AASHTOWare BrD/BrR 7.3

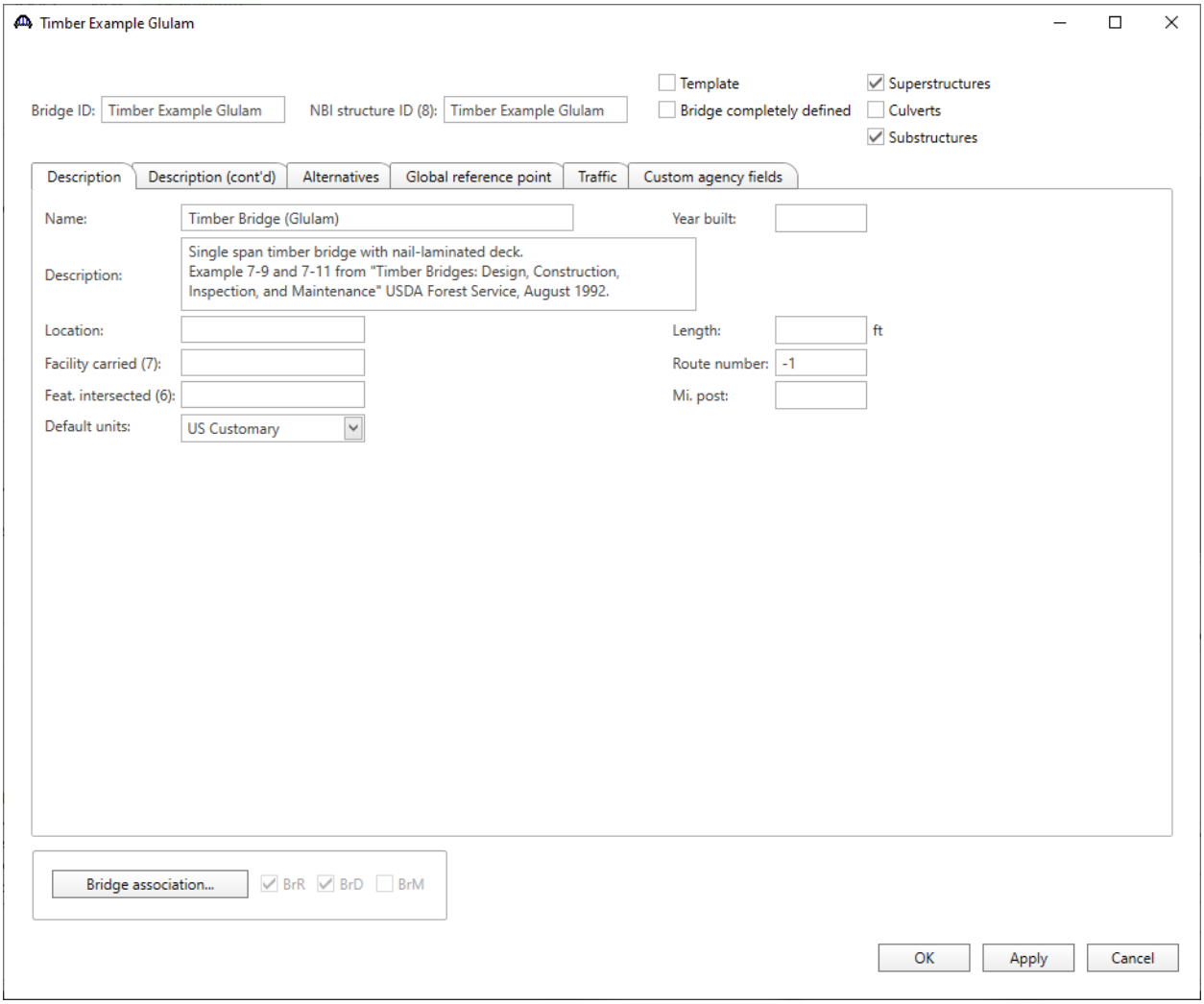
Timber Structure Tutorial

TMBR3- Single Span Timber Beam - Glulam Example

BrD and BrR Training

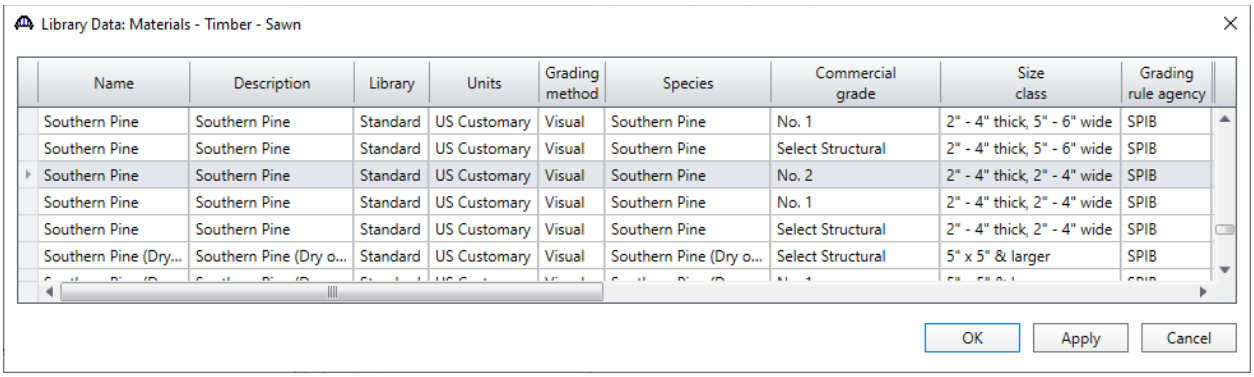
TMBR1- Single Span Timber Beam Example

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

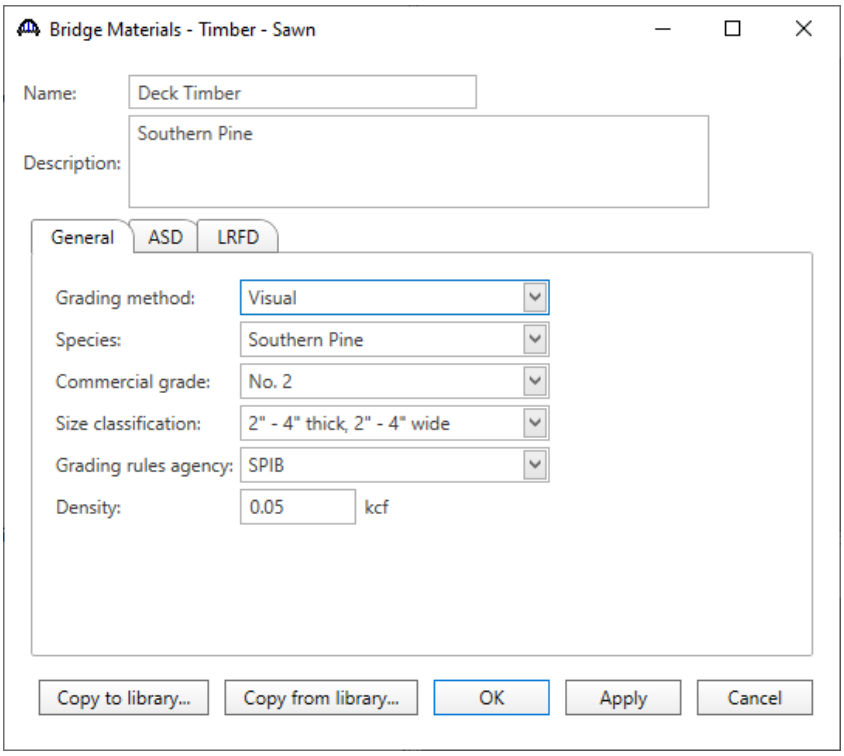


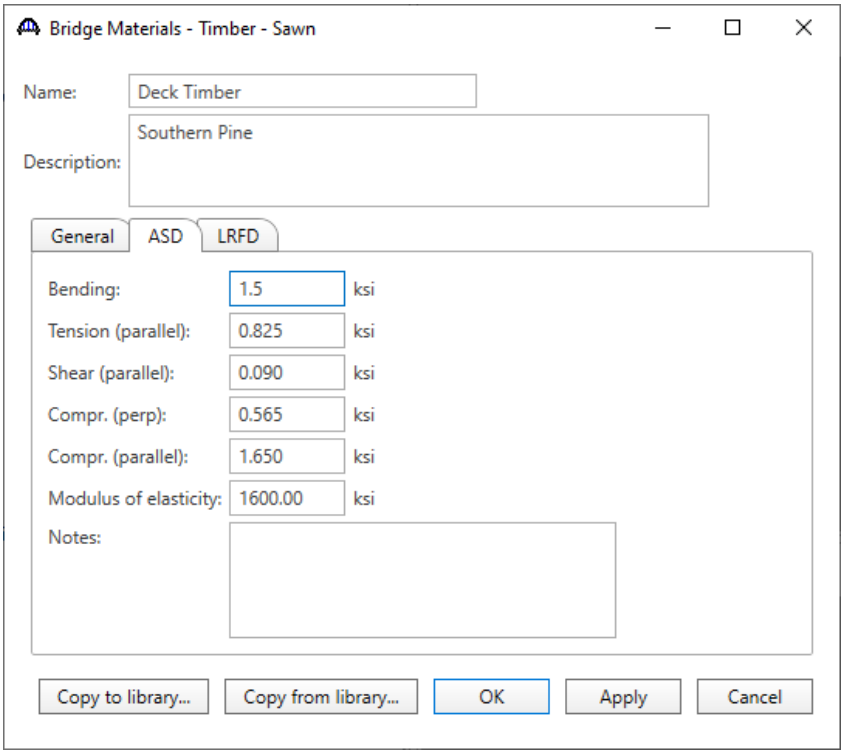
Close the window by clicking OK. This saves the data to memory and closes the window.

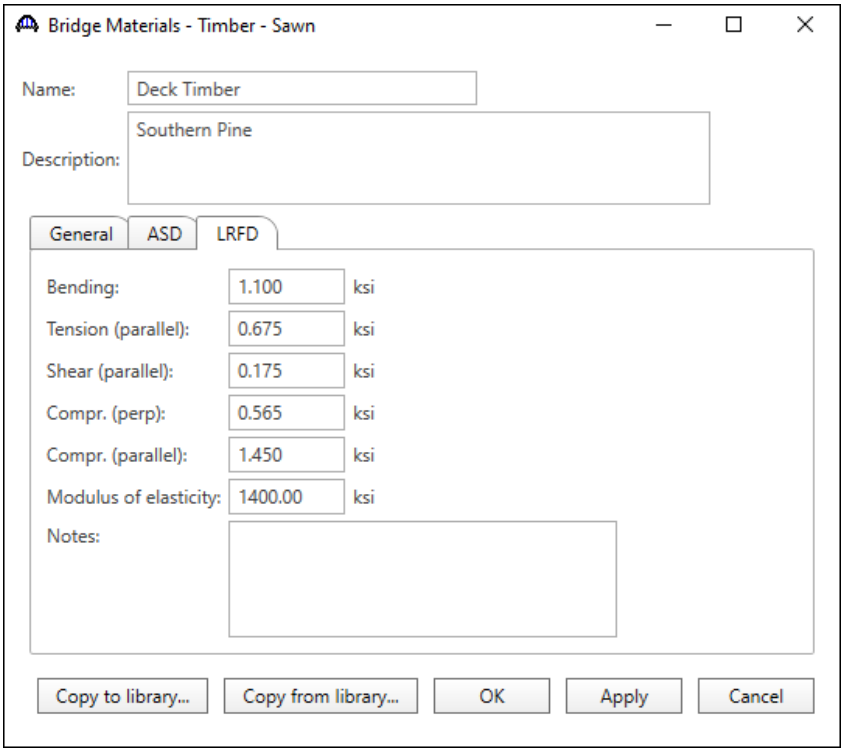
To add a new timber material for timber deck, click on Materials, Timber, Sawn in the tree and select New from the Manage group of the Workspace toolbar from the menu (or right mouse click on Sawn and select New). Click the Copy from Library button and select the following material from the library.



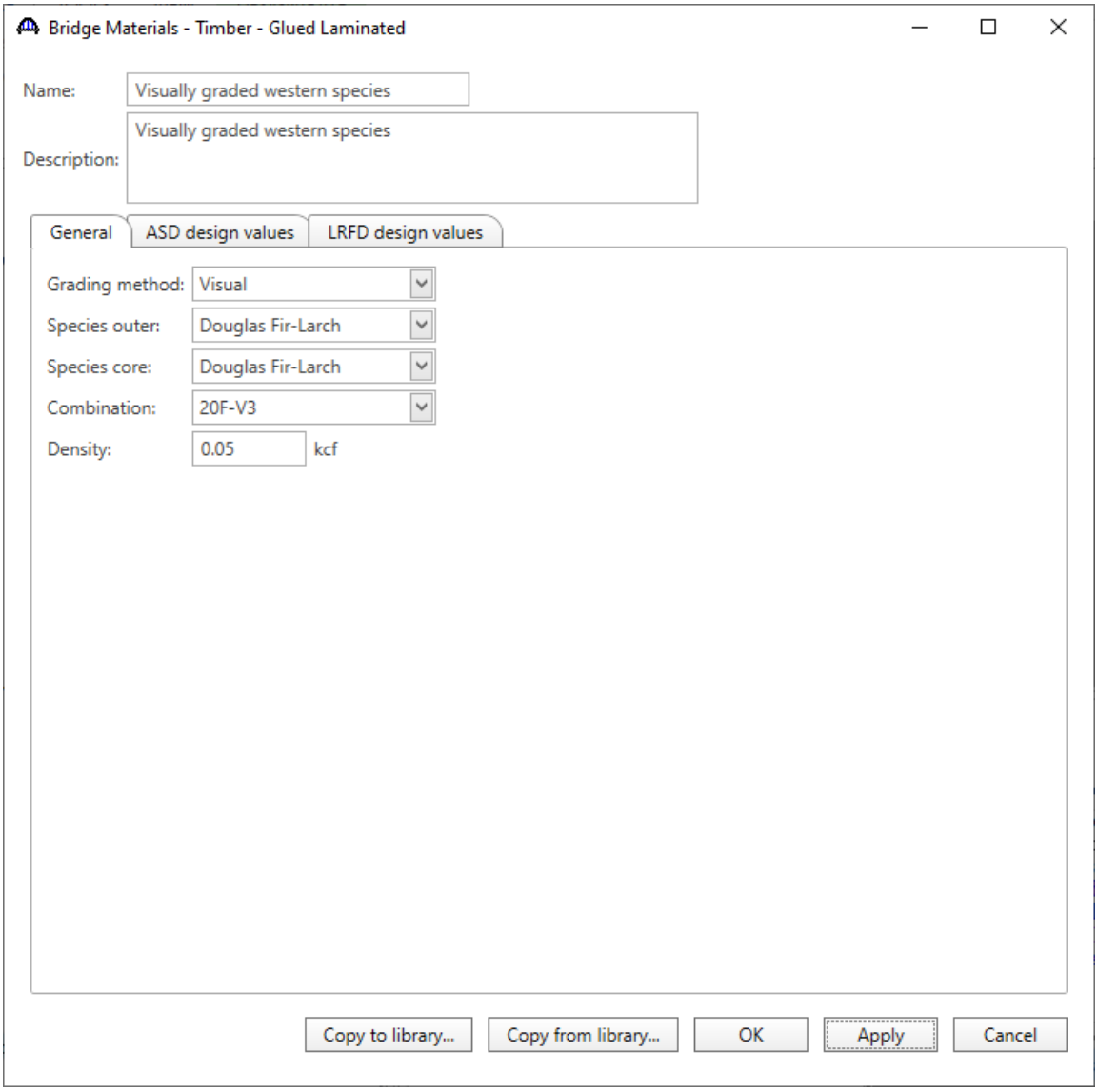
Click OK and the following window will open. Change the name of the material to "Deck Timber" from Southern Pine. The ASD Tabulated Design Values in the ASD tab of this window and the LRFD Reference design values in the LRFD tab of this window are based on dry conditions and do not include any adjustment factors based on usage conditions. Click OK to save this timber material to memory and close the window.

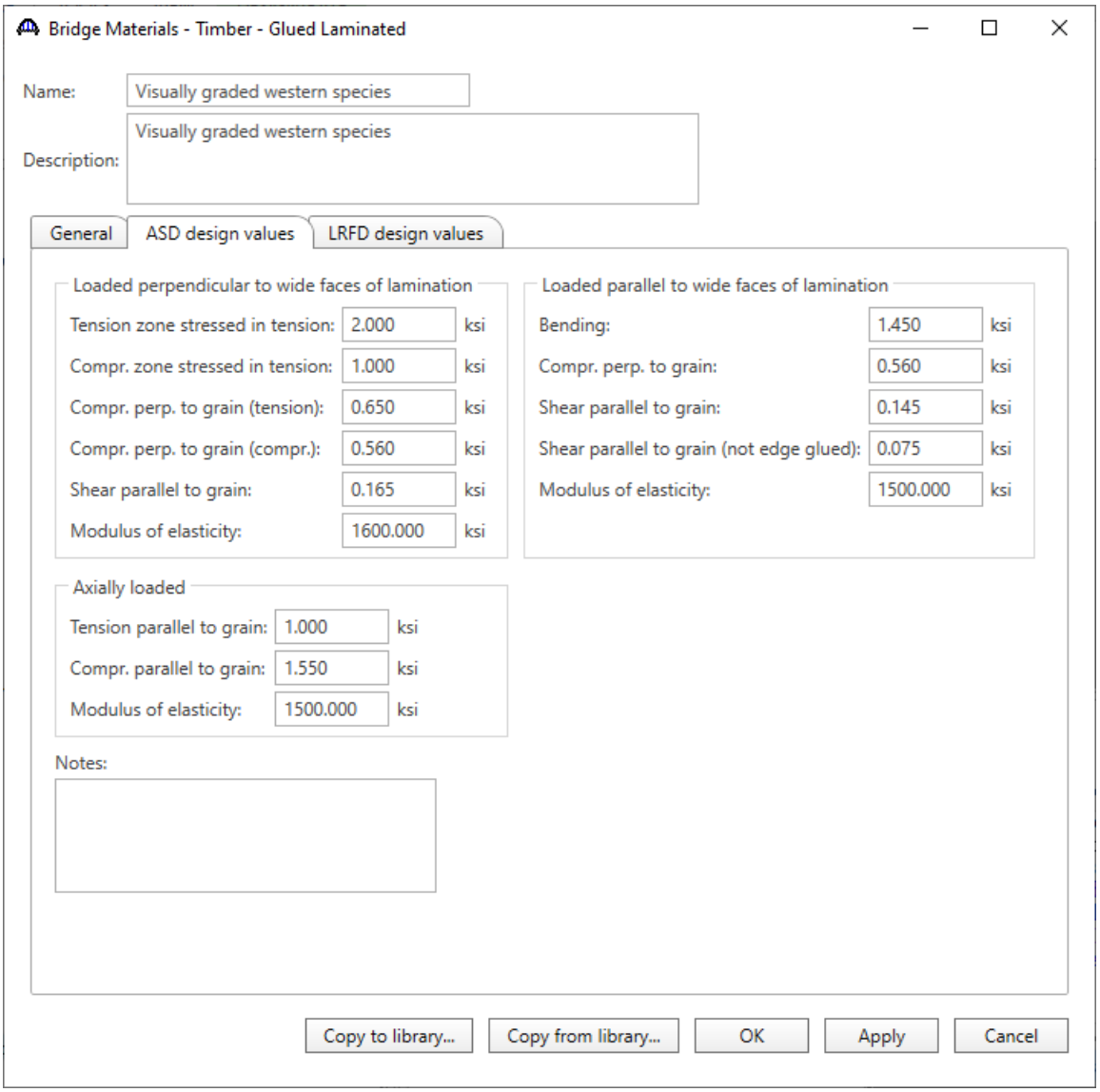


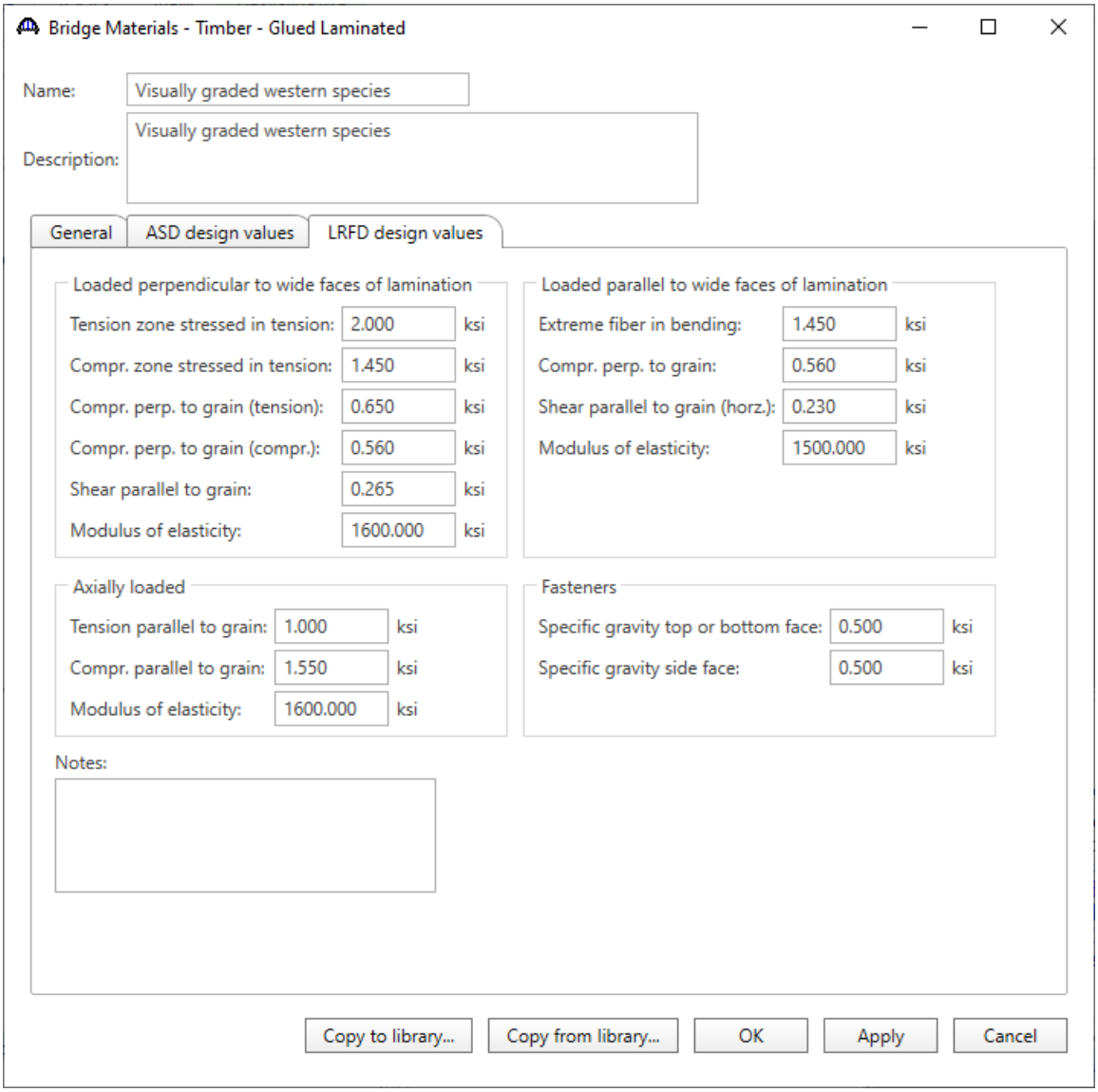

Bridge Materials - Timber - Sawn
Name:
Deck Timber
Description:
Southern Pine
General
ASD
LRFD
Bending:
1.5
ksi
Tension (parallel):
0.825
ksi
Shear (parallel):
0.090
ksi
Compr. (perp):
0.565
ksi
Compr. (parallel):
1.650
ksi
Modulus of elasticity:
1600.00
ksi
Notes:
Copy to library...
Copy from library...
OK
Apply
Cancel


Bridge Materials - Timber - Sawn
Name:
Deck Timber
Description:
Southern Pine
General
ASD
LRFD
Bending:
1.100
ksi
Tension (parallel):
0.675
ksi
Shear (parallel):
0.175
ksi
Compr. (perp):
0.565
ksi
Compr. (parallel):
1.450
ksi
Modulus of elasticity:
1400.00
ksi
Notes:
Copy to library...
Copy from library...
OK
Apply
Cancel

To add a new timber material for timber beam, click on Materials, Timber, Glued Laminated in the tree and select New from the Manage group of the Workspace toolbar from the menu (or right mouse click on Glued Laminated and select New). Enter the details of this material as shown in images below:

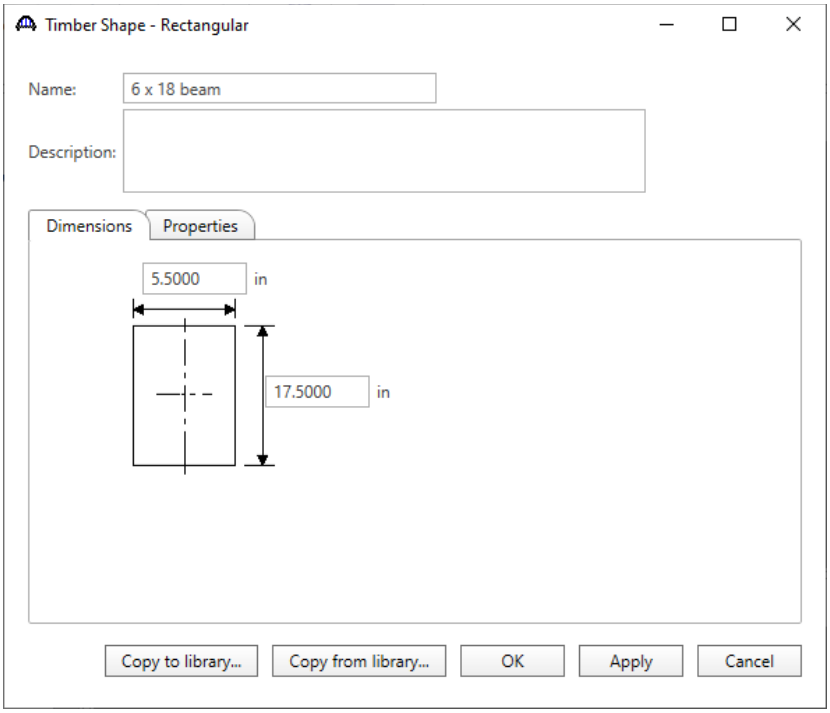


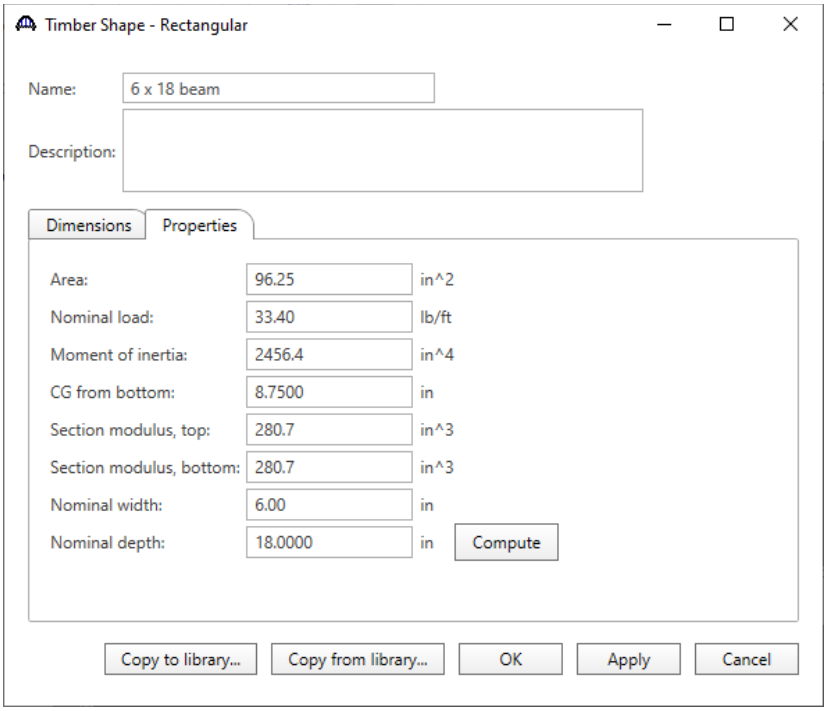

Bridge Materials - Timber - Glued Laminated
Name:
Visually graded western species
Description:
Visually graded western species
General
ASD design values
LRFD design values
Loaded perpendicular to wide faces of lamination
Tension zone stressed in tension: 2.000 ksi
Compr. zone stressed in tension: 1.000 ksi
Compr. perp. to grain (tension): 0.650 ksi
Compr. perp. to grain (compr.): 0.560 ksi
Shear parallel to grain: 0.165 ksi
Modulus of elasticity: 1600.000 ksi
Loaded parallel to wide faces of lamination
Bending: 1.450 ksi
Compr. perp. to grain: 0.560 ksi
Shear parallel to grain: 0.145 ksi
Shear parallel to grain (not edge glued): 0.075 ksi
Modulus of elasticity: 1500.000 ksi
Axially loaded
Tension parallel to grain: 1.000 ksi
Compr. parallel to grain: 1.550 ksi
Modulus of elasticity: 1500.000 ksi
Notes:
Copy to library...
Copy from library...
OK
Apply
Cancel



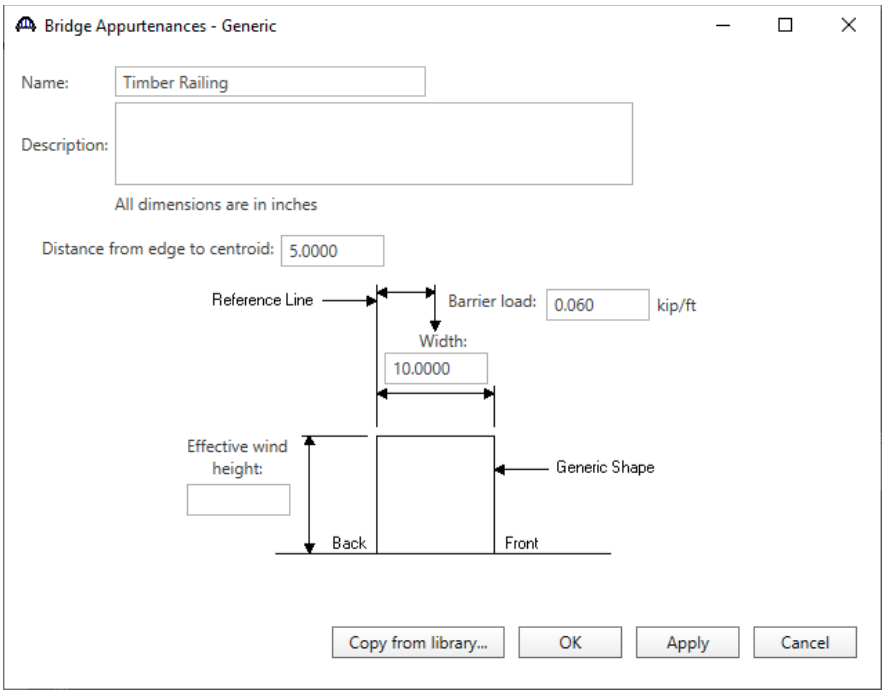
The ASD Tabulated Design Values in the ASD tab of this window and the LRFD Reference design values in the LRFD tab of this window are based on dry conditions and do not include any adjustment factors based on usage conditions. Click OK to save this timber material to memory and close the window.

Add a new timber beam shape by clicking on Beam Shapes, Timber, Rectangular in the tree and selecting New from the Manage group of the Workspace toolbar (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 and click on Compute button to compute the section properties. Click OK to save the data to memory and close the window.

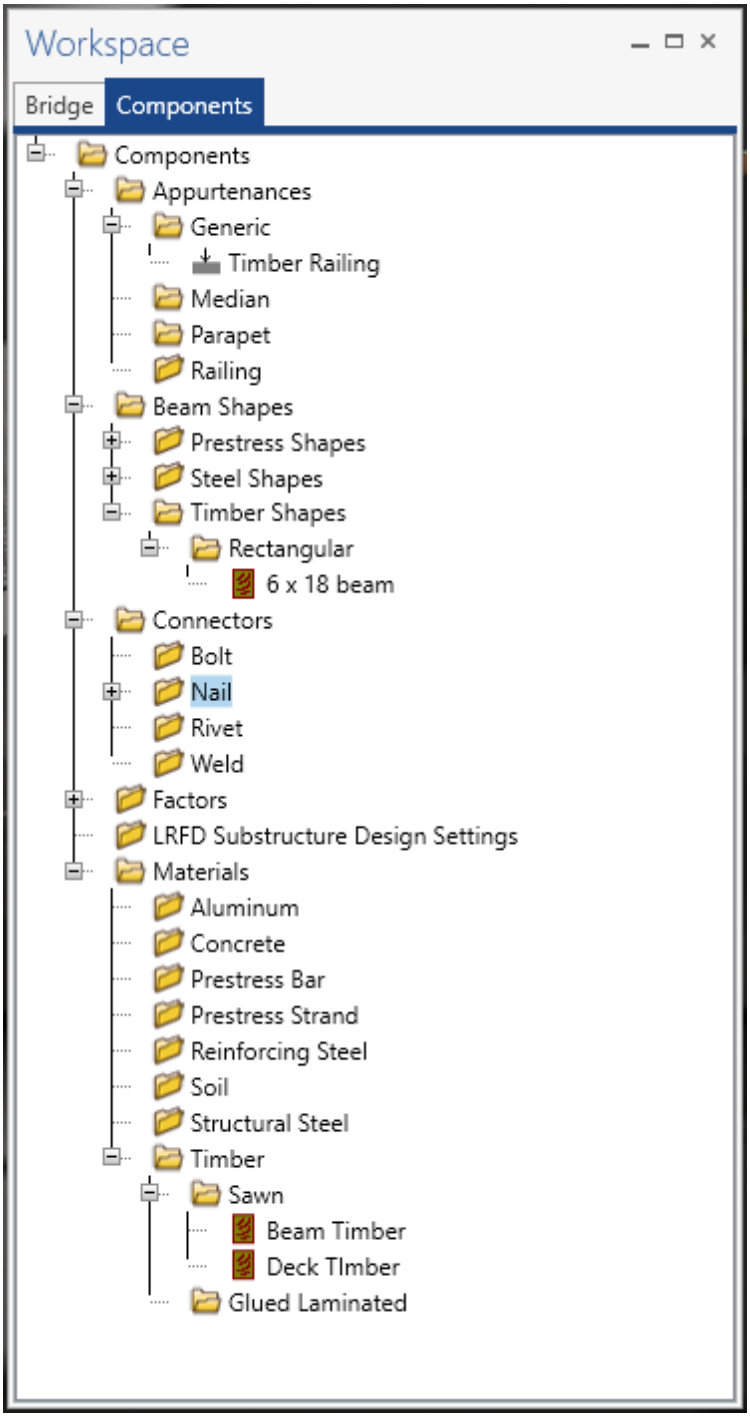




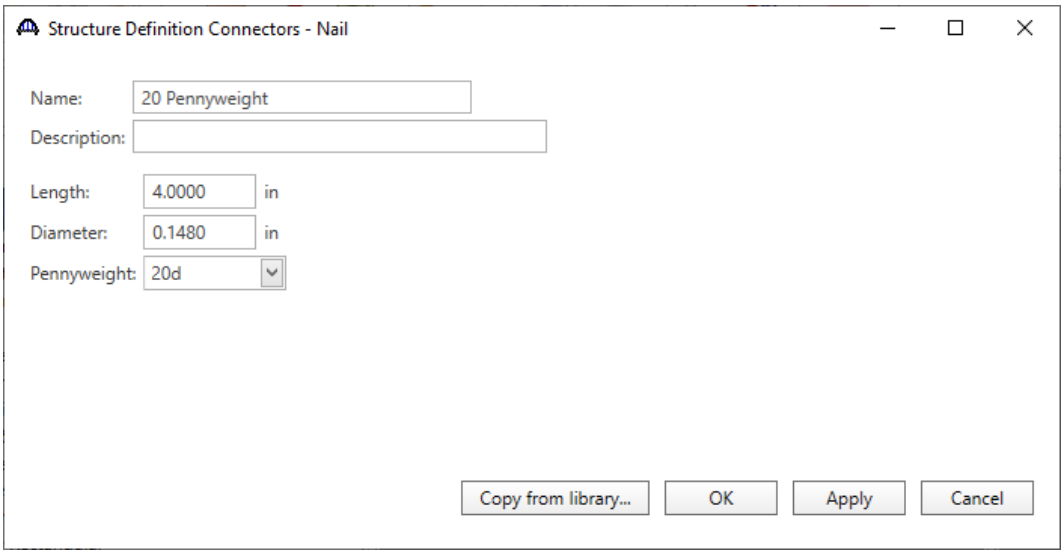
To enter the appurtenances to be used within the bridge, expand the tree branch labeled Appurtenances. To define a generic railing, double click on Generic in the tree and input the generic railing dimensions as shown below. Click OK to save the data to memory and close the window.



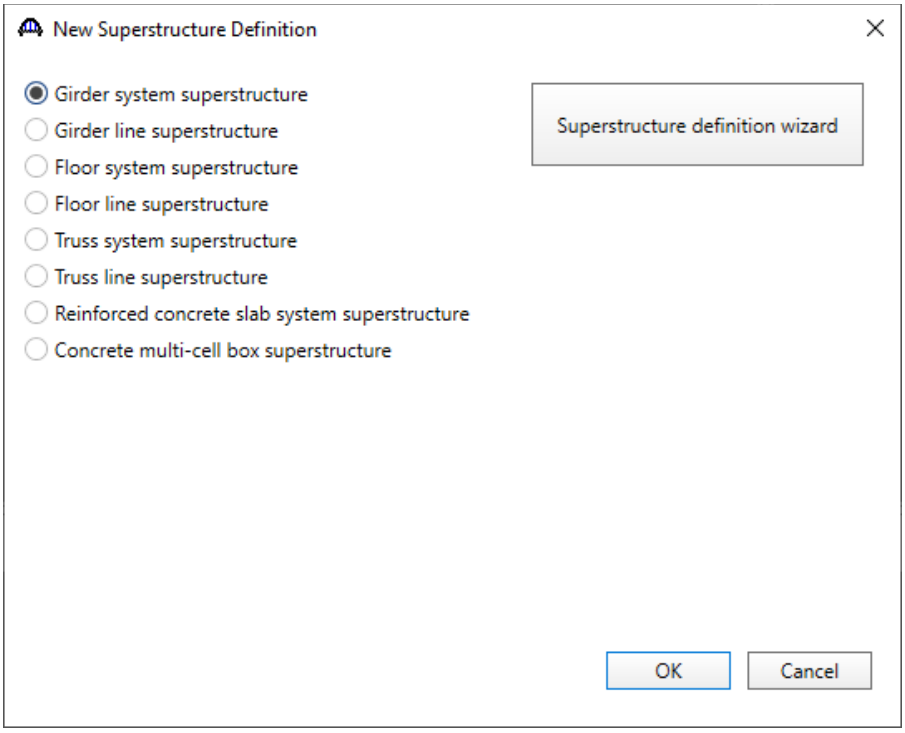
To create a nail definition, expand the Connectors tree item and double click on Nail.



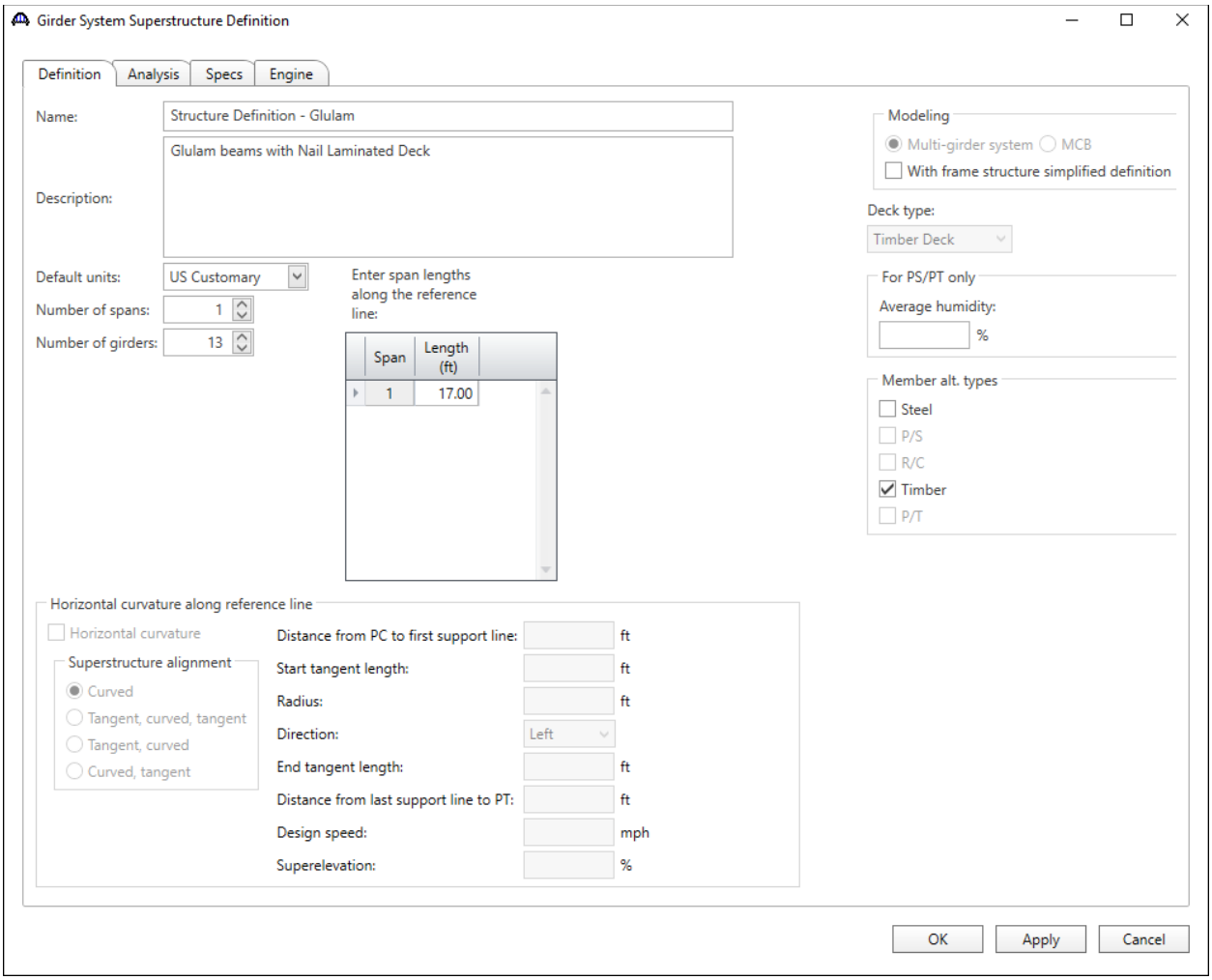
Define the nail as shown below. Click OK to save to memory and close the window.



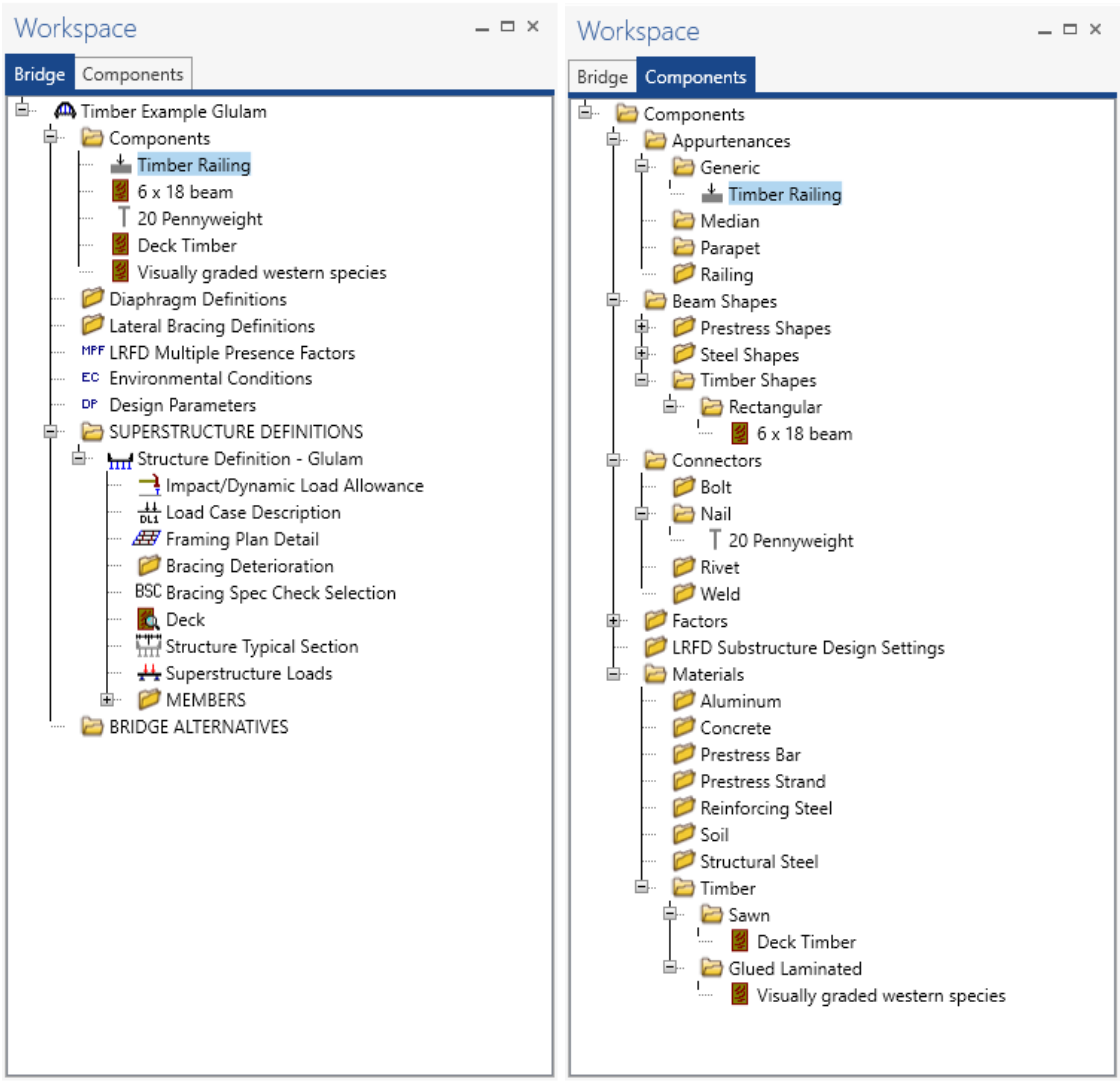
Double click on SUPERSTRUCTURE DEFINITIONS (or click on SUPERSTRUCTURE DEFINITIONS and select New from the Manage group of the Workspace toolbar or right mouse click on SUPERSTRUCTURE DEFINITIONS and select New from the popup menu) to create a new structure definition. The dialog shown below will appear.



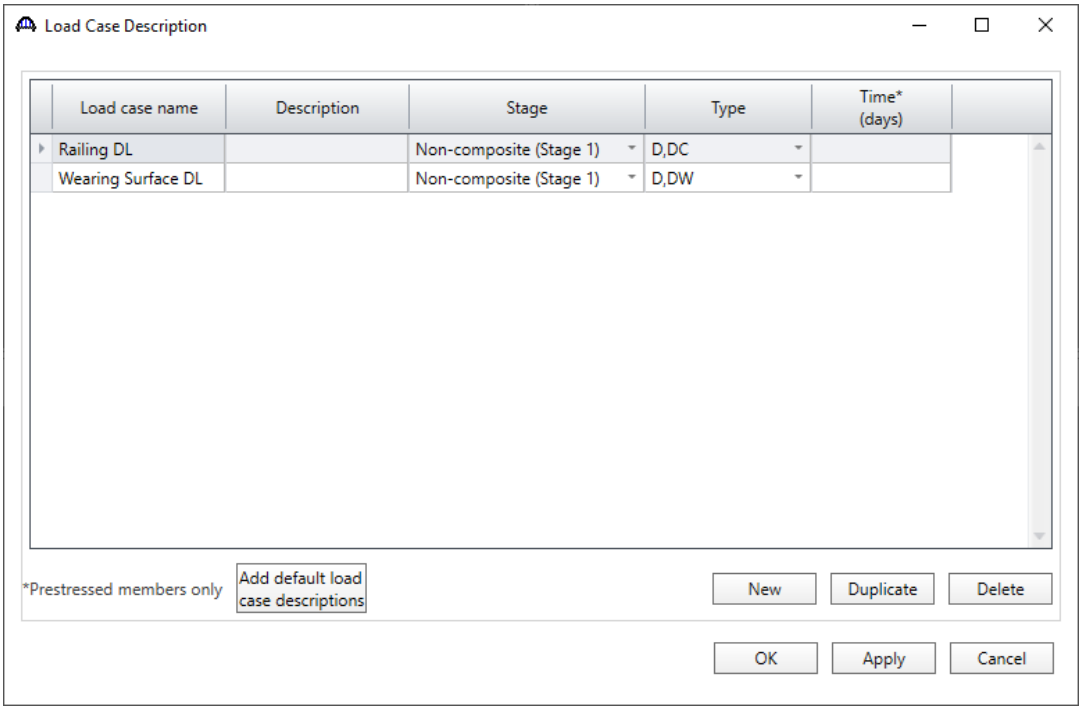
Select Girder System Superstructure and the Superstructure Definition window will open. Enter the appropriate data as shown below.



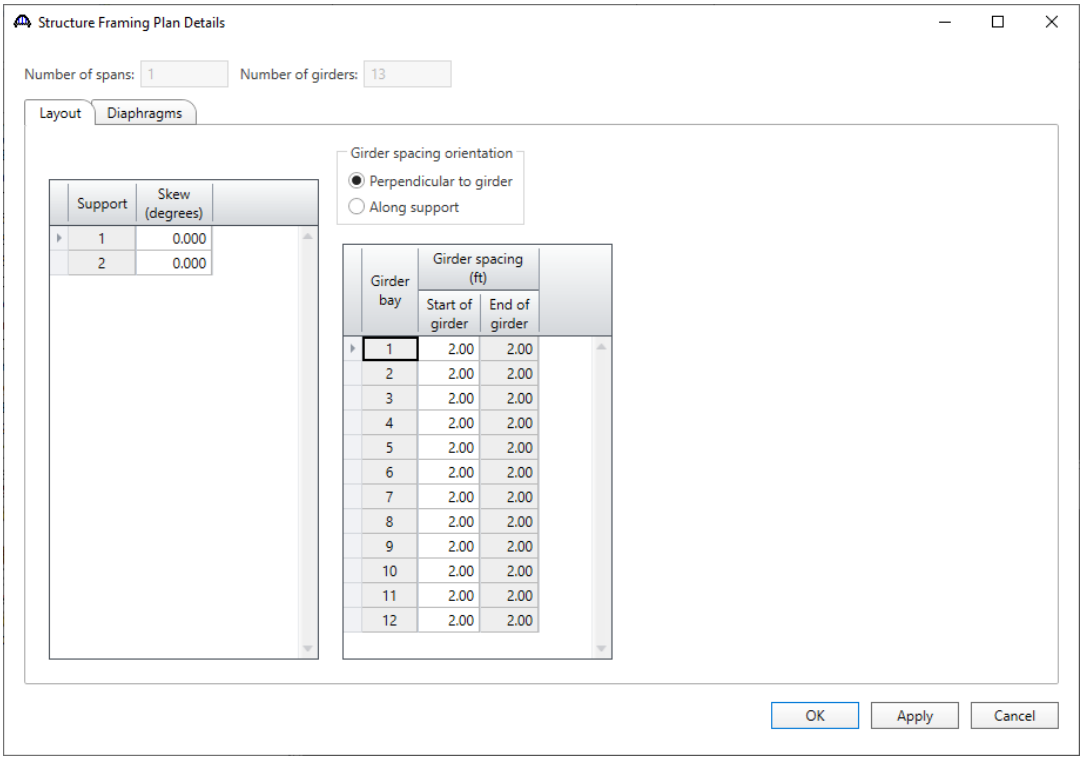
The partially expanded Bridge Workspace tree for each of its tabs are shown below:



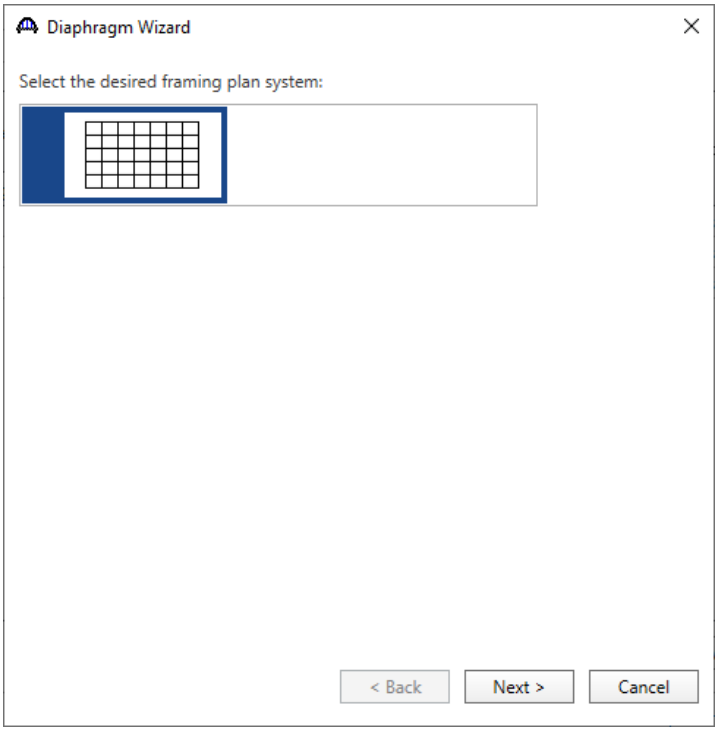
Click Load Case Description to define the dead load cases. The completed Load Case Description window is shown below.

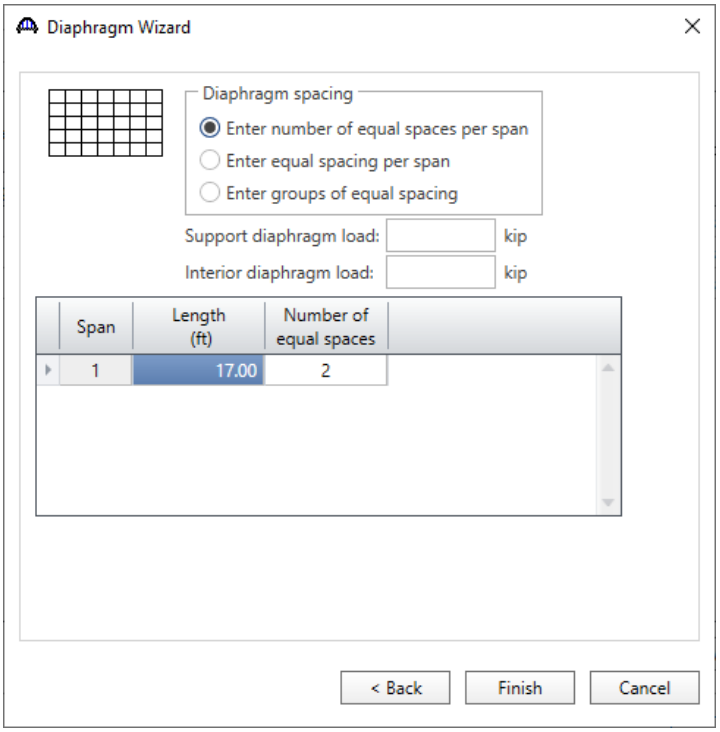


Double-click on Framing Plan Detail to describe the framing plan. Enter the appropriate data as shown below.



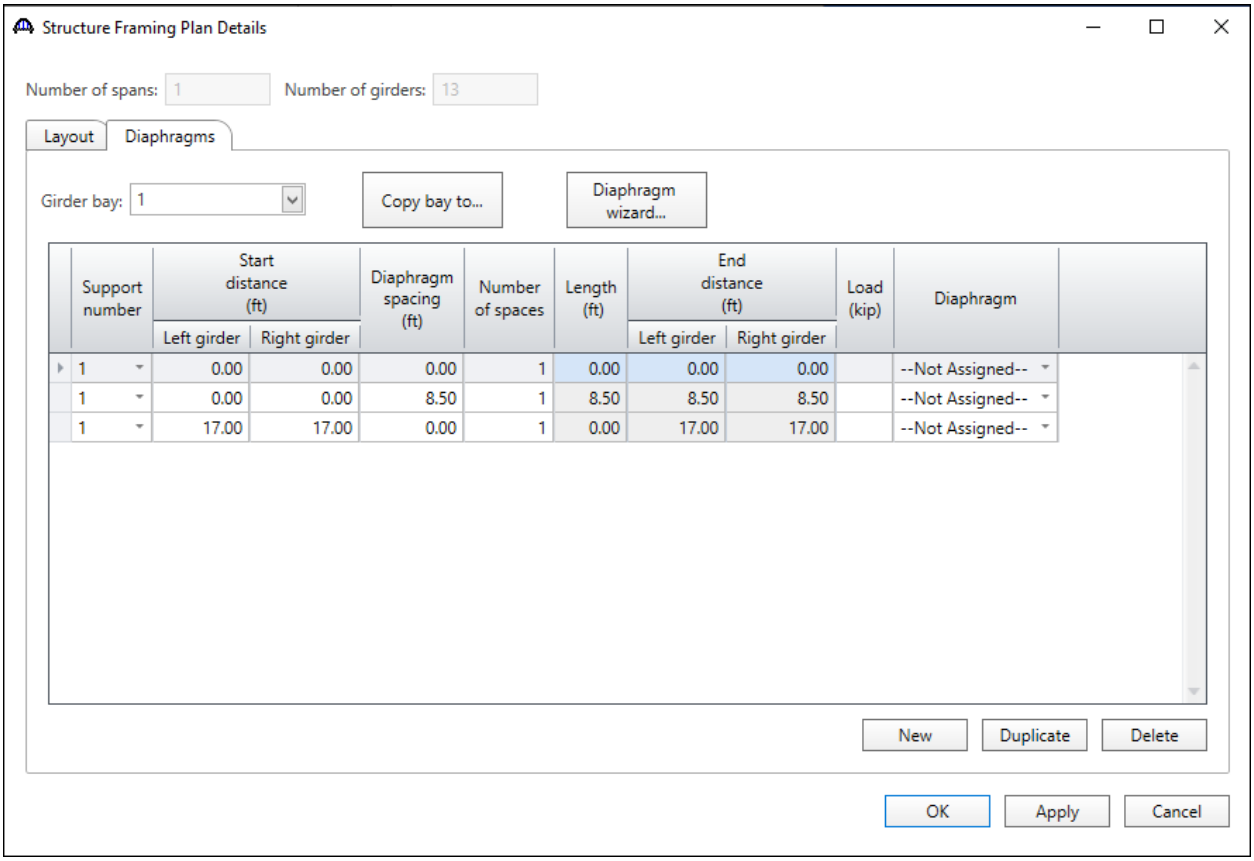
Switch to the Diaphragms tab to enter diaphragm spacing. Select the Diaphragm Wizard button to have BrR generate the diaphragm locations for you. The following window will appear. Select the Next button to continue.



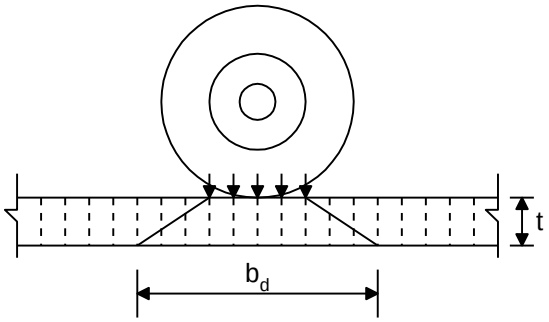


Enter 2 equal spaces in the span and click the Finish button.

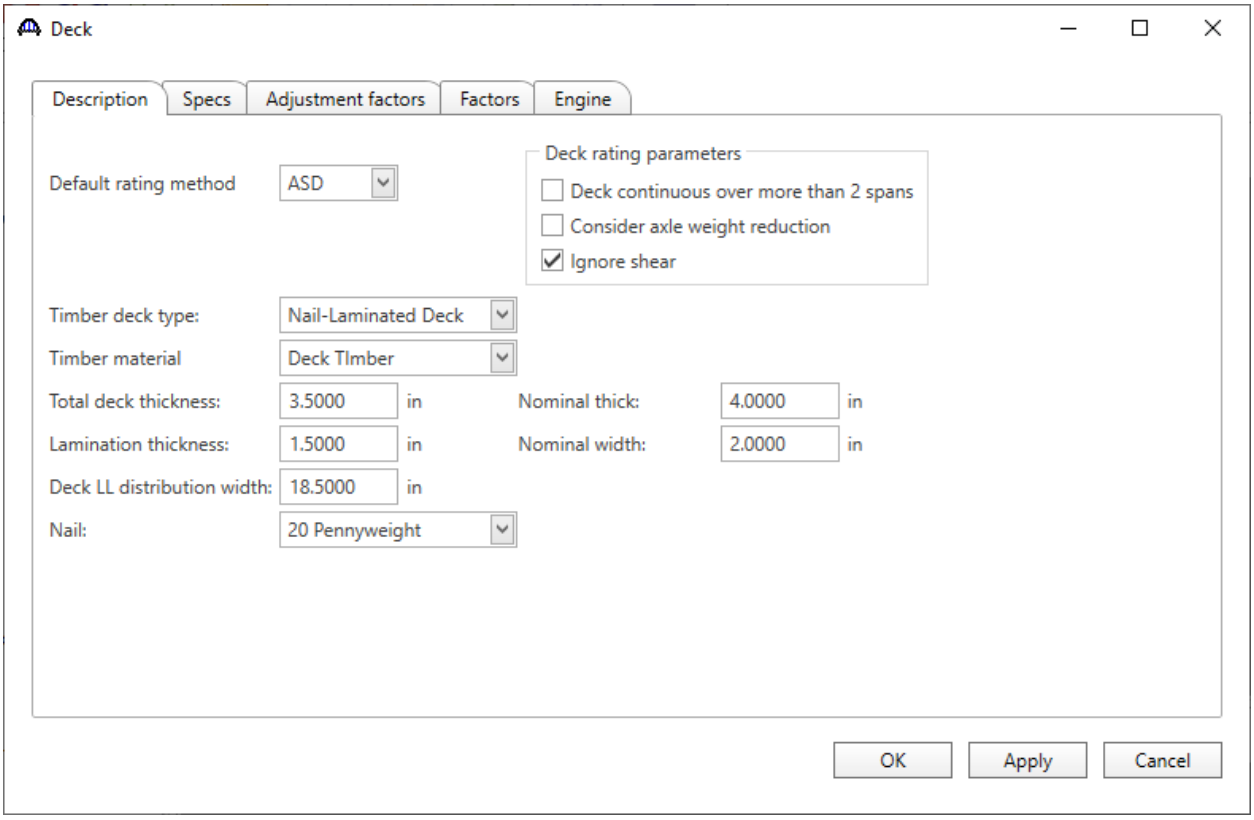
The Diaphragm Wizard generates the following diaphragm locations.



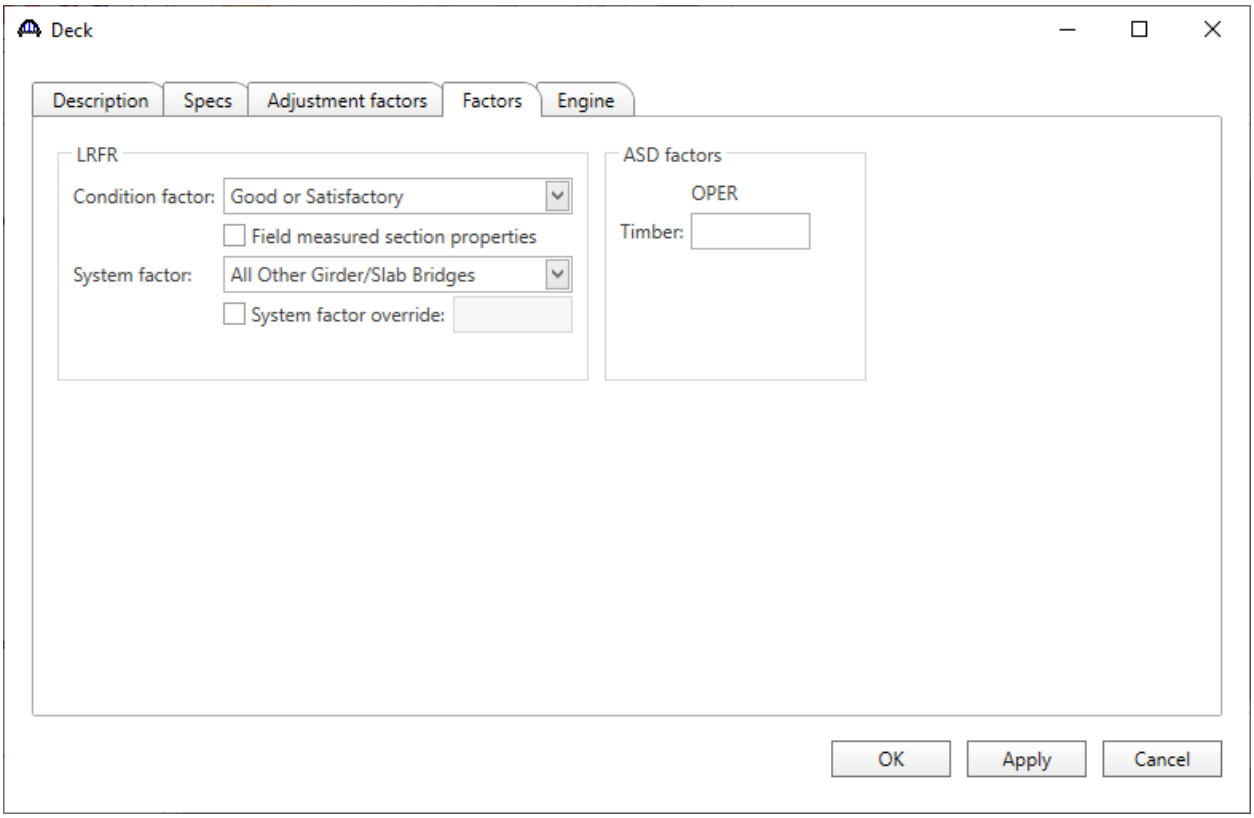
Enter the deck description by double-clicking on Deck in the Bridge Workspace tree. BrR/BrD only supports transverse timber decks. Select the type of deck as Nail-Laminated. The timber material to be used for the deck is selected from the list of bridge materials described above. Select the 20 Pennyweight nail definition as the Nail. 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.



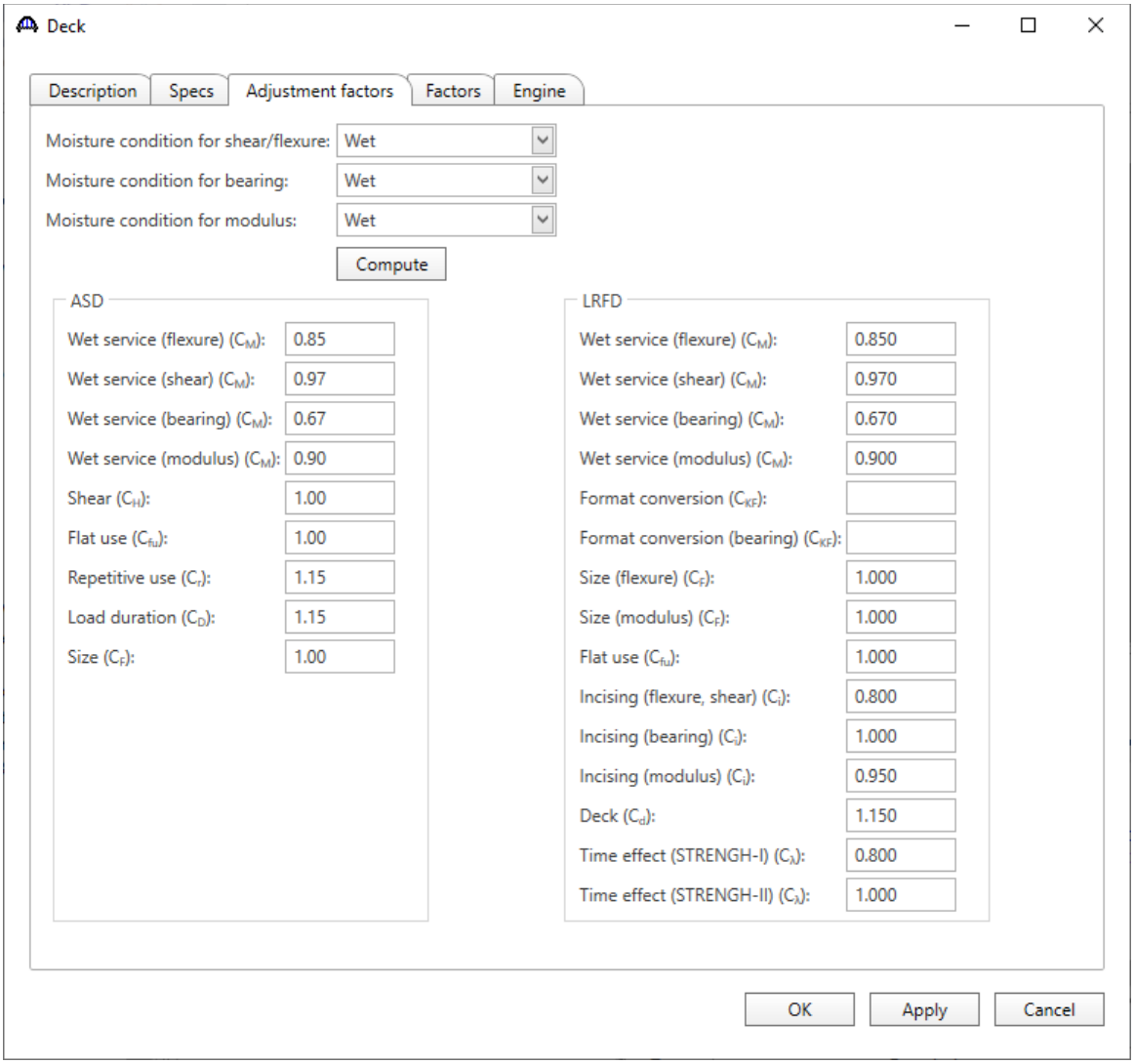
$b_d = t + 15$



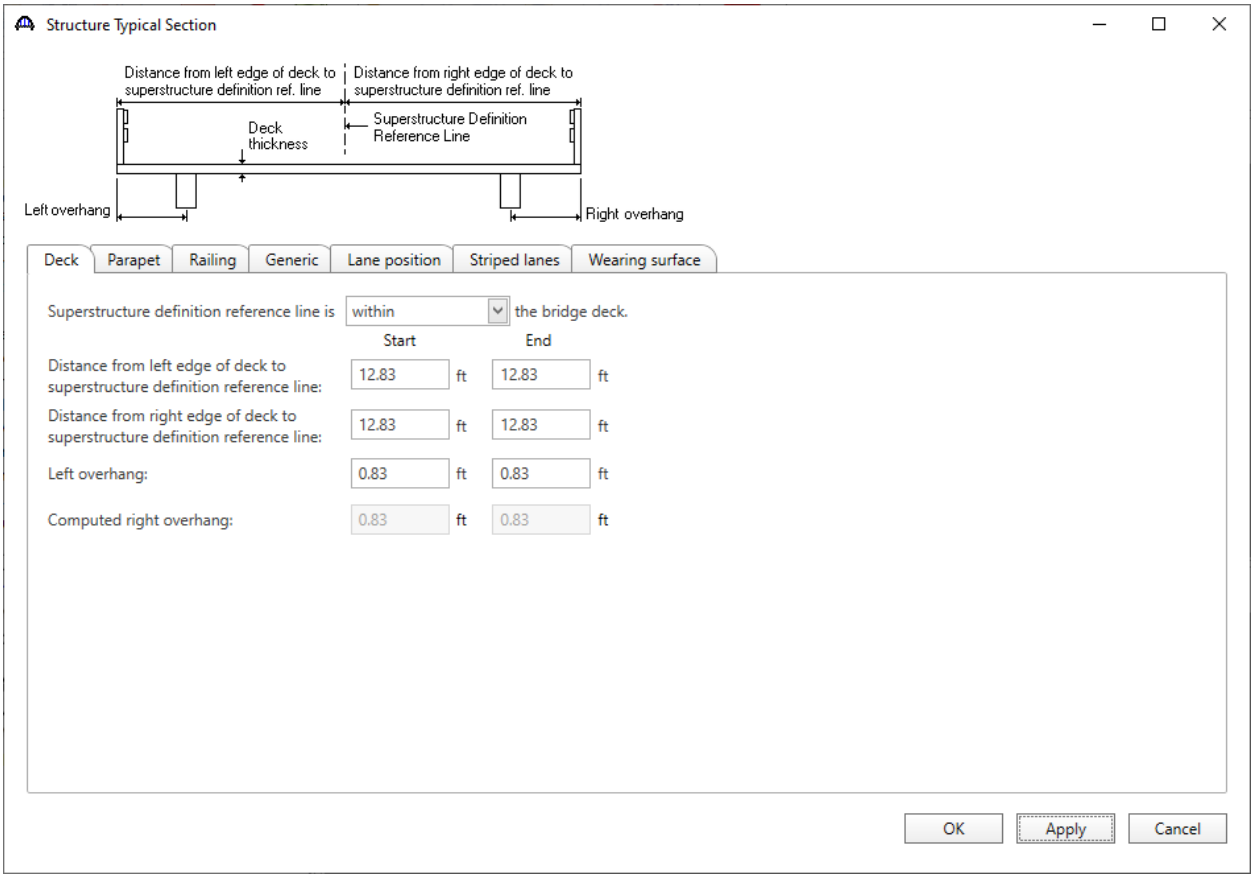
The Factors tab of the Deck window allows you to enter the LRFR and ASD factors to be used for the deck.



The Adjustment factors tab of the Deck window allows you to modify the ASD tabulated design values and LRFD reference 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.

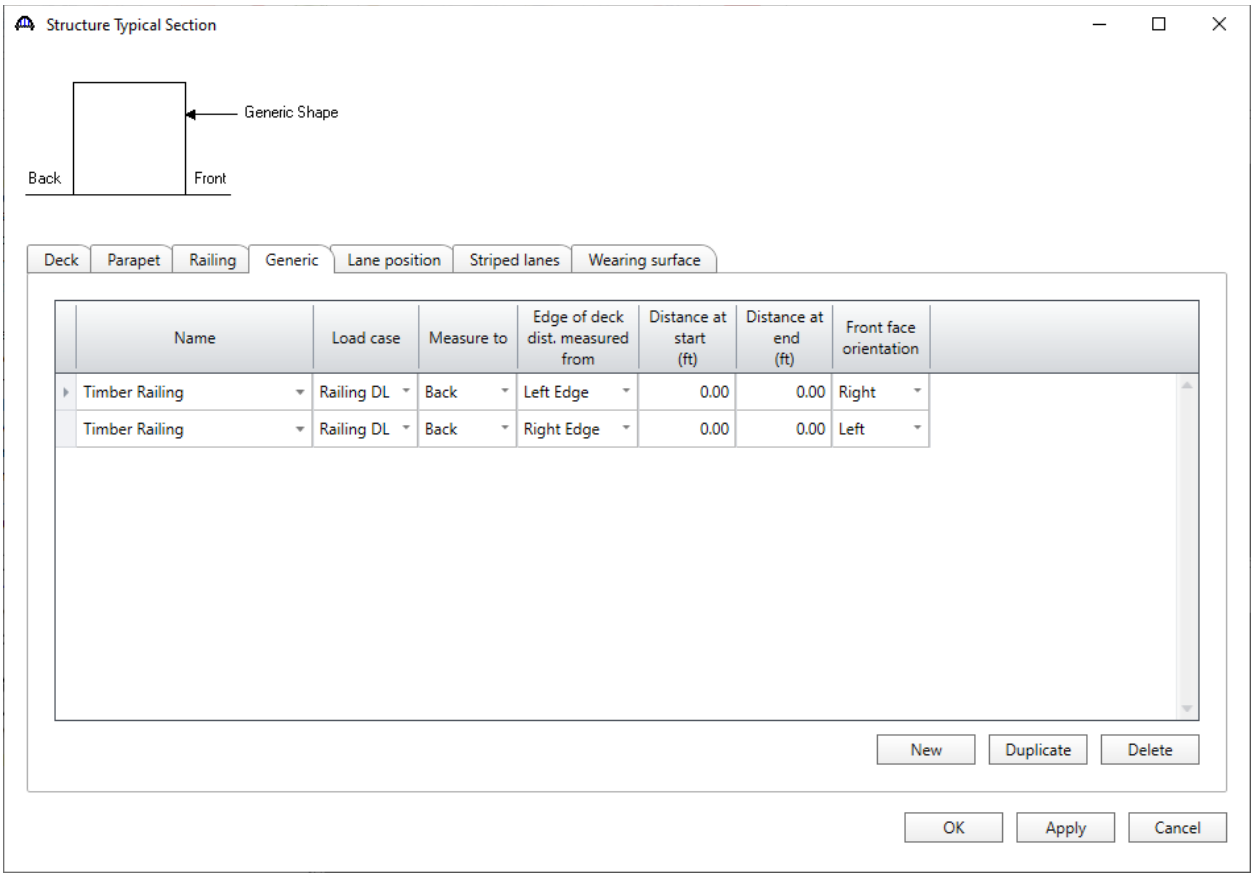


Next define the structure typical section by double-clicking on Structure Typical Section in the Bridge Workspace tree. Input the data describing the typical section as shown below.



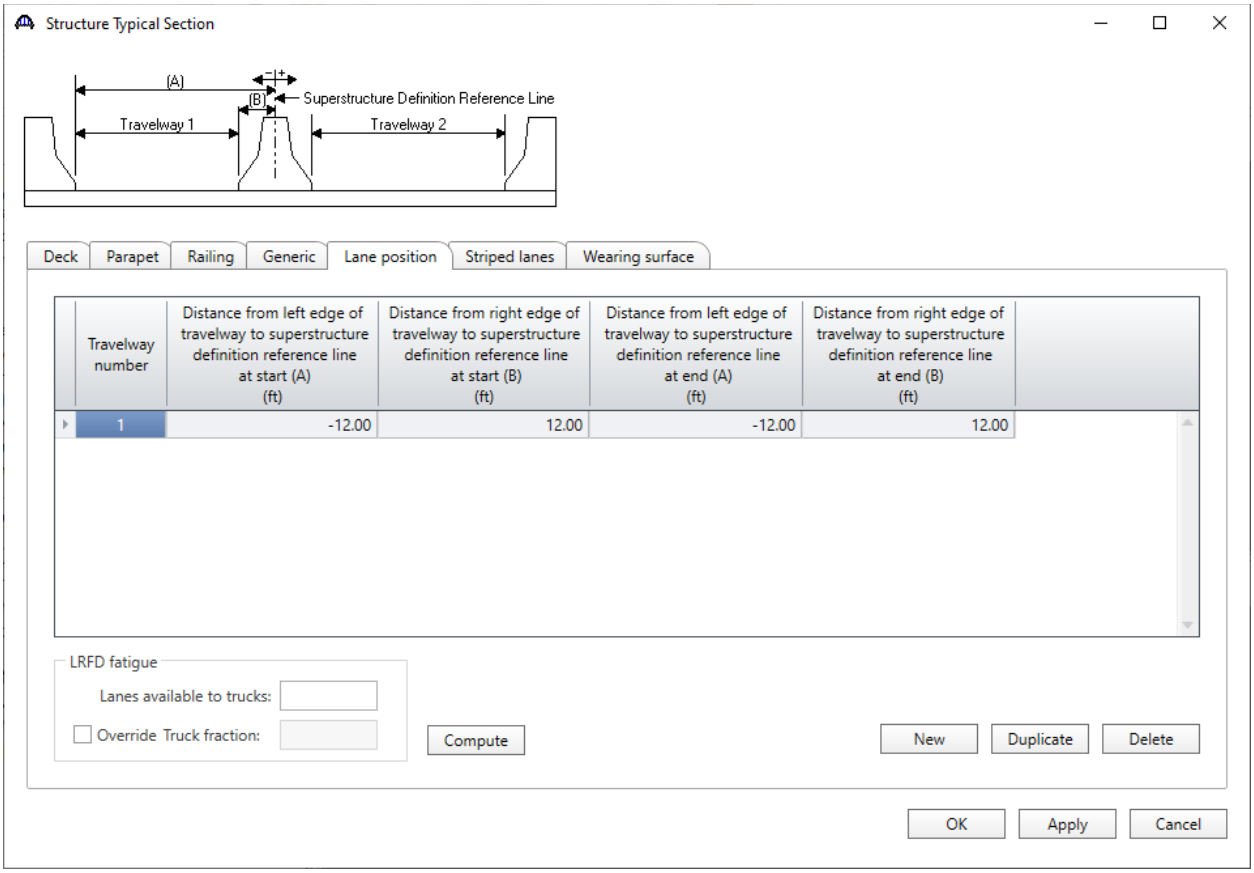
Generic Appurtenances:

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.

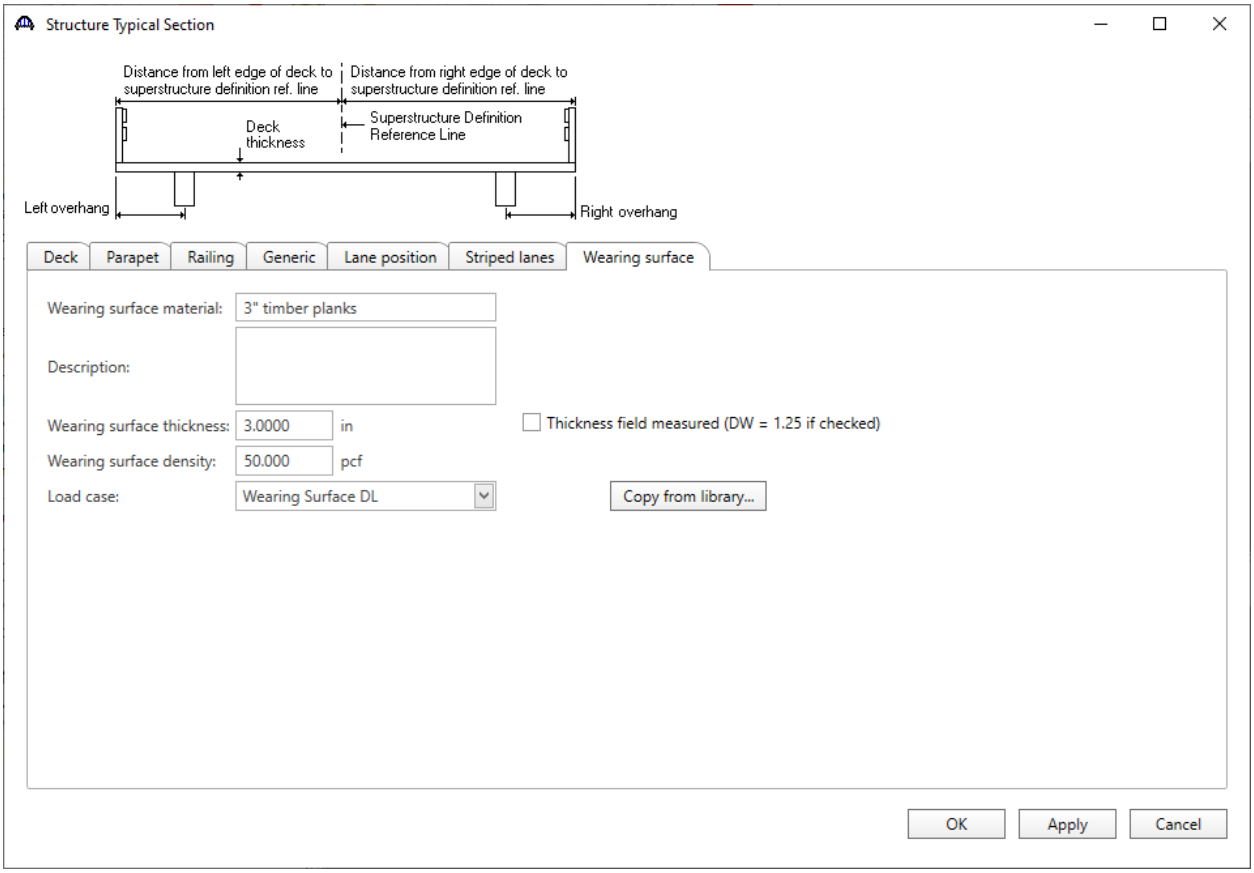


Lane Positions:

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.

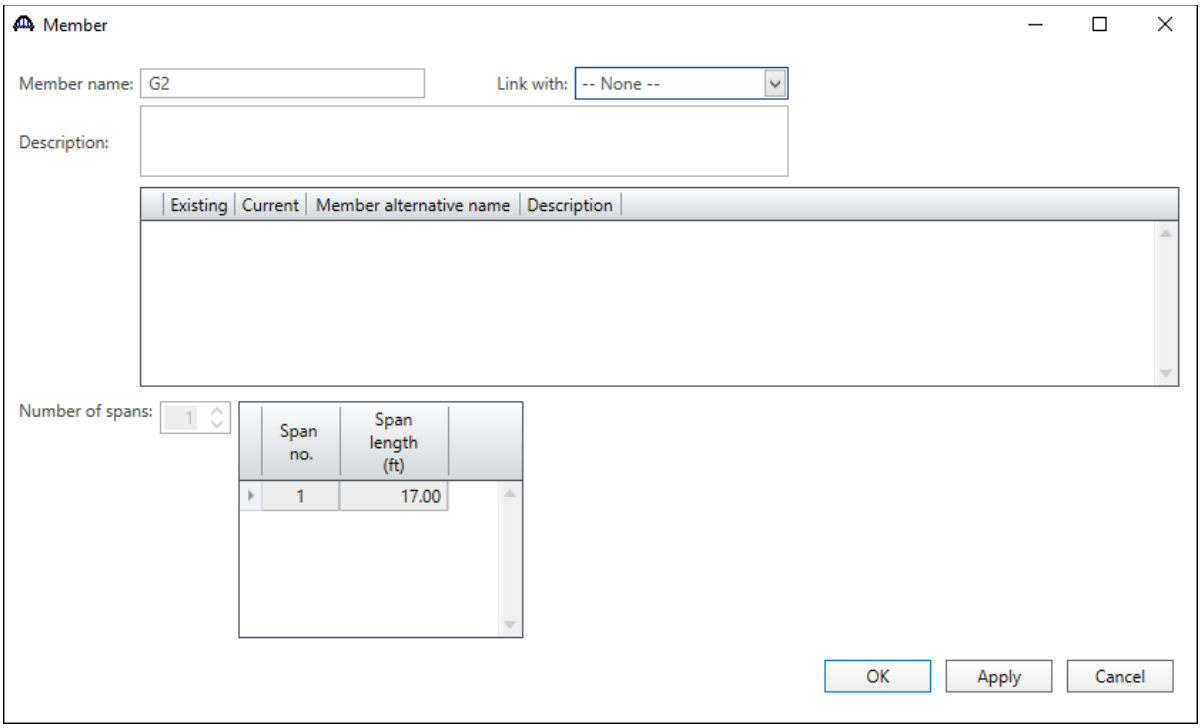


Enter the following wearing surface information on the Wearing Surface tab.

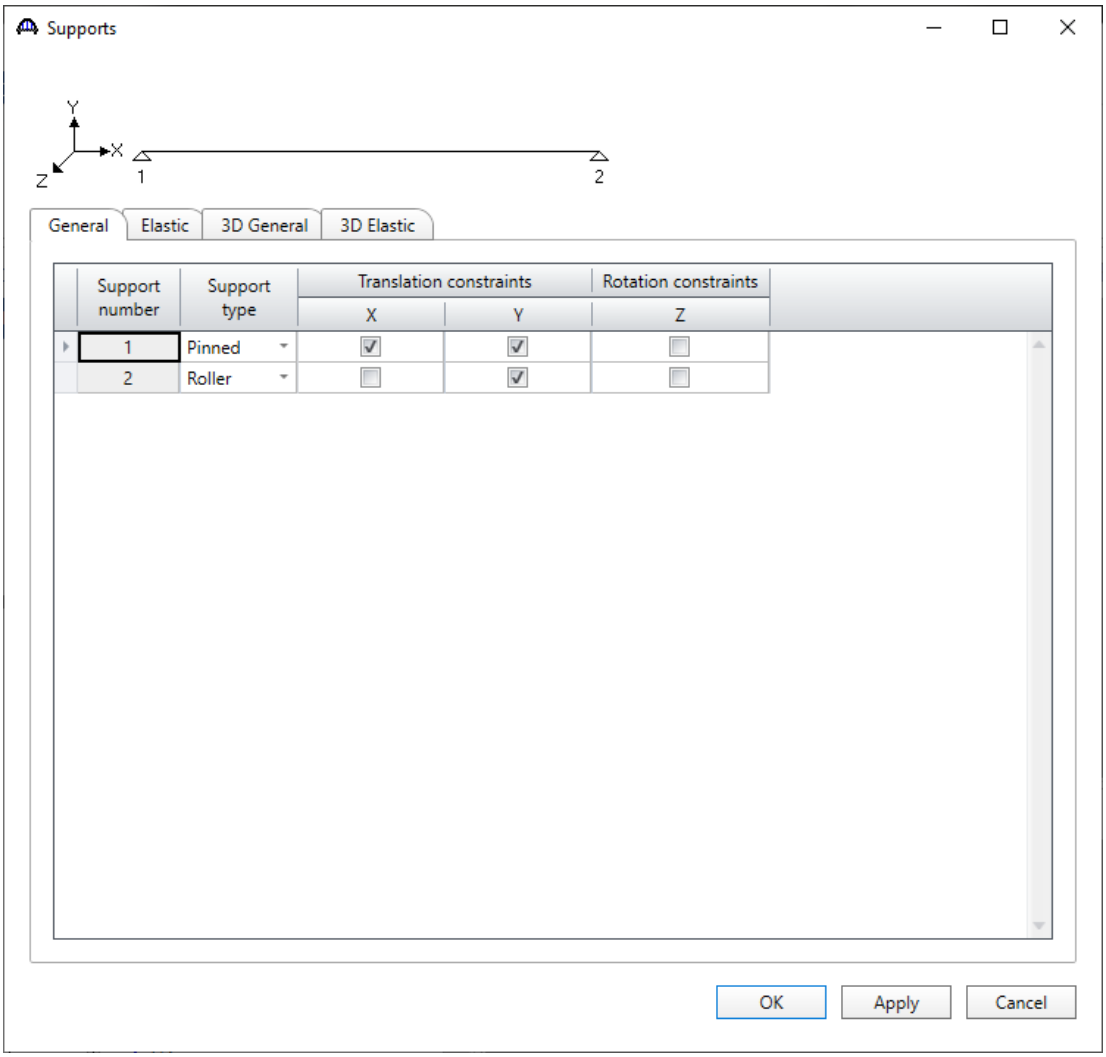


Describing a member:

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.

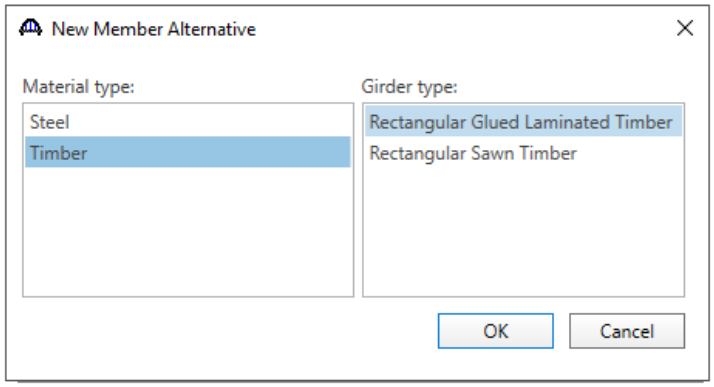


Support constraints were generated when the structure definition was created and are shown below.

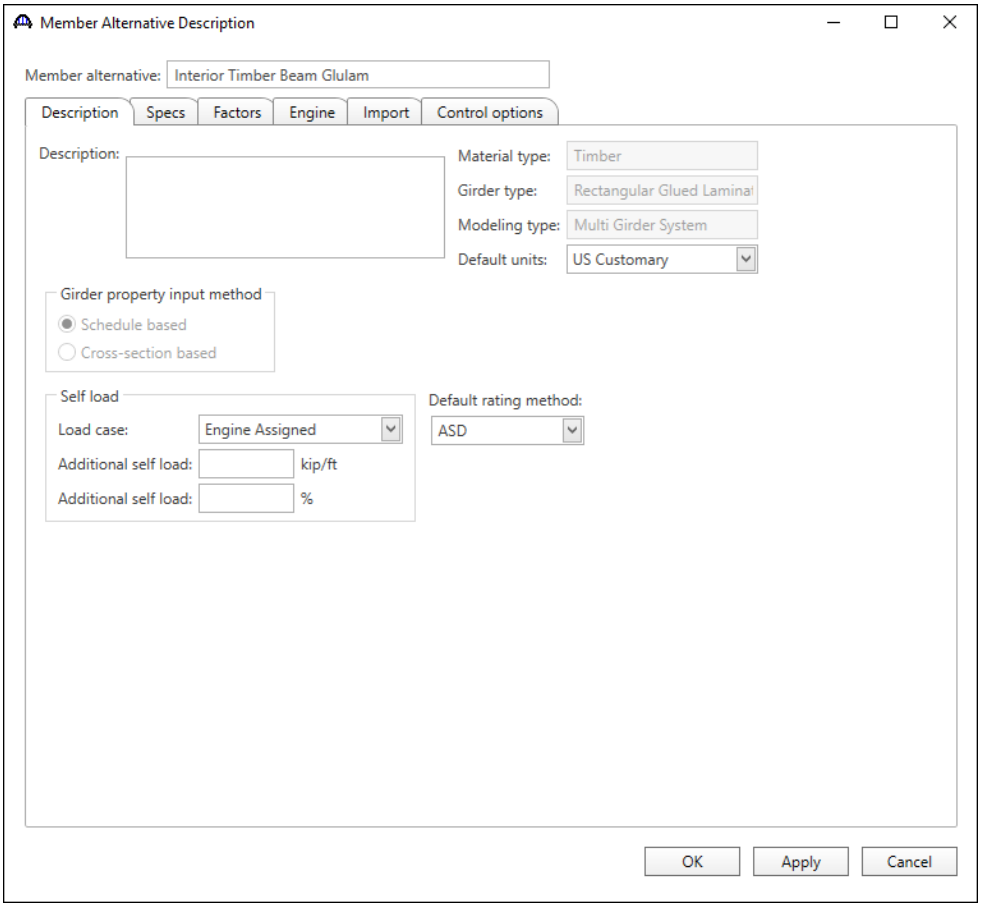


Defining a Member Alternative:

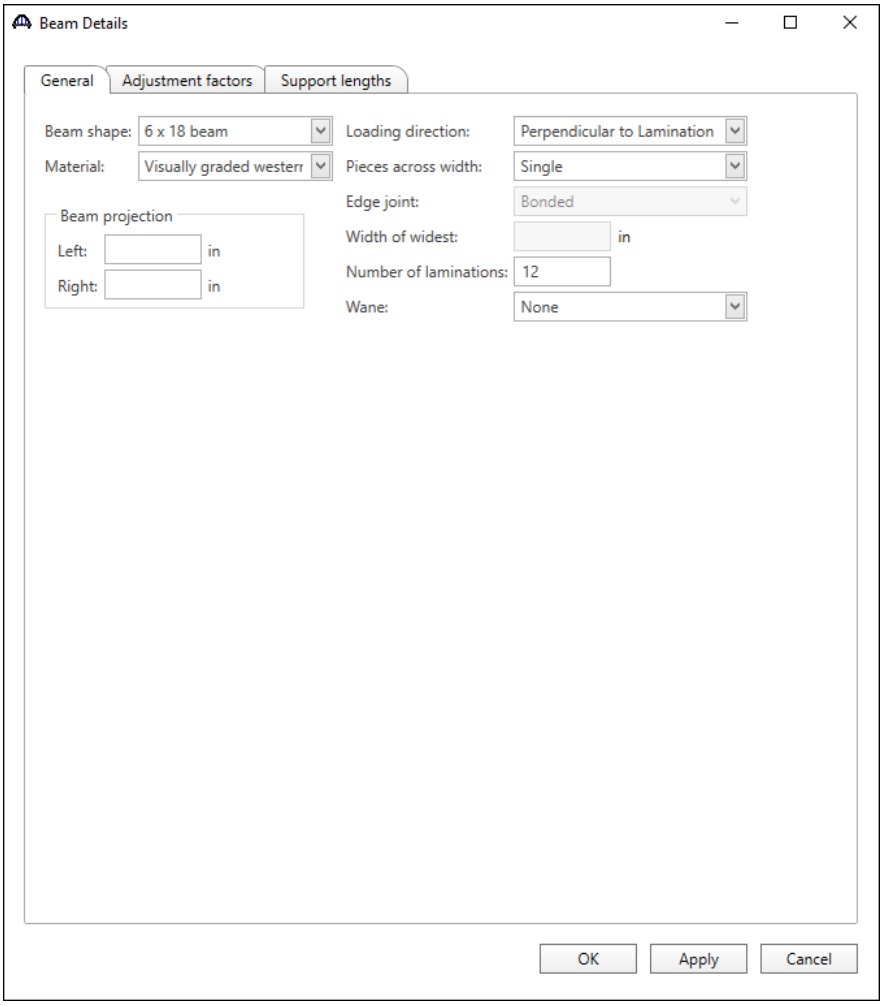
Double click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Timber for the Material Type and Rectangular Sawn Timber for the Girder Type. Only Timber is available for the Material Type since a timber deck type was selected 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.

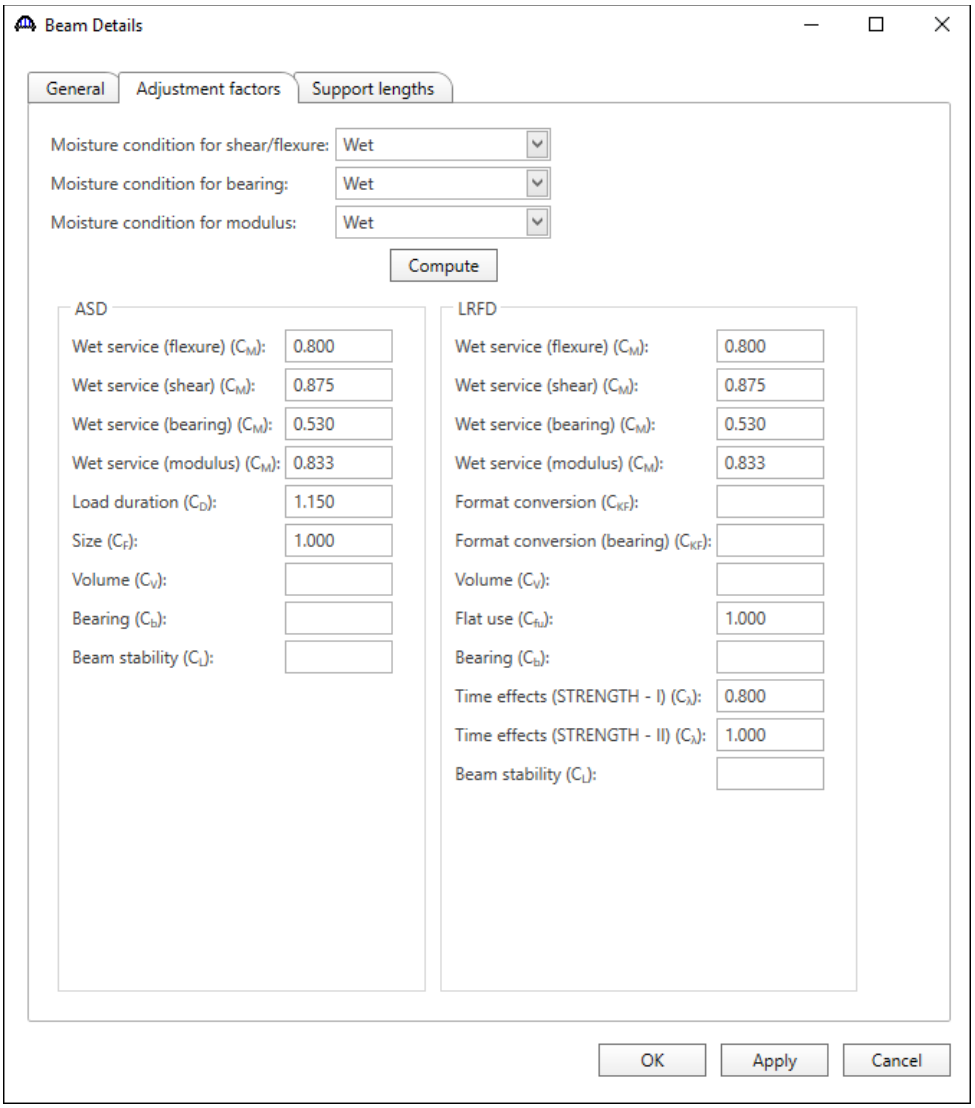


Open the Beam Details window by double clicking on Beam Details in the tree. The Beam Details window is shown below.

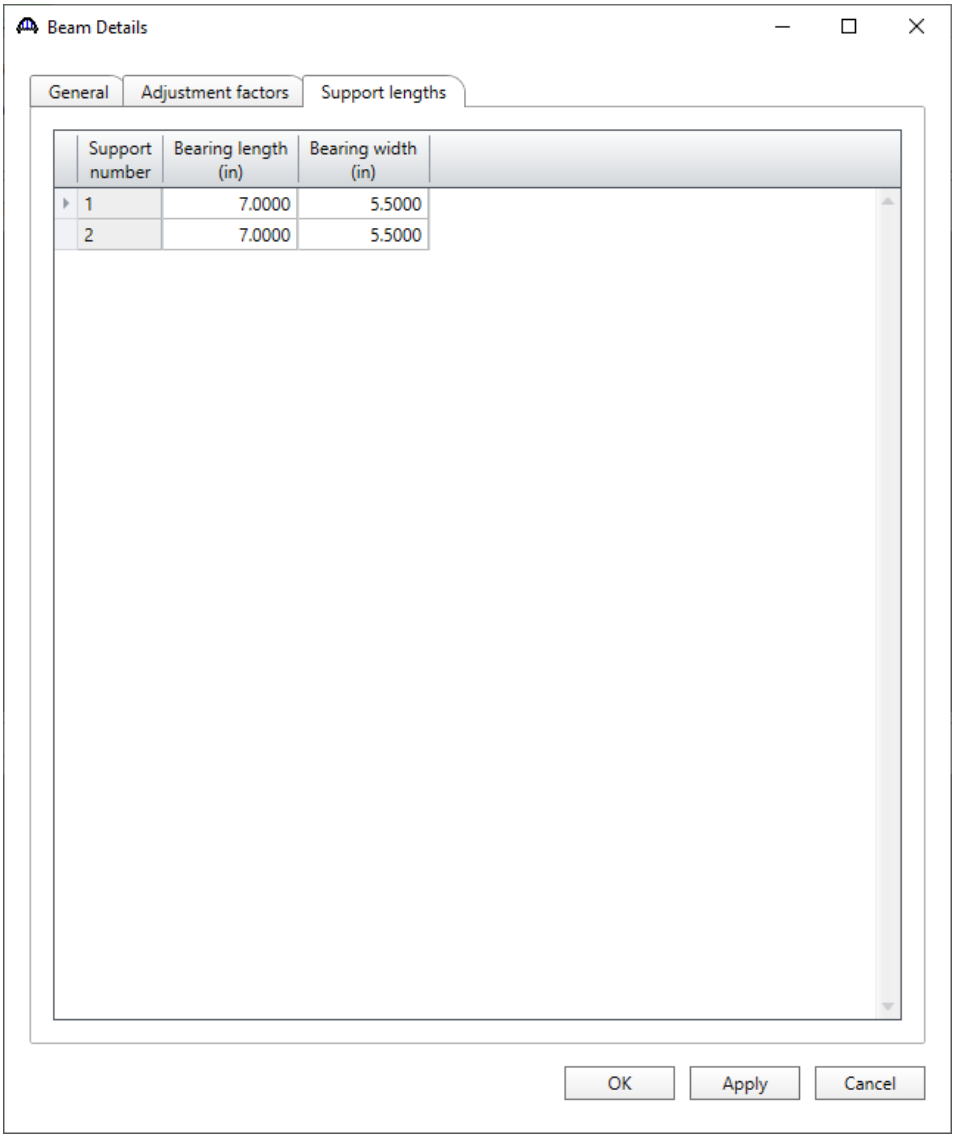


The Adjustment Factors tab of the Beam Details window allows you to enter adjustment factors to modify the ASD tabulated design values and the LRFD Reference design values entered on the Bridge Materials – Timber – Glued Laminated window. The tabulated design values modified by these adjustment factors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

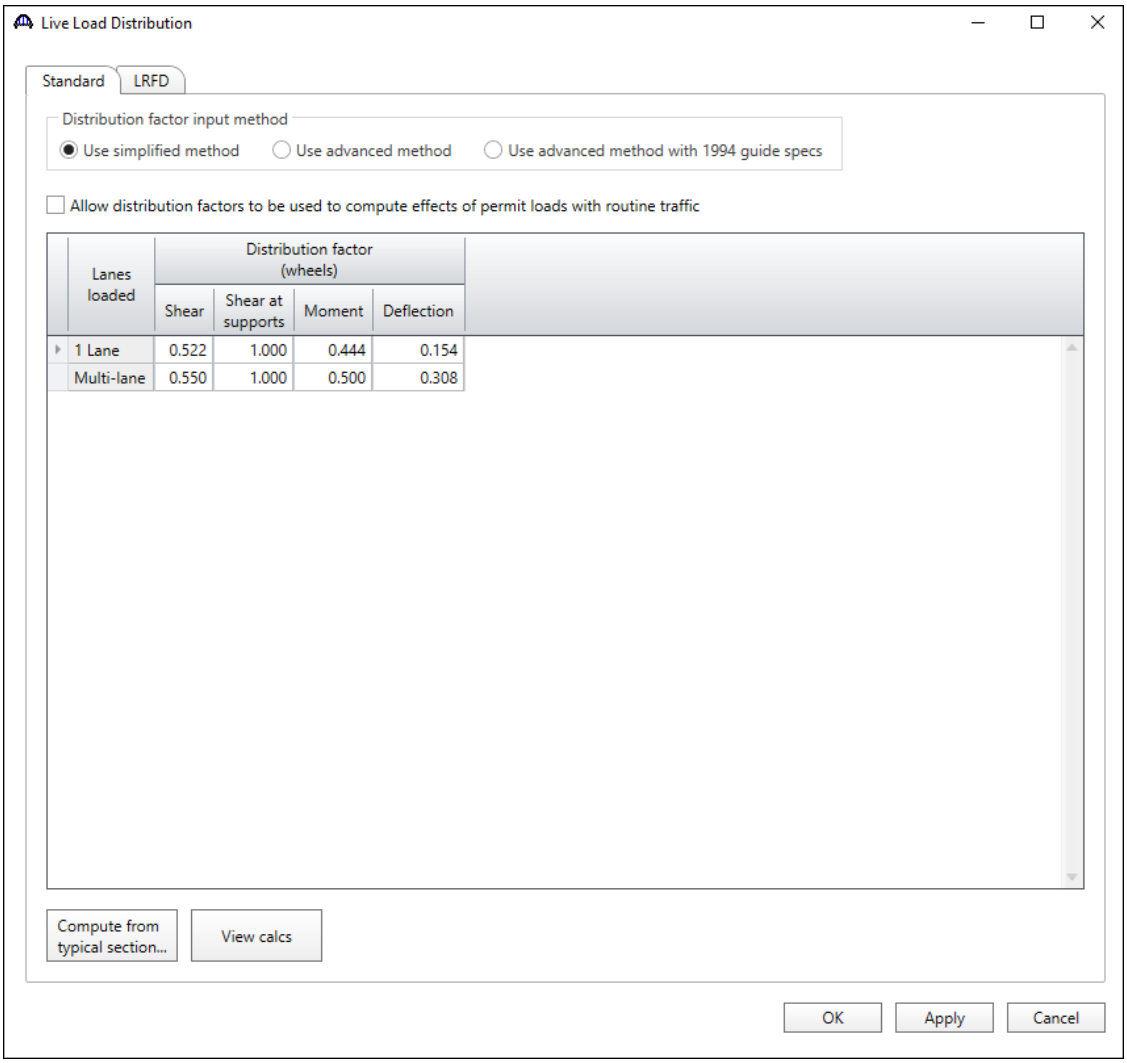
Select the Wet condition for Shear/Flexure, Bearing and Modulus. Use the Compute button to calculate the factors for the beam based on the Wet moisture conditions.



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



Open the Live Load Distribution window and in the Standard tab, use the Compute from Typical Section button to compute the following live load distribution factors for Standard 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

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

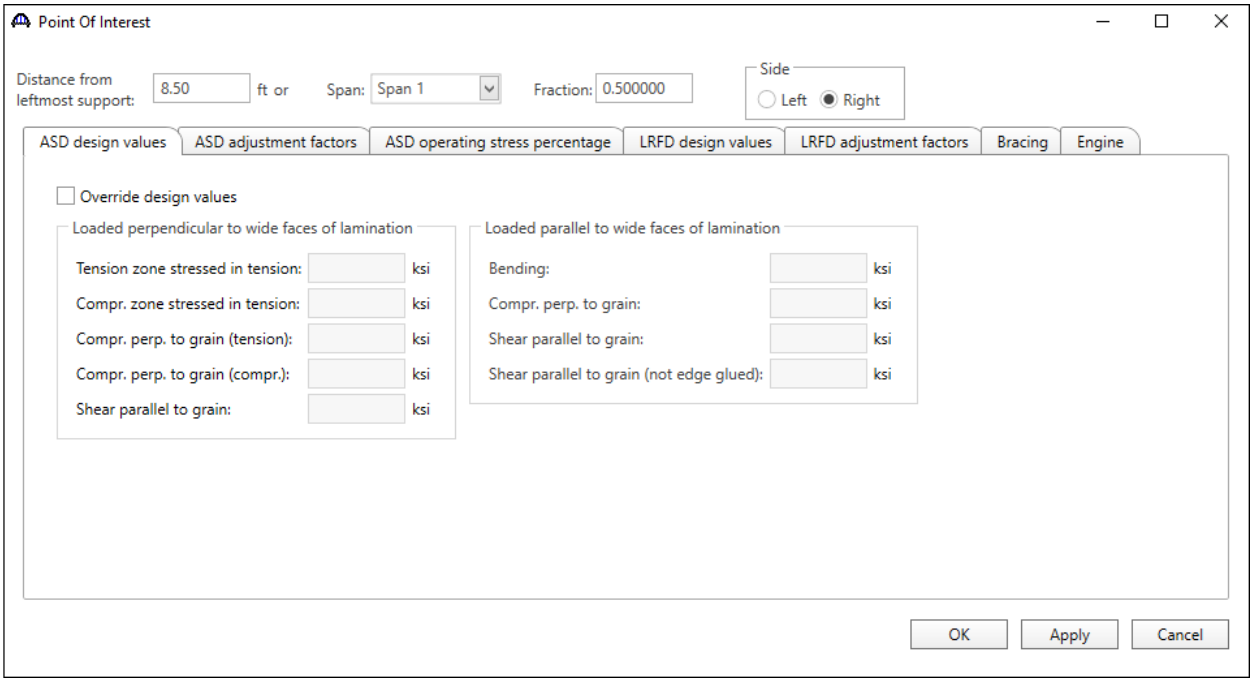
$$\text{Multi Lane Shear DF} = 0.50\left[(0.60(1) + 0.5000)\right] = 0.5500$$

Deflection DF

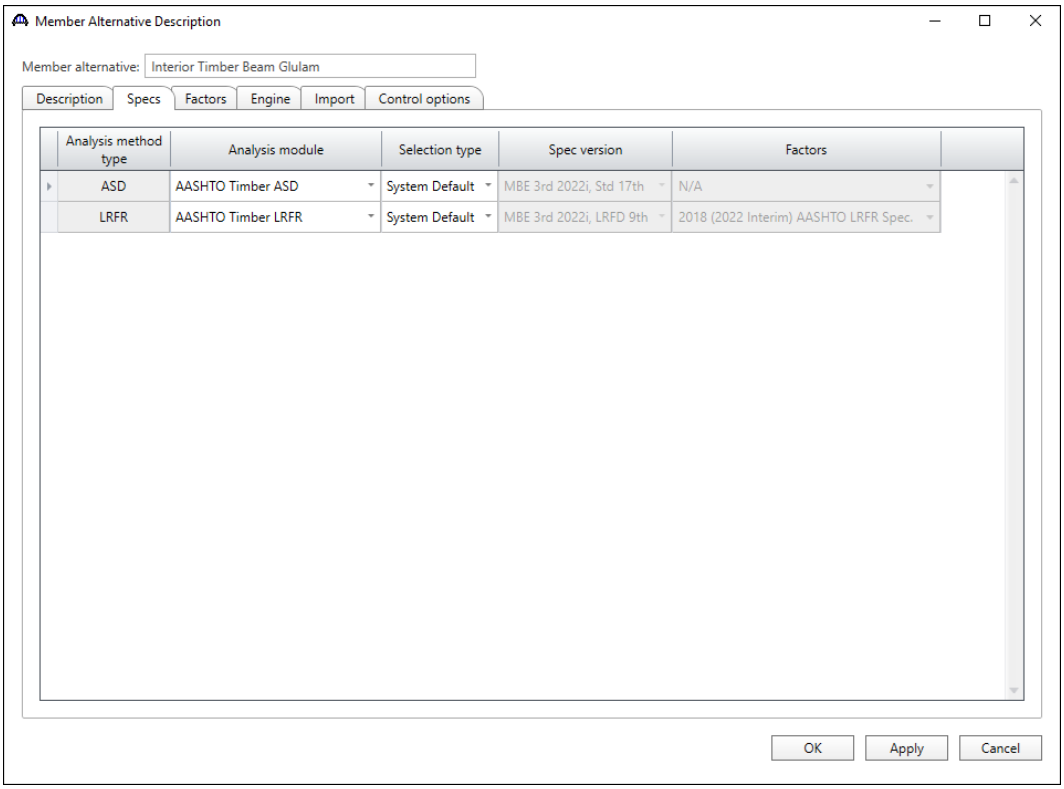
$$\text{Single Lane Deflection DF} = \frac{1\,\text{lane} * 2\,\text{wheels/lane}}{13\,\text{beams}} = 0.1538$$

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

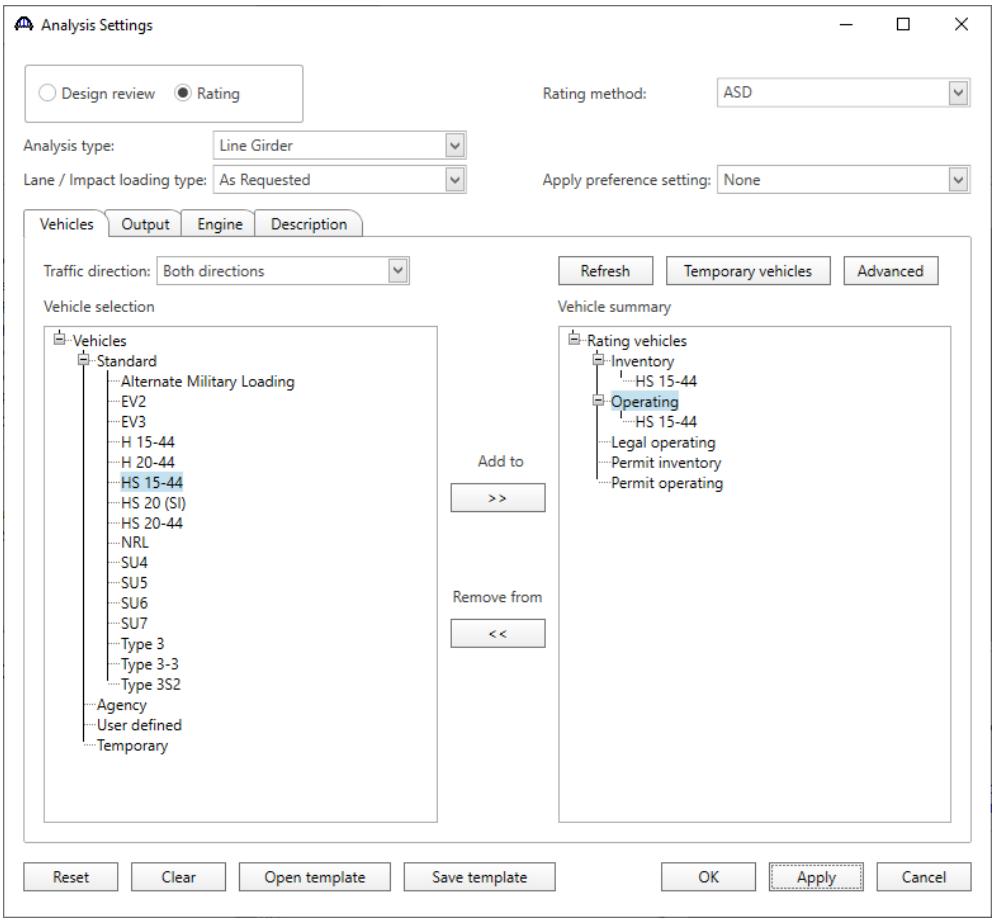
Define Points of Interest using the Point of Interest window shown below. A window for defining a Point of Interest is opened by double clicking on the Points of Interest tree item.



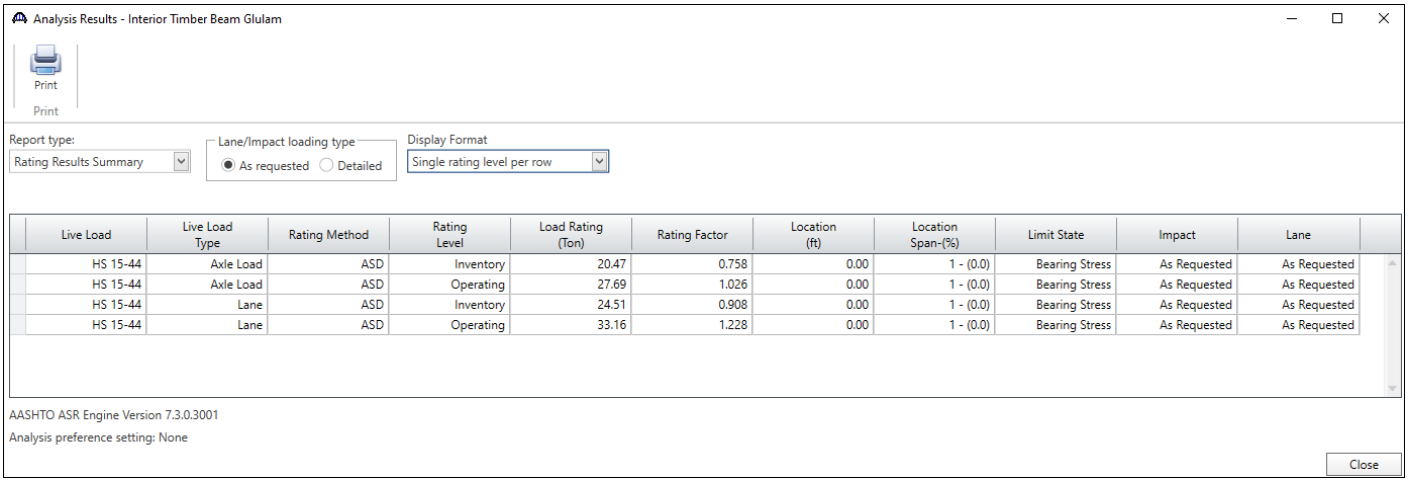
To select the analysis module for both ASD and LRFR analysis method types, double click on the member alternative Interior Timber Beam and click on the Specs tab. To run ASD analysis using AASHTO timber engine, select AASHTO Timber ASD option from the Analysis module options for ASD analysis method type. Similarly, to run LRFR analysis using AASHTO timber engine, select AASHTO Timber LRFR option from the Analysis module options for LRFR analysis method type.



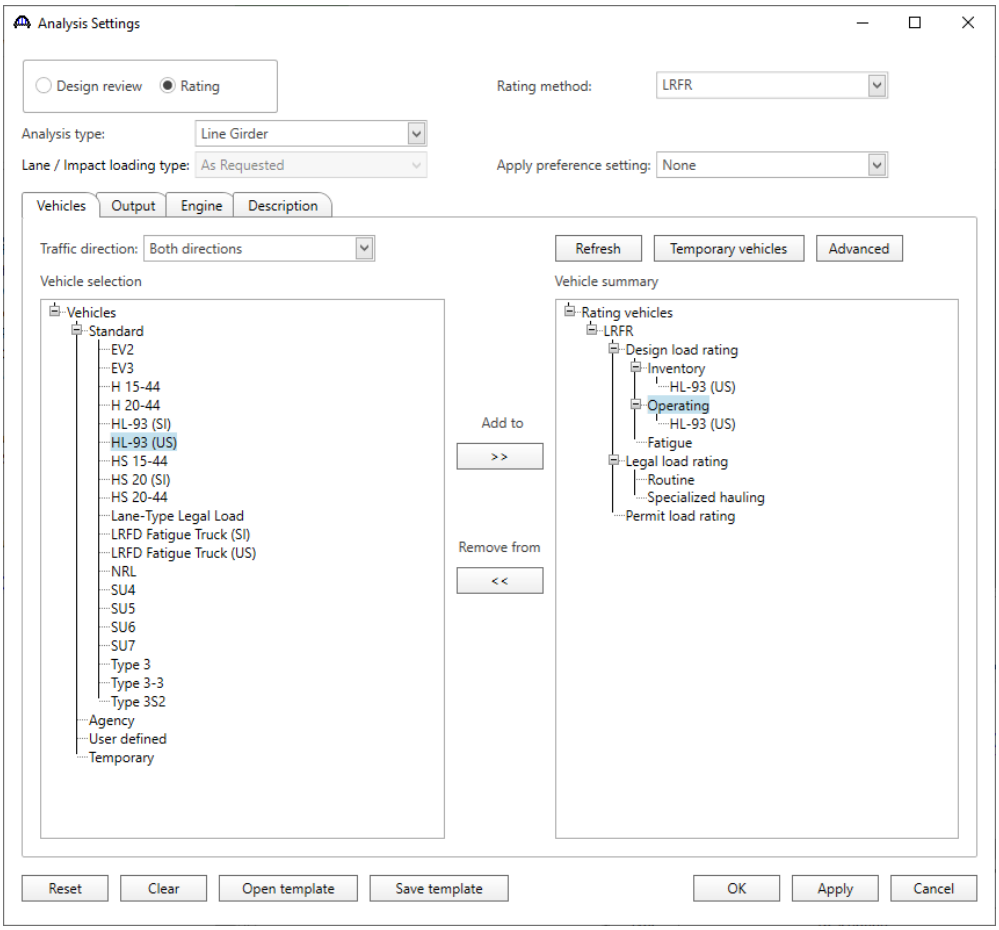
To perform a rating, select the Analysis Settings button on the Analysis group of the Design/Rate toolbar. To run ASD analysis, select ASD as the Rating Method, select the HS 15-44 vehicle to be used in the rating in inventory and operating and click OK.



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 Tabular Results button on the Results group of the Design/Rate toolbar. The window shown below will open.



To run LRFR analysis, in the Analysis Settings window, select LRFR as the Rating Method, select the HL-93(US) vehicle in inventory and operating 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 Tabular Results button on the toolbar. The window shown below will open.