AASHTOWare BrDR 7.5.0

Prestress Tutorial 13

Two Simple Span Prestressed I Beam with a Multi-Column Pier on Drilled Shafts Example

PS13 – 2 Simple Span Prestressed I Beam with a Multi-Column Pier on Drilled Shafts Example

BrDR Training

This example details the data input of a prestressed concrete I beam bridge and performing an analysis. It is a bridge from the Mississippi DOT inventory. The bridge is comprised of 8 total spans. However, only spans 3 and 4 are entered.

Topics Covered

- Comments and Assumptions
- Data Entry for a New Bridge
- Bridge Components
- Superstructure Definitions
- Describing a Member
- Bridge Alternatives
- Pier Data Entry
- Analysis and Results

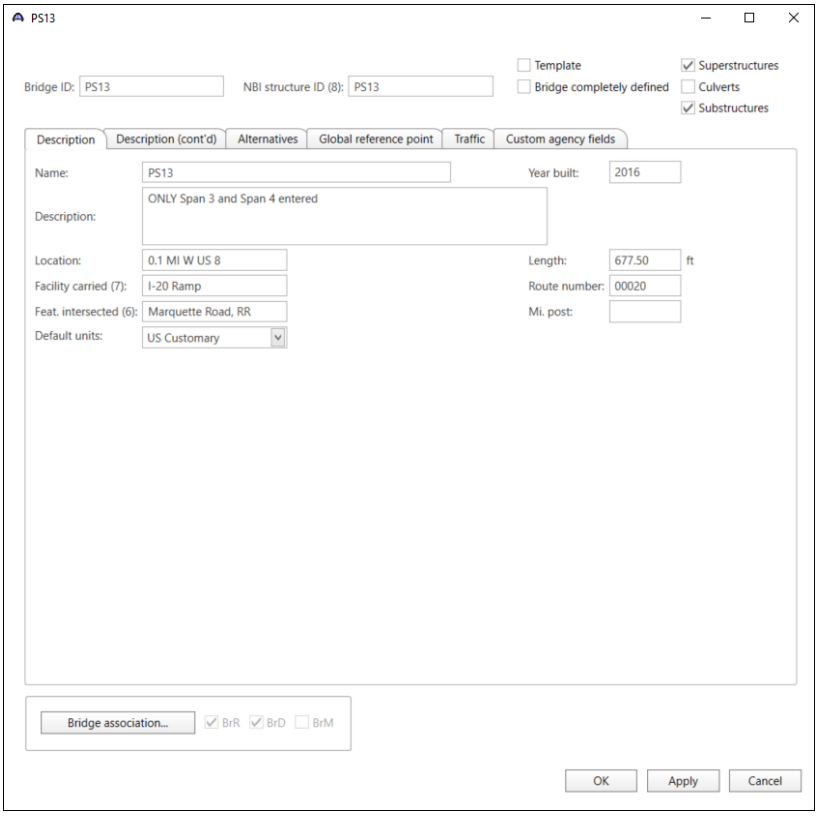
Comments and Assumptions

- Due to rounding on the design plans, the BrDR span lengths are slightly off from the design drawings. Lengths are within 1/16”.
- Fence Load = 0.015 k/ft
- Due to the varying overhang, use 2/3 point for constant overhangs in the program.
    - Span 3 Left Overhang = 2.7816’
    - Span 3 Right Overhang = 3.6133’
    - Span 4 Left Overhang = 3.0566’
    - Span 4 Right Overhang = 3.6133’
- Traffic data and design speed for LRFR analysis
    - Assumed ADTT = 469 per NBI
- Barriers are equally distributed to all beams.
- Assume 5000 psi for the 28-day compressive concrete strength of the Type III PS Beam for the 60-foot span.
- The plans show a discrepancy for strand type for the 135 ft beam details. The section indicates ½” diameter 270 K-LR strands, but the table and notes show 0.6” diameter 270 K-LR strands. Therefore, 0.6” diameter 270 K-LR strands will be used in the model.
- SIP form weight = 20 psf. The presence of SIP forms was verified using Google Maps.
    - Span 3, Exterior Beams = 0.016 k/ft

  - Span 3, Interior Beams = 0.032 k/ft
  - Span 4, Exterior Beams = 0.056 k/ft
  - Span 3, Interior Beams = 0.113 k/ft
- 0.25” Integral Wearing Surface
- HL-93 and HS 20-44 will be the vehicle used for ratings.
- District, County and Owner information is not populated.
- For the Span 3 exterior beams and Span 4 – G6, a LRFD effective width = Overhang + S/2 is used, even though the overhang is greater than S/2 (C4.6.2.6.1).
- Piers 3 and 5 are not entered into the program since the adjacent spans are not entered for this example.
- Due to the limitations of the program, Pier 4 cannot be analyzed with the current version. The issue results due to the fact of splayed framing plans and the overhangs varying from the back span to the ahead span.
- Soil density = 0.120 ksf.
- Finished ground line elevation = 376.5 ft.
- The column unbraced length is the average of all the columns.

Data Entry for a New Bridge

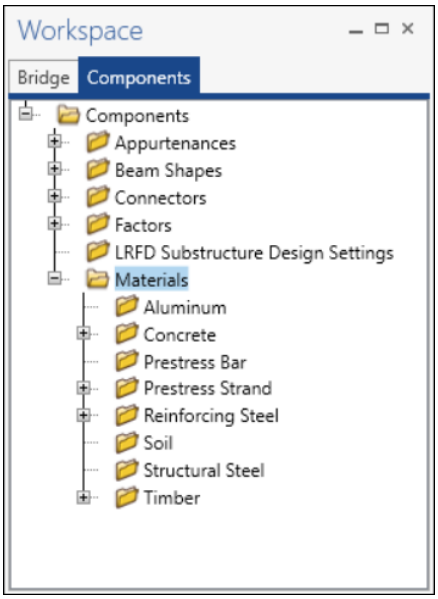
From the **Bridge Explorer** create a **new bridge** and enter the following description data.



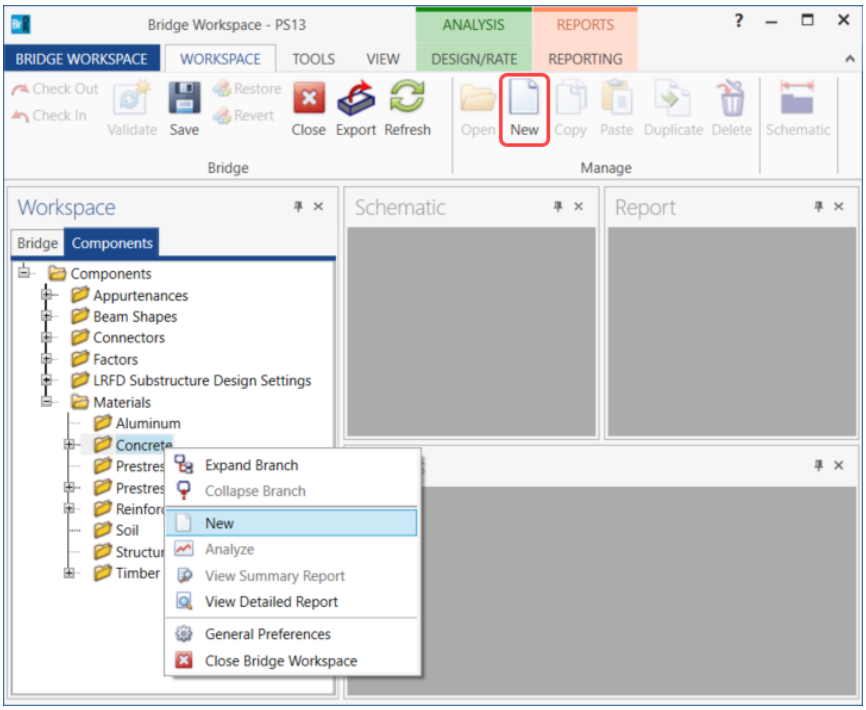
Click **OK** to apply the data and close the window.

Bridge Components

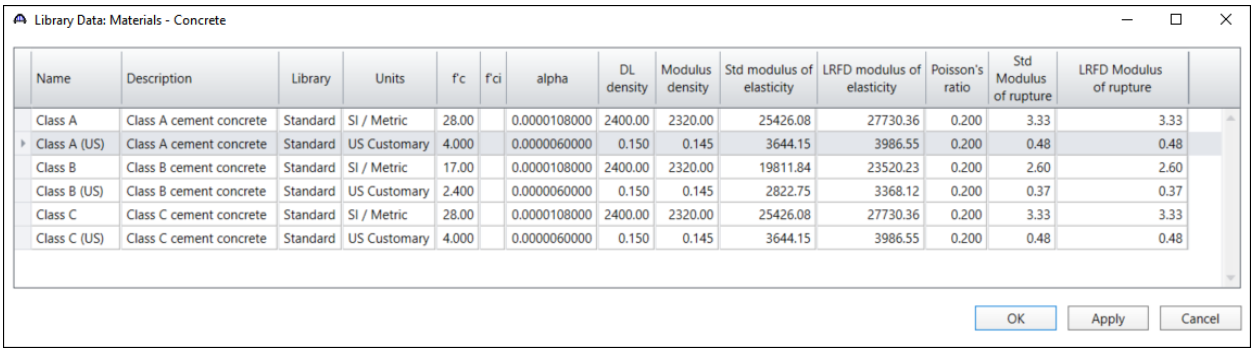
To enter the materials to be used by members of the bridge, open the **Components** tab, and click on the ⊞ button to expand the tree for **Materials**. The tree with the expanded **Materials** branch is shown below.



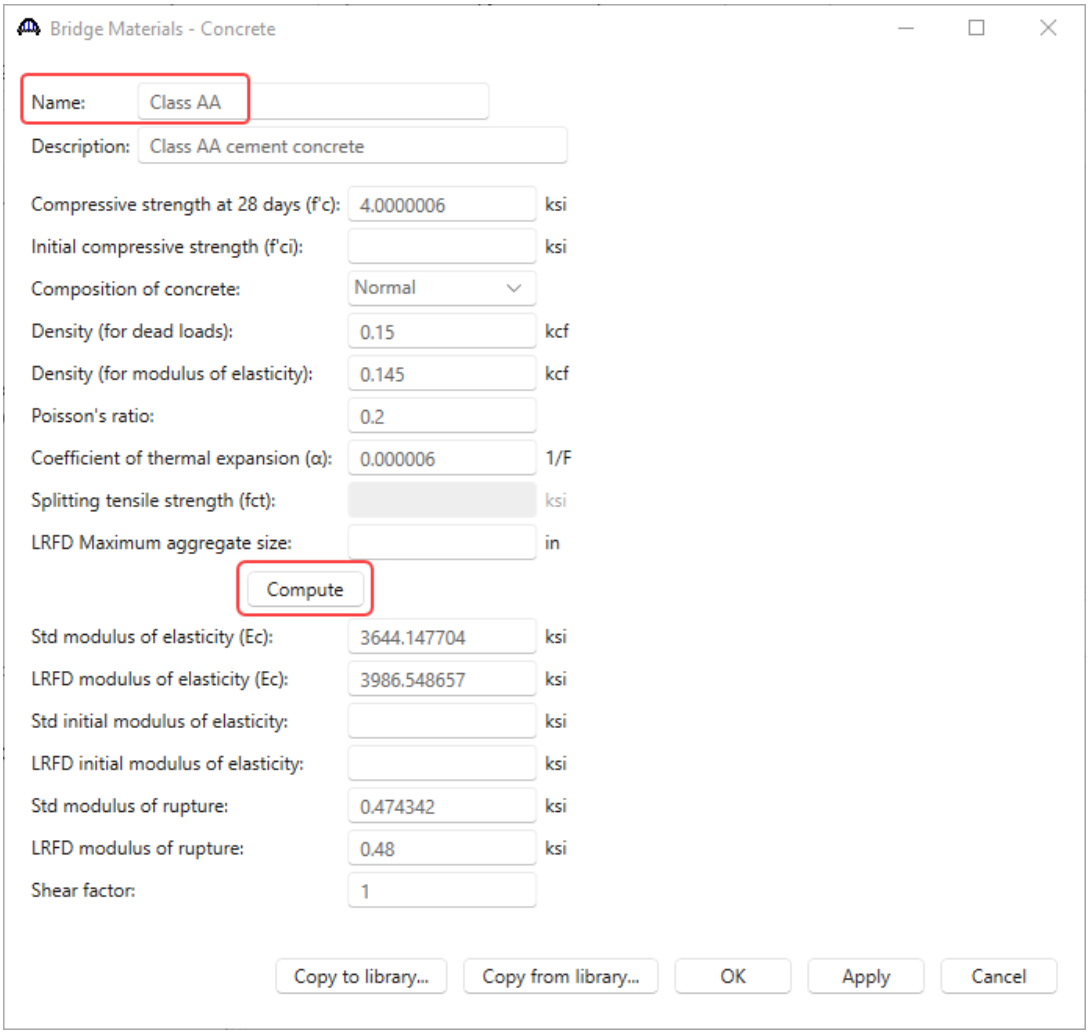
To add a new concrete material, in the **Components** tab of the Bridge Workspace, click on **Materials**, **Concrete,** and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Concrete** and select **New**). The window shown below will open.



Add the concrete material by selecting from the concrete materials library by clicking the **Copy from Library** button. The following window opens:

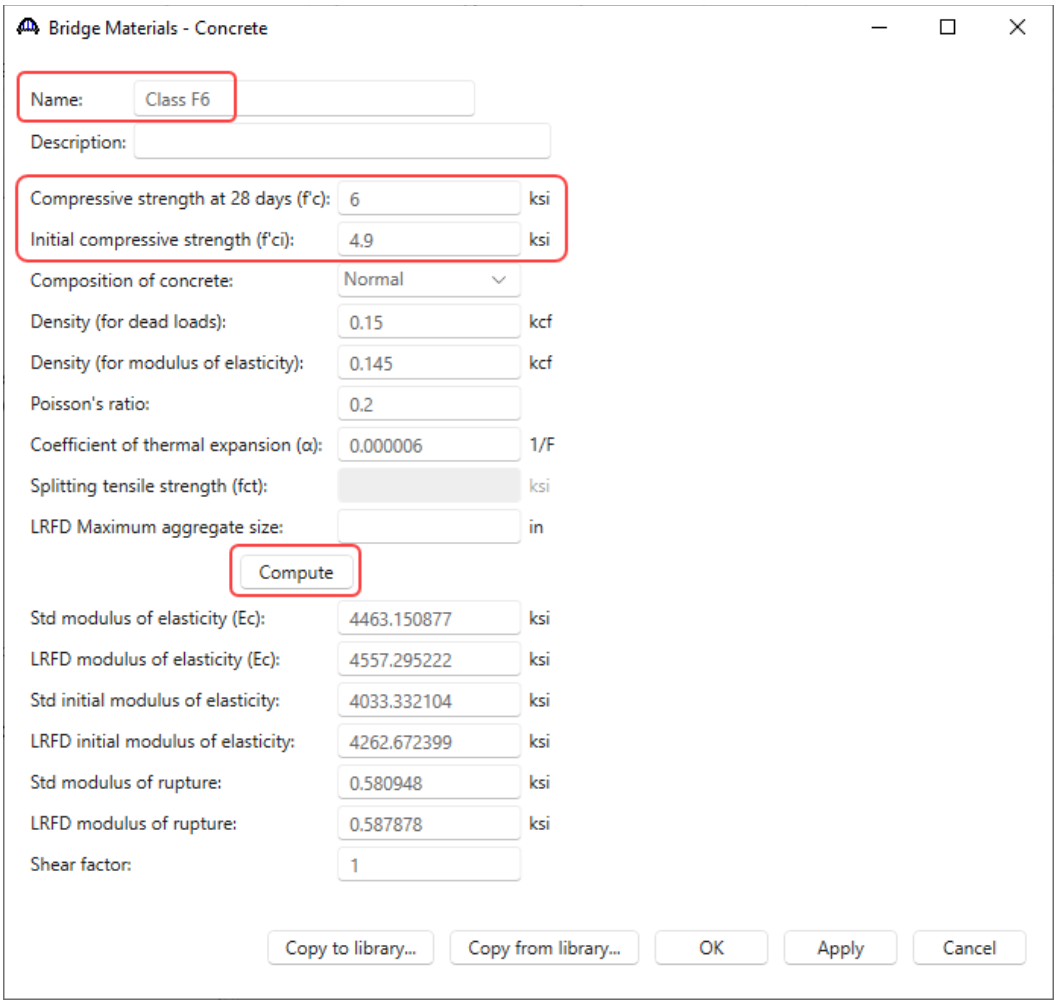


Select the **Class A (US)** material and click **OK.** The selected material properties are copied to the **Bridge Materials – Concrete** window as shown below. Change the name of this material to **Class AA** and click on the **Compute** button.

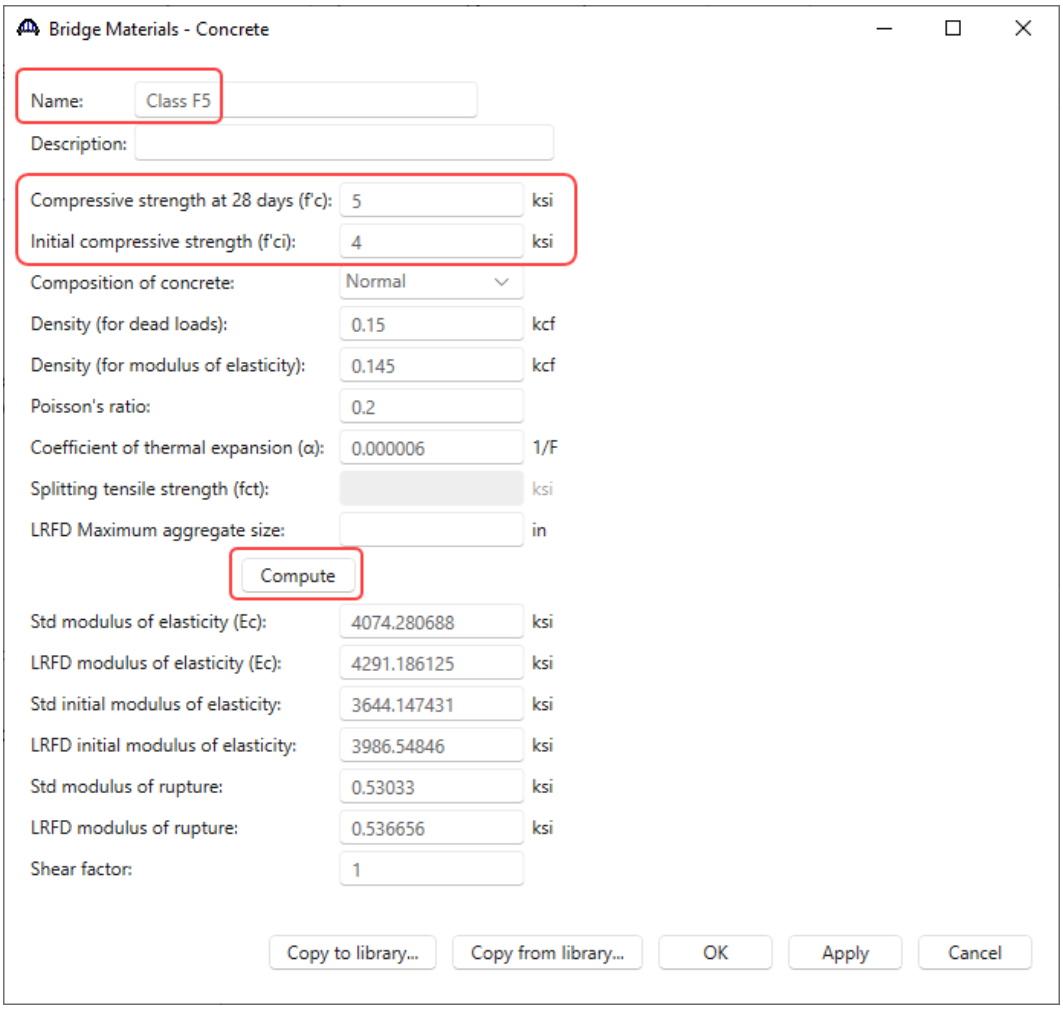


Click **OK** to apply the data and close the window.

To add the **6 ksi** and **5 ksi** prestressed concrete material, double click on the **Concrete** folder in the **Components** tree again. Repeat the process of copying the **Class A (US)** concrete material from the library. Update the **f'c** and **f'ci** for each of the concrete materials as shown below. After changing these values, click the **Compute** button to compute the material properties.

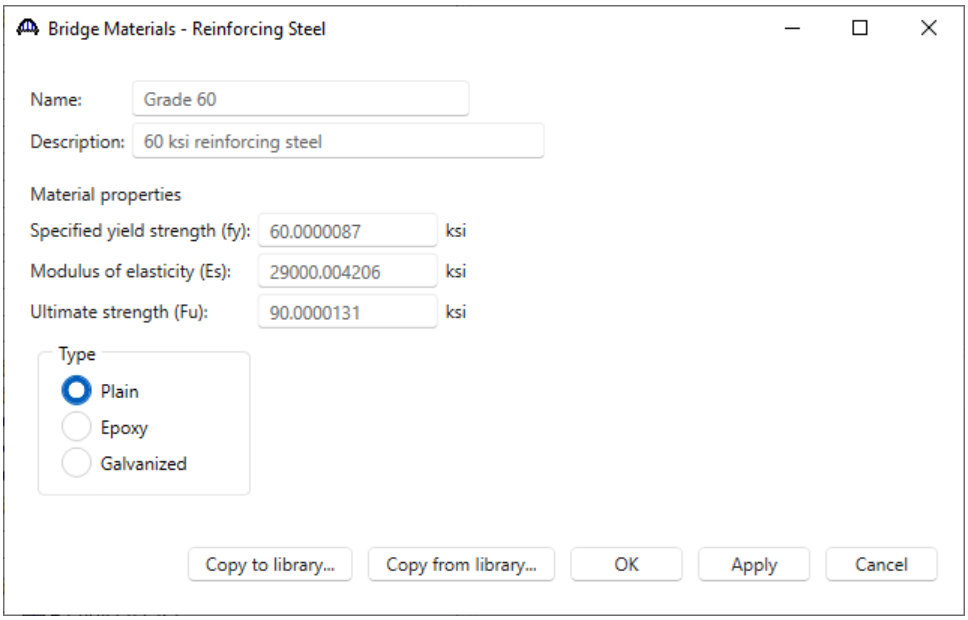


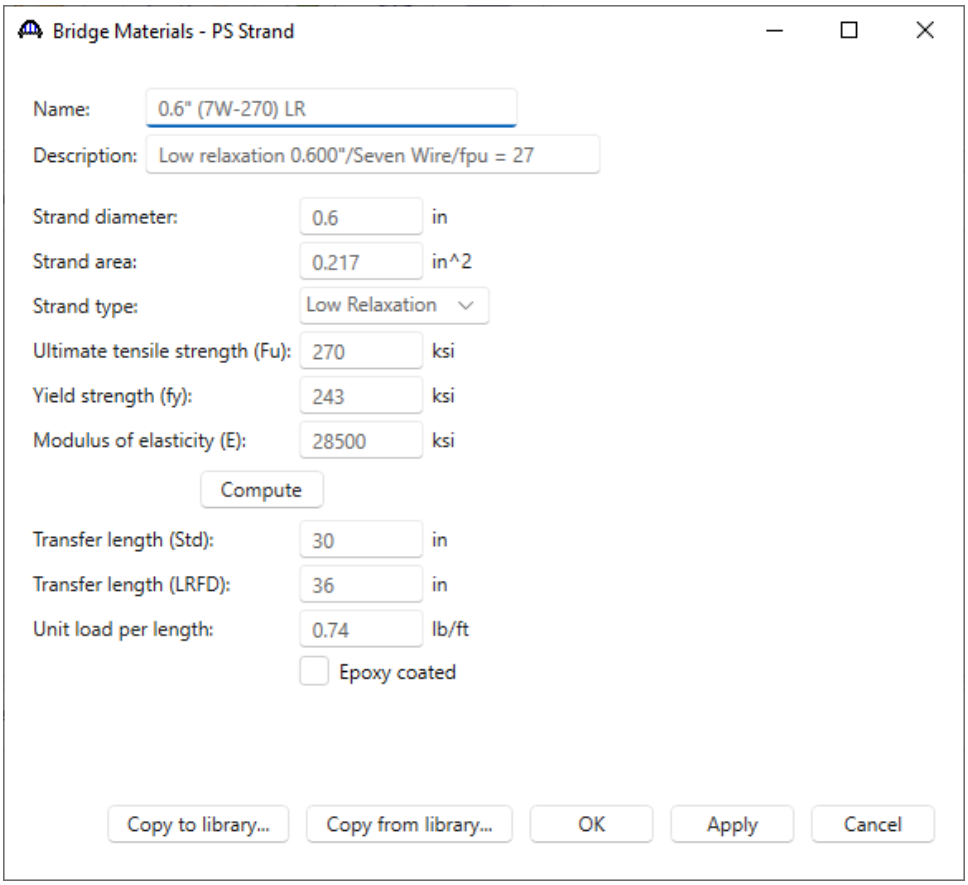
Click **OK** to apply the data and close the window.

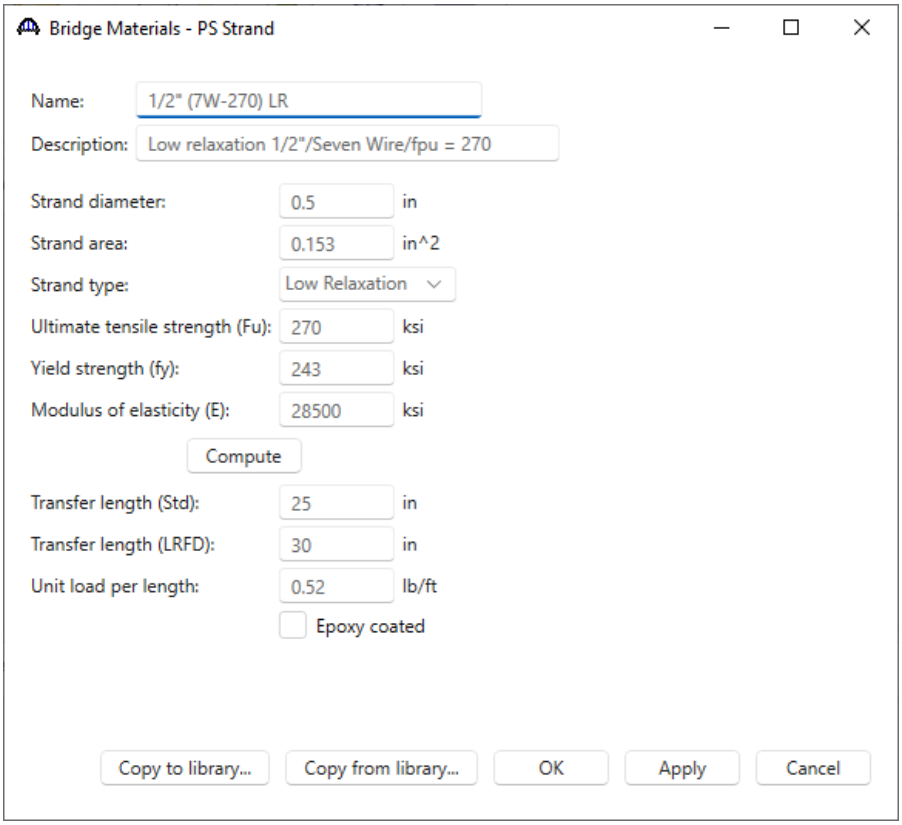


Click **OK** to apply the data and close the window.

Add the **reinforcement material** and **prestress strand** using the same techniques. The windows will look like these shown below.

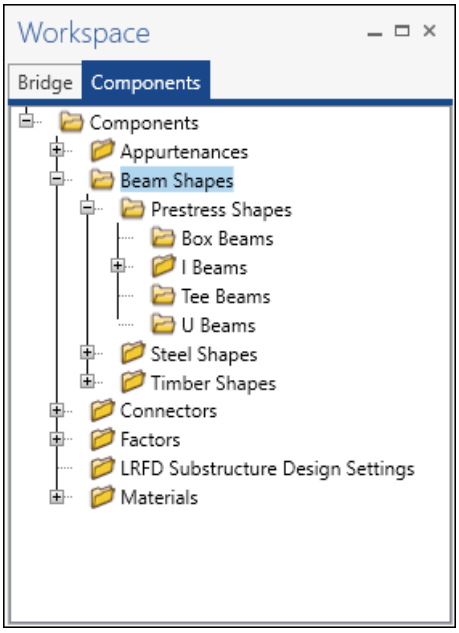




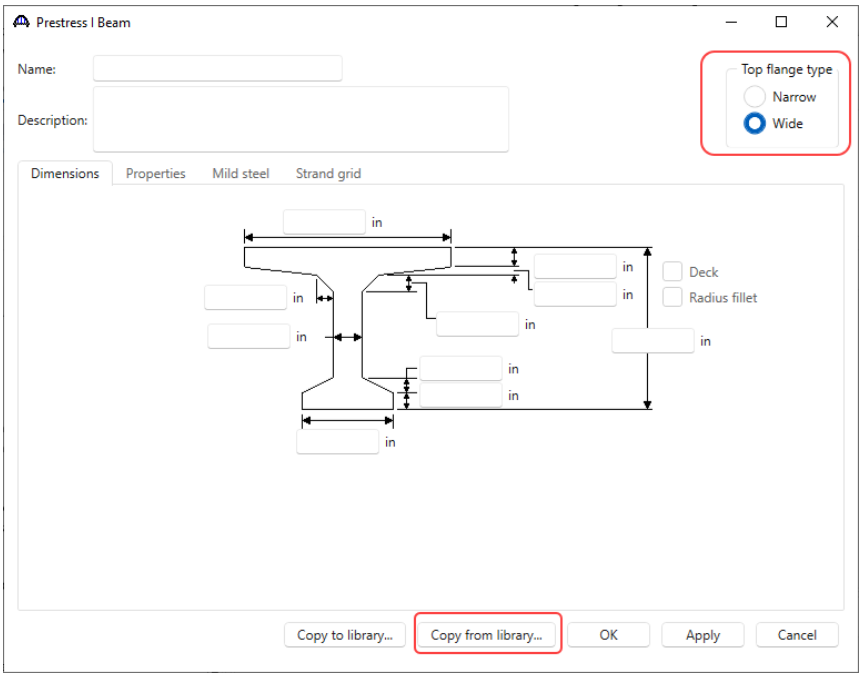


Beam Shapes

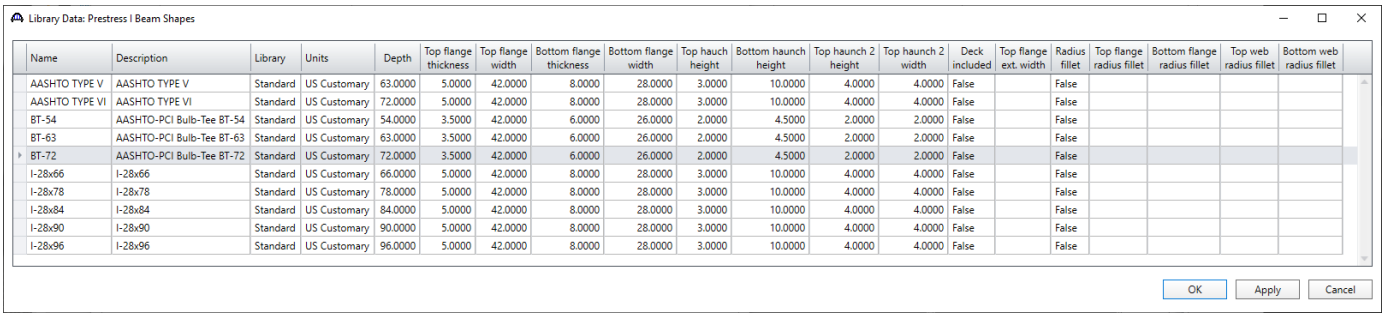
To enter a prestress beam shape to be used in this bridge expand the tree labeled **Beam Shapes** and **Prestress Shapes** as shown below.



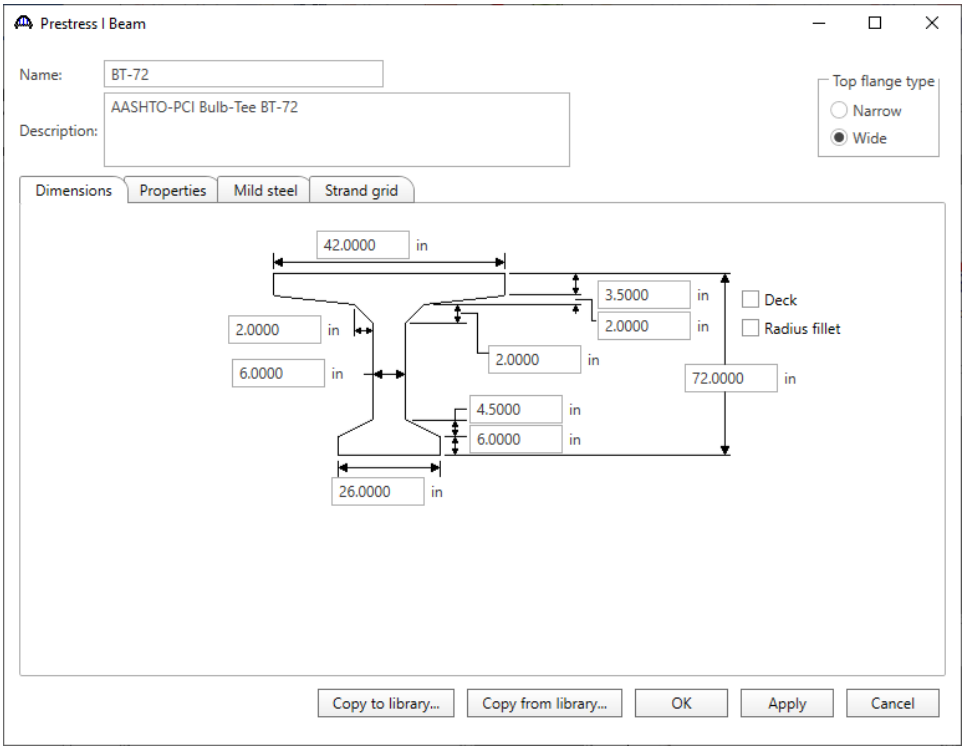
Click on the **I Beams** node in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **I Beams** and select **New** or double click on **I Beams** in the **Components** tree). The window shown below will open.



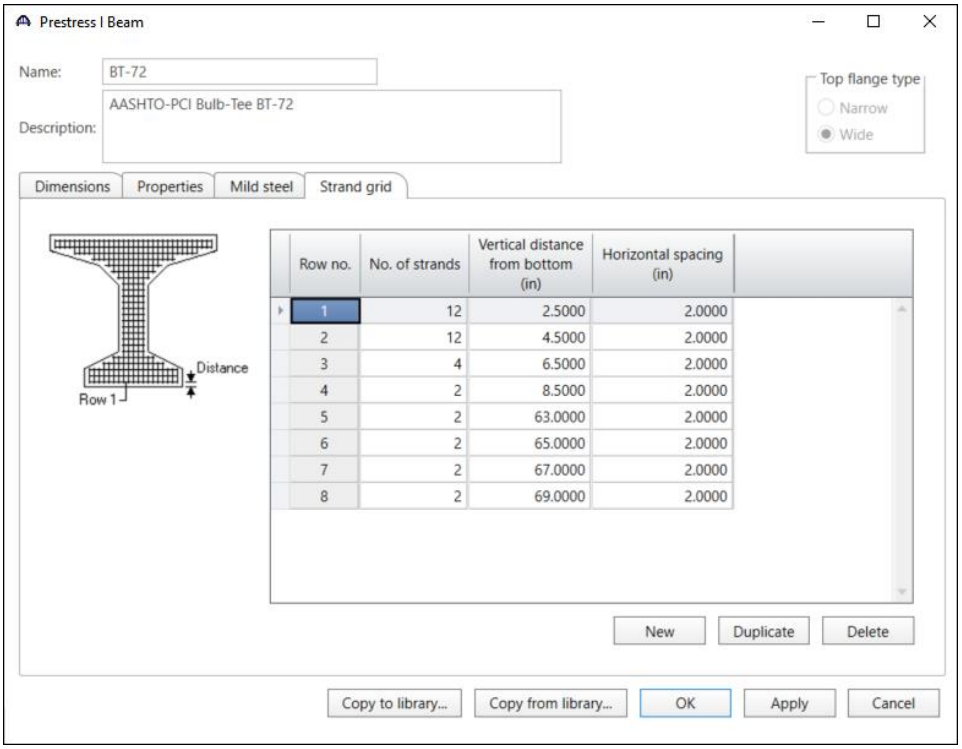
Select the **Top flange type** as **Wide** and click the **Copy from library…** button. Select **BT-72 (AASHTO-PCI Bulb-Tee BT-72)** and click **OK**. The beam properties are copied to the **Prestress I Beam** window as shown below.



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	63.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				
AASHTO TYPE VI	AASHTO TYPE VI	Standard	US Customary	72.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				
BT-54	AASHTO-PCI Bulb-Tee BT-54	Standard	US Customary	54.0000	3.5000	42.0000	6.0000	26.0000	2.0000	4.5000	2.0000	2.0000	False		False				
BT-63	AASHTO-PCI Bulb-Tee BT-63	Standard	US Customary	63.0000	3.5000	42.0000	6.0000	26.0000	2.0000	4.5000	2.0000	2.0000	False		False				
BT-72	AASHTO-PCI Bulb-Tee BT-72	Standard	US Customary	72.0000	3.5000	42.0000	6.0000	26.0000	2.0000	4.5000	2.0000	2.0000	False		False				
I-28x66	I-28x66	Standard	US Customary	66.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				
I-28x78	I-28x78	Standard	US Customary	78.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				
I-28x84	I-28x84	Standard	US Customary	84.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				
I-28x90	I-28x90	Standard	US Customary	90.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				
I-28x96	I-28x96	Standard	US Customary	96.0000	5.0000	42.0000	8.0000	28.0000	3.0000	10.0000	4.0000	4.0000	False		False				

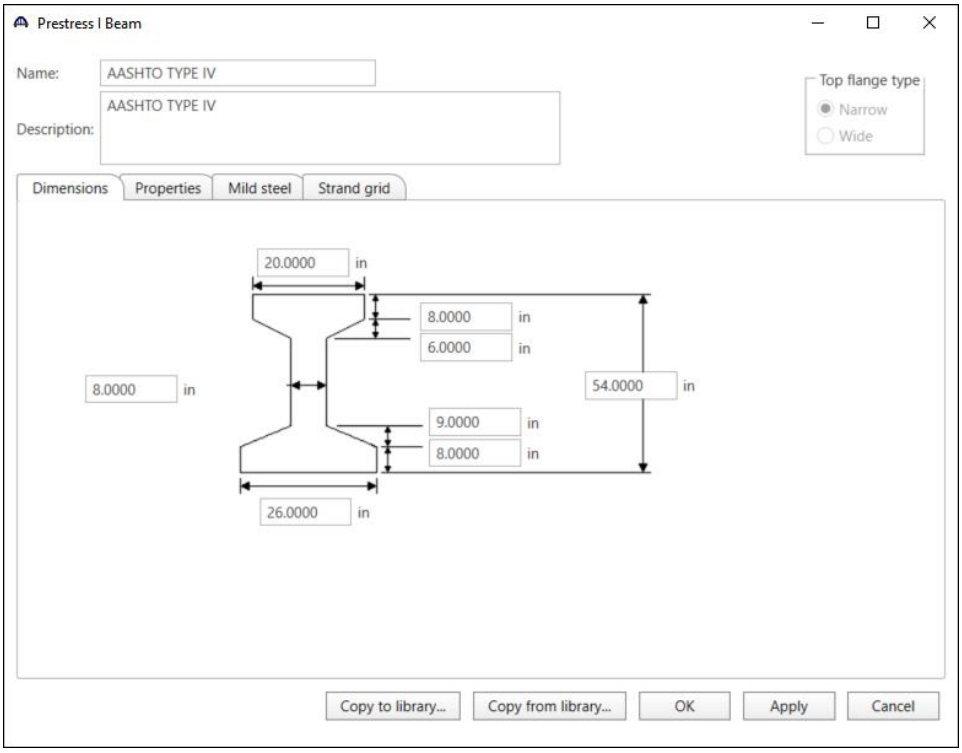


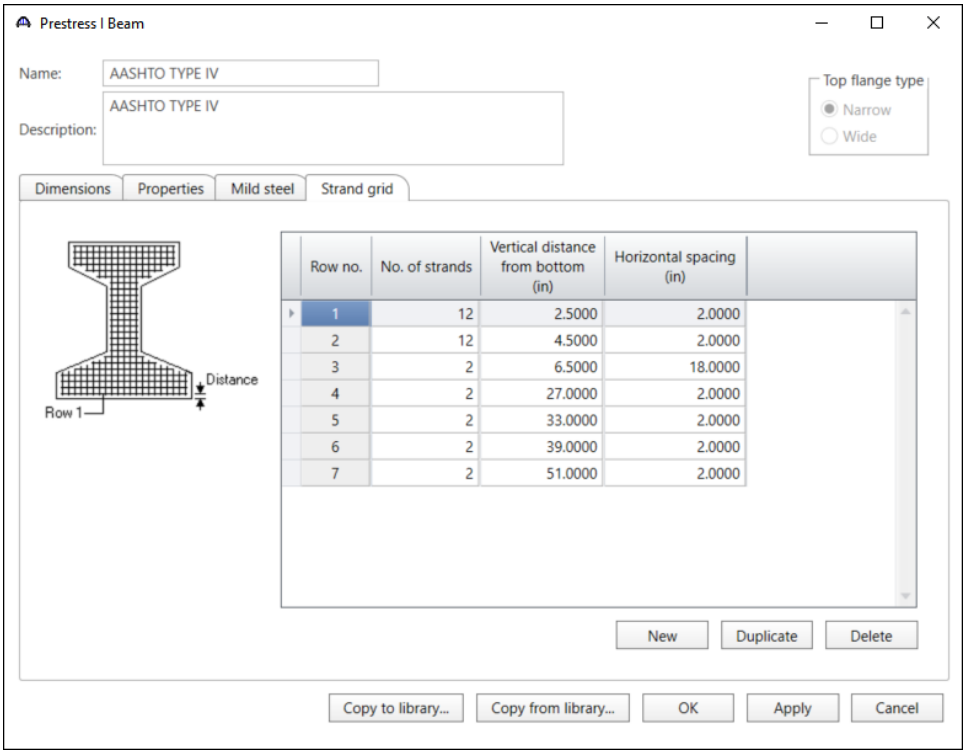
Navigate to the **Strand grid** tab and enter the following prestress strand locations.



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

Enter the **AASHTO Type IV** beam (**Narrow** top flange type) using the same technique. The windows are shown below.

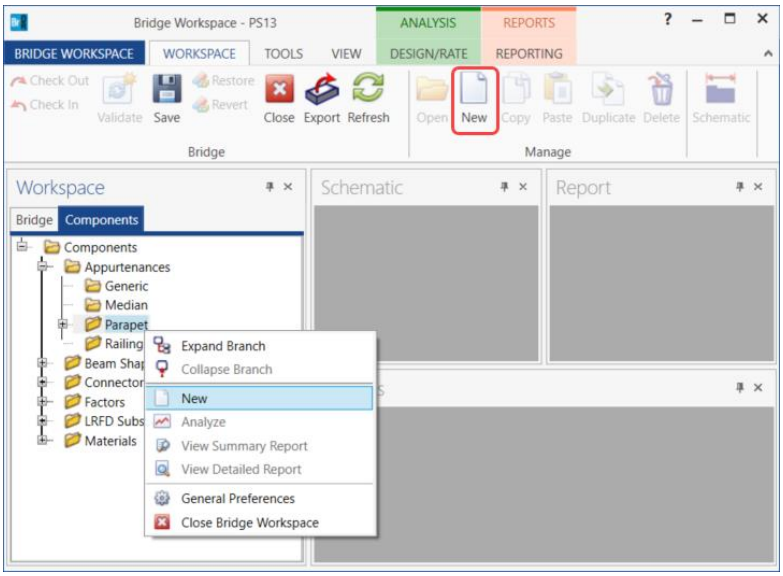




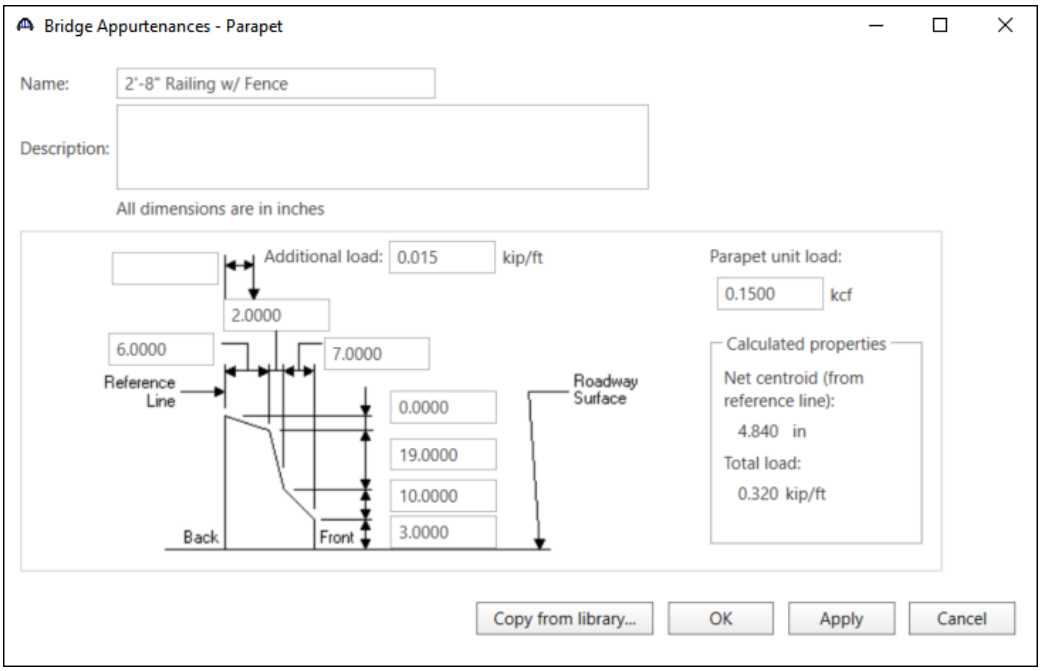
Click **OK** to apply the data and close the window.

Bridge - Appurtenances

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

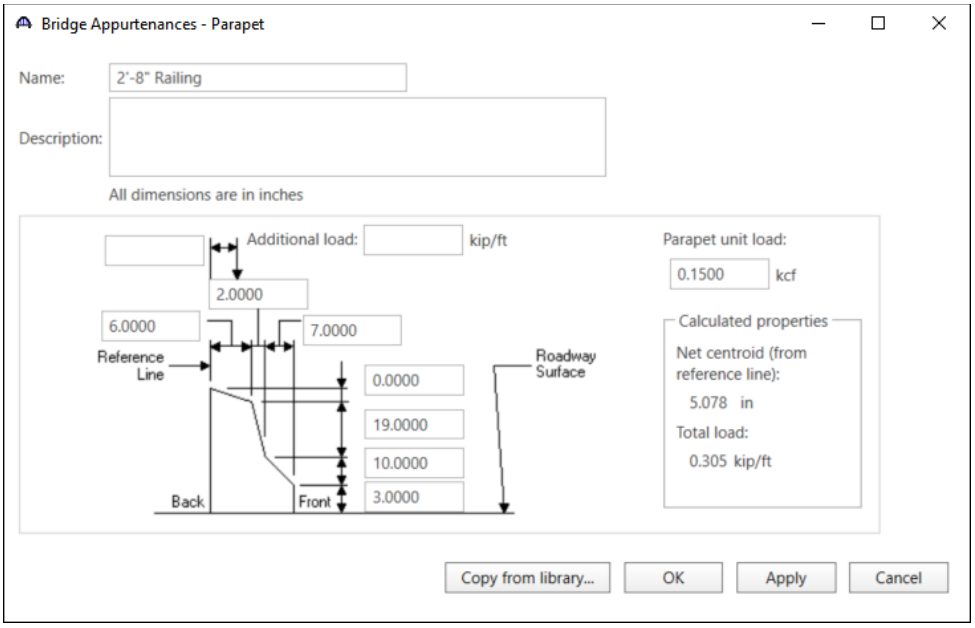


Enter the parapet details as shown below.



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

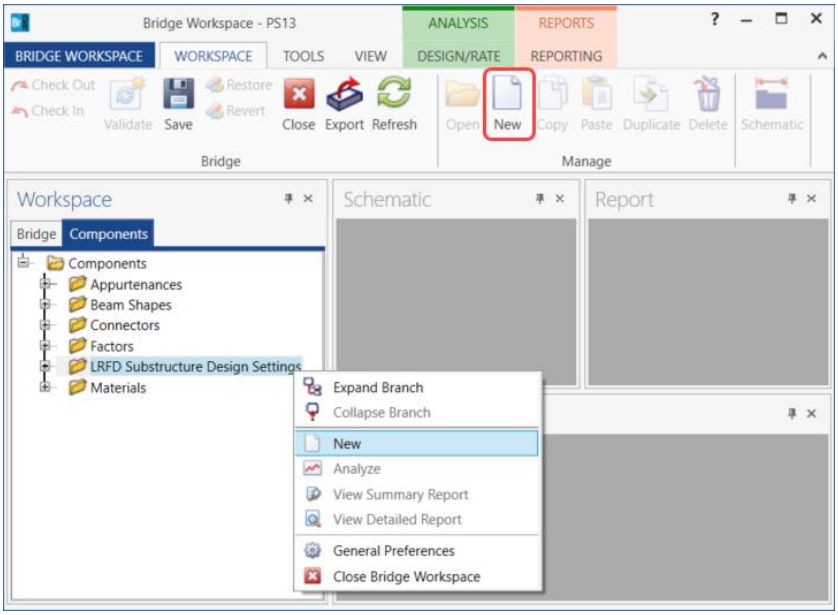
Create a second barrier without the additional load which accounts for the fence as shown below.



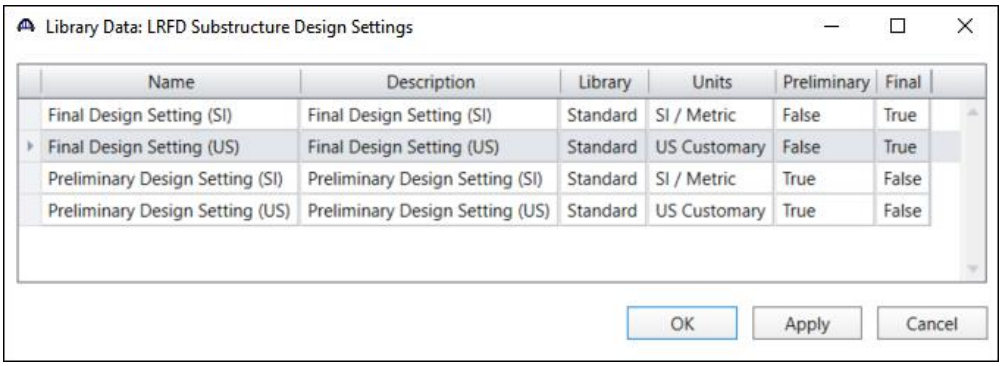
Click **OK** to apply the data and close the window.

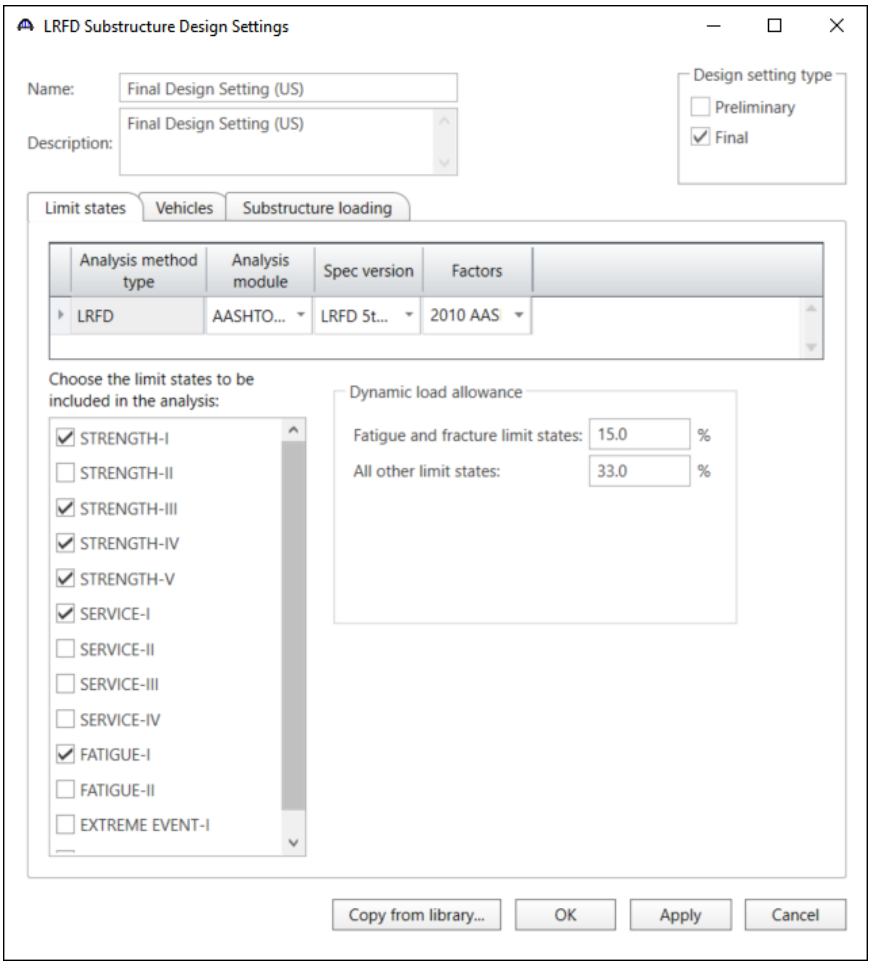
LRFD Substructure Design Settings

To define the substructure design settings, select **LRFD Substructure Design Settings** and click on **New** from the **Manage** button on the **WORKSPACE** ribbon (or right click on **LRFD Substructure Design Settings** in the **Components** tree and select **New** from the drop down menu).



Click the **Copy from library button…** Select **Final Design Setting (US)** and click **OK.** The selected design settings are copied to the **LRFD Substructure Design Settings** window as shown below.



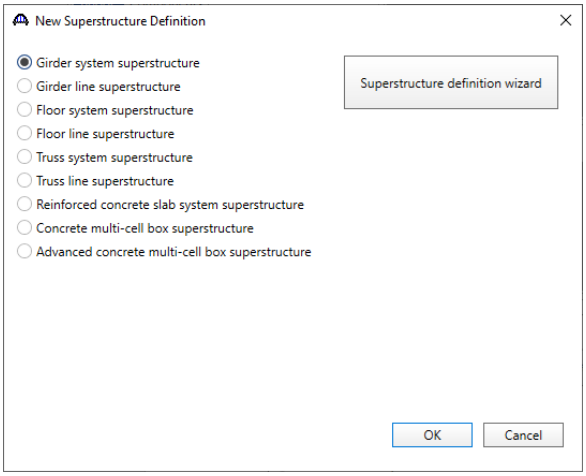


Click **OK** to apply the data and close the window.

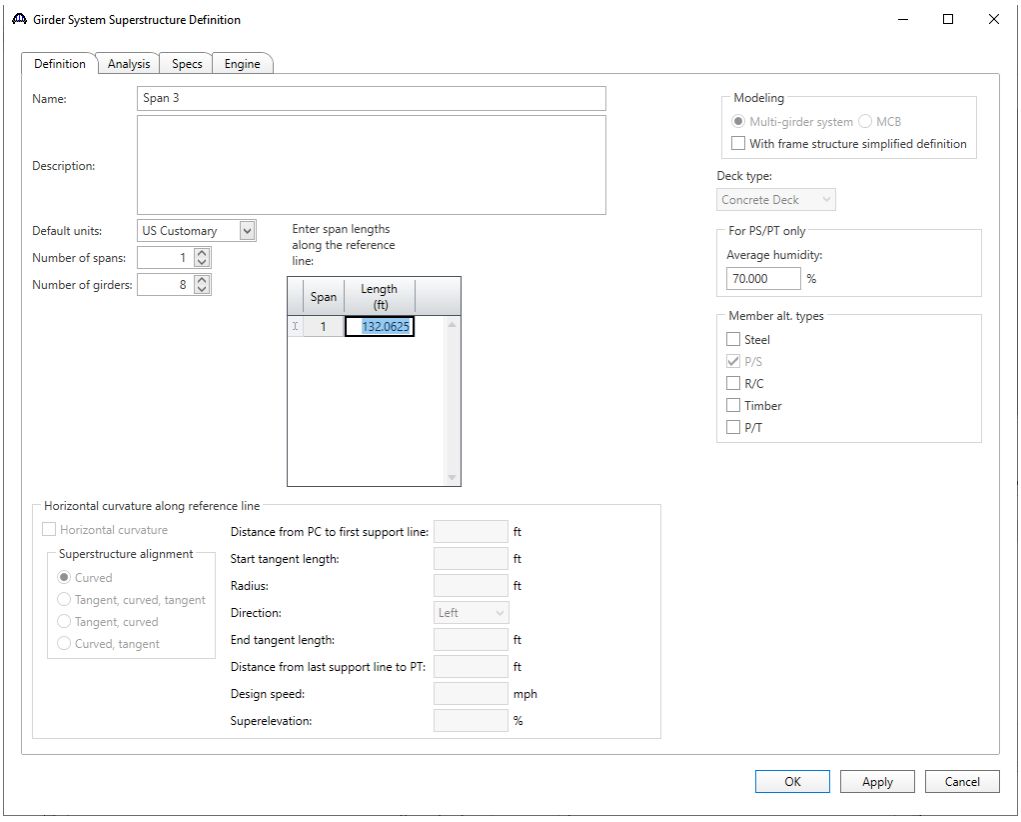
The default impact factors, standard LRFD and LFR factors will be used. Bridge Alternatives will be added after entering the Structure Definition.

Superstructure Definitions

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

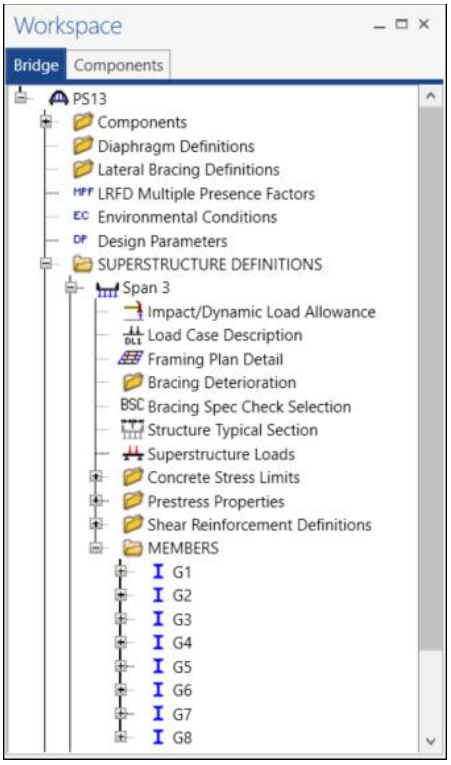


Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open. Enter the data as shown below.



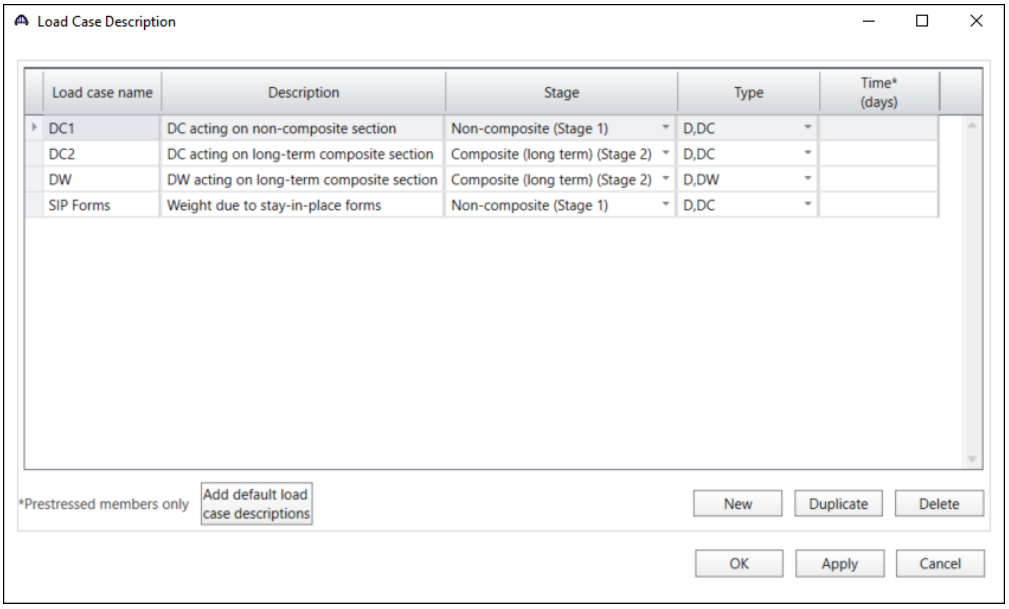
Click **OK** to apply the data and close the window.

The partially expanded Bridge Workspace tree is shown below.



Load Case Description

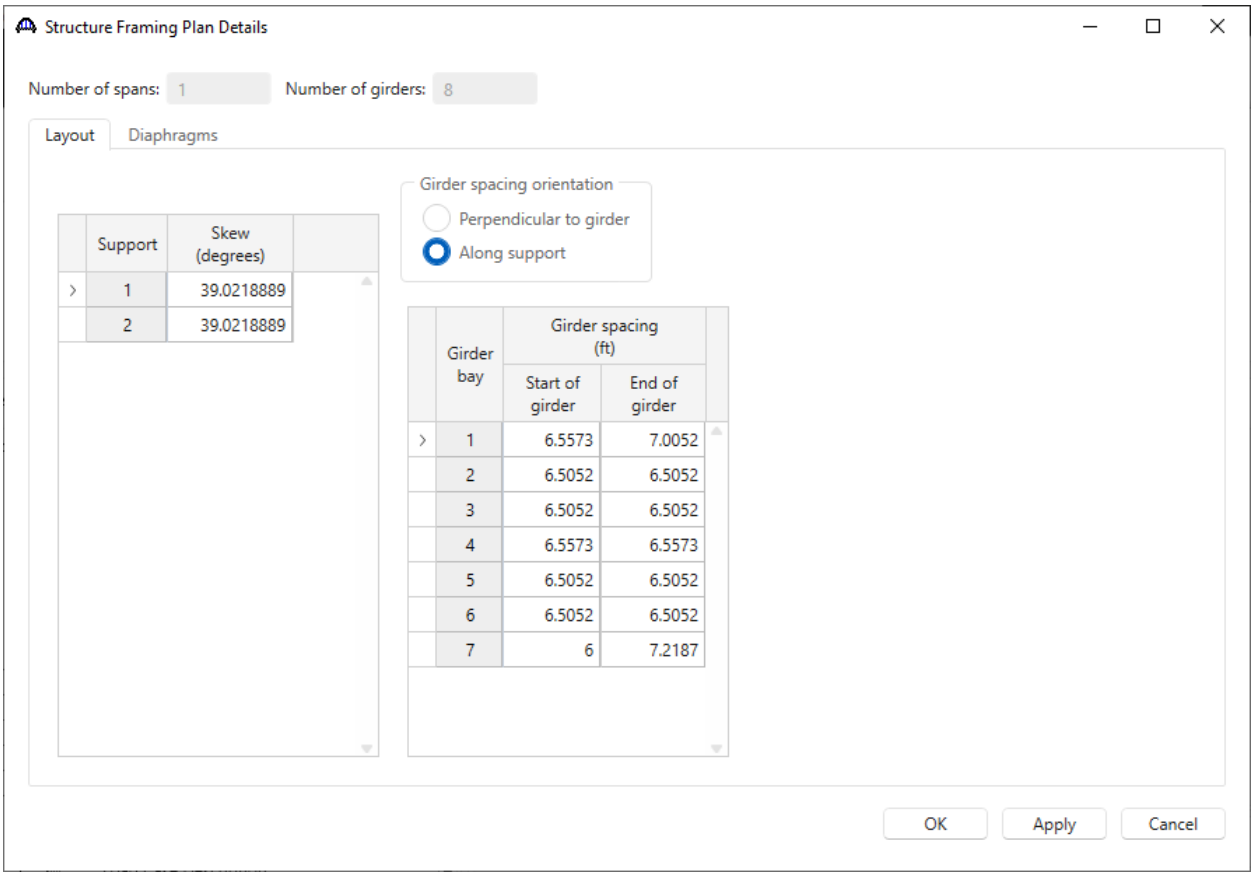
Double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window** and define the dead load cases as shown below. The completed **Load Case Description** window is shown below.



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

Structure Framing Plan Detail – Layout

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



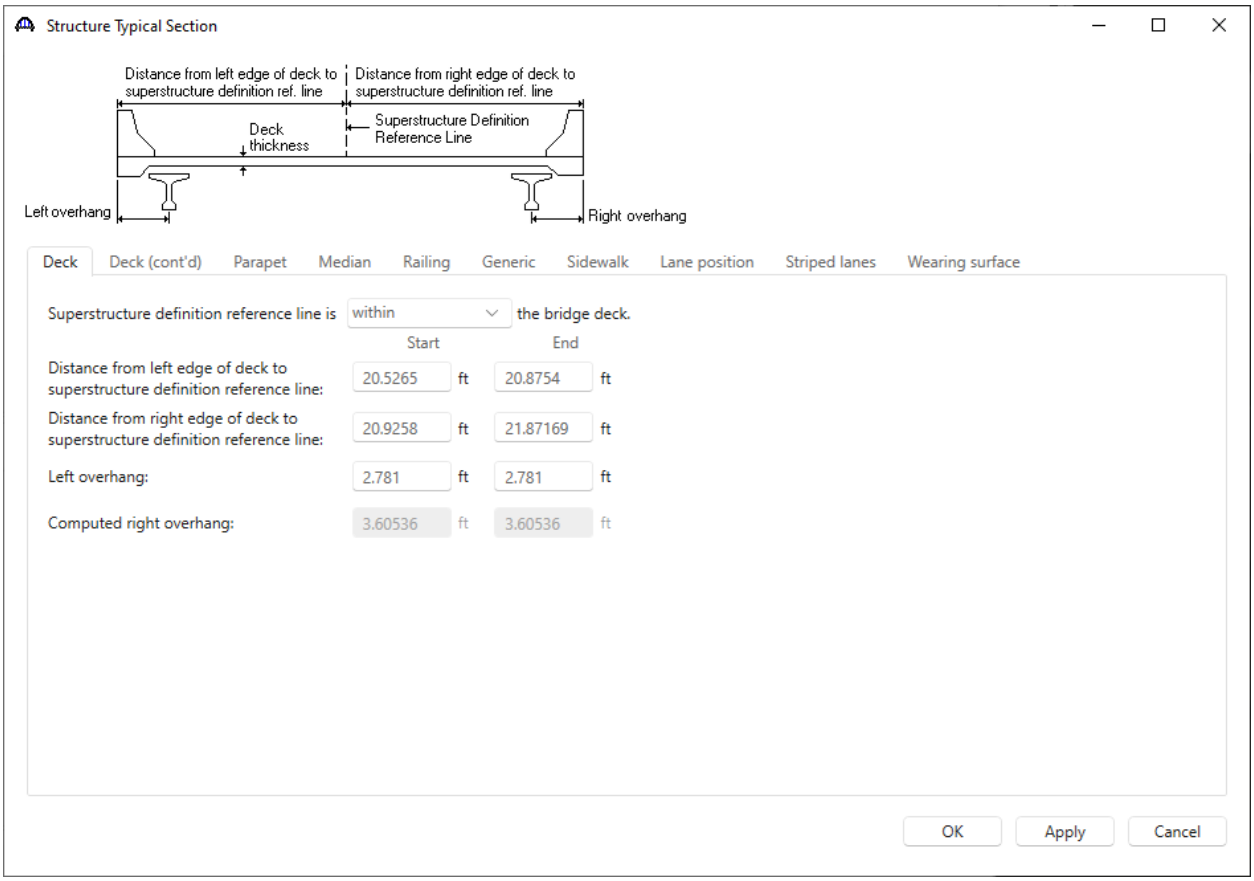
Click **OK** to apply the data and close the window.

Structure Framing Plan Detail – Diaphragms

This window needs to be revisited after the Structure Reference Line is set in the Structure Typical Section window.

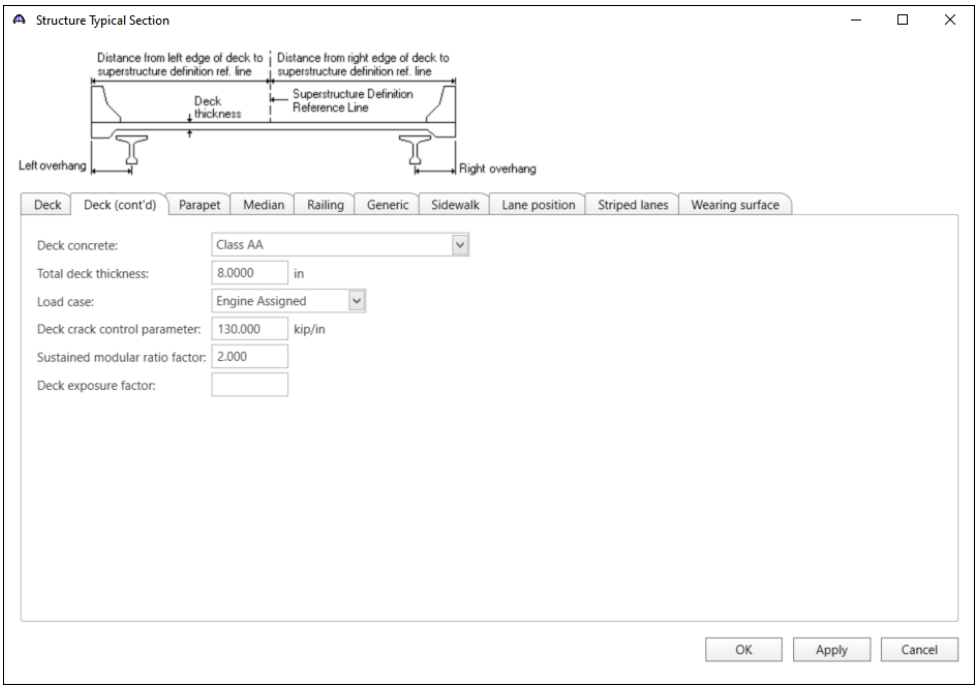
Structure Typical Section – Deck

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



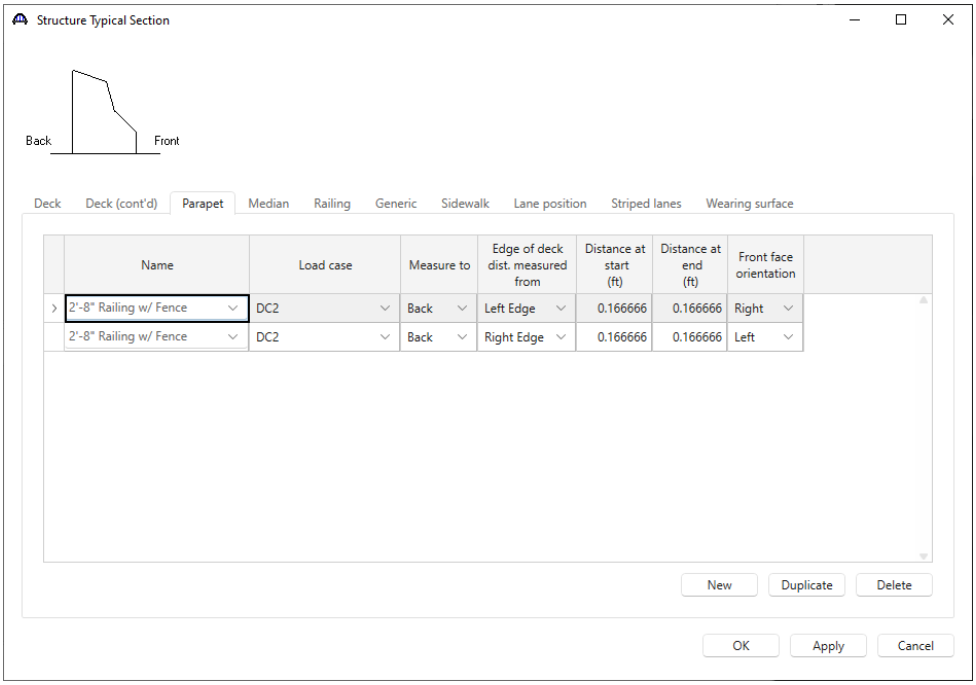
Structure Typical Section – Deck (cont'd)

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.



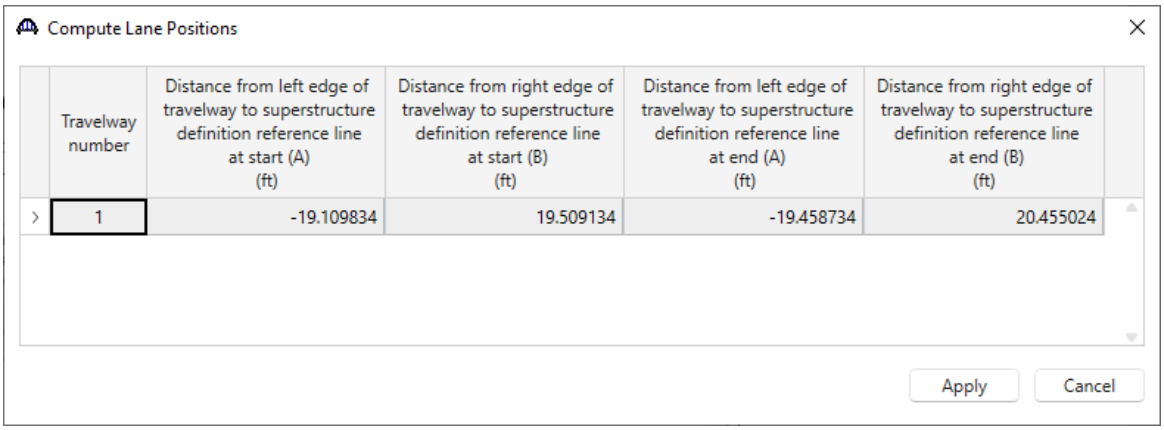
Structure Typical Section – Parapets

Add two parapets as shown below.

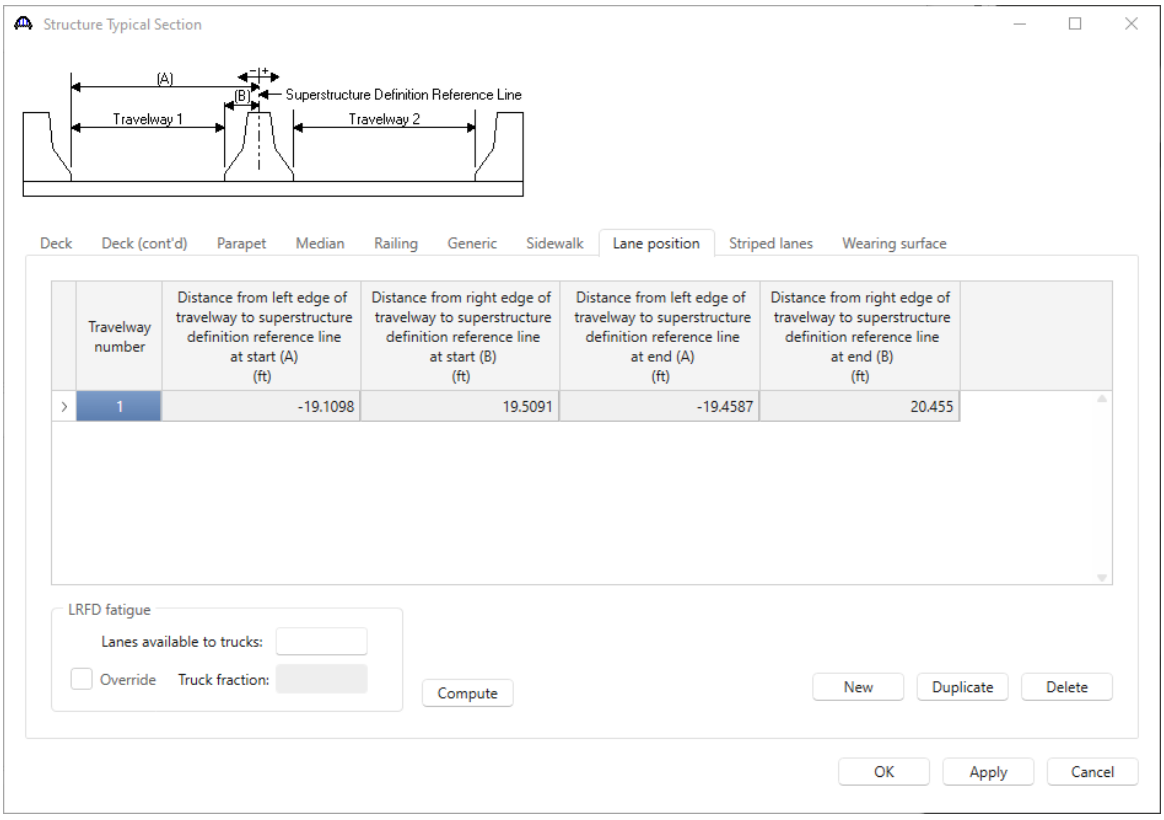


Structure Typical Section – Lane Position

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.



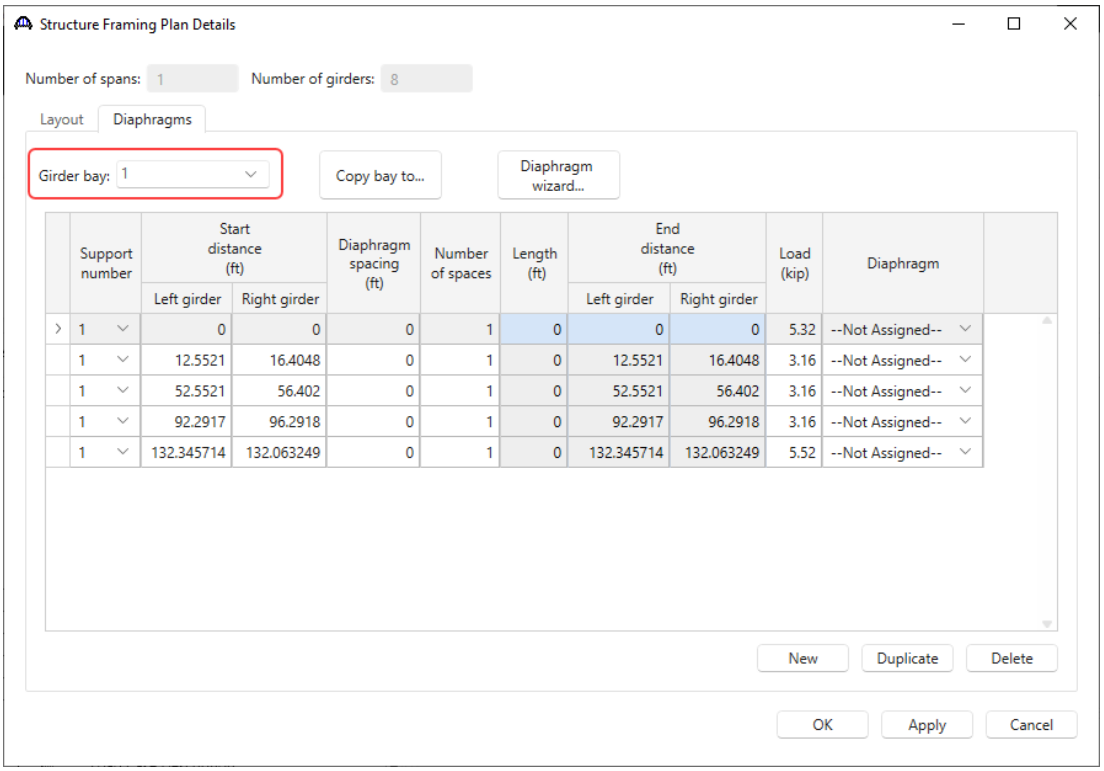
The **Lane Position** tab is populated as shown below.

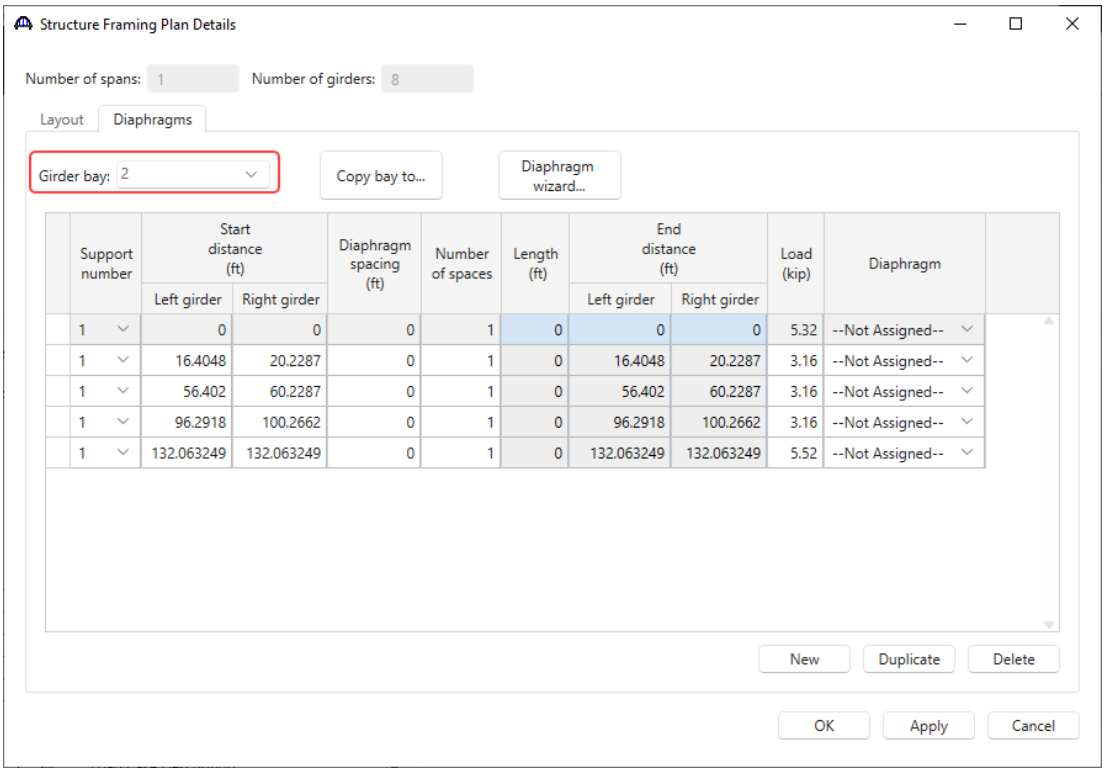


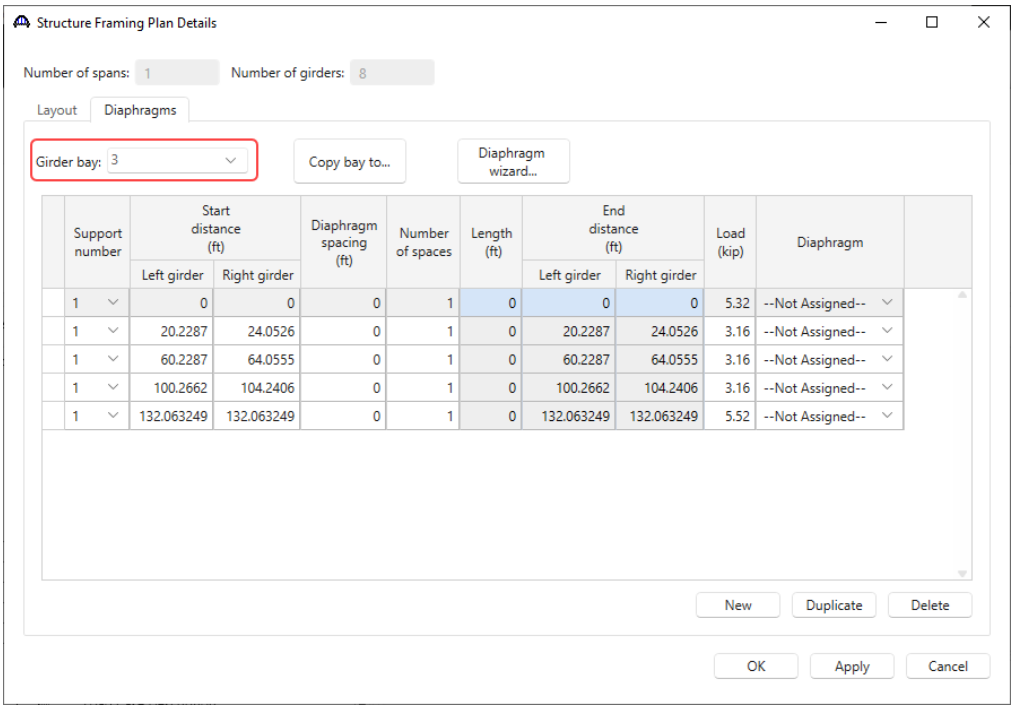
Click **OK** to apply the data and close the window.

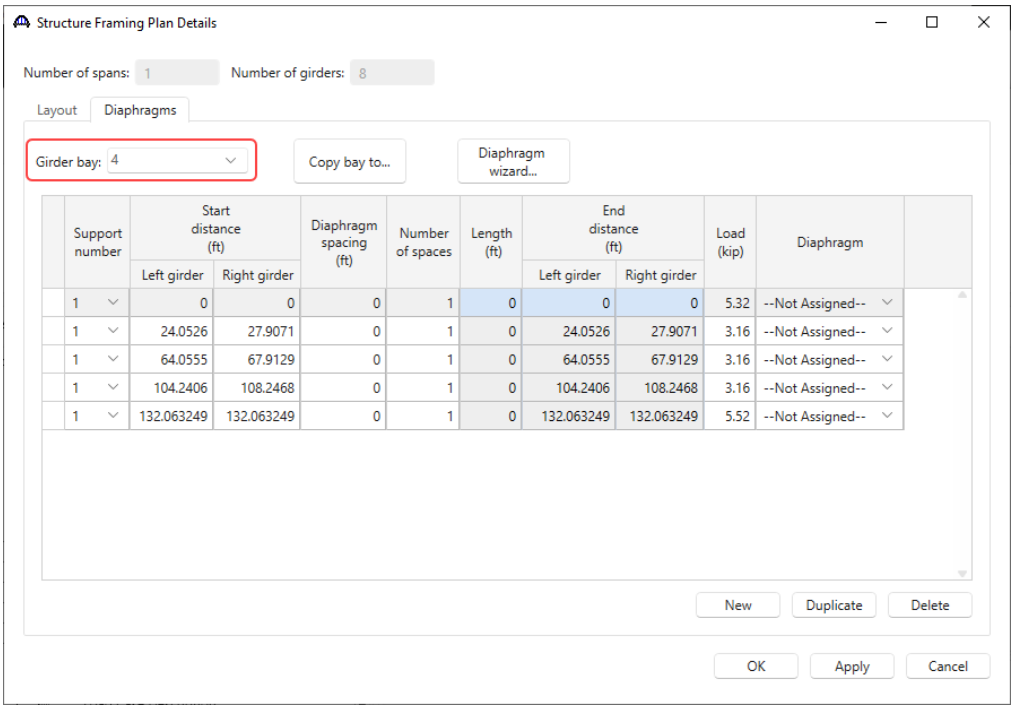
Structure Framing Plan Detail – Diaphragms

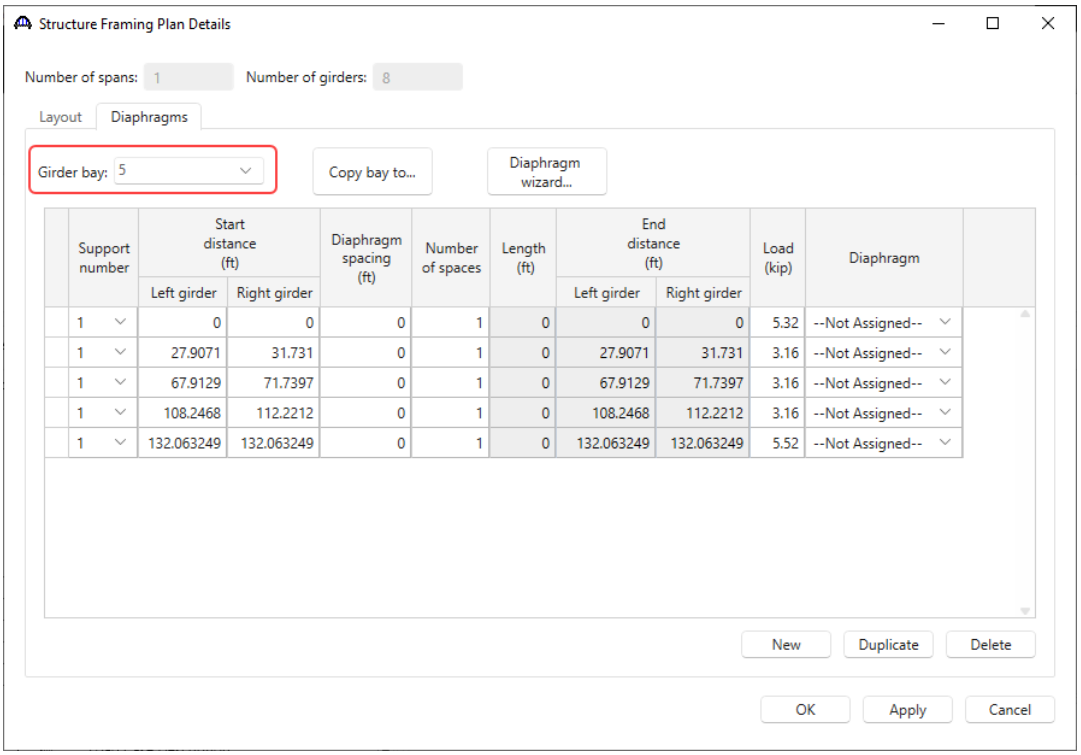
Re-open the **Structure Framing Plan Detail** window and navigate to the **Diaphragms** tab to enter the diaphragm spacing. Enter the information for each girder bay as shown below.

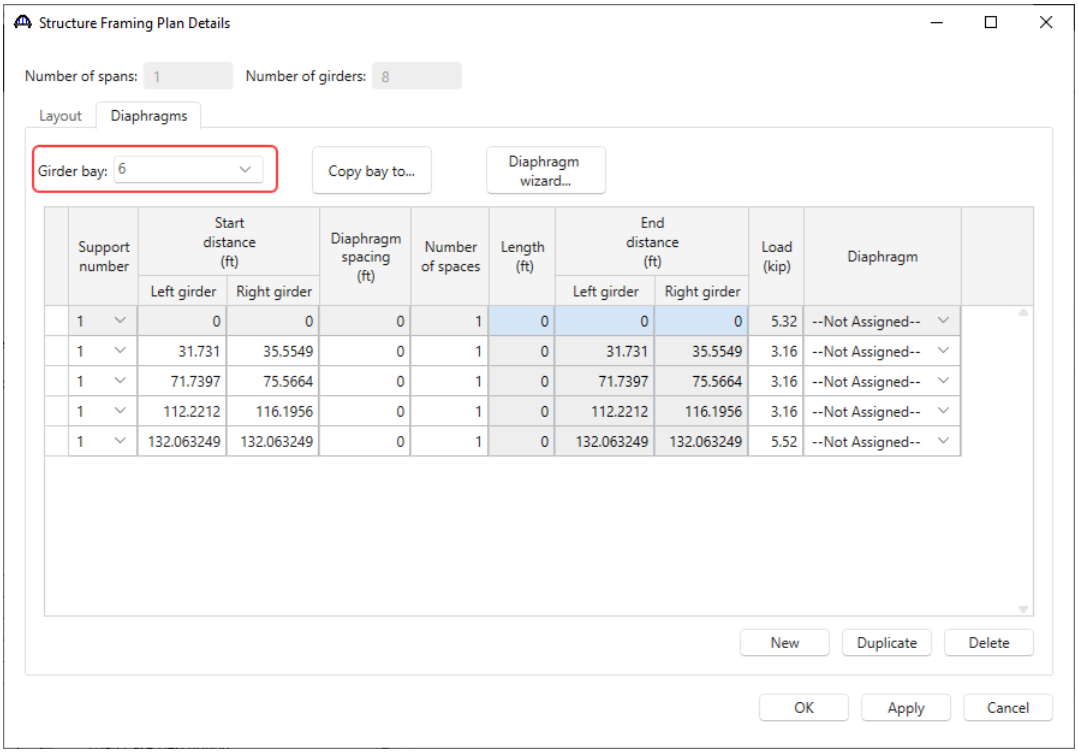


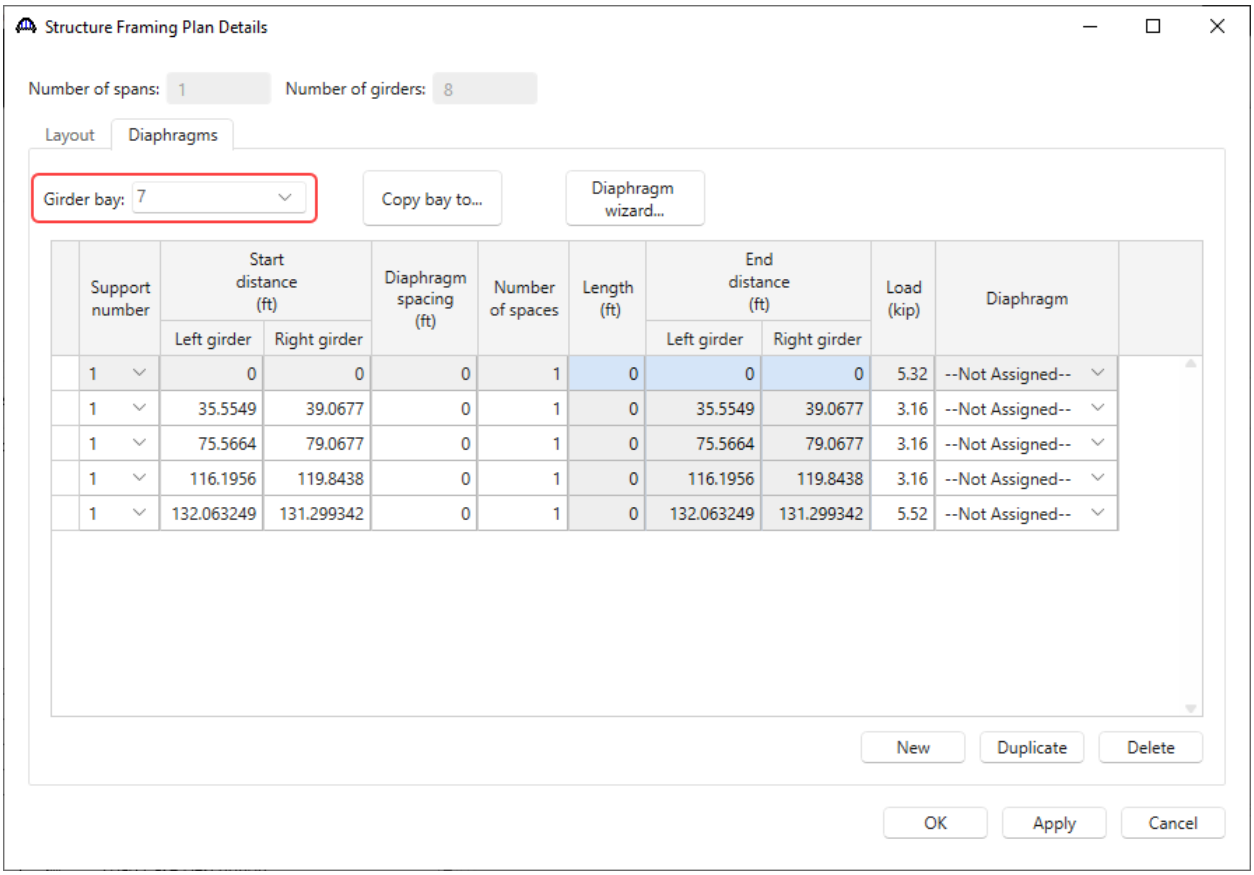



Structure Framing Plan Details
Number of spans: 1
Number of girders: 8
Layout
Diaphragms
Girder bay: 3
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.32 --Not Assigned--
1 20.2287 24.0526 0 1 0 20.2287 24.0526 3.16 --Not Assigned--
1 60.2287 64.0555 0 1 0 60.2287 64.0555 3.16 --Not Assigned--
1 100.2662 104.2406 0 1 0 100.2662 104.2406 3.16 --Not Assigned--
1 132.063249 132.063249 0 1 0 132.063249 132.063249 5.52 --Not Assigned--
New
Duplicate
Delete
OK
Apply
Cancel


Structure Framing Plan Details
Number of spans: 1
Number of girders: 8
Layout
Diaphragms
Girder bay: 4
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.32 --Not Assigned--
1 24.0526 27.9071 0 1 0 24.0526 27.9071 3.16 --Not Assigned--
1 64.0555 67.9129 0 1 0 64.0555 67.9129 3.16 --Not Assigned--
1 104.2406 108.2468 0 1 0 104.2406 108.2468 3.16 --Not Assigned--
1 132.063249 132.063249 0 1 0 132.063249 132.063249 5.52 --Not Assigned--
New
Duplicate
Delete
OK
Apply
Cancel


Structure Framing Plan Details
Number of spans: 1
Number of girders: 8
Layout
Diaphragms
Girder bay: 5
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.32 --Not Assigned--
1 27.9071 31.731 0 1 0 27.9071 31.731 3.16 --Not Assigned--
1 67.9129 71.7397 0 1 0 67.9129 71.7397 3.16 --Not Assigned--
1 108.2468 112.2212 0 1 0 108.2468 112.2212 3.16 --Not Assigned--
1 132.063249 132.063249 0 1 0 132.063249 132.063249 5.52 --Not Assigned--
New
Duplicate
Delete
OK
Apply
Cancel

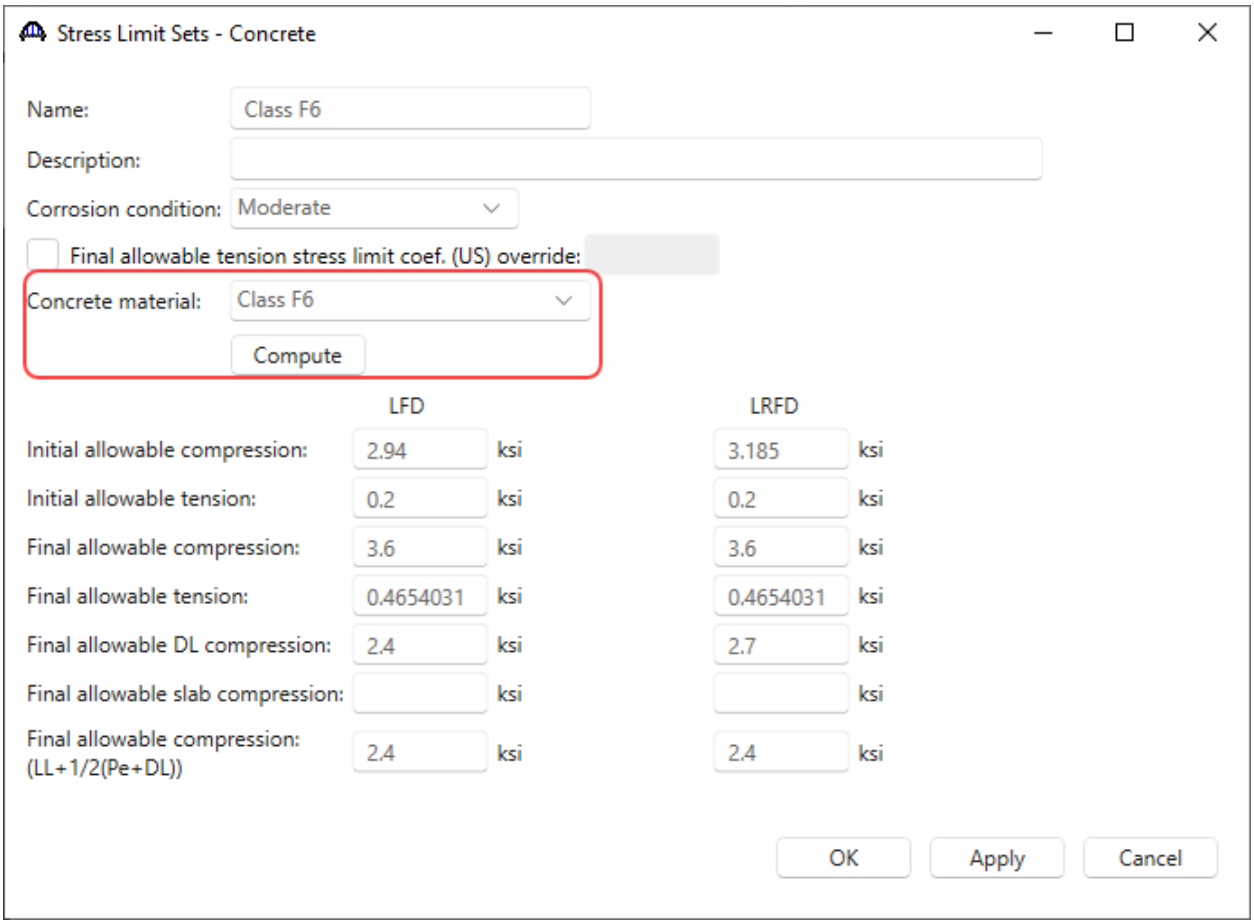

Structure Framing Plan Details
Number of spans: 1
Number of girders: 8
Layout
Diaphragms
Girder bay: 6
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.32 --Not Assigned--
1 31.731 35.5549 0 1 0 31.731 35.5549 3.16 --Not Assigned--
1 71.7397 75.5664 0 1 0 71.7397 75.5664 3.16 --Not Assigned--
1 112.2212 116.1956 0 1 0 112.2212 116.1956 3.16 --Not Assigned--
1 132.063249 132.063249 0 1 0 132.063249 132.063249 5.52 --Not Assigned--
New
Duplicate
Delete
OK
Apply
Cancel



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

Concrete Stress Limits

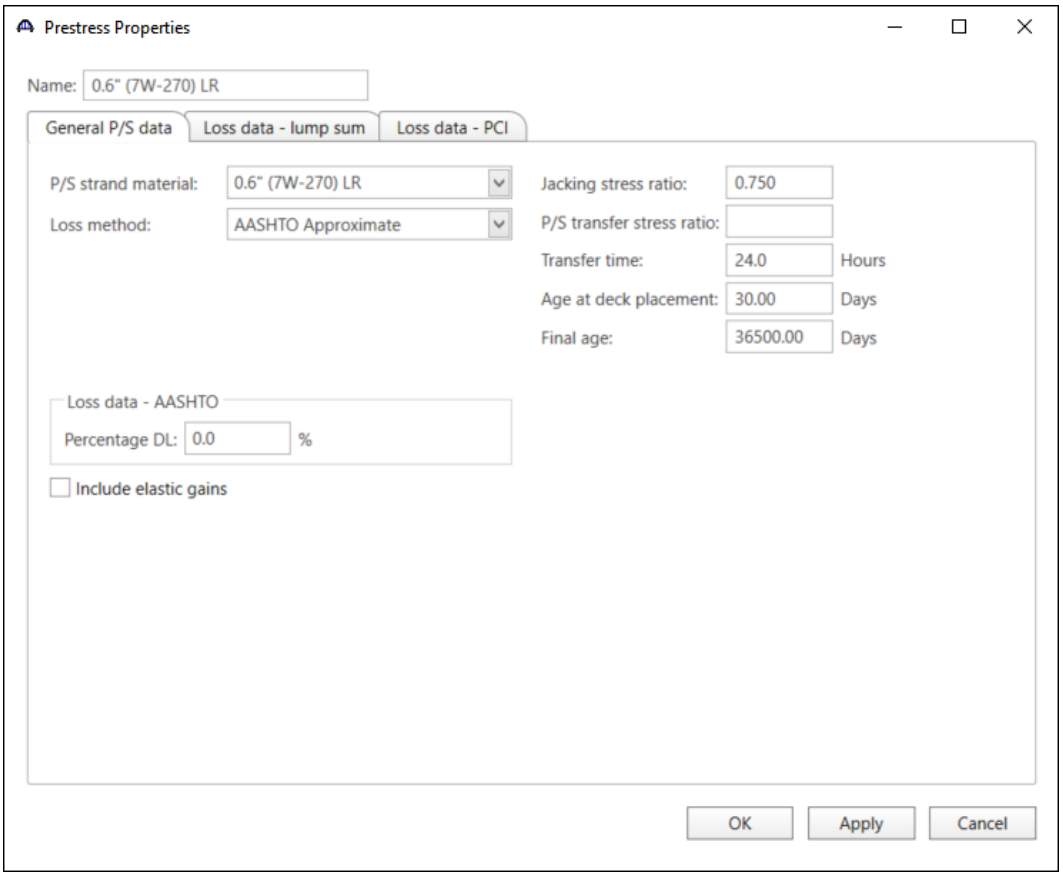
A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the **Concrete Stress Limits** node in the **Bridge Workspace** tree to open the **Stress Limit Sets – Concrete** window. Enter data shown above the **Compute** button, select the **Class F6** concrete 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

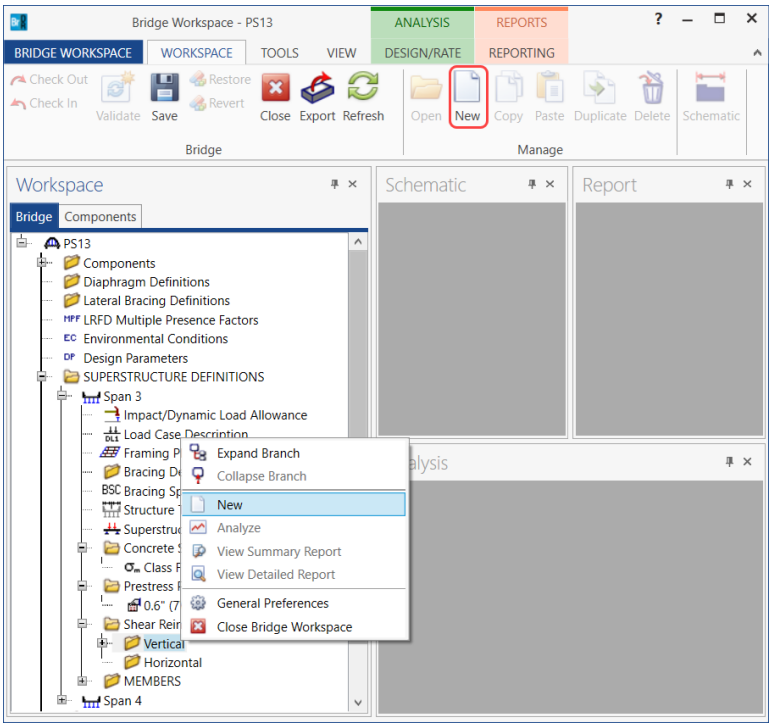
Double click on the **Prestress Properties** node in the **Bridge Workspace** tree to open the **Prestress Properties** window. Define the prestress properties as shown below. Since the **AASHTO Approximate** method is used to compute the losses, only the information on the **General P/S data** tab is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



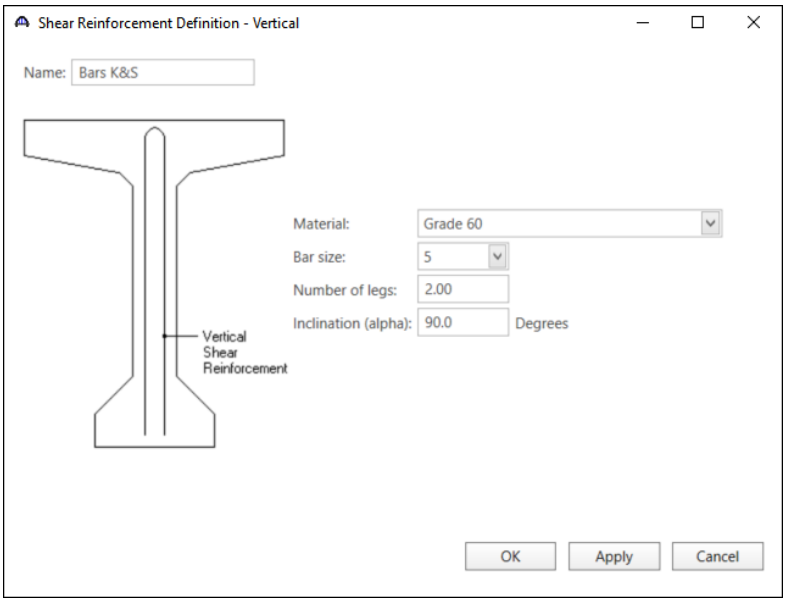
Click **OK** to apply the data and close the window.

Shear Reinforcement

Define shear reinforcement to be used for 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 right click on **Vertical** select **New)**.

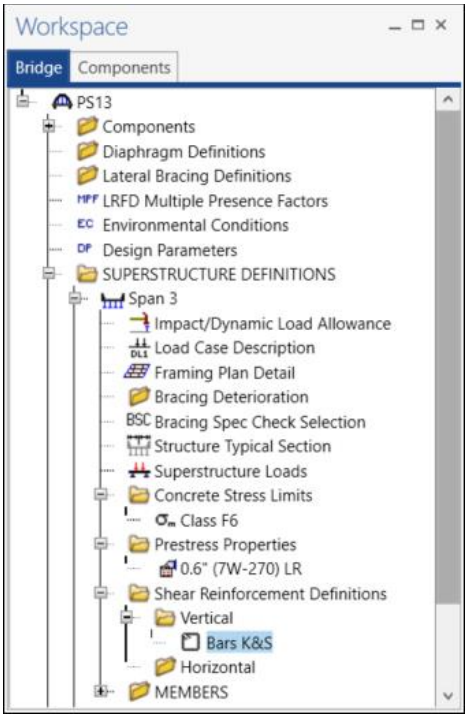


Define the stirrup as shown below.



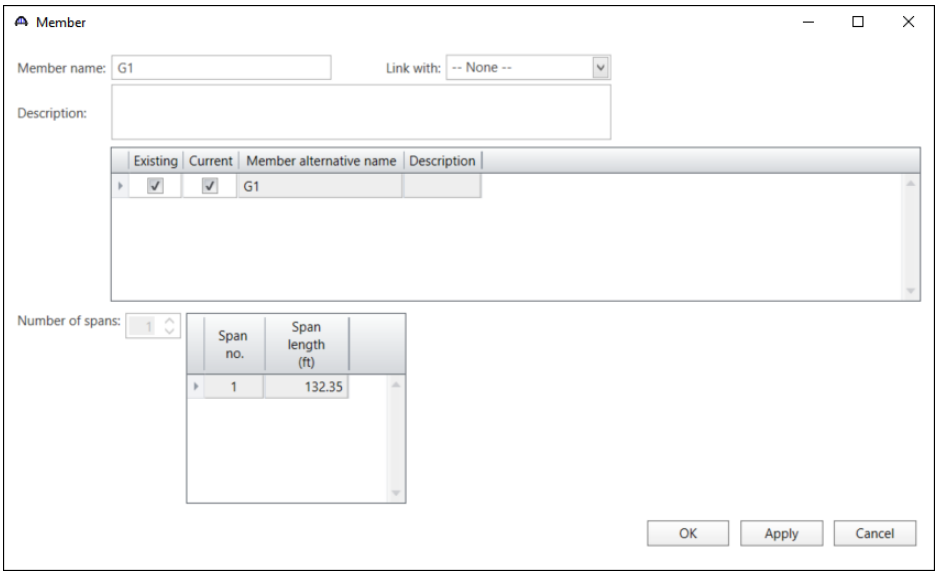
Click **OK** to apply the data and close the window.

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



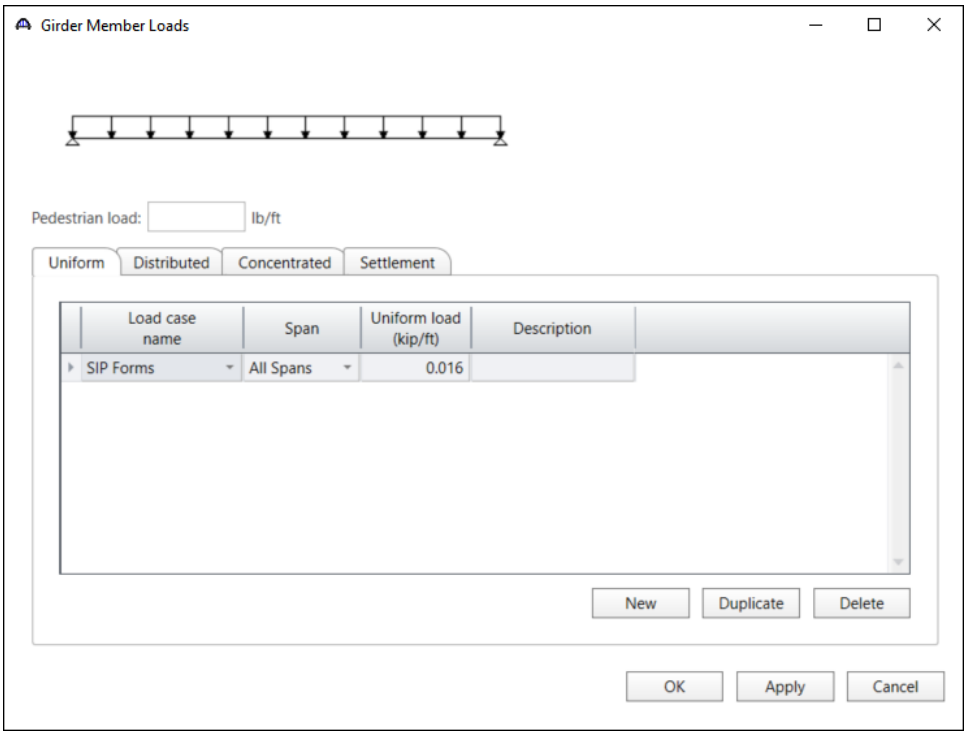
Describing a member

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



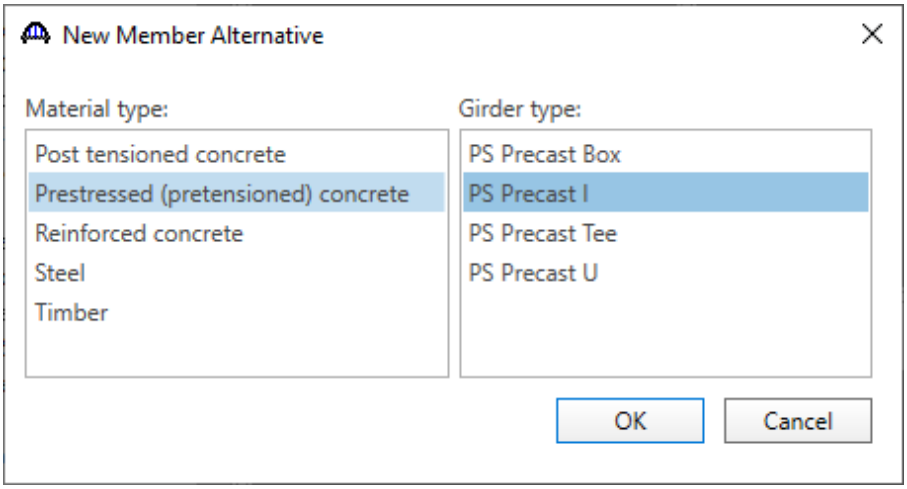
Member Loads

Double-click on the **Member Loads** node in the **Bridge Workspace** tree to open the **Girder Member Loads** window. Enter the **Uniform load** to account for the SIP forms.



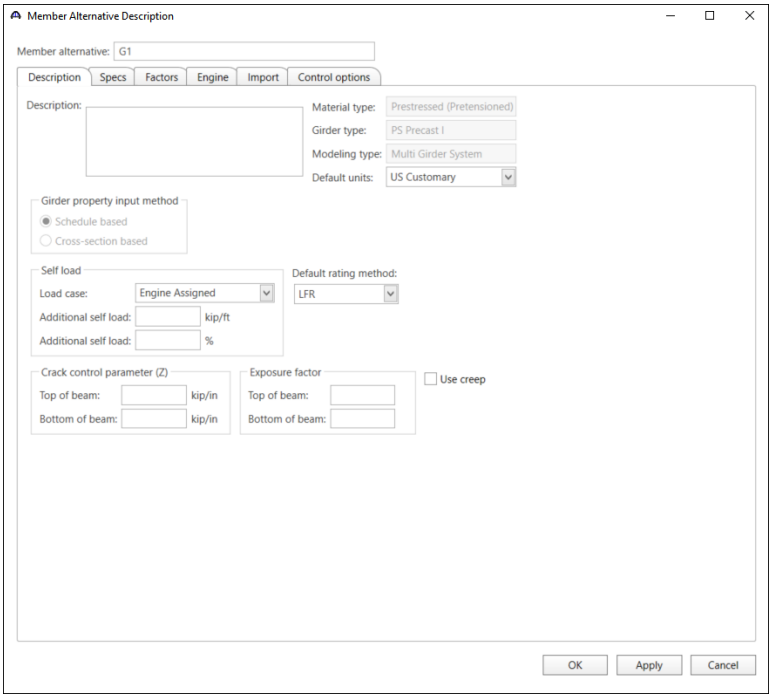
Defining a Member Alternative

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**.

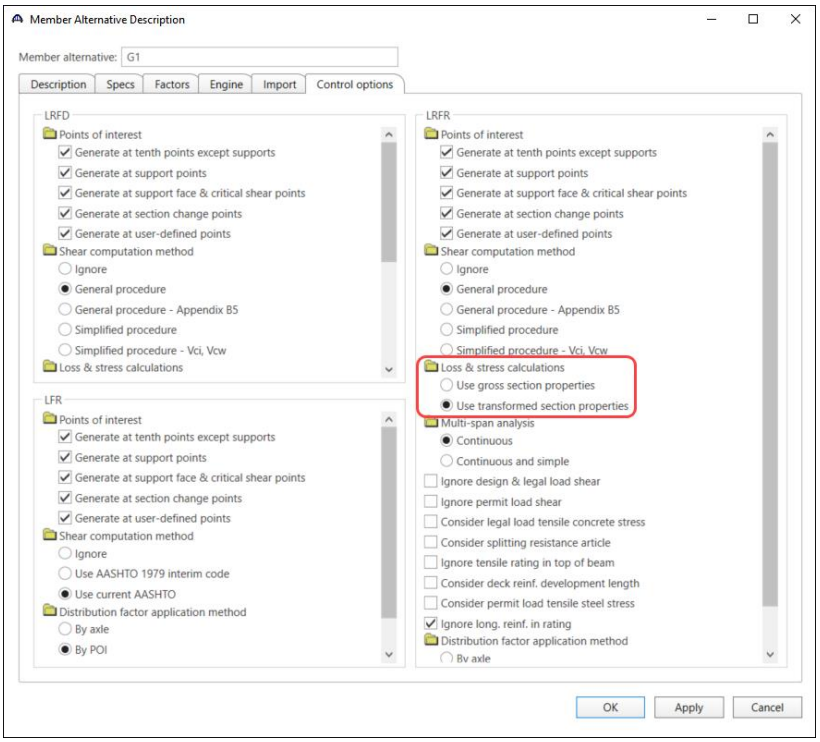


Click **OK** to close the window and create a new member alternative.

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



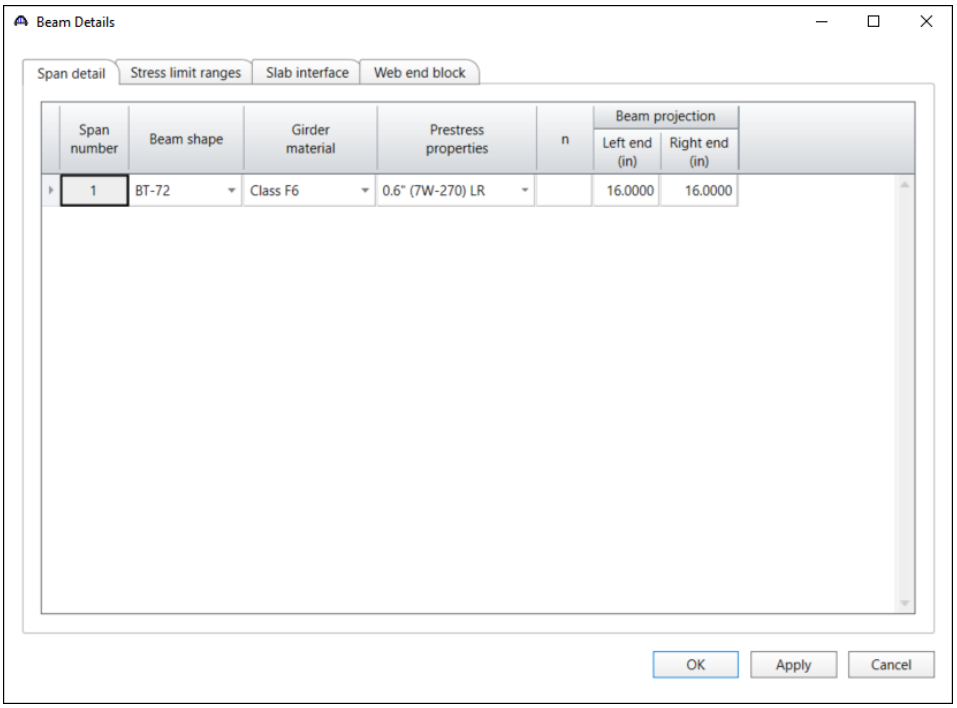
Navigate to the **Control options** tab and change the **Loss & stress calculations** to **Use transformed section properties** under **LRFR.**

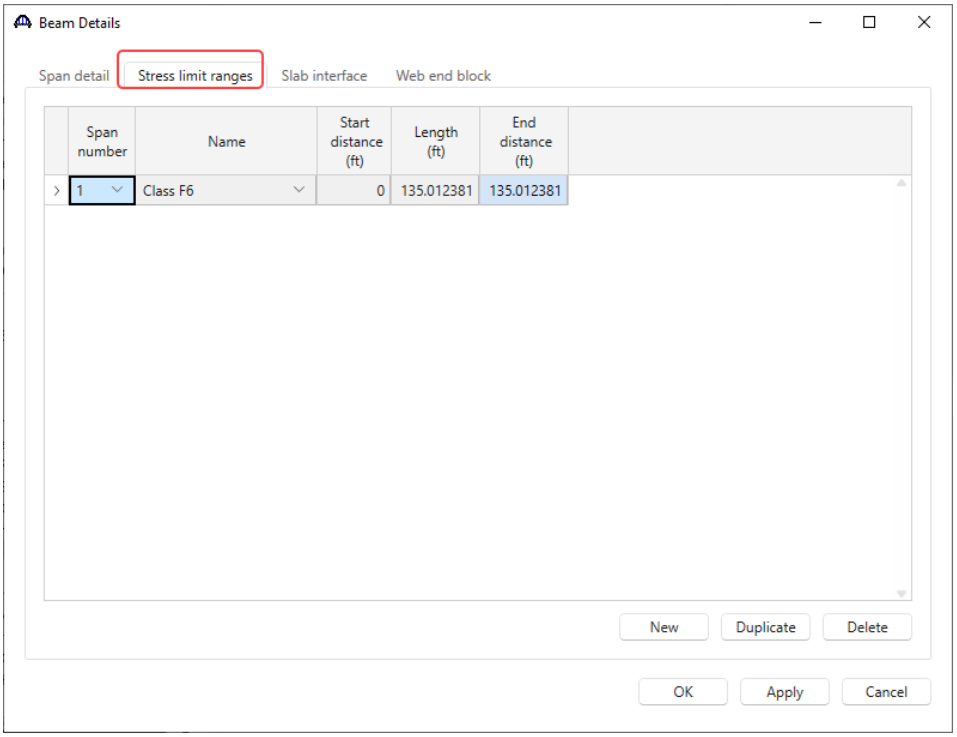


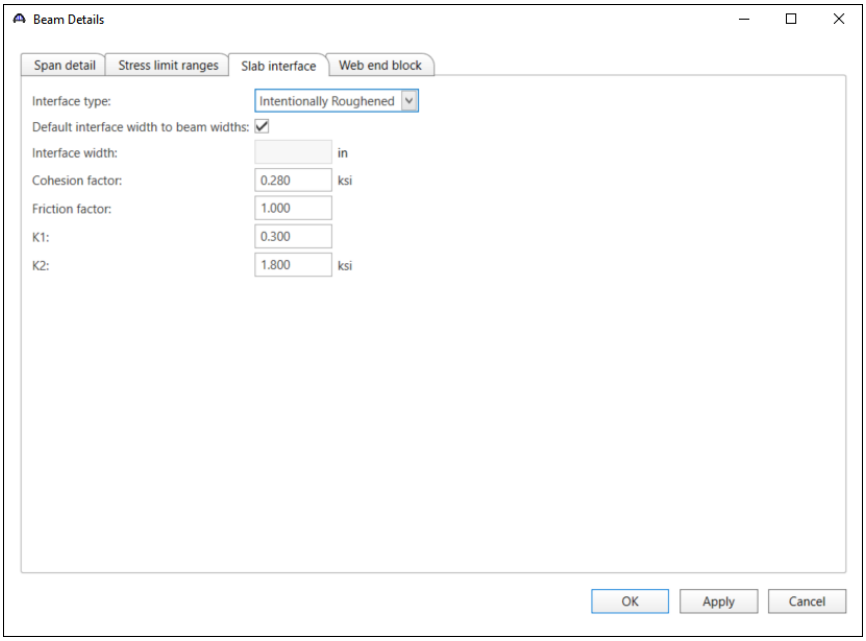
Click **OK** to close the window and create a new member alternative.

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.





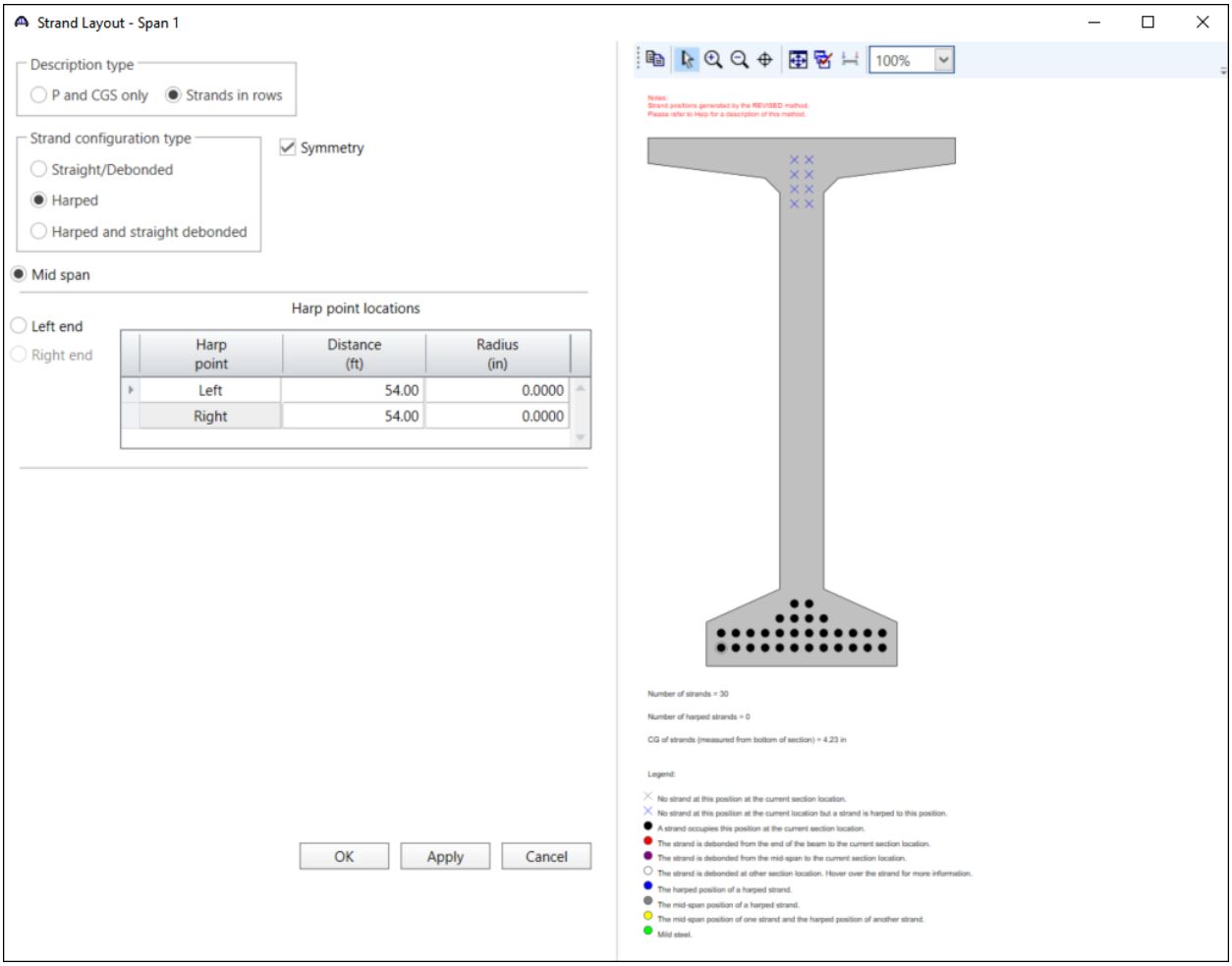


Click **OK** to apply the data and close the window.

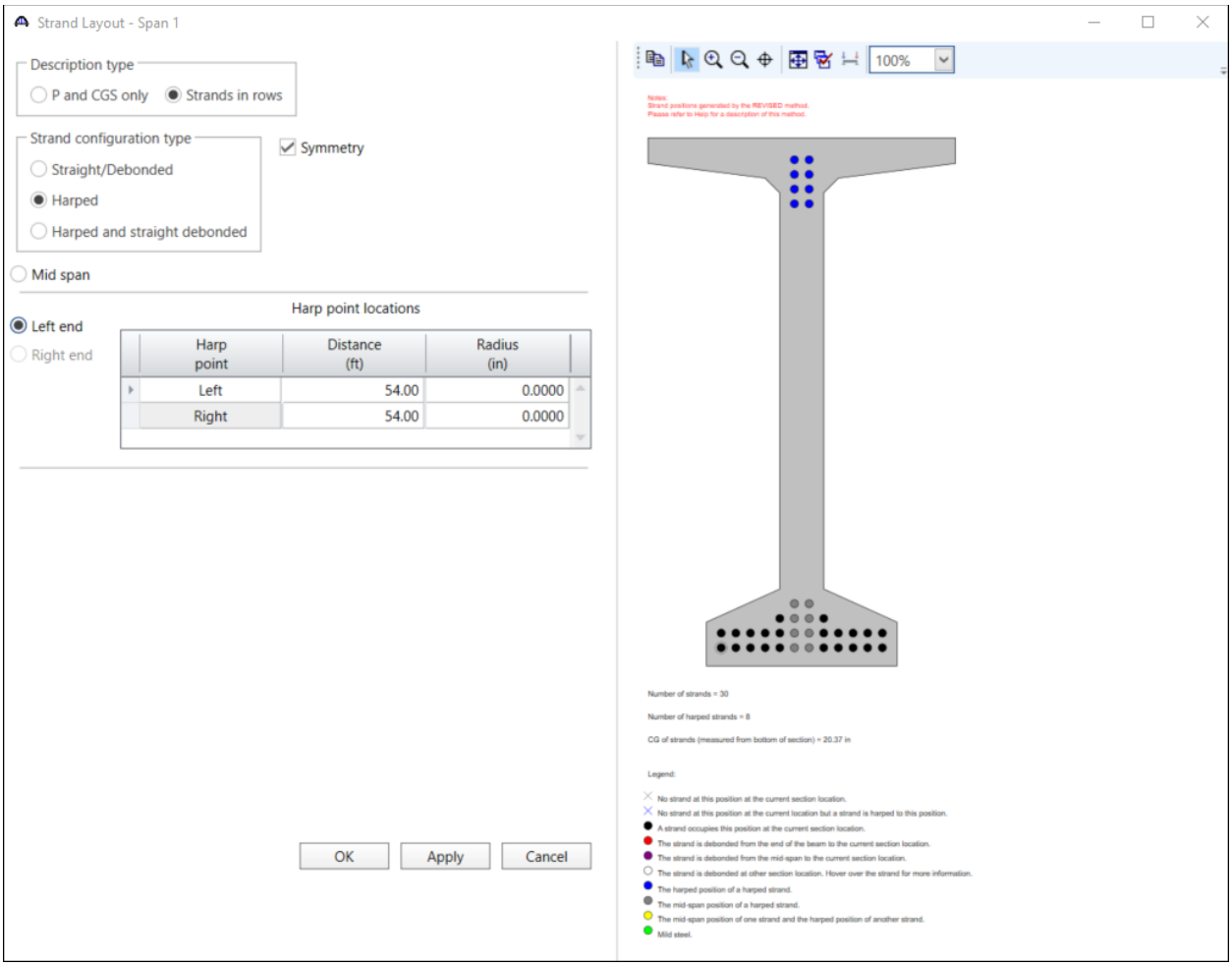
Strand Layout

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. Strands can now be defined at the middle of the span by selecting strands in the right hand schematic. Select the strands in the bottom flange of the schematic so that the CG of the strands is 4.23 inches.



Now select the **Left end** radio button to enter the harped strand locations at the left end of the precast beam. Place the cursor in the schematic view on the right side of the screen. The strands can be defined at the left end of the span by selecting strand locations in the right hand schematic. Select the top 8 strand locations in the schematic so that the CG of the strands is 20.37 inches.



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

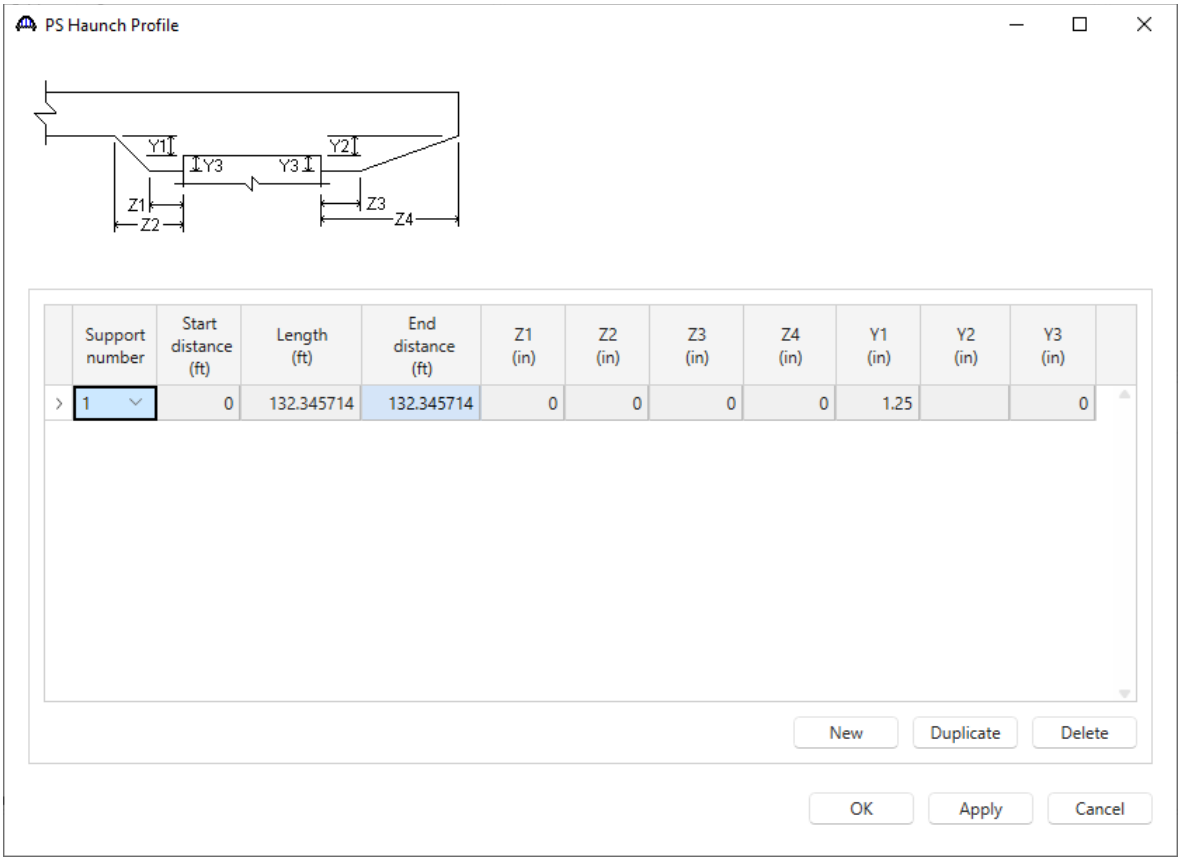
Deck Profile

This window needs to be revisited after the information for Beam 2-8 is entered.

No reinforcement is described.

Haunch Profile

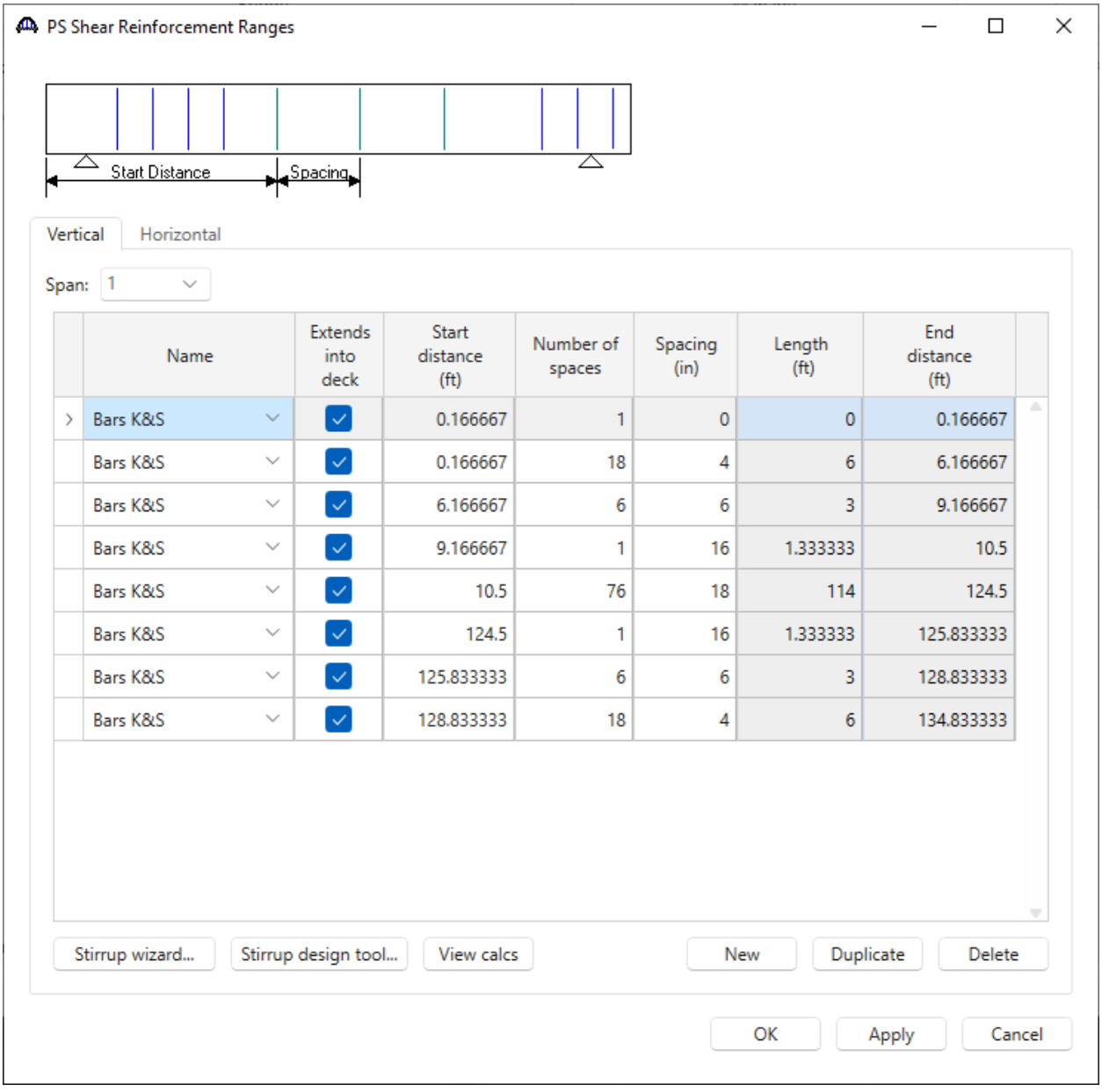
The haunch profile is defined by double-clicking on the **Haunch Profile** node in the **Bridge Workspace** tree. Enter data as shown below.



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

Shear Reinforcement Ranges

Double-click on the **Shear Reinforcement Ranges** node in the **Bridge Workspace** tree to open the **PS Shear Reinforcement Ranges** window. The Shear Reinforcement Ranges are entered as described below. The vertical shear reinforcement is defined as extending into the deck on the **Vertical** tab of this window. This indicates composite action between the beam and the deck. Data does not have to be entered on the **Horizontal** tab to indicate composite action since that has been defined by extending the vertical bars into the deck.



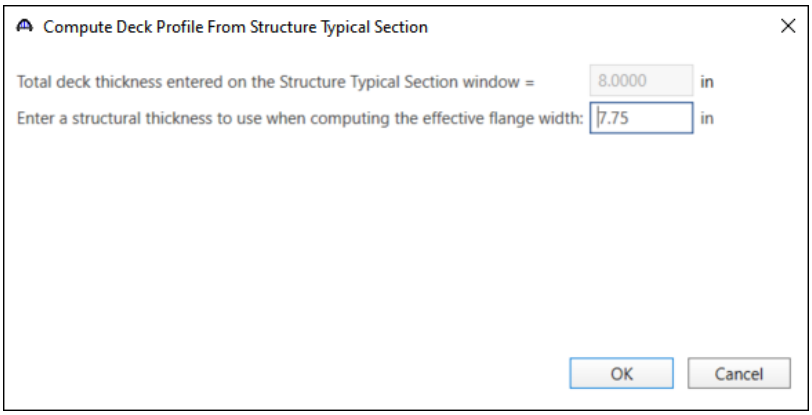
Click **OK** to apply the data and close the window.

The description of an exterior beam (except for the deck profile) for this structure definition is complete. Using the techniques used for Beam 1, enter the data for the remaining beams for Span 3.

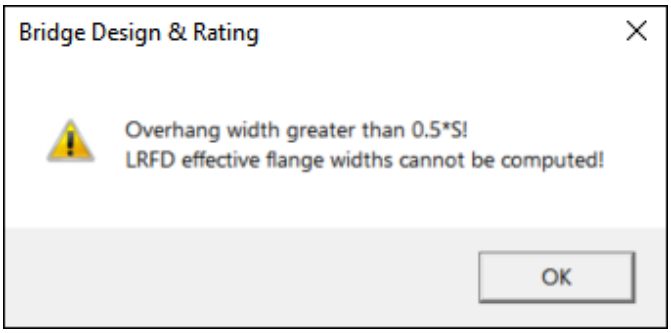
Beam No. ---	Span Length ft	Uniform Load k/ft	Beam Shape ---	Girder Material ---	Prestress Properties ---	Beam Projection		Stress Limit Range ft	Harp Point Location ft	Haunch Y1 in
						Left End in	Right End in			
G2	132.0632	0.032	BT-72	Class F6	0.6" (7W-270) LR	16	16	134.7299	53.8645	1.25
G3	132.0632	0.032	BT-72	Class F6	0.6" (7W-270) LR	16	16	134.7299	53.8645	1.25
G4	132.0632	0.032	BT-72	Class F6	0.6" (7W-270) LR	16	16	134.7299	53.8645	1.25
G5	132.0632	0.032	BT-72	Class F6	0.6" (7W-270) LR	16	16	134.7299	53.8645	1.25
G6	132.0632	0.032	BT-72	Class F6	0.6" (7W-270) LR	16	16	134.7299	53.8645	1.25
G7	132.0632	0.032	BT-72	Class F6	0.6" (7W-270) LR	16	16	134.7299	53.8645	1.25
G8	131.2993	0.016	BT-72	Class F6	0.6" (7W-270) LR	16	16	133.9660	53.4830	1.25

Deck Profile

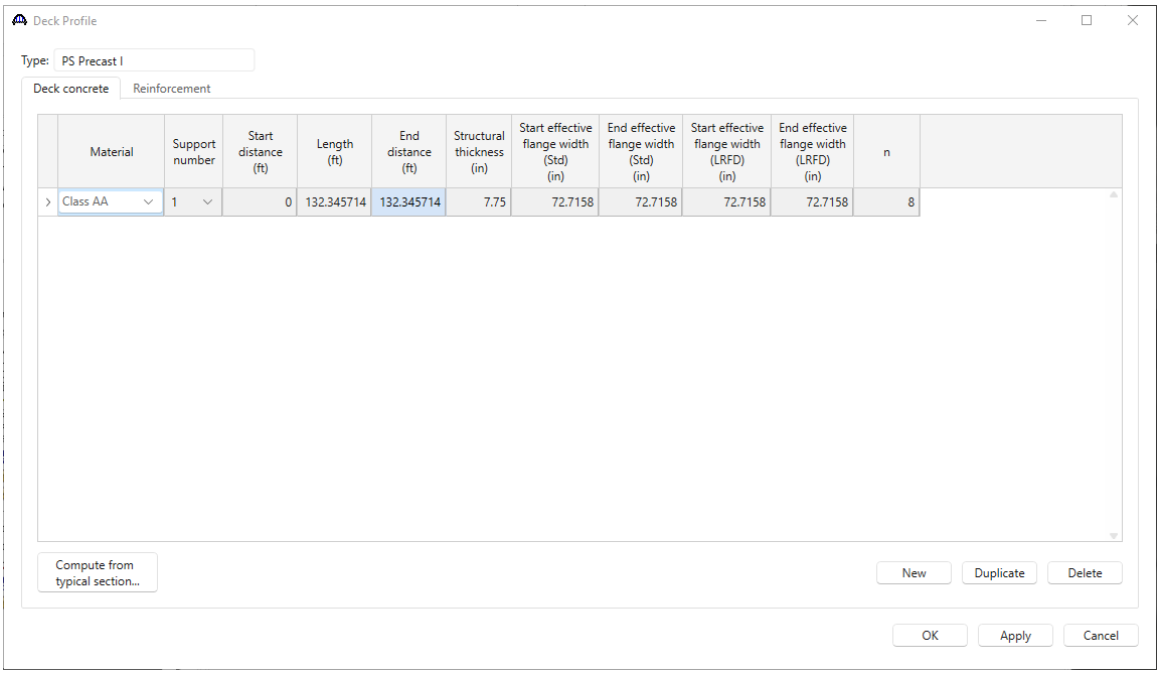
Next revisit the **Deck Profile** window by double-clicking the **Deck Profile** node in the **Bridge Workspace** tree for member **G1**. The window is shown below. Click the **Compute from typical section…** button to open the window as shown below. Enter the Structural thickness as shown below and click **OK.**



The following warning message will appear. This warning appears because the assumed constant overhang for the analysis is slightly larger than the limits per AASHTO C4.6.2.6.1 (0.5 * Beam Spacing).

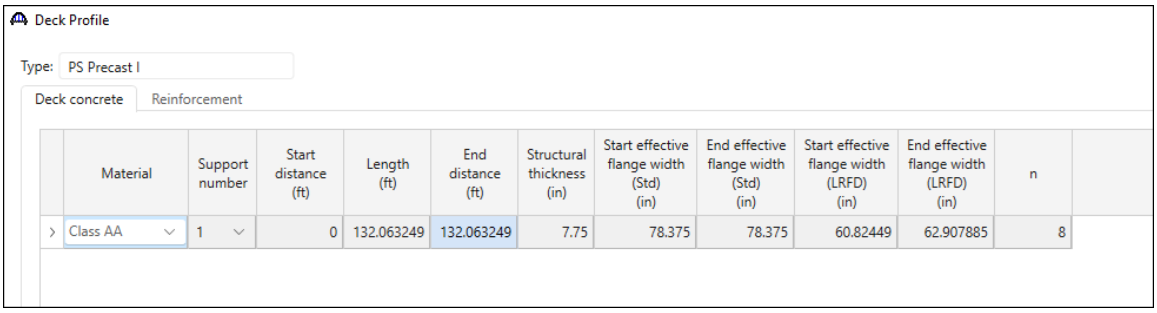


For this example, the user will enter the Std effective flange widths into the LRFD effective flange widths as shown below.

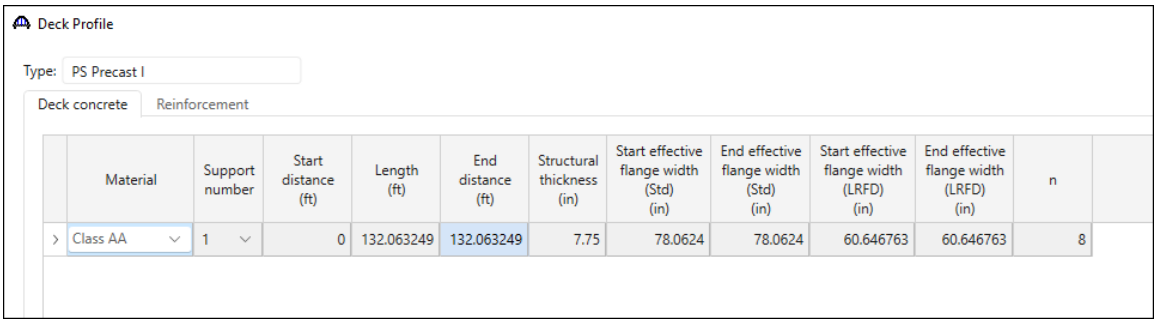


The **Deck Profile** windows for the remaining beams are shown below.

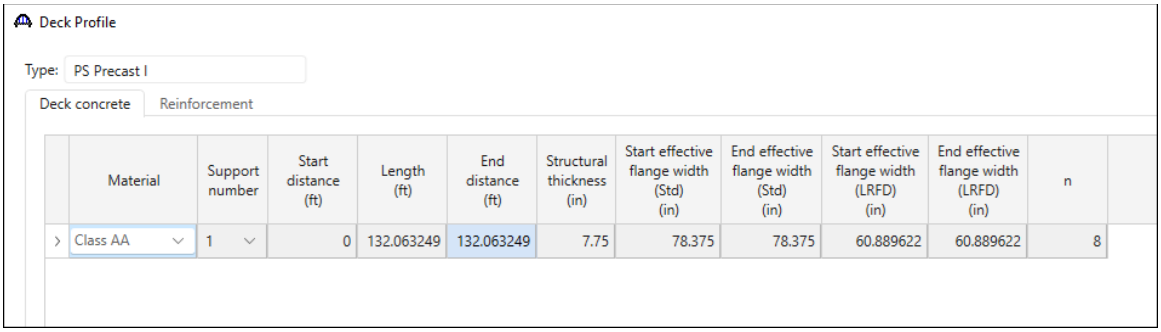
G2



G3



G4

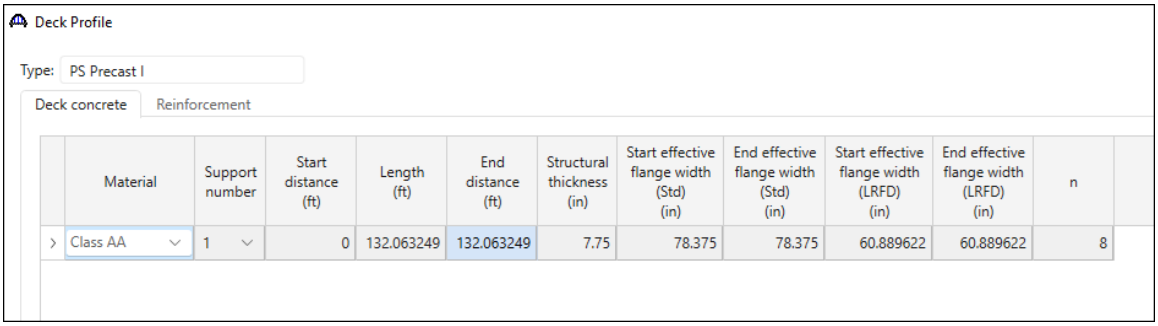

Deck Profile

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	1	0	132.063249	132.063249	7.75	78.375	78.375	60.889622	60.889622	8

G5

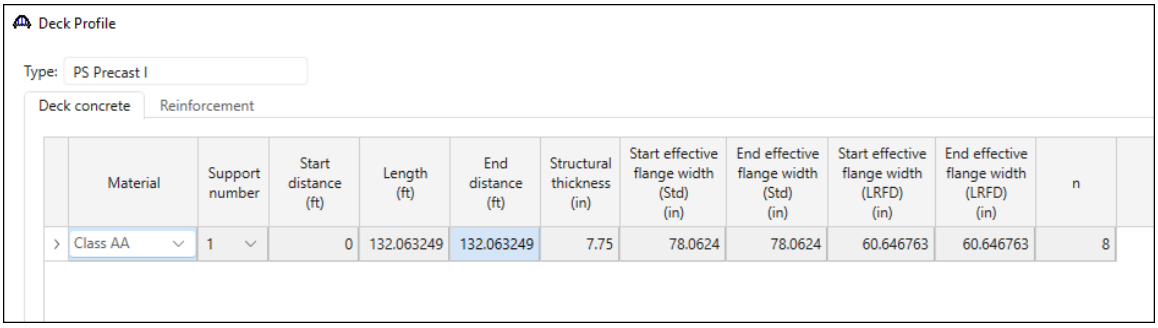

Deck Profile

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	1	0	132.063249	132.063249	7.75	78.375	78.375	60.889622	60.889622	8

G6

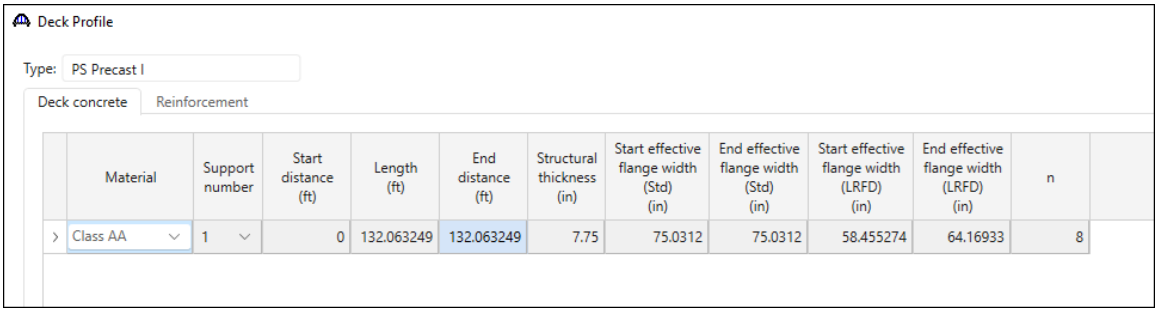

Deck Profile

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	1	0	132.063249	132.063249	7.75	78.0624	78.0624	60.646763	60.646763	8

G7

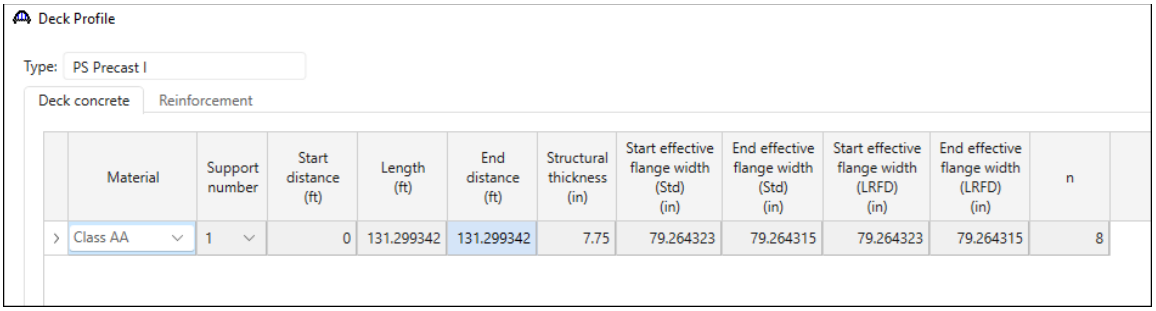

Deck Profile

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	1	0	132.063249	132.063249	7.75	75.0312	75.0312	58.455274	64.16933	8

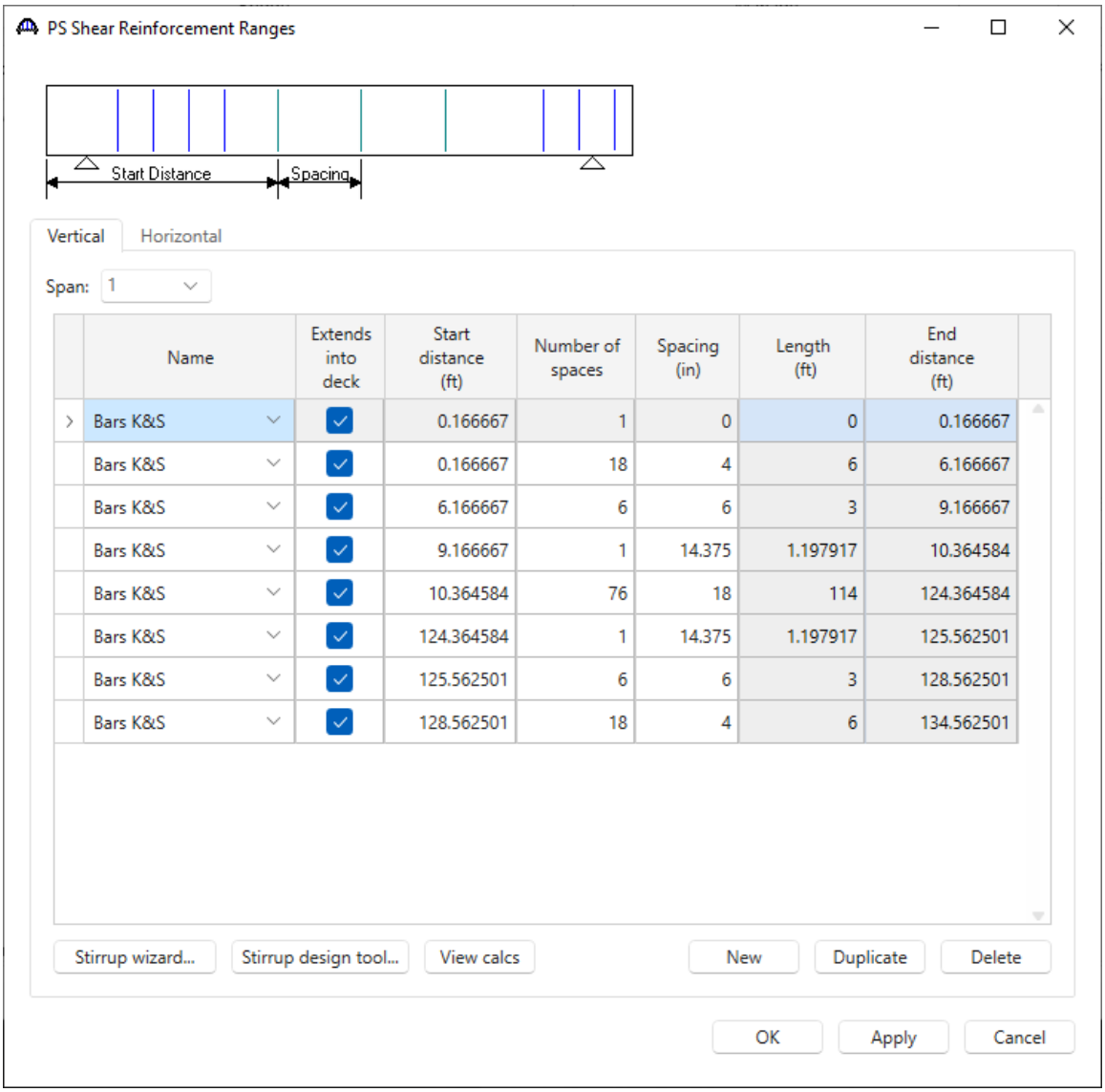
G8 (Note that the same warning message will appear as it did for G1. Enter the Std values for LRFD values)



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	1	0	131.299342	131.299342	7.75	79.264323	79.264315	79.264323	79.264315	8

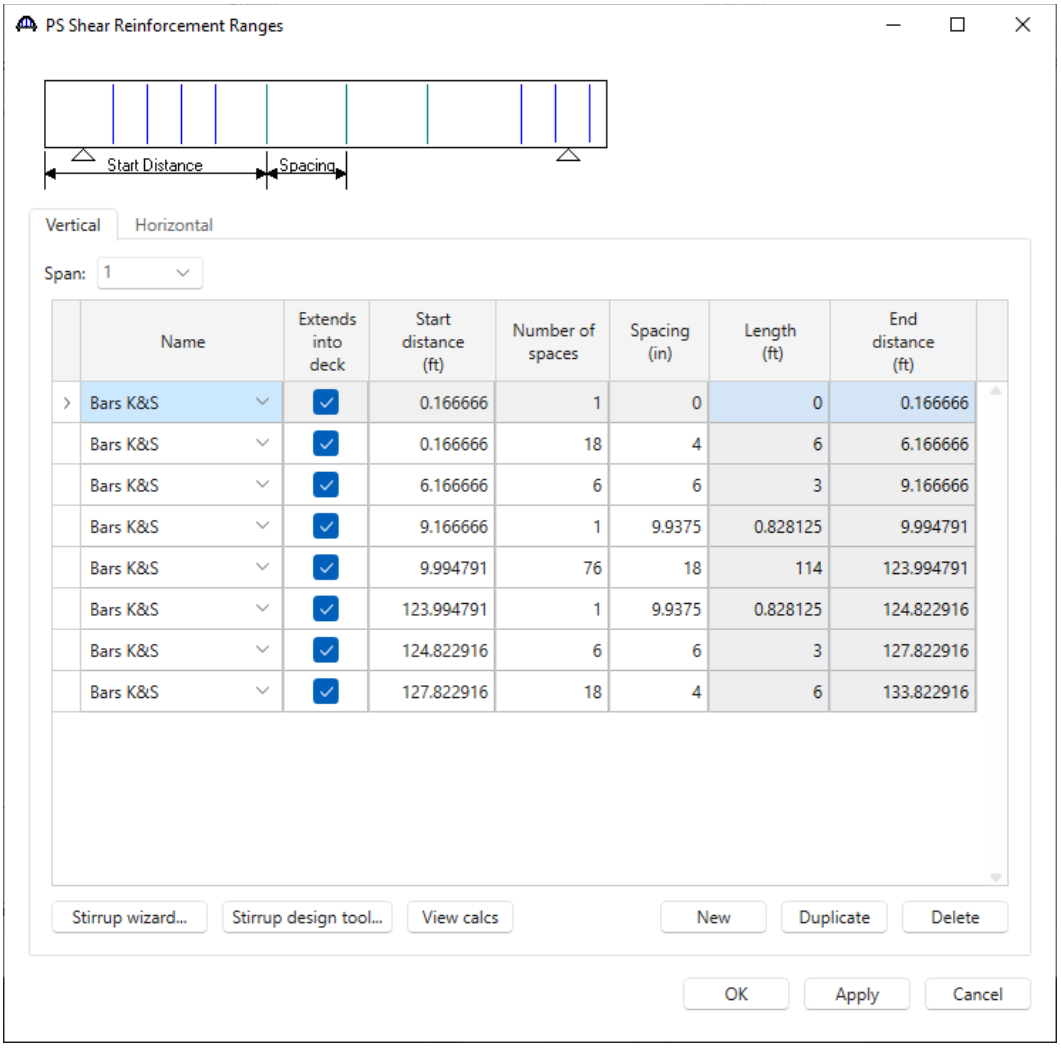
Shear Reinforcement Ranges for other members

G2-G7

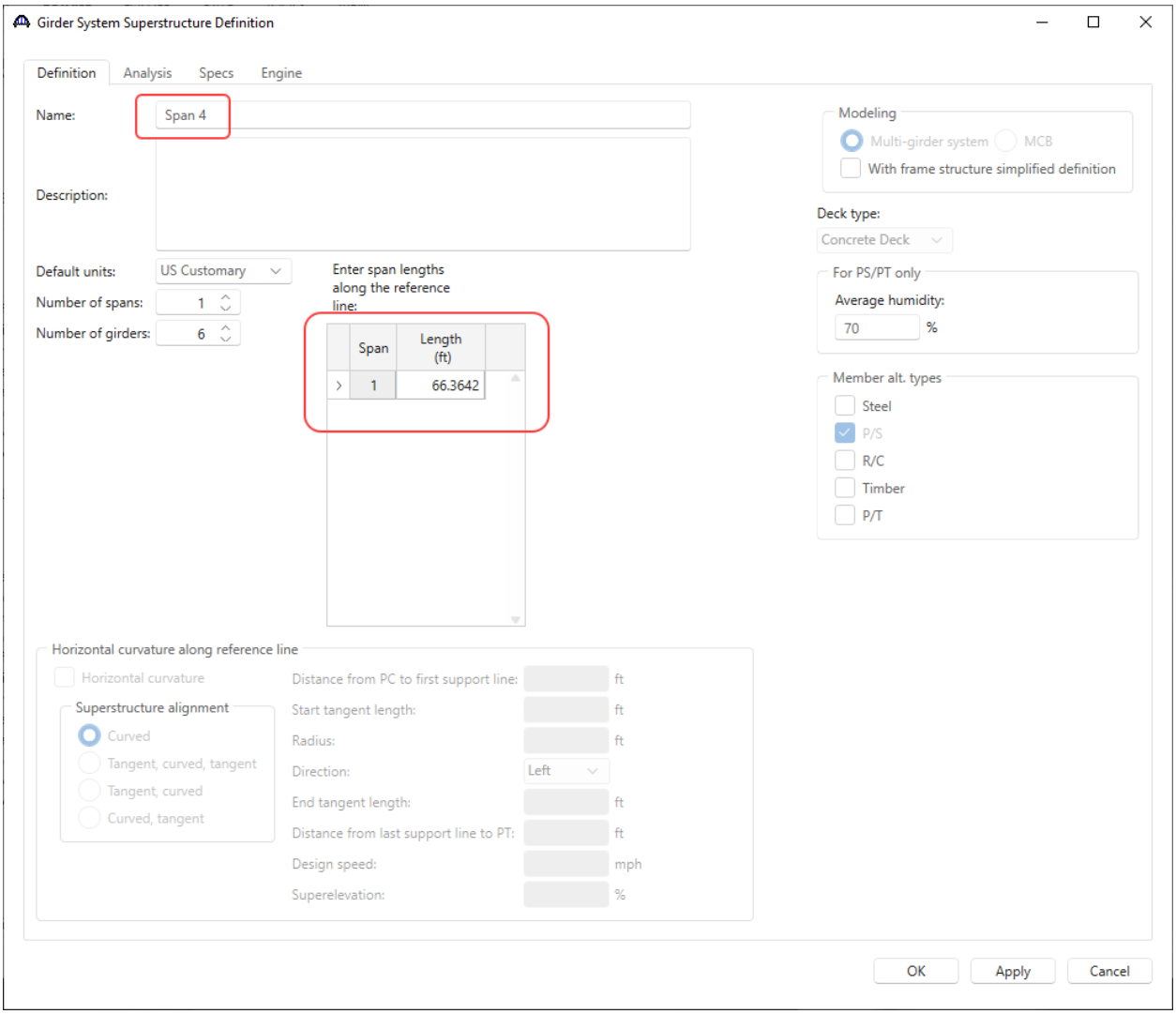


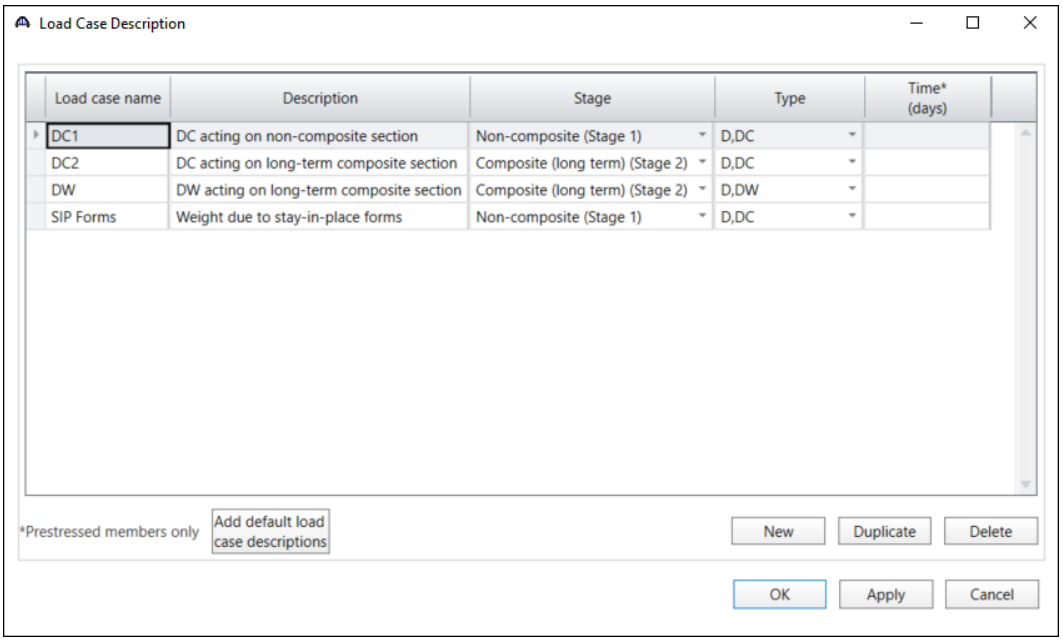
Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
Bars K&S	✓	0.166667	1	0	0	0.166667
Bars K&S	✓	0.166667	18	4	6	6.166667
Bars K&S	✓	6.166667	6	6	3	9.166667
Bars K&S	✓	9.166667	1	14.375	1.197917	10.364584
Bars K&S	✓	10.364584	76	18	114	124.364584
Bars K&S	✓	124.364584	1	14.375	1.197917	125.562501
Bars K&S	✓	125.562501	6	6	3	128.562501
Bars K&S	✓	128.562501	18	4	6	134.562501

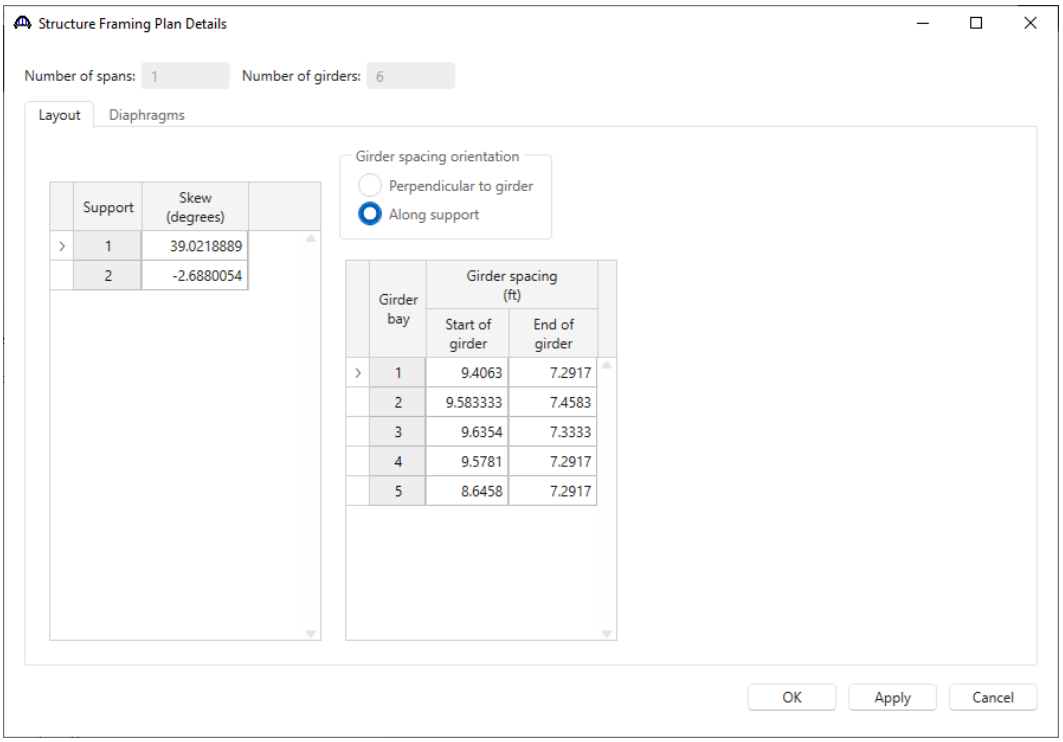
G8

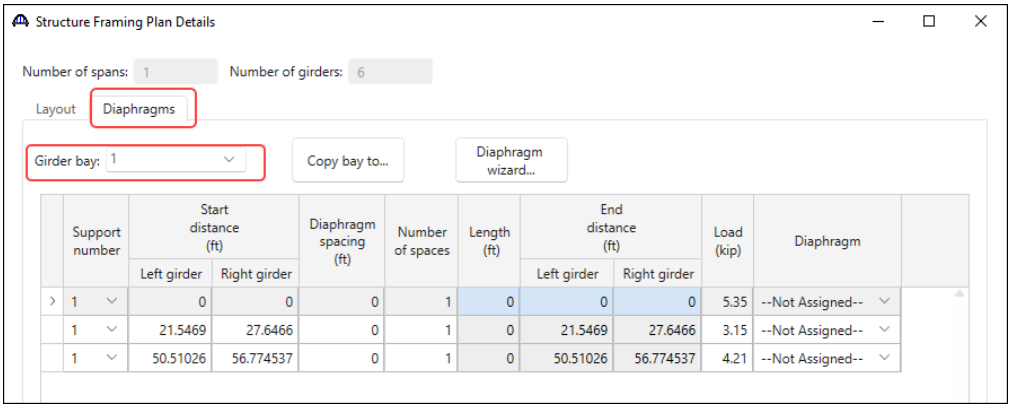

PS Shear Reinforcement Ranges
Start Distance
Spacing
Vertical
Horizontal
Span: 1
Name
Extends into deck
Start distance (ft)
Number of spaces
Spacing (in)
Length (ft)
End distance (ft)
Bars K&S 0.166666 1 0 0 0.166666
Bars K&S 0.166666 18 4 6 6.166666
Bars K&S 6.166666 6 6 3 9.166666
Bars K&S 9.166666 1 9.9375 0.828125 9.994791
Bars K&S 9.994791 76 18 114 123.994791
Bars K&S 123.994791 1 9.9375 0.828125 124.822916
Bars K&S 124.822916 6 6 3 127.822916
Bars K&S 127.822916 18 4 6 133.822916
Stirrup wizard...
Stirrup design tool...
View calcs
New
Duplicate
Delete
OK
Apply
Cancel

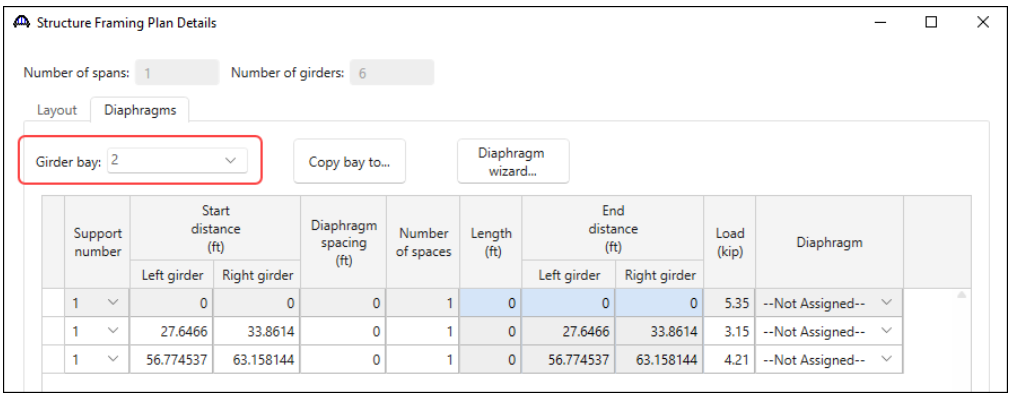
Once the input for Span 3 is complete, create Span 4 in a similar manner. The required superstructure input screens and member input data are shown below.

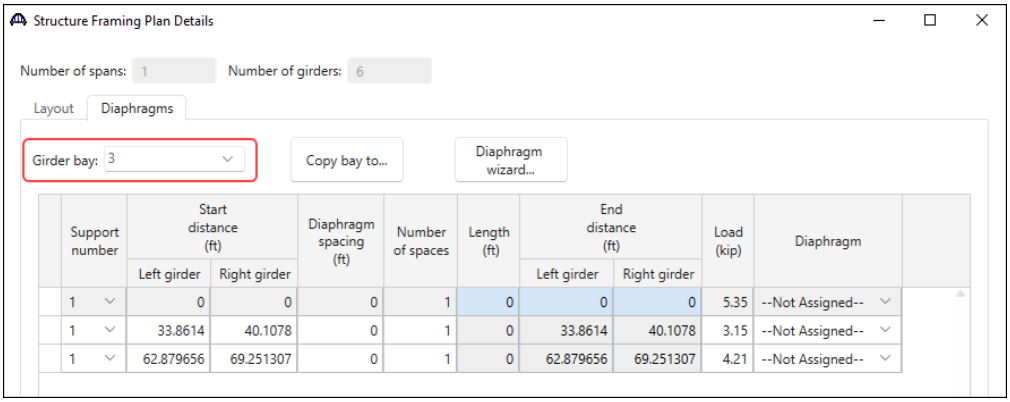


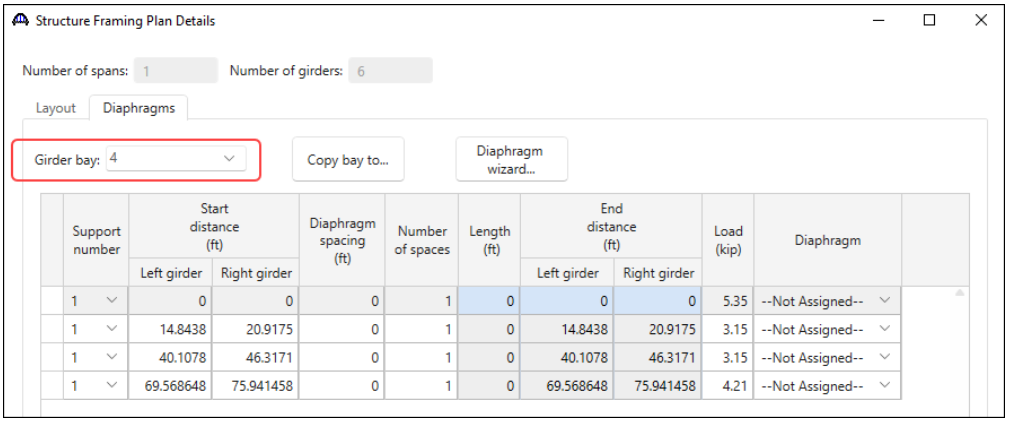

Load Case Description
Load case name
Description
Stage
Type
Time* (days)
DC1
DC acting on non-composite section
Non-composite (Stage 1)
D,DC
DC2
DC acting on long-term composite section
Composite (long term) (Stage 2)
D,DC
DW
DW acting on long-term composite section
Composite (long term) (Stage 2)
D,DW
SIP Forms
Weight due to stay-in-place forms
Non-composite (Stage 1)
D,DC
*Prestressed members only
Add default load case descriptions
New
Duplicate
Delete
OK
Apply
Cancel

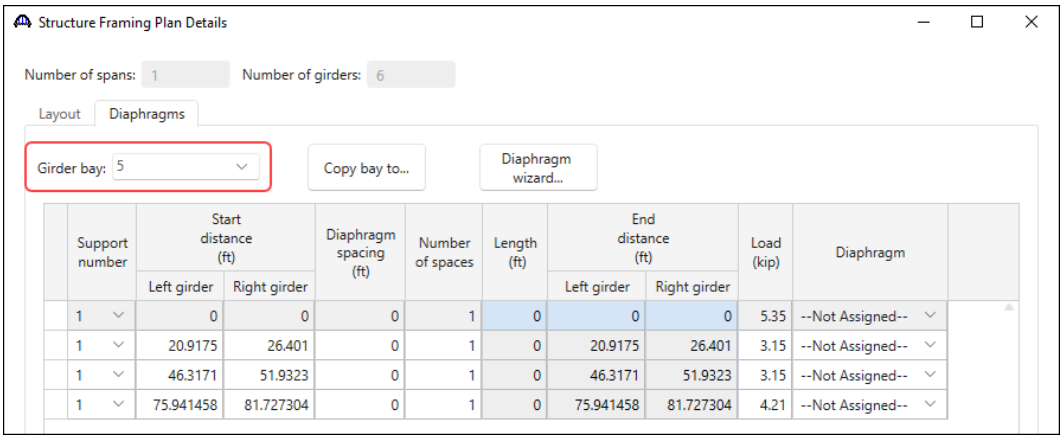

Structure Framing Plan Details
Number of spans: 1
Number of girders: 6
Layout
Diaphragms
Support
Skew (degrees)
1
39.0218889
2
-2.6880054
Girder spacing orientation
Perpendicular to girder
Along support
Girder bay
Girder spacing (ft)
Start of girder
End of girder
1
9.4063
7.2917
2
9.583333
7.4583
3
9.6354
7.3333
4
9.5781
7.2917
5
8.6458
7.2917
OK
Apply
Cancel

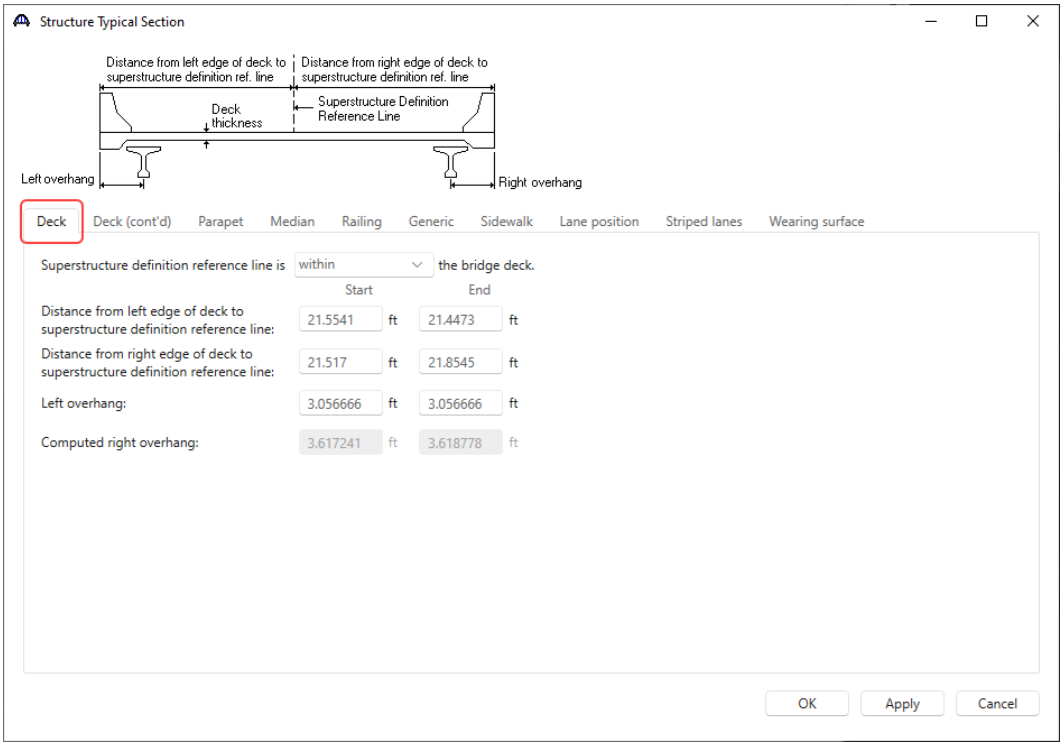

Structure Framing Plan Details
Number of spans: 1
Number of girders: 6
Layout
Diaphragms
Girder bay: 1
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.35 --Not Assigned--
1 21.5469 27.6466 0 1 0 21.5469 27.6466 3.15 --Not Assigned--
1 50.51026 56.774537 0 1 0 50.51026 56.774537 4.21 --Not Assigned--

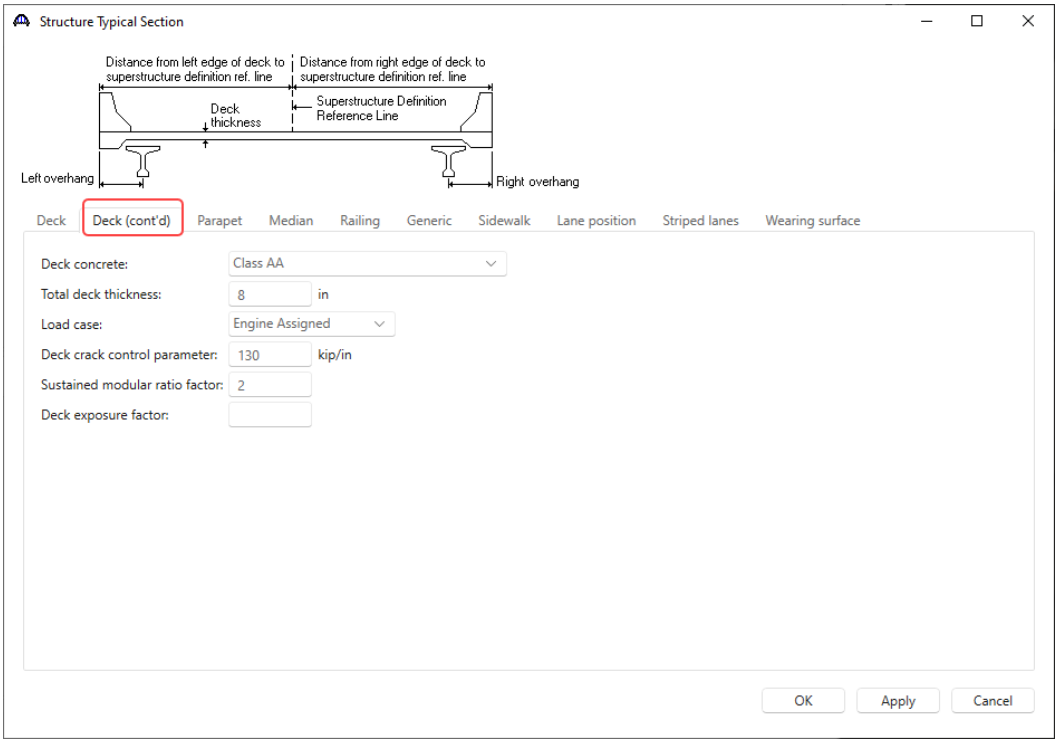

Structure Framing Plan Details
Number of spans: 1
Number of girders: 6
Layout
Diaphragms
Girder bay: 2
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.35 --Not Assigned--
1 27.6466 33.8614 0 1 0 27.6466 33.8614 3.15 --Not Assigned--
1 56.774537 63.158144 0 1 0 56.774537 63.158144 4.21 --Not Assigned--

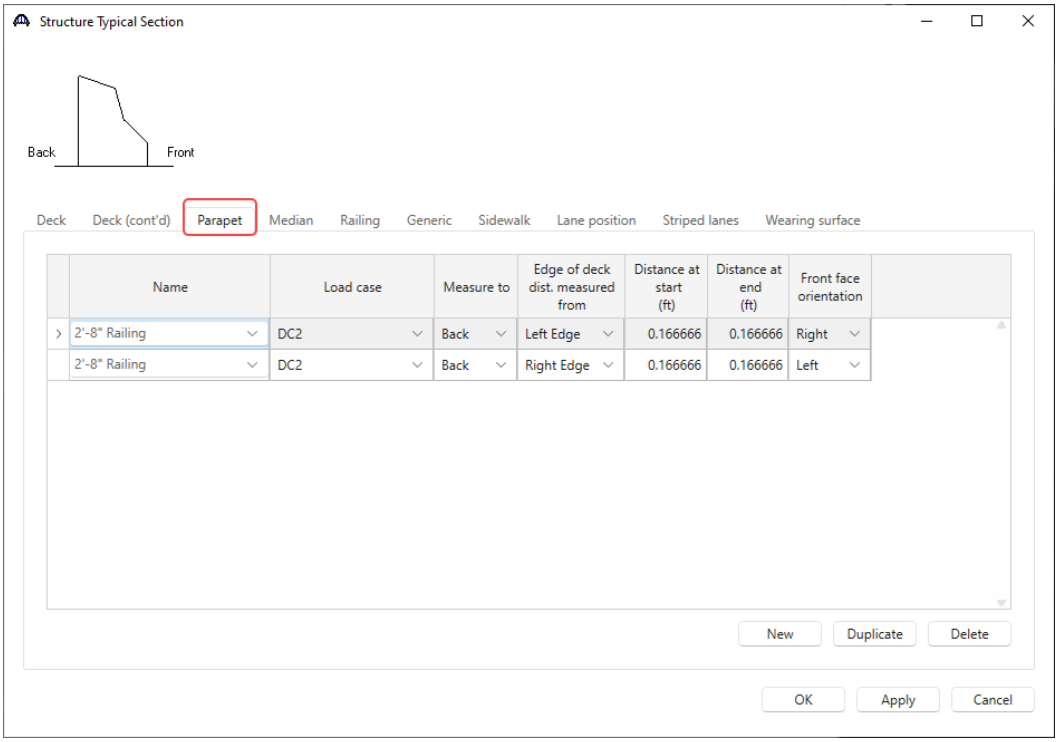

Structure Framing Plan Details
Number of spans: 1
Number of girders: 6
Layout
Diaphragms
Girder bay: 3
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.35 --Not Assigned--
1 33.8614 40.1078 0 1 0 33.8614 40.1078 3.15 --Not Assigned--
1 62.879656 69.251307 0 1 0 62.879656 69.251307 4.21 --Not Assigned--

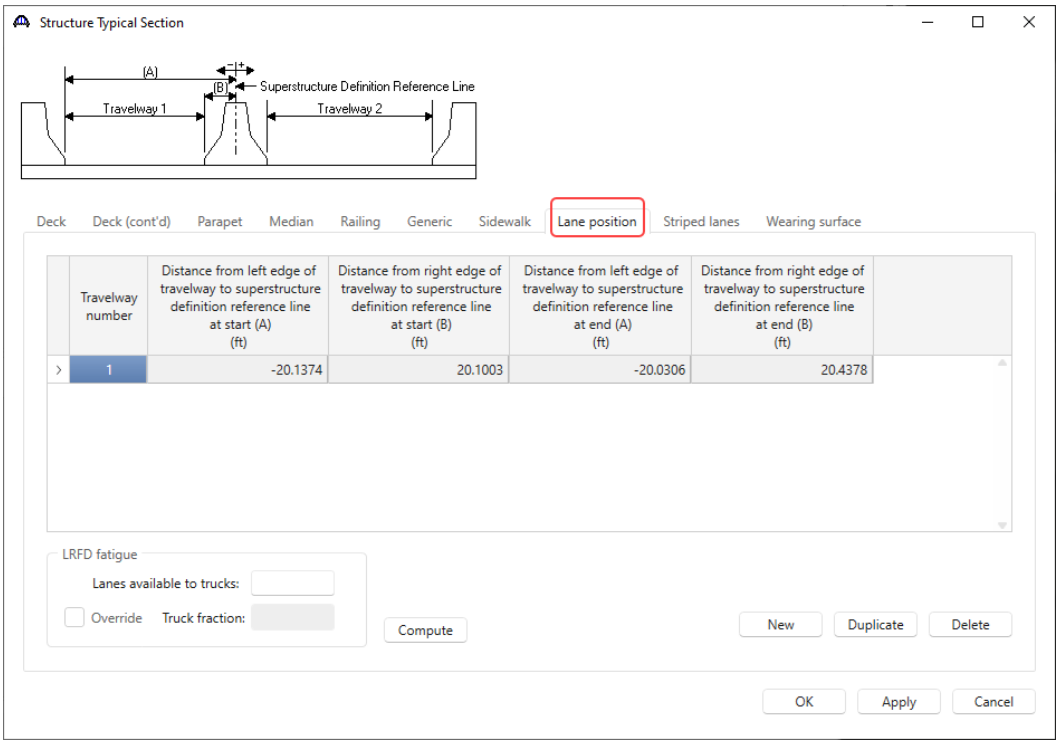

Structure Framing Plan Details
Number of spans: 1
Number of girders: 6
Layout
Diaphragms
Girder bay: 4
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.35 --Not Assigned--
1 14.8438 20.9175 0 1 0 14.8438 20.9175 3.15 --Not Assigned--
1 40.1078 46.3171 0 1 0 40.1078 46.3171 3.15 --Not Assigned--
1 69.568648 75.941458 0 1 0 69.568648 75.941458 4.21 --Not Assigned--

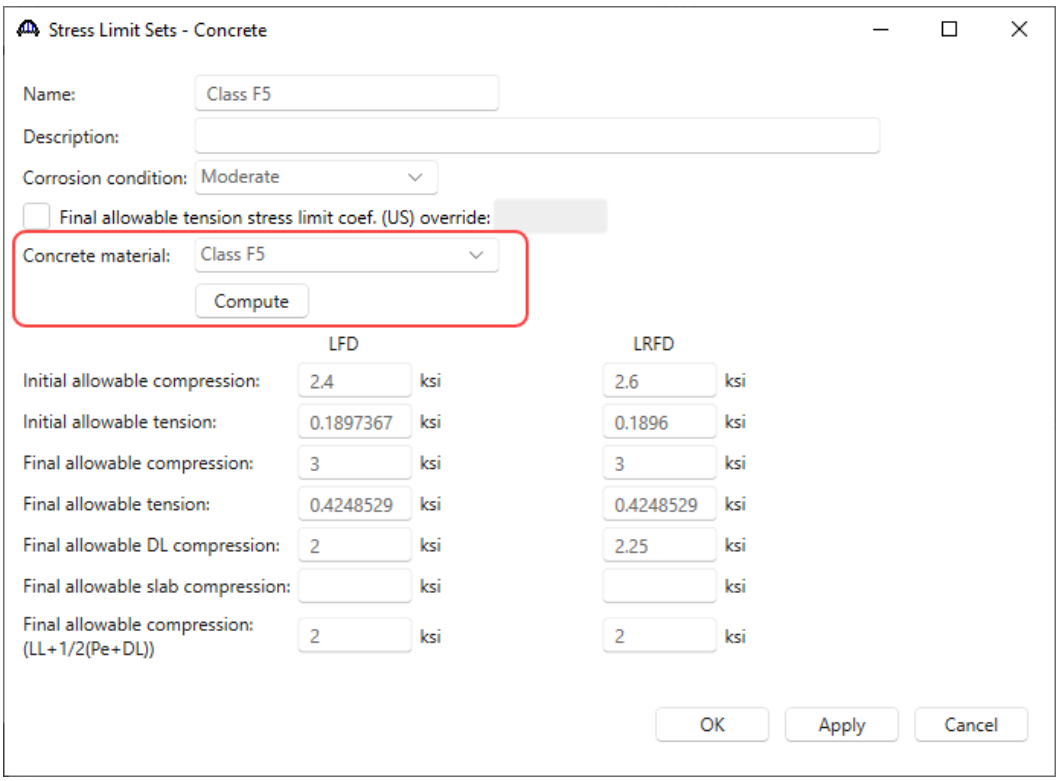

Structure Framing Plan Details
Number of spans: 1
Number of girders: 6
Layout
Diaphragms
Girder bay: 5
Copy bay to...
Diaphragm wizard...
Support number
Start distance (ft)
Left girder
Right girder
Diaphragm spacing (ft)
Number of spaces
Length (ft)
End distance (ft)
Left girder
Right girder
Load (kip)
Diaphragm
1 0 0 0 1 0 0 0 5.35 --Not Assigned--
1 20.9175 26.401 0 1 0 20.9175 26.401 3.15 --Not Assigned--
1 46.3171 51.9323 0 1 0 46.3171 51.9323 3.15 --Not Assigned--
1 75.941458 81.727304 0 1 0 75.941458 81.727304 4.21 --Not Assigned--

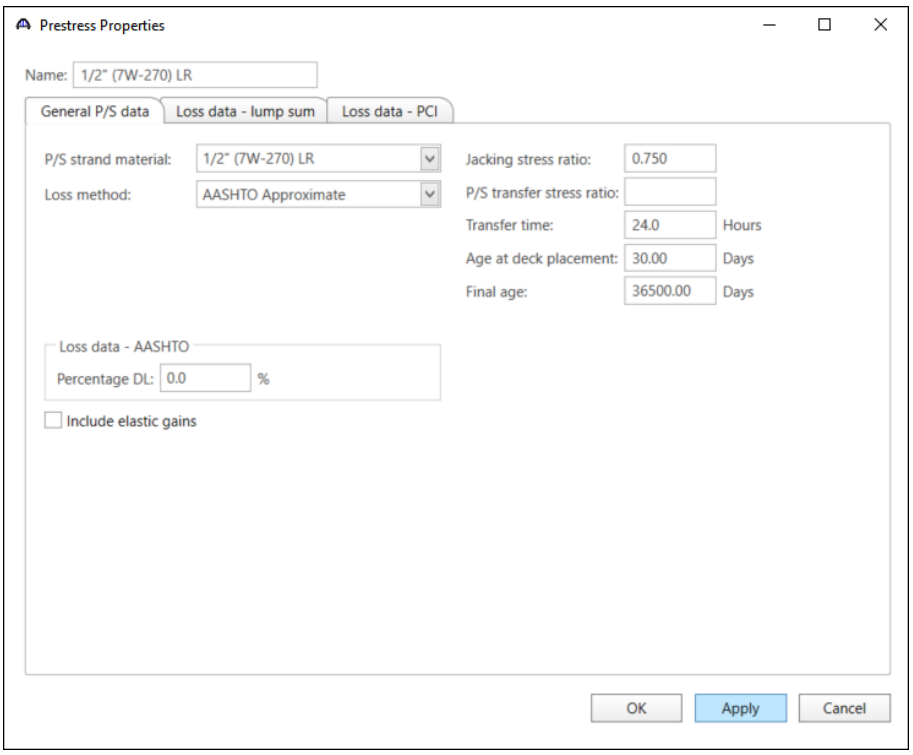

Structure Typical Section
Distance from left edge of deck to superstructure definition ref. line
Distance from right edge of deck to superstructure definition ref. line
Deck thickness
Superstructure Definition Reference Line
Left overhang
Right overhang
Deck
Deck (cont'd)
Parapet
Median
Railing
Generic
Sidewalk
Lane position
Striped lanes
Wearing surface
Superstructure definition reference line is within the bridge deck.
Start
End
Distance from left edge of deck to superstructure definition reference line: 21.5541 ft 21.4473 ft
Distance from right edge of deck to superstructure definition reference line: 21.517 ft 21.8545 ft
Left overhang: 3.056666 ft 3.056666 ft
Computed right overhang: 3.617241 ft 3.618778 ft
OK
Apply
Cancel

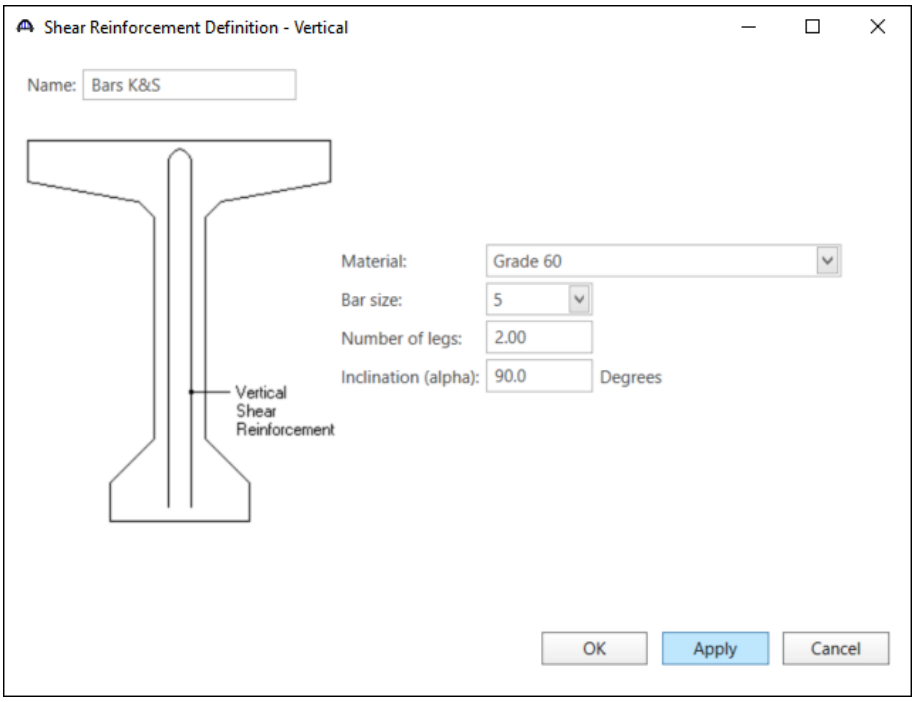

Structure Typical Section
Distance from left edge of deck to superstructure definition ref. line
Distance from right edge of deck to superstructure definition ref. line
Deck thickness
Superstructure Definition Reference Line
Left overhang
Right overhang
Deck
Deck (cont'd)
Parapet
Median
Railing
Generic
Sidewalk
Lane position
Striped lanes
Wearing surface
Deck concrete:
Class AA
Total deck thickness:
8
in
Load case:
Engine Assigned
Deck crack control parameter:
130
kip/in
Sustained modular ratio factor:
2
Deck exposure factor:
OK
Apply
Cancel


Structure Typical Section
Back
Front
Deck
Deck (cont'd)
Parapet
Median
Railing
Generic
Sidewalk
Lane position
Striped lanes
Wearing surface
Name
Load case
Measure to
Edge of deck dist. measured from
Distance at start (ft)
Distance at end (ft)
Front face orientation
2'-8" Railing
DC2
Back
Left Edge
0.166666
0.166666
Right
2'-8" Railing
DC2
Back
Right Edge
0.166666
0.166666
Left
New
Duplicate
Delete
OK
Apply
Cancel


Structure Typical Section
(A)
(B)
Superstructure Definition Reference Line
Travelway 1
Travelway 2
Deck
Deck (cont'd)
Parapet
Median
Railing
Generic
Sidewalk
Lane position
Striped lanes
Wearing surface
Travelway number
Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)
Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)
Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)
Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)
1
-20.1374
20.1003
-20.0306
20.4378
LRFD fatigue
Lanes available to trucks:
Override
Truck fraction:
Compute
New
Duplicate
Delete
OK
Apply
Cancel


Stress Limit Sets - Concrete
Name:
Class F5
Description:
Corrosion condition:
Moderate
Final allowable tension stress limit coef. (US) override:
Concrete material:
Class F5
Compute
LFD
LRFD
Initial allowable compression:
2.4
ksi
2.6
ksi
Initial allowable tension:
0.1897367
ksi
0.1896
ksi
Final allowable compression:
3
ksi
3
ksi
Final allowable tension:
0.4248529
ksi
0.4248529
ksi
Final allowable DL compression:
2
ksi
2.25
ksi
Final allowable slab compression:
ksi
ksi
Final allowable compression: (LL+1/2(Pe+DL))
2
ksi
2
ksi
OK
Apply
Cancel


Prestress Properties
Name: 1/2" (7W-270) LR
General P/S data
Loss data - lump sum
Loss data - PCI
P/S strand material: 1/2" (7W-270) LR
Loss method: AASHTO Approximate
Jacking stress ratio: 0.750
P/S transfer stress ratio:
Transfer time: 24.0 Hours
Age at deck placement: 30.00 Days
Final age: 36500.00 Days
Loss data - AASHTO
Percentage DL: 0.0 %
Include elastic gains
OK
Apply
Cancel


Shear Reinforcement Definition - Vertical
Name: Bars K&S
Material: Grade 60
Bar size: 5
Number of legs: 2.00
Inclination (alpha): 90.0 Degrees
Vertical Shear Reinforcement
OK
Apply
Cancel

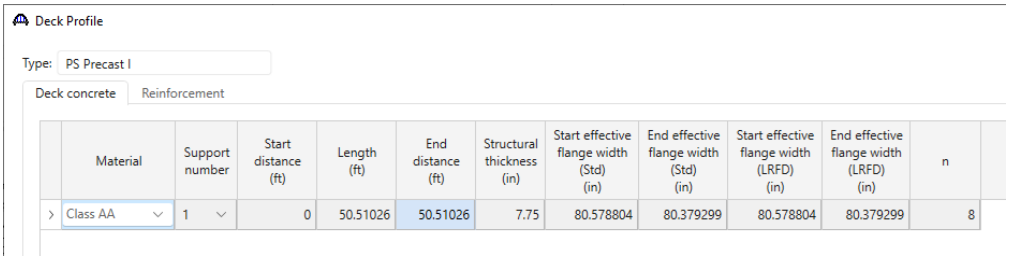
Member Input Data

Remember to wait to compute effective flange width until all member alternatives have been created.

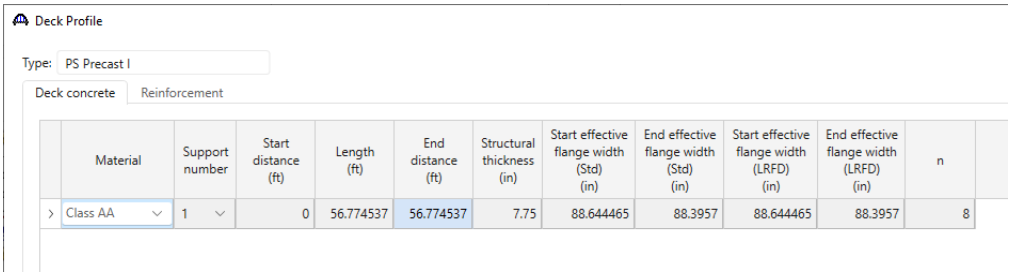
		SIP					Beam Projection		Stress	
Beam	Span	Uniform	Beam	Girder	Prestress		Left	Right	Limit	Haunch
No.	Length	Load	Shape	Material	Properties	n	End	End	Range	Y1
---	ft	k/ft	---	---	---	---	in	in	ft	in
G1	50.51026	0.056	AASHTO TYPE IV	Class F5	1/2" (7W-270) LR	7	16.875	9	52.6665	1.00
G2	56.77454	0.113	AASHTO TYPE IV	Class F5	1/2" (7W-270) LR	7	16.875	9	58.9308	1.00
G3	63.15814	0.113	AASHTO TYPE IV	Class F5	1/2" (7W-270) LR	7	16.875	9	65.3144	1.00
G4	69.56865	0.113	AASHTO TYPE IV	Class F5	1/2" (7W-270) LR	7	16.875	9	71.7249	1.00
G5	75.94146	0.113	AASHTO TYPE IV	Class F5	1/2" (7W-270) LR	7	16.875	9	78.0977	1.00
G6	81.7273	0.056	AASHTO TYPE IV	Class F5	1/2" (7W-270) LR	7	16.875	9	83.8836	1.00

The **Deck Profile** windows for the beams are shown below.

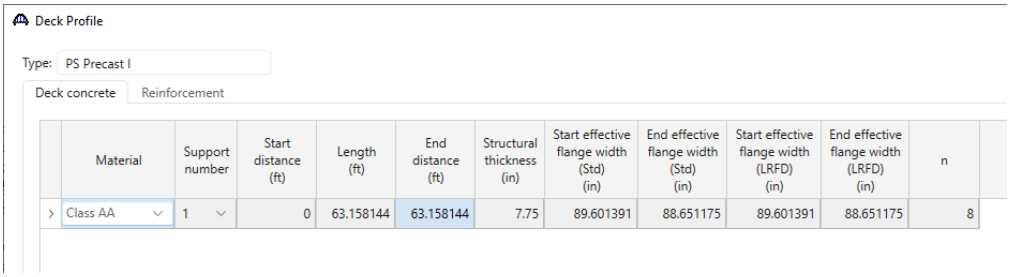
G1



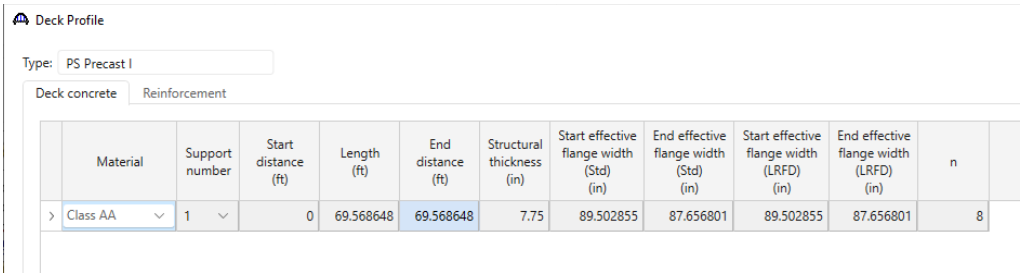
G2



G3

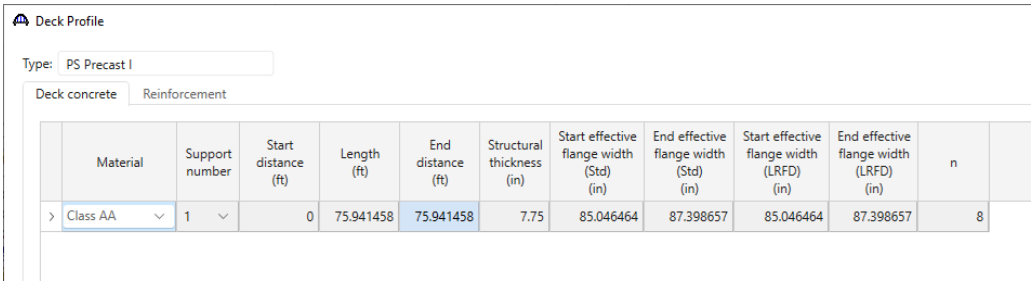


G4



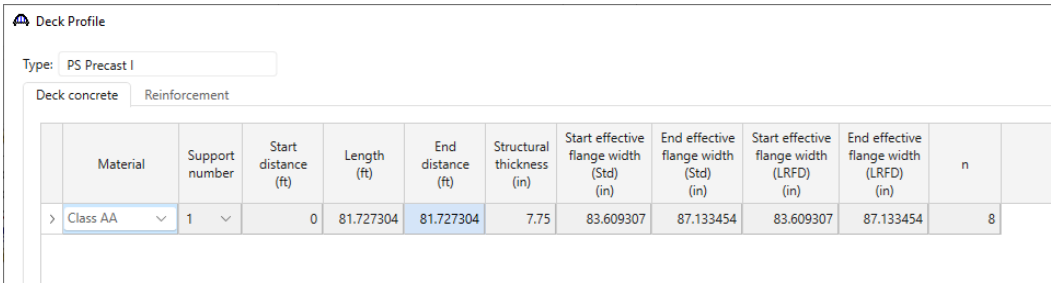
Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA	1	0	69.568648	69.568648	7.75	89.502855	87.656801	89.502855	87.656801	8

G5



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	1	0	75.941458	75.941458	7.75	85.046464	87.398657	85.046464	87.398657	8

G6 (Note that the same warning message will appear as it did for Span 3, G1 & G8. Enter the Std values for LRFD values)

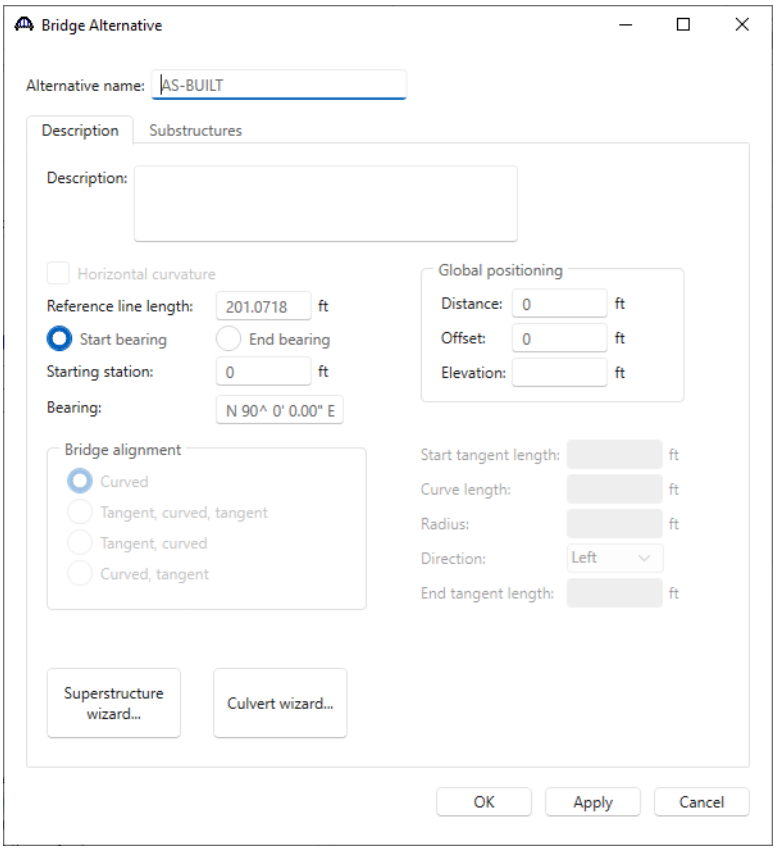


Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n
Class AA	1	0	81.727304	81.727304	7.75	83.609307	87.133454	83.609307	87.133454	8

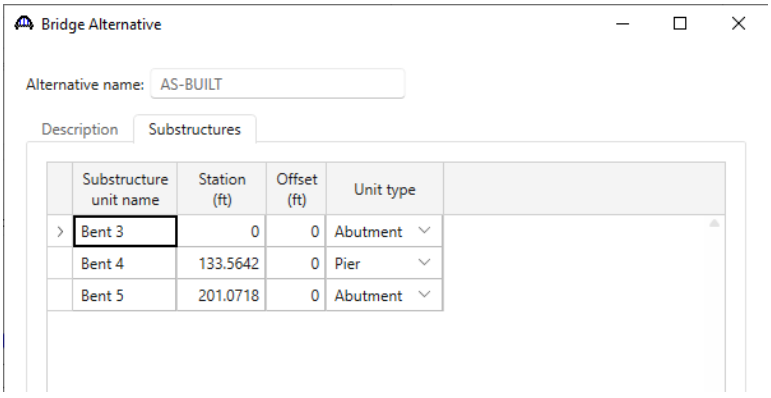
The Superstructure Definitions are now complete. Bridge Alternatives can now be created.

Bridge Alternatives

Double-click on **BRIDGE ALTERNATIVES** in the **Bridge Workspace** tree and enter the data as shown below.



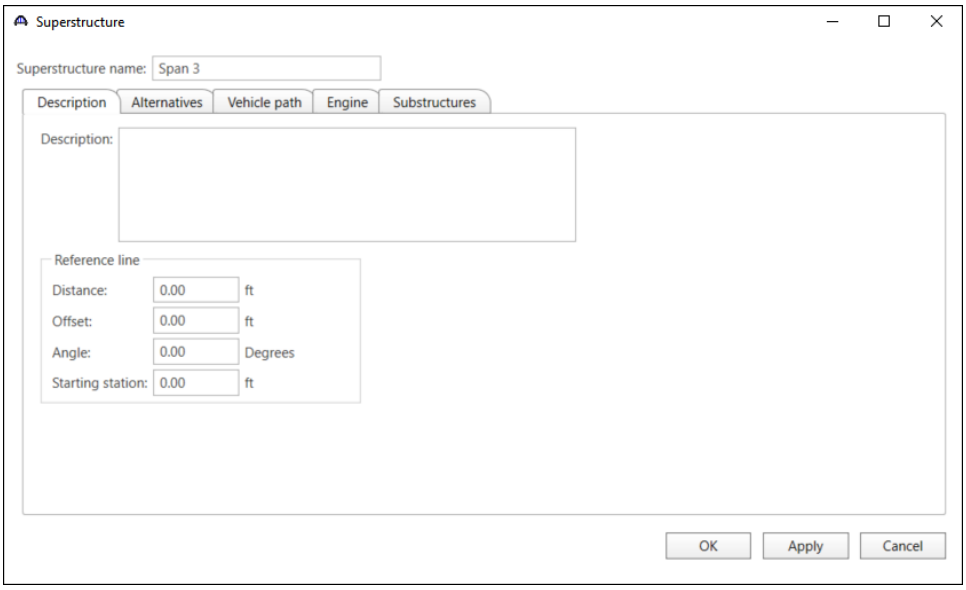
Navigate to the **Substructures** tab and define the substructure locations as shown below.



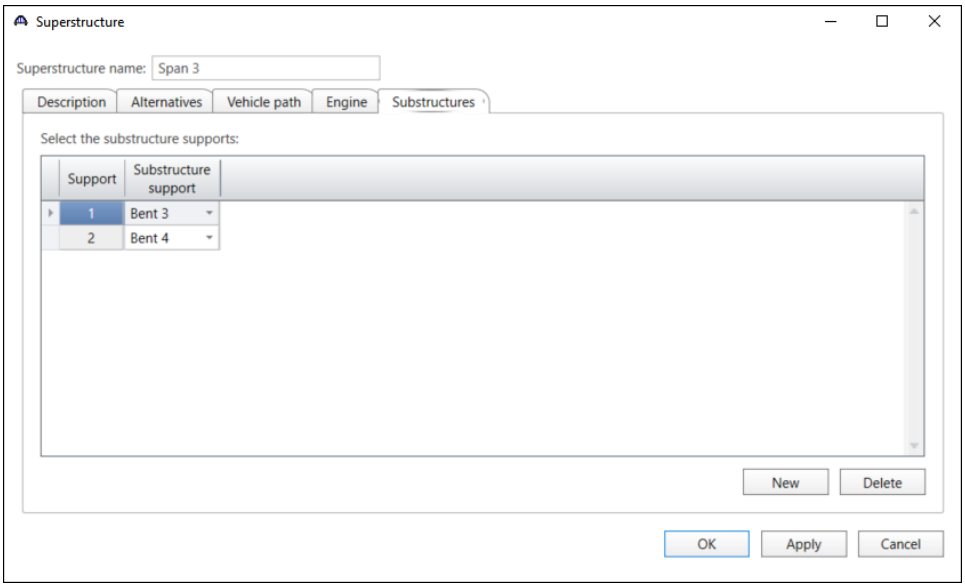
Click **OK** to apply the data and close the window.

SUPERSTRUCTURE

Double click on the **SUPERSTRUCTURES** node in the **Bridge Workspace** tree and enter **Span 3** as the **Superstructure Name**.



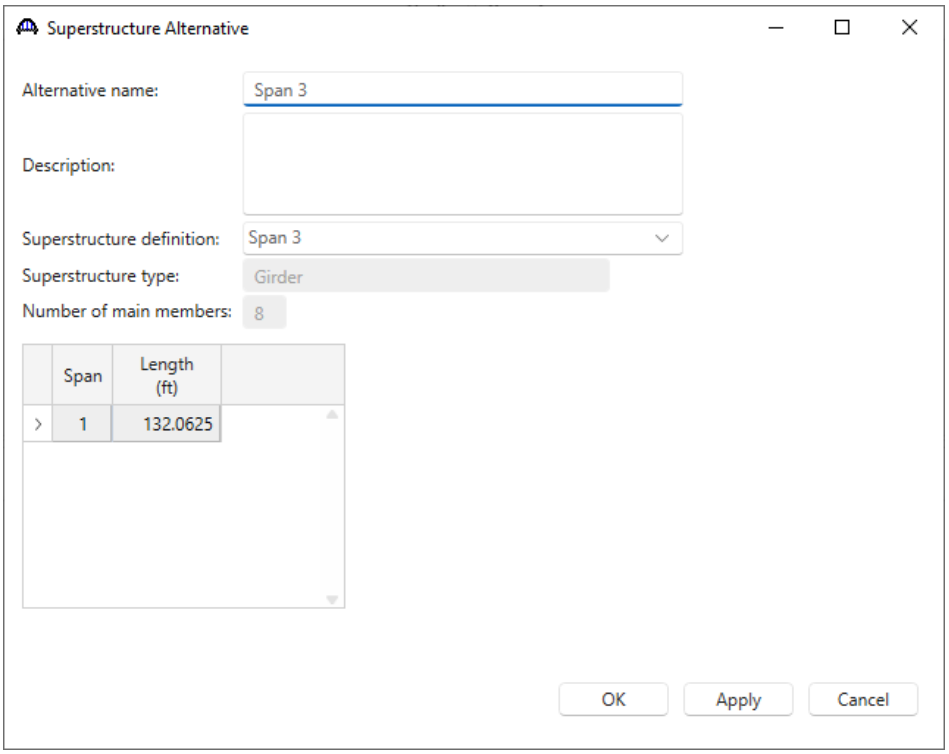
Navigate to the **Substructures** tab and assign substructures to each support.



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

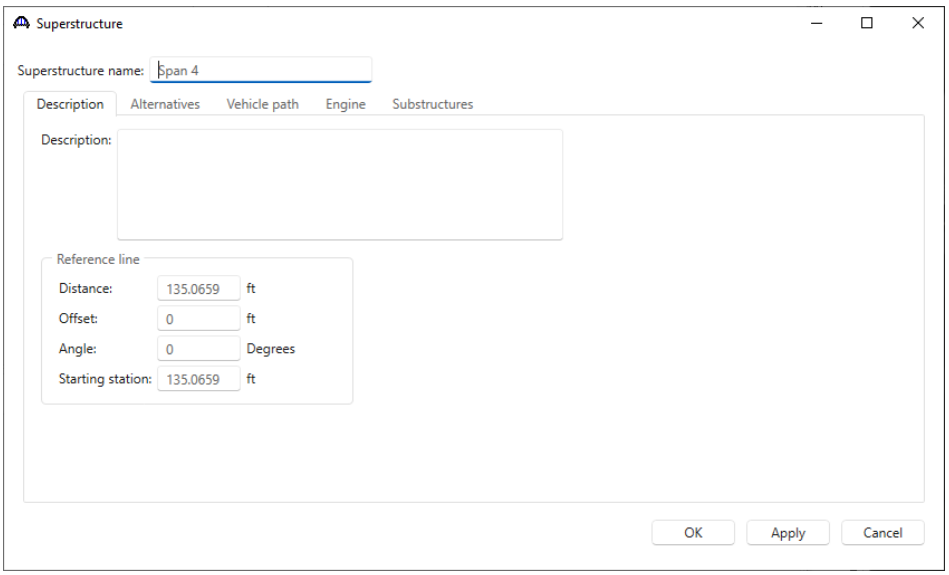
SUPERSTRUCTURE ALTERNATIVES

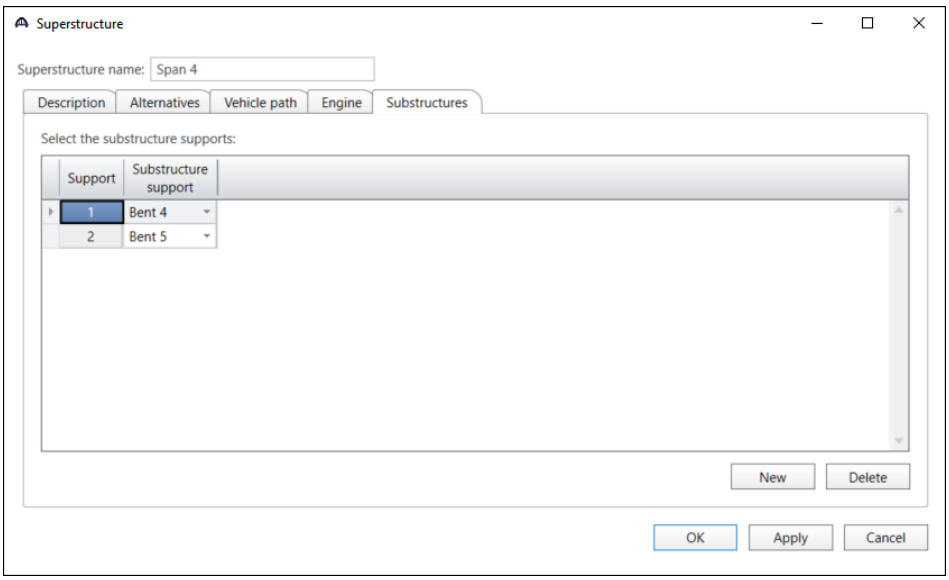
Double click on the **SUPERSTRUCTURE ALTERNATIVES** node in the **Bridge Workspace** tree and enter **Span 3** as the **Alternative Name** and select **Span 3** as the **Superstructure Definition**.

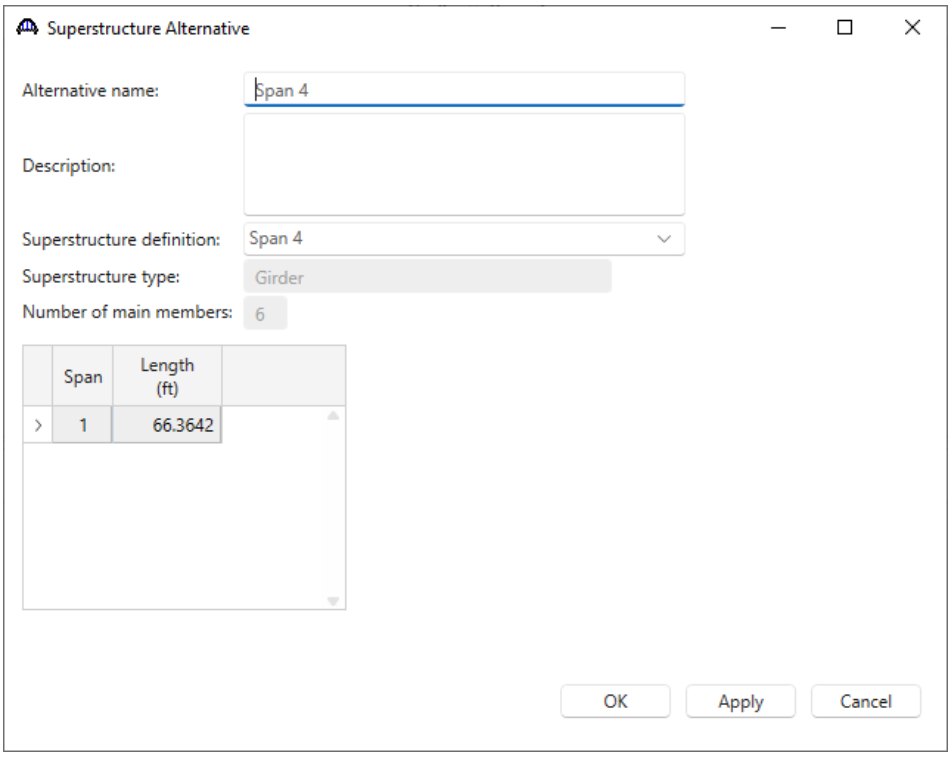


Click **OK** to apply the data and close the window.

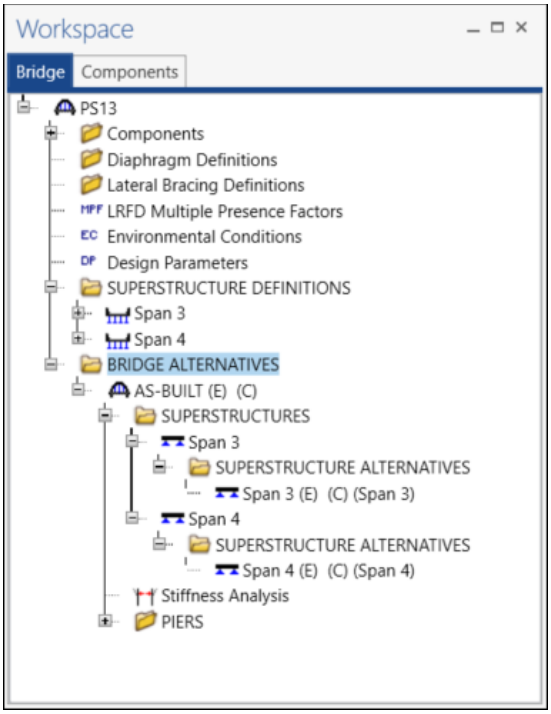
Repeat the process for creating a **Superstructure** and **Superstructure Alternative** for **Span 4**. See images below.




Superstructure
Superstructure name: Span 4
Description
Alternatives
Vehicle path
Engine
Substructures
Select the substructure supports:
Support
Substructure support
1
Bent 4
2
Bent 5
New
Delete
OK
Apply
Cancel

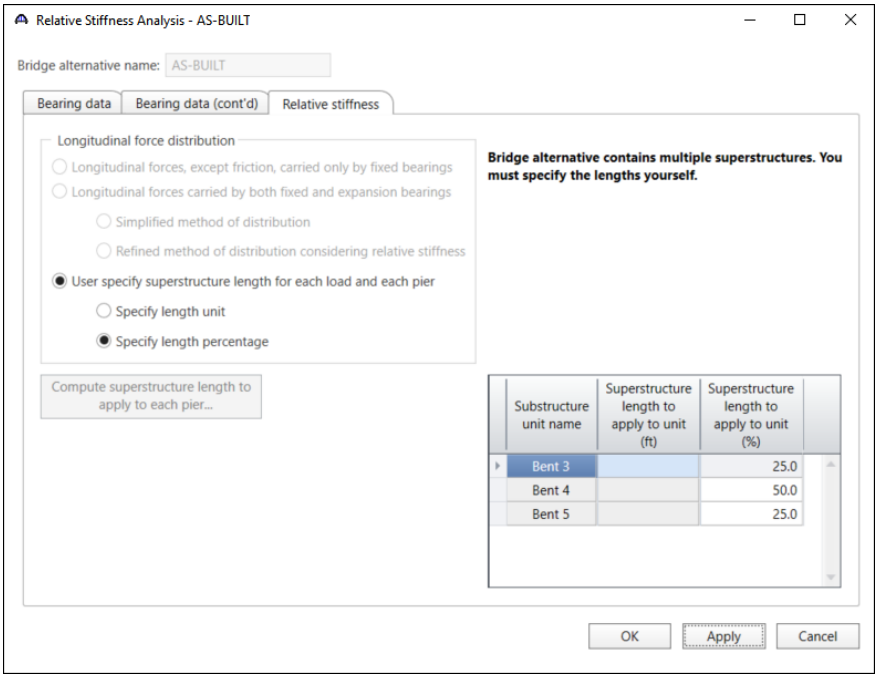

Superstructure Alternative
Alternative name:
Span 4
Description:
Superstructure definition:
Span 4
Superstructure type:
Girder
Number of main members:
6
Span
Length (ft)
1
66.3642
OK
Apply
Cancel

See the completed Bridge Alternative below.



Stiffness Analysis

The **Stiffness Analysis** information can now be entered by double clicking on the **Stiffness Analysis** node in the **Bridge Workspace** tree. Navigate to the **Relative stiffness** tab of this window. For this example, 50% of the total span length is applied to Bent 4 and 25% to the other units as shown below.

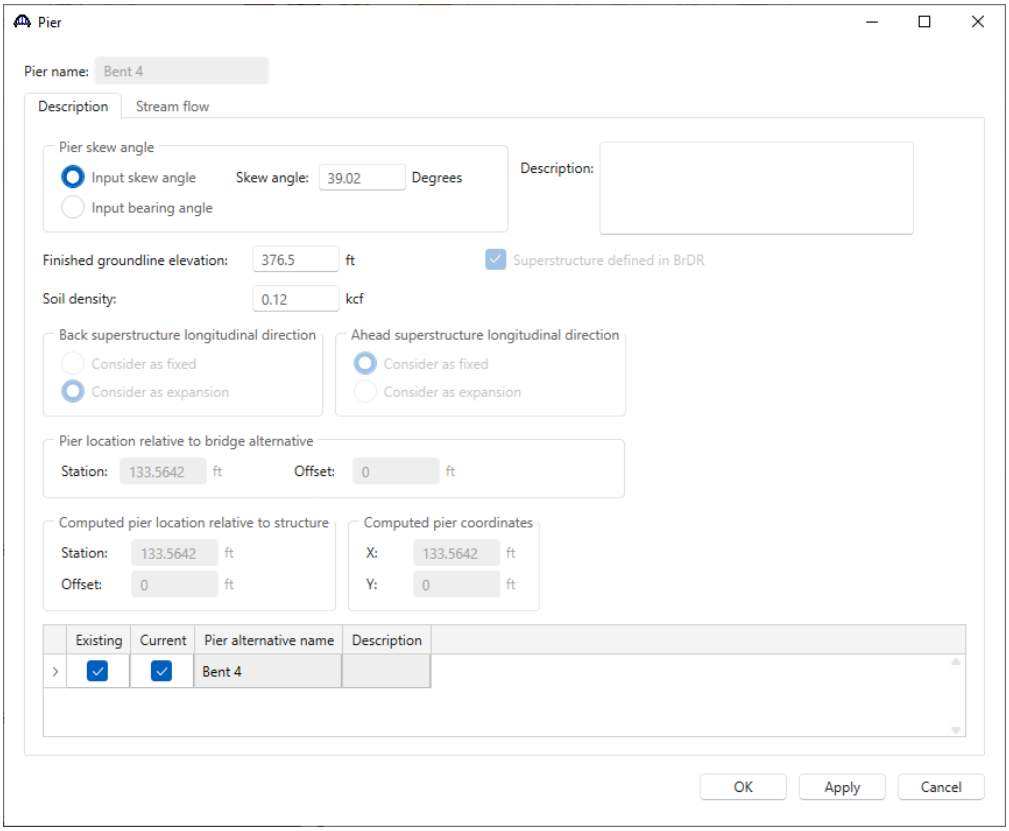


Click **OK** to apply the data and close the window.

Pier Data Entry

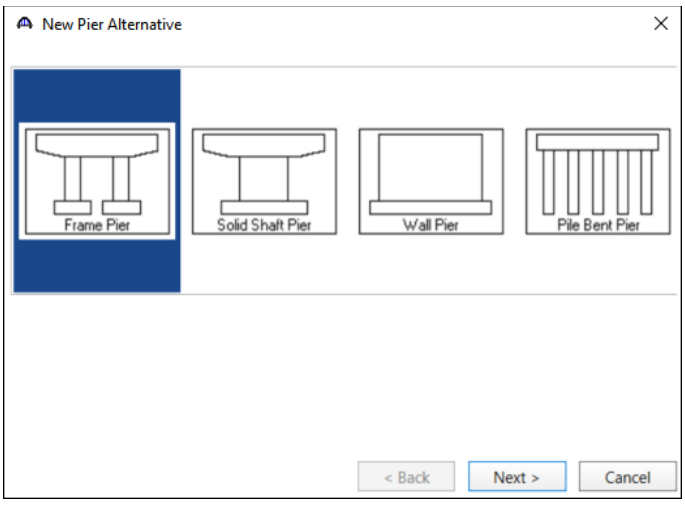
Piers

Double click on the **Bent 4** node in the **Bridge Workspace** tree and enter the information as shown below.

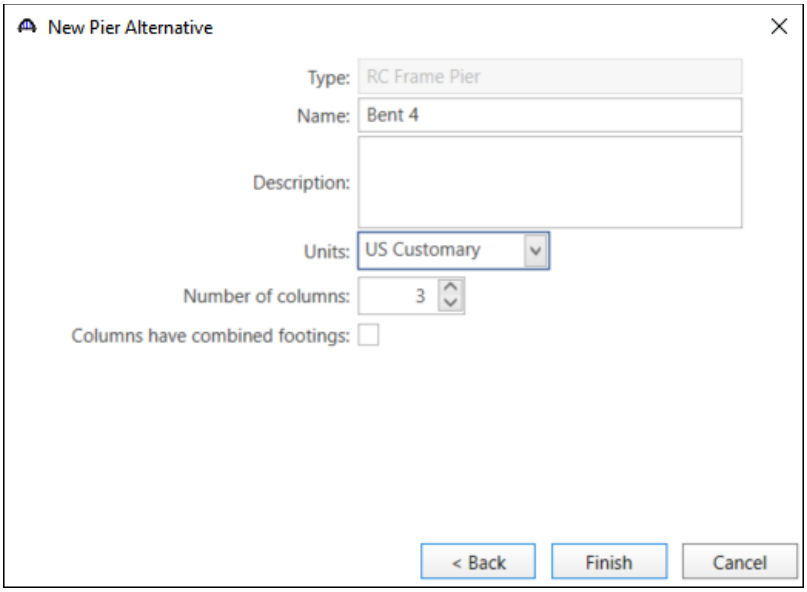


Pier Alternative

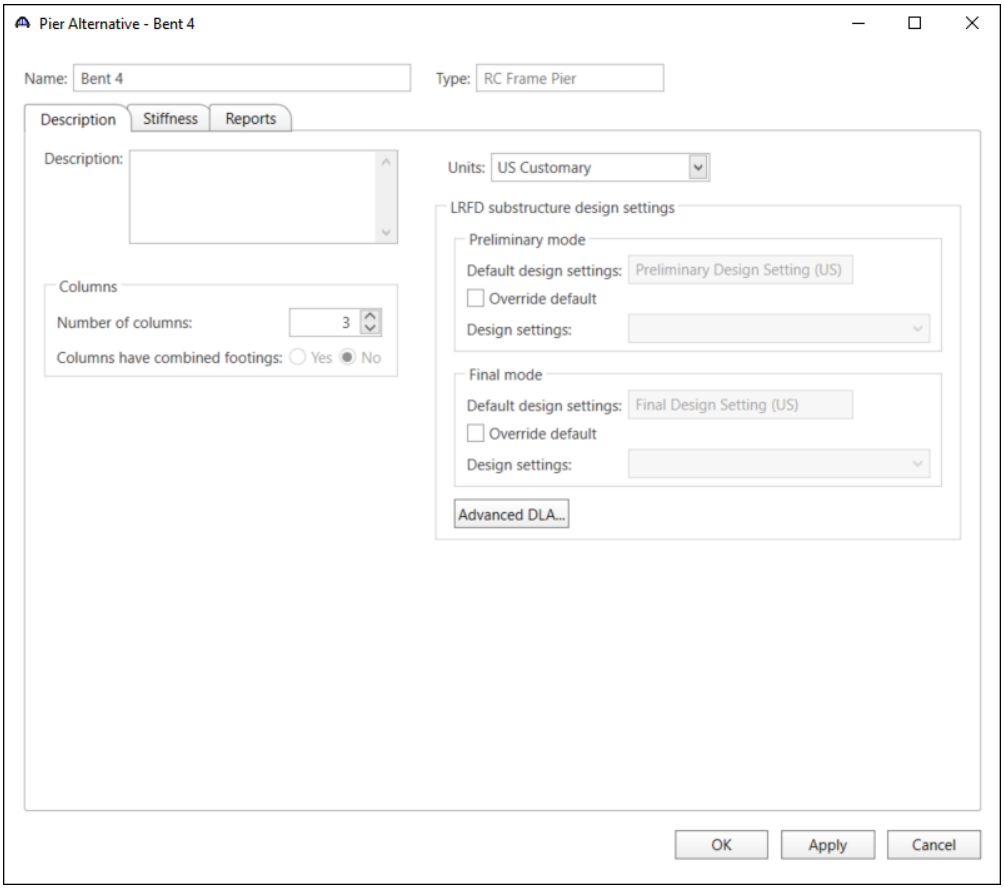
Double click on the **Pier Alternatives** node in the **Bridge Workspace** tree. Select the **Frame Pier** and click **Next**.



Enter the information as shown below in the **New Pier Alternative** window and click **Finish**.



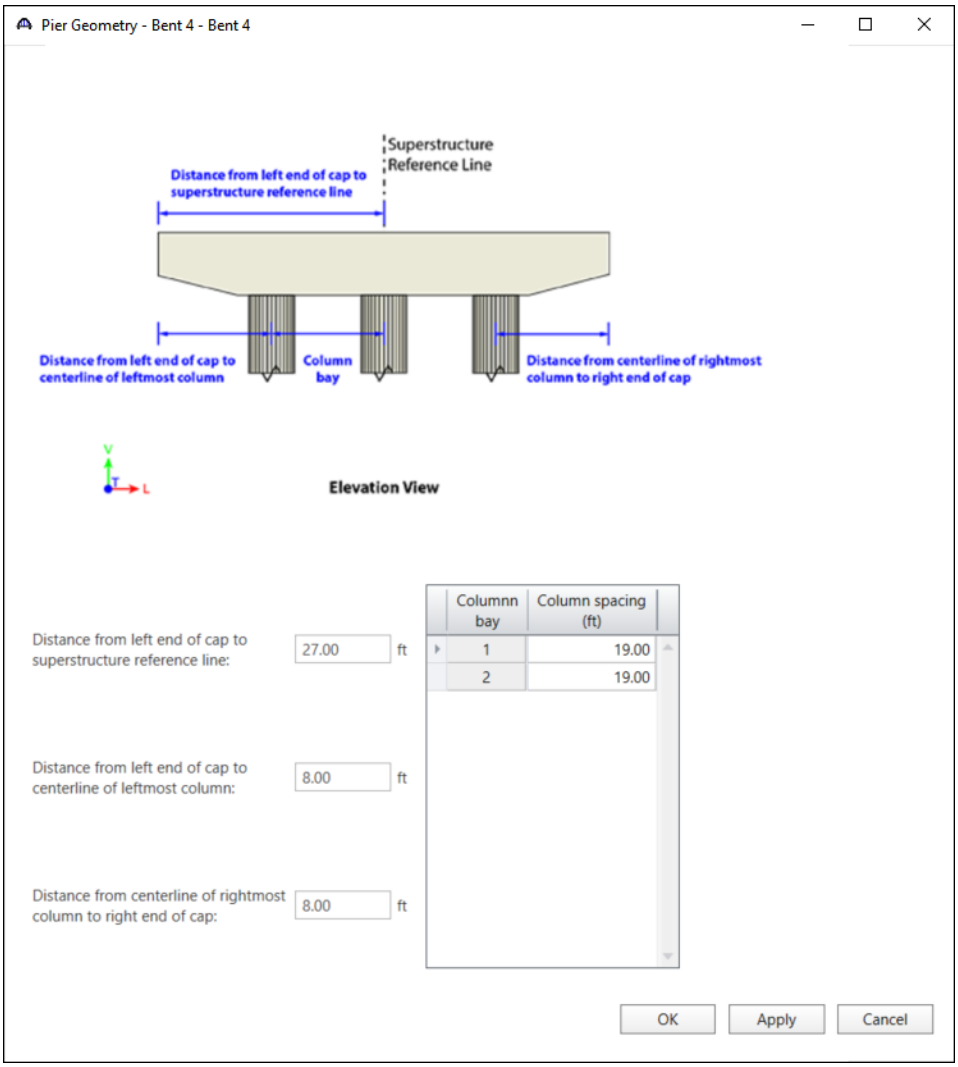
The following window will appear. There is no input required for this window.



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

Geometry

Double click on the **Geometry** node in the **Bridge Workspace** tree under **Bent 4**. Edit the dimensions in blue as shown below.



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

Cap

Double click on the **Cap** node in the **Bridge Workspace** tree under **Bent 4**. Enter the information as shown below.

Cap Properties - Bent 4 - Bent 4

Description | Additional loads

Cap type: Beam Shape Cap Cap top configuration: Sloped Cap material: Class AA

Pedestals Exposure factor:

Back span:

Member	CL bearing station (ft)	Angle between CL member and CL support (Degrees)	Bearing seat elevation (ft)	Pedestal width (ft)	Pedestal length (ft)
G1	146.726505	129.172937	408.8421	0	0
G2	142.315911	129.02229	409.133767	6.5	2.5
G3	138.220125	129.02229	409.399392	6.5	2.5
G4	134.124339	129.02229	409.659808	6.5	2.5
G5	129.995749	129.02229	409.920225	6.5	2.5
G6	125.899963	129.02229	410.175433	6.5	2.5
G7	121.804177	129.02229	410.420225	6.5	2.5
G8	117.259159	128.609122	410.68585	5.05	2.5

Ahead span:

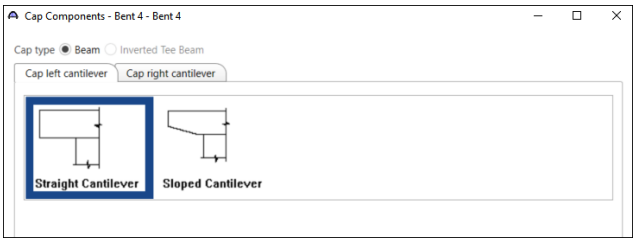
Member	CL bearing station (ft)	Angle between CL member and CL support (Degrees)	Bearing seat elevation (ft)	Pedestal width (ft)	Pedestal length (ft)
G1	150.056531	87.190847	410.519183	7.2031	2.3333
G2	144.134162	87.228565	410.909808	9.5	2.3333
G3	138.100331	87.232688	411.300433	9.5	2.3333
G4	132.033717	87.372234	411.68585	9.5	2.3333
G5	126.00318	87.486085	412.055642	9.5	2.3333
G6	120.559635	87.076463	412.378558	6.2969	2.3333

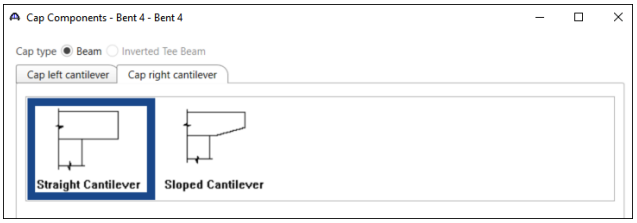
OK | Apply | Cancel

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

Components

Double click on the **Components** node in the **Bridge Workspace** tree under **Cap**. Select **Straight Cantilever** for both the **Cap Left Cantilever** and **Cap Right Cantilever** as shown below.

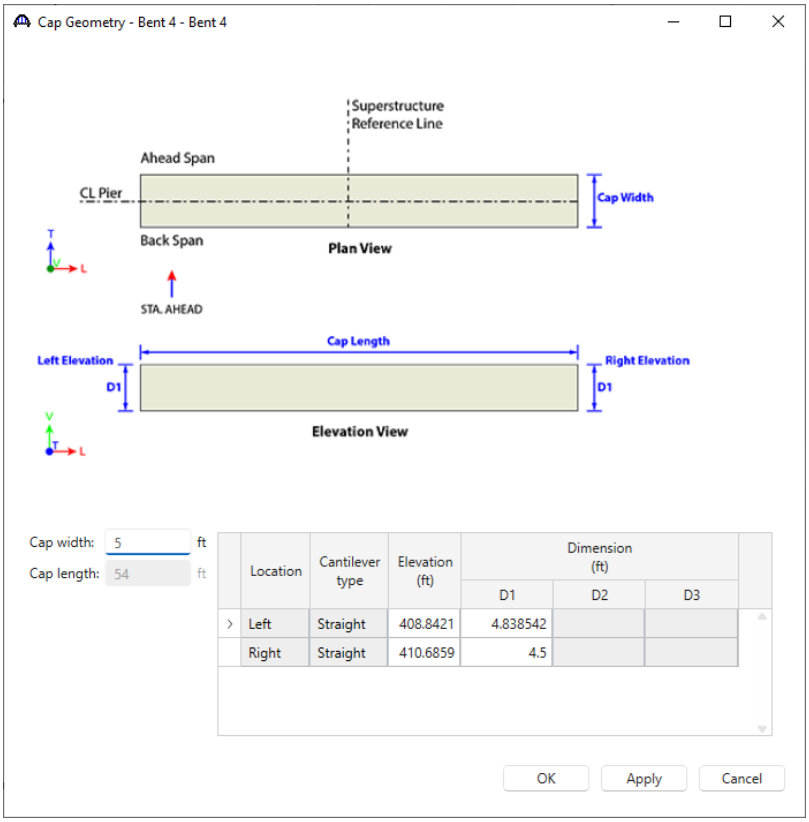




Click **OK** to apply the data and close the window.

Geometry

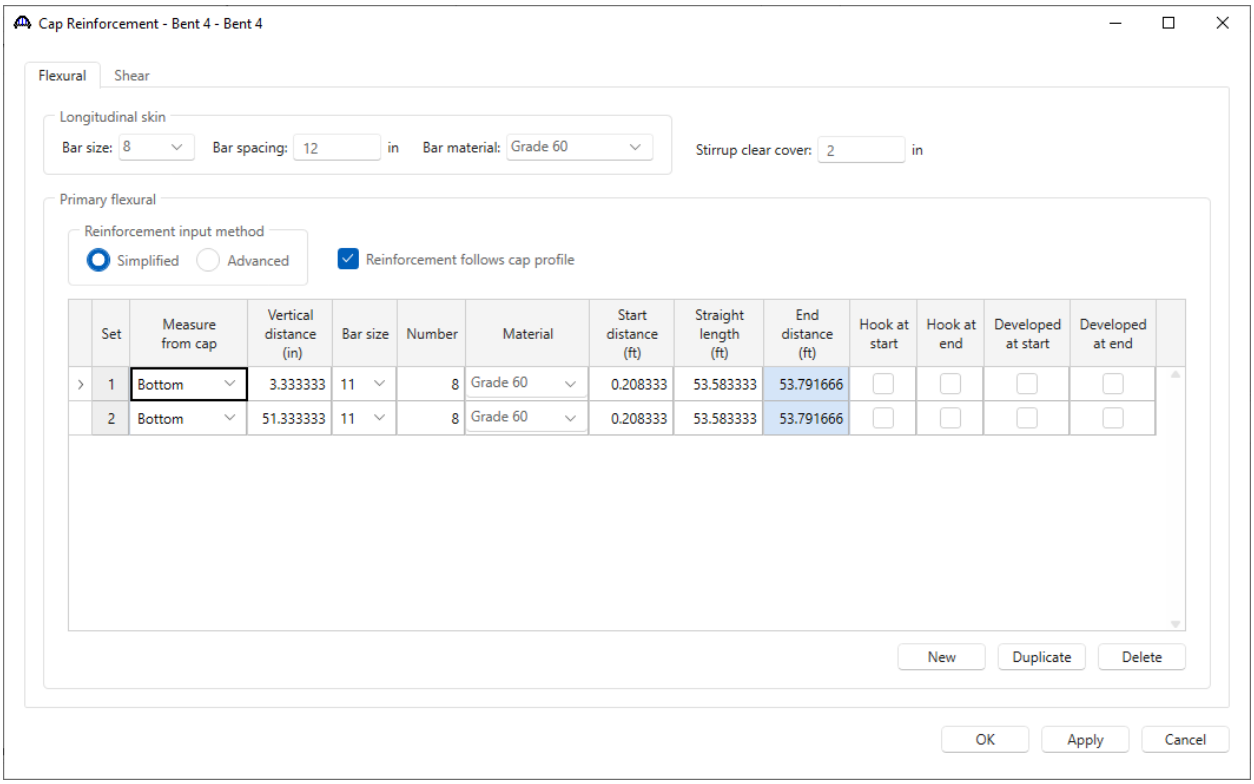
Double click on the **Geometry** node in the **Bridge Workspace** tree under **Cap**. Edit the dimensions in blue as shown below.

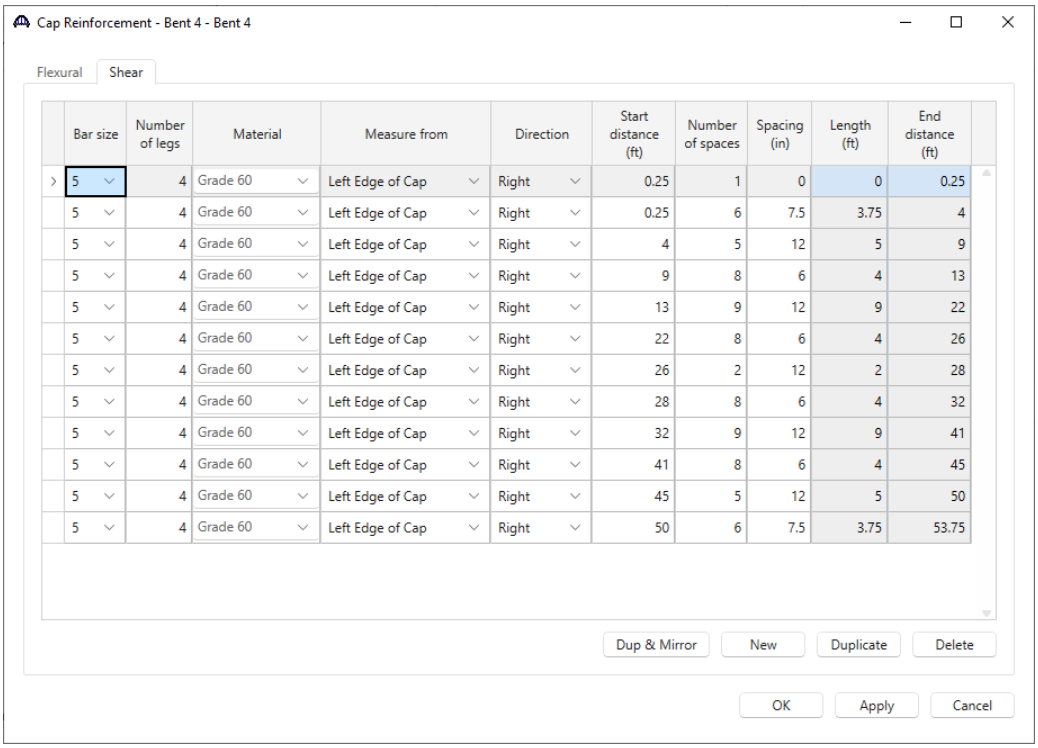


Click **OK** to apply the data and close the window.

Reinforcement

Double click on the **Reinforcement** node in the **Bridge Workspace** tree under **Cap**. Edit the information in both the **Flexural** and **Shear** tabs as shown below.

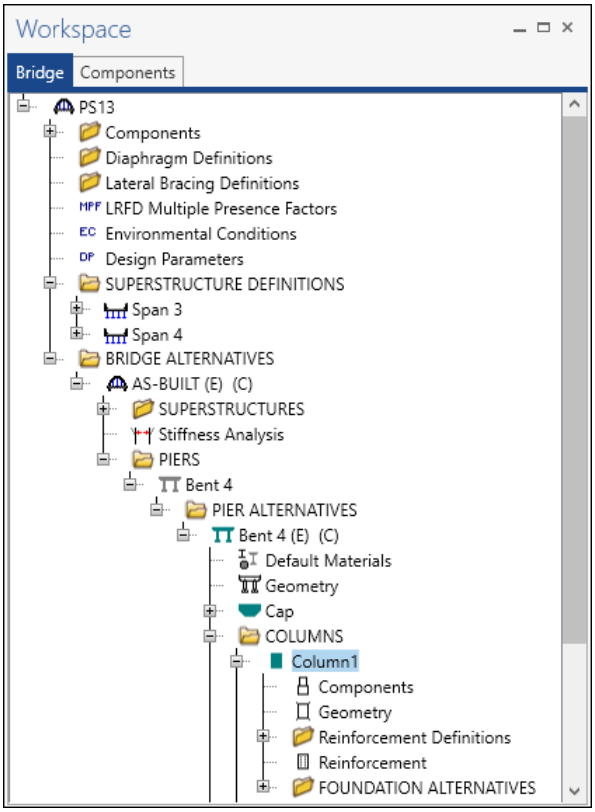




Click **OK** to apply the data and close the window.

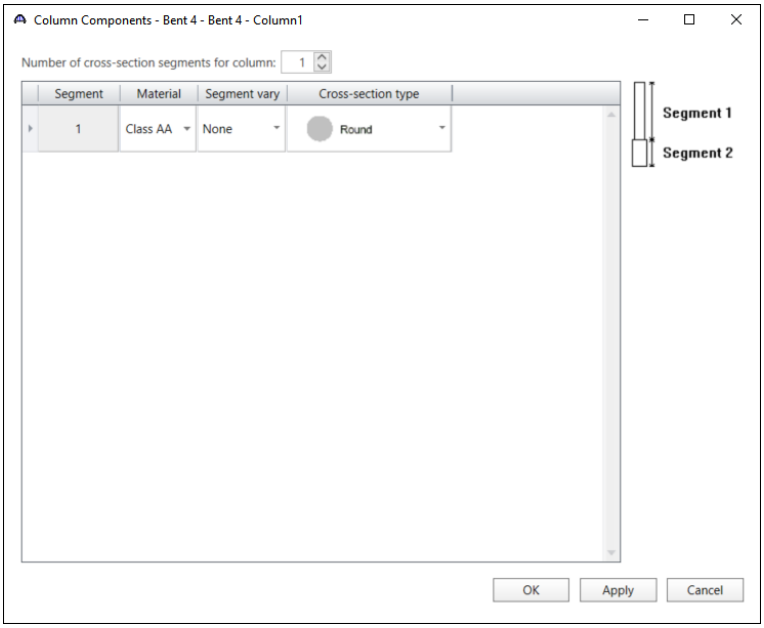
COLUMNS

Expand the **COLUMNS** and **Columns1** nodes in the Bridge Workspace tree.



Column1 - Components

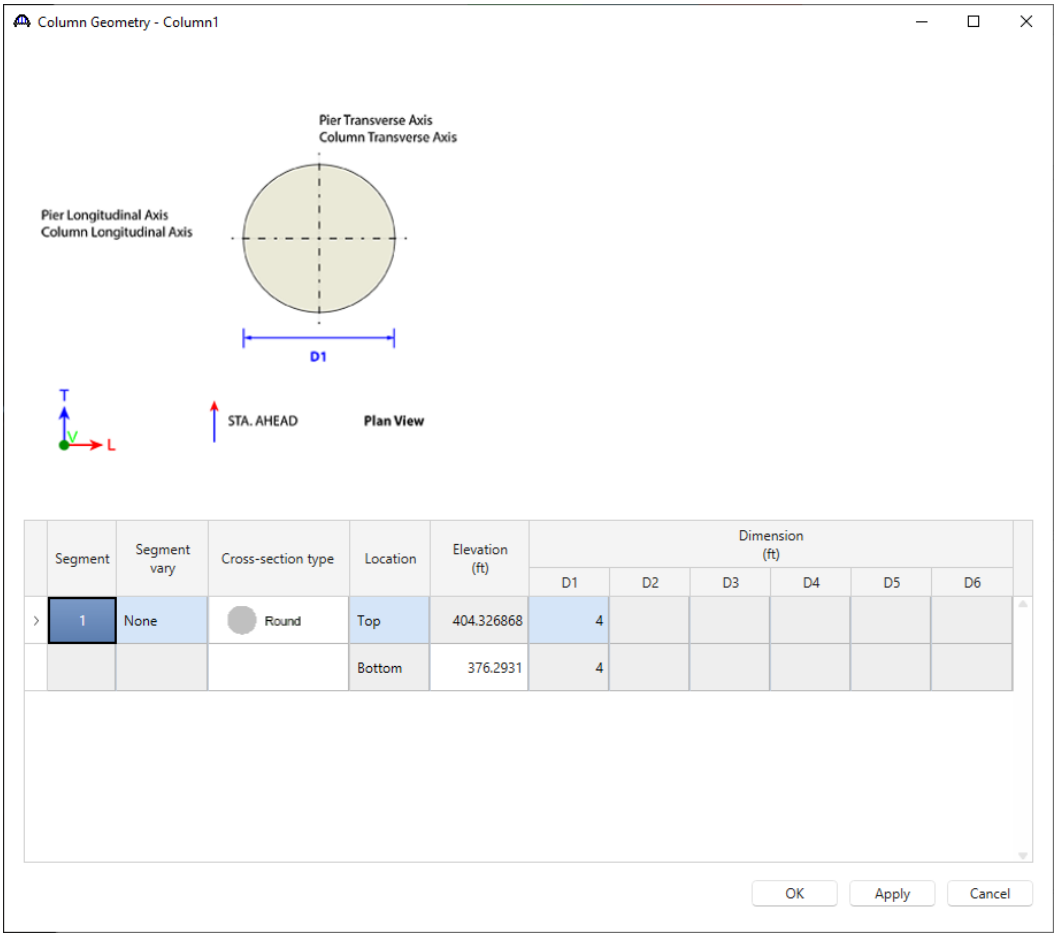
Double click on the **Components** node under **Columns1** and enter the information as shown below.



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

Column1 - Geometry

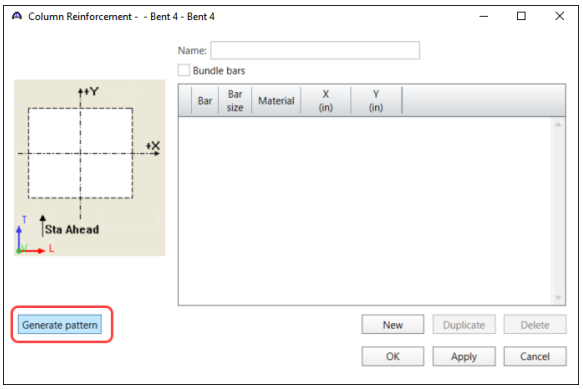
Double click on the **Geometry** node and edit the dimensions in blue as shown below.

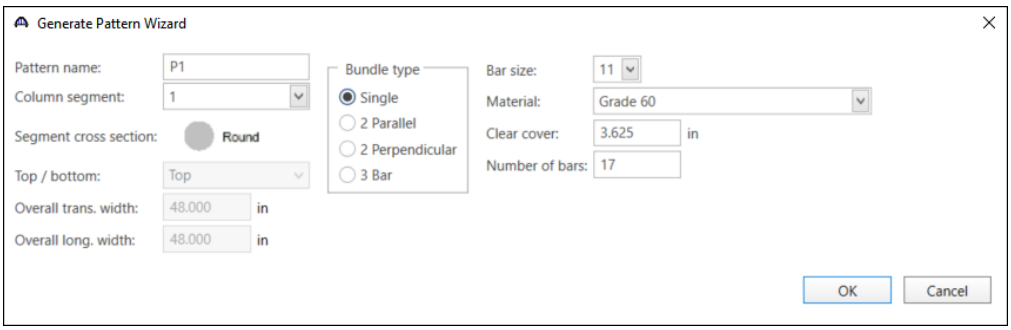


Click **OK** to apply the data and close the window.

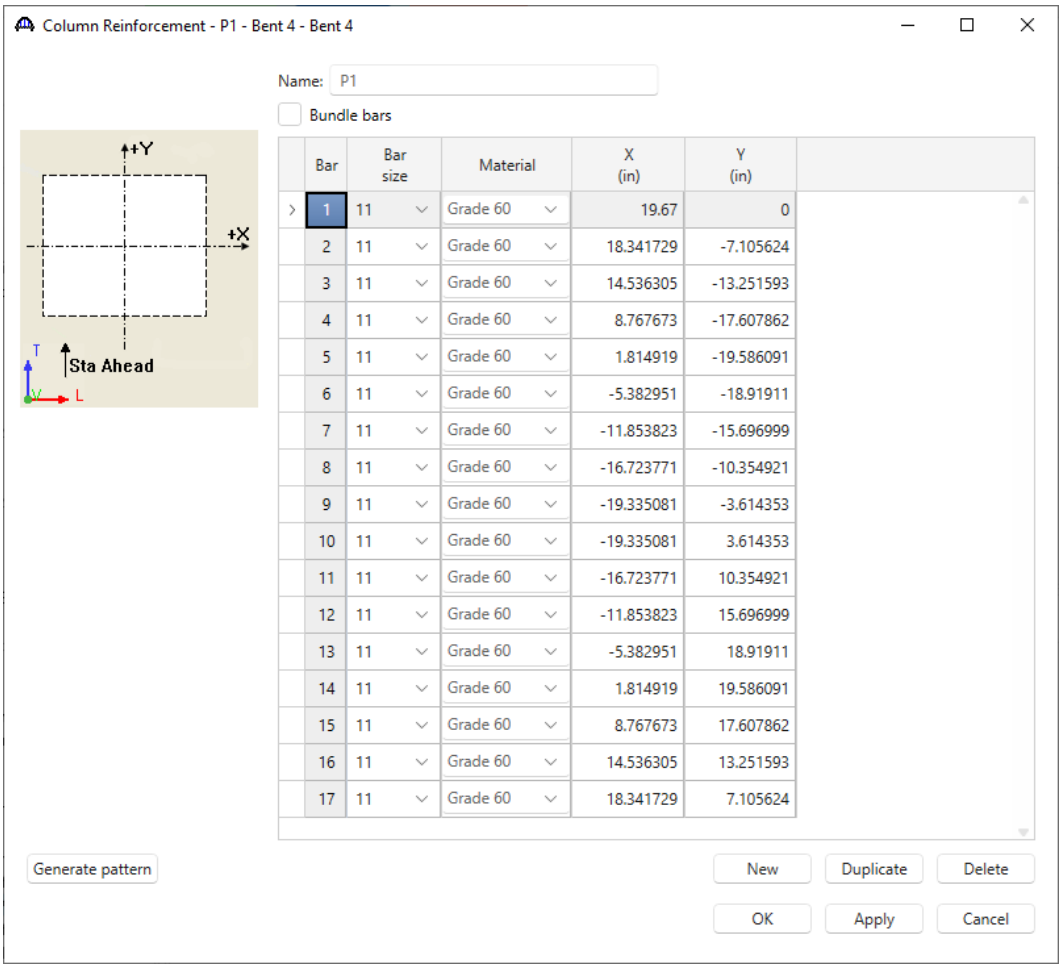
Column1 – Reinforcement Definitions

Double click on the **Reinforcement Definitions** node and click the **Generate Pattern** button. Enter the following information and click **Apply.**





The **Column Reinforcement** window will be populated as shown below.

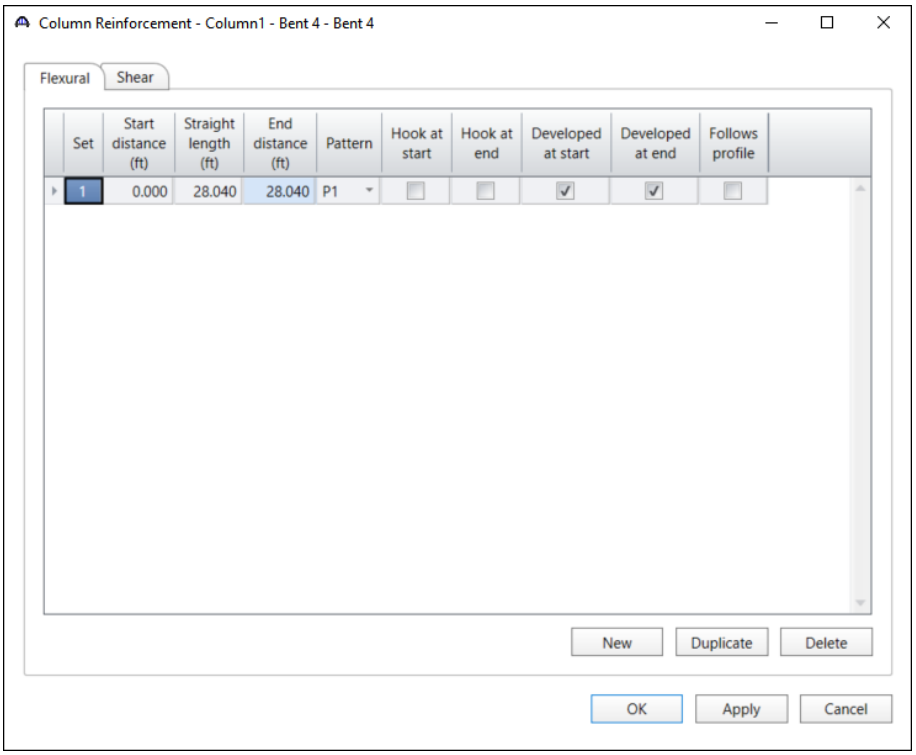


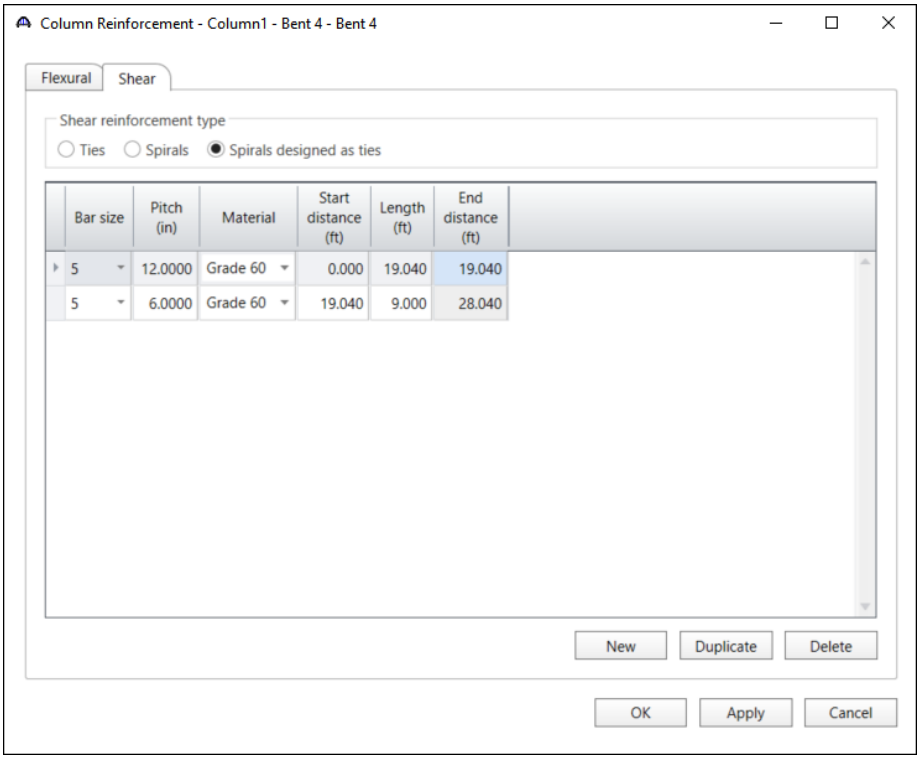
Bar	Bar size	Material	X (in)	Y (in)
1	11	Grade 60	19.67	0
2	11	Grade 60	18.341729	-7.105624
3	11	Grade 60	14.536305	-13.251593
4	11	Grade 60	8.767673	-17.607862
5	11	Grade 60	1.814919	-19.586091
6	11	Grade 60	-5.382951	-18.91911
7	11	Grade 60	-11.853823	-15.696999
8	11	Grade 60	-16.723771	-10.354921
9	11	Grade 60	-19.335081	-3.614353
10	11	Grade 60	-19.335081	3.614353
11	11	Grade 60	-16.723771	10.354921
12	11	Grade 60	-11.853823	15.696999
13	11	Grade 60	-5.382951	18.91911
14	11	Grade 60	1.814919	19.586091
15	11	Grade 60	8.767673	17.607862
16	11	Grade 60	14.536305	13.251593
17	11	Grade 60	18.341729	7.105624

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

Column1 - Reinforcement

Double click on the **Reinforcement** node and enter the information in both the **Flexural** and **Shear** tabs as shown below.

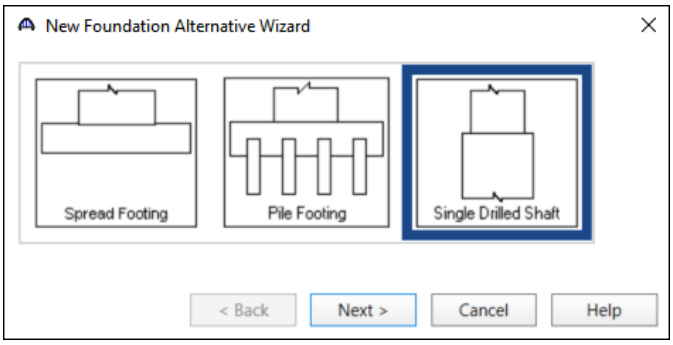


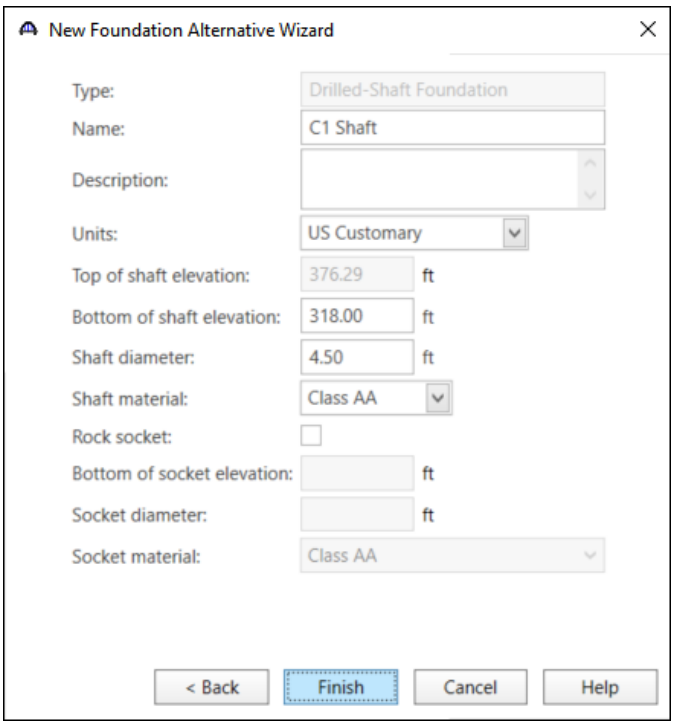


Click **OK** to apply the data and close the window.

FOUNDATION ALTERNATIVES

Double click on the **FOUNDATION ALTERNATIVES** nodes in the **Bridge Workspace** tree. Select the **Single Drilled Shaft** in the **New Foundation Alternative Wizard** and click **Next**.

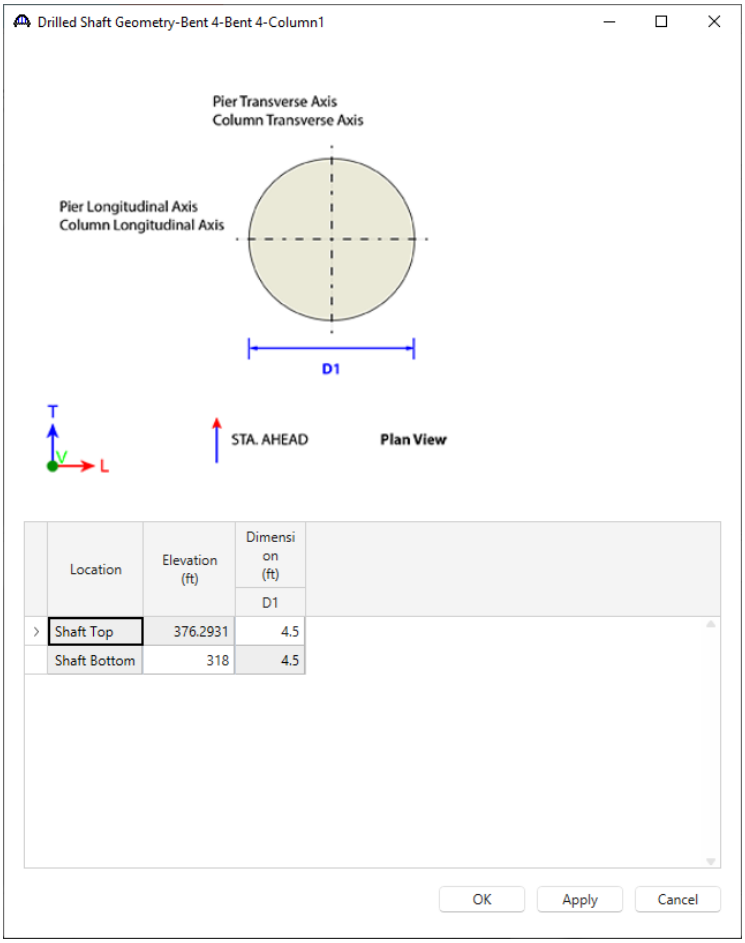




Enter the information as shown below and click **FINISH.**

C1 Shaft – Geometry

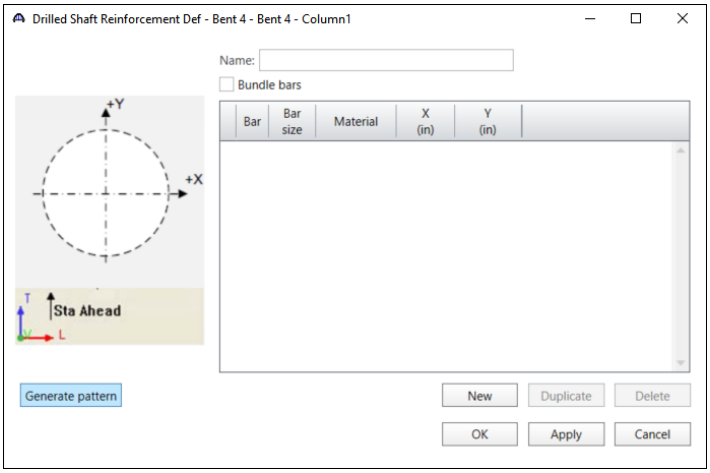
Double click on the **Geometry** node under **C1 Shaft** in the **Bridge Workspace** tree. Enter data as shown below.



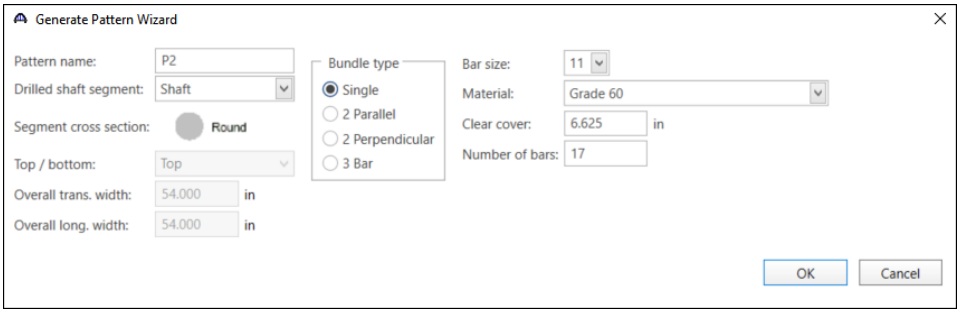
Click **OK** to apply the data and close the window.

C1 Shaft – Reinforcement Definitions

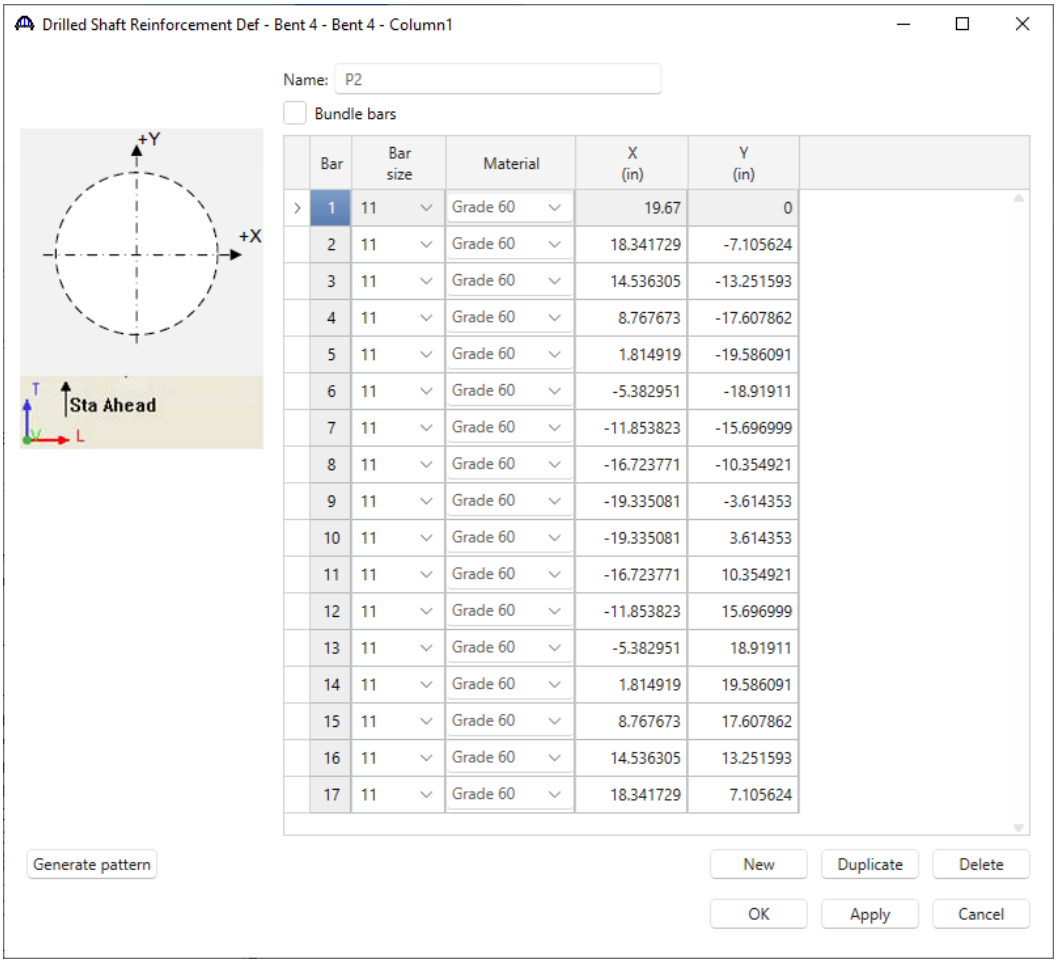
Double click on the **Reinforcement Definitions** node and click the **Generate Pattern** button.



Enter the following information and click **OK.**



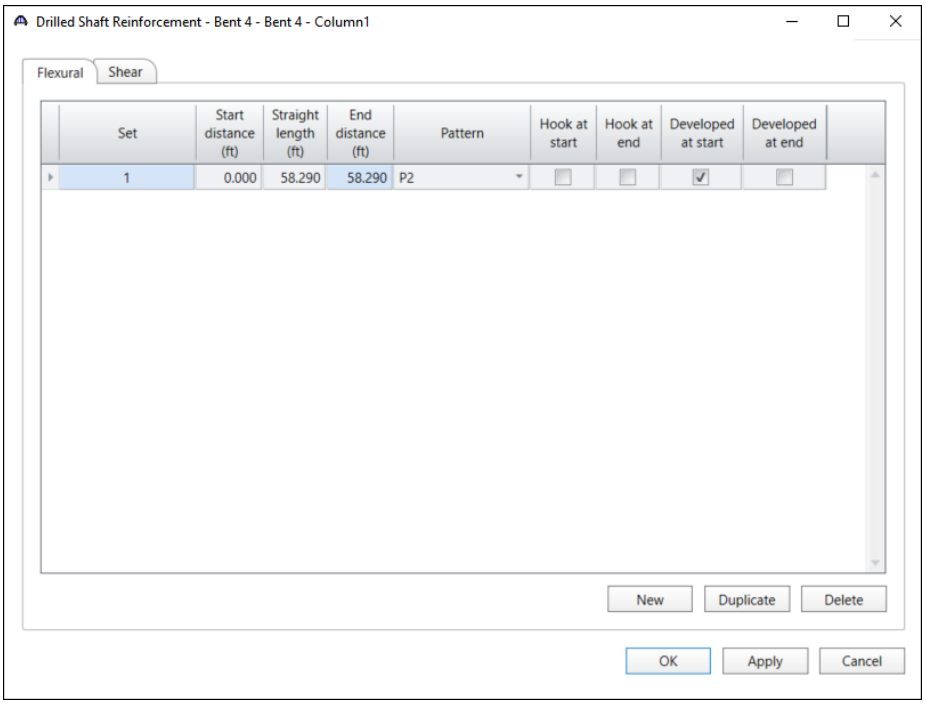
The **Drilled Shaft Reinforcement Def** window will be populated as shown below.

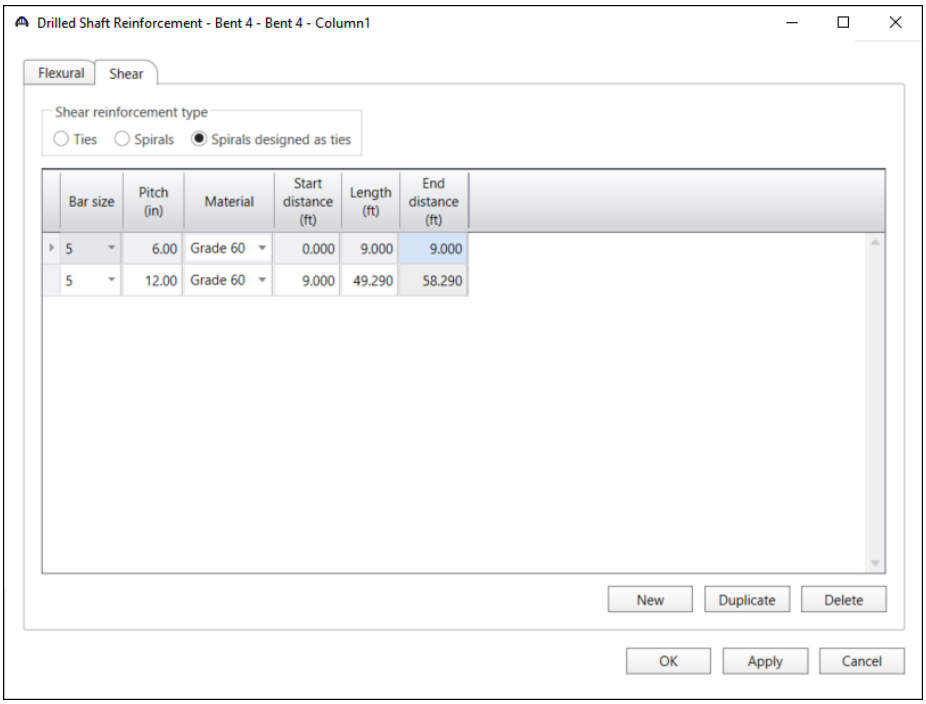


Click **OK** to apply the data and close the window.

Column1 - Reinforcement

Double click on the **Reinforcement** node and enter the information in both the **Flexural** and **Shear** tabs as shown below.

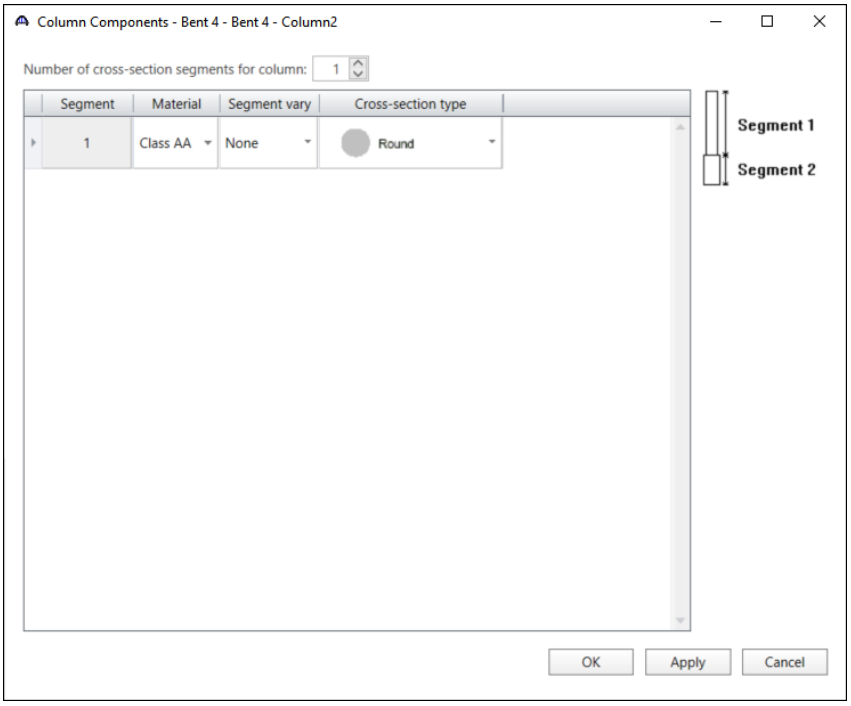


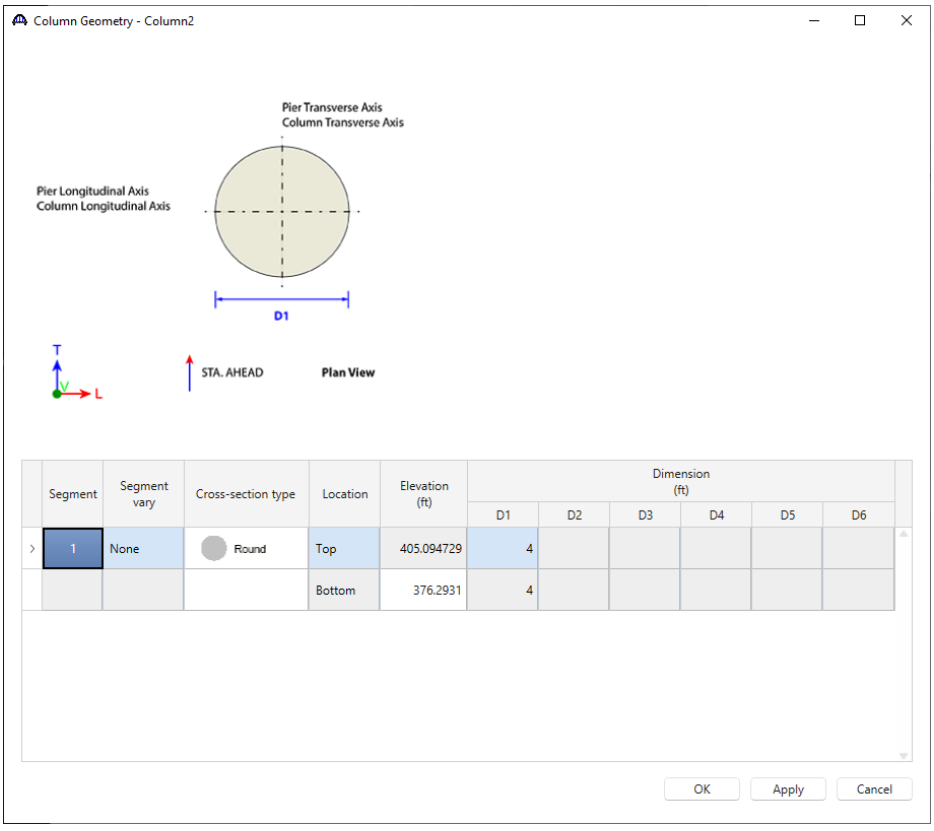


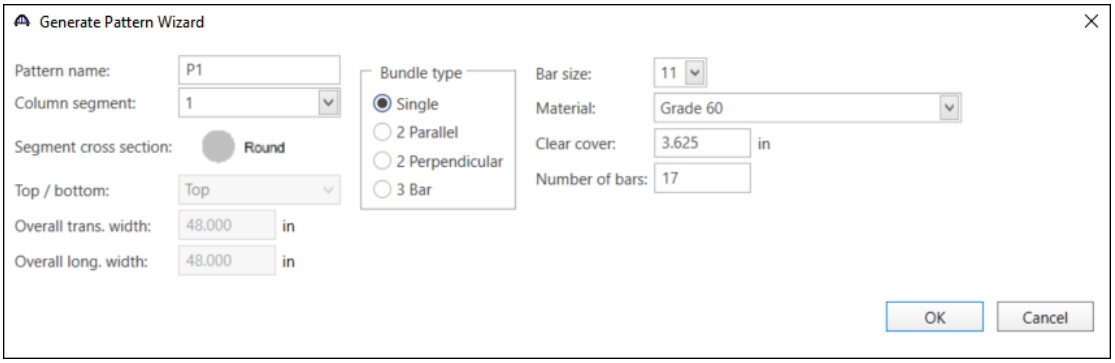
Click **OK** to apply the data and close the window.

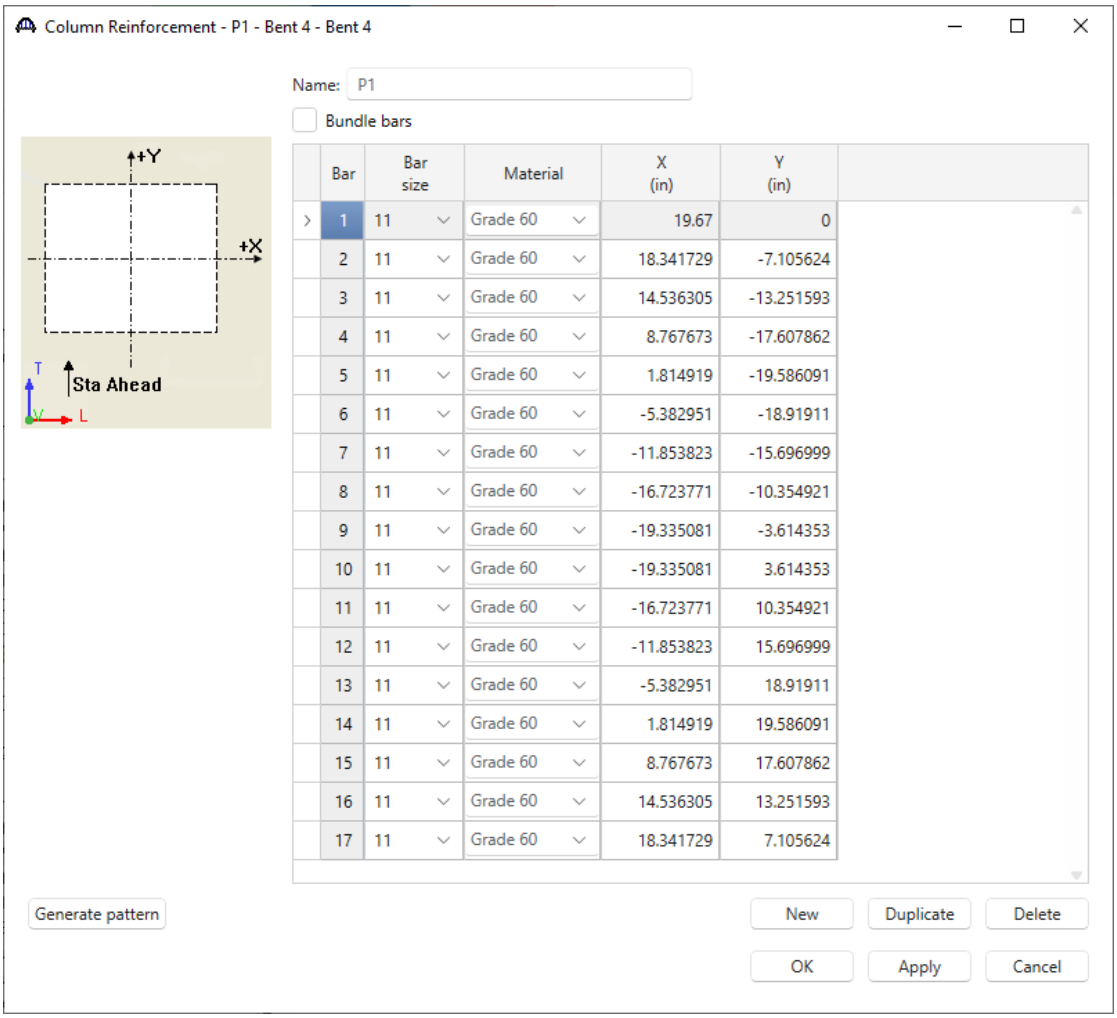
The input for Column 1 is complete. Use the same process to enter Columns 2 and 3. The input windows for each of the columns are shown below.

Column 2

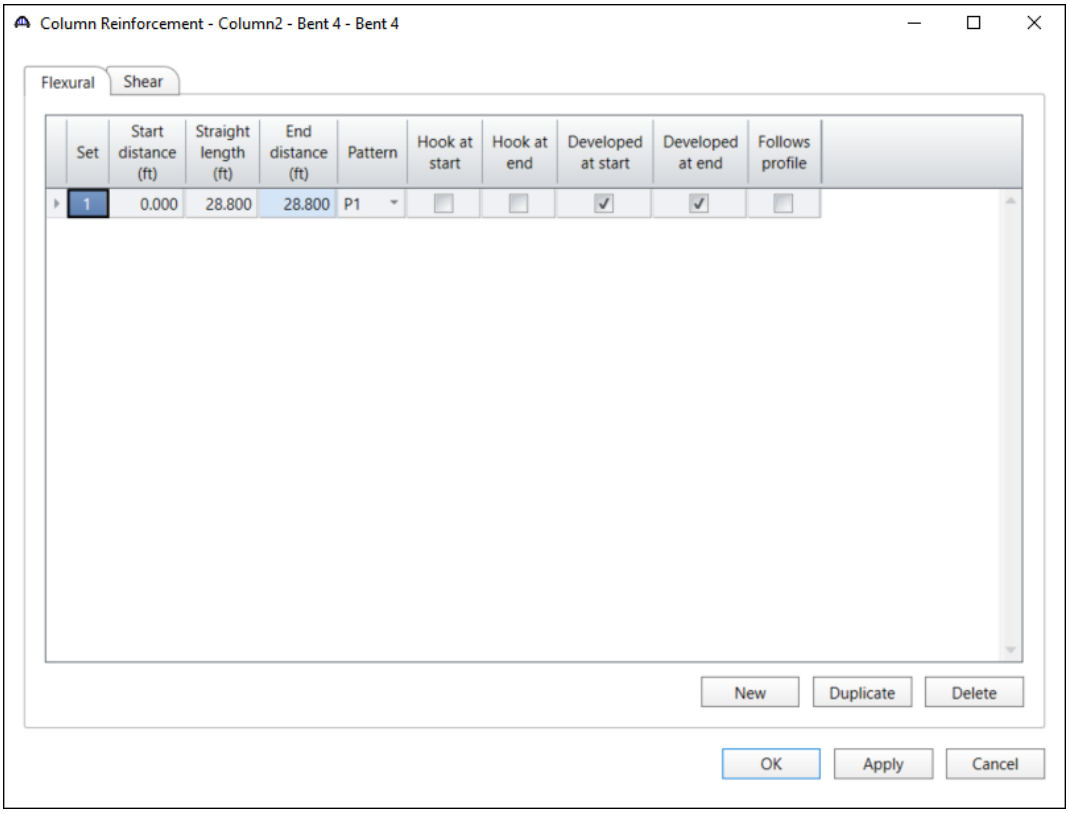


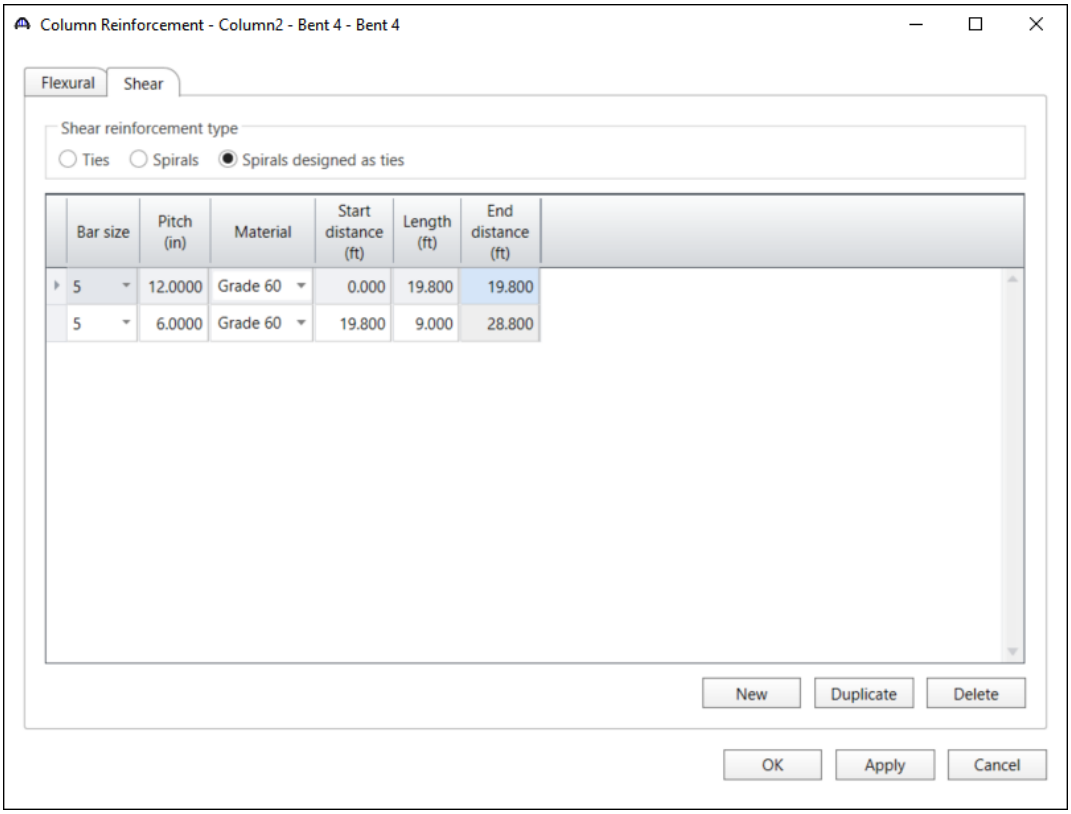




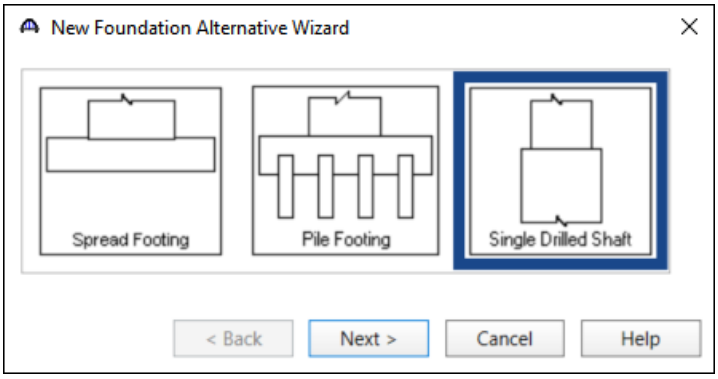


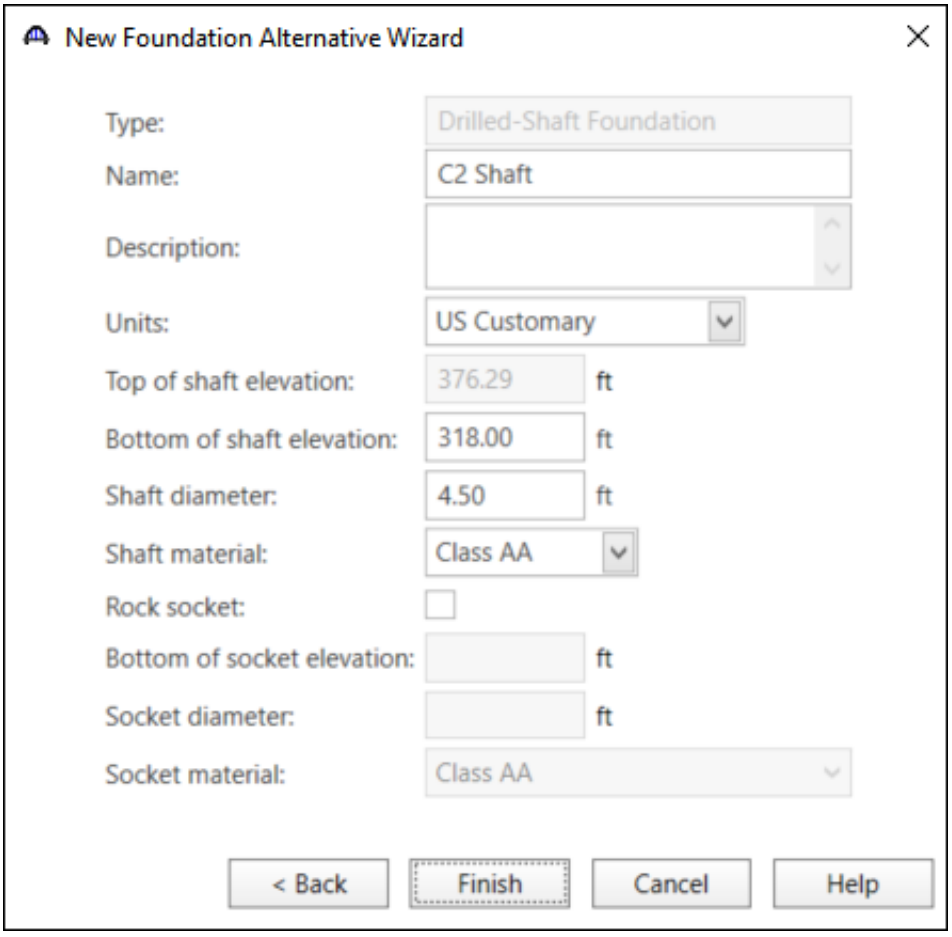
Bar	Bar size	Material	X (in)	Y (in)
1	11	Grade 60	19.67	0
2	11	Grade 60	18.341729	-7.105624
3	11	Grade 60	14.536305	-13.251593
4	11	Grade 60	8.767673	-17.607862
5	11	Grade 60	1.814919	-19.586091
6	11	Grade 60	-5.382951	-18.91911
7	11	Grade 60	-11.853823	-15.696999
8	11	Grade 60	-16.723771	-10.354921
9	11	Grade 60	-19.335081	-3.614353
10	11	Grade 60	-19.335081	3.614353
11	11	Grade 60	-16.723771	10.354921
12	11	Grade 60	-11.853823	15.696999
13	11	Grade 60	-5.382951	18.91911
14	11	Grade 60	1.814919	19.586091
15	11	Grade 60	8.767673	17.607862
16	11	Grade 60	14.536305	13.251593
17	11	Grade 60	18.341729	7.105624

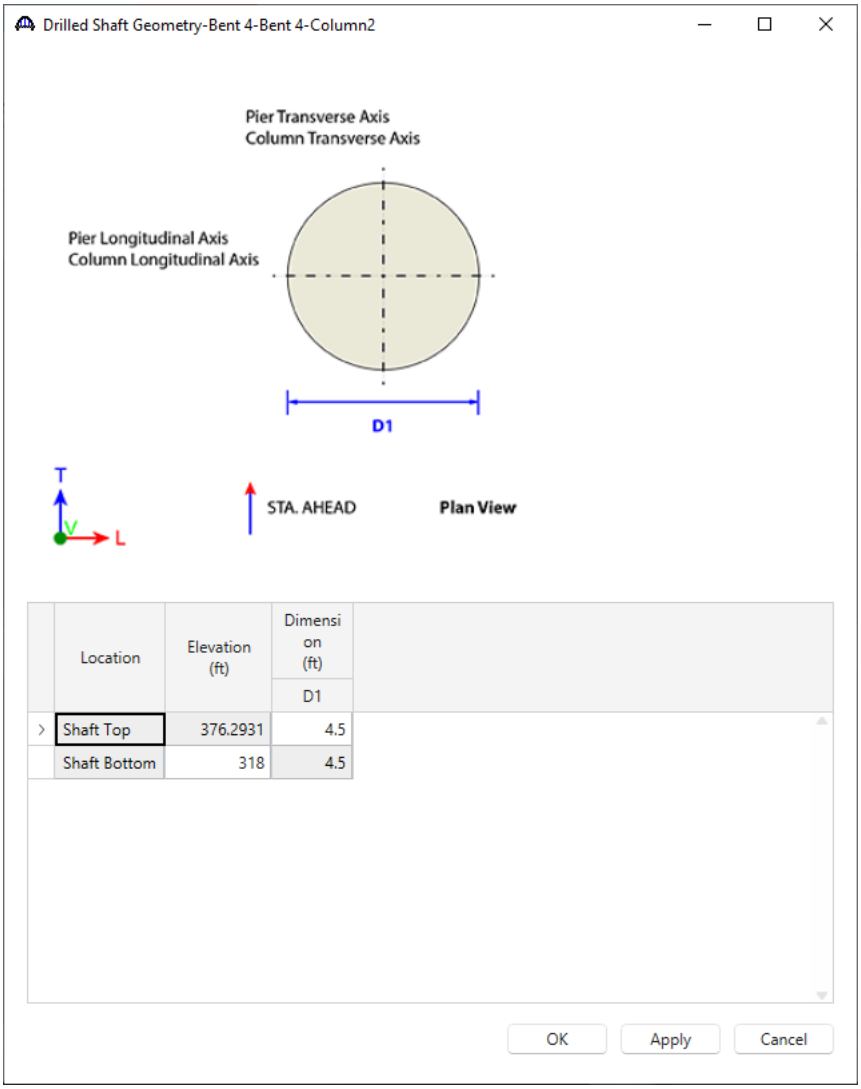

Column Reinforcement - Column2 - Bent 4 - Bent 4
Flexural
Shear
Set
Start distance (ft)
Straight length (ft)
End distance (ft)
Pattern
Hook at start
Hook at end
Developed at start
Developed at end
Follows profile
1
0.000
28.800
28.800
P1
New
Duplicate
Delete
OK
Apply
Cancel

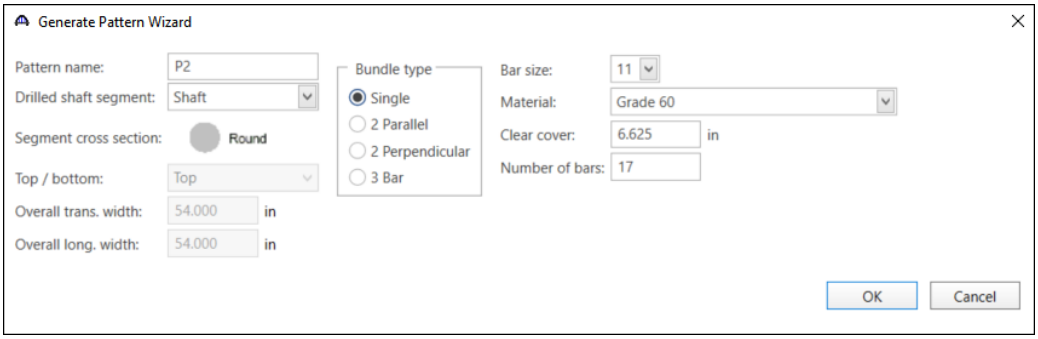

Column Reinforcement - Column2 - Bent 4 - Bent 4
Flexural
Shear
Shear reinforcement type
Ties
Spirals
Spirals designed as ties
Bar size
Pitch (in)
Material
Start distance (ft)
Length (ft)
End distance (ft)
5
12.0000
Grade 60
0.000
19.800
19.800
5
6.0000
Grade 60
19.800
9.000
28.800
New
Duplicate
Delete
OK
Apply
Cancel

C2 Shaft


New Foundation Alternative Wizard
Spread Footing
Pile Footing
Single Drilled Shaft
< Back
Next >
Cancel
Help


New Foundation Alternative Wizard
Type:
Drilled-Shaft Foundation
Name:
C2 Shaft
Description:
Units:
US Customary
Top of shaft elevation:
376.29
ft
Bottom of shaft elevation:
318.00
ft
Shaft diameter:
4.50
ft
Shaft material:
Class AA
Rock socket:
Bottom of socket elevation:
ft
Socket diameter:
ft
Socket material:
Class AA
< Back
Finish
Cancel
Help

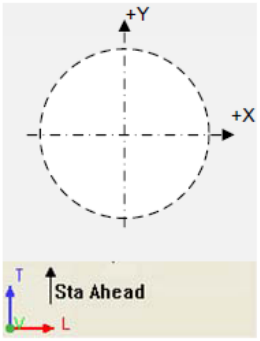

Drilled Shaft Geometry-Bent 4-Bent 4-Column2
Pier Transverse Axis
Column Transverse Axis
Pier Longitudinal Axis
Column Longitudinal Axis
D1
T
V
L
STA. AHEAD
Plan View
Location
Elevation (ft)
Dimension (ft)
D1
Shaft Top
376.2931
4.5
Shaft Bottom
318
4.5
OK
Apply
Cancel


Generate Pattern Wizard
Pattern name:
P2
Drilled shaft segment:
Shaft
Segment cross section:
Round
Top / bottom:
Top
Overall trans. width:
54.000
in
Overall long. width:
54.000
in
Bundle type
Single
2 Parallel
2 Perpendicular
3 Bar
Bar size:
11
Material:
Grade 60
Clear cover:
6.625
in
Number of bars:
17
OK
Cancel

Drilled Shaft Reinforcement Def - Bent 4 - Bent 4 - Column2

Name: P2

Bundle bars



Bar	Bar size	Material	X (in)	Y (in)
1	11	Grade 60	19.67	0
2	11	Grade 60	18.341729	-7.105624
3	11	Grade 60	14.536305	-13.251593
4	11	Grade 60	8.767673	-17.607862
5	11	Grade 60	1.814919	-19.586091
6	11	Grade 60	-5.382951	-18.91911
7	11	Grade 60	-11.853823	-15.696999
8	11	Grade 60	-16.723771	-10.354921
9	11	Grade 60	-19.335081	-3.614353
10	11	Grade 60	-19.335081	3.614353
11	11	Grade 60	-16.723771	10.354921
12	11	Grade 60	-11.853823	15.696999
13	11	Grade 60	-5.382951	18.91911
14	11	Grade 60	1.814919	19.586091
15	11	Grade 60	8.767673	17.607862
16	11	Grade 60	14.536305	13.251593
17	11	Grade 60	18.341729	7.105624

Generate pattern | New | Duplicate | Delete

OK | Apply | Cancel

Drilled Shaft Reinforcement - Bent 4 - Bent 4 - Column2

Flexural | Shear

Set	Start distance (ft)	Straight length (ft)	End distance (ft)	Pattern	Hook at start	Hook at end	Developed at start	Developed at end
1	0.000	58.290	58.290	P2	☐	☐	☑	☐

Drilled Shaft Reinforcement - Bent 4 - Bent 4 - Column2

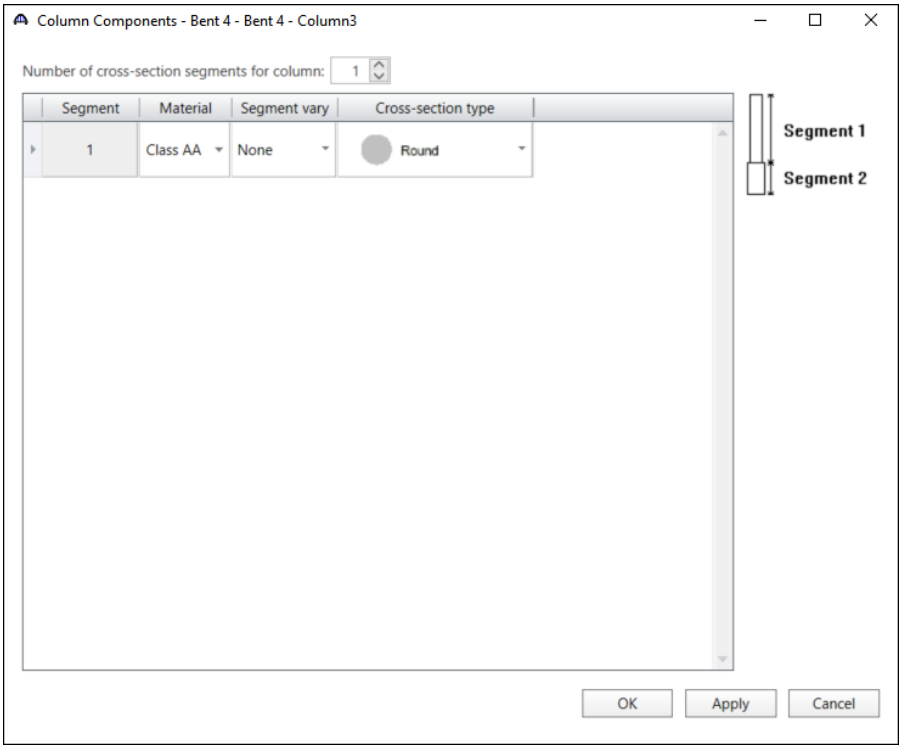
Flexural | Shear

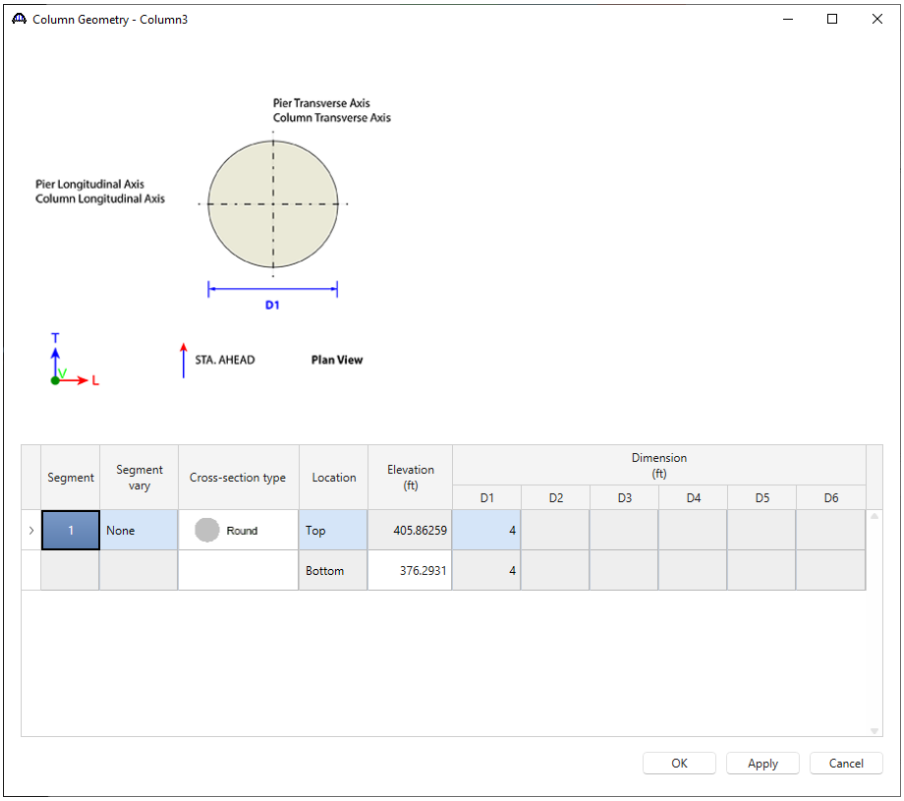
Shear reinforcement type

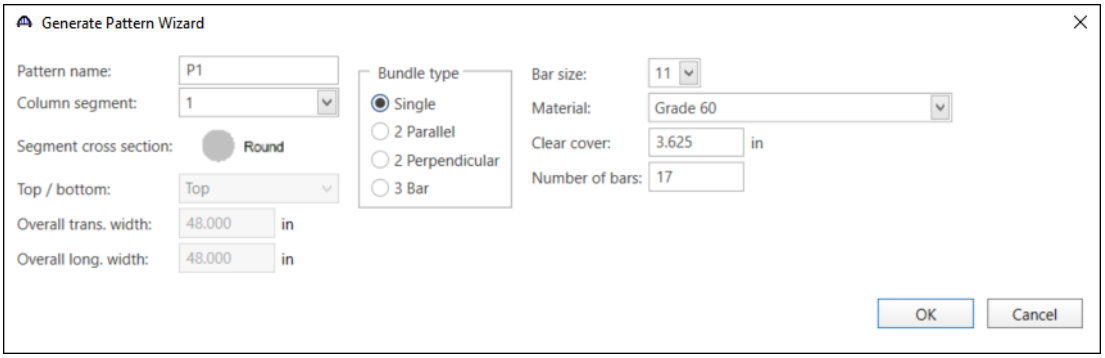
○ Ties ○ Spirals ◉ Spirals designed as ties

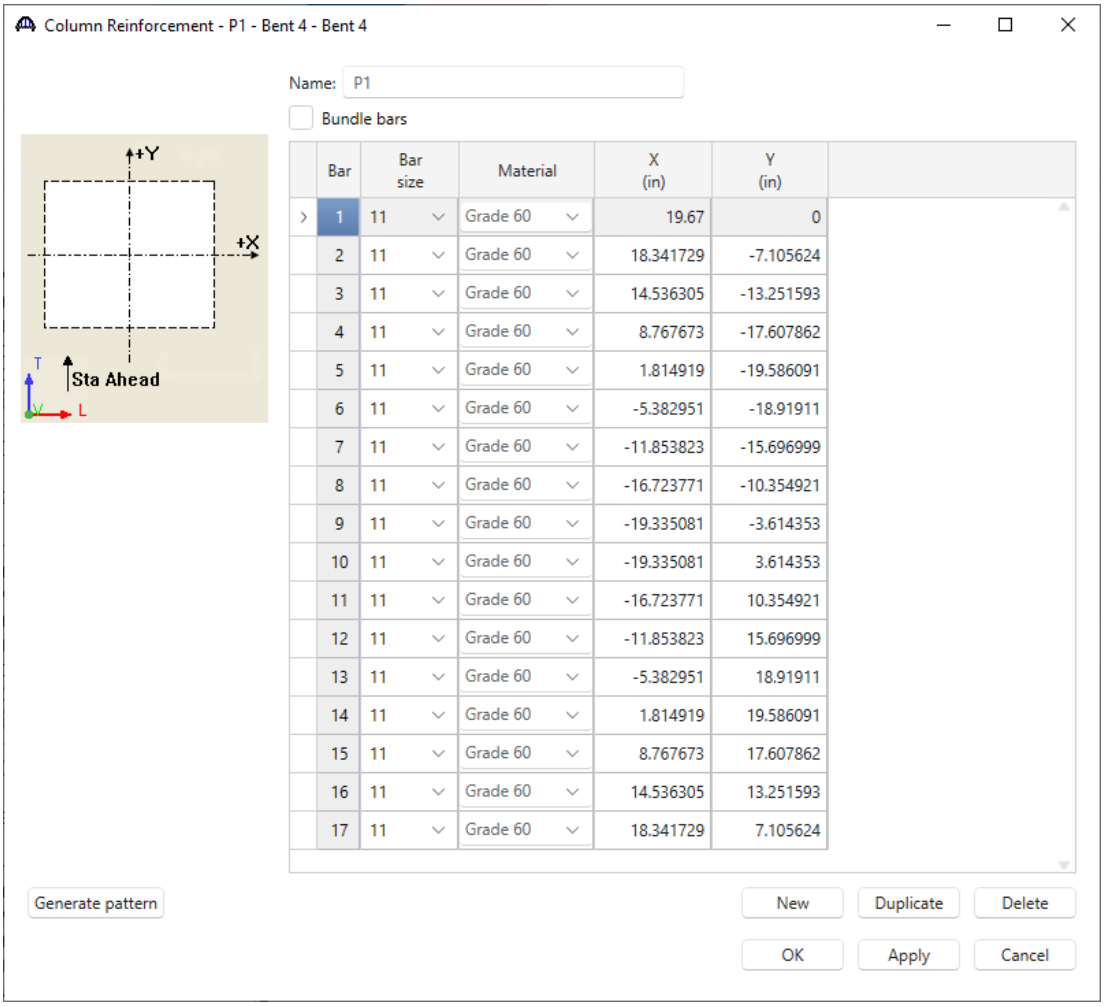
Bar size	Pitch (in)	Material	Start distance (ft)	Length (ft)	End distance (ft)
5	6.00	Grade 60	0.000	9.000	9.000
5	12.00	Grade 60	9.000	49.290	58.290

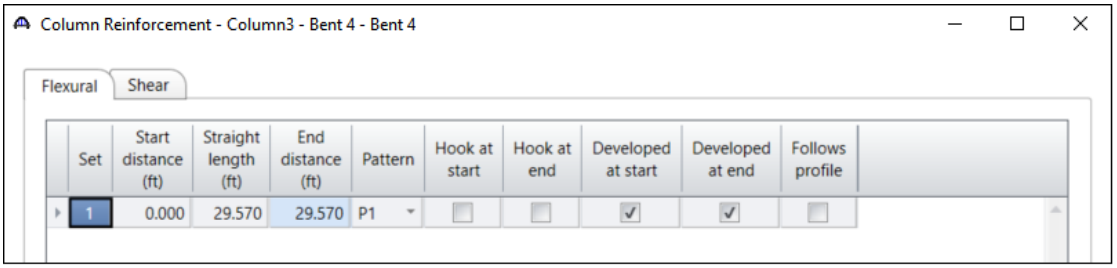
Column 3

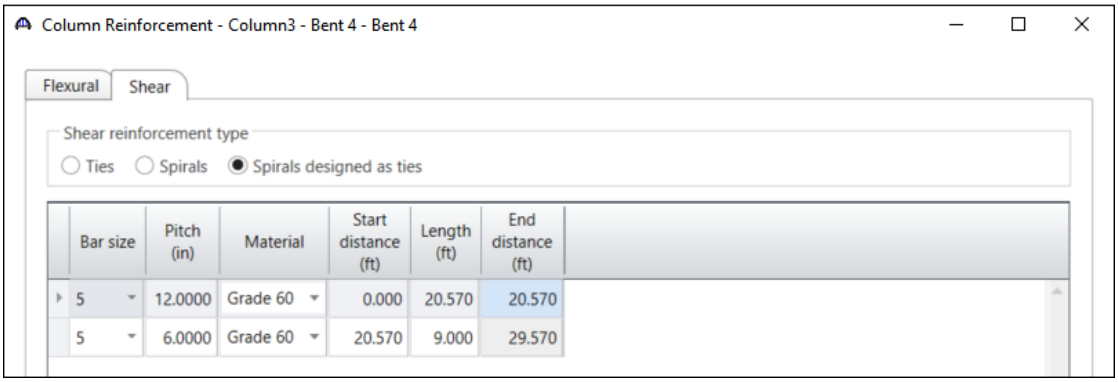

Column Components - Bent 4 - Bent 4 - Column3
Number of cross-section segments for column: 1
Segment
Material
Segment vary
Cross-section type
1
Class AA
None
Round
Segment 1
Segment 2
OK
Apply
Cancel


Column Geometry - Column3
Pier Transverse Axis
Column Transverse Axis
Pier Longitudinal Axis
Column Longitudinal Axis
D1
T
V
L
STA. AHEAD
Plan View
Segment
Segment vary
Cross-section type
Location
Elevation (ft)
Dimension (ft)
D1
D2
D3
D4
D5
D6
1
None
Round
Top
405.86259
4
Bottom
376.2931
4
OK
Apply
Cancel

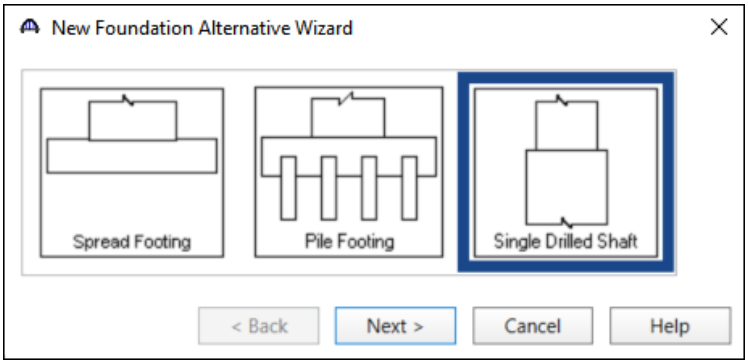

Generate Pattern Wizard
Pattern name:
P1
Column segment:
1
Segment cross section:
Round
Top / bottom:
Top
Overall trans. width:
48.000
in
Overall long. width:
48.000
in
Bundle type
Single
2 Parallel
2 Perpendicular
3 Bar
Bar size:
11
Material:
Grade 60
Clear cover:
3.625
in
Number of bars:
17
OK
Cancel

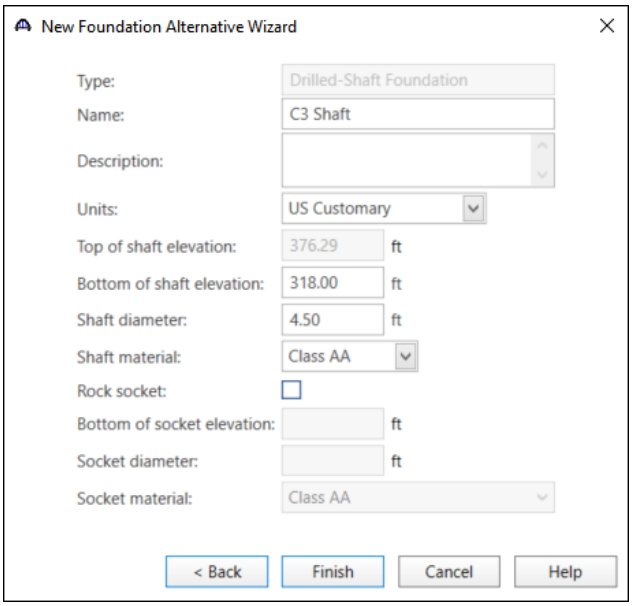

Column Reinforcement - P1 - Bent 4 - Bent 4
Name:
P1
Bundle bars
+Y
+X
Sta Ahead
T
V
L
Bar
Bar size
Material
X (in)
Y (in)
1 11 Grade 60 19.67 0
2 11 Grade 60 18.341729 -7.105624
3 11 Grade 60 14.536305 -13.251593
4 11 Grade 60 8.767673 -17.607862
5 11 Grade 60 1.814919 -19.586091
6 11 Grade 60 -5.382951 -18.91911
7 11 Grade 60 -11.853823 -15.696999
8 11 Grade 60 -16.723771 -10.354921
9 11 Grade 60 -19.335081 -3.614353
10 11 Grade 60 -19.335081 3.614353
11 11 Grade 60 -16.723771 10.354921
12 11 Grade 60 -11.853823 15.696999
13 11 Grade 60 -5.382951 18.91911
14 11 Grade 60 1.814919 19.586091
15 11 Grade 60 8.767673 17.607862
16 11 Grade 60 14.536305 13.251593
17 11 Grade 60 18.341729 7.105624
Generate pattern
New
Duplicate
Delete
OK
Apply
Cancel

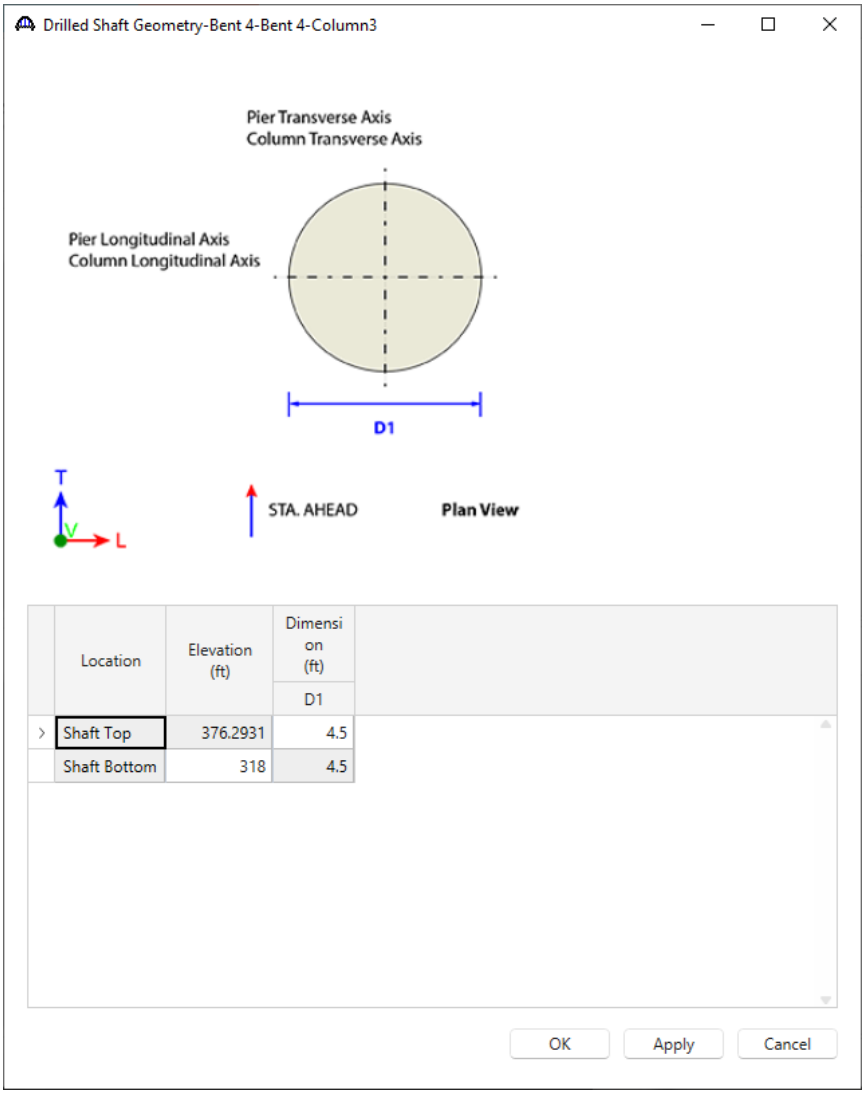

Column Reinforcement - Column3 - Bent 4 - Bent 4
Flexural
Shear
Set
Start distance (ft)
Straight length (ft)
End distance (ft)
Pattern
Hook at start
Hook at end
Developed at start
Developed at end
Follows profile
1
0.000
29.570
29.570
P1

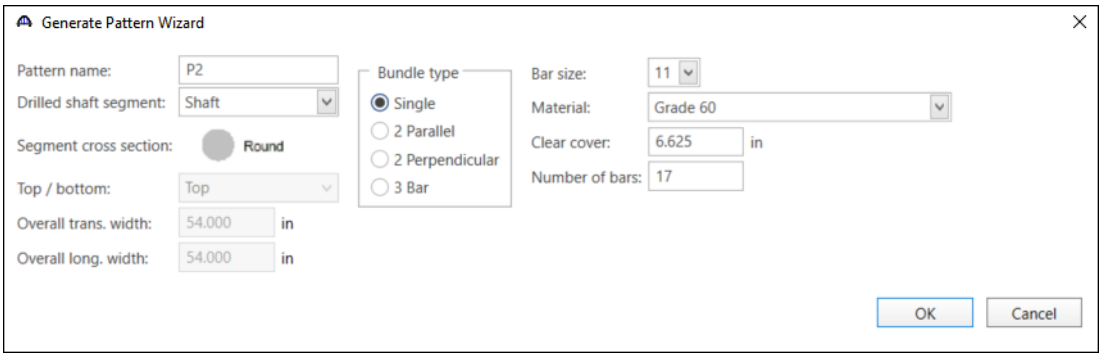

Column Reinforcement - Column3 - Bent 4 - Bent 4
Flexural
Shear
Shear reinforcement type
Ties
Spirals
Spirals designed as ties
Bar size
Pitch (in)
Material
Start distance (ft)
Length (ft)
End distance (ft)
5
12.0000
Grade 60
0.000
20.570
20.570
5
6.0000
Grade 60
20.570
9.000
29.570

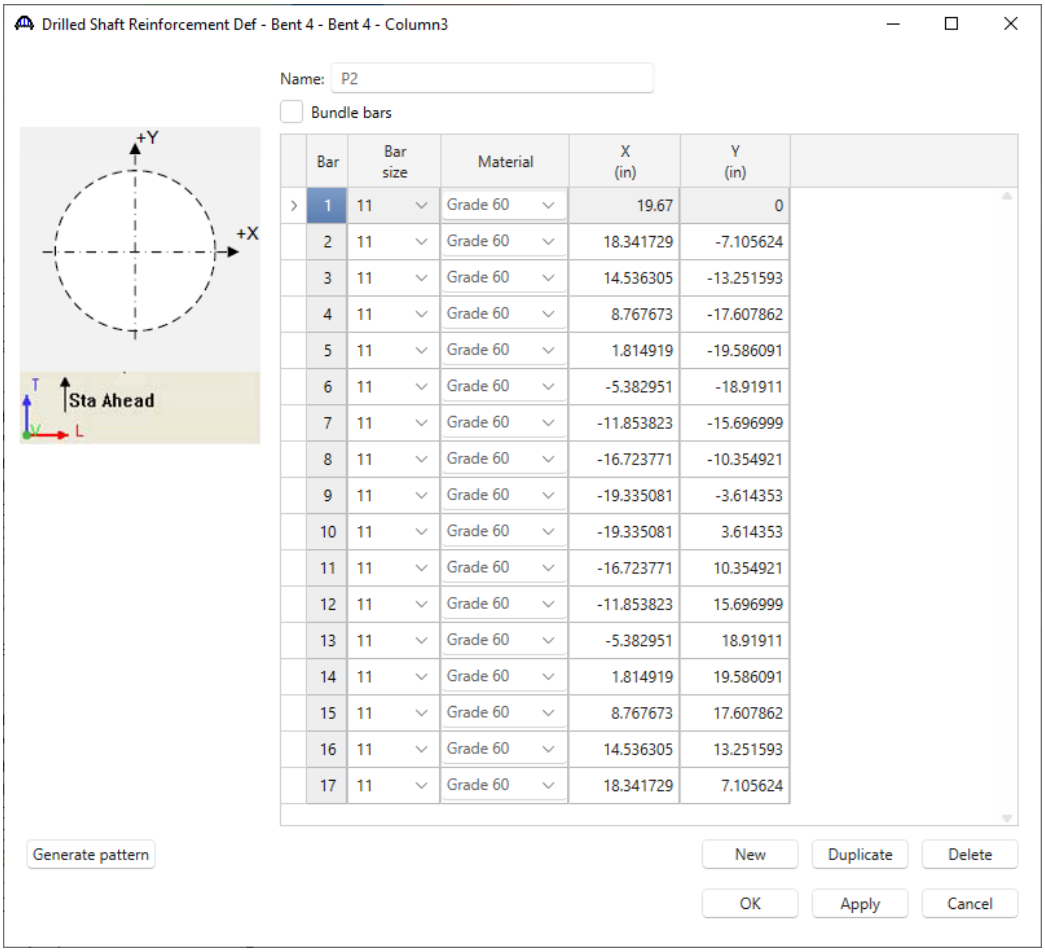
C3 Shaft

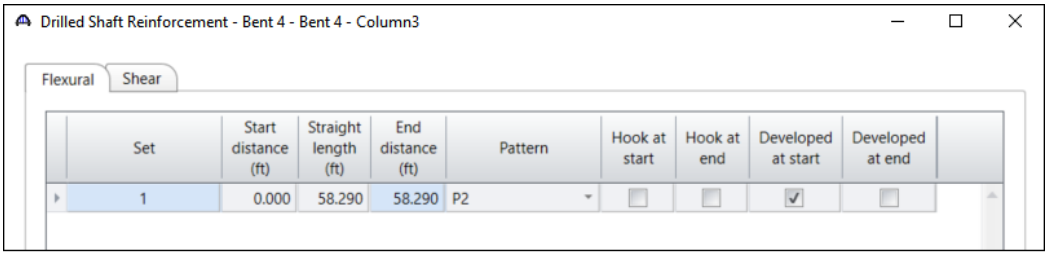

New Foundation Alternative Wizard
Spread Footing
Pile Footing
Single Drilled Shaft
< Back
Next >
Cancel
Help

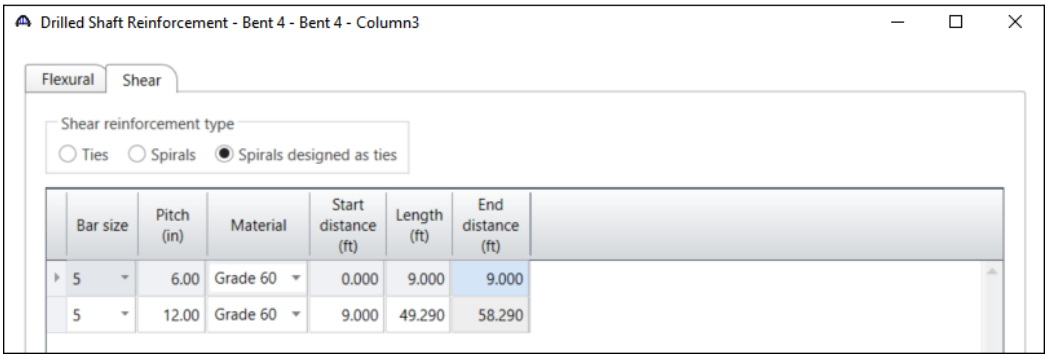

New Foundation Alternative Wizard
Type:
Drilled-Shaft Foundation
Name:
C3 Shaft
Description:
Units:
US Customary
Top of shaft elevation:
376.29
ft
Bottom of shaft elevation:
318.00
ft
Shaft diameter:
4.50
ft
Shaft material:
Class AA
Rock socket:
Bottom of socket elevation:
ft
Socket diameter:
ft
Socket material:
Class AA
< Back
Finish
Cancel
Help


Drilled Shaft Geometry-Bent 4-Bent 4-Column3
Pier Transverse Axis
Column Transverse Axis
Pier Longitudinal Axis
Column Longitudinal Axis
D1
T
V
L
STA. AHEAD
Plan View
Location
Elevation (ft)
Dimension (ft)
D1
Shaft Top
376.2931
4.5
Shaft Bottom
318
4.5
OK
Apply
Cancel


Generate Pattern Wizard
Pattern name:
P2
Drilled shaft segment:
Shaft
Segment cross section:
Round
Top / bottom:
Top
Overall trans. width:
54.000
in
Overall long. width:
54.000
in
Bundle type
Single
2 Parallel
2 Perpendicular
3 Bar
Bar size:
11
Material:
Grade 60
Clear cover:
6.625
in
Number of bars:
17
OK
Cancel





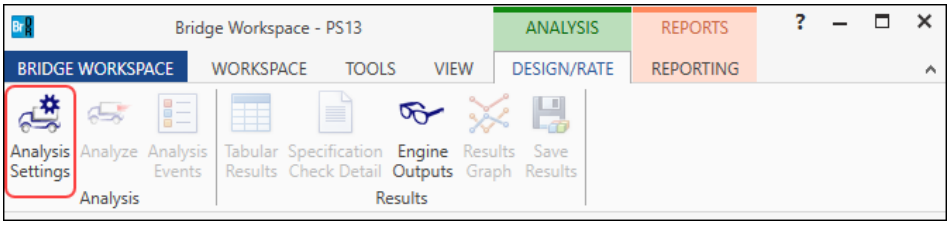


All the data entry for the pier columns is now complete.

Analysis and Results

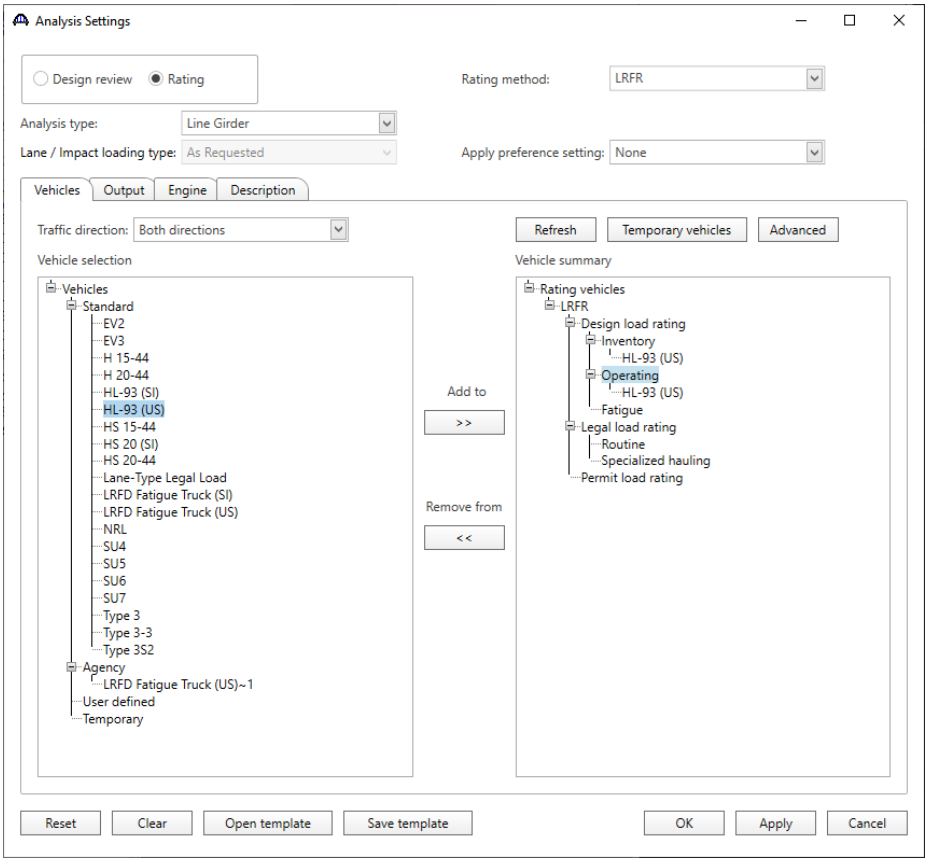
Typically, the Superstructure Loads and Substructure Loads windows can be opened and have the program automatically compute the loads to be applied to the substructure unit. However, Bent 4 in this example cannot be analyzed with the current version of the program. The is due to the splayed framing plans and the varying overhangs of this structure from the back span to the ahead span.

The superstructure can still be analyzed. To perform an **LRFR or LFR** rating, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.

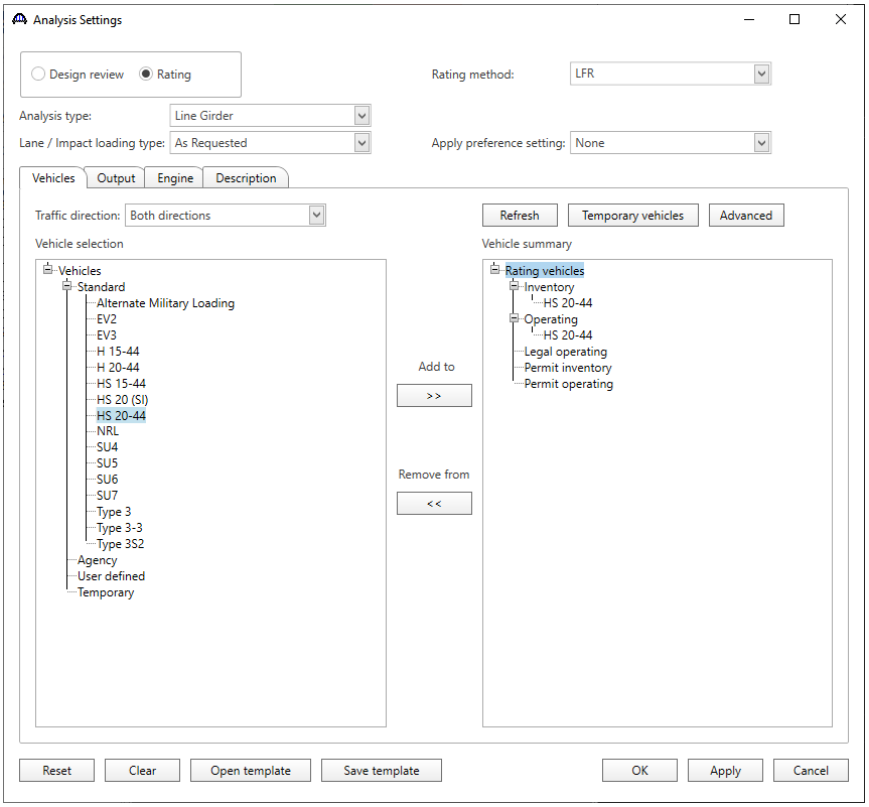


Choose the desired rating method and vehicles. See images below for analysis settings for both **LRFR** and **LFR** analysis.

LRFR



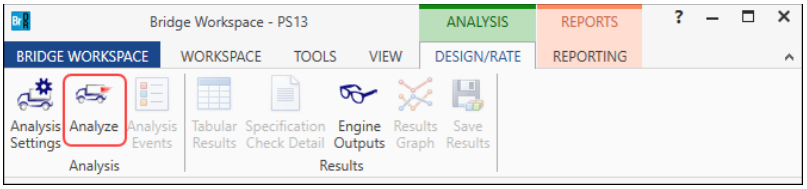
LFR



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

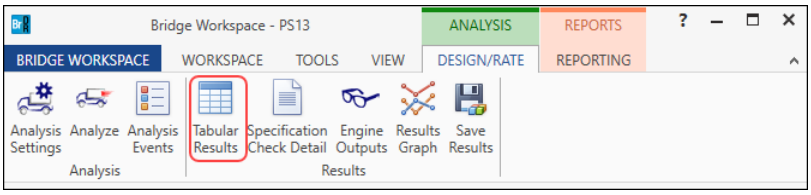
The entire structure, an individual superstructure or an individual member alternative can be analyzed by selecting either of them on the **Bridge Workspace** tree as shown below.

Select the **G1 (E)(C)** member alternative for superstructure **Span 3** in the **Bridge Workspace**. Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



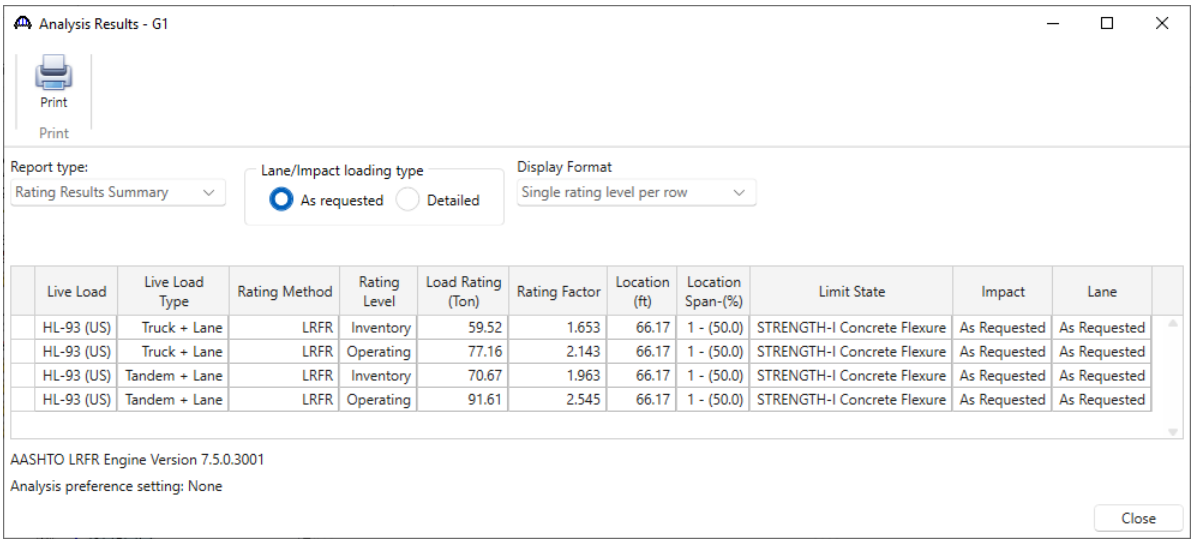
Tabular Results

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



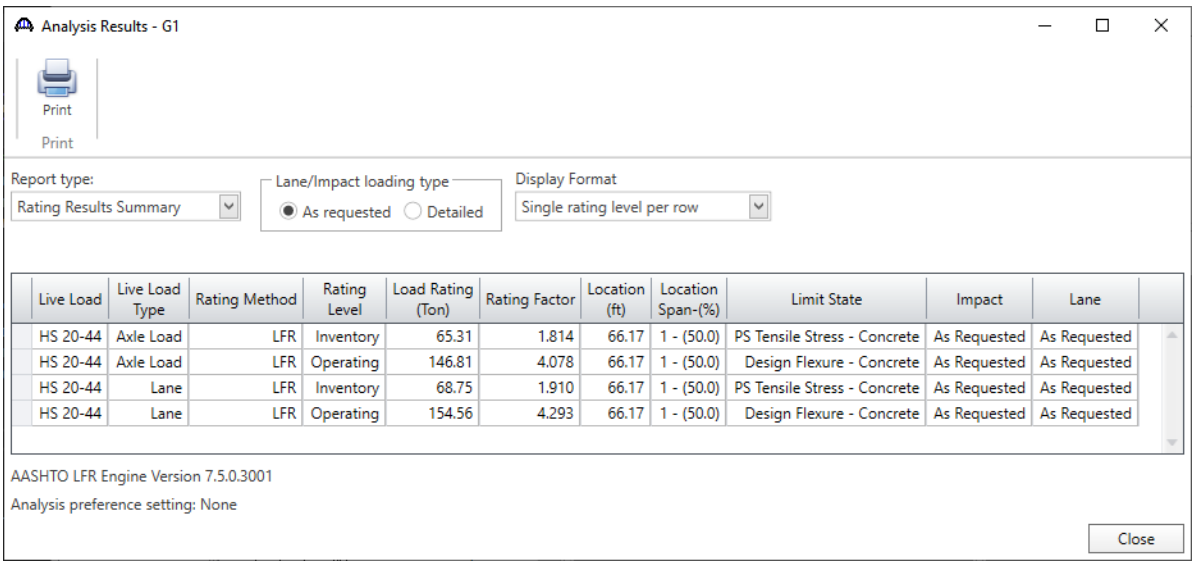
LRFR and **LFR** results for **Span 3, G1** are shown below.

LRFR



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HL-93 (US)	Truck + Lane	LRFR	Inventory	59.52	1.653	66.17	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	77.16	2.143	66.17	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	70.67	1.963	66.17	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	91.61	2.545	66.17	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested

LFR



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Axle Load	LFR	Inventory	65.31	1.814	66.17	1 - (50.0)	PS Tensile Stress - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	146.81	4.078	66.17	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Lane	LFR	Inventory	68.75	1.910	66.17	1 - (50.0)	PS Tensile Stress - Concrete	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	154.56	4.293	66.17	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested