AASHTOWare BrDR 7.4.1 Steel Flange Lateral Bending Stress Tutorial STL13 – Flange Lateral Bending Example

BrDR Training

Overview

User input flange lateral bending stresses can be defined for steel girders in girder line and girder system superstructure definitions. These lateral bending stresses are defined separately for the top and bottom flange and are used when evaluating a member for flexure using the 9th Edition AASHTO LRFD specifications. The lateral stresses must be defined at diaphragm locations. Load cases are defined specifically for the lateral bending stresses and include options for construction loads, wind loads, dead loads, live load, and proportioned loads.

The input flange lateral bending stresses are added to any lateral bending stresses resulting from the analysis. This input can be used to:

- Approximate lateral bending stresses from skew effects while running a line girder analysis.
- Add lateral stresses from components not explicitly modeled, such as deck overhang brackets, while running a line girder or 3D analysis.
- Define temporary lateral stresses occurring during construction on the non-composite model.

From the Bridge Explorer create a copy of the Splice Example (BID 29) bridge from the sample database.

To copy the bridge, first select the **Splice Example** bridge in the bridge explorer table. Select copy in the top ribbon to copy the bridge.

			AASHTOWare Bridge Design and Rating					?	
BRIDGE EXPLORER BRIDGE CORER Mew Open Bridge Bridge	RATE	Remove Delete							
Favorites Folder	EA	Bridge ID	Bridge Name	District	County	Facility	Location	Route	Feature Inter
- 🧭 Recent Bridges	1	TrainingBridge1	Training Bridge 1(LRED)	Unknown	Unknown (P)	SR 0051	Pittsburgh	0051	SR 6060
🖻 🏓 All Bridges	2	TrainingBridge2	Training Bridge 2(LRFD)	Unknown	Unknown (P)	N/A	N/A	-1	N/A
🗄 📁 Templates	3	TrainingBridge3	Training Bridge 3(LRFD)	Unknown	Unknown (P)	1-79	Pittsburgh	0079	Ohio River
Deleted Bridges	4	PCITrainingBridge1	PCI TrainingBridge1(LFD)					-1	
	5	PCITrainingBridge2	PCITrainingBridge2(LRFD)					-1	
	6	PCITrainingBridge3	PCI TrainingBridge3(LFD)					-1	
	7	PCITrainingBridge4	PCITrainingBridge4(LRFD)					-1	
	8	PCITrainingBridge5	PCI TrainingBridge5(LFD)					-1	
	9	PCITrainingBridge6	PCITrainingBridge6(LRFD)					-1	
	10	Example7	Example 7 PS (LFD)					-1	
	11	RCTrainingBridge1	RC Training Bridge1(LFD)					-1	
	12	TimberTrainingBridge1	Timber Tr. Bridge1 (ASD)					-1	
	13	FSys GFS TrainingBridge1	FloorSystem GFS Training Bridge 1	Unknown	Unknown (P)	NJ-Turnpike	NJCity	-1	
	14	FSys FS TrainingBridge2	FloorSystem FS Training Bridge 2	Unknown	Unknown (P)	1-95	NYC	-1	
	15	FSys GF TrainingBridge3	FloorSystem GF Training Bridge 3	Unknown	Unknown (P)	1-95	ATL	-1	
	16	FLine GFS TrainingBridge1	FloorLine GFS Training Bridge 1	Unknown	Unknown (P)	1-75	JAX	-1	
	17	FLine FS TrainingBridge2	FloorLine FS Training Bridge 2	Unknown	Unknown (P)	1-75	GNV	-1	
	18	FLine GF TrainingBridge3	FloorLine GF Training Bridge 3	Unknown	Unknown (P)	1-95	NY	15	
	19	TrussTrainingExample	Truss Training Example					5	
	20	LRFD Substructure Example 1	LRFD Substructure Example 1						
	21	LRFD Substructure Example 2	LRFD Substructure Example 2			SR 4034	ERIE COUNTY	4034	FOUR MILE
	22	LRFD Substructure Example 3	LRFD Substructure Example 3						
	23	LRFD Substructure Example 4	LRFD Substructure Example 4 (NHI Hammer Head)					-1	
	24	Visual Reference 1	Visual Reference 1	Unknown	Unknown (P)	1-76	WAITSFIELD	I-76	MAD RIVER
	25	Culvert Example 1	Culvert Example 1					STH60	
	26	LFD Curved Guide Spec	LFD Curved Guide Spec Example					1	
	27	MultiCell Box Examples	Multi Cell Box Examples					100	
	28	Gusset Plate Example	Gusset Plate Example	Unknown			Some Highway		
\triangleleft	▶ 29	Splice Example	Splice Example						
	30	Simple DL-Cont LL-Splice	Simple DL Splice	Unknown	Unknown (P)	N/A	N/A	-1	N/A
	31	MetalCulvertExample1	MetalCulvertExample 1					1	
	4		H						*

			AASHTOWare Bridge Design and Rating					?	- 🗆 X
BRIDGE EXPLORER BRIDGE FOLDER	RATE	TOOLS VIEW							
New Open Bridge	Cop To	Remove From							
	E	Bridge ID	Bridge Name	District	County	Facility	Location	Route	Feature Inter
- Content Bridges	3	TrainingBridge3	Training Bridge 3(LRED)	Unknown	Unknown (P)	1-79	Pittsburgh	0079	Ohio River
🖻 🏓 All Bridges	4	PCITrainingBridge1	PCI TrainingBridge1(LED)				, no start gri	-1	
🗷 💋 Templates	5	PCITrainingBridge2	PCITrainingBridge2(LBED)					-1	
Deleted Bridges	6	PCITrainingBridge3	PCI TrainingBridge3(LED)					-1	
	7	PCITrainingBridge4	PCITrainingBridge4(LRFD)					-1	
	8	PCITrainingBridge5	PCI TrainingBridge5(LFD)					-1	
	9	PCITrainingBridge6	PCITrainingBridge6(LRFD)					-1	
	10	Example7	Example 7 PS (LFD)					-1	
	11	RCTrainingBridge1	RC Training Bridge1(LFD)					-1	
	12	TimberTrainingBridge1	Timber Tr. Bridge1 (ASD)					-1	
	13	FSys GFS TrainingBridge1	FloorSystem GFS Training Bridge 1	Unknown	Unknown (P)	NJ-Turnpike	NJCity	-1	
	14	FSys FS TrainingBridge2	FloorSystem FS Training Bridge 2	Unknown	Unknown (P)	1-95	NYC	-1	
	15	FSys GF TrainingBridge3	FloorSystem GF Training Bridge 3	Unknown	Unknown (P)	1-95	ATL	-1	
	16	FLine GFS TrainingBridge1	FloorLine GFS Training Bridge 1	Unknown	Unknown (P)	1-75	JAX	-1	
	17	FLine FS TrainingBridge2	FloorLine FS Training Bridge 2	Unknown	Unknown (P)	1-75	GNV	-1	
	18	FLine GF TrainingBridge3	FloorLine GF Training Bridge 3	Unknown	Unknown (P)	1-95	NY	15	
	19	TrussTrainingExample	Truss Training Example					5	
	20	LRFD Substructure Example 1	LRFD Substructure Example 1						
	21	LRFD Substructure Example 2	LRFD Substructure Example 2			SR 4034	ERIE COUNTY	4034	FOUR MILE C
	22	LRFD Substructure Example 3	LRFD Substructure Example 3						
	23	LRFD Substructure Example 4	LRFD Substructure Example 4 (NHI Hammer Head)					-1	
	24	Visual Reference 1	Visual Reference 1	Unknown	Unknown (P)	1-76	WAITSFIELD	I-76	MAD RIVER
	25	Culvert Example 1	Culvert Example 1					STH60	
	26	LFD Curved Guide Spec	LFD Curved Guide Spec Example					1	
	27	MultiCell Box Examples	Multi Cell Box Examples					100	
	28	Gusset Plate Example	Gusset Plate Example	Unknown			Some Highway		
	▶ 29	Splice Example	Splice Example					-1	
	30	Simple DL-Cont LL-Splice	Simple DL Splice	Unknown	Unknown (P)	N/A	N/A	-1	N/A
	31	MetalCulvertExample1	MetalCulvertExample 1					1	
	32	M3701-STSP-Splice	Steel Splice-Line girder			1-75	Dayton, OH	75	Carillon Blvd
	33	M3702-STSP-Splice	4 span-Only look at two splices in G1				Washington, MC	47	
	4		18						*
						Total Bridge	Count	n	

Next, click **Paste** in the top ribbon to create a duplicate of the bridge.

The Copy Bridge window will open. Rename the bridge and select OK to save the bridge copy to the database.

🗛 Copy Bridge	×
Bridge ID:	FLB Example Add to current folder
NBI Structure ID (8):	FLB Example
Name:	Steel Flange Lateral Bending Stress Example
Description:	
	OK Cancel Help

Bridge Workspace

Open the newly created bridge model and expand the bridge workspace tree.

Support Skew

Update the support skew within the Framing Plan Detail window.



Assign a skew of 20° to each support.

ucture Framing Plan Details					-	
out Diaphragms Lateral bra	ber of girders:	5				
Support Skew (degrees)	Gir	der spacing orier Perpendicular to Along support	tation girder			
1 20 2 20 3 20		Girder Girder (bay Start of	spacing ft) End of			
	•	girder 1 9.75	girder 9.75	A		
		2 9.75 3 9.75 4 9.75	9.75			
	Ÿ			÷		
					OK Apply	Car

Use **OK** to save the data to memory and close the window.

Flange Lateral Bending

Define flange lateral bending stresses for G1. Expand the **Bridge Workspace Tree** to show the *Varying Flange Thickness 1* member alternative for G1.

First, set the control option for the member alternative to consider user-input flange lateral bending stresses. Open the **Member Alternative** window for the *Varying Flange Thickness 1* member alternative.



Open the **Control options** tab within the window.

ember alterna	ative: Var	ying Flange	Thickness	1]				
Description	Specs	Factors	Engine	Import	Control options					
Description:					Material type	Steel				
					Girder type:	Plate				
					Modeling ty	e: Multi Girder System				
					Default units	US Customary	\checkmark			
Girder pro	perty inpu	t method	End be	earing location	ons	Simple DL. continuous L	L			
Schedu	le based		Left:	12.0000	in					
O Cross-s	ection bas	ed	Right:	12.0000	in					
Load case:		Engine Ass	igned	>	Default rating me	ethod:				
Additional	self load:		kip/ft							
Additional	self load:		%							

Select the checkboxes labeled *Must consider user input lateral bending stress* for both LRFD and LRFR. When this control option is selected, the analysis engine will verify that the user has input flange lateral bending stresses. If no stresses are defined, the validation will fail and the analysis will stop. When not selected, the option is interpreted to mean must NOT consider user input lateral bending stress, so any user input lateral stresses are ignored during the analysis. Select **OK** to save the control option selections to memory and close the window.



	ANALYSIS	Bridge Workspace - FLB Example		? – 🗆 X
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW D	DESIGN/RATE			^
Check Out Check In Validate Save	Open Ne	Copy Paste Duplicate Delete Schematic		
Bridge		Manage		
Workspace	# ×	Schematic	₽ × Report	∓ ×
Bridge Components				
	,			
		Analysis		1 ×
Image: Second Secon				

The flange lateral bending stresses are defined within the Lateral Support window.

Select t	the Flange	lateral	bending t	ab within	the L	lateral S	upport	window.
Dereet t	me i iange	incer ai	venann <u>s</u> t	ao minin	une L	acci ai D	apport	

steral Support	
Start Distance Length	
anges Locations Flange lateral bending	
op flange	
Support Start Length End distance (ff) distance	
(ft) (ft) (ft) (ft) (ft)	*
	v
	New Duplicate Delete
	OK Apply Cancel
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steral Support	OK Apply Cancel
steral Support	OK Apply Cancel
ateral Support anges Locations Flange lateral bending	OK Apply Cancel
ateral Support anges Locations Flange lateral bending ateral bending stress load cases	OK Apply Cancel
ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for LRFR rating Load case name Description Stage Type Line girder 3D FEM design review	OK Apply Cancel
Iteral Support Index Sector Se	OK Apply Cancel
ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for Line girder 3D FEM design Line girder 3D FEM Review	OK Apply Cancel
ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for Line girder 3D FEM design review Consider for URFR rating	OK Apply Cancel
Atteral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for design Load case name Description Stage Type Include in analysis Consider for design Load case name Description Stage Type Include in analysis Consider for design Load case descriptions Stage	OK Apply Cancel
Add default load case descriptions	OK Apply Cancel
Add default load Case descriptions Add default load Case descriptions Manual Support Manual Support Manu	OK Apply Cancel
Add default load Case descriptions Add default load Case descriptions Diaphragm Support Diaphragm Support Diaphrage Support Diaphrage Support Consider for Line girder Diaphrage Support Consider for Consider for Line girder Diaphrage Support Consider for Consider for Consider for Line girder Diaphrage Consider for Consider for C	OK Apply Cancel
anges Locations Flange lateral bending ateral bending stress load cases	OK Apply Cancel - - New Duplicate Delete Support Girder reaction adjustment factor -
anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for design Consider for design Add default load case descriptions Stage Type Include in analysis Consider for design Line girder 3D FEM Censider for design Add default load case descriptions Unfactored lateral Bending stress Support Bending stress Bending stress Diaphragm Support number Top flange Bottom flange External flange	OK Apply Cancel - - New Duplicate Delete Support Girder reaction adjustment factor -
Add default load case descriptions Add default load case Unfactored lateral Diaphragm Support number	OK Apply Cancel - - - - New Duplicate Support Girder reaction adjustment factor
Ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for design design design review Add default load case descriptions Support Disphragm Support number Unfactored lateral bending stress (k3) Top flange Bottom flange	OK Apply Cancel - - New Duplicate Delete Support Girder reaction adjustment factor
Ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Line girder Consider for design review Consider for LINE girder Consider for design review Add default load case descriptions Unfactored lateral bending stress (Ss) Unfactored lateral bending stress (Ss) Diaphragm Support number Extraction flange Extraction flange	OK Apply Cancel - - New Duplicate Delete Support Girder reaction adjustment factor
Ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Line girder Consider for design review Consider for LIRR rating Add default load case descriptions Unfactored lateral bending stress (Gs) Unfactored lateral bending stress (Gs) Diaphragm Support number Top flange Bottom flange	OK Apply Cancel - - New Duplicate Delete Support Girder reaction adjustment factor
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Add default load Costions Flange lateral bending Load case name Description Stage Type Include in analysis Consider for design Consider for design Add default load Composition Stage Type Include in analysis Consider for design Line girder 3D FEM Consider for design Line for design Add default load Composition Support Unfactored lateral bending stress (Gs) Composition Compos	OK Apply Cancel - - New Duplicate Support Giddustnent factor
Add default load case descriptions Add default load case descriptions Diaphragm Support Diaphragm Suppo	OK Apply Cancel - - New Duplicate Support Girder reaction adjustment factor
Ateral Support anges Locations Flange lateral bending ateral bending stress load cases Load case name Description Stage Type Include in analysis Consider for design review Add default load case descriptions Diaphragm Support number Unfactored lateral bending stress (Rs) Top flange Bottom flange	OK Apply Cancel - - New Duplicate Support Girder reaction actor actor Image: Support Girder reaction actor actor

Lateral Bending Stress Load Cases

The first table in the lateral bending stress window defines the load cases for flange lateral bending stresses. These load cases are not the same as the load cases created within the **Load Case Description** window of the

superstructure definition.

Use the Add default load case descriptions button to populate the default load cases.

inges Locations													
	Flange latera	al bending											
ateral bending stress	load cases												
Load case name	Description	Stage Type	Include in Line girder	analysis 3D FEM	Consider for design review	Consider for LRFR rating							
												^	
												~	
Add default load ase descriptions)								New	Duplica	ate)elete	
Diaphragm S	upport		Unf	actored late ending stree (ksi)	eral ss			St	upport adju	r reaction ustment actor			
			Top flang	ge Bottor	m flange								
Add diaphragm locations					New	Duplicat	Delete						
									OK	A	vlg	Cancel	

The default load cases for an exterior girder are shown below, including overhang bracket dead load, overhang construction load and skew effect. The default load cases for interior girders do not include the overhang brackets. The columns for **Stage** and **Type** include options not available for superstructure load cases.

Construction (Stage 1) loads are considered during stage 1 spec checking only, whereas *Non-composite (Stage 1)* loads are considered during stage 1 and all subsequent loading stages.

Proportioned (Stage 1 + Stage 3) loads are proportioned into dead load and live load components in the same proportion as the unfactored major axis dead load and live load moments at the section under consideration.

The load type column determines the load factors which are applied to the user-defined unfactored lateral bending stress.

Use the provided checkboxes to indicate the analysis types for which to consider the lateral stresses.

era	i bending stre	ss load case						Include in	analysis	Consider for			
	Load	case name	Descri	ption	Stage		Туре	Line girder	3D FEM	design review	Consider for LRFR rating		
0	/erhang brack	et dead load	i i		Construction (Stage 1)	-	D,DC *	J	1	1			
0	erhang brack	et construct	ion load		Construction (Stage 1)	*	Construction *	1	1	v			
Sk	ew effect			1	Proportioned (Stage 1 + Stage 3)	Ť	DL+LL *	1		1	V		
id o se	default load descriptions	rress load ca	ise: Skew effect							New	Duplic	ate	Delete
	Diaphragm	Support	Distance (ft)		Unfactored lateral bending stress (ksi)					Support ad	ler reaction ljustment factor		
				Te	op flange Bottom flange					1			-
								^		2			
	Add diaphrag	m			Ne	w	Duplicate	Delete					

Lateral Bending Stress Load Case – Overhang bracket dead load

Compute the lateral stress transferred to the bottom flange of the exterior girder from the deck overhang brackets. Assume the brackets support the weight of the parapet.

Select the first row in the **Lateral bending stress load cases** table so the bottom left table title reads: *Lateral bending stress load case: Overhang bracket dead load*. Use the *Add diaphragm locations*... button to open a diaphragm locations tool.

eral bending stress load cases								
Load case name	Description	Stage	Tupe	Include in	analysis	Consider for	Consider for	
Load case name	Description	Stage	Type	Line girder	3D FEM	review	LRFR rating	
Overhang bracket dead load		Construction (Stage 1)	D,DC *	1	1	1		
Overhang bracket construction load		Construction (Stage 1)	Construction *	V	1	V		
Skew ellect		Proportioned (stage 1 + stage s)	DLTL	v		V	v	
dd default load						New	Duplicate	Delet
areral bending stress load case: Overhar	ng bracket de	ad load						
		Unfactored lateral				Gird	ler reaction	
Diaphragm Support Dist	ance	bending stress				Support ac	ljustment factor	
number (f	ft)	Top flange Bottom flange				1		
	1					2		
						3		
\frown				~				
Add diaphragm								

Select Add to add all diaphragm locations without estimating the skew effect stresses.

🗛 Add Diaphragm Lo	cations		×
Estimate stresses	due to skew effe	ects	
Estimation method:	AASHTO	O Based on FDOT Report BE535, Omin/bf	
Diaphragm layout:	Contiguous	O Discontinuous/Staggered	
		Add Cancel	

The table now includes all diaphragm locations.

ter	al bendir	ng stre	ss load cases										
									Include in	analysis	Consider for	Consider for	
		Load	case name	Description		Stage		Туре	Line girder	3D FEM	design review	LRFR rating	
C	verhang	brack	et dead load		Constructio	on (Stage 1)	-	D,DC	· J	J	J		
C	verhang	brack	et constructio	n load	Construction	on (Stage 1)	*	Construction	- V	1	1		
S	kew effe	ct			Proportion	ed (Stage 1 + Sta	age 3) 🔹 👻	DL+LL *	v 🗸		1	1	
dd ase Lat	default I descript teral ben Diaph	oad ions ding st	tress load case	: Overhang bracket de Distance	ad load Unfact bend	ored lateral ing stress					New Support Gird	Duplic der reaction djustment	ate Delete
	number		(ft)	Top flange	(KSI) Bottom flange					1	Tactor		
Þ	1-1	Ŧ	1	0	0	0					2		
	1-2	Ŧ	1	13.333333	0	0	1				3		
	1-3	*	1	26.666666	0	0							
	1-4	*	1	39.999999	0	0							
	1-5	*	1	53.333332	0	0							
	1-6	*	1	66.666665	0	0			-				
	1-7	-	1	79.999998	0	0							
	1-8	*	1	93.333331	0	0							
	1-9	*	1	106.666664	0	0							
	1-10	-	1	119.999997	0	0							
	1-11	*	2	13.333333	0	0							
	1-12	*	2	26.666666	0	0							
	1-13	*	2	39.999999	0	0							
	1-14	*	2	53.333332	0	0							
	Add dia loca	iphrag tions	m				New	Duplicate	Delete				

From the weight of the parapet, the diaphragm spacing, structure typical section and girder profile the following stresses can be computed for the bottom flange.

	Diaphra	agm	Support number	Distance (ft)	Unfacto bend	ored lateral ing stress (ksi)	
					Top flange	Bottom flange	
1	1-1	*	1	0	0	5.85	
1	1-2	*	1	13.333333	0	11.7	
1	1-3	*	1	26.666666	0	11.7	
1	1-4	*	1	39.999999	0	11.7	
1	1-5	*	1	53.333332	0	11.7	
1	1-6	*	1	66.666665	0	11.7	
1	1-7	*	1	79.999998	0	11.7	
1	1-8	*	1	93.333331	0	7.45	
1	1-9	*	1	106.666664	0	7.45	
1	1-10	*	1	119.999997	0	3.72	
1	1-11	*	2	13.333333	0	7.45	
1	1-12	*	2	26.666666	0	7.45	
1	1-13	*	2	39.999999	0	11.7	
1	1-14	*	2	53.333332	0	11.7	
	1-15	*	2	66.666665	0	11.7	
1	1-16	*	2	79.999998	0	11.7	
1	1-17	*	2	93.333331	0	11.7	
1	1-18	*	2	106.666664	0	11.7	
1	1-19	*	2	119.999997	0	5.85	

Select Apply to save the data to memory and keep the window open.

Lateral Bending Stress Load Case – Overhang bracket construction load

Compute the lateral stress transferred to the bottom flange of the exterior girder from the deck overhang brackets during construction. Assume the brackets support a 75plf load applied on the deck overhang.

Select the second row in the **Lateral bending stress load cases** table so the bottom left table title reads: *Lateral bending stress load case: Overhang bracket construction load*. Use the *Add diaphragm locations*... button to open a diaphragm locations tool.

Lo Overhang bra Overhang bra Skew effect	ad case name cket dead load cket constructio	Desc on load	cription Con	Stage		Туре					Consider	rtor		
Overhang bra Overhang bra Skew effect	cket dead load cket constructio	on load	Con	nstruction (Stage 1)				Line girder	3D FEM	design review	LRFR rat	ting		
Overhang bra Skew effect	cket constructio	on load			-	D,DC	-	1	1	1				
Skew effect			Con	nstruction (Stage 1)	*	Construction	*	1	1	1		>		
			Prop	portioned (Stage 1 + Stage	3) *	DL+LL	*	1		\checkmark	1			
ld default load	1													
se description	5										New		Duplicate	Dele
ateral bending	stress load cas	e: Overhang bra	acket construc	ction load										
Diaphrag	Support	Distance		Unfactored lateral bending stress (ksi)						S	upport ac	der reactio djustment factor	n	
	number	(11)	Top f	flange Bottom flange							1	100101		_
			1.040								2		-	
											3			
									Ţ					
Add diaph	agm					Neu	Dural	in the second	Poloto					

Select Add to add all diaphragm locations without estimating the skew effect stresses.

\land Add Diaphragm Lo	cations	×
Estimate stresses	s due to skew effects	
Estimation method:	AASHTO Based on FDOT Report BE535, Omin/bf	
Diaphragm layout:	Contiguous Discontinuous/Staggered	
	Add Cancel	

The table now includes all diaphragm locations.

ame Descripti i load truction load ad case: Overhang bracket	Construction Construction Proportion	Stage on (Stage 1) on (Stage 1) ed (Stage 1 + Stage 3)	v v	Type D,DC Construction DL+LL	* * *	Line girder	3D FEM	design review	LRFR rating		
d load truction load	Construction Construction Proportion	on (Stage 1) on (Stage 1) ed (Stage 1 + Stage 3)	v v	D,DC Construction DL+LL	Y Y	✓ ✓ ✓	V	✓ ✓			
ad case: Overhang bracket	Construction Proportion	on (Stage 1) ed (Stage 1 + Stage 3)	*	Construction DL+LL	* *	V J	1	1			
ad case: Overhang bracket	Proportion	ed (Stage 1 + Stage 3)	*	DL+LL	•	1	[[]]]]]]]]]]]]]]]]]]				
ad case: Overhang bracket	construction lo							\checkmark	\checkmark		
ad case: Overhang bracket	construction lo										
ad case: Overhang bracket	construction lo								New	Duplicate	Delete
		ad									
ort Distance	Unfacto bend	ored lateral ing stress (ksi)						Supp	Girder re port adjustr	action ment	
per (ft)	Top flange	Bottom flange						1	lacu		-
	0 0	0					A	2			
13.33333	3 0	0						3			
26.66666	5 0	0									
39.99999	9 0	0									
53.33333	2 0	0									
66.66666	5 0	0									
79.99999	3 0	0									
93.33333	1 0	0									
106.66666	1 0	0									
119.99999	7 0	0									
13.33333	3 0	0									
26.66666	5 0	0									
39,99999	9 0	0									
53,33333	> 0	0									
66,66666	5 0	0									
70 00000	3 0	0									
03 33333	0	0									
106 66666	1 0	0									
110,00000	7 0	0									
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From the diaphragm spacing, structure typical section and girder profile the following stresses can be computed for the bottom flange.

	Diaphr	agm	Support number	Distance (ft)	Unfacto bend	ored lateral ing stress (ksi)	
					Top flange	Bottom flange	
•	1-1	*	1	0	0	0.83	
	1-2	-	1	13.333333	0	1.65	
	1-3	-	1	26.666666	0	1.65	
	1-4	*	1	39.999999	0	1.65	
	1-5	-	1	53.333332	0	1.65	
	1-6	*	1	66.666665	0	1.65	
	1-7	-	1	79.999998	0	1.65	
	1-8	-	1	93.333331	0	1.05	
	1-9	*	1	106.666664	0	1.05	
	1-10	*	1	119.999997	0	0.53	
	1-11	*	2	13.333333	0	1.05	
	1-12	-	2	26.666666	0	1.05	
	1-13	*	2	39.999999	0	1.65	
	1-14	*	2	53.333332	0	1.65	
	1-15	*	2	66.666665	0	1.65	
	1-16	Ŧ	2	79.999998	0	1.65	
	1-17	*	2	93.333331	0	1.65	
	1-18	*	2	106.666664	0	1.65	
	1-19	*	2	119.999997	0	0.83	

Select Apply to save the data to memory and keep the window open.

Lateral Bending Stress Load Case – Skew effect

Approximate the lateral stress transferred to the exterior girder from the skew effects as specified in the AASHTO LRFD commentary.

Select the third row in the **Lateral bending stress load cases** table so the bottom left table title reads: *Lateral bending stress load case: Skew effect*. Use the *Add diaphragm locations*... button to open a diaphragm locations tool.

Los Overhang bra Overhang bra Skew effect	ad case name acket dead load acket constructio	Description	Stage			Include in	analysis	Consider for	C 11 C		
Overhang bra Overhang bra Skew effect	acket dead load acket constructio				Туре	Line girder	3D FEM	design review	LRFR rating		
Overhang bra Skew effect	cket constructio		Construction (Stage 1)	-	D,DC	- V	1	1			
Skew effect		on load	Construction (Stage 1)	*	Construction	· J	J	1			
			Proportioned (Stage 1 + Stag	je 3) 👻	DL+LL	- V		v	1		
id default load									New	Duplicate	Dele
se descriptions ateral bending	s g stress load cas	e: Skew effect							new	Dupicate	Dele
Diaphragn	Support	Distance	Unfactored lateral bending stress (ksi)					Sup	Girder re port adjustr	eaction ment or	
	number	(ft)	Top flange Bottom flange					1	1		
							-	2	2		
								3	3		
Add diade											

Select Add to approximate lateral stresses all diaphragm locations using the AASHTO commentary.

Add Diaphragm Locations	×
Estimate stresses due to skew effects	
Estimation method: AASHTO Based on FDOT Report BE535, Omin/bf	
Diaphragm layout: O Contiguous Discontinuous/Staggered	
Add Cance	el

Diaphr	agm	Support number	Distance (ft)	Unfacto bend	ored lateral ing stress (ksi)	
				Top flange	Bottom flange	
1-1	*	1	0	7.5	7.5	
1-2	*	1	13.333333	7.5	7.5	
1-3	*	1	26.666666	0	0	
1-4	*	1	39.999999	0	0	
1-5	*	1	53.333332	0	0	
1-6	*	1	66.666665	0	0	
1-7	*	1	79.999998	0	0	
1-8	*	1	93.333331	0	0	
1-9	*	1	106.666664	7.5	7.5	
1-10	*	1	119.999997	7.5	7.5	
1-11	*	2	13.333333	7.5	7.5	
1-12	*	2	26.666666	0	0	
1-13	*	2	39.999999	0	0	
1-14	*	2	53.333332	0	0	
1-15	*	2	66.666665	0	0	
1-16	*	2	79.999998	0	0	
1-17	*	2	93.333331	0	0	
1-18	*	2	106.666664	7.5	7.5	
1-19	*	2	119.999997	7.5	7.5	

The table now includes approximate lateral stresses at all diaphragm locations.

Select **OK** to save the data to memory and close the window.

LRFR Rating

To perform an **LRFR** rating, click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon which opens the **Analysis Settings** window.

WORKSPACE	TOOLS	VIEW	DESIGN/RATE
	9 -		A 10730
	0	8	
Tabular Spec	ification En	igine Resi	ults Save
Results Cheo	ck Detail Ou	itputs Gra	ph Results
	Tabular Spec Results Cheo	Tabular Specification Er Results Check Detail Ou Result	Tabular Specification Engine Ress Results Check Detail Outputs Gra Results

Select the vehicles to be used in the rating as shown below and click **OK**.

O Design review Rating	g	R	ating method:	LRFR	~	
nalysis type: Lir	ne Girder	>				
ane / Impact loading type: As	s Requested	~ A	pply preference setting:	None	~	
Vehicles Output Engin	ne Description					
Traffic direction: Both direct	tions		Refresh	Temporary vehicles	Advanced	
Vehicle selection			Vehicle summa	гу		
	Load uck (SI) uck (US) uck (US)~1 2'air ified	Add >> Remove	e from	icles ign load rating Inventory I — HL-93 (US) Operating I — HL-93 (US) Fatigue I — LRFD Fatigue Truck (US) al load rating Routine Specialized hauling mit load rating		

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



Tabular Results

When the rating is finished results can be reviewed by clicking the **Tabular Results** button on the **Results** group of the **DESIGN/RATE** ribbon. The window shown below will open.

🗛 Analysis Resu	lts - Varying Flange Thick	ness 1								-		×
Print Print												
leport type:	- Lan	e/impact load	ing type	Display Form	nat							
Rating Results Su	mmary	As requested	Detailed	Single ratin	a level per ro	w v						
Live Load	Live Load	Rating	Rating Level	Load Rating	Rating	Location	Location	Limit State	Impact	Lane		
HL-93 (US)	Truck + Lane	LRFR	Inventory	22.14	0.615	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		-
HL-93 (US)	Truck + Lane	LRFR	Operating	28.60	0.795	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	17.43	0.484	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	22.92	0.637	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
HL-93 (US)	Tandem + Lane	LRFR	Inventory	25.55	0.710	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
HL-93 (US)	Tandem + Lane	LRFR	Operating	33.04	0.918	106.67	1 - (88.9)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested		
ASHTO LRFR Eng	ine Version 7.4.1.3001											v
unalysis preference	e setting: None											
											C	lose
											C	JU SC