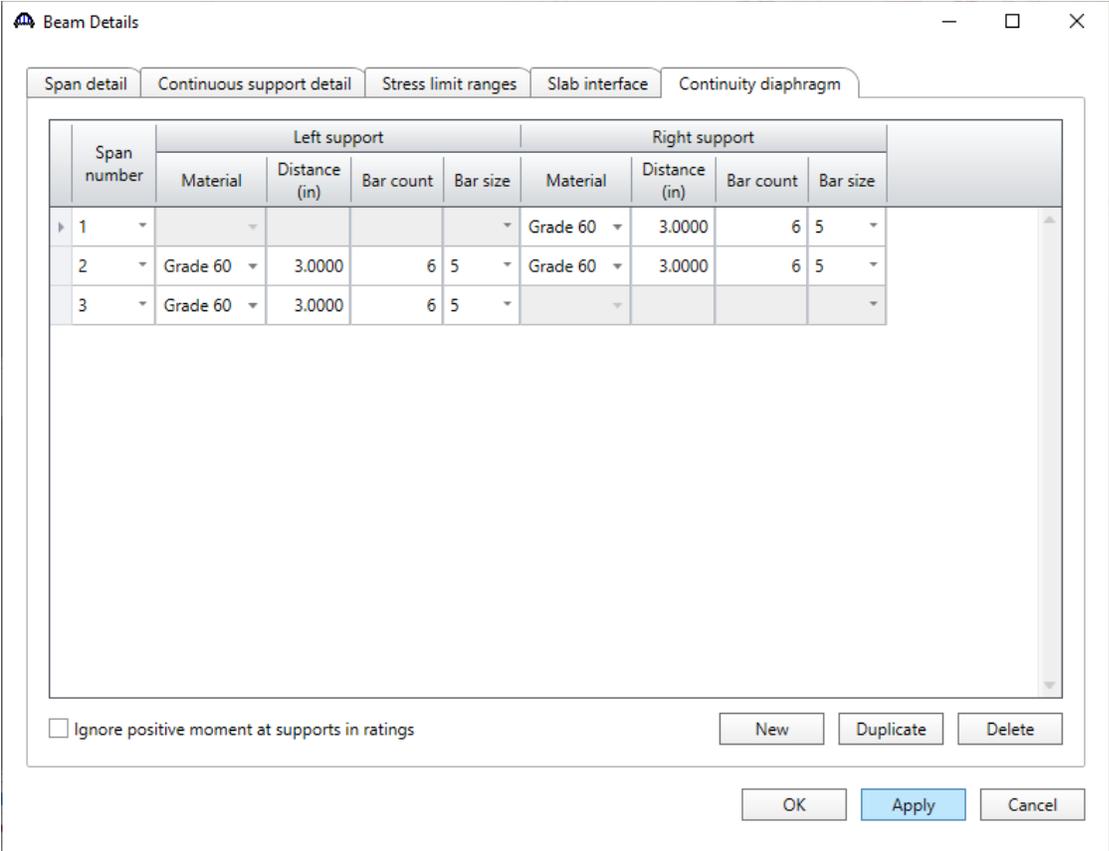
K1:

K2: ksi

Buttons: OK, Apply, Cancel

PS2 – Three Span Spread PS Box Beam Example

The **Continuity diaphragm** tab is only available for multi-span structures. The data on this tab defines the cast-in-place diaphragms used to make the structure continuous for live load. Press **F1** while on this tab to view the continuity diaphragm help topic describing the use of this information.



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

PS2 – Three Span Spread PS Box Beam Example

Strand Layout – Span 1

Expand the **Strand Layout** in the **Bridge Workspace** tree and double-click on **Span 1**. Place the cursor in the schematic view on the right side of the screen. Use the **Zoom** buttons to shrink/expand the schematic of the beam shape so that the entire beam is visible.

Select the **Description type** as **Strands in rows** and the **Strand configuration type** as **Harped**. The **Mid span** radio button will now become active. Strands can now be defined at the middle of the span by selecting strands in the right hand schematic. Select the bottom 26 strands in the schematic so that the CG of the strands is 2.31 inches.

Strand Layout - Span 1

Description type
 P and CGS only Strands in rows

Strand configuration type
 Straight/Debonded Harped Harped and straight debonded

Mid span

Harp point locations

Left end
 Right end

Harp point	Distance (ft)	Radius (in)
Left	0.00	0.0000
Right	0.00	0.0000

Notes:
Strand positions generated by the REVISED method.
Please refer to Help for a description of this method.

Number of strands = 26
Number of harped strands = 0
CG of strands (measured from bottom of section) = 2.31 in

Legend:

- × No strand at this position at the current section location.
- × No strand at this position at the current location but a strand is harped to this position.
- A strand occupies this position at the current section location.
- The strand is debonded from the end of the beam to the current section location.
- The strand is debonded from the mid-span to the current section location.
- The strand is debonded at other section location. Hover over the strand for more information.
- The harped position of a harped strand.
- The mid-span position of a harped strand.
- The mid-span position of one strand and the harped position of another strand.
- Mild steel.

OK Apply Cancel

PS2 – Three Span Spread PS Box Beam Example

Now select the **Left end** radio button to enter the following harped strand locations at the left end of the precast beam. Enter 22.5' as the distance from the left end of the precast beam to the harp point.

Strand Layout - Span 1

Description type
 P and CGS only Strands in rows

Strand configuration type
 Straight/Debonded Harped Harped and straight debonded

Symmetry

Mid span

Left end
 Right end

Harp point locations

Harp point	Distance (ft)	Radius (in)
Left	22.50	0.0000
Right	22.50	0.0000

Number of strands = 26
Number of harped strands = 4
CG of strands (measured from bottom of section) = 6.31 in

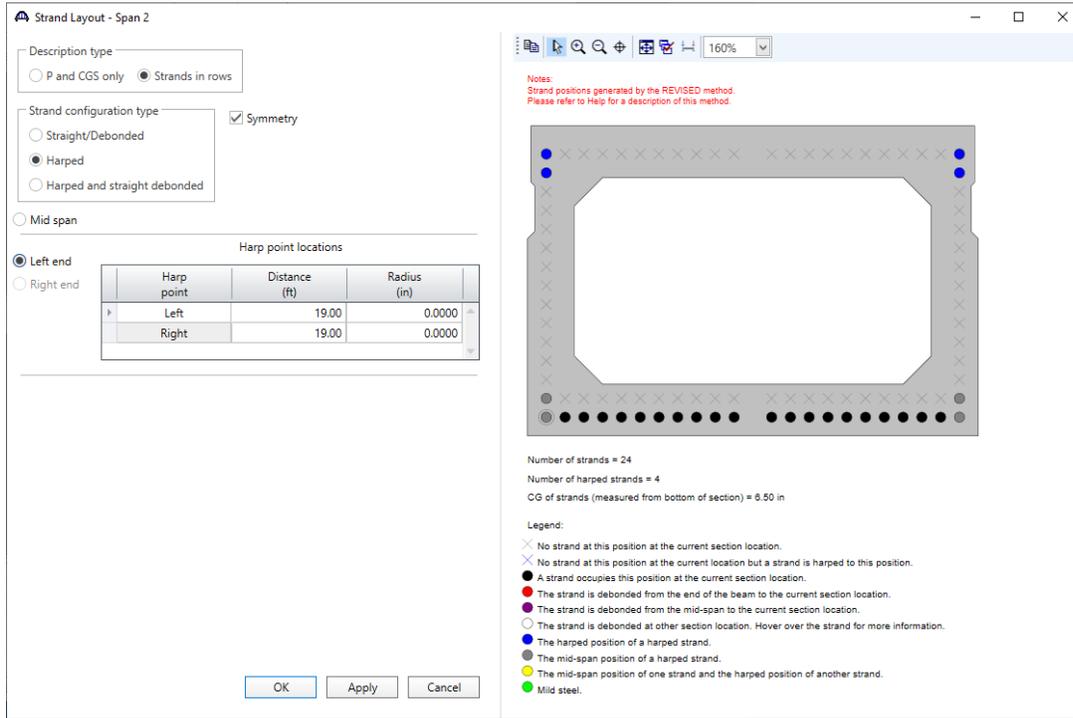
Legend:

- × No strand at this position at the current section location.
- × No strand at this position at the current location but a strand is harped to this position.
- A strand occupies this position at the current section location.
- The strand is debonded from the end of the beam to the current section location.
- The strand is debonded from the mid-span to the current section location.
- The strand is debonded at other section location. Hover over the strand for more information.
- The harped position of a harped strand.
- The mid-span position of a harped strand.
- The mid-span position of one strand and the harped position of another strand.
- Mild steel.

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

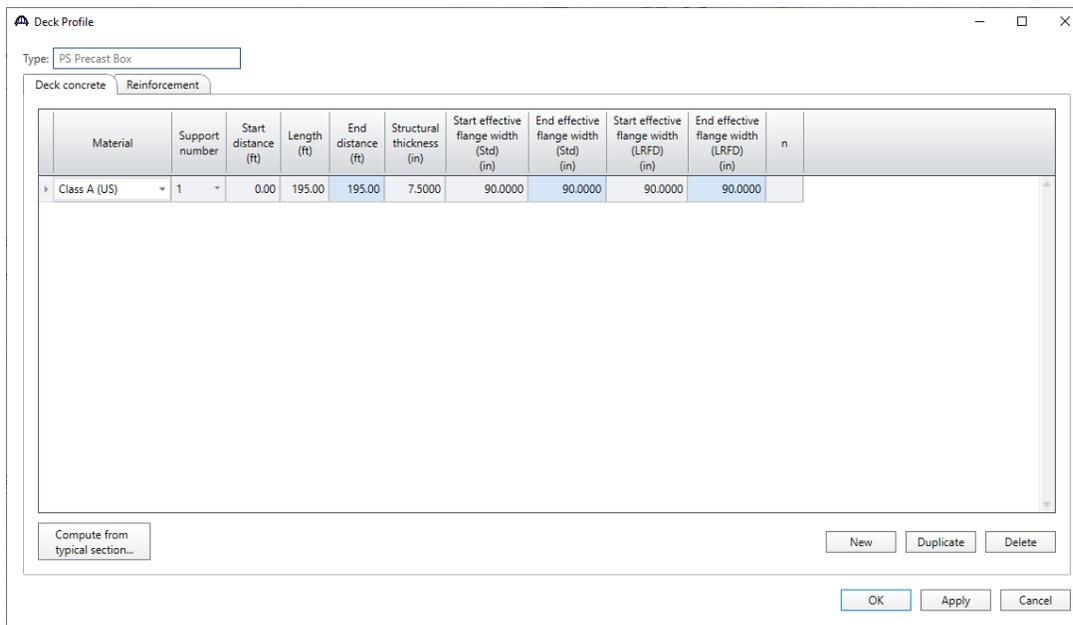
PS2 – Three Span Spread PS Box Beam Example

Enter the following data for Spans 2 and 3 in the same manner as described above. **Span 2** is shown below, **Span 3** has the same information as Span 2.



Deck Profile – Deck concrete

Next open the **Deck Profile** window by double-clicking the **Deck Profile** node in the **Bridge Workspace** tree and enter the data describing the structural properties of the deck. The window is shown below.



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

PS2 – Three Span Spread PS Box Beam Example

Deck Profile – Reinforcement

Navigate to the **Reinforcement** tab of this window and enter the deck reinforcement data in the negative moment regions as shown below.

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	60.00	30.00	90.00	11.00	11.00	6	3.5000	Top of Slab	
Grade 60	1	60.00	30.00	90.00	11.00	11.00	5	2.0000	Bottom of Slab	
Grade 60	2	45.00	30.00	75.00	11.00	11.00	6	3.5000	Top of Slab	
Grade 60	2	45.00	30.00	75.00	11.00	11.00	5	2.0000	Bottom of Slab	

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

Haunch Profile

Double-click on the **Haunch Profile** node in the **Bridge Workspace** tree to open the **PS Haunch Profile** window. The I shape shown is for illustrative purposes only. Enter the data as shown below.

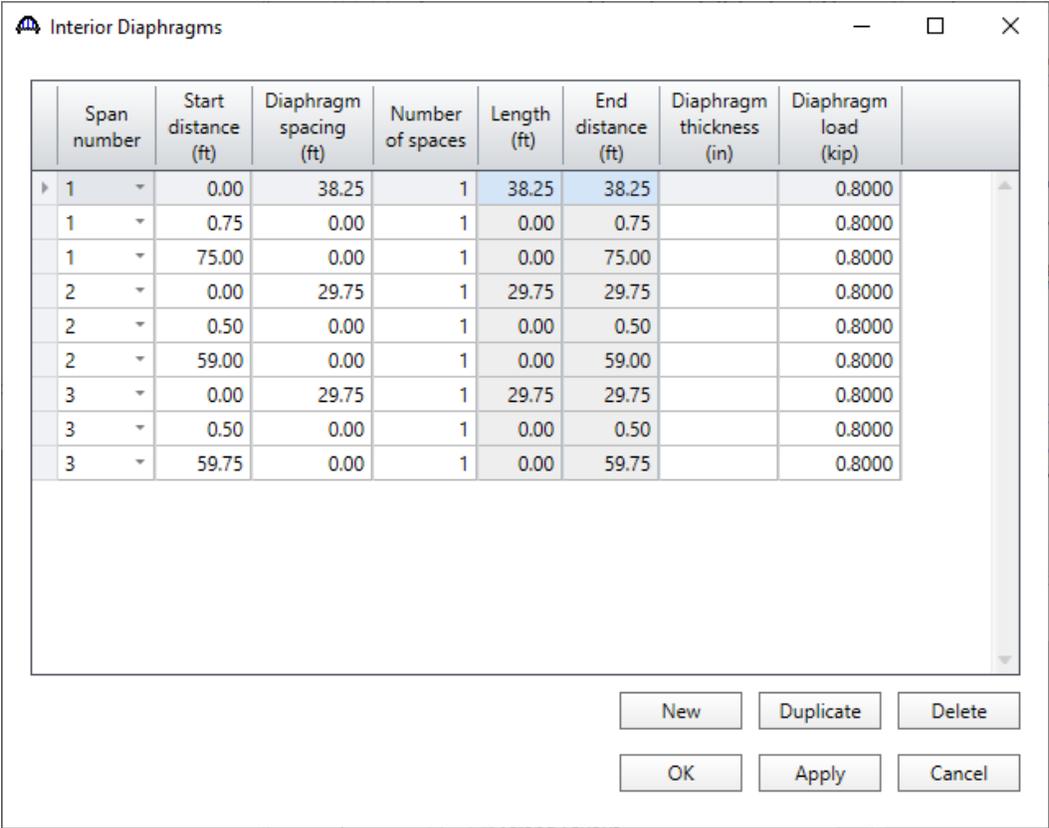
Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
1	0.00	195.00	195.00			0.5000	

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

PS2 – Three Span Spread PS Box Beam Example

Interior Diaphragms

Double-click on the **Interior Diaphragms** node in the **Bridge Workspace** tree to open the **Interior Diaphragms** window. The interior diaphragms for the box beam are entered as follows.



The screenshot shows a window titled "Interior Diaphragms" with a table of data and control buttons. The table has the following columns: Span number, Start distance (ft), Diaphragm spacing (ft), Number of spaces, Length (ft), End distance (ft), Diaphragm thickness (in), and Diaphragm load (kip). The data is as follows:

Span number	Start distance (ft)	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft)	Diaphragm thickness (in)	Diaphragm load (kip)
1	0.00	38.25	1	38.25	38.25		0.8000
1	0.75	0.00	1	0.00	0.75		0.8000
1	75.00	0.00	1	0.00	75.00		0.8000
2	0.00	29.75	1	29.75	29.75		0.8000
2	0.50	0.00	1	0.00	0.50		0.8000
2	59.00	0.00	1	0.00	59.00		0.8000
3	0.00	29.75	1	29.75	29.75		0.8000
3	0.50	0.00	1	0.00	0.50		0.8000
3	59.75	0.00	1	0.00	59.75		0.8000

Below the table are two rows of buttons: "New", "Duplicate", "Delete" and "OK", "Apply", "Cancel".

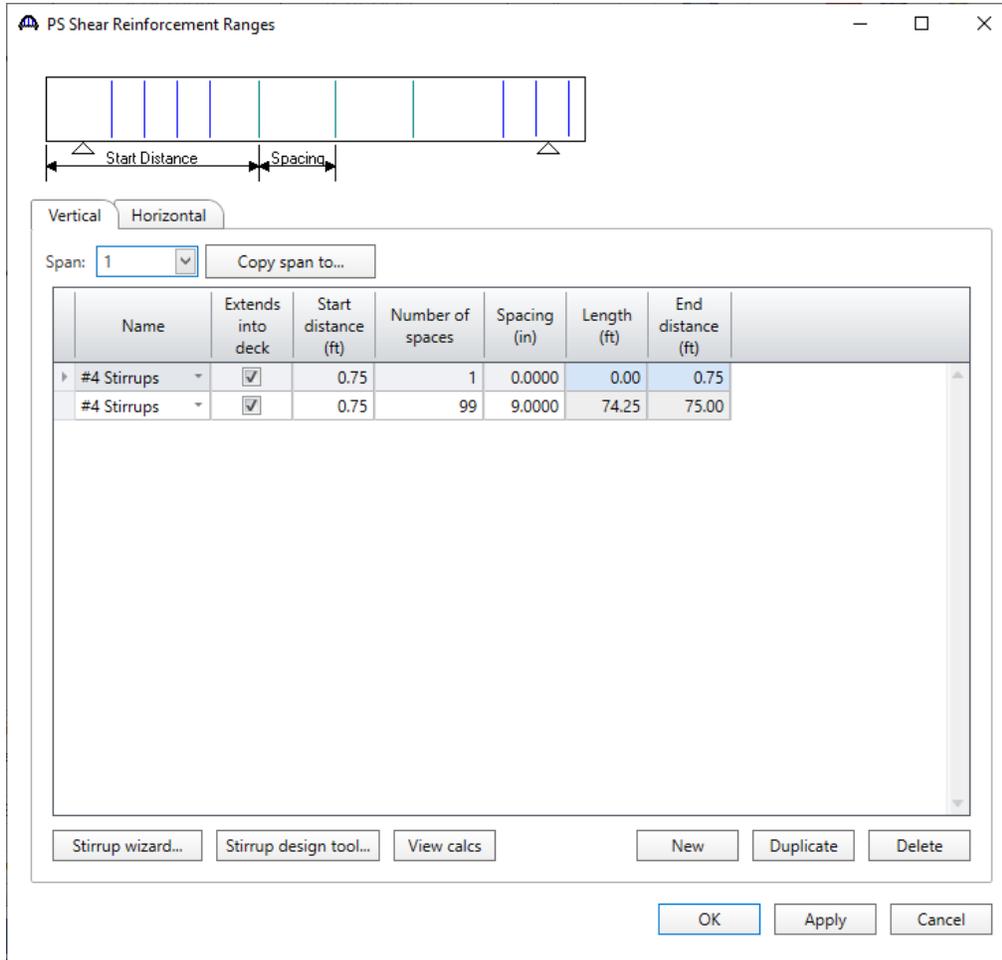
Click **OK** to apply the data and close the window

PS2 – Three Span Spread PS Box Beam Example

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. The vertical shear reinforcement is defined as extending into the deck on the **Vertical** tab of this window. This indicates composite action between the beam and the deck. Data does not have to be entered on the Horizontal tab to indicate composite action since that has been defined by extending the vertical bars into the deck.

Span 1



The screenshot shows the "PS Shear Reinforcement Ranges" window for Span 1. At the top, there is a diagram of a beam with vertical bars. Below the diagram, there are labels for "Start Distance" and "Spacing". The window has two tabs: "Vertical" and "Horizontal". The "Vertical" tab is selected. Below the tabs, there is a "Span:" dropdown menu set to "1" and a "Copy span to..." button. Below that is a table with the following data:

Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#4 Stirrups	<input checked="" type="checkbox"/>	0.75	1	0.0000	0.00	0.75
#4 Stirrups	<input checked="" type="checkbox"/>	0.75	99	9.0000	74.25	75.00

At the bottom of the window, there are several buttons: "Stirrup wizard...", "Stirrup design tool...", "View calcs", "New", "Duplicate", "Delete", "OK", "Apply", and "Cancel".

PS2 – Three Span Spread PS Box Beam Example

Span 2

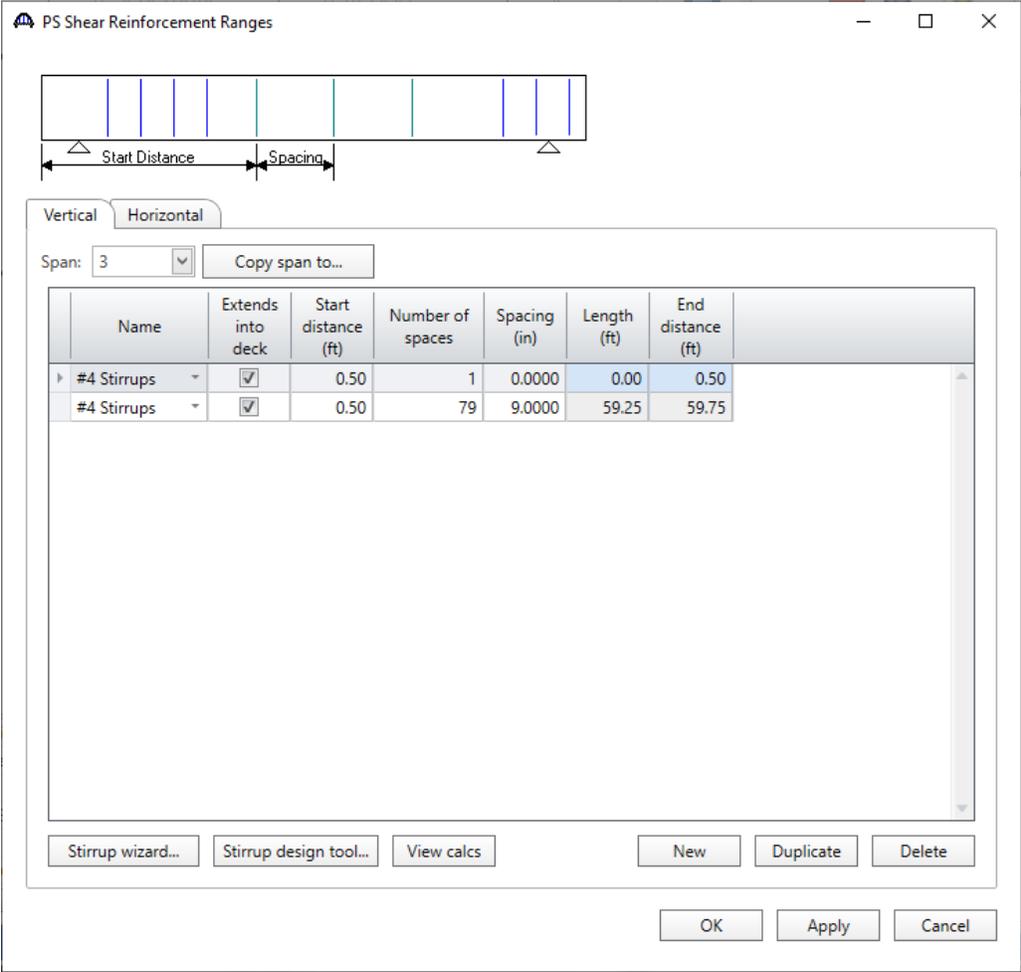
The dialog box, titled "PS Shear Reinforcement Ranges", features a diagram at the top showing a beam with vertical reinforcement lines. Below the diagram, a "Start Distance" and "Spacing" are indicated with arrows. The main area has two tabs: "Vertical" and "Horizontal", with "Horizontal" selected. Below the tabs, there is a "Span:" dropdown menu set to "2" and a "Copy span to..." button. A table with the following data is displayed:

Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#4 Stirrups	<input checked="" type="checkbox"/>	0.50	1	0.0000	0.00	0.50
#4 Stirrups	<input checked="" type="checkbox"/>	0.50	78	9.0000	58.50	59.00

At the bottom of the dialog, there are buttons for "Stirrup wizard...", "Stirrup design tool...", "View calcs", "New", "Duplicate", "Delete", "OK", "Apply", and "Cancel".

PS2 – Three Span Spread PS Box Beam Example

Span 3



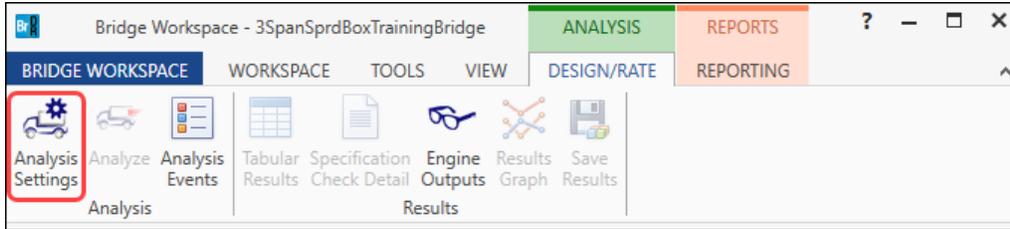
Click **OK** to apply the data and close the window

The Live Load Distribution factors will be computed automatically by BrDR while rating. The member alternative can now be analyzed.

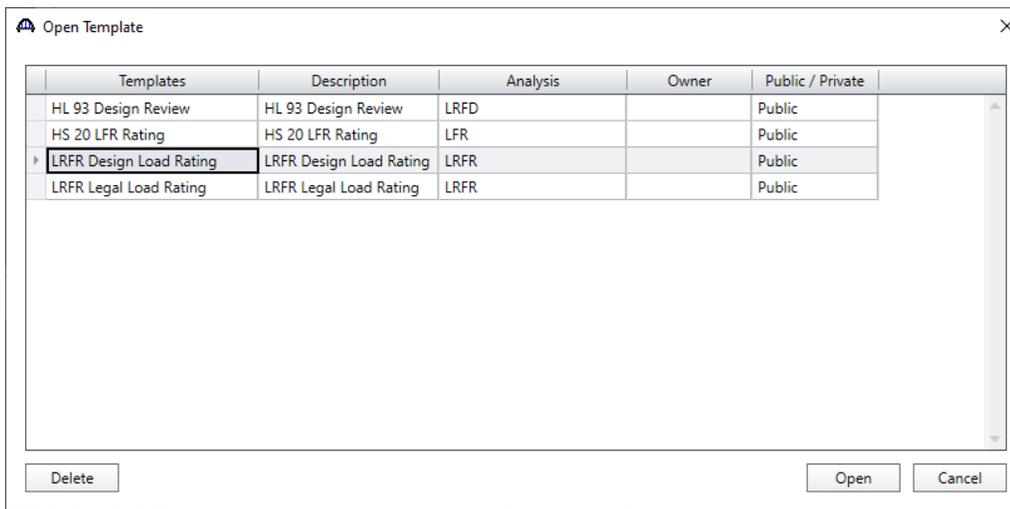
PS2 – Three Span Spread PS Box Beam Example

LRFR Rating

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

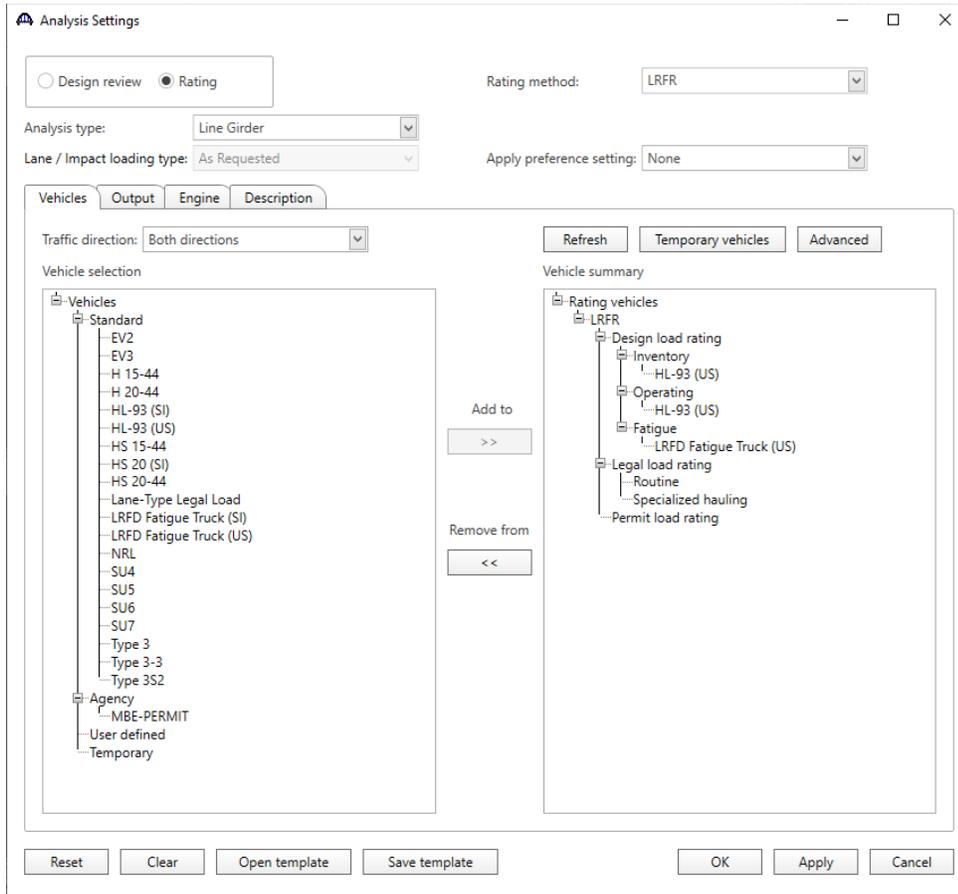


Click the **Open Template** button and select the **LRFR Design Load Rating** to be used in the rating and click **Open**.



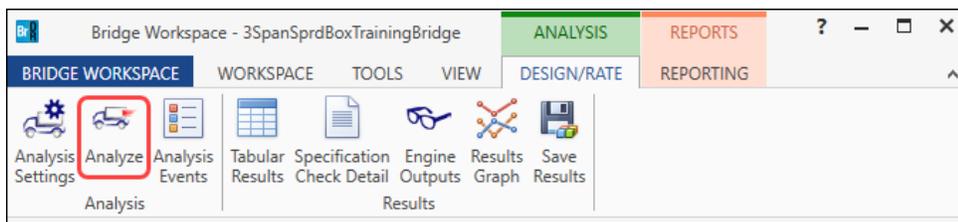
PS2 – Three Span Spread PS Box Beam Example

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

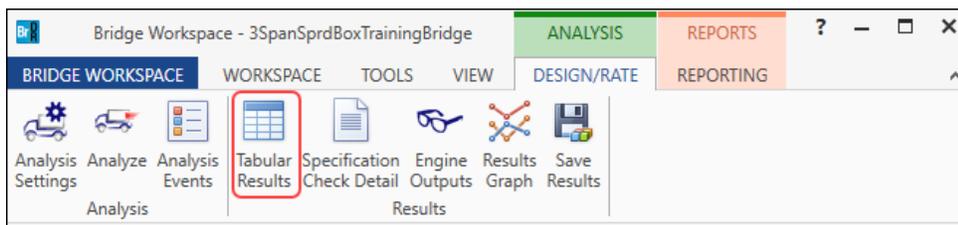


Tabular Results

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



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



PS2 – Three Span Spread PS Box Beam Example

The window shown below will open.

Analysis Results - 48" PS Box
— □ ×



Print

Report type: Rating Results Summary

Lane/Impact loading type: As requested Detailed

Display Format: Single rating level per row

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	33.51	0.931	37.13	1 - (49.5)	SERVICE-III PS Tensile Stress	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	50.52	1.403	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	35.39	0.983	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	45.87	1.274	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	37.78	1.049	37.13	1 - (49.5)	SERVICE-III PS Tensile Stress	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	60.97	1.694	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested

AASHTO LRFR Engine Version 7.5.0.3001

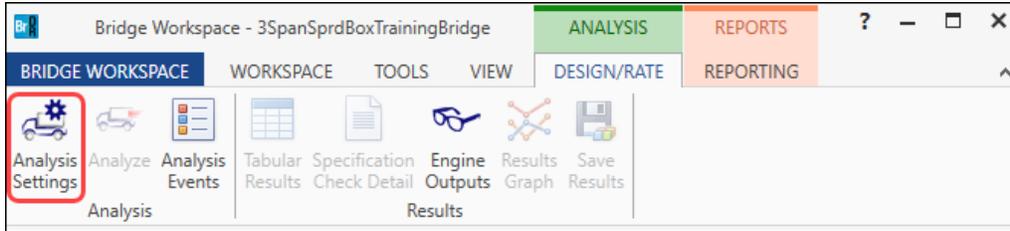
Analysis preference setting: None

Close

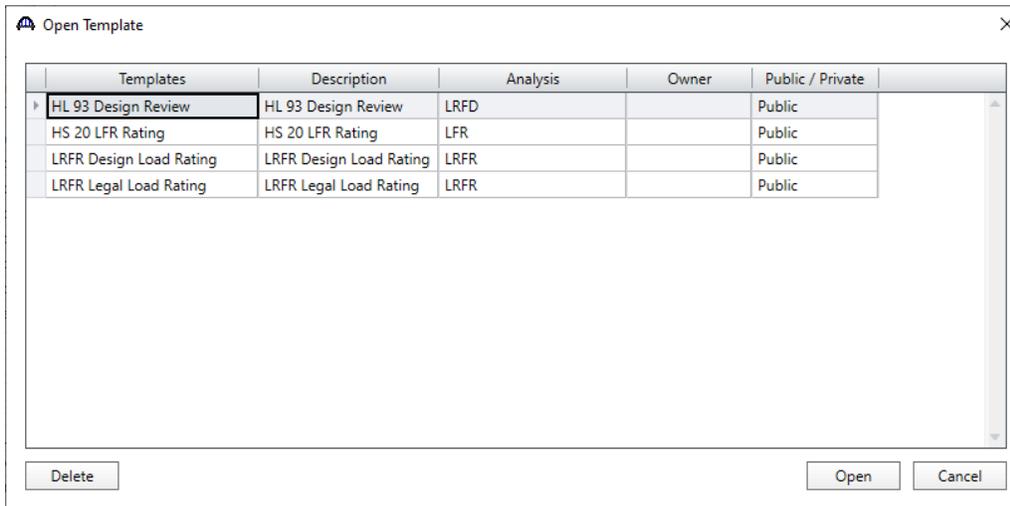
PS2 – Three Span Spread PS Box Beam Example

LRFD Design review

To perform an **LRFD design review** 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.

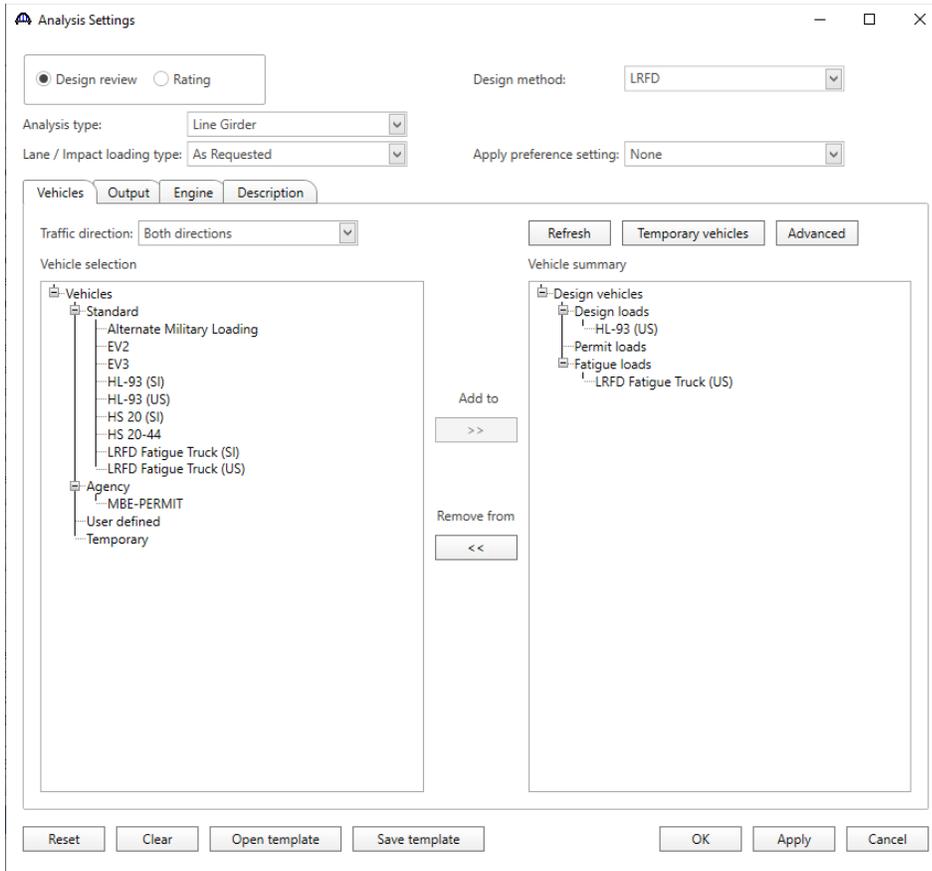


Click the **Open Template** button and select the **LRFR Design Load Rating** to be used in the rating and click **Open**.



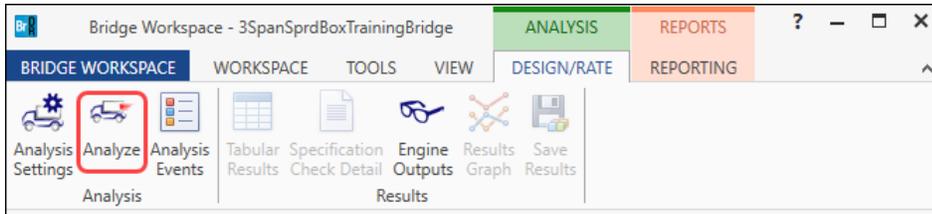
PS2 – Three Span Spread PS Box Beam Example

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

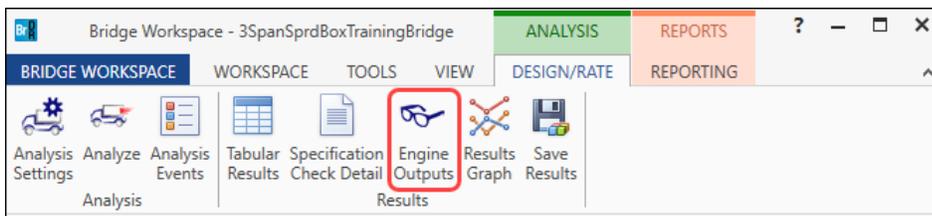


Engine Outputs

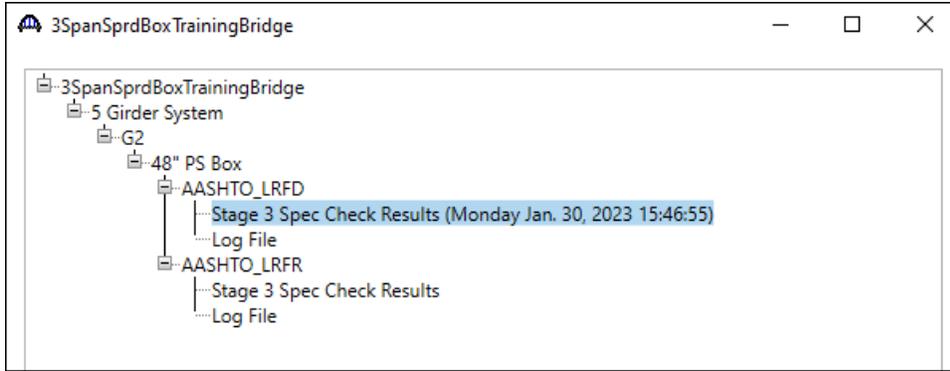
Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review.



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.



PS2 – Three Span Spread PS Box Beam Example



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

Bridge ID : 3SpanSprdBoxTrainingBridge NBI Structure ID : 3SpanSprdBoxTra
 Bridge : 3Span Sprd Box Trn Bridge Bridge Alt :
 Superstructure Def : 5 Girder System
 Member : G2 Member Alt : 48" PS Box
 Analysis Preference Setting :

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)	Fail
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	-3.315	0.048	-0.652	5.086	Pass
1.750	-3.315	0.103	-2.118	1.565	Pass
3.206	-3.315	0.065	-2.081	1.593	Pass
7.500	-3.315	-0.048	-1.970	1.683	Pass
15.000	-3.315	-0.175	-1.845	1.797	Pass
21.750	-3.315	-0.221	-1.800	1.841	Pass
22.500	-3.315	-0.237	-1.784	1.858	Pass