AASHTOWare BrD/BrR 6.8

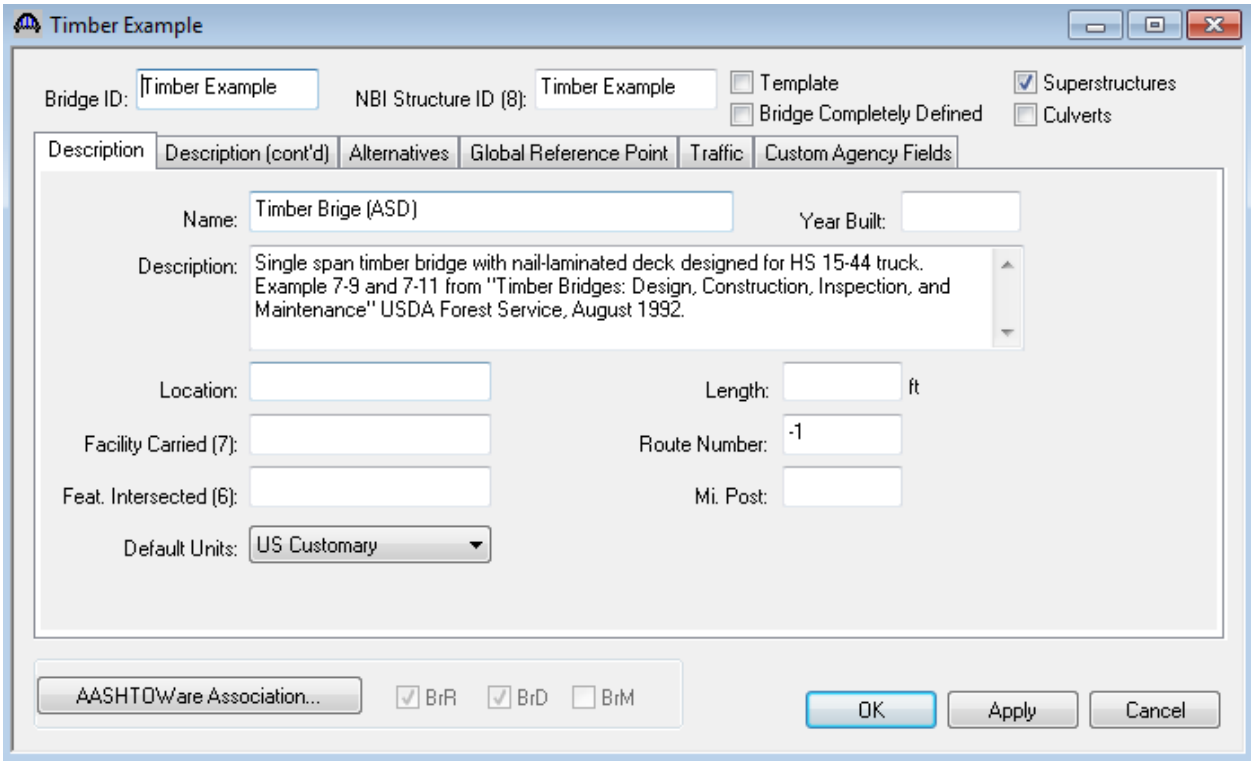
Timber Structure Tutorial

TMBR1- Single Span Timber Beam Example

BrD and BrR Training

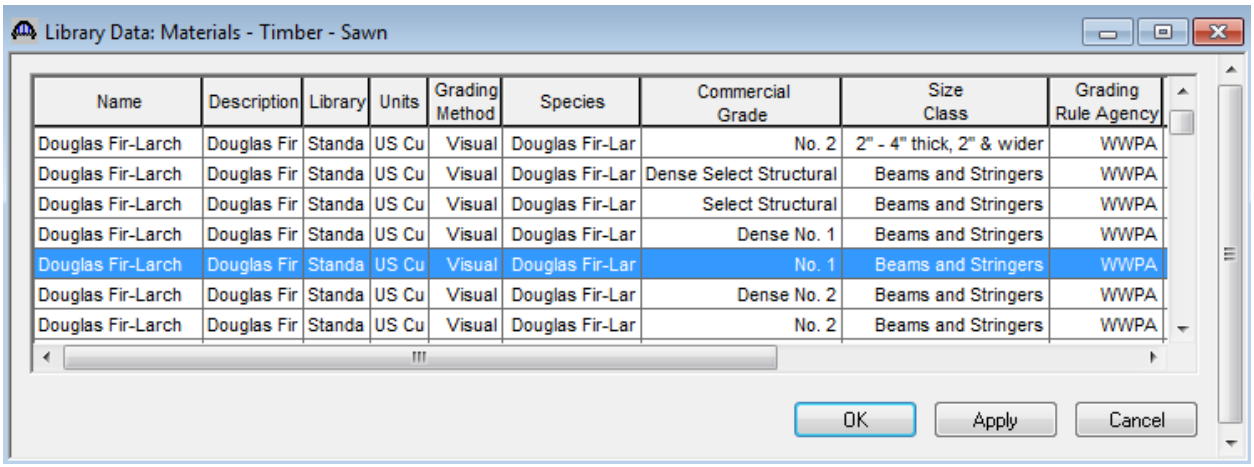
TMBR1- Single Span Timber Beam Example

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

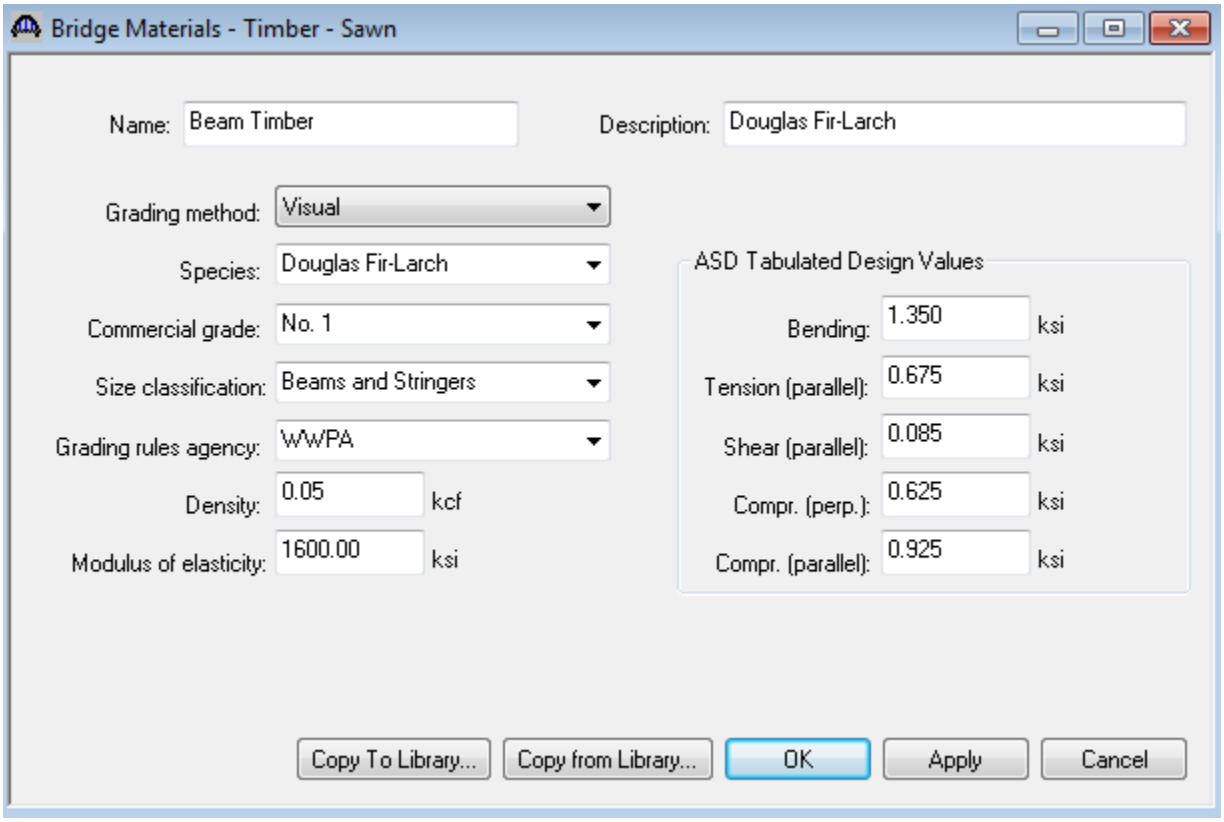


Close the window by clicking OK. This saves the data to memory and closes the window.

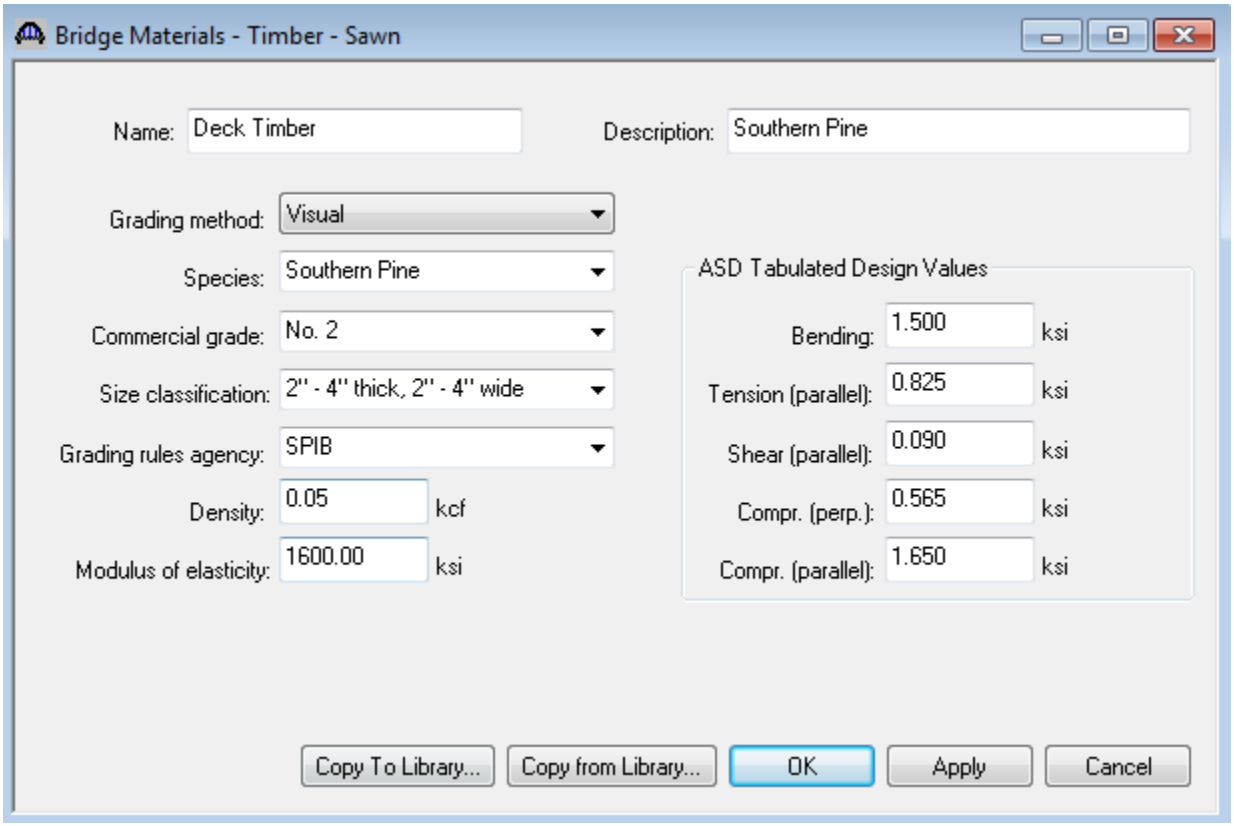
To add a new timber material, click on Materials, Timber, Sawn in the tree and select File/New from the menu (or right mouse click on Sawn and select New). Click the Copy from Library button and select the following material from the library.



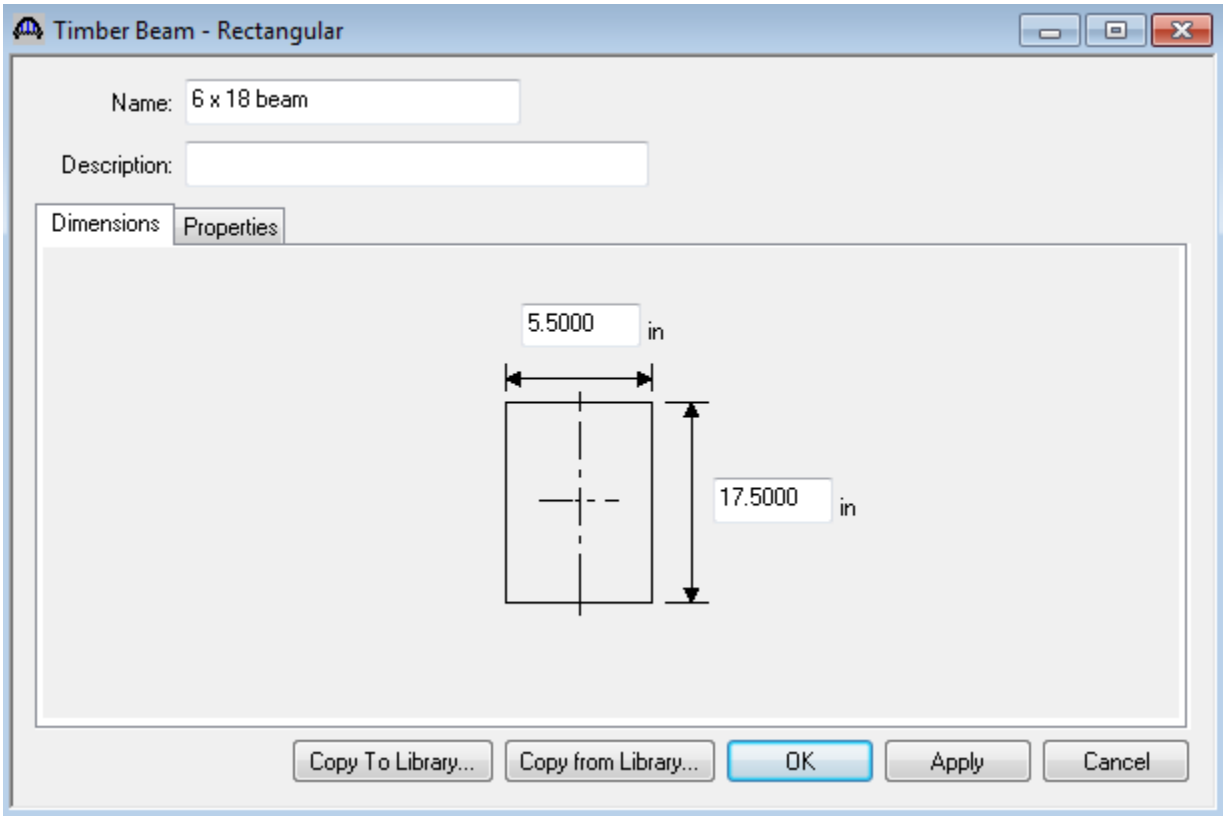
Click OK and the following window will open. Change the name of the material to “Beam Timber” from Douglas Fir-Larch. The ASD Tabulated Design Values in this window are based on dry conditions and do not include any adjustment factors based on usage conditions. Click OK to save this timber material to memory and close the window.

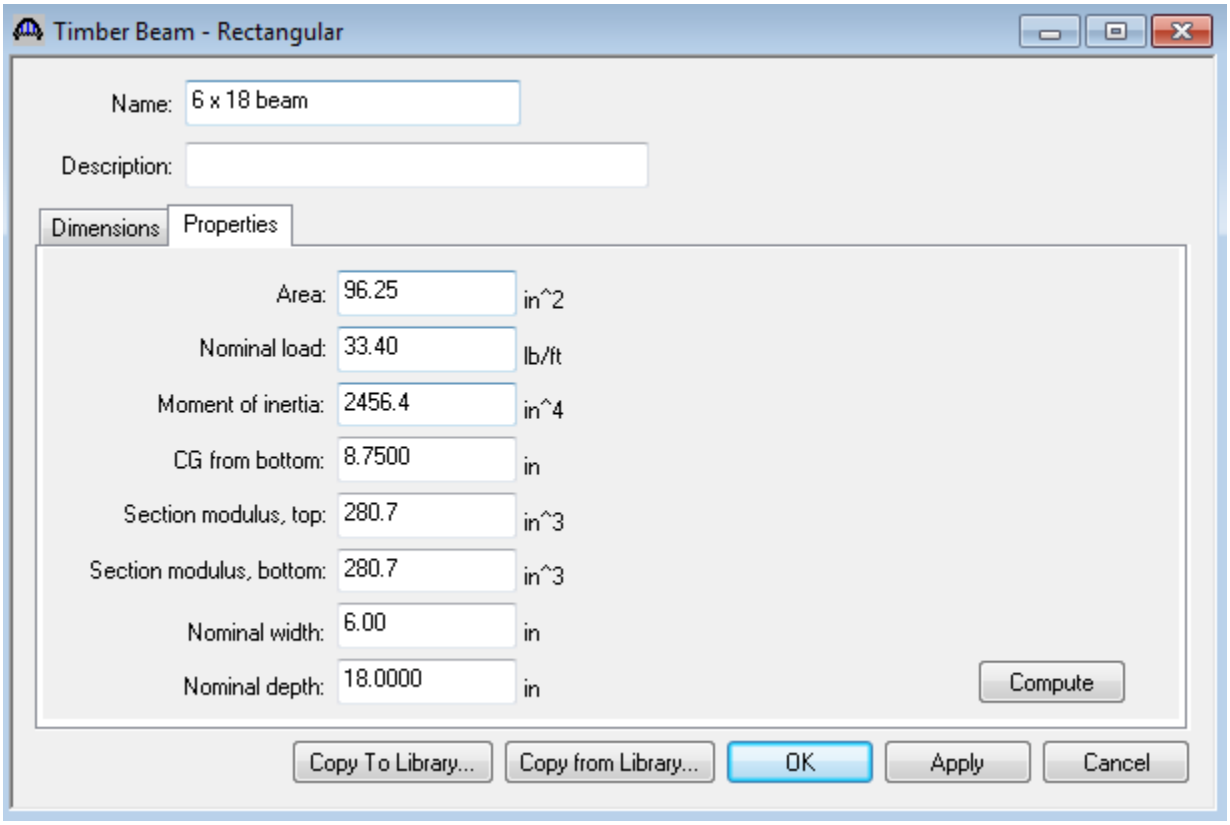


Follow the same procedure to copy Southern Pine, Visually graded No. 2, Size Class 2”-4” thick, 2”-4” wide, SPIB rules from the library for the deck material.

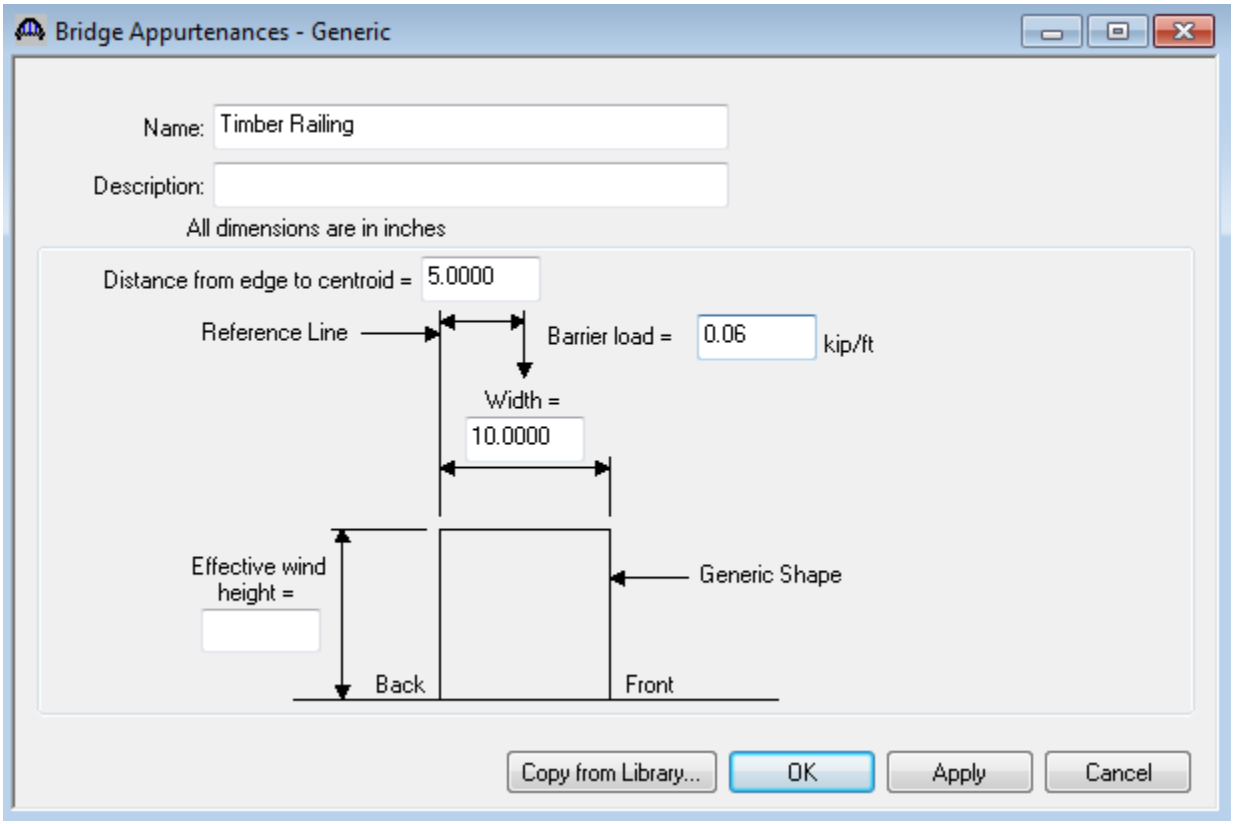


Add a new timber beam shape by clicking on Beam Shapes, Timber, Rectangular in the tree and selecting File/New from the menu (or double click on Rectangular). Enter the following data. Enter the actual beam dimensions to be used to calculate section properties on the Dimensions tab. Enter the nominal dimensions of the beam on the Properties tab. Click OK to save the data to memory and close the window.

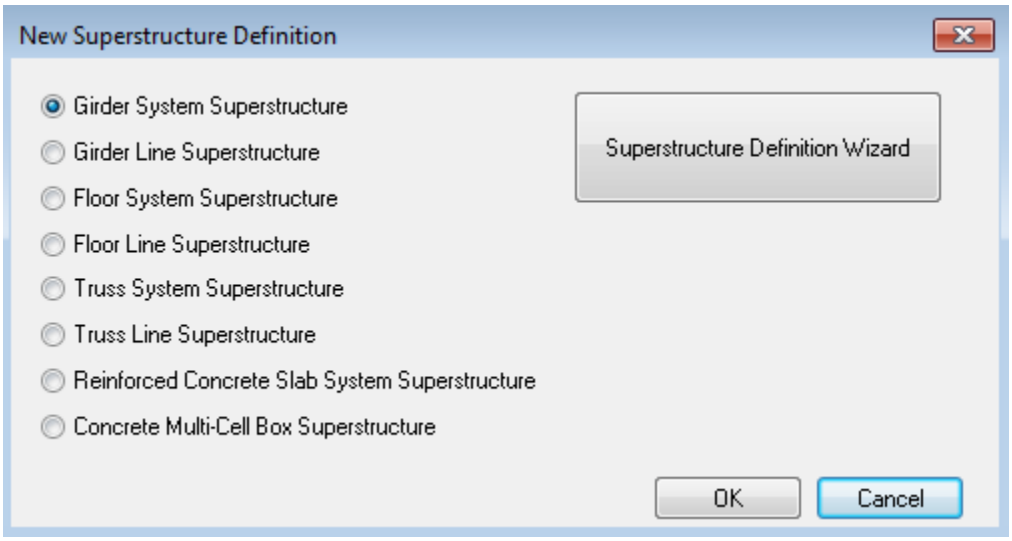



Timber Beam - Rectangular
Name: 6 x 18 beam
Description:
Dimensions
Properties
Area: 96.25 in^2
Nominal load: 33.40 lb/ft
Moment of inertia: 2456.4 in^4
CG from bottom: 8.7500 in
Section modulus, top: 280.7 in^3
Section modulus, bottom: 280.7 in^3
Nominal width: 6.00 in
Nominal depth: 18.0000 in
Compute
Copy To Library...
Copy from Library...
OK
Apply
Cancel

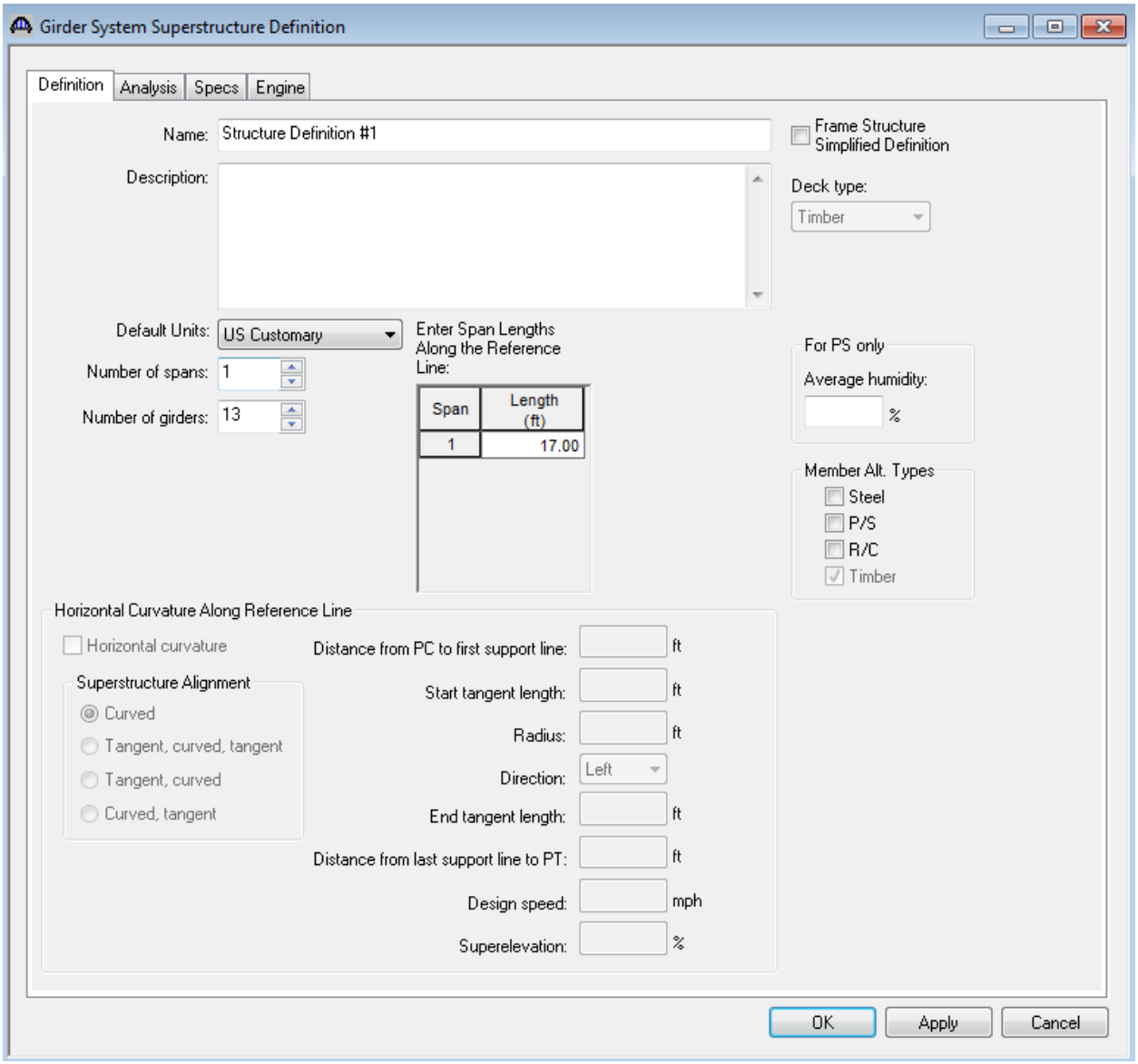
To enter the appurtenances to be used within the bridge, expand the tree branch labeled Appurtenances. To define a generic railing, double click on Generic in the tree and input the generic railing dimensions as shown below. Click OK to save the data to memory and close the window.



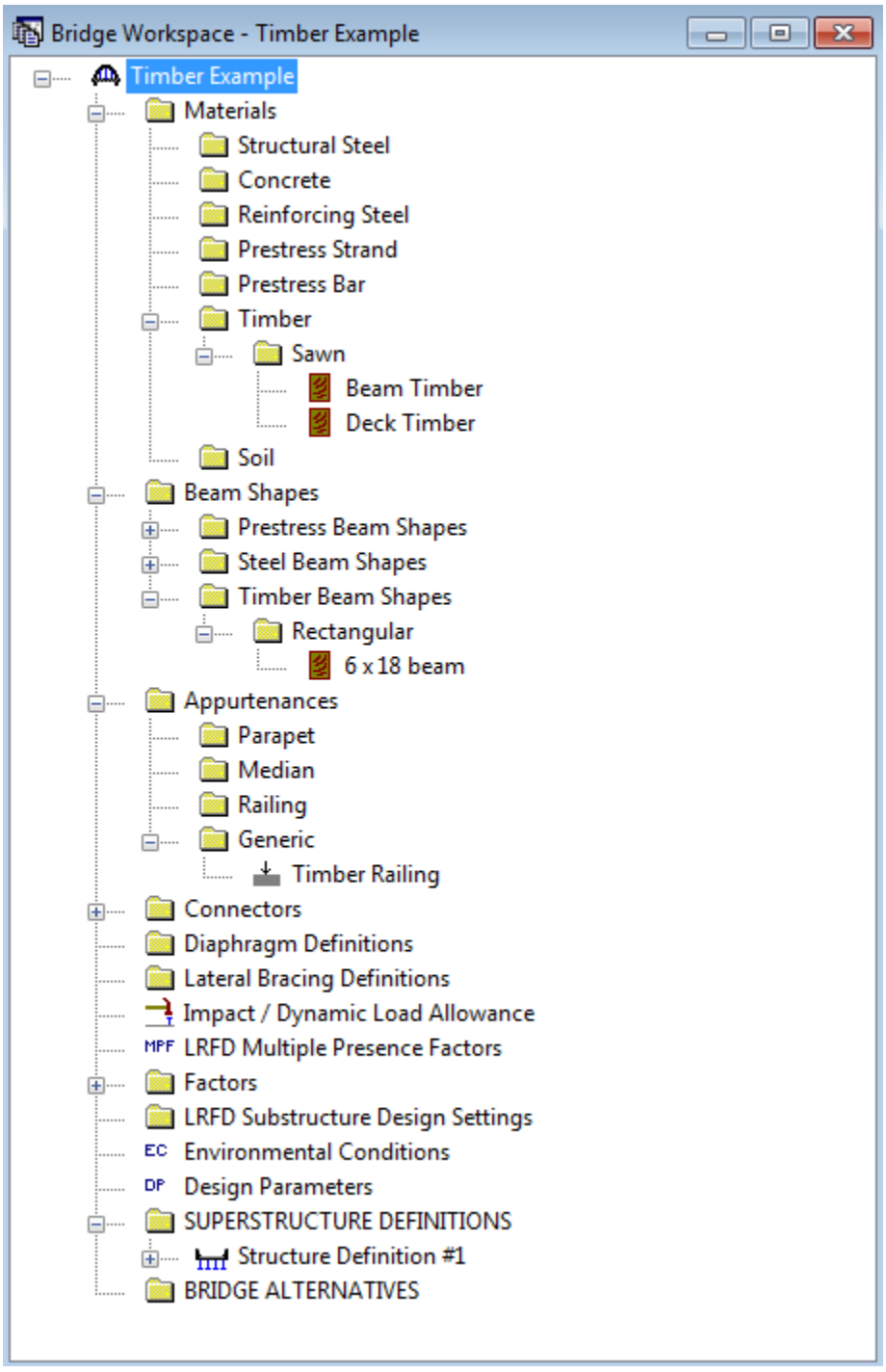
Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select File/New from the menu or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new structure definition. The dialog shown below will appear.



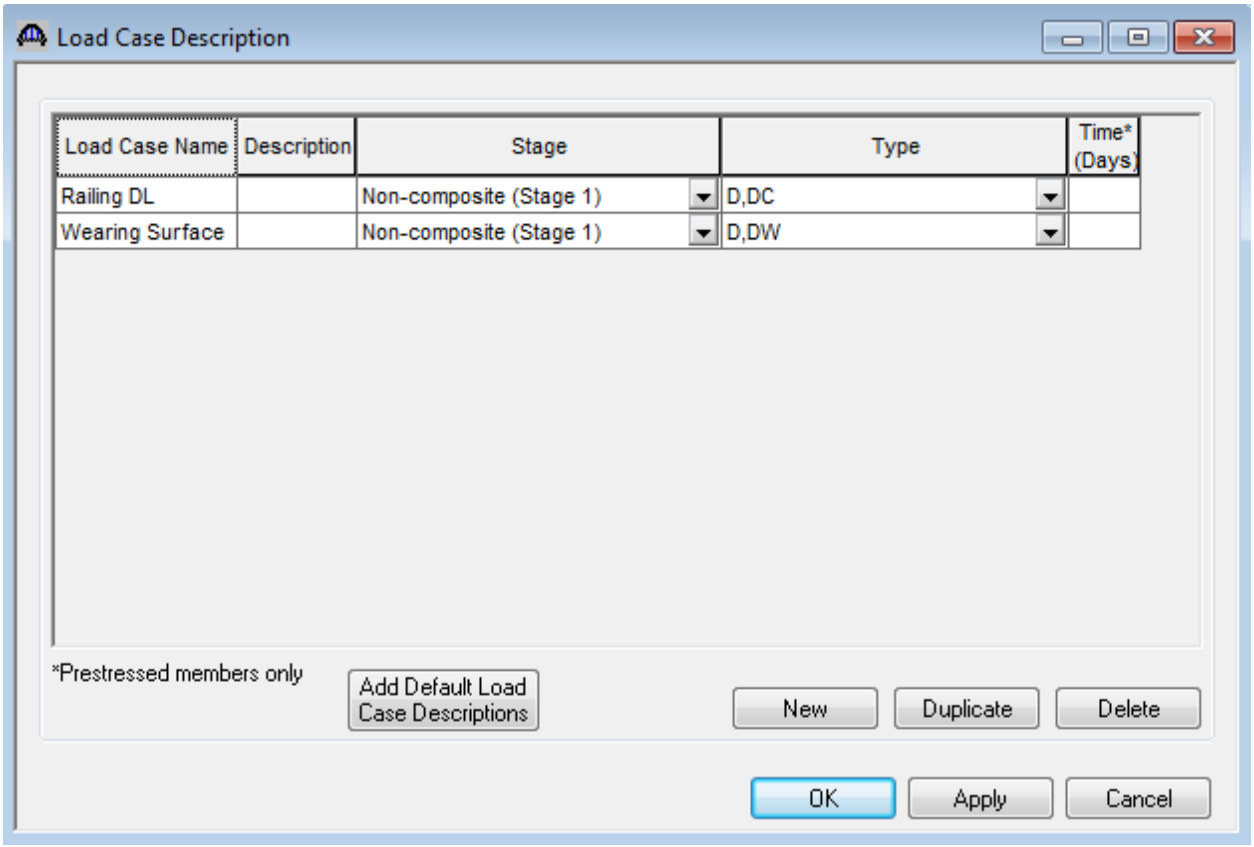
Select Girder System Superstructure and the Superstructure Definition window will open. Enter the appropriate data as shown below.



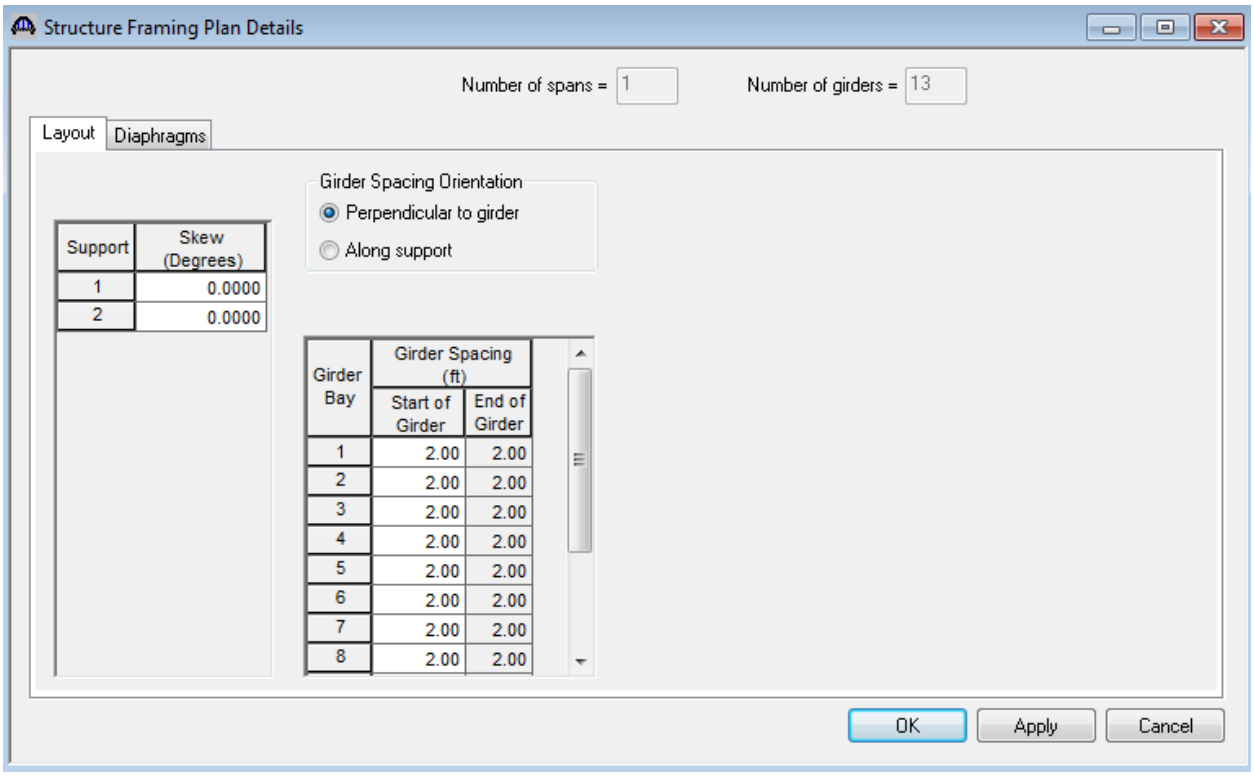
The partially expanded Bridge Workspace tree is shown below:



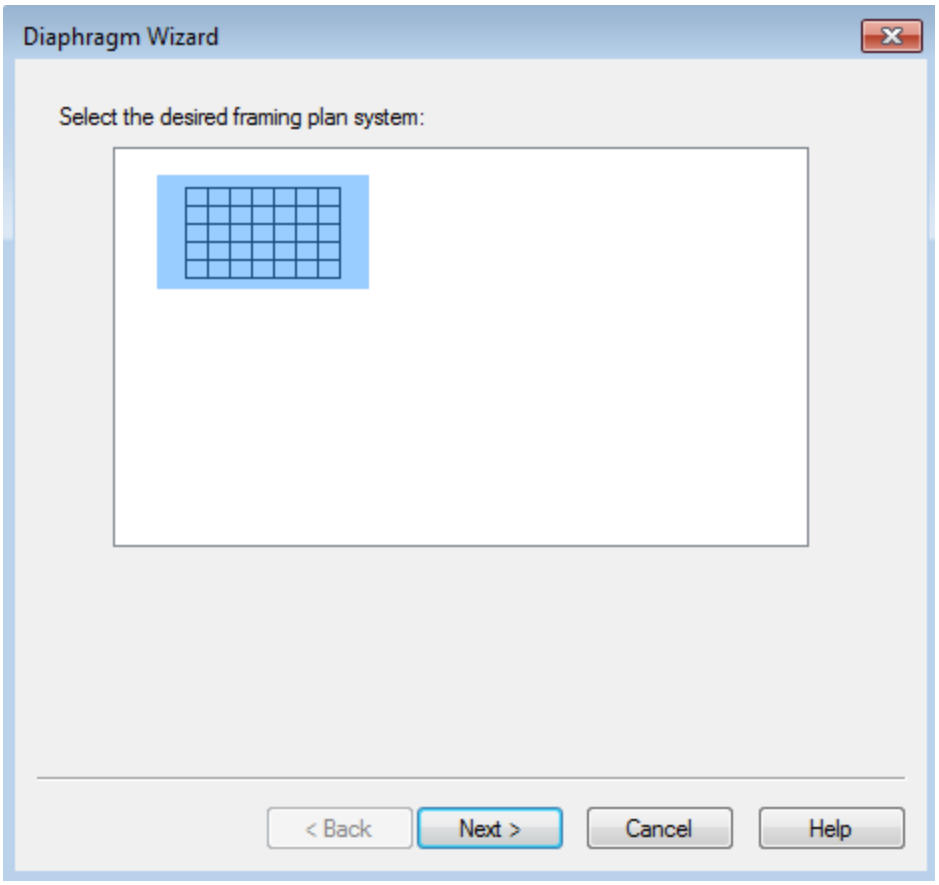
Click Load Case Description to define the dead load cases. The completed Load Case Description window is shown below.

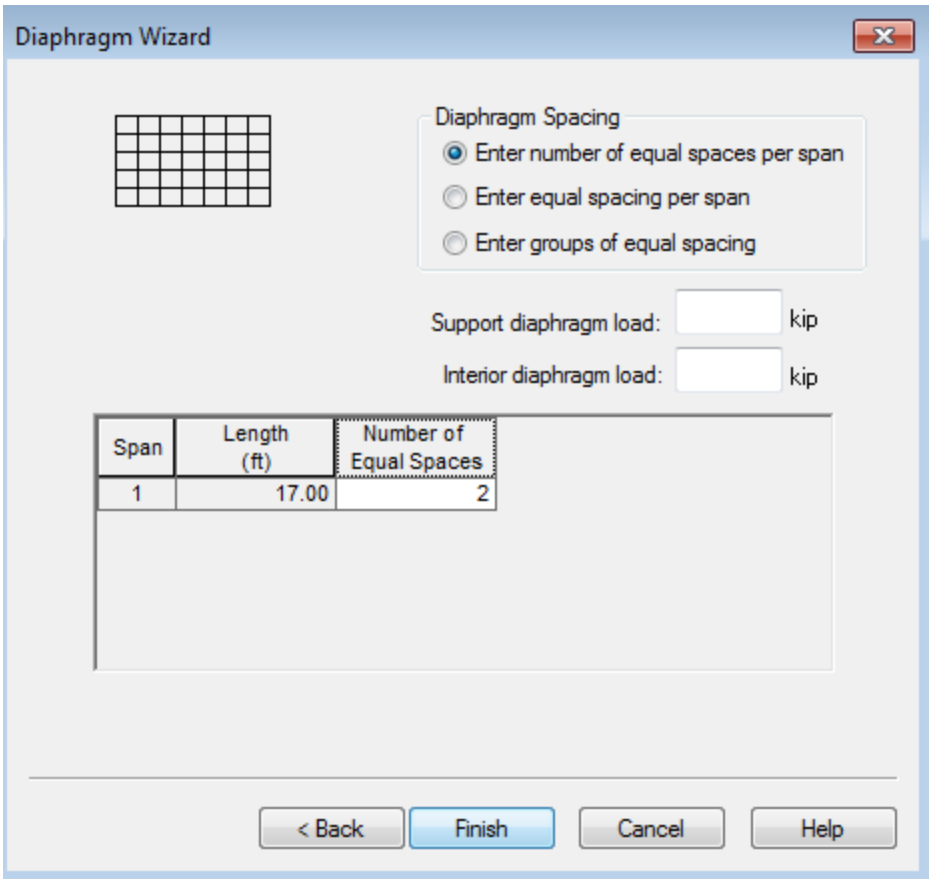


Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.



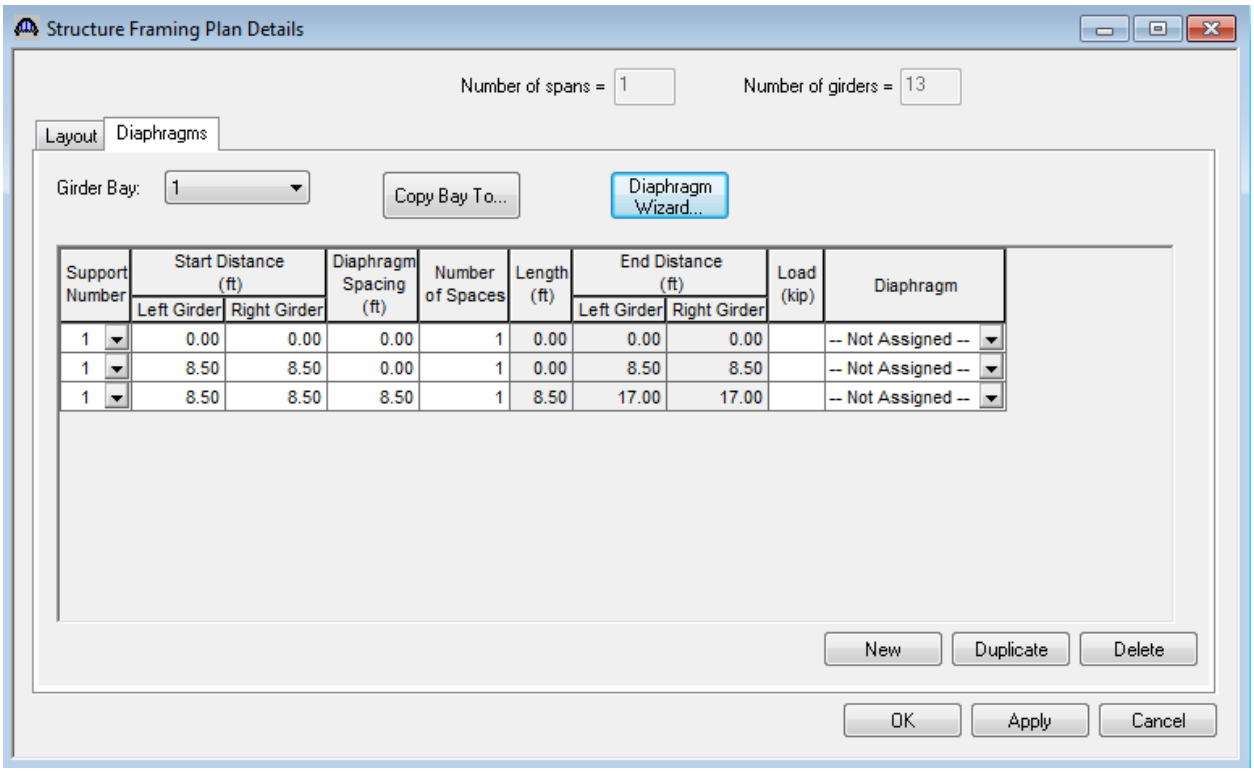
Switch to the Diaphragms tab to enter diaphragm spacing. Select the Diaphragm Wizard button to have BrR generate the diaphragm locations for you. The following window will appear. Select the Next button to continue.



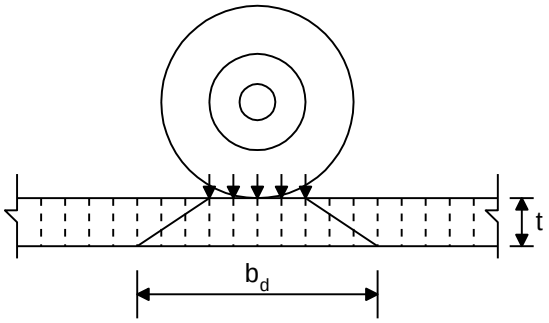


Enter 2 equal spaces in the span and click the Finish button.

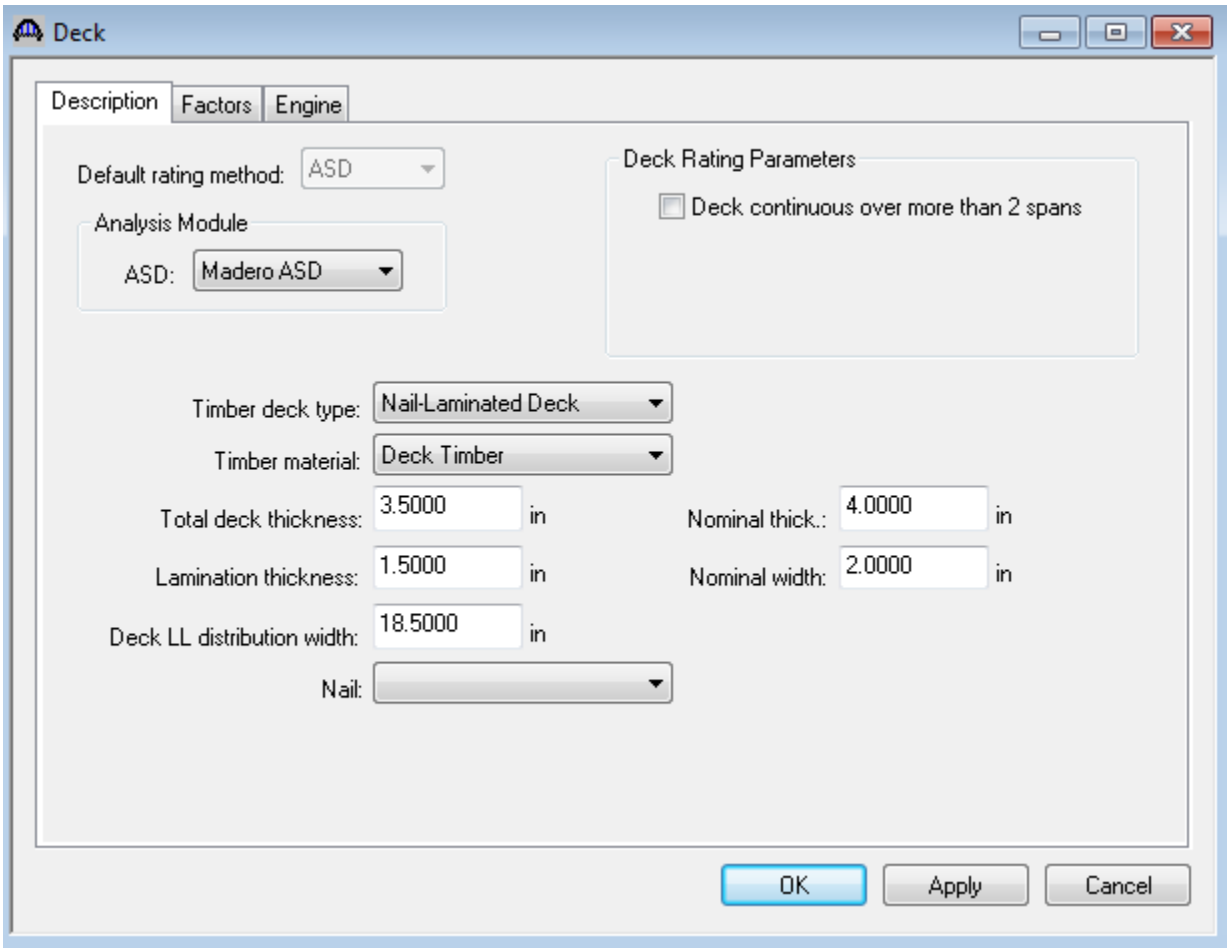
The Diaphragm Wizard generates the following diaphragm locations.



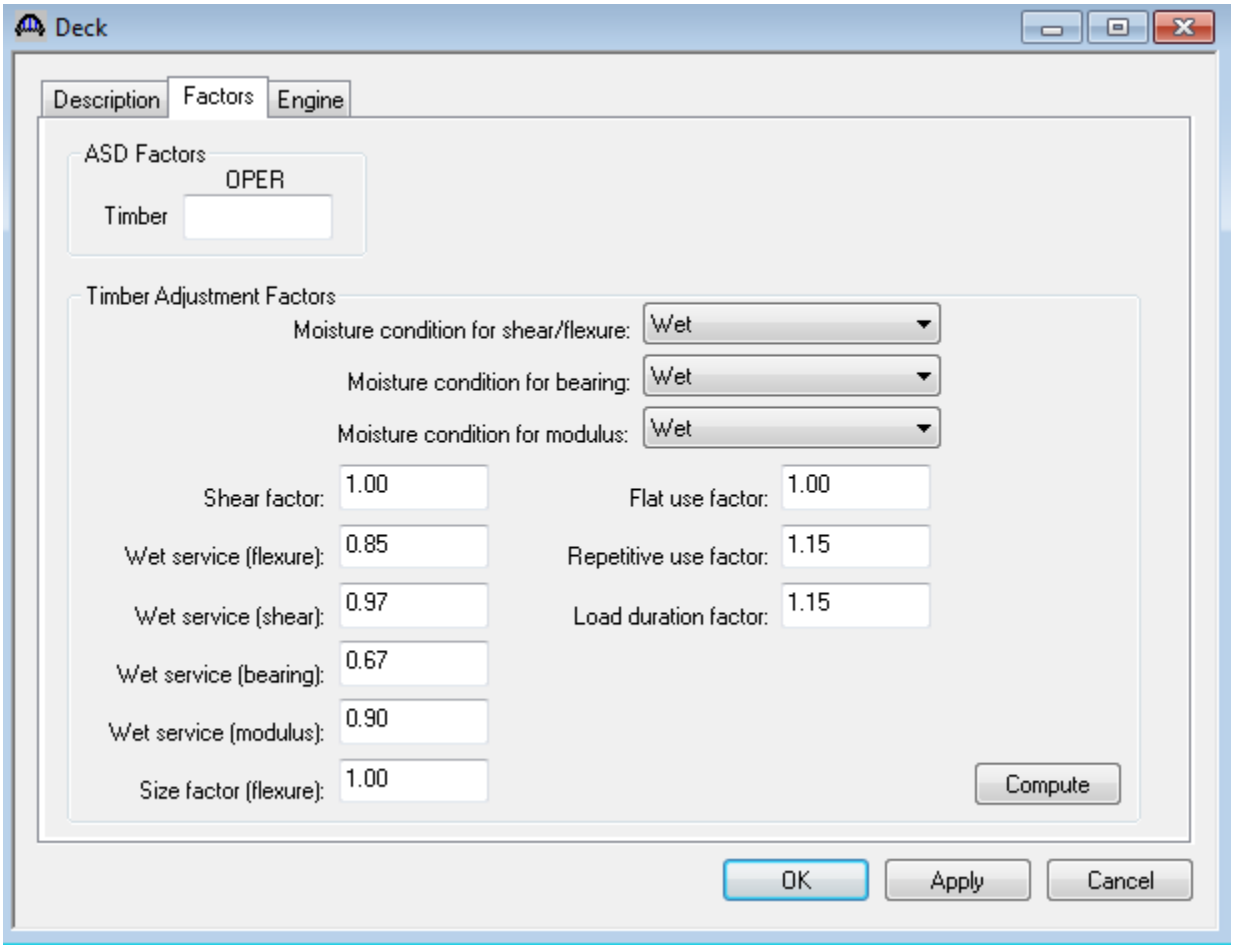
Enter the deck description by double-clicking on Deck in the Bridge Workspace tree. BrR/BrD only supports transverse timber decks. Select the type of deck as Nail-Laminated. The timber material to be used for the deck is selected from the list of bridge materials described above. A Nail definition has not been created yet so leave that field blank for now. The Deck LL distribution width is the wheel load distribution width in the direction perpendicular to the deck span as per AASHTO Standard Specifications for Highway Bridges, Article 3.25.1.1. This value equals 18.5" for this structure.



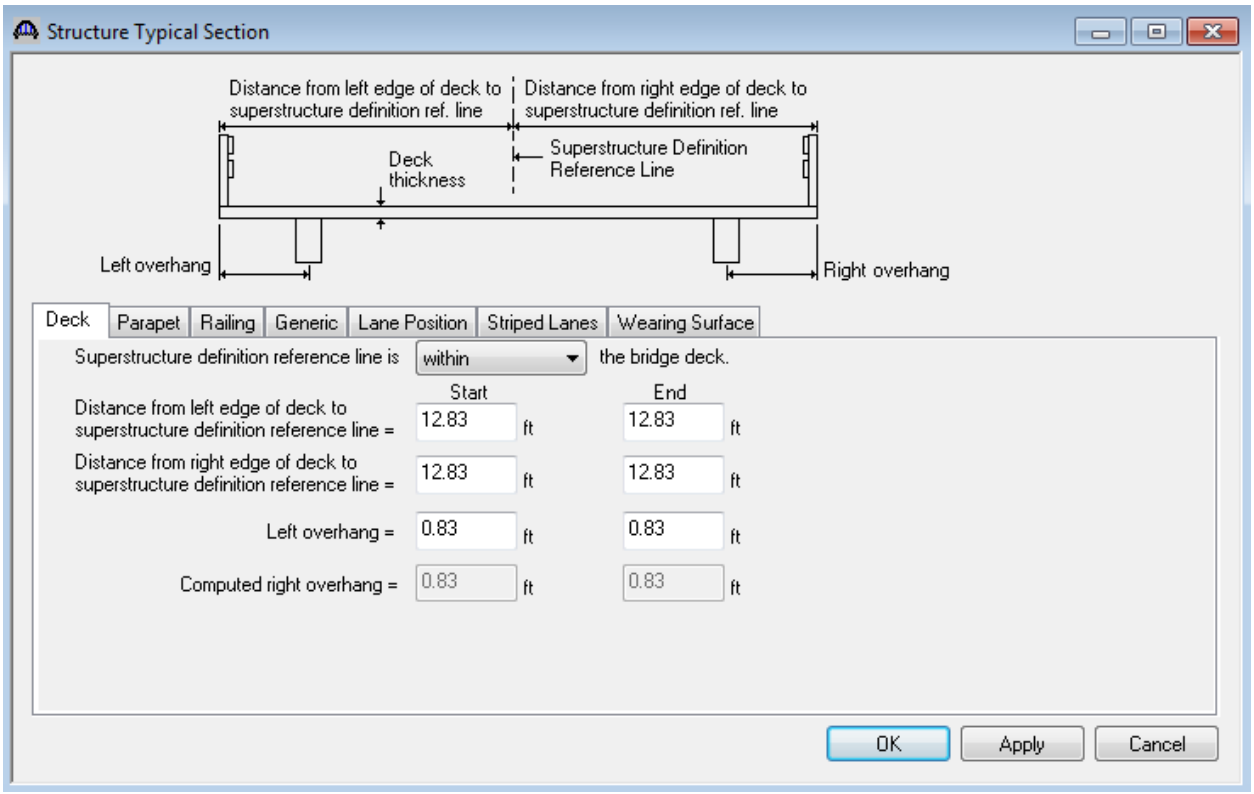
$b_d = t + 15$



The Factors tab of the Deck window allows you to enter adjustment factors to modify the tabulated design values entered on the Bridge Materials – Timber – Sawn window. Use the Compute button to compute the adjustment factors for the deck timber material based on Wet usage conditions. Enter the shear factor as 1.0.

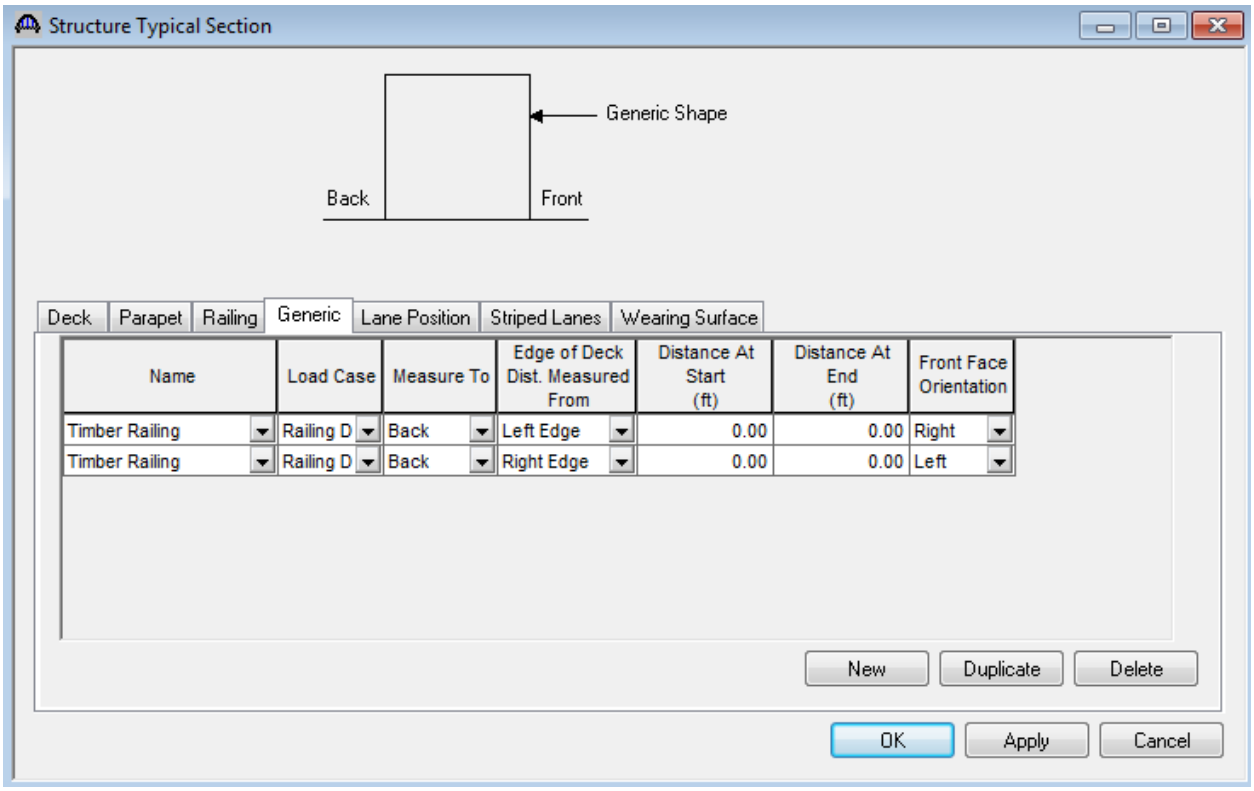


Next define the structure typical section by double-clicking on Structure Typical Section in the Bridge Workspace tree. Input the data describing the typical section as shown below.



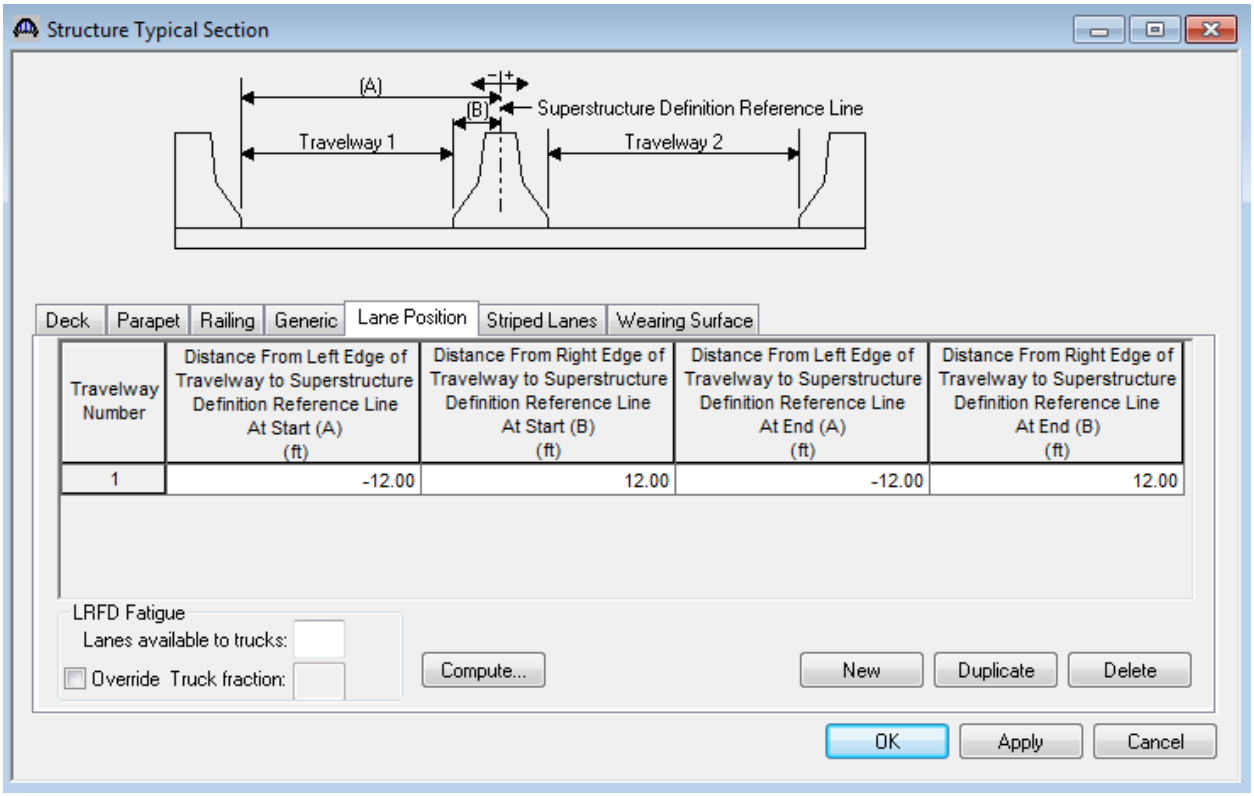
Generic Appurtenances:

Enter the railings on the Generic tab. Click New to add a row to the table. Enter the following data. The completed tab is shown below.

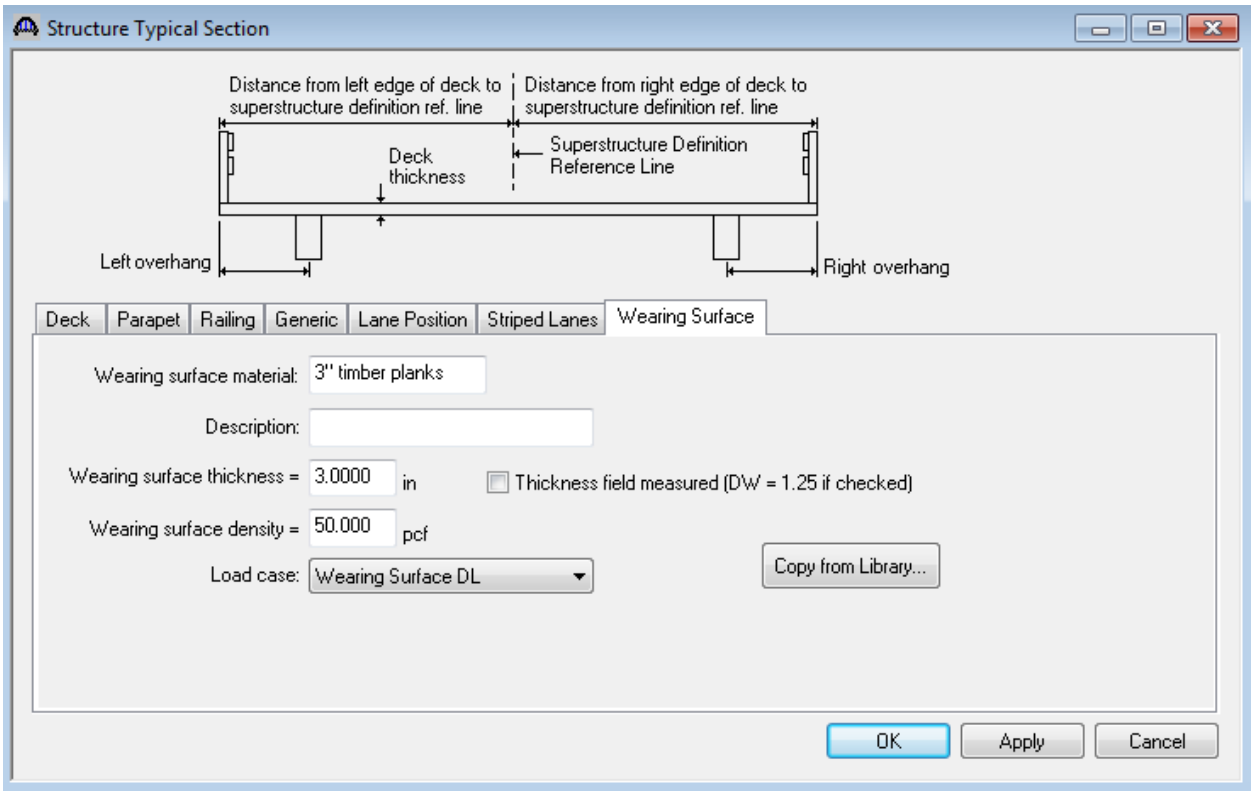


Lane Positions:

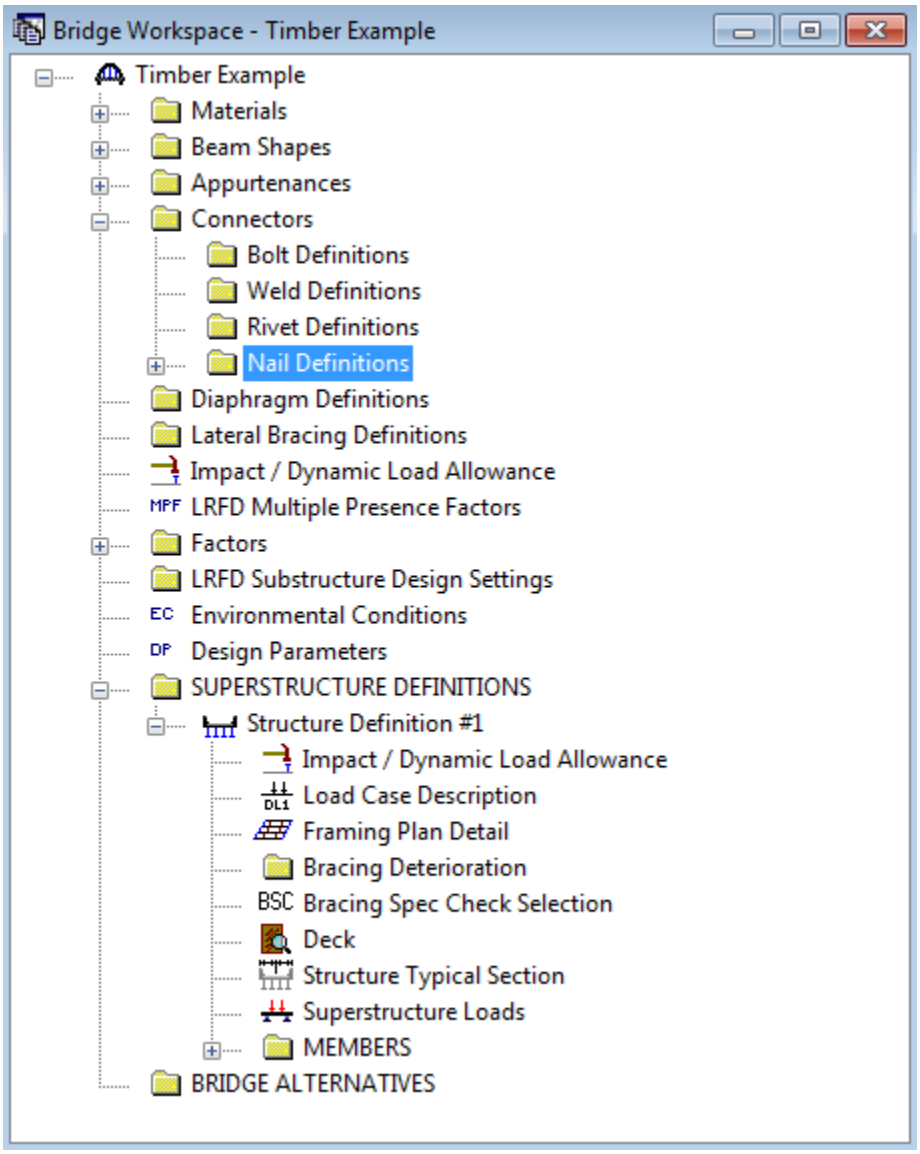
Select the Lane Position tab. Enter the values shown below or click the Compute… button to automatically compute the lane positions. A dialog showing the results of the computation opens. Click Apply to apply the computed values. The Lane Position tab is populated as shown below.



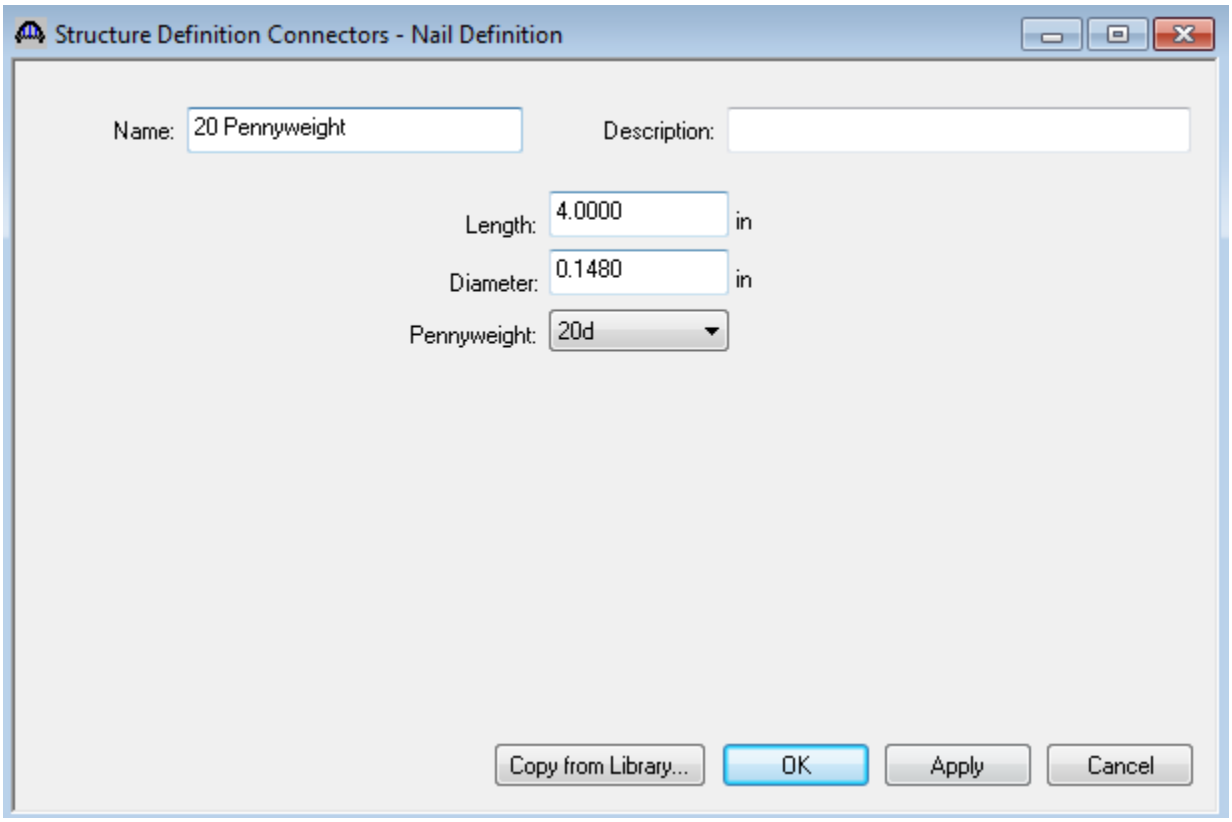
Enter the following wearing surface information on the Wearing Surface tab.



To create a nail definition, expand the Connectors tree item and double click on Nail.



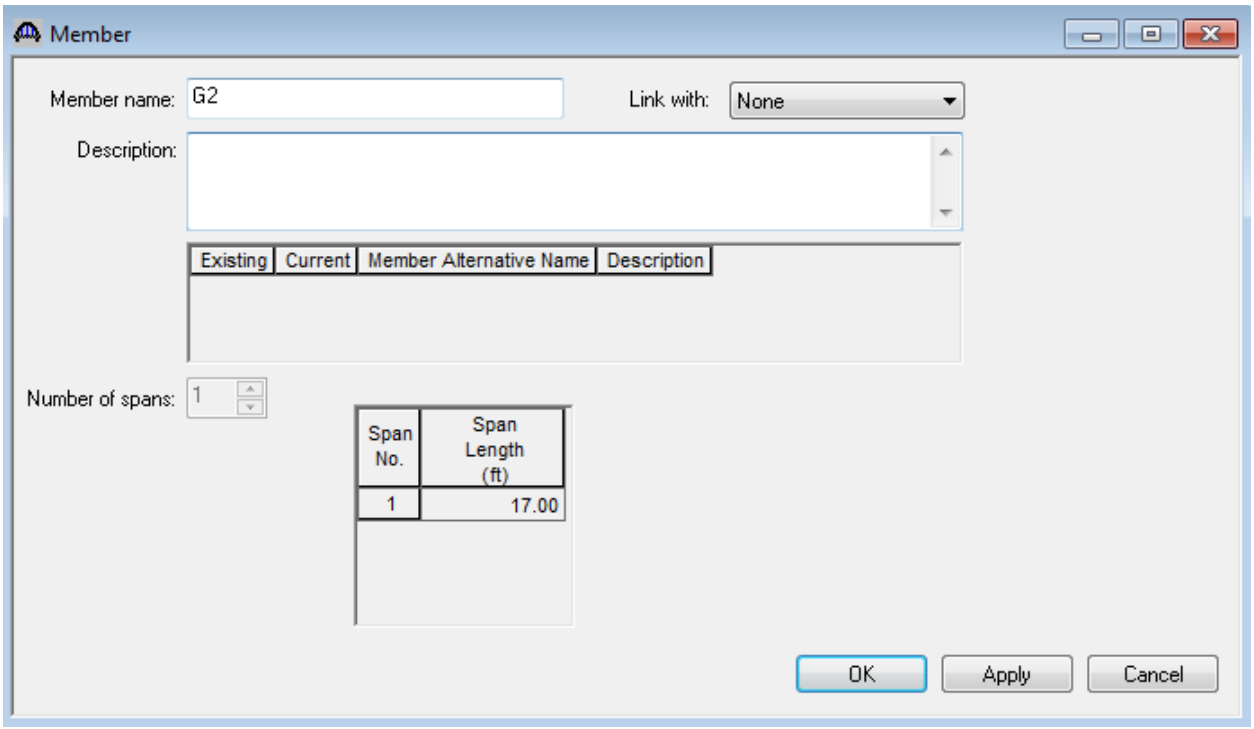
Define the nail as shown below. Click OK to save to memory and close the window.



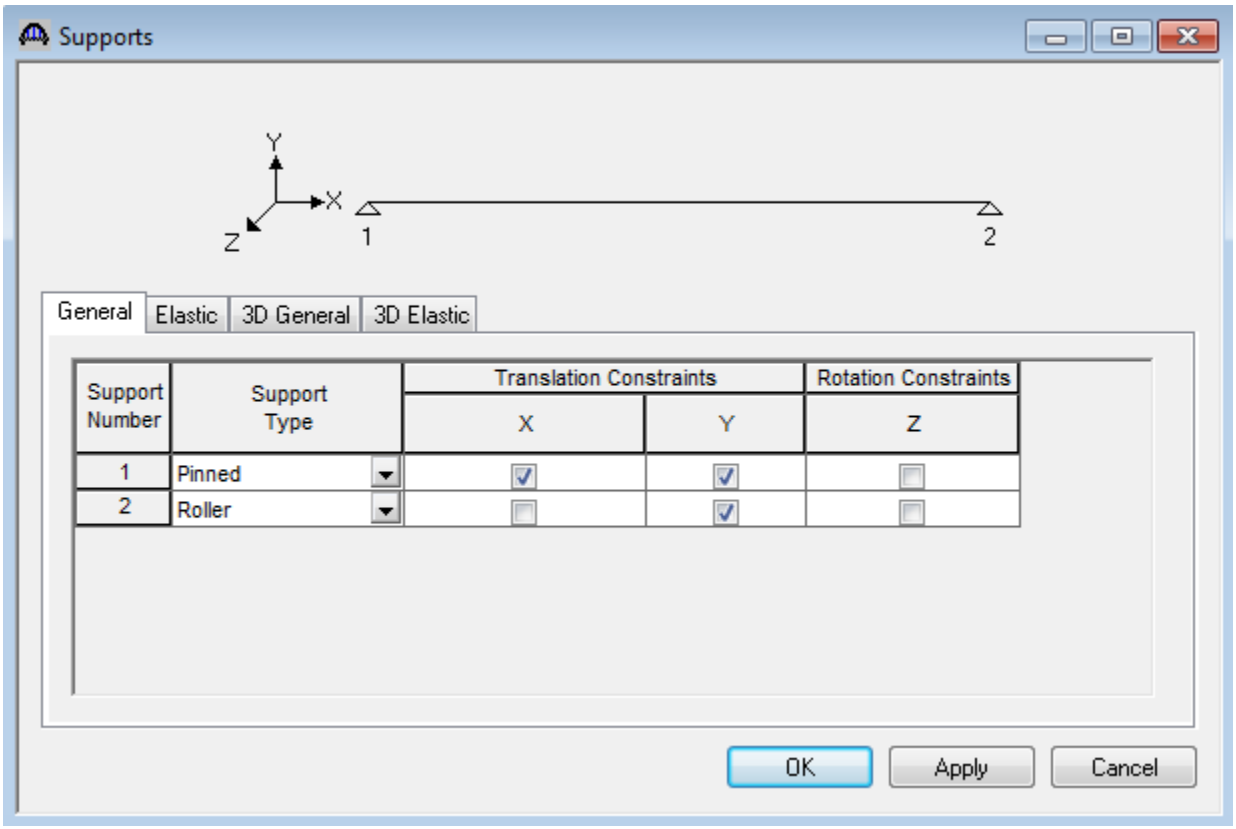
Now that we have created a nail definition we can apply this definition to nails in the deck. Reopen the Deck window. Select the 20 Pennyweight nail definition as the Nail. Click OK to save to memory and close the window.

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. After a Member Alternative is defined it will appear in the list of member alternatives.

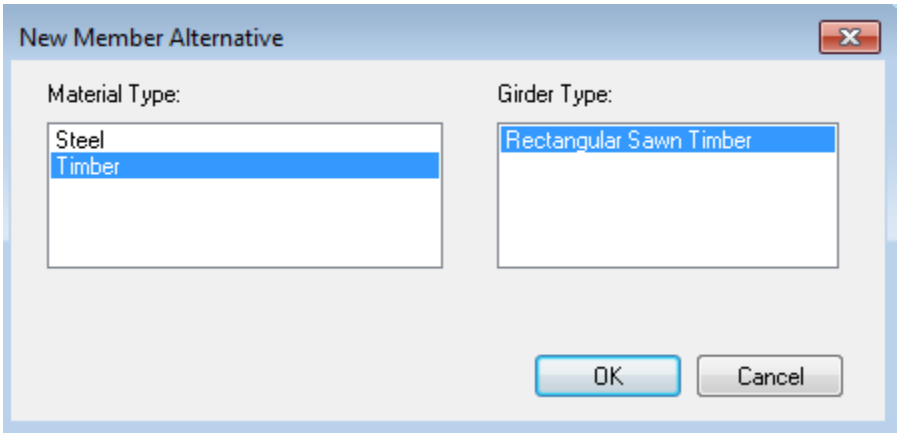


Support constraints were generated when the structure definition was created and are shown below.

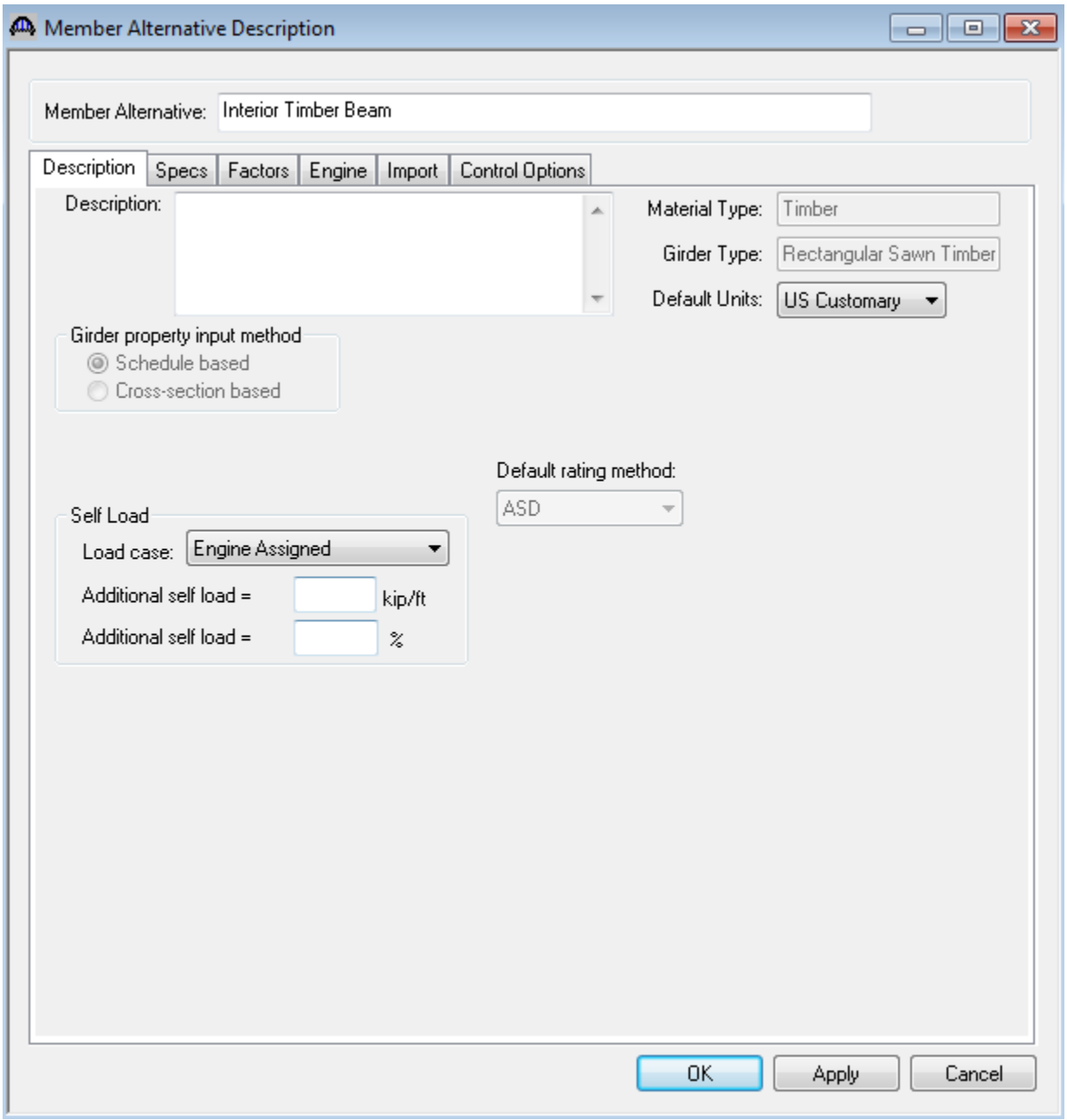


Defining a Member Alternative:

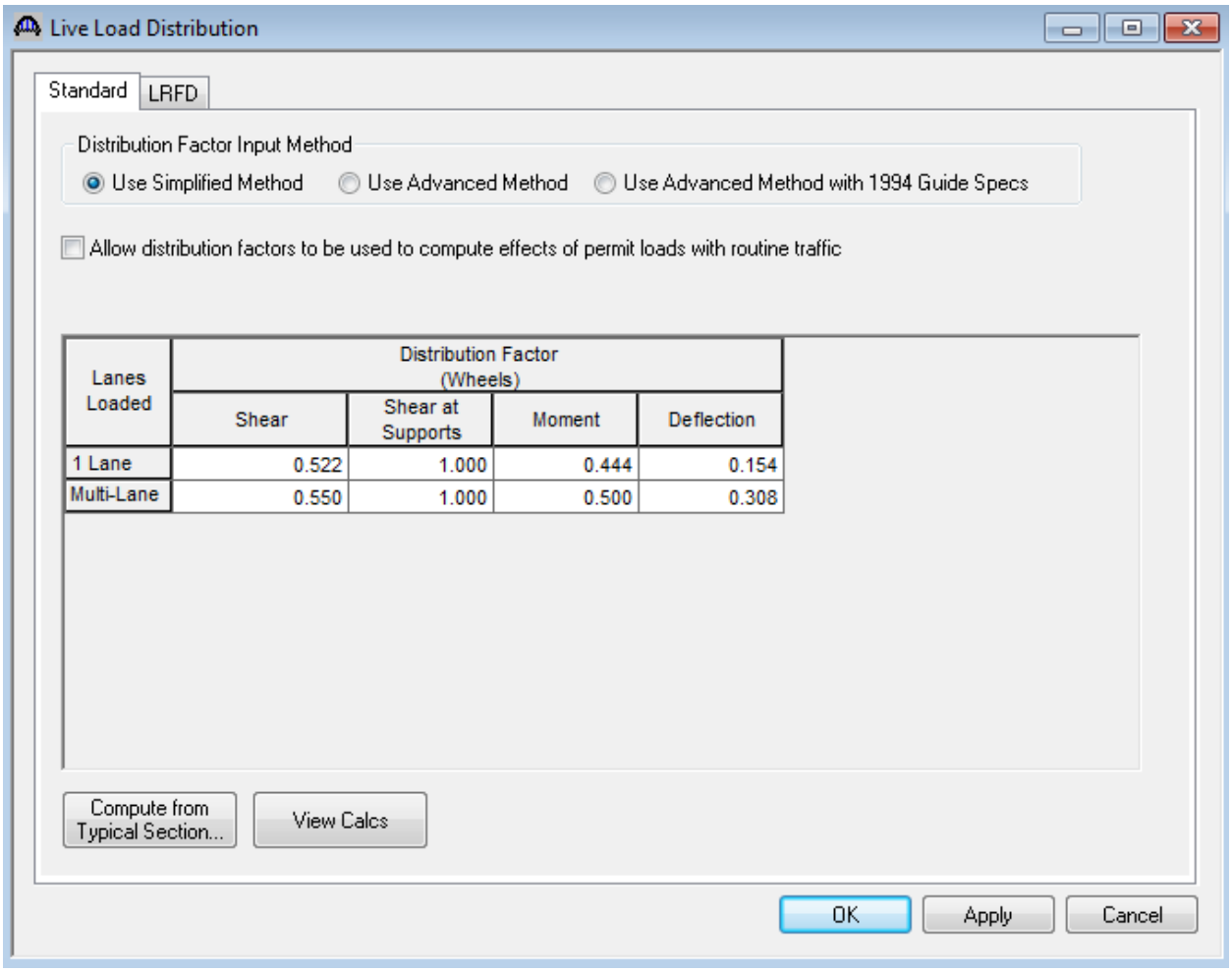
Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Timber for the Material Type and Rectangular Sawn Timber for the Girder Type. Only Timber is available for the Material Type since a timber deck type was selected on the Structure Definition window. Timber decks are limited to timber beams in BrR/BrD.



Enter the following data for the Member Alternative. Click OK to save to memory and close the window.



Use the Compute from Typical Section button to compute the following live load distribution factors.



The live load distribution factors are computed as follows:

Moment DF (AASHTO Table 3.23.1)

$$\text{Single Lane Moment DF} = \frac{S}{4.5} = \frac{2}{4.5} = 0.4444$$

$$\text{Multi Lane Moment DF} = \frac{S}{4.0} = \frac{2}{4.0} = 0.5000$$

Shear at Supports DF (AASHTO Article 3.23.1.2)

By simple beam distribution, both single and multi lane Shear at Support DF = 1.0000

Shear DF(AASHTO Article 3.23.1.2 refers to AASHTO Article 13.6.5.2)

$V_{LL} = 0.50\left[(0.60V_{LU}) + V_{LD}\right]$ (AASHTO Eq. 13-10)

where V_{LU} = shear due to undistributed wheel loads (ie, one line of wheels carried by one bending member) = 1

V_{LD} = shear due to wheel loads distributed laterally as specified for moment in Article 3.23

$$\text{Single Lane Shear DF} = 0.50\left[(0.60(1) + 0.4444\right] = 0.5222$$

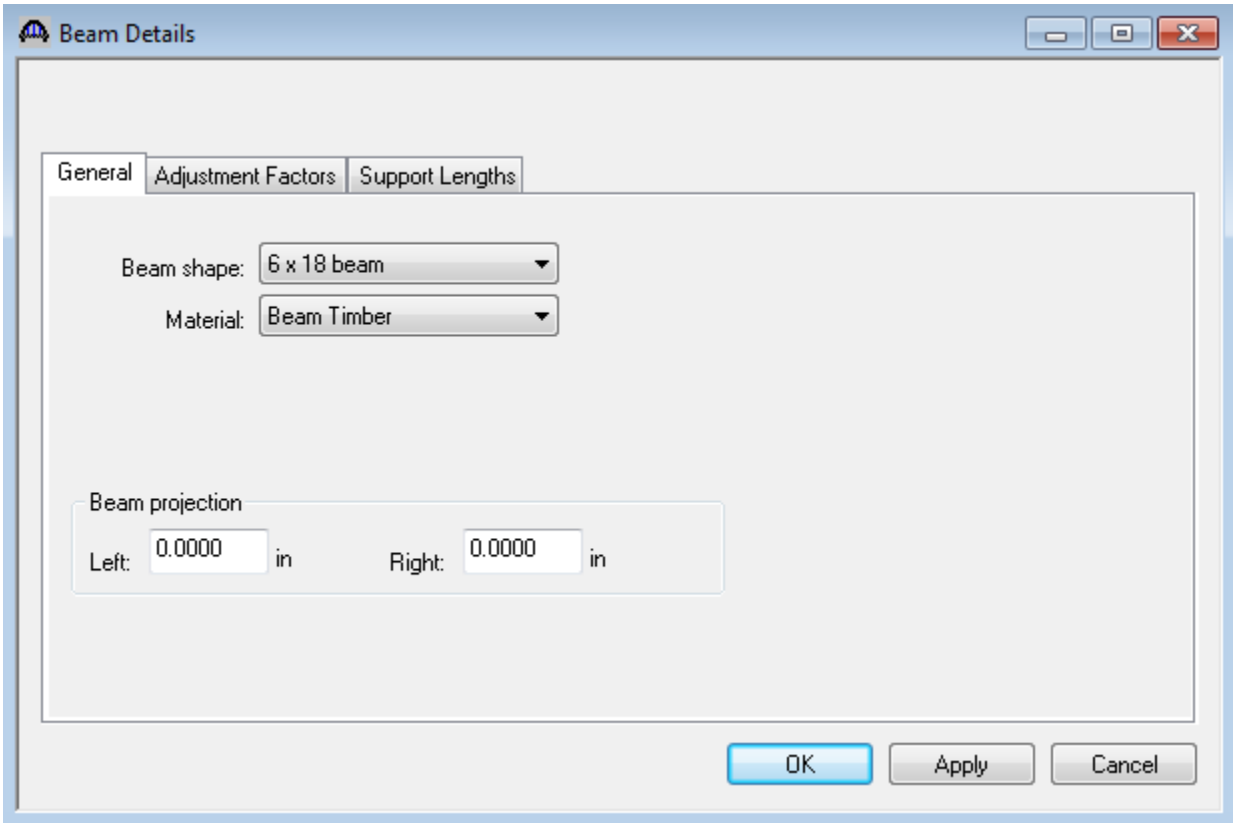
$$\text{Multi Lane Shear DF} = 0.50\left[(0.60(1) + 0.5000)\right] = 0.5500$$

Deflection DF

$$\text{Single Lane Deflection DF} = \frac{1\,\text{lane} * 2\,\text{wheels/lane}}{13\,\text{beams}} = 0.1538$$

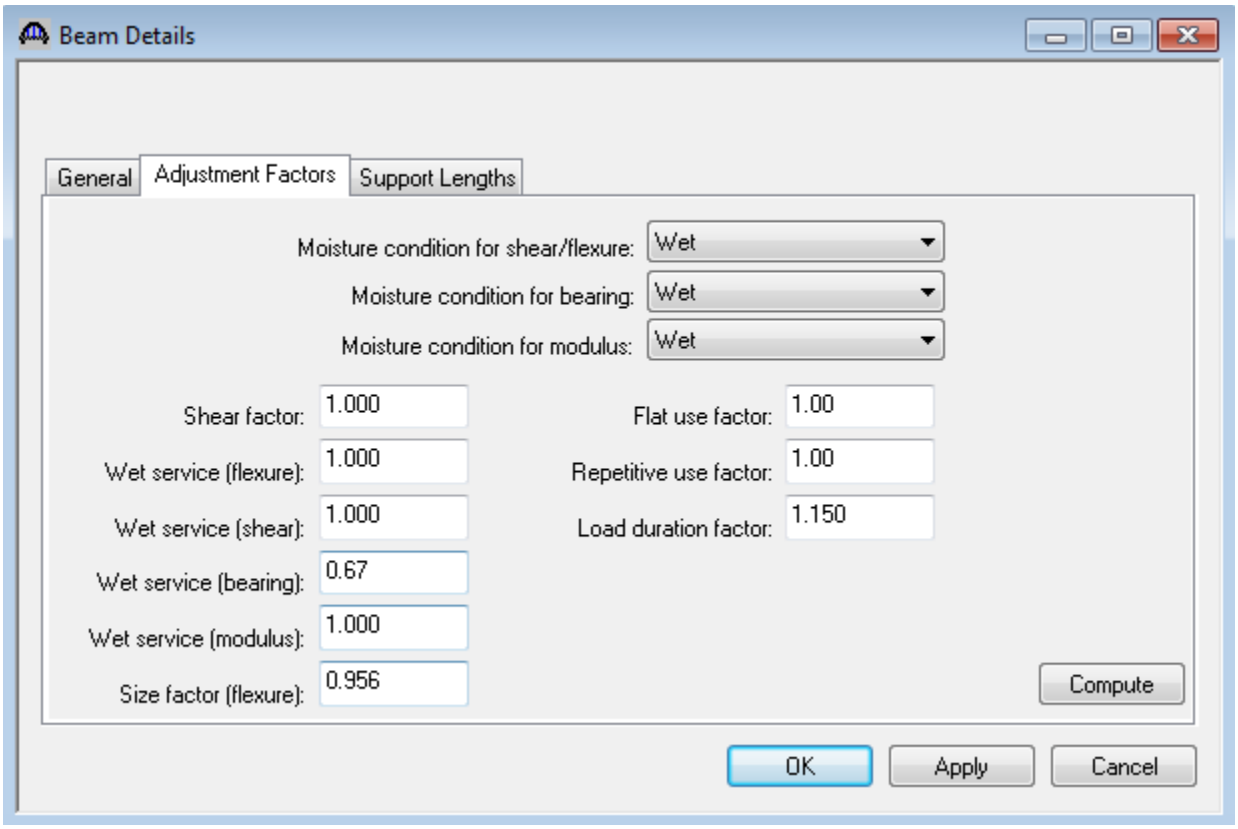
$$\text{Multi Lane Deflection DF} = \frac{2\,\text{lane} * 2\,\text{wheels/lane}}{13\,\text{beams}} = 0.3077$$

Open the Beam Details window by double clicking on Beam Details in the tree. The Beam Details window is shown below.

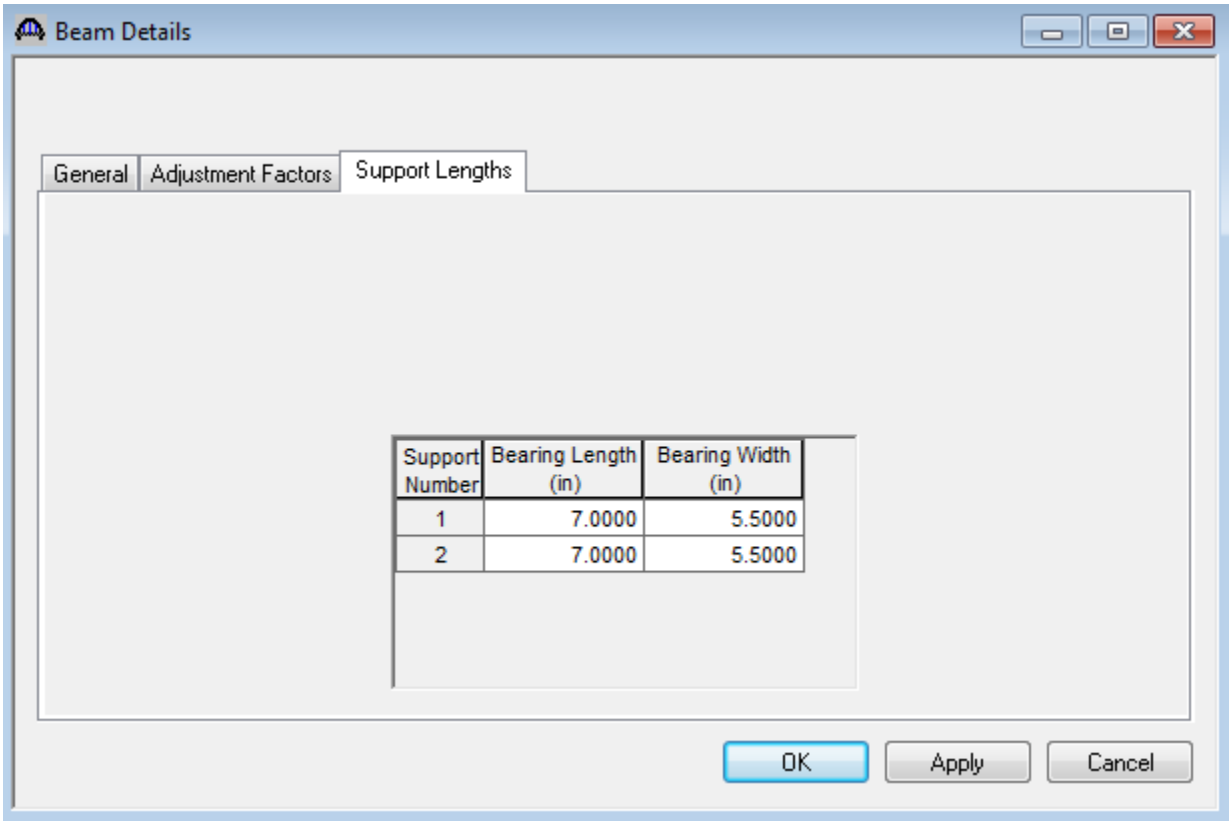


The Adjustment Factors tab of the Beam Details window allows you to enter adjustment factors to modify the tabulated design values entered on the Bridge Materials – Timber – Sawn window. The tabulated design values modified by these adjustment factors produce the design allowable stresses.

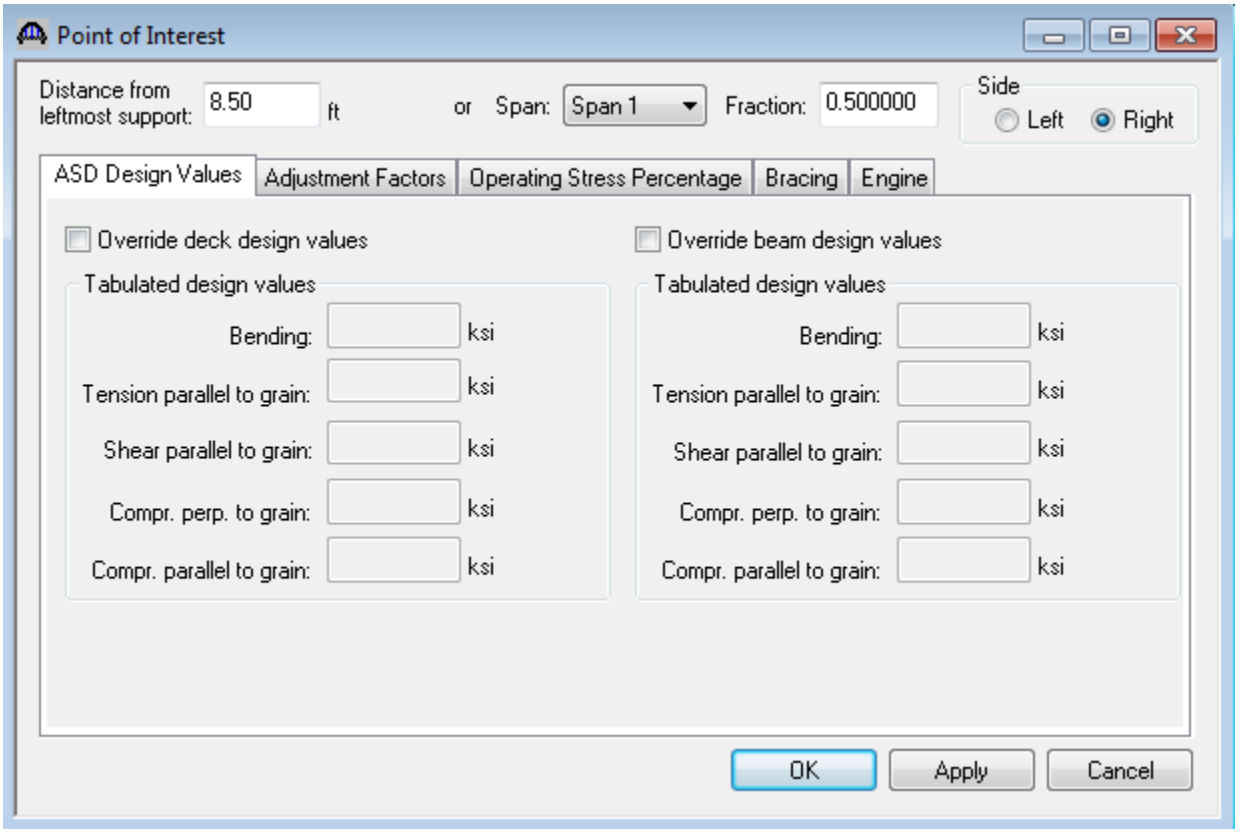
Select the Wet condition for Shear/Flexure, Bearing and Modulus. Use the Compute button to calculate the factors for the beam based on the Wet moisture conditions. Enter 1.0 for the Shear factor since it is not calculated by the Compute button. This factor is not computed for you since it is dependent on the visual characteristics of the actual timber material used.



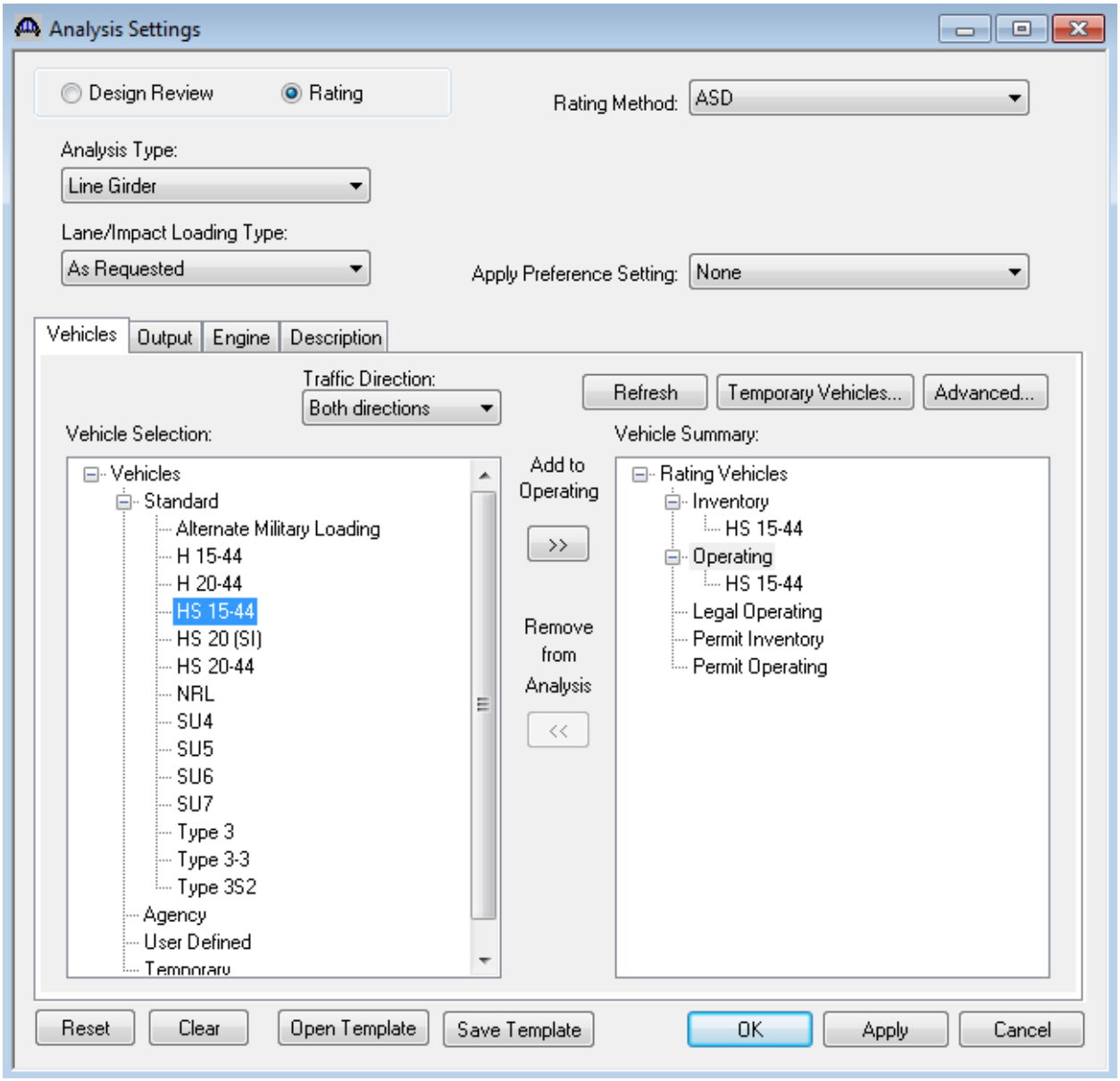
Enter the following data on the Support Lengths tab. Click OK to save to memory and close the Beam Details window.



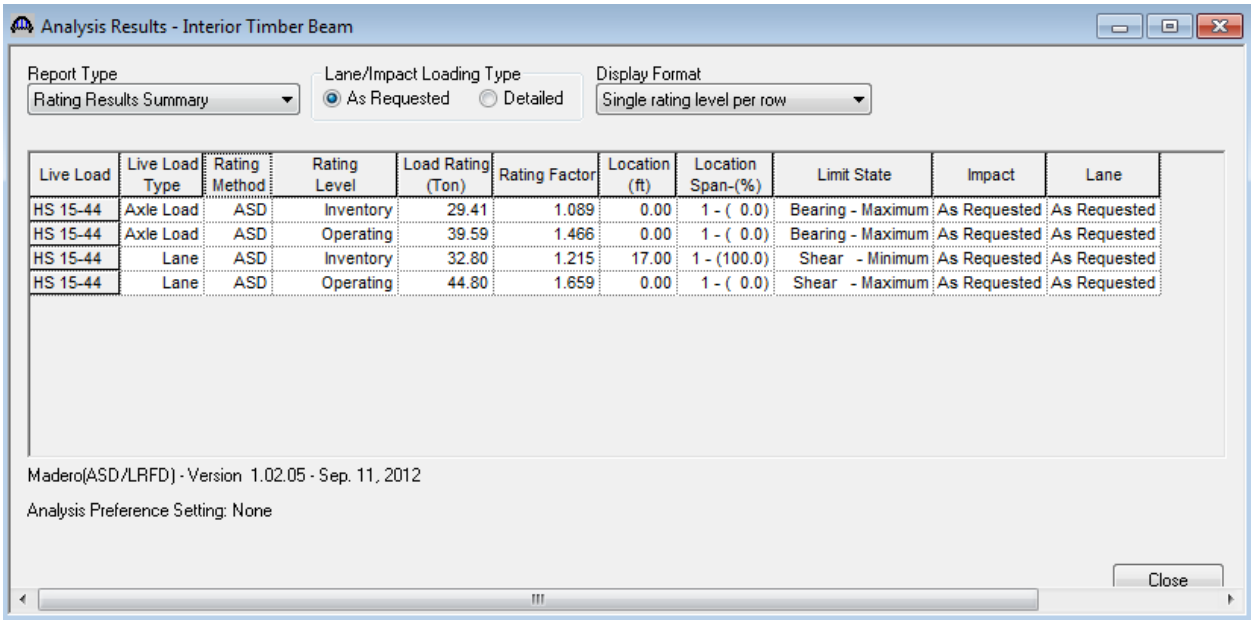
Define Points of Interest using the Point of Interest window shown below. A window for defining a Point of Interest is opened by double clicking on the Points of Interest tree item.



To perform a rating, select the View Analysis Settings button on the toolbar to open the window shown below. Select ASD as the Rating Method, select the HS15 vehicle to be used in the rating and click OK.



Next click the Analyze button on the toolbar to perform the rating. When the rating is finished you can review the results by clicking the View analysis Report on the toolbar. The window shown below will open.



Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
HS 15-44	Axle Load	ASD	Inventory	29.41	1.089	0.00	1 - (0.0)	Bearing - Maximum	As Requested	As Requested
HS 15-44	Axle Load	ASD	Operating	39.59	1.466	0.00	1 - (0.0)	Bearing - Maximum	As Requested	As Requested
HS 15-44	Lane	ASD	Inventory	32.80	1.215	17.00	1 - (100.0)	Shear - Minimum	As Requested	As Requested
HS 15-44	Lane	ASD	Operating	44.80	1.659	0.00	1 - (0.0)	Shear - Maximum	As Requested	As Requested