AASHTOWare BrDR 7.5.0

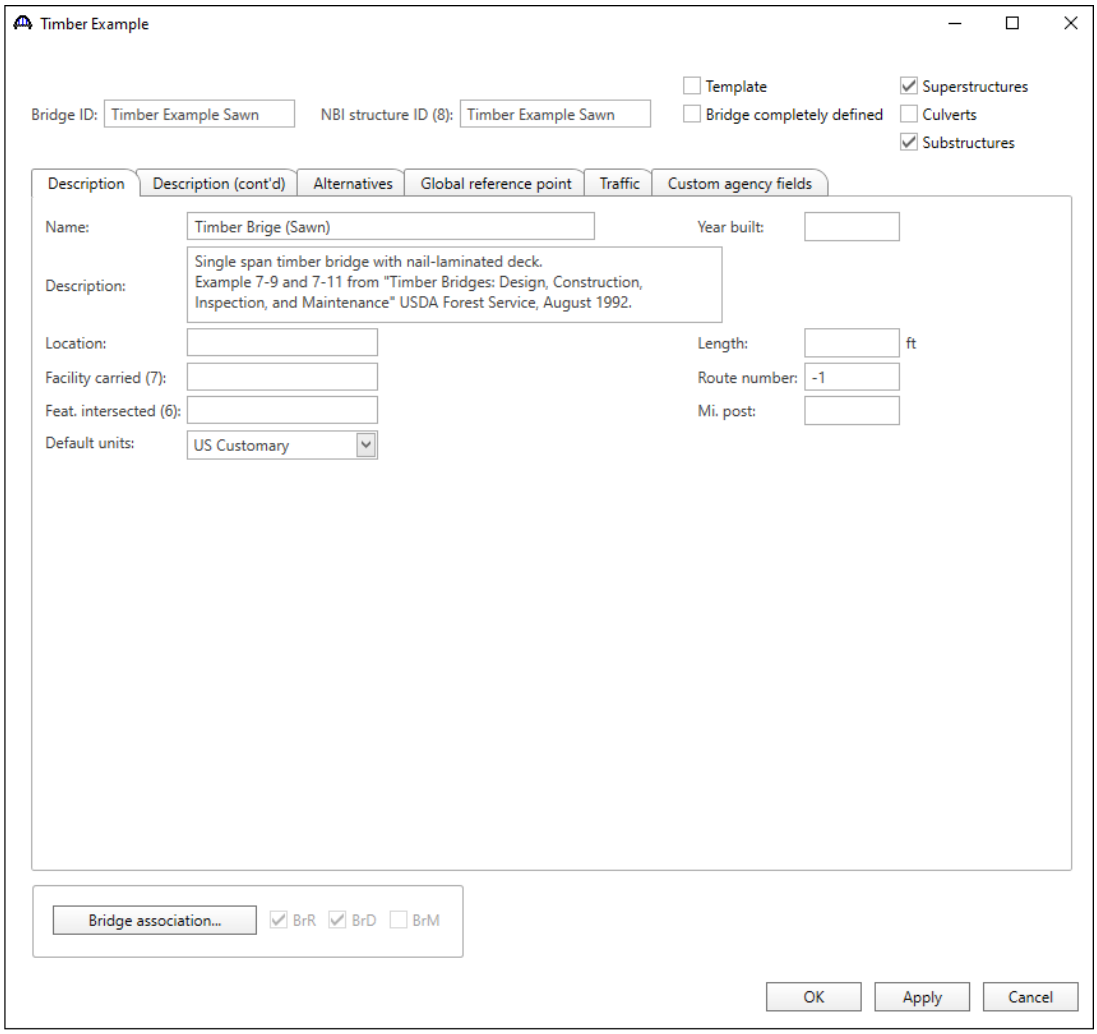
Timber Structure Tutorial

TMBR1- Single Span Timber Beam – Sawn Example

BrDR Training

TMBR1- Single Span Timber Beam Example

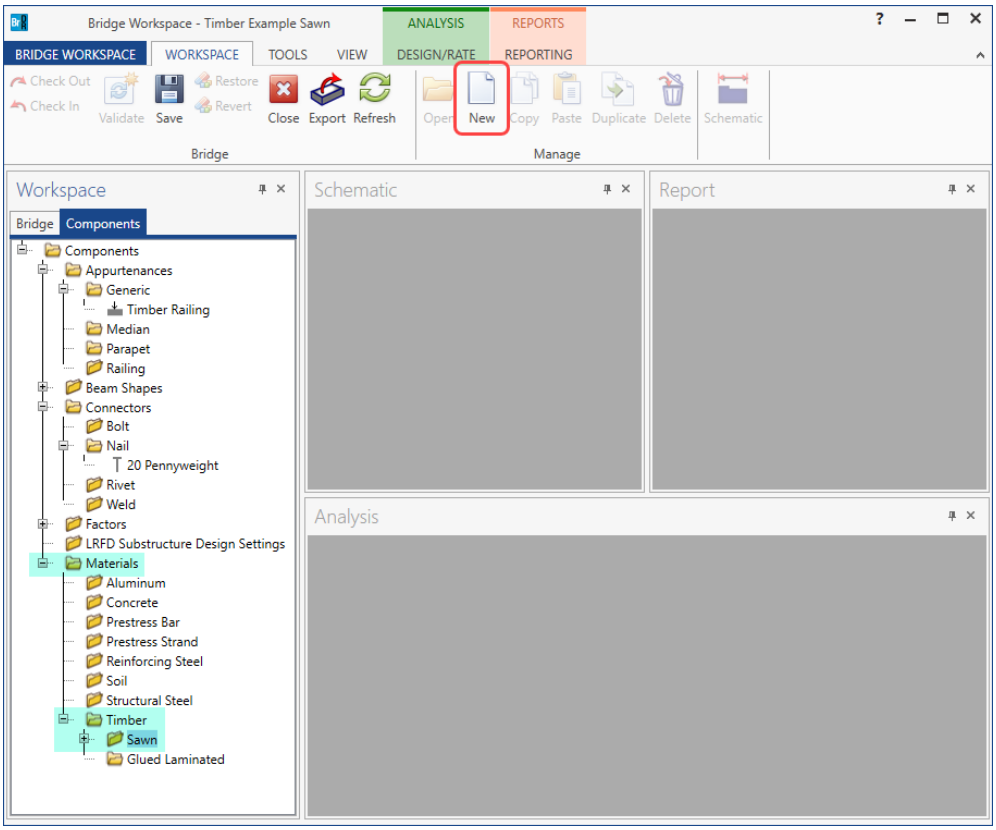
From the **Bridge Explorer,** create a new bridge and enter the following description data:



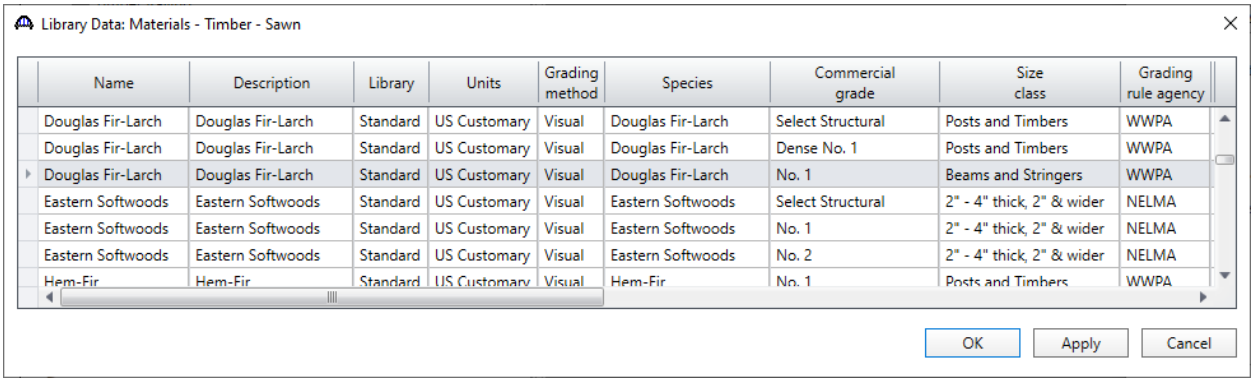
Close the window by clicking **OK**. This saves the data to memory and closes the window.

Bridge Materials

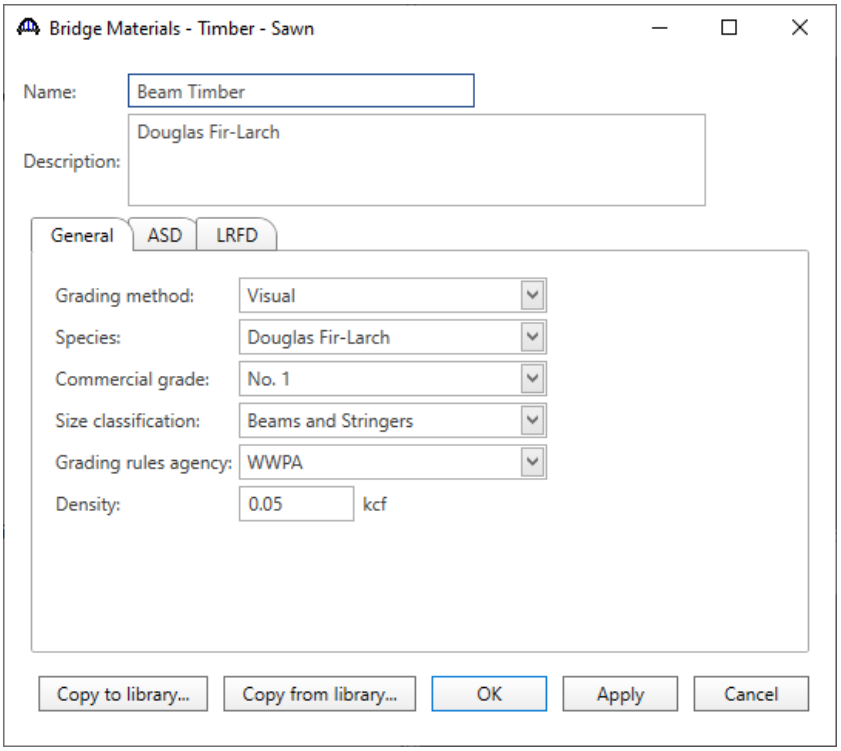
To add a new timber material, in the **Components** tab of the Bridge Workspace, click on **Materials**, **Timber**, **Sawn** and select **New** from the **Manage** group of the Workspace ribbon (or right mouse click on Sawn and select New).

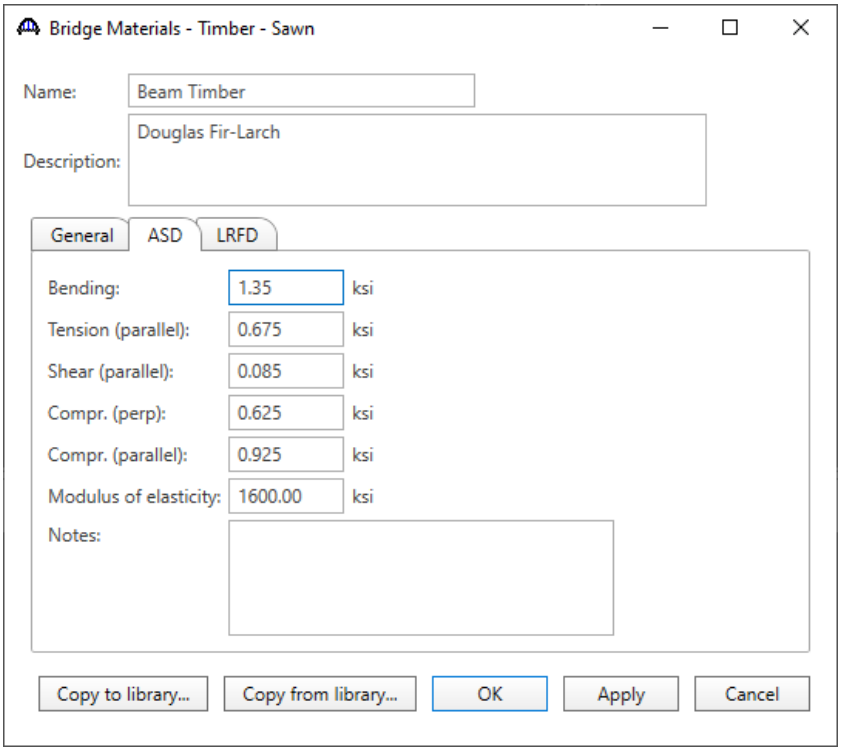


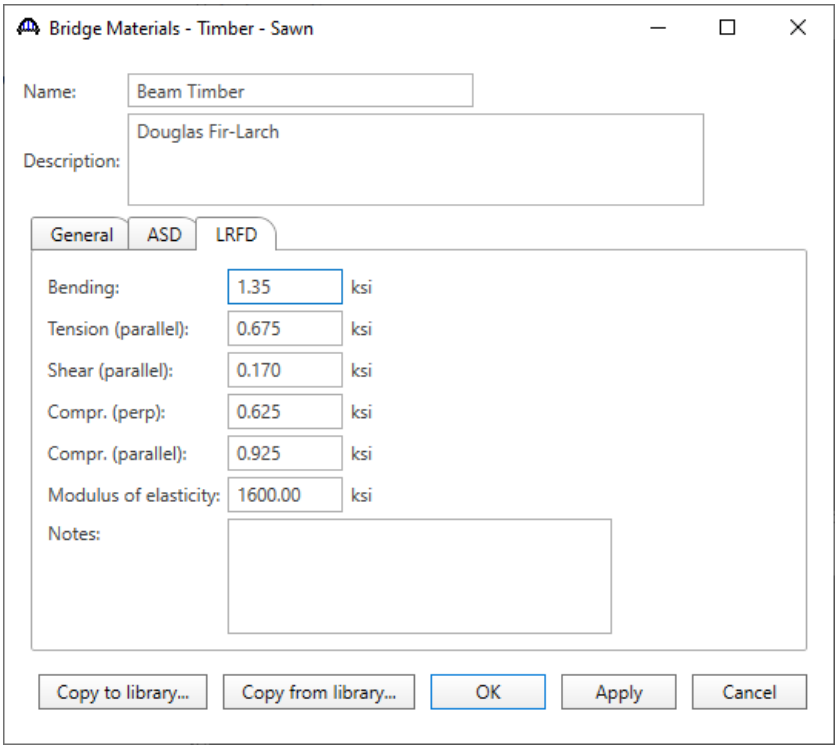
Click the **Copy from Library** button and select the following material from the library.



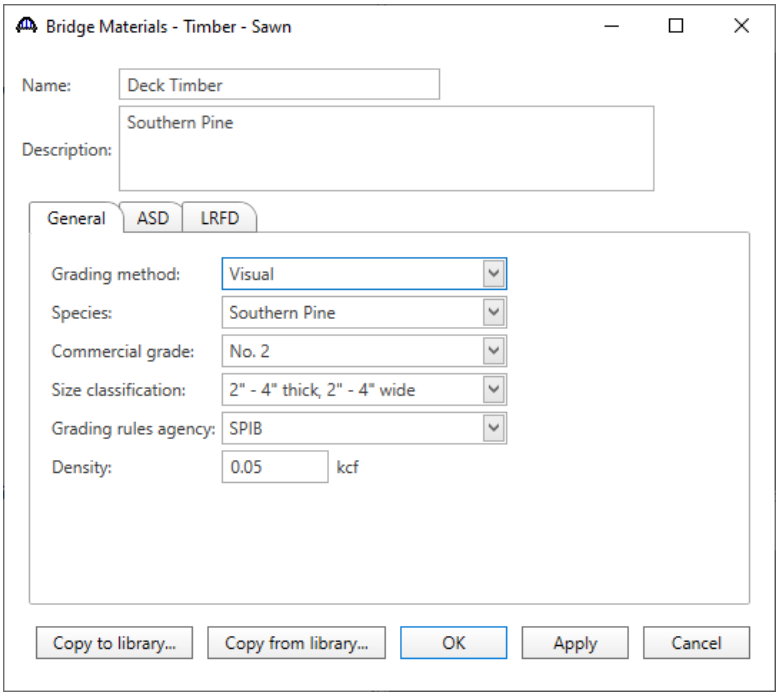
Click **OK** and the following window will open. Change the **Name** field to **Beam Timber** from Douglas Fir-Larch. The ASD Tabulated Design Values in the **ASD** tab of this window and the LRFD Reference design values in the **LRFD** tab of this window are based on dry conditions and do not include any adjustment factors based on usage conditions. Do not change any of the values on these tabs. Click **OK** to save this timber material to memory and close the window.

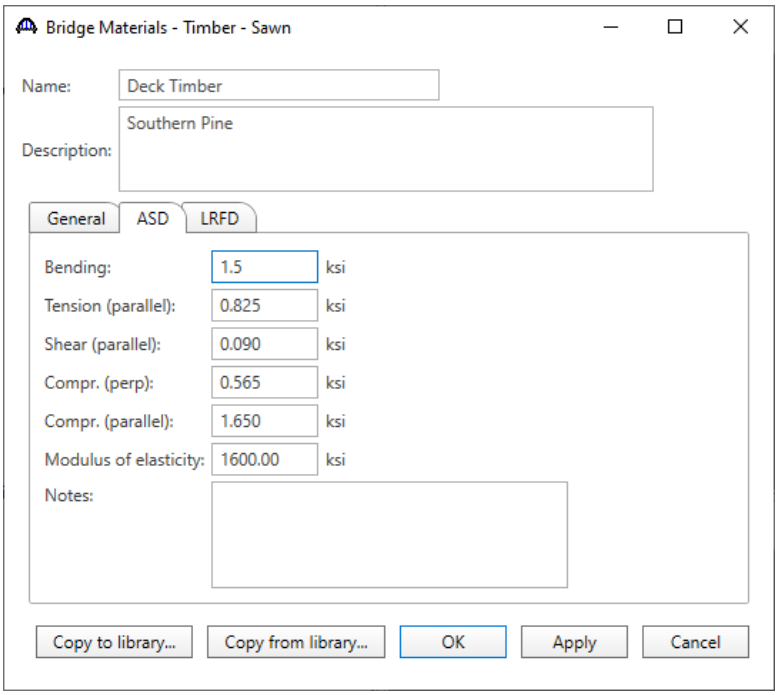

Bridge Materials - Timber - Sawn
Name:
Beam Timber
Description:
Douglas Fir-Larch
General
ASD
LRFD
Grading method:
Visual
Species:
Douglas Fir-Larch
Commercial grade:
No. 1
Size classification:
Beams and Stringers
Grading rules agency:
WWPA
Density:
0.05
kcf
Copy to library...
Copy from library...
OK
Apply
Cancel

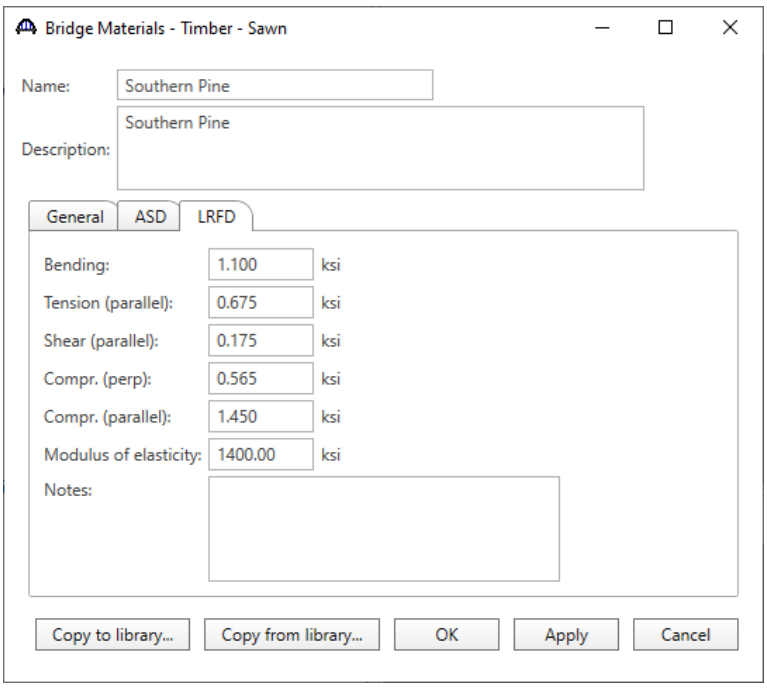

Bridge Materials - Timber - Sawn
Name:
Beam Timber
Description:
Douglas Fir-Larch
General
ASD
LRFD
Bending:
1.35
ksi
Tension (parallel):
0.675
ksi
Shear (parallel):
0.085
ksi
Compr. (perp):
0.625
ksi
Compr. (parallel):
0.925
ksi
Modulus of elasticity:
1600.00
ksi
Notes:
Copy to library...
Copy from library...
OK
Apply
Cancel



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.

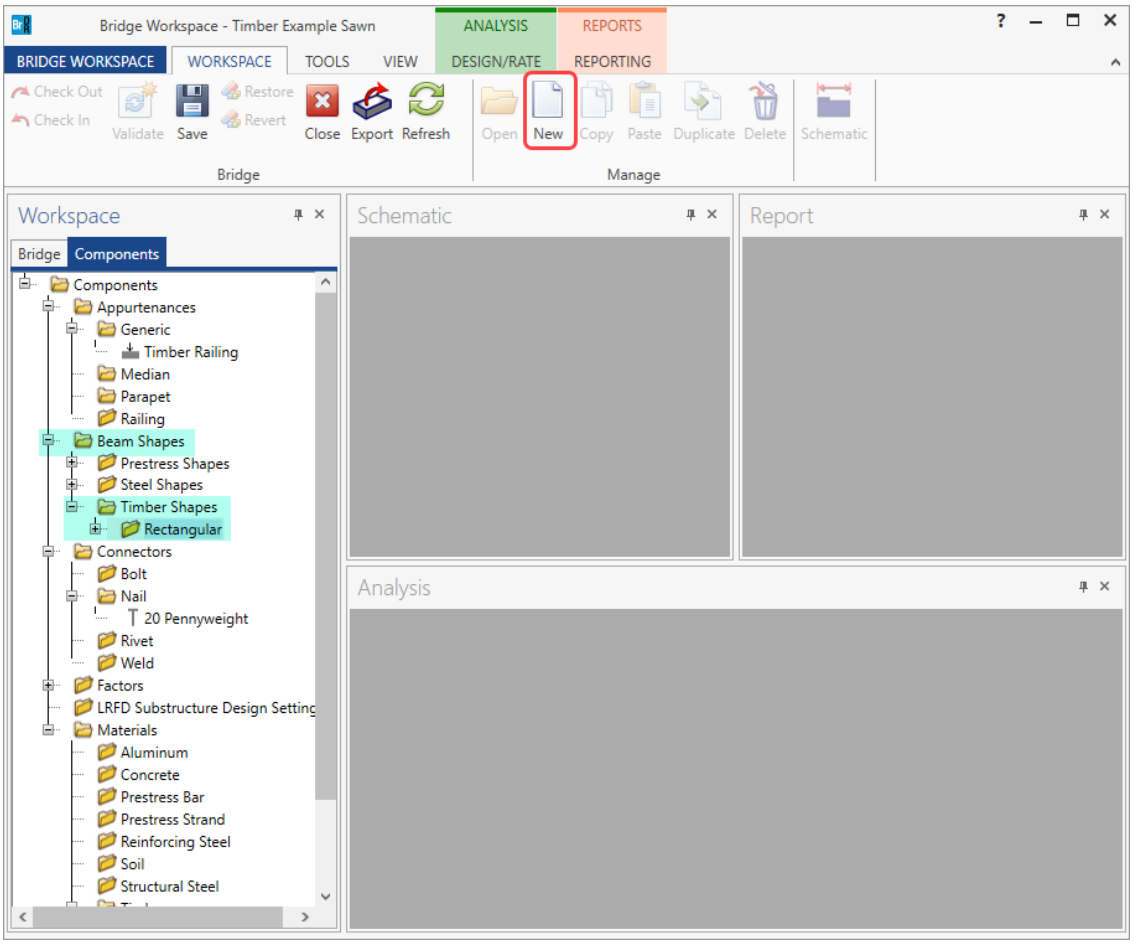



Bridge Materials - Timber - Sawn
Name:
Deck Timber
Description:
Southern Pine
General
ASD
LRFD
Bending:
1.5
ksi
Tension (parallel):
0.825
ksi
Shear (parallel):
0.090
ksi
Compr. (perp):
0.565
ksi
Compr. (parallel):
1.650
ksi
Modulus of elasticity:
1600.00
ksi
Notes:
Copy to library...
Copy from library...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

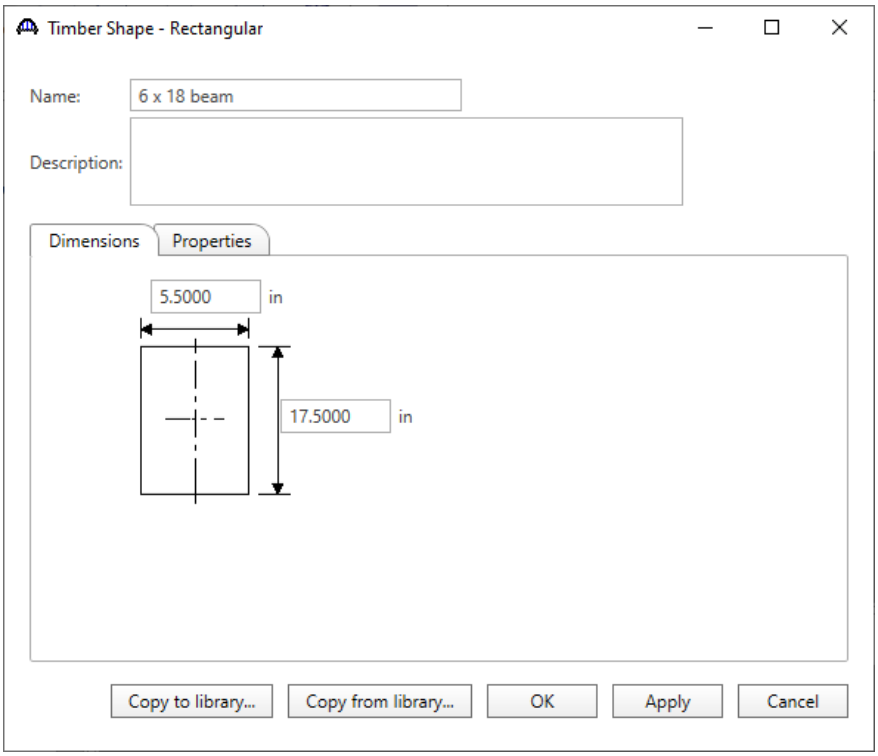

Bridge Materials - Timber - Sawn
Name:
Southern Pine
Description:
Southern Pine
General
ASD
LRFD
Bending:
1.100
ksi
Tension (parallel):
0.675
ksi
Shear (parallel):
0.175
ksi
Compr. (perp):
0.565
ksi
Compr. (parallel):
1.450
ksi
Modulus of elasticity:
1400.00
ksi
Notes:
Copy to library...
Copy from library...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

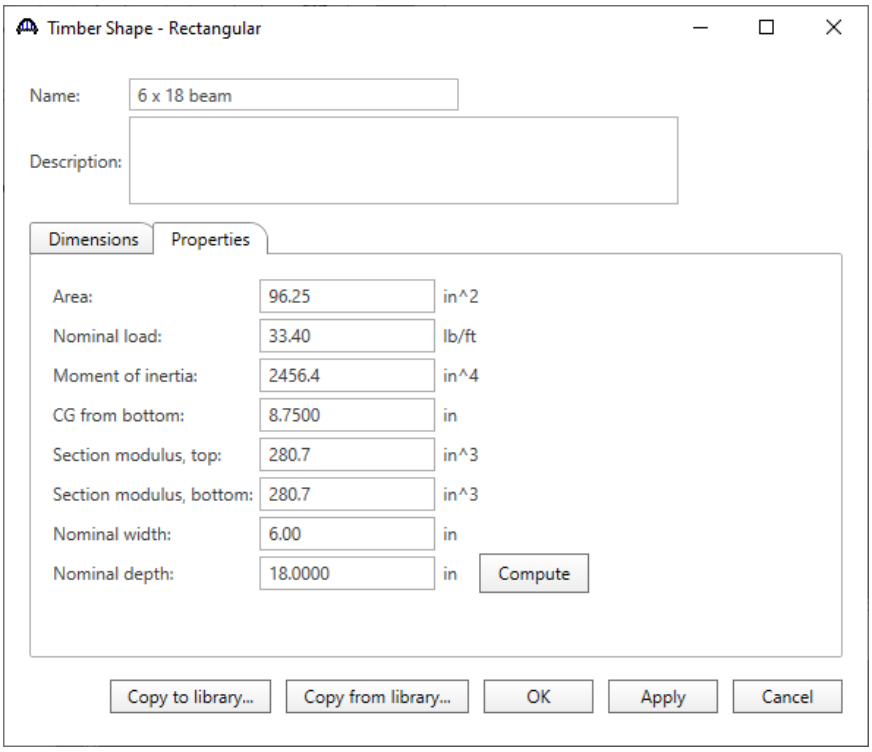
Timber Shape

Add a new timber beam shape by clicking on **Beam Shapes**, **Timber**, **Rectangular** in the **Components** tree and selecting **New** from the **Manage** group of the Workspace ribbon (or double click on Rectangular).



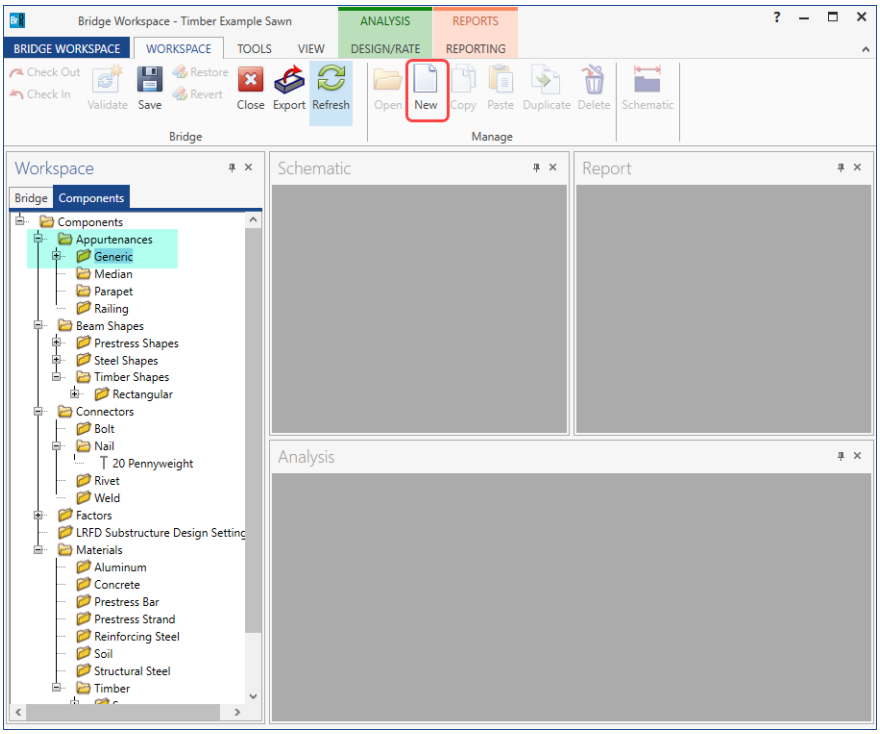
Enter the following data. Enter the actual beam dimensions to be used to calculate section properties on the **Dimensions** tab. Enter the nominal dimensions of the beam on the **Properties** tab and click on the **Compute** button to compute the section properties. Click **OK** to save the data to memory and close the window.


Timber Shape - Rectangular
Name:
6 x 18 beam
Description:
Dimensions
Properties
5.5000
in
17.5000
in
Copy to library...
Copy from library...
OK
Apply
Cancel

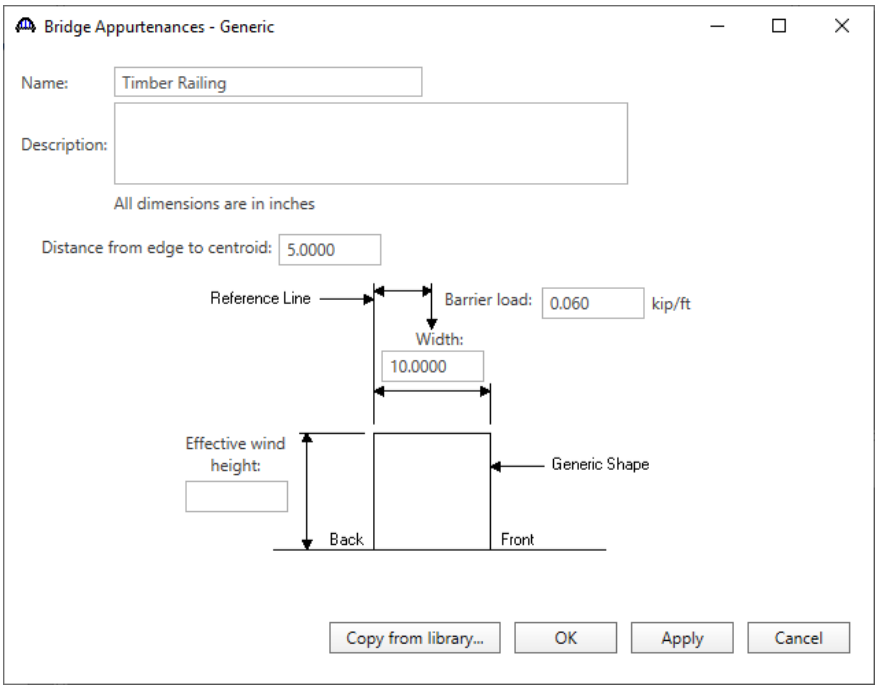

Timber Shape - Rectangular
Name:
6 x 18 beam
Description:
Dimensions
Properties
Area:
96.25
in^2
Nominal load:
33.40
lb/ft
Moment of inertia:
2456.4
in^4
CG from bottom:
8.7500
in
Section modulus, top:
280.7
in^3
Section modulus, bottom:
280.7
in^3
Nominal width:
6.00
in
Nominal depth:
18.0000
in
Compute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

Bridge Appurtenances

To enter the appurtenances to be used within the bridge, expand the tree branch labeled **Appurtenances**. To define a generic railing, select **Generic** in the Components tree and click **New** from the **Manage** group of the Workspace ribbon (or double click on Generic).



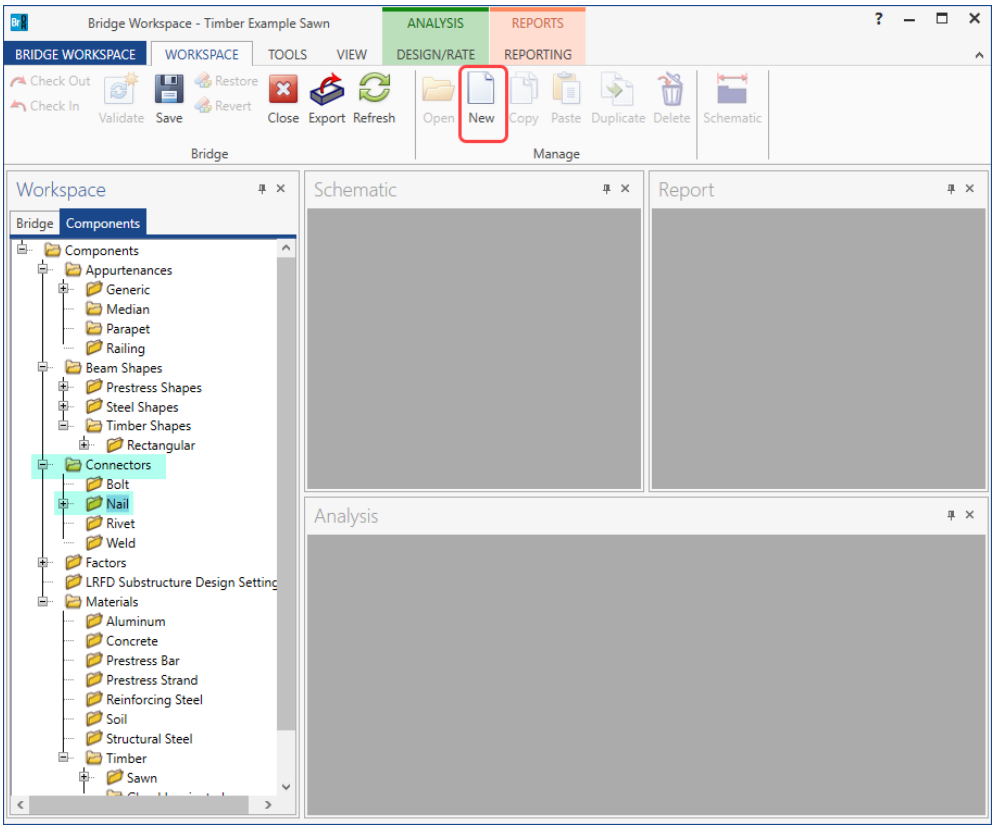
Input the generic railing dimensions as shown below.



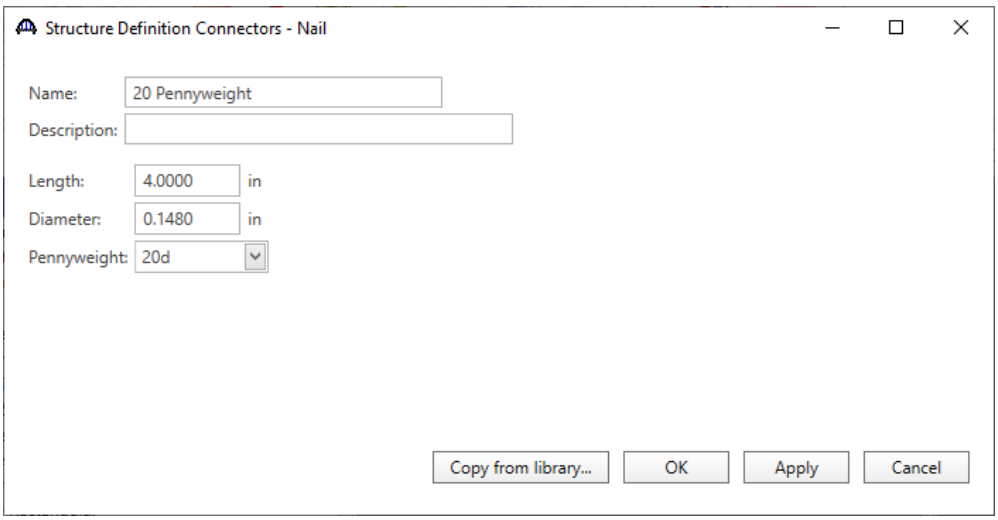
Click **OK** to save the data to memory and close the window.

Bridge Connectors – Nail

To create a nail definition, expand the **Connectors** tree item and select **Nail** in the Components tree and click **New** from the **Manage** group of the WORKSPACE ribbon (or double click on Nail).

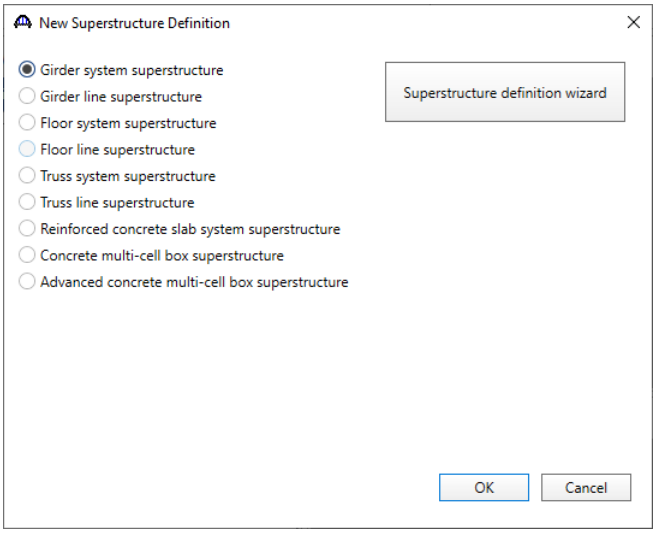


Define the nail as shown below. Click **OK** to save to memory and close the window.

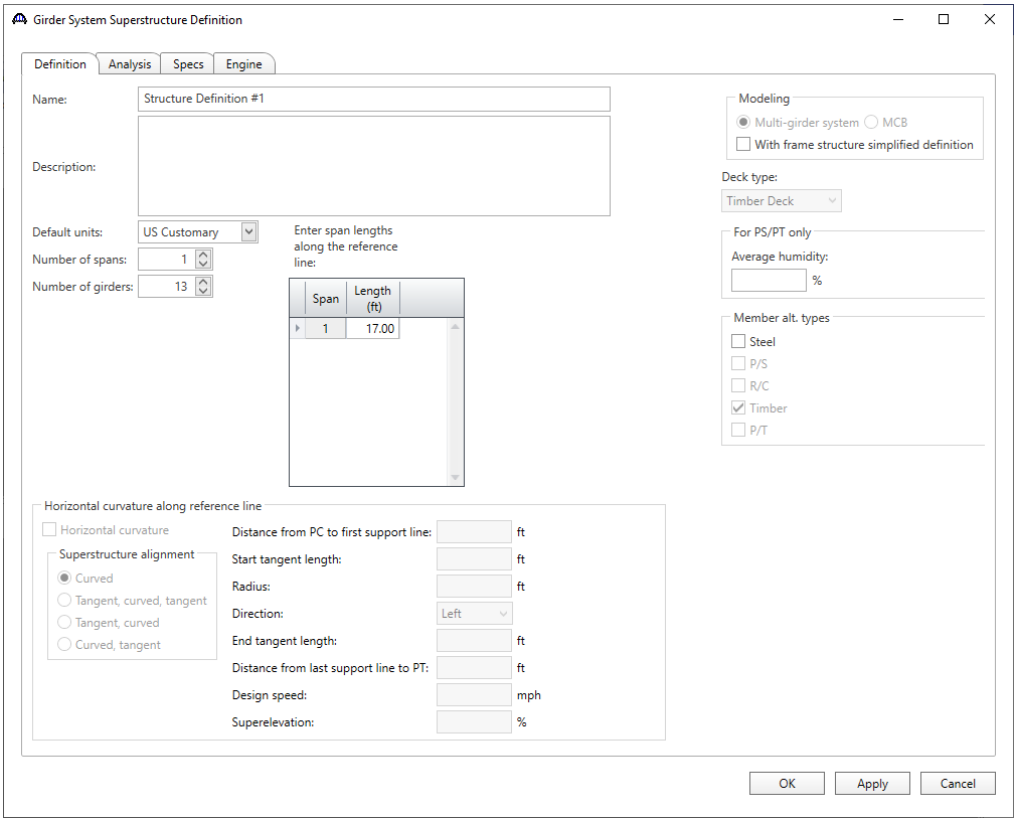


Superstructure Definition

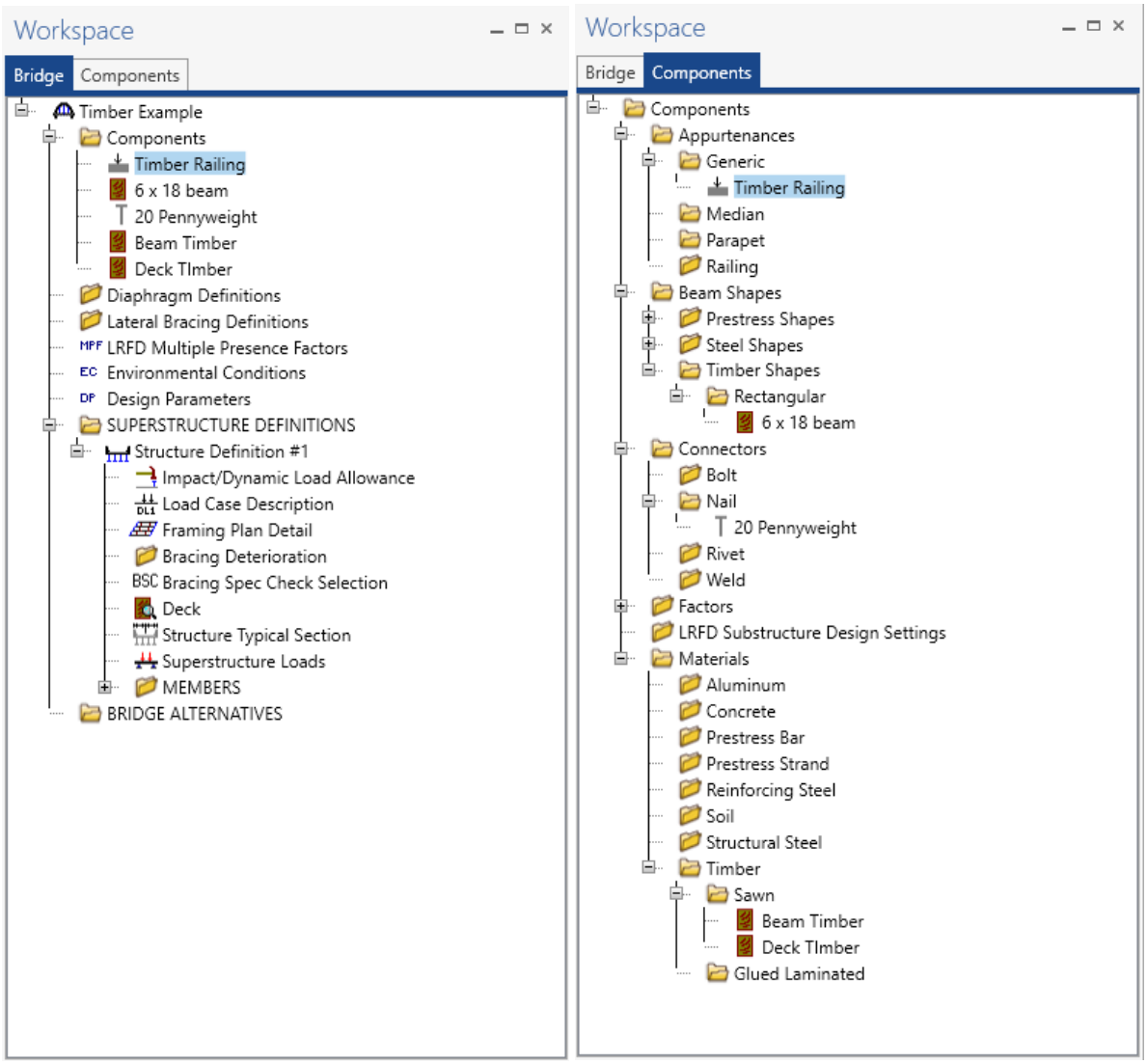
Double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the Workspace ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition. The window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



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

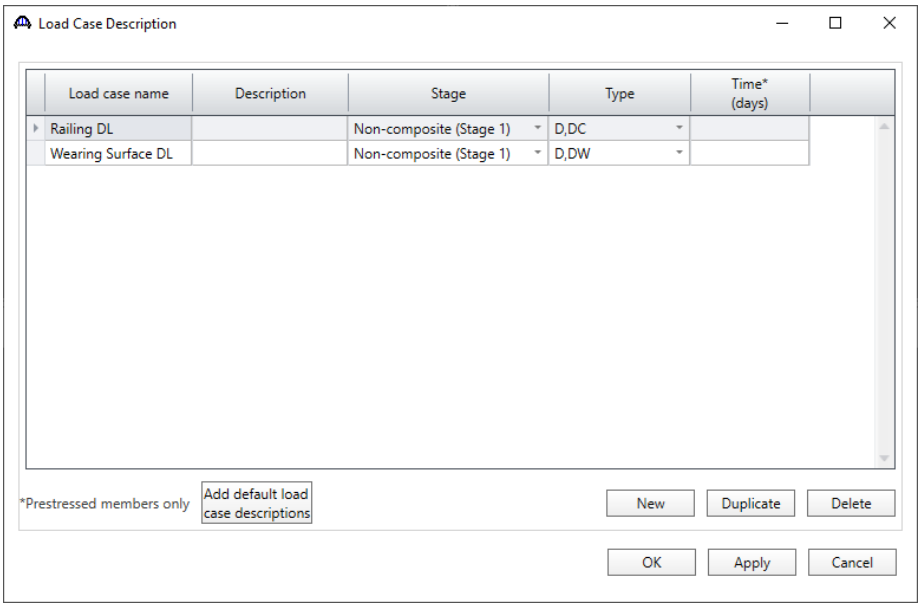


The partially expanded Bridge Workspace tree for each of its tabs are shown below



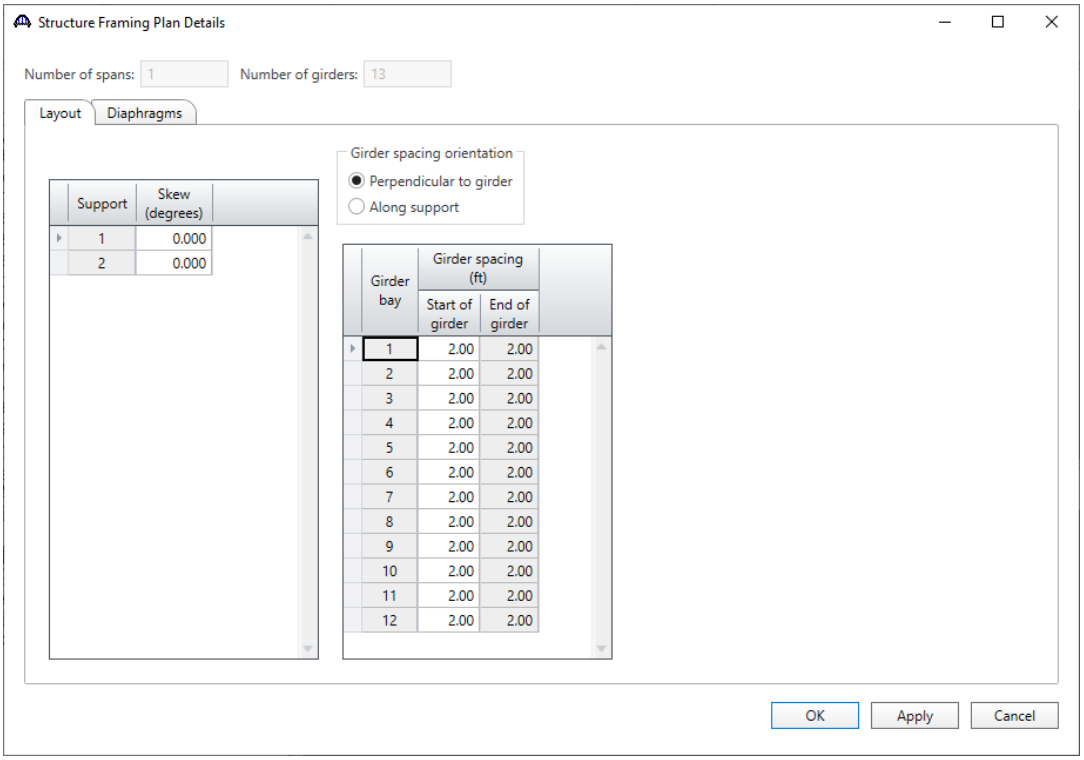
Load Case Description

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



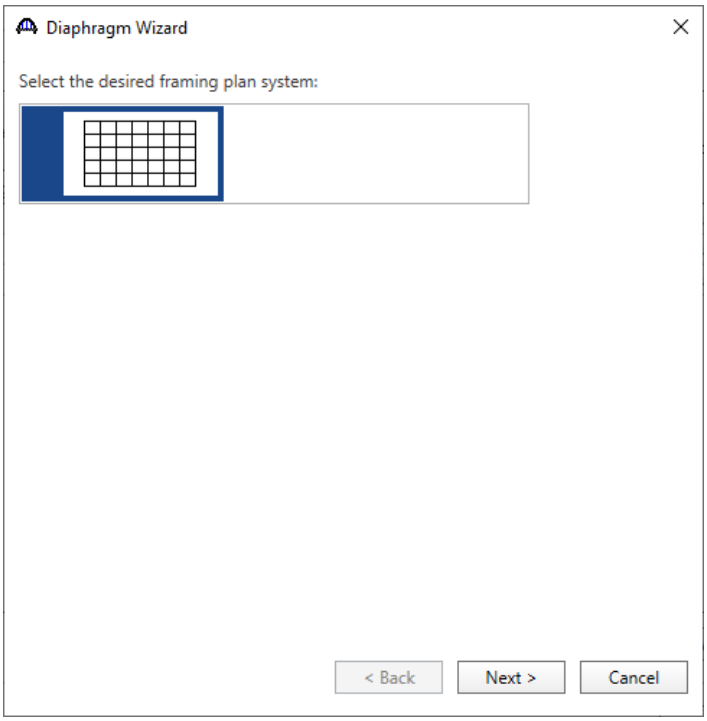
Framing Plan Detail

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

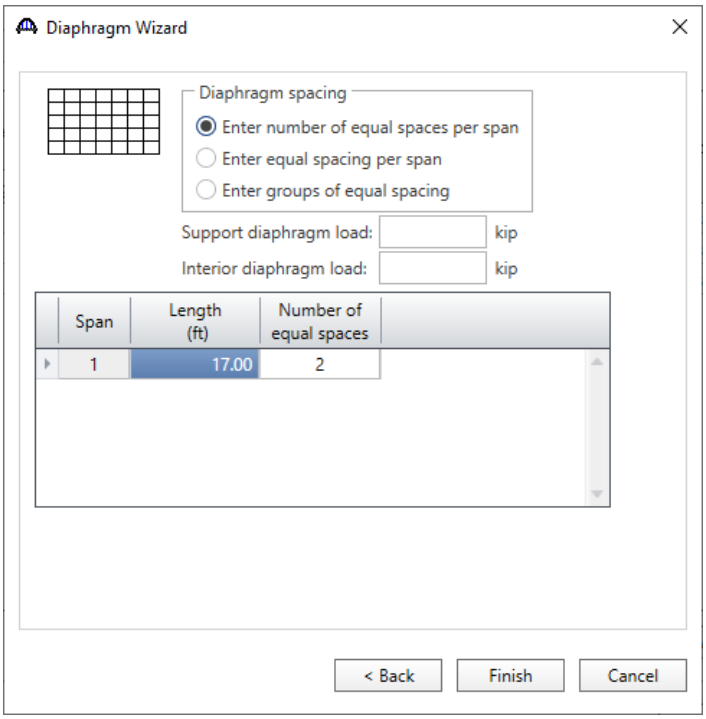


Diaphragms

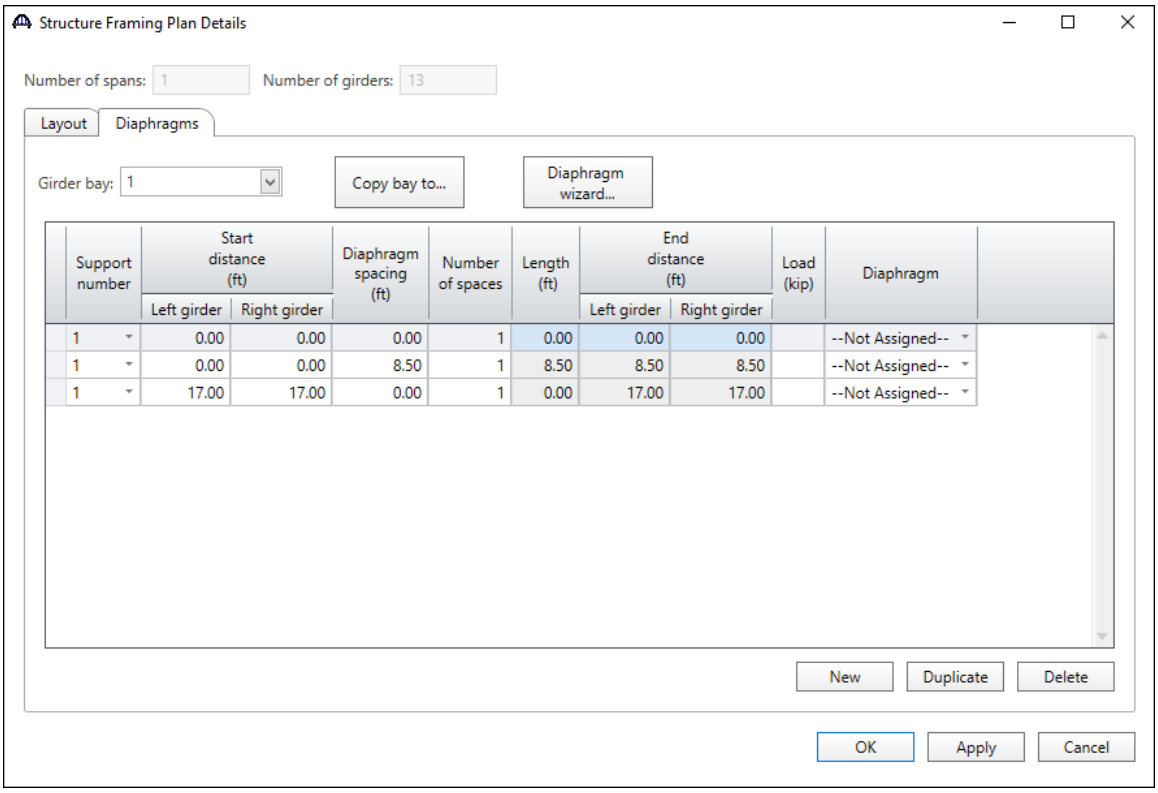
Switch to the **Diaphragms** tab to enter diaphragm spacing. Select the Diaphragm Wizard button to have BrDR generate the diaphragm locations. The following window appears. Select the **Next** button to continue.



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



The **Diaphragm Wizard** generates the following diaphragm locations.



Deck

Enter the deck description by double-clicking on **Deck** in the Bridge Workspace tree. BrDR 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 for the **Nail** field.

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 (see figure below). This value equals **18.5"** for this structure.

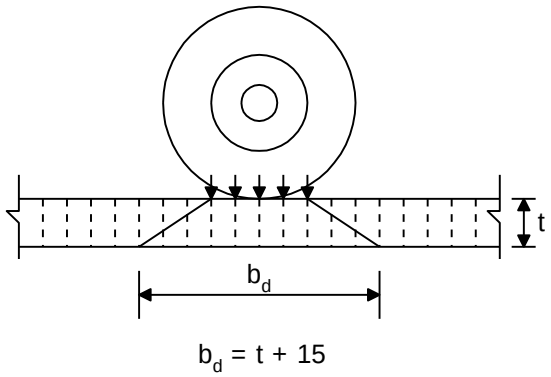
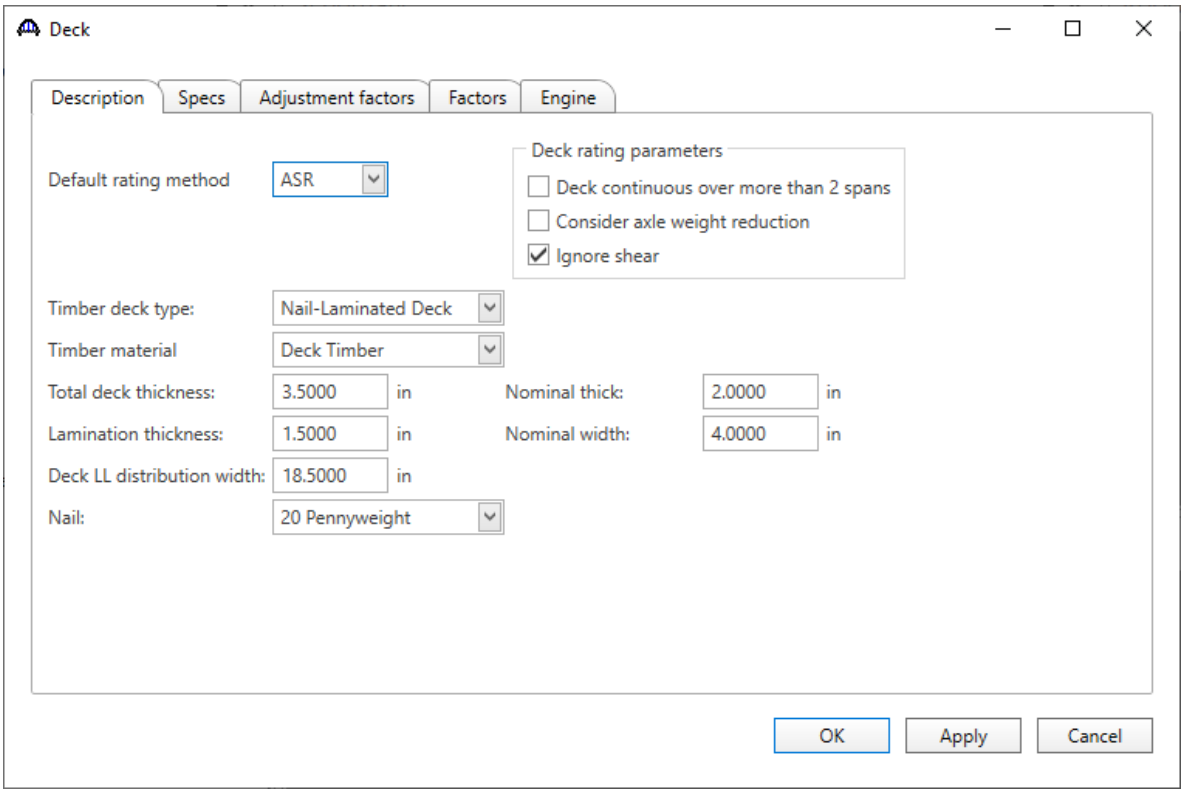
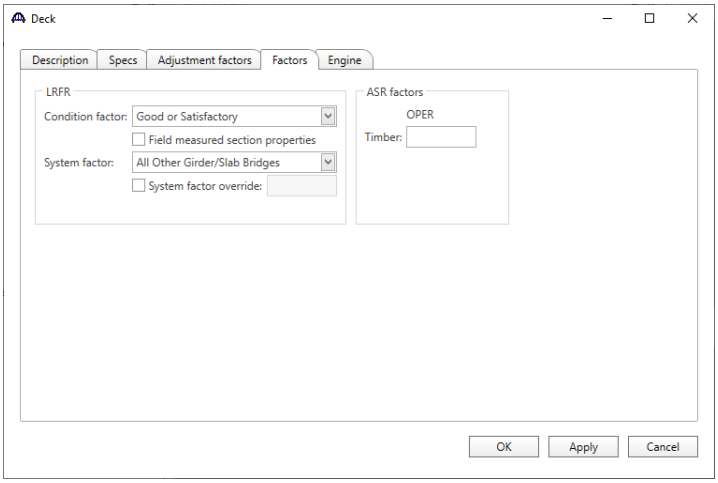


Figure – Relation between total deck thickness and deck LL distribution width as per Article 3.25.1.1



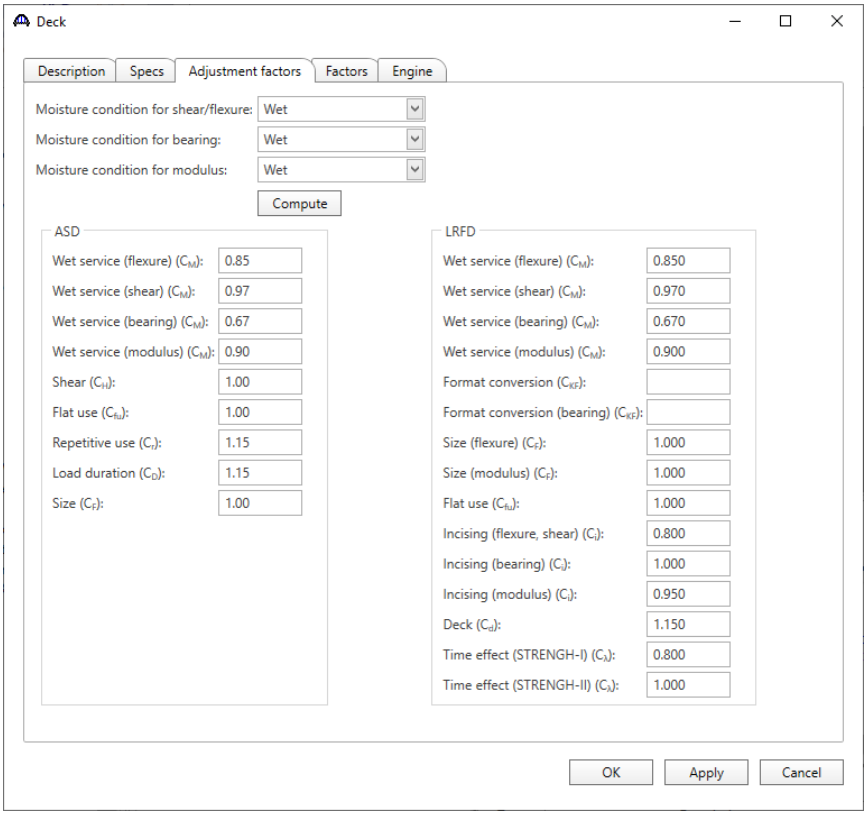
Deck – Factors

The **Factors** tab of the Deck window provides entries for the **LRFR** and **ASR** factors to be used for the deck.



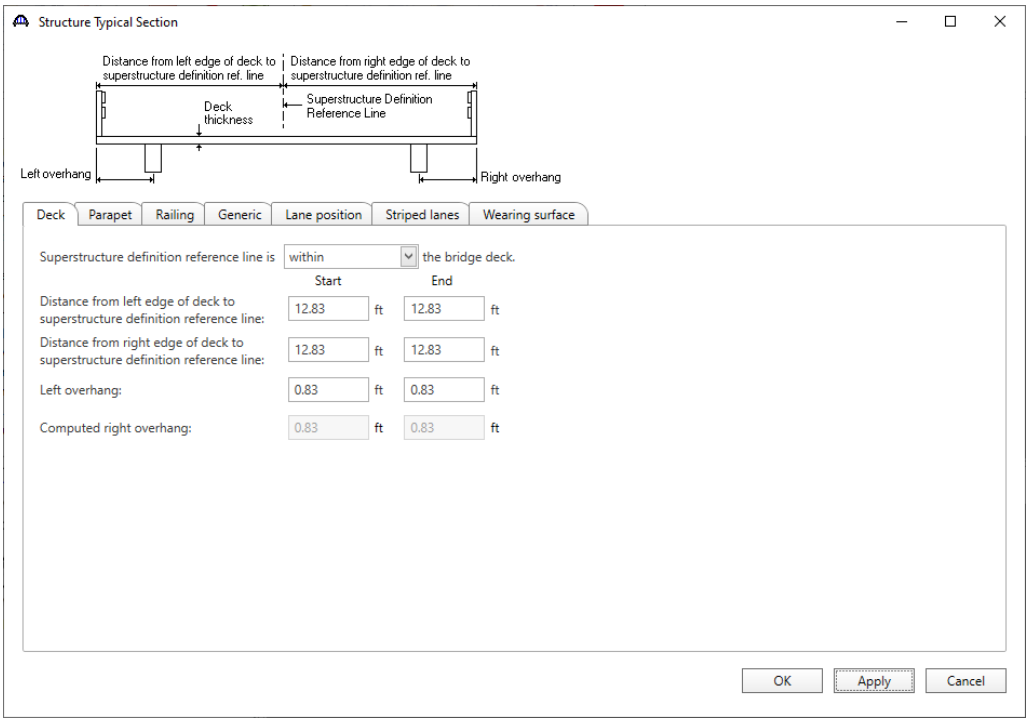
Deck – Adjustment Factors

The **Adjustment factors** tab of the Deck window provides entries 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.**



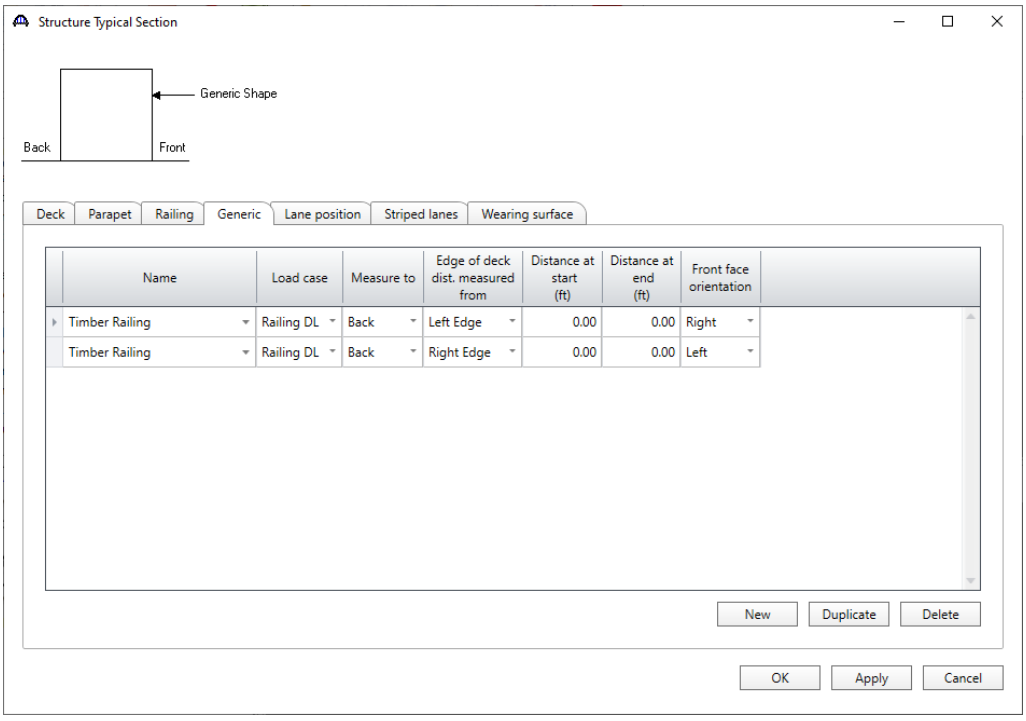
Structure Typical Section - Deck

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.



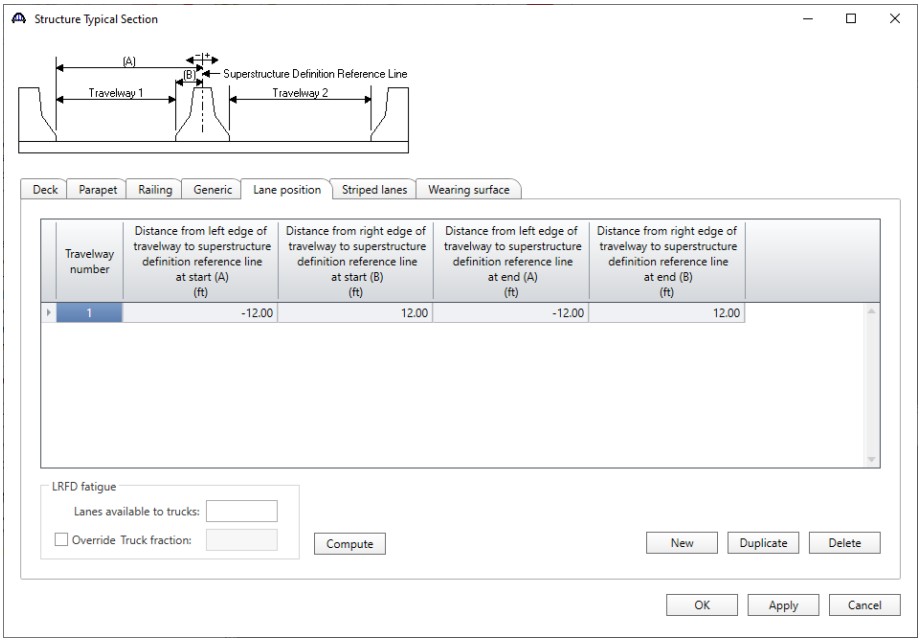
Structure Typical Section - Generic Appurtenances

Enter the railings on the **Generic** tab. Click **New** to add a row to the table. Enter the following data as shown below:



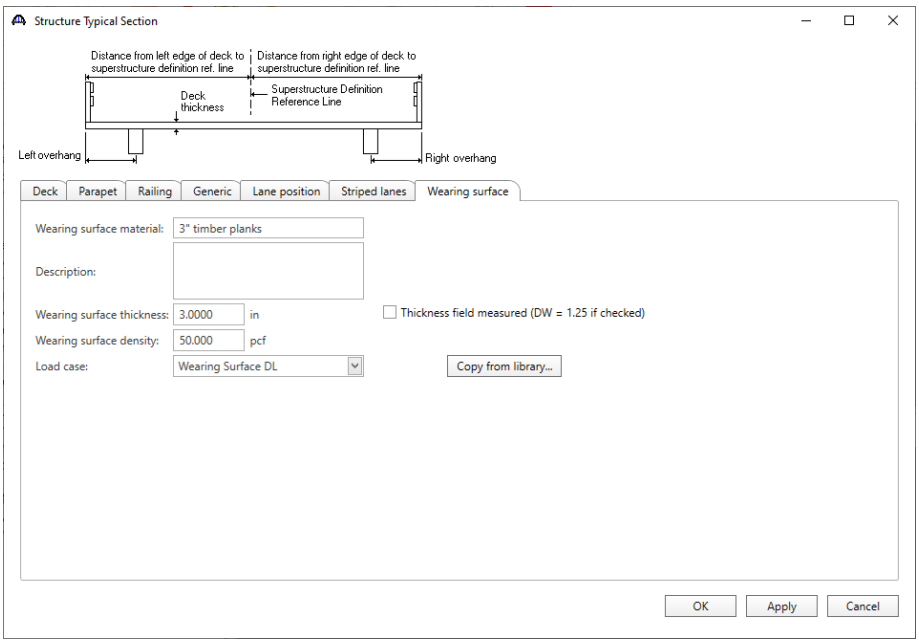
Structure Typical Section - Lane Positions

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



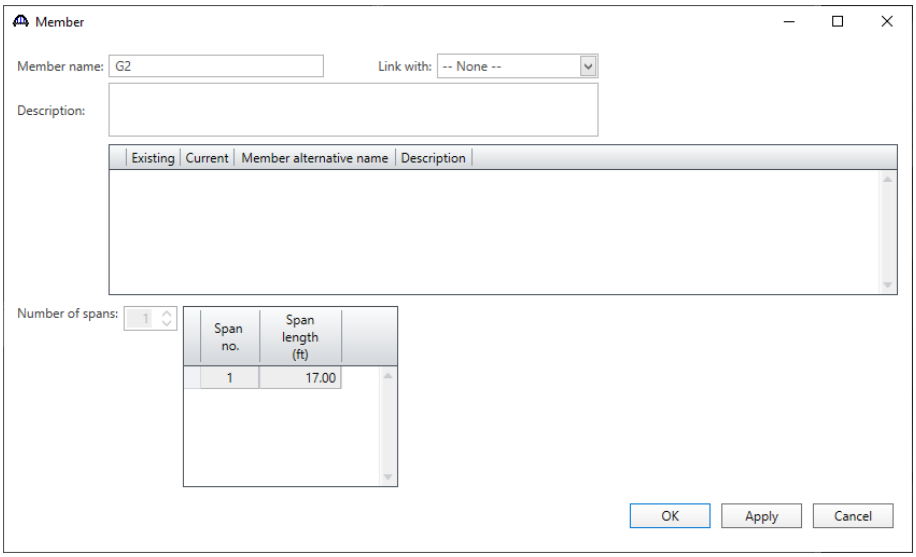
Structure Typical Section -Wearing Surface

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



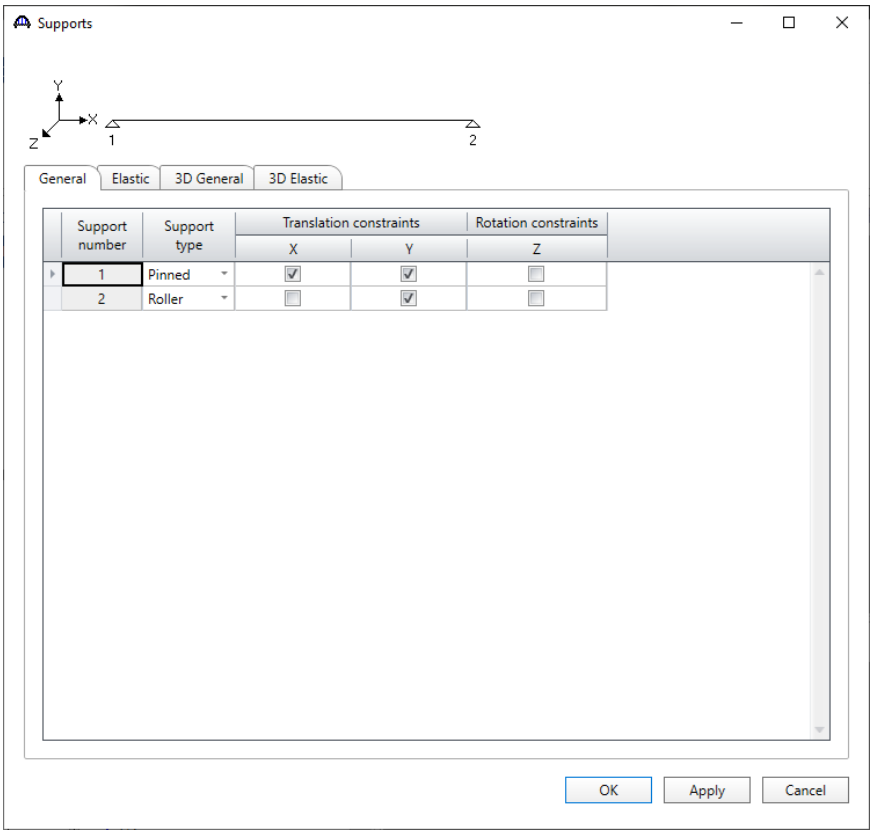
Describing a member

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.



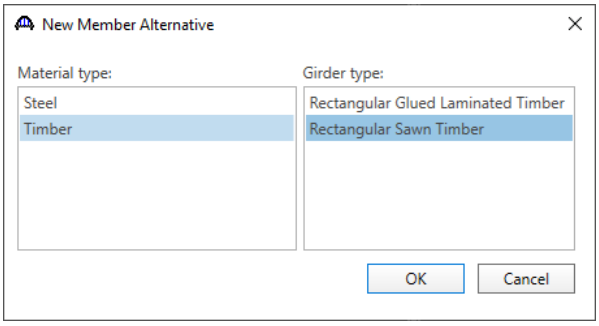
Support Constraints

Support constraints were generated when the structure definition was created and are shown below. No changes are required.

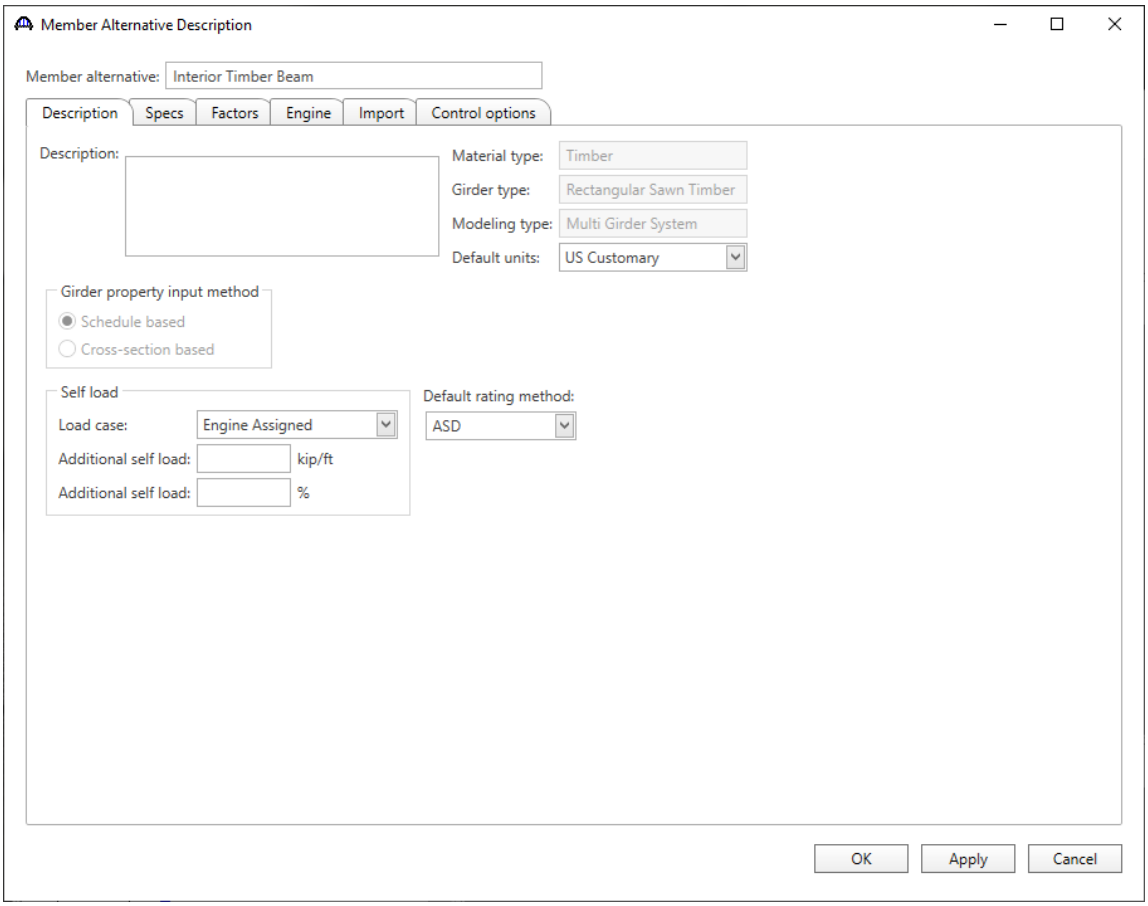


Defining a Member Alternative

Double click **MEMBER ALTERNATIVES** in the tree to create a new alternative. The **New Member Alternative** window shown below will open. Select **Timber** for the **Material Type** and **Rectangular Sawn Timber** for the **Girder Type**.

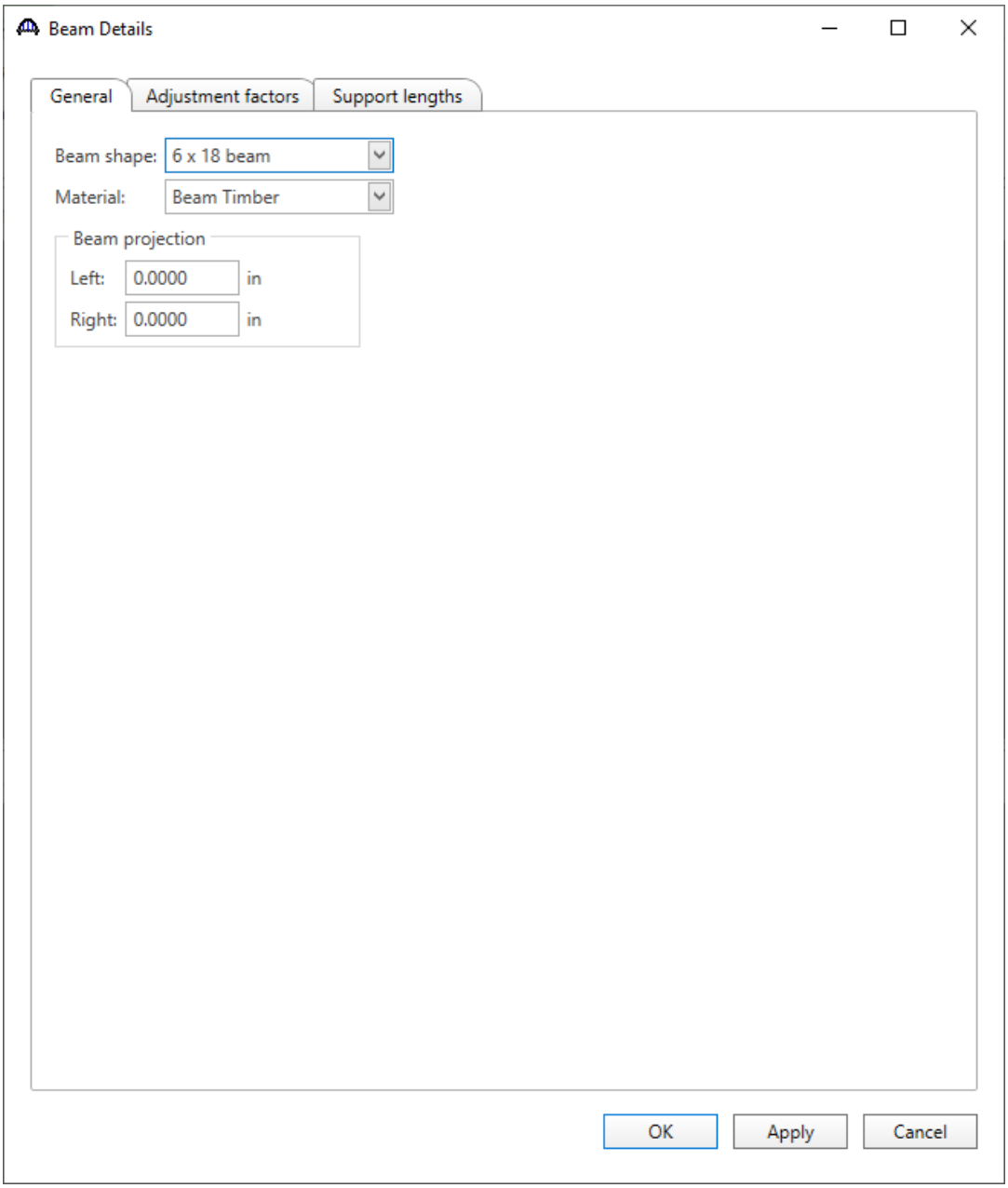


Enter the following data for the Member Alternative. Click **OK** to save to memory and close the window.



Beam Details - General

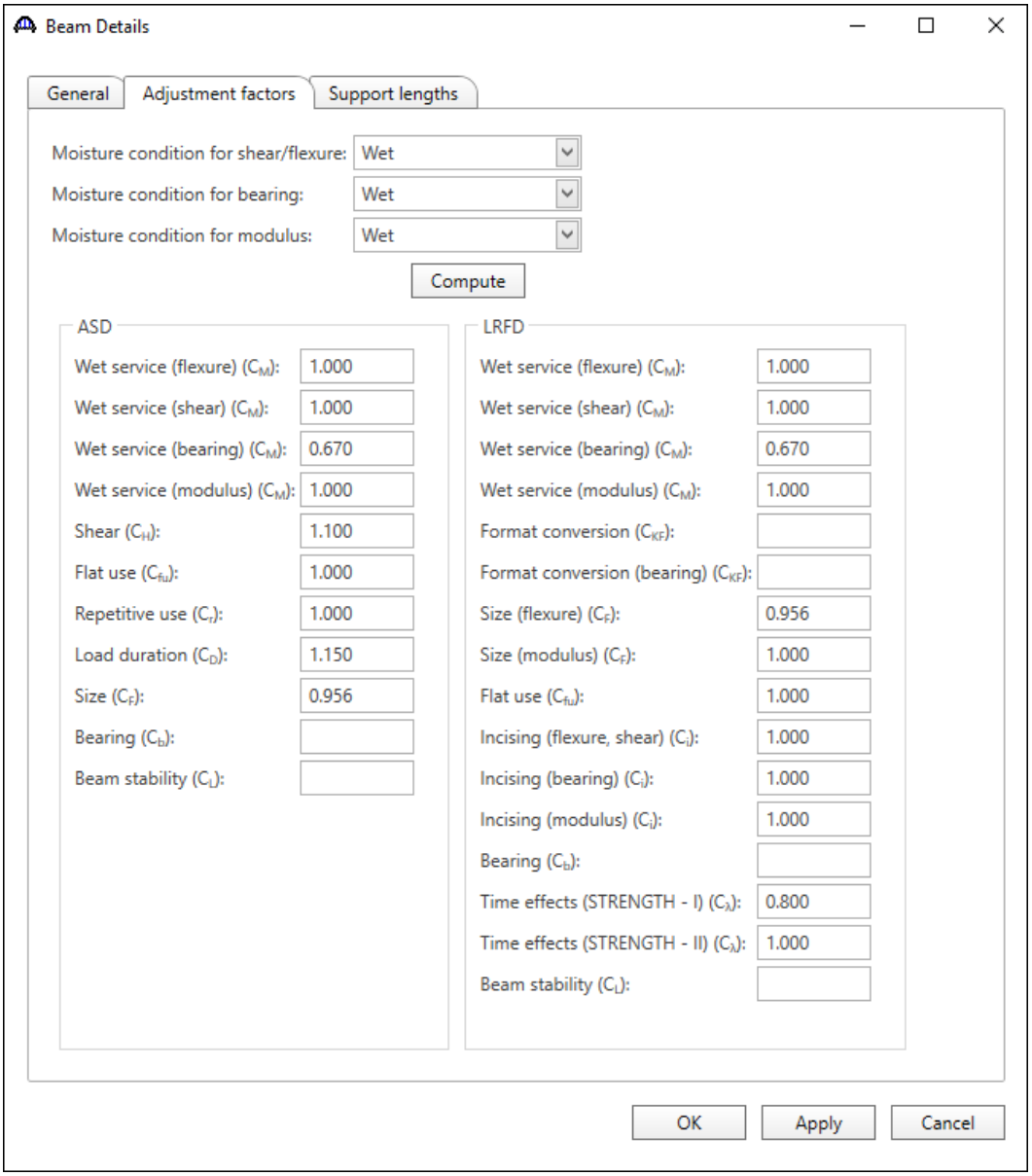
Open the **Beam Details** window by double clicking on **Beam Details** in the tree. The Beam Details window is shown below. No changes are required on the **General** tab



Beam Details - Adjustment Factors

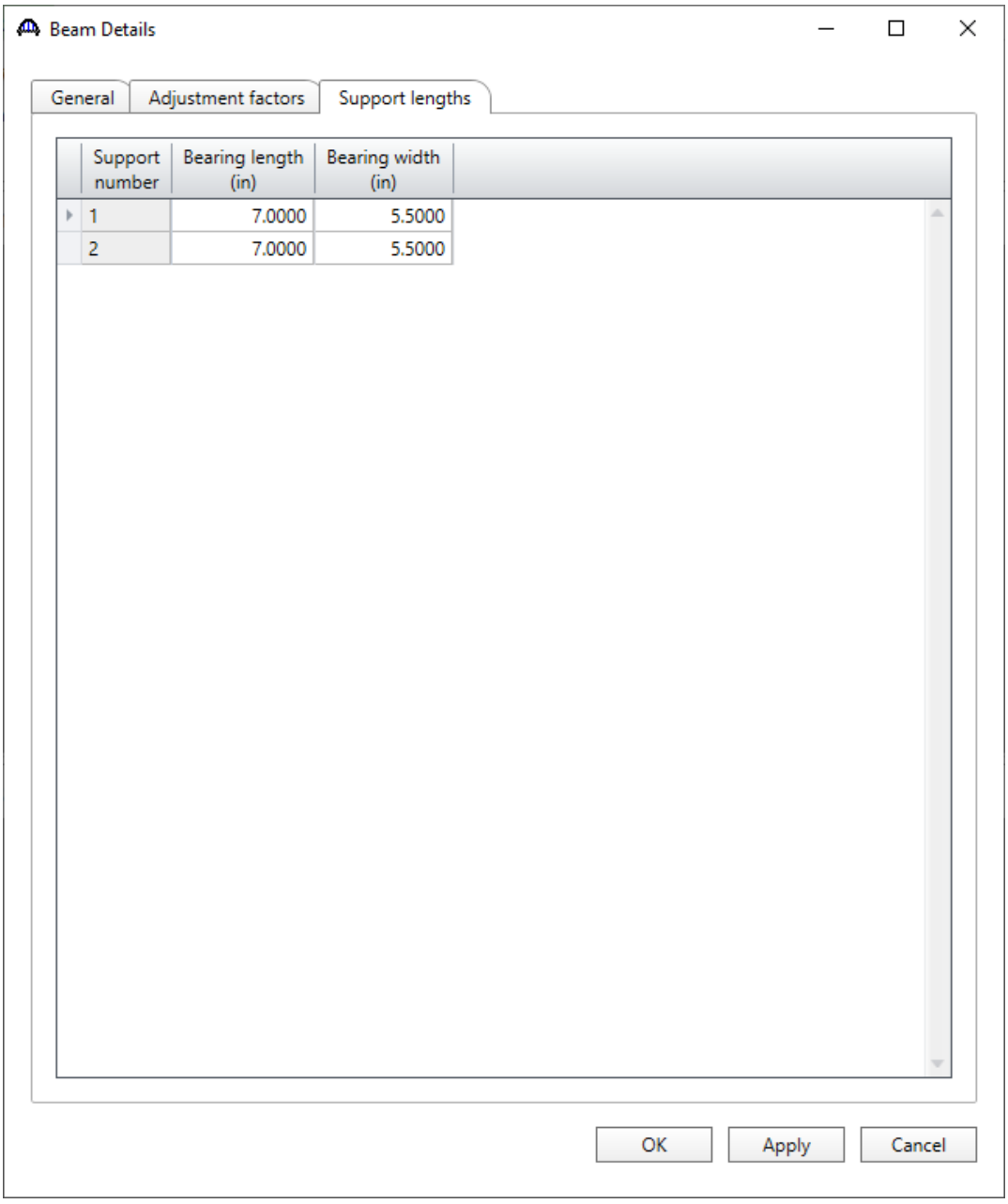
The **Adjustment Factors** tab of the Beam Details window provides input entry for the adjustment factors to modify the **ASD** tabulated design values and the **LRFD** Reference design values entered on the **Bridge Materials – Timber – Sawn** window. The tabulated design values modified by these adjustment factors produce the design allowable stresses.

Select the **Wet** condition for **Shear/Flexure, Bearing** and **Modulus** fields. Use the **Compute** button to calculate the factors for the beam based on the Wet moisture conditions. Enter **1.1 for the Shear factor** since it is not calculated by the Compute button. This factor is not computed since it is dependent on the visual characteristics of the actual timber material used.



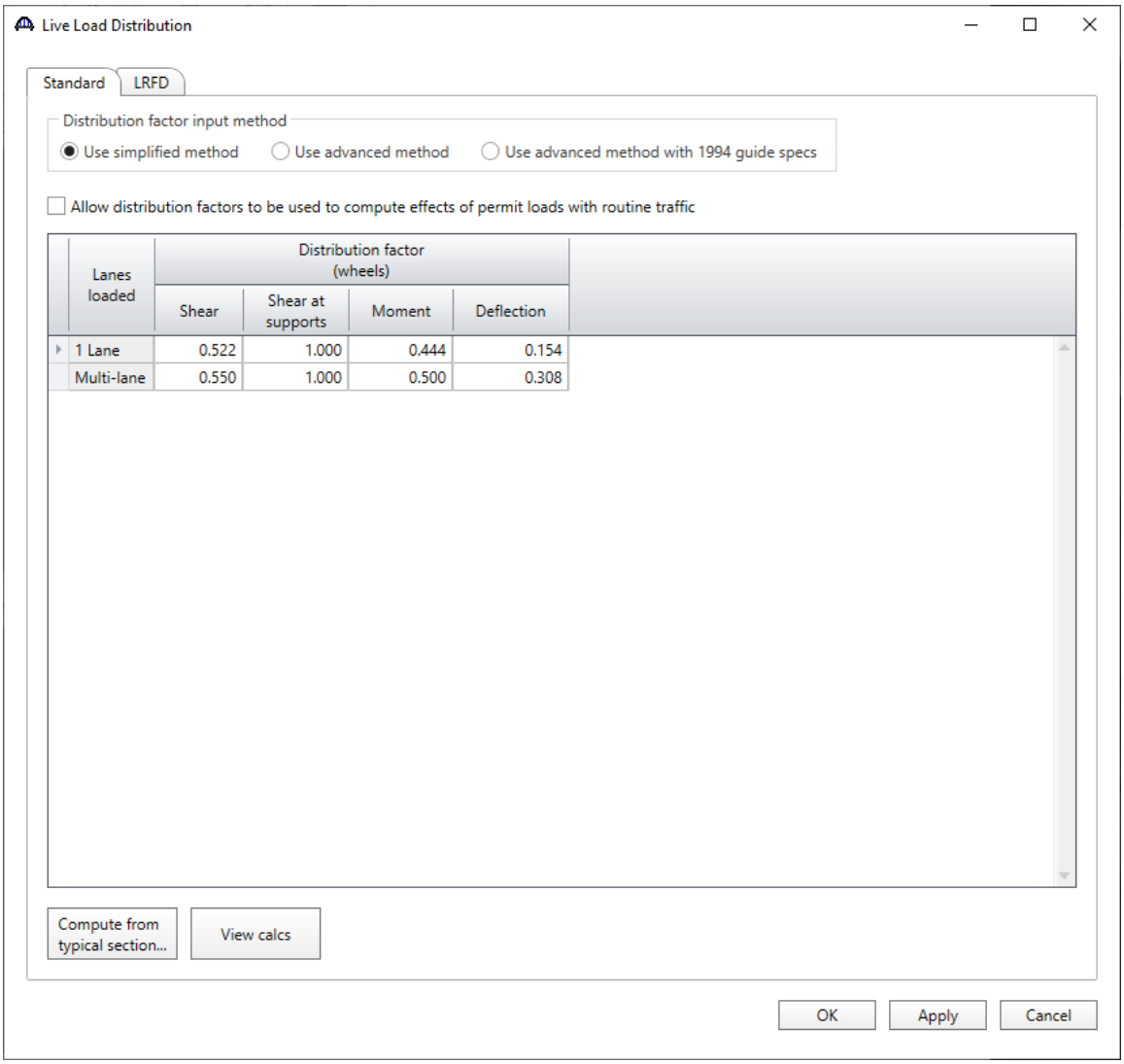
Beam Details - Support lengths

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



Live Load Distribution Factors

Open the **Live Load Distribution** window and in **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)

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

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)

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

where V_{LU} = shear due to undistributed wheel loads (i.e., 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

Single Lane Shear DF = 0.50[(0.60(1) + 0.4444)] = 0.5222

Multi Lane Shear DF = 0.50[(0.60(1) + 0.5000)] = 0.5500

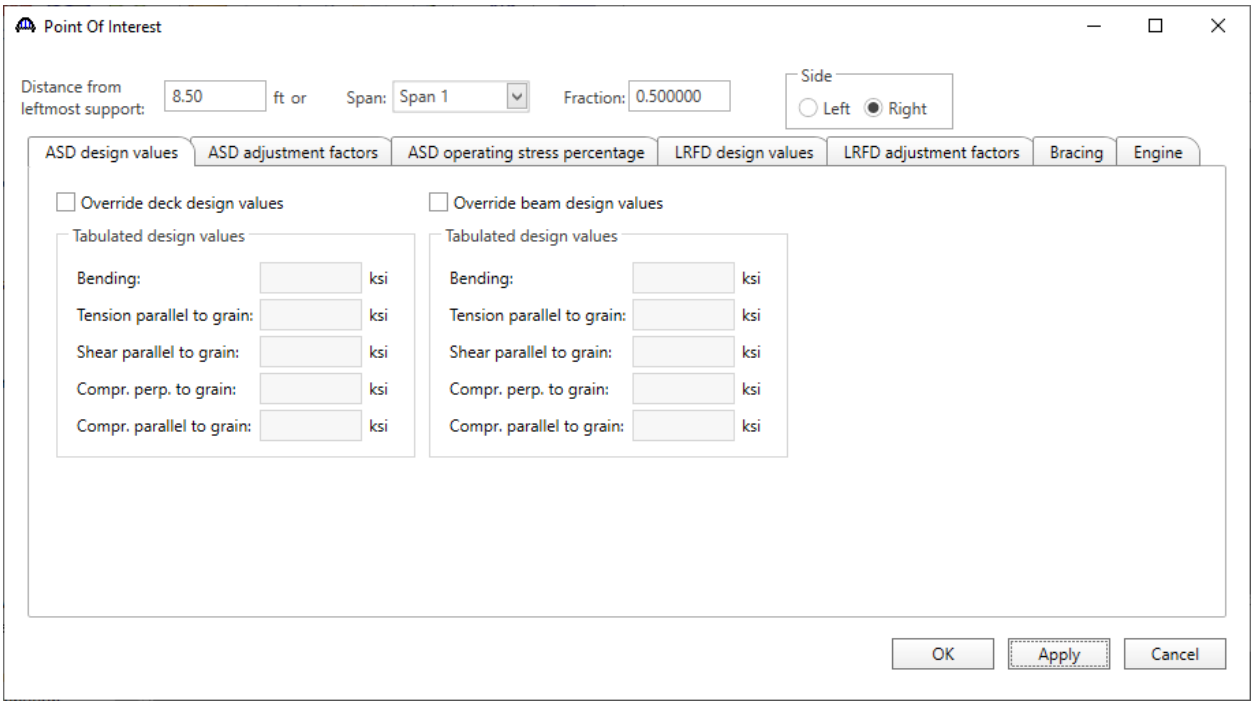
Deflection DF

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

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

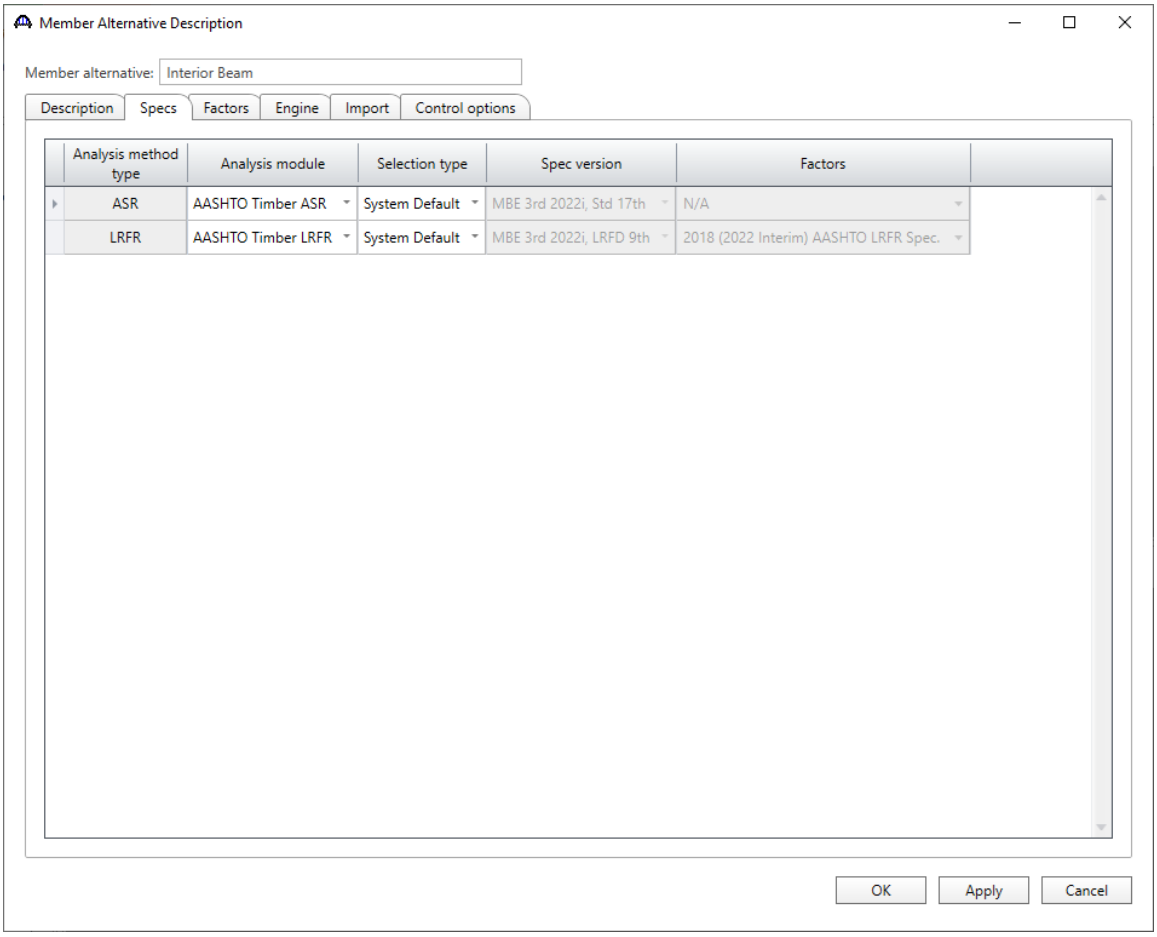
Point of Interest

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.



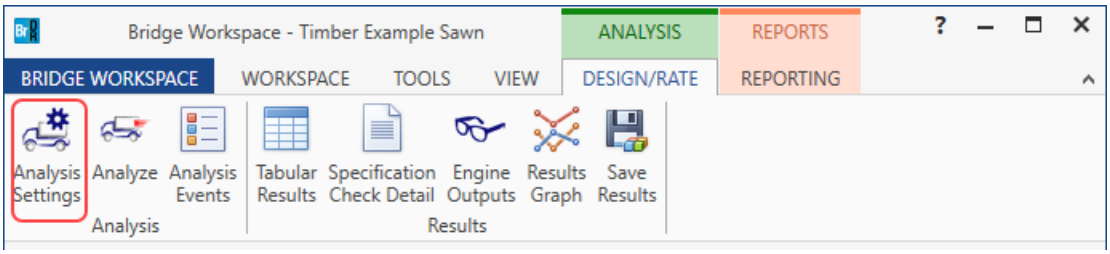
Member Alternative Description – Specs

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

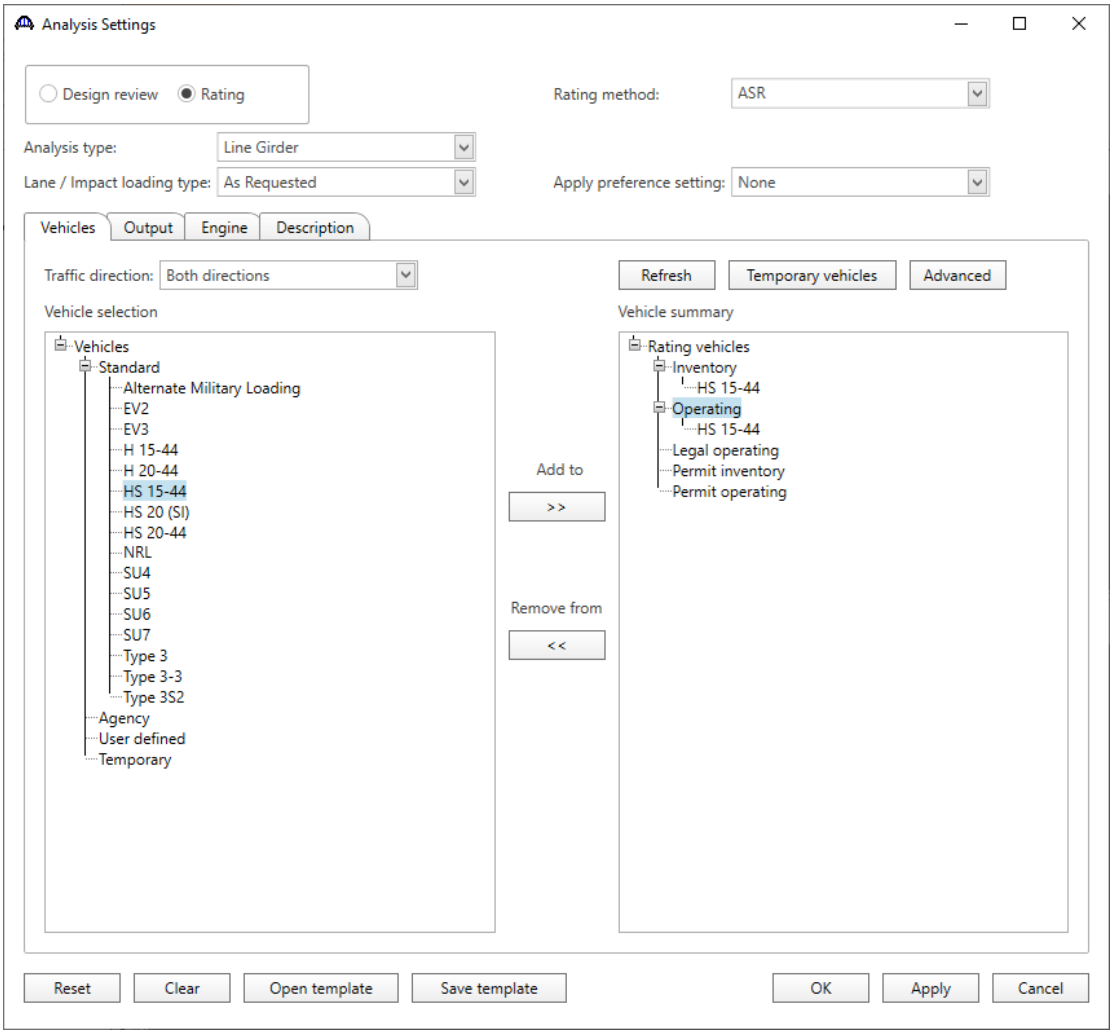


ASR Rating

To perform a rating, select the **Analysis Settings** button on the Analysis group of the **DESIGN/RATE** ribbon to open the window shown below.



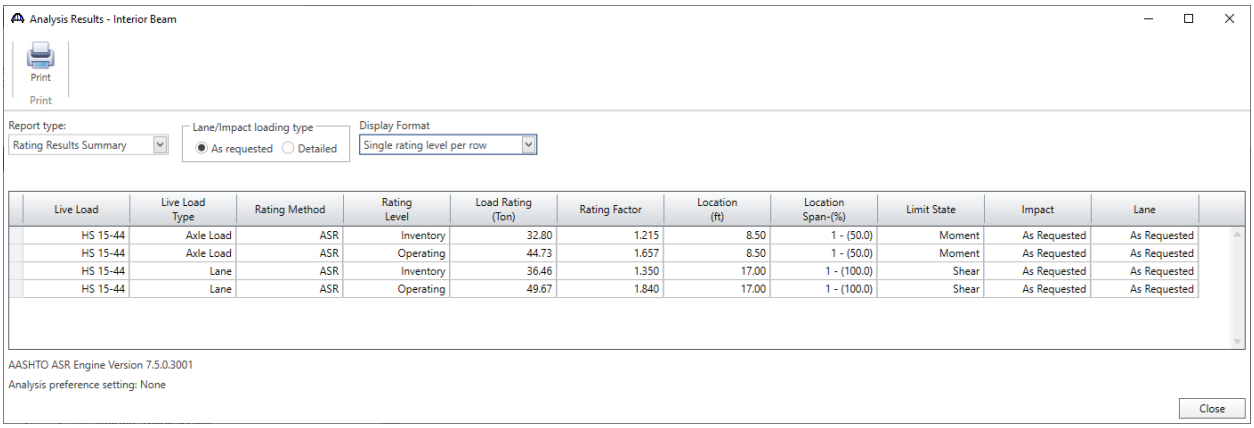
To run an ASR analysis, select **ASR** as the Rating Method, select the **HS 15-44** vehicle to be used in the rating in **Inventory** and **Operating** and click **OK**.



Next click the **Analyze** button on the Analysis group of the **DESIGN/RATE** ribbon to perform the rating.

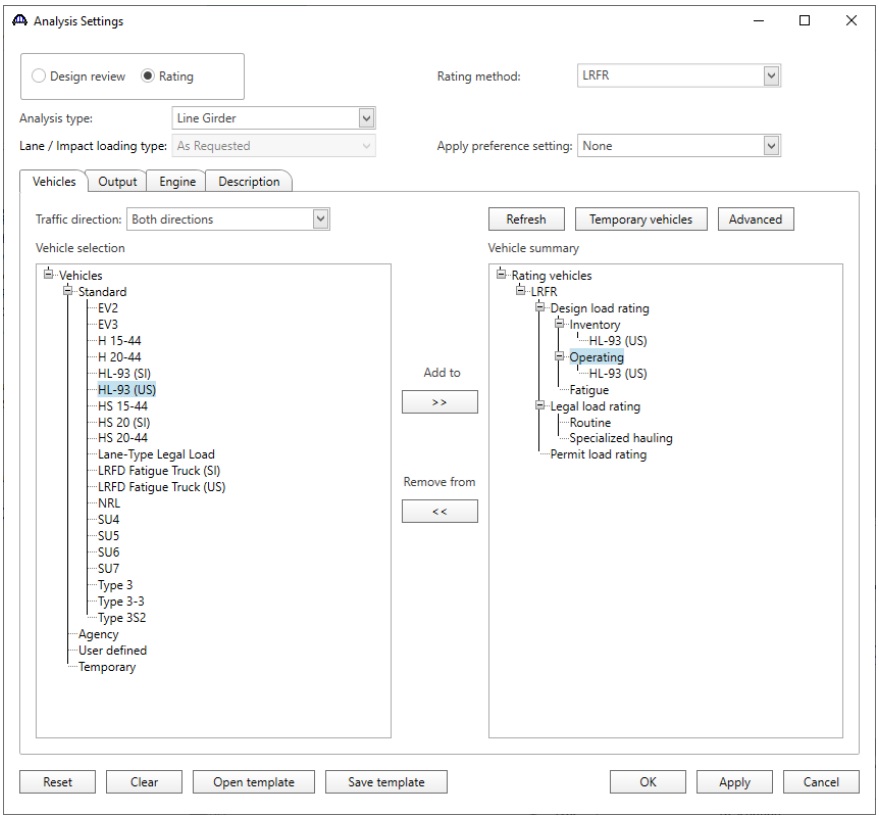
Tabular Results

When the rating is finished, the results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the **DESIGN/RATE** ribbon. The window shown below will open.



LRFR Rating

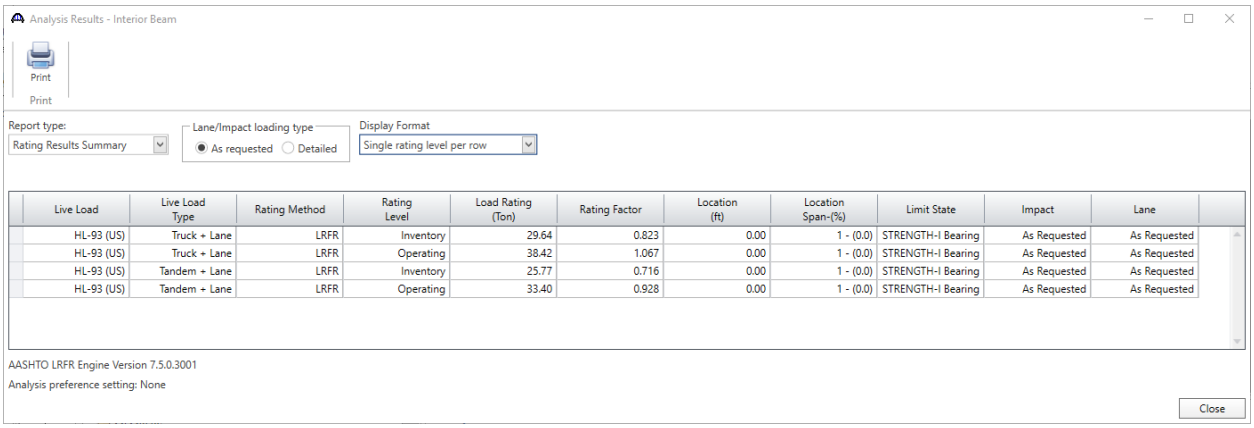
To run an LRFR analysis, in the **Analysis Settings** window, select **LRFR** as the Rating Method, select the **HL-93(US)** vehicle in **Inventory** and **Operating** and click **OK**.



Next click the **Analyze** button on the Analysis group of the **DESIGN/RATE** ribbon to perform the rating.

Tabular Results

When the rating is finished, the results can be reviewed by clicking the **Tabular Results** button on the **DESIGN/RATE** ribbon. 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
HL-93 (US)	Truck + Lane	LRFR	Inventory	29.64	0.823	0.00	1 - (0.0)	STRENGTH-I Bearing	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	38.42	1.067	0.00	1 - (0.0)	STRENGTH-I Bearing	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	25.77	0.716	0.00	1 - (0.0)	STRENGTH-I Bearing	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	33.40	0.928	0.00	1 - (0.0)	STRENGTH-I Bearing	As Requested	As Requested