

AASHTOWare BrDR 7.5.0

Reinforced Concrete Structure Tutorial
RC1 – Single Span Reinforced Concrete Tee Beam Example

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BrDR Training

RC1 - Single Span Reinforced Concrete Tee Beam Example

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

The screenshot shows the 'RCTeeBeamBridge' dialog box with the following data entered:

- Bridge ID: RCTeeBeamBridge
- NBI structure ID (8): RCTeeBeamBridge
- Template:
- Bridge completely defined:
- Superstructures:
- Culverts:
- Substructures:
- Name: RC Tee Beam Bridge
- Year built: [empty]
- Description: Reinforce Concrete Beam Bridge
- Location: [empty]
- Length: [empty] ft
- Facility carried (7): [empty]
- Route number: -1
- Feat. intersected (6): [empty]
- Mi. post: [empty]
- Default units: US Customary

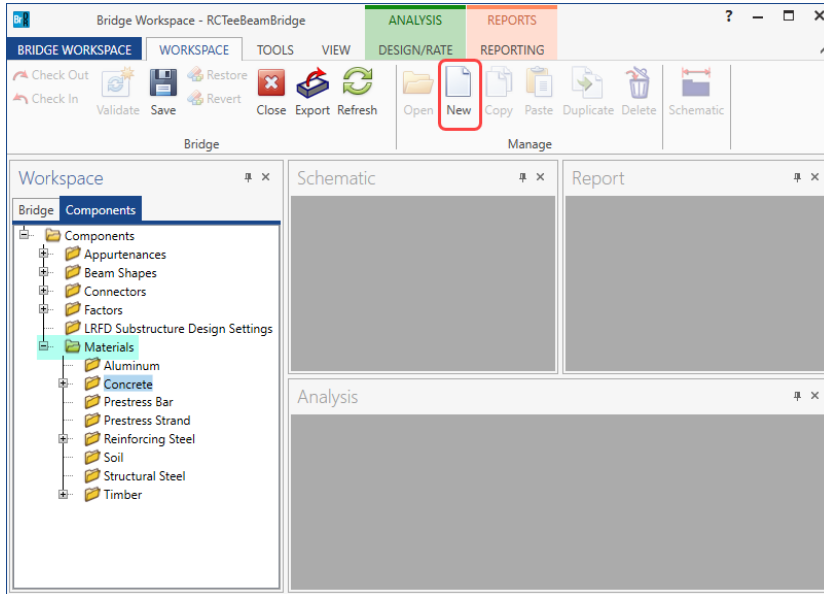
At the bottom, the 'Bridge association...' section has the following checked options: BrR, BrD, and BrM. The 'Apply' button is highlighted.

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

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Bridge Materials

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



The window shown below will open. Enter the values shown above the Compute button and click the **Compute** button to compute the remaining values below them.

Bridge Materials - Concrete	
Name:	<input type="text" value="Class A (US)"/>
Description:	<input type="text" value="Class A cement concrete"/>
Compressive strength at 28 days (f'c):	<input type="text" value="4.000"/> ksi
Initial compressive strength (f'ci):	<input type="text"/>
Composition of concrete:	<input type="text" value="Normal"/>
Density (for dead loads):	<input type="text" value="0.150"/> kcf
Density (for modulus of elasticity):	<input type="text" value="0.145"/> kcf
Poisson's ratio:	<input type="text" value="0.200"/>
Coefficient of thermal expansion (α):	<input type="text" value="0.0000060000"/> 1/F
Splitting tensile strength (fct):	<input type="text"/>
<input type="button" value="Compute"/>	
Std modulus of elasticity (Ec):	<input type="text" value="3644.15"/> ksi
LRFD modulus of elasticity (Ec):	<input type="text" value="3986.55"/> ksi
Std initial modulus of elasticity:	<input type="text" value="0.00"/> ksi
LRFD initial modulus of elasticity:	<input type="text" value="0.00"/> ksi
Modulus of rupture:	<input type="text" value="0.480"/> ksi
Shear factor:	<input type="text" value="1.000"/>
<input type="button" value="Copy to library..."/> <input type="button" value="Copy from library..."/> <input type="button" value="OK"/> <input type="button" value="Apply"/> <input type="button" value="Cancel"/>	

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

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Add the following **reinforcing steel** in the same manner.

Bridge Materials - Reinforcing Steel

Name:

Description:

Material properties

Specified yield strength (fy): ksi

Modulus of elasticity (Es): ksi

Ultimate strength (Fu): ksi

Type

Plain

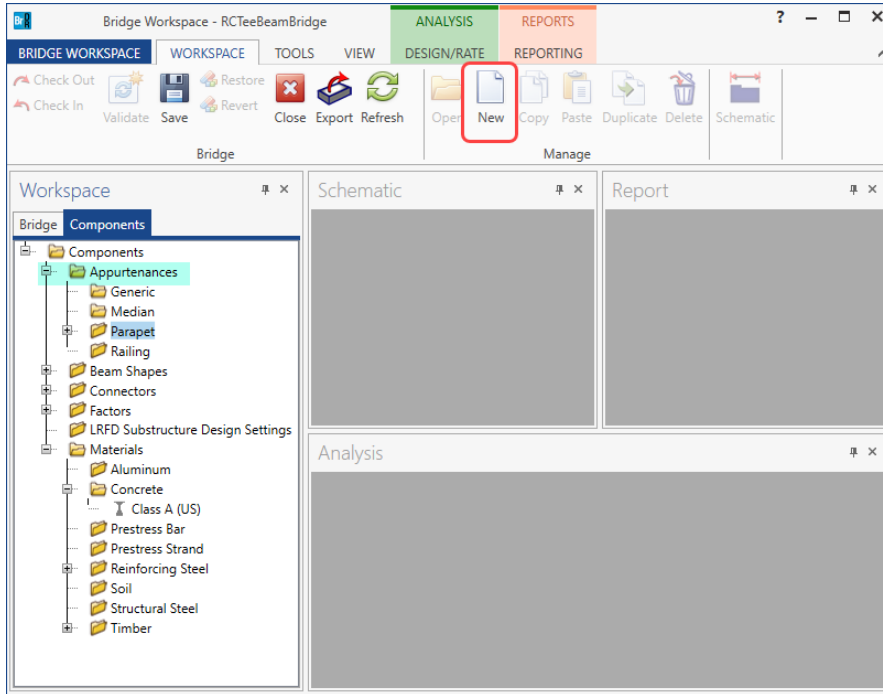
Epoxy

Galvanized

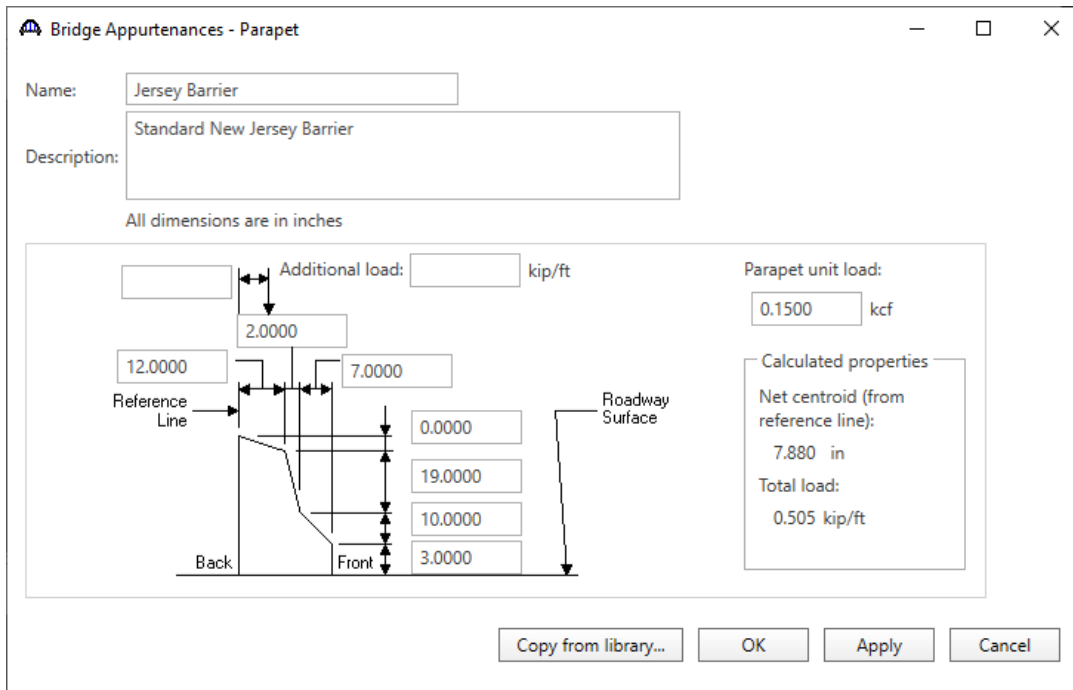
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Bridge Appurtenances

To enter the appurtenances to be used within the bridge expand the tree branch labeled **Appurtenances**. To define a parapet, select **Parapet** and click on **New** from the **Manage** button on the Workspace ribbon (double click on **Parapet** in the **Components** tree).



Enter the parapet dimensions as shown below.

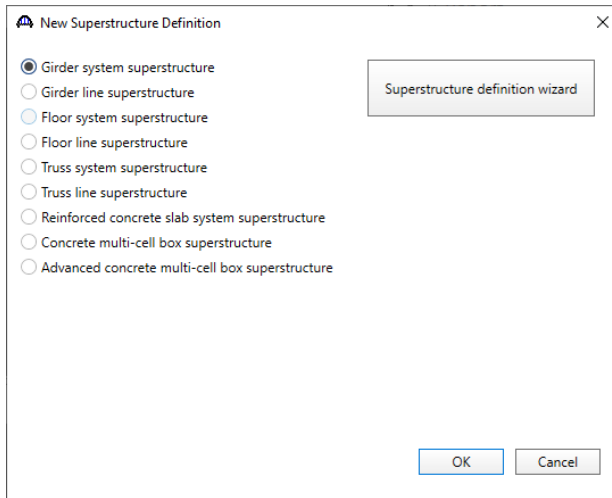


Click **OK** to save the data to memory and close the window.

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Superstructure definition

Returning to the **Bridge** tab of the **Bridge Workspace**, 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.



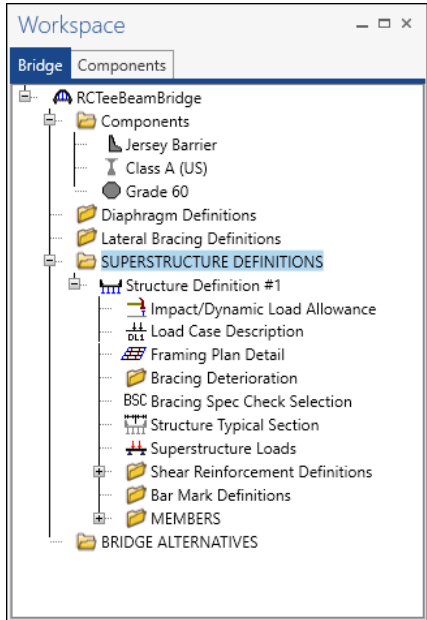
Select **Girder system superstructure**, click **OK** and the **Superstructure Definition** window will open. Enter the data as shown below:

The screenshot shows the "Girder System Superstructure Definition" window with the "Definition" tab selected. The "Name" field contains "Structure Definition #1" and the "Description" field contains "5 girder system, single span". The "Default units" are set to "US Customary". The "Number of spans" is 1 and the "Number of girders" is 5. A table shows the span length for span 1 as 40.00 ft. The "Modeling" section has "Multi-girder system" selected. The "Deck type" is "Concrete Deck". The "Member alt. types" section has "R/C" checked. The "Horizontal curvature along reference line" section has "Superstructure alignment" set to "Curved".

Span	Length (ft)
1	40.00

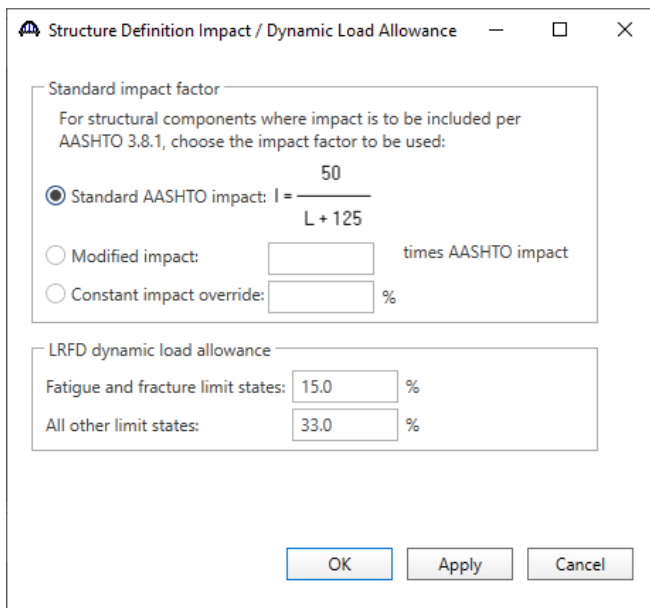
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The partially expanded **Bridge Workspace** tree is shown below:



Impact/Dynamic Load Allowance

Enter the impact to be used for the superstructure definition by double clicking on **Impact/Dynamic Load Allowance** in the Bridge Workspace tree. The **Structure Definition Impact / Dynamic Load Allowance** window shown below will open. The values shown below are default values. No changes are required



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Load Case Description

Double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window** and define the dead load cases. The completed **Load Case Description** window is shown below.

The screenshot shows the 'Load Case Description' dialog box. It contains a table with the following data:

Load case name	Description	Stage	Type	Time* (days)
Parapets		Composite (long term) (Stage 2)	D,DC	

Below the table, there is a checkbox for '*Prestressed members only' and a button 'Add default load case descriptions'. At the bottom, there are buttons for 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

Structure Framing Plan Detail - Layout

Double-click on **Framing Plan Detail** in the **Bridge Workspace** tree to describe the framing plan in the **Structure Framing Plan Details** window. Enter the data as shown below.

The screenshot shows the 'Structure Framing Plan Details' dialog box. It has two tabs: 'Layout' and 'Diaphragms'. The 'Layout' tab is active. At the top, there are input fields for 'Number of spans: 1' and 'Number of girders: 5'. Below this, there are two tables and a radio button group.

Girder spacing orientation:

- Perpendicular to girder
- Along support

Support Skew (degrees) table:

Support	Skew (degrees)
1	0.000
2	0.000

Girder bay Girder spacing (ft) table:

Girder bay	Girder spacing (ft)	
	Start of girder	End of girder
1	6.00	6.00
2	6.00	6.00
3	6.00	6.00
4	6.00	6.00

At the bottom, there are buttons for 'OK', 'Apply', and 'Cancel'.

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Structure Framing Plan Detail - Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing. Enter the diaphragm locations shown below for **girder bay 1**. Click on the **Copy bay to...** button to copy the diaphragm locations to bays 2 to 4.

Structure Framing Plan Details

Number of spans: 1 Number of girders: 5

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	1.2000	--Not Assigned--
1	0.00	0.00	20.00	2	40.00	40.00	40.00	1.2000	--Not Assigned--

New Duplicate Delete

OK Apply Cancel

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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.

The screenshot shows the 'Structure Typical Section' dialog box with the 'Deck' tab selected. At the top, a diagram illustrates the deck cross-section with labels for 'Distance from left edge of deck to superstructure definition ref. line', 'Deck thickness', 'Superstructure Definition Reference Line', and 'Distance from right edge of deck to superstructure definition ref. line'. Below the diagram, the 'Deck' tab is active, showing a dropdown menu set to 'within' and the text 'the bridge deck'. Below this, there are input fields for 'Start' and 'End' values for various dimensions:

Parameter	Start (ft)	End (ft)
Distance from left edge of deck to superstructure definition reference line:	15.00	15.00
Distance from right edge of deck to superstructure definition reference line:	15.00	15.00
Left overhang:	3.00	3.00
Computed right overhang:	3.00	3.00

Buttons for 'OK', 'Apply', and 'Cancel' are located at the bottom right of the dialog.

Structure Typical Section - Deck

The **Deck (cont'd)** tab is used to enter information about the deck concrete and thickness. The material to be used for the deck concrete is selected from the list of bridge materials described before.

The screenshot shows the 'Structure Typical Section' dialog box with the 'Deck (cont'd)' tab selected. At the top, the same diagram as in the previous screenshot is visible. Below the diagram, the 'Deck (cont'd)' tab is active, showing a dropdown menu set to 'Class A (US)'. Below this, there are input fields for various deck properties:

Deck concrete:	Class A (US)
Total deck thickness:	8.0000 in
Load case:	Engine Assigned
Deck crack control parameter:	130.000 kip/in
Sustained modular ratio factor:	2.000
Deck exposure factor:	1.000

Buttons for 'OK', 'Apply', and 'Cancel' are located at the bottom right of the dialog.

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Structure Typical Section - Parapets

The two parapets are described using the **Parapet** tab. Click **New** to add a row to the table. The name of the parapet defaults to the only barrier described for the bridge. Change the **Load Case** to **Parapets** and select **Back** in the **Measure to** field (we are locating the parapet on the deck by referencing the back of the parapet to the left edge of the deck). Enter **0.0** for the **Distance at start** and **Distance at end**. Change the **Front face orientation** to **Right**. The completed tab is shown below.

The screenshot shows the 'Structure Typical Section' window with the 'Parapet' tab selected. A diagram at the top left shows a cross-section of a parapet with 'Back' and 'Front' labels. Below the diagram is a table with the following columns: Name, Load case, Measure to, Edge of deck dist. measured from, Distance at start (ft), Distance at end (ft), and Front face orientation. The table contains two rows for 'Jersey Barrier'.

Name	Load case	Measure to	Edge of deck dist. measured from	Distance at start (ft)	Distance at end (ft)	Front face orientation
Jersey Barrier	Parap...	Back	Left Edge	0.00	0.00	Right
Jersey Barrier	Parap...	Back	Right Edge	0.00	0.00	Left

Buttons at the bottom of the window include 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

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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.

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	-13.25	13.25	-13.25	13.25

Click **Apply** to apply the computed values. The Lane position tab is populated as shown below.

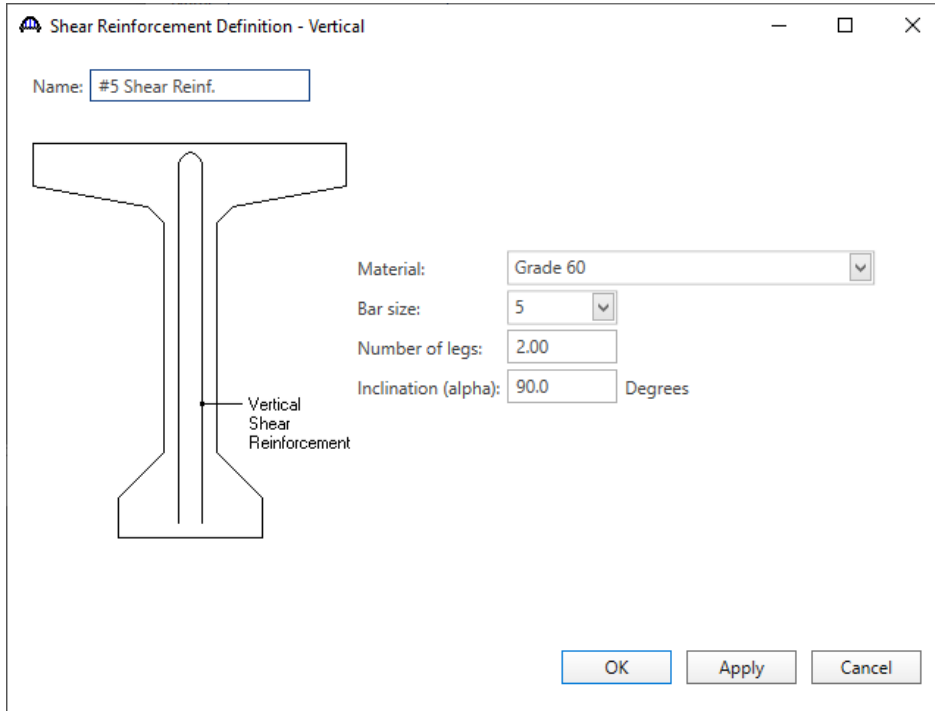
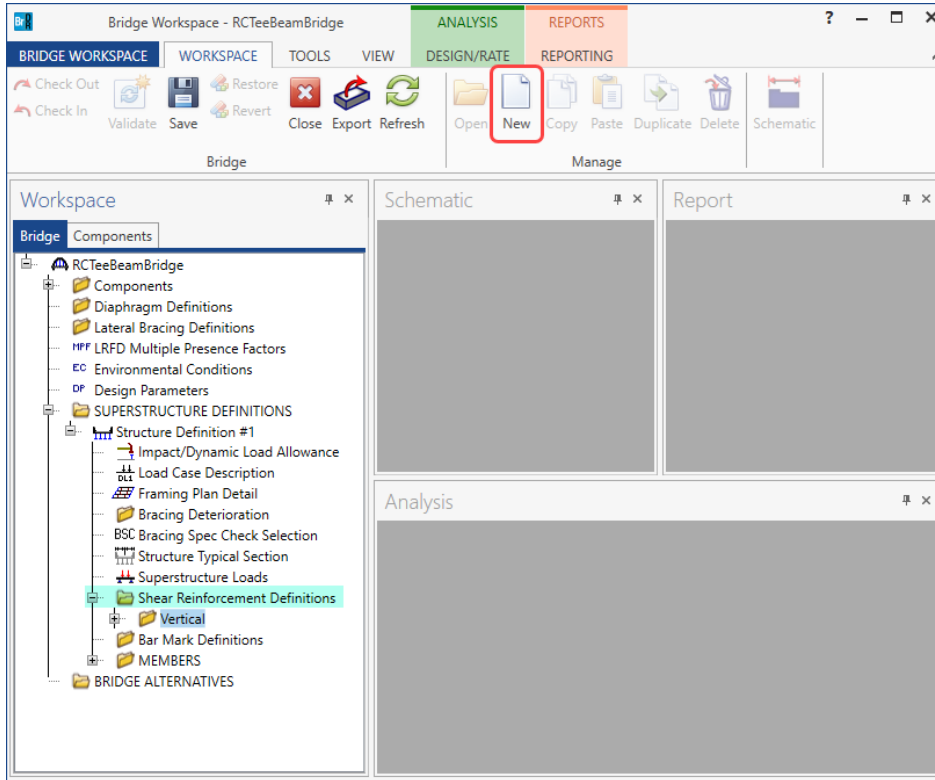
Travelway number	Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)	Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)
1	-13.25	13.25	-13.25	13.25

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Shear Reinforcement

Define shear reinforcement to be used by the girders. Expand the **Shear Reinforcement Definitions** on the Bridge Workspace tree and click on **New** from the **Manage** group of the Workspace ribbon (or double click on **Vertical**).

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



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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 Member Alternatives are 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	40.00

OK Apply Cancel

Support Constraints

Expand the **G2** member on the **Bridge Workspace** tree and double click on **Support constraints** to open the **Support Constraints** window. Support constraints were generated when the structure definition was created and are shown below. No changes are required.

Supports

Y
X
Z

1 2

General Elastic 3D General 3D Elastic

Support number	Support type	Translation constraints			Rotation constraints		
		X	Y	Z	X	Y	Z
1	Pinned	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2	Roller	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

OK Apply Cancel

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Defining a Member Alternative

Double click on **MEMBER ALTERNATIVES** in the Bridge Workspace tree for member **G2** to create a new alternative. The **New Member Alternative** window shown below will open. Select **Reinforced concrete** for the **Material type** and **Reinforced Concrete Tee** for the **Girder type**.

The 'New Member Alternative' dialog box contains two list boxes. The 'Material type' list includes: Post tensioned concrete, Prestressed (pretensioned) concrete, Reinforced concrete (selected), Steel, and Timber. The 'Girder type' list includes: Advanced Concrete RC, Reinforced Concrete I, and Reinforced Concrete Tee (selected). At the bottom are 'OK' and 'Cancel' buttons.

The **Member Alternative Description** window will open as shown below. Enter details as shown below and Click **OK** to save to memory and close the window.

The 'Member Alternative Description' dialog box has a title bar with a minus, maximize, and close button. The 'Member alternative' field contains 'Interior 36" RC Tee Beam'. Below are tabs for 'Description', 'Specs', 'Factors', 'Engine', 'Import', and 'Control options'. The 'Description' tab is active, showing a large empty text area for the description. To the right are dropdowns for 'Material type' (Reinforced Concrete), 'Girder type' (Reinforced Concrete Tee), 'Modeling type' (Multi Girder System), and 'Default units' (US Customary). Below these are two sections: 'Girder property input method' with radio buttons for 'Schedule based' and 'Cross-section based' (selected), and 'End bearing locations' with input fields for 'Left: 6.0000 in' and 'Right: 6.0000 in'. The 'Self load' section has a 'Load case' dropdown (Engine Assigned), and two 'Additional self load' input fields (kip/ft and %). The 'Default rating method' dropdown is set to 'LFR'. The 'Crack control parameter (Z)' section has an input field for 'Bottom of beam' (kip/in). The 'Exposure factor' section has an input field for 'Bottom of beam'. At the bottom are 'OK', 'Apply', and 'Cancel' buttons.

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Cross sections

Next create the cross sections that define the girder geometry by double clicking on **Cross Sections** in the Bridge Workspace tree. The **Dimensions** tab of the **Cross Sections** window is shown below.

The screenshot shows the 'Cross Sections' dialog box with the 'Dimensions' tab selected. The 'Name' is 'Cross Section A' and the 'Type' is 'Reinforced Concrete Tee'. The diagram shows a tee beam with a top flange width of 72.0000 in and a stem width of 24.0000 in. The flange thickness is 8.0000 in. The stem height is 36.0000 in. The effective width (Std) is 72.0000 in, and the effective width (LRFD) is also 72.0000 in. The structural thickness is 7.5000 in. The material is 'Class A (US)' and the modular ratio is 8.0. The 'Other parts' section also has 'Class A (US)' material and a modular ratio of 8.0.

The **Reinforcement** tab is shown below.

The screenshot shows the 'Cross Sections' dialog box with the 'Reinforcement' tab selected. The diagram shows the same tee beam with reinforcement details. The 'Distance from top of beam' and 'Distance from bottom of beam' are indicated. The table below shows the reinforcement parameters:

Row	Std bar count	LRFD bar count	Bar size	Distance (in)	Material	Bar spacing (in)
Bottom of Girder	8.00	8.00	9	6.0000	Grade 60	2.5000

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Cross section ranges

Next, describe the ranges over which the cross sections apply. Double-click on **Cross Section Ranges** on the Bridge Workspace tree to open the **Cross Section Ranges** window and enter data as shown below:

Start section	End section	Web variation	Support number	Start distance (ft)	Length (ft)	End distance (ft)
Cross Section A	Cross Section A	None	1	0.000	40.000	40.000

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Shear Reinforcement Ranges

Double-click on **Shear Reinforcement Ranges** on the Bridge Workspace tree to open the **Shear Reinforcement Ranges** window and enter data as shown below:

Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
#5 Shear Reinf.	1	0.00	1	0.0000	0.00	0.00
#5 Shear Reinf.	1	0.00	40	12.0000	40.00	40.00

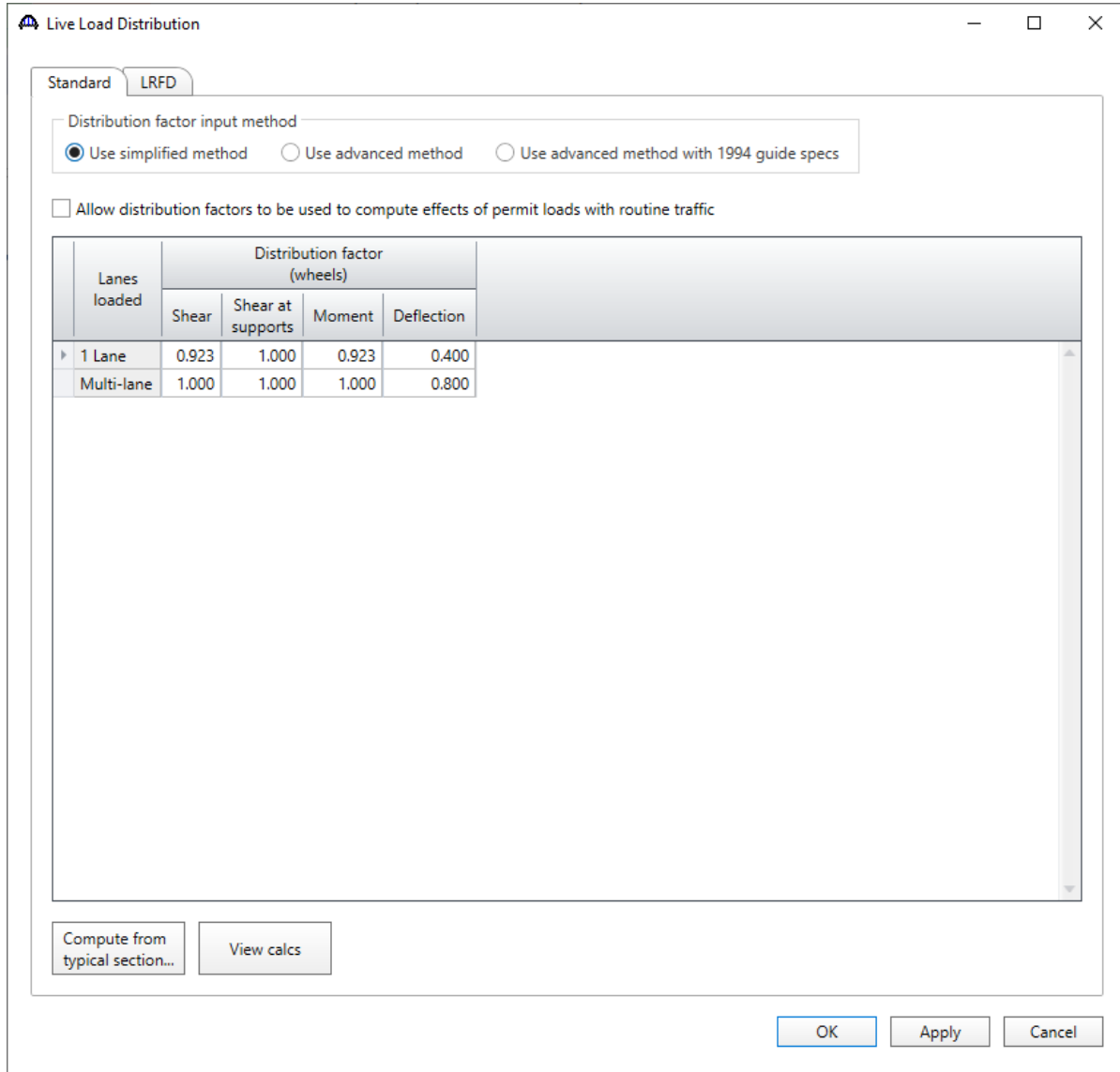
Because the range does not include a stirrup at the beginning of the range, we must define two ranges. The range that begins at the left end of the beam with one space and a spacing of 0.0 inches locates the first stirrup. The range that begins at the left end of the beam with 40 spaces and a spacing of 12 inches locates the rest of the stirrups.

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Live Load Distribution factors

Distribution Factors (Standard):

Open the **Live Load Distribution** window from the Bridge Workspace tree and enter the following values for Standard live load distribution factors.



The screenshot shows the 'Live Load Distribution' dialog box with the 'Standard' tab selected. The 'Distribution factor input method' section has three radio buttons: 'Use simplified method' (selected), 'Use advanced method', and 'Use advanced method with 1994 guide specs'. There is also a checkbox for 'Allow distribution factors to be used to compute effects of permit loads with routine traffic' which is unchecked. A table displays distribution factors for '1 Lane' and 'Multi-lane' across four categories: Shear, Shear at supports, Moment, and Deflection. At the bottom, there are buttons for 'Compute from typical section...', 'View calcs', 'OK', 'Apply', and 'Cancel'.

Lanes loaded	Distribution factor (wheels)			
	Shear	Shear at supports	Moment	Deflection
1 Lane	0.923	1.000	0.923	0.400
Multi-lane	1.000	1.000	1.000	0.800

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Point of Interest

Define points of interest using the **Points of Interest** window shown below. A window for defining a point of interest is opened by double-clicking on the **Points of Interest** Bridge Workspace tree item.

Point of Interest

Distance from leftmost support: 20.00 ft or Span: Span 1 Fraction: 0.500000 Side: Left Right

Shear | Shear capacity | Positive flexural capacity | Negative flexural capacity | Engine

Override schedule % Shear: 100.000 % Shear distance: in

Vertical shear rein.

Material: Bar size: # of legs: Area: in² Inclination: Degrees Spacing: in

LRFD

Computation method: General Procedure Sx: in Beta: Theta:

LFR

Ignore shear

LRFR

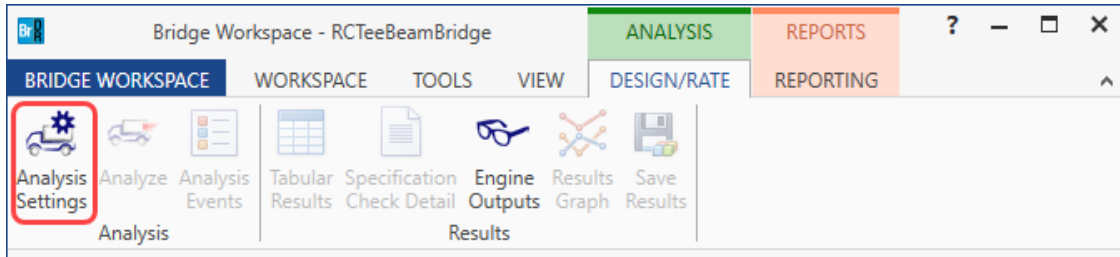
Ignore design & legal load shear Ignore permit load shear Consider permit load tensile steel stress

OK Apply Cancel

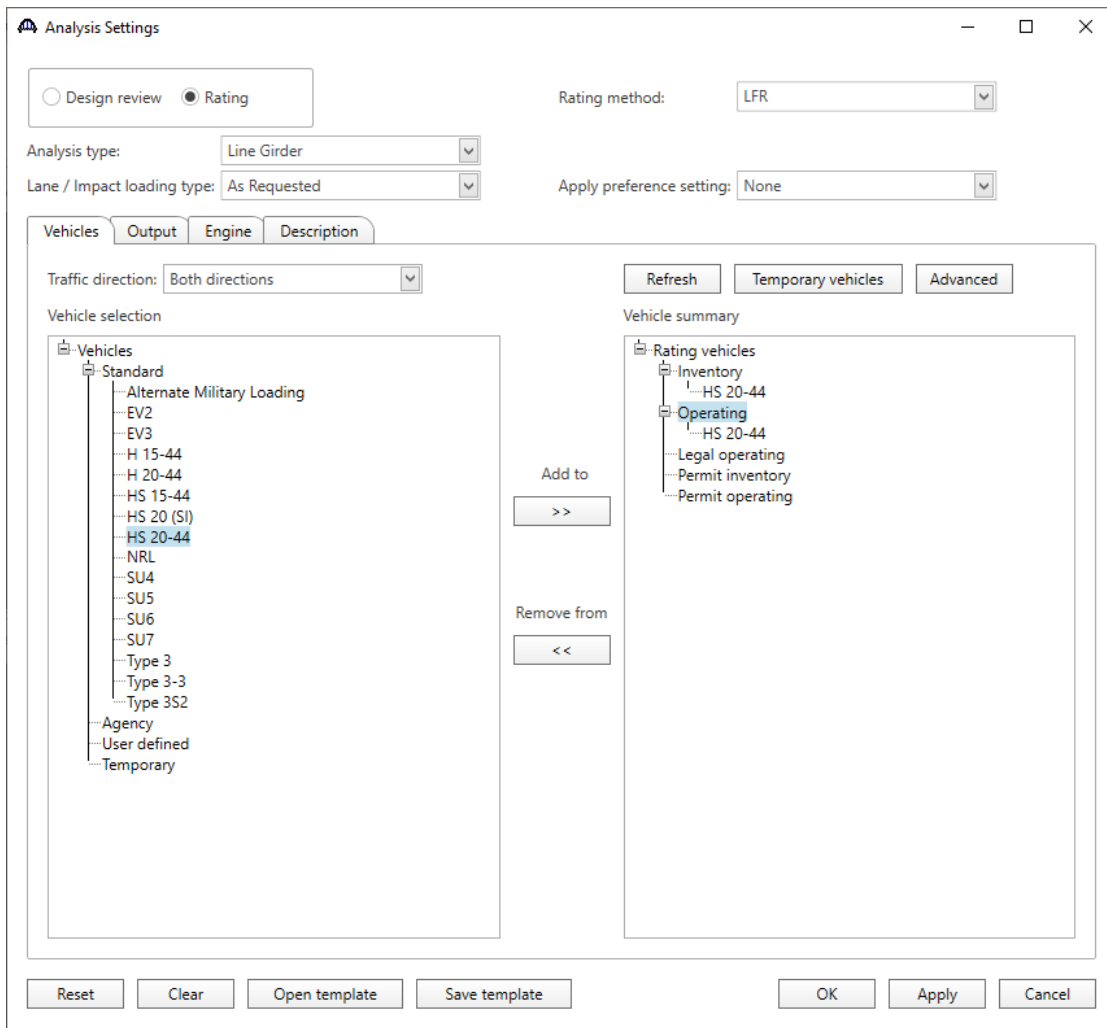
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LFR Rating

To perform an **LFR** rating, click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon which opens the **Analysis Settings** window.

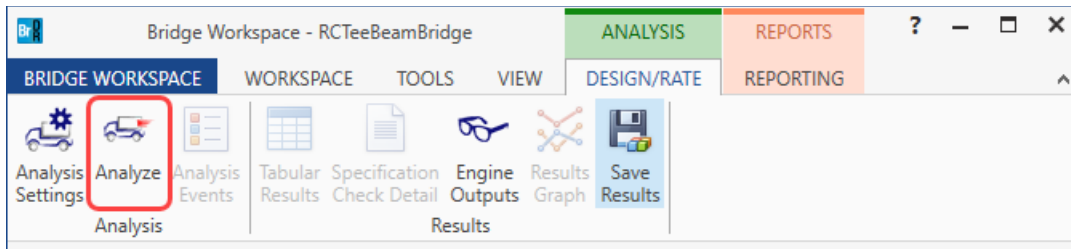


Select the vehicles to be used in the rating as shown below and click **OK**.



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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 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.

The screenshot shows the 'Analysis Results - Interior 36" RC Tee Beam' window. The window has a 'Print' button and a 'Report type' dropdown set to 'Rating Results Summary'. The 'Lane/Impact loading type' section has 'As requested' selected. The 'Display Format' dropdown is set to 'Single rating level per row'. The table below shows the results for four different loading scenarios.

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	35.98	0.999	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFR	Operating	60.08	1.669	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Lane	LFR	Inventory	51.40	1.428	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Lane	LFR	Operating	85.83	2.384	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested

AASHTO LFR Engine Version 7.5.0.3001
Analysis preference setting: None

Close