

AASHTOWare BrR/BrD 6.8

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

BrR and BrD 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. The 'Bridge ID' and 'NBI Structure ID (8)' fields are both filled with 'RCTeeBeamBridge'. The 'Template' checkbox is unchecked, while 'Superstructures' and 'Culverts' are checked. The 'Description' tab is active, showing the following data: 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), and Default Units: US Customary. At the bottom, the 'BrR' and 'BrD' checkboxes are checked, and 'BrM' is unchecked. The 'OK', 'Apply', and 'Cancel' buttons are visible.

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

RC1 – Single Span Reinforced Concrete Tee Beam Example

To add a new concrete material click on Materials, Concrete in the tree and select File/New from the menu (or right mouse click on Concrete and select New). The window shown below will open. Enter the values shown.

Bridge Materials - Concrete

Name: Description:

Compressive strength at 28 days (f'c) = ksi

Initial compressive strength (f'ci) = ksi

Coefficient of thermal expansion = 1/F

Density (for dead loads) = kcf

Density (for modulus of elasticity) = kcf

Std Modulus of elasticity (Ec) = ksi

LRFD Modulus of elasticity (Ec) = ksi

Std Initial modulus of elasticity = ksi

LRFD Initial modulus of elasticity = ksi

Poisson's ratio =

Composition of concrete =

Modulus of rupture = ksi

Shear factor =

Splitting tensile strength (fct) = ksi

RC1 – Single Span Reinforced Concrete Tee Beam Example

Do the same for the reinforcing steel.

Bridge Materials - Reinforcing Steel

Name: Description:

Material Properties

Specified yield strength (F_y) = ksi

Modulus of elasticity (E_s) = ksi

Ultimate strength (F_u) = ksi

Type

Plain
 Epoxy
 Galvanized
 Other

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

Bridge Appurtenances - Parapet

Name:

Description:

All dimensions are in inches

Additional Load = kip/ft

2.0000

12.0000

7.0000

Reference Line

0.0000

19.0000

10.0000

3.0000

Back

Front

Roadway Surface

Parapet unit load = kcf

Calculated Properties

Net centroid (from reference line) = in

Total load = kip/ft

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Enter the impact to be used for the entire bridge by clicking on Impact in the tree and selecting File/Open from the menu. The Bridge Impact window shown below will open. Enter the appropriate values as shown and click Ok to save the data to memory and close the window. The values shown below are default values.

Bridge Impact / Dynamic Load Allowance

Standard Impact Factor

For structural components where impact is to be included per AASHTO 3.8.1, choose the impact factor to be used:

Standard AASHTO impact $I = \frac{50}{L + 125}$

Modified impact = times AASHTO impact

Constant impact override = %

LRFD Dynamic Load Allowance

Fatigue and fracture limit states: %

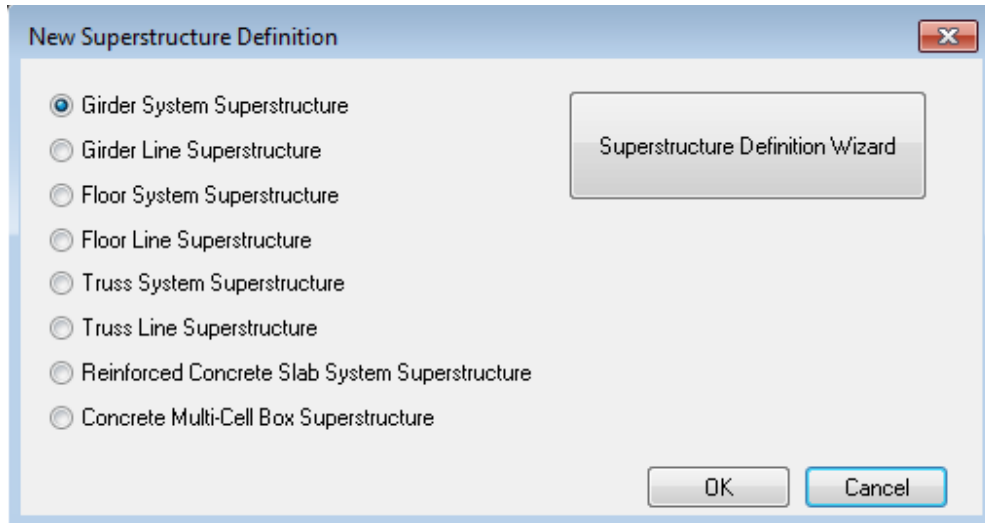
All other limit states: %

OK Apply Cancel

For this example problem we are not going to override the standard LRFD or LFD factors so we skip to Structure Definition.

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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.



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

Girder System Superstructure Definition

Definition | Analysis | Specs | Engine

Name: Structure Definition #1

Description: 5 girder system, single span

Default Units: US Customary

Number of spans: 1

Number of girders: 5

Enter Span Lengths Along the Reference Line:

Span	Length (ft)
1	40.00

Frame Structure Simplified Definition:

Deck type: Concrete

For PS only

Average humidity: %

Member Alt. Types

Steel

P/S

R/C

Timber

Horizontal Curvature Along Reference Line

Horizontal curvature

Superstructure Alignment

Curved

Tangent, curved, tangent

Tangent, curved

Curved, tangent

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

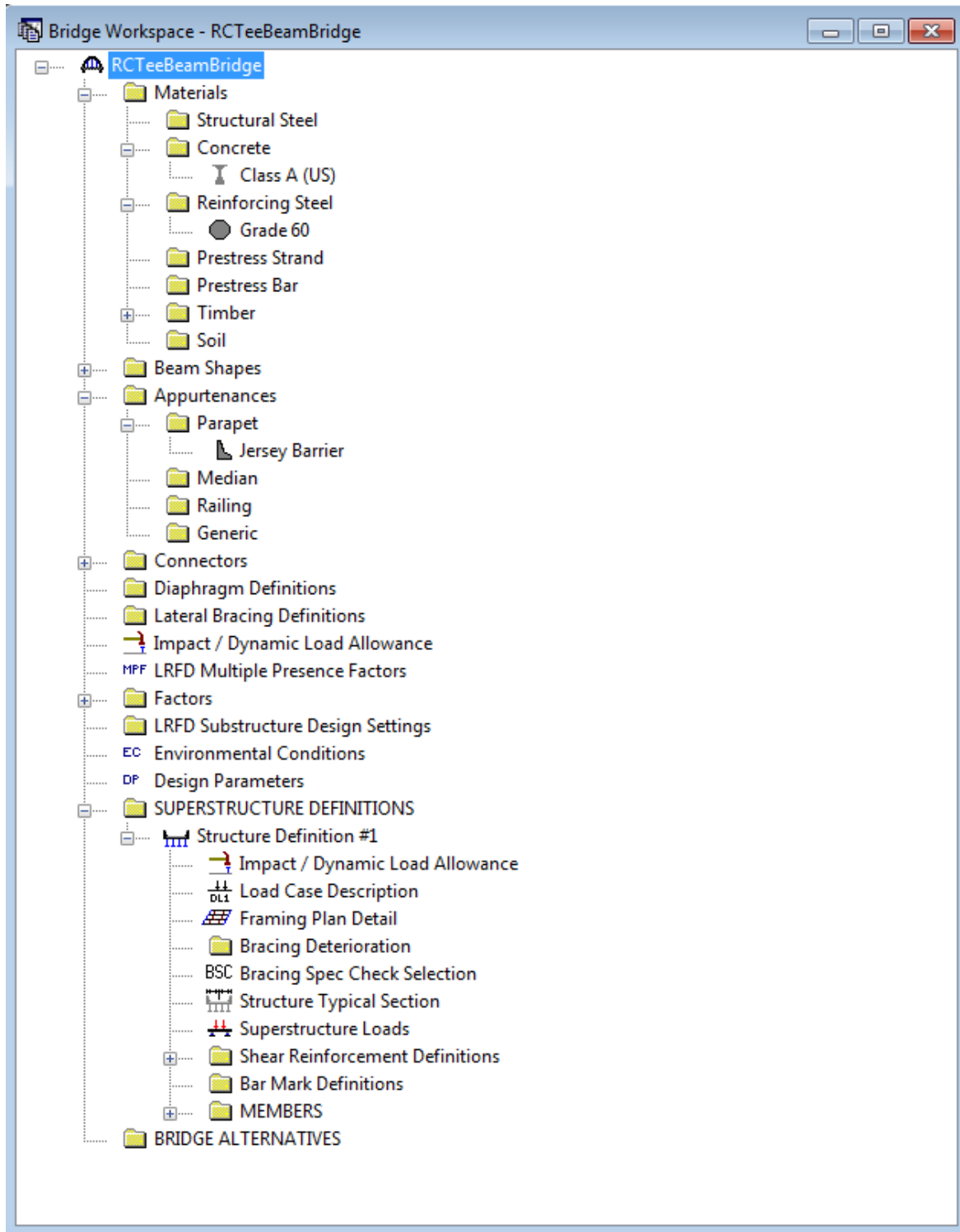
Design speed: mph

Superelevation: %

OK Apply Cancel

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The partially expanded Bridge Workspace tree is shown below:



RC1 – Single Span Reinforced Concrete Tee Beam Example

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

Load Case Name	Description	Stage	Type	Time* (Days)
Parapets		Composite (long term) (Stage 2)	D,DC	

*Prestressed members only

Add Default Load Case Descriptions

New Duplicate Delete

OK Apply Cancel

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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 = 5

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	6.00	6.00
2	6.00	6.00
3	6.00	6.00
4	6.00	6.00

OK Apply Cancel

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Switch to the Diaphragms tab to enter diaphragm spacing. Enter the diaphragm locations shown below for girder bay 1. Click on Copy Bay To button to copy the diaphragm locations to the bay 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 As
1	0.00	0.00	20.00	2	40.00	40.00	40.00	1.2000	-- Not As

New Duplicate Delete

OK Apply Cancel

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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. This screen initially shows steel girders as the default girder type until the member alternatives are defined.

Basic deck geometry:

The screenshot shows the 'Structure Typical Section' dialog box with the 'Deck' tab selected. At the top, a diagram illustrates the deck geometry with labels: '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', and 'Right overhang'. Below the diagram is a tabbed interface with the following tabs: Deck, Deck (Cont'd), Parapet, Median, Railing, Generic, Sidewalk, Lane Position, Striped Lanes, and Wearing Surface. The 'Deck' tab is active, showing the following settings:

Parameter	Start (ft)	End (ft)
Superstructure definition reference line is	within	the bridge deck.
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 at the bottom: OK, Apply, Cancel.

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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.

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 Deck (Cont'd) Parapet Median Railing Generic Sidewalk Lane Position Striped Lanes Wearing Surface

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

OK Apply Cancel

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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 “Measure To” to “Back” (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. At the top, a diagram illustrates a parapet cross-section with 'Back' and 'Front' labels. Below the diagram is a table with columns for 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 are present, both for 'Jersey Barrier' with 'Parapets' as the load case. The first row is measured from the 'Left Edge' and has a 'Right' orientation. The second row is measured from the 'Right Edge' and has a 'Left' orientation. Both rows have 0.00 for both distance values. At the bottom of the window 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
Jersey Barrier	Parapets	Back	Left Edge	0.00	0.00	Right
Jersey Barrier	Parapets	Back	Right Edge	0.00	0.00	Left

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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.

The screenshot shows the 'Structure Typical Section' dialog box with the 'Lane Position' tab selected. The diagram at the top illustrates a cross-section of a bridge with two travelways. Dimension (A) is the distance from the left edge of the travelway to the superstructure definition reference line at the start. Dimension (B) is the distance from the right edge of the travelway to the superstructure definition reference line at the start. The table below shows the computed values for these dimensions.

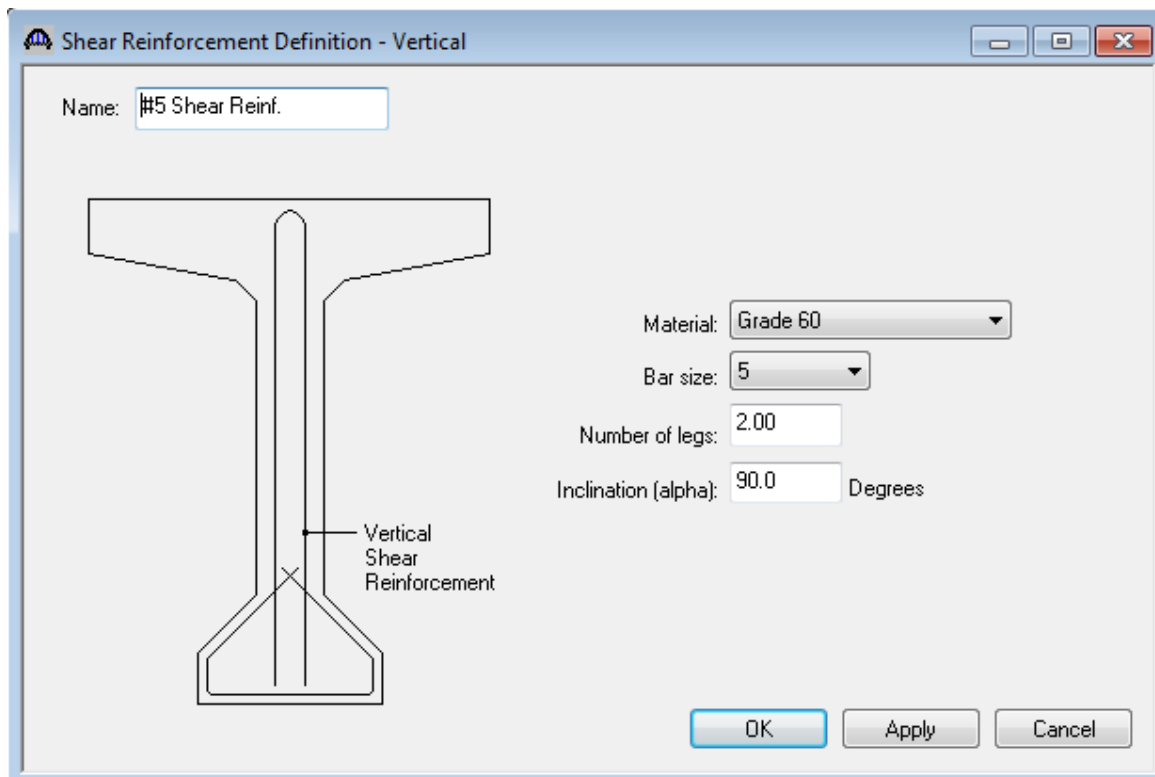
Travelway Number	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At Start (A) (ft)	Distance From Right Edge of Travelway to Superstructure Definition Reference Line At Start (B) (ft)	Distance From Left Edge of Travelway to Superstructure Definition Reference Line At End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

LRFD Fatigue
 Lanes available to trucks:
 Override Truck fraction:

Buttons: Compute..., New, Duplicate, Delete, OK, Apply, Cancel

RC1 – Single Span Reinforced Concrete Tee Beam Example

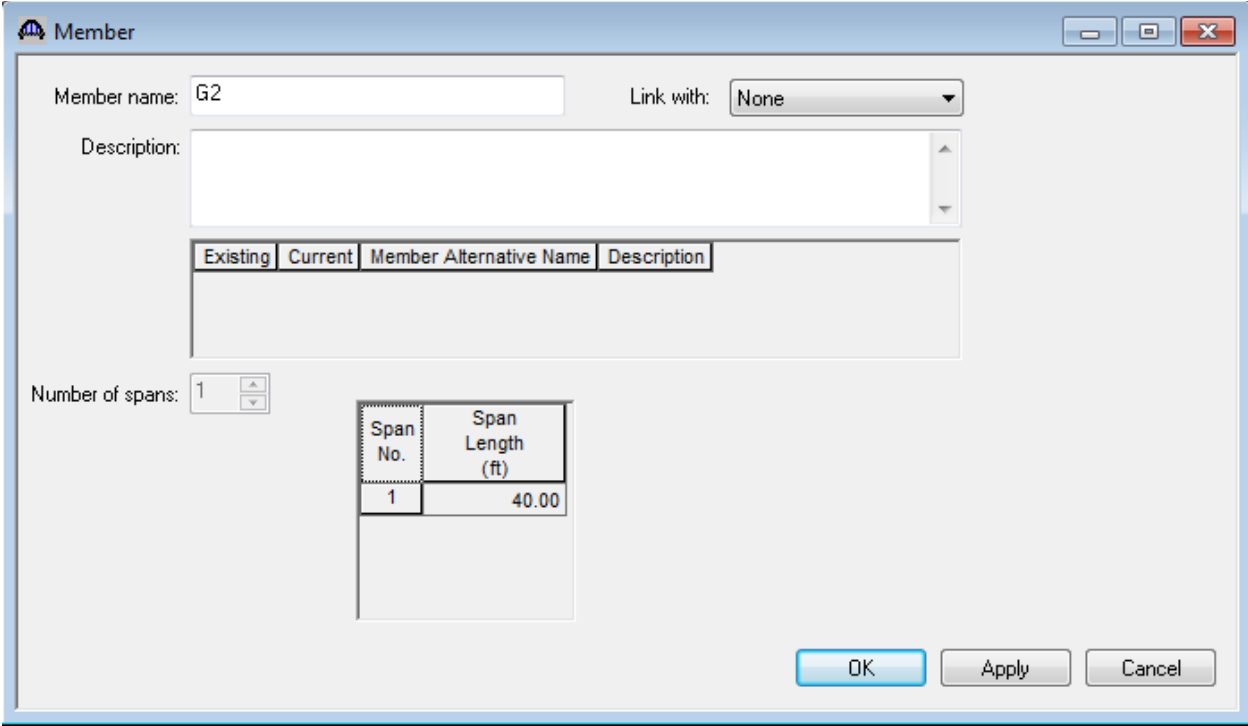
Define shear reinforcement to be used by the girders. Expand the shear Reinforcement Definitions tree item and double click on Vertical. Define the stirrup as shown below. Click Ok to save to memory and close the window.



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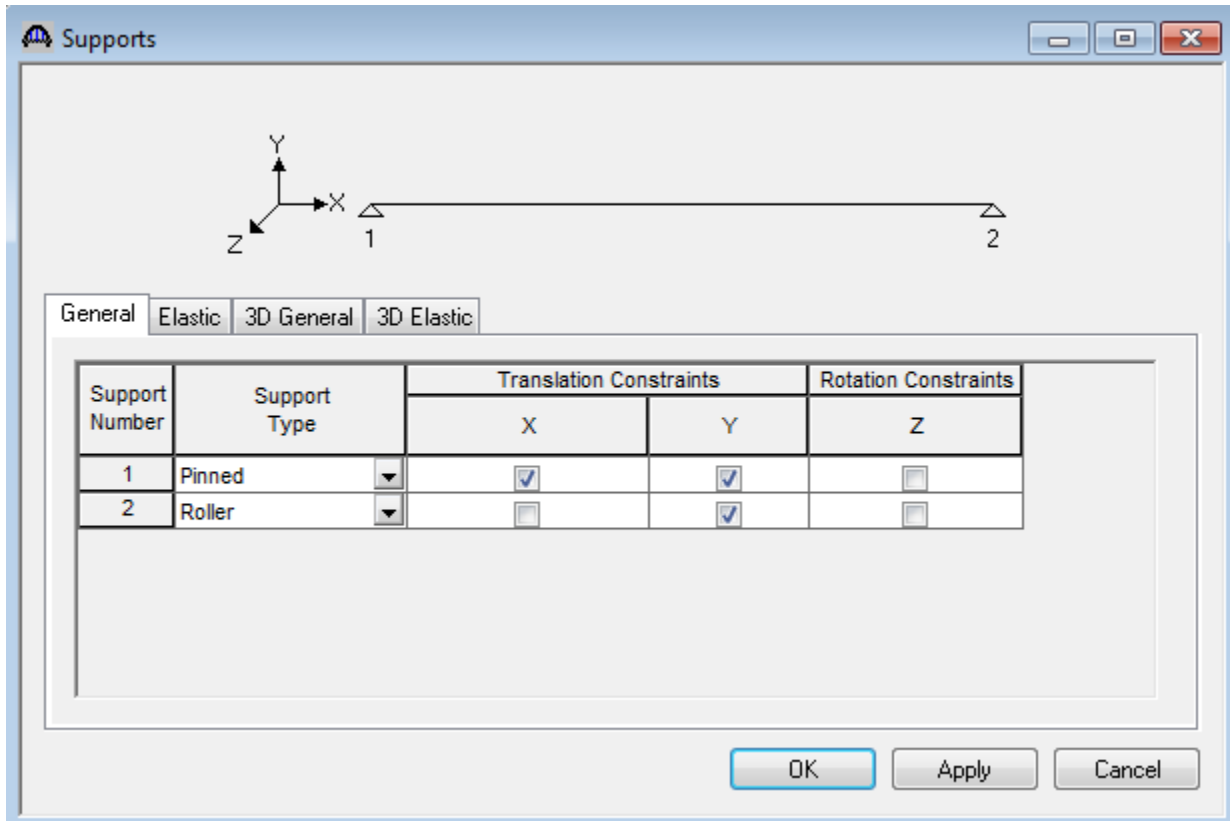
Describing a member:

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.



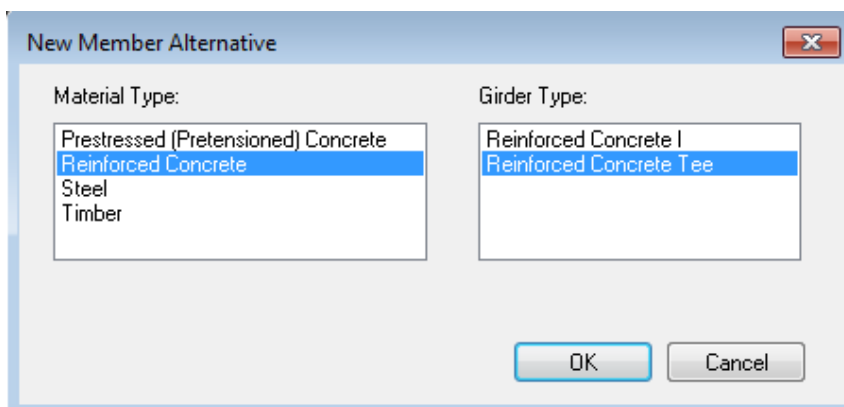
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Support constraints were generated when the structure definition was created and are shown below.



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 Reinforced Concrete for the Material Type and Reinforced Concrete Tee for the Girder Type.



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Member Alternative Description

Member Alternative: Interior 36" RC Tee Beam

Description | Specs | Factors | Engine | Import | Control Options

Description:

Material Type: Reinforced Concrete
Girder Type: Reinforced Concrete Tee
Default Units: US Customary

Girder property input method
 Schedule based
 Cross-section based

End bearing locations
Left: 6.0000 in
Right: 6.0000 in

Self Load
Load case: Engine Assigned
Additional self load = kip/ft
Additional self load = %

Default rating method:
LFD

Crack control parameter [Z]
Bottom of beam: kip/in

Exposure factor
Bottom of beam:

OK Apply Cancel

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Distribution Factors (Standard Spec):

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	0.923	1.000	0.923	0.400
Multi-Lane	1.000	1.000	1.000	0.800

Compute from Typical Section... View Calcs

OK Apply Cancel

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

The screenshot shows the 'Cross Sections' dialog box with the 'Dimensions' tab selected. The dialog is titled 'Cross Sections' and has a 'Name' field containing 'Cross Section A' and a 'Type' dropdown set to 'Reinforced Concrete Tee'. The 'Dimensions' tab contains a diagram of a tee beam cross-section with the following dimensions and parameters:

- Tributary width: 72.0000 in
- Flange width (from centerline): 8.0000 in
- Flange thickness: 24.0000 in
- Web width: 24.0000 in
- Web height: 36.0000 in
- Flange overhang (from web centerline): A = 0.0000 in
- Web height from top flange: CJ = [] in

On the right side of the dialog, there are two sections for material and modular ratio settings:

- Top Flange:**
 - Material: Class A (US)
 - Modular Ratio: 8.0
 - Eff. width (Std): 72.0000 in
 - Eff. width (LRFD): 72.0000 in
 - Struct. thick.: 7.5000 in
- Other Parts:**
 - Material: Class A (US)
 - Modular Ratio: 8.0

At the bottom of the dialog are three buttons: 'OK', 'Apply', and 'Cancel'.

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The Reinforcement tab is shown below.

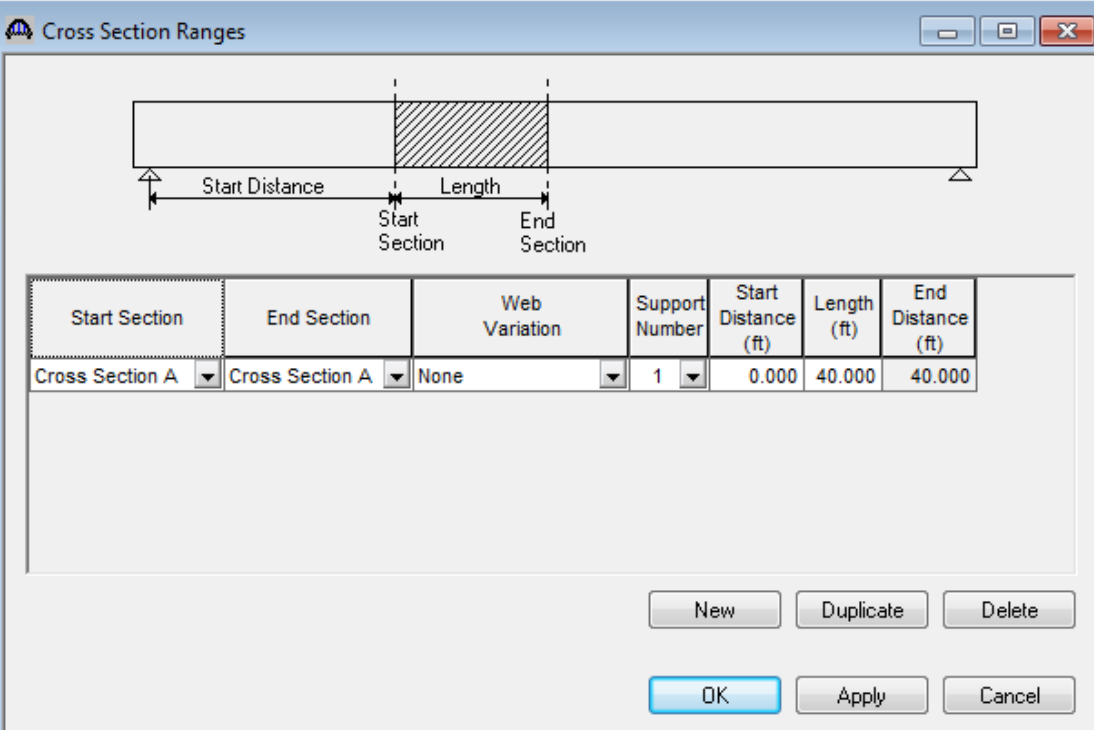
The screenshot shows the 'Cross Sections' software window with the 'Reinforcement' tab selected. The window title is 'Cross Sections'. The 'Name' field contains 'Cross Section A' and the 'Type' field contains 'Reinforced Concrete Tee'. The 'Reinforcement' tab is active, showing a diagram of a T-beam cross-section on the left and a table of reinforcement data on the right. The diagram labels the 'Distance from top of beam' and 'Distance from bottom of beam'. The table has the following data:

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

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

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Next describe the ranges over which the cross sections apply. The Cross Section Ranges window is shown below.



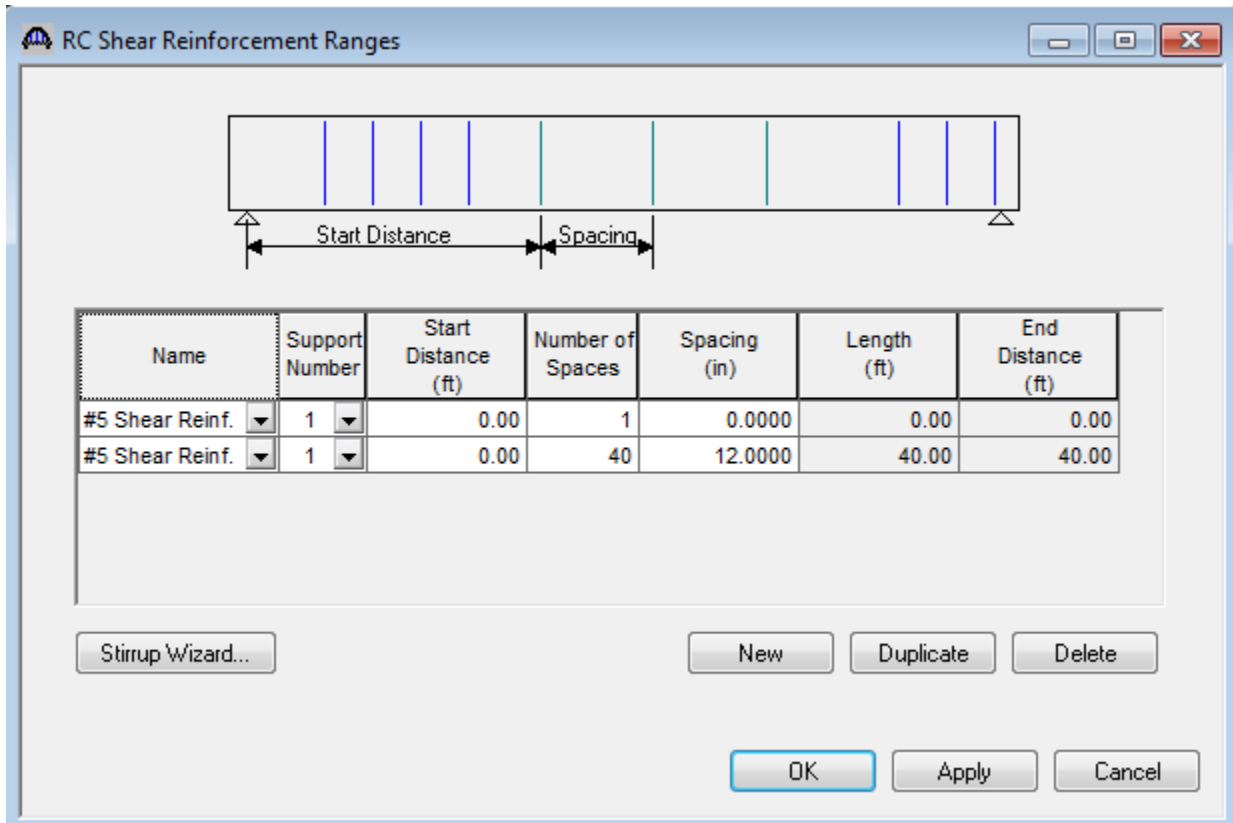
The diagram shows a horizontal beam with a shaded rectangular section in the middle. The start of the shaded section is labeled 'Start Section' and the end is labeled 'End Section'. The distance from the left end of the beam to the start of the shaded section is labeled 'Start Distance'. The length of the shaded section is labeled 'Length'. The beam is supported by a pin support on the left and a roller support on the right.

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

Buttons: New, Duplicate, Delete, OK, Apply, Cancel

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Shear reinforcement locations are described using the Shear Reinforcement Ranges window shown below.



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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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 tree item.

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 Reinf.

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

LRFD

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

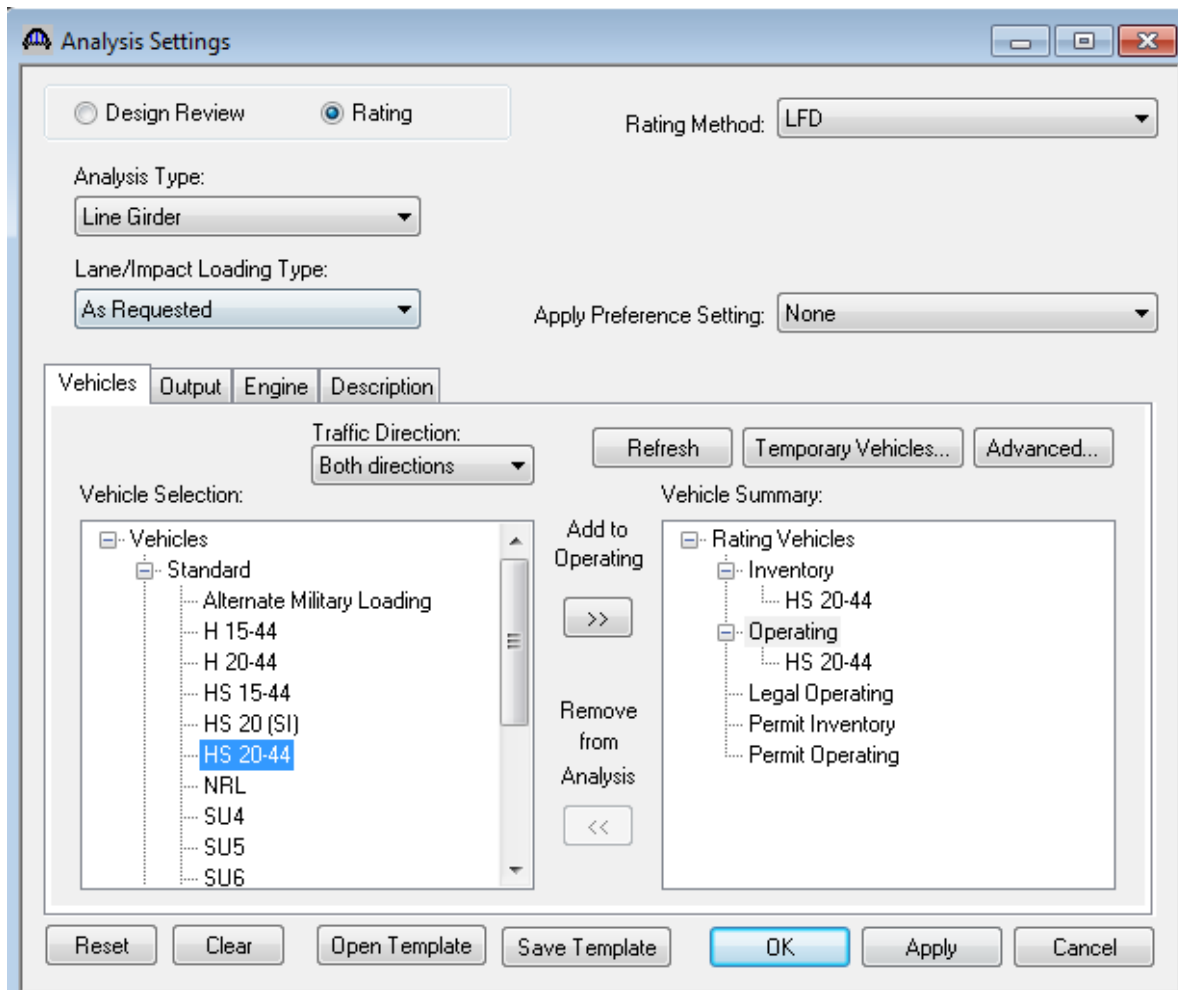
LFD Ignore shear

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

OK Apply Cancel

RC1 – Single Span Reinforced Concrete Tee Beam Example

To perform a rating, select the View Analysis Settings button on the toolbar to open the window shown below. Select the vehicles to be used in the rating and click Ok.



RC1 – Single Span Reinforced Concrete Tee 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 36" RC Tee 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 20-44	Lane	LFD	Inventory	51.39	1.428	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Lane	LFD	Operating	85.83	2.384	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFD	Inventory	35.98	0.999	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operating	60.08	1.669	20.00	1 - (50.0)	Design Flexure - Concrete	As Requested	As Requested

AASHTO LFR Engine Version 6.8.0.2005
Analysis Preference Setting: None

Close