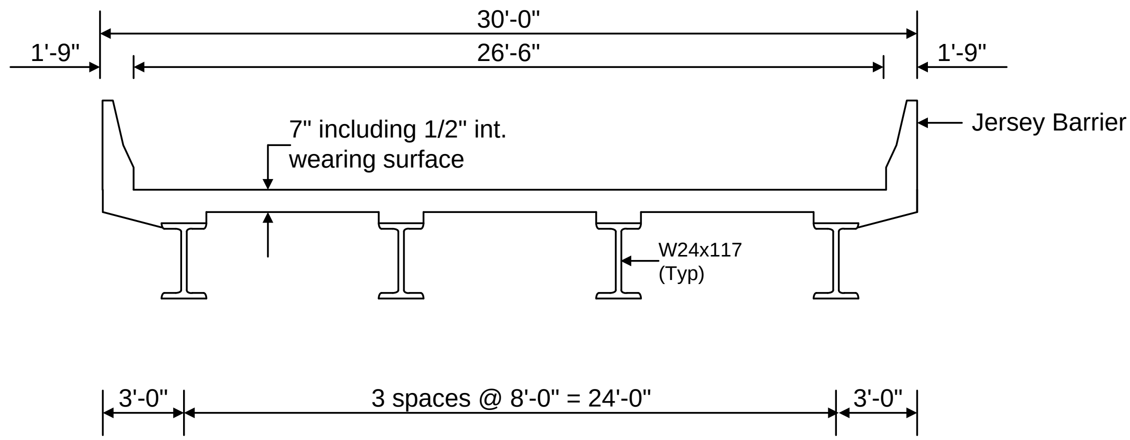
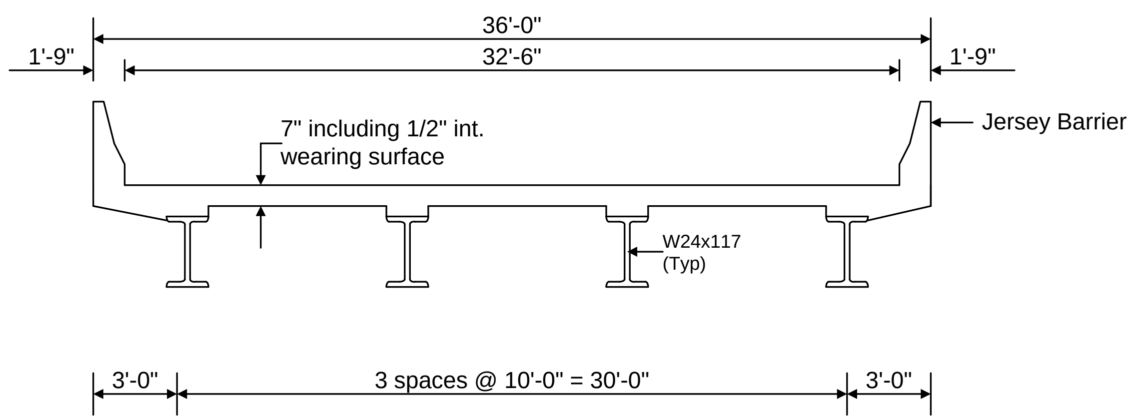
AASHTOWare BrDR 7.5.0

Feature Tutorial

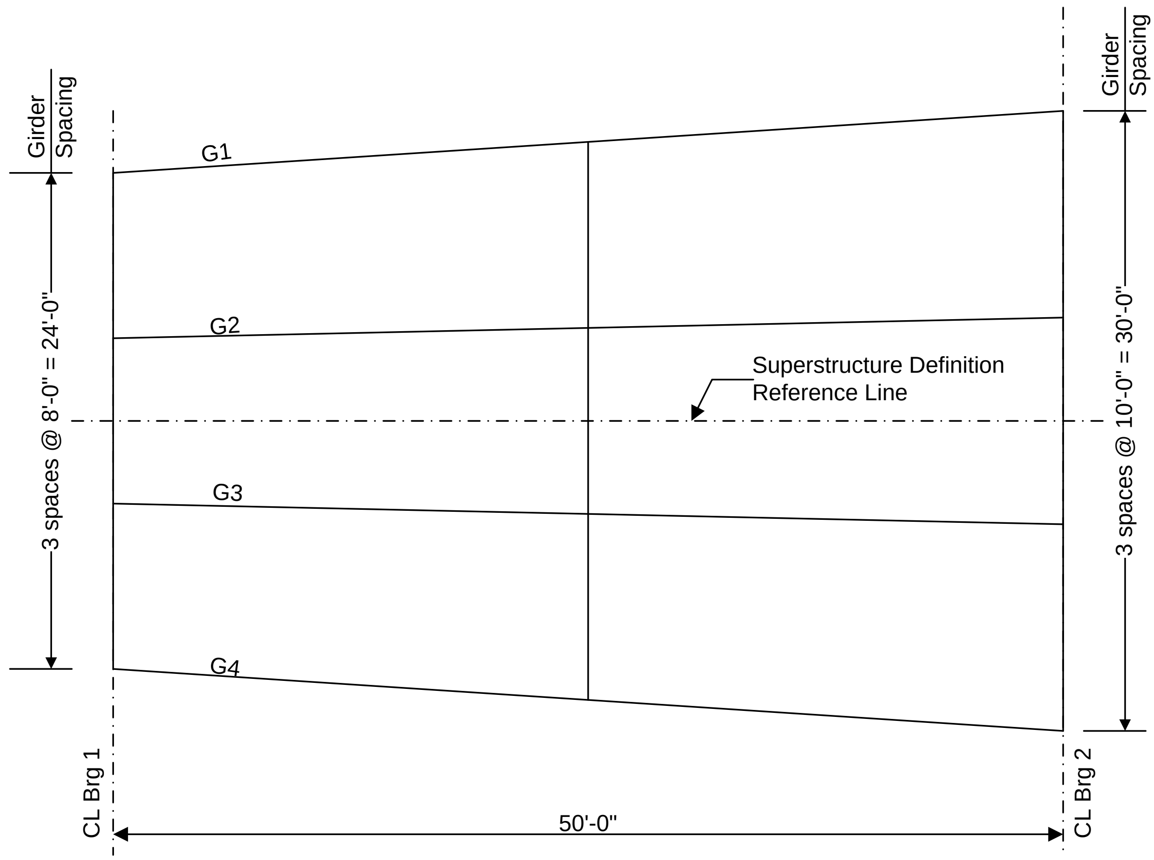
F1 – Flared Girder Example



Structure Typical Section
at Start of Structure



Structure Typical Section
at End of Structure



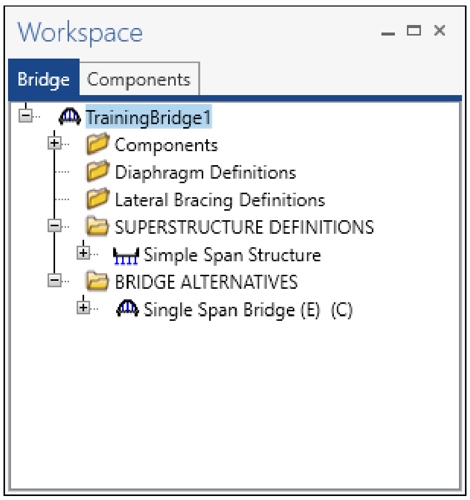
Framing Plan

This example describes entering a girder system with flared girders and performing a rating of one of the members. The term "flared girders" describes a situation where the girder spacing or deck overhang varies along the length of the superstructure. Flared girders are also sometimes called splayed girders.

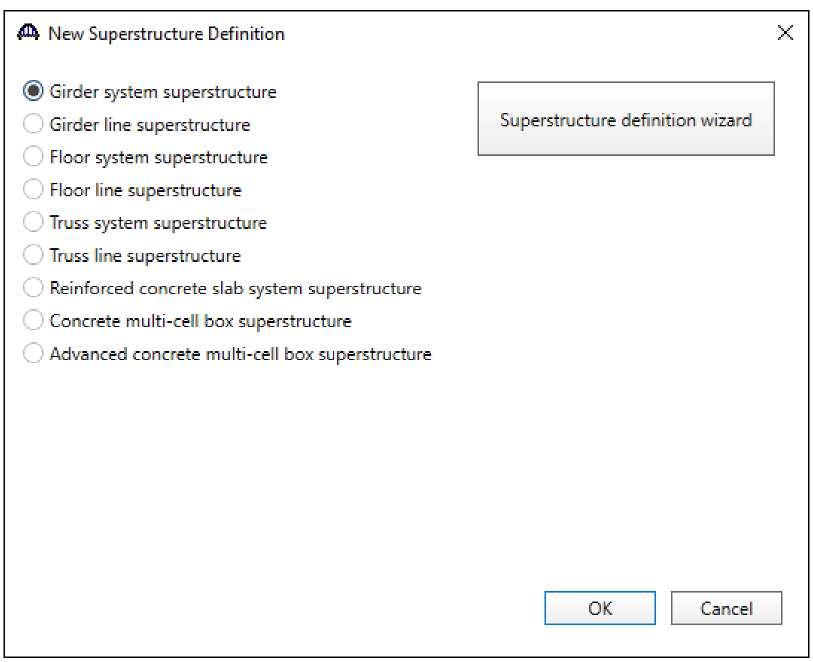
Topics covered:

- Flared girder geometry
- Std distribution factor ranges
- LFR rating

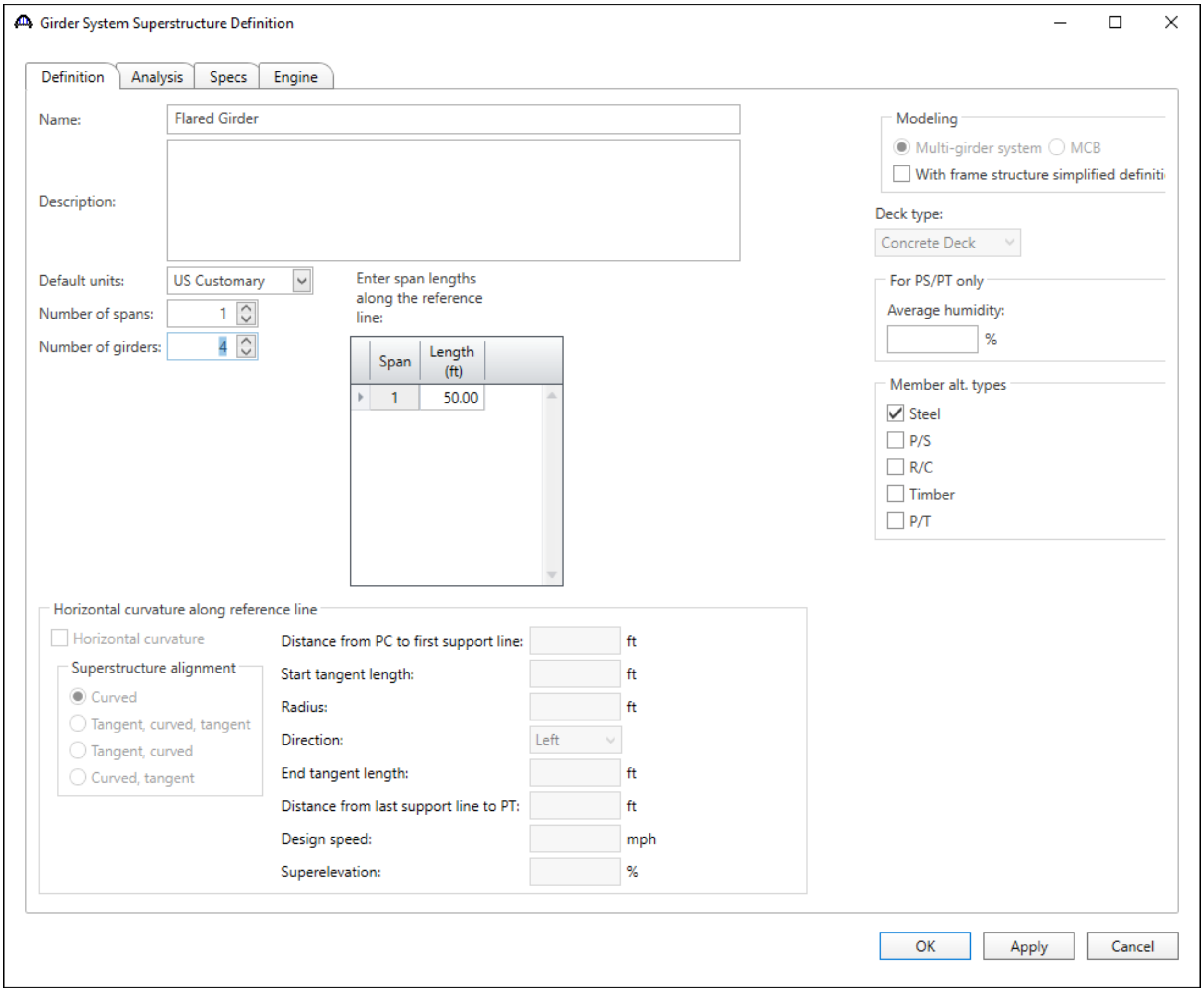
For this example, we are going to add a girder system superstructure with flared girders to **BID1 (TrainingBridge1)** in the BrDR sample database. Open the Bridge Workspace for BID1.



Double click on **SUPERSTRUCTURE DEFINITIONS**, select **Girder system superstructure**, and click **OK**.



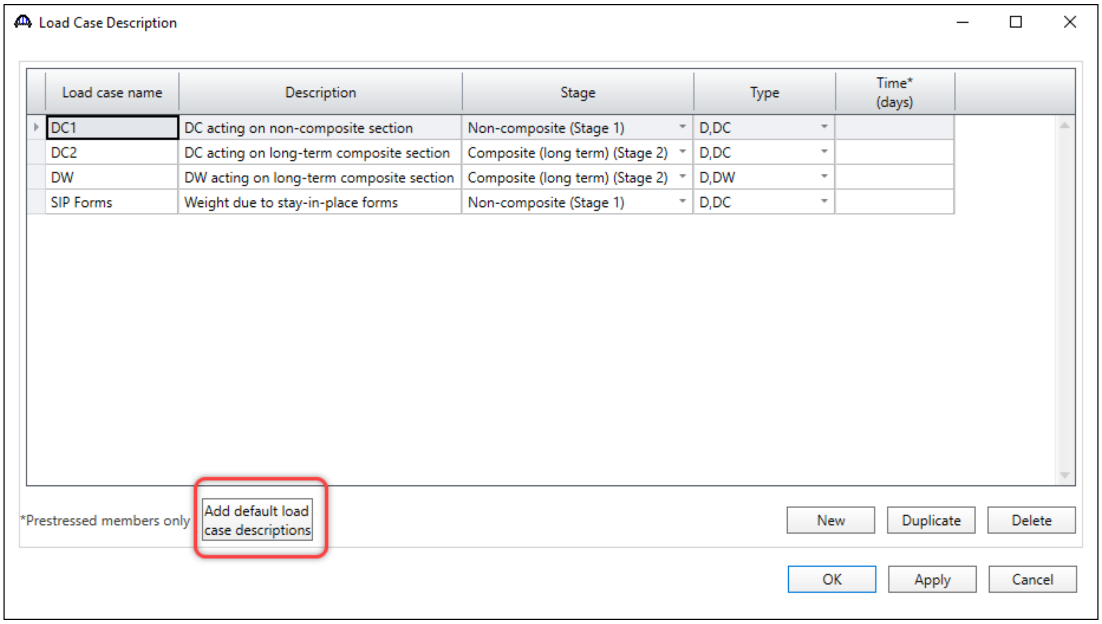
Enter the following data to describe the superstructure definition.



Note that the span length along the reference line is 50' but the actual length of each girder will be different due to the flared orientation of the girders.

Click **OK** to save the data to memory and close the window.

Open the **Load Case Description** window of the new superstructure and use the **Add default load case descriptions** button to create the following load cases.

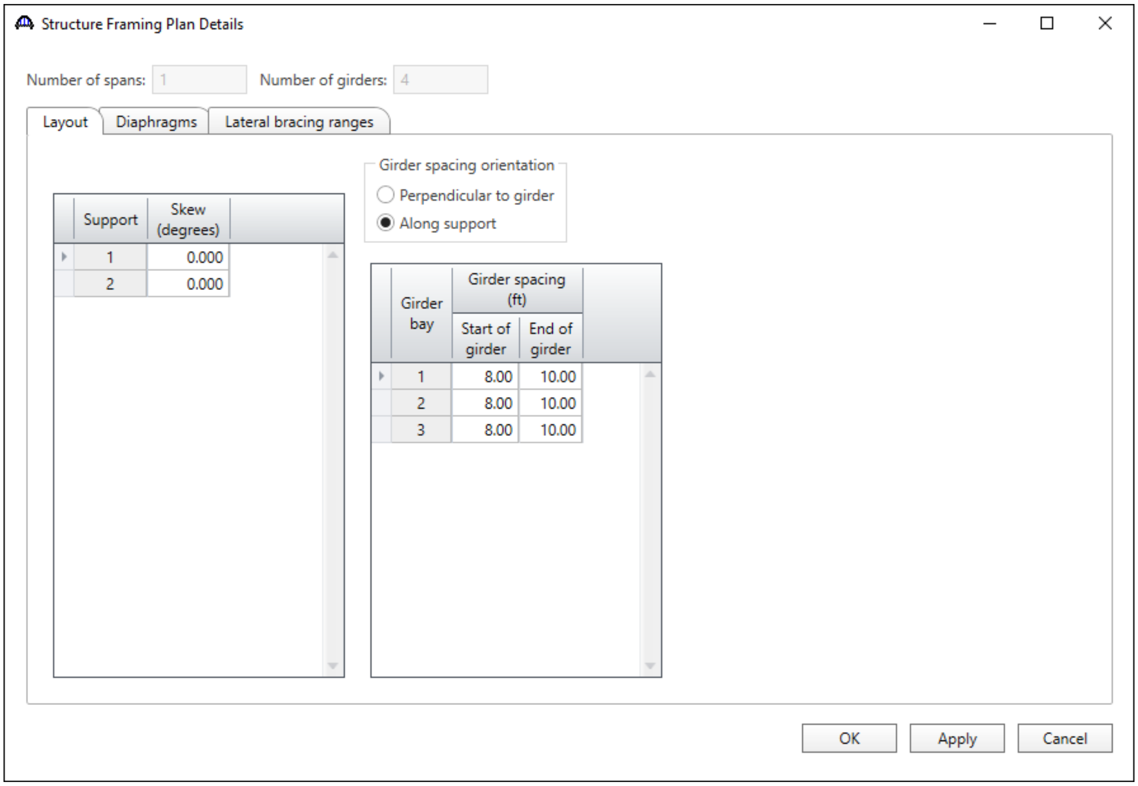


Click **OK** to save the data to memory and close the window.

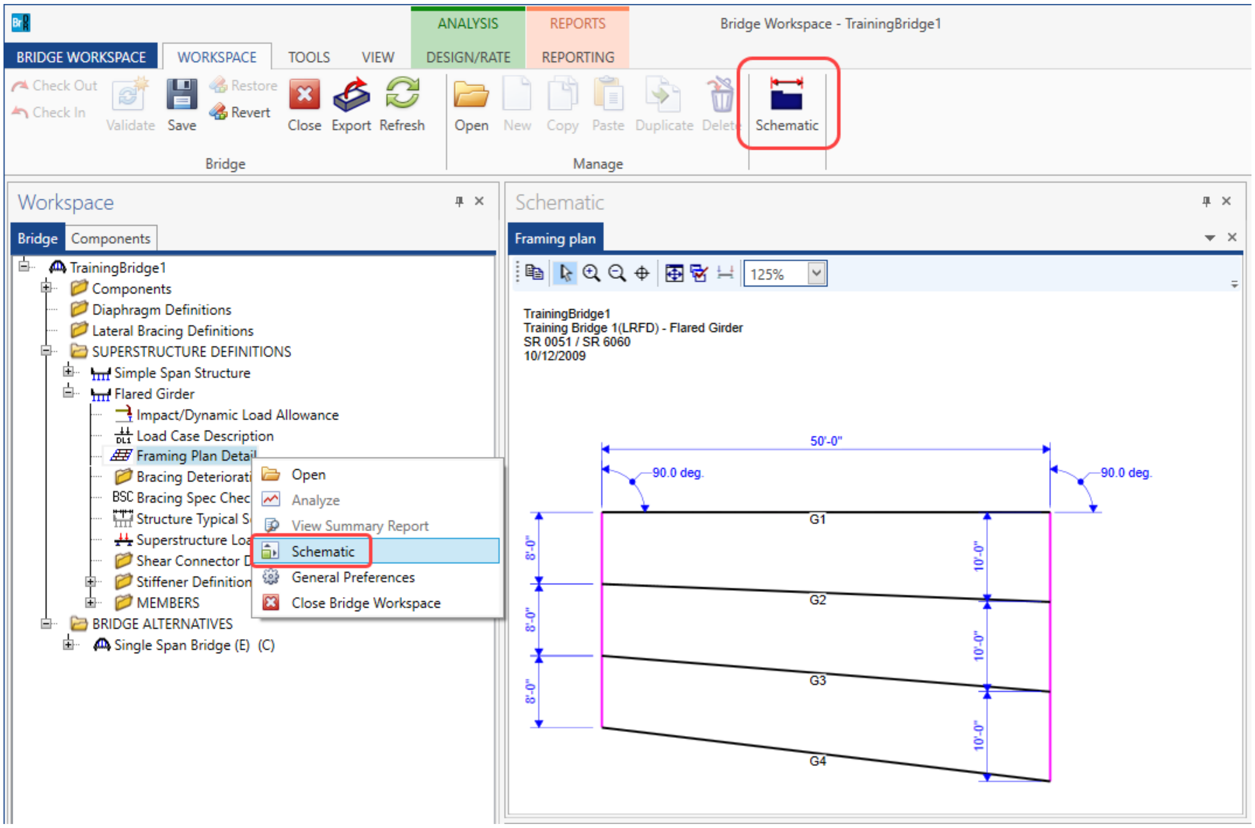
Flared girder geometry

Framing Plan Details

Open the **Framing Plan Details** window and enter the following data. You must select **Along support** as the girder spacing orientation to be able to enter the girder spacing at the end of the girder.



Click **OK** to save the data to memory and close the window, then open the **Framing Plan Schematic** by either right clicking on Framing Plan Detail and selecting **Schematic** or clicking on **Schematic** on the Workspace ribbon.

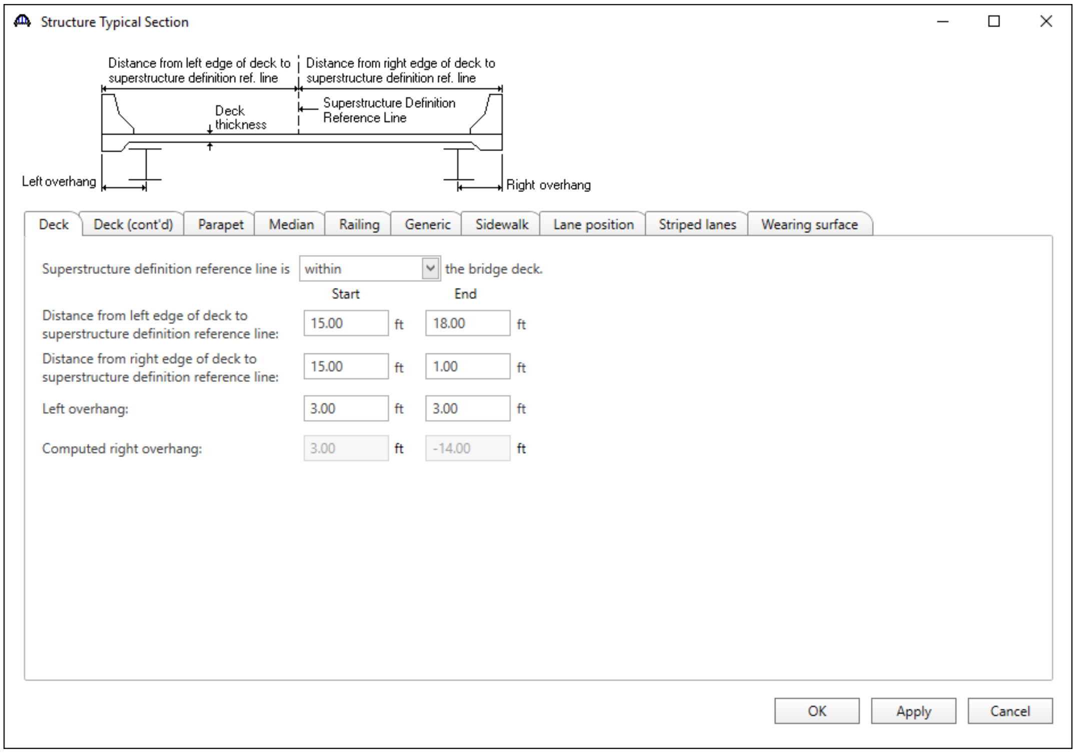


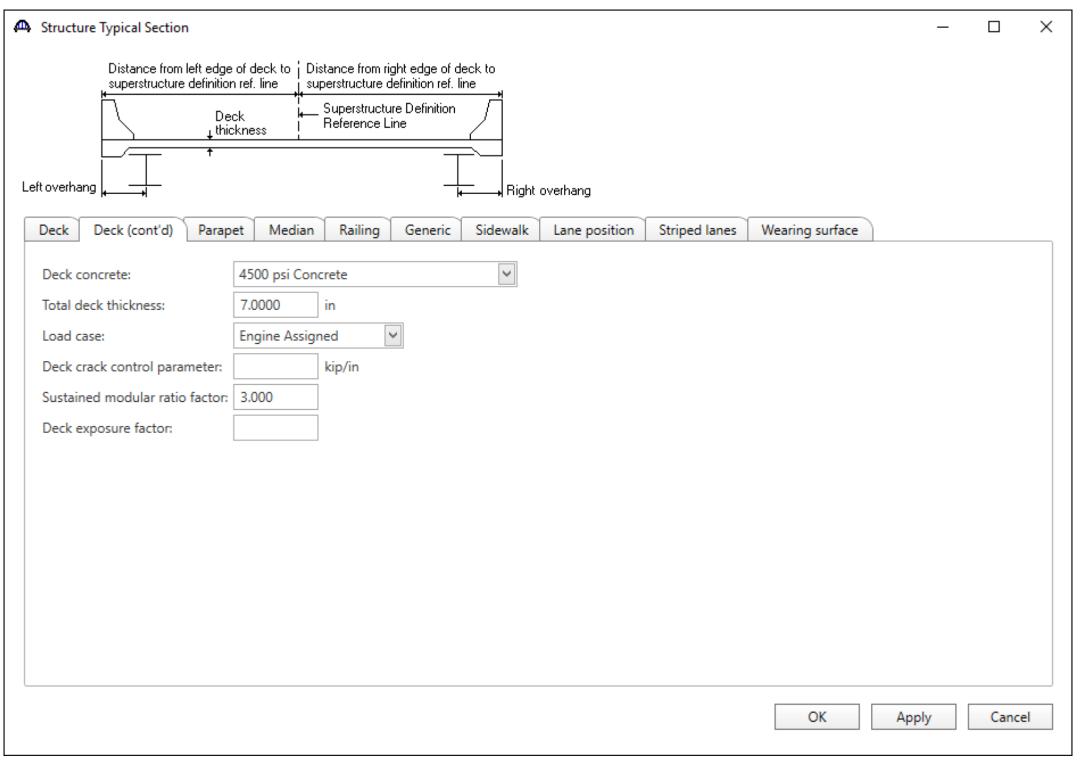
The girders are not oriented correctly until we enter their locations relative to the edge of deck in the **Structure Typical Section** window. The leftmost girder in the structure typical section will be oriented with respect to the left edge of the deck. Then the remaining girders are oriented relative to the leftmost girder according to the girder spacing entered on the **Framing Plan Details** window.

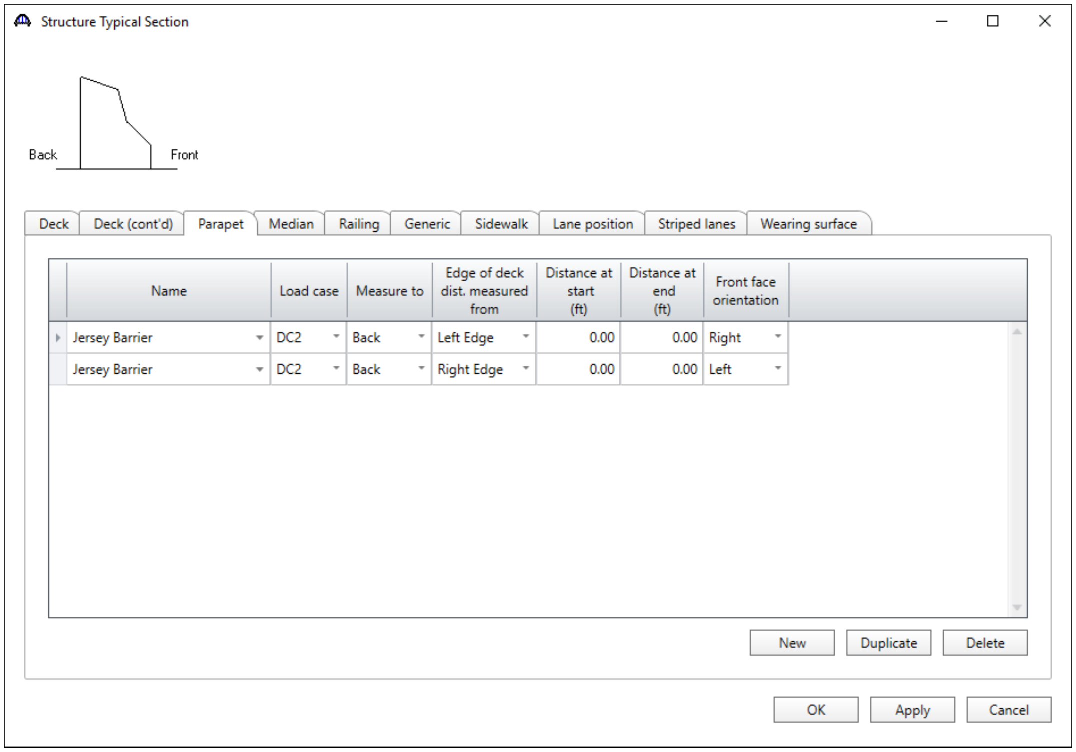
We will enter the diaphragm locations after we visit the **Structure Typical Section** window to correctly orient the girders.

Structure Typical Section

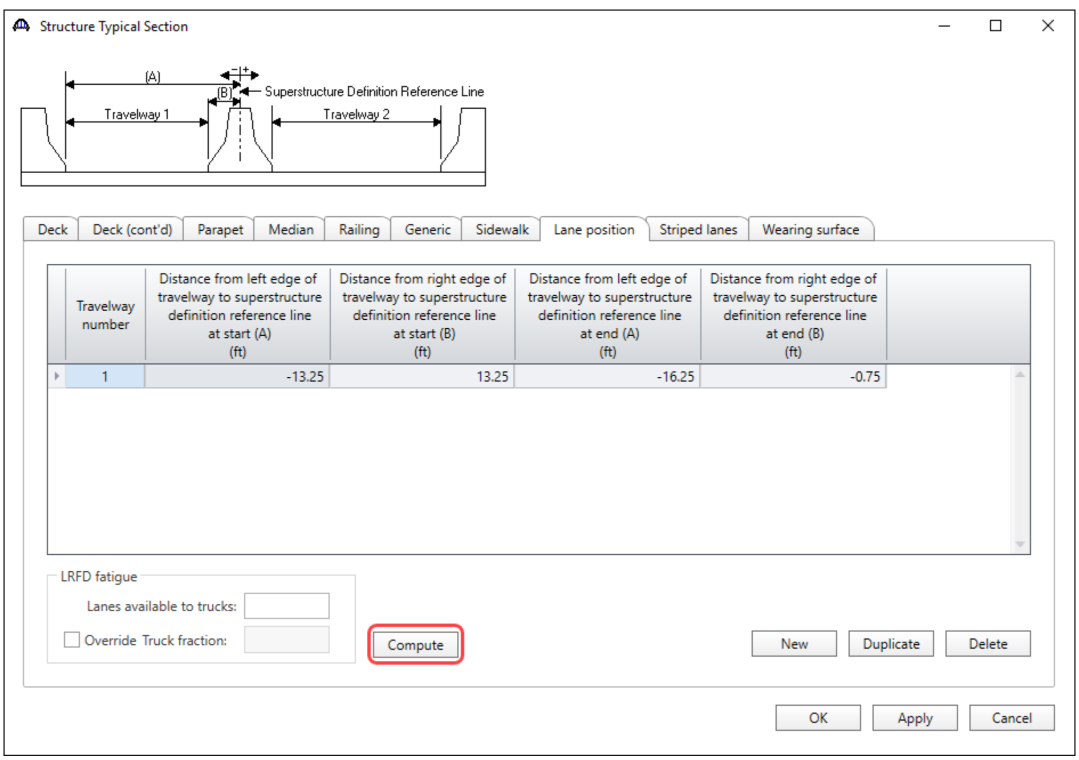
Open the **Structure Typical Section** window and enter the following information.







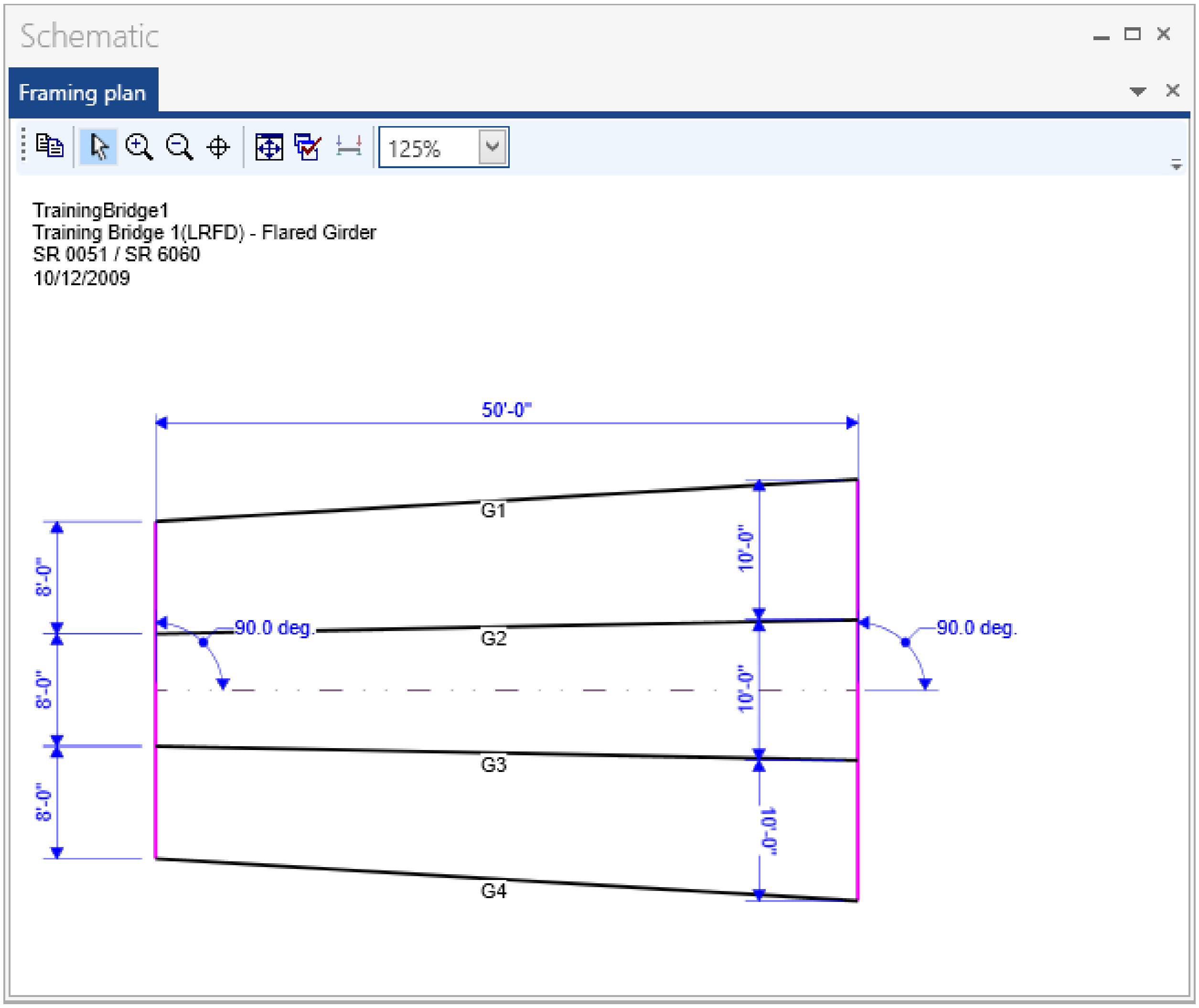
Use the **Compute** button on the **Lane Position** tab to compute the following lane positions:



Click **OK** to close the window and save the data to memory.

Framing Plan Schematic

Re-open the **Framing Plan Schematic**. We can now see that the girders are correctly oriented.



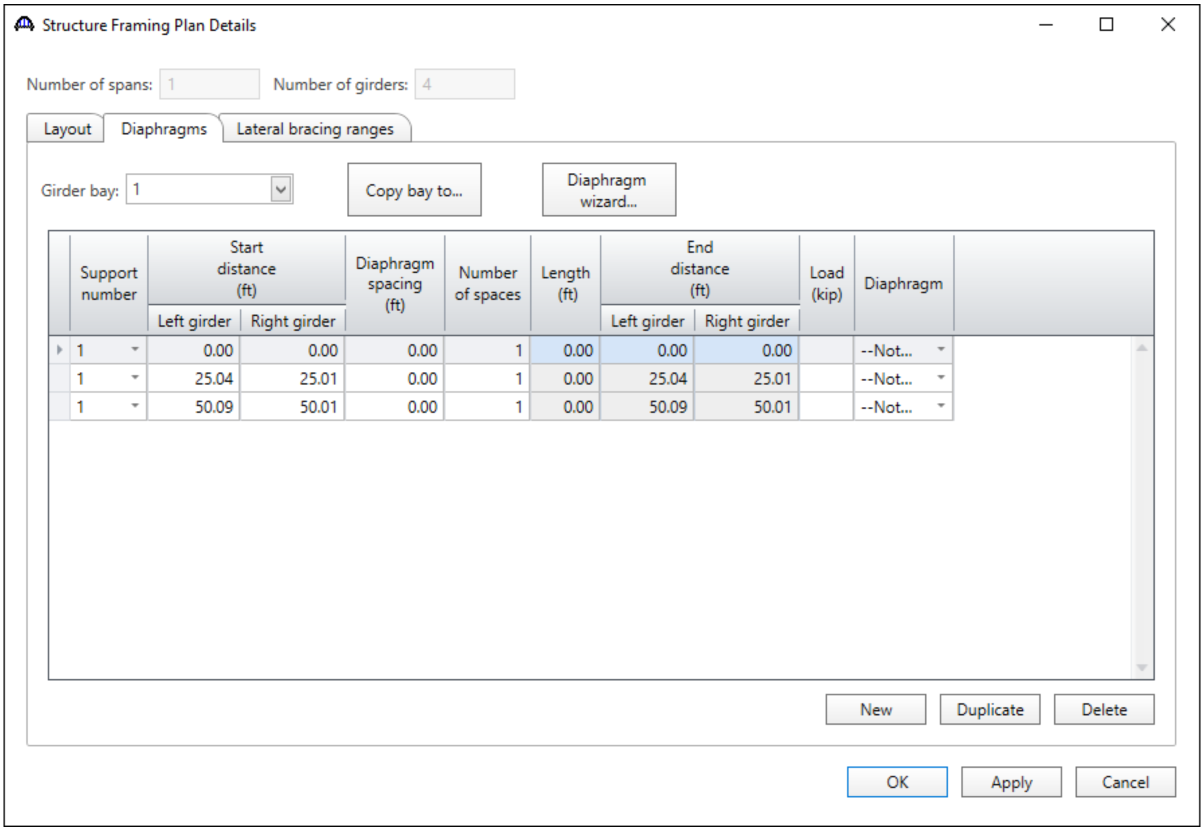
Diaphragms

Open the **Framing Plan Details** window, go to the **Diaphragms** tab and enter the following data. The diaphragms are entered manually for this example. The following table lists the diaphragm locations.

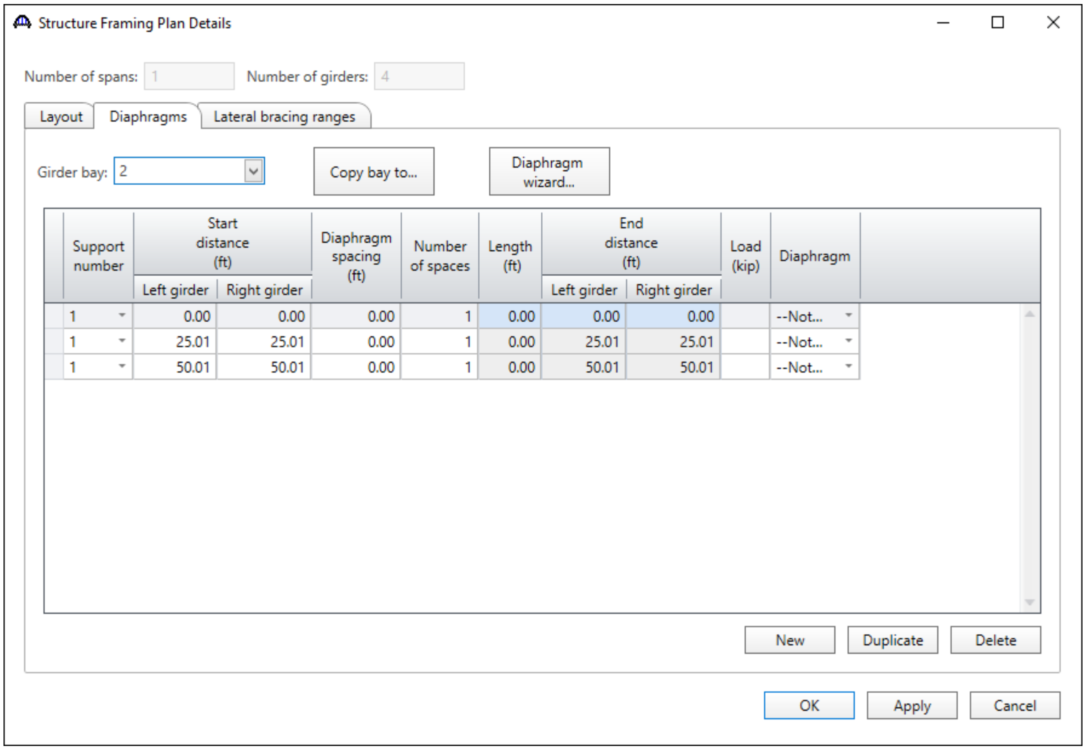
Bay 1 Diaphragms		Bay 2 Diaphragms		Bay 3 Diaphragms	
Girder 1 (ft)	Girder 2 (ft)	Girder 2 (ft)	Girder 3 (ft)	Girder 3 (ft)	Girder 4 (ft)
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
25.044960	25.005000	25.005000	25.005000	25.005000	25.044960
50.089919	50.009999	50.009999	50.009999	50.009999	50.089919

The preceding table lists the diaphragm locations down to the 6th decimal place precision. For our example we will enter the middle diaphragms at the 25.00' approximate location. The slight difference between the approximate location and the exact mathematical location will not cause a significant change in the computed unbraced lengths.

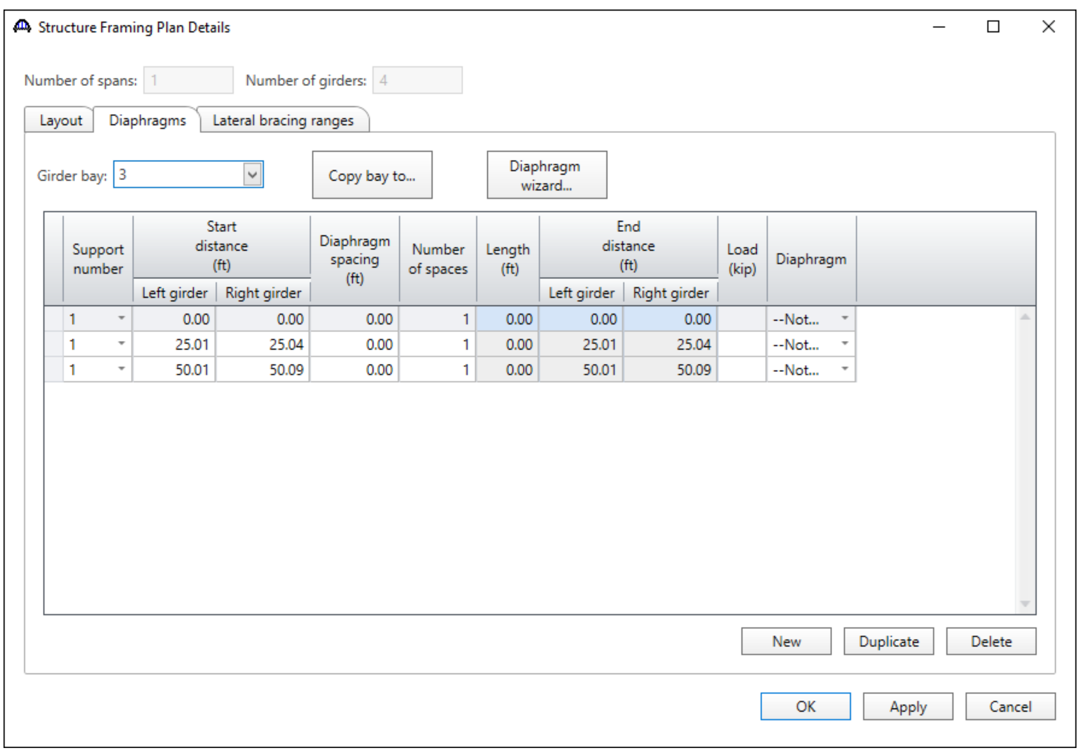
Enter the following data to locate the diaphragms at the start, at the middle and at the end of the structure.



The diaphragms in Bay 2 are entered as follows:



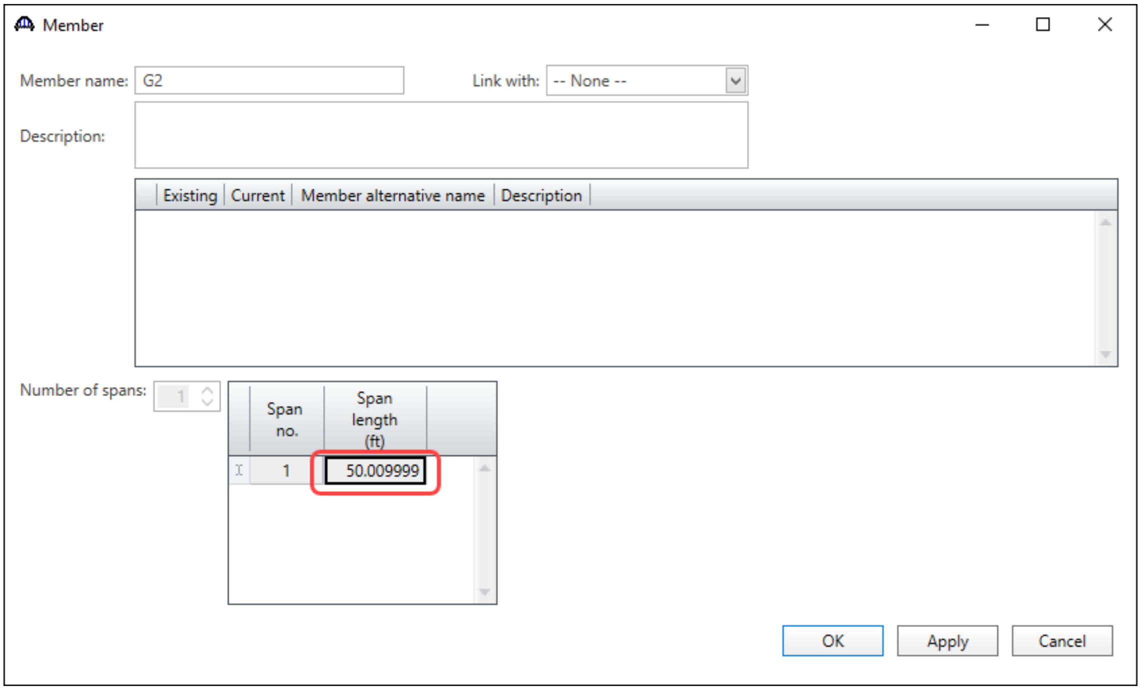
The diaphragms in Bay 3 are entered as follows:



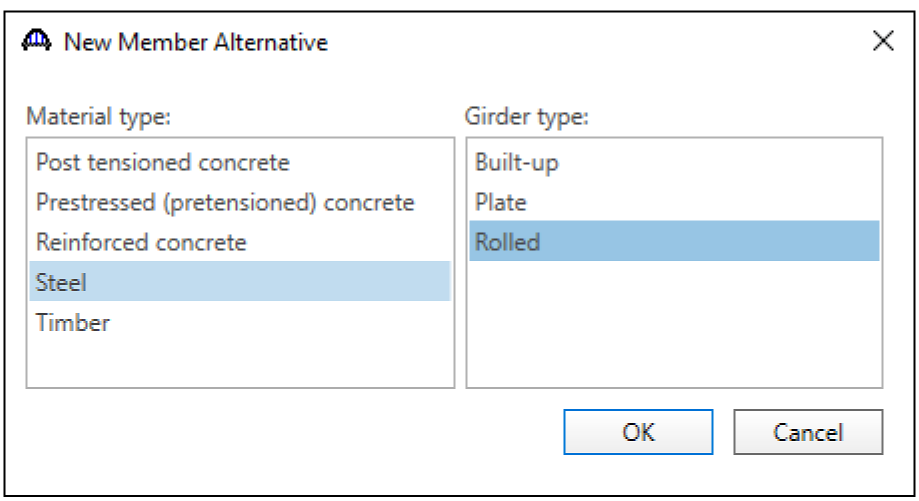
Click **OK** to close the window and save the data to memory.

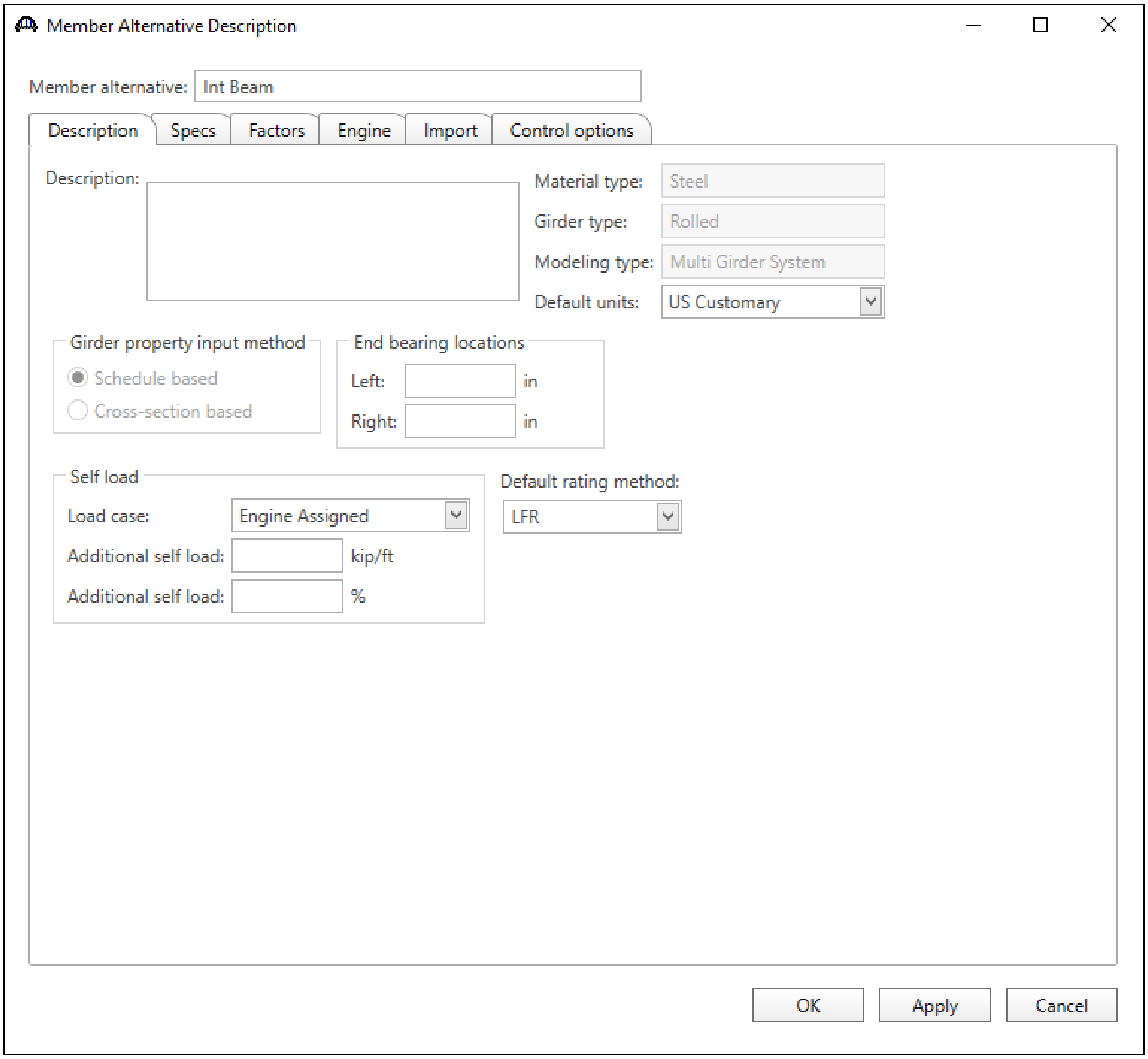
Member Alternative

Open the **Member** window for member **G2**. Note the computed member length is slightly different than the span length of 50' that we entered on the **Superstructure Definition** window. This is due to the flared orientation of the member.



Create a Steel Rolled Beam Member Alternative for member G2.



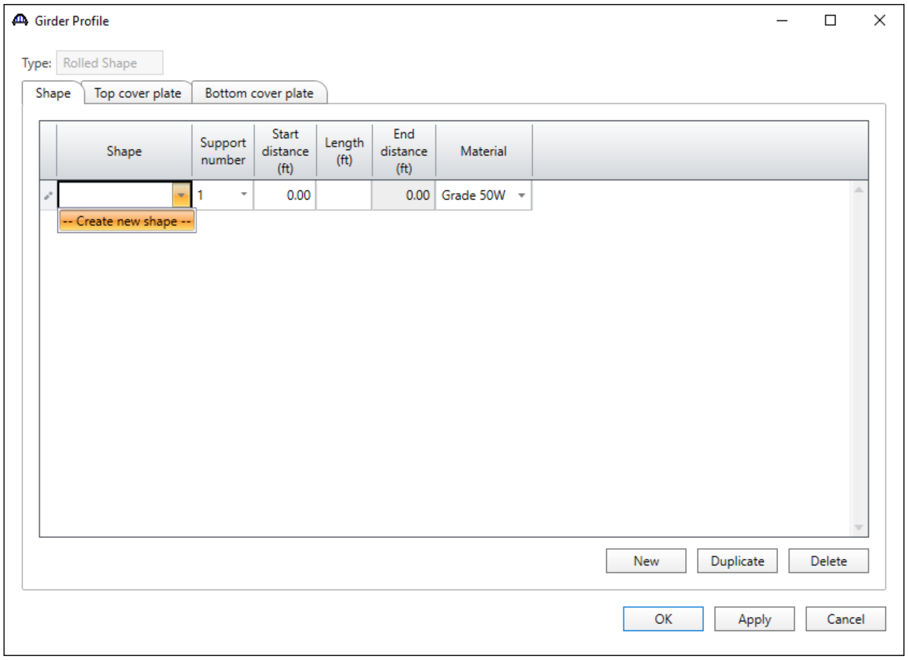


Click **OK** to close the window and save the data to memory.

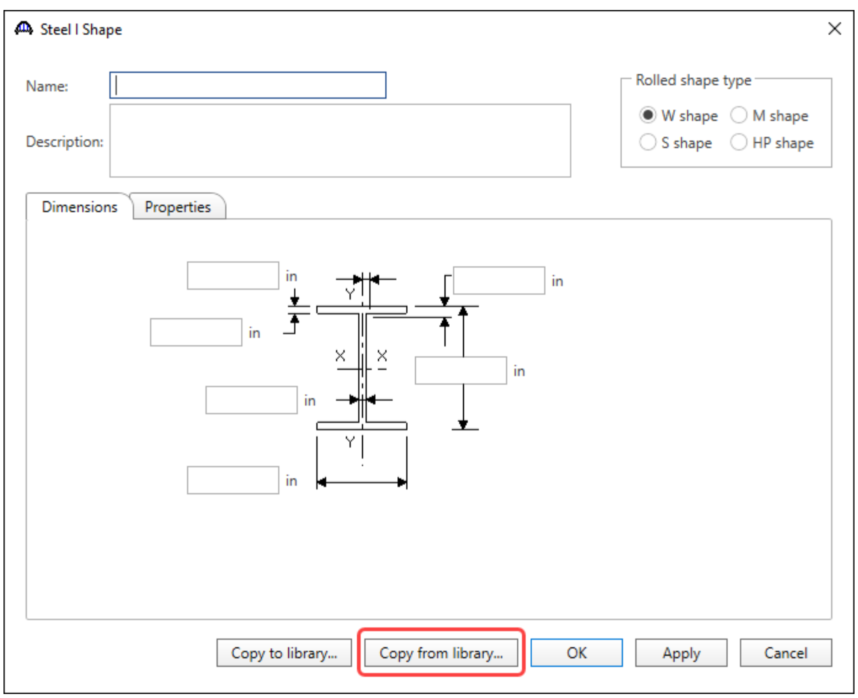
We will now describe the properties for this member.

Girder Profile

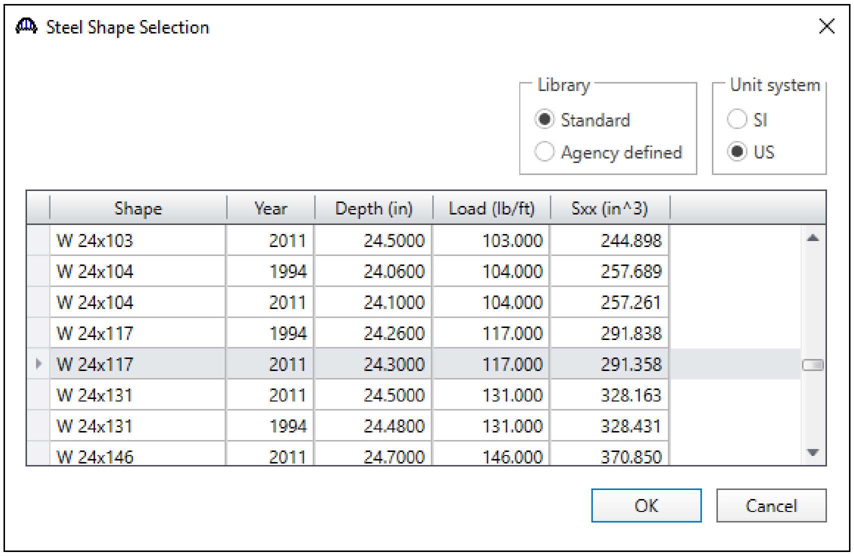
Open the **Girder Profile** window and in **Shape** tab click **New** to add a row to the grid. Select **Create a new shape** from the drop-down list in the **Shape** column.



This opens the **Steel I Shape** window. Select the **Copy from Library** button.

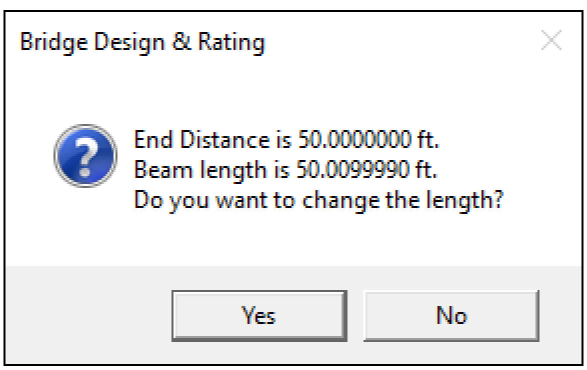


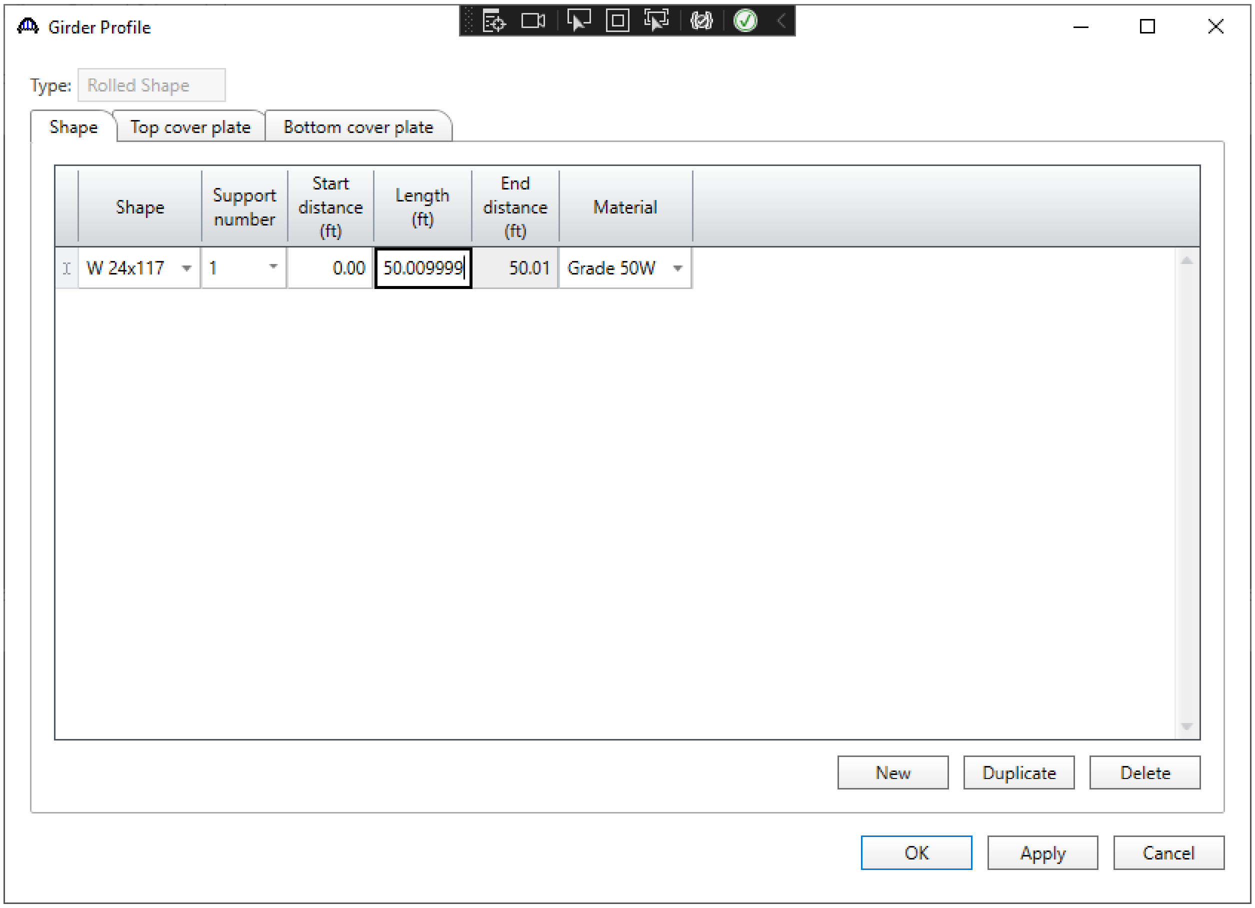
Select the **W24x117** shape from Year **2011** and click the **OK** button.



This will populate the Steel I Shape window with the W24x117 properties. Click **OK** to close the Steel I Shape window. This will copy the shape to the Bridge and populate the Shape Designation on the Girder Profile window.

Enter **50.00** as the length and click **Apply**. You will get a message stating that the Beam length is 50.009999' long. This is the beam length computed by BrDR based on the flared orientation of the girder. Select **Yes** and BrDR will change the length of the range to match the length of the girder. This procedure of entering a slightly smaller span length can be used to allow BrDR to compute the exact length with the correct number of decimal places.

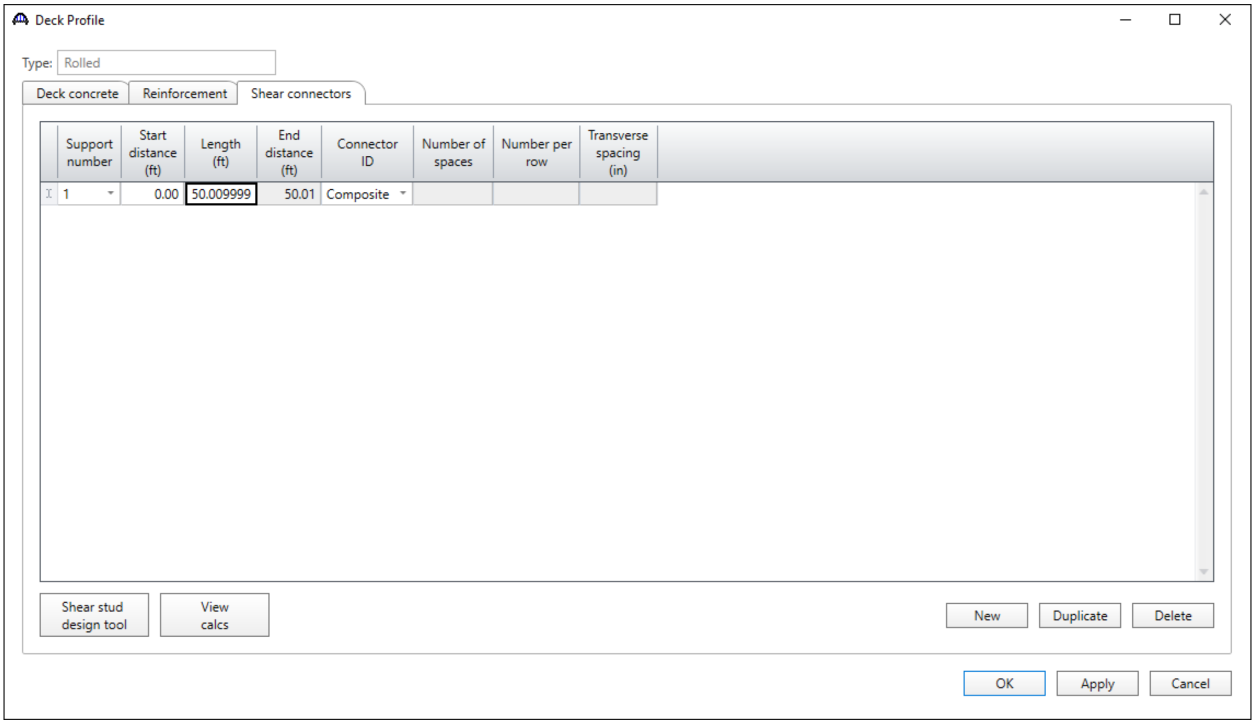




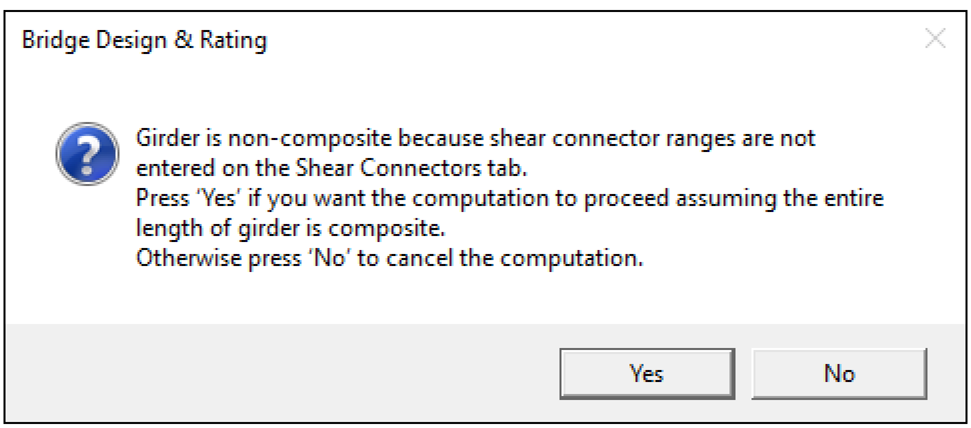
Click **OK** to close the window and save the data to memory.

Deck Profile

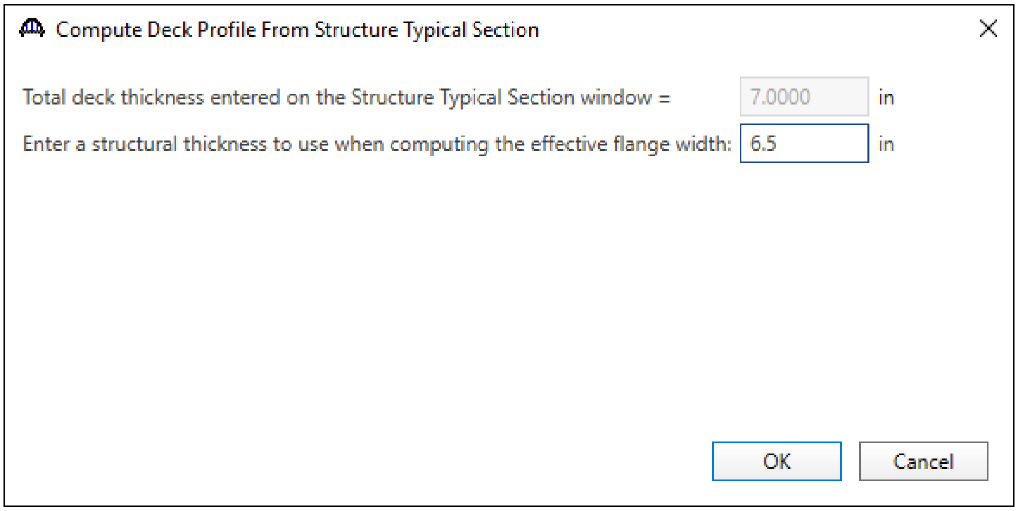
Open the **Deck Profile** window. Enter the following data on the **Shear connectors** tab to have the section considered as composite.

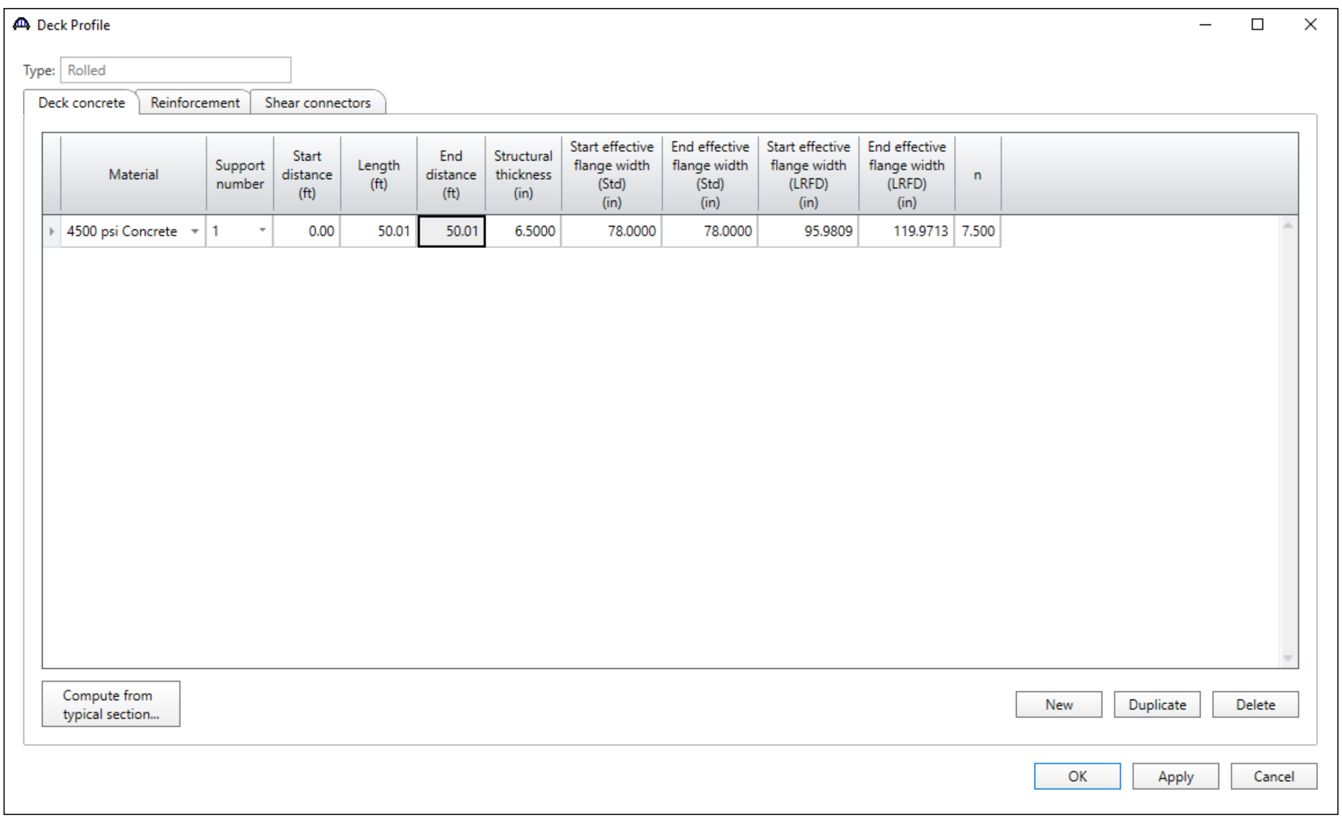


This needs to be entered before computing effective flange widths from structure typical section. If shear connector details are not entered, then the program gives the following message:



Click on the **Deck concrete** tab to Click the **Compute from typical section** button to have BrDR compute the effective flange widths for you.





Click **OK** to close the window and save the data to memory.

The Std effective flange widths are computed as follows:

At Start of Structure:

¼ Span Length = 50.009999'/4 = 12.5025' = 150.03"

Girder spacing = 8.0' = 96"

12 times structural slab thickness = 12*6.5" = 78" 🡐 Controls

At End of Structure:

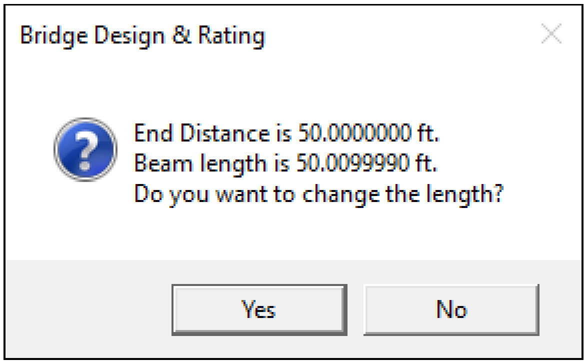
¼ Span Length = 50.009999'/4 = 12.5025' = 150.03"

Girder spacing = 10.0' = 120"

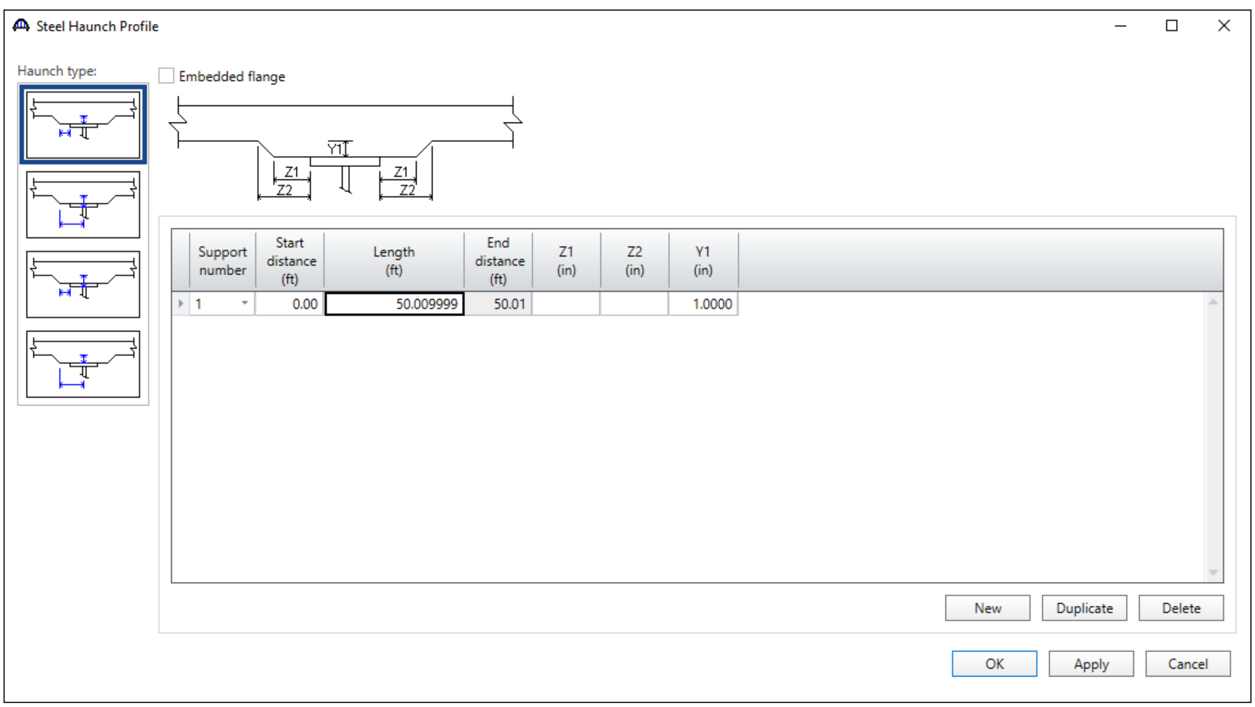
12 times structural slab thickness = 12*6.5" = 78" 🡐 Controls

Haunch Profile

Open the **Haunch Profile** window. Select the Haunch Type and enter **50.00** as the length and click **Apply**. You will get a message stating that the Beam length is 50.009999' long. This is the beam length computed by BrDR based on the flared orientation of the girder. Select **Yes** and BrDR will change the length of the range to match the length of the girder. This procedure of entering a slightly smaller span length can be used to allow BrDR to compute the exact length with the correct number of decimal places.



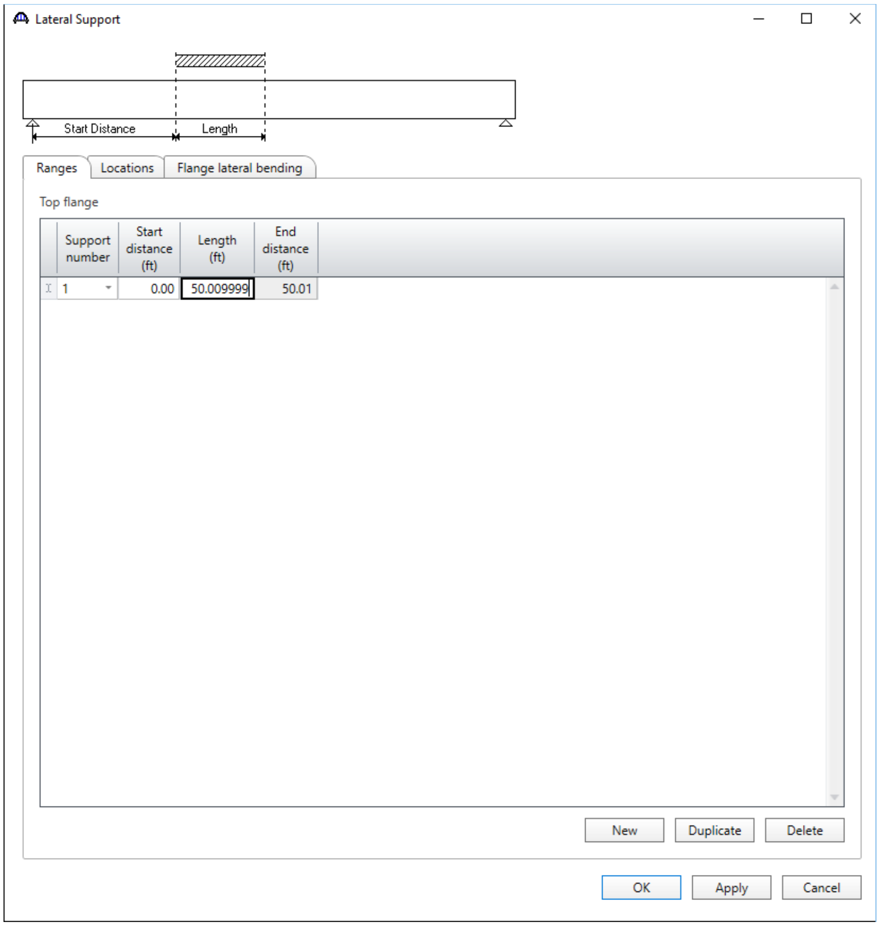
Enter other details as shown below and click OK**50.00** as the length and click **Apply**. You will get a message stating that the Beam length is 50.009999' long. This is the beam length



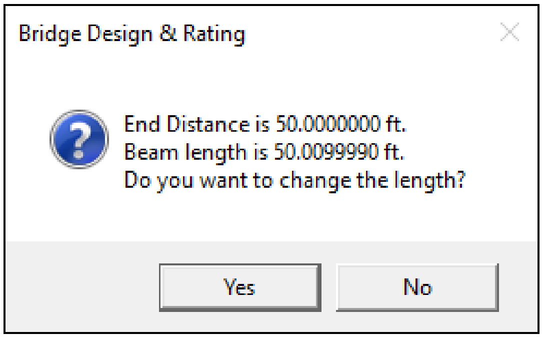
Click **OK** to close the window and save the data to memory.

Lateral Support

Open the **Lateral Support** window. On the Ranges tab click on **New** and add the following details:



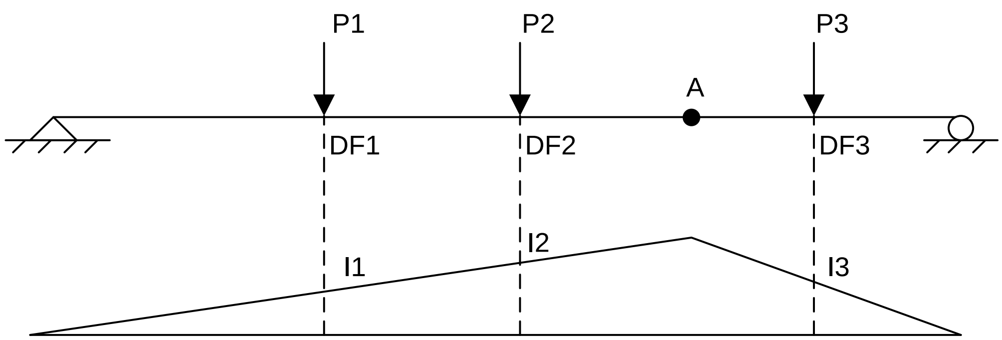
Enter **50.00** as the length and click **Apply**. You will get a message stating that the Beam length is 50.009999' long. This is the beam length computed by BrDR based on the flared orientation of the girder. Select **Yes** and BrDR will change the length of the range to match the length of the girder. This procedure of entering a slightly smaller span length can be used to allow BrDR to compute the exact length with the correct number of decimal places.



Std Distribution Factor Ranges

Now open the **Live Load Distribution** window. Select **Use advanced method** as the **Distribution factor input method**. This method allows you to enter ranges of distribution factors over the length of the girder. It also allows the distribution factor to vary based on the varying girder spacing. You could also use the Simplified method if you simply want to enter an average distribution factor.

The varying distribution factors are used in the following manner. For each range, the user enters the distribution factor for a given effect (moment, shear, or deflection) at the beginning and the end of the range. The program assumes that the given distribution factor varies linearly within a range. When an influence line for a given effect is analyzed for a moving load, the program calculates the influence line ordinate for the position of axle load, and it also calculates the distribution factor for the given effect from the corresponding range of the distribution factor assuming a linear variation. The load effect for a given position of the axle load is calculated by multiplying the axle load, the influence line ordinate and the distribution factor. The load effect for each axle load is calculated as described above and then all load effects are added to calculate the total live load effect. This procedure is illustrated below:



Influence Line for Moment at A

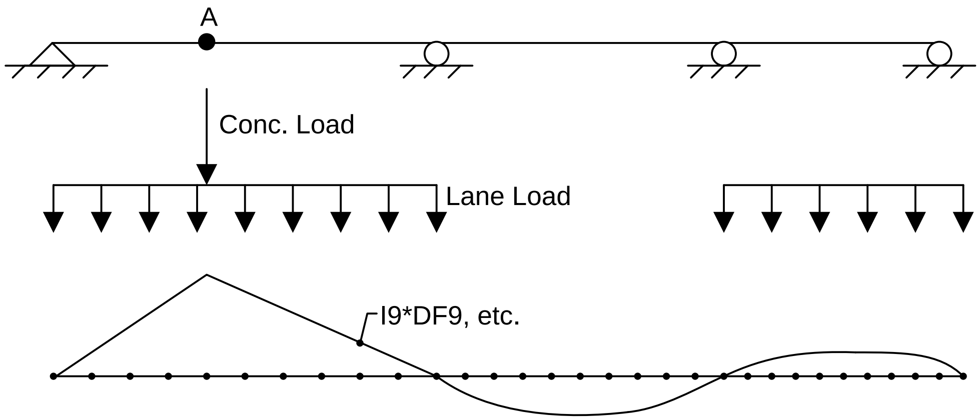
MA = P1*DF1*I1 + P2*DF2*I2 + P3*DF3*I3

The effect of lane loading at each point is calculated by adding the effects of uniform load and corresponding concentrated loads as described below:

(1) The influence line for the action at a point is multiplied by the distribution factor at each ordinate of the influence line. The effect of the uniform load at the point is then calculated by computing the area of the modified influence curve and multiplying that by the load intensity. In maximizing the effect of uniform loads, at most two regions with the largest effects are considered in the analysis.

(2) The effect of each concentrated load is calculated by multiplying the load, the influence line ordinate and the distribution factor at the location of the load. These effects are then added to calculate the total effect of the concentrated loads.

This procedure is illustrated below:



Influence Line for Moment at A
(Adjusted by multiplying by distribution factors found at each influence ordinate)

The Standard distribution factors are computed as follows:

Deflection

DF = Number wheels/number of girders. The distribution factor is constant over the length of the member.

1 Lane DF = 2 wheels/4 girders = 0.500

Multi Lane DF = 2*2 wheels/4 girders = 1.000

Moment

DF found using AASHTO Table 3.23.1.

1 Lane DF = S/7.0

Multi Lane DF = S/5.5

At start of structure:

1 Lane DF = 8.0/7.0 = 1.143

Multi Lane DF = 8.0/5.5 = 1.455

At end of structure:

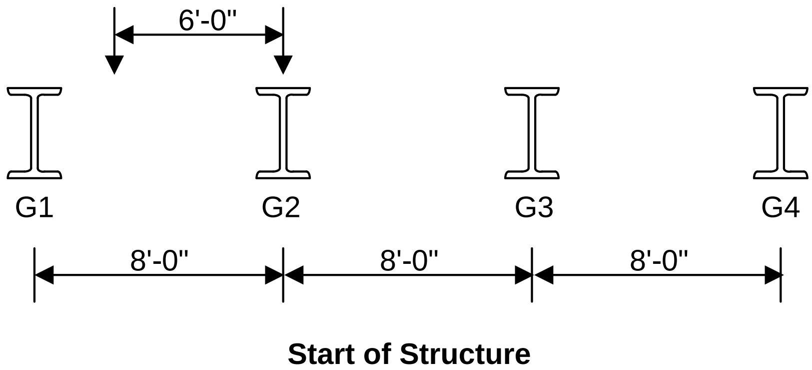
1 Lane DF = 10.0/7.0 = 1.429

Multi Lane DF = 10.0/5.5 = 1.818

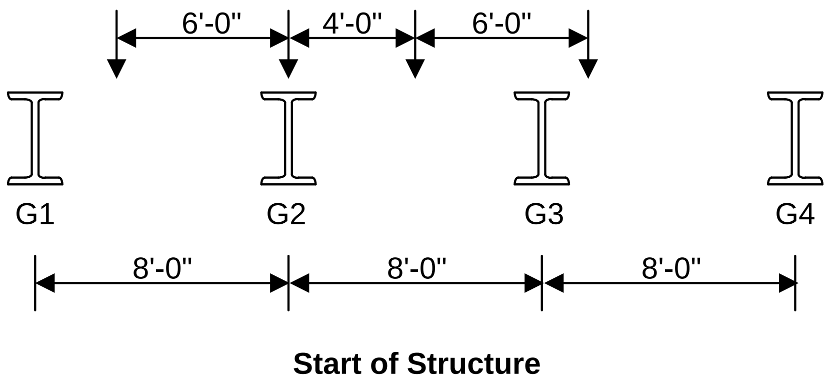
Shear

Shear at Supports found by simple beam distribution:

At start of structure:

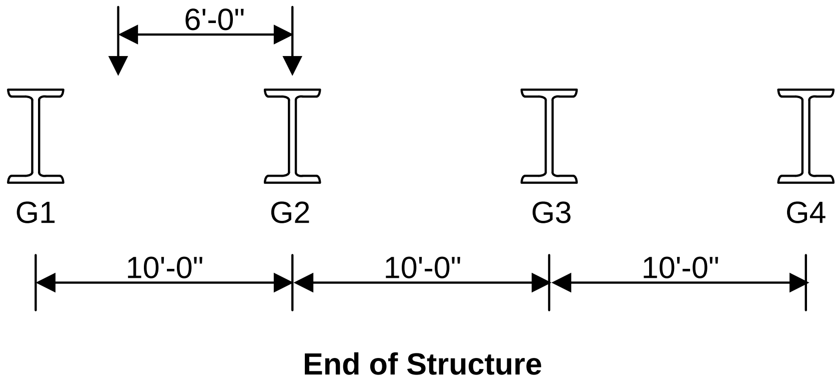


1 Lane DF = 1.0 + 2.0/8.0 = 1.25

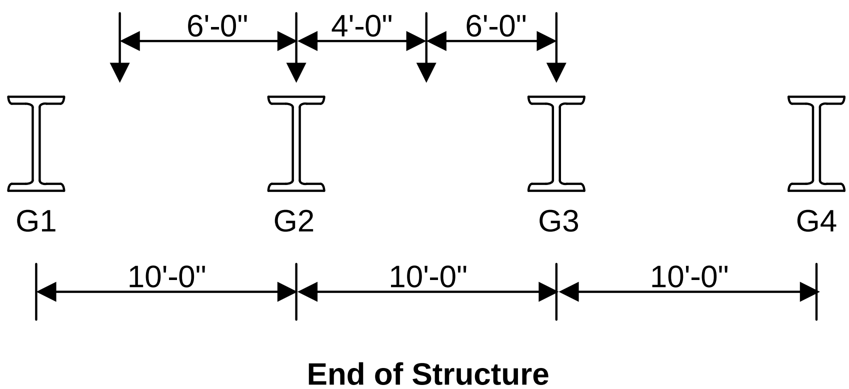


Multi Lane DF = 1.0 + 2.0/8.0 + 4.0/8.0 = 1.75

At end of structure:



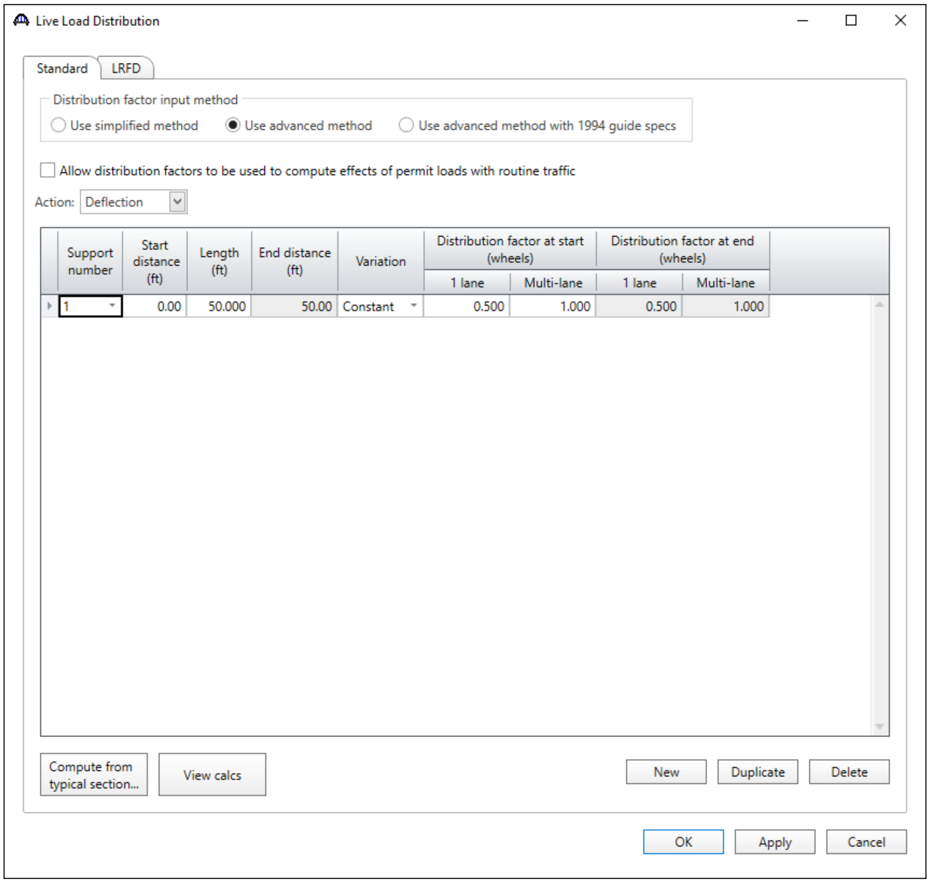
1 Lane DF = 1.0 + 4.0/10.0 = 1.40



Multi Lane DF = 1.0 + 4.0/10.0 + 6.0/10.0 = 2.0

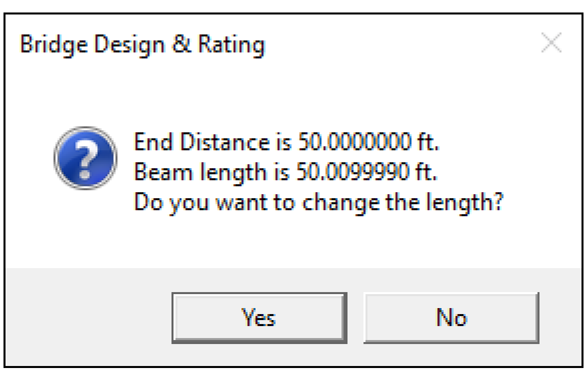
Shear distribution factors at locations other than a support are the same as the moment distribution factors.

Deflection



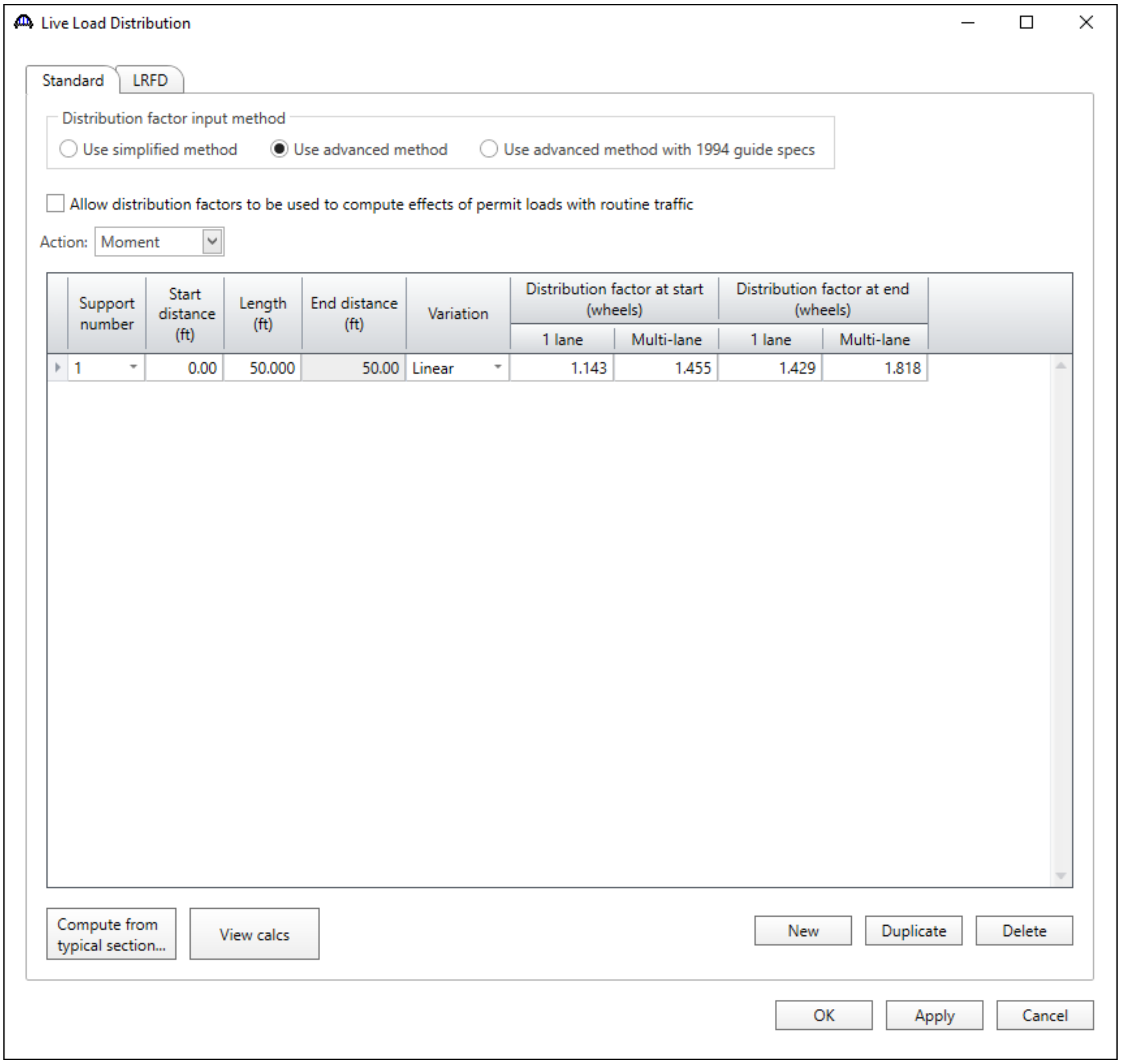
Enter the preceding values for the deflection distribution factor. The deflection distribution factor does not vary over the length of the member.

Enter **50.00** as the length of the range and click **Apply**. You will get a message stating that the Beam length is 50.009999' long. This is the beam length computed by BrDR based on the flared orientation of the girder. Select **Yes** and BrDR will change the length of the range to match the length of the girder. This procedure of entering a slightly smaller span length can be used to allow BrDR to compute the exact length with the correct number of decimal places.



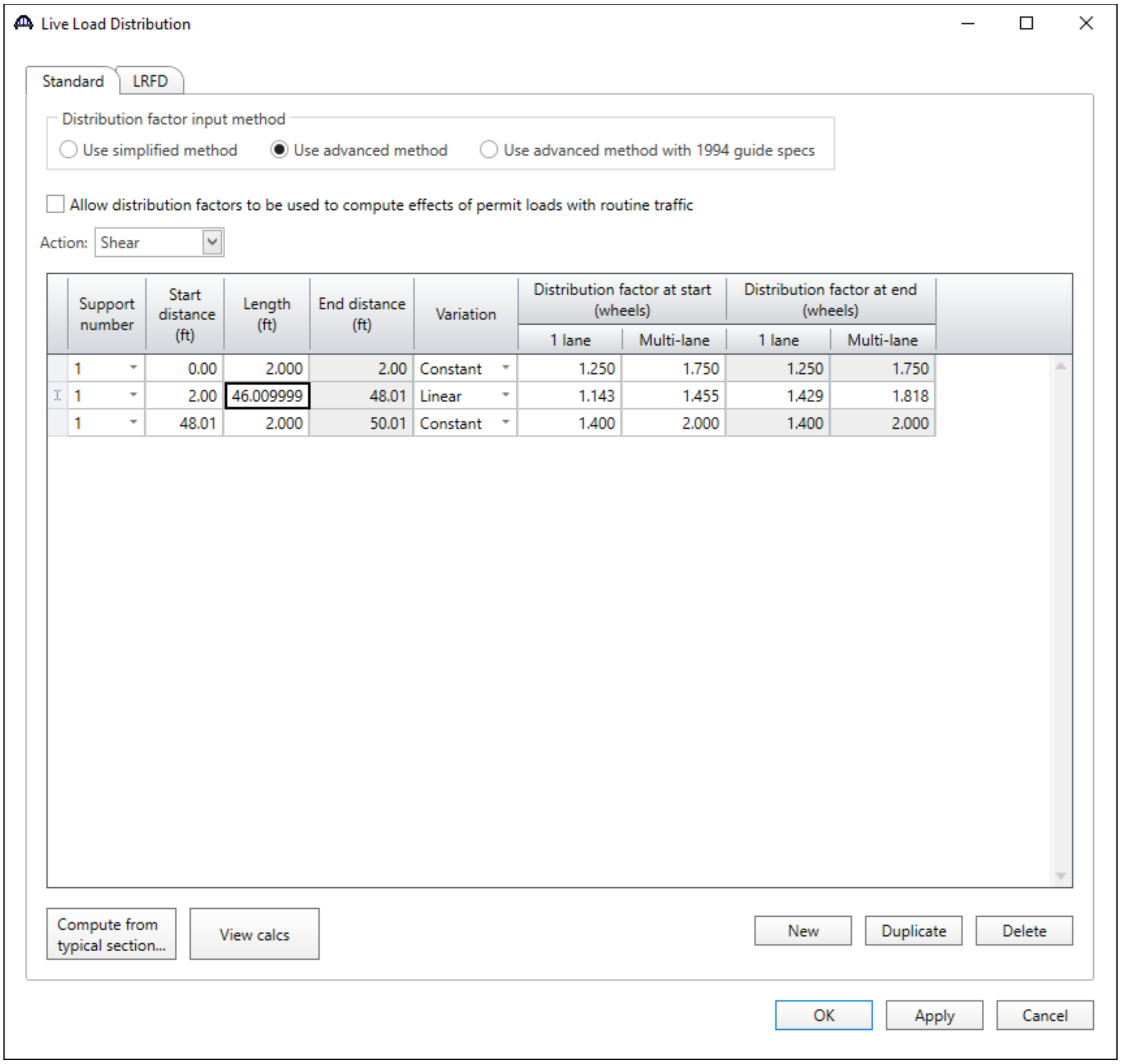
Moment

Select **Moment** from the drop-down menu of **Action** and enter the moment distribution factors in a similar manner.



Shear

The AASHTO Specifications do not specify a length over which the shear at supports distribution factor is to be applied. In our example, we are applying these distribution factors over a 2' length adjacent to the support. In your actual production usage of BrDR, you should determine this length based on the structure you are modeling using your own engineering judgment.

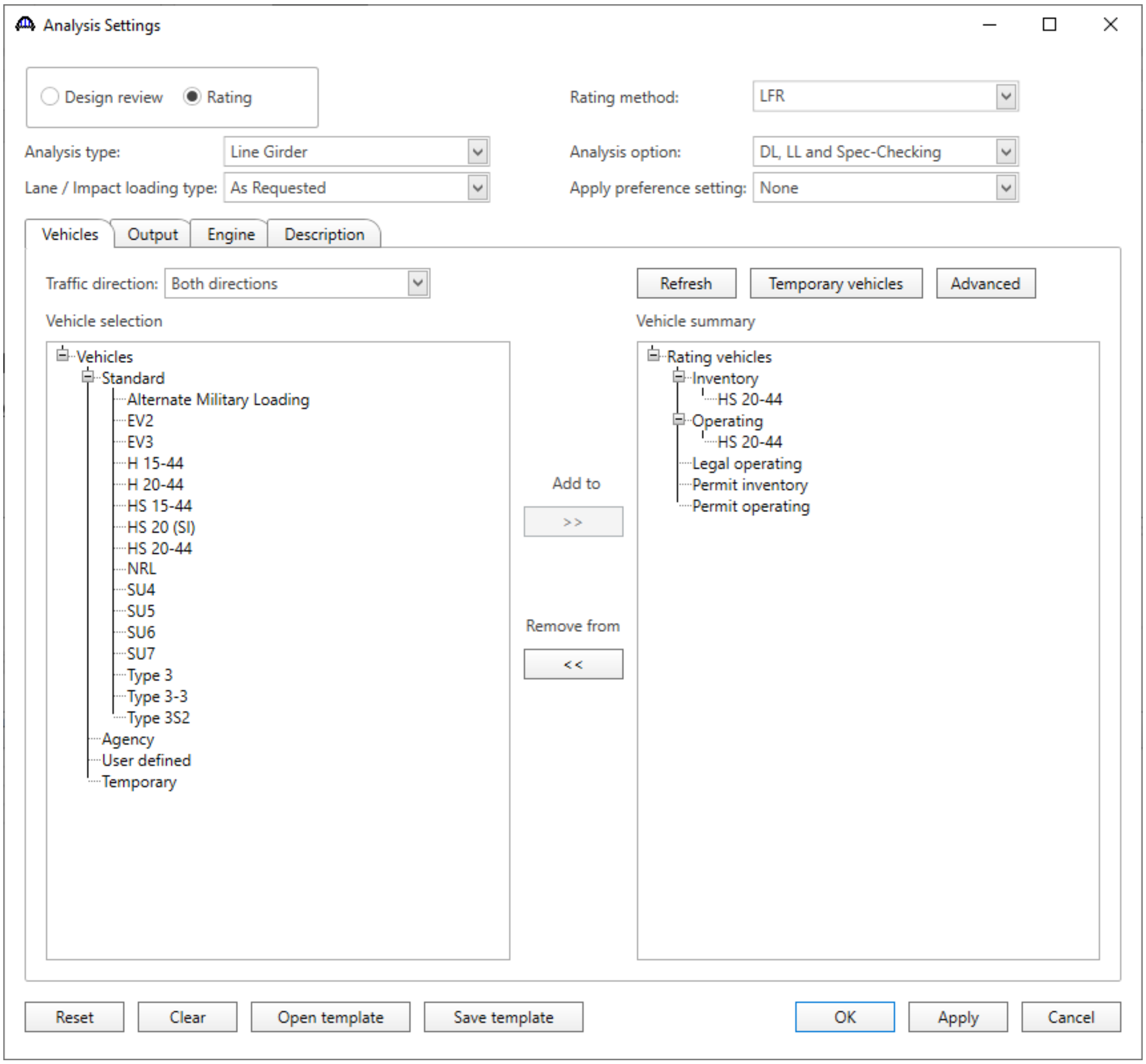


Click **OK** to close the window and save the data to memory.

LFR Rating

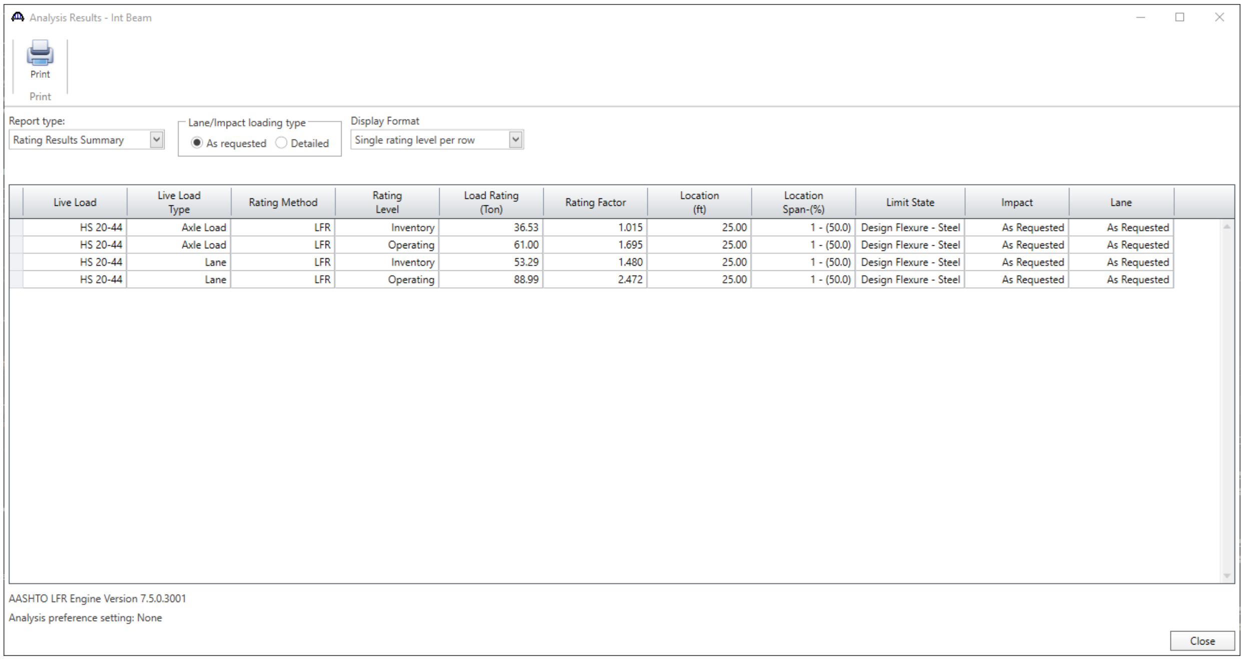
Analysis Settings

To perform an LFR rating, select the **Analysis Settings** button on the Analysis group of the DESIGN/RATE ribbon. Click on **Open template** and select **HS 20 LFR Rating** template to be used in the rating and click **OK.** The Analysis Settings window will be populated as shown below. Click **OK** to save the analysis settings to memory and close the window.



View Tabular Results

Select **Int Beam** member alternative in the Bridge Workspace tree and Click the **Analyze** button on the Analysis group of the DESIGN/RATE ribbon to start the rating process. Once the analysis is complete, click the **Tabular Results** button on the Results group of the DESIGN/RATE ribbon to review the 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	Axle Load	LFR	Inventory	36.53	1.015	25.00	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	61.00	1.695	25.00	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Inventory	53.29	1.480	25.00	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	88.99	2.472	25.00	1 - (50.0)	Design Flexure - Steel	As Requested	As Requested