AASHTOWare BrDR 7.5.0 Steel Tutorial STL10-Corrugated Deck Rating





Framing Plan







Cross-Section of Corrugated Deck

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 2" Corrugated steel plank: Grade 50 galvanized steel Cross Frame Connection Plates: 3/4" x 6" Bearing Stiffener Plates: 7/8" x 9"

BrDR Tutorial

This example assumes that the user has worked through STL11 - Steel Plate Girder Using AASHTO LRFD Engine.

For this example, use the bridge from the **STL6 tutorial** or import the bridge provided for the STL10 tutorial - *STL10* - *Corrugated Deck Rating.xml*.

Use the **Import** function of **BrDR** to import the bridge **STL6-AASHTO-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.



Select the bridge from the **STL6** tutorial and click the **Open** button to import this bridge into **BrDR**.

📲 Import						Х
← → • ↑	> This	PC > Desktop > STL6	~	Q J	Search STL6	
Organize 🔻 Ne	ew folder					?
💻 This PC	^	Name	Date modified	Туре	Size	
🧊 3D Objects		STL6-AASHTO-Steel-Plate-Girder	11/3/2022 10:12 AM	XML Docur	nent 562 KB	
📃 Desktop						
Documents						
🕹 Downloads						
👌 Music						
Pictures						
Videos						
🎬 OS (C:)						
🚔 DATA (D:)						
💣 Network						
	~					
	File nar	me: STL6-AASHTO-Steel-Plate-Girder		~ A4	SHTOWare Bridge XML (.xm	l ~
					Open Cancel	

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



Select the **Corrugated Deck – Steel Beam** node in the **Bridge Workspace** tree and click the **Open** button from the **Manage** group of the **WORKSPACE** ribbon (or double click on **Corrugated Deck – Steel Beam**) to open the selected superstructure definition. This was created by selecting the **Deck type** as **Corrugated** in this window.

Bridge Workspace - Stl6_Training		ANALYSIS	REPORTS	? – 🗆 ×
BRIDGE WORKSPACE WORKSPACE TOOLS	VIEW	DESIGN/RATE	REPORTING	·
Check Out Check In Validate Save Bridge	oort Refre	esh Open Nev	Copy Pas	te Duplicate Delete Schematic
Workspace # ×	Sche	matic	ųх	Report # ×
Bridge Components Image: Image of the state of the				
	Analy	ysis		т ×

	Specs Engine			
lame:	orrugated Deck - Stee	l Beam		Modeling
Description:	JS Customary	Enter span lengths		Multi-grader system () Micb With frame structure simplified definition Deck type: Corrugated Deck () For PS/PT only
lumber of spans:	2 💭	Span Length (ft) ▶ 1 90.00 2 90.00	A	Average humidity: % Member alt. types Steel P/S
Horizontal curvatur	e along reference line -		Ŷ	C R/C Timber P/T
Horizontal curva	ture Distanc	e from PC to first support line:	ft	
Superstructure a	ignment Start ta	ngent length:	ft	
Curved	ed, tangent Direction	on:	ft Left V	
 Tangent, curv Tangent, curv 			£1	
Tangent, curv Tangent, curv O Tangent, curv O Curved, tange	nt End tar	ngent length:	π	
Tangent, curv Tangent, curv Curved, tange	nt End tar Distanc	ngent length: e from last support line to PT:	ft mak	

The partially expanded **Bridge Workspace** tree for **Corrugated Deck – Steel Beam** member alternative is shown below.

Work	space	_ 🗆 ×
Bridge	Components	
🖻 🤷	Stl6_Training	
₽	📁 Components	
	📁 Diaphragm Definitions	
	📁 Lateral Bracing Definitions	
	MPF LRFD Multiple Presence Factors	
	Environmental Conditions	
	DP Design Parameters	
<u>₽</u> …	BUPERSTRUCTURE DEFINITIONS	
	🐑 📊 2 Span, 4 Girder system	
.	 Gorrugated Deck - Steel Beam Impact/Dynamic Load Allow Impact/Dynamic Load Case Description Impact/Dynamic Load Structure Typical Section Impact/Dynamic Load Structure Loads Impact/Dynamic Load Structure Definitions Impact/Description Impact/Dynamic Load Structure Dynamic Load Str	on

Much of the data entry will be the same as with the STL6 example. Impact, Load Case Description, and framing plan will be set up the same as for the STL6 example.

Topics Covered

- Impact/Dynamic Load Allowance
- Load Case Description
- Framing Plan Detail
- Structure Typical Section
- Superstructure Loads

Enter the data from the original bridge definition to the Corrugated Deck bridge definition (See image below).

Bridge Workspace - Stl6_Training	ANALYSIS REPORTS		? –		×
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW	DESIGN/RA 🗛 Structure Framing Plan Details	-		×	^ [
Check Out Check In Validate Save Bridge	h Open Layout Diaphragms Lateral bracing ranges			,	×
Bridge Components Image: Components Components Image: Components Image: Components	# × S S Girder spacing orientation > 1 0.000 2 0.000 3 0.000 3 0.000 1 10.000 2 10.000 3 0.000 3 10.000 1 10.000 3 0.000				×
- #t Load Case Description ## Framing Plan Detail - Bracing Deterioration - 850 Bracing Spec Check Selection - #Superstructure Loads - # Superstructure Loads - Stiftener Definitions - # Stiftener Definitions - # MEMBERS	Structure Framing Plan Details Number of spans: Number of girders: A	-		> ×	^
Corrugated Deck - Steel Beam Corru	Support Skew (degrees) 1 0.000 2 0.000 3 0.000 1 10.00 2 0.000 3 0.000			>	v

Framing Plan Detail

Structure Typical Section

The **Structure Typical Section** window for the **Corrugated deck** superstructure has fewer tabs (See image below). The remaining tabs are similar to the window for a common deck/steel girder typical definition.



Corrugated Deck Metal Panel

Double click on the **Deck** node for the superstructure **Corrugated Deck – Steel Beam** in the **Bridge Workspace** tree to open the **Corrugated Deck Metal Panel** window. Enter the data as shown below.

🗛 Corrugated Metal De	ck Panel						_		×
Default rating method:	LFR	~	Analys	is module AASHTO LF AASHTO LR	R	~	Wheel load distribution - Parallel to traffic: Perpendicular to traffic:	10	
Corrugated deck pla	nk								
Plank depth:	2	in Yield	l strength:	50	ksi	Copy fr	om library		
Plank thickness:	0.0635	in Pane	el length:	9	ft				
A:	1	in							
B:	2	in							
C:	2	in		Thickness - above plant	۲ †	F	Plank Jepth		
Comput	e properties			1			\frown		
Moment of inertia:	0.69752929	in^4/ft				\±	/ [
Section modulus:	0.67606425	in^3/ft		4	→ ^B → •				
Load:	20	psf							
Fill material Weight:	150	ncf							
Thickness above pla	ink: 8	in							
							OK Apply	Cancel	

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

Stiffener Definitions

Copy the stiffener definitions from the original bridge definition to the Corrugated deck definition (See image below).



Open the **MEMBER ALTERNATIVES** for Girder **G2** for the original bridge definition and the new **Corrugated Deck** definition. Member definitions cannot be copied because there are small differences in the definitions. For example, the Corrugated Deck will not have haunches. Go through the original member definition and reenter the data in the new member definition where such data is similar.



Live Load Distribution

Double click on the **Live Load Distribution** node for the superstructure **Corrugated Deck – Steel Beam** in the **Bridge Workspace** tree to open the **Live Load Distribution** window. BrDR can compute the Standard Specification Live Load Distribution Factors (**LLDF**) based on the corrugated deck definition. Click the **Compute from typical section** button to compute the factors. If left blank, AASHTO LFR engine will compute these factors during the analysis. The image below shows the differences in the standard LLDFs.

BR	YSIS	REPORT	s	Bridge Workspace -	Stl6_Training					?	-		\times
BRIDGE WORKSPACE WORKSPACE TOOLS VIEW DESIGN	/RATE	REPORTI	NG										
Check Out Check In Validate Save & Restore Check In Validate Save & Revert Close Export Refresh	Op #	Live Load	d Distributi	on	1							×	
	1	Distri	bution fact	or input method								- 11	
Workspace x	Sc	0	Use simplit	fied method	Use advanc	ed method	Use advance	ced method with 1994 gui	de specs			- H	X
Bridge Components	•	Allo	w distribut	tion factors to be use	ed to comput Distribution	e effects of permit n factor	t loads with ro	outine traffic					
I Plate Girder - Allow Moment Redistribution		k	baded	Shear	Shear at	Moment	Deflection					1	
· I G4 I G4 IIII G4 IIIII G4		> 1	Lane	1 4285714	supports	1 4285714	0.5						
		M	ulti-lane	1,8181818	2	1.8181818	1						
boo bracing spec check selection													
Considering Uper Criect Section Considering Uper Criect Section Considering Uper Considering Considering	4	Live Load	l Distributi LRFD bution fact Use simplif	on or input method	Use advance	ed method) Use advance	ced method with 1994 gui	de specs	-		×	\$ X
	A	Live Loar	I Distribution LRFD bution fact	on or input method ied method	Use advanc	ed method) Use advance	ced method with 1994 gui	de specs	_		×	×
	4	Live Loan	I Distributi LRFD bution fact Use simplif w distribut	on or input method fied method	Use advanc ed to comput Distribution	ed method ce effects of permit	Use advance loads with ro	ced method with 1994 gui	de specs	-		×	X X
	4	Live Load Standard Distri Allo	I Distributi LRFD bution fact Use simplif ww distribut	on or input method ified method tion factors to be use Shear	Use advance ed to comput Distribution (whee Shear at supports	ed method e effects of permit hfactor lay Moment	Use advance to loads with re Deflection	ced method with 1994 gui outine traffic	de specs	_			\$ X
	A	Live Load Standard Distri Allo	I Distribution LRFD bution fact Use simplifue www.distribut Lanes Lanes	on or input method ined method tion factors to be use Shear 1.8181818	Use advance ted to comput Distribution (whee Shear at supports 1,4	ed method e effects of permit hfactor ls) Moment 1.8181818	Use advance loads with ro Deflection 0.5	ced method with 1994 gui outine traffic	de specs	-			\$ X
	A.	Live Load Standard Distri Allo Allo Ma	I Distributii RFD UUSe simplit UUSe simplit	on or input method ied method ition factors to be use Shear 1.8181818 2.2222222	Use advance ted to comput Distribution (whee Shear at supports 1.4 2	ed method e effects of permit n factor s) Moment 1.8181818 2.2222222	Use advance Loads with re Deflection 1	ced method with 1994 gui	de specs	-		×	\$ X

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

LFR Analysis – Corrugated deck

To perform an **LFR** rating on the deck for the corrugated deck definition, select the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The window shown below opens.

Bridge W	ANALYSIS	REPORTS	?	-	×	
BRIDGE WORKSPACE	WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			^
Analyzis Analyze Analyzis	Tabular Specification Engine Res	🖌 📙 ults Save				
Settings Events	Results Check Detail Outputs Gra	ph Results				
Analysis	Results					

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

Open Template					
Templates	Description	Analysis	Owner	Public / Private	
HL 93 Design Review	HL 93 Design Review	LRFD		Public	4
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	
Delete				Open	Cancel

The Analysis Settings window is populated as shown below.

Design review Rating	Rating method: LFR	~
alysis type: Line Girder	~	
ne / Impact loading type: As Requested	Apply preference setting: None	~
Vehicles Output Engine Description		
Traffic direction: Both directions	Refresh Temporary vehicl	les Advanced
Vehicle selection	Vehicle summary	
 Herkides Standard Alternate Military Loading EV2 EV3 H 15-44 H 20-44 HS 20-44 HS 20-44 NRL SU5 SU5 SU6 SU7 Type 3-3 Type 3-3 Colorado Legal Type 3-2 Modried Tandem User defined User defined Colorado Dermit Vehinles_1 	Add to Add to Remove from <<	

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

Select the **Deck** node for this superstructure in the **Bridge Workspace** tree and click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon (or right click **Deck** and select **Analyze** from the menu) to perform the rating as shown below.



The Analysis window is shown below.

Analysis		_ 🗆 ×
Analysis - DECK		▼ ×
Analysis Event	- Support Location - 26.8333 (ft) - Support Location - 88,5000 (ft) - Support Location - 30.0667 (ft) - Support Location - 31.8333 (ft) - Support Location - 33.5000 (ft) - Support Location - 35.2500 (ft) - Support Location - 35.2500 (ft) - Support Location - 35.2500 (ft) - Completed Specification Check. Info - Finished LFR specification checking for Simple Deck Start Info - Critical Deck Section is: Simplified Start Section! Info - Populating specification checking results Info - Finished populating specification checking results Info - Analysis completed!	~
	C Errors 🗥 Warnings	
	Type Description	
	l	~
		Close

Tabular Results

Bridge Workspace - Stl6_Training			ANALYSIS	REPORTS	?	_	×
BRIDGE WORKSPACE	WORKSPACE TOOLS	VIEW	DESIGN/RATE	REPORTING			
Analysis Analyze Analysis Settings Events	Tabular Specification Results Check Detail 0	Fingine Resu Dutputs Grap	lts Save Results				
Analysis	Re	sults					

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

	Analysis F Print Print	esults - Dec	k							_		×
Re	Report type: Lane/Impact loading type											
R	Rating Results Summary 🔍 💿 As requested 🔾 Detailed											
	Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location	Limit State	Impact	Lane		
Þ	HS 20-44	Axle Load	LFR	Inventory	0.00	0.000	3.500	Design Flexure - Cont Steel	As Requested	As Requested	1	-
	HS 20-44	Axle Load	LFR	Operating	0.00	0.000	3.500	Design Flexure - Cont Steel	As Requested	As Requested	I	
	HS 20-44	Axle Load	LFR	Inventory	0.27	0.007	28.500	Design Flexure - Simple Steel	As Requested	As Requested	1	
	HS 20-44	Axle Load	LFR	Operating	0.45	0.012	28.500	Design Flexure - Simple Steel	As Requested	As Requested	1	
AASHTO LEP Engine Version 7.5.0.2001												
Aashrid Lrk engine version 7.3.0.0001												
Close										ose		

of the **DESIGN/RATE** ribbon.

Corrugated Deck Specification Check Detail

The specification checks for the deck analysis can be viewed by selecting the **Deck** and clicking the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.



Expand Continuous Start, Stage 3, CorrugatedDeck, select Span 2 – 5.00 ft. and open the article 6B.4 Corrugated Metal Deck as shown below.



🔣 Spec Check Detail for 6B.4 Corrugated Metal Deck	-		Х							
Part B - ALLOWABLE STRESS RATING AND LOAD FACTOR RATING 68.4 RATING EQUATION 68.4.1 General - Corrugated Metal Deck (AASHTO Manual for Bridge Evaluation, Second Edition with 2011 Interims)										
INPUT:										
Depth = 2.0000 (in) I = 0.6975 (in^4) S = 0.6761 (in^3) Fy = 50.0000 (ksi)										
RATING FACTOR CALCULATIONS:										
$RF = \frac{C - A1*DL}{A2*LL} $ (6B.4.1-1)										
where,										
A1 = Dead Load Factor A2 = Live Load Factor DL = Dead Load Moment = 0.18 (kip-ft) LL = Live Load Moment (includes impact)										
Rating Load Factors										
Level Vehicle LL A1 A2 Mu RF (kip-ft) (kip-ft)	Capa (To	ncity n)								
Inventory 1 39.34 1.300 2.171 2.82 0.030 Inventory 1 -11.64 1.300 2.171 -2.82 0.121 Operating 1 39.34 1.300 1.300 2.82 0.050 Operating 1 -11.64 1.300 1.300 -2.82 0.202	1. 4. 1. 7.	09 35 82 27								
Load Combination Legend:										
Code Vehicle										
1 HS 20-44 - Truck										
	[OK								

LFR Analysis - Plate Girder member alternative (Corrugated Deck - Steel Beam)

Similarly run an **LFR** analysis on the **Plate Girder** member alternative of the **Corrugated Deck** superstructure as shown below.



Tabular Results

View the tabular results for this analysis as shown below.

Analysis Results - Plate Girder								- 0	×		
Print Print											
Report type: Clane/Impact loading type Display Format											
Rating Resul	Rating Results Summary 🕑 💿 As requested 🔿 Detailed Single rating level per row										
Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane	
HS 20-44	Axle Load	LFR	Inventory	20.59	0.572	36.00	1 - (40.0)	Design Flexure - Steel	As Requested	As Requested	
HS 20-44	Axle Load	LFR	Operating	34.39	0.955	36.00	1 - (40.0)	Design Flexure - Steel	As Requested	As Requested	
HS 20-44	Lane	LFR	Inventory	18.25	0.507	90.00	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
HS 20-44	Lane	LFR	Operating	30.48	0.847	90.00	1 - (100.0)	Design Flexure - Steel	As Requested	As Requested	
AASHTO LFR Engine Version 7.5.0.3001											
Analysis preference setting: None											
	Close										