

*AASHTOWare BrD/BrR 6.8*

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*Prestressed Concrete Structure Tutorial*

*PS3 - Adjacent PS Box Example*

## BrD and BrR Training

### PS3 - Adjacent PS Box Example

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

Bridge ID: PSAdjBoxTrainingBr    NBI Structure ID (8): AdjBoxTraining1     Template     Superstructures  
 Bridge Completely Defined     Culverts

Description (selected)    Description (cont'd)    Alternatives    Global Reference Point    Traffic    Custom Agency Fields

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

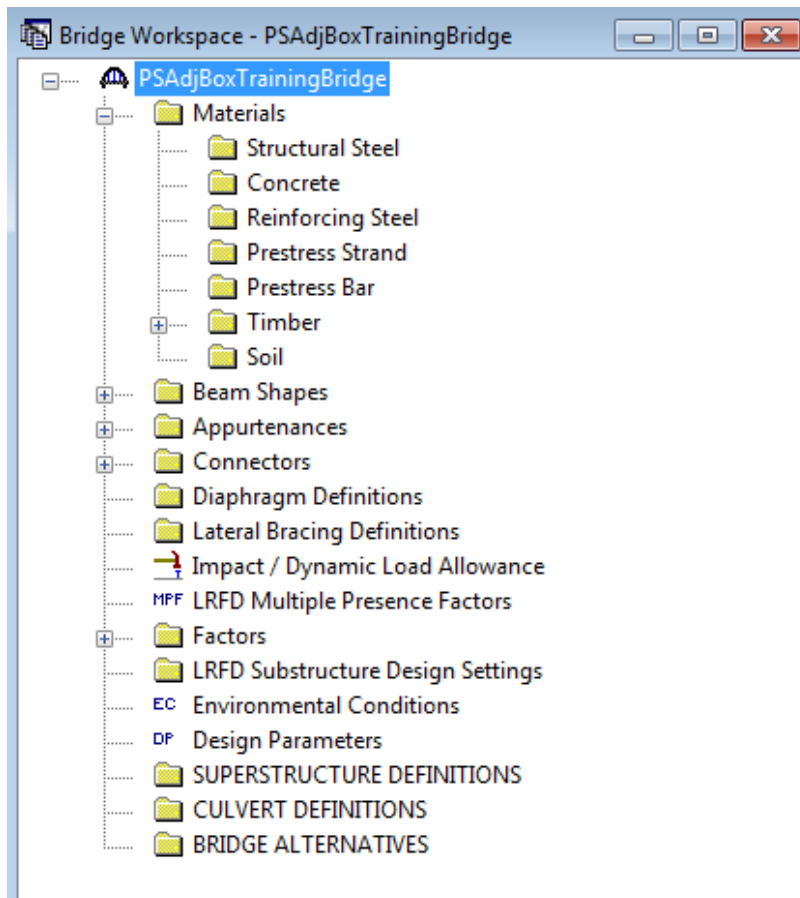
AASHTOWare Association...     BrR     BrD     BrM    OK    Apply    Cancel

Close the window by clicking Ok. This saves the data to memory and closes the window.

## PS3 - Adjacent PS Box Example

To enter the materials to be used by members of the bridge, click on the  to expand the tree for Materials.

The tree with the expanded Materials branch is shown below:



### PS3 - Adjacent PS Box Example

To add a new concrete material click on Concrete in the tree and select File/New from the menu (or right mouse click on Concrete and select New). Fill in the data for the beam concrete material as shown below:

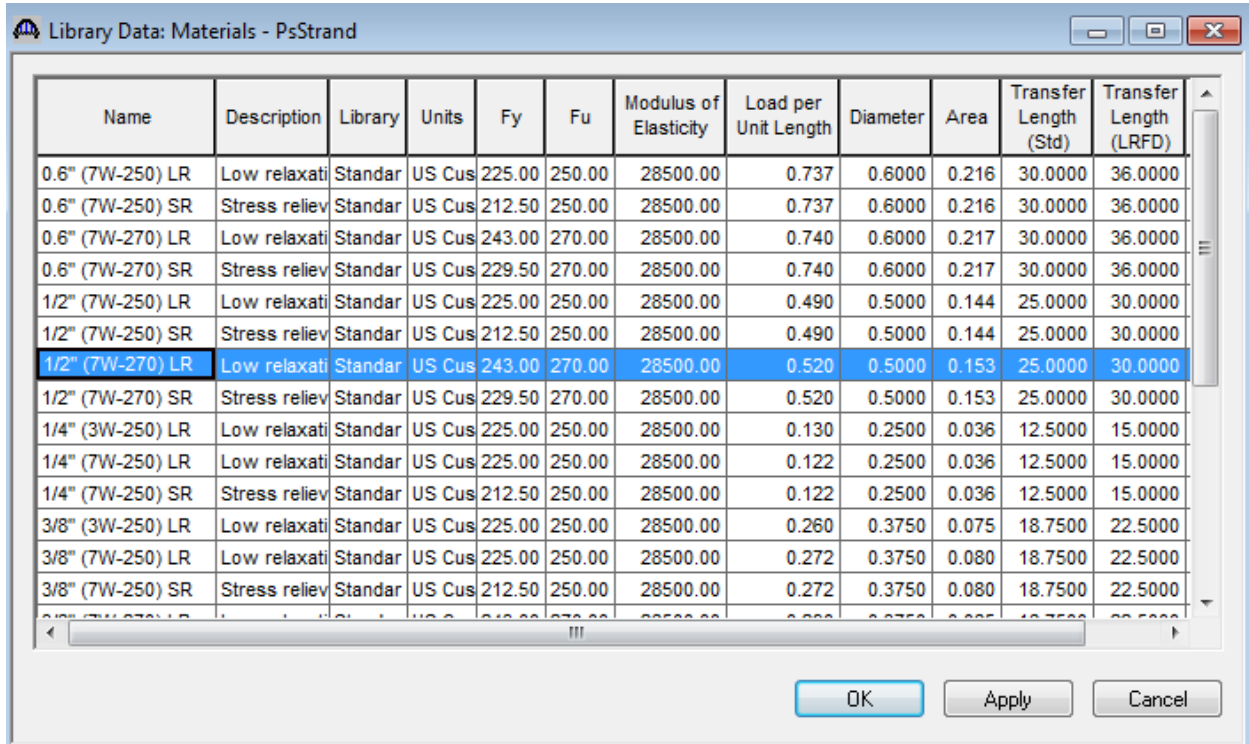
Property	Value	Unit
Name	5.0 ksi Beam Concrete	
Description		
Compressive strength at 28 days (f'c)	5.000	ksi
Initial compressive strength (f'ci)	4.000	ksi
Coefficient of thermal expansion	0.0000060000	1/F
Density (for dead loads)	0.150	kcf
Density (for modulus of elasticity)	0.150	kcf
Std Modulus of elasticity (Ec)	4286.83	ksi
LRFD Modulus of elasticity (Ec)	4286.83	ksi
Std Initial modulus of elasticity	3834.25	ksi
LRFD Initial modulus of elasticity	3834.25	ksi
Poisson's ratio	0.200	
Composition of concrete	Normal	
Modulus of rupture	0.537	ksi
Shear factor	1.000	
Splitting tensile strength (fct)		ksi

A bituminous surface will be used on this bridge as a wearing surface so we are not entering a deck concrete for this bridge.

PS3 - Adjacent PS Box Example

To add a new prestress strand material click on Prestress Strand in the tree and select File/New from the menu (or right mouse click on Prestress Strand and select New).

Add the prestress strand material by selecting from the Prestress Strand Materials Library by clicking the Copy from Library button. The following window opens:



Name	Description	Library	Units	Fy	Fu	Modulus of Elasticity	Load per Unit Length	Diameter	Area	Transfer Length (Std)	Transfer Length (LRFD)
0.6" (7W-250) LR	Low relaxati	Standar	US Cus	225.00	250.00	28500.00	0.737	0.6000	0.216	30.0000	36.0000
0.6" (7W-250) SR	Stress reliev	Standar	US Cus	212.50	250.00	28500.00	0.737	0.6000	0.216	30.0000	36.0000
0.6" (7W-270) LR	Low relaxati	Standar	US Cus	243.00	270.00	28500.00	0.740	0.6000	0.217	30.0000	36.0000
0.6" (7W-270) SR	Stress reliev	Standar	US Cus	229.50	270.00	28500.00	0.740	0.6000	0.217	30.0000	36.0000
1/2" (7W-250) LR	Low relaxati	Standar	US Cus	225.00	250.00	28500.00	0.490	0.5000	0.144	25.0000	30.0000
1/2" (7W-250) SR	Stress reliev	Standar	US Cus	212.50	250.00	28500.00	0.490	0.5000	0.144	25.0000	30.0000
1/2" (7W-270) LR	Low relaxati	Standar	US Cus	243.00	270.00	28500.00	0.520	0.5000	0.153	25.0000	30.0000
1/2" (7W-270) SR	Stress reliev	Standar	US Cus	229.50	270.00	28500.00	0.520	0.5000	0.153	25.0000	30.0000
1/4" (3W-250) LR	Low relaxati	Standar	US Cus	225.00	250.00	28500.00	0.130	0.2500	0.036	12.5000	15.0000
1/4" (7W-250) LR	Low relaxati	Standar	US Cus	225.00	250.00	28500.00	0.122	0.2500	0.036	12.5000	15.0000
1/4" (7W-250) SR	Stress reliev	Standar	US Cus	212.50	250.00	28500.00	0.122	0.2500	0.036	12.5000	15.0000
3/8" (3W-250) LR	Low relaxati	Standar	US Cus	225.00	250.00	28500.00	0.260	0.3750	0.075	18.7500	22.5000
3/8" (7W-250) LR	Low relaxati	Standar	US Cus	225.00	250.00	28500.00	0.272	0.3750	0.080	18.7500	22.5000
3/8" (7W-250) SR	Stress reliev	Standar	US Cus	212.50	250.00	28500.00	0.272	0.3750	0.080	18.7500	22.5000

Select the 1/2" (7W-270) material and click Ok.

### PS3 - Adjacent PS Box Example

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

Property	Value	Unit
Name	1/2" (7W-270) LR	
Description	Low relaxation 1/2"/Seven Wire/fpu = 270	
Strand diameter	0.5000	in
Strand area	0.153	in <sup>2</sup>
Strand type	Low Relaxation	
Ultimate tensile strength (Fu)	270.000	ksi
Yield strength (Fy)	243.000	ksi
Modulus of elasticity (E)	28500.00	ksi
Transfer length (Std)	25.0000	in
Transfer length (LRFD)	30.0000	in
Unit load per length	0.520	lb/ft

Epoxy coated

Buttons: Copy To Library..., Copy from Library..., OK, Apply, Cancel

Click Ok to save the data to memory and close the window.

### PS3 - Adjacent PS Box Example

Add the following reinforcement steel in the same manner.

Bridge Materials - Reinforcing Steel

Name:  Description:

Material Properties

Specified yield strength ( $F_y$ ) =  ksi

Modulus of elasticity ( $E_s$ ) =  ksi

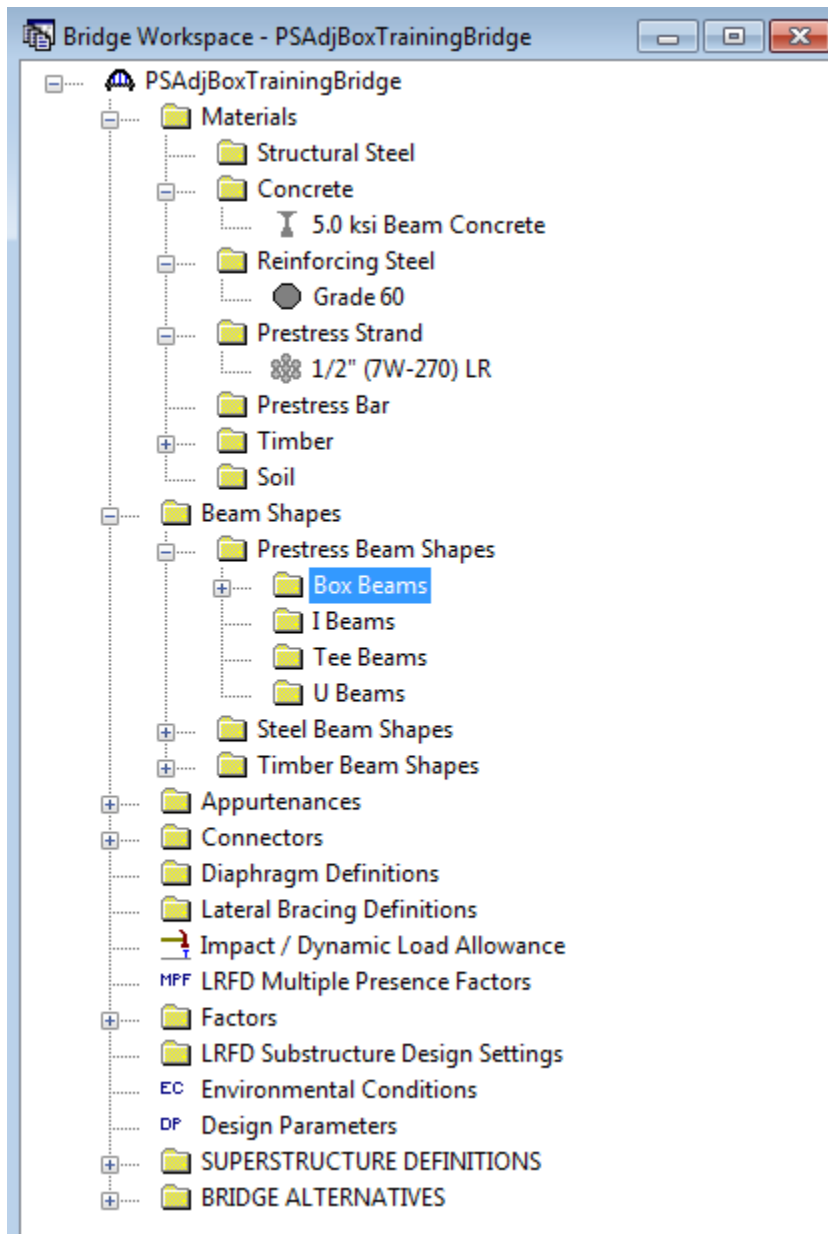
*Ultimate strength ( $F_u$ )* =  ksi

Type

Plain  
 Epoxy  
 Galvanized  
 Other

## PS3 - Adjacent PS Box Example

To enter a prestress beam shape to be used in this bridge expand the tree labeled Beam Shapes as shown below:





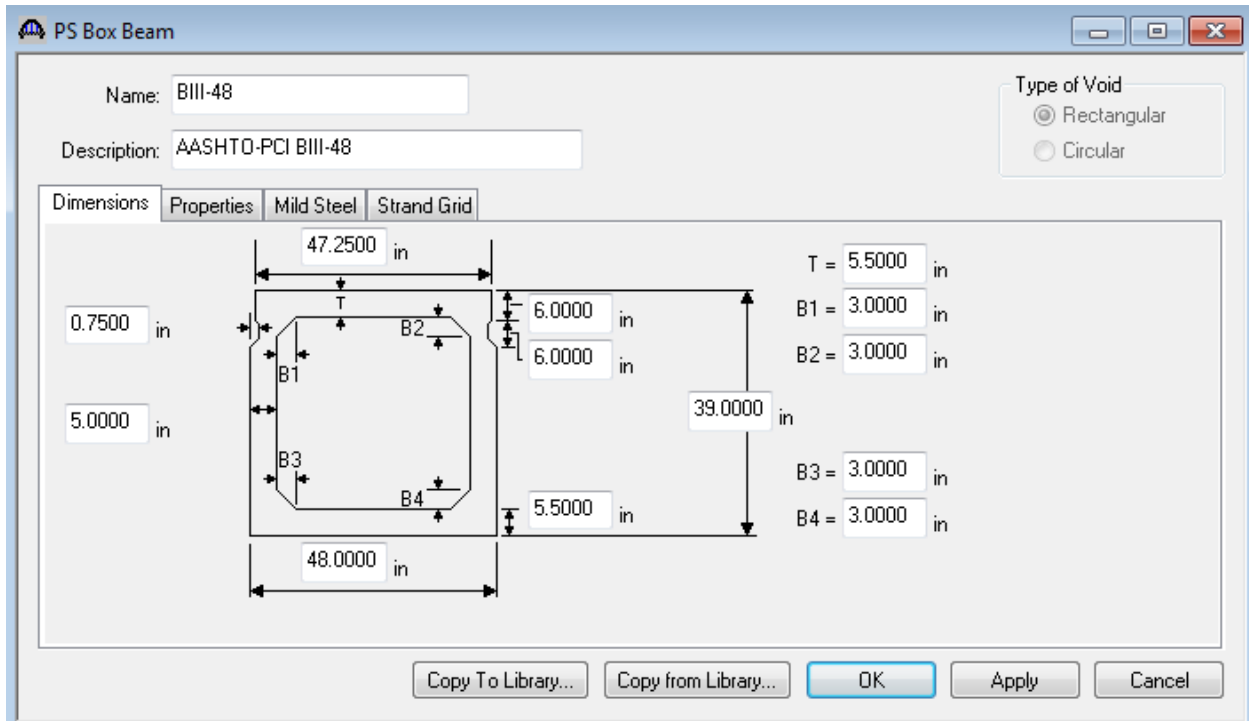
## PS3 - Adjacent PS Box Example

Click on Box Beams in the tree and select File/New from the menu (or double click on Box Beams in the tree). The window shown below will open.

The screenshot shows the 'PS Box Beam' software window. At the top, there are fields for 'Name:' and 'Description:'. To the right, under 'Type of Void', there are radio buttons for 'Rectangular' (selected) and 'Circular'. Below these are tabs for 'Dimensions', 'Properties', 'Mild Steel', and 'Strand Grid'. The main area contains a technical drawing of a box beam cross-section with various dimensions labeled: 'T' for top flange thickness, 'B1', 'B2', 'B3', and 'B4' for flange widths, and 'L' for lip length. To the right of the drawing are input fields for each of these dimensions, followed by the unit 'in'. At the bottom of the window are buttons for 'Copy To Library...', 'Copy from Library...', 'OK', 'Apply', and 'Cancel'.

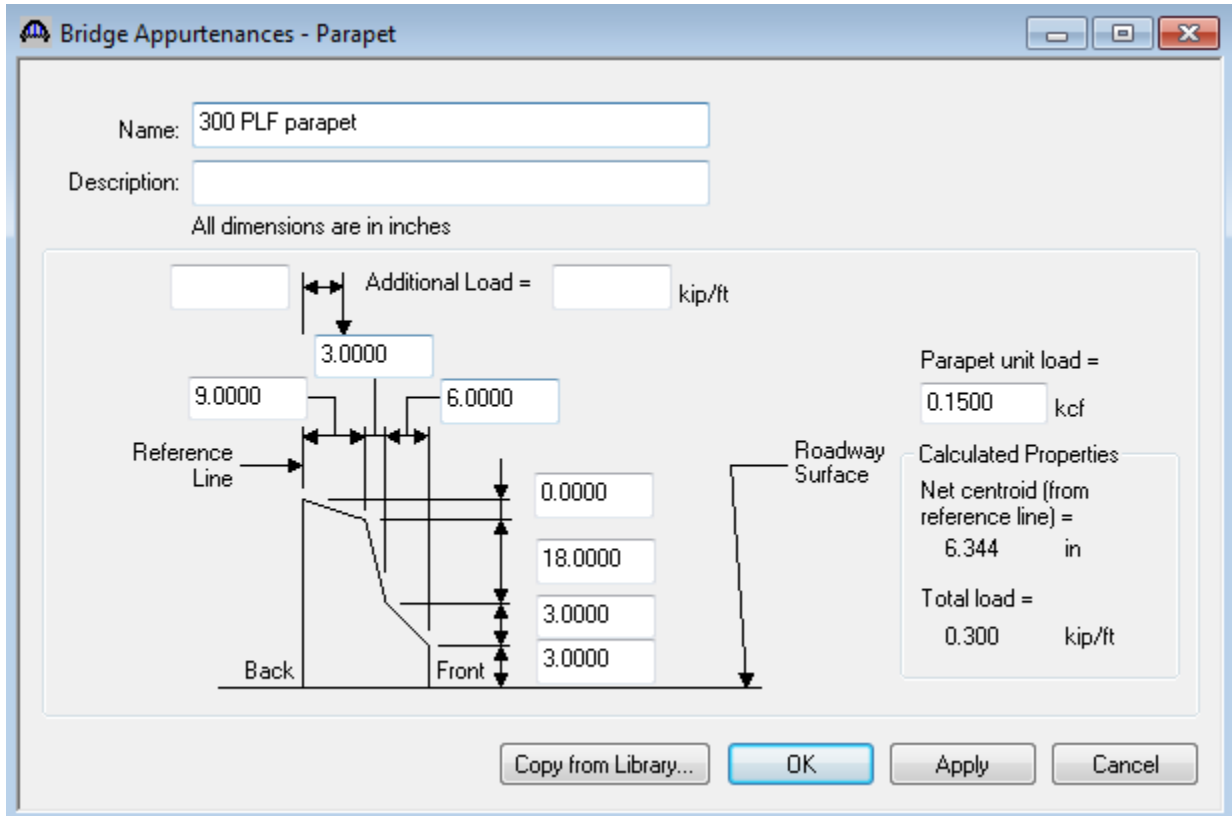
### PS3 - Adjacent PS Box Example

Select the Type of Void as Rectangular and click on the Copy from Library button. Select BIII-48 (AASHTO Box Beam, Type BIII-48) and click Ok. The beam properties are copied to the Box Beam window as shown below.



### PS3 - Adjacent PS Box Example

To enter the appurtenances to be used within the bridge expand the tree branch labeled Appurtenances. To define a parapet double click on Parapet in the tree and input the parapet dimensions as shown below. Click Ok to save the data to memory and close the window.



The default impact factors, standard LRFD and LFD factors will be used as they were in previous examples so we will skip to Structure Definition. Bridge Alternatives will be added after we enter the Structure Definition.

### PS3 - Adjacent PS Box Example

Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File/New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the pop up menu) to create a new structure definition.

Select Girder System and the Structure Definition window will open. Enter the appropriate 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

Frame Structure Simplified Definition:

Deck type: Concrete

For PS only

Average humidity: 0 %

Member Alt. Types

Steel

P/S

R/C

Timber

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

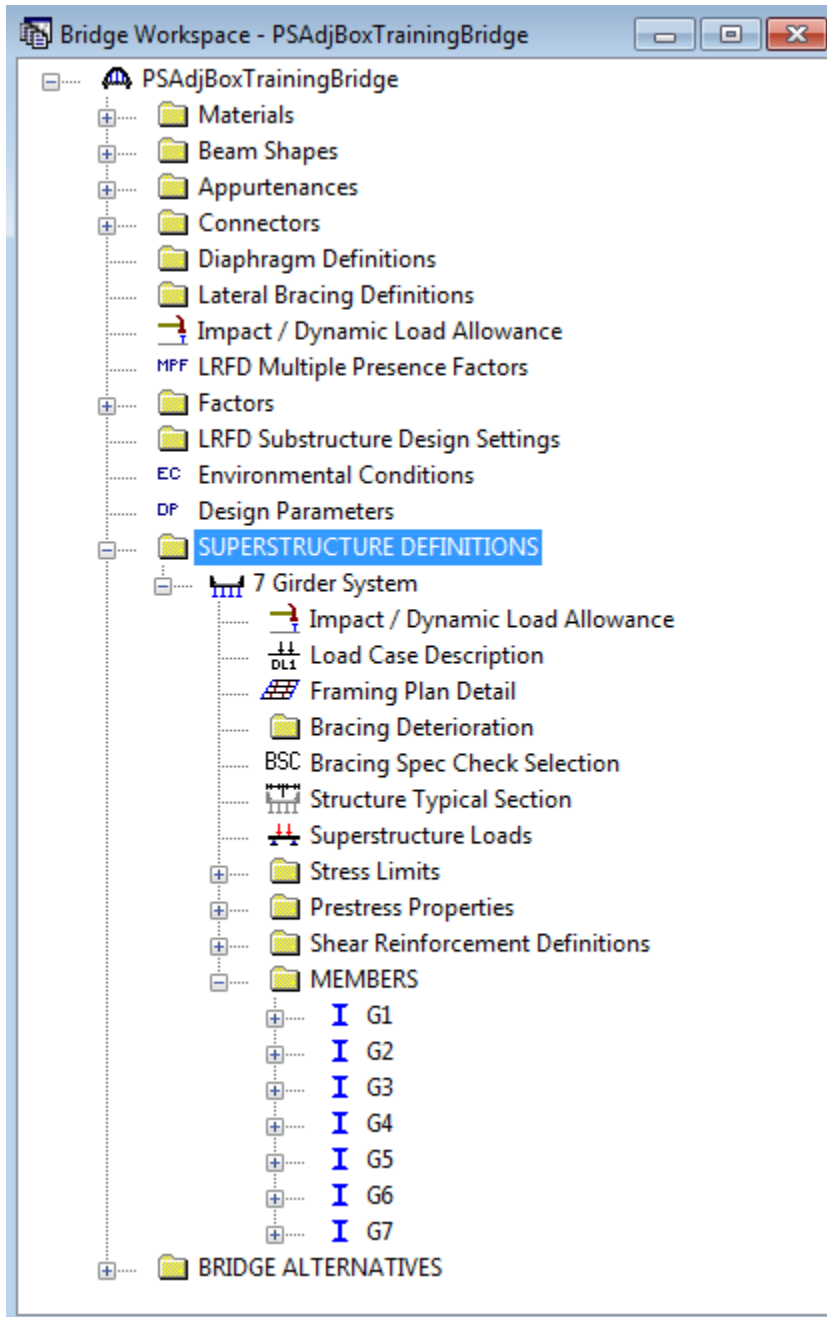
Superelevation: \_\_\_\_\_ %

OK Apply Cancel

Click on Ok to save the data to memory and close the window.

PS3 - Adjacent PS Box Example

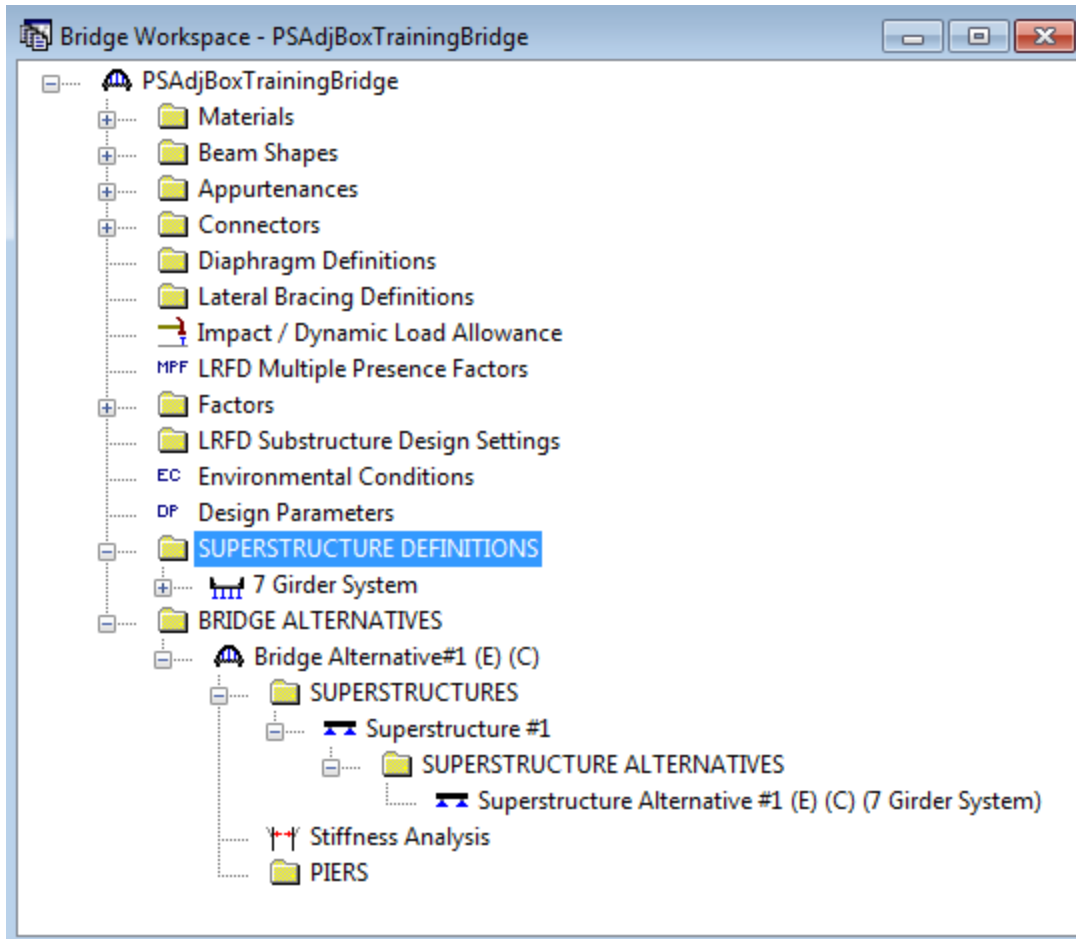
The partially expanded Bridge Workspace tree is shown below:



## PS3 - Adjacent PS Box Example

We now go back to the Bridge Alternatives and create a new Bridge Alternative, a new Superstructure, and a new Superstructure Alternative as we did previously.

The partially expanded Bridge Workspace tree is shown below:



## PS3 - Adjacent PS Box Example

Click Load Case Description to define the dead load cases. 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

### PS3 - Adjacent PS Box Example

Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.

The screenshot shows the 'Structure Framing Plan Details' dialog box with the 'Diaphragms' tab selected. At the top, there are two input fields: 'Number of spans = 1' and 'Number of girders = 7'. Below these, there are two tabs: 'Layout' and 'Diaphragms', with 'Diaphragms' being the active tab. The main area contains a 'Girder Spacing Orientation' section with two radio buttons: 'Perpendicular to girder' (which is selected) and 'Along support'. To the left of this section is a table with two columns: 'Support' and 'Skew (Degrees)'. To the right is another table with three columns: 'Girder Bay', 'Start of Girder', and 'End of Girder'. At the bottom right, there are three buttons: 'OK', 'Apply', and 'Cancel'.

Support	Skew (Degrees)
1	0.0000
2	0.0000

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

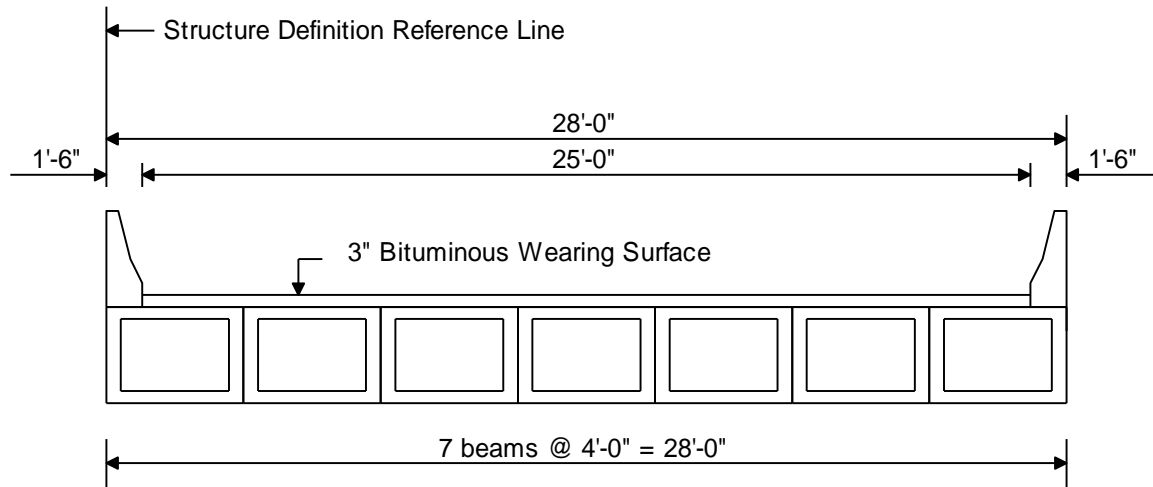
The diaphragms tab of this window is used to enter data for exterior diaphragms, in other words diaphragms located between girders. We do not have exterior diaphragms for a structure made up of adjacent box beams so we will not enter any data on the Diaphragms tab. Interior diaphragms for the box beams will be entered later after we have defined the Member Alternative as a PS box beam.



### PS3 - Adjacent PS Box Example

Next define the structure typical section by double-clicking on Structure Typical Section in the Bridge Workspace tree.

The basic deck geometry is shown by the following sketch:



### PS3 - Adjacent PS Box Example

Input the data describing the typical section as shown below.

Structure Typical Section

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

Deck | Deck (Cont'd) | Parapet | Median | Railing | Generic | Sidewalk | Lane Position | Striped Lanes | Wearing Surface

Superstructure definition reference line is within the bridge deck.

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

OK Apply Cancel

The Deck (Cont'd) tab is used to enter information about the deck concrete and thickness. This structure does not have a concrete deck so we will leave the information on this tab blank.

## PS3 - Adjacent PS Box Example

Parapets:

Add two parapets as shown below.

The screenshot shows the 'Structure Typical Section' window. At the top, there is a diagram of a parapet profile with 'Back' and 'Front' labels. Below the diagram is a tabbed interface with the 'Parapet' tab selected. The main area contains 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

At the bottom right of the window, there are buttons for 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

## PS3 - Adjacent PS Box Example

### Lane Positions:

Select the Lane Position tab and use the Compute... button to compute the lane positions. A dialog showing the results of the computation opens. Click Apply to apply the computed values. The Lane Position tab is populated as shown below.

The screenshot shows the 'Structure Typical Section' dialog box with the 'Lane Position' tab selected. The diagram at the top illustrates a bridge cross-section with two travelways, 'Travelway 1' and 'Travelway 2', and a central 'Superstructure Definition Reference Line'. Dimensions A and B are shown as distances from the reference line to the edges of the travelways at the start and end of the structure.

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

Below the table, there is an 'LRFD Fatigue' section with a checkbox for 'Override Truck fraction' and a 'Compute...' button. At the bottom right, there are buttons for 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

## PS3 - Adjacent PS Box Example

Wearing Surface:

Enter the data shown below.

Structure Typical Section

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

Deck | Deck (Cont'd) | Parapet | Median | **Railing** | Generic | Sidewalk | Lane Position | Striped Lanes | Wearing Surface

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


Copy from Library...

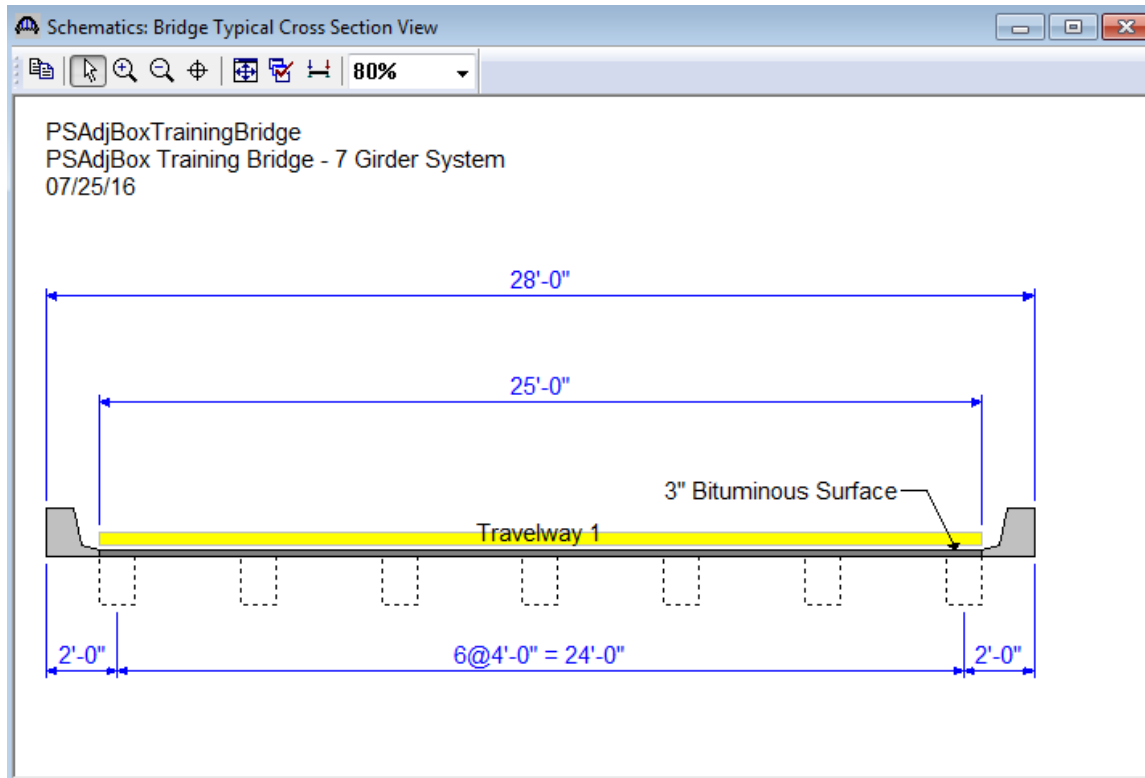
OK Apply Cancel

Click Ok to save the data to memory and close the window.

## PS3 - Adjacent PS Box Example

While Structure Typical Section is highlighted in the BWS tree, open the schematic for the typical section by

selecting the View Schematic toolbar button  or Bridge/Schematic from the menu. The following schematic will be displayed. Since we have not yet defined the member alternatives, the girders are displayed as dashed boxes. At this point BrR/BrD does not know if the girders will be PS Boxes, I-beams, steel rolled beams, etc.



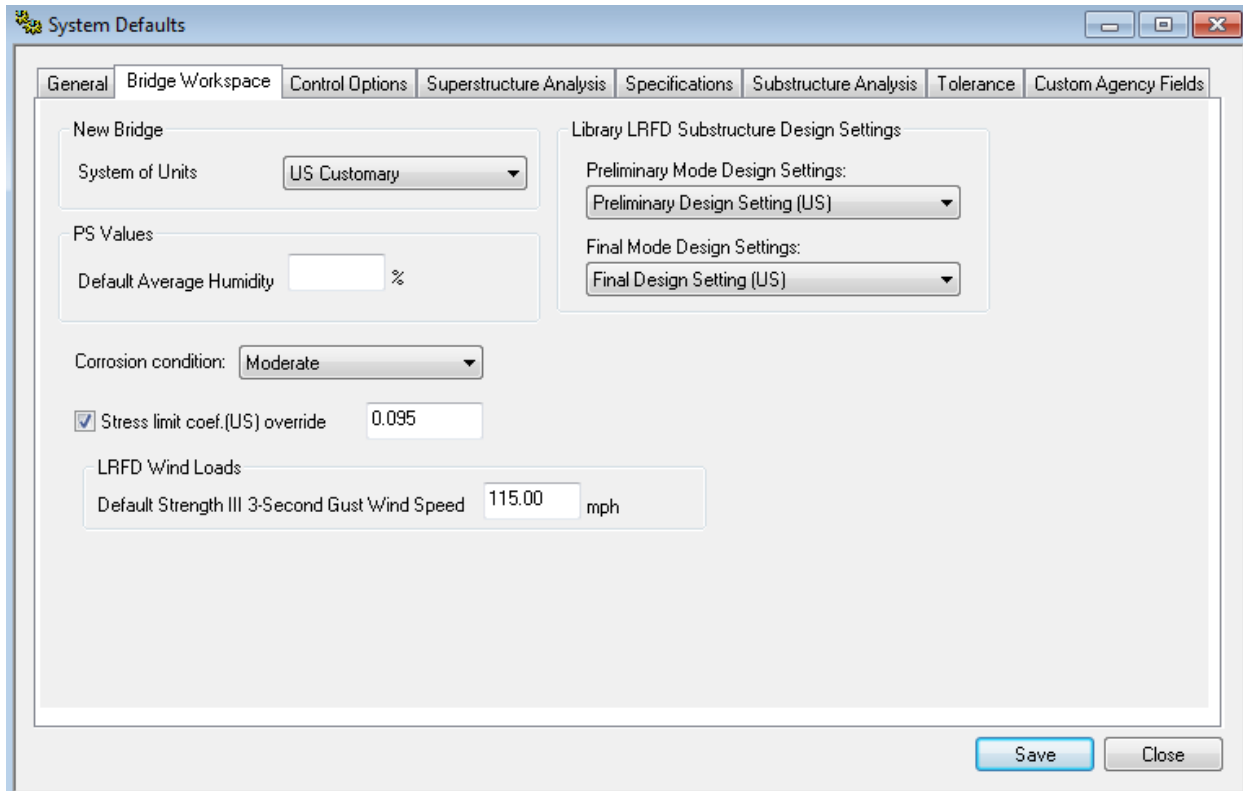
### PS3 - Adjacent PS Box Example

Now define a Stress Limit. A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the Stress Limits tree item to open the window. Select the “5.0 ksi Beam Concrete” concrete material. Default values for the allowable stresses will be computed based on this concrete and the AASHTO Specifications. A 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. We will leave this value blank since we do not have a concrete deck.

	LFD	LRFD
Name:	5.0 ksi Stress Limit	
Description:		
Concrete Material:	5.0 ksi Beam Concrete	
Initial allowable compression:	2.400 ksi	2.400 ksi
Initial allowable tension:	0.190 ksi	0.190 ksi
Final allowable compression:	3.000 ksi	3.000 ksi
Final allowable tension:	0.212 ksi	0.212 ksi
Final allowable DL compression:	2.000 ksi	2.250 ksi
Final allowable slab compression:		
Final allowable compression (LL + 1/2(Pe + DL)):	2.000 ksi	2.000 ksi

## PS3 - Adjacent PS Box Example

The Final Allowable Tension in the concrete is dependent upon the moderate or severe corrosive condition to which the member is exposed. In calculating the final allowable tension, BrR/BrD uses the Stress Limit Coefficient entered in the System Defaults – Bridge Workspace window. This window is accessed by opening the Configuration Browser and selecting System Defaults in the tree. This window is shown below:



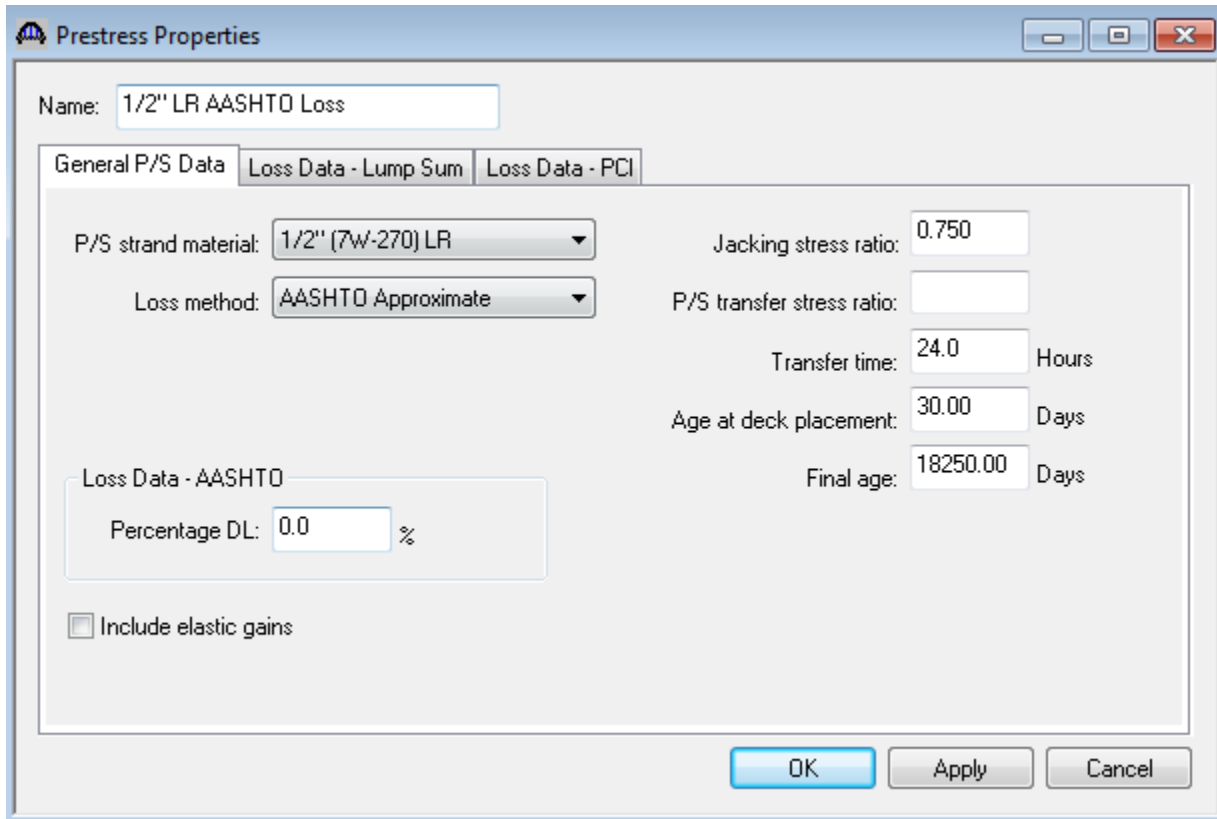
The coefficients entered here are for use with a concrete strength expressed in ksi. The coefficients shown correspond to severe corrosive conditions. Click Save to save the information in the System Defaults window and return to the Stress Limit Sets window.

Click Ok to save the information in the Stress Limit Sets window to memory and close that window.



### PS3 - Adjacent PS Box Example

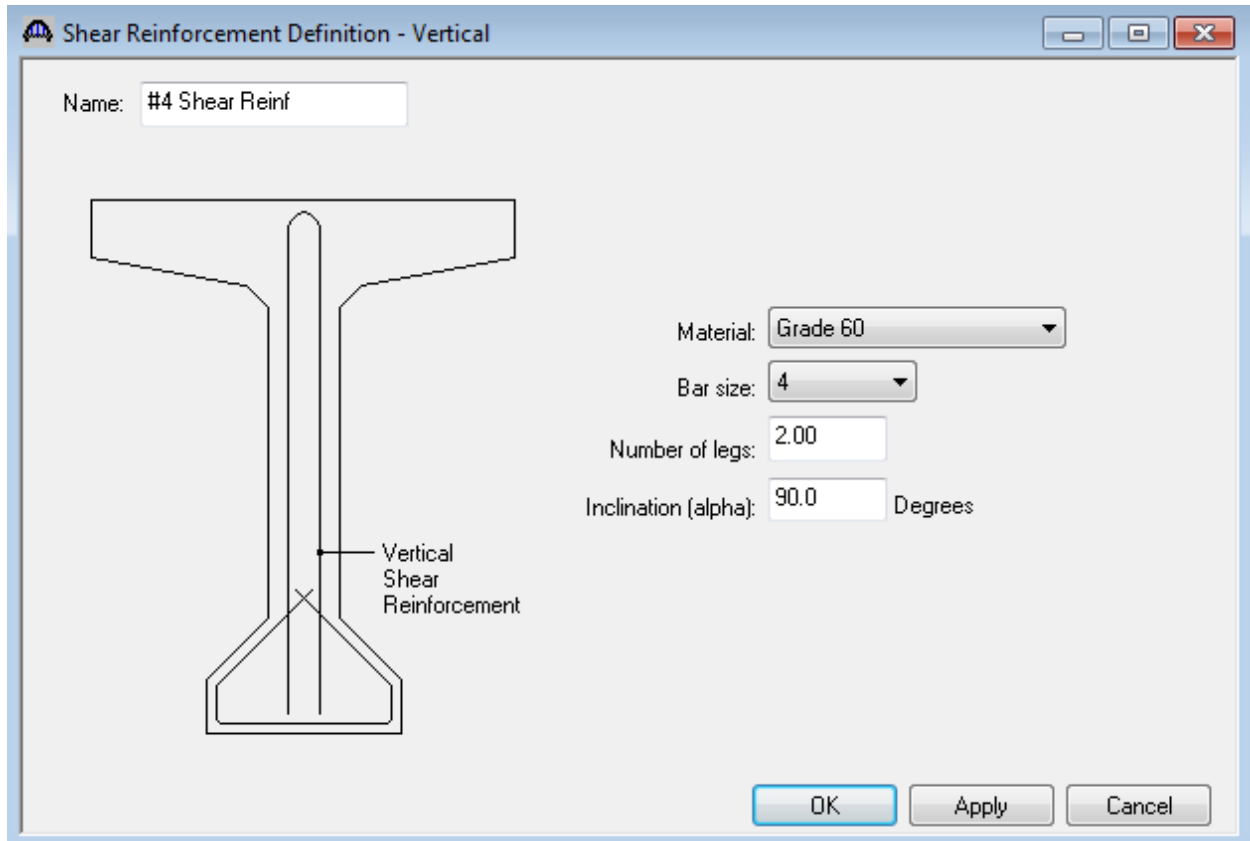
Double click on the Prestress Properties tree item to open a window in which to define the prestress properties for this structure definition. Define the Prestress Property as shown below. We are using the AASHTO Approximate method to compute losses so the “General P/S Data” tab is the only tab that we have to visit. Click Ok to save to memory and close the window.



The screenshot shows a software dialog box titled "Prestress Properties". At the top, there is a "Name" field containing the text "1/2\" LR AASHTO Loss". Below this, there are three tabs: "General P/S Data", "Loss Data - Lump Sum", and "Loss Data - PCI". The "General P/S Data" tab is selected. Inside this tab, there are several input fields and dropdown menus. On the left side, "P/S strand material" is set to "1/2\" (7W-270) LR" and "Loss method" is set to "AASHTO Approximate". On the right side, "Jacking stress ratio" is 0.750, "P/S transfer stress ratio" is empty, "Transfer time" is 24.0 Hours, "Age at deck placement" is 30.00 Days, and "Final age" is 18250.00 Days. In the bottom left of the tab area, there is a section for "Loss Data - AASHTO" with a "Percentage DL" field set to 0.0%. At the bottom of the dialog, there is a checkbox for "Include elastic gains" which is unchecked. At the very bottom, there are three buttons: "OK", "Apply", and "Cancel".

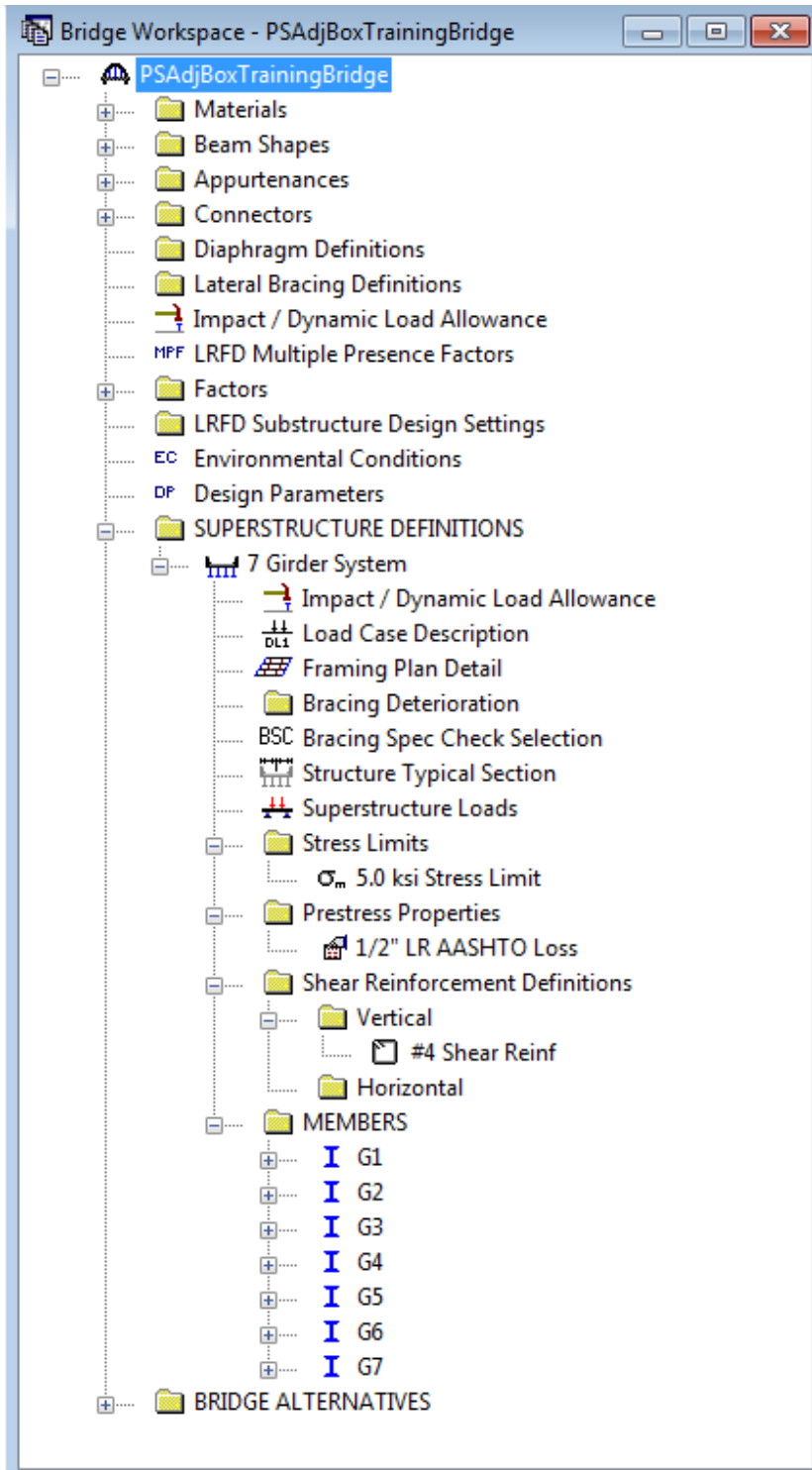
### PS3 - Adjacent PS Box Example

Now define the vertical shear reinforcement by double clicking on Vertical (under Shear Reinforcement Definitions in the tree). Define the reinforcement as shown below. This window displays a prestressed I-beam for illustrative purposes only, it is not meant to display the actual beam type. Click Ok to save to memory and close the window.



## PS3 - Adjacent PS Box Example

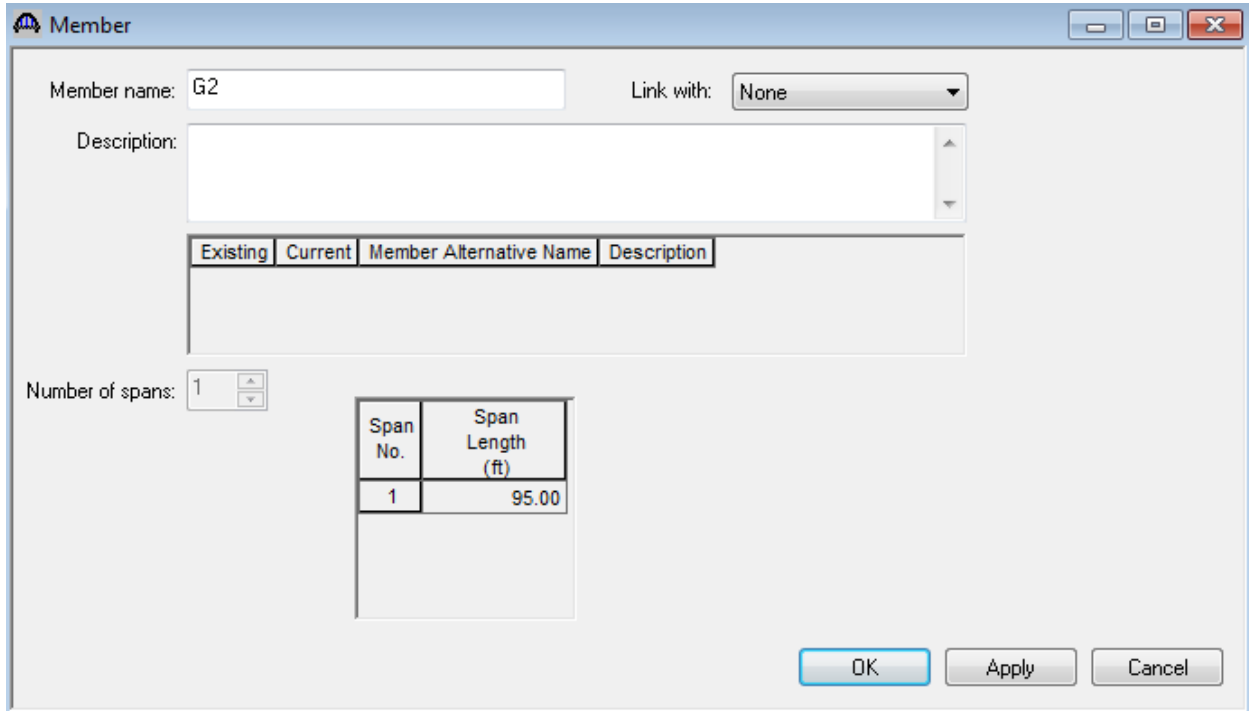
A partially expanded Bridge Workspace is shown below.



## 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 at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this Member.



Member

Member name: G2      Link with: None

Description:

Existing	Current	Member Alternative Name	Description
----------	---------	-------------------------	-------------

Number of spans: 1

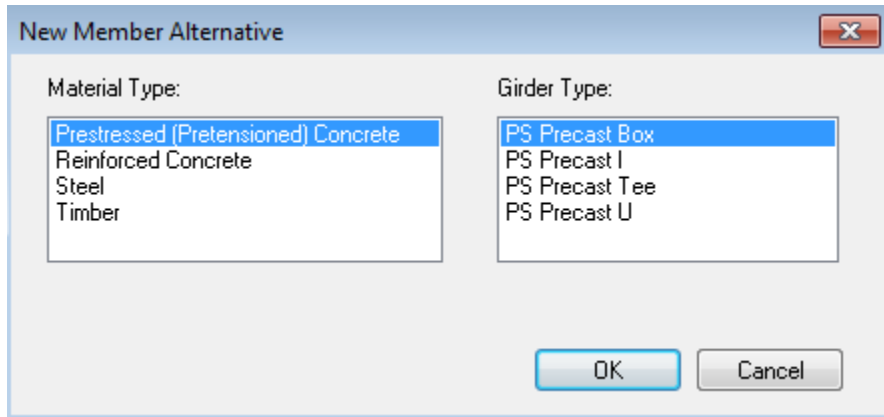
Span No.	Span Length (ft)
1	95.00

OK    Apply    Cancel

## PS3 - Adjacent PS Box Example

Defining a Member Alternative:

Double-click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Prestressed (Pretensioned) Concrete for the Material Type and PS Precast Box for the Girder Type.



Click Ok to close the dialog and create a new member alternative.

## PS3 - Adjacent PS Box Example

The Member Alternative Description window will open. Enter the appropriate 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 the "Member Alternative Description" dialog box. The "Member Alternative" field is set to "Precast Box Alternative". The "Description" tab is active, showing a large empty text area for the description. The "Material Type" is "Prestressed (Pretensioned)", the "Girder Type" is "PS Precast Box", and the "Default Units" are "US Customary". Under "Girder property input method", the "Schedule based" radio button is selected. The "Default rating method" is "LFD". In the "Self Load" section, the "Load case" is "Engine Assigned", and there are two empty input fields for "Additional self load" in "kip/ft" and "%". The "Crack control parameter (Z)" section has an empty input field for "Bottom of beam" in "kip/in". The "Exposure factor" section has an empty input field for "Bottom of beam". At the bottom, there are "OK", "Apply", and "Cancel" buttons.

Member Alternative:

Description | Specs | Factors | Engine | Import | Control Options

Description:

Material Type:

Girder Type:

Default Units:

Girder property input method

Schedule based

Cross-section based

Default rating method:

Self Load

Load case:

Additional self load =  kip/ft

Additional self load =  %

Crack control parameter (Z)

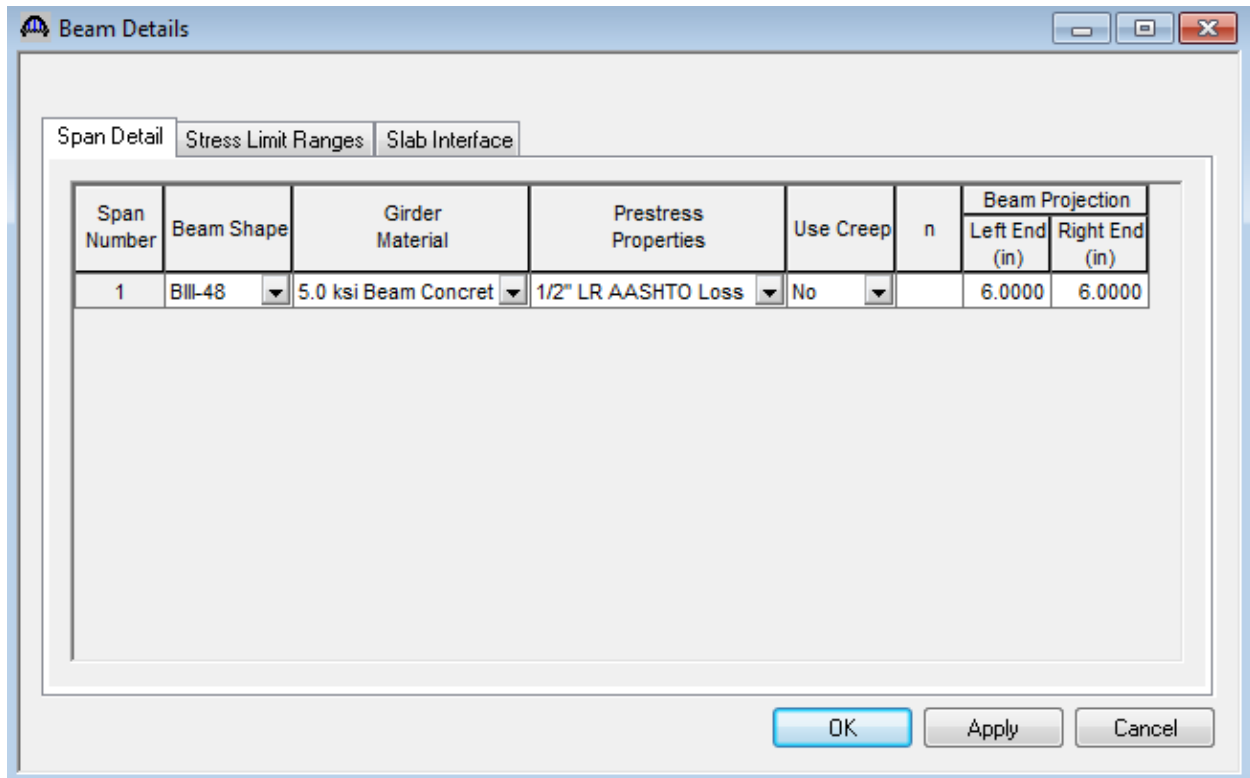
Bottom of beam:  kip/in

Exposure factor

Bottom of beam:

## PS3 - Adjacent PS Box Example

Enter the following information into the Beam Details window.



The screenshot shows a software window titled "Beam Details" with three tabs: "Span Detail", "Stress Limit Ranges", and "Slab Interface". The "Span Detail" tab is active and contains a table with the following data:

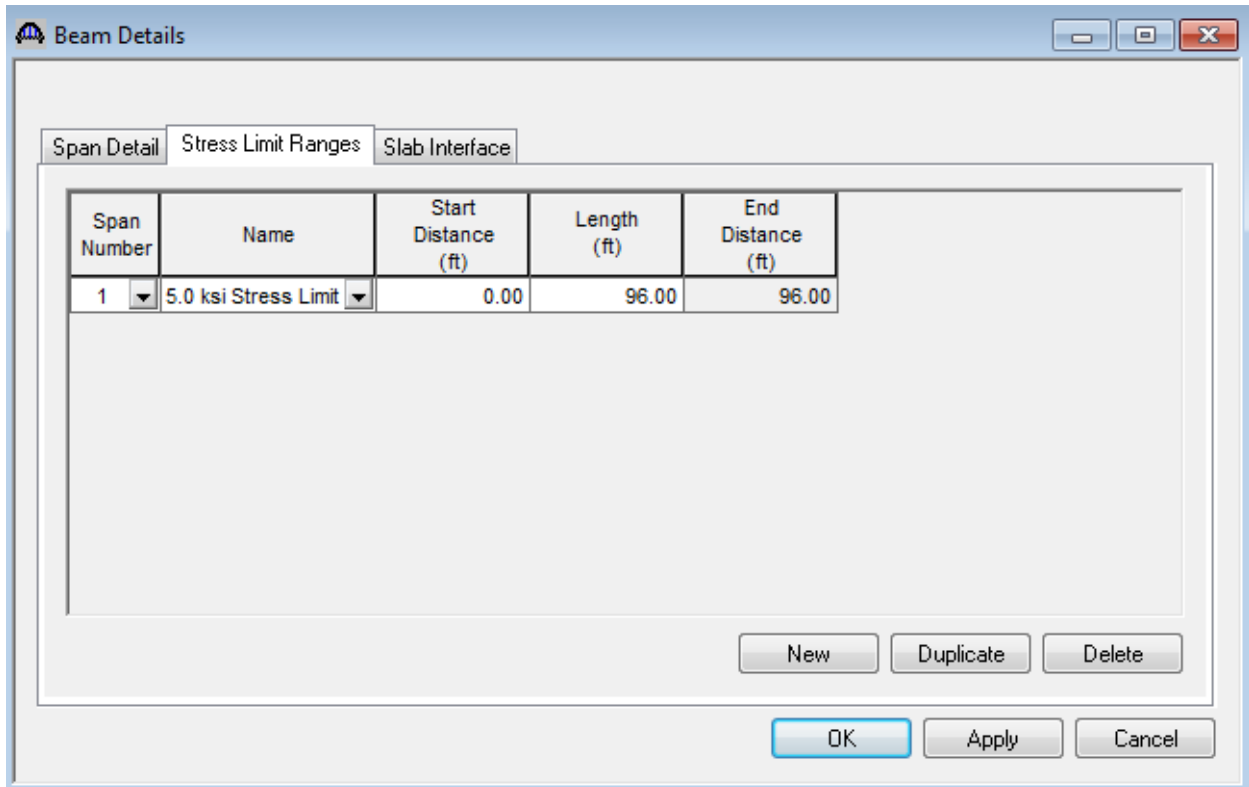
Span Number	Beam Shape	Girder Material	Prestress Properties	Use Creep	n	Beam Projection	
						Left End (in)	Right End (in)
1	BIII-48	5.0 ksi Beam Concret	1/2" LR AASHTO Loss	No		6.0000	6.0000

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

The Live Load Distribution window is not necessarily to be entered. BrR will compute the LRFD live load distribution factors automatically while doing analysis.

## PS3 - Adjacent PS Box Example

Note that 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 screenshot shows a software window titled "Beam Details" with three tabs: "Span Detail", "Stress Limit Ranges", and "Slab Interface". The "Stress Limit Ranges" tab is active, displaying a table with the following data:

Span Number	Name	Start Distance (ft)	Length (ft)	End Distance (ft)
1	5.0 ksi Stress Limit	0.00	96.00	96.00

Below the table are three buttons: "New", "Duplicate", and "Delete". At the bottom of the window are three buttons: "OK", "Apply", and "Cancel".

Since we do not have a concrete deck for this structure definition, we do not need to enter any information on the Slab Interface tab.

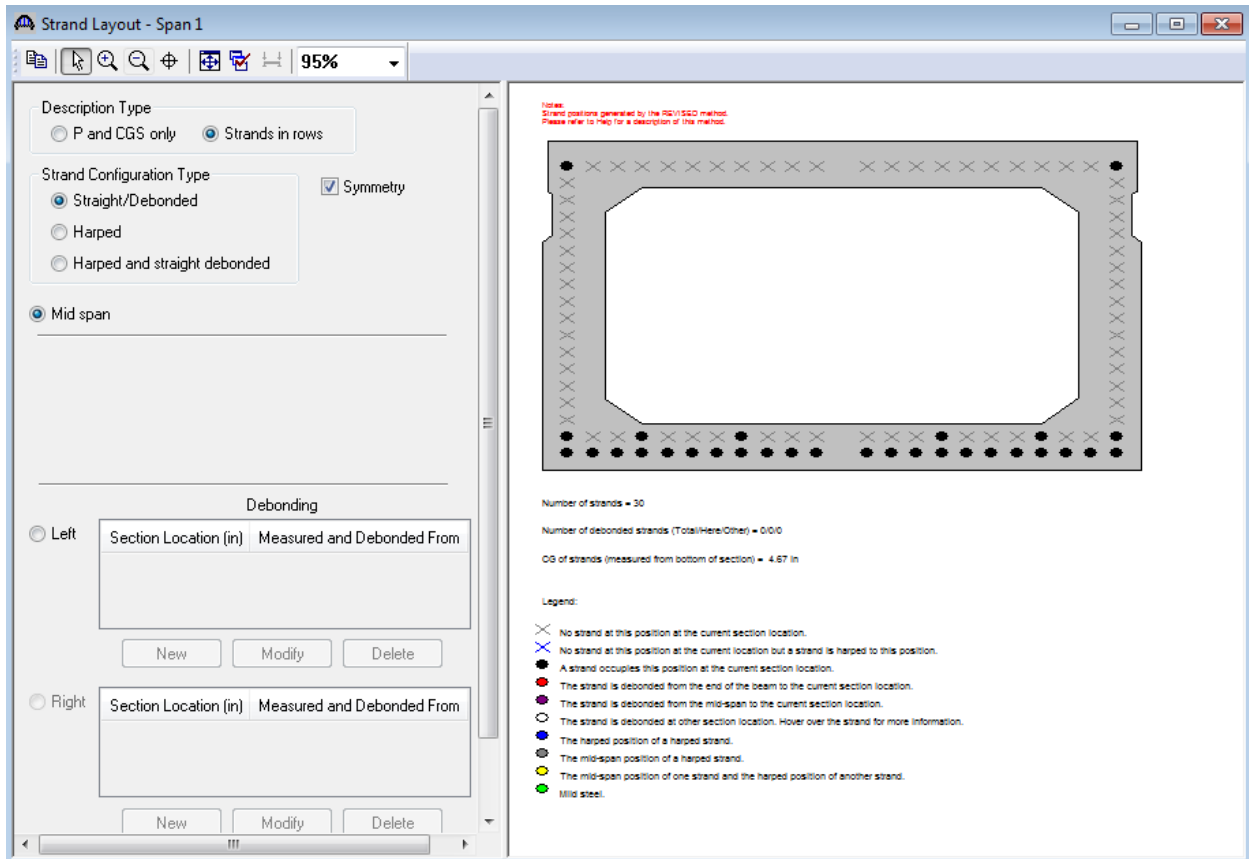
Click Ok to save the Beam Details data to memory and close the window.



## PS3 - Adjacent PS Box Example

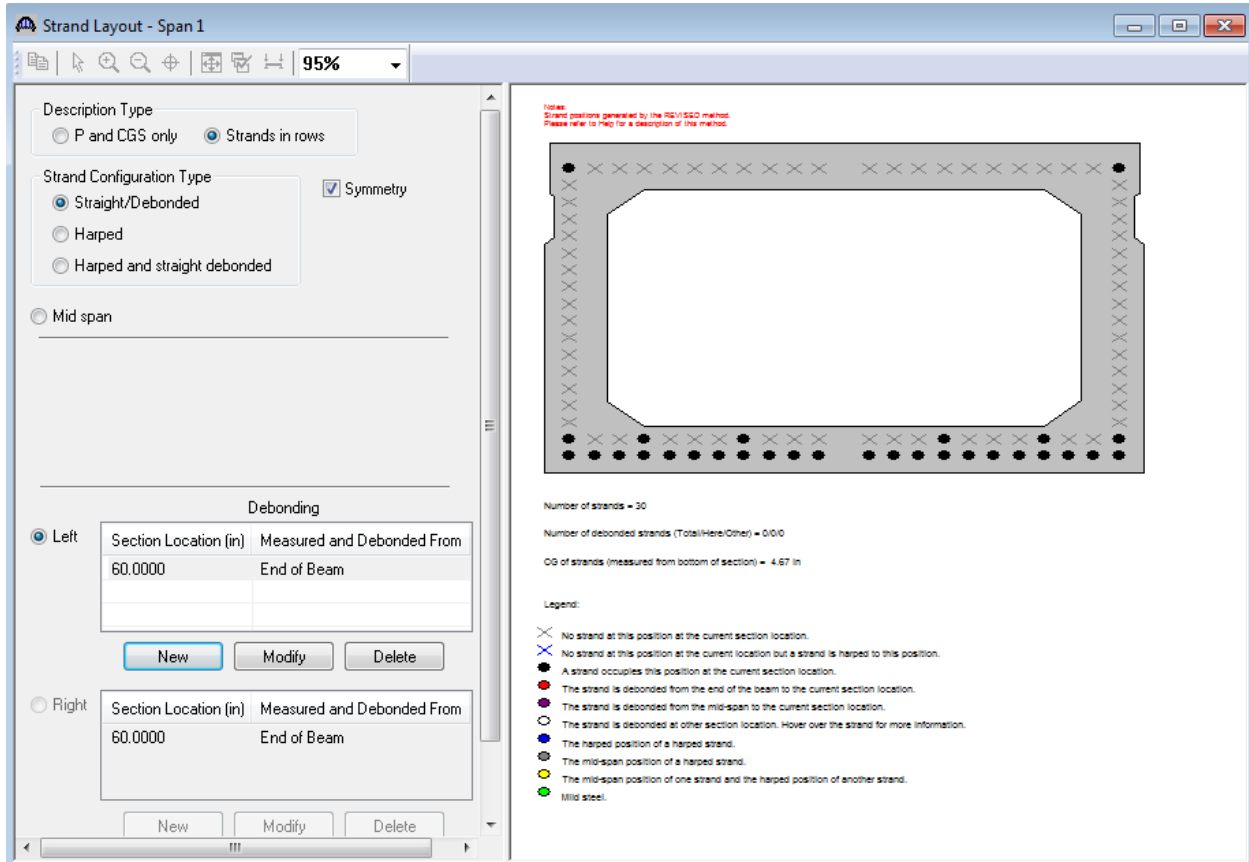
Expand the tree under Strand Layout and open the Span 1 window. Place the cursor in the schematic view on the right side of the screen. The toolbar buttons in this window will become active. Select the Zoom button to shrink the schematic of the beam shape so that the entire beam is visible.

Select the Description Type as Strands in rows and the Strand Configuration Type as Straight/Debonded. The Mid span radio button will now become active. You can now define the strands that are present 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 to memory.



## PS3 - Adjacent PS Box Example

Now select the Left radio button to enter data concerning the debonding of the strands. The New button can now be used 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 dialog that appears. Click Ok to close the dialog. 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.



This structure definition does not have a concrete deck, so we will not enter any Deck Profile or Haunch Profile information.

### PS3 - Adjacent PS Box Example

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

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

The Interior Diaphragms are entered as shown below.

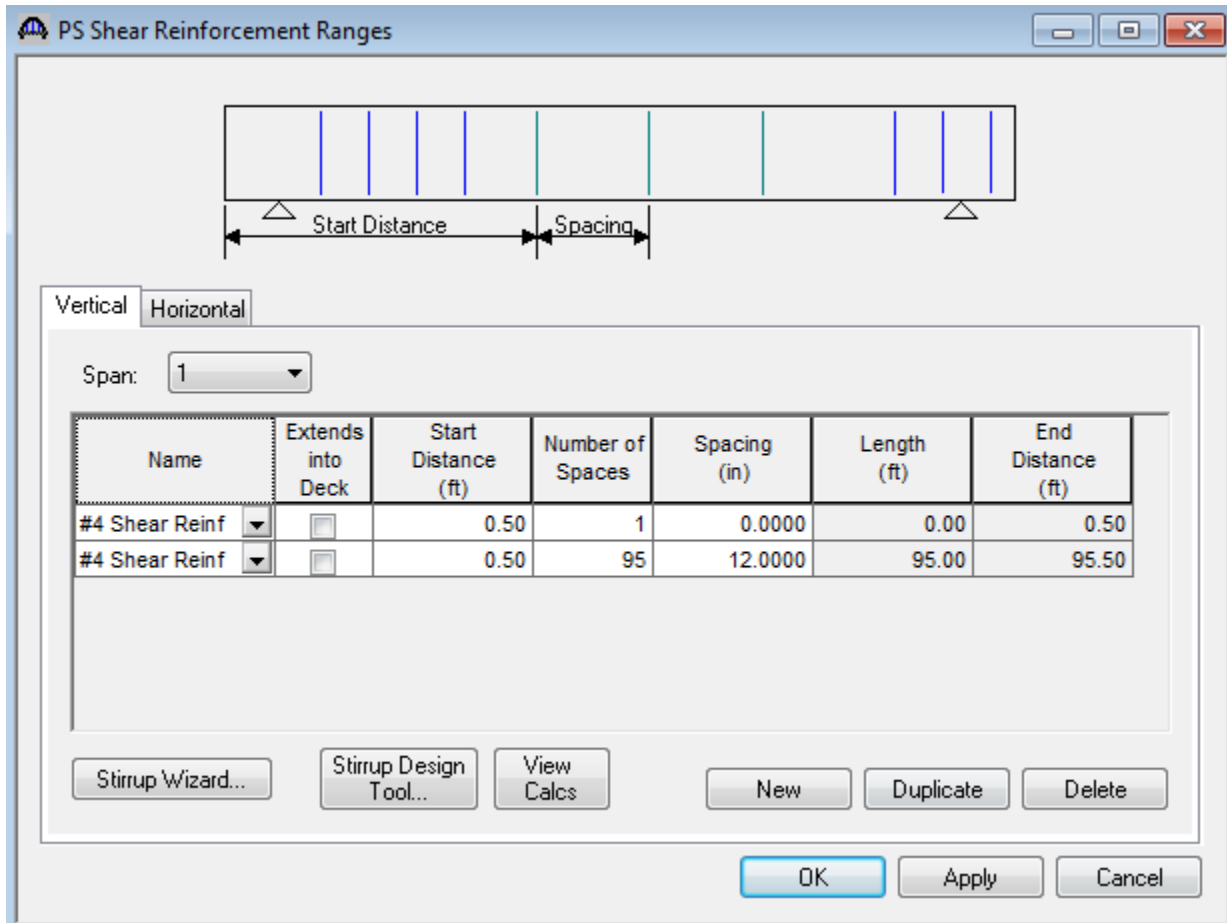
The screenshot shows a software window titled "Interior Diaphragms" with a table containing the following data:

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".

### PS3 - Adjacent PS Box Example

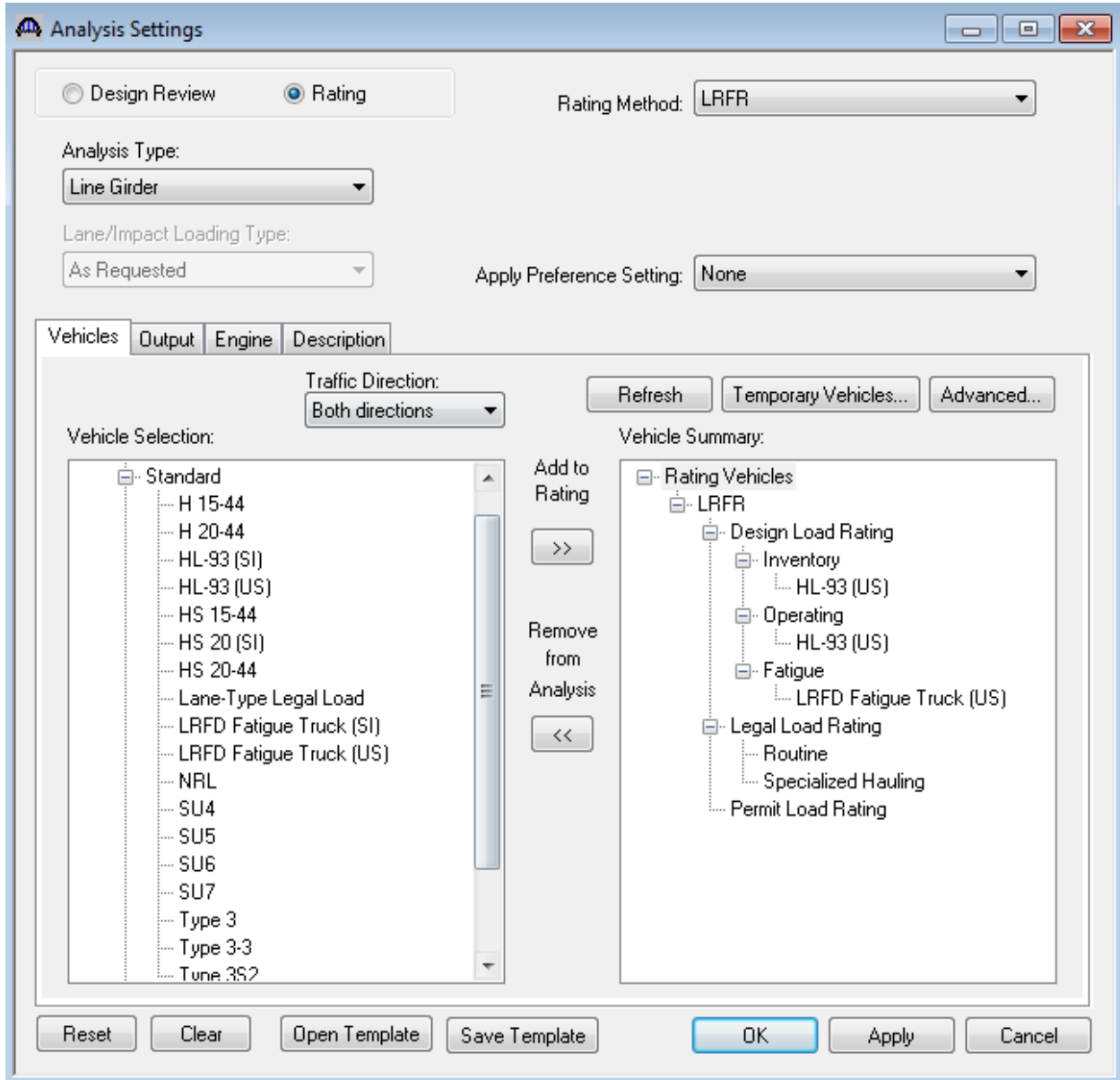
The Shear Reinforcement Ranges are entered as described below.



The description of an interior beam for this structure definition is complete.

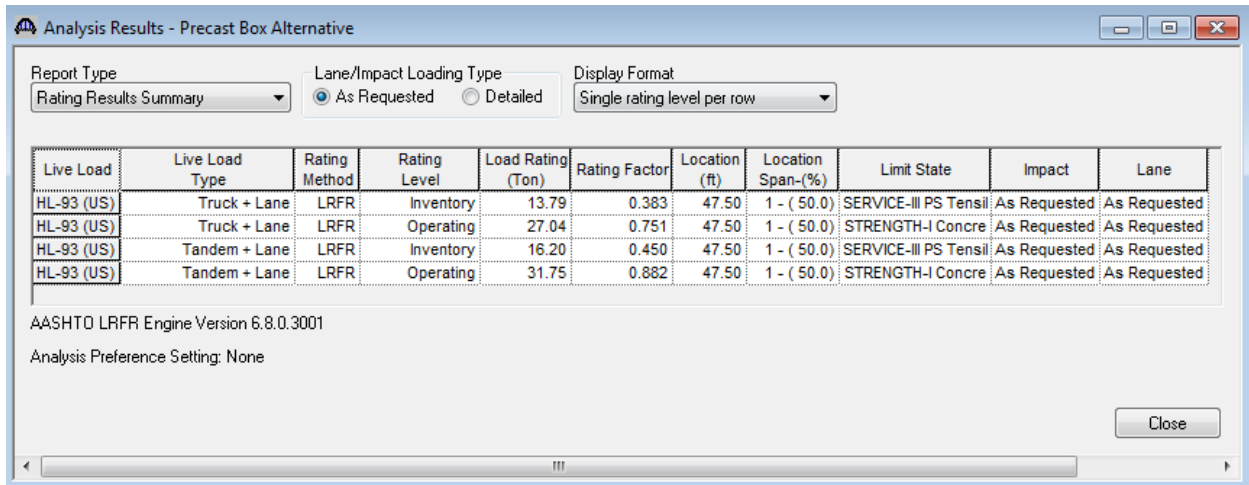
### PS3 - Adjacent PS Box Example

The member alternative can now be analyzed. To perform LRFR rating, select the View Analysis Settings button on the toolbar to open the window shown below. Click Open Template button and select the LRFR Design Load Rating to be used in the rating and click Ok.



## PS3 - Adjacent PS Box Example

Next click the Analyze button on the toolbar to perform the rating. When the rating is finished you can review the results by clicking the View analysis Report on the toolbar. The window shown below will open.



The screenshot shows a software window titled "Analysis Results - Precast Box Alternative". At the top, there are three controls: "Report Type" set to "Rating Results Summary", "Lane/Impact Loading Type" with radio buttons for "As Requested" (selected) and "Detailed", and "Display Format" set to "Single rating level per row". Below these controls is a table with 11 columns: Live Load, Live Load Type, Rating Method, Rating Level, Load Rating (Ton), Rating Factor, Location (ft), Location Span-(%), Limit State, Impact, and Lane. The table contains three rows of data. Below the table, the text "AASHTO LRFR Engine Version 6.8.0.3001" and "Analysis Preference Setting: None" is displayed. A "Close" button is located in the bottom right corner of the window.

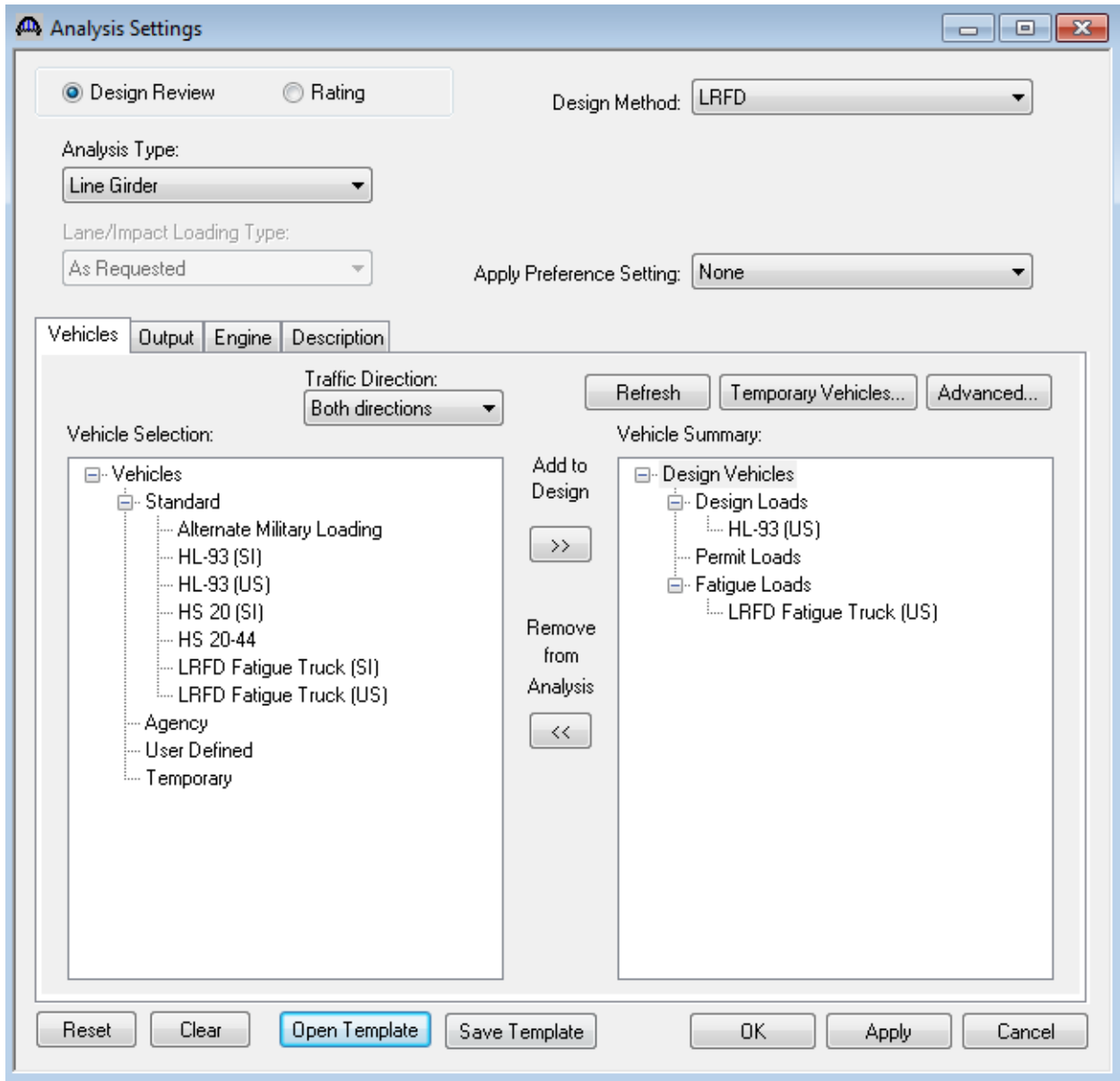
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HL-93 (US)	Truck + Lane	LRFR	Inventory	13.79	0.383	47.50	1 - ( 50.0)	SERVICE-III PS Tensil	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	27.04	0.751	47.50	1 - ( 50.0)	STRENGTH-I Concre	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	16.20	0.450	47.50	1 - ( 50.0)	SERVICE-III PS Tensil	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	31.75	0.882	47.50	1 - ( 50.0)	STRENGTH-I Concre	As Requested	As Requested

AASHTO LRFR Engine Version 6.8.0.3001  
Analysis Preference Setting: None


Close

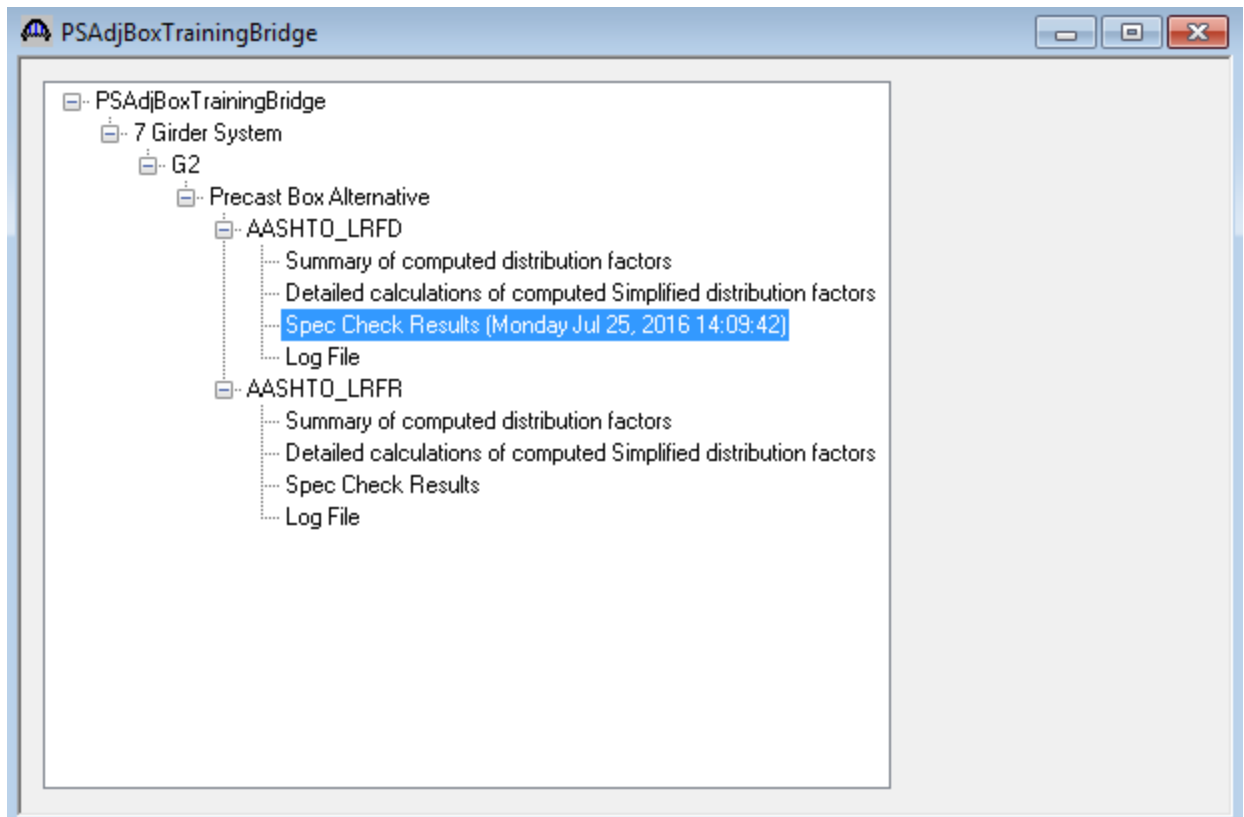
PS3 - Adjacent PS Box Example

An LRFD design review of this interior girder for HL93 loading can be performed by AASHTO LRFD. To do LRFD design review, enter the Analysis Settings window as shown below:



## PS3 - Adjacent PS Box Example

AASHTO LRFD analysis will generate a spec check results file. Click  on tool bar to open the following window.





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

Bridge ID : 56  
 Bridge : PSAdjBox Training Bridge  
 Superstructure Def : 7 Girder System  
 Member : G2  
 Analysis Preference Setting : None

NBI Structure ID : AdjBoxTraining1  
 Bridge Alt :  
 Member Alt : Precast Box Alternative

AASHTO LRFD Specification, Edition 7, Interim 2016

### Specification Check Summary

Article	Status
Initial Stress at Transfer (5.9.4.1.1, 5.9.4.1.2)	Fail
Final Stress due to Permanent and Transient Loads (5.9.4.2.1, 5.9.4.2.2)	Fail
Flexure (5.7.3.2, 5.7.3.3.2)	Fail
Shear (5.8.3.3, 5.8.2.5, 5.8.2.7, 5.8.3.5)	Fail
Deflection (5.7.3.6.2)	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)	Ratio	Code
0.000	-2.40	0.09	-0.52	4.65	Pass
2.000	-2.40	0.31	-2.47	0.97	Fail