

*AASHTOWare BrD/BrR 6.8.2*

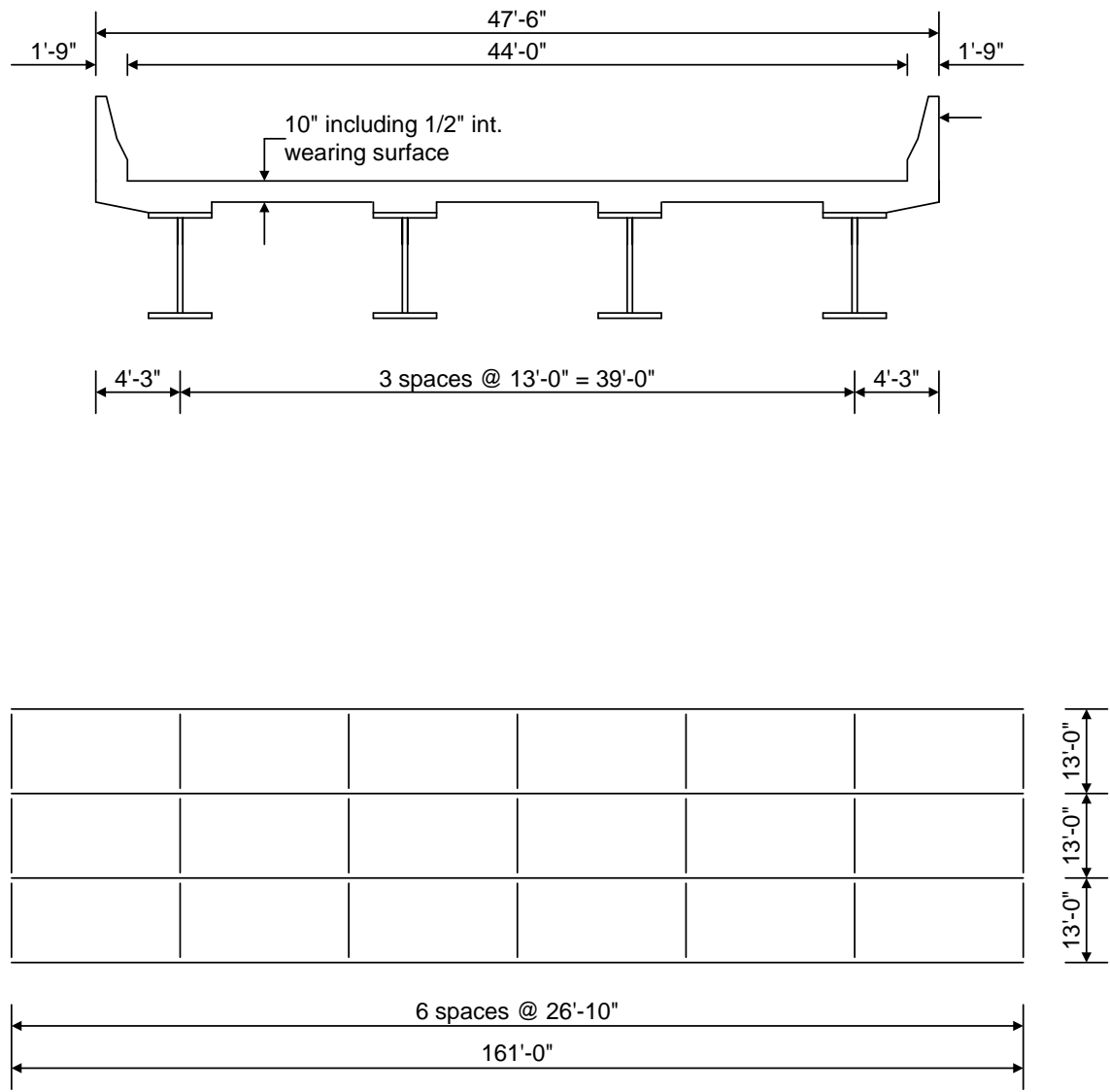
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***Steel Tutorial***

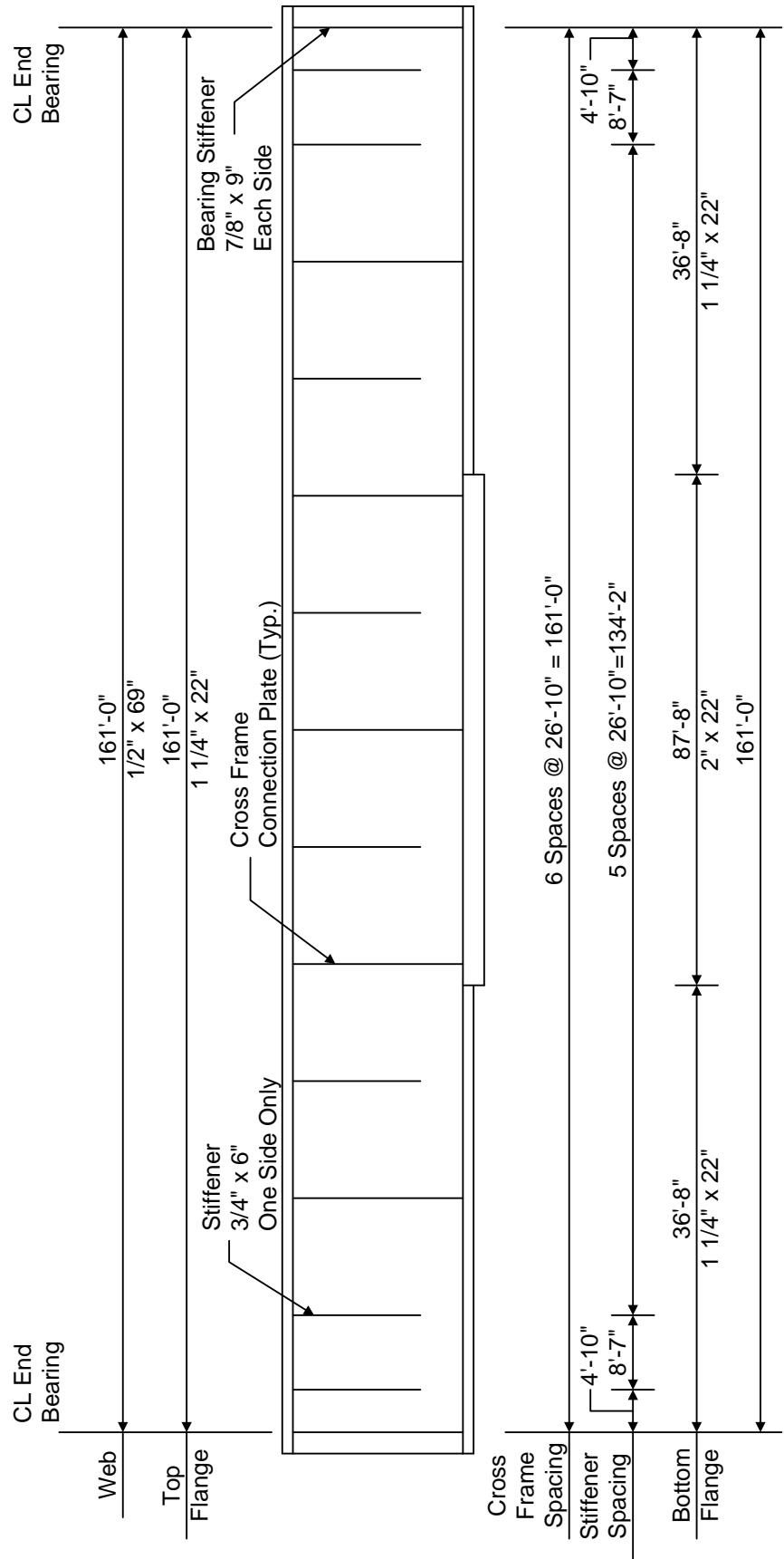
*STL1 – Simple Span Plate Girder Example*



STL1 - Simple Span Plate Girder Example



Framing Plan



Elevation of Interior Girder

**Material Properties**

Structural Steel: AASHTO M270, Grade 50W uncoated weathering steel with  $F_y = 50$  ksi

Deck Concrete:  $f'_c = 4.5$  ksi, modular ratio  $n = 8$

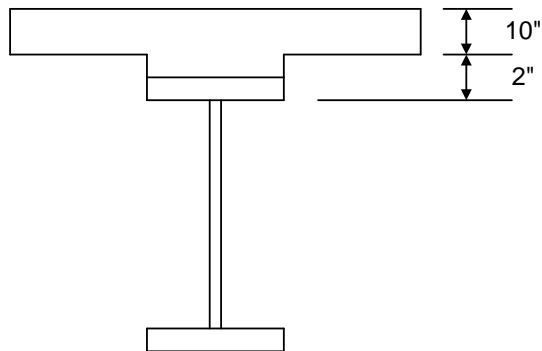
Slab Reinforcing Steel: AASHTO M31, Grade 60 with  $F_y = 60$  ksi

Transverse Stiffener Plates:  $3/4"$  x  $6"$

Cross Frame Connection Plates:  $3/4"$  x  $6"$

Bearing Stiffener Plates:  $7/8"$  x  $9"$

**Haunch Detail**



## STL1-SimpleSpanPlateGirderExample

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

This screenshot shows the 'Description' tab of a bridge creation window. The 'Bridge ID' and 'NBI Structure ID (8)' are both set to 'Example 4a'. Checkboxes for 'Template' and 'Bridge Completely Defined' are unchecked, while 'Superstructures' and 'Culverts' are checked. The 'Description' field is empty. The 'Location' is 'Sample', 'Length' is '161.00 ft', 'Facility Carried (7)' is 'Sample', 'Route Number' is '76', 'Feat. Intersected (6)' is 'Sample', and 'Mi. Post' is '2.00'. 'Default Units' are set to 'US Customary'. At the bottom, 'AASHTOWare Association...' is selected, and 'BrR' and 'BrD' are checked. 'OK', 'Apply', and 'Cancel' buttons are at the bottom right.

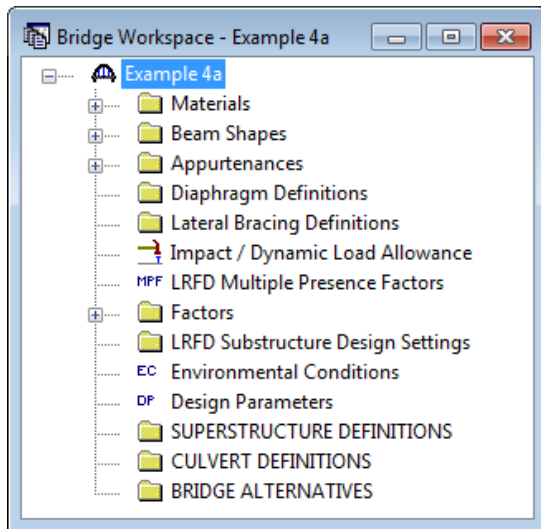
Bridge ID:	Example 4a	NBI Structure ID (8):	Example 4a	<input type="checkbox"/> Template	<input checked="" type="checkbox"/> Superstructures
				<input type="checkbox"/> Bridge Completely Defined	<input checked="" type="checkbox"/> Culverts
Description					
Name:	Example 4a		Year Built:		
Description:					
Location:	Sample	Length:	161.00	ft	
Facility Carried (7):	Sample	Route Number:	76		
Feat. Intersected (6):	Sample	Mi. Post:	2.00		
Default Units:	US Customary				
AASHTOWare Association... <input checked="" type="checkbox"/> BrR <input checked="" type="checkbox"/> BrD <input type="checkbox"/> BrM					
OK Apply Cancel					

This screenshot shows the 'Description (cont'd)' tab of the same bridge creation window. The 'District (2)' is 'Unknown', 'County' is 'Unknown (P)', 'Owner (22)' is 'State Highway Agency', 'Maintainer' is 'State Highway Agency', 'Admin. Area' is 'Unknown', 'NHS Indicator' is '0 Not on NHS', and 'Functional Class' is '17 Urban Collector'. The bottom section remains the same as the previous screenshot.


Bridge ID:	Example 4a	NBI Structure ID (8):	Example 4a	<input type="checkbox"/> Template	<input checked="" type="checkbox"/> Superstructures
				<input type="checkbox"/> Bridge Completely Defined	<input checked="" type="checkbox"/> Culverts
Description (cont'd)					
District (2):	Unknown				
County:	Unknown (P)				
Owner (22):	State Highway Agency				
Maintainer:	State Highway Agency				
Admin. Area:	Unknown				
NHS Indicator:	0 Not on NHS				
Functional Class:	17 Urban Collector				
AASHTOWare Association... <input checked="" type="checkbox"/> BrR <input checked="" type="checkbox"/> BrD <input type="checkbox"/> BrM					
OK Apply Cancel					

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

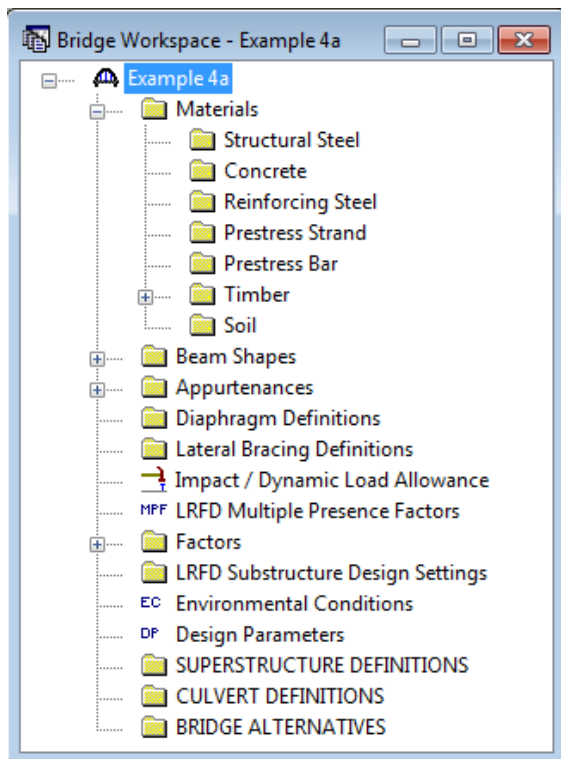
The Bridge Workspace tree after the bridge is created is shown below:



The tree is organized according to the definition of a bridge with data shared by many of the bridge components shown in the upper part of the tree. A bridge can be described by working from top to bottom within the tree.

To enter the materials to be used by members of the bridge, click on the  to expand the tree for Materials.

The tree with the expanded Materials branch is shown below:



To add a new structural steel material, click on Structural Steel in the tree and select File/New from the menu (or right mouse click on Structural Steel and select New). The window shown below will open.

Bridge Materials - Structural Steel

Name:  Description:

Material Properties

Specified minimum yield strength (Fy) =  ksi

Specified minimum tensile strength (Fu) =  ksi

Coefficient of thermal expansion =  1/F

Density =  kcf

Modulus of elasticity (E) =  ksi

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

Add structural steel materials by selecting from the Structural Steel Materials Library by clicking the Copy from Library button.

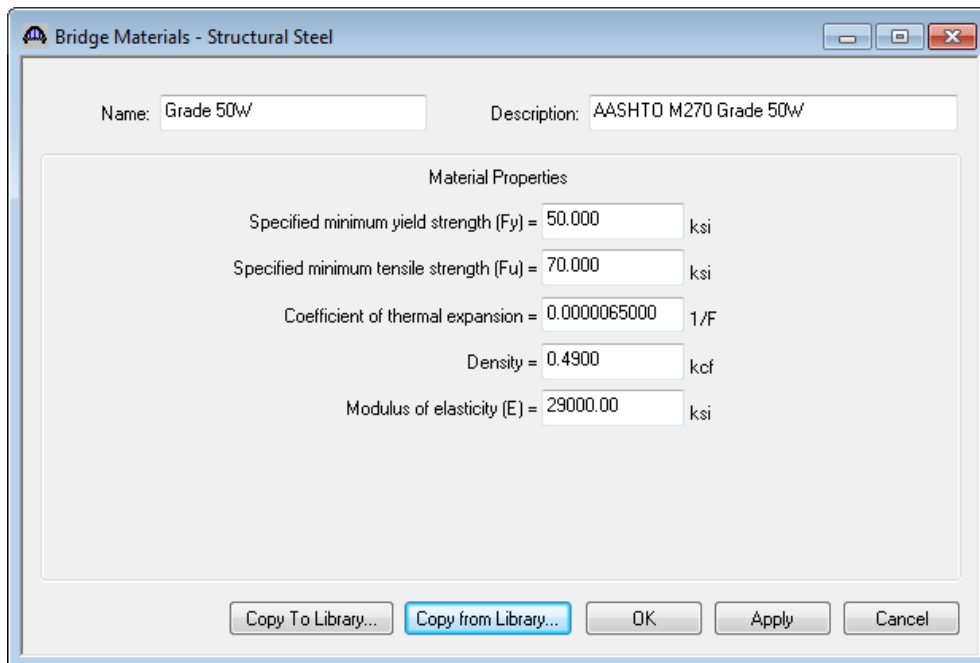
Library Data: Materials - Structural Steel

Name	Description	Library	Units	Fy	Fu	alpha	Density/ Unit Load	Modulus of Elasticity
ASTM A572 - 1/	ASTM A 572 - 1/2" thick max, Fy=65 ksi	Standar	US Cu	65.00	80.00	0.000	0.4900	29000.00
ASTM A588 - <	ASTM A588 - 4" and under, Fy=50 ksi	Standar	US Cu	50.00	70.00	0.000	0.4900	29000.00
ASTM A588 - >	ASTM A 588 - over 4" to 5" thick, inclusive	Standar	US Cu	46.00	67.00	0.000	0.4900	29000.00
ASTM A588 - >	ASTM A 588 - over 5" to 8" thick, inclusive	Standar	US Cu	42.00	63.00	0.000	0.4900	29000.00
ASTM A94 - <=	ASTM A 94 - 1 1/8" thick and under	Standar	US Cu	50.00	75.00	0.000	0.4900	29000.00
ASTM A94 - ov	ASTM A 94 - over 1 1/8" to 2" thick, inclusive	Standar	US Cu	47.00	72.00	0.000	0.4900	29000.00
Grade 100 - > 2	AASHTO M270 Grade 100 - over 2.5" to 4" thick, inclusive	Standar	US Cu	90.00	100.0	0.000	0.4900	29000.00
Grade 100 <= 2	AASHTO M270 Grade 100 up to 2.5" thick, inclusive	Standar	US Cu	100.0	110.0	0.000	0.4900	29000.00
Grade 100W - >	AASHTO M270 Grade 100W - over 2.5" to 4" thick, inclusive	Standar	US Cu	90.00	100.0	0.000	0.4900	29000.00
Grade 100W <=	AASHTO M270 Grade 100W up to 2.5" thick, inclusive	Standar	US Cu	100.0	110.0	0.000	0.4900	29000.00
Grade 250	AASHTO M270M Grade 250	Standar	SI / Me	250.0	400.0	0.000	7849.000	199948.00
Grade 345	AASHTO M270M Grade 345	Standar	SI / Me	345.0	450.0	0.000	7849.000	199948.00
Grade 345W	AASHTO M270M Grade 345W	Standar	SI / Me	345.0	485.0	0.000	7849.000	199948.00
Grade 36	AASHTO M270 Grade 36	Standar	US Cu	36.00	58.00	0.000	0.4900	29000.00
Grade 485W	AASHTO M270M Grade 485W	Standar	SI / Me	485.0	620.0	0.000	7849.000	199948.00
Grade 50	AASHTO M270 Grade 50	Standar	US Cu	50.00	65.00	0.000	0.4900	29000.00
Grade 50W	AASHTO M270 Grade 50W	Standar	US Cu	50.00	70.00	0.000	0.4900	29000.00
Grade 690 - > 6	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standar	SI / Me	620.0	690.0	0.000	7849.000	199947.95
Grade 690 <= 6	AASHTO M270M Grade 690 up to 65 mm thick, inclusive	Standar	SI / Me	690.0	760.0	0.000	7849.000	199948.00
Grade 690W - >	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standar	SI / Me	620.0	690.0	0.000	7849.000	199947.95
Grade 690W <=	AASHTO M270M Grade 690W up to 65 mm thick, inclusive	Standar	SI / Me	690.0	760.0	0.000	7849.000	199948.00
Grade 70W	AASHTO M270 Grade 70W	Standar	US Cu	70.00	90.00	0.000	0.4900	29000.00
Prior to 1905	Built prior to 1905 - steel unknown	Standar	US Cu	26.00	52.00	0.000	0.4900	29000.00

OK Apply Cancel

## STL1-SimpleSpanPlateGirderExample

Select the AASHTO M270 Grade 50W material and click Ok. The selected material properties are copied to the Bridge Materials – Structural Steel window as shown below.

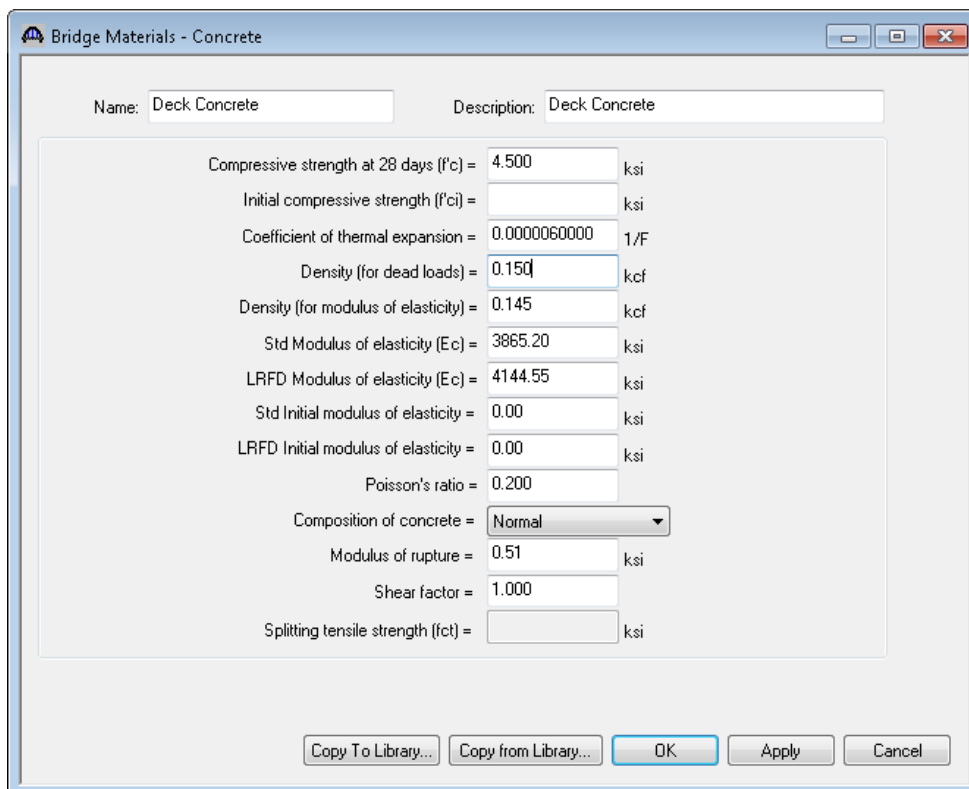


The dialog box titled "Bridge Materials - Structural Steel" contains the following fields and values:

Field	Value	Unit
Name	Grade 50W	
Description	AASHTO M270 Grade 50W	
Material Properties		
Specified minimum yield strength (Fy)	50.000	ksi
Specified minimum tensile strength (Fu)	70.000	ksi
Coefficient of thermal expansion	0.0000065000	1/F
Density	0.4900	kcf
Modulus of elasticity (E)	29000.00	ksi

Buttons at the bottom: Copy To Library..., Copy from Library..., OK, Apply, Cancel.

Add concrete materials and reinforcement materials using the same techniques. Enter the concrete material as shown below:



The dialog box titled "Bridge Materials - Concrete" contains the following fields and values:

Field	Value	Unit
Name	Deck Concrete	
Description	Deck Concrete	
Compressive strength at 28 days (f'c)	4.500	ksi
Initial compressive strength (f'ci)		ksi
Coefficient of thermal expansion	0.0000060000	1/F
Density (for dead loads)	0.150	kcf
Density (for modulus of elasticity)	0.145	kcf
Std Modulus of elasticity (Ec)	3865.20	ksi
LRFD Modulus of elasticity (Ec)	4144.55	ksi
Std Initial modulus of elasticity	0.00	ksi
LRFD Initial modulus of elasticity	0.00	ksi
Poisson's ratio	0.200	
Composition of concrete	Normal	
Modulus of rupture	0.51	ksi
Shear factor	1.000	
Splitting tensile strength (fct)		ksi

Buttons at the bottom: Copy To Library..., Copy from Library..., OK, Apply, Cancel.

**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

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

Reference Line

Back Front

Roadway Surface

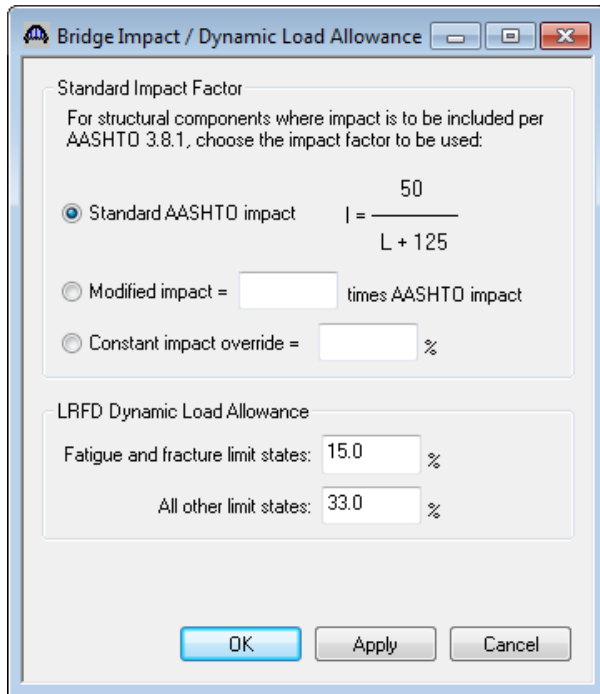
Parapet unit load =  kcf

Calculated Properties

Net centroid (from reference line) =  in

Total load =  kip/ft

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.



The dialog box is titled "Bridge Impact / Dynamic Load Allowance". It contains two main sections: "Standard Impact Factor" and "LRFD 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**

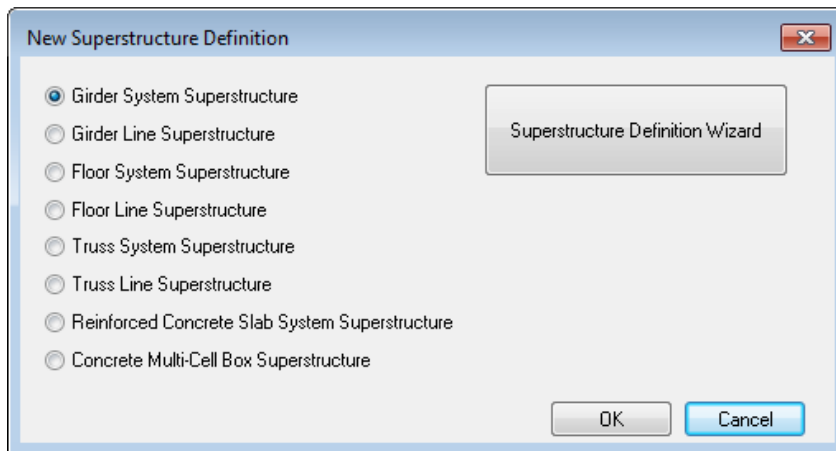
Fatigue and fracture limit states:  %

All other limit states:  %

Buttons: OK, Apply, Cancel

For this example problem we are not going to override the standard LRFD or LRFR factors so we skip to Structure Definition. We will come back to Bridge Alternatives after entering a Structure 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 structure definition. The dialog shown below will appear.



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

The 'Girder System Superstructure Definition' window is shown. It has tabs for 'Definition', 'Analysis', 'Specs', and 'Engine'. The 'Definition' tab is active. The window contains the following fields and controls:

- Name:** SD1
- Description:** (empty text area)
- Default Units:** US Customary
- Number of spans:** 1
- Number of girders:** 4
- Enter Span Lengths Along the Reference Line:**

Span	Length (ft)
1	161.00
- Frame Structure Simplified Definition:** (unchecked checkbox)
- Deck type:** Concrete
- For PS only:**
  - Average humidity:** (empty text box) %
- 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:** (empty text box) ft
  - Start tangent length:** (empty text box) ft
  - Radius:** (empty text box) ft
  - Direction:** Left
  - End tangent length:** (empty text box) ft
  - Distance from last support line to PT:** (empty text box) ft
  - Design speed:** (empty text box) mph
  - Superelevation:** (empty text box) %

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

**Girder System Superstructure Definition**

Definition Analysis Specs Engine

**Structural Slab Thickness**

☒ Consider structural slab thickness for rating

☒ Consider structural slab thickness for design

**Wearing Surface**

☒ Consider wearing surface for rating

☒ Consider wearing surface for design

☐ Consider striped lanes for rating

Default Analysis Type: **Line Girder**

**Longitudinal Loading**

Vehicle increment: **1.000** ft

**Transverse Loading**

Vehicle increment in lane: **2.000** ft

Lane increment: **4.000** ft

**3D Analysis Control Options**

☒ LFD: Model non-composite regions as non-composite

☐ LRFD: Model non-composite regions as non-composite

☐ LRFR: Model non-composite regions as non-composite

**Number of shell elements**

☒ In the deck between girders

☐ In the web between flanges

Slower More accurate Faster Less accurate

10 9 8 7 6 5 4 3 2 1

**Target aspect ratio for shell elements**

Slower More accurate Faster Less accurate

1.0 1.5 2.0 2.5 3.0 3.5 4.0

**3D Bracing Member End Connection Analysis**

☐ Calculated factored member force effects

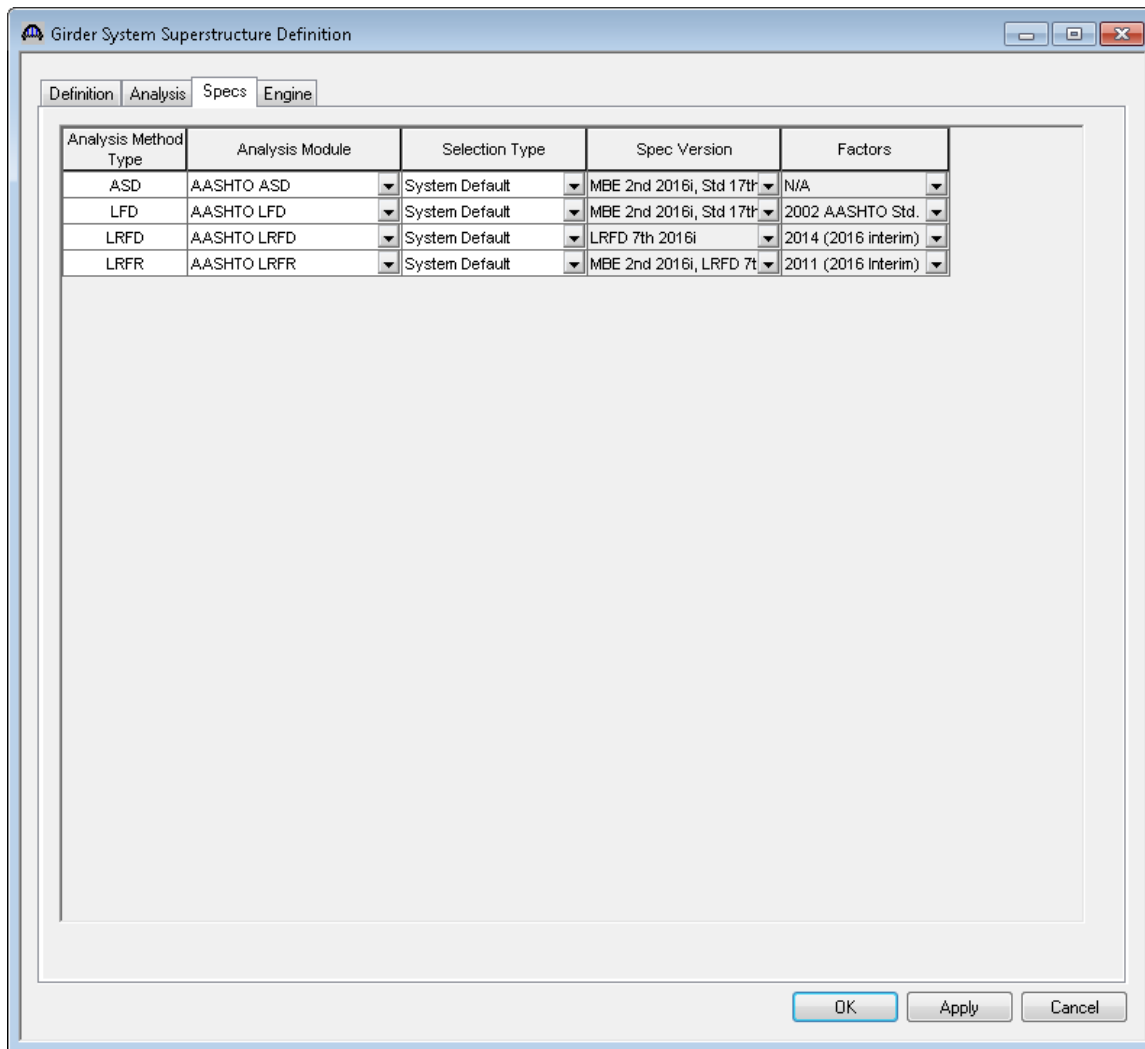
☐ Maximum of average (stress + strength) and 75% resistance

**Bracing Member LRFR Factors**

Condition Factor: **Good or Satisfactory**

☐ Field measured section properties

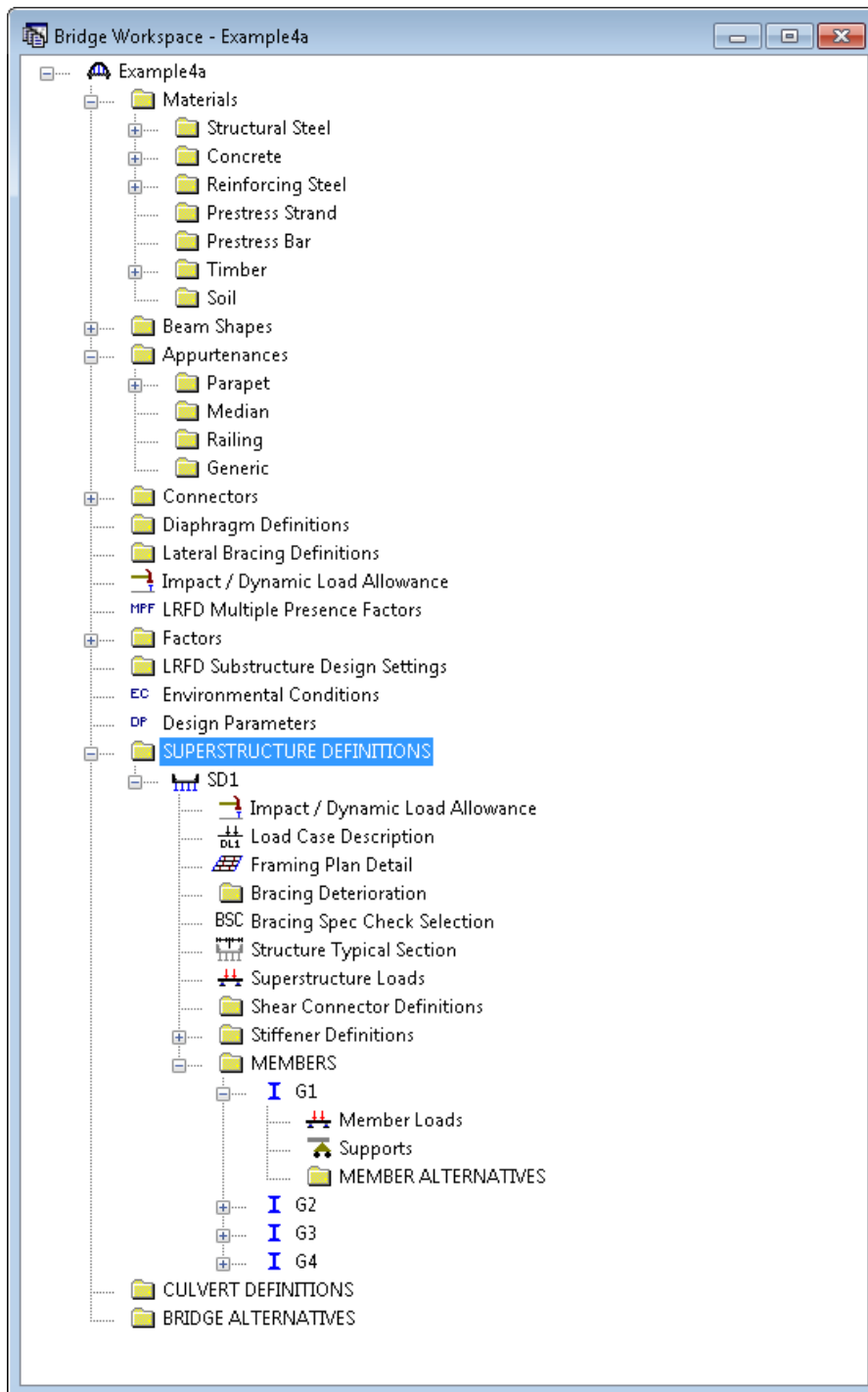
OK Apply Cancel



The Analysis tab and Specs tab are shown above with the default selections. Since we are not overriding default selections for this exercise, no changes are required.

Click on Ok to save the data to memory and close the window.

The partially expanded Bridge Workspace tree is shown below:



We now go back to the Bridge Alternatives and create a new Bridge Alternative by double-clicking on Bridge Alternatives. Enter the following data:

Bridge Alternative

Alternative Name: Bridge Alternative 1

Description Substructures

Description:

☐ Horizontal curvature

Reference Line Length = 0.00 ft

☒ Start bearing ☐ End bearing

Starting Station = ft

Bearing = N 00° 0' 0.00'' E

Global Positioning

Distance = 0.000 ft

Offset = 0.000 ft

Elevation = ft

Bridge Alignment

☒ Curved

☐ Tangent, curved, tangent

☐ Tangent, curved

☐ Curved, tangent

Start tangent length: ft

Curve length: ft

Radius: ft

Direction: Left

End tangent length: ft

Superstructure Wizard...

OK Apply Cancel

Click Ok to save the data to memory and close the window.

Double-click on Superstructures of the bridge alternative and enter the following new superstructure:

Superstructure

Superstructure Name: Structure 1

Description Alternatives Vehicle Path Engine Substructures

Description:

Reference Line

Distance = 0.000 ft

Offset = -0.000 ft

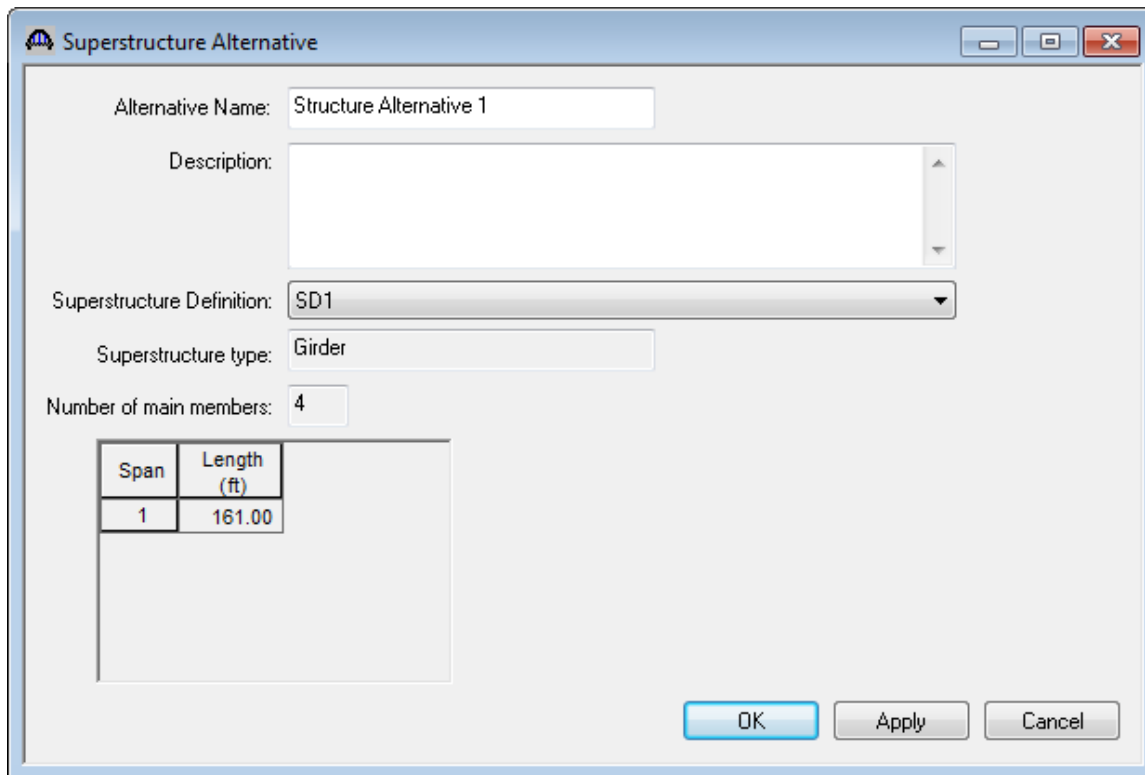
Angle = 0.00 Degrees

Starting Station = 0.00 ft

OK Apply Cancel

Click Ok to save the data to memory and close the window.

Double-click on Superstructure Alternatives and enter the following new Superstructure Alternative. Select the Superstructure definition SD1 as the current superstructure definition for this Superstructure Alternative.



Superstructure Alternative

Alternative Name: Structure Alternative 1

Description:

Superstructure Definition: SD1

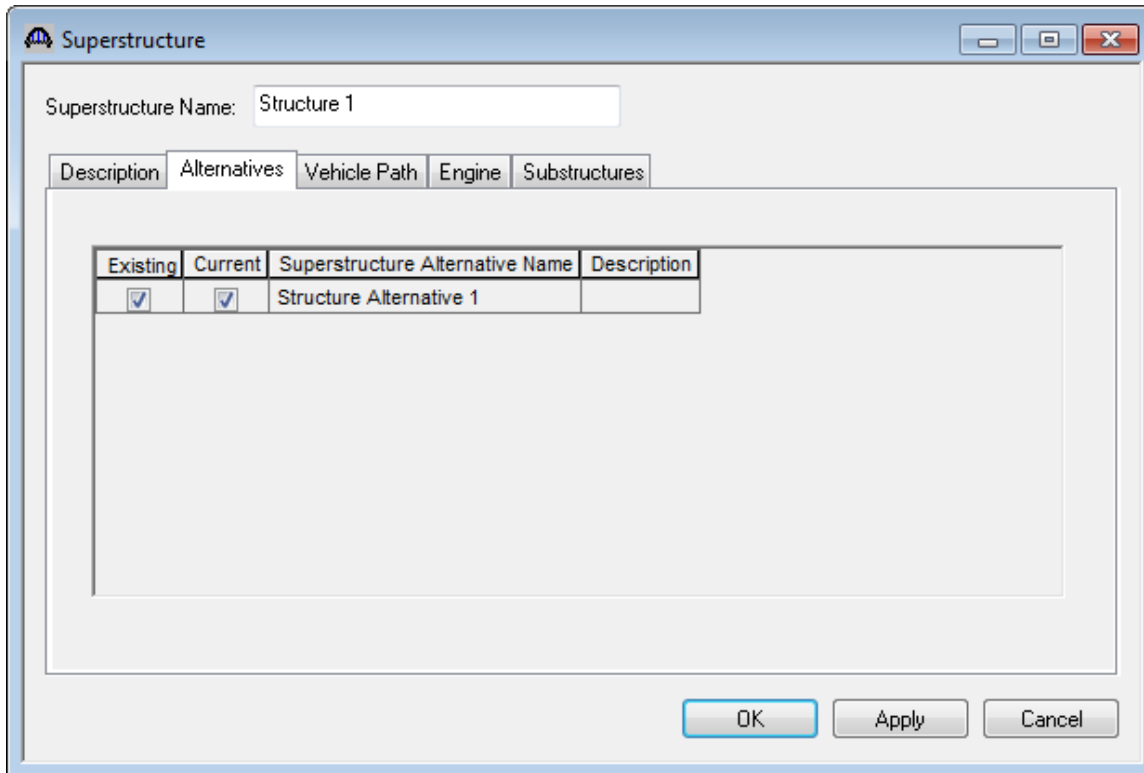
Superstructure type: Girder

Number of main members: 4

Span	Length (ft)
1	161.00

OK Apply Cancel

Re-open the Structure 1 window and select the Alternatives tab. The Structure Alternative 1 will be shown as the existing and current alternative for Structure 1.

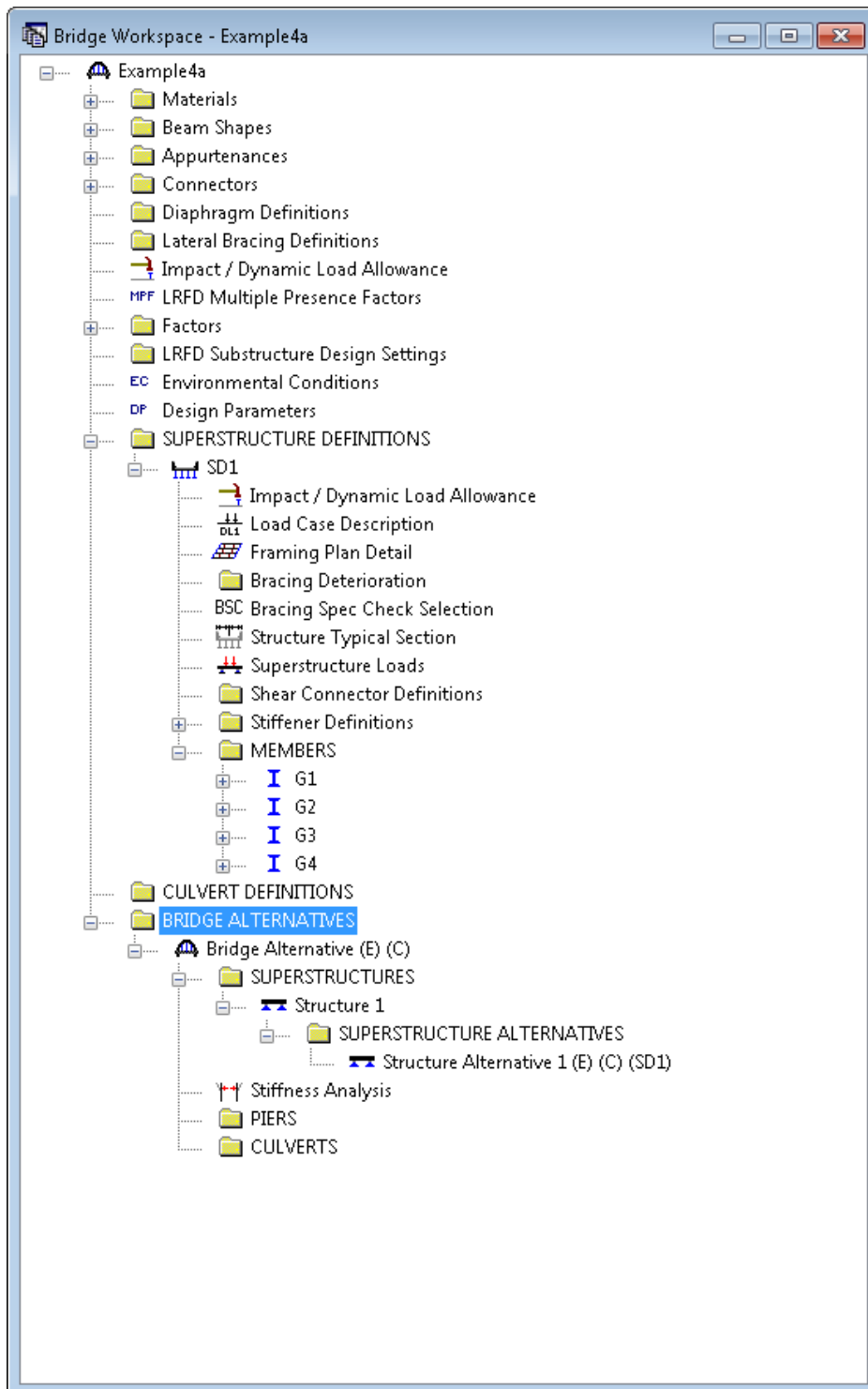


The screenshot shows a software window titled "Superstructure". At the top, there is a text field labeled "Superstructure Name:" containing the text "Structure 1". Below this is a tabbed interface with five tabs: "Description", "Alternatives", "Vehicle Path", "Engine", and "Substructures". The "Alternatives" tab is currently selected. Inside this tab, there is a table with the following columns: "Existing", "Current", "Superstructure Alternative Name", and "Description". The table contains one row with the following data:

Existing	Current	Superstructure Alternative Name	Description
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Structure Alternative 1	

At the bottom right of the window, there are three buttons: "OK", "Apply", and "Cancel".

The partially expanded Bridge Workspace tree is shown below:



Now, under the SD1 superstructure definition, click Load Case Description to define the dead load cases. You may click on the “Add Default Load Case Descriptions” button. The completed Load Case Description window is shown below.

**Load Case Description**

Load Case Name	Description	Stage	Type	Time* (Days)
DC1	DC acting on non-composite section	Non-composite (Stage 1)	D,DC	
DC2	DC acting on long-term composite section	Composite (long term) (Stage 2)	D,DC	
DW	DW acting on long-term composite section	Composite (long term) (Stage 2)	D,DW	
SIP Forms	Weight due to stay-in-place forms	Non-composite (Stage 1)	D,DC	

\*Prestressed members only

Add Default Load Case Descriptions

New Duplicate Delete

OK Apply Cancel

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 = 4

Layout   Diaphragms   Lateral Bracing Ranges

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	13.00	13.00
2	13.00	13.00
3	13.00	13.00

OK Apply Cancel

Switch to the Diaphragms tab to enter diaphragm spacing.

The screenshot shows the "Structure Framing Plan Details" dialog box. It has three tabs: "Layout", "Diaphragms", and "Lateral Bracing Ranges". The "Diaphragms" tab is active.

At the top, there are two input fields: "Number of spans =" with a value of 1, and "Number of girders =" with a value of 4.

Below the tabs, there are three controls: "Girder Bay:" with a dropdown menu showing 1, a "Copy Bay To..." button, and a "Diaphragm Wizard..." button.

A table is displayed below these controls. The table has columns for Support Number, Start Distance (ft), Diaphragm Spacing (ft), Number of Spaces, Length (ft), End Distance (ft), Load (kip), and Diaphragm. The Start Distance and End Distance columns are further divided into Left Girder and Right Girder sub-columns. The table body is currently empty.

At the bottom right of the dialog, there are four buttons: "New", "Duplicate", "Delete", and "OK". At the very bottom center, there are two more buttons: "Apply" and "Cancel".

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		

Click the Diaphragm Wizard button to add diaphragms for the entire structure. The Dialog shown below will appear.

Diaphragm Wizard

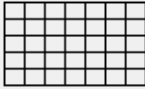
Select the desired framing plan system:

Next >

< Back Cancel Help

Click the Next button and enter the following spacing:

**Diaphragm Wizard**



**Diaphragm Spacing**

☒ Enter number of equal spaces per span  
☐ Enter equal spacing per span  
☐ Enter groups of equal spacing

Support diaphragm load:  kip

Interior diaphragm load:  kip

Span	Length (ft)	Number of Equal Spaces
1	161.00	6

Click the Finish button to add the diaphragms. The Diaphragm Wizard will create diaphragms for all of the girder bays in the structure.

The diaphragms created for Girder Bay 1 are shown below:

**Structure Framing Plan Details**

Number of spans =  Number of girders =

Layout Diaphragms Lateral Bracing Ranges

Girder Bay:

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	0.00	0.00	26.83	5	134.17	134.17	134.17		-- Not Assigned
1	161.00	161.00	0.00	1	0.00	161.00	161.00		-- Not Assigned

Select Ok to close the window.

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.

Basic deck geometry:

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

Superstructure definition reference line is within the bridge deck.

Distance from left edge of deck to superstructure definition reference line = 23.75 ft

Distance from right edge of deck to superstructure definition reference line = 23.75 ft

Left overhang = 4.25 ft

Computed right overhang = 4.25 ft

OK Apply Cancel

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 above.

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: Deck Concrete

Total deck thickness: 10.0000 in

Load case: Engine Assigned

Deck crack control parameter: 130.000 kip/in

Sustained modular ratio factor: 3.000

Deck exposure factor:

OK Apply Cancel

## 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 “DC2” 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.

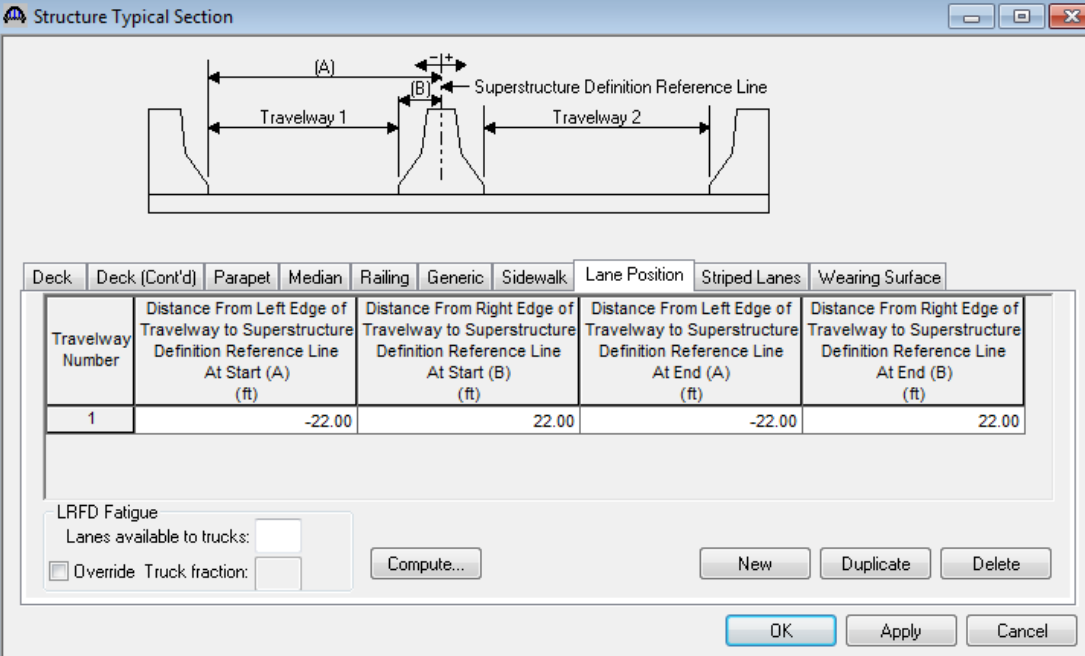
Name	Load Case	Measure To	Edge of Deck Dist. Measured From	Distance At Start (ft)	Distance At End (ft)	Front Face Orientation
Jersey Barrier	DC2	Back	Left Edge	0.00	0.00	Right
Jersey Barrier	DC2	Back	Right Edge	0.00	0.00	Left

## STL1-SimpleSpanPlateGirderExample

Lane Positions:

Select the Lane Position tab.

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.



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	-22.00	22.00	-22.00	22.00

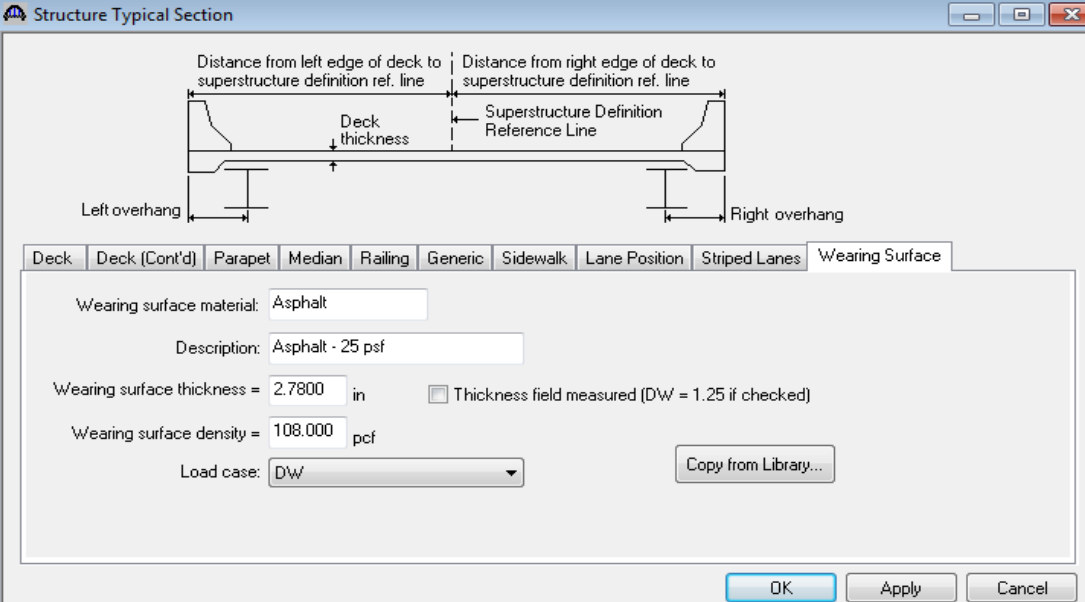
LRFD Fatigue  
Lanes available to trucks:   
☐ Override Truck fraction:

Compute... New Duplicate Delete

OK Apply Cancel

Wearing Surface:

Enter the data shown below.



Wearing surface material:	Description:	Wearing surface thickness =	Wearing surface density =	Load case:
Asphalt	Asphalt - 25 psf	2.7800 in	108.000 pcf	DW

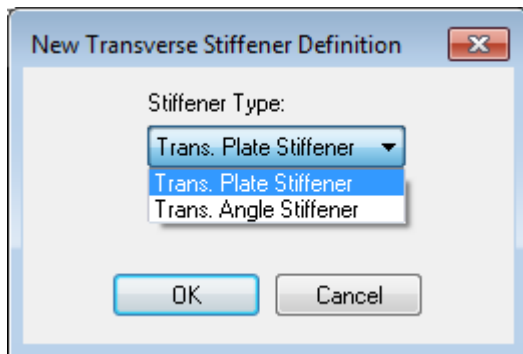
☐ Thickness field measured (DW = 1.25 if checked)

Copy from Library...

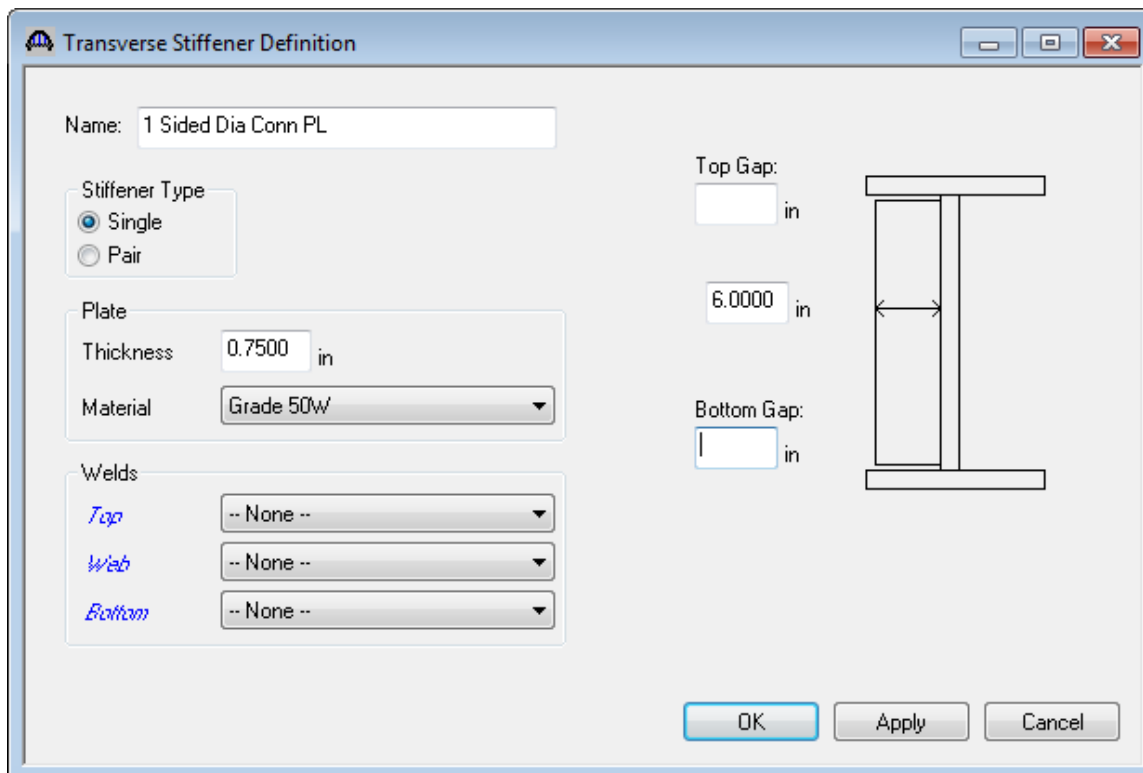
OK Apply Cancel

Click Ok to save the data to memory and close the window.

Define stiffeners to be used by the girders. Expand the Stiffener Definitions tree item and double click on Transverse. Select “Trans. Plate Stiffener” for stiffener type.



Define the stiffener as shown below. Click Ok to save to memory and close the window. Repeat this process to define the other two stiffeners. The windows are shown below.



**Transverse Stiffener Definition**

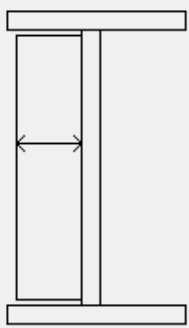
Name:

Stiffener Type  
☒ Single  
☐ Pair

Plate  
Thickness:  in  
Material:

Welds  
*Top*:   
*Web*:   
*Bottom*:

Top Gap:  in  
 in  
Bottom Gap:  in



OK Apply Cancel

**Transverse Stiffener Definition**

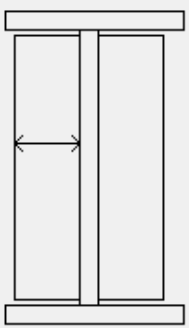
Name:

Stiffener Type  
☐ Single  
☒ Pair

Plate  
Thickness:  in  
Material:

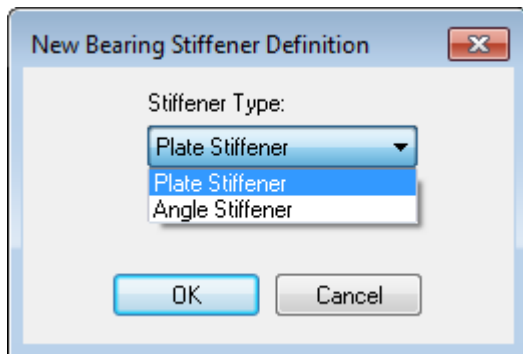
Welds  
*Top*:   
*Web*:   
*Bottom*:

Top Gap:  in  
 in  
Bottom Gap:  in

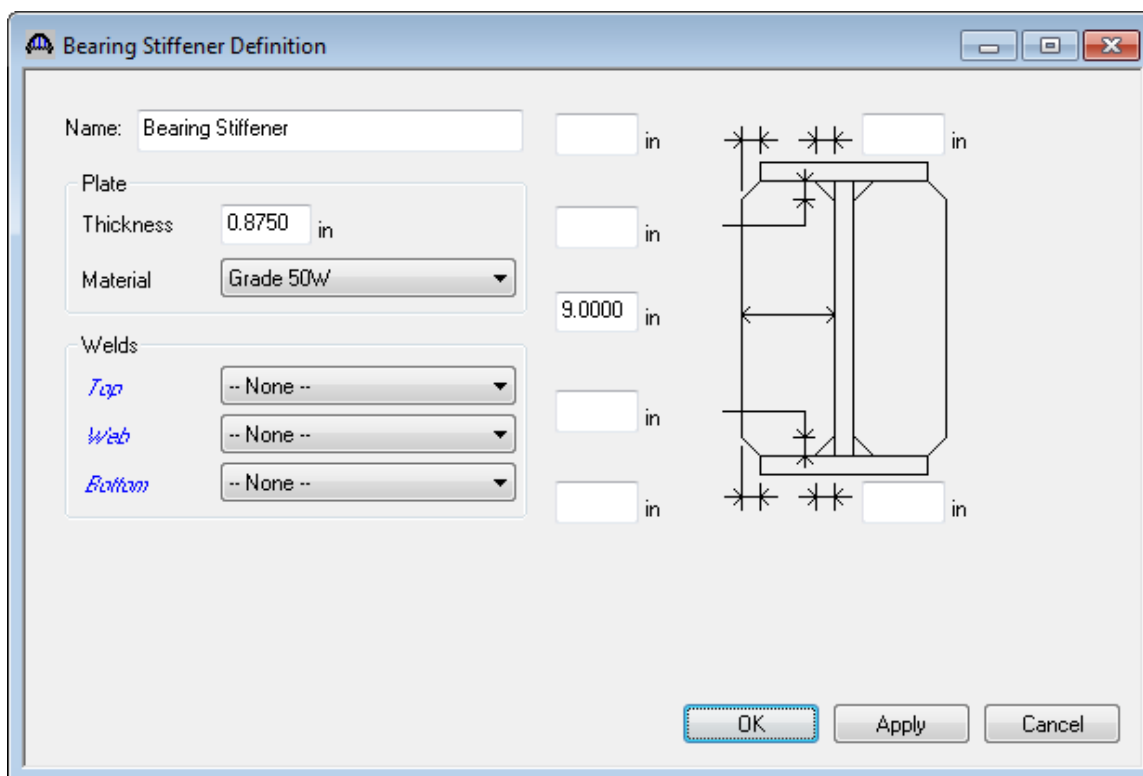


OK Apply Cancel

Now define the bearing stiffeners by double clicking on Bearing (under Stiffener Definitions in the tree). Select “Plate Stiffener” for stiffener type.

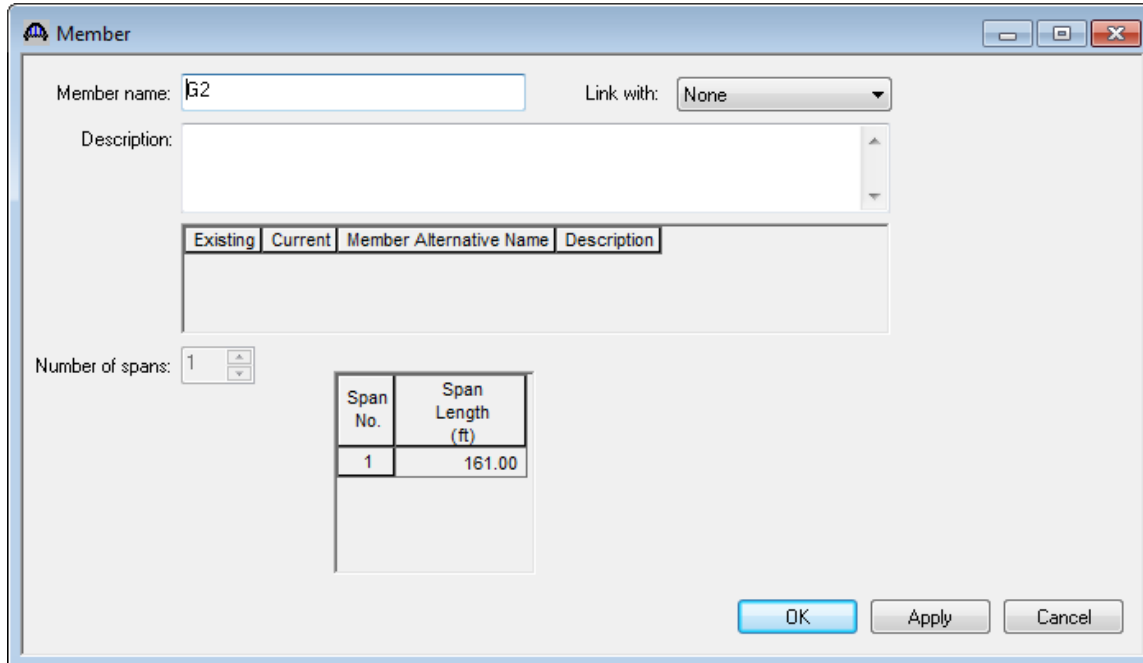


Define the stiffener as shown below. Click Ok to save to memory and close the window.



Describing a member:

The Member G2 window shows the data that was generated when the structure definition was created. No changes are required at this time. The first Member Alternative that we create will automatically be assigned as the Existing and Current Member alternative for this Member.



The Member G2 dialog box is shown with the following fields and controls:

- Member name:** G2
- Link with:** None
- Description:** (empty text area)
- Number of spans:** 1
- Table:**

Span No.	Span Length (ft)
1	161.00
- Buttons:** OK, Apply, Cancel

The table below shows the data entered in the dialog box:

Existing	Current	Member Alternative Name	Description

Next double click on the Member loads in the tree and select SIP Forms from the combobox. Enter the load due to stay-in-place forms as shown below.

Girder Member Loads

Pedestrian load:  lb/ft

Uniform Distributed Concentrated Settlement

Load Case Name	Span	Uniform Load (kip/ft)
SIP Fo	All Spans	0.078

New Duplicate Delete

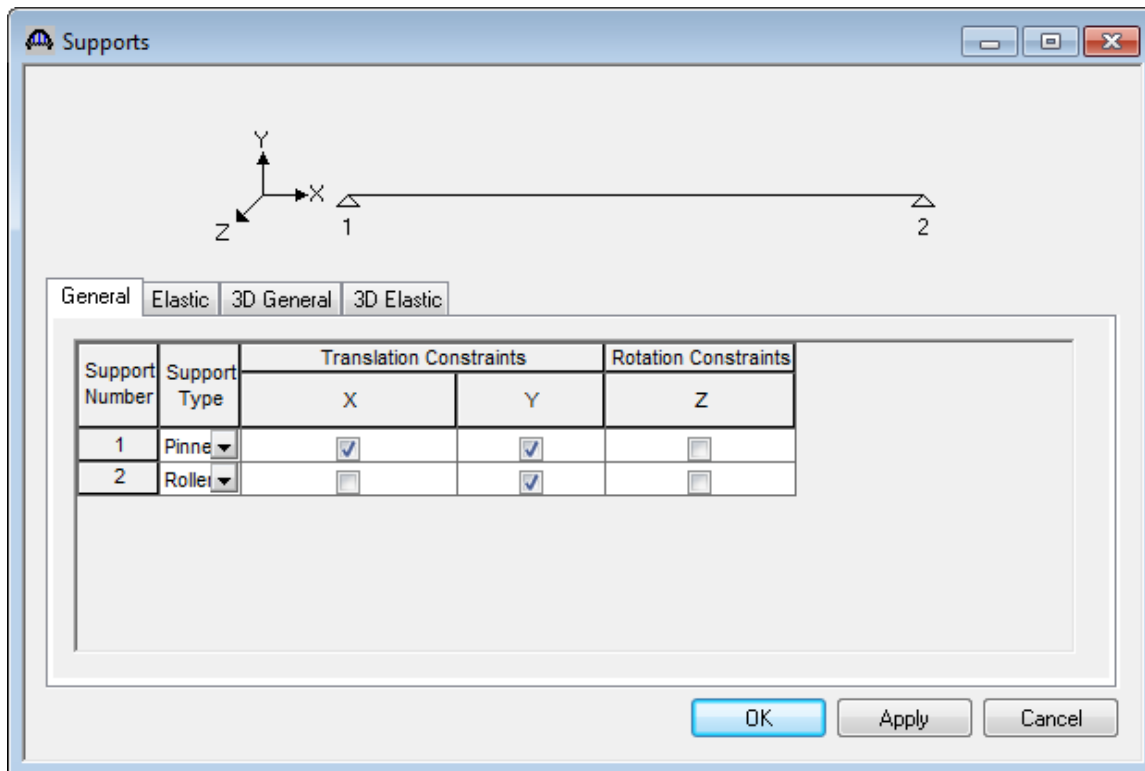
OK Apply Cancel

Member loads for this tutorials

Example	Struct Def	Member Definition	Loads(Interior beam, Exterior beam)
a	GS	<b>Schedule-based</b>	<b>SIP (0.078, 0.039)</b>
b	GL	Schedule-based	SIP (0.078,0.039) Barrier (DC2) (0.253, 0.253) WS (DW) (0.275, 0.275)
c	GL	Cross-section based	SIP (0.078, 0.078) Barrier (DC2) (0.253, 0.253) WS (DW) (0.275, 0.275) Haunch (DC1) (0.017, 0.059)
d	GS	Cross-section based	SIP (0.078, 0.078) Haunch (DC1) (0.017, 0.059)

The Help topic “Dead Loads” summarizes for each type of structure definition and member modeling method which dead load components are computed automatically by the engine and which must be entered by the user.

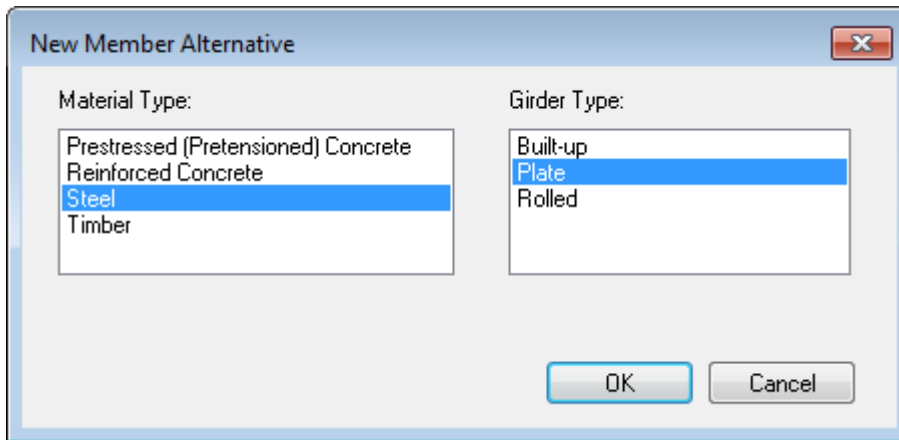
Support constraints were generated when the structure definition was created and are shown below.



Defining a Member Alternative:

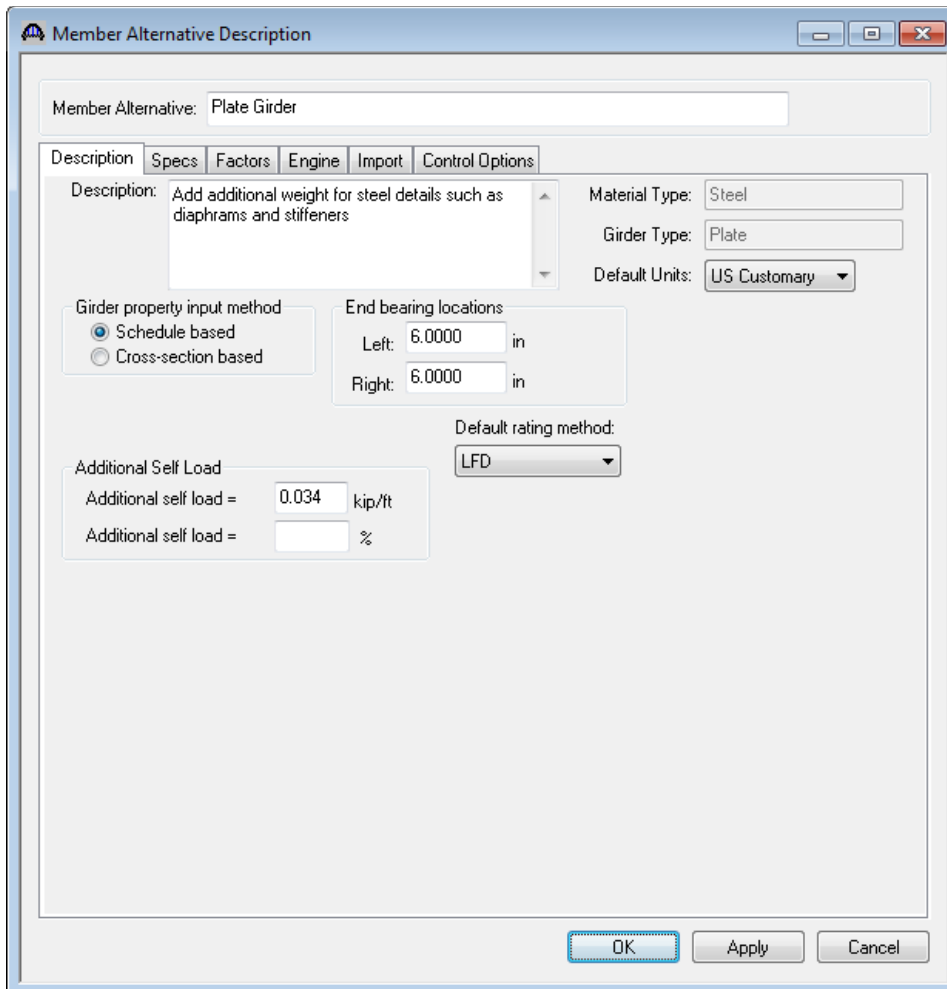
Double-click MEMBER ALTERNATIVES in the tree to create a new alternative. The New Member Alternative dialog shown below will open. Select Steel for the Material Type and Plate for the Girder Type.

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



The "New Member Alternative" dialog box is shown. It has two main sections: "Material Type" and "Girder Type". The "Material Type" list includes "Prestressed (Pretensioned) Concrete", "Reinforced Concrete", "Steel" (which is highlighted), and "Timber". The "Girder Type" list includes "Built-up", "Plate" (which is highlighted), and "Rolled". At the bottom, there are "OK" and "Cancel" buttons.

The Member Alternative Description window will open. Enter the appropriate data as shown below. Select Schedule-based Girder property input method.



The "Member Alternative Description" dialog box is shown. The "Member Alternative" field is set to "Plate Girder". The "Description" tab is selected, showing a text area with the description: "Add additional weight for steel details such as diaphragms and stiffeners". The "Material Type" is set to "Steel", "Girder Type" is set to "Plate", and "Default Units" is set to "US Customary". The "Girder property input method" section has "Schedule based" selected. The "End bearing locations" section shows "Left: 6.0000 in" and "Right: 6.0000 in". The "Default rating method" is set to "LFD". The "Additional Self Load" section shows "Additional self load = 0.034 kip/ft" and "Additional self load = %". At the bottom, there are "OK", "Apply", and "Cancel" buttons.

If we now re-open the Member G2 window, we will see this Member Alternative designated as the existing and current member alternative for this Member.

Member name: G2 Link with: None

Description:

Existing	Current	Member Alternative Name	Description
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plate Girder	Add additional weight for steel details

Number of spans: 1

Span No.	Span Length (ft)
1	161.00

OK Apply Cancel

Use “Compute” button to generate distribution factors.

Standard LRFD

Distribution Factor Input Method

☒ Use Simplified Method ☐ Use Advanced Method

☒ 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	1.538462	1.538462	1.538462	0.500000
Multi-Lane	2.363636	2.461538	2.363636	1.350000

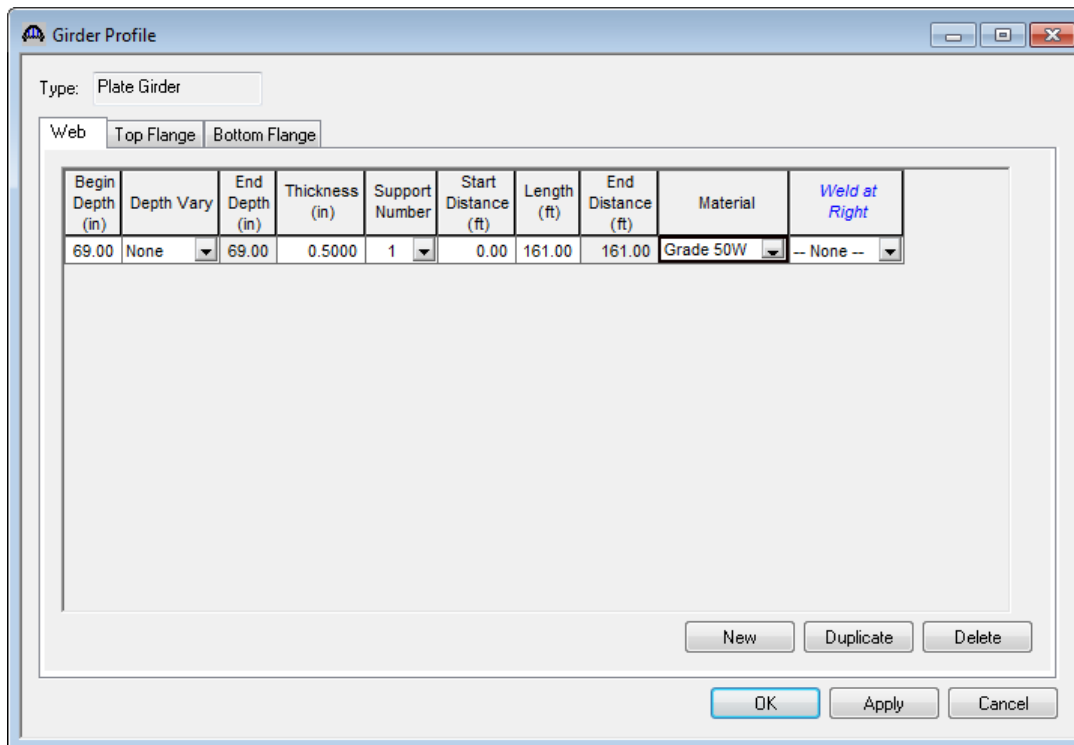
Compute from Typical Section... View Calcs

OK Apply Cancel

Live load distribution factor calculation details can be viewed by clicking “View Calcs” button.

## STL1-SimpleSpanPlateGirderExample

Next describe the girder profile by double clicking on Girder Profile in the tree. The window is shown below with the data describing the web.

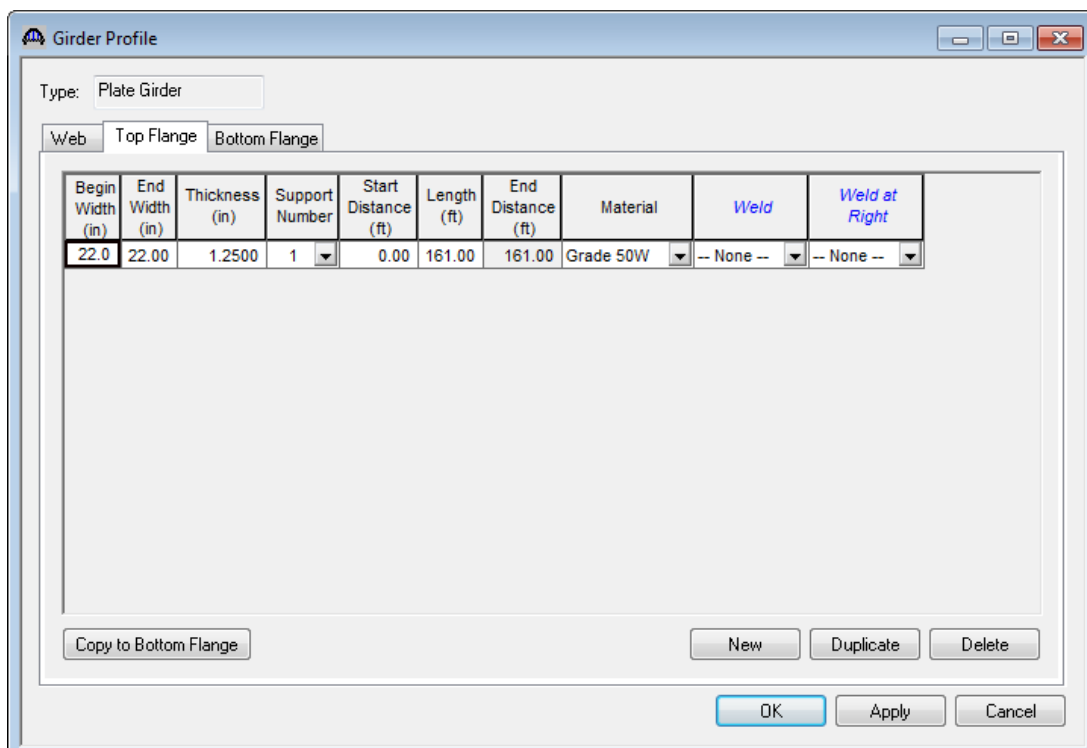


The 'Girder Profile' dialog box is shown with the 'Web' tab selected. The 'Type' is set to 'Plate Girder'. The 'Web' tab is active, and the 'Top Flange' and 'Bottom Flange' tabs are also visible. The table below shows the data for the web.

Begin Depth (in)	Depth Vary	End Depth (in)	Thickness (in)	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Material	Weld at Right
69.00	None	69.00	0.5000	1	0.00	161.00	161.00	Grade 50W	-- None --

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

Describe the flanges as shown below.



The 'Girder Profile' dialog box is shown with the 'Top Flange' tab selected. The 'Type' is set to 'Plate Girder'. The 'Web', 'Top Flange', and 'Bottom Flange' tabs are visible. The table below shows the data for the top flange.

Begin Width (in)	End Width (in)	Thickness (in)	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Material	Weld	Weld at Right
22.0	22.00	1.2500	1	0.00	161.00	161.00	Grade 50W	-- None --	-- None --

Buttons: Copy to Bottom Flange, New, Duplicate, Delete, OK, Apply, Cancel

## STL1-SimpleSpanPlateGirderExample

Enter the following starting distance and length to the bottom flange tab.

starting distance	bottom flange
0	36.666
36.666	87.667
124.333	36.667

The screenshot shows the 'Girder Profile' window with the 'Bottom Flange' tab selected. The window title is 'Girder Profile'. Below the title bar, there is a 'Type:' dropdown set to 'Plate Girder'. Below that are three tabs: 'Web', 'Top Flange', and 'Bottom Flange', with 'Bottom Flange' being the active tab. The main area contains a table with the following data:

Begin Width (in)	End Width (in)	Thickness (in)	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Material	Weld	Weld at Right
22.00	22.00	1.2500	1	0.00	36.67	36.67	Grade 50W	-- None --	-- None --
22.00	22.00	2.0000	1	36.67	87.67	124.33	Grade 50W	-- None --	-- None --
22.00	22.00	1.2500	1	124.33	36.67	161.00	Grade 50W	-- None --	-- None --

Below the table, there is a 'Copy to Top Flange' button on the left and 'New', 'Duplicate', and 'Delete' buttons on the right. At the bottom right, there are 'OK', 'Apply', and 'Cancel' buttons.

Next open the Deck Profile and enter the data describing the structural properties of the deck. The window is shown below.

The screenshot shows the 'Deck Profile' window with the 'Deck Concrete' tab selected. The 'Type' is set to 'Plate'. The table below contains the structural properties of the deck.

Material	Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Structural Thickness (in)	Start Effective Flange Width (Std) (in)	End Effective Flange Width (Std) (in)	Start Effective Flange Width (LRFD) (in)	End Effective Flange Width (LRFD) (in)	n
Deck Concrete	1	0.00	161.00	161.00	9.5000	114.0000	114.0000	125.0000	125.0000	8.000

Buttons at the bottom include 'Compute from Typical Section...', 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

No reinforcement is described. Composite regions are described using the Shear Connectors tab as shown below.

The screenshot shows the 'Deck Profile' window with the 'Shear Connectors' tab selected. The 'Type' is set to 'Plate'. The table below describes the shear connectors.

Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Connector ID	Number per Row	Number of Spaces	Transverse Spacing (in)
1	0.00	161.00	161.00	Composite			

Buttons at the bottom include 'Shear Stud Design Tool', 'View Calcs', 'New', 'Duplicate', 'Delete', 'OK', 'Apply', and 'Cancel'.

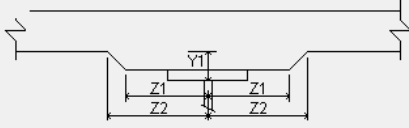
## STL1-SimpleSpanPlateGirderExample

The haunch profile is defined by double clicking on Haunch Profile in the tree. The window is shown below.

Interior Girder (G2):

**Haunch Profile**

Haunch Type: ☐ Embedded flange



Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)
1	0.00	161.00	161.00	11.0000	11.0000	2.0000

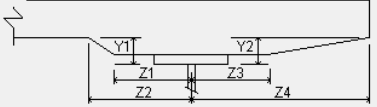
New Duplicate Delete

OK Apply Cancel

Exterior Girder (G1):

**Haunch Profile**

Haunch Type: ☐ Embedded flange

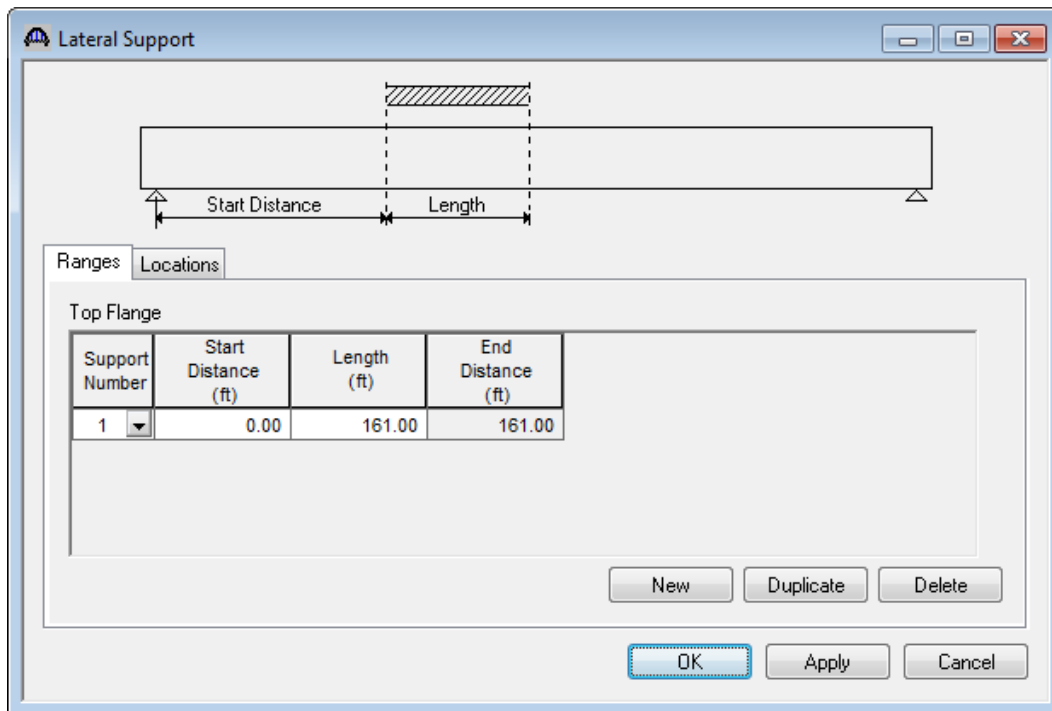


Support Number	Start Distance (ft)	Length (ft)	End Distance (ft)	Z1 (in)	Z2 (in)	Z3 (in)	Z4 (in)	Y1 (in)	Y2 (in)
1	0.00	161.00	161.00	11.0000	11.0000	11.0000	51.0000	2.0000	2.0000

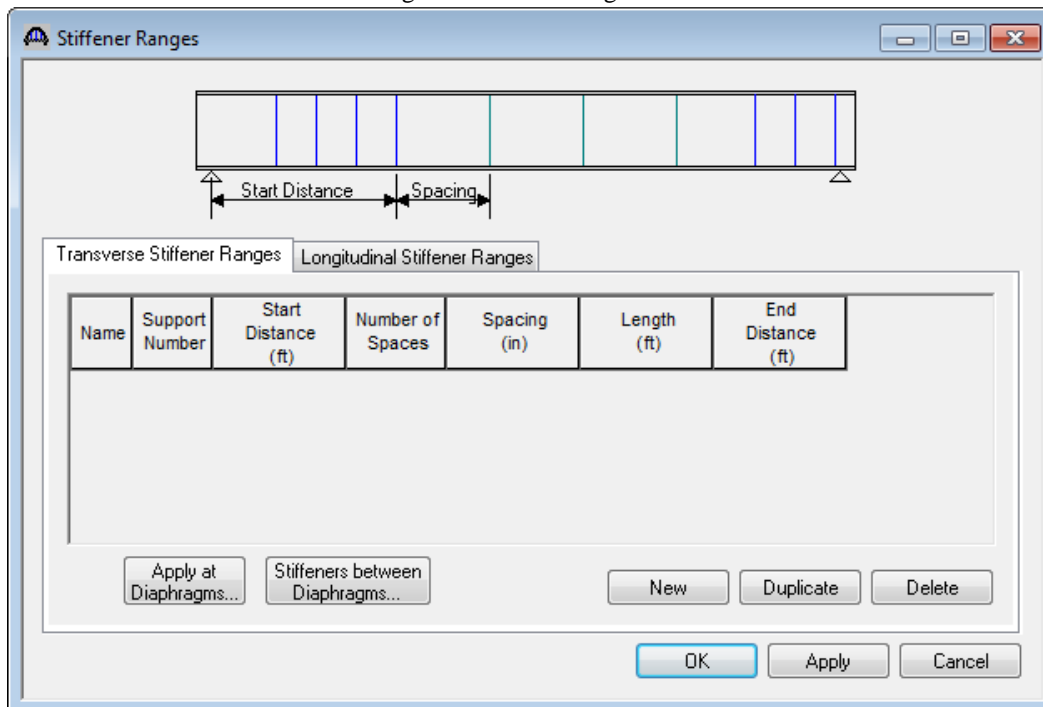
New Duplicate Delete

OK Apply Cancel

Regions where the slab is considered to provide lateral support for the top flange are defined using the Lateral Support window shown below. It can be opened by double clicking on Lateral Support in the tree.



Stiffener locations are described using the Stiffener Ranges window shown below.



Click on the Apply at Diaphragms... button to open the following dialog. Select the 2 Sided Conn PL as the stiffener to apply at the interior diaphragms.

**Diaphragm Connection Plates**

Apply the following stiffener definitions to the diaphragm locations:


End Diaphragms and Diaphragms At Piers  
 Bearing Stiffener: Bearing Stiffener

Interior Diaphragms  
 Transverse Stiffener: 2 Sided Dia Conn PL

Apply Cancel

Selecting Apply will create the following transverse stiffener locations.

**Stiffener Ranges**



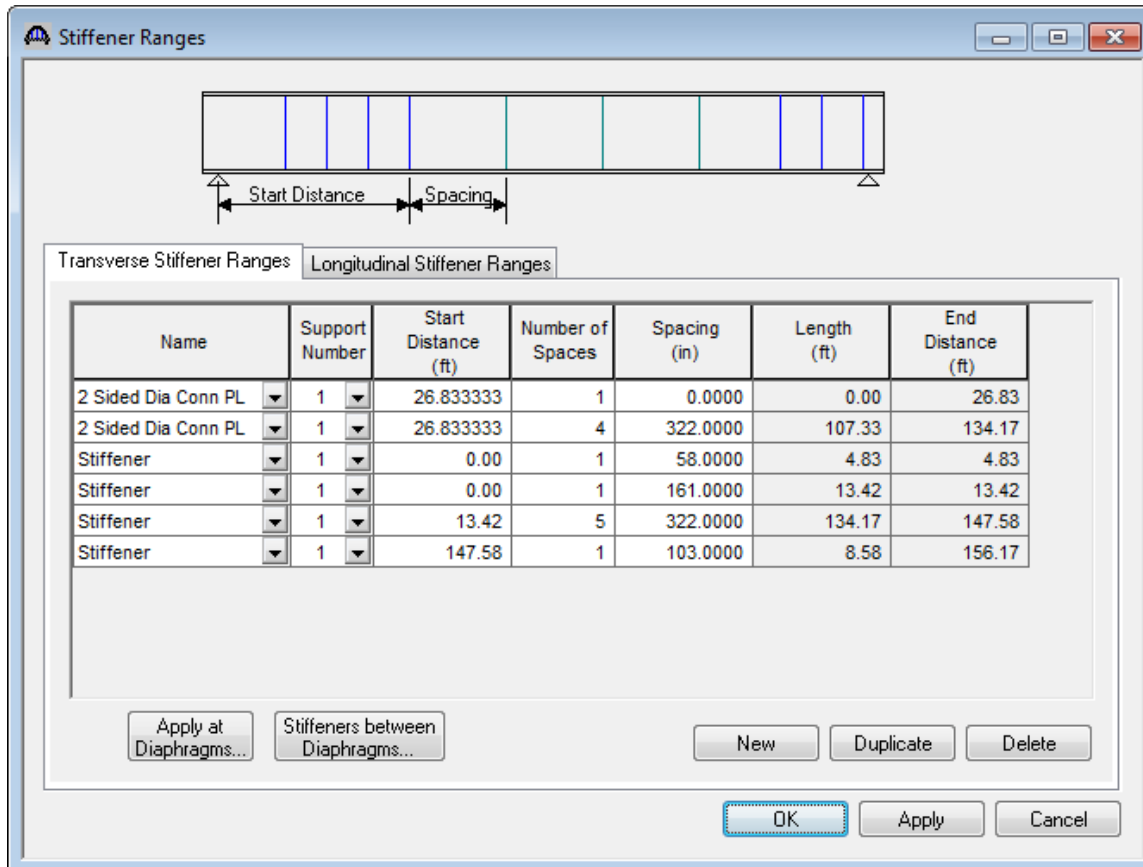
Transverse Stiffener Ranges Longitudinal Stiffener Ranges

Name	Support Number	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)
<span>2 Sided Dia Conn PL</span>	<span>1</span>	26.833333	1	0.0000	0.00	26.83
<span>2 Sided Dia Conn PL</span>	<span>1</span>	26.833333	4	322.0000	107.33	134.17

Apply at Diaphragms... Stiffeners between Diaphragms... New Duplicate Delete

OK Apply Cancel

The intermediate transverse stiffeners are now located. Note that a range does not include a stiffener at the beginning of the range. The range that begins at the left end of the beam with one space and a spacing of 58 inches locates the first stiffener. The remaining intermediate stiffeners are located as follows.



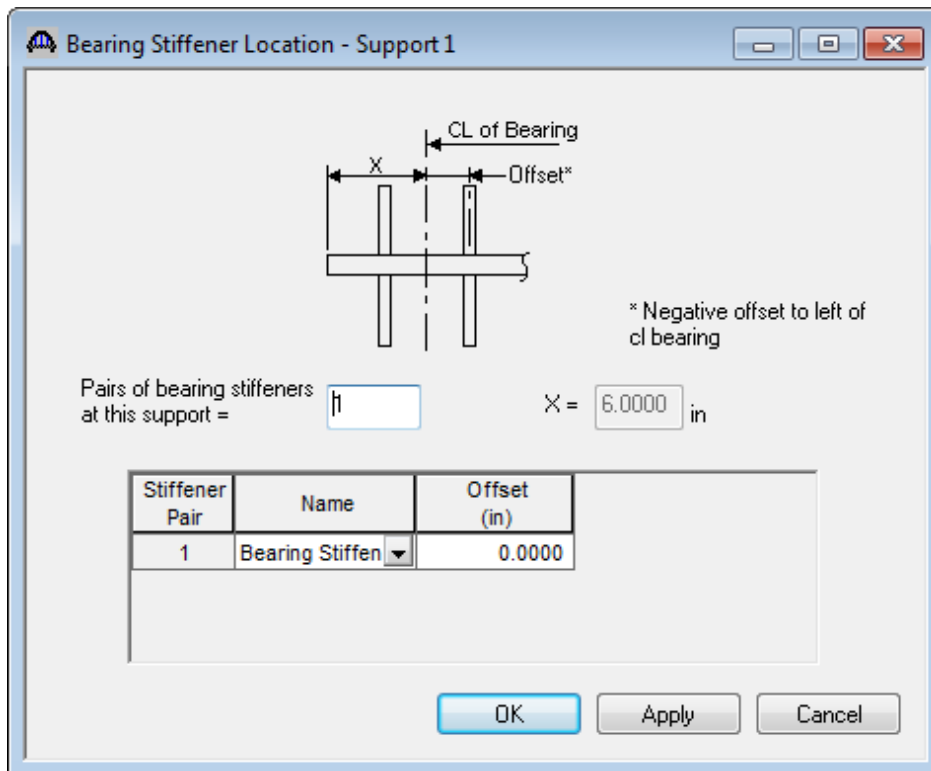
The dialog box titled "Stiffener Ranges" displays a beam diagram at the top with vertical lines representing stiffeners. Below the diagram are two tabs: "Transverse Stiffener Ranges" (selected) and "Longitudinal Stiffener Ranges". The table below lists the defined ranges.

Name	Support Number	Start Distance (ft)	Number of Spaces	Spacing (in)	Length (ft)	End Distance (ft)
2 Sided Dia Conn PL	1	26.833333	1	0.0000	0.00	26.83
2 Sided Dia Conn PL	1	26.833333	4	322.0000	107.33	134.17
Stiffener	1	0.00	1	58.0000	4.83	4.83
Stiffener	1	0.00	1	161.0000	13.42	13.42
Stiffener	1	13.42	5	322.0000	134.17	147.58
Stiffener	1	147.58	1	103.0000	8.58	156.17

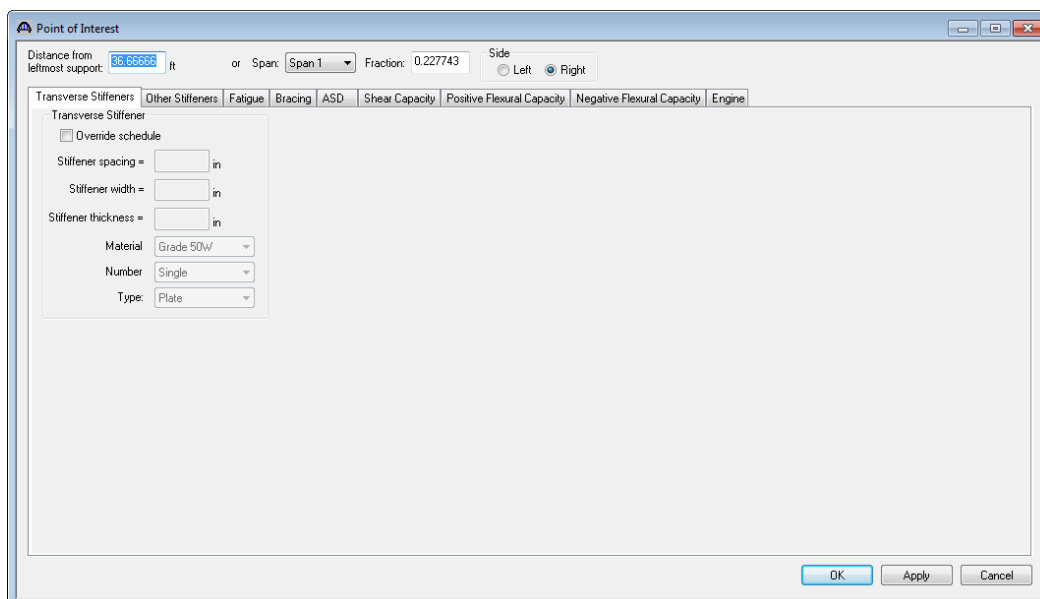
At the bottom of the dialog, there are buttons for "Apply at Diaphragms...", "Stiffeners between Diaphragms...", "New", "Duplicate", "Delete", "OK", "Apply", and "Cancel".

Bearing stiffener definitions were assigned to locations when we used the Apply at Diaphragms... button on the Transverse Stiffener Ranges window. The Bearing Stiffener Location window is opened by expanding the Bearing

Stiffener Locations branch in the tree and double clicking on each support. The assignment for support 1 is shown below.



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.



The description of an interior beam for a structure definition is complete.

## STL1-SimpleSpanPlateGirderExample

This example bridge is modeled after Example 1 from “Four LRFD Design Examples of Steel Highway Bridges”, Volume II, Chapter 1B of the Highway Structures Design Handbook produced by the American Iron and Steel Institute except this example bridge is not skewed like the one in the handbook.

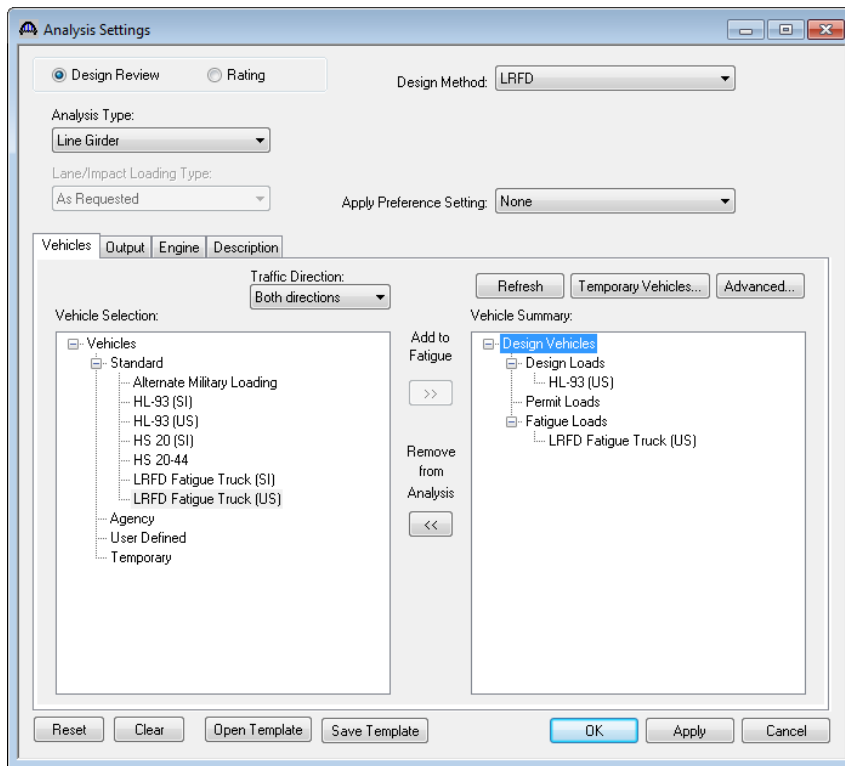
To do LRFR Design Load Rating, enter the Analysis Settings window as shown below:


AASHTO LRFR results for HL93 loading for an interior girder are shown below:

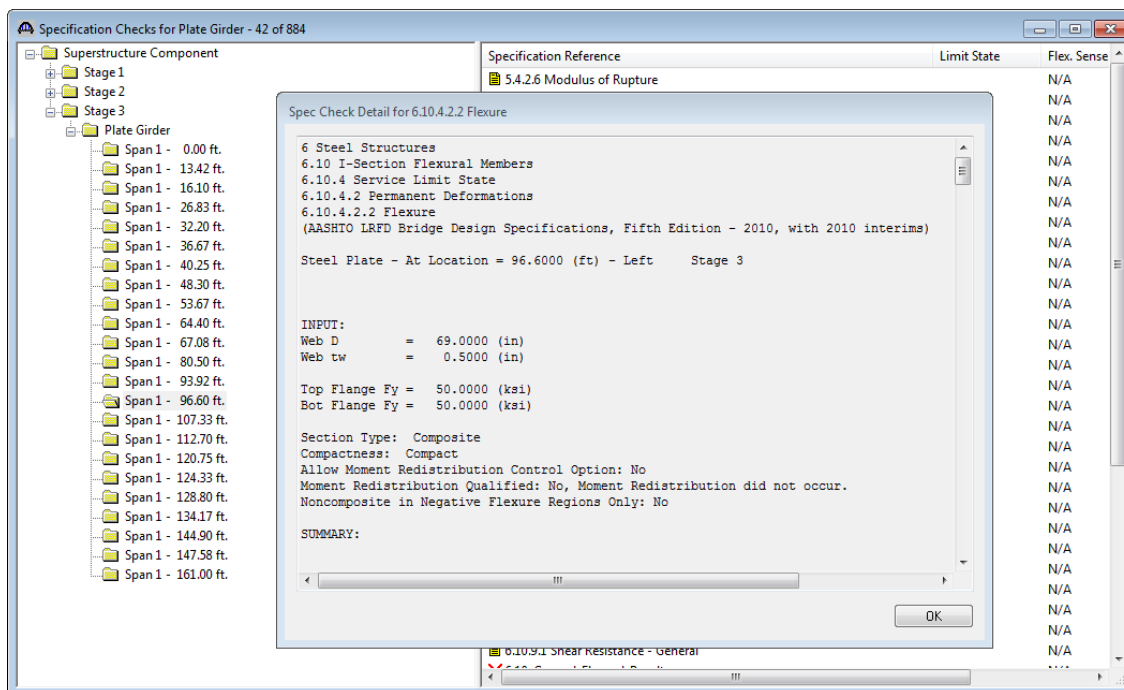
Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Legal Load Rating (Ton)	Permit Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Legal Rating Factor	Permit Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)
HL-93 (US)	Truck + Lane	LRFR	19.45	25.21			0.540	0.700			80.50	1 - ( 50.0)	80.50	1 - ( 50.0)
HL-93 (US)	Tandem + Lane	LRFR	23.07	29.91			0.641	0.831			80.50	1 - ( 50.0)	80.50	1 - ( 50.0)
LRFD Fatigue Truck (US)	Axle Load	LRFR	52.61				1.754				80.50	1 - ( 50.0)		

AASHTO LRFR Engine Version 6.8.2.3001  
Analysis Preference Setting: None


An LRFD design review of this interior girder for HL93 loading can be performed by AASHTO LRFD. To do LRFD design review, enter the Analysis Settings window as shown below:

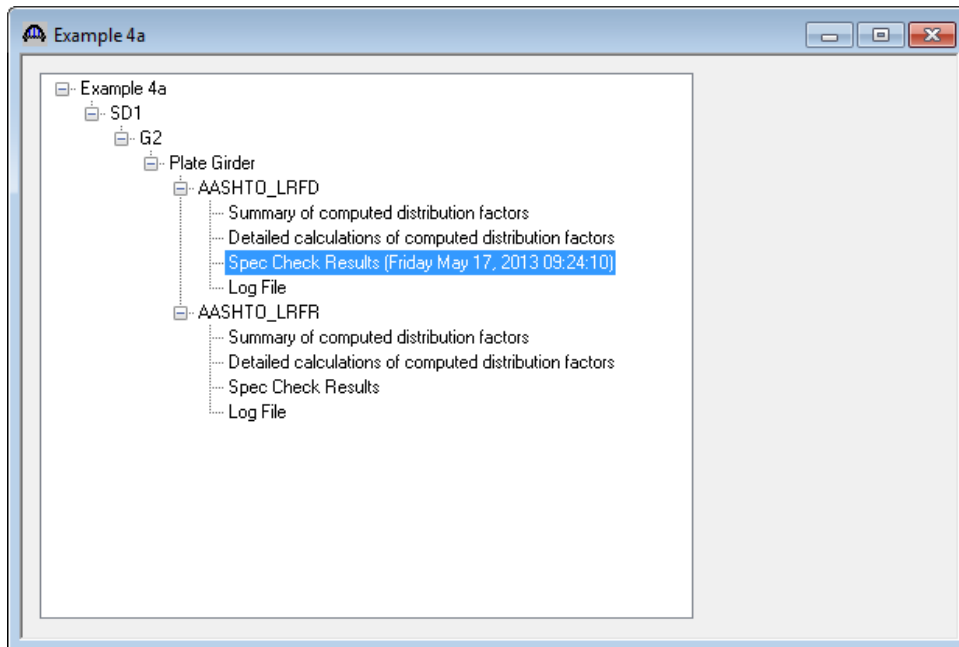


A summary of the specification checks is shown by selecting the View Spec Check button, , from the toolbar. The details for one of the spec checks is shown below.



## STL1-SimpleSpanPlateGirderExample

AASHTO LRFD analysis will generate a spec check results file. Click  on tool bar to open the following window.



To view the spec check results, double click the Spec Check Results in this window.

Bridge ID : 32  
 Bridge : Example 4a  
 Superstructure Def: SD1  
 Member : G2  
 Analysis Preference Setting : None

NBI Structure ID : Example 4a  
 Bridge Alt :  
 Member Alt : Plate Girder

[AASHTO LRFD Specification, Edition 7, Interim 2015](#)

### Specification Check Summary

Article	Status
Flexure (6.10.7.1.1, 6.10.7.2.1)	Pass
Shear (6.10.9)	Pass
Fatigue (6.10.5.3)	Fail
Serviceability (6.10.4.2.2)	Pass
Constructability (6.10.3.2.1, 6.10.3.2.2, 6.10.3.2.3)	Pass
Transverse Stiffeners (6.10.11.1.2, 6.10.11.1.3)	Pass
Longitudinal Stiffeners (6.10.11.3.1, 6.10.11.3.2, 6.10.11.3.3)	NA
Bearing Stiffeners (6.10.11.2.2, 6.10.11.2.3, 6.10.11.2.4)	Pass
Shear Connector (6.10.10.1, 6.10.10.4)	NA
Field Splice (6.13.6.1.4a, 6.13.2.6, 6.13.2.7, 6.13.6.1.4b, 6.13.6.1.4c)	NA

### Girder Member Proportions and Compactness (Stage 3)

Location (ft)	Composite	Proportion Code	Code Check	Compact	Code Check
0.000	Yes	Pass	---	Compact	E
16.100	Yes	Pass	---	Compact	E
32.200	Yes	Pass	---	Compact	E
36.667	Yes	Pass	---	Compact	E
36.670	Yes	Pass	---	Compact	E
48.300	Yes	Pass	---	Compact	E
64.400	Yes	Pass	---	Compact	E
80.500	Yes	Pass	---	Compact	E
96.600	Yes	Pass	---	Compact	E
112.700	Yes	Pass	---	Compact	E
124.330	Yes	Pass	---	Compact	E
128.800	Yes	Pass	---	Compact	E
144.900	Yes	Pass	---	Compact	E
161.000	Yes	Pass	---	Compact	E