AASHTOWare BrD/BrR 7.2.0

Steel Structure Tutorial

STL2 - Two Span Plate Girder Example

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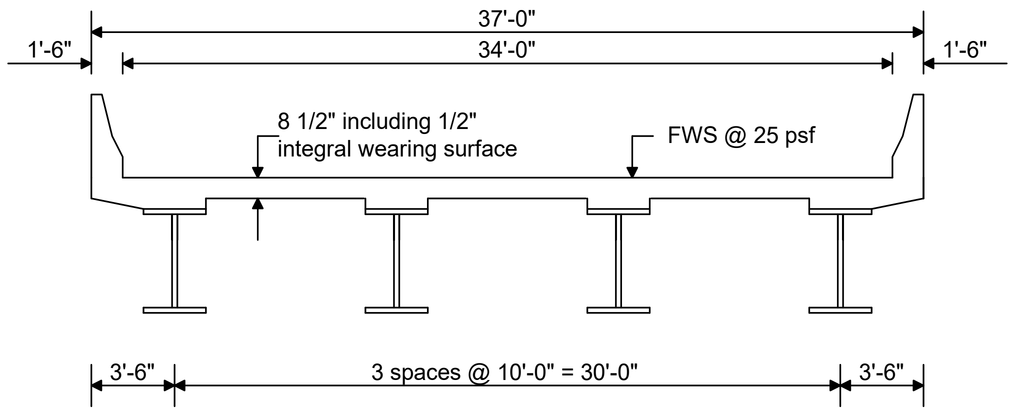
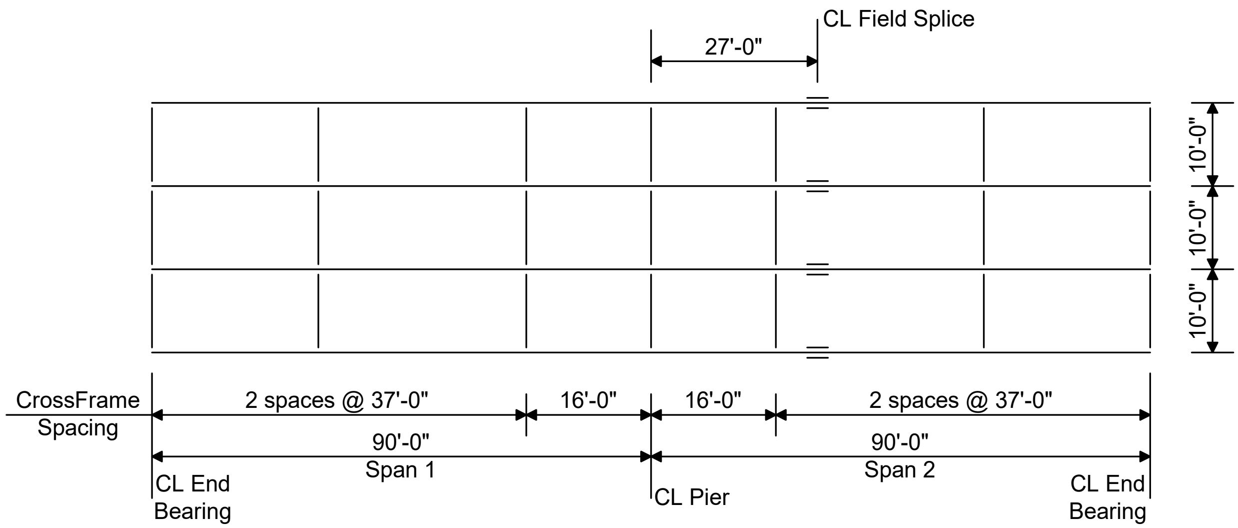
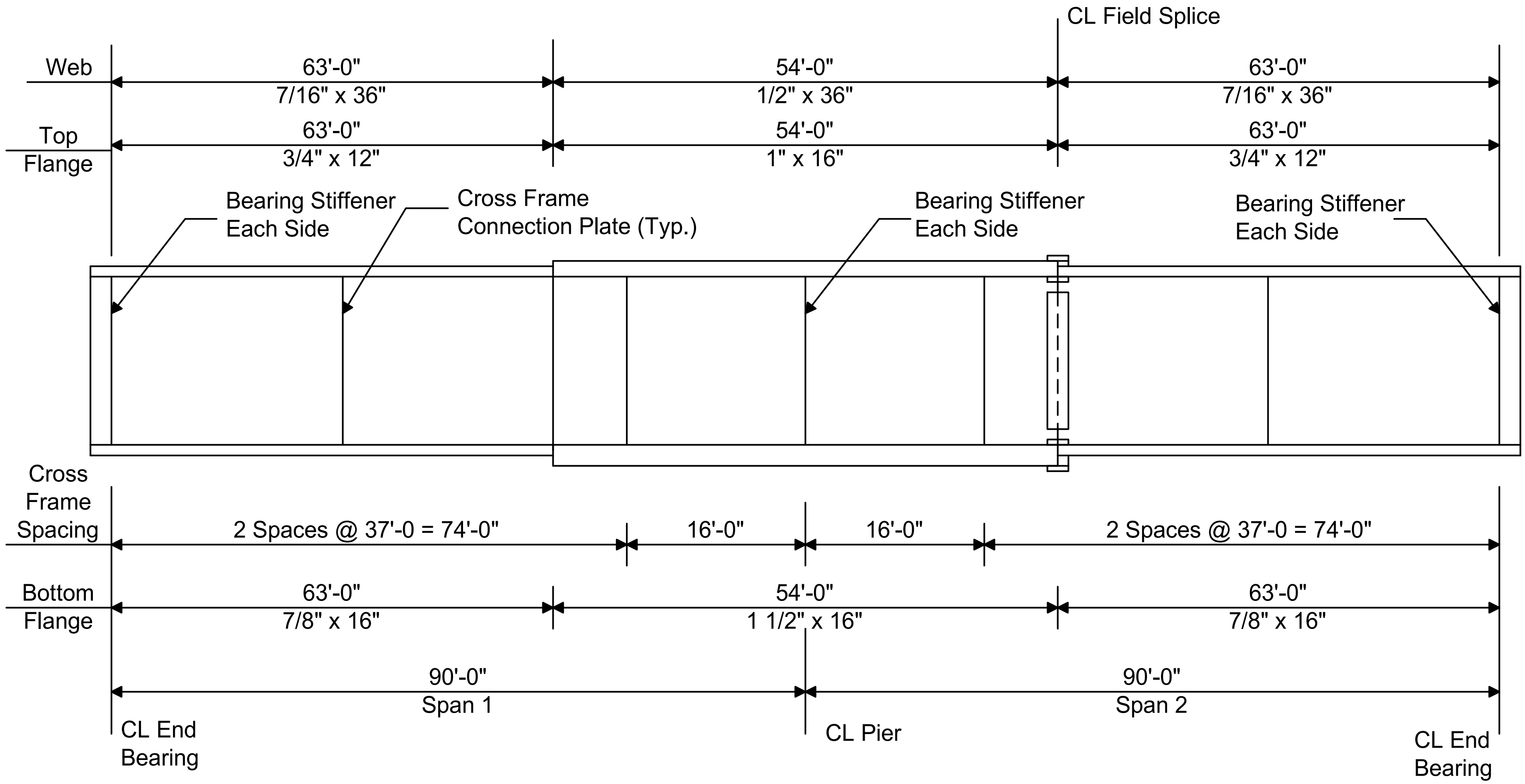
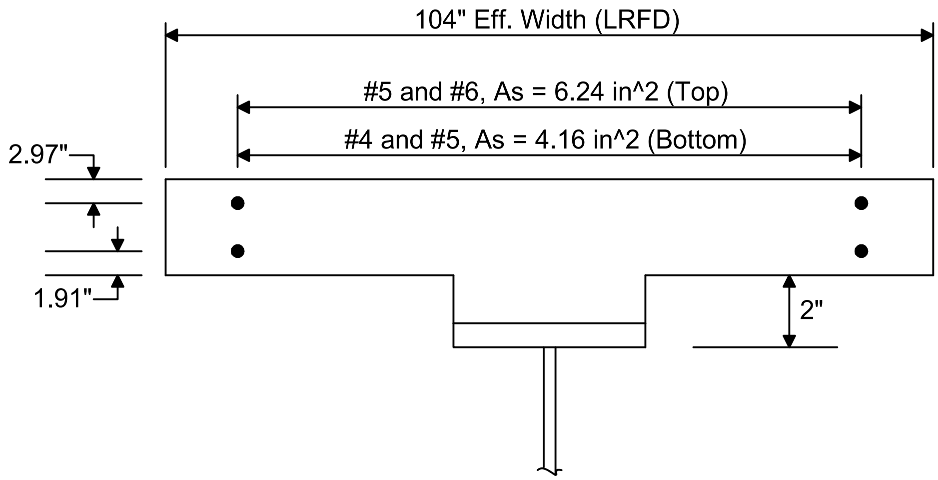




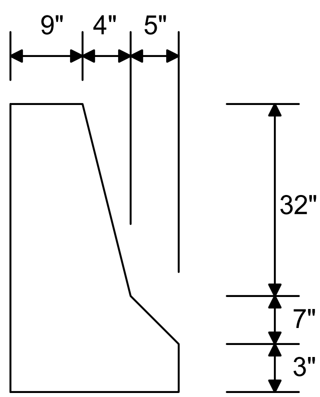
Framing Plan



Elevation of Interior Girder

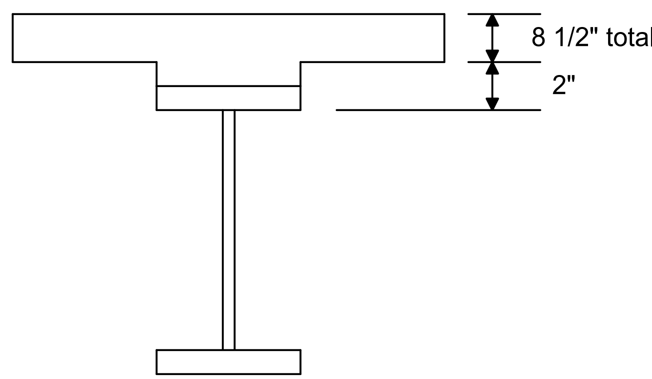


Composite Section at Pier



Weight = 536 plf

Parapet Detail



Haunch Detail

__Material Properties__

Structural Steel: AASHTO M270, Grade 50W uncoated weathering steel with Fy = 50 ksi

Deck Concrete: f'c = 4.0 ksi, modular ratio n = 8

Slab Reinforcing Steel: AASHTO M31, Grade 60 with Fy = 60 ksi

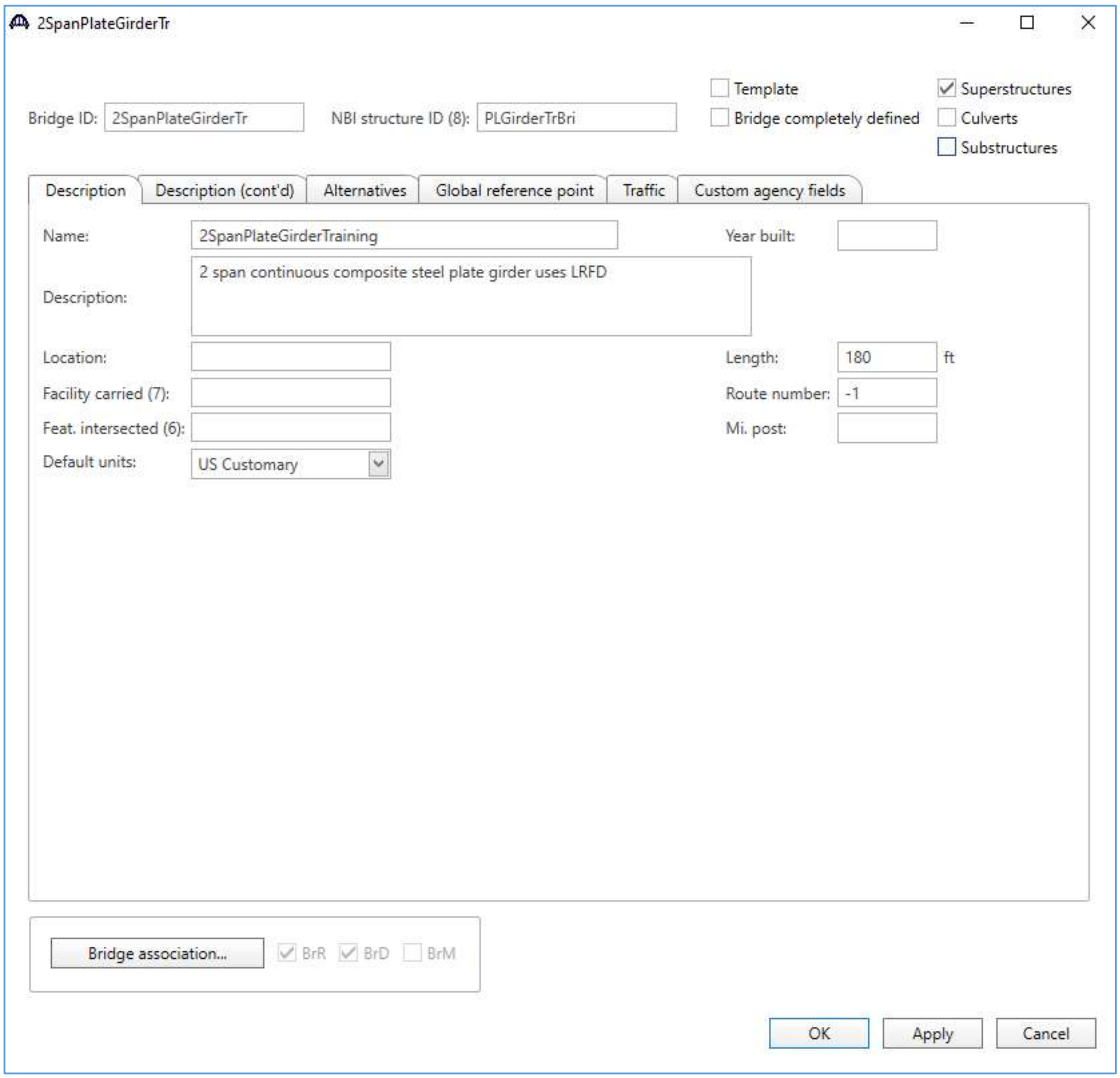
Cross Frame Connection Plates: 3/4" x 6"

Bearing Stiffener Plates: 7/8" x 9"

AASHTOWare Bridge Design and Rating Training

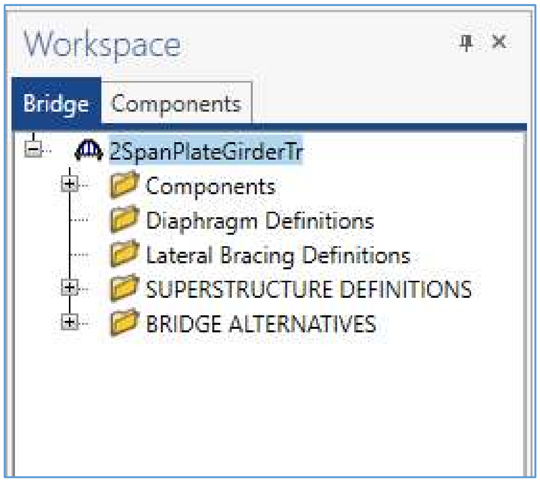
STL2 - Two Span Plate Girder Example

From the Bridge Explorer, click the New button under the BRIDGE tab in the ribbon to create a new bridge. Enter the following description data:

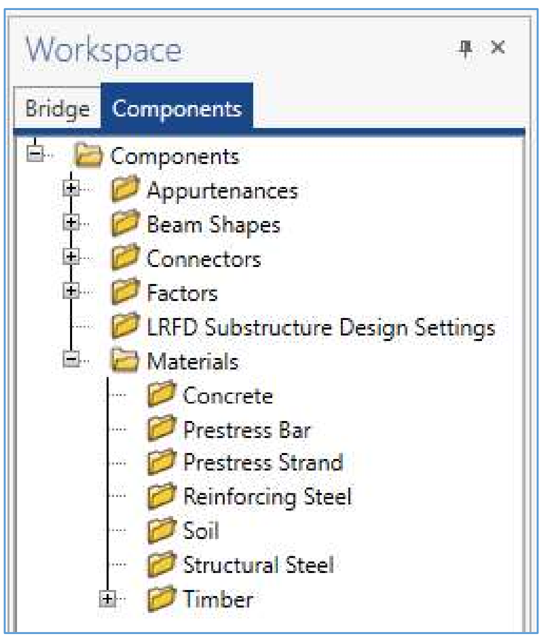


Close the window by clicking Ok. This saves the data to memory and closed the window.

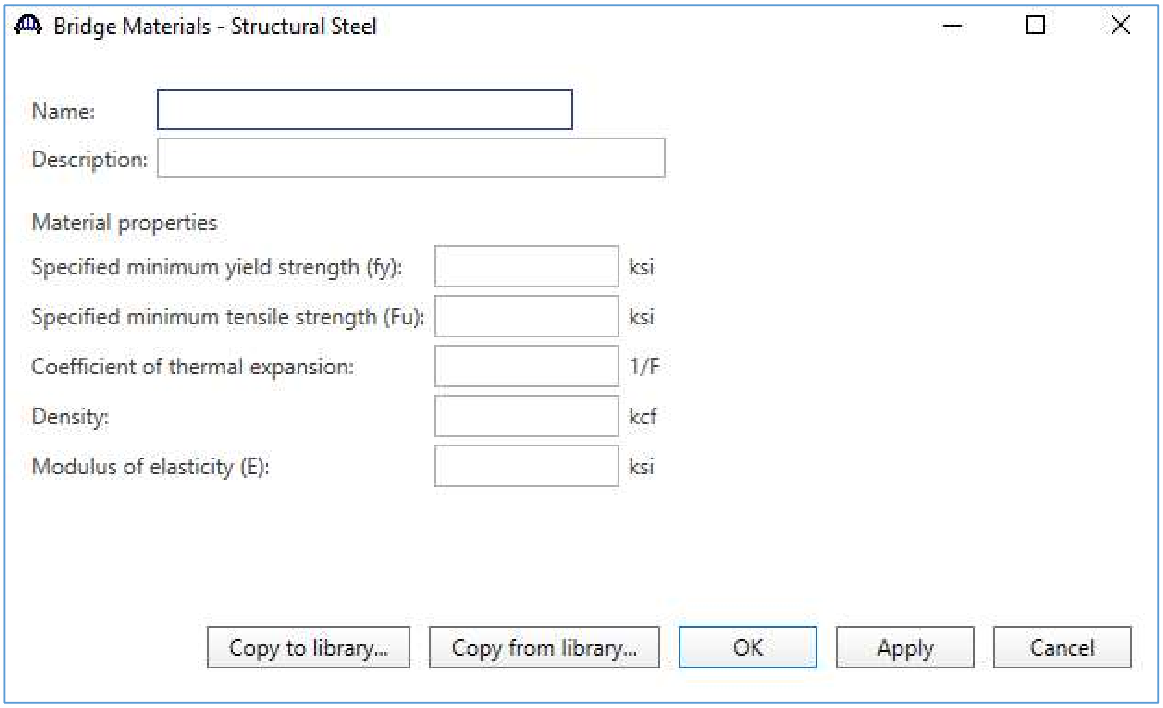
The Bridge Workspace tree after the bridge is created is shown below:



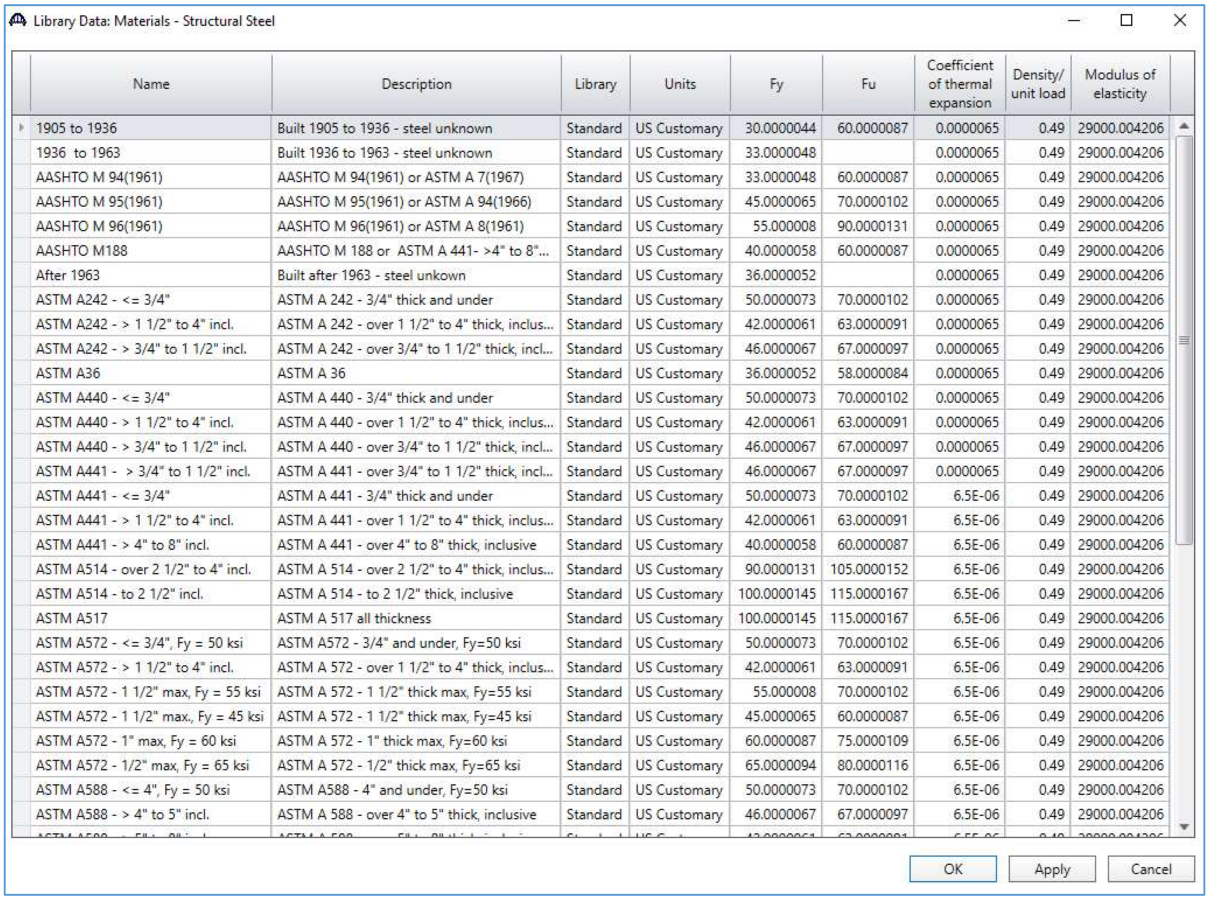
To enter the materials to be used by members of the bridge, click on the  to expand the tree for Materials under the Components tab. The tree with the expanded Materials branch is shown below:



To add a new structural steel material, click on Structural Steel in the tree and select File/New from the menu (or right mouse click on Structural Steel and select New). The window shown below will open.



Add structural steel materials by selecting from the Structural Steel Materials Library by clicking the Copy from Library button.

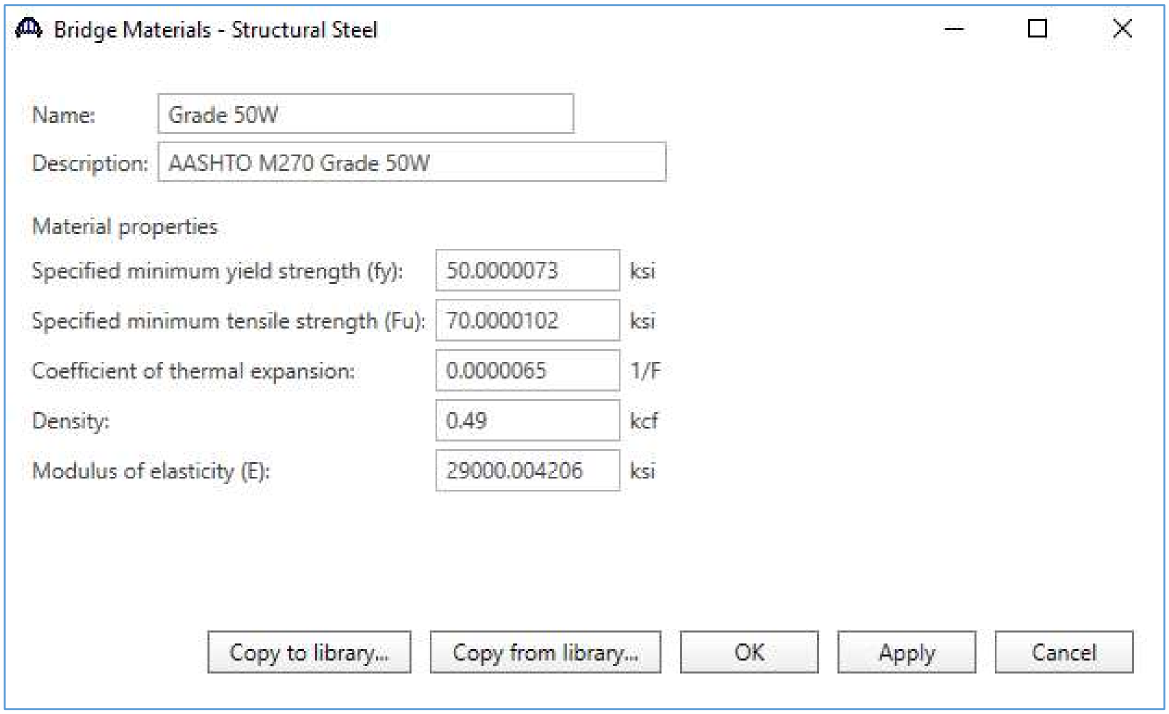


Library Data: Materials - Structural Steel

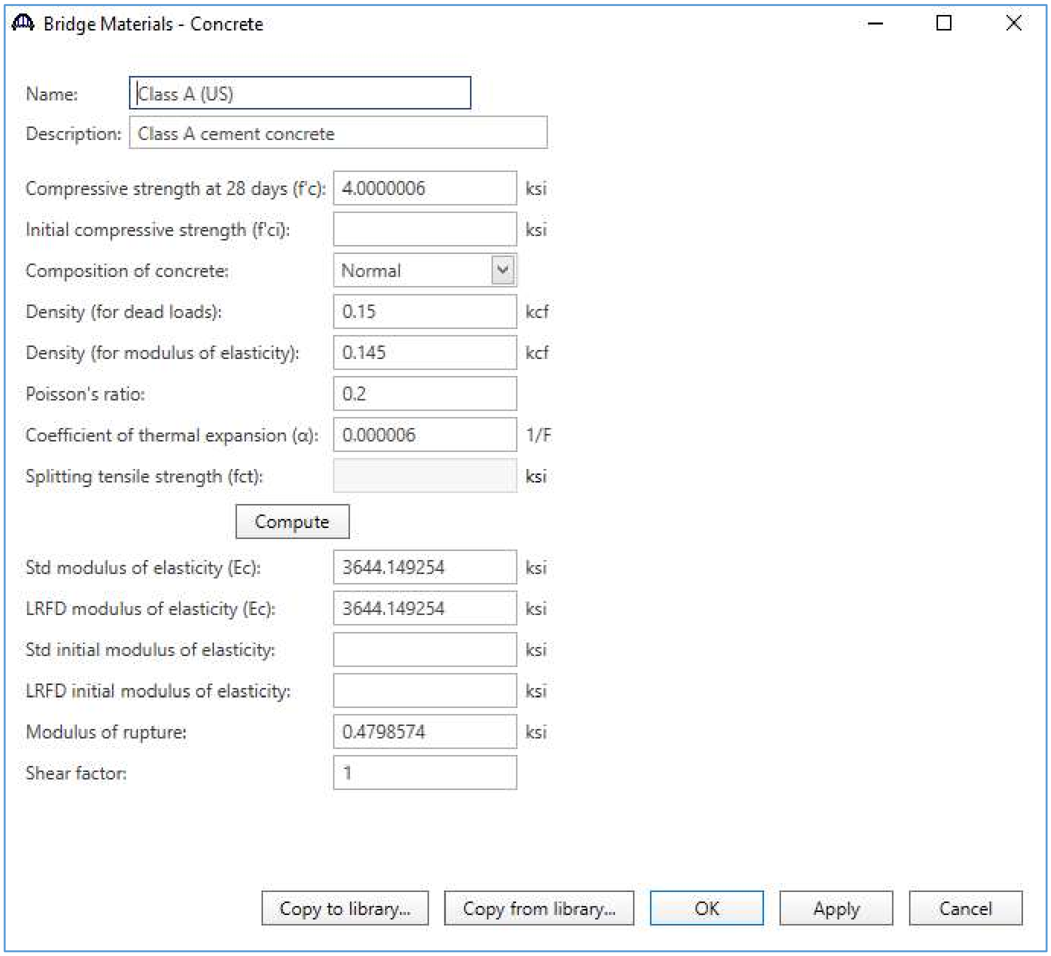
Name	Description	Library	Units	Fy	Fu	Coefficient of thermal expansion	Density/ unit load	Modulus of elasticity
1905 to 1936	Built 1905 to 1936 - steel unknown	Standard	US Customary	30.0000044	60.0000087	0.0000065	0.49	29000.004206
1936 to 1963	Built 1936 to 1963 - steel unknown	Standard	US Customary	33.0000048		0.0000065	0.49	29000.004206
AASHTO M 94(1961)	AASHTO M 94(1961) or ASTM A 7(1967)	Standard	US Customary	33.0000048	60.0000087	0.0000065	0.49	29000.004206
AASHTO M 95(1961)	AASHTO M 95(1961) or ASTM A 94(1966)	Standard	US Customary	45.0000065	70.0000102	0.0000065	0.49	29000.004206
AASHTO M 96(1961)	AASHTO M 96(1961) or ASTM A 8(1961)	Standard	US Customary	55.000008	90.0000131	0.0000065	0.49	29000.004206
AASHTO M188	AASHTO M 188 or ASTM A 441- >4" to 8"...	Standard	US Customary	40.0000058	60.0000087	0.0000065	0.49	29000.004206
After 1963	Built after 1963 - steel unkown	Standard	US Customary	36.0000052		0.0000065	0.49	29000.004206
ASTM A242 - <= 3/4"	ASTM A 242 - 3/4" thick and under	Standard	US Customary	50.0000073	70.0000102	0.0000065	0.49	29000.004206
ASTM A242 - > 1 1/2" to 4" incl.	ASTM A 242 - over 1 1/2" to 4" thick, inclus...	Standard	US Customary	42.0000061	63.0000091	0.0000065	0.49	29000.004206
ASTM A242 - > 3/4" to 1 1/2" incl.	ASTM A 242 - over 3/4" to 1 1/2" thick, incl...	Standard	US Customary	46.0000067	67.0000097	0.0000065	0.49	29000.004206
ASTM A36	ASTM A 36	Standard	US Customary	36.0000052	58.0000084	0.0000065	0.49	29000.004206
ASTM A440 - <= 3/4"	ASTM A 440 - 3/4" thick and under	Standard	US Customary	50.0000073	70.0000102	0.0000065	0.49	29000.004206
ASTM A440 - > 1 1/2" to 4" incl.	ASTM A 440 - over 1 1/2" to 4" thick, inclus...	Standard	US Customary	42.0000061	63.0000091	0.0000065	0.49	29000.004206
ASTM A440 - > 3/4" to 1 1/2" incl.	ASTM A 440 - over 3/4" to 1 1/2" thick, incl...	Standard	US Customary	46.0000067	67.0000097	0.0000065	0.49	29000.004206
ASTM A441 - > 3/4" to 1 1/2" incl.	ASTM A 441 - over 3/4" to 1 1/2" thick, incl...	Standard	US Customary	46.0000067	67.0000097	0.0000065	0.49	29000.004206
ASTM A441 - <= 3/4"	ASTM A 441 - 3/4" thick and under	Standard	US Customary	50.0000073	70.0000102	6.5E-06	0.49	29000.004206
ASTM A441 - > 1 1/2" to 4" incl.	ASTM A 441 - over 1 1/2" to 4" thick, inclus...	Standard	US Customary	42.0000061	63.0000091	6.5E-06	0.49	29000.004206
ASTM A441 - > 4" to 8" incl.	ASTM A 441 - over 4" to 8" thick, inclusive	Standard	US Customary	40.0000058	60.0000087	6.5E-06	0.49	29000.004206
ASTM A514 - over 2 1/2" to 4" incl.	ASTM A 514 - over 2 1/2" to 4" thick, inclus...	Standard	US Customary	90.0000131	105.0000152	6.5E-06	0.49	29000.004206
ASTM A514 - to 2 1/2" incl.	ASTM A 514 - to 2 1/2" thick, inclusive	Standard	US Customary	100.0000145	115.0000167	6.5E-06	0.49	29000.004206
ASTM A517	ASTM A 517 all thickness	Standard	US Customary	100.0000145	115.0000167	6.5E-06	0.49	29000.004206
ASTM A572 - <= 3/4", Fy = 50 ksi	ASTM A572 - 3/4" and under, Fy=50 ksi	Standard	US Customary	50.0000073	70.0000102	6.5E-06	0.49	29000.004206
ASTM A572 - > 1 1/2" to 4" incl.	ASTM A 572 - over 1 1/2" to 4" thick, inclus...	Standard	US Customary	42.0000061	63.0000091	6.5E-06	0.49	29000.004206
ASTM A572 - 1 1/2" max, Fy = 55 ksi	ASTM A 572 - 1 1/2" thick max, Fy=55 ksi	Standard	US Customary	55.000008	70.0000102	6.5E-06	0.49	29000.004206
ASTM A572 - 1 1/2" max., Fy = 45 ksi	ASTM A 572 - 1 1/2" thick max, Fy=45 ksi	Standard	US Customary	45.0000065	60.0000087	6.5E-06	0.49	29000.004206
ASTM A572 - 1" max, Fy = 60 ksi	ASTM A 572 - 1" thick max, Fy=60 ksi	Standard	US Customary	60.0000087	75.0000109	6.5E-06	0.49	29000.004206
ASTM A572 - 1/2" max, Fy = 65 ksi	ASTM A 572 - 1/2" thick max, Fy=65 ksi	Standard	US Customary	65.0000094	80.0000116	6.5E-06	0.49	29000.004206
ASTM A588 - <= 4", Fy = 50 ksi	ASTM A588 - 4" and under, Fy=50 ksi	Standard	US Customary	50.0000073	70.0000102	6.5E-06	0.49	29000.004206
ASTM A588 - > 4" to 5" incl.	ASTM A 588 - over 4" to 5" thick, inclusive	Standard	US Customary	46.0000067	67.0000097	6.5E-06	0.49	29000.004206

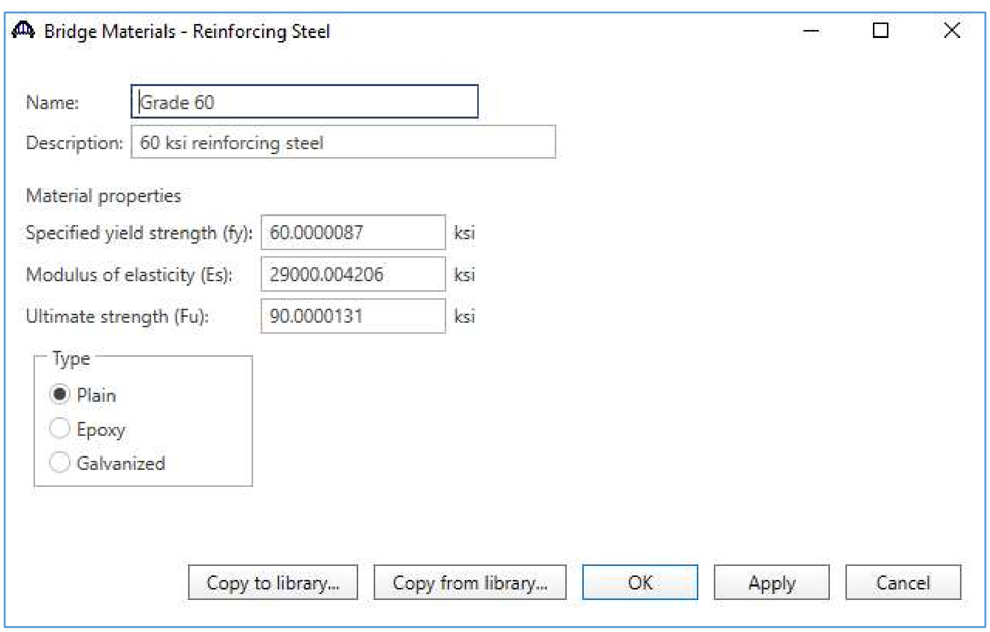
OK Apply Cancel

Select the AASHTO M270 Grade 50W material and click Ok. The selected material properties are copied to the Bridge Materials – Structural Steel window as shown below.

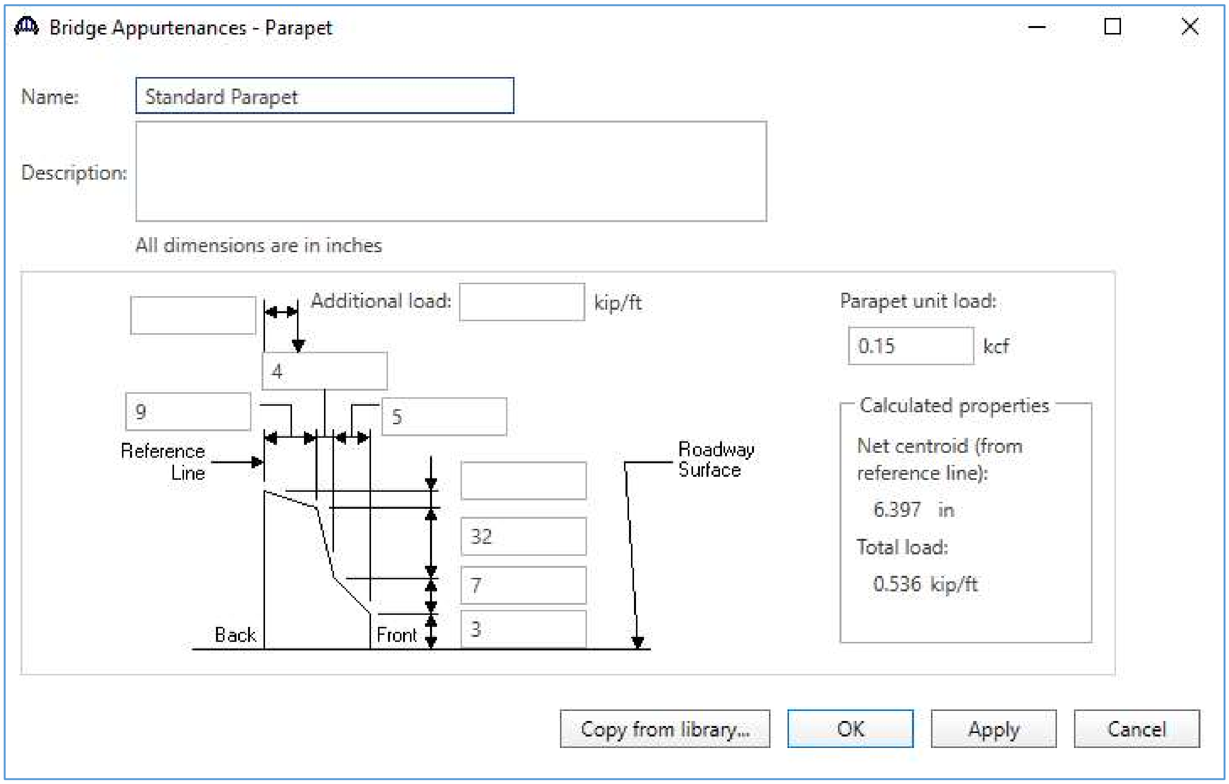


Add concrete and reinforcement materials using the same techniques. The windows will look like these:

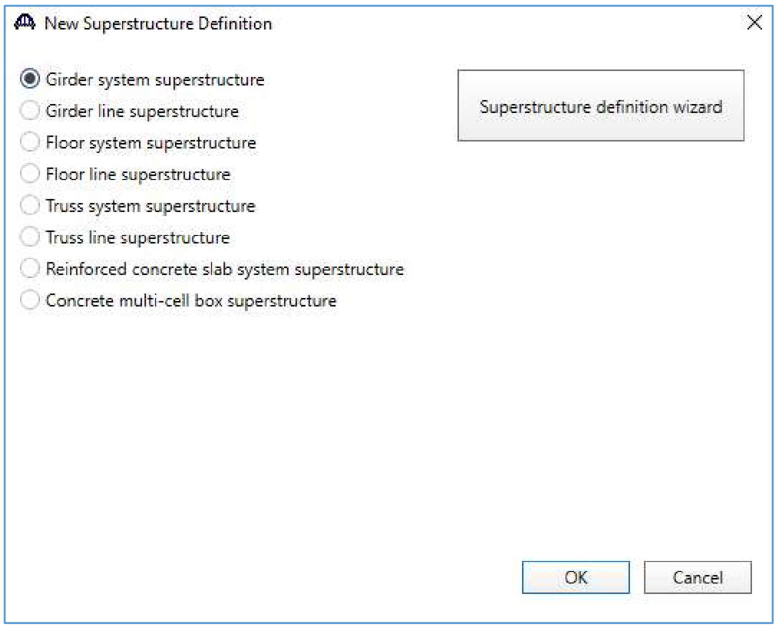




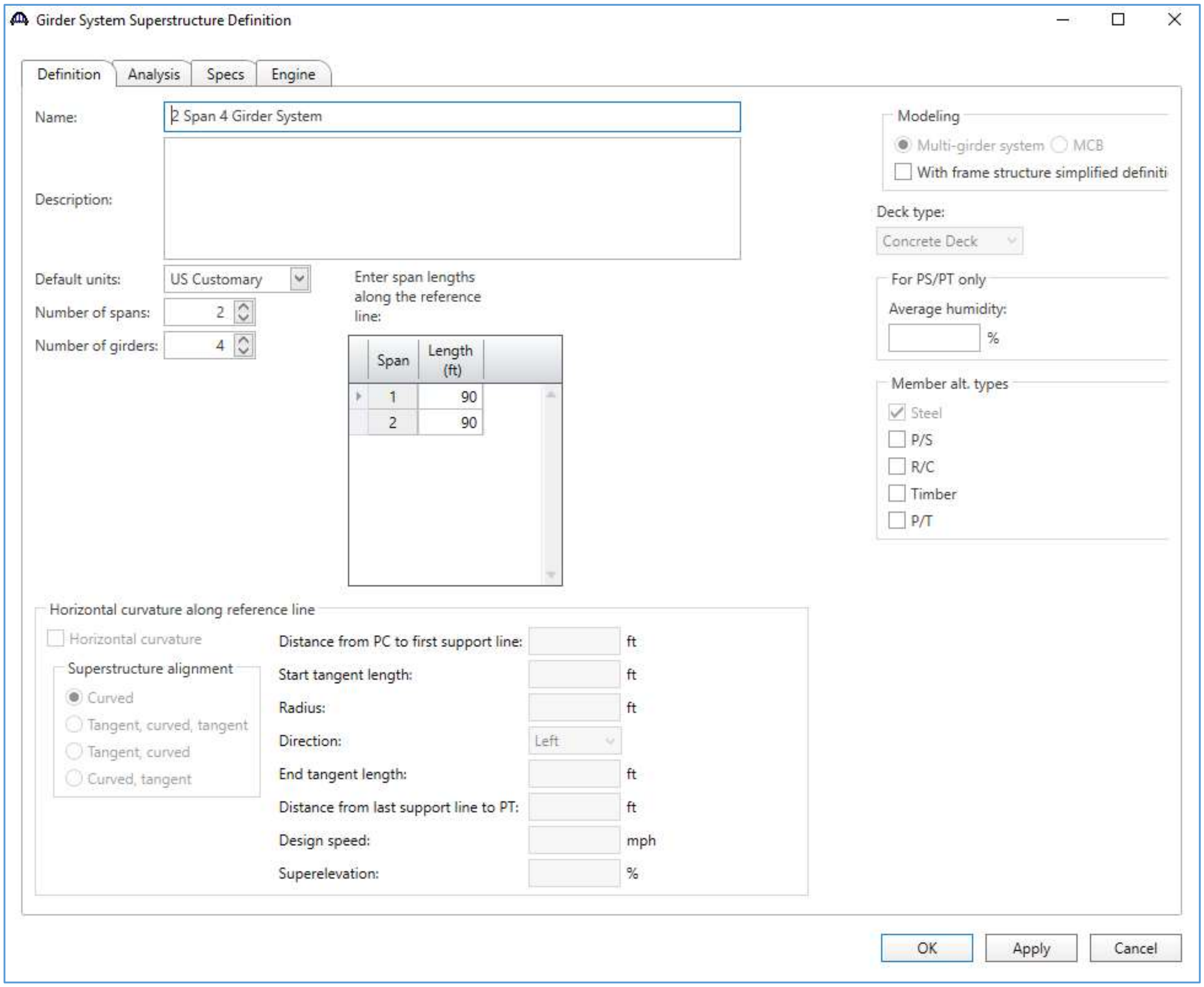
To enter the appurtenances to be used within the bridge expand the tree branch labeled Appurtenances. To define a parapet, double click on Parapet in the tree. Enter the parapet as shown below. Click Ok to save the data to memory and close the window.

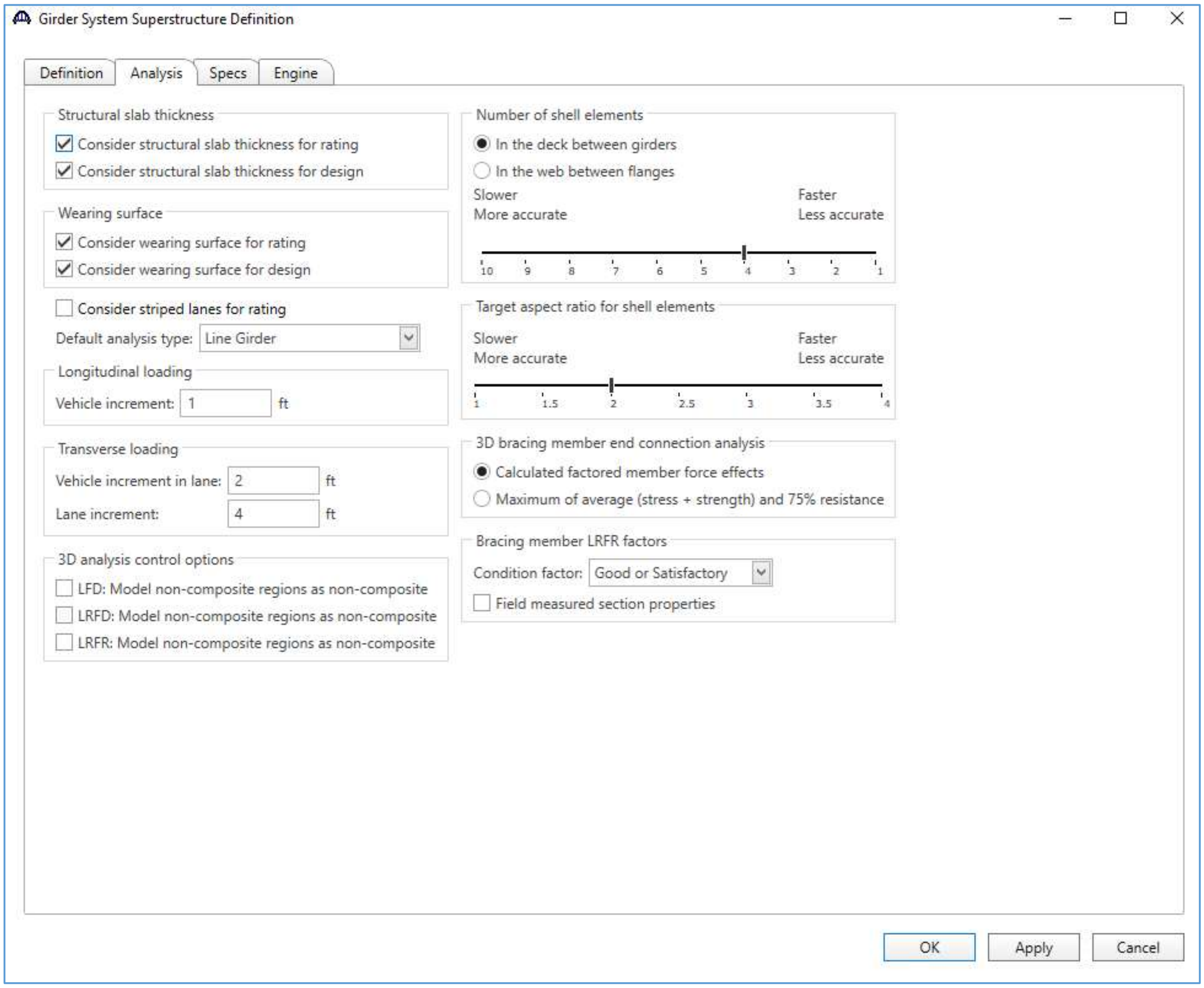


Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and click the New button under the WORKSPACE tab in the ribbon or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new structure definition. The dialog shown below will appear.



Select Girder System and the Structure Definition window will open. Enter the appropriate data as shown below:

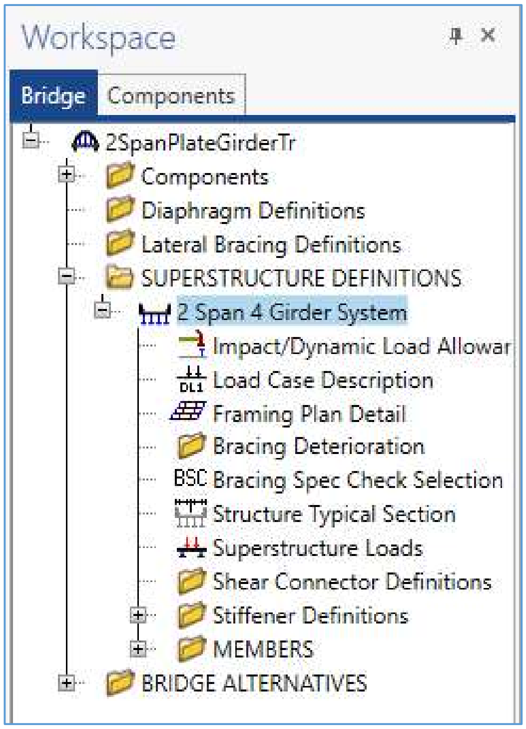




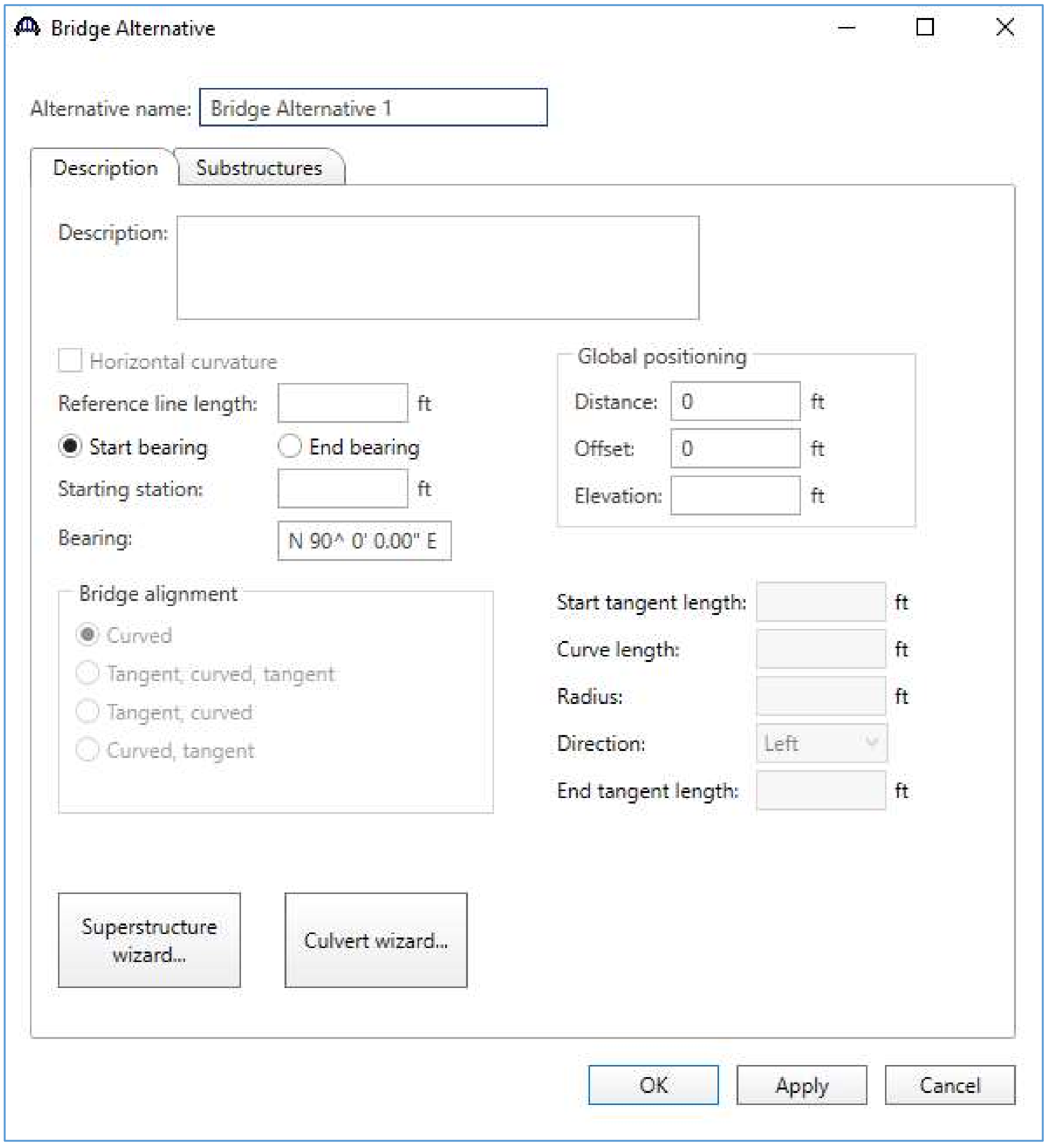
The Analysis tab is shown above with the default selections. Since we are not overriding default selections for this exercise, no changes are required.

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

The partially expanded Bridge Workspace tree is shown below:

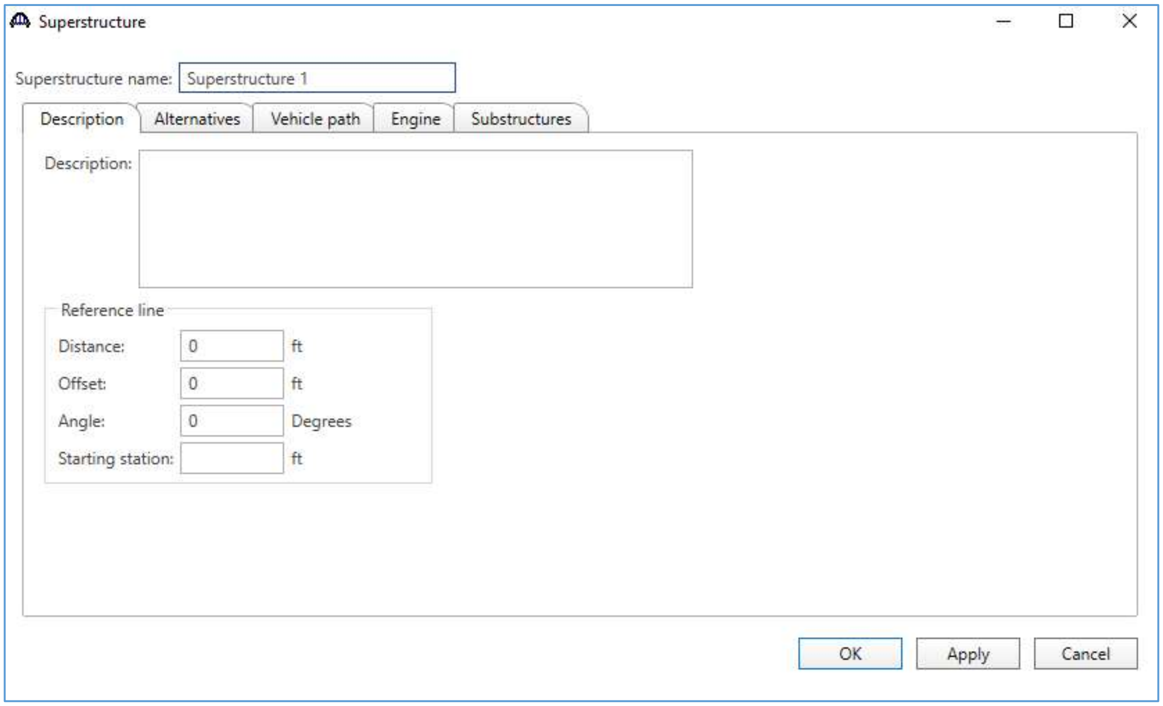


We now go back to the Bridge Alternatives and create a new Bridge Alternative by double-clicking on Bridge Alternatives in the tree. Enter the following data:

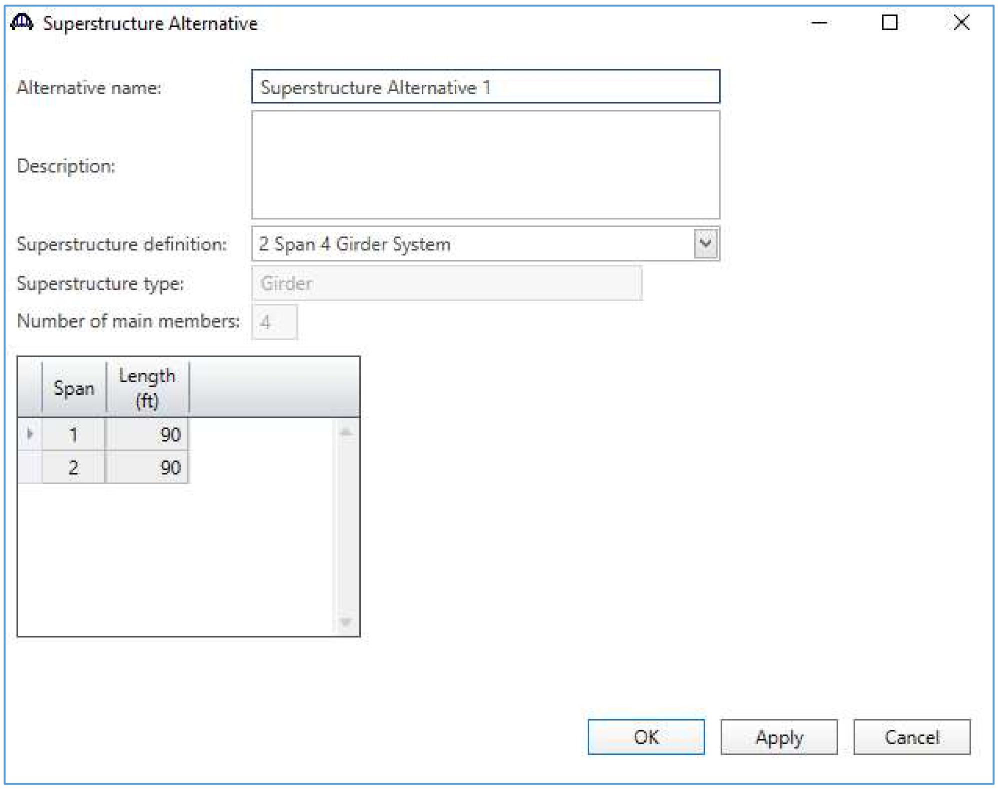


Click Ok to save the data to memory and close the window.

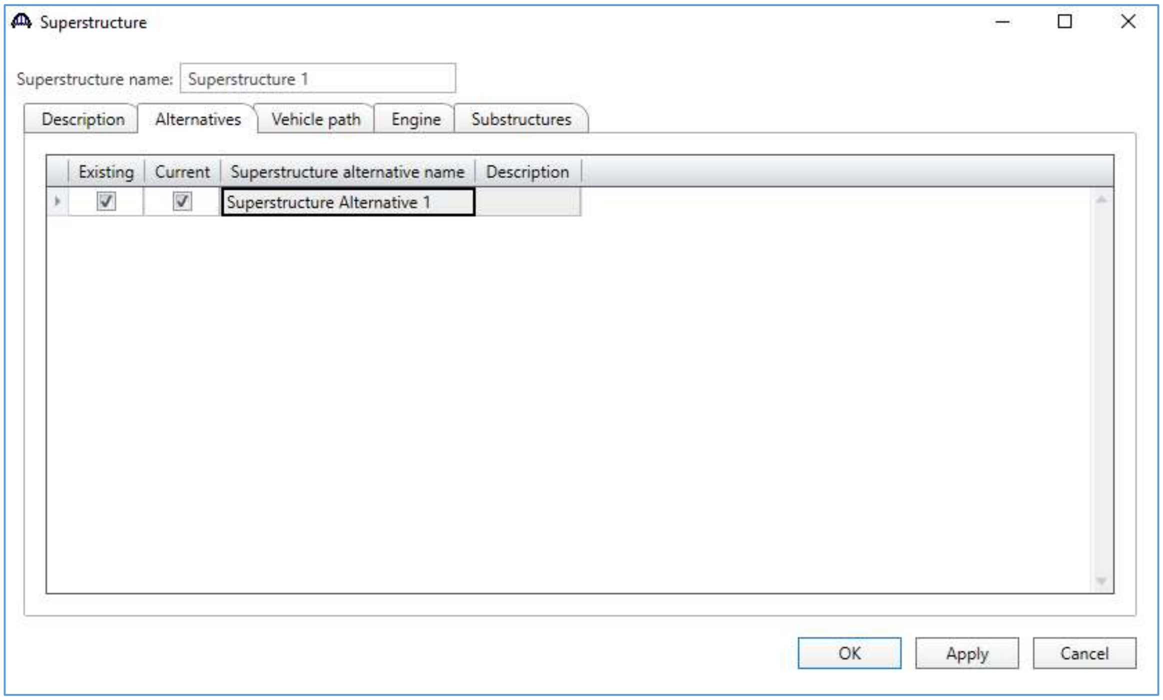
Double-click on Superstructures in the tree and enter the following new superstructure:



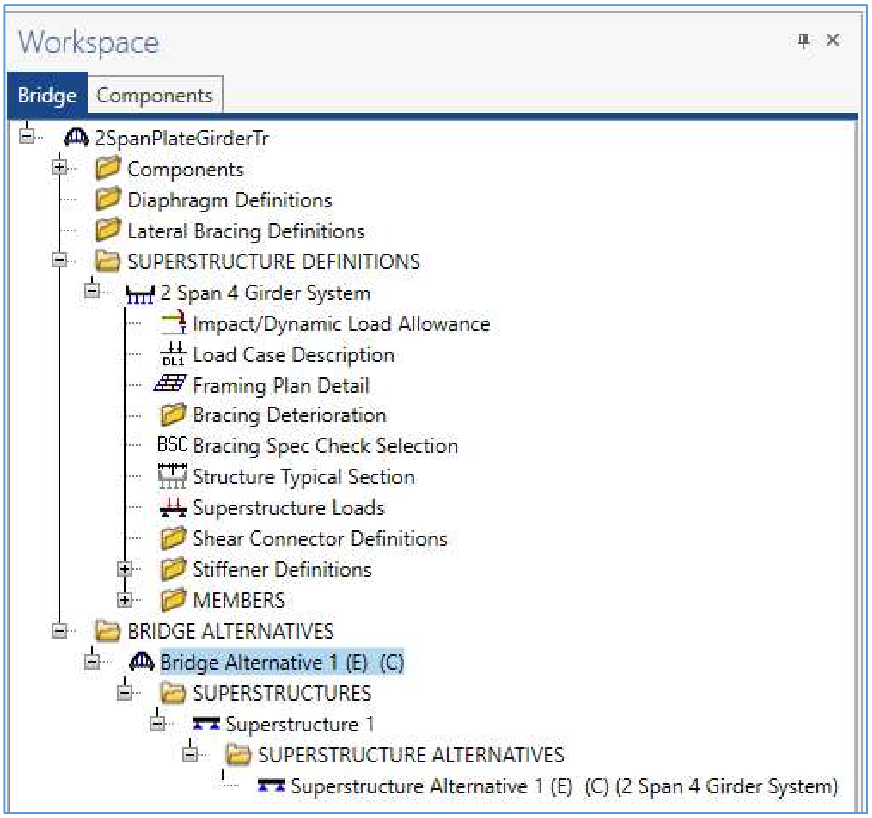
Double-click on Superstructure Alternatives and enter the following new Superstructure Alternative. Select the superstructure definition 2 Span, 4 Girder System as the current superstructure definition for this Superstructure Alternative.



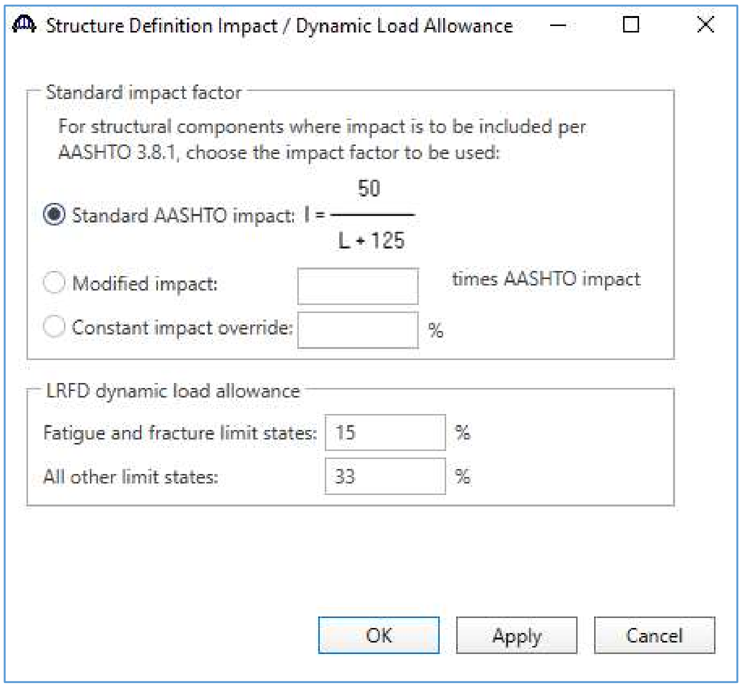
Re-open the Superstructure 1 window and select the Alternatives tab. The Superstructure Alternative 1 will be shown as the existing and current alternative for Superstructure 1.



The partially expanded Bridge Workspace tree is shown below:

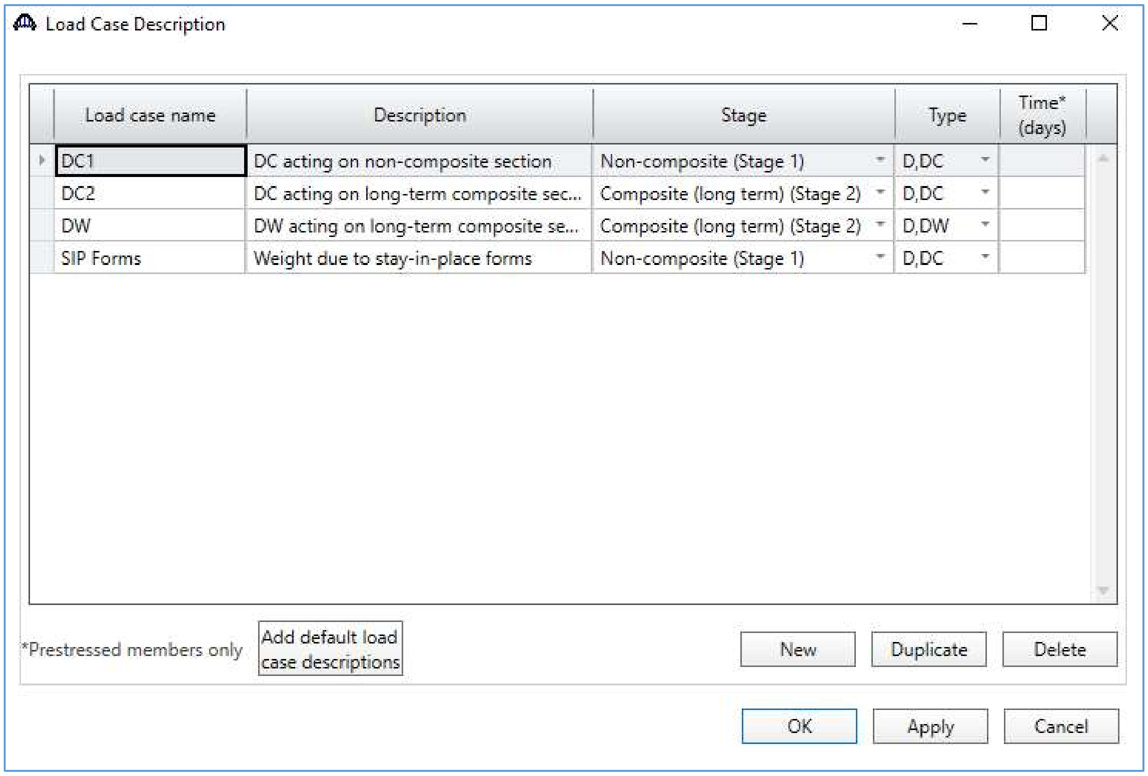


Enter the impact to be used for the entire bridge by double clicking on Impact/Dynamic Load Allowance in the Bridge tree (or by clicking on Impact/Dynamic Load Allowance in the tree and selecting Open from the ribbon under the WORKSPACE tab, or by right clicking Impact/Dynamic Load Allowance and selecting Open from the popup menu). The Structure Definition Impact/Dynamic Load Allowance window shown below will open. Enter the appropriate values as shown and click Ok to save the data to memory and close the window. The values shown below are default values.

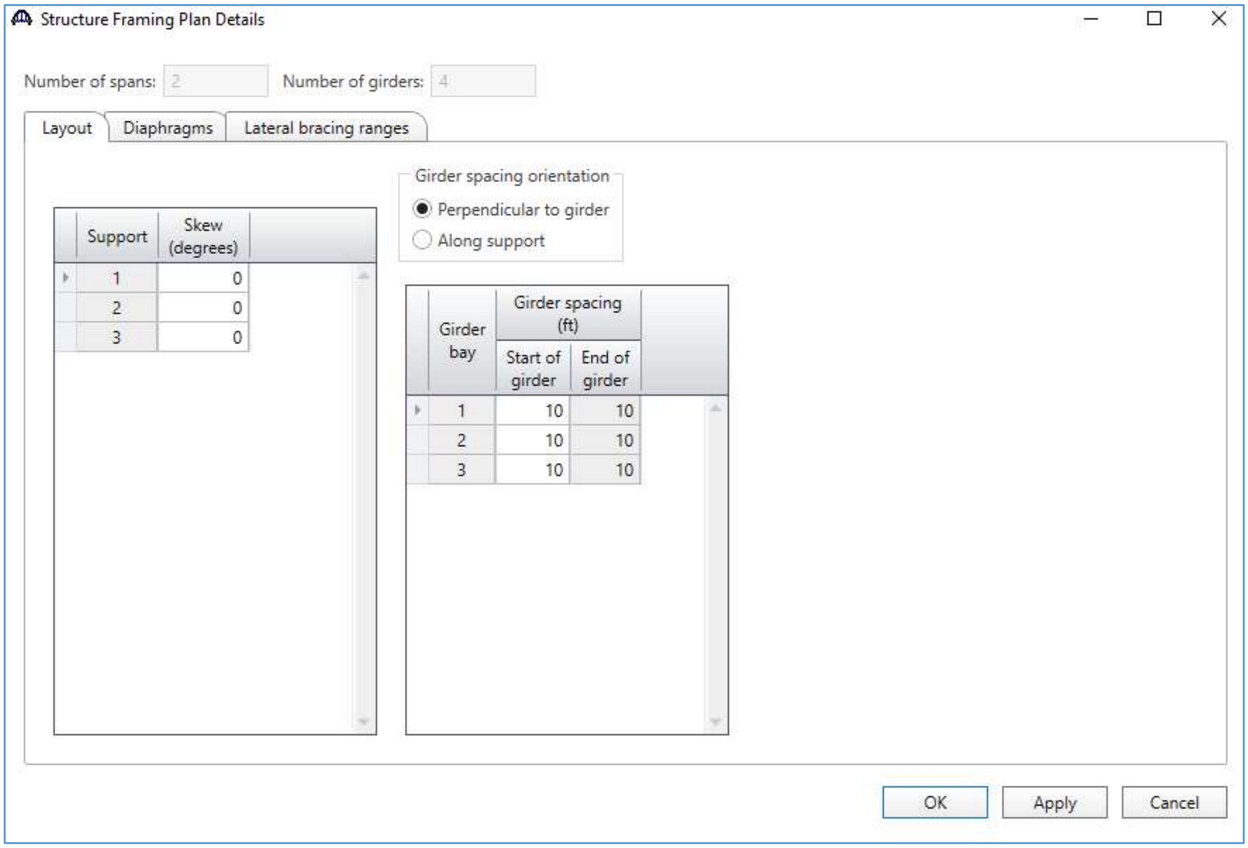


For this example problem we are not going to override the standard LRFD or LRFR factors.

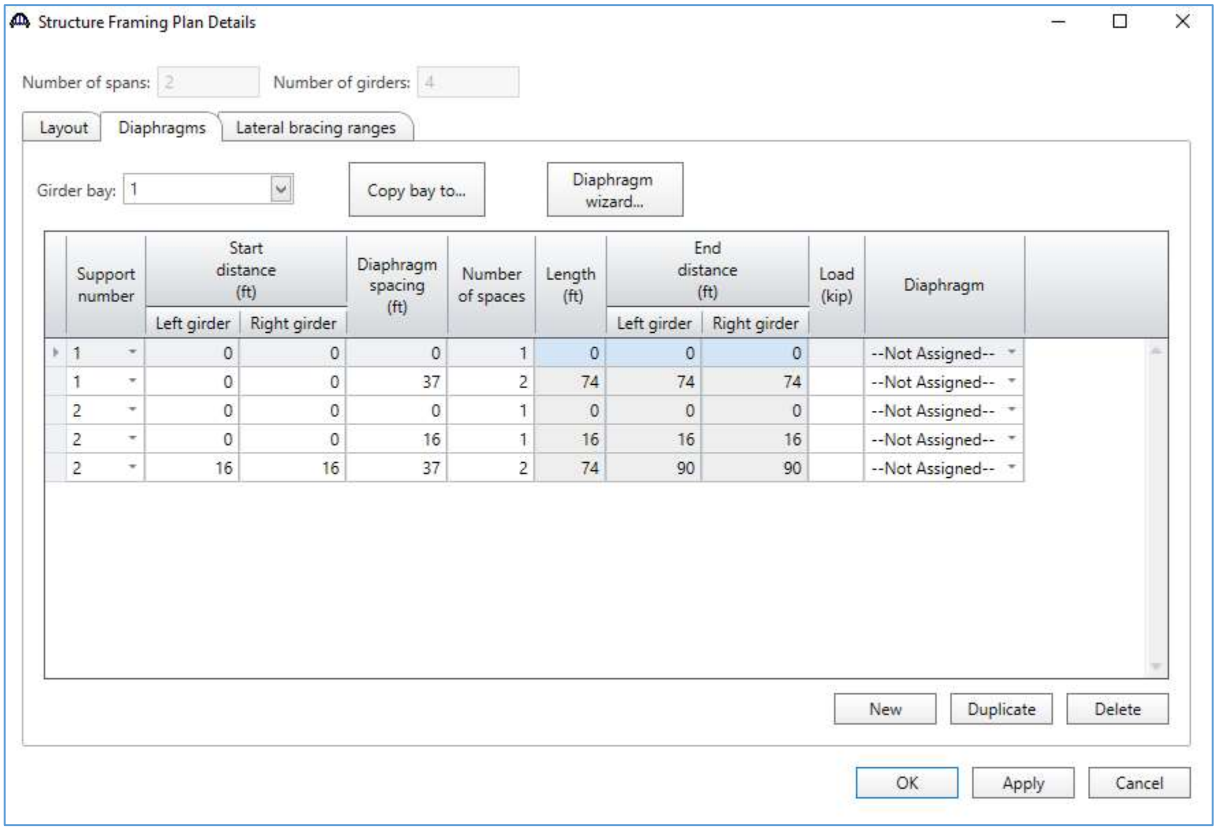
Click Load Case Description to define the dead load cases. The completed Load Case Description window is shown below. Click the “Add Default Load Case Descriptions” generate the table below.



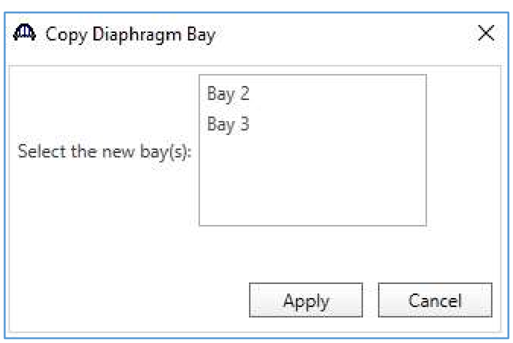
Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.



Switch to the Diaphragms tab to enter diaphragm spacing. Enter the following diaphragms for Girder Bay 1 as shown below:



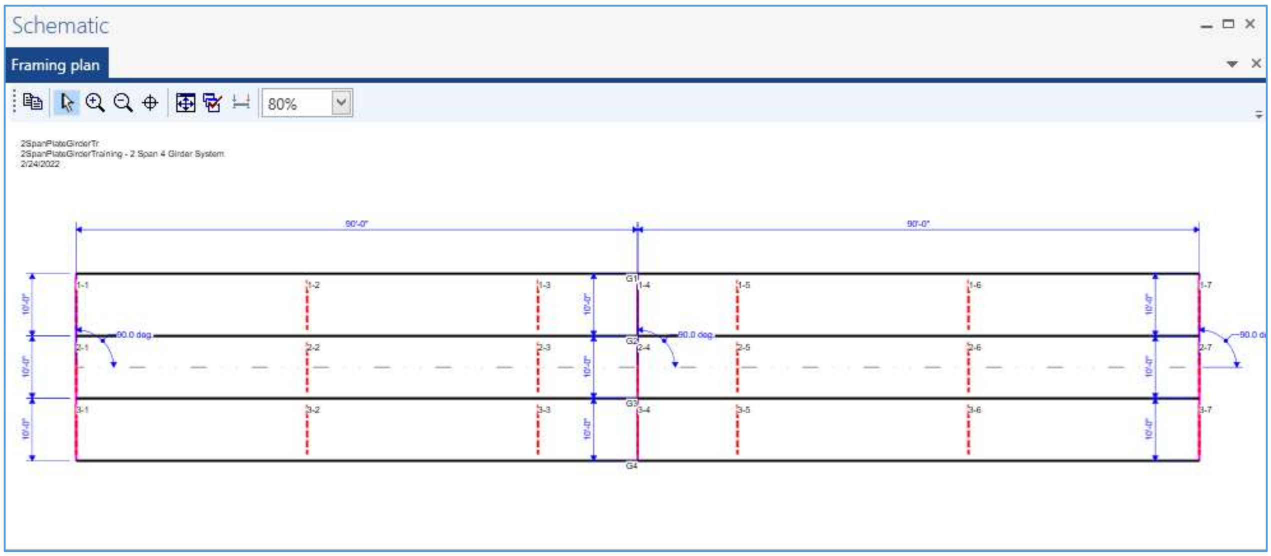
Click the Copy Bay To button to copy the diaphragms entered for Bay to the other bays. The following dialog will appear. Click Apply to copy the diaphragms to girder bay 2.



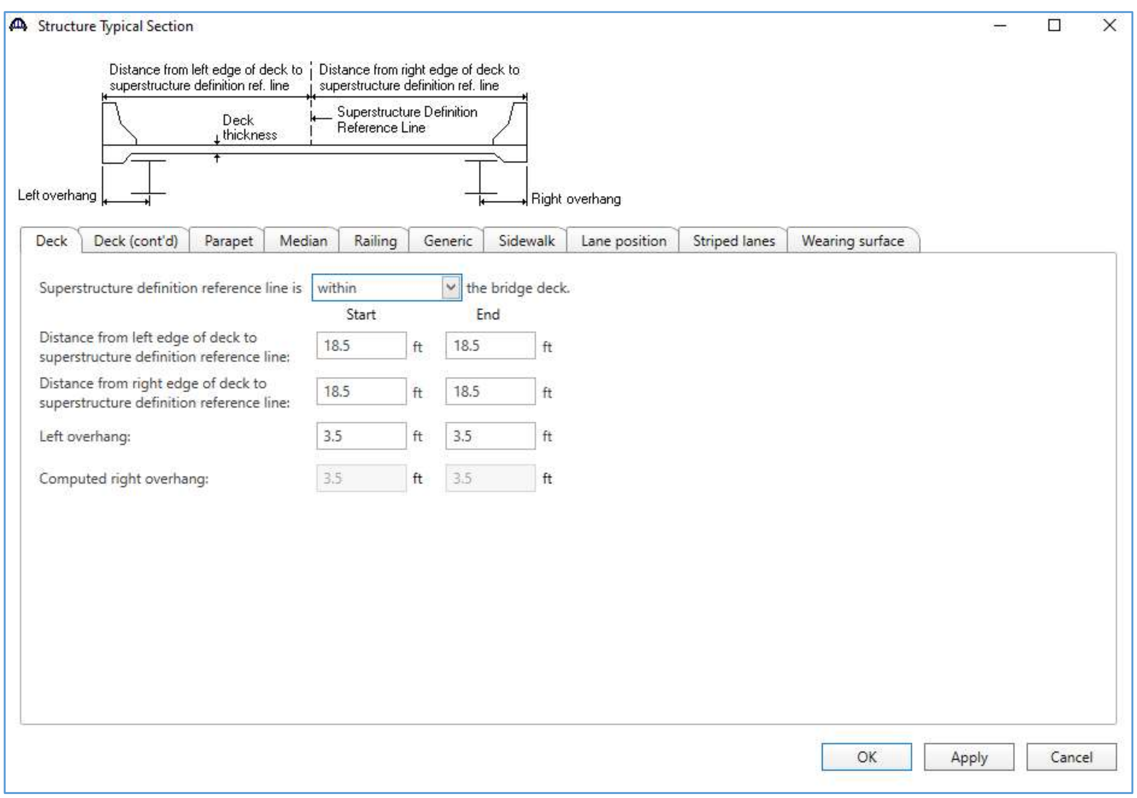
Click the Copy Bay To button again, this time selecting 3 as the new bay. Click Apply to copy the diaphragms to girder bay 3.

Select Ok to close Structure Framing Plan Details window.

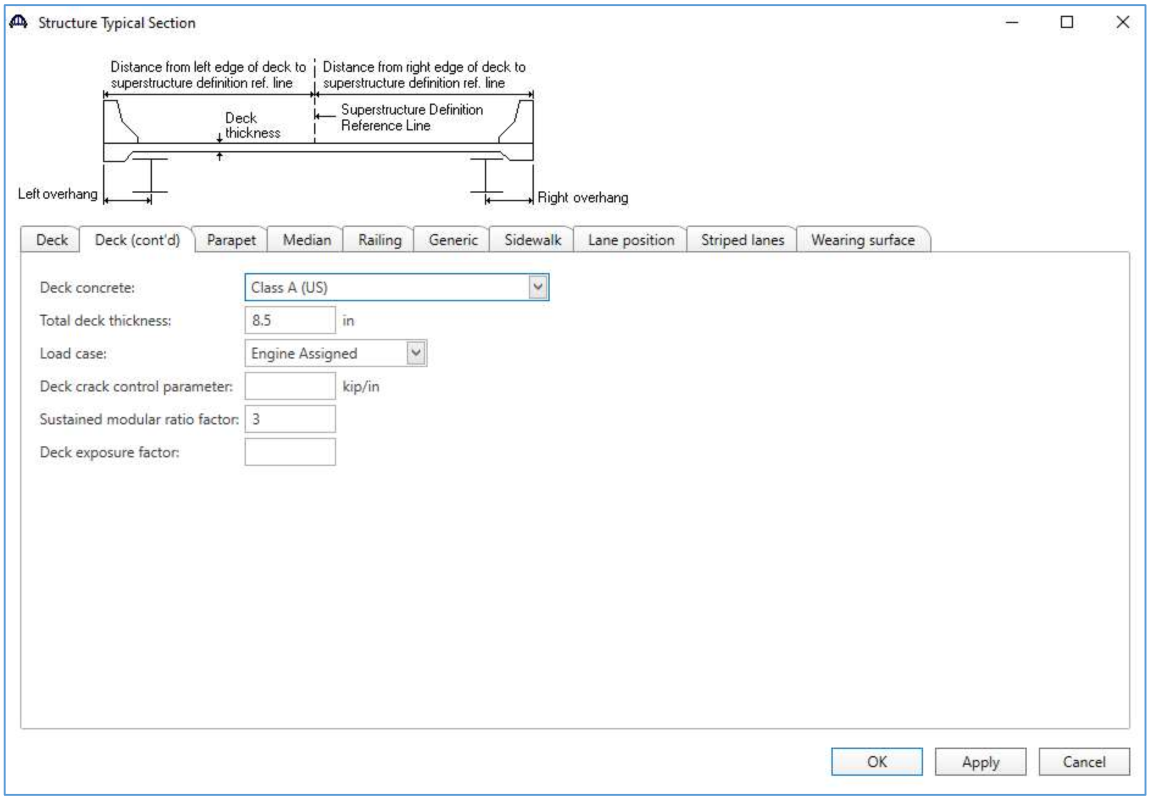
While Framing Plan Detail is selected in the Bridge tree, open the schematic for the framing plan by selecting the Schematic button under the WORKSPACE tab in the ribbon (or by right clicking Framing Plan Detail and selecting Schematic from the popup menu). The following schematic will be displayed.



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

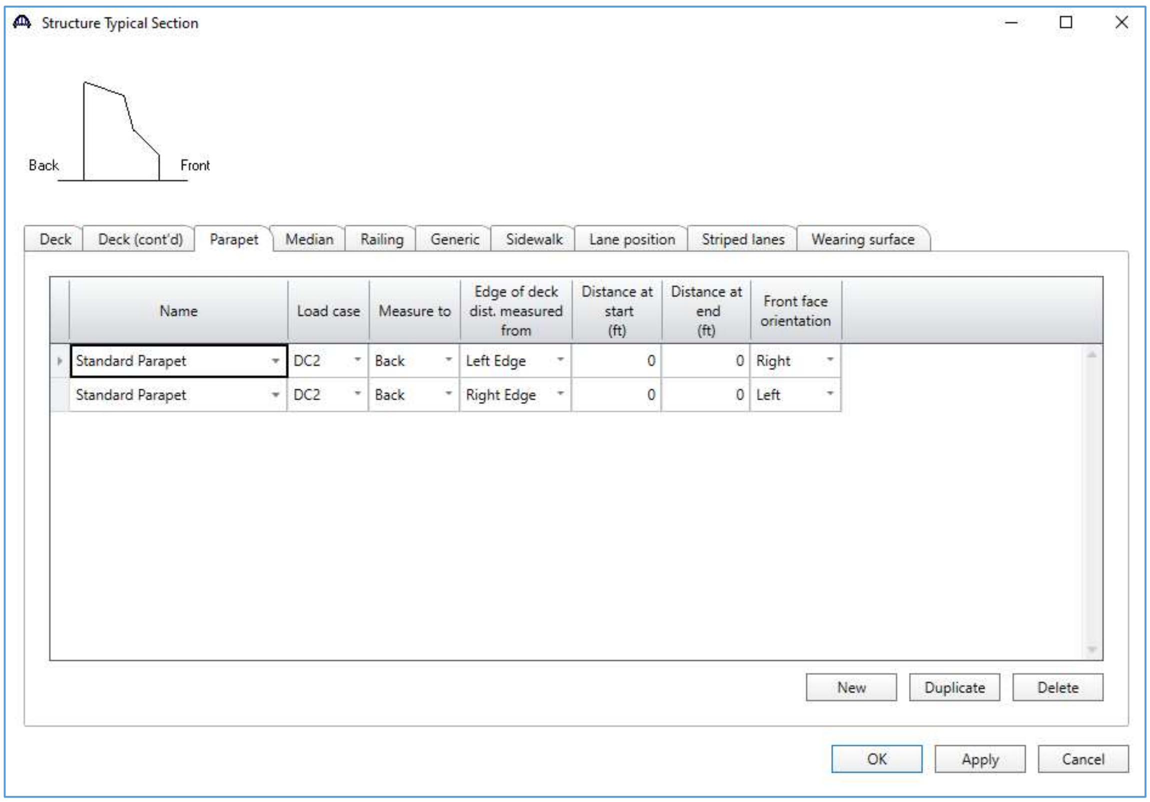


The Deck (cont'd) tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described above.



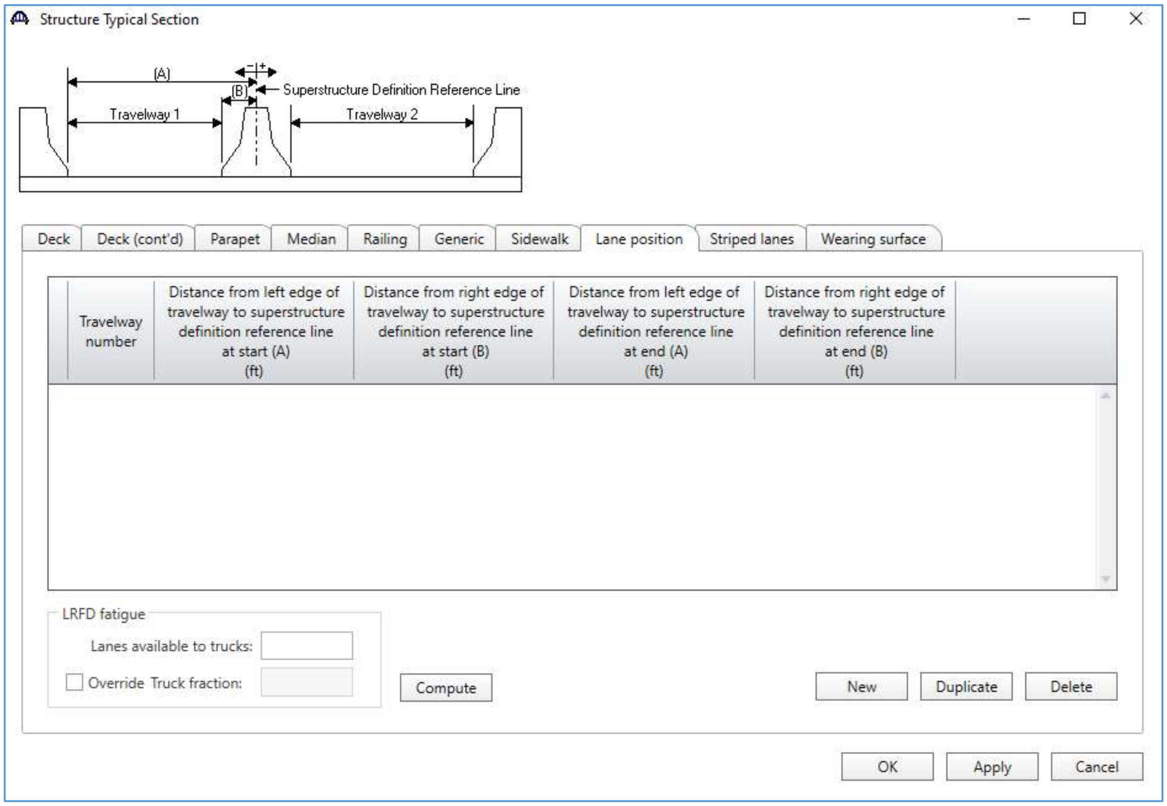
Parapets:

The two parapets are described using the Parapet tab. Click New to add a row to the table. The name of the parapet defaults to the only barrier described for the bridge. Change the “Load Case” to “DC2” and “Measure To” to “Back” (we are locating the parapet on the deck by referencing the back of the parapet to the left edge of the deck). Enter 0.0 for the “Distance at Start” and “Distance at End”. Change the “Front Face Orientation” to “Right”. The completed tab is shown below.

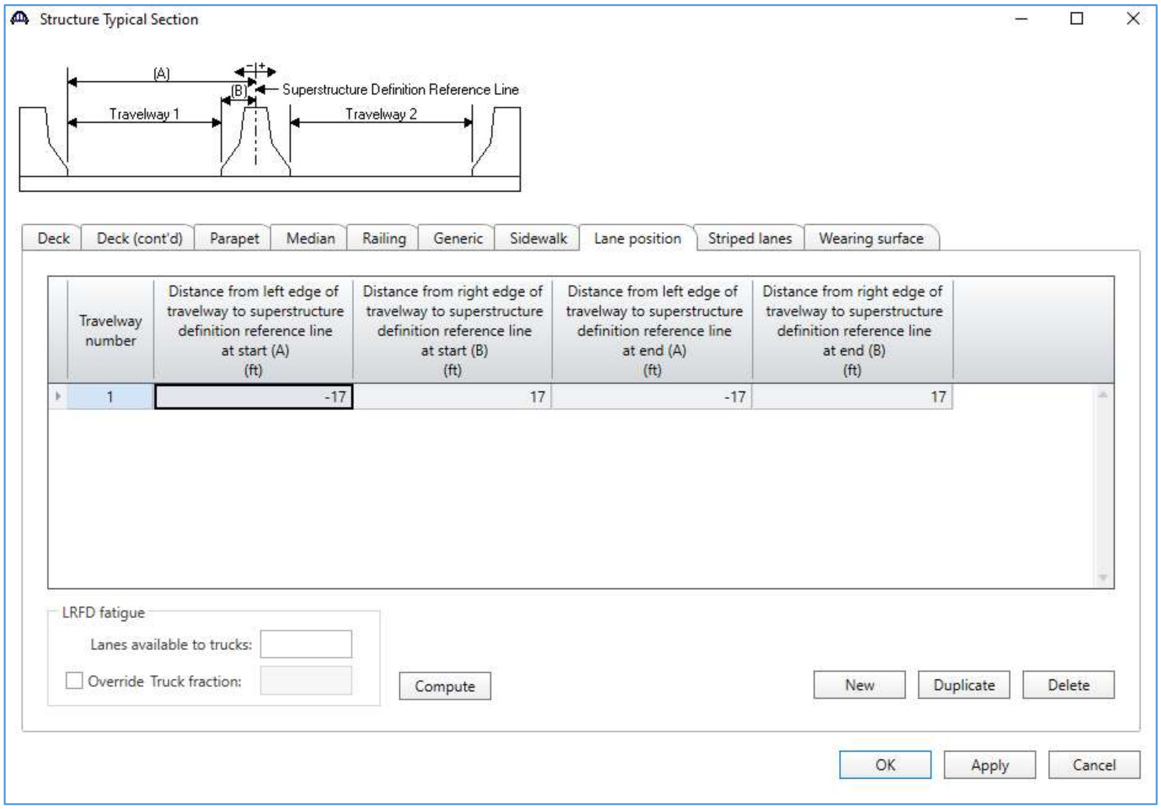


Lane Positions:

Select the Lane Position tab.

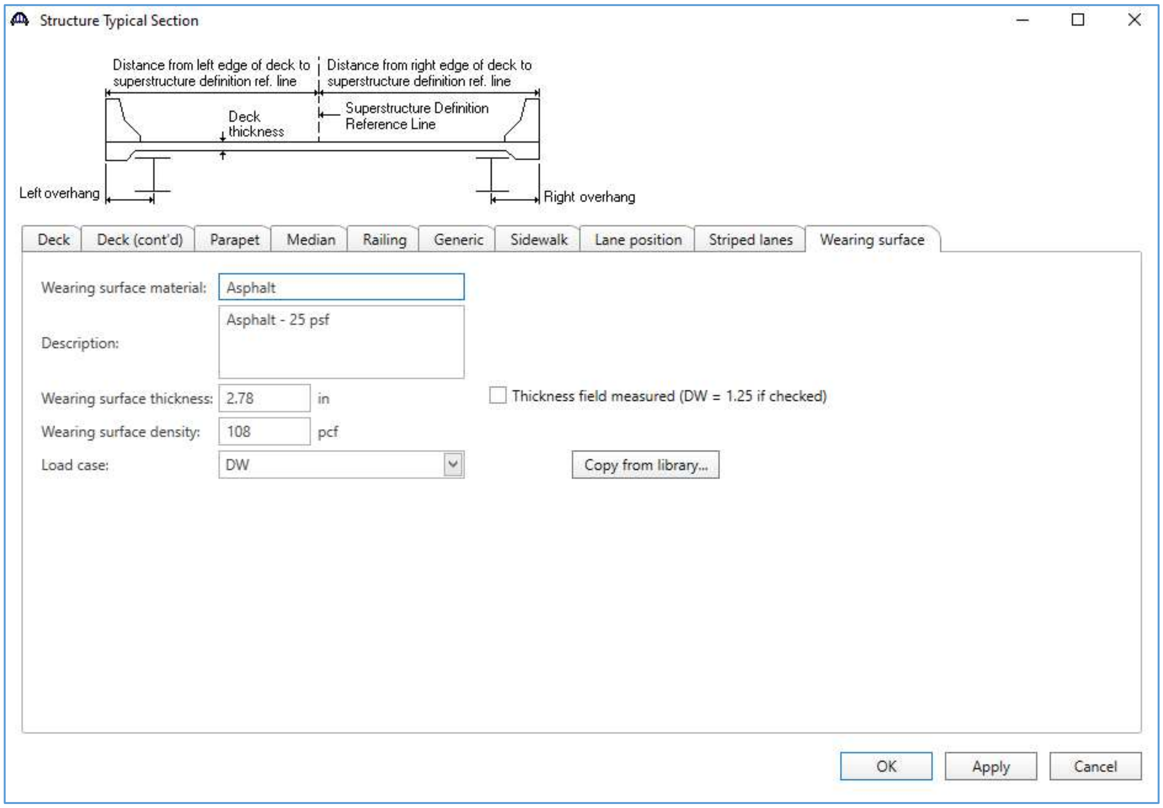


Click the Compute… button to automatically compute the lane positions. A dialog showing the results of the computation opens. Click Apply to apply the computed values. The Lane Position tab is populated as shown below.



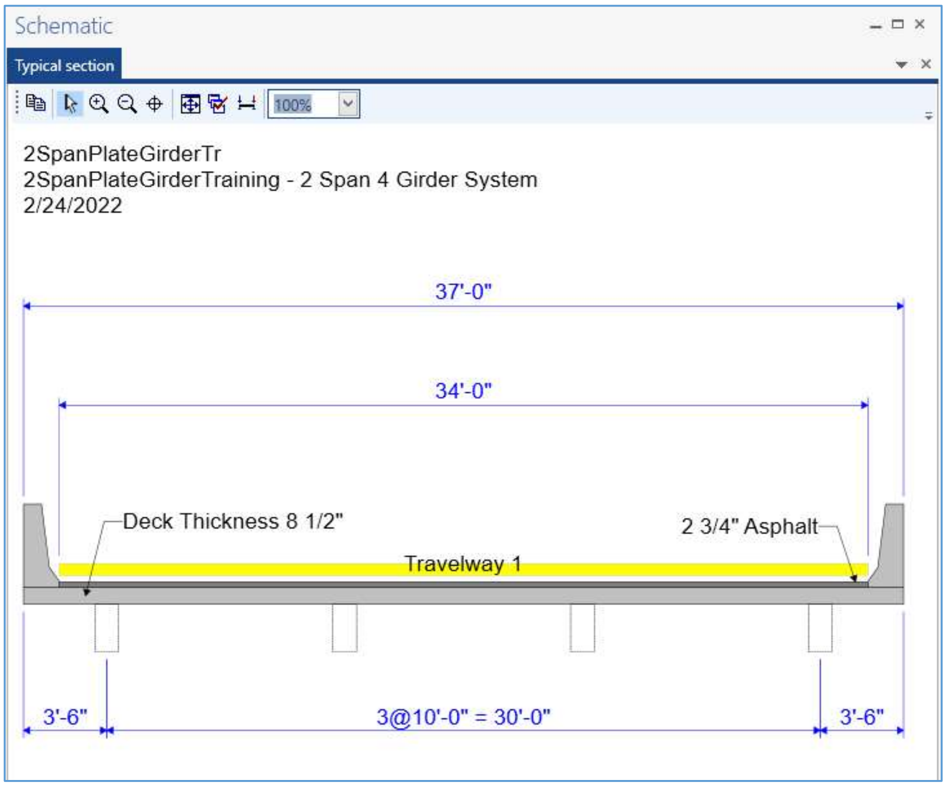
Wearing Surface:

Enter the data shown below.

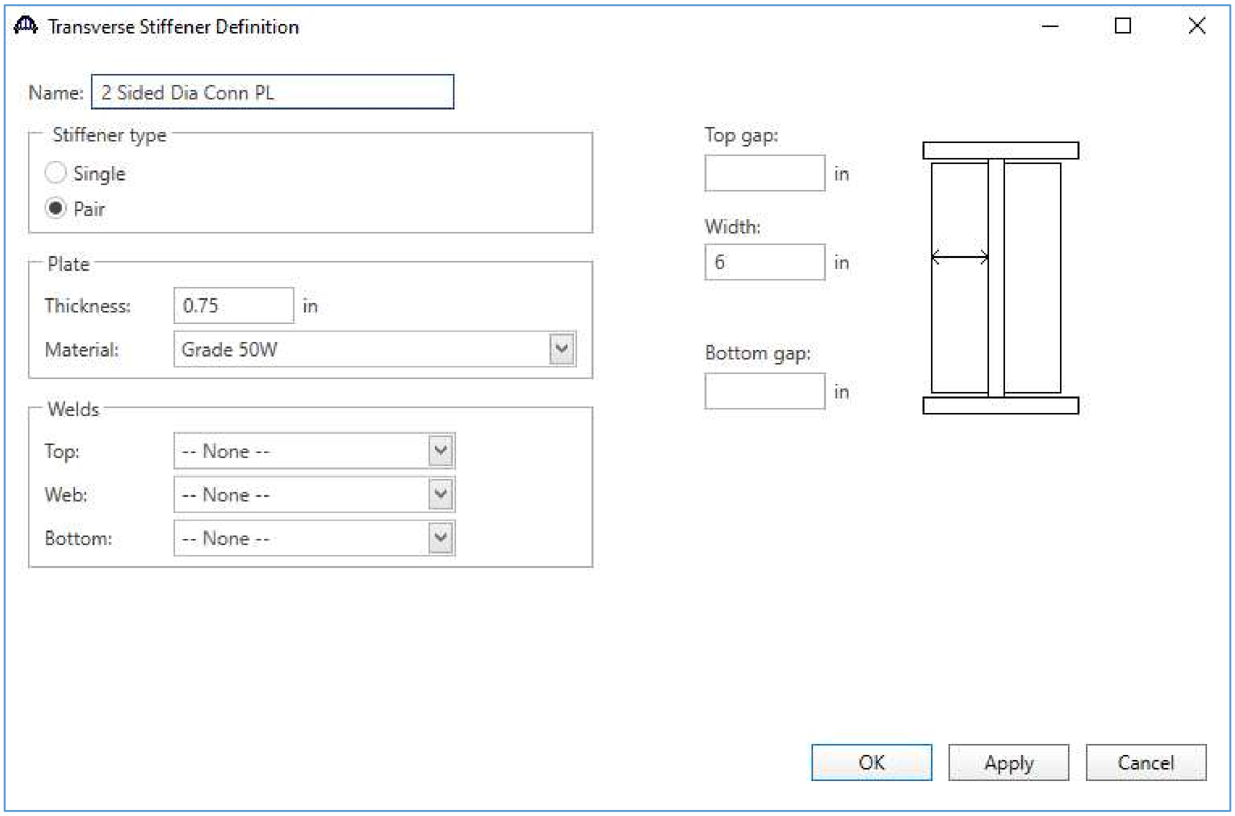


Click Ok to save the data to memory and close the window.

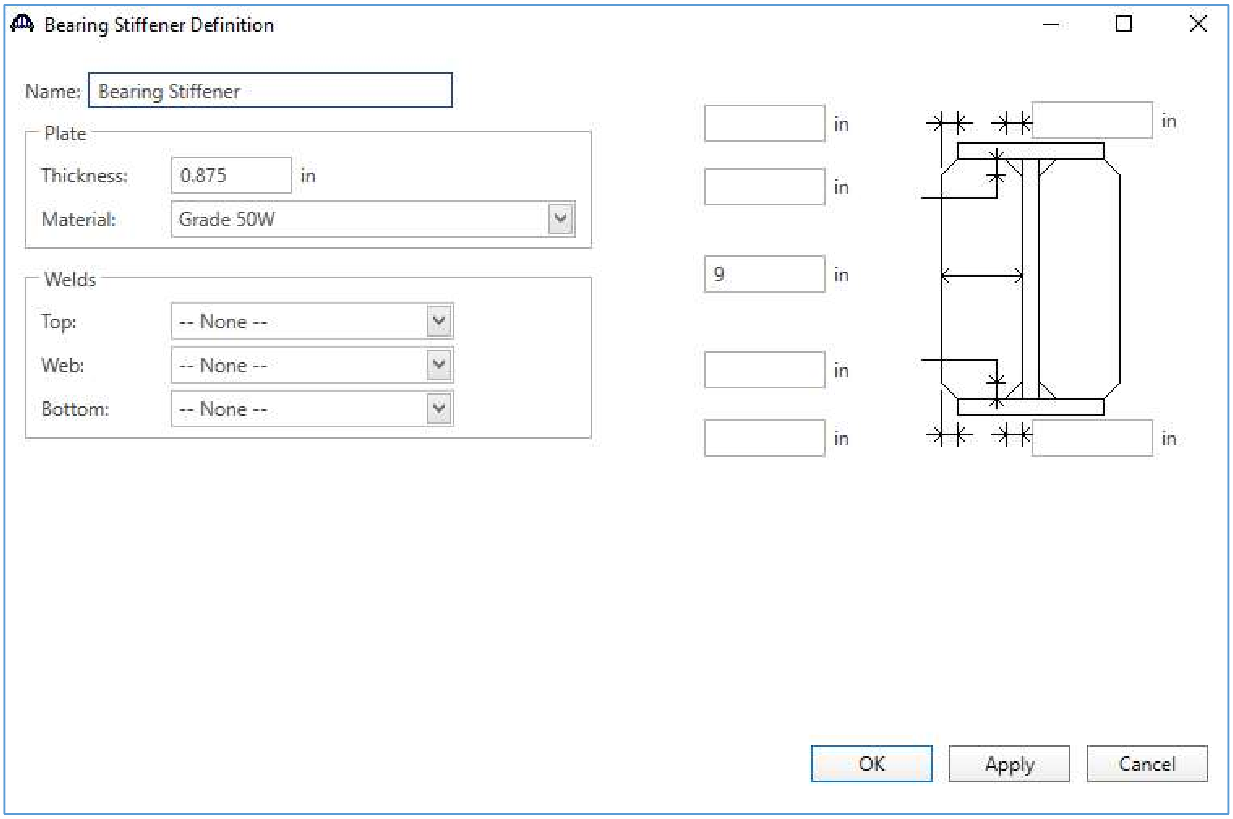
While Structure Typical Section is selected in the Bridge tree, open the schematic for the framing plan by selecting the Schematic button under the WORKSPACE tab in the ribbon (or by right clicking Structure Typical Section and selecting Schematic from the popup menu). The following schematic will be displayed. The girders are displayed as dashed boxes since we have not yet defined what type of girder we will have.



Define stiffeners to be used by the girders. Expand the Stiffener Definitions tree item and double click on Transverse. Select “Trans. Plate Stiffener” for stiffener type. Define the stiffener as shown below. Click Ok to save to memory and close the window.

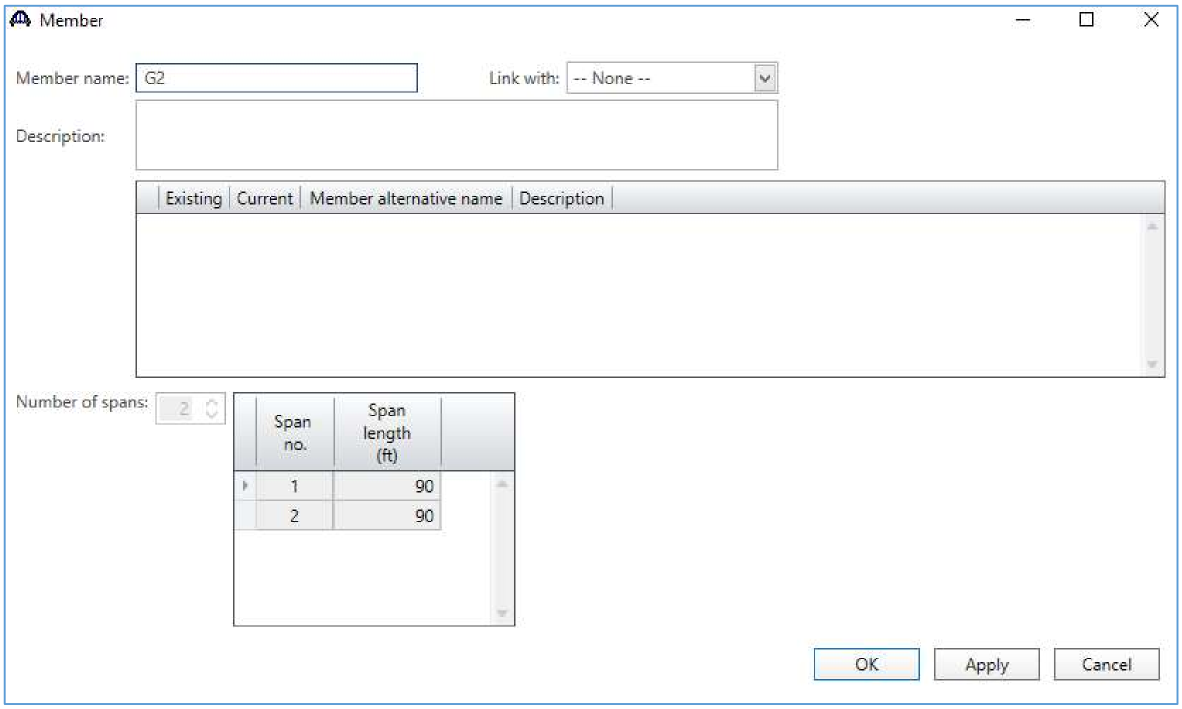


Now define the bearing stiffeners by double clicking on Bearing (under Stiffener Definitions in the tree). Select “Plate Stiffener” for stiffener type. Define the stiffener as shown below. Click Ok to save to memory and close the window.

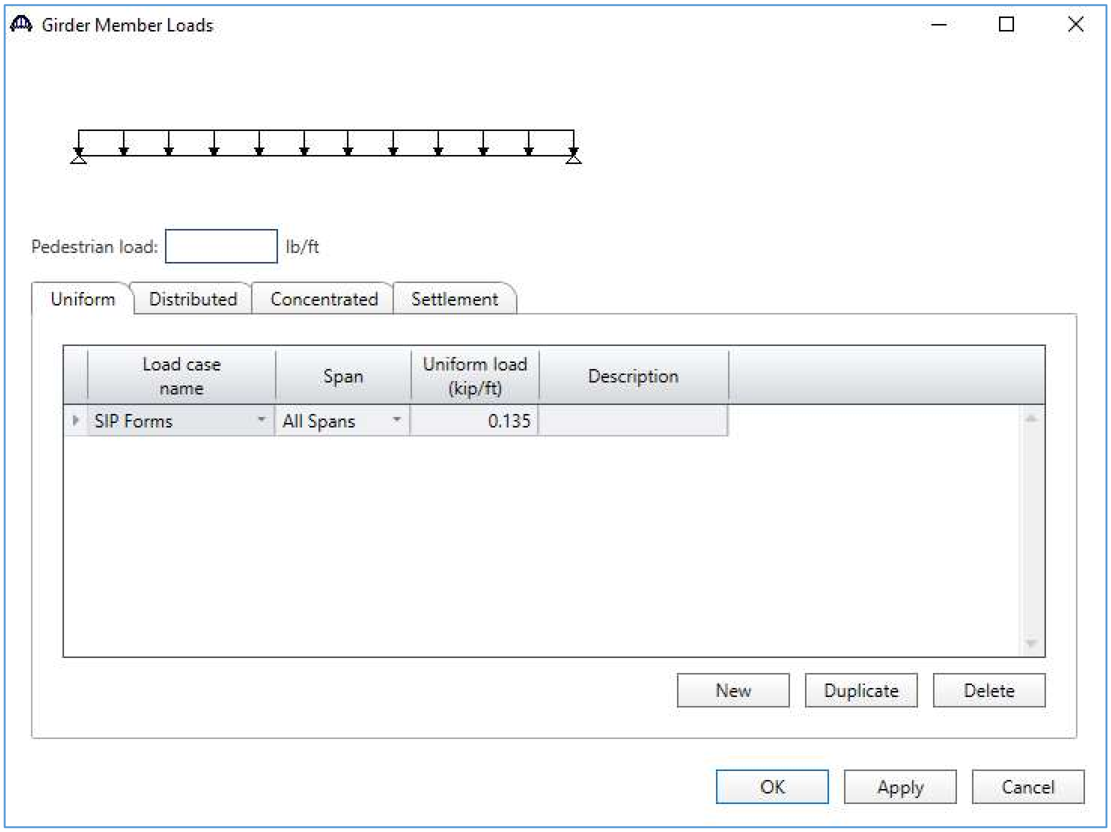


Describing a member:

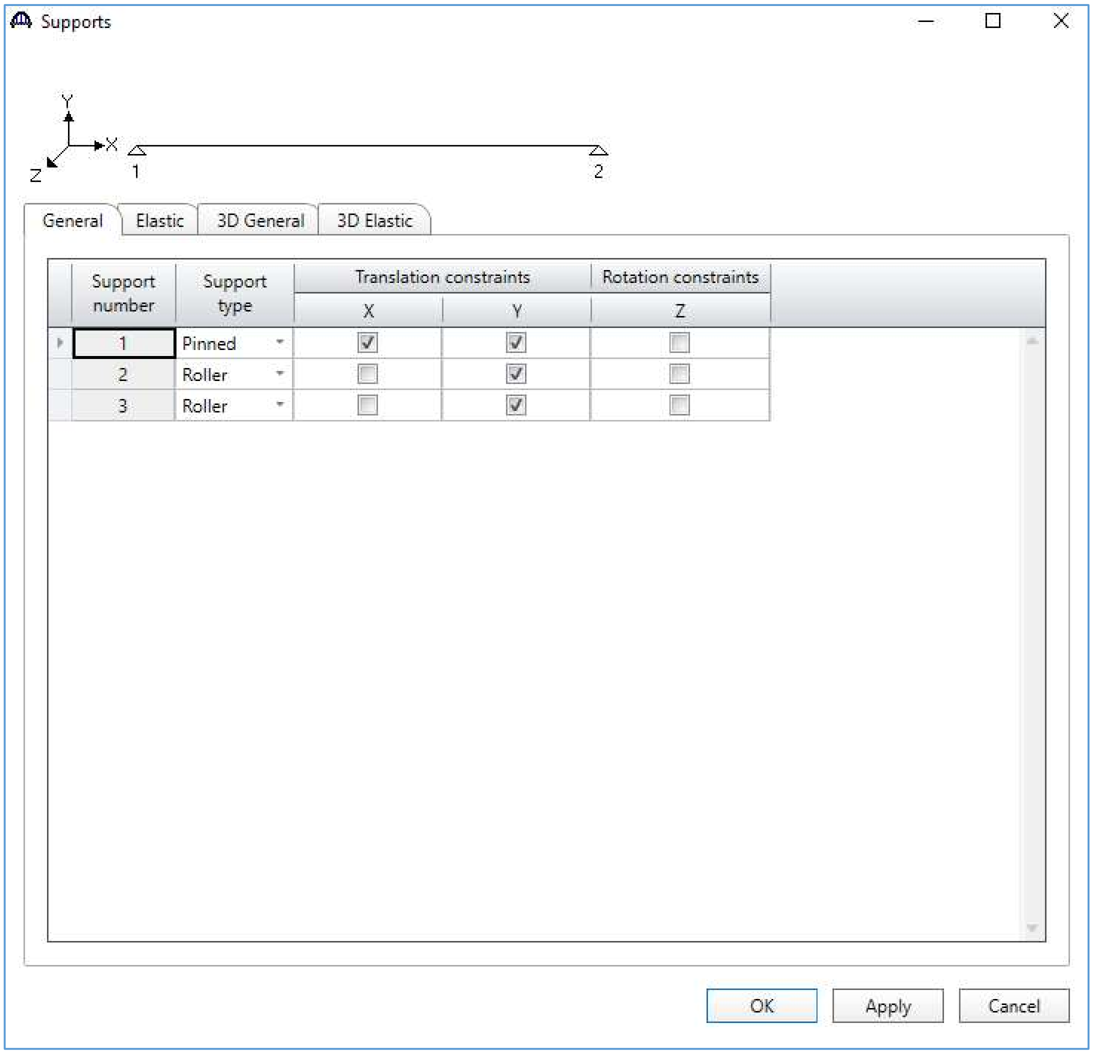
Expand MEMBERS in the tree. The G2 member window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this Member.



Next double click on the Member loads in the tree and select SIP Forms from the dropdown list. Enter the load due to stay-in-place forms as shown below.

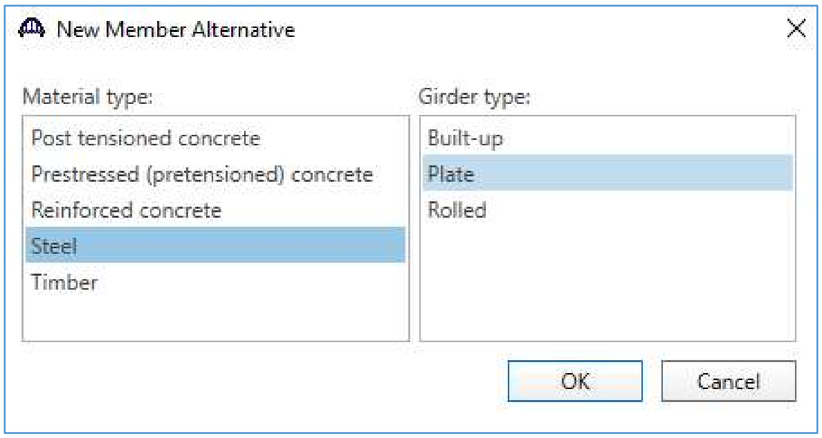


Support constraints were generated when the structure definition was created and are shown below.



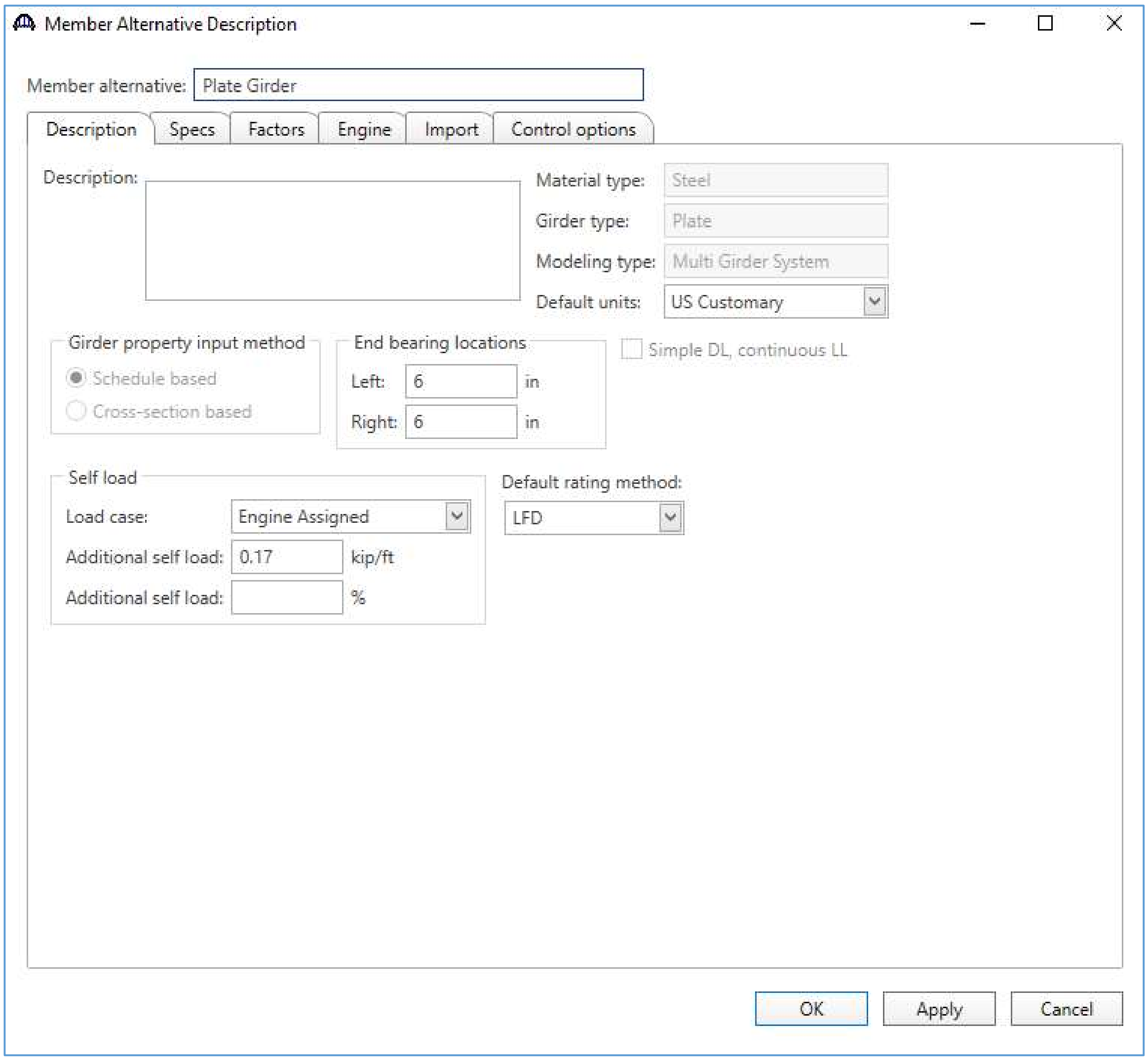
Defining a Member Alternative:

Double-click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Steel for the Material Type and Plate for the Girder Type.

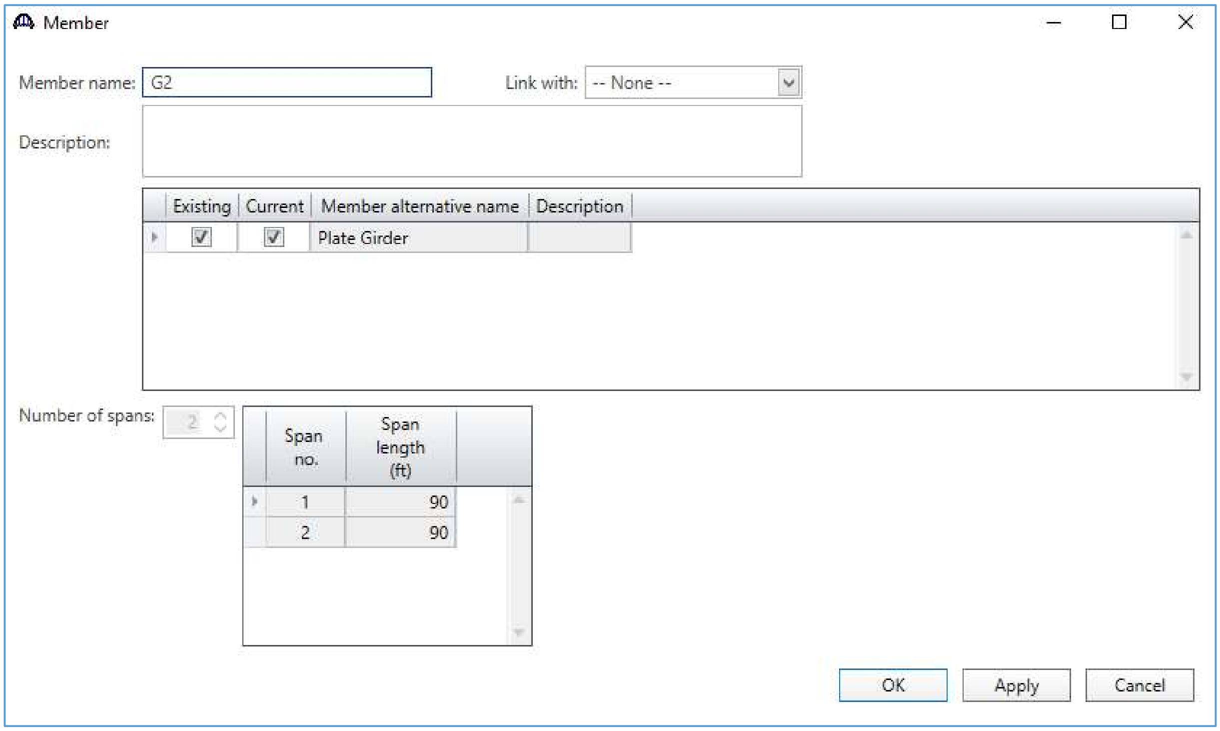


Click Ok to close the dialog and create a new member alternative.

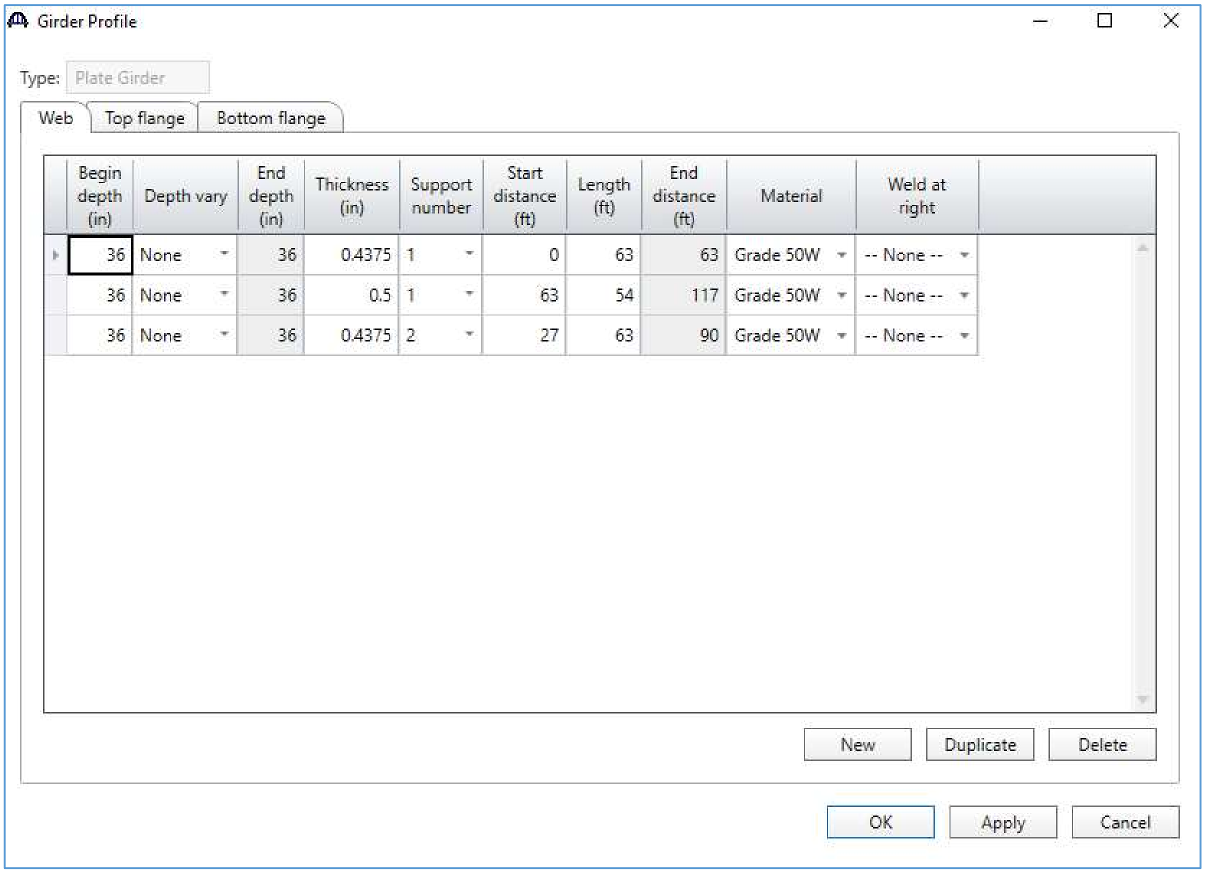
The Member Alternative Description window will open. Enter the appropriate data as shown below. Select Schedule-based Girder property input method. The additional self-weight of 0.170 kip/ft is estimated for the weight of the diaphragms and stiffeners.



If we now re-open the Member G2 window, we will see this Member Alternative designated as the existing and current member alternative for this Member.

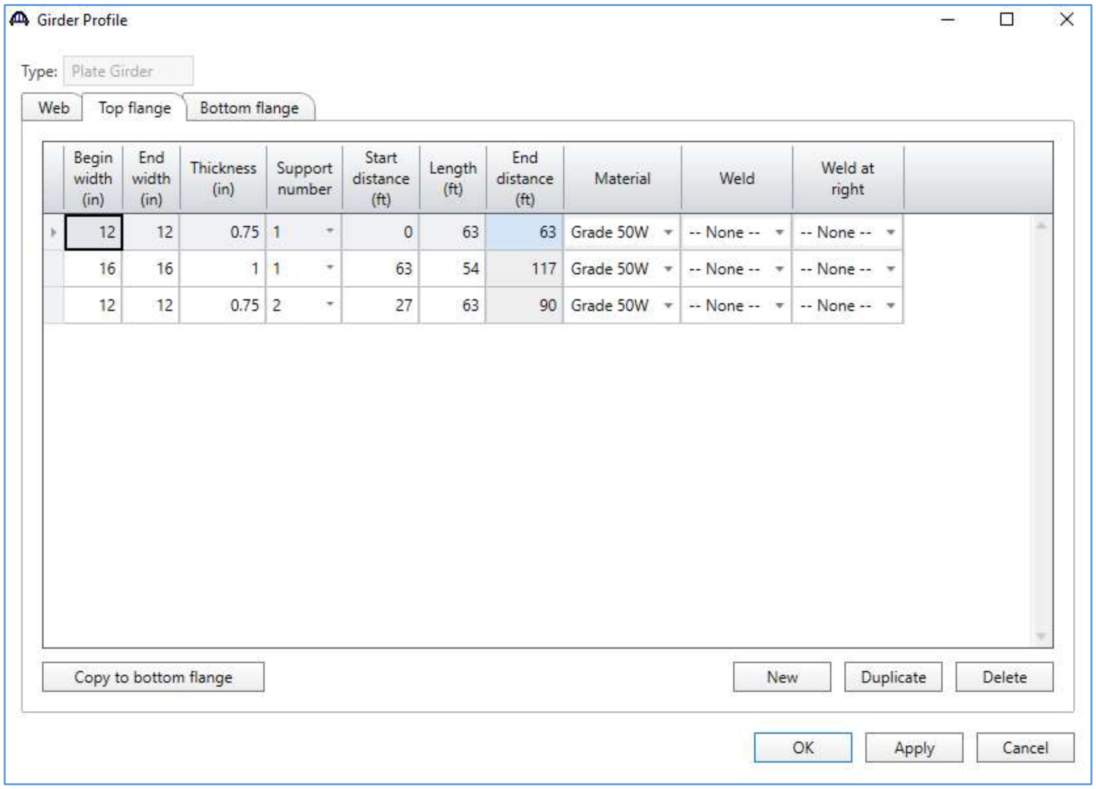


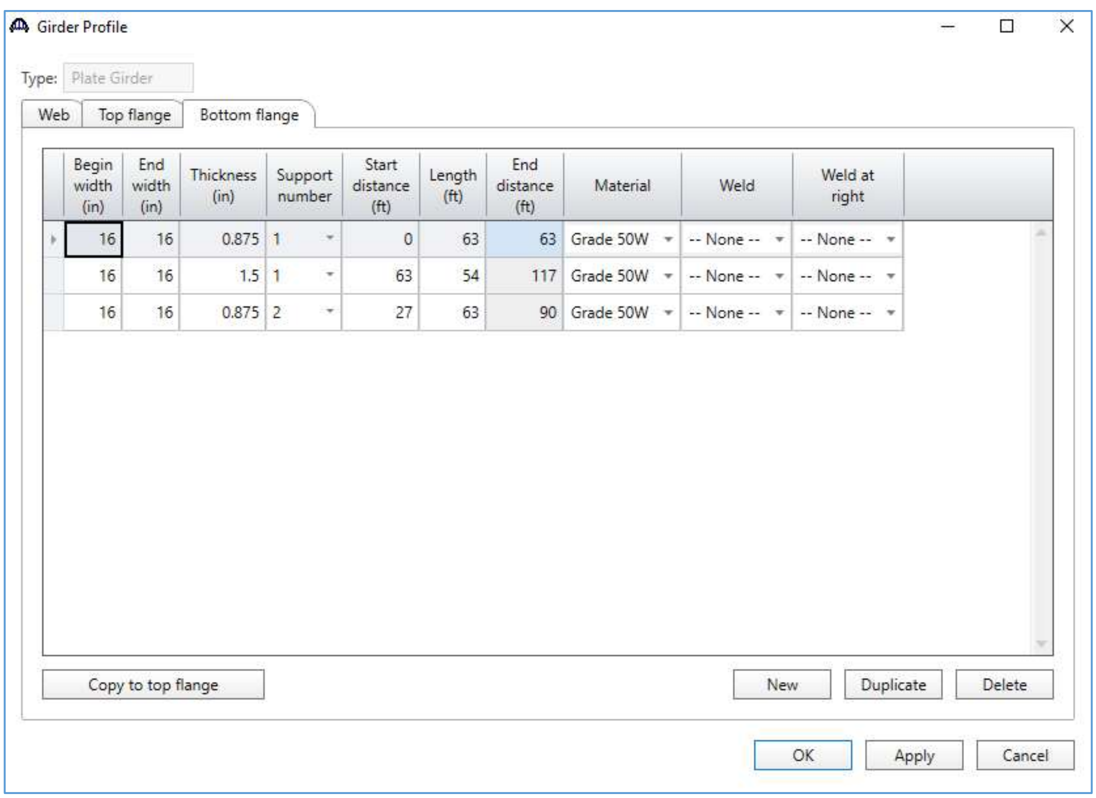
Next describe the girder profile by double clicking on Girder Profile in the tree. The window is shown below with the data describing the web.



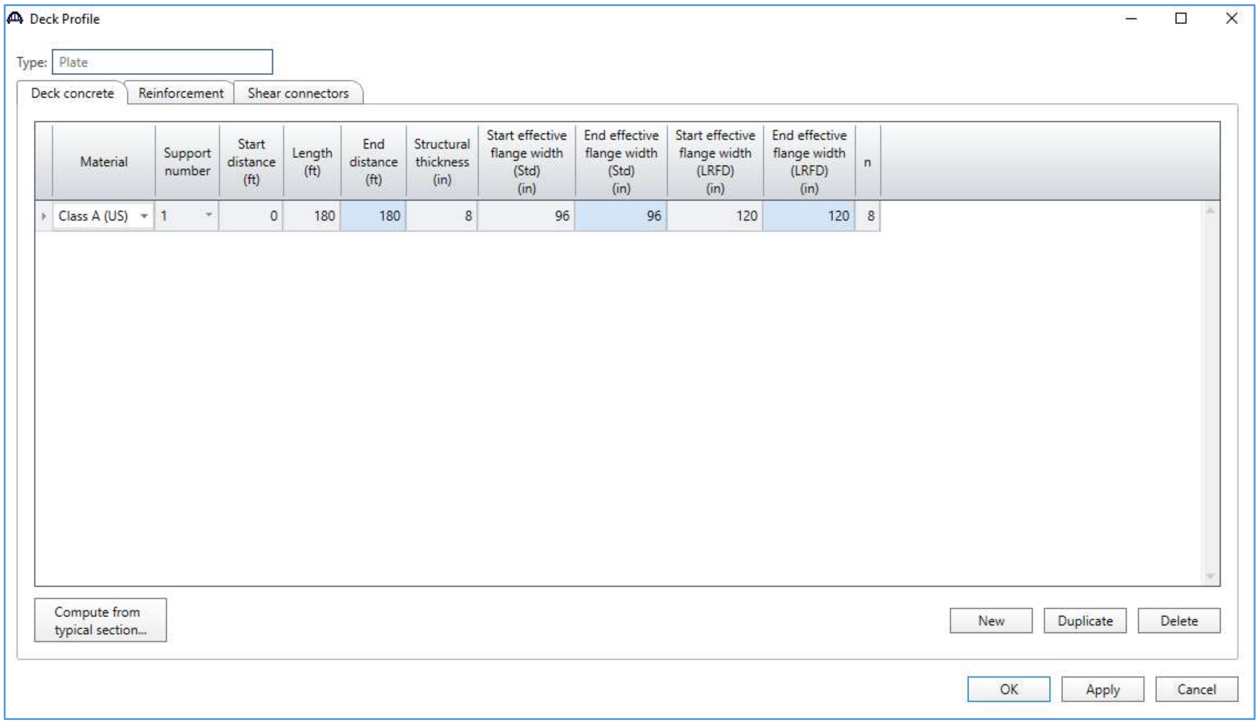
Begin depth (in)	Depth vary	End depth (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld at right
36	None	36	0.4375	1	0	63	63	Grade 50W	-- None --
36	None	36	0.5	1	63	54	117	Grade 50W	-- None --
36	None	36	0.4375	2	27	63	90	Grade 50W	-- None --

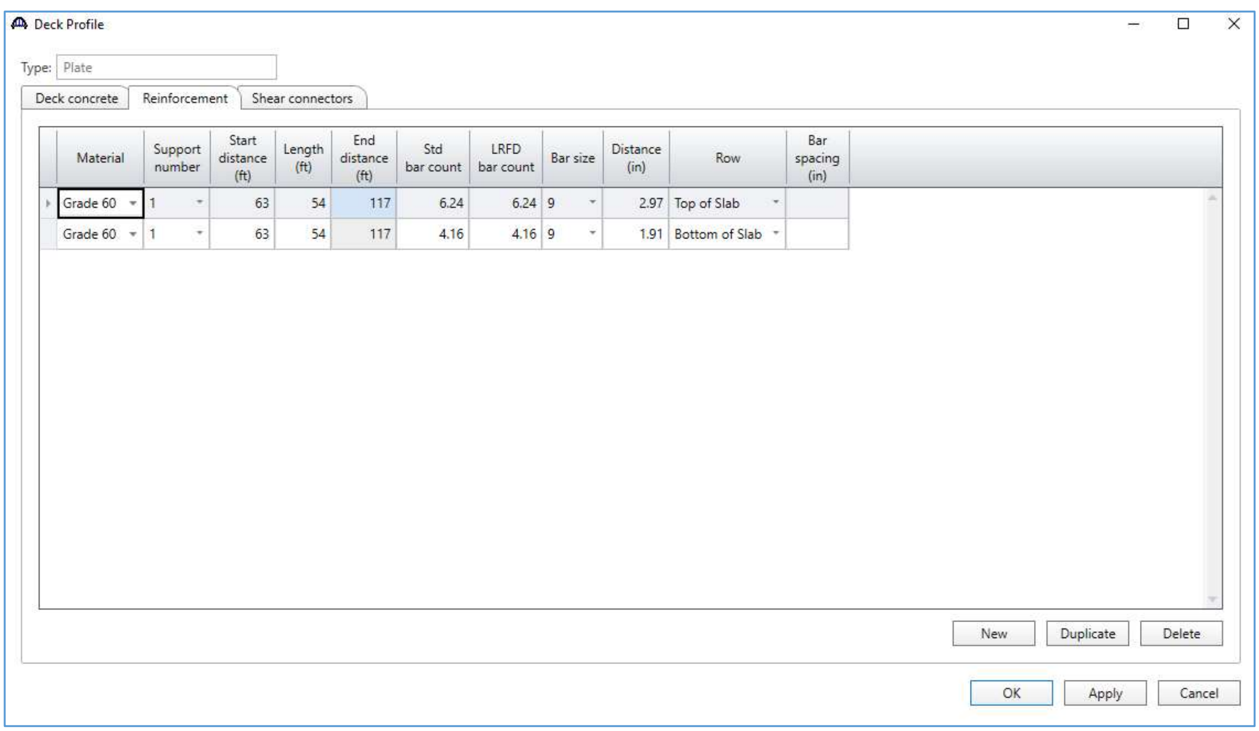
Describe the flanges as shown below.



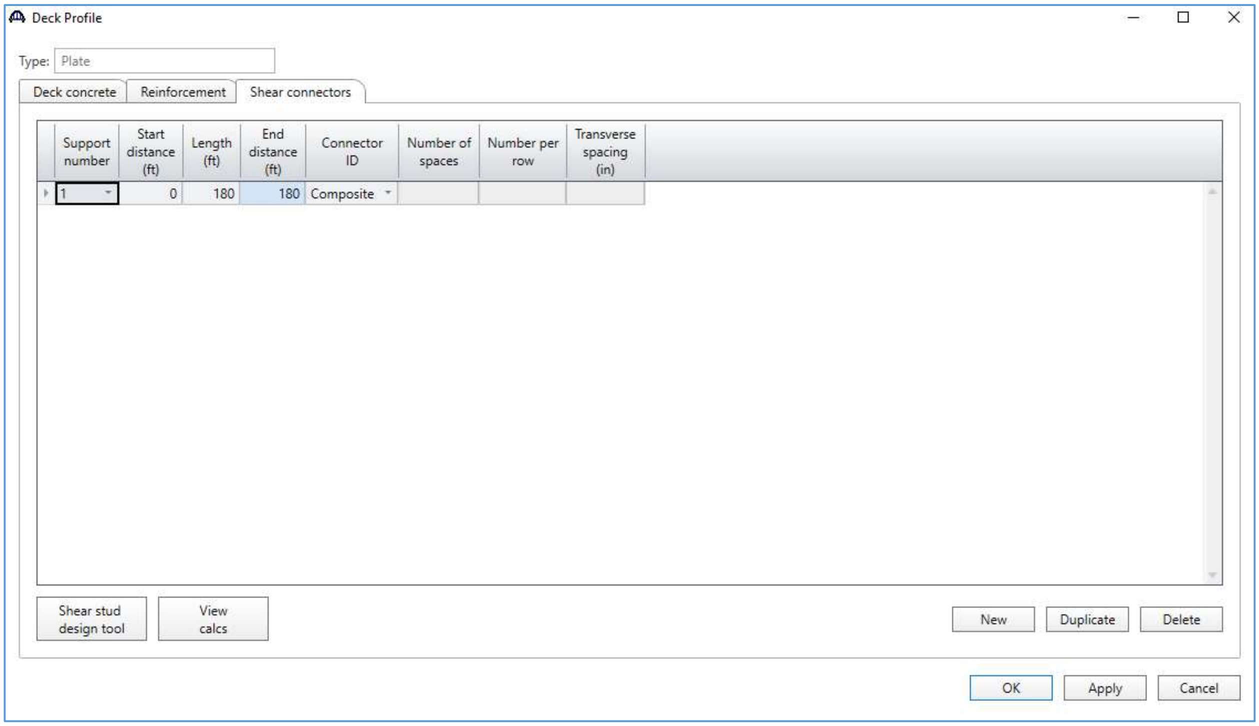


Next open the Deck Profile and enter the data describing the structural properties of the deck. The deck concrete and reinforcement windows are shown below.

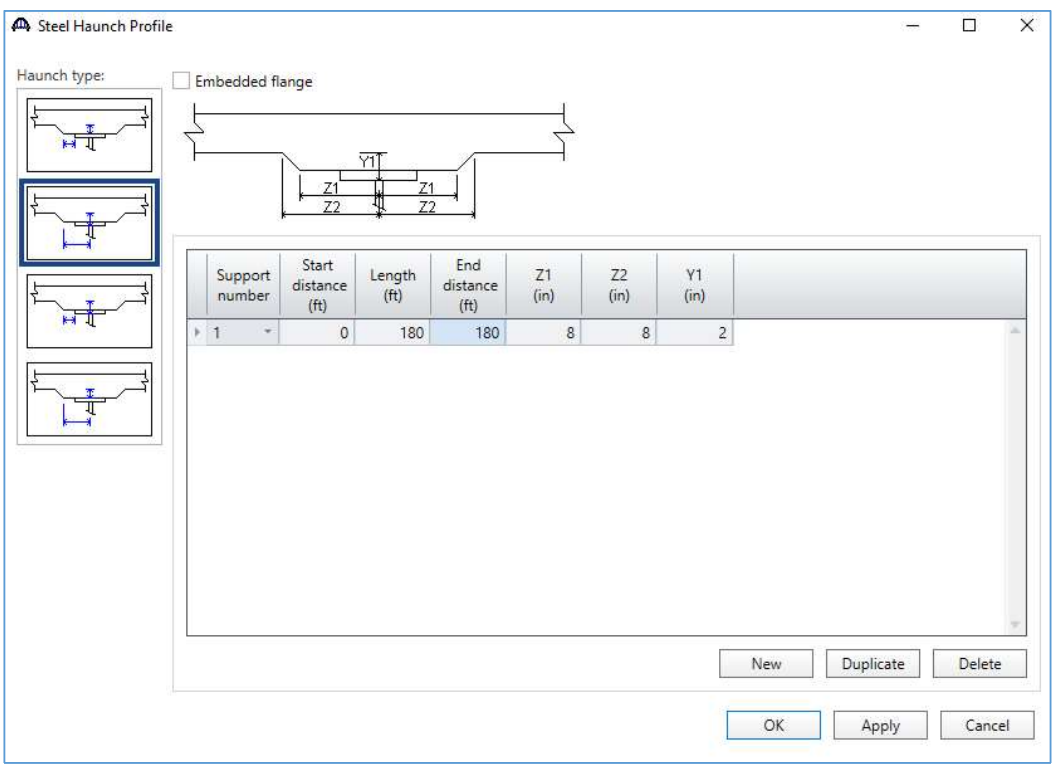




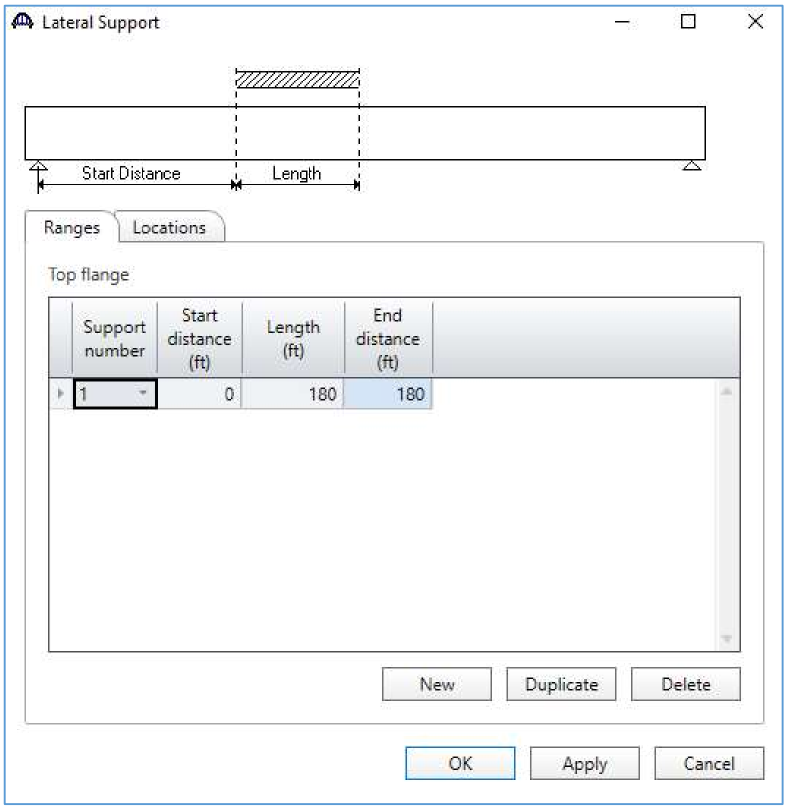
Composite regions are described using the Shear Connectors tab as shown below.



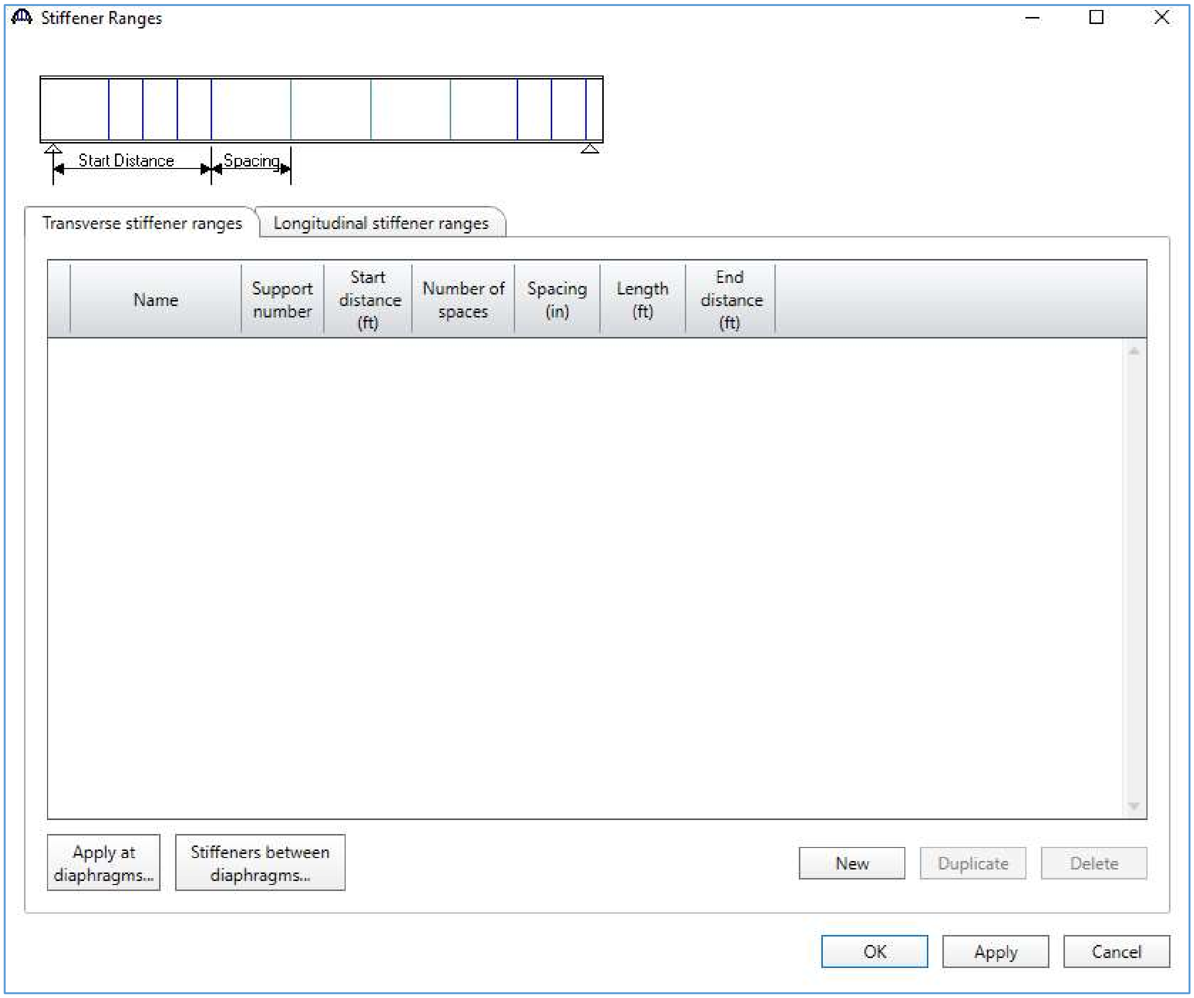
The haunch profile is defined by double clicking on Haunch Profile in the tree. The window is shown below.



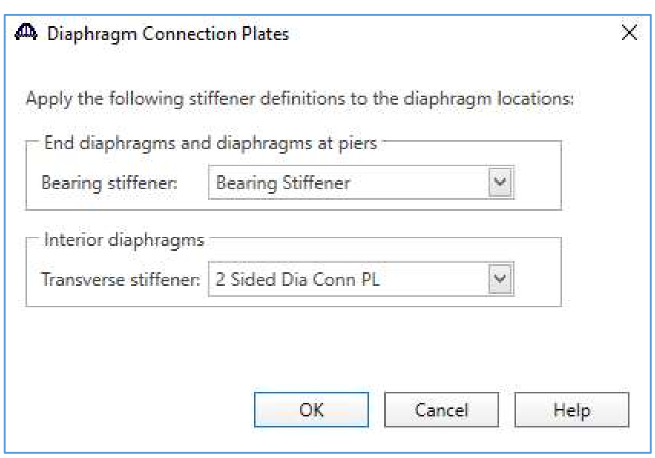
Regions where the slab is considered to provide lateral support for the top flange are defined using the Lateral Support window shown below. It can be opened by double clicking on Lateral Support in the tree.



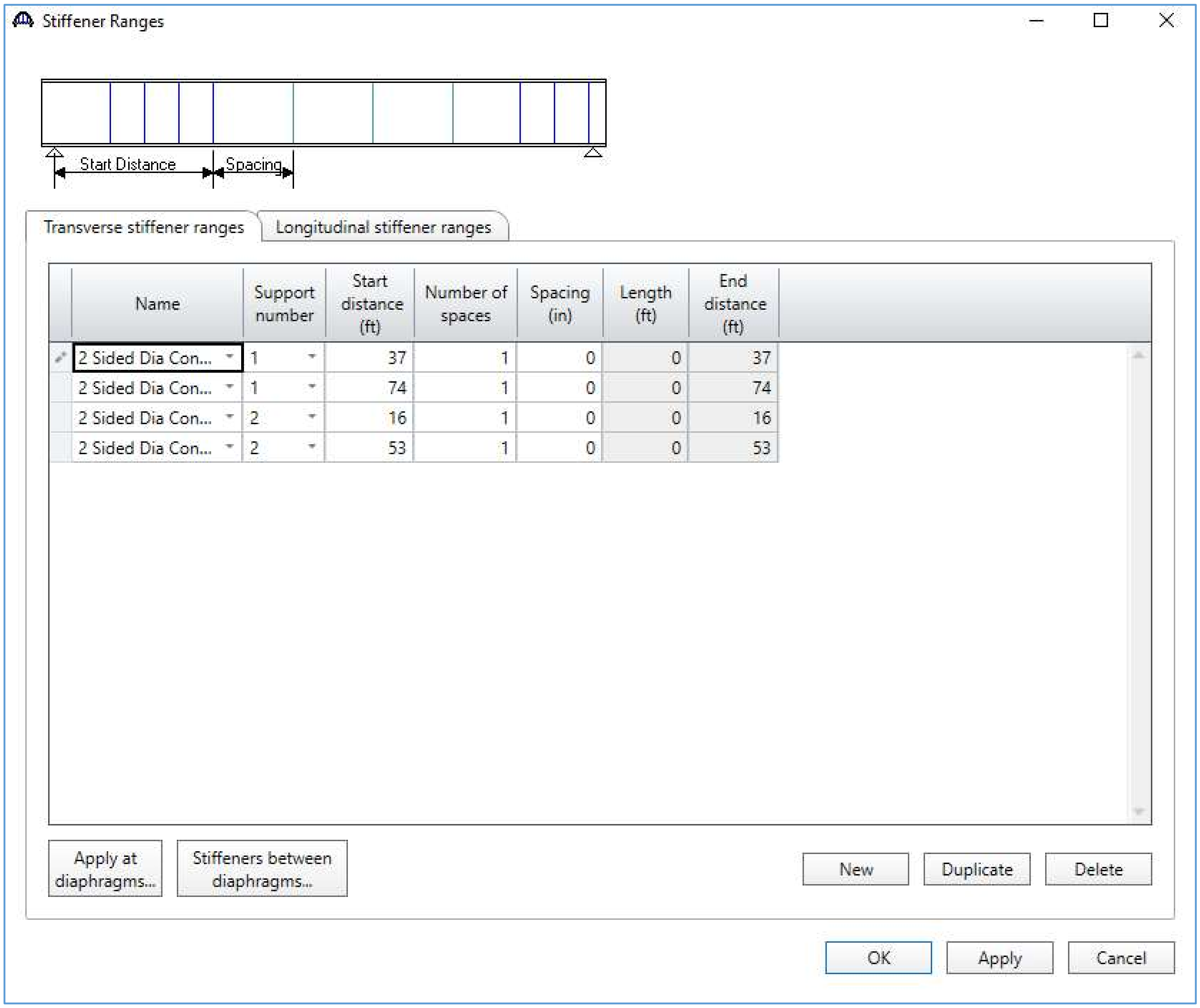
Stiffener locations are described using the Stiffener Ranges window shown below.



Click on the "Apply at Diaphragms…" button to open the following dialog. Select the 2 Sided Conn PL as the stiffener to apply at the interior diaphragms.

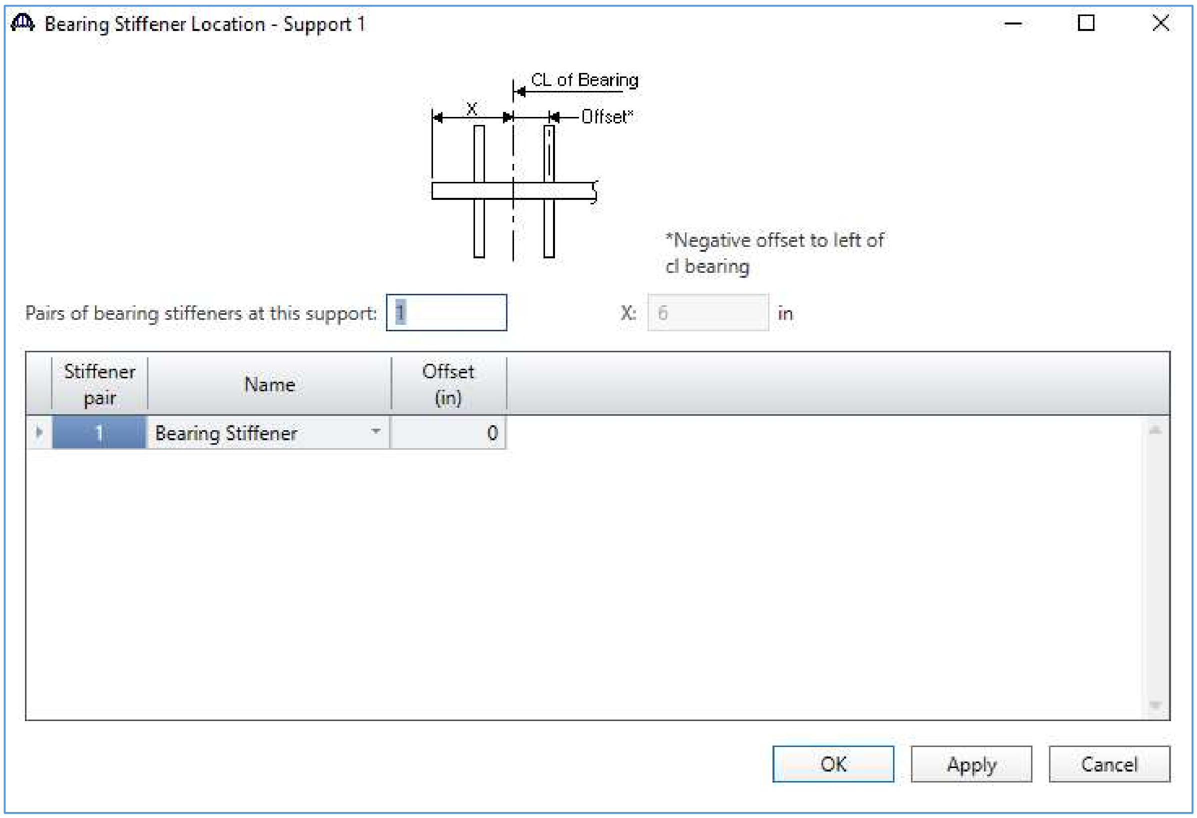


Selecting Apply will create the following transverse stiffener locations.



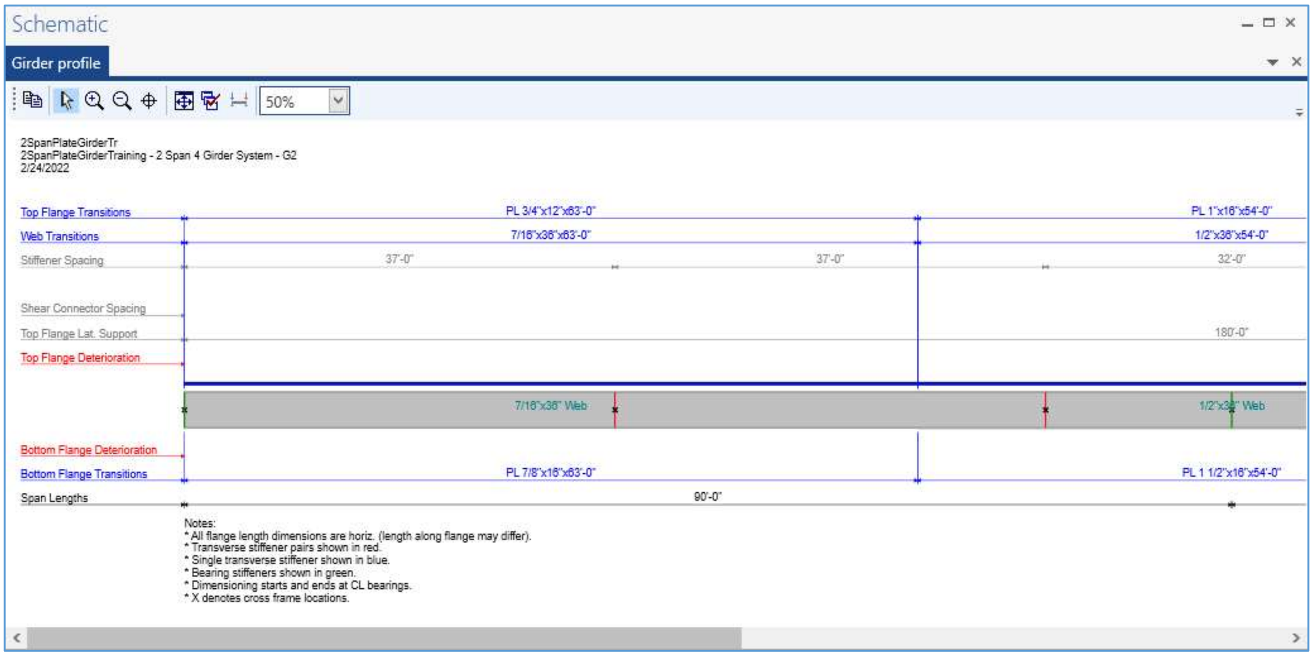
This example does not have any intermediate transverse stiffeners so we can click Ok to close this window

Bearing stiffener definitions were assigned to locations when we used the Apply at Diaphragms… button on the Transverse Stiffener Ranges window. The Bearing Stiffener Location window is opened by expanding the Bearing Stiffener Locations branch in the tree and double clicking on each support. The assignment for Support 1 is shown below.



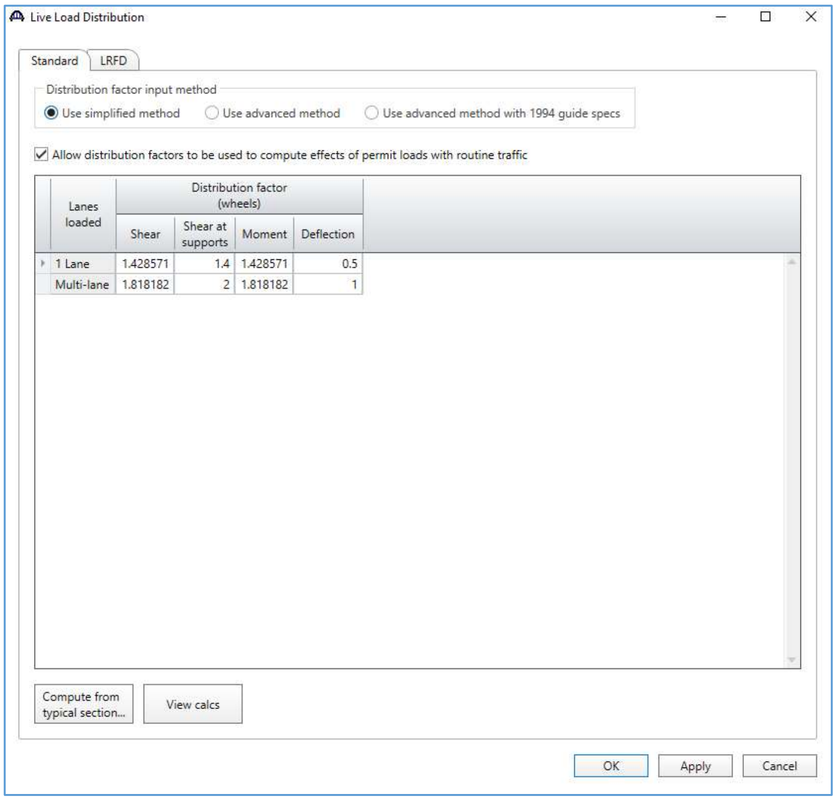
The description of an interior beam for a structure definition is complete.

While "Plate Girder" is selected in the Bridge tree, open the schematic for the girder by selecting the Schematic button under the WORKSPACE tab in the ribbon (or by right clicking Plate Girder and selecting Schematic from the popup menu). The following schematic will be displayed.



Distribution Factors (Standard):

Double click Live Load Distribution to open the window, and use the Compute from Typical Section button to compute the following Standard (LFD) distribution factors.



We do not need to enter any LRFD distribution factors since AASHTO LRFD will compute them for us since we have a girder system structure definition.

Interior (LFD wheels)

Lanes Loaded	Shear	Shear at Support	Moment	Deflection
1 lane	1.43	1.4	1.43	0.5
Multi-lane	1.81	2.0	1.81	1.0

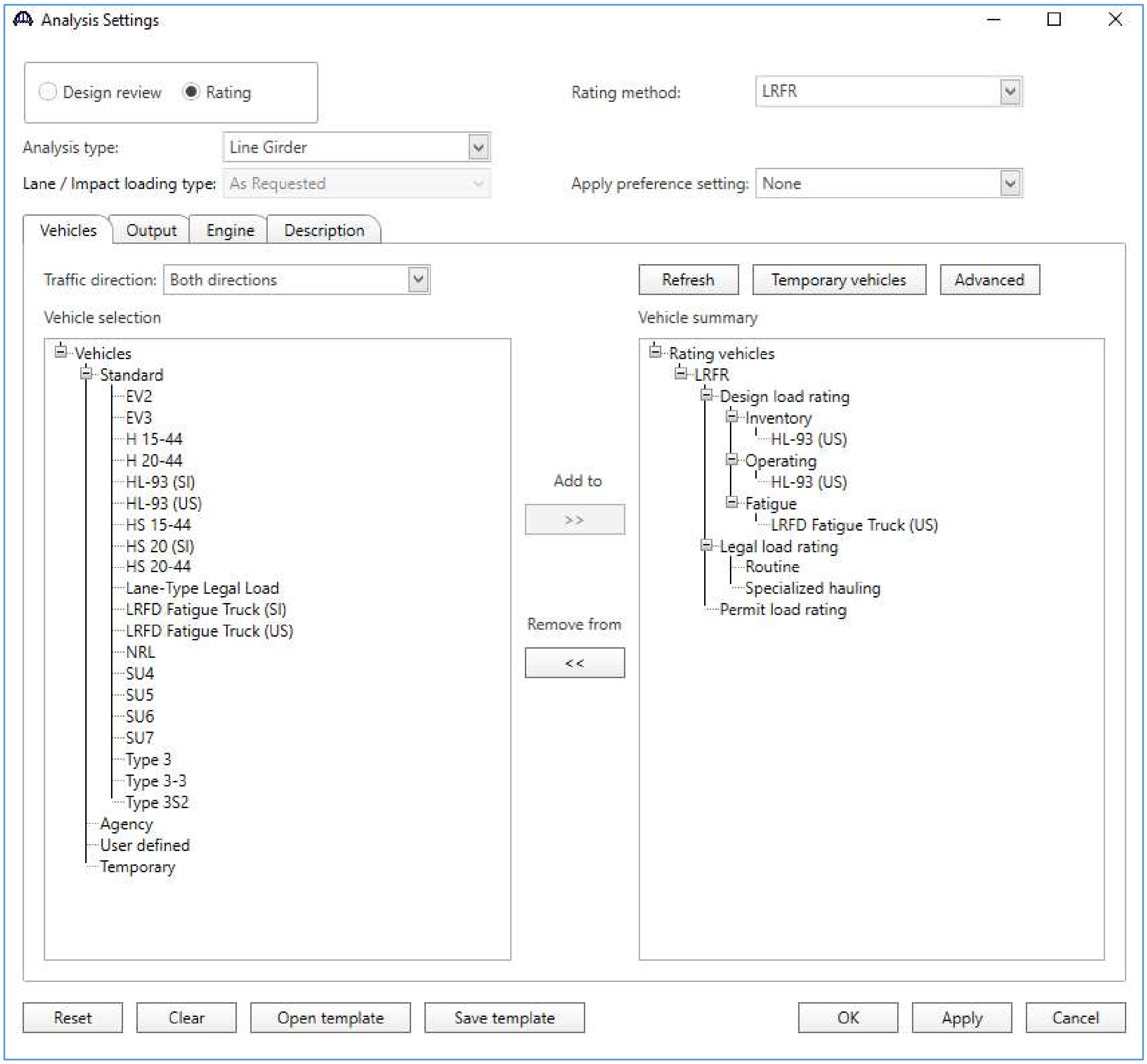
Interior (LRFD lanes)

Lanes Loaded	Shear	Shear at Support	Pos. Moment	Neg. Moment	Deflection
1 lane	0.76	0.76	0.484	0.503	0.3*
Multi-lane	0.952	0.952	0.698	0.726	0.5

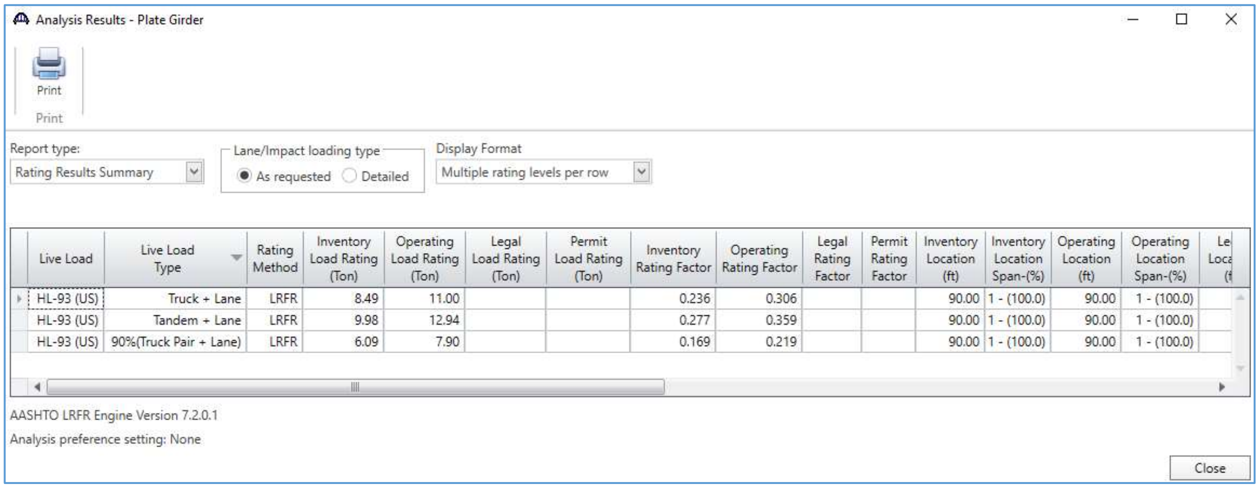
* includes 1.20 multiple presence factor

Live load distribution factor calculation details can be viewed by clicking “View Calcs” button.

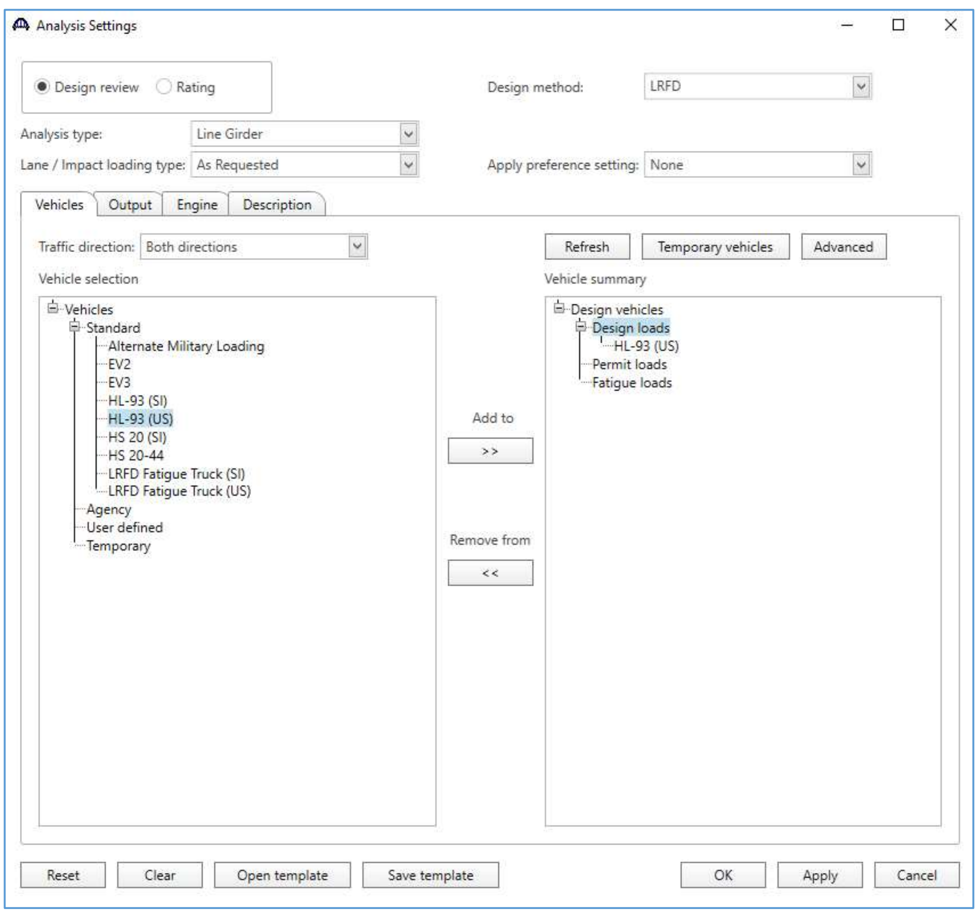
The member alternative can now be analyzed. To perform LRFR rating, select the Analysis Settings button on the DESIGN/RATE tab of the ribbon to open the window shown below. Click Open Template button and select the LRFR Design Load Rating to be used in the rating and click Ok.



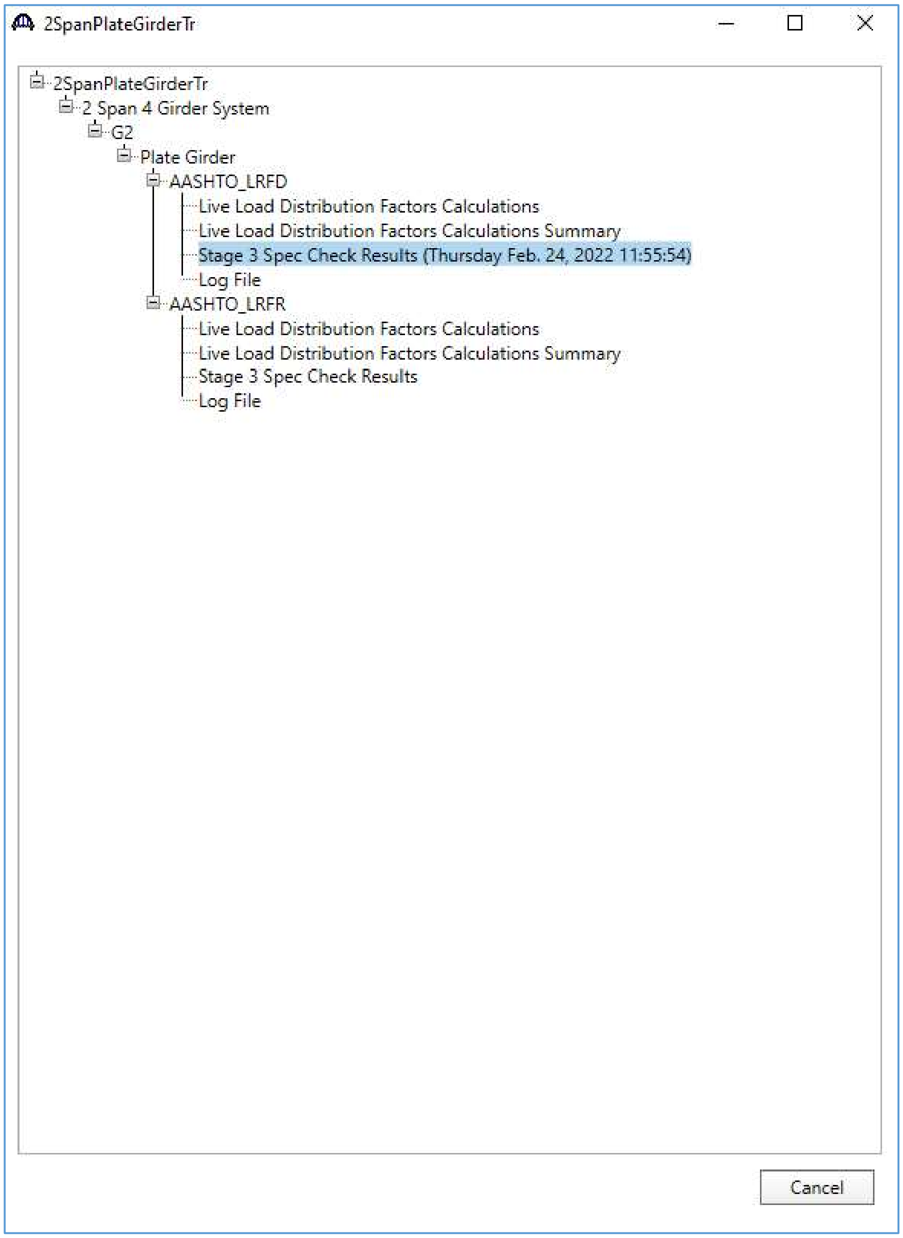
Next click the Analyze button on the DESIGN/RATE tab to perform the rating. When the rating is finished you can review the results by clicking the Tabular Results button on the ribbon. The window shown below will open.



An LRFD design review of this girder for HL-93 loading can be performed by AASHTO LRFD. To do LRFD design review, enter the Analysis Settings window as shown below:



AASHTO LRFD analysis will generate a spec check results file. Click the Engine Outputs button on the DESIGN/RATE tab in the ribbon to open the following window.



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