

# 2024 RADBUG Annual Meeting Training Materials

Buffalo, New York August 6-7, 2024





 $^{\odot}$  American Association of State Highway and Transportation Officials. 555  $12^{\rm th}$  Street NW, Suite 1000, Washington, DC 20004

# **2024 RADBUG Annual Meeting**

# AASHO Ware<sup>M</sup> BRIDGE DESIGN AND RATING

# **Fundamentals Training Session**

# Tuesday August 6, 2024 Part 1: 10:30 AM – 12:00 PM Part 2: 1:00 PM – 3:00 PM

- 1. Overview Instructor only
  - Introduction to the Bridge Explorer (Visual Reference)
  - Review the Bridge Workspace tree
  - On-line help and manuals
  - Review STL2
  - Output
- 2. Libraries (LIB1, Hands-on)
- 3. Two-Span Steel Plate Girder Example (STL2, Hands-on)
- 4. Simple Span Prestressed I Beam Example (PS1, Hands-on)
- 5. Available Help and Training (HLP1)

# Introducing BrDR Environment Guide to Using BrDR 7.5.1

## **Getting Started**

AASHTOWare Bridge Design and Rating Overview

#### What is AASHTOWare Bridge Design and Rating?

AASHTOWare Bridge Design and Rating is a software package that aids in the design and load rating of bridges. The software includes the applications BrD (Bridge Design) and BrR (Bridge Rating) with analytical engines that support AASHTO ASR/LFR and LRFD/LRFR. Additional engines are available through third party developers.

#### BrR



BrR (Bridge Rating) is used for a variety of bridge superstructure and culvert load rating. The application features a graphical user interface that aid in the preparation of the data and application of the results. Using the AASHTO ASR/LFR/LRFR as its analytical engine for load rating, BrR provides an integrated database where rating inputs and outputs can readily be stored, reviewed, and reused.

#### BrD

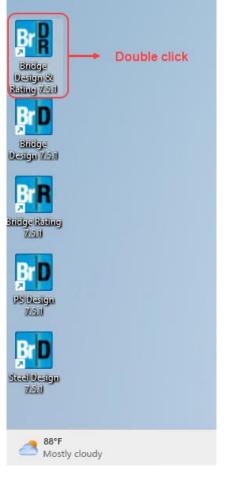


BrD (Bridge Design) is a bridge superstructure, substructure and culvert design software product using the AASHTO Load and Resistance Factor Design (LRFD) Bridge Specifications. BrD employs the same database and graphical user interface as BrR, and shares much of the same source code. Development of both products began in 1997. The AASHTO LRFD Engine provides the system's structural analysis and specification checking engines.

Starting AASHTOWare Bridge Design and Rating – Version 7.5.1

#### From the Desktop

The AASHTOWare Bridge Design and Rating software may be accessed through the desktop icon (see figure to the right). Using the BrDR icon provides the features of both BrD and BrR in one environment.



#### $\leftarrow$ All Apps Documents Web Sett Best match for apps Bridge Design & Rating 7.5.1 Br 🖁 Select App Apps Bridge Design & Rating 7.5.1 Br B > Setup.exe - in Version 7.5.1 Bridge Design & Rating 7.5.1 Br 🖁 > Setup.exe - in 751 Bridge Design and Rating 7.3 > Bridge Design 7.3 > Bridge Design 7.4.1 > SRASS Import > Bridge Copy Utility 7.3 > Bridge Rating 6.8.4 > Bridge Copy Utility > Bridge Design 7.0 > Bridge Design 6.8.4 > 🔾 Apps: Bridge Design & Rati 🛛 🔲 C

#### From the Start Menu

The software may also be accessed from the start menu if the icons are not in the desktop.

#### **Entering Username and Password**

Once initiated, the AASHTOWare Bridge Design and Rating **Connect** window will pop up. Enter the username and password in the provided fields. To connect to a different database, or if **Connect to** field is empty, click on the ellipsis button (...)

Brr B	Saroware Bridge Design & Rating Version 7.5.1.3001 Build date Feb 26 2024	
		1. Enter username and password
Username Password	bridge	2. Click to select
Connect to OK	AASHTOWareBr75	Connect to database

#### **Connecting to the Database**

Once in the **Manage Connections** window, follow the instructions in the figure below.

Manage Connections			-		×
Connection details					
AASHTOWareBr75 AASHTOWareBr75s J 1. Select one of the databases provided	AASHTOWareBr75 Microsoft SQL Server  nection details  Iocalhost AASHTOWareBr75 Windows Authentication SQL Encrypt	×	Refresh		
New Delete					
	<b>2. Click ОК ←</b> ОК	Ca	Incel	t conne	tion

#### AASHTOWare Bridge Design and Rating Basics

#### AASHTOWare Bridge Design and Rating Environment Tour

Once successfully connected, the **Bridge Explorer** opens. The **Bridge Explorer** allows the entry of new bridge information into BrD/BrR or access existing bridge information. The left portion of the **Bridge Explorer** contains a tree. Each tree item includes a button, a folder and a name. The right portion of the **Bridge Explorer** presents a complete list of the bridges corresponding to the folder selected on the tree.

8		AASHTOWare Bridge Design and Rating	
BRIDGE EXPLORER BRIDGE FOLI	DER RATE TOOLS VIEW		
New Open Batch ~ Find Co Bridge	א 💷 🍌 🕪 🛄 🔒 נו	change Out 😢 Cancel change In 📑 Information ch ~ Exchange	Bridge list correspondi to the selected folde
🚖 Favorites Folder	BID Bridge ID	Bridge Name	District County
Recent Bridges	> 1 TrainingBridge1	Training Bridge 1(LRFD)	Unknown Unknown (P)
All Bridges	2 TrainingBridge2	Training Bridge 2(LRFD)	Unknown Unknown (P)
	3 TrainingBridge3S	Training Bridge 3(LRFD)	Unknown Unknown (P)
Deleted bridges	4 PCITrainingBridge1	PCI TrainingBridge1(LFR)	
+	5 PCITrainingBridge2	PCITrainingBridge2(LRFD)	
Bridge Explorer	6 PCITrainingBridge3	PCI TrainingBridge3(LFR)	
tree	7 PCITrainingBridge4	PCITrainingBridge4(LRFD)	
uee	8 PCITrainingBridge5	PCI TrainingBridge5(LFR)	
	9 PCITrainingBridge6	PCITrainingBridge6(LRFD)	
	10 Example7	Example 7 PS (LFR)	
	11 RCTrainingBridge1	RC Training Bridge1(LFR)	
	12 TimberTrainingBridge1	Timber Tr. Bridge1 (ASR)	
	13 FSys GFS TrainingBridge1	FloorSystem GFS Training Bridge 1	Unknown Unknown (P)
	14 FSys FS TrainingBridge2	FloorSystem FS Training Bridge 2	Unknown Unknown (P)
	15 FSys GF TrainingBridge3	FloorSystem GF Training Bridge 3	Unknown Unknown (P)
	16 FLine GFS TrainingBridge1	FloorLine GFS Training Bridge 1	Unknown Unknown (P)
	17 FLine FS TrainingBridge2	FloorLine FS Training Bridge 2	Unknown Unknown (P)
	18 FLine GF TrainingBridge3	FloorLine GF Training Bridge 3	Unknown Unknown (P)
	19 TrussTrainingExample	Truss Training Example	
	20 LRFD Substructure Example 1	LRFD Substructure Example 1	
	21 LRFD Substructure Example 2	LRFD Substructure Example 2	

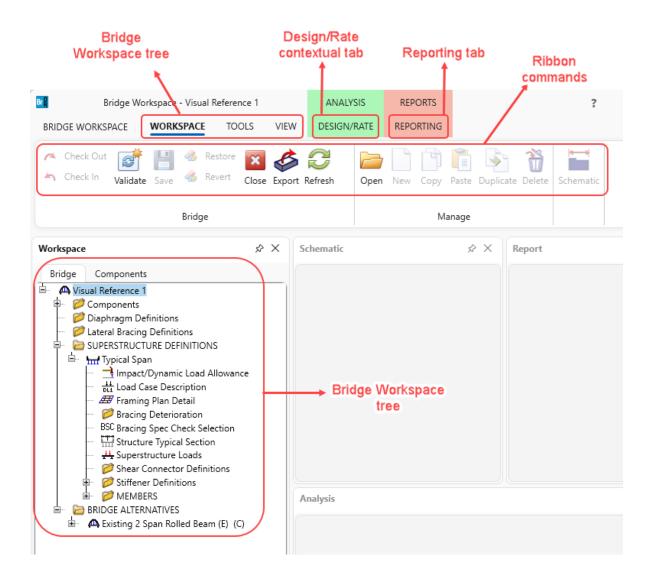
# AASHTOWare Bridge Design and Rating Environment Overview

# Bridge Explorer Window

Br				AASHTOWare Bridge Design and Rating		
BRIDGE EXPLORER BRID	GE FOLDER	RATE	TOOLS VIEW	Bridge Explorer tabs		
New Open C Batch ~ Bridge	Find Copy I	Paste Co To Manag	py Remove Delete From Ba		Bridge Exp comr	lorer ribbo nands
		BID	Bridge ID	Bridge Name	District	County
🧭 Recent Bridges		> 1	TrainingBridge1	Training Bridge 1(LRFD)	Unknown	Unknown (P)
All Bridges		2	TrainingBridge2	Training Bridge 2(LRFD)	Unknown	Unknown (P)
···· ∕∕ Templates ···· ∕∕ Deleted Bridges		3	TrainingBridge3S	Training Bridge 3(LRFD)	Unknown	Unknown (P)
Deleted bridges		4	PCITrainingBridge1	PCI TrainingBridge1(LFR)		
		5	PCITrainingBridge2	PCITrainingBridge2(LRFD)		
		6	PCITrainingBridge3	PCI TrainingBridge3(LFR)		
		7	PCITrainingBridge4	PCITrainingBridge4(LRFD)		
		8	PCITrainingBridge5	PCI TrainingBridge5(LFR)		
		9	PCITrainingBridge6	PCITrainingBridge6(LRFD)		
		10	Example7	Example 7 PS (LFR)		
		11	RCTrainingBridge1	RC Training Bridge1(LFR)		
		12	TimberTrainingBridge1	Timber Tr. Bridge1 (ASR)		
		13	FSys GFS TrainingBridge1	FloorSystem GFS Training Bridge 1	Unknown	Unknown (P)
		14	FSys FS TrainingBridge2	FloorSystem FS Training Bridge 2	Unknown	Unknown (P)
		15	FSys GF TrainingBridge3	FloorSystem GF Training Bridge 3	Unknown	Unknown (P)
		16	FLine GFS TrainingBridge1	FloorLine GFS Training Bridge 1	Unknown	Unknown (P)
		17	FLine FS TrainingBridge2	FloorLine FS Training Bridge 2	Unknown	Unknown (P)
		18	FLine GF TrainingBridge3	FloorLine GF Training Bridge 3	Unknown	Unknown (P)
		19	TrussTrainingExample	Truss Training Example		
		20	LRFD Substructure Example 1	LRFD Substructure Example 1		
		21	LRFD Substructure Example 2	LRFD Substructure Example 2		

## AASHTOWare Bridge Design and Rating Environment Overview

## Bridge Workspace Window



#### Bridge Explorer Window

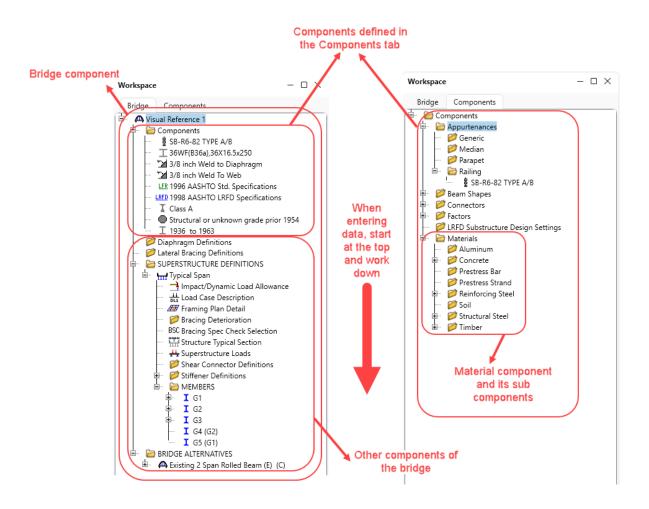
#### Sorting the Bridge List

Once a folder is selected to find a bridge, the corresponding bridge list may be sorted to make the search easier. Sorting the bridge list requires double clicking on a column heading. The first time this is done, it will sort alphabetically in ascending order. Double clicking again will result in a descending sort. This sorting works for all the columns in the Bridge Explorer.

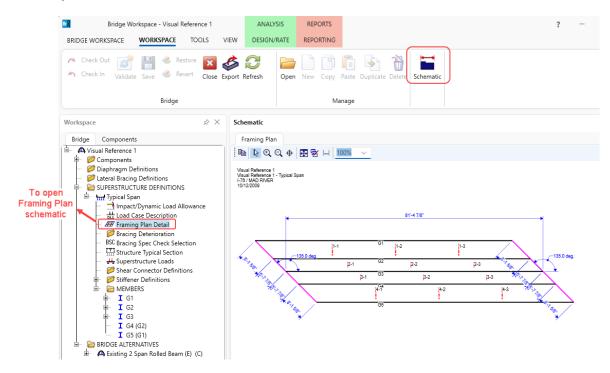
column heading to	BID	Bridge ID	Bridge Name	District	County	Facility	Location	Route	🗕 he	eading
ort the bridge	1	TrainingBridge1	Training Bridge 1(LRFD)	Unknown	Unknown (P)		Pittsburgh	0051	SI .	sort
ID in	2	TrainingBridge2	Training Bridge 2(LRFD)	Unknown	Unknown (P)		N/A	-1	N IO	ocation
ascending	3	TrainingBridge3S	Training Bridge 3(LRFD)		Unknown (P)		Pittsburgh	0079	o as	scendi
order	4	PCITrainingBridge1	PCI TrainingBridge1(LFR)					-1	-	order
0, 00,	5	PCITrainingBridge2	PCITrainingBridge2(LRFD)					-1		
	6	5 5	PCI TrainingBridge3(LFR)					-1		
	7	5 5	PCITrainingBridge4(LRFD)					-1		
	8		PCI TrainingBridge5(LFR)					-1		
	9	PCITrainingBridge6	PCITrainingBridge6(LRFD)					-1		
	10	Example7	Example 7 PS (LFR)					-1		
	11	RCTrainingBridge1	RC Training Bridge1(LFR)					-1		
	12	TimberTrainingBridge1	Timber Tr. Bridge1 (ASR)					-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)	I-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	FC	
	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	M	
	25	Culvert Example 1	Culvert Example 1					STH60		
	26	Curved Guide Spec	Curved Guide Spec Example(LFR)					1		
	27	MultiCell Box Examples	Multi Cell Box Examples					100		
	28		Gusset Plate Example	Unknown			Some Highway			
	29	· · · ·	Splice Example					-1		
3. Select bridge		Simple DL-Cont LL-Splice	Simple DL Splice	Unknown	Unknown (P)	N/A	N/A	-1	N	

Double-clicking on a bridge from the bridge list opens the **Bridge Workspace**. The **Bridge Workspace** houses multiple docked panels namely **Workspace**, **Schematic**, **Report** and **Analysis**. These panels can be docked, undocked, moved, or resized.

The **Workspace** window consists of **Bridge** and **Components** tab. The tree in these tabs work like the File Explorer file tree, except that instead of sorting files and folders, these tabs sort out different components of a bridge. The components include the items the bridge uses, girders or beams, and deck to name a few. The **Components** folder consists of all the items defined in the **Components** tab. Each major component has components unto itself. The **Materials** component of the **Components** tab, for example, is broken down into **Structural** and **Reinforcing Steel**, **Concrete**, **Prestress Strand/Bar**, **Soil** and **Timber**. These separate divisions are again broken down to the different materials of that division's type. For example, under Concrete, there may be a description for concrete class A, B and C.



The schematics of various items in **Bridge Workspace** can be viewed in the **Schematic** window. To view a schematic, highlight the item on the **Bridge Workspace** tree and click on the **Schematic** button on **WORKSPACE** tab.

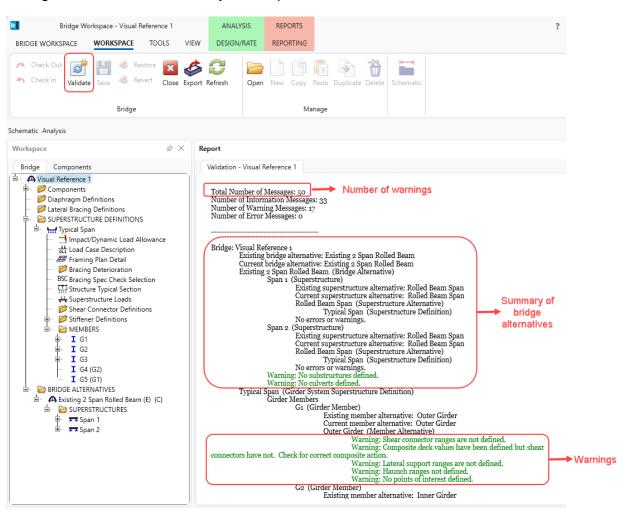


The **Analysis** Window of **Bridge Workspace** has panels to display the analysis event, analysis progress, and error/warning messages. The analysis progress and the error/warning messages displayed are corresponding to the highlighted item in the Analysis Event panel.

Analysis - Typical Span		🔔 Analysis
<ul> <li>Analysis Event</li> <li>Typical Span</li> <li>GIRDER-SYSTEM MEMBERS</li> <li>G1 [Outer Girder]</li> <li>G2 [Inner Girder]</li> <li>G3 [Center Girder]</li> </ul>	Info - Generating model domain for line girder analysis Info - G3: Center Girder User-defined Std live load distribution factors will used. Info - Finished generating model domain for line girder analysis Info - Capacities determined using AASHTO Std Specifications 17th Edition Info - Ratings determined using AASHTO MBE Specifications 3rd Edition, 20 Interims Error - No vehicle has been defined for live load analysis! Error - Line girder engine validation failed! Error - Analysis failed!	
😵 G4 [Inner Girder]	S Errors A Warnings	message
8 G5 [Outer Girder]	Type Description	
Analysis Event	<ul> <li>Error - No vehicle has been defined for live load analysis!</li> <li>Error - Line girder engine validation failed!</li> <li>Error - Analysis failed!</li> </ul>	Ĵ

#### **Checking Data Integrity**

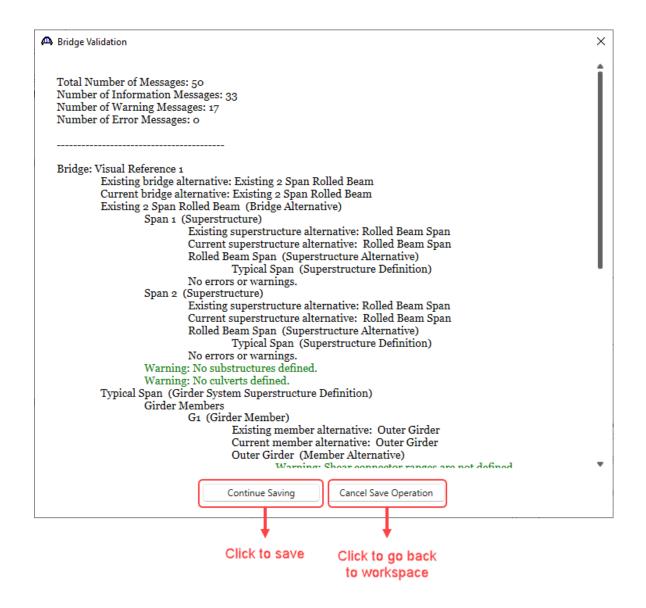
After completing data entry for a bridge, the next step is to check the data for missing components. In some cases, this may not be necessary, but in general practice, it is always good to ensure all the data is entered for bridge design or rating. To run the check, click on the **Validate** button from the **WORKSPACE** tab. The **Validation** tab will appear on the **Report** Window. This window will provide a summary of the bridge data that has been entered. It will also list a series of warnings regarding the data. If something is missing, it will be listed here. Use this as a guide to ensure data entry is complete.



#### Saving the Bridge Data

Once the data has been entered and verified, click on the **Save** button from the **WORKSPACE** tab to save the data. If the bridge workspace is closed before saving, AASHTOWare Bridge Design and Rating will prompt to save the data. Before saving, AASHTOWare Bridge Design and Rating will validate the data and ask if you want to continue.

? – D 🗙 🔭 1. Click to close	Bridge Workspace - Visual Reference 1	ANALYSIS	REPORTS
Bridge Design & Rating	BRIDGE WORKSPACE WORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING
Save changes to Visual Reference 1?	🗥 Check Out 💣 📳 🚳 Restore 🕱 🎸		🗋 📬 📋
Yes No Cancel	Check In Validate Save Revert Close Export		New Copy Paste [
↓ × × 2. Saved	Bridge		Manage



AASHTOWare BrDR 7.5.1 Library Tutorial LIB1 - Libraries

#### LIB1 – Libraries

#### Library Concepts

The libraries of BrDR allow for the description of items that are standardized or used frequently in the description of a bridge or by analysis events. The libraries of BrDR currently define the following items:

- Appurtenances (parapets, medians, railings, etc.)
- Connectors (bolts, nails)
- Corrugated Metal Panel
- Factors
- LRFD DF Applicability Ranges
- LRFD Substructure Design Settings
- Materials (steel, concrete, etc.)
- Metal Box Culvert
- Metal Pipe Culvert (corrugated, spiral rib, structural plate)
- Prestress Shapes
- Steel Shapes
- Timber Shapes
- Vehicles

BrDR is pre-loaded with library items selected by AASHTO. These items were taken from various sources including the following:

- AASHTO LRFD Bridge Design Specifications
- AASHTO Manual for Bridge Evaluation
- AASHTO Standard Specifications for Highway Bridges
- AASHTO Standard Specifications for Transportation Materials
- AISC Manual of Steel Construction
- PCI Precast Prestressed Concrete Bridge Design Manual

#### LIB1 - Libraries

#### Library Types

Three types of library items:

Standard	Items added to database by AASHTO. Standard library items are not editable.
Agency	All items added to the library by a user.
User Defined	Only available for vehicles.

#### Using Library Data

Two methods to use library items:

- *Linking* Library item associated with a bridge component or analysis event. If the library item is modified, then the updated data is used by the bridge component or analysis event. (Factors, Vehicles, LRFD DF Applicability Ranges)
- Copying Data from library item copied from a library item to a bridge item. A change in the library item has no effect on bridge items that use data previously copied from library item. (Steel Shapes, PS Shapes, Timber Shapes, Factors, LRFD Substructure Design Settings, Materials, Appurtenances, Connections, Corrugated Metal Panel)

Linking is used to reduce amount of data stored in database for items that are unlikely to be modified.

#### Library Security

- Library access can be restricted for read, write, create, and delete access.
- Access restrictions apply to all libraries for a given user or group of users.
- Limit number of users with write, create, and delete access.
  - Reduce possibility of incorrect data.
  - Reduce duplicate items and inappropriate items.

#### LIB1 – Libraries

#### Library Explorer

The Library Explorer is used to navigate the various libraries. The tree control in the left pane organizes the libraries. The item selected in the tree control determines the library items to be listed in the right pane of the window.

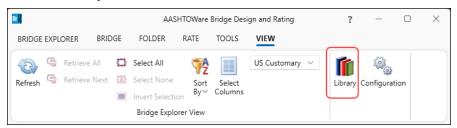
LIBRARY		AASHTOWare	Bridge Design and Rating	? - 🗆
RIDGE EXPLORER				
ew Duplicate Open Delete	-			
Manage				
Appurtenances	Library	Units	Name	Description
Generic	Standard	SI / Metric	Grade 250	AASHTO M270M Grade 250
🧭 Median 🧭 Parapet	Standard	SI / Metric	Grade 345	AASHTO M270M Grade 345
	Standard	SI / Metric	Grade 345W	AASHTO M270M Grade 345W
Connectors		SI / Metric	Grade 485W	AASHTO M270M Grade 485W
Bolt	Standard			
🧭 Nail Discorrugated Metal Panel	Standard	SI / Metric	Grade 690 <= 65 mm	AASHTO M270M Grade 690 up to 65 mm thick, inclusive
Factors	Standard	SI / Metric	Grade 690W <= 65 mm	AASHTO M270M Grade 690W up to 65 mm thick, inclusive
🧭 LFR	Standard	SI / Metric	Grade 690 - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive
LRFD	Standard	SI / Metric	Grade 690W - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive
LRFR     LRFD DF Applicability Ranges	Standard	US Customary	Grade 36	AASHTO M270 Grade 36
LRFD Substructure Design Settings	Standard	US Customary	Grade 50	AASHTO M270 Grade 50
Materials	Standard	US Customary	Grade 50W	AASHTO M270 Grade 50W
🧭 Aluminum 🗭 Concrete	Standard	US Customary	Grade 70W - Fu = 90 ksi	AASHTO M270 Grade 70W - Fu = 90 ksi
Prestress Bar	Standard	US Customary	Grade 70W - Fu = 85 ksi	AASHTO M270 Grade 70W - Fu = 85 ksi
Prestress Strand	Standard	US Customary	Grade 100 <= 2.5"	AASHTO M270 Grade 100 up to 2.5" thick, inclusive
Reinforcing Steel				· · · ·
📁 Soil 🔁 Structural Steel	Standard	US Customary	Grade 100W <= 2.5"	AASHTO M270 Grade 100W up to 2.5" thick, inclusive
E Diriber	Standard	US Customary	Grade 100 - > 2.5" to 4" incl.	AASHTO M270 Grade 100 - over 2.5" to 4" thick, inclusive
···· 🧭 Wearing Surface	Standard	US Customary	Grade 100W - > 2.5" to 4" incl.	AASHTO M270 Grade 100W - over 2.5" to 4" thick, inclusiv
Weld	Standard	US Customary	Prior to 1905	Built prior to 1905 - steel unknown
🞾 Metal Box Culvert 渣 Metal Pipe Culvert	Standard	US Customary	1905 to 1936	Built 1905 to 1936 - steel unknown
Corrugated Metal Pipe	Standard	US Customary	1936 to 1963	Built 1936 to 1963 - steel unknown
🖙 📁 Spiral Rib Metal Pipe	Standard	US Customary	After 1963	Built after 1963 - steel unkown
📁 Structural Plate Pipe Prestress Shapes	Standard	US Customary	AASHTO M 94(1961)	AASHTO M 94(1961) or ASTM A 7(1967)
Prestress Snapes     Box Beams	Standard	US Customary	AASHTO M 95(1961)	AASHTO M 95(1961) or ASTM A 94(1966)
I Beams	Standard	· · ·		
📁 Tee Beams		US Customary	AASHTO M 96(1961)	AASHTO M 96(1961) or ASTM A 8(1961)
📁 U Beams D Steel Shapes	Standard	US Customary	ASTM A94 - <= 1 1/8"	ASTM A 94 - 1 1/8" thick and under
- Steel Shapes - Ø Angle	Standard	US Customary	ASTM A94 - over 1 1/8" to 2" incl.	ASTM A 94 - over 1 1/8" to 2" thick, inclusive
- Channel	Standard	US Customary	ASTM A572 - 1 1/2" max., Fy = 45 ksi	ASTM A 572 - 1 1/2" thick max, Fy=45 ksi
🧭 Rolled Beam	Standard	US Customary	ASTM A572 - 1/2" max, Fy = 65 ksi	ASTM A 572 - 1/2" thick max, Fy=65 ksi
Tee	Standard	US Customary	ASTM A514 - over 2 1/2" to 4" incl.	ASTM A 514 - over 2 1/2" to 4" thick, inclusive
Timber Shapes Ø Rectangular	Standard	US Customary	ASTM A242 - <= 3/4"	ASTM A 242 - 3/4" thick and under
Vehicles	Standard	US Customary	ASTM A440 - <= 3/4"	ASTM A 440 - 3/4" thick and under
📁 Non Standard Gage				

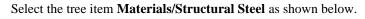
#### LIB1 - Libraries

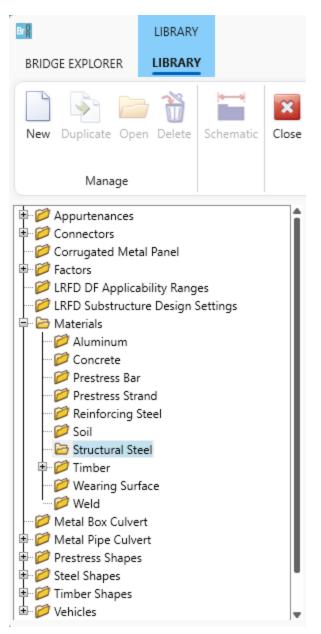
#### Exercise

Add Steel Material Library Item

1. Click the **Library** button under the **VIEW** tab in the ribbon.







2. Click the **New** button in the ribbon. A **Materials: Structural Steel: New Item** window will appear in the panel below the list of Standard library items.

LIBRARY		AASHTOWare	e Bridge Design and Rating	? — 🗆
BRIDGE EXPLORER				
New Duplicate Open Delete Schematic Close				
Manage				
2 Appurtenances	Library	Units	Name	Description
🧭 Connectors 🎾 Corrugated Metal Panel	Standard	SI / Metric	Grade 250	AASHTO M270M Grade 250
Pactors	Standard	SI / Metric	Grade 345	AASHTO M270M Grade 345
ERFD DF Applicability Ranges	Standard	SI / Metric	Grade 345W	AASHTO M270M Grade 345W
General Content of Content o	Standard	SI / Metric	Grade 485W	AASHTO M270M Grade 485W
🎾 Aluminum	Standard	SI / Metric	Grade 690 <= 65 mm	AASHTO M270M Grade 690 up to 65 mm thick, inclu
🧭 Concrete 📂 Prestress Bar	Standard	SI / Metric	Grade 690W <= 65 mm	AASHTO M270M Grade 690W up to 65 mm thick, inc
Prestress Bar     Prestress Strand	Standard	SI / Metric	Grade 690 - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive
🧭 Reinforcing Steel	Standard	SI / Metric	Grade 690W - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive
Soil     Structural Steel     Structural Steel     Wearing Surface     Weld     Metal Box Culvert     Metal Box Culvert     Metal Pipe Culvert     Steel Shapes     Steel Shapes     Timber Shapes     Vehicles				

3. Select the system of units using the radio buttons and then fill in the structural steel information as shown below. Note that the name must be unique among all structural steel library items.

Description:	TO M270 50W				
				O US SI	Standard O Agency defined
Material properties					
Specified minimum y	yield strength (Fy):	50.000	ksi		
Specified minimum to	tensile strength (Fu):	70.000	ksi		
Coefficient of therma	al expansion:	0.0000065000	1/F		
Density:		0.4000			
Modulus of elasticity		0.4900	kcf		

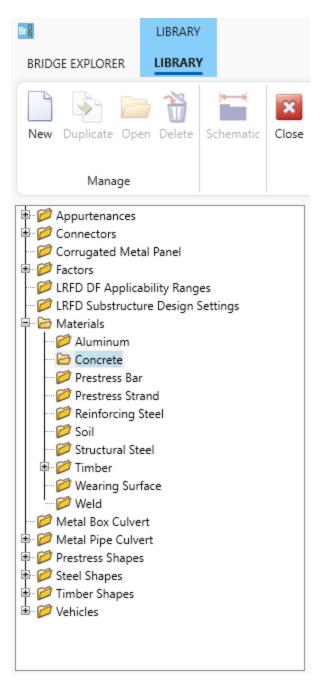
4. Click **Save**. The new structural steel material will now be listed in the right pane of the Library Explorer for the tree items **Materials/Structural Steel** as an Agency Defined item.

BRIDGE EXPLORER       LIBRARY         New       Duplicate       Open       Delete       Schematic       Close         New       Duplicate       Open       Delete       Schematic       Close         Orall       Close       Close       Close       Close         Orall       Close       Standard       US Customary       ASTM A588 - > 4" to 5" incl.       ASTM A 588 - over 4" to 5" thick, inclusive         Conceptors       Standard       US Customary       ASTM A572 - 11/2" max, Fy = 55       ASTM A 572 - 11/2" thick max, Fy=55 ksi         Check DF Applicability Ranges       Standard       US Customary       ASTM A572 - 11/2" to 4" incl.       ASTM A 441 - over 11/2" to 4" thick, inclusive         Materials       Standard       US Customary       ASTM A41 - 11/2" to 4" incl.       ASTM A 572 - over 11/2" to 4" thick, inclusive         Standard       US Customary       ASTM A572 - 11/2" to 4" incl.       ASTM A 572 - over 11/2" to 4" thick, inclusive         Standard       US Customary       ASTM A572 - 11/2" to 4" incl.       ASTM A 572 - over 11/2" to		-		?				Design and Rating	ASHTOWare Br			Y	LIBRARY	
Liew       Duplicate       Open       Delete       Schematic       Close         Manage       Manage       Manage       Manage       Manage       Manage         Appurtenances       Connectors       Standard       US Customary       ASTM A588 - > 4" to 5" incl.       ASTM A588 - over 4" to 5" thick, inclusive         Factors       Standard       US Customary       ASTM A572 - 11/2" max, Fy = 55       ASTM A572 - 11/2" thick max, Fy=55 ksi         IRFD Substructure Design Settings       Standard       US Customary       ASTM A572 - 1" max, Fy = 60 ksi       ASTM A572 - 1" thick max, Fy=60 ksi         Aluminum       Concrete       Standard       US Customary       ASTM A440 - > 11/2" to 4" incl.       ASTM A440 - over 11/2" to 4" thick, inclusive         Standard       US Customary       ASTM A440 - > 11/2" to 4" incl.       ASTM A440 - over 11/2" to 4" thick, inclusive         Prestress Bar       Standard       US Customary       ASTM A572 - 1 1/2" to 4" incl.       ASTM A588 - over 4" to 8" thick, inclusive         Standard       US Customary       ASTM A440 - > 11/2" to 4" incl.       ASTM A440 - over 11/2" to 4" thick, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A588 - over 4" to 8" thick, inclusive         Standard       US Customary       ASTM A4441 - > 11/2" to 4" incl.       ASTM A5												Y	LIBRAR	IDGE EXPLORER
Appurtenances       Library       Units       Name       Description         Connectors       Connectors       Standard       US Customary       ASTM A588 - > 4" to 5" incl.       ASTM A 588 - over 4" to 5" thick, inclusive         Factors       Standard       US Customary       ASTM A588 - > 4" to 5" incl.       ASTM A 588 - over 4" to 5" thick, inclusive         IRFD Dsburtucture Design Settings       Standard       US Customary       ASTM A572 - 1 1/2" max, Fy = 60 ksi       ASTM A 572 - 1 1/2" to 4" thick max, Fy=55 ksi         Standard       US Customary       ASTM A572 - 1 1/2" to 4" incl.       ASTM A 572 - 0 ver 1 1/2" to 4" thick, inclusive         Materials       Standard       US Customary       ASTM A440 - > 1 1/2" to 4" incl.       ASTM A 440 - over 1 1/2" to 4" thick, inclusive         Concrete       Prestress Bar       Standard       US Customary       ASTM A572 - 2 in 1/2" to 4" incl.       ASTM A 572 - 0 ver 1 1/2" to 4" thick, inclusive         Standard       US Customary       ASTM A440 - > 1 1/2" to 4" incl.       ASTM A440 - over 1 1/2" to 4" thick, inclusive         Prestress Bar       Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 588 - over 4" to 8" thick, inclusive         Standard       US Customary<												Schematic	en Delete	ew Duplicate Ope
Connectors       Distury       Distury       ASTM A588 - > 4" to 5" incl.       ASTM A 588 - over 4" to 5" thick, inclusive         Corrugated Metal Panel       Standard       US Customary       ASTM A588 - > 4" to 5" incl.       ASTM A 588 - over 4" to 5" thick, inclusive         Factors       LRFD DF Applicability Ranges       Standard       US Customary       ASTM A572 - 1 1/2" max, Fy = 55       ASTM A 588 - over 4" to 5" thick, inclusive         Materials       Standard       US Customary       ASTM A572 - 1 1/2" to 4" incl.       ASTM A 40 - over 1 1/2" to 4" thick, inclusive         Concrete       Standard       US Customary       ASTM A440 - > 1 1/2" to 4" incl.       ASTM A 440 - over 1 1/2" to 4" thick, inclusive         Prestress Bar       Standard       US Customary       ASTM A572 - > 1 1/2" to 4" thick, inclusive         Standard       US Customary       ASTM A441 - > 1 1/2" to 4" incl.       ASTM A 441 - over 1 1/2" to 4" thick, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A441 - > 11/2" to 4" thick, inclusive       Standard       US Customary         Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" incl. </td <td></td> <td>Manage</td>														Manage
Corrugated Metal Panel       Standard       US Customary       ASTM A366 - 2 4 to 3 mCl.       ASTM A366 - over 4 to 3 mLc.       ASTM A566 - over 4 to 4 mLc.       ASTM A566 - over 4 to 4 mLc.       ASTM A566 - over						scription		Name	its	Library				
Factors       Standard       US Customary       ASTM A572 - 1 1/2" max, Fy = 55       ASTM A 572 - 1 1/2" tick max, Fy=55 ksi         LRFD Dr Applicability Ranges       Standard       US Customary       ASTM A572 - 1 1/2" tick max, Fy=50 ksi       ASTM A 572 - 1 1/2" tick max, Fy=55 ksi         LRFD Ds Usbructure Design Settings       Standard       US Customary       ASTM A572 - 1 1/2" to 4" tinck.       ASTM A 472 - 0 ver 1 1/2" to 4" tinck.       ASTM A 422 - 0 ver 1 1/2" to 4" tinck.       ASTM A 422 - 0 ver 1 1/2" to 4" tinck.       ASTM A 440 - 0 ver 1 1/2" to 4" tinck.       ASTM A 440 - 0 ver 1 1/2" to 4" tinck.       ASTM A 441 - 0 ver 1 1/2" to 4" tinck.       ASTM A 441 - 0 ver 1 1/2" to 4" tinck.       ASTM A 441 - 0 ver 1 1/2" to 4" tinck.       ASTM A 441 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 441 - 0 ver 1 1/2" to 4" tinck.       ASTM A 441 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.       ASTM A 572 - 0 ver 1 1/2" to 4" tinck.<		lusive	inclu	5" thick, in	4" to 5	FM A 588 - over	l.	ASTM A588 - > 4" to 5" incl.	Customary	Standard			- De se al	
LRFD Substructure Design Settings       Standard       US Customary       ASTM A242 - > 11/2" to 4" incl.       ASTM A 242 - over 1 1/2" to 4" thick, inclusi         Materials       Standard       US Customary       ASTM A440 - > 1 1/2" to 4" incl.       ASTM A 440 - over 1 1/2" to 4" thick, inclusi         Prestress Bar       Standard       US Customary       ASTM A441 - > 1 1/2" to 4" incl.       ASTM A 441 - over 1 1/2" to 4" thick, inclusi         Prestress Strand       Standard       US Customary       ASTM A441 - > 1 1/2" to 4" incl.       ASTM A 572 - over 1 1/2" to 4" thick, inclusive         Standard       US Customary       ASTM A572 - > 1 1/2" to 4" incl.       ASTM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 441 - over 4" to 8" thick, inclusive         Standard       US Customary       ASTM A36       ASTM A 36         Timber       Standard       US Customary       ASTM A441 - > 4" to 8" incl.         Wearing Surface       Standard       US Customary       ASTM A441 - > 4" to 8" incl.         Metal Box Culvert       Standard       US Customary       ASTM A441 - > 4" to 8" incl.         Metal Pipe Culvert       Standard       US Customary		i5 ksi	=55	k max, Fy=	2" thick	FM A 572 - 1 1/2	y = 55	ASTM A572 - 1 1/2" max, Fy =	Customary	Standard			ai Panei	
Materials       Standard       US Customary       ASIM A242 - S 1 1/2" to 4" incl.       ASIM A 242 - over 1 1/2" to 4" incl.         Aluminum       Standard       US Customary       ASIM A440 - S 1 1/2" to 4" incl.       ASIM A 242 - over 1 1/2" to 4" incl.         Concrete       Standard       US Customary       ASIM A440 - S 1 1/2" to 4" incl.       ASIM A 441 - over 1 1/2" to 4" thick, inclusis         Prestress Bar       Standard       US Customary       ASIM A441 - S 1 1/2" to 4" incl.       ASIM A 572 - over 1 1/2" to 4" thick, inclusis         Standard       US Customary       ASIM A441 - S 1 1/2" to 4" incl.       ASIM A 588 - over 5" to 8" thick, inclusive         Prestress Strand       Standard       US Customary       ASIM A588 - S" to 8" incl.       ASIM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASIM A588 - S" to 8" incl.       ASIM A 588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASIM A588       ASHTO M188       AASHTO M188 or ASIM A441 - v4" to 8" thick, inclusive         Standard       US Customary       ASIM A36       ASIM A 441 - over 4" to 8" thick, inclusive         Wearing Surface       Standard       US Customary       ASIM A441 - v4" to 8" incl.       ASIM A441 - over 4" to 8" thick, inclusive         Metal Box Culvert       Standard       US Customary       ASIM A441 - v4" to 8"		si	ksi	ax, Fy=60 k	nick ma	TM A 572 - 1" th	50 ksi	ASTM A572 - 1" max, Fy = 60	Customary	Standard				
Aluminum       Standard       US Customary       ASTM A440 - > 1 1/2" to 4" incl.       ASTM A 440 - over 1 1/2" to 4" incl.         Concrete       Prestress Bar       Standard       US Customary       ASTM A441 - > 1 1/2" to 4" incl.       ASTM A 441 - over 1 1/2" to 4" incl.         Prestress Bar       Standard       US Customary       ASTM A441 - > 1 1/2" to 4" incl.       ASTM A 441 - over 1 1/2" to 4" incl.       ASTM A 441 - over 1 1/2" to 4" incl.         Prestress Strand       Standard       US Customary       ASTM A572 - > 1 1/2" to 4" incl.       ASTM A 572 - over 1 1/2" to 4" thick, inclusive         Solid       Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 588 - over 5" to 8" thick, inclusive         Solid       Standard       US Customary       ASTM A588 - > 5" to 8" incl.       ASTM A 441 - over 4" to 8" thick, inclusive         Wearing Surface       Standard       US Customary       ASTM A441 - > 4" to 8" incl.       ASTM A 441 - over 4" to 8" thick, inclusive         Wearing Surface       Standard       US Customary       ASTM A441 - > 4" to 8" incl.       ASTM A 441 - over 4" to 8" thick, inclusive         Metail Box Culvert       Standard       US Customary       ASTM A588 - <= 3/4", Fy = 50 ksi	ive	, inclusiv	ick, i	" to 4" thic	1 1/2"	TM A 242 - over	incl.	ASTM A242 - > 1 1/2" to 4" in	Customary	Standard		Settings	ire Design	
Prestress Bar       Standard       US Customary       ASTM A441 - 5 + 1/2 to 4 incl.       ASTM A441 - 5 ver 1 1/2 ito 4 incl.         Prestress Strand       Standard       US Customary       ASTM A572 - 5 11/2" to 4" incl.       ASTM A572 - over 1 1/2" to 4" thick, inclusive         Prestress Strand       Standard       US Customary       ASTM A572 - 5 11/2" to 4" incl.       ASTM A572 - over 1 1/2" to 4" thick, inclusive         Solid       Standard       US Customary       ASTM A588 - 5" to 8" incl.       ASTM A588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A588 - 5" to 8" incl.       ASTM A588 - over 5" to 8" thick, inclusive         Standard       US Customary       ASTM A441 - 5" to 8" incl.       ASTM A588 - over 4" to 8" thick, inclusive         Standard       US Customary       ASTM A36       ASTM A36         Wearing Surface       Standard       US Customary       ASTM A441 - 5" to 8" incl.       ASTM A441 - over 4" to 8" thick, inclusive         Metal Box Culvert       Standard       US Customary       ASTM A441 - 5" to 8" incl.       ASTM A572 - 3/4" and under, Fy=50 ksi         Metal Pipe Culvert       Standard       US Customary       ASTM A588 - 4", Fy = 50 ksi       ASTM A588 - 4" and under, Fy=50 ksi	ive	, inclusiv	ick, i	" to 4" thic	1 1/2"	TM A 440 - over	incl.	ASTM A440 - > 1 1/2" to 4" ir	Customary	Standard				
Prestress Strand       JS Customary       ASTM A572 - > 11/2" to 4" tincl.       ASTM A 572 - over 11/2" to 4" tinck, inclusive         Prestress Strand       Standard       US Customary       ASTM A572 - > 11/2" to 4" tinck, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" tinck, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" tinck, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" tinck, inclusive         Standard       US Customary       ASTM A588 - > 5" to 8" tinck, inclusive         Standard       US Customary       ASTM A36       ASTM A 36         Wearing Surface       Standard       US Customary       ASTM A441 - > 4" to 8" tincl.       ASTM A441 - over 4" to 8" tinck, inclusive         Weala Box Culvert       Standard       US Customary       ASTM A572 -        ASTM A572 - 3/4" and under, Fy=50 ksi         Metal Pipe Culvert       Standard       US Customary       ASTM A588 - <= 4", Fy = 50 ksi	ive	, inclusiv	ick, i	" to 4" thic	1 1/2"	TM A 441 - over	incl.	ASTM A441 - > 1 1/2" to 4" ir	Customary	Standard				
Peinforcing Steel       Standard       US Customary       ASTM A588 - >5" to 8" incl.       ASTM A588 - over 5" to 8" thick, inclusive         Soil       Standard       US Customary       AASHTO M188       AASHTO M188 or ASTM A 441 - >4" to 8" thick, inclusive         Standard       US Customary       ASTM A36       ASTM A 36         Waring Surface       Standard       US Customary       ASTM A441 - >4" to 8" incl.       ASTM A 441 - over 4" to 8" thick, inclusive         Metal Box Culvert       Standard       US Customary       ASTM A572 - <= 3/4", Fy = 50 ksi	ive	, inclusiv	ick, i	" to 4" thic	1 1/2"	TM A 572 - over	incl.	ASTM A572 - > 1 1/2" to 4" in	Customary	Standard				
Standard       US Customary       AASHTO M188       AASHTO M188       AASHTO M188 or ASTM A 441 ->4" to 8"		lusive	inclu	8" thick, in	5" to 8	TM A 588 - over	I	ASTM A588 - > 5" to 8" incl.	Customary	Standard				Preinforcing
Implement     Standard     US Customary     ASTM A36     ASTM A 36       Wearing Surface     Standard     US Customary     ASTM A41 - > 4" to 8" incl.     ASTM A 441 - over 4" to 8" thick, inclusive       Metal Box Culvert     Standard     US Customary     ASTM A572 - <= 3/4", Fy = 50 ksi	thick, incl	" to 8" th	>4"	1 A 441- >4	ASTM	SHTO M 188 or		AASHTO M188	Customary	Standard				
Weld         Standard         Obscussionary         ASTM AF72 - 4 do mich         ASTM AF72 - 4 do mich           Metal Box Culvert         Standard         US Customary         ASTM AF72 - 4 do mich         ASTM AF72 - 3/4* and under, Fy=50 ksi           Metal Pipe Culvert         Standard         US Customary         ASTM A588 - 4*, Fy = 50 ksi         ASTM A588 - 4* and under, Fy=50 ksi						FM A 36		ASTM A36	Customary	Standard			eei	
Metal Box Culvert         Standard         US Customary         ASTM A572 - <= 3/4*, Fy = 50 ksi         ASTM A572 - 3/4* and under, Fy=50 ksi           Metal Pipe Culvert         Standard         US customary         ASTM A588 - <= 4*, Fy = 50 ksi		lusive	inclu	8" thick, in	4" to 8	TM A 441 - over	I	ASTM A441 - > 4" to 8" incl.	Customary	Standard			face	
Metal Pipe Culvert     Standard     US Customary     ASTM A588 - <= 4", Fy = 50 ksi     ASTM A588 - 4" and under, Fy=50 ksi		ksi	50 k	nder, Fy=5	and un	TM A572 - 3/4" a	50 ksi	ASTM A572 - <= 3/4", Fy = 50	Customary	Standard				
Prestrare Shaner		si	) ksi	ler, Fy=50 k	nd unde	TM A588 - 4" an	0 ksi	ASTM A588 - <= 4", Fy = 50 k	Customary	Standard				
		50")	0.25	s 0.176"-0.	ickness	uctural plate (thi		Steel - Corrugated	Customary	Standard			5	Prestress Shapes
✓ Steel Shapes     ✓ Timber Shapes     ✓ Agency Defined     US Customary     Steel 1     AASHTO M270 50W			_						Customary	Agency Defined	C			Timber Shapes

#### LIB1 - Libraries

#### Add Concrete Material Library Item

1. Select the tree item Materials/Concrete as shown below.



2. Click the **New** button in the ribbon. A **Materials: Concrete: New Item** window will appear in the panel below the list of Standard library items.

2 <b>R</b>	LIBRARY			AASHTOWare Br	idge Design and Rating		?	-		×
BRIDGE EXPLORER	LIBRARY									
New Duplicate Op	en Delete Sche	ematic Close								
Appurtenances			Library	Units	Name	Description				
⊖ Ø Connectors Ø Corrugated Met	al Danel		Standard	SI / Metric	Class A	Class A cement concrete				
Factors	airailei		Standard	SI / Metric	Class B	Class B cement concrete				
LRFD DF Applica			Standard	SI / Metric	Class C	Class C cement concrete				
- 📁 LRFD Substructu	ire Design Setting	gs	Standard	US Customary	Class A (US)	Class A cement concrete				
🧭 Aluminum			Standard	US Customary	Class B (US)	Class B cement concrete	oncrete			
🗁 Concrete			Standard	US Customary	Class C (US)	Class C cement concrete				
Prestress Ba			Agency	US Customary	PS 6.5 ksi	PS 6.5 ksi (f'ci=5.5 ksi)				
Reinforcing :     Soil     Soil     Wearing Structural St     Wearing Sur     Wed     Metal Box Culve     Metal Box Culve     Metal Box Shape     Steel Shapes     Timber Shapes     Vehicles	eel face ert									

3. Select the system of units using the radio buttons and then fill in the concrete information as shown below. Note that the name must be unique among all concrete library items.

Name: F	PS 6.5 ksi			Store units as	Library
Description:	PS 6.5 ksi (f'ci=5.5 ksi)			O US SI	Standard O Agency defined
Specified comp	pressive strength at 28 days (f'c):	6.500	ksi		
Initial compres	sive strength (f'ci):	5.500	ksi		
Composition o	f concrete:	Normal ~			
Density (for de	ad loads):	0.150	kcf		
Density (for mo	odulus of elasticity):	0.150	kcf		
Poisson's ratio:		0.200			
Coefficient of t	hermal expansion:	0.000060000	1/F		
Splitting tensile	e strength (fct):		ksi		
LRFD maximum	n aggregate size:		in		
	Compute				
Std modulus of	f elasticity (Ec):		ksi		
LRFD modulus	of elasticity (Ec):		ksi		
Std initial mode	ulus of elasticity:		ksi		
LRFD initial mo	dulus of elasticity:		ksi		
Std modulus of	f rupture:		ksi		
LRFD modulus	of rupture:		ksi		
Shear factor:		1.000			

#### LIB1 - Libraries

4. Click the **Compute** button to calculate the remaining properties or manually enter the values.

Materials: Concrete: New Item				×
Name: PS 6.5 ksi PS 6.5 ksi (f'ci = 5.5 ksi)			Store units as	LibraryStandard
Description:			SI	O Agency defined
Specified compressive strength at 28 days (f'c):	6.5	ksi		
Initial compressive strength (f'ci):	5.5	ksi		
Composition of concrete:	Normal $\checkmark$			
Density (for dead loads):	0.15	kcf		
Density (for modulus of elasticity):	0.15	kcf		
Poisson's ratio:	0.2			
Coefficient of thermal expansion:	0.000006	1/F		
Splitting tensile strength (fct):		ksi		
LRFD maximum aggregate size:		in		
Compute				
Std modulus of elasticity (Ec):	4887.73337	ksi		
LRFD modulus of elasticity (Ec):	5007.548587	ksi		
Std initial modulus of elasticity:	4496.060776	ksi		
LRFD initial modulus of elasticity:	4738.96446	ksi		
Std modulus of rupture:	0.604669	ksi		
LRFD modulus of rupture:	0.611882	ksi		
Shear factor:	1	]		
				Save Close

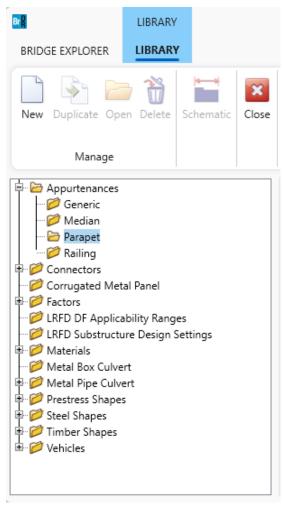
5. Click **Save**. The new concrete material will now be listed in the right pane of the Library Explorer for the tree items **Materials/Concrete** as an Agency Defined item.

Br 🖁	LIBRARY		AASHTOWare Brid	lge Design and Rating	?	?	-	×
BRIDGE EXPLORER	LIBRARY							
New Duplicate Ope	Delete Schematic	Close						
Appurtenances		Library	Units	Name	Description			
Connectors	l Panel	Standard	SI / Metric	Class A	Class A cement concrete			
Factors		Standard	SI / Metric	Class B	Class B cement concrete			
LRFD DF Applical		Standard	SI / Metric	Class C	Class C cement concrete			
E CRFD Substructur	re Design Settings	Standard	US Customary	Class A (US)	Class A cement concrete			
📁 Aluminum		Standard	US Customary	Class B (US)	Class B cement concrete			
Concrete		Standard	US Customary	Class C (US)	Class C cement concrete			
Prestress Bar		> Agency Defined	US Customary	PS 6.5 ksi	PS 6.5 ksi (f'ci = 5.5 ksi)			
Reinforcing S	teel				,			
🗁 Structural Ste	el							

#### LIB1 - Libraries

#### Add Parapet Library Item

1. Select the tree item **Appurtenances/Parapet** as shown below.



2. Click the **New** button in the ribbon. An **Appurtenances: Parapet: New Item** window will appear in the panel below the list of Standard library items.

<b>BR :</b>	LIBRARY				AASHTOWare B	ridge Design and Rating	?	-	×
BRIDGE EXPLORER	LIBRARY								
New Duplicate Ope	en Delete	Schematic	Close						
P D Appurtenances				Library	Units	Name	Description		
Generic Median				Agency	US Customary	Jersey Barrier	Standard New Jersey Barrier		
Concectors     Connectors     Concectors     Concugated Met     Concugated Met     Concugated Met     Concugated Met     Concugated Met     Materials     Metal Box Culve     Metal Box Culve     Metal Box Culve     Perstress Shapes     Step Shapes     Concugated Metal     Vehicles	ability Range ire Design S rt ert								

#### LIB1 – Libraries

3. Select the system of units using the radio buttons and then fill in the parapet information as shown below. Note that the name must be unique among all parapet library items.

Name: Description:	Parapet 1 Standard Jersey Barrier All dimensions are in inches		Store units as US SI SI
ŗ		kip/ft Roadway Surface	Parapet unit load: 0.150 kcf Calculated properties Net centroid (from reference line): 7.880 in Total load: 0.505 kip/ft

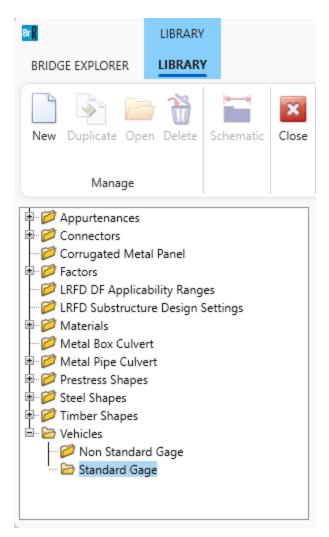
4. Click **Save**. The new parapet will now be listed in the right pane of the Library Explorer for the tree items **Appurtenances/Parapet** as an Agency Defined item.

BRIDGE EXPLORER	LIBRARY					AASHTOWare Brid	ge Design and Rating		?	-	×
New Duplicate Ope	n Delete	Schematic	Clos	-							
Appurtenances     Appurtenances     Generic     Median     Parapet     Parapet     Corrugated Meta     Factors     CARD DF Applica     LRFD DF Applica     Materials     Materials     Metal Pipe Culve     Metal Pipe Culve     Steel Shapes     Steel Shapes     Vehicles	bility Rang re Design S rt :rt			>	Library Agency Defined Agency Defined	Units US Customary US Customary	Name Jersey Barrier Parapet 1	Description Standard New Jer Standard Jersey B	 rier		

#### LIB1 - Libraries

#### Add Vehicle Library Item

1. Select the tree item Vehicles/Standard Gage as shown below.



2. Click the New button in the ribbon. A Vehicle: Standard Gage: New Item window will appear.

							•	
R	LIBRARY				AASHTOWare Br	idge Design and Rating	? –	
BRIDGE EXPLORER	LIBRARY							
New Duplicate Ope	n Delete	Schematic	Close					
- 🧭 Appurtenances	1			Library	Units	Name	Description	
Connectors     Corrugated Metal Panel     Corrugated Metal Panel     Factors     LFFD DF Applicability Ranges     LFFD DF Substructure Design Settings				Standard	SI / Metric	HL-93 (SI)	AASHTO LRFD Live Load - SI unit system	Т
				Standard	US Customary	HL-93 (US)	AASHTO LRFD Live Load - US unit system	
				Standard	US Customary	HS 20-44	AASHTO H 20-S 16 Loading, 1944 Edition	
- 🧭 LKFD Substructu	re Design 5	ettings		Standard	US Customary	HS 15-44	AASHTO H 15-S 12 Loading, 1944 Edition	
🧭 Metal Box Culver				Standard	US Customary	H 20-44	AASHTO H 20 Loading, 1944 Edition	
- 📁 Metal Pipe Culve - 📁 Prestress Shapes				Standard	US Customary	H 15-44	AASHTO H 15 Loading, 1994 Edition	
🧭 Steel Shapes				Standard	US Customary	Туре 3	AASHTO Type 3	
				osculonary	l ibe 2			

3. Select the system of units using the radio buttons and then fill in the vehicle information as shown below for all items not on the tab control. Note that the name must be unique among all vehicle library items. The checkboxes inside the **Design** and **Rating** groups are used to filter the vehicle during an analysis event based on the type of event and the type of analysis engine selected. The **Vehicle Library** has a library type called **User Defined**. This library allows users to add their own vehicles.

Nan	ne:	Vehi	:le 1					inits as	Library
Des	cript		HTO H20-16 Loa	ading, 1944 Editi	ion				Standard Agency defined User defined
Tr	uck	Tanden	n Lane						
		Axle no.	Axle Ioad (kip)	Gage dist. (ft)	Wheel contact width	Ax spac (fi	ing		Rating
			(mp)	(14)	(in)	Minimum	Maximum		ASR/LFR
	>	1	8.00	6.00	10.0000			-	LRFR
		2	32.00	6.00	20.0000	14.00	14.00		Design
		3	32.00	6.00	20.0000	14.00	30.00	Ŧ	✓ LRFD ASD/LFD
		Totals: 7	2.0 kip		28.	New	44.00 Duplicate D	elete	

- 4. Click the **New** button to add an axle to the vehicle.
- 5. Enter the first axle's dimensions. (Axle spacing is not applicable for the first axle.)
- 6. Repeat steps 4 and 5 for each additional axle.
- 7. Select the Lane Tab. Enter data on the Lane tab as shown below.

#### LIB1 – Libraries

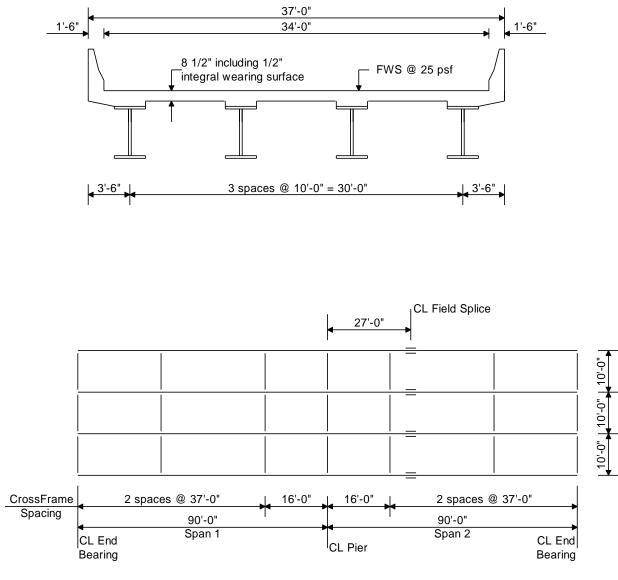
ame:	Vehicle 1			Store units a	,
escription:	AASHTO H20-16 Loading	, 1944 Edition		US SI	Standard Agency defined User defined
Truck T	Fandem Lane				
— Load r	per axle line				Notional vehicl
	rm lane load:	0.640	kip/ft		Rating
Conce	entrated load for moment:	18.0	kip		LRFD     ASR/LFR
Conce	entrated load for shear:	26.0	kip		
one	a second, equal magnitude other span to determine m nent for continuous spans				Design LRFD ASD/LFD

8. Click **Save**. The new vehicle will now be listed in the right pane of the Library Explorer for the tree items **Vehicles/Standard Gage**.

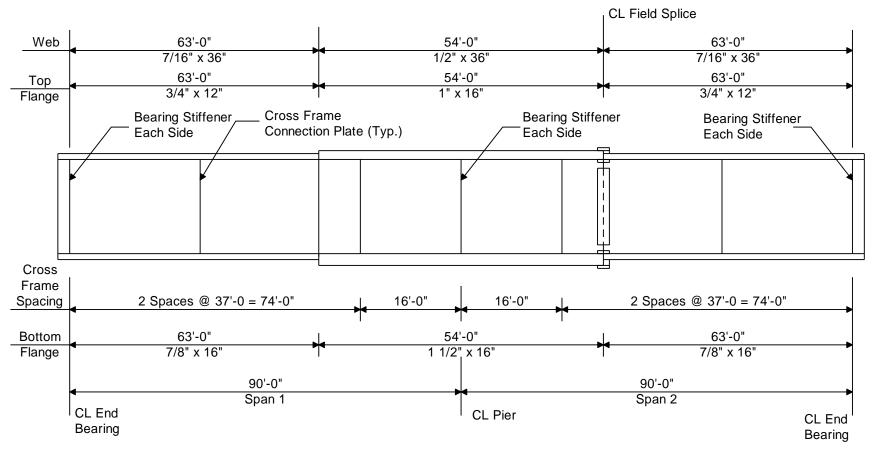
Br	LIBRARY				AASHTOWare B	ridge Design and Rating	? – 🗆	×										
BRIDGE EXPLORER	LIBRARY																	
New Duplicate Ope	n Delete	Schematic	Close															
Appurtenances				Library	Units	Name	Description											
Connectors     Orrugated Meta	igated Metal Panel Standard Standard Standard		US Customary	SU4	SU4 - Single-Unit Bridge Posting Loads	1												
Factors				Standard	US Customary	SU5	SU5 - Single-Unit Bridge Posting Loads											
	IRFD DF Applicability Ranges IRFD Substructure Design Settings							Standard	US Customary	SU6	SU6 - Single-Unit Bridge Posting Loads							
🛛 📁 Materials	rt		ert		ert		ulvert		erials	x Culvert	ert	ulvert	als Box Culvert	laterials Standard US Customary SU7 SU7 - Single: letal Box Culvert Standard US Customary EV2 2 Axle FAST /	Jesign Settings		SU7 - Single-Unit Bridge Posting Loads	
🧭 Metal Box Culver ≣ 阿 Metal Pipe Culve																		
Prestress Shapes				Standard	US Customary	EV3	3 Axle FAST Act Emergency Vehicle 2016											
🕬 💋 Steel Shapes				Agency Defined	US Customary	Vehicle 1	AASHTO H20-16 Loading, 1944 Edition											
🖻 🗁 Vehicles	<ul> <li>✓ Timber Shapes</li> <li>➢ Vehicles</li> <li>→ Ø Non Standard Gage</li> <li>→ Standard Gage</li> </ul>																	

AASHTOWare BrDR 7.5.1 Steel Tutorial STL2 – Two Span Plate Girder Example



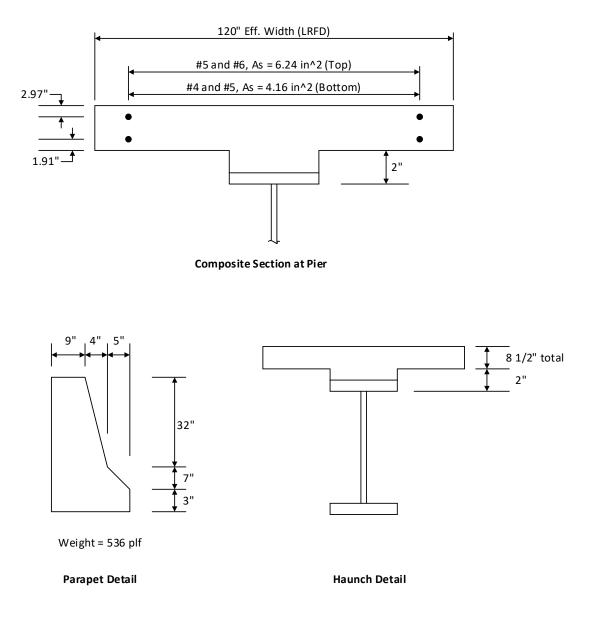


Framing Plan



**Elevation of Interior Girder** 

#### STL2 – Two Span Plate Girder Example



*Note: The area of steel is provided in the section at the pier but the number of #4, #5, and #6 bars are not provided. For simplicity, the bars will be input using an equivalent number of #9 bars which have a unit area of 1.0 in<sup>2</sup>.* 

#### **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"

#### STL2 – Two Span Plate Girder Example

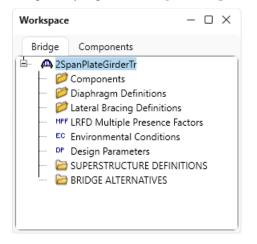
#### **BrDR** Tutorial

From the	Bridge	Explorer	create a Ne	w bridge a	nd enter the	e following	description	data

Bridge ID: ZpanPlateGirdeTr     NBI structure ID (B): P.GirdeTrBri     Bridge completely defined     Superstructures     Substructures     Substructures	🕰 2SpanPlateGirderTr						H.		×
Name:       2SpanPlateGirderTraining       Year built:         Description:       2 span continuous composite steel plate girder uses LRFD         Location:       Length:       180         Facility carried (7):       Route number:       -1         Feat. intersected (6):       Mi. post:          Default units:       US Customary       >	Bridge ID: 2SpanPlat	eGirderTr NBI	structure ID (8): PLGirderTrBri			etely defined	Superstr	uctures	
Description:     Location:     Length:     10     Feat. intersected (6):     Default units:   US Customary   US Customary     Bridge association     Bridge association     Bridge association     Bridge association	Description Desc	cription (cont'd) Alter	natives Global reference point	Traffic C	ustom agency fie	lds			
Description:   Location: Facility carried (7): Reat. intersected (6): Default units: US Customary US Customary US Customary Bridge association Br BrD BrM	Name:	2SpanPlateGirderTraini	ng		Year built:				
Facility carried (7): Route number: -1   Feat. intersected (6): Mi. post:    Default units:   US Customary V    Bridge association   Bridge association V    BrM	Description:	2 span continuous com	nposite steel plate girder uses LRFD						
Feat. intersected (6):     Default units:     US Customary     Bridge association     Bridge association     Br B	Location:				Length:	180	ft		
Default units: US Customary V Bridge association V BrR V BrD BrM	Facility carried (7):				Route number:	-1			
Bridge association	Feat. intersected (6):				Mi. post:				
	Default units:	US Customary	$\sim$						
OK Annly Cancel	Bridge associ	ation SrR	BrD BrM						
OK Apply Cancer						ОК	Apply	Cance	

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

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

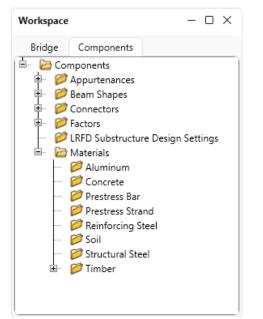


#### Bridge Components

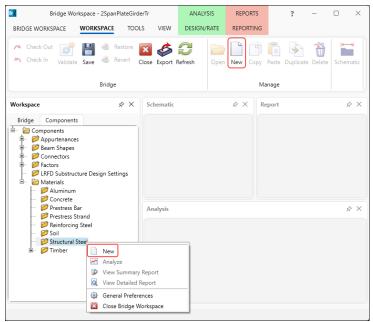
#### Bridge Materials

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

The tree with the expanded Materials branch is shown below.



To add a new steel material, in the **Components** tab of the **Bridge Workspace**, click on **Materials**, **Structural Steel**, and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Structural Steel** and select **New**). The window shown below will open.



		_		×
ksi				
ksi				
1/F				
kcf				
ksi				
r from library	OK	Apply	Cano	:el
	ksi 1/F kcf	ksi 1/F kcf ksi	ksi 1/F kcf ksi	ksi ksi l/F kcf ksi

Add the structural steel material by clicking the **Copy from library...** button. The following window opens. Select the **AASHTO M270 Grade 50W** material and click **OK**.

Name	Description	Library	Units	F
Grade 250	AASHTO M270M Grade 250	Standard	SI / Metric	
Grade 345	AASHTO M270M Grade 345	Standard	SI / Metric	
Grade 345W	AASHTO M270M Grade 345W	Standard	SI / Metric	
Grade 36	AASHTO M270 Grade 36	Standard	US Customary	36.00
Grade 485W	AASHTO M270M Grade 485W	Standard	SI / Metric	
Grade 50	AASHTO M270 Grade 50	Standard	US Customary	50.00
Grade 50W	AASHTO M270 Grade 50W	Standard	US Customary	50.00
Grade 690 - > 65 to 100 incl.	AASHTO M270M - over 65 to 100 mm thick, inclusive	Standard	SI / Metric	
Grade 690 <= 65 mm	AASHTO M270M Grade 690 up to 65 mm thick, inclusive	Standard	SI / Metric	
Grade 600W - > 65 to 100 incl	AASHTO M270M - over 65 to 100 mm thick inclusive	Standard	SI / Matric	

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

🗛 Bridge Ma	terials - Structural Steel				-		×
Name:	Grade 50W						
Description:	AASHTO M270 Grade 50W						
Material prop	perties						
Specified mir	nimum yield strength (Fy):	50.000073	ksi				
Specified mir	nimum tensile strength (Fu):	70.0000102	ksi				
Coefficient o	f thermal expansion:	0.0000065	1/F				
Density:		0.49	kcf				
Modulus of e	elasticity (E):	29000.004206	ksi				
	Copy to library	Copy from libra	ry	OK	Apply	Cance	4

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

Add the following reinforcing steel and concrete material using the same techniques.

🕰 Bridge Ma	terials - Reinforc	ing Steel					_		×
Name:	Grade 60								
Description:	60 ksi reinforci	ng steel							
Material prop	perties								
Specified yiel	ld strength (fy):	60.000087		ksi					
Modulus of e	elasticity (Es):	29000.00420	06	ksi					
Ultimate stre	ngth (Fu):	90.0000131		ksi					
Type Plain Epo Galv									
	Copy t	o library	Copy f	rom library	ОК	Apply		Cance	1

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

🗛 Bridge Mat	terials - Concrete			-		×
Name:	Class A (US)					
Description:	Class A cement concrete	e				
Compressive	strength at 28 days (f'c):	4.0000006	ksi			
Initial compre	essive strength (f'ci):		ksi			
Composition	of concrete:	Normal ~				
Density (for d	lead loads):	0.15	kcf			
Density (for n	nodulus of elasticity):	0.145	kcf			
Poisson's rati	0:	0.2				
Coefficient of	f thermal expansion (α):	0.000006	1/F			
Splitting tens	ile strength (fct):		ksi			
LRFD Maximu	um aggregate size:		in			
	Compute					
Std modulus	of elasticity (Ec):	3644.149254	ksi			
LRFD modulu	is of elasticity (Ec):	3986.548657	ksi			
Std initial mo	dulus of elasticity:		ksi			
LRFD initial m	nodulus of elasticity:		ksi			
Std modulus	of rupture:		ksi			
LRFD modulu	is of rupture:	0.479857	ksi			
Shear factor:		1	]			
	Copy t	to library Copy	from library OK Ap	ply	Cance	el

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

### Bridge Appurtenances

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

Bridge Wor	kspace - 2SpanPlate	eGirderTr	ANALYSIS	REPORTS	?	-		×
BRIDGE WORKSPACE	WORKSPACE	TOOLS VIEW	DESIGN/RATE	REPORTING				
A Check Out	Save 🔏 Resto	e 🛀	Refresh Open	New Copy	Paste Duplicat	) e Delete	Schema	etic
	Bridge			Ma	anage			
Workspace	\$2	X Schemati	c.	\$ × ₽	eport		Ś	×
Bridge Components								
- P Railing P P P Connector P P P Connector P P P Connector P P P P P Connector P P P P P P P P P P P P P P P P P P P	View Summary R View Detailed Re General Preferen	port ces					Ŷ	×

#### Enter the parapet details as shown below.

📣 Bridge Ap	purtenances - Parapet		-		×
Name:	Standard Parapet				
Description:					
	All dimensions are in inches				
	Additional load:	kip/ft	Parapet unit load:		
	4		0.15 kcf		
	9 5		Calculated properties		
R		Roadway Surface	Net centroid (from reference line):		
			6.397 in		
	32		Total load:		
			0.536 kip/ft		
	Back Front 🖡 3	<b>•</b>			
		Copy from library	OK Apply	Canc	el

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

The default standard LRFD and LFR factors will be used. Bridge alternatives will be added after entering the structure definition.

### Superstructure Definition

Returning to the **Bridge** tab of the **Bridge Workspace**, double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the **WORKSPACE** ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition. The window shown below will appear.

A New Superstructure Definition		×
Girder system superstructure Girder line superstructure	Superstructure definition wizard	
Floor system superstructure		
Truss system superstructure		
Truss line superstructure     Reinforced concrete slab system superstructure		
Concrete multi-cell box superstructure Advanced concrete multi-cell box superstructure		
	OK Cancel	

Select **Girder system superstructure**, click **OK** and the **Girder System Superstructure Definition** window will open.

	Specs Engine	2			
lame: 2	Span 4 Girder Syster	n			Modeling O Multi-girder system MCB
escription:					With frame structure simplified definit
	Customary V	Enter span lengths along the reference			Concrete Deck ~ For PS/PT only Average humidity:
lumber of spans: lumber of girders:	2 () 4 ()	line: Span Length (ft)			%
		>         1         90           2         90	A		Member alt. types Steel P/S R/C Timber
	along reference line		V		P/T
Horizontal curvature	ature [	Distance from PC to first support li	ne:	ft	
Horizontal curvature	lignment	tart tangent length:		ft	
Horizontal curva	igninen.				
Horizontal curva Superstructure a O Curved Tangent, cu	rved, tangent	Radius: Direction:	Left 🗸	ft	
Horizontal curva Superstructure a O Curved Tangent, cu Tangent, cu	rved, tangent C rved E		Left 🗸	ft ft	
Horizontal curva Superstructure a O Curved Tangent, cu	rved, tangent C rved E gent	Direction:			
Horizontal curva Superstructure a O Curved Tangent, cu Tangent, cu	rved, tangent C rved E gent C	Direction: and tangent length:		ft	
Horizontal curva Superstructure a O Curved Tangent, cu Tangent, cu	rved, tangent C rved E gent C	Direction: ind tangent length: Distance from last support line to P		ft ft	

Enter the data as shown below and click **Apply** to apply the data and keep the window open.

The **Analysis** tab is shown below with the default selections. For this example, the default values will not be overridden. No changes are required on this tab.

Structural slab thickness	Number of she	ell elements				
Consider structural slab thickness for rating	O In the de	ck between gird	lers			
Consider structural slab thickness for design	In the we	b between flan	ges			
	Slower			Faster		
Wearing surface	More accurate	2		Less accurate		
Consider wearing surface for rating				3 2 1		
Consider wearing surface for design	10 9	8 7	5 5 4	3 2 1		
Consider striped lanes for rating	Target aspect i	atio for shell el	ements			
	Slower			Faster		
Default analysis type: Line Girder	More accurate			Less accurate		
Longitudinal loading	1 1	.5 2	2.5 3	3.5 4		
Vehicle increment: 1 ft						
Transvers landing	3D FE node ge	neration tolera	nce			
Transverse loading	O Percenta	ge				
Vehicle increment in lane: 2 ft	Length					
Lane increment: 4 ft	Span	Length (ft)	Tolerance (%)			
3D analysis control options	> 1	90	0.1			
LFR: Model non-composite regions as non-composite	2	90	0.1			
LRFD: Model non-composite regions as non-composite						
LRFR: Model non-composite regions as non-composite						
	- 3D bracing me	mber end conn	ection analysis			
	O Calculate	d factored men	ber force effects			
	Maximun	n of average (st	ress + strength) a	nd 75% resistance		
	-	er LRFR factors				
		or: Good or Sa				
	Field mea	sured section p	roperties			

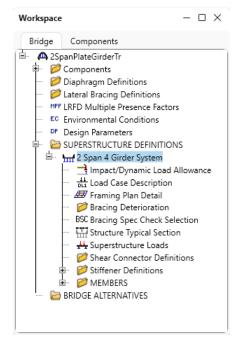
Click **OK** to apply the data and close the window.

#### Impact/Dynamic Load Allowance

Enter the impact to be used for the superstructure definition by double clicking on **Impact/Dynamic Load Allowance** in the **Bridge Workspace** tree. The **Structure Definition Impact / Dynamic Load Allowance** window shown below will open. The values shown below are default values. No changes are required to these values.

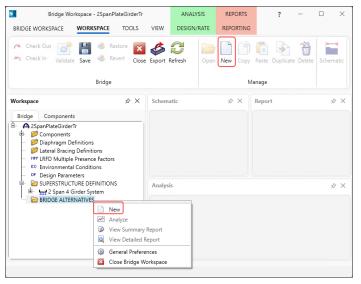
	50	
Standard AASHTO impact: I	= L + 125	
Modified impact:		times AASHTO impact
Constant impact override:		%
RFD dynamic load allowance		
atigue and fracture limit states:	15	%
All other limit states:	33	%

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



#### BRIDGE ALTERNATIVES

Navigate to the **BRIDGE ALTERNATIVES** node in the **Bridge Workspace** tree and create a new bridge alternative by double-clicking on **BRIDGE ALTERNATIVES** (or click on **BRIDGE ALTERNATIVES** and select **New** from the **Manage** group of the **WORKSPACE** ribbon).



Enter the following data.

Bridge Alternativ	/e			-		
Alternative name:	Bridge Alte	ernative 1				
Description	Substructure	25				
Description:						
Horizontal	curvature		Global positioning			
Reference line l	Reference line length: ft		Distance:	ft		
		End bearing	Offset:	ft		
Starting station	-	ft	Elevation:	ft		
Bearing:	Ν	1 90^ 0' 0.00" E				
Bridge alignr	nent		Start tangent length:		ft	
O Curved			Curve length:		ft	
Tangen	t, curved, tar	igent	Radius:		ft	
			Direction:	Left $\sim$		
Curved,	Start bearing     End bearing     Starting station:		End tangent length:		ft	
	re	Culvert wizard				
			ОК	A 1		
			UK	Apply	Cano	cei

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

Expand the **Bridge Alternative 1** node in the **Bridge Workspace** tree by clicking the H button. Double-click on the **SUPERSTRUCTURES** node (or select **SUPERSTRUCTURES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure.

Bridge Workspa BRIDGE WORKSPACE	ace - 2SpanPla	ateGirderTr TOOLS	VIEW	ANALYSIS DESIGN/RATE	REPORTS		_	
Check Out Check In Validate Sat	📕 🚷 Rev	vert Close	کی Export	Refresh	en New Cop		ate Delete	e Schematic
	Bridge		N			Manage		
Workspace		× ×	Schem	atic	\$ ×	Report		s> ×
Components     Diaphragm Definitions     Diaphragm Definitions     Iff Lateral Bracing Definitions     Iff LRFD Multiple Presence Factors     Ec Environmental Conditions     Or Design Parameters     SUPERSTRUCTURE DEFINITIONS								
	VES ive 1 (E) (C)		Analys	is				\$ X
- H Stiffness Ana - P Stiffness Ana - PIERS		New Analyze View Summ View Detaile	· ·					
	\$\$ <b>X</b>	General Pret Close Bridge		ace				

A Superstructure							-		$\times$
Superstructure name	e: Superstud	tture 1							
Description 4	Alternatives	Vehicle path En	gine Substructure	S					
Description:									
Reference line	2								
Distance:	0	ft							
Offset:	0	ft							
Angle:	0	Degrees							
Starting stati	on:	ft							
					ОК	Apr	y v	Canc	el
					OK		<i>r</i> y	Carro	

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

Expand the **Superstructure 1** node in the **Bridge Workspace** tree by clicking the 🛨 button. Double-click on the **SUPERSTRUCTURE ALTERNATIVES** node (or select **SUPERSTRUCTURE ALTERNATIVES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure alternative.

Bridge Workspace	- 2SpanPlate0	GirderTr		ANALY	SIS	REPORTS		?	-		$\times$
BRIDGE WORKSPACE	SPACE T	OOLS	VIEW	DESIGN/	RATE	REPORTING					
Check Out Check In Validate Save	🚷 Restor	<u> </u>	é Export	<b>2</b> Refresh	Open	New Copy	Paste	Duplicat	) Delete	Scher	matic
	Bridge					N	lanage				
Workspace		×	×	Schemati	c	\$	R	eport			× x
Components     Components     Components     Diaphragm Definitions     Components     Compo	ions e Factors ons FINITIONS stem 5 1 (E) (C) JRES ure 1	TERNATIV	6;	Analysis						;	\$ ×
— ++ Stiffness Analys — 🥬 PIERS	is			New Analyze View Summa View Detaile General Pref Close Bridge	d Repor	t					

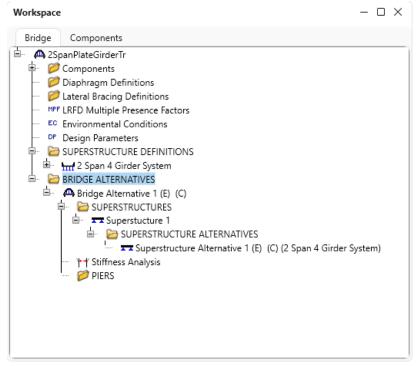
Select the **Superstructure definition 2 Span 4 Girder System** as the current superstructure definition for this Superstructure Alternative.

a, s	Superstru	cture Alternativ	/e									-		×
Alte	rnative n	ame:	Supe	erstructu	ure /	Altern	ative 1							
Desc	cription:													
Supe	erstructu	re definition:	2 Spa	n 4 Giro	der S	Systen	n			~				
Supe	erstructu	re type:	Girde	er										
Num	nber of m	nain members:	4											
	Span	Length (ft)												
	1		90	-										
	2		90											
									OK		Apply	,	Cance	el

Re-open the **Superstructure 1** window and navigate to the **Alternatives** tab. The **Superstructure Alternative 1** linked to **2 Span 4 Girder System** is shown as the **Existing** and **Current** alternative for **Superstructure 1**.

<b>A</b>	Superstructur	e						_		×
Sup	erstructure n	ame: Superst	tucture 1							
	Description	Alternatives	Vehicle path Engine	Substructures						
	Existing	Current S	uperstructure alternative name	Description						
	> 🔽	SI SI	uperstructure Alternative 1							^
										Ψ
						OK	Appl	у	Cance	el

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



#### Load Case Description

Navigate to the **2 Span 4 Girder System** superstructure definition and double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window.** Click on the **Add default load case description** button to create the following load cases.

	Load case name	Description	Stage		Туре	Time* (days)	
	DC1	DC acting on non-composite section	Non-composite (Stage 1) 🛛 🗸	D,DC	$\sim$		
	DC2	DC acting on long-term composite section	Composite (long term) (Stage 2) 🗸 🗸	D,DC	$\sim$		
	DW	DW acting on long-term composite section	Composite (long term) (Stage 2) 🗸 🗸	D,DW	$\sim$		
>	SIP Forms	Weight due to stay-in-place forms	Non-composite (Stage 1) 🗸 🗸	D,DC	~		

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

#### Structure Framing Plan Detail – Layout

Double-click on Framing Plan Detail in the Bridge Workspace tree to describe the framing plan in the Structure

Plan Details window. Enter the data as shown below.

A Structure Framing Plan Details								-		$\times$
Number of spans: 2 Number of gir	ders:	4								
Layout Diaphragms Lateral bracing ran	ges									
	Gir	der spac	ing orienta	ation						
Support Skew (degrees)		Perpe	ndicular to support							
> 1 0			sepport							
2 0 3 0		Girder	Girder s (ff							
5 0		bay	Start of girder	End of girder						
	>	1	10	10						
		2	10	10						
		3	10	10						
										-
						L	ОК	Apply	Cance	ei

### Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing. Enter the following diaphragms for **Girder bay 1** as shown below and click the **Apply** button.

.ayo	ut	Diap	ohragms I	Lateral bracing	ranges									
ird	er ba	ау: 1		~	Copy bay to		Diaph wiza	ard						
	Support distance number (ft)		ort distance ber (ft)	tance	Diaphragm spacing	Number of spaces	Length (ft)	dis	nd tance (ft)	Load (kip)	Diaphragm			
			Left girder	Right girder	(ft)			Left girder	Right girder					
	1	$\sim$	0	0	0	1	0	0	0		Not Assigned $\sim$	/		6.
	1	$\sim$	0	0	37	2	74	74	74		Not Assigned $\sim$	,		
	2	$\sim$	0	0	0	1	0	0	0		Not Assigned 🗸	,		
	2	$\sim$	0	0	16	1	16	16	16		Not Assigned 🗸	,		
>	2	$\sim$	16	16	37	2	74	90	90		Not Assigned 🗸	·		
											New Duplicat	e	Delete	

Click the **Copy bay to...** button to copy the diaphragms entered for bay 1 to the other bays. The following window appears. Select **Bay 2** and **Bay 3** by holding the **Ctrl** key and click **Apply**.

🕰 Copy Diaphragm B	ау	×
	Bay 2	
Select the new bay(s):	Bay 3	
	Apply Can	cel

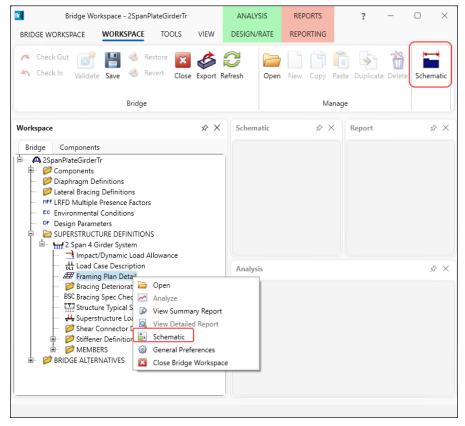
The following message appears indicating that the diaphragms have been copied. Click OK.



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

#### Schematic - Framing Plan Detail

While the **Framing Plan Detail** is selected in the **Bridge Workspace** tree, open the schematic for the framing plan by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Framing Plan Detail** in the Bridge Workspace and select **Schematic** from the menu).



### The following schematic is displayed.

Schematic					- 🗆 ×
Framing					$\sim \times$
🗈 🕞 🖗	Q, ⊕ 🖶 🗟 ∺ 100% - ✓				÷
2SpanPlateGir 2SpanPlateGir 7/17/2024	derTr derfTraining - 2 Span 4 Girder System				
	90'-0'' 	•	90.0 deg.	90-0"	90.0 deg.
10-0	1-1 (1-2	1-3 G1	1-4 1-5	1-8 5-5	1-7
10-0'	2-1 2-2	2-3 G2	24 25	2-0 	2-7
10:01	3-1 3-2	3-3 G3		3-0 .5.01	3-7
		G4			

### Structure Typical Section - Deck

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

Structure Typical Section								-		$\times$
Distance from left edge of deck to superstructure definition ref. line Deck thickness	Distance from superstructure Superstruct Reference	definitio ure Del	on ref. line	o ➡ ➡ ➡ Right ove	erhang					
Deck Deck (cont'd) Parapet Med	ian Railing	G	eneric	Sidewalk	Lane position	Striped lanes	Wearing surface			
Superstructure definition reference line is		`		lge deck.						
Distance from left edge of deck to superstructure definition reference line:	Start 18.5	ft	En 18.5	d ft						
Distance from right edge of deck to superstructure definition reference line:	18.5	ft	18.5	ft						
Left overhang:	3.5	ft	3.5	ft						
Computed right overhang:	3.5	ft	3.5	ft						
							OK	Apply	Cance	:

# Structure Typical Section – Deck (cont'd)

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

A Structure Typical Section	-		×
Left overhang			
Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface			
Deck concrete: Class A (US)   Total deck thickness: 8.5   I. Load case: Engine Assigned    Deck crack control parameter: kip/in   Sustained modular ratio factor: 3   Deck exposure factor:			
OK Ap	pply	Cance	!

### Structure Typical Section – Parapet

Navigate to the **Parapet** tab. Click the **New** button to add a row to the table. The **Name** of the parapet defaults to the only barrier described for the bridge. Change the **Load case** to **DC2** and select **Back** in the **Measure to** column (in this example, locate the parapet on the deck by referencing the back of the parapet to the left edge of the deck). Enter **0.0** for the **Distance at start** and **Distance at end**. Change the **Front face orientation** to **Right**. Enter another parapet as shown below. The completed tab is shown below.

<b>A</b>	Struc	ture Typical Section										-		×
	ack	Deck (cont'd)		Median	Railing	Generi	c Sidewalk	Lane position	Striped la	nes Weari	ng surface			
		Name	:		Load case		Measure to	Edge of deck dist. measured from	Distance at start (ft)	Distance at end (ft)	Front face orientation			
	>	Standard Parapet	~	DC2		~	Back $\checkmark$	Left Edge 🛛 🗸	0	0	Right $\vee$			
		Standard Parapet	$\sim$	DC2		$\sim$	Back $\vee$	Right Edge 🛛 🗸	0	0	Left $\checkmark$			
										New	Duplicat	te [	Delete	
										C	K Ap	oply	Cance	el

#### Structure Typical Section – Lane Positions

Select the **Lane position** tab and use the **Compute...** button to compute the lane positions. A window showing the results of the computation opens. Click **Apply** to apply the computed values.

Travelway number	Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)	Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)	
1	-17	17	-17	17	
) 1	-17	17	-17	17	

The Lane Position tab is populated as shown below.

eck	Deck (co	nt'd) Parapet Median	Railing Generic Sidew	valk Lane position Strip	ed lanes Wearing surface	
	Travelway number	Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)	Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)	
>	1	-17	17	-17	17	
	RFD fatigue Lanes av	ailable to trucks:			New Dupi	Delete

### Structure Typical Section – Wearing surface

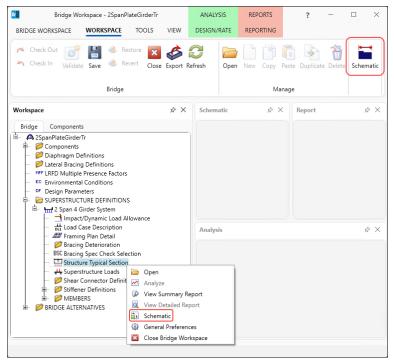
Navigate to the **Wearing surface** tab. Enter the data shown below.

A Structure Typical Section				×
Distance from left superstructure def	edge of deck to inition ref. line Deck Wickness Teference Line Reference Line Right overhang			
Deck Deck (cont'd)	Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface			
Wearing surface material:	Asphalt			
Description:	Asphalt - 25 psf			
Wearing surface thickness:	2.78 in Thickness field measured (DW = 1.25 if checked)			
Wearing surface density:	108 pcf			
Load case:	DW V Copy from library			
	OK App	oly	Cance	al

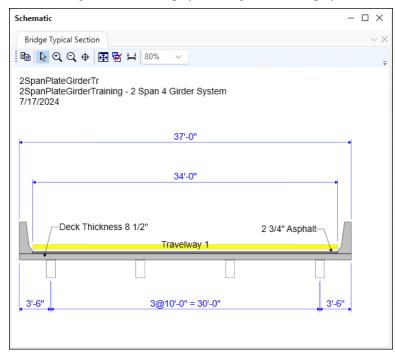
Click **OK** to apply the data and close the window.

#### Schematic – Structure Typical Section

While the **Structure Typical Section** is selected in the **Bridge Workspace** tree, open the schematic for the structure typical section by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click on **Structure Typical Section** in the **Bridge Workspace** and select **Schematic** from the menu).

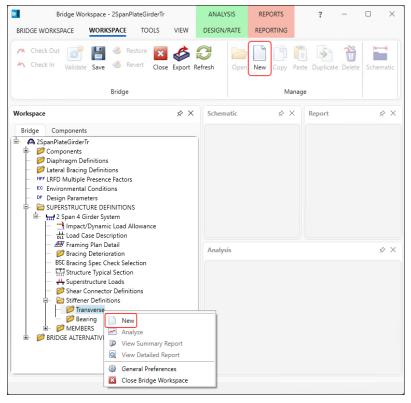


The following schematic is displayed. The girders are displayed as dashed boxes since they are not defined yet.



#### Stiffener Definitions – Transverse

Define the transverse stiffeners to be used by the girders. Expand the **Stiffener Definitions** node in the **Bridge Workspace** tree, select **Transverse** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New** from the drop-down menu) as shown below.



Select **Trans. Plate Stiffener** for **Stiffener Type** in the **New Transverse Stiffener Definition** window and click **OK** to open the **Transverse Stiffener Definition** window as shown below.

🗛 New Tran	sverse Stiffener Definition	×
	Stiffener Type:	
	Trans. Plate Stiffener 🗸	
	Trans. Plate Stiffener	
	Trans. Angle Stiffener	
	OK Canc	el

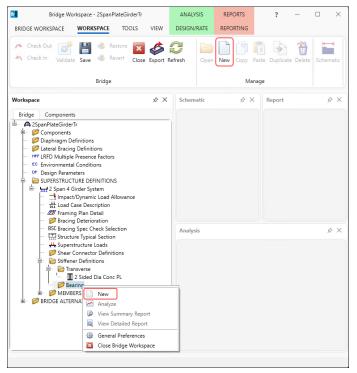
Define the stiffener as shown below.

Stiffener type   Single   Pair     Plate   Thickness:   0.75   in   Waterial:   Grade 50W     Bottom gap:   in     Bottom gap:     in	me: 2 Sideo	d Dia Conc PL		
Plate       Thickness:     0.75       Material:     Grade 50W       Welds       Top:     None       Web:     None	Stiffener type		in	
Thickness: 0.75 in Material: Grade 50W   Bottom gap: in Welds Top: None V Web: None V	Plate		6 in	$\leftrightarrow$
Welds           Top:         None           Web:         None	Thickness:			
Top:         None         V           Web:         None         V	Welds		in in	
		None 🗸		
Bottom: None V	Web:	None V		
	Bottom:	None V		

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

#### Stiffener Definitions – Bearing

Define the bearing stiffeners to be used by the girders. Expand the **Stiffener Definitions** node in the **Bridge Workspace** tree, select **Bearing** and click on the **New** button from the **Manage** group of the **WORKSPACE** ribbon (or right click and select **New** from the drop-down menu) as shown below.



Select **Plate Stiffener** for **Stiffener type** in the **New Transverse Stiffener Definition** window and click **OK** to open the **Transverse Stiffener Definition** window as shown below.

A New Bearing Stiffener Definition	Х
Stiffener Type:	
Plate Stiffener	
Plate Stiffener	
Angle Stiffener	
	_
OK Cancel	

#### Define the stiffener as shown below.

Plate   Thickness:   0.875   in   Material:   Grade 50W     9   in   Welds   Top:   None   Web:   None   Web:   None   in   in   in   in   in	ame: Bearin	g Stiffener				
Thickness: 0.875 in Material: Grade 50W				i	n <u>+k_+k</u>	i
Material: Grade 50W		0.875 in		i		
Welds         Top:         None         web:         None         web:         None         web:         None         web:         None         web:         None         web:         None	Material:	Grade 50W	~			
Welds         Top:         None          in           Web:         None          Image: Second seco				9 ii	n 🔶	
Web: None V in the second secon		N				
web:				i	n	
in <del>**</del>						
	Bottom:	None	<u> </u>	ii	n <del>++++</del>	i

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

### Describing a member

The **Member** window shows the data generated when the structure definition is created. Expand the **MEMBERS** folder and double click on **G2** node. No changes are required in this window. The first member alternative created will automatically be assigned as the **Existing** and **Current member alternative** for this member.

🗛 Member										-		$\times$
Member name:	G2				Link	with: None	~					
Description:												
	Existin	9	Current	Member a	lternative na	ne Description						
												-
Number of span	2 û		Span no.	Span length (ft)								
		>	1	9	0							
			2	g	90							
					-							
								OK	Apply	,	Canc	el

#### Member Loads

Expand the G2 member node. Double-click on the Member Loads node in the Bridge Workspace tree to open the Girder Member Loads window. Add a new row and select SIP Forms from the options for Load case name. Enter the Uniform load due to the stay-in-place forms as shown below.

[		+ + +	+ + +	7		
Ž	<u> </u>	* * *		<u>-</u> ±		
loct	trian load:	lb/ft				
nif	form Distributed (	Concentrated	Settlement			
	Load case name	Span	Uniform load (kip/ft)	Description		
>	> SIP Forms ~	All Spans 🗸	0.135			A
				N	New Duplicate	Delete

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

#### Supports

Double click on **Supports** node in the **Bridge Workspace** tree for member **G2** to open the **Supports** window. Support constraints generated when the structure definition is created and are shown below. No changes are required to this window.

L	→× <u>~</u>				2		
	1				2		
ne	eral Elast	ic 3D General	3D Elastic				
	Support	Support	Translation	constraints	Rotation constraints		
	number	type	х	Y	Z		
>	1	Pinned 🗠	$\checkmark$	$\checkmark$			
	2	Roller 🗸		$\checkmark$			
	3	Roller 🗸					

### Defining a Member Alternative

Double-click on **MEMBER ALTERNATIVES** in the **Bridge Workspace** tree for member **G2** to create a new member alternative. The **New Member Alternative** window shown below will open. Select **Steel** for the **Material type** and **Plate** for the **Girder Type**.

A New Member Alternative		×
Material type:	Girder type:	
Reinforced concrete	Built-up	
Steel	Plate	
Timber	Rolled	
	OK Canc	el

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

lember alternative: Pla	te Girder								
Description Specs	Factors	Engine	Import	Control options					
Description:				Material type: Girder type:	Steel Plate				
				Modeling type: Default units:	Multi Gir	rder System marv	~		
Girder property inp Schedule base Cross-section	d	Left: Right:	aring locatio 6 6	in in	Simple DL,	continuous	LL		
Self load				Default rating me	thod:				
Load case:	Engine Ass	-	~	LFR	~				
Additional self load		kip/ft %							

The Member Alternative Description window will open. Enter the data as shown below.

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

mber alternative: Plate Girder	
Description Specs Factors Engine Import Control options	
LRFD	CLRFR
Points of interest	Points of interest
Generate at tenth points	Generate at tenth points
Generate at section change points	Generate at section change points
Generate at user-defined points	<ul> <li>Generate at user-defined points</li> </ul>
Generate at stiffeners	Generate at stiffeners
Allow moment redistribution	Allow moment redistribution
Use Appendix A6 for flexural resistance	Use Appendix A6 for flexural resistance
Allow plastic analysis	Allow plastic analysis
Ignore long. reinf. in negative moment capacity	Evaluate remaining fatigue life
Consider deck reinf. development length	Ignore long. reinf. in negative moment capacity
Must consider user input lateral bending stress	Include field splices in rating
Consider concurrent moments in Cb calculation	Consider deck reinf. development length
Distribution factor application method	Consider tension-field action in stiffened web end panels
By axle	Must consider user input lateral bending stress
O By POI	Consider concurrent moments in Cb calculation
	Distribution factor application method
	By axle
LFR	C ASB
Points of interest	Doints of interest
Generate at tenth points	Generate at tenth points
Generate at section change points	Generate at section change points
Generate at user-defined points	Generate at user-defined points
Allow moment redistribution	Ignore long. reinf. in negative moment capacity
Allow plastic analysis of cover plates	Consider deck reinf. development length
Include field splices in rating	Consider tension-field action in stiffened web end panels
Include bearing stiffeners in rating	
Allow plastic analysis	
Ignore long. reinf. in negative moment capacity	
Ignore overload operating rating	
Ignore shear	
Consider deck reinf. development length	
Consider tension-field action in stiffened web end panels	
Distribution factor application method	
By axle	
O By POI	
· · · · · · · · · · · · · · · · · · ·	

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

Reopen the member **G2** window. The newly added member alternative will automatically be assigned as the **Existing** and **Current** member alternative for this member.

A Member													-		×
Member name:	G2						Link w	th: No	ne	$\sim$					
Description:															
		Existin	g	Current	Member a	lterna	tive nam	Descri	iption						
	>	$\checkmark$		$\checkmark$	Plate Girde	er									-
Number of span	15:	2 🗘		Span no.	Span length (ft)										Ŧ
			>	1	Ģ	90	-								
				2	ġ	90									
							v								
											OK	Apply		Canc	el

#### Girder Profile

Expand the newly added **Plate Girder** member alternative for member **G2**. Next describe the girder profile by double clicking on the **Girder Profile** node in the **Bridge Workspace** tree. Enter the data in each tab of the **Girder Profile** window as shown below.

#### Web

	Begin depth (in)	Depth	i vary	End depth (in)	Thickness (in)		port nber	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld at right	
>	36	None	$\sim$	36	0.4375	1	$\sim$	0	63	63	Grade 50W $$	None 🗸 🗸	1
	36	None	$\sim$	36	0.5	1	~	63	54	117	Grade 50W 🗸 🗸	None 🗸	
	36	None	$\sim$	36	0.4375	2	$\sim$	27	63	90	Grade 50W 🗸	None 🗸	

# Top flange

Veb	Plate Gi	flange	Bottom fla	ange										
	Begin width (in)	End width (in)	Thickness (in)	Su	pport mber	Start distance (ft)	Length (ft)	End distance (ft)	Materia	I	Weld	Weld at right		
	12	12	0.75	1	$\sim$	0	63	63	Grade 50W	$\sim$	None 🗸 🗸	None	~	
	16	16	1	1	$\sim$	63	54	117	Grade 50W	$\sim$	None 🗸	None	~	
>	12	12	0.75	2	$\sim$	27	63	90	Grade 50W	$\sim$	None 🗸	None	$\sim$	

### **Bottom flange**

	Begin width (in)	End width (in)	Thickness (in)		oport nber	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right	
>	16	16	0.875	1	$\sim$	0	63	63	Grade 50W 🗸	None 🗸 🗸	None 🗸 🗸	
	16	16	1.5	1	$\sim$	63	54	117	Grade 50W 🗸	None 🗸	None 🗸 🗸	
	16	16	0.875	2	$\sim$	27	63	90	Grade 50W 🗸 🗸	None 🗸	None 🗸 🗸	

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

#### Deck Profile

Next open the **Deck Profile** window by double-clicking the **Deck Profile** node in the **Bridge Workspace** tree and enter the data describing the structural properties of the deck. The window is as shown below.

ck	cc	oncre	ete	Rei	inforc	.eme	nt	Sh	near conn	nectors											
			Mate	erial		Sup nur	ppor mbe	τ.	Start distance (ft)	Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)	n				
>	CI	lass /	A (US)	5)	~	1	~	Ē	0	180	180	8	96	96	120	120	8				
			ute fro															New	Duplicate	Delete	

Enter the reinforcement data as shown below.

	Plate concrete	Re	infor	cement	t Shear	connecto	rs										
	Materia	ı	Sup nui	oport mber	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row		Bar spacing (in)			
ľ	Grade 60	~	1	~	63	54	117	6.24	6.24	9 ~	2.97	Top of Slab	~				
	Grade 60	~	1	~	63	54	117	4.16	4.16	9 ~	1.91	Bottom of Slab	~				

Note: As mentioned in the Note under the composite section details in Page 3 of this tutorial, for simplicity, the bars will be input using an equivalent number of #9 bars which have a unit area of 1.0 in<sup>2</sup>.

<b>A</b>	Deck	Profile									-		×
Ту	pe:	Plate											
	Decl	concrete	Reinford	ement	Shear cor	inectors							
		Support number	Start distance (ft)	Length (ft)	End distance (ft)	Connector ID	Number of spaces	Number per row	Transverse spacing (in)				
	x	1 ~	0	180	180	Composite 🗠						-	
													<u>r</u>
		Shear stud design tool		View calcs						New Duplicat	e [	Delete	
										ОК Арр	ly	Cance	4

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

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

#### Haunch Profile

To define the haunch profile, double-click on the **Haunch Profile** node in the **Bridge Workspace** tree. Select the Haunch type and enter data as shown below.

🕰 Steel Haunch Profile		-		Х
Haunch type:	Embedded flange			
	Support number     Start distance (ft)     Length (ft)     End distance (ft)     Z1 (in)     Z2 (in)     Y1 (in)       > 1 ~     0     180     180     8     8     2			•
	New Dup	icate	Delete	
	OK	pply	Cance	4

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

### Lateral Support

Open the Lateral Support window by double clicking on the Lateral Support node in the Bridge Workspace tree.

Regions where the slab	provides lateral	support for t	he top flange a	re defined as	shown	below.
------------------------	------------------	---------------	-----------------	---------------	-------	--------

		Z		Z	 	
	Start Distan		Length		 	
Rang Top f	es Loca flange	ations F	lange lateral	bending		
	Support number	Start distance (ft)	Length (ft)	End distance (ft)		
>	1 ~	0	180	180		

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

### Stiffener Ranges

Double click on the **Stiffener Ranges** node in the **Bridge Workspace** to open the **Stiffener Ranges** window. Click the **Apply at diaphragms...** button to open the **Diaphragm Connection Plates** window.

Start	Distance		Spacir	9.													
	stiffene		es	Longit	udinal	stiffer	ner rang	es									
	Nam	ie		upport umber	dist	art tance ft)	Numb space		Spac (ir	Lengt (ft)	th	End distan (ft)					
Apply	at	Stiff	nerc	petwee										290	Duplic		Delete

Select the 2 Sided Conn PL as the Transverse Stiffener to be applied at the interior diaphragms and click OK.

A Diaphragm Connection Plates	×
Apply the following stiffener definitions to the diaphragm locations:	
End diaphragms and diaphragms at piers	
Bearing stiffener: Bearing Stiffener	
Interior diaphragms	
Transverse stiffener: 2 Sided Dia Conn PL	
	_
OK Cancel Help	

The Stiffener Ranges window will be updated as shown below.

	Name		pport mber	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)		
	2 Sided Dia Conc PL 🗸	1	~	37	1	0	0	37		
	2 Sided Dia Conc PL $$	1	$\sim$	74	1	0	0	74		
	2 Sided Dia Conc PL $$	2	$\sim$	16	1	0	0	16		
>	2 Sided Dia Conc PL $$	2	$\sim$	53	1	0	0	53		

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

#### Bearing Stiffener Locations

Bearing stiffener definitions were assigned to locations when the **Apply at diaphragms...** option was used on the **Stiffener Ranges** window. The **Bearing Stiffener Location – Support 1** window is opened by expanding the **Bearing Stiffener Locations** node in the **Bridge Workspace** tree and double clicking on the **Support 1** node. The assignment for support 1 is shown below. No changes are required to this window.

, В	earing Stiff	ener Location - Support 1				_		×
Pair	rs of bearin	g stiffeners at this support:		<mark>← CL of Bearing </mark>	offset to left of			
	Stiffener pair	Name	Offset (in)					
•	1	Bearing Stiffener 🔹	0.0000					-
								4
					ОК	Apply	Cance	I

#### Live Load Distribution

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

tand	dard LRFD								
D	istribution fac	tor input method							
	🔵 Use simpli		Use advanced n	nethod 🔿 Us	e advanced method	with 1994 gu	ide specs		
						-			
~]	Allow distribu	tion factors to be	e used to compute ef	fects of permit load	Is with routine traffi	c			
			Distributio						
	Lanes loaded		(whee	els)					
	loaded	Shear	Shear at supports	Moment	Deflection				
>	1 Lane	1.4285714	1.4	1.4285714	0.5				
	Multi-lane	1.8181818	2	1.8181818	1				
	ompute from pical section	View calcs	4						

LRFD distribution factors are computed by the BrDR engine using the girder system structure definition.

#### Interior (LFR wheels)

Lanes Loaded	Shear	Shear at Support	Moment	Deflection
1 lane	1.43	1.4	1.43	0.5
Multi-lane	1.82	2.0	1.82	1.0

Interior (LRFD lanes)

Lanes Loaded	Shear	Shear at Support	Pos. Moment	Neg. Moment	Deflection
1 lane	0.76	0.76	0.480	0.499	0.3*
Multi-lane	0.952	0.952	0.692	0.720	0.5

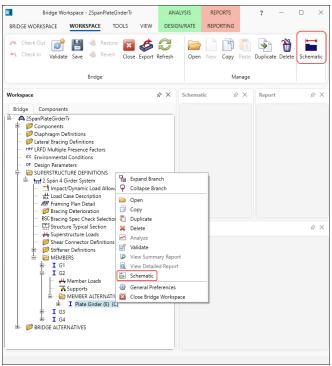
\* includes 1.20 multiple presence factor

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

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

#### Schematic – Member alternative

While the member alternative **Plate Girder** for member **G2** is selected in the **Bridge Workspace** tree, open the schematic for the girder profile by selecting the **Schematic** button on the **WORKSPACE** ribbon (or right click and select **Schematic** from the menu).



The following schematic will be displayed.

Schematic				- 🗆 ×
Girder profile				$^{\vee} \times$
🖻 📘 🖸 😋 🕁 🗃 😽 🖂	75% 🗸			÷
2SpanPlateGirderTr 2SpanPlateGirderTraining - 2 Spa 7/17/2024	n 4 Girder System - G2			
Top Flange Transitions	• PL 3/4	4"x12"x63'-0"		
Web Transitions	7/16	"x36"x63'-0"	,	
Stiffener Spacing	37"-0"	24	37'-0"	H
Shear Connector Spacing				
Top Flange Lat. Support	4			
Top Flange Deterioration				
	د 7/16	5"x36" Web 🗙		×
Bottom Flange Deterioration				
Bottom Flange Transitions	PI 7/	8"x16"x63'-0"		
Span Lengths			90'-0"	
	4 N -		30-0	
	Notes: * All fange length dimensions are horiz. (length along flange may differ). * Transverse stiffener pairs shown in blue. * Single transverse stiffener shown in green. * Dimensioning starts and ends at CL bearings. * X denotes cross frame locations.			٨

# LRFR Analysis

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

Bridge Work	space - 2SpanPlateGirderTr	ANALYSIS	REPORTS	?	_	×
BRIDGE WORKSPACE	WORKSPACE TOOLS VIEW	DESIGN/RAT	REPORTING			
a 📾	₩ ₩	🔀 🖪				
Analysis Analyze Analysis Settings Events	Tabular Specification Engine F Results Check Detail Outputs					
Analysis						

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

Ģ	• (	Open Template					×
		Templates	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	
		Delete				Op	en Cancel

Design review       Rating         Analysis type:       Line Girder         Lane / Impact loading type:       As Requested         Vehicles       Output         Traffic directions:       None         Vehicles       Both directions:         Vehicles selection       Vehicles summary         Properties       FV3         +H 15-44       +H 20-44         +H 20-440       +H 20-44         +H 20-441       +H 20-44         +H 20-441       +H 20-44         +H 20-441       +H 20-44         +H 52 0.5(3)       -HL-93 (US)         +H 152 0.41       -HL-93 (US)         -HL-93 (US)       -HL-93 (US)	Analysis Settings			-	×
Lane / Impact loading type: As Requested Lane / Impact loading type: As Requested Vehicles Output Engine Description Traffic direction: Both directions Vehicle selection Vehicle selection Vehicles	Design review O Rating	Rating method:	LRFR	~	
Vehicle selection Vehicles Vehicles Vehicles Standard Vehicles Standard Vehicle summary Vehicle summary  Add to Vehicle summary  Add to	Lane / Impact loading type:     As Requested       Vehicles     Output       Engine     Description			×	
<ul> <li>➡ Vehicles</li> <li>➡ Standard</li> <li>➡ EV2</li> <li>➡ EV3</li> <li>➡ H 15-44</li> <li>➡ H.93 (SI)</li> <li>➡ H.93 (SI)</li> <li>➡ H.93 (US)</li> <li>➡ H.93 (US)</li> <li>➡ HS 15-44</li> <li>➡ S20 (SI)</li> <li>➡ HS 20-44</li> <li>➡ Lane-Type Legal Load</li> <li>\_ LRFD Fatigue Truck (US)</li> <li>➡ Remove from</li> <li>■ Su5</li> <li>➡ SU6</li> <li>➡ SU7</li> <li>¬Type 3</li> <li>¬Type 3.3</li> <li>¬Type 3.4</li> <li>¬Type 3.4</li> <li>¬Type 3.5</li> <li>¬Type 3</li></ul>				Advanced	
	<ul> <li>Standard</li> <li>EV2</li> <li>EV3</li> <li>H 15-44</li> <li>H 20-44</li> <li>HL-93 (US)</li> <li>HS 15-44</li> <li>HS 20 (SI)</li> <li>HS 20-44</li> <li>Lane-Type Legal Load</li> <li>LRFD Fatigue Truck (US)</li> <li>NRL</li> <li>SU5</li> <li>SU6</li> <li>SU7</li> <li>Type 3-3</li> <li>Type 322</li> <li>Agency</li> <li>User defined</li> </ul>	Add to	ign load rating Inventory 'HL-93 (US) Operating 'HL-93 (US) Fatigue 'LRFD Fatigue Truck (US al load rating Specialized hauling	)	

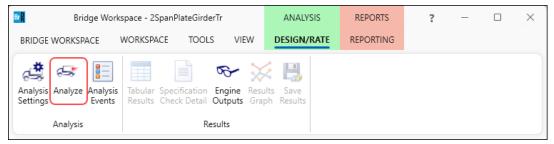
The Analysis Settings window will be populated as shown below.

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

### Tabular Results

With G2 member alternative – Plate Girder selected, click the Analyze button on the Analysis group of the

**DESIGN/RATE** ribbon to perform the rating.



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

Bridge Works	pace - 2SpanPlat	eGirderTr		ANALYSIS	REPORTS	?	—	$\times$
BRIDGE WORKSPACE	WORKSPACE	TOOLS	VIEW	DESIGN/RATE	REPORTING			
Analysis Analyze Analysis Settings	Tabular Results	ation Engi	ne Results					
Analysis		Results						

The window shown below will open. Select **Rating Results Summary** as the **Report Type** and **Single rating level per row** as the **Display Format** option to have the ratings arranged as shown below.

	alysis Resu	ults - Plate Girder									- 0	×
Print Print	t											
eport ty	ype:	⊂ La	ne/Impact loadin	g type	Displa	y Format						
Rating R	Results Su		As requested		ad Single	e rating level pe	r row	$\sim$				
Live	ve 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	8.56	0.238	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested	
	-93 (US)	Truck + Lane	LRFR	Operating	11.09	0.308	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested	-
HL-	-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	6.14	0.171	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested	1
HL-	-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	7.96	0.221	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested	1
HL-	-93 (US)	Tandem + Lane	LRFR	Inventory	10.06	0.279	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested	1
	-93 (US)	Tandem + Lane	LRFR	Operating	13.04	0.362	90.00	1 - (100.0)	STRENGTH-I Steel Flexure Stress	As Requested	As Requested	1

# LRFD Design Review

An LRFD design review of this girder for HL93 loading can be performed by AASHTO LRFD. To perform an
LRFD design review, enter the Analysis Settings window as shown below.

Analysis Settings			-		×
O Design review Rating	Design method:	LRFD	~		
Analysis type:     Line Girder     ✓       Lane / Impact loading type:     As Requested     ✓       Vehicles     Output     Engine     Description	Girder	None	~		
Traffic direction: Both directions Vehicle selection Devehicles	Add to	icles Ioads 93 (US) Ioads	Advanced		
Reset Clear Open template Save	template	ОК	Apply	Canc	el

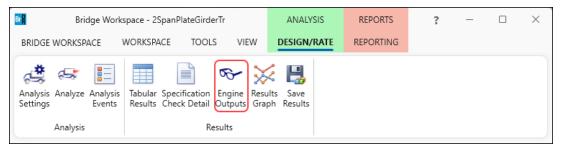
Click **OK** to apply the data and close the window.

Bridge Works	pace - 2SpanPlateGirderTr	ANALYSIS	REPORTS	?	_	$\times$
BRIDGE WORKSPACE	NORKSPACE TOOLS VIEW	DESIGN/RATE	REPORTING			
Analysis Settings	Tabular Specification Results Check Detail Outputs Grap					
Analysis	Results					

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

#### **Engine Outputs**

AASHTO LRFD analysis will generate a spec check results file. Click the **Engine Outputs** button from the **Results** group of the **DESIGN/RATE** ribbon to open the following window.

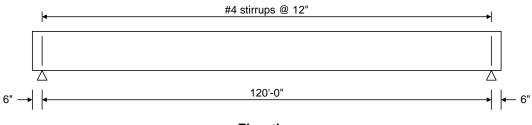


To view the LRFD spec check results (shown below), double click on the **Stage 3 Spec Check Results** under the **AASHTO\_LRFD** branch in this window.

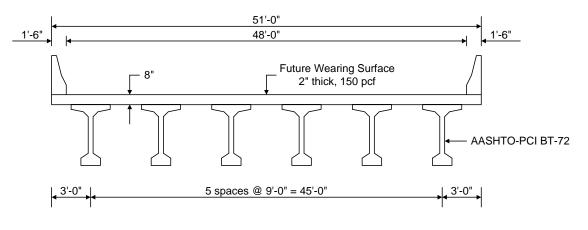
A 2SpanPlateGirderTr	_	×

AASHTOWare BrDR 7.5.1 Prestress Tutorial 1 PS1 - Simple Span Prestressed I Beam Example

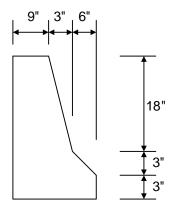
### PS1 - Simple Span Prestressed I Beam Example





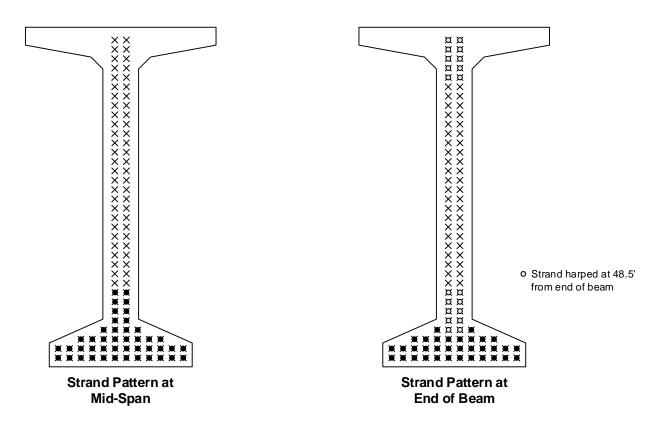


**Typical Section** 



Weight = 300 plf





### **Material Properties**

Beam Concrete: f'c = 6.5 ksi, f'ci = 5.5 ksi Deck Concrete: f'c = 4.5 ksi Prestressing Strand: 1/2" dia., 7 Wire strand, Fu = 270 ksi, Low Relaxation

## BrDR Training

# PS1 – Simple Span PS I Beam Example

From the **Bridge Explorer** create a **new bridge** by clicking on the **New** button from the **BRIDGE** tab as shown below.

Br	AASHTOWare Bridge Design and Rating	?	_	×
BRIDGE EXPLORER BRIDGE	FOLDER RATE TOOLS VIEW			
New Open C Batch ~	Find Copy Paste Copy Remove Delete To~ From			
Bridge	Manage			

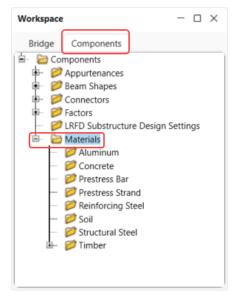
### Enter the following description data.

S Training Bridg	ge1							- 0
ridge ID: PS T	Training	Bridge1	NBI structu	rre ID (8): PS Tr.Bridge1		Template Bridge comp	oletely defined	Bridge Workspace View Superstructures Culverts Substructures
Description	Descr	iption (cont'd)	Alternative	s Global reference poir	nt Traffic	Custom agency f	ields	
Name:		PS1 Training Bri	dge			Year built:		
Description:		This is PCI deisg	gn example 9.	9.3, which uses the Load F	actor Design (	(LFD).		
Location:	ĺ					Length:		ft
Facility carried	d (7):					Route number	: -1	
Feat. intersect	ted (6):					Mi. post:		

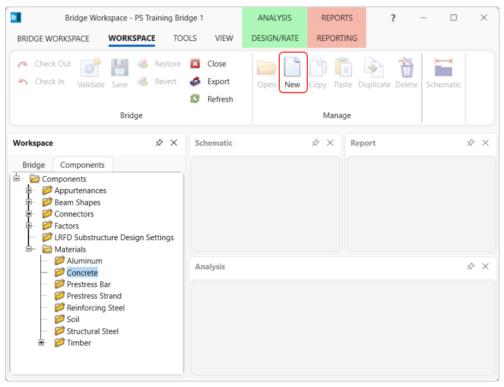
Click **OK** to apply the data and close the window.

#### Bridge Materials

To enter the materials to be used by members of the bridge, navigate to the **Components** tab, and click on the + button to expand the tree for **Materials**. The tree with the expanded **Materials** branch is shown below.



To add a new concrete material, click on **Concrete**, and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **Concrete** and select **New**). The window shown below will open.



A Bridge Materials - Concrete			-		×
Name:					
Description:					
Compressive strength at 28 days (f'c):		ksi			
Initial compressive strength (f'ci):		ksi			
Composition of concrete:	Normal				
Density (for dead loads):		kcf			
Density (for modulus of elasticity):		kef			
Poisson's ratio:	0.200				
Coefficient of thermal expansion (α):	0.0000060000	] 1/F			
Splitting tensile strength (fct):	0.000000000	ksi			
		1			
LRFD Maximum aggregate size:		in			
Compute					
Std modulus of elasticity (Ec):		ksi			
LRFD modulus of elasticity (Ec):		ksi			
Std initial modulus of elasticity:		ksi			
LRFD initial modulus of elasticity:		ksi			
Std modulus of rupture:		ksi			
LRFD modulus of rupture:		ksi			
Shear factor:	1.000				
Сору	to library Copy	from library OK Ap	ply	Canc	al

Enter the values shown above the **Compute** button and click the **Compute** button to compute the remaining values below them. Click the **Copy to library...** button to save this concrete material to the library.

🗛 Bridge Mat	terials - Concrete			_		$\times$
Name:	PS 6.5 ksi					
Description:	PS 6.5 ksi (f'ci=5.5 ksi)					
Compressive	strength at 28 days (f'c):	6.5	ksi			
Initial compre	essive strength (f'ci):	5.5	ksi			
Composition	of concrete:	Normal ~				
Density (for o	dead loads):	0.15	kcf			
Density (for r	modulus of elasticity):	0.15	Bridge Design & Rating X			
Poisson's rati	io:	0.2				
Coefficient of	f thermal expansion (α):	0.000006	The Concrete Material was successfully copied to the library.			
Splitting tens	sile strength (fct):					
LRFD Maximu	um aggregate size:		ОК			
	Compute					
Std modulus	of elasticity (Ec):	4887.73337	ksi			
LRFD modulu	us of elasticity (Ec):	5007.548587	ksi			
Std initial mo	odulus of elasticity:	4496.060776	ksi			
LRFD initial m	nodulus of elasticity:	4738.96446	ksi			
Std modulus	of rupture:	0.604669	ksi			
LRFD modulu	us of rupture:	0.611882	ksi			
Shear factor:		1				
			Copy to library Copy from library OK Ap	oply	Cancel	

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

Bridge Mat	terials - Concrete					-	- 🗆	×
Name:	Deck Concrete							
Description:	Deck Concrete							
Compressive	strength at 28 days (f'c)	: 4.5		ksi				
Initial compr	essive strength (f'ci):			ksi				
Composition	of concrete:	Normal	~					
Density (for o	Density (for dead loads):			kcf				
Density (for modulus of elasticity):		0.15		kcf				
Poisson's rati	io:	0.2						
Coefficient o	f thermal expansion (α):	0.000006		1/F				
Splitting tens	sile strength (fct):			ksi				
LRFD Maxim	um aggregate size:			in				
	Comput	e						
Std modulus	of elasticity (Ec):	4066.83998	39	ksi				
LRFD modulu	us of elasticity (Ec):	4435.30912	22	ksi				
Std initial mo	odulus of elasticity:			ksi				
LRFD initial n	nodulus of elasticity:			ksi				
Std modulus	of rupture:	0.503115		ksi				
LRFD modulu	us of rupture:	0.509117		ksi				
Shear factor:		1						
	Сору	to library	Copy fr	om library	ОК	Apply	Cano	:el

Add concrete material for the deck using the same technique. See below for deck concrete material.

**Reinforcement** material and **Prestress strand** material can be added by using the **Copy from library** option and selecting the materials shown below.

### **Reinforcing Steel**

Bridge Materials - Reinforcing	Steel	_	×
Name:			
Description:			
Material properties			
Specified yield strength (fy):	ksi		
Modulus of elasticity (Es):	ksi		
Ultimate strength (Fu):	ksi		
Туре			
O Plain			
С Ероху			
Galvanized			

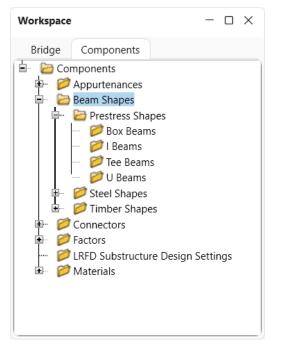
	Name	Descri	otion	Library	Units	Fy	Fu	Es	
Grade 300		300 MPa reinforcing s	eel	Standard	SI / Metric	300	500	199948	
Grade 350		350 MPa reinforcing s	eel (rail-steel)	Standard	SI / Metric	350	550	199948	
Grade 40		40 ksi reinforcing stee		Standard	US Customary	40.0	70.00	29000.0	
Grade 400		400 MPa reinforcing s	eel	Standard	SI / Metric	400	600	199948	
Grade 50		50 ksi reinforcing stee	(rail-steel)	Standard	US Customary	50.0	80.00	29000.0	
Grade 500		500 MPa reinforcing st	eel	Standard	SI / Metric	500	700	199948	
Grade 60		60 ksi reinforcing stee		Standard	US Customary	60.0	90.00	29000.0	
Grade 75		75 ksi reinforcing stee		Standard	US Customary	75.0	100.0	29000.0	
Structural or uni	known grade prior 19	54 Structural or unknown	grade prior to 1954	Standard	US Customary	33.0	60.00	29000.0	
						OK	A	pply	Cano
						OK	A	pply	Cano
🔊 Bridge Mat Name:	erials - Reinforc Grade 60	ing Steel				OK	A	pply	Cano
-				]		OK	A		
Name:	Grade 60 60 ksi reinforci				(	OK			
Name: Description: Material prop	Grade 60 60 ksi reinforci		ksi	]		OK	A		
Name: Description: Material prop	Grade 60 60 ksi reinforci erties d strength (fy):	ng steel	ksi			OK	A		
Name: Description: Material prop Specified yield Modulus of e	Grade 60 60 ksi reinforci erties d strength (fy): lasticity (Es):	ng steel 60.0000087 29000.004206	ksi	]		ОК	_		
Name: Description: Material prop Specified yield Modulus of e Ultimate stree	Grade 60 60 ksi reinforci erties d strength (fy): lasticity (Es):	ng steel 60.000087	-	]		OK			
Name: Description: Material prop Specified yield Modulus of e	Grade 60 60 ksi reinforci erties d strength (fy): lasticity (Es):	ng steel 60.0000087 29000.004206	ksi	]		OK			
Name: Description: Material prop Specified yield Modulus of e Ultimate stree	Grade 60 60 ksi reinforci erties d strength (fy): lasticity (Es): ngth (Fu):	ng steel 60.0000087 29000.004206	ksi			ОК			
Name: Description: Material prop Specified yiel Modulus of e Ultimate strer Type	Grade 60 60 ksi reinforci erties d strength (fy): lasticity (Es): ngth (Fu):	ng steel 60.0000087 29000.004206	ksi			ОК	4		
Name: Description: Material prop Specified yiel Modulus of e Ultimate strer Type Type Plain Epox	Grade 60 60 ksi reinforci erties d strength (fy): lasticity (Es): ngth (Fu):	ng steel 60.0000087 29000.004206	ksi			OK	4		

### Similarly, copy the following **Prestress strand** material.

	rials - PS Strand					_	X
Name: 1	1/2" (7W-270) L	R					
Description: L	ow relaxation 1	/2"/Seven	Wire/fpu =	270			
Strand diamete	er:	0.5	in				
Strand area:		0.153	in^2				
Strand type:		Low Relaxa	ation $\vee$				
Ultimate tensile	e strength (Fu):	270	ksi				
Yield strength (	(fy):	243	ksi				
Modulus of ela	sticity (E):	28500	ksi				
	Compute	:					
Transfer length	(Std):	25	in				
Transfer length	(LRFD):	30	in				
Unit load per le	ength:	0.52	lb/ft				
		Ероху	coated				

### Beam Shapes

To enter a prestress beam shape, expand the tree labeled **Beam Shapes** and **Prestress Shapes** as shown below.



Click on the **I Beams** node in the **Components** tree and select **New** from the **Manage** group of the **WORKSPACE** ribbon (or right mouse click on **I Beams** and select **New** or double click on **I Beams** in the **Components** tree). The window shown below will open.

Bridge Wor	kspace - PS Traiı	ning Bridge 1		ANALYSIS	REPORTS	?	-		×
BRIDGE WORKSPACE	WORKSPACE	TOOLS	VIEW	DESIGN/RATE	REPORTIN	G			
Check Out Check In Validate		estore 🛛 evert 🍻	Close Export Refresh	Open New	Copy Paste		elete Sch	nematic	
			wanage						
Workspace	x	? × So	hematic		\$? × F	Report		\$	×
Bridge Components	New Analyze View Sun View Det	imary Report ailed Report Preferences dge Workspa						æ :	×

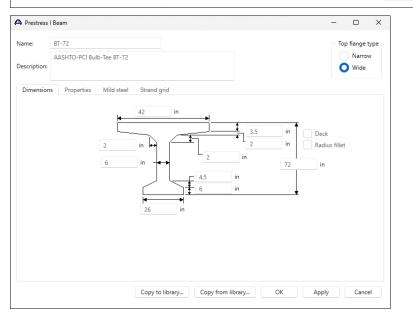
Prestress   Beam		- 🗆 X
Name:		Top flange type Narrow Wide
Dimensions Propert	ties Mild steel Strand grid	in Deck in Radius fillet in
	Copy to library Copy from library	OK Apply Cancel

Select the **Top flange type** as **Wide** and click the **Copy from library...** button.

Select BT-72 (AASHTO-PCI Bulb-Tee BT-72) and click OK. The beam properties are copied to the Prestress I

Beam window as shown below.

	Name	Description	Library	Units	Depth	Top flange thickness	Top flange width	Bottom flange thickness	Bottom flange width	Top hauch height	Bottom haunch height	Top ł
	BT-63	AASHTO-PCI Bulb-Tee BT-63	Standard	US Customary	63	3.5	42	6	26	2	4.5	
>	BT-72	AASHTO-PCI Bulb-Tee BT-72	Standard	US Customary	72	3.5	42	6	26	2	4.5	
	I-28x66	I-28×66	Standard	US Customary	66	5	42	8	28	3	10	
	I-28x78	I-28x78	Standard	US Customary	78	5	42	8	28	3	10	
	I-28x84	I-28x84	Standard	US Customary	84	5	42	8	28	3	10	



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

### Bridge - Appurtenances

To enter the appurtenances, expand the tree branch labeled **Appurtenances**. To define a parapet, select **Parapet** and click on **New** from the **Manage** button on the **WORKSPACE** ribbon (or double click on **Parapet** in the **Components** tree).

Bridge Workspace - PS	Fraining Bridg	e 1	ANALYSIS	REPORTS	?	-	
BRIDGE WORKSPACE WORKSPA	CE TOOL	S VIEW	DESIGN/RATE	REPORTIN	IG		
Check Out Check In Validate Save	Revert	<ul> <li>Close</li> <li>Export</li> <li>Refresh</li> </ul>	Open New	Copy Paste	Duplicate Del	ete Sch	ematic
Bridge							
Workspace	\$ ×	Schematic		\$ × 1	Report		\$ ×
Components  Appurtenances  Components  Appurtenances  Components  Appurtenances  Components  Appurtenances  Components  Appurtenances  Appurtenances Appurtenances  Appurtenances  Appurtenances  Appurtenances  Appurtenances Appurtenances  Appurtenances Appurten							
i	Settings	Analysis					\$ X

Enter the parapet details as shown below.

Name: 300 PLF Parapet Description: All dimensions are in inches Additional load: kip/ft 9 Additional load: kip/ft 9 Reference Line Back Front 3 3 4 4 4 4 4 4 4 4 4 4 4 4 4	🕰 Bridge A	ppurtenances - Parapet		-	
All dimensions are in inches  All dimensions are in inches  Additional load: kip/ft Parapet unit load: 0.15 kcf  Galculated properties Net centroid (from reference line): 6.344 in Total load: 0.300 kip/ft	Name:	300 PLF Parapet			
Additional load:	Description	:			
9 8 9 8 9 10 10 10 10 10 10 10 10 10 10		All dimensions are in inches			
3 9 Reference Line 0 18 3 18 3 Calculated properties Net centroid (from reference line): 6.344 in Total load: 0.300 kip/ft		Additional load:	kip/ft	Parapet unit load:	
9 Reference Line 0 18 3 Calculated properties Net centroid (from reference line): 6.344 in Total load: 0.300 kip/ft				0.15 kcf	
Reference				Calculated properties	
6.344 in 18 18 10 10 10 10 10 10 10 10 10 10			Roadway		
3 0.300 kip/ft					
		18		Total load:	
Back Front I 3		· · · · · · · · · · · · · · · · · · ·		0.300 kip/ft	
		Back Front 🖡 3	<b>\</b>		

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

The default impact factors, standard LRFD and LFR factors will be used. Bridge Alternatives will be added after entering the Structure Definition.

### Superstructure definition

Returning to the **Bridge** tab of the **Bridge Workspace**, double click on **SUPERSTRUCTURE DEFINITIONS** (or click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the **Manage** group of the **WORKSPACE** ribbon or right mouse click on **SUPERSTRUCTURE DEFINITIONS** and select **New** from the popup menu) to create a new structure definition. The window shown below will appear.

A New Superstructure Definition		×
Girder system superstructure Girder line superstructure	Superstructure definition wizard	
Floor system superstructure		
Truss system superstructure		
Truss line superstructure Reinforced concrete slab system superstructure		
Concrete multi-cell box superstructure Advanced concrete multi-cell box superstructure		
	OK Cancel	

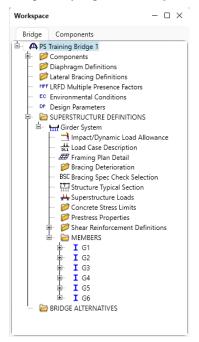
Select Girder system superstructure, click OK

	structure Definition		-	- 0
Definition Analys	sis Specs Eng	jine		
Name:	Girder System		Modeling Multi-girder system	
Description:			Deck type:	nplified definitio
efault units: lumber of spans:	US Customary V	Enter span lengths along the reference line:	For PS/PT only Average humidity:	
lumber of girders:	6 🗘	Span Length (ft)	70 %	
Horizontal curvatu	ire along reference li	> 1 120	Member alt. types Steel P/S R/C Timber P/T	
Horizontal cu	rvature	Distance from PC to first support line:	ft	
	alignment	Start tangent length:	ft	
Superstructure Curved	curved, tangent curved	Radius: Direction: End tangent length: Distance from last support line to PT: Design speed: Superelevation:	ft Left   ft	

The Girder System Superstructure Definition window will open. Enter the data as shown below.

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

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



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

#### BRIDGE ALTERNATIVES

Navigate to the **BRIDGE ALTERNATIVES** node in the **Bridge Workspace** tree and create a new bridge alternative by double-clicking on **BRIDGE ALTERNATIVES** (or click on **BRIDGE ALTERNATIVES** and select **New** from the **Manage** group of the **WORKSPACE** ribbon). Enter the following data.

ridge Alternative			- 0
ernative name: Bridge	Alternative #1		
Description Substruc	tures		
Description:			
Horizontal curvatur	e	Global positioning	
Reference line length:	ft	Distance: 0	ft
Start bearing	End bearing	Offset: 0	ft
Starting station:	ft	Elevation:	ft
Bearing:	N 90^ 0' 0.00" E		
Bridge alignment		Start tangent length:	ft
Curved		Curve length:	ft
Tangent, curved,		Radius:	ft
Tangent, curved		Direction:	~
<ul> <li>Curved, tangent</li> </ul>		End tangent length:	ft
Superstructure wizard	Culvert wizard		
		ОК	Apply Cancel

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

Expand the **Bridge Alternative #1** node in the **Bridge Workspace** tree. Double-click on the **SUPERSTRUCTURES** node (or select **SUPERSTRUCTURES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure.

Superstructure							-		×
Superstructure name	Structure	:1							
Description Al	ternatives	Vehicle path	Engine	Substructures					
Description:									
Reference line									
Distance:	0	ft							
Offset:	0	ft							
Angle:	0	Degrees							
Starting statio	n:	ft							
					ОК	Anal	_	Canc	-1
					UK	Appl	<b>/</b>	Canc	ei

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

Expand the **Structure 1** node in the **Bridge Workspace** tree. Double-click on the **SUPERSTRUCTURE ALTERNATIVES** node (or select **SUPERSTRUCTURE ALTERNATIVES** and click **New** from the **Manage** group of the **WORKSPACE** ribbon) and enter the following new superstructure alternative. Select the superstructure definition **Girder System** as the current superstructure definition for this **Superstructure Alternative**.

<b>A</b>	Superstru	ucture Alternati	/e	-		×
Alte	ernative r	name:	Structure Alternative 1			
Des	cription:					
Sup	erstruct	ure definition:	Girder System $\lor$	]		
Sup	erstructi	ure type:	Girder			
Nu	mber of I	main members:	6			
	Span	Length (ft)				
>	1	120	A			
			V			
			ОК	Apply	Cance	2

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

Re-open the **Structure 1** window and navigate to the **Alternatives** tab. The **Structure Alternative #1** will be shown as the **Existing** and **Current** alternative for **Structure #1**.

A Superstructure Superstructure name: Structure 1  Description Alternatives Vehicle path Engine Substructures  Existing Current Superstructure alternative name Description  V V Structure Alternative 1  OK Apply Cancel						 					
Description Alternatives Vehicle path Engine Substructures	Sup	perstructure							-		×
Existing       Current       Superstructure alternative name       Description         Image: Construct of the second sec	upers	tructure na	me: Struc	ture 1							
Structure Alternative 1	Des	scription	Alternativ	ves Vehicle path Engine	Substructures						
Structure Alternative 1		Existing	Current	Superstructure alternative name	Description						
	>		$\checkmark$	Structure Alternative 1						1	
OK Apply Cancel											
							OK	Apply		Cance	1

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

Bridge Components	
i ti i i i i i i i i i i i i i i i i i	
Diaphragm Definitions	
Point Contraction     Contraction     Point Contraction     P	
C Environmental Conditions	
P     Design Parameters     SUPERSTRUCTURE DEFINITIONS	
<ul> <li>BRIDGE ALTERNATIVES</li> <li>ABridge Alternative #1 (E) (C)</li> </ul>	
E SUPERSTRUCTURES	
SUPERSTRUCTURE ALTERNATIVES	

#### Load Case Description

Navigate back to the superstructure definition – **Girder System**. Double-click on the **Load Case Description** node in the **Bridge Workspace** tree to open the **Load Case Description window** and define the dead load cases as shown below. The completed **Load Case Description** window is shown below.

	Load case name	Description	Stage			Туре		Time (day:	
>	Parapets		Composite (long term) (Stage 2)	$\sim$	D,DC		$\sim$		
	Future wearing surface		Composite (long term) (Stage 2)	$\sim$	D,DW		$\sim$		
		Add default lo							

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

### Structure Framing Plan Detail – Layout

Double-click on **Framing Plan Detail** in the **Bridge Workspace** tree to describe the framing plan in the **Structure Framing Plan Details** window. Enter the data as shown below and click **Apply** to apply the data and not close the window.

<b>A</b> 9	Struc	ture Framin	ig Plan Det	ails									-		×
Nu	mbe	r of spans:	1	Number of gi	rders:	6									
L	.ayoı	ut Diapł	hragms												
					G	irder spac	ing orient	ation							
		Support	Skew (degrees				ndicular to support	girder							
	>	1		o 🔷											
		2		ט		Girder	Girder s (f								
						bay	Start of girder	End of girder							
					>	1	9	9	A						
						2	9	9							
						3	9	9							
						4	9	9							
						5	9	9							
				v											
											OK	Ap	ply	Canc	el

### Structure Framing Plan Detail – Diaphragms

Switch to the **Diaphragms** tab to enter diaphragm spacing. Click the **Diaphragm wizard...** button to add diaphragms for the entire structure. **Select the desired framing plan system** and click the **Next** button. Enter the following data on the window shown below.

A Diaphragm Wizard X	A Diaphragm Wizard X
Select the desired framing plan system:	Diaphragm spacing  Diaphragm spacing  Enter number of equal spaces per span  Enter equal spacing per span  Enter groups of equal spacing
	Support diaphragm load: kip Interior diaphragm load: kip
	Span Length Number of equal spaces
	> 1 120 2
< Back Next > Cancel	< Back Finish Cancel

Click the **Finish** button to add the diaphragms. The **Diaphragm Wizard** will create diaphragms for all the girder bays in the structure. The diaphragms created for **Girder bay 1** are shown below.

irde	er ba	ay: 1		~	Copy bay to			nragm ard				
		upport umber	dis	tart tance (ft)	Diaphragm spacing	Number of spaces	Length (ft)	dis	ind tance (ft)	Load (kip)	Diaphragm	
			Left girder	Right girder	(ft)			Left girder	Right girder	()		
	1	$\sim$	0	0	0	1	0	0	0		Not Assigned 🗸	
	1	$\sim$	0	0	60	1	60	60	60		Not Assigned 🗸	
	1	$\sim$	120	120	0	1	0	120	120		Not Assigned $~~$	
											New Duplicate	Delete

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

### Structure Typical Section - Deck

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

Veck       Deck (cont'd)       Parapet       Median       Railing       Generic       Sidewalk       Lane position       Striped lanes       Wearing surface         Superstructure definition reference line is       within       v       the bridge deck.         Start       End         Distance from left edge of deck to       To contended       To contended	Structure Typical Section								-	
Beck       Deck (cont'd)       Parapet       Median       Railing       Generic       Sidewalk       Lane position       Striped lanes       Wearing surface         Superstructure definition reference line:       within       the bridge deck.       Start       End         Distance from right edge of deck to superstructure definition reference line:       25.5       ft       25.5       ft         Distance from right edge of deck to superstructure definition reference line:       25.5       ft       25.5       ft         Left overhang:       3       ft       3       ft       1       ft	superstructure definition ref. line	superstructu	ure definit ucture Di	tion ref. line	<sup>to</sup>					
Superstructure definition reference line is within $\checkmark$ the bridge deck. Start End Distance from right edge of deck to superstructure definition reference line: Left overhang: 3 ft 3 ft	overhang	dian Raili	ina	Generic			Striped Janes	Wearing surface		
Start     End       Distance from left edge of deck to upperstructure definition reference line:     25.5     ft       25.5     ft     25.5     ft       upperstructure definition reference line:     25.5     ft       25.5     ft     3     ft			-			cane posicion	outped tailes	Treating Surface		
Distance from left edge of deck to upperstructure definition reference line:       25.5       ft       25.5       ft         Distance from right edge of deck to upperstructure definition reference line:       25.5       ft       25.5       ft         Left overhang:       3       ft       3       ft	Superstructure definition reference line is				-					
superstructure definition reference line:	Distance from left edge of deck to superstructure definition reference line:									
		25.5	ft	25.5	ft					
Computed right overhang: 3 ft 3 ft	Left overhang:	3	ft	3	ft					
	Computed right overhang:	3	ft	3	ft					

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

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

A Structure Typical Section				-		×
Distance from left edge superstructure definition De <u>4 thic</u> teft overhang	n ref. line	tance from right edge of deck to erstructure definition ref. line Superstructure Definition Reference Line Right overhang				
Deck Deck (cont'd) Parap	oet Mediar	Railing Generic Sidewalk Lane position Striped lanes Wea	aring surface			
Deck concrete:	Deck Concre	× ×				
Total deck thickness:	8	in				
Load case:	Engine Assig	ed 🗸				
Deck crack control parameter:	130	kip/in				
Sustained modular ratio factor:	2					
Deck exposure factor:						
			ОК Арр	ly	Cance	:

### Structure Typical Section – Parapets

sk       Front         eck       Deck (cont'd)       Parapet       Median       Railing       Generic       Sidewalk       Lane position       Striped lanes       Wearing surface         Image: Sidewalk       Load case       Measure to       Edge of deck dist. measured from       Distance at start (ft)       Distance at end orientation       Front face orientation         300 PLF Parapet       V       Parapets       V       Back       Left Edge       0       0       Right $\leq$ 300 PLF Parapet       V       Parapets       V       Back       Right Edge       0       0       Left       V	truci	ture Typical Section											-	
Name     Load case     Measure to     Edge of deck dist. measured dist. measured from     Distance at from (ft)     Distance at end (ft)     Front face orientation       >     300 PLF Parapet     Parapets     Back     Left Edge     0     0     Right        300 PLF Parapet     Parapets     Back     Right Edge     0     0     Left	*	Fro	ant											
Name     Load case     Measure to from     dist. measured (ft)     start (ft)     end (ft)     Prontrace orientation       300 PLF Parapet     Parapets     Back     Left Edge     0     0     Right <	eck	Deck (cont'd)	Parapet	Median	Railing Ge	eneric	: Side	walk	Lane position	Striped la	nes Weari	ng surface		
300 PLF Parapet     V     Back     V     Right Edge     0     0     Left     V		Name	e	L	.oad case		Measure	e to	dist. measured	start	end			
	>	300 PLF Parapet	~	Parapets		~	Back	$\sim$	Left Edge 🛛 🗸	0	0	Right $\sim$		
New Duplicate Delete		300 PLF Parapet	~	Parapets		~	Back	$\sim$	Right Edge 🗸 🗸	0	0	Left $\sim$		

### Structure Typical Section – Lane Positions

Select the **Lane position** tab and use the **Compute...** button to compute the lane positions. A window showing the results of the computation opens. Click **Apply** to apply the computed values.

¢	Compute Lar	ne Positions				×
	Travelway number	Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)	Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)	
>	1	-24	24	-24	24	
					Anth	•
					Apply Cance	el

	Travelw		re Definition Reference Line				
Ϊ			<u>/</u>				
eck	Deck (co	nt'd) Parapet Median	Railing Generic Sidev	valk Lane position Strip	ed lanes Wearing surface		
	Travelway number	Distance from left edge of travelway to superstructure definition reference line at start (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at start (B) (ft)	Distance from left edge of travelway to superstructure definition reference line at end (A) (ft)	Distance from right edge of travelway to superstructure definition reference line at end (B) (ft)		
>	1	-24	24	-24	24		
- L	RFD fatigue						
	-	ailable to trucks: Truck fraction:	Compute		New Dup	licate	Delete

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

### Structure Typical Section – Wearing surface.

### Enter the data shown below.

A Structure Typical Section	-		×
Distance from left edge of deck to superstructure definition ref. line Deck thickness Ceft overhang			
Deck Deck (cont'd) Parapet Median Railing Generic Sidewalk Lane position Striped lanes Wearing surface			
Wearing surface material: Bituminous Description:			
Wearing surface thickness:     2     in     Thickness field measured (DW = 1.25 if checked)       Wearing surface density:     150     pcf			
Load case: Future wearing surface V Copy from library			
ОК	Apply	Cance	el

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

#### Concrete Stress Limits

A Stress Limit defines the allowable concrete stresses for a given concrete material. Double click on the **Concrete Stress Limits** node in the **Bridge Workspace** tree to open the **Stress Limit Sets – Concrete** window. Enter data shown above the **Compute** button, select **Moderate** for the **Corrosion condition** and select the **PS 6.5 ksi** concrete material from the drop-down menu of the **Concrete material**. Click the **Compute** button. Default values for the allowable stresses will be computed based on the **Concrete material** selected and the AASHTO Specifications. A default value for the **Final allowable slab compression** is not computed since the deck concrete is typically different from the concrete used in the beam. Enter the value shown below for the **LFD Final allowable slab compression**.

A Stress Limit Sets -	Concrete							-		×
Name:	6.5 ksi Cond	rete Stress Li	mit							
Description:	Stress limit	for 6.5 ksi cor	ncrete used i	in beam						
Corrosion condition:	Moderate		~							
Final allowable te	ension stress	limit coef. (US	) override:							
Concrete material:	PS 6.5 ksi		~							
	Compute									
		LFD			LRFD					
Initial allowable comp	pression:	3.3	ksi		3.575	ksi				
Initial allowable tensi	on:	0.2	ksi		0.2	ksi				
Final allowable comp	ression:	3.9	ksi		3.9	ksi				
Final allowable tensio	on:	0.4844069	ksi		0.4844069	ksi				
Final allowable DL co	mpression:	2.6	ksi		2.925	ksi				
Final allowable slab c	ompression:	2.4	ksi			ksi				
Final allowable comp (LL+1/2(Pe+DL))	ression:	2.6	ksi		2.6	ksi				
					C	ж	Apply		Cance	4

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

### Prestress Properties

Double click on the **Prestress Properties** node in the **Bridge Workspace** tree to open the **Prestress Properties** window. Define the prestress properties as shown below. Since the **AASHTO Approximate** method is used to compute the losses, only the information on the **General P/S data** tab is required.

A Prestress Properties				_		×
Name: 1/2" LR AASHTO	Loss					
General P/S data Los	ss data - lump sum Loss data - PCI					
P/S strand material:	1/2" (7W-270) LR	Jacking stress ratio:	0.750	]		
Loss method:	AASHTO Approximate	P/S transfer stress ratio:	0.690			
		Transfer time:	24.0	Hours		
		Age at deck placement:	60.00	Days		
		Final age:	36525.00	Days		
Loss data - AASHTO Percentage DL: 0.0	%					
			OK	Apply	Cance	:I

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

### Shear Reinforcement

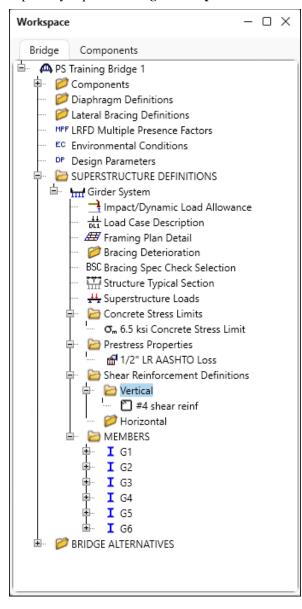
Define shear reinforcement to be used by the girders. Expand the **Shear Reinforcement Definitions** on the **Bridge Workspace** tree, select the **Vertical** node and click on **New** from the **Manage** group of the **WORKSPACE** ribbon (or double click on **Vertical**).

Bridge Workspace - PS Training Bridge 1 BRIDGE WORKSPACE WORKSPACE TOOLS	VIEW	ANALYSIS DESIGN/RATE	REPORTS			?	-		×
A Check Out		g 🖻	New Copy	Paste Duplicate	Delete Schemat	ic			
Workspace       Bridge       Components       Image: PS Training Bridge 1       Image: PS Training Plan Detail	\$ X	Schematic		\$ X	Report				\$ X
Porticing Deterioration     Porticing Spec Check Selection     Tructure Typical Section     H Structure Typical Section     Generate Stress Limits     Generate Stress Limits     Generate Stress Limit     Generate Stress     Ge		Analysis						:	×

Define the stirrup as shown below. Click **OK** to apply the data and close the window.

A Shear Reinforcement Definition - Vertic	al	_		×
Name: #4 shear reinf				
Vertical Shear Reinforcement	Material: Bar size: Number of legs: Inclination (alpha):	pply	Cance	1

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



#### Describing a member:

The **Member** window shows the data that was generated when the structure definition was created. No changes are required in this window. The first Member Alternative created will automatically be assigned as the **Existing** and **Current member alternative** for this Member.

A Member									-		×
Member name: G1				Link with	: None	~	·				
Description:											
E	kisting	Current	Member alte	rnative name	Description						
											-
Number of spans: 1		Span no.	Span length (ft)								
	>	1	120	-							
				-							
							OK	Ар	ply	Cance	el

#### Defining a Member Alternative

Double-click on **MEMBER ALTERNATIVES** in the **Bridge Workspace** tree for member **G1** to create a new member alternative. The **New Member Alternative** window shown below will open. Select **Prestressed** (pretensioned) concrete for the **Material type** and **PS Precast I** for the **Girder Type**.

A New Member Alternative	×
Material type:	Girder type:
Post tensioned concrete	PS Precast Box
Prestressed (pretensioned) concrete	PS Precast I
Reinforced concrete	PS Precast Tee
Steel	PS Precast U
	OK Cancel
	OK Cancel

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

The **Member Alternative Description** window will open as shown below. Enter the data as shown below. The **Schedule based Girder property input method** is the only input method available for a prestressed concrete beam.

Member alternative:       Precast I Beam Alternative         Description       Specs       Factors       Engine       Import       Control options         Description:       Material type:       Prestressed (Pretensioned)       Girder type:       PS Precast I         Modeling type:       Multi Girder System       Default units:       US Customary       V         Girder property input method       Official self load       Default rating method:       LFR       V         Additional self load:       %       Default rating method:       LFR       V         Crack control parameter (Z)       Exposure factor       Top of beam:       Use creep         Bottom of beam:       kip/in       Bottom of beam:       Use creep	Description       Specs       Factors       Engine       Import       Control options         Description:       Material type:       Prestressed (Pretensioned)         Girder type:       PS Precast I         Modeling type:       Multi Girder System         Default units:       US Customary         Girder property input method       Schedule based         Cross-section based       Default rating method:         Load case:       Engine Assigned         Additional self load:       %         Crack control parameter (Z)       Exposure factor         Top of beam:       Use creep		-					scription	rnative Des	Member Alter
Description:       Material type:       Prestressed (Pretensioned)         Girder type:       PS Precast I         Modeling type:       Multi Girder System         Default units:       US Customary         ©       Schedule based         Cross-section based       Default rating method:         Load case:       Engine Assigned         Additional self load:       %         Crack control parameter (Z)       Exposure factor         Top of beam:       kip/in       Top of beam:	Description:       Material type:       Prestressed (Pretensioned, Girder type:         Girder type:       PS Precast 1         Modeling type:       Multi Girder System         Default units:       US Customary v         Girder property input method       Schedule based         Cross-section based       Default rating method:         Load case:       Engine Assigned v         Additional self load:       %         Crack control parameter (Z)       Exposure factor         Top of beam:       Use creep						Alternative	cast I Beam	tive: Pred	Member alterna
Girder type: PS Precast I Modeling type: Multi Girder System Default units: US Customary V Girder property input method Schedule based Cross-section based Self load Load case: Engine Assigned Additional self load: kip/ft Additional self load: % Crack control parameter (Z) Exposure factor Top of beam: Use creep	Girder type: PS Precast I Modeling type: Multi Girder System Default units: US Customary v Girder property input method Schedule based Cross-section based Self load Load case: Engine Assigned Lifk v Additional self load: kip/ft Additional self load: % Crack control parameter (Z) Exposure factor Top of beam: Use creep				Control options	Import	Engine	Factors	Specs	Description
Modeling type: Multi Girder System   Default units: US Customary     Girder property input method   Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   LFR     Additional self load:   %     Crack control parameter (Z)   Exposure factor   Top of beam:     Use creep	Modeling type: Multi Girder System   Default units: US Customary     Girder property input method   Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   LFR     Additional self load:   %     Crack control parameter (Z)   Exposure factor   Top of beam:     Use creep			Prestressed (Pretensioned)	Material type:					Description:
Girder property input method   Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   LFR     Additional self load:   %     Crack control parameter (Z)   Top of beam:     Use creep	Girder property input method   Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   Lift   Additional self load:   %     Crack control parameter (Z)   Exposure factor   Top of beam:     Use creep			PS Precast I	Girder type:					
Girder property input method   Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   Additional self load:   %     Crack control parameter (Z)   Top of beam:     Use creep	Girder property input method   Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   Additional self load:   %     Crack control parameter (Z)   Top of beam:     Use creep			Multi Girder System	Modeling type:					
Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   LFR     Additional self load:   %     Crack control parameter (Z)   Top of beam:     Use creep	Schedule based   Cross-section based     Self load   Load case:   Engine Assigned   Additional self load:   kip/ft   Additional self load:   %     Crack control parameter (Z)   Top of beam:     Use creep			US Customary V	Default units:					
Load case: Engine Assigned   Additional self load: kip/ft   Additional self load: %    Crack control parameter (Z)  Crack control parameter (Z)  Top of beam:  Use creep	Load case:       Engine Assigned          Additional self load:       kip/ft         Additional self load:       %         Crack control parameter (Z)       Exposure factor         Top of beam:       Use creep			thod:	Default rating me					Cross
Additional self load:       kip/ft         Additional self load:       %         Crack control parameter (Z)       Exposure factor         Top of beam:       Top of beam:         Use creep	Additional self load:       kip/ft         Additional self load:       %         Crack control parameter (Z)       Exposure factor         Top of beam:       Use creep					~	signed	Engine As	:	
Additional self load:     %       Crack control parameter (Z)     Exposure factor       Top of beam:     Use creep	Additional self load:     %       Crack control parameter (Z)     Exposure factor       Top of beam:     Use creep								I self load:	Additiona
Top of beam: Top of beam: Use creep	Top of beam: Top of beam: Use creep						=		l self load:	Additiona
Use creep	Use creep				re factor	Exposu		eter (Z)	trol param	Crack cont
					beam:	Top of	kip/in		am:	Top of bea
				Ose creep	n of beam:	Bottom	kip/in		f beam:	Bottom of
	OK Apply	Cancel	Apply	ОК						

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

#### Beam Details

Expand the newly added member alternative in the workspace. Next describe the beam by double clicking on the **Beam Details** node in the **Bridge Workspace** tree. Enter the data in each tab of the **Beam Details** window as shown below.

pan	detail	Stress lin	nit ranges	Slab int	terface Web e	nd block				Beam r	projection	
	Span number		Beam shape		Girde mater		Prestress properties		n	Left end (in)	Right end (in)	
>	1	BT-72		$\sim$	PS 6.5 ksi	~	1/2" LR AASHTO Loss	~		6	6	1

Navigate to the **Stress limit ranges** tab and enter data as shown below. Note that the **Stress limit ranges** are defined over the entire length of the precast beam, including the projections of the beam past the centerline of bearing which were entered on the **Span detail** tab of this window.

ean									
par	n detail	Stress limit ranges Slab interface	e Web e	nd block					
	Span number	number		Length (ft)	End distance (ft)				
>	1 ~	6.5 ksi Concrete Stress Limit $$	0	121	121				-
									~
						New	Duplicate	Dele	ete
						New	Duplicate	Dele	

A	Beam Details			-		×
	Span detail	Stress limit ranges	Slab interface	Web end block		
	Interface type	:	Intentionally	Roughened 🗸		
	Default interfa	ace width to beam widt	ths: 🔽			
	Interface widt	h:		in		
	Cohesion fact	or:	0.1	ksi		
	Friction factor	:	1			
	K1:		0.3			
	K2:		1.8	ksi		
				OK Apply	Cancel	

Navigate to the **Slab interface** tab and enter data as shown below.

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

### Strand Layout

Expand the tree under **Strand Layout** and open the **Span 1** window. Use the **Zoom** buttons on the right side of this window to shrink/expand the schematic of the beam shape so that the entire beam is visible.

Select the **Description type** as **Strands in rows** and the **Strand configuration type** as **Harped**. The **Mid span** radio button will now become active. Strands can now be defined at the middle of the span by selecting strands in the right hand schematic. Select the bottom 44 strands in the schematic so that the CG of the strands is 5.82 inches and click the **Apply** button.

🕰 Strand Layout - Span 1				-	×
Description type P and CGS only  Strands in ro	NMC				Ŧ
	5W5		Showd positions generated by the ORIGINAL method. Pleases refer to Prage for a description of the method.		
Strand configuration type	Symmetry		$\times \times$		
Straight/Debonded					
Harped					
O Harped and straight debonded					
Mid span					
Left end	Harp point locations		×× ××		
Right end Right	Distance (ft)	Radius (in)			
Left	0.00	0.0000			
Right	0.00	0.0000			
	OK A	pply Cancel	<image/>		

Now select the **Left end** radio button to enter the following harped strand locations at the left end of the precast beam. Place the cursor in the schematic view on the right side of the screen. The strands can be defined at the left end of the span by selecting strand locations in the right hand schematic. Select the top 10 strand locations in the schematic so that the CG of the strands is 18.09 inches.

🕰 Strand Layout - Span 1			_	×
Description type			🗈 🖹 🕄 🔍 🕂 🗃 🗟 🗮 100%	
O P and CGS only       Strands in rot	WS		Nafasi: Shawd pushters generated by Rix OVSCRNUL method. Pissee sufw to help for a discription of the method.	
Strand configuration type	✓ Symmetry		••	
Straight/Debonded	_ , ,			
Harped				
<ul> <li>Harped and straight debonded</li> </ul>			×× ××	
O Mid span				
Left end	Harp point locations		×× ××	
Right end Right	Distance (ft)	Radius (in)		
Left	48.50	0.0000 -		
Right	48.50	0.0000	**	
	ОК Аррі	y Cancel	Image: Control of the conton of the control of the control of the control of the	

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

### Deck Profile

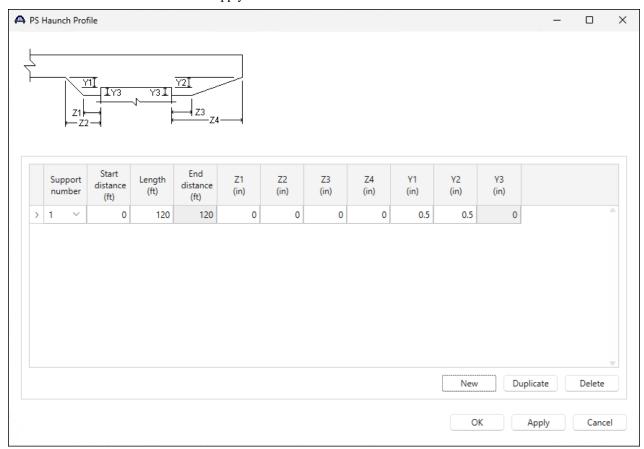
Next open the **Deck Profile** window by double-clicking the **Deck Profile** node in the **Bridge Workspace** tree and enter the data describing the structural properties of the deck. The window is shown below.

4	Dec	k Profile													-		×
-		PS Precast k concrete	Reinfo	rcem	ent												
		Material S n		Su	Support number (ft)		Length (ft)	End distance (ft)	Structural thickness (in)	Start effective flange width (Std) (in)	End effective flange width (Std) (in)	Start effective flange width (LRFD) (in)	End effective flange width (LRFD) (in)				
	>	Deck Cond	rete 🗸	1	~	0	120	120	7.5		90					-	
		Compute fr typical secti												New Duplicate		Delete	
														OK Apply		Cance	ł

No reinforcement is described. Click **OK** to apply the data and close the window.

#### Haunch Profile

The haunch profile is defined by double-clicking on the **Haunch Profile** node in the **Bridge Workspace** tree. Enter data as shown below and Click **OK** to apply the data and close the window.



#### Shear Reinforcement Ranges

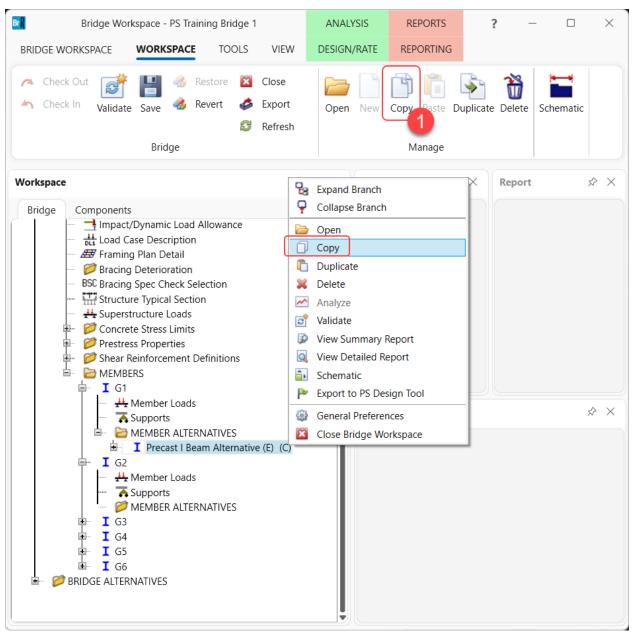
Double-click on the **Shear Reinforcement Ranges** node in the **Bridge Workspace** tree to open the **PS Shear Reinforcement Ranges** window. The shear reinforcement ranges are entered as described below. The vertical shear reinforcement is defined as extending into the deck on the **Vertical** tab of this window. This indicates composite action between the beam and the deck. Data does not have to be entered on the **Horizontal** tab to indicate composite action since that has been defined by extending the vertical bars into the deck.

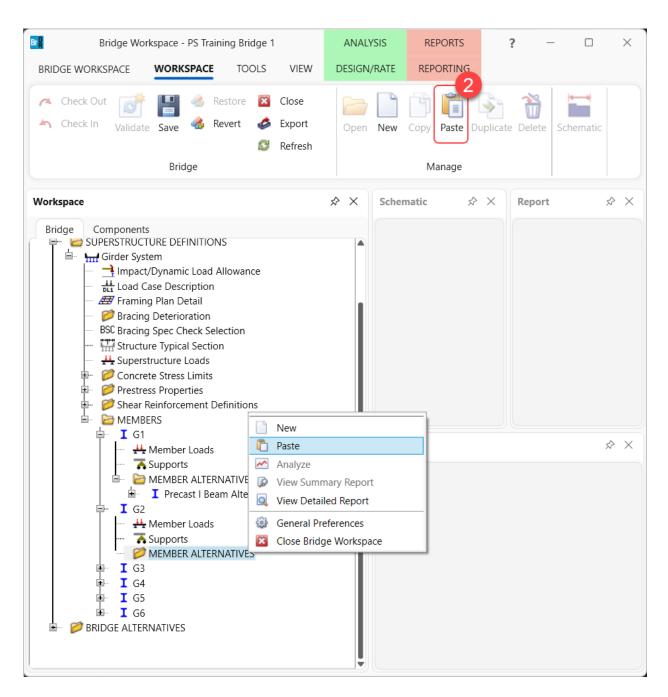
-	△ Start Distance	Spacir	na						
Verti	ical Horizontal								
spar	n: <u>1 ~</u>								
	Name	Extends into deck	Start distance (ft)	Number of spaces	Spacing (in)	Length (ft)	End distance (ft)		
>	#4 shear reinf $\sim$		0.5	1	0	0	0.5		-
	#4 shear reinf $\sim$	$\sim$	0.5	120	12	120	120.5		
S	Stirrup wizard	Stirrup desig	gn tool	View calcs			New	Duplicate	Delete

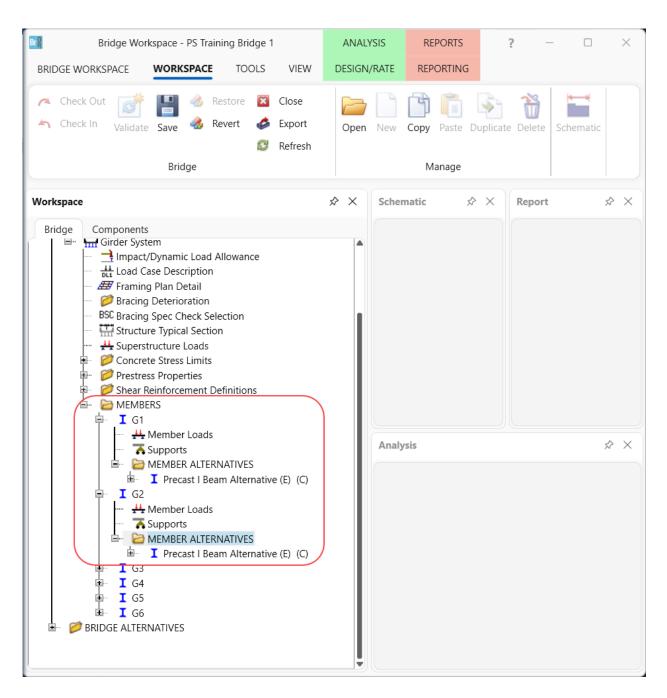
Click **OK** to apply the data and close the window.

#### Live Load Distribution

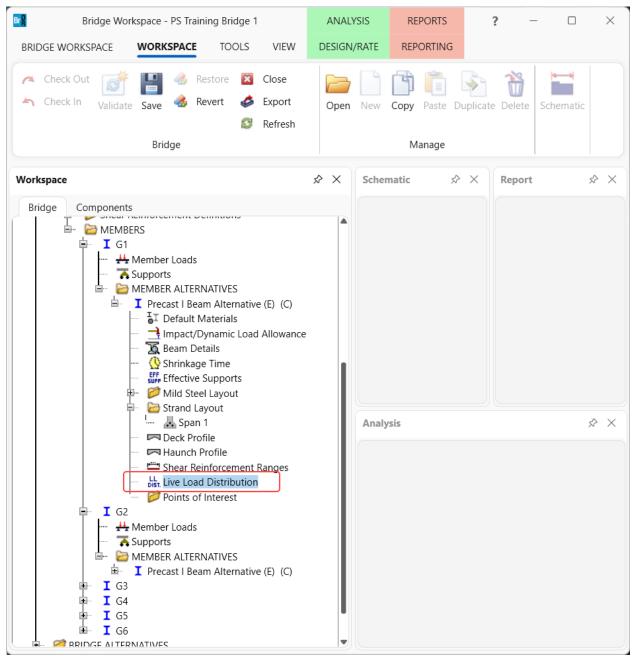
To compute the LRFD live load distribution factors, the interior girder adjacent to exterior girder must be defined. BrDR uses the beam shape assigned to this member alternative and the beam shapes assigned to the adjacent member alternatives to compute the distribution factors. If the **Compute from typical section...** button is used on this window without the adjacent girder defined, BrDR will throw a warning message indicating that since beam shapes are not assigned to adjacent member alternative, BrDR cannot calculate the distribution factors. In this case, the factors will have to be manually entered. For this example, copy the **Precast I Beam** member alternative of member **G1** and paste to **G2** as a member alternative.







Double click on the Live Load Distribution node in the Bridge Workspace tree for member G1 to open the Live Load Distribution window.



Navigate to the **LRFD** tab of this window. Click the **Compute from typical section . . .** button to compute the LRFD live load distribution factors.

🗛 Live	Load Distri	bution									_		×
Star	ndard LF	RFD											
	Distribution	factor input	method -										
	O Use sir			Use advanced	method								
							vith routine traf	TIC					
Ac	tion: Deflec	tion ∨	Su	fficiently conne	cted to act	as a unit							
	Support	Start	Length	End distance		tion factor ines)							
	number	distance (ft)	(ft)	(ft)	1 lane	Multi-lane							
													•
	ompute fro pical sectio	m n V	iew calcs						New	Duplicat	e	Delete	
									ОК	Apr	bly	Canc	el

The LRFD Distribution Factor Progress window opens as shown below.

А	LRFD Distribution Factor Progress	×
	<ul> <li>Info: Generating model domain for line girder analysis</li> <li>Info: Finished generating model domain for line girder analysis</li> <li>Info: Computing contraflexure ranges for Stage 3 Span Model</li> <li>FEA - Beam Contraflexure Ranges - Initiating finite element analysis</li> <li>FEA - Beam Contraflexure Ranges - Creating nodes</li> <li>FEA - Beam Contraflexure Ranges - Creating genemets</li> <li>FEA - Beam Contraflexure Ranges - Creating support constraints</li> <li>FEA - Beam Contraflexure Ranges - Creating support constraints</li> <li>FEA - Beam Contraflexure Ranges - Verifying finite element model</li> <li>FEA - Beam Contraflexure Ranges - Verifying finite element model</li> <li>FEA - Beam Contraflexure Ranges - Preparing linear solution</li> <li>FEA - Beam Contraflexure Ranges - Performing linear solution</li> <li>FEA - Beam Contraflexure Ranges - Successful finite element analysis</li> <li>Info: Finished computing contraflexure ranges for Stage 3 Span Model</li> <li>Info: Finished computing LRFD live load distribution factors</li> <li>Info: Finished processing live load distribution factors</li> <li>Info: Finished processing live load distribution factor ranges for Stage 3 Span Model</li> <li>Info: Finished processing live load distribution factors</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>Info: Finished processing live load distribution factor stage 3 Span Model</li> <li>In</li></ul>	< > >
	Print OK	

Once the analysis is complete, click **OK** to close this window. The **Live Load Distribution** window is now populated with the distribution factors. Uncheck the **Allow distribution factors to be used to compute effects of permit loads with routine traffic checkbox** and click **OK** to apply these factors and close the window. If these are left blank, BrDR will compute them during the analysis runtime.

🗛 Live	Load Distrib	oution							-		×
Stan	idard LR	FD									
	Distribution	factor input	method								
	🔘 Use sim	plified met	hod	Use advanced	method						
	Allow distr	ibution fact	ors to be u	sed to compute	offects of r	permit loads w	vith routine traffic				
							with routine traine				
Act	ion: Deflect	tion ~	Su	fficiently conne	cted to act	as a unit					_
	Support	Start distance	Length	End distance		ition factor anes)					
	number	(ft)	(ft)	(ft)	1 lane	Multi-lane					
	1 ~	0	120	120	0.2	0.4333333				4	
										1	
ty	ompute fron pical sectior	n V	iew calcs					New Duplicat	te	Delete	
								ОК Ар	ply	Cance	<u>+</u>

The description of an exterior beam for this structure definition is complete.

## LRFR Analysis

The member alternative for girder G1 can now be analyzed. To perform an LRFR rating, select the Analysis Settings button on the Analysis group of the DESIGN/RATE ribbon.

Bridge Works	pace - PS Training Bridge	1	ANALYSIS	REPORTS	?	_	×
BRIDGE WORKSPACE	WORKSPACE TOOLS	VIEW	DESIGN/RATE	REPORTING			
a 🛤		☞ 🕉	2 🖪				
Analysis Analyze Analysis Settings Events	Tabular Specification Results Check Detail C						
Analysis	Res	ults					

#### Click the **Open template** button.

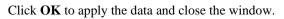
Analysis Settings						_		×
Design review	Rating		Rating me	thod:	LFR	~		
Analysis type:	Line Girder	~						
Lane / Impact loading type:	As Requested	~	Apply pret	erence setting:	None	~		
Vehicles Output Er	ngine Description							
Traffic direction: Both direction	rections ~			Refresh	Temporary vehicles	Advanced	)	
Vehicle selection			N	/ehicle summar	y			
└	itary Loading		Add to >> Remove from <<	- Rating vehic - Inventor - Operatin - Legal op - Permit in - Permit c	ry ng perating			
Reset Clear	Open template	Save	template		ОК	Apply	Canc	el

	Templates	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	
T	LRFR Legal Load Rating	LRFR Legal Load Rating	LRFR		Public	

#### Select the LRFR Design Load Rating to be used in the rating and click Open.

The Analysis Settings window will be populated as shown below.

Analysis Settings					_	×
Design review O Rating		Rating metho	d:	LRFR	~	
Analysis type: Line Girder	~					
ane / Impact loading type: As Requested	~	Apply prefere	nce setting:	None	~	
Vehicles Output Engine Description						
Traffic direction: Both directions			Refresh	Temporary vehicles	Advanced	
<ul> <li>➡ Vehicles</li> <li>➡ Standard</li> <li>↓ = EV2</li> <li>↓ = EV2</li> <li>↓ = H 15-44</li> <li>↓ + 120-44</li> <li>↓ + H293 (SI)</li> <li>↓ - H293 (SI)</li> <li>↓ - H293 (SI)</li> <li>↓ - H293 (SI)</li> <li>↓ - SU6</li> <li>↓ - Type 3.3</li> <li>↓ - Type 3.4</li> <li>↓ - Type 3.52</li> <li>→ Agency</li> <li>↓ - User defined</li> <li>↓ - Temporary</li> </ul>		Add to	E-Legal	les yn load rating ywentory HL-93 (US) yeperating HL-93 (US) titgue LRPD Fatigue Truck (US I load rating outine pecialized hauling it load rating	)	

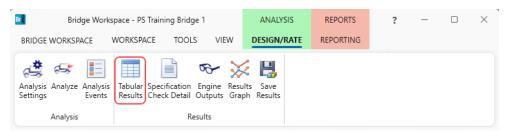


#### Tabular Results

With member alternative **Precast I Beam Alternative** for member **G1** selected, click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.

Bridge Work	space - PS Training Brid	ge1	ANALYSIS	REPORTS	?	_	$\times$
BRIDGE WORKSPACE	WORKSPACE TOOL	S VIEW	DESIGN/RATE	REPORTING			
a 🖙 🗉		∞ 🖗	2 📙				
Analysis Analyze Analysis Settings Events	Tabular Specification Results Check Detail						
Analysis	R	esults					

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



The window shown below will open. Select **Rating Results Summary** as the **Report Type** and **Single rating level per row** as the **Display Format** option to have the ratings arranged as shown below.

🗛 Analysis Re	sults - Precast I Bea	am Alternative								- 0	Х
Print Print											
Report type:		Lane/Impact	loading typ	e	Display Forma	t					
Rating Results	Summary 🗸		uested	Detailed	Single rating	level per ro	w ~				
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	42.44	1.179	60.00	1 - (50.0)	SERVICE-III PS Tensile Stress	As Requested	As Requested	1
HL-93 (US)	Truck + Lane	LRFR	Operating	62.30	1.731	60.00	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
HL-93 (US)	Tandem + Lane	LRFR	Inventory	50.32	1.398	60.00	1 - (50.0)	SERVICE-III PS Tensile Stress	As Requested	As Requested	
HL-93 (US)	Tandem + Lane	LRFR	Operating	73.86	2.052	60.00	1 - (50.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
ASHTO LRFR E	ngine Version 7.5.1	1.3001									
nalysis prefere	nce setting: None										
										Clo	se
							0.0.0				

## LRFD Design Review

An LRFD design review of this girder for **HL93** loading can be performed by AASHTO LRFD. To perform an LRFD design review, enter the **Analysis Settings** window as shown below or select the **HL 93 Design Review** template from the Open Template button as shown in the previous section.:

Analysis Settings	- 🗆 ×	(
Design review Rating	LRFD	
Analysis type: Line Girder $\checkmark$		
Lane / Impact loading type: As Requested $\checkmark$ Apply preference setting:	None ~	
Vehicles Output Engine Description		
Traffic direction: Both directions ~ Refresh	Temporary vehicles Advanced	
Vehicle selection Vehicle summary		
<ul> <li>Vehicles</li> <li>Standard</li> <li>Alternate Military Loading</li> <li>EV2</li> <li>EV3</li> <li>HL-93 (SI)</li> <li>HL-93 (US)</li> <li>HS 20 (SI)</li> <li>HS 20-44</li> <li>LRFD Fatigue Truck (SI)</li> <li>LRFD Fatigue Truck (US)</li> <li>Agency</li> <li>User defined</li> <li>Temporary</li> </ul>	ads ¢ (US) ads	
Reset         Clear         Open template         Save template	OK Apply Cancel	]

#### Analysis Settings - Output

O Design review	Rating	Design method:	LRFD	$\checkmark$	
alysis type:	Line Girder ~				
ne / Impact loading type:	As Requested ~	Apply preference setting:	None	~	
Vehicles Output E	ngine Description				
Tabular results		AASHTO engine rep	ports		
Dead load action	report	🚞 Miscellaneous r	eports:		
Live load action re		Girder prop	perties		
	te summary report	🔽 Summary ir	nfluence line loading		
LRFD critical loads		Detailed int	fluence line loading		
		Capacity su	immary		
LRFD specification		Capacity de	etailed computations		
PS concrete stress		FE model fo	or DL analysis		
RC service stress I			or LL analysis		
Steel limit state su	ummary report		e lines FE model		
			e lines FE actions		
			actor computations		
			actor summary		
		Regression	-		
		Camber	uata		
		Fatigue stre	200 500 000		
			ress ranges		
		Service if st	-		
			conc article detailed		
Select all Clear	all	Select all Cle	ear all		

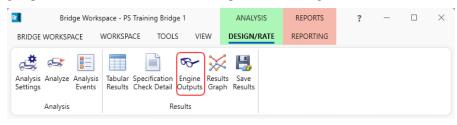
Navigate to the **Output** tab and enter the **Analysis Settings** as shown below.

#### **Engine Outputs**

Next with member alternative **Precast I Beam Alternative** for member **G1** selected click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon to perform the design review.



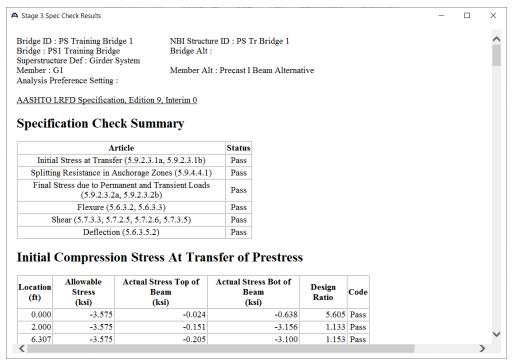
AASHTO LRFD analysis will generate a spec check results file. Click the **Engine Outputs** button from the **Results** group of the **DESIGN/RATE** ribbon to open the following window.



A PS Training Bridge 1	_	×

To view the LRFD spec check results (shown below), double click on the **Stage 3 Spec Check Results** under the AASHTO\_LRFD branch in this window.

The following file opens.



AASHTOWare BrDR 7.5.1 Feature Tutorial HLP1– Help Features

## Topics Covered

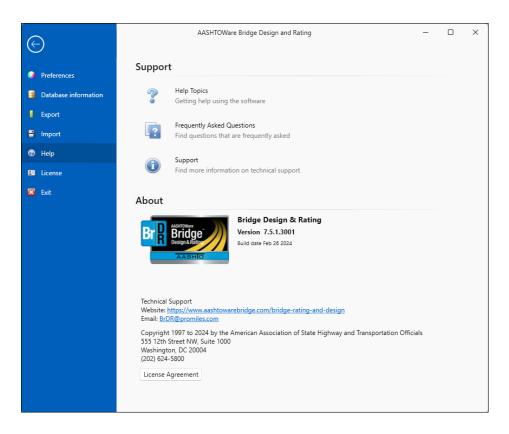
This topic describes the various help features and training available in BrDR.

- Online Help
- Engine Related Help
- Limitations Help Topic
- Training Aids

## Online Help (BrDR 7.5.1)

There are many different online help files available in BrDR. To access BrDR help, open BrDR, click on **Bridge Explorer** and select **Help** from the left ribbon to open the following Help options.

Br			AASHTOWare Brid	ge Design and Rating	?	- 0	$\times$
BRIDGE EXPLORER BRID	GE FOLDER	RATE	TOOLS VIEV	V			
New Open Batch ~	Find Copy Pas	ste Copy To~	Remove Delete From				
		BID	Bridge ID	Bridge Name		Distric	
🧭 Recent Bridges			rainingBridge1	Training Bridge 1(LRFD)		Unknov	
🖙 📁 All Bridges			rainingBridge1	Training Bridge 2(LRFD)		Unknov	
🗄 🏓 Templates			rainingBridge3	Training Bridge 3(LRFD)		Unknov	
🗁 📁 Deleted Bridges			CITrainingBridge1	PCI TrainingBridge1(LFR)		OTIKITOV	
			CITrainingBridge2	PCITrainingBridge2(LRFD)			- II
			CITrainingBridge3	PCI TrainingBridge3(LFR)			
			CITrainingBridge4	PCITrainingBridge4(LRFD)			
			CITrainingBridge5	PCI TrainingBridge5(LFR)			
			CITrainingBridge6	PCITrainingBridge6(LRFD)			
			xample7	Example 7 PS (LFR)			
			CTrainingBridge1	RC Training Bridge1(LFR)			
			imberTrainingBridg	e1 Timber Tr. Bridge1 (ASR)			
		4					
				Total Bridge Count:	31		



- Selecting **Help Topics** from the menu opens the BrDR help file where you can view the **Contents**, the **Index** and **Search** for specific words.
- Selecting **Frequently Ask Questions** from the menu opens a BrDR help file containing Basic, Technical and Non-Technical frequently asked questions about BrDR.
- Selecting **Support** from the menu opens the Support page of BrDR help with technical support information and license support options.

Online, context-sensitive help is available in each window of BrDR by clicking the F1 button while a window is open. This will open the BrDR help topic for that window.

## Engine-Related Help

BrDR has been designed to enter data describing the physical characteristics of a bridge irrespective of the analysis engine that will be used to analyze the bridge. Therefore, there may be some data in BrDR that may not be used by a particular analysis engine. Each BrDR help topic contains a link to **Engine Related Help** that helps determine which data is not used by the configured engine.

Engine Related help can be configured from the **Bridge Workspace** for a selected bridge. The steps to configure Engine related help are as follows:

1. Open the Bridge Workspace for the bridge you wish to access/set up Engine related help.

Bridge Worksp	pace - TrainingBridg	e1	ANALYSIS	REPORTS	?	_		$\times$
BRIDGE WORKSPACE	RKSPACE TOO	LS VIEW	DESIGN/RATE	REPORTING				
A Check Out		🔀 🍻 Close Export F	Refresh Open		Paste Duplicate	) Delete	Schematic	
Workspace	shuge ☆ ×	Schematic			Report		\$	· ×
Bridge Components								

Click on the Help button (1) on the leftmost column. Select the relevant Engine Help (2) you wish to access for this bridge during this session from the Engine Help menu. The selected Engine Help and its Method of Solution gets populated on the Engine Help Configuration (3) menu on the right side, as shown below:

$\bigcirc$	Bridge Workspace - TrainingBridge1	-	×
🖶 Print 👝	Support		
Telp	Help Topics Getting help using the software		
🕱 Close	Frequently Asked Questions Find questions that are frequently asked		
	G Support Find more information on technical support		
	Engine	3	
	Engine Help Engine Help Configura	ation	
	AASHTO Culvert LRFD Engine Help		
	AASHTO Culvert LRFR Method of Solution		
	AASHTO LFR 2		
	AASHTO LRFD		
	AASHTO LRFD Substructure (BrD)		
	AASHTO LRFR		
	AASHTO Metal Culvert LFR		
	AASHTO Matal Culvart I RER		
	Set As Main Engine Help		

3. Click on the **Set As Main Engine Help** button to set the above selected engine help as the **Default Engine Help** as shown below:

Engine	
Engine Help	Engine Help Configuration
AASHTO Culvert LRFD	Engine Help
AASHTO Culvert LRFR	Method of Solution
AASHTO LFR	
AASHTO LRFD Default Engine Help	
AASHTO LRFD Substructure (BrD)	1
AASHTO LRFR	
AASHTO Metal Culvert LFR	
AARHTO Metal Cubrert LRER	•
Set As Main Engine Help	

4. The engine help has been configured and can be accessed from any help topic that contains an Engine Related Help link. For example, the BrDR help for Bridge Materials – Reinforcing Steel contains a link to its respective Engine Related Help as shown below:

<sub>2</sub> AASHTOWare BrDR - Help	- 🗆 X
T (	
Contents Index Search	Bridge Materials - Reinforcing Steel
E-∲ Getting Started	This window allows you to enter material properties for reinforcing steel. The reinforcing steel can be used in the deck, in reinforced concrete beams, or in other reinforced concrete members. You can also copy material properties from the library. Enter the required information and click the OK button.
	Engine Related Help
	Name
	Enter the name assigned to the reinforcing steel.

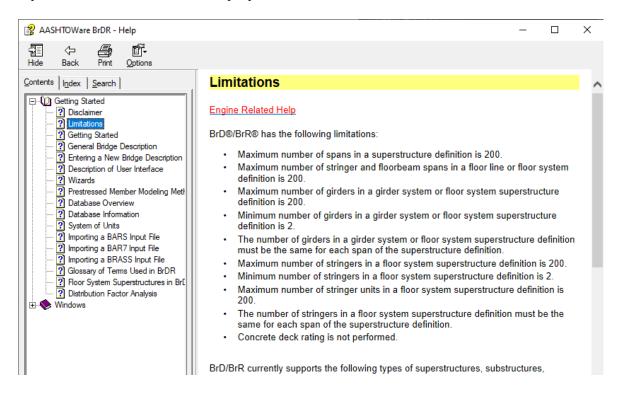
5. Clicking on the **Engine Related Help** link redirects to the **AASHTO LRFD Engine help** for Bridge Materials – Reinforcing Steel as shown below:

🔗 AASHTOWare BrDR - Help	- 0	×
1 다 🚑 🗊 Hide Back Print Options		
Contents Index Search	Bridge Materials - Reinforcing Steel (AASHTO LRFD/LR	FR)
<ul> <li>➡ Getting Started</li> <li>➡ Windows</li> </ul>	Description Not used by AASHTO LRFD/LRFR.	

## Limitations Help Topic

The **Limitations** help topic, available in **BrDR Help**, merits special attention. This topic should be reviewed to determine if BrDR supports a particular type of bridge. An **Engine Related Help** link is also available to describe any analysis engine limitations.

A portion of the BrDR Limitations help topic is shown below:



## Training Aids

The BrDR Technical Support website contains example problems that can be used as self-study guides for new users. The BrDR Technical Support website address is

https://www.aashtowarebridge.com

The Training section of this website

https://www.aashtowarebridge.com/bridge-rating-and-design/training

contains approximately 150 example problems for various activities such as entering different bridge and girder types, importing/exporting, rating, etc.

# **2024 RADBUG Annual Meeting**



## **BrD Training Session**

Wednesday August 7, 2024 10:00 AM – 12:00 AM

- 1. LRFD Cb Calculation using Concurrent Moments
- 2. Steel Design Tool Two Span Girder Design

AASHTOWare BrDR 7.5.1

Steel Tutorial STL14-LRFD Cb Calculation using Concurrent Moments Example

## AASHTOWare Bridge Design and Rating Training

STL14 –LRFD Cb Calculation using Concurrent Moments Example

#### Topics Covered

- Modify STL2 Example Bridge
- Cb Calculation Control Option
- Cb Calculation Comparison

#### Features (introduced in version 7.5.0):

- LRFD Analysis Control option: "Consider concurrent moments in Cb calculation"
- LRFR Analysis Control option: "Consider concurrent moments in Cb calculation"

This tutorial demonstrates how to select the calculation method for the AASHTO LRFD Cb moment gradient factor. By default, the moment gradient factor is computed using the envelope actions at brace points. The control option to consider concurrent moments in Cb calculation will compute the factor using concurrent moments at brace points. The concurrent brace moment reports and the changes to the spec output for concurrent actions are presented.

#### Modify STL2 Example Bridge

Start with the completed STL2 example bridge. This is a two-span steel girder system bridge with four girders. Follow the steps below to modify the structure definition. The moment gradient factor is used to compute the lateral torsional buckling resistance, so the girder is modified so that the lateral torsional buckling resistance controls the flexural capacity over the interior support.

Import the STL2 example bridge and open the copied structure. Update the **Bridge ID**, **NBI structure ID**, **Name** and **Description**. Select **OK** to apply the data and close the window.

Cb Factor							_		×
Bridge ID: Cb Factor	NB	l structure ID (8)	Cb Factor		Template Bridge compl	etely defined	Bridge Workspace View Superstructures Culverts Substructures		
Description Desc	ription (cont'd) Alte	ernatives Glo	bal reference point	Traffic	Custom agency fie	lds			
Name:	Cb Factor Example Br	idge			Year built:				
Description:	Cb moment gradient	factor calculatio	n example						
							1.		
Location: Facility carried (7):					Length: Route number:	180	ft		
Feat. intersected (6):					Mi. post:				
Default units:	US Customary	~							
Bridge associa		BrD B	rM						
Bridge associa	Brk	BrD B	nvi						
						0	K Apply	Cance	el
						·			

Open the **Superstructure Definition** window and update the superstructure name as shown below.

		ne					
Name: E	nvelope Moments						Modeling
	? Span 4 Girder Syste actor	m using e	envelope	moments to compu	ute Cb moment	t gradient	Multi-girder system MCB     With frame structure simplified definition Deck type:
							Concrete Deck $\sim$
Default units: U	S Customary V			lengths eference			For PS/PT only Average humidity:
Number of girders:	4 🗘		Span	Length (ft)			%
		>	1 2	90			Member alt. types Steel P/S R/C Timber
	a along reference "						D/T
lla in the second	along reference line		from DC	to first support line:		ft	
Horizontal curvatur	ature		TOTTPC	to first support fille.		ft	
Horizontal cur			ent lena	the			
	alignment	Start tang	jent leng	th:		ft	
Horizontal cur Superstructure	alignment		_	th:	Left V	ft	
Horizontal cur Superstructure	alignment	Start tang Radius:			Left v	ft	
Horizontal curr Superstructure Curved Tangent, c	urved, tangent urved	Start tang Radius: Direction: End tange	ent lengt		Left 🗸		
Horizontal curved Curved Tangent, c	alignment urved, tangent urved ngent	Start tang Radius: Direction: End tange	ent lengt	h:	Left v	ft	
Horizontal curved Curved Tangent, c	alignment urved, tangent urved ngent	Start tang Radius: Direction: End tange Distance f	ent lengt from last peed:	h:	Left ~	ft ft	

#### Structure Framing Plan Details

Within the **Framing Plan Detail window**, update the diaphragm definitions. Navigate to the **Diaphragms** tab and update the diaphragm spacing for **Girder bay 1** as shown below. Select **Apply** to apply the data and keep the window open. Then click on the **Copy bay to...** button and copy the diaphragms to **Bay 2** and **Bay 3** as shown below.



		Copy bay to	wiz	hragm ard		c	ind				
Support distance Diaphragm Number		Number of spaces				Load (kip)	Diaphragm				
	Left girder	Right girder	(ft)			Left girder	Right girder	. 17			
1 \	< 0	0	0	1	0	0	0		Not Assigned	$\sim$	
1	< 0	0	30	2	60	60	60		Not Assigned	$\sim$	
2	< 0	0	0	1	0	0	0		Not Assigned	$\sim$	
2	< C	0	30	2	60	60	60		Not Assigned	~	

Girder Bays 2 and 3:

🕰 Copy Diaphragm B	ay	×
	Bay 2	
Select the new bay(s):	Bay 3	
	Apply Cance	el

## Framing Plan Schematic

Review the **framing plan schematic** to verify the framing plan details are correct.

Framing Plan							– 🗆 ×
i 🗈 📐 Q, Q, 🕂 🛃 🗟 🛏	97% 🗸						÷
Cb Factor Cb Factor Example Bridge - Envelope Moments = 10/20/2023							
+	90-0		*	901	-o*	+	
1.1	1-2	1-3	G1 5	1-5	1-6	5	
P			P90	deg		90.0 deg	
2-1	2-2	2-3	G22-4	26	2-6		
P			10			10	
3-1	3-2	3-3	G3 <sub>0-4</sub>	3-5	3-6	a la	
			G4			Ĩ,	
			34				

#### Girder Profile

Update the **girder profile** for the **G2** member alternative in each tab as shown below.

late Giro	der											
Top f	lange Bot	tom flan	ge									
Begin depth (in)	Depth vary	End depth (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld at right			
45	None 🗸	45	0.5	1 ~	0	180	180	Grade 50W $\sim$	None 🚿	/		-
												v
	Top f Begin depth (in)	Top flange Bot Begin depth Depth vary	Top flange Bottom flan Begin (in) Depth vary End depth (in)	Top flange     Bottom flange       Begin (in)     Depth vary     End depth (in)     Thickness (in)	Top flange     Bottom flange       Begin (in)     Depth vary     End depth (in)     Thickness (in)     Support number	Top flange     Bottom flange       Begin (in)     Depth vary     End depth (in)     Thickness (in)     Support number     Start distance (ft)	Top flange     Bottom flange       Begin (in)     Depth vary     End depth (in)     Thickness (in)     Support number     Start distance (ft)     Length (ft)	Top flange     Bottom flange       Begin (in)     Depth vary     End depth (in)     Thickness (in)     Support number     Start distance (ft)     Length (ft)     End distance (ft)	Top flange     Bottom flange       Begin (in)     Depth vary     End depth (in)     Thickness (in)     Support number     Start distance (ft)     Length (ft)     End distance (ft)     Material	Top flange     Bottom flange       Begin (in)     Depth vary       Length (in)     Thickness (in)       Support (in)     Start (in)       Material (in)     Weld at right	Top flange     Bottom flange       Begin depth (in)     Depth vary       Image: Given the strength (in)     Thickness (in)       Support (in)     Support (in) <t< td=""><td>Top flange     Bottom flange       Begin (in)     Depth vary (in)     End depth (in)     Thickness (in)     Support number     Start distance (ft)     Length (ft)     End distance (ft)     Weld at right</td></t<>	Top flange     Bottom flange       Begin (in)     Depth vary (in)     End depth (in)     Thickness (in)     Support number     Start distance (ft)     Length (ft)     End distance (ft)     Weld at right

The top and bottom flange have the same definition, so to save time, the top flange can be input and then copied to the bottom flange with the **Copy to bottom flange** button. If there is any existing data for bottom flange, a warning will appear while copying. Click **OK** to proceed.

	r Profile											-	-		
ype:	Plate Gi	rder													
Web	Тор	flange	Bottom fla	ange											
	Begin width (in)	End width (in)	Thickness (in)	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right					
>	12	12	1.375	1 ~	0	180	180	Grade 50W $$	- ~	N 🗸					
	Convito	bottom	flange							Ne	w P	uplicate	D	elete	

<b>A</b>	Girde	r Profile												-		×
Ту	pe:	Plate Gi	rder													
	Web	Тор	flange	Bottom fla	ange											
		Begin width (in)	End width (in)	Thickness (in)	Suppo numbe	ort Start distance (ft)	Length (ft)	End distance (ft)	Material	Weld	Weld at right					
	>	12	12	1.375	1 \	~	0 180	180	Grade 50W 🗸	- ~	N ~				1	
		Сору	to top fl	ange							N	lew	Duplicate		Delete	
												ОК	Apply	/	Cance	2

## STL14 – LRFD Cb Calculation using Concurrent Moments Example

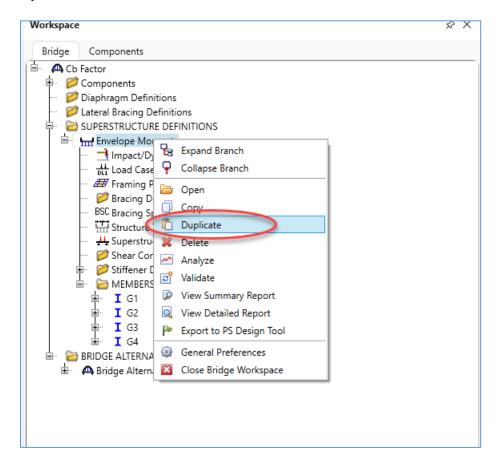
#### Deck Profile

Update the reinforcement within the **Deck Profile window** to satisfy the AASHTO LRFD 6.10.1.7 requirements.

🕰 De	ck Profile												_		×
Type:	Plate														
De	ck concrete	Reinford	cement	Shear con	inectors										
	Material	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar size	Distance (in)	Row		Bar spacing (in)			
;	Gra v	1 ~	63	54	117	12	12	6 ~	2.97	Top of Slab	$\sim$				-
	Gra v	1 ~	63	54	117	12	12	6 V	1.91	Bottom of Slab	$\sim$				
															v
													New Duplicate	Delete	
													OK Apply	Cano	cel

Duplicate the superstructure definition and modify the control options in the second structure to use concurrent moments for computing Cb.

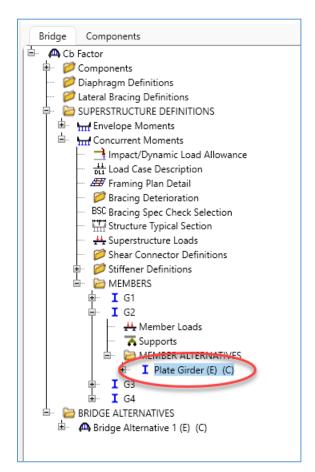
Right click on the **Envelope Moments** superstructure definition and select **Duplicate** from the menu to duplicate the superstructure definition.



lame:	Concurrent Mome	ents										Modeling	
	2 Span 4 Girder Sy factor	ystem usii	ing con	ncurrer	nt moment	s to com	pute Cb	mome	t gradient			Multi-girder system With frame structure	
escription:											0	Deck type:	
											•	Concrete Deck 🛛 🗸	
efault units: umber of spans:	US Customary	~	Enter span lengths along the reference line:							For PS/PT only Average humidity:			
umber of girders:			Span Length						%				
			>	1	90							Member alt. types	
				2	90							🗹 Steel	
												P/S	
												R/C	
Horizontal curva	sture along references	line										R/C Timber	
Horizontal curva	ature along reference		nce froi	m PC t	to first sup	port line:			ît			R/C Timber	
Horizontal	-	Distan	nce fron			port line:			ît ît			R/C Timber	
Horizontal	curvature ure alignment	Distan	tangen			port line:						R/C Timber	
Horizontal C Superstructur Curved Tangen	curvature ure alignment	Distan Start t	tangen is:			port line:	Left		it			R/C Timber	
Horizontal ( Superstructur Curved Tangen Tangen	curvature ure alignment d nt, curved, tangent nt, curved	Distan Start t Radiu: Direct	tangen is:	it lengi	th:	port line:			it			R/C Timber	
Horizontal ( Superstructur Curved Tangen Tangen	curvature ure alignment	Distan Start t Radius Direct End ta	tangen is: tion: angent	it lengt	th:		Left		it it			R/C Timber	
Horizontal ( Superstructur Curved Tangen Tangen	curvature ure alignment d nt, curved, tangent nt, curved	Distan Start t Radiu: Direct End ta Distan	tangen is: tion: angent	it lengi t lengtl m last	th:		Left		it it			R/C Timber	

Rename the new superstructure definition within the **Superstructure definition** window.

Expand the bridge workspace tree and open the **Member Alternative Description** window for the **G2 – Plate Girder** member alternative in the **Concurrent Moments** superstructure.

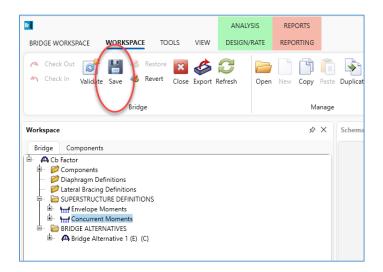


## Cb Calculation Control Option

Navigate to the **Control options** tab in the window and select the **LRFD** and **LRFR** control options to **Consider concurrent moments in Cb calculation**.

Member Alternative Description			
lember alternative: Plate Girder			
Description Specs Factors Engine Import Control options			
LRFD	LRFR		
Allow moment redistribution	Evaluate remaining fatigue life		
Use Appendix A6 for flexural resistance	Ignore long. reinf. in negative moment capacity		
Allow plastic analysis	<ul> <li>Include field splices in rating</li> </ul>		
Ignore long. reinf. in negative moment capacity	Consider deck reinf. development length		
Consider deck reinf. development length	Consider tension-field action in stiffened web end panels	1	
Must consider user input lateral bending stress	Must consider user input lateral bending stress	- I.	
Consider concurrent moments in Cb calculation	Consider concurrent moments in Cb calculation	- I.	
Distribution factor application method	Distribution factor application method	- I.	
By axle	By axle	- I.	
By POI	O By POI	Ť	
LFR	ASR		
Generate at tenth points	Generate at tenth points		
Generate at section change points	Generate at section change points		
Generate at user-defined points	Generate at sector change points		
Allow moment redistribution	Ignore long, reinf, in negative moment capacity		
Allow plastic analysis of cover plates	Consider deck reinf. development length		
Include field splices in rating	Consider tension-field action in stiffened web end panels		
<ul> <li>Include bearing stiffeners in rating</li> </ul>			
Allow plastic analysis			
Ignore long. reinf. in negative moment capacity		v	
	OK Apply	Cano	el

This completes the data entry for this example. Now is a good time to save the bridge to the database.



#### Cb Calculation comparison

Follow the steps below to analyze the plate girder member alternative using envelope moments to compute Cb and the plate girder member alternative using concurrent moments to compute Cb.

Open the **Analysis Settings** window and add an **EV2** vehicle to the **LRFR Permit load rating** category. In the **Advanced** options define a 200plf permit lane load.

Br			ANAL	YSIS	REPORTS	Bridg
BRIDGE WORKSPACE	WORKSPACE TO	OOLS VIEW	DESIGN	/RATE	REPORTING	
Analysis knalyze Analysis Settings	Tabular Specificati Results Check Det	ion Engine Res		5		
Analysis		Results				
Workspace			\$ ×	Schem	atic	
Bridge Components						
Cb Factor Components Component Compo	Definitions IRE DEFINITIONS oments Moments IATIVES					

# STL14 – LRFD Cb Calculation using Concurrent Moments Example

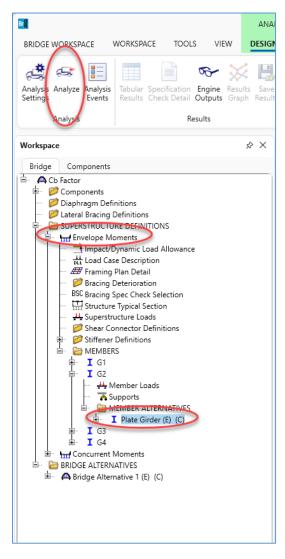
Analysis Settings

Design review       Rating         Rating method:       IPR         Analysis type:       Ine Girder         Lane / Impact loading type:       As Requested         Vehicles       Output Engine Description         Testfic direction:       Both directions         Vehicles       Vehicles         Image: Standard       Vehicle summary         Vehicles       Vehicles         Image: Standard       Vehicle summary         Image: Standard       Vehicle summary         Image: Standard       Vehicle summary         Image: Standard       Properating         Image: Standard	Analysis Settings								-	>
ane / Impact loading type:       As Requested       Apply preference setting:       None         Vehicles       Output       Engine       Description         Traffic direction:       Both directions <ul> <li>Refresh</li> <li>Temporary vehicles</li> <li>Advanced</li> <li>Vehicle selection</li> <li>Vehicle selection</li> <li>Vehicle selection</li> <li>Vehicle selection</li> <li>Vehicle summary</li> <li>Standard</li> <li>Vehicle selection</li> <li>Solid</li> <li>Solid</li></ul>	Design review	Rating			Rating n	nethod:	LRFR		~	
Vehicles       Output       Engine       Description         Traffic direction:       Both directions <ul> <li>Refresh</li> <li>Temporary vehicles</li> <li>Advanced</li> </ul> Image: Standard standar	nalysis type:	Line Girder	~							
Traffic direction:       Both directions <ul> <li>Refresh</li> <li>Temporary vehicles</li> <li>Advanced</li> </ul> Image: Standard       Vehicle summary         Image: Standard <ul> <li>Standard</li> <li>Standard</li></ul>	ane / Impact loading type	As Requested			Apply p	eference setting:	None		~	
Vehicle selection       Vehicle summary         Image: Standard       Fating vehicles         Image: Standard       Image: Standard         Image: Standard       Image: Standardd <t< td=""><td>Vehicles Output</td><td>Engine Descripti</td><td>on</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></t<>	Vehicles Output	Engine Descripti	on							
Vehicle selection       Vehicle summary         Image: Standard selection       File Standard selection         Image: Standard selection selecti	Traffic direction: Both d	directions	$\sim$			Refresh	Tempo	orary vehicles	dvanced	
								<b>\</b>	_	
Image: Temporary       Reset       Clear       Open template       Save template       OK       Apply       Cancel         Vehicle Properties       Vehicle Tandem Scale Impact Single Iane Ioaded Pair       Override Iver Ioad International Pair       Prequency       Loading condition       Override	<ul> <li>□-Standard</li> <li>□-Ev2</li> <li>□-Ev3</li> <li>□-H 15-44</li> <li>□-HL-93 (SI)</li> <li>□-HL-93 (SI)</li> <li>□-HS 20 (SI)</li> <li>□-HS 20 (SI)</li> <li>□-HS 20-44</li> <li>□-LRFD Fatigue</li> <li>□-LRFD Fatigue</li> <li>□-LRFD Fatigue</li> <li>□-NRL</li> <li>□-SU4</li> <li>□-SU5</li> <li>□-SU6</li> <li>□-SU7</li> <li>□-Type 3</li> <li>□-Type 3S2</li> <li>□-Agency</li> </ul>	e Truck (SI)		] ] ]	>>	□-LRFR □-Desig □-Desig □-C □-C □-Lega □-Lega □-Lega □-Rem □-R □-R □-R □-R □-R □-R □-R □-R □-R □-R	gn load ra nventory Operating atigue I load rat outine pecialized it load ra V2	ing d hauling tting		
EV2 1 Single Trip V Mixed with traffic V	Reset Clear Vehicle Properties Vehicle Tandem Si train fa	cale Impact Sing Ictor Impact Ian Ioad	gle Legal O		Legal live load			Loading condition	(	 el
	> EV2	1				Single Trip	~	Mixed with traffic	~	

Vehicl	Tandem train	Scale factor	Impact	Single Iane Ioaded	Legal pair	Override	Legal live load factor	Frequency	Loading condition	Override
EV2		1						Single Trip $$	Mixed with traffic $\qquad \qquad \qquad$	
mit lane	load: 0.2		· /		nicle live loa	ad factor:				
mit lane	load: 0.2		· /			ad factor:			ОК	Cance

#### Analyzing Girder with Envelope Moment Cb Calculation

Analyze the plate girder member alternative within the **Envelope Moments** superstructure.



After the analysis is complete, review the results. Open the **Tabular Results** window to view the critical rating factor.

₽	Analysis Re	sults - Plate Gi	rder								- 0	×
	Print Print											
	ort type: ng Results :	Summary	V Cane/Imp	oact load requeste		Circula	/ Format rating leve	el per row	~			
	Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane	
	EV2	Truck + Lane	LRFR	Permit	26.91	0.936	72.00	1 - (80.0)	STRENGTH-II Steel Flexure Stress	As Requested	As Requested	.4
		ngine Version 7										
Anal	ysis prefere	nce setting: No	one								Clo	ose

Open the Specification Check Detail window to review the specification calculations for the controlling location.

Properties (	Senerate f	All articles  All articles  Format Bullet list  Report				
a 📋 Superstructure C	omponent 🛔	Specification reference	Limit State	Flex. Sense	Pass/Fail	
Stage 1		6.10.6.2.2 Composite Sections in Positive Flexure		N/A	General Comp.	
Stage 2		6.10.6.2.3 Composite Sections in Negative Flexure and Noncomposite	ite	N/A	General Comp.	
🔺 🚞 Stage 3		NA 6.10.7.1.1 General		N/A	Not Applicable	
a 🚞 Plate Gird		NA 6.10.7.1.2 Nominal Flexural Resistance		N/A	Not Applicable	
🚞 Span 1		NA 6.10.7.2.1 General		N/A	Not Applicable	
🚞 Span 1		6.10.7.2.2 Nominal Flexural Resistance		N/A	General Comp.	
— .	1 - 15.00 ft.	NA 6.10.7.3 Flexural Resistance - Ductility Requirement		N/A	Not Applicable	
	1 - 18.00 ft.	✗ 6.10.8.1.1 Discretely Braced Flanges in Compression		N/A	Failed	
	- 27.00 ft.	NA 6.10.8.1.2 Discretely Braced Flanges in Tension		N/A	Not Applicable	
	- 30.00 ft.	✓ 6.10.8.1.3 Continuously Braced Flanges in Tension or Compression		N/A	Passed	
	1 - 36.00 ft. 1 - 45.00 ft.	6.10.8.2.1 General		N/A	General Comp.	
— ·	1 - 43.00 ft.	6.10.8.2.2 Local Buckling Resistance		N/A	General Comp.	
	1 - 60.00 ft.	6.10.8.2.3 Lateral Torsional Buckling Resistance		N/A	General Comp.	
	63.00 ft.	6.10.8.2.3.Cb Lateral Torsional Buckling Resistance - Cb Calculation		J/A	General Comp.	
	- 72.00 ft.	6.10.8.2.3.rt Lateral Torsional Buckling Resistance - rt and Lp Calcul	atio	N/A	General Comp.	
	75.00 ft.	6.10.8.3 Flexural Resistance Based on Tension Flange Yielding		N/A	General Comp.	
	- 81.00 ft.	✓ 6.10.9 LRFD Shear Resistance		N/A	Passed	
	1 - 90.00 ft.	6.10.9.1 Shear Resistance - General		N/A	General Comp.	
🚞 Span 2		× 6.10_General_Flexural_Results		N/A	Failed	
🚞 Span 2	2 - 15.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Moment		N/A	Passed	
🚞 Span 2	2 - 18.00 ft.	× 6A.4.2.1 General Load Rating Equation - Steel Flexure Stress		N/A	Failed	
🚞 Span 2	2 - 27.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed	
🚞 Span 2	2 - 30.00 ft.	■ 6A.4.2.1.fl		N/A	General Comp.	
🚞 Span 2	2 - 36.00 ft.	✓ 6A.6.4.2.2 Service Limit State		N/A	Passed	
🚞 Span 2	2 - 45.00 ft.	APPD6.1 Plastic Moment		N/A	General Comp.	
	2 - 54.00 ft.	APPD6.2 Yield Moment		N/A	General Comp.	
	2 - 60.00 ft.	APPD6.3.1 In the Elastic Range (Dc)		N/A	General Comp.	
	2 - 63.00 ft.	APPD6.3.2 Depth of the Web in Compression at Plastic Moment		N/A	General Comp.	
	2 - 72.00 ft.	Steel Elastic Section Properties		N/A	General Comp.	
🚞 Span 2	2 - 75.00 ft. 2 - 81.00 ft.	Unbraced Length Calculations		N/A	General Comp.	

The rating is controlled by lateral torsional buckling within the negative flexure region over the interior pier. The Cb factor is computed in 6.10.8.2.3.Cb Lateral Torsional Buckling Resistance – Cb Calculation. Open this article to view the envelope Cb calculations.

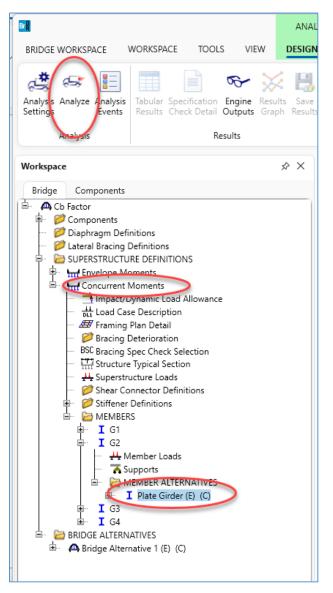
.10 I-Se .10.8 Fl .10.8.2 .10.8.2	Structures Ection Flexural Me exural Resistance Compression-Flance 3 Lateral Torsion RFD Bridge Design	e-Composite ge Flexural nal Buckling	Resistance Resistance	- Cb Calcu		Noncomposite	e Sections				
teel Pla	ate - At Location	= 72.0000 (	ft) - Left	Stage 3							
ection w	ithin Top Flange	Continuous	Bracing Reg	ion							
	adient Modifier,										
ection P	Prismatic in Top P Prismatic in Botto s Unbraced Canti	om Flange Un	braced Leng								
op Flang	ge Left Brace Loca ge Middle of Unbra ge Right Brace Loc	aced Length	Location =		(ft)						
	ge Left Brace Loca										
	ge Right Brace Loo		Location = =								
ot Flang											
ot Flang UMMARY:		cation									
Ot Flang UMMARY: 3b = 1.0	ge Right Brace Loo	cation 5)	-	90.0000	(ft)						
ot Flang UMMARY: b = 1.0 b = 1.75	ge Right Brace Loo (6.10.8.2.3-4 5 - 1.05*(f1/f2) -	Cation 5) ⊦ 0.3*(f1/f2	=	90.0000 (6.10.	(ft) 8.2.3-7)			- Output			1
ot Flang UMMARY: b = 1.0 b = 1.75 Limit State	(6.10.8.2.3-4 (6.10.8.2.3-4 5 - 1.05*(f1/f2) - Load Comb	5) 5) Flexure Type	= )^2 <= 2.3   Left Stress (ksi)	90.0000 (6.10. Input Mid Stress (ksi)	(ft) 8.2.3-7) 	Concave Moment	fmid (ksi)	f2 (ksi)	f1 (ksi)	Eq.	Съ
ot Flang UMMARY: b = 1.0 b = 1.75 Limit State	ge Right Brace Loo (6.10.8.2.3-4 5 - 1.05*(f1/f2) - Load	Sation 5) F 0.3*(f1/f2 Flexure Type	= 1)^2 <= 2.3   Left Stress (ksi)	90.0000 (6.10. Input Mid Stress (ksi)	(ft) 8.2.3-7) 	Concave Moment	fmid (ksi)	f2 (ksi)	fl (ksi)	Eq.	Съ
ot Flang UMMARY: b = 1.0 b = 1.75 Limit State STR-II STR-II SER-II SER-II SER-II SER-II SER-II	(6.10.8.2.3-4 (6.10.8.2.3-4 5 - 1.05*(f1/f2) - Load Comb	5) 6) 6) - 0.3*(f1/f2 Flexure Type Negative Negative Negative Negative Negative Compression	= 1)^2 <= 2.3 1 Left Stress (ksi) 12.10 4.49 9.74 3.79 1 is negativ	90.0000 (6.10. Input Mid Stress (ksi) -7.05 -13.27 -5.24 -9.83 e, tension	(ft) 8.2.3-7) 	Concave Moment Yes Yes Yes Yes	fmid (ksi) 7.05 13.27 5.44 9.83	f2 (ksi)	fl (ksi)	Eq.	Съ
ot Flang UMMARY: b = 1.0 b = 1.75 Limit State STR-II STR-II SER-II SER-II SER-II ote: For For	<pre>(6.10.8.2.3-( (6.10.8.2.3-( 5 - 1.05*(f1/f2) - Load Comb 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~</pre>	5) 6) 6) - 0.3*(f1/f2 Flexure Type Negative Negative Negative Negative Negative Compression	= 1)^2 <= 2.3 1 Left Stress (ksi) 12.10 4.49 9.74 3.79 1 is negativ	90.0000 (6.10. Input Mid Stress (ksi) -7.05 -13.27 -5.24 -9.83 e, tension	(ft) 8.2.3-7) 	Concave Moment Yes Yes Yes Yes	fmid (ksi) 7.05 13.27 5.44 9.83	f2 (ksi)	fl (ksi)	Eq.	Съ
ot Flang UMMARY: b = 1.0 b = 1.75 Limit State STR-II STR-I	<pre>(6.10.8.2.3-( (6.10.8.2.3-( ) - 1.05*(f1/f2) - Load Comb 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~ 1, Permit~</pre>	5) 6) 6) - 0.3*(f1/f2 Flexure Type Negative Negative Negative Negative Negative Compression	= 1)^2 <= 2.3 1 Left Stress (ksi) 12.10 4.49 9.74 3.79 1 is negativ	90.0000 (6.10. Input Mid Stress (ksi) -7.05 -13.27 -5.24 -9.83 e, tension	(ft) 8.2.3-7) 	Concave Moment Yes Yes Yes Yes	fmid (ksi) 7.05 13.27 5.44 9.83	f2 (ksi)	fl (ksi)	Eq.	Съ
ot Flang UMMARY: b = 1.0 b = 1.75 Limit State STR-II STR-I	<pre>(6.10.8.2.3-( (6.10.8.2.3-( )))) (6.10.8.2.3-( ))) (6.10.8.2.3-( ))) (6.10.8.2.3-( )) (6.10.8.2.3-( )) (6.10.8.2.3-( )) (6.10.8.2.3-( ))) (6.10.8.2.3-( )) (6.10.8.2.3-( ))) (6.10.8.2.3-( ))) (6.10.8.2.3-( ))) (6.10.8.2.3-( ))) (6.10.8.2.3-( ))) (6.10.8.2.3-( ))) (6.10.8.2.3-( )))) (6.10.8.2.3-( )))) (6.10.8.2.3-( ))))) (6.10.8.2.3-( )))))) (6.10.8.2.3-( ))))))))))))))))))))))))))))))))))))</pre>	5) Flexure Type Negative Negative Negative Negative Segativ	= 1)^2 <= 2.3 1 Left Stress (ksi) 12.10 4.49 9.74 3.79 1 is negativ	90.0000 (6.10. Input Mid Stress (ksi) -7.05 -13.27 -5.24 -9.83 e, tension	(ft) 8.2.3-7) 	Concave Moment Yes Yes Yes Yes	fmid (ksi) 7.05 13.27 5.44 9.83	f2 (ksi)	fl (ksi)	Eq.	Съ

Since each of these load cases has negative flexure, the bottom flange brace points are used to compute Cb. The computed brace point stresses are computed within the 6.10.1.1.1b Stresses article for the POI at the brace point. Here, the left brace stresses are computed within the 6.10.1.1.1b article at the Span 1 - 60 ft POI on the right side, the mid stresses are computed at Span 1 - 75 ft and the right brace stresses are computed at 90 ft left.

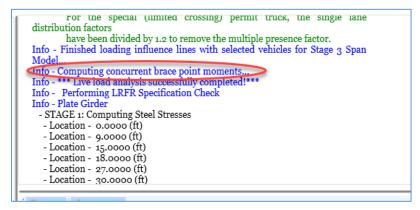
		Articles				
$\langle\rangle$		All articles	×			
Properties	Generate	Format Bullet list	~			
pecification filter		Report				
▲ 🚞 Superstruct	ure Component	Specificati	on reference	Limit State	Flex. Sense	Pass/Fail
🕨 🚞 Stage 1		3.4.2.6	5 Modulus of Rupture		N/A	General Comp.
🕨 🚞 Stage 2		3.4.2.8	8 Concrete Density Modification Factor		N/A	General Comp.
🔺 🚞 Stage 3		6.10.1	Estimated Flange Lateral Bending Stress Proportioning		N/A	General Comp.
a 🚞 Plate		6.10.1	.1.1b Stresses for Sections in Positive Flexure		N/A	General Comp.
_	pan 1 - 0.00 ft.	6.10.1	.10.1 Hybrid Factor, Kn		N/A	General Comp.
_	pan 1 - 9.00 ft.		.10.2 Web Load-Shedding Factor, Rb		N/A	General Comp.
	pan 1 - 15.00 ft.	6.10.1	.6 Flange Stress and Member Bending Moments		N/A	Passed
_	pan 1 - 18.00 ft.	6.10.1	.7 Minimum Negative Flexure Concrete Deck Reinforce	ment	N/A	Passed
_	pan 1 - 27.00 ft.	6.10.1	.9.1 Webs without Longitudinal Stiffeners		N/A	General Comp.
	pan 1 - 30.00 ft. pan 1 - 36.00 ft.	6 10 1	1.1.2 Transverse Stiffeners - Projecting Width		N/A	Passed
	pan 1 - 30.00 ft. pan 1 - 45.00 ft.	6 10 1	1.1.3 Transverse Stiffeners - Moment of Inertia		N/A	Passed
_	pan 1 - 45.00 ft.	1 6 10 2	Cross-Section Proportion Limits		N/A	Passed
	pan 1 - 60.00 ft.	4 6 4 6 4	.2.2 Flexure		N/A	Passed
	pan 1 - 63.00 ft.	B 6 40 6	.2.2 Composite Sections in Positive Flexure		N/A	General Comp.
_	pan 1 - 72.00 ft.	<b>D C C C C</b>	2.3 Composite Sections in Negative Flexure and Nonco	omposite	N/A	General Comp.
	pan 1 - 75.00 ft.		.1.1 General		N/A	Not Applicable
	pan 1 - 81.00 ft.		.1.2 Nominal Flexural Resistance		N/A	Not Applicable
	, pan 1 - 90.00 ft.		.2.1 General		N/A	Not Applicable
	pan 2 - 9.00 ft.		.2.2 Nominal Flexural Resistance		N/A	General Comp.
👝 s	pan 2 - 15.00 ft.	NA 6.10.7	.3 Flexural Resistance - Ductility Requirement		N/A	Not Applicable
🧰 S	pan 2 - 18.00 ft.	× 6,10.8	.1.1 Discretely Braced Flanges in Compression		N/A	Failed

#### Analyzing Girder with Concurrent Moment Cb Calculation

Next, analyze the G2 – Plate Girder member alternative within the Concurrent Moments superstructure.



The analysis progress log will indicate when program is loading the concurrent moments at brace points.



#### STL14 - LRFD Cb Calculation using Concurrent Moments Example

Review the tabular results to see the critical rating factor. Using concurrent moments, the rating factor improves from 0.936 to 1.025.

<b>A</b> ,	Analysis Re	sults - Plate Gi	rder								- 0	×
	Print Print											
	rt type:	_	Lane/Im	pact load	ing type		Format					
Ratir	ng Results	Summary	✓ O As	request	ed 🔵 Detail	ed Single	rating leve	l per row	~			
	Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane	
	EV2	Truck + Lane	LRFR	Permit	29.47	1.025	90.00	1 - (100.0)	STRENGTH-II Steel Flexure Stress	As Requested	As Requested	4 A
AASH	ITO LRFR E	ngine Version	7.5.1.3001									v
Analy	/sis prefere	nce setting: No	one									
											Cle	ose

The Engine Outputs will include a Concurrent Moment Report which details the computed corresponding

A Cb Factor Х \_ Cb Factor Concurrent Moments ⊟-G2 Plate Girder ≜-AASHTO\_LRFR Stage 3 Infl Lines Span Model Live Load Distribution Factors Calculations "Live Load Distribution Factors Calculations Concurrent Moment Report (Monday Oct. 23, 2023 05:37:03) Stage 3 Spec Check Results Stage 3 Service II Stress Ranges Stage 3 Fatigue Stress Ranges Stage 1 Span Model Stage 1 Span Model Actions Stage 2 Span Model Stage 2 Span Model Actions Stage 3 Span Model Actions Log File

moments within all unbraced regions on the member.

#### Brace Point Concurrent Moment Report

Open the Concurrent Moment Report to view the computed corresponding moments at brace points.

	Moment Repo	rt									
	Factor Exam Concurrent M 5/2023			E	NBI Structure ID: Bridge Alt: Member: Plate Gir						
Brace	e Poin	t Con	current	Momen	t Repor	t					
	legend										
	pe Moment										
Corres	ponding Mo	ment									
V2 - Per	mit Truck	x + Lane - !	Maximum								
Note: Brac	e point locati	ions are meas	red from start o	fmemher							
				OF, and MPF when	n applicable.						
	nbraced Re	•		Left Primary			Middle Primary			Right Primary	
Left Brace	e Middle (ft)	Right Brace (ft)	Left Moment (kip-ft)	Middle Moment (kip-ft)	Right Moment (kip-ft)	Left Moment (kip-ft)	Middle Moment (kip-ft)	Right Moment (kip-ft)	Left Moment (kip-ft)	Middle Moment (kip-ft)	Right Moment (kip-ft)
(ft)	(u)										
(ft) 0.0000	15.0000	30.0000	0.00	0.00	0.00	0.00	343.22	404.50	0.00	249.13	498.25
			0.00 498.25	0.00 465.45	0.00 230.66						
0.0000	15.0000	30.0000				0.00	343.22	404.50	0.00	249.13	498.25
0.0000 30.0000	15.0000 45.0000	30.0000 60.0000	498.25	465.45	230.66	0.00 468.46	343.22 500.70	404.50 251.02	0.00 299.86	249.13 449.78	498.25 397.73
0.0000 30.0000 60.0000 90.0000	15.0000 45.0000 75.0000	30.0000 60.0000 90.0000	498.25 397.73	465.45 63.74	230.66 -270.24	0.00 468.46 310.67	343.22 500.70 186.35	404.50 251.02 -219.90	0.00 299.86 0.00	249.13 449.78 0.00	498.25 397.73 0.00

#### Specification Check Detail

Open the **Specification Check Detail** window to review the specification calculations. The articles indicated with arrows below are particularly relevant to the LTB rating.

Properties	Generate	Articles All articles  Format			
ecification filter		Bullet list ~ Report			
	<u> </u>		Line Contra	Fl	Pass/Fail
Superstruction Stage 1	ure Component	Specification reference	Limit State	Flex. Sense N/A	Pass/Fail Passed
Stage 1		6.10.6.2.2 Composite Sections in Positive Flexure		N/A	General Comp.
Stage 2				N/A	1 (A)
■ Stage 5	Girder	6.10.6.2.3 Composite Sections in Negative Flexure and Noncomposite NA 6.10.7.1.1 General			General Comp.
	pan 1 - 0.00 ft.	NA 6.10.7.1.1 General NA 6.10.7.1.2 Nominal Flexural Resistance		N/A N/A	Not Applicable
	pan 1 - 9.00 ft.	NA 6.10.7.1.2 Nominal Flexural Resistance			Not Applicable
🚞 S	pan 1 - 15.00 ft.	6.10.7.2.1 General		N/A	Not Applicable
🚞 S	pan 1 - 18.00 ft.			N/A	General Comp.
🚞 Sj	pan 1 - 27.00 ft.	NA 6.10.7.3 Flexural Resistance - Ductility Requirement		N/A	Not Applicable
🚞 Sj	pan 1 - 30.00 ft.	✓ 6.10.8.1.1 Discretely Braced Flanges in Compression		N/A	Passed
🚞 Sj	pan 1 - 36.00 ft.	NA 6.10.8.1.2 Discretely Braced Flanges in Tension		N/A	Not Applicable
🚞 Sj	pan 1 - 45.00 ft.	✓ 6.10.8.1.3 Continuously Braced Flanges in Tension or Compression		N/A	Passed
🚞 Sj	pan 1 - 54.00 ft.	🗎 6.10.8.2.1 General		N/A	General Comp.
🚞 Sj	pan 1 - 60.00 ft.	6.10.8.2.2 Local Buckling Resistance		N/A	General Comp.
🚞 Sj	pan 1 - 63.00 ft.	6.10.8.2.3 Lateral Torsional Buckling Resistance		N/A	General Comp.
🚞 Sj	pan 1 - 72.00 ft.	6.10.8.2.3 Concurrent Moment Brace Point Stresses	<u> </u>	N/A	General Comp.
🚞 Sj	pan 1 - 75.00 ft.	6.10.8.2.3.Cb Concurrent Moment Lateral Torsional Buckling Resistance		N/A	General Comp.
🚞 Sj	pan 1 - 81.00 ft.	6.10.8.2.3.rt Lateral Torsional Buckling Resistance - rt and Lp Calculatio		N/A	General Comp.
😑 Sj	pan 1 - 90.00 ft.	6.10.8.3 Flexural Resistance Based on Tension Flange Yielding		N/A	General Comp.
🚞 Sj	pan 2 - 9.00 ft.	✓ 6.10.9 LRFD Shear Resistance		N/A	Passed
🚞 Sj	pan 2 - 15.00 ft.	6.10.9.1 Shear Resistance - General		N/A	General Comp.
🚞 Sj	pan 2 - 18.00 ft.	✓ 6.10_General_Flexural_Results		N/A	Passed
🚞 Sj	pan 2 - 27.00 ft.	6.9.4.1 Bearing Stiffener Nominal Resistance		N/A	General Comp.
🚞 Sj	pan 2 - 30.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Moment		N/A	Passed
	pan 2 - 36.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Stress		N/A	Passed
	pan 2 - 45.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed
	pan 2 - 54.00 ft.			N/A	General Comp.
	pan 2 - 60.00 ft.	✓ 6A.6.4.2.2 Service Limit State		N/A	Passed
	pan 2 - 63.00 ft.	APPD6.1 Plastic Moment		N/A	General Comp.
	pan 2 - 72.00 ft.	APPD6.2 Yield Moment		N/A	General Comp.
	pan 2 - 75.00 ft.	ADDDE 2.1 la the Electic Berner (De)		N/A	General Comp.
🚞 Sj	pan 2 - 81.00 ft.	APPD632 Depth of the Web in Compression at Plastic Moment		N/A	General Comp

The brace point stresses for envelope actions are computed in the 6.10.1.1.1b stresses article. An additional article is included when the concurrent actions are enabled to compute the brace point stresses for concurrent actions. This is the 6.10.8.2.3 Concurrent Moment Brace Point Stresses article. As with the envelope stresses, these stresses are computed at the POI corresponding to the actual brace point location.

The Cb concurrent moment calculation article computes Cb for each loading scenario, left brace envelope, mid brace envelope and right brace envelope.

	1.05*(f1/f2) + 0.	8*(f1/f2)^2	2 <= 2.3	(6.10.8.2.3	3-7)						
calculat	ion for loading le:	ft brace									
				Input				- Output			
Limit	Load		Left		Right						
State	Comb		Stress (ksi)		(ksi)		fmid (ksi)			Eq.	Cb
STR-II	1. PermitSpec	Nea	12.10	-8.61	-38.14	Yes	8.61	38.14	-12.10	7	2.1134
STR-TT	1. PermitSpec	Neg	4.49	-13.25	-38.74	Yes	13.25	38.74	-4.49	7	1.8758
SER-IT	1. PermitSpec	Neg	9.74	-6.64	-28.81	Yes	6.64	28.81	-9.74	7	2,1390
SER-II	1, PermitSpec 1, PermitSpec 1, PermitSpec 1, PermitSpec	Neg	3.79	-9.82	-29.23	Yes	9.82	29.23	-3.79	7	1.8910
	ion for loading mid			Input				- Output			
Limit	Load	Flexure	Left	Mid	Right	Concave		-			
State	Comb	Type	Stress	Stress	Stress	Moment	fmid	f2	f1	Eq.	Cb
							fmid (ksi)			-	
STR-TT	1. PermitSpec	Nea	11.08	-7.05	-37.42	Yes	7.05	37.42	-11.08	7	2.0871
STR-TT	1. PermitSpec	Nea	4.68	-13.27	-38.96	Yes	13.27	38,96	-4.68	7	1.8806
SFR-TT	1 PermitSpec	Nea	8 88	-5 44	-28 32	Yes	5 44	28 32	-8.88	7	2 1088
SER-II	1, PermitSpec 1, PermitSpec 1, PermitSpec 1, PermitSpec	Neg	3.90	-9.83	-29.37	Yes	9.83	29.37	-3.90	7	1.8949
	nput Stresses, com utput Stresses sign ion for loading rig	ns are swit ght brace	ched. Compre	ession is p	ositive, te		gative.	0			
								- Output			
	Load	Flexure		Mid				£0	f1	Ea.	Cb
	Load	Flexure Type	Left	Mid Stress	Stress	Moment	fmid				
Limit State	Comb	Туре	Left Stress (ksi)	Stress (ksi)	Stress (ksi)	Moment	(ksi)	(ksi)			
Limit State	Comb	Туре	Left Stress (ksi)	Stress (ksi)	Stress (ksi)	Moment	(ksi)	(ksi)			1.9913
Limit State	Comb	Туре	Left Stress (ksi)	Stress (ksi)	Stress (ksi)	Moment	(ksi)	(ksi)			1.9913
Limit State	Comb	Туре	Left Stress (ksi)	Stress (ksi)	Stress (ksi)	Moment	(ksi)	(ksi)			1.9913 2.1075 1.9989
imit tate	Comb	Туре	Left Stress (ksi)	Stress (ksi)	Stress (ksi)	Moment	(ksi)	(ksi)			1.9913 2.1075 1.9989 2.1342

The article summary indicates the Cb factor which is used for each load case.

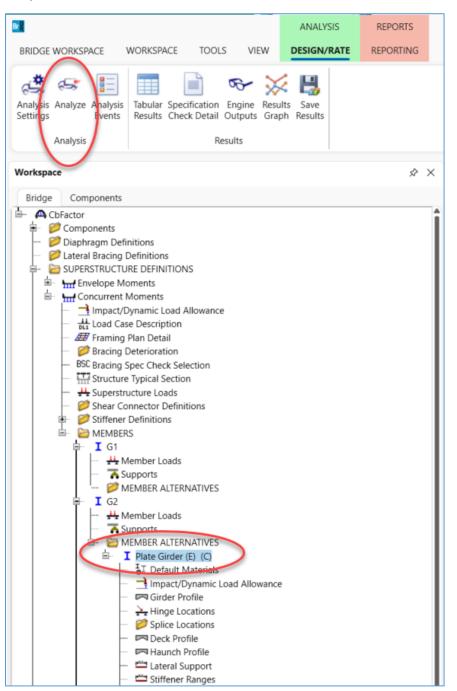
Limit	Load		
State	Comb	Cb	Critical Concurrent Loading
STR-II	1, PermitSpec	2.1134	Left brace
STR-II	1, PermitSpec	2.1075	Right brace
SER-II	1, PermitSpec	2.1390	Left brace
SER-II	1, PermitSpec	2.1342	Right brace

#### LRFD Design Review

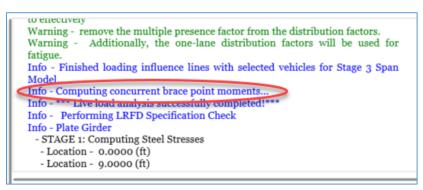
Open the **Analysis Settings window**. Open the **HL 93 Design Review** template to perform a design review using concurrent moments to compute the Cb factor.

Analysis Settings						>
Design review     Rating     Alaysis type:     Line Girder     As Requested	× ×	Design m Apply pre	ethod: ference setting:	None	~	
Vehicles Output Engine Description Traffic direction: Both directions Vehicle selection	~		Refresh Vehicle summary	Temporary vehicles	Advanced	
Vehicle selection  Vehicles  Standard  Alternate Military Loading  -EV2 -EV3 -HL-93 (SI) -HL-93 (US) -HS 20 (SI) -HS 20 (SI) -HS 20-44 -LRFD Fatigue Truck (SI) -LRFD Fatigue Truck (US) -Agency User defined -Temporary		Add to >> Remove from <<	Design vehi Design I - Design I - HL-9 - Permit k	cles oads 93 (US) pads		

Analyze the Plate Girder member alternative under G2 for the Concurrent Moments superstructure definition.



The analysis progress log will indicate when the program computes the concurrent brace point moments.



The Engine Outputs window includes a Concurrent Moment Report which shows the computed envelope and

corresponding moments for each unbraced region along the member.

CbFactor	<u>.</u>		×
Cobfactor Concurrent Moments Concurrent Moments Concurrent Moments Concurrent Moment Report (Tuesday Jul. 09, 2024 16:50:0) Cog File Concurrent Moment Report (Tuesday Jul. 09, 2024 16:50:0) Cog File Cog File Concurrent Moment Report Concurrent Moment Concurrent Moment Concurrent Concurrent Moment Concurrent Concurrent Moment Concurrent C	6		
		Cano	el

Open the report to review the computed actions. The report includes tables for each component of the vehicle live load. For the design vehicle this includes the load components such as truck and lane and the design combinations such as 90% truck pair plus lane.

												-	(
ate : 7/9/2	oncurrent N	nple Bridge foments		NBI Structur Bridge Alt: Member: Pla	e ID: Cb Factor ite Girder								
srace	e Poin	t Conc	<u>urrent</u> :	Momen	t Repor	<u>·t</u>							
L	egend				-								
Envelop	e Moment												
Corresp	onding Mor	nent											
L-93 (U	S) - Desig	n Truck +	Lane - Max	amum									
atas Deca	n n n int la na		asured from star	t of mombor									
				LDF, and MPF w	when applicable.								
	braced Re	<i>.</i>		Left Primary			Middle Primary			<b>Right Primary</b>			
eft Brace (ft)	Middle (ft)	Right Brace (ft)	Left Moment (kip-ft)	Middle Moment (kip-ft)	Right Moment (kip-ft)	Left Moment (kip-ft)	Middle Moment (kip-ft)	Right Moment (kip-ft)	Left Moment (kip-ft)	Middle Moment (kip-ft)	t Right Moment (kip-ft)		
0.0000	15.0000	30,0000	0.00	0.00	0.00	0.00	926.63	1250.35	0.00	786.52	1358.94		
30.0000	45.0000	60.0000	1358.94	1320.68	741.72	1321.36	1388.72	845.40	961.70	1284.69	1066.99		
60.0000	75.0000	90.0000	1066.99	238.60	-803.89	898.06	423.93	-653.11	0.00	0.00	0.00		
	105.0000	120.0000	0.00	0.00	0.00	-653.11	423.93	898.06	-803.89	238.60	1066.99		
	105.0000		1066.99	1284.69	961.70	845.40	1388.72	1321.36	741.72	1320.68	1358.94		
90.0000	135.0000	150.0000	1000.99										

AASHTOWare BrDR 7.5.1 Steel Design Tool Two Span Girder Design Example

# Two Span Girder Design Example

Start the **Steel Design Tool** program, create a new input file using the **File** | **New** command. The program will switch from the **File** tab to the **Design Input** tab.

### File | New and File | Save As

AASHTOWare Bridge Design: Steel Design Tool	-	)
New		
Open		
3 Save		
Save As		
Print .		
a Recent		
1 Library		
Configuration		
Help		
License		
Close		
Exit		

Before proceeding with **Design Input** return to the **File** tab and click **Save As** to rename the file from **New Project** to **STL15 Design Example**.

	AASHTOWare I	ridge Design: Ste	el Design Tool			-	2
File Design	Input Design						
New							
Dpen							
Save							
Save As							
Print	_						
Recent							
Library							
) Configur	tion						
) Help							
License							
Close							
Exit							

The new file name will appear in the program title bar and the program will again bring up the the **Design Input** with the **Project** input screen. The **Project** property will still say **New Project** and this will be changed in the next step. The **Project** property determines the name of the subfolder in the Documents\AASHTOWare\SteelDesign75\ folder where design run output files will be stored. In the bottom left corner of the program window, there is a **Validation** button that enables input validation. When validation is enabled, the program will mark sections and input boxes with missing or incorrect information. For the purposes of this example, the **Validation** will be disabled during input and will be enabled after all input is entered to verify that there are no validation errors.

#### Design Input | Project

On the Design Input | **Project** input screen, enter the data as shown below.

STL15 Design Example.brdx - AAS	SHTOWare Bridge Design: Steel Design Tool	- 0	
Project	Project: STL15 Design Example		
Project Library	Description: 2 Span 4 Girder Bridge		
Geometry			
Deck	Designer:		
Typical Section Loads	Date: 7/11/2024 15		
Beam Parameters	LRFD specifications       Edition:     AASHTO LRFD 9th		
Lateral Support	Limit states: Strength-I Strength-II Strength-II Strength-V		
Member Loads	Service-II		
Control Options	Fatigue-I Fatigue-II		
Input Report	Design vehicles		
	Permit load:		
	Fatigue load:		
	Design ADTT: 0		
lidation Off	Back	Forward	

## Design Input | Project Library | Appurtenance

On the **Apputenance** tab, select **Parapet** for **Type** from the drop down menu and click the **Copy from library** button to add a new parapet. Select the Jersey Barrier.

Design Input Design														
oject	Appurtenance Mate	rial Vehicle												
oject Library	Type Parapet	~												
ometry	Additional load ++	,												
ck	X1 Reference	X2 X3		Ro	adway urface									
ical Section Loads		V1 Y2			anace									
am Parameters		Front V3												
eral Support	Back	Front 🚽 🤫		*										
mber Loads	Name	Description	X1 (in)	X2 (in)	X3 (in)	Y1 (in)	Y2 (in)	Y3 (in)	Y4 (in)	Additional load centroid (in)	Additional load (kip/ft)	Parapet unit load (kcf)	Calculated Net centroid (in)	properties Total load (kip/ft)
ntrol Options														
but Report														
	Copy from library												New	Duplicate Del
tion Off													Back	Forward

Br D	Select Item	-		×
	Name	Description		
>	Jersey Barrier	Standard New Jersey Barrier	ŗ	^
		ОК		Cancel

# STL15 - Steel Design Tool Example

STL15 Design Example.brdx - AASHTOV	Vare Bridge Design: Steel Design	Tool											-		×
File Design Input Design															
Project	Appurtenance Material	Vehicle													
Project Library	Type: Parapet	~													
Geometry	Additional load Ac centroid	lditional load													
Deck	X1 Reference	×3	Ro	adway											
Typical Section Loads	line	Y1 Y2	Si	urface											
Beam Parameters	Back	Front Y4													
Lateral Support	Dack	riont#	*												
Member Loads	Name	Description X1 (in)	X2 (in)	X3 (in)	Y1 (in)	Y2 (in)	Y3 (in)	Y4 (in)	Additional load centroid (in)	Additional load (kip/ft)	Parapet unit load (kcf)	Calculated Net centroid (in)	Total load (kip/ft)	I	
Control Options	> Jersey Barrier Sta	andard New Jers 12.00	2.0000	7.0000	0.0000	19.0000	10.0000	3.0000			0.1500	7.8801	0.5	05	
Input Report	Copy from library											New	Duplicate		
Validation Off												d Back	Forv	vard Þ	

## Design Input | Project Library | Material

On the **Material** tab, select **Concrete** for **Type** from the drop down menu and click the **Copy from library** button to copy the **Class A** (**US**) concrete material definition from **File** | **Library** to the **Project Library**.

oject	Appurtenance Materia	al Vehicle										
roject Library	Type: Concrete	~										
eometry	Name	Description	Compressive strength at 28 days f'c (ksi)	Initial compr strength f <sup>°</sup> ci	Coefficient thermal expa (1/F)	Density for DL (kcf)	Density modulus of e (kcf)	Std Modulus of elasticity* (ksi)	LRFD Modulus of elasticity (ksi)	Std Initial moduli of elasticity' (ksi)	Poisson's ratio	
eck			_									
pical Section Loads			Select Item		-		×					
			Name		Description							
am Parameters			Class A	Class A cemer		_						
			Class A (US) Class B	Class A cemer Class B cemer								
teral Support			Class B (US)	Class B cemer								
ember Loads			Class C	Class C cemer	nt concrete							
			Class C (US)	Class C cemer	nt concrete							
ontrol Options												
out Report					OK	Can	el					
Jucheport												
												-

On the **Material** tab, select **Structural Steel** for **Type** from the drop down menu and click the **Copy from library** button to copy the **Grade 50W** steel material definition from **File** | **Library** to the **Project Library**.

STL15 Design Example.brdx - AASHTOWa	are Bridge Design: Steel De	sign Tool							- 0	$\times$
File Design Input Design										
Project	Appurtenance	erial Vehicle								
Project Library	Type: Structural Steel	~	-							
Geometry	Name	Description	Specified yield strength (Fy) (ksi)	Specified tensile strength (Fu) (ksi)	Modulus of elasticity (ksi)	Coefficient of thermal expansion	Density			
Deck										
Typical Section Loads			BI Select H	em ame	Description	- 🗆 X				
Beam Parameters					0 M270M - over 6 0 M270M - over 6					
Lateral Support			Grade Grade		0 M270 Grade 36 0 M270 Grade 50					
Member Loads			Grade		0 M270 Grade 50	v				
			Grade		0 M270 Grade 70\					
Control Options					0 M270 Grade 100 0 M270 Grade 100	up to 2.5" t W up to 2.5" •				
Input Report					OK					
										_
	Copy from library							 New Du	plicate Del	ete
Validation Off								Back	Forward	

On the **Material** tab, select **Reinforcing Steel** for **Type** from the drop down menu and click the **Copy from library** button to copy the **Grade 60** reinforcing steel material definition from **File** | **Library** to the **Project Library**.

STL15 Design Example.brdx - AASHTOW	Vare Bridge Design: Steel Des	ign Tool							—		$\times$
File Design Input Design	[										
Project	Appurtenance Mater	ial Vehicle									
Project Library	Type: Reinforcing Steel	Ŷ	)								
Geometry	Name	Description	Specified yield strength (Fy) (ksi)	Modulus of elasticity (ksi)	Ultimate strength (Fu) (ksī)	Туре					
Deck											
Typical Section Loads			BD Select Ite		-						
Beam Parameters			Na > Grade 30		Description Pa reinforcing steel	1					
			Grade 3 Grade 40		Pa reinforcing steel (i reinforcing steel	rail-steel)					
Lateral Support			Grade 40		Pa reinforcing steel						
Member Loads			Grade 50 Grade 50		reinforcing steel (rail- Pa reinforcing steel	-steel)					
Control Options			Grade 60	) 60 ksi	reinforcing steel	I					
Input Report			Grade 7	i 75 ksi	reinforcing steel	Cancel					
inputrieport											
	Copy from library							New	Duplicate	Delete	
Validation Off	1							Back	Fo	orward 🕽	

# Design Input | Project Library | Vehicle

On the Vehicle tab, copy the HL-93 (US) and LRFD Fatigue Truck (US) vehicle definitions from library.

		ial Vehicle										
Project Library						Tandem			I	Lane		
eometry	Name	Description	Library type	Notional	Axle load (kip)	Spacing between axles (ft)	Transverse wheel spacing* (ft)	Uniform lane load (kip/ft)	Concentrat load for mon (kip)	Concentrated load for shea (kip)	Add second concentrated load*	
,	HL-93 (US)	AASHTO LRFD Live Load - US unit system	Standard 🗸 🗸		25.0000	4.00	6.00	0.640				Г
eck	LRFD Fatigue Truc	AASHTO LRFD Fatigue Truck - US unit sys	Standard 🗸 🗸									1
am Parameters teral Support	Carry Street Vibra									Neur	Dualizata	
	Copy from library									New	Duplicate [	Dele
ember Loads	Truck:											
	Axle I		Axle spacin	g (ft)								
lember Loads ontrol Options		oad Gage distance		g (ft) Maximum								
	Axle I	oad Gage distance contact width*										
ontrol Options	Axle I	oad Gage distance contact width*										

## Design Input | Project

Return to the **Project** tab to define the vehicles for the girder design. Click on the ellipsis button to assign the HL-93 (US) vehicle as the design load and the LRFD Fatigue Truck (US) as the fatigue load. Leave the permit load blank. Define the design average daily truck traffic as 5000.

STL15 Design Example.brdx - AASH	1TOWare Bridge Design: Steel Design Tool	-		×
Project	Project:         STL15 Design Example           Description:         2 Span 4 Girder Bridge			
Project Library				
Geometry				
Deck	Designer:           Date:         7/11/2024			
Typical Section Loads				
Beam Parameters	LRED specifications Edition: AASHTO LRED 9th			
Lateral Support	Limit states: 🗹 Strength-I 🗹 Strength-II 🗹 Strength-III 🗹 Strength-V			
Member Loads	<ul> <li>✓ Service-II</li> <li>✓ Fatigue-II</li> <li>✓ Fatigue-II</li> </ul>			
Control Options				
Input Report	Design vehicles Design load: HL-93 (US) Permit load: Single lane permit load Fatigue load: LRFD Fatigue Truck (US)			
	Design ADTT: 5000			
alidation Off		Back	rward 🕻	

# Design Input | Geometry

On the **Geometry** tab, enter the data as shown below. Depending on your screen resolution, scroll down to enter the **Support** information.

STL15 Design Example.brdx - AASH	TOWare Bridge Design: Steel Design Tool	—		×
le Design Input Design				
Project	Superstructure definition type: System definition			
Project Library	Number of spans: 2 🗘			
Geometry	Number of beams: 4 🗘			
-	Girder spacing: 10 ft			
Deck	Support skew: 0 Degrees			
Typical Section Loads	Number of design lanes: 3 🗘			
Beam Parameters	Spans:			
Lateral Support	Span         Length (ft)           >         1         100.00			
Member Loads	2 100.00			
Control Options				
Input Report				
npurneport	Supports:			
	Support Support type			
	1 Pinned V			
	2 Roller V			
	3 Roller V			
	End bearing location: Left: 0 in Right: 0 in			
lidation Off	a Ba	ck Fc	orward 🛛	

## Design Input | Deck

On the **Deck** tab, enter the data as shown below. The **Splice location gaps** table can be used to input regions where the program should avoid placing shear studs. For this example, leave this table empty.

Design Input Design											
roject		oncrete:	Class A (US)		~						
roject Library		otal thickness: tructural thickness:	10 in 9 in								
eometry		k reinforcement									
Deck		Support	Start distance (ft)	Length (ft)	End distance (ft)	Bar size	Clear cover (in)	Measured from	Bar spacing (in)		
Typical Section Loads	>	1 ~	80.00	40.00	120.00	6 ~		Top of Str $$	4.000		*
Beam Parameters											
Lateral Support											
Member Loads											-
Member Loads Control Options									New Duplicate	Delet	te
Member Loads Control Options	Haunch Edge o	verhang: h depth: f haunch to edge c	3 2 0	ft in in					New Duplicate	Delet	te
Lateral Support Member Loads Control Options Input Report	Haunch Edge o Co	h depth: If haunch to edge o omposite deck	2	in					New Duplicate	Delet	te
Member Loads Control Options	Haunch Edge o Co Shee Stuc	h depth: f haunch to edge o omposite deck ar connectors d diameter: 0.5 Provide shear stud	2	in in					New Duplicate	Delet	te
Member Loads Control Options	Haunch Edge o Co Shee Stuc	h depth: f haunch to edge o omposite deck ar connectors d diameter: 0.5	2 of beam: 0 in s in negative flexure	in in	Left gap	Right gap			New Duplicate	Delet	te

Design Input | Typical Section Loads

On the **Parapet** tab in **Typical Section Loads**, enter the data as shown below.

oject	Stag	e 2 load distributio	n: 🜔 Unifo	rmly to all girders							
oject Library				butary area	r:%	First inte	rior:	%			
ometry	Wea	ring surface:	Thickness:	2 in	Density:	120 pcf					
ck	Арр	urtenance loads:									
pical Section Loads	Pa	Medi	an Railing	Generic	Sidewalk						
am Parameters		P. d									
eral Support		Back	Front								
mber Loads ntrol Options		Name	Stage	Load type	Measure to	Edge of deck distance measure from	Distance at start (ft)	Distance at end (ft)	Front face orientation		
ntroi Options		Jersey Bar \vee	Stage 2 🛛 🗸	DC ~	Back ~	Left Edge 🗸	0.00	0.00	Right ~	/	
ut Report	>	Jersey Bar \vee	Stage 2 $\sim$	DC ~	Back $\vee$	Right Edge 🛛 🗸	0.00	0.00	Left 🗸 🗸	·	
										New Duplicate	Delete
	Diap	hragm loads:									
	Gird	er bay: 1	✓ Copy bay	y to							
		Support		istance (t)	Diaphragm spacing	Number of spaces	Length (ft)	End di (fi		Load (kip)	

Make sure to scroll to the bottom of the page to define the diaphragm loads. Input the diaphragm loads as shown for Girder Bay 1 and use the **Copy bay to...** button to copy the loads to Girder Bay 2 and Girder Bay 3.

Control Options				gm loads: bay: 1	✓ Copy bay	• to								
Input Report Copy diaphragm to ba	ay(s)	×		Support	Start di (fi		Diaphragm spacing	Number	Length	End di (f		Load		
Select the new bay(s):	Bay 2				Left girder	Right girder	(ft)	of spaces	(ft)	Left girder	Right girder	(kip)		
		-	1	~	0.00	0.00	0.00	1	0.00	0.00	0.00	1.000		
	Bay 3		1	~	0.00	0.00	25.00	8	200.00	200.00	200.00	1.000		
											Ν	New Duplicate	Delete	
ОК	Canc	el											ac	k Forwar

#### Design Input | Beam Parameters

In the **Beam Parameters** input section, enter the data as shown below. All of the plate dimensions except for the web depth can be designed. Providing a larger range of values for any given parameter can help the design tool converge on a solution. The program will design transverse stiffeners for shear resistance if the **Use transverse** stiffeners button is selected. This example does not use this option.

STL15 Design Example.brdx - AASH	ITOWare Bridge Design: St	eel Design Tool			- 0
roject	- Section configura	tion			
,	Web	Min	Max	Increment	
Project Library	Depth	60 in	60 in		
	Thickness	0.3750 ~	0.7500 ~	1/8" ~	
eometry	Top flange	Min	Max	Increment	
eck	Width	12 in	20 in	2 in	
	Thickness	0.5000 ~	2.0000 ~	1/4" ~	
Typical Section Loads	Bottom flange	Min	Мах	Increment	
Beam Parameters	Width	12 in	20 in	2 in	
Sealli Falameters	Thickness	0.5000 ~	2.0000 ~	1/4" ~	
Control Options	Exterior	One side	d Max spac (in)		
Control Ontingo		One side	(in)		
	Interior				
nput Report					
	Structural steel ma     Web:	Grade 50W		~	
	Top flange:	Grade 50W		~	
	Bottom flange:	Grade 50W	-	~	
	Transverse stiffene			~	
	Bearing stiffener:	Grade 50W	_	~	
dation Off					Back Forwar

### Design Input | Lateral Support

In the **Lateral Support** input section, enter the data as shown below. Top flange lateral support ranges are regions where the top flange is continuously laterally supported and top flange lateral support locations are discrete points of lateral support. These entries define the top flange lateral support for Stage 2 and Stage 3.

ges Locatio	ns						
Support	Start distance (ft)	Length (ft)	End distance (ft)				
1 🗸	0.00	200.00	200.00				
						New	Duplicate Del
ange Lateral Suppo							
Support	Start distance (ft)	Spacing (ft)	Number of spaces	Length End (ft) (ft)			
1 🗸	0.00	0.00	1	0.00 0.			
1 🗸	0.00	25.00	8	200.00 200.	0		

#### Design Input | Member Loads

There are no member loads assigned in this example. Member concentrated loads, member distributed loads and pedestrian loads could be assigned here.

## Design Input | Control Options

The **Control Options** input section provides options for analysis and design. For this example, leave the options as is.

STL15 Design Example.brdx - AAS	TOWare Bridge Design: Steel Design Tool –	- 0	
le Design Input Design			
Project	Allow moment redistribution Use appendix A6 for flexural resistance		
Project Library	Allow plastic analysis     Jgnore longitudinal reinforcement in negative moment capacity		
Geometry	Consider deck reinforcement development length		
Deck			
Typical Section Loads			
eam Parameters			
ateral Support			
lember Loads			
ontrol Options			
nput Report			
dation Off	Back	Forward	

At this point, all design data has been defined. Turn **Validation** on and ensure that there are no validation error marks displayed next to the input section. Otherwise, go back to these sections and resolve the errors.

Validation	On	

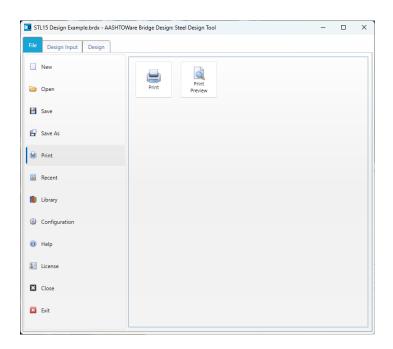
# Design Input | Input Report

The Input Report section provides a detailed report of the input data.

STL15 Design Example.brdx - AASHTC	Ware Bridge Design: Steel Design Tool											-		×
File Design Input Design														
Project	Project													
Project Library	Project: STL15 Design Exam Description: 2 Span 4 Gird Designer: Date: 07/11/2024													
Geometry	LRFD specifications Edition: AASHTO LRFD 9 Limit states: Strength		ath-III Strenati	-V Sanui	ce.TT Fr	time.T	Fatime.T							
Deck	Design vehicles Design load: HL-93 (US			,										
Typical Section Loads	Permit load: Single lane permit loa Fatigue load: LRFD Fat													
Beam Parameters	Design ADTT: 5000													
Lateral Support	Project Library													
Member Loads	Appurtenance Parapet													
Control Options														
Input Report	Name	Description	Distance from edge to centroid (in)	X1 (in)	X2 (in)	X3 (in)	Υ1 (in)	Y2 (in)	Υ3 (in)	Y4 (in)	Additional load (kip/ft)	Median unit load (kcf)	Net	Cal t cer (i
	Jersey Barrier	Standard New Jersey Barrier		12.0000	2.0000	7.0000	0.0000	19.0000	10.0000	3.0000		0.1	500	
	Material													
	Concrete													
	Name	Description	Compressive strength at 28 days f'c (ksi)	Initi compress strength (in)	ive f'ci e	efficient thermal expansion (1/F)	fo	nsity r DL kcf)	Density modulus elastic (kcf	of ity	Poisson's ratio	Composition of concrete	of ru	ksi)
alidation	4									_		Back	Forward	

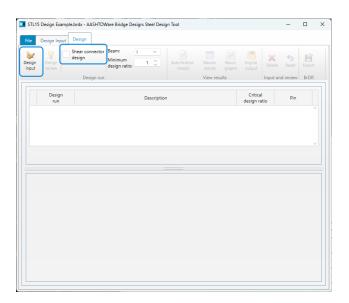
# File | Print

The **Print** and **Print Preview** buttons in the **File** | **Print** section apply to the **Input Report**.



#### Design | Design Input

After the input data is entered and reviewed, **Design Input** run can be performed by clicking on the **Design Input** button located on the **Design ribbon**. **Design Input** run is based on the input data and produces a design that is displayed in the **Design Run** grid with a brief description and values of the critical design ratios. Select the checkbox for **Shear connector design** to design the shear connectors along with the girder in the composite regions. The beam dropdown is the selection for which girder the program will design and the input for minimum design ratio defines the target design ratio for which the girder will be designed.



#### Design | Results Table

The results of the **Design Input** run are displayed in the table. The user can click on the **Critical design ratio** to open the **Analysis engine feedback report**, and on the page icon next to the **Critical design ratio** to open the **Specification Check Summary**.

D STL1	5 Design Example.	brdx - AASHTOW	/are Bridge Des	ign: Steel Desi	gn Tool					-		×
File	Design Input	Design										
Design input		Shear connector design	Beam: Minimum design ratio:	1 ~	Specification checks	Tabular results	Result graphs	Engine output	X Delete	<b>S</b> Reset	Export	
		Design run				View res	ults		Input an	d review	BrDR	
	Design run			Description	n			Critica design ra		Pin		
	1-11.1	G1 - Design (	Volume = 79.9f	t^3)				✓ 1.010		-(#1		

### Design | Girder Profile

The **Girder Profile** tab displays the ranges for steel plates along the web and flanges. After a design input run is completed, these tables will display the program computed ranges. The user may modify these ranges and reanalyze the member using the **Design Review** option.

Sirder p	orofile Stiffene	rs Shear conne	ectors Schema	tics: Profile View				
Veb:								
	Depth (in)	Thickness (in)	Support	Start distance (ft)	Length (ft)	End distance (ft)		
>	60.000	0.500	1 ~	0.000	75.000	75.000	A	
	60.000	0.625	1 ~	75.000	50.000	125.000		
	60.000	0.500	2 ~	25.000	75.000	100.000		
	,		,			,		
							~	
						Ne	w Duplicate Delete	

#### Design | Stiffeners

The **Stiffeners** tab displays the results of the stiffener design. This includes transverse stiffeners and bearing stiffeners. The transverse stiffeners will only be designed when the design input option to **Use Transverse Stiffeners** in the **Design Input** | **Beam Parameters** window is selected.

Des	sign Input	Design Shear connector design		1 ~			<b>X</b>	<b>*</b>	<b>X</b> 5				
	Design review	ucagn	Minimum design rati	io: 1 🗘	Specification	Tabular results	Result E	Engine output De	elete Rese				
		Design run				View resul			ut and revie	w BrDR			
	Design										Critical		
	run				Descr	iption					design ratio	Pin	
2 1-11	1.1	G1 - Design (	Volume = 7	'9.9ft^3)							🖌 1.010 📄	-141	
Trans	er profile werse Stiffe One sided		r connector	s Schematic	cs: Profile View								
Transv () Transv	verse Stiffe One sided sverse Stiffe	ener Width:	in in in stance	n	Spacing (in)	Lengti (ft)	h Er	nd Distance (ft)					

# Design | Shear connectors

The **Shear connectors** tab shows the results of the shear connector design if enabled and if the member has composite regions.

it n		Design Shear connector design Design run	Minimun design ra		checks	Tabular Result results graphs	Engine output	Reset Export			
		besign run				rew results	mpaca				
	Design run				Descripti	on			Critical design ratio	Pin	
/ 1-11	1.1	G1 - Design	(Volume =	79.9ft^3)					🖌 1.010 📄	-jaj	
- Shea	ar Connectors										
Stud	d Height:		6.000	in							
	-	; ensile Strength:		in ksi							
	-	ensile Strength: Numbe	60.000 r per		Transverse Spacing (in)	Support	Start Distance (ft)	Length (ft)	End Distance (ft)		
Stee	el Minimum T Shear	ensile Strength: Numbe	60.000 r per	ksi Number of				(ft)			
Stee	el Minimum T Shear Connecto Shear Stud Shear Stud	r Rov	60.000 r per v 3 3	ksi Number of Spaces 80 120	(in) 4.600 4.600	1 ~ 1 ~	(ft) 0.000 40.000	(ft) 40.000 60.000	(ft) 40.000 100.000		
Stee	el Minimum T Shear Connecto Shear Stud	r Rov	60.000 er per v 3	ksi Number of Spaces 80	(in) 4.600	1 ~ 1 ~ 2 ~	(ft) 0.000	(ft) 40.000 60.000 60.000	(ft) 40.000		

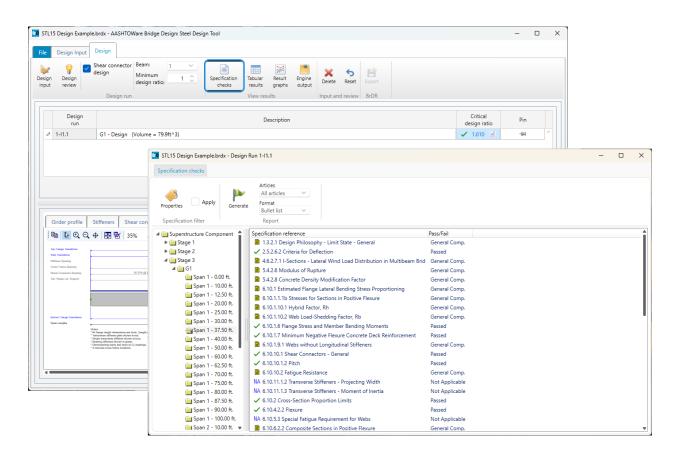
Design | Schematics: Profile View

The Schematics: Profile View tab shows a schematic of the girder design.

	🕁 🖶 🔂 35% 🔹					
Plange Transitions	0,305(25)747		PL 1514569-47		P. WY1277847	
ta Tranadiorea	1014010701-01		580-80-50-01		10560578-01	_
ener Specing			8 579.43 25-01-2007-01			
ea Frame Specing er Connector Specing	10 SIN Q 1"	120 SPA-Q 4"	1 57Kg 25-0 Kall-0	120 EFA-R 4*	a) 57%, g e*	-
Flenge Lat. Support	a a reg a		200-0*	and and a	*	
	107407 996		Nervecr wwo		121467 Web	
om Planca Transiliona	PL 13(45)(547		PL 15(8560-07		PL 13(43)/8-17	
n Langitu	100-4"	•		107-4*		
	Nom: - Yes lange length dimensions are hold: (length along lange may differ). - Tomoverse stifferer parts shown in hub. - Single stamoverse stifferer davies in hub.					

# Design | Specification Check

To view the specification check results, click on the **Specification checks** button from the **View results** group of the **Design** ribbon.



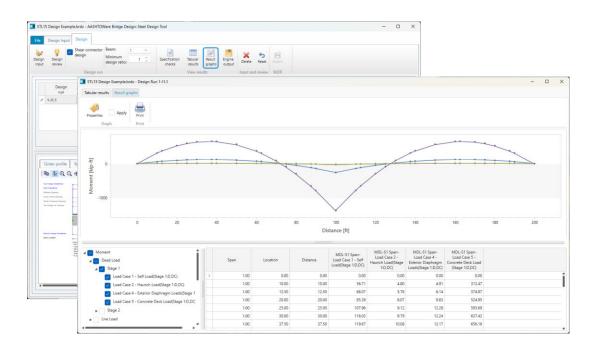
# Design | Tabular Results

To view the tabular results, click on the **Tabular results** button from the **View results** group of the **Design** ribbon.

TL15 Design Examp	ple.brdx - AASHTOWare Bridg	e Design: Steel De	sign Tool								-	×		
Design Input	Design Shear connector design Design run		Specification checks	Tabular results	graphs ou	igine utput		Export						
Design run	Design fun				scription	mput	and review	biok 1		Critical design ratio	Pin			
0 1-11.1	G1 - Design (Volume =	Tabular results Print Print		Design Run 1	-11.1								-	
			ad Load Actions	~	Stage Stage	: 1	~	Dead load case	Load Case 1 - !	Self Load(Stage 1:D,DC)	~			
Girder profile	Stiffeners Shear connec	Span	Location	Moment (kip-ft)	Shear (kip)	Axial (kip)	Reaction (kip)	X deflection (in)	Y deflection (in)					
the Fierce Treations		1	0.00	0.00	6.57	0.00	6.57	0.0000	0.0000					
Web Transitiona Software Specing		1	10.00	56.71	4.77	0.00		0.0000	-0.0678					
Cross Freme Specing Shear Connector Specing	10 57% (j i*	1	12.50	68.07	4.32	0.00		0.0000	-0.0834					
Top Flange Lat. Support		> 1	20.00	95.39	2.97	0.00		0.0000	-0.1246					
		1	25.00	107.96	2.06	0.00		0.0000	-0.1463					
		1	25.00	107.96 116.03	2.06	0.00		0.0000	-0.1463					
Before Flange Transitions		1	37.50	119.67	-0.19	0.00		0.0000	-0.1763					
Span Langtha	Notes: "All fange langth dimensions are horie, (langth along t	1	40.00	118.63	-0.64	0.00		0.0000	-0.1779					
	Ail Tanga length dimensions are trutic, (anglit along L <sup>1</sup> Tontovene attliener pairs about in red. <sup>1</sup> Single transverse stiffener shoen in blue. <sup>1</sup> Dansverse stiffener shoen is green. <sup>1</sup> Unmentoring starts and entits at CL, beeinge. <sup>1</sup> X, denotes crass frame locations.	1	50.00	103.20	-2.44	0.00		0.0000	-0.1697					
	* X denotes cross frame locations.	1	50.00	103.20	-2.44	0.00		0.0000	-0.1697					
		1	60.00	69.74	-4.25	0.00		0.0000	-0.1413					
		1	62.50	58.56	-4.70	0.00		0.0000	-0.1317					
4		1	70.00	18.24	-6.05	0.00		0.0000	-0.0993					
		1	75.00	-14.27	-6.95	0.00		0.0000	-0.0763					
		1	75.00	-14.27	-6.95	0.00		0.0000	-0.0763					

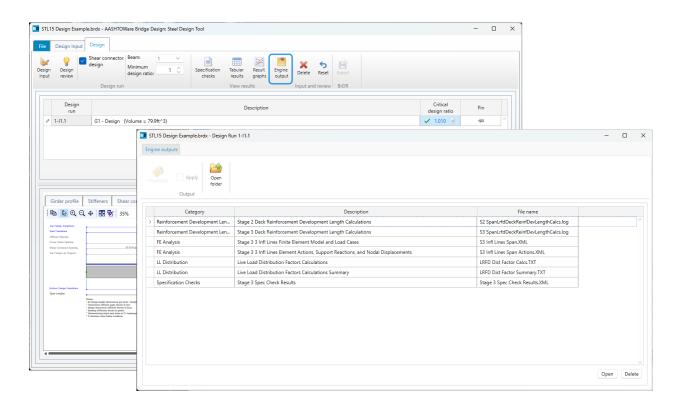
# Design | Result Graphs

To view the result graphs, click on the **Result graphs** button from the **View results** group of the **Design** ribbon.



# Design | Engine Outputs

To view the contents of the engine output files, click on the **Engine outputs** button from the **View results** group of the **Design** ribbon, and then double-click on the row corresponding to the required file.



# Design | Design Review

To illustrate the ability of the program to adjust results of the **Design Input** run, modify the **Top flange** table to define a top flange width of 14 inches for all ranges and a thickness of 0.625 for the first and third range as shown below. Select **Design Review** to analyze this modified design.

Desig	5	Design															
		esign M	am: inimum sign rat	1 ×		Tabular Resu results grapi	t Engine			<b>xport</b>							
<u> </u>		Design run				View results		put and rev	view	BrDR							
[	Design run					Descripti	on						Cri desig	ical n ratio	P	Pin	
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After the program finishes performing the design review, it will add another row to the design run grid. The design review runs are indicated with an **R** displayed in the **Design run** column in contrast to an **I** shown in that column for design input runs. The results for the **Design review** runs are displayed and can be reviewed or further modified the same way as design input runs. Additional design input runs can be performed by modifying the input on the **Design Input** tab. Each of the design runs, either input or review, stores a copy of its design input data that is reloaded every time the design input run is selected in the design run grid.

L15 Des	esign Input	Design														
🖉 gn D		Shear connector design	Beam: Minimu design			Tabular Resu results grap	lt Engine	× Delete	<b>S</b> Reset	Export						
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1-11.	11.1	G1 - Design (	Volume	= 79.9ft^3)								 / 1.01	0 🗎	-(#1		
> 1-R1	R1.1	G1 - Design Re	view									/ 1.00	B 📄	-jµ		]
Top fla	lange:															
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	Width (in) 14	(in) 1.000	0.625	1 × 1 ×	(ft)	(ft)	(ft)	00								

# **2024 RADBUG Annual Meeting**



# **BrR Training Session**

# Wednesday August 7, 2024 10:00 AM – 12:00 AM

- 1. Concrete Shear LRFR Rating Iteration
- 2. LRFR Concrete Moment Redistribution

AASHTOWare BrDR 7.5.1

# Concrete Shear LRFR Rating Iteration Tutorial

MBE 2023 Spec Interim Update – Shear Rating Iteration Example

#### **BrDR** Training

#### MBE 2023 Spec Interim Shear Rating Iteration Example

This example illustrates the effects of using concurrent load effects, iterative shear rating and Modified Compression Field Theory (MCFT) control options for Load and Resistance Factor Rating (LRFR) shear rating of concrete structures (prestressed, post tensioned and reinforced) based on the MBE 3<sup>rd</sup> edition, 2023 specification interim update.

## **Topics Covered**

- Concurrent forces considered for non-iterative shear rating
- Control option added to consider iterative shear rating
- Control option added to consider modifying MCFT theta
- Control option added to consider modifying MCFT size effect
- MBE 2023 specification interim update for reinforced concrete box culverts

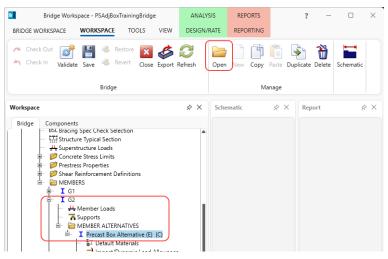
This tutorial uses the bridge from prestressed concrete structure tutorial PS3. From the **Bridge Explorer** import the bridge given with the PS3 tutorial.

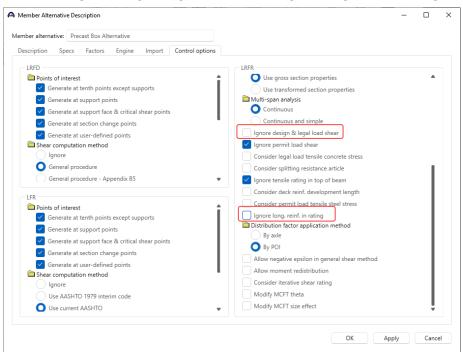
#### Concurrent forces considered for non-iterative shear rating

This section discusses the effects of using concurrent forces for LRFR shear rating of concrete bridges without any iterations. This is applicable to all concrete structures, i.e., reinforced concrete, prestressed concrete, post tensioned concrete and reinforced concrete box culverts.

#### Member Alternative Description – Control options

Navigate to the member alternative Precast Box Alternative of member **G2**, double click on it (or click the **Open** button from the **WORKSPACE** ribbon) to open its **Member Alternative Description** window. Navigate to the **Control options** tab as shown below.





Uncheck the Ignore design & legal load shear and Ignore long. reinf. in rating for this example.

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

#### LRFR Rating

Perform an LRFR rating of the member alternative using the analysis settings shown below.

Analysis Settings			-	)
Design review <b>O</b> Rating	Rating method	LRFR	~	
nalysis type: Line Girder 🗸				
nne / Impact loading type: As Requested V	Apply preferen	ce setting: None	~	
Vehicles Output Engine Description				
Traffic direction: Both directions	Re	fresh Temporary vehicle	Advanced	
Vehicle selection	Vehic	e summary		
<ul> <li>→ Vehicles</li> <li>→ EV2</li> <li>→ EV3</li> <li>→ H 15-44</li> <li>→ H 20-44</li> <li>→ H -93 (S)</li> <li>→ H 15-44</li> <li>→ H -93 (S)</li> <li>→ H 15-44</li> <li>→ H 20-44</li> <li>→ H 20-44<!--</td--><td>Add to &gt;&gt; Remove from &lt;&lt;</td><td>ating vehicles ⇒LRFR ⇒ Design load rating ⇒ Design load rating ⇒ Design load rating ↓ - (1-1-93 (US) ⇒ Fatigue ↓ _ LRFD Fatigue Truc → LRFD Fatigue Truc ↓ _ LRFD Fatigue Tru</td><td>k (US)</td><td></td></li></ul>	Add to >> Remove from <<	ating vehicles ⇒LRFR ⇒ Design load rating ⇒ Design load rating ⇒ Design load rating ↓ - (1-1-93 (US) ⇒ Fatigue ↓ _ LRFD Fatigue Truc → LRFD Fatigue Truc ↓ _ LRFD Fatigue Tru	k (US)	

#### Specification Check Detail

When the rating is finished, the specification check detail can be reviewed by clicking the **Specification Check Detail** button from the **Results** group of the **DESIGN/RATE** ribbon.

Bridge Workspa	ace - PSAdjBoxTraining	gBridge	ANALYSIS	REPORTS	?	_	$\times$
BRIDGE WORKSPACE	WORKSPACE TOO	OLS VIEW	DESIGN/RATE	REPORTING			
at a 📰		ेक 🛪	2 <b>B</b>				
Analysis Analyze Analysis							
Settings Events Analysis		Results	pri Results				
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The window shown below will open. Navigate to the **Stage 3** specification check detail for the analyzed member alternative and select the **Span 1 – 19.00 ft** point of interest.

Properties Generate F	rticles All articles ormat Bullet list Report			
📋 Superstructure Component	Specification reference	imit State	Flex. Sense	Pass/Fail
Prestress Calculations	✓ 5.4.2.1 Compressive Strength		N/A	Passed
🕨 🚞 Stage 1	5.4.2.5 Poisson's Ratio		N/A	General Comp.
🕨 🚞 Stage 2	5.4.2.6 Modulus of Rupture		N/A	General Comp.
🔺 🚞 Stage 3	5.4.2.8 Concrete Density Modification Factor		N/A	General Comp.
4 🚞 Precast Box Alternative	NA 5.5.3.2 Reinforcing Bars and Welded Wire Reinforcement		N/A	Not Required
Span 1 - 0.00 ft.	5.5.4.2 PS Strength Limit State - Resistance Factors		N/A	General Comp.
i Span 1 - 2.00 ft.	5.6.2.2 Rectangular Stress Distribution		N/A	General Comp.
in Span 1 - 3.01 ft.	✓ 5.6.3.2 PS Flexural Resistance (Prestressed Concrete)		N/A	Passed
Span 1 - 9.50 ft.	✓ 5.6.3.3 Minimum Reinforcement		N/A	Passed
Span 1 - 19.00 ft.	NA 5.7.4 Interface Shear Transfer		N/A	Not Required
Span 1 - 28.00 ft.	NA 5.7.4.2 Minimum Area of Interface Shear Reinforcement		N/A	Not Required
ig Span 1 - 30.00 ft.	✓ 5.9.2.3.2b Tensile Stresses		N/A	Passed
ing Span 1 - 57.00 ft.	5.9.4.3.2 Bonded Strand		N/A	General Comp.
i Span 1 - 66.50 ft.	✓ 6A.4.2.1 Design Load Rating Prestress Service III Tensile Stress		N/A	Passed
in Span 1 - 76.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Concrete Flexure		N/A	Passed
in Span 1 - 85.50 ft.	✗ 6A.4.2.1 General Load Rating Equation - Concrete Shear		N/A	Failed
🚞 Span 1 - 91.99 ft.	🔋 6A.4.2.1 Shear-5.6.3.3 Minimum Reinforcement		N/A	General Comp.
🚞 Span 1 - 93.00 ft.	✓ 6A.4.2.1 Shear-5.7.2.5 Minimum Transverse Reinforcement		N/A	Passed
🚞 Span 1 - 95.00 ft.	✓ 6A.4.2.1 Shear-5.7.2.6 Maximum Spacing of Transverse Reinforcement		N/A	Passed
	6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance		N/A	General Comp.
	6A.4.2.1 Shear-5.7.3.4 Procedures for Determining Shear Resistance		N/A	General Comp.
	× 6A.5.8 Evaluation for Shear		N/A	Failed
	Computation of Vp		N/A	General Comp.
	Cracked_Moment_of_Inertia Section Property Calculations		N/A	General Comp.
	PS_Basic_Properties Calculation		N/A	General Comp.
	PS_Gross_Composite_Section_Properties PS Gross Composite Section		N/A	General Comp.

The highlighted articles for MBE 6A.4.2.1 shear rating are available for an LRFR shear rating of concrete structures. These articles along with 6A.5.8 Evaluation of Shear and 6A.4.2.1 General Load Rating Equation – Concrete Shear articles, use the concurrent load effects to compute the shear capacity and rating factors.

Following sections highlight the MBE 3<sup>rd</sup> edition 2023 spec interim implementation for an LRFR analysis.

Article 6A.4.2.1 Shear-5.6.3.3 Minimum Reinforcement computes the cracking moment (Mcr) for each load case as shown below.

A new column – "Governing Action" has been added to indicate the primary action considered. For example, in 2022 interim, rating factors were computed using the envelope moment and shear values. In 2023 interim, shear concurrent actions with maximum (Max M) and minimum (Min M) moment, moment concurrent actions with maximum (Max V) and minimum (Min V) shear are being considered for load rating.

6A.4.2.1 SI	hear - 5 Concrete hear - 5.6 Design hear - 5.6.3 Flex hear - 5.6.3.3 Mi	n for Flexural as Kural Members		fects - B Regio	ns				
(AASHTO Mai	nual for Bridge H	Evaluation, Thire	d Edition wi		ms)				
	t Void - At Locat								
	ion Properties fo				d				
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Beam Heigh Fop Slab W: Fop Slab TI Bottom Slal Bottom Slal Bottom Slal Bottom Slal Bottom Slal Bottom Sla Bottom Sla Bott	idth = hick = b Width = b Thick = lop = Height = Depth = =	47.25 (in) 5.50 (in) 48.00 (in) 5.50 (in) 6.00 (in) 6.00 (in) 0.75 (in) 3.00 (in) 3.00 (in)	Side Wall 1	[hickness	= 5.00(in)				
Slab f'c Sffective :	= Slab Width = Slab Thickness =	0.00(ksi) 0.00(in) 0.00(in)	Haunch	Width Thickness	=	0.00(in) 0.00(in)			
ScBot = Sammal = :	0.54ksi -8569.07in^3 8734.21in^3		= 88 pt = 87	312.35kip-in 734.21in^3					
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Jamma 2 = : Jamma 3 = : Jamma 3 = : Othe: If tl Othe: If tl Othe: If tl STR-I	<pre>1.10 1.00 (Prestressed 0.67 (Reinforced a3 * [( gamma1*fn he capacity has h rwise the Resista Load Load</pre>	Concrete) c + Gamma2*fcpe) been overridden, ance is computed fcpe	the Resista as per the fr	ance is compute Specification: Gamma3 	d as override Governing Action Max M Min M Max V Min V Min M Max V Min V Max M Min M Max V Min V Max M Min V Max M Min M Max V Min V Min V Max M Min V Min V V V Min V V V Min V V Min V V Min V V Min V V Min V	Mu kip-in 32228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 27322.31 20159.68 27322.31 20159.68 25376.52 11318.68 28377.37 28578.56 25376.52 11318.68 28377.37 28578.56 25376.52 11318.68 28377.37 28578.56 25376.52 11318.68 28377.37 28578.56 25376.52 11318.68 25376.52 11318.58 25376.52 115576.58 11557	Vu ktp 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.27	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-: 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801 28801
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Jamma 2 = : Jamma 3 = : Gamma 3 = : Other: If the second s	<pre>1.10 1.00 (Prestressed 0.67 (Reinforced a3 * [( gamma1*fn he capacity has h rwise the Resista Load Load</pre>	Concrete) c + Gamma2*fcpe) been overridden, ance is computed fcpe	the Resista as per the fr	ance is compute Specification. Gamma3  1.00 1.00 1.00 1.00 1.00 1.00	d as override Governing Action Max M Min M Max V Min V Max M Min V Max M Min V Max M Min V Max M Min M Max V Min V Min V Max M Min V Min V	Mu kip-in 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 29541.81 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.59 11318.68 28377.37 28878.59 11318.68 28378.59 11318.68 25376.52 113176.55 11318.68 25376.55 11318.68 25376.55 25576.55 2	Vu ktp 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.27	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	k1p-1 28801.
Jamma2 = : Jamma3 = : Jamma3 = : Other: If tl Other: If tl Other: If tl State STR-I	<pre>1.10 1.00 (Prestressed 0.67 (Reinforced a3 * [( gamma1*fn he capacity has h rwise the Resista Load Load</pre>	Concrete) c + Gamma2*fcpe) been overridden, ance is computed fcpe	the Resista as per the fr	ance is compute Specification. Gamma3  1.00 1.00 1.00 1.00 1.00 1.00	d as override Governing Action Max M Min M Max V Min V Max M Min V Max M Min V Max M Min V Max M Min M Max V Min V Min V Max M Min V Min V	Mu kip-in 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 29541.81 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.59 11318.68 28377.37 28878.59 11318.68 28378.59 11318.68 25376.52 113176.55 11318.68 25376.55 11318.68 25376.55 25576.55 2	Vu ktp 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.27	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	k1p-1 28801.
3amma2 = : 3amma3 = : 0amma3 = : 0tc = Gamma Note: If ti Othe: STR-I STR	<pre>1.10 1.00 (Prestressed 0.67 (Reinforced a3 * [( gamma1*fn he capacity has h rwise the Resista Load Load</pre>	Concrete) c + Gamma2*fcpe) been overridden, ance is computed fcpe	the Resista as per the fr	ance is compute Specification: Gamma3 	d as override Governing Action Max M Min M Max V Min V Min M Max V Min V Max M Min M Max V Min V Max M Min V Max M Min M Max V Min V Min V Max M Min V Min V V V Min V V V Min V V Min V V Min V V Min V V Min V	Mu kip-in 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 29541.81 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.59 11318.68 28377.37 28878.59 11318.68 28378.59 11318.68 25376.52 113176.55 11318.68 25376.55 11318.68 25376.55 25576.55 2	Vu ktp 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.27	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-i 28801.
Jamma 2 = : Jamma 3 = : Jamma 3 = : Other: If tl Other: If tl Other: If tl Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Strain Stra	<pre>1.10 1.00 (Prestressed 0.67 (Reinforced a3 * [( gamma1*fn he capacity has h rwise the Resista Load Load</pre>	Concrete) c + Gamma2*fcpe); been overridden, ance is computed fcpe ksi	the Resista as per the fr	ance is compute Specification. Gamma3  1.00 1.00 1.00 1.00 1.00 1.00	d as override Governing Action Max M Min M Max V Min V Max M Min V Max M Min V Max M Min V Max M Min M Max V Min V Min V Max M Min V Min V	Mu kip-in 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 29541.81 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.59 11318.68 28377.37 28878.59 11318.68 28378.59 11318.68 25376.52 113176.55 11318.68 25376.55 11318.68 25376.55 25576.55 2	Vu ktp 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.27	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	k1p-1 28801.
Jamma 2 = : Jamma 3 = : Jamma 3 = : Othe: Limit STR-I	1.10 1.00 (Prestressed 0.67 (Reinforced as * [( gammal*f] he capacity has h Load Comb 1. DesInv 1. DesInv 1. DesInv 1. DesInv 1. DesOp 2. DesOv 2. DesInv 1. DesInv 1. DesInv 1. DesInv 1. DesInv 2. DesI	Concrete) c + Gamma2*fcpe) been overridden, ance is computed fcpe	the Resista as per the fr	ance is compute Specification. Gamma3  1.00 1.00 1.00 1.00 1.00 1.00	d as override Governing Action Max M Min M Max V Min V Max M Min V Max M Min V Max M Min V Max M Min M Max V Min V Min V Max M Min V Min V	Mu kip-in 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 29541.81 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.56 25376.52 11318.68 28377.37 28878.59 11318.68 28377.37 28878.59 11318.68 28378.59 11318.68 25376.52 113176.55 11318.68 25376.55 11318.68 25376.55 25576.55 2	Vu ktp 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.27	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	k1p-1 28801.

Figure 1 - 6A.4.2.1 Shear-5.6.3.3 Minimum Reinforcement

Note: Article "LRFD 5.6.3.3 Minimum Reinforcement" will only be applicable for determining Mcr for flexural resistance using the envelope moment.

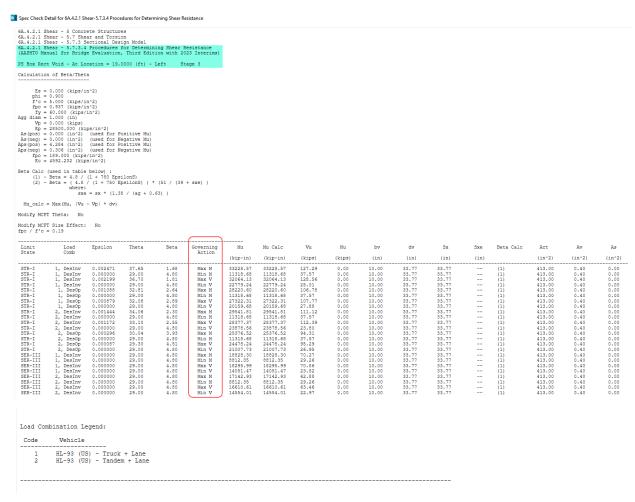


Figure 2 - 6A.4.2.1 Shear-5.7.3.4 Procedures for Determining Shear Resistance

A.4.2.1 SI	hear - 5 Concret hear - 5.7 Shear hear - 5.7.2 Gen	and Torsion	nts								
	hear - 5.7.2.5 M nual for Bridge (				ns)						
Box Rec	t Void - At Loca	ion = 19.0000	(ft) - Left	Stage 3							
	00ksi 00			(5.7.2.5 - 1)							
	Yield strength				si.						
Limit State	Load Comb	Vc (kip)	Vp (kip)	Governing Action	Vu (kip)	Vu> 0.5*phi*(Vc+Vp)	s (in)	bv (in)	Av Provided(in^2)	>= 0.0316 *lambda *SQRT(f'c) *bv * s/fy	Pass/Fa:
TR-I	1, DesInv	40.13	0.00	Max M	127.29	Yes	12.00	10.00	0.40	0.14	Pass
TR-I TR-I	1, DesInv 1, DesInv	114.52 43.22	0.00	Min M Max V	37.57 128.56	No Yes	12.00	10.00	0.40	0.14	Pass
TR-I TR-I	1, DesInv 1, DesOp	114.52 63.05	0.00	Min V Max M	25.01 106.78	No	12.00	10.00	0.40	n/a	Pass
TR-I	1, DesOp	114.52	0.00	Min M	37.57	No	12.00	10.00	0.40	n/a	
TR-I TR-I	1, DesOp 1, DesOp	69.03 114.52	0.00	Max V Min V	107.77	Yes	12.00	10.00	0.40	0.14 	Pass
TR-I	2, DesInv	54.97	0.00	Max M	111.12	Yes	12.00	10.00	0.40	0.14	Pass
TR-I TR-I	2, DesInv 2, DesInv	114.52 60.94	0.00	Min M Max V	37.57 112.39	No Yes	12.00	10.00	0.40	0.14	Pass
TR-I	2, DesInv	114.52	0.00	Min V	23.80	No	12.00	10.00	0.40	n/a	
TR-I TR-I	2, DesOp 2, DesOp	93.69 114.52	0.00	Max M Min M	94.31 37.57	Yes	12.00	10.00	0.40	0.14 p/a	Pass
TR-I	2, DesOp	107.53	0.00	Max V	95.29	Yes	12.00	10.00	0.40	0.14	Pass
STR-I SER-III	2, DesOp 1, DesInv	114.52	0.00	Min V Max M	26.95	No Yes	12.00	10.00	0.40	n/a 0.14	Pass
ER-III ER-III	1, DesInv 1, DesInv	114.52 114.52	0.00	Min M Max V	29.26	No Yea	12.00	10.00	0.40	n/a 0.14	Pass
ER-III	1, DesInv	114.52	0.00	Min V	23.52	No	12.00	10.00	0.40	n/a	Fass
SER-III	2, DesInv 2, DesInv	114.52	0.00	Max M Min M	62.88 29.26	Yes	12.00	10.00	0.40	0.14	Pass
SER-III	2, Desinv 2, Desinv	114.52	0.00	Max V	63.46	Yes	12.00	10.00	0.40	0.14	Pass
SER-III	2, DesInv	114.52	0.00	Min V	22.97	No	12.00	10.00	0.40	n/a	
ad Combin	nation Legend:										
ode	Vehicle										
		ck + Lane									

Figure 3 - 6A.4.2.1 Shear-5.7.2.5 Minimum Transverse Reinforcement

Spec Check Detail for 6A.4.2.1 Shear-5.7.2.6 Maximum Spacing of Transverse Reinforcement

alculation of Shear Stre u > 0.5*phi * (Vc+Vp) phi = 0.9000 f*c = 5.000ksi	(5.8.2.4-1)	rete										
Limit Load State Comb	Vc (kip)	Vp (kip)	Governing Action	Vu (kip)	Vu> 0.5*phi*(Vc+Vp)	bv (in)	dv (in)	vu (ksi)	vu< 0.125*f'c	s (in)	Spacing criteria	Statu
STR-I     1, Deslnv       STR-I     2, Deslnv       STR-I     1, Deslnv       STR-I     1, Deslnv       STR-I     1, Deslnv       STR-III     1, Deslnv       STR-III     1, Deslnv       STR-IIII     1, Deslnv       STR-IIII     2, Deslnv       STR-IIII     2, Deslnv       STR-IIII     2, Deslnv       STR-IIII     2, Deslnv	$\begin{array}{c} 40.13\\ 114,52\\ 43.22\\ 114,52\\ 63.05\\ 114,52\\ 69.03\\ 114,52\\ 69.03\\ 114,52\\ 114,$	$\begin{smallmatrix} & & & & & & & & & & & & & & & & & & &$	Max M Min M Max V Max W Max M Max M Max M Max M Max V Min M Max V Min M Max V Min M Max V Min M Max V Min M Max V Min M Min M Min M Min M Min M	$\begin{array}{c} 127.29\\ 37.57\\ 128.56\\ 25.01\\ 106.78\\ 37.57\\ 107.77\\ 27.88\\ 111.12\\ 37.57\\ 112.39\\ 23.80\\ 94.31\\ 37.57\\ 95.29\\ 26.95\\ 70.27\\ 29.26\\ 63.52\\ 62.88\\ 29.26\\ 63.46\\ 22.97\end{array}$	TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE TRUE FALSE	10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA 10.00 NA	33.77 HA 33.77 NA 33.77 HA 33.77 NA 33.77 HA 33.77 NA 33.77 NA 33.77 NA 33.77 NA 33.77 NA 33.77 NA 33.77 NA 33.77 NA 33.77 NA	0.42 NA 0.42 0.35 NA 0.35 NA 0.37 NA 0.37 NA 0.37 NA 0.31 NA 0.31 NA 0.23 NA 0.23 NA 0.23 NA 0.23 NA 0.23 NA NA 0.21 NA	TRUE NA TRUE NA TRUE NA TRUE NA TRUE NA TRUE NA TRUE NA TRUE NA TRUE NA TRUE NA	12.00 NR 12.00 NN 12.00 NN 12.00 NN 12.00 NN 12.00 NN 12.00 NN 12.00 NN 12.00 NN 12.00 NN NN	$\begin{array}{c} s{<\!$	Pass Pass Pass Pass Pass Pass Pass Pass

Figure 4 - 6A.4.2.1 Shear-5.7.2.6 Maximum Spacing of Transverse Reinforcement

🔐 Spec Check Detail for 6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance

6A.4.2.1 Shear - 5 Concrete Structures 6A.4.2.1 Shear - 5.7 Shear and Torsion 6A.4.2.1 Shear - 5.7.3 Sectional Design Model 6A.4.2.1 Shear - 5.7.3.3 Nominal Shear Resistance		
(AASHTO Manual for Bridge Evaluation, Third Edition with	2023 Interims)	
PS Box Rect Void - At Location = 19.0000 (ft) - Left	Stage 3	
Calculation of Shear Resistance Vr		
Vc = 0.0316 * Beta * lambda * SQRT(f'c) * bv * dv		(5.7.3.3-3)
kv1 * fy1 * dv (cot(theta) + cot(alpha1)) * si           Vs1 =		(5.7.3.3-4)
Vs2 = Av2 * fy2 * sin(alpha2) * lambda_duct Vs2Max = 0.095 * lambda * SQRT(f'c) * bv * dv Vs = Vs1 + min(Vs2, Vs2Max)		(5.7.3.3-6) (5.7.3.3-6)
Post tensioned = FALSE lambda_duct = 1.0000		
Vn1 = Vc + Vs + Vp Vn2 = 0.25 * f'c * bv * dv + Vp		(5.7.3.3-1) (5.7.3.3-2)
Vn = min(Vn1, Vn2) Vr = phi * Vn where:		(5.7.2.1-1)
<ul> <li>Write: Resistance due to concrete.</li> <li>Vo: Resistance due to stirrups.</li> <li>Vs2: Resistance due to only center 3/4 of sloped po</li> <li>Vp: Resistance due to prestressing.</li> <li>Vrs1: Resistance due to force in inclined bars.</li> <li>*Note: Vr includes the value Vrs1</li> <li>Av1: Area of stirrups.</li> <li>Aphal: Angle of inclination of stirrups.</li> <li>Av2: Area of bent up longitudinal rebars.</li> <li>fy1: Yield Strength of bent up longitudinal rebars.</li> <li>alpha2: Angle of inclination of bent up longitudinal rebars.</li> </ul>	ebars.	(Article 5.7.3.3)
<pre>Input: phi = 0.900 f'c = 5.000 (ksi) fyl = 60.000 (ksi) alphal = 90.000 (Degrees) lambda = 1.000 Consider inclined forces option: No Consider sloped portion of longitudinal rebar option: Consider iterative shear rating option (applies only Consider MCFT theta option: No Shear computation method: General Iteration required: No</pre>	to General and GeneralAppB shear o	computation methods): No

Figure 5 - 6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance Part 1

Limit State	Load Combo	Governing Action	Mu (kip-in)	MuDL (kip-in)	MuLL (kip-in)	Vu (kip)	VuDL (kip)	VuLL (kip)	Nu (kip)	bv (in)	dv (in)	s (in)	Av1 (in^2)	Beta	cot (Theta)	Epsilon
STR-I	1, DesInv	Max M	33228.57	11318.68	21909.89	127.29	37.57	89.71	0.00	10.00	33.77	12.00	0.40	1.682	1.296	0.002471
STR-I	1, DesInv		11318.68	11318.68	0.00	37.57	37.57	0.00	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.000000
STR-I	1, DesInv		32064.13	11318.68	20745.45	128.56	37.57	90.99	0.00	10.00	33.77	12.00	0.40	1.812	1.342	0.00219
TR-I	1, DesInv	Min V	22779.24	11318.68	11460.56	25.01	37.57	-12.57	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
TR-I	1, DesOp	Max M	28220.60	11318.68	16901.91	106.78	37.57	69.21	0.00	10.00	33.77	12.00	0.40	2.643	1.551	0.001088
TR-I	1, DesOp	Min M	11318.68	11318.68	0.00	37.57	37.57	0.00	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
TR-I	1, DesOp	Max V	27322.31	11318.68	16003.63	107.77	37.57	70.19	0.00	10.00	33.77	12.00	0.40	2.893	1.596	0.00087
TR-I	1, DesOp	Min V	20159.68	11318.68	8841.00	27.88	37.57	-9.69	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
TR-I	2, DesInv		29541.81	11318.68	18223.13	111.12	37.57	73.54	0.00	10.00	33.77	12.00	0.40	2.304	1.479	0.00144
TR-I	2, DesInv	Min M	11318.68	11318.68	0.00	37.57	37.57	0.00	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
TR-I	2, DesInv	Max V	28377.37	11318.68	17058.69	112.39	37.57	74.82	0.00	10.00	33.77	12.00	0.40	2.554	1.534	0.00117
TR-I	2, DesInv	Min V	23878.56	11318.68	12559.88	23.80	37.57	-13.77	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.000000
TR-I	2, DesOp	Max M	25376.52	11318.68	14057.84	94.31	37.57	56.73	0.00	10.00	33.77	12.00	0.40	3.927	1.729	0.00029
TR-I	2, DesOp	Min M	11318.68	11318.68	0.00	37.57	37.57	0.00	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
TR-I	2, DesOp	Max V	24478.24	11318.68	13159.56	95.29	37.57	57.72	0.00	10.00	33.77	12.00	0.40	4.507	1.782	0.00008
TR-I	2, DesOp	Min V	21007.73	11318.68	9689.05	26.95	37.57	-10.62	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.000000
ER-III	1, DesInv	Max M	18828.30	8812.35	10015.95	70.27	29.26	41.01	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.000000
ER-III	1, DesInv	Min M	8812.35	8812.35	0.00	29.26	29.26	0.00	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.000000
ER-III	1. DesInv	Max V	18295.99	8812.35	9483.63	70.86	29.26	41.59	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.000000
ER-III	1, DesInv	Min V	14051.47	8812.35	5239.11	23.52	29.26	-5.74	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
ER-III	2, DesInv	Max M	17142.93	8812.35	8330.57	62.88	29.26	33.62	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
ER-III	2, DesInv	Min M	8812.35	8812.35	0.00	29.26	29.26	0.00	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
ER-III	2, DesInv	Max V	16610.61	8812.35	7798.26	63.46	29.26	34.20	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
ER-III	2, DesInv	Min V	14554.01	8812.35	5741.66	22.97	29.26	-6.30	0.00	10.00	33.77	12.00	0.40	4.800	1.804	0.00000
SER-III oad Combina Code N		Min V d:	14554.01													

Figure 6 - 6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance Part 2

Ve	Val	Ma2	Vs2Max	Vo	Vinal	Vn 1	Vn2	Ov	erride Vn	Vr
(kip)	(kip)			(kip)		(kip)		Phi	(kip)	
40.13	87.53	0.00	71.73	0.00	0.00	127.67	422.06			114.90
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
43.22	90.61	0.00	71.73	0.00	0.00	133.83	422.06			120.45
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
63.05	104.75	0.00	71.73	0.00	0.00	167.80	422.06			151.02
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
69.03	107.76	0.00	71.73	0.00	0.00	176.78	422.06			159.11
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
54.97	99.91	0.00	71.73	0.00	0.00	154.88	422.06			139.39
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
60.94	103.58	0.00	71.73	0.00	0.00	164.51	422.06			148.06
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
93.69	116.79	0.00	71.73	0.00	0.00	210.48	422.06			189.43
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
107.53	120.32	0.00	71.73	0.00	0.00	227.86	422.06			205.07
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71
114.52	121.83	0.00	71.73	0.00	0.00	236.35	422.06			212.71

Figure 7 - 6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance Part 3

#### In 2022 interim, the load cases shown in the LL column are only envelope shear actions.

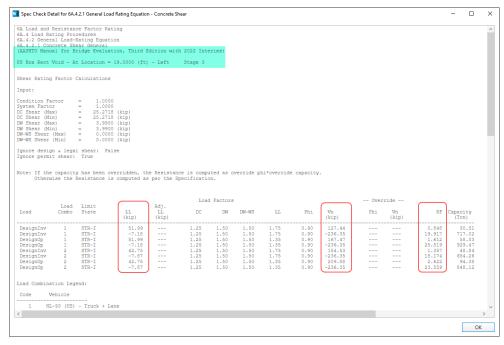


Figure 8 - 6A.4.2.1 General Load Rating Equation - Concrete Shear MBE 3rd edition, 2022 interim

In 2023 interim, the LL values shown for governing action Max V and Min V are the envelope shear values. For govening action Max M and Min M, shear concurrent with moment are considered. This results in new load cases.

Spec Check Detail for 6A.4.2.1 General Load Rating Equation - Concrete Shear			>
6% Load and Resistance Factor Rating 6%.4 Load Rating Frocedures 6%.4.2 General Load-Rating Equation 6%.4.2.1 Concrete Shear General (AASTIO Manual for Bridge Pavlaution, Third Edition with 2023 Interima)			
PS Box Rect Void - At Location = 19.0000 (ft) - Left Stage 3			
Shear Rating Factor Calculations			
Input:			
Condition Factor = 1.0000 System Factor = 1.0000			
DC Shear (Max) = 25.2718 (kip) CS Shear (Max) = 25.2718 (kip) RW Shear (Max) = 3.9900 (kip) RW Shear (Max) = 0.0900 (kip) LW+HS Shear (Max) = 0.0000 (kip)			
Ignore design & legal shear: False			
Ignore permit shear: True			
Note: If the capacity has been overridden, the Resistance is computed as override phi*override capacity. Otherwise the Resistance is computed as per the Specification.	Override		
Load Limit Governing Adj. Load Combo State Action LL LL DC DW DW-WS LL Phi Vn	Phi Vn	RF	Capacity
Load Compo State Action LL LL DC DW DW-WS LL Phi Vn (kip) (kip) (kip)	Phi Vn (kip)	KP	(Ton)
DesignTim         1         STR-1         Max M         51.26          1.25         1.50         1.57         0.90         127.6           DesignTim         1         STR-1         Max M         0.00          1.25         1.50         1.50         1.75         0.90         127.6           DesignTim         1         STR-1         Max M         0.00          1.25         1.50         1.50         1.75         0.90         133.1           DesignTim         1         STR-1         Max M         51.26          1.25         1.50	5            3            5            5            5            8            9            15            16            17            18            19            10            11            12            13            14            15            16	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677 99.000 2.902 23.559	31.03 3564.00 32.79 717.02 59.01 3564.00 62.33 929.47 49.84 3564.00 53.16 654.26 96.36 3564.00 104.47 848.12
Code Vehicle			
			ОК

Figure 9 - 6A.4.2.1 General Load Rating Equation -Concrete Shear MBE 3rd edition, 2023 interim

Highlighted portion in image below shows the improvement of rating factor from 0.848 in 2022 interim to 0.911 in 2023 interim for Design inventory, load case 1, STR-1 limit state.

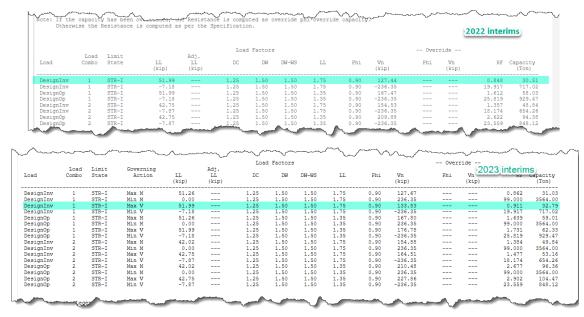


Figure 10 - 6A.4.2.1 General Load Rating Equation -Concrete Shear rating comparison

Spec Check Detail for 6A.5.8 Evaluation for Shear

<b>1</b>	Specifick Detail for 04.3.6 Evaluation for Shear
	6A Load and Resistance Factor Rating 6A.S Concrete Structures 6A.S.S: Evaluation for Shear (AASHTO Manual for Bridge Evaluation, Third Edition with 2023 Interims)
	PS Box Rect Void - At Location = 19.0000 (ft) - Left Stage 3
	Longitudinal Reinforcement
	From LRFD 5.7.3.5-1
	LHS or Tr = Aps+fps + As+fy
	$RHS = \frac{ Mu }{dv^*phif} + 0.5 + \frac{Nu}{phic} + \frac{  Vu }{  -v-v } + \frac{  v  }{  v-v } + \frac{  v  }{v} +$
	IMuDL          NuDL         IVuDL         I           T(DL) = SignMDL *        +         (SignVDLp *   Vp  - 0.5 * Vs) * cot(theta), where Vs = min(Vs, Vu/phiv)         (Based on LRFD 5.7.3.5-1 and MBE 6A.5.8)           dv*phif         phic          phiv
	IMulL          NulL         IVulL            T(LL) = SignMLL *+         0.5 * SignNLL *+         (SignVLL *   ) * cot(theta)         (Based on LRFD 5.7.3.5-1 and MBE 6A.5.8)           dv*phif         phic          phiv          (Based on LRFD 5.7.3.5-1 and MBE 6A.5.8)
	Where:
	VuDL         VuDL         VuDL           Mu = MuDL + MuLL; Nu = NuDL + NuLL; VT =
	<pre>/ MuDL \ / MuDL \ / NuDL \ / NuDL \ / VuDL \ / VuDL \ / VuDL \ / VuDL \ / VuLL \ / VuL / \ / Vu / \ / VU / / VU / \ / VU / / VU / \ / VU / VU</pre>
	$T(\mathbf{r}) - T(DL)$
	RF = T(L)
	Ignore design & legal shear : No Ignore permit shear : Yes Consider iterative shear rating : No Consider MCRT theta : No Shear computation method type : General Iteration required : No
	phif = 1.000 phic = 0.750 phiv = 0.900
	As (pos) =       0.000 (in^2) (used for Positive Mu)         As (neg) =       0.000 (in^2) (used for Negative Mu)         fy(pos) =       0.000 (ksi) (used for Negative Mu)         fy(pos) =       0.000 (ksi) (used for Positive Mu)         Aps(pos) =       4.884 (in^2) (used for Positive Mu)         Aps(pos) =       4.884 (in^2) (used for Positive Mu)         Aps(pos) =       4.884 (in^2) (used for Positive Mu)         Aps(pos) =       10.000 (ksi) (used for Positive Mu)         Aps(pos) =       141.252 (ksi) (used for Positive Mu)         Bv(pos) =       10.000 (in) (used for Positive Mu)         Bv(pos) =       10.000 (in) (used for Positive Mu)         Dv(pos) =       33.765 (in) (used for Positive Mu)         Dv(pos) =       28.080 (in) (used for Negative Mu)

#### Figure 11 - 6A.5.8 Evaluation for Shear MBE 3rd edition, 2023 interim

Limit State	Load Comb	dv (in)	As*fy (kips)	Aps*fps (kips)	Tr (kips)	MuDL (kip-in)	NuDL (kips)	VuDL (kips)	Vp (kips)	Governing Action	MuLL (kip-in)	NuLL (kips)	VuLL (kips)	epsilon	beta	theta (Deg.)	Av (in^2)	5 (1n)	Vs (kips)	TDL (kips)	TLL (kips)	LHS/RHS	RF	Capacity (Ton)
STR-I	1. DesInv	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Max M	21909.89	0.00	89.71	0.002471	1.68	37.65	0.40	12.00	87.53	332.60	778.10	0.95	0.925	33.29
STR-I	1, DesInv	33.77	0.00	1052.17	1052,17	11318.68	0.00	37.57	0.00	Min M	0.00	0.00	0.00	0.000000	4.80	29.00	0.40	12,00	121,83	372.88	0.00	2.82	99,000	3564.00
STR-I	1, DesInv	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Max V	20745.45	0.00	90.99	0.002199	1.81	36.70	0.40	12.00	90.61	330.45	750.05	0.97	0,962	34.64
STR-I	1. DesInv	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Min V	11460.56	0.00	-12.57	0.000000	4.80	29.00	0.40	12.00	121.83	385.47	314.23	1.50	2.122	76.38
STR-I	1, DesOp	33.77	0.00	1052.17	1052,17	11318,68	0.00	37.57	0.00	Max M	16901.91	0.00	69.21	0.001088	2.64	32.81	0.40	12.00	104.75	318.74	619.85	1,12	1,183	42.60
STR-I	1, DesOp	33.77	0.00	1052.17	1052,17	11318,68	0.00	37.57	0.00	Min M	0.00	0.00	0.00	0.000000	4.80	29.00	0.40	12,00	121.83	372.88	0.00	2.82	99.000	3564.0
STR-I	1. DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Max V	16003.63	0.00	70.19	0.000879	2.89	32.08	0.40	12.00	107.76	315.87	598.42	1.15	1,230	44.30
STR-I	1. DesOp	33,77	0.00	1052.17	1052.17	11318,68	0.00	37.57	0.00	Min V	8841.00	0.00	-9,69	0.000000	4.80	29.00	0.40	12,00	121.03	382.59	242.41	1,68	2.762	99.44
STR-I	2, DesInv	33.77	0.00	1052.17	1052.17	11318,68	0.00	37.57	0.00	Max M	18223.13	0.00	73.54	0.001444	2.30	34.06	0.40	12,00	99.91	323.08	660,60	1.07	1.104	39.73
STR-I	2, DesInv	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Min M	0.00	0.00	0.00	0.000000	4.80	29.00	0.40	12.00	121.83	372.88	0.00	2.82	99,000	3564.0
STR-I	2, DesInv	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Max V	17058.69	0.00	74.82	0.001172	2.55	33.10	0.40	12.00	103.58	319,82	632.72	1,10	1,157	41.67
STR-I	2, DesInv	33.77	0.00	1052.17	1052,17	11318,68	0.00	37.57	0.00	Min V	12559.88	0.00	-13.77	0.000000	4.80	29.00	0.40	12.00	121.83	386.68	344.37	1.44	1,932	69.57
STR-I	2, DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Max M	14057.84	0.00	56.73	0.000296	3,93	30.04	0.40	12.00	116.79	316.81	525.36	1.25	1,400	50.39
STR-I	2, DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Min M	0.00	0.00	0.00	0.000000	4.80	29.00	0.40	12.00	121.83	372.88	0.00	2.82	99.000	3564.0
STR-I	2, DesOp	33.77	0.00	1052.17	1052,17	11318.68	0.00	37.57	0.00	Max V	13159.56	0.00	\$7,72	0.000087	4.51	29.30	0.40	12,00	120.32	315.28	504.00	1.28	1.462	52.63
STR-I	2. DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Min V	9689.05	0.00	-10,62	0.000000	4.80	29.00	0.40	12,00	121.83	383.53	265.66	1.62	2.517	90.61

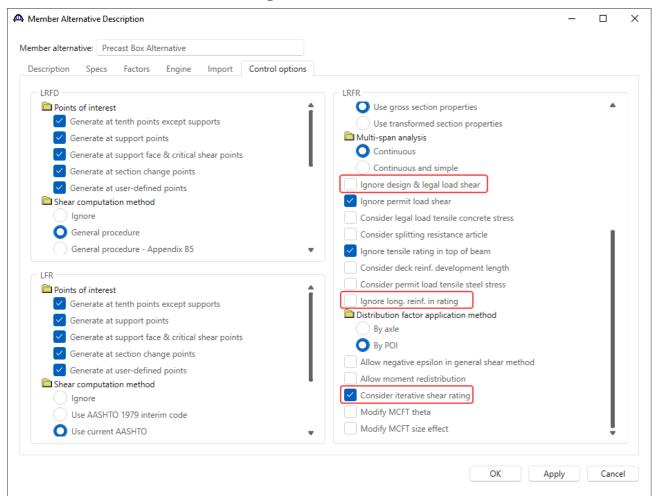
Figure 12 - 6A.5.8 Evaluation for Shear MBE 3rd edition, 2023 interim

#### Control option added to consider iterative shear rating

This section details the effects of considering an iterative process to compute the shear capacity used in the LRFR shear rating of concrete bridges. The shear strength for a load rating with Modified Compression Field Theory (MCFT) is an iterative process due to the underlying differences in strain's role in determining shear capacity in design versus load rating. In the iterative process, the factored shear capacity ( $C = PhiC * PhiS * \phi Vn$ ) is compared to the applied Vu. If they are not equal, iterations will begin by updating Vu, Mu and Nu by proportionally increasing or decreasing the live load portion of these force effects until the C is equal to the applied Vu. This is applicable to all concrete structures, i.e., reinforced concrete, prestressed concrete, post tensioned concrete and reinforced concrete box culverts.

#### Member Alternative Description - Control options

Navigate to the member alternative Precast Box Alternative of member **G2**, double click on it (or click the **Open** button from the **WORKSPACE** ribbon) to open its **Member Alternative Description** window. Navigate to the **Control options** tab as shown below.



Check the box - Consider iterative shear rating as shown below.

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

Run an LRFR analysis using the analysis settings shown in the previous step.

#### Specification Check Detail

Once the analysis is complete, open the Specification Check Detail. The specification check articles for the analyzed member alternative for Stage 3 at Span 1 - 19.00 ft, is shown below. Highlighted are the articles where the iteration process is detailed.

Properties Generate F	ticles  Il articles   irmat Ullet list   Report				
Superstructure Component	Specification reference	Limit State	Flex. Sense	Pass/Fail	-
Prestress Calculations	✓ 5.4.2.1 Compressive Strength		N/A	Passed	
Stage 1	5.4.2.5 Poisson's Ratio		N/A	General Comp.	
🕨 🚞 Stage 2	5.4.2.6 Modulus of Rupture		N/A	General Comp.	
🛯 🚞 Stage 3	5.4.2.8 Concrete Density Modification Factor		N/A	General Comp.	
a 🚞 Precast Box Alternative	NA 5.5.3.2 Reinforcing Bars and Welded Wire Reinforcement		N/A	Not Required	
🚞 Span 1 - 0.00 ft.	5.5.4.2 PS Strength Limit State - Resistance Factors		N/A	General Comp.	
🚞 Span 1 - 2.00 ft.	5.6.2.2 Rectangular Stress Distribution		N/A	General Comp.	
🚞 Span 1 - 3.01 ft.	✓ 5.6.3.2 PS Flexural Resistance (Prestressed Concrete)		N/A	Passed	
i Span 1 - 9.50 ft.	✓ 5.6.3.3 Minimum Reinforcement		N/A	Passed	
Span 1 - 19.00 ft. implication	NA 5.7.4 Interface Shear Transfer		N/A	Not Required	
Span 1 - 28.00 ft.	NA 5.7.4.2 Minimum Area of Interface Shear Reinforcement		N/A	Not Required	
Span 1 - 38.00 ft.	✓ 5.9.2.3.2b Tensile Stresses		N/A	Passed	
Span 1 - 47.50 ft.	5.9.4.3.2 Bonded Strand		N/A	General Comp.	
in Span 1 - 66.50 ft.	✓ 6A.4.2.1 Design Load Rating Prestress Service III Tensile Stress		N/A	Passed	
Span 1 - 76.00 ft.	✓ 6A.4.2.1 General Load Rating Equation - Concrete Flexure		N/A	Passed	
in Span 1 - 85.50 ft.	× 6A.4.2.1 General Load Rating Equation - Concrete Shear		N/A	Failed	
ing Span 1 - 91.99 ft.	6A.4.2.1 Shear-5.6.3.3 Minimum Reinforcement		N/A	General Comp.	
ing Span 1 - 93.00 ft.	✓ 6A.4.2.1 Shear-5.7.2.5 Minimum Transverse Reinforcement		N/A	Passed	
ig Span 1 - 95.00 ft.	✓ 6A.4.2.1 Shear-5.7.2.6 Maximum Spacing of Transverse Reinforcement		N/A	Passed	
	6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance		N/A	General Comp.	
	6A.4.2.1 Shear-5.7.3.4 Procedures for Determining Shear Resistance		N/A	General Comp.	
	X 6A.5.8 Evaluation for Shear		N/A	Failed	
	Computation of Vp		N/A	General Comp.	
	Cracked_Moment_of_Inertia Section Property Calculations		N/A	General Comp.	
	PS_Basic_Properties Calculation		N/A	General Comp.	
	PS Gross Composite Section Properties PS Gross Composite Section		N/A	General Comp.	

Double click on the 6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance article to view the iterations. Additional columns in the final iteration table (shown below) details the status of iteration, convergence, and any failure reason, if applicable, for each load case. If iterations for a given load case converge, then this table will show the result of the final iteration. The capacity from the final iteration is used in the rating equation. If the iteration process does not converge, then the corresponding row from the initial capacity table will be used.

nit ate	Load G Combo	Governing		MuDL	- MuLL kip-in)	Vu (kip)	VuDL (kip)	VuLL (kip)	Nu (kip)	bv (in)	dv (in)	5 (in)	Av1 (in^2)	Beta	cot (Theta) Epsil	Vc n (kip)	Vs1 (kip)	Vs2 (kip)	Vs2Max (kip)	Vp (kip)	Vrsl (kip)	Vn1 (kip)	Vn2 (kip)	Phi	Vn (kip)	Vr (kip)	
	1, DesInv 1, DesOp 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp	Min M Max M Min V Max M Min M Max M Min W Max W Min V Min V Min V Max M Min W Max M Min V Max M Min V Max M Min V Min M	3228.57 11318.68 32064.13 22779.24 2220.60 11318.68 27522.31 20159.68 23541.81 11318.68 24376.52 11318.68 24376.52 11318.68 24376.52 11318.68 24376.24 24077.37 18828.30 8812.35 18225.99 14051.47 17142.93 8812.35 16610.61	11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 812.35 812.35 812.35 812.35 812.35	21909.89 0.00 20745.45 11460.54 1603.63 8841.00 18223.13 8841.00 17058.69 12559.88 4087.84 0.00 9483.63 5299.11 9483.63 5299.11 8330.57 0.00	127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 6.95 70.88 29.26 6.3.46	37, 57 37, 57 32, 26 29, 26 39,	89.71 0.00 90.99 -12.57 69.21 -0.00 70.19 -9.69 73.54 0.00 74.82 -13.77 55.73 0.00 57.72 -10.62 41.01 0.00 55.74 41.01 0.00 55.74 41.01 0.00 55.74 41.01 0.00 55.72 -10.62 41.01 0.00 55.72 -10.62 -10.57 -5.74 -0.00 55.72 -0.00 55.75 -0		10.00 10	33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	12.00 12.00	0.40 0.40 0.40 0.40 0.40 0.40 0.40 0.40	1.682 4.800 1.812 4.800 2.643 4.800 2.893 4.800 2.304 4.800 2.554 4.800 4.800 4.800 4.800 4.800 4.800 4.800 4.800 4.800 4.800 4.800	1.226 0.000 1.804	000         114.52           99         43.22           000         114.52           818         63.05           000         114.52           779         66.03           000         114.52           72         66.04           001         114.52           96         93.69           001         114.52           000         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52           001         114.52	90.61 121.83 104.75 121.83 107.76 121.83 99.91 121.83 103.58 121.83 121.83 121.83 121.83 121.83 121.83 121.83 121.83 121.83 121.83 121.83 121.83 121.83		71.73 71.73			$\begin{array}{c} 127.\ 67\\ 236.\ 35\\ 133.\ 83\\ 236.\ 35\\ 167.\ 80\\ 236.\ 35\\ 176.\ 78\\ 236.\ 35\\ 154.\ 82\\ 236.\ 35\\ 210.\ 48\\ 210.\ 48\\ 246.\ 35\\ 247.\ 36\\ 246.\ 35\\ 346.\ 35\\$	422.06 422.06			114.00 212.71 102.71 102.71 105.10 212.71 105.10 212.71 105.11 213.71	
C = Vul ere she C = ph: th cone phiC = phiC = phi =	1.000 0.900 * phiS >= 0.8 Load G	w, live lo u pacity hi * Vn m, and re: 85 Governing	oad is incre sistance fac	eased or decre. ptors MuDL	5741.66 ased to ac? MuLL kip-in)	22.97 hieve, if p Vu (kip)	29.26 nossible, th VuDL (kip)	-6.30 we final she (6A.4.2.1- VuLL (kip)		10.00 when bv (in)	33.77 dv (in)	3 (in)	0.40 Av1 (in^2)	4.800 Beta	0.000 cot (Theta) Epsil	Vc	Vs1 (kip)	0.00 Vs2 (kip)	71.73 Vs2Max (kip)	0.00 Vp (kip)	Vrsl (kip)	236.35 Vn1 (Xip)	422.06 Vn2 (kip)	Phi	rride Vn (kip)	c (kp) (Iterated? Converged?	Failure Reason
	1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp	Max M Min M Max V Min V Max M Min M Max M Min W Max M Min V Min W Min M Min M Min W Max V Max M Min V Max M Min V	31965.50 11318.68 31296.33 109188.20 31965.49 11318.68 31298.30 109188.16 32107.99 11318.68 31298.32 109188.12 32108.06 11318.68 31298.22 32108.06 11318.68 31298.29 32108.06 11318.68 31298.74 3100.06.19 99100.49 31897.41	11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 11312.68 812.35 812.35 812.35	20646.82 0.00 19979.65 97869.52 20646.81 0.00 19979.62 97869.48 20789.31 0.00 19979.60 97869.49 20789.38 20789.38 20789.38 20789.38 20789.38 20789.38 20789.49 22528.05 0.00 22193.84 90288.14 23085.06	122.11 37.57 125.20 -69.74 122.11 37.57 125.20 -69.74 121.47 37.57 125.20 -69.74 121.47 125.20 -69.74 121.47 125.20 -69.74 123.14 29.26 6.60 -69.74 123.14 29.26	37.57 32.26 29.26 29.26 29.26	84.54 0.00 87.63 -107.31 84.54 0.00 87.63 -107.31 83.90 0.00 87.63 -107.31 83.90 0.00 87.63 -107.31 93.88 0.00 97.34 -99.00 93.16		10,00 10	33,77 35,77 35,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77 33,77	12.00 12.00	0.40 0.40 0.40 0.40 0.40 0.40 0.40 0.40	1.852 4.800 1.928 0.873 1.852 4.800 1.928 0.873 1.836 4.800 1.928 0.873 1.836 4.800 1.928 0.873 1.836 4.800 1.928 0.873 1.837 4.800 1.928 0.873 1.837 1.836 4.800 1.928 0.873 1.837 1.836 1.936 1.937 1.836 1.936 1.937 1.836 1.936 1.937 1.836 1.936 1.937 1.836 1.936 1.937 1.836 1.937 1.836 1.937 1.836 1.937 1.8377 1.837 1.8377 1.837 1.8377 1.8377 1.8377 1.8377 1.8377 1.8377 1.83	1.355 0.002 1.826 0.002 1.829 0.003 1.839 0.004 1.855 0.002 1.829 0.003 1.839 0.004 1.859 0.003 1.839 0.004 1.839 0.004 1.839 0.004 1.839 0.004 1.839 0.004 1.846 0.002 1.846	22         44.18           000         114.52           826         46.00           000         20.82           22         44.18           000         114.52           826         46.00           000         114.52           826         46.00           000         20.82           52         43.81           001         114.52           826         46.00           001         20.82           776         44.78           001         144.52           201         144.52           201         144.52           201         214.58	91.50 121.83 93.12 56.66 91.50 93.12 56.66 91.16 121.83 93.12 56.66 91.16 121.83 93.12 56.66 91.16 93.23 93.23 93.23 93.23 93.23 93.83		71.73 71.73			135.68 236.35 139.12 77.49 135.68 236.35 139.12 77.49 134.97 236.35 139.12 77.49 134.97 236.35 139.12 77.49 134.97 236.35 139.12 77.49 136.62 236.35 140.67 77.49	422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06 422.06			122.12         Yes         Yes           122.11         Yes         No           212.71         Yes         Yes           65.74         Yes         Yes           75.74         Yes         Yes           122.12         Yes         Yes           123.21         Yes         Yes           124.74         Yes         Yes           125.21         Yes         Yes           121.74         Yes         Yes           122.71         Yes         Yes           123.71         Yes         Yes           225.21         Yes         Yes           221.71         Yes         Yes           122.71         Yes         Yes           123.74         Yes         Yes           123.74         Yes         Yes           124.60         Yes         Yes <tr< td=""><td>Zero live load </td></tr<>	Zero live load 

Figure 13 - 6A.4.2.1 Shear-5.7.3.3 Nominal Shear Resistance

Here is a comparison of rating factors at this location with and without iterations.

Load and L4 Load Ra L4.2 Gener L4.2.1 Con	ating Pro ral Load-1 ncrete She	cedures Rating Eq ear Gener	uation al												
			luation, Third :			.m.s)									
Box Rect	Void - A	t Locatio	n = 19.0000 (ft	) - Left	Stage 3										
ear Rating	g Factor (	Calculati	ons												
ut:															
dition Fa	actor	- 1	0000												
tem Facto			0000												
Shear (Ma Shear (Mi			2718 (kip) 2718 (kip)												
Shear (Ma Shear (Mi	in)	= 3.	9900 (kip) 9900 (kip)												
WS Shear WS Shear			0000 (kip) 0000 (kip)												
ore desig	gn & lega	l shear:	False												
ore permi	it shear:	True													
			n overridden, t				rride phi	*override	capacity.						
			n overridden, t e is computed a				-		capacity.						
Otherw	wise the l	Resistanc	e is computed a Governing	s per the S	pecification.	Loa	d Factors	1				Over			)
Otherw	wise the l	Resistanc	e is computed a		pecification.		-		capacity. LL	Phi	Vn (kip)	Over Phi	ride Vn (kip)	RF	Capacity (Ton)
Otherw ad signInv	Load Combo	Limit State STR-I	Governing Action Max M	LL (kip) 51.26	Adj. LL	Loa DC 1.25	i Factors DW 1.50	DW-WS	LL 1.75	0.90	(kip) 127.67		Vn	0.862	(Ton) 31.0
Otherw ad signInv signInv signInv	Load Combo	Limit State STR-I STR-I STR-I	Governing Action Max M Min M Max V	LL (kip) 51.26 0.00 51.99	Adj. LL (kip) 	Loa DC 1.25 1.25 1.25	1 Factors DW 1.50 1.50 1.50	DW-WS 1.50 1.50	LL 1.75 1.75 1.75	0.90 0.90 0.90	(kip) 127.67 236.35 133.83	Phi	Vn (kip)	0.862 99.000 0.911	(Ton) 31.0 3564.0 32.7
Otherw ad signInv signInv signInv signInv signInv	Load Combo	Limit State STR-I STR-I STR-I STR-I STR-I STR-I	Governing Action Max M Min M Max V Min V Max M	LL (kip) 51.26 0.00 51.99 -7.18 51.26	Adj. LL (kip)    	Loa DC 1.25 1.25 1.25 1.25 1.25	1 Factors DW 1.50 1.50 1.50 1.50 1.50	DW-WS 1.50 1.50 1.50 1.50 1.50	LL 1.75 1.75 1.75 1.75 1.35	0.90 0.90 0.90 0.90 0.90	(k1p) 127.67 236.35 133.83 -236.35 167.80	Phi	Vn (kip)	0.862 99.000 0.911 19.917 1.639	(Ton) 31.0 3564.0 32.7 717.0 59.0
Otherw ad signInv signInv signInv signOp signOp signOp	Load Combo	Limit State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Governing Action Max M Min M Max V Min V Max M Min M Max V	LL (kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99	Adj. LL (kip)      	Loa: DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	1 Factors DW 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	LL 1.75 1.75 1.75 1.75 1.35 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90	(k1p) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78	Phi	Vn (kip)	0.862 99.000 0.911 19.917 1.639 99.000 1.731	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3
Otherw ad signInv signInv signInv signInv signOp signOp signOp	Load Combo	Limit State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Governing Action Max M Min M Max V Min V Max M Min M	LL (kip) 51.26 0.00 51.99 -7.18 51.26 0.00	Adj. LL (kip)     	Loa DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25	i Factors DW 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	LL 1.75 1.75 1.75 1.75 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90	(k1p) 127.67 236.35 133.83 -236.35 167.80 236.35	Phi	Vn (kip)	0.862 99.000 0.911 19.917 1.639 99.000	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4
Otherw ad signInv signInv signInv signInv signInv signOp signOp signOp signInv	Load Combo 1 1 1 1 1 1 1 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	Governing Action Max M Min M Max V Min W Max M Max V Max W Max W Min W Min W	LL (k1p) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00	Adj. IL (kip)         	Loaw DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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	LL 1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(k1p) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35	Ph1	Vn (kip)        	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.8 3564.0
Otherw ad signInv signInv signInv signOp signOp signOp signInv signInv signInv	Load Combo 1 1 1 1 1 1 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 STR-I	Governing Action Nax M Min M Max V Max V Min M Min M Min W Max W Min W Min W Min W Min W	LL (ktp) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 42.75 -7.87	Adj. LL (klp)   	Loax DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	1 Factors 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 1.75 1.35 1.35 1.35 1.35 1.75 1.75 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 167.80 236.35 154.88 236.35 154.88 236.35 164.51 -236.35	Ph1	Vn (kip)         	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.8 3564.0 53.1 654.2
Otherw ad signInv signInv signInv signOp signOp signOp signOp signInv signInv signInv signInv	Load Combo 1 1 1 1 1 1 1 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 STR-I	Governing Action Max M Min M Max V Min V Max M Min V Max W Min V Max M Min M Max V Min M Max W Min V Max M	LL (kip) 51.26 0.00 0.1.99 -7.18 51.26 0.00 0.51.99 -7.18 42.02 0.00 42.75 -7.87 42.02	Adj. LL (kip)         	Loa: DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.75 1.35 1.35 1.35 1.75 1.75 1.75 1.75 1.75 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35 164.51 -236.35 210.48	Ph1	Vn (kip)	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.8 3564.0 53.1 654.2 96.3
otherw ad signInv signInv signInv signOp signOp signOp signInv signInv signInv signInv signInv signInv signInv	Load Combo 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 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 STR-I STR-I STR-I STR-I	Governing Action Max M Min M Max V Max V Max M Max V Max M Max V Min V Max M Min V Max M Min V Max W Max W Max V	LL (kip) 51.26 0.000 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 51.99 -7.7.87 42.02 0.00 42.75 -7.87 42.02 0.00	Adj. LL (kip)         	Loas DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	1 Factors 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 1.75 1.75 1.35 1.35 1.35 1.35 1.75 1.75 1.75 1.75 1.75 1.75 1.35 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35 210.48 236.35 227.86	Ph1	Vn (kip)        	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677 99.000 2.902	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.8 3564.0 53.1 654.2 96.3 3564.0 104.4
otherw ad signInv signInv signInv signOp signOp signOp signInv signInv signInv signInv signInv signInv signInv	Load Combo 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 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 STR-I STR-I STR-I	Governing Action Max M Min M Min V Min V Min V Min V Min V Min V Min W Min M Min M Min M Min M Min M	LL (kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 42.75 -7.87 -7.87 -7.87 -7.80 -7.80 -7.80 -7.80 -7.80 -7.80 -7.18 -7.19 -7.18 -7.18 -7.18 -7.19 -7.18 -7.19 -7.18 -7.18 -7.19 -7.19 -7.18 -7.19 -7.18	Adj. IL (kip)         	Loax DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	d Factors 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 1.75 1.75 1.35 1.35 1.35 1.75 1.75 1.75 1.75 1.75 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 176.78 236.35 176.78 236.35 154.88 236.35 154.88 236.35 164.51 -236.35 210.48 236.35	Phi	Vn (kip)	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677 99.000	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.8 3564.0 53.1 654.2 96.3 3564.0 104.4
Otherw ad signInv signInv signInv signInv signOp signOp signOp signInv signInv signInv signInv signInv signInv signOp signOp signOp	Load Combo 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 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 STR-I STR-I STR-I STR-I	Governing Action Max M Min M Max V Max V Max M Max V Max M Max V Min V Max M Min V Max M Min V Max W Max W Max V	LL (kip) 51.26 0.000 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 51.99 -7.7.87 42.02 0.00 42.75 -7.87 42.02 0.00	Adj. LL (kip)         	Loas DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	1 Factors 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 1.75 1.75 1.35 1.35 1.35 1.35 1.75 1.75 1.75 1.75 1.75 1.75 1.35 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35 210.48 236.35 227.86	Ph1	Vn (kip)	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677 99.000 2.902	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.8 3564.0 53.1 654.2 96.3 3564.0 104.4
otherw ad signInv signInv signInv signInv signOp signOp signInv signInv signInv signInv signInv signInv signOp signOp signOp	Load Combo 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 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 STR-I STR-I STR-I STR-I	Governing Action Max M Min M Max V Max V Max M Max V Max M Max V Min V Max M Min V Max M Min V Max W Max W Max V	LL (kip) 51.26 0.000 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 51.99 -7.7.87 42.02 0.00 42.75 -7.87 42.02 0.00	Adj. LL (kip)         	Loas DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	1 Factors 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 1.75 1.75 1.35 1.35 1.35 1.35 1.75 1.75 1.75 1.75 1.75 1.75 1.35 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35 210.48 236.35 227.86	Ph1	Vn (kip)	0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677 99.000 2.902	(Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 59.0 3564.0 52.3 929.4 49.8 3564.0 53.1 654.2 96.3 3564.0

Figure 14 - 6A.4.2.1 General Load Rating Equation - Concrete Shear without iterations

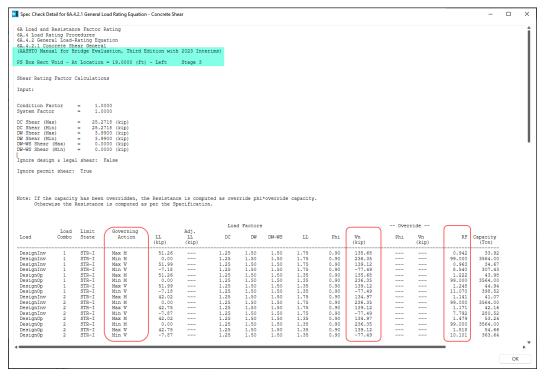


Figure 15 - 6A.4.2.1 General Load Rating Equation - Concrete Shear with iterations

DesignInv	Load Combo	Limit State	Governing Action		Adj.										
			ACCION	LL (kip)	LL (kip)	DC	DW	DW-WS	LL	Phi	Vn (kip)	Phi	Vn (kip)	RF	Capacity (Ton)
	1	STR-I	Max M	51.26		1.25	1.50	1.50	1.75	0.90	135.68			0.942	33.9
esignInv	1	STR-I	Min M	0.00		1.25	1.50	1.50	1.75	0.90	236.35			99.000	3564.(
esignInv	1	STR-I	Max V	51.99		1.25	1.50	1.50	1.75	0.90	139.12			0.963	34.0
esignInv	1	STR-I	Min V	-7.18		1.25	1.50	1.50	1.75	0.90	-77.49			8.540	307.
signOp	1	STR-I	Max M	51.26		1.25	1.50	1.50	1.35	0.90	135.68			1.222	43.
esignOp	1	STR-I	Min M	0.00		1.25	1.50	1.50	1.35	0.90	236.35			99.000	3564.
signOp	1	STR-I	Max V	51.99		1.25	1.50	1.50	1.35	0.90	139.12			1.248	44.
signOp	1	STR-I	Min V	-7.18		1.25	1.50	1.50	1.35	0.90	-77.49			11.070	398.
signInv	2	STR-I	Max M	42.02		1.25	1.50	1.50	1.75	0.90	134.97			1.141	41.
signInv	2	STR-I	Min M	0.00		1.25	1.50	1.50	1.75	0.90	236.35			99,000	3564.
signInv	2	STR-I	Max V	42.75		1.25	1.50	1.50	1.75	0.90	139.12			1.171	42.
signInv	2	STR-I	Min V	-7.87		1.25	1.50	1.50	1.75	0.90	-77.49			7.792	280.
signOp	2	STR-I	Max M	42.02		1.25	1.50	1.50	1.35	0.90	134.97			1.479	53.
esignOp	2	STR-I	Min M	0.00		1.25	1.50	1.50	1.35	0.90	236.35			99.000	3564.
esignOp	2	STR-I	Max V	42.75		1.25	1.50	1.50	1.35	0.90	139.12			1.518	54.
esignOp esignOp	2	STR-I STR-I	Min V	-7.87		1.25	1.50	1.50	1.35	0.90	-77.49			10.101	363.0
d Combinati	ion Lege	end:													
															O
	Lord	Limit	Governing		).di	Load	i Factors					Over	ride	Withoutit	
	Load Combo	Limit State	Governing Action	LL (kip)	Adj. LL (kip)	Load	i Factors DW	DW-WS	LL	Phi	Vn (kip)	Over Phi	Vn (kip)	RF	Capacity (Ton)
	Combo				LL				LL 1.75	Phi 0.90			Vn		Capacity (Ton)
signInv	Combo	State	Action Max M Min M	(kip)	LL (kip)	DC	DW	DW-WS			(kip)	Phi	Vn (kip)	RF	Capacity (Ton)
signInv	Combo	State STR-I	Action Max M	(kip) 51.26	LL (kip)	DC	DW 1.50	DW-WS	1.75	0.90	(kip) 127.67	Phi	Vn (kip)	RF 0.862	Capacity (Ton) 31.0 3564.0
signInv signInv signInv	Combo	State STR-I STR-I	Action Max M Min M	(kip) 51.26 0.00	LL (kip)	DC 1.25 1.25	DW 1.50 1.50	DW-WS	1.75	0.90	(kip) 127.67 236.35	Phi	Vn (kip)	RF 0.862 99.000	Capacity (Ton) 31.0 3564.0 32.7
signInv signInv signInv signInv	Combo	State STR-I STR-I STR-I	Action Max M Min M Max V	(kip) 51.26 0.00 51.99	LL (kip)	DC 1.25 1.25 1.25	DW 1.50 1.50 1.50	DW-WS	1.75 1.75 1.75	0.90 0.90 0.90	(kip) 127.67 236.35 133.83	Phi	Vn (kip)	RF 0.862 99.000 0.911	Capacity (Ton) 31.0 3564.0 32.7 717.0
signInv signInv signInv signInv signOp	Combo 1 1 1 1	State STR-I STR-I STR-I STR-I	Action Max M Min M Max V Min V	(kip) 51.26 0.00 51.99 -7.18	LL (kip)	DC 1.25 1.25 1.25 1.25	DW 1.50 1.50 1.50 1.50	DW-WS	1.75 1.75 1.75 1.75	0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917	Capacity (Ton) 3564.0 32.7 717.0 59.0
signInv signInv signInv signInv signOp signOp	Combo	State STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Min V Max M	(kip) 51.26 0.00 51.99 -7.18 51.26	LL (kip)	DC 1.25 1.25 1.25 1.25 1.25	DW 1.50 1.50 1.50 1.50 1.50	DW-WS 1.50 1.50 1.50 1.50 1.50	1.75 1.75 1.75 1.75 1.35	0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639	Capacity (Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0
signInv signInv signInv signInv signOp signOp signOp	Combo	State STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Min V Max M Min M	(kip) 51.26 0.00 51.99 -7.18 51.26 0.00	LL (kip)	DC 1.25 1.25 1.25 1.25 1.25 1.25	DW 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	1.75 1.75 1.75 1.75 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35	Phi	Vn (kip)	RF 99.000 0.911 19.917 1.639 99.000	Capacity (Ton) 31.0 3564.0 3564.0 59.0 3564.0 62.3
signInv signInv signInv signOp signOp signOp signOp	Combo	State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Min V Max M Min M Max V Min V	(kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18	LL (kip)	DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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	1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819	Capacity (Ton) 31.0 3564.0 32.7 717.0 59.0 3564.0 62.2 929.4
signInv signInv signInv signOp signOp signOp signOp signInv	Combo	State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Min V Min M Max V Min M Max M	(kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02	LL (kip)	DC 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	DW 1.50 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	1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.35	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384	Capacity (Ton) 3564.0 3564.0 32.7 717.0 59.0 3564.0 62.3 929.4 49.5
signInv signInv signInv signOp signOp signOp signInv signInv	Combo	State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Max M Min V Max V Min V Max M Min M	(kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00	LĽ (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	DW 1.50 1.50 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	1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.35 1.75 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000	Capacity (Ton) 3564.0 3564.0 59.0 3564.0 62.3 929.4 49.0 3564.0
signInv signInv signInv signOp signOp signOp signOp signInv signInv signInv	Combo 1 1 1 1 1 1 1 2 2 2 2	State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Min V Max M Min V Max M Min V Max M Min M Max V	(k1p) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 42.75	LĽ (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	DW 1.50 1.50 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	1.75 1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.75 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477	Capacity (Ton) 31.0 3564.0 59.0 3564.0 929.4 929.4 3564.0 53.1
signInv signInv signInv signOp signOp signOp signOp signInv signInv signInv signInv	Combo 1 1 1 1 1 1 1 2 2 2 2 2	State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Max M Max M Min V Max M Min W Max M Min M Max V Min V Min V	(kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 42.75 -7.87	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 1.25	DW 1.50 1.50 1.50 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	1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.35 1.75 1.75 1.75 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 9.000 1.384 99.000 1.477 18.174	Capacity (Ton) 31.0 32.7 717.0 59.0 3564.0 59.0 3564.0 53.0 53.0 53.1 654.2
signInv signInv signInv signOp signOp signOp signOp signOp signInv signInv signInv signInv signInv	Combo 1 1 1 1 1 1 1 1 2 2 2 2 2	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 STR-I	Action Max M Min M Max V Min V Min M Min M Max M Min M Max V Min V Max M	(k1p) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 42.75 -7.87 42.02	LL (kip)	DC 1.25	DW 1.50 1.50 1.50 1.50 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	1.75 1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.75 1.75 1.75 1.75 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35 210.48	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 1.384 99.000 1.477 18.174 2.677	Capacity (Ton) 31.0 3564.0 59.0 3564.0 62.2 929.4 49.2 3564.0 53.1 53.1 53.1 654.2 96.3
esigninv signinv signinv signinv signinv signip signip signip signip signip signip signip	Combo 1 1 1 1 1 1 1 2 2 2 2 2	State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	Action Max M Min M Max V Max M Max M Min V Max M Min W Max M Min M Max V Min V Min V	(kip) 51.26 0.00 51.99 -7.18 51.26 0.00 51.99 -7.18 42.02 0.00 42.75 -7.87	LĽ (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 1.25	DW 1.50 1.50 1.50 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	1.75 1.75 1.75 1.35 1.35 1.35 1.35 1.35 1.75 1.75 1.75 1.75	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	(kip) 127.67 236.35 133.83 -236.35 167.80 236.35 176.78 -236.35 154.88 236.35 164.51 -236.35	Phi	Vn (kip)	RF 0.862 99.000 0.911 19.917 1.639 99.000 1.731 25.819 9.000 1.384 99.000 1.477 18.174	Capacity (Ton)

#### Image below highlights some examples of improvements in rating factors with the iteration process.

Figure 16 - 6A.4.2.1 General Load Rating Equation - Concrete Shear rating comparison

Longitudinal reinforcement evaluation for shear rating is based on the equilibrium of tensile capacity and demand of the longitudinal reinforcement (LRFD eq. 5.7.3.5-1) determined by iterating the live load component of Vu, Mu and Nu.

Spec Check Detail for 6A.5.8 Evaluation for Shea 6A Load and Resistance Factor Rating 6A.5 Concrete Structures 6A.5.8 Evaluation for Shear (AASHTO Manual for Bridge Evaluation, Third Edition with 2023 I PS Box Rect Void - At Location - 19.0000 (ft) - Left Stage 3 Longitudinal Reinforcement From LRFD 5.7.3.5-1 |Mu| + 0.5 ----- + ||---- - Vp| -0.5 \* Vz| \* cot(theta) (LRFD 5.7.3.5-1)  $T\left(LL\right) = \text{SignMLL} + \frac{|\text{MuLL}|}{dv^{*}\text{phif}} + 0.5 + \text{SignMLL} + \frac{\text{NuLL}}{\text{phic}} + (\text{SignVLL} + \frac{|\text{VuLL}|}{|\text{phiv}|} ) + \text{cot(theta)}$ (Based on LRFD 5.7.3.5-1 and MBE 6A.5.8) Where  $\texttt{Mu} = \texttt{MuDL} + \texttt{MuLL}; \; \texttt{Nu} = \texttt{NuDL} + \texttt{NuLL}; \; \texttt{VT} = \frac{\texttt{VuDL} + \texttt{VuLL}}{\texttt{phiv}} - \texttt{Vp}; \; \texttt{VuDLp} = -\frac{\texttt{VuDL}}{\texttt{phiv}} - \texttt{Vp}$ / MuDL / / MuLL / / M T(r) - T(DL) RF = -----T(LL) Ignore design & legal shear : Ignore permit shear : Consider iterative shear rating : Consider MCFT theta : Shear computation method type : Iteration required : phif = 1.000 phic = 0.750 phiv = 0.900

Figure 17 - 6A.5.8 Evaluation for shear - Part 1

As (pos)				r Positive									
As (neg)				r Negative									
fy(pos) fy(neg)				r Positive r Negative									
s (pos)				r Positive									
s(pos)	= 0.306	(in^2)		r Negative									
s (pos)	= 245.606	(ksi)		r Positive									
s(neg)	= 141.252	(ksi)	(used for	r Negative	Mu)								
v (pos)	= 10.000 = 10.000	(in)	(used for	r Positive	Mu)								
8v (neg)	= 10.000	(in)	(used for	r Negative	Mu)								
v(pos)	= 33.765	(in)	(used for	r Positive	Mu)								
)v(neg)	= 28.080	(in)	(used for	r Negative	Mu)								
r (pos)		(kips-in)	(used for	r Positive	Mu)								
r (neg)	= -4929.748	(kips-in)	(used for	r Negative	Mu)								
(shear)	= 60.000	(£81)			-								
Limit	Load												
State	Comb	dv	As*fy	Aps*fps	Tr	MuDL	NuDL	VuDL	Vp	Governing	MuLL	NuLL	VuLL
		(in)	(kips)	(kips)	(kips)	(kip-in)	(kips)	(kips)	(kips)	Action	(kip-in)	(kips)	(kips)
TR-I TR-I	1, DesInv	33.77	0.00			11318.68	0.00	37.57	0.00	Max M	21909.89	0.00	89.71
SIR-I STR-I	1, DesInv 1, DesInv	33.77 33.77	0.00	1052.17		11318.68 11318.68	0.00	37.57 37.57	0.00	Min M Max V	0.00 20745.45	0.00	0.00
TR-I	1, DesInv	22.77	0.00	1052.17		11318.68	0.00	37.57	0.00		11460.56	0.00	-12.57
TR-I	1, DesOp	33.77	0.00	1052.17		11318.68	0.00	37.57	0.00	Max M	16901.91	0.00	69.21
TR-I	1, DesOp	33.77 33.77 33.77	0.00	1052.17		11318.68	0.00	37.57	0.00		0.00	0.00	0.00
TR-I	1, DesOp	33.77	0.00	1052.17		11318.68	0.00	37.57	0.00		16003.63	0.00	70.19
STR-I	1, DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00	37.57	0.00	Min V	8841.00	0.00	-9.69
STR-I	2, DesInv	33.77 33.77 33.77 33.77 33.77	0.00	1052.17		11318.68	0.00	37.57	0.00		18223.13	0.00	
TR-I	2, DesInv	33.77	0.00	1052.17		11318.68	0.00	37.57	0.00		0.00	0.00	0.00
TR-I	2, DesInv	33.77 33.77	0.00			11318.68	0.00	37.57	0.00		17058.69	0.00	74.82
TR-I	2, DesInv	33.77	0.00	1052.17	1052.17	11318.68	0.00		0.00		12559.88	0.00	
STR-I STR-I	2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00		0.00		14057.84		56.73 0.00
STR-I STR-I	2, DesOp	33.77	0.00	1052.17	1052.17	11318.08	0.00		0.00			0.00	
STR-I STR-I	2, DesOp 2 DesOp	33.77	0.00	1052.17	1052.17	11318.68	0.00				9689.05	0.00	
ad Comb	ination Legend:												
Code	Vehicle												
	HL-93 (US) - Truck HL-93 (US) - Tande												

Figure 18 - 6A.5.8 Evaluation for shear – Part 2

Shown below is a comparion of rating factors between non-iteration and iteration from LRFD equation 5.7.3.5-1

			N	ion-Itera	ted				f					Iterat	ed					
epsilon	beta	(Deg.)	Av (in^2)	s (in)	Vs (kips)	TDL (kips)	TLL (kips)	LHS/RHS	RF	epsilon	beta	(Deg.)	Av (in^2)	s (in)	Vs (kips)	TDL (kips)	TLL (kips)	LHS/RHS	RF	Capacity (Ton)
			· · · · · · · · · · · · · · · · · · ·																	
0.002471	1.68	37.65	0.40	12.00	87.53	332.60	778.10	0.95	0.925											33.29
0.00000	4.80	29.00	0.40	12.00	121.83	372.88	0.00	2.82	99.000											3564.00
0.002199	1.81	36.70	0.40	12.00	90.61	330.45	750.05	0.97	0.962											34.64
0.000000	4.80	29.00	0.40	12.00	121.83	385.47	314.23	1.50	2.122	0.002006	1.92	36.02	0.40	12.00	92.87	373.53	320.22	1.00	2.119	76.38
0.001088	2.64	32.81	0.40	12.00	104.75	318.74	619.85	1.12	1.183	0.001986	1.93	35.95	0.40	12.00	93.11	328.59	606.60	1.00	1.193	42.60
0.000000	4.80	29.00	0.40	12.00	121.83	372.88	0.00	2.82	99.000											3564.00
0.000879	2.89	32.08	0.40	12.00	107.76	315.87	598.42	1.15	1.230	0.001963	1.94	35.87	0.40	12.00	93.39	328.38	581.83	1.00	1.244	44.30
0.00000	4.80	29.00	0.40	12.00	121.83	382.59	242.41	1.68	2.762	0.002006	1.92	36.02	0.40	12.00	92.88	371.34	247.02	1.00	2.756	99.44
0.001444	2.30	34.06	0.40	12.00	99.91	323.08	660.60	1.07	1.104	0.001992	1.92	35.97	0.40	12.00	93.05	328.64	652.29	1.00	1.109	39.73
0.000000	4.80	29.00	0.40	12.00	121.83	372.88	0.00	2.82	99.000											3564.00
0.001172	2.55	33.10	0.40	12.00	103.58	319.82	632.72	1.10	1.157	0.001964	1.94	35.87	0.40	12.00	93.38	328.38	620.18	1.00	1.167	41.67
0.000000	4.80	29.00	0.40	12.00	121.83	386.68	344.37	1.44	1.932	0.002006	1.92	36.02	0.40	12.00	92.87	374.45	350.93	1.00	1.931	69.57
0.000296	3.93	30.04	0.40	12.00	116.79	316.81	525.36	1.25	1.400	0.001985	1.93	35.95	0.40	12.00	93.12	328.58	503.27	1.00	1.438	50.39
0.000000	4.80	29.00	0.40	12.00	121.83	372.88	0.00	2.82	99.000											3564.00
0.000087	4.51	29.30	0.40	12.00	120.32	315.28	504.00	1.28	1.462	0.001966	1.94	35.88	0.40	12.00	93.36	328.40	478.40	1.00	1.513	52.63
0.000000	4.80	29.00	0.40	12.00	121.83	383.53	265.66	1.62	2.517	0.002006	1.92	36.02	0.40	12.00	92.88	372.05	270.72	1.00	2.512	90.61

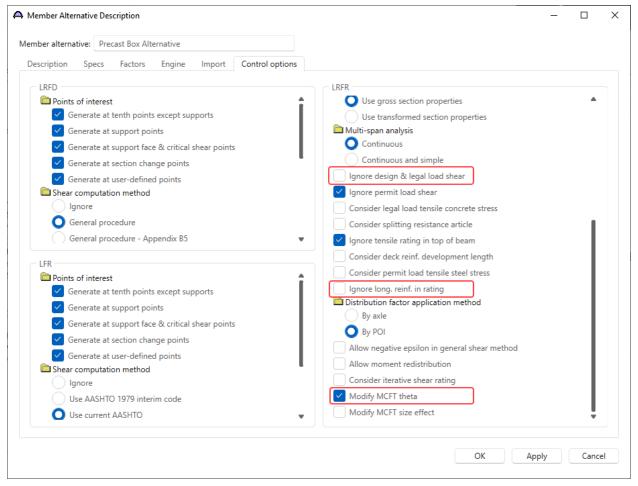
Figure 19 - 6A.5.8 Evaluation for shear – Part 3

# Control option added to consider modifying MCFT theta

This section discusses the control option "Modify MCFT theta" added for all concrete structures, i.e., reinforced concrete, prestressed concrete, post tensioned concrete and reinforced concrete box culverts.

#### Member Alternative Description – Control options

Navigate to the member alternative **Precast Box Alternative** of member **G2**, double click on it (or click the **Open** button from the **WORKSPACE** ribbon) to open its **Member Alternative Description** window. Navigate to the **Control options** tab as shown below. Check the box - **Modify MCFT theta** as shown below.



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

Run an LRFR analysis using the analysis settings shown in the previous step.

#### Specification Check Detail

Once the analysis is complete, open the 6A.4.2.1 Shear-5.7.3.4 Procedures for Determining Shear Resistance article for the analyzed member alternative for Stage 3 at Span 1 - 19.00 ft. This article highlights the status of the "Modify MCFT Theta" control option. With this control option checked, in areas of low strain where the section remains uncracked i.e., if the factored moment at this section is less than the cracking moment (Mu < Mcr), the strain  $\varepsilon s$  may be assumed to be zero regardless of the values of moment (Mu) and shear (Vu), therefore, "Theta" can be taken as 29°.

📴 Spec Check Detail for 6A.4.2.1 Shear-5.6.3.3 Minimum Reinforcement

63 4 2 1 Shear - 5 Concrete Structures

			and Axial Ef:						
6A.4.2.1 She	ear - 5.6.3 Flex		und Aarur Dr.						
	ear - 5.6.3.3 Mi		cement						
(AASHTO Manu	ual for Bridge E	Valuation, Th:	ird Edition w	ith 2023 Inter	ims)				
PS Box Rect	Void - At Locat	ion = 19.0000	(ft) - Left	Stage 3					
	on Properties fo				id				
	48 Girder f'c								
Beam Height	=	39.00(in)	Side Wall :	Thickness	= 5.00(in)				
Top Slab Wid	dth = ick = Width = Thick =	47.25(in)							
Top Slab Thi	ick =	5.50(in)							
Bottom Slab	Width =	48.00(1n)							
Shear Key To		6.00(in)							
Shear Key H	op -	6.00(in)							
Shear Key De	eight = epth =	0.75(in)							
B1	=	3.00(in)							
B2	=	3.00(in)							
B3	=	3.00(in)							
B4	=	3.00(in)							
Slab f'c	_	0.00(ltai)							
Fffective S	lah Width =	0.00(kB1)	Hauncl	h Width	-	0 00(in)			
Effective S	= lab Width = lab Thickness =	0.00(in)	Haunch	h Thickness	=	0.00(in)			
		,				,			
Input:									
fr_beam =									
	-8569.07in^3	Mdi	nc = 81 cBot = 81	812.35kip-in					
	8734.21in^3	Sno	cBot = 8'	734.21in^3					
Gamma1 = 1.									
Gamma2 = 1.	.10	(operate)							
Gamma2 = 1. Gamma3 = 1.	.10 .00 (Prestressed								
Gamma2 = 1. Gamma3 = 1.	.10								
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3	.10 .00 (Prestressed .67 (Reinforced 3 * [( gamma1*fr	Concrete) r + Gamma2*fcpe		* (Sc/Snc - 1)					
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the	.10 .00 (Prestressed .67 (Reinforced	Concrete) r + Gamma2*fcpe been overridder	n, the Resista	* (Sc/Snc - 1) ance is comput	ed as override		apacity.		
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gamma1*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe been overridder ance is compute fcpe	n, the Resista ed as per the	* (Sc/Snc - 1) ance is comput Specification	ed as override • Governing	phi*override c Mu		Sc	Mcr
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	Sc in^3 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-ir
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-ir 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-ir 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-ir 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-ir 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe een overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1
Gamma2 = 1. Gamma3 = 1. Gamma3 = 0. Mcr = Gamma3 Note: If the Otherw Limit	.10 .00 (Prestressed .67 (Reinforced 3 * [( gammal*fr e capacity has b wise the Resista Load Comb	Concrete) c + Gamma2*fcpe ceen overridder ance is compute fcpe	n, the Resista ed as per the fr	* (Sc/Snc - 1) ance is comput Specification Gamma3	ed as override • Governing	phi*override c Mu	Vu	8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21 8734.21	kip-in 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1 28801.1

Figure 20 6A.4.2.1 Shear 5.6.3.3 Minimum Reinforcement

📴 Spec Check D	Detail for 6A.4.2.1 Sh	ear-5.7.3.4 Proced	dures for Dete	ermining Shear Re	sistance		~~~
6A.4.2.1 S 6A.4.2.1 S 6A.4.2.1 S	hear - 5 Concr hear - 5.7 She hear - 5.7.3 S hear - 5.7.3.4 nual for Bridg	ar and Torsio ectional Desi Procedures f	n gn Model or Determ				
PS Box Rec	t Void - At Lo	cation = 19.0	000 (ft) ·	- Left Sta	age 3		ł
Calculatio	n of Beta/Thet	a					Ł
phi = f'c = fpc = fy = Agg diam = Ep = As(pos) = As(pos) = Aps(pos) = Aps(pos) =	<pre>0.000 (kips/i: 0.900 5.000 (kips/i: 0.937 (kips/i: 1.000 (kips/ 1.000 (kips) 28500.000 (kips) 0.000 (in^2) 0.000 (in^2) 4.284 (in^2) 0.306 (in^2) 189.000 (kips)</pre>	n^2) n^2) in^2) (used for Po (used for Po (used for Po (used for Ne	gative Mu sitive Mu	)			
Ec =	4592.232 (kip	s/in^2)					
(1) -	(used in table Beta = 4.8 / Beta = ( 4.8 where:	(1 + 750 Epsi / (1 + 750 Ep		* <mark>(</mark> 51 / (39 -	+ sxe) )		1
		= sx * (1.38	/ (ag +	0.63))			
Mu_calc	= Max(Mu,  Vu	$-vp(\wedge av)$					
Modify MCF	T Thata: Vac					4	Ś
Modify MCF						<b>ء</b> ا	2
-	T Size Effect:					4 	
Modify MCF	T Size Effect: = 0.19	No	Theta	Beta	Governing		
Modify MCF fpc / f'c	T Size Effect:		Theta	Beta	Governing Action	Mu (kip-in)	
Modify MCF fpc / f'c Limit State	T Size Effect: = 0.19 Load Comb	No Epsilon			Action	(kip-in)	
Modify MCF fpc / f'c Limit	T Size Effect: = 0.19 Load Comb 1, DesInv	No	Theta 37.65 29.00	Beta 1.68 4.80	-		
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.00000 0.002199	37.65 29.00 36.70	1.68 4.80 1.81	Action Max M Min M Max V	(kip-in) 33228.57 11318.68 32064.13	
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb  1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000	37.65 29.00 36.70 29.00	1.68 4.80 1.81 4.80	Action Max M Min M Max V Min V	(kip-in) 33228.57 11318.68 32064.13 22779.24	
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00	1.68 4.80 1.81 4.80 4.80	Action Max M Min M Max V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60	
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68	
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00	1.68 4.80 1.81 4.80 4.80	Action Max M Min M Max V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60	
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.00000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 29.00 34.06	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 2.30	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81	
Modify MCF fpc / f'c Limit State STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 34.06 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 2.30 4.80	Action Max M Min M Max V Max M Min M Max M Min M Max M Min M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68	
Modify MCF fpc / f'c 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 STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv	No Epsilon 0.002471 0.000000 0.002199 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 34.06 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37	
Modify MCF fpc / f'c 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 STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.001444 0.000000 0.001444	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 34.06 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min M Max V Min V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56	
Modify MCF fpc / f'c 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 STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 34.06 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 2.30 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Max V Min V Max M Min M Min M Max V Min V Min V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52	
Modify MCF fpc / f'c 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 STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.001444 0.000000 0.001444	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 34.06 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min M Max V Min V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56	
Modify MCF fpc / f'c 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 STR-I STR-I STR-I STR-I STR-I STR-I STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp	No Epsilon 0.002471 0.00000 0.002199 0.00000 0.00000 0.00000 0.00000 0.001444 0.00000 0.001444 0.00000 0.00000 0.00000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min M Max V Min V Min V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73	
Modify MCF fpc / f'c Limit State STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp 1, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp 2, DesOp	No Epsilon 0.002471 0.00000 0.002199 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.00000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 34.06 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min V Max M Min W Max M Min M Max V Min M Max V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18828.30	
Modify MCF fpc / f'c Limit State STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 2, DesOp 1, DesInv 1, DesOp	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.001444 0.000000 0.001444 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18228.30 8812.35	
Modify MCF fpc / f'c Limit State STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.001444 0.000000 0.001444 0.000000 0.001444 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Max M Min V Max M Min M Max V Min V Min V Min V Min M Min M Max V Min V Min V Min V Min V Min V Min V Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18228.30 8812.35 18295.99	
Modify MCF fpc / f'c Limit State STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 2, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.000000 0.002199 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M Max V Min V Max M Min V Max M Min V Max M Min V Max V Min V Max V Min V Max V Min V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18228.30 812.35 18295.99 14051.47	
Modify MCF fpc / f'c Limit State STR-I	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.001444 0.000000 0.001444 0.000000 0.001444 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min M Max V Max M Min V Max M Min M Max V Min V Min V Min V Min M Min M Max V Min V Min V Min V Min V Min V Min V Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18228.30 8812.35 18295.99	
Modify MCF fpc / f'c Limit State STR-I STR	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp 2, DesOp 1, DesInv 1, DesInv 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000	37.65 29.00 36.70 29.00	1.68 4.80 1.81 4.80	Action Max M Min M Max V Max M Min W Max M Min M Max V Min V Max M Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18228.30 8812.35 18295.99 14051.47 17142.93 8812.35 16610.61	
Modify MCF fpc / f'c Limit State STR-I STR	T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesInv 1, DesInv 1, DesInv 1, DesInv 2, DesInv 2, DesInv 2, DesInv 1, DesInv 1, DesInv 1, DesInv 2, DesInv	No Epsilon 0.002471 0.00000 0.002199 0.000000 0.000000 0.000000 0.000000 0.000000	37.65 29.00 36.70 29.00	1.68 4.80 1.81 4.80	Action Max M Min M Max V Min V Max M Min M Max M Min M Max M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73 18828.30 8812.35 18295.99 14051.47 17142.93 8812.35	

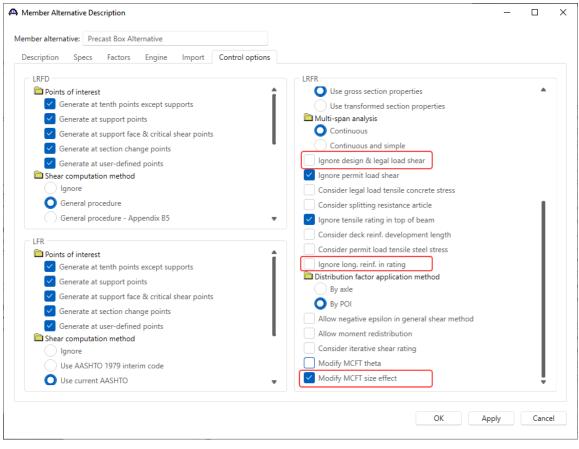
Figure 21 6A.4.2.1 Shear 5.7.3.4 Procedures for Determining Shear Resistance

## Control option added to consider modifying MCFT size effect

This section discusses the control option "Modify MCFT size effect" added for prestressed concrete and posttensioned concrete structures only. This does not apply to reinforced concrete structures and culverts.

#### Member Alternative Description – Control options

Navigate to the member alternative **Precast Box Alternative** of member **G2**, double click on it (or click the **Open** button from the **WORKSPACE** ribbon) to open its **Member Alternative Description** window. Navigate to the **Control options** tab as shown below. Check the box - **Modify MCFT size effect** as shown below.



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

Run an LRFR analysis using the analysis settings shown in the previous step.

#### Specification Check Detail

Once the analysis is complete, open the 6A.4.2.1 Shear-5.7.3.4 Procedures for Determining Shear Resistance article for the analyzed member alternative for Stage 3 at Span 1 – 19.00 ft. This article highlights the status of the "Modify MCFT size effect" control option. With this control option checked, if the ratio fpc/f'c is greater than 0.02, the size effect is neglected regardless of the amount of shear reinforcement present. The article is shown below.

.4.2.1 S .4.2.1 S	hear - 5 Concr hear - 5.7 She hear - 5.7.3 S hear - 5.7.3 S	ar and Torsi ectional Des Procedures	on ign Model for Determini	ng Shear	Resistance									
	nual for Bridg													
	t Void - At Lo		0000 (ft) - I	eft S	tage 3									
	n of Beta/Thet													
-	0.000 (kips/i	0)												
	0.900 (kips/)	.n^2)												
	5.000 (kips/i 0.937 (kips/i													
	60.000 (kips/													
g diam =	1.000 (in)													
	0.000 (kips) 28500.000 (ki	ns/in^2)												
s(pos) =	: 0.000 (in^2)	(used for P												
s(neg) =	0.000 (in^2) 4.284 (in^2)	(used for N	egative Mu)											
	0.306 (in^2)													
fpo =	189.000 (kips 4592.232 (kip	/in^2)												
EC -	- 4092.202 (XI	(5/11°2)												
	(used in table													
	Beta = 4.8 / Beta = (4.8			(51 / (39	+ sxe) )									
				( / (										
	where:													
			8 / (ag + 0.6	3))										
Mu_calc		= sx * (1.3	8 / (ag + 0.6	i3) )										
-	sxe = Max(Mu,  Vu	= sx * (1.3	8 / (ag + 0.6	3))										
dify MCF	sxe = Max(Mu, ∣Vu T Theta: No	: = sx * (1.3 - Vp  * dv)	8 / (ag + 0.6	;3) )										
dify MCF dify MCF	sxe = Max(Mu,  Vu T Theta: No T Size Effect:	: = sx * (1.3 - Vp  * dv)	8 / (ag + 0.6	3))										
dify MCF	sxe = Max(Mu,  Vu T Theta: No T Size Effect:	: = sx * (1.3 - Vp  * dv)	8 / (ag + 0.6	3))										
dify MCF dify MCF c / f'c  imit	T Theta: No T Size Effect: = 0.19 Load	: = sx * (1.3 - Vp  * dv)	8 / (ag + 0.6	3)) Beta	Governing	 Mu	Mu Calc	Vu	Nu	bv	dv	Sx	Sxe	Beta Calc
- dify MCF dify MCF c / f'c imit	SXE = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19	:= sx * (1.3 - Vp  * dv) Yes			Governing Action	(kip-in)	(kip-in)	(kips)	(kips)	(in)	(in)	(in)	Sxe (in)	Beta Calc
dify MCF dify MCF c / f'c  imit tate	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb	:= sx * (1.3 - Vp  * dv) Yes					(kip-in)	(kips)	(kips)		(in)			
- dify MCF dify MCF c / f'c  imit tate IR-I IR-I	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.000000</pre>	Theta 37.65 29.00	Beta 1.68 4.80	Action Max M Min M	(kip-in) 33228.57 11318.68	(kip-in) 33228.57 11318.68	(kips) 127.29 37.57	(kips) 0.00 0.00	(in) 10.00 10.00	(in) 33.77 33.77	(in) 33.77 33.77	(in) 	(1) (1)
- dify MCF c / f'c imit tate IR-I IR-I IR-I IR-I	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb DesInv 1, DesInv 1, DesInv	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.000249</pre>	Theta 37.65 29.00 36.70	Beta 1.68 4.80 1.81	Action Max M Min M Max V	(kip-in) 33228.57 11318.68 32064.13	(kip-in) 33228.57 11318.68 32064.13	(kips) 127.29 37.57 128.56	(kips) 0.00 0.00 0.00	(in) 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77	(in)	(1) (1) (1)
dify MCF dify MCF c / f'c imit tate IR-I IR-I IR-I IR-I IR-I IR-I IR-I	= Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.00000 0.02199 0.000000 0.01088</pre>	Theta 37.65 29.00 36.70 29.00 32.81	Beta 1.68 4.80 1.81 4.80 2.64	Action Max M Min M Max V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60	(kips) 127.29 37.57 128.56 25.01 106.78	(kips) 0.00 0.00 0.00 0.00 0.00	(in) 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77	(in)    	(1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c imit tate TR-I TR-I TR-I TR-I TR-I TR-I TR-I TR-I	= Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb I, DesInv I, DesInv I, DesInv I, DesInv I, DesInv I, DesOp	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.000000 0.0022199 0.000000 0.001088 0.000000</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00	Beta 1.68 4.80 1.81 4.80 2.64 4.80	Action Max M Min M Max V Min V Max M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68	(kips) 127.29 37.57 128.56 25.01 106.78 37.57	(kips) 0.00 0.00 0.00 0.00 0.00 0.00	(in) 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)     	(1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c imit tate IR-I IR-I IR-I IR-I IR-I IR-I IR-I IR-	= Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.00000 0.02199 0.000000 0.01088 0.000000</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 32.08	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.89	Action Max M Min M Max V Min V Max M Min M Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77	(kips) 0.00 0.00 0.00 0.00 0.00 0.00 0.00	(in) 10.00 10.00 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)    	(1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c imit tate TR-I TR-I TR-I TR-I TR-I TR-I TR-I TR-I	= Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb I, DesInv I, DesInv I, DesInv I, DesInv I, DesInv I, DesOp	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.000000 0.0022199 0.000000 0.001088 0.000000</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00	Beta 1.68 4.80 1.81 4.80 2.64 4.80	Action Max M Min M Max V Min V Max M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68	(kips) 127.29 37.57 128.56 25.01 106.78 37.57	(kips) 0.00 0.00 0.00 0.00 0.00 0.00	(in) 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)     	(1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c imit tate TR-I TR-I TR-I TR-I TR-I TR-I TR-I TR-I	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb Load Comb Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Comb Load Load Load Load Load Load Load Load	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon </pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 32.08 29.00 34.06 29.00	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.30 4.80 2.30 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min V Max M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57	(kips) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	(in) 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)        	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c  tate TR-I TR-I TR-I TR-I TR-I TR-I TR-I TR-I	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb Comb Load Co Comb Load Comb Load	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.00200 0.002139 0.000000 0.0002139 0.000000 0.001088 0.000000 0.000000 0.001088 0.000000 0.001444 0.000000 0.01172</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 32.08 29.00 34.06 29.00 33.10	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.89 4.80 2.30 4.80 2.30 4.80 2.30	Action Max M Min M Max V Min V Max M Min M Max M Min V Max M Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39	(kips) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	(in) 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)        	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c  imit tate TR-I TR-I TR-I TR-I TR-I TR-I TR-I TR-I	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb Load Comb Load Comb Load DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - 0.002471 0.000000 0.002199 0.000000 0.000000 0.000000 0.000000 0.000000</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 32.08 29.00 34.06 29.00 33.10 29.00	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.89 2.80 2.80 4.80 2.55 4.80	Action Max M Min M Max V Min V Max M Min M Max V Min M Min M Min M Max V Min V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23678.56	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80	(kips) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	(in) 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)        	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c  trate  TR-I TR-I TR-I TR-I TR-I TR-I T	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb Comb Load Co Comb Load Comb Load	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.00200 0.002139 0.000000 0.0002139 0.000000 0.001088 0.000000 0.000000 0.001088 0.000000 0.001444 0.000000 0.01172</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 32.08 29.00 34.06 29.00 33.10	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.89 4.80 2.30 4.80 2.30 4.80 2.30	Action Max M Min M Max V Min V Max M Min M Max M Min V Max M Min M Max V	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39	(kips) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.	(in) 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00 10.00	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)        	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
- dify MCF dify MCF c / f'c  imit tate  TR-I TR-I TR-I TR-I TR-I TR-I T	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon 0.002471 0.00000 0.002009 0.002009 0.000000 0.001088 0.000000 0.001088 0.000000 0.001444 0.000000 0.01172 0.000000 0.000296 0.0000296</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 32.08 29.00 34.06 29.00 33.10 29.00 33.10 29.00 30.04 29.00 29.00 29.00	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.30 4.80 2.30 4.80 3.93 4.80 4.81	Action Max M Min M Max V Min V Min M Min M Max M Min M Max M Min V Max M Min W Max V	(kip-in) 33228.57 11318.68 32064.13 2779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 29541.81 11318.68 28377.37 28778.56 25376.52 11318.68 24378.24	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29	(kips) 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	(in) 10.00 10.	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)          -	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
<pre></pre>	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb . DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 2, DesOp	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - 0.002471 0.000000 0.002199 0.000000 0.000000 0.000000 0.000000 0.00172 0.000000 0.001244 0.000000 0.001245 0.000000 0.000296 0.000000</pre>	Theta 32.00 32.00 32.00 32.00 32.00 32.00 32.00 34.06 29.00 33.10 29.00 33.10 29.00 30.04 29.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20	Beta 1.68 4.80 1.81 4.80 2.89 4.80 2.30 4.80 2.30 4.80 3.93 4.80 4	Action Max M Max V Min V Min W Min M Min W Min W Min M Min M Min M Min M Min M Min M Min M Min M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23678.56 25376.52 11318.68 24478.24 21007.73	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23878.56 25376.52 11318.68 24478.24 21007.73	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95	(kips) 0.00	(in) 10.00 10.	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77	(in)	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
dify MCF dify MCF c / f'c  imit tate  TR-I TR-I TR-I TR-I TR-I TR-I T	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - 0.002471 0.00000 0.002199 0.000000 0.000009 0.000000 0.000009 0.000000 0.000000 0.00172 0.000000 0.000000</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 34.06 29.00 33.10 29.00 33.10 29.00 30.04 29.00 29.00 29.00 29.00 29.00 29.00	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.30 4.80 2.30 4.80 3.93 4.80 4	Action Max M Min M Max V Min V Max M Min M Max M Min M Max M Min M Max V Min V Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 2877.55 25376.52 11318.68 25376.52 11318.68 24478.24 21007.73 18828.30	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23678.56 25376.52 11318.68 24478.24 21007.73 18228.30	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 28.80 94.31 37.57 95.29 26.95 70.27	(kips) 	(in) 10.00 10.	(in) 33.77	(1n) 33.77	(in)          -	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
- dify MCF dify MCF c / f'c  imit tate  TR-I TR-I TR-I TR-I TR-I TR-I T	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb . DesInv 1, DesInv 1, DesInv 1, DesInv 1, DesOp 1, DesOp 1, DesOp 2, DesInv 2, DesInv 2, DesInv 2, DesInv 2, DesOp 2, DesOp 1, DesOp 2, DesOp 2, DesOv 1, DesInv	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - 0.002471 0.000000 0.002199 0.000000 0.000000 0.001028 0.000000 0.00124 0.000000 0.001444 0.000000 0.001444 0.000000 0.001444 0.000000 0.000000 0.000000</pre>	Theta 37.65 28.00 28.00 28.00 29.00 29.00 34.06 29.00 33.10 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	Beta 1.68 4.80 2.64 4.80 2.80 4.80 2.30 4.80 2.55 4.80 3.93 4.80 4	Action Max M Max V Max V Max M Min M Max V Min V Min V Min M Min M Min M Min M Min M Min M Min M Min M Min M	(kip-in) 33228.57 11318.68 32064.13 32024.43 2220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 28278.56 25376.52 24478.24 21007.73 18828.30 8812.35	(k1p-in) 33228.57 11318.68 32064.13 22779.24 82204.13 22722.31 20159.68 29541.81 11318.68 28377.37 23878.56 23378.56 23376.52 11318.68 24478.24 21007.73 18228.30 8812.35	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26	(kips) 0.00	(in) 10.00 10.	(1)) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in)          -	(1) (1) (1) (1) (1) (1) (1) (1) (1) (1)
- dify MCF dify MCF c / f'c  imit tate  TR-I TR-I TR-I TR-I TR-I TR-I T	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - 0.002471 0.000000 0.002199 0.000000 0.000000 0.00172 0.000000 0.00172 0.000000 0.000000 0.000000 0.000000 0.000000</pre>	Theta 31.65 29.00 26.00 28.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	Beta 1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min W Max V Mix V Mix V Mix V Mix V Mix V Mix V Mix M Mix V Mix V	(kip-in) 33228.57 11318.68 20064.13 2202.060 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 28278.56 25376.52 24478.24 21007.73 18228.30 821.35 18225.99 14051.47	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23378.56 25376.52 24378.56 24478.24 21007.73 18228.30 8212.35 18225.99 14051.47	(kips) 127.29 37.57 128.56 126.78 37.57 107.77 127.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.86 23.52	(kips) 	(in) 10.00 10.	(1)) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77	(in)          -	(1) (1) (1) (1) (2) (2) (2) (2) (2) (2) (2) (2) (2) (2
dify MCF dify MCF c / f'c imit tate 	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 Load Comb	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - D02471 0.00000 0.002199 0.000000 0.001088 0.000000 0.001088 0.000000 0.00172 0.000000 0.000000 0.000000 0.000000 0.000000</pre>	Theta 37.65 29.00 36.70 29.00 32.81 29.00 34.06 29.00 33.10 29.00 33.10 29.00 30.04 29.00 29	Beta 1.68 4.80 1.81 4.80 2.64 4.80 2.30 4.80 2.30 4.80 4	Action Max M Max M Max V Max M Min V Max M Max V Max M Max V Min V Max M Max V Min V Max M Max M Max M	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 28377.37 23878.56 28377.57 23878.56 25376.52 11318.68 28377.37 23878.56 25376.52 11318.68 28377.37 23878.56 25376.52 11318.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.78 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.68 1132.78 1132.68 1132.78 1132.68 1132.78 1132.68 1132.78 1132.68 1132.78	(k1p-1n) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 27322.31 20159.68 29541.81 11318.68 28377.37 23678.56 25376.52 11318.68 284378.24 21007.73 18228.30 88122.35 18295.99 14051.47 17122.93	(kips) 127.29 37.57 128.56 25.01 106.78 37.57 107.77 27.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.86 23.52 62.88	(kips) 0.00	(in) 10.00 10.	(in) 33.77 37.77 33.77 37.77 37.77 37.77 37	(in) 33.77 37.77 37.	(in)	
- dify MCF dify MCF c / f'c  imit tate  TR-I TR-I TR-I TR-I TR-I TR-I T	sxe = Max(Mu,  Vu T Theta: No T Size Effect: = 0.19 	<pre>:= sx * (1.3 - Vp  * dv) Yes Epsilon - 0.002471 0.000000 0.002199 0.000000 0.000000 0.00172 0.000000 0.00172 0.000000 0.000000 0.000000 0.000000 0.000000</pre>	Theta 31.65 29.00 26.00 28.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00 29.00	Beta 1.68 4.80 1.81 4.80 4.80 4.80 4.80 4.80 4.80 4.80 4.80	Action Max M Min W Max V Mix V Mix V Mix V Mix V Mix V Mix V Mix M Mix V Mix V	(kip-in) 33228.57 11318.68 20064.13 2202.060 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 28278.56 25376.52 24478.24 21007.73 18228.30 821.35 18225.99 14051.47	(kip-in) 33228.57 11318.68 32064.13 22779.24 28220.60 11318.68 27322.31 20159.68 29541.81 11318.68 28377.37 23378.56 25376.52 24378.56 24478.24 21007.73 18228.30 8212.35 18225.99 14051.47	(kips) 127.29 37.57 128.56 126.78 37.57 107.77 127.88 111.12 37.57 112.39 23.80 94.31 37.57 95.29 26.95 70.27 29.26 70.86 23.52	(kips) 	(in) 10.00 10.	(1)) 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77 33.77	(in) 33.77	(in)          -	(1) (1) (1) (1) (2) (2) (2) (2) (2) (2) (2) (2) (2) (2

Figure 22 6A.4.2.1 Shear-5.7.3.4 Procedures for Determining Shear Resistance

# MBE 2023 specification interim update for reinforced concrete box culverts

The specification update for culvert will impact culvert wall (6A.4.2.1-5.7.3.3 Nominal shear resistance) and culvert slab specification checking (6A.4.2.1-5.7.3.3 Nominal shear resistance and 6A.4.2.1-5.12.7.3 Nominal shear resistance).

Import the culvert bridge provided with the CVT1 tutorial. Expand the **Bridge Workspace** tree and navigate to the **CULVERT ALTERNATIVES** node. Double click on **Culvert Alt 1** to open the culvert alternative. Navigate to the **Control options** tab of the **Culvert Alternative Description** window to access the **LRFR** control options. **Consider iterative shear rating** and **Consider MCFT theta** control options are added for iterative shear rating.



These options are applicable when **General procedure** - Shear computation method is used. Select these options to perform iterative shear rating and consider modifying the MCFT theta value and view results as discussed in previous sections of this tutorial.

Specification Check	for Culvert Seg 1 - 9 of 857					1
	Articles All articles	×				
Properties 0	nerate Format Bullet list	<b>v</b>				
ecification filter	Report					
📋 Culvert Compone	t Specification reference	e	Limit State	Flex. Sense	Pass/Fail	
🔺 🚞 Ext. Wall 1	5.4.2.8 Concrete	Density Modification Factor		N/A	General Comp.	
i 0.00 ft.	✓ 5.6.4.5.BoxCulver	t Biaxial Flexure		N/A	Passed	
<u> </u> 0.73 ft.	5.6.7.Crack.BoxC	ulvert Control of Cracking by Distribution of Reinforcement	:	N/A	General Comp.	
🚞 1.20 ft.	🗎 6A.4.2.1 Shear-5.	6.3.3.BoxCulvert Minimum Reinforcement		N/A	General Comp.	
🚞 2.40 ft.	🗎 6A.4.2.1 Shear-5.	7.3.3 Box Culvert Nominal Shear Resistance		N/A	General Comp.	
🚞 3.60 ft.	🗎 6A.4.2.1 Shear-5.	7.3.4.BoxCulvert Procedures for Determining Shear Resista	nce	N/A	General Comp.	
iii 4.80 ft.	6A.4.2.1.BoxCulv	ert.Concrete Shear General Load Rating Equation - Concret	e Shear	N/A	Passed	
🧰 6.00 ft.	✓ APPC.6.1 P-M Int	eraction Diagram		N/A	Passed	
i 7.20 ft.	Cracked_Momen	t_Of_Inertia_BoxCulvert Section Property Calculations		N/A	General Comp.	
🚞 8.40 ft.						
i 9.60 ft.						
in 10.80 ft.						
🚞 11.27 ft. 🚞 12.00 ft.						

The following articles detail the iterative process of shear rating.

Figure 23 - Specification check article for Exterior wall 1

Properties becification filter	Generat	Articles All articles e Format Bullet list Report	~					
ecification filter	Generat	e Format Bullet list						
ecification filter	Generat	Bullet list	$\sim$					
		Report						
		Report						
🔺 🚞 Culvert Component		Specification reference	e		Limit State	Flex. Sense	Pass/Fail	_
<ul> <li>Ext. Wall 1</li> <li>Int. Wall 1</li> </ul>		🔋 5.4.2.8 Concrete	Density M	dification Factor		N/A	General Comp.	
		5.5.4.2.BoxCulver	t Strength	imit State - Resistance Factors		N/A	General Comp.	
🕨 🚞 Ext. Wall 2	_	✓ 5.6.3.2.BoxCulver	t Flexural	esistance (Reinforced Concrete)		N/A	Passed	
🛯 🚞 Top Slab 1		✓ 5.6.3.3.BoxCulver	t Minimur	Reinforcement		N/A	Passed	
iii 0.00 ft.		5.6.7.Crack.BoxCu	ulvert Con	ol of Cracking by Distribution of Reinforcement		N/A	General Comp.	
🔁 0.75 ft.		🗎 6A.4.2.1 Shear-5.	12.7.3.Box	ulvert Design for Shear in Slabs of Box Culverts		N/A	General Comp.	
🚞 1.20 ft.		6A.4.2.1 Shear-5.0	6.3.3.Box0	Ivert Minimum Reinforcement		N/A	General Comp.	
🚞 2.40 ft.		6A.4.2.1 Shear-5.	7.3.4.Box0	Ivert Procedures for Determining Shear Resistance		N/A	General Comp.	
🚞 3.60 ft.		✓ 6A.4.2.1.BoxCulve	ert.Concre	Flexure General Load Rating Equation - Concrete Flexure		N/A	Passed	
i 4.80 ft.		✓ 6A.4.2.1.BoxCulve	ert.Concre	Shear General Load Rating Equation - Concrete Shear		N/A	Passed	
🚞 6.00 ft.		Cracked_Moment	t_Of_Inert	BoxCulvert Section Property Calculations		N/A	General Comp.	
i 7.20 ft.		-	-					
🚞 8.40 ft.								
ing 9.60 ft.								
i 10.80 ft.								
i 11.24 π. i 12.00 ft.								

Figure 24 - Specification check articles for Top slab 1

AASHTOWare BrDR 7.5.1

# LRFR Concrete Moment Redistribution Tutorial

Moment Redistribution in Three Span Spread PS Box Beam

# LRFR Concrete Moment Redistribution Tutorial

# Moment Redistribution in Three Span Spread PS Box Beam

This example illustrates the effects of moment redistribution for Load and Resistance Factor Rating (LRFR) flexure rating of concrete structures (prestressed, post tensioned, and reinforced). The moment redistribution option is available in BrDR 7.5 for the Manual for Bridge Evaluation (MBE) 3<sup>rd</sup> edition, with 2022 and 2023 specification interim updates.

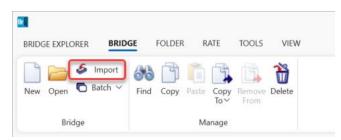
Details, including flowcharts, about moment redistribution in concrete structures can be found in the AASHTO LRFD/LRFR Superstructure Method of Solution Manual accessible from the Help menu in BrDR (search for Concrete Moment Redistribution).

# Topics Covered

- Bridge Model
- Analysis Settings
- Member Alternative Description Control options
- LRFR Rating
- Specification Check Detail
- LRFR Rating with Moment Redistribution
- Specification Check Detail with Moment Redistribution
- Moment Redistribution Report

# Bridge Model

This tutorial uses the bridge created from prestressed concrete structure tutorial PS2 with some minor modifications to satisfy moment redistribution requirements and to illustrate the impact of moment redistribution on rating. From the **Bridge Explorer** import the bridge given with the PS2 tutorial by selecting the **Import** option as shown below.



If information is displayed about the version of the imported file being different than the current version of the program, confirm by clicking **Yes** to have the imported file migrated to the current version of the program. In the **Bridge Description** window, which pops up after the bridge is imported, add MR (for Moment Redistribution) to **Bridge ID** and **NBI structure ID** to distinguish this bridge from the PS2 example bridge.

A 3SpanSprdBoxTraining	gBridge				- 🗆 X
Bridge ID: SprdBoxTra	iningBridg <mark>eMR NBI struct</mark>	ure ID (8): 3SpanSprdBoxTra	MR	Template Bridge completely define	Bridge Workspace View Superstructures Culverts Substructures
Description Desc	ription (cont'd) Alternative	s Global reference point	Traffic	Custom agency fields	
Name:	3Span Sprd Box Trn Bridge			Year built:	
Description:	3 span spread PS box beam continuity	bridge made continuous for li	ve load thro	ugh	
Location:				Length:	ft
Facility carried (7):				Route number: -1	
Feat. intersected (6):				Mi. post:	
Default units:	US Customary ~				
Bridge associa	ation 🔽 BrR 🔽 Brt	D BrM		ОК	Apply Cancel

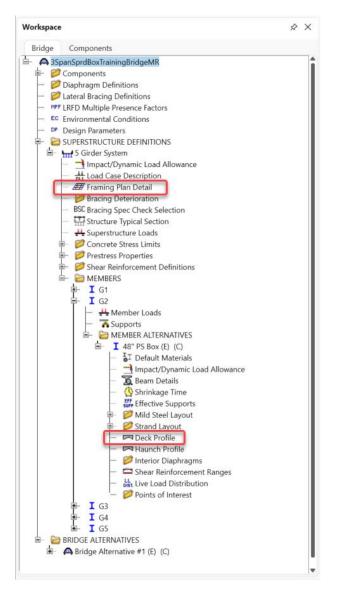
Click **OK** to close the Bridge Description window.

Moment Redistribution in Three Span Spread PS Box Beam

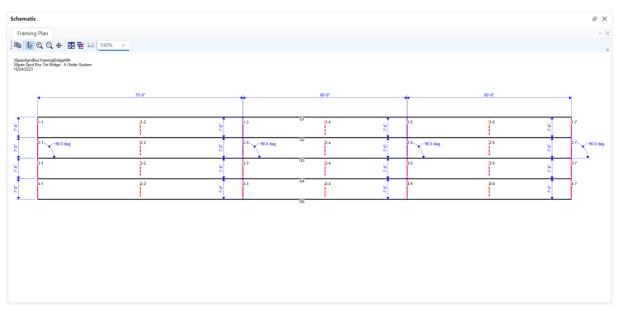


Save the imported bridge to the database using the Save button located on the WORKSPACE ribbon.

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



Right-click on the **Framing Plan Detail** and select **Schematic** to display the Framing Plan schematic showing a three span girder system with five girders and span lengths of 75.0, 60.0, and 60.0 ft.



Moment Redistribution in Three Span Spread PS Box Beam

Double-click on the **Deck Profile** tree item of the G2 member alternative -48" PS Box, to open the **Deck Profile** window and go to the **Reinforcement** tab. The reinforcement data imported from the PS2 example consists of two sets of top and bottom reinforcement that extend 15 ft in each direction over each interior support as shown here:

	PS Precast	Box														
eck	concrete	Re	inforcemen	nt												
	Materia	al	Support number	Start distance (ft)	Length (ft)	End distance (ft)	Std bar count	LRFD bar count	Bar siz	e Distance (in)	Row		Bar spacing (in)			
>	Grade 60	$\sim$	1 ~	60.00	30.00	90.00	11.00	11.00	6 \	3.5000	Top of Slab	$\sim$				
	Grade 60	~	1 ~	60.00	30.00	90.00	11.00	11.00	5 \	2.0000	Bottom of Slab	$\sim$				
	Grade 60	~	2 ~	45.00	30.00	75.00	11.00	11.00	6 \	3.5000	Top of Slab	$\sim$				
	Grade 60	$\sim$	2 ~	45.00	30.00	75.00	11.00	11.00	5 \	2.0000	Bottom of Slab	$\sim$				

Delete the last two rows and modify start distance, length, and bar counts in the first two rows as shown below:

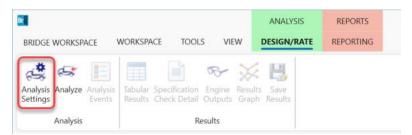
Material     Support number     Start distance (ft)     Length distance (ft)     End distance (ft)     Std bar count     LRFD bar count     Distance Bar size     Bar (in)     Bar spacing (in)	Autorial         Support number         Start (ft)         Length (ft)         End distance (ft)         Std bar count         LRFD bar count         Bar size         Distance (in)         Row         Bar spacing (in)           Grade 60         1         55.00         100.00         155.00         9.00         6         3.5000         Top of Slab         Image: Count of Slab	Material     Support number     Start distance (ft)     Length distance (ft)     Std     LRFD bar count     Bar size     Distance (ft)     Row     Bar size (ft)     Bar size (ft)       >     Grade 60      1      55.00     100.00     155.00     9.00     6      3.5000     Top of Slab	Row spacing (in) op of Slab V	k conce M Grade
Material     Support number     Start (ft)     Length     End distance (ft)     Std bar count     LRFD bar count     Bar size     Distance (in)     Row     Bar spacing (in)       > Grade 60 ~     1 ~     55.00     100.00     155.00     9.00     9.00     6 ~     3.5000     Top of Slab ~     Image: Start spacing spa	Material     Support number     Stat distance (ft)     Length distance (ft)     End distance (ft)     Std bar count     LRFD bar count     Bar size     Distance (in)     Row     Bar spacing (in)       Grade 60 V     1 V     55.00     100.00     155.00     9.00     6 V     3.5000     Top of Slab     V	Material     Support number     Stat distance (ft)     Length (ft)     End distance (ft)     Stat barcount     LRFD barcount     Bar size     Distance (in)     Row     Bar spacing (in)       > Grade 60 v     1 v     55.00     100.00     155.00     9.00     6 v     3.5000     Top of Slab     V	Row spacing (in) op of Slab V	M
Material     Support (ft)     Gistance (ft)     Lengu distance (ft)     Stat bar count     Lengu bar count     Bar size bar count     Distance (in)     Row     spacing (in)       > Grade 60     1     55.00     100.00     155.00     9.00     9.00     6     3.5000     Top of Slab	Material     Support number     distance (ft)     Length distance (ft)     distance (ft)     State distance (ft)     Length bar count     Bar size     Distance (in)     Row     spacing (in)       Grade 60 V     1 V     55.00     100.00     155.00     9.00     6 V     3.5000     Top of Slab     V	Material     Support number     Length distance (ft)     Length distance (ft)     Length distance (ft)     Length distance (ft)     Length bar sount     Distance Bar size     Row     spacing (in)       3     Grade 60 V     1 V     55.00     100.00     155.00     9.00     6 V     3.5000     Top of Slab     V	Row spacing (in) op of Slab V	Grad
Grade 60 v 1 v 55.00 100.00 155.00 9.00 9.00 5 v 2.0000 Bottom of Slab v	Grade 60 V 1 V 55.00 100.00 155.00 9.00 9.00 5 V 2.0000 Bottom of Slab V	Grade 60 V 1 V 55.00 100.00 155.00 9.00 9.00 5 V 2.0000 Bottom of Slab V	Rottom of Slab V	Grad
New Duplicate Delete	New Duplicate Delete	New Duplicate D	New Duplicate Delete	
New Duplicate Delete	New Duplicate Delete	New Duplicate D	New Duplicate Delete	
New Duplicate Delete	New Duplicate Delete	New Duplicate D	New Duplicate Delete	
New Duplicate Delete	New Duplicate Delete	New Duplicate D	New Duplicate Delete	
New Duplicate Delete	New Duplicate Delete	New Duplicate D	New Duplicate Delete	

Moment Redistribution in Three Span Spread PS Box Beam

Deleting the last two rows and changing the start distance and length simplifies the reinforcement layout from two separate sets of top and bottom reinforcement over each internal support to one set of top and bottom reinforcement. The modified reinforcement now starts 20 ft before the first internal support in Span 1 and continues to pass over to Span 2 and then 20 ft after the second internal support into Span 3. This change is required to satisfy the moment redistribution requirements for reinforcement extension and termination which will be discussed later in the tutorial. The purpose of reducing bar counts is to decrease the flexure rating factors over interior supports and to examine whether applying moment redistribution helps to offset the reduction.

## Analysis Settings

To select rating vehicles and rating levels, open the **Analysis Settings** window by clicking the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon.



In the **Analysis Settings** window, select **Rating** and **LRFR** as the **Rating Method**. Then assign vehicles from the **Vehicle selection** tree on the left to the rating levels under the **Vehicle summary** tree on the right as shown in the screenshot below. The assignment is done in three steps. First clicking on a rating level, next by clicking on a vehicle,

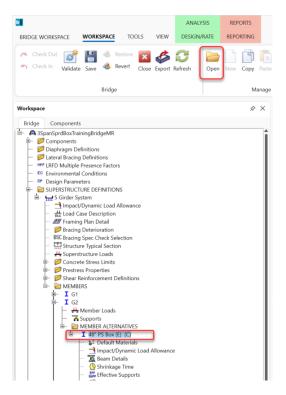
and then by clicking on the **Add to** button. To assign multiple vehicles to the same level, only the last two steps need to be repeated. Also, double-clicking on a vehicle has the same effect as the last two steps.

Analysis Settings     Design review     Rating	- C X
Analysis type:     Line Girder        Lane / Impact loading type:     As Requested        Vehicles     Output     Engine     Description	Apply preference setting: None
Traffic direction: Both directions	Refresh     Temporary vehicles     Advanced       Vehicle summary
<ul> <li>➡-Vehicles</li> <li>➡-Standard</li> <li>→EV2</li> <li>→EV3</li> <li>→H 15-44</li> <li>→H 20-44</li> <li>→H1-93 (SI)</li> <li>→HS 15-44</li> <li>→HS 20 (SI)</li> <li>→HS 20 (SI)</li> <li>→HS 20-44</li> <li>→Lane-Type Legal Load</li> <li>→LRFD Fatigue Truck (SI)</li> <li>→LRFD Fatigue Truck (US)</li> <li>→NRL</li> <li>→SU4</li> <li>→SU5</li> <li>→SU6</li> <li>→SU7</li> <li>→Type 3-3</li> <li>→Type 3S2</li> <li>→Agency</li> <li>→User defined</li> <li>→Temporary</li> </ul>	Add to >> Remove from << Remove from << Remove from << Remove from << Remove from <br Remove from <br <br <br Remove from <br <br <br Remove from <br <br Remove from </td

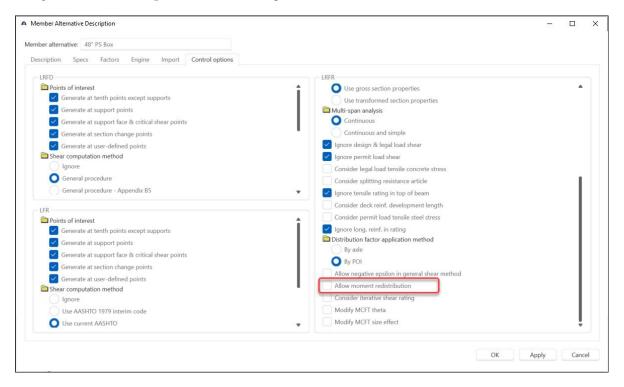
Click **OK** to apply the settings and close the window.

### Member Alternative Description - Control options

Navigate to the **48**" **PS Box Member Alternative** of member **G2**, double click on it (or click the **Open** button from the **WORKSPACE** ribbon) to open its **Member Alternative Description** window.



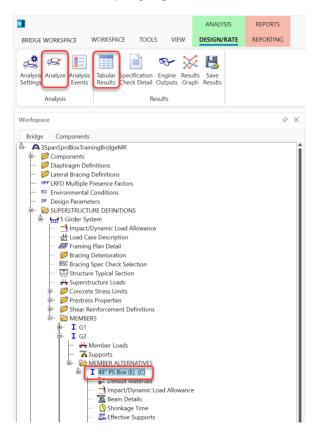
Navigate to the **Control options** tab where the option to allow moment redistribution is located as shown below.



This option will be toggled to compare ratings without and with moment redistribution. The first analysis will be without moment redistribution so make sure the option is unchecked and click the **OK** button to apply the data and close the window.

# LRFR Rating

To perform the rating select the **48**" **PS Box** member alternative in **Bridge Workspace** tree and click the **Analyze** button on the **Analysis** group of the **DESIGN/RATE** ribbon.

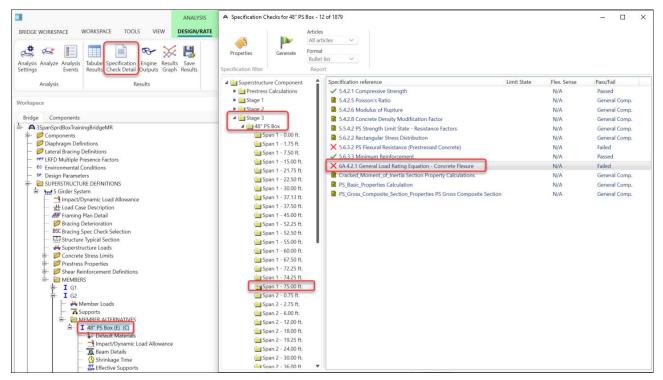


After the analysis is complete, click the **Tabular Results** button to display the ratings. Select **Rating Results Summary** as the **Report Type** and **Single rating level per row** as the **Display Format** option to have the ratings arranged as shown below. Notice there are two ratings less than 1.0 and they both happen due to flexure at the first interior support location at 75.00 ft for the STRENGTH-I limit state.

		6		el per row	~					
Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane	
Truck + Lane	LRFR	Inventory	31.39	0.872	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Truck + Lane	LRFR	Operating	40.69	1.130	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
%(Truck Pair + Lane)	LRFR	Inventory	28.50	0.792	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
%(Truck Pair + Lane)	LRFR	Operating	36.95	1.026	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Tandem + Lane	LRFR	Inventory	37.78	1.049	37.13	1 - (49.5)	SERVICE-III PS Tensile Stress	As Requested	As Requested	
Tandem + Lane	LRFR	Operating	49.11	1.364	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Truck + Lane	LRFR	Legal	3960.00	99.000	0.00	1 - (0.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Axle Load	LRFR	Legal	61.57	1.539	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Axle Load	LRFR	Legal	61.25	2.450	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Axle Load	LRFR	Legal	79.83	1.996	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Axle Load	LRFR	Legal	70.96	1.971	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
	Live Load Type Truck + Lane Truck + Lane (s(Truck Pair + Lane) (s(Truck Pair + Lane) Tandem + Lane Tandem + Lane Truck + Lane Axle Load Axle Load	Live Load Type Rating Method Truck + Lane LRFR Truck + Lane LRFR (fruck Pair + Lane) LRFR (fruck Pair + Lane) LRFR Tandem + Lane LRFR Tandem + Lane LRFR Truck + Lane LRFR Axde Load LRFR Axde Load LRFR Axde Load LRFR	Live Load       As requested       Detailed         Type       Rating Method       Rating Level         Truck + Lane       LRFR       Inventory         Truck + Lane       LRFR       Operating         %(Truck Pair + Lane)       LRFR       Operating         Tandem + Lane       LRFR       Inventory         Tandem + Lane       LRFR       Operating         Truck + Lane       LRFR       Inventory         Tandem + Lane       LRFR       Inventory         Tandem + Lane       LRFR       Legal         Axie Load       LRFR       Legal         Axie Load       LRFR       Legal         Axie Load       LRFR       Legal	As requested         Detailed         Single rating level           Live Load Type         Rating Method         Rating Level         Load Rating Level         Coad Rating (Ton)           Truck + Lane         LRFR         Inventory         31.39           Truck + Lane         LRFR         Operating         40.69           %(Truck Pair + Lane)         LRFR         Inventory         28.50           %(Truck Pair + Lane)         LRFR         Operating         36.95           Tandem + Lane         LRFR         Operating         396.00           Axile Load         LRFR         Legal         3960.00           Axile Load         LRFR         Legal         61.57           Axile Load         LRFR         Legal         61.25           Axile Load         LRFR         Legal         79.83	Live Load Type       Rating Method       Rating Level       Load Rating (Ton)       Rating Factor         Truck + Lane       LRFR       Inventory       31.39       0.872         Truck + Lane       LRFR       Inventory       31.39       0.872         Truck + Lane       LRFR       Operating       40.69       1.130         & (Fruck Pair + Lane)       LRFR       Operating       36.95       1.026         Tandem + Lane       LRFR       Inventory       37.78       1.049         Tandem + Lane       LRFR       Legal       3960.00       99.000         Axle Load       LRFR       Legal       61.57       1.539         Axle Load       LRFR       Legal       61.25       2.450         Axle Load       LRFR       Legal       79.83       1.996	Live Load Type       Rating Method       Rating Level       Load Rating (Ton)       Rating Factor       Location (ft)         Truck + Lane       LRFR       Inventory       31.39       0.872       75.00         Truck + Lane       LRFR       Operating       40.69       1.130       75.00         (Furck Pair + Lane)       LRFR       Inventory       28.50       0.792       75.00         (Gruck Pair + Lane)       LRFR       Operating       36.95       1.026       75.00         Tandem + Lane       LRFR       Operating       349.50       1.726       75.00         Truck + Lane       LRFR       Inventory       37.78       1.049       37.13         Tandem + Lane       LRFR       Operating       3960.00       99.000       0.00         Axle Load       LRFR       Legal       61.57       1.539       75.00         Axle Load       LRFR       Legal       61.25       2.450       75.00	Live Load Type         Rating Method Level         Rating Level         Load Rating (Ton)         Rating Factor         Location (ft)         Span-(%)           Truck + Lane         LRFR         Inventory         31.39         0.872         75.00         1 - (100.0)           Truck + Lane         LRFR         Inventory         31.39         0.872         75.00         1 - (100.0)           G(Truck + Lane)         LRFR         Operating         40.69         1.130         75.00         1 - (100.0)           G(Truck Pair + Lane)         LRFR         Operating         36.95         1.026         75.00         1 - (100.0)           G(Truck Pair + Lane)         LRFR         Operating         36.95         1.026         75.00         1 - (100.0)           Tandem + Lane         LRFR         Operating         49.11         1.364         75.00         1 - (100.0)           Truck + Lane         LRFR         Legal         3960.00         99.000         0.00         1 - (00.0)           Axle Load         LRFR         Legal         61.57         1.539         75.00         1 - (100.0)           Axle Load         LRFR         Legal         79.83         1.996         75.00         1 - (100.0)	Live Load Type       Rating Method       Rating Level       Load Rating (Ton)       Rating Factor       Location (ft)       Location Span-(%)       Limit State         Truck + Lane       LRFR       Inventory       31.39       0.872       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure         K[Truck + Lane]       LRFR       Inventory       31.39       0.872       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure         K[Truck + Lane]       LRFR       Inventory       28.50       0.792       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure         K[Truck Pair + Lane]       LRFR       Inventory       37.78       1.049       37.13       1 - (49.5)       SERVICE-III PS Tensile Stress         Tandem + Lane       LRFR       Operating       49.11       1.364       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure         Truck + Lane       LRFR       Legal       3960.00       99.000       0.00       1 - (00.0)       STRENGTH-I Concrete Flexure         Axle Load       LRFR       Legal       61.57       1.539       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure         Axle Load       LRFR       Legal       61.25       2.450       75.00       1 - (100.0)       STRENGTH-I Concrete F	Live Load Type       Rating Method Person       Rating Level       Load Rating (Ton)       Rating Factor       Location (Ht)       Location Span-(%)       Limit State       Impact         Truck + Lane       LRFR       Inventory       31.39       0.872       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure       As Requested         G(Truck + Lane       LRFR       Inventory       31.39       0.872       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure       As Requested         G(Truck Pair + Lane)       LRFR       Inventory       28.50       0.792       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure       As Requested         G(Truck Pair + Lane)       LRFR       Inventory       28.50       0.792       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure       As Requested         Tandem + Lane       LRFR       Inventory       37.78       1.049       37.13       1 - (49.5)       SERVICE-III PS Tensile Stress       As Requested         Truck + Lane       LRFR       Operating       49.11       1.364       75.00       1 - (100.0)       STRENGTH-I Concrete Flexure       As Requested         Truck + Lane       LRFR       Legal       3960.00       99.000       0.00       1 - (00.0)       STRENGTH-I Concrete Flexure <td>Line Inspire rooms of yre       Single rating level per row         Live Load Type       Rating Method       Rating Level       Load Rating (Ton)       Rating Factor (H)       Location Span-(%)       Limit State       Impact       Lane         Truck + Lane       LRFR       Inventory       31.39       0.872       77.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Truck + Lane       LRFR       Operating       40.69       1.130       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         (Fruck Pair + Lane)       LRFR       Operating       36.95       1.026       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Tandem + Lane       LRFR       Operating       36.95       1.026       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Tandem + Lane       LRFR       Operating       49.11       1.364       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Tandem + Lane       LRFR       Operating       49.11       1.364       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       A</td>	Line Inspire rooms of yre       Single rating level per row         Live Load Type       Rating Method       Rating Level       Load Rating (Ton)       Rating Factor (H)       Location Span-(%)       Limit State       Impact       Lane         Truck + Lane       LRFR       Inventory       31.39       0.872       77.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Truck + Lane       LRFR       Operating       40.69       1.130       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         (Fruck Pair + Lane)       LRFR       Operating       36.95       1.026       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Tandem + Lane       LRFR       Operating       36.95       1.026       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Tandem + Lane       LRFR       Operating       49.11       1.364       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       As Requested         Tandem + Lane       LRFR       Operating       49.11       1.364       75.00       1-(100.0)       STRENGTH-I Concrete Flexure       As Requested       A

## Specification Check Detail

The ratings displayed in the **Rating Results Summary** come from the rating specification articles that are processed during analysis. All specification check articles can be reviewed by clicking the **Specification Check Detail** button on the **Results** group of the **DESIGN/RATE** ribbon which opens the **Specification Check** window as shown below.



To review the flexure ratings at the 75.0 ft location, navigate to the **Stage 3** specification check detail for the analyzed member alternative, select the **Span 1 – 75.00 ft** point of interest, and then double-click on article **6A.4.2.1** 

**General Load Rating Equation – Concrete Flexure**. This opens the **Spec Check Detail** window (see Figure 1) which shows the details of how the ratings were calculated. It is worth noting that since moment redistribution was not considered, the moment increments (DeltaM) for dead plus adjacent vehicle load (DL+AdjLL) and primary vehicle with impact (LL+I) are not available and they do not affect the rating factors (RF).

uput: vodition Factor : Moment (Ma : Moment (Mi : Moment (Mi : Moment (Mi :-WS Moment :-WS Moment :	tor = = x) = x) = x) = (Max) = (Min) = re Moment = X * Mn - Ga		(kip-ft) (kip-ft) (kip-ft) (kip-ft) (kip-ft) (kip-ft) DC - GammaI	DW ★ M_DW -	Stage 3 GammaDW_WS			ase * M_se	- GammaAc	ij_LL * M_Adj	_LL + Delta	M(DL+AdjLL)					
ndition Fac stem Factor Moment (Ma Moment (Mi Moment (Mi Hows Moment Hows Moment more Positi Phi *	1) = (X) = (Max) = (Min) = ye Moment = (X * Mn - Ga	-104.9793 ( 0.0000 ( 0.0000 ( 0.0000 ( 0.0000 ( = No	(kip-ft) (kip-ft) (kip-ft) (kip-ft) (kip-ft) DC - GammaI					ase * M_se	- GammaAc	ij_LL * M_Adj	_LL + Delta	M(DL+AdjLL)					
Moment (Mi Moment (Ma Moment (Mi N-WS Moment M-WS Moment phore Positi Phi *	1) = (X) = (Max) = (Min) = ye Moment = (X * Mn - Ga	-104.9793 ( 0.0000 ( 0.0000 ( 0.0000 ( 0.0000 ( = No	(kip-ft) (kip-ft) (kip-ft) (kip-ft) (kip-ft) DC - GammaI					ase * M_se	- GammaAc	ij_LL * M_Adj	_LL + Delta	M(DL+AdjIL)					
Phi *	K * Mn - Ga	ammaDC * M_D	DC - GammaI					ase * M_se	- GammaAd	ij_LL * M_Adj	_LL + Delta	M(DL+AdjLL)					
RF =																	
				Gi			Larl(LL+I)										
		as been over istance is c					verride pl	hi*overrid	e capacity	1.							
o o nez w z			oompuoed ut	, ber oue p													
					Long	Factors					Overn	ide					
	Load L:			Adj.										DeltaM	DeltaM		
ad	Combo St	(	LL (kip-ft)		DC		DW-WS	LL		Mn (kip-ft)		Mn kip-ft)	K	DL+AdjLL (kip-ft)	LL+I (kip-ft)	RF	Capa (T
			84.75		1.25	1.50	1.50	1.75	1.00	459.84			1.00			3.986	14
esignInv	1 S1					1.50		1.75		-1213.95 -1213.95			1.00			0.872 NA	
	1 ST 1 ST	FR-I			1.25	1.50	1.50	1.35	0.90	-1213.95			1.00			1,130	
signInv signInv signOp signOp	1 ST 1 ST 1 ST 1 ST	TR-I TR-I TR-I	84.75 -629.99			1 50		1.75	0.90	-1213.95			1.00				
signInv signInv signOp signOp signInv	1 ST 1 ST 1 ST 1 ST 2 ST	<mark>[R-I</mark> [R-I [R-I [R-I	84.75 -629.99 69.58		1.25	1.50			0.90							NA	
signInv signInv signOp signOp signInv signInv	1 51 1 51 1 51 1 51 2 51 2 51 2 51	<b>FR-I</b> FR-I FR-I FR-I FR-I	84.75 -629.99 69.58 -522.04		1.25 1.25 1.25			1.75		-1213.95			1.00			NA 1.052	
signInv signInv signOp signOp signInv signInv signInv	1 51 1 51 1 51 1 51 2 51 2 51 2 51 2 51	[R-I [R-I [R-I [R-I [R-I [R-I	84.75 -629.99 69.58 -522.04 69.58		1.25	1.50			0.90	-1213.95			1.00			NA 1.052 NA	
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signInv signOp signOp signInv signInv signInv signOp signOp signInv	1 51 1 51 1 51 2 51 2 51 2 51 2 51 3 51	TR-I TR-I TR-I TR-I TR-I TR-I TR-I TR-I	84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00		1.25 1.25 1.25	1.50 1.50 1.50	1.50 1.50 1.50	1.35 1.35 1.75	0.90	-1213.95 -1213.95 -1213.95 -1213.95			1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000	35
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signInv signOp signOp signInv signInv signInv signOp signOp signInv signInv signOp	1 51 1 51 1 51 2 51 2 51 2 51 2 51 3 51 3 51 3 51	FR-I FR-I FR-I FR-I FR-I FR-I FR-I FR-I FR-I	84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86		1.25 1.25 1.25	1.50 1.50 1.50 1.50 1.50	1.50 1.50 1.50 1.50 1.50 1.50	1.35 1.35 1.75 1.75 1.35 1.35	0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95			1.00 1.00 1.00 1.00	·		NA 1.052 NA 1.364 99.000	35
signInv signOp signOp signOp signInv signInv signInv signInv signInv signInv signOp signOp	1 57 1 57 1 57 2 57 2 57 2 57 2 57 3 57 3 57 3 57 3 57 3 57 3 57	FR-I FR-I FR-I FR-I FR-I FR-I FR-I FR-I FR-I	84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86		1.25 1.25 1.25 1.25 1.25 1.25	1.50 1.50 1.50 1.50 1.50	1.50 1.50 1.50 1.50 1.50 1.50	1.35 1.35 1.75 1.75 1.35 1.35	0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95			1.00 1.00 1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000 0.792 99.000	35
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signInv signInv signOp signOp signInv signInv signInv signInv signInv signInv signInv signAp signRot- galSpec~	1 57 1 57 1 57 2 57 2 57 2 57 3 57 3 57 3 57 4 57 4 57 5 57	I           IR-I           IR-I <td>84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 74.61</td> <td>  </td> <td>1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25</td> <td>1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50</td> <td>1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.50</td> <td>1.35 1.35 1.75 1.35 1.35 1.35 1.30 1.30 1.30</td> <td>0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90</td> <td>-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95</td> <td>     </td> <td></td> <td>1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00</td> <td></td> <td>    </td> <td>NA 1.052 NA 1.364 99.000 1.026 99.000 99.000 NA</td> <td>35 35 39 39</td>	84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 74.61	  	1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.50	1.35 1.35 1.75 1.35 1.35 1.35 1.30 1.30 1.30	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95	     		1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00		    	NA 1.052 NA 1.364 99.000 1.026 99.000 99.000 NA	35 35 39 39
signInv signInv signOp signInv signInv signInv signInv signOp signInv signOp signRout~ galRout~ galSpec~ galSpec~	1 51 1 51 1 51 2 51 2 51 2 51 2 51 3 51 3 51 3 51 4 51 5 51 5 51	(R-I (R-1 (R-1))))))))))))))))))))))))))))))))))))	84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 0.00 0.00 74.61 -480.38		1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.50	1.35 1.35 1.75 1.35 1.35 1.30 1.30 1.30 1.30	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95	      		1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000 0.792 99.000 1.026 99.000 99.000 99.000 NA 1.539	35 35 39 39
signInv signInv signOp signOp signInv signInv signOp signInv signOp signOp signOp signOp signOp signOp signOp signOp signOp signOp signOp signSpec~ galRout~	1 51 1 51 1 51 2 51 2 51 2 51 2 51 3 51 3 51 3 51 4 51 5 51 6 51 6 51 6 51 6 51 6 51 5 51 6 51 6 51 6 51 6 51 6 51 6 51 6 51 7 51	R-I           IR-I	84.75 -629.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 -693.86 0.00 74.61 -480.38 46.97		1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.50	1.35 1.35 1.75 1.35 1.35 1.30 1.30 1.30 1.30 1.30	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95	       		1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000 1.026 99.000 99.000 99.000 NA 1.539 NA	35 35 39 39
signInv signInv signOp signOp signInv signInv signInv signInv signInv signOp signInv signOp signRout~ sgalRout~ sgalSpec~ sgalRout~	1 57 1 57 2 57 2 57 2 57 2 57 3 57 3 57 4 57 5 57 6 57 6 57	R-I (R-1 (R-1))))))))))))))))))))))))))))))))))))	84.75 -62.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 -693.86 0.00 74.61 -480.38 46.97 -301.82		1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.50	1.35 1.35 1.75 1.35 1.35 1.30 1.30 1.30 1.30 1.30 1.30	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95	       		1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000 1.026 99.000 99.000 NA 1.539 NA 2.450	35 35 39 39
signInv signInv signOp signInv signInv signInv signOp signInv signOp signInv signOp signRout~ sgalRout~ sgalRout~ sgalRout~ sgalRout~	1 57 1 57 1 57 2 57 2 57 2 57 3 57 3 57 3 57 4 57 5 57 5 57 6 57 6 57 7 57 7 57	IR-I	84.75 -629.99 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 74.61 -480.38 46.97 -301.82 49.77		1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.50	1.35 1.35 1.75 1.35 1.35 1.30 1.30 1.30 1.30 1.30 1.30 1.30	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95			1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000 1.026 99.000 99.000 NA 1.539 NA 2.450 NA	35 35 39 39
signInv signInv signOp signOp signInv signInv signInv signInv signInv signOp signInv signOp signRout~ sgalRout~ sgalSpec~ sgalRout~	1 51 1 55 1 55 2 51 2 51 2 51 2 51 2 51 2 51 3 51 3 51 3 51 5 51 5 51 6 51 7 51 7 51 8 51 7 51 8 51 7 51 8 51 7 51 8 51 7 51 8 51 7 51 8 51	R-I (R-1 (R-1))))))))))))))))))))))))))))))))))))	84.75 -62.99 69.58 -522.04 69.58 -522.04 0.00 -693.86 0.00 -693.86 0.00 -693.86 0.00 74.61 -480.38 46.97 -301.82		1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	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 1.50	1.35 1.35 1.75 1.35 1.30 1.30 1.30 1.30 1.30 1.30 1.30 1.30	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	-1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95 -1213.95		      	1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00			NA 1.052 NA 1.364 99.000 1.026 99.000 99.000 NA 1.539 NA 2.450	35 35 39 39

6 Type 3 - Legal Truck 7 Type 3-3 - Legal Truck 8 Type 3S2 - Legal Truck

Figure 1 – 6A.4.2.1 Concrete Flexure General

# LRFR Rating with Moment Redistribution

Select the control option to allow moment redistribution as shown in <u>Member Alternative Description – Control</u> options and rerun the analysis as shown in <u>LRFR Rating</u>. During analysis with the moment redistribution allowed, the program displays information and warnings about applying moment redistribution to the bending moments for the considered live load types. As shown in the screenshot below, moment redistribution was applied to the HL-93 – Truck + Lane vehicular load and the load rating for this load may improve. For the HL-93 – 90% (Truck Pair + Lane) load, however, moment redistribution could not be applied which means load rating for this load will not improve.

Analysis	
Analysis - 48" PS Box	~
<ul> <li> <sup>(2)</sup> Analysis Event         <sup>(2)</sup> 48" PS Box         <sup>(2)</sup> <sup>(2)</sup></li></ul>	<ul> <li>STACE 3</li> <li>Thio - Moment redistribution for Type 3:52 - Legal Truck at LegalRoutine rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for Type 3 - Legal Truck at LegalRoutine rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for NPR 3 - Legal Truck at LegalRoutine rating level and StrengthI limit state.</li> <li>Info - Moment redistribution cannot improve critical LegalRoutine rating for Lane-Type Legal Load - Legal Truck + Lane because it is powrned by positive flexure.</li> <li>Warning - Moment redistribution cannot improve rating for Lane-Type Legal Load - Legal Truck + Lane because it is powrned by positive flexure.</li> <li>Warning - Moment redistribution cannot improve rating for Lane-Type Legal Load - Legal Truck + Lane because it is powrned by positive flexure.</li> <li>Warning - Moment redistribution cannot improve rating for HL-93 (US) - 90% (Truck Pair + Lane at LegalRoutine rating level.</li> <li>Warning - Moment redistribution cannot improve rating for HL-93 (US) - Tandem + Lane at Designal v rating level.</li> <li>Info - Moment redistribution for HL-93 (US) - Tandem + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tandem + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tandem + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tandem + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tandem + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tande + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tande + Lane at DesignOp rating level and StrengthI limit state.</li> <li>Info - Moment redistribution for HL-93 (US) - Tande + Lane at DesignOp rating level an</li></ul>
	Image: Stream       Description         Type       Description         A Warning - Superstructure definition humidity and System Default humidity is not entered. Default value of 60% will be used.         A Warning - Reaction Distribution Factors are averaged from the Shear Distribution Factors!         A Warning - Fatigue vehicle LRFD Fatigue Truck (US) is not applicable for prestressed concrete members.         A Warning - Moment redistribution cannot improve critical LegalRoutine rating for Lane-Type Legal Load - Legal Truck + Lane because it is governed by positive flexure.         A Warning - Softwe region moments are not considered for HL-93 (US) = 70%(Truck Pair + Lane). Moment redistribution cannot improve critical DesignInv rating for HL-93 (US) = Tandem + Lane because it is not governed by flexure.         A Warning - Moment redistribution cannot improve rating for HL-93 (US) - Tandem + Lane at DesignInv rating level.
	Close

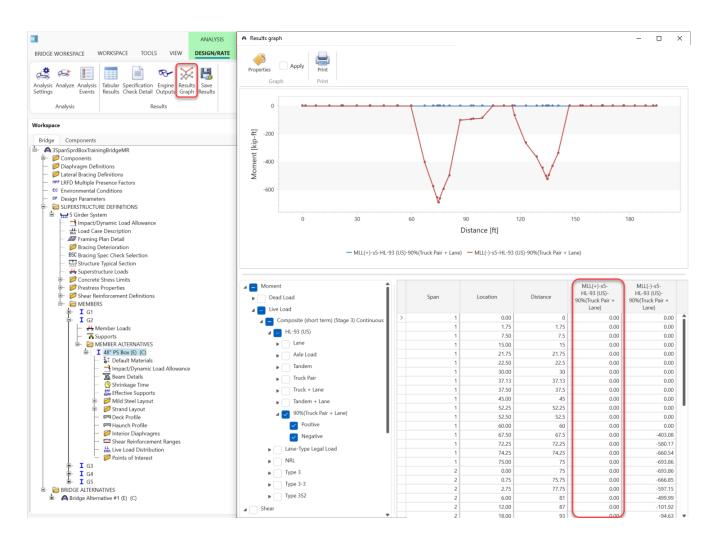
The new **Rating Results Summary** with moment redistribution allowed is as shown below and it can be observed that the critical rating factor for the HL-93 Truck + Lane load at inventory level increased with moment redistribution to 0.913 from 0.872 without moment redistribution. However, the new factor is now at a different location and due to SERVICE-III PS Tensile Stress and not due to STRENGTH-I Concrete Flexure. This means that tensile stress now controls for this load combination and the rating factor due to flexure is even higher which will be verified by reviewing the flexure rating article in <u>Specification Check Detail with Moment Redistribution</u>.

Print Print											
port type: ating Results Summary	Lane/Impact			splay Format ingle rating lev	el per row	~					
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	33.51	0.931	37.13	1 - (49.5)	SERVICE-III PS Tensile Stress	As Requested	As Requested	
HL-93 (US)	Truck + Lane	LRFR	Operating	52.25	1.451	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Inventory	28.50	0.792	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
HL-93 (US)	90%(Truck Pair + Lane)	LRFR	Operating	36.95	1.026	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
HL-93 (US)	Tandem + Lane	LRFR	Inventory	37.78	1.049	37.13	1 - (49.5)	SERVICE-III PS Tensile Stress	As Requested	As Requested	
HL-93 (US)	Tandem + Lane	LRFR	Operating	61.32	1.703	37.13	1 - (49.5)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Lane-Type Legal Load	Truck + Lane	LRFR	Legal	3960.00	99.000	0.00	1 - (0.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
NRL	Axle Load	LRFR	Legal	72.91	1.823	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Type 3	Axle Load	LRFR	Legal	71.59	2.864	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Type 3-3	Axle Load	LRFR	Legal	102.51	2.563	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
Type 3S2	Axle Load	LRFR	Legal	91.12	2.531	75.00	1 - (100.0)	STRENGTH-I Concrete Flexure	As Requested	As Requested	
SHTO LRFR Engine Versio										, <u> </u>	

For the HL-93 – 90% (Truck Pair + Lane) load at the inventory level, moment redistribution could not be applied, and the rating remained the same at 0.792. This is because moment redistribution reduces negative moments over supports at the expense of increasing positive midspan moments. Since vehicular loads consisting of truck pair and lane load are only considered for negative bending moments, it is not possible to determine the increase of positive midspan moments and moment redistribution cannot be applied.

To confirm that only negative moments are considered for the HL-93 - 90% (Truck Pair + Lane) load, display the bending moment diagram using the **Results Graph** window as shown below.

### Moment Redistribution in Three Span Spread PS Box Beam



# Specification Check Detail with Moment Redistribution

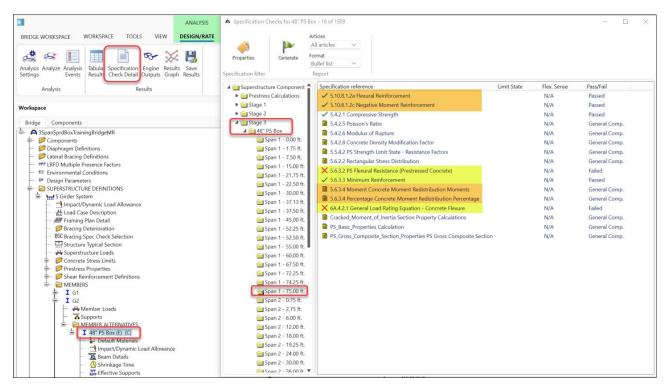
When the control option to allow moment redistribution is selected by the user, the program processes the following additional specification check articles during analysis:

- 5.10.8.1.2a Flexural Reinforcement (in negative moment regions)
- 5.10.8.1.2c Negative Moment Reinforcement (at support locations)
- 5.6.3.4 Moment Redistribution Percentage (at support locations)
- 5.6.3.4 Maximum Allowable Moment Redistribution Moments (at support locations)

As described in AASHTO LRFD/LRFR Superstructure Method of Solution Manual, these articles (highlighted in orange in the screenshot below) check if requirements for applying moment redistribution are satisfied and determine the maximum value of moment redistribution that can occur at support locations. Based on the support values and the redistribution optimization procedure, moment increments (denoted DeltaM) are interpolated at each POI between supports and applied to bending moments in the following specification check articles (highlighted in yellow in the screenshot below):

- 5.6.3.2 Flexural Resistance
- 5.6.3.3 Minimum Reinforcement
- 6A.4.2.1 General Load-Rating Equation Concrete Flexure

Open each of the highlighted articles and review their contents.



To verify that the flexure load rating factor increased for HL-93 Truck + Lane load at inventory level, open the article titled **6A.4.2.1 General Load-Rating Equation – Concrete Flexure** (see Figure 2). On the second row in

the table, the rating factor is now 1.120 which is an increase of 0.248 (28%) from the initial value of 0.872. This increase is due to the DeltaM moment increments which are the result of moment redistribution.

Since moment redistribution does not apply to the HL-93 - 90% (Truck Pair + Lane) vehicle, the DeltaM values for that vehicle are not calculated and its rating factor at the inventory level stayed the same at 0.792 with and without moment redistribution.

Spec Check Detail for 6A.	4.2.1 General Load	Rating Equation - Concrete	Flexure
6A Load and Resistan		ing	
6A.4 Load Rating Pr			
6A.4.2 General Load			
6A.4.2.1 Concrete F	lexure General		
(AASHTO Manual for 1	Bridge Evaluat:	ion, Third Edition w:	ith 2023 Interims)
PS Box Rect Void - A	At Location = '	75.0000 (ft) - Left	Stage 3
Input:			
Condition Factor	= 1.0000		
System Factor	= 1.0000		
System Factor DC Moment (Max)	= -104.9793	(kip-ft)	
DC Moment (Min)	= -104.9793	(kip-ft)	
DW Moment (Max)			
DW Moment (Min)			
DW-WS Moment (Max)			
DW-WS Moment (Min)		(Kip-IC)	
Ignore Positive Mom	ent = NO		

Note: If the capacity has been overridden, the Resistance is computed as override phi\*override capacity. Otherwise the Resistance is computed as per the Specification.

	Load	Limit		Adj.	Load	i Factors					Ove	rride		DeltaM	DeltaM		
Load	Combo	State	LL (kip-ft)	LL (kip-ft)	DC	DW	DW-WS	LL	Phi	Mn (kip-ft)	Phi	Mn (kip-ft)	ĸ	DL+AdjLL (kip-ft)	LL+I (kip-ft)	RF	Capacity (Ton)
DesignInv	1	STR-I	84.75		1.25	1.50	1.50	1.75	1.00	459.84			1.00	26.24	220.50	1 532	55.13
DesignInv	1	STR-I	-629.99		1.25	1.50	1.50	1.75	0.90	-1213.95			1.00	26.24	220.50	1.120	40.31
DesignOp	1	STR-I	84.75		1.25	1.50	1.50	1.35	1.00	459.84			1.00	26.24	170.10	1.985	71.47
DesignOp	1	STR-I	-629.99		1.25	1.50	1.50	1.35	0.90	-1213.95			1.00	26.24	170.10	1.451	52.25
DesignInv	2	STR-I	69.58		1.25	1.50	1.50	1.75	0.90	-1213.95			1.00			NA	NA
DesignInv	2	STR-I	-522.04		1.25	1.50	1.50	1.75	0.90	-1213.95			1.00			1.052	37.88
DesignOp	2	STR-I	69.58		1.25	1.50	1.50	1.35	1.00	459.84			1.00	23.58	126.64	2.573	92.62
DesignOp	2	STR-I	-522.04		1.25	1.50	1.50	1.35	0.90	-1213.95			1.00	23.58	126.64	1.704	61.33
DesignInv	3	STR-I	0.00		1.25	1.50	1.50	1.75	0.90	-1213.95			1.00			99 000	3564.00
DesignInv	3	STR-I	-693.86		1.25	1.50	1.50	1.75	0.90	-1213.95			1.00			0.792	28.50
DesignOp	3	STR-I	0.00		1.25	1.50	1.50	1.35	0.90	-1213.95			1.00			99.000	3564.00
DesignOp	3	STR-I	-693.86		1.25	1.50	1.50	1.35	0.90	-1213.95			1.00			1.026	36.95
LegalRout~	4	STR-I	0.00		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00			99.000	3960.00
LegalRout~	4	STR-I	0.00		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00			99.000	3960.00
LegalSpec~	5	STR-I	74.61		1.25	1.50	1.50	1.30	1.00	459.84			1.00	18.30	87.09	3.112	124.46
LegalSpec~	5	STR-I	-480.38		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00	18.30	87.09	1.823	72.91
LegalRout~	6	STR-I	46.97		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00	16.97	50.73	NA	NA
LegalRout~	6	STR-I	-301.82		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00	16.97	50.73	2.864	71.59
LegalRout~	7	STR-I	49.77		1.25	1.50	1.50	1.30	1.00	459.84			1.00	26.24	96.34	3.507	140.29
LegalRout~	7	STR-I	-370.52		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00	26.24	96.34	2.563	102.51
LegalRout~	8	STR-I	53.25		1.25	1.50	1.50	1.30	1.00	459.84			1.00	26.24	97.54	3.387	121.93
LegalRout~	8	STR-I	-375.16		1.25	1.50	1.50	1.30	0.90	-1213.95			1.00	26.24	97.54	2.531	91.12

Legend: NA. Resistance and live load are of opposite sign so rating factor is not applicable.  $\ast$  - Positive moment rating ignored.



Figure 2 - 6A.4.2.1 General Load-Rating Equation - Concrete Flexure

The flexural resistance article (see Figure 3) is also affected by moment redistribution through moment increments DeltaMu. For HL-93 Truck + Lane load at inventory level, the Mr/Mu ratio with moment redistribution is equal to:

$$\frac{M_r}{M_u} = \frac{-1092.55}{-1233.71 + 246.74} = 1.107$$

which is an increase from the ratio without moment redistribution that is equal to:

$$\frac{M_r}{M_u} = \frac{-1092.55}{-1233.71} = 0.886$$

In negative moment regions, moment redistribution can potentially increase flexure rating factor and design ratios, but it is worth remembering that in positive moment regions the rating factors and design ratios may decrease due to moment redistribution as the moment increments DeltaM will increase the positive moments. The design ratios for the HL-93 - 90% (Truck Pair + Lane) vehicle are unchanged as moment redistribution does not apply to this vehicle and DeltaMu increments are not calculated.

The increments are also not calculated for any load combination under the SER-III limit state because moment redistribution applies only to the strength limit states.

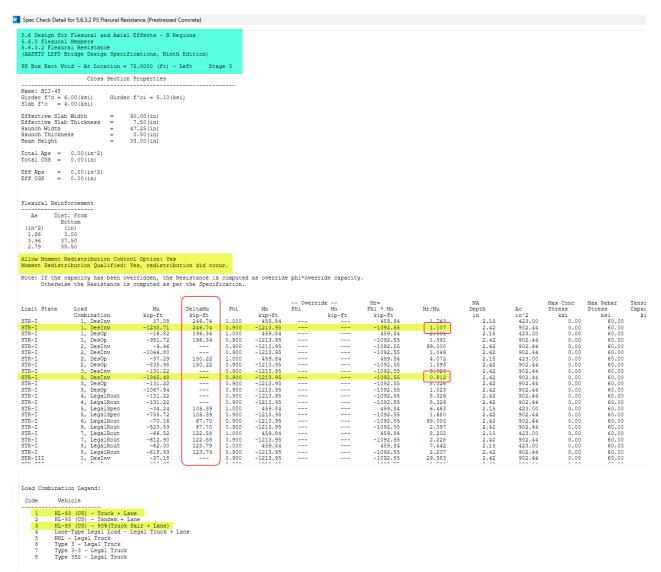


Figure 3 – 5.6.3.2 Flexural Resistance

One more specification check article affected by moment redistribution is the minimum reinforcement article (see Figure 4). When moment redistribution is applied to Mu through the DeltaMu increment, the Mr/MrMin ratio may change if MrMin is governed by Mr2 which in turn is equal to 1.33 Mu.

R = MrMin
1.311 Pass 1.296 Pass
1.926 Pass 1.296 Pass
86.856 Pass 1.296 Pass 3.062 Pass
1.296 Pass 6.260 Pass
1.296 Pass 6.260 Pass
1.296 Pass 6.260 Pass
6.260 Pass 4.859 Pass 1.296 Pass
1.250 Pass 333.283 Pass 1.802 Pass
6.167 Pass 1.675 Pass
5.596 Pass 1.659 Pass
22.093 Pass 1.349 Pass
16.658 Pass 1.572 Pass
7.825 Pass 1.296 Pass
7.825 Pass 7.825 Pass 27.045 Pass
1.403 Pass 14.161 Pass
2.019 Pass 14.880 Pass
1.728 Pass 15.880 Pass 1.711 Pass

Figure 4 – 5.6.3.3 Minimum Reinforcement

All specification check articles affected by moment redistribution are related to flexure only because moment redistribution does not apply to shear effects. In the bridge model considered in this tutorial, shear effects are

ignored, and no shear related articles are shown but even if shear was not ignored and shear articles were processed, they would not be affected by moment redistribution.

The additional specification check articles processed only when the moment redistribution is allowed by the user are shown in Figure 5 through Figure 8. Open each article and review its contents.



Figure 5 - 5.10.8.1.2a Flexural Reinforcement

The articles shown in Figure 5 and Figure 6 check several reinforcement requirements that must pass for moment redistribution to be applied. For instance, in the negative moment reinforcement article (Figure 6), the required length of the reinforcement on the right side of the first interior support is calculated to be 28.881 ft which is almost half of the 60.0 ft span between interior supports. Since the reinforcement in the original imported bridge model extended only 15.0 ft from the support, the reinforcement length had to be adjusted. Otherwise, the length check would fail, and redistribution would not be applied at all.

### Moment Redistribution in Three Span Spread PS Box Beam

Spec Check Detail for 5.10.8.1.2c Negative Moment Reinforcement

.10.8.1 Ger .10.8.1.2 H .10.8.1.2c	eral lexural Negative	and Splices o: Reinforcement Moment Rein: Design Speci:	t forcement		on)				
S Box Rect	Void - 7	At Location =	75.0000 (	ft) - Left	Stage 3				
	epth length Inflecti		3.96(ft)						
		tension = Ma ngth = (1							
f (Sum of T Then <pa< th=""><th></th><th>As with Requi: (LeftTerm)</th><th></th><th></th><th>&gt;= (AsTensi &gt;= (Right</th><th></th><th>en <pass></pass></th><th></th><th></th></pa<>		As with Requi: (LeftTerm)			>= (AsTensi >= (Right		en <pass></pass>		
	Bar Size	Bar Diameter (in)		Number of Bars			Extension		Length
37.50	6 5	0.75	0.44	9.00	3.96	20.000	4.641 4.641		
verall Dept ffective De lear Span I	h epth ength Inflecti	= 3 = 5 ion Point = 2	1.00(in) 6.67(in) 8.50(ft) 5.22(ft) .75(in^2) ax(Effecti	ve Depth, 1/	16 * Clear	Span Lengt			
			red Length	Catiofied)	>= (AsTonsi	ion (3) Th	en <pass></pass>		
op Bar Requ	-	As with Requi: (LeftTerm)			>= (Right				
op Bar Requ f (Sum of T Then <pa Dist. From Bottom</pa 	Bar		Bar Area	Number	>= (Right	Length	Extension	Required Length (ft)	Length

#### Figure 6 - 5.10.8.1.2c Negative Moment Reinforcement

Spec Che	ck Detail for 5.6.3.4 Per	centage Concret	e Moment Redis	tribution Percentag	e			
5.6 DESI 5.6.3 F1 5.6.3.4 1 (AASHTO	te Structures GN FOR FLEXURAL A exural Members Moment Redistribu LRFD Bridge Desig ect Void - At Loc	tion Percent m Specificat	age - At Sup ions, Ninth	port Location Edition)	3			
If Et >=	1.5Etl and Flexu moment reduction	re Type is N	eg, moment r	edistribution				
Minimum	value of left sid	e MRP and ri	ght side MRP	will be used	as MRP on b	oth sides	of this	support.
Limit State		Maxi Negat exure Mu Type (kip-	ive	Etl	1.5Etl	Redist. Can occur?		Maximum Reduction Percentage (%)
STR-I STR-I STR-I STR-I	2, DesInv	Neg -98	1.72 0.043	538 0.005	0.0075 0.0075 0.0075 0.0075	Yes	43.54 43.54 43.54 43.54	20.00
STR-I STR-I STR-I STR-I	3, DesInv 3, DesOp 4, LegalR~ 5, LegalS~	Neg -134 Neg -106 Neg -13 Neg -75		538 0.005 538 0.005 538 0.005	0.0075 0.0075 0.0075 0.0075	Yes Yes Yes	43.54 43.54 43.54 43.54	20.00 20.00
	6, LegalR~ 7, LegalR~ 8, LegalR~	Neg -61	3.59 0.043 2.90 0.043 8.93 0.043	538 0.005	0.0075 0.0075 0.0075	Yes	43.54 43.54 43.54	20.00
Load Com	bination Legend:							
Code	Vehicle							
1 2 3 4 5 6 7 8	HL-93 (US) - Tr HL-93 (US) - Ta HL-93 (US) - 90 Lane-Type Legal NRL - Legal Tru Type 3 - Legal Type 3-3 - Lega Type 352 - Lega	ndem + Lane %(Truck Pair Load - Lega ck Truck 1 Truck		ne				



In the moment redistribution percentage article (Figure 7), strain requirements are checked to determine if moment redistribution can be applied. Also, the maximum percentages of moment reduction at supports are calculated. Based on the percentages, the maximum moment increments (DeltaM) at supports are calculated in the maximum allowable moment redistribution moments article (Figure 8).

# Moment Redistribution in Three Span Spread PS Box Beam

🔐 Spec Check Detail for 5.6.3.4 Moment Concrete Moment Redistribution Moments

6 DESIGN 6.3 Flex 6.3.4 Ma	e Structures I FOR FLEXURAL tural Members eximum Allowab RFD Bridge Des	le Moment I	Redistribu	tion Momen	ts - At Sup	port Locati	on						
	rt Void - At L												
DW = DW-WS = PT =	-104.98 kip-ft 0.00 kip-ft 0.00 kip-ft 0.00 kip-ft 0.00 kip-ft	t											
imit tate	Load Combo												
TTR-I TTR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	1, DesInv 1, DesOp 2, DesOp 3, DesInv 3, DesOp 4, LegalR~ 5, LegalR~ 7, LegalR~ 8, LegalR~				0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0								
imit State	Lond Combo	DC	TK4	DG_52	<b>CT</b>	DT		7.di	LL				
STR-I STR-I		1.25 1.25 1.25 1.25 1.25 1.25 1.25 1.25	1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	0 1. 0 1.	50         0.           50         0.      50         0.	00         0.           00         0.	00         1           00         1           00         1           00         1           00         1           00         1           00         1           00         1           00         1           00         1           00         1           00         0           00         1           00         0           00         1           00         1           00         1           00         1           00         1	75 35 75 35 35 30 30 30 30 30 30 30 30 30 30 30 30 30					
ax_Delta_ here: RP = maxi = elas	M = -MRP * M mum reduction tic moment du	percentage to applie	e ed load	ents:	DW (kip-ft)		Unfactored	Max Delta	м		AdjLL	Factored M DL+AdjLL	iax_Delta_M LL+I
State	Load Combo	Туре	(%)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-	ft) (k	(ip-ft)	(kip-ft)	(kip-ft)
STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I STR-I	1, DesInv 1, DesOp 2, DesInv 2, DesOp 3, DesInv 3, DesOp 4, LegalR- 5, LegalS- 6, LegalR- 8, LegalR-	Neg Neg Neg Neg Neg Neg Neg Neg Neg	20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00 20.00	21.00 21.00 21.00 21.00 21.00 21.00 21.00 21.00 21.00 21.00 21.00			0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00		0 12: 0 12: 0 10: 0 10: 0 10: 13: 0 13: 0 9: 0 9: 0 6: 0 7: 0 7: 0 7:	6.00 4.41 4.41 8.77 8.77 0.00 6.08 0.36 4.10 5.03		26.24 26.24 26.24 26.24 26.24 26.24 26.24 26.24 26.24 26.24 26.24	242.85 187.34 0.00 124.90 78.47 96.34
oad Combi	nation Legend	:											
	Vehicle	_											
2 3 4 5 6	HL-93 (US) - HL-93 (US) - HL-93 (US) - Lane-Type Leg NRL - Legal T Type 3 - Lega Type 3-3 - Le Type 3S2 - Le	Tandem + La 90%(Truck I al Load - I ruck 1 Truck gal Truck gal Truck	ane Pair + Lan	e) k + Lane									

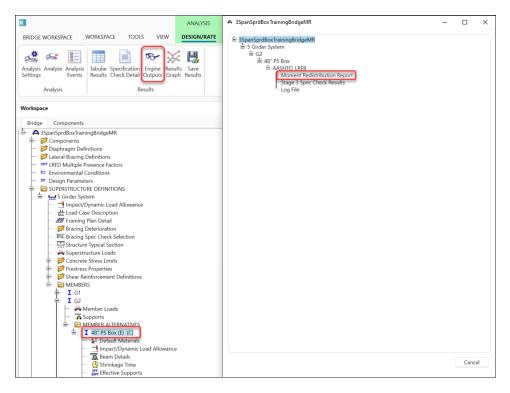
Figure 8 - 5.6.3.4 Maximum Allowable Moment Redistribution Moments

The actual amount of moment redistribution applied for each vehicle is reported in the Moment Redistribution

**Report** discussed in the next section.

# Moment Redistribution Report

Detailed information about the amount of moment redistribution applied for each vehicle at each location and how moment redistribution affects the flexure rating factors is available in the **Moment Redistribution Report**. To view the report, click on the **Engine Output** button located on the **Results** group of the **DESIGN/RATE** ribbon and then double-click on the **Moment Redistribution Report** item in the tree showing the available engine output files as shown in the screenshot below.



The report is a text file, and it will be open in the default text viewer. The format of the report file is shown in Figure 9 and Figure 10 which include locations from the first span for selected vehicles. Highlighted in the figures are the controlling rating factors before and after moment redistribution, and the percentages of applied moment redistribution at the first interior supports.

For the HL-93 Truck + Lane vehicle (Figure 9), the applied redistribution percentage at Support 2 (first interior support) is 20% which is equal to the maximum redistribution percentage. This is because even when the maximum redistribution percentage is applied, the minimum negative flexure rating factor is still smaller than the positive flexure rating factor, so it is beneficial overall to apply as much redistribution as allowed.

On the other hand, for the Type 3 Legal Truck vehicle (Figure 10), the applied redistribution percentage at Support 2 (first interior support) is 12.93% which is smaller than the maximum redistribution percentage of 20%. This is because if the maximum redistribution percentage was applied the minimum positive flexure rating factor would become smaller than the negative flexure rating factor. In other words, too much redistribution would be applied and the detrimental effect of moment redistribution in the positive flexure would exceed the beneficial effect in negative flexure. In such cases, the program attempts to optimize the amount of applied moment redistribution by reducing

the applied redistribution percentages at supports so that the rating factors in positive and negative flexure after moment redistribution are equal. Reducing the applied redistribution percentage to 12.93% achieves this goal and both positive and negative flexure rating factors after moment redistribution are equal to 2.864 which is an increase of 0.414 (16.9%) from the controlling negative flexure rating factor before moment redistribution of 2.450.

MomentRe File Edit Fo	distributionRep		otepad											
			L-93 (US) -	Truck + La	ne at Desi	gn Inventor	y rating lev	/el and Stren	gthI limit	state.				
						5	, ,		0					
Before mom				4 050										
			rating fact rating fact											
After mome				01 0.872	@ 75.000 T									
			rating fact	or = 1.151	@ 37.125 f	t								
			rating fact											
			0					Max	Appli	ed				
					Percent		Re	distribution	Redistrib	ution				
Location						DL+AdjLL	LL+I	Percentage	Percent	age				
(ft)	Support		Span	(ft)			(kip-ft)	(%)	(%)					
0.00		Right	1	0.000	0.000	0.00	0.00	0.000		0.000				
75.00		Left	1	75.000	100.000	-131.22	-1102.49	20.000		0.000				
75.00 135.00		Right Left	2	0.000 60.000	0.000 100.000	-131.22 -80.87	-1102.49 -807.27	20.000 20.000		0.000 0.000				
135.00		Right	2	0.000	0.000	-80.87	-807.27	20.000		0.000				
195.00		Left	3	60.000	100.000	0.00	0.00	0.000		0.000				
155100	• •	2010	-	001000	1001000	0.00	0.00	01000						
					Positive	Negative	Initial				Max	Max	Applied	Applied
			Location	Percent	Flexure	Flexure		Initial	Initial	Initial	Delta	Delta	Delta	Delta
Location			in Span	in Span	Capacity			DL+AdjLL	LL+I	Controlling		LL+I	DL+AdjLL	LL+I
(ft)	Side	Span	(ft)	(%)	(kip-ft)	(kip-ft)		(kip-ft)	(kip-ft)	Flexure RF	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)
0.00		1							0.00	99.000	0.00	0.00	0.00	0.00
1.75		1			1931.1 1931.1				165.56 165.56	10.826 10.826	0.61 0.61	5.14 5.14	0.61 0.61	5.14 5.14
7.50		1							629.93	3.520	2.62	22.05	2.62	22.05
7.50		1							629.93	3.520	2.62	22.05	2.62	22.05
15.00		1							1057.44	2.009	5.25	44.10	5.25	44.10
15.00		1			3095.5				1057.44	2.009	5.25	44.10	5.25	44.10
21.75		1			3202.9	6 -54.3	2 3202.96	5 1246.07	1278.76	1.530	7.61	63.94	7.61	63.94
21.75	0 Right	1	21.750	29.000	3202.9	5 <b>0.0</b>	0 3202.96	5 1246.07	1278.76	1.530	7.61	63.94	7.61	63.94
22.50	0 Left	1	22.500	30.000	3202.9	5 0.0	0 3202.96	1270.45	1296.81	1.490	7.87	66.15	7.87	66.15
22.50		1							1296.81	1.490	7.87	66.15	7.87	66.15
30.00	0 Left	1	30.000	40.000	3202.9	5 0.0	0 3202.96	5 1446.09	1395.08	1.259	10.50	88.20	10.50	88.20

Location			in Span	in Span	Capacity	Capacity	Capacity	DL+AdjLL	LL+I	Controlling	DL+AdjLL	LL+I	DL+AdjLL	LL+I	Positive	Negative
(ft)	Side	Span	(ft)	(%)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	Flexure RF	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	Flexure RF	Flexure RF
0.000	Right	1	0.000	0.000	596.96	-87.16	596.96	0.00	0.00	99.000	0.00	0.00	0.00	0.00	99.000	99.000
1.750	Left	1	1.750	2.333	1931.13	-231.92	1931.13	138.81	165.56	10.826	0.61	5.14	0.61	5.14	10.496	99.000
1.750	Right	1	1.750	2.333	1931.13	-231.92	1931.13	138.81	165.56		0.61	5.14	0.61	5.14	10.496	99.000
7.500	Left	1	7.500	10.000	2764.96	-234.38	2764.96	547.41	629.93	3.520	2.62	22.05	2.62	22.05	3.397	99.000
7.500	Right	1	7.500	10.000	2764.96	-234.38	2764.96	547.41	629.93	3.520	2.62	22.05	2.62	22.05	3.397	99.000
15.000	Left	1	15.000	20.000	3095.55	-142.67	3095.55	970.89	1057.44		5.25	44.10	5.25	44.10	1.924	99.000
15.000	Right	1	15.000	20.000	3095.55	-142.67	3095.55	970.89	1057.44		5.25	44.10	5.25	44.10	1.924	99.000
21.750	Left	1	21.750	29.000	3202.96	-54.32	3202.96	1246.07	1278.76	1.530	7.61	63.94	7.61	63.94	1.452	99.000
21.750	Right	1	21.750	29.000	3202.96	0.00	3202.96	1246.07	1278.76		7.61	63.94	7.61	63.94	1.452	99.000
22.500	Left	1	22.500	30.000	3202.96	0.00	3202.96	1270.45	1296.81	1.490	7.87	66.15	7.87	66.15	1.412	99.000
22.500	Right	1	22.500	30.000	3202.96	0.00	3202.96	1270.45	1296.81	1.490	7.87	66.15	7.87	66.15	1.412	99.000
30.000	Left	1	30.000	40.000	3202.96	0.00	3202.96	1446.09	1395.08		10.50	88.20	10.50	88.20	1.177	99.000
30.000	Right	1	30.000	40.000	3202.96	0.00	3202.96	1446.09	1395.08		10.50	88.20	10.50	88.20	1.177	99.000
37.125	Left	1	37.125	49.500	3202.96	0.00	3202.96	1498.15	1361.17	1.252	12.99	109.15	12.99	109.15	1.151	99.000
37.125	Right	1	37.125	49.500	3202.96	0.00	3202.96	1498.15	1361.17	1.252	12.99	109.15	12.99	109.15	1.151	99.000
37.500	Left	1	37.500	50.000	3202.96	0.00	3202.96	1497.79	1357.21	1.256	13.12	110.25	13.12	110.25	1.153	99.000
37.500	Right	1	37.500	50.000	3202.96	0.00	3202.96	1497.79	1357.21	1.256	13.12	110.25	13.12	110.25	1.153	99.000
45.000	Left	1	45.000	60.000	3202.96	0.00	3202.96	1408.70	1195.36	1.501	15.75	132.30	15.75	132.30	1.340	99.000
45.000	Right	1	45.000	60.000	3202.96	0.00	3202.96	1408.70	1195.36	1.501	15.75	132.30	15.75	132.30	1.340	99.000
52.250	Left	1	52.250	69.667	3202.96	0.00	3202.96	1204.78	908.51	2.199	18.28	153.61	18.28	153.61	1.864	99.000
52.250	Right	1	52.250	69.667	3202.96	-54.32	3202.96	1204.78	908.51	2.199	18.28	153.61	18.28	153.61	1.864	99.000
52.500	Left	1	52.500	70.000	3198.98	-56.97	3198.98	1195.68	896.81	2.234	18.37	154.35	18.37	154.35	1.888	99.000
52.500	Right	1	52.500	70.000	3198.98	-56.97	3198.98	1195.68	896.81	2.234	18.37	154.35	18.37	154.35	1.888	99.000
55.000	Left	1	55.000	73.333	3159.20	-87.73	3159.20	1083.36	762.75	2.722	19.25	161.70	19.25	161.70	2.225	99.000
55.000	Right	1	55.000	73.333	3170.05	-1105.95	3170.05	1083.36	762.75	2.736	19.25	161.70	19.25	161.70	2.236	99.000
60.000	Left	1	60.000	80.000	3091.18	-1172.08	3091.18	858.73	494.63	4.513	21.00	176.40	21.00	176.40	3.296	99.000
60.000	Right	1	60.000	80.000	3091.18	-1172.08	3091.18	858.73	494.63	4.513	21.00	176.40	21.00	176.40	3.296	99.000
67.500	Left	1	67.500	90.000	2631.54	-1259.15	-1259.15	397.86	-497.68	3.329	23.62	198.45	23.62	198.45	99.000	5.617
67.500	Right	1	67.500	90.000	2944.68	-1261.62	-1261.62	397.86	-497.68	3.334	23.62	198.45	23.62	198.45	99.000	5.625
72.250	Left	1	72.250	96.333	2265.85	-1267.13	-1267.13	41.88	-861.37	1.520	25.28	212.41	25.28	212.41	99.000	2.056
72.250	Right	1	72.250	96.333	2265.85	-1267.13	-1267.13	41.88	-861.37	1.520	25.28	212.41	25.28	212.41	99.000	2.056
74.250	Left	1	74.250	99.000	826.20	-1133.46	-1133.46	-122.88	-1035.74		25.98	218.29	25.98	218.29	99.000	1.268
75.000	Left	1	75.000	100.000	459.84	-1092.55	-1092.55	-131.22	-1102.49	0.872	26.24	220.50	26.24	220.50	99.000	1.120
75.000	Right	2	0.000	0.000	459.84	-1092.55	-1092.55	-131.22	-1102.49	0.872	26.24	220.50	26.24	220.50	99.000	1.120

Figure 9 - Moment redistribution for HL-93 (US) - Truck + Lane at Design Inventory rating level and Strength I limit state

MomentRedistributionReport.txt - Notepad     File Edit Format View Help																
Moment redistribution for Type 3 - Legal Truck at Legal Routine rating level and StrengthI limit state.																
Before moment redistribution: Minimum positive flexure rating factor = 3.005 @ 37.125 ft Minimum negative flexure rating factor = 2.864 @ 37.125 ft Minimum positive flexure rating factor = 2.864 @ 37.125 ft Minimum negative flexure rating factor = 2.864 @ 75.000 ft Max Applied																
Location Percent Redistribution Redistribution																
Location	<i>.</i> .	<i></i>				L+AdjLL		Percentage	Percenta	age						
(ft) 0.000	Support 1		Span 1	(ft) 0.000	(%) ( 0.000	kip-ft) ( 0.00	kip-ft) 0.00	(%) 0.000	(%)	0.000						
75.000	2		1	75.000	100.000	-131.22	-392.37	20.000		2.930						
75.000	2		2	0.000	0.000	-131.22	-392.37	20.000		2.930						
135.000			2	60.000	100.000	-80.87	-282.98	20.000		0.000						
135.000	3		3	0.000	0.000	-80.87	-282.98	20.000								
195.000	4	Left	3	60.000	100.000	0.00	0.00	0.000	(	0.000						
			Location	Percent	Positive Flexure	Negative Flexure	Initial Flexure	Initial	Initial	Initial	Max Delta	Max Delta	Applied Delta	Applied Delta		
Location			in Span	in Span	Capacity	Capacity	Capacity	DL+AdjLL	LL+I	Controlling	DL+AdjLL	LL+I	DL+AdjLL	LL+I	Positive	Negative
(ft)	Side	Span	(ft)	(%)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	Flexure RF	(kip-ft)	(kip-ft)	(kip-ft)	(kip-ft)	Flexure RF	
0.000	Right	. 1	0.000	0.000	596.96	-87.16	596.96	0.00	0.00	99.000	0.00	0.00	0.00	0.00	99.000	99.000
1.750	Left	1		2.333	1931.13			138.81	70.29	25.499	0.61	1.83	0.40	1.18		99.000
1.750	Right	1		2.333	1931.13	-231.92		138.81	70.29	25.499	0.61	1.83	0.40	1.18	25.071	99.000
7.500 7.500	Left Right	1		10.000 10.000	2764.96 2764.96			547.41 547.41	266.82 266.82	8.311 8.311	2.62	7.85 7.85	1.70 1.70	5.07 5.07	8.150 8.150	99.000 99.000
15.000	Left	1		20.000	3095.55	-254.50		970.89	445.96	4.764	5.25	15.69	3.39	10.15		99.000 99.000
15.000	Right	1		20.000	3095.55			970.89	445.96	4.764	5.25	15.69	3.39	10.15		99.000
21.750	Left	1		29.000	3202.96			1246.07	537.01	3.644	7.61	22.76	4.92	14.71		99.000
21.750	Right	1	21.750	29.000	3202.96	0.00	3202.96	1246.07	537.01	3.644	7.61	22.76	4.92	14.71	3.538	99.000
22.500	Left	1		30.000	3202.96	0.00		1270.45	544.31	3.550	7.87	23.54	5.09	15.22		99.000
22.500	Right	1		30.000	3202.96			1270.45	544.31	3.550	7.87	23.54	5.09	15.22		99.000
30.000 30.000	Left Right	1		40.000 40.000	3202.96 3202.96			1446.09 1446.09	583.96 583.96	3.009 3.009	10.50 10.50	31.39 31.39	6.79 6.79	20.29 20.29	2.896 2.896	99.000 99.000
37.125	Left	1		49.500	3202.90			1498.15	567.28	3.005	12.99	38.84	8.40	25.11	2.864	99.000
37.125	Right	1		49.500	3202.96			1498.15	567.28	3.005	12.99	38.84	8.40	25.11	2.864	99.000
37.500	Left	1	37.500	50.000	3202.96	0.00	3202.96	1497.79	565.46	3.016	13.12	39.24	8.48	25.37	2.872	99.000
37.500	Right	1		50.000	3202.96	0.00		1497.79	565.46	3.016	13.12	39.24	8.48	25.37	2.872	99.000
45.000	Left	1		60.000	3202.96			1408.70	497.47	3.607	15.75	47.08	10.18	30.44		99.000
45.000 52.250	Right Left	1		60.000 69.667	3202.96 3202.96	0.00		1408.70 1204.78	497.47 383.16	3.607 5.215	15.75 18.28	47.08 54.67	10.18 11.82	30.44 35.34		99.000 99.000
52.250	Right	1		69.667	3202.96			1204.78	383.16	5.215	18.28	54.67	11.82	35.34		99.000
52.500	Left	1		70.000	3198.98			1195.68	378.52	5.292	18.37	54.93	11.88	35.51	4.810	99.000
52.500	Right	1	52.500	70.000	3198.98			1195.68	378.52	5.292	18.37	54.93	11.88	35.51	4.810	99.000
55.000	Left	1		73.333	3159.20	-87.73		1083.36	326.97	6.349	19.25	57.55	12.44	37.20		99.000
55.000	Right	1		73.333	3170.05			1083.36	326.97	6.382	19.25	57.55	12.44	37.20		99.000
60.000 60.000	Left Right	1		80.000 80.000	3091.18 3091.18			858.73 858.73	223.88 223.88	9.972 9.972	21.00 21.00	62.78 62.78	13.57 13.57	40.59 40.59	8.390 8.390	99.000 99.000
67.500	Left	1		90.000	2631.54			397.86	54.95	40.646	23.62	70.63	15.27	40.39		99.000
67.500	Right	1		90.000	2944.68			397.86	54.95	46.344	23.62	70.63	15.27	45.66		99.000
72.250	Left	1		96.333	2265.85			41.88	-303.03	4.320	25.28	75.60	16.34	48.87	99.000	5.215
72.250	Right	1		96.333	2265.85			41.88	-303.03	4.320	25.28	75.60	16.34	48.87	99.000	5.215
74.250	Left	1		99.000	826.20			-122.88	-368.13	2.745	25.98	77.69	16.80	50.22		3.232
75.000	Left	1		100.000	459.84			-131.22	-392.37	2.450	26.24	78.47	16.97	50.73	99.000	2.864
75.000	Kight	2	0.000	0.000	459.84	-1092.55	-1092.55	-131.22	-392.37	2.450	26.24	78.47	16.97	50.73	99.000	2.864

Figure 10 - Moment redistribution for Type 3 - Legal Truck at Legal Routine rating level and Strength I limit state