AASHTOWare BrDR 7.5.0 Steel Tutorial STL8 – Pin and Hanger Rolled Beam Example

### BrDR Tutorial

### **Topics** Covered

- Steel rolled beam with cover plates input as girder system.
- Schedule based input.
- Pin and hanger in center span
- LFR analysis

# Steel rolled beam with cover plates input as girder system

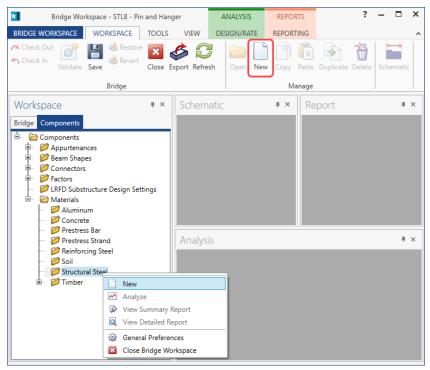
From the Bridge Explorer create a New bridge and enter the following description data.

A New Bridge	- 0	Х
Bridge ID: STL8 - Pin and Hanger NBI structure ID (8): STL8 Bridge completely defined	Superstructures	
Description Description (cont'd) Alternatives Global reference point Traffic Custom agency fields		_
Name: Pin and Hanger Year built:		
Description:		
Location: Length:	ft	
Facility carried (7): Route number:		
Feat. intersected (6): Mi. post:		
Default units: US Customary		
Bridge association BrR BrD BrM		
OK	Apply Cancel	

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

### Bridge Components

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



Add the structural steel material by clicking the Copy from library... button. The following window opens.

Name	Description	Library	Units	Fy	
Grade 345	AASHTO M270M Grade 345	Standard	SI / Metric	345.00	Î
Grade 345W	AASHTO M270M Grade 345W	Standard	SI / Metric	345.00	
Grade 36	AASHTO M270 Grade 36	Standard	US Customary	36.000	
Grade 485W	AASHTO M270M Grade 485W	Standard	SI / Metric	485.00	
Grade 50	AASHTO M270 Grade 50	Standard	US Customary	50.000	
Grade 50W	AASHTO M270 Grade 50W	Standard	US Customary	50.000	
Grade 690 - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standard	SI / Metric	620.00	
Grade 690 <= 65 mm	AASHTO M270M Grade 690 up to 65 mm thick, inclusive	Standard	SI / Metric	690.00	1
Grade 690W - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standard	SI / Metric	620.00	
Grade 690W <= 65 mm	AASHTO M270M Grade 690W up to 65 mm thick, inclusive	Standard	SI / Metric	690.00	
Grade 70W	AASHTO M270 Grade 70W	Standard	US Customary	70.000	1
Prior to 1005	Puilt prior to 1005 steal unknown	Ctondard	IIS Customany	26.000 ∳	

Select the Grade 36 material and click OK.

🕰 Bridge Mat	erials - Structural Steel				_		×
Name:	Grade 36						
Description:	AASHTO M270 Grade 36						
Material prop	perties						
Specified mir	nimum yield strength (Fy):	36.000052	ksi				
Specified mir	nimum tensile strength (Fu):	58.0000084	ksi				
Coefficient of	f thermal expansion:	0.0000065	1/F				
Density:		0.49	kcf				
Modulus of e	lasticity (E):	29000.004206	ksi				
	Copy to library	Copy from libra	ry	OK	Apply	Ca	ncel

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

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

🗛 Bridge Mat	terials - Concrete			_		×
Name:	Class A (US)					
Description:	Class A cement concrete	e				
Compressive	strength at 28 days (f'c):	4.0000006	ksi			
Initial compre	essive strength (f'ci):		ksi			
Composition	of concrete:	Normal				
Density (for o	dead loads):	0.15	kcf			
Density (for r	modulus of elasticity):	0.145	kcf			
Poisson's rati	io:	0.2				
Coefficient of	f thermal expansion (α):	0.000006	1/F			
Splitting tens	ile strength (fct):		ksi			
LRFD Maximu	um aggregate size:		in			
	Compute					
Std modulus	of elasticity (Ec):	3644.147704	ksi			
LRFD modulu	us of elasticity (Ec):	3986.548657	ksi			
Std initial mo	odulus of elasticity:		ksi			
LRFD initial n	nodulus of elasticity:		ksi			
Std modulus	of rupture:	0.474342	ksi			
LRFD modulu	us of rupture:	0.48	ksi			
Shear factor:		1				
	Сору	to library Co	by from library OK	Apply	Canc	el

Add the Class A (US) concrete material using the same techniques. The window is updated as shown below.

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

#### Beam Shapes

To enter a steel rolled beam shape used in this bridge expand the tree labeled **Beam Shapes** and **Steel Shapes** as shown below. Click on the **I Shapes** node in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **I Shapes** and select **New** or double click on **I Shapes** in the **Components** tree). The window shown below will open.

Bridge Workspa	ace - STL8 - Pin	and Hang	ger	ANALYSIS	REPOR	RTS	? – 🗆 ×
BRIDGE WORKSPACE	/ORKSPACE	TOOLS	VIEW	DESIGN/RATE	REPORT	ING	^
Check Out	Restore Revert Bridge	Close E	🎸 <table-cell> xport Refre</table-cell>	sh Open Ne		Paste Duplicate	Delete
	bridge				IVIC	l	
Workspace		щ ×	Schem	atic	щ×	Report	Ψ×
Bridge Components	apes s						
📁 I Shapes 📁 Tees	New						μ×
<ul> <li>Imber Sha</li> <li>Connectors</li> <li>Factors</li> <li>Factors</li> <li>IRFD Substruct</li> <li>Materials</li> </ul>	Analyze View Sum	ailed Repo	ort s				

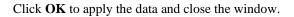
Steel I Shape Name: Description:		Rolled shape type W shape M shape S shape HP shape
Dimensions Prop		
	Copy to library Copy from library	OK Apply Cancel

Select the **Rolled shape type** as **W shape** and click the **Copy from library...** button. The **Steel Shape Selection** window will appear. This window displays all of the steel shapes available in the library. The list can be sorted by clicking on any of the column headers (e.g. **Shape**, **Year**, **Depth** etc.). Select **W36x135** and click **OK**.

					brary ) Standard ) Agency define	d Unit system
	Shape	Year	Depth (in)	Load (lb/ft)	Sxx (in^3)	
_	W 33x354	2011	35.6000	354.000	1235.955	
	W 33x387	2011	36.0000	387.000	1350.000	
Þ	W 36x135	1994	35.5500	135.000	438.819	
	W 36x135	2011	35.6000	135.000	438.202	
	W 36x150	1994	35.8500	150.000	504.324	
	W 36x150	2011	35.9000	150.000	503.621	-
	W 36x160	1994	36.0100	160.000	541.516	
	W 36x160	2011	36.0000	160.000	542.222	

The beam properties are copied to the Steel I Shape window as shown below.

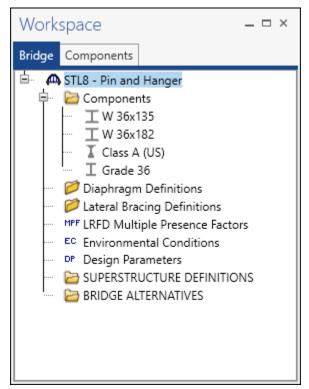
🗛 Steel I Sha	pe	- 🗆 ×
Name:	W 36x135	Rolled shape type
Description:	W 36x135 Imported from AISC Tables (1994)	<ul> <li>W shape</li> <li>M shape</li> <li>S shape</li> <li>HP shape</li> </ul>
Dimension	Properties	
	Copy to library Copy from library OK	Apply Cancel



Steel I Sh	ape	-
Name:	W 36x182	Rolled shape type
Descriptior	W 36x182 Imported from AISC Tables (1994)	<ul> <li>W shape</li> <li>M shape</li> <li>S shape</li> <li>HP shape</li> </ul>
Dimensio	Properties	
	0.7250 in Y 12.0750 in	
	Copy to library Copy from library C	0K Apply Cancel

Follow the same procedure to copy a **W36x182** shape from the library.

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



#### Bridge Appurtenances

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

Bridge Workspace -	STL8 - Pin and Hanger	ANALYSIS	REPORTS	?	– 🗆 ×
BRIDGE WORKSPACE WORK	SPACE TOOLS VIE	EW DESIGN/RATE	REPORTING		^
17-7 E	Restore Revert Close Export	Refresh Open N	ew Copy Past	e Duplicate Delete	Schematic
Br	idge		Manag	e	
Workspace	<b>я ×</b> Sch	nematic	я × R	leport	щ×
Railing Vie Beam Shap Connectors Vie Factors G Ge I RFD Subst	ew Summary Report ew Summary Report ew Detailed Report eneral Preferences ose Bridge Workspace	5			# X

Enter the data as shown below.

🕰 Bridge Ap	opurtenances - Generic	_		×
Name:	Brush Block			
Description:				
	All dimensions are in inches			
Distance f	from edge to centroid:			
	Reference Line Barrier load: 0.530 kip/ft Width: 23.5000			
	Effective wind height: 37.0000 Back Front			
	Copy from library OK Apply		Cance	el

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

Bridge Alternatives will be added after entering the Structure Definition.

### 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.

	×
Superstructure definition wizard	
OK Cancel	

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

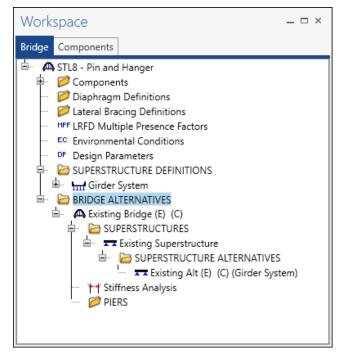
Girder System Superstructure Defin	ition		 - 🗆 X
Definition Analysis Specs	Engine		
Name: Girder System			Modeling Multi-girder system O MCB
Description:			With frame structure simplified definition Deck type:
Default units: US Customary Number of spans: 3 0 Number of girders: 5 0	▼       Enter span lengths along the reference line:         Span       Length (ft)         ▶       1       40.00         2       82.00         3       40.00	A	Concrete Deck
Horizontal curvature along refere			
Horizontal curvature     Superstructure alignment	Distance from PC to first support line:	ft	
Curved	Start tangent length: Radius:	ft	
O Tangent, curved, tangent	Direction:	Left v	
<ul> <li>Tangent, curved</li> <li>Curved, tangent</li> </ul>	End tangent length:	ft	
	Distance from last support line to PT:	ft	
	Design speed:	mph	
	Superelevation:	%	
			OK Apply Cancel

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

### **Bridge Alternative**

Navigate to the **Bridge Alternatives** node in the **Bridge Workspace** tree and create a new **Bridge Alternative**, a new **Structure**, and a new **Structure Alternative** as shown in **STL1 tutorial**.

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



#### Load Case Description

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 name	Description	Stage		Туре		Time* (days)	
DC1	DC acting on non-composite section	Non-composite (Stage 1)	D,DC		*		Τ
DC2	DC acting on long-term composite section	Composite (long term) (Stage 2)	D,DC		*		
DW	DW (acts 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		*		

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 and click the **Apply** button to apply this data.

Strue	cture Frami	ng Plan Details											-		>
lumbe	er of spans:	3	Number of gird	ers: 5											
Layo	ut Diap	hragms La	teral bracing range	25											
				Girde	r spacing orie	ntatio	n								
					rpendicular to										
	Support	Skew (degrees)			ong support										
Þ	1	0.000							_						
	2	0.000				er spac (ft)	cing								
	3	0.000			rder ay Start o		nd of								
	4	0.000			girde		girder								
						.75	8.75	-	-						
						.75	8.75								
						.75	8.75 8.75								
					+ 0		0.75								
			-					-	-						
											K	Appl		Cance	
											n .	Appi	У	Cance	-

#### Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab and enter diaphragm spacing for Girder Bay 1 as shown below.

irde	r ba	ау: 1		<b>~</b>	Copy bay to		Diaphra wizaro						
		ipport imber	dist	art ance ft)	Diaphragm spacing	Number of spaces	Length (ft)	dista	End distance (ft)		Diaphragm		
			Left girder	Right girder	(ft)			Left girder	Right girder	(kip)			
>	1	~	0	0	0	1	0	0	0	0.325	Not Assigned	$\sim$	
	1	~	0	0	20	1	20	20	20	0.22	Not Assigned	$\sim$	
	1	~	20	20	20	1	20	40	40	0.325	Not Assigned	$\sim$	
	2	~	0	0	5.25	1	5.25	5.25	5.25	0.22	Not Assigned	$\sim$	
	2	~	5.25	5.25	2	1	2	7.25	7.25	0.22	Not Assigned	$\sim$	
	2	~	7.25	7.25	16.875	4	67.5	74.75	74.75	0.22	Not Assigned	$\sim$	
	2	~	74.75	74.75	2	1	2	76.75	76.75	0.22	Not Assigned	$\sim$	
	2	~	76.75	76.75	5.25	1	5.25	82	82	0.325	Not Assigned	$\sim$	
	3	~	0	0	20	1	20	20	20	0.22	Not Assigned	$\sim$	
	3	~	20	20	20	1	20	40	40	0.325	Not Assigned	$\sim$	

Click the **Apply** button to apply this data.

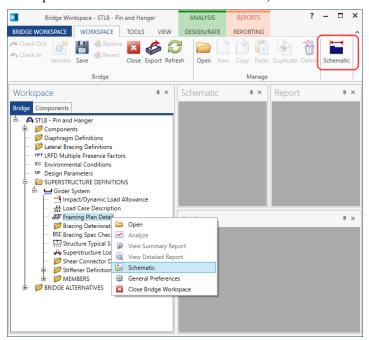
Click the **Copy bay to...** button, select **Bay 2**, **Bay 3** and **Bay 4** by holding the **Shift** key and click the **Apply** button to copy the **Bay 1** diaphragm spacing to all other bays.

🗛 Copy Diaphragm B	ау	×
	Bay 2	
	Bay 3	
Select the new bay(s):	Bay 4	
	Apply Cancel	
Bridge Design & Rating	I	×
Diaphragms t 4!	from bay 1 are successfully copied to	o bay 2, 3 and
		ОК

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).



The following schematic is displayed.

Schematic							_ 🗆 ×
Framing plan							▼ ×
i 🗈 📐 Q. Q. 🔶 🛃 🗟 🖂 100%	~						÷
STL8 - Pin and Hanger Pin and Hanger - Girder System 2/23/2023							
40-0".	90.0 deg.		82'-0"		-90.0 deg.	40'-0"	90.0 deg.
	1-3 1-41-5	1-6	G1 <sub>1-7</sub>	1-8	1-91-10 1-11	1-12	1-13
2-1 2-2	2-3 2-42-5	2-6	G2 <sub>2-7</sub>	2-8	2-92-10 2-11	2-12	2-13
3-1 3-2	3-3 3-43-5	3-6	63 <sub>3-7</sub>	3-8	3-93-10 3-11	3-12	3-13
	4-3 4-44-5	4-8	G4 <sub>4-7</sub>	4-8	4-94-10 4-11	4-12	4-13
			G5				

### Structure Typical Section – Deck

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

A Structure Typical Section	_		×
Distance from left edge of deck to Distance from right edge of deck to superstructure definition ref. Ine superstructure definition ref. Ine			
Deck Reference Line			
Left 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: 20.00 ft 20.00 ft			
Distance from right edge of deck to superstructure definition reference line: 20.00 ft 20.00 ft			
Left overhang:         2.50         ft         2.50         ft			
Computed right overhang: 2.50 ft 2.50 ft			
ОК	Apply	Cance	el

#### Structure Typical Section – Deck (cont'd)

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

Д	Structure Typical Section	_		×
	Distance from left edge of deck to Distance from right edge of deck to superstructure definition ref. line			
	Deck Superstructure Definition			
L	Left overhang			
	Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface			
	Deck concrete: Class A (US)			
	Total deck thickness: 8.0000 in			
	Load case: Engine Assigned			
	Deck crack control parameter: 130.000 kip/in			
	Sustained modular ratio factor: 3.000			
	Deck exposure factor:			
		-	6	
	OK Ap	ply	Cance	21

#### Structure Typical Section – Generic

Click the **New** button to add a row to the table. The **Name** of the curb defaults to the only generic appurtenance described for the bridge. Change the **Load case** to **DC2** and select **Back** in the **Measure to** column (in this example, locate the curb on the deck by referencing the back of the curb to the left edge of the deck). Enter **-0.2083' (2.5")** for the **Distance at start** and **Distance at end**. Change the **Front face orientation** to **Right**. Enter another parapet as shown below. The competed tab is shown below.

ſ		Generic Sł	nape								
		Front									
1	I										
ck	Deck (cont'o	d) Parapet	Median Railing	Gen	eric Sidew	alk Lane positio	on Striped	lanes Wea	aring surface		
	N	ame	Load case		Measure to	Edge of deck dist. measured from	Distance at start (ft)	Distance at end (ft)	Front face orientation		
>	Brush Block	~	DC2	$\sim$	Back $\vee$	Left Edge 🗸 🗸	-0.2083	-0.2083	Right $\vee$		
	Brush Block	~	DC2	~	Back 🗸	Right Edge 🗸	-0.2083	-0.2083	Left 🗸		
								Nev	w Dup	licate	Delete

Note: When validating or saving this bridge, an error message will appear that the appurtenance is not located on the deck. This can be ignored.

#### 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.

۵	Compute La	ane Positions				×
	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	-18.25	18.25	-18.25	18.25	-
						Ŧ
					Apply Ca	ncel

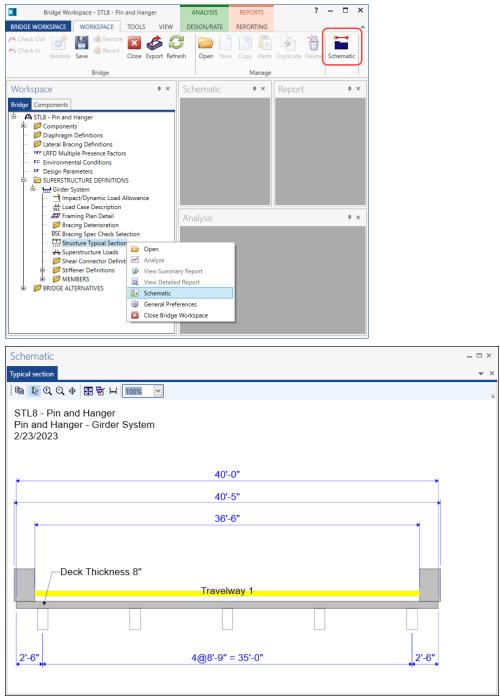
#### The Lane Position tab is populated as shown below.

A Structure Typical Section	– 🗆 X
(A) (B) Superstructure Definition Reference Line Travelway 1 Travelway 2 (B) Travelway 2 (C)	
Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Str	ped lanes Wearing surface
Travelway number         Distance from left edge of travelway to superstructure definition reference line at start (A)         Distance from right edge of travelway to superstructure definition reference line at start (B)         Distance from left edge of travelway to superstructure definition reference line at start (B)         Distance from left edge of travelway to superstructure definition reference line at start (B)         Distance from left edge of travelway to superstructure definition reference line at start (B)         Distance from left edge of travelway to superstructure definition reference line at start (B)	re travelway to superstructure
▶ <u>1</u> -18.25 18.25 -18	25 18.25
LRFD fatigue         Lanes available to trucks:         Override Truck fraction:         Compute	New Duplicate Delete
	OK Apply Cancel

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

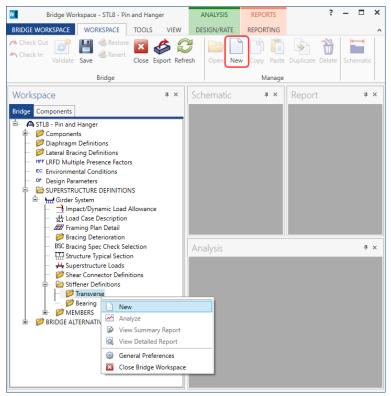
#### Schematic – Structure Typical Section

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).



#### Stiffener Definitions – Transverse

Define the transverse stiffeners 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.

🗛 New Transve	rse Stiffener Definition	×
	Stiffener Type:	
	Trans. Plate Stiffener	
	Trans. Plate Stiffener	
	Trans. Angle Stiffener	
	OK	Cancel

Define the stiffener as shown below.

A Transverse St	iffener Definition			_		×
Name: Diaphi	agm Conn Plate					
Stiffener typ Single Pair	e ————		Top gap: in Width:			
Plate Thickness:	0.5000 in		4.5000 in	$\longleftrightarrow$		
Material:	Grade 36	>	Bottom gap:			
Welds			in			
Тор:	None 🗸					
Web:	None 🗸					
Bottom:	None 💙					
			ОК	Apply	Cance	el

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

#### Stiffener Definitions – Bearing

Define the bearing stiffeners 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.

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.

A New Bearing	g Stiffener Definition	×
	Stiffener Type:	
	Plate Stiffener	
	Plate Stiffener	
	Angle Stiffener	
	OK Cancel	

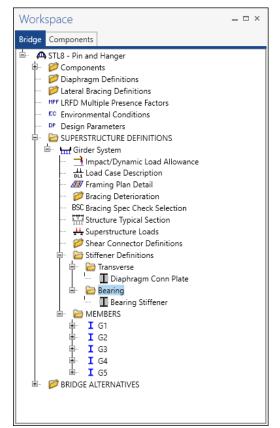
Name: Beari	ng Stiffener					
Plate				in	<del>** **</del>	
Thickness:	0.5000 in			in		4
Material:	Grade 36	~				
Welds			4.5000	in	$\longleftrightarrow$	
Тор:	None 🗸					
Web:	None 🗸			in	╧┱╢	ļ
Bottom:	None 🗸			_		<u>∟</u>
				in	<del>** **</del>	

×

Define the stiffener as shown below

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

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



### Describing a member

The **Member** window shows the data that was generated when the structure definition was created. Open the window for **Member G2** by double clicking on **G2** in the **Bridge Workspace** tree. 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.

A Member									-		×
Member name:	G2			Link	with: None	~					
Description:											
	Existing	Current	Member alte	rnative name			Description				*
Number of spar	15: 3 🗘	Spar           ▶         1           2         3		00			OK	Apply	y [	Cance	2]

#### 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 **Rolled** for the **Girder Type**.

laterial type:	Girder type:
Post tensioned concrete	Built-up
Prestressed (pretensioned) concrete	Plate
Reinforced concrete	Rolled
Steel	
Timber	

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

### Schedule based input

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

A Member Alternative Description					_		Х
Member alternative: Rolled Beam Alt							
Description Specs Factors	Engine Import	Control options					
Description:		Material type:	Steel				
		Girder type:	Rolled				
		Modeling type:	Multi Girder System				
		Default units:	US Customary	~			
Girder property input method	End bearing locat	tions S	imple DL, continuous LL				
Schedule based	Left: 6.0000	in					
Cross-section based	Right: 6.0000	in					
Self load		Default rating meth	od:				
Load case: Engine Assig	gned 🗸	LFR	<b>~</b>				
Additional self load:	kip/ft						
Additional self load:	%						
				OK	Apply	Cance	:I

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

mber alternative: Rolled Beam Alt		
Description Specs Factors Engine Import Control optio	ins	
LRFD	LRFR	
Doints of interest	<ul> <li>Points of interest</li> </ul>	$\sim$
Generate at tenth points	Generate at tenth points	
Generate at section change points	Generate at section change points	
Generate at user-defined points	✓ Generate at user-defined points	
Generate at stiffeners	Generate at stiffeners	
Allow moment redistribution	Allow moment redistribution	
Use Appendix A6 for flexural resistance	Use Appendix A6 for flexural resistance	
✓ Allow plastic analysis	Allow plastic analysis	
☐ Ignore long. reinf. in negative moment capacity	Evaluate remaining fatigue life	
Consider deck reinf. development length	Ignore long. reinf. in negative moment capacity	
Must consider user input lateral bending stress	✓ Include field splices in rating	
Consider concurrent moments in Cb calculation	Consider deck reinf. development length	
Distribution factor application method	Consider tension-field action in stiffened web end panels	
O By axle	Must consider user input lateral bending stress	
By POI	Consider concurrent moments in Cb calculation	
	Distribution factor application method	
	O By axle	
	By POI	~
LFR	ASR	
Points of interest	Points of interest	~
Generate at tenth points	Generate at tenth points	
Generate at section change points	Generate at section change points	
Generate at user-defined points	Generate at user-defined points	
Allow moment redistribution	Ignore long. reinf. in negative moment capacity	
Allow plastic analysis of cover plates	Consider deck reinf. development length	
✓ Include field splices in rating	Consider tension-field action in stiffened web end panels	
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		
O By axle		
By POI		
	~	$\sim$
	OK Apply	Cance

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

#### Girder Profile

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.

					plate			
	Shape		pport mber	Start distance (ft)	Length (ft)	End distance (ft)	Material	
>	₩ 36x135 ∨	1	$\sim$	0	46	46	Grade 36 V	
	W 36x182 V	2	$\sim$	6	70	76	Grade 36 $\lor$	
	W 36x135 V	2	$\sim$	76	46	122	Grade 36 🗸 🗸 🗸	

Describe the bottom cover plate as shown below.

	er Profile Rolled Sha	ipe											_		I
Shap		over plat	e Bo	ttom cover p	olate										
0	Welded	Bolte	ed												
	Relative position	Begin width (in)	End width (in)	Thickness (in)	Supp num		Start distance (ft)	Length (ft)	End distance (ft)	Materi	al	Side weld	End we at righ		
>	1	10.5	10.5	1.5	2	$\sim$	6	70	76	Grade 36	$\sim$	None 🗸	None	$\sim$	-
	Copy to to	D COVER D	ates									New Du	plicate	Dele	te
												ок	Apply		ancel
												UK	Арріу		ance

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

#### Hinge - Pin and hanger in center span

Next open the **Hinge Locations** window by double-clicking on the **Hinge** node in the **Bridge Workspace** tree and describe the pin locations as shown below.

H	linge				_	
	· ·	Hing	e loca	ition		
	Support number	Left or rig of suppo	ght prt	Distance (ft)		
	2 -	Right	-	6.00		
•	3 -	Left	-	6.00		
					New	Delet
					OK Apply	Cance
					OK Apply	

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

#### Deck Profile – Shear connectors

Navigate to the Shear connectors tab. Composite regions are described in the Shear connectors tab as shown below.

ck	k concrete	Reinfor	cement	Shear co	nnectors												
	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connec	tor	Number of spaces	Number per row	Transverse spacing (in)								
	2 *	6.00	70.00	76.00	Composite												
	Shear stu	4	View														
	Shear stu		View calcs										New	Dup	licate	D	Delet

#### Deck Profile – Deck concrete

Navigate to the **Deck concrete** tab. Click the **Compute from typical section...** button. Enter the following data. The points of contraflexure are required for the computation of the LRFD effective flange width. Enter the hinge locations as the points of contraflexure in span 2 as shown below and click **OK**.

A Compute Deck Profile From Structure Typical Section			×	
Total deck thickness entered on the Structure Typical Section window =	8.0000	in		
Enter a structural thickness to use when computing the effective flange width:	6.5000	in		
	OK	Cancel		

The completed **Deck concrete** tab of this window is shown below. Note that the distance to the top row of steel is measured from the top of the effective deck slab thickness. Enter a value for the modular ratio of the concrete. The **Compute from typical section...** button could not compute this since a reinforcing steel material is not defined.

<b>A</b>	Dec	ck Profile															-		×
Ту	pe:	Rolled																	
	Dee	ck concrete	Reinford	em	ent S	hear conne	ctors												
		Materi	al	S	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	-	0.00	46.00	46.00	6.5000	0.0000	0.0000	0.0000	0.0000	8.000					-
		Class A (US)	*	2	*	6.00	70.00	76.00	6.5000	78.0000	78.0000	105.0000	105.0000	8.000					
	Þ	Class A (US)	Ŧ	2	*	76.00	46.00	122.00	6.5000	0.0000	0.0000	0.0000	0.0000	8.000					
																			*
		Compute fron typical section													New	Duplicate		Delete	
															OK	Apply	/	Canc	el

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

#### Haunch Profile

Define the haunch by double-clicking on the **Haunch Profile** node in the **Bridge Workspace** tree. Enter data as shown below.

A Steel 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         162.00         162.00         2.0000         2.0000         2.0000			
	New Duplica	ite	Delete	•
	ОК Арр	ly	Cance	el

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

#### 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.

🕰 Lateral Support	- 🗆 X
个 Start Distance Length 。	
Ranges Locations Flange lateral bendir	a l
Top flange	
Support Start Length distance (ft) (ft)	nce
▶ 1 · · 0.00 162.00 162	2.00

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. Click **OK** to create the following transverse stiffener locations.

🕰 Diaphragm Connection Plates	×								
Apply the following stiffener definitions to the diaphragm locations:									
End diaphragms and diaphragms at piers									
Bearing stiffener: Bearing Stiff	ener 🖌								
Interior diaphragms									
Transverse stiffener: Diaphragm	Conn Plate 🗸								
0	K Cancel Help								
0	K Cancel Help								

The Stiffener Ranges window are updated as shown below.

	Name			oport mber	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)		
> [	Diaphragm Conn Plate	~	1	~	20	1	0	0	20		
	Diaphragm Conn Plate	$\sim$	2	~	5.25	1	0	0	5.25		
	Diaphragm Conn Plate	$\sim$	2	$\sim$	7.25	1	0	0	7.25		
	Diaphragm Conn Plate	$\sim$	2	$\sim$	7.25	4	202.5	67.5	74.75		
	Diaphragm Conn Plate	$\sim$	2	$\sim$	76.75	1	0	0	76.75		
	Diaphragm Conn Plate	$\sim$	3	$\sim$	20	1	0	0	20		

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

A Bearing Stiffener Location - Support 1	_		×
Pairs of bearing stiffeners at this support: 1 X: 6.0000 in			
Stiffener Name Offset pair (in)			
1 Bearing Stiffener      0.0000			-
			~
ОК Ар	oply	Cance	:I

#### Live Load Distribution

Open the Live Load Distribution window from the Bridge Workspace tree. Click the Compute from typical section... button to compute the standard live load distribution factors.

	Load Distributio									
tand	dard LRFD									
D	istribution facto	or input method								
	🔵 Use simplifi		Use advanced me	thod Use	advanced me	thod with 19	94 guide spec	s		
~]	Allow distribut	ion factors to be used	d to compute effe	cts of permit loads	with routine	traffic				
	Lanes		Distribution fa (wheels)	actor						
	loaded	Shear	Shear at supports	Moment	Deflection					
>	1 Lane	1.25	1.3142857	1.25	0.4					-
	Multi-lane	1.590909	1.8	1.590909	1.08					
Co	ompute from pical section	View calcs								

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

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

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

#### Schematic – Member alternative

While the member alternative **Rolled Beam with Cover Plates** 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).

Schematic			_ 🗆 ×
Girder profile			▼ X
i 🖻 📘 🔍 🔍 🕂 🖥			-
STL8 - Pin and Hanger Pin and Hanger - Girder System - 2/23/2023	- 02		
Top Flange Transitions	W38x135	W 30x182	W38x135
Web Transitions	19/32"x35 9/16"x46-0"	28/32%86 11/32%70*-0*	19/32"x35 9/16"x46"-0"
Stiffener Spacing	20-0" 25-3"	Z-0" 4 SPA @ 15-10 9/15"=57-6 1/4" 1-11 3/	4" 25-3"
Shear Connector Spacing Top Flange Lat. Support Top Cover Plate Deterioration Top Flange Deterioration		162-47	
	* * *	** * * *	
Bottom Flange Deterioration Bottom Cover Plate Deterioration Bottom Flange Transitions Spain Lengths	45 5" 45 5" 16 50 16 50 yet develops are hole: hope lang lang ray offer). 16 50 yet annexes at there are a down in the 16 offer annexes at there are a down in the 16 offer annexes at the area of the area 16 offer annexes at the area of the area 16 offer annexes at the area of the area of the 16 offer annexes at the area of the area of the 16 offer annexes at the area of the area of the 16 offer annexes at the area of the area of the 16 offer annexes at the area of the area of the 16 offer at the area of the area of the area of the 16 offer at the area of the area of the area of the area of the 16 offer at the area of the area of the area of the area of the 16 offer at the area of the 16 offer at the area of the 16 offer at the area of the area of the area of the area of the 16 offer at the area of the area of the area of the area of the 16 offer at the area of the 16 offer at the area of the area	74 174 174	45 45

## LFR Analysis

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

Bridge Works	pace - STL8 - Pin and Hanger	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE	WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analysis Settings Analysis Analysis Analysis Analysis	Tabular Specification Engine Results Results Check Detail Outputs Gra Results					

Click the **Open Template** button and select the **HS 20 LFR Rating** used in the rating and click **Open**.

	Description	Analysis	Owner	Public / Private	
HL 93 Design Review	HL 93 Design Review	LRFD		Public	
HS 20 LFR Rating	HS 20 LFR Rating	LFR		Public	
LRFR Design Load Rating	LRFR Design Load Rating	LRFR		Public	
LRFR Legal Load Rating	LRFR Legal Load Rating	LRFR		Public	

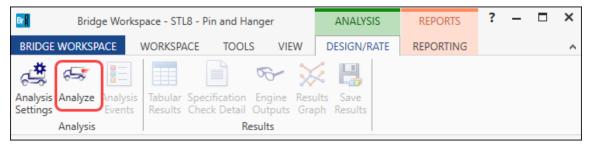
Design review   Rating		
	Rating method: LFR 🗸	
	<ul> <li>✓ Apply preference setting: None ✓</li> </ul>	
Vehicles Output Engine Description		
Traffic direction: Both directions	Refresh Temporary vehicles Advanced	
Vehicle selection	Vehicle summary	
-Vehicles -Standard -Alternate Military Loading -EV2 EV3 -H 15-44 -H 20-44 -HS 15-44 -HS 20 (SI) -HS 20-44 -NRL SU4 SU5 SU5 SU6 SU7 -SU6 SU7 -Type 3 -Type 3-3 -Type 352 -Agency Colorado Legal Type 3 Colorado Legal Type 3-2 Colorado Legal Type 3-2 Colorado Legal Type 3-2 Colorado Legal Type 3-2 -Colorado Legal Type 3-2 -Colorado Legal Type 3-2 -Colorado Legal Type 3-2 -Colorado Legal Type 3-2 -Interstate Legal Type 3-2 -Interstate Legal Type 3-2 -Interstate Legal Type 352 -Modified Tandem -User defined -Colorado Permit Vehicle-1	Add to Ad	

The Analysis Settings window are populated as shown below.

Click **OK** to save the analysis settings and close the window.

#### Tabular Results

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



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

Bridge Workspace - STL8 - Pin and Hanger	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analysis Analyze Analysis Events Results Check Detail Outputs Gra Analysis Analysis Results	vits Save ph Results				

### The window shown below will open.

Analysis Results - Rolled Beam Alt										- 🗆	×
Print Print											
Report type:  Cane/Impact loading type Display Format											
Rating Resul	ts Summary	× ()	Δs requester	d 🔿 Detailed	Single ra	Single rating level per row					
	Live Load		Rating	Load Rating		Location	Location				
Live Load	Туре	Rating Method	Level	(Ton)	Rating Factor	(ft)	Span-(%)	Limit State	Impact	Lane	
HS 20-44	Axle Load	LFR	Inventory	40.13	1.115	122.00	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
HS 20-44	Axle Load	LFR	Operating	67.02	1.862	122.00	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
HS 20-44	Lane	LFR	Inventory	59.18	1.644	122.00	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
HS 20-44	Lane	LFR	Operating	98.82	2.745	122.00	2 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
ASHTO LFR	Engine Versio	on 7.5.0.3001									
nalvsis prefe	erence setting	g: None									
		·									
											Close