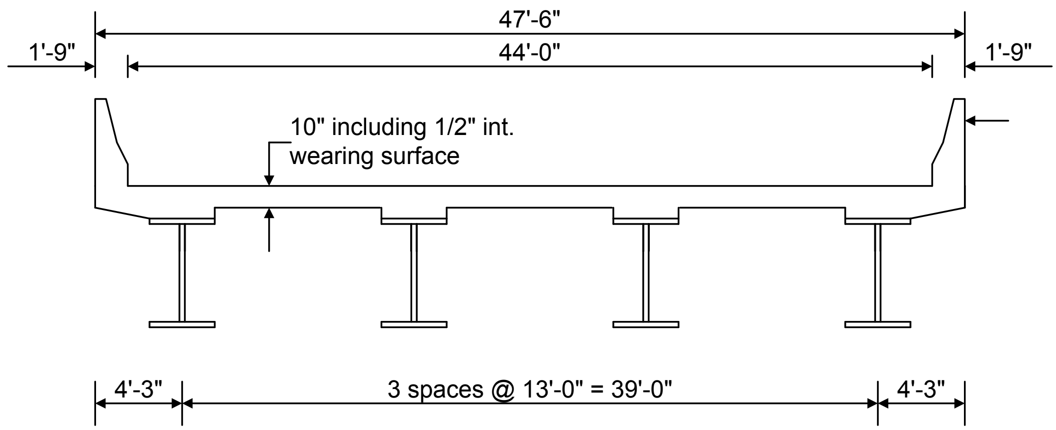
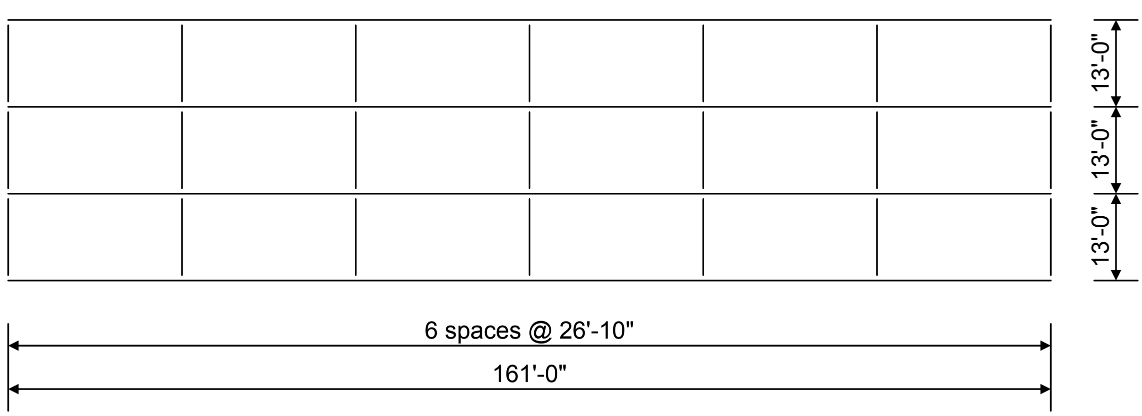
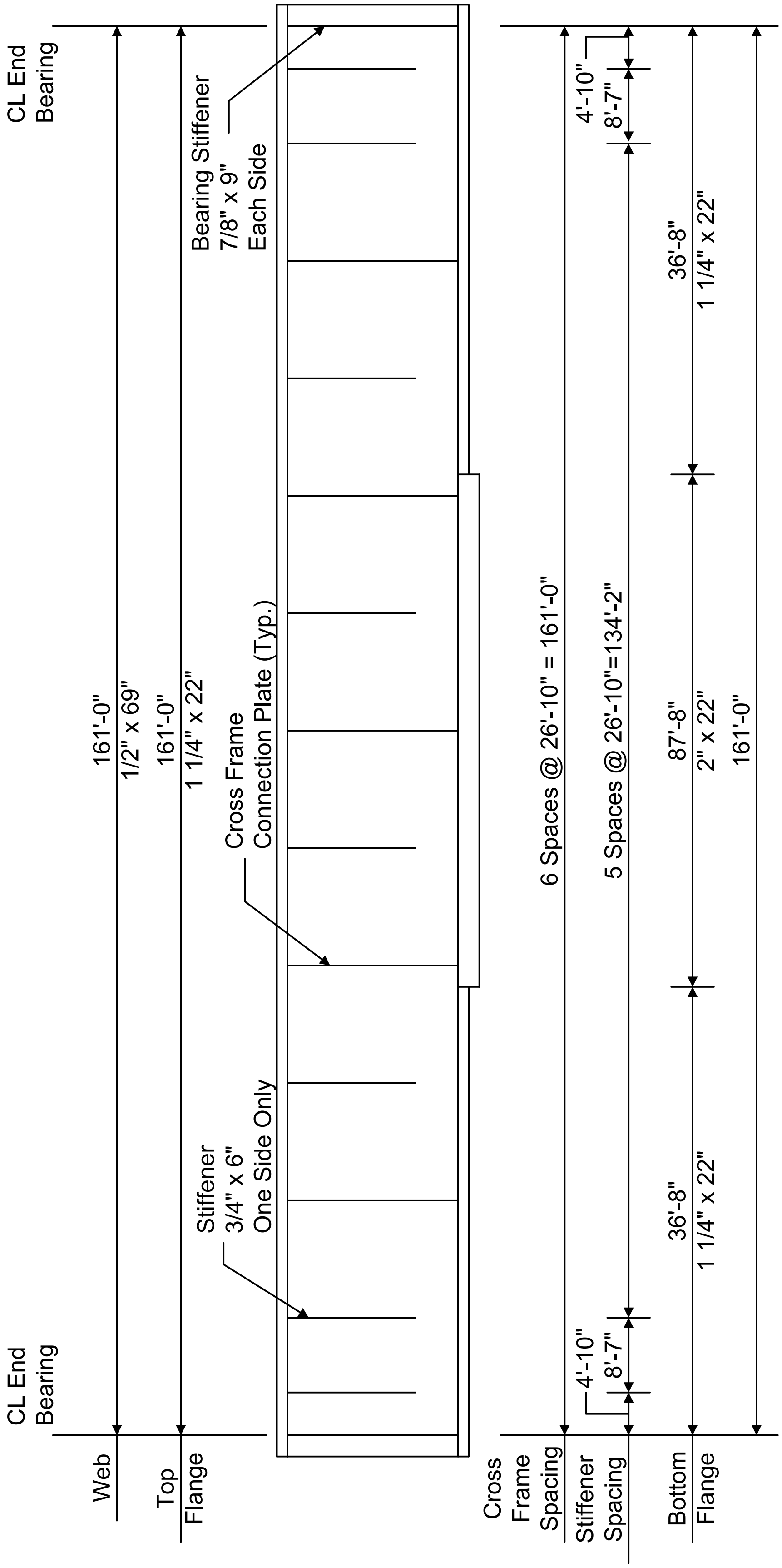
STL1 - Simple Span Plate Girder Example





Framing Plan



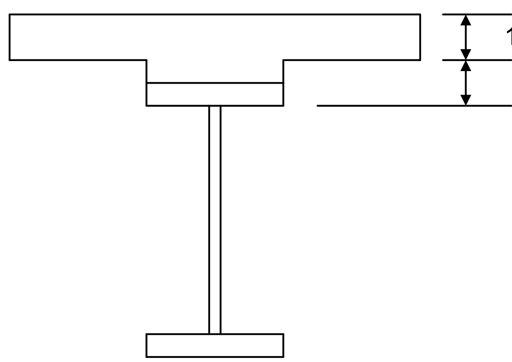
Elevation of Interior Girder

Material Properties

Structural Steel: AASHTO M270, Grade 50W uncoated weathering steel with Fy = 50 ksi
Deck Concrete: f'c = 4.5 ksi, modular ratio n = 8
Slab Reinforcing Steel: AASHTO M31, Grade 60 with Fy = 60 ksi

Transverse Stiffener Plates: 3/4" x 6"
Cross Frame Connection Plates: 3/4" x 6"
Bearing Stiffener Plates: 7/8" x 9"

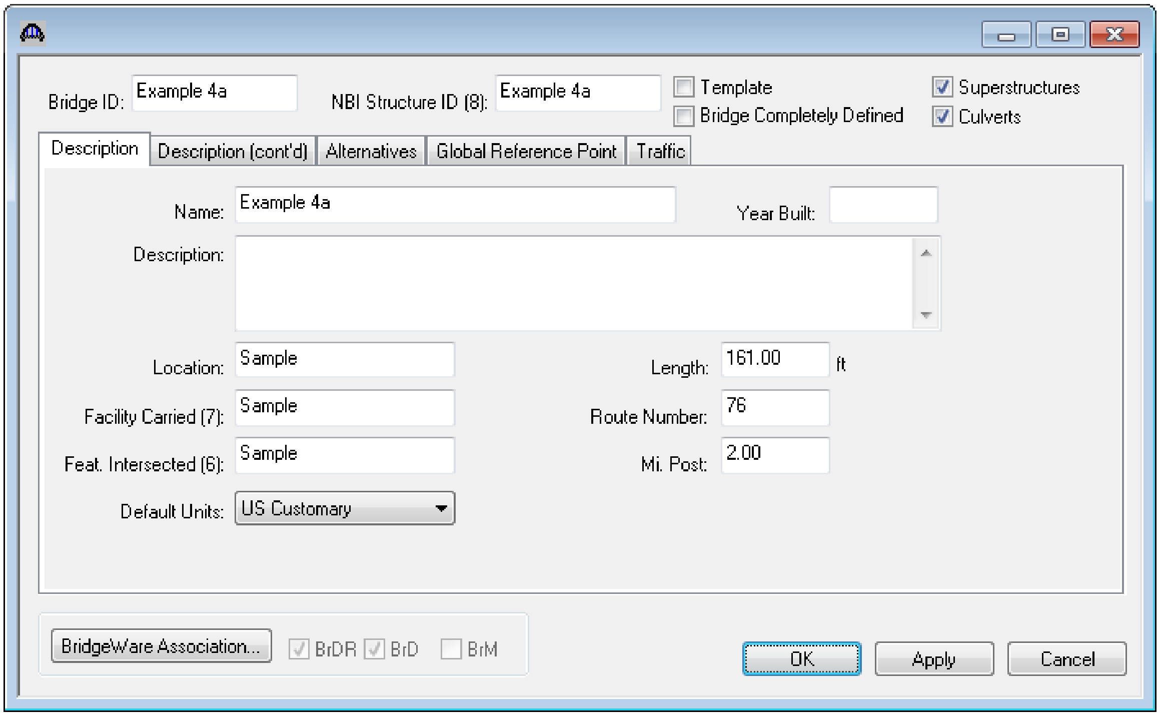
Haunch Detail

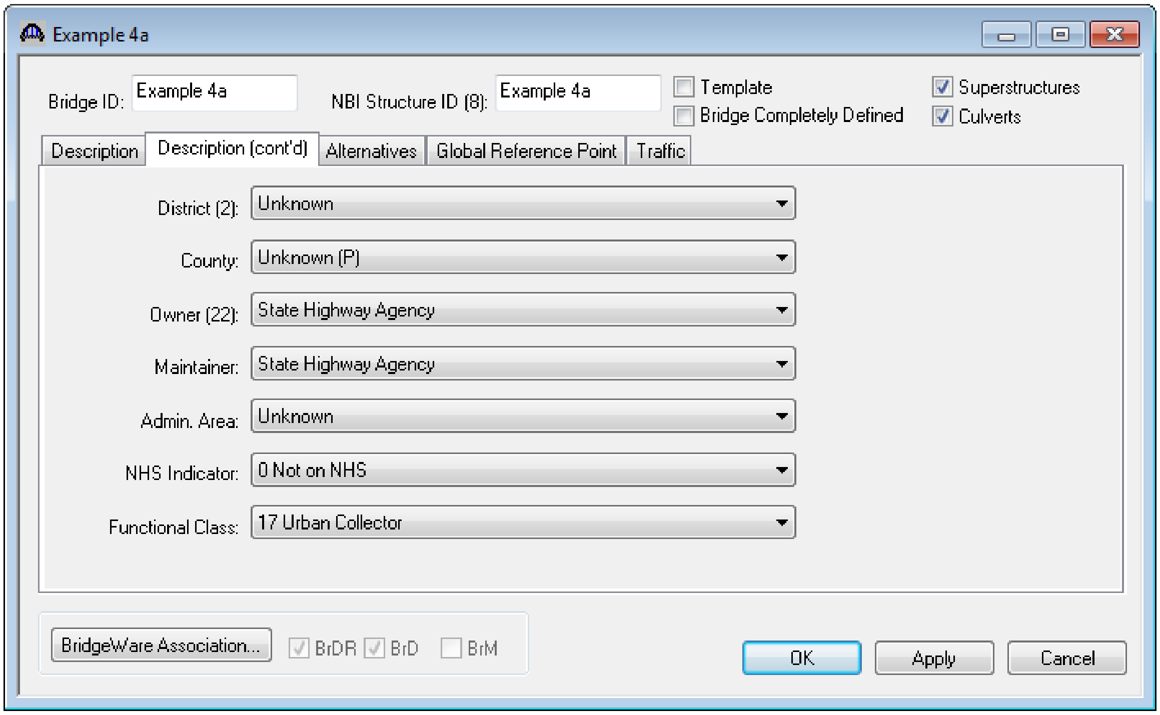


AASHTOWare Bridge Design and Rating Training

STL1– Simple Span Plate Girder Example (BrD/BrR 6.5)

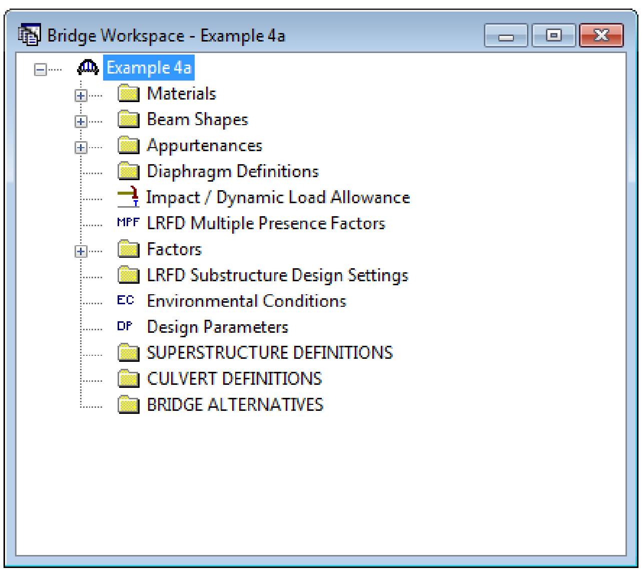
From the Bridge Explorer create a new bridge and enter the following description data:





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

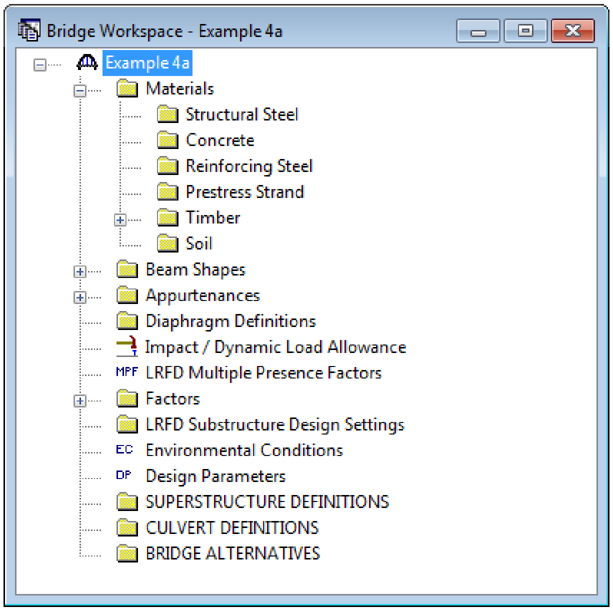
The Bridge Workspace tree after the bridge is created is shown below:



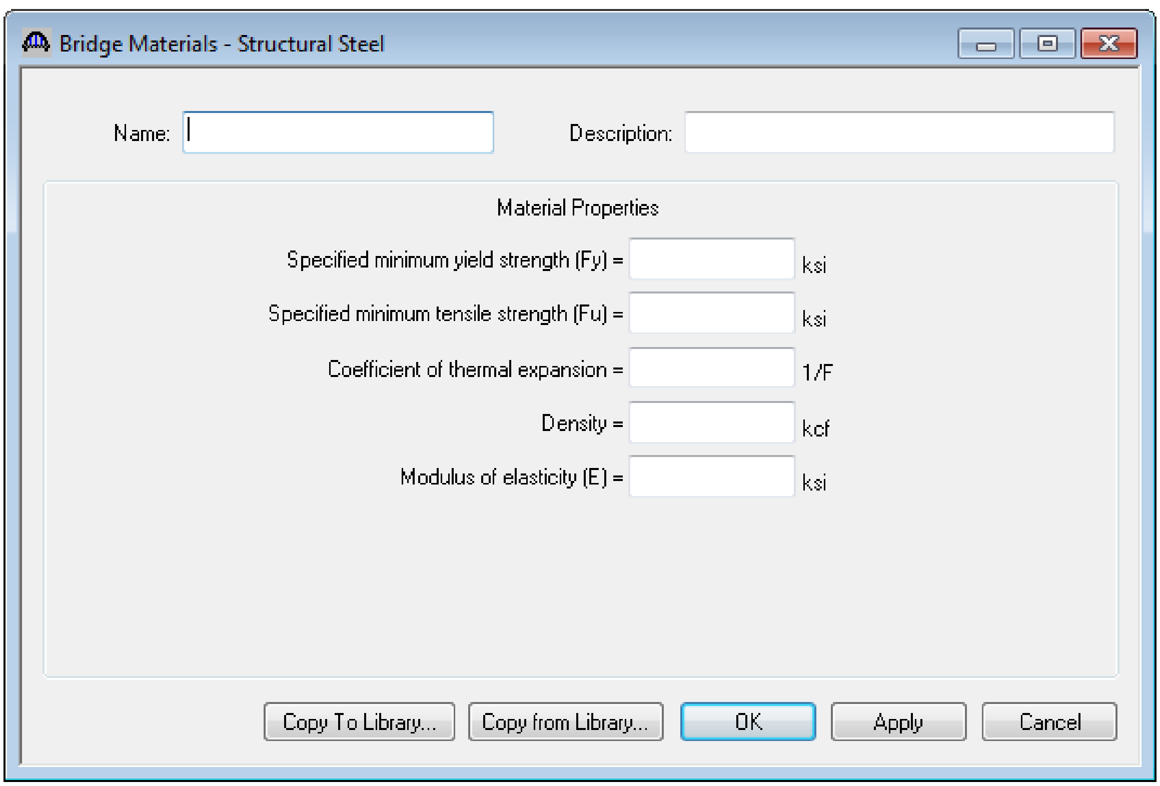
The tree is organized according to the definition of a bridge with data shared by many of the bridge components shown in the upper part of the tree. A bridge can be described by working from top to bottom within the tree.

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

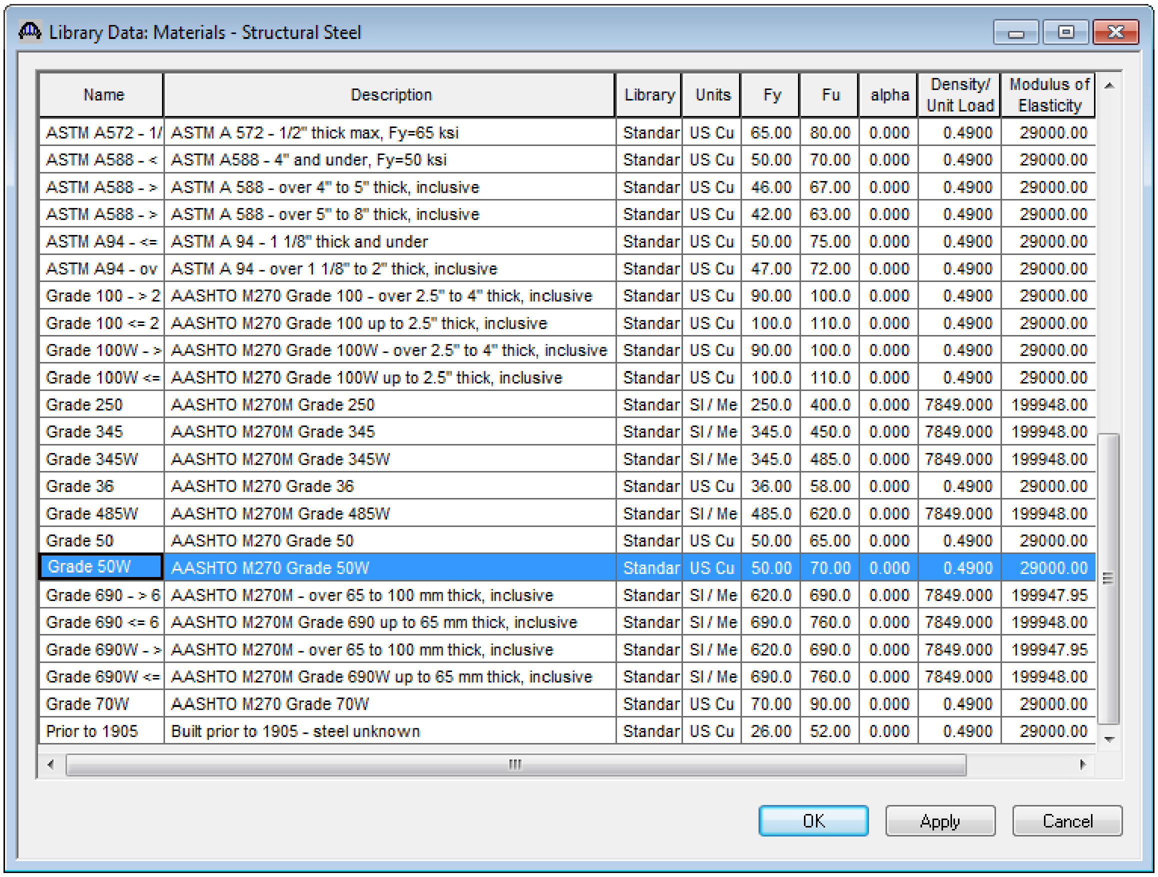
The tree with the expanded Materials branch is shown below:



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.

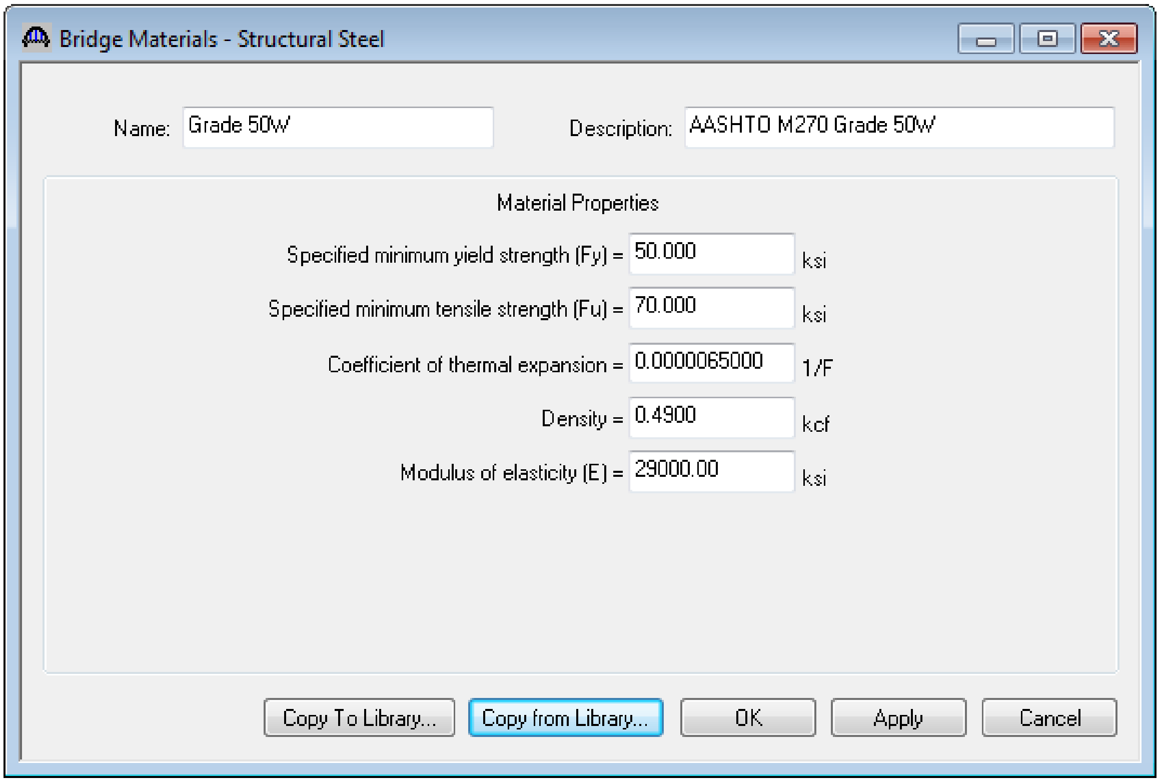


Add structural steel materials by selecting from the Structural Steel Materials Library by clicking the Copy from Library button.

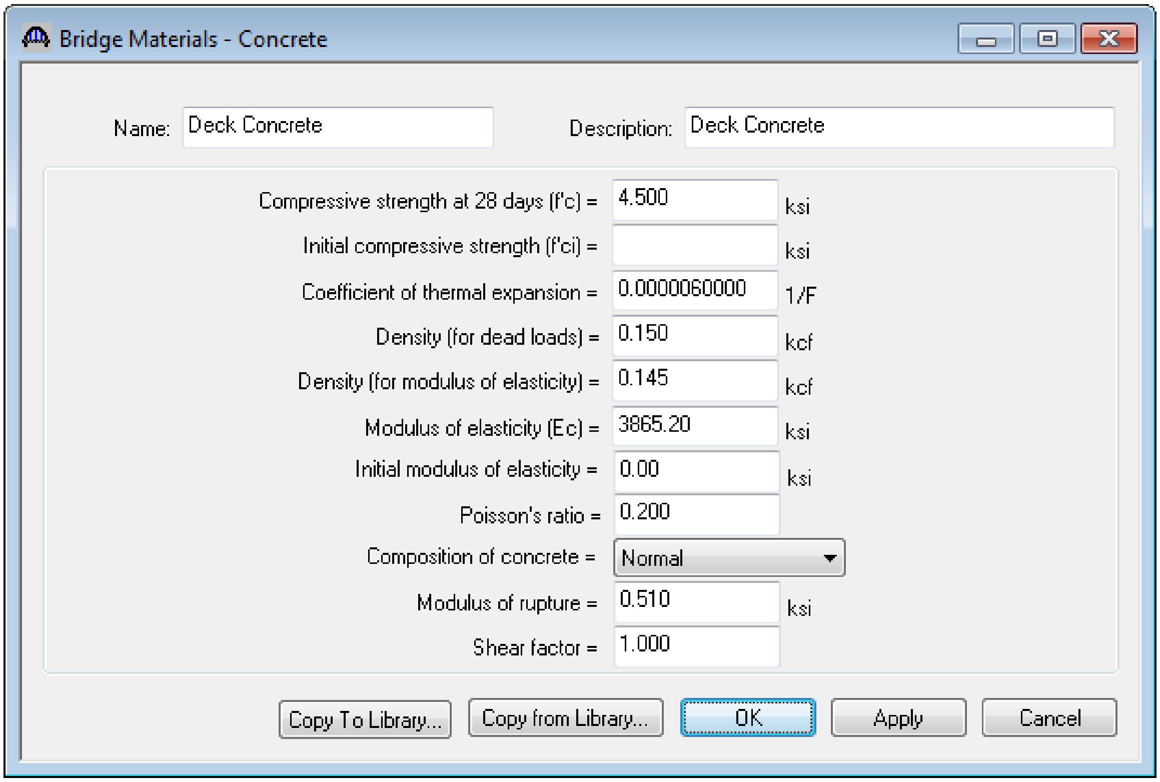


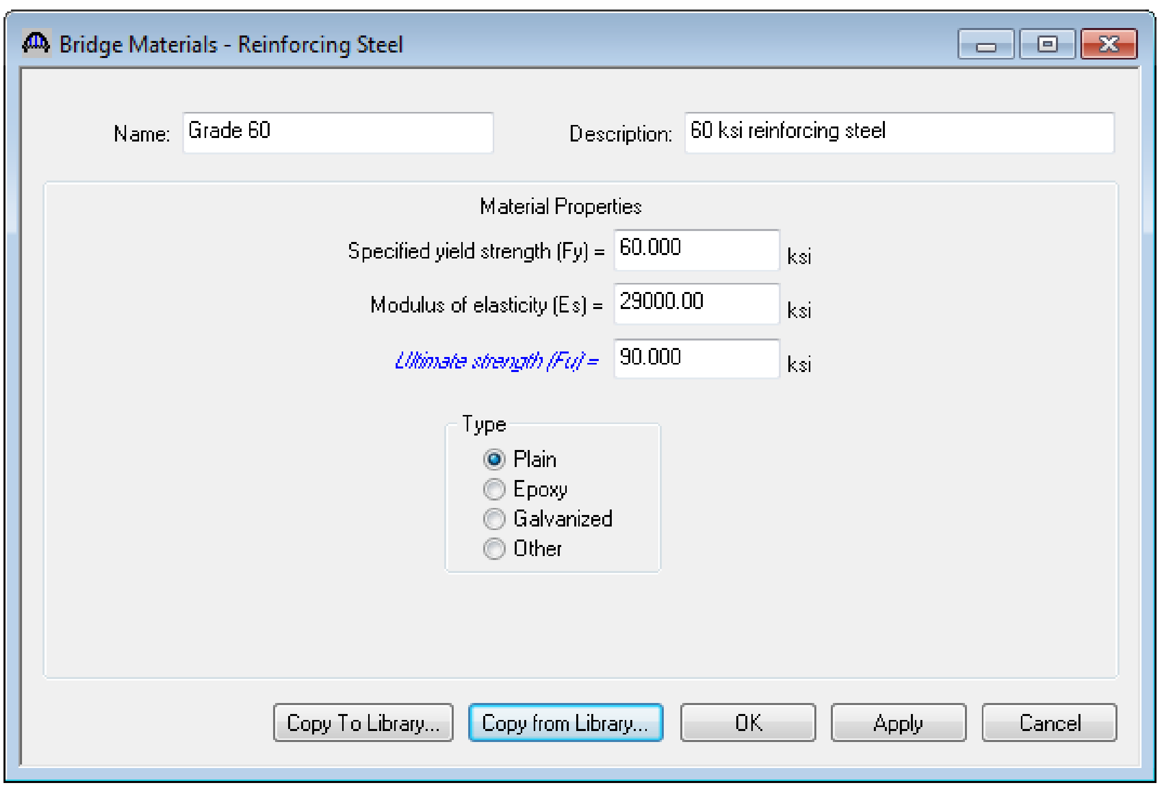
Name	Description	Library	Units	Fy	Fu	alpha	Density/ Unit Load	Modulus of Elasticity
ASTM A572 - 1/	ASTM A 572 - 1/2" thick max, Fy=65 ksi	Standar	US Cu	65.00	80.00	0.000	0.4900	29000.00
ASTM A588 - <	ASTM A588 - 4" and under, Fy=50 ksi	Standar	US Cu	50.00	70.00	0.000	0.4900	29000.00
ASTM A588 - >	ASTM A 588 - over 4" to 5" thick, inclusive	Standar	US Cu	46.00	67.00	0.000	0.4900	29000.00
ASTM A588 - >	ASTM A 588 - over 5" to 8" thick, inclusive	Standar	US Cu	42.00	63.00	0.000	0.4900	29000.00
ASTM A94 - <=	ASTM A 94 - 1 1/8" thick and under	Standar	US Cu	50.00	75.00	0.000	0.4900	29000.00
ASTM A94 - ov	ASTM A 94 - over 1 1/8" to 2" thick, inclusive	Standar	US Cu	47.00	72.00	0.000	0.4900	29000.00
Grade 100 - > 2	AASHTO M270 Grade 100 - over 2.5" to 4" thick, inclusive	Standar	US Cu	90.00	100.0	0.000	0.4900	29000.00
Grade 100 <= 2	AASHTO M270 Grade 100 up to 2.5" thick, inclusive	Standar	US Cu	100.0	110.0	0.000	0.4900	29000.00
Grade 100W - >	AASHTO M270 Grade 100W - over 2.5" to 4" thick, inclusive	Standar	US Cu	90.00	100.0	0.000	0.4900	29000.00
Grade 100W <=	AASHTO M270 Grade 100W up to 2.5" thick, inclusive	Standar	US Cu	100.0	110.0	0.000	0.4900	29000.00
Grade 250	AASHTO M270M Grade 250	Standar	SI / Me	250.0	400.0	0.000	7849.000	199948.00
Grade 345	AASHTO M270M Grade 345	Standar	SI / Me	345.0	450.0	0.000	7849.000	199948.00
Grade 345W	AASHTO M270M Grade 345W	Standar	SI / Me	345.0	485.0	0.000	7849.000	199948.00
Grade 36	AASHTO M270 Grade 36	Standar	US Cu	36.00	58.00	0.000	0.4900	29000.00
Grade 485W	AASHTO M270M Grade 485W	Standar	SI / Me	485.0	620.0	0.000	7849.000	199948.00
Grade 50	AASHTO M270 Grade 50	Standar	US Cu	50.00	65.00	0.000	0.4900	29000.00
Grade 50W	AASHTO M270 Grade 50W	Standar	US Cu	50.00	70.00	0.000	0.4900	29000.00
Grade 690 - > 6	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standar	SI / Me	620.0	690.0	0.000	7849.000	199947.95
Grade 690 <= 6	AASHTO M270M Grade 690 up to 65 mm thick, inclusive	Standar	SI / Me	690.0	760.0	0.000	7849.000	199948.00
Grade 690W - >	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standar	SI / Me	620.0	690.0	0.000	7849.000	199947.95
Grade 690W <=	AASHTO M270M Grade 690W up to 65 mm thick, inclusive	Standar	SI / Me	690.0	760.0	0.000	7849.000	199948.00
Grade 70W	AASHTO M270 Grade 70W	Standar	US Cu	70.00	90.00	0.000	0.4900	29000.00
Prior to 1905	Built prior to 1905 - steel unknown	Standar	US Cu	26.00	52.00	0.000	0.4900	29000.00

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.

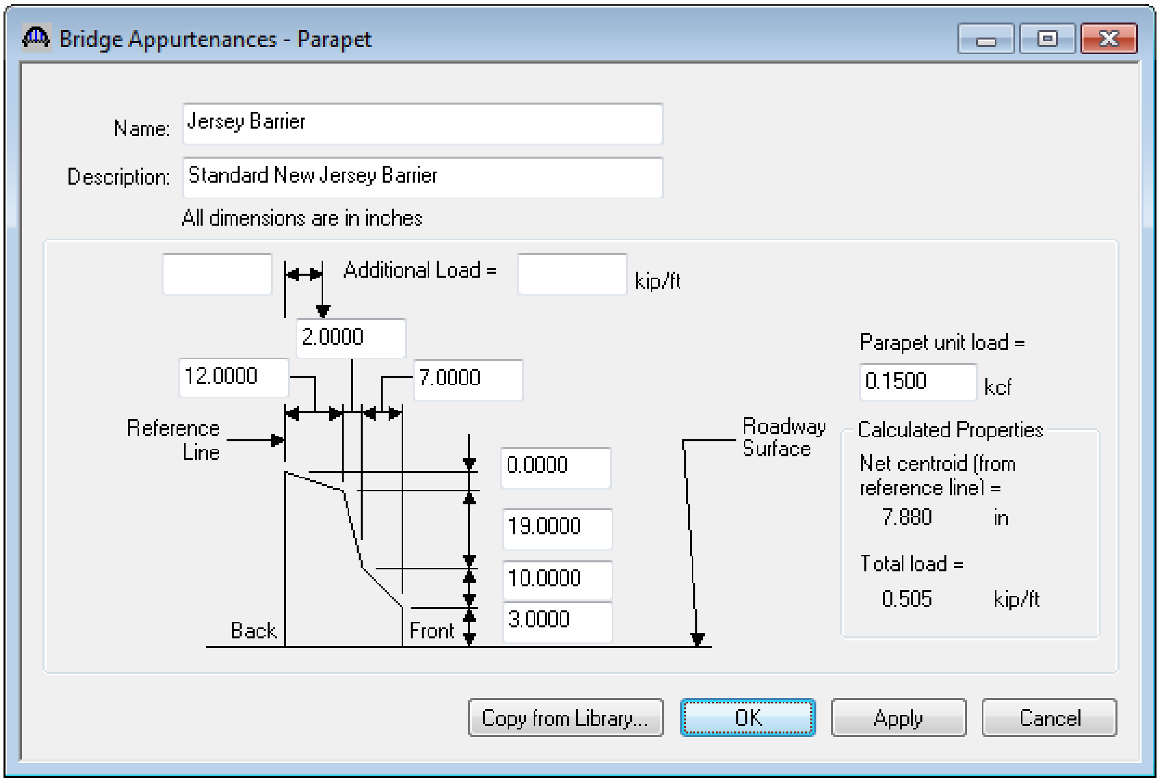


Add concrete materials and reinforcement materials using the same techniques. Enter the concrete material as shown below:

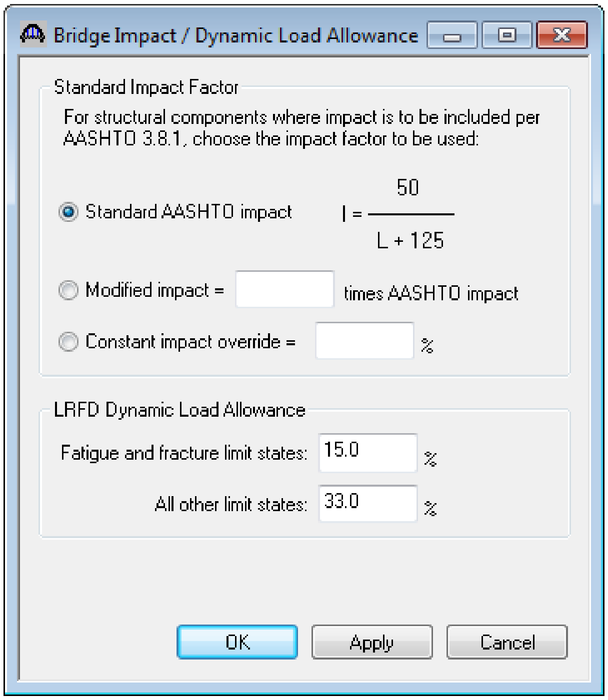




To enter the appurtenances to be used within the bridge expand the tree branch labeled Appurtenances. To define a parapet double click on Parapet in the tree and input the parapet dimensions as shown below. Click Ok to save the data to memory and close the window.

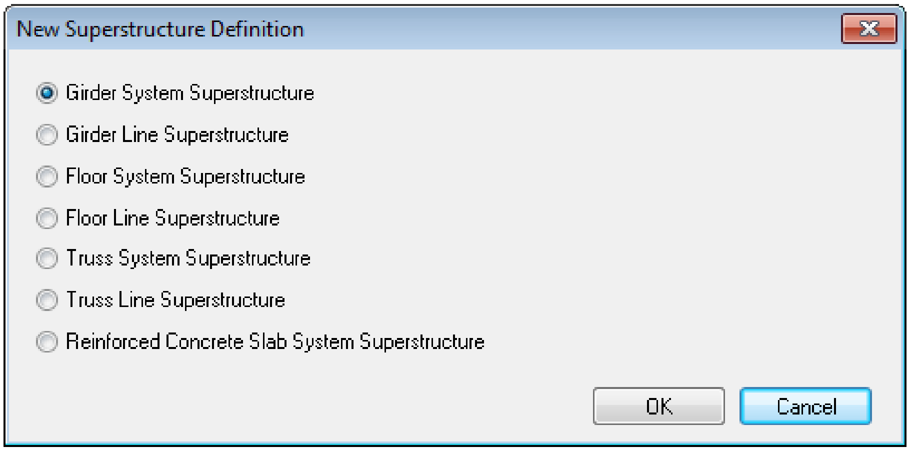


Enter the impact to be used for the entire bridge by clicking on Impact in the tree and selecting File/Open from the menu. The Bridge Impact window shown below will open. Enter the appropriate values as shown and click Ok to save the data to memory and close the window. The values shown below are default values.

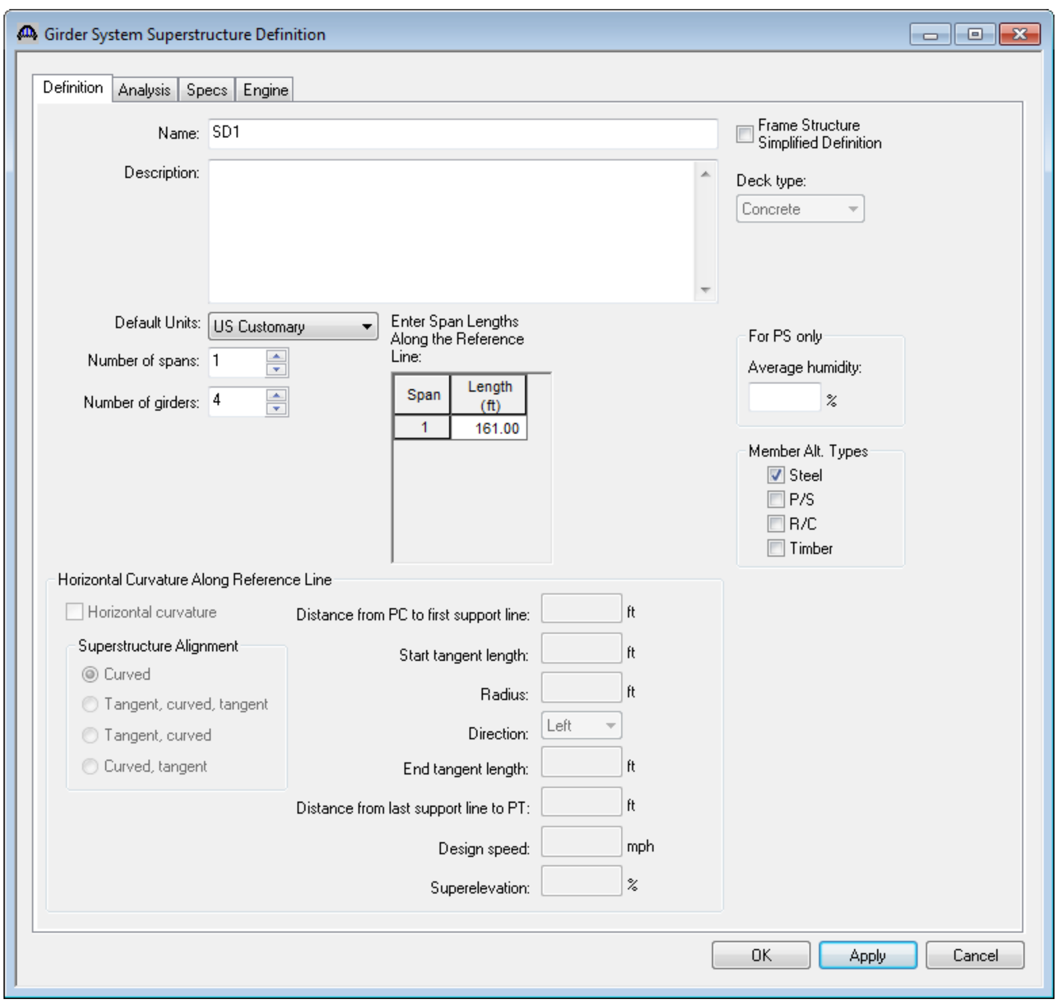


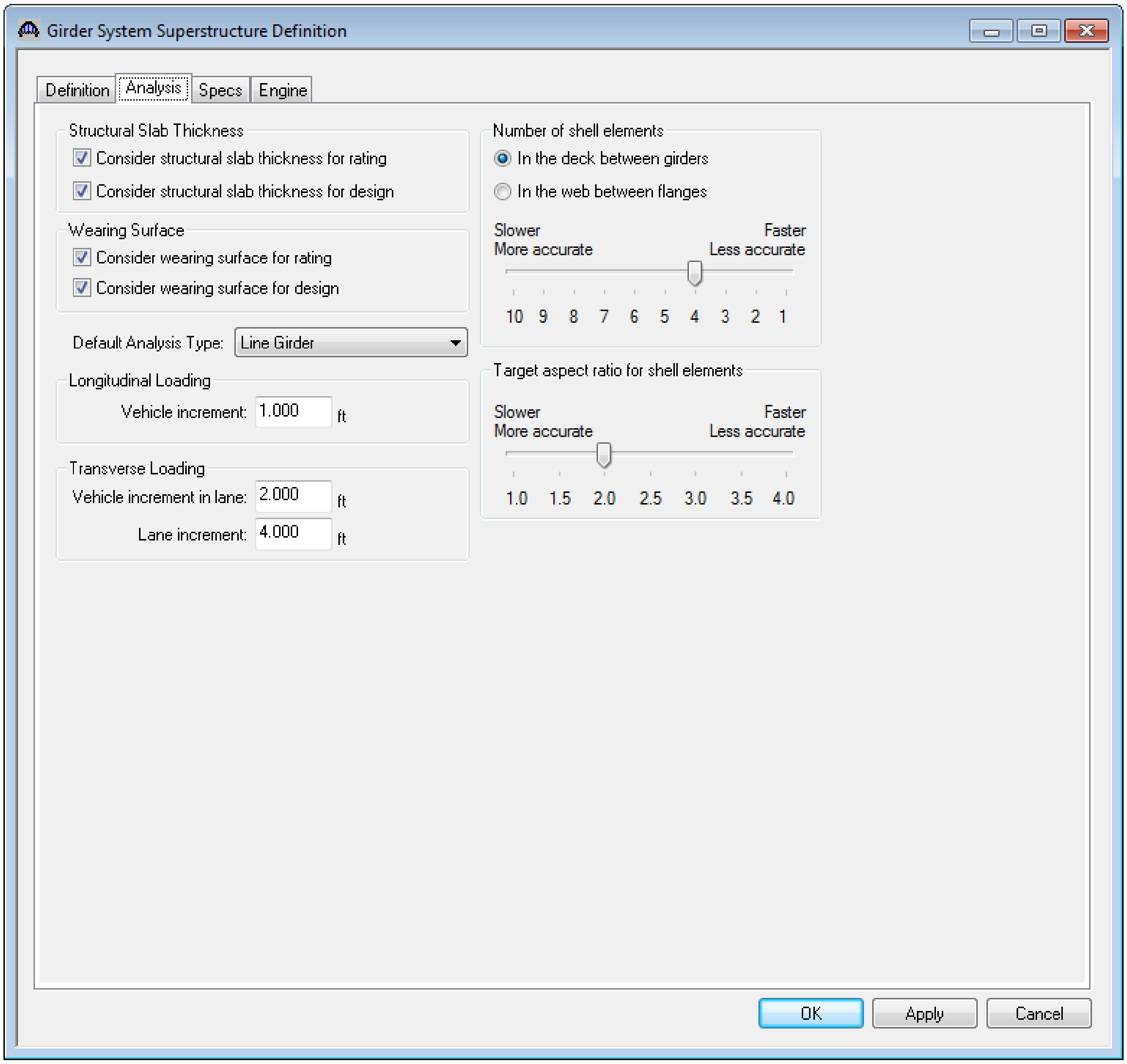
For this example problem we are not going to override the standard LRFD or LRFR factors so we skip to Structure Definition. We will come back to Bridge Alternatives after entering a Structure Definition.

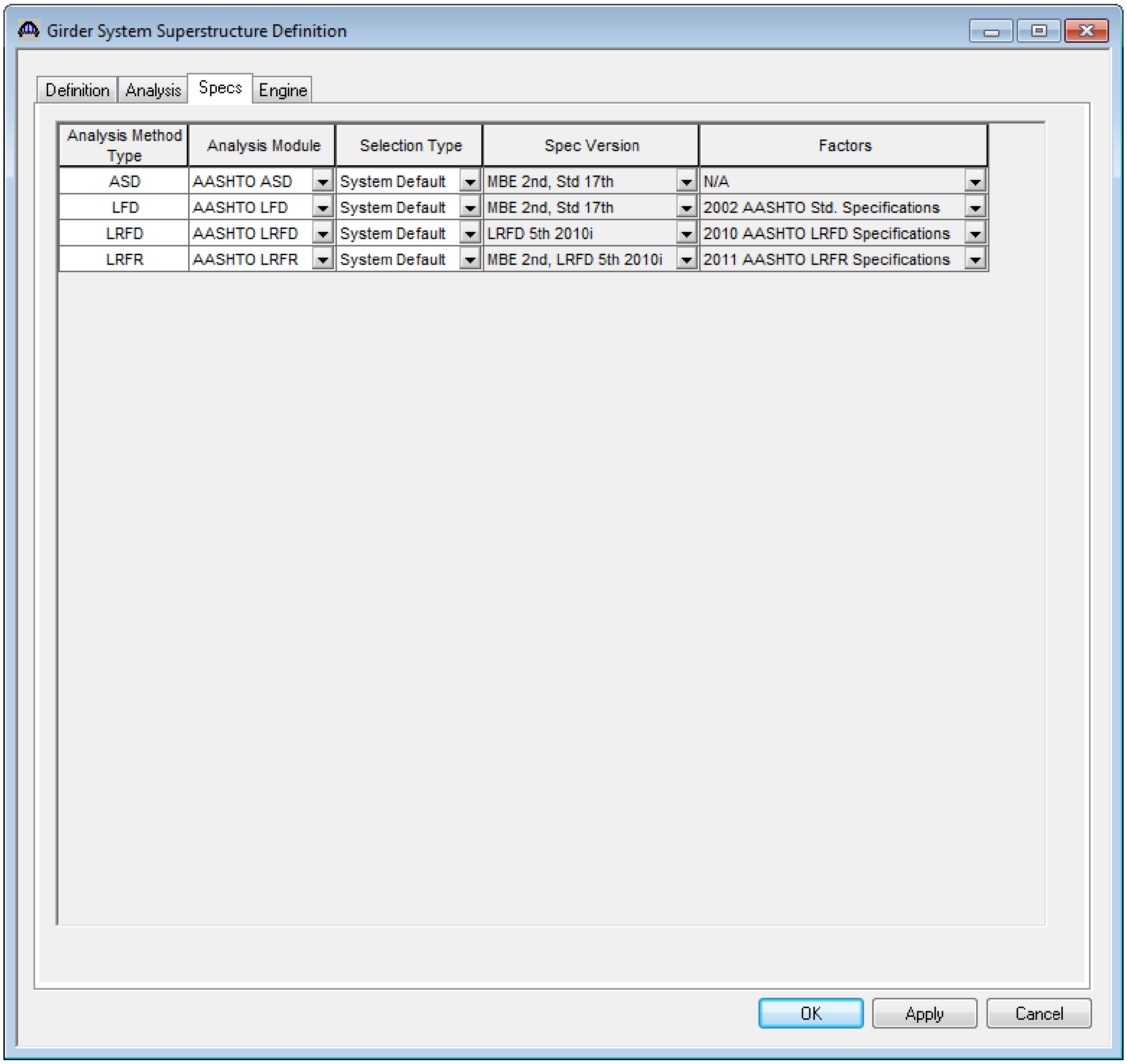
Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File/New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new structure definition. The dialog shown below will appear.



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



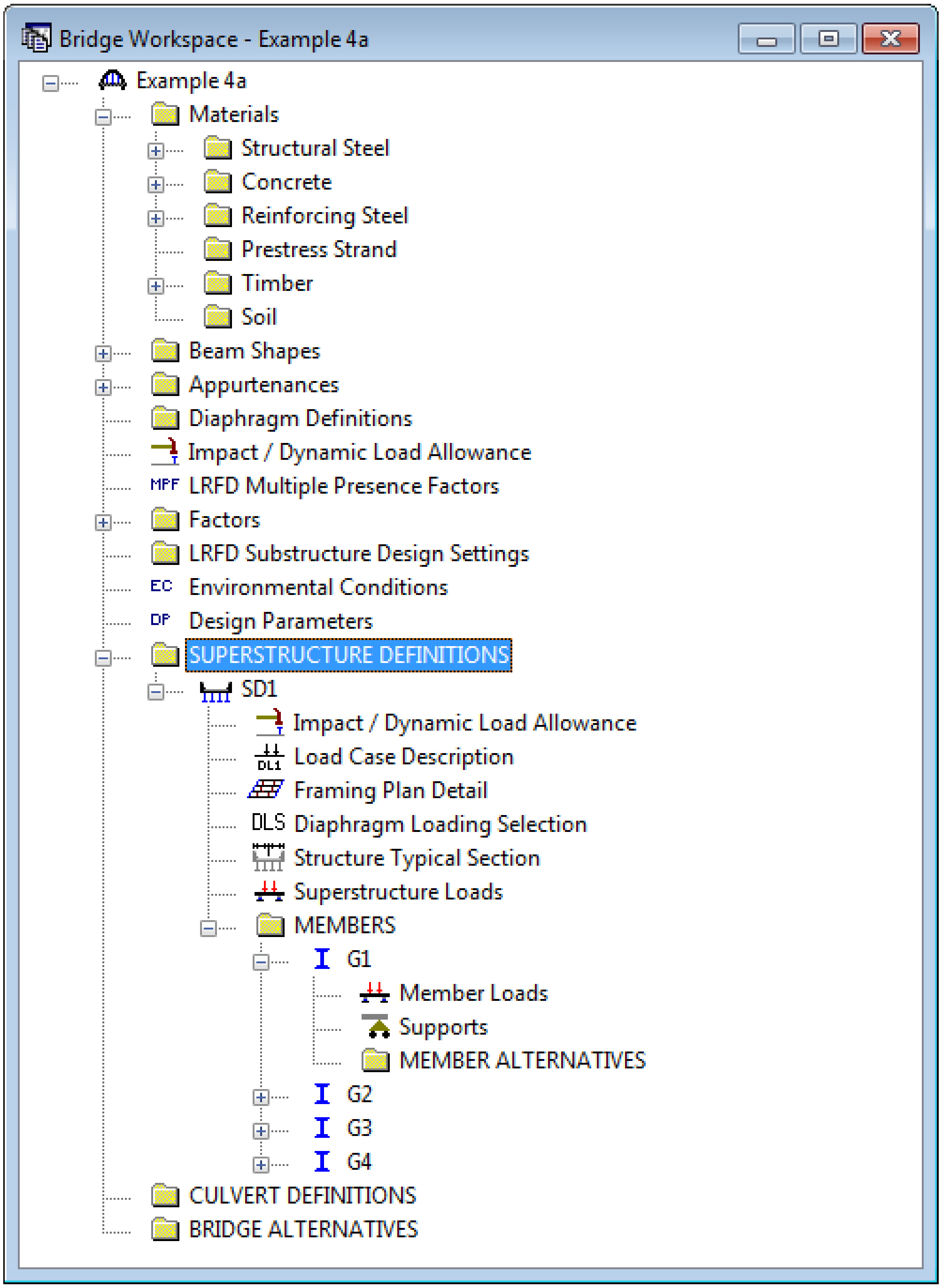

Girder System Superstructure Definition
Definition
Analysis
Specs
Engine
Structural Slab Thickness
Consider structural slab thickness for rating
Consider structural slab thickness for design
Wearing Surface
Consider wearing surface for rating
Consider wearing surface for design
Default Analysis Type:
Line Girder
Longitudinal Loading
Vehicle increment:
1.000
ft
Transverse Loading
Vehicle increment in lane:
2.000
ft
Lane increment:
4.000
ft
Number of shell elements
In the deck between girders
In the web between flanges
Slower
More accurate
Faster
Less accurate
10 9 8 7 6 5 4 3 2 1
Target aspect ratio for shell elements
Slower
More accurate
Faster
Less accurate
1.0 1.5 2.0 2.5 3.0 3.5 4.0
OK
Apply
Cancel



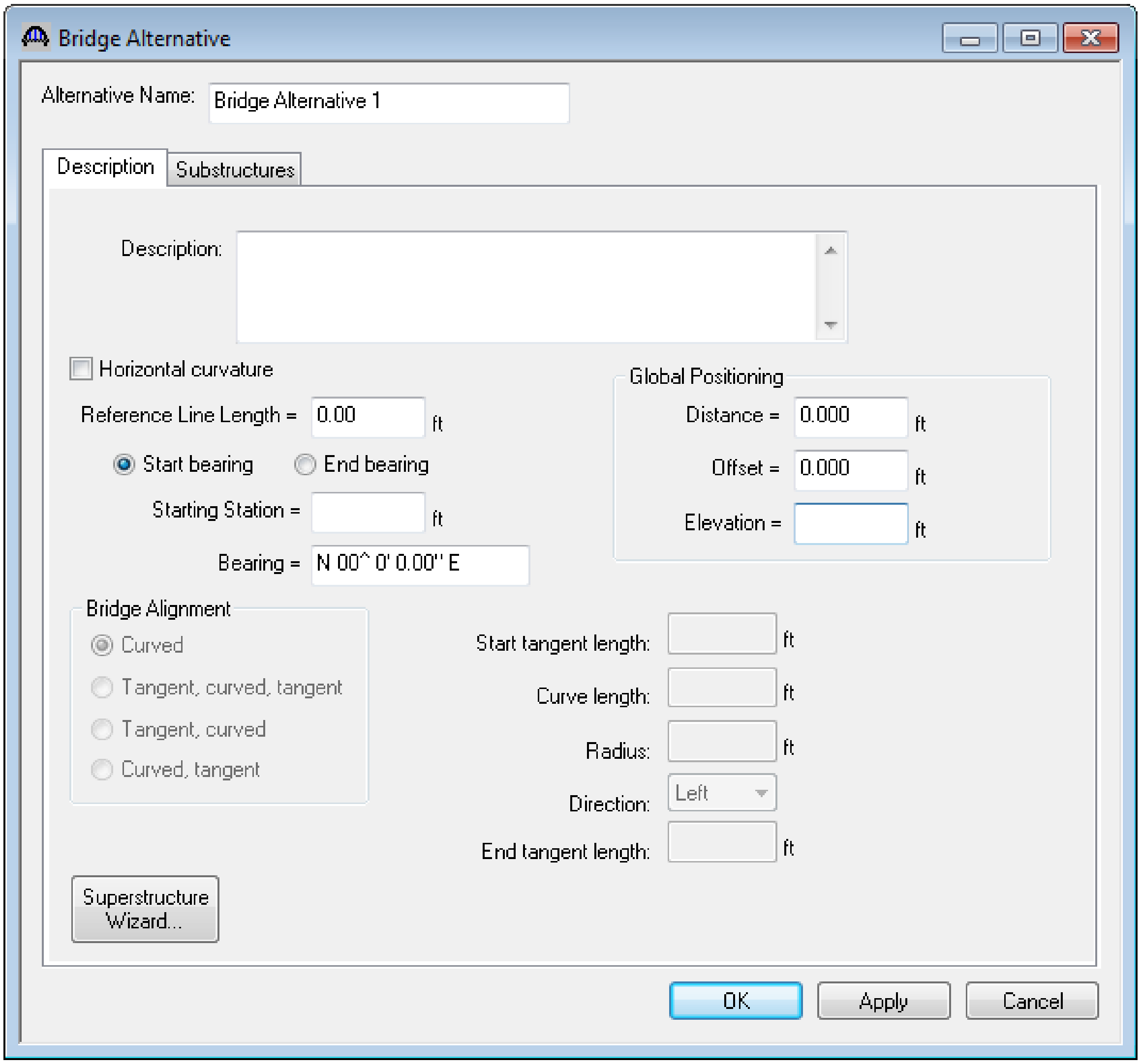
The Analysis tab and Specs tab are shown above with the default selections. Since we are not overriding default selections for this exercise, no changes are required.

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

The partially expanded Bridge Workspace tree is shown below:

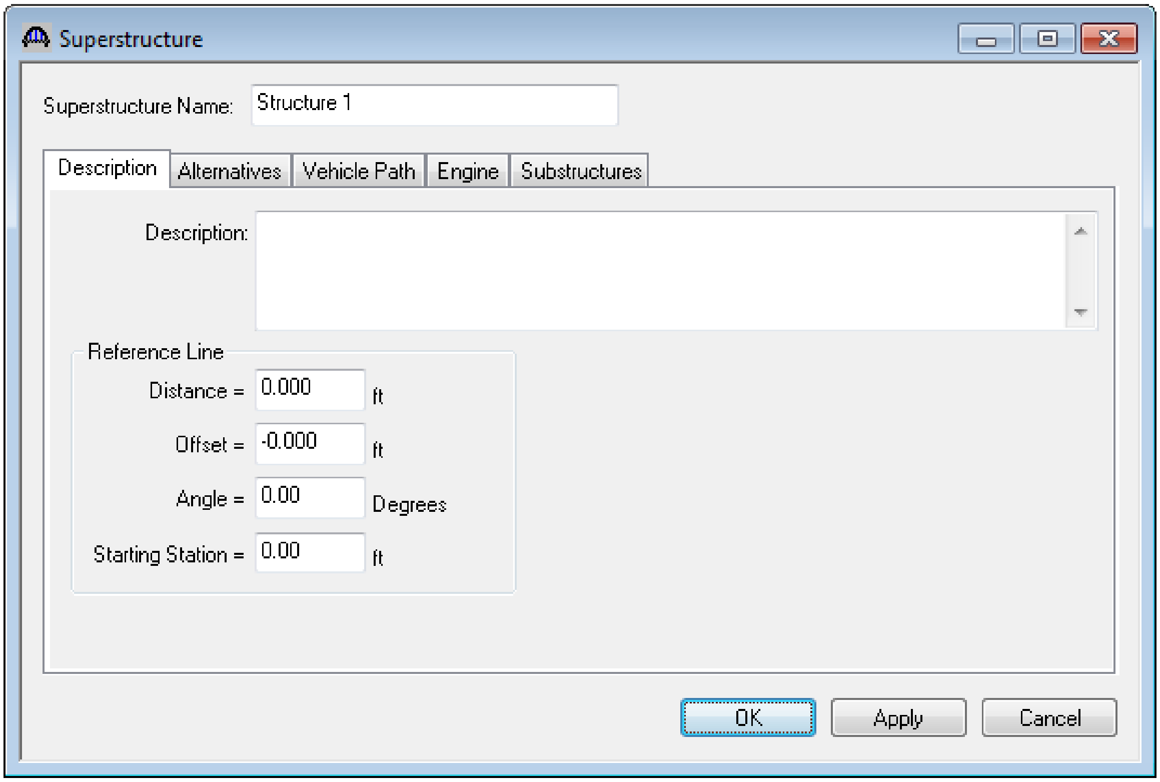


We now go back to the Bridge Alternatives and create a new Bridge Alternative by double-clicking on Bridge Alternatives. Enter the following data:

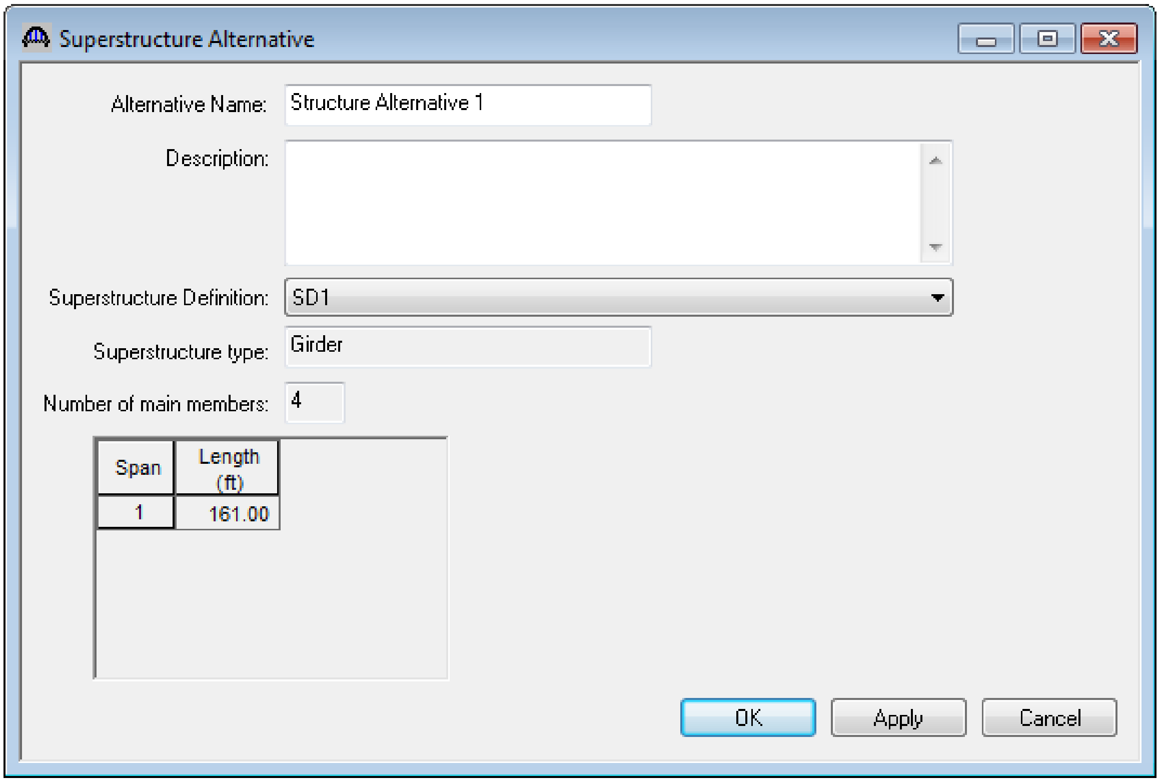


Click Ok to save the data to memory and close the window.

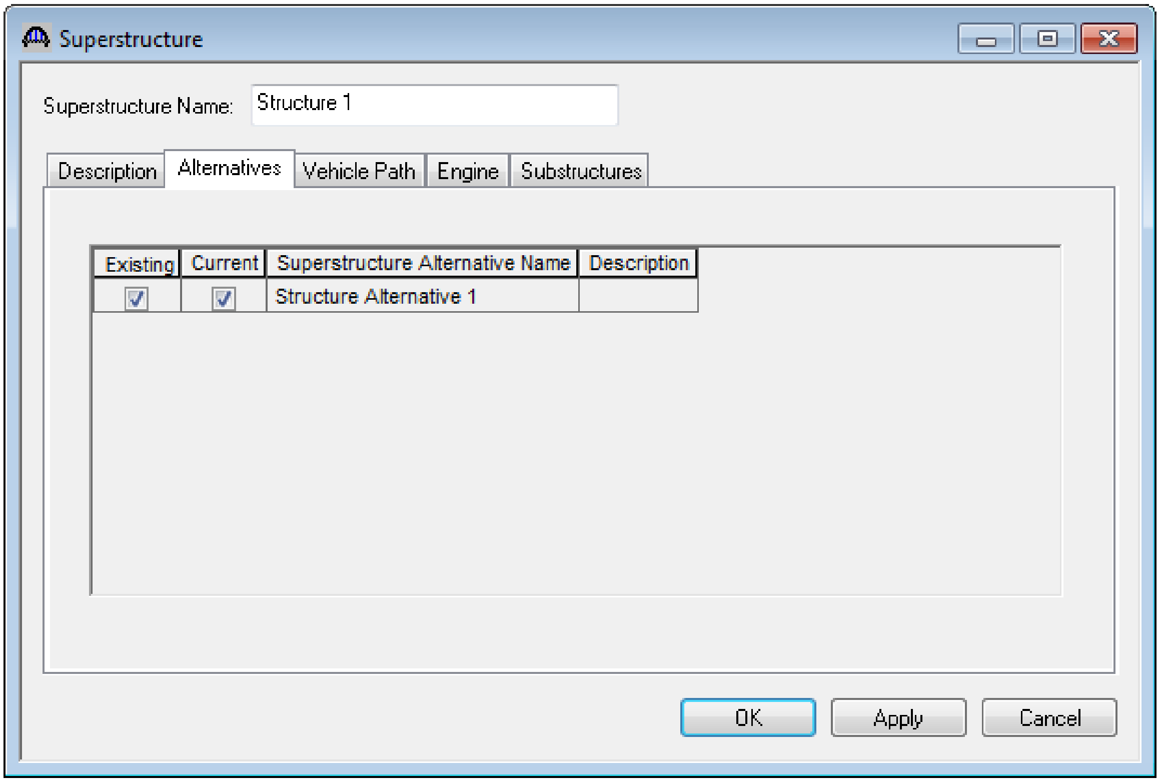
Double-click on Superstructures and enter the following new superstructure:



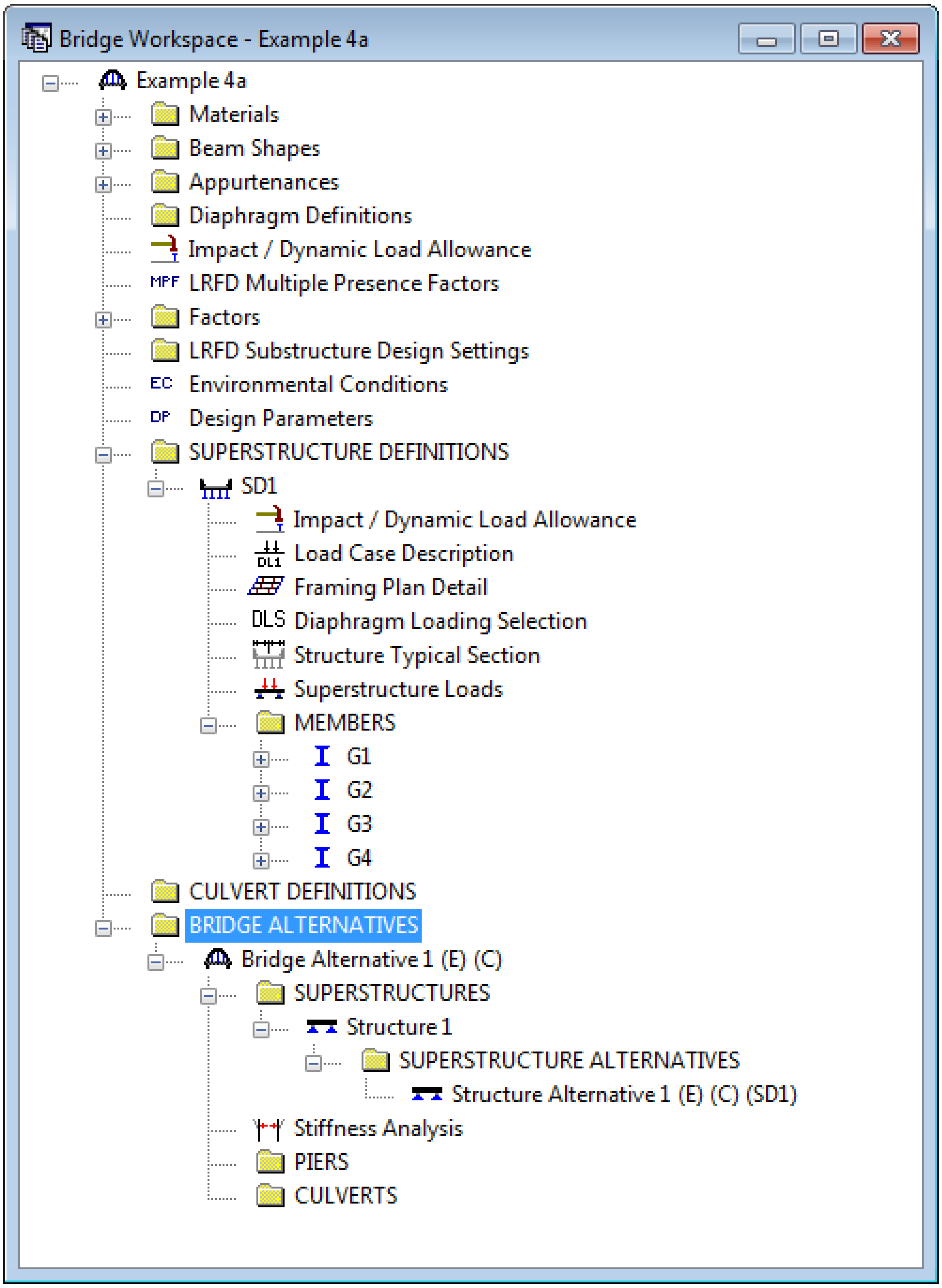
Double-click on Superstructure Alternatives and enter the following new Superstructure Alternative. Select the Superstructure definition SD1 as the current superstructure definition for this Superstructure Alternative.



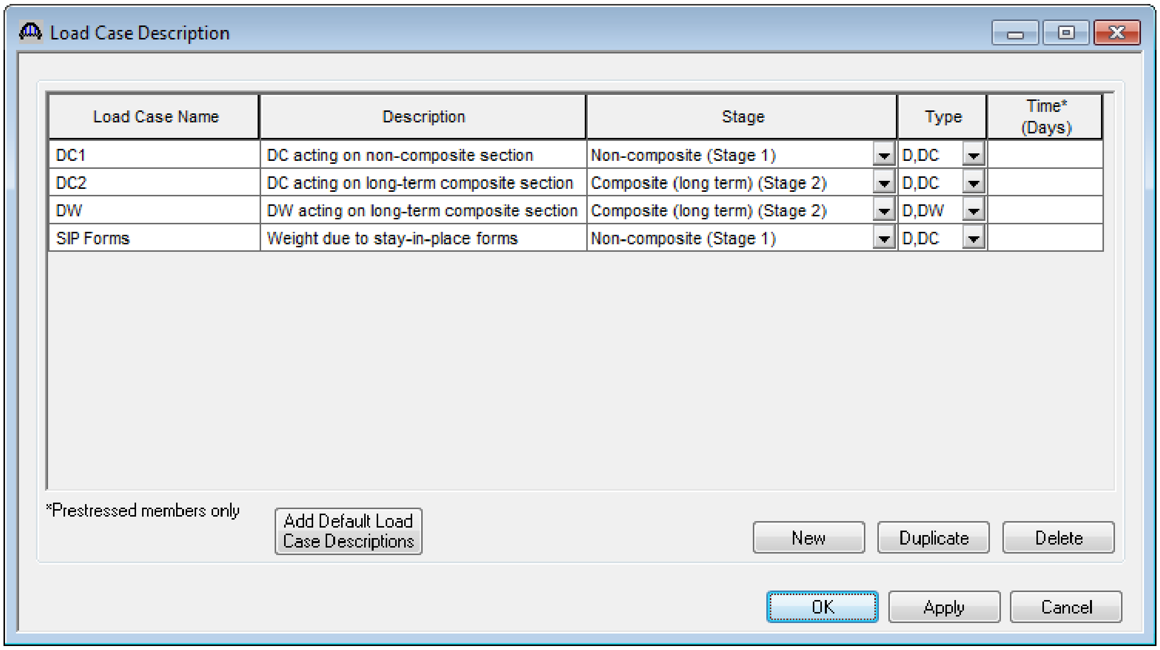
Re-open the Structure 1 window and select the Alternatives tab. The Structure Alternative 1 will be shown as the existing and current alternative for Structure 1.



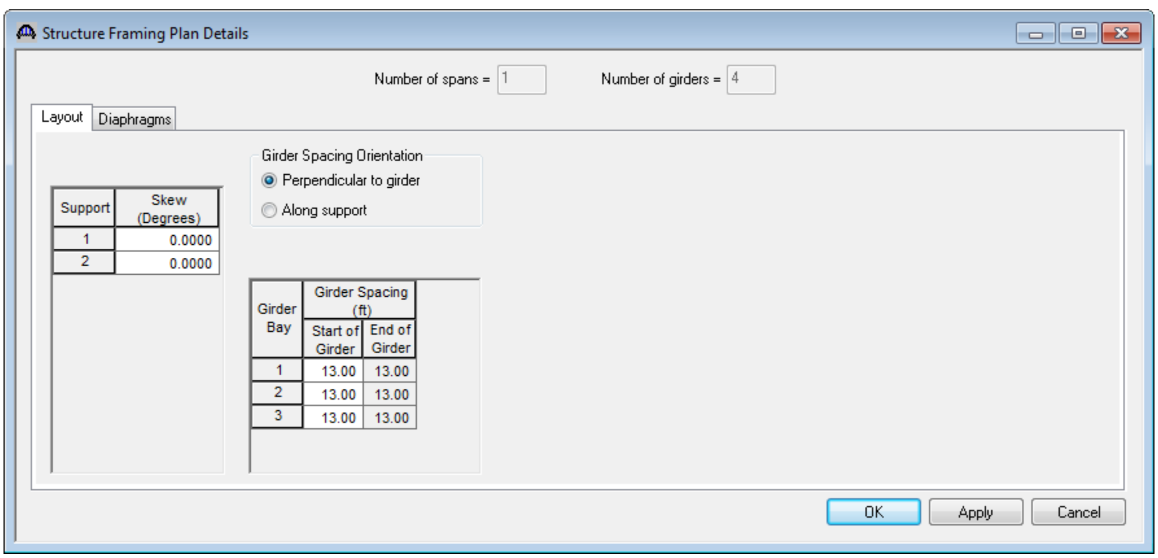
The partially expanded Bridge Workspace tree is shown below:



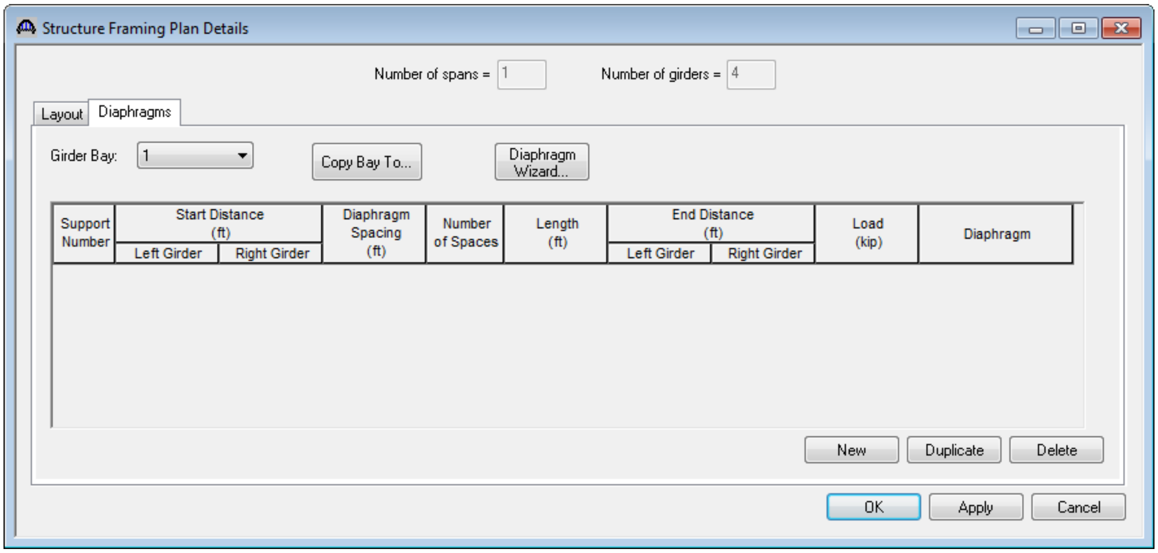
Click Load Case Description to define the dead load cases. The completed Load Case Description window is shown below.



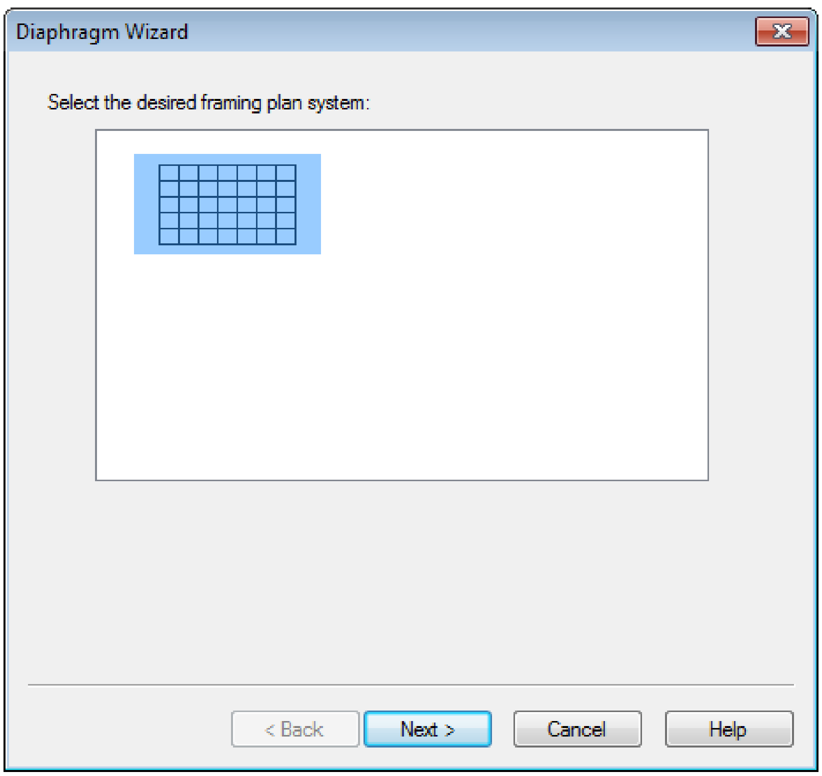
Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.



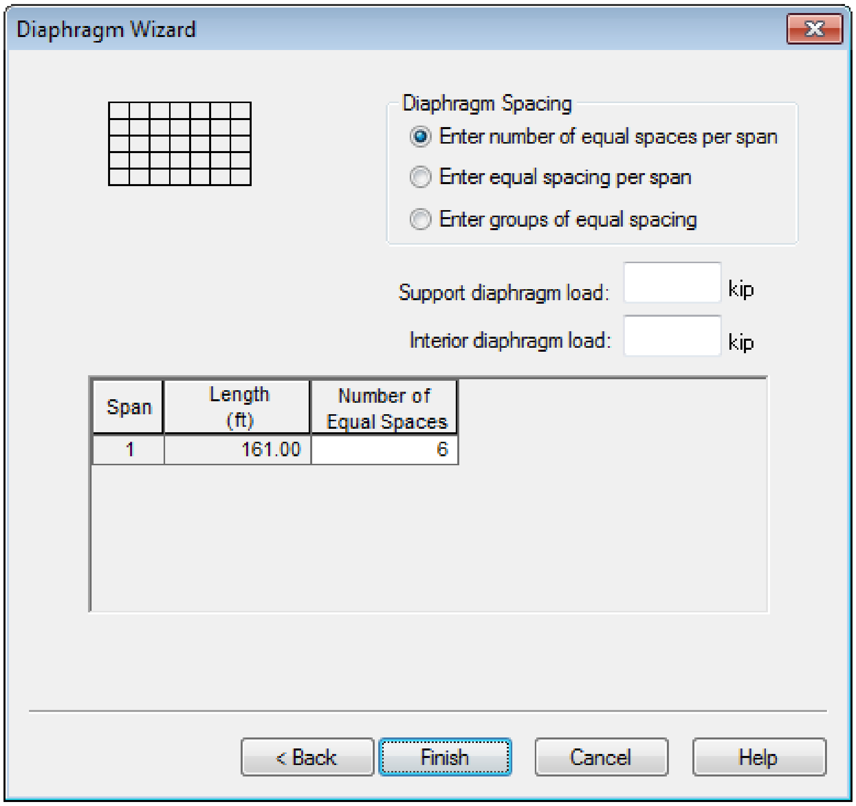
Switch to the Diaphragms tab to enter diaphragm spacing.



Click the Diaphragm Wizard button to add diaphragms for the entire structure. The Dialog shown below will appear.

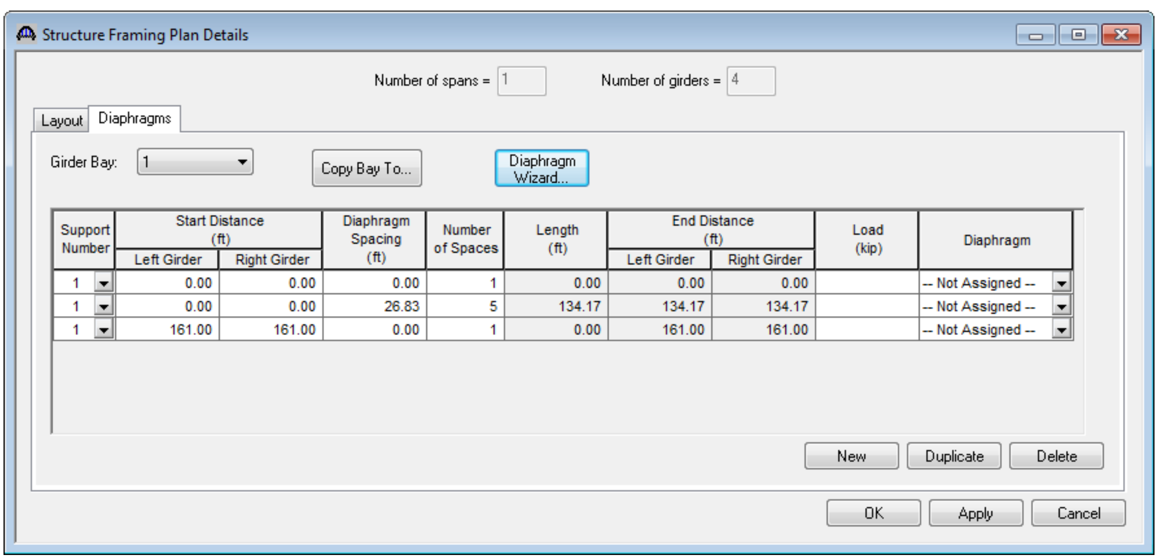


Click the Next button and enter the following spacing:



Click the Finish button to add the diaphragms. The Diaphragm Wizard will create diaphragms for all of the girder bays in the structure.

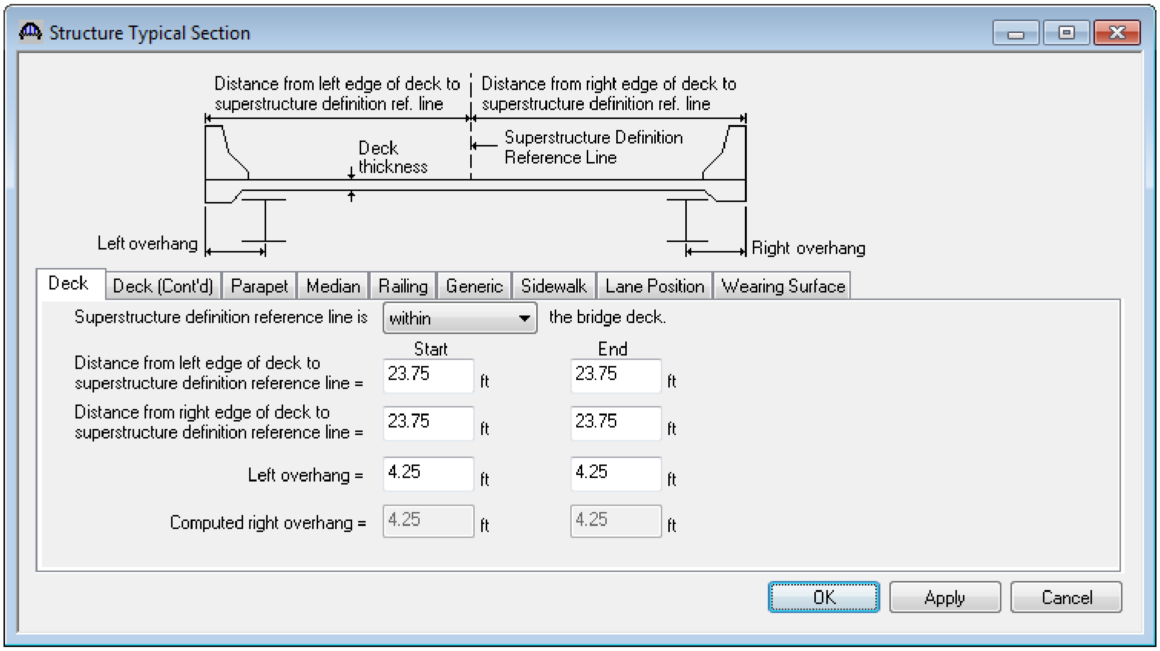
The diaphragms created for Girder Bay 1 are shown below:



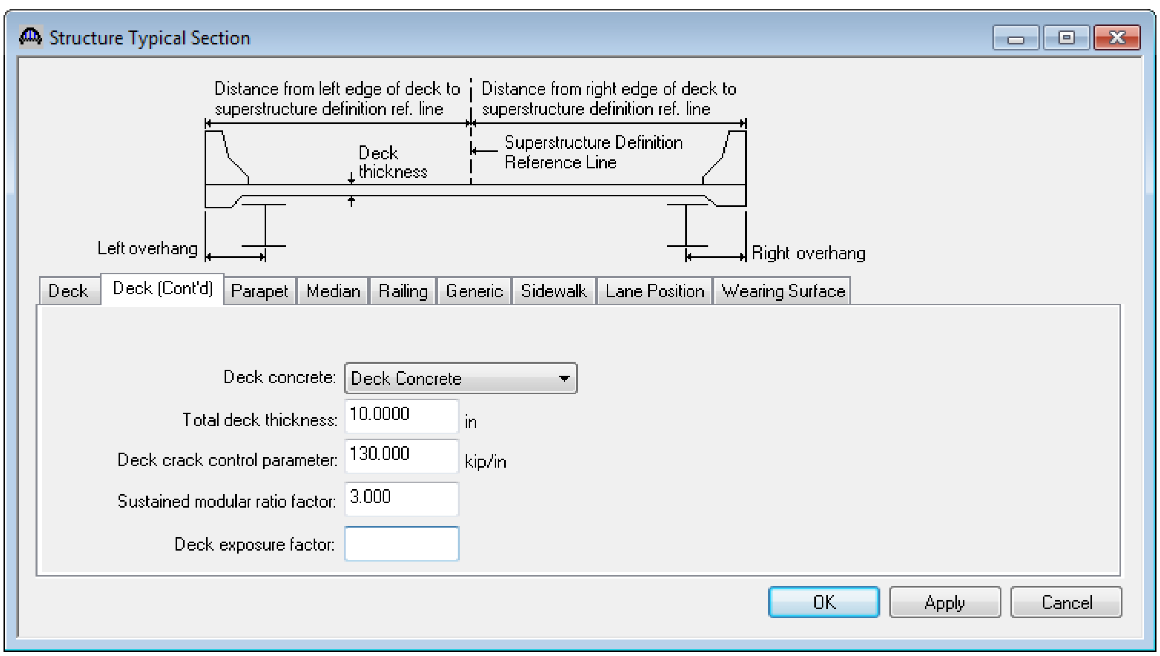
Select Ok to close the window.

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.

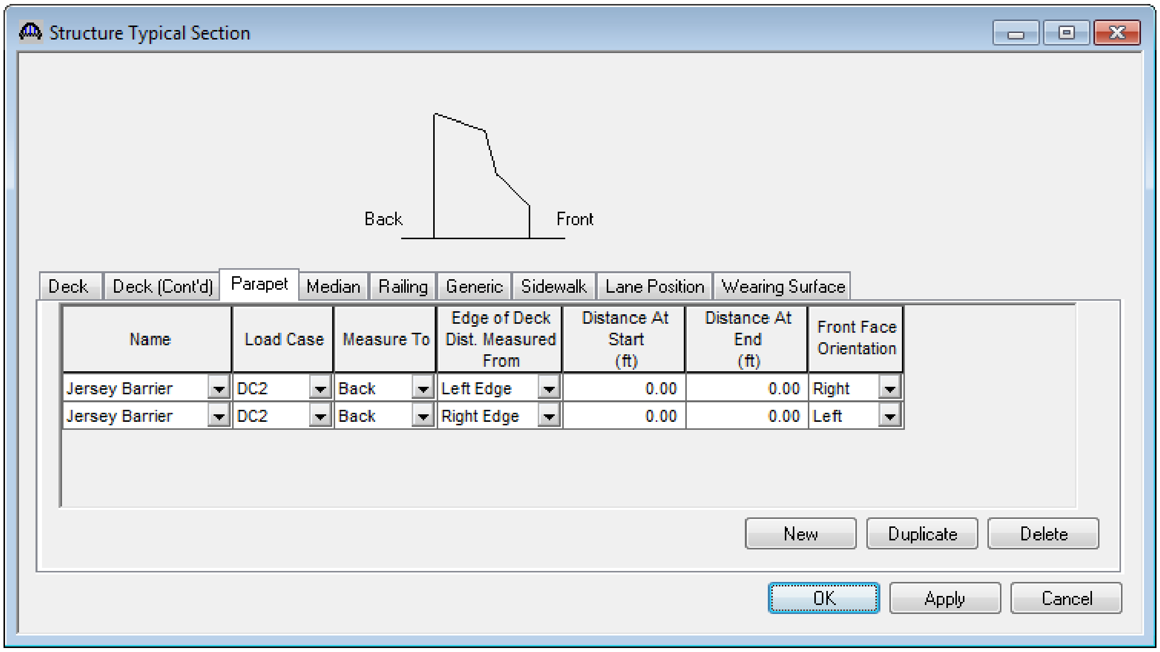
Basic deck geometry:



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.

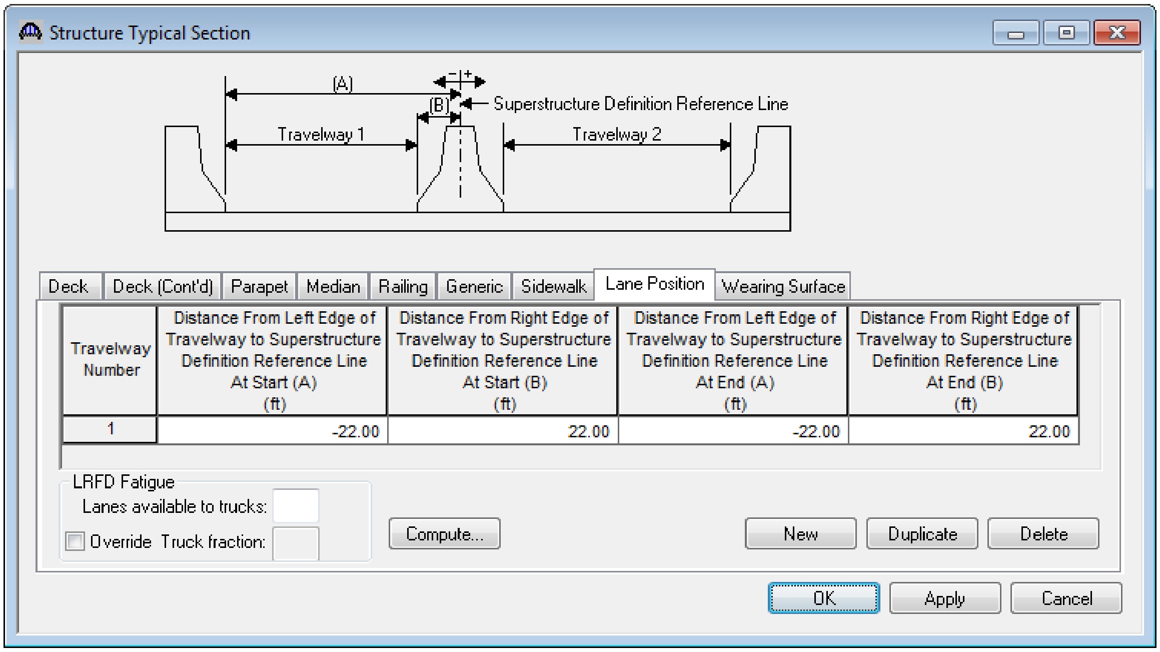


Parapets:
The two parapets are described using the Parapet tab. Click New to add a row to the table. The name of the parapet defaults to the only barrier described for the bridge. Change the “Load Case” to “DC2” and “Measure To” to “Back” (we are locating the parapet on the deck by referencing the back 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.

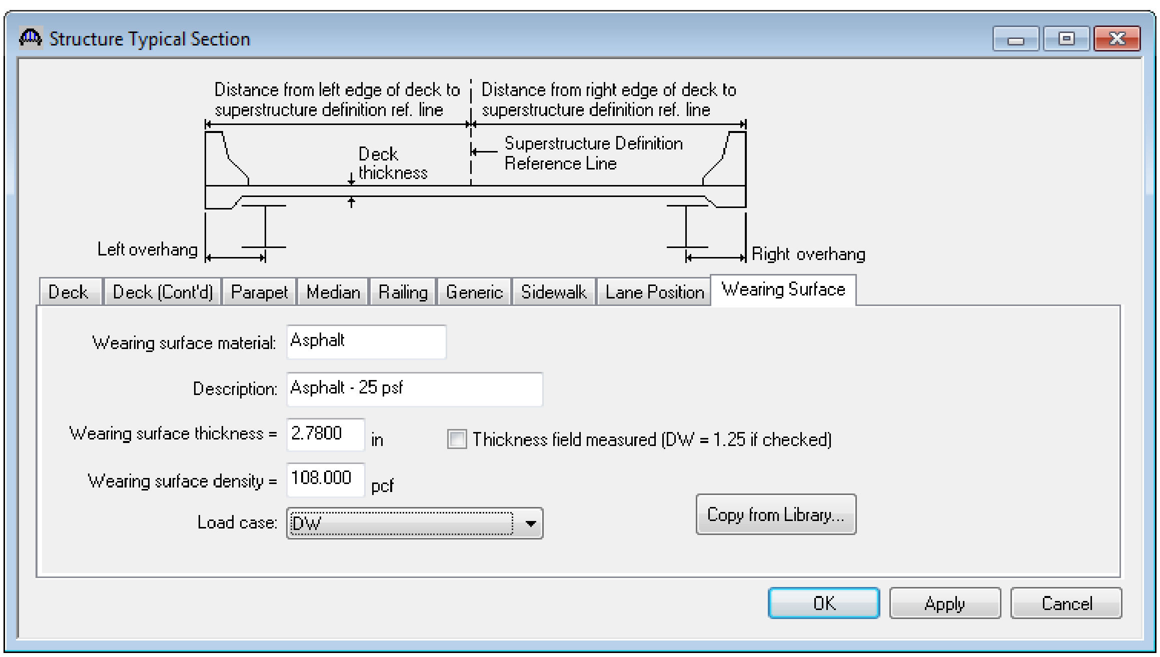


Lane Positions:
Select the Lane Position tab.

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.

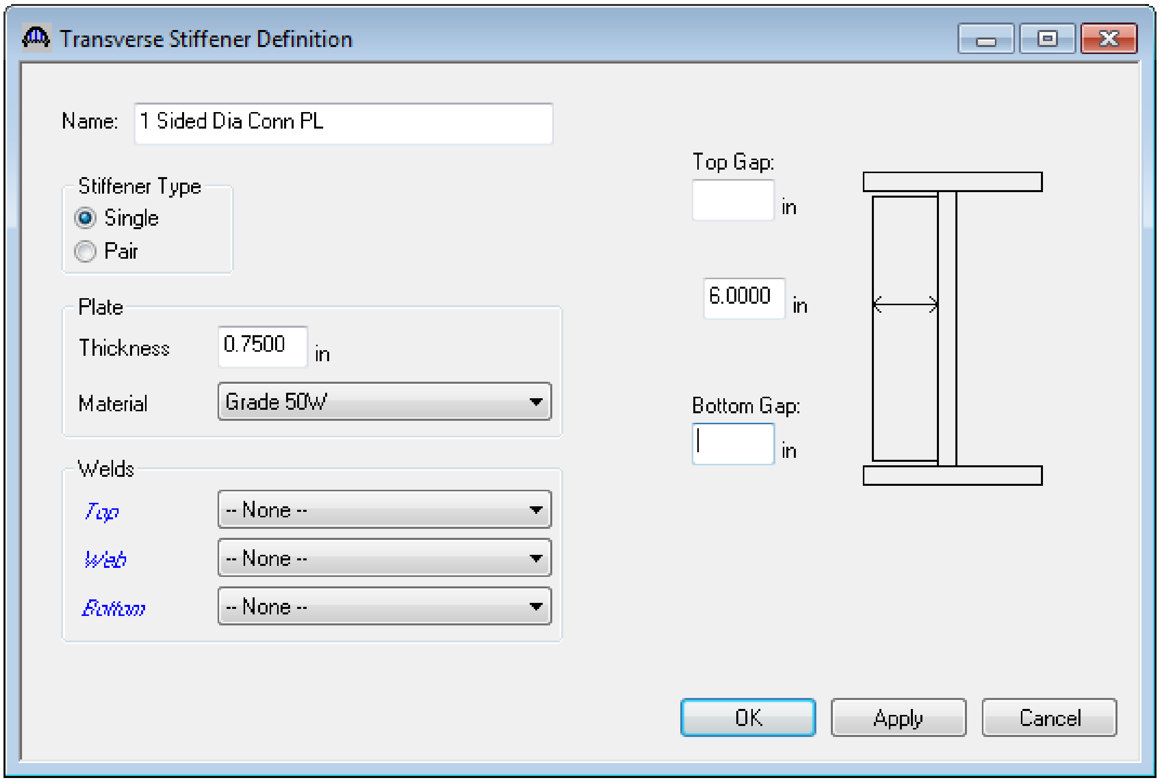


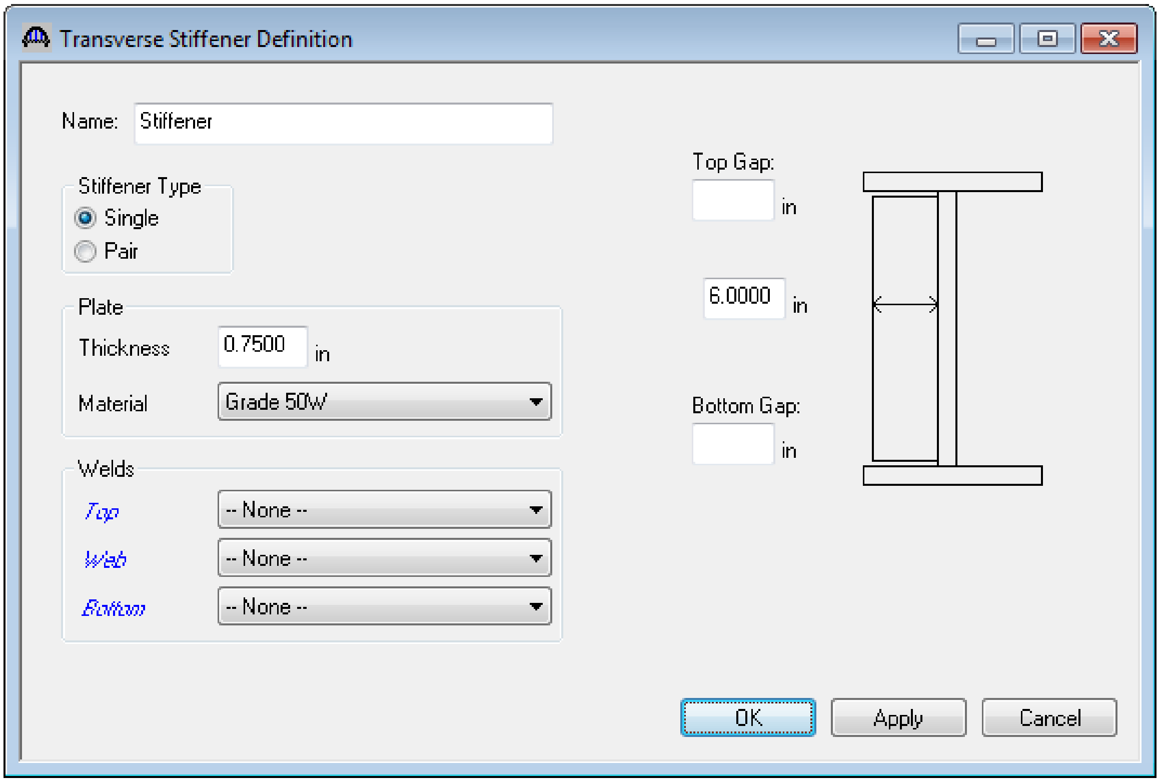
Wearing Surface:
Enter the data shown below.

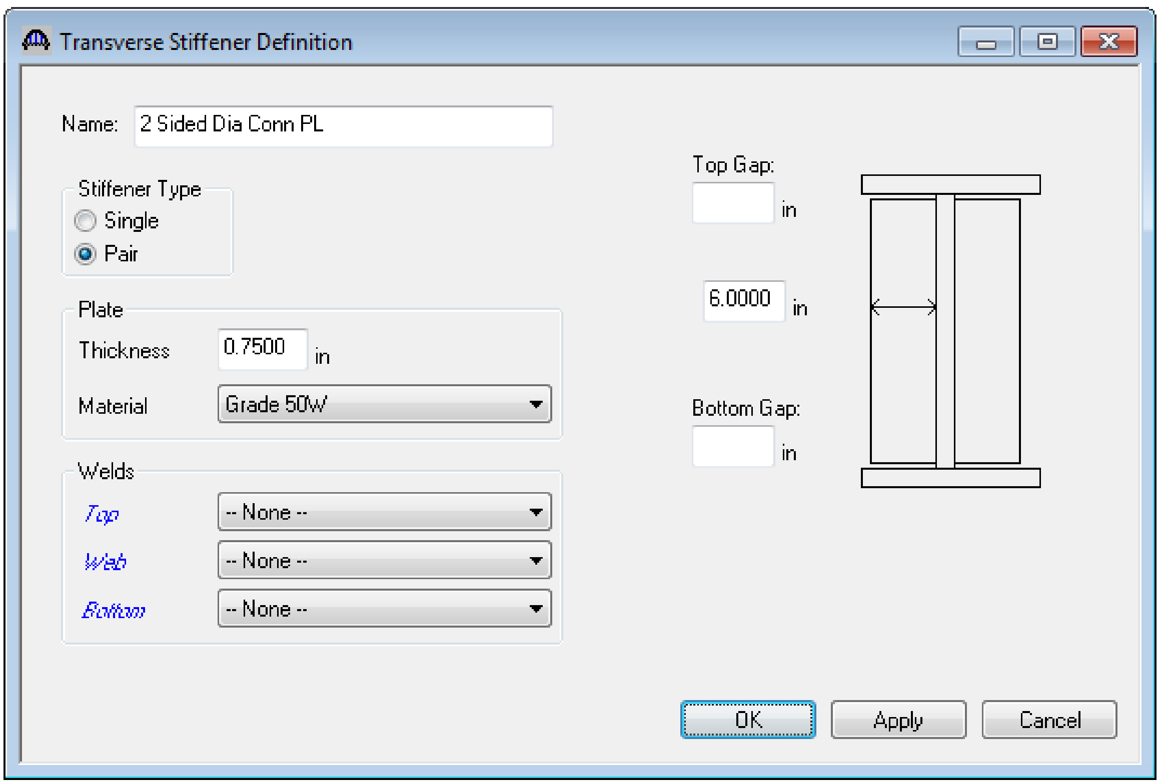


Click Ok to save the data to memory and close the window.

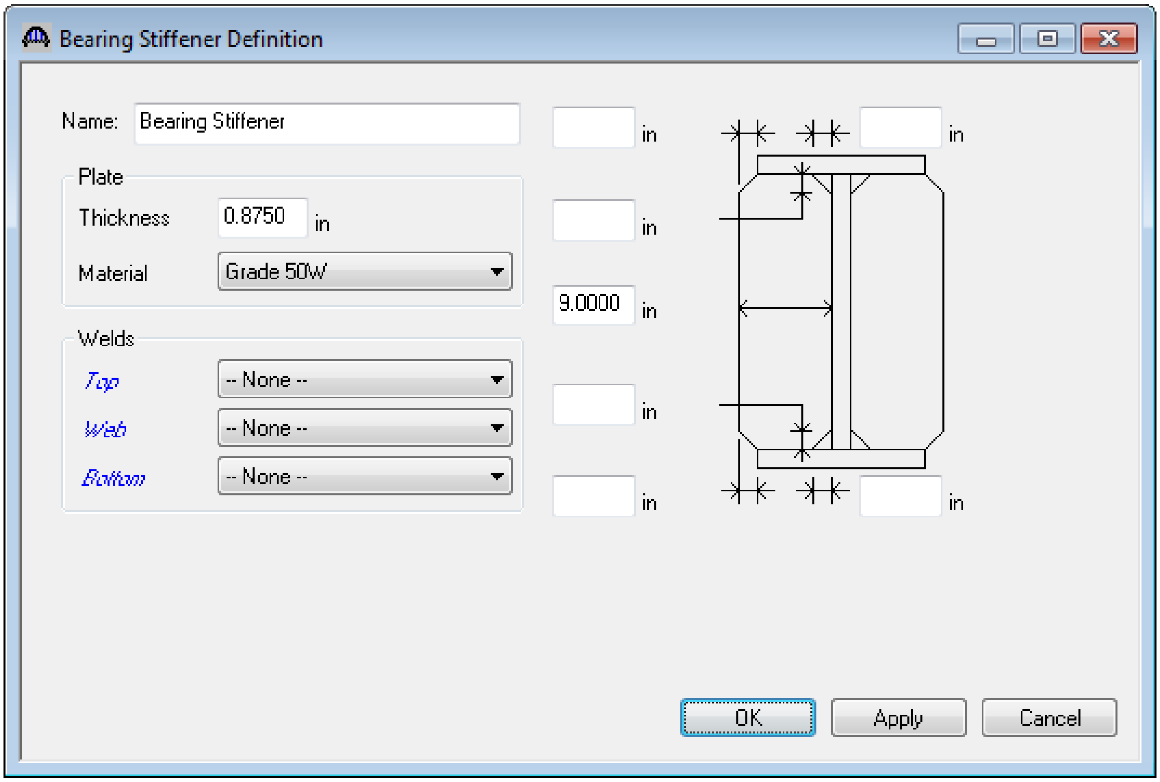
Define stiffeners to be used by the girders. Expand the Stiffener Definitions tree item and double click on Transverse. Select "Trans. Plate Stiffener" for stiffener type. Define the stiffener as shown below. Click Ok to save to memory and close the window. Repeat this process to define the other two stiffeners. The windows are shown below.



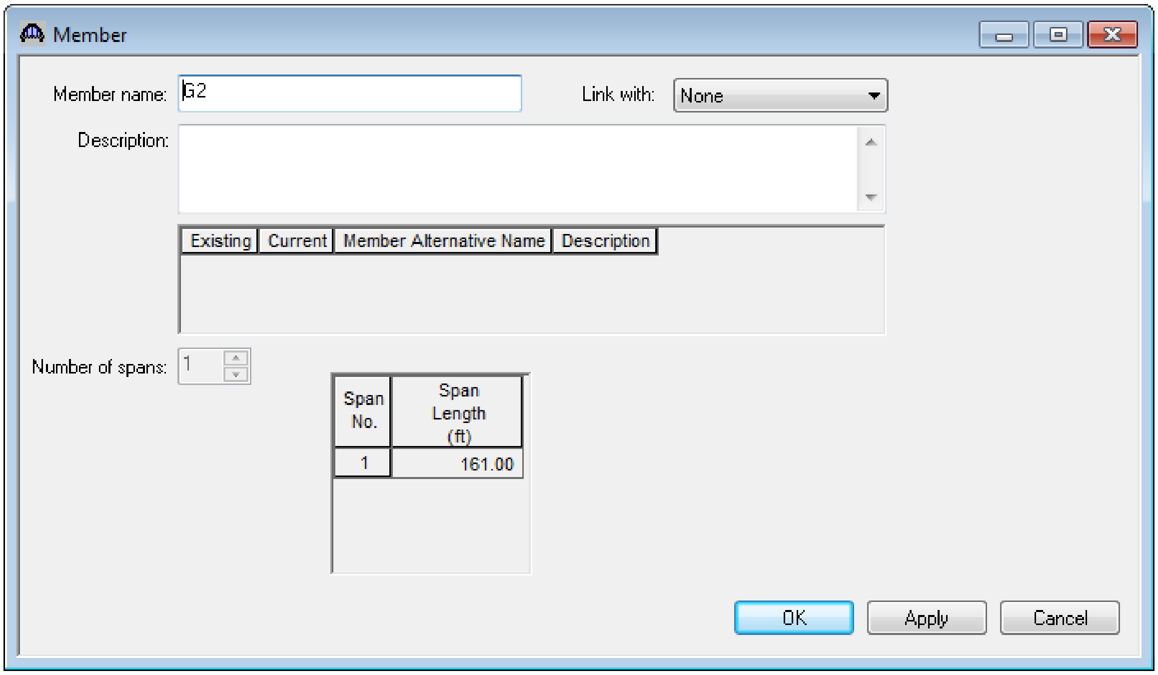

Transverse Stiffener Definition
Name:
Stiffener
Stiffener Type
Single
Pair
Plate
Thickness
0.7500
in
Material
Grade 50W
Welds
Top
-- None --
Web
-- None --
Bottom
-- None --
Top Gap:
in
6.0000
in
Bottom Gap:
in
OK
Apply
Cancel


Transverse Stiffener Definition
Name:
2 Sided Dia Conn PL
Stiffener Type
Single
Pair
Plate
Thickness
0.7500
in
Material
Grade 50W
Welds
Top
-- None --
Web
-- None --
Bottom
-- None --
Top Gap:
in
6.0000
in
Bottom Gap:
in
OK
Apply
Cancel

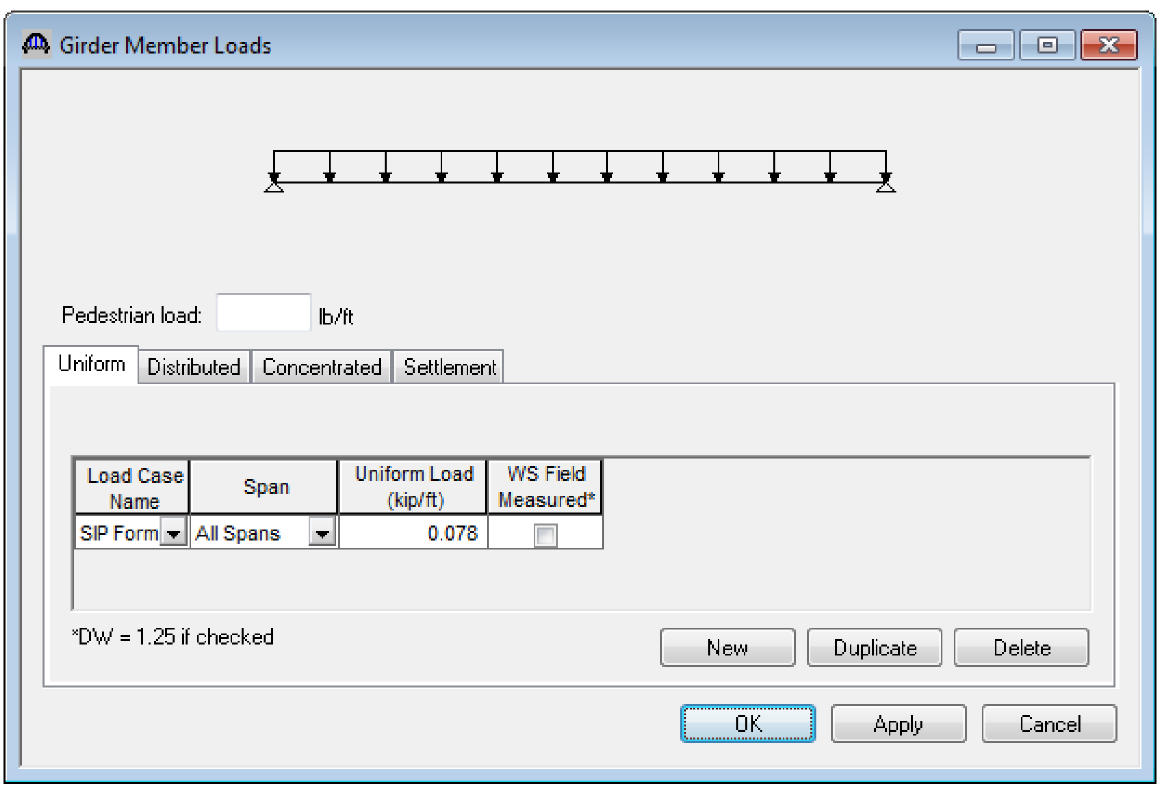
Now define the bearing stiffeners by double clicking on Bearing (under Stiffener Definitions in the tree). Select “Trans. Plate Stiffener” for stiffener type. Define the stiffener as shown below. Click Ok to save to memory and close the window.



Describing a member:
The member window shows the data that was generated when the structure definition was created. No changes are required 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 combobox. Enter the load due to stay-in-place forms as shown below.

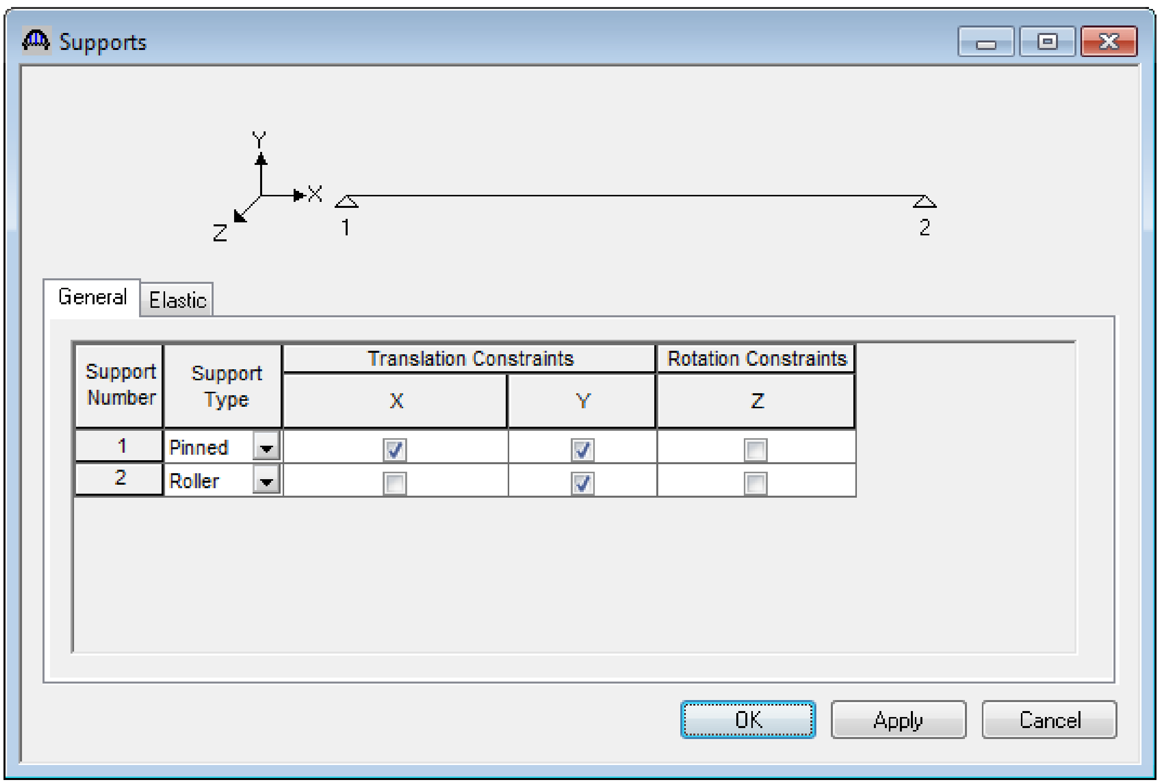


Member loads for Example 4

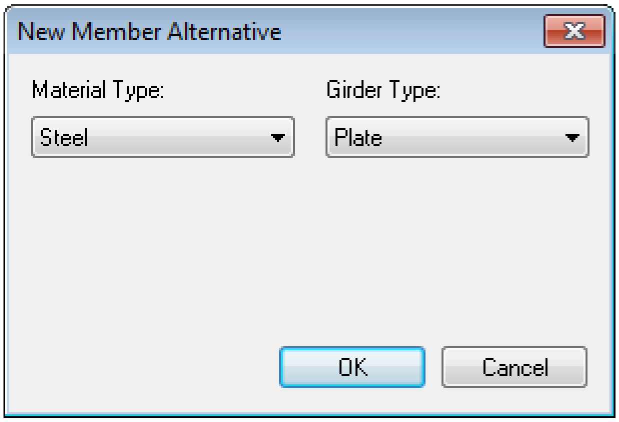
Example	Struct Def	Member Definition	Loads(Interior beam, Exterior beam)
a	**GS**	**Schedule-based**	**SIP (0.078, 0.039)**
b	GL	Schedule-based	SIP (0.078,0.039) Barrier (DC2) (0.253, 0.253) WS (DW) (0.275, 0.275)
c	GL	Cross-section based	SIP (0.078, 0.078) Barrier (DC2) (0.253, 0.253) WS (DW) (0.275, 0.275) Haunch (DC1) (0.017, 0.059)
d	GS	Cross-section based	SIP (0.078, 0.078) Haunch (DC1) (0.017, 0.059)

The Help topic "Dead Loads" summarizes for each type of structure definition and member modeling method which dead load components are computed automatically by the engine and which must be entered by the user.

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

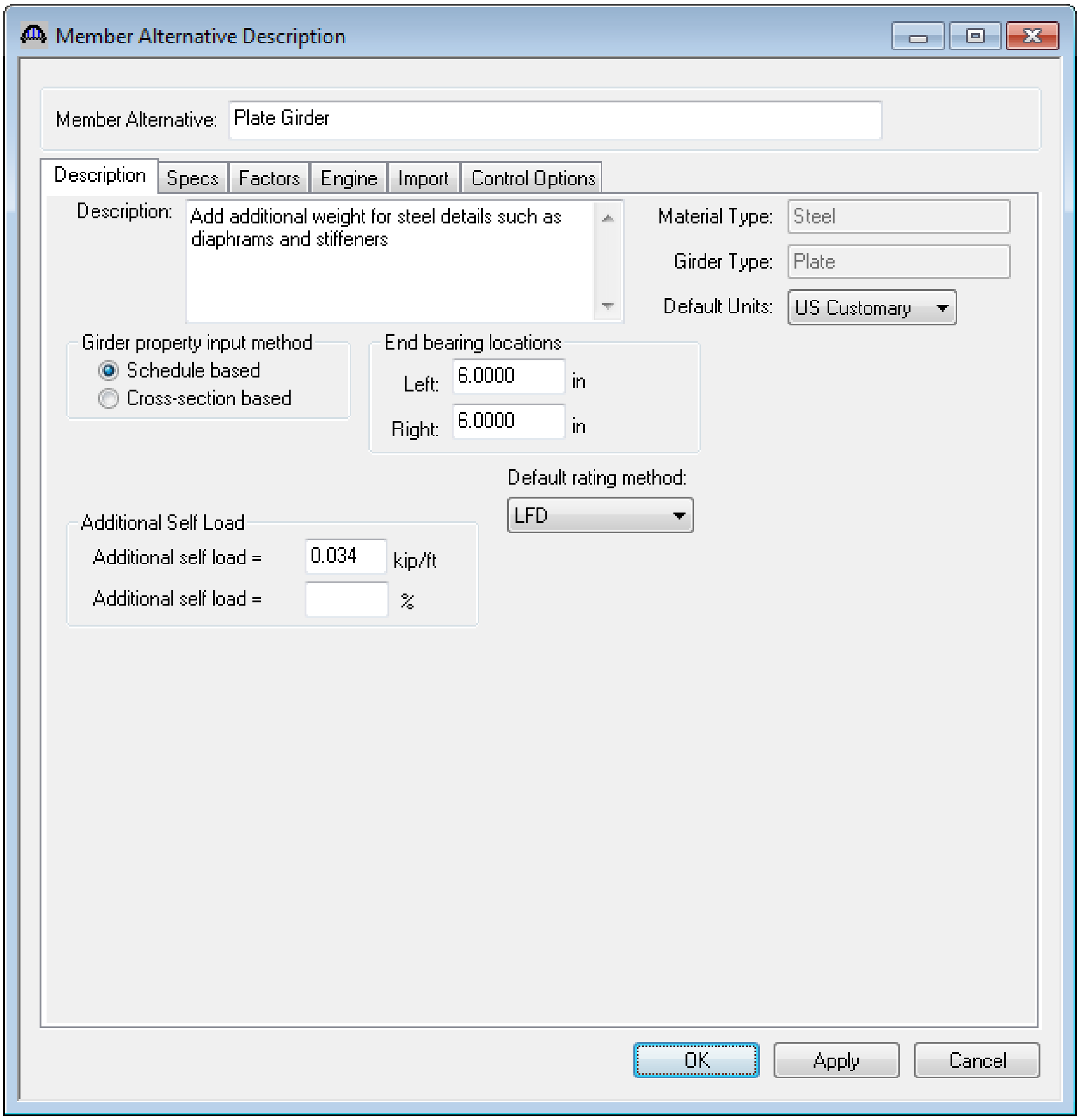


Defining a Member Alternative:
Double-click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Steel for the Material Type and Plate for the Girder Type.

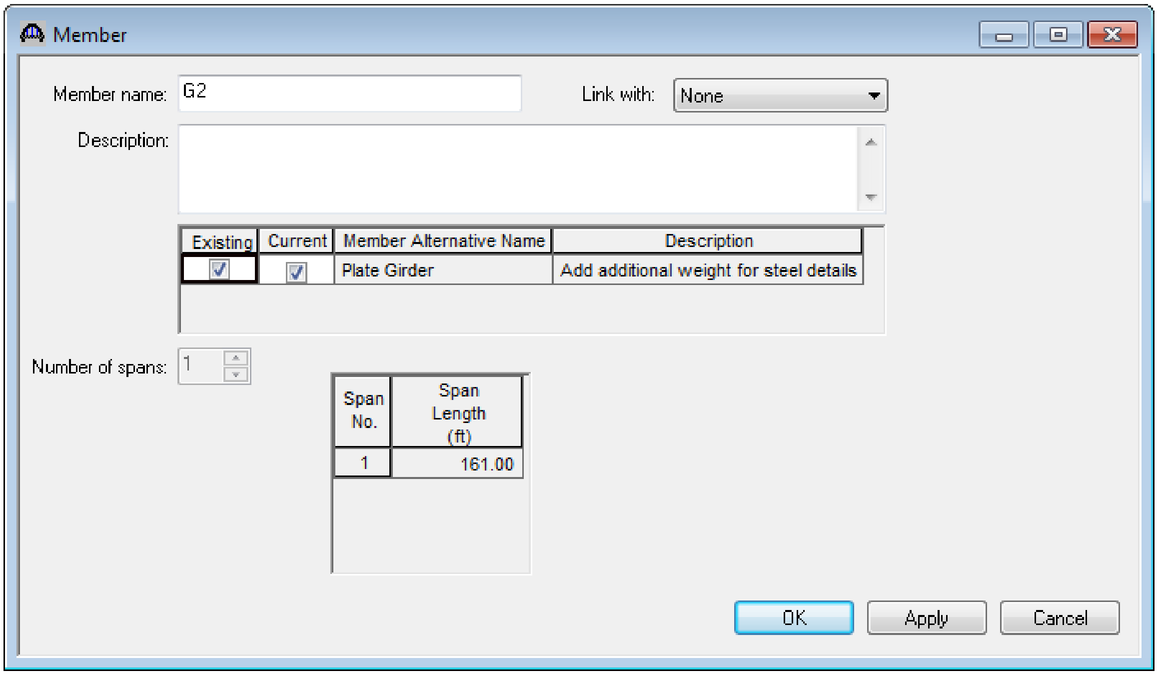


Click Ok to close the dialog and create a new member alternative.

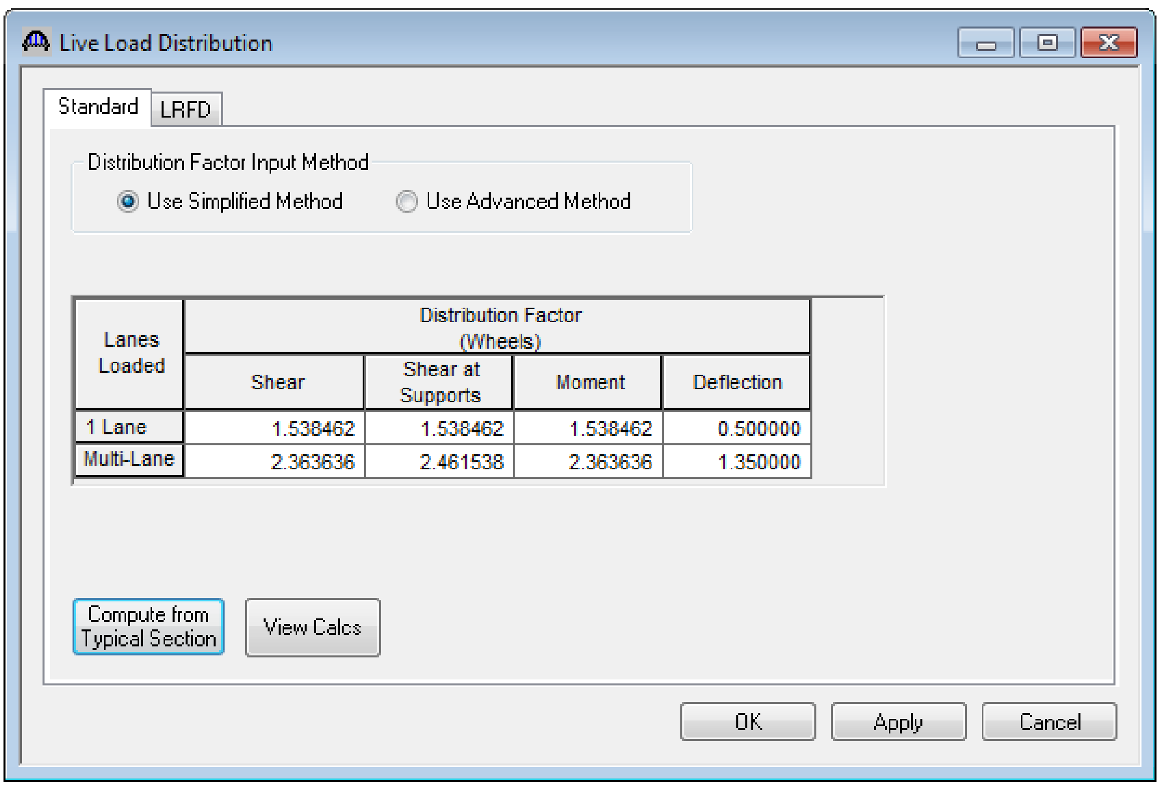
The Member Alternative Description window will open. Enter the appropriate data as shown below. Select Schedule-based Girder property input method.



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.

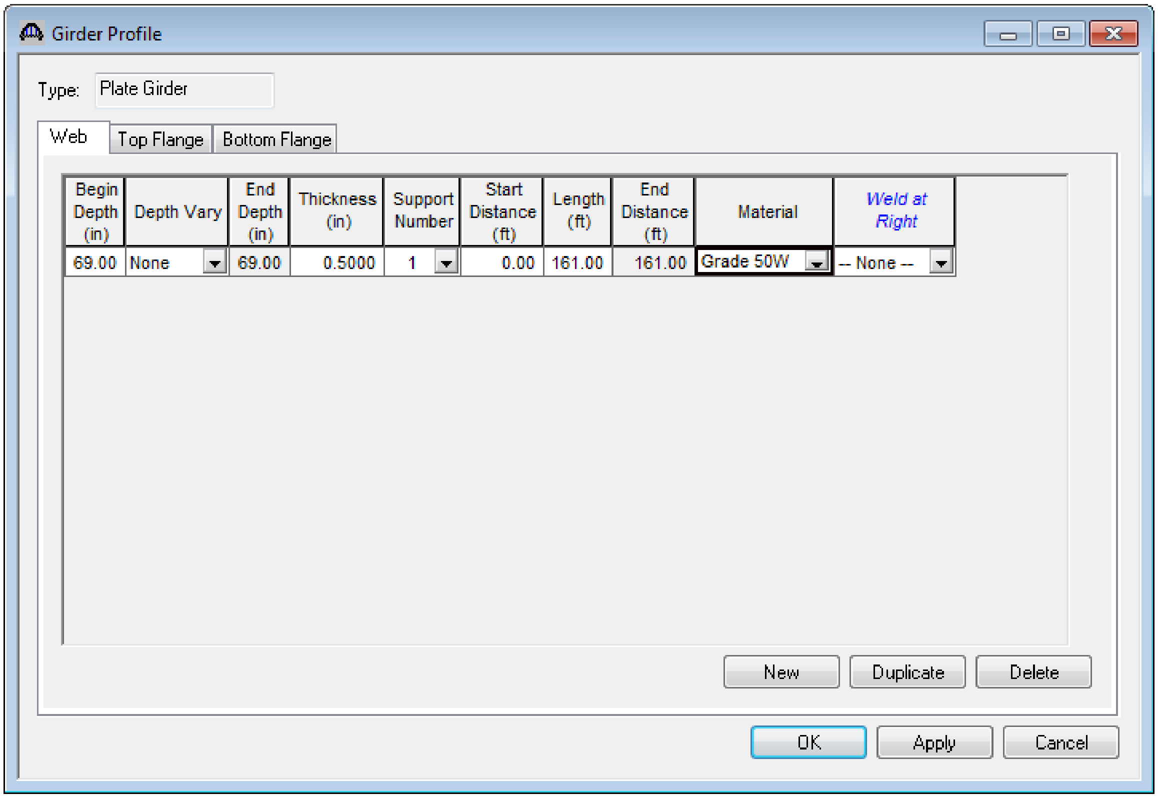


Use “Compute” button to generate distribution factors.

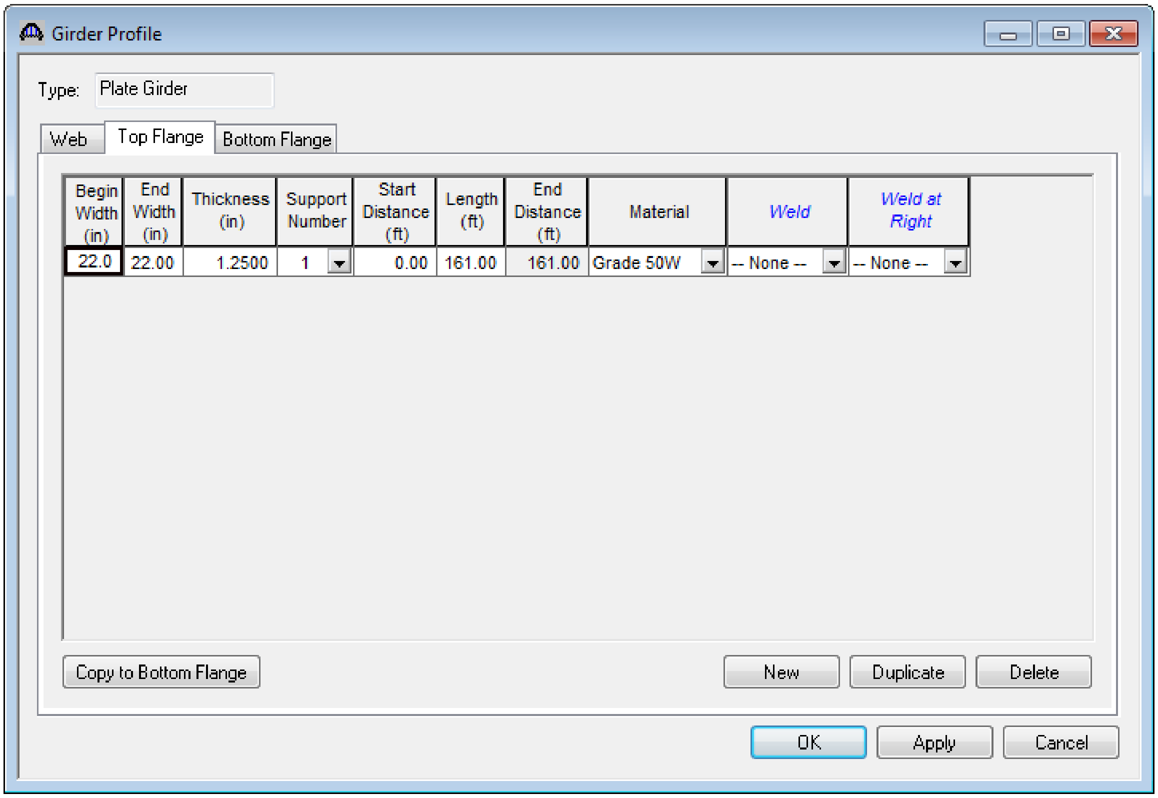


Live load distribution factor calculation details can be viewed by clicking “View Calcs” button.

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.

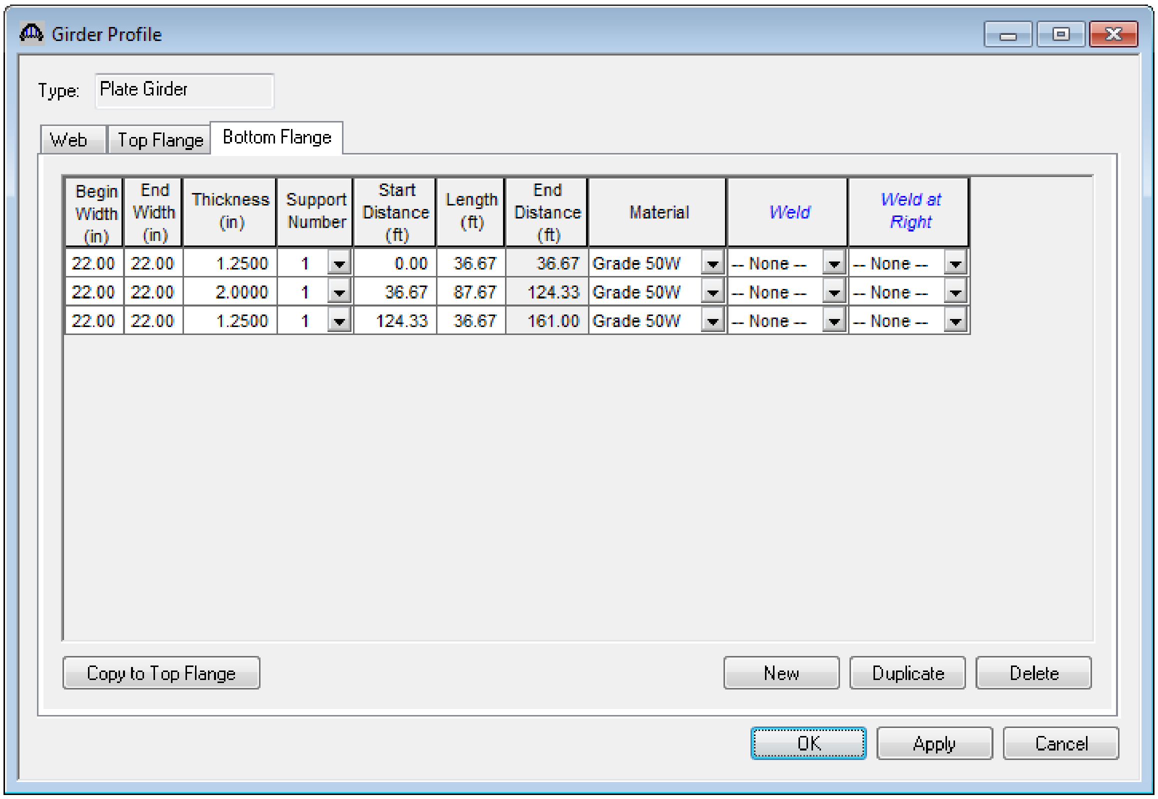


Describe the flanges as shown below.

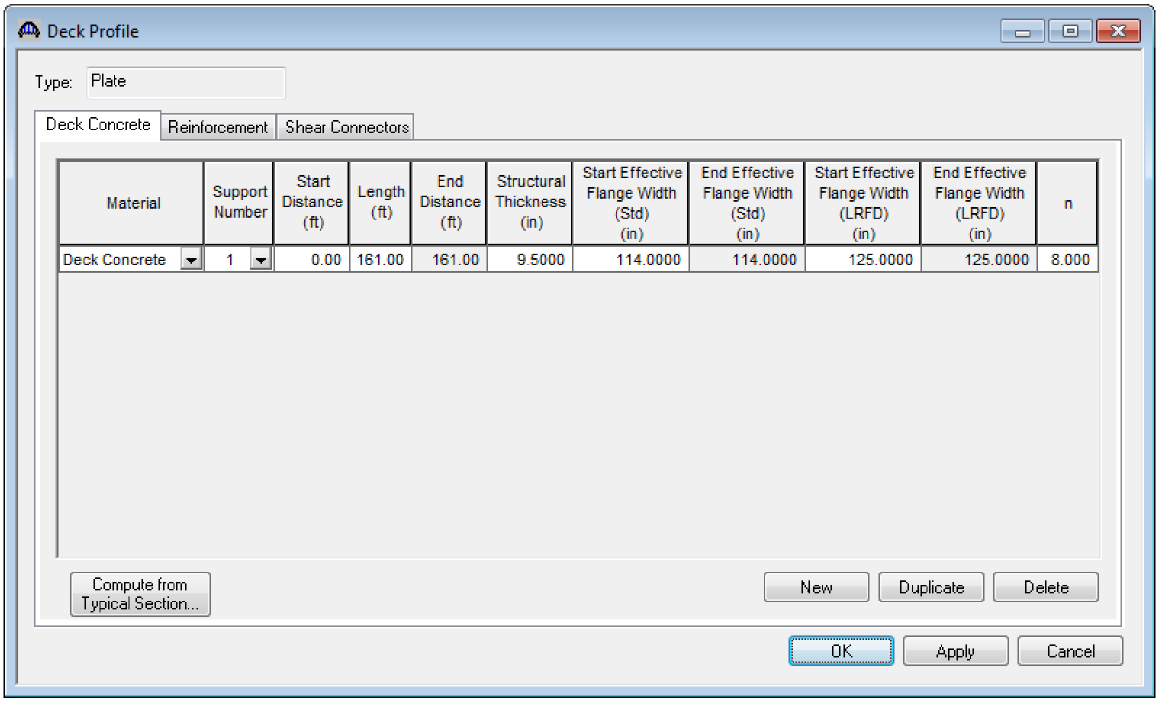


Enter the following starting distance and length to the bottom flange tab.

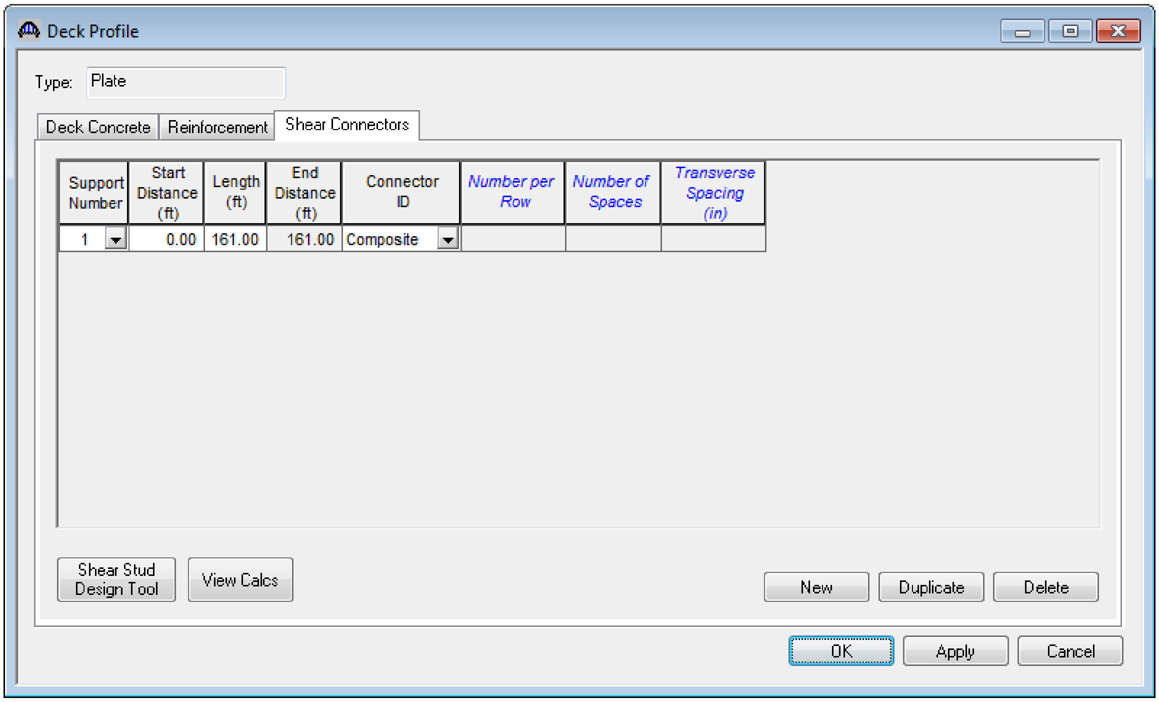
starting distance	bottom flange
0	36.666
36.666	87.667
124.333	36.667



Next open the Deck Profile and enter the data describing the structural properties of the deck. The window is shown below.

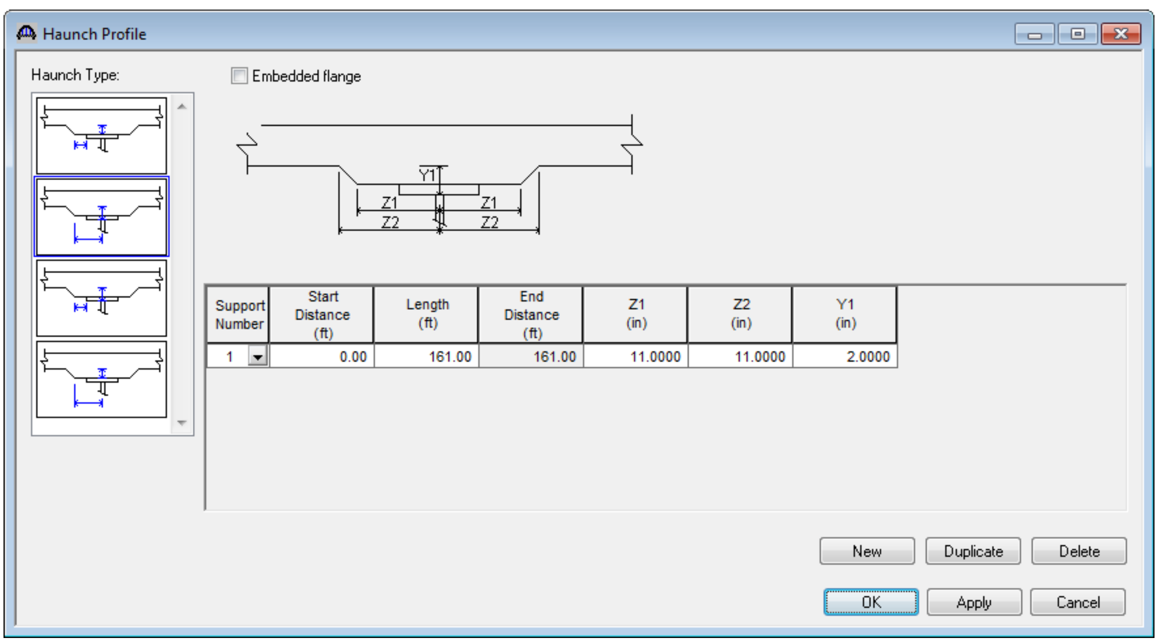


No reinforcement is described. Composite regions are described using the Shear Connectors tab as shown below.

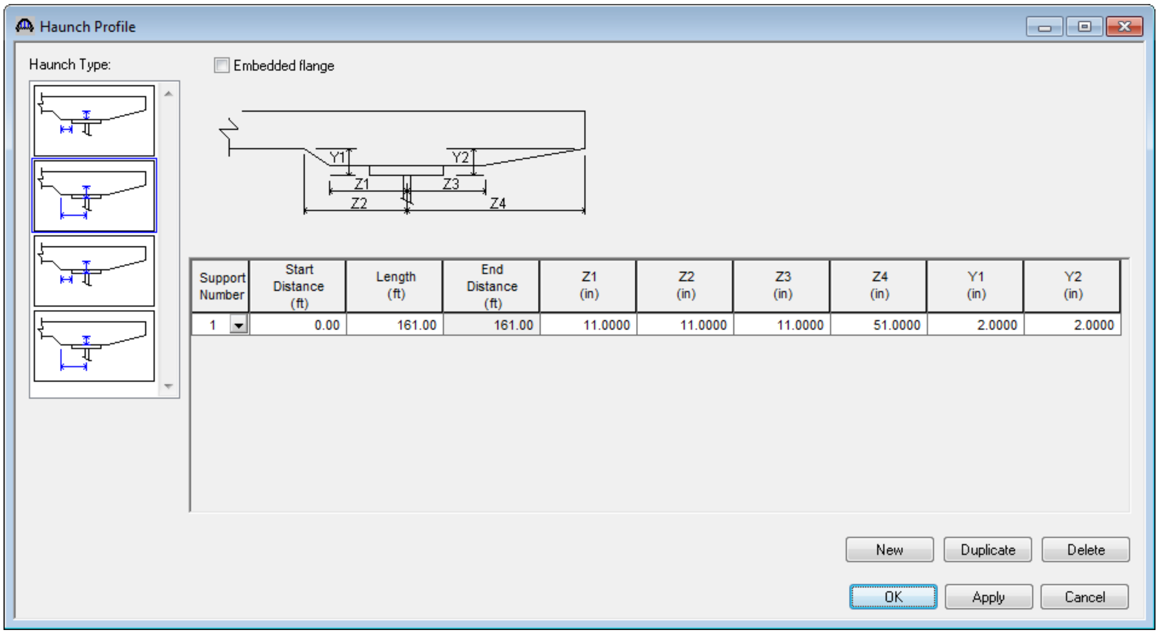


The haunch profile is defined by double clicking on Haunch Profile in the tree. The window is shown below.

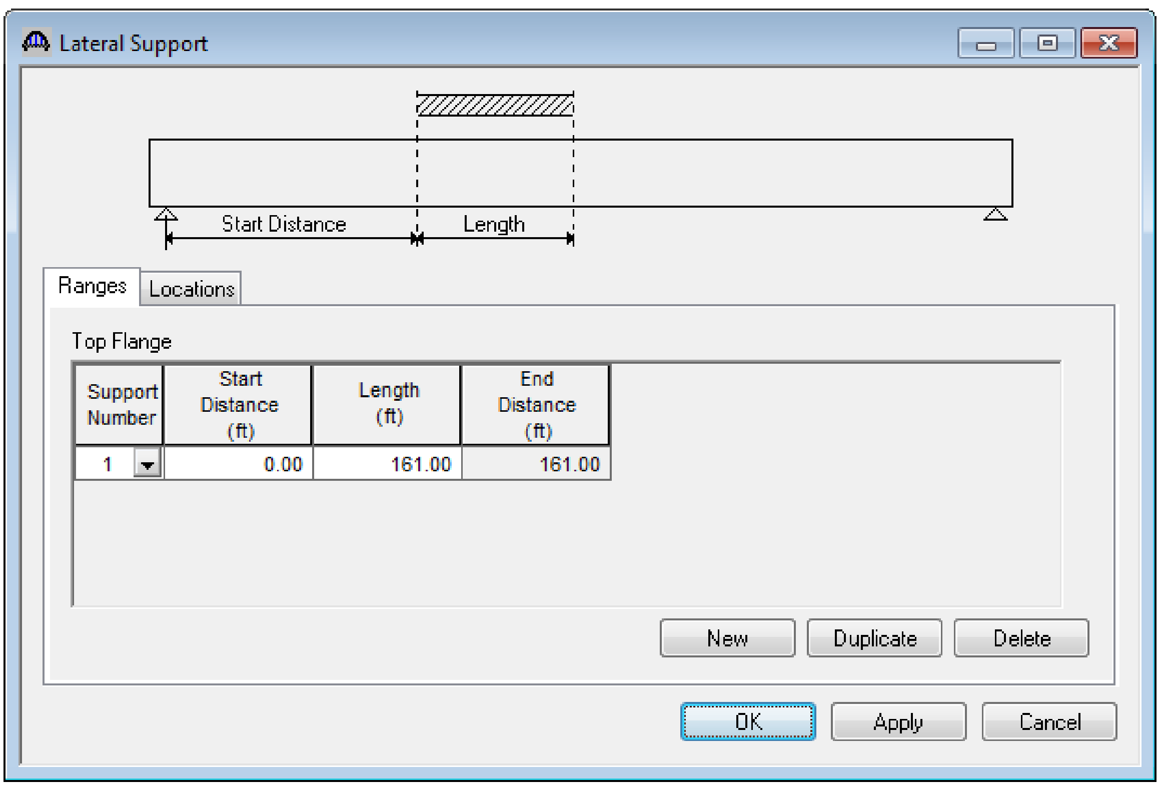
Interior Girder (G2):



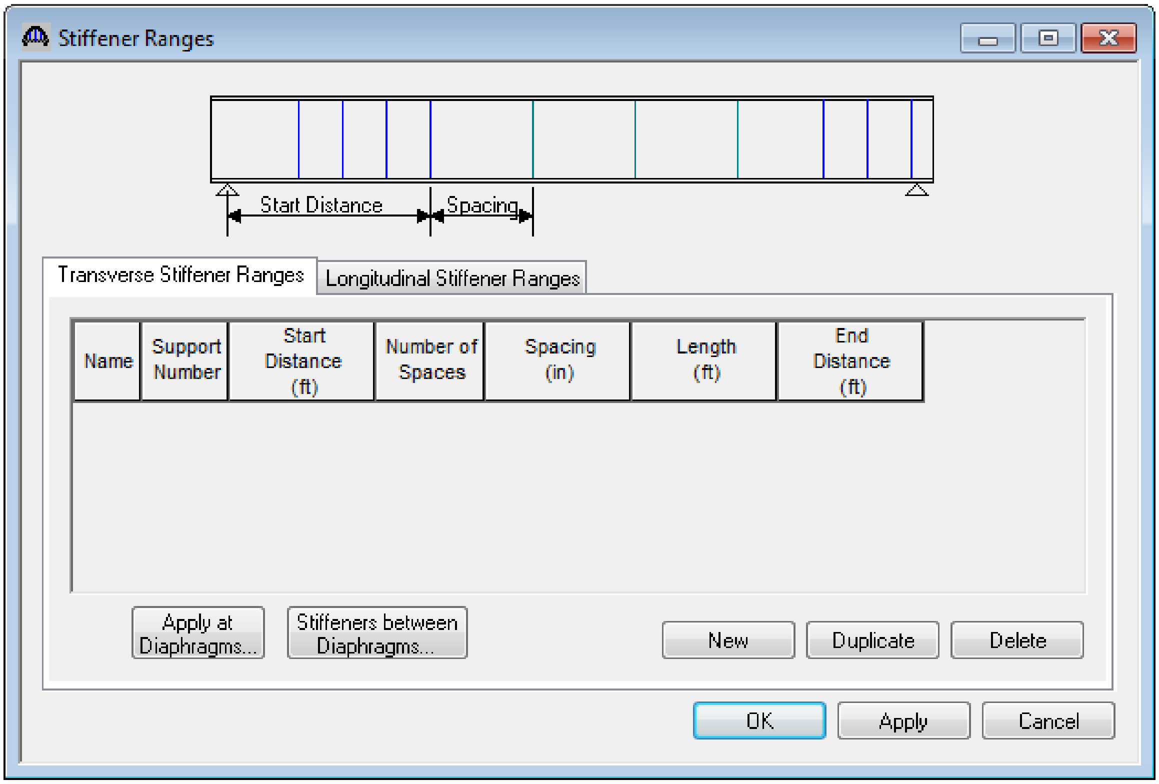
Exterior Girder (G1):



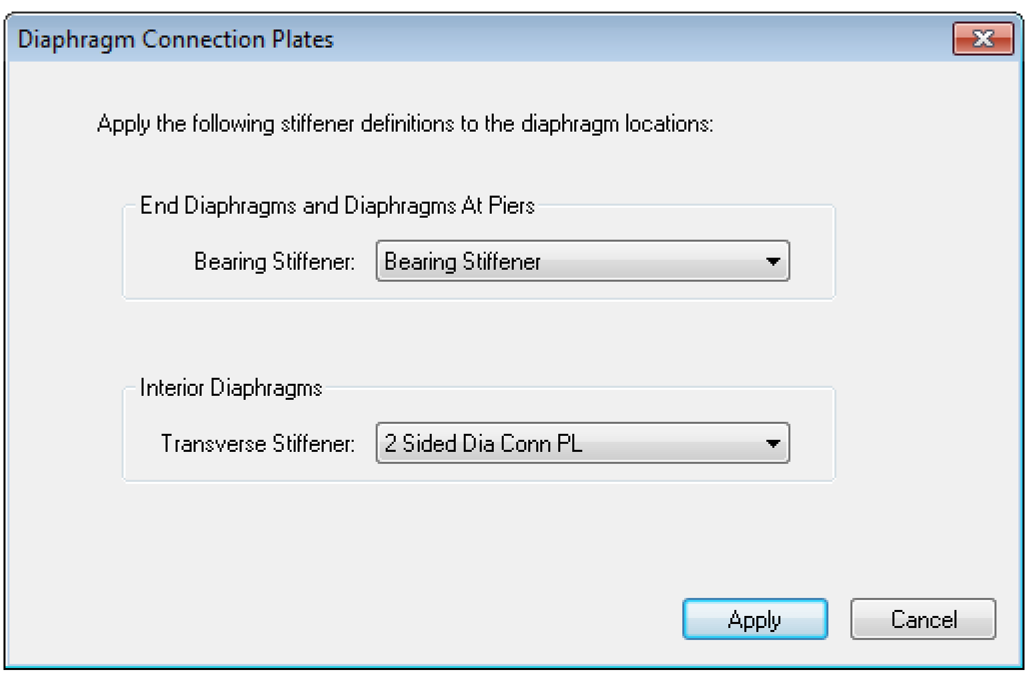
Regions where the slab is considered to provide lateral support for the top flange are defined using the Lateral Support window shown below. It can be opened by double clicking on Lateral Support in the tree.



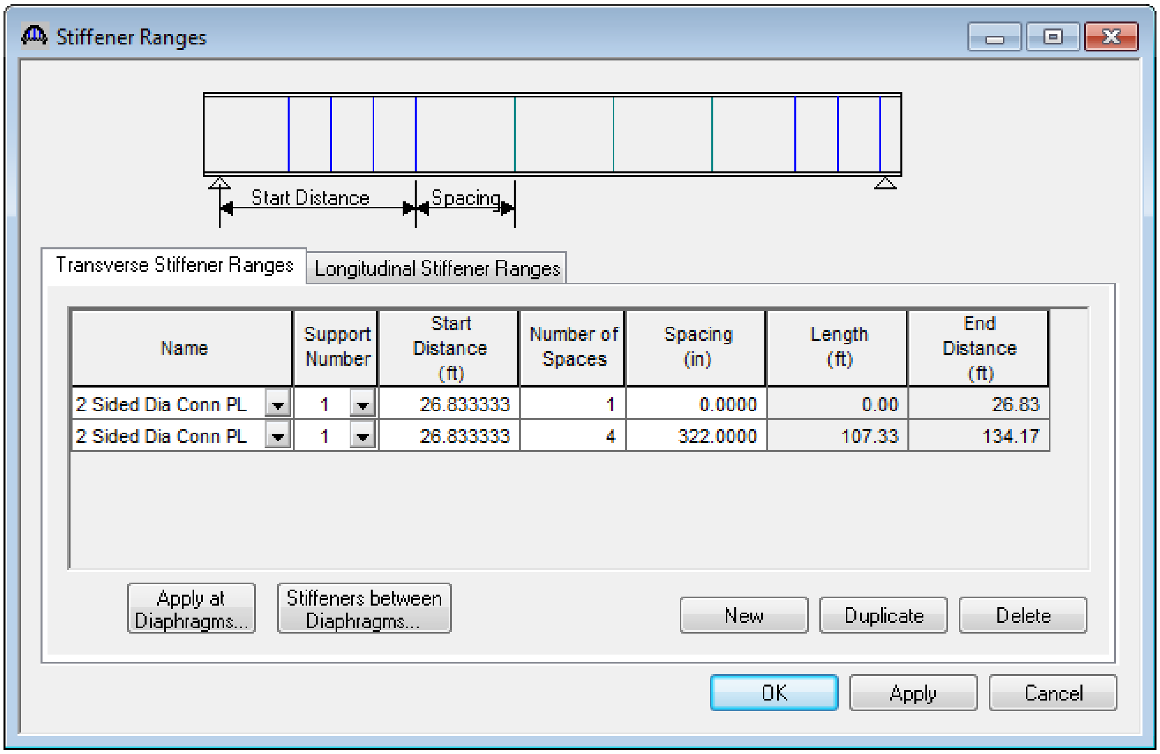
Stiffener locations are described using the Stiffener Ranges window shown below.



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.

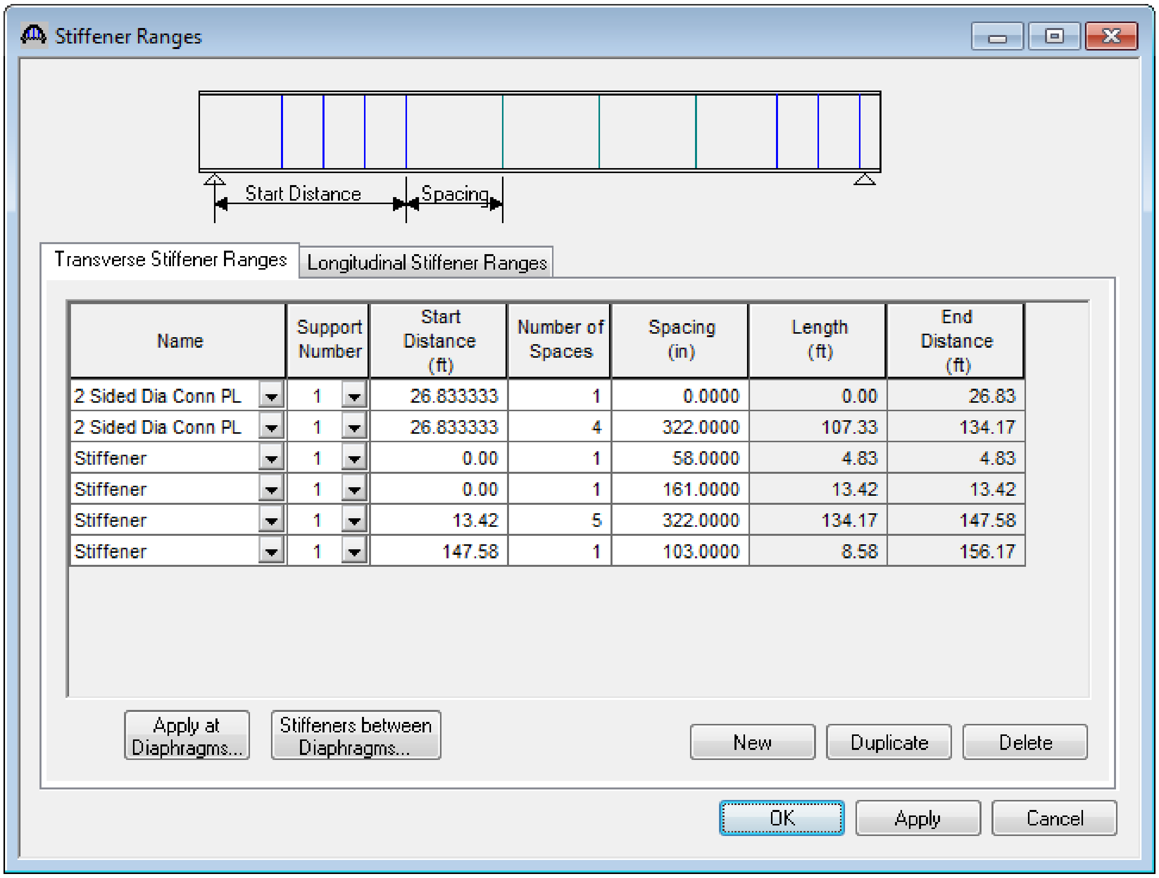


Selecting Apply will create the following transverse stiffener locations.

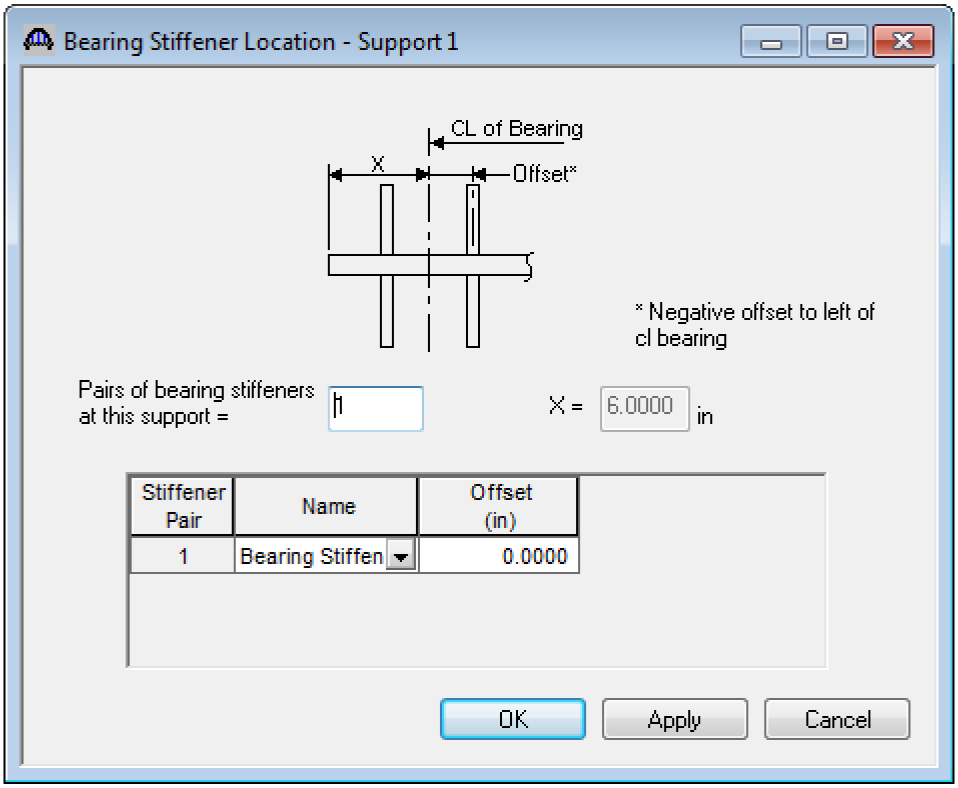


Name	Support Number	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)
2 Sided Dia Conn PL	1	26.833333	1	0.0000	0.00	26.83
2 Sided Dia Conn PL	1	26.833333	4	322.0000	107.33	134.17

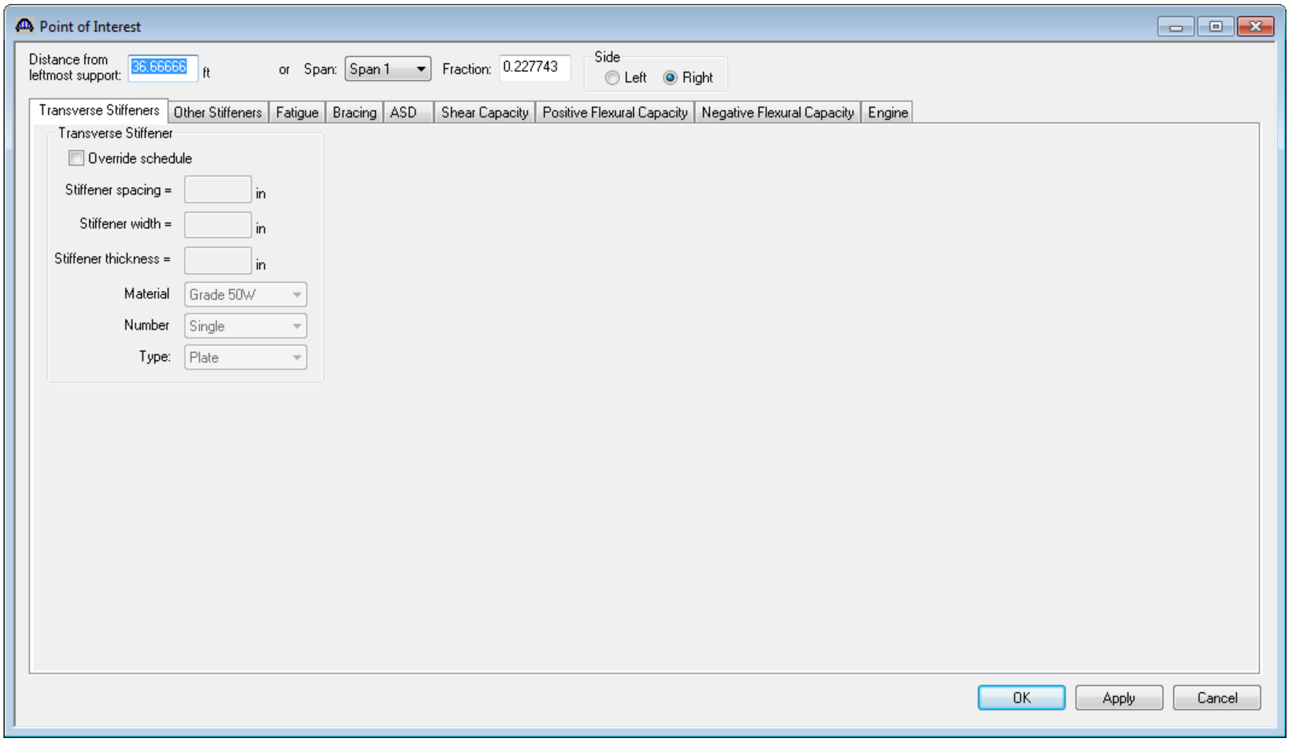
The intermediate transverse stiffeners are now located. Note that a range does not include a stiffener at the beginning of the range. The range that begins at the left end of the beam with one space and a spacing of 58 inches locates the first stiffener. The remaining intermediate stiffeners are located as follows.



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.



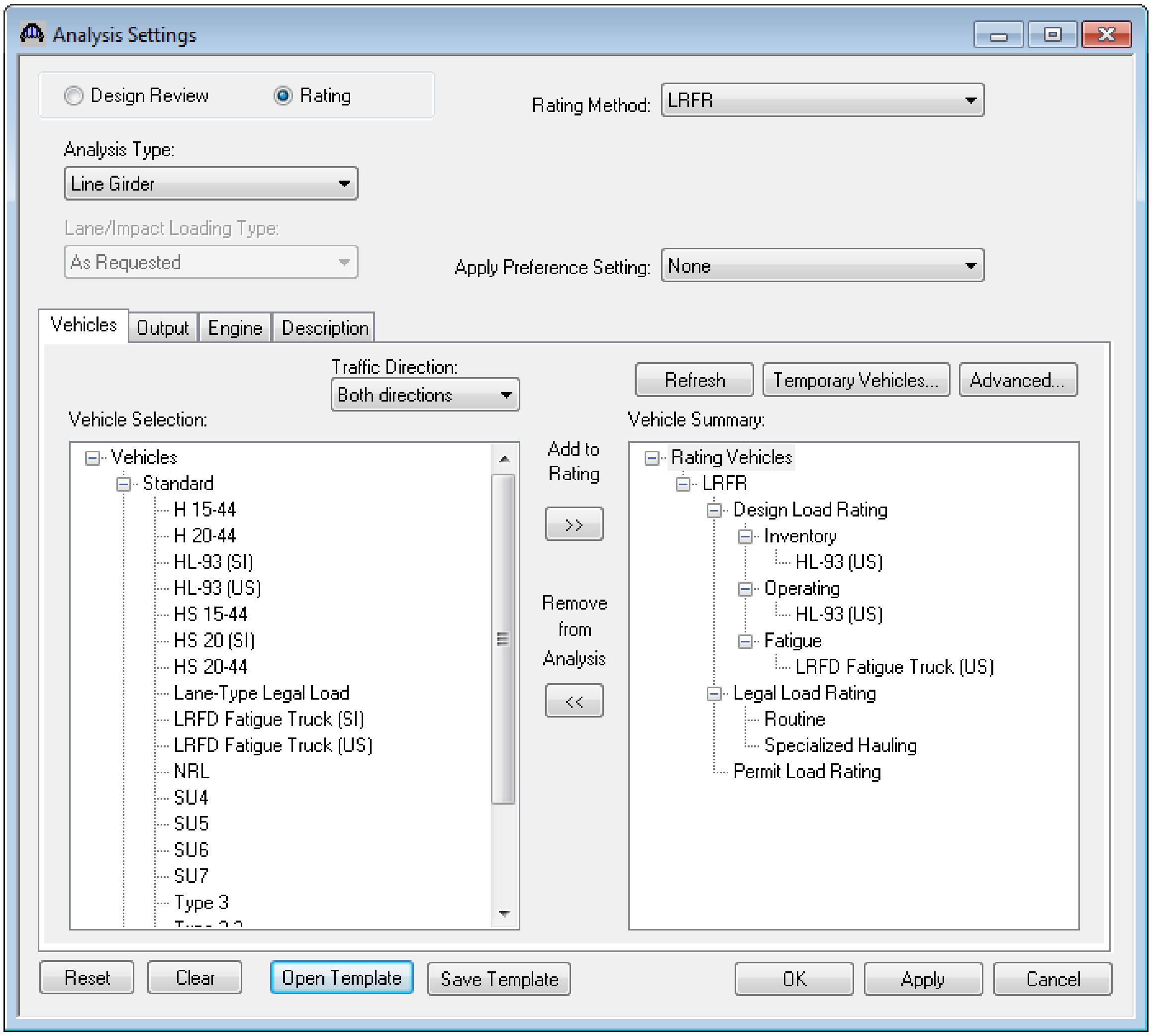
Define Points of Interest using the Points of Interest window shown below. A window for defining a Point of Interest is opened by double clicking on the Points of Interest tree item.



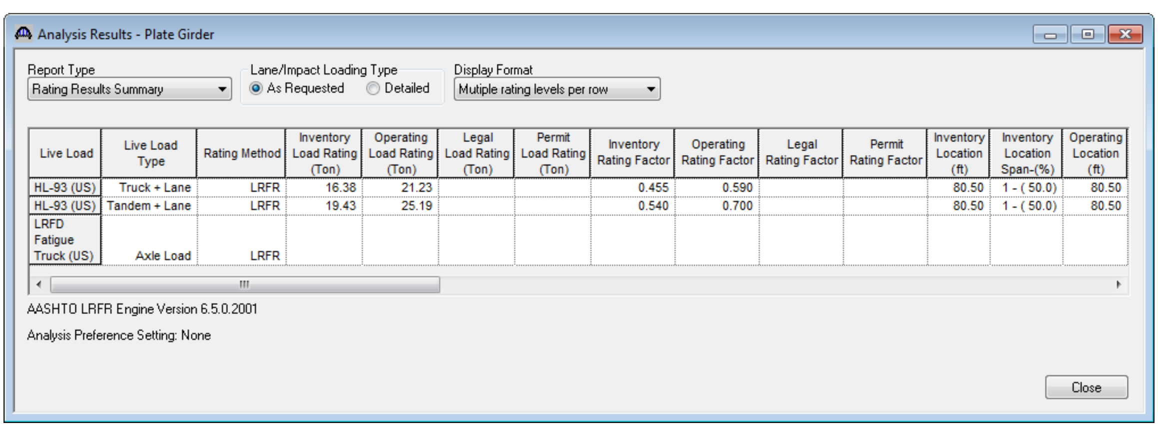
The description of an interior beam for a structure definition is complete.

This example bridge is modeled after Example 1 from "Four LRFD Design Examples of Steel Highway Bridges", Volume II, Chapter 1B of the Highway Structures Design Handbook produced by the American Iron and Steel Institute except this example bridge is not skewed like the one in the handbook.

To do LRFR Design Load Rating, enter the Analysis Settings window as shown below:

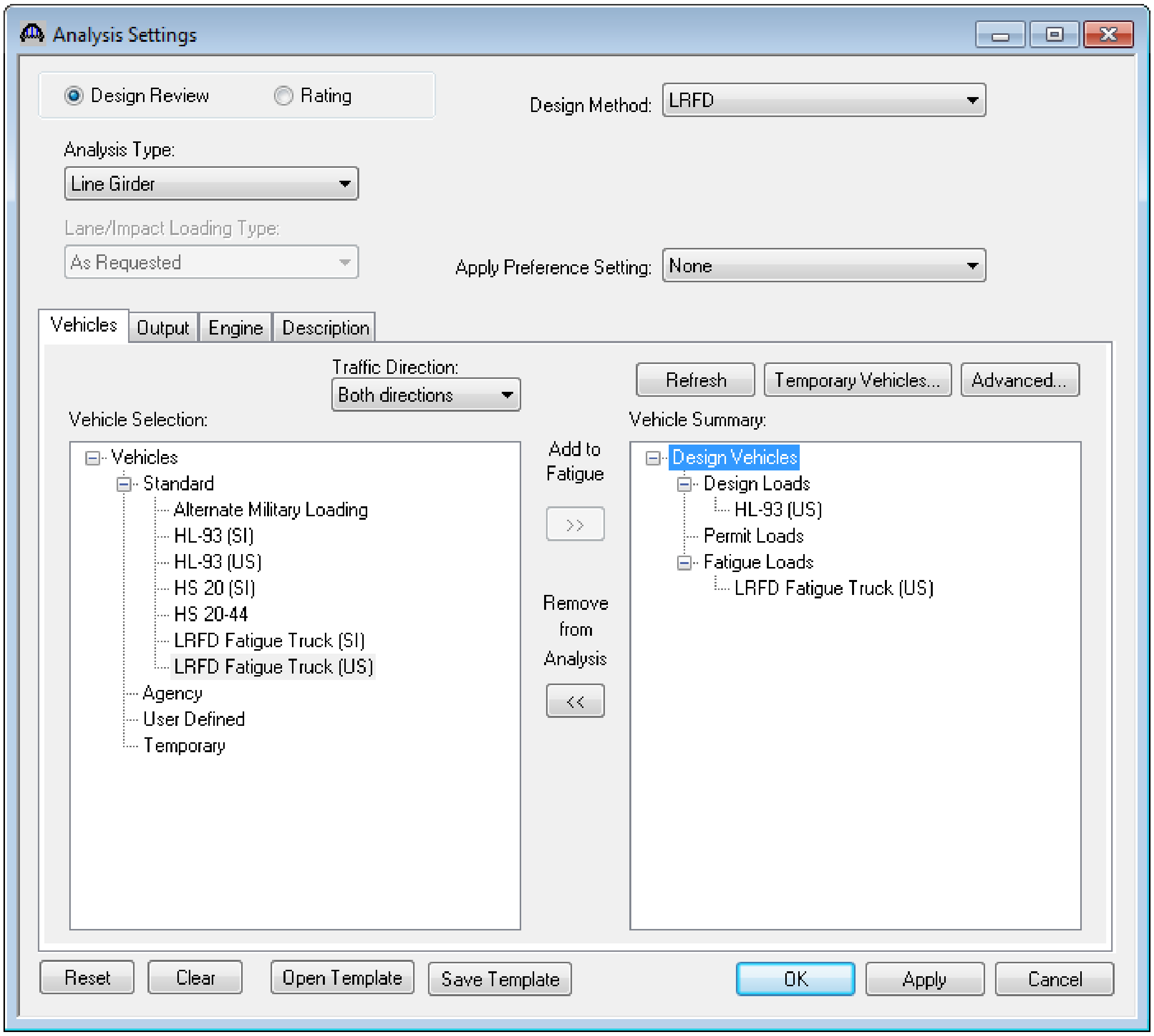


AASHTO LRFR results for HL93 loading for an interior girder are shown below:

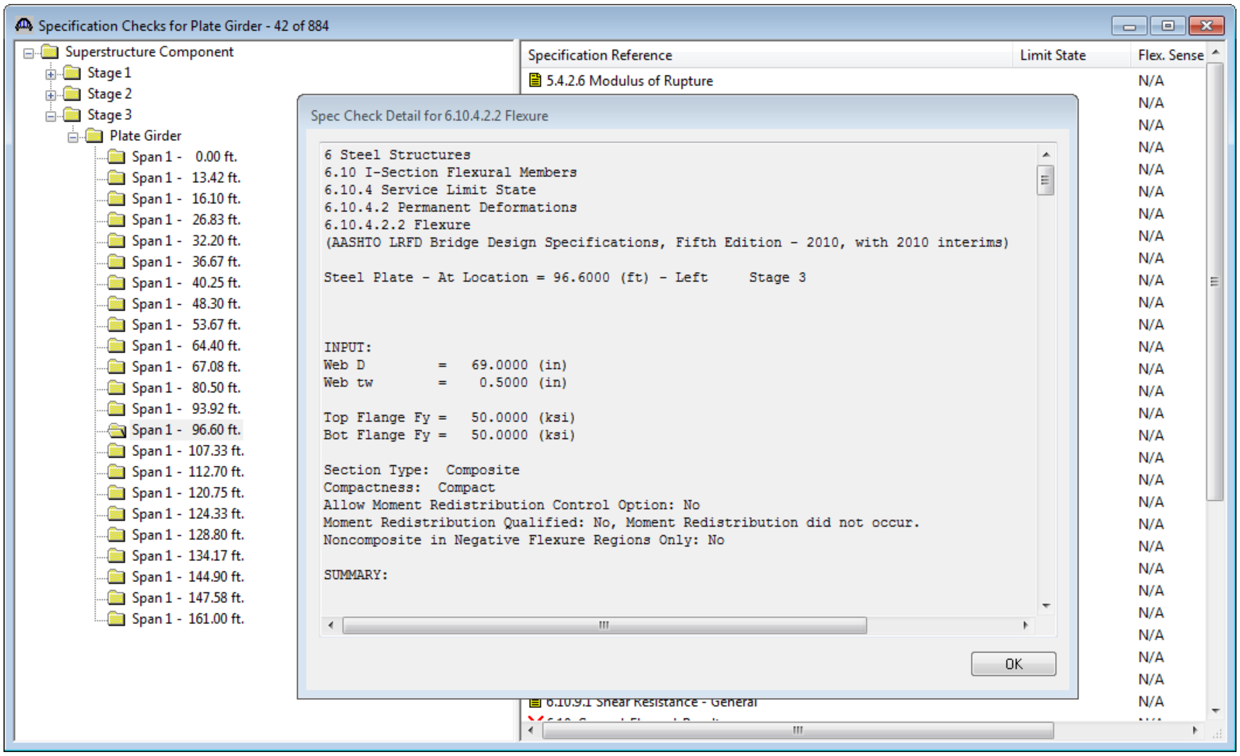


Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Legal Load Rating (Ton)	Permit Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Legal Rating Factor	Permit Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)
HL-93 (US)	Truck + Lane	LRFR	16.38	21.23			0.455	0.590			80.50	1 - (50.0)	80.50
HL-93 (US)	Tandem + Lane	LRFR	19.43	25.19			0.540	0.700			80.50	1 - (50.0)	80.50
LRFD Fatigue Truck (US)	Axle Load	LRFR											

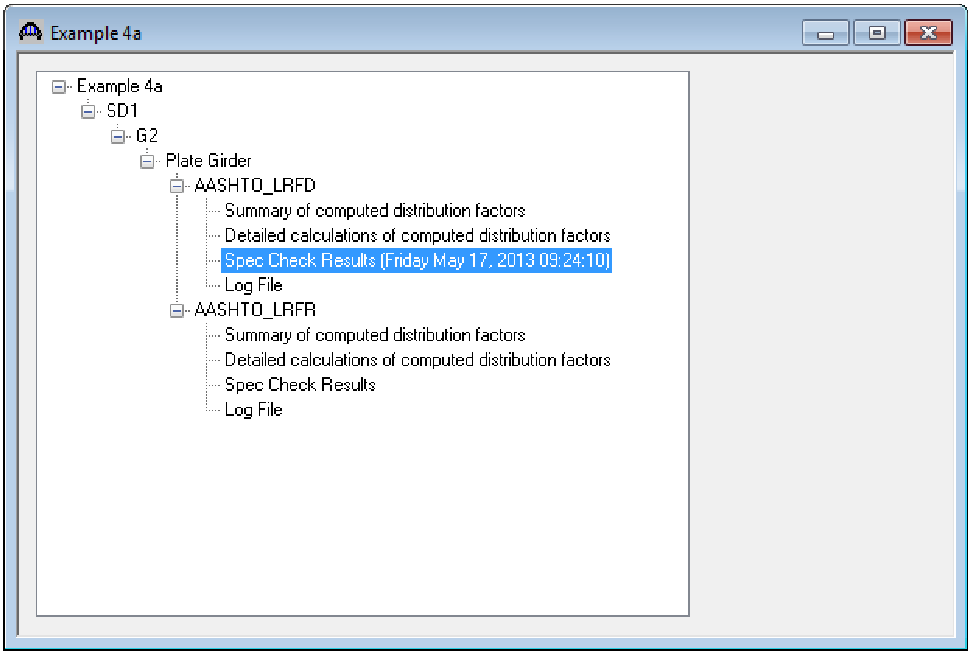
An LRFD design review of this interior girder for HL93 loading can be performed by AASHTO LRFD. To do LRFD design review, enter the Analysis Settings window as shown below:



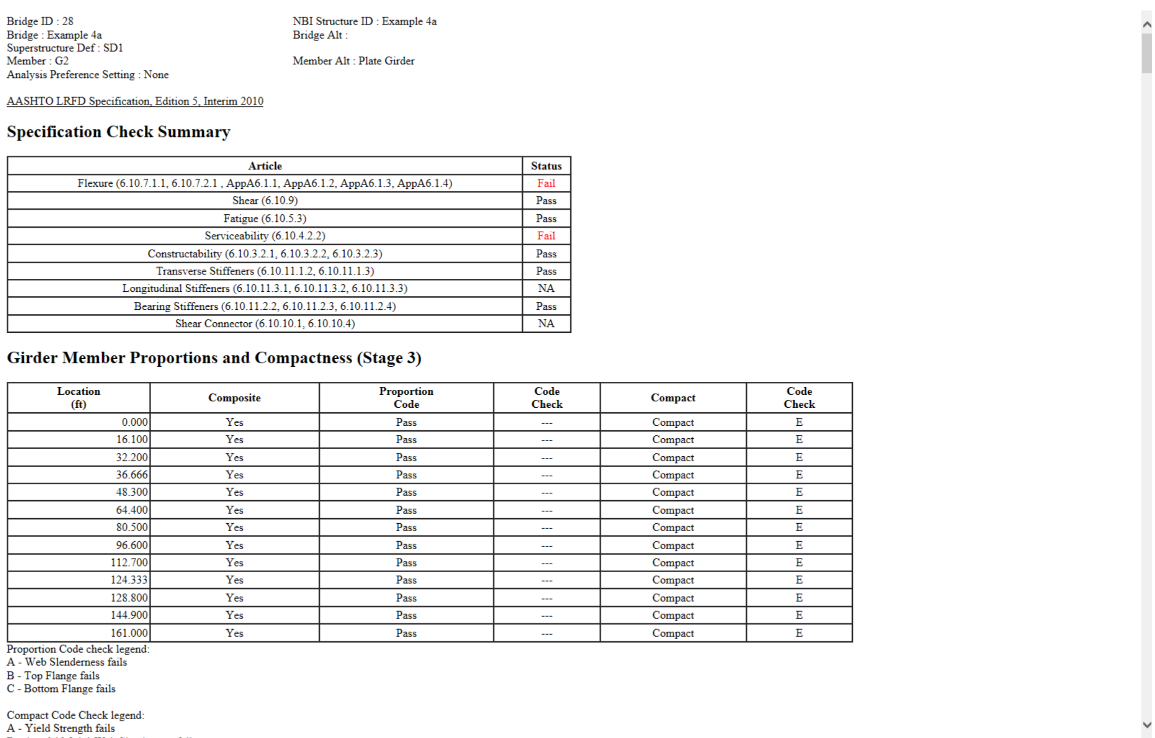
A summary of the specification checks is shown by selecting the View Spec Check button, , from the toolbar. The details for one of the spec checks is shown below.



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



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



Bridge ID : 28
Bridge : Example 4a
Superstructure Def : SD1
Member : G2
Analysis Preference Setting : None

NBI Structure ID : Example 4a
Bridge Alt :

Member Alt : Plate Girder

AASHTO LRFD Specification, Edition 5, Interim 2010

Specification Check Summary

Article	Status
Flexure (6.10.7.1.1, 6.10.7.2.1 , AppA6.1.1, AppA6.1.2, AppA6.1.3, AppA6.1.4)	Fail
Shear (6.10.9)	Pass
Fatigue (6.10.5.3)	Pass
Serviceability (6.10.4.2.2)	Fail
Constructability (6.10.3.2.1, 6.10.3.2.2, 6.10.3.2.3)	Pass
Transverse Stiffeners (6.10.11.1.2, 6.10.11.1.3)	Pass
Longitudinal Stiffeners (6.10.11.3.1, 6.10.11.3.2, 6.10.11.3.3)	NA
Bearing Stiffeners (6.10.11.2.2, 6.10.11.2.3, 6.10.11.2.4)	Pass
Shear Connector (6.10.10.1, 6.10.10.4)	NA

Girder Member Proportions and Compactness (Stage 3)

Location (ft)	Composite	Proportion Code	Code Check	Compact	Code Check
0.000	Yes	Pass	---	Compact	E
16.100	Yes	Pass	---	Compact	E
32.200	Yes	Pass	---	Compact	E
36.666	Yes	Pass	---	Compact	E
48.300	Yes	Pass	---	Compact	E
64.400	Yes	Pass	---	Compact	E
80.500	Yes	Pass	---	Compact	E
96.600	Yes	Pass	---	Compact	E
112.700	Yes	Pass	---	Compact	E
124.333	Yes	Pass	---	Compact	E
128.800	Yes	Pass	---	Compact	E
144.900	Yes	Pass	---	Compact	E
161.000	Yes	Pass	---	Compact	E

Proportion Code check legend:
A - Web Slenderness fails
B - Top Flange fails
C - Bottom Flange fails

Compact Code Check legend:
A - Yield Strength fails