

Truss Gusset Plate Capabilities and Limitations

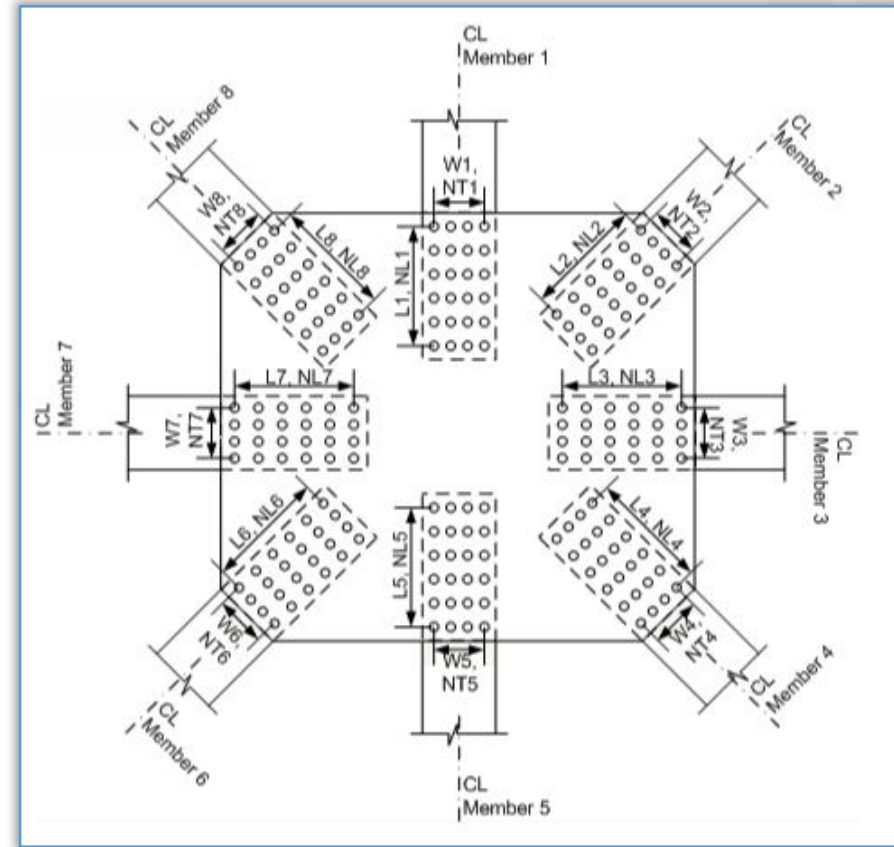
Carolyn Kois, P.E.
ckois@promiles.com

AASHTOWare RADBUG
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Truss Gusset Plate Capabilities and Limitations

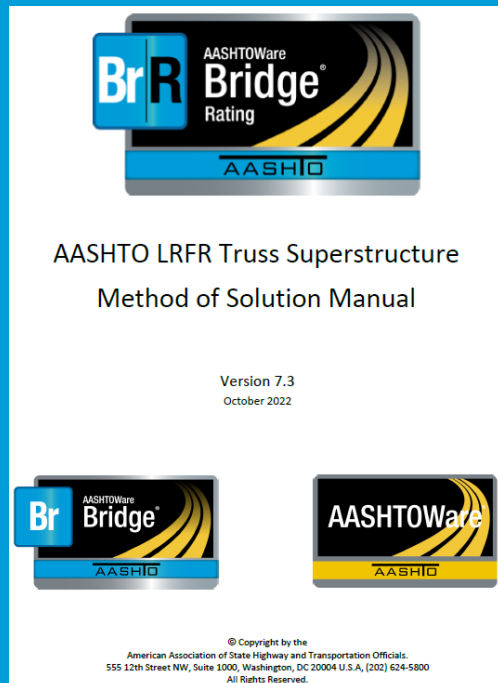
- Current Capabilities and Limitations (AASHTOWare BrR v7.4.1 and prior)
- Enhancements in v7.5
- Upcoming changes and future enhancements



Gusset Plate Analysis

For additional detail refer to:

AASHTO LFD Truss Method of Solution or
AASHTO LRFD Truss Method of Solution



ProMiles

Analysis Process:

- DL and LL analysis performed using the AASHTO 2-D finite element engine
- Linear analysis for trusses without counters
- Non-linear analysis for trusses with counters
- Collect maximum force effects for all members
- Collect concurrent force effects for panel points
- Perform spec check based on AASHTO MBE

Specification Checks

AASHTO Manual for Bridge Evaluation

AASHTO LFR

Article	Description
L6B.2.6.1	Fasteners – Shear
L6B.2.6.1	Fasteners – Rivets in Shear
L6B5.3.1	Bolt Slip Resistance
L6B.2.6.1	Fasteners – Bearing
L6B.2.6.3	Gusset Plate Shear Resistance
L6B.2.6.3	Gusset Plate Shear Resistance – Partial Shear Plane
L6B.2.6.4	Gusset Plate Compressive Resistance
L6B.2.6.5	Gusset Plate Tensile Resistance – Block Shear Rupture
L6B.2.6.5	Gusset Plate Tensile Resistance – Whitmore Yielding
L6B.2.6.6	Chord Splices – Compressive Resistance
L6B.2.6.6	Chord Splices – Tensile Resistance

Article	Description
6A.6.12.6.2	Fastener Shear Resistance
6A.6.12.5.1	Rivets in Shear
6A.6.12.6.3	Bolt Slip Resistance
6A.6.12.6.4	Bearing Resistance at Fastener Holes
6A.6.12.6.6	Gusset Plate Shear Resistance
6A.6.12.6.6	Gusset Plate Shear Resistance – Partial Shear Plane
6A.6.12.6.7	Gusset Plate Compressive Resistance
6A.6.12.6.8	Gusset Plate Tensile Resistance – Block Shear Rupture
6A.6.12.6.8	Gusset Plate Tensile Resistance – Whitmore Yielding
6A.6.12.6.9	Chord Splices – Compressive Resistance
6A.6.12.6.9	Chord Splices – Tensile Resistance
6A.6.12.6.1	Resistance Reduction for DL/LL Ratio

AASHTO LRFR



Chord Splices

If “Consider chord splice” is checked:

- Tension/compression chord splice articles are included in the rating

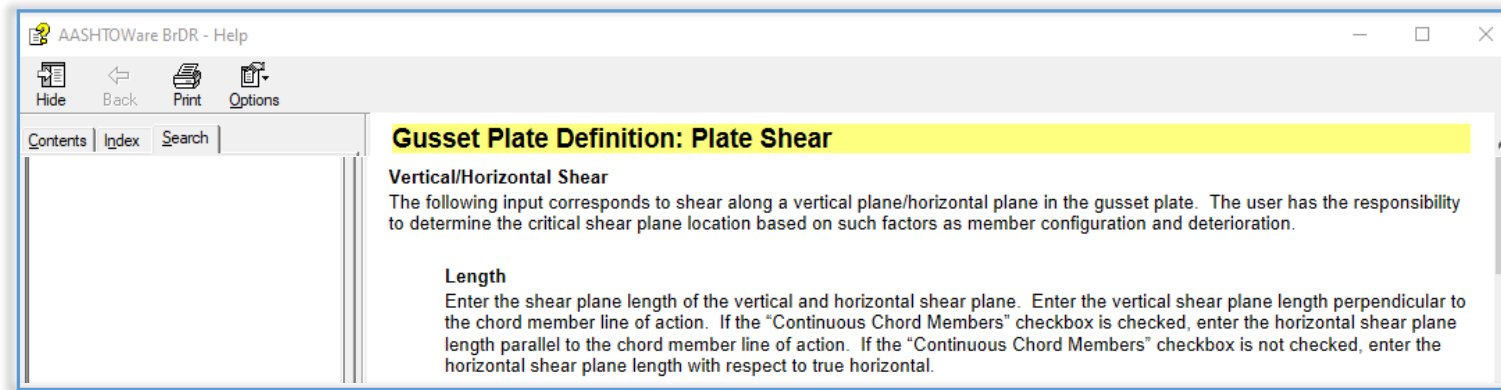
If “Continuous chord members” is checked:

- Gusset plate vertical shear is not evaluated
- Gusset plate horizontal shear plane taken as parallel to the chord member

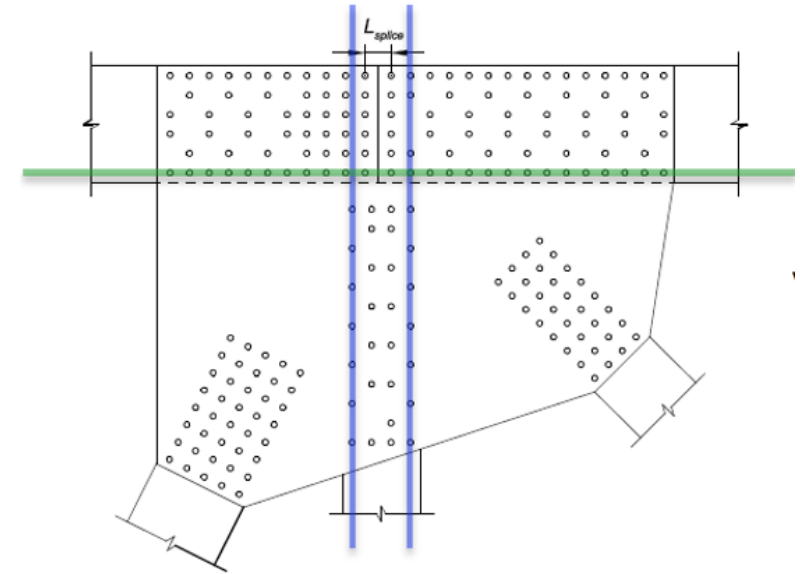
The screenshot shows the 'Gusset Plate Definition' window with the following details:

- Name:** L1 GP (L2 Mathcad)
- Navigation tabs:** Description, Panel point, Fasteners, Plate tension, Plate compression, Plate shear, Chord splice (selected), Load transfer
- Checkboxes:**
 - Consider chord splice
 - Continuous chord members
- Input fields:**
 - Gross area: [] in²
 - Gross section modulus: [] in³
 - epg: [] in
 - Compression splice:
 - Lsplice: [] in
 - K: []
 - Gusset plate thickness: [] in
 - Computed slenderness ratio: []
 - Fcr: [] ksi
 - Tension splice:
 - Net area: [] in²
 - Net section modulus: [] in³
 - ept: [] in
- Buttons:** Compute slenderness ratio

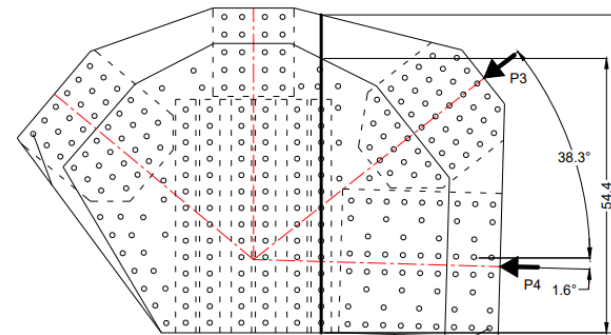
Plate Shear



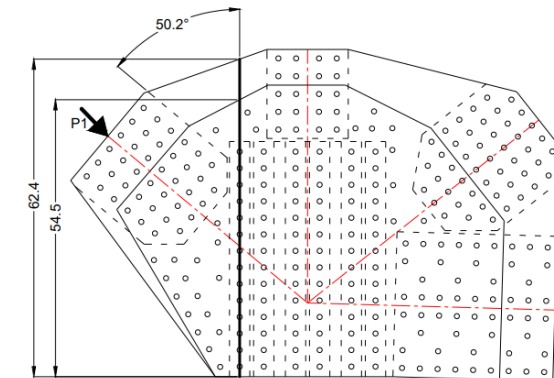
- If "Continuous chord members" is checked on the Chord Splice tab, the horizontal shear plane is considered parallel to the chord
- Otherwise the horizontal plane is considered parallel to true horizontal



Vertical Plane 1 Shear Check

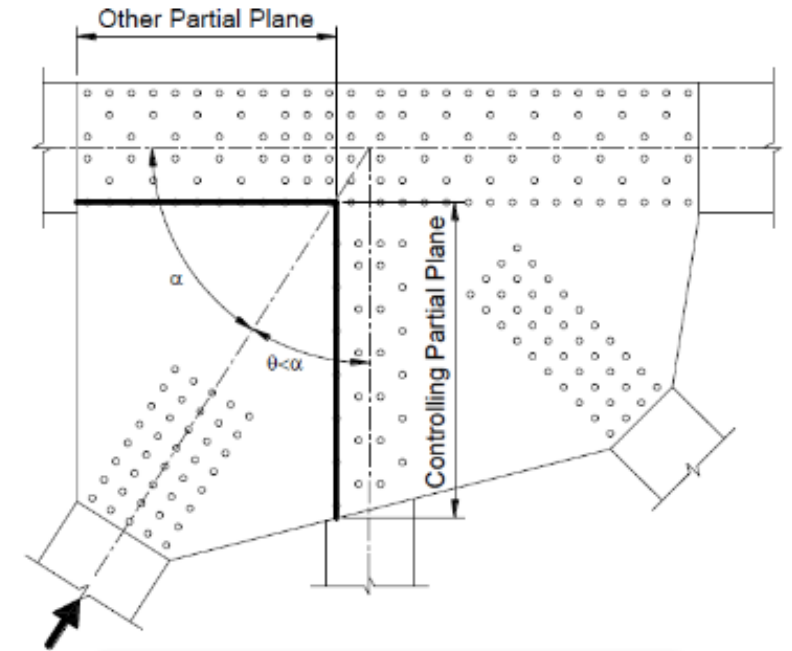
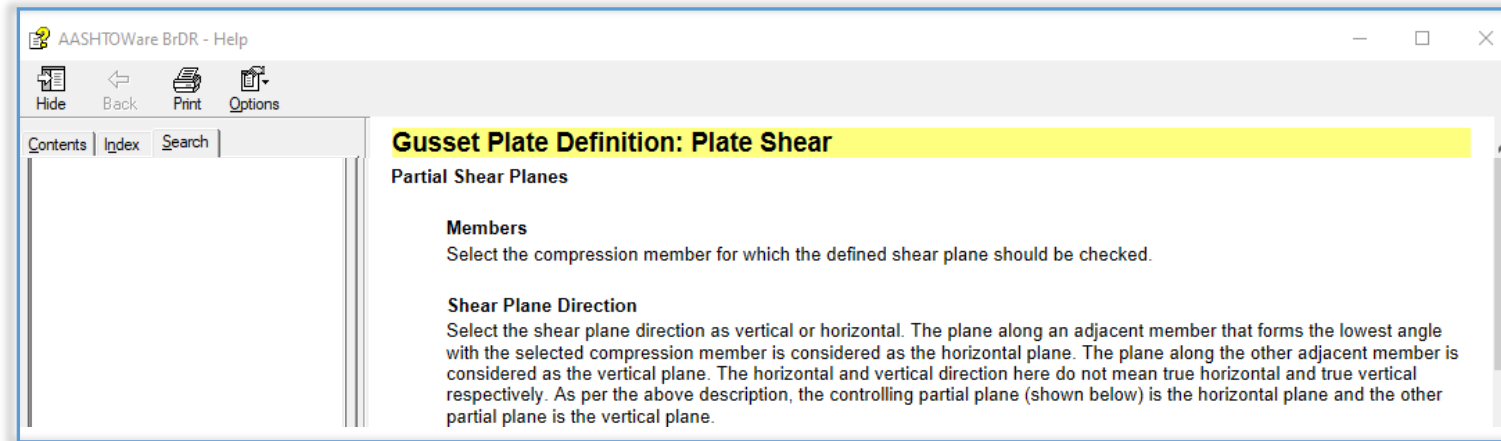


Vertical Plane 2 Shear Check



NCHRP 12-84

Partial Shear



- Plane along adjacent member that forms the smallest angle with the selected compression member is considered the horizontal plane
- Plane along the other adjacent member is considered the vertical plane

Partial shear planes

Member	Shear plane direction	Length (in)	Thickness (in)
Member 6	Horizontal	8.000	0.250
Member 6	Vertical	6.000	0.250

New Duplicate Delete

Plate Tension and Compression

Yielding/Net Fracture/Compression

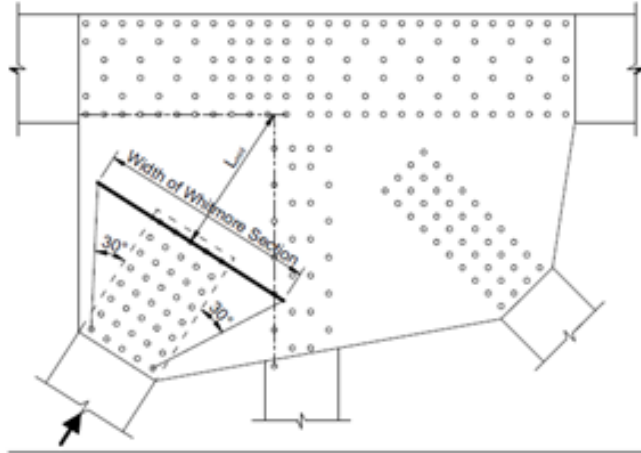


Figure 6A.6.12.6.7-1—Example Connection Showing the Whitmore Section for a Compression Member Derived From 30 Degree Dispersion Angles and the Distance L_{mid}

Block Shear

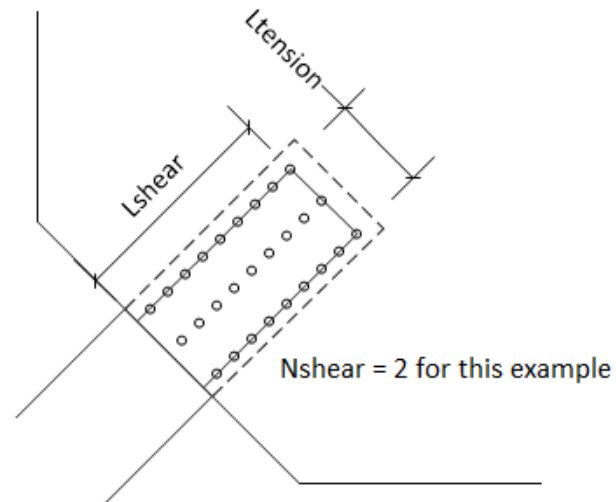
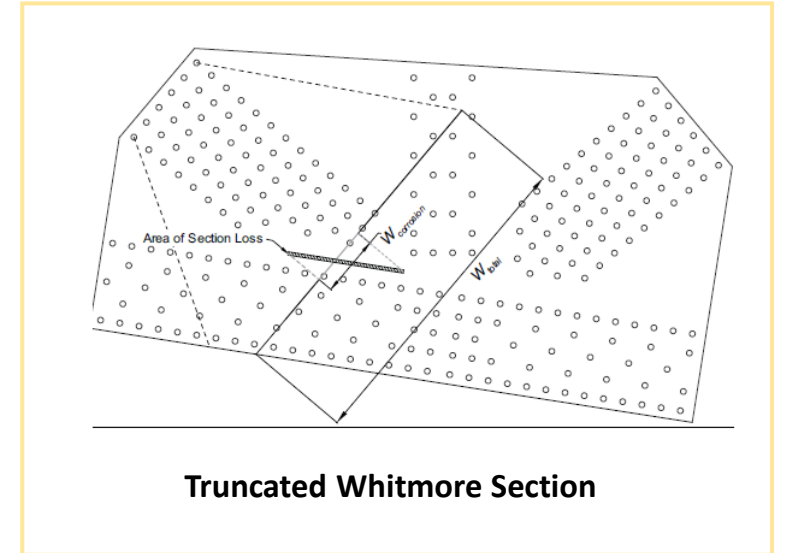


Figure: Block Shear Example



- Whitmore section width will be computed as $W + 2 * L * \tan(30)$ if left blank
- User should manually enter Whitmore width if section is truncated

Fasteners

Gusset Plate Definition

Name: L1 GP (L2 Mathcad)

Description Panel point Fasteners Plate tension Plate compression Plate shear Chord splice Load transfer

Left plate

	Connector	NL	L (in)	NT	W (in)	N total	Le (in)	SLmin (in)	Af (in ²)	Ap (in ²)	NShear	NSlip
Member 1	3/4" rivet	4.000	5.000	1.000			1.875	2.500	2.000	2.000	1.000	
Member 2	3/4" rivet	3.000	7.000	1.000			2.616	3.500	2.000	2.000	1.000	
Member 3	3/4" rivet	5.000	10.500	1.000			1.500	2.500	2.000	2.000	1.000	
Member 7	3/4" rivet	3.000	5.500	1.000			1.500	2.500	2.000	2.000	1.000	
Member 8	3/4" rivet	3.000	5.000	2.000		5.000	1.250	2.500	2.000	2.000	1.000	

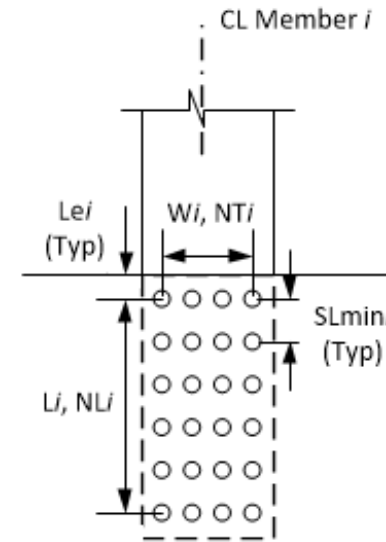
Right plate

Same as left plate

	Connector	NL	L (in)	NT	W (in)	N total	Le (in)	SLmin (in)	Af (in ²)	Ap (in ²)	NShear	NSlip
Member 1												
Member 2												
Member 3												
Member 7												
Member 8												

Member arrangement

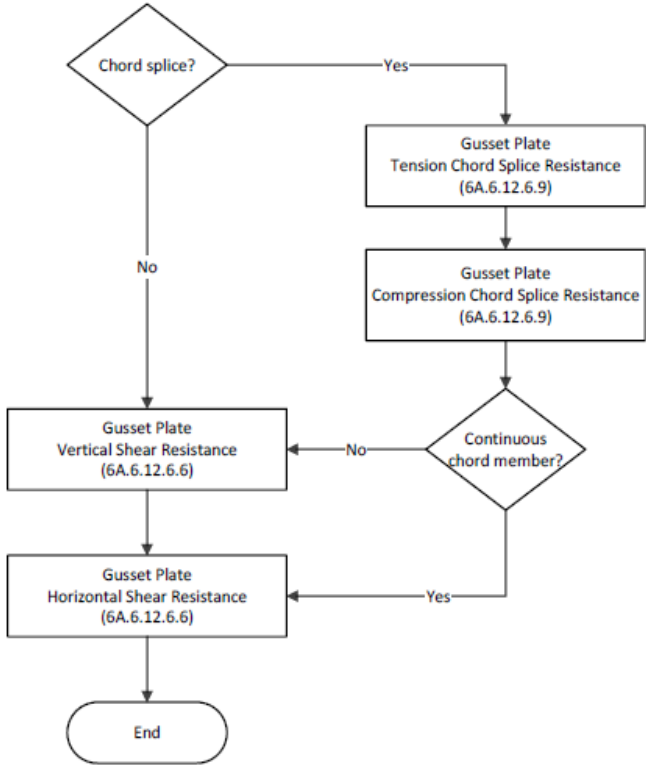
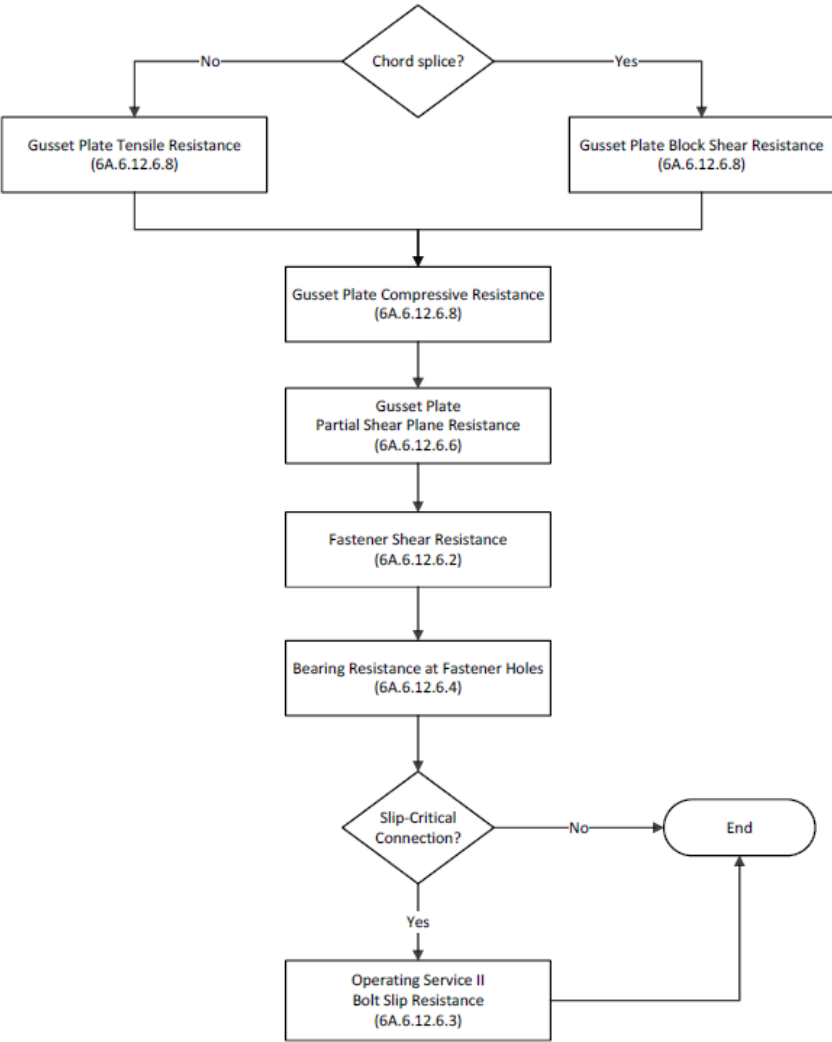
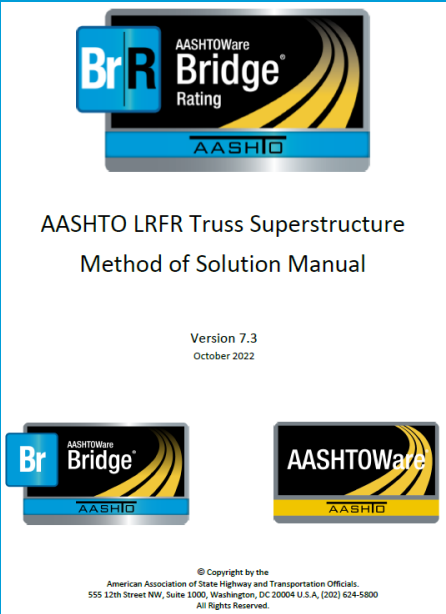
OK Apply Cancel



- Evaluate fastener shear and bearing
- Bolts or rivets
- Refer to F1 Help menu for input definitions

Resources

- AASHTO LFD Truss Method of Solution
- AASHTO LRFD Truss Method of Solution
- F1 Help Menu
- ProMiles BrDR Support



Analysis Limitations

For additional detail refer to:

AASHTO LFD Truss Method of Solution or
AASHTO LRFD Truss Method of Solution

- 2-D finite element engine is used, therefore out of plane deformation requires refined analysis
- Gusset plate analysis input is parametric rather than geometric, therefore refined analysis (FEA for the actual plate geometry) is not supported

Analysis Limitations

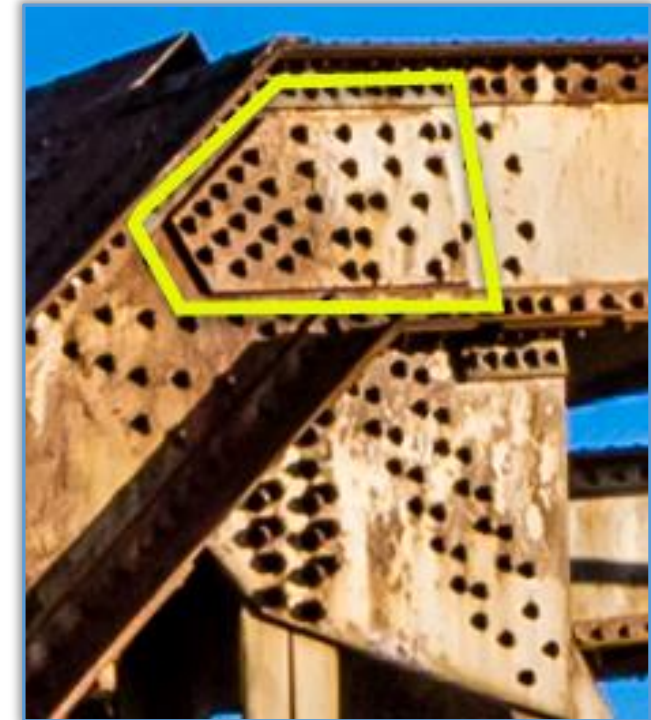
For additional detail refer to:

AASHTO LFD Truss Method of Solution or
AASHTO LRFD Truss Method of Solution

BSSD-3849 Chord
Splice Plate

BSSD-3836
Eccentricity for
fasteners

BSSD-
3229/5718/2982
Load position for
concurrent force



BrDR v7.5 Enhancements

Adjacent Vehicle Analysis (LFR and LRFR)

- Main vehicle uses single lane LLDF
- Adjacent vehicle LLDF is the difference between multi-lane LLDF and single-lane LLDF

Table 6A.4.5.4.2a-1—Permit Load Factors: γ_L

Permit Type	Frequency	Loading Condition	DF ^a	ADTT (one direction)	Load Factor by Permit Weight Ratio ^b		
					GVW / AL < 2.0 (kip/ft)	GVW / AL < 3.0 (kip/ft)	GVW / AL > 3.0 (kip/ft)
Routine or Annual	Unlimited Crossings	Mix with traffic (other vehicles may be on the bridge)	Two or more lanes	>5,000	1.4	1.35	1.30
				=1,000	1.35	1.25	1.20
				<100	1.30	1.20	1.15
	Unlimited Crossings (Reinforced Concrete Box Culverts) ^c	Mix with traffic (other vehicles may be on the bridge)	One lane	All ADTTs	1.40		
All Weights							
Special or Limited Crossing	Single-Trip	Escorted with no other vehicles on the bridge	One lane	N/A	1.10		
	Single-Trip	Mix with traffic (other vehicles may be on the bridge)	One lane	All ADTTs	1.20		
	Multiple Trips (less than 100 crossings)	Mix with traffic (other vehicles may be on the bridge)	One lane	All ADTTs	1.40		

BrDR v7.5 Enhancements

Modified Shear Planes (LFR and LRFR)

BrR v7.4 and Prior

- Horizontal shear plane parallel to the chord member line of action if “Continuous Chord Members” is checked, parallel to true horizontal if not
- Vertical shear plane parallel to true vertical

BrR v7.5

- User can override the angle of the shear planes for global shear



Image from BSSD-2370

BrDR v7.5 Enhancements

Engine Overrides (LFR and LRFR)

- User can override engine to exclude certain members from gusset plate evaluation
- NOTE: This does not run a separate analysis without that member, it just excludes that member force from the evaluation of the shear plane

Gusset Plate Definition

Name: asdf

Description Panel point Fasteners Plate tension Plate compression Chord splice **Plate shear** Plate partial shear Load transfer

Shear reduction factor: 0.88

Left plate

Shear plane	Length (in)	Thickness (in)	Number holes	Hole diameter (in)	Override angle	Override angle (Degrees)	Override member selection	Member Selection							
								1	2	3	4	5	6	7	8
> Vertical	18.00		8.00	1.00	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Horizontal	16.00		8.00	1.00	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Right plate

Same as left plate

Shear plane	Length (in)	Thickness (in)	Number holes	Hole diameter (in)	Override angle	Override angle (Degrees)	Override member selection	Member Selection							
								1	2	3	4	5	6	7	8
> Vertical					<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Horizontal					<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Member arrangement

OK Apply Cancel

Upcoming changes and future enhancements

- Refined analysis methods adapted from IDOT Gusset Plate Evaluation Guide to be incorporated into MBE
- Generic structure
- Truss Engine 2.0

A blue-tinted photograph of a long bridge over a body of water. In the foreground, there are large, dark rocks. A small boat is visible on the water in the middle ground. The sky is overcast with some clouds. The word "Questions?" is written in white, bold, sans-serif font across the center of the image.

Questions?

A blue-tinted photograph of a long bridge over a body of water. In the foreground, there are large, dark rocks. A person is visible in a kayak on the water. The sky is overcast with light clouds. The text "Thank you!" is overlaid in the center in a white, bold, sans-serif font.

Thank you!