AASHTOWare BrD/BrR 6.8

Floor System Tutorial

FS2 - Floorbeam Stringer Line Example

Advanced BrR and BrD Training

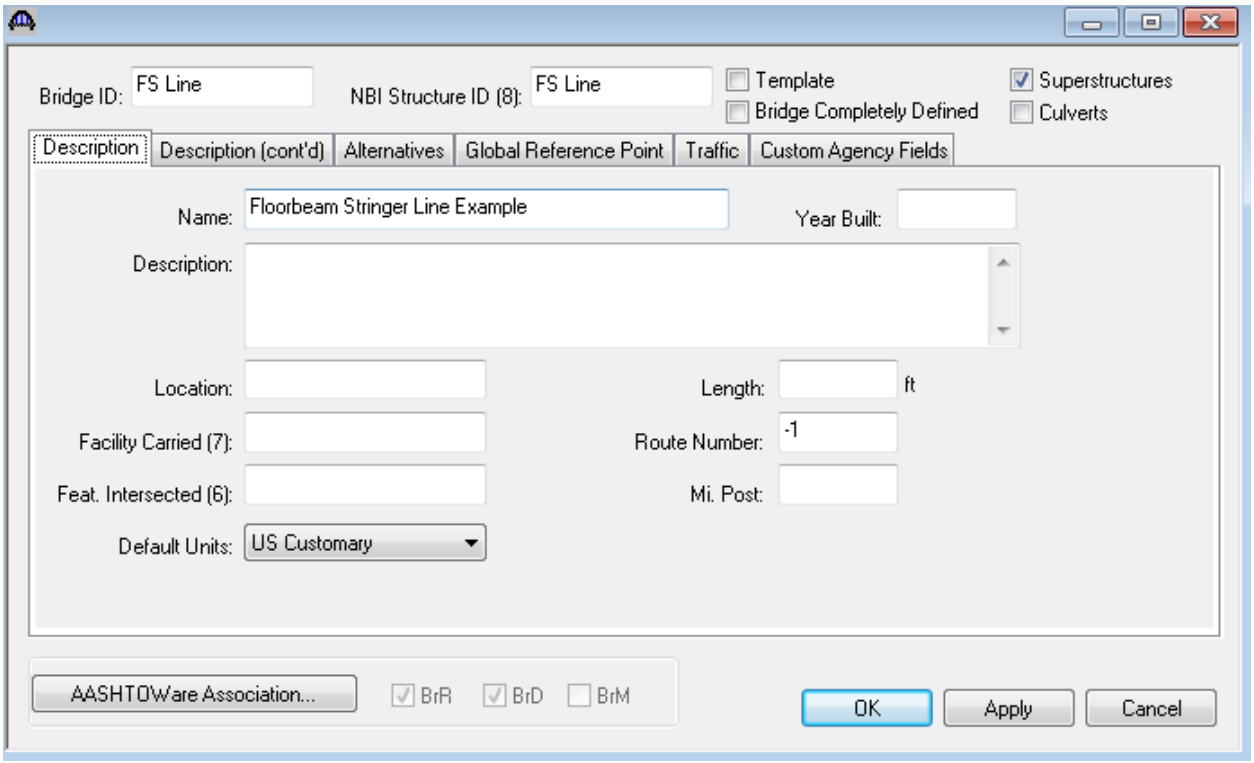
FS2 - Floorbeam Stringer Line Example

Topics Covered

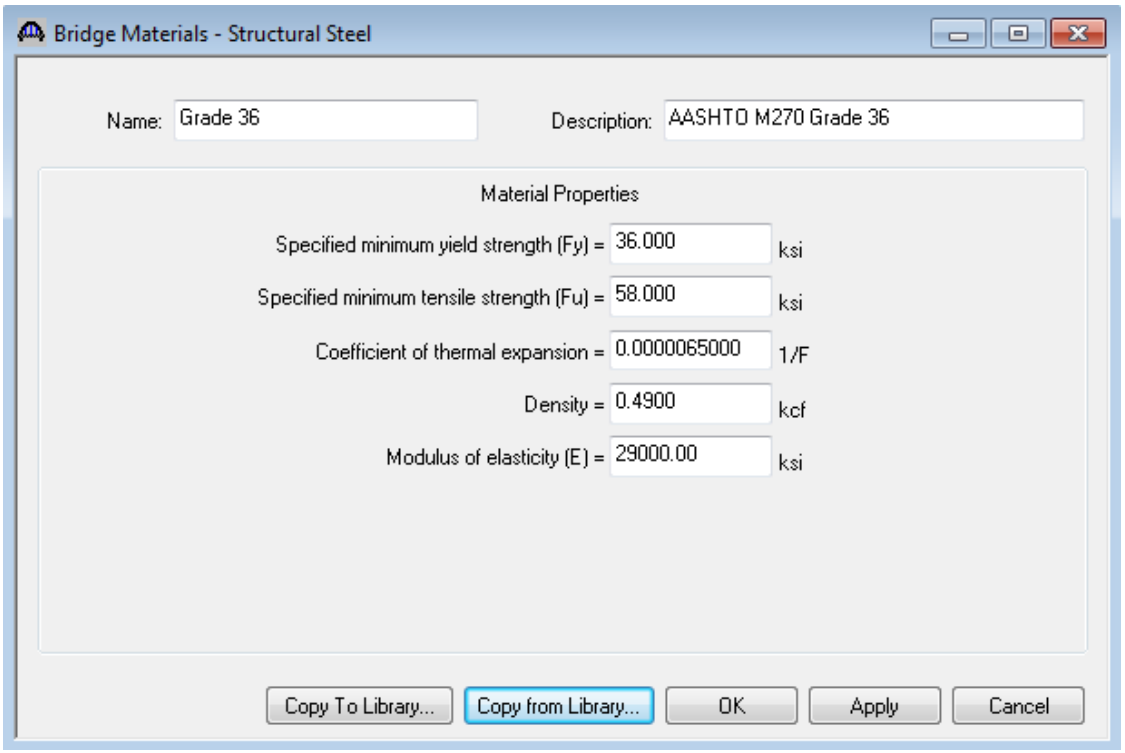
- Superstructure composed of floorbeams and stringers
- Line Superstructure Definition
- Rolled beam stringers
- Plate girder floorbeams, linearly varying web

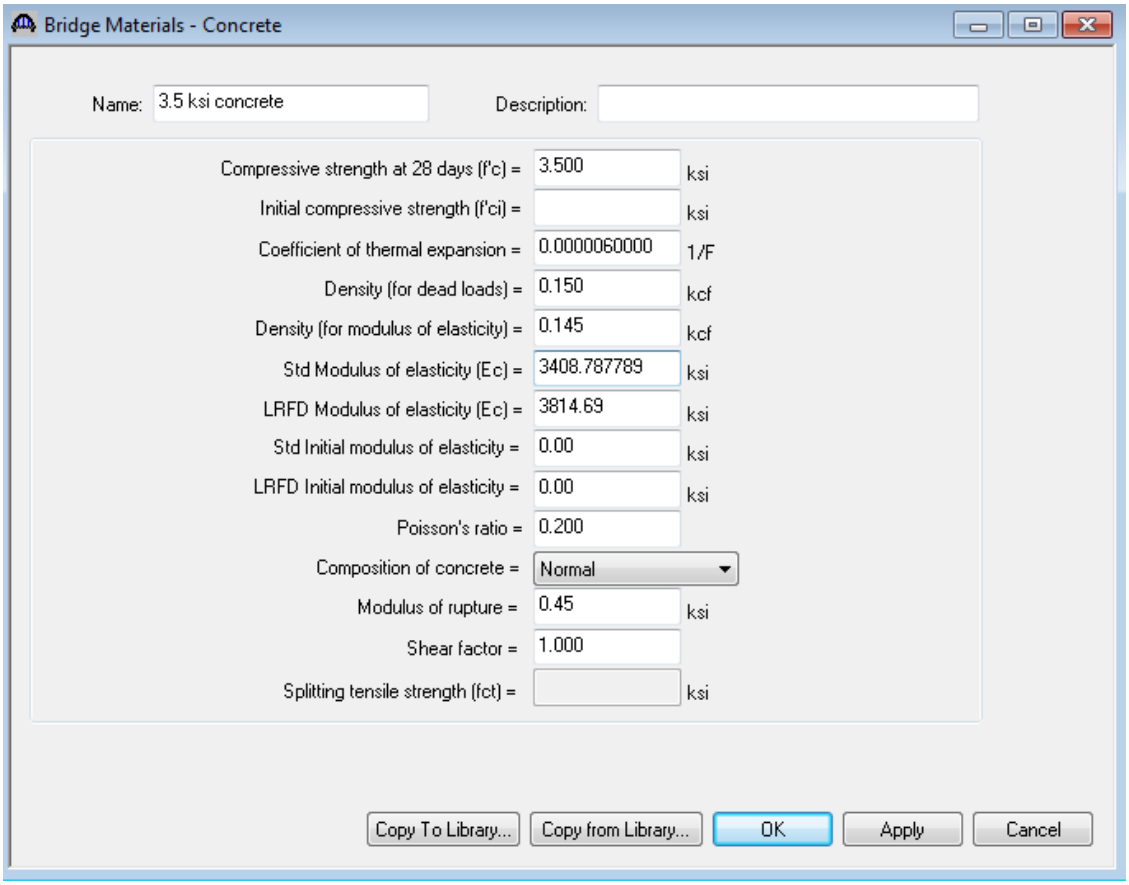
This example demonstrates entering a Floorbeam-Stringer superstructure in BrR using the Line superstructure definition approach. It is assumed that the user of this example is an advanced user who is familiar with the basics of BrR. As such, the details of creating bridge materials, beam shapes, etc., are not presented in great detail in this example.

From the Bridge Explorer, select File/New/New Bridge to create a new bridge. Enter the following description data:

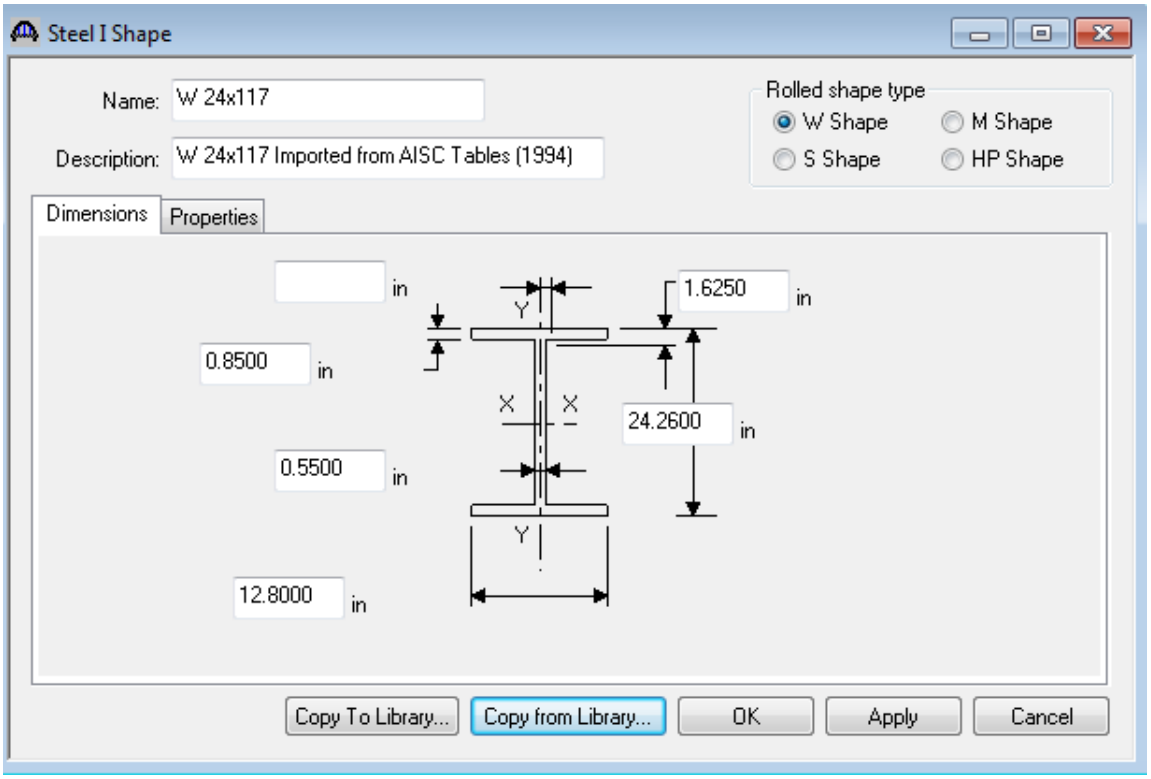


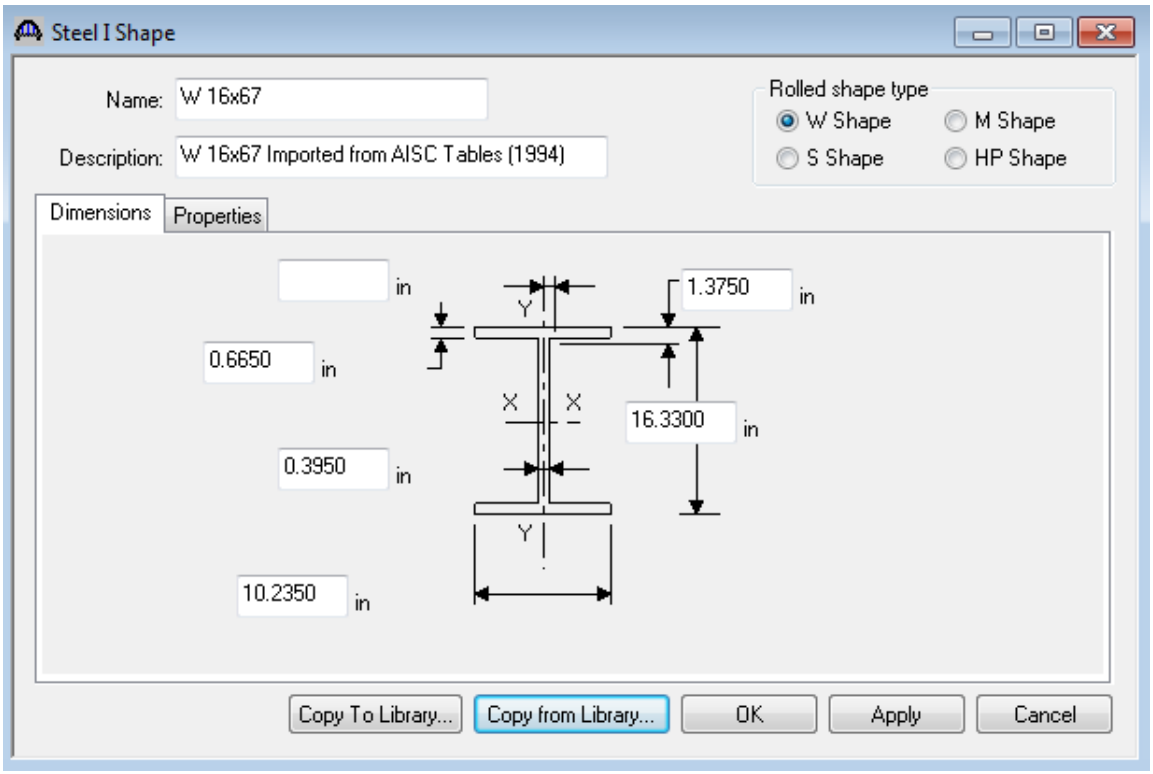
Create the following materials for the bridge. (The structural steel can be copied from the library.)



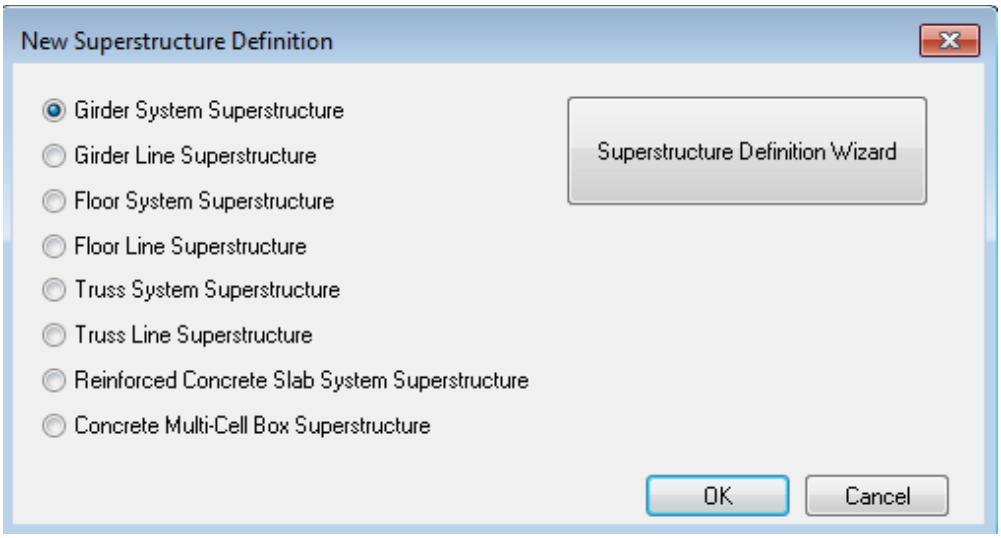


Copy the following steel beam shapes from the library to the bridge. These shapes will be used for the stringers in this superstructure.

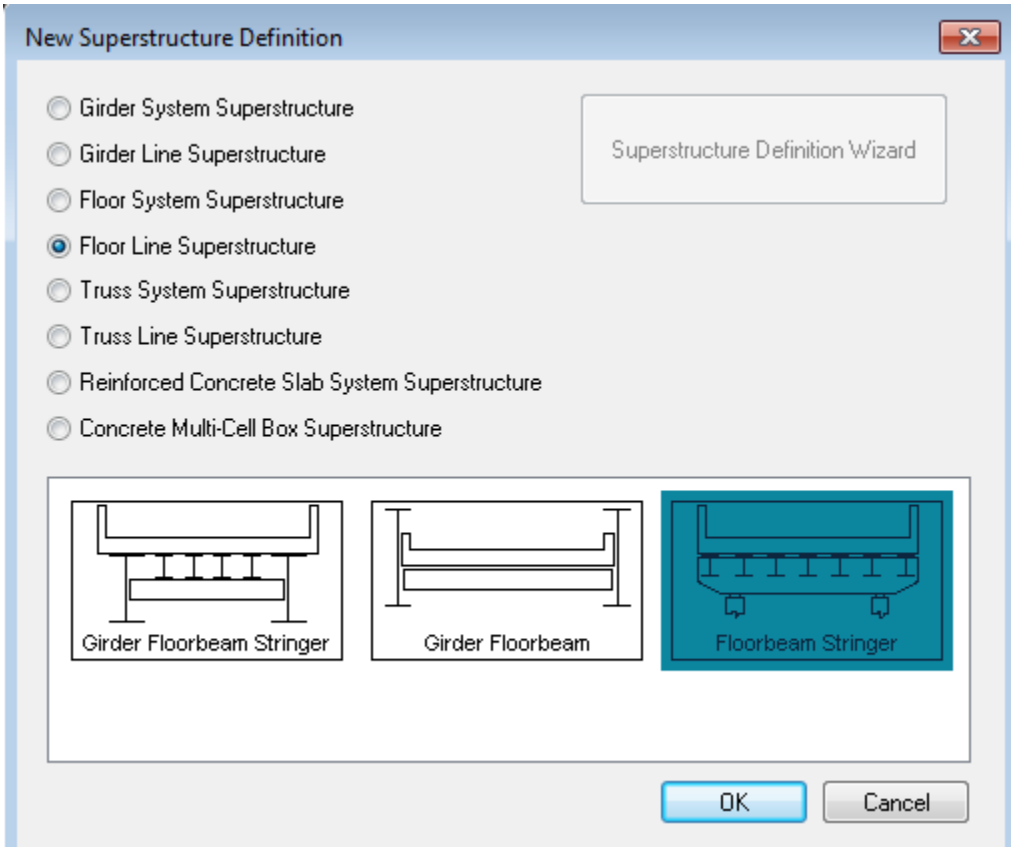




Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File/New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new superstructure definition. The dialog shown below will appear.

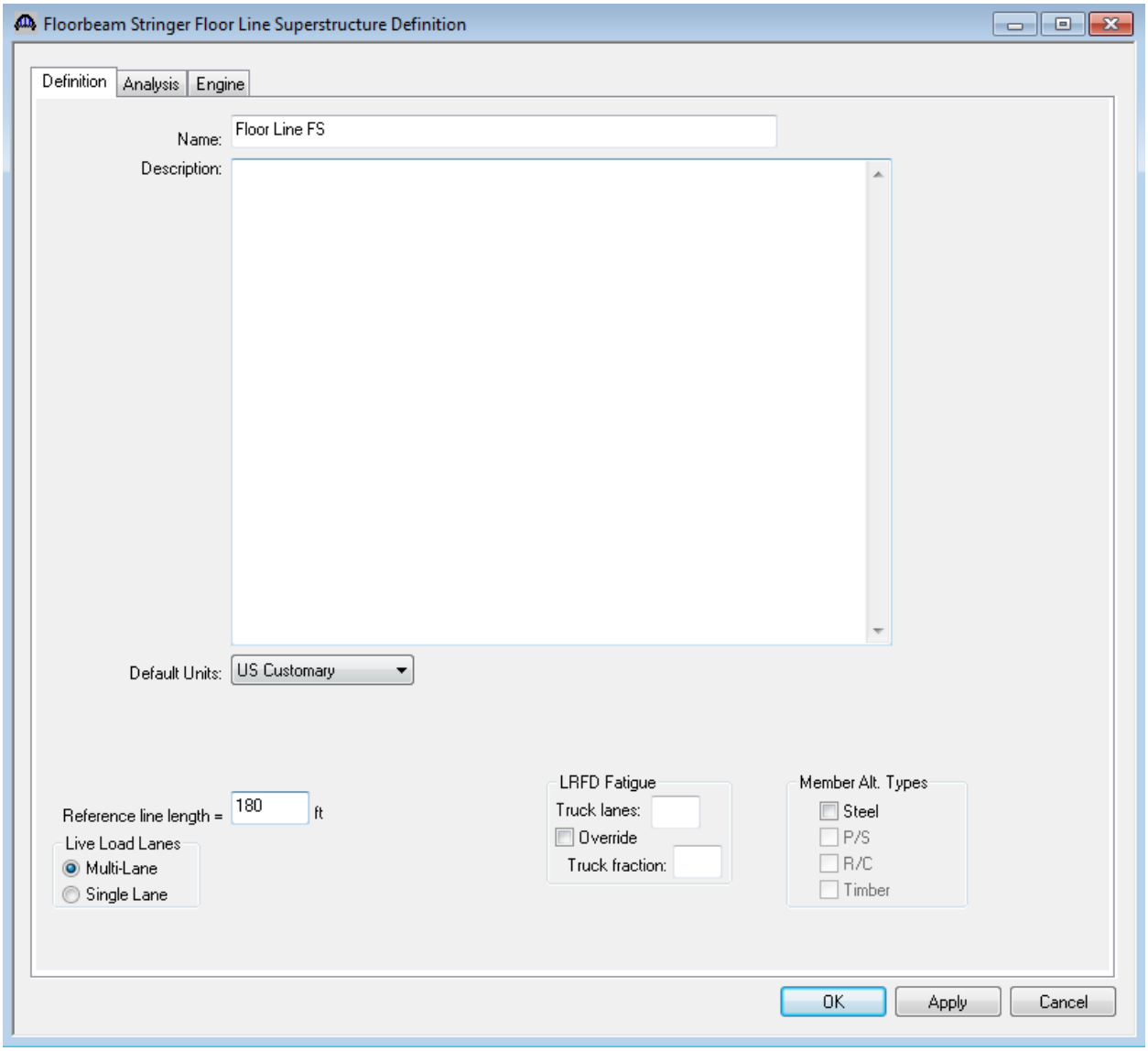


Selecting Floor Line Superstructure will display three types of floor line superstructure definitions.

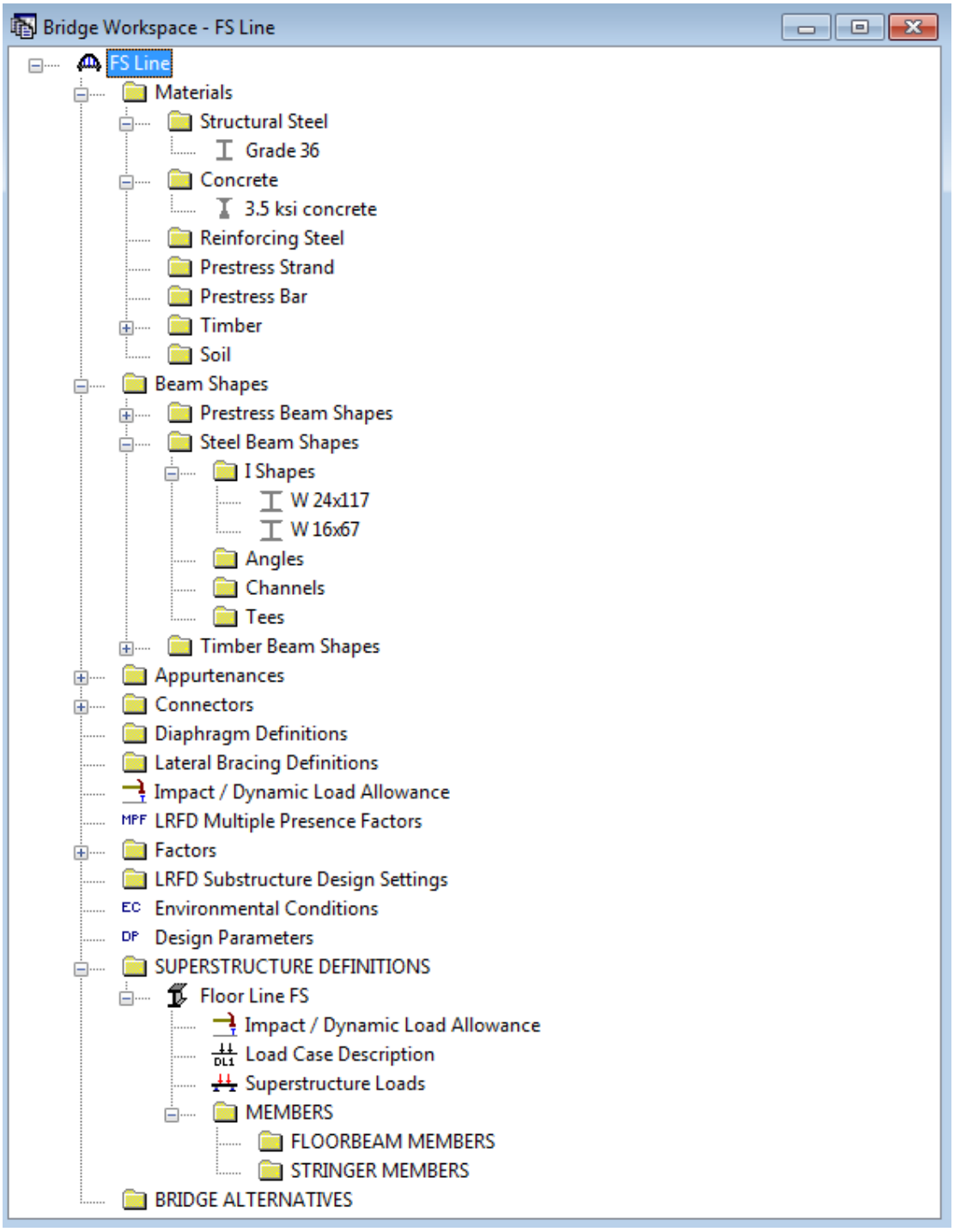


Select Floorbeam Stringer and click OK. The Floorbeam Stringer Floor Line Superstructure Definition window will open.

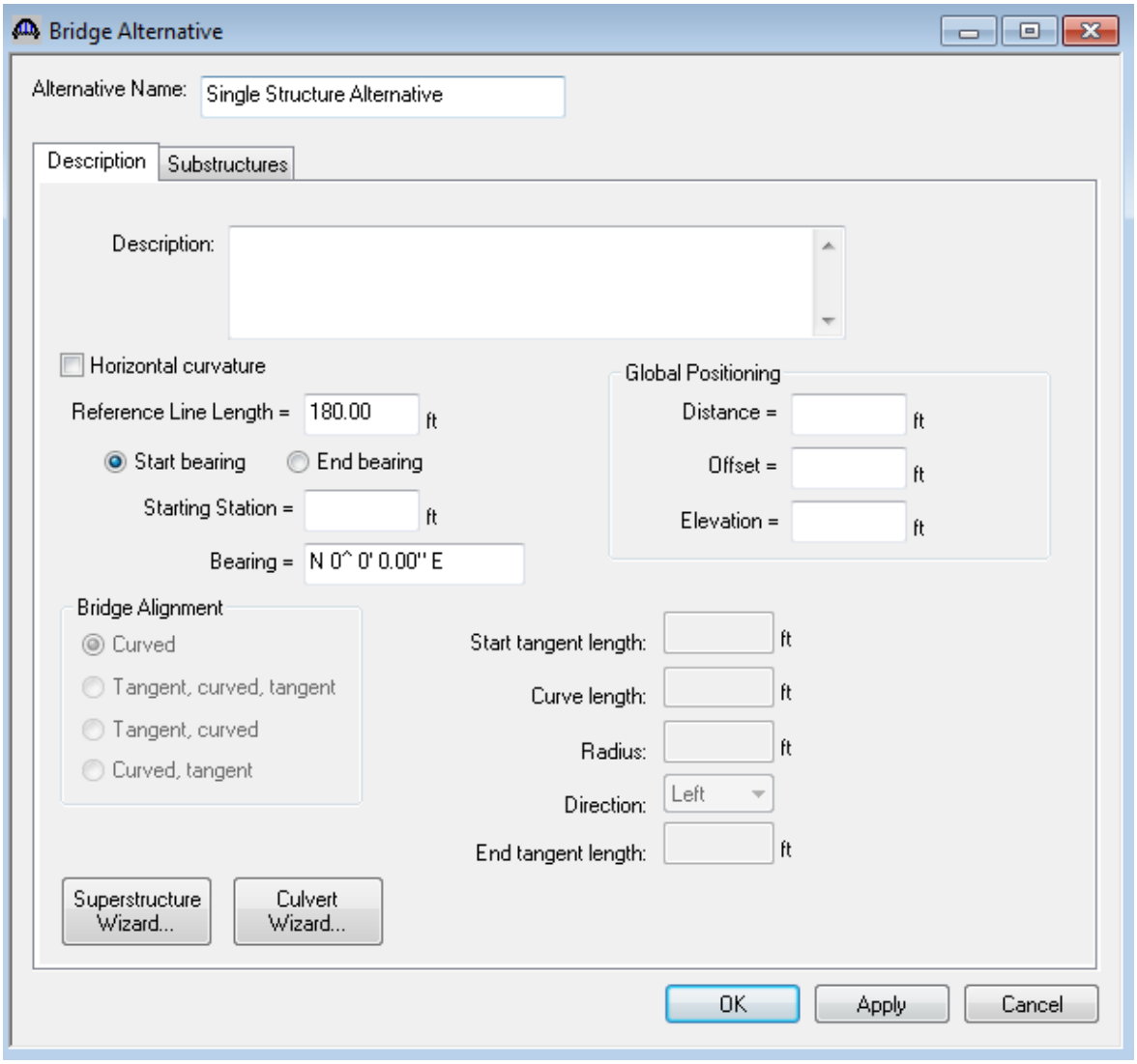
Enter the appropriate data as shown below.

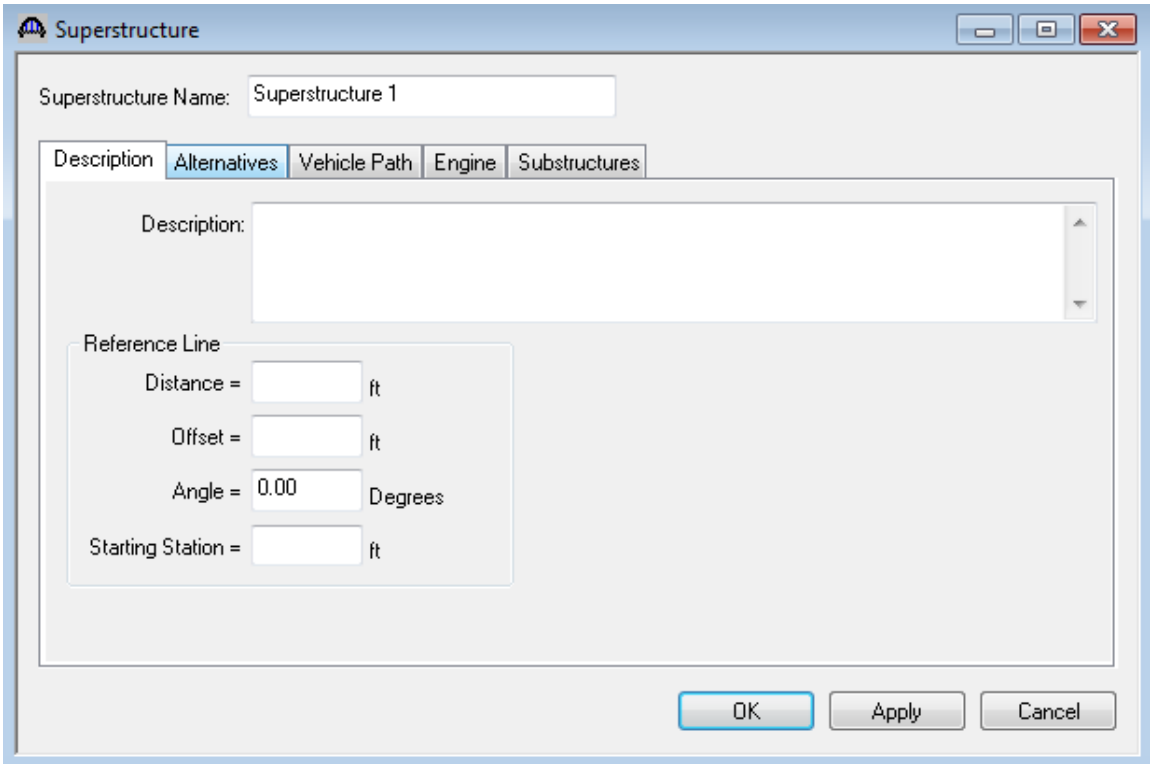


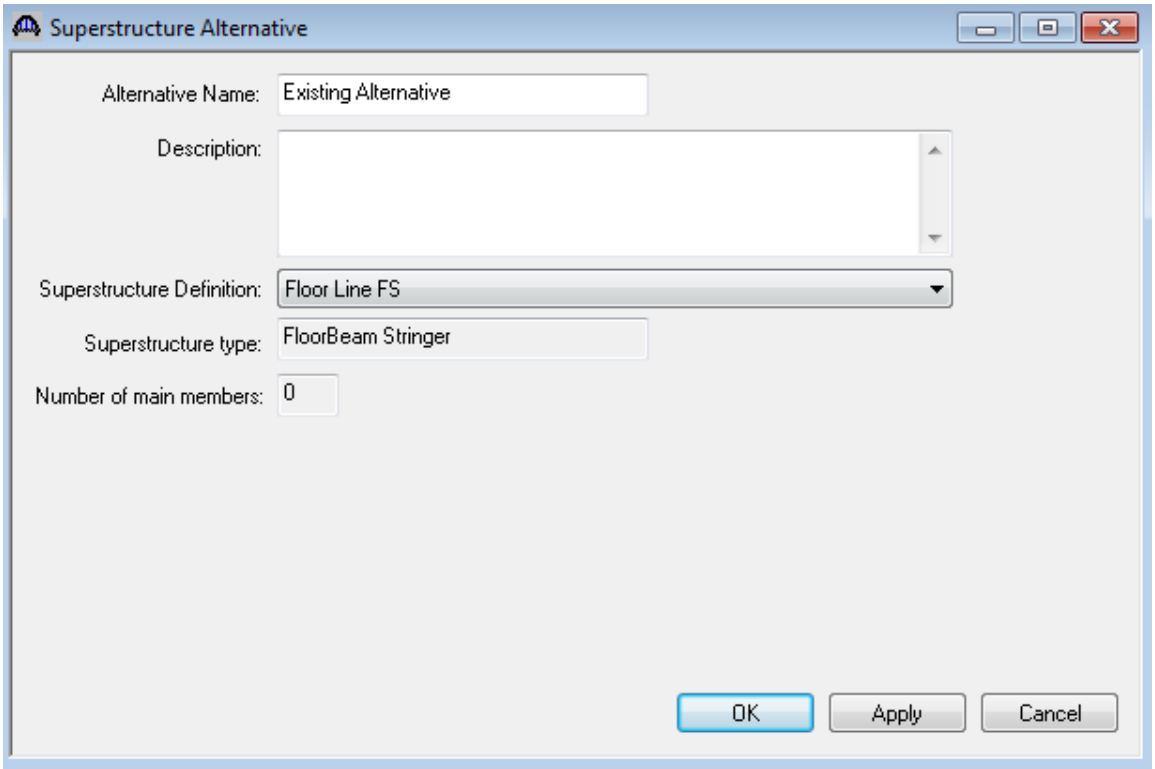
The partially expanded Bridge Workspace tree is shown below:



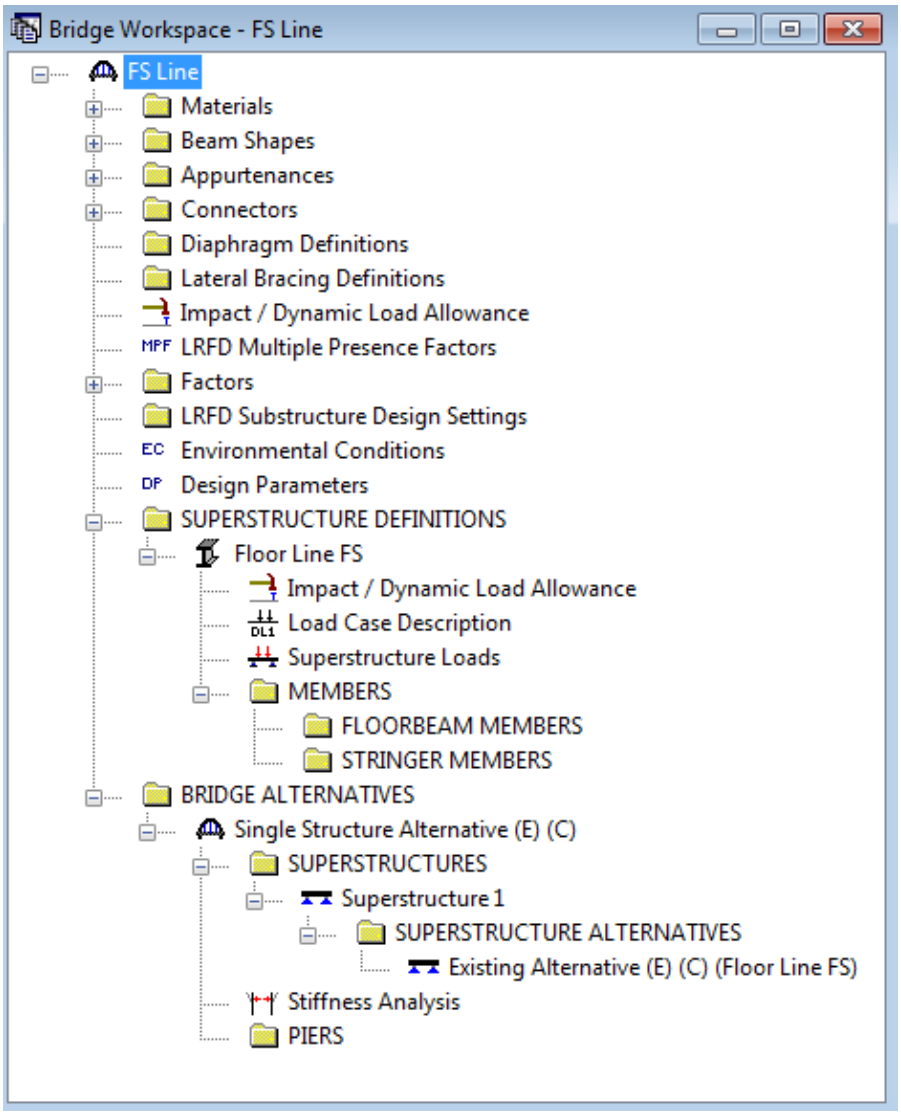
Now create a Bridge Alternative, a Superstructure, a Superstructure Alternative and assign the superstructure definition we just created to the Superstructure Alternative. Enter the data shown in the following windows.




Superstructure
Superstructure Name:
Superstructure 1
Description
Alternatives
Vehicle Path
Engine
Substructures
Description:
Reference Line
Distance =
ft
Offset =
ft
Angle =
0.00
Degrees
Starting Station =
ft
OK
Apply
Cancel

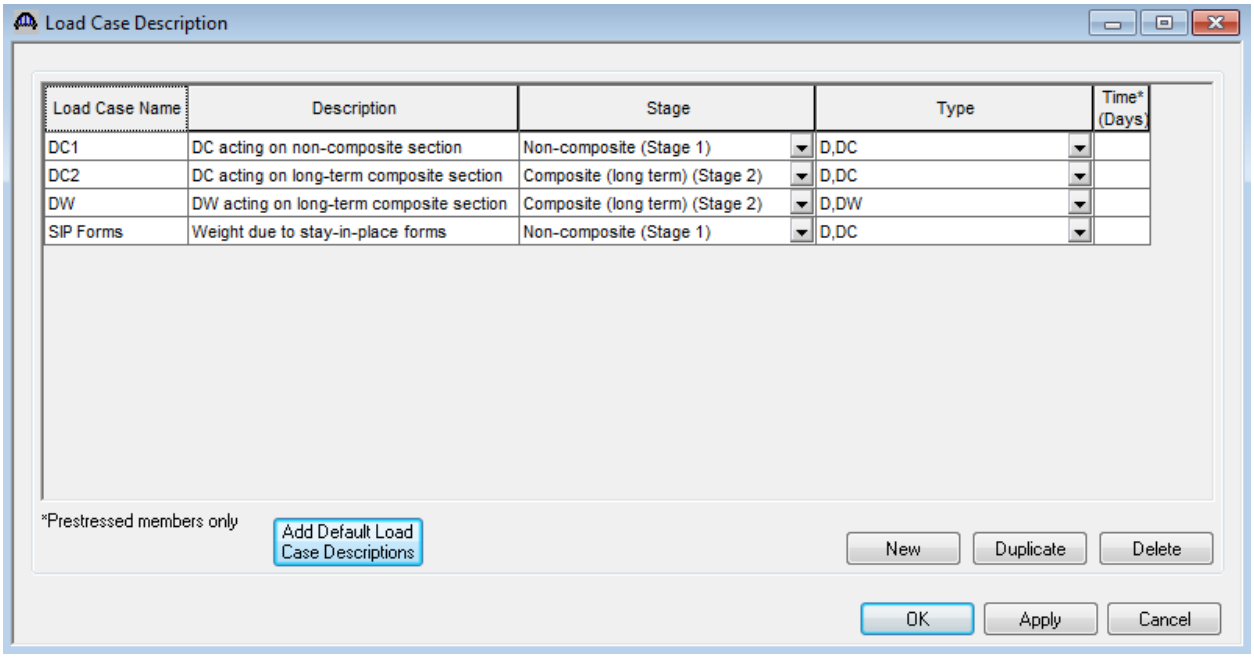

Superstructure Alternative
Alternative Name:
Existing Alternative
Description:
Superstructure Definition:
Floor Line FS
Superstructure type:
FloorBeam Stringer
Number of main members:
0
OK
Apply
Cancel

The partially expanded Bridge Workspace tree is shown below:



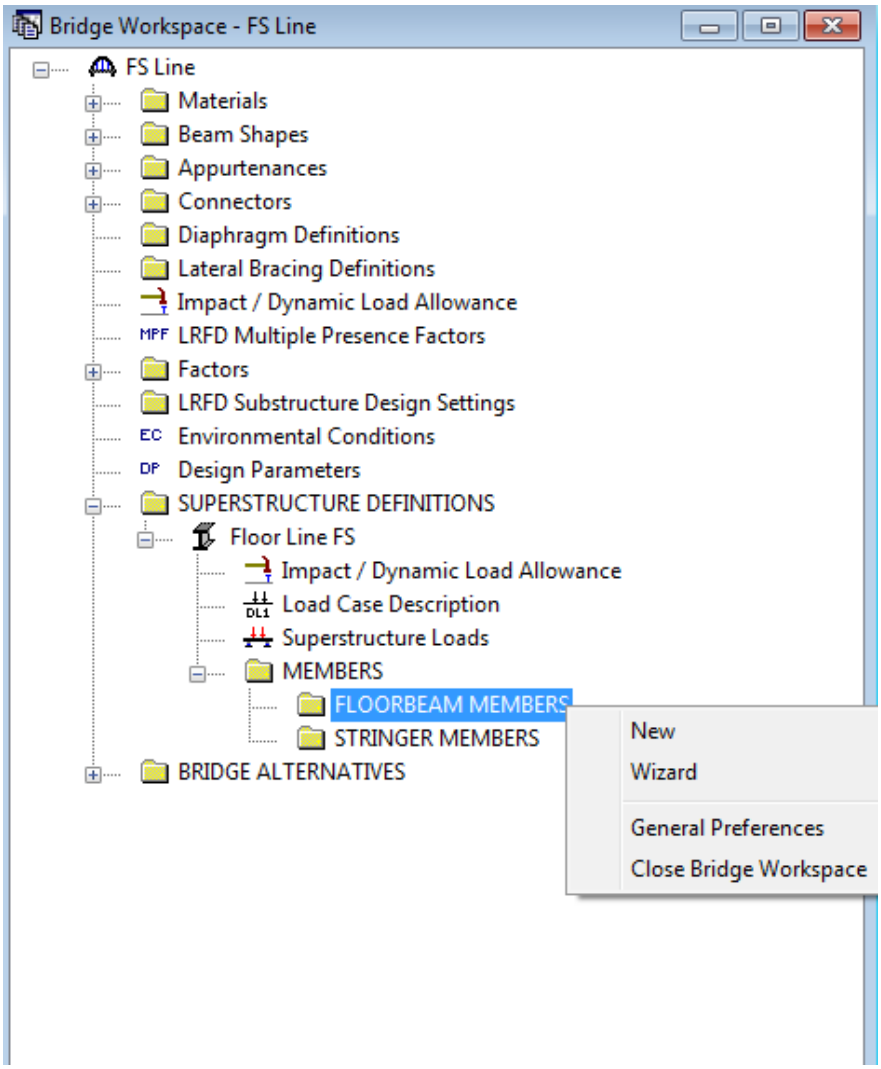
Now go back to defining the superstructure definition.

Double click on Load Case Description to define the dead load cases. Click the Add Default Load Case Descriptions button to add four default load cases. The completed Load Case Description window is shown below:

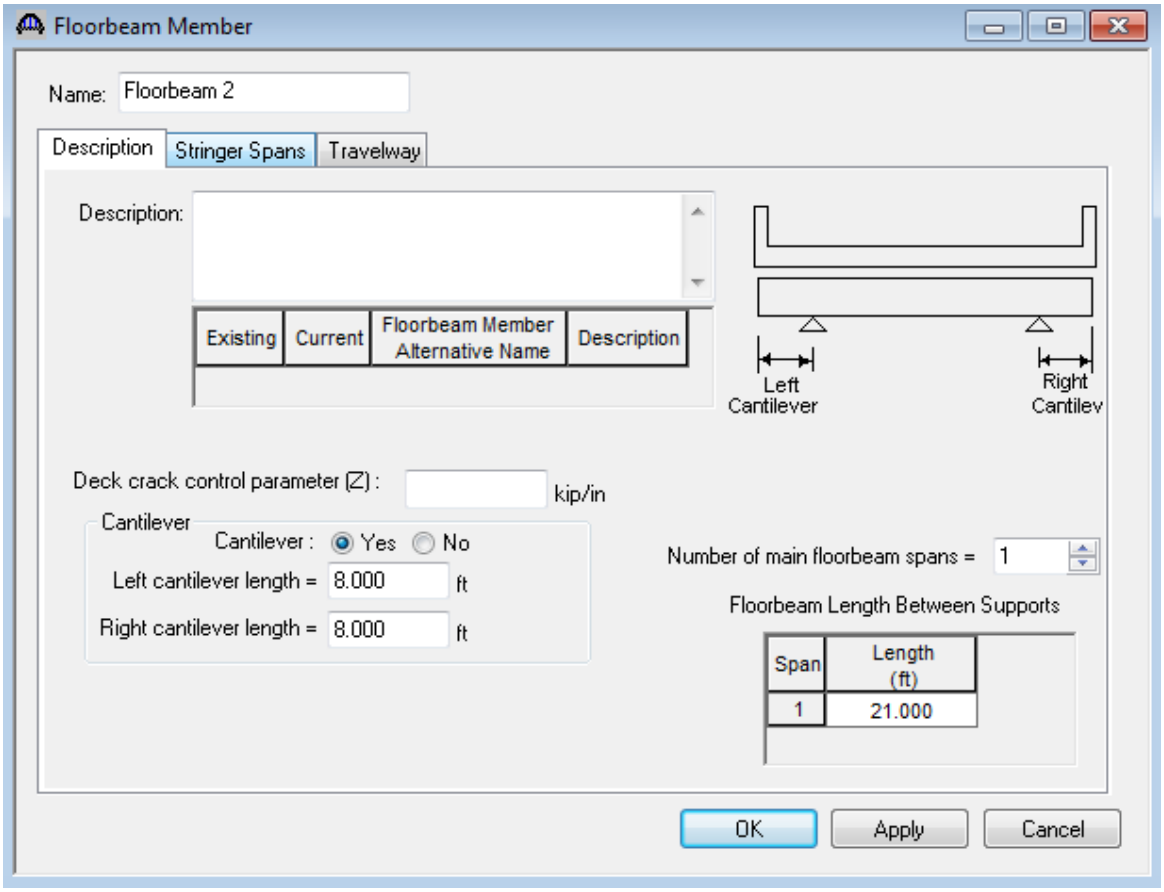


This superstructure does not contain any transverse or bearing stiffeners so we will not create any stiffener definitions.

We will describe the second floorbeam in the superstructure. Create a new Floorbeam member by highlighting "FLOORBEAM MEMBERS" in the BWS tree and right clicking the mouse. Select "New" from the menu that appears.

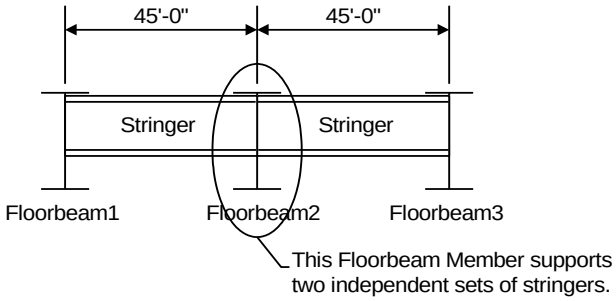


Enter the following data in the Description tab of the Floorbeam Member window.



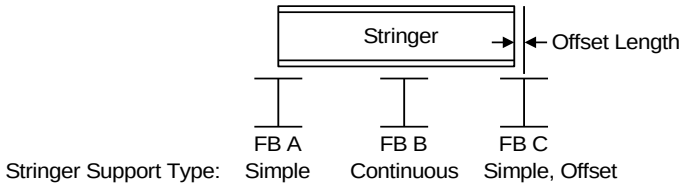
The next tab on the Floorbeam Member window describes the Stringer Spans that the Floorbeam Member supports. The Stringer Spans tab allows you to describe the stringers that contribute live load to this floorbeam member. This tab allows the analysis engine to compute the stringer live load reaction on the floorbeam due to one wheel line of a vehicle. The analysis engine will then use data from the Floorbeam Member: Travelway to place the appropriate number of wheel lines on the floorbeam member and move the wheel lines across the floorbeam to produce the critical loading. The actual stringer spacing is not entered nor used to transfer the live load from the stringers to the floorbeam.

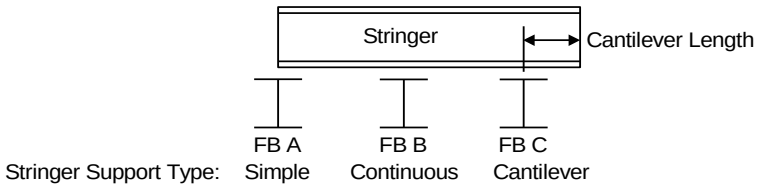
The first item on this tab is the question "Is this floorbeam shared by two independent sets of stringer spans?". Select Yes since this floorbeam is supporting two structurally independent sets of stringers as shown in the sketch below. You will now be able to specify the span lengths for the stringer to the left of Floorbeam 2 and for the stringer to the right of Floorbeam 2.

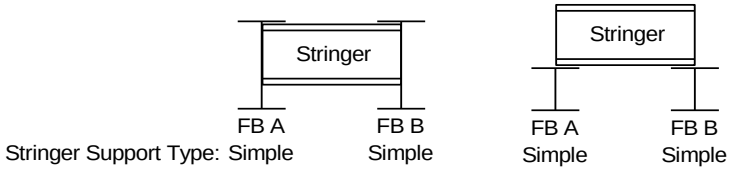


2 floorbeams support the stringer to the left in this example.
2 floorbeams support the stringer to the right in this example.

When entering the floorbeam spacing in the grid, you are able to specify the type of stringer support at each floorbeam. The following sketches illustrate the different types of stringer supports you can specify.

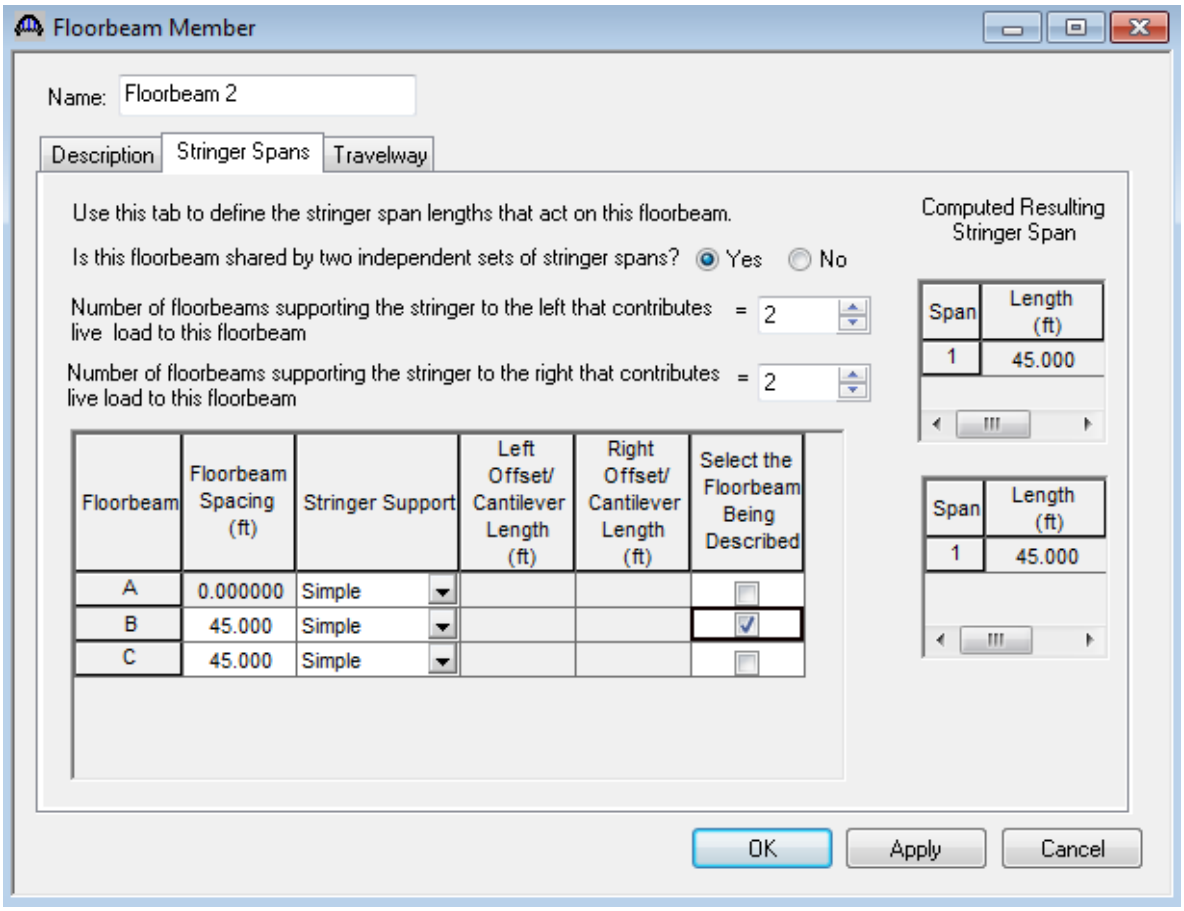




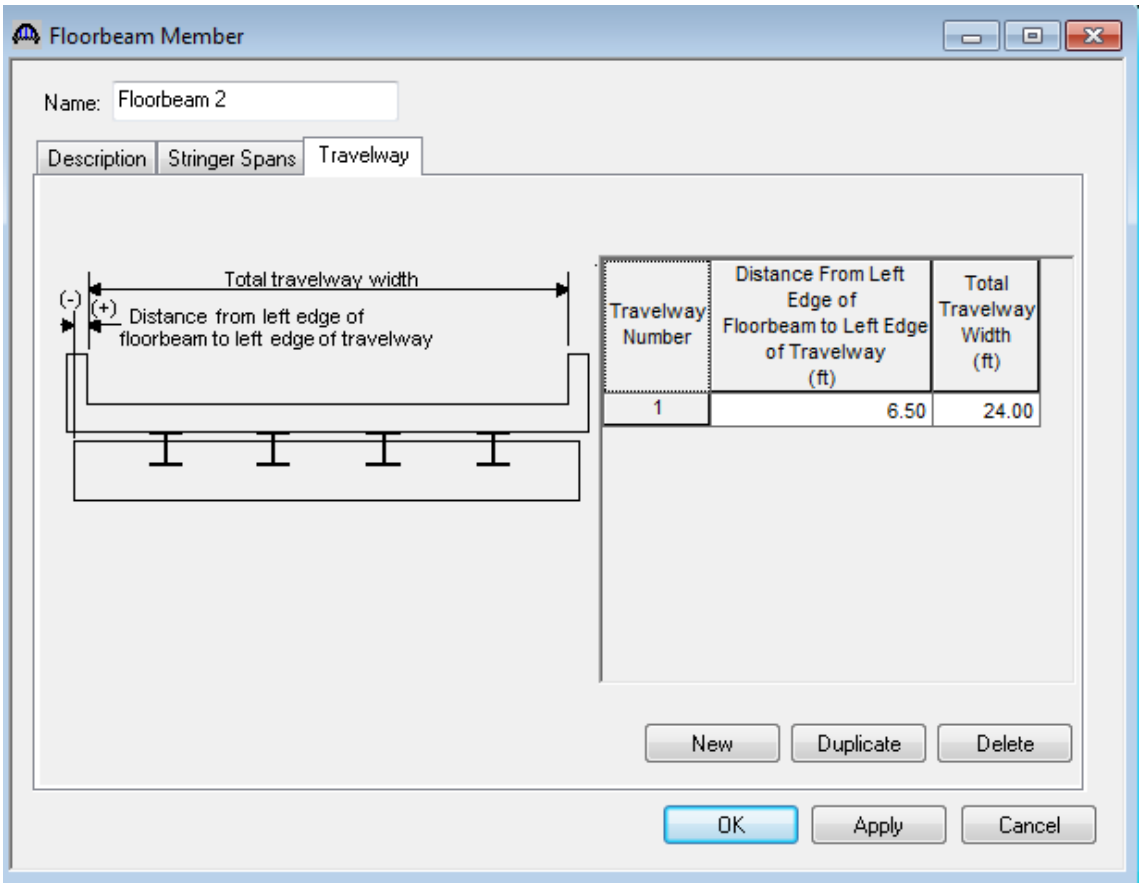


For our example, the stringer support types are all Simple. Lastly, check the floorbeam member that we are describing in the grid.

The completed Stringer Spans tab is shown below.



The last tab is the Travelway tab where you can define the following lane positions for loading the floorbeam.



Since this floorbeam member is being described using the Line approach, the dead loads from the stringers acting on the floorbeam must be entered. We will describe the deck slab acting on the floorbeam when we describe the floorbeam member alternative so the dead load due to the deck slab will not be input as a load on the floorbeam. It will be computed by the system when the member alternative is exported to the analysis engine.

The stringer dead loads acting on the floorbeam can be input as either a uniform load acting over the length of the floorbeam or as concentrated loads acting at the stringer locations. This example is inputting these loads as concentrated loads at the stringer locations.

The following shows how the interior stringer DC1 dead loads are computed. The hand calculations for determining these loads are found at the beginning of this example problem.

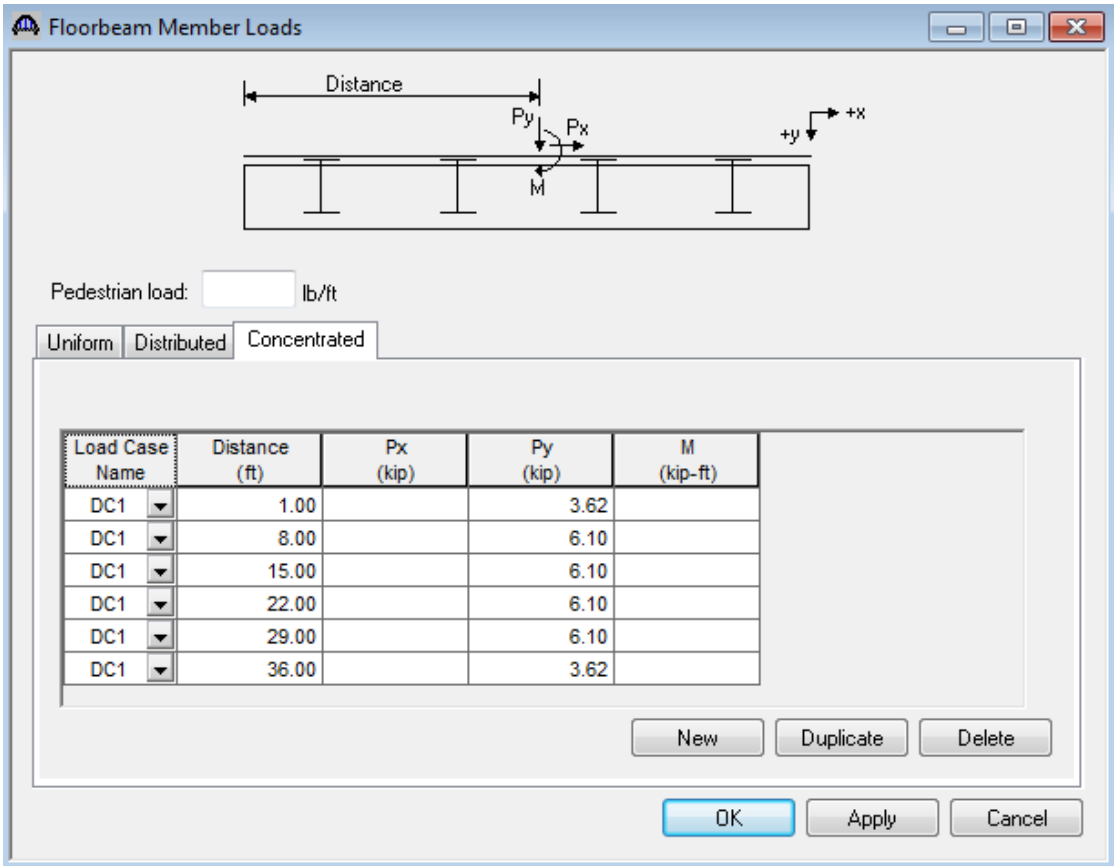
Interior Stringer DC1 Load on Floorbeam

Component	Load (lb/ft)
Selfweight	117
Haunch	13.3
Diaphragms	5.27
Total =	135.57

The reaction on the floorbeam due to the stringer load is computed as follows:

$$R = \frac{(135.57lb/\ ft) * 45'}{2} = 3050lb = 3.05kips$$

Since the floorbeam is supporting 2 sets of stringers, the total reaction on the floorbeam for an interior stringer is 6.10 kips. This load is applied as a concentrated load on the floorbeam at the stringer location. The same type of procedure is followed to determine the dead load reaction on the floorbeam for the exterior stringers.

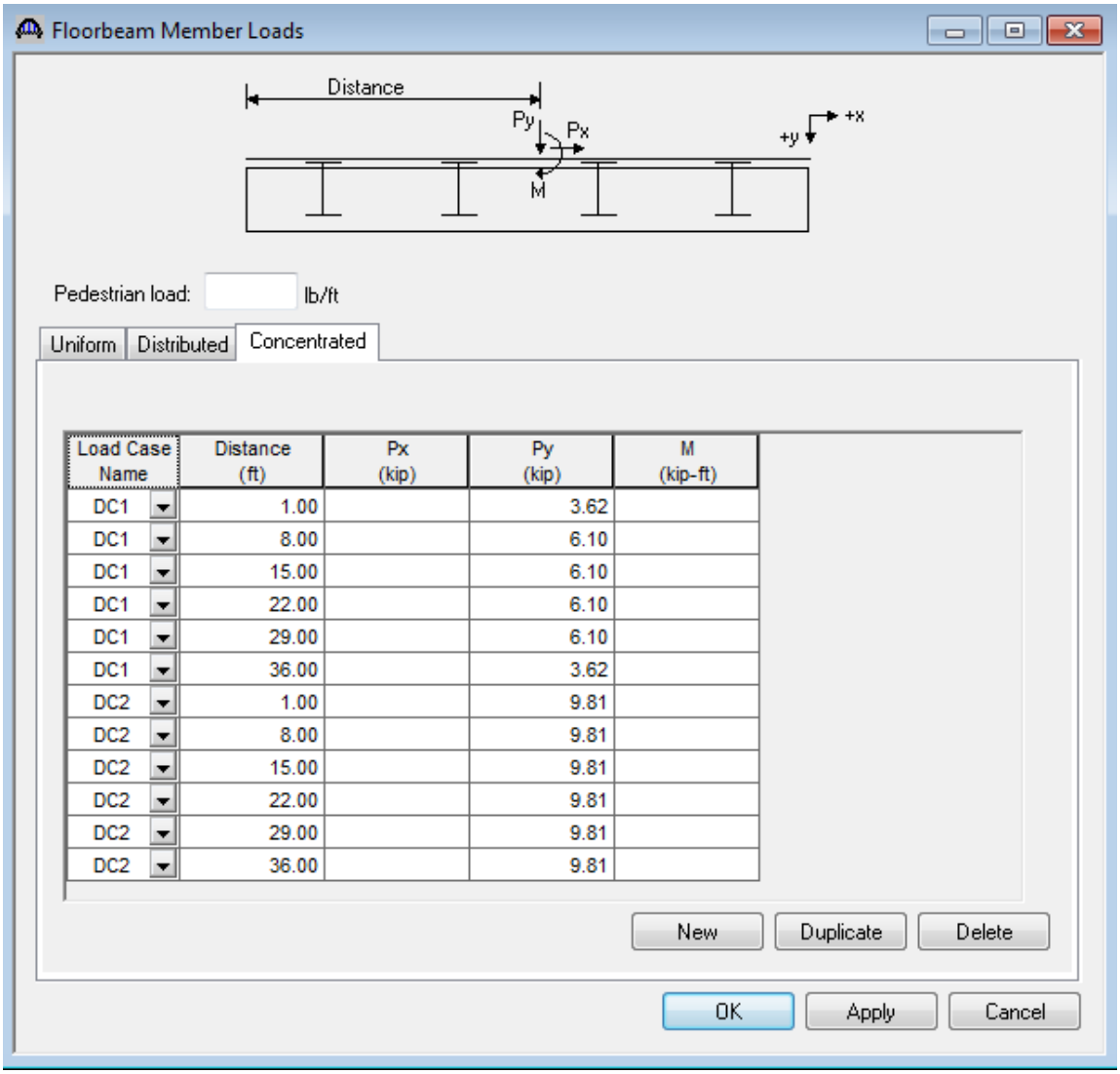


The DC2 dead load on the floorbeam is the load due to the appurtenances. This load is also applied to the floorbeam as concentrated loads at the stringer locations.

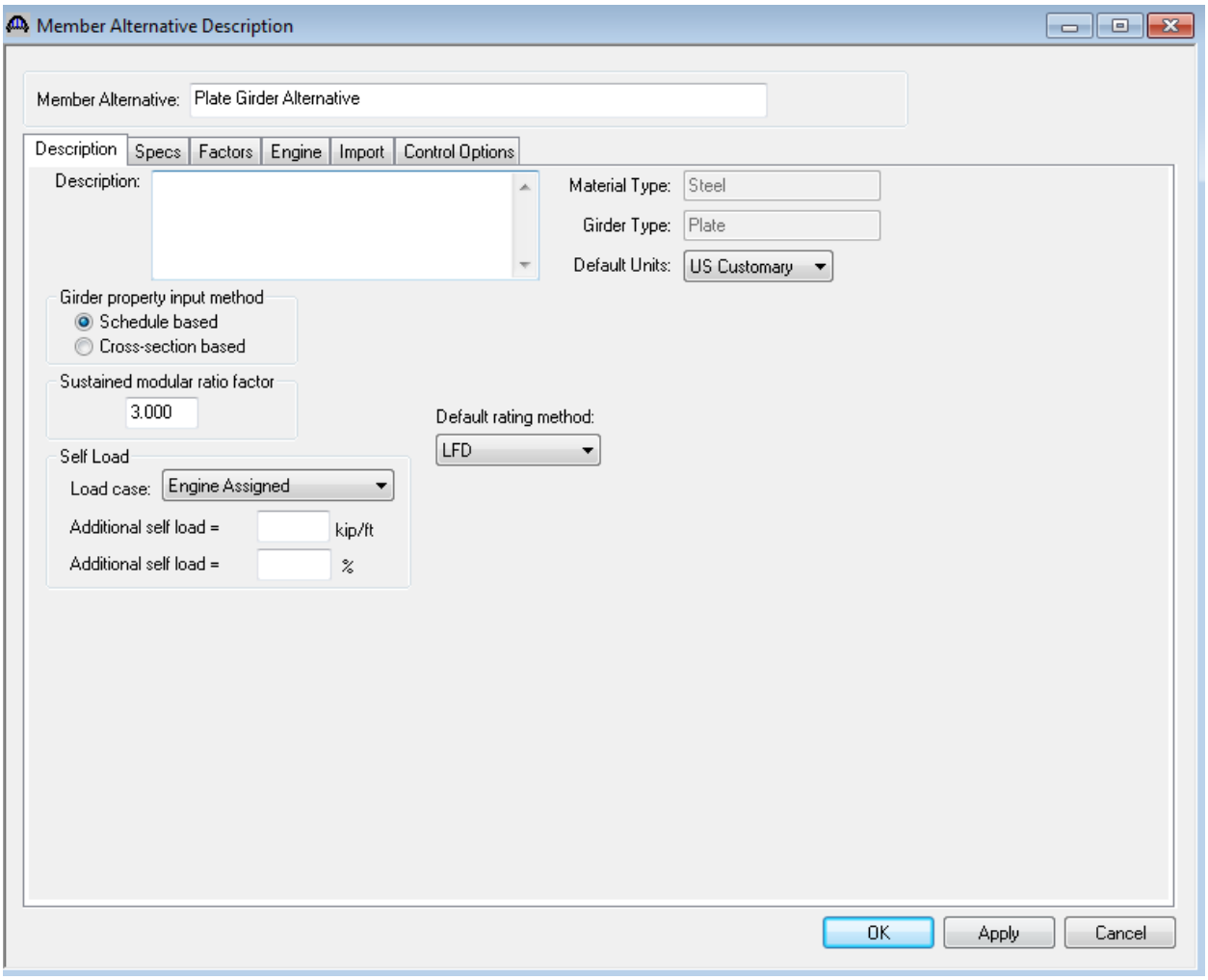
$$\text{Uniform dead load on each stringer} = \frac{2(150\ \text{lb/ft}) + 2(505\ \text{lb/ft})}{6\ \text{stringers}} = 218\ \text{lb/ft}$$

$$\text{Concentrated load on the floorbeam} = (218\ \text{lb/ft})\ \frac{45'}{2} = 4905lb = 4.905kips$$

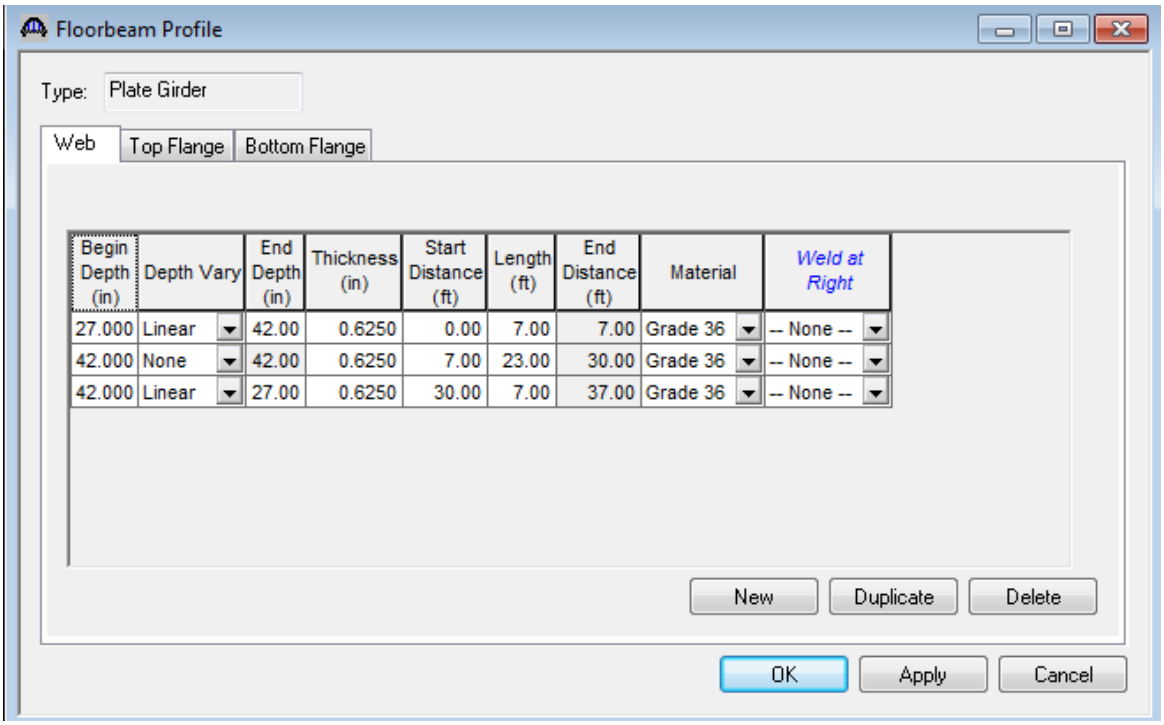
Since the floorbeam is supporting 2 sets of stringers, the total reaction due to the appurtenances on the floorbeam for a stringer is 9.81 kips.

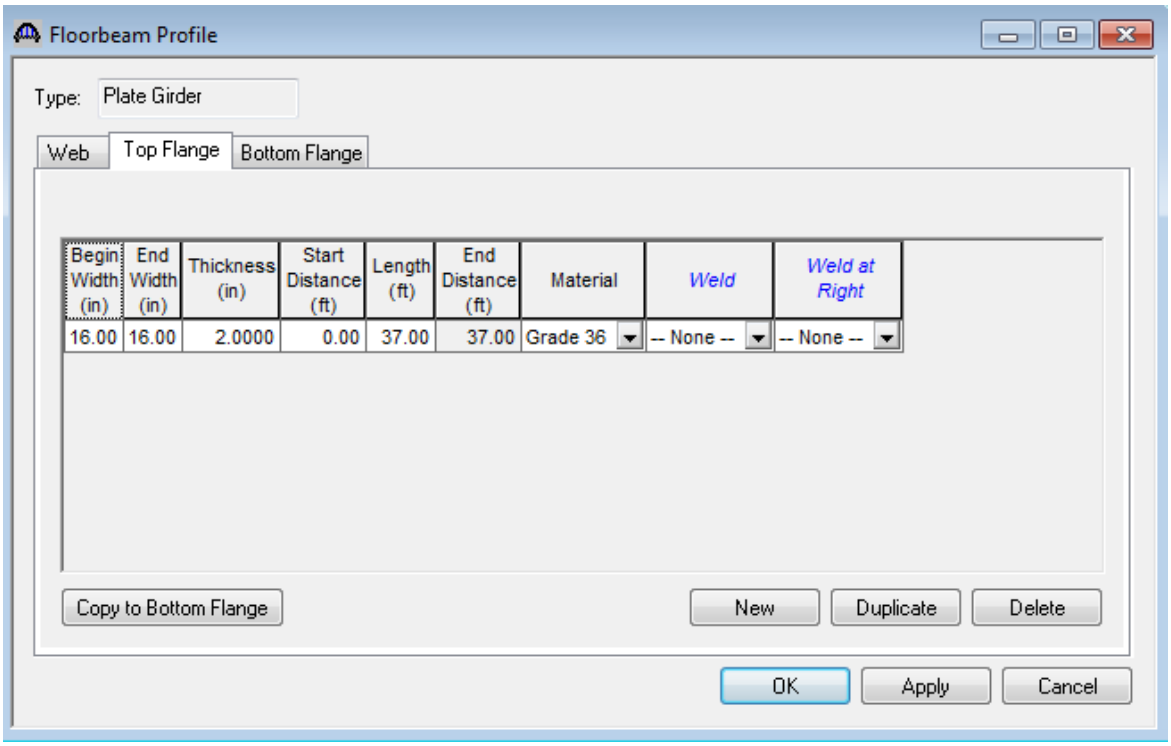


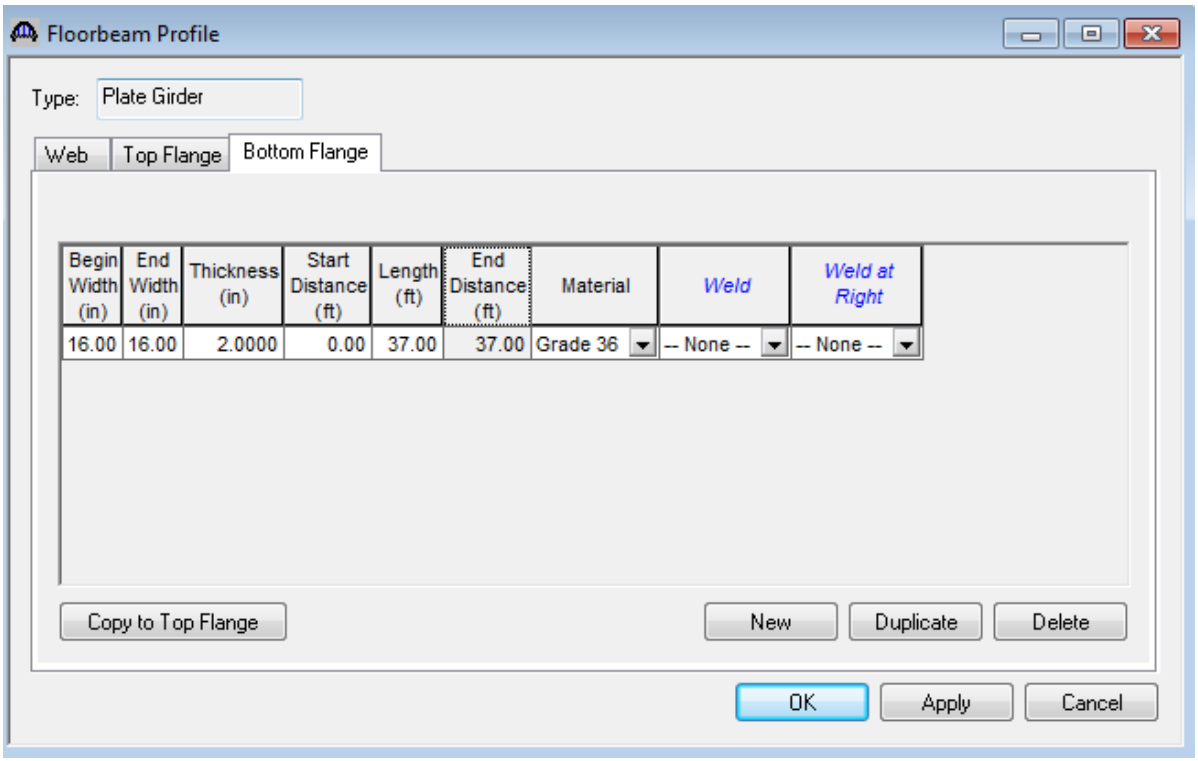
Now create a schedule based steel plate girder Floorbeam Member Alternative with the following description.



Describe the floorbeam profile with the following data.

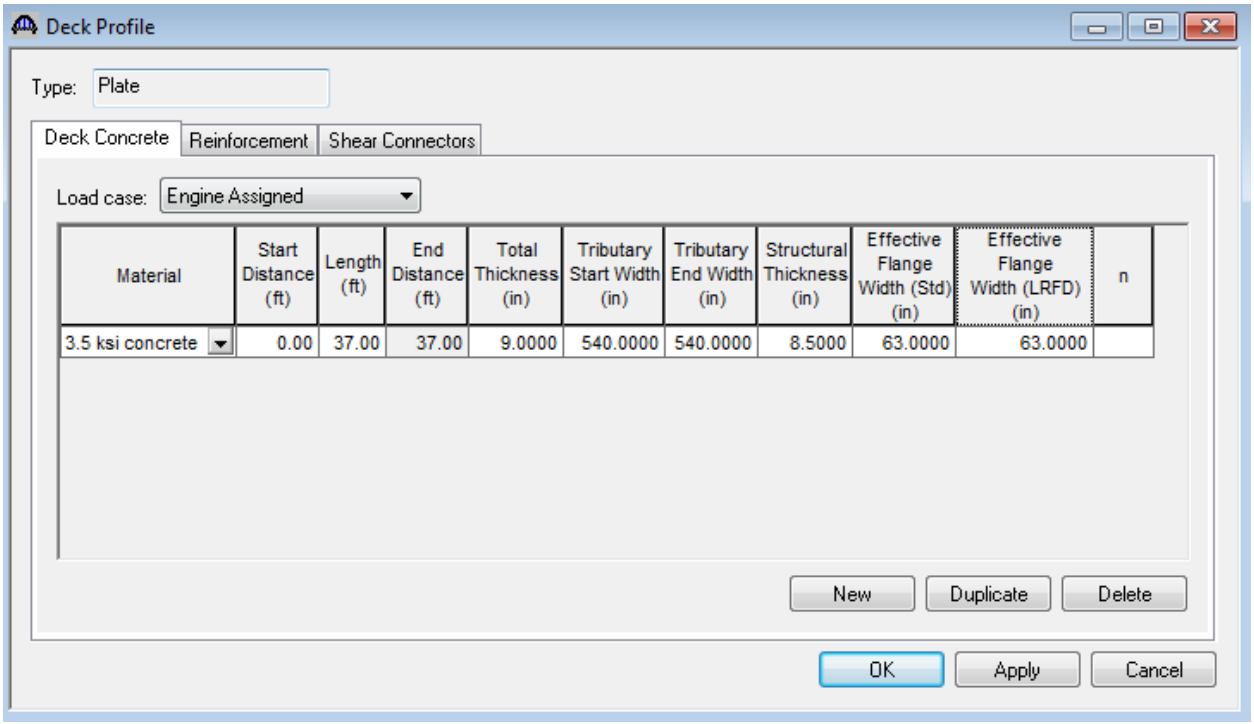


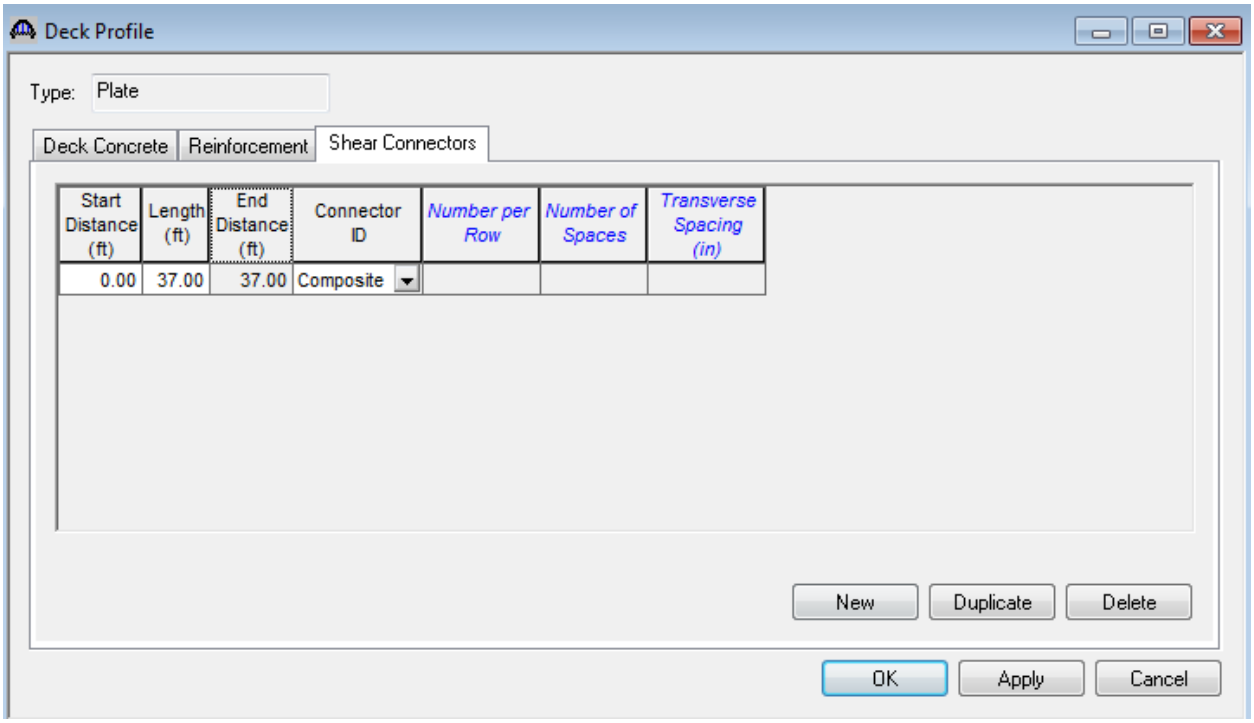



Floorbeam Profile
Type:
Plate Girder
Web
Top Flange
Bottom Flange
Begin Width (in)
End Width (in)
Thickness (in)
Start Distance (ft)
Length (ft)
End Distance (ft)
Material
Weld
Weld at Right
16.00
16.00
2.0000
0.00
37.00
37.00
Grade 36
-- None --
-- None --
Copy to Top Flange
New
Duplicate
Delete
OK
Apply
Cancel

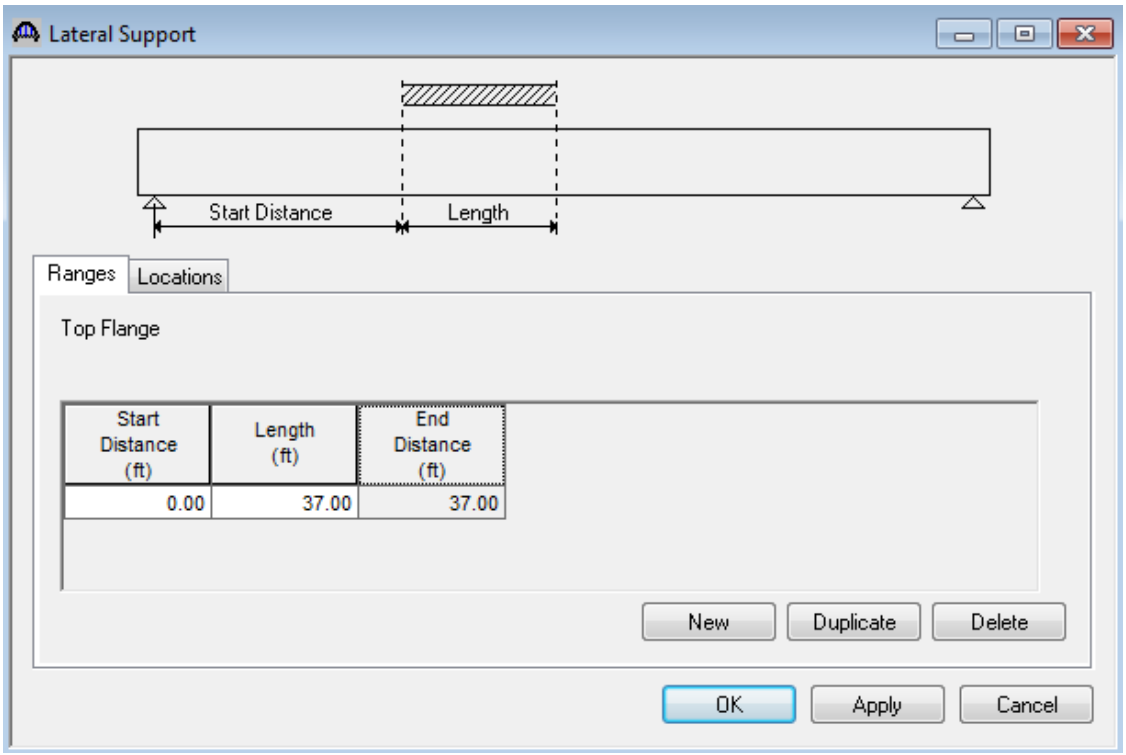
Enter the following data for the deck profile. The floorbeam spacing is entered as the tributary width of the deck so the export can compute the dead load of the deck slab.

floorbeam deck effective flange width is calculated according to AASHTO Article 10.38.3, the effective flange width shall not exceed one-fourth of the span length of the floorbeam, 21'/4 = 63", the distance center to center of floorbeams, 45', and twelve times the least thickness of the slab, 12x9" = 108". One-fourth of the span length of the floorbeam, 63" controls.



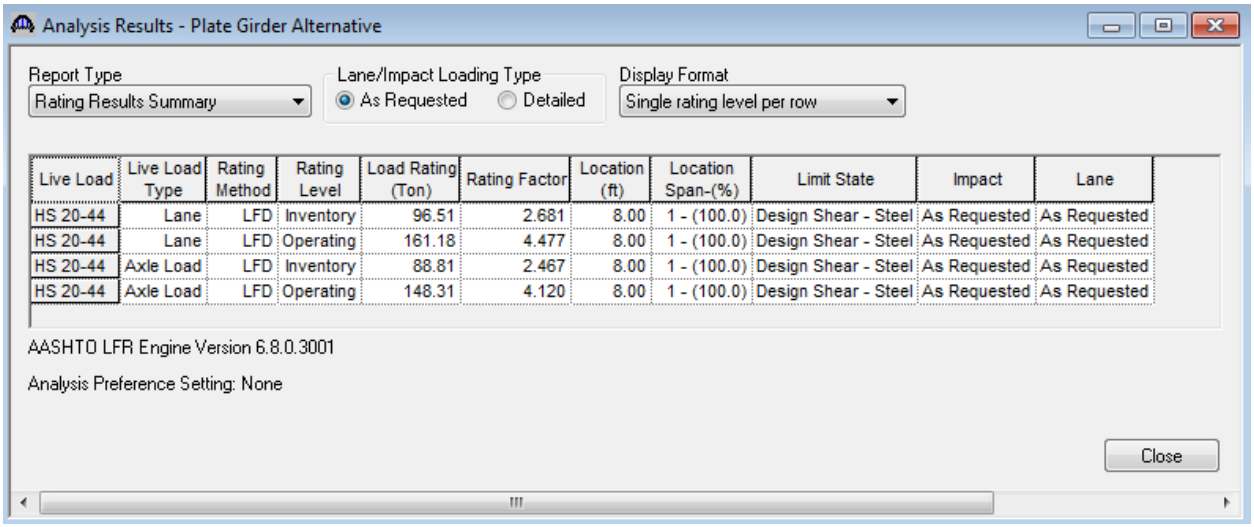


Define the lateral support for the top flange of the floorbeam as follows:



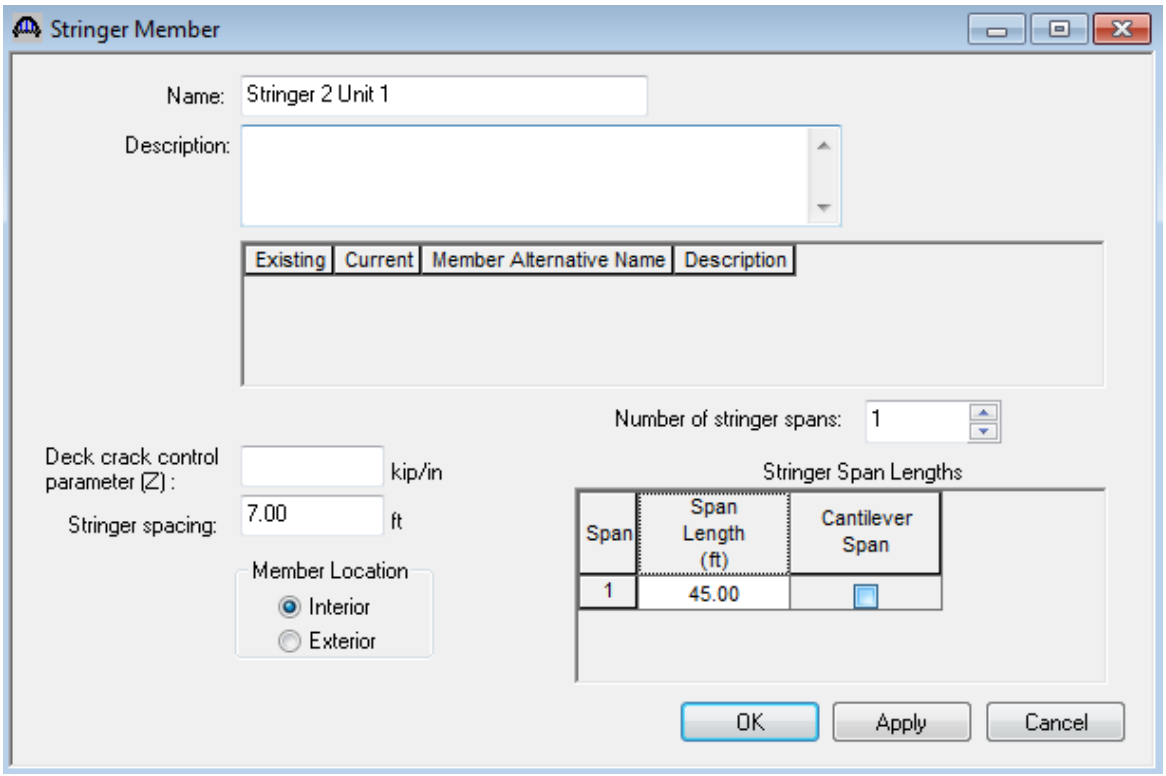
The description of the floorbeam member alternative is complete.

A rating for the HS20 vehicle produces the following results:

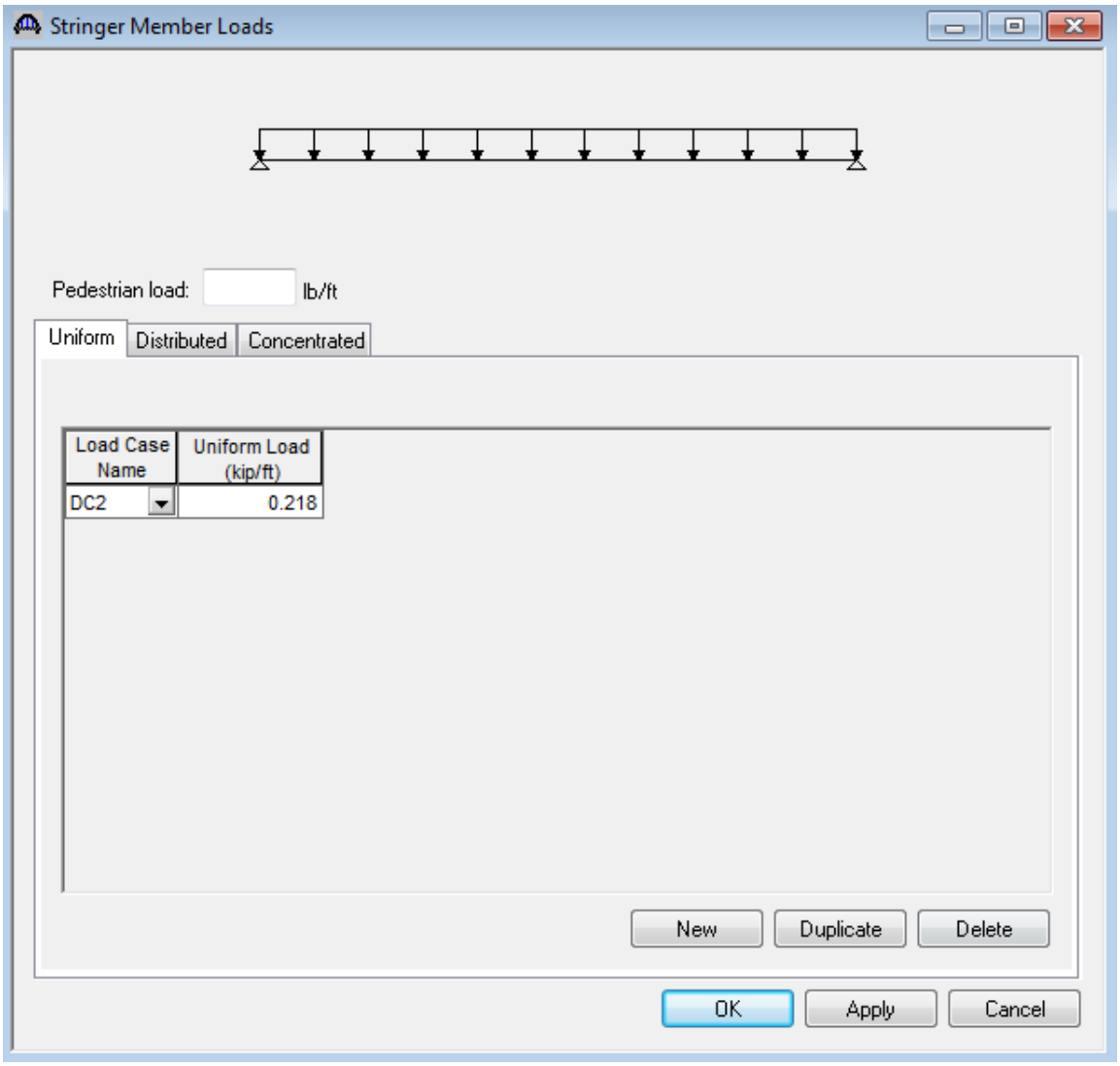


Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 20-44	Lane	LFD	Inventory	96.51	2.681	8.00	1 - (100.0)	Design Shear - Steel	As Requested	As Requested
HS 20-44	Lane	LFD	Operating	161.18	4.477	8.00	1 - (100.0)	Design Shear - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFD	Inventory	88.81	2.467	8.00	1 - (100.0)	Design Shear - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operating	148.31	4.120	8.00	1 - (100.0)	Design Shear - Steel	As Requested	As Requested

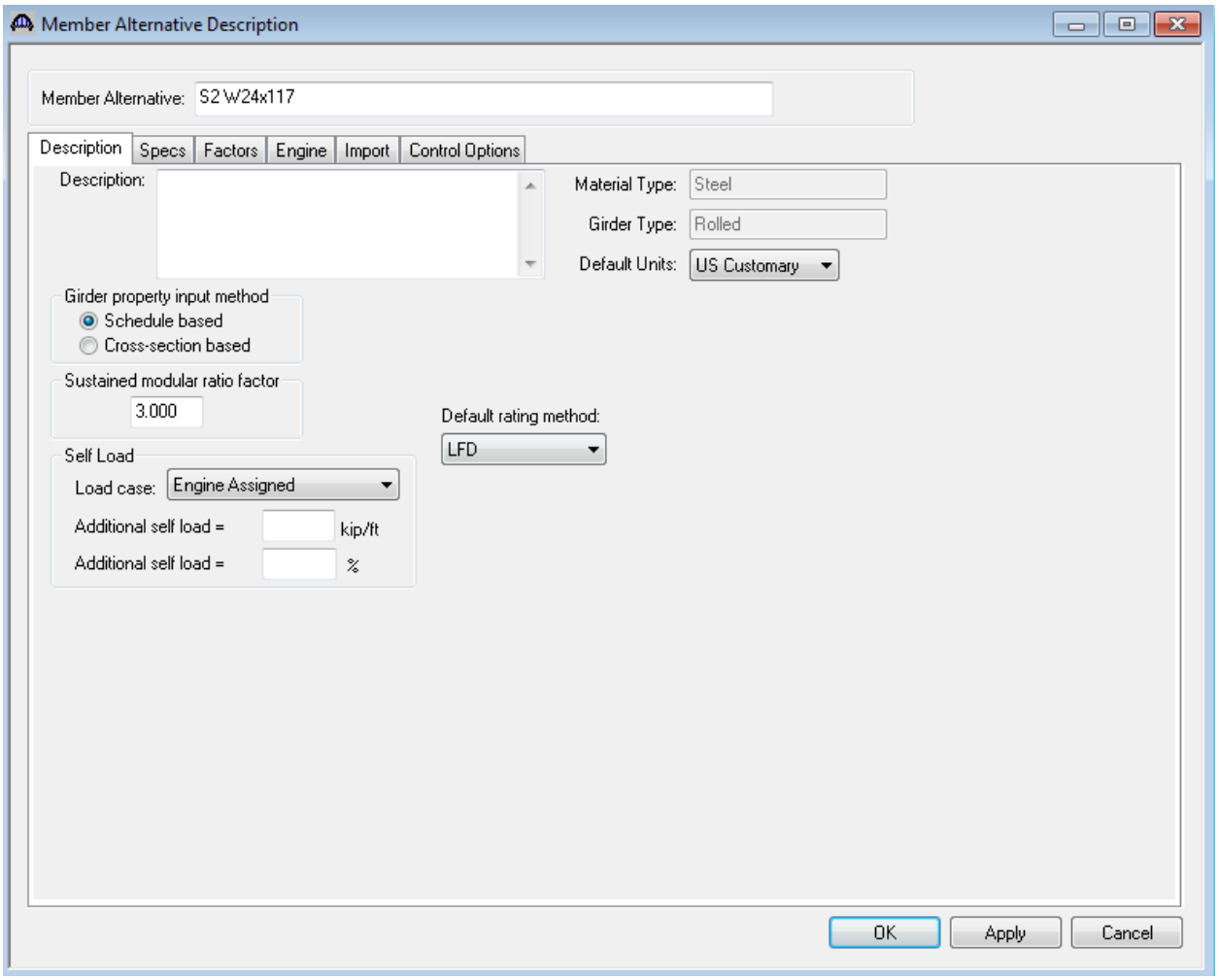
Now we will create one of the interior stringer members. Enter the following data for the stringer member.



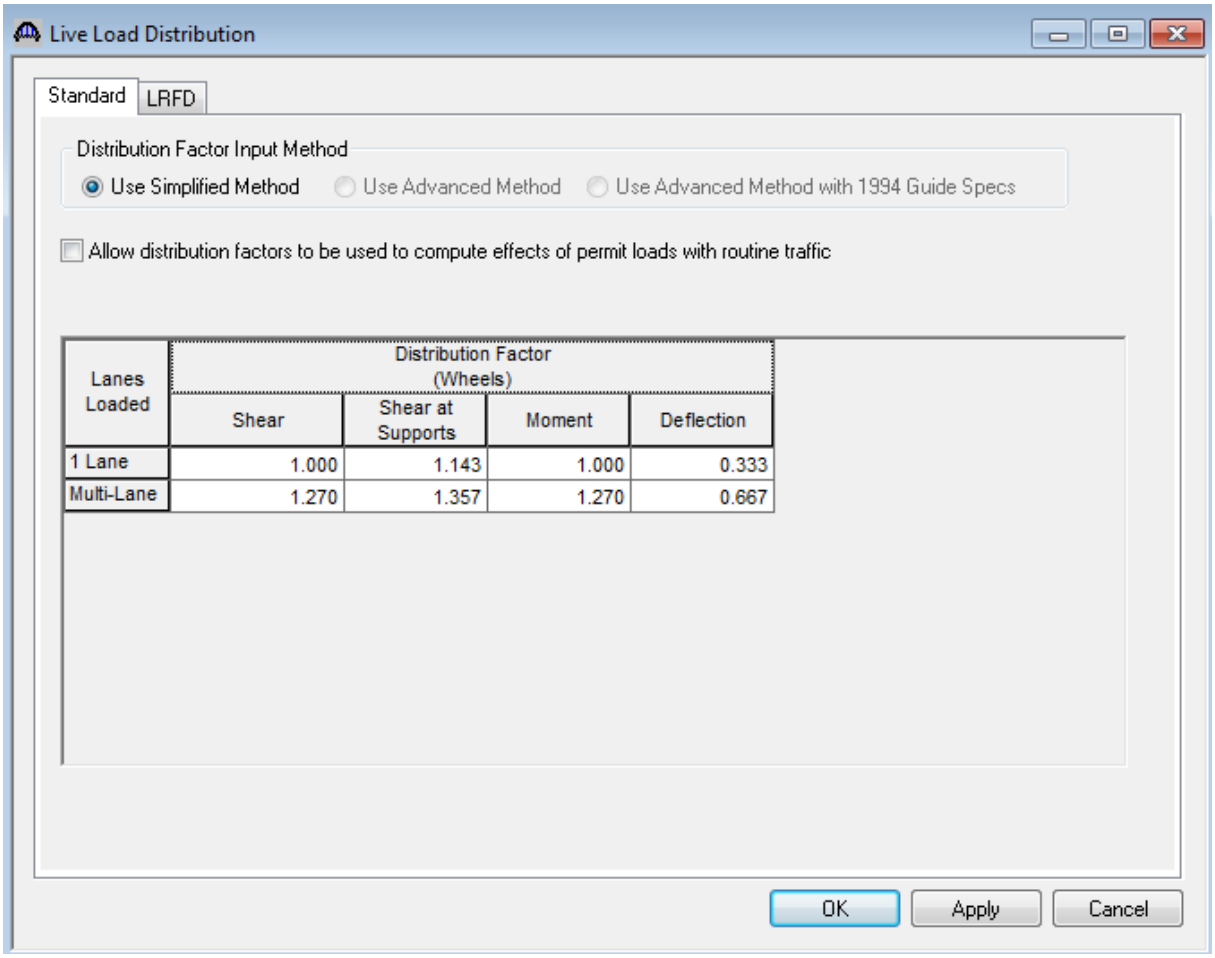
Add the following member load to the stringer for the weight of the appurtenances.



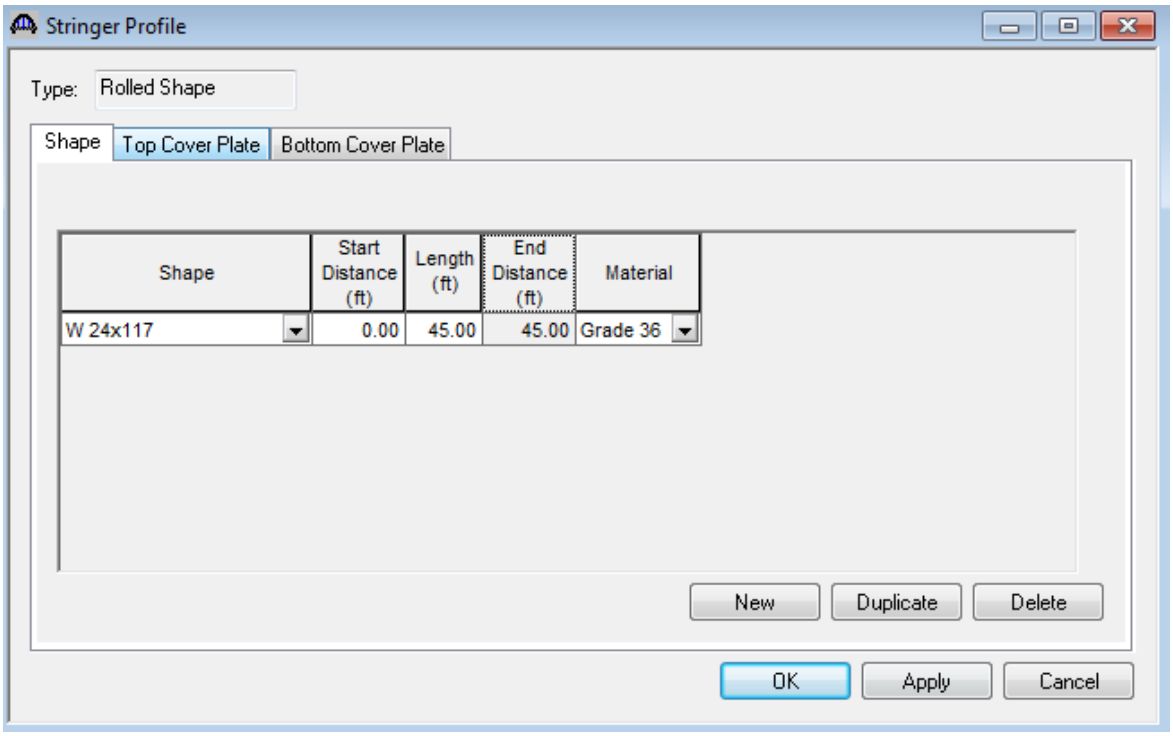
Create a schedule based rolled beam alternative for this stringer member.



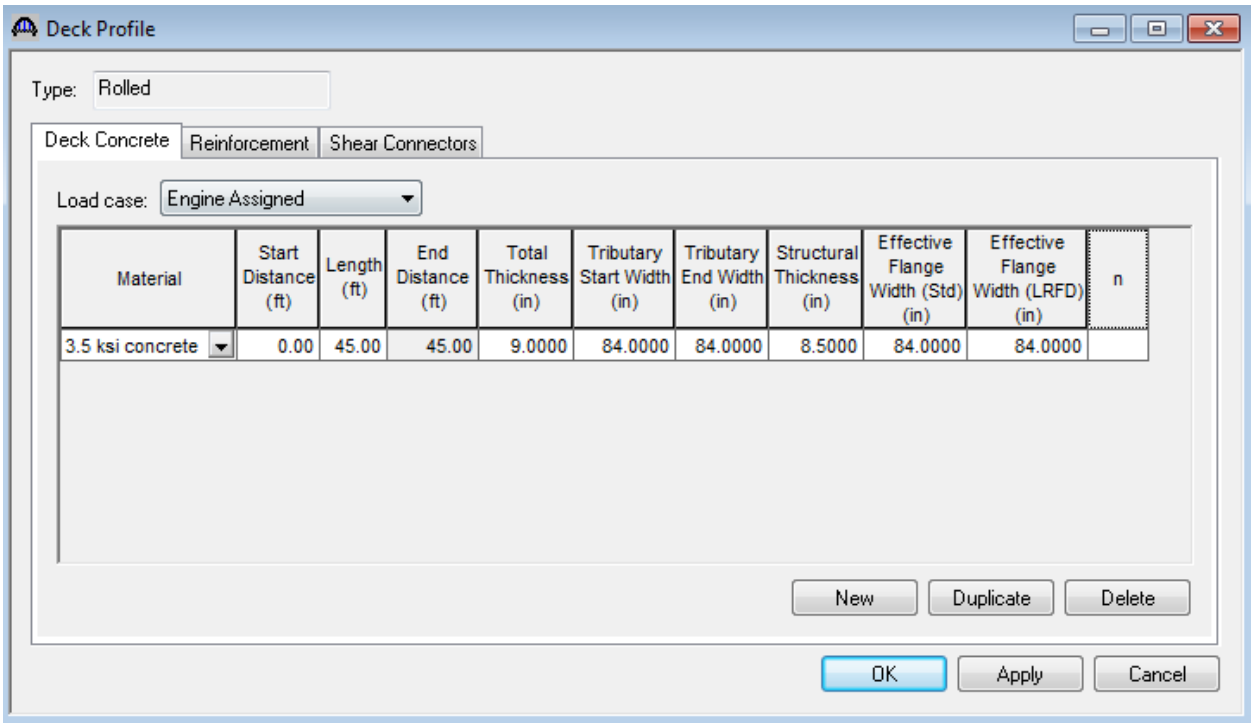
Enter the live load distribution factors as follows.



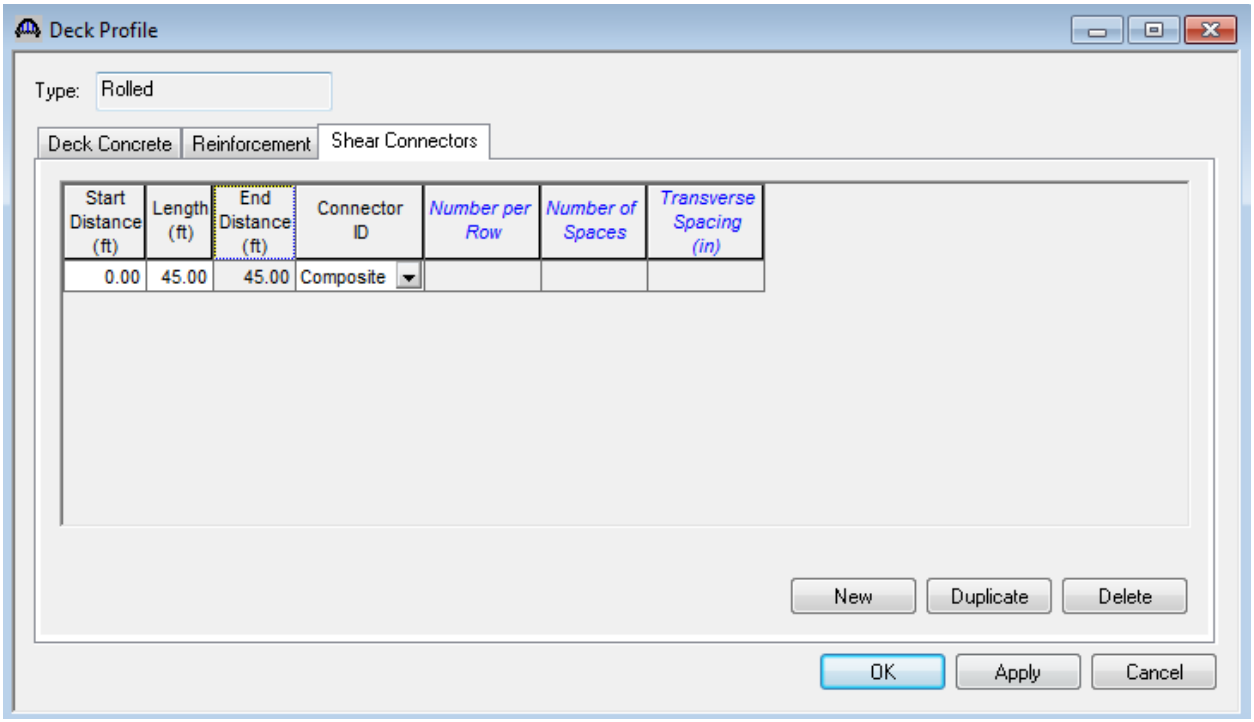
Define the Stringer Profile as follows:



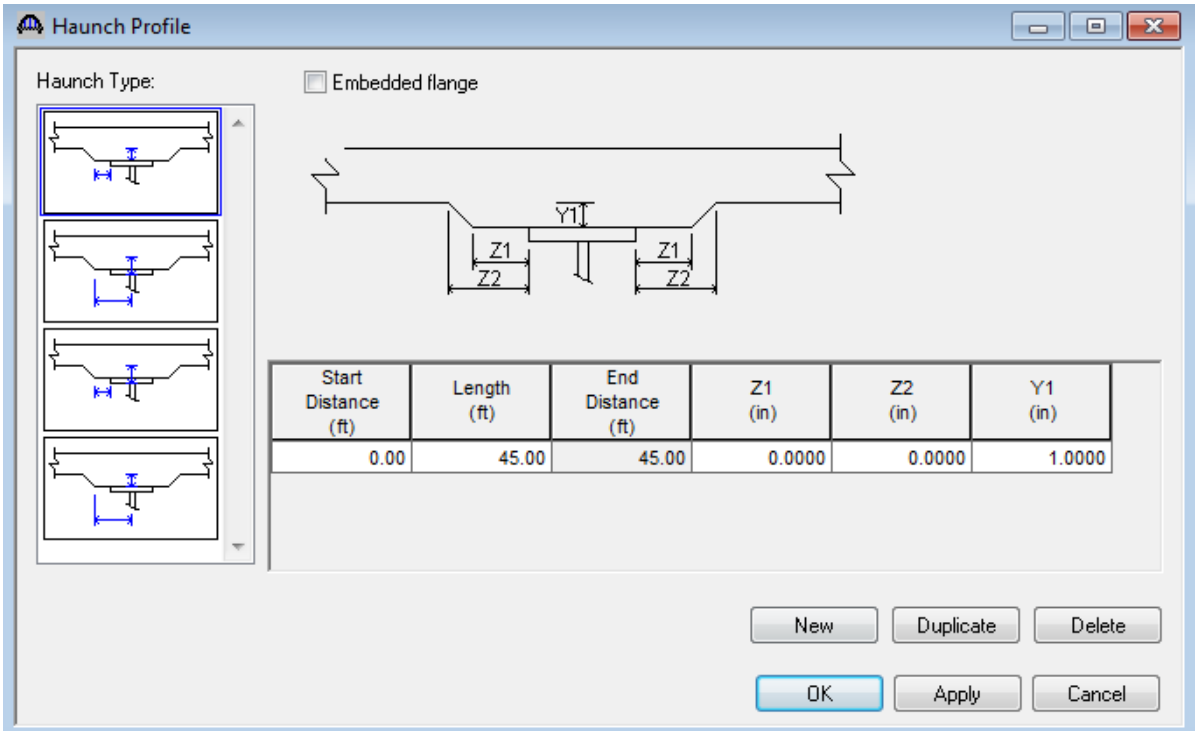
Define the Deck Profile as follows:



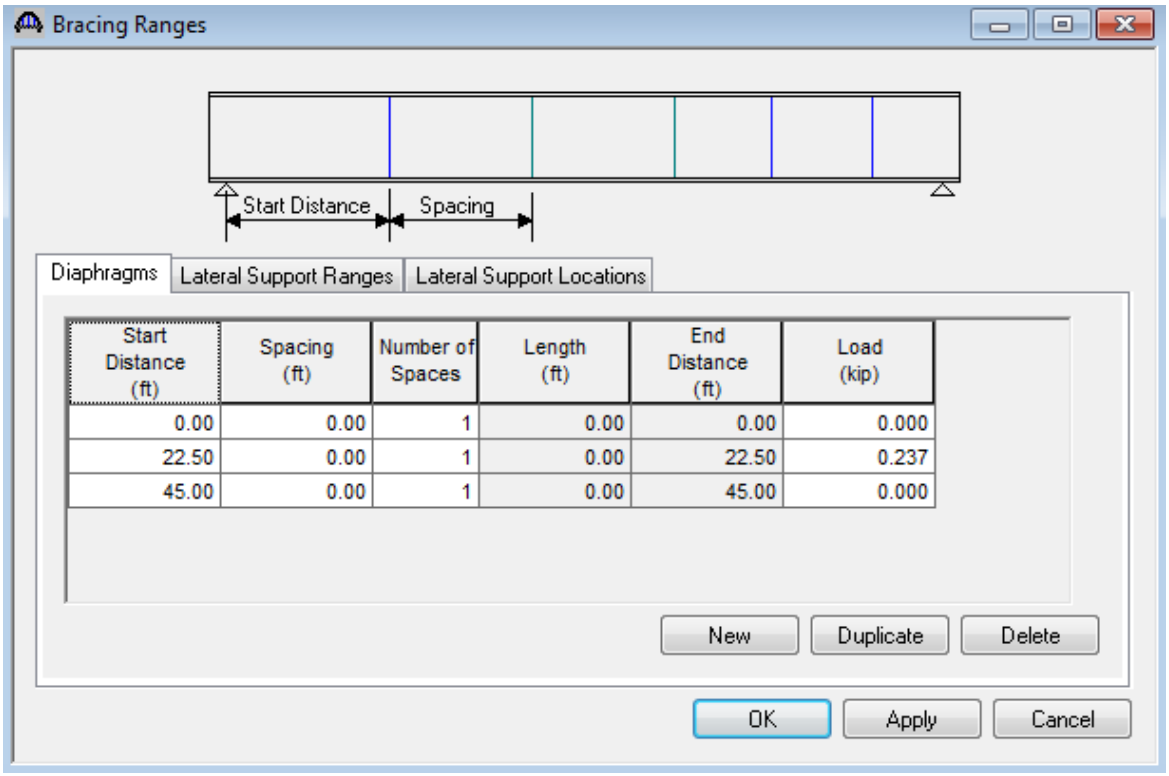
Interior stringer deck effective flange width is calculated according to AASHTO Article 10.38.3, the effective flange width shall not exceed one-fourth of the span length of the stringer, 45'/4 = 11.25' = 135", the distance center to center of stringers, 7' = 84", and twelve times the least thickness of the slab, 12x9" = 108". The distance center to center of stringers, 84" controls.



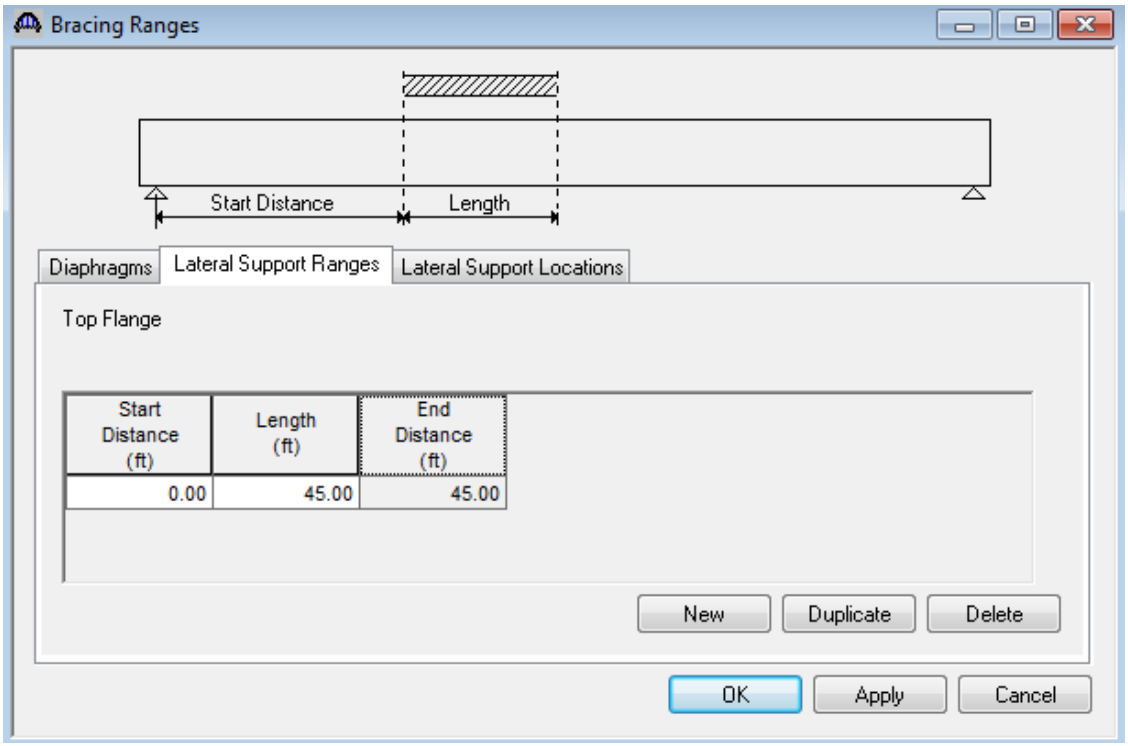
Enter the haunch profile as follows:



22Now specify the brace points for the stringer. Specify a brace point at the beginning and end of the stringer where the stringer frames into the floorbeams. Specify the load as 0 kips since there really is not a diaphragm at those locations.



Describe the lateral support for the top flange of the stringer as follows.



The definition of an interior stringer member is now complete. This stringer member alternative can now be rated for an HS20 vehicle.