

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:

The screenshot shows a dialog box titled "Timber Example". At the top, there are two text input fields: "Bridge ID:" with the value "Timber Example" and "NBI Structure ID (8):" with the value "Timber Example". To the right of these fields are three checkboxes: "Template" (unchecked), "Bridge Completely Defined" (unchecked), and "Superstructures" (checked). Below these is another checkbox "Culverts" (unchecked). A tabbed interface is visible with the "Description" tab selected. The "Name:" field contains "Timber Brige (ASD)" and the "Year Built:" field is empty. The "Description:" field contains the text: "Single span timber bridge with nail-laminated deck designed for HS 15-44 truck. Example 7-9 and 7-11 from 'Timber Bridges: Design, Construction, Inspection, and Maintenance' USDA Forest Service, August 1992." Below the description are several other fields: "Location:" (empty), "Length:" (empty) followed by "ft", "Facility Carried (7):" (empty), "Route Number:" with the value "-1", "Feat. Intersected (6):" (empty), and "Mi. Post:" (empty). At the bottom left, there is a dropdown menu for "Default Units:" set to "US Customary". At the bottom of the dialog, there is a button "AASHTOWare Association..." and three checkboxes: "BrR" (checked), "BrD" (checked), and "BrM" (unchecked). On the far right are three buttons: "OK", "Apply", and "Cancel".

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

TMBR1- Single Span Timber Beam Example

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.

Name	Description	Library	Units	Grading Method	Species	Commercial Grade	Size Class	Grading Rule Agency
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	No. 2	2" - 4" thick, 2" & wider	WWPA
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	Dense Select Structural	Beams and Stringers	WWPA
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	Select Structural	Beams and Stringers	WWPA
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	Dense No. 1	Beams and Stringers	WWPA
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	No. 1	Beams and Stringers	WWPA
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	Dense No. 2	Beams and Stringers	WWPA
Douglas Fir-Larch	Douglas Fir	Standa	US Cu	Visual	Douglas Fir-Lar	No. 2	Beams and Stringers	WWPA

TMBR1- Single Span Timber Beam Example

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.

Bridge Materials - Timber - Sawn

Name: Beam Timber Description: Douglas Fir-Larch

Grading method: Visual

Species: Douglas Fir-Larch

Commercial grade: No. 1

Size classification: Beams and Stringers

Grading rules agency: WWPA

Density: 0.05 kcf

Modulus of elasticity: 1600.00 ksi

ASD Tabulated Design Values

Bending: 1.350 ksi

Tension (parallel): 0.675 ksi

Shear (parallel): 0.085 ksi

Compr. (perp.): 0.625 ksi

Compr. (parallel): 0.925 ksi

Copy To Library... Copy from Library... OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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

Grading method: Visual

Species: Southern Pine

Commercial grade: No. 2

Size classification: 2" - 4" thick, 2" - 4" wide

Grading rules agency: SPIB

Density: 0.05 kcf

Modulus of elasticity: 1600.00 ksi

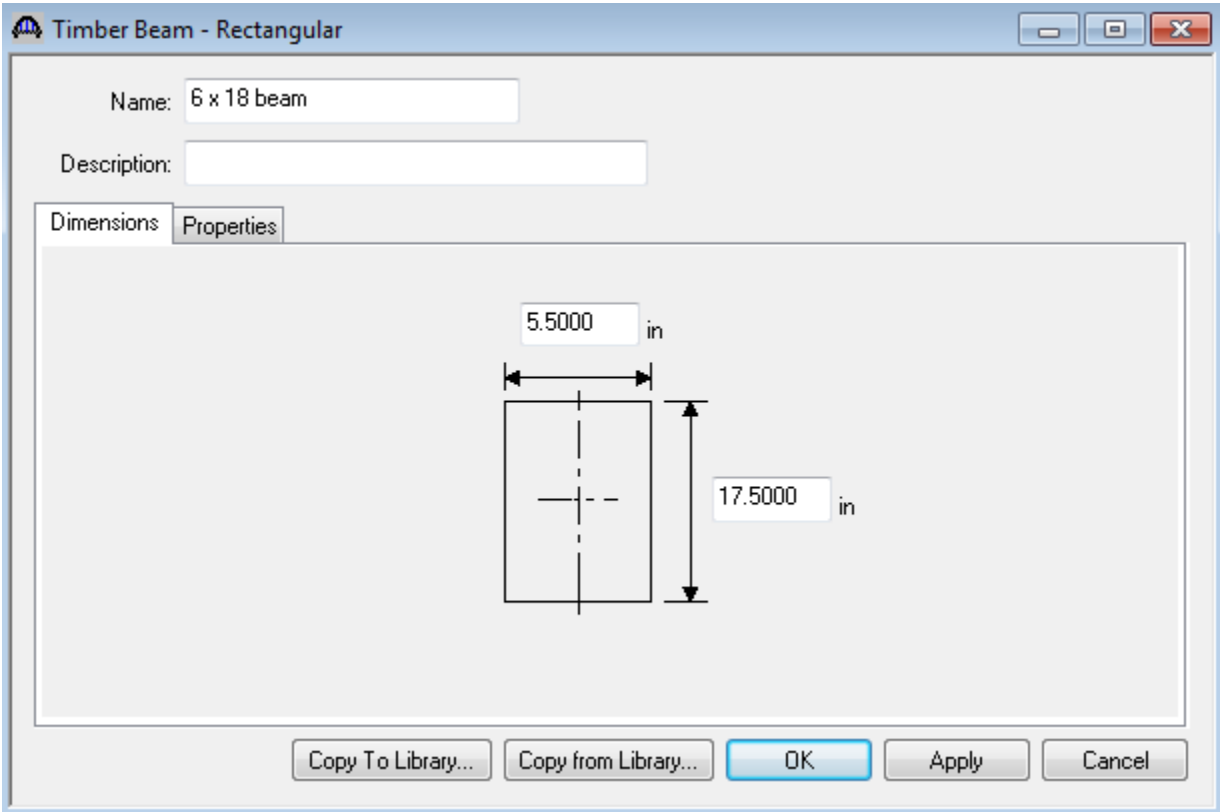
ASD Tabulated Design Values

Bending:	1.500	ksi
Tension (parallel):	0.825	ksi
Shear (parallel):	0.090	ksi
Compr. (perp.):	0.565	ksi
Compr. (parallel):	1.650	ksi

Copy To Library... Copy from Library... OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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.



TMBR1- Single Span Timber Beam Example

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

TMBR1- Single Span Timber Beam Example

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.

Bridge Appurtenances - Generic

Name: Timber Railing

Description:

All dimensions are in inches

Distance from edge to centroid = 5.0000

Reference Line

Barrier load = 0.06 kip/ft

Width = 10.0000

Effective wind height =

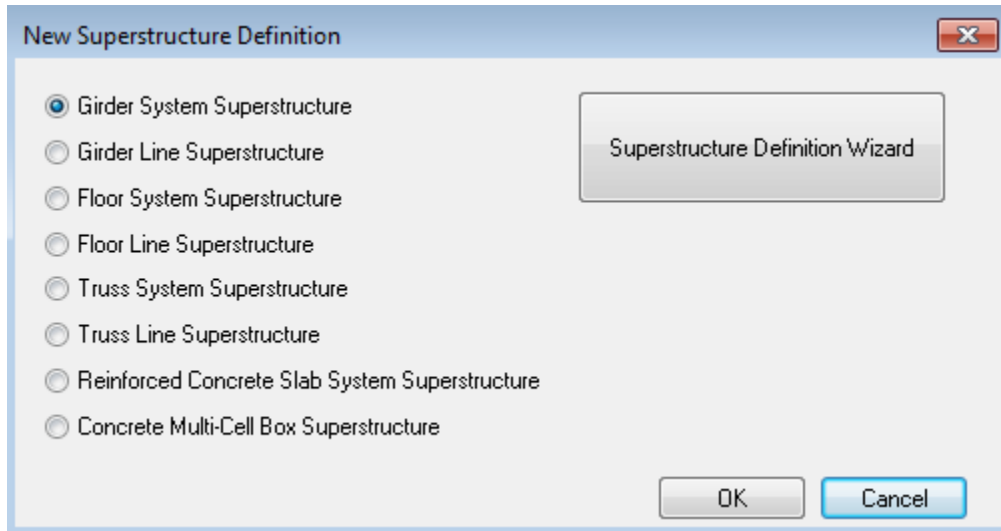
Generic Shape

Back Front

Copy from Library... OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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 pop up menu) to create a new structure definition. The dialog shown below will appear.



TMBR1- Single Span Timber Beam Example

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

Girder System Superstructure Definition

Definition | Analysis | Specs | Engine

Name: Structure Definition #1

Description:

Default Units: US Customary

Number of spans: 1

Number of girders: 13

Enter Span Lengths Along the Reference Line:

Span	Length (ft)
1	17.00

Frame Structure Simplified Definition

Deck type: Timber

For PS only

Average humidity: %

Member Alt. Types

Steel

P/S

R/C

Timber

Horizontal Curvature Along Reference Line

Horizontal curvature

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: Left

End tangent length: ft

Distance from last support line to PT: ft

Design speed: mph

Superelevation: %

Superstructure Alignment

Curved

Tangent, curved, tangent

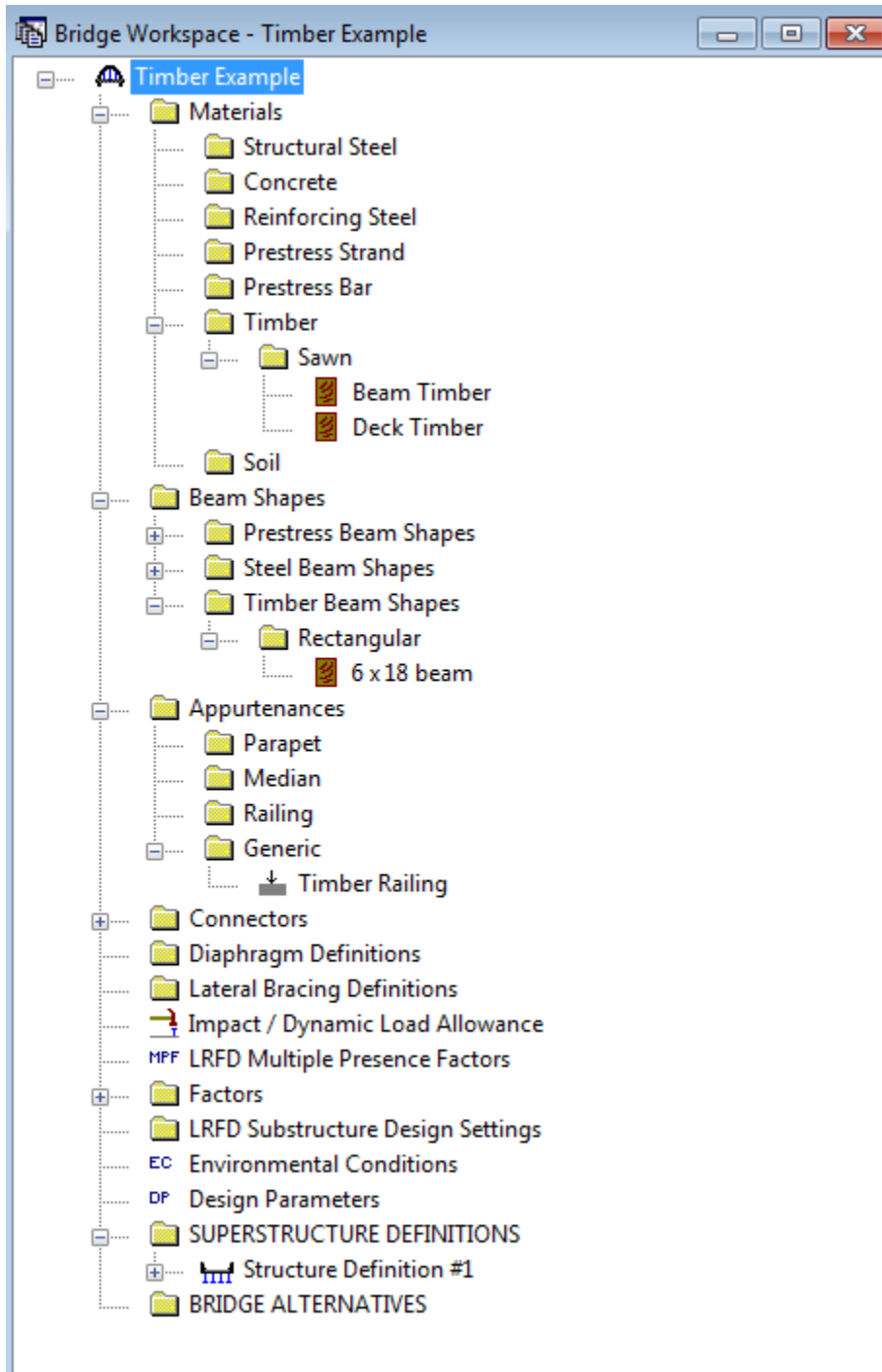
Tangent, curved

Curved, tangent

OK Apply Cancel

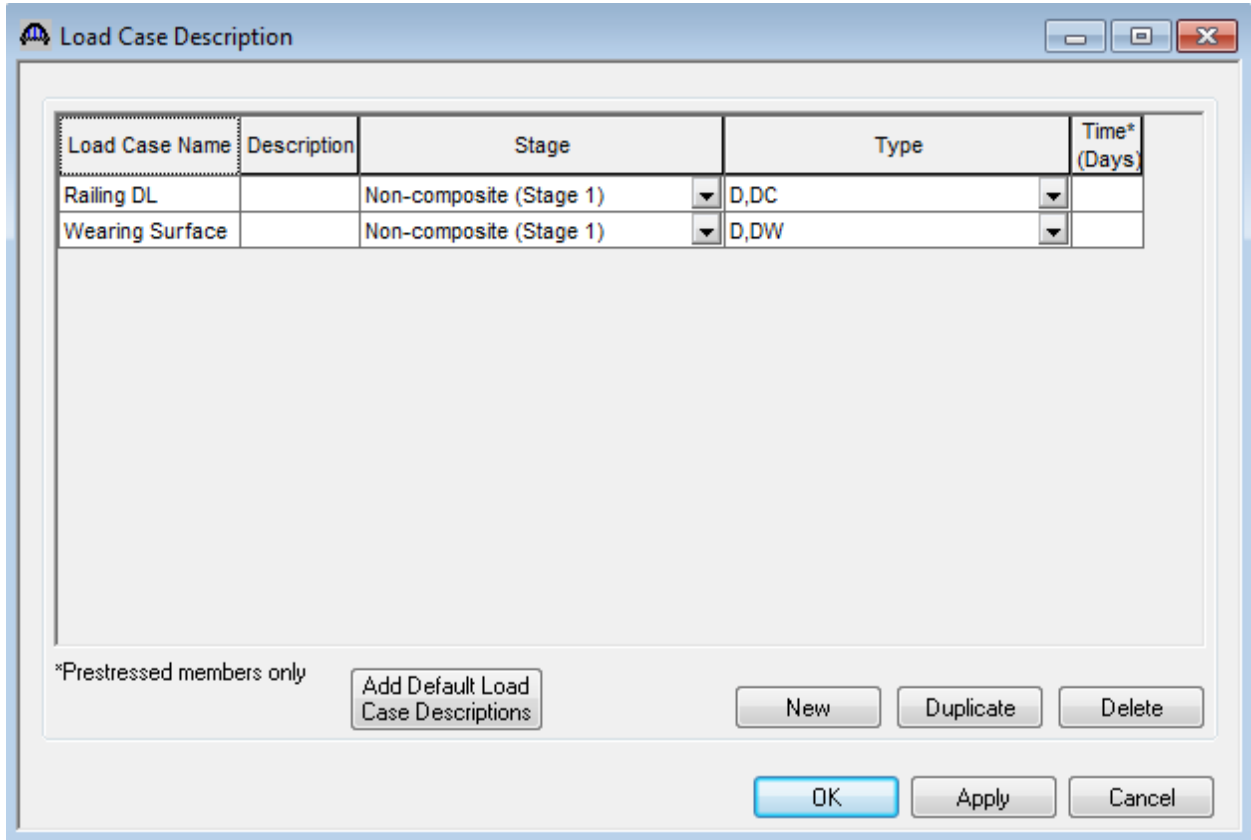
TMBR1- Single Span Timber Beam Example

The partially expanded Bridge Workspace tree is shown below:



TMBR1- Single Span Timber Beam Example

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



TMBR1- Single Span Timber Beam Example

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

Structure Framing Plan Details

Number of spans = 1 Number of girders = 13

Layout Diaphragms

Girder Spacing Orientation

- Perpendicular to girder
- Along support

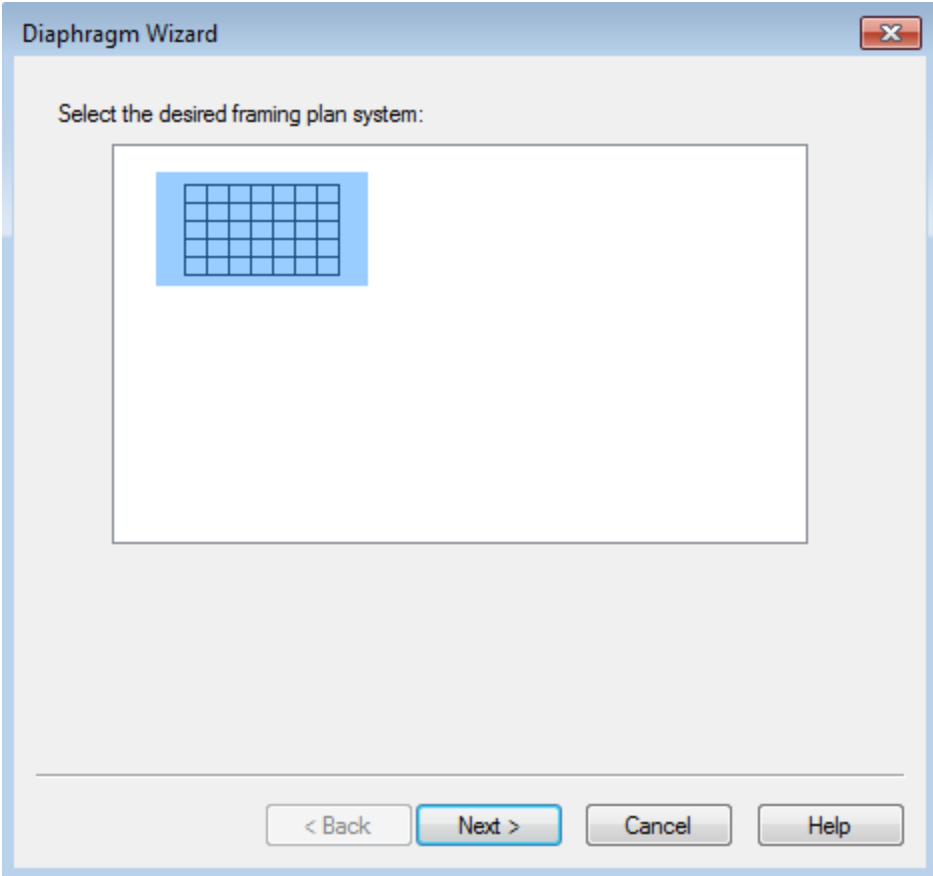
Support	Skew (Degrees)
1	0.0000
2	0.0000

Girder Bay	Girder Spacing (ft)	
	Start of Girder	End of Girder
1	2.00	2.00
2	2.00	2.00
3	2.00	2.00
4	2.00	2.00
5	2.00	2.00
6	2.00	2.00
7	2.00	2.00
8	2.00	2.00

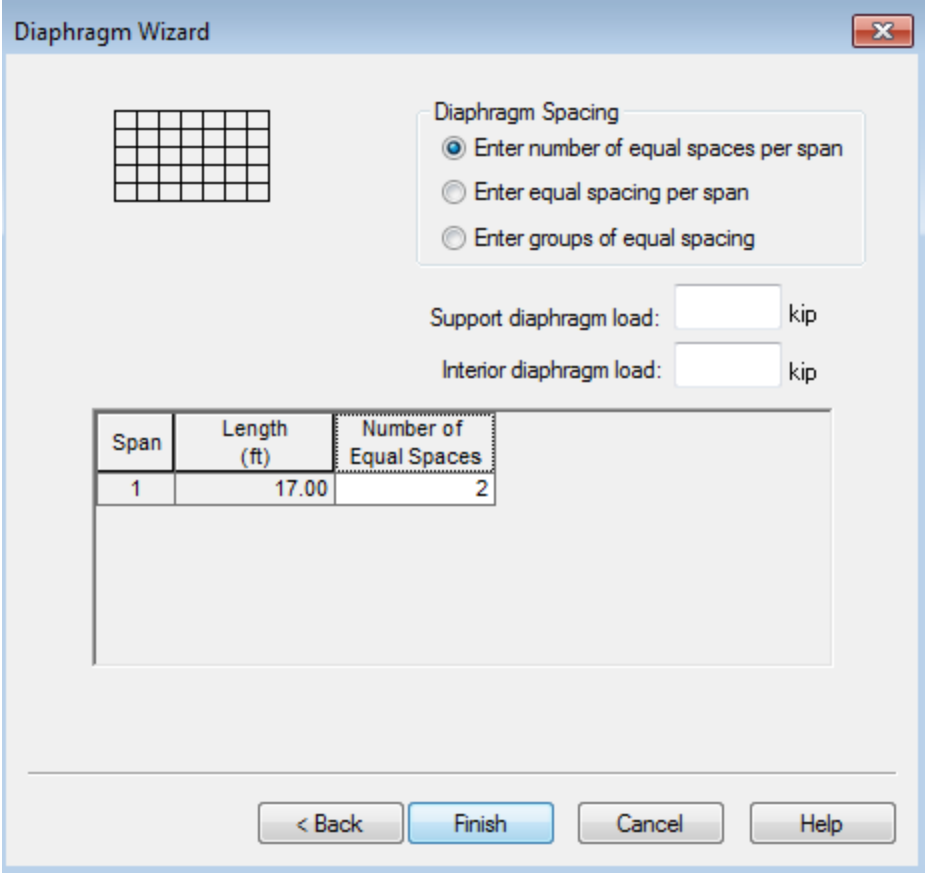
OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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.



TMBR1- Single Span Timber Beam Example



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

TMBR1- Single Span Timber Beam Example

The Diaphragm Wizard generates the following diaphragm locations.

Structure Framing Plan Details

Number of spans = 1 Number of girders = 13

Layout Diaphragms

Girder Bay: 1 Copy Bay To... Diaphragm Wizard...

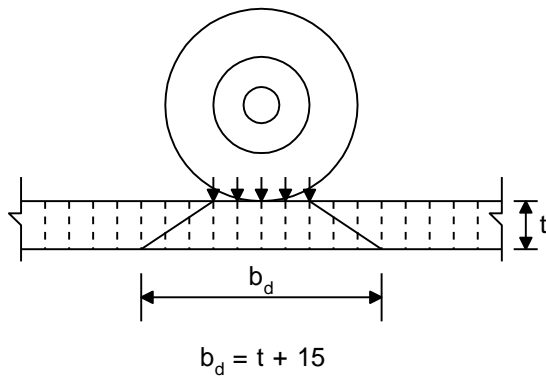
Support Number	Start Distance (ft)		Diaphragm Spacing (ft)	Number of Spaces	Length (ft)	End Distance (ft)		Load (kip)	Diaphragm
	Left Girder	Right Girder				Left Girder	Right Girder		
1	0.00	0.00	0.00	1	0.00	0.00	0.00		-- Not Assigned --
1	8.50	8.50	0.00	1	0.00	8.50	8.50		-- Not Assigned --
1	8.50	8.50	8.50	1	8.50	17.00	17.00		-- Not Assigned --

New Duplicate Delete

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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.



Deck

Description Factors Engine

Default rating method: ASD

Analysis Module
ASD: Madero ASD

Deck Rating Parameters
 Deck continuous over more than 2 spans

Timber deck type: Nail-Laminated Deck

Timber material: Deck Timber

Total deck thickness: 3.5000 in Nominal thick.: 4.0000 in

Lamination thickness: 1.5000 in Nominal width: 2.0000 in

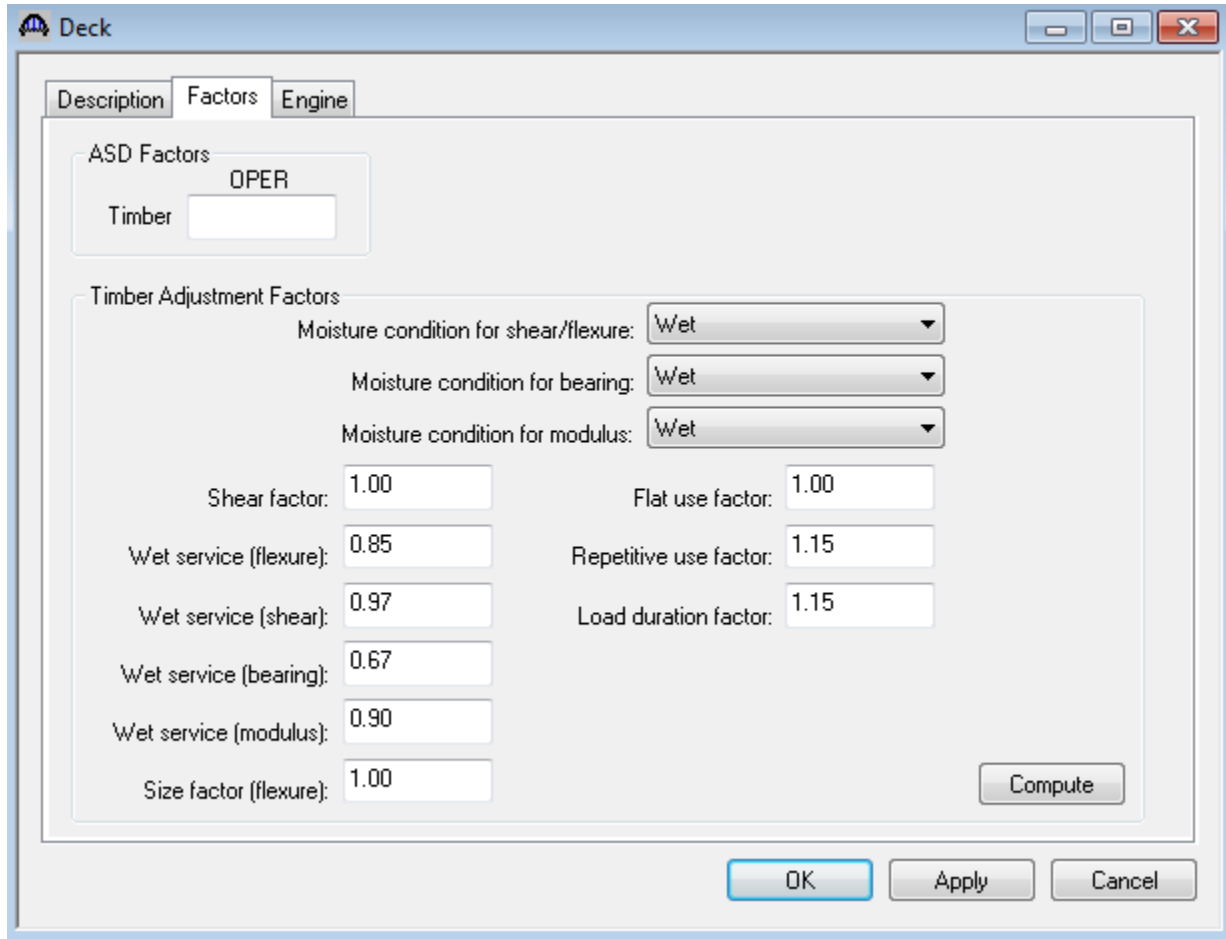
Deck LL distribution width: 18.5000 in

Nail:

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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.



The screenshot shows the 'Deck' software window with the 'Factors' tab selected. The window contains the following fields and controls:

- ASD Factors:** A dropdown menu set to 'OPER' and a text input field for 'Timber'.
- Timber Adjustment Factors:**
 - Moisture condition for shear/flexure: Wet (dropdown)
 - Moisture condition for bearing: Wet (dropdown)
 - Moisture condition for modulus: Wet (dropdown)
 - Shear factor: 1.00 (text input)
 - Flat use factor: 1.00 (text input)
 - Wet service (flexure): 0.85 (text input)
 - Repetitive use factor: 1.15 (text input)
 - Wet service (shear): 0.97 (text input)
 - Load duration factor: 1.15 (text input)
 - Wet service (bearing): 0.67 (text input)
 - Wet service (modulus): 0.90 (text input)
 - Size factor (flexure): 1.00 (text input)
- Buttons:** 'Compute', 'OK', 'Apply', and 'Cancel'.

TMBR1- Single Span Timber Beam Example

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

Distance from left edge of deck to superstructure definition ref. line

Distance from right edge of deck to superstructure definition ref. line

Deck thickness

Superstructure Definition Reference Line

Left overhang

Right overhang

Deck Parapet Railing Generic Lane Position Striped Lanes Wearing Surface

Superstructure definition reference line is within the bridge deck.

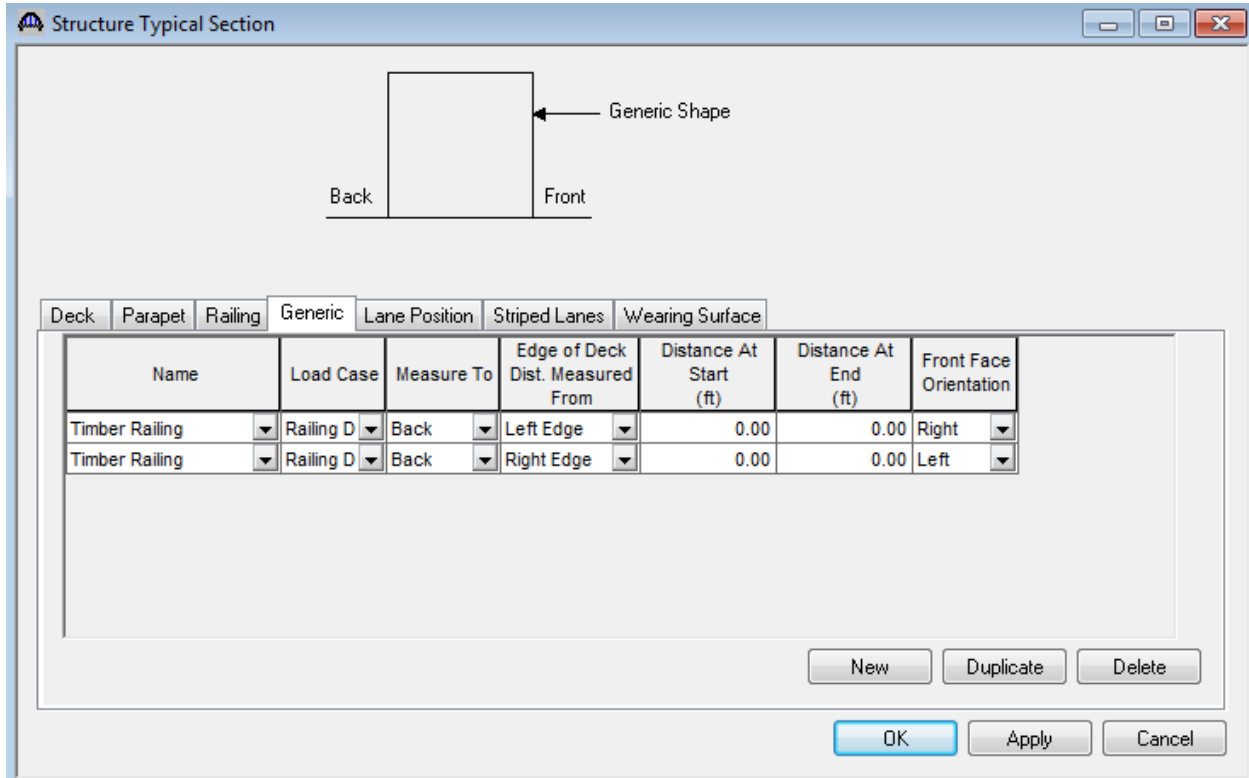
	Start	End
Distance from left edge of deck to superstructure definition reference line =	12.83 ft	12.83 ft
Distance from right edge of deck to superstructure definition reference line =	12.83 ft	12.83 ft
Left overhang =	0.83 ft	0.83 ft
Computed right overhang =	0.83 ft	0.83 ft

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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.



The screenshot shows the 'Structure Typical Section' window with the 'Generic' tab selected. At the top, a diagram illustrates a rectangular 'Generic Shape' with 'Back' and 'Front' labels. Below this is a table with columns: Name, Load Case, Measure To, Edge of Deck Dist. Measured From, Distance At Start (ft), Distance At End (ft), and Front Face Orientation. Two rows of data are present, both for 'Timber Railing' with 'Railing D' load case and 'Back' measure to. The first row is for the 'Left Edge' with start and end distances of 0.00 ft and a 'Right' orientation. The second row is for the 'Right Edge' with start and end distances of 0.00 ft and a 'Left' orientation. At the bottom right, there are buttons for 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

Name	Load Case	Measure To	Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation
Timber Railing	Railing D	Back	Left Edge	0.00	0.00	Right
Timber Railing	Railing D	Back	Right Edge	0.00	0.00	Left

TMBR1- Single Span Timber Beam Example

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.

Structure Typical Section

Distance From Left Edge of Travelway to Superstructure Definition Reference Line At Start (A) (ft)

Distance From Right Edge of Travelway to Superstructure Definition Reference Line At Start (B) (ft)

Distance From Left Edge of Travelway to Superstructure Definition Reference Line At End (A) (ft)

Distance From Right Edge of Travelway to Superstructure Definition Reference Line At End (B) (ft)

Travelway Number	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At Start (A) (ft)	Distance From Right Edge of Travelway to Superstructure Definition Reference Line At Start (B) (ft)	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At End (A) (ft)	Distance From Right Edge of Travelway to Superstructure Definition Reference Line At End (B) (ft)
1	-12.00	12.00	-12.00	12.00

LRFD Fatigue
Lanes available to trucks:

Override Truck fraction:

Compute... New Duplicate Delete

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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

Structure Typical Section

Distance from left edge of deck to superstructure definition ref. line

Distance from right edge of deck to superstructure definition ref. line

Deck thickness

Superstructure Definition Reference Line

Left overhang

Right overhang

Deck Parapet Railing Generic Lane Position Striped Lanes **Wearing Surface**

Wearing surface material: 3" timber planks

Description:

Wearing surface thickness = 3.0000 in Thickness field measured (D/W = 1.25 if checked)

Wearing surface density = 50.000 pcf

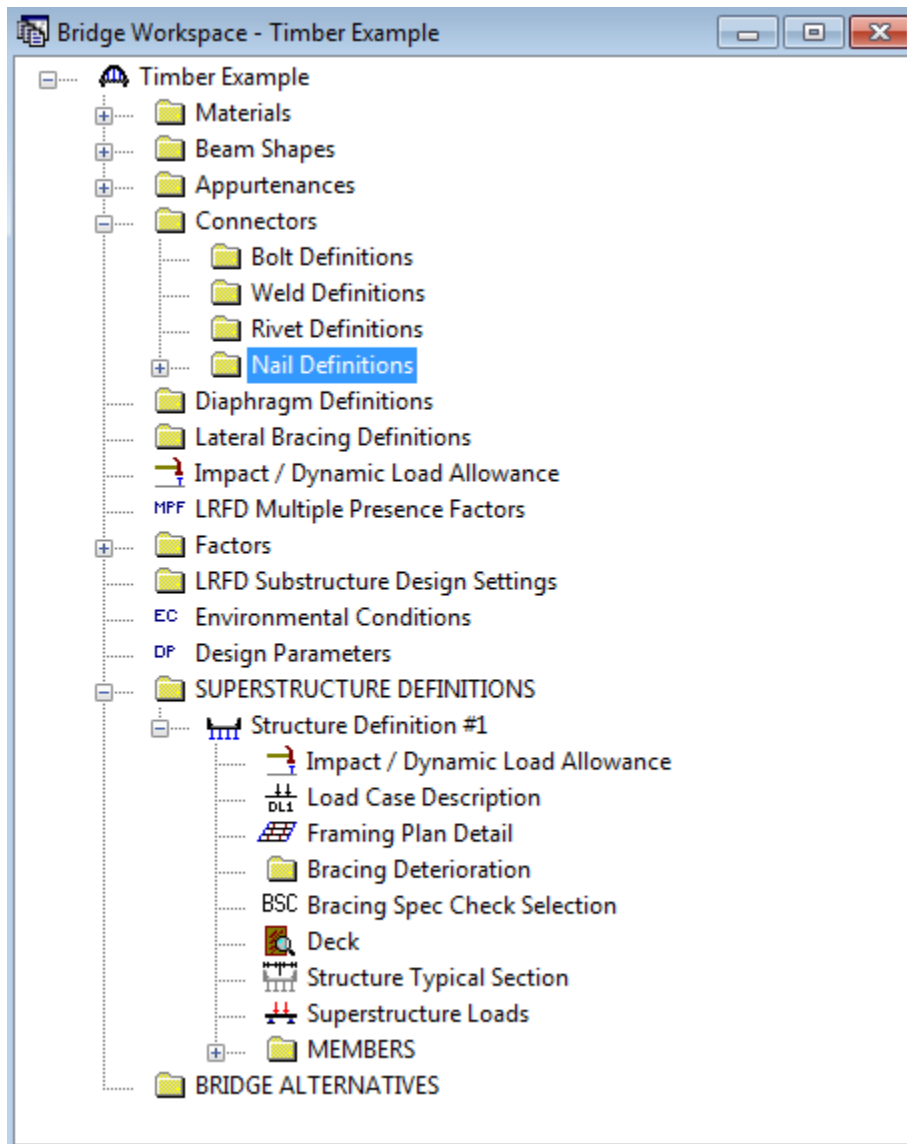
Load case: Wearing Surface DL

Copy from Library...

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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



TMBR1- Single Span Timber Beam Example

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

Structure Definition Connectors - Nail Definition

Name: 20 Pennyweight Description:

Length: 4.0000 in

Diameter: 0.1480 in

Pennyweight: 20d

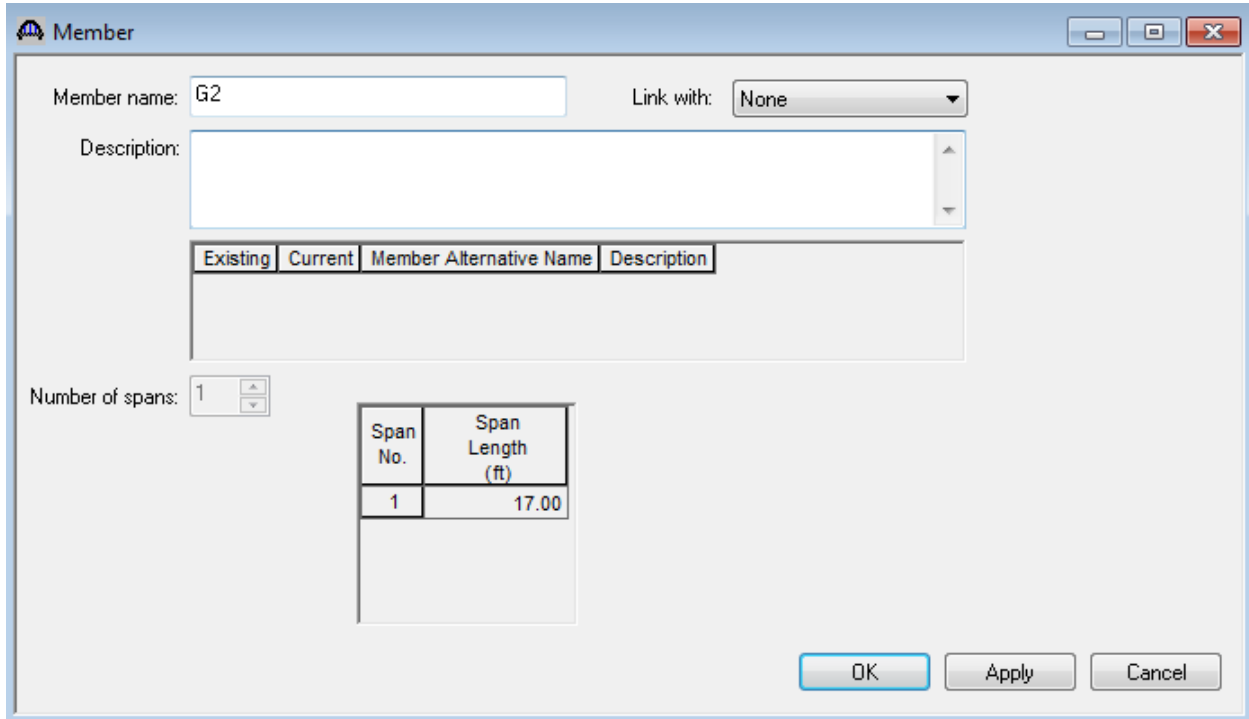
Copy from Library... OK Apply Cancel

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.

TMBR1- Single Span Timber Beam Example

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.



Member name: G2 Link with: None

Description:

Existing	Current	Member Alternative Name	Description
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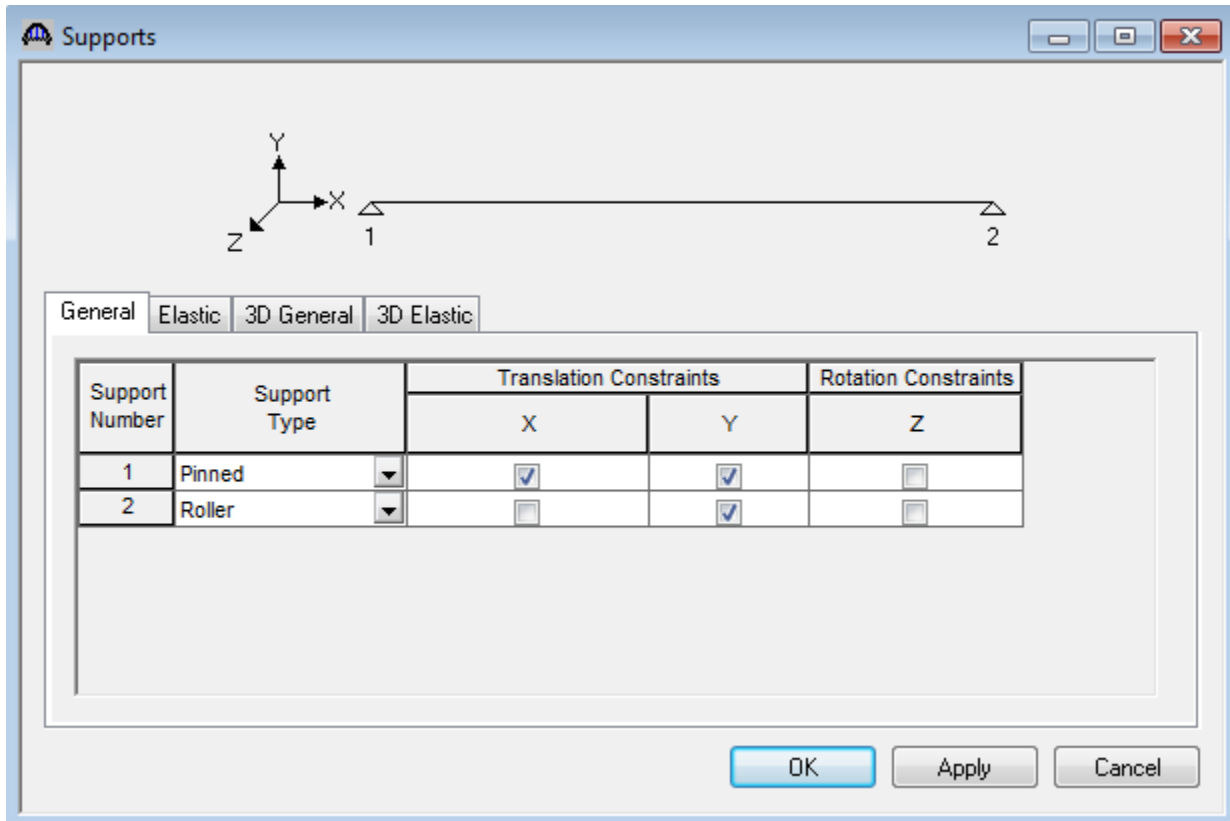
Number of spans: 1

Span No.	Span Length (ft)
1	17.00

OK Apply Cancel

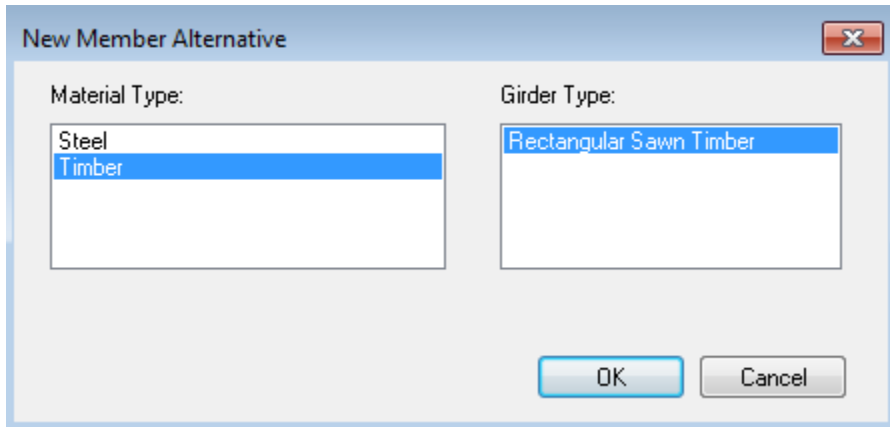
TMBR1- Single Span Timber Beam Example

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.



TMBR1- Single Span Timber Beam Example

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

Member Alternative: Interior Timber Beam

Description Specs Factors Engine Import Control Options

Description:

Material Type: Timber

Girder Type: Rectangular Sawn Timber

Default Units: US Customary

Girder property input method

Schedule based

Cross-section based

Self Load

Load case: Engine Assigned

Additional self load = kip/ft

Additional self load = %

Default rating method: ASD

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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

Standard LRFD

Distribution Factor Input Method

Use Simplified Method Use Advanced Method Use Advanced Method with 1994 Guide Specs

Allow distribution factors to be used to compute effects of permit loads with routine traffic

Lanes Loaded	Distribution Factor (Wheels)			
	Shear	Shear at Supports	Moment	Deflection
1 Lane	0.522	1.000	0.444	0.154
Multi-Lane	0.550	1.000	0.500	0.308

Compute from Typical Section... View Calcs

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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)

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

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

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

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

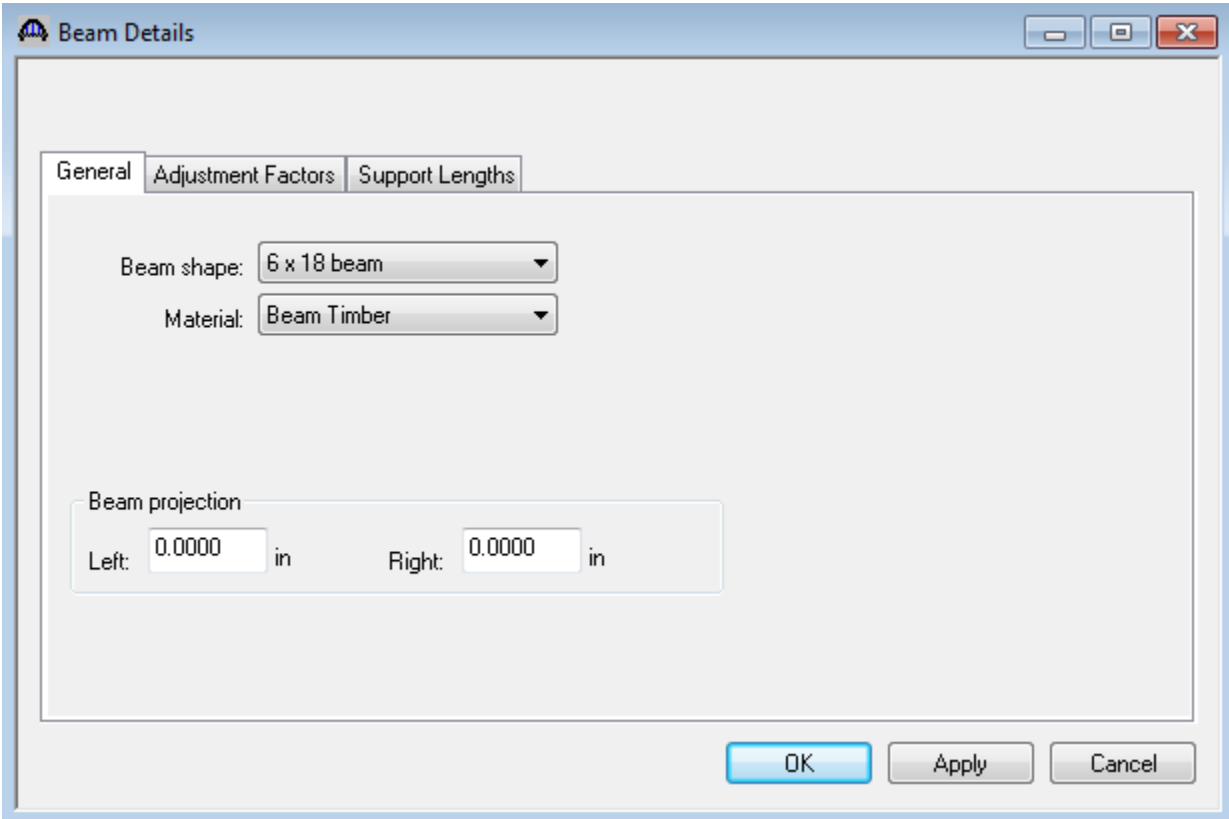
Deflection DF

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

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

TMBR1- Single Span Timber Beam Example

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



TMBR1- Single Span Timber Beam Example

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.

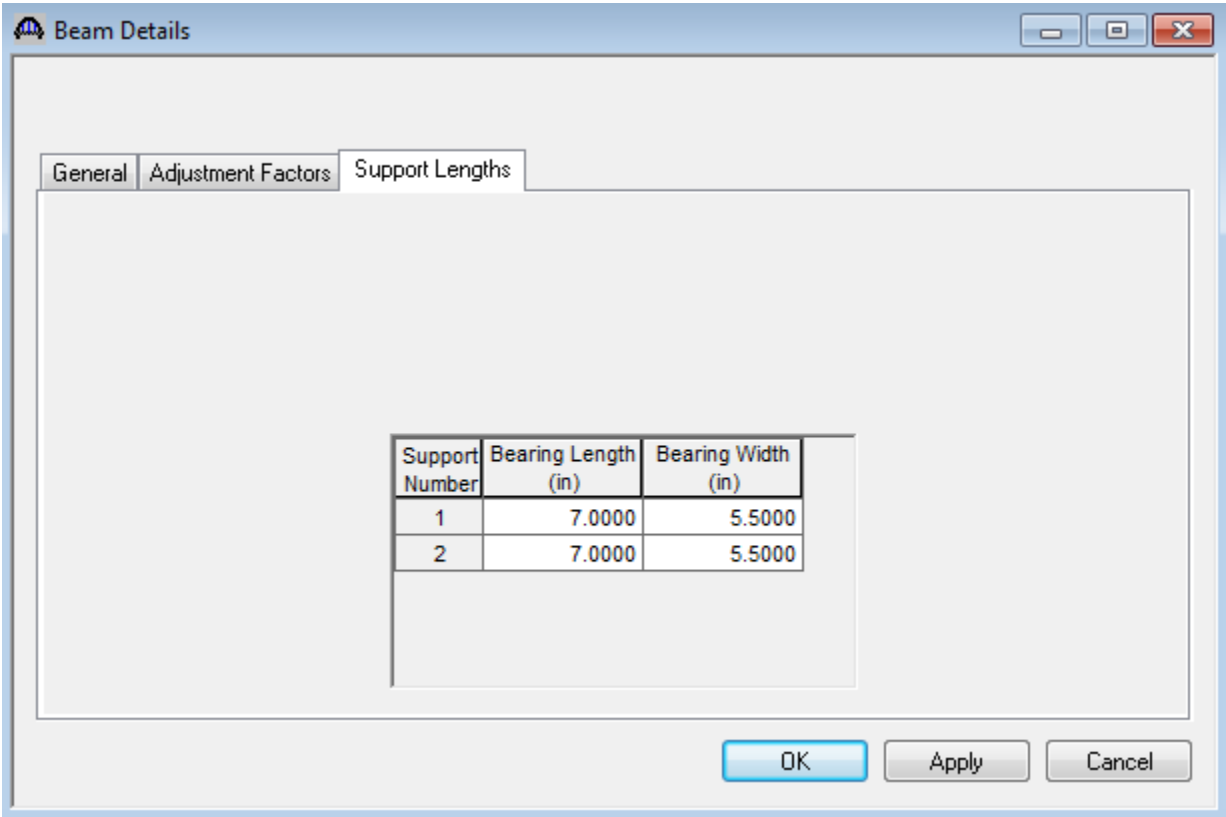
Select the Wet condition for Shear/Flexure, Bearing and Modulus. Use the Compute button to calculate the factors for the beam based on the Wet moisture conditions. Enter 1.0 for the Shear factor since it is not calculated by the Compute button. This factor is not computed for you since it is dependent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

The screenshot shows the 'Beam Details' software window with the 'Adjustment Factors' tab selected. The window contains several input fields and buttons. The 'Moisture condition' dropdowns for shear/flexure, bearing, and modulus are all set to 'Wet'. The 'Shear factor' is set to 1.000. The 'Flat use factor' is 1.00. The 'Wet service' factors for flexure, shear, bearing, and modulus are 1.000, 1.000, 0.67, and 1.000 respectively. The 'Repetitive use factor' is 1.00 and the 'Load duration factor' is 1.150. The 'Size factor (flexure)' is 0.956. A 'Compute' button is located at the bottom right of the input area. At the very bottom of the window are 'OK', 'Apply', and 'Cancel' buttons.

Parameter	Value
Moisture condition for shear/flexure	Wet
Moisture condition for bearing	Wet
Moisture condition for modulus	Wet
Shear factor	1.000
Flat use factor	1.00
Wet service (flexure)	1.000
Repetitive use factor	1.00
Wet service (shear)	1.000
Load duration factor	1.150
Wet service (bearing)	0.67
Wet service (modulus)	1.000
Size factor (flexure)	0.956

TMBR1- Single Span Timber Beam Example

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



TMBR1- Single Span Timber Beam Example

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.

Point of Interest

Distance from leftmost support: 8.50 ft or Span: Span 1 Fraction: 0.500000 Side: Left Right

ASD Design Values | Adjustment Factors | Operating Stress Percentage | Bracing | Engine

Override deck design values Override beam design values

Tabulated design values

Bending: ksi

Tension parallel to grain: ksi

Shear parallel to grain: ksi

Compr. perp. to grain: ksi

Compr. parallel to grain: ksi

Tabulated design values

Bending: ksi

Tension parallel to grain: ksi

Shear parallel to grain: ksi

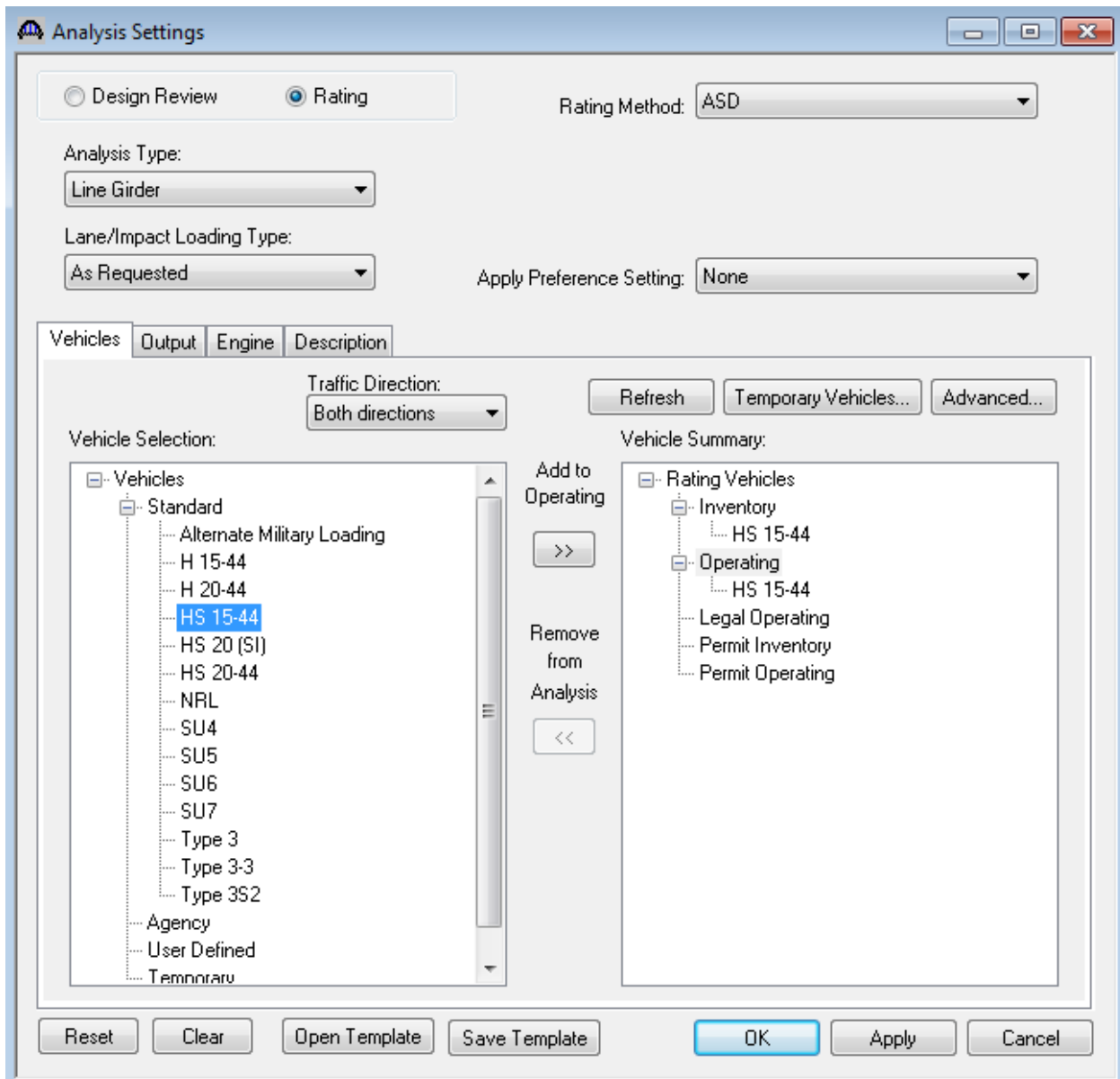
Compr. perp. to grain: ksi

Compr. parallel to grain: ksi

OK Apply Cancel

TMBR1- Single Span Timber Beam Example

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.



TMBR1- Single Span Timber Beam Example

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.

Analysis Results - Interior Timber Beam

Report Type: Rating Results Summary

Lane/Impact Loading Type: As Requested Detailed

Display Format: Single rating level per row

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

Madero(ASD/LRFD) - Version 1.02.05 - Sep. 11, 2012

Analysis Preference Setting: None

Close