AASHTOWare BrDR 7.5.0 3D FEM Analysis Tutorial Steel Diaphragm and Lateral Bracing Specification Checking Example

BrDR Training

3DFEM1 - Steel Diaphragm and Lateral Bracing Specification Checking Example

Topics Covered

- Steel Diaphragm Connection Data Entry
- Bracing Deterioration
- Bracing Specification Checking

Steel Diaphragm Connection Data Entry

This example describes data entry and specification checking for a steel diaphragm. Bottom flange lateral bracing members have the same features as diaphragms.

From the **Bridge Explorer**, import the **3DFEM1-Diaphragm-Spec-Checking.xml** file provided with this tutorial into **BrDR**.

Br	AASHTO	War	e Brid	ge Design and Ratin	9	?	_		×
BRIDGE EXPLORER BRIDGE	FOLDER		RATE	TOOLS VIE	W				
New Open Batch ~ Find	Copy	Past	e Co To	py Remove Delete From					
Bridge		ľ	Manag	e					
			Eヘ	Bridge ID)			Bride	gel
Recent Bridges		>	1	TrainingBridge1		Training	, Bridge	1(LRFD)	
All Bridges			2	TrainingBridge2		Training	, Bridge	2(LRFD)	
me Sample Bridges			3	TrainingBridge3		Training	, Bridge	3(LRFD)	
Deleted bloges			4	PCITrainingBridge1		PCI Trai	ningBri	dge1(LFF	2)
			5	PCITrainingBridge2		PCITrair	ningBrid	lge2(LRF	D)
			6	PCITrainingBridge3		PCI Trai	ningBri	dge3(LFF	2)
			7	PCITrainingBridge4		PCITrair	ningBrid	lge4(LRF	D)
			8	PCITrainingBridge5		PCI Trai	ningBri	dge5(LFF	(3
			9	PCITrainingBridge6		PCITrair	ningBrid	lge6(LRF	D)
			10	Example7		Example	e 7 PS (LFR)	
			11	PCTrainingPridge1		DC Train	nina Dri	da a 1/1 E E	•
				Total Bridge Co	unt:	45			

Bridge ID: DiaphTrair	ning	NBI structure	ID (8): DiaphTraining		Template Bridge compl	etely defined	Bridge Workspace View Superstructures Culverts Substructures
Description Desc	cription (cont'd)	Alternatives	Global reference point	Traffic	Custom agency fie	lds	
Name:	Steel Diaphragm	Example			Year built:		
Description:							
Location:					Length:		ft
Facility carried (7):					Route number:	1	
Feat. intersected (6):					Mi. post:		
Default units:	US Customary	\sim					

Click **OK** to close the **Bridge** window.

Bridge Materials – Concrete

Navigate to the **Components** tab of the **Bridge Workspace** and expand the **Materials** -> **Concrete** folders. Double click on the **Class A (US)** concrete material. Click on the **Compute** button to compute the values based on the input.

🕰 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 Maxim	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				
	Copy t	co library Copy	from library OK App	oly	Cance	el

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

Connectors

In the **Components** tab of the **Bridge Workspace** and expand the **Connectors** node. The **Connectors** folder is provided to add **Bolt**, **Nail**, **Rivet** and **Weld** definitions.



	onnectors	- Bolt					- 0
ame: 7,	/8" A325]			
escription:							
brary designation: A	ASHTO M 1	164 (US) 🗸			Bolt	t threads excluded from sh	iear plane
olt diameter: 0.8	875	∼ in			Hole dia	meter: 0.9375	in
Connection type Slip-critical Bearing		Hole size Standa Oversi: Short s	rd ze ilot	d direction Any direction Transverse Parallel	Surface class Class A Class B Class C	Hole type Punched full siz Drilled full size Subpunched an	e id reamed to size
100							
ASD Allowable shear	r stress:	23.75	ksi	.FD Allowable shear s	tress: 43	ksi	
Nominal slip re	sistance:	23	ksi	Design slip resista	ance: 32	ksi	
LRFD							
Minimum tensil	le strength,	, Fub: 120	ksi Kh	1	Ks: 0.5	Compute fre	
Required tensio	on, Pt:		kip			library	m

Double click on the 7/8" A325 bolt definition to review the bolt to be used in the diaphragms.

Diaphragm Definitions

The following sketch illustrates the intermediate diaphragm that will be described for this example.



Navigate to the **Bridge** tab of the **Bridge Workspace** tree and double-click on the **Diaphragm Definitions** folder (or click on **New** from the **Manage** group of the **WORKSPACE** ribbon, or right click and select **New**) to create a new diaphragm definition as shown below.



ie: Type 2	2 Connections types: Men A C A C A C A C A C A C A C A C A C C A C C A C C C C C C C C C C C C C		Diaphrag	gm type	e: Type 2	~	Nu	umber of element	s in fixed mem	ber: 1 v
embers Connecti	Definitions									
iaphragm types:	m Definitions De 2 Connections m types: M Type: 1 Consections Consections M Consections	Member	Shape		Section orientation	Section	location	Material		
		AB	L 3-1/2x3-1/2x3/	/8 ~	Vertical $$	Bottom F	light 🗸	Grade 50 🗸		-
		CD	L 3-1/2x3-1/2x3/	/8 ~	Vertical $$	Bottom F	light 🗸	Grade 50 🗸		
C Ly Type: 1		AE	L 3-1/2x3-1/2x3/	/8 ~	Vertical 🗸	Bottom F	ight ∨	Grade 50 🗸		
1300.1		EB	L 3-1/2x3-1/2x3/	/8 ~	Vertical ∨	Bottom F	ight 🗸	Grade 50 🗸		
٨										
	2 Connections n types: Type: 1 \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow	Connectio	Support	Y	Measured					
C Type: 3	2 Connections	Connectio	n Support type	Y (in)	Measured from					
C Type: 3	Type: 1	Connectio A B	n Support type Pinned V	Y (in) 6	Measured from Top of Web	~				
Type: 3	Type: 1	Connection A B C	n Support type Pinned ~ Pinned ~	Y (in) 6 6	Measured from Top of Web Top of Web Bottom of Web	~ ~ ~				
Type: 3	B D B 	Connectio A B C D	n Support type Pinned × Pinned × Pinned × Pinned ×	Y (in) 6 6 6 6	Measured from Top of Web Top of Web Bottom of Web Bottom of Web	~ ~ ~				

Create the following diaphragm definition.

Click the **Apply** button to save.

The following sketch from the **AASHTOWare BrDR Help** illustrates the **Section Location** selection. This can be accessed by hitting the **F1** key on this window.



Navigate to the **Connections** tab. Enter the following data to describe the bolts in the diaphragm.

Members Connection Member Work point offset (in) Number longitudinal bolt lines Bolt sper line Bolt line spacing (trans) (in) Bolt line spacing (trans) (in) Bolt line spacing (trans) (in) Long, edge distance (in) AB AB Bolt ~ Interview	ne:	Type 2				Dia	phragm type:	Туре 2		Nur	mber of ele	ments in fix	ed member: 1 🗸
Neth definition: 7/8" A325 × Member Connection Member connection hype Work point offset (in) Number longitudinal bolt lines Bolt sper line Bolt line spacing (long) (long) Trans. ledge distance (in) Long- distance (in) AB A Bolt * 0 1 2 3 2 1.75 AB B Bolt * 0 1 2 3 2 1.75 CD C Bolt * 0 1 2 3 2 1.75 CD C Bolt * 0 1 2 3 2 1.75 AE A Bolt * 0 1 2 3 2 1.75 AE Bolt * 0 1 2 3 2 1.75 AE Bolt * 0 1 2 3 2 1.75 AE Bolt * 0 1 2 3 2 1.75 EB B Bolt * 0 1 2 3 2 1.75 E	lem	bers Co	onnections										
Member Connection Member connection type Work point offset (in) Number longitudinal bolt lines Bolt ser line Bolt line spacing (in) Bolt line spacing (in) Bolt line spacing (in) Indicate and transform (in) AB AB Bolt Solt 1 2 3 2 1.75 AB B Bolt Solt 1 1 2 3 2 1.75 CD C Bolt 1 1 2 3 2 1.75 CD C Bolt 1 1 2 3 2 1.75 CD D Bolt 1 1 2 3 2 1.75 AE A Bolt 1 1 2 3 2 1.75 AE Bolt Bolt 1 1 2 3 2 1.75 AE Bolt Bolt 1 1 2 3 2 1.75 EB B Bolt 1 1 2 3 2 1.75	olt	definition:	7/8" A325		\sim								
AB A Bolt Image: Constraint of the constrain		Member	Connection	Mem conne typ	iber ction be	Work point offset (in)	Number longitudinal bolt lines	Bolts per line	Bolt line spacing (long) (in)	Bolt line spacing (trans.) (in)	Trans. edge distance (in)	Long. edge distance (in)	
AB B Bolt \checkmark 1 2 3 2 1.75 CD C Bolt \checkmark 1 2 3 2 1.75 CD D Bolt \checkmark 1 1 2 3 2 1.75 AE A Bolt \checkmark 1 1 2 3 2 1.75 AE A Bolt \checkmark 1 1 2 3 2 1.75 AE E Bolt \checkmark 1 1 2 3 2 1.75 AE E Bolt \checkmark 1 1 2 3 2 1.75 EB B Bolt \checkmark 1 2 3 2 1.75 EB B Bolt \checkmark 1 2 3 2 1.75		AB	А	Bolt	\sim		1	2	3		2	1.75	
CD C Bolt I 1 2 3 2 1.75 CD D Bolt V 1 2 3 2 1.75 AE A Bolt V 1 2 3 2 1.75 AE A Bolt V 1 2 3 2 1.75 AE E Bolt V 1 2 3 2 1.75 AE E Bolt V 1 2 3 2 1.75 EB B Bolt V 1 2 3 2 1.75 EB B Bolt V 1 2 3 2 1.75		AB	В	Bolt	\sim		1	2	3		2	1.75	
CD D Bolt 1 2 3 2 1.75 AE A Bolt 1 2 3 2 1.75 AE E Bolt 1 2 3 2 1.75 AE E Bolt 1 2 3 2 1.75 AE E Bolt 1 2 3 2 1.75 EB B Bolt 1 2 3 2 1.75 EB B Bolt 1 2 3 2 1.75		CD	С	Bolt	\sim		1	2	3		2	1.75	
AE A Bolt Comparison 1 2 3 2 1.75 AE E Bolt Comparison 1 2 3 2 1.75 EB E Bolt Comparison 1 2 3 2 1.75 EB E Bolt Comparison 1 2 3 2 1.75 EB B Bolt Comparison 1 2 3 2 1.75 EB B Bolt Comparison 1 2 3 2 1.75		CD	D	Bolt	\sim		1	2	3		2	1.75	
AE E Bolt 1 2 3 2 1.75 EB E Bolt 1 2 3 2 1.75 EB B Bolt 1 1 2 3 2 1.75 EB B Bolt 1 1 2 3 2 1.75		AE	А	Bolt	\sim		1	2	3		2	1.75	
EB E Bolt 1 2 3 2 1.75 EB B Bolt V 1 2 3 2 1.75		AE	E	Bolt	\sim		1	2	3		2	1.75	
EB B Bolt V 1 2 3 2 1.75		EB	E	Bolt	\sim		1	2	3		2	1.75	
		EB	В	Bolt	\sim		1	2	3		2	1.75	

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

The following sketch from the **AASHTOWare BrDR Help** provides a description of the **Work Point Offset**. This can be accessed by hitting the **F1** key on this window.

Description of the Work Point Offset:



calculations.

The following sketch from the **AASHTOWare BrDR Help** describes the bolt entry fields. For this example, 1 longitudinal bolt line that contains 2 bolts per line is described.



After reviewing the **AASHTOWare BrDR Help**, click **OK** on the **Diaphragm Definitions** window to create the diaphragm and close the window.

Girder System Superstructure Definition

Double click on the superstructure definition **Single Span Example** in the **Bridge Workspace** tree (or click **Open** from the **Manage** group of the **WORKSPACE** ribbon, or right click and select **Open**) and navigate to the **Analysis** tab.



The following options on the **Analysis** tab of the **Girder System Superstructure Definition** window control the bracing specification checking. Options under **3D bracing member end connection analysis** allows the user to specify what forces should be used when connection specification checking is implemented in the future. The **Bracing member LRFR factor** data selected here will be used for all bracing members unless the bracing member has different factor data entered on the **Bracing Deterioration** window.

efinition Analysis Specs Engine		
Structural clab thickness	Number of shall elements	
Concider structural slab thickness for rating		
Consider structural slab thickness for facing		
Consider structural slab unconess for design	Slower Faster	
Wearing surface	More accurate Less accurate	
Consider wearing surface for rating		
Consider wearing surface for design	10 9 8 7 6 5 4 3 2 1	
Consider striped lanes for rating	Target aspect ratio for shell elements	
Default analysis type: Line Girder \checkmark	Slower Faster More accurate Less accurate	
Longitudinal loading		
Vehicle increment: 1 ft	1 1.5 2 2.5 3 3.5 4	
	3D FE node generation tolerance	
Transverse loading	O Percentage	
Vehicle increment in lane: 2 ft	Length	
Lane increment: 4 ft	Span Length Tolerance	
3D analysis control options	· (ft) (%)	
IFR: Model non-composite regions as non-composite	> 1 /5 0.1	
I RFD: Model non-composite regions as non-composit	a	
IRER: Model non-composite regions as non-composite		
	3D bracing member end connection analysis	
	Calculated factored member force effects	
	Maximum of average (stress + strength) and 75% resistance	
	Design marsh as LDED factors	
	bracing member LICPK factors	
	Condition factor: Good or Satisfactory	
	Field measured section properties	

Select the options shown above and click **OK** to apply the selections and close the window.

Load Case Description

The finite element analysis can consider wind load applied to the FE model. Open the **Load Case Description** window by double clicking on the **Load Case Description** node in the **Bridge Workspace** tree. Add the following load case for the wind load.

Load case name	Description	Stage		Туре	Time* (days)	
DC1	DC acting on non-composite section	Non-composite (Stage 1)	V D,DC	~		
DC2	DC acting on long-term composite section	Composite (long term) (Stage 2)	V D,DC	~		
DW	DW acting on long-term composite secti	Composite (long term) (Stage 2)	V D,DW	~		
SIP Forms	Weight due to stay-in-place forms	Non-composite (Stage 1)	✓ D,DC	~		
Wind		Composite (short term) (Stage 3)	✓ W, WS	~		
Wind		Composite (short term) (Stage 3)	~ W, WS	~		

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

Framing Plan Details

Double click on the **Framing Plan Detail** node in the **Bridge Workspace tree** and navigate to the Diaphragms tab. Assign the diaphragm definitions to the interior diaphragm locations for all 3 girder bays as shown below.

iyou	t Di	aphragms L	ateral bracing r	anges							
rder	bay: 1		~	Copy bay to	Diapł wiz	nragm ard					
	Suppor	t dist	tart tance ft)	Diaphragm spacing	Number of spaces	Length (ft)	E dist (nd ance ft)	Load (kip)	Diaphragm	
		Left girder	Right girder	(#)			Left girder	Right girder			
	1 ~	0	0	0	1	0	0	0		Not Assigned	\sim
>	1 ~	· 0	0	25	2	50	50	50		Type 2	\sim
	1 ~	75	75	0	1	0	75	75		Not Assigned	\sim

Select **Girder bay 2** from the drop down options and apply the same diaphragm definition. Do this for **Girder bay 3** as well. Once done, click **OK** to apply the data and close the window.

irder	bay: 1	hragms La	eteral bracing r	Copy bay to	Diapł	nragm ard						
	1 Supp 2 numt 3			Diaphragm spacing	Number of spaces	Length (ft)	E dist (nd ance ft)	Load (kip)	Diaphragm		
		Lett girder	кıght girder	(π)			Left girder	Right girder				
1	1 ~	0	0	0	1	0	0	0		Not Assigned	~	
> 1	1 ~	0	0	25	2	50	50	50		Type 2	\sim	
1	1 ×	75	75	0	1	0	75	75		Not Assigned	\sim	

Schematic – Framing Plan Details

With **Framing Plan Detail** selected in the **Bridge Workspace** tree, click on the **Schematic** button on the **WORKSPACE** ribbon (or right click and select **Schematic**) to view the framing plan as shown below.



The Framing Plan Schematic displays the location labels for the bracing members as shown below.



Bracing Deterioration

The **Bracing Deterioration** window allows the user to describe deterioration on the bracing members. Double-click on the **Bracing Deterioration** node in the **BWS** tree and create a new deterioration description for the diaphragm assigned to **Location 1-2** in **Bay 1** as shown below.

Bridge Workspace - DiaphTraining		ANALYSIS	REPORTS	?			\times
BRIDGE WORKSPACE TOOLS	VIEW	DESIGN/RATE	REPORTING				
Check Out 💣 🔡 🎄 Restore 🛛 Check In Validate Save 🚳 Revert 🤣	Close Export Refresh	Open New	Copy Paste	Duplicate) Delete	Schematic	-
bhage			wanage				
Workspace	Schemat	v Bracing Deteriora ing type Diaphragm	S> × R ation Lateral brack Location: 1-2	ing OK		× Cancel	

Enter the following values for section loss on **Member AB**. This section loss will be used in rating, not in design review. The superstructure definition **LRFR Condition factor** can also be overriden for this particular member on this tab.

acie									
	Diaphragm 🔵 Lat	eral Bay: 1	Location: 1	-2 Diaphrag	m type: Type 2				
mb	er AB Member	CD Member AE	Member EB						
ape	L 3-1/2x3-1,	LRFR Condition factor: G	ood or Satisfactory section properties	~					
	Leg	% Width/depth Ioss (%)	% Thickness loss (%)	Location	Start distance (ft)	Length (ft)	End distance (ft)		
>	Horizontal 🗸 🗸	20	20	Distance \vee	3	2	5		1
						New	Duplicate	Delete	

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

Bracing Spec Check Selection

The **Bracing Specification Check Selection** window allows the user to select which diaphragms and lateral bracing should be specification-checked. Double click on **Bracing Spec Check Selection** node in the **BWS** tree and make the following selections.

A	Bracing	g Specifi	cation Che	ck Selecti	on				_		×	
	Diaphr	agms	Lateral b	racing								
	Select	diaphrag	gms for spe	cification	checking	g in a 3D	analysis:					
	Sele	ect all	Clea	r all								
		Bay 1	Bay 2	Bay 3								
		1-1	2-1	3-1							1	
	> [1-2	2-2	3-2								
		1-3	2-3	3-3								
		1-4	2-4	3-4								
											-	
								OK	Apply	Can	cel	

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

Superstructure Loads

Double click on the **Superstructure Loads** in the **BWS** tree and navigate to the **Wind** tab to enter the following information. Note that wind is only considered in an LRFD design review, not in a rating. The wind load path data only applies to line girder analysis where the wind load is approximated on the exterior girder.

Superstructure Loads				_		\times
Uniform temperature	Gradient temperature	Wind	DL distribution			
Load case name: Wir	nd	\sim				
Wind load basis						
O Gust speed						
Fastest-mile s	peed					
Gust speed wind lo	ad		Fastest-mile speed wind lo	ad		
Limit state	Wind Ioad (psf)		Wind load:	psf		
> Strength III	60	-				
Strength V	70					
Service I	55					
Service IV	52					
Truss action Frame action Flange subject	ted to lateral force					
			ОК	Apply	Cance	2

Supports – Member G1

Expand the **G1** member and double click on the **Supports** node for **G1**. Navigate to the **3D** General tab of this window. Since wind is a horizontal load that is now being considered, at least 2 bearings should be constrained in the Z direction for at least 1 girder. Review the selections in this tab. No change is required at this time.



LRFD Design Review

Analysis Settings

To run a **3D LRFD design review for** the superstructure definition, from the **Analysis** group of the **DESIGN/RATE** ribbon, click on **Analysis Settings** button to open the **Analysis Settings** window as shown below.

Bridge Wo	orkspace - DiaphTrainir	9	ANALYSIS	REPORTS	?	_	×
BRIDGE WORKSPACE	WORKSPACE TOO	LS VIEW	DESIGN/RATE	REPORTING			
a 🛤		∽ ⅔	2 🖪				
Analysis Analyze Analysis Settings Events	Tabular Specification Results Check Detai	Engine Resu Outputs Gra	ults Save ph Results				
Analysis	F	Results					

Select the following setttings for a 3D LRFD design review.

O Design review Rating	Design method:	LRFD	~	
e / Impact loading type: As Requested	Analysis option: Apply preference setting	DL, LL and Spec-Checki	ing ×	
ehicles Output Engine Description Iraffic direction: Both directions V	Refresh	Temporary vehicles	Advanced	
Vehicle selection	Add to	ry iicles Ioads 93 (US) Ioads D Fatigue Truck (US)		

Analysis Settings			-		>
O Design review Rating	Design method:	LRFD	~		
Analysis type: 3D FEM V	Analysis option:	DL, LL and Spec-Checking	~		
ane / Impact loading type: As Requested \sim	Apply preference setting:	None	~		
Vehicles Output Engine Description					
C Tabular results	AASHTO engine rep	ports			
Dead load action report	🚞 Miscellaneous r	eports:			
Live load action report	Girder prop	perties			
	Summary in	nfluence line loading			
	Detailed in	fluence line loading			
	Capacity su	Immary			
LRFD specification check report	Capacity de	atailed computations			
PS concrete stress report					
RC service stress report		or DL analysis			
Steel limit state summary report	FE model to	or LL analysis			
	LL influence	e lines FE model			
	LL influence	e lines FE actions			
	LL distrib. f	actor computations			
	LL distrib. f	actor summary			
	Regression	data			
	Camber				
	Estique stra	acc ranges			
		itout:			
		conc article detailed			
Select all Clear all	Select all Cle	ear all			
				_	

Navigate to the **Output** tab of this window and make the following selections for this design review.

Click **OK** to apply these settings for the design review and close the window.

Design Review

With the **Single Span Example** superstructure node selected, click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon.

Bridge Wo	vrkspace - Diapl	hTraining		ANALYSIS	REPORTS		?	_	×
BRIDGE WORKSPACE	WORKSPACE	TOOLS	VIEW	DESIGN/RATE	REPORTING				
Analysis Settings Analysis Analysis Analysis	Tabular Speci Results Chec	ification Er k Detail Ou Resul	Gine Resu tputs Gra ts	k III ults Save ph Results					
Workspace Bridge Components		× &	Schem	atic	× &	Report			\$ ×
Components Diaphragm Defi Oiaphragm Defi Oiaphragm Lateral Bracing [Oiaphragm CRFD Multiple P	nitions Definitions resence Factors	5							
Construction of the second secon	.onditions ers RE DEFINITION Example ATIVES Alt (E) (C)	S	Analys	is					× \$

In this example, only the selected diaphragms will be analyzed and specification checked. None of the girder members have member alternatives marked as Existing (E), so they are not included in the analysis.



Tabular Results

After the analysis completes, open the **Tabular Results** window by clicking on the **Tabular Results** button from the **Results** group of the **DESIGN/RATE** ribbon while the superstructure definition is selected to see the bracing member results.

Br 🖁		Bridge V	Vorkspace -	DiaphTra	ining		ANALYS	IS	REPORTS	? -	· 🗆	×		
BF	IDGE WOR	KSPACE	WORKSPA	CE T	DOLS	VIEW	DESIGN/R	ATE R	EPORTING					
G An Set	alysis Analy tings Analy	yze Analysi Events	Tabular Results	Specifica Check De	tion Engi etail Outp Results	ne Result: outs Graph	Save Results							
D)	Analysis F Print Print	Results - Si	mple Span	Structu	re Bracin	9							_	×
ep	ort type:			Stage				De	ad Load Case	e		Girde	er Bay	
Dei	ad Load A	ctions	\sim	Non	composi	te (Stage	1)	 ✓ Se 	lf Load(Stag	e 1:D,DC).	\sim	All B	Bays	\sim
	Bracing	Element	Bracing Member	Node	Axial (kip)	Y Shear (kip)	Z Shear (kip)	Torsion (kip-ft)	Y Moment (kip-ft)	Z Moment (kip-ft)				
>	1-2	321	AB	22	-0.012	0.000	0.000	0.000	0.000	0.000				
				85	0.012	0.000	0.000	0.000	0.000	0.000				
		322	CD1	24	0.000	0.000	0.000	0.000	0.000	0.000				
				253	0.000	0.000	0.000	0.000	0.000	0.000				
		323	CD2	253	0.024	0.000	0.000	0.000	0.000	0.000				
				87	-0.024	0.000	0.000	0.000	0.000	0.000				
		324	AE	22	0.016	0.000	0.000	0.000	0.000	0.000				
				253	-0.016	0.000	0.000	0.000	0.000	0.000	-			
		325	EB	253	-0.016	0.000	0.000	0.000	0.000	0.000	-			
_		226		85	0.016	0.000	0.000	0.000	0.000	0.000	-			
	2-2	331	AB	85	-0.104	0.000	0.000	0.000	0.000	0.000	-			
_		222		148	0.104	0.000	0.000	0.000	0.000	0.000	-			
		332	CDT	255	0.024	0.000	0.000	0.000	0.000	0.000	-			
		222	CD2	255	-0.024	0.000	0.000	0.000	0.000	-0.001	-			
		222	02	150	-0.103	0.000	0.000	0.000	0.000	0.000	-			
		22/	٨F	85	0.102	0.000	0.000	0.000	0.000	0.000	-			
		554	ME	00	0.103	0.000	0.000	0.000	0.000	0.000	-			
				255					0.000	. 0.000				
		335	FR	255	-0.103	0.000	0.000	0.000	0.000	0.001	1			

🕰 Analysis Results - Simple Span Structure Bracing \times Print Print Girder Bay Report type: Stage Dead Load Case Dead Load Actions \sim Composite (short term) (Stage \sim WS from Left (Strength III:Stage All Bays \sim Bracing Axial Y Shear Z Shear Torsion Y Moment Z Moment Node Bracing Element Member (kip) (kip) (kip) (kip-ft) (kip-ft) (kip-ft) 0.627 0.000 0.000 0.000 0.000 1-2 321 AB 30 0.000 0.000 0.000 114 -0.627 0.000 0.000 0.000 322 CD1 32 -6.288 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 337 6.288 0.000 -0.001 323 CD2 337 -2.160 -0.002 0.000 0.000 0.000 -0.008 116 2.160 0.002 0.000 0.000 0.000 0.000 324 AE 30 2.683 0.001 0.000 0.000 0.000 0.000 337 -2.683 -0.001 0.000 0.000 0.000 0.008 325 0.000 0.000 0.000 0.002 EB 337 -2.680 0.000 114 2.680 0.000 0.000 0.000 0.000 0.000 331 2-2 -0.201 0.000 0.000 0.000 0.000 0.000 AB 114 198 0.201 0.000 0.000 0.000 0.000 0.000 332 CD1 116 -2.154 0.000 0.000 0.000 0.000 0.000 0.000 2.154 0.000 0.000 0.001 -0.002 339 333 CD2 339 -0.874 0.000 0.000 0.000 0.001 0.000 0.000 0.000 0.000 200 0.874 0.000 0.000 334 AE 114 0.833 0.000 0.000 0.000 0.000 0.000 339 -0.833 0.000 0.000 0.000 -0.001 0.001 335 0.000 0.000 0.000 -0.001 0.002 EB 339 -0.830 198 0.000 0.000 0.000 0.000 0.000 0.830 AASHTO LRFD 3D Engine Version 7.5.0.3001 Analysis preference setting: None Close

The wind load results can also be viewed in this window as shown below.

Specificatiton Check Details

Specification Check Details can be viewed for the bracing members by clicking on the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.

📲 Bridge Wo	rkspace - DiaphTraining	ANALYSIS	REPORTS	?	- 0	×	
BRIDGE WORKSPACE	VORKSPACE TOOLS VIEV	DESIGN/RATE	REPORTING				
Analysis Analyze Analysis Settings Analyze Analysis Events Analysis	Tabular Specification Outputs Results Check Detail	Results Save Graph Results					
A Specification Checks for Sim	ple Span Structure Bracing - 19 of 230 Articles All articles)				- 0	×
Properties Generate	Format Bullet list V Report						
Superstructure Compone	nt Specification reference			Limit State	Flex, Sense	Pass/Fail	
Stage 1	1.3.2.1 Design Philosophy	- Limit State - General			N/A	General Comp.	
Stage 2	4.6.2.7.1 I-Sections - Later	al Wind Load Distribution	in Multibeam Brid		N/A	General Comp.	
🔺 🚞 Stage 3	6.10.1.1.1b Stresses for Sec	tions in Positive Flexure			N/A	General Comp.	
a 🚞 1-2	✓ 6.13.4 Block Shear Rupture	Resistance			N/A	Passed	
AB	6.8.2 Tensile Resistance				N/A	General Comp.	
CD-1	NA 6.8.2.3.1 General				N/A	Not Applicable	
CD-2	NA 6.8.2.3.3 Tension Rupture	Jnder Axial Tension or Co	mpression Combir		N/A	Not Applicable	
	✓ 6.8.4 Tension Limiting Sler	derness Ratio			N/A	Passed	
	✓ 6.9.2.1 Axial Compression				N/A	Passed	
2-2	NA 6.9.2.2.1 Combined Axial C	ompression and Flexure	General		N/A	Not Applicable	
	✓ 6.9.3 Compression Limiting	g Slenderness Ratio			N/A	Passed	
	6.9.4.1.1 Nonslender Elem	ent Nominal Compressive	Resistance		N/A	General Comp.	
	6.9.4.1.2 Truss Elastic Flexu	ral Buckling Resistance of	Truss Members		N/A	General Comp.	
	NA 6.9.4.1.3 Elastic Torsional B	uckling and Flexural-Tors	onal Buckling Resi		N/A	Not Applicable	
	6.9.4.2.2 Slender Longitudi	nally Unstiffened Cross-S	ection Elements		N/A	General Comp.	
	6.9.4.2.2b Effective Width	of Slender Elements			N/A	General Comp.	
	 6.9.4.4 Single-Angle Effect 	ive Slenderness			N/A	Passed	
	NA 6.9.4.5 Plate Buckling unde	er Service and Construction	n Loads		N/A	Not Applicable	
	Steel Elastic Section Prope	rties			N/A	General Comp.	

limit State	Load Comb	Force Type	Axial Force (kip)	Design Ratio	Status		
TR-I	1	Tension			NA		
TR-I	1	Compression	-7.06	2.845	Pass		
TR-I	2	Tension			NA		
TR-I	2	Compression	-7.18	2.799	Pass		
STR-III	1	Compression	-2.03	9.894	Pass		
TR-III	1	Compression	-2.82	7.124	Pass		
TR-III	2	Compression	-2.03	9.894	Pass		
TR-III	2	Compression	-2.82	7.124	Pass		
STR-III	4	Compression	-2.03	9.894	Pass		
STR-III	4	Compression	-2.82	7.124	Pass		
TR-III	5	Compression	-2.03	9.894	Pass		
IK-III	5	compression	-2.82	7.124	Pass		
IK-III	6	Compression	-2.03	9.894	Pass		
TD TTT	6	Compression	-2.82	/.124	Pass		
TR-III	7	Compression	-2.03	9.894	Pass		
TD N	1	Compression	-2.82	1.124	Pass		
TD V	1	Tension	6 00	2 209	NA		
TD V	2	Toppion	-0.09	3.290	Pass		
TD_V	2	Compression	-6 19	3 250	Dage		
TD_V	2	Tension	-0.10	3.250	NA		
TP_V	4	Compression	-6.09	3 298	Dage		
TD_V	5	Tension	-0.03	3.250	NA		
TR-V	š	Compression	-6.18	3 250	Pass		
TR-V	6	Tension			NA		
TR-V	6	Compression	-6.09	3,298	Pass		
TR-V	7	Tension			NA		
TR-V	7	Compression	-6.18	3.250	Pass		
ad Combin	ation Legen	d:					
.oae	venicie						
1 H 2 H 5 H 6 H 7 H 3 I	L-93 (US):T L-93 (US):T L-93 (US):T L-93 (US):T L-93 (US):T L-93 (US):T L-93 (US):T RFD Fatigue	+L a+L +L + Wind from Le a+L + Wind from I +L + Wind from Ri a+L + Wind from F Truck (US):T	ft eft ght ight				
						 	 _

The following specification article illustrates how the wind load is combined with the live load:

Engine Outputs

To view **Engine Output** files, click on the **Engine Outputs** button from the **Results** group of the **DESIGN/RATE** ribbon as shown below.



The following output files are available.



Wind load is calculated based on the projected area of the superstructure elevation. Wind load on the barrier, deck and ¹/₂ the girder depth (as measured between the top flange and bottom flange nodes in the FE model) is applied to the top flange node in the windward side exterior beam. Wind load on the bottom ¹/₂ the girder depth is applied to the bottom flange node in the windward side exterior beam.



For curved structures, wind is applied along the chord length. This is done by adjusting the user input wind pressure by the ratio of the chord length divided by the arc length. For curved girder systems with superelevation, wind load is also computed for the additional height of exposed barrier and additional exposed beam depth.

3DFEM1 – Steel Diaphragm and Lateral Bracing Specification Checking Example



A summary of the bracing specification check results is also available from the results folder saved in the location prefered by the user (as shown in the **Preferences** window shown below).

Preferences		
Bridge Explorer Bridge Workspace Confirmations Analysis	is Report Tool	ОК
Default analysis settings template		Cancel
	~	
	Reset	
Analysis output		
Analysis engines report folder		
✓ Use the current user's "My Documents" folder	Browse	

lame	Date modified	Туре	Size
Data	12/13/2023 8:14 AM	File folder	
Details	12/13/2023 8:14 AM	File folder	
- Diaphragms	12/13/2023 8:14 AM	File folder	
- G1	12/13/2023 8:14 AM	File folder	
G2	12/13/2023 8:14 AM	File folder	
G3	12/13/2023 8:14 AM	File folder	
G4	12/13/2023 8:14 AM	File folder	
S1 Span	12/13/2023 8:14 AM	File folder	
S2 Span	12/13/2023 8:14 AM	File folder	
S3 Span	12/13/2023 8:14 AM	File folder	
3DGirderNodes.txt	12/13/2023 8:14 AM	Text Document	4 KB
] EngineFiles.LST	12/13/2023 8:14 AM	LST File	2 KB
ModelGenNodeMergeReport.txt	12/13/2023 8:14 AM	Text Document	16 KB
] NsgVehicles.dat	12/13/2023 8:14 AM	DAT File	1 KB
SingleSpanExample.log	12/13/2023 8:14 AM	Text Document	7 KB
Stage 3 Bracing Spec Check Results.XML	12/13/2023 8:14 AM	XML File	331 KB
Vehicles.dat	12/13/2023 8:14 AM	DAT File	3 KB

BrDR XML Report Viewer

AASHTO LRFD Specification, Edition 9, Interim 0

Specification Check Summary

Article	Status
Flexure (6.10.8.1.1, 6.10.8.1.2, 6.8.2.3, 6.9.2.2)	NA
Axial Tension (6.8.2)	NA
Axial Compression (6.9.4.1.1)	Fail
Block Shear Rupture (6.13.4)	Pass

Tensile Resistance

Bracing	Bracing Member	LS	LC	Pu (kip)	Pr (kip)	Design Ratio	Code
---------	-------------------	----	----	-------------	-------------	-----------------	------

Compressive Resistance

Bracing	Bracing Member	LS	LC	Pu (kip)	Pr (kip)	Design Ratio	Code
1-2	AB	STR-I	1	11.62	20.09	99.000	NA
	AB	STR-I	1	-7.06	20.09	2.845	Pass
	AB	STR-I	2	12.31	20.09	99.000	NA
	AB	STR-I	2	-7.18	20.09	2.799	Pass
	AB	STR-III	1	-2.03	20.09	9.894	Pass
	AB	STR-III	1	-2.82	20.09	7.124	Pass
	AB	STR-III	2	-2.03	20.09	9.894	Pass
	AB	STR-III	2	-2.82	20.09	7.124	Pass
	AB	STR-III	4	-2.03	20.09	9.894	Pass
	AB	STR-III	4	-2.82	20.09	7.124	Pass
	AB	STR-III	5	-2.03	20.09	9.894	Pass
	AB	STR-III	5	-2.82	20.09	7.124	Pass
							-

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LRFR/LFR Rating

Analysis Settings

In a similar manner, an LRFR or LFR rating can be performed. Note that wind load is not included in the rating analysis but section loss is.

To run an **LRFR rating** on the superstructure definition, from the **Analysis** group of the **DESIGN/RATE** ribbon click on **Analysis Settings** to open the **Analysis Settings** window as shown below.

Bridge Wo	orkspace - DiaphTraining	ANALYSIS	REPORTS	?	_	\times
BRIDGE WORKSPACE	WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			
* =	• • ;	× B				
Analysis Analyze Analysis Settings Events	Tabular Specification Engine Re Results Check Detail Outputs Gr	sults Save aph Results				
Analysis	Results					

Select the vehicles to be used in the rating as shown below.

Analysis Settings			
Design review O Rating	Rating method:	LRFR ~	
Analysis type: 3D FEM ~ Lane / Impact loading type: As Requested ~	Analysis option: Apply preference setting:	DL, LL and Spec-Checking V	
Vehicles Output Engine Description			
Traffic direction: Both directions \checkmark	Refresh	Temporary vehicles Advanced	
E Vehicles → Standard → EV2 → EV3 → H 15-44 → H20-44 → HL-93 (SI) → H-93 (US) → HS 15-44 → HS 20 (SI) → HS 20-44 → Lane-Type Legal Load → LRFD Fatigue Truck (SI) → LRFD Fatigue Truck (US) → NRL → SU4 → SU5 → SU6 → SU7 → Type 3-3 → Type 3-3 → Type 3-2 → Gency → User defined → Temporary	Add to	cles gn load rating nventory Type 3 Joperating +-Type 3 ratigue I load rating Routine specialized hauling nit load rating	
Reset Clear Open template Sav	e template	OK Apply	Cancel

Analyze

With the **Single Span Example** superstructure node selected, click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon.

Bridge Wo	rkspace - Diapł	Training		ANALYSIS	REPORTS		?	_	×
BRIDGE WORKSPACE	VORKSPACE	TOOLS	VIEW	DESIGN/RATE	REPORTING				
Analysis Settings Analysis Analyze Analysis Analysis Analysis	Tabular Speci Results Check	fication En c Detail Out	Gine Resu tputs Gra	k III ults Save ph Results					
Workspace		\$ X	Schem	atic	× &	Report			× x
Bridge Components DiaphTraining Components Diaphragm Defir Lateral Bracing D MFT LRFD Multiple Pr	nitions Definitions resence Factors								
Cenvironmental C Design Paramete SUPERSTRUCTUF Design Paramete Design Parametee Design Parameteee Design Parameteeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeeee	onditions ers RE DEFINITION: Example ATIVES Alt (E) (C)	5	Analys	is					& X

Tabular Results

After the analysis completes, open the **Tabular Results** window by clicking on the **Tabular Results** button from the **Results** group of the **DESIGN/RATE** ribbon while the superstructure definition is selected to see the bracing member results.

BLE	Br	idge Workspa	ace - Diap	hTraining		ANA	ALYSIS	REI	PORTS	? –		\times
BRIDGE V	VORKSPA	CE WOR	KSPACE	TOOLS	VIEW	DESIG	N/RATE	REP	ORTING			
Analysis Settings	Analyze /	Analysis Events Res	ular Spec ults Chec	ification E k Detail O Resu	ngine Resu utputs Graj ılts	k Its Save	e Its					
🕰 Analysis Re	esults - Simp	le Span Structure	Bracing								- 0	×
Print												
Print Print		Display	Format									
Print Print Report type: Rating Results	Summary	Display Single	Format rating level p	er row .	~							
Print Print Report type: Rating Results	Summary Live Load Type	Display Single Rating Method	Format rating level p Rating Level	Load Rating (Ton)	× Rating Factor	Location (ft)	Location Span-(%)	Element Name	Limit State	Impact	Lane	
Print Print Report type: Rating Results	Summary Live Load Type Axle Load	Display Single : Rating Method LRFR	Format rating level p Rating Level Inventory	Load Rating (Ton) 51.29	Rating Factor	Location (ft) 0.00	Location Span-(%) 0 - (100.0)	Element Name 2-2 CD-2	Limit State STRENGTH-I Axial	Impact As Requested	Lane As Requested	<u> </u>
Print Print Report type: Rating Results	Summary Live Load	Display Single	Format rating level p Rating	er row	V	Location	Location	Element	Lincia Ganas	Innert	1	
Print Print Print Print Live Load Type 3 Type 3 ASHTO LRFR 5	Summary Live Load Axle Load Axle Load 3D Engine Ve	Display Single I Rating Method LRFR LRFR	Format rating level p Rating Level Inventory Operating	er row	Rating Factor 2.052 2.660	Location (ft) 0.00 0.00	Location Span-(%) 0 - (100.0) 0 - (100.0)	Element Name 2-2 CD-2 2-2 CD-2	Limit State STRENGTH-I Axial STRENGTH-I Axial	Impact As Requested As Requested	Lane As Requested As Requested	

Specificatiton Check Details

Specification check details can be viewed by clicking on the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.

Bridge Wo	orkspace - DiaphTraini	ng	ANALYSIS	REPORTS	?	_	\times
BRIDGE WORKSPACE	WORKSPACE TOO	DLS VIEW	DESIGN/RAT	REPORTING			
at as 🗉		े न्द्र	2 🖪				
Analysis Analyze Analysis Settings Events	Tabular Specificatio Results Check Deta	n Engine Resu il Outputs Gra	ults Save ph Results				
Analysis		Results					

The section loss that was entered for member **AB** in diaphragm **1-2** is considered as shown below.

A Specification Checks for Simple	Span Structure Bracing - 21 of 250			- 0	×
<i>i</i>	Articles All articles				
Properties Generate	Format Bullet list V				
Specification filter	Report				
🔺 🚞 Superstructure Component	Specification reference	Limit State	Flex. Sense	Pass/Fail	
🕨 🚞 Stage 1	1.3.2.1 Design Philosophy - Limit State - General		N/A	General Comp.	
Stage 2	4.6.2.7.1 I-Sections - Lateral Wind Load Distribution in Multibeam Brid		N/A	General Comp.	
🔺 🚞 Stage 3	6.10.1.1.1b Stresses for Sections in Positive Flexure		N/A	General Comp.	
a 🛄 1-2	✓ 6.13.4 Block Shear Rupture Resistance		N/A	Passed	
AB	6.8.2 Tensile Resistance		N/A	General Comp.	
CD-1	NA 6.8.2.3.1 General		N/A	Not Applicable	
	NA 6.8.2.3.3 Tension Rupture Under Axial Tension or Compression Combin		N/A	Not Applicable	
AE CD CD	× 6.8.4 Tension Limiting Slenderness Ratio		N/A	Failed	
ED	✓ 6.9.2.1 Axial Compression		N/A	Passed	
2-2	NA 6.9.2.2.1 Combined Axial Compression and Flexure - General		N/A	Not Applicable	
	× 6.9.3 Compression Limiting Slenderness Ratio		N/A	Failed	
	6.9.4.1.1 Nonslender Element Nominal Compressive Resistance		N/A	General Comp.	
	6.9.4.1.2 Truss Elastic Flexural Buckling Resistance of Truss Members		N/A	General Comp.	
	NA 6.9.4.1.3 Elastic Torsional Buckling and Flexural-Torsional Buckling Resi	i	N/A	Not Applicable	
	6.9.4.2.2 Slender Longitudinally Unstiffened Cross-Section Elements		N/A	General Comp.	
	6.9.4.2.2b Effective Width of Slender Elements		N/A	General Comp.	
	✓ 6.9.4.4 Single-Angle Effective Slenderness		N/A	Passed	
	NA 6.9.4.5 Plate Buckling under Service and Construction Loads		N/A	Not Applicable	
	✓ 6A.6.6-7 Truss Axial Tension and Compression Rating		N/A	Passed	
	NA 6A.6.8 Truss Combined Axial and Flexure Rating		N/A	Not Applicable	
	Steel Elastic Section Properties		N/A	General Comp.	

Resistance Spec Check Detail for 6.8.2 Tensile Resistance		_		×
6 Steel Structures 6.8 Tension Members 6.8.2 Tensile Resistance (AASHTO LRFD Bridge Design Specifications, Nin Diaphragm 1-2 AB - Start Stage 3	th Edition)			Î
<pre>Punched Holes Phiy Phiu Rp Fu Fy Ag Net area deduction Net Area, An = Ag - Net area deduction Connected Element A_connected U_table U_min U = max(U_table, U_min)</pre>	: No = 0.95 = 0.80 = 1.00 = 65.00 (ksi) = 2.04 (in ²) = 0.35 (in ²) = 1.69 (in ²) = Vertical Leg = 1.31 (in ²) = 0.6434 = 0.6434 = 0.6434 (6.8.2.1-1) (6.8.2.1-2) (6.13.4-1)			
Phiu*Pnu = 56.49 (kip) Pr = 56.49 (kip)				Ŧ
			OK	

If the user wants to change a piece of data that does not directly impact the FE analysis or results, such as the bolt details in a diaphragm, the **Analysis Settings** window allows the user to process just a specification check without redoing a full analysis.

The following shows the details for Article 6.8.2 Tensile Resistance for member EB in the diaphragm 1-2. Note the

Net Area.



Open the **Diaphragm Definitions** window for the **Type 2** diaphragm, navigate to the **Connections** tab and modify the bolt details for member **EB** by adding an extra line of bolts:

Members C Nember AB AB CD CD AE	Connections 7/8" A325 Connection A B	Memi connec type Bolt	> ber ttion e	Work point offset	Number		Bolt line				
Member AB AB CD CD AE	Connection A B	Memi connec type Bolt	> ber tion e	Work point offset	Number		Bolt line				
Member AB AB CD CD AE	Connection A B	Meml connec type Bolt	ber tion e	Work point offset	Number		Bolt line				
AB AB CD CD AE	A B	Bolt		(in)	bolt lines	Bolts per line	spacing (long) (in)	Bolt line spacing (trans.) (in)	Trans. edge distance (in)	Long. edge distance (in)	
AB CD CD AE	В		\sim		1	2	3		2	1.75	
CD CD AE		Bolt	\sim		1	2	3		2	1.75	
CD AE	С	Bolt	\sim		1	2	3		2	1.75	
AE	D	Bolt	\sim		1	2	3		2	1.75	
	Α	Bolt	\sim		1	2	3		2	1.75	
AE	E	Bolt	\sim			2	3		2	1.75	
EB	E	Bolt	\sim		2	2	1.5)	2	1.75	
EB	В	Bolt	\sim		1	2	3		2	1.75	

Open the **Analysis Settings** window and select the **Spec-Checking only** option under **Analysis Option**. Click **OK** and run the analysis again.

Design review 🔘 Rating		Rating metho	d:	LRFR	~	
alysis type: 3D FEM	~	Analysis optic	n:	Spec-Checking Only	~	
ne / Impact loading type: As Requested		Apply prefere	nce setting:	None	~	
Vehicles Output Engine Description						
Traffic direction: Both directions		F	lefresh	Temporary vehicles	Advanced	
Vehicle selection		Vehi	cle summary	r		
⇒ Standard ⇒ Standard −EV2 −EV3 −H 15-44 −H 20-44 −H 20-44 −H 20-43 −H 20 (SI) −HS 20 (SI) −NFD Fatigue Truck (US) −NF −SU6 −SU6 −SU6 −SU7 −Vpe 33 −Temporary		Add to >> Remove from <<	Lega - Lega - Lega - Lega - Lega - Lega - Rem	gn load rating wentory perating atigue I load rating outine pecialized hauling pecialized hauling it load rating		

BrDR will regenerate the FE Models and compare them to the previously generated FE models. Since the models are the same, the previous FE results are re-used and the specification checking considers the revised details:

nalysis - Single Span Example		~
🮯 Analysis Event	Adding structure typical section loads to Stage 1 Model Span Checking feasibility of reusing previous FEA results	
 Single Span Example 	Reusing FEA results from previous analysis	
GIRDER-SYSTEM MEMBERS	Writing Stage 1 actions report.	
🮯 G1 [Plate Girder]	begin processing beam and shell forces into moments and shears Finished processing beam and shell forces into moments and shears Adding structure typical section loads to Stage 2 Model Span	
🥝 G2 [Plate Girder]	Checking feasibility of reusing previous FEA results	
🥝 G3 [Plate Girder]	Reusing FEA results from previous analysis	
🥝 G4 [Plate Girder]	Writing Stage 2 actions report. Begin processing beam and shall forces into moments and shears Finished processing beam and shell forces into moments and shears Reducing live load cases by only generating the influence surface for the loaded region	
	Of the 357 deck nodes in the model, 357 are within the loaded region	
	Final Stage 3D Model Summary:	
	Number of nodes = 725	
	Number of reference nodes = 110	
	Number of frame elements in the beams = 160	
	Number of frame elements in the diaphragms = 30	
	Number of shell elements in the deck = 320	
	Number of links between deck and beams = o	
	Number of load cases = 357	
	Number of degrees of freedom = 3690	
	Checking feasibility of reusing previous FEA results	
	Reusing FEA results from previous analysis	
	Processing the FE results files Computing transverse lane positions Info - Populating all stages of diaphragm results Info - Finished populating all stages of diaphragm results	
	🕴 🔕 Errors 🖾 Warnings	
	Type Description	
	Warning - Design ADTT is not entered. Fatigue details wi	
	Warning - Shear Connector articles in Section 6.10.10 will	
	Warning - Design ADTT is not entered. Fatigue details with with a set of set	

Open specification check article 6.8.2 Tensile Resistance for member EB as shown below.

Properties Generate	Articles All articles Format Bullet list Report			
A 📋 Superstructure Component	Specification reference	Limit State	Flex. Sense	Pass/Fail
Stage 1	1.3.2.1 Design Philosophy - Limit State - General		N/A	General Comp.
🕨 🚞 Stage 2	🔋 4.6.2.7.1 I-Sections - Lateral Wind Load Distribution in Multibeam Brid		N/A	General Comp.
🛯 🚞 Stage 3	6.10.1.1.1b Stresses for Sections in Positive Flexure		N/A	General Comp.
4 🚞 1-2	✓ 6.13.4 Block Shear Rupture Resistance		N/A	Passed
i AB i CD-1 i CD-2 i AE i CD-2 i AE i CD-2 i AE i CD-2 i AB i CD-2 i CD-2	6.8.2 Tensile Resistance		N/A	General Comp.
	NA 6.8.2.3.1 General		N/A	Not Applicable
	NA 6.8.2.3.3 Tension Rupture Under Axial Tension or Compression Combir		N/A	Not Applicable
	✓ 6.8.4 Tension Limiting Slenderness Ratio		N/A	Passed
	NA 6.9.2.1 Axial Compression		N/A	Not Applicable
	NA 6.9.2.2.1 Combined Axial Compression and Flexure - General		N/A	Not Applicable
	NA 6.9.3 Compression Limiting Slenderness Ratio		N/A	Not Applicable
	6.9.4.1.1 Nonslender Element Nominal Compressive Resistance		N/A	General Comp.
	6.9.4.1.2 Truss Elastic Flexural Buckling Resistance of Truss Members		N/A	General Comp.
	NA 6.9.4.1.3 Elastic Torsional Buckling and Flexural-Torsional Buckling Resi		N/A	Not Applicable
	6.9.4.2.2 Slender Longitudinally Unstiffened Cross-Section Elements		N/A	General Comp.
	6.9.4.2.2b Effective Width of Slender Elements		N/A	General Comp.
	✓ 6.9.4.4 Single-Angle Effective Slenderness		N/A	Passed
	NA 6.9.4.5 Plate Buckling under Service and Construction Loads		N/A	Not Applicable
	✓ 6A.6.6-7 Truss Axial Tension and Compression Rating		N/A	Passed
	NA 6A.6.8 Truss Combined Axial and Flexure Rating		N/A	Not Applicable
	Steel Elastic Section Properties		N/A	General Comp.

