AASHTOWare BrDR 7.5.0 Steel Tutorial STL11 – Steel Plate Girder Using LRFR Engine





Framing Plan



Elevation of Interior Girder

Material Properties

Structural Steel: AASHTO M270, Grade 50W uncoated weathering steel with Fy = 50 ksi Deck Concrete: f'c = 4.0 ksi, modular ratio n = 8 Slab Reinforcing Steel: AASHTO M31, Grade 60 with Fy = 60 ksi

Cross Frame Connection Plates: 3/4" x 6" Bearing Stiffener Plates: 7/8" x 9"



Composite Section at Pier



BrDR Tutorial

Topics Covered

- LRFD distribution factor calculation wizard for steel members
- Using AASHTO LRFD Bridge Design Specifications 9th Edition
- Using AASHTO Manual of Bridge Evaluation, 3rd Edition with 2023 interims
- Steel Member Alternative Control Options
 - Moment redistribution
 - Use Appendix A6 for flexural resistance.
 - Allow plastic analysis.
 - Evaluate remaining fatigue life.
 - Ignore longitudinal reinforcement in negative moment capacity.
- Export of steel girders to the BrDR LRFR analysis engine
- BrDR LRFR analysis
- Output review

LRFD distribution factor calculation wizard for steel members

Use the **Import** function of **BrDR** to import the bridge **STL11-Steel-Plate-Girder.xml** provided for this tutorial. Open **BrDR** and click on the **Import** button from the **Bridge** group of the **BRIDGE** ribbon as shown below.

AASHTOWare Bridge Design and Rating ? -									
BRIDGE EXPLORER BRIDGE	FOLDER	RATE	TOOLS VIEW						
New Open Open	Find Copy	Paste	Copy To - From						
Bridge		Ma	anage						
····☆ Favorites Folder ····ジ Recent Bridges □··ジ All Bridges □··ジ Templates ····ジ Deleted Bridges		E 1 2 3 4 5	Bridge ID TrainingBridge1 TrainingBridge2 TrainingBridge3 PCITrainingBridge1 PCITrainingBridge2	•					
Total Bridge Count: 32									

Select the bridge from the STL11 tutorial and click the Open button to import this bridge into BrDR.

📲 Import				×
\leftarrow \rightarrow \checkmark \uparrow \square \Rightarrow This	PC > Desktop > STL11	~	ට , Search	STL11
Organize 🔻 New folder				::: • 💷 ?
PittsburghBridge ^	Name	Date modified	Туре	Size
PittsburghBridge	STL11-Steel-Plate-Girder	11/3/2022 10:12 AM	XML Document	443 KB
This PC This PC Dobjects Desktop Documents Downloads Music Pictures Videos CC:) CC: DATA (D:)				
File nar	me: STL11-Steel-Plate-Girder		 ✓ AASHTOWar Open 	re Bridge XML (.xm 🗸 Cancel

Open the Bridge Workspace tree for Stl6_Training to show the member alternative Plate Girder for member G2.

The partially expanded Bridge Workspace tree is shown below.



Live Load Distribution Factor - LRFD

BrDR can compute the LRFD live load distribution factors for steel girder with concrete decks. Double click on the Live Load Distribution node in the Bridge Workspace tree for member alternative Plate Girder to open the Live Load Distribution window and navigate to the LRFD tab as shown below.

A Live Load Distribution	-		×
Standard LRFD			
Distribution factor input method Ouse simplified method Ouse advanced method			
Allow distribution factors to be used to compute effects of permit loads with routine traffic			
Action: Deflection			
Support Start Length End distance (H) (lanes)			
number (ft) (it) 1 lane Multi-lane			
Compute from typical section View calcs Duplicat	e	Delete	F
ОК Арј	y	Cance	<u>؛</u> ا

Click the **Compute from typical section...** button and BrDR will compute the distribution factors. If these fields are left blank, then the AASHTO LRFR engine will compute the distribution factors during the analysis. For this example, these fields will be left blank allowing the AASHTO LRFR engine to compute these values.

Member Alternative Description – Specs

Double click on the **Plate Girder** member alternative for member **G2** in the **Bridge Workspace** tree to open the **Member Alternative Description** window and navigate to the **Specs** tab of this window as shown below.

nb	er alternative:	Plat	e Girder								
esc	cription Sp	pecs	Factors Engine	Import	Control options						
	Analysis me type	thod	Analysis mod	dule	Selection type	Spec version		Factors			
	ASR		AASHTO ASR	~	System Default 🗸	MBE 3rd 2023i, Std 17th		N/A	\sim		1
>	LFR		AASHTO LFR	~	System Default 🗸 🗸	MBE 3rd 2023i, Std 17th	~	2002 AASHTO Std. Specifications	\sim	_	
	LRFD		AASHTO LRFD	~	System Default 🗸 🗸	LRFD 9th		2020 AASHTO LRFD Specifications	\sim		
	LRFR		AASHTO LRFR	~	System Default 🗸	MBE 3rd 2023i, LRFD 9th		2018 (2022 Interim) AASHTO LRFR Spec.	\sim		

AASHTO LRFR engine is selected as the LRFR Analysis module.

Member Alternative Description – Control options

Navigate to the **Control options** tab of this window. This tab allows the user to select the analysis features.



Allow moment redistribution

This control option considers moment redistribution as per Appendix B6 of the specifications. In the moment redistribution process, some of the negative moment at the pier is redistributed along the beam. This option will first initiate the spec checks in Appendix B6.2 to determine if moment redistribution is permissible as per the specifications. If redistribution is not permissible, then it will not occur even if this option is selected.

Use Appendix A6 for flexural resistance

This control option considers Appendix A6 of the Specifications for flexural resistance. Using Appendix A6 can result in flexural resistances greater than the yield moment, My, for certain types of sections. The program will first check if Appendix A6 is permissible by checking the requirements in Article 6.10.6.2.3. If the use of Appendix A6 is not permissible, then it will not be used even if this option has been selected.

Allow plastic analysis

This control option considers the plastic moment capacity for compact, composite sections in positive flexure. If this option is selected, the program will evaluate Articles 6.10.7.1.1 and 6.10.7.1.2. If this option is not selected, Articles 6.10.7.1.1 and 6.10.7.1.2 will not be evaluated and all positive flexure sections will be considered non-compact.

Evaluate remaining fatigue life

This control option evaluates the remaining fatigue life specified in MBE 7.2. If this option is not selected, MBE 7.2 will still be evaluated but the remaining fatigue life will not be computed.

Ignore long. reinforcement in negative moment capacity

This control option allows the user to ignore the contribution of the longitudinal deck reinforcement when computing the negative moment capacity of the section.

LRFR Rating

To perform an LRFR rating, select the Analysis Settings button on the Analysis group of the DESIGN/RATE ribbon.

Br Bridge V	Vorkspace - Stl6_Training	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE	WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
at 10	📄 📄 🍫 💥	2 📙				
Analysis Analyze Analysis Settings Events	Tabular Specification Engine Resu Results Check Detail Outputs Gra	ults Save ph Results				
Analysis	Results					

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

remplates	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	

Oesign review Rating	Rating method:
alysis type: Line Girder te / Impact loading type: As Requested	Apply preference setting: None
/ehicles Output Engine Description Traffic directions V V Vehicle selection V	Refresh Temporary vehicles Advanced Vehicle summary
 ➡ Vehicles ➡ Standard Fv2 FV3 H 15-44 H 29-44 H 393 (JS) H 15-34 (JS) H 51-44 H 20 (SI) H 51-44 H 20 (SI) H 52 0 (SI)	Add to Ad

The Analysis Settings window will be populated as shown below.

Navigate to the **Output** tab of this window and select the following reports to be generated during the analysis.

Analysis Settings			- 0	ı x
O Design review Rating	Rating method:	LRFR	~	
Analysis type: Line Girder 🗸				
Lane / Impact loading type: As Requested 🗸 🗸	Apply preference setting:	None	~	
Vehicles Output Engine Description				
Tabular results Dead load action report Live load action report Truss panel point concurrent forces report Truss panel point maximum forces report	AASHTO engine rep Girder proper Girder proper Gurder proper Gurder proper Gurder proper Gurder proper Gapacity deta F model for 1 L influence li L influence li L influence li L influence li L influence li Gapacity deta F model for 1 Gurder for 1 Gurde	orts ports: ties uence line loading mary DL analysis DL analysis LL analysis nes FE model nes FE actions for computations or or summary ta ranges ss ranges put:		
Select all Clear all	Select all	ar all		
Reset Clear Open template Save template		ОК Арріу	r (Cancel

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

Next click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating. The **Analysis** window should be reviewed for any warning messages.



Export of steel girders to the AASHTO LRFR analysis engine

The following steps are performed when performing an LRFR analysis of a steel girder using the BrDR LRFR analysis engine:

Finite element models are generated for the dead load and live load analyses. A Stage 1 FE model is generated for the beam dead load and non-composite dead loads. A Stage 2 FE model is generated for dead loads applied to the long-term composite section properties. A Stage 3 FE model is generated for the live load analysis.
 Stage 2 FE model contains section properties corresponding to the sustained modular ratio factor entered in BrDR (e.g. 3n). Stage 3 FE model contains section properties corresponding to the modular ratio (n). The FE models will consider the presence of shear connectors when setting the composite properties in the FE models. Regions

that do not contain shear connectors will use non-composite section properties in the Stage 2 and 3 FE models. In addition to the points selected on the **Member Alternative Description** window's **Control options** tab, the model generated by the export to the BrDR LRFR analysis engine will always contain node points at brace point locations and locations midway between the brace points. Only the articles required to compute stresses are processed at these points if the point is not being processed for one of the options chosen on this tab. The stresses at these locations are required when determining the flexural capacity of the steel girders.

2. The specification checks required for the LRFR analysis will be performed. The specification checking occurs in two phases. The first phase determines the type of flexure present at each point for each controlling load combination. This is necessary because the flexural articles to be considered in the specification are dependent on the type of flexure the beam is subject to. The second phase performs the specification checks taking into consideration the flexure type determined in the first phase.

Phase 1:

Positive flexure is defined as the bending condition that produces compressive stress (denoted by a negative sign in the program) in the slab for composite construction or the top flange for non-composite construction. Negative flexure is defined as the bending condition that produces tensile stress (denoted by a positive sign) in the slab or top flange. As per Article 6.10.1.1.1b, the stress in the top of the slab (or top flange for non-composite construction) is first computed using the positive flexure section properties. If this stress is compressive, the stresses in each component of the beam (slab, longitudinal reinforcement, flanges, cover plates, and web) are computed using the positive flexure section properties. If the slab (or top flange for non-

composite construction) is tensile, the stresses in each component of the beam are computed using the negative section properties.

If the resulting computed stress in the bottom flange is tensile, the beam is in positive flexure for the load combination. If the resulting computed stress in the bottom flange is compressive, the beam is in negative flexure for the load combination.

Phase 2:

The remaining articles are evaluated taking into consideration the flexure type determined in the first phase.

Output Review

Tabular Results – Rating Results Summary

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

Bridge Workspace - Stl6_Training	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analysis Analyze Analysis Events Analysis Analysis Analysis Events Results	llts Save Results				

The **Rating Results Summary** is shown below. The critical inventory rating factor for **Truck** + **Lane** is **0.986**. The controlling location is at the pier and the limit state is **Strength-I Steel Shear**.

4	Analysis Re	sults - Plate Girder									-		×
	Print Print												
Re	port type:	La	ane/Impact loadii	ng type	Display F	ormat							
R	ating Results	Summary 🖌 🧃	As requested	O Detailed	Single ra	iting level per r	ow	\sim					
	1		1		1.10.0	1			1	1	1	1	
	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	35.48	0.986	90.00	1 - (100.0)	STRENGTH-I Steel Shear	As Requested	As Requested		-
	HL-93 (US)	Truck + Lane	LRFR	Operating	45.99	1.278	90.00	1 - (100.0)	STRENGTH-I Steel Shear	As Requested	As Requested]	
	HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	37.95	1.054	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
	HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	49.20	1.367	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
	HL-93 (US)	Tandem + Lane	LRFR	Inventory	43.74	1.215	90.00	1 - (100.0)	STRENGTH-I Steel Shear	As Requested	As Requested		
	HL-93 (US)	Tandem + Lane	LRFR	Operating	56.69	1.575	90.00	1 - (100.0)	STRENGTH-I Steel Shear	As Requested	As Requested		
													-
AA	ISHTO LRFR E	ngine Version 7.5.0.3001											
An	alysis prefere	nce setting: None									_		
												Clos	se

Specification Check Detail

The specification checks can be viewed by selecting the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.

Bridge Workspace - Stl6_Training	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analysis Analyze Analysis Events Analysis Analysis Analysis Analysis Events Analysis	sults Save aph Results				

Select Stage 3, Plate Girder from the Specification Checks tree and open the article 6A.4.2.1 General Load Rating

Equation – Steel Shear @ Span 1 – 90.00 ft. by double clicking on the article as shown below.

A Specification Checks	for Plate Gi	irder - 5) of 1713			_	×
Properties G	enerate	Articles All arti Format Bullet Repor	ist v				
A Superstructure Co	omponent	^	Specification reference	Limit State	Flex, Sense	Pass/Fail	^
Stage 1	omponent		6.10.8.2.2 Local Buckling Resistance		N/A	General Comp.	_
Stage 2			6.10.8.2.3 Lateral Torsional Buckling Resistance		N/A	General Comp.	
🔺 🚞 Stage 3			6.10.8.2.3.Cb Lateral Torsional Buckling Resistance - Cb Calculation		N/A	General Comp.	
🔺 🚞 Plate Gird	er		6.10.8.2.3.rt Lateral Torsional Buckling Resistance - rt and Lp Calculation	0	N/A	General Comp.	
🚞 Span 1	1 - 0.00 ft.		6.10.8.3 Flexural Resistance Based on Tension Flange Yielding		N/A	General Comp.	
🚞 Span 1	1 - 9.00 ft.		✗ 6.10.9 LRFD Shear Resistance		N/A	Failed	
🚞 Span 1	1 - 16.00 ft.		🛢 6.10.9.1 Shear Resistance - General		N/A	General Comp.	
🚞 Span 1	1 - 18.00 ft.		✓ 6.10_General_Flexural_Results		N/A	Passed	
🚞 Span 1	1 - 27.00 ft.		✓ 6.6.1.2.2 Design Criteria		N/A	Passed	
🛄 Span 1	1 - 32.00 ft.		6.9.4.1 Bearing Stiffener Nominal Resistance		N/A	General Comp.	
Span 1	1 - 36.00 ft.		✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Moment		N/A	Passed	
Span 1	1 - 45.00 ft.		✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Stress		N/A	Passed	
Span 1	1 - 48.00 ft.		× 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Failed	
Span	1 - 54.00 ft.		6A.4.2.1.fl		N/A	General Comp.	
Span	1 64 00 #		✓ 6A.6.4.2.2 Service Limit State		N/A	Passed	
Span 1	1 - 04.00 IL 1 - 70 50 ft		X 7.2 Load-Induced Fatigue-Damage Evaluation		N/A	Failed	
Span 1	1 - 72 00 ft		7.2.6 Fatigue Serviceability Index		N/A	General Comp.	
Span 1	1 - 77.00 ft.		APPD6.1 Plastic Moment		N/A	General Comp.	
Span 1	1 - 81.00 ft.		APPD6.2 Yield Moment		N/A	General Comp.	
🚞 Span 1	1 - 83.50 ft.		APPD6.3.1 In the Elastic Range (Dc)		N/A	General Comp.	
🔁 Span 1	1 - 90.00 ft.		APPD6.3.2 Depth of the Web in Compression at Plastic Moment		N/A	General Comp.	
🚞 Span 2	2 - 6.50 ft.	~	Steel Elastic Section Properties		N/A	General Comp.	~

	Detail for 6A.4	4.2.1 General Loa	ad Rating Equation	n - Steel Shear										-		×
6A Load and 6A.4 Load R 6A.4.2 Gene 6A.4.2.1 St (AASHTO Mar	i Resistan Rating Pro eral Load- ceel Shear nual for B	ce Factor Ra cedures Rating Equat General ridge Evalua	ting tion tion, Third E	dition wit	h 2022 Int	erims)										^
Steel Plate	e - At Loc	ation = 90.0	0000 (ft) - Le	ft Sta	ge 3											
Section wit	thin Top F	lange Contin	uous Bracing	Region												
Section at	Bottom Fl	ange Brace P	Point													
Shear Ratin	ng Factor	Calculations	8													
Input:																
Condition F System Fact DC shear DW shear DW-WS shear	factor	= 1.0000 = 1.0000 = -106.986 = -12.1490 = 0.0000	58 (kip)) (kip) (kip)													
Vn comes fr Note: If th Other	com LRFD 6 ne capacit wise the 3	.10.9 unless y has been o Resistance i	s capacity is overridden, th is computed as	overridden We Resistan Per the S	ce is comp pecificatio	uted as o on.	verride p	hi*overri	de capacit	су.						
						Lond Front	0.10.0				Orrownid	0				
	Load	Limit		Adj.	1	Load Fact	ors				Overrid	e				
Load	Load Combo	Limit State	LL (kip)	Adj. LL (kip)	DC	Load Fact DW	DW-WS	LL	Phi	Vn (kip)	Overrid Phi	Vn (kip)	RF	Capacity (Ton)		
Load DesignInv DesignInv DesignOp DesignInv DesignOp DesignOp DesignInv DesignOp DesignOp DesignOp	Load Combo 1 1 1 2 2 2 2 3 3 3 3 3 3	Limit State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	LL (kip) -119.93 -119.93 0.00 -97.29 0.00 -97.29 0.00 0.00 0.00 0.00 0.00	Adj. LL (kip)	DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	Load Fact DW 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	DW-WS 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	LL 1.75 1.75 1.35 1.35 1.75 1.75 1.75 1.75 1.75 1.35 1.35	Phi 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0	Vn (kip) 358.80 -358.80 358.80 -358.80 -358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80	Overrid Phi 	Vn (kip)	RF 99.000 0.986 99.000 1.278 99.000 1.275 99.000 99.000 99.000 99.000 99.000 99.000	Capacity (Ton) 3564.00 35.48 3564.00 3564.00 3564.00 3564.00 3564.00 3564.00		
Load DesignInv DesignInv DesignOp DesignOp DesignOp DesignOp DesignInv DesignOp DesignInv DesignOp Load Combin Code	Load Combo 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3 3 2 2 2 2	Limit State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	LL (kip) -119.33 -119.33 -0.00 -119.33 0.00 -97.29 0.00 0.00 0.00 0.00	Adj. LL (kip)	DC 1.25	Load Fact DW 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	DW-WS 1.50	LL 1.75 1.75 1.35 1.35 1.35 1.35 1.35 1.35 1.35 1.3	Phi 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0	Vn (kip) 358.80 -358.80 -358.80 -358.80 -358.80 -358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80	Overrid Phi 	e (kip) 	RF 99.000 0.986 99.000 1.278 99.000 1.215 99.000 1.575 99.000 99.000 99.000 99.000	Capacity (Ton) 3564.00 35.48 3564.00 45.99 3564.00 3564.00 3564.00 3564.00 3564.00		
Load DesignInv DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp Load Combin Code 1 H 2 H	Load Combo 1 1 1 2 2 2 2 2 3 3 3 3 3 4 ation Leg Wehicle H_93 (US) H_93 (US)	Limit State STR-I	LL (kip) -119.93 -119.93 -0.00 -97.29 0.00 -97.29 0.00 0.00 0.00 0.00	Adj. LL (kip) 	DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	Load Fact DW 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	DW-WS 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	LL 1.75 1.75 1.35 1.35 1.35 1.35 1.75 1.35 1.75 1.35 1.35	Phi 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	Vn (k1p) 358.80 -358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80	Overrid Phi 	le Vn (kip) 	RF 99.000 0.986 99.000 1.278 99.000 1.215 99.000 99.000 99.000 99.000	Capacity (Ton) 3564.00 35.48 3364.00 45.99 3364.00 56.69 3564.00 3564.00 3564.00		
Load DesignInv DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp Code 1 H 2 H 3 L	Load Combo 1 1 1 2 2 2 3 3 3 3 3 wation Leg Vehicle HI-93 (US) HI-93 (US) HI-93 (US) RED Fatig	Limit State STR-I	LL (kip) -119.33 -0.00 -119.33 -97.29 0.00 -97.29 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	Adj. LL (kip) 	DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	Load Fact DW 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	DW-WS	LL 1.75 1.35 1.35 1.75 1.35 1.35 1.35 1.35 1.35 1.35	Phi 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0	Vn (ktp) 358.80 -358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80	Overrid Phi 	le Vn (kip) 	RF 99.000 0.986 99.000 1.278 99.000 1.215 99.000 99.000 99.000 99.000 99.000	Capacity (Ton) 3564.00 45.99 3564.00 43.74 3564.00 3564.00 3564.00 3564.00		
Load DesignInv DesignInv DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp DesignOp Load Combin Code 1 H 2 H 3 H 4 L	Load Combo 1 1 1 2 2 2 2 3 3 3 3 3 4 tion Leg Vehicle IL-93 (US) IL-93 (US) IL-93 (US) IL-93 (US) IL-93 (US)	Limit State STR-I	LL (kip) -119.33 -0.00 -119.33 -97.29 0.00 -97.29 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0	Adj. LL (kip) 	DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	Load Fact DW 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50	DW-WS 1.50	LL 1.75 1.35 1.35 1.75 1.35 1.75 1.35 1.75 1.35 1.35 1.35	Phi 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.0	Vn (ktp) 358.80 -358.80 358.80 -358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80 358.80	Overrid Phi	Vn (kip)	RF 99.000 0.986 99.000 1.278 99.000 1.575 99.000 99.000 99.000 99.000	Capacity (Ton) 3564.00 35.48 3364.00 45.99 3364.00 3364.00 3364.00 3364.00 3364.00	2	>

To review the **Vn** computation at this location, double click on the **6.10.9 LRFD Shear Resistance** article. The article is shown below.

💀 Spec Check Detail for 6.10.9 LRFD Shear Resistance × 6 Steel Structures \sim 6.10 I-Section Flexural Members 6.10.9 Shear Resistance (AASHTO LRFD Bridge Design Specifications, Ninth Edition) Steel Plate - At Location = 90.0000 (ft) - Left Stage 3 Section within Top Flange Continuous Bracing Region Section at Bottom Flange Brace Point Article 6.10.9.2 Unstiffened Panels INPUT: INFUT: Top Flange bf = 16.0000 (in) Top Flange tf = 1.2500 (in) Web D = 46.0000 (in) Web tw = 0.5000 (in) Bot Flange bf = 18.0000 (in) Bot Flange tf = 1.5000 (in) Fyw = 50.0000 (ksi) do = 192.0000 (in) phi = 1.0000 SUMMARY: k = 5.0D/tw = 92.0000Limit 1: 1.12*SQRT(E*k/Fyw) = 60.3138 Limit 2: 1.40*SQRT(E*k/Fyw) = 75.3923 D/tw > Limit2 therefore 1.57*(E*k/Fyw) C = (6.10.9.3.2-6)(D/tw)^2 C = 0.5379Vn = Vcr = C * Vp(6.10.9.2 - 1)Vp = 0.58*fyw*D*tw (6.10.9.2-2) Vp = 667.0001 (kip) Vn = 358.7962 (kip) Vr = phi*Vn = 358.80 < > ОК

To generate a **Spec Check Report** for the **6A.4.2.1 Steel Shear General Load Rating Equation check** for all the locations, click on the **Properties** button from the **Specification filter** ribbon to open the **Spec-Check Viewer Filter Properties** window as shown below.

A Specification Checks for Plate Girder - 1076	of 1713		- 🗆	×
Properties Specification filter				
▲ 🔄 Superstructure Component	Specification reference Limit Stat	e Flex. Sense	Pass/Fail	^
Stage 1	5.4.2.6 Modulus of Rupture	N/A	General Comp.	
Stage 2	5.4.2.8 Concrete Density Modification Factor	N/A	General Comp.	
🔺 🔄 Stage 3	6.10.1 Estimated Flange Lateral Bending Stress Proportioning	N/A	General Comp.	
🔺 🚞 Plate Girder	6.10.1.1.1b Stresses for Sections in Positive Flexure	N/A	General Comp.	
🚞 Span 1 - 0.00 ft.	6.10.1.10.1 Hybrid Factor, Rh	N/A	General Comp.	
🚞 Span 1 - 9.00 ft.	6.10.1.10.2 Web Load-Shedding Factor, Rb	N/A	General Comp.	
i Span 1 - 16.00 ft.	✓ 6.10.1.6 Flange Stress and Member Bending Moments	N/A	Passed	
Span 1 - 18.00 ft.	✓ 6.10.1.7 Minimum Negative Flexure Concrete Deck Reinforcement	N/A	Passed	
Span 1 - 27.00 ft.	6.10.1.9.1 Webs without Longitudinal Stiffeners	N/A	General Comp.	
Span 1 - 32.00 ft.	✓ 6.10.11.1.2 Transverse Stiffeners - Projecting Width	N/A	Passed	
Span 1 - 36.00 ft.	✓ 6.10.11.1.3 Transverse Stiffeners - Moment of Inertia	N/A	Passed	
Span I - 45.00 ft.	✓ 6.10.11.2.2 Minimum Thickness	N/A	Passed	
Span 1 - 46.00 ft.	✓ 6.10.11.2.3 Bearing Stiffeners - Bearing Resistance	N/A	Passed	
Span 1 - 54.00 ft	✓ 6.10.11.2.4 Axial Resistance of Bearing Stiffeners	N/A	Passed	
Span 1 - 64.00 ft	✓ 6.10.2 Cross-Section Proportion Limits	N/A	Passed	
Span 1 - 70.50 ft.	✓ 6.10.4.2.2 Flexure	N/A	Passed	
Span 1 - 72.00 ft.	6.10.6.2.2 Composite Sections in Positive Flexure	N/A	General Comp.	
Span 1 - 77.00 ft.	6.10.6.2.3 Composite Sections in Negative Flexure and Noncomposite	N/A	General Comp.	
i Span 1 - 81.00 ft.	✓ 6.10.7.1.1 General	N/A	Passed	
i Span 1 - 83.50 ft.	6.10.7.1.2 Nominal Flexural Resistance	N/A	General Comp.	
i Span 1 - 90.00 ft.	NA 6.10.7.2.1 General	N/A	Not Applicable	
🚞 Span 2 - 6.50 ft. 🗸 🗸	6.10.7.2.2 Nominal Flexural Resistance	N/A	General Comp.	~

Navigate to the **Spec articles** tab. Click the **Clear all** button and select the article **6A.4.2.1 General Load Rating Equation – Steel Shear** from the **Reference** column as shown below.

🔐 Spec-Check Viewer Filter Properties		- [- X
Filter name: <default filter=""> New Open Save</default>	Delete	•	~
General Spec articles Description			
Reference	Article		^
6.6.1.2.2	Design Crite	ria	
6.9.4.1	Bearing Stiff	ener Nor	minal
6A.4.2.1 General Load Rating Equation - Steel Flexure Moment			
6A.4.2.1 General Load Rating Equation - Steel Flexure Stress			
✓ 6A.4.2.1 General Load Rating Equation - Steel Shear			
6A.4.2.1.fl			
6A.6.4.2.2 Service Limit State			
7.2 Load-Induced Fatigue-Damage Evaluation			
7.2.6 Fatigue Serviceability Index			
			~
			2
Select all Clear all			
ОК	Appl	y	Cancel

Click **OK** to apply the filter and close this window.

Select the **Stage 3** in the **Superstructure Component Tree** to filter all the **6A.4.2.1 General Load Rating Equation** – **Steel Shear** checks in **Stage 3**.

A Specification Checks for Plate C	Girder - 21 of 1713	-	×
Properties Generate	Articles All articles Format Bullet list Report		
▲ ▲ Superstructure Component	Specification reference Limit State Flex. Sense ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Steel Shear N/A ✓ 6A.4.2.1 General Load Rating Equation - Stee	Pass/Fail Passed Passed Passed Passed Passed Passed Passed Passed Failed Passed	
■ Span 1 - 48.00 ft ■ Span 1 - 54.00 ft ■ Span 1 - 64.00 ft ■ Span 1 - 65.00 ft ■ Span 1 - 70.00 ft ■ Span 1 - 72.00 ft ■ Span 1 - 77.00 ft ■ Span 1 - 81.00 ft ■ Span 1 - 83.50 ft ■ Span 1 - 90.00 ft ■ Span 2 - 6.50 ft.	 6A.4.2.1 General Load Rating Equation - Steel Shear 	Passed Passed Passed Passed Passed Passed Passed Passed	

In the **Report** group of the ribbon, select **All articles** under **Articles** and **Verbose** under **Format** and click the **Generate** button to generate a report (**.xml**) as shown below.

A Specification Checks for Plate Girder - 21	of 1713			-	×
Properties Specification filter	es V				
🔺 🛄 Superstructure Component 🛛 🔨	Specification reference	Limit State	Flex. Sense	Pass/Fail	
Stage 1	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Stage 2	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
🔺 🔄 Stage 3	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
🔺 🚞 Plate Girder	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
i Span 1 - 0.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
i Span 1 - 9.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 16.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 18.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 27.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 32.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 36.00 ft.	✗ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Failed	
Span 1 - 45.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 48.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 54.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 64.00 ft	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 70.50 ft	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 72.00 ft	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 77.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 81.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
Span 1 - 83.50 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
i Span 1 - 90.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	

BrDR XML Report Viewer × 1 Bridge Name: 2 Span Plate Girder Training NBI Structure ID: Stl6_Training Bridge ID: Stl6_Training Analyzed By: Bridge Analyze Date: 2/14/2024 5:33:44 AM Analysis Engine: AASHTO LRFR Engine Version 7.5.0.3001 Analysis Preference Setting: None Report By: bridge Report Date: Wednesday, February 14, 2024 5:34:47 AM Structure Definition Name: 2 Span, 4 Girder system Member Name: G2 Member Alternative Name: Plate Girder 6A.4.2.1 General Load Rating Equation - Steel Shear Limit State: Stage: 3 Flex Sense: N/A Vehicle: 6A Load and Resistance Factor Rating 6A.4 Load Rating Procedures 6A.4.2 General Load-Rating Equation 6A.4.2.1 Steel Shear General (AASHTO Manual for Bridge Evaluation, Third Edition with 2023 Interims) Steel Plate - At Location = 0.0000 (ft) - Right Stage 3 Section within Top Flange Continuous Bracing Region Section at Bottom Flange Brace Point Shear Rating Factor Calculations Input: Condition Factor = 1.0000 System Factor = 1.0000 DC shear = 59.3860 (kip) DC shear DW shear DW-WS shear = 6.9913 (kip) = 0.0000 (kip) Vn comes from LRFD 6.10.9 unless capacity is overridden.

Tabular Results – Dead Load / Live Load Actions

Tabular dead load and live load analysis results are available in the Analysis Results window.

Dead Load

Select **Dead Load Actions** under **Report Type**. The **Dead Load Case** description contains all the load cases used in this analysis.

۵	Analys	is Results -	Plate G	irder										-		×
	Print															
6	Print			_	C 1				1							
Кер	ort type	e:			Stage				1	Dead L	oad Case					
De	ad Load	Actions		\sim	Non-comp	osite (St	age 1)	~		Load	Case 1 - Self Loi	ad(Stage 1				
									L	Load	d Case 1 - Self L	oad(Stage 1:l	D,DC)			
	Span	Location (ft)	% Span	Side	Moment (kip-ft)	Shear (kip)	Axial (kip)	Torsion (kip-ft)	Re	Load	l Case 2 - Add'l	Self Load (In	Force/Length)(Stage 1:D,DC)			
	1	0.00	0.0	Right	0.00	5.88	0.00	0.00	Г	Load	d Case 3 - Mem	ber Dist'd Loa	ads(SIP Forms:Stage 1:D,DC)			
	1	9.00	10.0	Both	45.65	4.26	0.00	0.00		Load	d Case 4 - Haun	ch Load(Stag	e 1:D,DC)			- 11
	1	16.00	17.8	Both	71.06	3.00	0.00	0.00		Load	Case 6 - Conci	rete Deck Loa	d(Stage 1:D DC)			- 1
	1	18.00	20.0	Both	76.70	2.64	0.00	0.00				0	alouge ho,oo,			- 1
	1	27.00	30.0	Both	93.14	1.01	0.00	0.00		_	0.0000	-0.1547				- 1
	1	32.00	35.6	Both	95.96	0.11	0.00	0.00			0.0000	-0.1654	l l			- 1
	1	36.00	40.0	Both	94.97	-0.61	0.00	0.00			0.0000	-0.1689)			- H
	1	45.00	50.0	Both	82.19	-2.23	0.00	0.00			0.0000	-0.1608	\$			- 1
	1	48.00	53.3	Both	74.68	-2.77	0.00	0.00			0.0000	-0.1536	i			- 1
	1	54.00	60.0	Both	54.80	-3.85	0.00	0.00			0.0000	-0.1335	i			- 1
	1	63.00	70.0	Both	12.81	-5.48	0.00	0.00			0.0000	-0.0934	ł			- 1
	1	64.00	71.1	Both	7.21	-5.72	0.00	0.00			0.0000	-0.0886	j			- H
	1	70.50	78.3	Both	-34.98	-7.26	0.00	0.00			0.0000	-0.0573				- 1
	1	72.00	80.0	Both	-46.14	-7.62	0.00	0.00			0.0000	-0.0504	ł			- H
	1	77.00	85.6	Both	-87.22	-8.81	0.00	0.00			0.0000	-0.0291				- 1
	1	81.00	90.0	Both	-124.38	-9.77	0.00	0.00			0.0000	-0.0151				- H
	1	83.50	92.8	Both	-149.54	-10.36	0.00	0.00			0.0000	-0.0083				
	1	90.00	100.0	Left	-221.91	-11.91	0.00	0.00		23.82	0.0000	0.0000				
	2	0.00	0.0	Right	-221.91	11.91	0.00	0.00		23.82	0.0000	0.0000				
	2	6.50	7.2	Both	-149.54	10.36	0.00	0.00			0.0000	-0.0083				
	2	9.00	10.0	Both	-124.38	9.77	0.00	0.00			0.0000	-0.0151				
	2	13.00	14.4	Both	-87.22	8.81	0.00	0.00			0.0000	-0.0291				
	2	18.00	20.0	Both	-46.14	7.62	0.00	0.00			0.0000	-0.0504	Ļ			
	2	19.50	21.7	Both	-34.98	7.26	0.00	0.00			0.0000	-0.0573				
	2	26.00	28.9	Roth	721	5 72	0.00	0.00			0 0000	-0.0886				Ŧ
AAS	SHTO LE	RFR Engine	Version	7.5.0.3	001											
Ana	lysis pr	eference se	tting: N	one												
															CI	ose

Live Load

🕰 Analys	is Results -	Plate Gi	rder															— C	1
Print																			
eport type			Star	ne -			Live L	oad			Live Load	Type							
Live Load	Actions		√ Co	mposite (sh	ort term) ((Stage : 🗸	HL-9	3 (US)		\sim	Axle Loa	d	\sim						
											<u> </u>								
Span	Location (ft)	% Span	Positive Moment (kip-ft)	Negative Moment (kip-ft)	Positive Shear (kip)	Negative Shear (kip)	Positive Axial (kip)	Negative Axial (kip)	Positive Torsion (kip-ft)	Negative Torsion (kip-ft)	Positive Reaction (kip)	Negative Reaction (kip)	Positive X Deflection (in)	Negative X Deflection (in)	Positive Y Deflection (in)	Negative Y Deflection (in)	% Impact Pos Reaction	% Impact Neg Reaction	
1	0.00	0.0	0.00	0.00	79.19	-9.01	0.00	0.00			79.19	-9.01	0.0000	0.0000	0.0000	0.0000	33.000	33.000	1
1	9.00	10.0	473.01	-62.83	67.84	-9.01	0.00	0.00					0.0000	0.0000	0.0558	-0.1613			
1	16.00	17.8	733.81	-111.70	59.20	-10.29	0.00	0.00					0.0000	0.0000	0.0970	-0.2751			
1	18.00	20.0	791.65	-125.66	56.77	-12.56	0.00	0.00					0.0000	0.0000	0.1081	-0.3044			
1	27.00	30.0	970.06	-188.49	46.26	-22.65	0.00	0.00					0.0000	0.0000	0.1533	-0.4121			
1	32.00	35.6	1025.72	-223.40	40.63	-28.72	0.00	0.00					0.0000	0.0000	0.1740	-0.4524			
1	36.00	40.0	1043.19	-251.33	36.32	-33.57	0.00	0.00					0.0000	0.0000	0.1878	-0.4732			
1	45.00	50.0	1015.67	-314.16	27.23	-44.19	0.00	0.00					0.0000	0.0000	0.2080	-0.4822			
1	48.00	53.3	990.44	-335.10	24.36	-47.58	0.00	0.00					0.0000	0.0000	0.2110	-0.4729			
1	54.00	60.0	907.00	-376.99	18.99	-54.12	0.00	0.00					0.0000	0.0000	0.2105	-0.4368			
1	63.00	70.0	703.71	-439.82	11.79	-63.32	0.00	0.00					0.0000	0.0000	0.1917	-0.3478			
1	64.00	71.1	677.15	-446.80	11.12	-64.28	0.00	0.00					0.0000	0.0000	0.1882	-0.3356			
1	70.50	78.3	497.09	-505.60	6.95	-70.24	0.00	0.00					0.0000	0.0000	0.1591	-0.2535			
1	72.00	80.0	447.68	-516.36	6.07	-71.55	0.00	0.00					0.0000	0.0000	0.1509	-0.2335			
	77.00	85.6	271.34	-552.22	3.47	-75.78	0.00	0.00					0.0000	0.0000	0.1188	-0.1659]

Select Live Load Actions under Report Type and Axle Load under Live Load Type.

Note these values include dynamic load allowance, distribution factors and any live load scale factor entered on the **Analysis Settings** window.

AASHTO LRFR FE model outputs

The **FE model outputs** that was turned on in the **Analysis Settings** window is available from the **Engine Outputs** window. Click the **Engine Outputs** button from the **Results** group of the **DESIGN/RATE** ribbon to open the following window.

Bric Bric	dge Workspace - Stl6	_Training	ANALYSIS	REPORTS	?	-	×
BRIDGE WORKSPACE	WORKSPACE	TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analysis Analyze Ana Settings Analysis Analysis	alysis ents Tabular Speci Results Chec	ification k Detail Results	esults Save Graph Results				
A Stl6_Training				_			×
iaStl6_Training ia2 Span, 4 G iaG2 iaPlat ia	Birder system AASHTO_LRFD AASHTO_LRFR Stage 3 Infl Line Live Load Distril Stage 3 Spec Ch Stage 1 Span M Stage 1 Span M Stage 2 Span M Stage 2 Span M Stage 2 Span M Stage 3 Span M Stage 3 Span M Stage 3 Span M Stage 3 Span M	es Span Model bution Factors Calc bution Factors Calc neck Results lodel lodel Actions lodel lodel Actions lodel Actions	ulations ulations Summary				