AASHTOWare BrDR 7.5.0

Prestress Tutorial 14

PS14 – Prestressed Concrete I Beam Example

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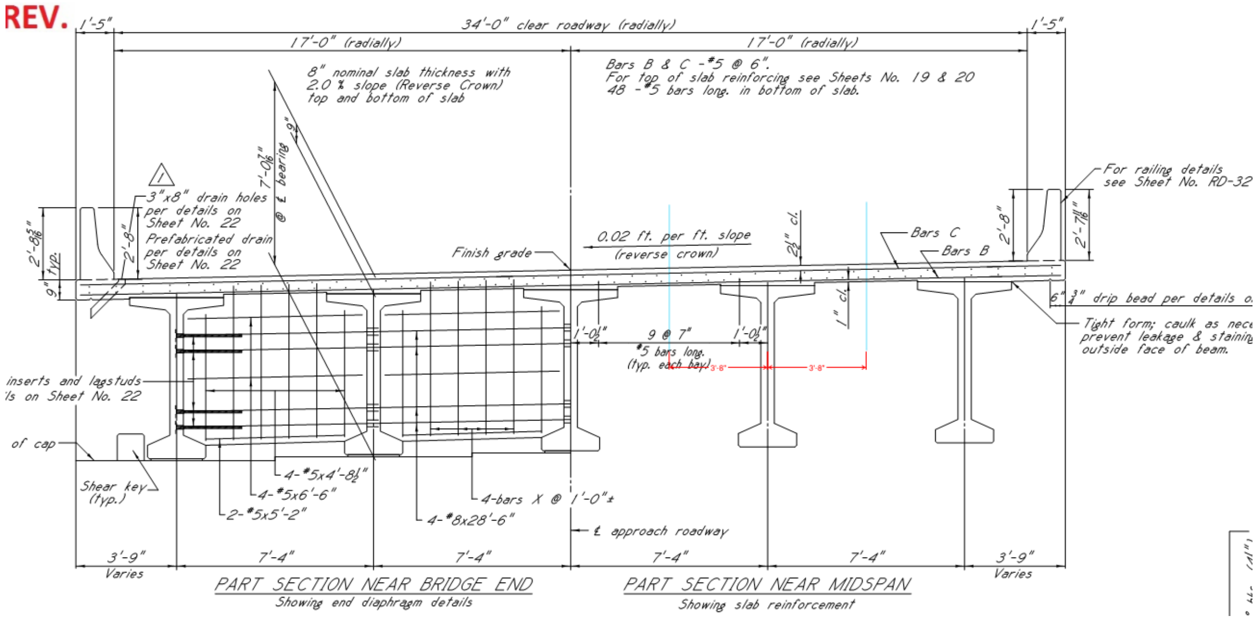
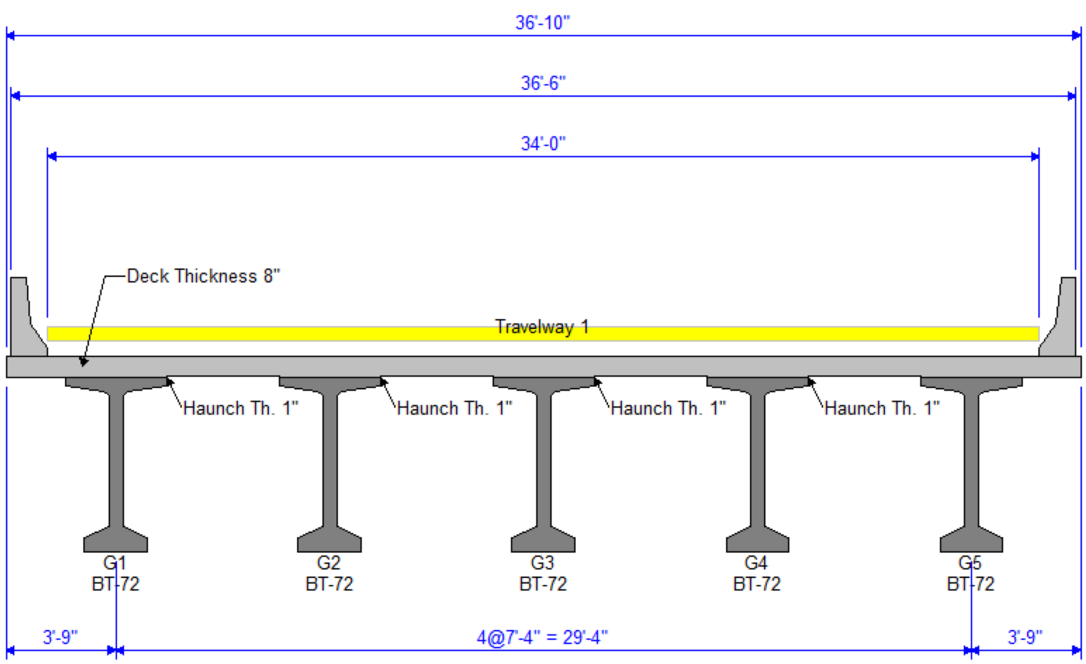
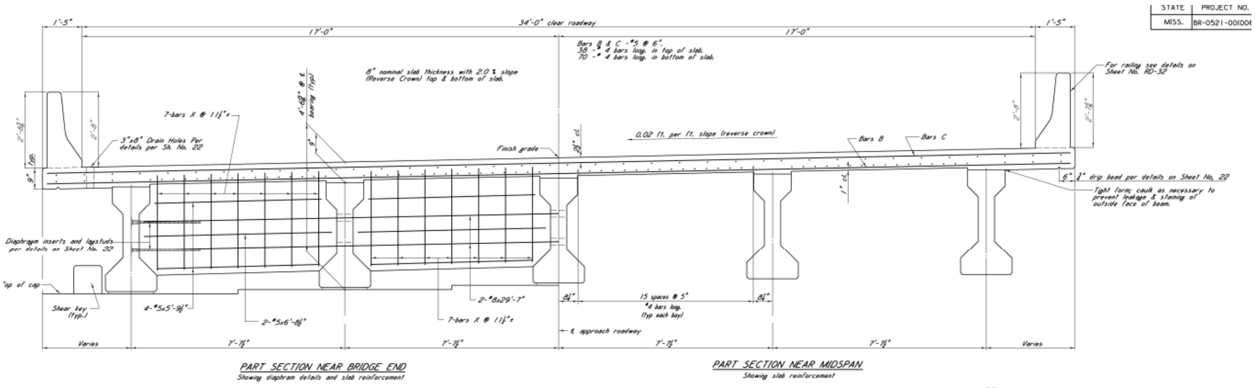
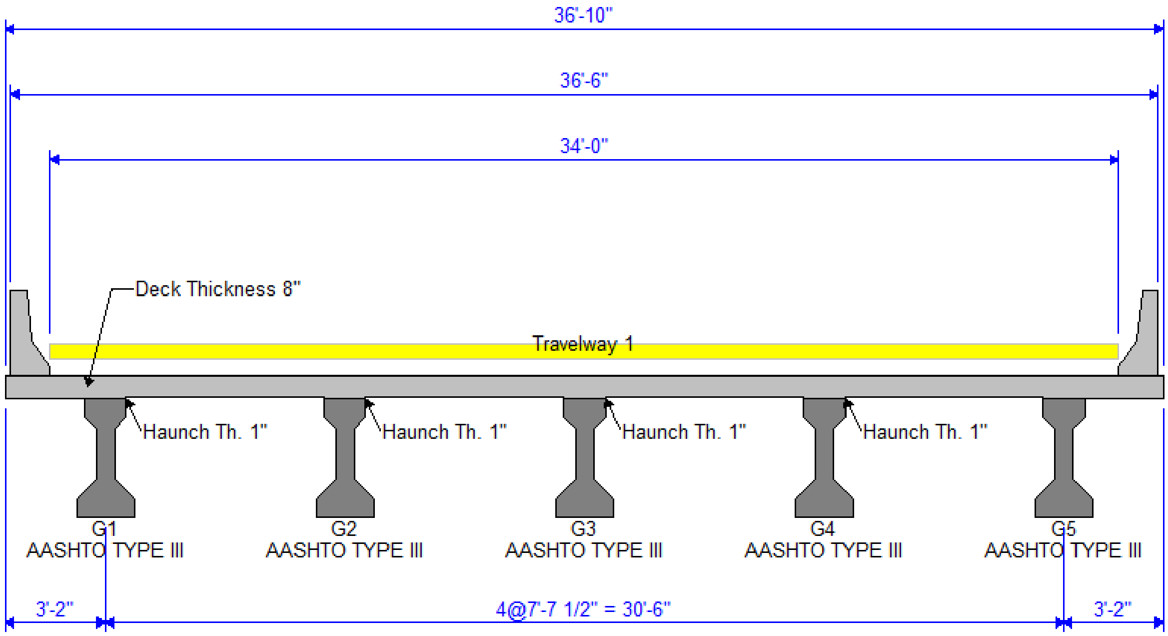
This example details the data input of a prestressed concrete I beam bridge and performing an analysis. This is a bridge from the Mississippi DOT inventory which includes two units of SR 429, a three-span (138 ft each) continuous unit and a single 80 ft span unit.

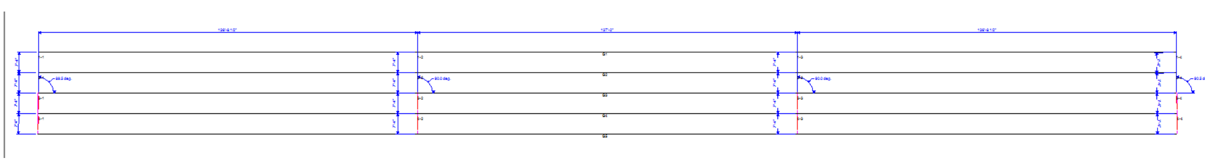


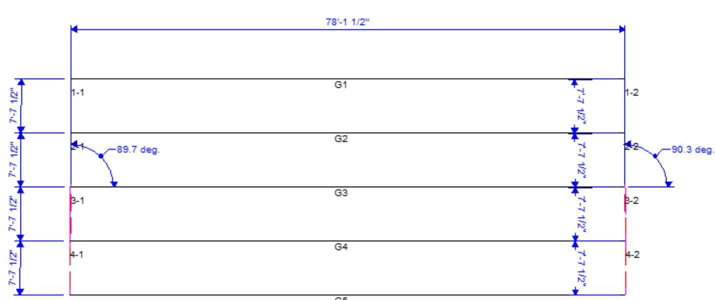


PS14 – Prestressed Concrete I Beam Example









Topics Covered

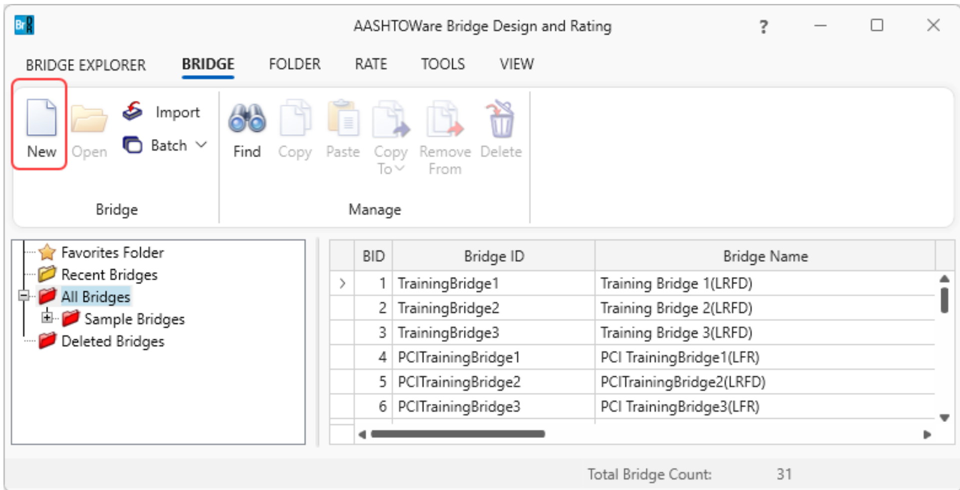
- Comments and Assumptions
- Data Entry of Prestressed concrete I beam with draped strands input as girder system.
- Prestressed multi-span modeling options.
    - Multi-span continuous
    - Multi-span continuous and simple span
- Export of prestressed concrete beams to the BrDR LRFD analysis engine
- Analysis and Results

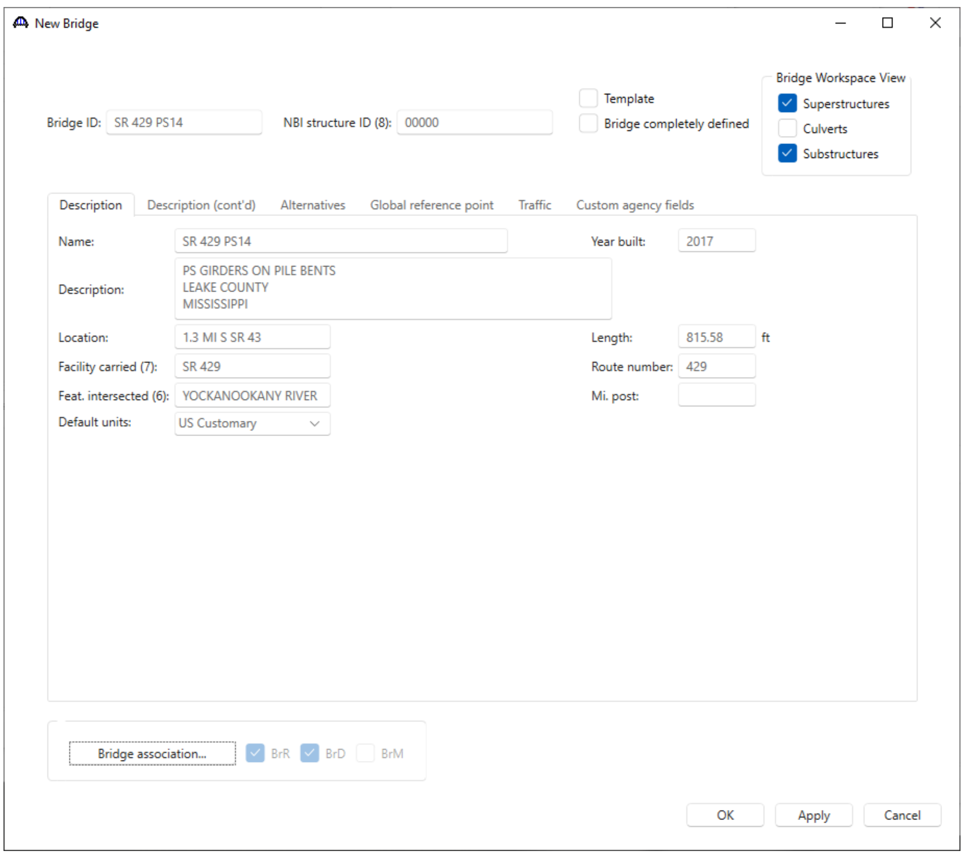
Comments and Assumptions

- Assume 5000 psi for the 28-day compressive concrete strength of the Type III PS Beam for the 80-foot span.
- Due to rounding on the design plans, the BrDR span lengths are slightly off from the design drawings. Lengths are within 1/16”.
- The plans show a discrepancy for strand type for the 138 ft beam details. The notes indicate ½” diameter 270 K-LR strands where the table and section show 0.6” diameter 270 K-LR strands so 0.6” diameter 270 K-LR strands will be used in the model.
- With larger radius, assume the overhangs as equal.
- Due to the limitations in BrDR, the skew angle at Support 2 & 3 of the three-span continuous unit will be 90 degrees.
- Traffic data and design speed for LRFR analysis
    a. Assumed ADTT = 41 per NBI
- ¼” Integral Wearing Surface
- HL93 will be the vehicle used for ratings.
- District, County and Owner information is not populated.
- For the exterior beams, an LRFD effective width = Overhang + S/2 is used, even though the overhang is greater than S/2 (C4.6.2.6.1).

Data Entry of Prestressed concrete I beam with draped strands input as girder system.

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

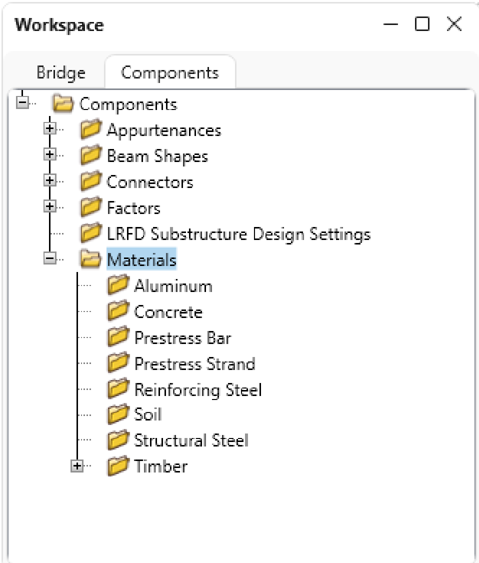




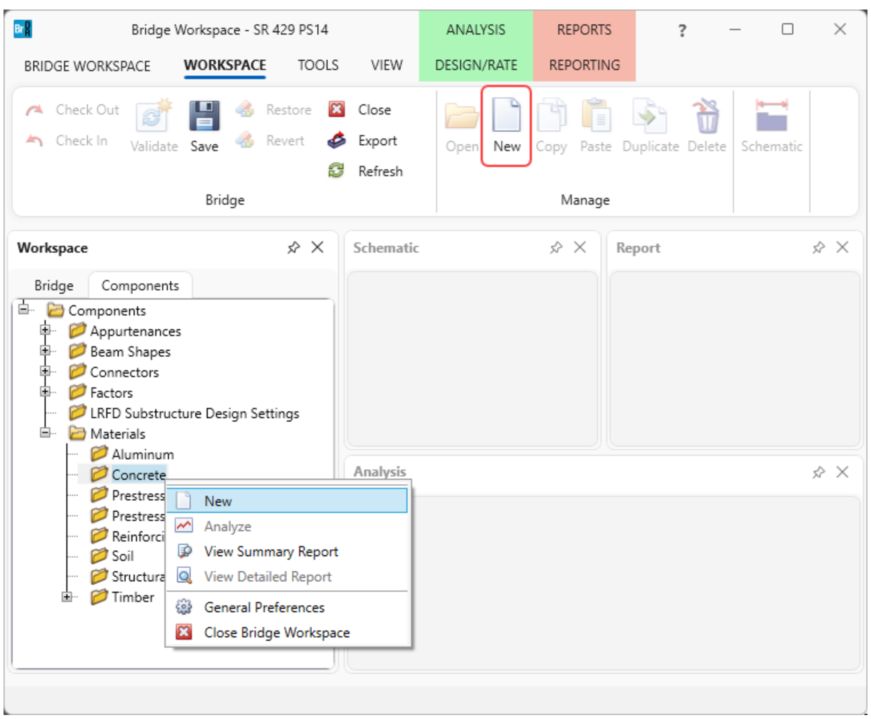
Click **OK** to apply the data and close the window.

Bridge Materials

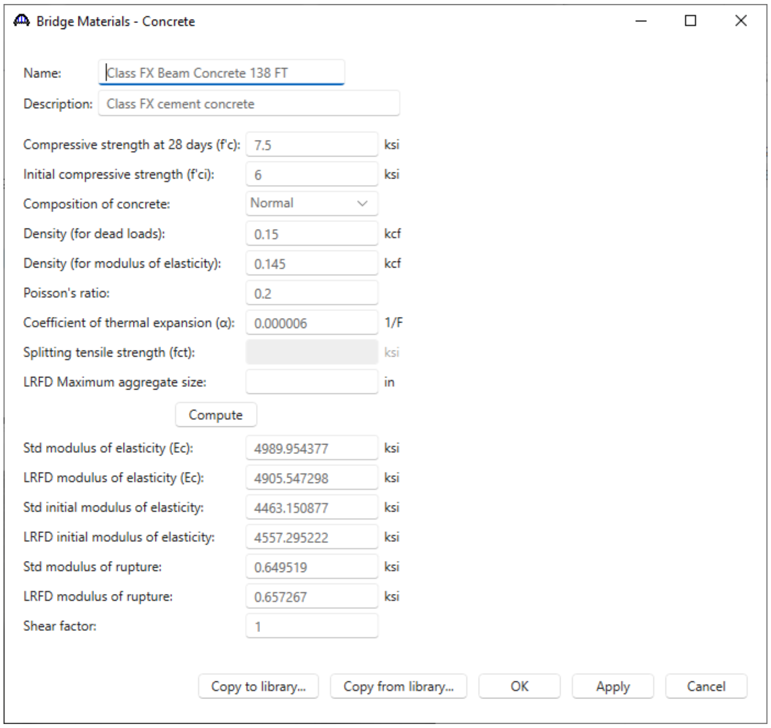
To enter the materials to be used by members of the bridge, open the **Components** tab, and click on the ⊞ button to expand the tree for **Materials**. The tree with the expanded **Materials** branch is shown below.



To add a new concrete material, in the **Components** tab of the Bridge Workspace, click on **Materials**, **Concrete,** and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Concrete** and select **New**).

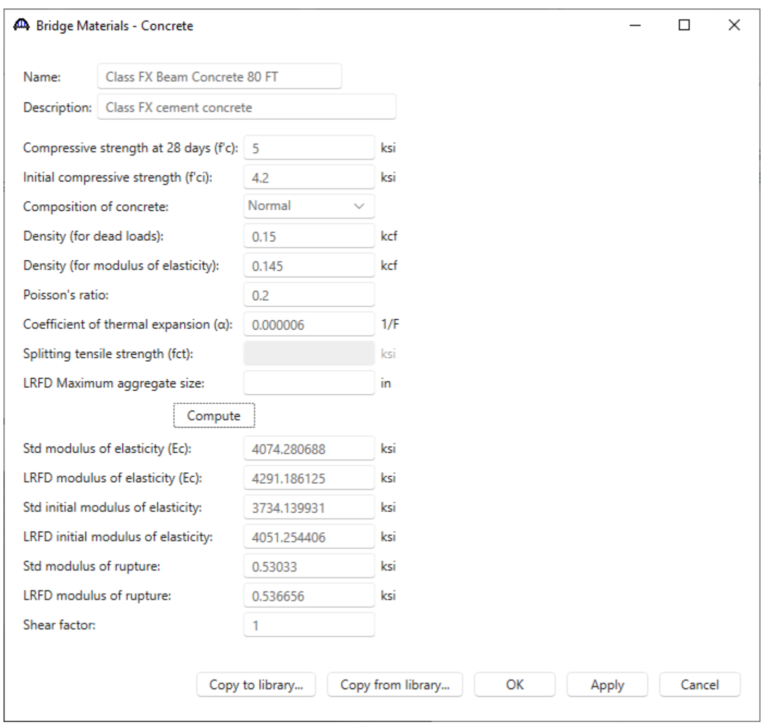


Enter the values shown above the **Compute** button and click the **Compute** button to compute the remaining values below them.



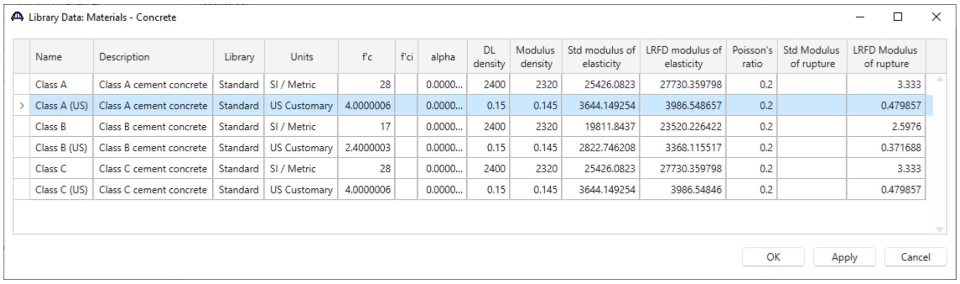
Click **OK** to apply the data and close the window.

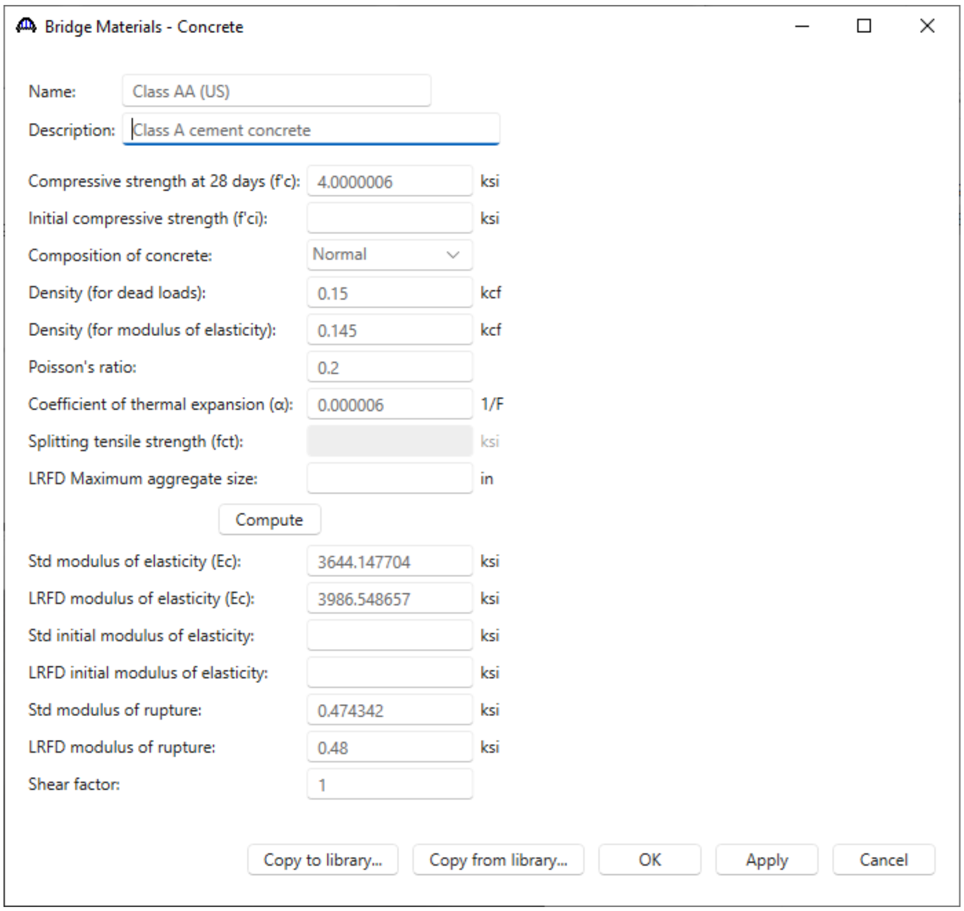
Add another concrete material in a similar manner. See image below.



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

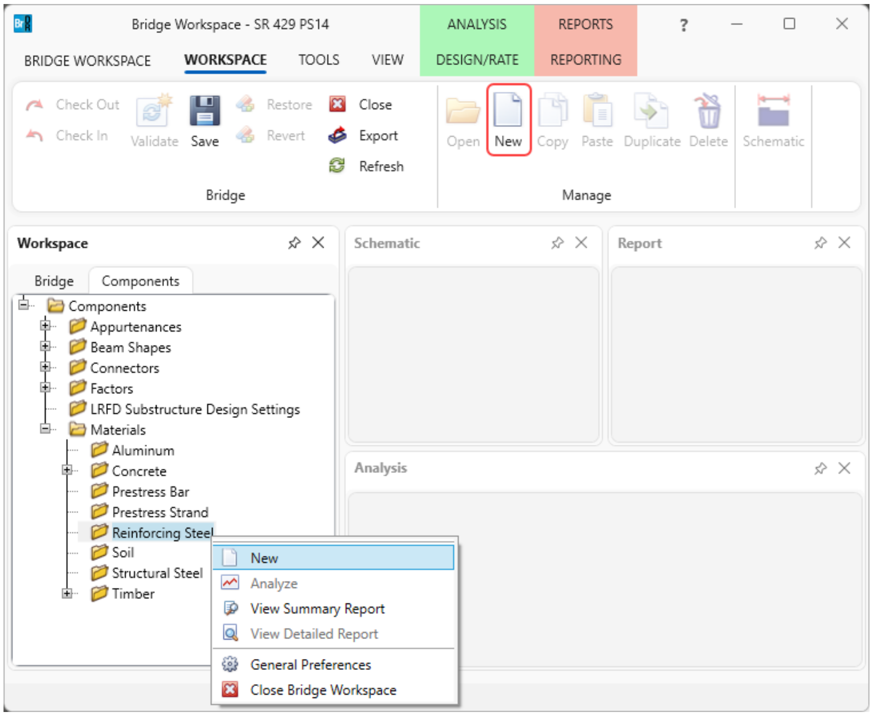
Add concrete material for the deck from the library. Click the **Copy from library…** button and use the **Class A (US)** material. Once the material is copied, change the **Name** to **Class AA** and click on the **Compute** button as shown below.



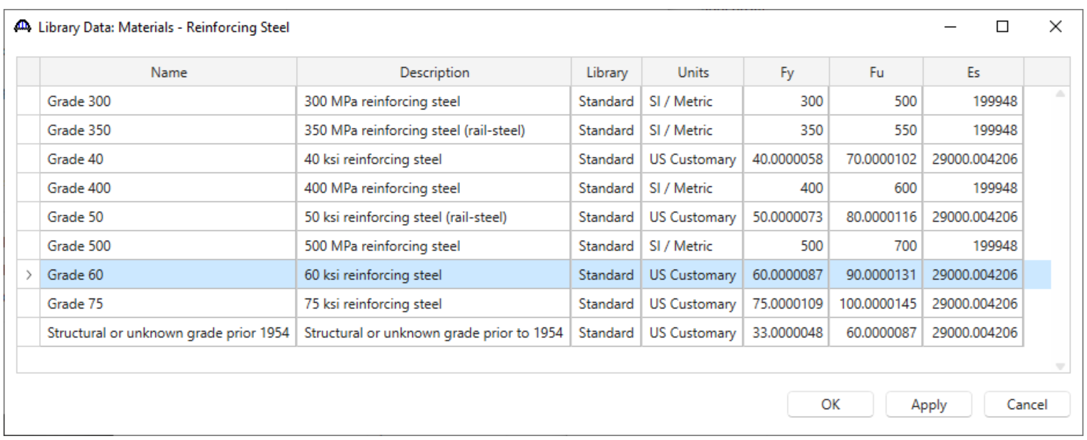


Click **OK** to apply the data and close the window.

To add a reinforcement material, select **Reinforcing Steel** in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Reinforcing Steel** and select **New**)



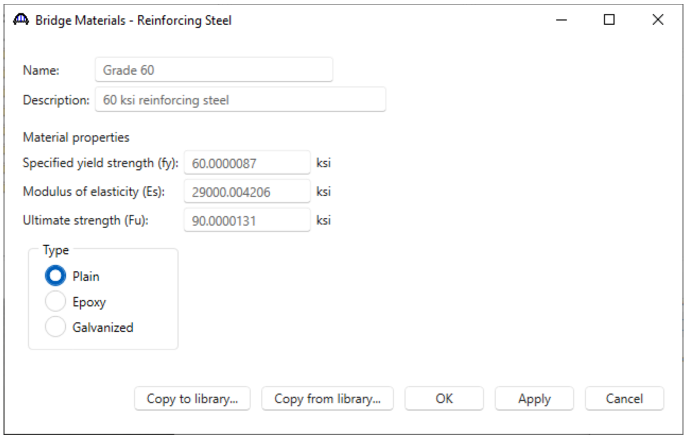
Click on the **Copy from library…** button in this window and select **Grade 60** from the library and click **OK.**


Library Data: Materials - Reinforcing Steel

Name	Description	Library	Units	Fy	Fu	Es
Grade 300	300 MPa reinforcing steel	Standard	SI / Metric	300	500	199948
Grade 350	350 MPa reinforcing steel (rail-steel)	Standard	SI / Metric	350	550	199948
Grade 40	40 ksi reinforcing steel	Standard	US Customary	40.0000058	70.0000102	29000.004206
Grade 400	400 MPa reinforcing steel	Standard	SI / Metric	400	600	199948
Grade 50	50 ksi reinforcing steel (rail-steel)	Standard	US Customary	50.0000073	80.0000116	29000.004206
Grade 500	500 MPa reinforcing steel	Standard	SI / Metric	500	700	199948
Grade 60	60 ksi reinforcing steel	Standard	US Customary	60.0000087	90.0000131	29000.004206
Grade 75	75 ksi reinforcing steel	Standard	US Customary	75.0000109	100.0000145	29000.004206
Structural or unknown grade prior 1954	Structural or unknown grade prior to 1954	Standard	US Customary	33.0000048	60.0000087	29000.004206

OK Apply Cancel

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



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

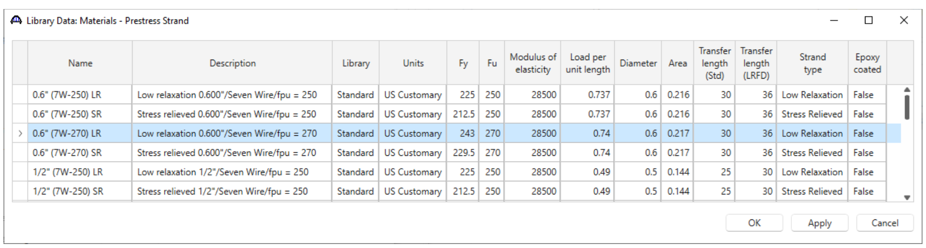
Add the following prestress strands using the same **Copy from Library** technique. The window will be updated as shown below.

LR indicates low-relaxation strands

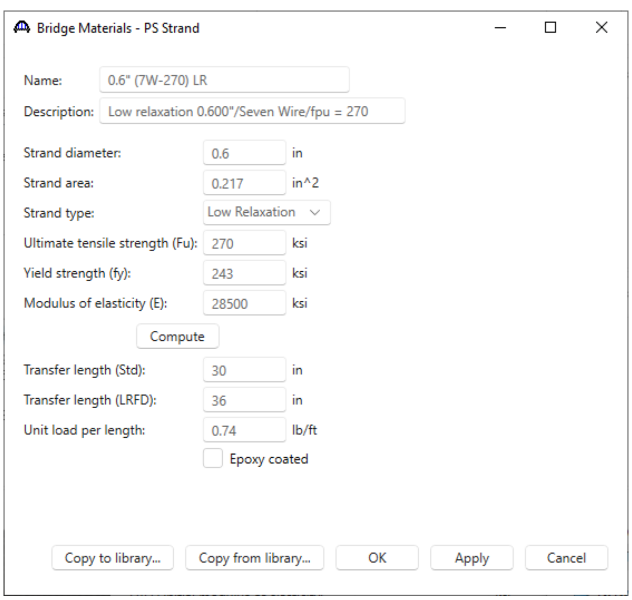
PRESTRESS REQUIREMENTS

For deflection diagram, see Misc. Span Details per Sheet No. 22

Strand type	Minimum breaking strength lbs/strand	Initial tension lbs/strand	Required number and location of strands: Total number strands	Straight strands: Number strands	Straight strands: Centroid (in.)	Draped strands: Number strands	Draped strands: Centroid (in.) ℄ span	Draped strands: Centroid (in.) Beam end	Centroid for total number of strands (in.): At ℄ span	Centroid for total number of strands (in.): At beam end	Distance from ℄ span to hold-down point	Camber limits	Deflection diagram: A	Deflection diagram: B	Deflection diagram: C	Minimum concrete strength at time of release (psi)
0.6"ø270 K-LR	45,000	43,940	36	26	4.19	10	6.50	65.00	4.83	21.08	14'-0"	0 to 5[illegible]"	[illegible]	[illegible]	[illegible]	6000



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
0.6" (7W-250) LR	Low relaxation 0.600"/Seven Wire/fpu = 250	Standard	US Customary	225	250	28500	0.737	0.6	0.216	30	36	Low Relaxation	False
0.6" (7W-250) SR	Stress relieved 0.600"/Seven Wire/fpu = 250	Standard	US Customary	212.5	250	28500	0.737	0.6	0.216	30	36	Stress Relieved	False
0.6" (7W-270) LR	Low relaxation 0.600"/Seven Wire/fpu = 270	Standard	US Customary	243	270	28500	0.74	0.6	0.217	30	36	Low Relaxation	False
0.6" (7W-270) SR	Stress relieved 0.600"/Seven Wire/fpu = 270	Standard	US Customary	229.5	270	28500	0.74	0.6	0.217	30	36	Stress Relieved	False
1/2" (7W-250) LR	Low relaxation 1/2"/Seven Wire/fpu = 250	Standard	US Customary	225	250	28500	0.49	0.5	0.144	25	30	Low Relaxation	False
1/2" (7W-250) SR	Stress relieved 1/2"/Seven Wire/fpu = 250	Standard	US Customary	212.5	250	28500	0.49	0.5	0.144	25	30	Stress Relieved	False



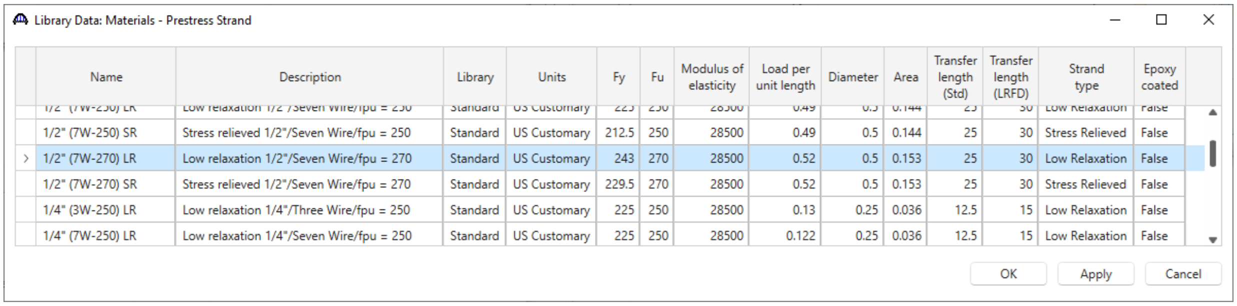
Click **OK** to apply the data and close the window.

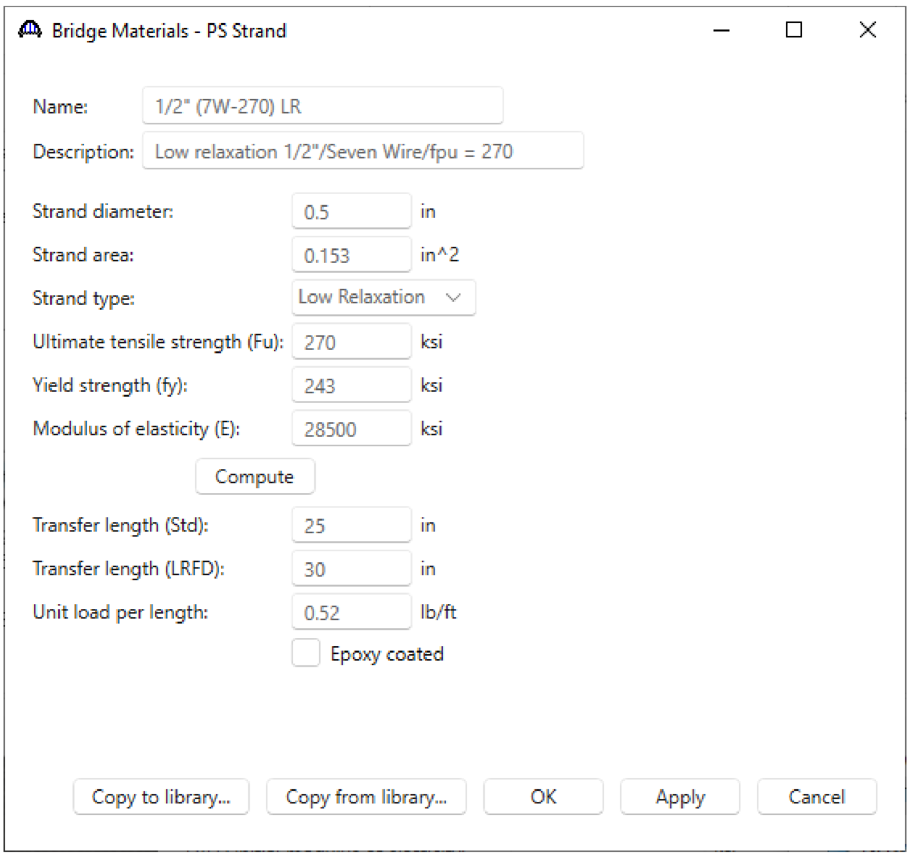
LR indicates low-relaxation strands

PRESTRESS REQUIREMENTS

For deflection diagram, see Misc. Span Details per Sheet No. 22

Strand type	Minimum breaking strength lbs/strand	Initial tension lbs/strand	Required number and location of strands: Total number strands	Straight strands: Number strands	Straight strands: Centroid (in.)	Draped strands: Number strands	Draped strands: Centroid (in.) ℄ span	Draped strands: Centroid (in.) Beam end	Centroid for total number of strands (in.): At ℄ span	Centroid for total number of strands (in.): At beam end	Distance from ℄ span to hold-down point	Camber limits	Deflection diagram A	Deflection diagram B	Deflection diagram C	Minimum concrete strength at time of release (psi)
½"φ270 K-LR	41,300	30,980	26	20	4.10	6	4.50	40.00	4.19	12.38	8'-0"	0 to 2¾"	1⅞"	1 5/16"	9/16"	4200

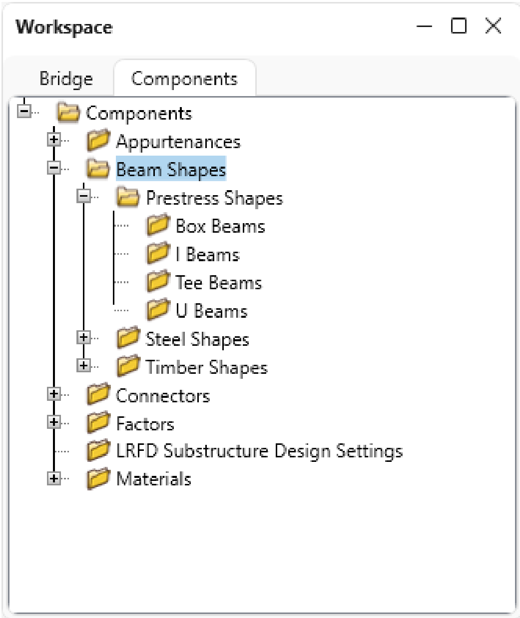




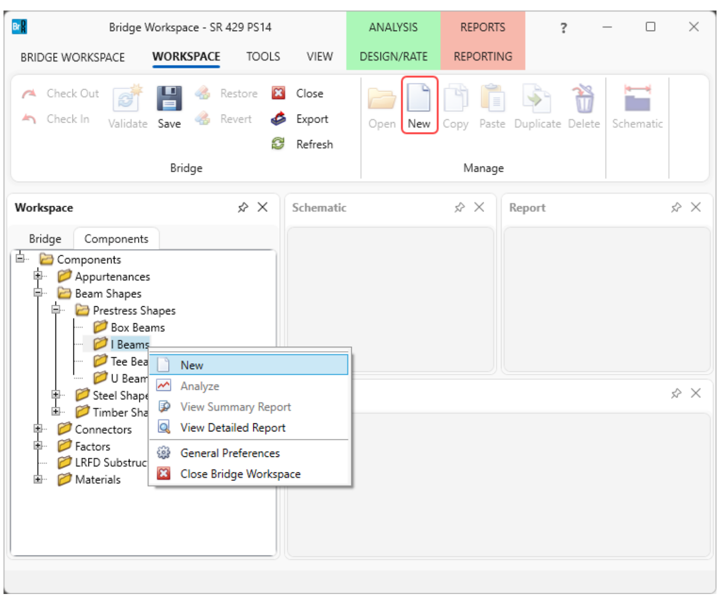
Click **OK** to apply the data and close the window.

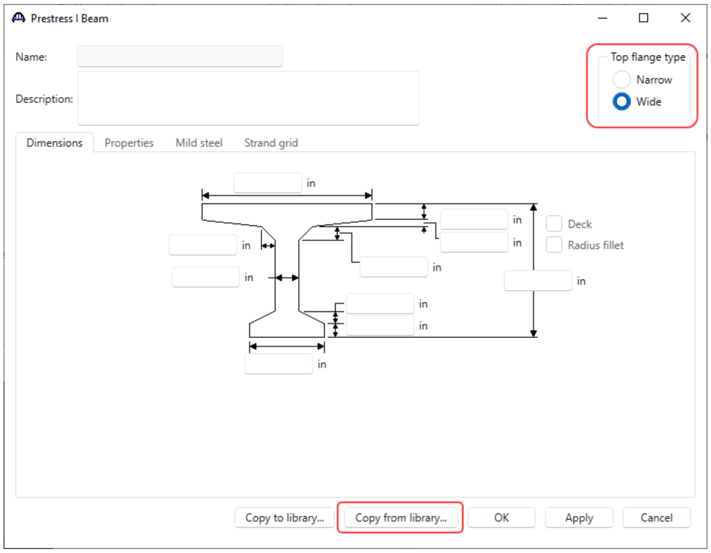
Beam Shapes

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

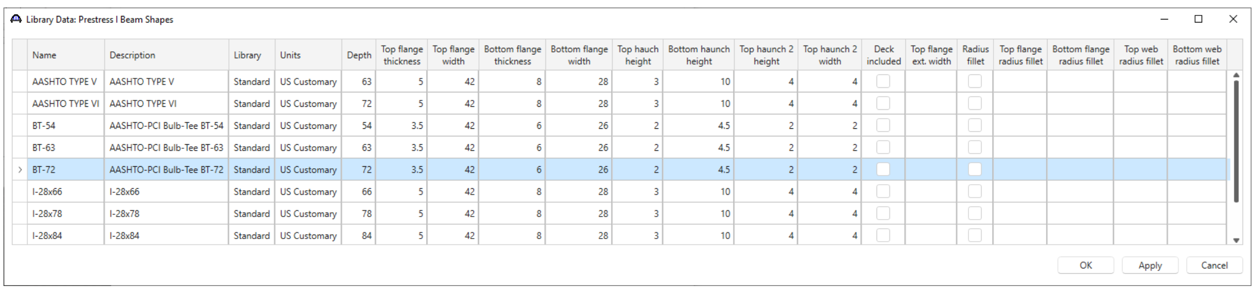


Click on the **I Beams** node in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **I Beams** and select **New** or double click on **I Beams** in the **Components** tree). The window shown below will open.



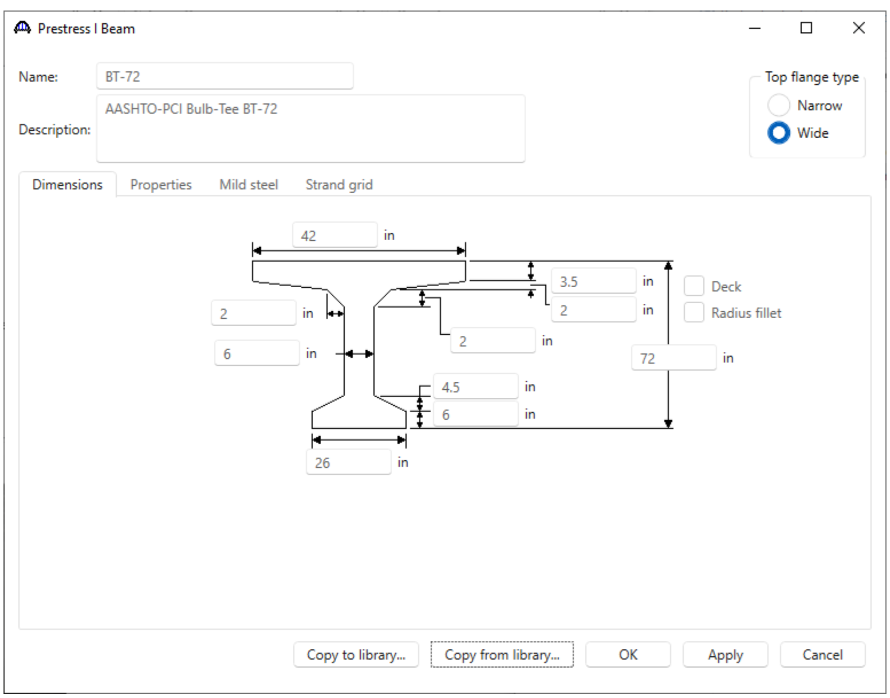


Select the **Top flange type** as **Wide** and click the **Copy from library…** button. Select **BT-72 (AASHTO-PCI Bulb-Tee BT-72)** and click **OK**. The beam properties are copied to the **Prestress I Beam** window as shown below.


Library Data: Prestress I Beam Shapes

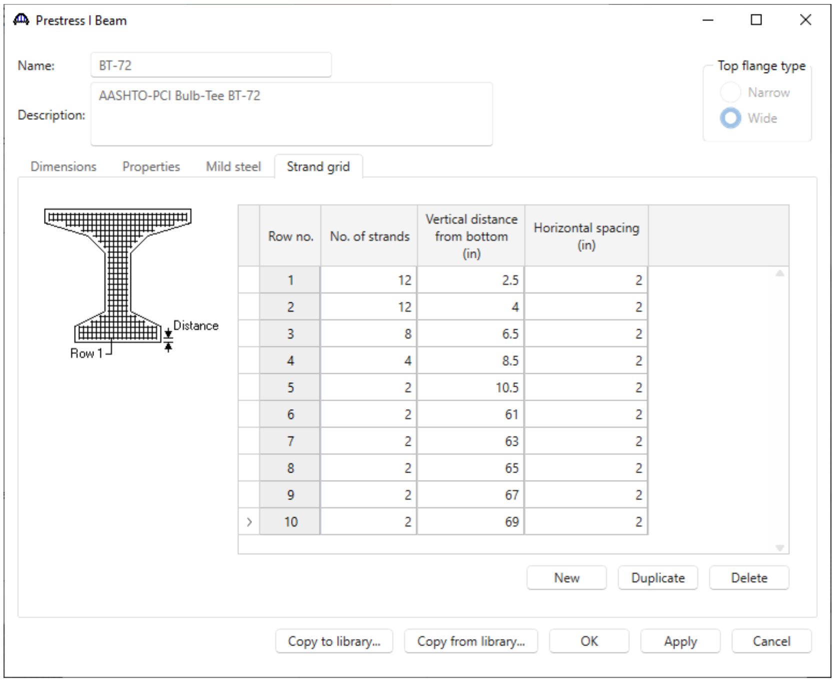
Name	Description	Library	Units	Depth	Top flange thickness	Top flange width	Bottom flange thickness	Bottom flange width	Top hauch height	Bottom haunch height	Top haunch 2 height	Top haunch 2 width	Deck included	Top flange ext. width	Radius fillet	Top flange radius fillet	Bottom flange radius fillet	Top web radius fillet	Bottom web radius fillet
AASHTO TYPE V	AASHTO TYPE V	Standard	US Customary	63	5	42	8	28	3	10	4	4	☐		☐				
AASHTO TYPE VI	AASHTO TYPE VI	Standard	US Customary	72	5	42	8	28	3	10	4	4	☐		☐				
BT-54	AASHTO-PCI Bulb-Tee BT-54	Standard	US Customary	54	3.5	42	6	26	2	4.5	2	2	☐		☐				
BT-63	AASHTO-PCI Bulb-Tee BT-63	Standard	US Customary	63	3.5	42	6	26	2	4.5	2	2	☐		☐				
BT-72	AASHTO-PCI Bulb-Tee BT-72	Standard	US Customary	72	3.5	42	6	26	2	4.5	2	2	☐		☐				
I-28x66	I-28x66	Standard	US Customary	66	5	42	8	28	3	10	4	4	☐		☐				
I-28x78	I-28x78	Standard	US Customary	78	5	42	8	28	3	10	4	4	☐		☐				
I-28x84	I-28x84	Standard	US Customary	84	5	42	8	28	3	10	4	4	☐		☐				

OK Apply Cancel



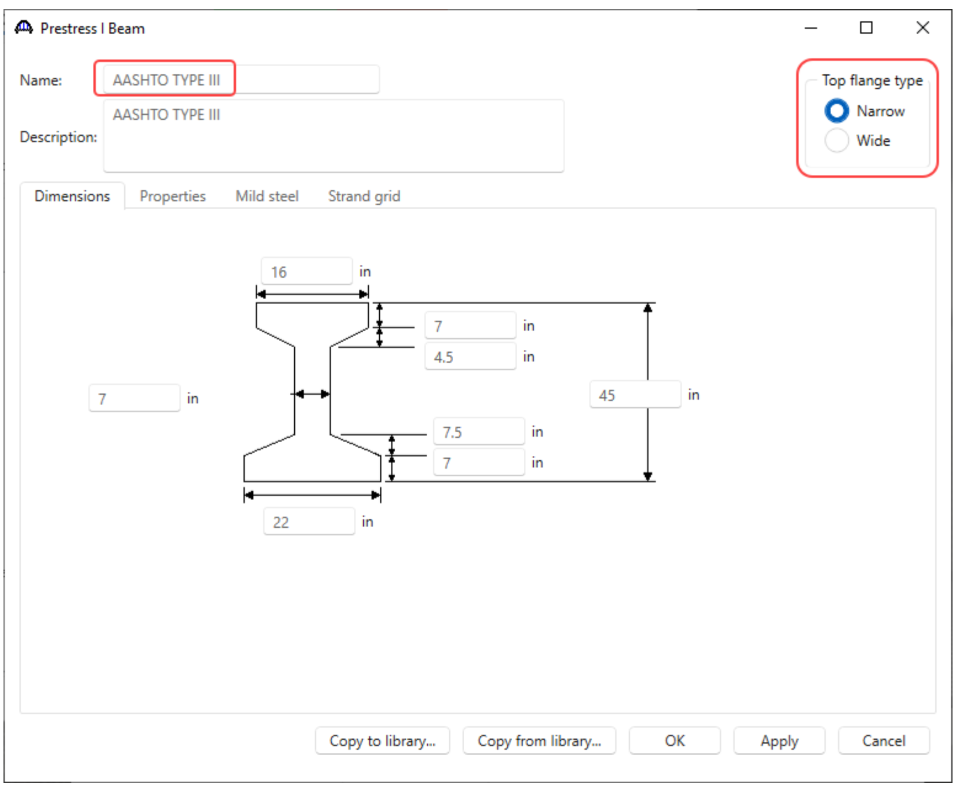
Click **OK** to apply the data and close the window.

Navigate to the **Strand grid** tab. Delete the existing rows and add the following strand layout.

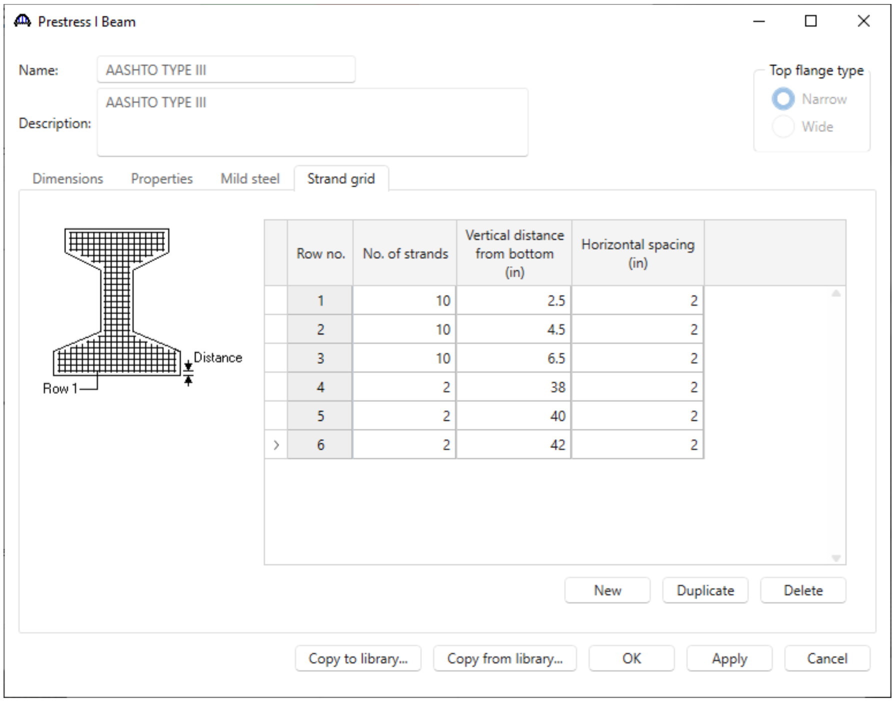


Click **OK** to apply the data and close the window.

Add another I beam **AASHTO Type III** in a similar way. The window will be updated as shown below.



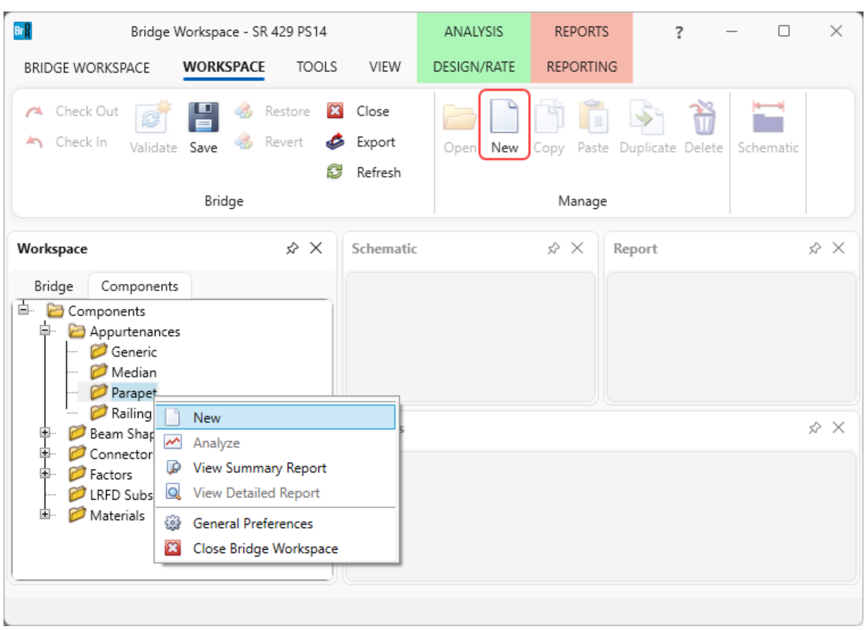
Navigate to the **Strand grid** tab, delete the existing strands, and add the following.



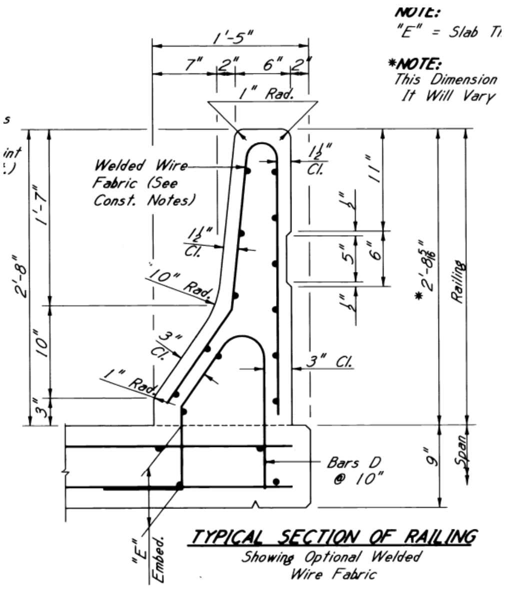
Click **OK** to apply the data and close the window.

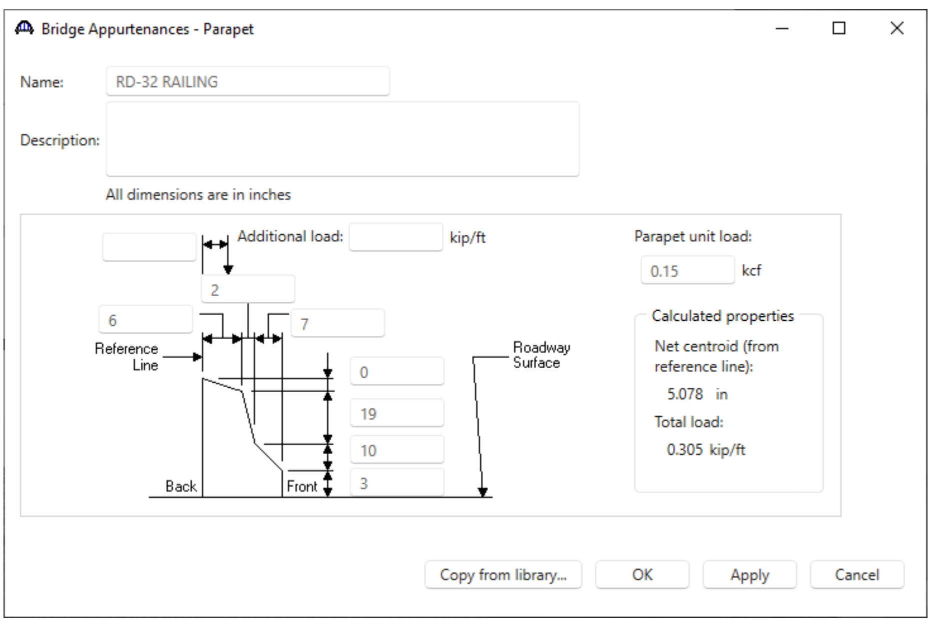
Bridge - Appurtenances

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).



Enter the parapet details as shown below.

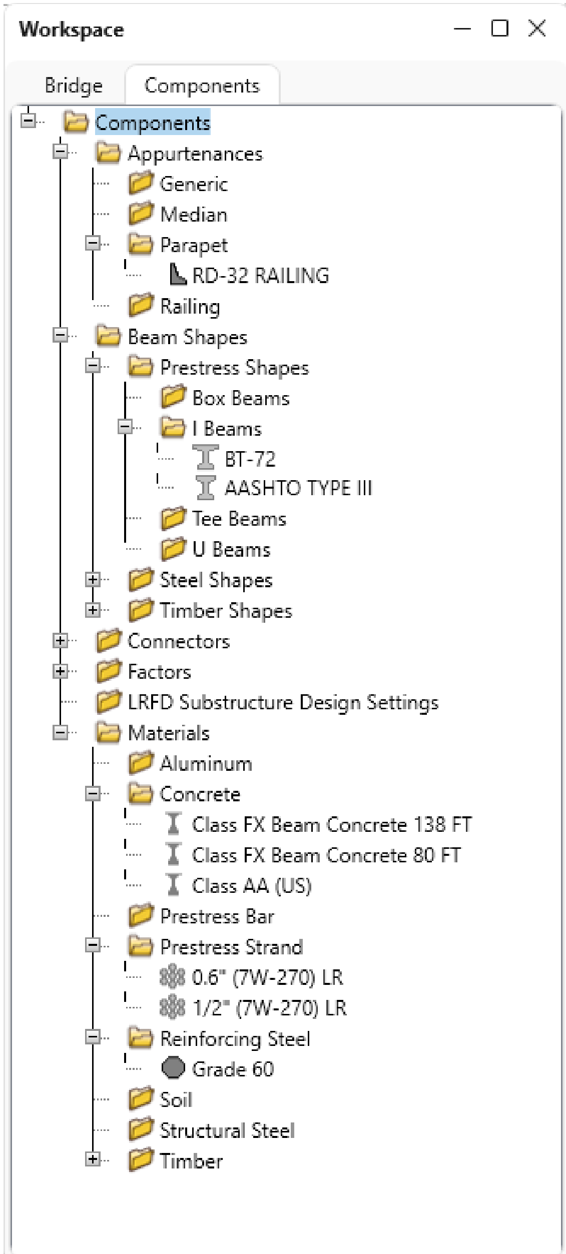




Click **OK** to apply the data and close the window.

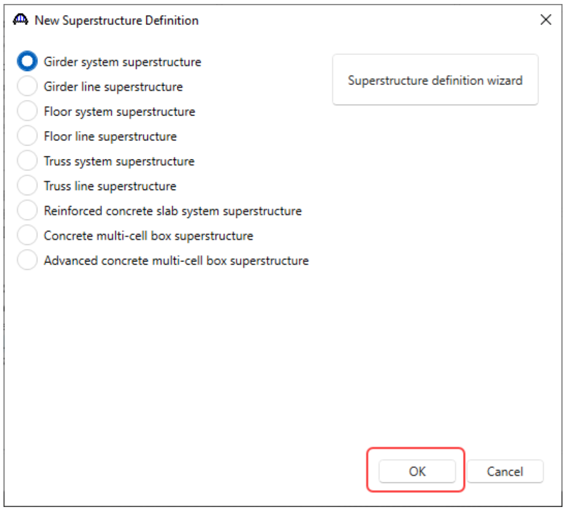
The default impact factors, standard LRFD and LFR factors will be used**.**

The partially expanded **Bridge Workspace** tree in the **Components** tab is shown below.

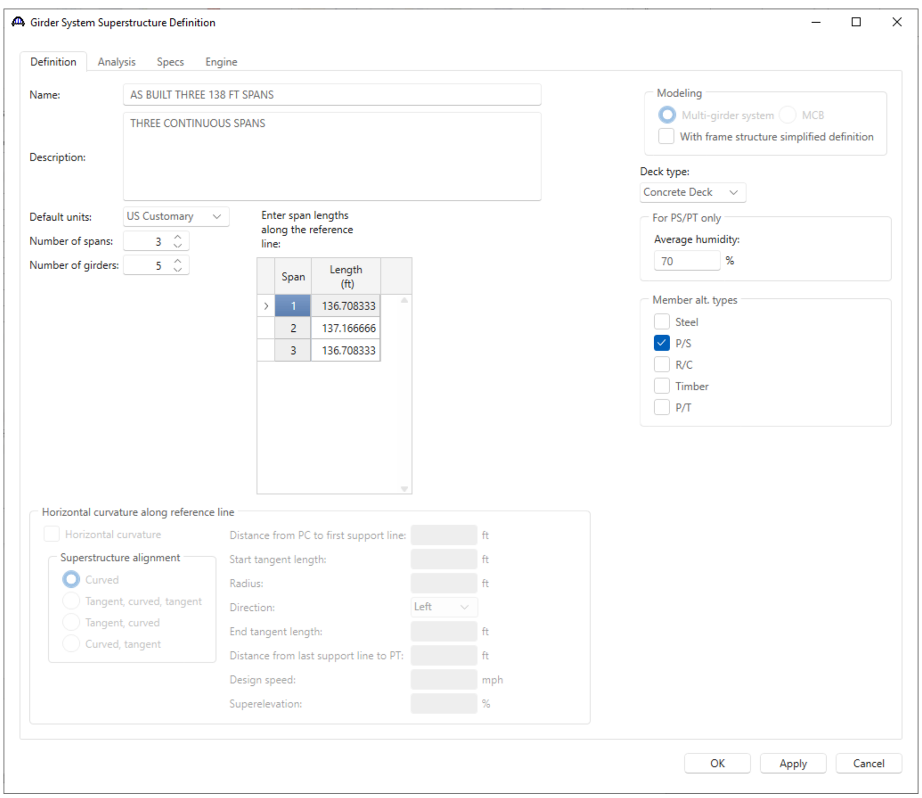


Superstructure definition – AS BUILT THREE 138 FT SPANS

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



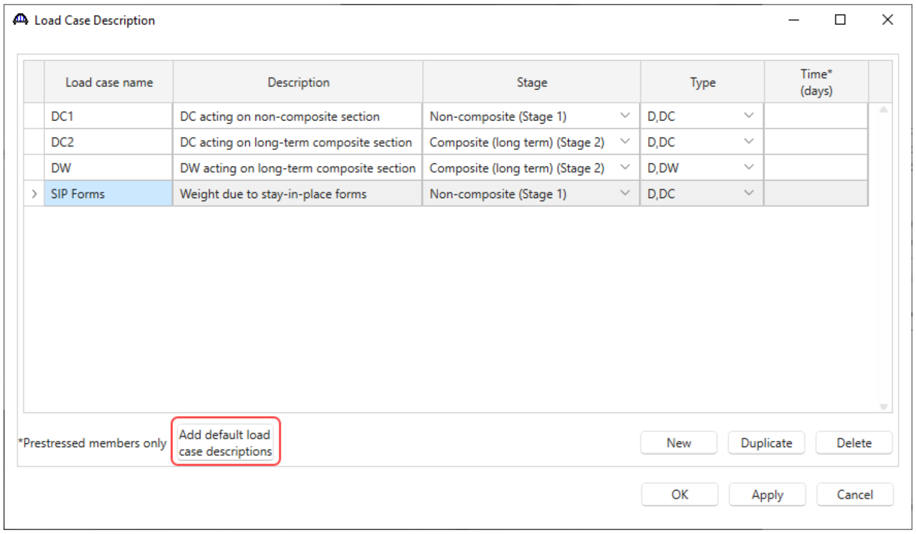
Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open. Enter the data as shown below.



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

Load Case Description

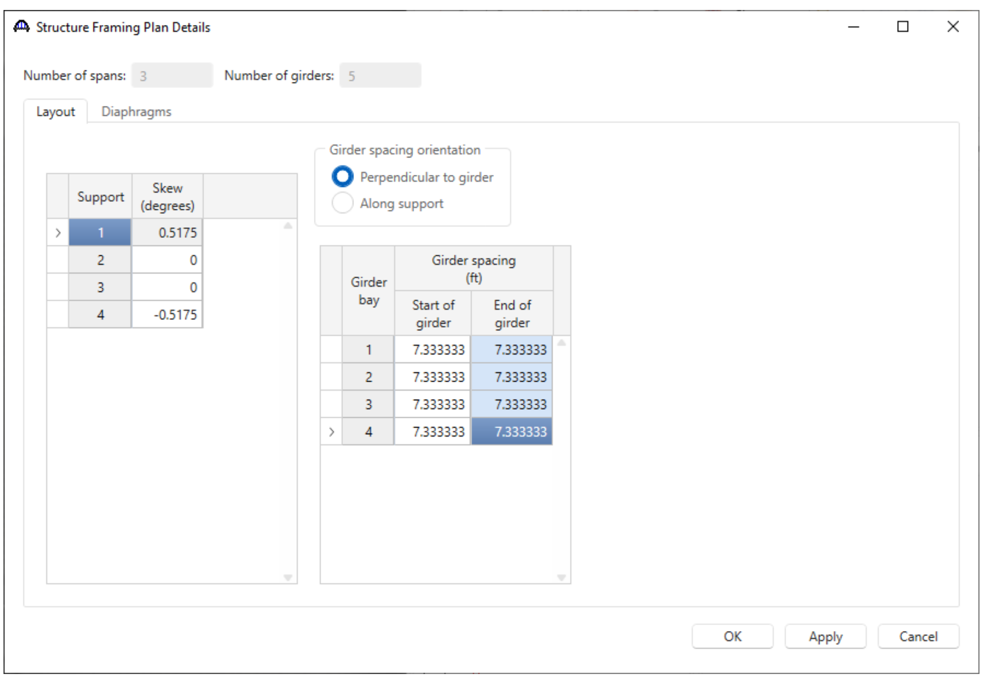
Expand the **AS BUILT THREE 138 FT SPANS** superstructure definition. Double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window**. Click the **Add default load case descriptions** button to create the following load cases.



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

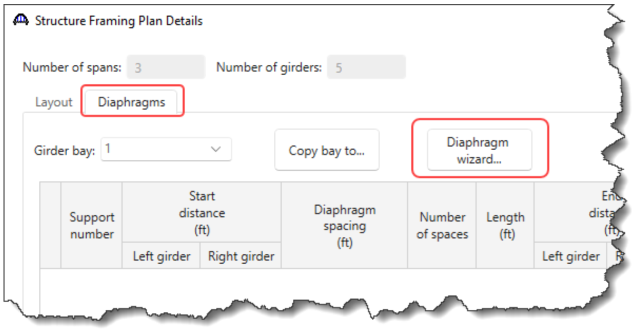
Structure Framing Plan Detail – Layout

Double-click on **Framing Plan Detail** in the **Bridge Workspace** tree to describe the framing plan in the **Structure Framing Plan Details** window. In this example, all the data will be entered to 4 significant digits, for example enter the 7'-4" spacing as **7.3333.** Click **Apply** after entering the data as shown below.

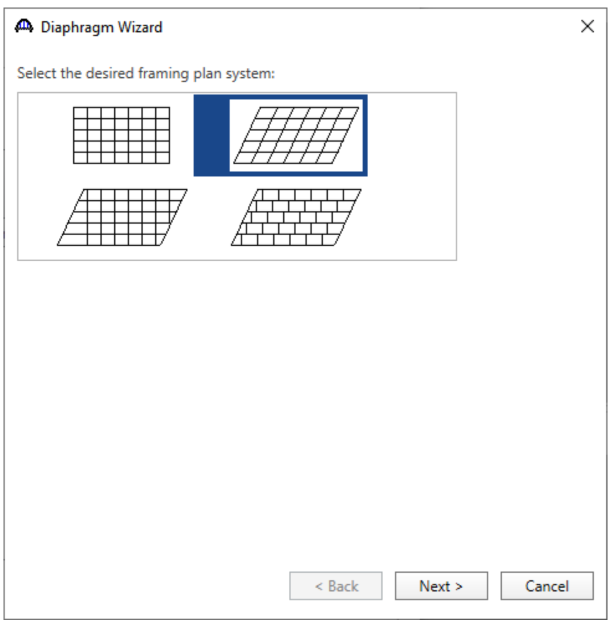


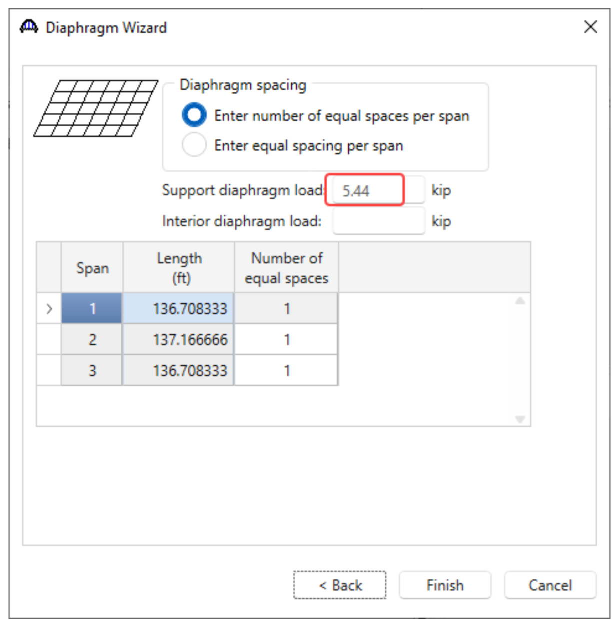
Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing. Click the **Diaphragm wizard…** button to add diaphragms for the entire structure.



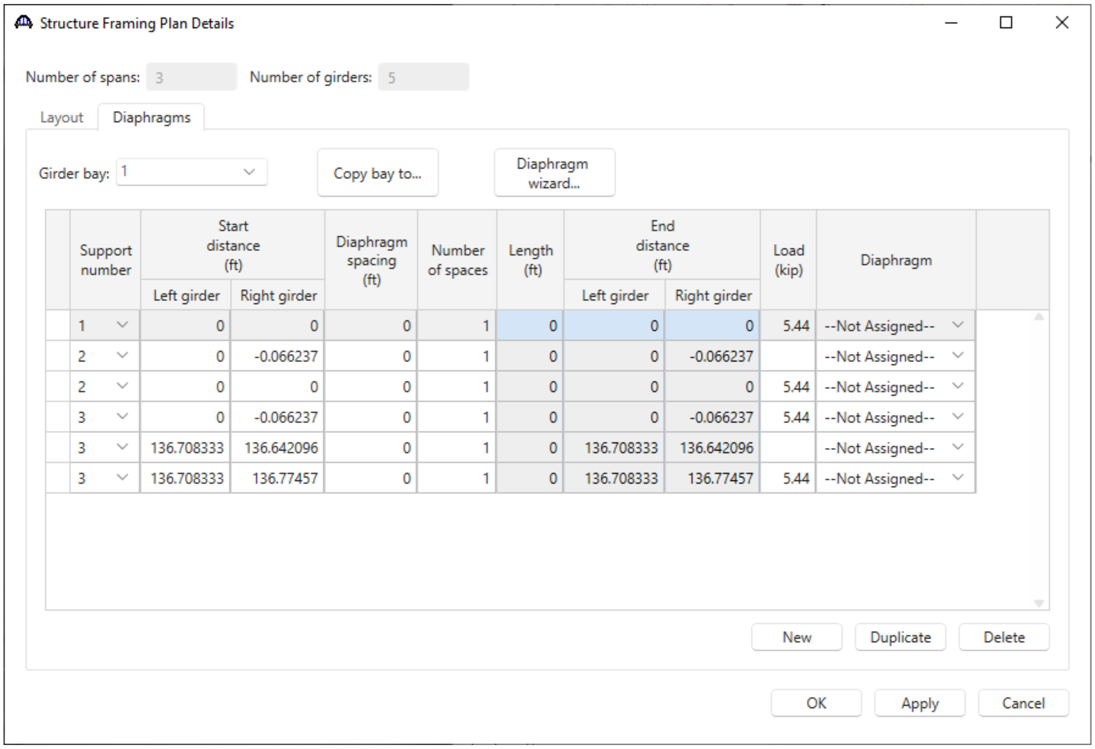
Select the desired framing plan system and click the **Next** button. Enter the following data on the window shown below.



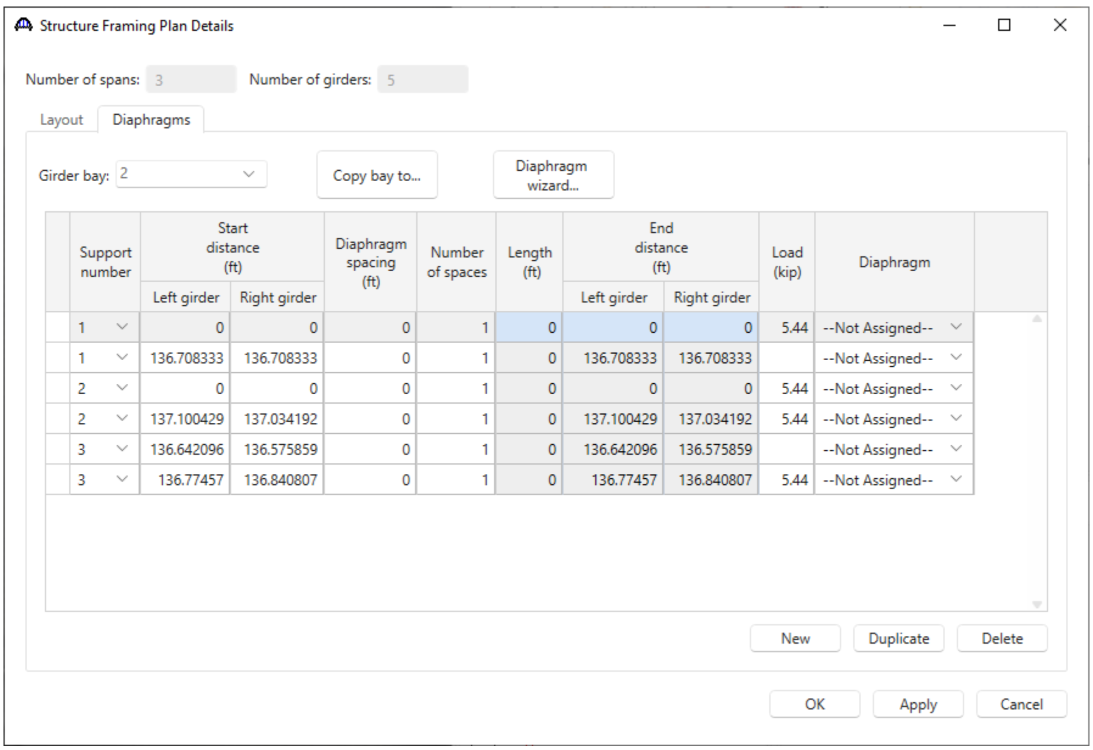


Click the **Finish** button to add the diaphragms.

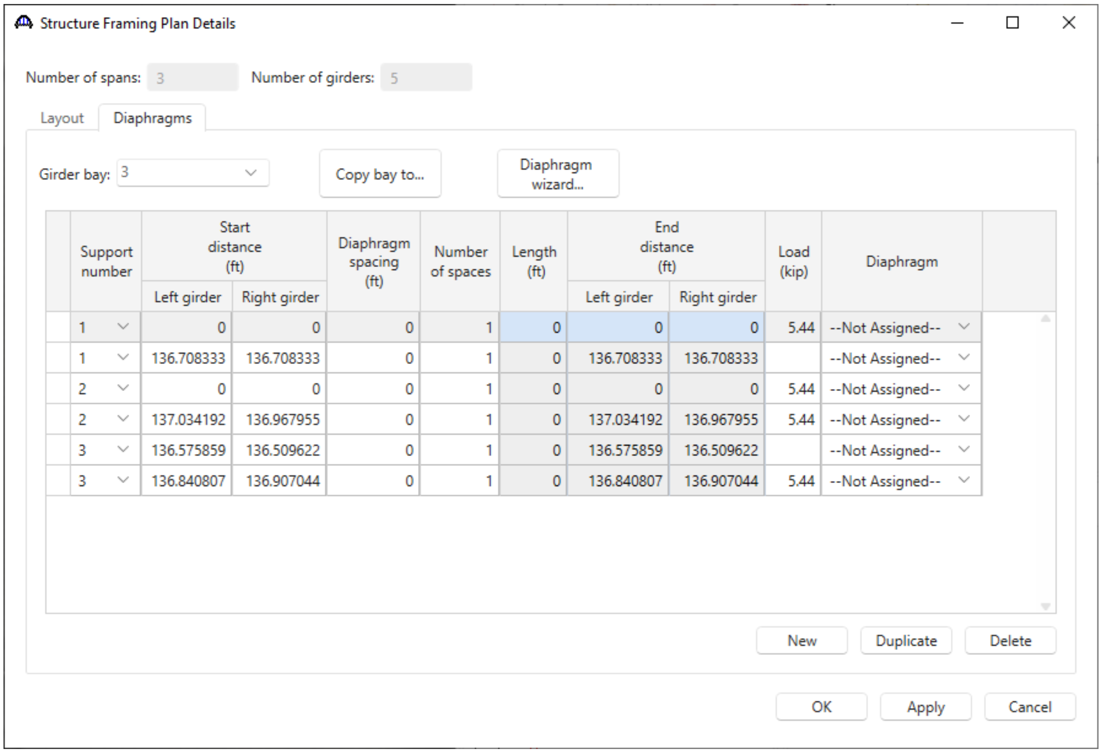
The **Diaphragm Wizard** will create diaphragms for all the girder bays in the structure. The diaphragms created for **each girder bay** is shown below.



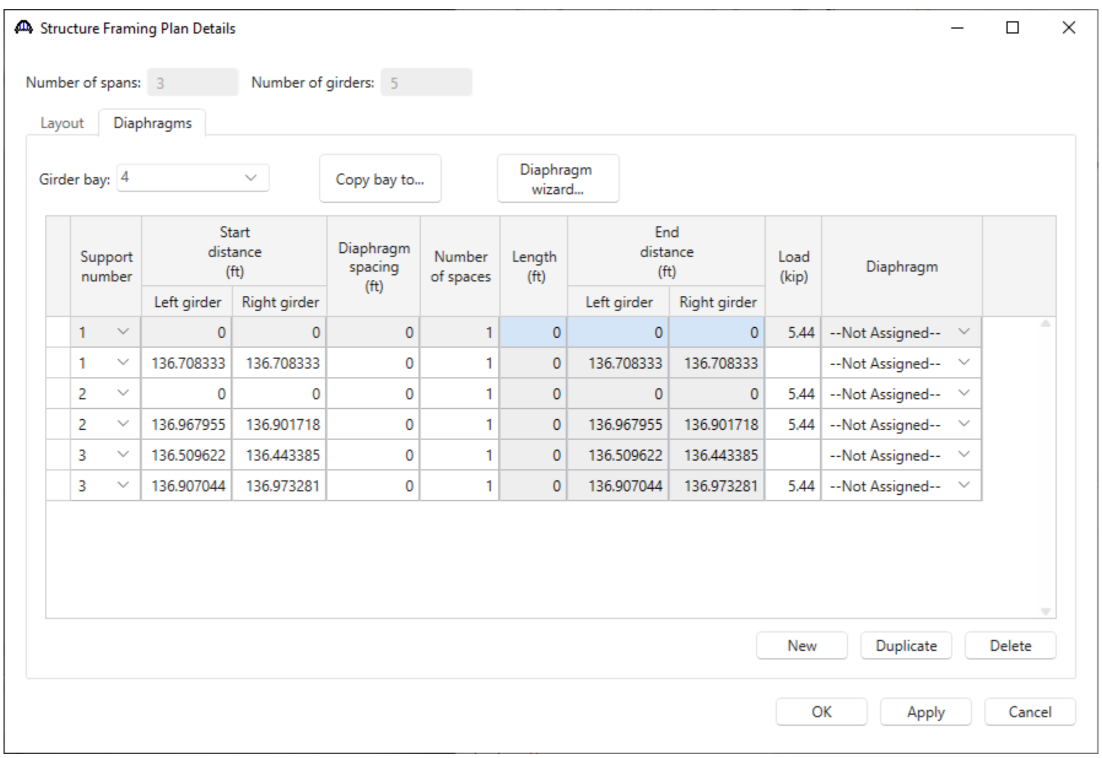
Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
1	0	0	0	1	0	0	0	5.44	--Not Assigned--
2	0	-0.066237	0	1	0	0	-0.066237		--Not Assigned--
2	0	0	0	1	0	0	0	5.44	--Not Assigned--
3	0	-0.066237	0	1	0	0	-0.066237	5.44	--Not Assigned--
3	136.708333	136.642096	0	1	0	136.708333	136.642096		--Not Assigned--
3	136.708333	136.77457	0	1	0	136.708333	136.77457	5.44	--Not Assigned--



Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
1	0	0	0	1	0	0	0	5.44	--Not Assigned--
1	136.708333	136.708333	0	1	0	136.708333	136.708333		--Not Assigned--
2	0	0	0	1	0	0	0	5.44	--Not Assigned--
2	137.100429	137.034192	0	1	0	137.100429	137.034192	5.44	--Not Assigned--
3	136.642096	136.575859	0	1	0	136.642096	136.575859		--Not Assigned--
3	136.77457	136.840807	0	1	0	136.77457	136.840807	5.44	--Not Assigned--



Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
1	0	0	0	1	0	0	0	5.44	--Not Assigned--
1	136.708333	136.708333	0	1	0	136.708333	136.708333		--Not Assigned--
2	0	0	0	1	0	0	0	5.44	--Not Assigned--
2	137.034192	136.967955	0	1	0	137.034192	136.967955	5.44	--Not Assigned--
3	136.575859	136.509622	0	1	0	136.575859	136.509622		--Not Assigned--
3	136.840807	136.907044	0	1	0	136.840807	136.907044	5.44	--Not Assigned--

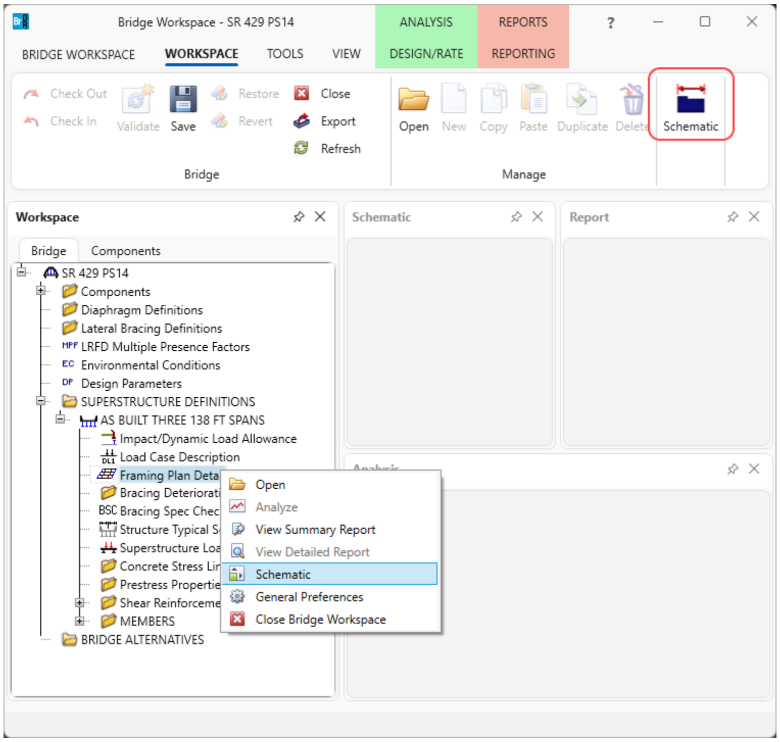


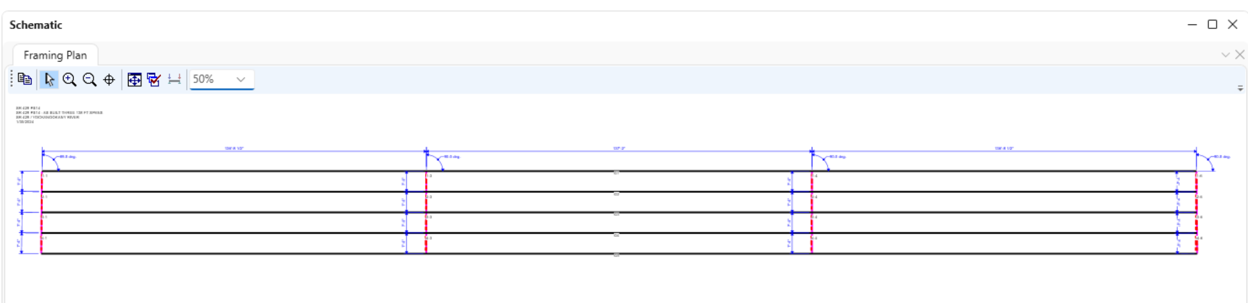
Support number	Start distance (ft) Left girder	Start distance (ft) Right girder	Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft) Left girder	End distance (ft) Right girder	Load (kip)	Diaphragm
1	0	0	0	1	0	0	0	5.44	--Not Assigned--
1	136.708333	136.708333	0	1	0	136.708333	136.708333		--Not Assigned--
2	0	0	0	1	0	0	0	5.44	--Not Assigned--
2	136.967955	136.901718	0	1	0	136.967955	136.901718	5.44	--Not Assigned--
3	136.509622	136.443385	0	1	0	136.509622	136.443385		--Not Assigned--
3	136.907044	136.973281	0	1	0	136.907044	136.973281	5.44	--Not Assigned--

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

Schematic - Framing Plan Detail

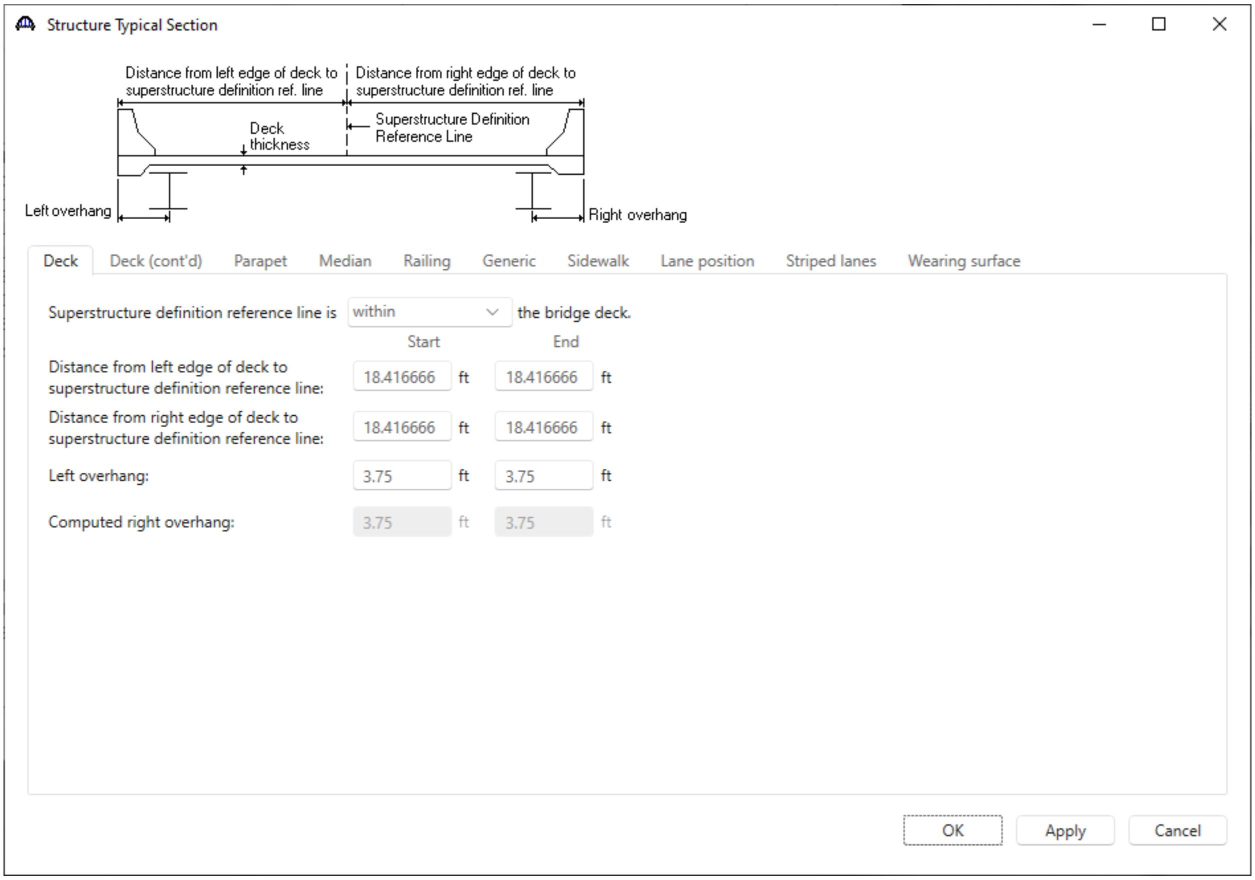
While **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu).





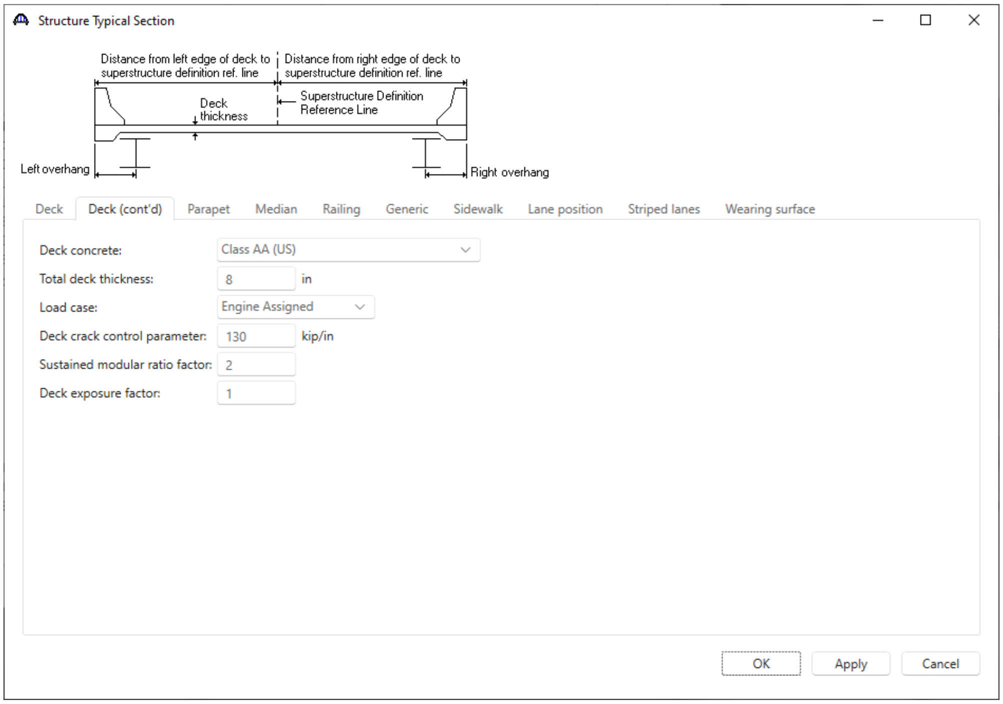
Structure Typical Section - Deck

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



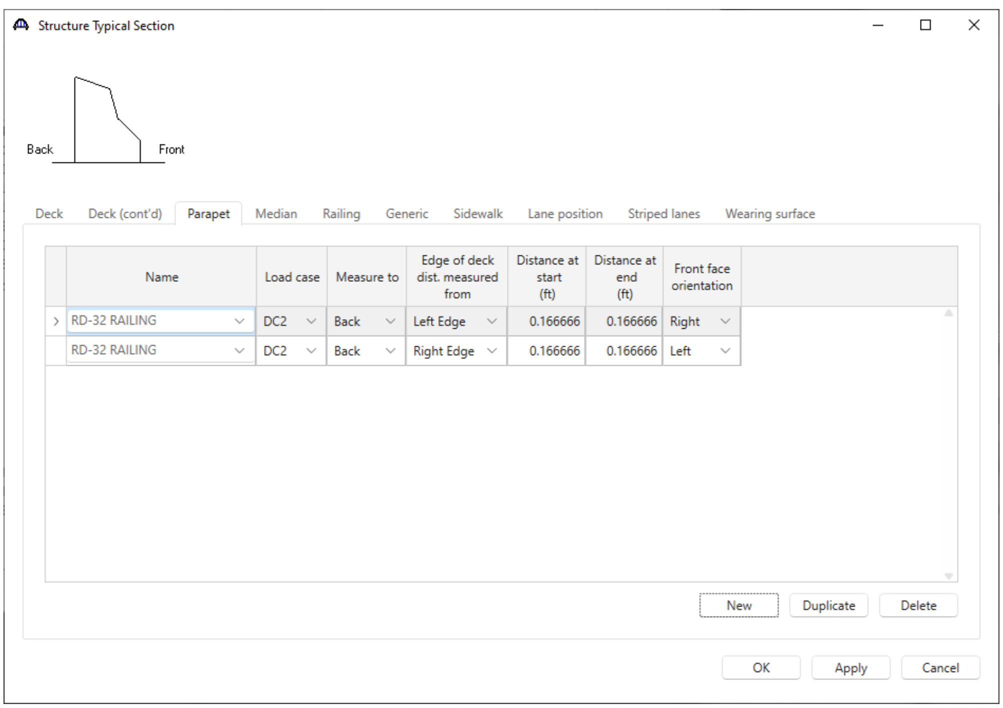
Structure Typical Section – Deck (cont'd)

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.



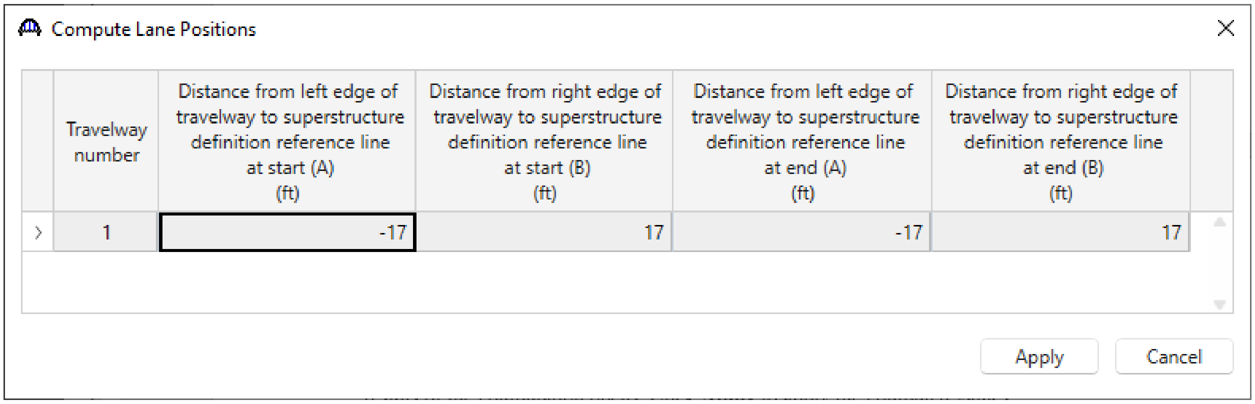
Structure Typical Section – Parapets

Add two parapets as shown below.

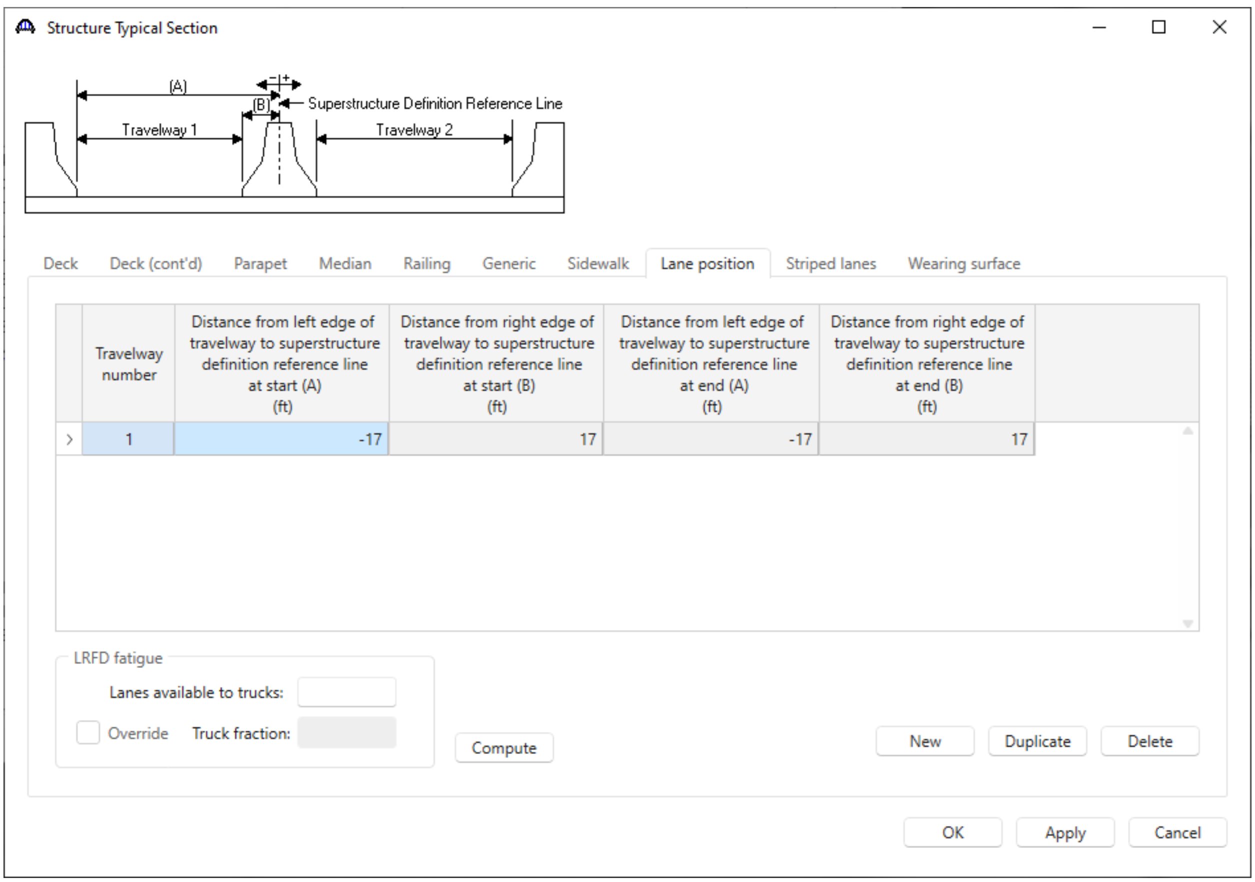


Structure Typical Section – Lane Positions

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.



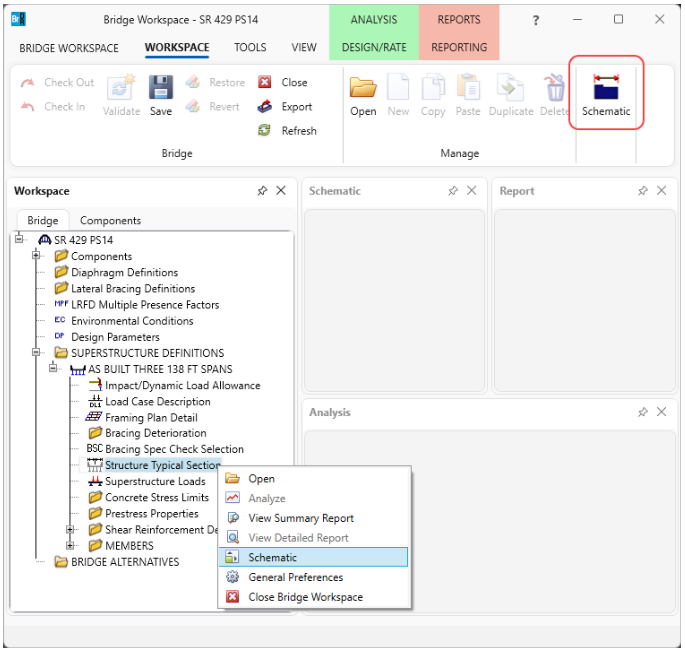
The **Lane Position** tab is populated as shown below.

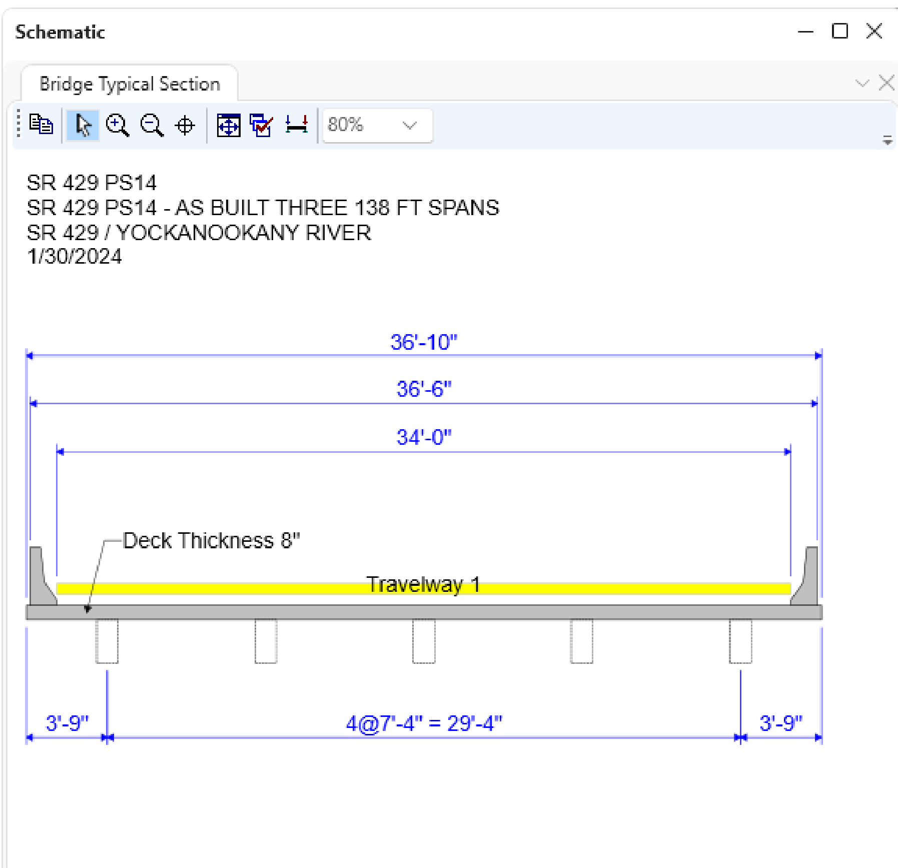


Click **OK** to apply the data and close the window.

Schematic – Structure Typical Section

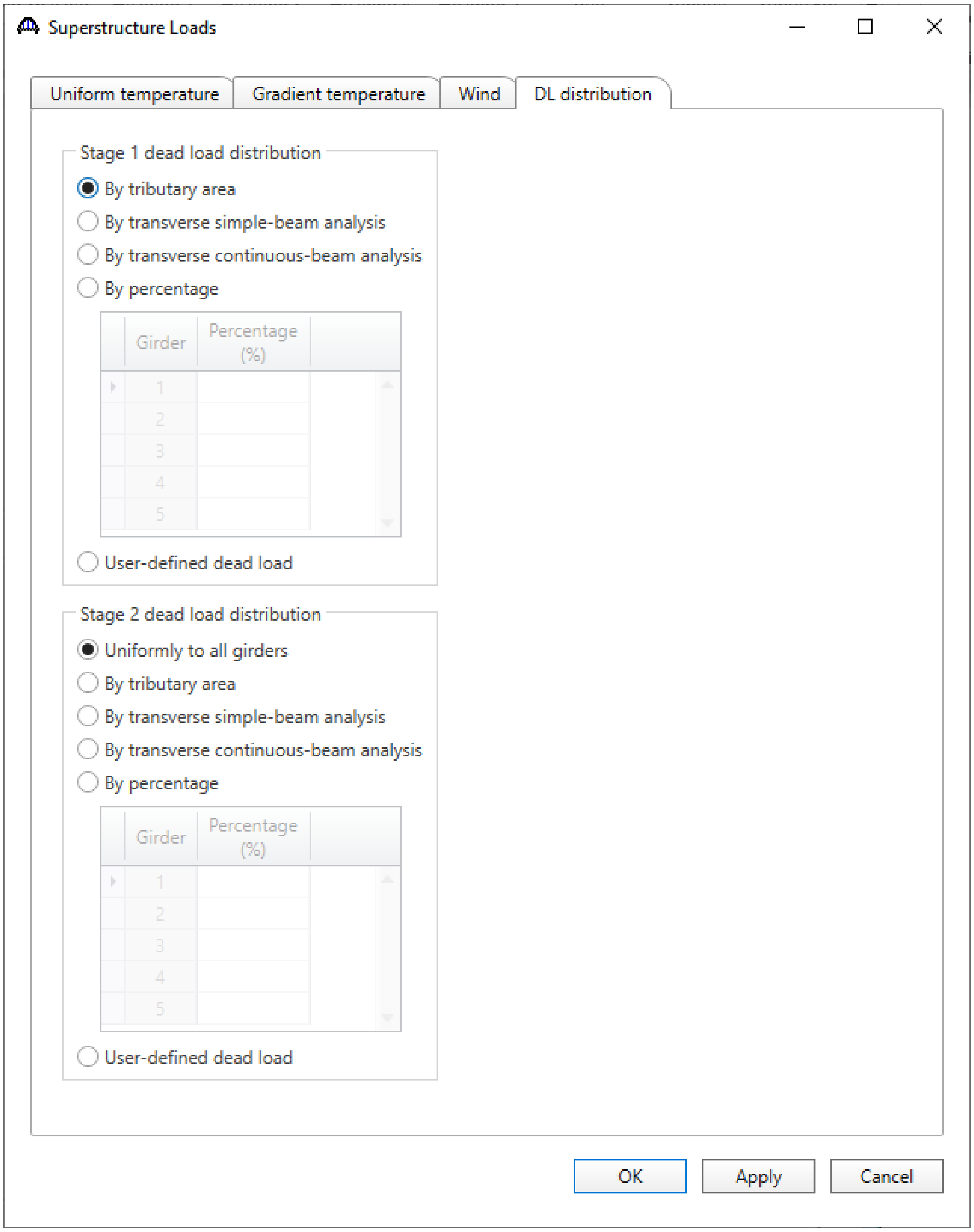
While **Structure Typical Section** is selected in the **Bridge Workspace** tree, open the schematic for the structure typical section by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Structure Typical Section** in the **Bridge Workspace** and select **Schematic**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





Superstructure Loads

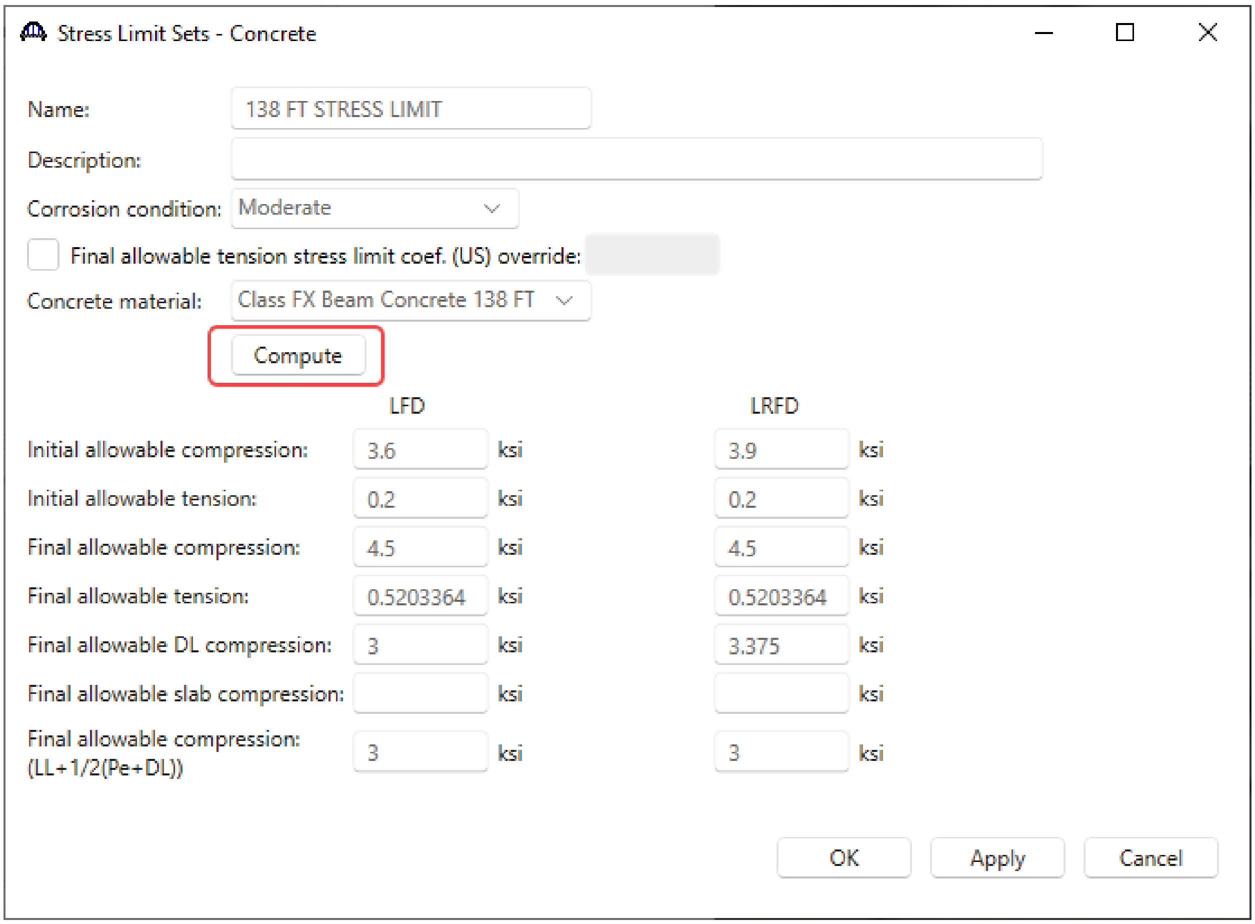
Double click on the **Superstructure Loads** node in the **Bridge Workspace** tree to open the **Superstructure Loads** window. Navigate to the **DL distribution** tab in this window. Select options in this window as shown below. The BrDR LRFD engine does not support the transverse continuous beam analysis option.



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

Concrete Stress Limits

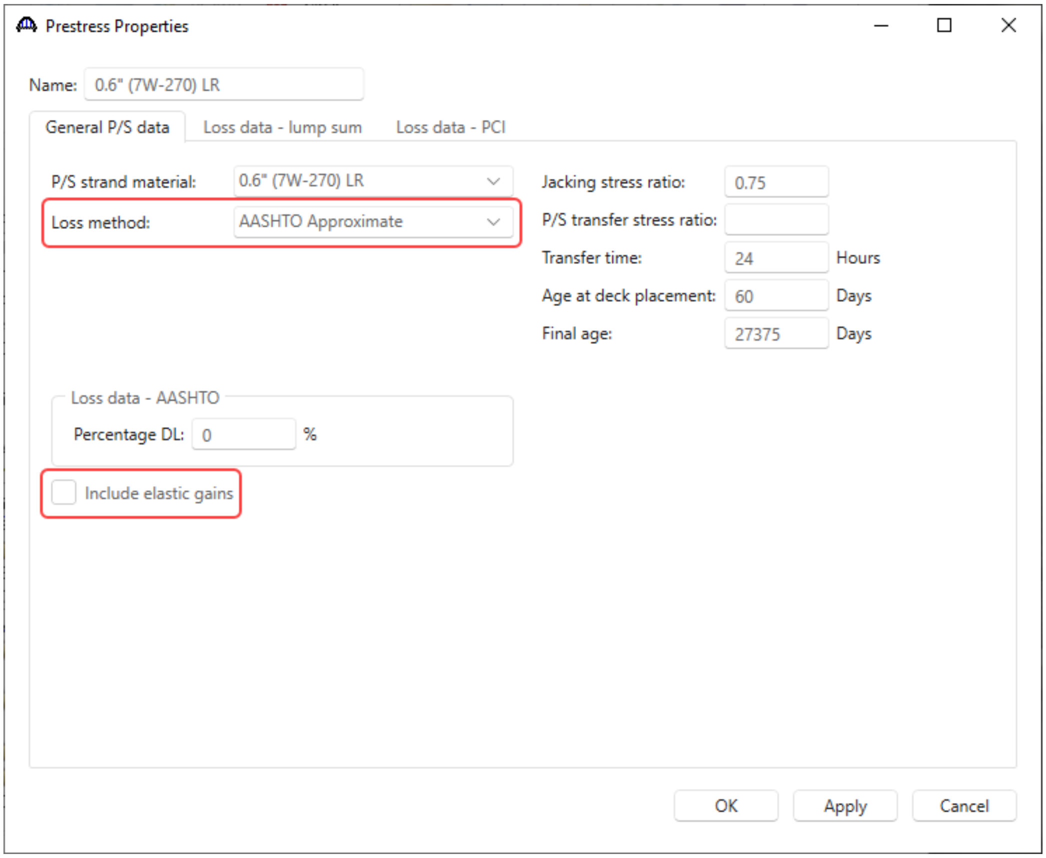
A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the **Concrete Stress Limits** node in the **Bridge Workspace** tree to open the **Stress Limit Sets – Concrete** window. Enter data shown above the **Compute** button, select **Moderate** for the **Corrosion condition** and select the **Class FX Beam Concrete 138 FT** 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. 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.



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

Prestress Properties

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



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

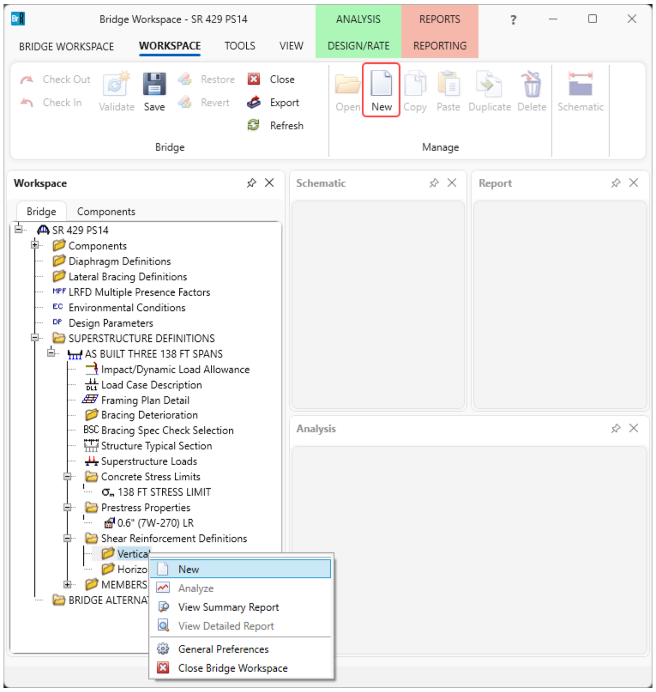
The following loss methods are available in the BrDR LRFD engine.

- AASHTO Approximate
- AASHTO Refined
- Lump Sum
- PCI
- Pre-2005 AASHTO Refined (AASHTO Refined, Third edition, 2004 without interims)

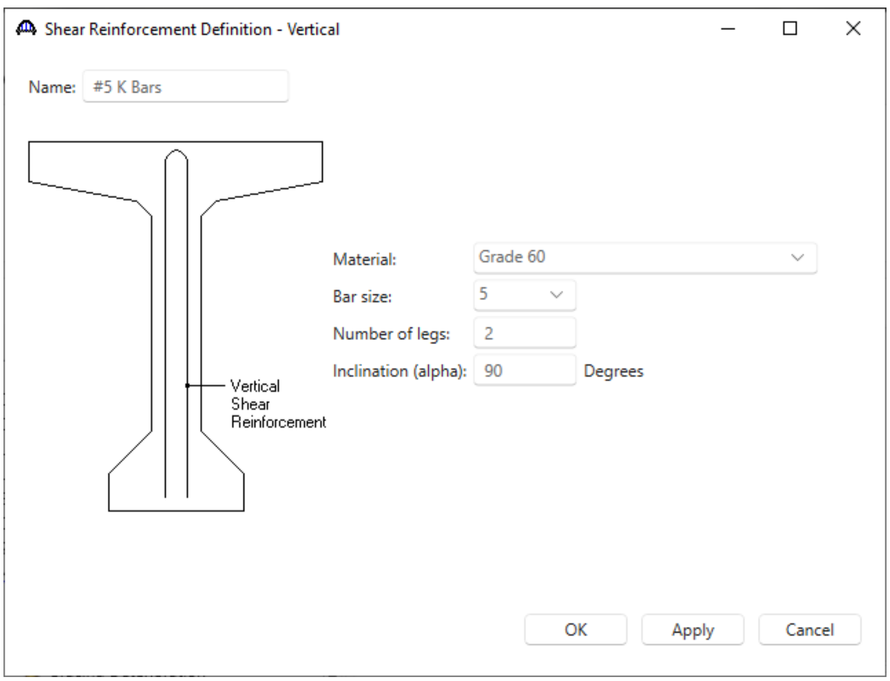
Another feature for prestress loss calculations in the BrDR LRFD engine is the ability to include elastic gains and losses due to dead load application.

Shear Reinforcement

Define 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)**.

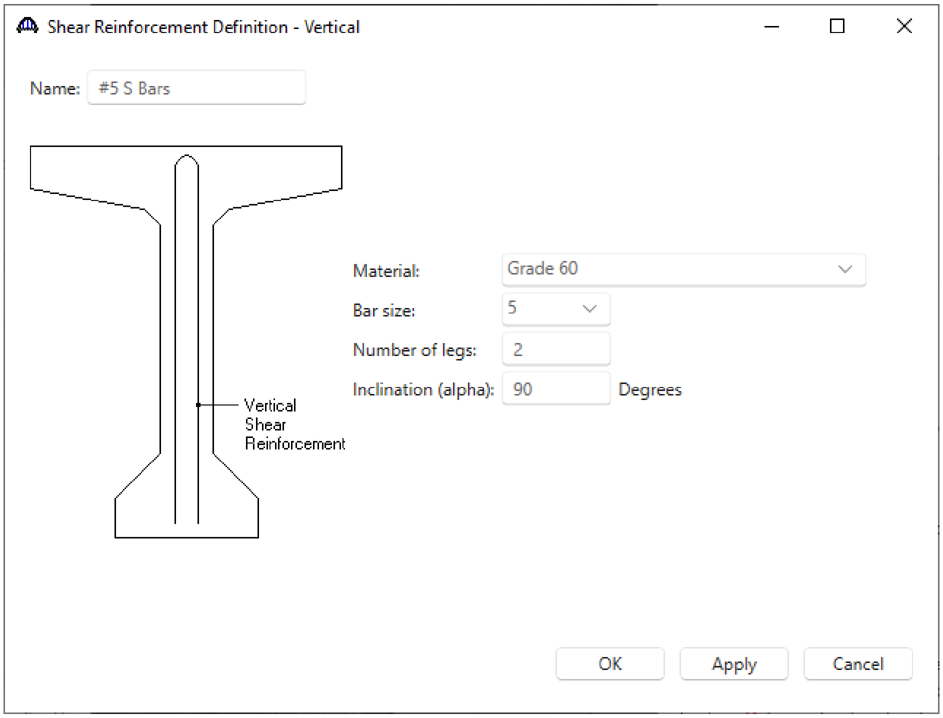


Define the stirrups as shown below.



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

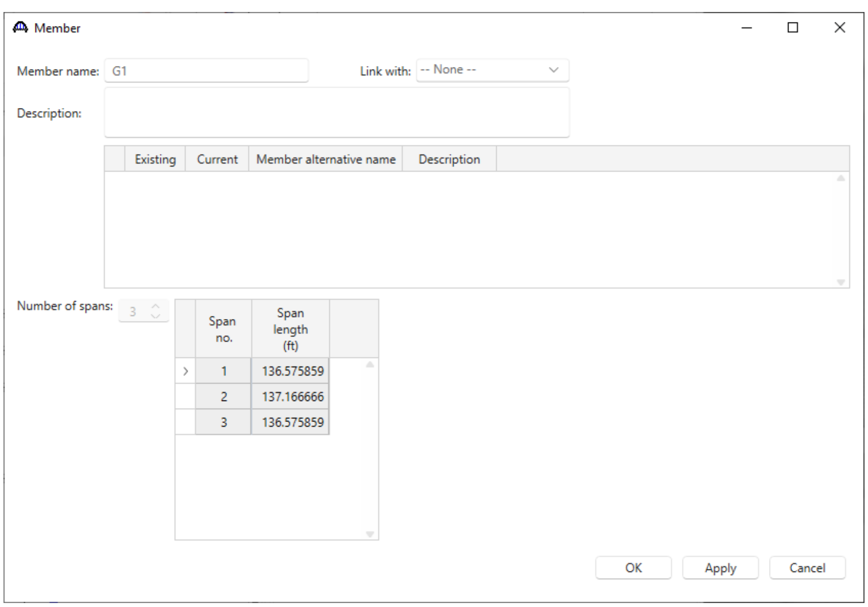
Define the #5 S Bars stirrup definition as shown below. Note that the #5 S Bars are the same definition as the #5 K Bars.



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

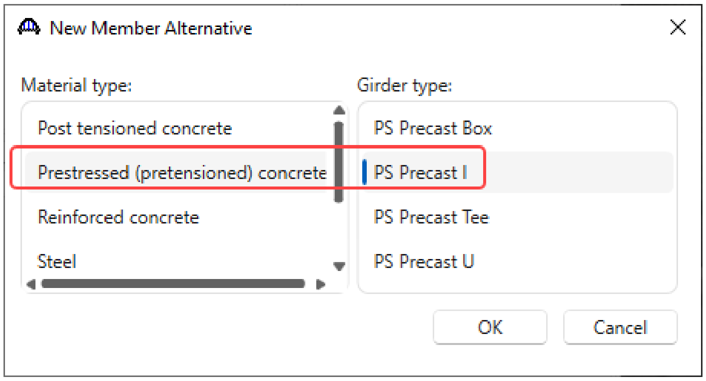
Describing a member:

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



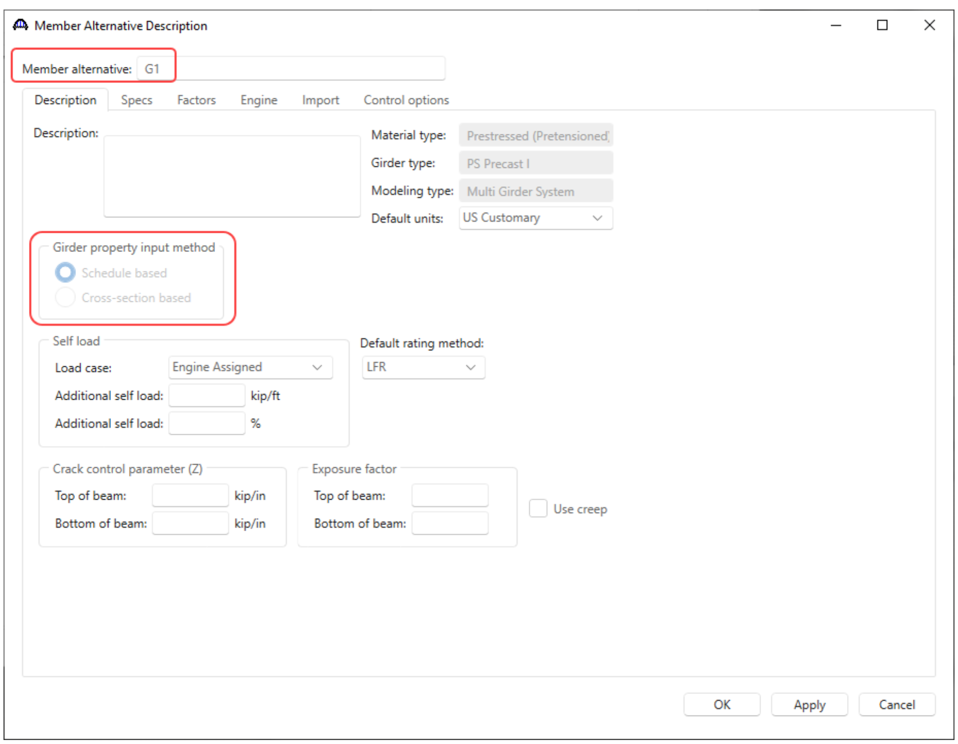
Defining a Member Alternative

Double-click on **MEMBER ALTERNATIVES** in the **Bridge Workspace** tree for member **G1** 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 I** for the **Girder Type**.



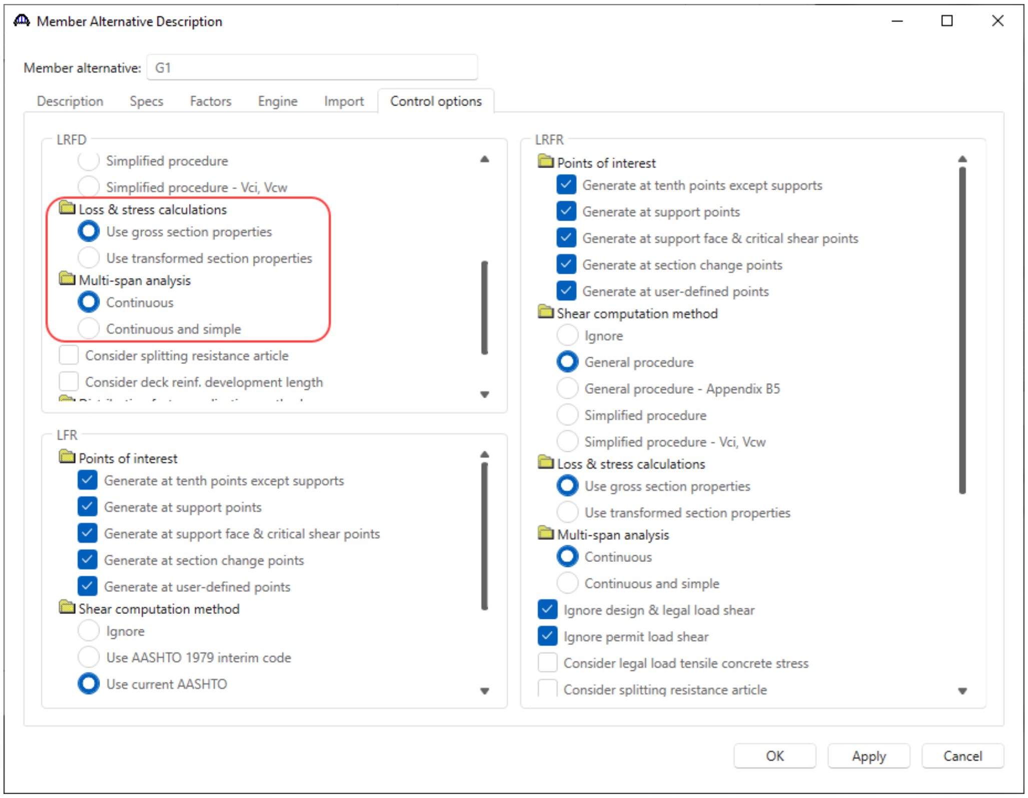
Click **OK** to close the window and create a new member alternative.

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



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

Navigate to the **Control options** tab and check the **LRFD** options as shown below.



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

The BrDR LRFD engine allows to select either gross or transformed section properties to be used in the loss and stress calculations. Note that the gross section properties are always used in structural analysis.

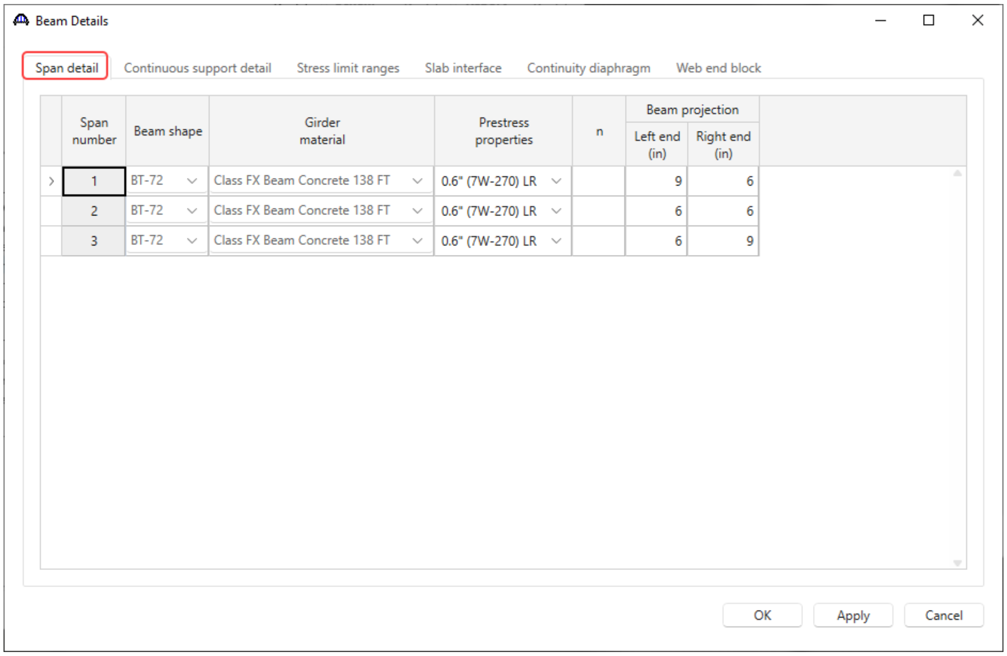
Prestressed multi-span modeling options

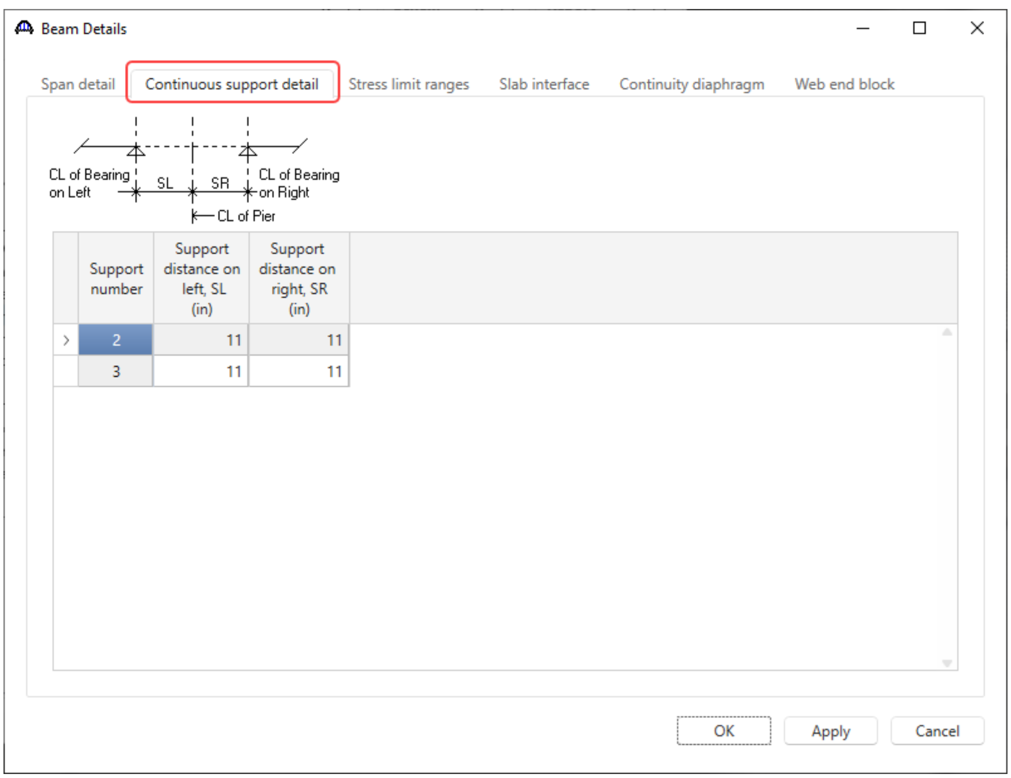
The BrDR LRFD engine also allows to model prestress beams made continuous for live load in two ways.

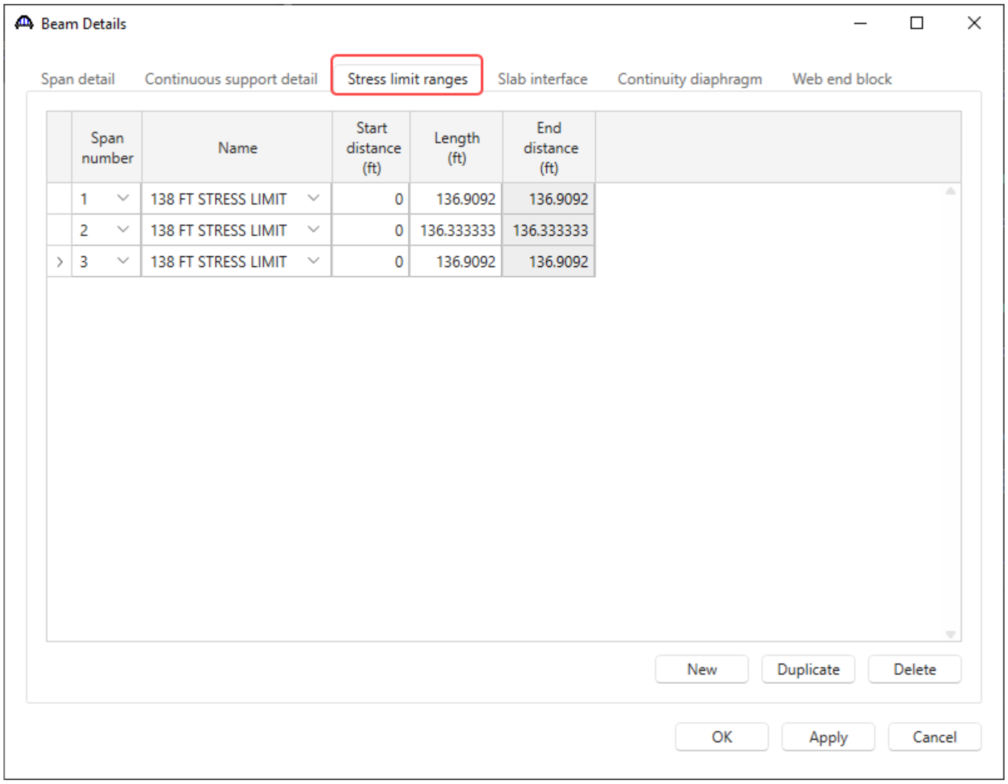
- Multi-span continuous
  The Continuous analysis method considers multi-span structures to be simply supported for beam self-weight and uncured deck and continuously supported for composite dead and live loads. This method takes advantage of the continuity connection to reduce the maximum positive moment at mid-spans.
- Multi-span continuous and simple span
  The Continuous and Simple method analyzes the structure as simply supported for beam self-weight and uncured deck and both continuously and simply supported for composite dead and live loads. The maximum effects from the two analyses are then used in the specification checking. This method accounts for the condition where full continuity is not provided at interior supports and does not reduce the maximum positive moment at mid-spans.

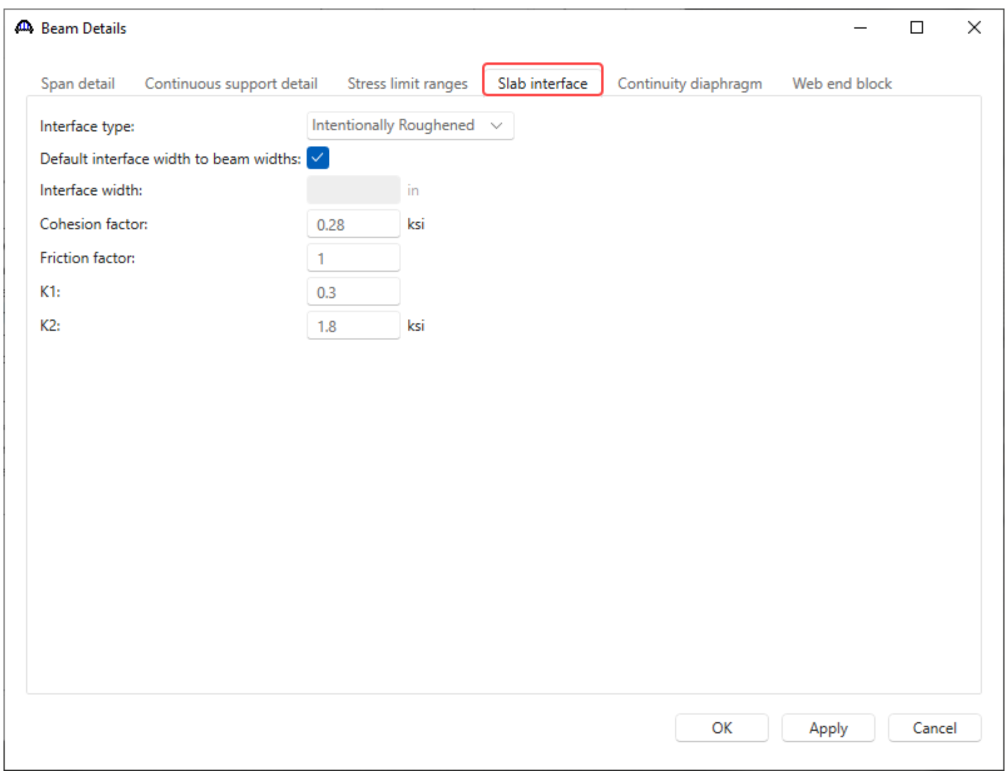
Beam Details

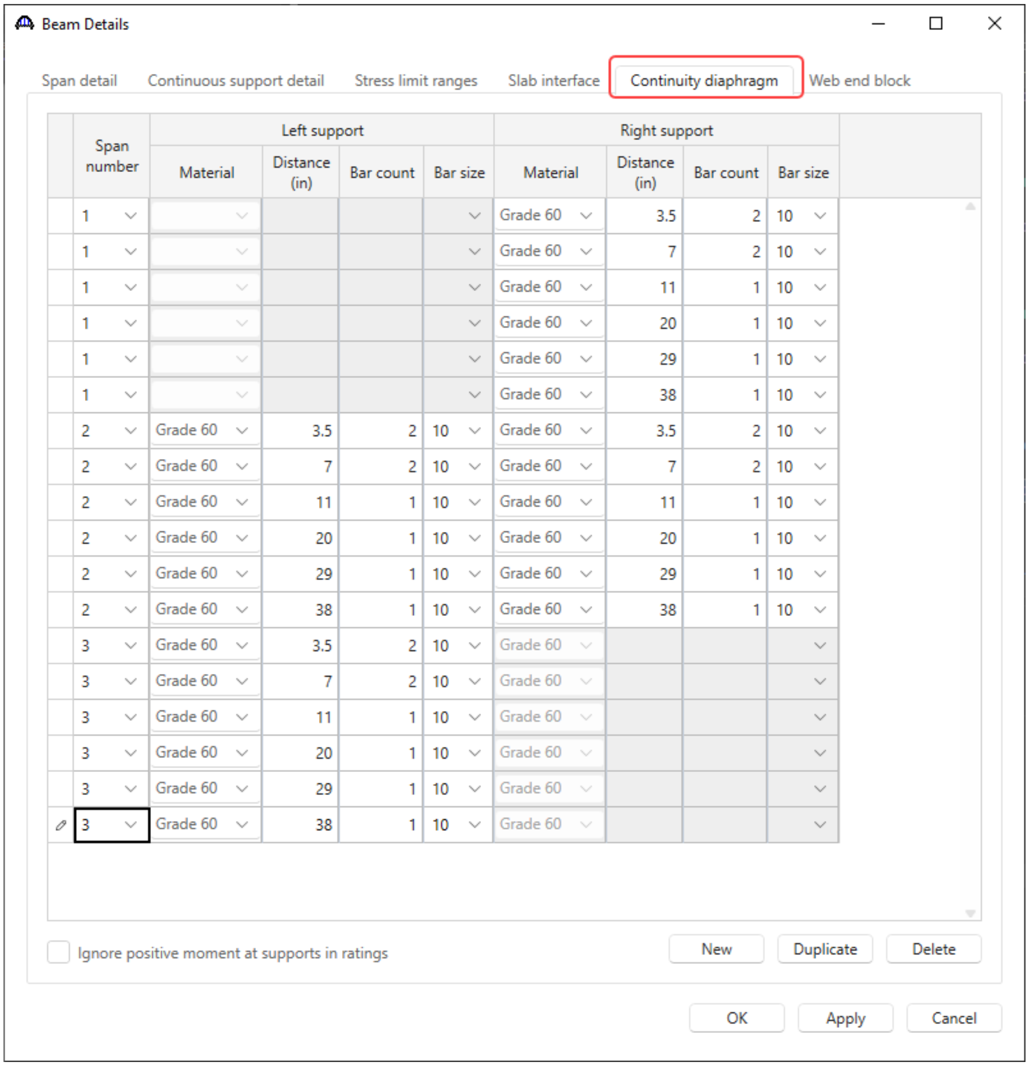
Next describe the beam by double clicking on the **Beam Details** node in the **Bridge Workspace** tree. Enter the data in each tab of the **Beam Details** window as shown below.






Beam Details
Span detail
Continuous support detail
Stress limit ranges
Slab interface
Continuity diaphragm
Web end block
Span number
Name
Start distance (ft)
Length (ft)
End distance (ft)
1
138 FT STRESS LIMIT
0
136.9092
136.9092
2
138 FT STRESS LIMIT
0
136.333333
136.333333
3
138 FT STRESS LIMIT
0
136.9092
136.9092
New
Duplicate
Delete
OK
Apply
Cancel


Beam Details
Span detail
Continuous support detail
Stress limit ranges
Slab interface
Continuity diaphragm
Web end block
Interface type:
Intentionally Roughened
Default interface width to beam widths:
Interface width:
in
Cohesion factor:
0.28
ksi
Friction factor:
1
K1:
0.3
K2:
1.8
ksi
OK
Apply
Cancel

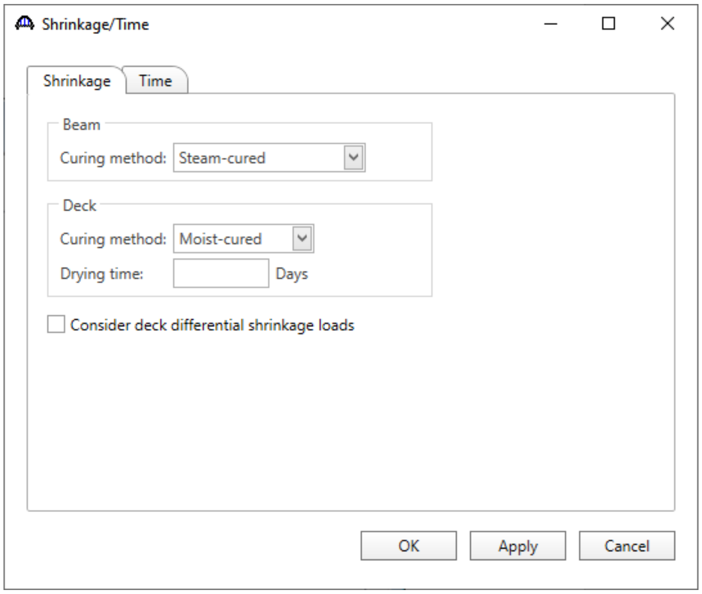


Span number	Left support Material	Left support Distance (in)	Left support Bar count	Left support Bar size	Right support Material	Right support Distance (in)	Right support Bar count	Right support Bar size
1					Grade 60	3.5	2	10
1					Grade 60	7	2	10
1					Grade 60	11	1	10
1					Grade 60	20	1	10
1					Grade 60	29	1	10
1					Grade 60	38	1	10
2	Grade 60	3.5	2	10	Grade 60	3.5	2	10
2	Grade 60	7	2	10	Grade 60	7	2	10
2	Grade 60	11	1	10	Grade 60	11	1	10
2	Grade 60	20	1	10	Grade 60	20	1	10
2	Grade 60	29	1	10	Grade 60	29	1	10
2	Grade 60	38	1	10	Grade 60	38	1	10
3	Grade 60	3.5	2	10	Grade 60			
3	Grade 60	7	2	10	Grade 60			
3	Grade 60	11	1	10	Grade 60			
3	Grade 60	20	1	10	Grade 60			
3	Grade 60	29	1	10	Grade 60			
3	Grade 60	38	1	10	Grade 60			

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

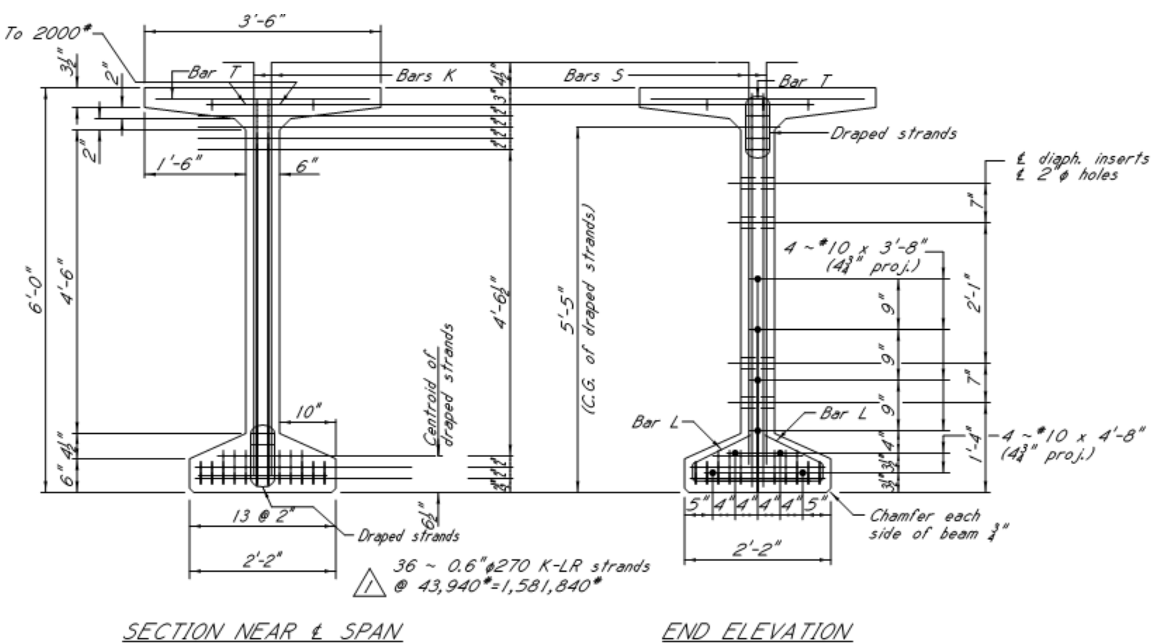
Shrinkage Time

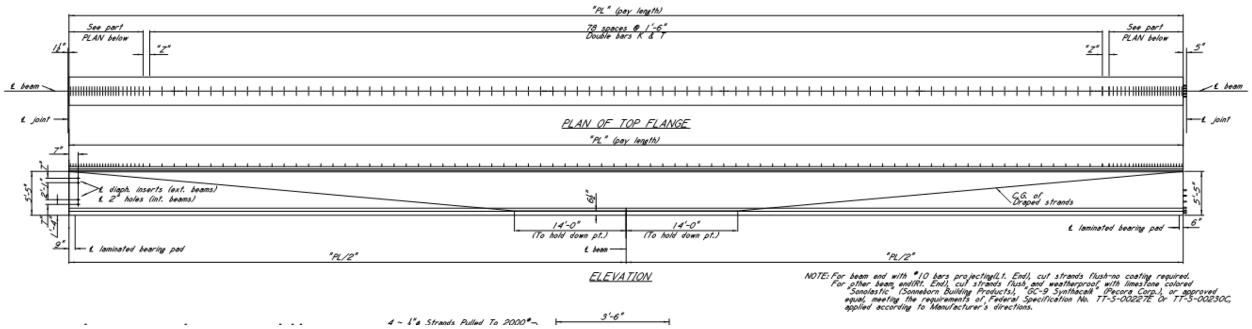
Double-click on the **Shrinkage Time** node in the **Bridge Workspace** tree to open the **Shrinkage/Time** window. Enter the data as shown below.



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

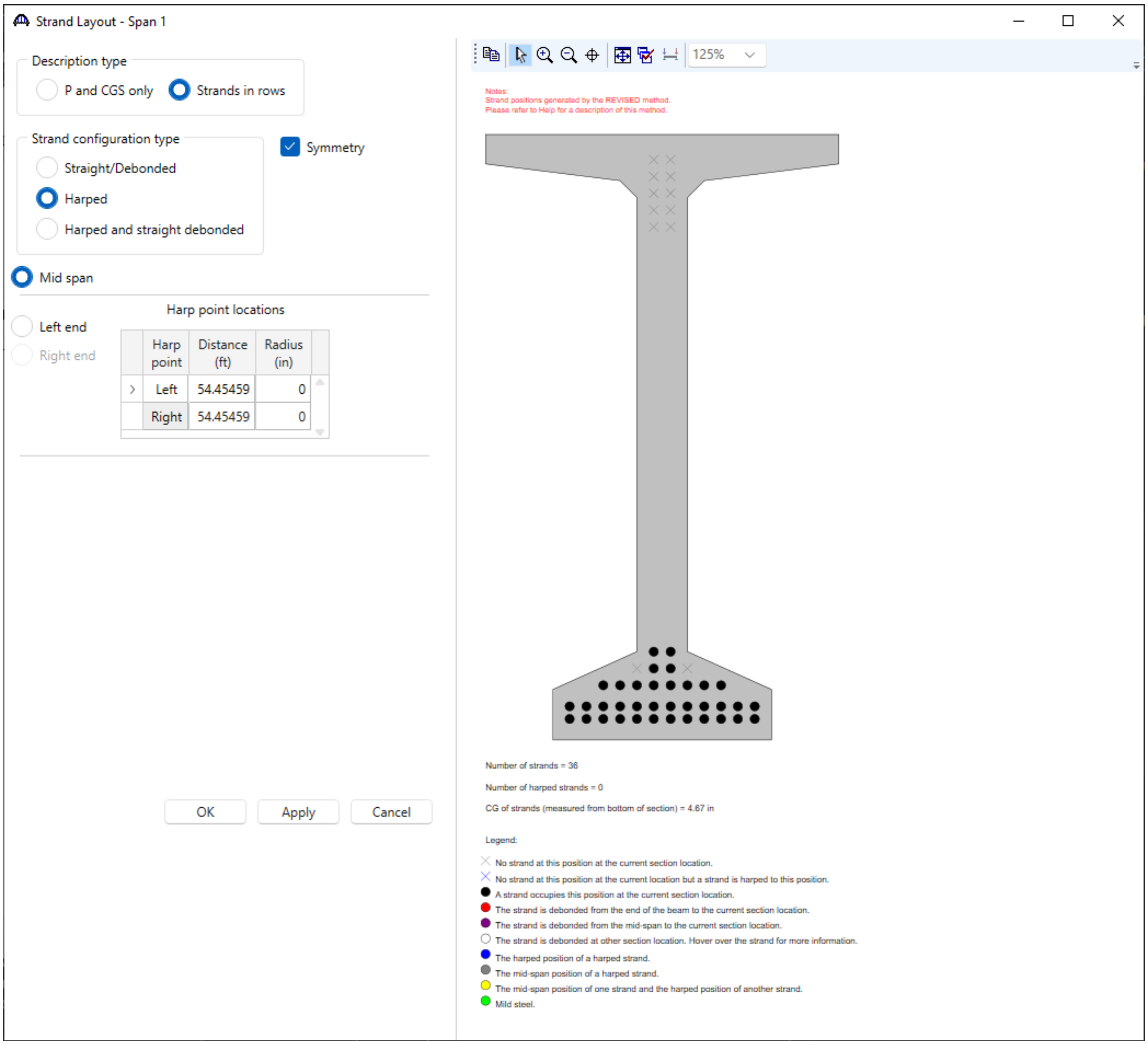
Strand Layout



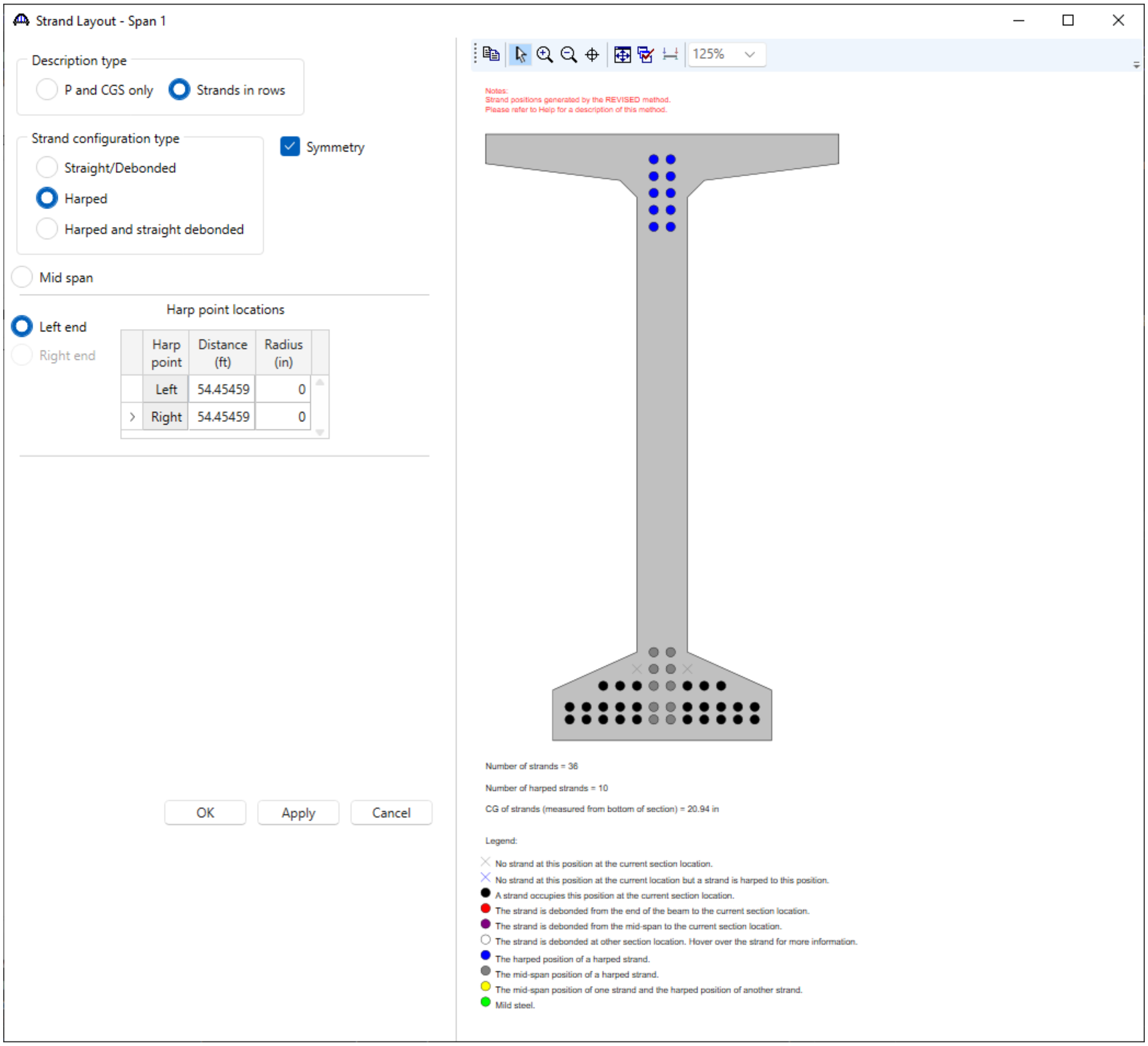


Expand the tree under **Strand Layout** and open the **Span 1** window. Use the **Zoom** buttons on the right side of this window to shrink/expand the schematic of the beam shape so that the entire beam is visible.

Select the **Description type** as **Strands in rows** and the **Strand configuration type** as **Harped**. The **Mid span** radio button will now become active. Enter details as shown below.



Now select the **Left end** radio button to enter the following harped strand locations at the left end of the precast beam. The strands can be defined at the left end of the span by selecting strand locations in the right hand schematic. Select strands as shown below.

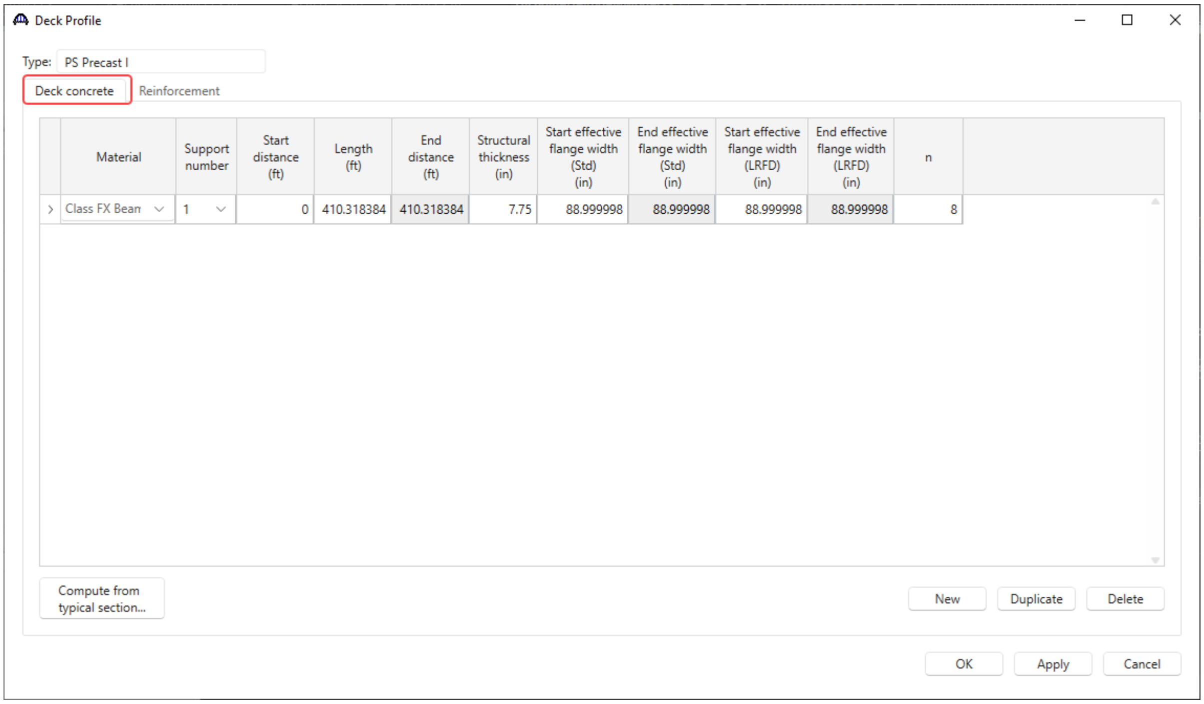


Click **OK** to apply the data and close the window.

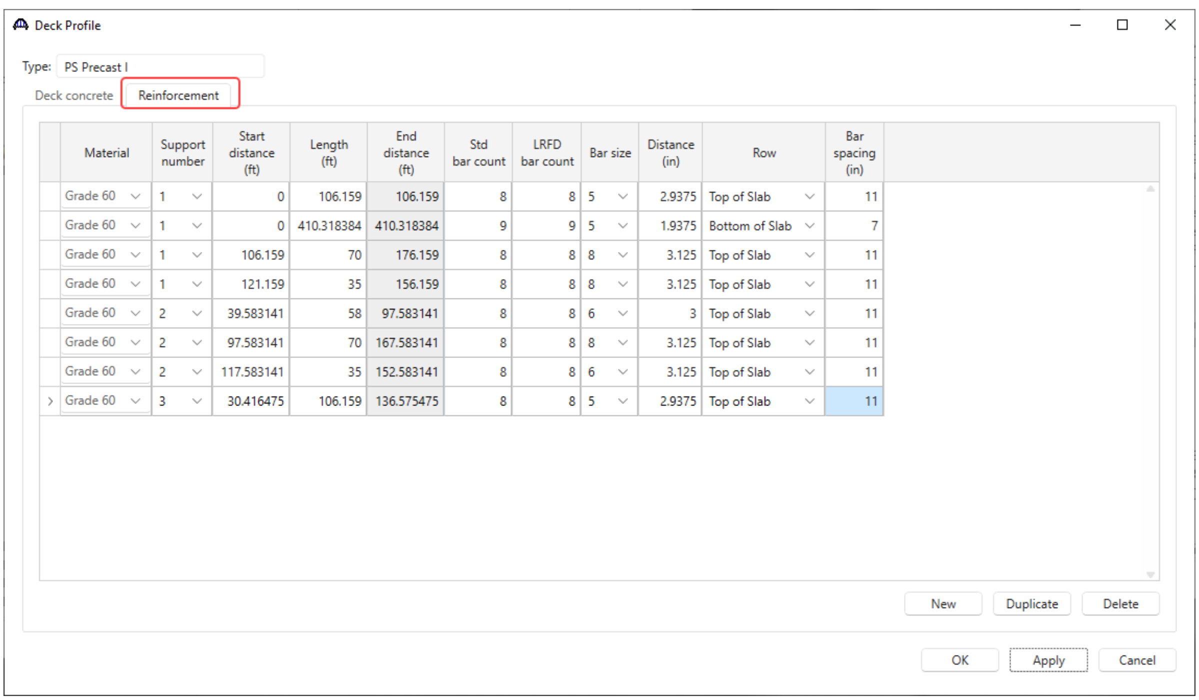
Repeat the process to describe the same strand layout for **Span 2** and **Span 3**. Span 2 Harp point is located at **54.16666** ft and Span 3 Harp point is located at **54.45460** ft.

Deck Profile

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.



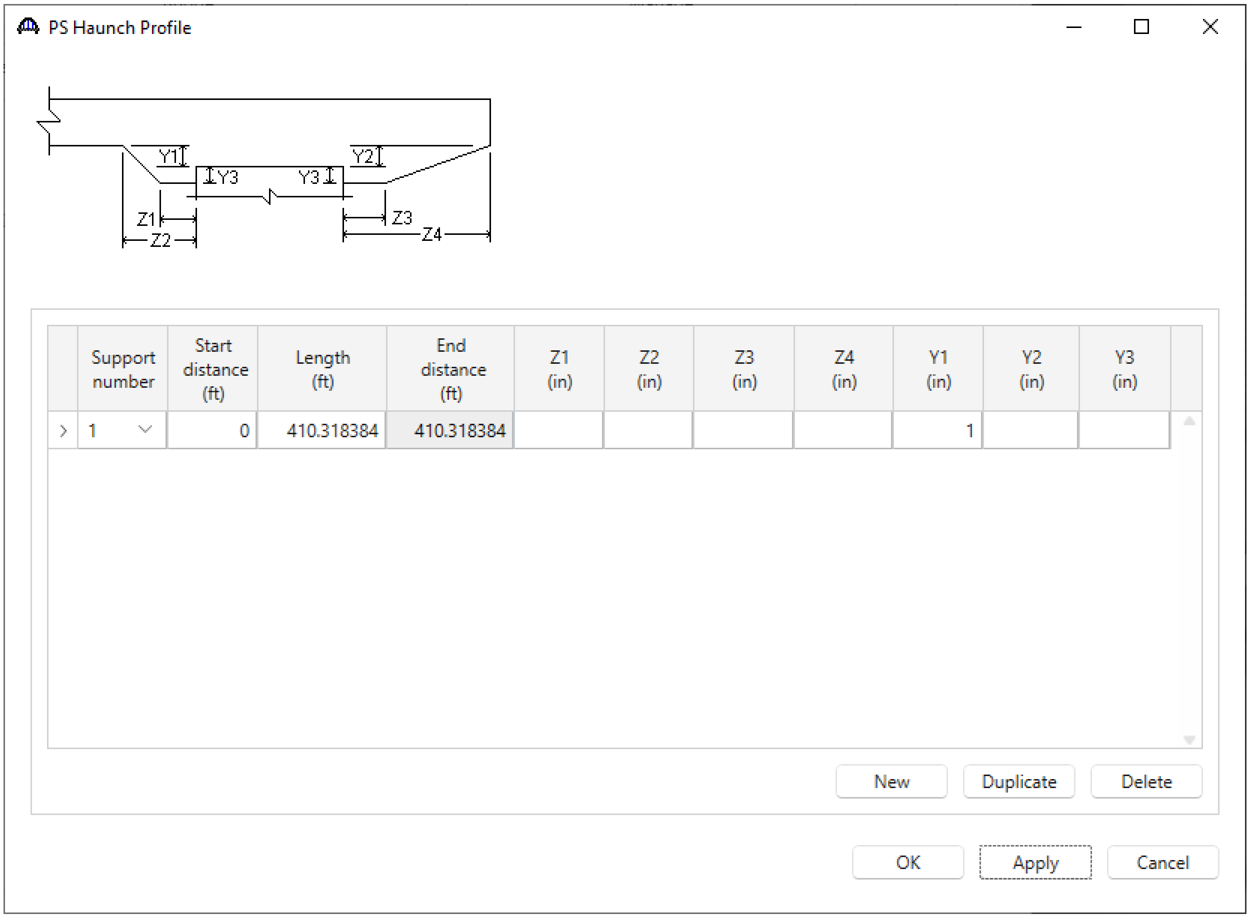
Navigate to the **Reinforcement** tab and describe the deck reinforcement as shown below.



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

Haunch Profile

The haunch profile is defined by double-clicking on the **Haunch Profile** node in the **Bridge Workspace** tree. Enter data as shown below and Click **OK** to apply the data and close the window.

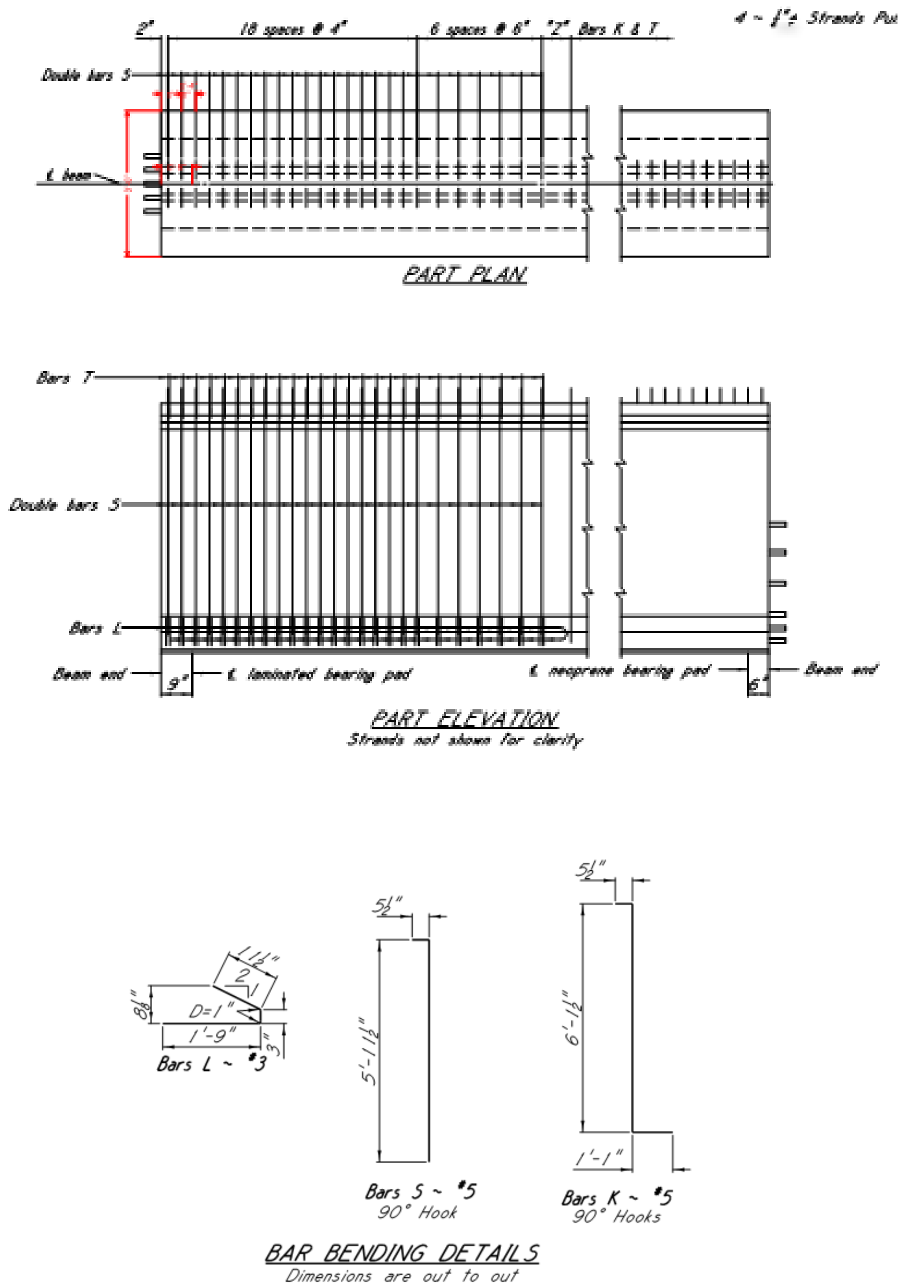


Click **OK** to apply the data and close the window.

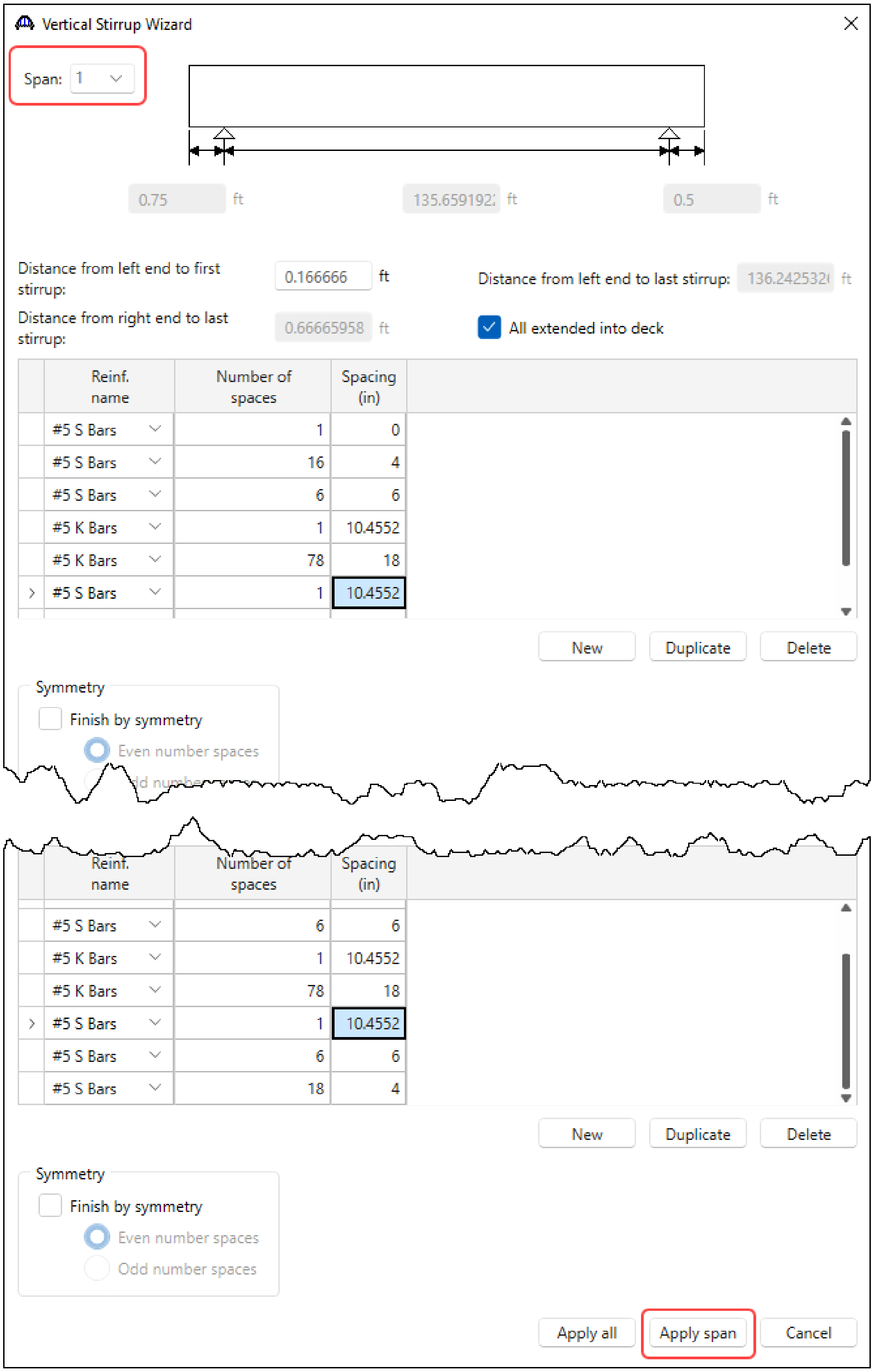
Shear Reinforcement Ranges

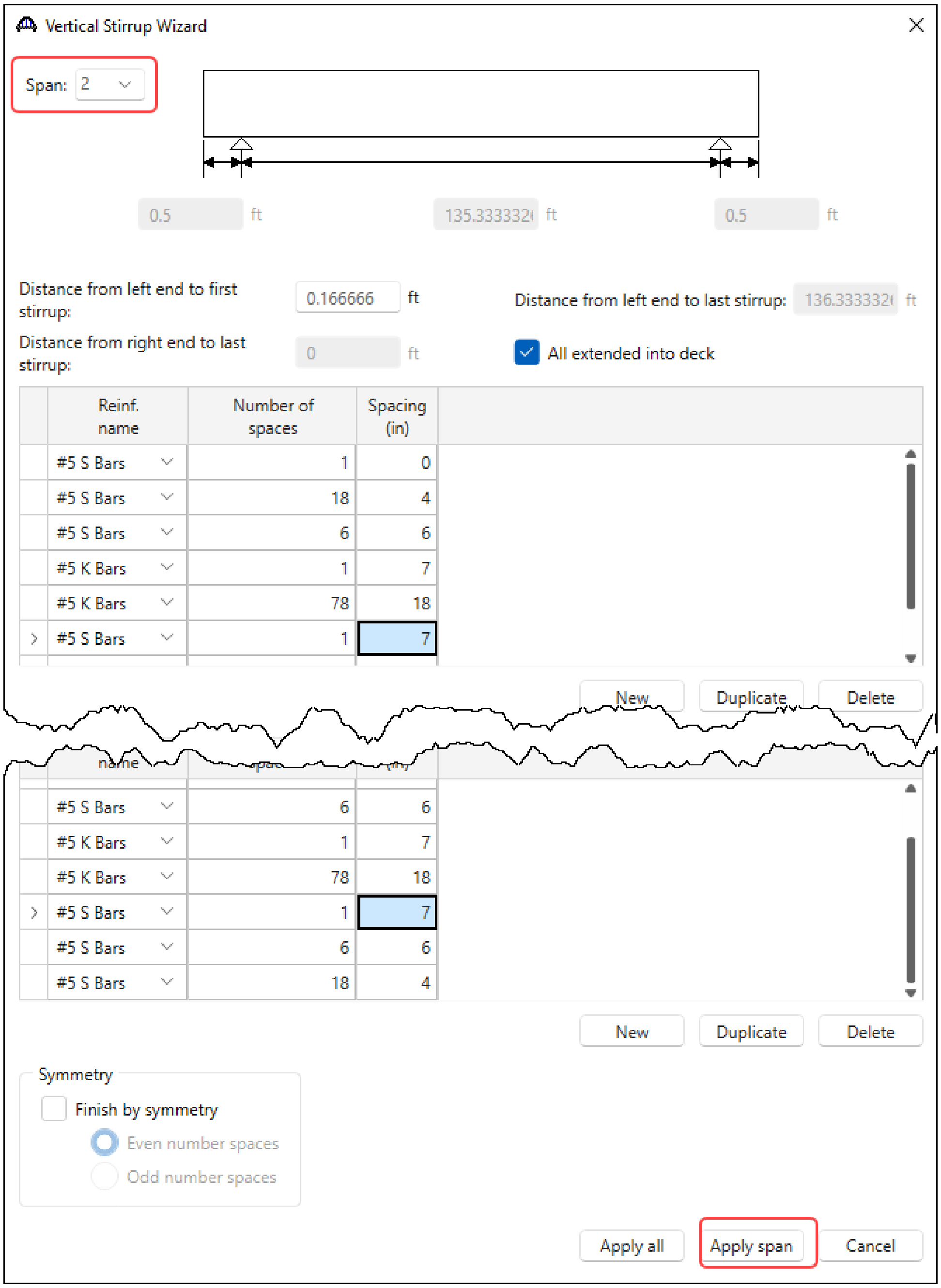
Use the **Stirrup wizard** from the **Shear Reinforcement Ranges** window to create the following shear stirrups. Double-click on the **Shear Reinforcement Ranges** node in the **Bridge Workspace** tree to open the **PS Shear Reinforcement Ranges** window.

Beam elevation showing stirrups

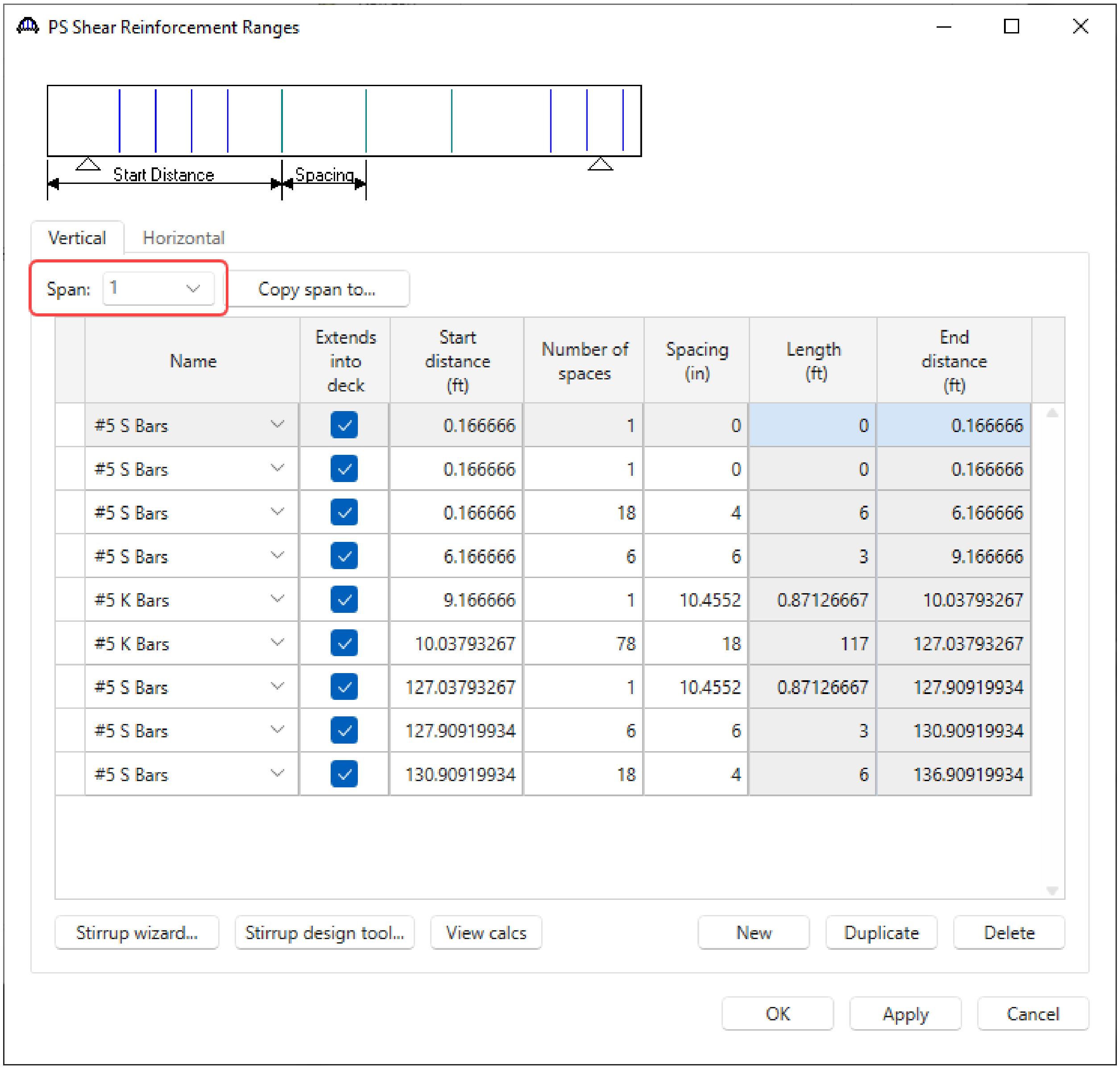


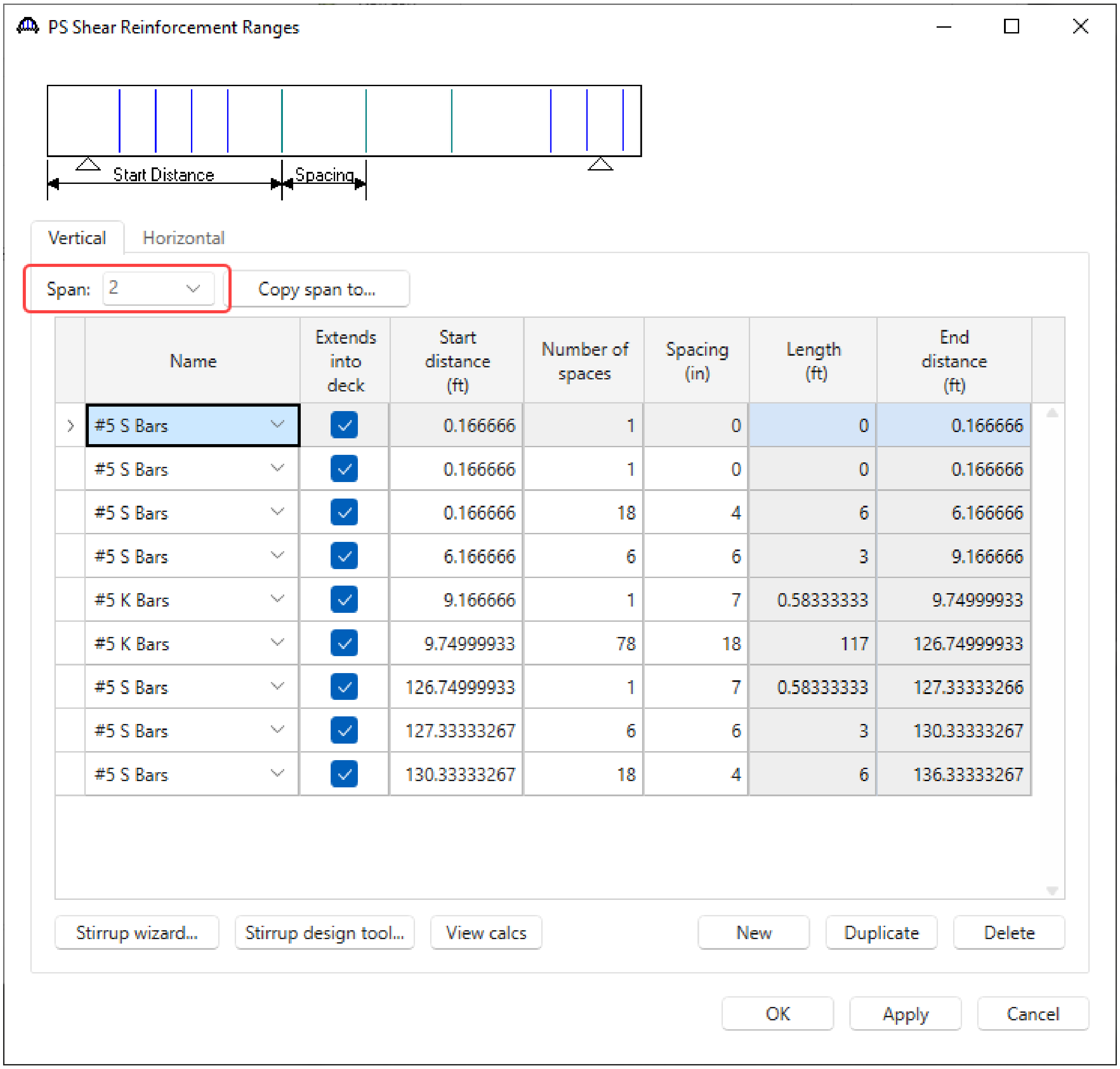
Click on the **Stirrup Wizard** button and enter the following data for each span as shown below.



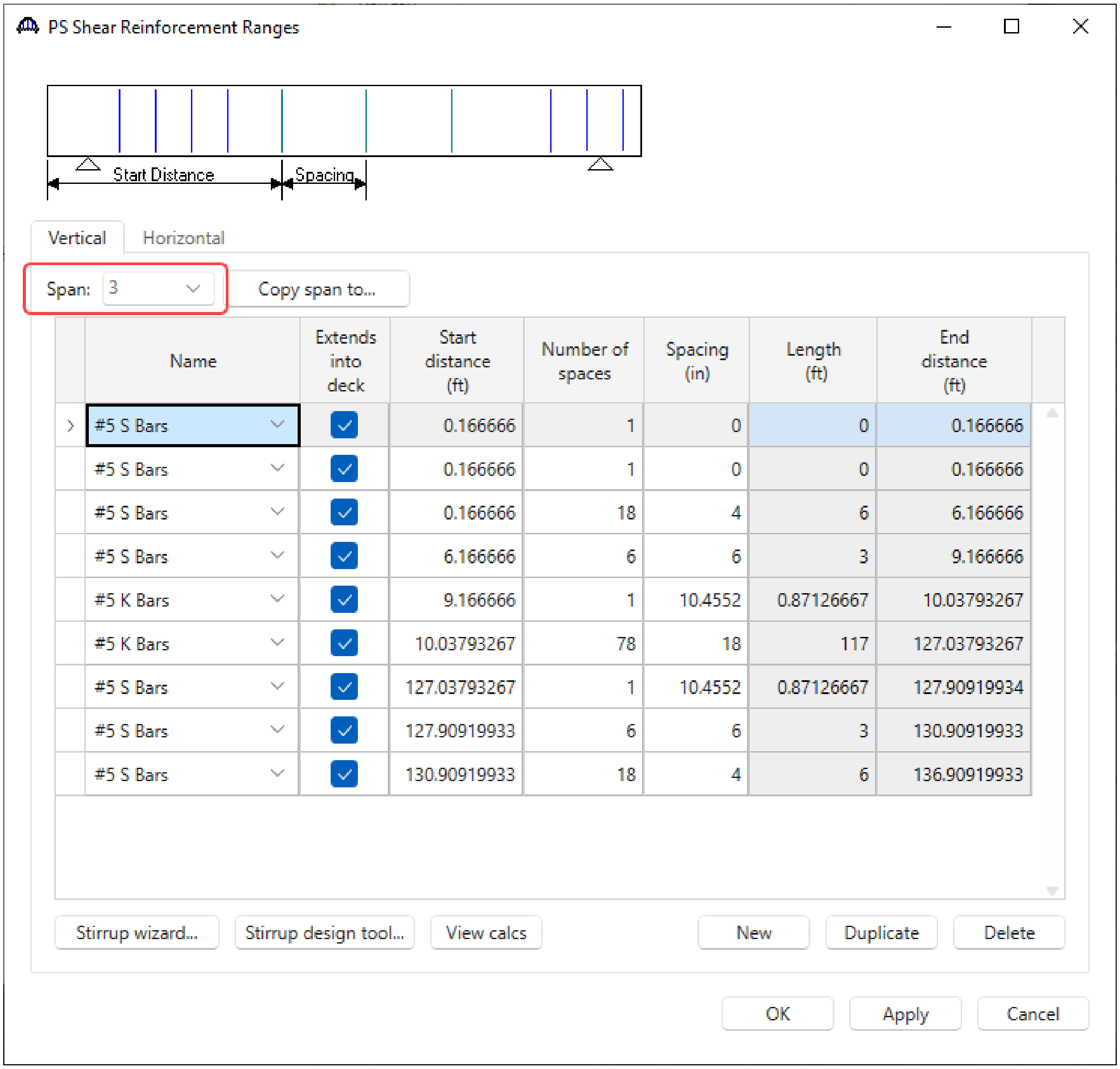

Vertical Stirrup Wizard
Span: 2
0.5 ft
135.333332 ft
0.5 ft
Distance from left end to first stirrup: 0.166666 ft
Distance from left end to last stirrup: 136.333332 ft
Distance from right end to last stirrup: 0 ft
All extended into deck
Reinf. name
Number of spaces
Spacing (in)
#5 S Bars 1 0
#5 S Bars 18 4
#5 S Bars 6 6
#5 K Bars 1 7
#5 K Bars 78 18
#5 S Bars 1 7
New
Duplicate
Delete
name
#5 S Bars 6 6
#5 K Bars 1 7
#5 K Bars 78 18
#5 S Bars 1 7
#5 S Bars 6 6
#5 S Bars 18 4
New
Duplicate
Delete
Symmetry
Finish by symmetry
Even number spaces
Odd number spaces
Apply all
Apply span
Cancel

Click **Apply all** and the wizard closes returning to the **PS Shear Reinforcement Ranges** window populated as shown below.


PS Shear Reinforcement Ranges
Start Distance
Spacing
Vertical
Horizontal
Span: 1
Copy span to...
Name | Extends into deck | Start distance (ft) | Number of spaces | Spacing (in) | Length (ft) | End distance (ft)
#5 S Bars | 0.166666 | 1 | 0 | 0 | 0.166666
#5 S Bars | 0.166666 | 1 | 0 | 0 | 0.166666
#5 S Bars | 0.166666 | 18 | 4 | 6 | 6.166666
#5 S Bars | 6.166666 | 6 | 6 | 3 | 9.166666
#5 K Bars | 9.166666 | 1 | 10.4552 | 0.87126667 | 10.03793267
#5 K Bars | 10.03793267 | 78 | 18 | 117 | 127.03793267
#5 S Bars | 127.03793267 | 1 | 10.4552 | 0.87126667 | 127.90919934
#5 S Bars | 127.90919934 | 6 | 6 | 3 | 130.90919934
#5 S Bars | 130.90919934 | 18 | 4 | 6 | 136.90919934
Stirrup wizard...
Stirrup design tool...
View calcs
New
Duplicate
Delete
OK
Apply
Cancel



Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	0.166666	18	4	6	6.166666
#5 S Bars	✓	6.166666	6	6	3	9.166666
#5 K Bars	✓	9.166666	1	7	0.58333333	9.74999933
#5 K Bars	✓	9.74999933	78	18	117	126.74999933
#5 S Bars	✓	126.74999933	1	7	0.58333333	127.33333266
#5 S Bars	✓	127.33333267	6	6	3	130.33333267
#5 S Bars	✓	130.33333267	18	4	6	136.33333267



Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	0.166666	18	4	6	6.166666
#5 S Bars	✓	6.166666	6	6	3	9.166666
#5 K Bars	✓	9.166666	1	10.4552	0.87126667	10.03793267
#5 K Bars	✓	10.03793267	78	18	117	127.03793267
#5 S Bars	✓	127.03793267	1	10.4552	0.87126667	127.90919934
#5 S Bars	✓	127.90919933	6	6	3	130.90919933
#5 S Bars	✓	130.90919933	18	4	6	136.90919933

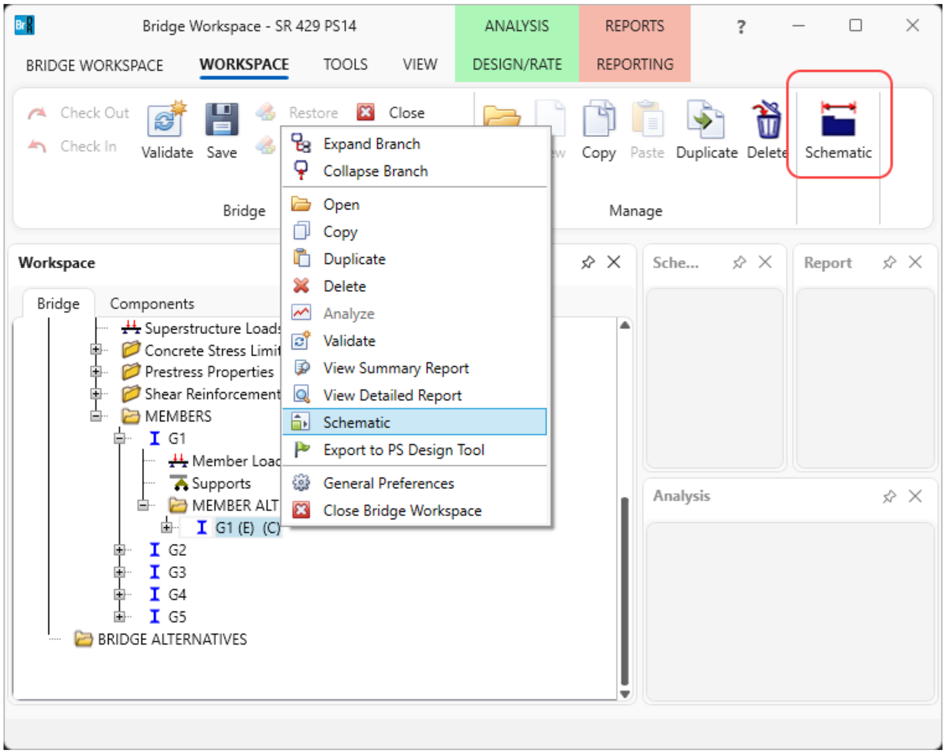
Click **OK** to apply the data and close the window.

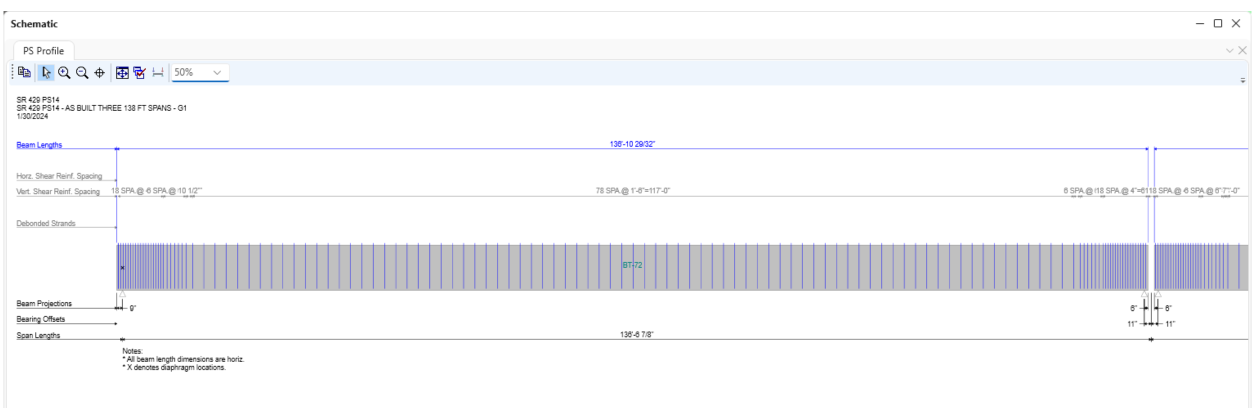
Live Load Distribution

The live load distribution factors will be computed by the BrDR LRFD engine during analysis.

Schematic – G1 Member Alternative

While the member alternative **G1 (E) (C)** is selected in the **Bridge Workspace** tree, open the schematic for the member alternative by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **G1 (E) (C)** in the **Bridge Workspace** and select **Schematic** from the menu).





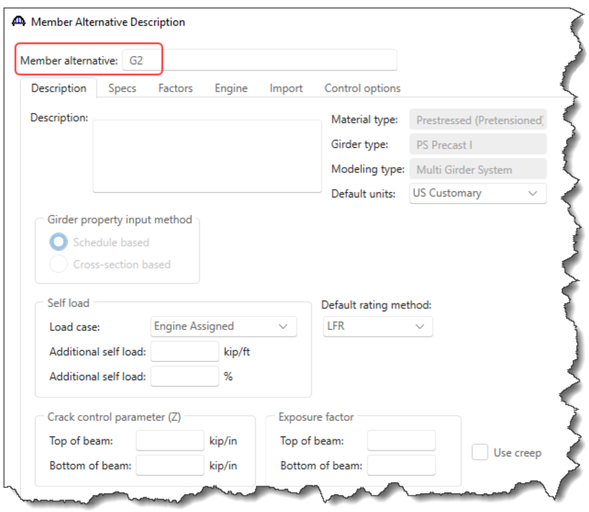
Girder 1 is complete. Girders G2-G5 are similar but the lengths are different.

Harp Locations			
Girder	Span 1	Span 2	Span 3
1	54.45460	54.16667	54.45460
2	54.48771	54.16667	54.48771
3	54.52083	54.16667	54.52083
4	54.55395	54.16667	54.55395
5	54.58707	54.16667	54.58707

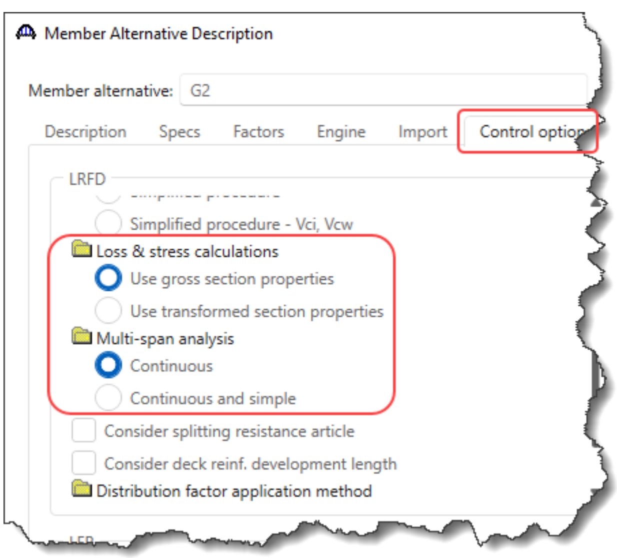
Enter the girder G2-G5 and see images to update the differences in windows shown below.

Girder G2

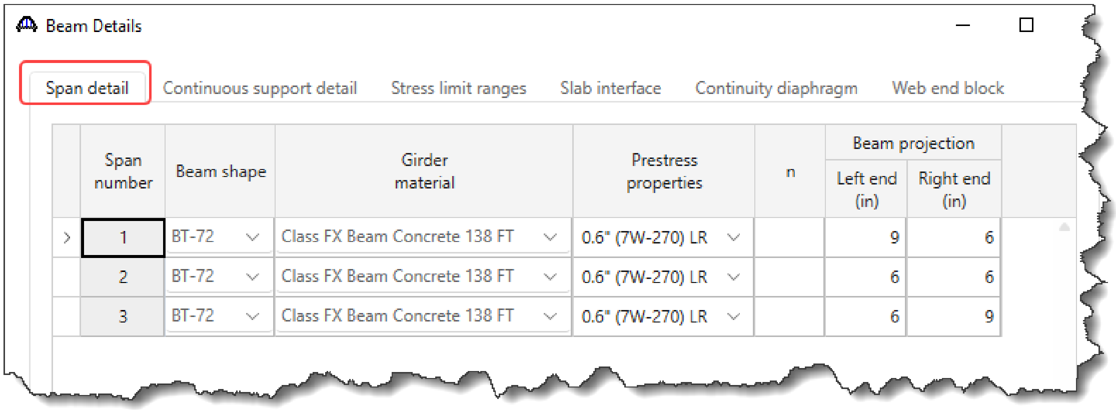
Member Alternative Description



Member Alternative Description – Control Options

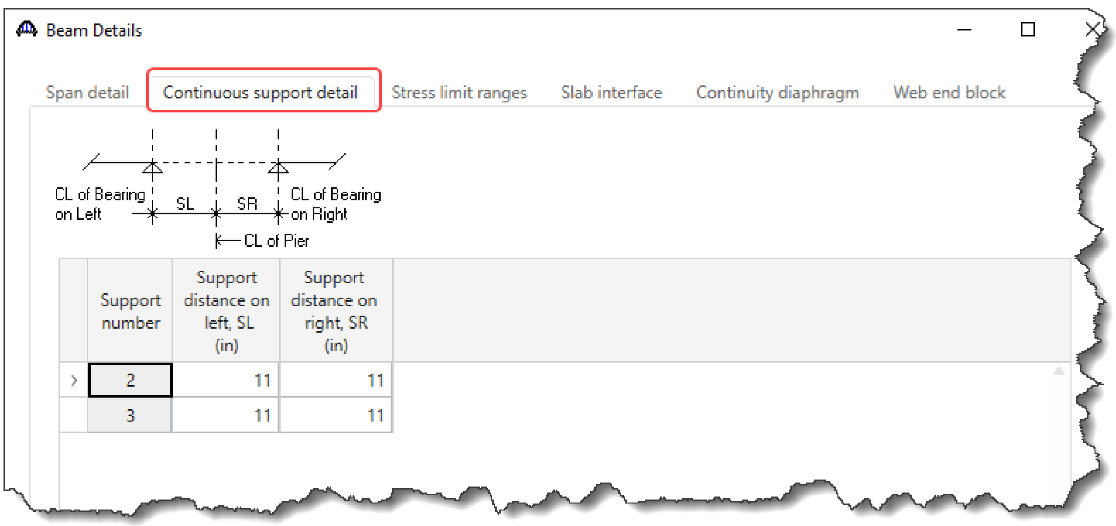


Beam Details – Span detail



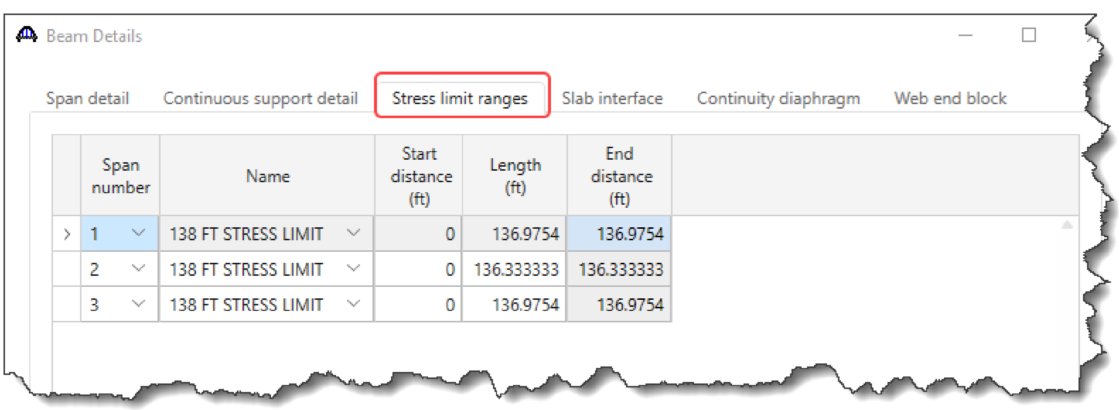
Span number	Beam shape	Girder material	Prestress properties	n	Beam projection Left end (in)	Beam projection Right end (in)
1	BT-72	Class FX Beam Concrete 138 FT	0.6" (7W-270) LR		9	6
2	BT-72	Class FX Beam Concrete 138 FT	0.6" (7W-270) LR		6	6
3	BT-72	Class FX Beam Concrete 138 FT	0.6" (7W-270) LR		6	9

Beam Details – Continuous support detail



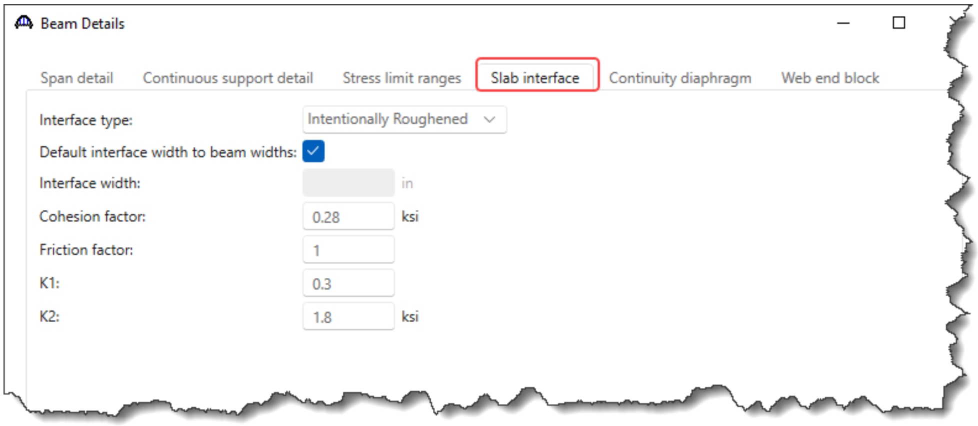
Support number	Support distance on left, SL (in)	Support distance on right, SR (in)
2	11	11
3	11	11

Beam Details – Stress limit ranges

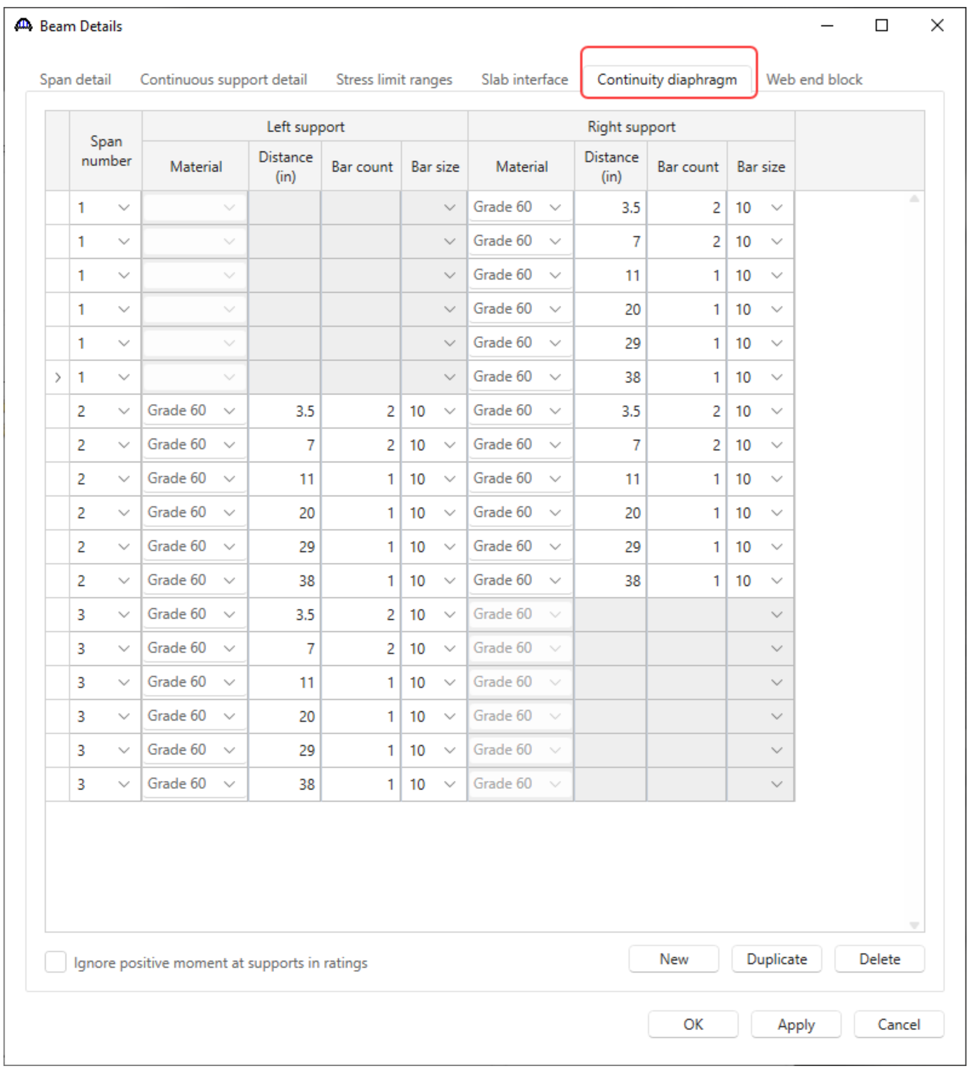


Span number	Name	Start distance (ft)	Length (ft)	End distance (ft)
1	138 FT STRESS LIMIT	0	136.9754	136.9754
2	138 FT STRESS LIMIT	0	136.333333	136.333333
3	138 FT STRESS LIMIT	0	136.9754	136.9754

Beam Details – Slab interface



Beam Details – Continuity diaphragm



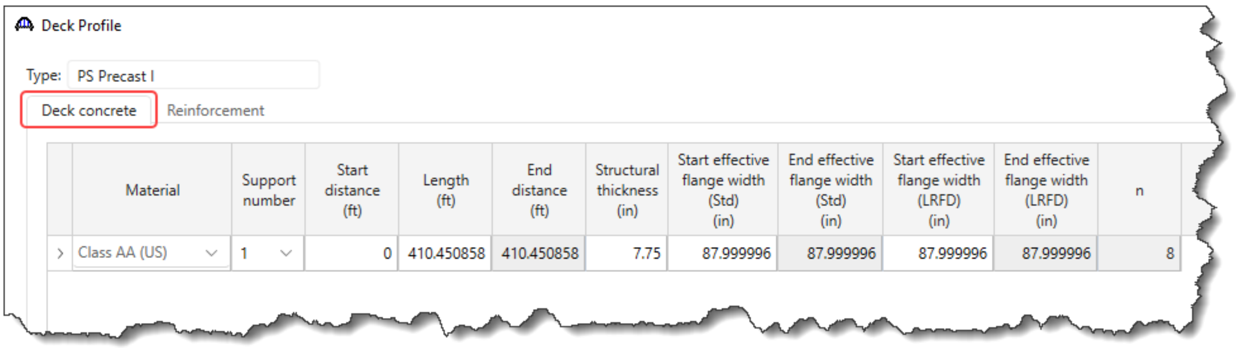
Span number	Left support				Right support			
	Material	Distance (in)	Bar count	Bar size	Material	Distance (in)	Bar count	Bar size
1					Grade 60	3.5	2	10
1					Grade 60	7	2	10
1					Grade 60	11	1	10
1					Grade 60	20	1	10
1					Grade 60	29	1	10
1					Grade 60	38	1	10
2	Grade 60	3.5	2	10	Grade 60	3.5	2	10
2	Grade 60	7	2	10	Grade 60	7	2	10
2	Grade 60	11	1	10	Grade 60	11	1	10
2	Grade 60	20	1	10	Grade 60	20	1	10
2	Grade 60	29	1	10	Grade 60	29	1	10
2	Grade 60	38	1	10	Grade 60	38	1	10
3	Grade 60	3.5	2	10	Grade 60			
3	Grade 60	7	2	10	Grade 60			
3	Grade 60	11	1	10	Grade 60			
3	Grade 60	20	1	10	Grade 60			
3	Grade 60	29	1	10	Grade 60			
3	Grade 60	38	1	10	Grade 60			

Strand Layout

Strand layout is similar to **G1**, but the length is different. See below for **G2** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations			
Girder	Span 1	Span 2	Span 3
2	54.48771	54.16667	54.48771

Deck Profile – Deck concrete



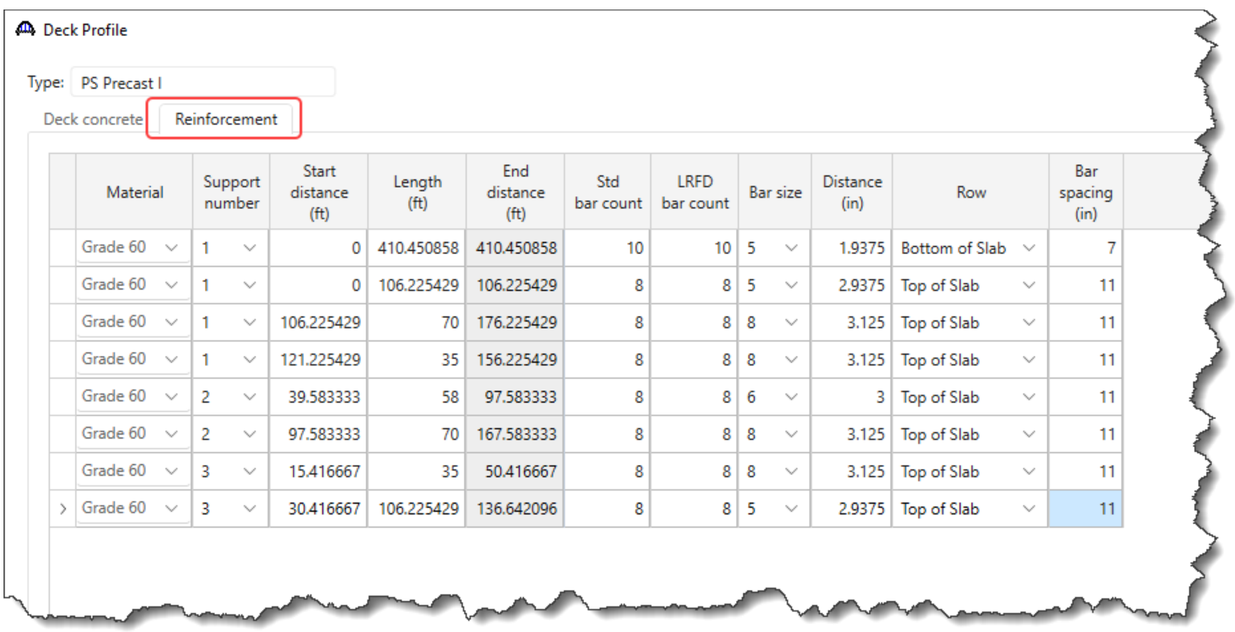
Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	410.450858	410.450858	7.75	87.999996	87.999996	87.999996	87.999996	8

Deck Profile – Reinforcement



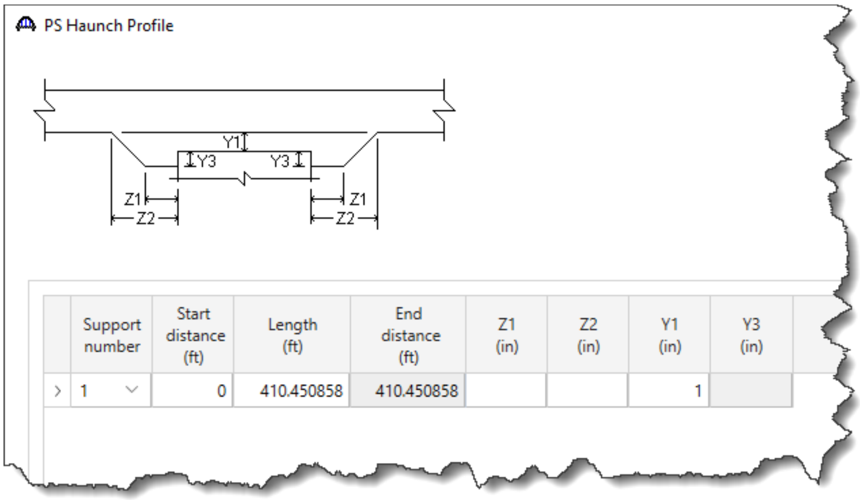
Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

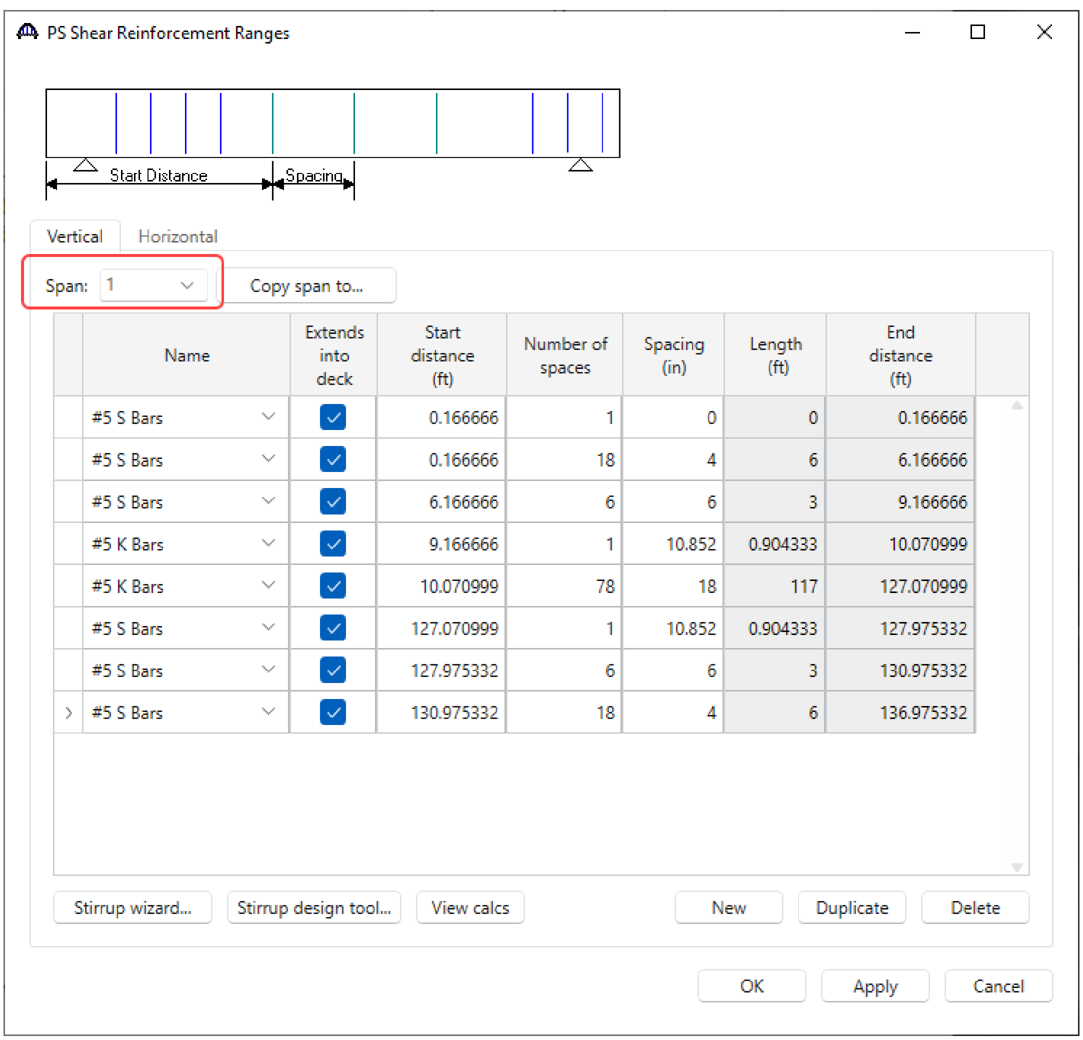
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	410.450858	410.450858	10	10	5	1.9375	Bottom of Slab	7
Grade 60	1	0	106.225429	106.225429	8	8	5	2.9375	Top of Slab	11
Grade 60	1	106.225429	70	176.225429	8	8	8	3.125	Top of Slab	11
Grade 60	1	121.225429	35	156.225429	8	8	8	3.125	Top of Slab	11
Grade 60	2	39.583333	58	97.583333	8	8	6	3	Top of Slab	11
Grade 60	2	97.583333	70	167.583333	8	8	8	3.125	Top of Slab	11
Grade 60	3	15.416667	35	50.416667	8	8	8	3.125	Top of Slab	11
Grade 60	3	30.416667	106.225429	136.642096	8	8	5	2.9375	Top of Slab	11

PS Haunch Profile

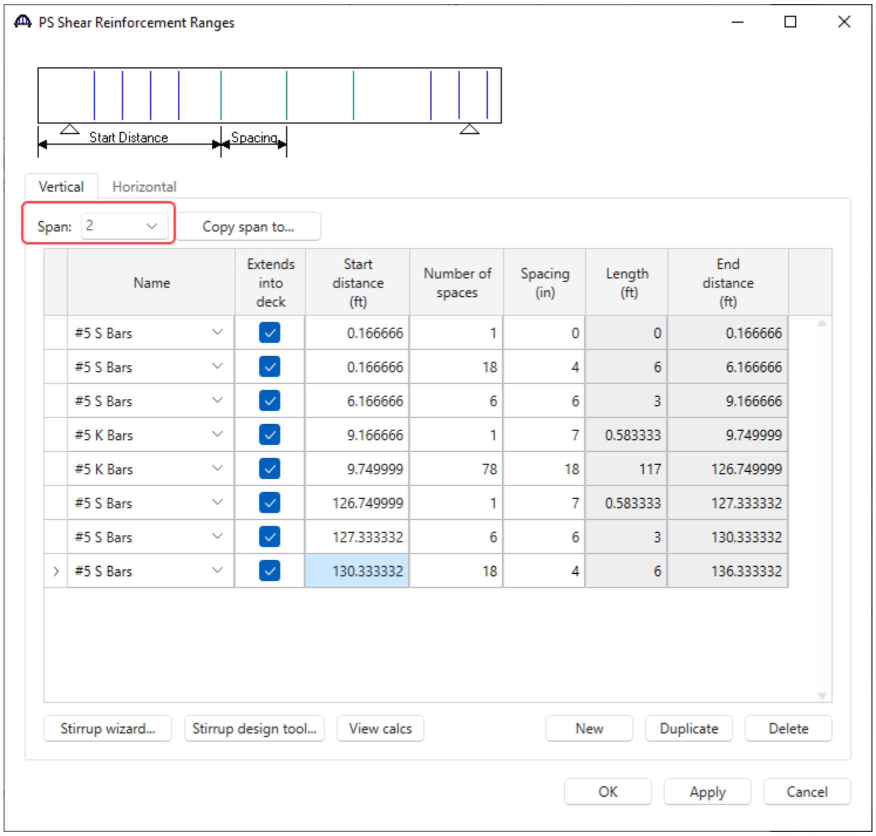


	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
>	1	0	410.450858	410.450858			1	

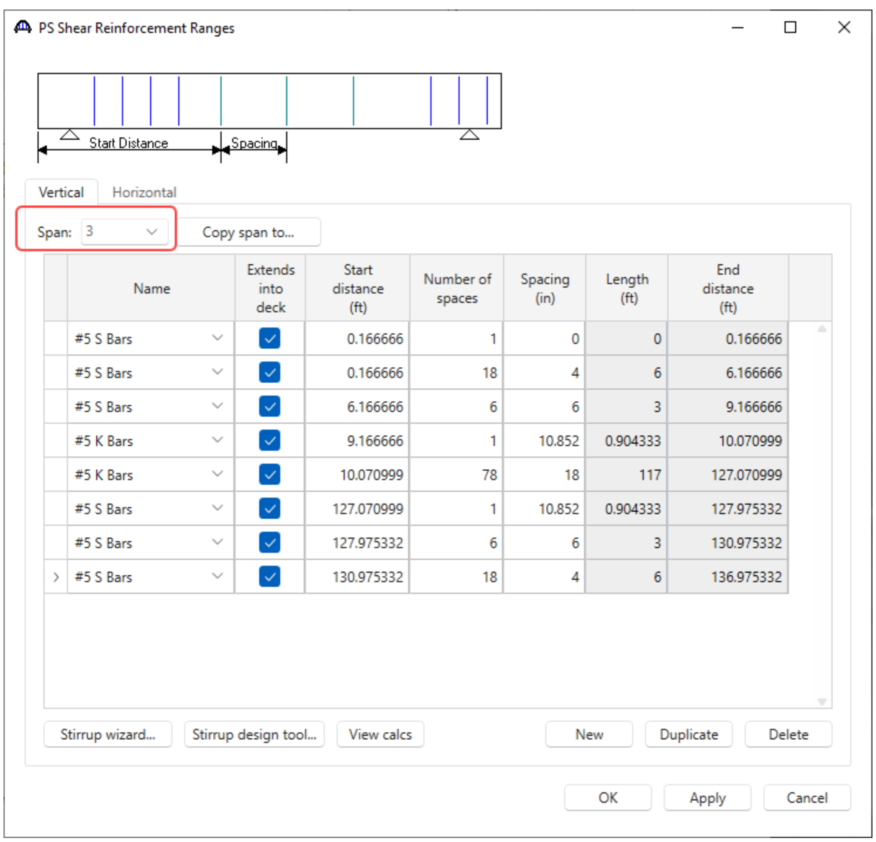
PS Shear Reinforcement Ranges



	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
	#5 S Bars	☑	0.166666	1	0	0	0.166666
	#5 S Bars	☑	0.166666	18	4	6	6.166666
	#5 S Bars	☑	6.166666	6	6	3	9.166666
	#5 K Bars	☑	9.166666	1	10.852	0.904333	10.070999
	#5 K Bars	☑	10.070999	78	18	117	127.070999
	#5 S Bars	☑	127.070999	1	10.852	0.904333	127.975332
	#5 S Bars	☑	127.975332	6	6	3	130.975332
>	#5 S Bars	☑	130.975332	18	4	6	136.975332



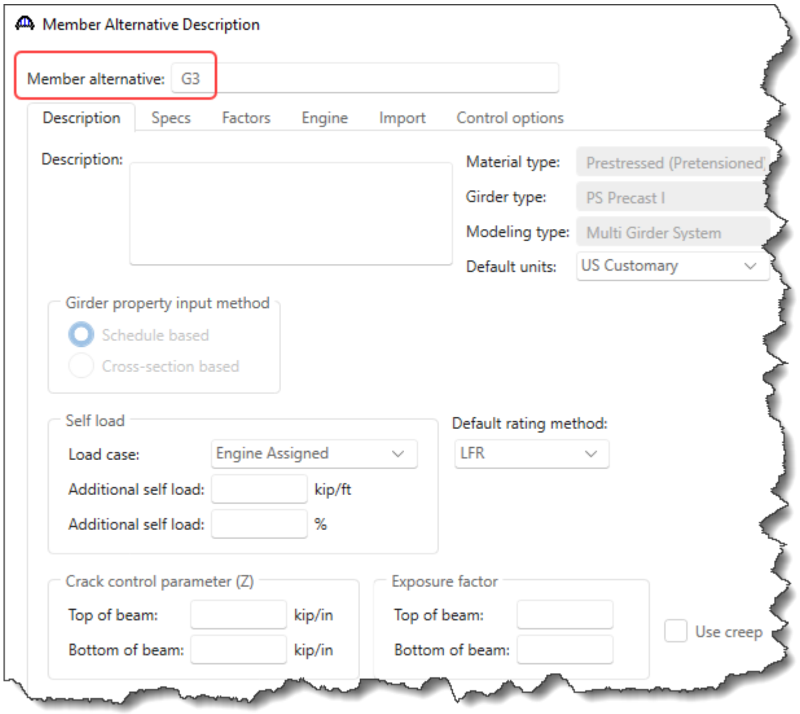
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	☑	0.166666	1	0	0	0.166666
#5 S Bars	☑	0.166666	18	4	6	6.166666
#5 S Bars	☑	6.166666	6	6	3	9.166666
#5 K Bars	☑	9.166666	1	7	0.583333	9.749999
#5 K Bars	☑	9.749999	78	18	117	126.749999
#5 S Bars	☑	126.749999	1	7	0.583333	127.333332
#5 S Bars	☑	127.333332	6	6	3	130.333332
#5 S Bars	☑	130.333332	18	4	6	136.333332



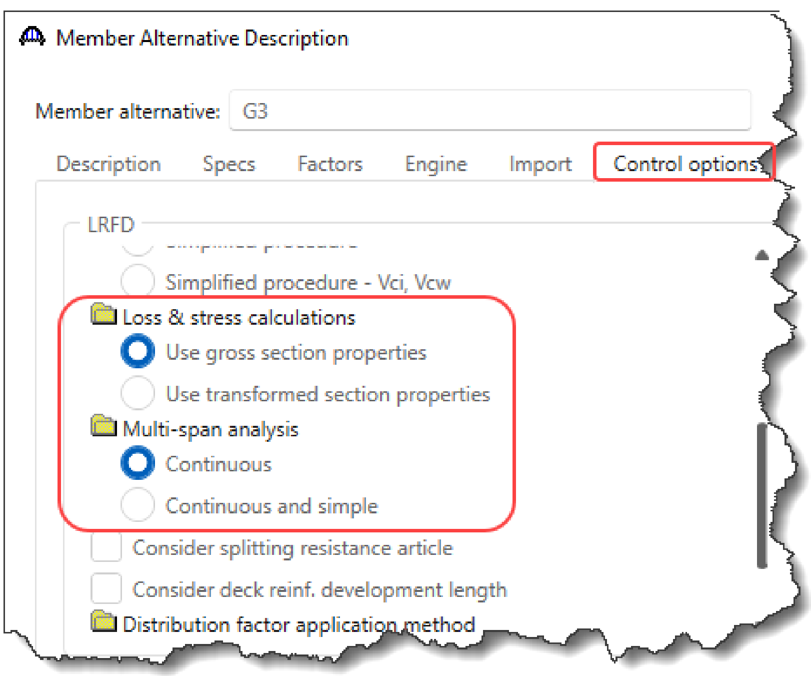
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	☑	0.166666	1	0	0	0.166666
#5 S Bars	☑	0.166666	18	4	6	6.166666
#5 S Bars	☑	6.166666	6	6	3	9.166666
#5 K Bars	☑	9.166666	1	10.852	0.904333	10.070999
#5 K Bars	☑	10.070999	78	18	117	127.070999
#5 S Bars	☑	127.070999	1	10.852	0.904333	127.975332
#5 S Bars	☑	127.975332	6	6	3	130.975332
#5 S Bars	☑	130.975332	18	4	6	136.975332

Girder G3

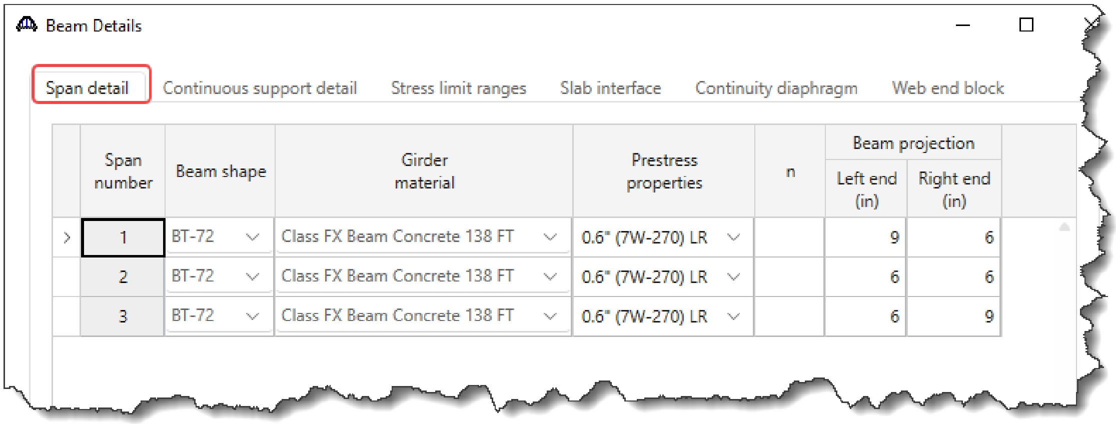
Member Alternative Description



Member Alternative Description – Control Options

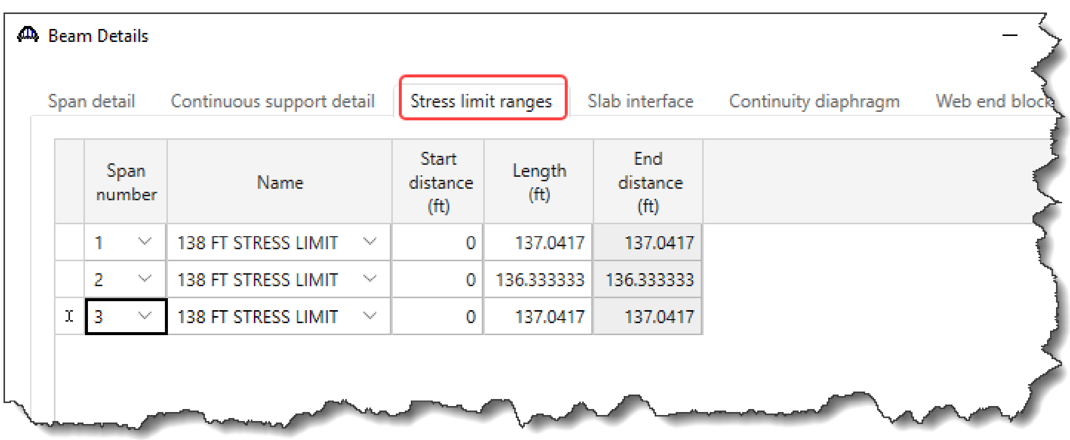


Beam Details – Span detail

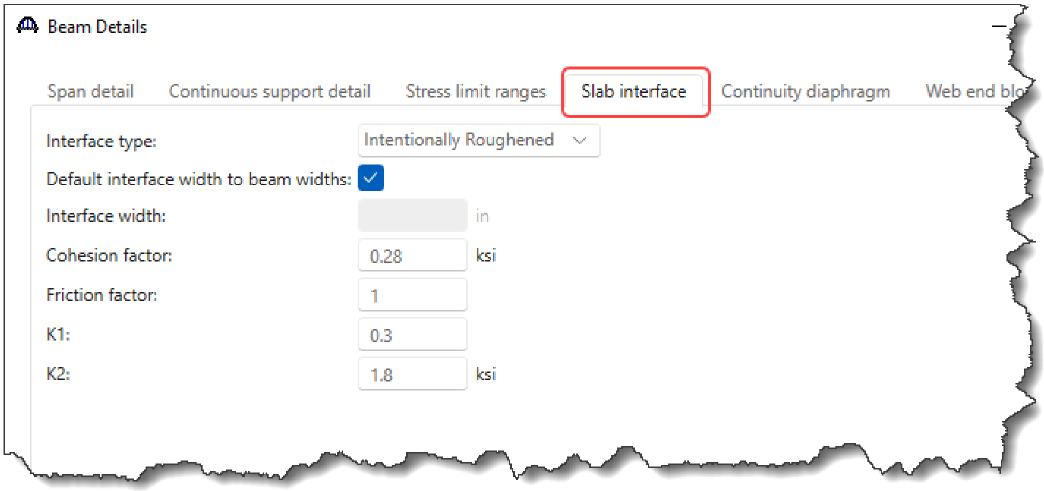


Beam Details – Continuous support detail

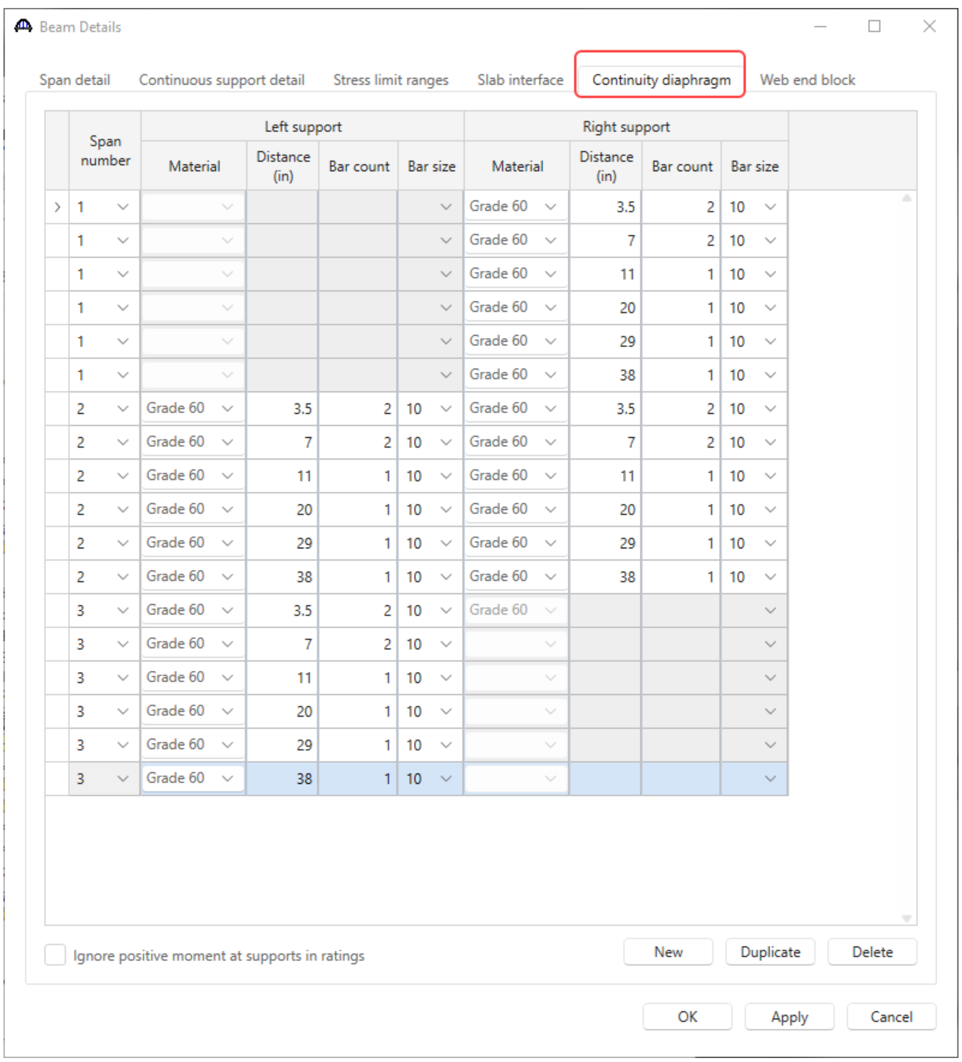
Beam Details – Stress limit ranges



Beam Details – Slab interface



Beam Details – Continuity diaphragm



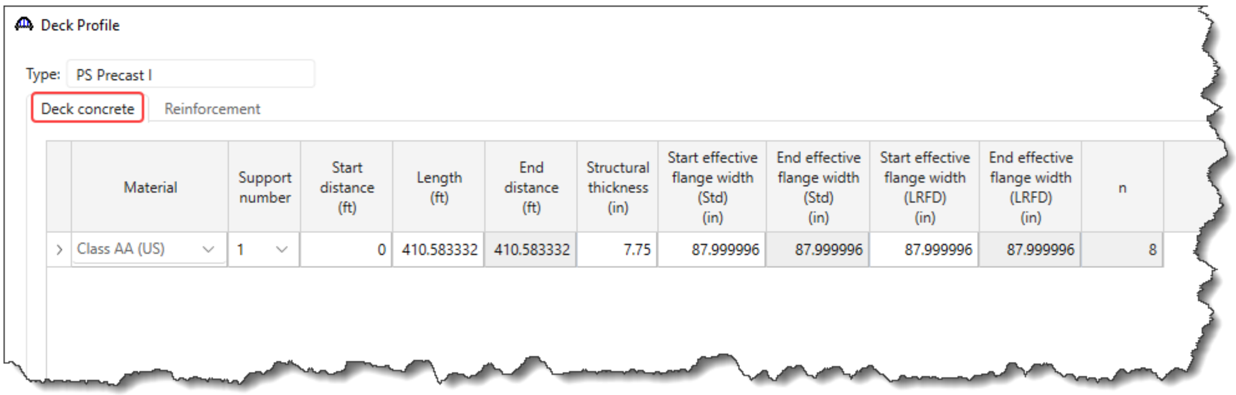
Span number	Left support Material	Left support Distance (in)	Left support Bar count	Left support Bar size	Right support Material	Right support Distance (in)	Right support Bar count	Right support Bar size
1					Grade 60	3.5	2	10
1					Grade 60	7	2	10
1					Grade 60	11	1	10
1					Grade 60	20	1	10
1					Grade 60	29	1	10
1					Grade 60	38	1	10
2	Grade 60	3.5	2	10	Grade 60	3.5	2	10
2	Grade 60	7	2	10	Grade 60	7	2	10
2	Grade 60	11	1	10	Grade 60	11	1	10
2	Grade 60	20	1	10	Grade 60	20	1	10
2	Grade 60	29	1	10	Grade 60	29	1	10
2	Grade 60	38	1	10	Grade 60	38	1	10
3	Grade 60	3.5	2	10	Grade 60			
3	Grade 60	7	2	10				
3	Grade 60	11	1	10				
3	Grade 60	20	1	10				
3	Grade 60	29	1	10				
3	Grade 60	38	1	10				

Strand Layout

Strand layout is similar to **G1**, but the length is different. See below for **G3** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations			
Girder	Span 1	Span 2	Span 3
3	54.52083	54.16667	54.52083

Deck Profile – Deck concrete

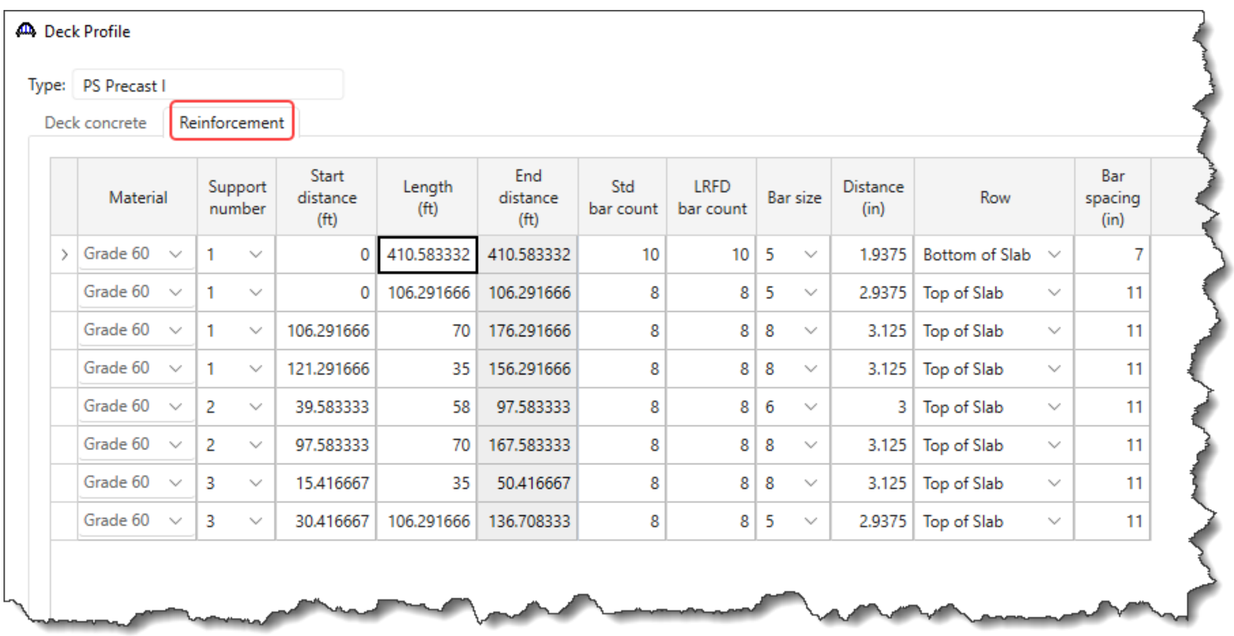

Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	410.583332	410.583332	7.75	87.999996	87.999996	87.999996	87.999996	8

Deck Profile – Reinforcement

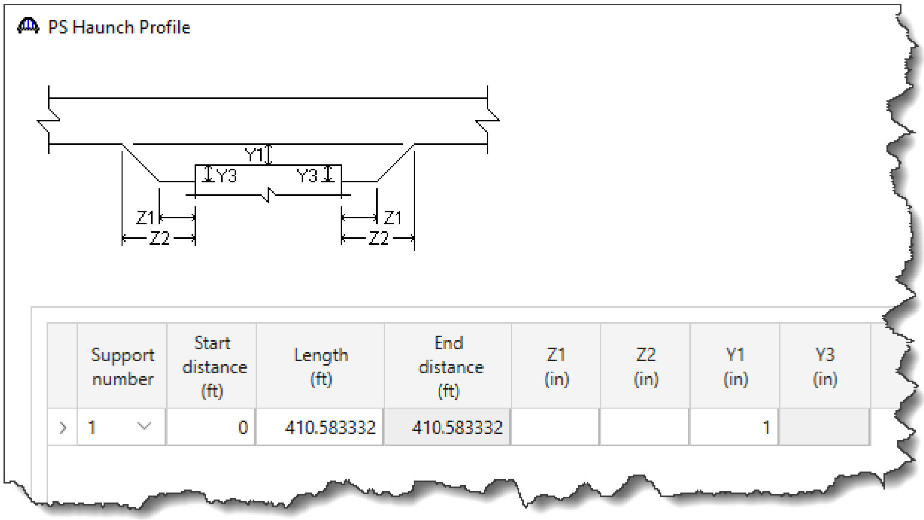

Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

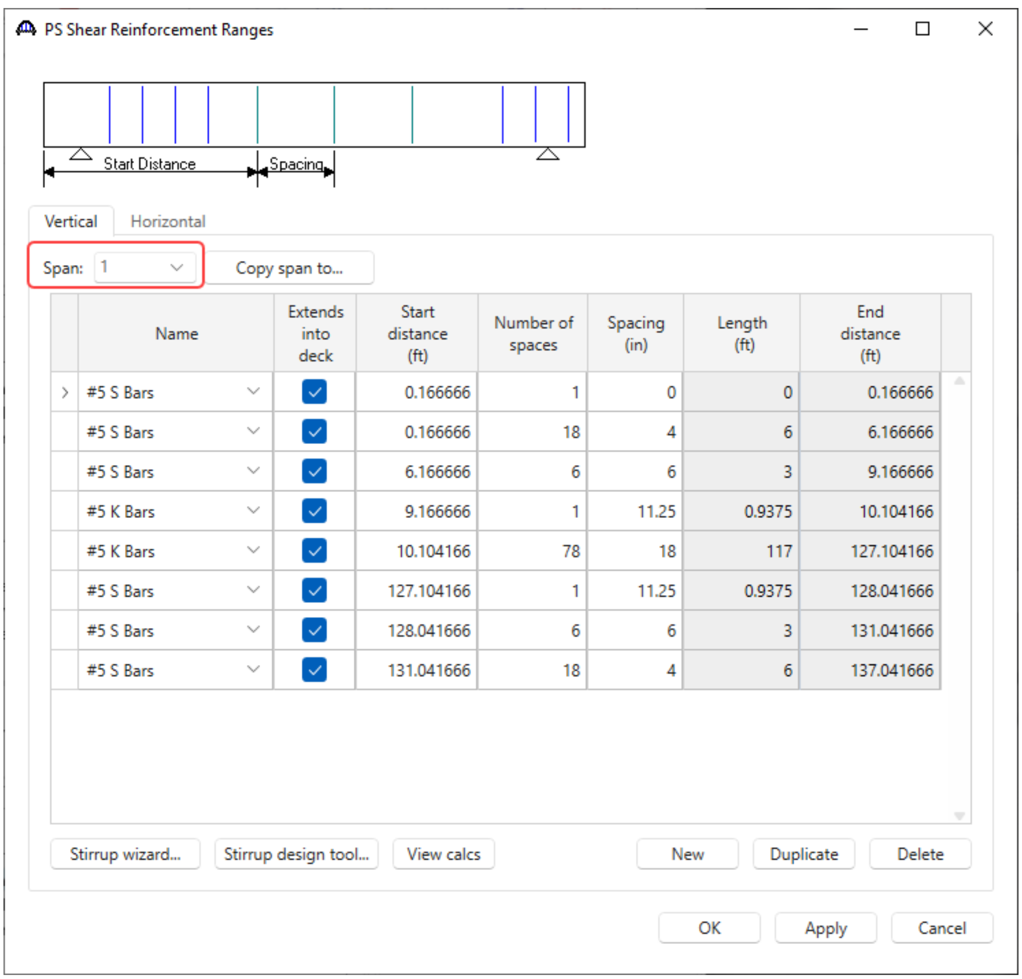
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	410.583332	410.583332	10	10	5	1.9375	Bottom of Slab	7
Grade 60	1	0	106.291666	106.291666	8	8	5	2.9375	Top of Slab	11
Grade 60	1	106.291666	70	176.291666	8	8	8	3.125	Top of Slab	11
Grade 60	1	121.291666	35	156.291666	8	8	8	3.125	Top of Slab	11
Grade 60	2	39.583333	58	97.583333	8	8	6	3	Top of Slab	11
Grade 60	2	97.583333	70	167.583333	8	8	8	3.125	Top of Slab	11
Grade 60	3	15.416667	35	50.416667	8	8	8	3.125	Top of Slab	11
Grade 60	3	30.416667	106.291666	136.708333	8	8	5	2.9375	Top of Slab	11

PS Haunch Profile

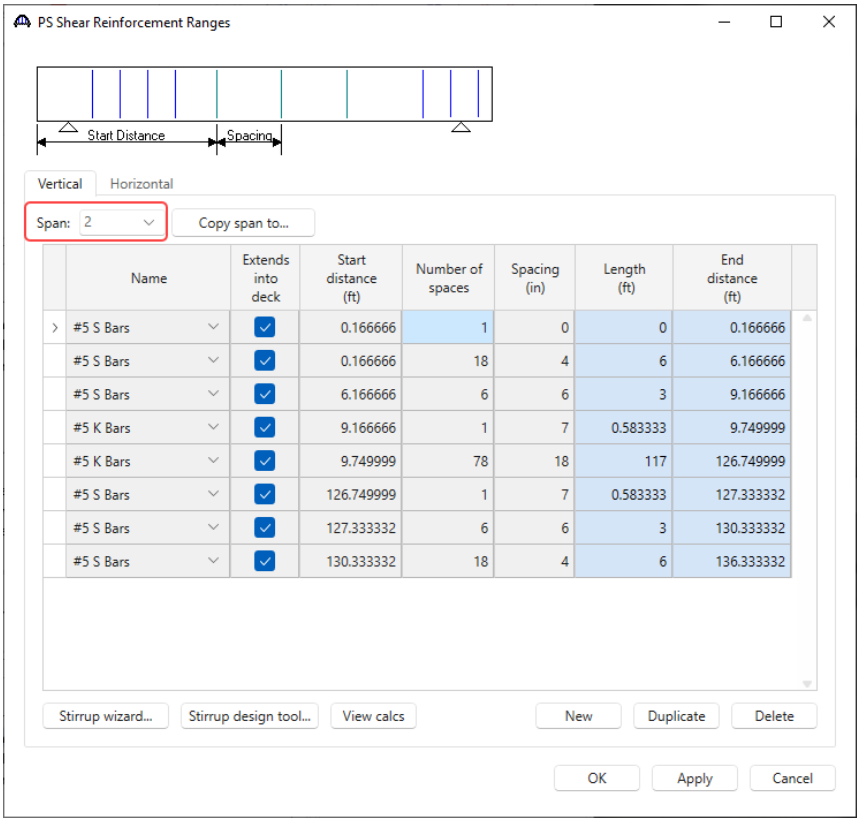


	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
›	1	0	410.583332	410.583332			1	

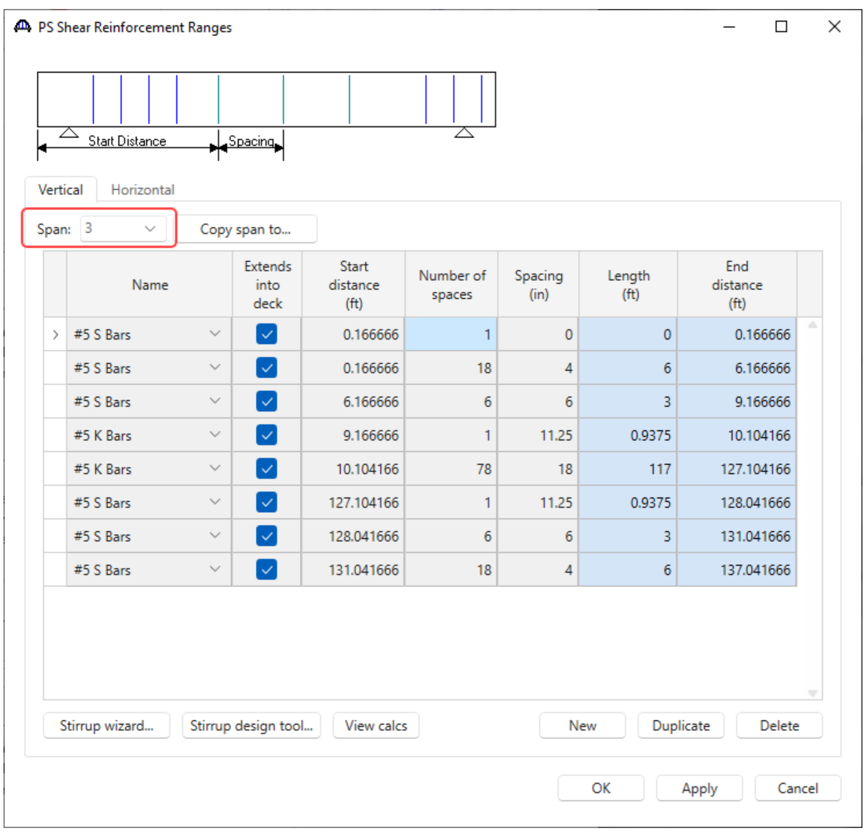
PS Shear Reinforcement Ranges



	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
›	#5 S Bars	☑	0.166666	1	0	0	0.166666
	#5 S Bars	☑	0.166666	18	4	6	6.166666
	#5 S Bars	☑	6.166666	6	6	3	9.166666
	#5 K Bars	☑	9.166666	1	11.25	0.9375	10.104166
	#5 K Bars	☑	10.104166	78	18	117	127.104166
	#5 S Bars	☑	127.104166	1	11.25	0.9375	128.041666
	#5 S Bars	☑	128.041666	6	6	3	131.041666
	#5 S Bars	☑	131.041666	18	4	6	137.041666



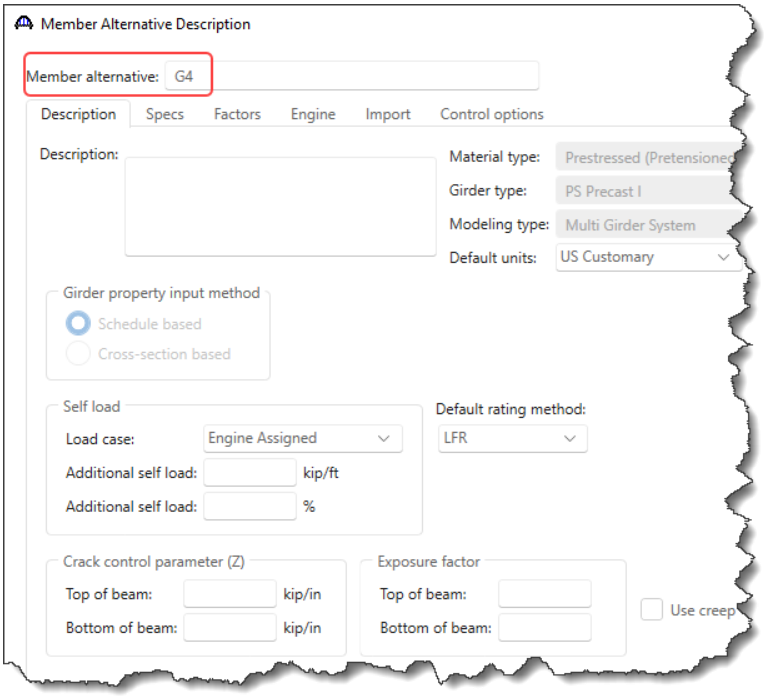
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	☑	0.166666	1	0	0	0.166666
#5 S Bars	☑	0.166666	18	4	6	6.166666
#5 S Bars	☑	6.166666	6	6	3	9.166666
#5 K Bars	☑	9.166666	1	7	0.583333	9.749999
#5 K Bars	☑	9.749999	78	18	117	126.749999
#5 S Bars	☑	126.749999	1	7	0.583333	127.333332
#5 S Bars	☑	127.333332	6	6	3	130.333332
#5 S Bars	☑	130.333332	18	4	6	136.333332



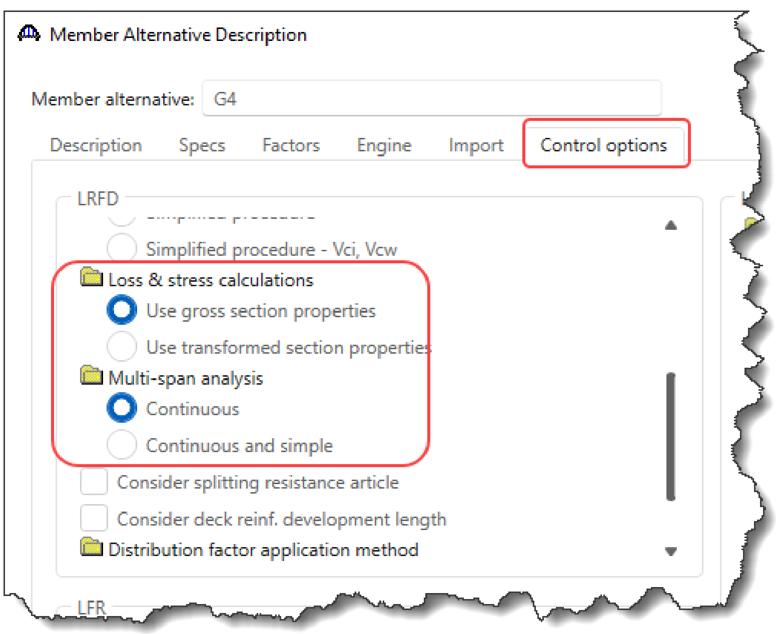
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	☑	0.166666	1	0	0	0.166666
#5 S Bars	☑	0.166666	18	4	6	6.166666
#5 S Bars	☑	6.166666	6	6	3	9.166666
#5 K Bars	☑	9.166666	1	11.25	0.9375	10.104166
#5 K Bars	☑	10.104166	78	18	117	127.104166
#5 S Bars	☑	127.104166	1	11.25	0.9375	128.041666
#5 S Bars	☑	128.041666	6	6	3	131.041666
#5 S Bars	☑	131.041666	18	4	6	137.041666

Girder G4

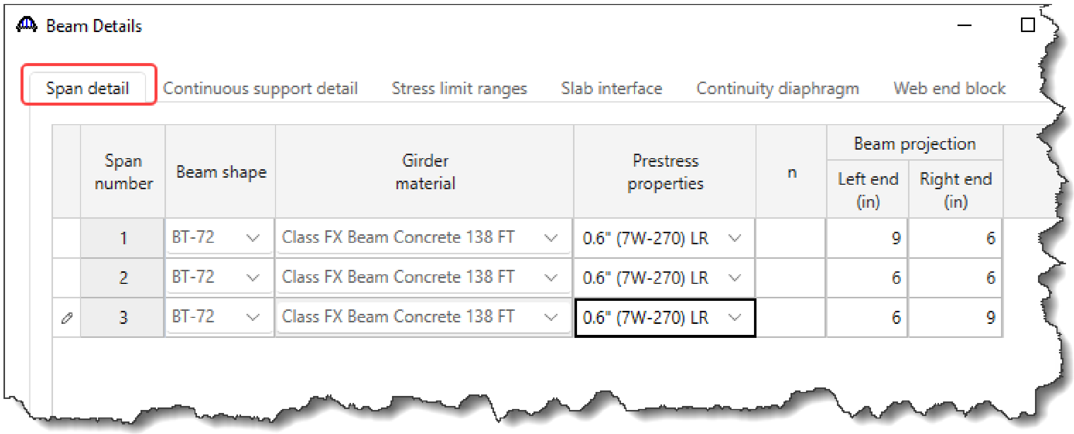
Member Alternative Description



Member Alternative Description – Control Options

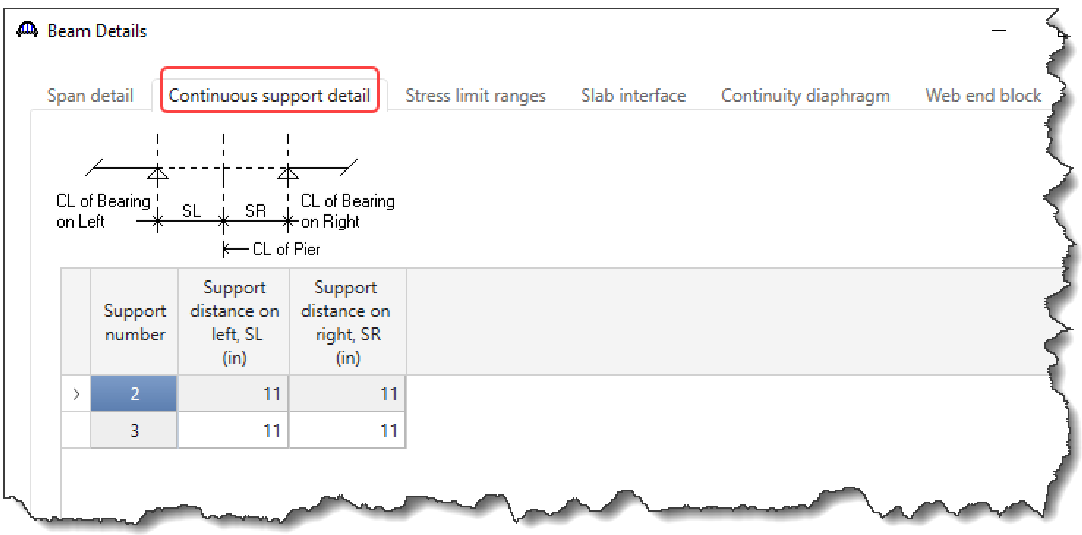


Beam Details – Span detail



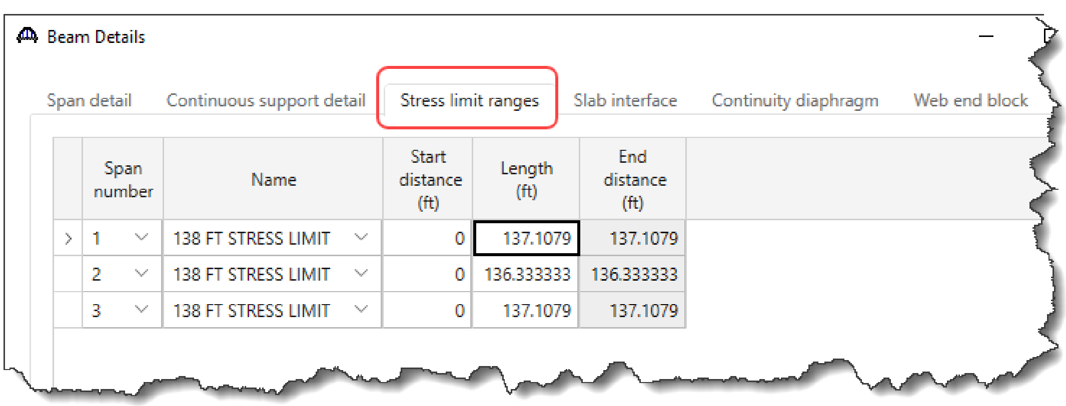
Span number	Beam shape	Girder material	Prestress properties	n	Beam projection Left end (in)	Beam projection Right end (in)
1	BT-72	Class FX Beam Concrete 138 FT	0.6" (7W-270) LR		9	6
2	BT-72	Class FX Beam Concrete 138 FT	0.6" (7W-270) LR		6	6
3	BT-72	Class FX Beam Concrete 138 FT	0.6" (7W-270) LR		6	9

Beam Details – Continuous support detail



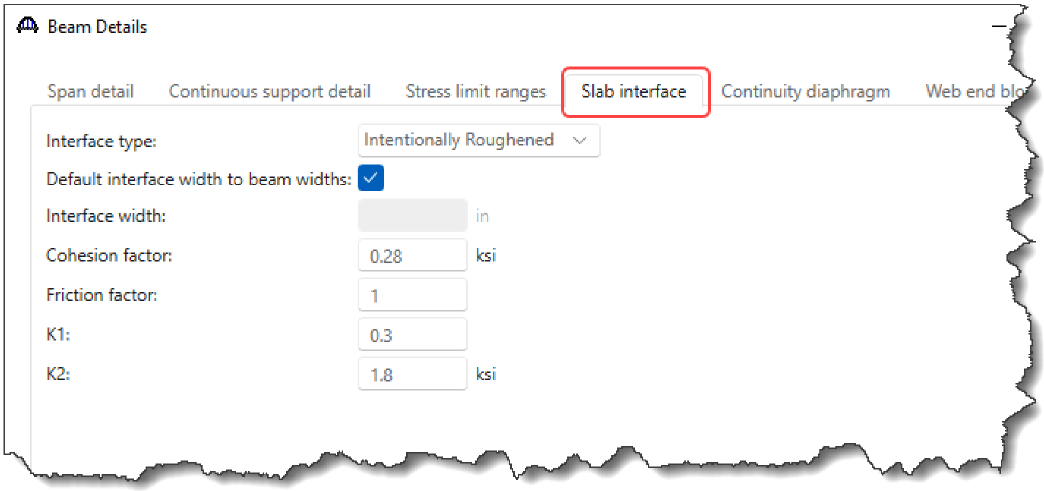
Support number	Support distance on left, SL (in)	Support distance on right, SR (in)
2	11	11
3	11	11

Beam Details – Stress limit ranges

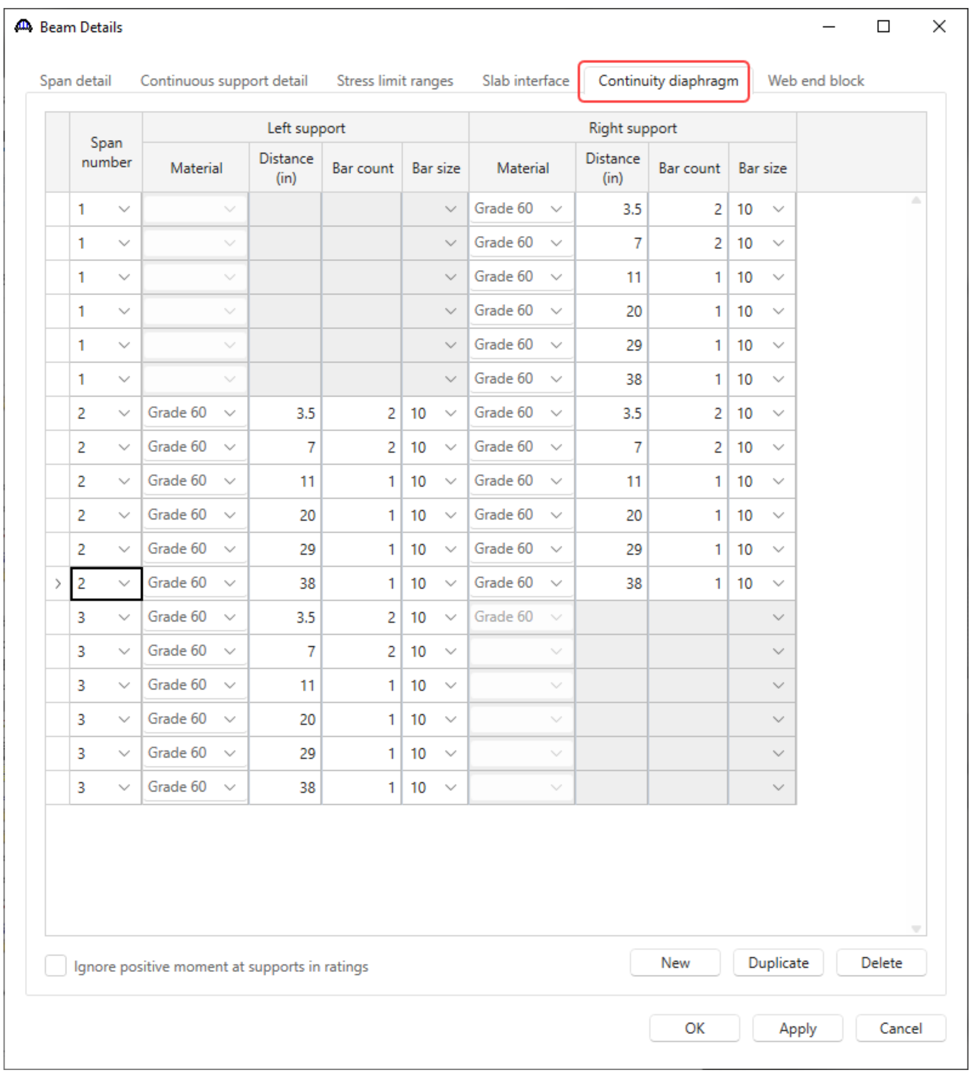


Span number	Name	Start distance (ft)	Length (ft)	End distance (ft)
1	138 FT STRESS LIMIT	0	137.1079	137.1079
2	138 FT STRESS LIMIT	0	136.333333	136.333333
3	138 FT STRESS LIMIT	0	137.1079	137.1079

Beam Details – Slab interface



Beam Details – Continuity diaphragm

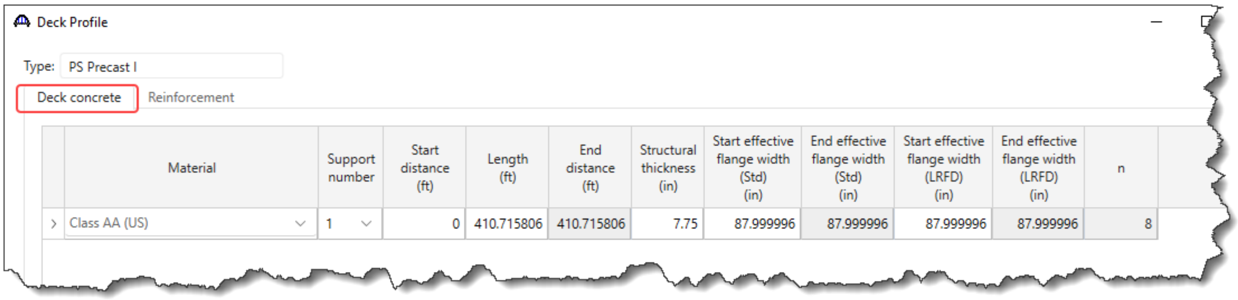


Strand Layout

Strand layout is similar to **G1**, but the length is different. See below for **G3** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations			
Girder	Span 1	Span 2	Span 3
4	54.55395	54.16667	54.55395

Deck Profile – Deck concrete



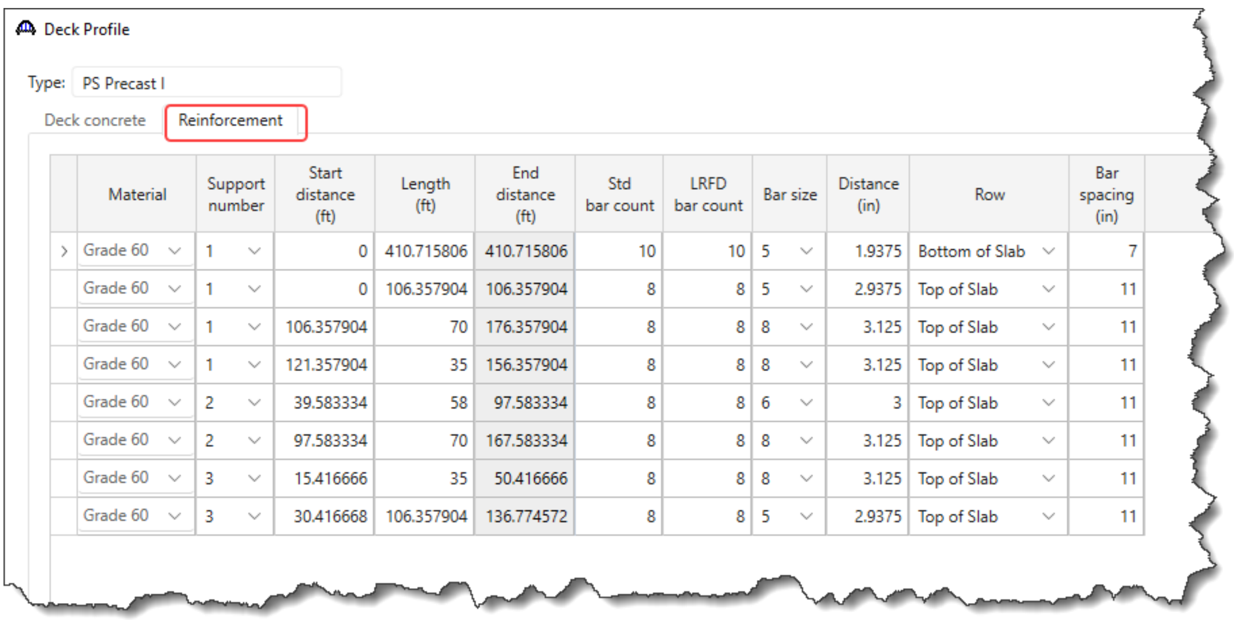
Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	410.715806	410.715806	7.75	87.999996	87.999996	87.999996	87.999996	8

Deck Profile – Reinforcement



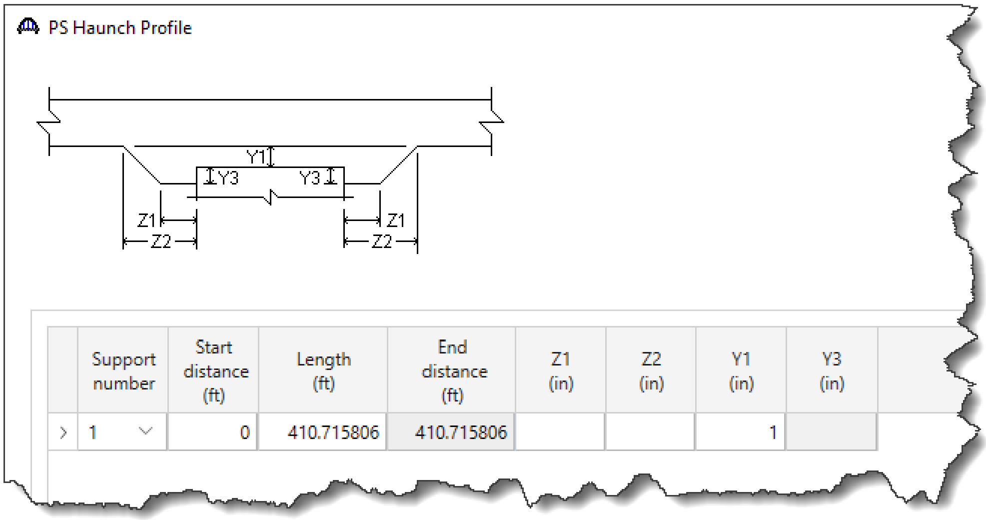
Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

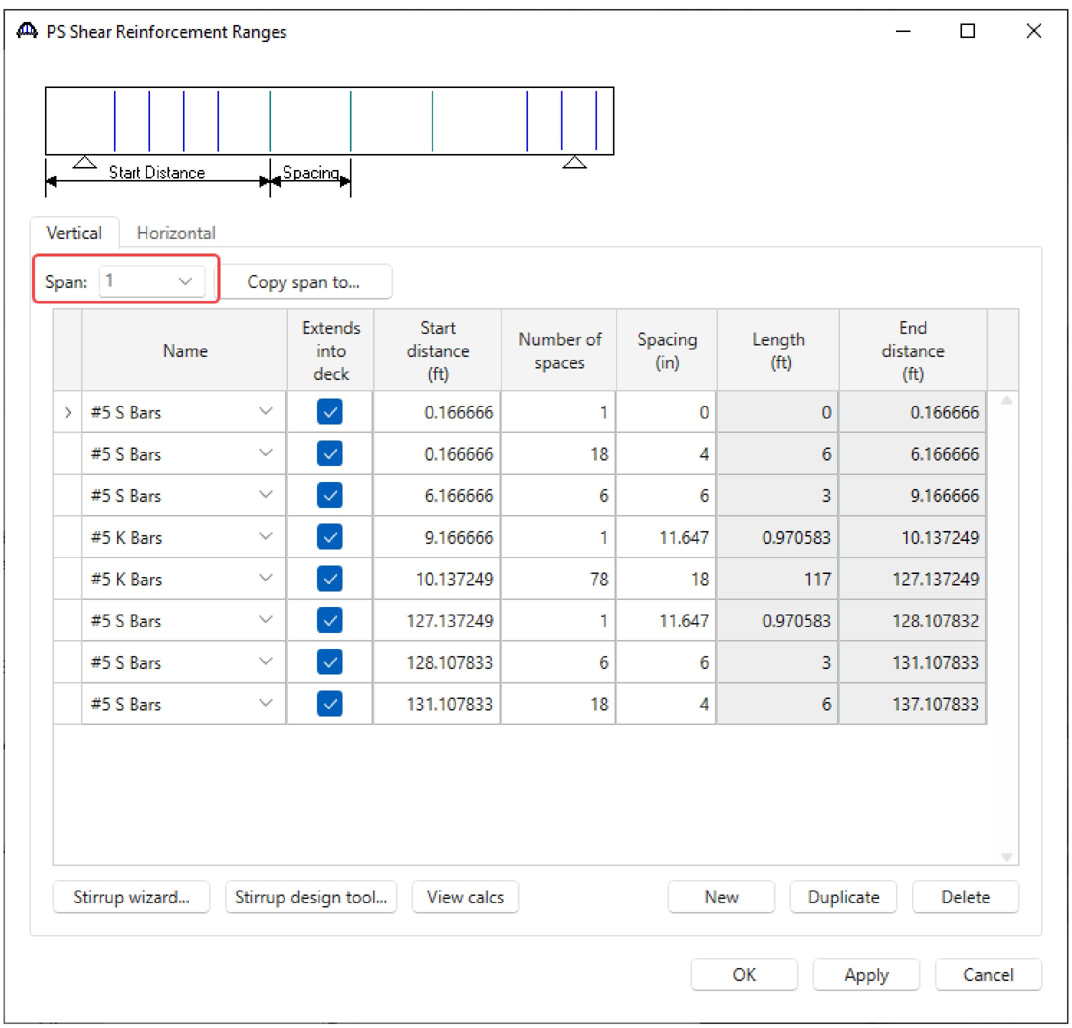
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	410.715806	410.715806	10	10	5	1.9375	Bottom of Slab	7
Grade 60	1	0	106.357904	106.357904	8	8	5	2.9375	Top of Slab	11
Grade 60	1	106.357904	70	176.357904	8	8	8	3.125	Top of Slab	11
Grade 60	1	121.357904	35	156.357904	8	8	8	3.125	Top of Slab	11
Grade 60	2	39.583334	58	97.583334	8	8	6	3	Top of Slab	11
Grade 60	2	97.583334	70	167.583334	8	8	8	3.125	Top of Slab	11
Grade 60	3	15.416666	35	50.416666	8	8	8	3.125	Top of Slab	11
Grade 60	3	30.416668	106.357904	136.774572	8	8	5	2.9375	Top of Slab	11

PS Haunch Profile

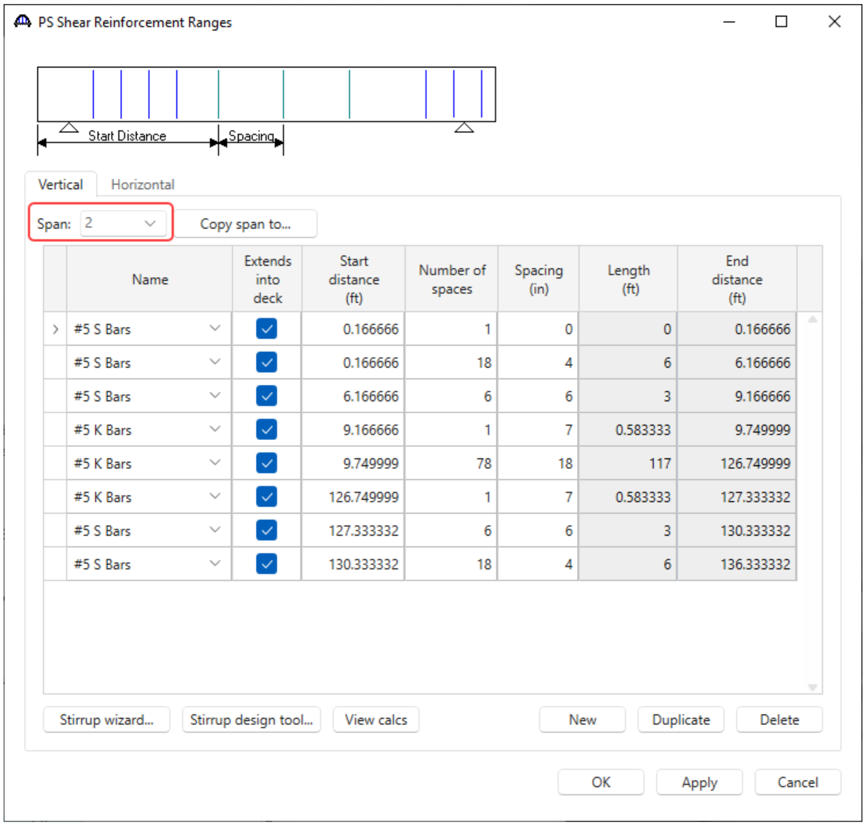


	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
>	1	0	410.715806	410.715806			1	

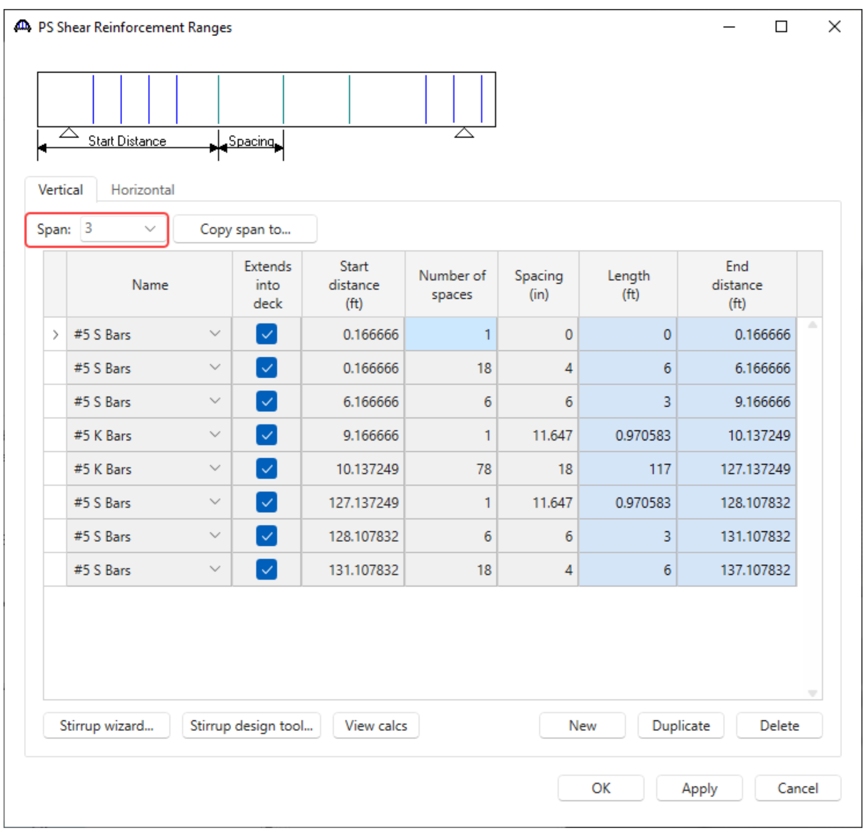
PS Shear Reinforcement Ranges



	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
>	#5 S Bars	✓	0.166666	1	0	0	0.166666
	#5 S Bars	✓	0.166666	18	4	6	6.166666
	#5 S Bars	✓	6.166666	6	6	3	9.166666
	#5 K Bars	✓	9.166666	1	11.647	0.970583	10.137249
	#5 K Bars	✓	10.137249	78	18	117	127.137249
	#5 S Bars	✓	127.137249	1	11.647	0.970583	128.107832
	#5 S Bars	✓	128.107833	6	6	3	131.107833
	#5 S Bars	✓	131.107833	18	4	6	137.107833



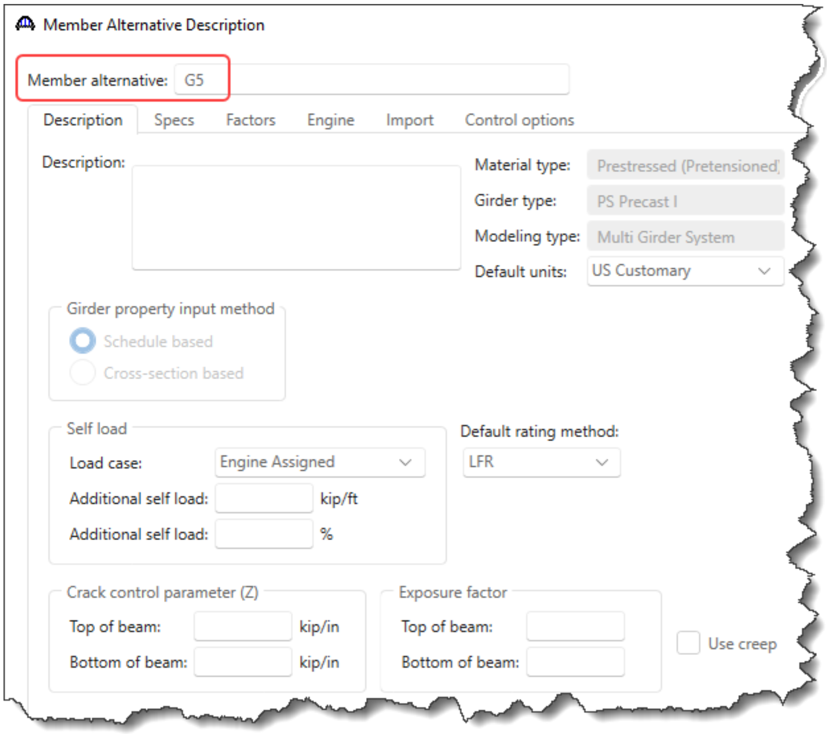
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	☑	0.166666	1	0	0	0.166666
#5 S Bars	☑	0.166666	18	4	6	6.166666
#5 S Bars	☑	6.166666	6	6	3	9.166666
#5 K Bars	☑	9.166666	1	7	0.583333	9.749999
#5 K Bars	☑	9.749999	78	18	117	126.749999
#5 K Bars	☑	126.749999	1	7	0.583333	127.333332
#5 S Bars	☑	127.333332	6	6	3	130.333332
#5 S Bars	☑	130.333332	18	4	6	136.333332



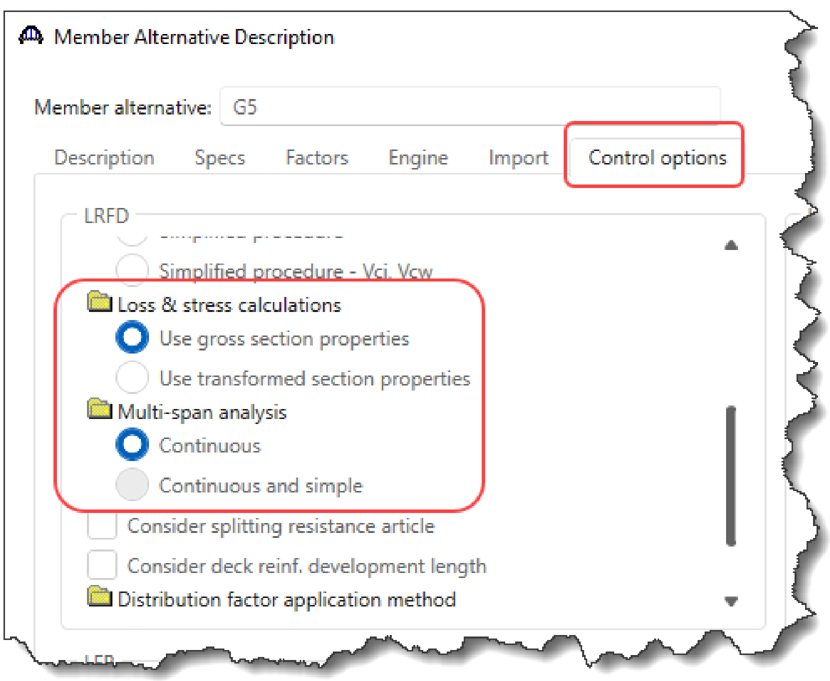
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	☑	0.166666	1	0	0	0.166666
#5 S Bars	☑	0.166666	18	4	6	6.166666
#5 S Bars	☑	6.166666	6	6	3	9.166666
#5 K Bars	☑	9.166666	1	11.647	0.970583	10.137249
#5 K Bars	☑	10.137249	78	18	117	127.137249
#5 S Bars	☑	127.137249	1	11.647	0.970583	128.107832
#5 S Bars	☑	128.107832	6	6	3	131.107832
#5 S Bars	☑	131.107832	18	4	6	137.107832

Girder G5

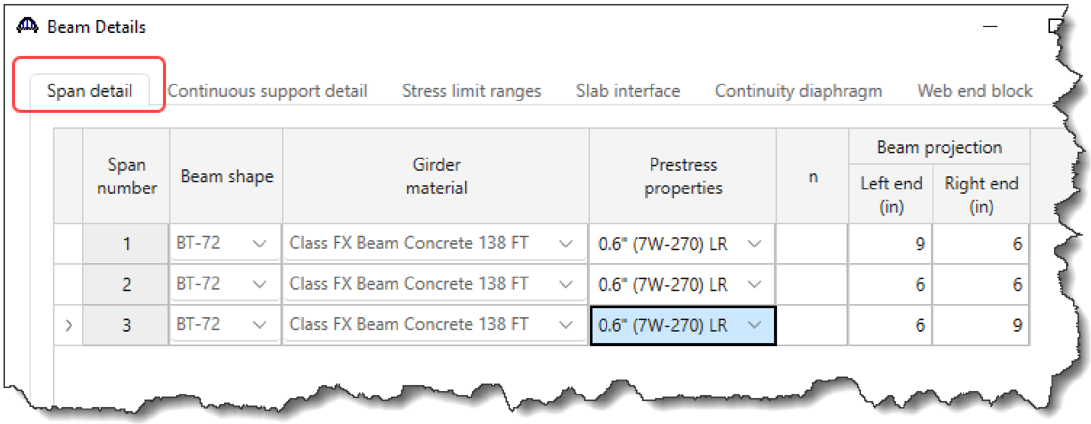
Member Alternative Description



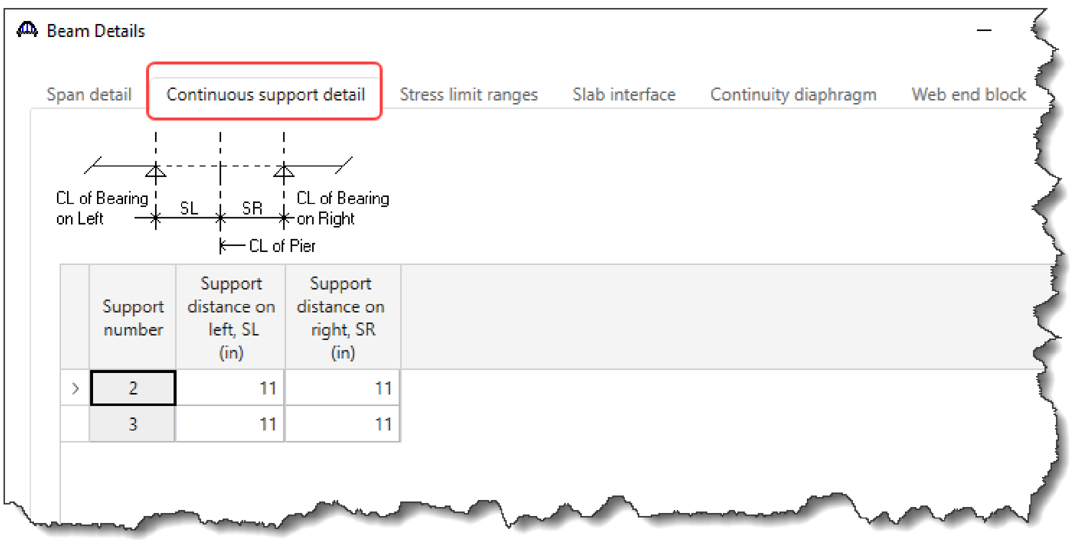
Member Alternative Description – Control Options



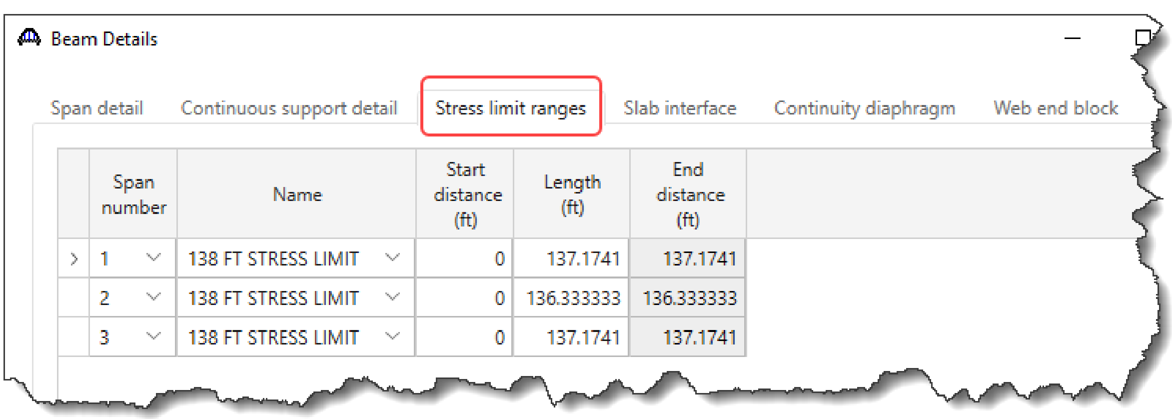
Beam Details – Span detail



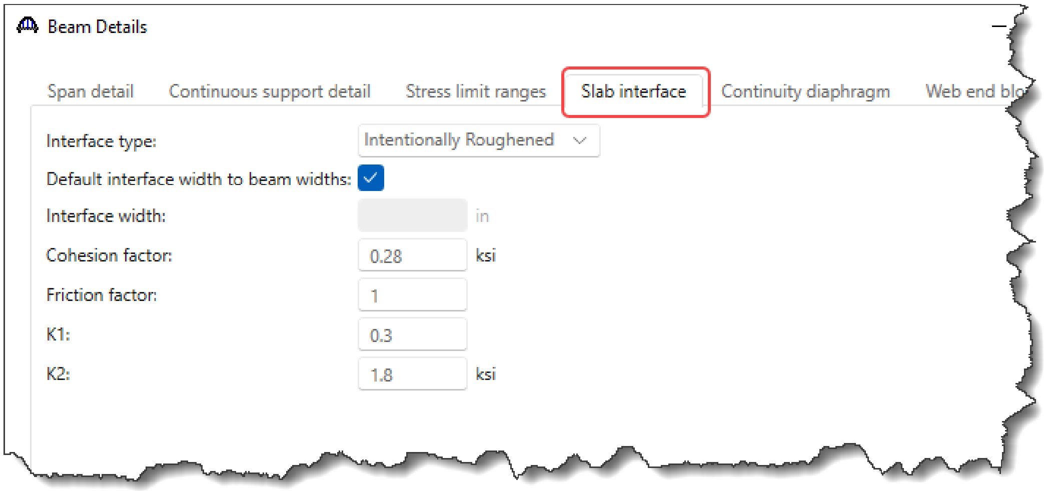
Beam Details – Continuous support detail



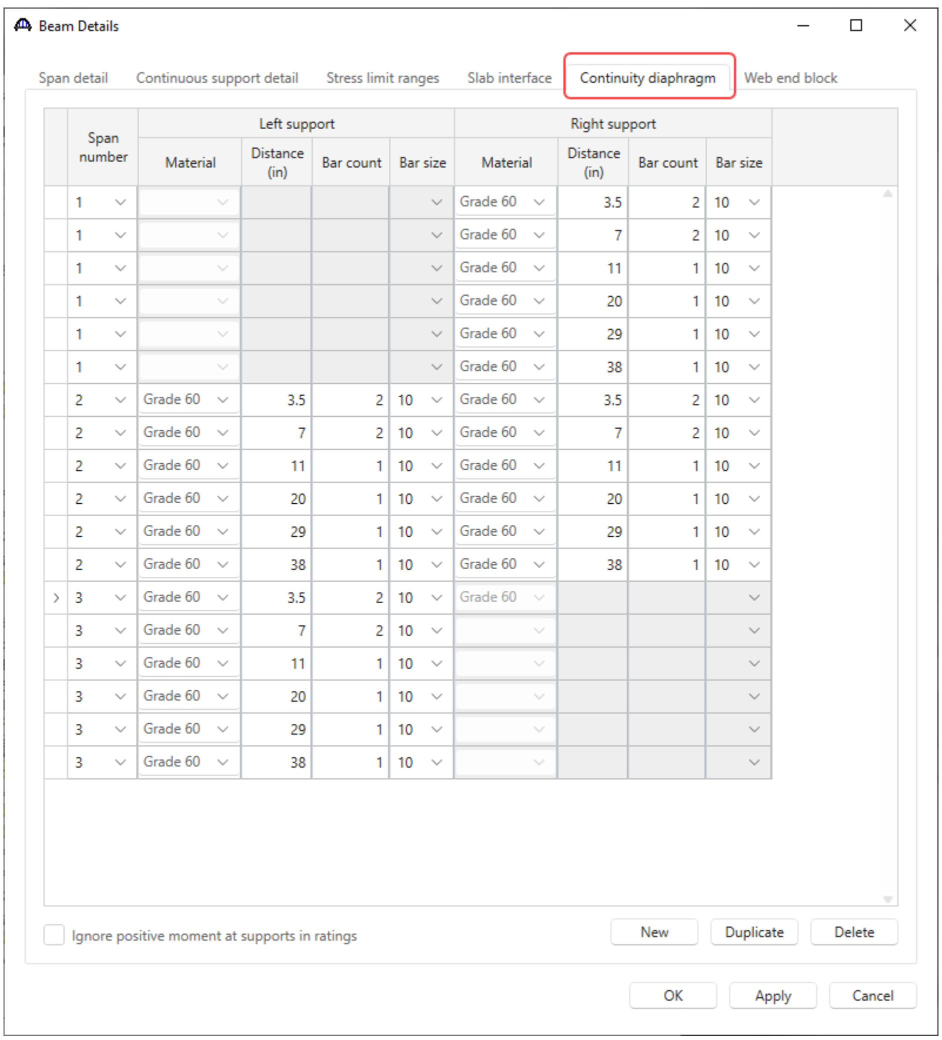
Beam Details – Stress limit ranges



Beam Details – Slab interface



Beam Details – Continuity diaphragm



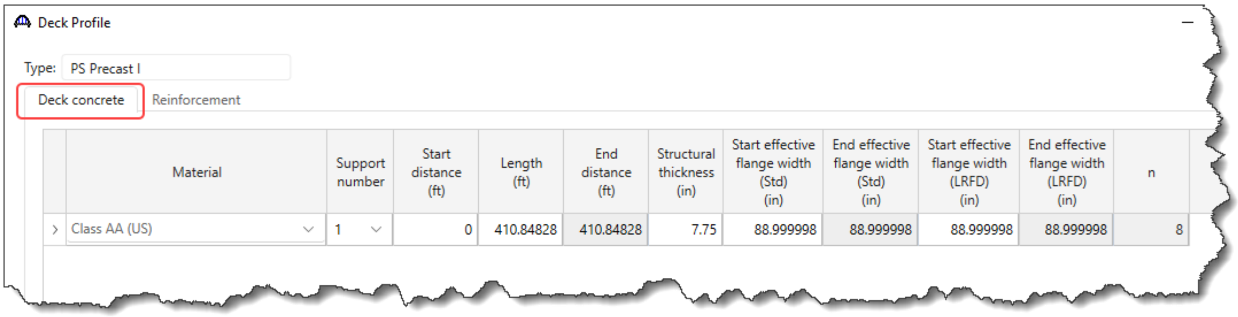
Span number	Left support Material	Left support Distance (in)	Left support Bar count	Left support Bar size	Right support Material	Right support Distance (in)	Right support Bar count	Right support Bar size
1					Grade 60	3.5	2	10
1					Grade 60	7	2	10
1					Grade 60	11	1	10
1					Grade 60	20	1	10
1					Grade 60	29	1	10
1					Grade 60	38	1	10
2	Grade 60	3.5	2	10	Grade 60	3.5	2	10
2	Grade 60	7	2	10	Grade 60	7	2	10
2	Grade 60	11	1	10	Grade 60	11	1	10
2	Grade 60	20	1	10	Grade 60	20	1	10
2	Grade 60	29	1	10	Grade 60	29	1	10
2	Grade 60	38	1	10	Grade 60	38	1	10
3	Grade 60	3.5	2	10	Grade 60			
3	Grade 60	7	2	10				
3	Grade 60	11	1	10				
3	Grade 60	20	1	10				
3	Grade 60	29	1	10				
3	Grade 60	38	1	10				

Strand Layout

Strand layout is similar to **G1**, but the length is different. See below for **G5** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations			
Girder	Span 1	Span 2	Span 3
5	54.58707	54.16667	54.58707

Deck Profile – Deck concrete



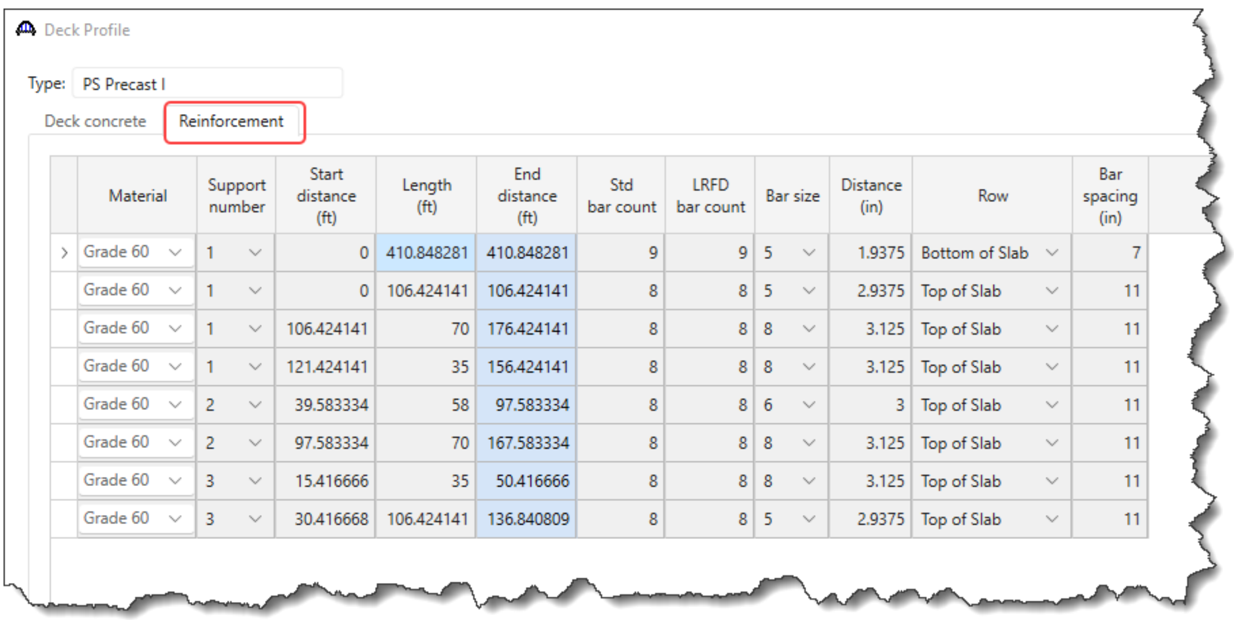
Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	410.84828	410.84828	7.75	88.999998	88.999998	88.999998	88.999998	8

Deck Profile – Reinforcement



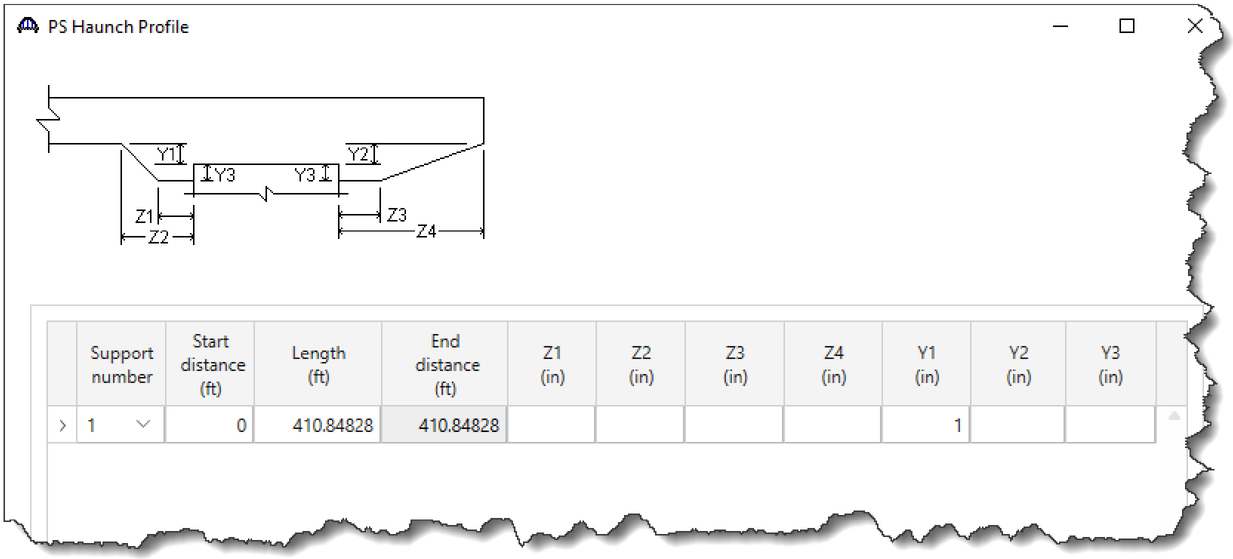
Deck Profile

Type: PS Precast I

Deck concrete | Reinforcement

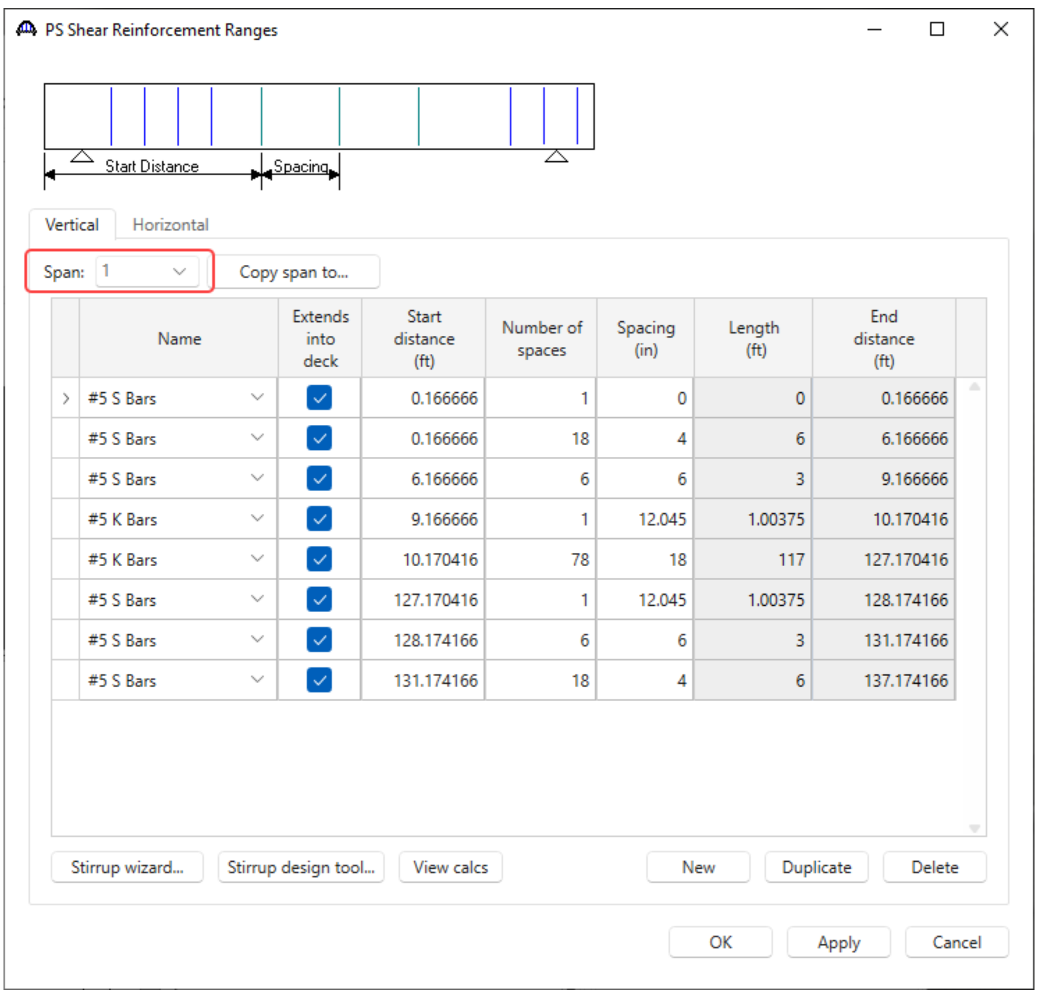
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
Grade 60	1	0	410.848281	410.848281	9	9	5	1.9375	Bottom of Slab	7
Grade 60	1	0	106.424141	106.424141	8	8	5	2.9375	Top of Slab	11
Grade 60	1	106.424141	70	176.424141	8	8	8	3.125	Top of Slab	11
Grade 60	1	121.424141	35	156.424141	8	8	8	3.125	Top of Slab	11
Grade 60	2	39.583334	58	97.583334	8	8	6	3	Top of Slab	11
Grade 60	2	97.583334	70	167.583334	8	8	8	3.125	Top of Slab	11
Grade 60	3	15.416666	35	50.416666	8	8	8	3.125	Top of Slab	11
Grade 60	3	30.416668	106.424141	136.840809	8	8	5	2.9375	Top of Slab	11

PS Haunch Profile

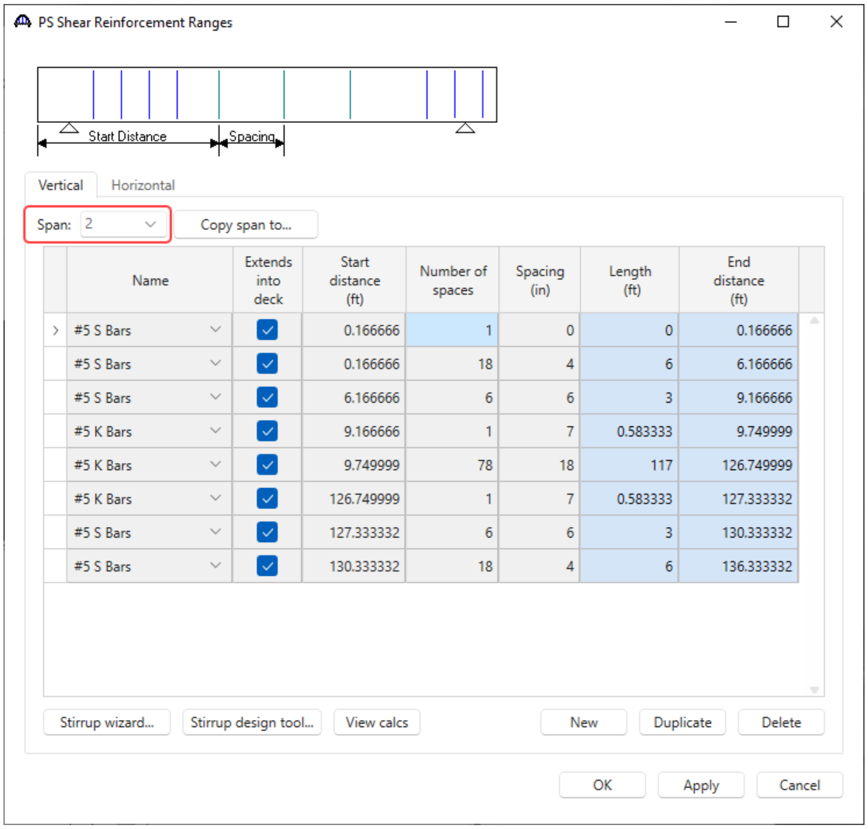


	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Z3 (in)	Z4 (in)	Y1 (in)	Y2 (in)	Y3 (in)
>	1	0	410.84828	410.84828					1		

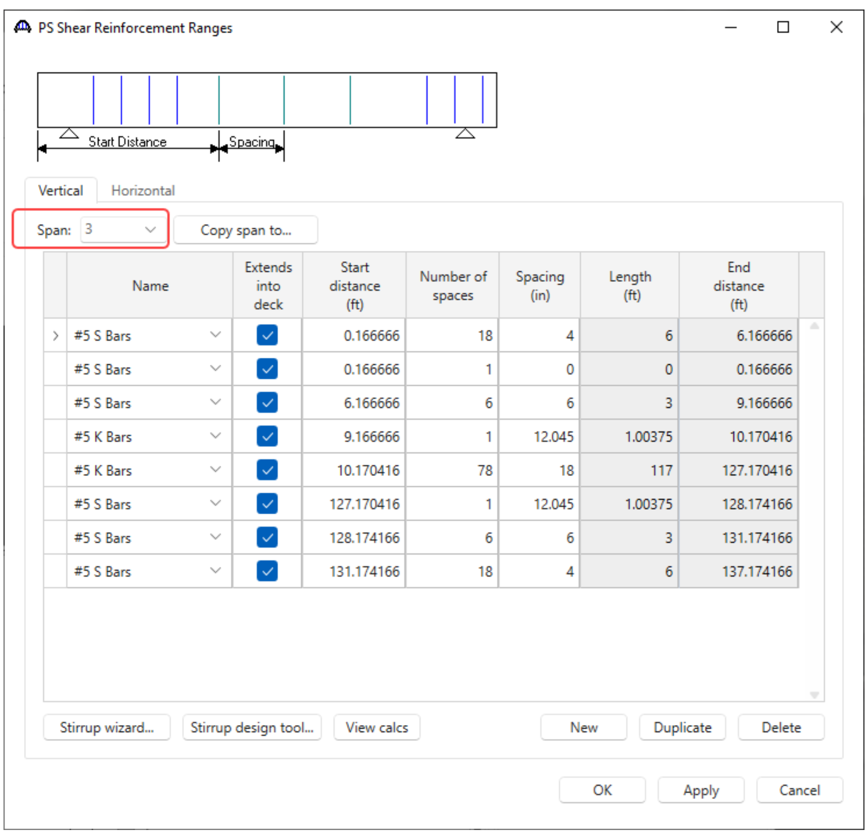
PS Shear Reinforcement Ranges



	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
>	#5 S Bars	✓	0.166666	1	0	0	0.166666
	#5 S Bars	✓	0.166666	18	4	6	6.166666
	#5 S Bars	✓	6.166666	6	6	3	9.166666
	#5 K Bars	✓	9.166666	1	12.045	1.00375	10.170416
	#5 K Bars	✓	10.170416	78	18	117	127.170416
	#5 S Bars	✓	127.170416	1	12.045	1.00375	128.174166
	#5 S Bars	✓	128.174166	6	6	3	131.174166
	#5 S Bars	✓	131.174166	18	4	6	137.174166



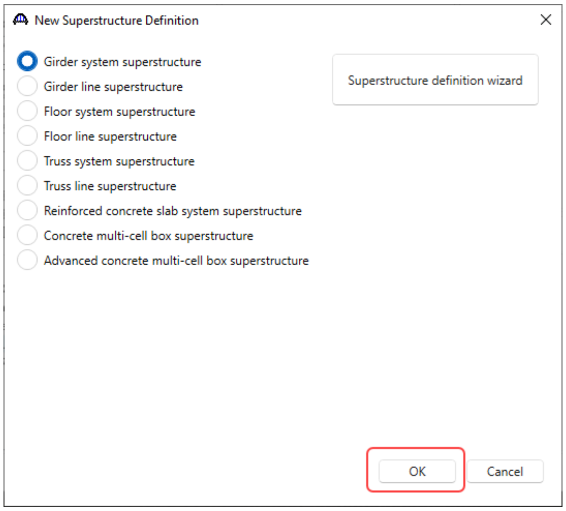
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	0.166666	18	4	6	6.166666
#5 S Bars	✓	6.166666	6	6	3	9.166666
#5 K Bars	✓	9.166666	1	7	0.583333	9.749999
#5 K Bars	✓	9.749999	78	18	117	126.749999
#5 K Bars	✓	126.749999	1	7	0.583333	127.333332
#5 S Bars	✓	127.333332	6	6	3	130.333332
#5 S Bars	✓	130.333332	18	4	6	136.333332



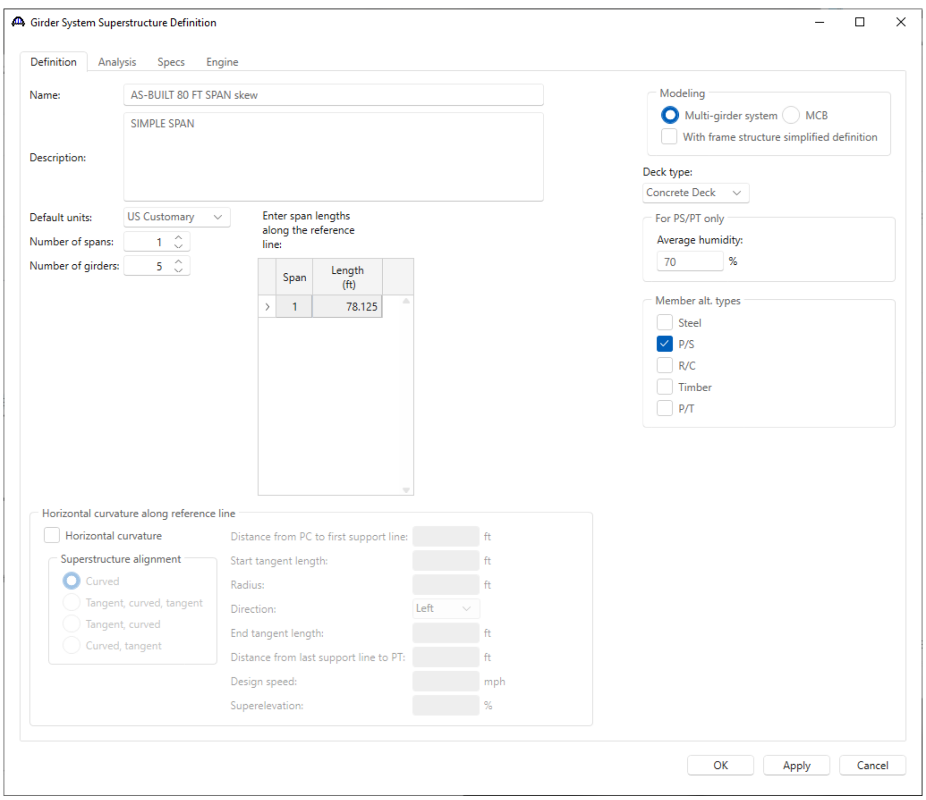
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	✓	0.166666	18	4	6	6.166666
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	6.166666	6	6	3	9.166666
#5 K Bars	✓	9.166666	1	12.045	1.00375	10.170416
#5 K Bars	✓	10.170416	78	18	117	127.170416
#5 S Bars	✓	127.170416	1	12.045	1.00375	128.174166
#5 S Bars	✓	128.174166	6	6	3	131.174166
#5 S Bars	✓	131.174166	18	4	6	137.174166

Superstructure definition – AS BUILT 80 FT SPAN skew

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 for the 80 ft span. The window shown below will appear.



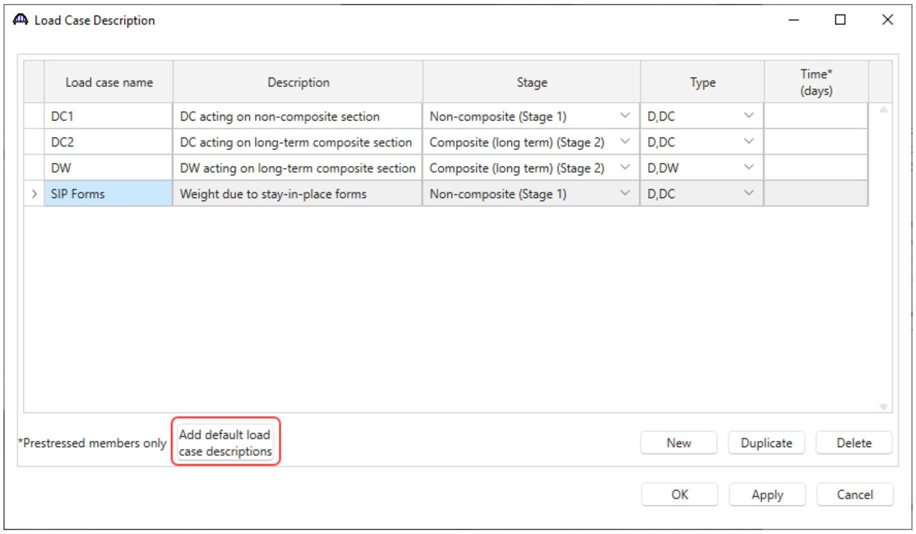
Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open. Enter the data as shown below.



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

Load Case Description

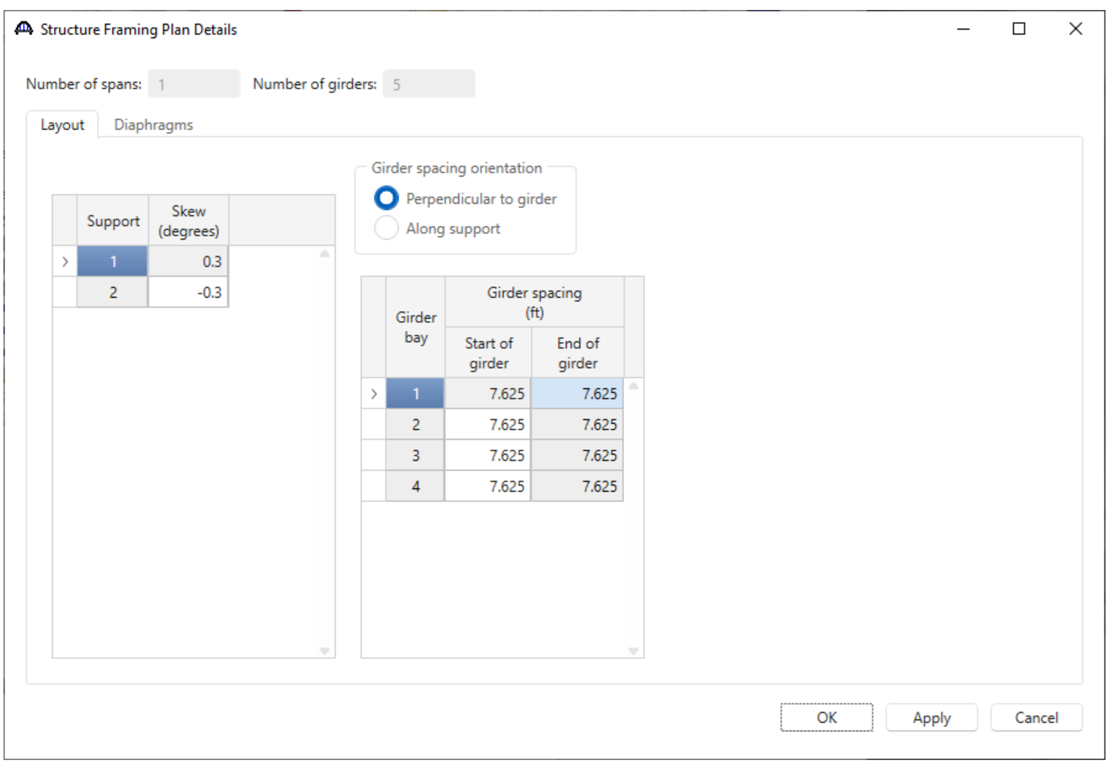
Expand the **AS-BUILT 80 FT SPAN skew** superstructure definition. Double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window**. Click the **Add default load case descriptions** button to create the following load cases.



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

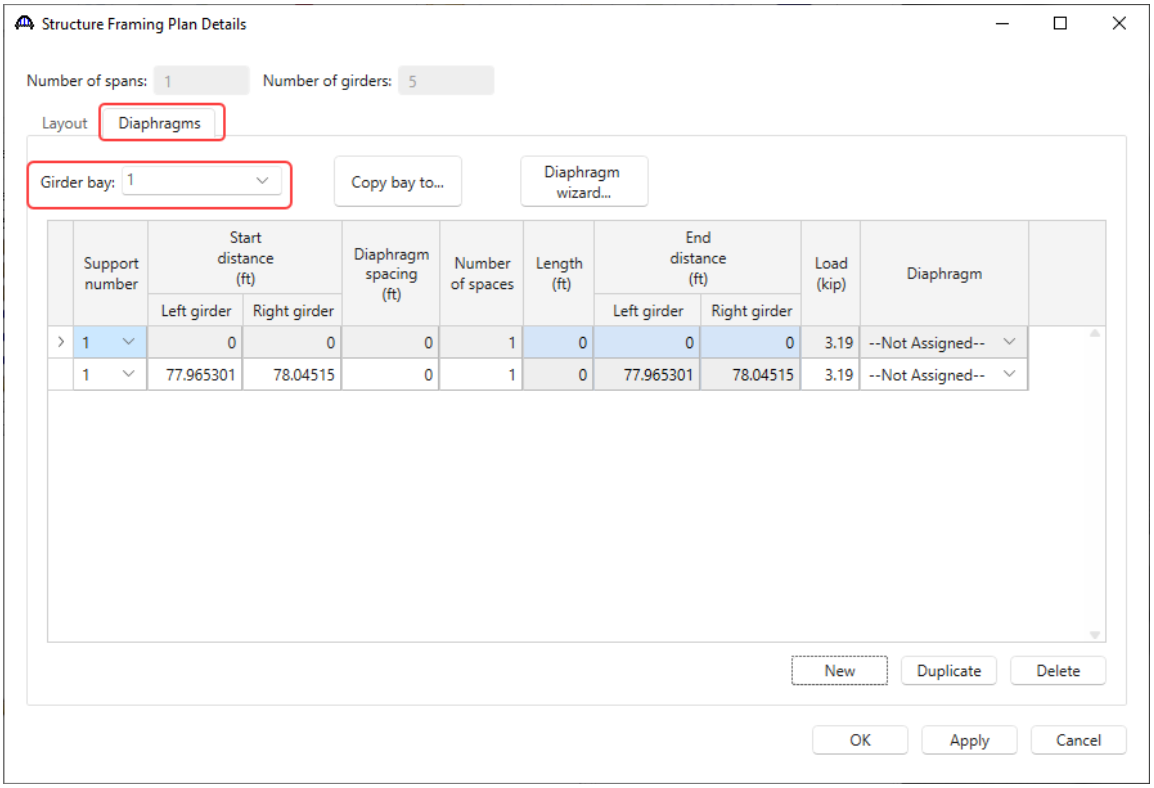
Structure Framing Plan Detail – Layout

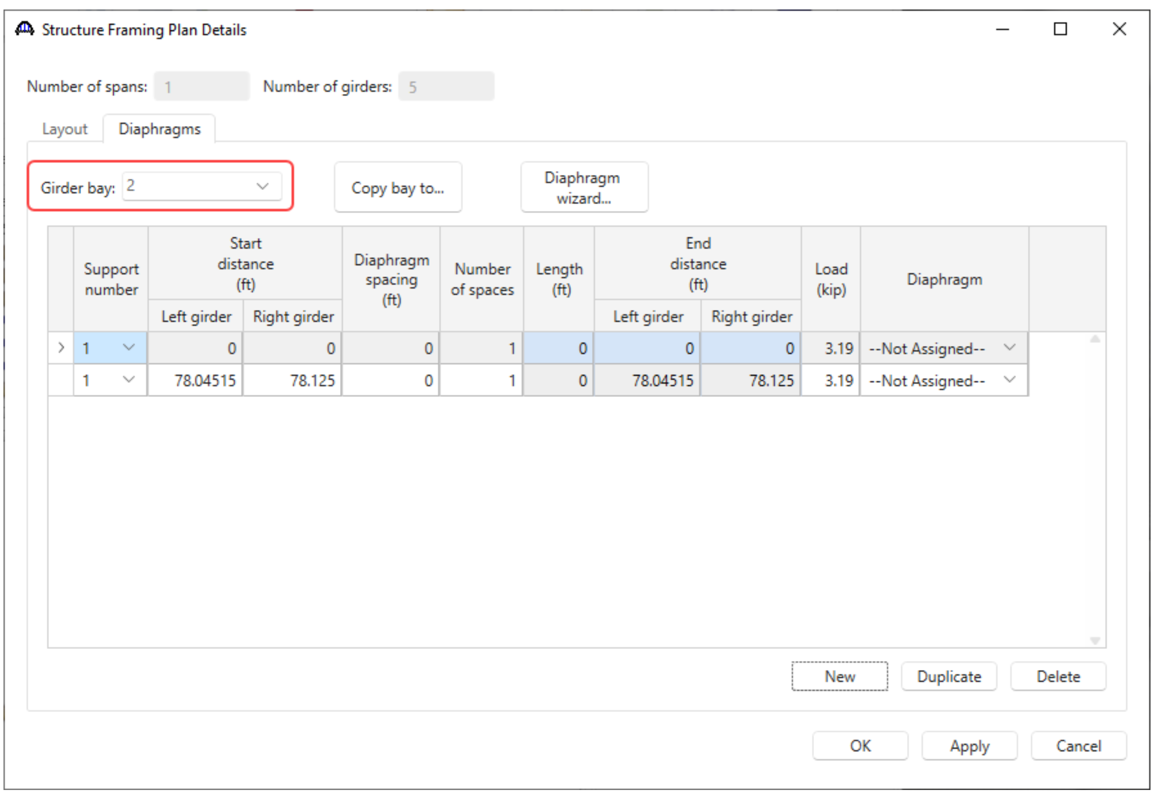
Double-click on **Framing Plan Detail** in the **Bridge Workspace** tree to describe the framing plan in the **Structure Framing Plan Details** window**.** Click **Apply** after entering the data as shown below.

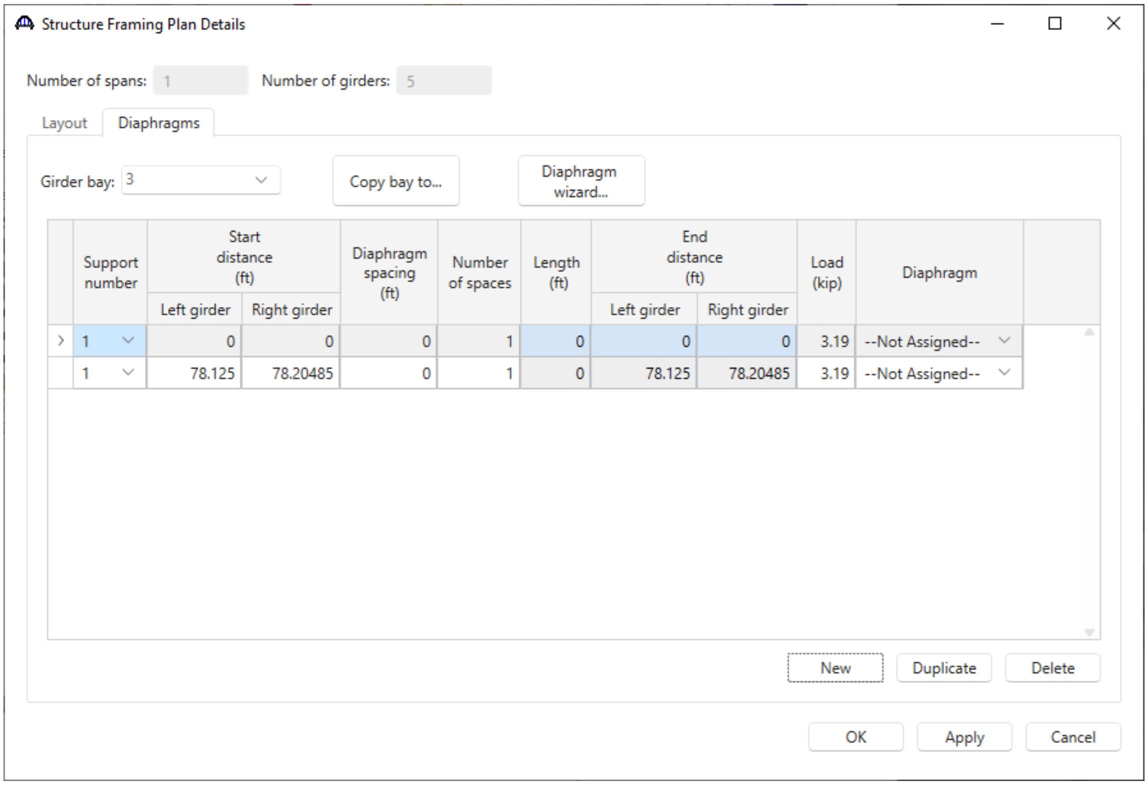


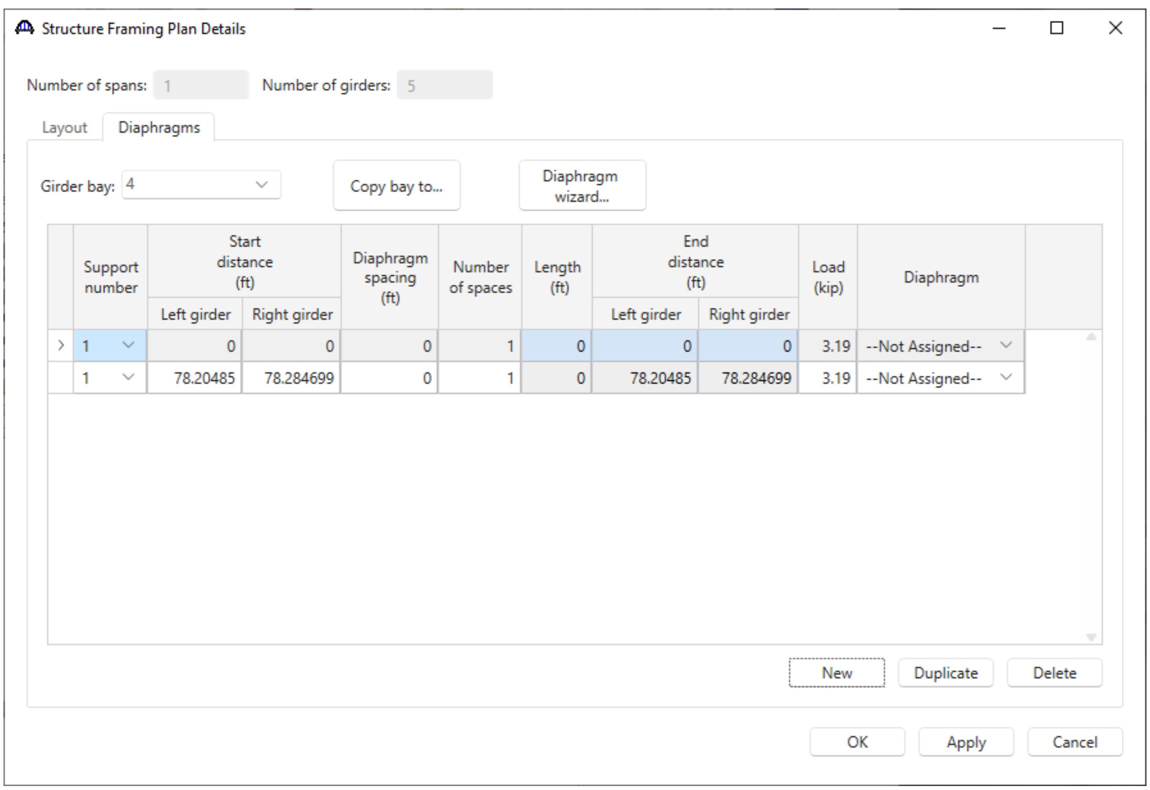
Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing for each girder bay as shown below.





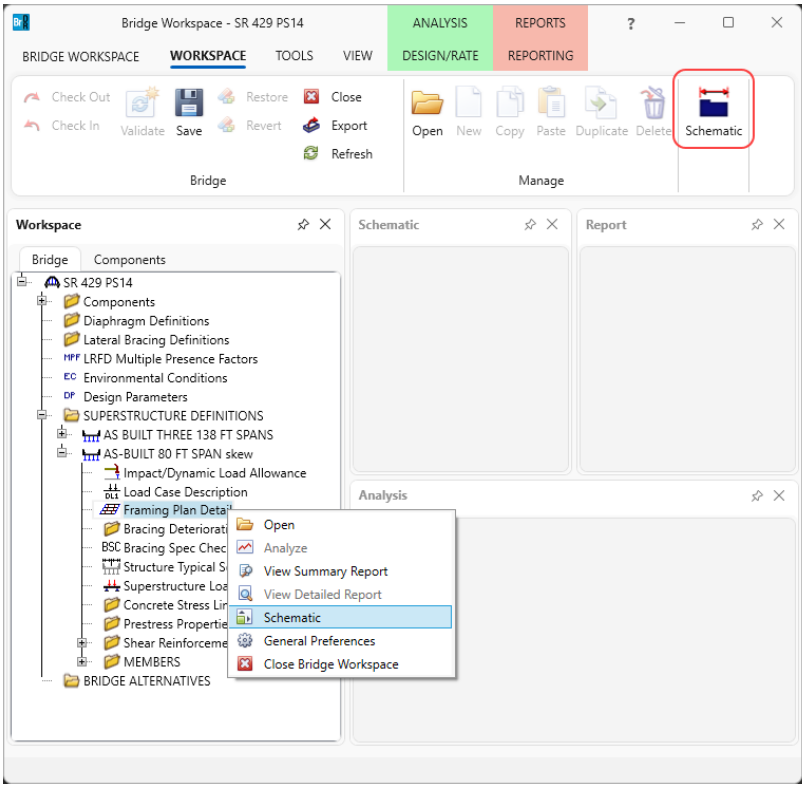


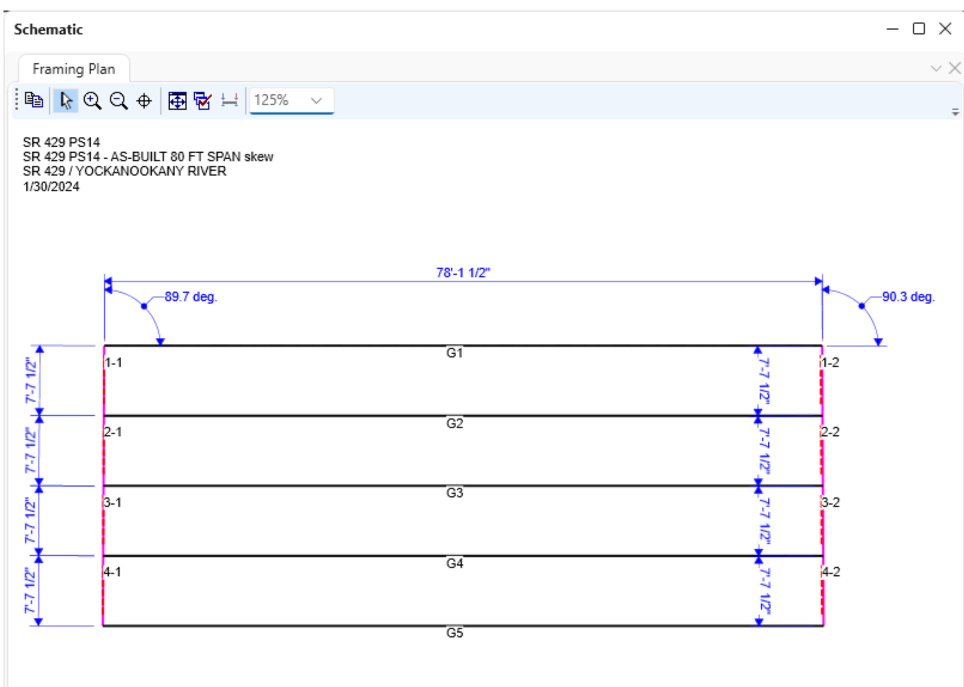


Click **OK** to apply the data and close the window.

Schematic - Framing Plan Detail

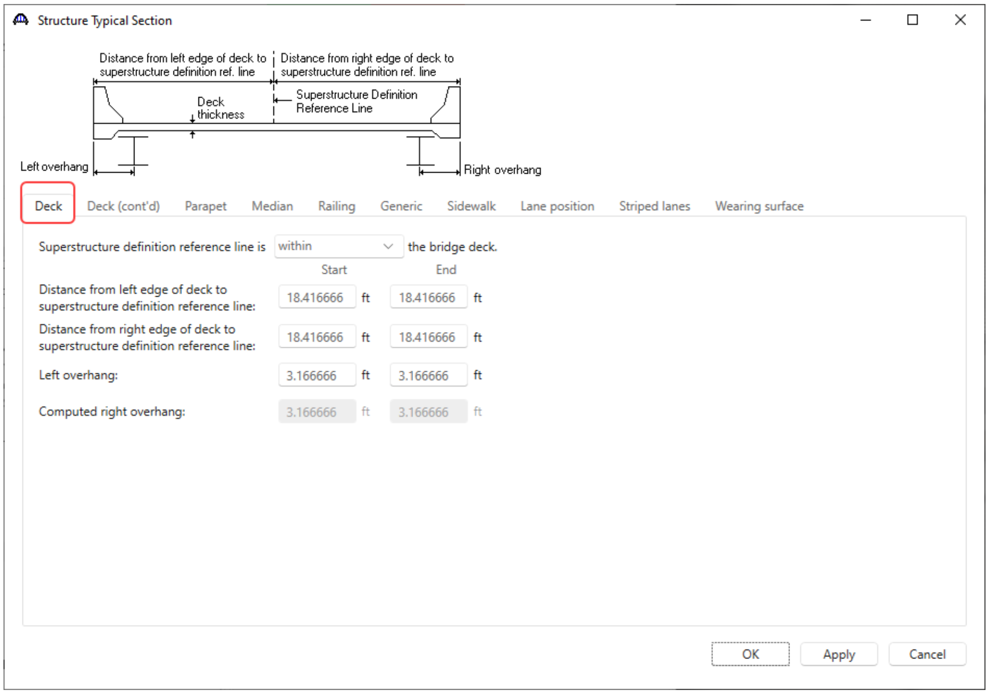
While **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu).





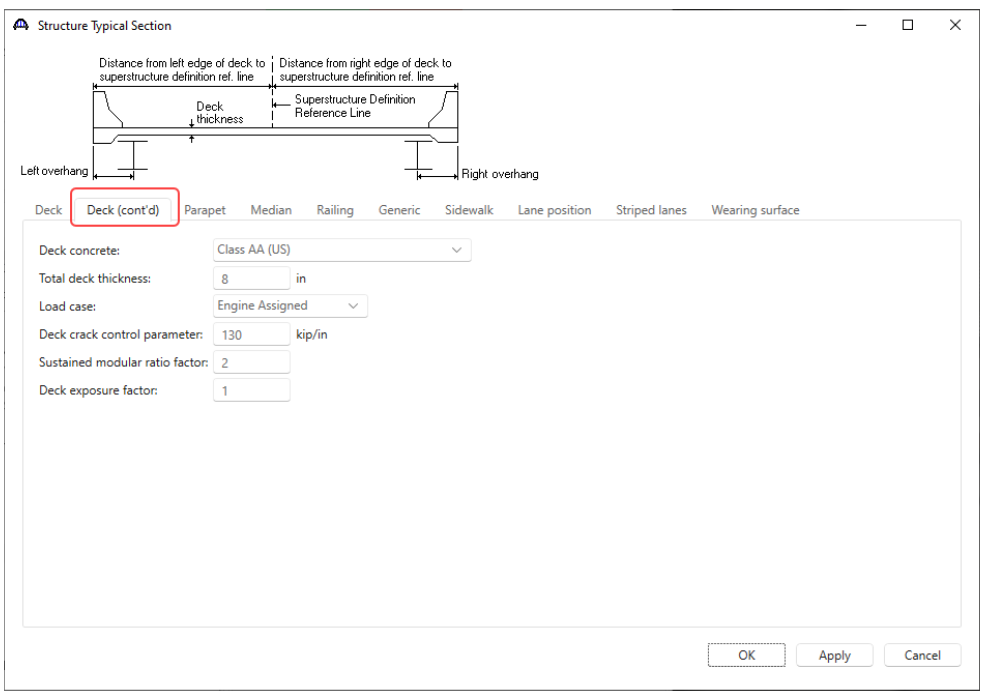
Structure Typical Section - Deck

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



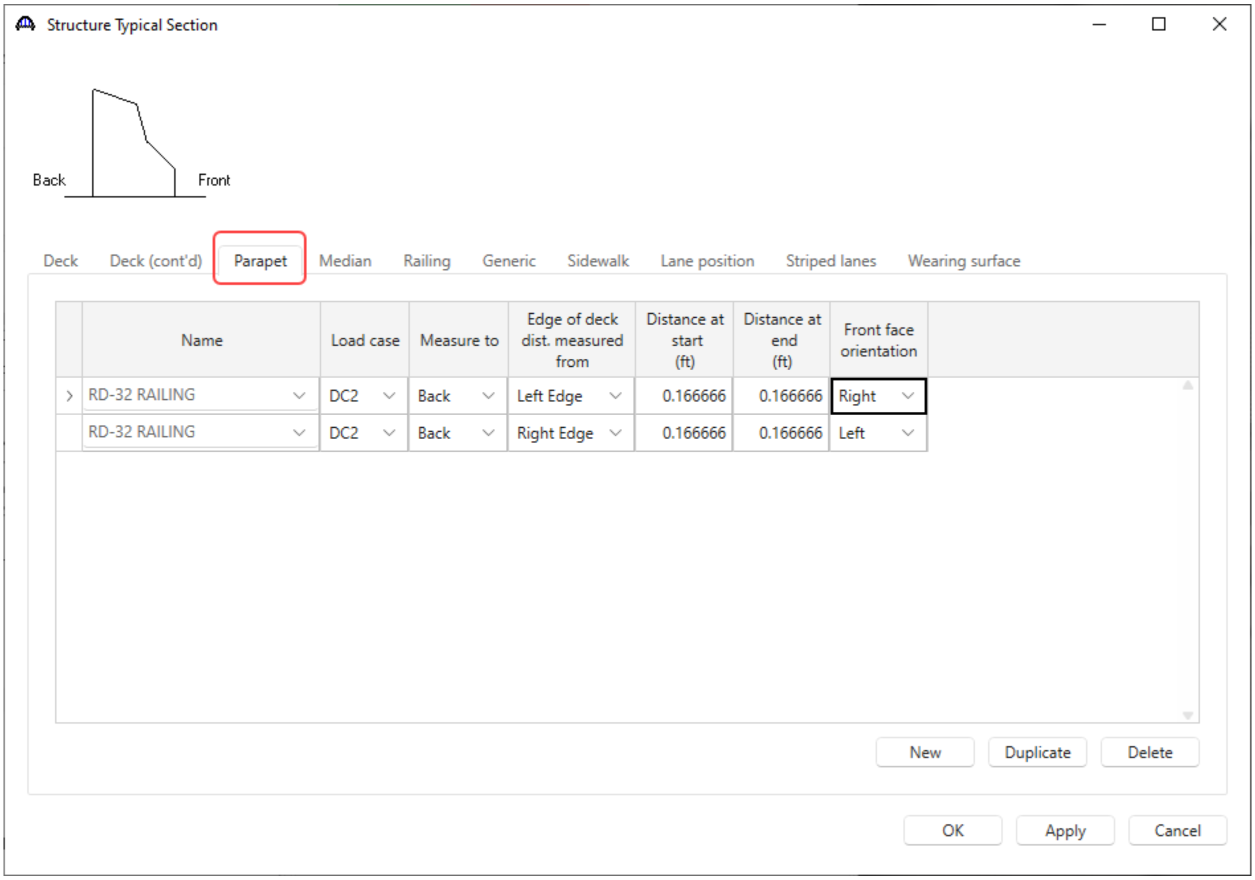
Structure Typical Section – Deck (cont'd)

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.



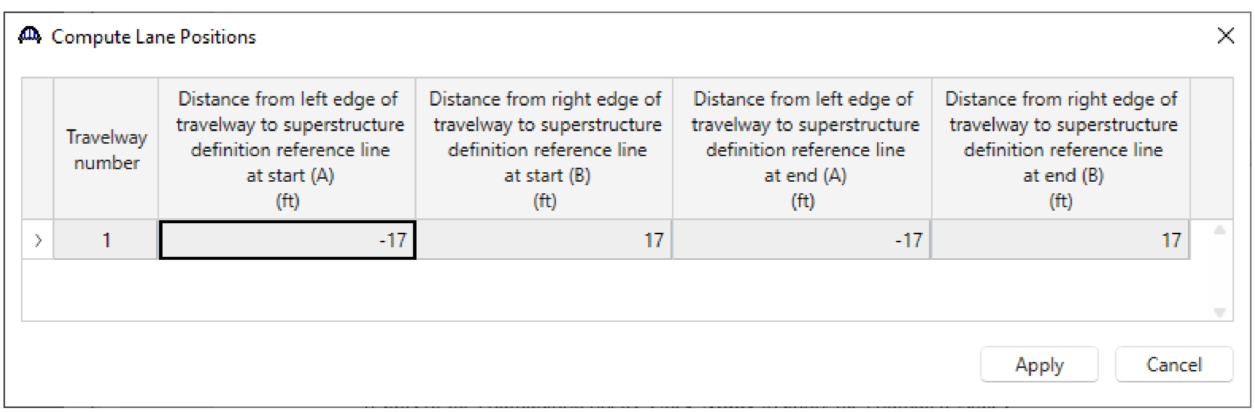
Structure Typical Section – Parapets

Add two parapets as shown below.

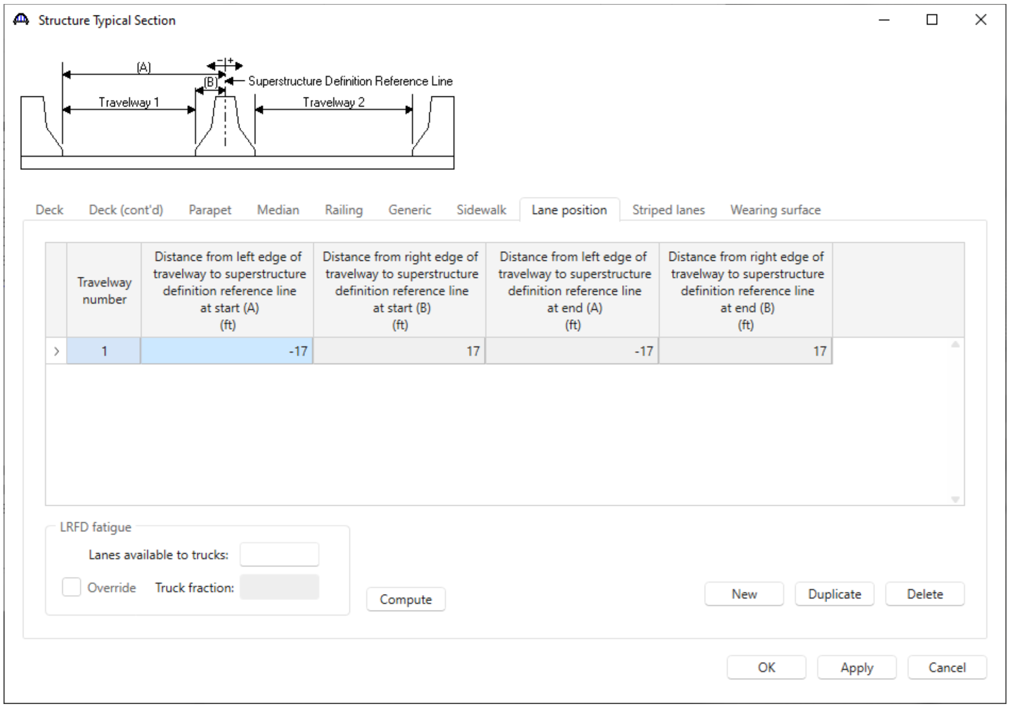


Structure Typical Section – Lane Positions

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.



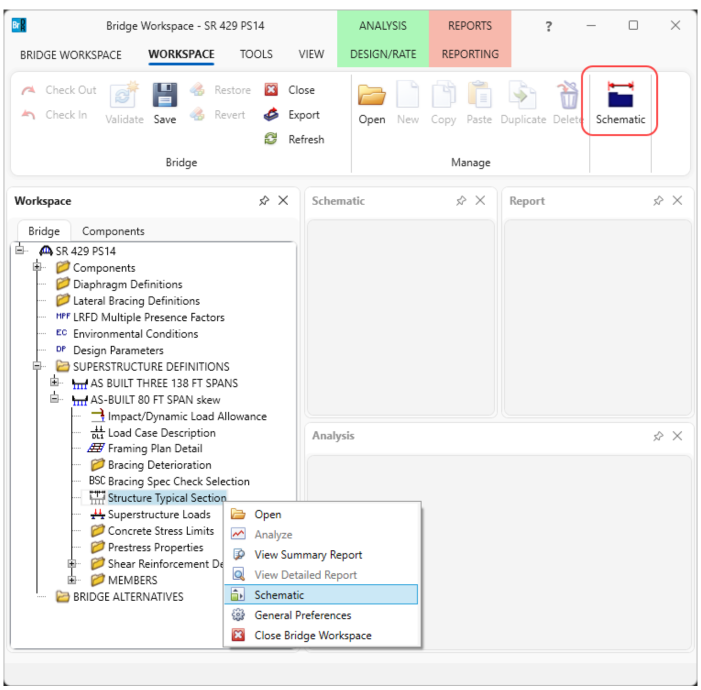
The **Lane Position** tab is populated as shown below.

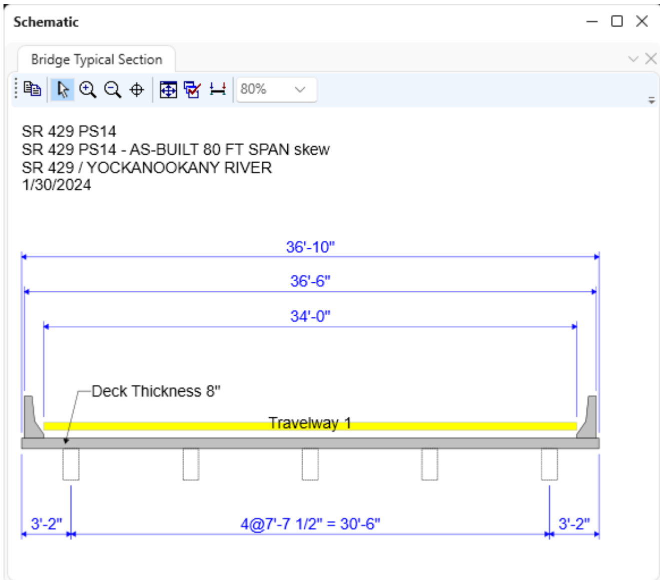


Click **OK** to apply the data and close the window.

Schematic – Structure Typical Section

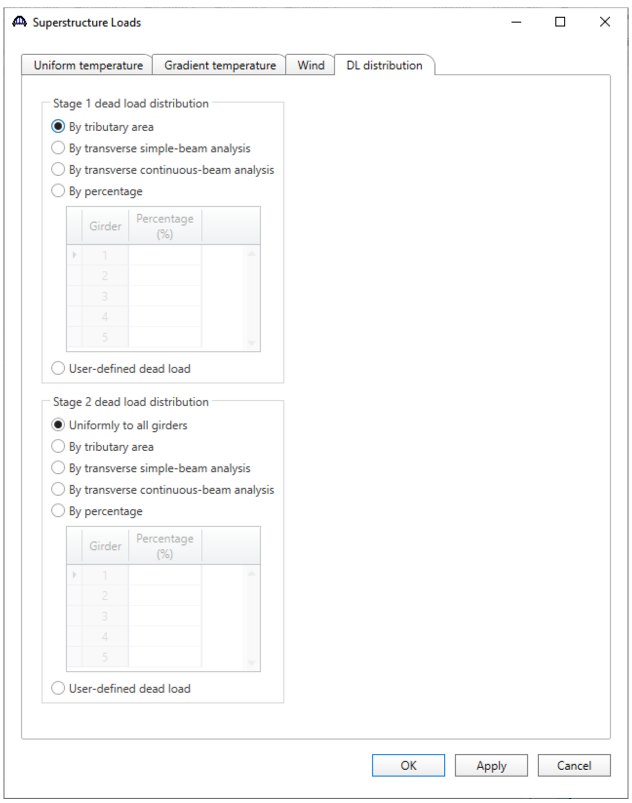
While the **Structure Typical Section** is selected in the **Bridge Workspace** tree, open the schematic for the structure typical section by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Structure Typical Section** in the **Bridge Workspace** and select **Schematic**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





Superstructure Loads

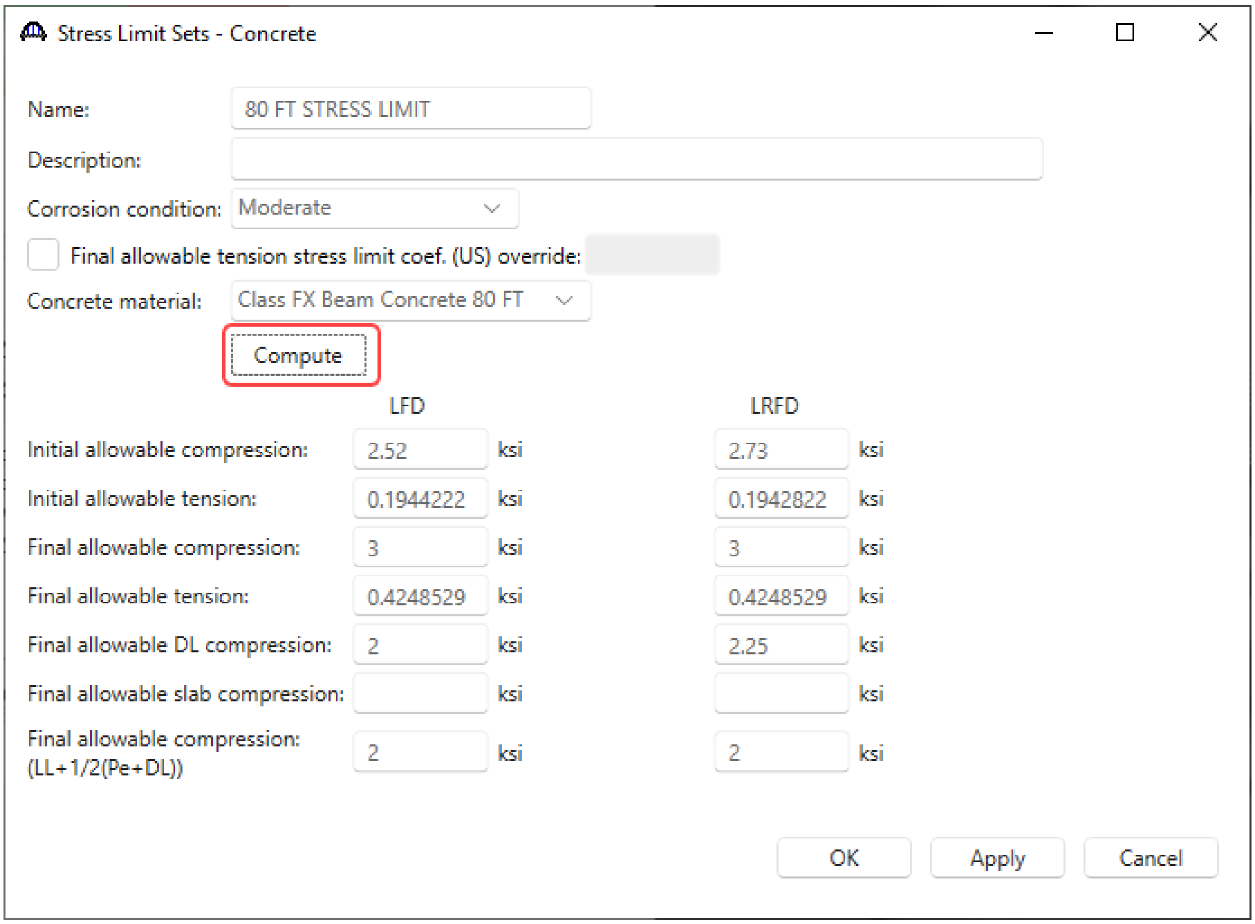
Double click on the **Superstructure Loads** node in the **Bridge Workspace** tree to open the **Superstructure Loads** window. Navigate to the **DL distribution** tab in this window. Select options in this window as shown below. The BrDR LRFD engine does not support the transverse continuous beam analysis option.



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

Concrete Stress Limits

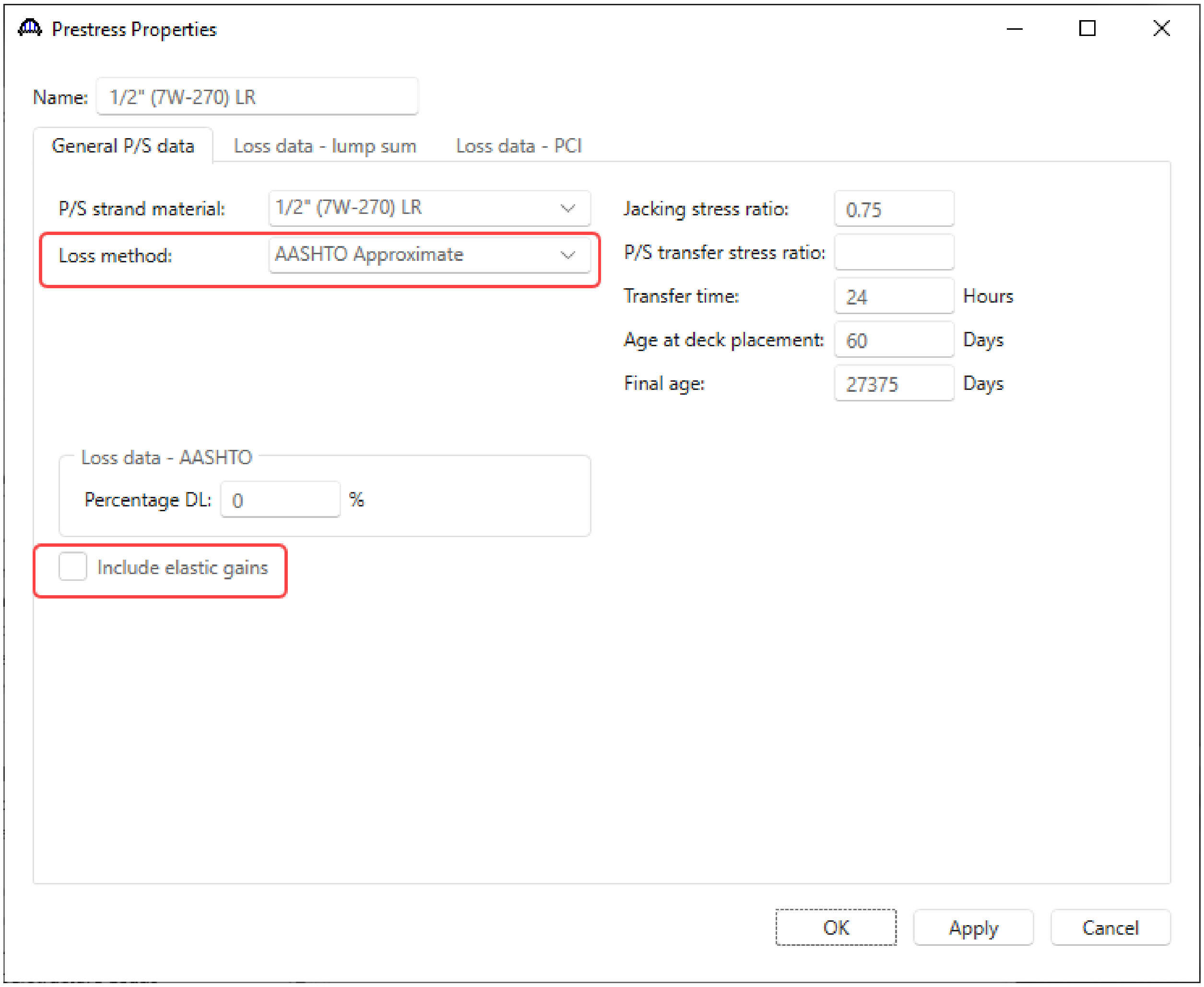
A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the **Concrete Stress Limits** node in the **Bridge Workspace** tree to open the **Stress Limit Sets – Concrete** window. Enter data shown above the **Compute** button, select **Moderate** for the **Corrosion condition** and select the **Class FX Beam Concrete 138 FT** 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. 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.



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

Prestress Properties

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



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

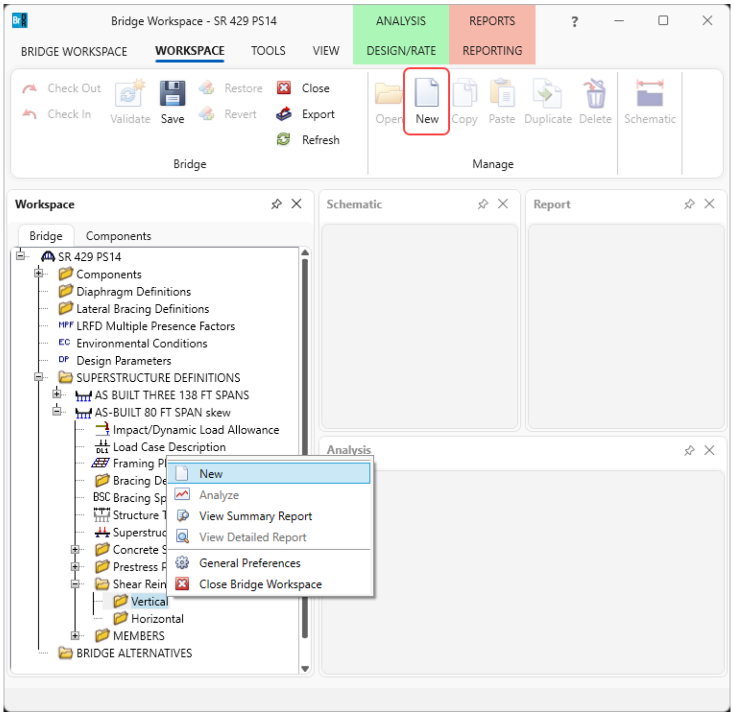
The following loss methods are available in the BrDR LRFD engine.

- AASHTO Approximate
- AASHTO Refined
- Lump Sum
- PCI
- Pre-2005 AASHTO Refined (AASHTO Refined, Third edition, 2004 without interims)

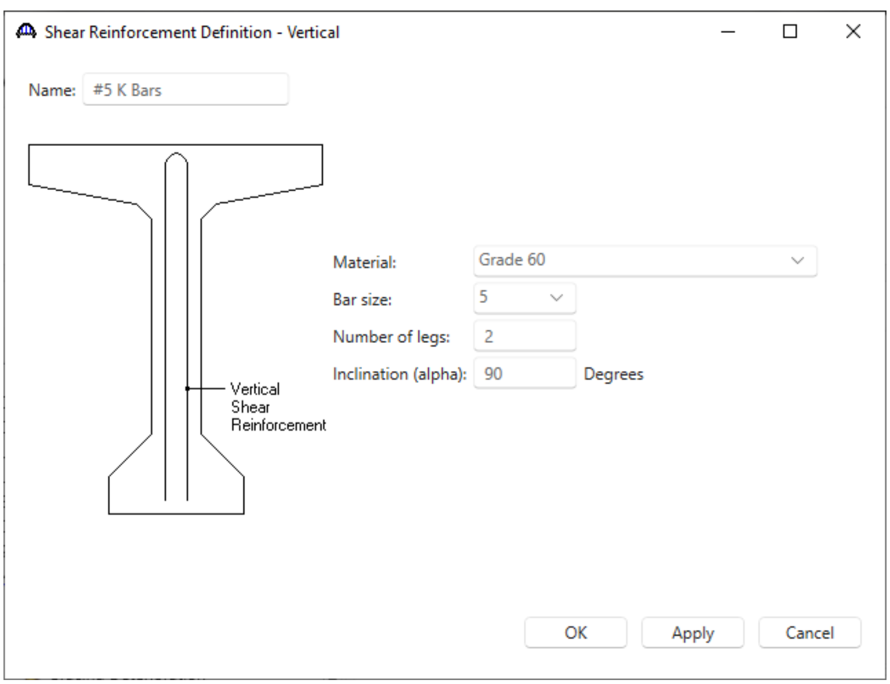
Another feature for prestress loss calculations in the BrDR LRFD engine is the ability to include elastic gains and losses due to dead load application.

Shear Reinforcement

Define 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)**.

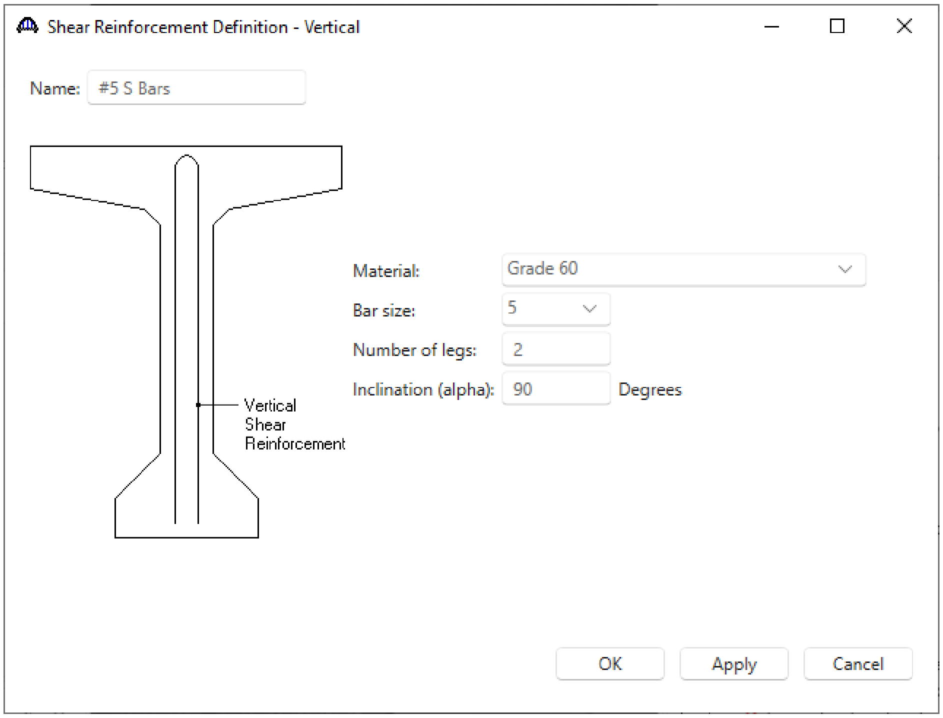


Define the stirrups as shown below.



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

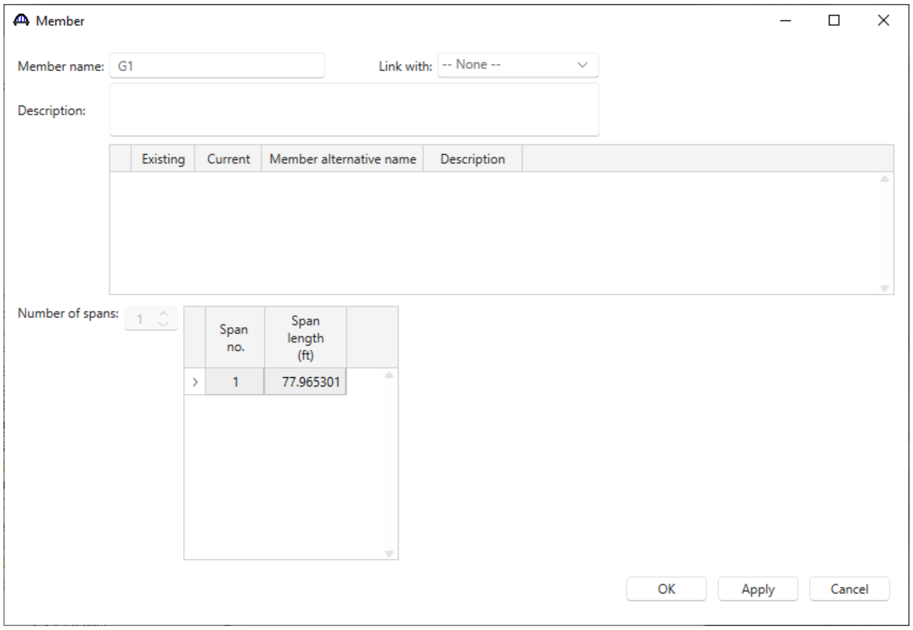
Define the #5 S Bars stirrup definition as shown below. Note that the #5 S Bars are the same definition as the #5 K Bars.



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

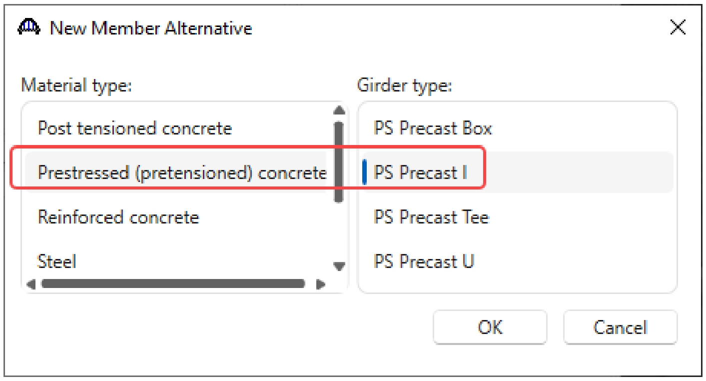
Describing a member:

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



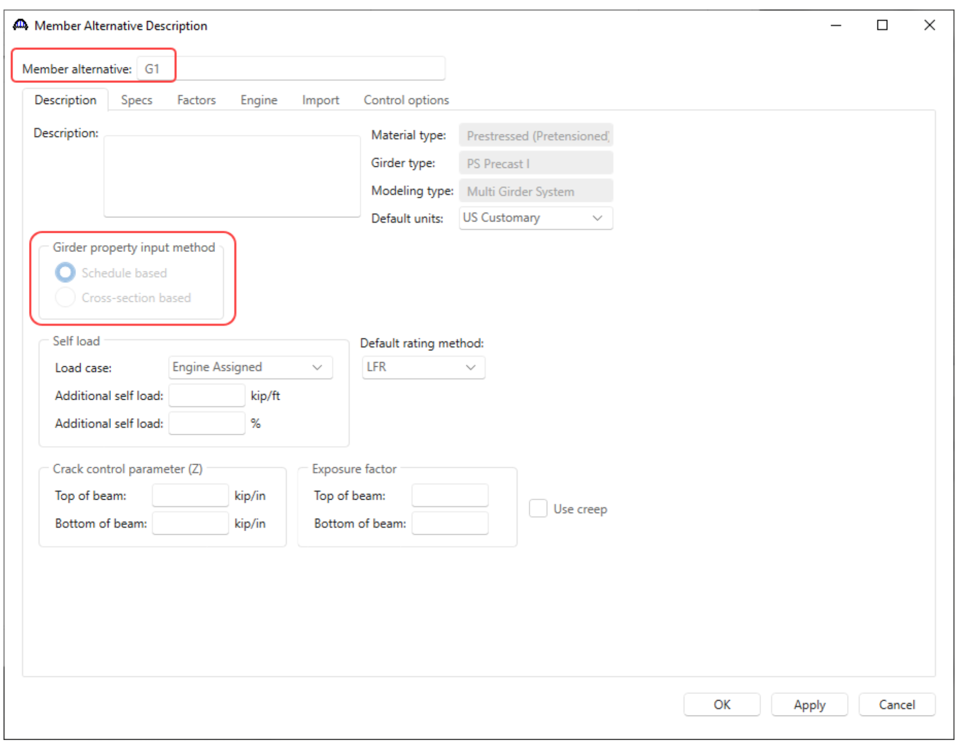
Defining a Member Alternative

Double-click on **MEMBER ALTERNATIVES** in the **Bridge Workspace** tree for member **G1** 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 I** for the **Girder Type**.



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

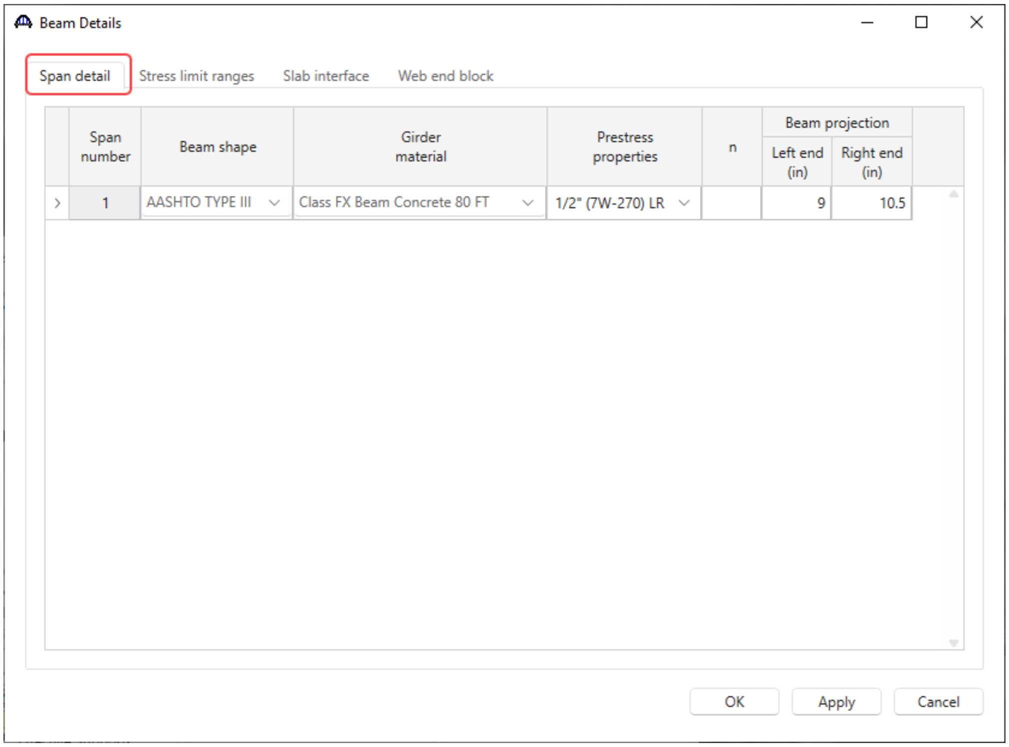
The **Member Alternative Description** window will open as shown below. Enter the name for this member alternative as shown below. The **Schedule based Girder property input method** is the only input method available for a prestressed concrete beam.

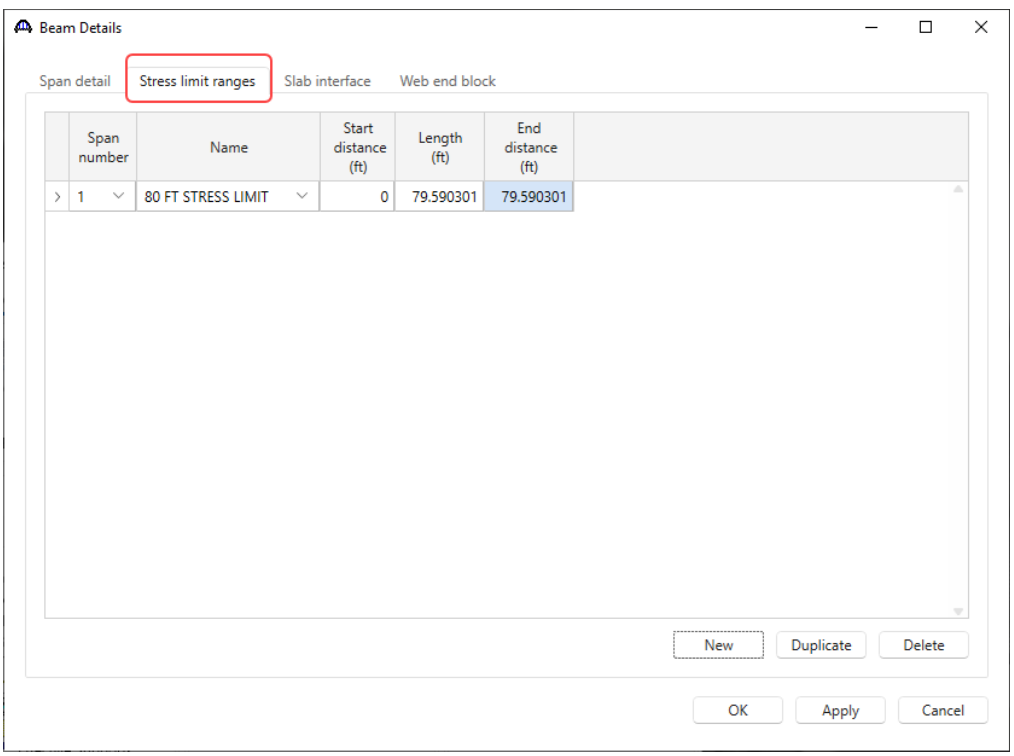


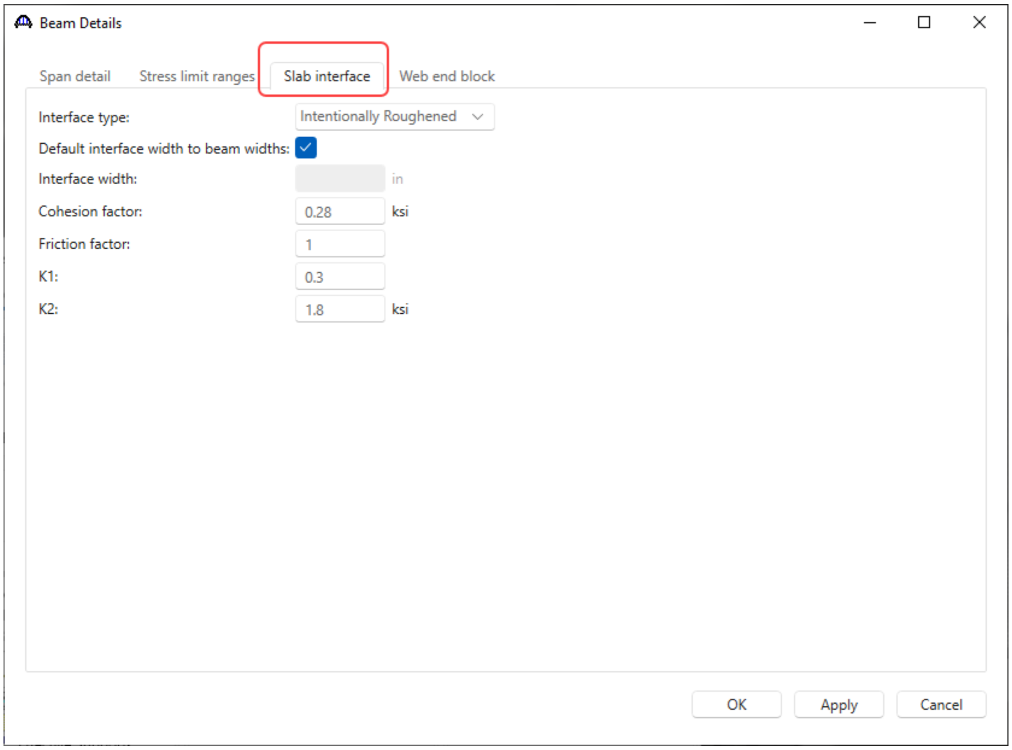
Click **OK** to apply the data and close the window.

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.



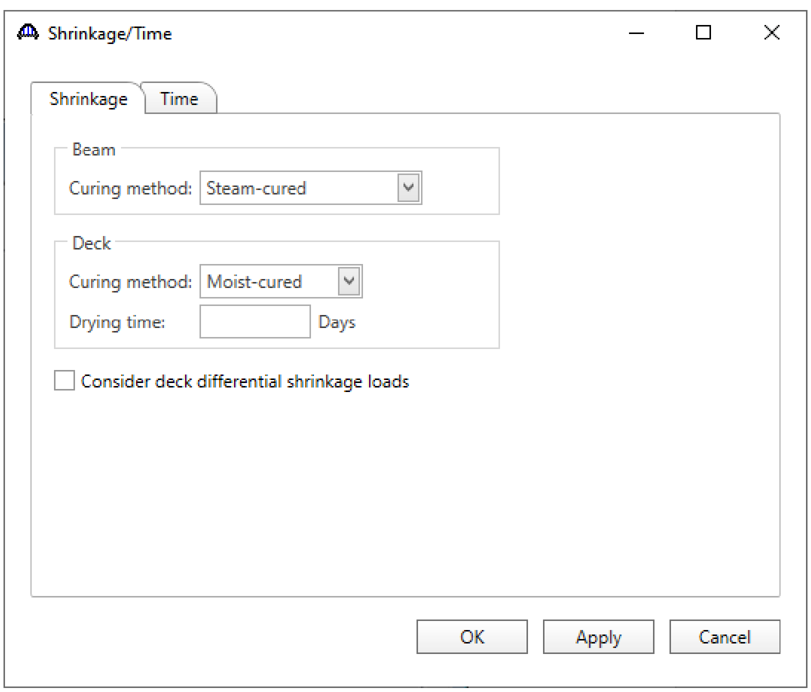




Click **OK** to apply the data and close the window.

Shrinkage Time

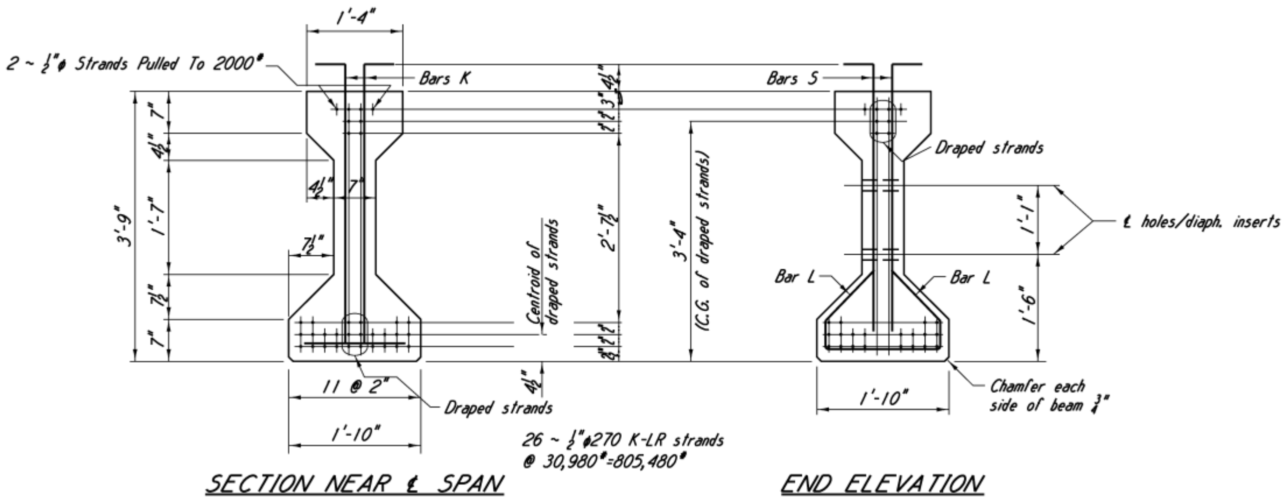
Double-click on the **Shrinkage Time** node in the **Bridge Workspace** tree to open the **Shrinkage/Time** window. Enter the data as shown below.

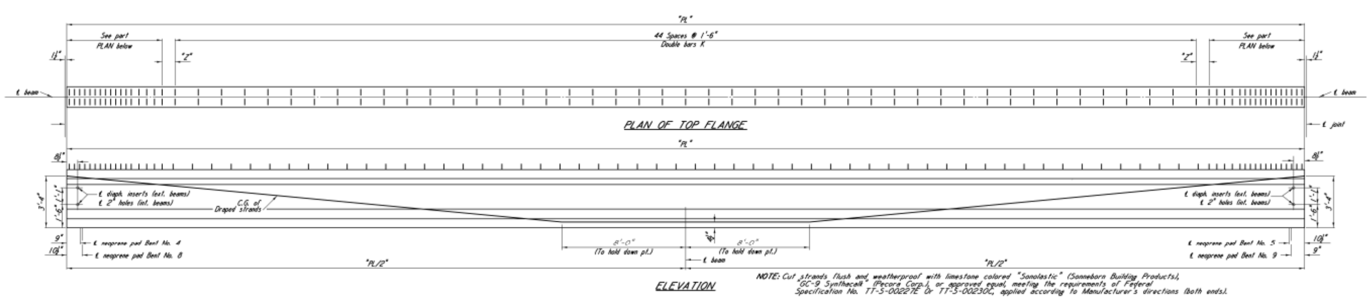


Click **OK** to apply the data and close the window.

Strand Layout

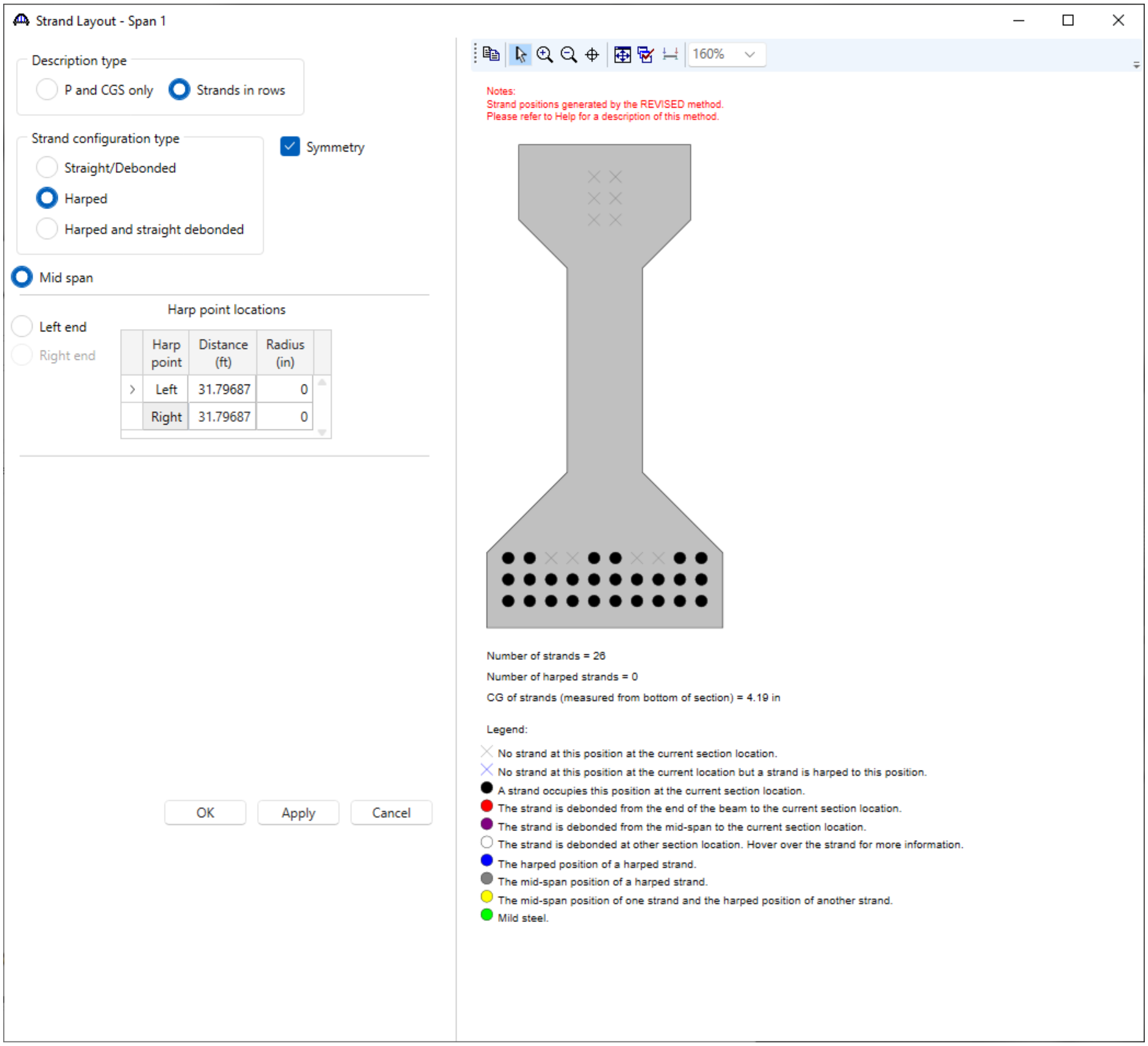
Define the following strand layout at midspan using the screen captures from the drawings shown below.



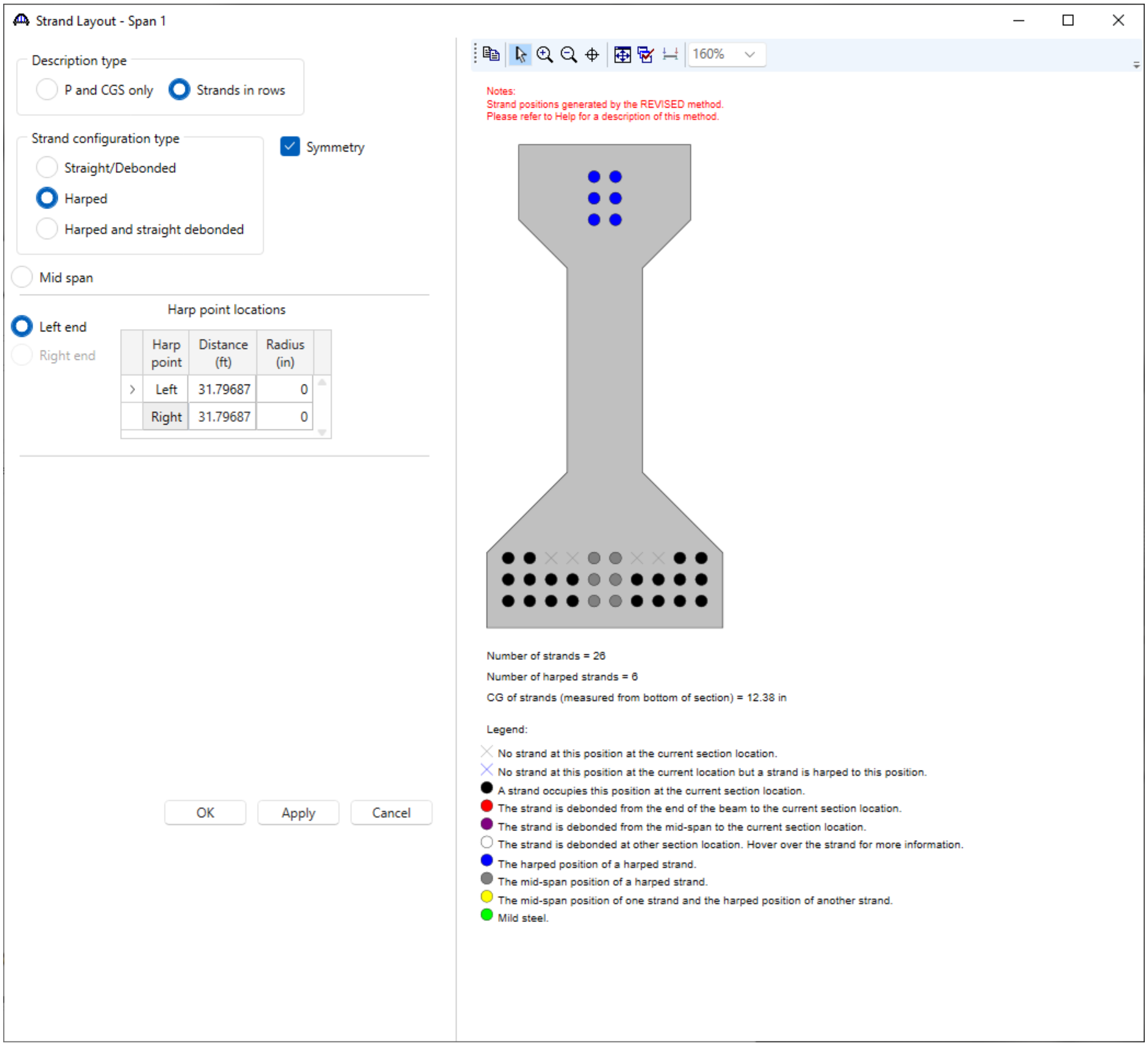


Expand the tree under **Strand Layout** and open the **Span 1** window. Use the **Zoom** buttons on the right side of this window to shrink/expand the schematic of the beam shape so that the entire beam is visible.

Select the **Description type** as **Strands in rows** and the **Strand configuration type** as **Harped**. The **Mid span** radio button will now become active. Enter details as shown below.



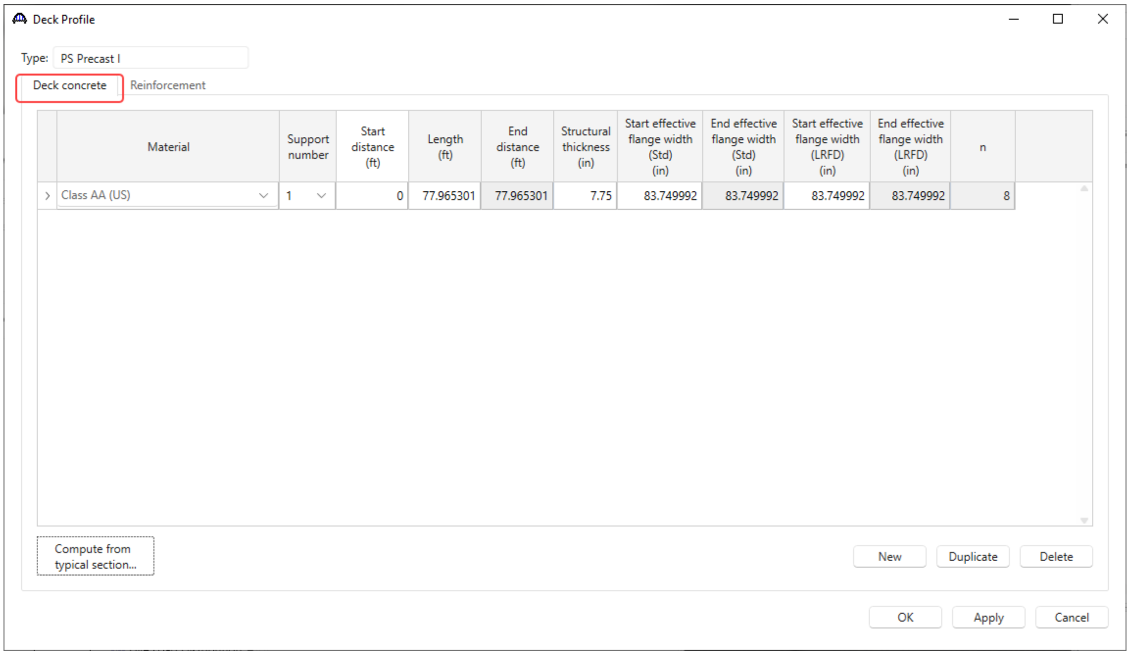
Now select the **Left end** radio button to enter the following harped strand locations at the left end of the precast beam. The strands can be defined at the left end of the span by selecting strand locations in the right hand schematic. Select strands as shown below.



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

Deck Profile

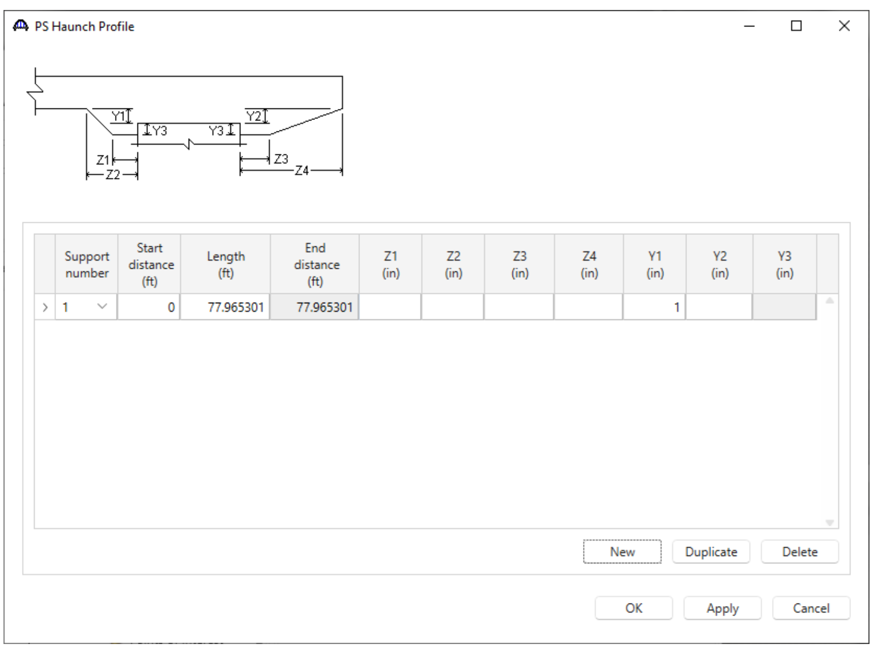
Next open the **Deck Profile** window by double-clicking the **Deck Profile** node in the **Bridge Workspace** tree and enter the data describing the structural properties of the deck. The window is shown below.



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

Haunch Profile

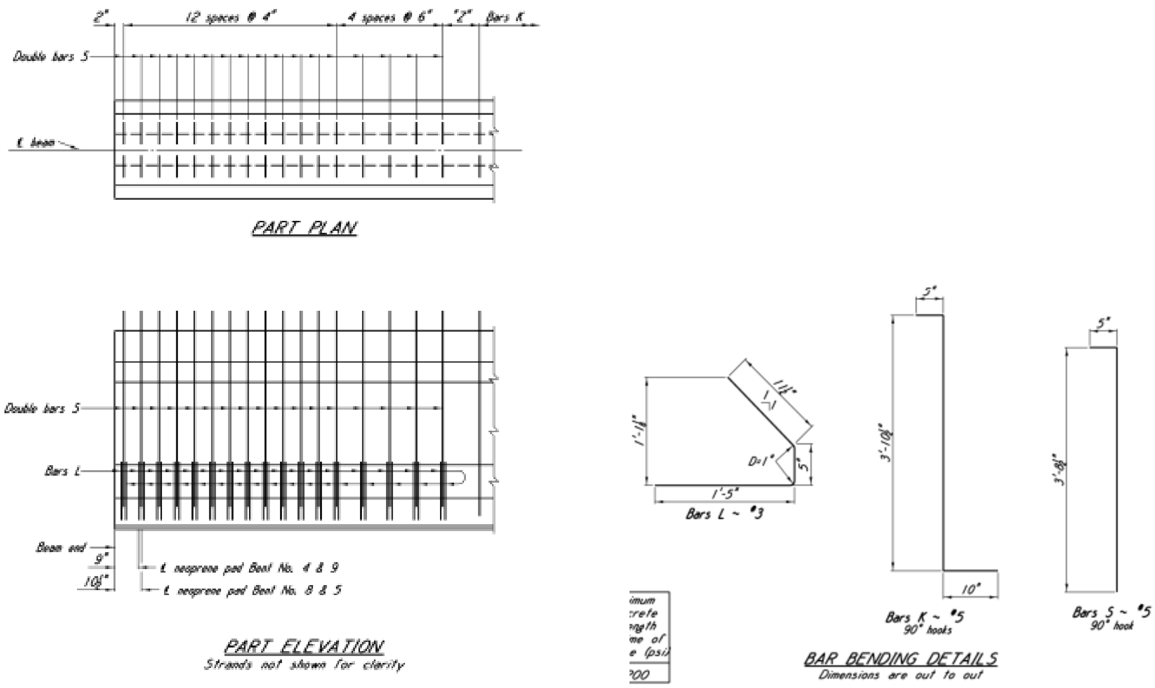
The haunch profile is defined by double-clicking on the **Haunch Profile** node in the **Bridge Workspace** tree. Enter data as shown below and Click **OK** to apply the data and close the window.



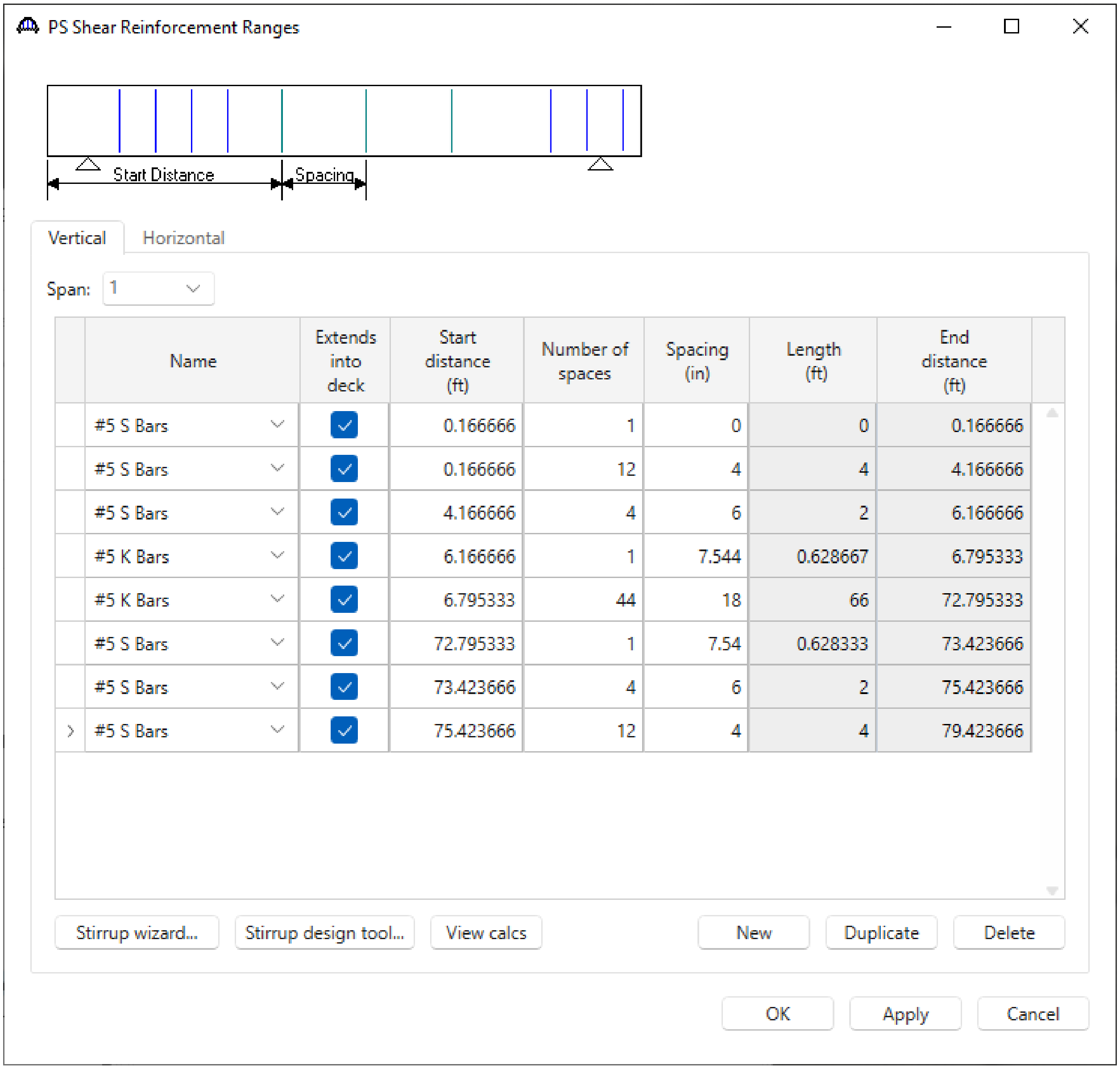
Click **OK** to apply the data and close the window.

Shear Reinforcement Ranges

Use the Stirrup wizard from the **Shear Reinforcement Ranges** window to create the following shear stirrups. Double-click on the **Shear Reinforcement Ranges** node in the **Bridge Workspace** tree to open the **PS Shear Reinforcement Ranges** window.



Enter data as shown below.



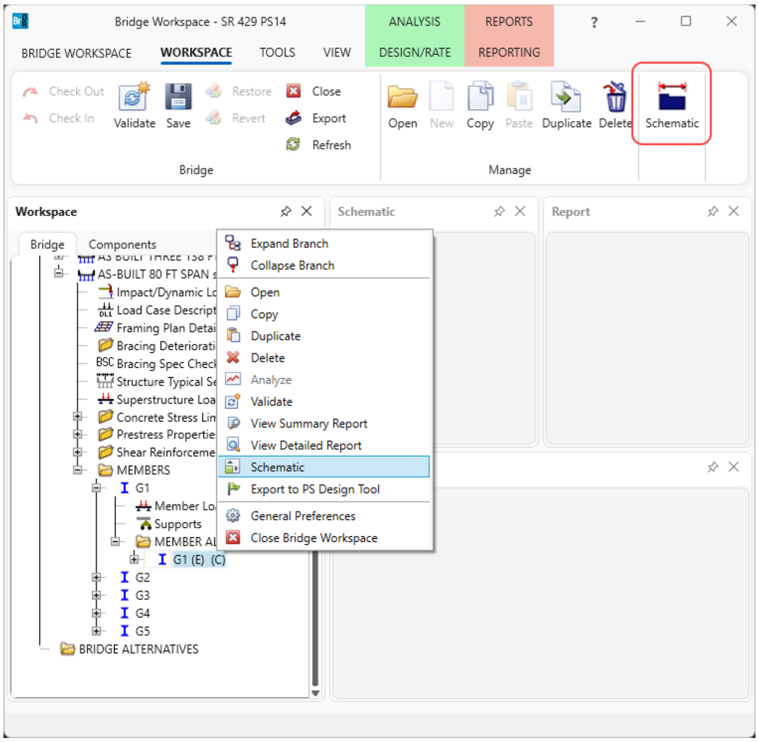
Click **OK** to apply the data and close the window.

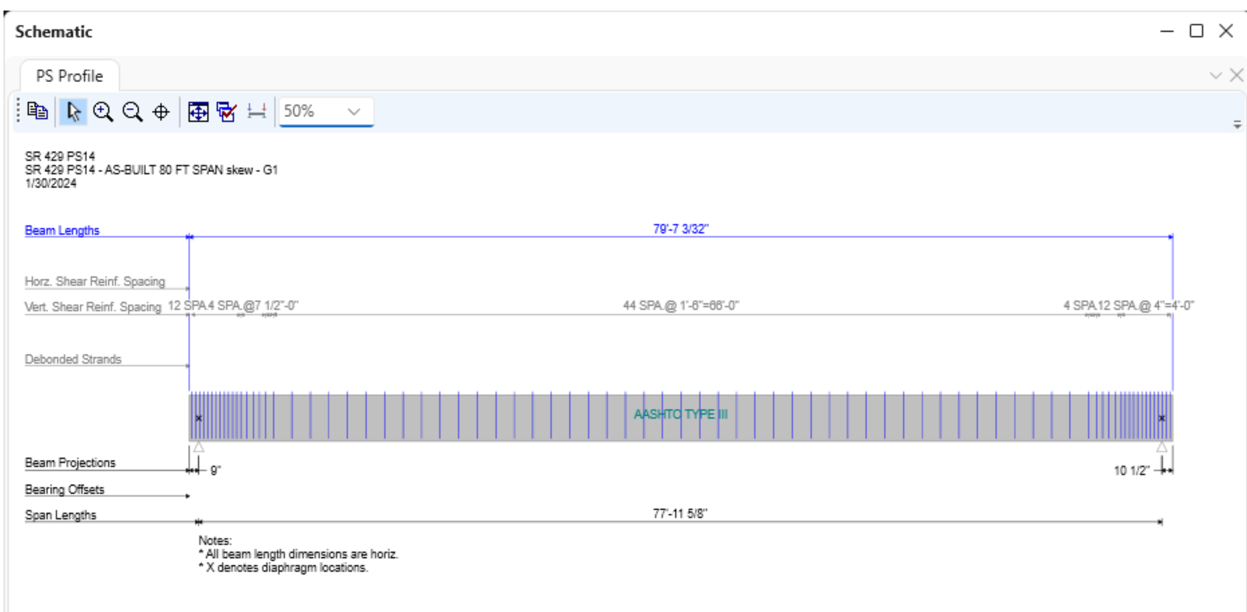
Live Load Distribution

The live load distribution factors will be computed by the BrDR LRFD engine during analysis.

Schematic – G1 Member Alternative

While the member alternative **G1 (E) (C)** is selected in the **Bridge Workspace** tree, open the schematic for the member alternative by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **G1 (E) (C)** in the **Bridge Workspace** and select **Schematic** from the menu).





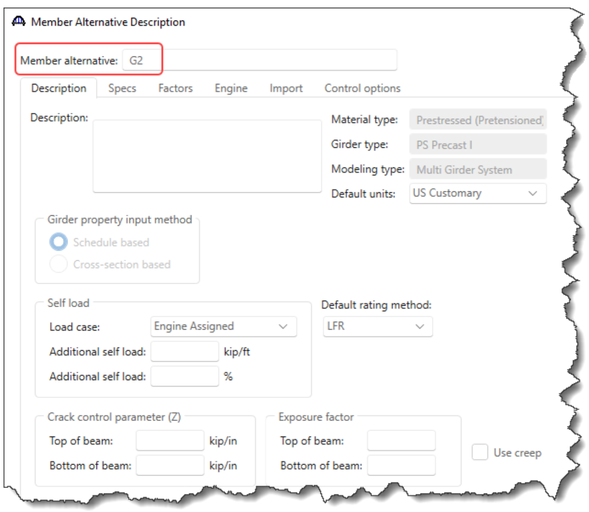
Girder 1 is complete. Girders G2-G5 are similar but the lengths are different.

Harp Locations	
Girder	DRAPE
1	31.79688
2	31.83333
3	31.875
4	31.91667
5	31.95833

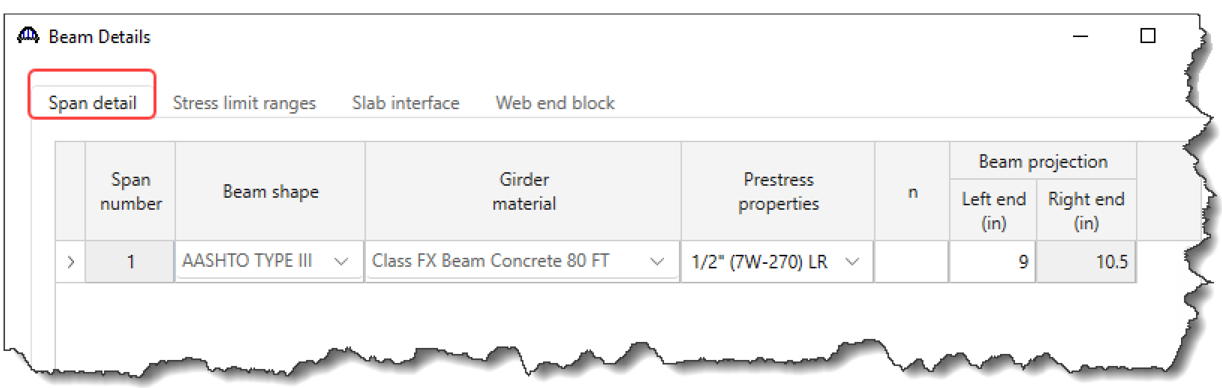
Enter the girder G2-G5 and see images to update the differences in windows shown below.

Girder G2

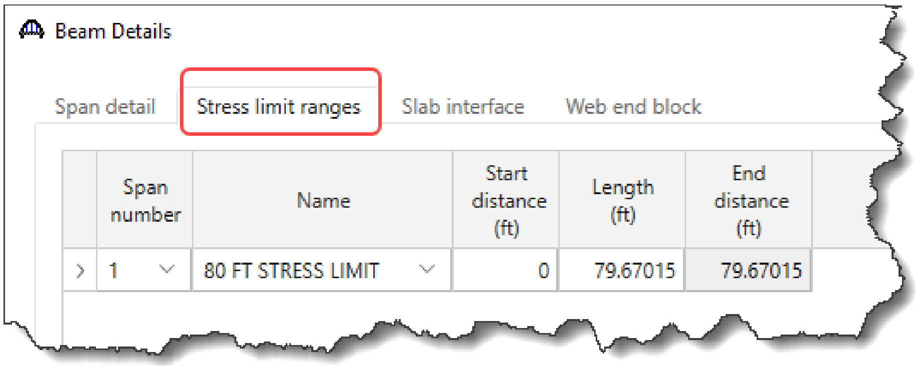
Member Alternative Description



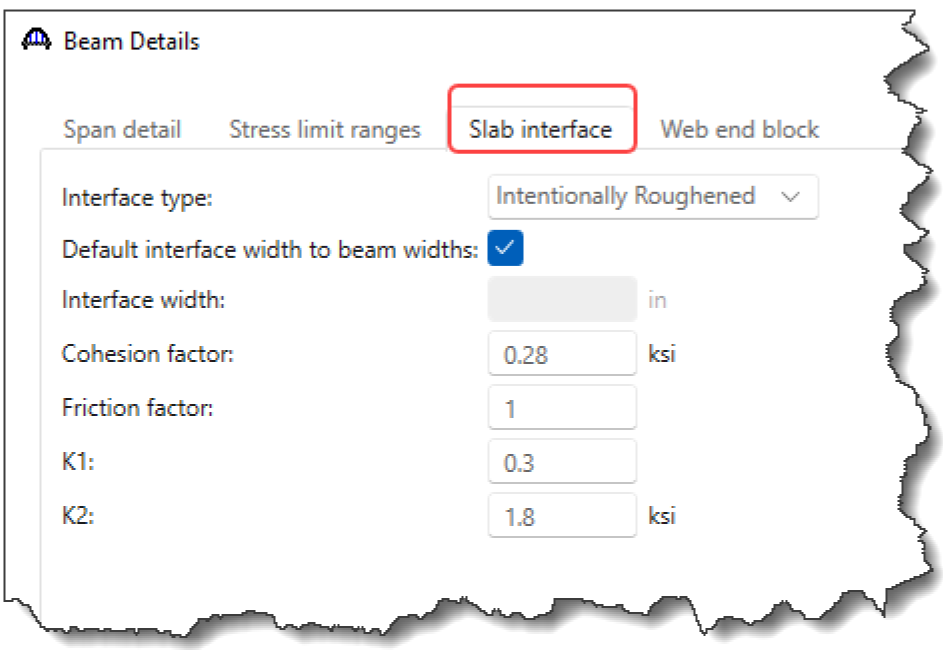
Beam Details – Span detail



Beam Details – Stress limit ranges



Beam Details – Slab interface



Strand Layout

Strand layout is similar to **G1**, but the length is different. See below for **G2** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations	
Girder	DRAPE
2	31.83333

Deck Profile – Deck concrete

Deck Profile

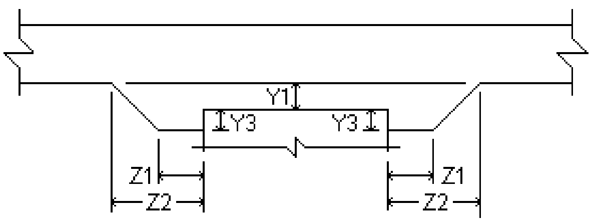
Type: PS Precast I

Deck concrete | Reinforcement

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA (US)	1	0	78.04515	78.04515	7.75	91.5	91.5	91.5	91.5	8

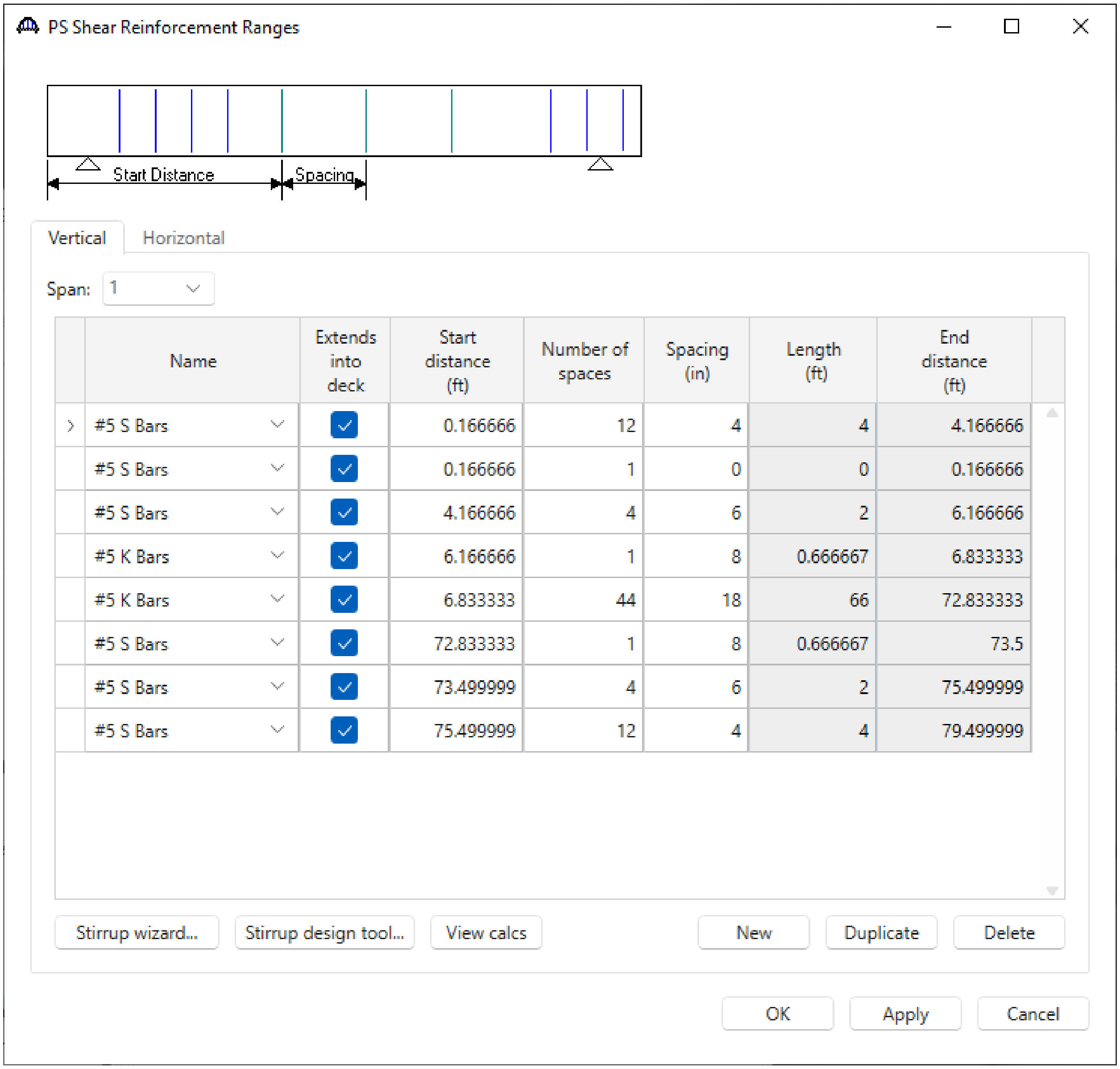
PS Haunch Profile

PS Haunch Profile



Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
1	0	78.04515	78.04515			1	

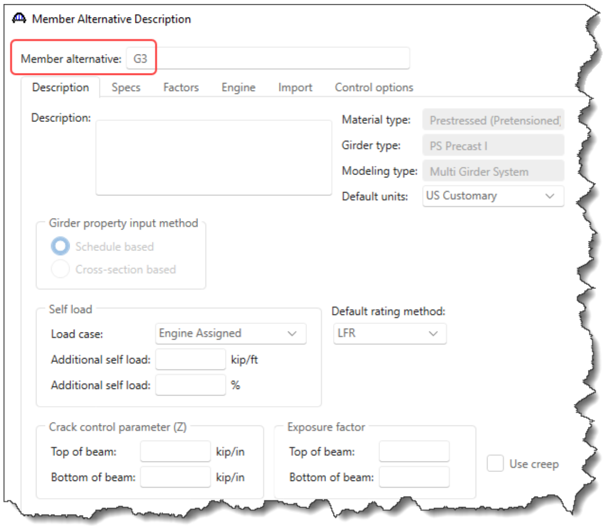
PS Shear Reinforcement Ranges



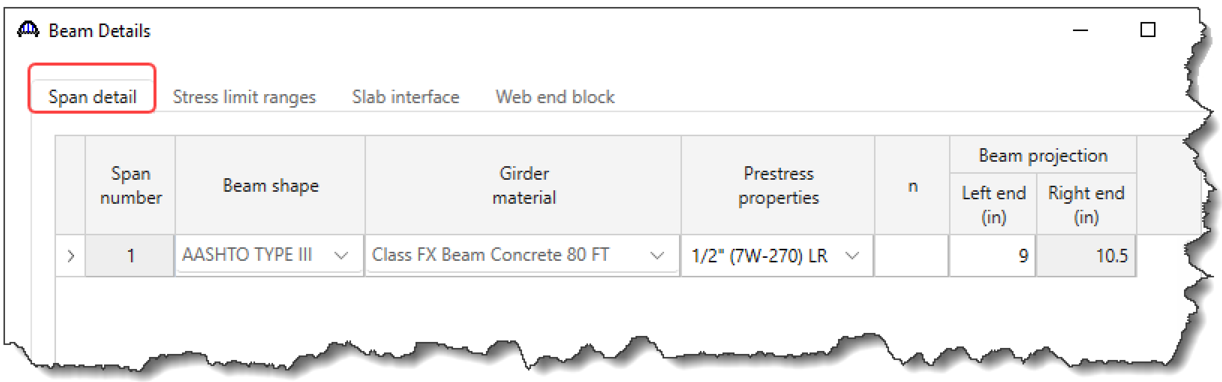
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	✓	0.166666	12	4	4	4.166666
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	4.166666	4	6	2	6.166666
#5 K Bars	✓	6.166666	1	8	0.666667	6.833333
#5 K Bars	✓	6.833333	44	18	66	72.833333
#5 S Bars	✓	72.833333	1	8	0.666667	73.5
#5 S Bars	✓	73.499999	4	6	2	75.499999
#5 S Bars	✓	75.499999	12	4	4	79.499999

Girder G3

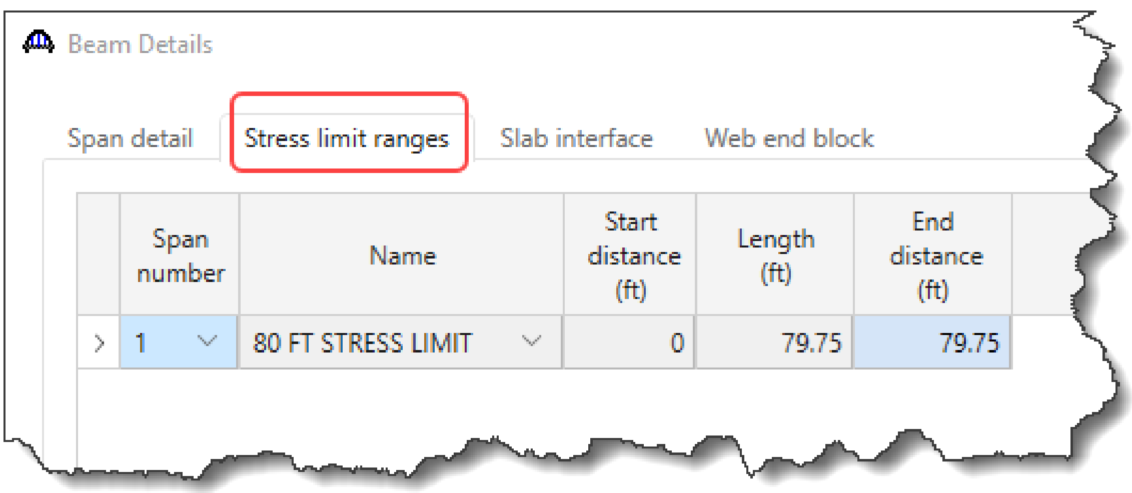
Member Alternative Description



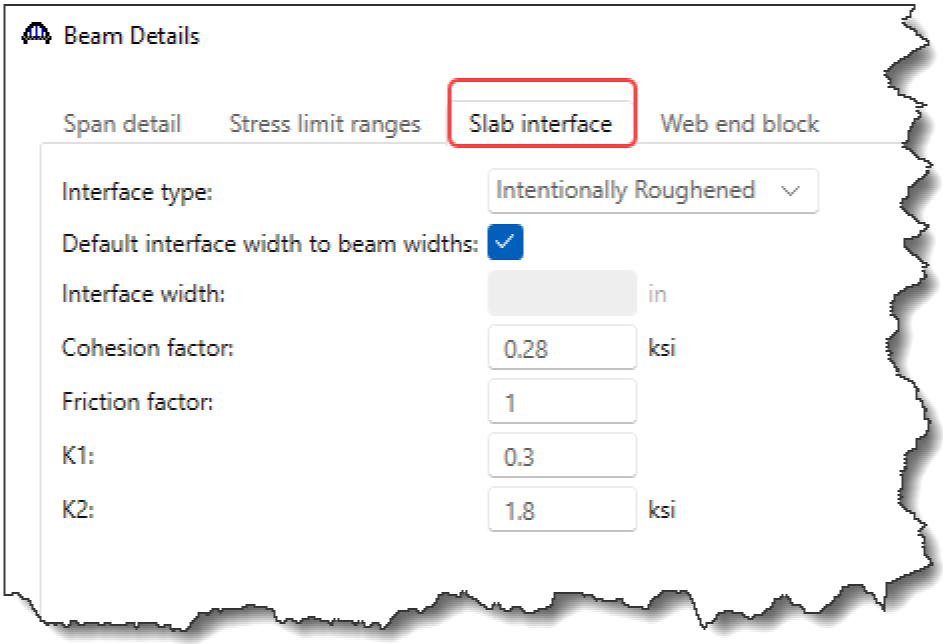
Beam Details – Span detail



Beam Details – Stress limit ranges



Beam Details – Slab interface

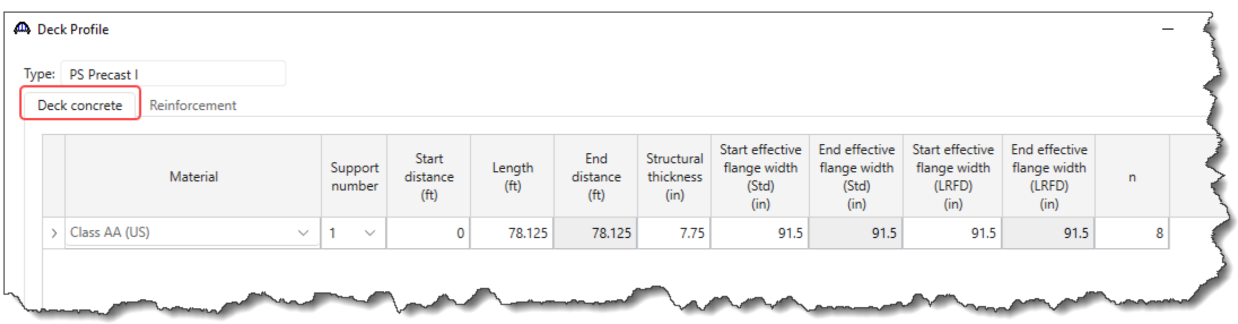


Strand Layout

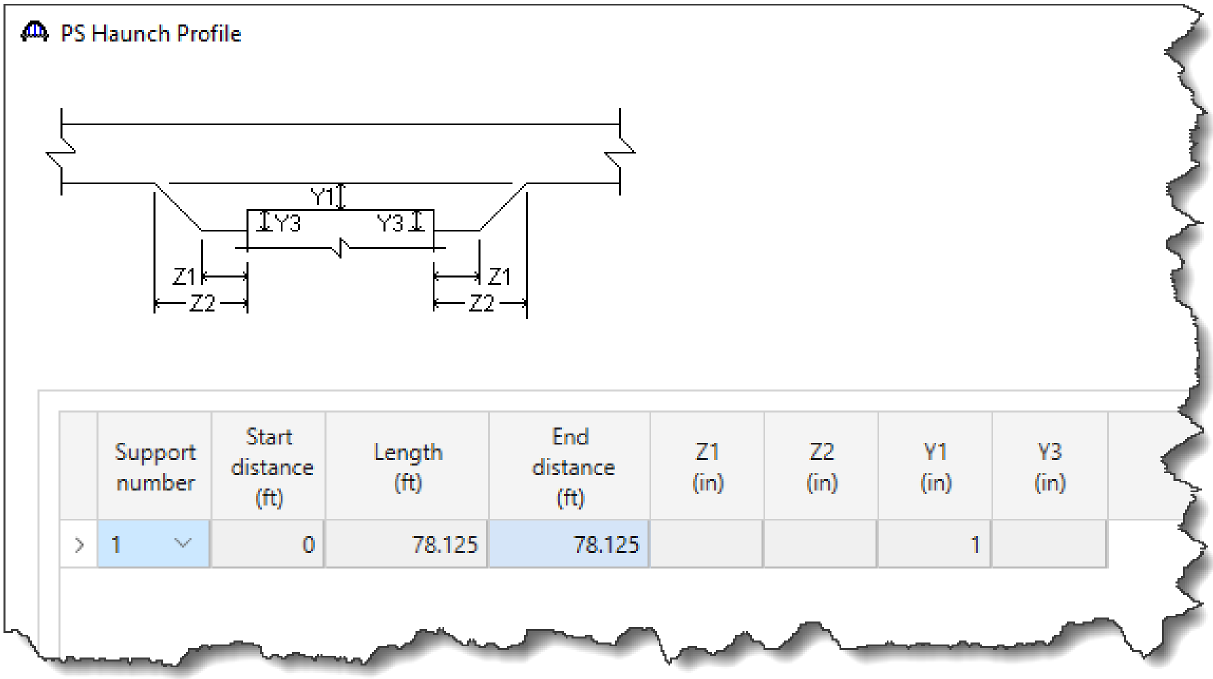
Strand layout is similar to **G1**, but the length is different. See below for **G2** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations	
Girder	DRAPE
3	31.875

Deck Profile – Deck concrete

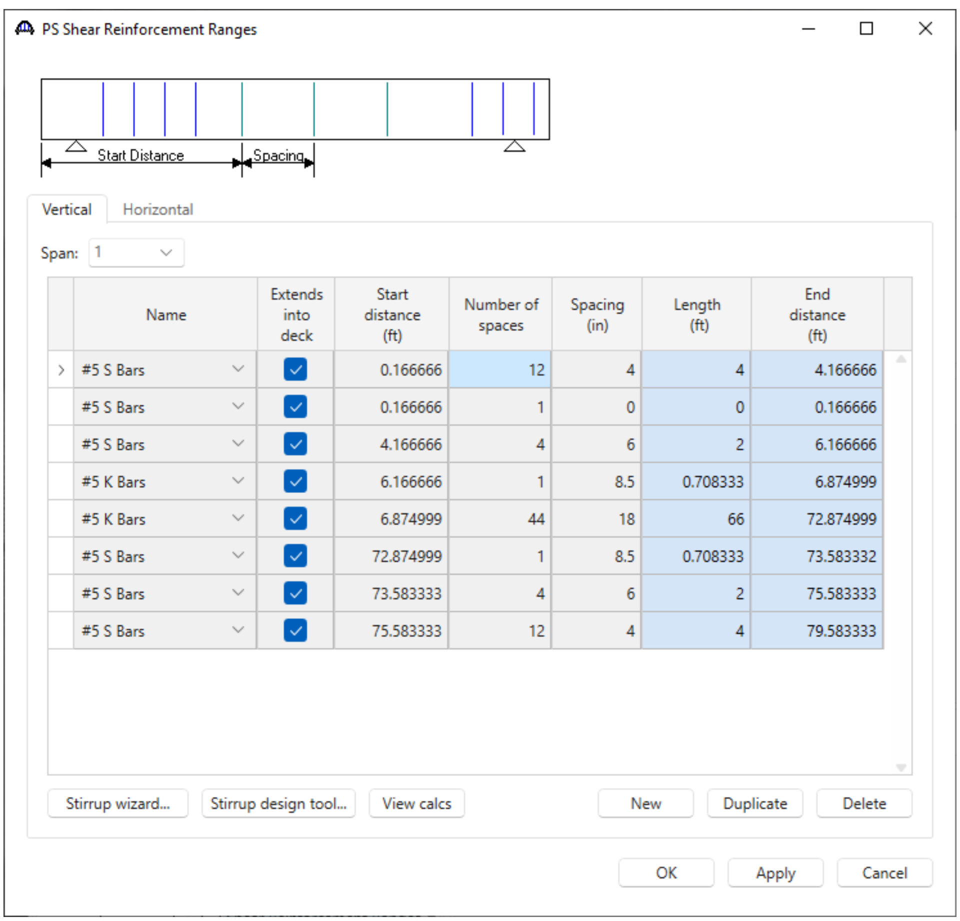


PS Haunch Profile



	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
>	1	0	78.125	78.125			1	

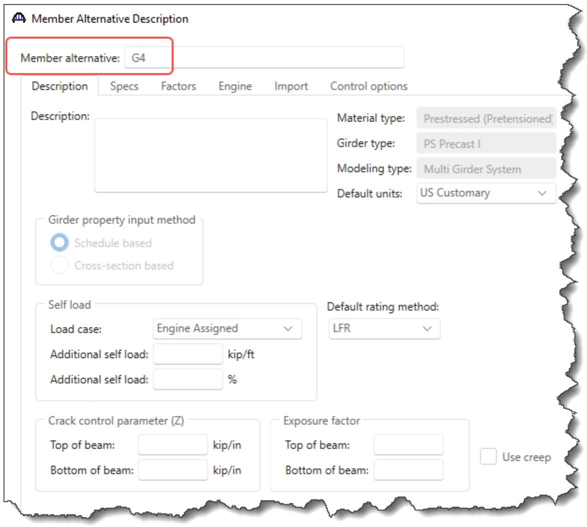
PS Shear Reinforcement Ranges



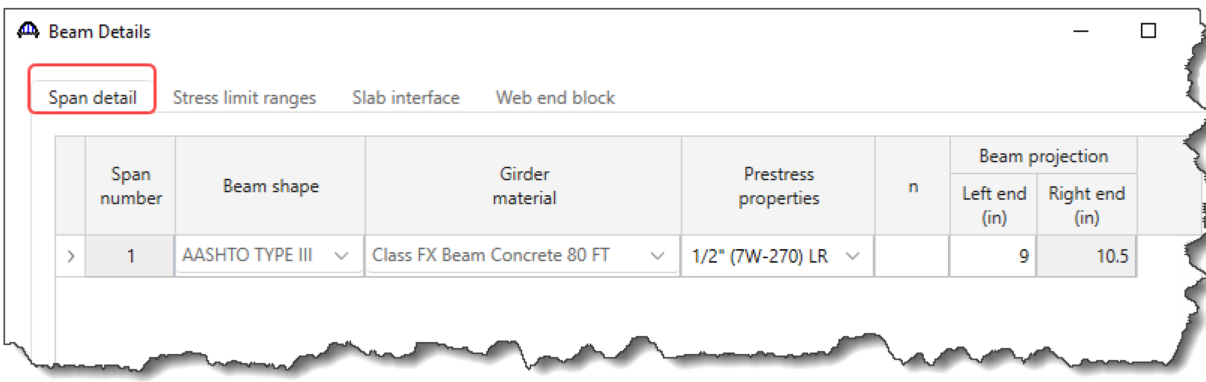
	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
>	#5 S Bars	☑	0.166666	12	4	4	4.166666
	#5 S Bars	☑	0.166666	1	0	0	0.166666
	#5 S Bars	☑	4.166666	4	6	2	6.166666
	#5 K Bars	☑	6.166666	1	8.5	0.708333	6.874999
	#5 K Bars	☑	6.874999	44	18	66	72.874999
	#5 S Bars	☑	72.874999	1	8.5	0.708333	73.583332
	#5 S Bars	☑	73.583333	4	6	2	75.583333
	#5 S Bars	☑	75.583333	12	4	4	79.583333

Girder G4

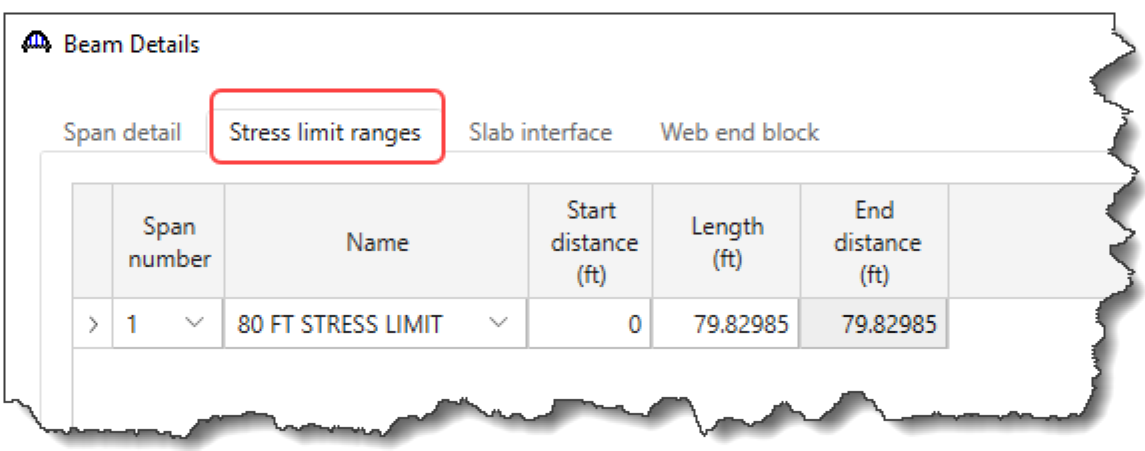
Member Alternative Description



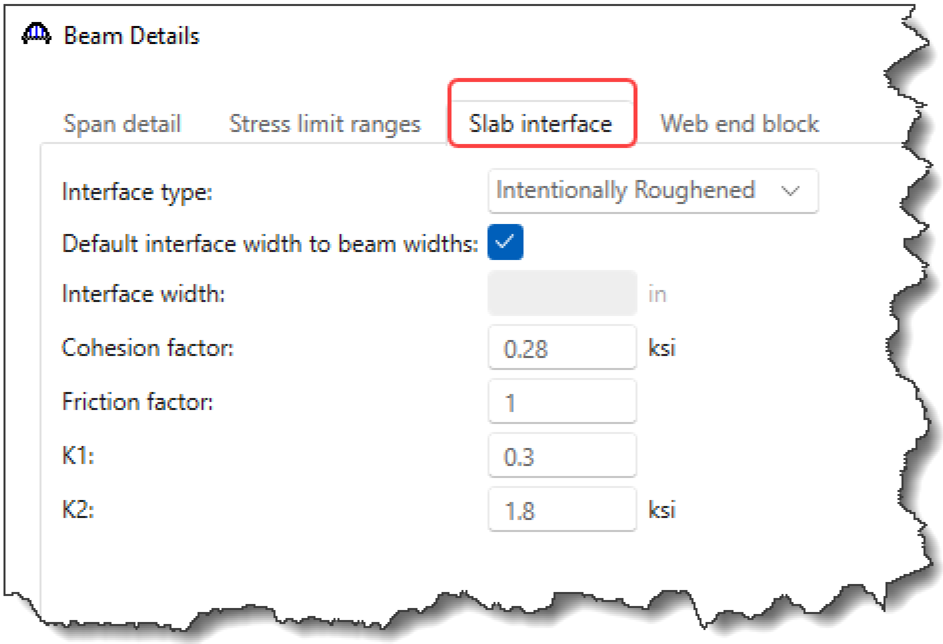
Beam Details – Span detail



Beam Details – Stress limit ranges



Beam Details – Slab interface

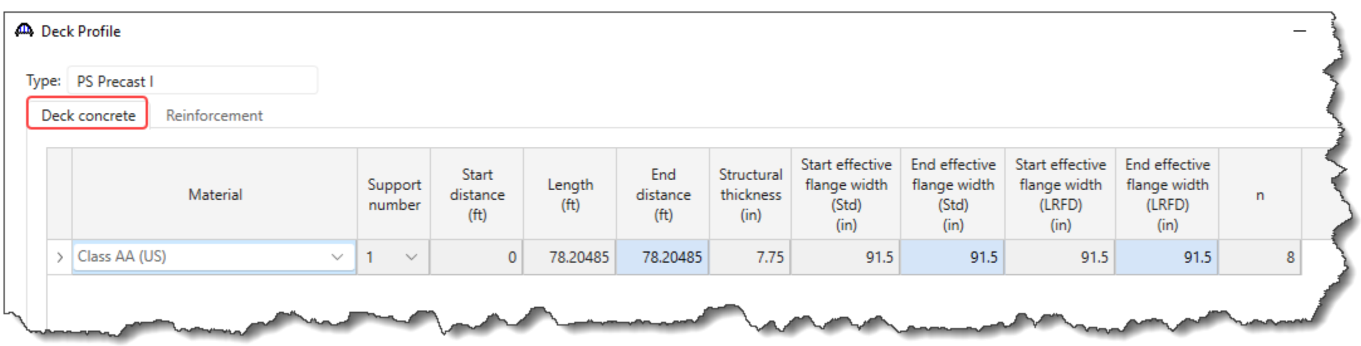


Strand Layout

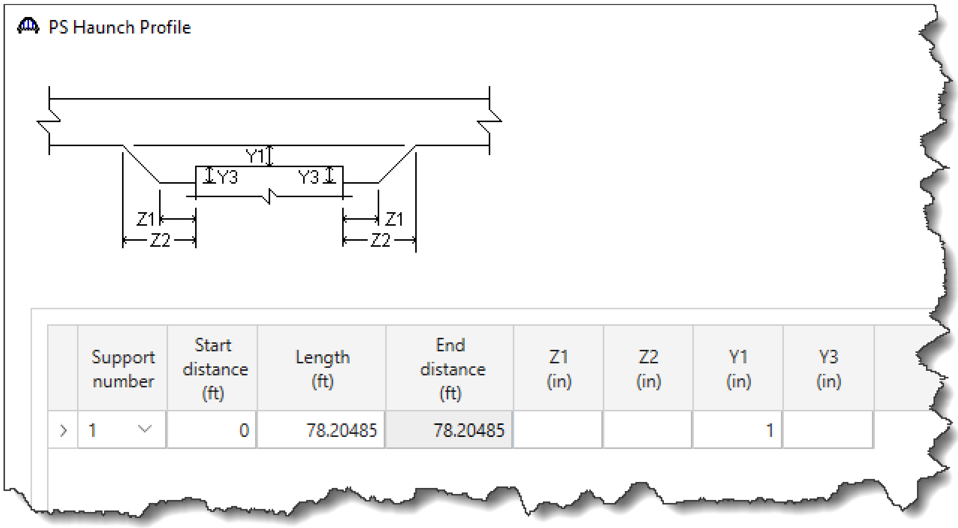
Strand layout is similar to **G1**, but the length is different. See below for **G2** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations	
Girder	DRAPE
4	31.91667

Deck Profile – Deck concrete

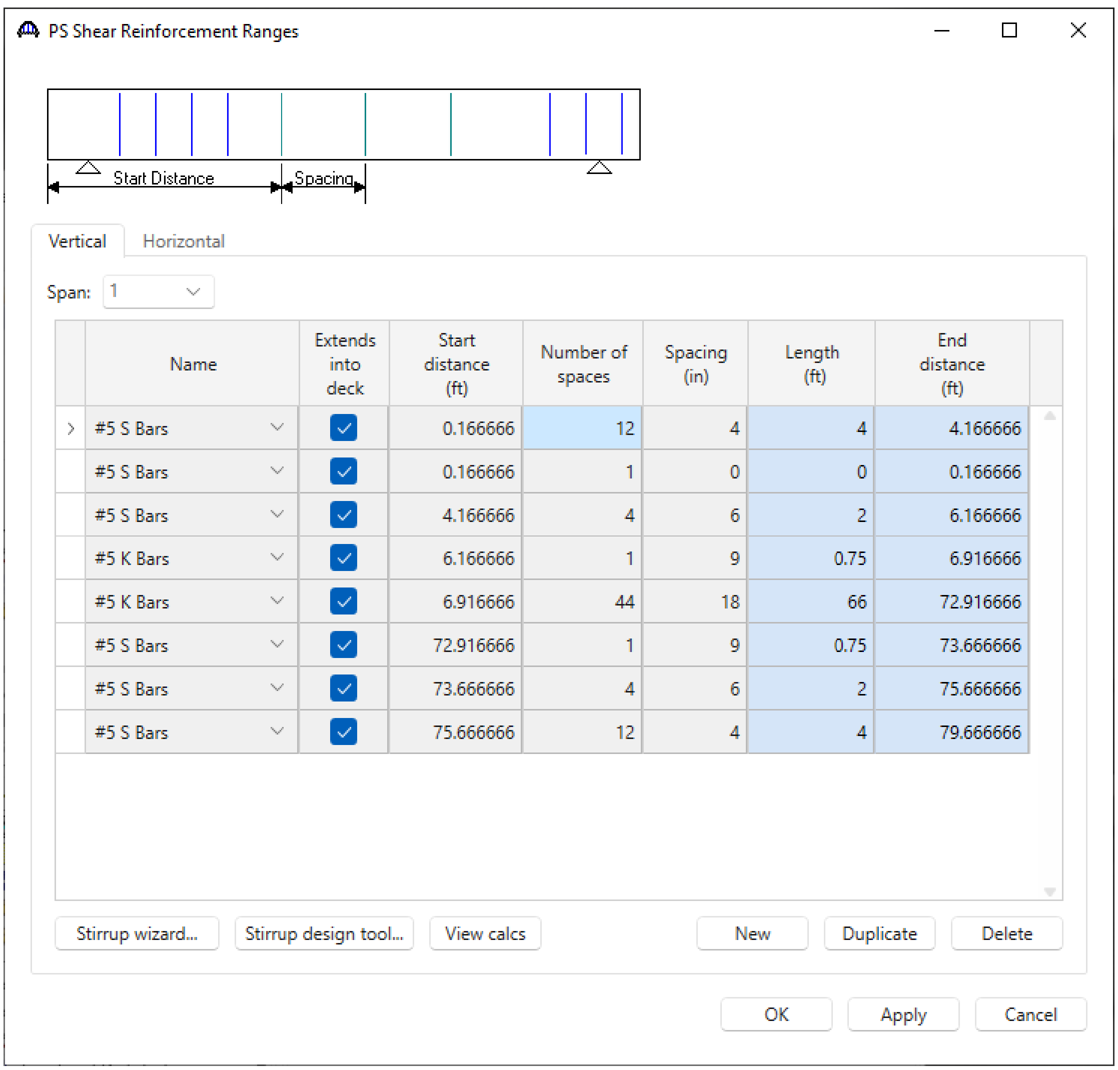


PS Haunch Profile



	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)	Y3 (in)
>	1	0	78.20485	78.20485			1	

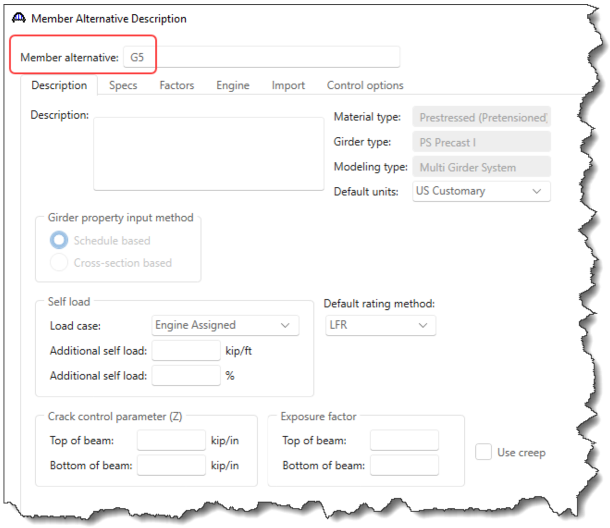
PS Shear Reinforcement Ranges



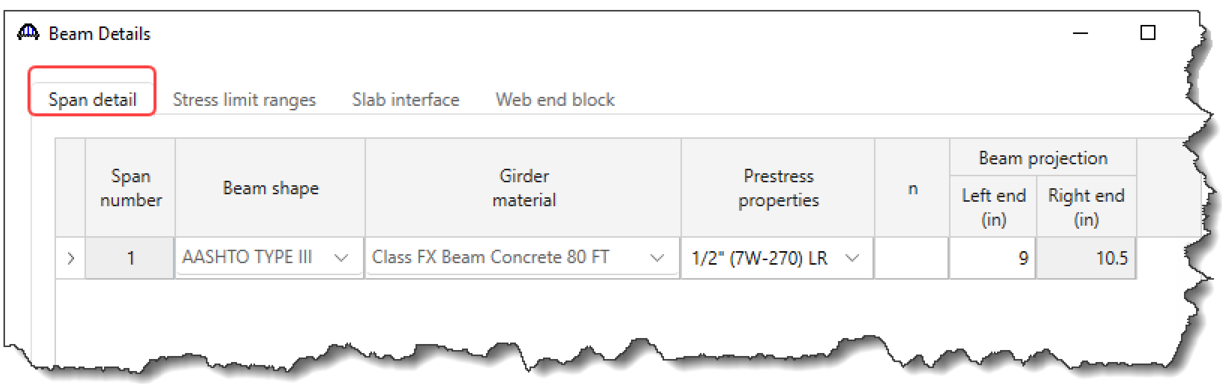
	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
>	#5 S Bars	✓	0.166666	12	4	4	4.166666
	#5 S Bars	✓	0.166666	1	0	0	0.166666
	#5 S Bars	✓	4.166666	4	6	2	6.166666
	#5 K Bars	✓	6.166666	1	9	0.75	6.916666
	#5 K Bars	✓	6.916666	44	18	66	72.916666
	#5 S Bars	✓	72.916666	1	9	0.75	73.666666
	#5 S Bars	✓	73.666666	4	6	2	75.666666
	#5 S Bars	✓	75.666666	12	4	4	79.666666

Girder G5

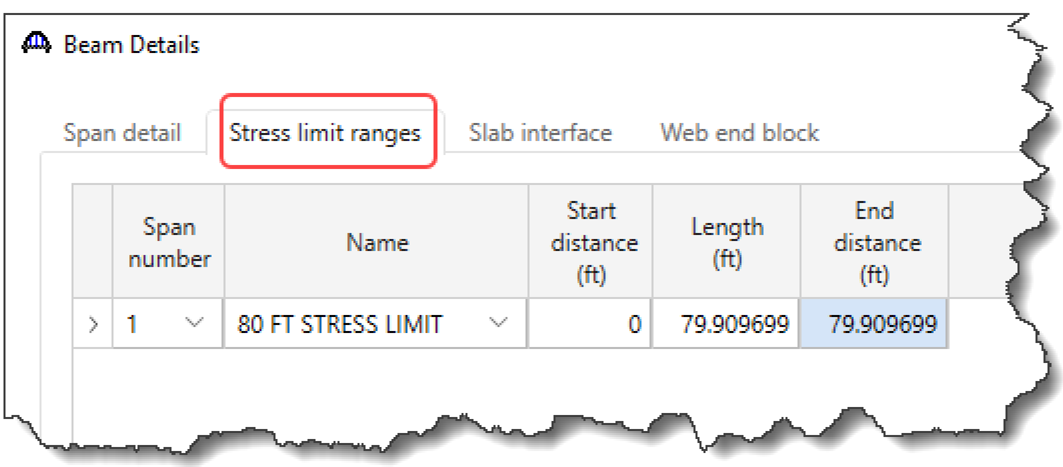
Member Alternative Description



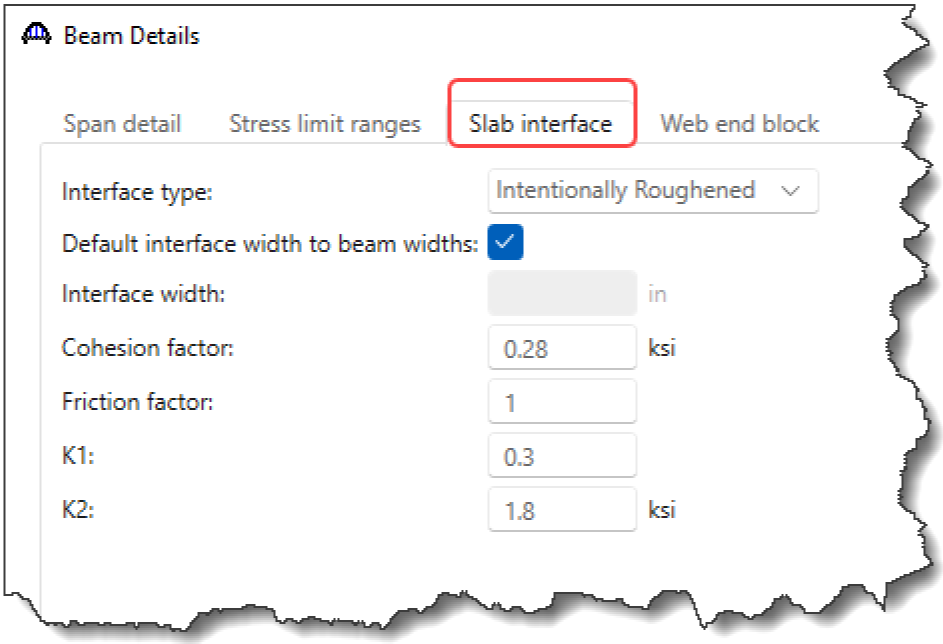
Beam Details – Span detail



Beam Details – Stress limit ranges



Beam Details – Slab interface

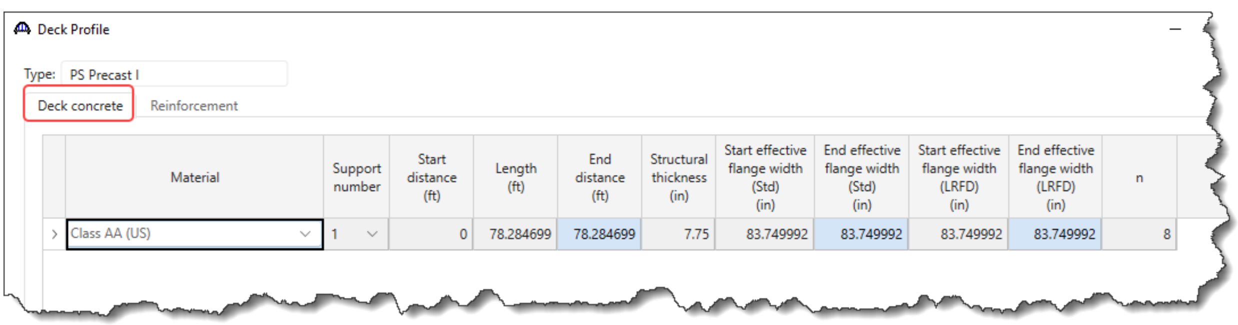


Strand Layout

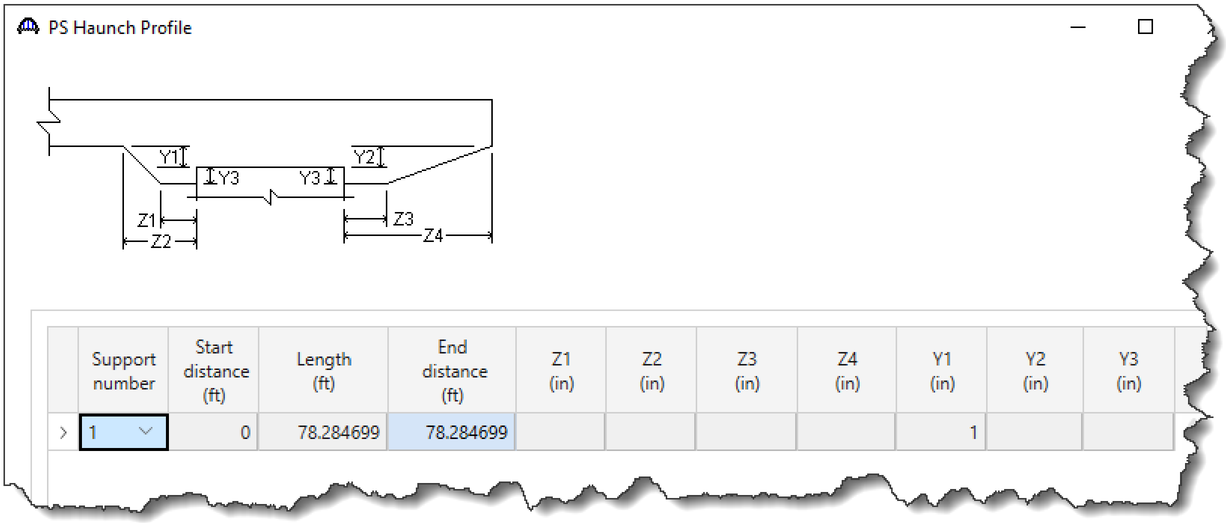
Strand layout is similar to **G1**, but the length is different. See below for **G2** harp locations and enter them in the window by following the steps used for **G1**.

Harp Locations	
Girder	DRAPE
5	31.95833

Deck Profile – Deck concrete

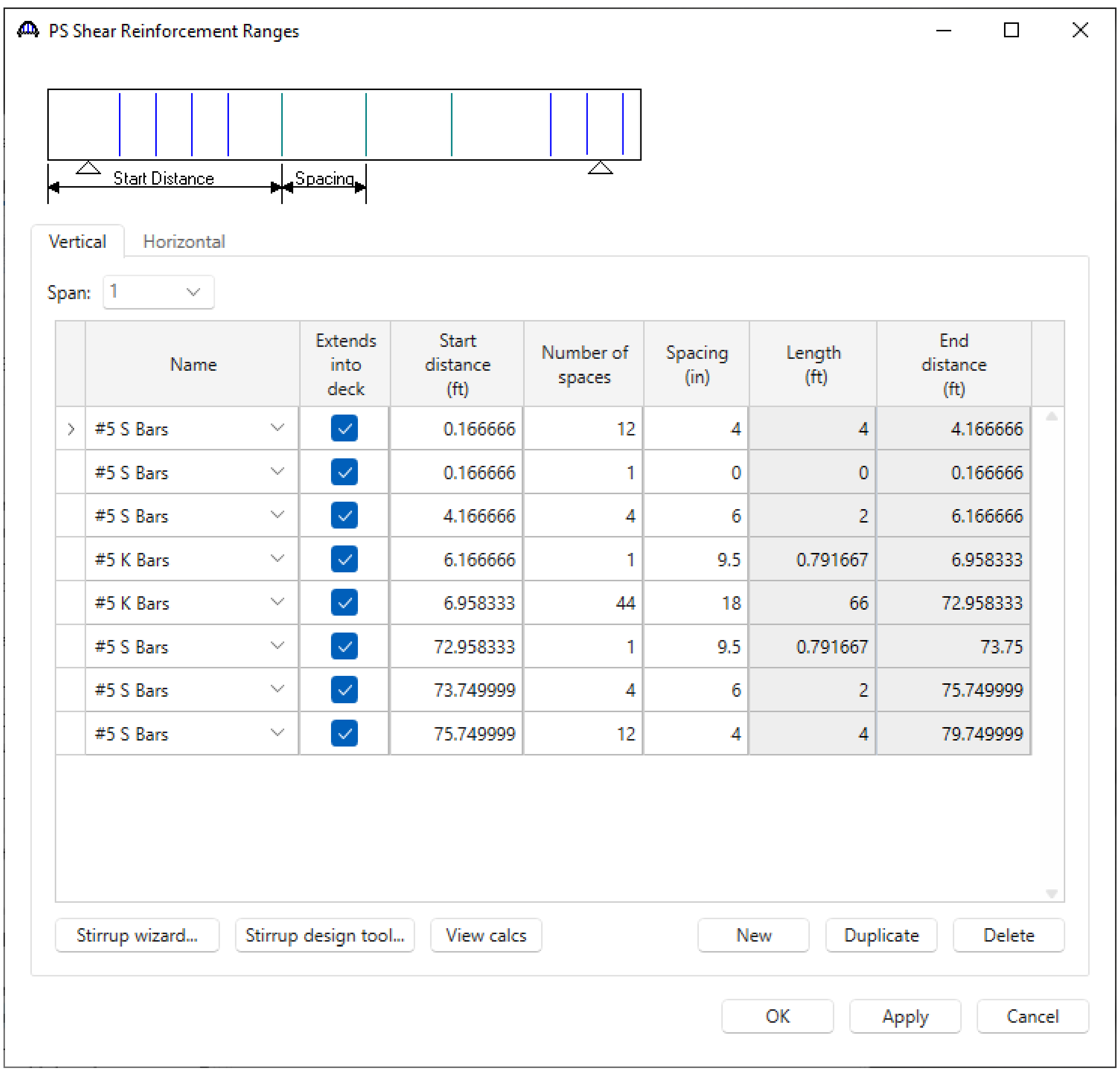


PS Haunch Profile



Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Z3 (in)	Z4 (in)	Y1 (in)	Y2 (in)	Y3 (in)
1	0	78.284699	78.284699					1		

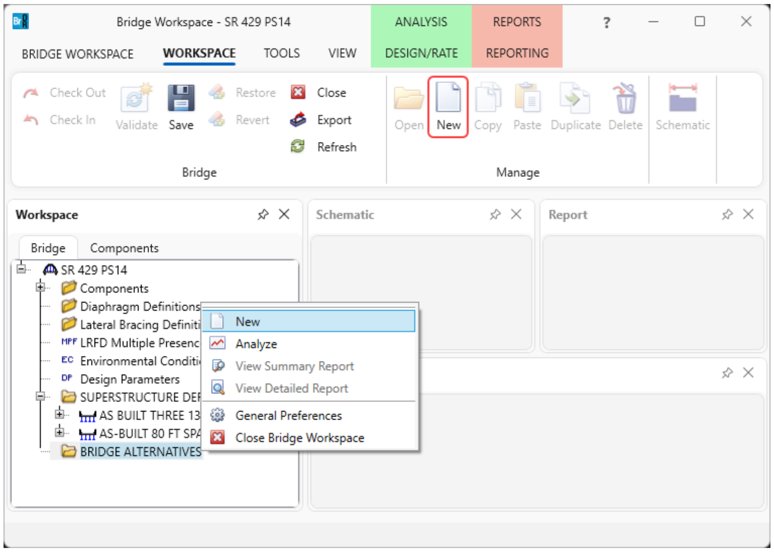
PS Shear Reinforcement Ranges



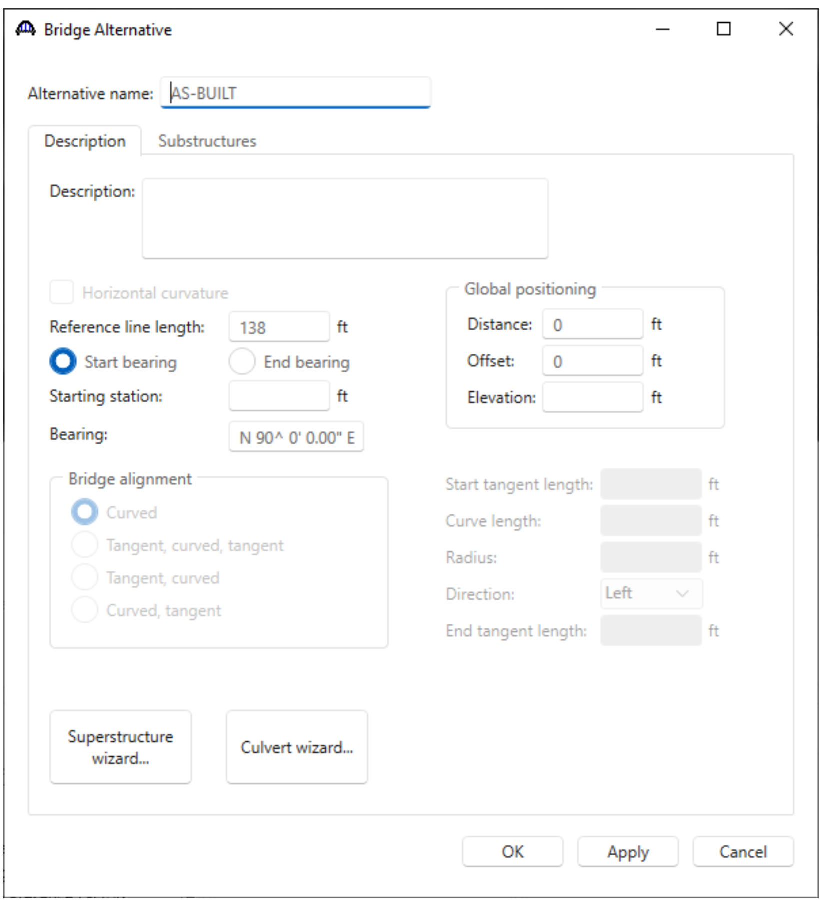
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 S Bars	✓	0.166666	12	4	4	4.166666
#5 S Bars	✓	0.166666	1	0	0	0.166666
#5 S Bars	✓	4.166666	4	6	2	6.166666
#5 K Bars	✓	6.166666	1	9.5	0.791667	6.958333
#5 K Bars	✓	6.958333	44	18	66	72.958333
#5 S Bars	✓	72.958333	1	9.5	0.791667	73.75
#5 S Bars	✓	73.749999	4	6	2	75.749999
#5 S Bars	✓	75.749999	12	4	4	79.749999

Bridge Alternative

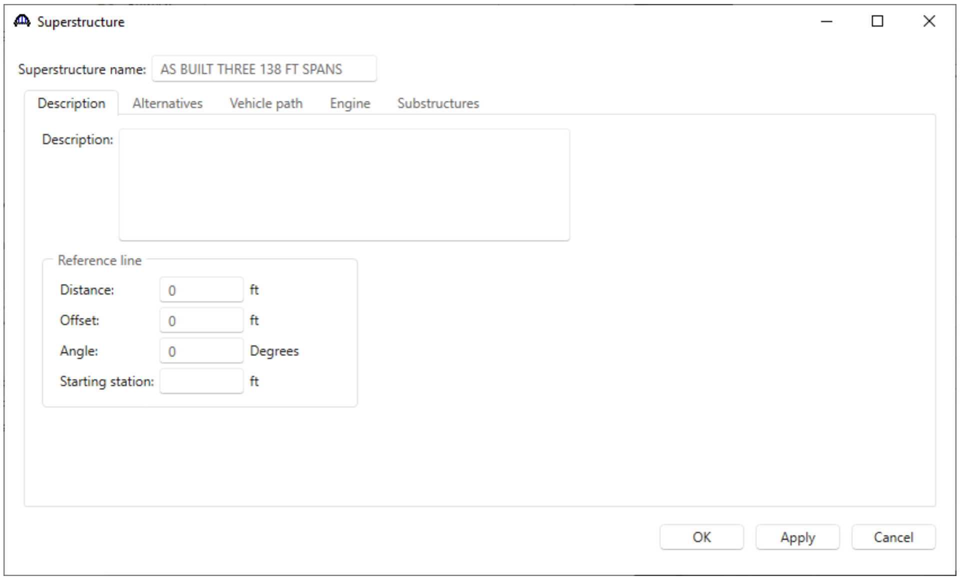
Navigate to the **BRIDGE ALTERNATIVES** node in the **Bridge Workspace** tree and create a new bridge alternative by double-clicking on **BRIDGE ALTERNATIVES** (or click on **BRIDGE ALTERNATIVES** and select **New** from the **Manage** group of the **WORKSPACE** ribbon).



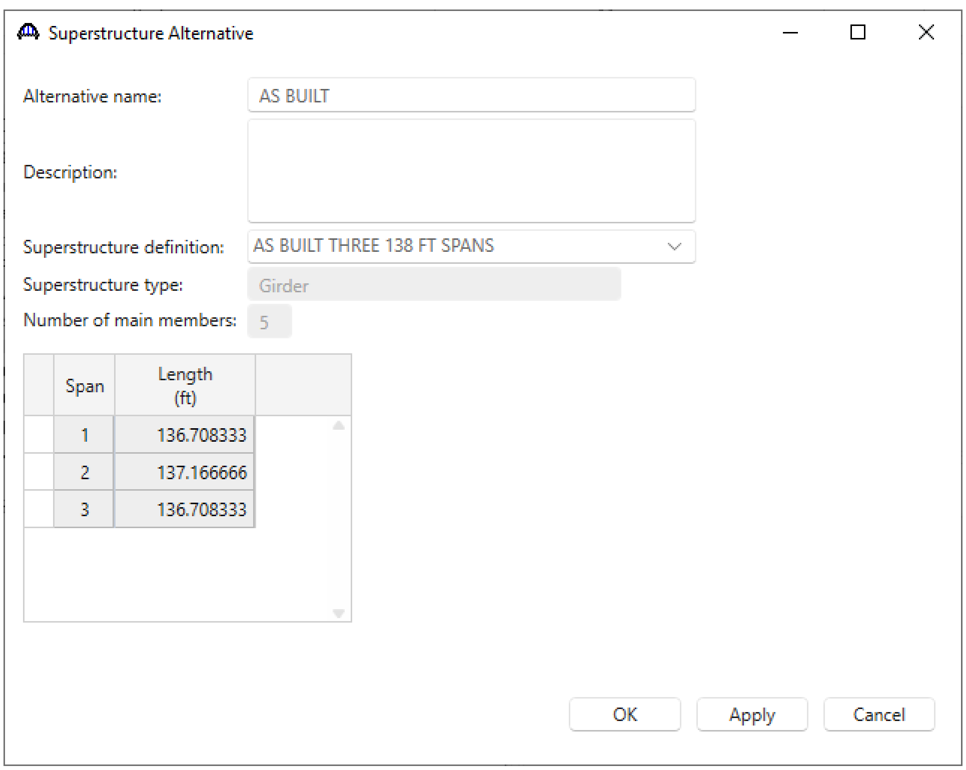
Enter the following data and Click **OK** to apply the data and close the window.



Expand the **AS-BUILT** 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.

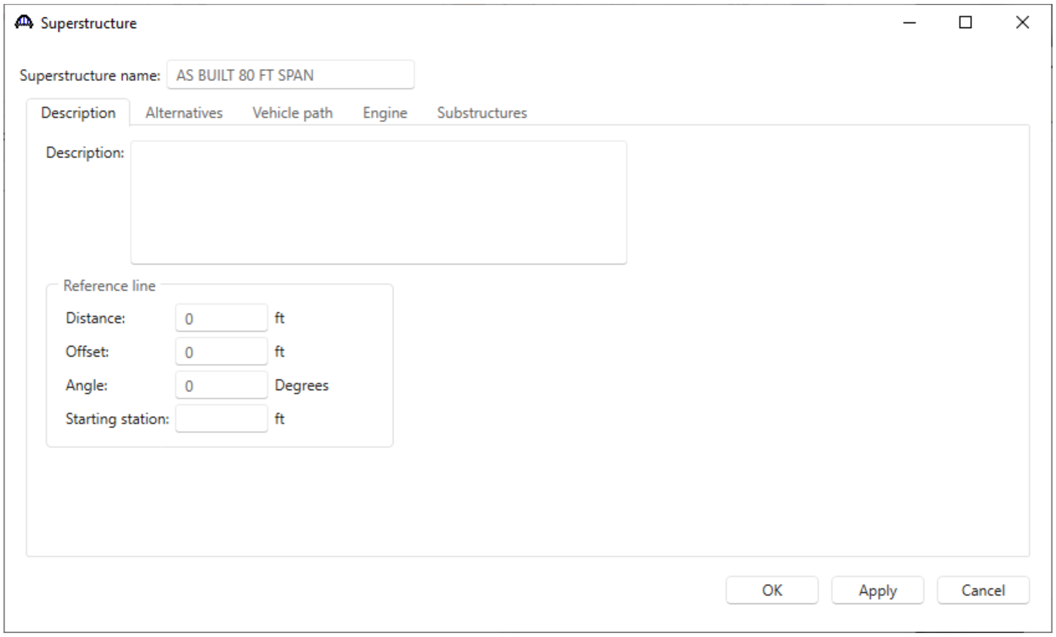


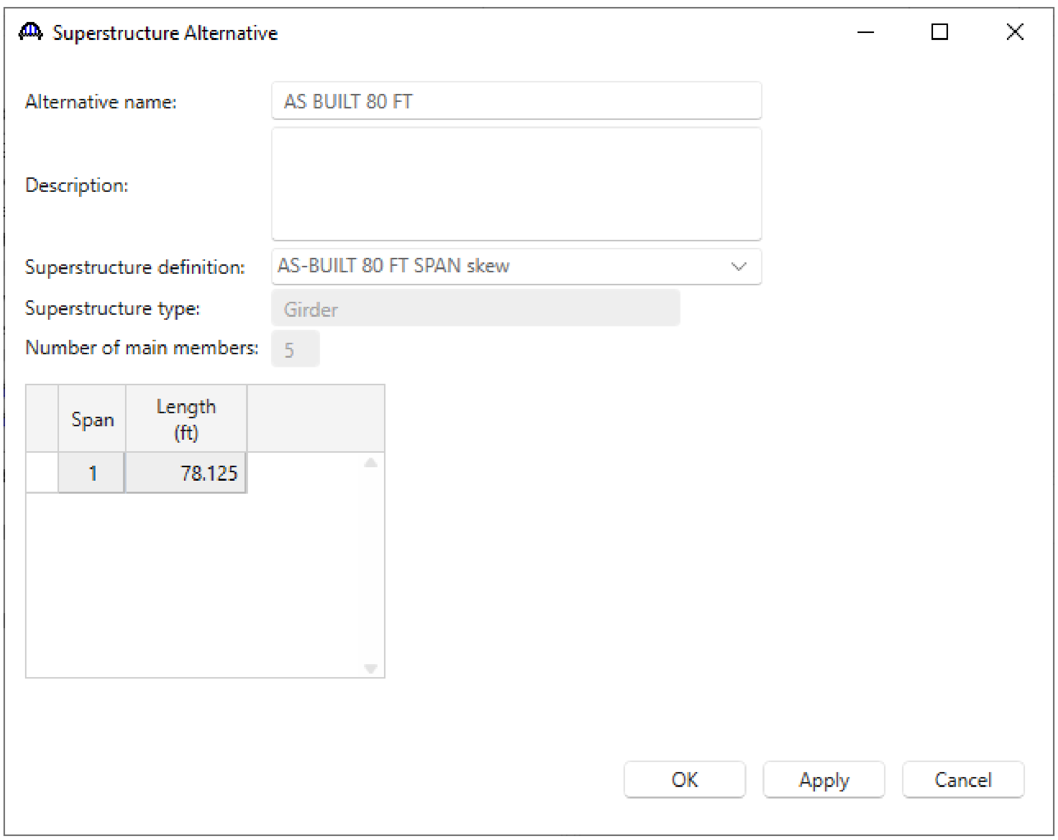
Expand the **AS BUILT THREE 138 FT SPANS** node in the **Bridge Workspace** tree. Double-click on the **SUPERSTRUCTURE ALTERNATIVES** node (or select **SUPERSTRUCTURE ALTERNATIVES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure alternative.



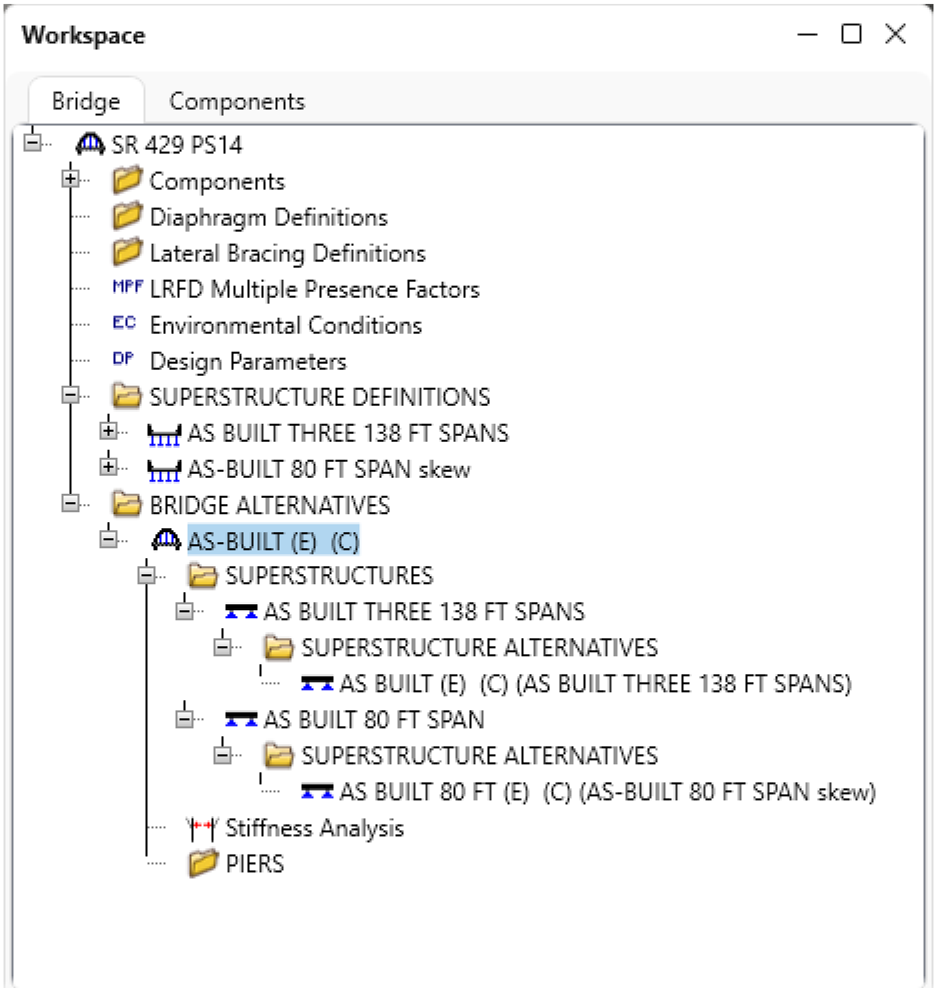
Click **OK** to apply the data and close the window.

Similarly add another **Superstructure** definition and **Superstructure alternative** as shown below.



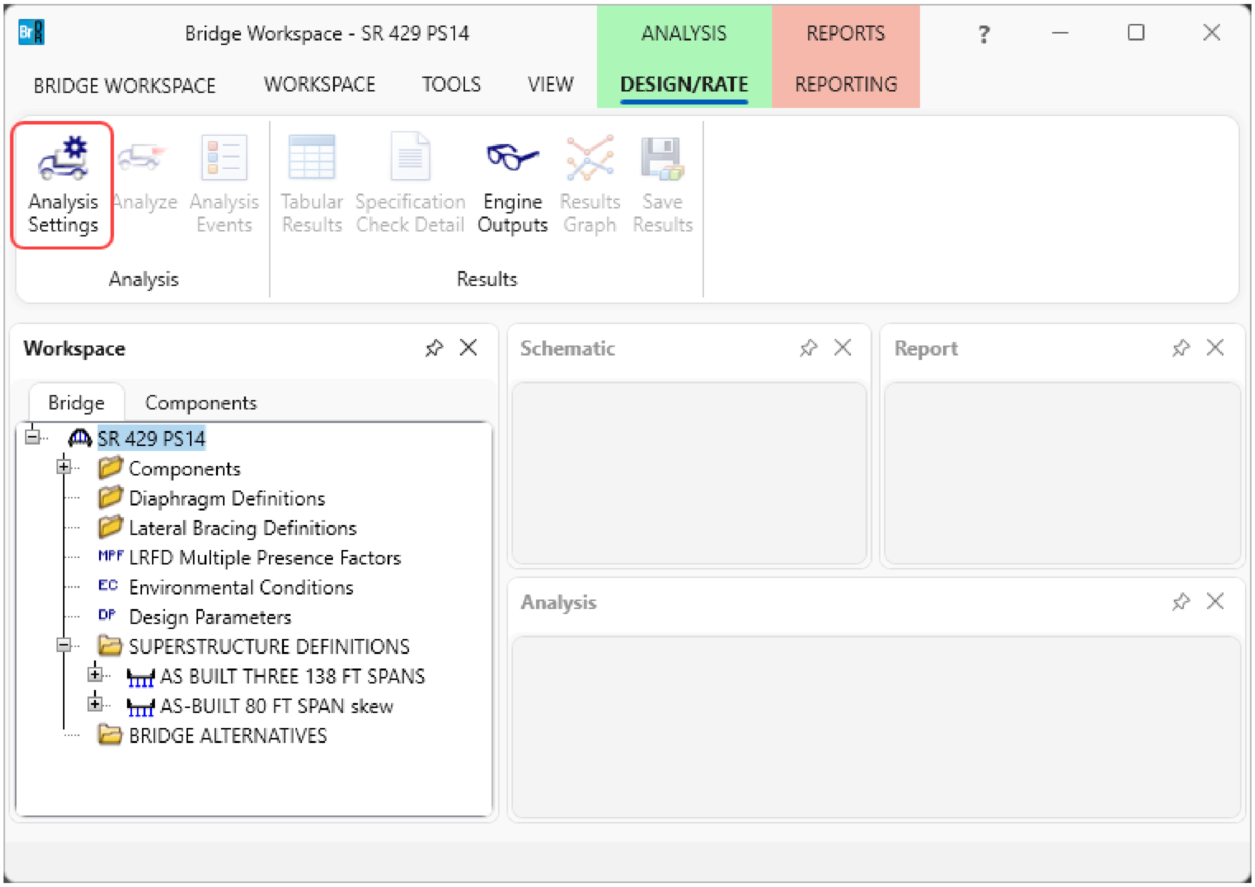


The partially expanded **Bridge Workspace** tree is shown below.

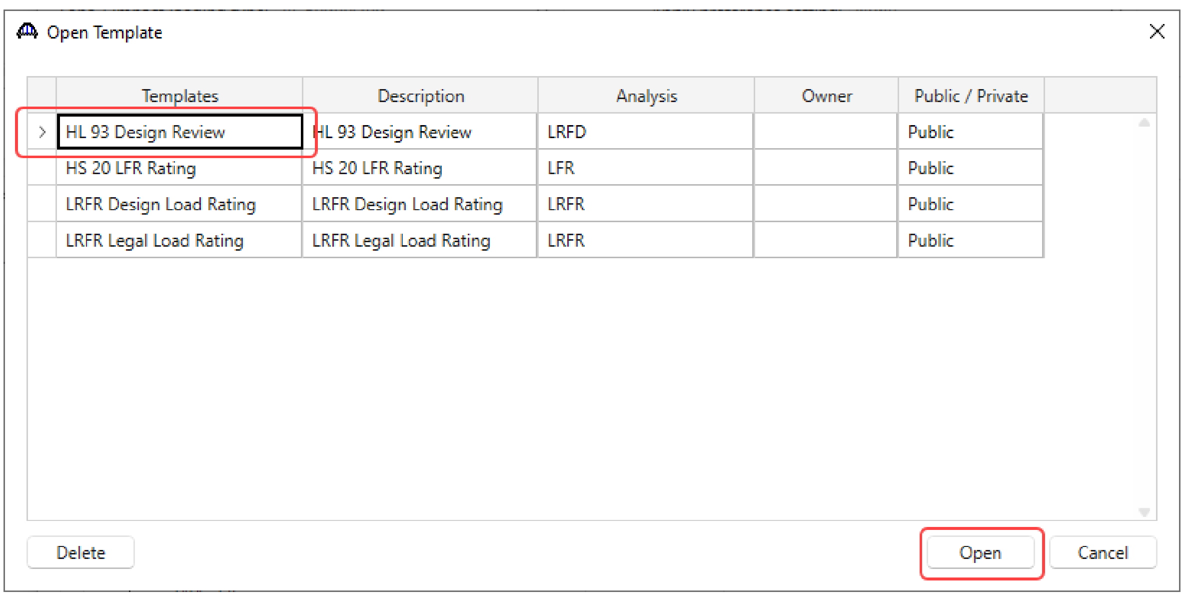


Analysis and Results

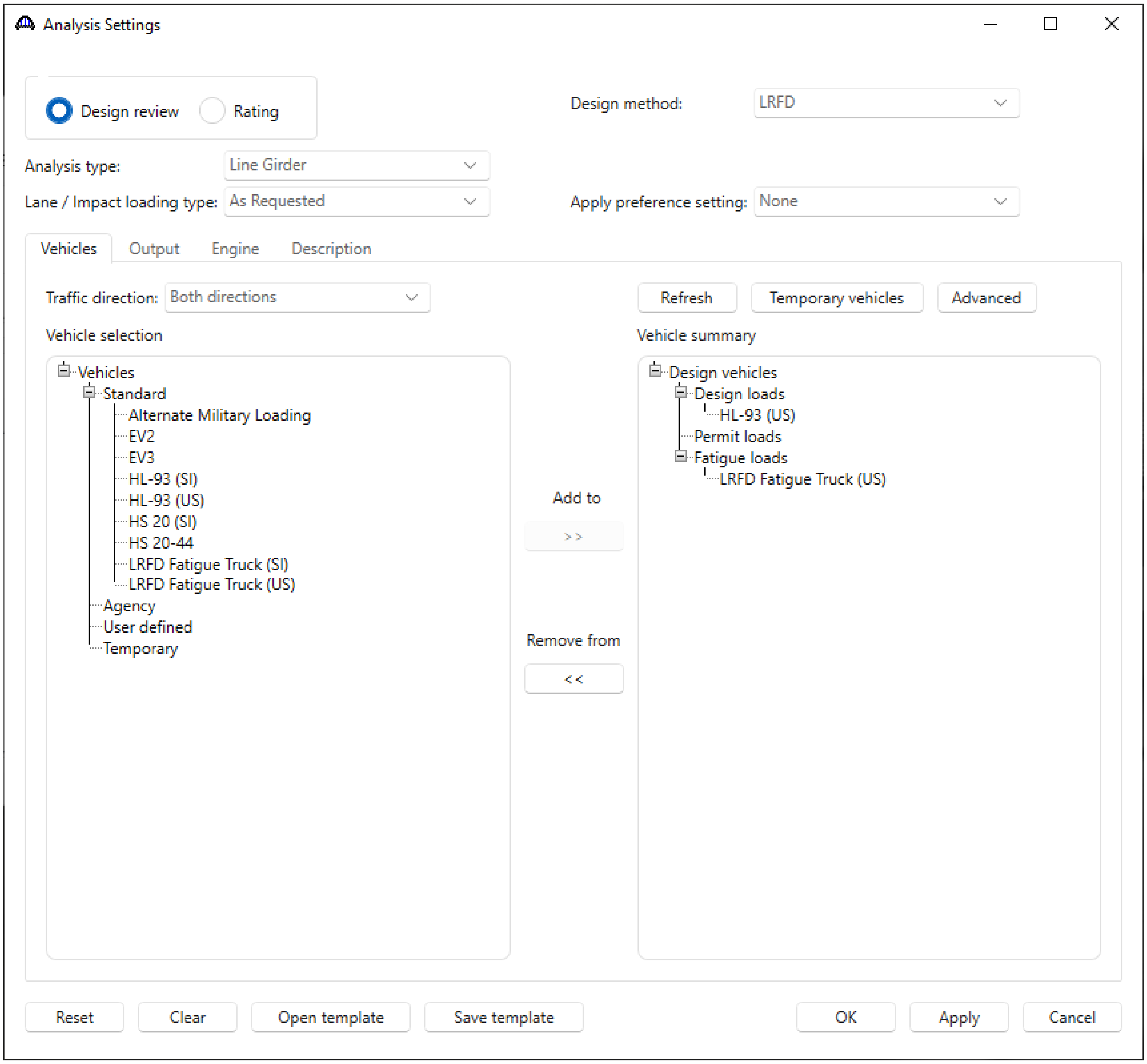
To perform an LRFD design review of the entire bridge, select the bridge **SR 429 PS14** in the **Bridge Workspace** tree and select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon as shown below:



Click the **Open Template** button and select the **HL93 Design Review** to be used in the rating and click **Open**.

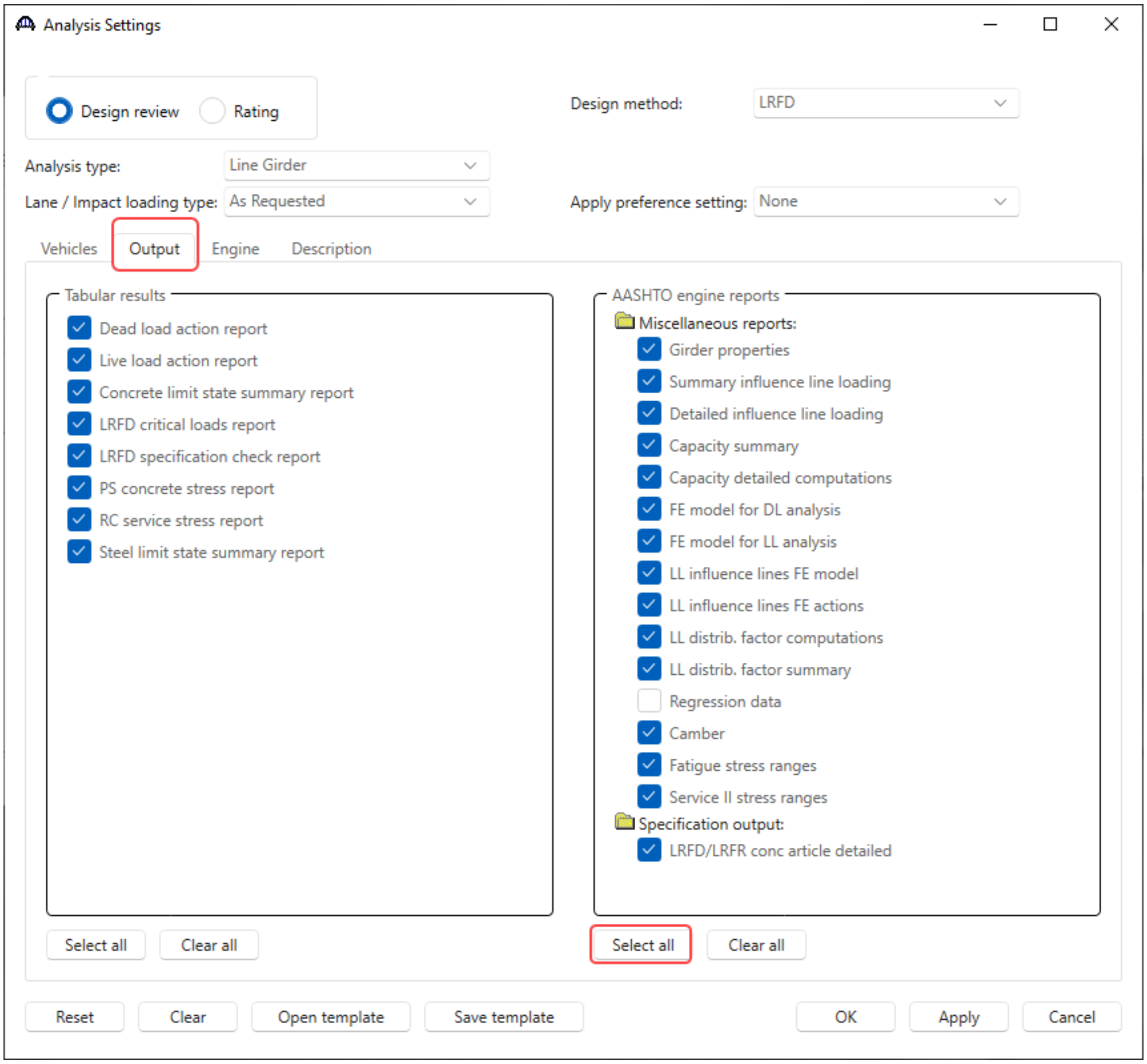


The **Analysis Settings** window will be populated as shown below.



Analysis Settings - Output

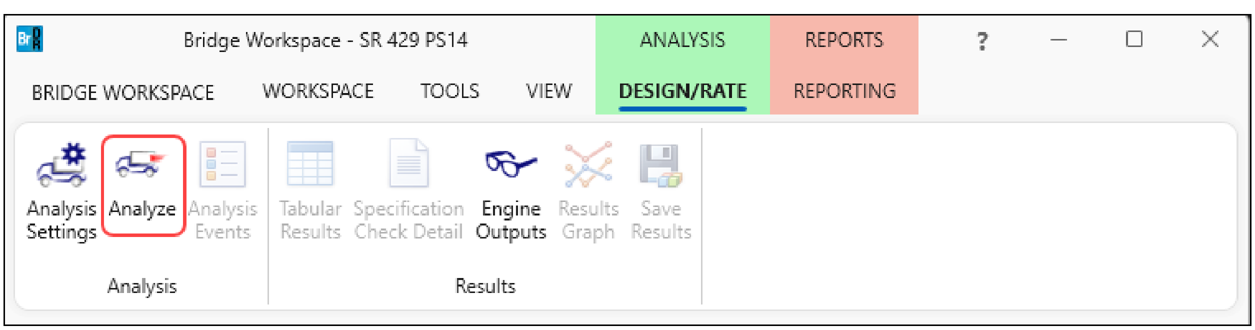
Navigate to the Output tab and enter the **Analysis Settings** as shown below.



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

Engine Outputs

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review. The **Analysis** window should be reviewed for any warning messages.



Export of prestressed concrete beams to the BrDR LRFD analysis engine.

The following steps are performed when performing a design review of a multi-span prestressed beam using the BrDR LRFD analysis engine:

1. Finite element models are generated for the dead load and live load analyses. A Stage 1 FE model is generated for the dead loads on the non-composite simple span prestressed concrete beam.

   For Continuous method of analysis:

   A Stage 2 FE model is generated for the continuous final span condition for composite dead load analysis. A Stage 3 FE model is generated for the continuous final span condition for the live load analysis.

   For Continuous and Simple method of analysis:

   Two Stage 2 FE models are generated:

   Continuous final span condition

   Simple span condition

   Two Stage3 FE models are generated:

   Continuous final span condition

   Simple span condition

   Stage 2 models contain section properties corresponding to the sustained modular ratio factor entered in BrDR (e.g., 2n). Stage 3 models contain section properties corresponding to the modular ratio (n).

   The model generated by the export to the BrDR LRFD analysis engine will always contain node points at the middle of each simple span, at simple support locations, at harp points, at debond locations and at prestress strand transfer length locations so that the prestress force distribution can be computed.

2. The Stage 1 and 2 FE models are analyzed for the dead load. The prestress loss calculations are then performed along with determining the prestress forces at transfer and the restraint effects for the creep and shrinkage analysis for multi-span structures.

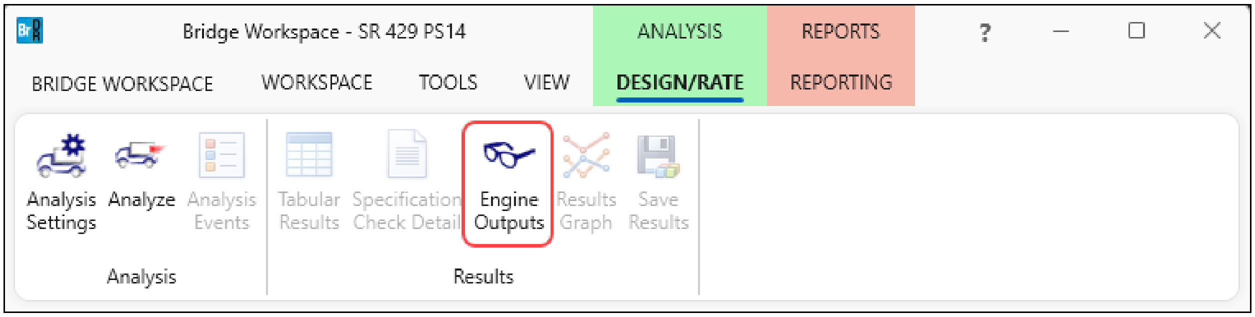
3. The final analysis then takes place. The prestress forces at transfer are applied to the Stage 1 FE model solely to determine the prestress camber in the beam. They are not included in the load combination generation. Creep and shrinkage forces are applied to the Stage 2 FE model.

   The Stage 1 and 2 FE models are analyzed for the dead load. The Stage 3 FE model is loaded with unit loads at each node to generate influence lines for the beam. The influence loads are then loaded with the selected vehicles to find the maximum live load effects.

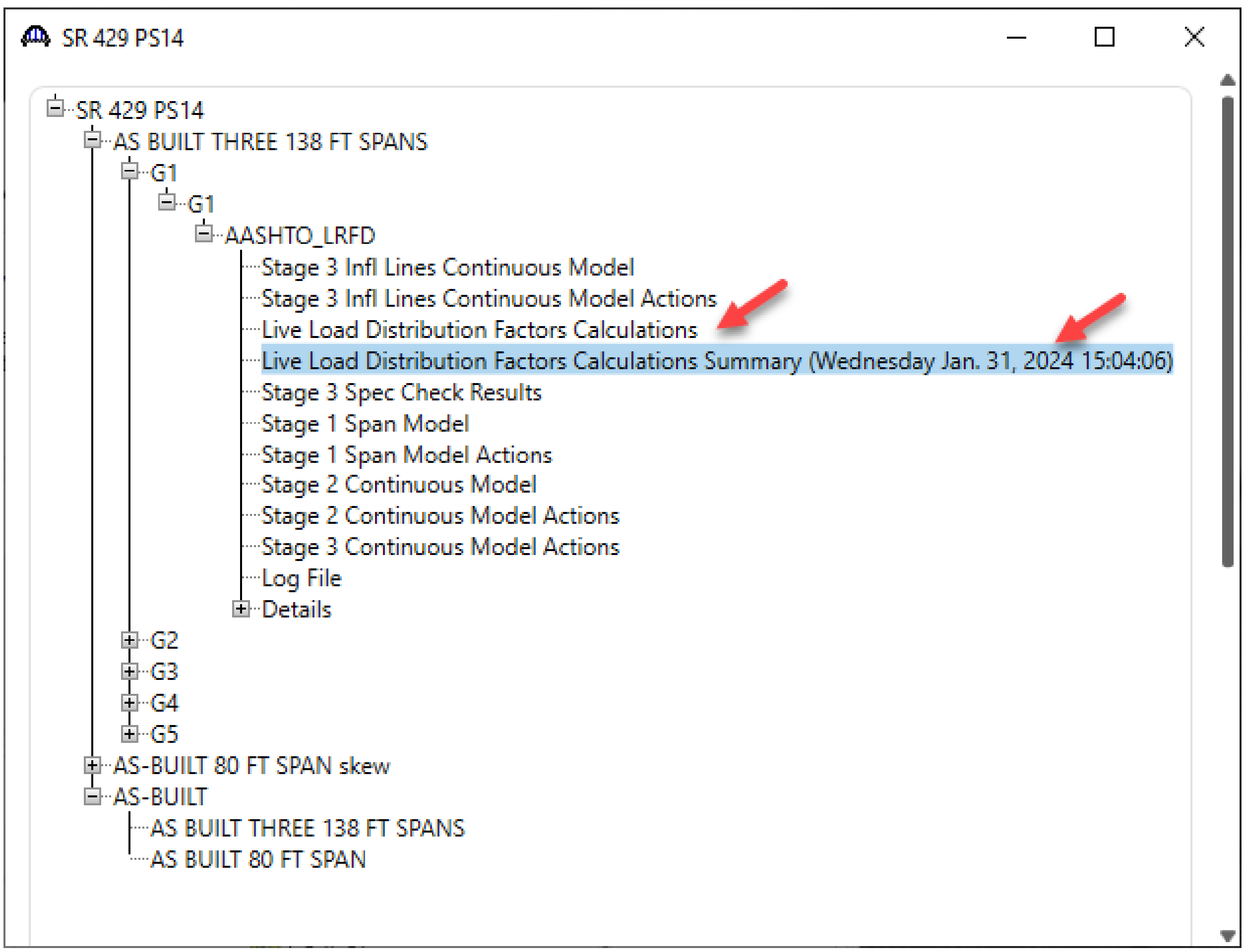
4. Load combinations are generated for the loadings and specification checks are performed at each of the nodes in the finite element model. For the Continuous and Simple method of analysis the maximum force effects between the 2 sets of models are used to generate the load combinations.

Engine Outputs

Click the **Engine Outputs** button from the **Results** group of the **DESIGN/RATE** ribbon to open the following window.



A summary and a detailed report of the computed live load distribution factors are available.



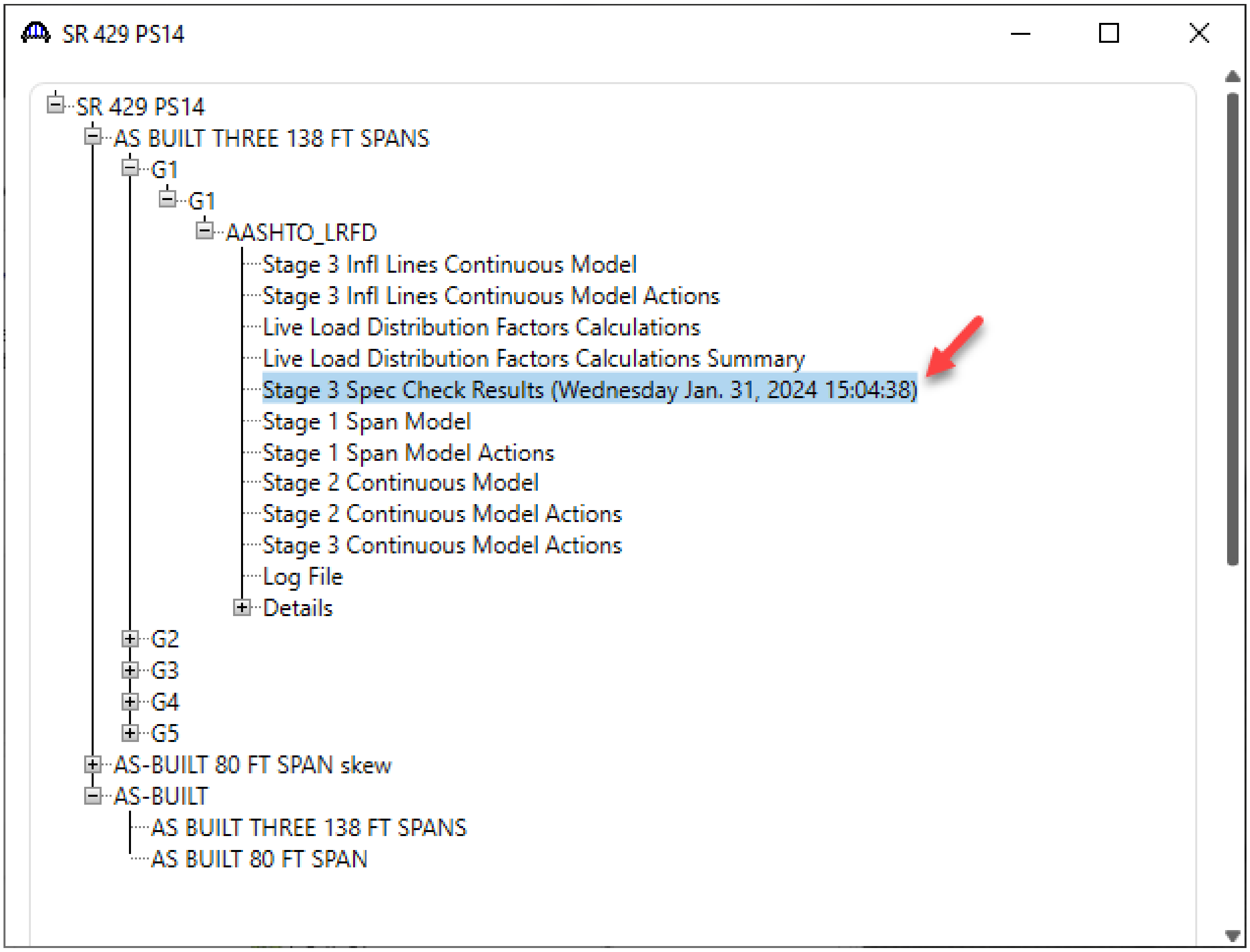
LRFD Dist Factor Summary - Notepad

File Edit Format View Help

```
*****************************************************************
** Note that this file contains the distribution factors       **
** computed by the BrD wizard based on the bridge description  **
** in BrD on the date and time below.  These computed values   **
** may not match those shown in BrD if the user has changed    **
** the BrD bridge description after these distribution         **
** factors were computed.                                      **
*****************************************************************

Bridge: SR 429 PS14
Bridge ID: SR 429 PS14          NBI Structure ID: 00000
BID: 0

Superstructure Def: AS BUILT THREE 138 FT SPANS
Member: G1
Member Alternative: G1

Date:  1/31/2024        Time:  3:04:05 PM

AASHTO LRFD Bridge Design Specifications, Edition 9, Interim 0

            Moment Distribution Factor Schedule

   Start            End          Single Lane     Multi Lane
 Distance         Distance          DF              DF
   (ft)             (ft)          (Lanes)         (Lanes)
----------------------------------------------------------
    0.00          109.14          0.764(L)        0.621(A)
  109.14          174.72          0.764(L)        0.621(A)
  174.72          235.59          0.764(L)        0.621(A)
  235.59          301.18          0.764(L)        0.621(A)
  301.18          410.32          0.764(L)        0.621(A)


            Shear Distribution Factor Schedule

   Start            End          Single Lane     Multi Lane
 Distance         Distance          DF              DF
   (ft)             (ft)          (Lanes)         (Lanes)
----------------------------------------------------------
    0.00            6.83          0.765(L)        0.640(A)
    6.83           20.49          0.764(L)        0.640(A)
   20.49           34.14          0.764(L)        0.640(A)
   34.14           47.80          0.764(L)        0.640(A)
   47.80           61.46          0.764(L)        0.640(A)
   61.46           68.29          0.764(L)        0.639(A)
   68.29          136.58          0.764(L)        0.639(A)
  136.58          273.74          0.764(L)        0.639(A)
  273.74          342.03          0.764(L)        0.639(A)
  342.03          348.86          0.764(L)        0.639(A)
  348.86          362.52          0.764(L)        0.640(A)
  362.52          376.17          0.764(L)        0.640(A)
  376.17          389.83          0.764(L)        0.640(A)
  389.83          403.49          0.764(L)        0.640(A)
  403.49          410.32          0.765(L)        0.640(A)
```

Ln 14, Col 48 | 80% | Windows (CRLF) | UTF-8

A summary report of the specification check results is also available. This summary report lists the design ratios for each spec article at each spec check location point. The design ratio is the ratio of capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand. To view the LRFD spec check results (shown below), double click on the **Stage 3 Spec Check Results** under the **AASHTO_LRFD** branch in this window.



The following file opens.

Stage 3 Spec Check Results

Bridge ID : SR 429 PS14
Bridge : SR 429 PS14
Superstructure Def : AS BUILT THREE 138 FT SPANS
Member : G1
Analysis Preference Setting :

NBI Structure ID : 00000
Bridge Alt : AS-BUILT

Member Alt : G1

AASHTO LRFD Specification, Edition 9, Interim 0

Specification Check Summary

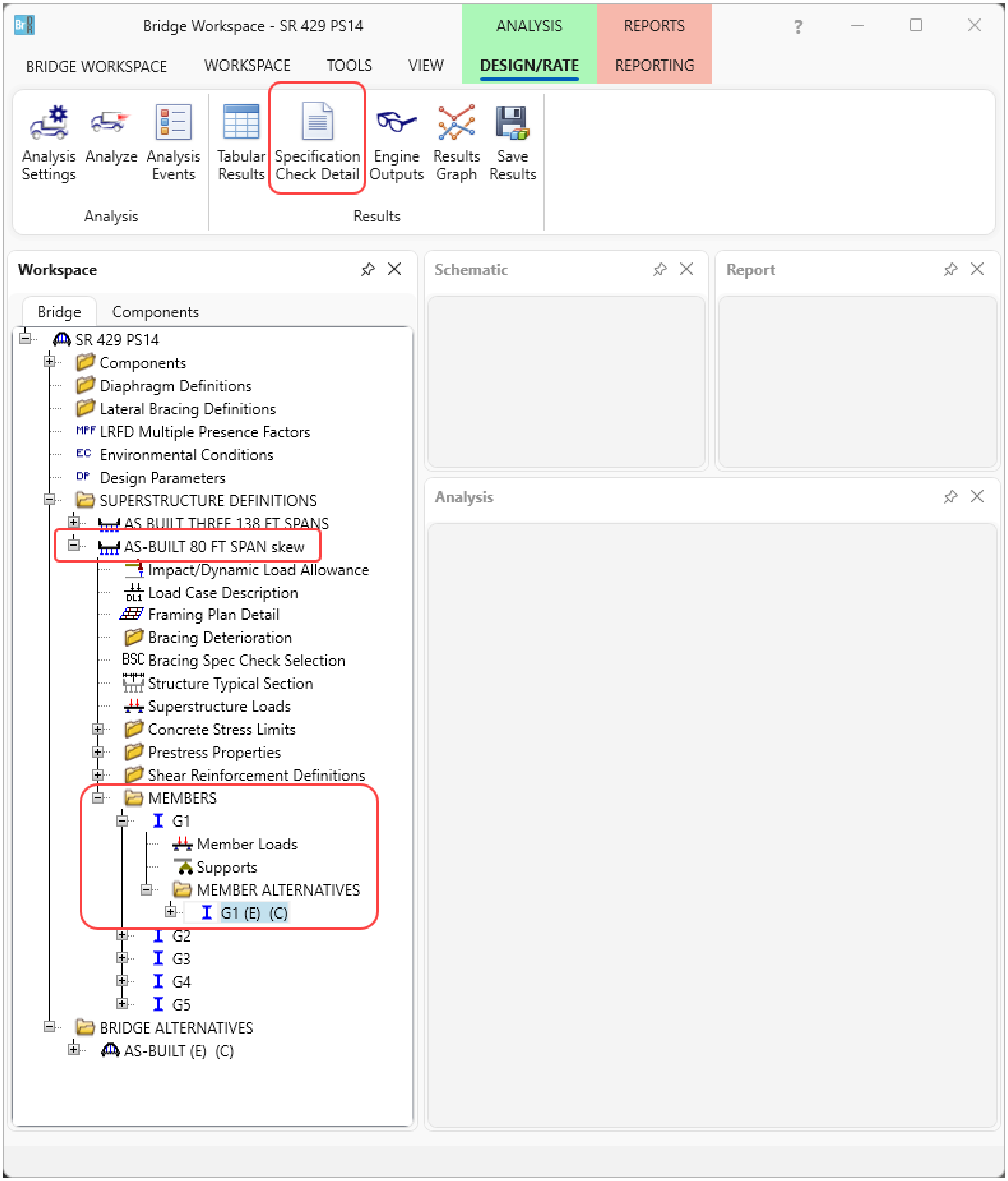
Article	Status
Initial Stress at Transfer (5.9.2.3.1a, 5.9.2.3.1b)	Pass
Splitting Resistance in Anchorage Zones (5.9.4.4.1)	Pass
Final Stress due to Permanent and Transient Loads (5.9.2.3.2a, 5.9.2.3.2b)	Pass
Flexure (5.6.3.2, 5.6.3.3)	Pass
Shear (5.7.3.3, 5.7.2.5, 5.7.2.6, 5.7.3.5)	Pass
Deflection (5.6.3.5.2)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

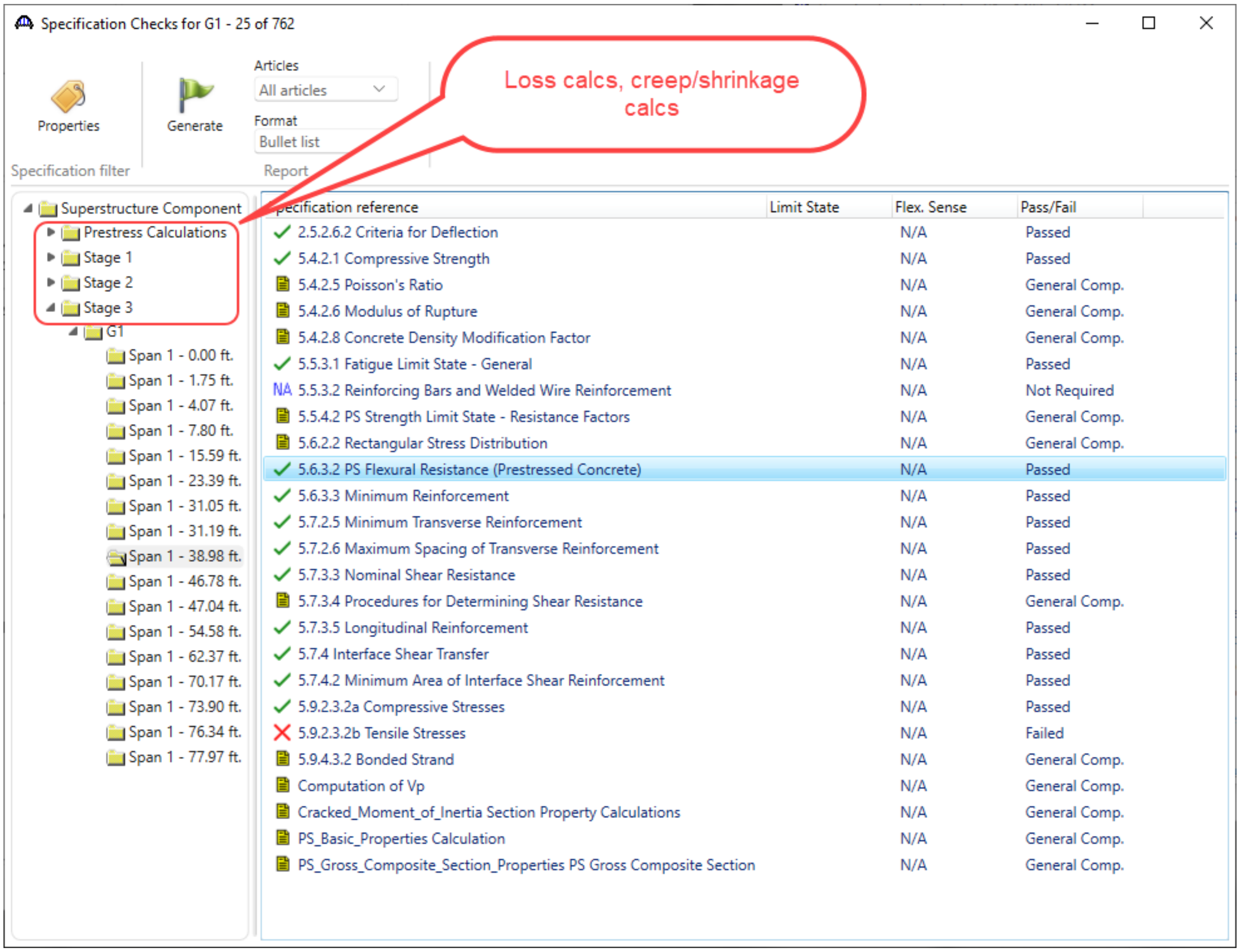
Initial Compression Stress At Transfer of Prestress

Location (ft)	Allowable Stress (ksi)	Actual Stress Top of Beam (ksi)	Actual Stress Bot of Beam (ksi)	Design Ratio	Code
0.000	-3.900	-0.101	-0.841	4.639	Pass
2.250	-3.900	-0.434	-3.330	1.171	Pass
6.267	-3.900	-0.473	-3.290	1.185	Pass
13.658	-3.900	-0.544	-3.217	1.212	Pass
27.315	-3.900	-0.570	-3.190	1.222	Pass
40.973	-3.900	-0.479	-3.284	1.188	Pass
53.705	-3.900	-0.290	-3.479	1.121	Pass
54.630	-3.900	-0.298	-3.471	1.124	Pass

Specification Check Detail

The specification checks can be viewed by selecting the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.




Specification Checks for G1 - 25 of 762
Properties
Generate
Articles
All articles
Format
Bullet list
Specification filter
Report
Loss calcs, creep/shrinkage calcs
Superstructure Component
Prestress Calculations
Stage 1
Stage 2
Stage 3
G1
Span 1 - 0.00 ft.
Span 1 - 1.75 ft.
Span 1 - 4.07 ft.
Span 1 - 7.80 ft.
Span 1 - 15.59 ft.
Span 1 - 23.39 ft.
Span 1 - 31.05 ft.
Span 1 - 31.19 ft.
Span 1 - 38.98 ft.
Span 1 - 46.78 ft.
Span 1 - 47.04 ft.
Span 1 - 54.58 ft.
Span 1 - 62.37 ft.
Span 1 - 70.17 ft.
Span 1 - 73.90 ft.
Span 1 - 76.34 ft.
Span 1 - 77.97 ft.
pecification reference
Limit State
Flex. Sense
Pass/Fail
2.5.2.6.2 Criteria for Deflection N/A Passed
5.4.2.1 Compressive Strength N/A Passed
5.4.2.5 Poisson's Ratio N/A General Comp.
5.4.2.6 Modulus of Rupture N/A General Comp.
5.4.2.8 Concrete Density Modification Factor N/A General Comp.
5.5.3.1 Fatigue Limit State - General N/A Passed
NA 5.5.3.2 Reinforcing Bars and Welded Wire Reinforcement N/A Not Required
5.5.4.2 PS Strength Limit State - Resistance Factors N/A General Comp.
5.6.2.2 Rectangular Stress Distribution N/A General Comp.
5.6.3.2 PS Flexural Resistance (Prestressed Concrete) N/A Passed
5.6.3.3 Minimum Reinforcement N/A Passed
5.7.2.5 Minimum Transverse Reinforcement N/A Passed
5.7.2.6 Maximum Spacing of Transverse Reinforcement N/A Passed
5.7.3.3 Nominal Shear Resistance N/A Passed
5.7.3.4 Procedures for Determining Shear Resistance N/A General Comp.
5.7.3.5 Longitudinal Reinforcement N/A Passed
5.7.4 Interface Shear Transfer N/A Passed
5.7.4.2 Minimum Area of Interface Shear Reinforcement N/A Passed
5.9.2.3.2a Compressive Stresses N/A Passed
5.9.2.3.2b Tensile Stresses N/A Failed
5.9.4.3.2 Bonded Strand N/A General Comp.
Computation of Vp N/A General Comp.
Cracked_Moment_of_Inertia Section Property Calculations N/A General Comp.
PS_Basic_Properties Calculation N/A General Comp.
PS_Gross_Composite_Section_Properties PS Gross Composite Section N/A General Comp.

Open the spec check detail window for the flexural resistance (**5.6.3.2 PS Flexural Resistance (Prestressed Concrete)**) at the middle of the simple span (**38.98 ft**). The following is noted for this window, other spec articles are similar:

1. For each spec check location, both the left and right sides of the point are evaluated. The Deflection article is an exception to this since deflection must be the same between the left and right sides of a point.
2. The design ratio is printed out for the article. The design ratio is the ratio of capacity to demand. A design ratio less than one indicates the demand is greater than the capacity and the spec article fails. A design ratio equal to 99.0 indicates the section is subject to zero demand.
3. The Strength-I, Service-I, Service III and Fatigue limit states are the only limit states investigated. For each limit state, the max and min force effect is checked. Thus, each limit state shows two rows of data.
4. The LL load combination is shown in this column. If the location is not at a node in the FE model (e.g., the node is at a point where the rebar is fully developed), this column will list two load combinations separated by a comma. The first load combination is the combination considered at the left end and the second load combination is the combination considered at the right end of the FE element that contains this location. The resulting load displayed is a linear interpolation between the two displayed load cases.

Spec Check Detail for 5.6.3.2 PS Flexural Resistance (Prestressed Concrete)

```
5.6 Design for Flexural and Axial Effects - B Regions
5.6.3 Flexural Members
5.6.3.2 Flexural Resistance
(AASHTO LRFD Bridge Design Specifications, Ninth Edition)

PS I Narrow - At Location = 38.9827 (ft) - Left     Stage 3

                    Cross Section Properties
-----------------------------------------------------------------
Name: AASHTO TYPE III
Girder f'c = 5.00(ksi)     Girder f'ci = 4.20(ksi)
Slab f'c   = 4.00(ksi)

Effective Slab Width       =     83.75(in)
Effective Slab Thickness   =      7.75(in)
Haunch Width               =     16.00(in)
Haunch Thickness           =      0.50(in)
Beam Height                =     45.00(in)

Total Aps  =   3.98(in^2)
Total CGS  =   4.19(in)

Eff Aps    =   3.98(in^2)
Eff CGS    =   4.19(in)

Allow Moment Redistribution Control Option: No
Moment Redistribution Qualified: No, redistribution did not occur.

Note: If the capacity has been overridden, the Resistance is computed as override phi*override capacity.
      Otherwise the Resistance is computed as per the Specification.
```

Limit State	Load Combination	Mu kip-ft	DeltaMu kip-ft	Phi	Mn kip-ft	-- Override -- Phi	Mn kip-ft	Mr= Phi * Mn kip-ft	Mr/Mu	NA Depth in	Ac in^2	Max Conc Stress ksi
STR-I	1	3788.52	---	1.000	4115.98	---	---	4115.98	1.086	4.59	347.63	0.0
STR-I	1	1009.68	---	1.000	4115.98	---	---	4115.98	4.077	4.59	347.63	0.0
STR-I	2	3469.92	---	1.000	4115.98	---	---	4115.98	1.186	4.59	347.63	0.0
STR-I	2	1009.68	---	1.000	4115.98	---	---	4115.98	4.077	4.59	347.63	0.0
SER-I	1	2485.40	---	1.000	4115.98	---	---	4115.98	1.656	4.59	347.63	0.0
SER-I	1	1121.86	---	1.000	4115.98	---	---	4115.98	3.669	4.59	347.63	0.0
SER-I	2	2303.34	---	1.000	4115.98	---	---	4115.98	1.787	4.59	347.63	0.0
SER-I	2	1121.86	---	1.000	4115.98	---	---	4115.98	3.669	4.59	347.63	0.0
SER-III	1	2212.69	---	1.000	4115.98	---	---	4115.98	1.860	4.59	347.63	0.0
SER-III	1	1121.86	---	1.000	4115.98	---	---	4115.98	3.669	4.59	347.63	0.0
SER-III	2	2067.05	---	1.000	4115.98	---	---	4115.98	1.991	4.59	347.63	0.0
SER-III	2	1121.86	---	1.000	4115.98	---	---	4115.98	3.669	4.59	347.63	0.0
FAT-I	3	1001.57	---	1.000	4115.98	---	---	4115.98	4.110	4.59	347.63	0.0
FAT-I	3	0.00	---	1.000	4115.98	---	---	4115.98	99.000	4.59	347.63	0.0
FAT-II	3	457.86	---	1.000	4115.98	---	---	4115.98	8.990	4.59	347.63	0.0
FAT-II	3	0.00	---	1.000	4115.98	---	---	4115.98	99.000	4.59	347.63	0.0

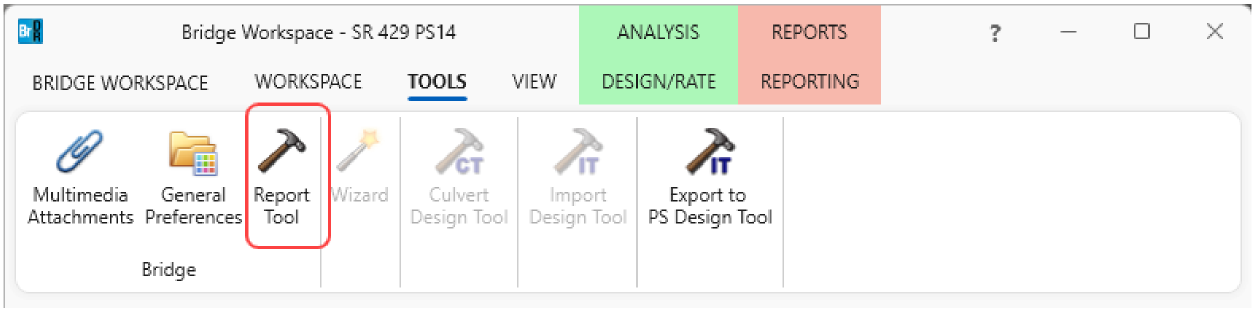
```
Load Combination Legend:

 Code      Vehicle
-------------------------
```

OK

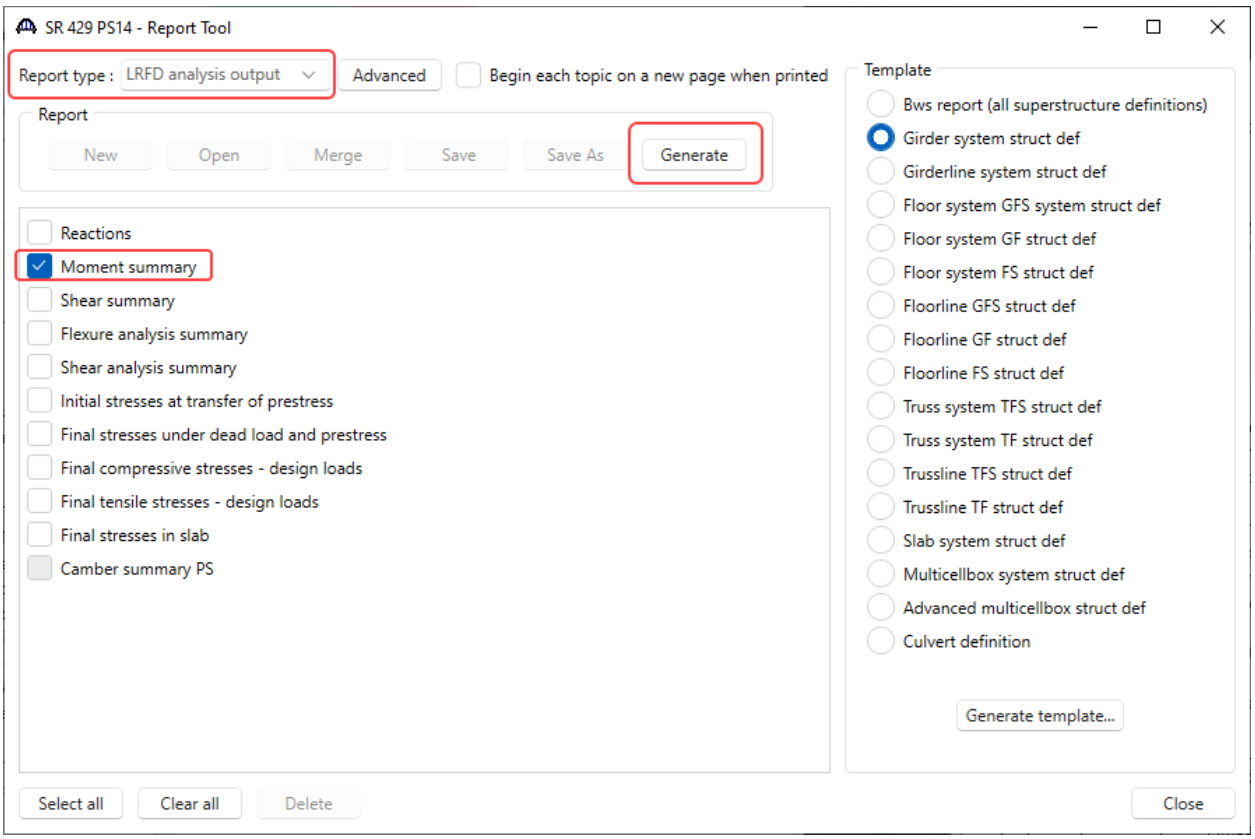
The loads making up the Mu = 3788.52 k-ft for the maximum Strength-I limit state can be tracked down in Moment Summary report.

Report Tool – Moment Summary

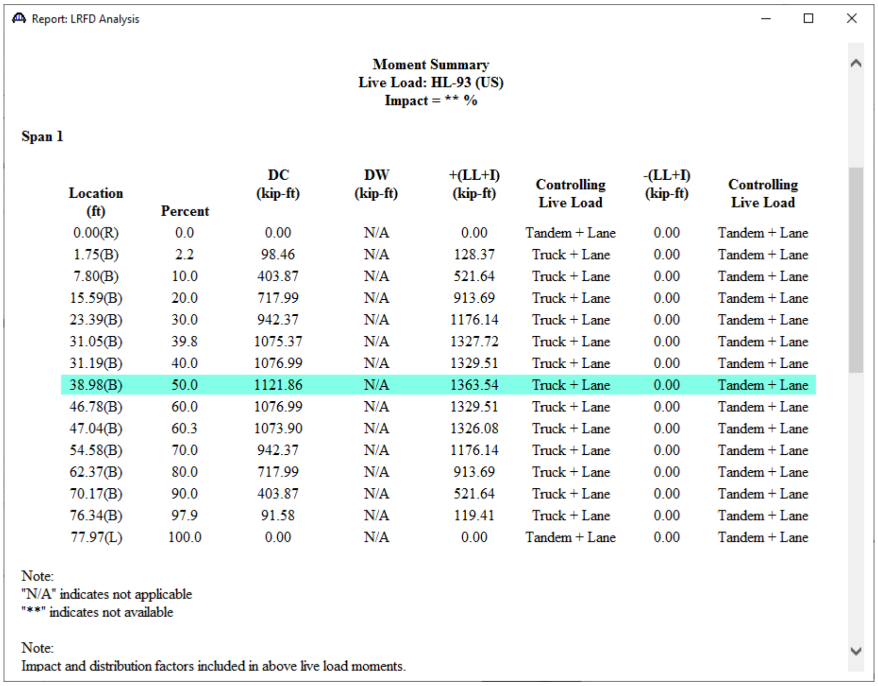
The **Moment Summary** report can be viewed by selecting the **Report Tool** button from the **Bridge** group of the **TOOLS** ribbon as shown below.



Select the **LRFD analysis output** as the **Report type**. Select the **Moment summary** checkbox and click on the **Generate** button to populate the moment summary report as shown below.



The resulting maximum moment for Strength-I at the midspan is equal to **(1.25 * 1121.86) + (1.75 * 1363.54) = 3788.52** kft.


Report: LRFD Analysis

Moment Summary
Live Load: HL-93 (US)
Impact = ** %

Span 1

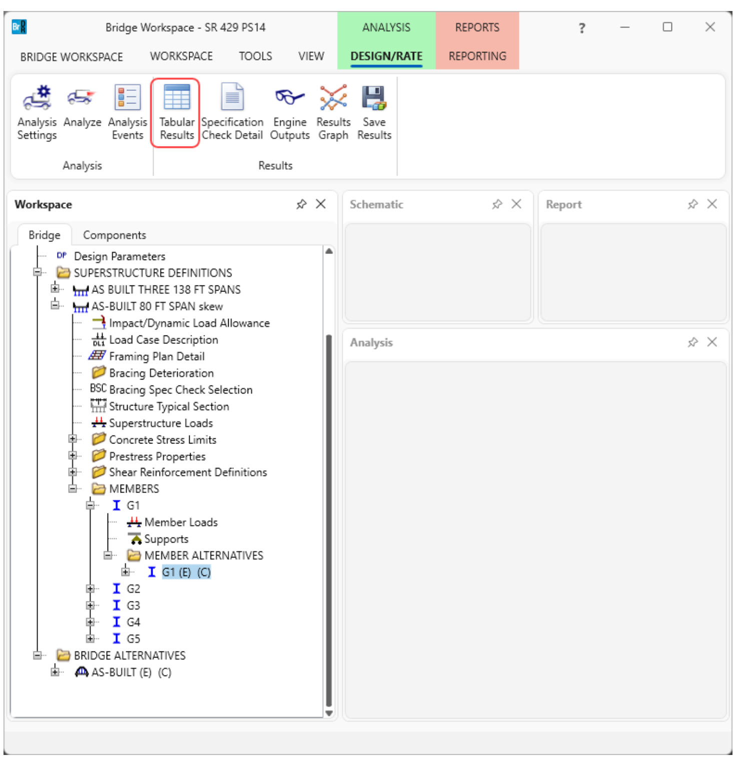
Location (ft)	Percent	DC (kip-ft)	DW (kip-ft)	+(LL+I) (kip-ft)	Controlling Live Load	-(LL+I) (kip-ft)	Controlling Live Load
0.00(R)	0.0	0.00	N/A	0.00	Tandem + Lane	0.00	Tandem + Lane
1.75(B)	2.2	98.46	N/A	128.37	Truck + Lane	0.00	Tandem + Lane
7.80(B)	10.0	403.87	N/A	521.64	Truck + Lane	0.00	Tandem + Lane
15.59(B)	20.0	717.99	N/A	913.69	Truck + Lane	0.00	Tandem + Lane
23.39(B)	30.0	942.37	N/A	1176.14	Truck + Lane	0.00	Tandem + Lane
31.05(B)	39.8	1075.37	N/A	1327.72	Truck + Lane	0.00	Tandem + Lane
31.19(B)	40.0	1076.99	N/A	1329.51	Truck + Lane	0.00	Tandem + Lane
38.98(B)	50.0	1121.86	N/A	1363.54	Truck + Lane	0.00	Tandem + Lane
46.78(B)	60.0	1076.99	N/A	1329.51	Truck + Lane	0.00	Tandem + Lane
47.04(B)	60.3	1073.90	N/A	1326.08	Truck + Lane	0.00	Tandem + Lane
54.58(B)	70.0	942.37	N/A	1176.14	Truck + Lane	0.00	Tandem + Lane
62.37(B)	80.0	717.99	N/A	913.69	Truck + Lane	0.00	Tandem + Lane
70.17(B)	90.0	403.87	N/A	521.64	Truck + Lane	0.00	Tandem + Lane
76.34(B)	97.9	91.58	N/A	119.41	Truck + Lane	0.00	Tandem + Lane
77.97(L)	100.0	0.00	N/A	0.00	Tandem + Lane	0.00	Tandem + Lane

Note:
"N/A" indicates not applicable
"**" indicates not available

Note:
Impact and distribution factors included in above live load moments.

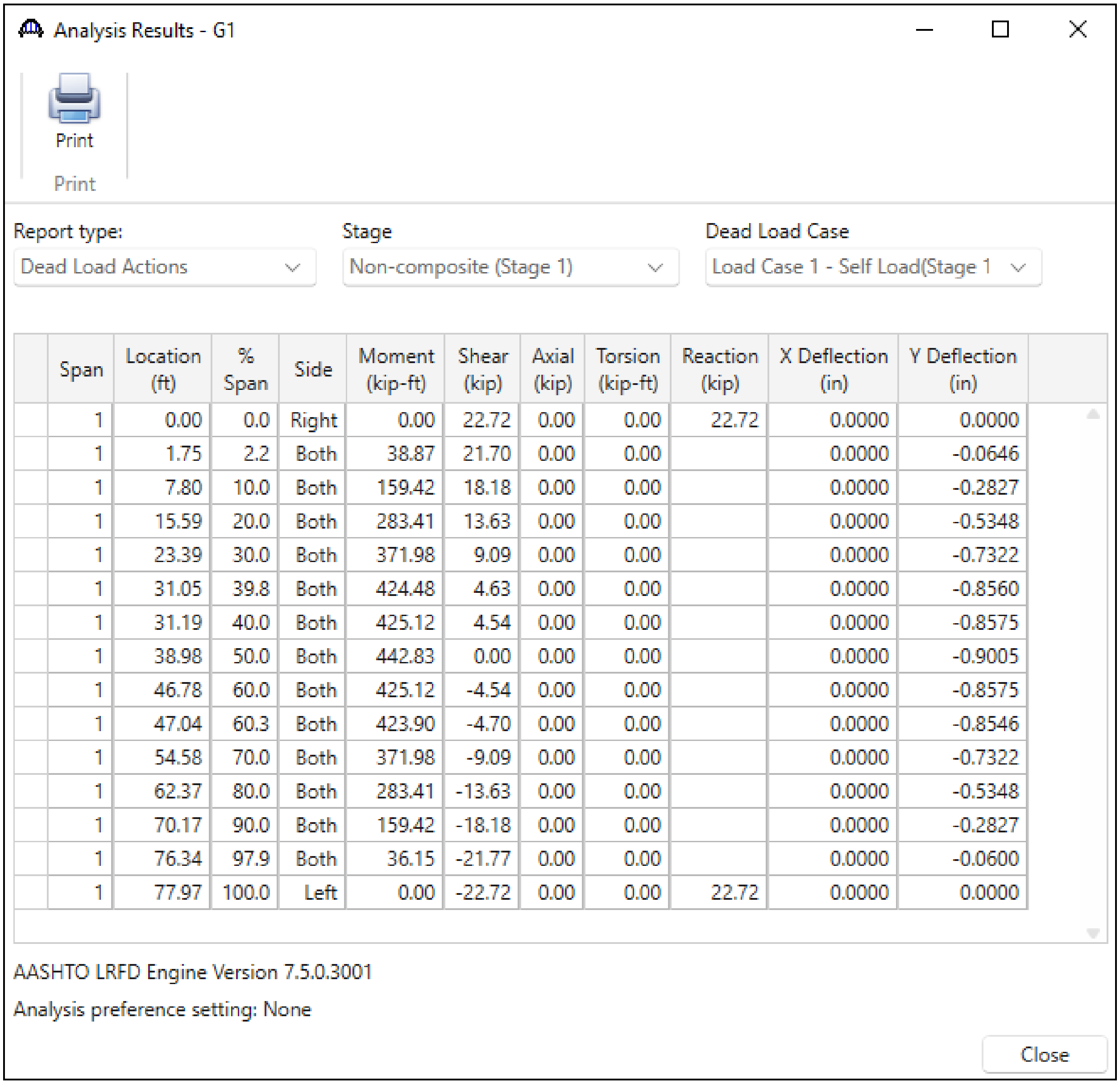
Tabular Results

To review the dead load and live load analysis results, click on the **Tabular Results** button from the **Results** group of the **DESIGN/RATE** ribbon as shown below.

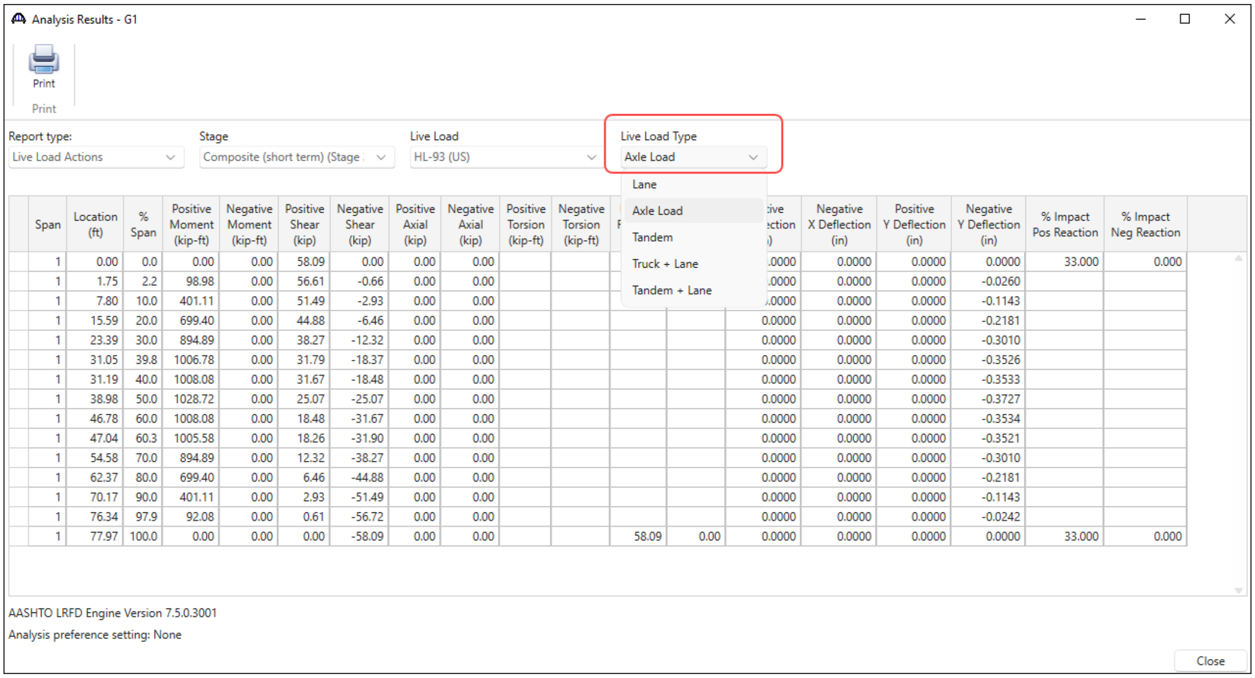


The **Analysis Results** window will open as shown below.

Note: *These values include dynamic load allowance, distribution factors and any live load scale factor entered on the* ***Analysis Settings*** *window.*



Span	Location (ft)	% Span	Side	Moment (kip-ft)	Shear (kip)	Axial (kip)	Torsion (kip-ft)	Reaction (kip)	X Deflection (in)	Y Deflection (in)
1	0.00	0.0	Right	0.00	22.72	0.00	0.00	22.72	0.0000	0.0000
1	1.75	2.2	Both	38.87	21.70	0.00	0.00		0.0000	-0.0646
1	7.80	10.0	Both	159.42	18.18	0.00	0.00		0.0000	-0.2827
1	15.59	20.0	Both	283.41	13.63	0.00	0.00		0.0000	-0.5348
1	23.39	30.0	Both	371.98	9.09	0.00	0.00		0.0000	-0.7322
1	31.05	39.8	Both	424.48	4.63	0.00	0.00		0.0000	-0.8560
1	31.19	40.0	Both	425.12	4.54	0.00	0.00		0.0000	-0.8575
1	38.98	50.0	Both	442.83	0.00	0.00	0.00		0.0000	-0.9005
1	46.78	60.0	Both	425.12	-4.54	0.00	0.00		0.0000	-0.8575
1	47.04	60.3	Both	423.90	-4.70	0.00	0.00		0.0000	-0.8546
1	54.58	70.0	Both	371.98	-9.09	0.00	0.00		0.0000	-0.7322
1	62.37	80.0	Both	283.41	-13.63	0.00	0.00		0.0000	-0.5348
1	70.17	90.0	Both	159.42	-18.18	0.00	0.00		0.0000	-0.2827
1	76.34	97.9	Both	36.15	-21.77	0.00	0.00		0.0000	-0.0600
1	77.97	100.0	Left	0.00	-22.72	0.00	0.00	22.72	0.0000	0.0000



Span	Location (ft)	% Span	Positive Moment (kip-ft)	Negative Moment (kip-ft)	Positive Shear (kip)	Negative Shear (kip)	Positive Axial (kip)	Negative Axial (kip)	Positive Torsion (kip-ft)	Negative Torsion (kip-ft)	F		ive ction)	Negative X Deflection (in)	Positive Y Deflection (in)	Negative Y Deflection (in)	% Impact Pos Reaction	% Impact Neg Reaction
1	0.00	0.0	0.00	0.00	58.09	0.00	0.00	0.00					.0000	0.0000	0.0000	0.0000	33.000	0.000
1	1.75	2.2	98.98	0.00	56.61	-0.66	0.00	0.00					.0000	0.0000	0.0000	-0.0260		
1	7.80	10.0	401.11	0.00	51.49	-2.93	0.00	0.00					.0000	0.0000	0.0000	-0.1143		
1	15.59	20.0	699.40	0.00	44.88	-6.46	0.00	0.00					0.0000	0.0000	0.0000	-0.2181		
1	23.39	30.0	894.89	0.00	38.27	-12.32	0.00	0.00					0.0000	0.0000	0.0000	-0.3010		
1	31.05	39.8	1006.78	0.00	31.79	-18.37	0.00	0.00					0.0000	0.0000	0.0000	-0.3526		
1	31.19	40.0	1008.08	0.00	31.67	-18.48	0.00	0.00					0.0000	0.0000	0.0000	-0.3533		
1	38.98	50.0	1028.72	0.00	25.07	-25.07	0.00	0.00					0.0000	0.0000	0.0000	-0.3727		
1	46.78	60.0	1008.08	0.00	18.48	-31.67	0.00	0.00					0.0000	0.0000	0.0000	-0.3534		
1	47.04	60.3	1005.58	0.00	18.26	-31.90	0.00	0.00					0.0000	0.0000	0.0000	-0.3521		
1	54.58	70.0	894.89	0.00	12.32	-38.27	0.00	0.00					0.0000	0.0000	0.0000	-0.3010		
1	62.37	80.0	699.40	0.00	6.46	-44.88	0.00	0.00					0.0000	0.0000	0.0000	-0.2181		
1	70.17	90.0	401.11	0.00	2.93	-51.49	0.00	0.00					0.0000	0.0000	0.0000	-0.1143		
1	76.34	97.9	92.08	0.00	0.61	-56.72	0.00	0.00					0.0000	0.0000	0.0000	-0.0242		
1	77.97	100.0	0.00	0.00	0.00	-58.09	0.00	0.00			58.09	0.00	0.0000	0.0000	0.0000	0.0000	33.000	0.000