

AASHTOWare BrDR 7.5.0

## *Steel Tutorial*

*STL14-LRFD Cb Calculation using Concurrent Moments in LRFR Rating  
Example*

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### AASHTOWare Bridge Design and Rating Training

## STL14 –LRFD Cb Calculation using Concurrent Moments in LRFR Rating 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.

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### 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 save the data to memory and close the window.

**Cb Factor**

Bridge ID:  NBI structure ID (8):

☐ Template ☐ Bridge completely defined

Bridge Workspace View

- ☒ Superstructures
- ☐ Culverts
- ☐ Substructures

Description | Description (cont'd) | Alternatives | Global reference point | Traffic | Custom agency fields

Name:  Year built:

Description:

Location:  Length:  ft

Facility carried (7):  Route number:

Feat. intersected (6):  Mi. post:

Default units:

Bridge association... ☒ BrR ☒ BrD ☐ BrM

OK Apply Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

Open the **Structure Definition** window and update the superstructure name.

**Girder System Superstructure Definition**

Definition Analysis Specs Engine

Name: Envelope Moments

Description: 2 Span 4 Girder System using envelope moments to compute Cb moment gradient factor

Default units: US Customary

Number of spans: 2

Number of girders: 4

Enter span lengths along the reference line:

	Span	Length (ft)
>	1	90
	2	90

Modeling

☒ Multi-girder system ☐ MCB

☐ With frame structure simplified definition

Deck type: Concrete Deck

For PS/PT only

Average humidity: %

Member alt. types

☒ Steel

☐ P/S

☐ R/C

☐ Timber

☐ P/T

Horizontal curvature along reference line

☐ Horizontal curvature

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: Left

End tangent length: ft

Distance from last support line to PT: ft

Design speed: mph

Superelevation: %

Superstructure alignment

☒ Curved

☐ Tangent, curved, tangent

☐ Tangent, curved

☐ Curved, tangent

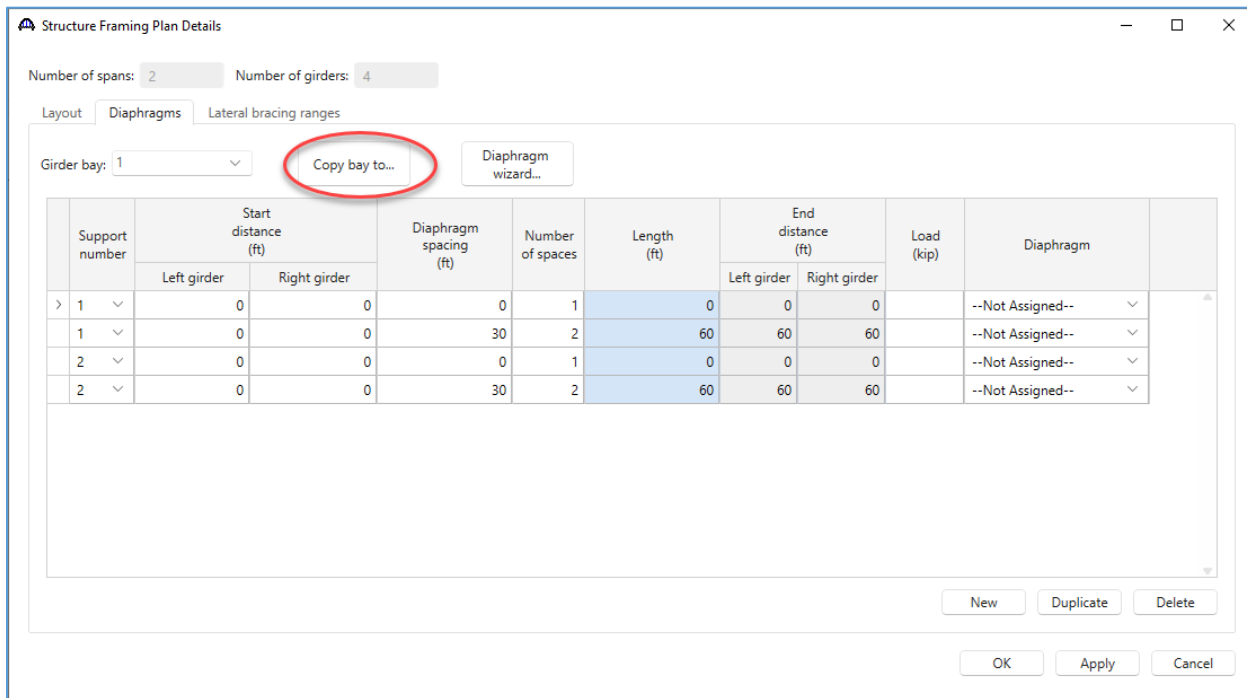
OK Apply Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### 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 save the data to memory and keep the window open. Then select 'Copy bay to...' and copy the diaphragms to Bay 2 and Bay 3.

*Girder Bay 1:*



Structure Framing Plan Details

Number of spans: 2 Number of girders: 4

Layout Diaphragms Lateral bracing ranges

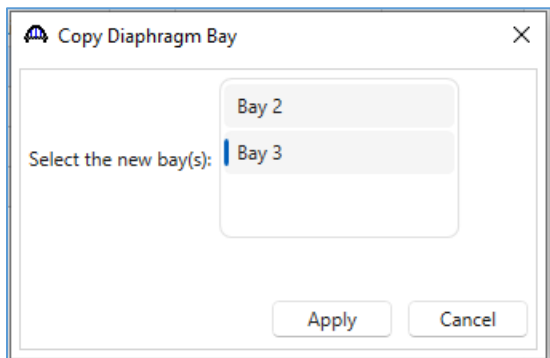
Girder bay: 1 **Copy bay to...** Diaphragm wizard...

Support number	Start distance (ft)		Diaphragm spacing (ft)	Number of spaces	Length (ft)	End distance (ft)		Load (kip)	Diaphragm
	Left girder	Right girder				Left girder	Right girder		
> 1	0	0	0	1	0	0	0	--Not Assigned--	
1	0	0	30	2	60	60	60	--Not Assigned--	
2	0	0	0	1	0	0	0	--Not Assigned--	
2	0	0	30	2	60	60	60	--Not Assigned--	

New Duplicate Delete

OK Apply Cancel

*Girder Bays 2 and 3:*



Copy Diaphragm Bay

Select the new bay(s):

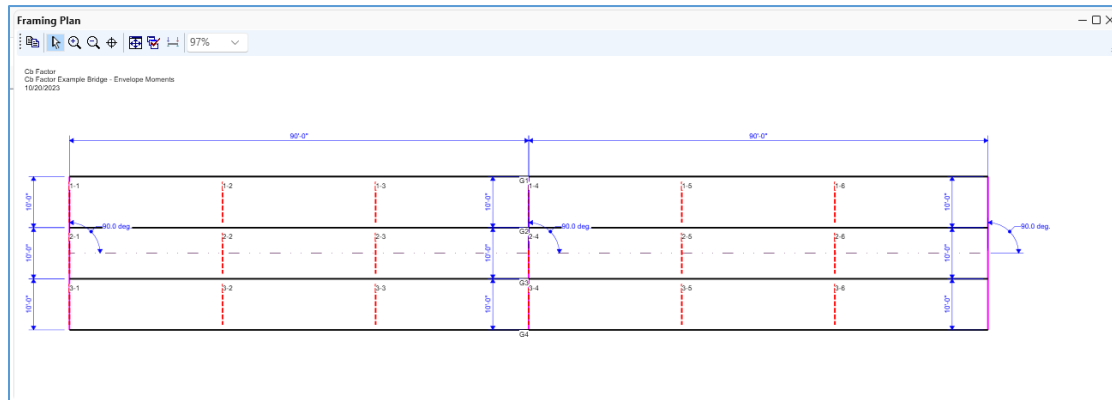
- Bay 2
- Bay 3

Apply Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### Framing Plan Schematic

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



### Girder Profile

Update the **girder profile** for the G2 member alternative. 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.

The Girder Profile dialog box is shown with the 'Plate Girder' type selected. The 'Web' tab is active, and the 'Top flange' and 'Bottom flange' tabs are also visible. The table below shows the configuration for the top flange.

	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	-- None --

Buttons: New, Duplicate, Delete, OK, Apply, Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

Girder Profile

Type: Plate Girder

Web Top flange Bottom flange

	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	-	--	

Copy to bottom flange

New Duplicate Delete

OK Apply Cancel

Girder Profile

Type: Plate Girder

Web Top flange Bottom flange

	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	-	--	

Copy to top flange

New Duplicate Delete

OK Apply Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### Deck Profile

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

Deck Profile

Type:

Deck concrete   Reinforcement   Shear connectors

	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)
>	Grav	1	63	54	117	12	12	6	2.97	Top of Slab	
	Grav	1	63	54	117	12	12	6	1.91	Bottom of Slab	

New   Duplicate   Delete

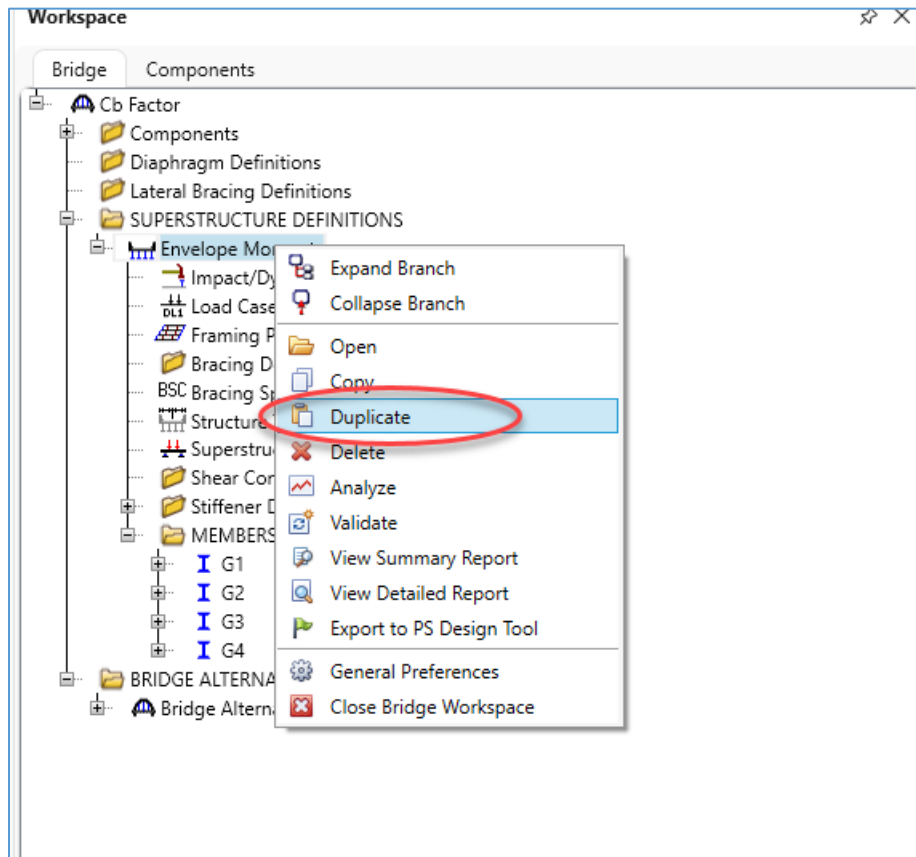
OK   Apply   Cancel



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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.



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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

**Girder System Superstructure Definition**

Definition Analysis Specs Engine

Name: Concurrent Moments

Description: 2 Span 4 Girder System using concurrent moments to compute Cb moment gradient factor

Default units: US Customary

Number of spans: 2

Number of girders: 4

Enter span lengths along the reference line:

Span	Length (ft)
1	90
2	90

Modeling

☒ Multi-girder system ☐ MCB

☐ With frame structure simplified definition

Deck type: Concrete Deck

For PS/PT only

Average humidity: %

Member alt. types

☒ Steel

☐ P/S

☐ R/C

☐ Timber

☐ P/T

Horizontal curvature along reference line

☐ Horizontal curvature

Superstructure alignment

☒ Curved

☐ Tangent, curved, tangent

☐ Tangent, curved

☐ Curved, tangent

Distance from PC to first support line: ft

Start tangent length: ft

Radius: ft

Direction: Left

End tangent length: ft

Distance from last support line to PT: ft

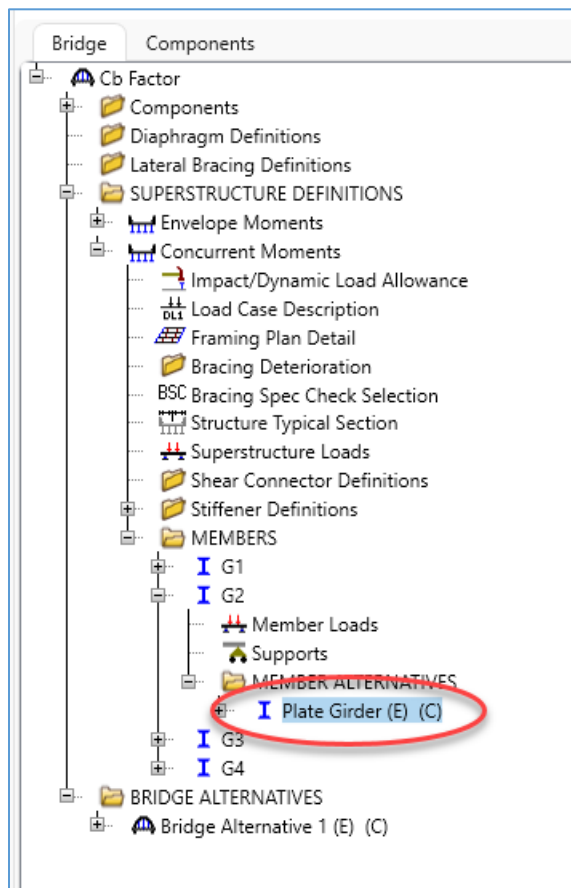
Design speed: mph

Superelevation: %

OK Apply Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

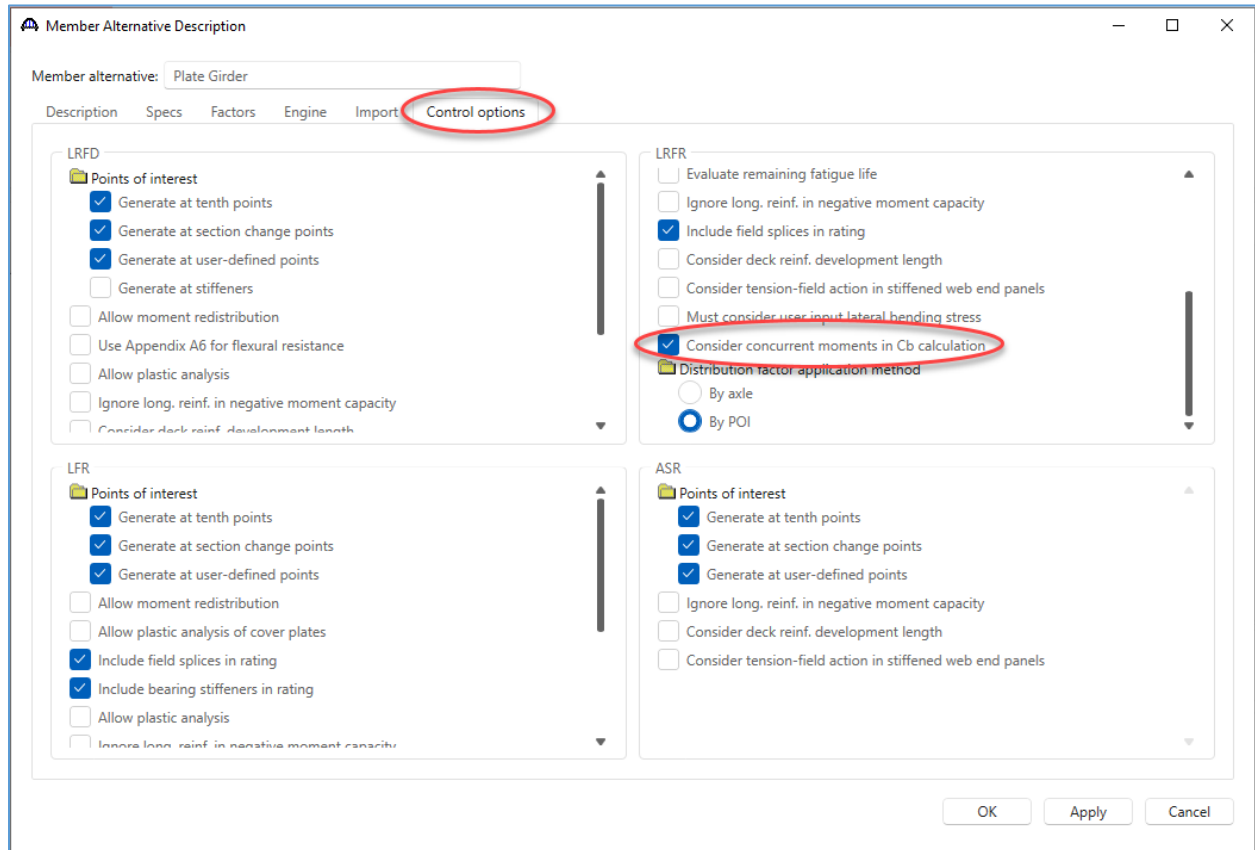
Expand the bridge workspace tree and open the **member alternative window** for the G2 – Plate Girder member alternative in the Concurrent Moments superstructure.



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

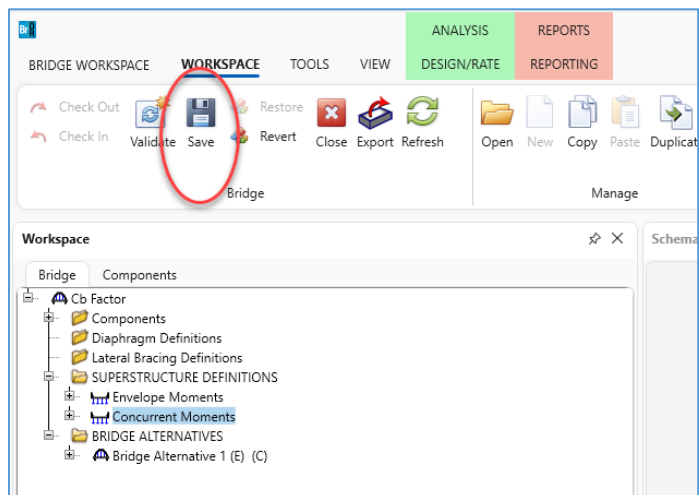
### Cb Calculation Control Option

Navigate to the control options tab in the window and select the LRFR control option to ‘Consider concurrent moments in Cb calculation.’



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

This completes the data entry for this example. Now would be a good time to save the bridge to the database if you haven't already done so.

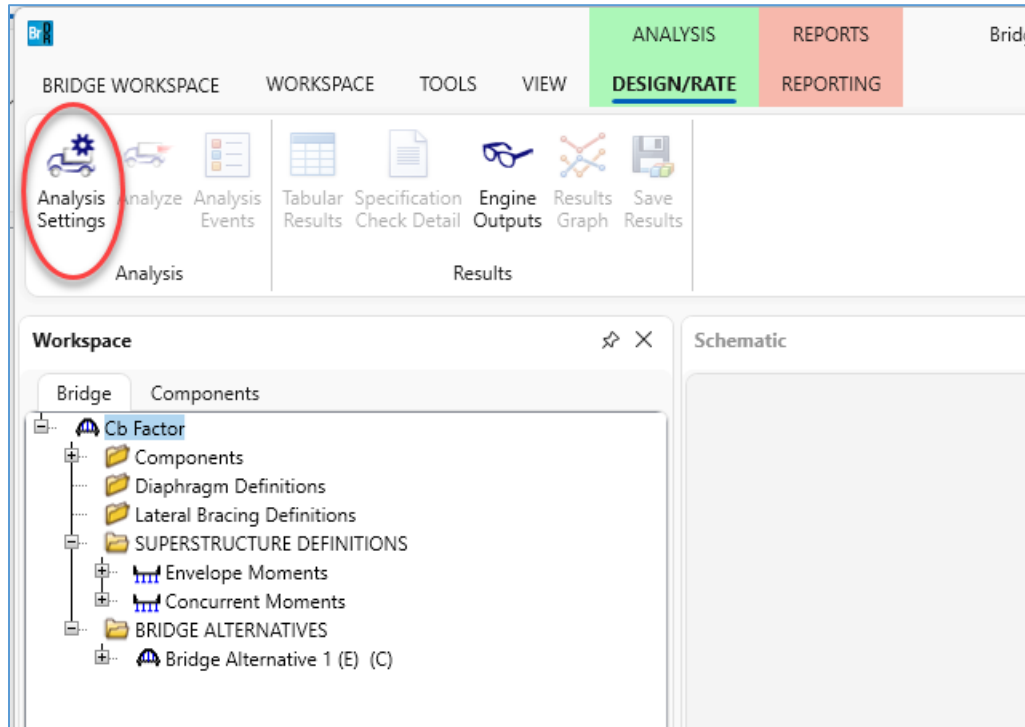


## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### 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.



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### Analysis Settings

Analysis Settings

☐ Design review ☒ Rating

Rating method: LRFR

Analysis type: Line Girder

Lane / Impact loading type: As Requested

Apply preference setting: None

Vehicles Output Engine Description

Traffic direction: Both directions

Refresh Temporary vehicles **Advanced**

Vehicle selection

Vehicle summary

Rating vehicles

LRFR

Design load rating

Inventory

Operating

Fatigue

Legal load rating

Routine

Specialized hauling

Permit load rating

EV2

Adjacent vehicle

Reset Clear Open template Save template OK Apply Cancel

Vehicle Properties

Vehicle	Tandem train	Scale factor	Impact	Single lane loaded	Legal pair	Override	Legal live load factor	Frequency	Loading condition	Override
> EV2	<input type="checkbox"/>	1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		Single Trip	Mixed with traffic	<input type="checkbox"/>

Permit lane load: 0.2 kip/ft Adjacent vehicle live load factor:

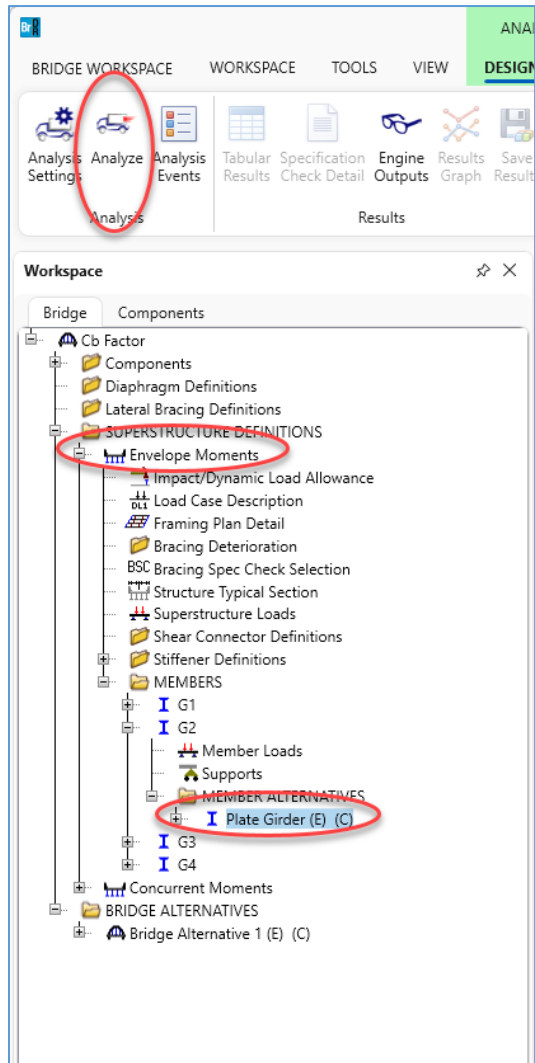
☐ Exclude permit lane load from permit vehicle location

OK Cancel

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### Analyzing Girder with Envelope Moment Cb Calculation

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





## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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

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

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

Specification reference	Limit State	Flex. Sense	Pass/Fail
6.10.6.2.2 Composite Sections in Positive Flexure		N/A	General Comp.
6.10.6.2.3 Composite Sections in Negative Flexure and Noncomposite		N/A	General Comp.
NA 6.10.7.1.1 General		N/A	Not Applicable
NA 6.10.7.1.2 Nominal Flexural Resistance		N/A	Not Applicable
NA 6.10.7.2.1 General		N/A	Not Applicable
6.10.7.2.2 Nominal Flexural Resistance		N/A	General Comp.
NA 6.10.7.3 Flexural Resistance - Ductility Requirement		N/A	Not Applicable
6.10.8.1.1 Discretely Braced Flanges in Compression		N/A	Failed
NA 6.10.8.1.2 Discretely Braced Flanges in Tension		N/A	Not Applicable
6.10.8.1.3 Continuously Braced Flanges in Tension or Compression		N/A	Passed
6.10.8.2.1 General		N/A	General Comp.
6.10.8.2.2 Local Buckling Resistance		N/A	General Comp.
6.10.8.2.3 Lateral Torsional Buckling Resistance		N/A	General Comp.
6.10.8.2.3.Cb Lateral Torsional Buckling Resistance - Cb Calculation		N/A	General Comp.
6.10.8.2.3.rt Lateral Torsional Buckling Resistance - rt and Lp Calculatio		N/A	General Comp.
6.10.8.3 Flexural Resistance Based on Tension Flange Yielding		N/A	General Comp.
6.10.9 LRFD Shear Resistance		N/A	Passed
6.10.9.1 Shear Resistance - General		N/A	General Comp.
6.10_General_Flexural_Results		N/A	Failed
6A.4.2.1 General Load Rating Equation - Steel Flexure Moment		N/A	Passed
6A.4.2.1 General Load Rating Equation - Steel Flexure Stress		N/A	Failed
6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed
6A.4.2.1.fl		N/A	General Comp.
6A.6.4.2.2 Service Limit State		N/A	Passed
APPD6.1 Plastic Moment		N/A	General Comp.
APPD6.2 Yield Moment		N/A	General Comp.
APPD6.3.1 In the Elastic Range (Dc)		N/A	General Comp.
APPD6.3.2 Depth of the Web in Compression at Plastic Moment		N/A	General Comp.
Steel Elastic Section Properties		N/A	General Comp.
Unbraced Length Calculations		N/A	General Comp.



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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.

Specification Checks for Plate Girder - 43 of 1560

Properties Generate Articles: All articles Format: Bullet list Report

Specification filter

Specification reference	Limit State	Flex. Sense	Pass/Fail
5.4.2.6 Modulus of Rupture		N/A	General Comp.
5.4.2.8 Concrete Density Modification Factor		N/A	General Comp.
6.10.1 Estimated Flange Lateral Bending Stress Proportioning		N/A	General Comp.
6.10.1.1.1b Stresses for Sections in Positive Flexure		N/A	General Comp.
6.10.1.10.1 Hybrid factor, Rn		N/A	General Comp.
6.10.1.10.2 Web Load-Shedding Factor, Rb		N/A	General Comp.
6.10.1.6 Flange Stress and Member Bending Moments		N/A	Passed
6.10.1.7 Minimum Negative Flexure Concrete Deck Reinforcement		N/A	Passed
6.10.1.9.1 Webs without Longitudinal Stiffeners		N/A	General Comp.
6.10.11.1.2 Transverse Stiffeners - Projecting Width		N/A	Passed
6.10.11.1.3 Transverse Stiffeners - Moment of Inertia		N/A	Passed
6.10.2 Cross-Section Proportion Limits		N/A	Passed
6.10.4.2.2 Flexure		N/A	Passed
6.10.6.2.2 Composite Sections in Positive Flexure		N/A	General Comp.
6.10.6.2.3 Composite Sections in Negative Flexure and Noncomposite		N/A	General Comp.
NA 6.10.7.1.1 General		N/A	Not Applicable
NA 6.10.7.1.2 Nominal Flexural Resistance		N/A	Not Applicable
NA 6.10.7.2.1 General		N/A	Not Applicable
6.10.7.2.2 Nominal Flexural Resistance		N/A	General Comp.
NA 6.10.7.3 Flexural Resistance - Ductility Requirement		N/A	Not Applicable
6.10.8.1.1 Discretely Braced Flanges in Compression		N/A	Failed

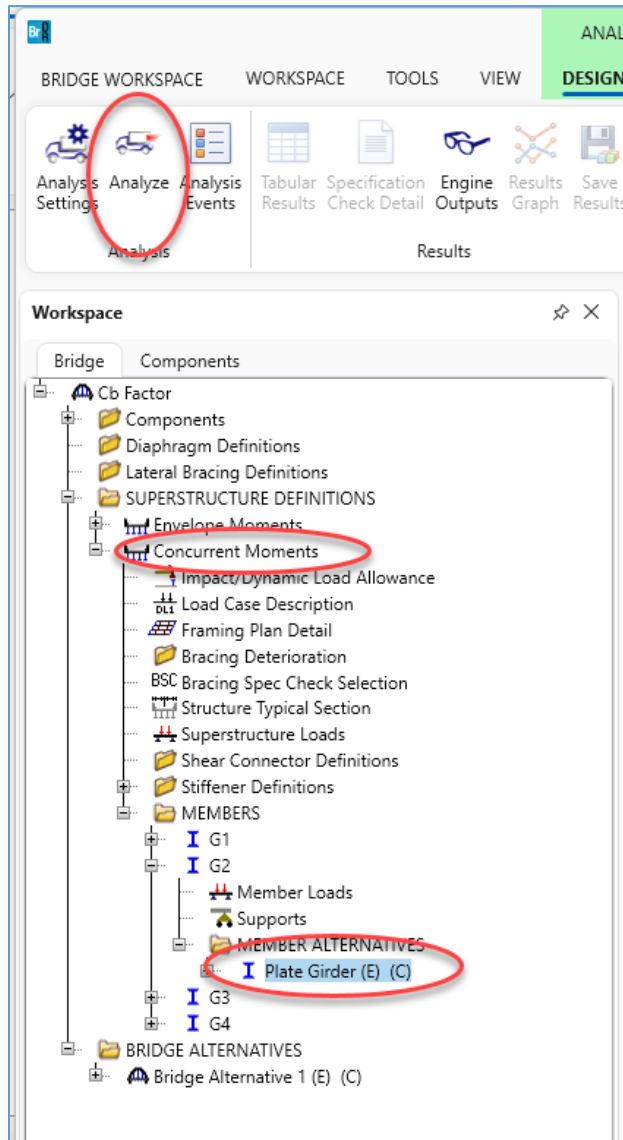
Superstructure Component

- Stage 1
- Stage 2
- Stage 3
  - Plate Girder
    - Span 1 - 0.00 ft.
    - Span 1 - 9.00 ft.
    - Span 1 - 15.00 ft.
    - Span 1 - 18.00 ft.
    - Span 1 - 27.00 ft.
    - Span 1 - 30.00 ft.
    - Span 1 - 36.00 ft.
    - Span 1 - 45.00 ft.
    - Span 1 - 54.00 ft.
    - Span 1 - 60.00 ft.
    - Span 1 - 63.00 ft.
    - Span 1 - 72.00 ft.
    - Span 1 - 75.00 ft.
    - Span 1 - 81.00 ft.
    - Span 1 - 90.00 ft.
    - Span 2 - 9.00 ft.
    - Span 2 - 15.00 ft.
    - Span 2 - 18.00 ft.

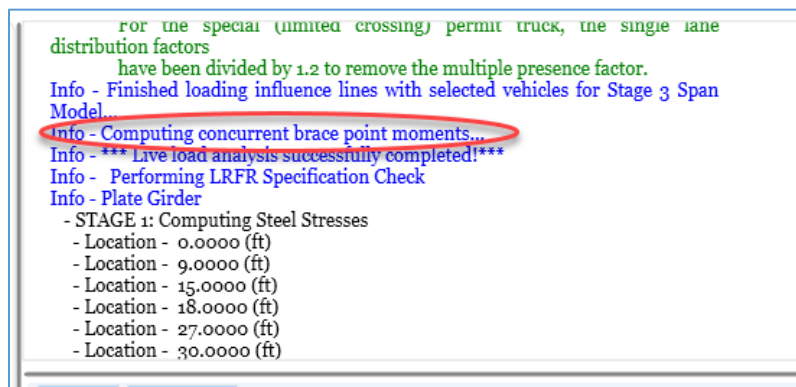
## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

### Analyzing Girder with Concurrent Moment Cb Calculation

Next, analyze the G2 – plate girder member alternative within the concurrent moment superstructure.

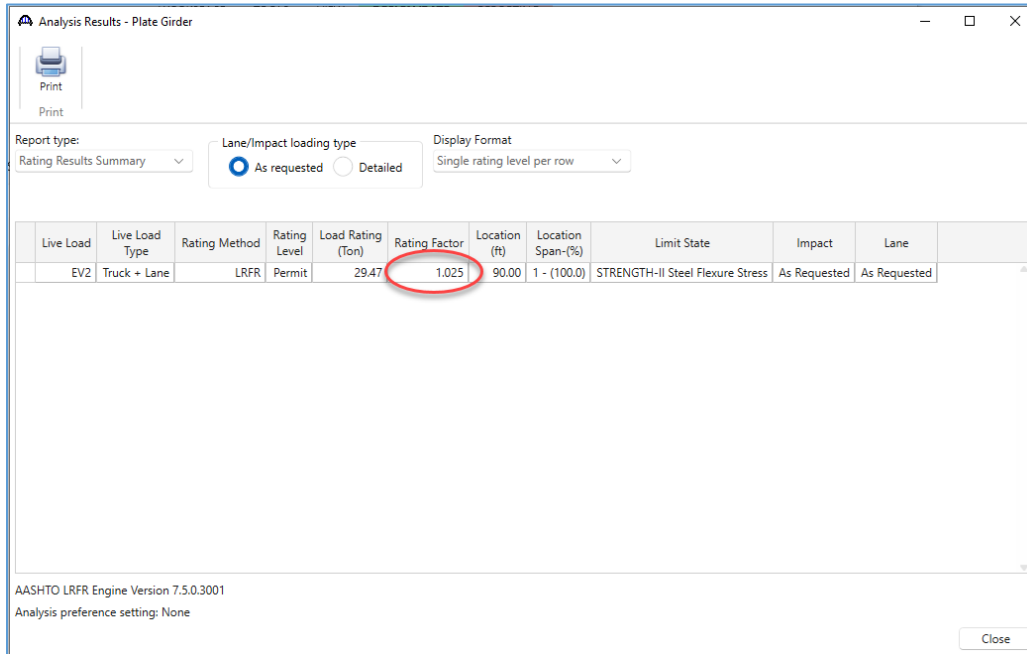


The analysis progress log will indicate when program is loading the concurrent moments at brace points.



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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

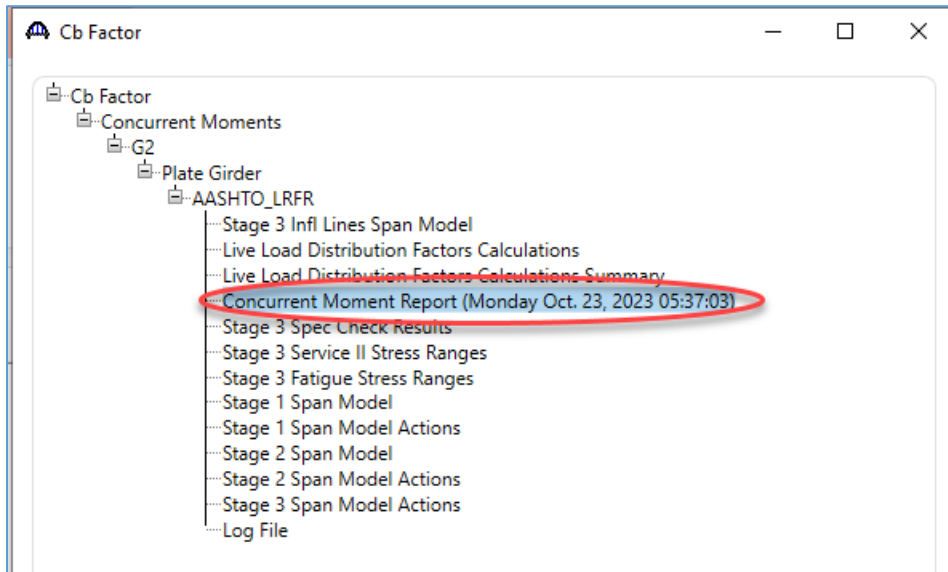


Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Location (ft)	Location Span-(%)	Limit State	Impact	Lane
EV2	Truck + Lane	LRFR	Permit	29.47	1.025	90.00	1 - (100.0)	STRENGTH-II Steel Flexure Stress	As Requested	As Requested

AASHTO LRFR Engine Version 7.5.0.3001  
Analysis preference setting: None

Close

The engine outputs will include a Concurrent Moment Report which details the computed corresponding moments within all unbraced regions on the member.



- 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 Summary
          - 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



## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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

Specification reference	Limit State	Flex. Sense	Pass/Fail
✓ 6.10.4.2.2 Flexure		N/A	Passed
6.10.6.2.2 Composite Sections in Positive Flexure		N/A	General Comp.
6.10.6.2.3 Composite Sections in Negative Flexure and Noncomposite		N/A	General Comp.
NA 6.10.7.1.1 General		N/A	Not Applicable
NA 6.10.7.1.2 Nominal Flexural Resistance		N/A	Not Applicable
NA 6.10.7.2.1 General		N/A	Not Applicable
6.10.7.2.2 Nominal Flexural Resistance		N/A	General Comp.
NA 6.10.7.3 Flexural Resistance - Ductility Requirement		N/A	Not Applicable
✓ 6.10.8.1.1 Discretely Braced Flanges in Compression		N/A	Passed
NA 6.10.8.1.2 Discretely Braced Flanges in Tension		N/A	Not Applicable
✓ 6.10.8.1.3 Continuously Braced Flanges in Tension or Compression		N/A	Passed
6.10.8.2.1 General		N/A	General Comp.
6.10.8.2.2 Local Buckling Resistance		N/A	General Comp.
6.10.8.2.3 Lateral Torsional Buckling Resistance		N/A	General Comp.
6.10.8.2.3 Concurrent Moment Brace Point Stresses		N/A	General Comp.
6.10.8.2.3 Cb Concurrent Moment Lateral Torsional Buckling Resistance		N/A	General Comp.
6.10.8.2.3.rt Lateral Torsional Buckling Resistance - rt and Lp Calculation		N/A	General Comp.
6.10.8.3 Flexural Resistance Based on Tension Flange Yielding		N/A	General Comp.
✓ 6.10.9 LRFD Shear Resistance		N/A	Passed
6.10.9.1 Shear Resistance - General		N/A	General Comp.
✓ 6.10_General_Flexural_Results		N/A	Passed
6.9.4.1 Bearing Stiffener Nominal Resistance		N/A	General Comp.
✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Moment		N/A	Passed
✓ 6A.4.2.1 General Load Rating Equation - Steel Flexure Stress		N/A	Passed
✓ 6A.4.2.1 General Load Rating Equation - Steel Shear		N/A	Passed
6A.4.2.1.fl		N/A	General Comp.
✓ 6A.6.4.2.2 Service Limit State		N/A	Passed
APPD6.1 Plastic Moment		N/A	General Comp.
APPD6.2 Yield Moment		N/A	General Comp.
APPD6.3.1 In the Elastic Range (Dc)		N/A	General Comp.
APPD6.3.2 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.b 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.

## STL14 – LRFD Cb Calculation using Concurrent Moments in LRFR Rating Example

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

**Spec Check Detail for 6.10.8.2.3.Cb Concurrent Moment Lateral Torsional Buckling Resistance - Cb Calculation**

$C_b = 1.75 - 1.05*(f_1/f_2) + 0.3*(f_1/f_2)^2 \leq 2.3$  (6.10.8.2.3-7)

Cb calculation for loading left brace

Limit State	Load Comb	Flexure Type	Left Stress (ksi)	Mid Stress (ksi)	Right Stress (ksi)	Concave Moment	fmid (ksi)	f2 (ksi)	f1 (ksi)	Eq.	Cb
STR-II	1, PermitSpec	Neg	12.10	-8.61	-38.14	Yes	8.61	38.14	-12.10	7	2.1134
STR-II	1, PermitSpec	Neg	4.49	-13.25	-38.74	Yes	13.25	38.74	-4.49	7	1.8758
SER-II	1, PermitSpec	Neg	9.74	-6.64	-28.81	Yes	6.64	28.81	-9.74	7	2.1390
SER-II	1, PermitSpec	Neg	3.79	-9.82	-29.23	Yes	9.82	29.23	-3.79	7	1.8910

Note: For Input Stresses, compression is negative, tension is positive.  
For Output Stresses signs are switched. Compression is positive, tension is negative.

Cb calculation for loading mid brace

Limit State	Load Comb	Flexure Type	Left Stress (ksi)	Mid Stress (ksi)	Right Stress (ksi)	Concave Moment	fmid (ksi)	f2 (ksi)	f1 (ksi)	Eq.	Cb
STR-II	1, PermitSpec	Neg	11.08	-7.05	-37.42	Yes	7.05	37.42	-11.08	7	2.0871
STR-II	1, PermitSpec	Neg	4.68	-13.27	-38.96	Yes	13.27	38.96	-4.68	7	1.8806
SER-II	1, PermitSpec	Neg	8.88	-5.44	-28.32	Yes	5.44	28.32	-8.88	7	2.1088
SER-II	1, PermitSpec	Neg	3.90	-9.83	-29.37	Yes	9.83	29.37	-3.90	7	1.8949

Note: For Input Stresses, compression is negative, tension is positive.  
For Output Stresses signs are switched. Compression is positive, tension is negative.

Cb calculation for loading right brace

Limit State	Load Comb	Flexure Type	Left Stress (ksi)	Mid Stress (ksi)	Right Stress (ksi)	Concave Moment	fmid (ksi)	f2 (ksi)	f1 (ksi)	Eq.	Cb
STR-II	1, PermitSpec	Neg	7.42	-9.52	-34.27	Yes	9.52	34.27	-7.42	7	1.9913
STR-II	1, PermitSpec	Neg	12.30	-8.96	-39.35	Yes	8.96	39.35	-12.30	7	2.1075
SER-II	1, PermitSpec	Neg	5.83	-7.27	-26.17	Yes	7.27	26.17	-5.83	7	1.9989
SER-II	1, PermitSpec	Neg	9.90	-6.88	-29.64	Yes	6.88	29.64	-9.90	7	2.1342

Note: For Input Stresses, compression is negative, tension is positive.  
For Output Stresses signs are switched. Compression is positive, tension is negative.

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

**Cb calculation summary**

Limit State	Load 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

Note: Use Cb corresponding to brace point with largest compressive stress.