

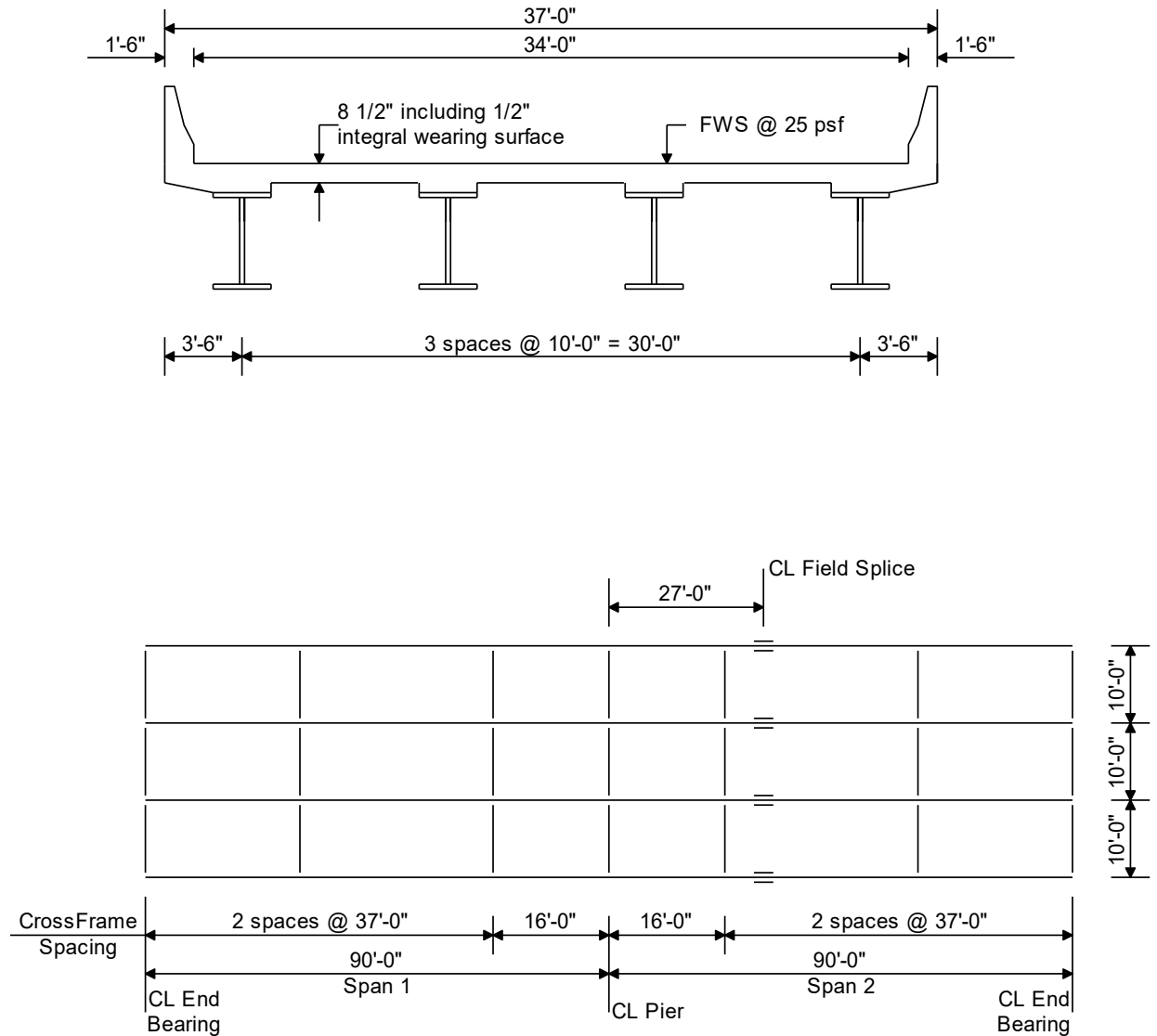
AASHTOWare BrDR 7.6.1

Steel Tutorial

STL2 – Two Span Plate Girder Example

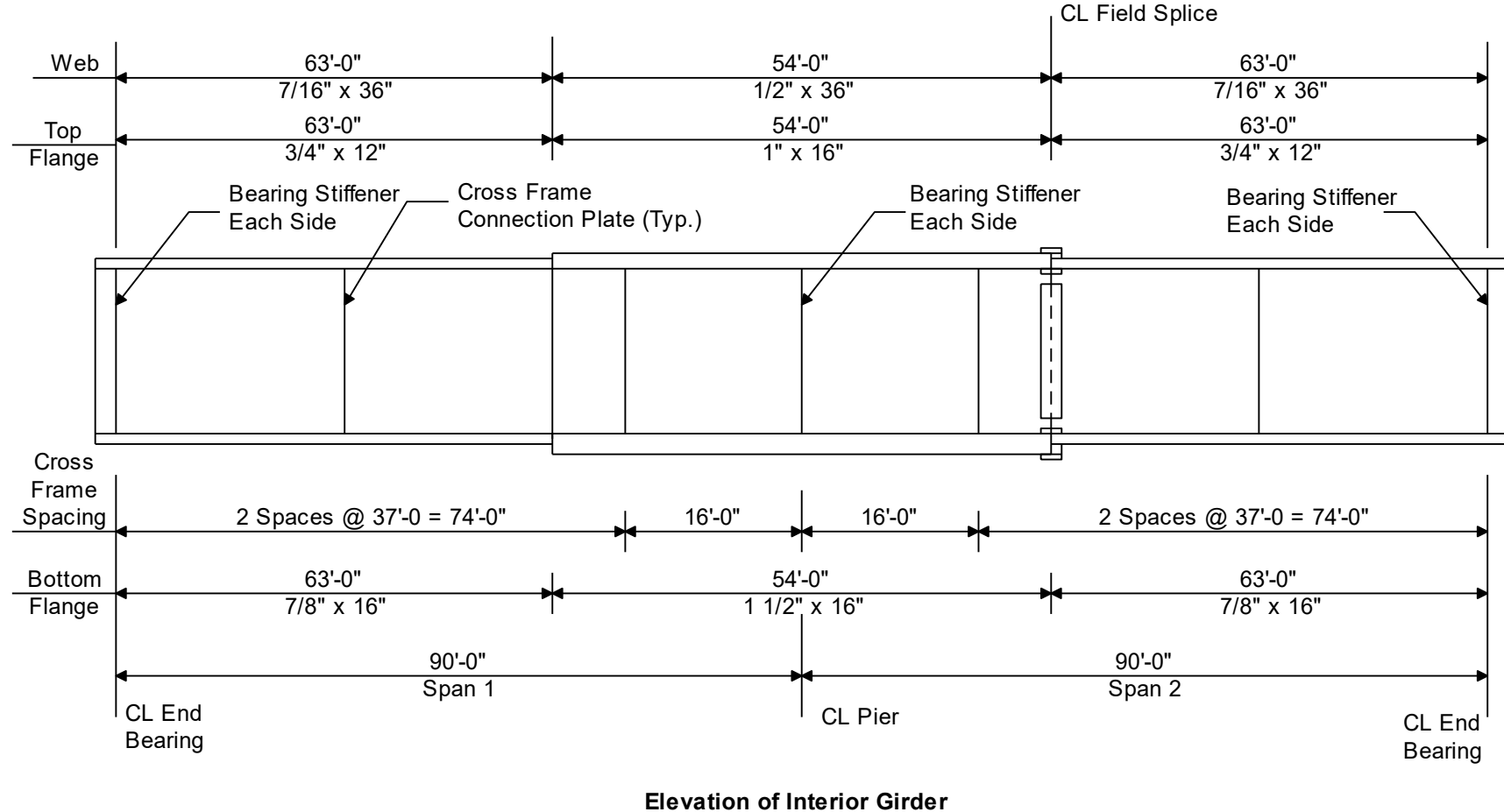
STL2 – Two Span Plate Girder Example

STL2 - Two Span Plate Girder Example

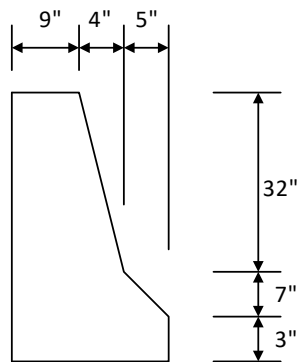
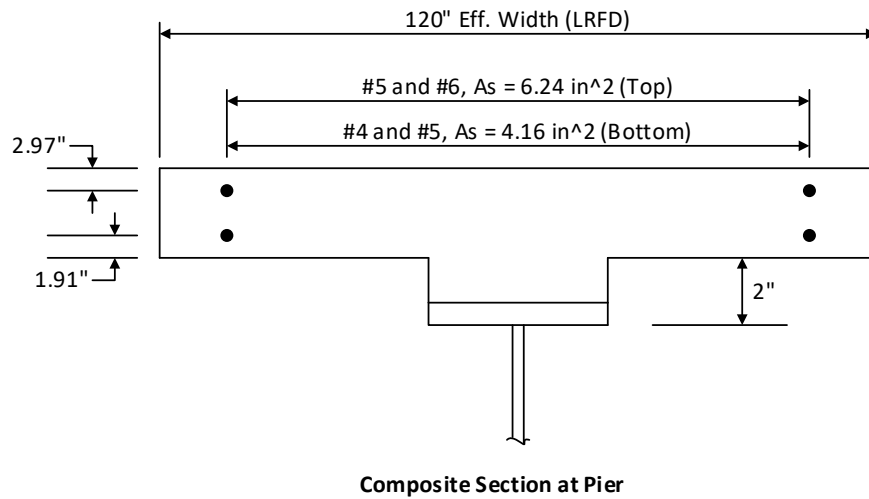


Framing Plan

STL2 – Two Span Plate Girder Example

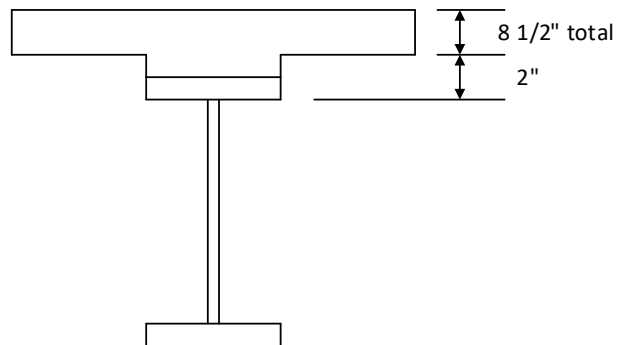


STL2 – Two Span Plate Girder Example



Weight = 536 plf

Parapet Detail



Haunch Detail

Note: The area of steel is provided in the section at the pier but the number of #4, #5, and #6 bars are not provided. For simplicity, the bars will be input using an equivalent number of #9 bars which have a unit area of 1.0 in^2 .

Material Properties

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

Deck Concrete: $f'_c = 4.0 \text{ ksi}$, modular ratio $n = 8$

Slab Reinforcing Steel: AASHTO M31, Grade 60 with $F_y = 60 \text{ ksi}$

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

Bearing Stiffener Plates: 7/8" x 9"

STL2 – Two Span Plate Girder Example

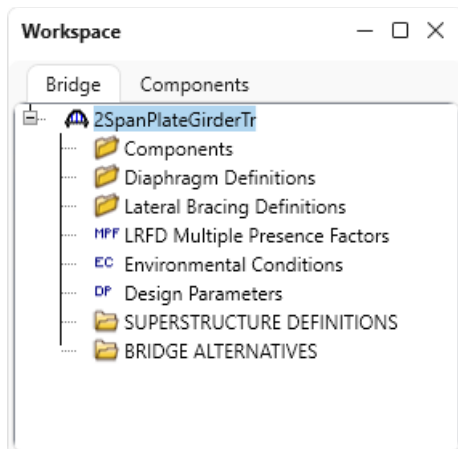
BrDR Tutorial

From the **Bridge Explorer** create a **New** bridge and enter the following description data.

The screenshot shows the '2SpanPlateGirderTr' dialog box. At the top, there are input fields for 'Bridge ID' (2SpanPlateGirderTr) and 'NBI structure ID (8)' (PLGirderTrBri). To the right, there are checkboxes for 'Template' (unchecked), 'Bridge completely defined' (unchecked), and a 'Bridge Workspace View' section with 'Superstructures' (checked), 'Culverts' (unchecked), and 'Substructures' (checked). Below these are tabs for 'Description', 'Description (cont'd)', 'Alternatives', 'Global reference point', 'Traffic', and 'Custom agency fields'. The 'Description' tab is active, showing fields for 'Name' (2SpanPlateGirderTraining), 'Year built' (empty), 'Description' (2 span continuous composite steel plate girder uses LRFD), 'Location' (empty), 'Length' (180 ft), 'Facility carried (7)' (empty), 'Route number' (-1), 'Feat. intersected (6)' (empty), 'Mi. post' (empty), and 'Default units' (US Customary). At the bottom, there is a 'Bridge association...' button and checkboxes for 'BrR' (checked), 'BrD' (checked), and 'BrM' (unchecked). 'OK', 'Apply', and 'Cancel' buttons are at the bottom right.

Click **OK** to apply the data and close the window.

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



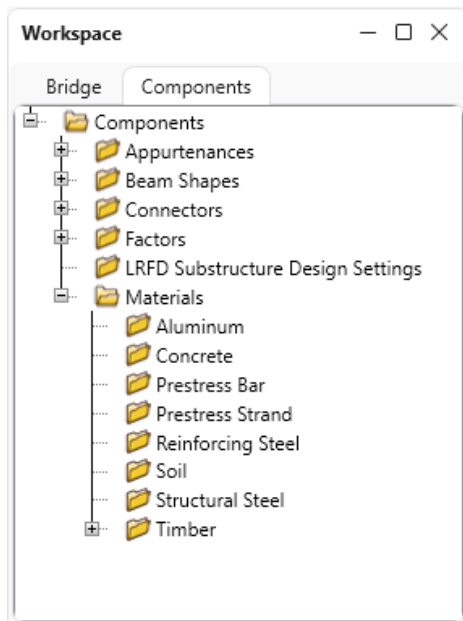
STL2 – Two Span Plate Girder Example

Bridge Components

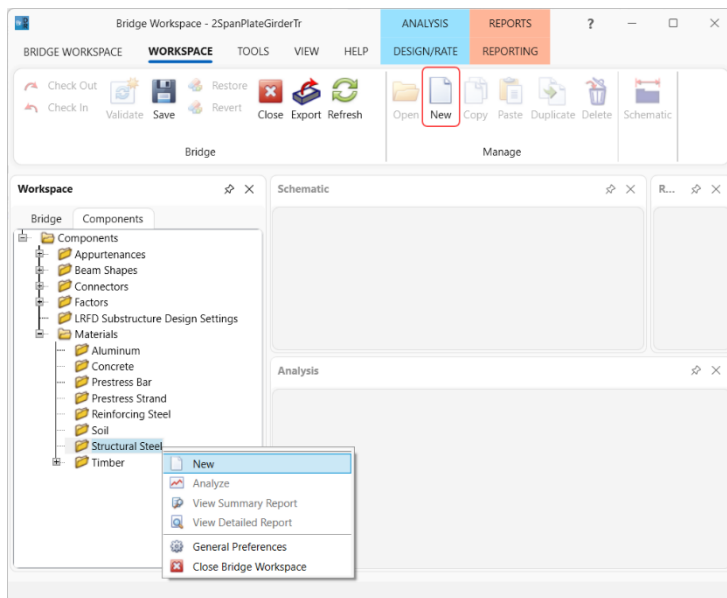
Bridge Materials

To enter the materials to be used by members of the bridge, in the **Components** tab of the **Bridge Workspace**, click on the **+** button to expand the tree for **Materials**.

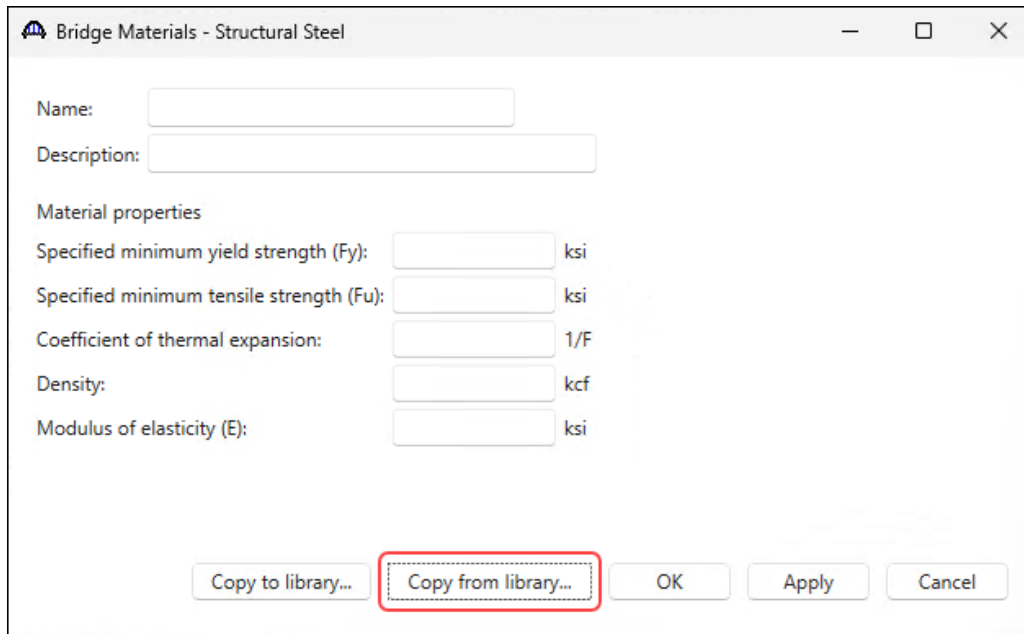
The tree with the expanded **Materials** branch is shown below.



To add a new steel material, in the **Components** tab of the **Bridge Workspace**, click on **Materials**, **Structural Steel**, and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Structural Steel** and select **New**). The window shown below will open.



STL2 – Two Span Plate Girder Example



Bridge Materials - Structural Steel

Name:

Description:

Material properties

Specified minimum yield strength (Fy): ksi

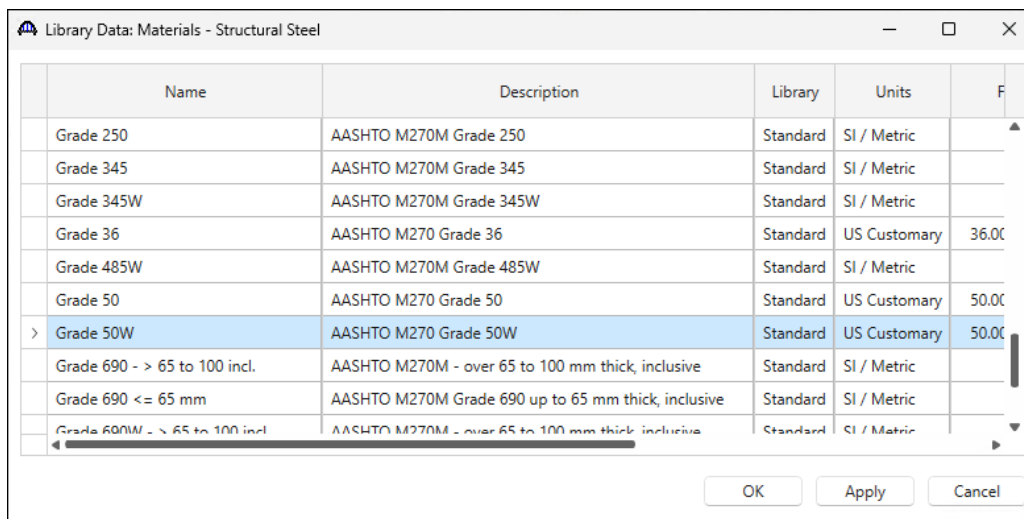
Specified minimum tensile strength (Fu): ksi

Coefficient of thermal expansion: 1/F

Density: kcf

Modulus of elasticity (E): ksi

Add the structural steel material by clicking the **Copy from library...** button. The following window opens. Select the **AASHTO M270 Grade 50W** material and click **OK**.

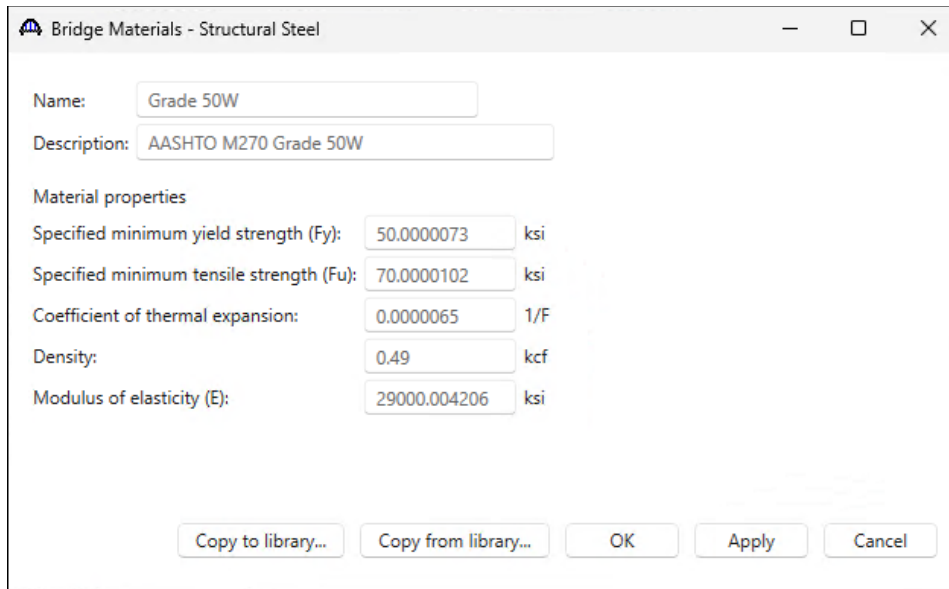


Library Data: Materials - Structural Steel

Name	Description	Library	Units	F
Grade 250	AASHTO M270M Grade 250	Standard	SI / Metric	
Grade 345	AASHTO M270M Grade 345	Standard	SI / Metric	
Grade 345W	AASHTO M270M Grade 345W	Standard	SI / Metric	
Grade 36	AASHTO M270 Grade 36	Standard	US Customary	36.00
Grade 485W	AASHTO M270M Grade 485W	Standard	SI / Metric	
Grade 50	AASHTO M270 Grade 50	Standard	US Customary	50.00
> Grade 50W	AASHTO M270 Grade 50W	Standard	US Customary	50.00
Grade 690 - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standard	SI / Metric	
Grade 690 <= 65 mm	AASHTO M270M Grade 690 up to 65 mm thick, inclusive	Standard	SI / Metric	
Grade 690W - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standard	SI / Metric	

STL2 – Two Span Plate Girder Example

The selected material properties are copied to the Bridge Materials – Structural Steel window as shown below.



Bridge Materials - Structural Steel

Name:

Description:

Material properties

Specified minimum yield strength (Fy): ksi

Specified minimum tensile strength (Fu): ksi

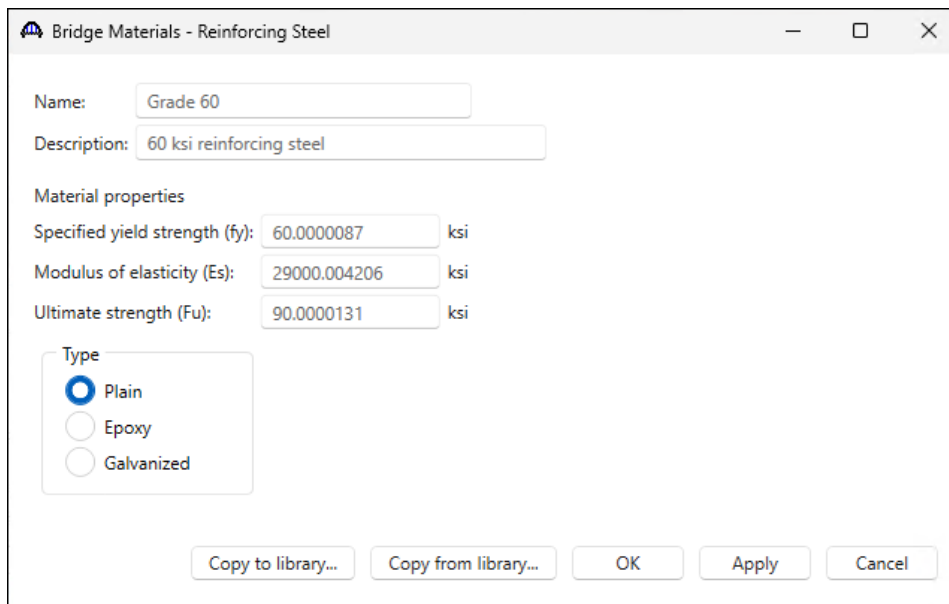
Coefficient of thermal expansion: 1/F

Density: kcf

Modulus of elasticity (E): ksi

Click **OK** to apply the data and close the window.

Add the following reinforcing steel and concrete material using the same techniques.



Bridge Materials - Reinforcing Steel

Name:

Description:

Material properties

Specified yield strength (fy): ksi

Modulus of elasticity (Es): ksi

Ultimate strength (Fu): ksi

Type

☒ Plain

☐ Epoxy

☐ Galvanized

Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Bridge Materials - Concrete

Name:

Description:

Compressive strength at 28 days (f'_c): ksi

Initial compressive strength (f'_{ci}): ksi

Composition of concrete: ▼

Density (for dead loads): kcf

Density (for modulus of elasticity): kcf

Poisson's ratio:

Coefficient of thermal expansion (α): 1/F

Splitting tensile strength (f_{ct}): ksi

LRFD Maximum aggregate size: in

Std modulus of elasticity (E_c): ksi

LRFD modulus of elasticity (E_c): ksi

Std initial modulus of elasticity: ksi

LRFD initial modulus of elasticity: ksi

Std modulus of rupture: ksi

LRFD modulus of rupture: ksi

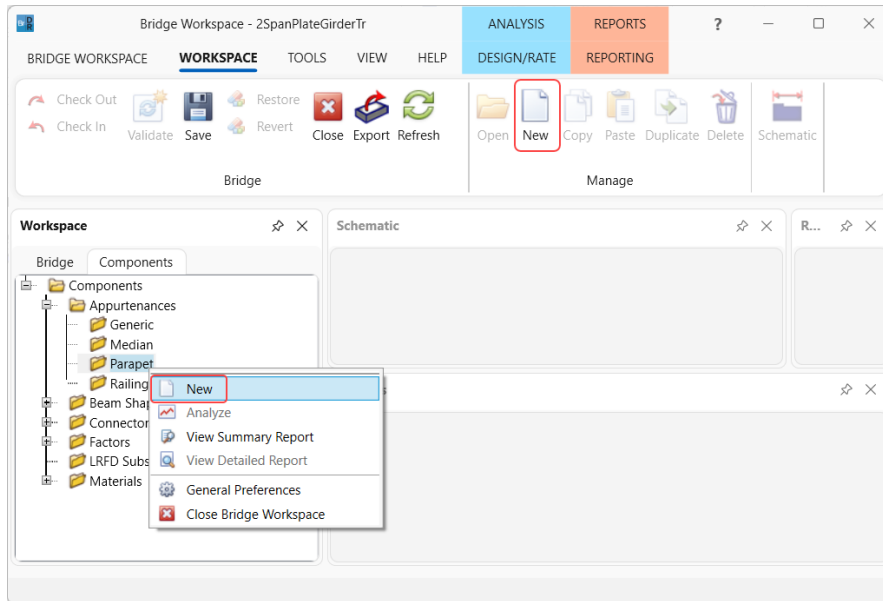
Shear factor:

Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Bridge Appurtenances

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



Enter the parapet details as shown below.

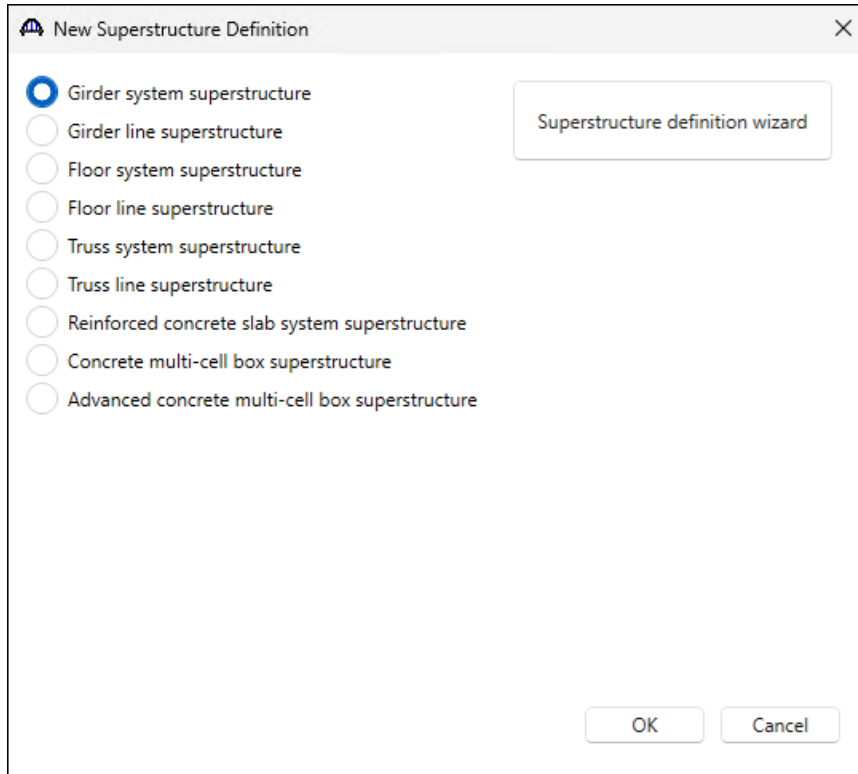
Click **OK** to apply the data and close the window.

The default standard LRFD and LFR factors will be used. Bridge alternatives will be added after entering the structure definition.

STL2 – Two Span Plate Girder Example

Superstructure Definition

Returning to the **Bridge** tab of the **Bridge Workspace**, double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the **WORKSPACE** ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition. The window shown below will appear.



Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open.

STL2 – Two Span Plate Girder Example

Enter the data as shown below and click **Apply** to apply the data and keep the window open.

Girder System Superstructure Definition

Definition Analysis Specs Engine

Name: 2 Span 4 Girder System

Description:

Default units: US Customary

Number of spans: 2

Number of girders: 4

Enter span lengths along the reference line:

Span	Length (ft)
1	90
2	90

Modeling

☒ Multi-girder system ☐ MCB

☐ With frame structure simplified definition

Deck type: Concrete Deck

For PS/PT only

Average humidity: %

Member alt. types

☒ Steel

☐ P/S

☐ R/C

☐ Timber

☐ P/T

Horizontal curvature along reference line

☐ Horizontal curvature

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: Left

End tangent length: ft

Distance from last support line to PT: ft

Design speed: mph

Superelevation: %

Superstructure alignment

☒ Curved

☐ Tangent, curved, tangent

☐ Tangent, curved

☐ Curved, tangent

OK Apply Cancel

STL2 – Two Span Plate Girder Example

The **Analysis** tab is shown below with the default selections. For this example, the default values will not be overridden. No changes are required on this tab.

The screenshot shows the 'Girder System Superstructure Definition' window with the 'Analysis' tab selected. The window contains several configuration panels for structural analysis settings.

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 ft

Transverse loading

Vehicle increment in lane: 2 ft

Lane increment: 4 ft

3D analysis control options

- ☒ LFR: 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

Target aspect ratio for shell elements

Slower More accurate | Faster Less accurate

3D FE node generation tolerance

☒ Percentage

☐ Length

	Span	Length (ft)	Tolerance (%)
>	1	90	0.1
	2	90	0.1

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

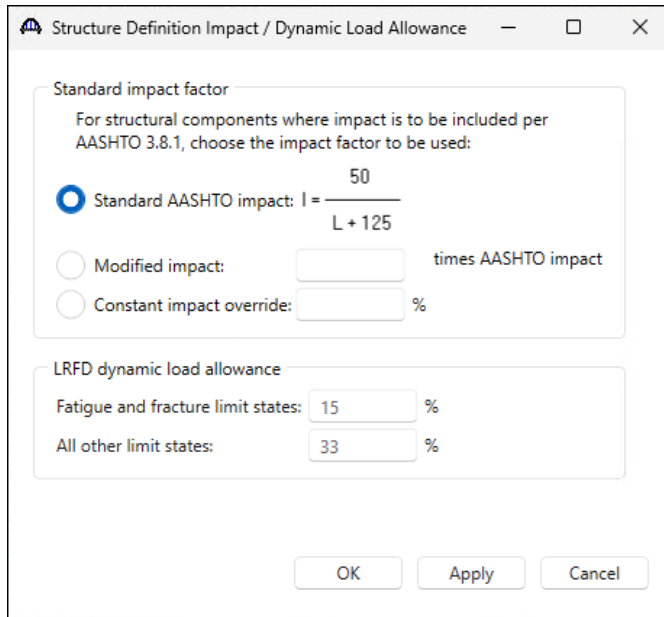
OK Apply Cancel

Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Impact/Dynamic Load Allowance

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



Structure Definition 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: %

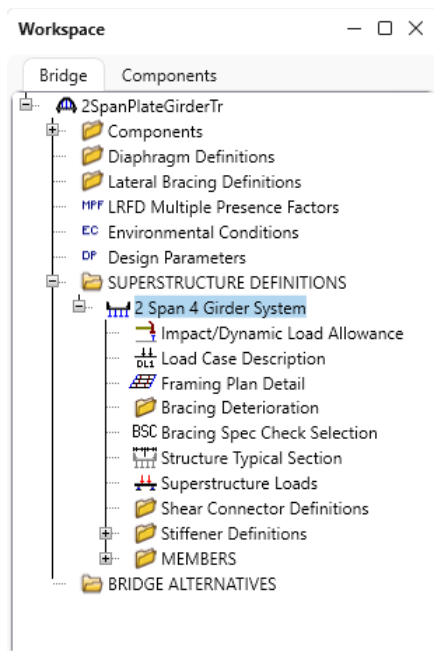
LRFD dynamic load allowance

Fatigue and fracture limit states: %

All other limit states: %

OK Apply Cancel

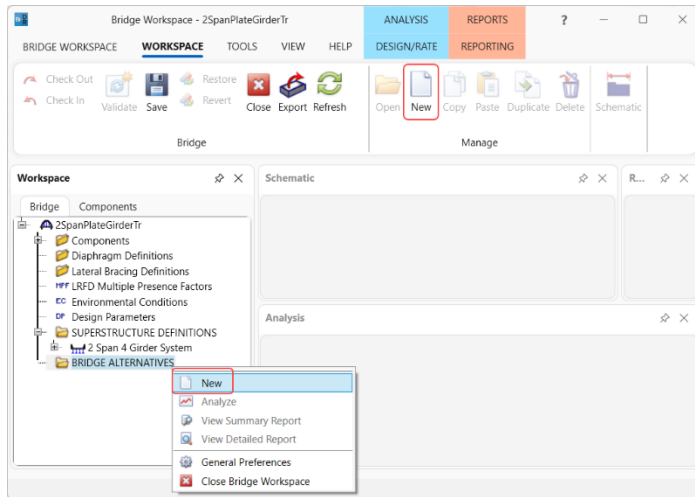
The partially expanded **Bridge Workspace** tree is shown below.



STL2 – Two Span Plate Girder Example

BRIDGE ALTERNATIVES

Navigate to the **BRIDGE ALTERNATIVES** node in the **Bridge Workspace** tree and create a new bridge alternative by double-clicking on **BRIDGE ALTERNATIVES** (or click on **BRIDGE ALTERNATIVES** and select **New** from the **Manage** group of the **WORKSPACE** ribbon).



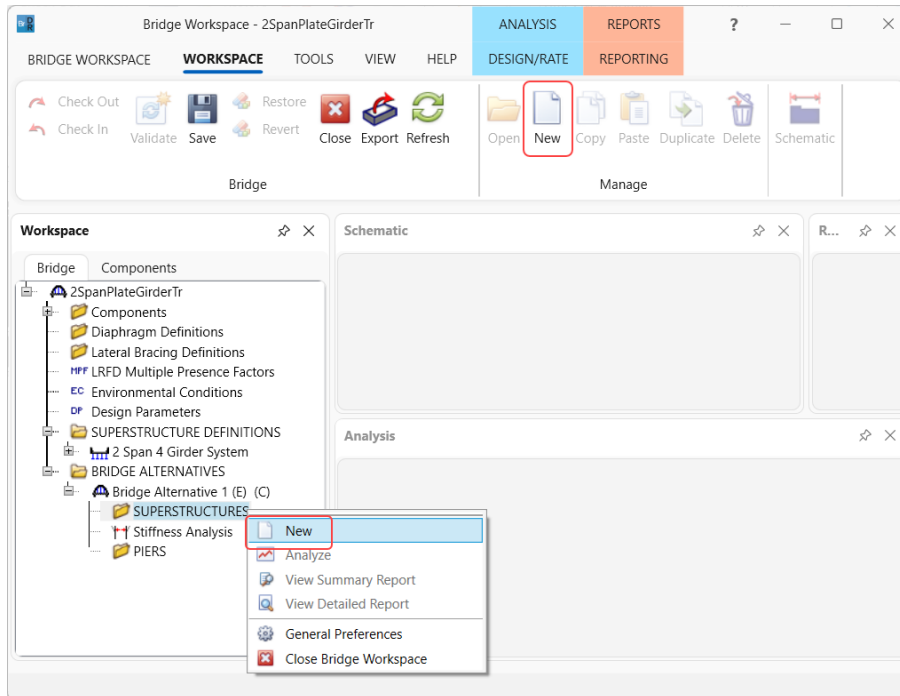
Enter the following data.

A screenshot of the 'Bridge Alternative' dialog box. The 'Alternative name' is 'Bridge Alternative 1'. The 'Description' tab is selected. The 'Description' field is empty. The 'Horizontal curvature' checkbox is unchecked. The 'Reference line length' is 0 ft. The 'Start bearing' radio button is selected. The 'Starting station' is 0 ft. The 'Bearing' is N 90° 0' 0.00" E. The 'Global positioning' section has 'Distance' at 0 ft, 'Offset' at 0 ft, and 'Elevation' at 0 ft. The 'Bridge alignment' section has 'Curved' selected. The 'Start tangent length' is 0 ft, 'Curve length' is 0 ft, 'Radius' is 0 ft, 'Direction' is 'Left', and 'End tangent length' is 0 ft. There are buttons for 'Superstructure wizard...' and 'Culvert wizard...'. At the bottom are 'OK', 'Apply', and 'Cancel' buttons.

Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example


Expand the **Bridge Alternative 1** node in the **Bridge Workspace** tree by clicking the **+** button. Double-click on the **SUPERSTRUCTURES** node (or select **SUPERSTRUCTURES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure.

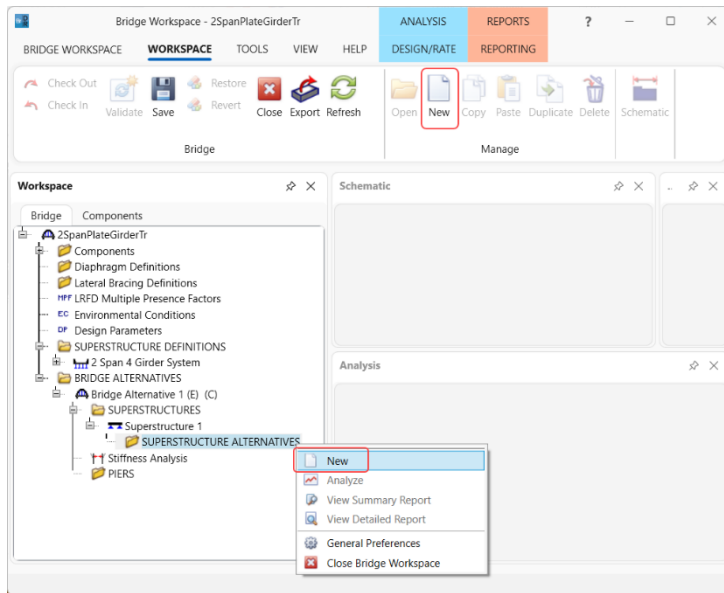


The screenshot shows the 'Superstructure' dialog box. The title bar reads 'Superstructure'. The 'Superstructure name' field contains 'Superstructure 1'. The 'Description' tab is selected, showing a large text area for the description. Below the description area, there is a 'Reference line' section with input fields for 'Distance' (0 ft), 'Offset' (0 ft), 'Angle' (0 Degrees), and 'Starting station' (ft). At the bottom right, there are 'OK', 'Apply', and 'Cancel' buttons.

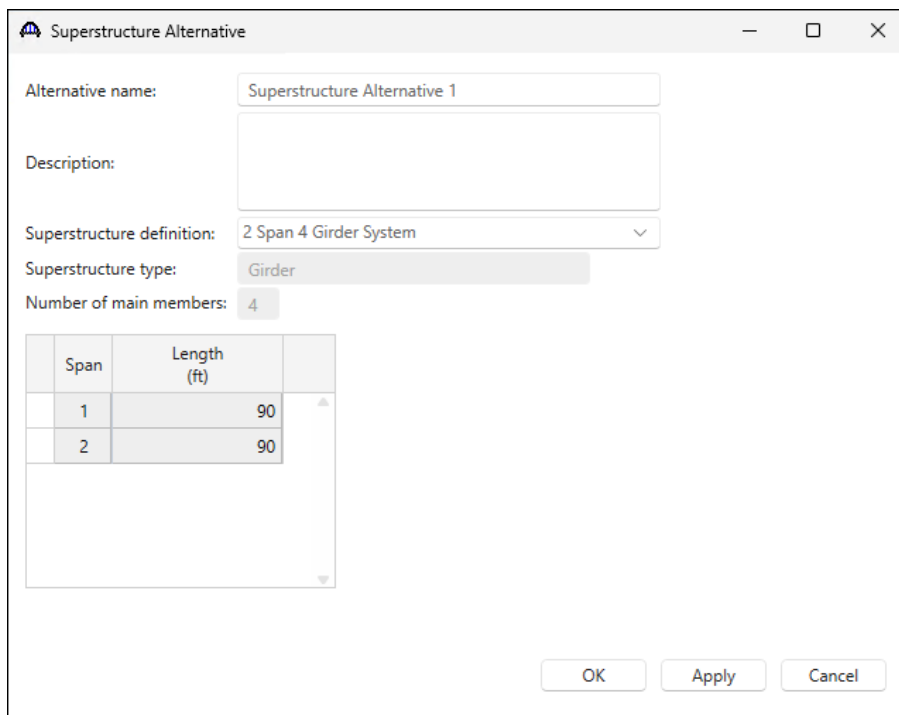
Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Expand the **Superstructure 1** node in the **Bridge Workspace** tree by clicking the  button. Double-click on the **SUPERSTRUCTURE ALTERNATIVES** node (or select **SUPERSTRUCTURE ALTERNATIVES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure alternative.



Select the **Superstructure definition 2 Span 4 Girder System** as the current superstructure definition for this Superstructure Alternative.



Alternative name:

Description:

Superstructure definition:

Superstructure type:

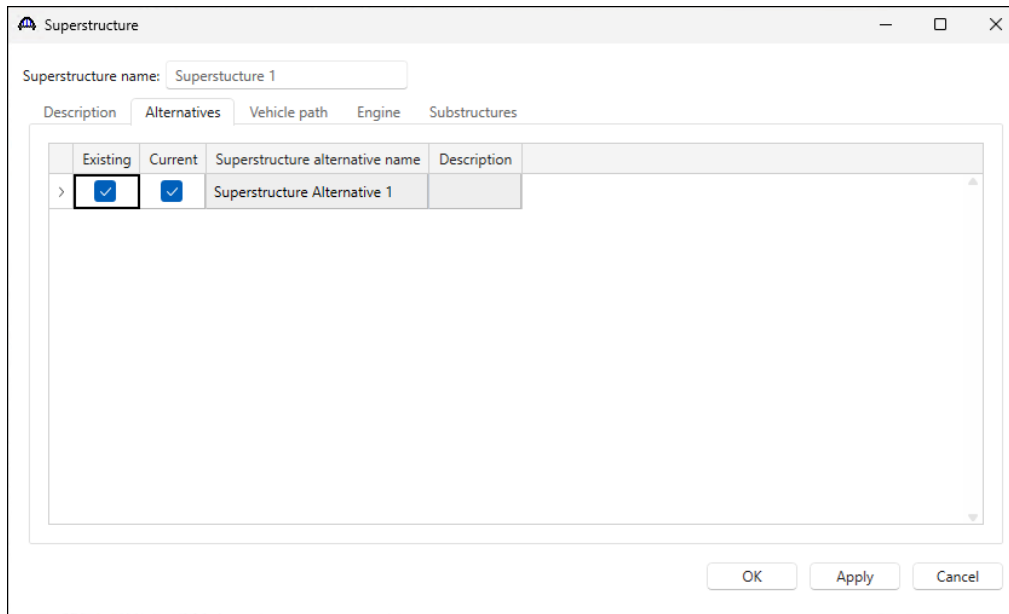
Number of main members:

Span	Length (ft)
1	90
2	90

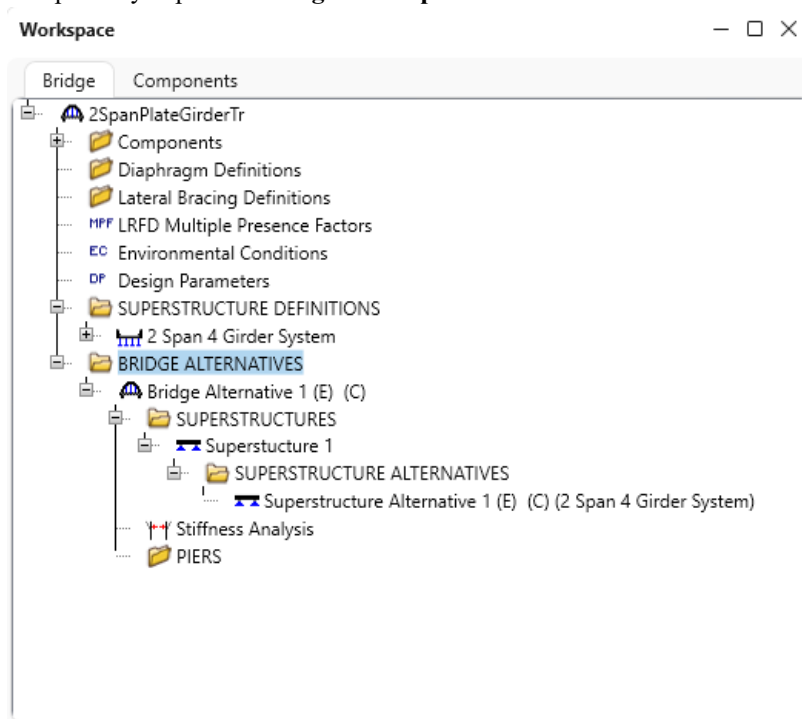
OK Apply Cancel

STL2 – Two Span Plate Girder Example

Re-open the **Superstructure 1** window and navigate to the **Alternatives** tab. The **Superstructure Alternative 1** linked to **2 Span 4 Girder System** is shown as the **Existing** and **Current** alternative for **Superstructure 1**.



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



STL2 – Two Span Plate Girder Example

Load Case Description

Navigate to the **2 Span 4 Girder System** superstructure definition and double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description** window. Click on the **Add default load case description** button to create the following load cases.

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

Click **OK** to apply the data and close the window.

Structure Framing Plan Detail – Layout

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

Structure Framing Plan Details

Number of spans: 2 Number of girders: 4

Layout Diaphragms Lateral bracing ranges

Girder spacing orientation

☒ Perpendicular to girder
☐ Along support

Support	Skew (degrees)
> 1	0
2	0
3	0

Girder bay	Girder spacing (ft)	
	Start of girder	End of girder
> 1	10	10
2	10	10
3	10	10

OK Apply Cancel

STL2 – Two Span Plate Girder Example

Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing. Enter the following diaphragms for **Girder bay 1** as shown below and click the **Apply** button.

Structure Framing Plan Details

Number of spans: 2

Number of girders: 4

Layout

Diaphragms

Lateral bracing ranges

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	0	0	1	0	0	0	--Not Assigned--	
1	0	0	37	2	74	74	74	--Not Assigned--	
2	0	0	0	1	0	0	0	--Not Assigned--	
2	0	0	16	1	16	16	16	--Not Assigned--	
> 2	16	16	37	2	74	90	90	--Not Assigned--	

New

Duplicate

Delete

OK

Apply

Cancel

Click the **Copy bay to...** button to copy the diaphragms entered for bay 1 to the other bays. The following window appears. Select **Bay 2** and **Bay 3** by holding the **Ctrl** key and click **Apply**.

Copy Diaphragm Bay

Select the new bay(s):

Bay 2

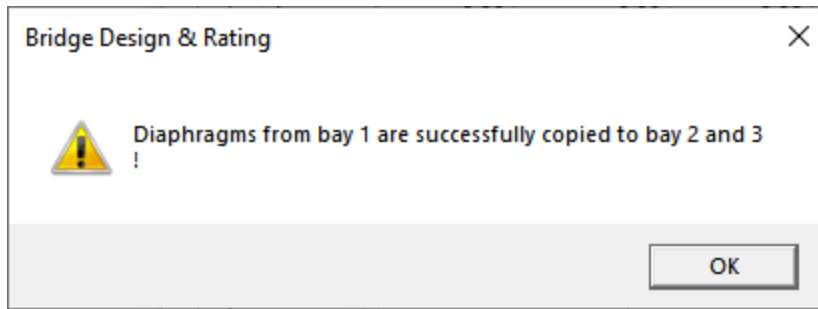
Bay 3

Apply

Cancel

STL2 – Two Span Plate Girder Example

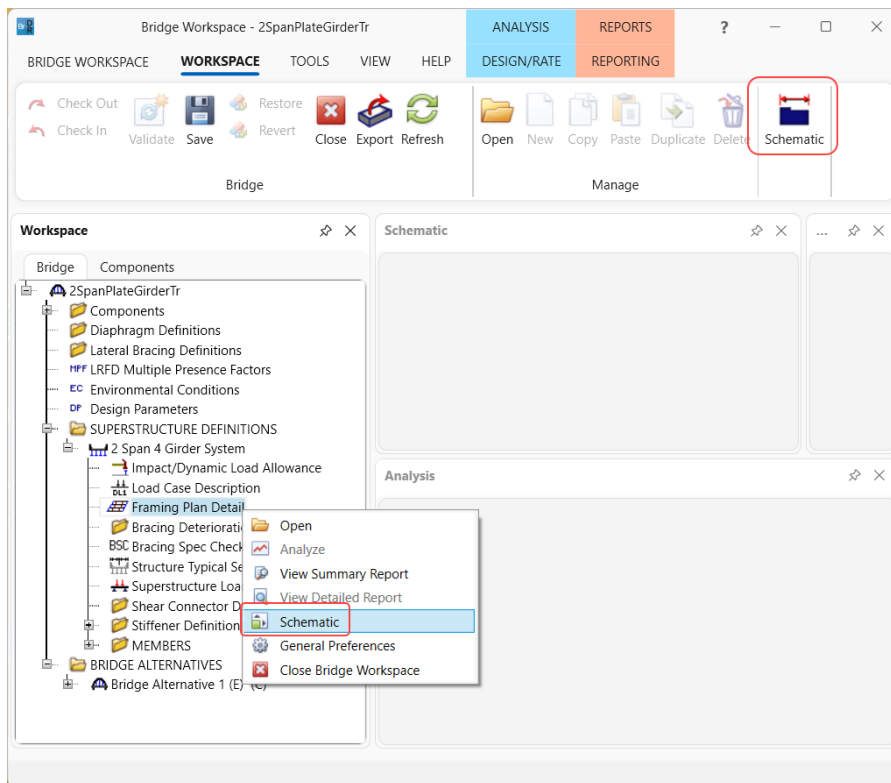
The following message appears indicating that the diaphragms have been copied. Click **OK**.



Click **OK** to apply the data and close the window.

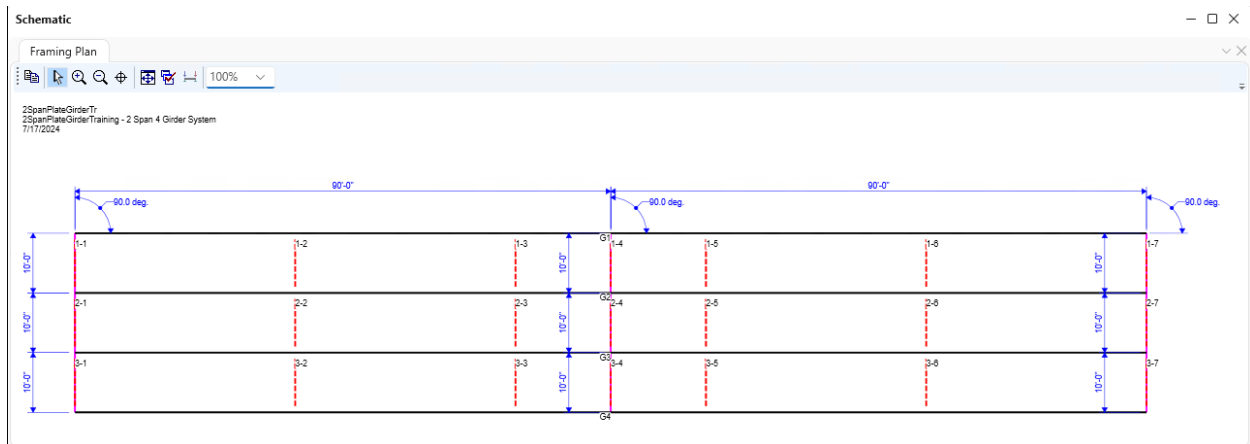
Schematic - Framing Plan Detail

While the **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu).



STL2 – Two Span Plate Girder Example

The following schematic is displayed.



Structure Typical Section - Deck

Next define the structure typical section by double-clicking on **Structure Typical Section** node in the **Bridge Workspace** tree. Input the data describing the typical section as shown below.

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.

	Start	End
Distance from left edge of deck to superstructure definition reference line:	18.5 ft	18.5 ft
Distance from right edge of deck to superstructure definition reference line:	18.5 ft	18.5 ft
Left overhang:	3.5 ft	3.5 ft
Computed right overhang:	3.5 ft	3.5 ft

OK Apply Cancel

STL2 – Two Span Plate Girder Example

Structure Typical Section – Deck (cont'd)

The **Deck (cont'd)** tab provides input options for the **Deck concrete** and the **Total deck thickness**. The material for the deck concrete is selected from the list of bridge materials. Enter the data as shown below.

Structure Typical Section

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

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

Deck thickness

Superstructure Definition Reference Line

Left overhang

Right overhang

Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface

Deck concrete: Class A (US)

Total deck thickness: 8.5 in

Load case: Engine Assigned

Deck crack control parameter: kip/in

Sustained modular ratio factor: 3

Deck exposure factor:

OK Apply Cancel

STL2 – Two Span Plate Girder Example

Structure Typical Section – Parapet

Navigate to the **Parapet** tab. Click the **New** button 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 select **Back** in the **Measure to** column (in this example, locate 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**. Enter another parapet as shown below. The completed tab is shown below.

The screenshot shows the 'Structure Typical Section' window with the 'Parapet' tab selected. A diagram at the top left shows a cross-section of a parapet with 'Back' and 'Front' labels. Below the diagram is a table with the following data:

	Name	Load case	Measure to	Edge of deck dist. measured from	Distance at start (ft)	Distance at end (ft)	Front face orientation
>	Standard Parapet	DC2	Back	Left Edge	0	0	Right
	Standard Parapet	DC2	Back	Right Edge	0	0	Left

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

Structure Typical Section – Lane Positions

Select the **Lane position** tab and use the **Compute...** button to compute the lane positions. A window showing the results of the computation opens. Click **Apply** to apply the computed values.

The screenshot shows the 'Compute Lane Positions' window with a table containing the following data:

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	-17	17	-17	17

Buttons at the bottom right include 'Apply' and 'Cancel'.

STL2 – Two Span Plate Girder Example

The **Lane Position** tab is populated as shown below.

Structure Typical Section

Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk **Lane position** Striped lanes 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	-17	17	-17	17

LRFD fatigue

Lanes available to trucks:

☐ Override Truck fraction:

Compute New Duplicate Delete

OK Apply Cancel

Structure Typical Section – Wearing surface

Navigate to the **Wearing surface** tab. Enter the data shown below.

Structure Typical Section

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

Deck thickness Superstructure Definition Reference Line

Left overhang Right overhang

Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes **Wearing surface**

Wearing surface material:

Description:

Wearing surface thickness: in ☐ Thickness field measured (DW = 1.25 if checked)

Wearing surface density: pcf

Load case:

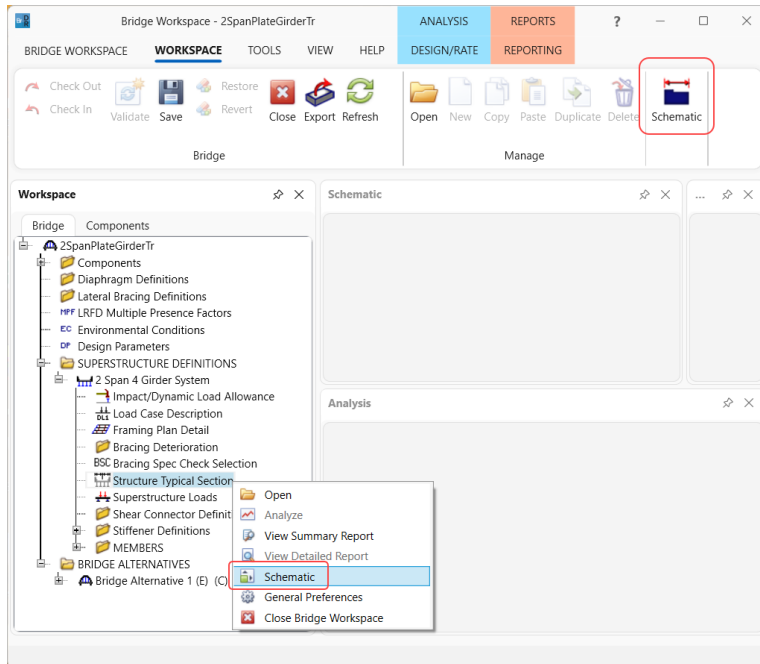
OK Apply Cancel

Click **OK** to apply the data and close the window.

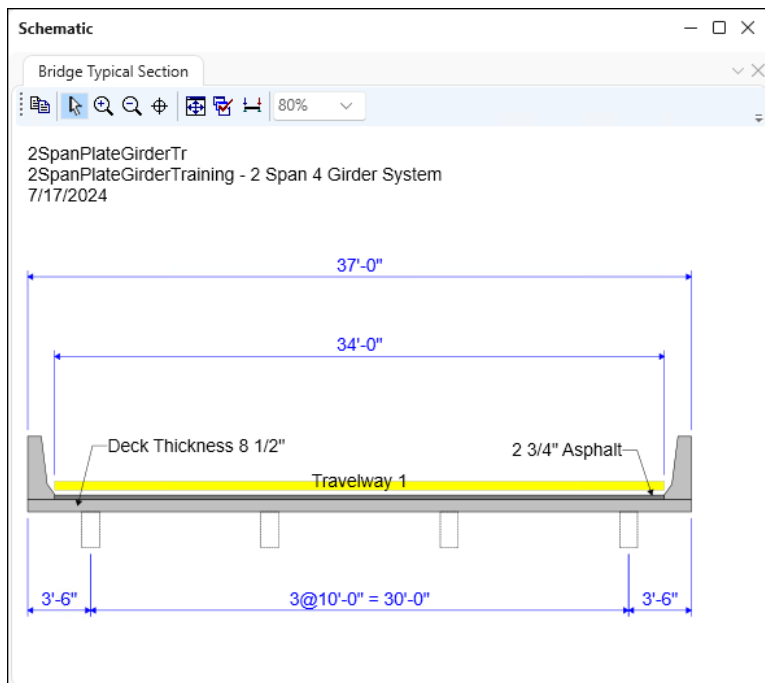
STL2 – Two Span Plate Girder Example

Schematic – Structure Typical Section

While the **Structure Typical Section** is selected in the **Bridge Workspace** tree, open the schematic for the structure typical section by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Structure Typical Section** in the **Bridge Workspace** and select **Schematic** from the menu).



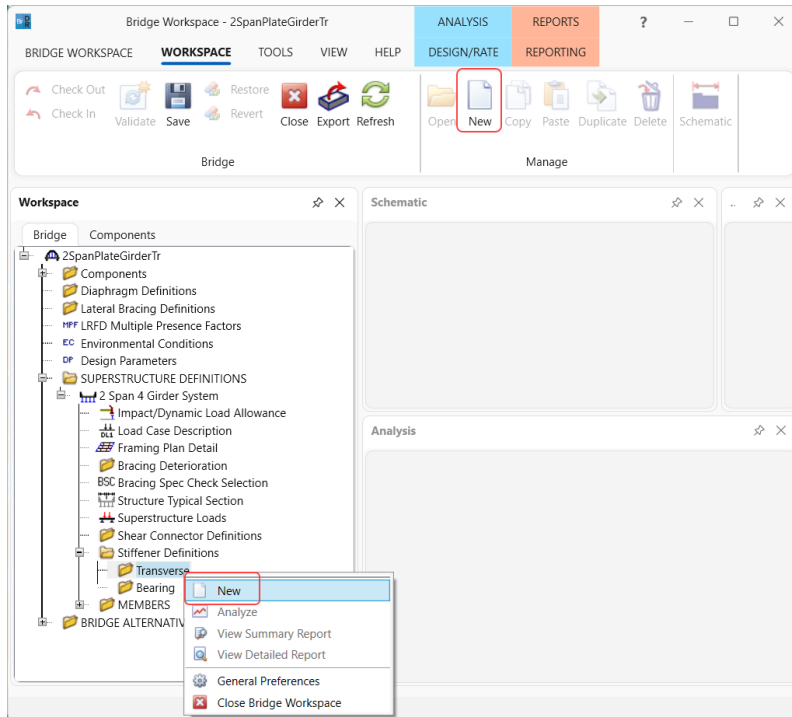
The following schematic is displayed. The girders are displayed as dashed boxes since they are not defined yet.



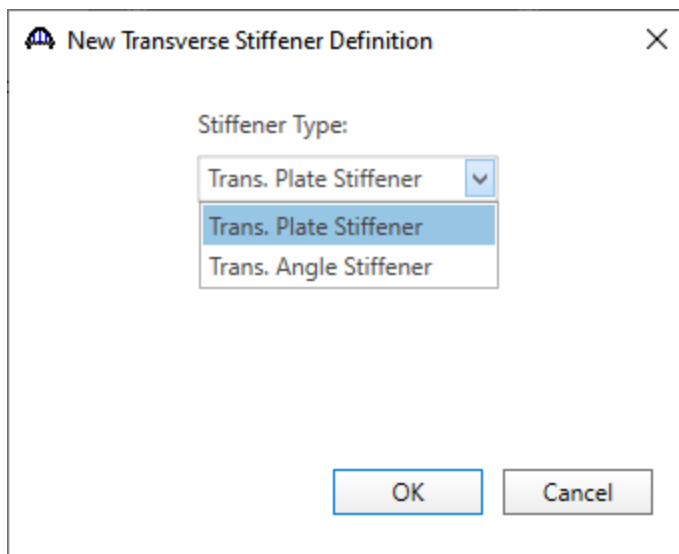
STL2 – Two Span Plate Girder Example

Stiffener Definitions – Transverse

Define the transverse stiffeners to be used by the girders. Expand the **Stiffener Definitions** node in the **Bridge Workspace** tree, select **Transverse** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New** from the drop-down menu) as shown below.

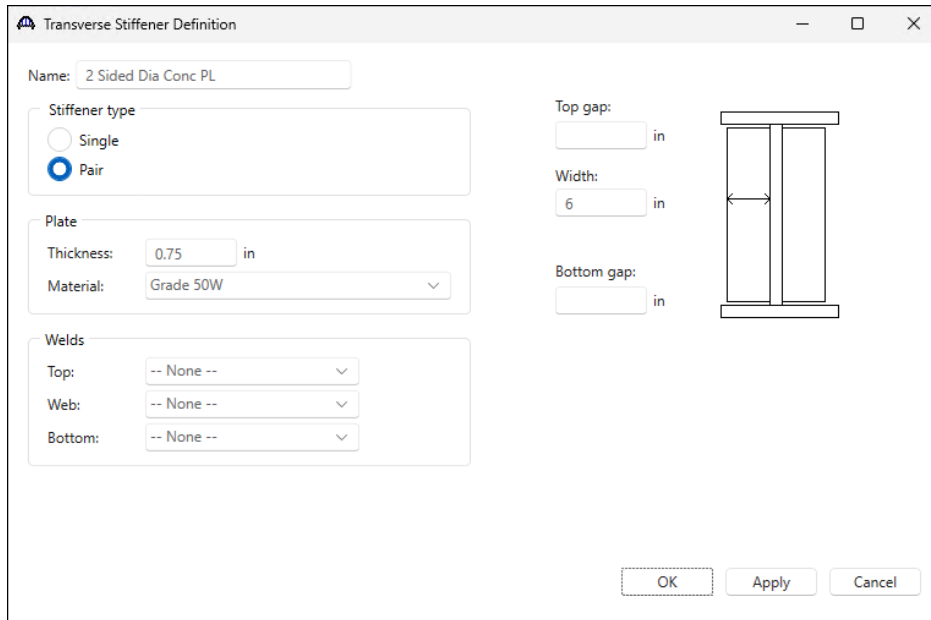


Select **Trans. Plate Stiffener** for **Stiffener Type** in the **New Transverse Stiffener Definition** window and click **OK** to open the **Transverse Stiffener Definition** window as shown below.



Define the stiffener as shown below.

STL2 – Two Span Plate Girder Example



The dialog box is titled "Transverse Stiffener Definition". It contains the following fields and options:

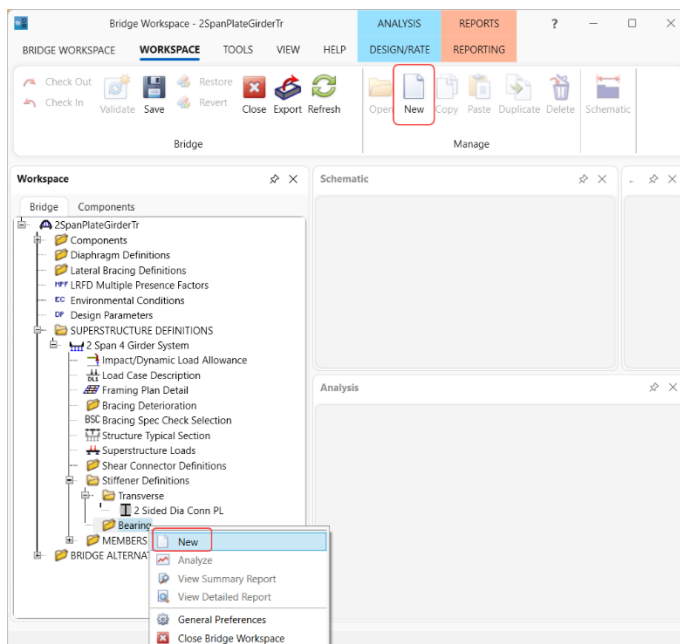
- Name:** 2 Sided Dia Conc PL
- Stiffener type:** Radio buttons for "Single" and "Pair". "Pair" is selected.
- Plate:**
 - Thickness:** 0.75 in
 - Material:** Grade 50W
- Welds:** Three dropdown menus for "Top:", "Web:", and "Bottom:", all set to "-- None --".
- Top gap:** [] in
- Width:** 6 in
- Bottom gap:** [] in

On the right side of the dialog, there is a schematic diagram of a plate girder cross-section showing two vertical stiffeners. At the bottom of the dialog are three buttons: "OK", "Apply", and "Cancel".

Click **OK** to apply the data and close the window.

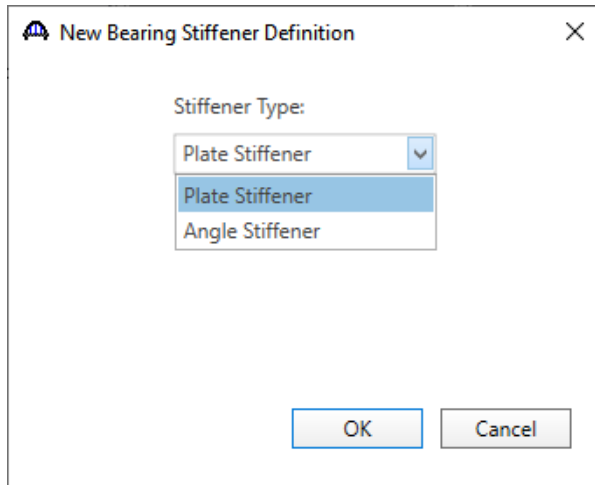
Stiffener Definitions – Bearing

Define the bearing stiffeners to be used by the girders. Expand the **Stiffener Definitions** node in the **Bridge Workspace** tree, select **Bearing** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New** from the drop-down menu) as shown below.

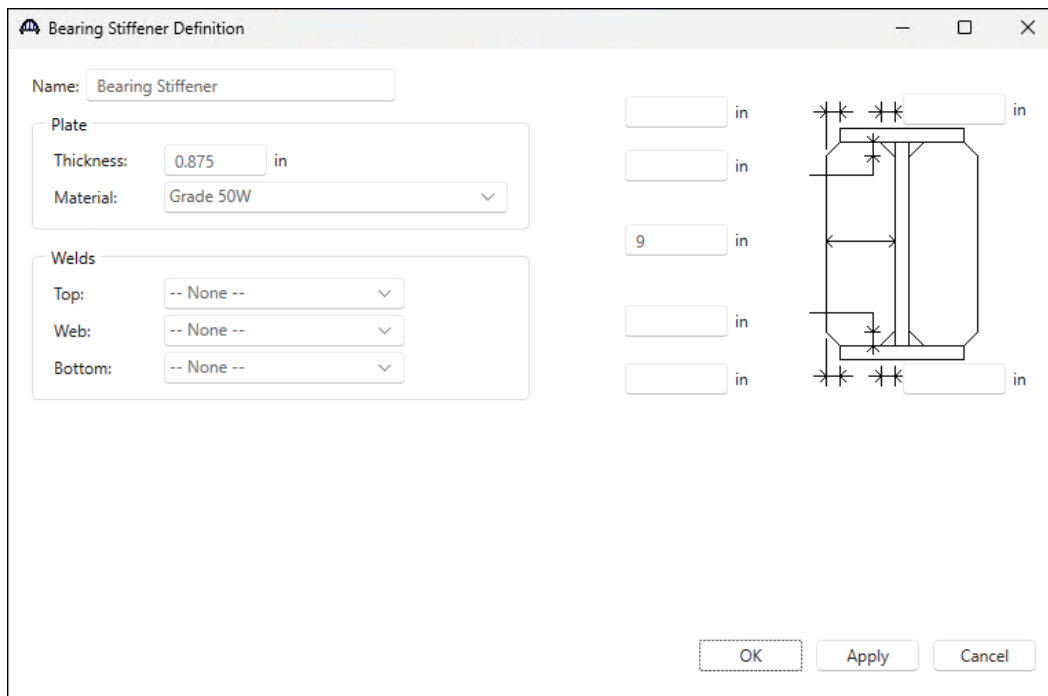


STL2 – Two Span Plate Girder Example

Select **Plate Stiffener** for **Stiffener type** in the **New Transverse Stiffener Definition** window and click **OK** to open the **Transverse Stiffener Definition** window as shown below.



Define the stiffener as shown below.

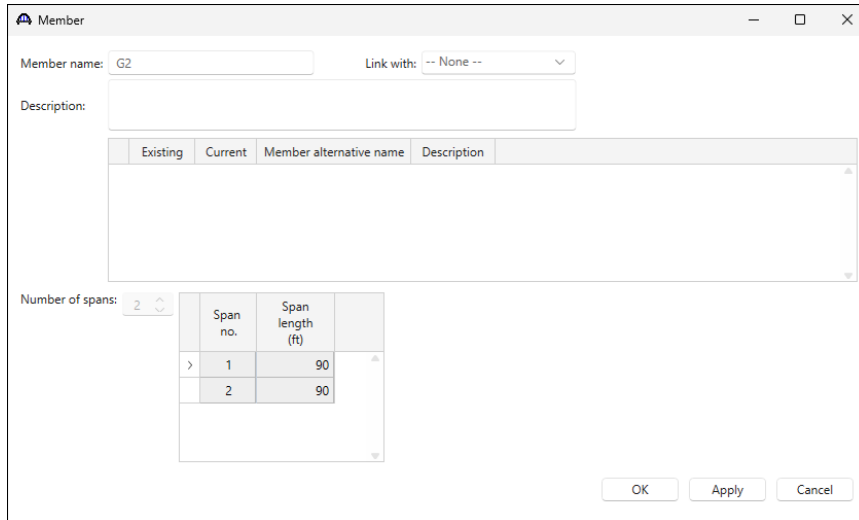


Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Describing a member

The **Member** window shows the data generated when the structure definition is created. Expand the **MEMBERS** folder and double click on **G2** node. No changes are required in this window. The first member alternative created will automatically be assigned as the **Existing** and **Current member alternative** for this member.



The Member window displays the following information:

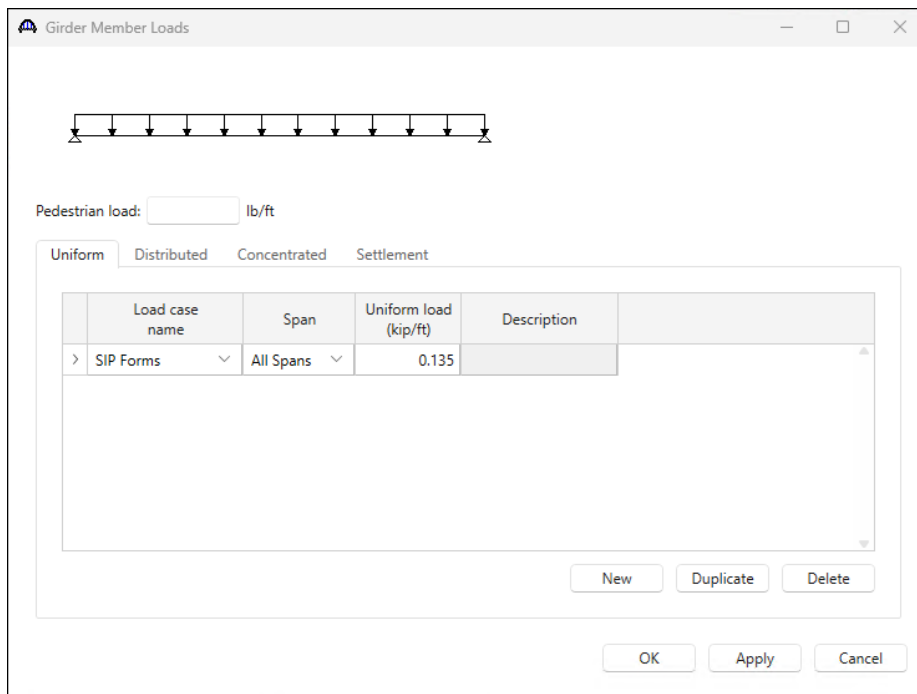
- Member name: G2
- Link with: -- None --
- Description: (empty text box)
- Table with columns: Existing, Current, Member alternative name, Description
- Number of spans: 2
- Span table:

	Span no.	Span length (ft)
>	1	90
	2	90

Buttons: OK, Apply, Cancel

Member Loads

Expand the **G2** member node. Double-click on the **Member Loads** node in the **Bridge Workspace** tree to open the **Girder Member Loads** window. Add a new row and select **SIP Forms** from the options for **Load case name**. Enter the **Uniform load** due to the stay-in-place forms as shown below.



The Girder Member Loads window displays the following information:

- Diagram of a two-span girder with a uniform load applied across both spans.
- Pedestrian load: (empty text box) lb/ft
- Load type tabs: Uniform (selected), Distributed, Concentrated, Settlement
- Table with columns: Load case name, Span, Uniform load (kip/ft), Description
- Buttons: New, Duplicate, Delete
- Buttons: OK, Apply, Cancel

	Load case name	Span	Uniform load (kip/ft)	Description
>	SIP Forms	All Spans	0.135	

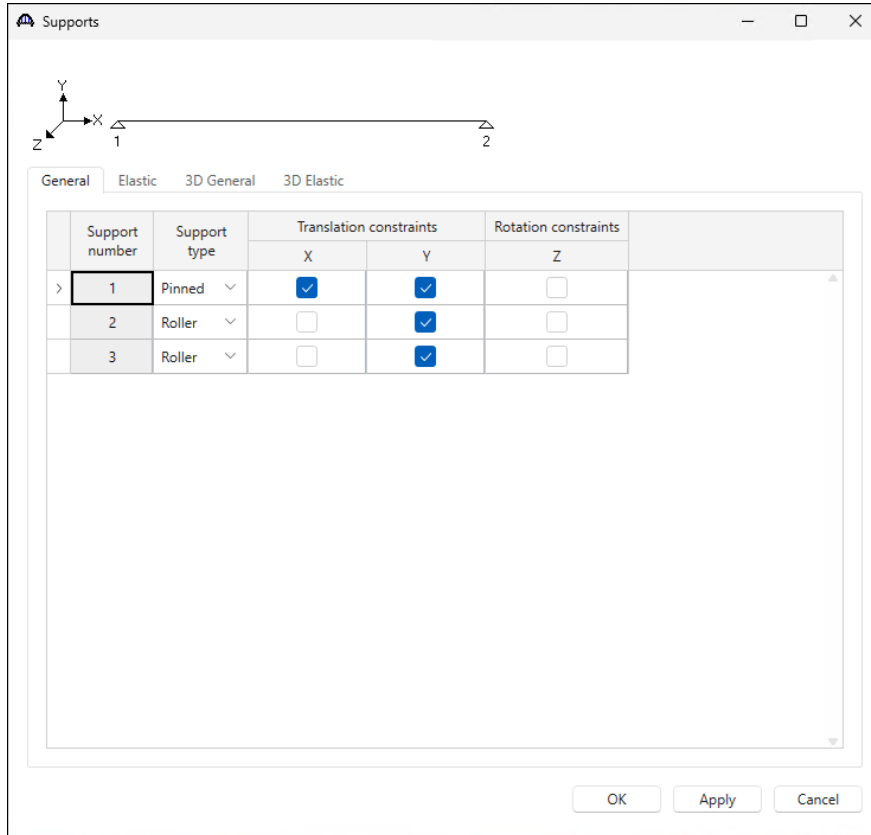
Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Supports

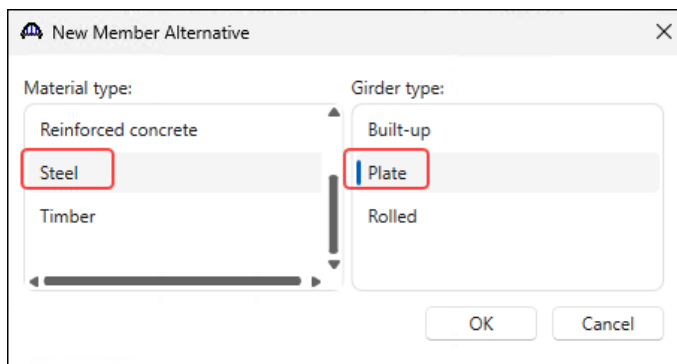
Double click on **Supports** node in the **Bridge Workspace** tree for member **G2** to open the **Supports** window.

Support constraints generated when the structure definition is created and are shown below. No changes are required to this window.



Defining a Member Alternative

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



Click **OK** to close the window and create a new member alternative.

STL2 – Two Span Plate Girder Example

The **Member Alternative Description** window will open. Enter the data as shown below.

The screenshot shows the 'Member Alternative Description' window with the following settings:

- Member alternative:** Plate Girder
- Description:** (Empty text box)
- Material type:** Steel
- Girder type:** Plate
- Modeling type:** Multi Girder System
- Default units:** US Customary
- Girder property input method:**
 - ☒ Schedule based
 - ☐ Cross-section based
- End bearing locations:**
 - Left: 6 in
 - Right: 6 in
- ☐ Simple DL, continuous LL
- Self load:**
 - Load case: Engine Assigned
 - Additional self load: 0.17 kip/ft
 - Additional self load: %
- Default rating method:** LFR

Buttons at the bottom: OK, Apply, Cancel

STL2 – Two Span Plate Girder Example

Navigate to the **Control options** tab of this window and select all options as shown below.

*Note: Make sure to uncheck the “**Must consider user input lateral bending stress**” checkbox for both LRFD and LRFR for this bridge.*

Member Alternative Description

Member alternative: Plate Girder

Description Specs Factors Engine Import Control options

LRFD

- Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
 - ☐ Generate at stiffeners
- ☐ Allow moment redistribution
- ☐ Use Appendix A6 for flexural resistance
- ☐ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Consider deck reinf. development length
- ☐ **Must consider user input lateral bending stress**
- ☐ Consider concurrent moments in Cb calculation
- LTB GammaE Method

LRFR

- Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
 - ☐ Generate at stiffeners
- ☐ Allow moment redistribution
- ☐ Use Appendix A6 for flexural resistance
- ☐ Allow plastic analysis
- ☐ Evaluate remaining fatigue life
- ☐ Ignore long. reinf. in negative moment capacity
- ☒ Include field splices in rating
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end panels

LFR

- Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Allow moment redistribution
- ☐ Allow plastic analysis of cover plates
- ☒ Include field splices in rating
- ☒ Include bearing stiffeners in rating
- ☐ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Ignore overload operating rating
- ☐ Ignore shear
- ☐ Consider deck reinf. development length

ASR

- Points of interest
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end panels

OK Apply Cancel

STL2 – Two Span Plate Girder Example

Member Alternative Description

Member alternative: Plate Girder

Description Specs Factors Engine Import Control options

LRFD

- ☐ Allow moment redistribution
- ☐ Use Appendix A6 for flexural resistance
- ☐ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Consider deck reinf. development length
- ☐ Must consider user input lateral bending stress
- ☐ Consider concurrent moments in Cb calculation
- LTB GammaE Method**
 - ☒ Method A
 - ☐ Method B
- Distribution factor application method**
 - ☐ By axle
 - ☒ By POI

LRFR

- ☐ Ignore long. reinf. in negative moment capacity
- ☒ Include field splices in rating
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end panels
- ☐ Must consider user input lateral bending stress
- ☐ Consider concurrent moments in Cb calculation
- ☐ Use compact web alternate Cb calculation
- LTB GammaE Method**
 - ☒ Method A
 - ☐ Method B
- Distribution factor application method**
 - ☐ By axle
 - ☒ By POI

LFR

- ☐ Allow moment redistribution
- ☐ Allow plastic analysis of cover plates
- ☒ Include field splices in rating
- ☒ Include bearing stiffeners in rating
- ☐ Allow plastic analysis
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Ignore overload operating rating
- ☐ Ignore shear
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end panels
- Distribution factor application method**
 - ☐ By axle
 - ☒ By POI

ASR

- Points of interest**
 - ☒ Generate at tenth points
 - ☒ Generate at section change points
 - ☒ Generate at user-defined points
- ☐ Ignore long. reinf. in negative moment capacity
- ☐ Consider deck reinf. development length
- ☐ Consider tension-field action in stiffened web end panels

OK Apply Cancel

Click **OK** to close the window and create a new member alternative.

STL2 – Two Span Plate Girder Example

Reopen the member **G2** window. The newly added member alternative will automatically be assigned as the **Existing** and **Current** member alternative for this member.

The Member window displays the following information:

- Member name: G2
- Link with: -- None --
- Description: (empty)
- Table of member alternatives:

	Existing	Current	Member alternative name	Description
>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	Plate Girder	

Number of spans: 2

	Span no.	Span length (ft)
>	1	90
	2	90

Buttons: OK, Apply, Cancel

Girder Profile

Expand the newly added **Plate Girder** member alternative for member **G2**. Next describe the girder profile by double clicking on the **Girder Profile** node in the **Bridge Workspace** tree. Enter the data in each tab of the **Girder Profile** window as shown below.

Web

The Girder Profile window displays the following information:

- Type: Plate Girder
- Tab: 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
>	36	None	36	0.4375	1	0	63	63	Grade 50W	-- None --
	36	None	36	0.5	1	63	54	117	Grade 50W	-- None --
	36	None	36	0.4375	2	27	63	90	Grade 50W	-- None --

Buttons: New, Duplicate, Delete

Buttons: OK, Apply, Cancel

STL2 – Two Span Plate Girder Example

Top flange

Girder Profile

Type: **Plate Girder**

Web **Top flange** Bottom flange

	Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right	
	12	12	0.75	1 ▾	0	63	63	Grade 50W ▾	-- None -- ▾	-- None -- ▾	
	16	16	1	1 ▾	63	54	117	Grade 50W ▾	-- None -- ▾	-- None -- ▾	
>	12	12	0.75	2 ▾	27	63	90	Grade 50W ▾	-- None -- ▾	-- None -- ▾	

Copy to bottom flange New Duplicate Delete

OK Apply Cancel

Bottom flange

Girder Profile

Type: **Plate Girder**

Web Top flange **Bottom flange**

	Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right	
>	16	16	0.875	1 ▾	0	63	63	Grade 50W ▾	-- None -- ▾	-- None -- ▾	
	16	16	1.5	1 ▾	63	54	117	Grade 50W ▾	-- None -- ▾	-- None -- ▾	
	16	16	0.875	2 ▾	27	63	90	Grade 50W ▾	-- None -- ▾	-- None -- ▾	

Copy to top flange New Duplicate Delete

OK Apply Cancel

Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Deck Profile

Next open the **Deck Profile** window by double-clicking the **Deck Profile** node in the **Bridge Workspace** tree and enter the data describing the structural properties of the deck. The window is as 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 data for the deck concrete.

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
> Class A (US) ▾	1 ▾	0	180	180	8	96	96	120	120	8

Buttons at the bottom: Compute from typical section..., New, Duplicate, Delete, OK, Apply, Cancel.

Enter the reinforcement data as shown below.

The screenshot shows the 'Deck Profile' window with the 'Reinforcement' tab selected. The 'Type' is set to 'Plate'. The table below contains the data for the reinforcement.

Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row	Bar spacing (in)
> Grade 60 ▾	1 ▾	63	54	117	6.24	6.24	9 ▾	2.97	Top of Slab ▾	
Grade 60 ▾	1 ▾	63	54	117	4.16	4.16	9 ▾	1.91	Bottom of Slab ▾	

Buttons at the bottom: New, Duplicate, Delete, OK, Apply, Cancel.

Note: As mentioned in the Note under the composite section details in Page 3 of this tutorial, for simplicity, the bars will be input using an equivalent number of #9 bars which have a unit area of 1.0 in^2 .

STL2 – Two Span Plate Girder Example

Composite regions described in the **Shear connectors** tab as shown below.

The **Deck Profile** dialog box has three tabs: **Deck concrete**, **Reinforcement**, and **Shear connectors**. The **Shear connectors** tab is active. Under **Input method type**, the **Ranges** radio button is selected. A table lists the shear connector data:

Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)
> 1	0	180	180	Composite			

Buttons at the bottom include **Shear stud design tool**, **View calcs**, **New**, **Duplicate**, **Delete**, **OK**, **Apply**, and **Cancel**.

Click **OK** to apply the data and close the window.

Haunch Profile

To define the haunch profile, double-click on the **Haunch Profile** node in the **Bridge Workspace** tree. Select the **Haunch** type and enter data as shown below.

The **Steel Haunch Profile** dialog box shows the **Haunch type** section with five cross-sectional diagrams. The second diagram from the top is selected. A diagram to the right shows the haunch geometry with dimensions $Z1$, $Z2$, and $Y1$. The **Embedded flange** checkbox is unchecked. A table lists the haunch data:

Support number	Start distance (ft)	Length (ft)	End distance (ft)	Z1 (in)	Z2 (in)	Y1 (in)
> 1	0	180	180	8	8	2

Buttons at the bottom include **New**, **Duplicate**, **Delete**, **OK**, **Apply**, and **Cancel**.

Click **OK** to apply the data and close the window.

STL2 – Two Span Plate Girder Example

Lateral Support

Open the **Lateral Support** window by double clicking on the **Lateral Support** node in the **Bridge Workspace** tree. Regions where the slab provides lateral support for the top flange are defined as shown below.

Support number	Start distance (ft)	Length (ft)	End distance (ft)
1	0	180	180

Click **OK** to apply the data and close the window.

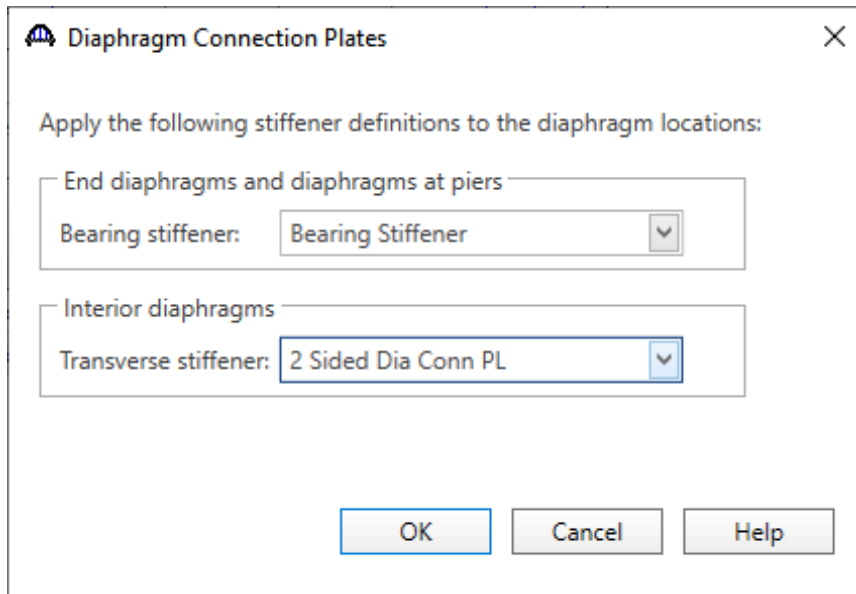
Stiffener Ranges

Double click on the **Stiffener Ranges** node in the **Bridge Workspace** to open the **Stiffener Ranges** window. Click the **Apply at diaphragms...** button to open the **Diaphragm Connection Plates** window.

Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
------	----------------	---------------------	------------------	--------------	-------------	-------------------

STL2 – Two Span Plate Girder Example

Select the **2 Sided Conn PL** as the **Transverse Stiffener** to be applied at the interior diaphragms and click **OK**.



Diaphragm Connection Plates

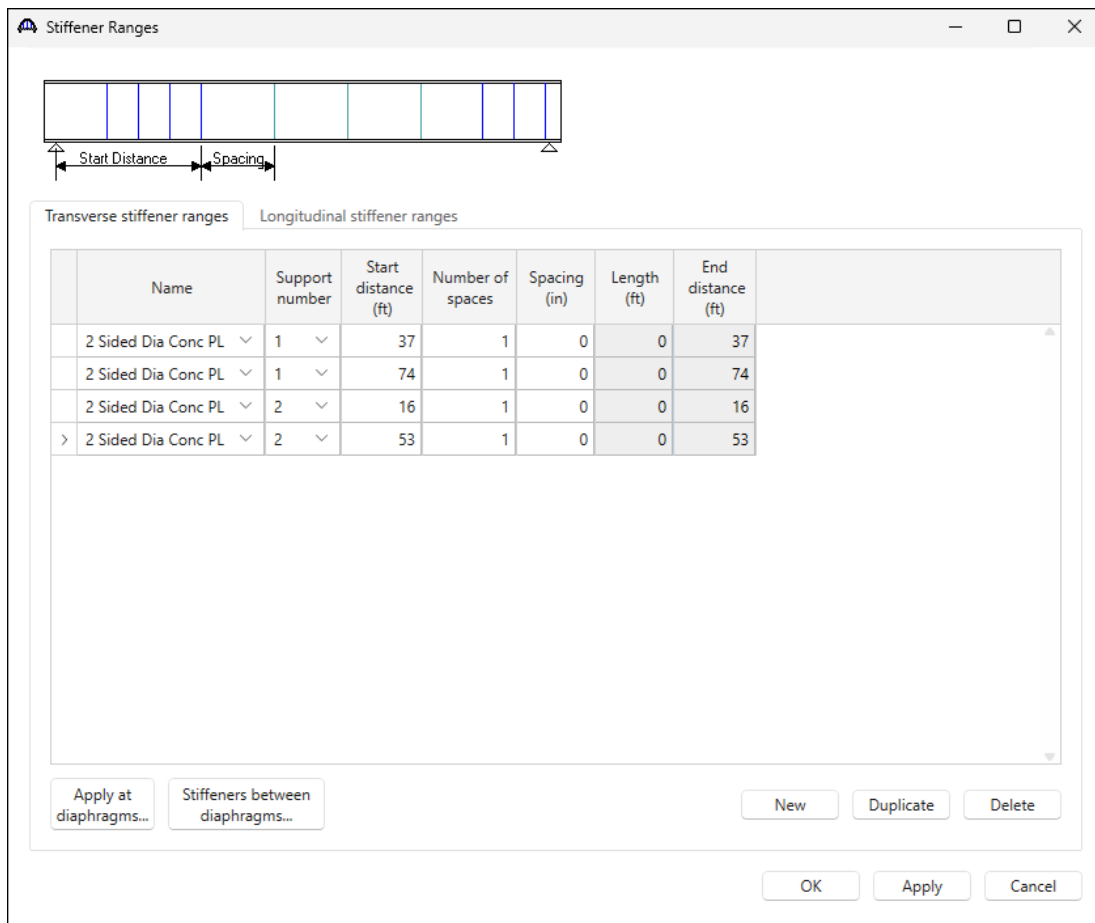
Apply the following stiffener definitions to the diaphragm locations:

End diaphragms and diaphragms at piers
Bearing stiffener: Bearing Stiffener

Interior diaphragms
Transverse stiffener: 2 Sided Dia Conn PL

OK Cancel Help

The **Stiffener Ranges** window will be updated as shown below.



Stiffener Ranges

Diagram showing a beam with vertical stiffeners. Labels: Start Distance, Spacing.

Transverse stiffener ranges Longitudinal stiffener ranges

	Name	Support number	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)
	2 Sided Dia Conc PL	1	37	1	0	0	37
	2 Sided Dia Conc PL	1	74	1	0	0	74
	2 Sided Dia Conc PL	2	16	1	0	0	16
>	2 Sided Dia Conc PL	2	53	1	0	0	53

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

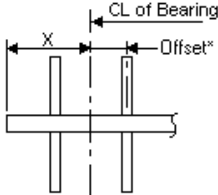
OK Apply Cancel

STL2 – Two Span Plate Girder Example

This example does not have any intermediate transverse stiffeners. Click **OK** to apply the data and close the window.

Bearing Stiffener Locations

Bearing stiffener definitions were assigned to locations when the **Apply at diaphragms...** option was used on the **Stiffener Ranges** window. The **Bearing Stiffener Location – Support 1** window is opened by expanding the **Bearing Stiffener Locations** node in the **Bridge Workspace** tree and double clicking on the **Support 1** node. The assignment for support 1 is shown below. No changes are required to this window.



Pairs of bearing stiffeners at this support: X: in

Stiffener pair	Name	Offset (in)
1	Bearing Stiffener	0.0000

OK Apply Cancel

STL2 – Two Span Plate Girder Example

Live Load Distribution

Standard

Open the **Live Load Distribution** window from the **Bridge Workspace** tree. On **Standard** tab, click the **Compute from typical section...** button to compute the standard live load distribution factors.

Live Load Distribution

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	1.4285714	1.4	1.4285714	0.5
Multi-lane	1.8181818	2	1.8181818	1

Compute from typical section... View calcs

OK Apply Cancel

Interior (LFR wheels)

Lanes Loaded	Shear	Shear at Support	Moment	Deflection
1 lane	1.43	1.4	1.43	0.5
Multi-lane	1.82	2.0	1.82	1.0

Live load distribution factor calculation details can be viewed by clicking the **View Calcs** button.

STL2 – Two Span Plate Girder Example

LRFD

Leave this tab blank. When left blank, LRFD distribution factors are computed by the BrDR engine using the girder system structure definition. BrDR computes the following LRFD distribution factors:

Interior (LRFD lanes)

Moment DFs

Lanes Loaded	Start Distance	End Distance	Moment DF
1 lane	0.0	64.8	0.480
	64.8	115.2	0.499
	115.2	180	0.48
Multi-lane	0.0	64.8	0.692
	64.8	115.2	0.720
	115.2	180	0.692

Shear DFs

Lanes Loaded	Start Distance	End Distance	Shear DF
1 lane	0.0	90.0	0.760
	90.0	180.0	0.760
Multi-lane	0.0	90.0	0.952
	90.0	180.0	0.952

Deflection DFs

Lanes Loaded	Start Distance	End Distance	Shear DF
1 lane	0.0	180	0.3*
Multi-lane	0.0	180	0.5

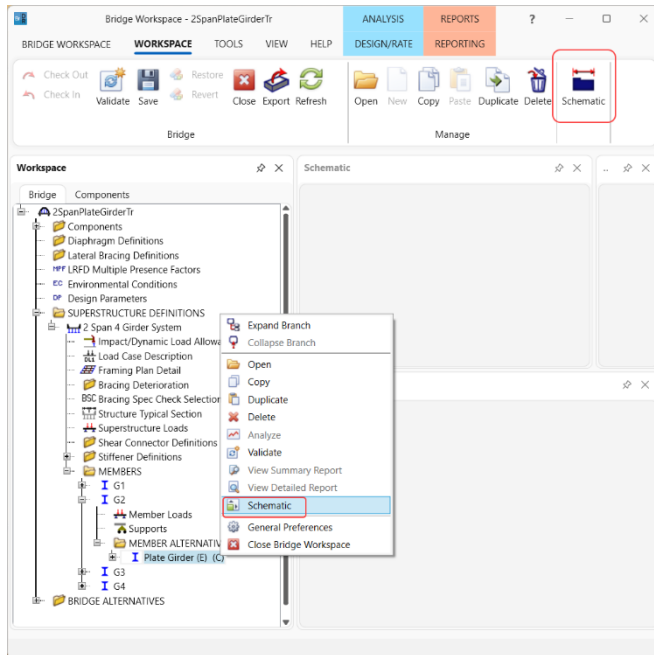
* includes 1.20 multiple presence factor (MPF).

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

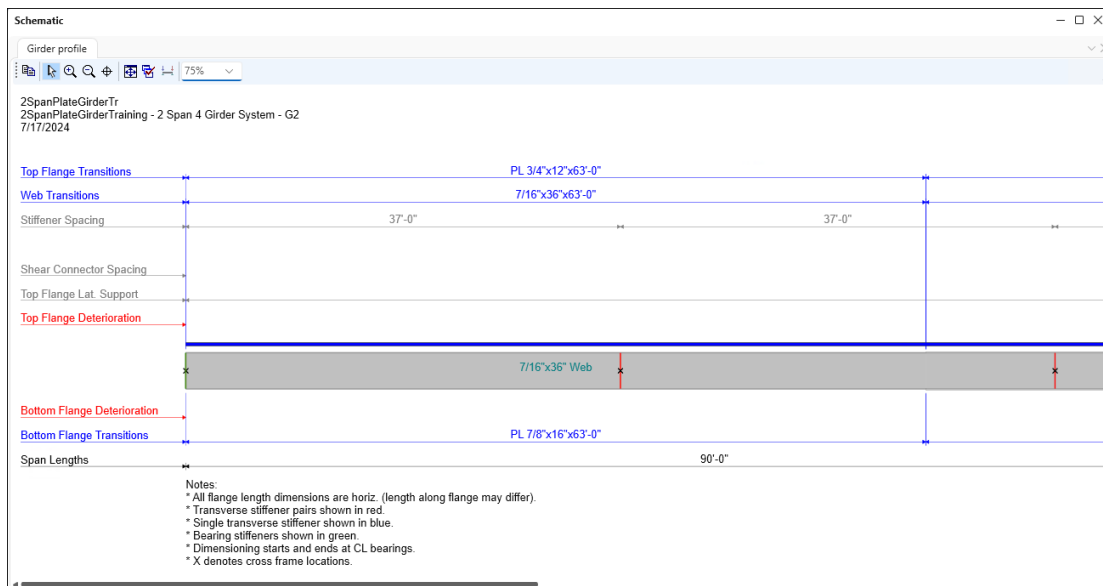
STL2 – Two Span Plate Girder Example

Schematic – Member alternative

While the member alternative **Plate Girder** for member **G2** is selected in the **Bridge Workspace** tree, open the schematic for the girder profile by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click and select **Schematic** from the menu).



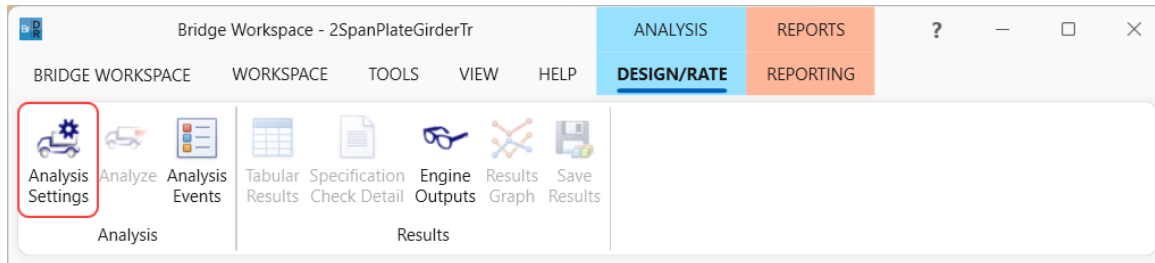
The following schematic will be displayed.



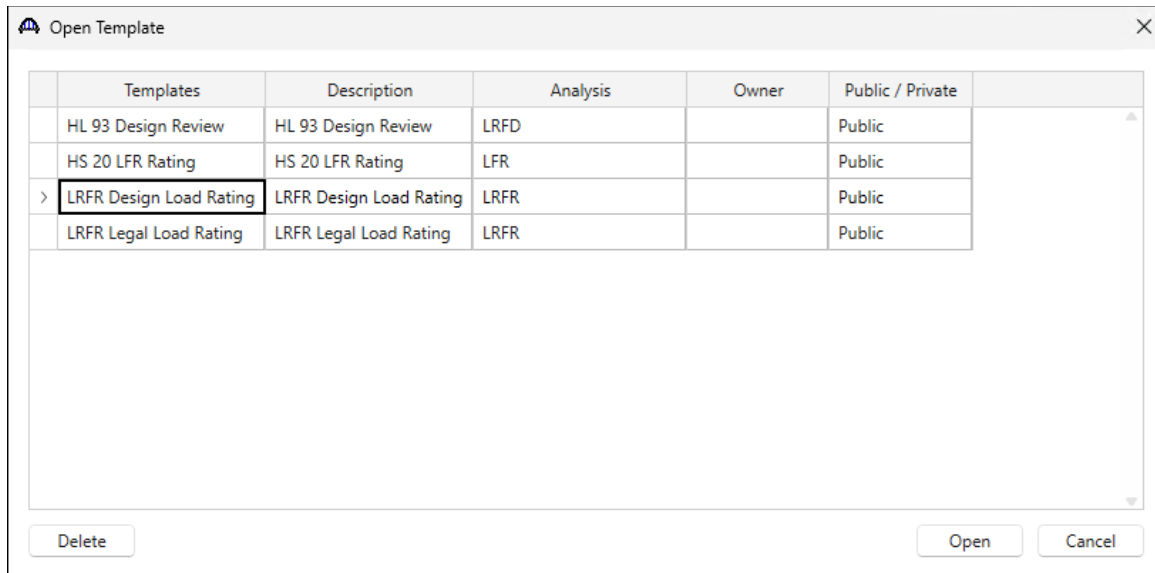
STL2 – Two Span Plate Girder Example

LRFR Analysis

The interior member alternative can now be analyzed. To perform an **LRFR** rating, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.



Click the **Open Template** button and select the **LRFR Design Load Rating** to use in the rating and click **Open**.



STL2 – Two Span Plate Girder Example

The **Analysis Settings** window will be populated as shown below.

Analysis Settings

☐ Design review ☒ Rating

Rating method: LRFR

Analysis type: Line Girder

Lane / Impact loading type: As Requested

Apply preference setting: None

Vehicles Output Engine Description

Traffic direction: Both directions

Refresh Temporary vehicles Advanced

Vehicle selection

- Vehicles
 - Standard
 - EV2
 - EV3
 - 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
 - Type 3-3
 - Type 3S2
 - Agency
 - User defined
 - Temporary

Add to >>

Remove from <<

Vehicle summary

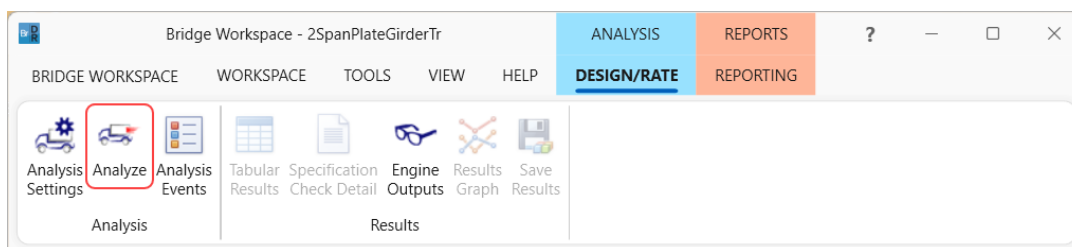
- Rating vehicles
 - LRFR
 - Design load rating
 - Inventory
 - HL-93 (US)
 - Operating
 - HL-93 (US)
 - Fatigue
 - LRFD Fatigue Truck (US)
 - Legal load rating
 - Routine
 - Specialized hauling
 - Permit load rating

Reset Clear Open template Save template OK Apply Cancel

Click **OK** to apply the data and close the window.

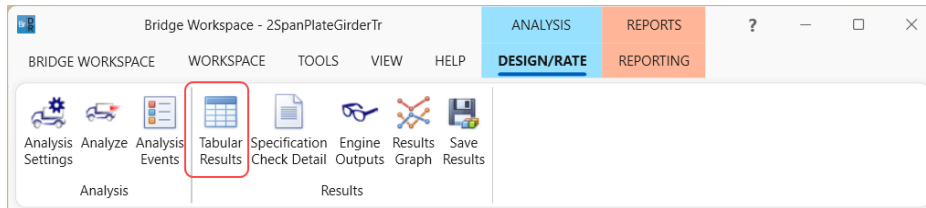
Tabular Results

With **G2** member alternative – **Plate Girder** selected, click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



STL2 – Two Span Plate Girder Example

When the rating analysis is finished, results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the ribbon.



The window shown below will open. Select **Rating Results Summary** as the **Report Type** and **Single rating level per row** as the **Display Format** option to have the ratings arranged as shown below.

Analysis Results - Plate Girder

Print

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
HL-93 (US)	Truck + Lane	LRFR	Inventory	8.54	0.237	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	11.08	0.308	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	6.13	0.170	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	7.95	0.221	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	10.04	0.279	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	13.01	0.362	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested

AASHTO LRFR Engine Version 7.6.1.3001
Analysis preference setting: None

Close

STL2 – Two Span Plate Girder Example

LRFD Design Review

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

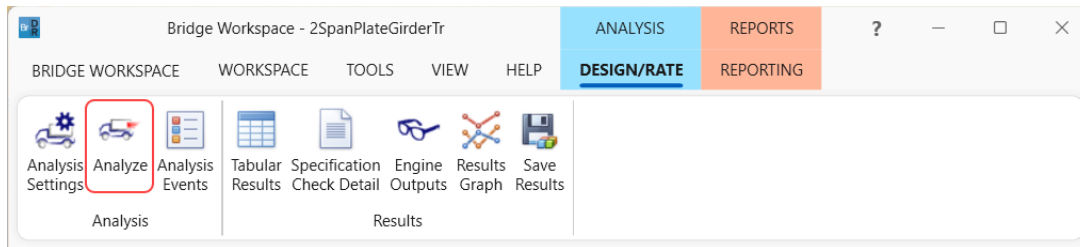
The screenshot shows the 'Analysis Settings' window with the following configuration:

- Design review** (selected) and **Rating** (unselected) radio buttons.
- Design method:** LRFD (dropdown menu).
- Analysis type:** Line Girder (dropdown menu).
- Lane / Impact loading type:** As Requested (dropdown menu).
- Apply preference setting:** None (dropdown menu).
- Traffic direction:** Both directions (dropdown menu).
- Vehicle selection** panel on the left lists various vehicle types under 'Standard', including 'HL-93 (US)'. The 'Add to' button is highlighted.
- Vehicle summary** panel on the right shows the selected 'Design vehicles' list, which includes 'Design loads', 'HL-93 (US)', 'Permit loads', and 'Fatigue loads'.
- Buttons:** 'Reset', 'Clear', 'Open template', 'Save template', 'OK', 'Apply', 'Cancel', 'Refresh', 'Temporary vehicles', and 'Advanced' are visible.

Click **OK** to apply the data and close the window.

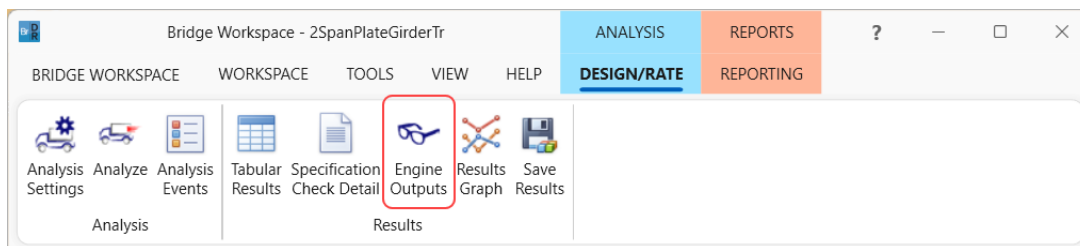
STL2 – Two Span Plate Girder Example

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review.



Engine Outputs

AASHTO LRFD analysis will generate a spec check results file. Click the **Engine Outputs** button from the **Results** group of the **DESIGN/RATE** ribbon to open the following window.



To view the LRFD spec check results (shown below), double click on the **Stage 3 Spec Check Results** under the **AASHTO_LRFD** branch in this window.

