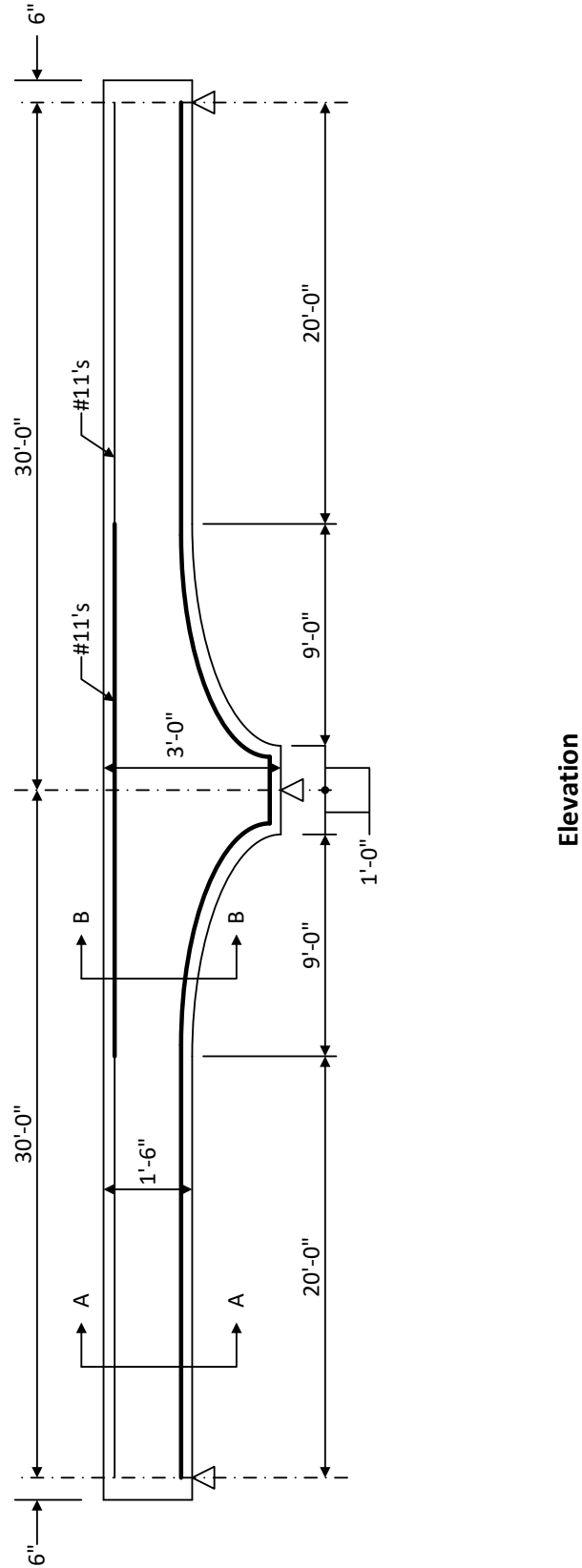


AASHTOWare BrD/BrR 6.8.4

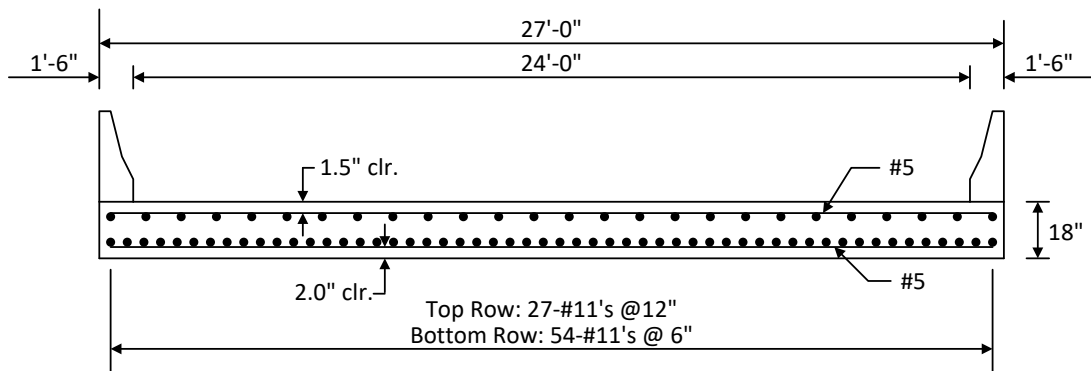
Reinforced Concrete Structure Tutorial
RC6 – Two Span Reinforced Concrete Slab System Example

AASHTOWare Bridge Design and Rating Training

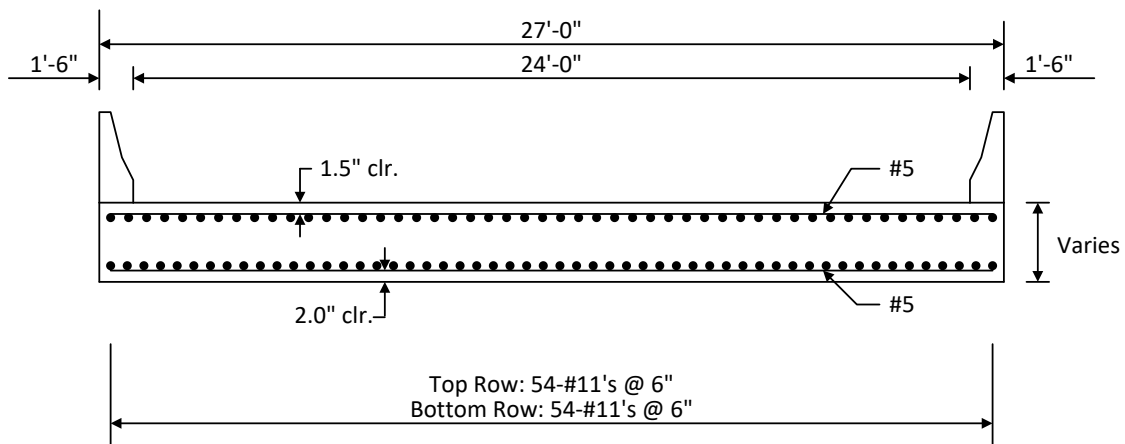


Elevation

RC6 – Two Span RC Slab System



Section A-A



Section B-B

Material Properties

Slab Concrete: Class A (US) $f'_c = 4.0$ ksi, modular ratio $n = 8$

Slab Reinforcing Steel: AASHTO M31, Grade 60 with $F_y = 60$ ksi

Parapets

Weigh 300 lb/ft each

RC6 – Two Span Reinforced Concrete Slab System Example

Topics Covered

Part 1: Reinforced concrete slab system input. Slab is not integral with pier.

- Schedule based input of slab strip.
- Slab depth varies parabolically over the pier.

Part 2: Frame structure simplified definition slab structure type.

Part 1: Reinforced concrete slab system input. Slab is not integral with pier.

From the Bridge Explorer, select File/New/New Bridge from the menu to create a new bridge and enter the following description data.

2SpanRCSlabSystem

Bridge ID: 2SpanRCSlabSystem NBI Structure ID (8): 2SpanRCSlabSys Template Superstructures
 Bridge Completely Defined Culverts

Description Description (cont'd) Alternatives Global Reference Point Traffic Custom Agency Fields

Name: 2SpanRCSlab Year Built:

Description:

Location: Length: ft

Facility Carried (7): Route Number: -1

Feat. Intersected (6): Mi. Post:

Default Units: US Customary

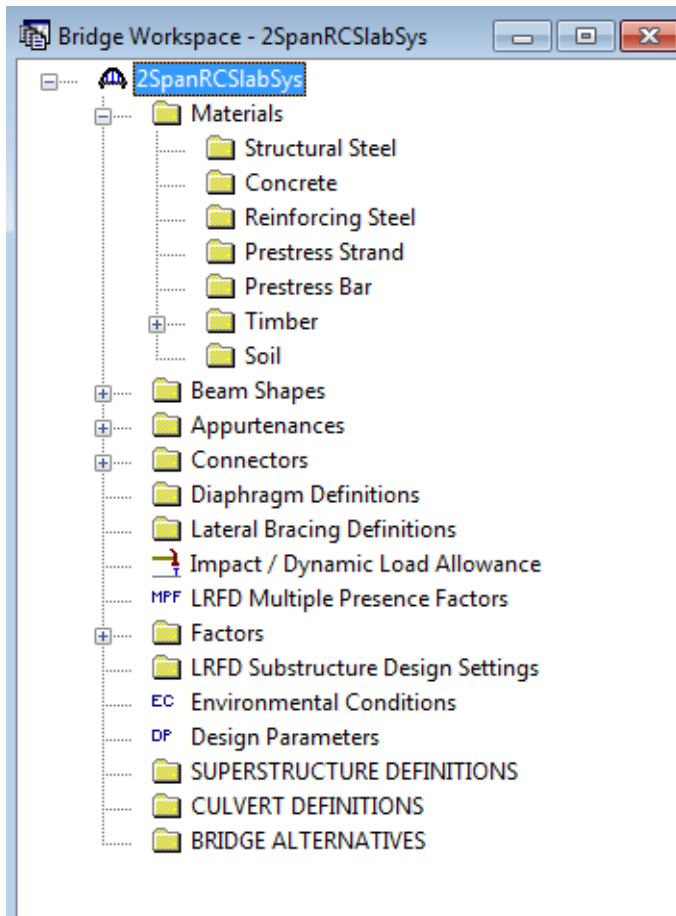
AASHTOWare Association... BrR BrD BrM

OK Apply Cancel

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

RC6 – Two Span RC Slab System

To enter the materials to be used by members of the bridge, expand the tree for Materials. The tree with the expanded Materials branch is shown below.



To add a new concrete material, click on Concrete in the tree and select File/New from the menu (or right mouse click on Concrete and select New).

Add the concrete material by selecting from the Concrete Materials Library by clicking the Copy from Library button. The following window opens.

RC6 – Two Span RC Slab System

Name	Description	Library	Units	f _c	f _{ci}	alpha	DL Density	Modulus Density	Modulus of Elasticity	Poisson's Ratio	Modulus of Rupture
Class A	Class A cement	Standar	SI / Me	28.00		0.000	2400.0	2320.00	25426.08	0.200	3.33
Class A (US)	Class A cement	Standar	US Cu	4.000		0.000	0.150	0.145	3644.15	0.200	0.480
Class B	Class B cement	Standar	SI / Me	17.00		0.000	2400.0	2320.00	19811.84	0.200	2.60
Class B (US)	Class B cement	Standar	US Cu	2.400		0.000	0.150	0.145	2822.75	0.200	0.372
Class C	Class C cement	Standar	SI / Me	28.00		0.000	2400.0	2320.00	25426.08	0.200	3.33
Class C (US)	Class C cement	Standar	US Cu	4.000		0.000	0.150	0.145	3644.15	0.200	0.480

Select the Class A (US) material and click Ok. The selected material properties are copied to the Bridge Materials - Concrete window as shown below.

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

Modulus of elasticity (E_c) = ksi

Initial modulus of elasticity = ksi

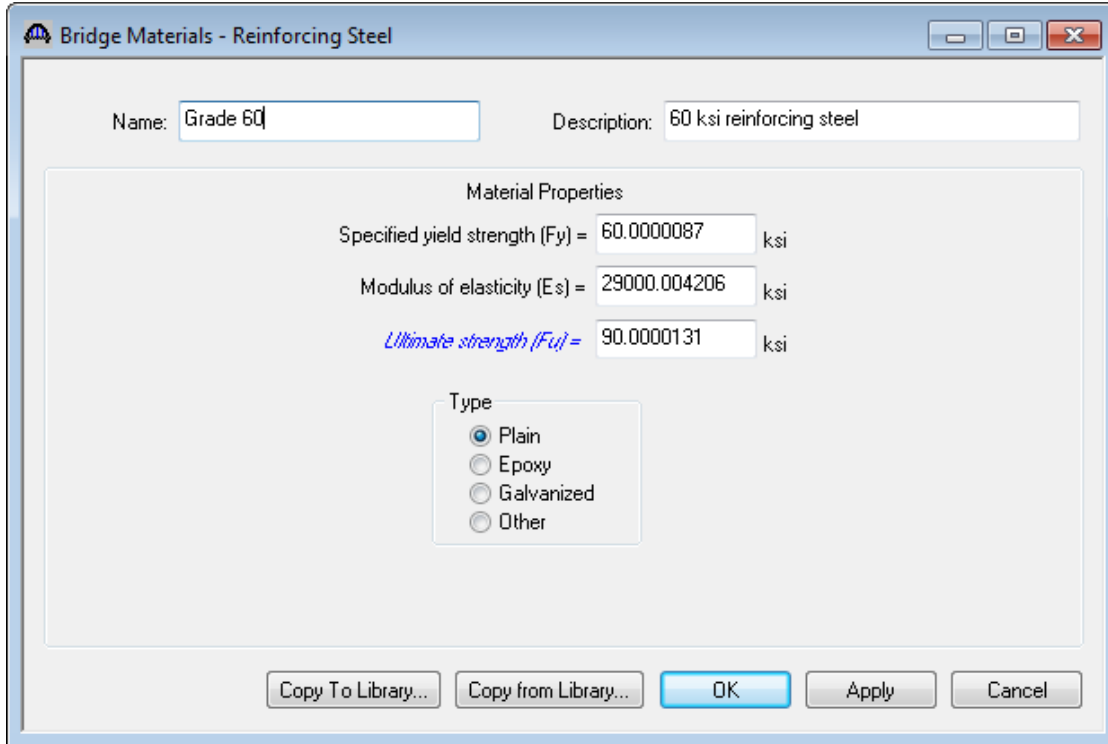
Poisson's ratio =

Composition of concrete =

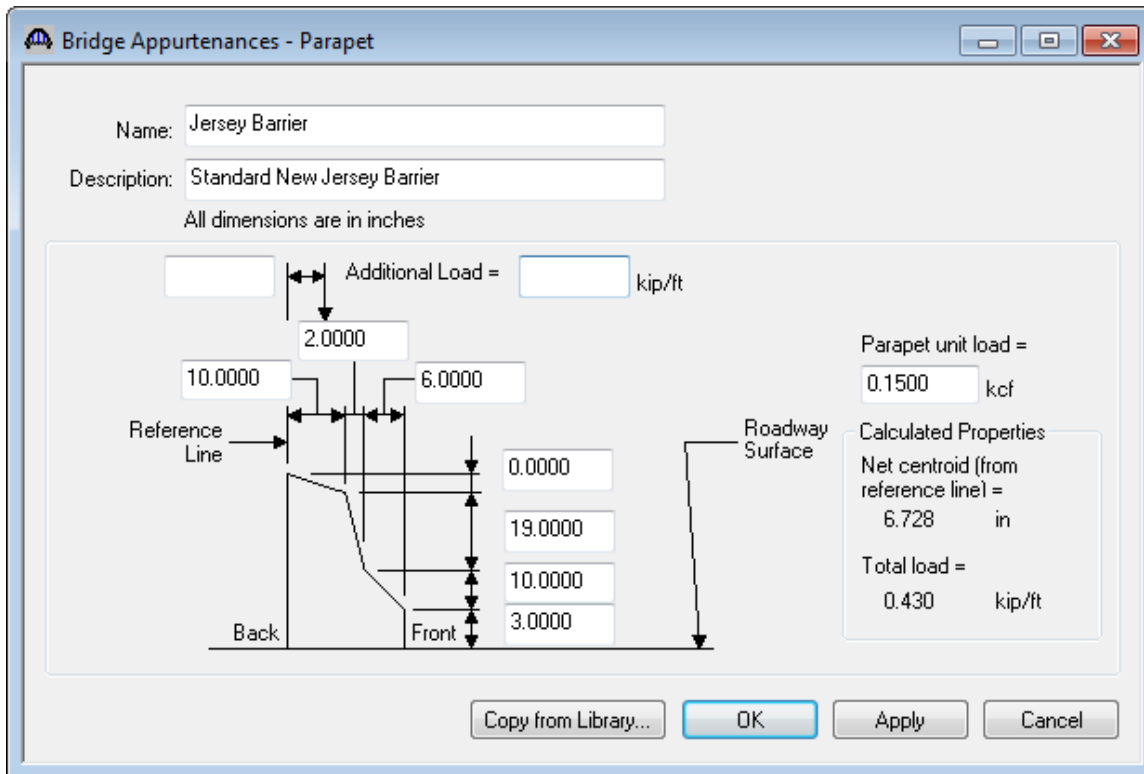
Modulus of rupture = ksi

Shear factor =

Click OK to save the data to memory and close the window. Add the following reinforcement steel details in the same manner.



Also add parapet information in similar maner under Appurtenances.

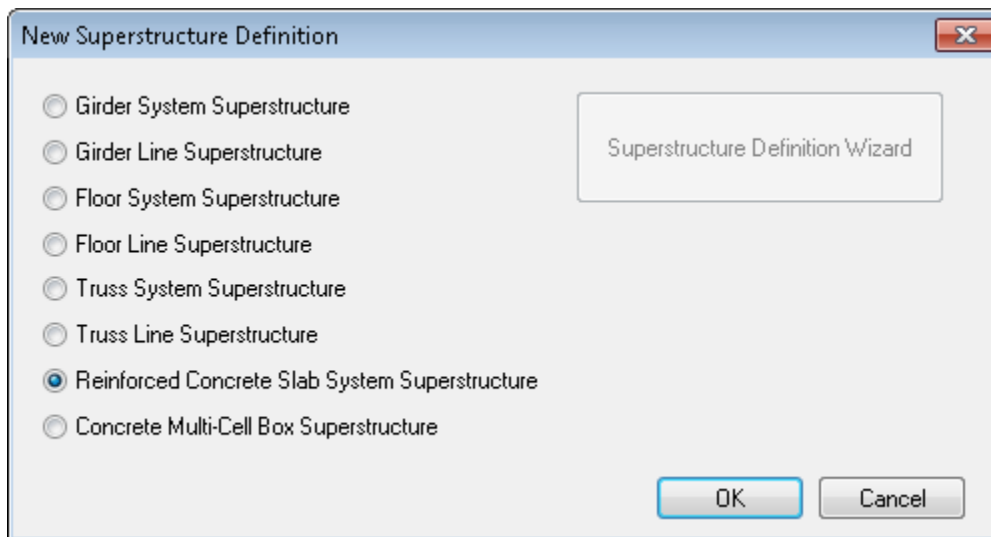


RC6 – Two Span RC Slab System

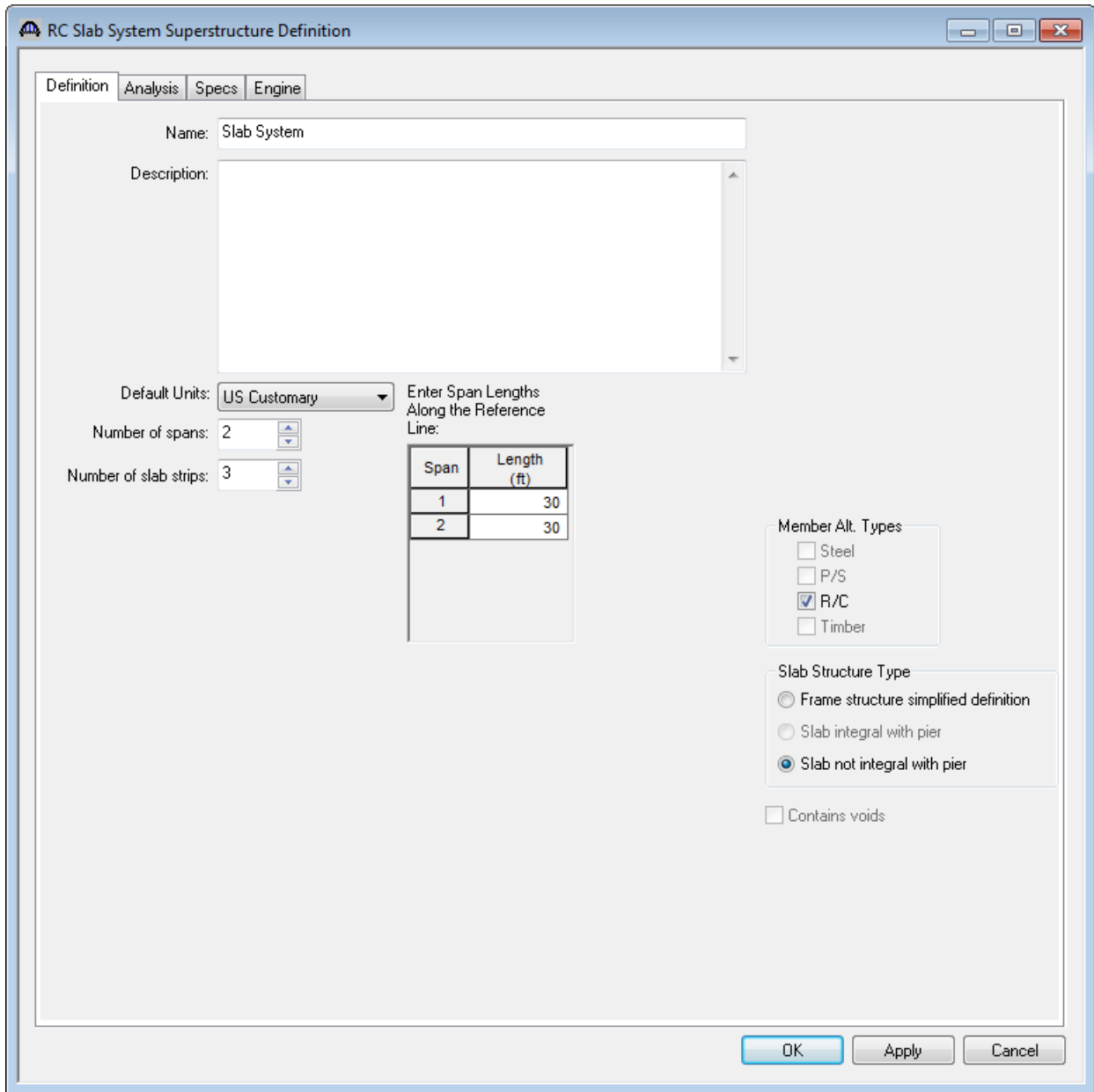
We do not need to define any beam shapes since we are using a reinforced concrete slab. The slab details will be entered later when we define the strip profile.

The default impact factors, standard LRFD and LFD factors will be used so we will skip to superstructure definition. A bridge alternative will be added after we enter the superstructure definition.

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 popup menu) to create a new Superstructure definition.



Select Reinforced Concrete Slab System Superstructure, click OK and the RC Slab System Superstructure Definition window will open.



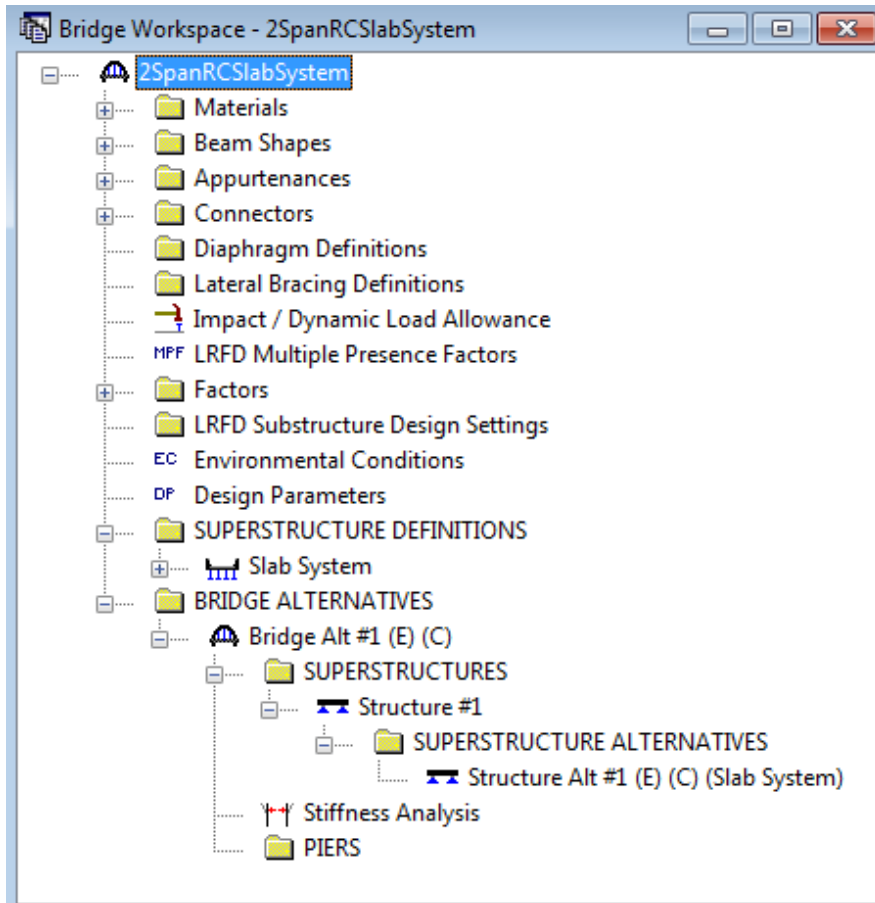
In this superstructure definition, we will select Slab Structure Type as Slab not integral with pier. Number of spans is 2 and Number of slab strips is 3. We are going to set the width of the edge strips to 7.5 ft and the width of the interior strip to 12 ft. Enter the rest of the data as shown above and click on OK to save the data to memory and close the window.

To enter a slab with voids, select Contains voids in the superstructure definition window which allows you to define void patterns and assign the patterns along the slab. For this example, we are going to define a solid slab so Contains voids should remain unchecked.

RC6 – Two Span RC Slab System

We now go back to the BRIDGE ALTERNATIVES and create a new Bridge Alternative, a new Superstructure, and a new Superstructure Alternative with the Slab System we just created as the superstructure definition.

The partially expanded Bridge Workspace tree is shown below.



RC6 – Two Span RC Slab System

Open Load Case Description window under Slab System superstructure definition to define the dead load case to be used by the parapets. 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)
Stage 1 DC DL	Parapets	Non-composite (Stage 1)	D,DC	

Below the table, there is a note: '*Prestressed members only'. There are buttons for 'Add Default Load Case Descriptions', 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

Open Structure Framing Plan Details window and enter data as shown below. Since we are going to set the width of the edge strips to 7.5 ft and the width of the interior strip to 12 ft, enter the CL Strip Spacing as 9.75 ft for both strip bays. Click on OK to save data and close window.

The screenshot shows the 'Structure Framing Plan Details' dialog box. It includes the following information:

- Number of spans = 2
- Number of strips = 3
- Layout section with a table for Support and Skew (Degrees):

Support	Skew (Degrees)
1	0
2	0
3	0
- Strip Spacing Orientation:
 - Perpendicular to strip
 - Along support
- CL Strip Spacing (ft) table:

Strip Bay	CL Strip Spacing (ft)	
	Start of Strip	End of Strip
1	9.75	9.75
2	9.75	9.75

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

RC6 – Two Span RC Slab System

Now in Structure Typical Section window under Deck tab enter data as shown below.

The screenshot shows the 'Structure Typical Section' window with the 'Deck' tab selected. At the top, a diagram illustrates the deck layout with labels: 'Distance from left edge of deck to superstructure definition ref. line', 'Distance from right edge of deck to superstructure definition ref. line', 'Superstructure Definition Reference Line', 'Half left strip width', 'CL Strip', and 'Half right strip width'. Below the diagram is a tabbed interface with 'Deck' selected. The 'Superstructure definition reference line is' dropdown is set to 'within' and 'the bridge deck.'. The input fields are as follows:

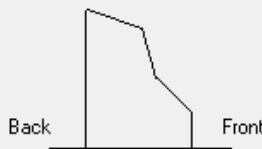
	Start	End
Distance from left edge of deck to superstructure definition reference line =	13.5 ft	13.5 ft
Distance from right edge of deck to superstructure definition reference line =	13.5 ft	13.5 ft
Half left strip width =	3.75 ft	3.75 ft
Computed half right strip width =	3.75 ft	3.75 ft

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

RC6 – Two Span RC Slab System

Also enter Parapet and Lane Position details as shown below in their respective tabs. Then click on OK to save and close the window.

Structure Typical Section



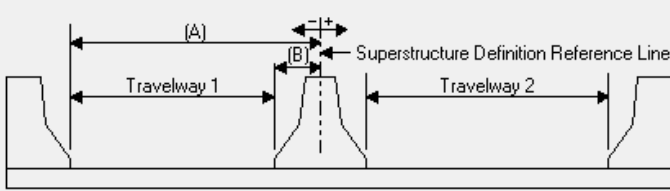
Deck | Deck (Cont'd) | Parapet | Median | Railing | Generic | Sidewalk | Lane Position | Wearing Surface

Name	Load Case	Measure To	Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation
Jersey Barrier	Stage 1 DC DL	Back	Left Edge	0	0	Right
Jersey Barrier	Stage 1 DC DL	Back	Right Edge	0	0	Left

New Duplicate Delete

OK Apply Cancel

Structure Typical Section



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


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	12	-12	12

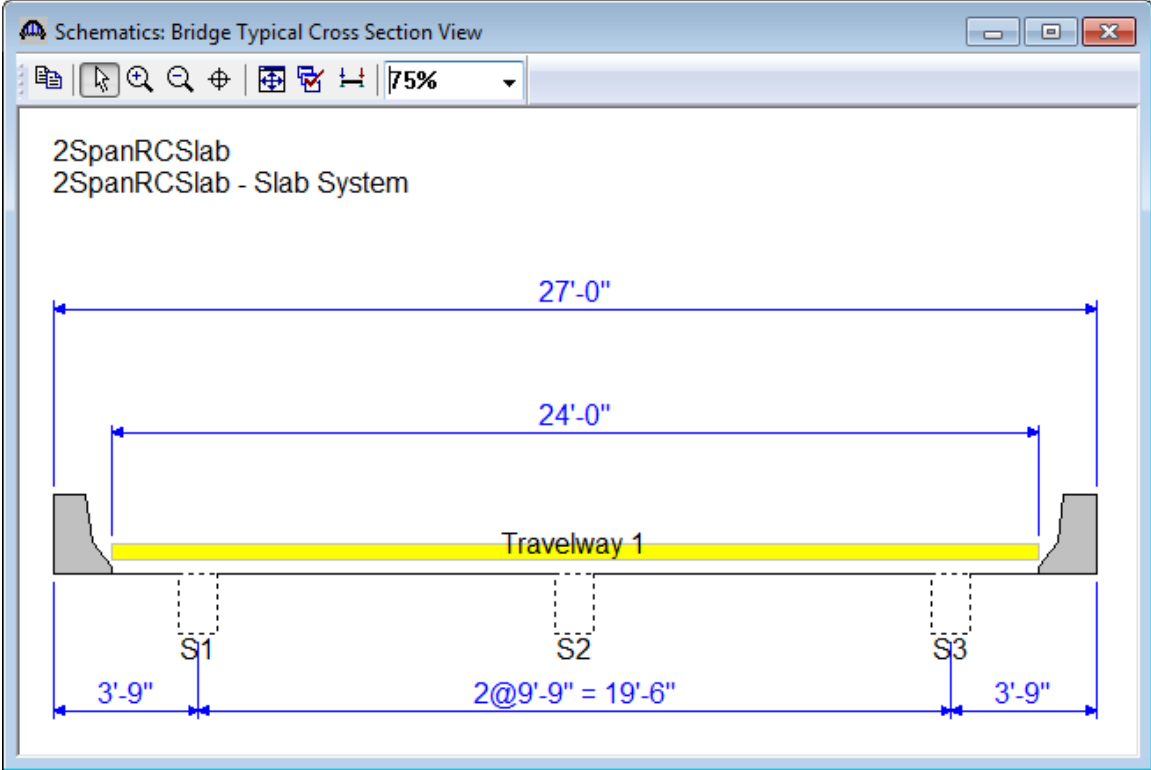
LRFD Fatigue
 Lanes available to trucks:
 Override Truck fraction: Compute...

New Duplicate Delete

OK Apply Cancel

RC6 – Two Span RC Slab System

Now select Structure Typical Section in the tree and click on  View schematics button to open Schematic: Bridge Typical Cross Section View window as shown below. Since we haven't entered the slab strip profile, the slab strips are represented by dotted line boxes in the schematic.



RC6 – Two Span RC Slab System

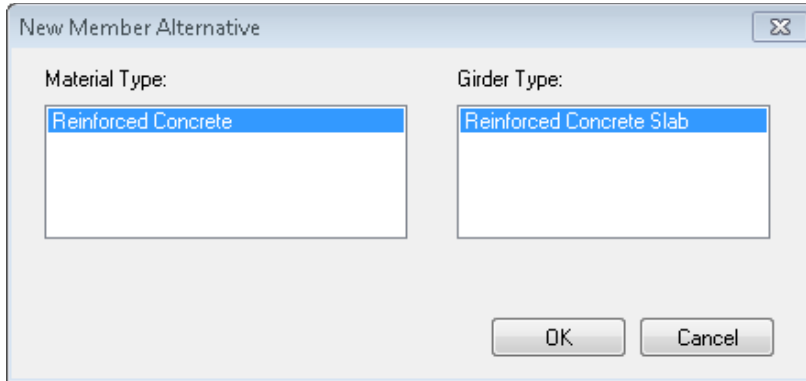
Close the Schematic window and double-click on Bar Mark Definitions in the Bridge Workspace tree to create a new Bar Mark Definition. Enter data for BarMark #1 as shown below. Then click on Ok to save data and close the window. Create another Bar Mark Definition for BarMark #2 in the same manner.

The screenshot shows the 'Bar Mark Definition' dialog box for 'BarMark #1'. The 'Name' field contains 'BarMark #1'. The 'Material' is set to 'Grade 60', 'Bar size' is '11', and 'Bar type' is 'Straight'. The 'Dimension' section shows 'A = 30 ft'. On the left, under 'Bar Types', there are four diagrams: 'Type: Straight' (a simple horizontal line), 'Type: 1' (a horizontal line with a U-shaped hook at the end), 'Type: 2' (a horizontal line with diagonal bars at both ends), and 'Type: 3' (a horizontal line with diagonal bars at both ends and U-shaped hooks at the ends). The 'OK' button is highlighted in blue.

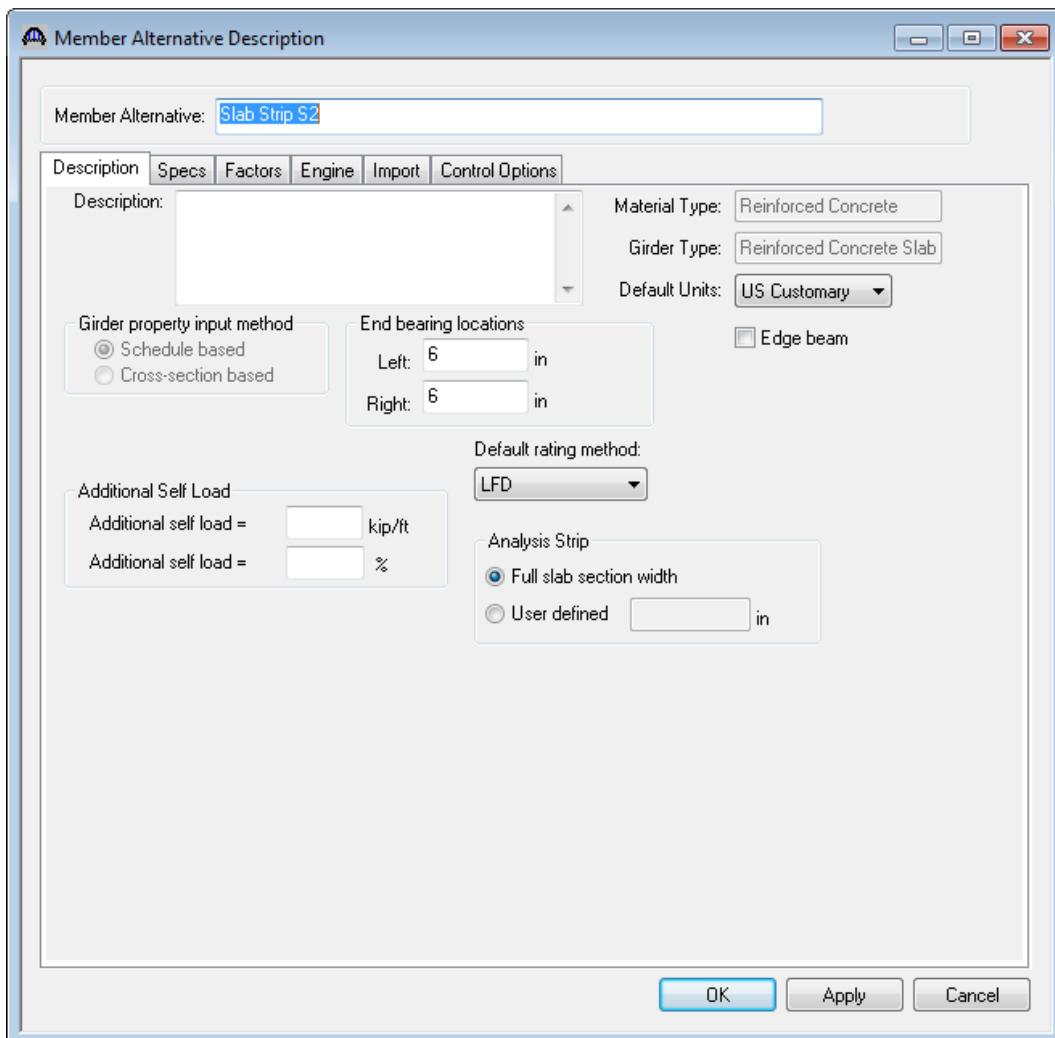
The screenshot shows the 'Bar Mark Definition' dialog box for 'BarMark #2'. The 'Name' field contains 'BarMark #2'. The 'Material' is set to 'Grade 60', 'Bar size' is '11', and 'Bar type' is 'Straight'. The 'Dimension' section shows 'A = 10.0000 ft'. On the left, under 'Bar Types', there are four diagrams: 'Type: Straight' (a simple horizontal line), 'Type: 1' (a horizontal line with a U-shaped hook at the end), 'Type: 2' (a horizontal line with diagonal bars at both ends), and 'Type: 3' (a horizontal line with diagonal bars at both ends and U-shaped hooks at the ends). The 'OK' button is highlighted in blue.

Defining a Member Alternative:

Double-click MEMBER ALTERNATIVES in the tree under the interior strip S2 to create a new alternative. The New Member Alternative dialog shown below will open. Select Reinforced Concrete for the Material Type and Reinforced Concrete Slab for the Girder Type.



Click Ok to close the dialog and create a new member alternative.



RC6 – Two Span RC Slab System

The first Member Alternative that we create will automatically be assigned as the Existing and Current Member Alternative for this Member. In the Member Alternative Description window enter the data as shown above.

The Analysis Strip selection allows you to specify the width of the strip for the analysis. If User defined is selected, an average reinforcement area per user defined width will be computed based on the reinforcement defined for the full slab section width. For this example, we select Full slab section width.

The Edge beam selection indicates the member alternative is an edge beam in the LRFD live load distribution factors computation. Since we are entering the interior strip, leave Edge beam as unchecked.

Click OK to save the data and close the window.

Live Load Distribution factors can be computed only after Strip Profile information is entered. To enter Strip Profile information, double-click on Strip Profile in the tree to open Strip Profile window.

Enter strip section and depth details as shown below.

Strip Profile

Type: Reinforced Concrete Slab

Section | Depth | Reinforcement

Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Start Width (in)	End Width (in)	Concrete Material	Modular Ratio
1	0.00	60.00	60.00	144.0	144.0	Class	

New Duplicate Delete

OK Apply Cancel

RC6 – Two Span RC Slab System

Type: Reinforced Concrete Slab

Section | **Depth** | Reinforcement

Begin Depth (in)	Depth Vary	End Depth (in)	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)
18	None	18	1	0	20	20
18	Parabolic	36	1	20	9	29
36	None	36	1	29	2	31
36	Parabolic	18	2	1	9	10
18	None	18	2	10	20	30

New Duplicate Delete

OK Apply Cancel

Now switch to Reinforcement tab and enter reinforcement information as shown below.

Type: Reinforced Concrete Slab

Section | Depth | **Reinforcement**

Vary bar spacing


Set	Bar Mark	Invert	Measured From	Clear Cover (in)	Number	Start Bar Spacing (in)	End Bar Spacing (in)	Start Side Cover (in)	End Side Cover (in)	Support Number	Direction	Start Distance (ft)	Straight Length (ft)	End Distance (ft)	Start Fully Developed	End Fully Developed
1	BarMark #1	<input type="checkbox"/>	Top of Slab	1.5000	13.00	12.0000	12.0000	2.000	2.000	1	Left	0.000	30.000	30.000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
2	BarMark #1	<input type="checkbox"/>	Top of Slab	1.5000	13.00	12.0000	12.0000	2.000	2.000	2	Left	0.000	30.000	30.000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
3	BarMark #1	<input type="checkbox"/>	Bottom of Slab	2.0000	24.00	6.0000	6.0000	2.000	2.000	1	Left	0.000	30.000	30.000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
4	BarMark #1	<input type="checkbox"/>	Bottom of Slab	2.0000	24.00	6.0000	6.0000	2.000	2.000	2	Left	0.000	30.000	30.000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
5	BarMark #2	<input type="checkbox"/>	Top of Slab	1.5000	13.00	12.0000	12.0000	2.000	2.000	1	Right	20.000	10.000	30.000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
6	BarMark #2	<input type="checkbox"/>	Top of Slab	1.5000	13.00	12.0000	12.0000	2.000	2.000	2	Left	0.000	10.000	10.000	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

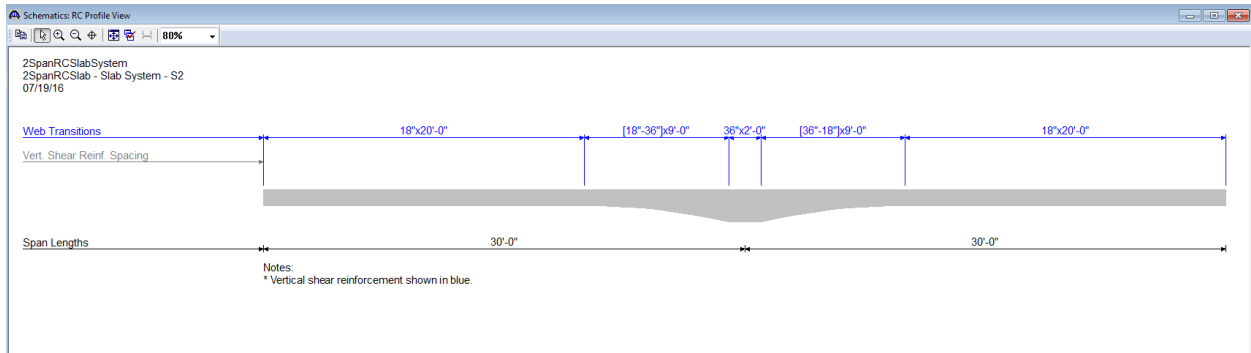
New Duplicate Delete

OK Apply Cancel

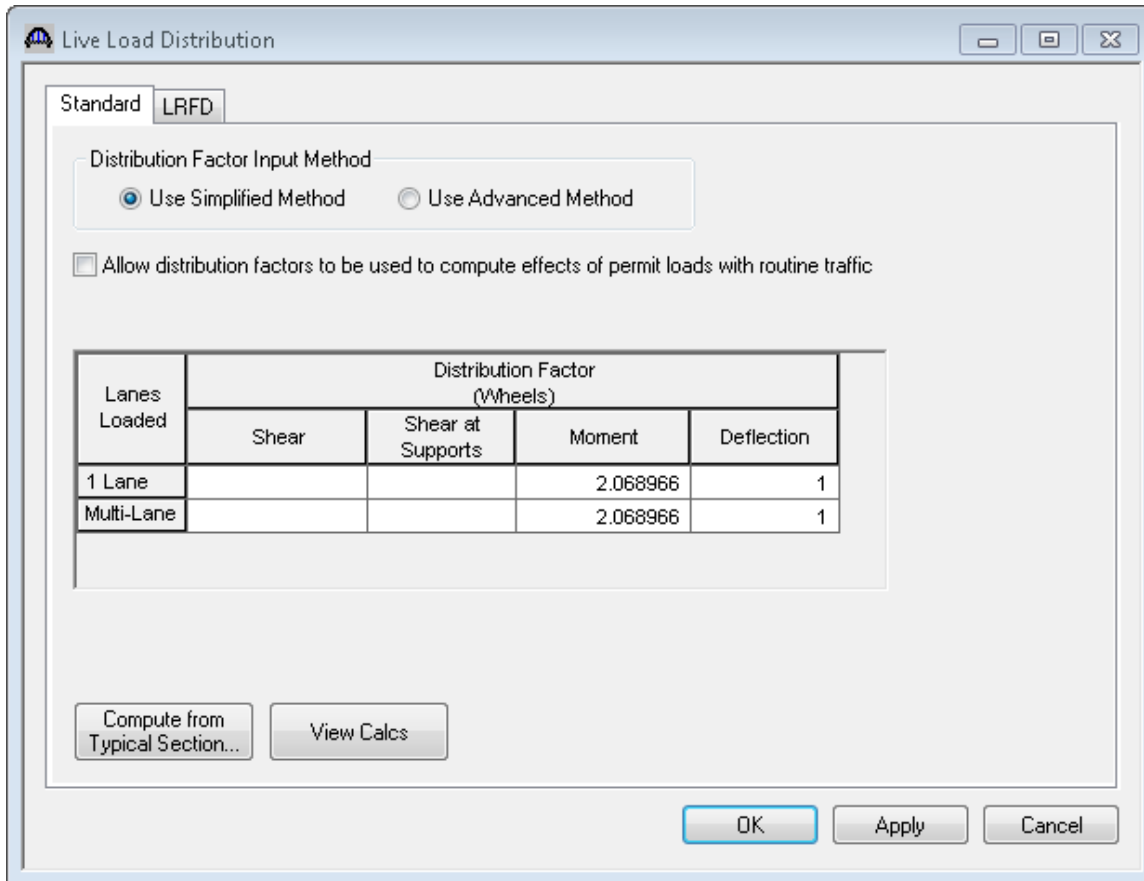
After strip profile is defined, click on Ok to save data and close the window.

RC6 – Two Span RC Slab System

The profile of the slab strip can be viewed by selecting the member alternative and click on the  View schematic button on the toolbar. Schematic for Slab Strip S2 member alternative is as shown below.



We can now enter the live load distribution factors for this member. Open Live Load Distribution window. Under Standard tab, click on Compute from Typical Section button. Live load distribution factors will be populated as shown below. If live load distribution factors are not entered, the AASHTO Engine will compute the distribution factors during the analysis.



The Live Load Distribution window is shown with the LFRD tab selected. The Distribution Factor Input Method is set to Use Simplified Method. The checkbox for "Allow distribution factors to be used to compute effects of permit loads with routine traffic" is unchecked. The table below shows the distribution factors for 1 Lane and Multi-Lane loading.

Lanes Loaded	Distribution Factor (Wheels)			
	Shear	Shear at Supports	Moment	Deflection
1 Lane			2.068966	1
Multi-Lane			2.068966	1

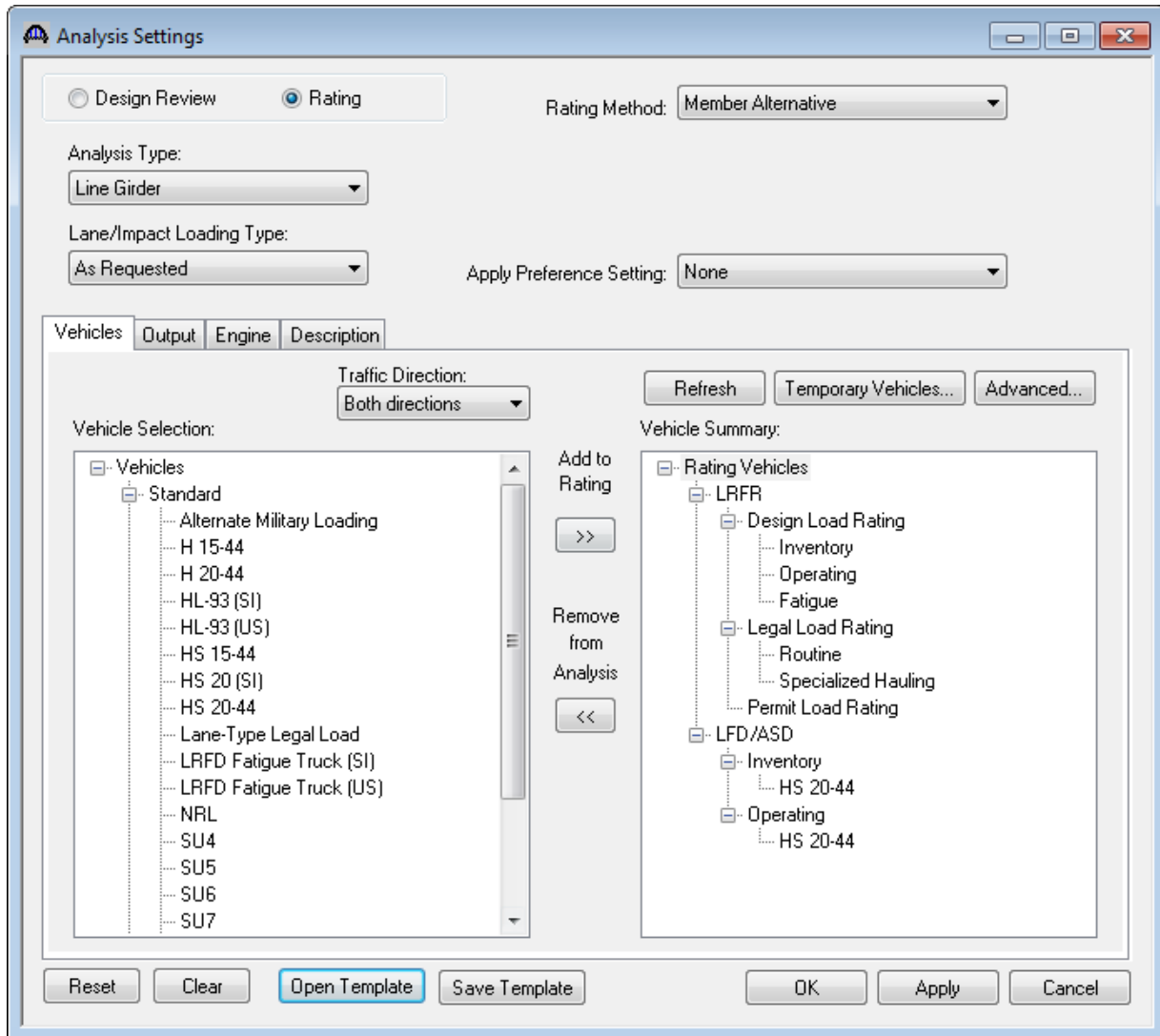
Buttons: Compute from Typical Section..., View Calcs, OK, Apply, Cancel

Click on Ok to save data and close the window.

RC6 – Two Span RC Slab System

We do not need to define any Points of Interest since we will not be overriding any information we have entered. The description of this member alternative is complete.

The member alternative Slab Strip S2 can now be analyzed. To perform LFR analysis, select the View Analysis Settings button on the toolbar to open the window shown below. Click Open Template button and select the HS 20 Rating template to be used in the rating. Click on Ok to save the settings and close the window.



RC6 – Two Span RC Slab System

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 analysis results window shown below will open.

Analysis Results - Slab Strip S2

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	171.66	4.768	12.00	1 - (40.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Lane	LFD	Operatin	286.67	7.963	12.00	1 - (40.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFD	Inventory	123.47	3.430	9.00	1 - (30.0)	Design Flexure - Concrete	As Requested	As Requested
HS 20-44	Axle Load	LFD	Operatin	206.19	5.728	9.00	1 - (30.0)	Design Flexure - Concrete	As Requested	As Requested

Legacy AASHTO LFR Engine Version 6.8.3.3001
Analysis Preference Setting: None

Close

To perform LRFR analysis, select the View Analysis Settings button on the toolbar to open the window shown below. Click Open Template button and select the LRFR Design Load Rating template to be used in the rating. Click on Ok to save the settings and close the window.

Analysis Settings

Design Review Rating | Rating Method: LRFR

Analysis Type: Line Girder

Lane/Impact Loading Type: As Requested | Apply Preference Setting: None

Traffic Direction: Both directions

Buttons: Refresh, Temporary Vehicles..., Advanced...

Vehicle Selection:

- Vehicles
 - Standard
 - H 15-44
 - H 20-44
 - HL-93 (SI)
 - HL-93 (US)
 - HS 15-44
 - HS 20 (SI)
 - HS 20-44
 - Lane-Type Legal Load
 - LRFD Fatigue Truck (SI)
 - LRFD Fatigue Truck (US)
 - NRL
 - SU4
 - SU5
 - SU6
 - SU7
 - Type 3
 - Tune 3:3

Add to Operating: >>

Remove from Analysis: <<

Vehicle Summary:

- Rating Vehicles
 - LRFR
 - Design Load Rating
 - Inventory
 - HL-93 (US)
 - Operating
 - HL-93 (US)
 - Fatigue
 - Legal Load Rating
 - Routine
 - Specialized Hauling
 - Permit Load Rating

Buttons: Reset, Clear, Open Template, Save Template, OK, Apply, Cancel

RC6 – Two Span RC Slab System

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 analysis results window shown below will open.

Analysis Results - Slab Strip S2

Report Type: Rating Results Summary | Lane/Impact Loading Type: As Requested | 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
HL-93 (US)	Truck + Lane	LRFR	Inventory	113.92	3.165	20.00	1 - (66.7)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operatin	147.68	4.102	20.00	1 - (66.7)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + La	LRFR	Inventory	102.12	2.837	12.00	1 - (40.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	Tandem + La	LRFR	Operatin	132.37	3.677	12.00	1 - (40.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	90%(Truck P	LRFR	Inventory	129.50	3.597	20.00	1 - (66.7)	STRENGTH-I Concrete Flexure	As Requested	As Requested
HL-93 (US)	90%(Truck P	LRFR	Operatin	167.86	4.663	20.00	1 - (66.7)	STRENGTH-I Concrete Flexure	As Requested	As Requested

Legacy AASHTO LRFR Engine Version 6.8.3.3001
Analysis Preference Setting: None

To perform LRFD design review, open the Analysis Settings window and select the HL 93 Design Review template as shown below.

Analysis Settings

Design Review Rating | Design Method: LRFD

Analysis Type: Line Girder | Lane/Impact Loading Type: As Requested | Apply Preference Setting: None

Traffic Direction: Both directions

Vehicle Selection:


- Vehicles
 - Standard
 - Alternate Military Loading
 - HL-93 (SI)
 - HL-93 (US)
 - HS 20 (SI)
 - HS 20-44
 - LRFD Fatigue Truck (SI)
 - LRFD Fatigue Truck (US)
 - Agency
 - User Defined
 - Temporary

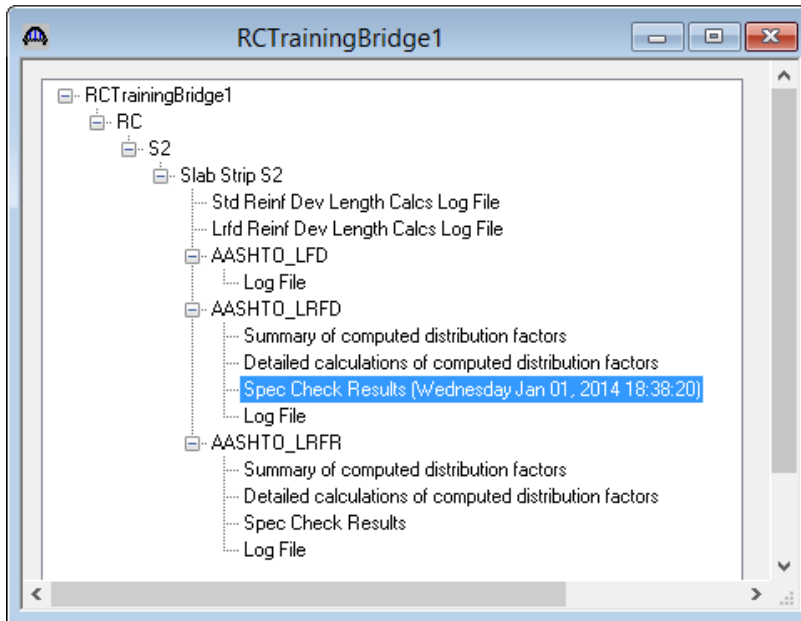
Vehicle Summary:

- Design Vehicles
 - Design Loads
 - HL-93 (US)
 - Permit Loads
 - Fatigue Loads
 - LRFD Fatigue Truck (US)

Buttons: Refresh, Temporary Vehicles..., Advanced..., Add to Design, Remove from Analysis, Reset, Clear, Open Template, Save Template, OK, Apply, Cancel

RC6 – Two Span RC Slab System

Next click the Analyze button on the toolbar to perform the design review. Click on  View Analysis Output button on toolbar and double-click Spec Check Results for a summary of the specification check results.



Bridge ID : -1002
 Bridge : 2SpanRCSlab
 Superstructure Def : Slab System
 Member : S2
 Analysis Preference Setting : None

NBI Structure ID : 2SpanRCSlabSys5
 Bridge Alt :
 Member Alt : Slab Strip S2

AASHTO LRFD Specification, Edition 8, Interim 0

Specification Check Summary

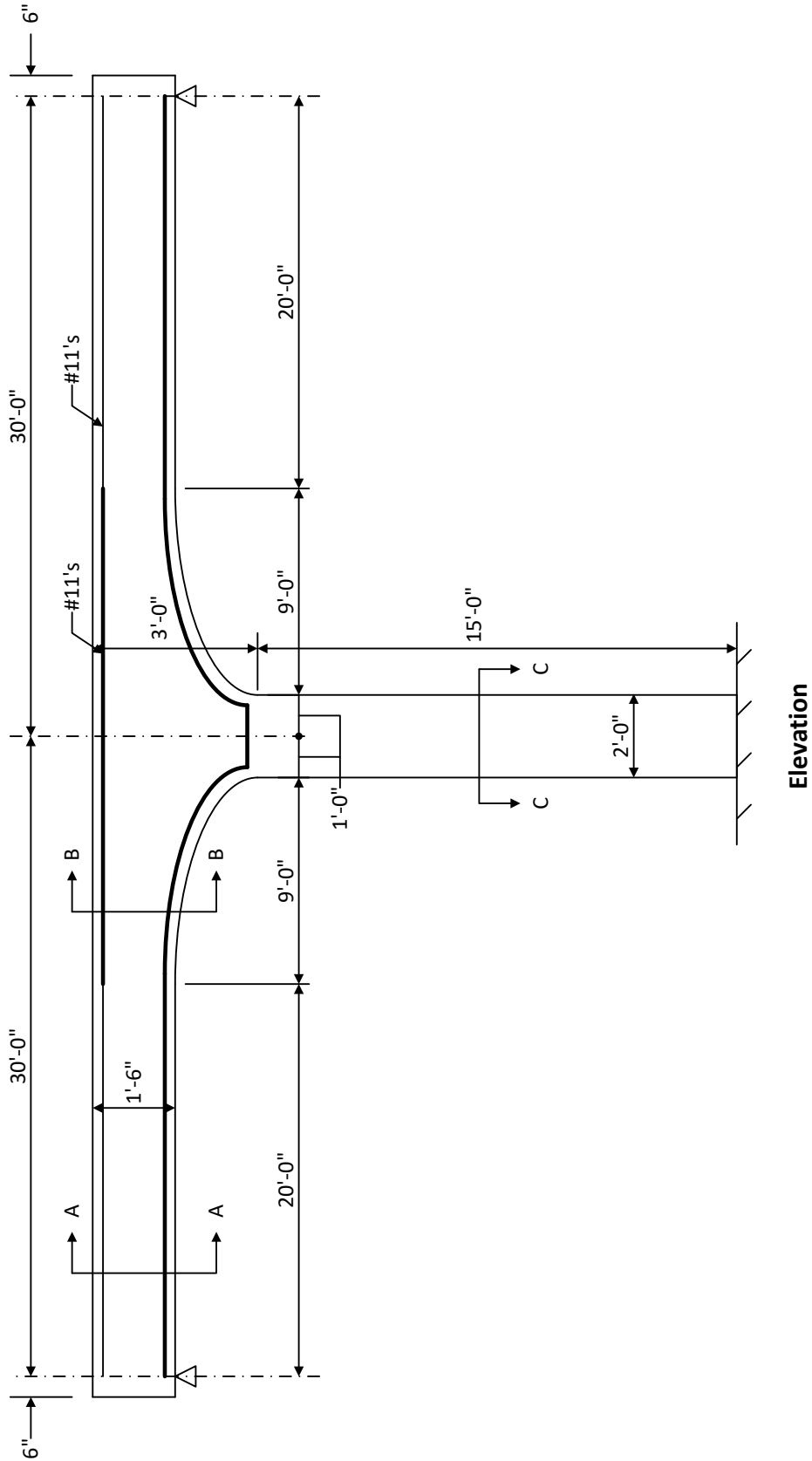
Article	Status
Flexure (5.6.3.2, 5.6.3.3)	Pass
Crack Control (5.6.7)	Fail
Shear (5.7.3.3, 5.7.2.5, 5.7.2.6, 5.7.3.5)	Ignore by User
Fatigue (5.5.3.2)	Pass
Deflection (2.5.2.6.2)	Pass

Girder Positive Flexure Analysis

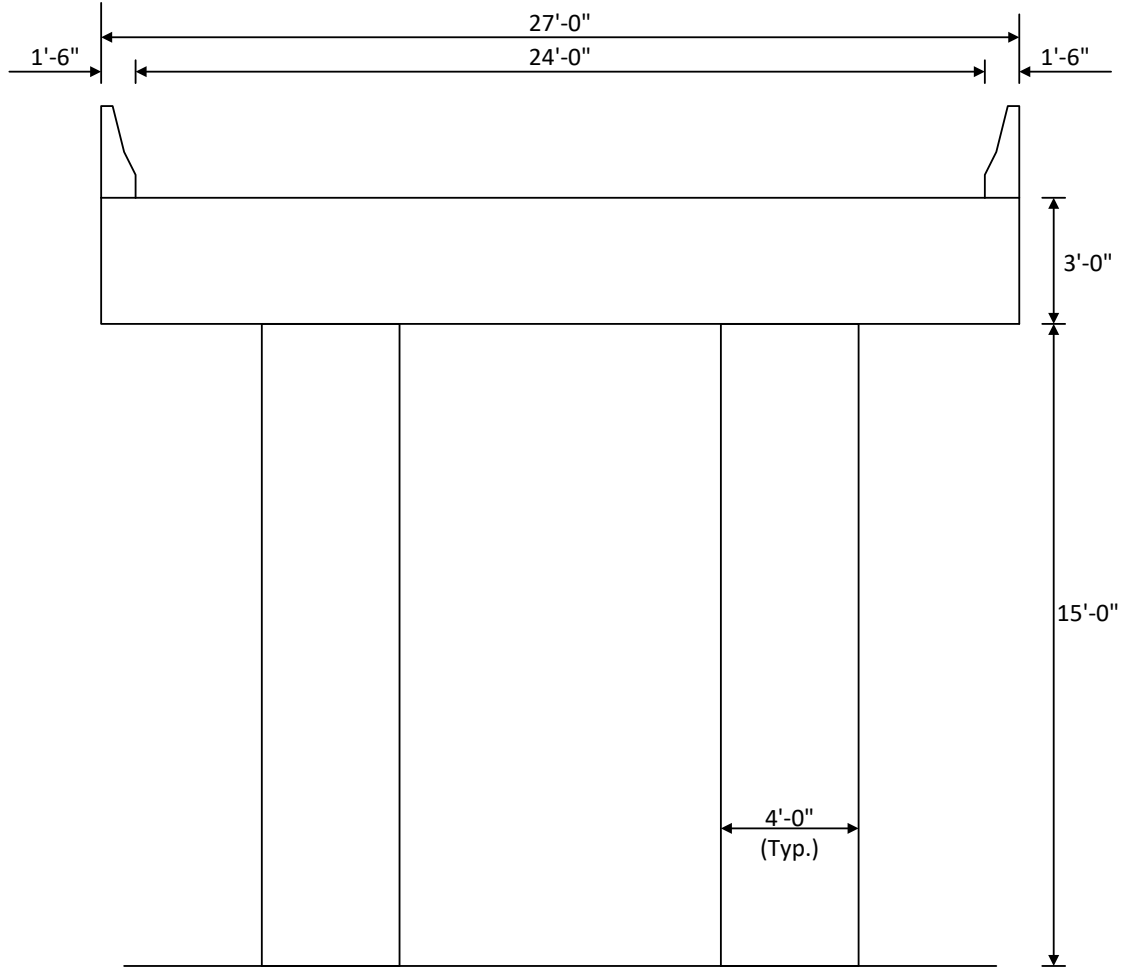
Location (ft)	LS	Load Comb	Mr (kip-ft)	Mu (kip-ft)	Mr/Mu	Code
0.000	STR-I	1	2275.92	0.00	99.00	Pass
3.000	STR-I	2	2275.92	437.40	5.20	Pass
6.000	STR-I	2	2275.92	727.47	3.13	Pass
9.000	STR-I	2	2275.92	878.22	2.59	Pass
12.000	STR-I	2	2275.92	901.62	2.52	Pass

Part 2: Frame structure simplified definition slab structure type.

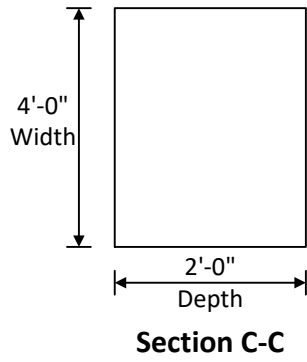
RC6 – Two Span RC Slab System



RC6 – Two Span RC Slab System



Structure Typical Section at Pier



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Slab system with frame leg support can be defined by selecting Slab Structure Type as Frame structure simplified definition in the superstructure definition window.

Double-click on SUPERSTRUCTURE DEFINITIONS and create a new Reinforced Concrete Slab System Superstructure similar to the one we just completed. Select Frame structure simplified definition and specify Frame Connection for support 2. Click Ok to save and close the window.

RC Slab System Superstructure Definition

Definition Analysis Specs Engine

Name: Frame Slab System

Description:

Default Units: US Customary

Number of spans: 2

Number of slab strips: 3

Enter Span Lengths Along the Reference Line:

Span	Length (ft)
1	30
2	30

Frame Connections:

Support	Frame Connection
1	<input type="checkbox"/>
2	<input checked="" type="checkbox"/>
3	<input type="checkbox"/>

Member Alt. Types

Steel

P/S

R/C

Timber

Slab Structure Type

Frame structure simplified definition

Slab integral with pier

Slab not integral with pier

Contains voids

OK Apply Cancel

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Follow the instructions in Part 1 to enter the following data for this superstructure definition.

1. Load Case Description
2. Structure Framing Plan
3. Structure Typical Section
4. BarMark #1 and BarMark #2
5. Member Alternative Description
6. Strip Profile

Now we begin the windows with specific information for the Frame structure simplified definition.

Open Structure Framing Plan Detail window, switch to Frame Connections tab and enter data as show below.

The screenshot shows the 'Structure Framing Plan Details' dialog box with the 'Frame Connections' tab selected. At the top, there are two input fields: 'Number of spans = 2' and 'Number of strips = 3'. Below these are two tabs: 'Layout' and 'Frame Connections'. The 'Frame Connections' tab contains a table with the following data:

Support Line	Bent Cap Width (in)	Number of Columns	Material	Column Length (ft)	Percent Fixity at Base (%)	Column Type	Constant/Tapered	Top Depth (in)	Bottom Depth (in)	Top Width (in)	Bottom Width (in)	Column Stiffness (kip-in/rad)
2	48	2	Class ▾	15	100	Rectangula ▾	Consta ▾	24	24	48	48	

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

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Select the Compute button to open the Compute Column Stiffness dialog. Click on the Compute button to compute the column stiffness coefficient.

Compute Column Stiffness

Support Line: 2 Number of strips: 3

Column

Bent Cap Width: 48 in Column Length: 15 ft

Number of Columns: 2 Percent Fixity at Base: 100 %

Column Cross Section

Cross Section Type

Rectangular Circular

Material: Class A (US)

Cross Section Dimensions

Constant Tapered

Top Depth: 24 in Top Width: 48 in

Bottom Depth: 24 in Bottom Width: 48 in

Computed Column Stiffness

Properties at Top of Column

Area: 1152 in² Modulus of Elasticity: 3644.149254 ksi

Moment of Inertia: 55296 in⁴ Computed Column Stiffness: 8955861.205995 kip-in/rad

Properties at Bottom of Column

Area: 1152 in²

Moment of Inertia: 55296 in⁴

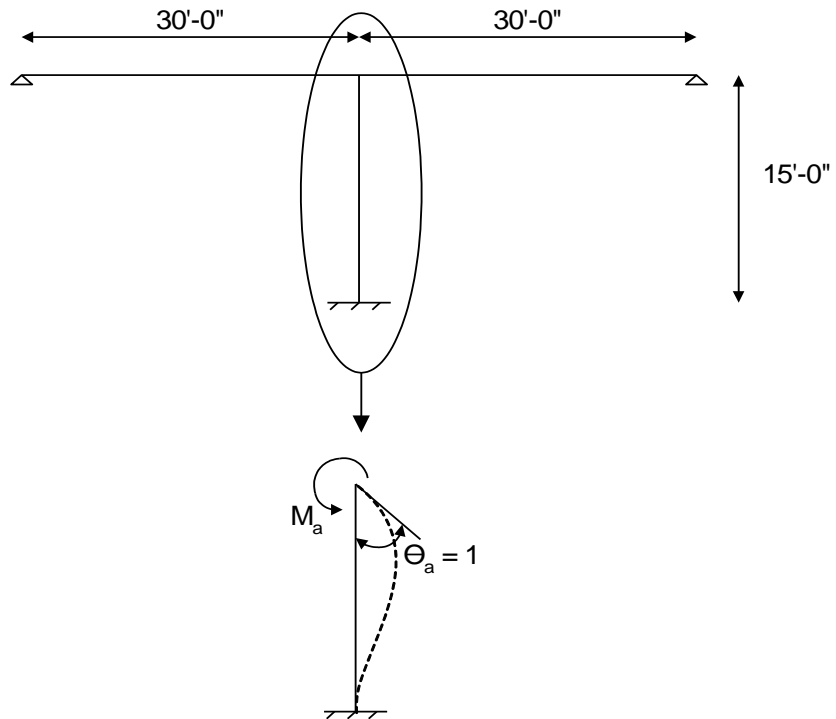
Compute

Apply Cancel

The column stiffness coefficient is computed using the Stiffness Method. In the stiffness method, a unit rotation in the Z direction is applied to the top of the column with all other displacements equal to zero. The member end loads that are required to produce this unit rotation are the stiffness coefficients. The moment applied at the top of the column to produce this unit rotation is the stiffness coefficient computed in this window.

The following diagram shows the frame leg and the moment applied to produce the unit rotation. You will need to use engineering judgment to determine the length of the frame leg based on the geometry and reinforcement of the frame structures you wish to analyze.

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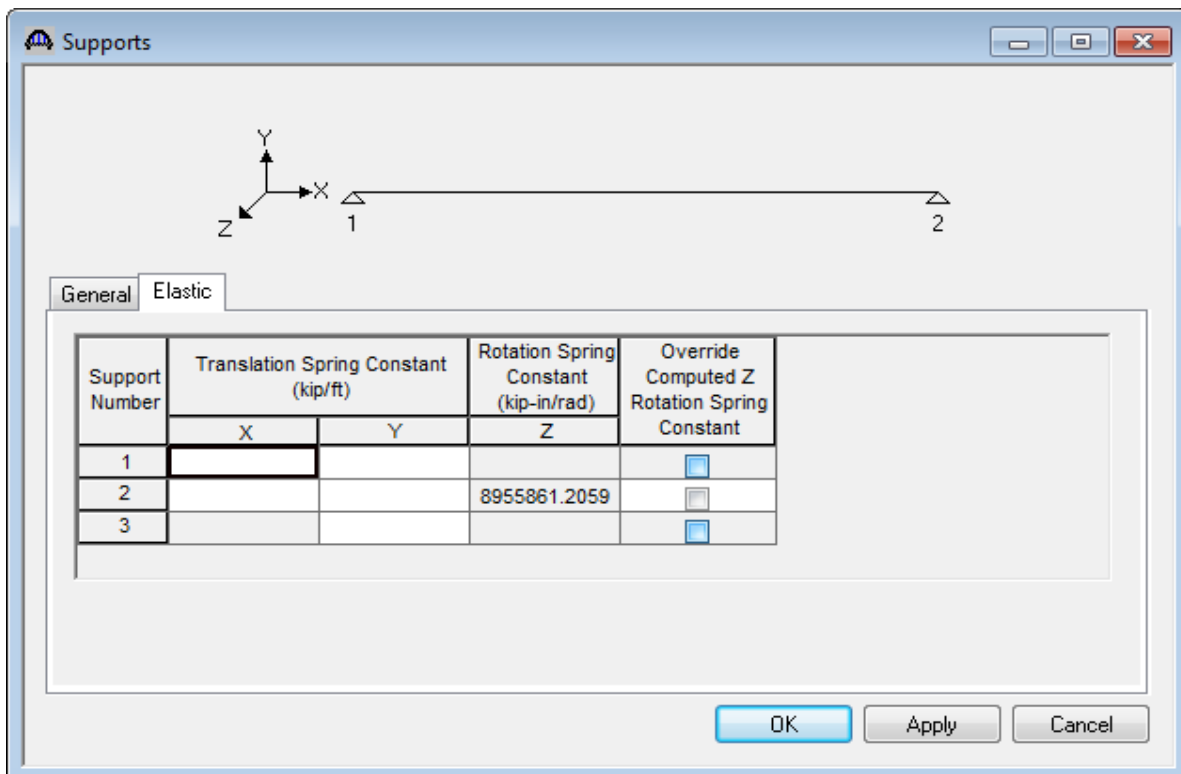
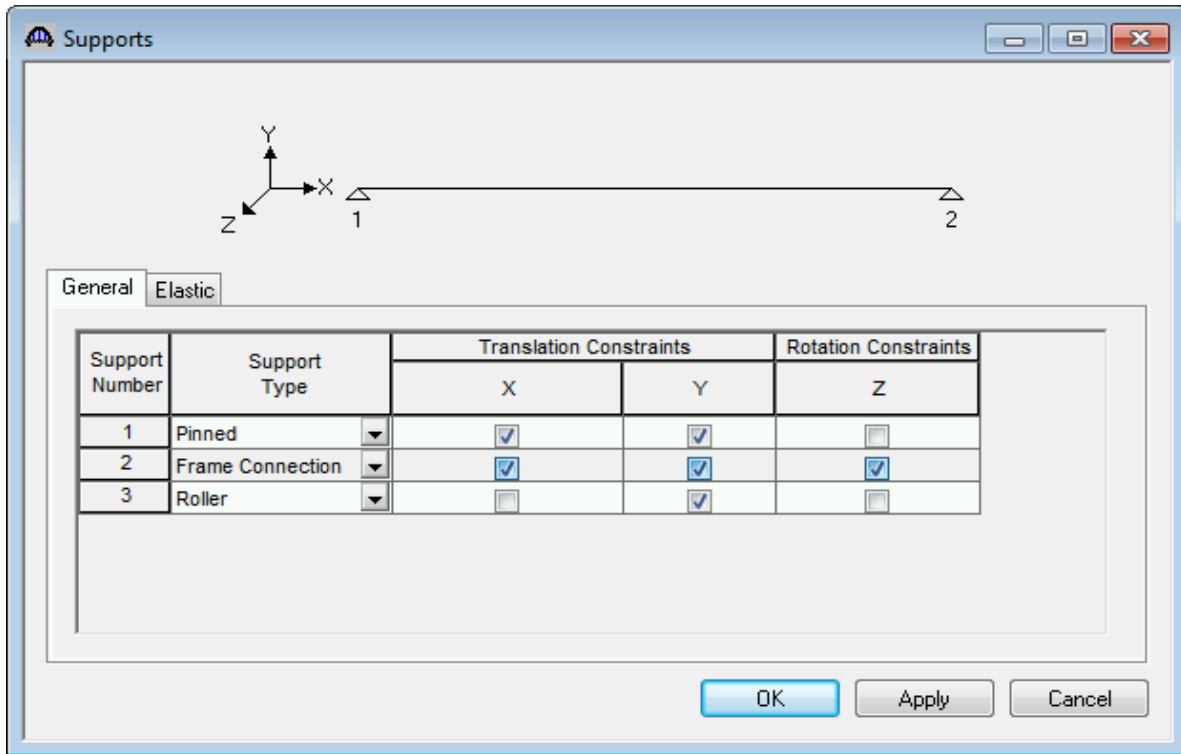
The moment required to produce a unit rotation at the top of the cantilever column is $M_a = 4EI/L$.

The computed column stiffness coefficient is based on the entered number of columns. Click on Apply button to apply this stiffness coefficient to Support 2.

Click Ok to save and close the Structure Framing Plan Detail window.

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Open Supports window, Support 2 is a frame connection with all constraints fixed. The computed column stiffness coefficient is entered in the Elastic tab as the Z rotation spring constant.



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In similar manner as performed above, LFR, LRFR and LRFD analysis can be performed by selecting their respective templates. As this slab bridge is not designed with framed connection at pier, we are not going to perform rating and design analysis in this example.