

AASHTOWare BrDR 7.5.0

Prestressed Concrete Structure Tutorial

PS3 – Adjacent PS Box Example

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BrDR Training

PS3 - Adjacent PS Box Example

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

The screenshot shows a dialog box titled "PSAdjBoxTrainingBridge" with the following fields and options:

- Bridge ID: PSAdjBoxTrainingBridge
- NBI structure ID (8): AdjBoxTraining1
- Template:
- Bridge completely defined:
- Superstructures:
- Culverts:
- Substructures:

The "Description" tab is active, showing:

- Name: PSAdjBox Training Bridge
- Year built: []
- Description: Similar to PCI TrainingBridge2, input as a girder system. Single span, ps adjacent box beam bridge.
- Location: []
- Length: [] ft
- Facility carried (7): []
- Route number: -1
- Feat. intersected (6): []
- Mi. post: []
- Default units: US Customary

At the bottom, there is a "Bridge association..." section with checkboxes for BrR, BrD, and BrM, and a "Sync with BrM" button. The "OK", "Apply", and "Cancel" buttons are at the bottom right.

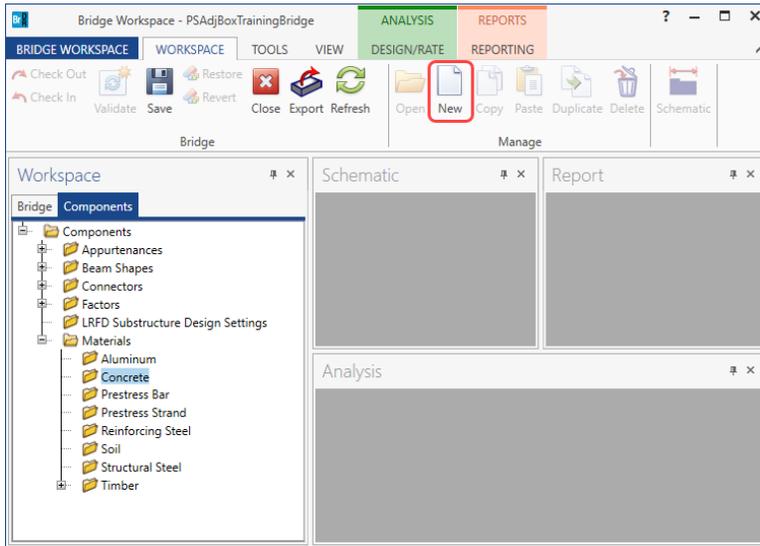
Click **OK** to apply the data and close the window.

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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 below.

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

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Since a bituminous surface will be used on this bridge as a wearing surface, deck concrete material is not required.

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 **1/2" (7W-270) LR** from the library and click **OK**.

Library Data: Materials - Prestress Strand

Name	Description	Library	Units	Fy	Fu	Modulus of elasticity	Load per unit length	Diameter	Area	Transfer length (Std)	Transfer length (LRFD)	Strand type	Epoxy coated
1/2" (7W-250) LR	Low relaxation 1/2"/Seven Wire/fpu = 250	Standard	US Customary	225.000	250.000	28500.00	0.490	0.5000	0.144	25.0000	30.0000	Low Relaxation	False
1/2" (7W-250) SR	Stress relieved 1/2"/Seven Wire/fpu = 250	Standard	US Customary	212.500	250.000	28500.00	0.490	0.5000	0.144	25.0000	30.0000	Stress Relieved	False
1/2" (7W-270) LR	Low relaxation 1/2"/Seven Wire/fpu = 270	Standard	US Customary	243.000	270.000	28500.00	0.520	0.5000	0.153	25.0000	30.0000	Low Relaxation	False
1/2" (7W-270) SR	Stress relieved 1/2"/Seven Wire/fpu = 270	Standard	US Customary	229.500	270.000	28500.00	0.520	0.5000	0.153	25.0000	30.0000	Stress Relieved	False
1/4" (BW-250) LR	Low relaxation 1/4"/Three Wire/fpu = 250	Standard	US Customary	225.000	250.000	28500.00	0.130	0.2500	0.036	12.5000	15.0000	Low Relaxation	False
1/4" (7W-250) LR	Low relaxation 1/4"/Seven Wire/fpu = 250	Standard	US Customary	225.000	250.000	28500.00	0.122	0.2500	0.036	12.5000	15.0000	Low Relaxation	False
1/4" (7W-250) SR	Stress relieved 1/4"/Seven Wire/fpu = 250	Standard	US Customary	212.500	250.000	28500.00	0.122	0.2500	0.036	12.5000	15.0000	Stress Relieved	False
3/8" (BW-250) LR	Low relaxation 3/8"/Three Wire/fpu = 250	Standard	US Customary	225.000	250.000	28500.00	0.260	0.3750	0.075	18.7500	22.5000	Low Relaxation	False
3/8" (7W-250) LR	Low relaxation 3/8"/Seven Wire/fpu = 250	Standard	US Customary	225.000	250.000	28500.00	0.272	0.3750	0.080	18.7500	22.5000	Low Relaxation	False

OK Apply Cancel

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

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

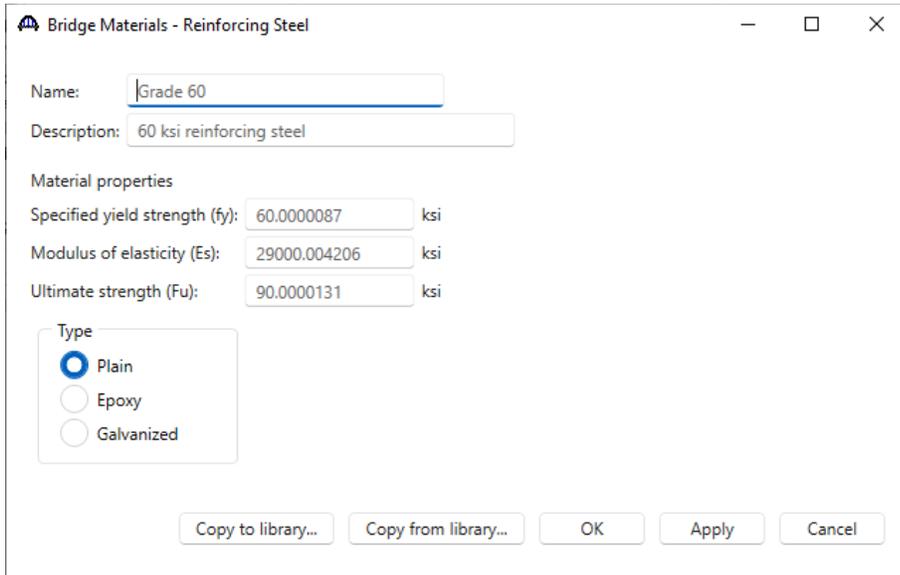
Unit load per length: lb/ft

Epoxy coated

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

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Add the following reinforcement steel in the same manner.



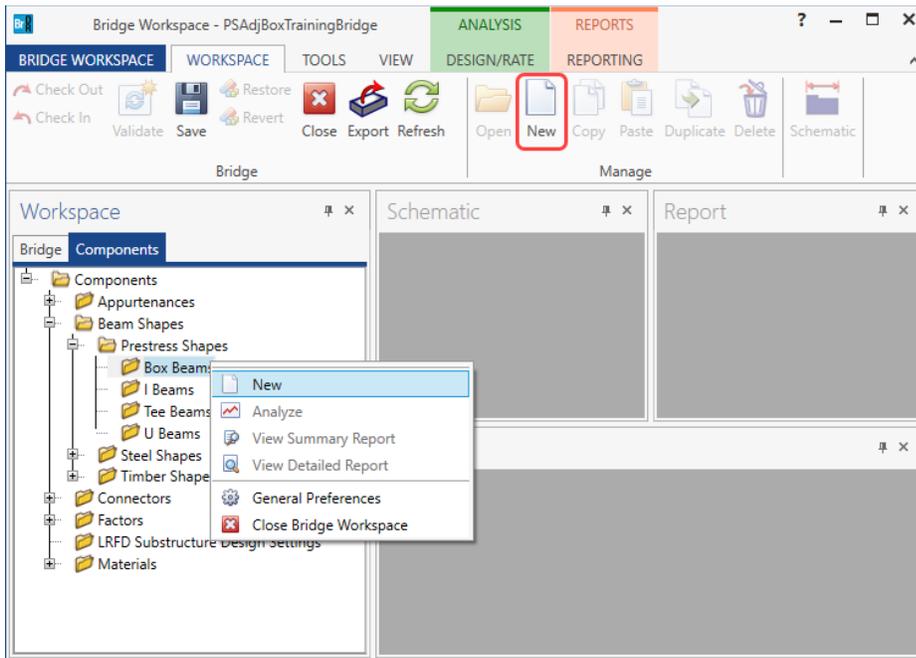
The dialog box titled "Bridge Materials - Reinforcing Steel" contains the following fields and options:

- Name: Grade 60
- Description: 60 ksi reinforcing steel
- Material properties:
 - Specified yield strength (fy): 60.0000087 ksi
 - Modulus of elasticity (Es): 29000.004206 ksi
 - Ultimate strength (Fu): 90.0000131 ksi
- Type:
 - Plain
 - Epoxy
 - Galvanized
- Buttons: Copy to library..., Copy from library..., OK, Apply, Cancel

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).



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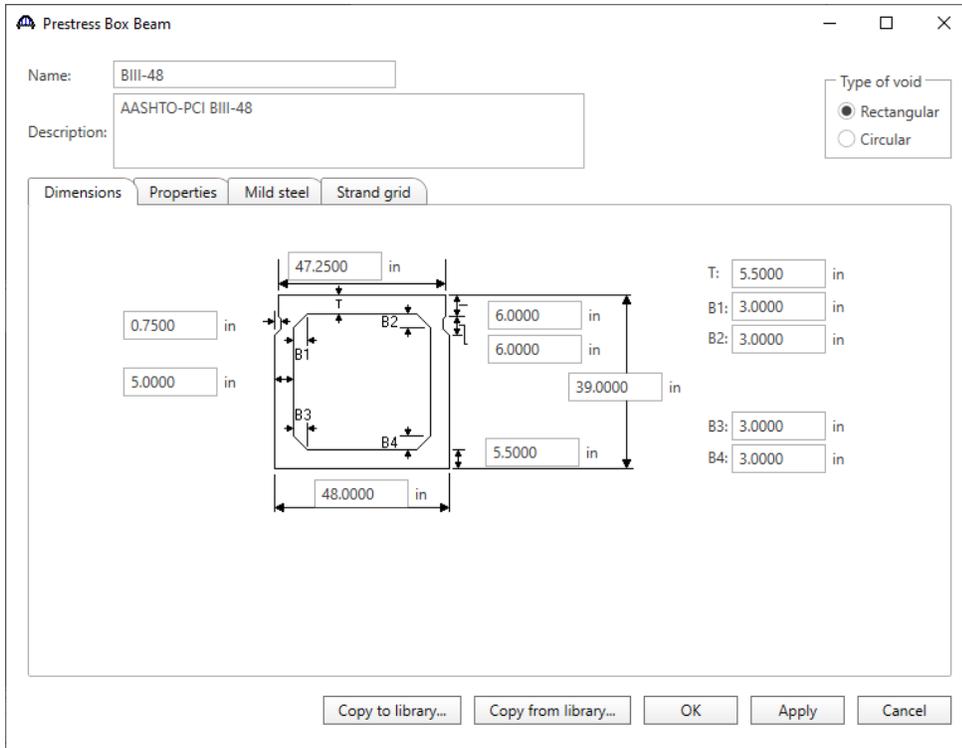
The **Prestress Box Beam** window shown below will open.

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

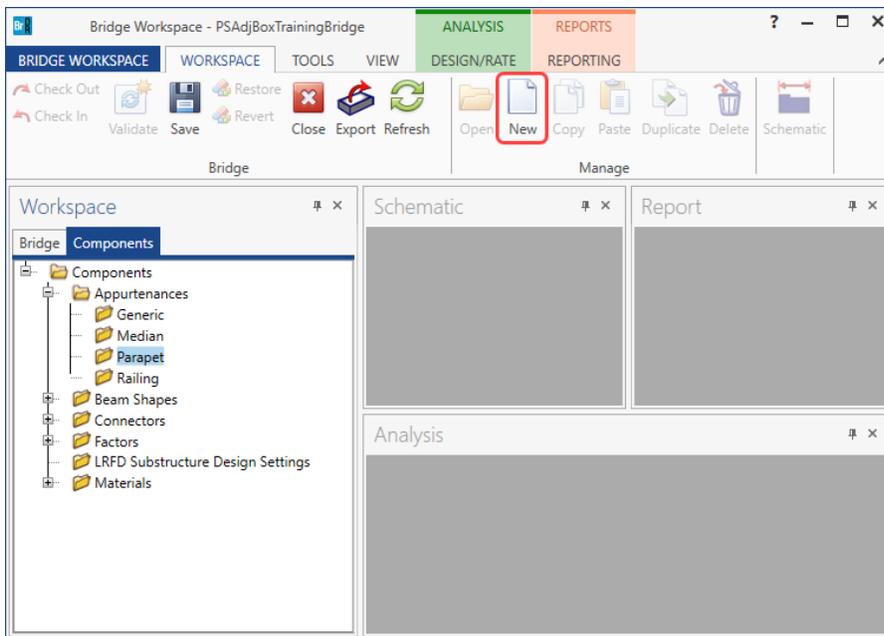
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Click **OK** to apply the data and close the window.

Bridge - Appurtenances

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



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Enter the data as shown below.

Bridge Appurtenances - Parapet

Name: 300 PLF Parapet

Description:

All dimensions are in inches

Additional load: 0.0000 kip/ft

Parapet unit load: 0.1500 kcf

Calculated properties

Net centroid (from reference line): 6.344 in

Total load: 0.300 kip/ft

Copy from library... OK Apply Cancel

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.

New Superstructure Definition

Girder system superstructure

Girder line superstructure

Floor system superstructure

Floor line superstructure

Truss system superstructure

Truss line superstructure

Reinforced concrete slab system superstructure

Concrete multi-cell box superstructure

Advanced concrete multi-cell box superstructure

Superstructure definition wizard

OK Cancel

Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open.

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Enter the data as shown below.

Girder System Superstructure Definition

Definition | Analysis | Specs | Engine

Name: 7 Girder System

Description:

Default units: US Customary

Number of spans: 1

Number of girders: 7

Enter span lengths along the reference line:

Span	Length (ft)
1	95.00

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

Superstructure alignment:
 Curved
 Tangent, curved, tangent
 Tangent, curved
 Curved, tangent

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

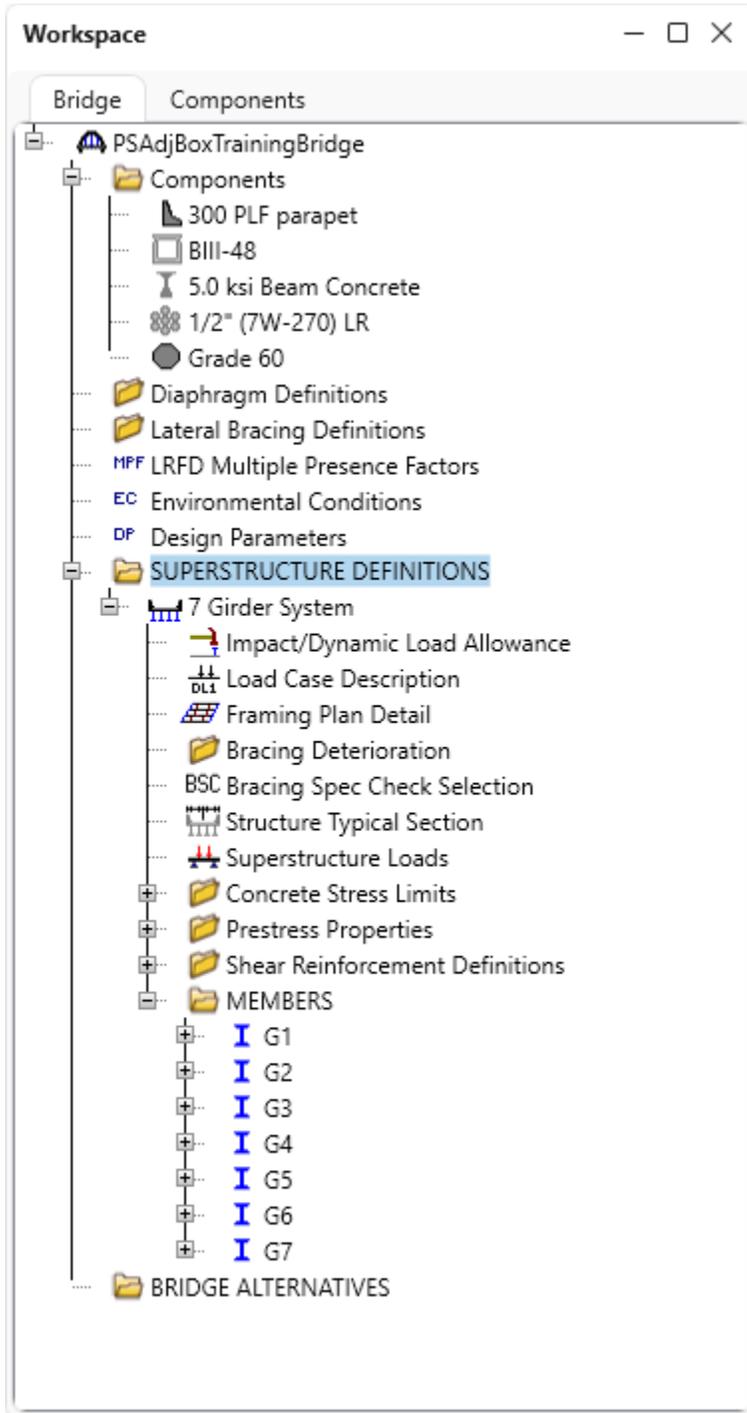
Superelevation: %

OK Apply Cancel

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

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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 Substructures

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

Superstructure wizard...

Culvert wizard...

OK Apply Cancel

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.

PS3 – Adjacent PS Box 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 **7 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	95

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:

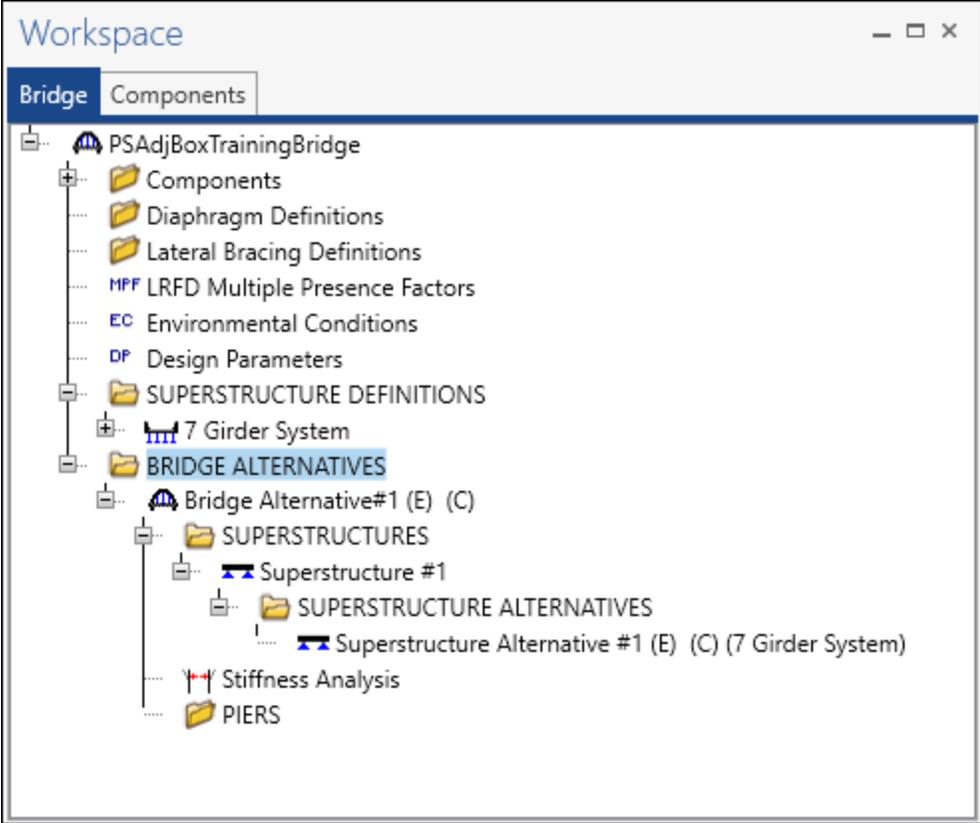
Description Alternatives Vehicle path Engine Substructures

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

OK Apply Cancel

PS3 – Adjacent PS Box Example

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



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Load Case Description

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.

Load case name	Description	Stage	Type	Time* (days)
Wearing Surface		Non-composite (Stage 1)	D,DW	
Parapets		Non-composite (Stage 1)	D,DC	

*Prestressed members only [Add default load case descriptions](#)

New Duplicate Delete

OK Apply Cancel

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.

Number of spans: 1 Number of girders: 7

Layout Diaphragms

Girder spacing orientation

Perpendicular to girder
 Along support

Support	Skew (degrees)
1	0.000
2	0.000

Girder bay	Girder spacing (ft)	
	Start of girder	End of girder
1	4.00	4.00
2	4.00	4.00
3	4.00	4.00
4	4.00	4.00
5	4.00	4.00
6	4.00	4.00

OK Apply Cancel

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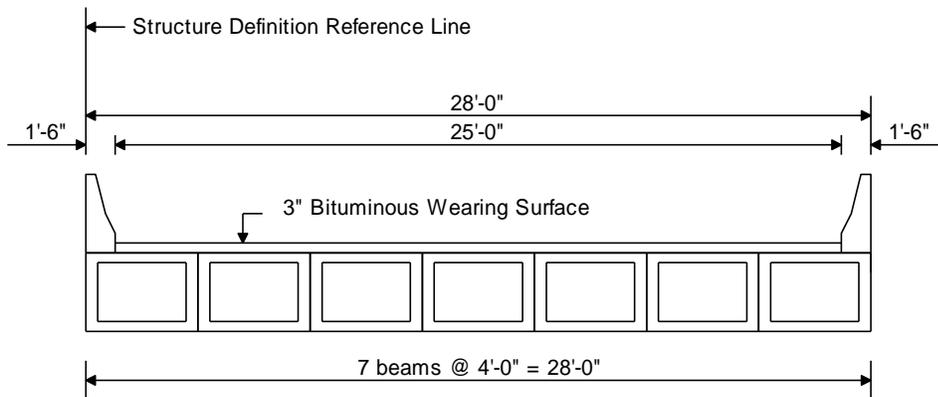
Structure Framing Plan Detail – Diaphragms

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. Interior diaphragms for the box beams will be entered after defining the Member Alternative as a PS box beam.

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.



Input the data describing the typical section as shown below.

The screenshot shows the **Structure Typical Section** dialog box. The **Deck** tab is selected. The dialog includes a diagram of the deck cross-section with labels for **Distance from left edge of deck to superstructure definition ref. line**, **Distance from right edge of deck to superstructure definition ref. line**, **Deck thickness**, **Superstructure Definition Reference Line**, **Left overhang**, and **Right overhang**. The input fields are as follows:

Parameter	Start (ft)	End (ft)
Distance from left edge of deck to superstructure definition reference line:	0.00	0.00
Distance from right edge of deck to superstructure definition reference line:	28.00	28.00
Left overhang:	2.00	2.00
Computed right overhang:	2.00	2.00

Buttons at the bottom: **OK**, **Apply**, **Cancel**.

PS3 – Adjacent PS Box Example

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**. Since this structure does not have a concrete deck, this tab will be left blank.

Structure Typical Section – Parapets

Add two parapets as shown below.

The screenshot shows the 'Structure Typical Section' window with the 'Parapet' tab selected. A small diagram at the top left shows a cross-section of a structure with 'Back' and 'Front' labels. Below the diagram is a tabbed interface with 'Deck', 'Deck (cont'd)', 'Parapet', 'Median', 'Railing', 'Generic', 'Sidewalk', 'Lane position', 'Striped lanes', and 'Wearing surface'. The 'Parapet' tab is active, displaying a table with the following data:

Name	Load case	Measure to	Edge of deck dist. measured from	Distance at start (ft)	Distance at end (ft)	Front face orientation
300 PLF parapet	Parapets	Back	Left Edge	0.00	0.00	Right
300 PLF parapet	Parapets	Back	Right Edge	0.00	0.00	Left

Buttons for 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel' are visible at the bottom of the window.

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.

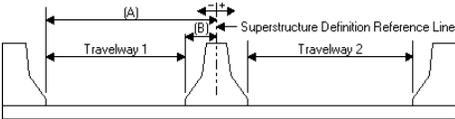
The screenshot shows the 'Compute Lane Positions' dialog box. It contains a table with the following data:

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	1.50	26.50	1.50	26.50

'Apply' and 'Cancel' buttons are located at the bottom right of the dialog box.

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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	1.50	26.50	1.50	26.50

LRFD fatigue

Lanes available to trucks:

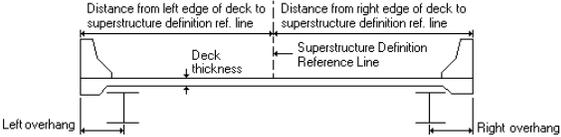
Override Truck fraction:

Compute New Duplicate Delete

OK Apply Cancel

Structure Typical Section – Wearing surface

Enter the data shown below.



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

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

Deck thickness

Superstructure Definition Reference Line

Left overhang

Right overhang

Wearing surface material: Bituminous Surface

Description:

Wearing surface thickness: 3.0000 in Thickness field measured (DW = 1.25 if checked)

Wearing surface density: 140.000 pcf

Load case: Wearing Surface

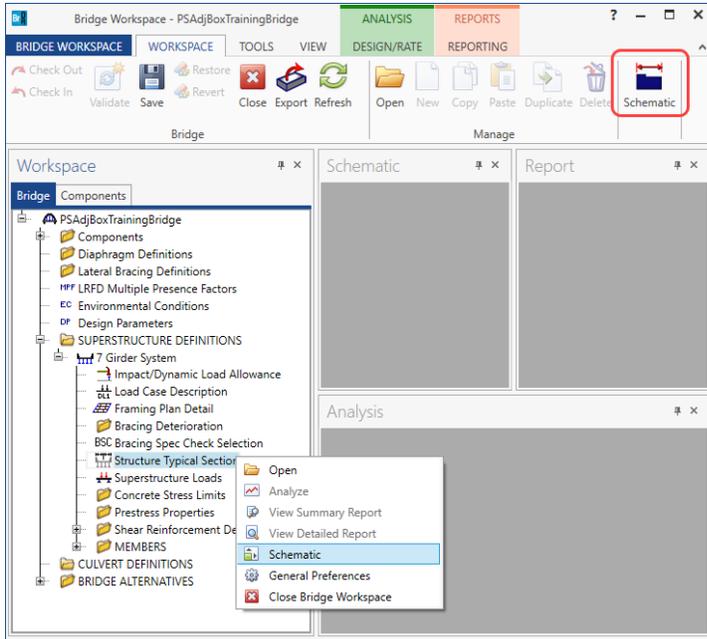
OK Apply Cancel

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

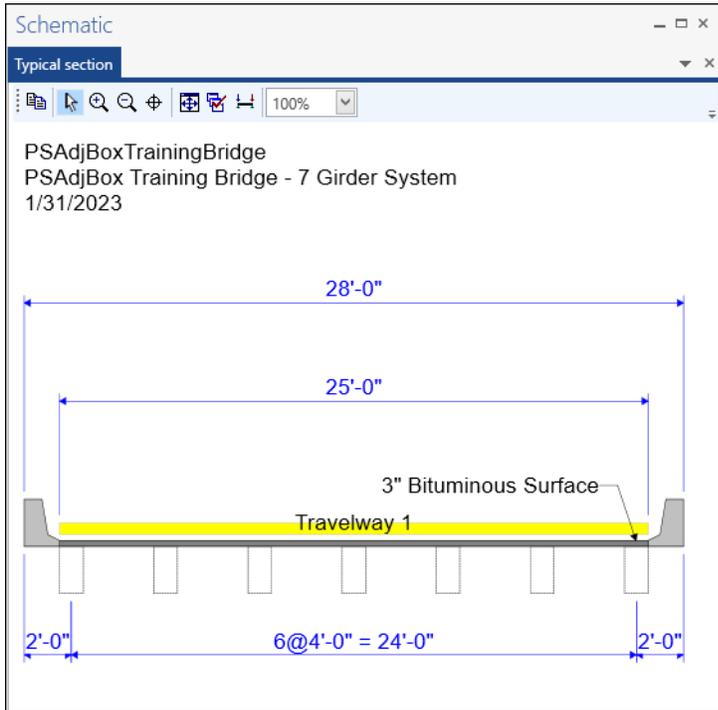
PS3 – Adjacent PS Box Example

Schematic – Structure Typical Section

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).



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.



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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 **5.0 ksi Beam Concrete** material from the drop-down menu of the **Concrete material**. The **Final allowable tension** in the concrete is dependent upon the moderate or severe corrosive condition to which the member is exposed. BrDR uses the **stress limit coefficient** to calculate this value. For this example, check the **Final allowable tension stress limit coef. (US) override checkbox** and enter the overridden value as shown below. If not overridden, BrDR uses the default stress limit coefficient.

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.

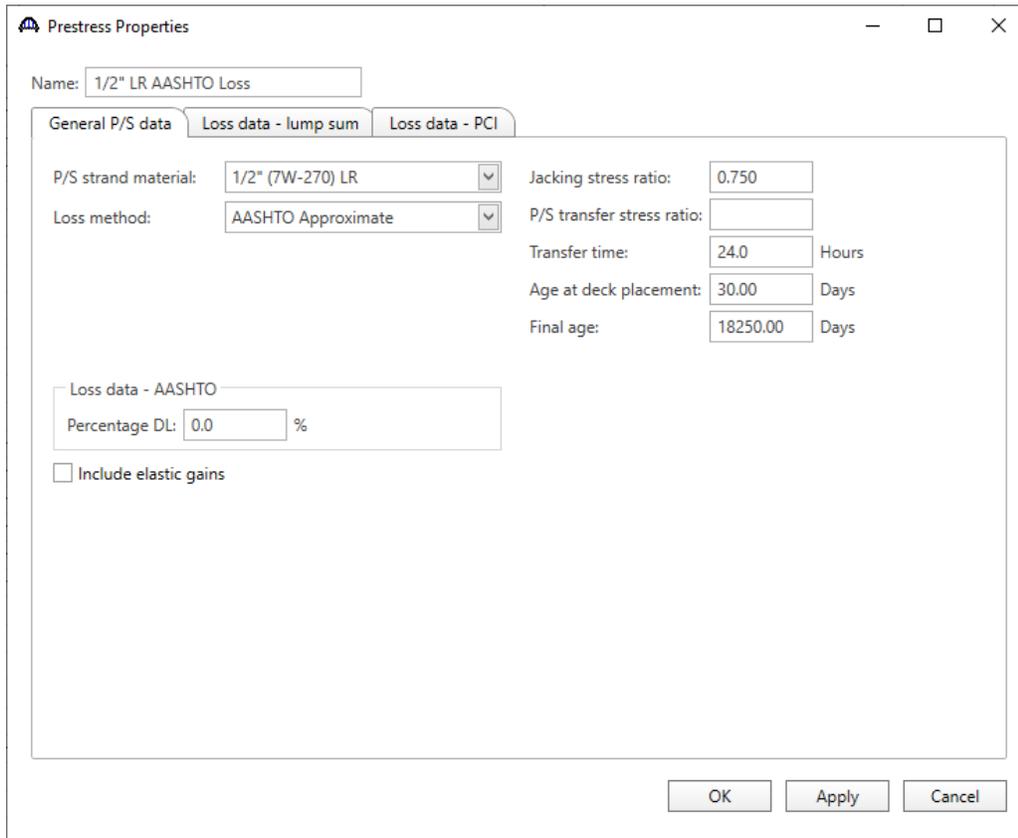
	LFD	LRFD
Initial allowable compression:	2.4 ksi	2.6 ksi
Initial allowable tension:	0.1897367 ksi	0.1896 ksi
Final allowable compression:	3 ksi	3 ksi
Final allowable tension:	0.2124265 ksi	0.2124265 ksi
Final allowable DL compression:	2 ksi	2.25 ksi
Final allowable slab compression:		
Final allowable compression: (LL+1/2(Pe+DL))	2 ksi	2 ksi

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

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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 the 'Prestress Properties' dialog box with the following settings:

- Name: 1/2" LR AASHTO Loss
- General P/S data tab is selected.
- P/S strand material: 1/2" (7W-270) LR
- Loss method: AASHTO Approximate
- Jacking stress ratio: 0.750
- P/S transfer stress ratio: (empty)
- Transfer time: 24.0 Hours
- Age at deck placement: 30.00 Days
- Final age: 18250.00 Days
- Loss data - AASHTO section: Percentage DL: 0.0 %
- Include elastic gains:

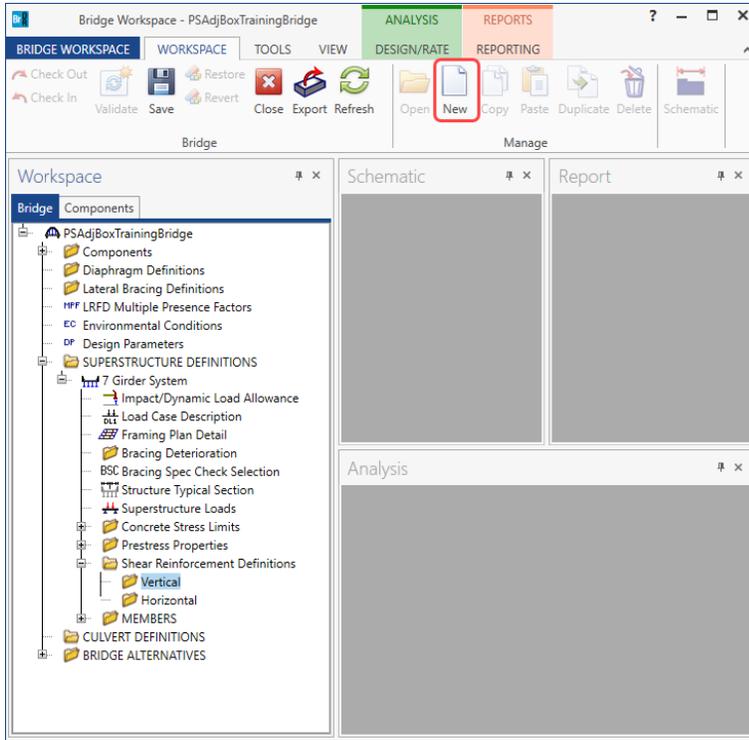
Buttons at the bottom: OK, Apply, Cancel

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

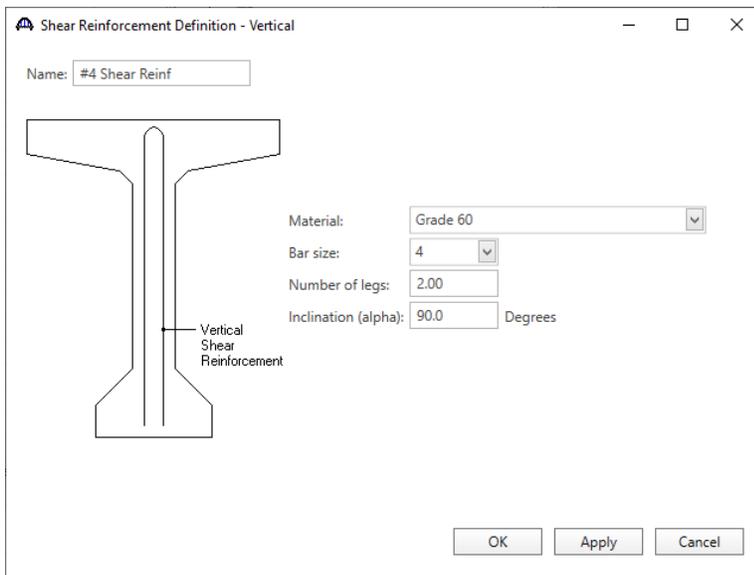
PS3 – Adjacent PS Box Example

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**).



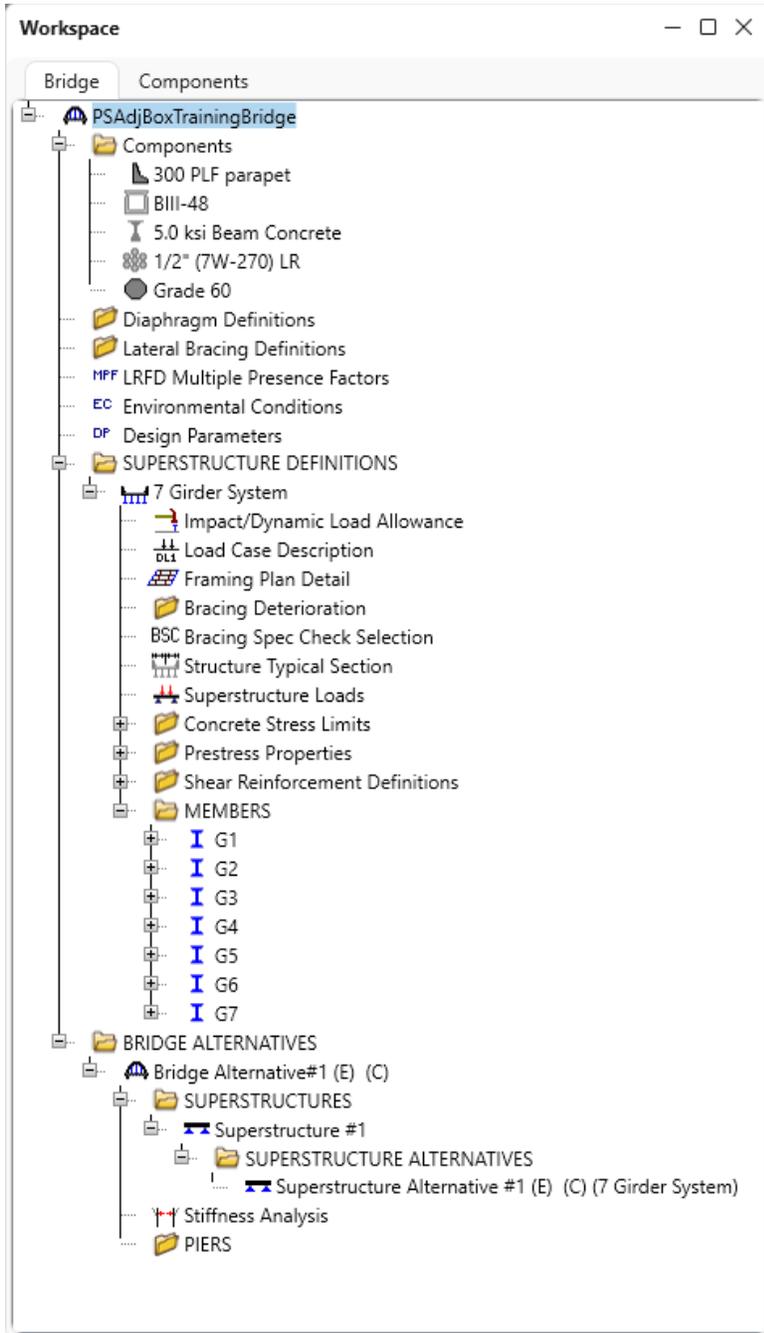
The I shape shown is for illustrative purposes only, it is not meant to display the actual beam shape. Enter data as shown below.



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

PS3 – Adjacent PS Box Example

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



PS3 – Adjacent PS Box Example

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.

The Member window displays the following information:

- Member name: G2
- Link with: -- None --
- Description: (empty text box)
- Table with columns: Existing, Current, Member alternative name, Description (empty table)
- Number of spans: 1
- Table with columns: Span no., Span length (ft)

Span no.	Span length (ft)
1	95.00

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 New Member Alternative window displays the following information:

- 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.

PS3 – Adjacent PS Box 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. Enter data as shown below.

Member Alternative Description

Member alternative:

Description | Specs | Factors | Engine | Import | Control options

Description:

Material type:

Girder type:

Modeling type:

Default units:

Girder property input method

Schedule based

Cross-section based

Self load

Load case:

Additional self load: kip/ft

Additional self load: %

Default rating method:

Crack control parameter (Z)

Bottom of beam: kip/in

Exposure factor:

Use creep

OK Apply Cancel

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

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

Span detail | Stress limit ranges | Slab interface

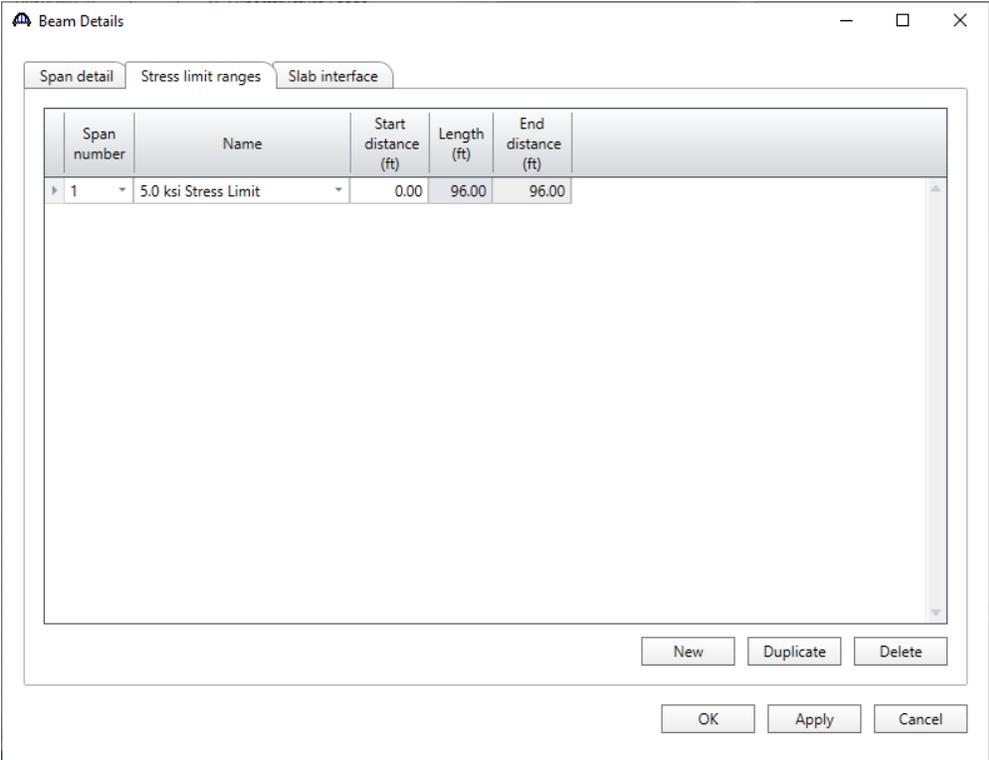
Span number	Beam shape	Girder material	Prestress properties	n	Beam projection	
					Left end (in)	Right end (in)
1	B111-48	5.0 ksi Beam Concrete	1/2" LR AASHTO Loss		6.0000	6.0000

OK Apply Cancel

PS3 – Adjacent PS Box Example

Beam Details – Stress limit ranges

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.



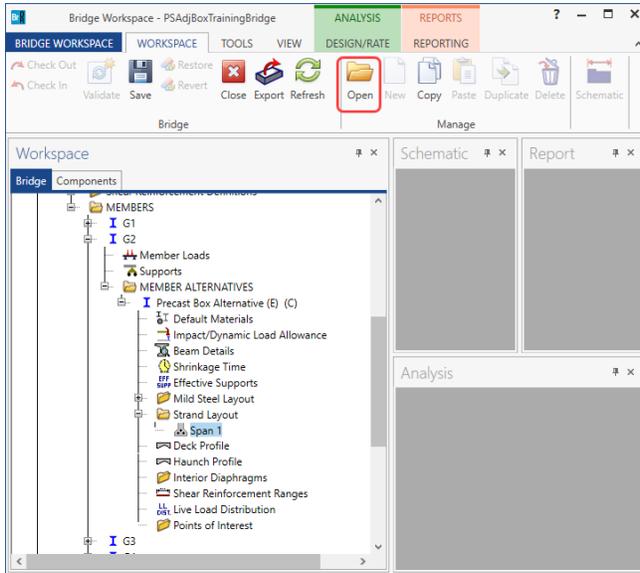
Since this example does not have a concrete deck, the **Slab interface** tab can be left blank.

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

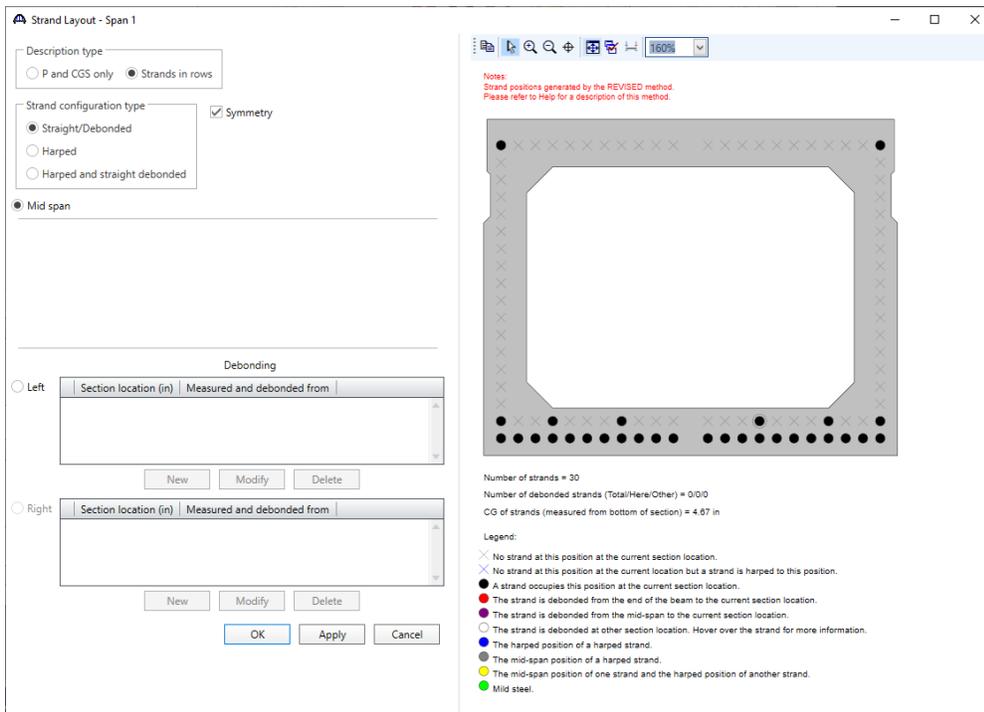
PS3 – Adjacent PS Box Example

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.

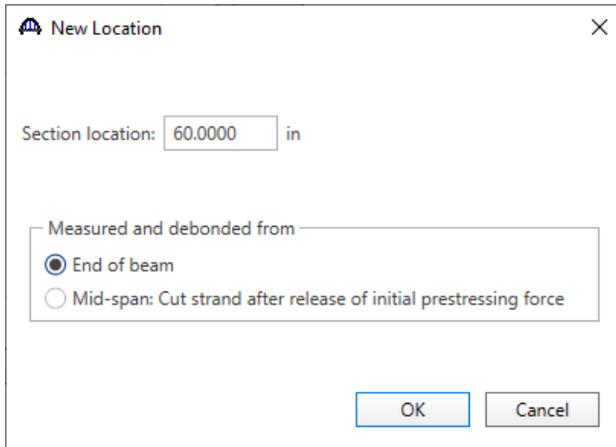


Use the **Zoom** buttons to shrink/expand the schematic of the beam shape on the right side of the screen so that the entire beam is visible. Select the **Description type** as **Strands in rows** and the **Strand configuration type** as **Straight/Debonded**. The **Mid span** radio button will now become active. Strands can now be defined at the middle of the span by selecting strands in the right-hand schematic. Select the following strands in the schematic so that the CG of the strands is 4.67 inches. Click the **Apply** button to save this information.



PS3 – Adjacent PS Box Example

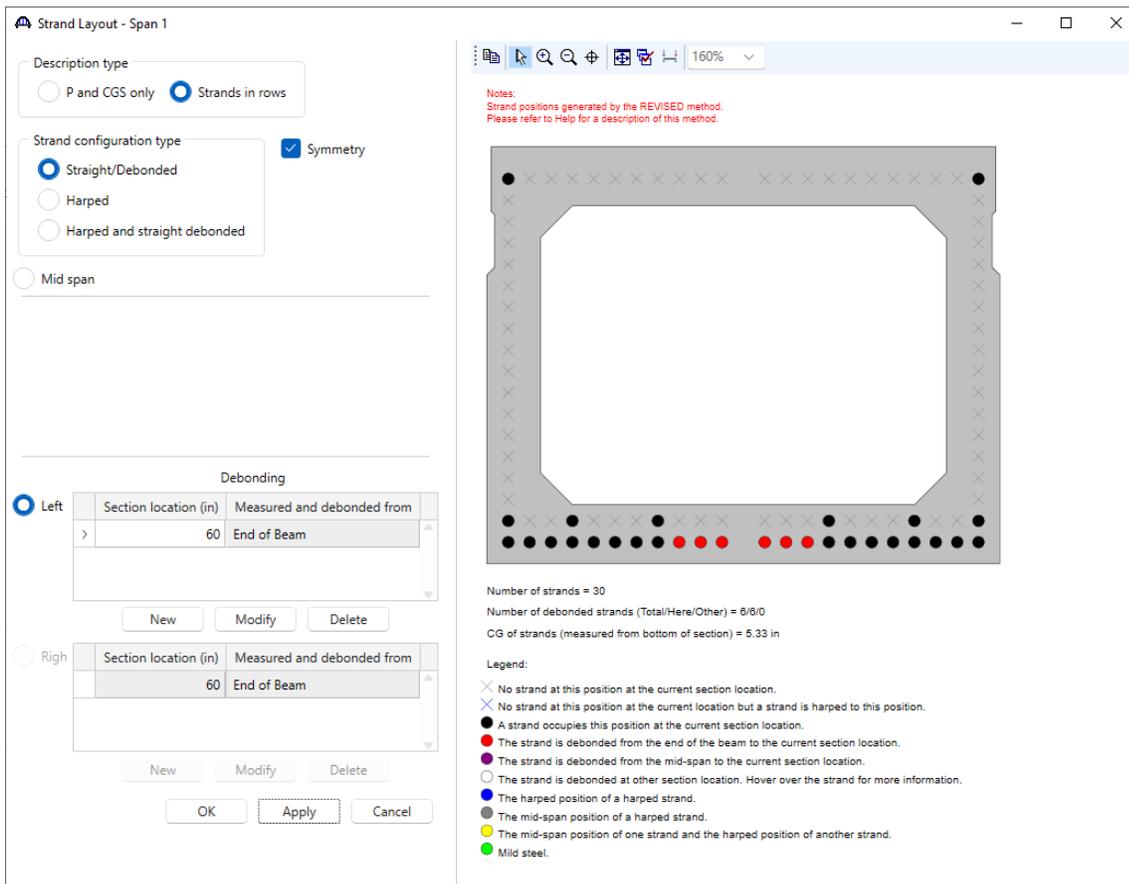
Now select the **Left** radio button to enter data for debonding of the strands. Click the **New** button to enter the location of the debonding point as a distance from the left end of the precast beam. Enter the new location as **60** inches from the left end of the precast beam to the debonding point in the window as shown below.



The 'New Location' dialog box is shown. It has a title bar with a close button. The main content area contains a text input field labeled 'Section location:' with the value '60.0000' and the unit 'in'. Below this is a group box titled 'Measured and debonded from' containing two radio buttons: 'End of beam' (which is selected) and 'Mid-span: Cut strand after release of initial prestressing force'. At the bottom of the dialog are 'OK' and 'Cancel' buttons.

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

Select 6 strands in the bottom row in the schematic as being debonded at the section 60 inches from the left end of the beam as shown below.



The 'Strand Layout - Span 1' window is shown. On the left is a configuration panel with the following settings:

- Description type: P and CGS only, Strands in rows
- Strand configuration type: Straight/Debonded, Harped, Harped and straight debonded
- Symmetry
- Mid span
- Debonding: Left, Right

Section location (in)	Measured and debonded from
60	End of Beam

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

On the right is a schematic of a rectangular precast beam cross-section. The top and bottom edges are marked with 'x' symbols representing strand positions. The bottom edge has 6 red dots, indicating 6 strands debonded at the current section location. A legend at the bottom right explains the symbols:

- × 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.

Additional information displayed:

- Number of strands = 30
- Number of debonded strands (Total/Here/Other) = 6/0/0
- CG of strands (measured from bottom of section) = 5.33 in

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

PS3 – Adjacent PS Box Example

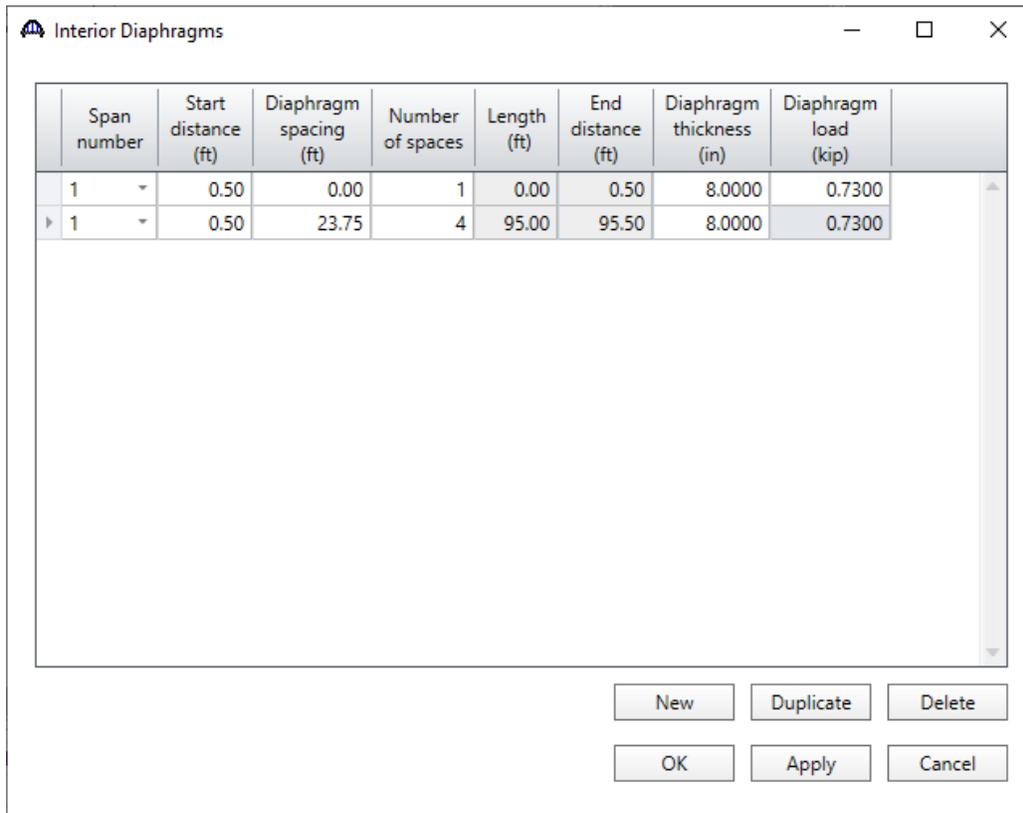
This structure definition does not have a concrete deck, so **Deck profile** and **Haunch profile** data will not be entered.

Interior Diaphragms

Eight inch thick, full depth diaphragms are located at quarter points. The weight of an individual diaphragm is calculated as follows.

$$\frac{8}{12} \left[\frac{(48 - 10)}{12} * \frac{(39 - 11)}{12} - 4 \left(\frac{1}{2} \right) \left(\frac{3}{12} \right) \left(\frac{3}{12} \right) \right] (0.15) = 0.73k / \text{diaphragm}$$

Double-click on the **Interior Diaphragms** node in the **Bridge Workspace** tree to open the **Interior Diaphragms** window and enter data in this window as shown below.



The screenshot shows a window titled "Interior Diaphragms" with a table containing the following data:

Span number	Start distance (ft)	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft)	Diaphragm thickness (in)	Diaphragm load (kip)
1	0.50	0.00	1	0.00	0.50	8.0000	0.7300
1	0.50	23.75	4	95.00	95.50	8.0000	0.7300

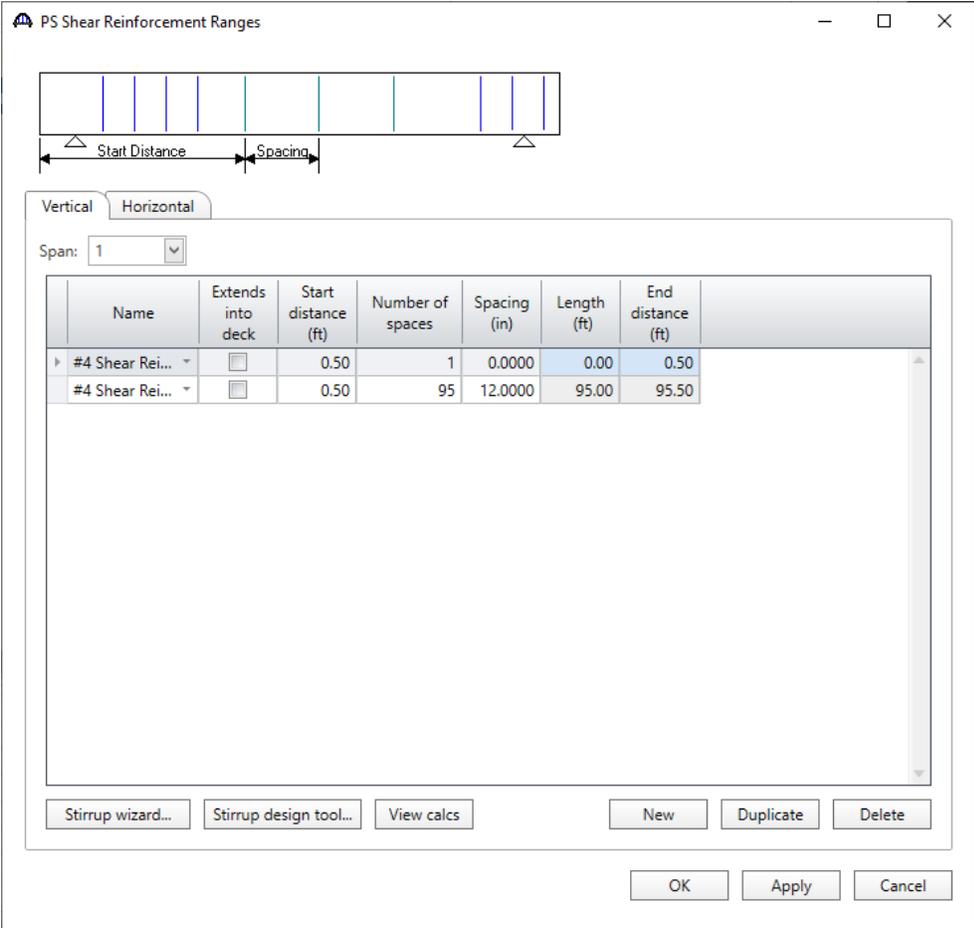
Below the table are buttons for "New", "Duplicate", "Delete", "OK", "Apply", and "Cancel".

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

PS3 – Adjacent PS Box 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.



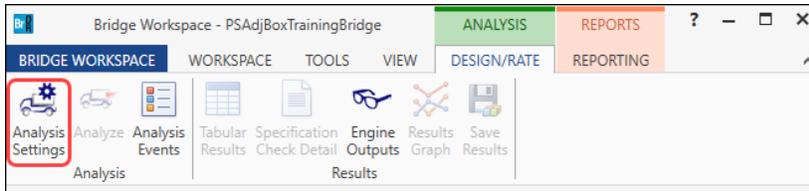
Click **OK** to apply the data and close the window.

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

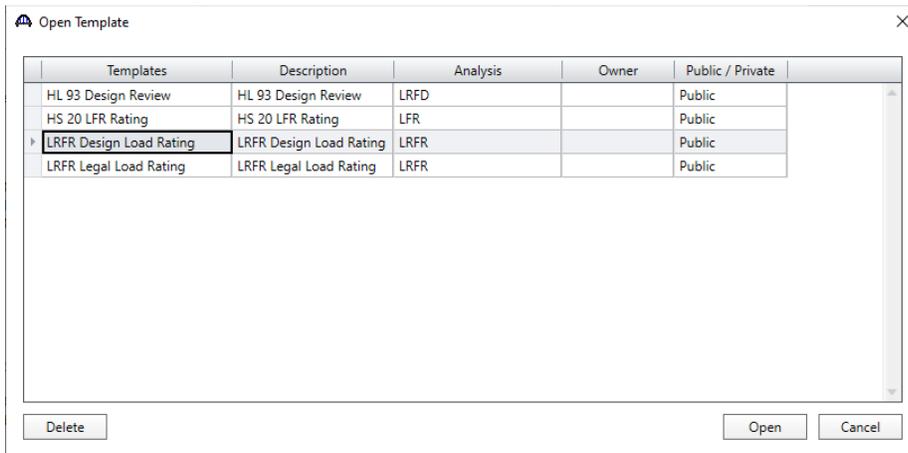
PS3 – Adjacent PS Box Example

LRFR Rating

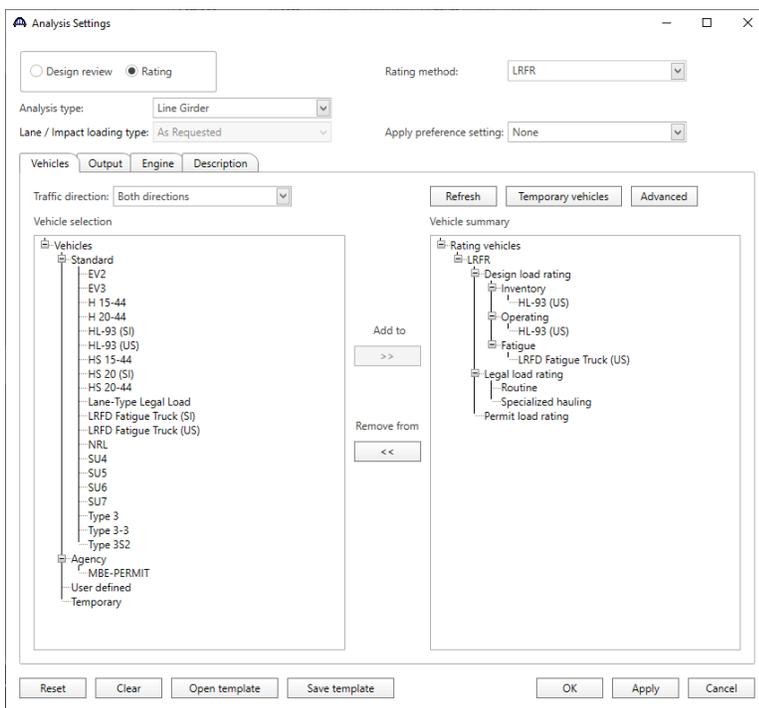
To perform an **LRFR** rating, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon to open the window shown below.



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



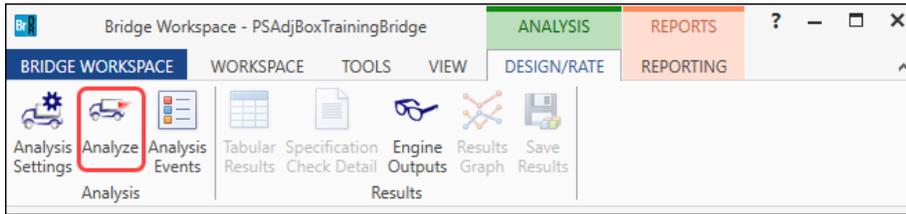
The **Analysis Settings** window will be updated as shown below.



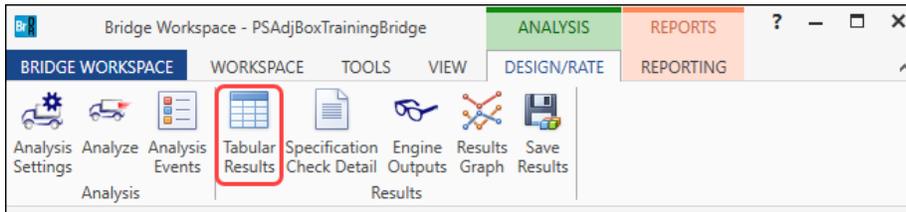
PS3 – Adjacent PS Box Example

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 **DESIGN/RATE** ribbon.



The window shown below will open.

Analysis Results - Precast Box Alternative

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	17.69	0.491	47.50	1 - (50.0)	SERVICE-III PS Tensile Stress	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	27.04	0.751	47.50	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	20.76	0.577	47.50	1 - (50.0)	SERVICE-III PS Tensile Stress	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	31.75	0.882	47.50	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested

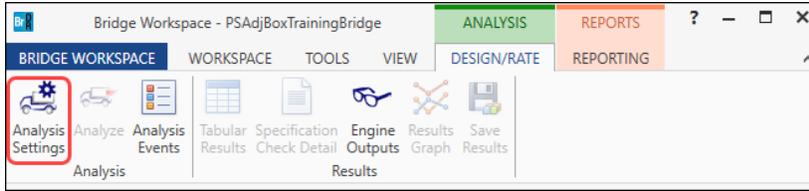
AASHTO LRFR Engine Version 7.5.0.3001
Analysis preference setting: None

Close

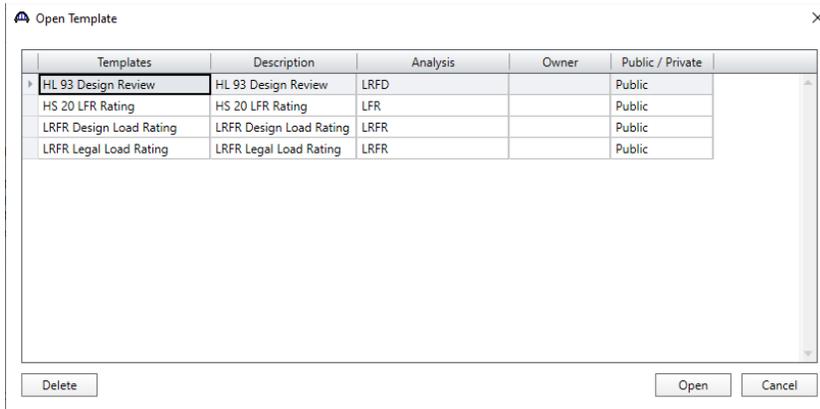
PS3 – Adjacent PS Box Example

LRFD Design review

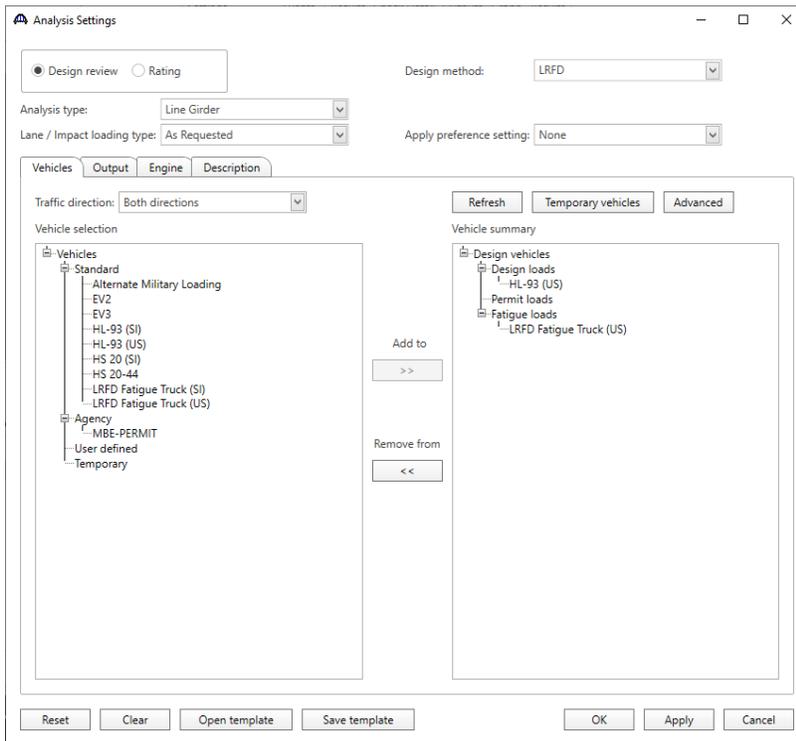
To perform an **LRFD design review** of this girder for HL93 loading, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon to open the window shown below.



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



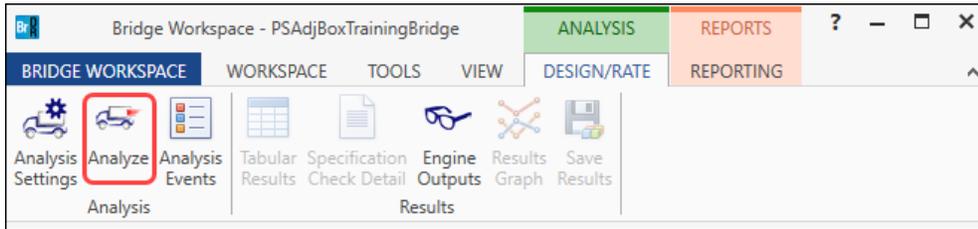
The **Analysis Settings** window will be updated as shown below.



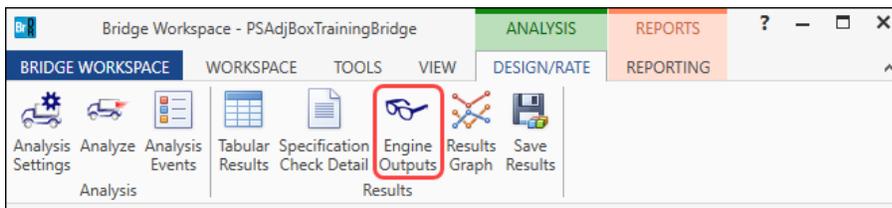
PS3 – Adjacent PS Box Example

Engine Outputs

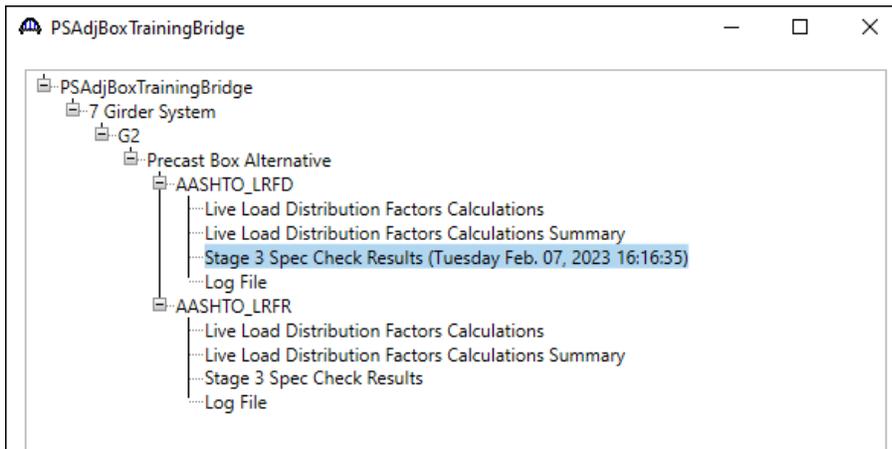
Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review.



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.



PS3 – Adjacent PS Box Example

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 : PSAAdjBoxTrainingBridge
 Bridge : PSAAdjBox Training Bridge
 Superstructure Def : 7 Girder System
 Member : G2
 Analysis Preference Setting :

NBI Structure ID : AdjBoxTraining1
 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)	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	-2.600	0.058	-0.404	6.435	Pass
2.000	-2.600	0.175	-1.909	1.362	Pass
3.010	-2.600	0.120	-1.855	1.402	Pass
4.500	-2.600	0.095	-1.831	1.420	Pass
7.000	-2.600	0.053	-2.224	1.169	Pass
9.500	-2.600	-0.067	-2.106	1.235	Pass