Truss Gusset Plate Capabilities and Limitations

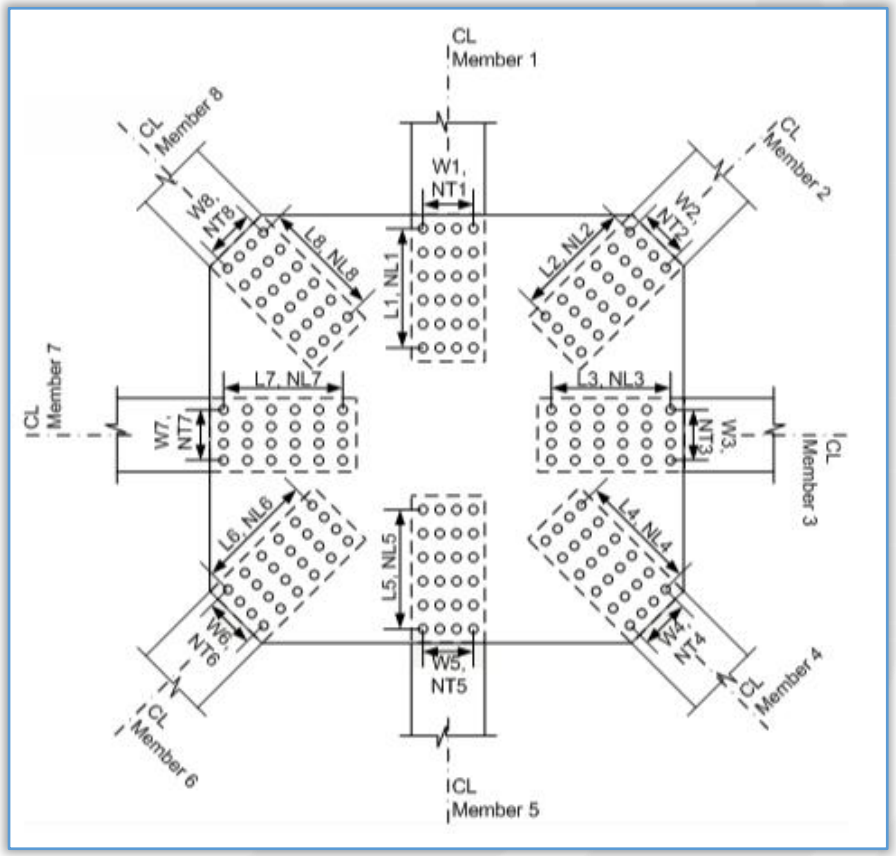
Carolyn Kois, P.E.
ckois@promiles.com

AASHTOWare RADBUG
August 9, 2023

AASHTOWare™ BRIDGE
DESIGN AND RATING

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



ProMiles®

AASHTOWare™ BRIDGE DESIGN AND RATING

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

AASHTOWare™ BRIDGE DESIGN AND RATING

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

AASHTO LRFR

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

ProMiles

AASHTOWare™ BRIDGE DESIGN AND RATING

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

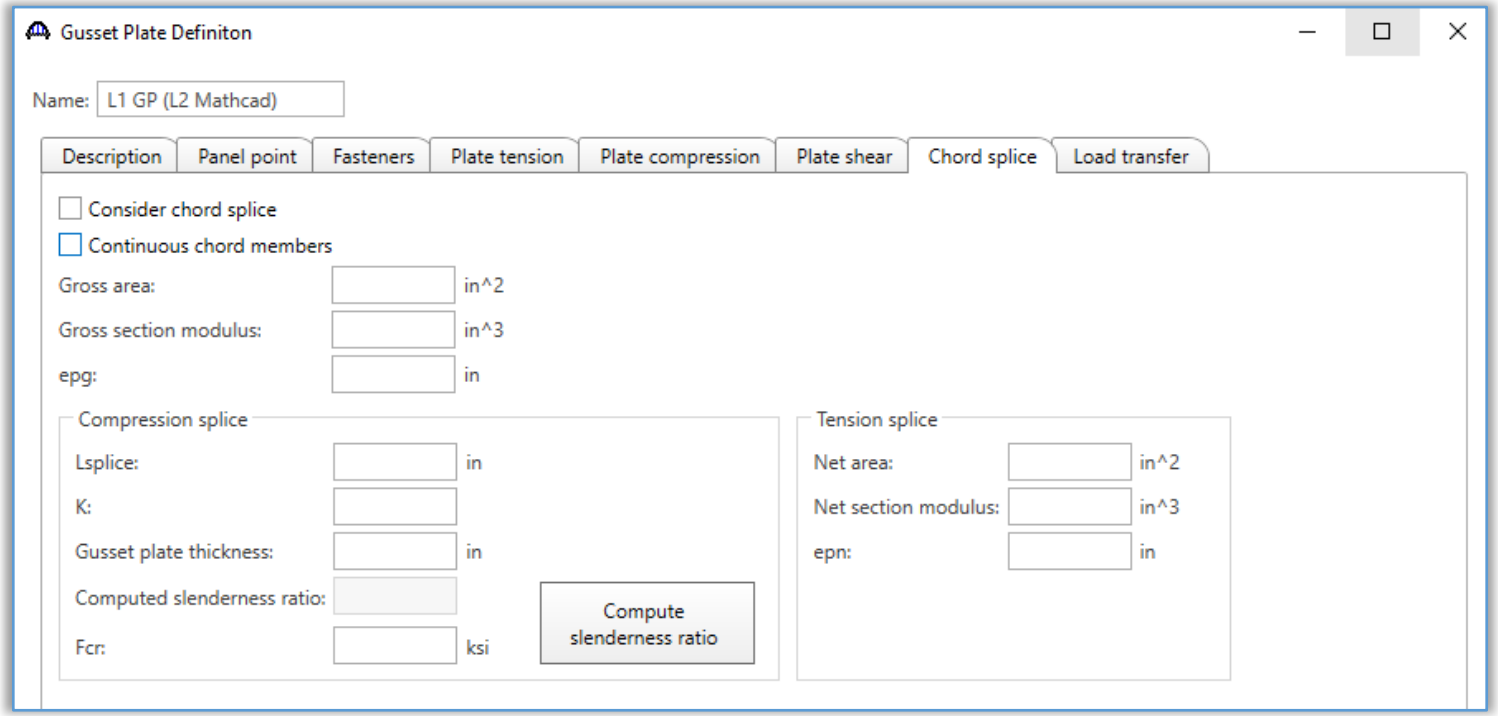
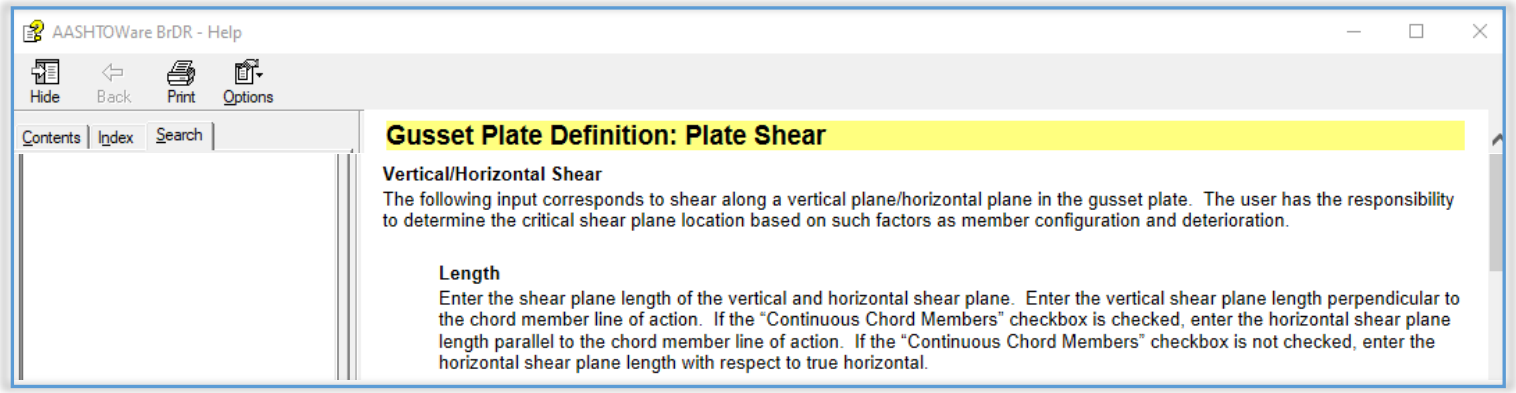
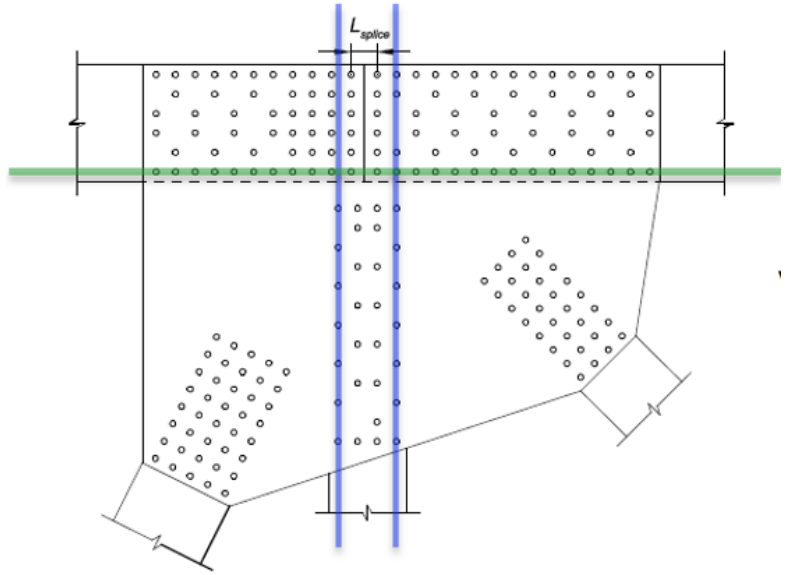


Plate Shear

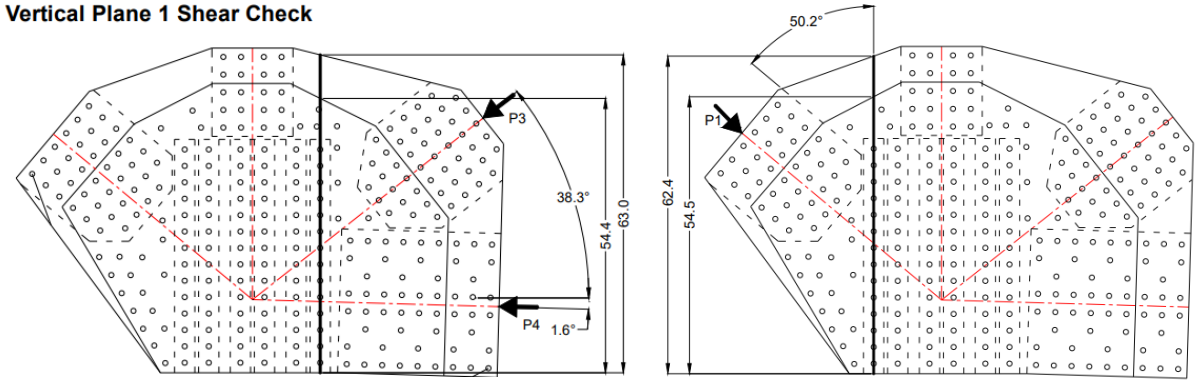




Vertical Plane 2 Shear Check

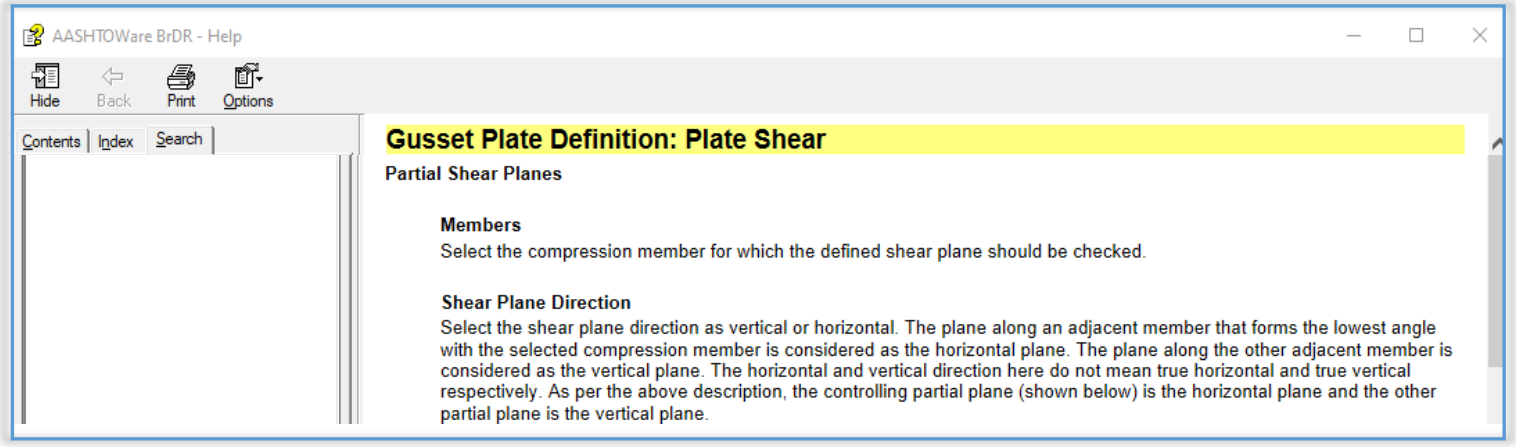
- If "Continuous chord members" is checked on the Chord Splice tab, the horizontal shear plane is considered parallel to the chord
- Otherwise the horizontal plane is considered parallel to true horizontal

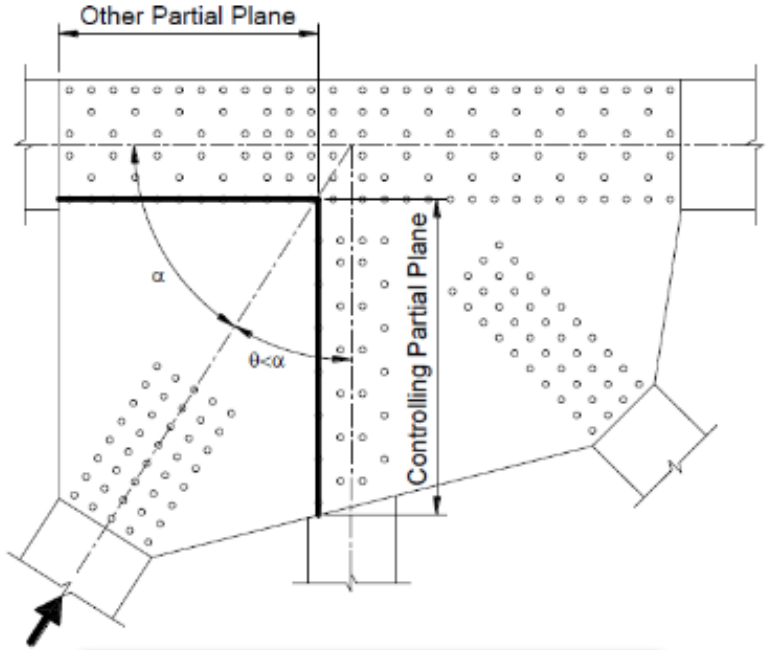
Vertical Plane 1 Shear Check



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

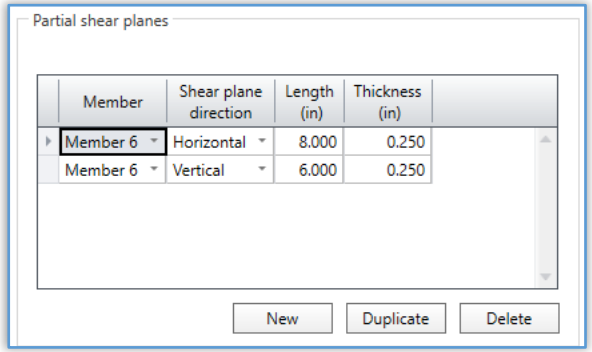


Plate Tension and Compression

Yielding/Net Fracture/Compression

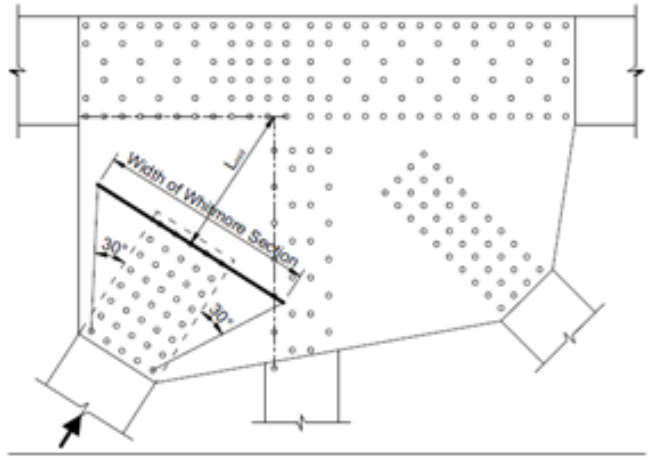


Figure 6A.6.12.6.7-1—Example Connection Showing the Whitmore Section for a Compression Member Derived From 30 Degree Dispersion Angles and the Distance L_{mid}

Block Shear

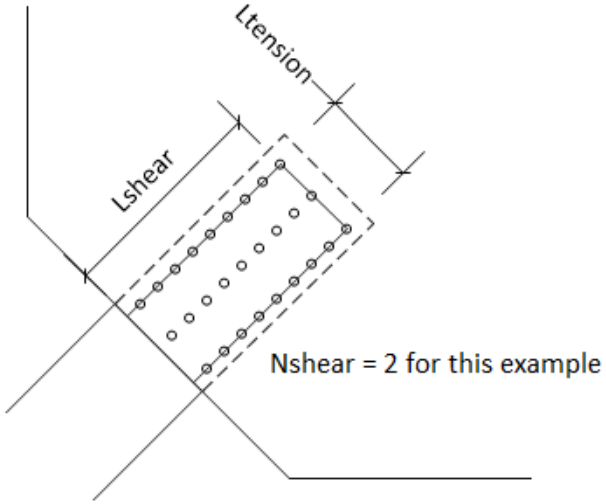
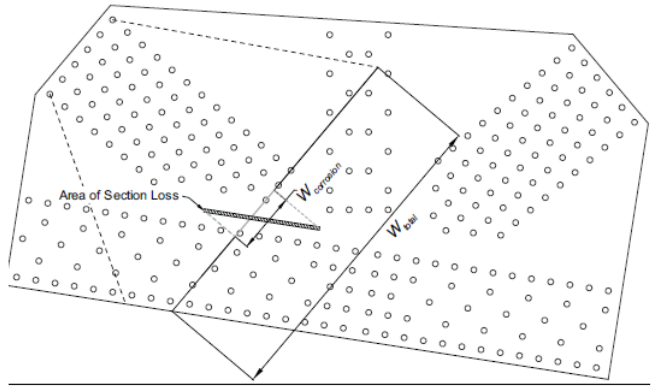


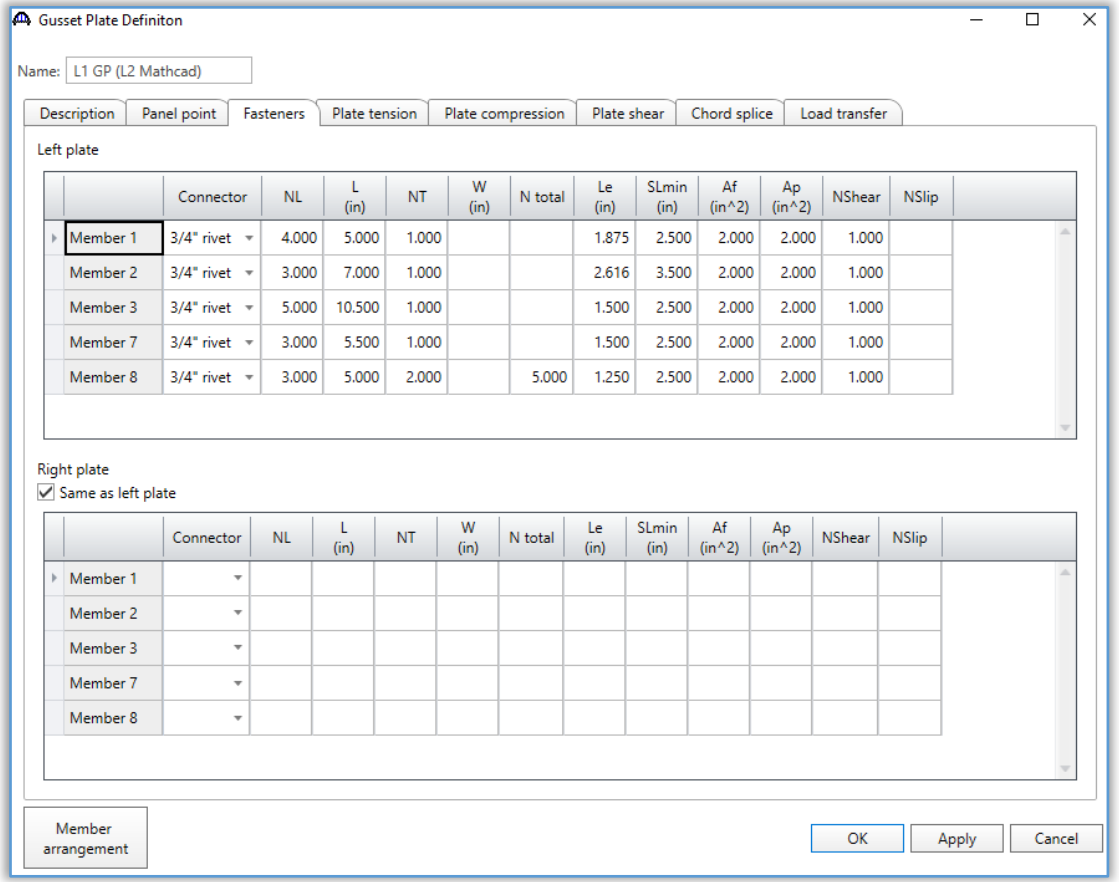
Figure: Block Shear Example

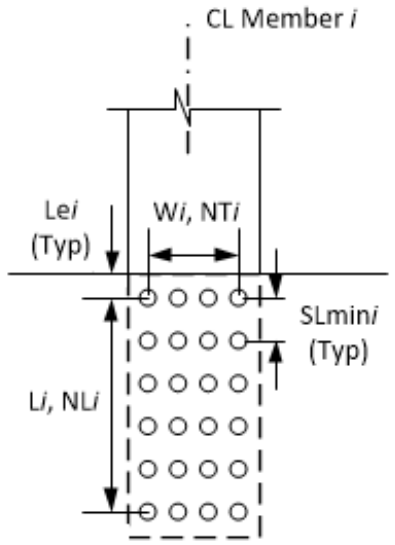


Truncated Whitmore Section

- 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



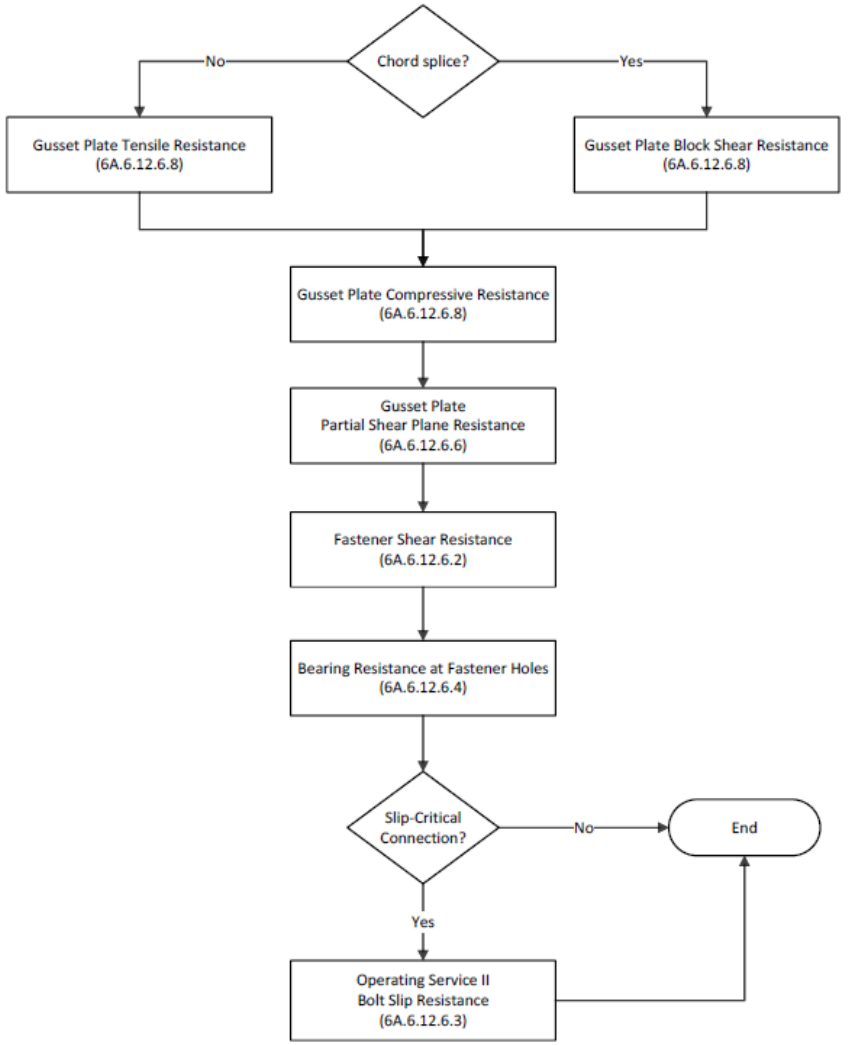


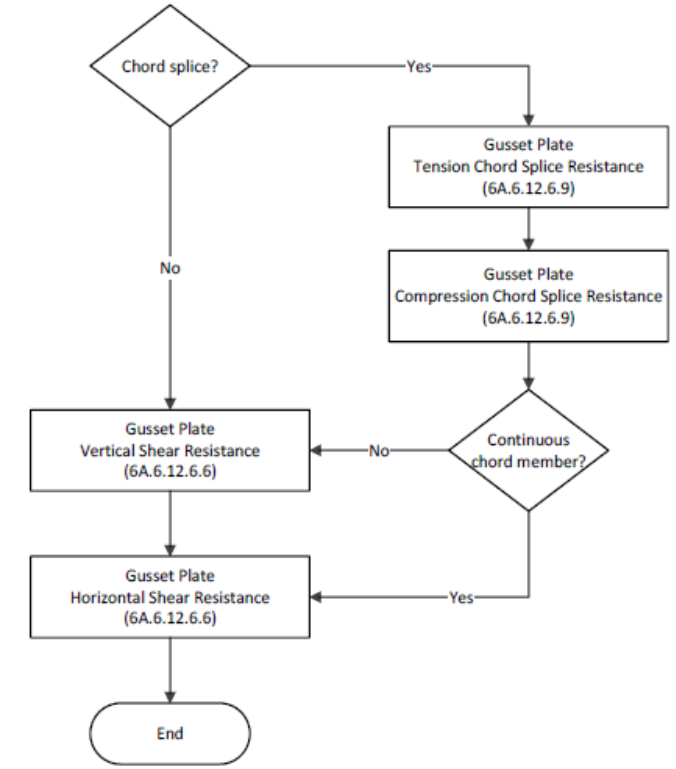
- Evaluate fastener shear and bearing
- Bolts or rivets
- Refer to F1 Help menu for input definitions

Resources

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

ProMiles





AASHTOWare™ BRIDGE DESIGN AND RATING

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

ProMiles

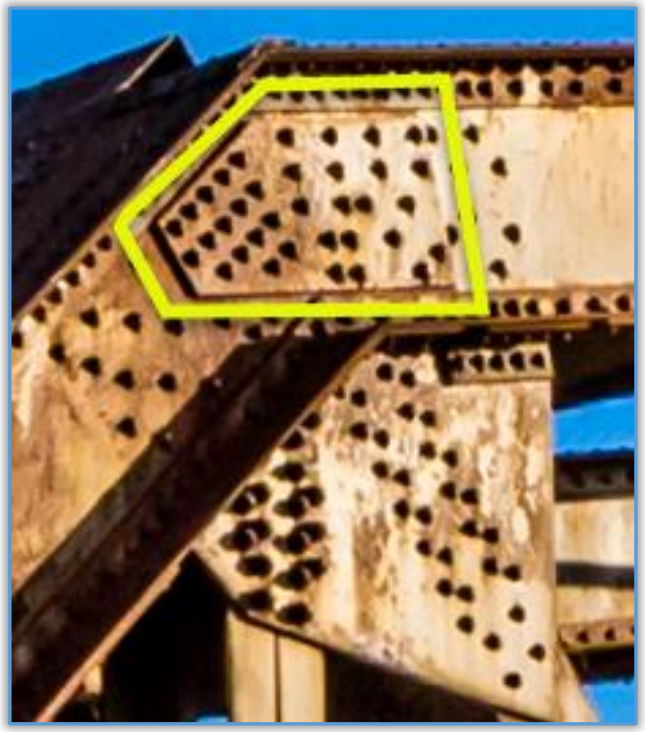
AASHTOWare™ BRIDGE DESIGN AND RATING

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



ProMiles

AASHTOWare™ BRIDGE DESIGN AND RATING

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)	2.0 < 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 *ADTT*s	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 *ADTT*s	1.20		
	Multiple Trips (less than 100 crossings)	Mix with traffic (other vehicles may be on the bridge)	One lane	All *ADTT*s	1.40		

BrDR v7.5 Enhancements

Modified Shear Planes (LFR and LRFR)

<u>BrR v7.4 and Prior</u>

- 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

<u>BrR v7.5</u>

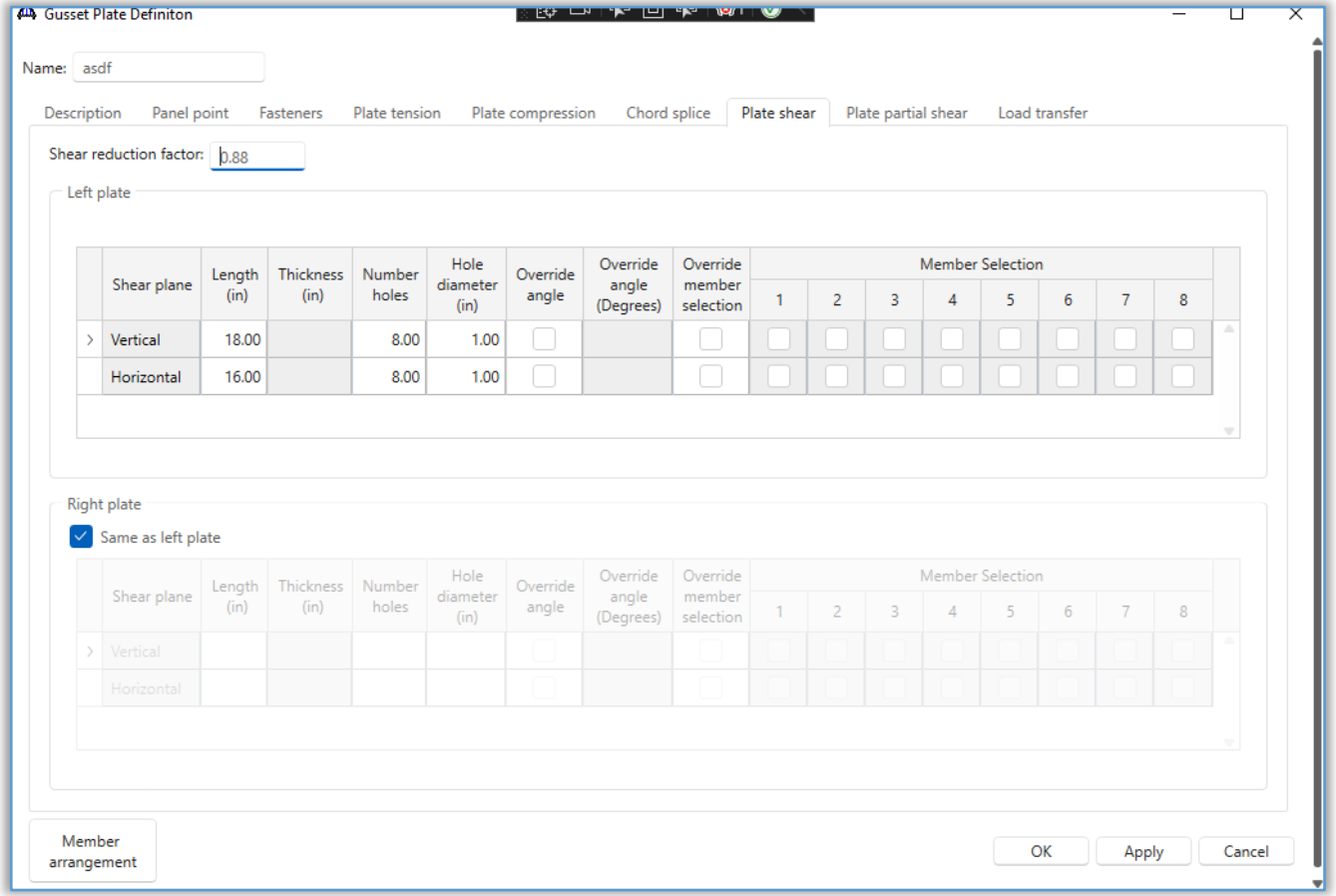
- User can override the angle of the shear planes for global shear

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



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


Questions?


Thank you!