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*AASHTOWare BrDR 7.6.1*  
*Truss Tutorial*  
*Truss Gusset Plate Example*

# TPG1-Truss Gusset Plate Example

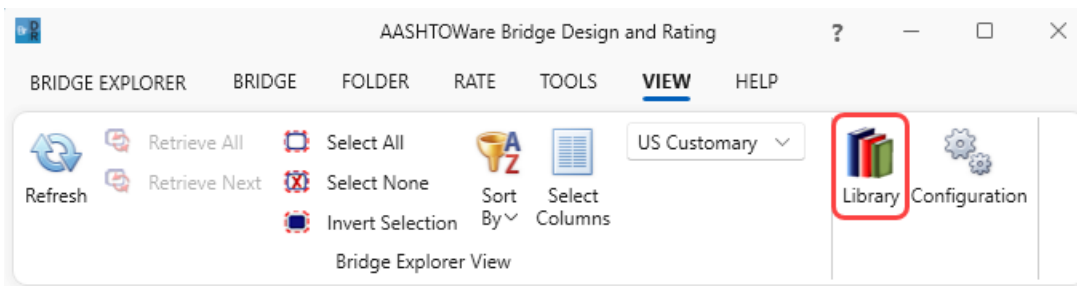
## BrDR Tutorial

### Topics Covered

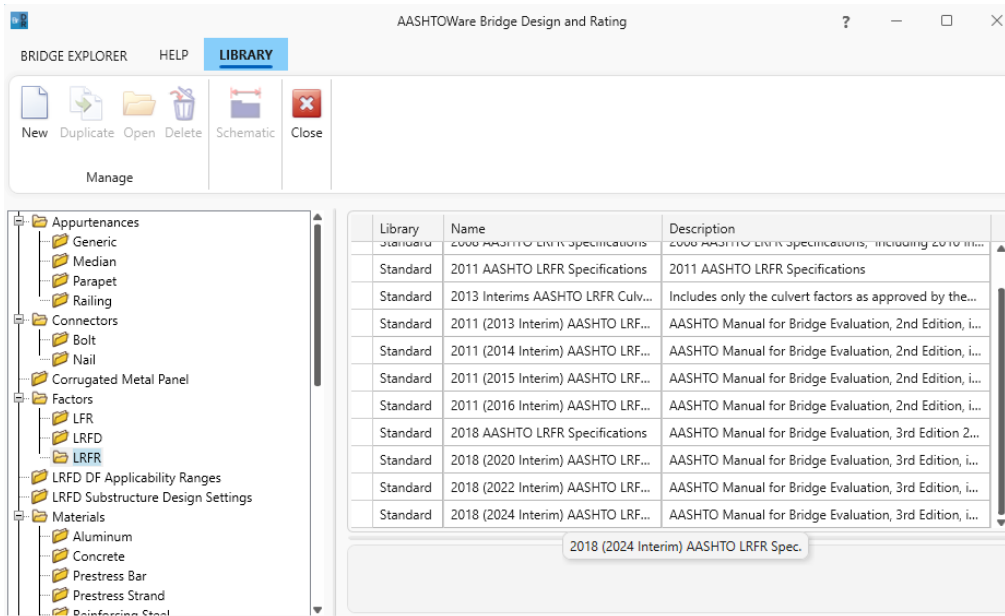
- Gusset plate LRFR factors and LFR factors
- Enter a gusset plate definition
- Assign a gusset plate definition at a panel point
- Perform truss rating with gusset plates and review the results
- Using Manual for Bridge Evaluation, 3<sup>rd</sup> Edition with 2024 interims
- Using AASHTO LRFD Bridge Design Specifications, 10<sup>th</sup> Edition

### Gusset plate LRFR factors and LFR factors

Start BrDR and open the **Library** from the **VIEW** ribbon as shown below.



Select the **LRFR** node under **Factors** to view all the **Standard** LRFR factors as shown below.



Double click on the **2018 (2024 interim) AASHTO LRFR Spec.** to open the following window and select the **Steel** tab. The gusset plate LRFR resistance factors are listed at the bottom of the table.

# TPG1-Truss Gusset Plate Example

AASHTOWare Bridge Design and Rating

BRIDGE EXPLORER    HELP    **LIBRARY**

New Duplicate Open Delete Schematic Close

Manage

- Appurtenances
  - Generic
  - Median
  - Parapet
  - Railing
- Connectors
  - Bolt
  - Nail
  - Corrugated Metal Panel
- Factors
  - LFR
  - LRFD
  - LRFR**
- LRFD DF Applicability Ranges
- LRFD Substructure Design Settings
- Materials
  - Aluminum
  - Concrete
  - Prestress Bar
  - Prestress Strand
  - Reinforcing Steel
  - Soil
  - Structural Steel
  - Timber
  - Wearing Surface
  - Weld
- Metal Box Culvert
- Metal Pipe Culvert
  - Corrugated Metal Pipe
  - Spiral Rib Metal Pipe
  - Structural Plate Pipe
- Prestress Shapes
  - Box Beams
  - I Beams
  - Tee Beams
  - U Beams

Library	Name	Description
Standard	2011 (2014 Interim) AASHTO LRF...	AASHTO Manual for Bridge Evaluation, 2nd Edition, i...
Standard	2011 (2015 Interim) AASHTO LRF...	AASHTO Manual for Bridge Evaluation, 2nd Edition, i...
Standard	2011 (2016 Interim) AASHTO LRF...	AASHTO Manual for Bridge Evaluation, 2nd Edition, i...
Standard	2018 AASHTO LRFR Specifications	AASHTO Manual for Bridge Evaluation, 3rd Edition 2...
Standard	2018 (2020 Interim) AASHTO LRF...	AASHTO Manual for Bridge Evaluation, 3rd Edition, i...
Standard	2018 (2022 Interim) AASHTO LRF...	AASHTO Manual for Bridge Evaluation, 3rd Edition, i...
> Standard	2018 (2024 Interim) AASHTO LRF...	AASHTO Manual for Bridge Evaluation, 3rd Edition, i...

Factors: LRFR: 2018 (2024 Interim) AASHTO LRFR Spec. X

Weld metal - partial penetration: shear par...	0.800
Weld metal - partial penetration: tension n...	0.800
Weld metal - fillet welds: shear in throat of...	0.800
Axial compression: built-up section	0.900
Axial compression: built-up section without...	0.950
Gusset plate: compression	0.950
Gusset plate: basic corner check	1.000
Gusset plate: chord splice	0.850
Gusset plate: shear yielding	1.000
Gusset plate: block shear rupture	1.000
Gusset plate: shear fracture	0.800
Fasteners: bearing on material	0.800
Rivet: shear	0.800

Save Close

## TPG1-Truss Gusset Plate Example

Similarly, click on **LFR** to view the LFR standard factors. Double click on the **2002 AASHTO Std. Specifications** to open the following window and select the **Resistance factors** tab. The gusset plate LFR resistance factors are listed in the table as shown below.

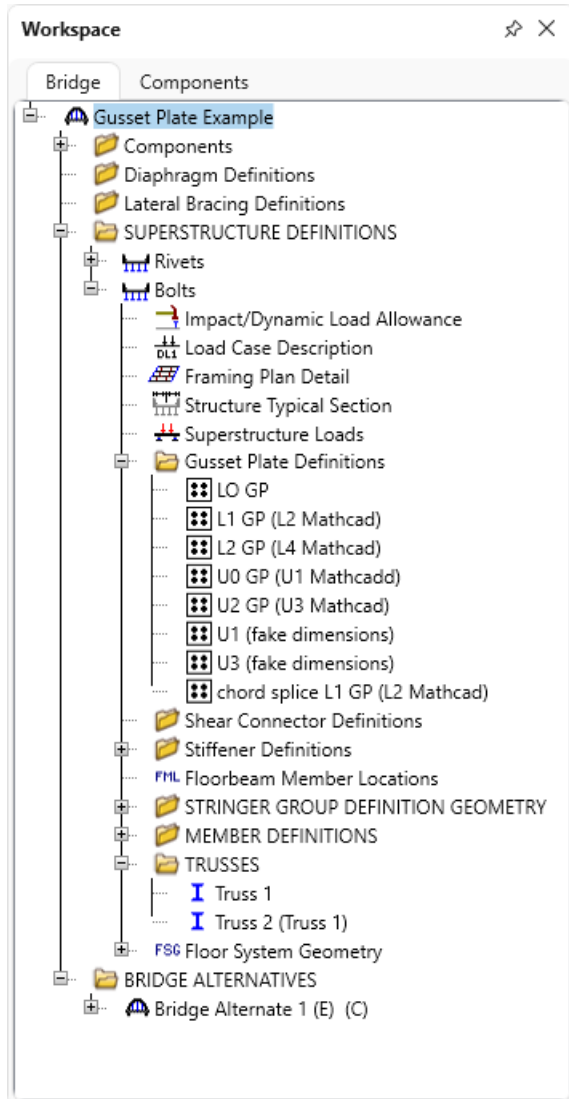
The screenshot shows the AASHTOWare Bridge Design and Rating software interface. The left sidebar displays a tree view of the library structure, with the 'LFR' folder selected under 'Factors'. The main window shows the 'Factors: LFR: 2002 AASHTO Std. Specifications' dialog box. The 'Resistance factors' tab is active, displaying a table of strength reduction factors. A red box highlights the gusset plate and rivet resistance factors.

Resistance	Resistance factor
Precast reinforced concrete culvert: shear	0.900
Gusset plate: shear yielding	1.000
Gusset plate: block shear rupture	0.850
Gusset plate: shear fracture	0.850
Gusset plate: compression	1.000
Gusset plate: chord splice	1.000
Tension: yielding in gross section	1.000
Rivet: shear	0.800
Helical pipe with lock seam or fully welded seam: wall area and buckling	1.000
Annular pipe with spot welded, riveted or bolted seam: wall area and buckling	1.000

## TPG1-Truss Gusset Plate Example

### Enter gusset plate definition

From the **Bridge Explorer**, double click on **BID 28 Gusset Plate Example** to open this bridge. Expand **Bolts** Superstructure definition and the **Gusset Plate Definitions** node in the **Bridge Workspace** tree as shown below.



## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition - Description

Double click on the **L2 GP (L4 Mathcad)** to open the **Gusset Plate Definition** window. **Identical double gusset plates** is selected for this gusset plate definition and the **Material** and **Dimensions** are entered for the **Left plate**. **Left plate** is the plate on the left side of the connection when looking stations ahead. **Right plate** is the plate on the right side of the connection when looking stations ahead. If **Different double gusset plates** is selected, the right plate details must be entered. If **Identical double gusset plates** is selected and **Contains corrosion** is checked, the right plate details must be entered.

The screenshot shows the 'Gusset Plate Definition' window. At the top, the 'Name' field is set to 'L2 GP (L4 Mathcad)'. Below this, there are several tabs: 'Plate compression - partial shear', 'Chord splice', 'Plate shear', 'Load transfer', and 'Control options'. The 'Description' tab is active, showing a large text area for description. Below the description, there are radio buttons for 'Plates': 'Single gusset plates', 'Identical double gusset plates' (which is selected), and 'Different double gusset plates'. To the right of these, there is a 'Condition factor' dropdown set to 'Good or Satisfactory' and a checkbox for 'Contains corrosion' which is unchecked. Below the 'Plates' section, there is a 'Dimensions' section with a checkbox for 'Field measured section properties' which is unchecked. This section is divided into 'Left plate' and 'Right plate' details. The 'Left plate' details include: 'Material' (dropdown set to 'gusset plate 1969'), 'As-built plate thickness' (0.25 in), 'Length' (22.5 in), and 'Height' (12 in). The 'Right plate' details include: 'Material' (dropdown set to 'After 1963'), 'As-built plate thickness' (empty field), 'Length' (empty field), and 'Height' (empty field). At the bottom left, there is a 'Member arrangement' button. At the bottom right, there are 'OK', 'Apply', and 'Cancel' buttons.

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Panel point

Navigate to the **Panel point** tab of this window. This tab specifies the arrangement of truss members present in the gusset plate definition. Member 1,2,3,7 and 8 are present in this gusset plate definition. The truss member arrangement will be validated when the **Gusset Plate Definition** is assigned to a **Panel Point**.

**Gusset Plate Definition**

Name: L2 GP (L4 Mathcad)

Plate compression - partial shear    Chord splice    Plate shear    Load transfer    Control options

Description    **Panel point**    Fasteners    Plate tension    Plate compression - whitmore section    Plate compression - basic corner check

	Present in panel point?
> Member 1	<input checked="" type="checkbox"/>
Member 2	<input checked="" type="checkbox"/>
Member 3	<input checked="" type="checkbox"/>
Member 4	<input type="checkbox"/>
Member 5	<input type="checkbox"/>
Member 6	<input type="checkbox"/>
Member 7	<input checked="" type="checkbox"/>
Member 8	<input checked="" type="checkbox"/>

The diagram illustrates a truss gusset plate arrangement. It shows a central rectangular gusset plate with various members connected to it. Members 1, 2, 3, 7, and 8 are highlighted with blue checkmarks in the table, indicating they are present in the panel point. The diagram includes labels for members (e.g., CL Member 1, ICL Member 2, ICL Member 3, ICL Member 4, ICL Member 5, ICL Member 6, ICL Member 7, ICL Member 8) and fasteners (e.g., W1, NT1, W2, NT2, W3, NT3, W4, NT4, W5, NT5, W6, NT6, W7, NT7, W8, NT8). Dimensions (e.g., L1, NL1, L2, NL2, L3, NL3, L4, NL4, L5, NL5, L6, NL6, L7, NL7, L8, NL8) are also indicated.

Member arrangement

OK    Apply    Cancel

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Fasteners

Navigate to the **Fasteners** tab of this window. Only truss members present in this definition are listed in the tables. **Same as left plate** is checked specifying the fasteners information for the **Right Plate** is the same as the **Left Plate**.

Gusset Plate Definition

Name: L2 GP (L4 Mathcad)

Plate compression - partial shear

Chord splice

Plate shear

Load transfer

Control options

Description

Panel point

Fasteners

Plate tension

Plate compression - whitmore section

Plate compression - basic corner check

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	bolt user defined ▾	3	5	1			1.87505	2.5			1	1	▲
	Member 2	bolt user defined ▾	3	7	1			2.64375	3.5			1	1	
	Member 3	bolt user defined ▾	3	7	1			2.5	3.5			1	1	
	Member 7	bolt user defined ▾	3	7	1			2.5	3.5			1	1	
	Member 8	bolt user defined ▾	3	7	1			2.64375	3.5			1	1	

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

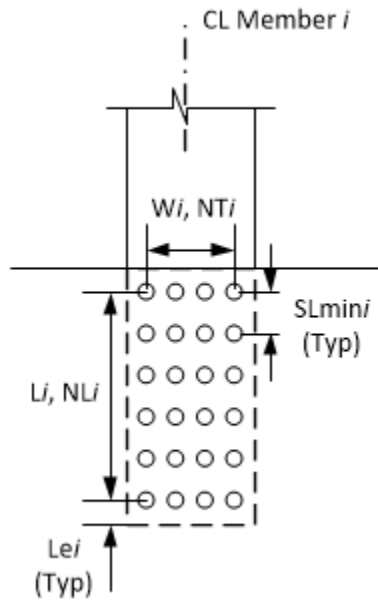
OK

Apply

Cancel



## TPG1-Truss Gusset Plate Example



NL = Number of fasteners in a row along the longitudinal axis of the truss member.

L = Length between extreme fasteners in a row along the longitudinal axis of the truss member.

NT = Number of fasteners in a row along the transverse axis of the truss member.

W = Width between extreme fasteners in a row along the transverse axis of the truss member.

N Total = Total number of fasteners in the connection. Computed as  $NL \times NT$  if left blank.

Le = Distance between center of last fastener and end of gusset plate measured in the direction of the applied bearing force (along the longitudinal axis of the truss member).

SLmin = Minimum center-to-center spacing of fasteners along the longitudinal axis of the truss member.

Af, Ap = Used to compute the fastener shear resistance reduction factor in MBE 6A.6.12.6.2. Leave Af and Ap blank if the reduction factor should not be computed.

NShear = Number of shear planes per fastener.

NSlip = Number of slip planes per fastener.

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Plate tension

Navigate to the **Plate tension** tab of this window. T, Ttension and Tshear are disabled and defaulted to the As-built plate thickness when **Contains corrosion** is not checked in the **Description** tab.

Gusset Plate Definition

Name: L2 GP (L4 Mathcad)

Plate compression - partial shear

Chord splice

Plate shear

Load transfer

Control options

Description
Panel point
Fasteners
**Plate tension**
Plate compression - whitmore section
Plate compression - basic corner check

Left plate

		Yielding and net fracture						Block shear						
		Whitmore width (in)	T (in)	Nfasteners	U	Rp	Beta (LFR)	Ltension (in)	Ttension (in)	NTfasteners	Lshear (in)	Tshear (in)	NVfasteners	NShear
>	Member 1	5.75		1		0.9	0.15	0.75		1	6.875		3	1
	Member 2	8.125		1		0.9	0.15	0.75		1	9.6436		3	1
	Member 3	5.4165		1		0.9	0.15	1.375		1	9.5		3	1
	Member 7	5.4165		1		0.9	0.15	1.375		1	9.5		3	1
	Member 8	8.125		1		0.9	0.15	0.75		1	9.6436		3	1

Right plate

☒ Same as left plate

		Yielding and net fracture						Block shear						
		Whitmore width (in)	T (in)	Nfasteners	U	Rp	Beta (LFR)	Ltension (in)	Ttension (in)	NTfasteners	Lshear (in)	Tshear (in)	NVfasteners	NShear
>	Member 1													
	Member 2													
	Member 3													
	Member 7													
	Member 8													

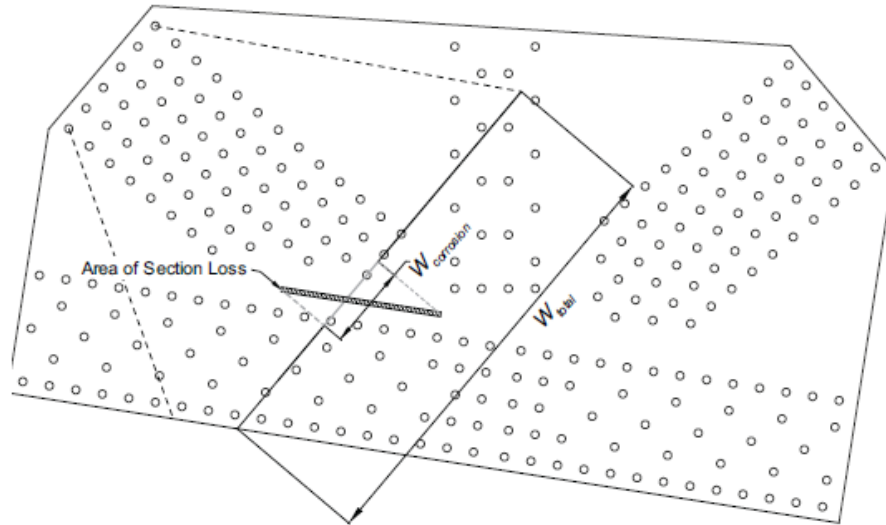
Member arrangement

OK
Apply
Cancel

## TPG1-Truss Gusset Plate Example

### Yielding and Net Fracture:

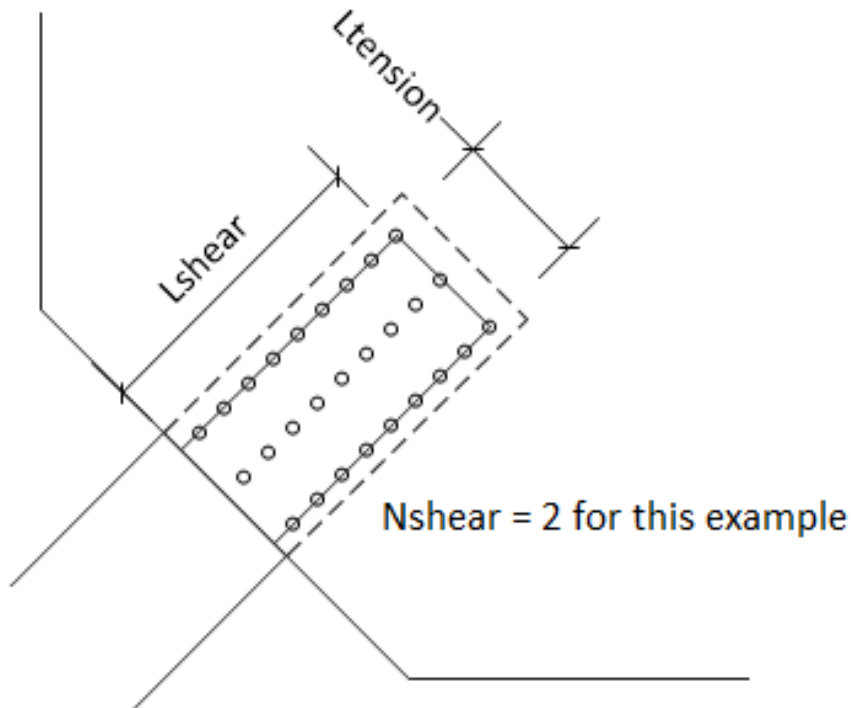
Whitmore Width = Width of the Whitmore section. If left blank, computed as  $W + 2L \times \tan 30^\circ$  where W is the transverse width between extreme fasteners. Refer to MBE Figure 6A.6.12.6.8-1 and Figure C6A.6.5-1. The user should verify that the computed Whitmore Width Cannot be truncated due to the edge of the gusset plate.



- T = Thickness of the gusset plate along the Whitmore section.
- Nfasteners = Number of fasteners along the Whitmore section. Used to compute the net area of the Whitmore section. Defaults to NT if left blank.
- U = Shear lag reduction factor. Defaults to 1.0 if left blank.
- Rp = Reduction factor for holes. Defaults to values in MBE 6A.6.12.6.8-1 based on the assigned bolt definition if left blank.
- Beta = LFR adjustment factor from MBE L6B.2.6.5. Defaults to value from spec if left blank.

## TPG1-Truss Gusset Plate Example

### Block Shear:



$L_{tension}$	= Length of the tension plane.
$T_{tension}$	= Thickness of the gusset plate along the tension plane.
$N_{Tfasteners}$	= Number of fasteners along the tension plane.
$L_{shear}$	= Length of the shear plane.
$T_{shear}$	= Thickness of the gusset plate along the shear plane.
$N_{Vfasteners}$	= Number of fasteners along the shear plane.
$N_{shear}$	= Number of shear planes

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Plate compression

Navigate to the **Plate compression** tab of this window.  $T$ ,  $T_M$ ,  $T_R$  and  $T_L$  are disabled and defaulted to the As-built plate thickness when **Contains corrosion** is not checked in the **Description** tab.

This tab contains input fields for Whitmore section and truncated Whitmore section. Whitmore section is used for LFR analysis and is the default compression method of LRFR analysis.

**Gusset Plate Definition**

Name: L2 GP (L4 Mathcad)

Plate compression - partial shear      Chord splice      Plate shear      Load transfer      Control options

Description      Panel point      Fasteners      Plate tension      **Plate compression - whitmore section**      Plate compression - basic corner check

Left plate

		Whitmore section				Truncated whitmore section (in)								
		Whitmore width (in)	T (in)	Lmid (in)	K (LFR)	$T_M$	$L_M$	$W_M$	$T_R$	$L_R$	$W_R$	$T_L$	$L_L$	$W_L$
>	Member 1	5.75		3.75	0.5									
	Member 2	8.125		3.75	0.5									
	Member 3	5.4165		3.5	0.5									
	Member 7	5.4165		3.5	0.5									
	Member 8	8.125		5.25	0.5									

Right plate

☒ Same as left plate

		Whitmore section				Truncated whitmore section (in)								
		Whitmore width (in)	T (in)	Lmid (in)	K (LFR)	$T_M$	$L_M$	$W_M$	$T_R$	$L_R$	$W_R$	$T_L$	$L_L$	$W_L$
>	Member 1													
	Member 2													
	Member 3													
	Member 7													
	Member 8													

Member arrangement

OK      Apply      Cancel

### Plate Compression – Whitmore Section

Whitmore Width = Width of the Whitmore section. Computed as  $W + 2L \times \tan 30^\circ$  if left blank. Refer to MBE Figure 6A.6.12.6.7a-1.

$T$  = Thickness of the gusset plate along the Whitmore section.

$L_{mid}$  = Distance from the middle of the Whitmore section to the nearest member fastener line in the direction of the member

$K$  = Column effective length factor. Defaults to 0.5 if left blank.

## TPG1-Truss Gusset Plate Example

### Plate Compression – Truncated Whitmore Section (LRFR only)

If the Whitmore section for a specific member is not truncated or if the Basic Corner Check method is to be used for a specific member, no input is required in these fields for that member.

$L_M$ ,  $L_R$  and  $L_L$  = Distance from the middle, right or left of the truncated Whitmore section to the nearest fastener line. Refer to MBE Figure 6A.6.12.6.7-1.

$W_M$ ,  $W_R$  and  $W_L$  = Width of the middle, right or left portion of the truncated Whitmore section as shown in MBE Figure 6A.6.23.6.7-1.

$T_M$ ,  $T_R$  and  $T_L$  = Thickness of gusset plate along the corresponding portion of the truncated Whitmore section.

Gusset Plate Definition

Name:
L2 GP (L4 Mathcad)

Plate compression - partial shear
Chord splice
Plate shear
Load transfer
Control options

Description
Panel point
Fasteners
Plate tension
Plate compression - whitmore section
Plate compression - basic corner check

Left plate

		Basic corner check													
		Parallel surface			Orthogonal surface			Short buckling span				Long buckling span			
		Area (in^2)	e (in)	d (in)	Area (in^2)	e (in)	d (in)	L1 (in)	L2 (in)	r (in)	Adj. surface	a (in)	b (in)	r (in)	T (in)
>	Member 1										▼				
	Member 2										▼				
	Member 3										▼				
	Member 7										▼				
	Member 8										▼				

Right plate
☐ Same as left plate

		Basic corner check													
		Parallel surface			Orthogonal surface			Short buckling span				Long buckling span			
		Area (in^2)	e (in)	d (in)	Area (in^2)	e (in)	d (in)	L1 (in)	L2 (in)	r (in)	Adj. surface	a (in)	b (in)	r (in)	T (in)
>	Member 1										▼				
	Member 2										▼				
	Member 3										▼				
	Member 7										▼				
	Member 8										▼				

Member arrangement

OK
Apply
Cancel

### Plate Compression – Basic Corner Check (LRFR Only)

This input is used for LRFR analysis when the **Basic corner check** is selected in the **Control options** tab. If the Basic Corner Check compression analysis is not applicable for a specific member or if this option is not enabled in the **Control options** tab, no input is required in these fields for that member.

## TPG1-Truss Gusset Plate Example

### Parallel Surface and Orthogonal Surface

These values correspond to the surface that is parallel or orthogonal to the chord member. Refer to MBE Figure 6A.6.12.6.7b-1.

- Area = Area of the surface that is parallel or orthogonal to the chord member.
- e = Distance from the work point to the plane of the parallel or orthogonal surface as shown in MBE Figure 6A.6.12.6.7b-1.
- d = Distance from the work point to the centroid of the parallel or orthogonal surface as shown in MBE Figure 6A.6.12.6.7b-1.

### Short Buckling Span

- L1 = Unbraced length for column buckling of the short buckling span measured orthogonally to surface with smaller of the unbraced plate buckling lengths. Distance is from the intersection of the member centerline with the row of rivets nearest work point to nearest member edge. Refer to MBE Figure 6A.6.12.6.7b-2.
- L2 = Unbraced length for column buckling of the short buckling span measured orthogonally to surface with smaller of the unbraced plate buckling lengths. Distance is from the intersection of member centerline with the leading member edge to nearest fastener of another truss member. Refer to MBE Figure 6A.6.12.6.7b-2.
- r = Radius of gyration for short buckling span. Defaults to As-built plate thickness / sqrt (12.0) if left blank.
- Adj. Surface = Surface adjacent with short buckling span (parallel or orthogonal surface to the chord). The other surface will be considered to be adjacent to the long buckling span.

### Long Buckling Span

- a = Plate buckling length. Refer to MBE Figure 6A.6.12.6.7b-1.
- b = Plate buckling width. Refer to MBE Figure 6A.6.12.6.7b-1.
- r = Radius of gyration for long buckling span. Defaults to As-built plate thickness / sqrt (12.0) if left blank.
- T = Thickness of plate at long buckling span.

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Control Options (LRFR Only)

The screenshot shows the 'Gusset Plate Definition' dialog box with the 'Control options' tab selected. The 'Name' field contains 'L2 GP (L4 Mathcad)'. The 'LRFR' section is expanded, showing the 'Plate compression' options. The 'Whitmore section and partial shear' option is selected with a radio button. Other options include 'Truncated whitmore section', 'Warren truss with vertical member framing into the joint' (unchecked), and 'Basic corner check'. At the bottom, there is a 'Member arrangement' button and 'OK', 'Apply', and 'Cancel' buttons.

The default selection for plate compressive resistance is **Whitmore section and partial shear**.

**Truncated Whitmore section** and **Basic corner check** are only applicable for specific geometric configurations. If the Whitmore section is not truncated or if the basic corner check is not applicable for a specific member, values need not be entered for **Truncated Whitmore section** and **Basic corner check** for that member.

If **Truncated Whitmore section** is selected, but no Truncated Whitmore section values are entered for a specific member, compression analysis for that member will default back to **Whitmore section and partial shear**. The **Truncated Whitmore section** compression resistance method will however be used for members that have values entered for **Truncated Whitmore section** compressive resistance.

If **Basic corner check** is selected, but no values are entered for a specific member or if the member is not adjacent to a chord member, compression analysis for that member will default back to **Truncated Whitmore section** (if values are entered) or **Whitmore Section and partial shear** if values for **Truncated Whitmore section** are not entered. The **Basic corner check** compressive resistance method will be used for members that have values entered for this compressive resistance method and are adjacent to a chord member.



## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Plate shear

Navigate to the **Plate shear** tab of this window. Thickness is disabled and defaulted to the As-built plate thickness when **Contains corrosion** is not checked in the **Description** tab. The user has the responsibility to determine the critical shear plane locations based on such factors as member configuration and deterioration.

The screenshot shows the 'Gusset Plate Definition' dialog box with the 'Plate shear' tab selected. The 'Name' field is 'L2 GP (L4 Mathcad)'. The 'Shear reduction factor' is 0.88. The 'Left plate' section contains a table with 2 rows: 'Vertical' and 'Horizontal'. The 'Right plate' section has a checked box 'Same as left plate' and an empty table. At the bottom are 'Member arrangement', 'OK', 'Apply', and 'Cancel' buttons.

Name: L2 GP (L4 Mathcad)

Description    Panel point    Fasteners    Plate tension    Plate compression - whitmore section    Plate compression - basic corner check  
Plate compression - partial shear    Chord splice    **Plate shear**    Load transfer    Control options

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	12		3	0.8125	<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	22.5		6	0.8125	<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

Shear reduction factor    = Shear reduction factor for the gusset plate. Defaults to 0.88.

#### Vertical Shear Plane and Horizontal Shear Plane:

Length    = Length of the shear plane.

Thickness    = Thickness of the gusset plate along the shear plane.

Number of Holes    = Number of holes in the shear plane for the shear rupture check.

Hole Diameter    = Diameter of holes in the shear plane.

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Plate partial shear

Navigate to the **Plate partial shear** tab of this window.

The screenshot shows the 'Gusset Plate Definition' dialog box with the 'Plate partial shear' tab selected. The 'Name' field is 'L2 GP (L4 Mathcad)'. The 'Description' is 'Plate compression - partial shear'. The 'Panel point' is 'Chord splice'. The 'Fasteners' tab is active. The 'Plate tension' tab is also visible. The 'Plate compression - whitmore section' and 'Plate compression - basic corner check' tabs are also visible. The 'Plate partial shear' tab is selected. The 'Load transfer' and 'Control options' tabs are also visible. The 'Left plate partial shear planes' table is shown with 4 rows. The 'Right plate partial shear planes' section is empty, with a checkbox 'Same as left plate' checked. The 'Member arrangement' button is at the bottom left. The 'OK', 'Apply', and 'Cancel' buttons are at the bottom right.

Member	Shear plane direction	Length (in)	Thickness (in)	Advanced options	Override Angle (Degrees)
> Member 8	Horizontal	11.25		<input type="checkbox"/>	
Member 8	Vertical	10.625		<input type="checkbox"/>	
Member 2	Horizontal	11.25		<input type="checkbox"/>	
Member 2	Vertical	10.625		<input type="checkbox"/>	

Right plate partial shear planes

☒ Same as left plate

Member	Shear plane direction	Length (in)	Thickness (in)	Advanced options	Override Angle (Degrees)
--------	-----------------------	-------------	----------------	------------------	--------------------------

Member arrangement

OK Apply Cancel

### Partial Shear Planes:

- Member = Specify the compression member for which the defined shear plane should be checked.
- Shear Plane Direction = Specify the direction of the partial shear plane.
- Length = Length of the partial shear plane.
- Thickness = Thickness of the gusset plate along the partial shear plane.

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Chord splice

Navigate to the **Chord splice** tab of this window.

The screenshot shows the 'Gusset Plate Definition' dialog box with the 'Chord splice' tab selected. The 'Name' field is 'L2 GP (L4 Mathcad)'. The 'Chord splice' tab is active, showing options for 'Consider chord splice' (unchecked) and 'Continuous chord members' (checked). Below these are input fields for 'Gross area' (in^2), 'Gross section modulus' (in^3), and 'epg' (in). There are two main sections: 'Compression splice' and 'Tension splice'. The 'Compression splice' section includes 'Lsplice' (in), 'K' (unitless), 'Gusset plate thickness' (in), 'Computed slenderness ratio' (disabled), and 'Fcr' (ksi). The 'Tension splice' section includes 'Net area' (in^2), 'Net section modulus' (in^3), and 'epn' (in). A 'Compute slenderness ratio' button is located between the two splice sections. At the bottom, there is a 'Member arrangement' button and 'OK', 'Apply', and 'Cancel' buttons.

Consider chord splice

= Check this box if the chord splice articles should be considered.

Continuous chord members

= Check this box if the chord is continuous at this gusset plate. If the chord is continuous, there is no need to check the vertical shear plane capacity. This does not affect % load transfer. If checked, the horizontal shear plane force calculation will be along the corresponding chord member. If not checked, the horizontal shear plane force calculation will be with respect to true horizontal.

Gross area

= Gross area,  $A_g$ , of all plates in the cross-section intersecting the spliced plane.

Gross section modulus

= Gross section modulus,  $S_g$ , of all plates in the cross-section intersecting the spliced plane. Use the section modulus that corresponds to the edge of the splice (top or bottom) that sees the maximum axial plus bending stress.

## TPG1-Truss Gusset Plate Example

$e_{pg}$  = Distance between the centroid of the gross cross-section and the resultant force perpendicular to the spliced plane.

### Compression Splice:

$L_{splice}$  = Center-to-center distance between the first lines of fasteners in adjoining chords.

$K$  = Effective column length factor. Defaults to 0.5 if left blank.

Gusset plate thickness = Thickness of the gusset plate. Used to compute the slenderness ratio. Defaults to the minimum of left and right As-built plate thickness if left blank.

Computed slenderness ratio = The computed slenderness ratio of the chord splice.

$F_{cr}$  = If the computed slenderness ratio is less than 25 as per MBE 6A.6.12.6.9-2, the  $F_{cr}$  is set to  $F_y$ .

### Tension Splice:

Net area = Net area,  $A_n$ , of all plates in the cross-section intersecting the spliced plane.

Net section modulus = Net section modulus,  $S_n$ , of all plates in the cross-section intersecting the spliced plane. Use the section modulus that corresponds to the edge of the splice (top or bottom) that sees the maximum axial plus bending stress.

$e_{pn}$  = Distance between the centroid of the net cross-section and the resultant force perpendicular to the spliced plane.

## TPG1-Truss Gusset Plate Example

### Gusset Plate Definition – Load transfer

Navigate to the **Load transfer** tab of this window.

The screenshot shows the 'Gusset Plate Definition' window with the 'Load transfer' tab selected. The window title is 'Gusset Plate Definition'. Below the title bar, there is a 'Name' field containing 'L2 GP (L4 Mathcad)'. A series of tabs are visible: 'Description', 'Panel point', 'Fasteners', 'Plate tension', 'Plate compression - whitmore section', 'Plate compression - basic corner check', 'Plate compression - partial shear', 'Chord splice', 'Plate shear', 'Load transfer' (selected), and 'Control options'. The main content area contains a table with the following data:

		% Load transfer via fasteners (%)	% Load transfer
>	Member 1		
	Member 2		
	Member 3	100	100
	Member 7	100	100
	Member 8		

Below the table is a 'Member arrangement' button. At the bottom right are 'OK', 'Apply', and 'Cancel' buttons.

% Load Transfer via Fasteners = The dead and live loads used in the fastener rating equations will be adjusted by this percentage. Defaults to 100% if left blank.

% Load Transfer = The dead and live loads used in the gusset plate rating equations will be adjusted by this percentage. Defaults to 100% if left blank.

Close the **L2 GP (L4 Mathcad) Gusset Plate Definition** window by clicking either the **OK** or the **Cancel** button.

## TPG1-Truss Gusset Plate Example

### Truss - Gusset plates

Expand the **TRUSSES** folder in the **Bridge Workspace** tree. Open the **Truss 1** window and navigate to the **Gusset plates** tab. The **L2 GP (L4 Mathcad)** Gusset Plate Definition is assigned to the **L2 Panel point**. The **L2** panel point's gusset plate is included in the truss analysis. If the **Definition Flipped?** option is checked, the member arrangement in the assigned **Gusset Plate Definition** will be flipped vertically. The gusset plate definition's member arrangement will be validated against the panel point's member arrangement when **OK** or **Apply** is clicked.

Truss

Name: Truss 1 Link with: None

Description Gusset plates Specs Factors

Panel point	Gusset plate def	Definition flipped?	Include in analysis?
L0	LO GP	<input type="checkbox"/>	<input checked="" type="checkbox"/>
L1	L1 GP (L2 Mathcad)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
L2	L2 GP (L4 Mathcad)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
L3	L1 GP (L2 Mathcad)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
L4	LO GP	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
U0	U0 GP (U1 Mathcad)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
U1	--None--	<input type="checkbox"/>	<input type="checkbox"/>
U2	U2 GP (U3 Mathcad)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
U3	--None--	<input type="checkbox"/>	<input type="checkbox"/>
U4	U2 GP (U3 Mathcad)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
U5	--None--	<input type="checkbox"/>	<input type="checkbox"/>
U6	U0 GP (U1 Mathcad)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

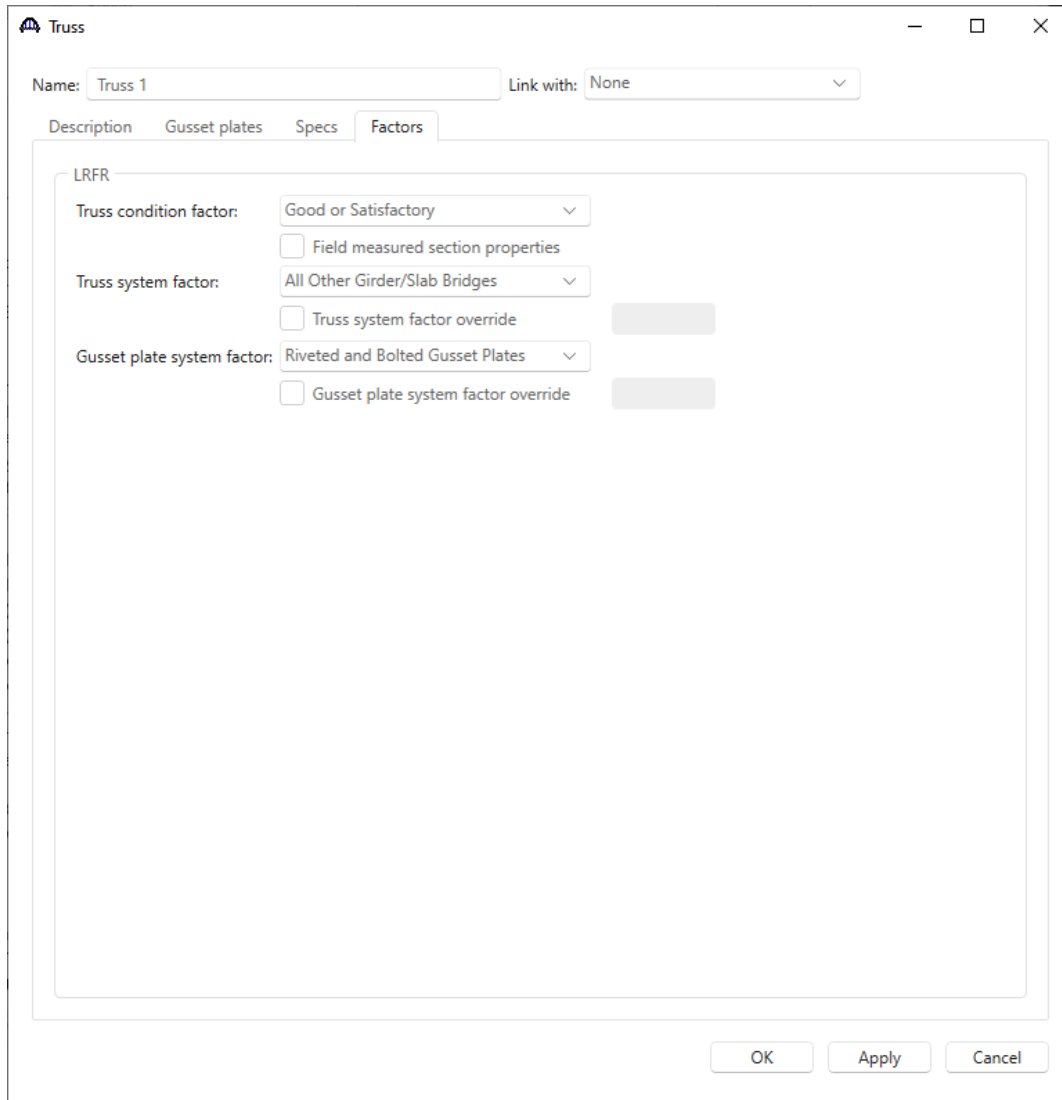
Select all for analysis Clear all for analysis

OK Apply Cancel

## TPG1-Truss Gusset Plate Example

### Truss - Factors

Navigate to the **Factors** tab of this window. The **Gusset plate system factor** is defaulted to **Riveted and Bolted Gusset Plates**.



The screenshot shows the 'Truss' dialog box with the 'Factors' tab selected. The 'Name' field is 'Truss 1' and the 'Link with' dropdown is 'None'. The 'Factors' tab contains the following settings:

- LRFR**
  - Truss condition factor: Good or Satisfactory (dropdown)
  - ☐ Field measured section properties
  - Truss system factor: All Other Girder/Slab Bridges (dropdown)
  - ☐ Truss system factor override
  - Gusset plate system factor: Riveted and Bolted Gusset Plates (dropdown)
  - ☐ Gusset plate system factor override

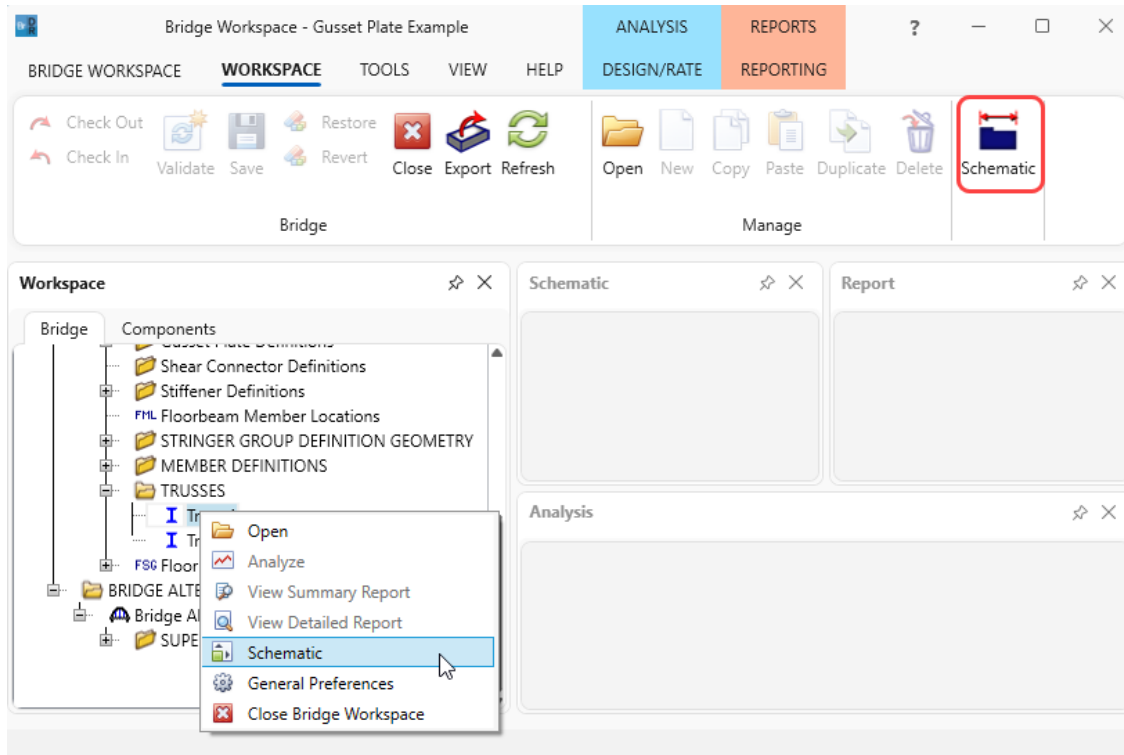
At the bottom of the dialog are three buttons: OK, Apply, and Cancel.

Close the **Truss** window by clicking either the **OK** or the **Cancel** button.

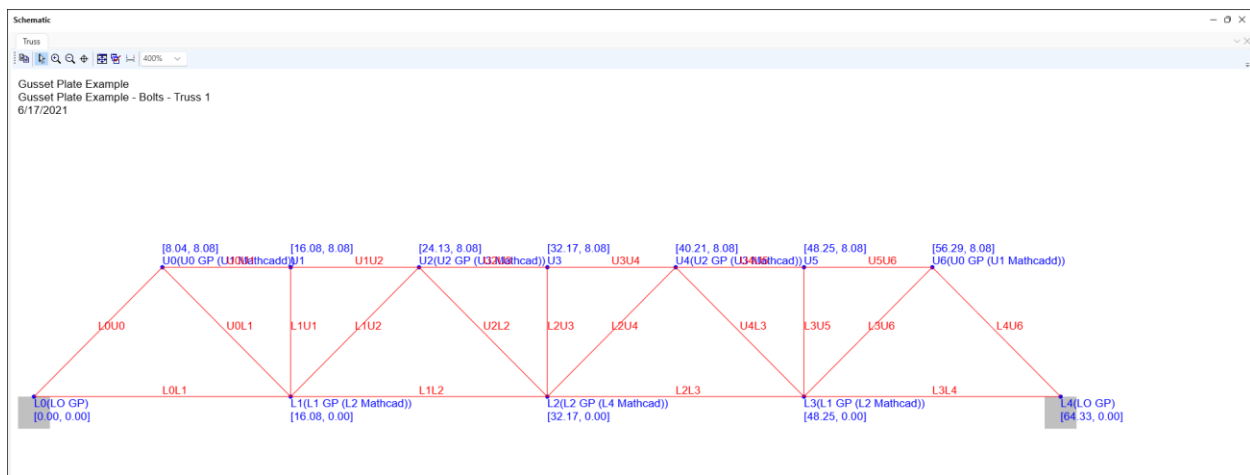
## TPG1-Truss Gusset Plate Example

### Schematic - Truss 1

Select **Truss 1** in the **Bridge Workspace** tree and click the **Schematic** button in the **WORKSPACE** ribbon (or right click and select **Schematic**) to view the schematic of this truss definition as shown below.



The panel point is labeled with the assigned Gusset plate definition.

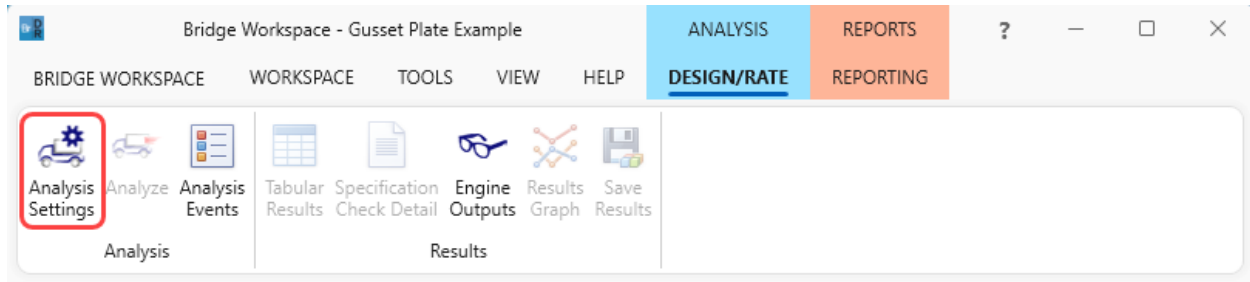




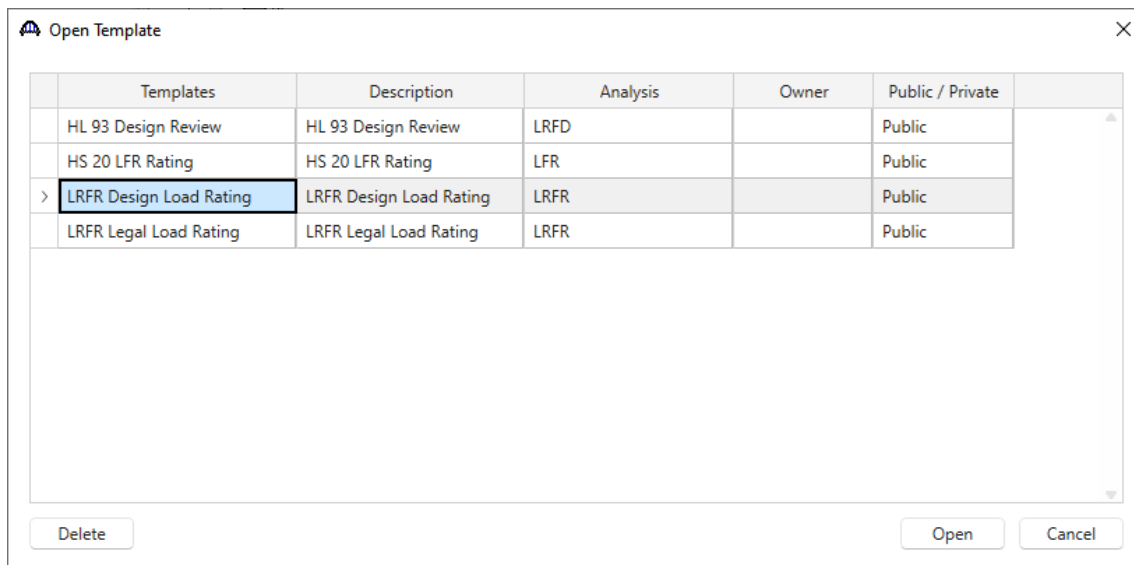
## TPG1-Truss Gusset Plate Example

### LRFR Analysis

To perform an LRFR rating on **Truss 1**, click the **Analysis Settings** button on the **Analysis** group of the **DESIGN/RATE** ribbon. The **Analysis Settings** window shows up.



Click on the **Open template** button in the **Analysis Settings** window. The following window opens. Select the **LRFR Design Load Rating** template and click the **Open** button to apply the template.



## TPG1-Truss Gusset Plate Example

The **Analysis Settings** window gets updated as shown below.

The screenshot shows the 'Analysis Settings' window with the 'Rating' tab selected. The 'Rating method' is set to 'LRFR'. The 'Analysis type' is 'Line Girder' and 'Lane / Impact loading type' is 'As Requested'. The 'Vehicles' tab is active, showing a list of vehicle selection options on the left and a 'Vehicle summary' tree on the right. The 'Vehicle summary' tree includes 'Rating vehicles', 'LRFR', 'Design load rating', 'Inventory', 'HL-93 (US)', 'Operating', 'Fatigue', 'LRFD Fatigue Truck (US)', 'Legal load rating', 'Routine', 'Specialized hauling', and 'Permit load rating'. The 'Add to' and 'Remove from' buttons are visible between the two lists. At the bottom, there are buttons for 'Reset', 'Clear', 'Open template', 'Save template', 'OK', 'Apply', and 'Cancel'.

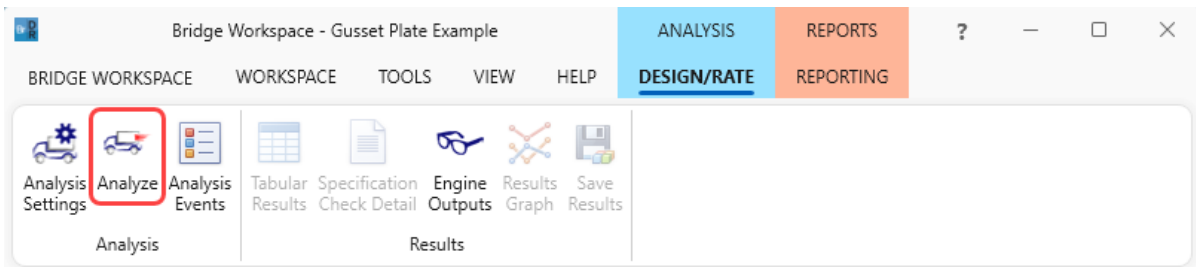
Navigate to the **Output** tab of this window and select the **Truss panel point concurrent forces report** and **Truss panel point maximum forces report**.

The screenshot shows the 'Analysis Settings' window with the 'Output' tab selected. The 'Tabular results' section on the left has four checkboxes: 'Dead load action report', 'Live load action report', 'Truss panel point concurrent forces report', and 'Truss panel point maximum forces report'. The last two are checked and highlighted with a red box. The 'AASHTO engine reports' section on the right has two sub-sections: 'Miscellaneous reports' and 'Specification output'. The 'Specification output' section has a checked checkbox for 'LRFD/LRFR conc article detailed'. At the bottom, there are buttons for 'Reset', 'Clear', 'Open template', 'Save template', 'OK', 'Apply', and 'Cancel'.

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

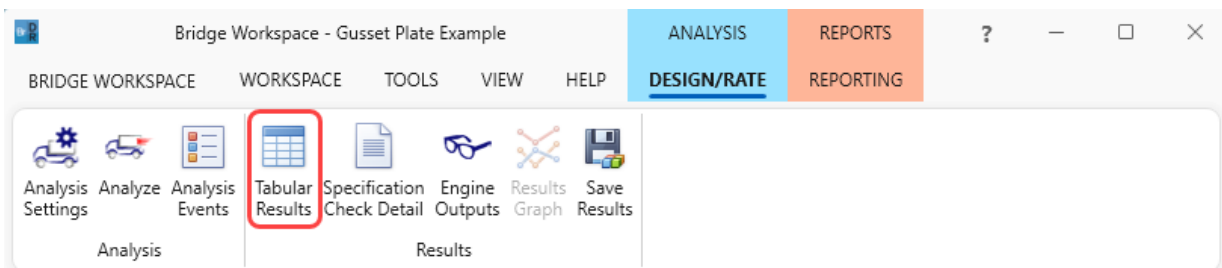
## TPG1-Truss Gusset Plate Example

Select **Truss 1** in the **Bridge Workspace** tree and click the **Analyze** button from the **Analysis** group of the **DESIGN/RATE** ribbon to perform the rating.



### Tabular Results

When the rating analysis is completed, results can be reviewed by selecting the **Truss 1** member in the **Bridge Workspace** tree and clicking the **Tabular Results** button on the **Results** group of the ribbon.



The **Analysis Results** shown below will open. This window shows the critical rating factor considering all truss members and the panel point gusset plates that were included in the analysis. The limit states specific to gusset plate are Gusset Plate Fastener, Gusset Plate Bolt Slip, Gusset Plate Tension, Gusset Plate Compression, Gusset Plate Vertical Shear and Gusset Plate Horizontal Shear. The Rating Results Summary is the only report type available.

Analysis Results - Truss 1

Print

Report type: Rating Results Summary

Lane/Impact loading type: ☒ As requested ☐ Detailed

Display Format: Single rating level per row

Live Load	Live Load Type	Rating Method	Rating Level	Load Rating (Ton)	Rating Factor	Element Name	Limit State	Impact	Lane
HL-93 (US)	Truck + Lane	LRFR	Inventory	8.96	0.249	L3L4 : L4	STR-I Gusset Plate Tension	As Requested	As Requested
HL-93 (US)	Truck + Lane	LRFR	Operating	8.04	0.223	L2L3 : L2	SER-II Gusset Plate Bolt Slip	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Inventory	7.22	0.289	L3L4 : L4	STR-I Gusset Plate Tension	As Requested	As Requested
HL-93 (US)	Tandem + Lane	LRFR	Operating	6.83	0.273	L2L3 : L2	SER-II Gusset Plate Bolt Slip	As Requested	As Requested

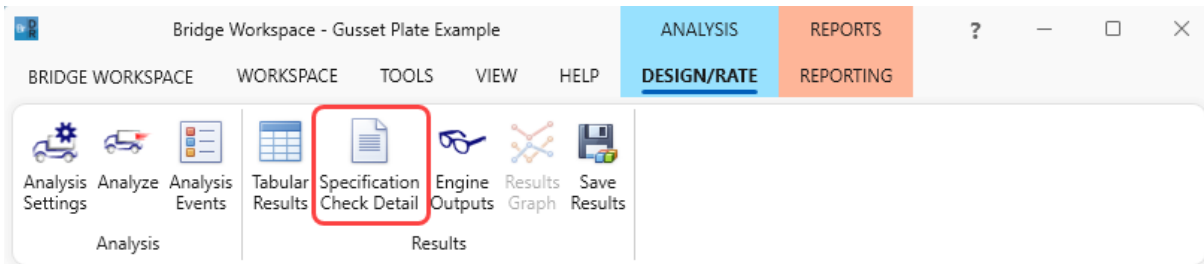
AASHTO LRFR Engine Version 7.6.1.3001  
Analysis preference setting: None

Close

## TPG1-Truss Gusset Plate Example

### Specification Check Detail

From the **Results** tab of the ribbon, click on **Specification Check Detail** to open the **Specification Checks** window.



Gusset plate specification articles specific to a member and the member loads (like fasteners, tension and compression) are listed under the truss member. Gusset plate specification articles that are for the gusset plate and all loads coming into the gusset plate (like shear and chord splice) will be listed under the panel point.

Specification Checks for Truss 1 - 54 of 1130

Properties Generate

Articles: All articles  
Format: Bullet list  
Report

Specification filter

Superstructure Component	Specification reference	Limit State	Flex. Sense	Pass/Fail
Stage 3	6.9.2.1 Axial Compression		N/A	Passed
Truss 1	6.9.2.2.1 Combined Axial Compression and Flexure - General		N/A	Passed
U0U1	6.9.3 Compression Limiting Slenderness Ratio		N/A	Failed
U1U2	6.9.4.1.1 Non slender Element Nominal Compressive Resistance		N/A	General Comp.
U2U3	6.9.4.1.2 Truss Elastic Flexural Buckling Resistance of Truss Members		N/A	General Comp.
U3U4	6.9.4.1.3 Elastic Torsional Buckling and Flexural-Torsional Buckling Resi		N/A	Passed
U4U5	6.9.4.2.2 Slender Longitudinally Unstiffened Cross-Section Elements		N/A	General Comp.
U5U6	6.9.4.2.2b Effective Width of Slender Elements		N/A	General Comp.
L0U0	6.9.4.5 Plate Buckling under Service and Construction Loads		N/A	Passed
L4U6	6A.6.12.5.1 Gusset Plate Rivets in Shear		N/A	Not Applicable
U0L1	6A.6.12.6.1 Gusset Plate Axial Force Rating		N/A	Failed
L1U2	6A.6.12.6.1 Gusset Plate Bolt Slip Resistance Rating		N/A	Passed
U2L2	6A.6.12.6.1 Gusset Plate Fastener Rating		N/A	Passed
L2U4	6A.6.12.6.1 Gusset Plate Partial Shear Plane Rating		N/A	Passed
U4L3	6A.6.12.6.2 Gusset Plate Fastener Shear Resistance - Bolt		N/A	General Comp.
L3U6	6A.6.12.6.3 Gusset Plate Bolt Slip Resistance		N/A	General Comp.
L1U1	6A.6.12.6.4 Gusset Plate Bearing Resistance at Fastener Holes		N/A	General Comp.
L2U3	6A.6.12.6.7a Gusset Plate Compressive Resistance Partial Shear Plane		N/A	General Comp.
L3U5	6A.6.12.6.7a Gusset Plate Compressive Resistance Truncated Whitmore		N/A	Not Applicable
L0L1	6A.6.12.6.7a Gusset Plate Compressive Resistance Whitmore Section		N/A	General Comp.
L1L2	6A.6.12.6.7b Gusset Plate Compressive Resistance Basic Corner Check		N/A	Not Applicable
L2L3	6A.6.12.6.8 Gusset Plate Tensile Resistance		N/A	General Comp.
L3L4	6A.6.12.6.8 Gusset Plate Tensile Resistance Block Shear Rupture		N/A	General Comp.
Truss 1 Panel Points	6A.6.12.6.8 Gusset Plate Tensile Resistance Whitmore Net Fracture		N/A	General Comp.
L0	6A.6.12.6.8 Gusset Plate Tensile Resistance Whitmore Yielding		N/A	General Comp.
L1	6A.6.6-7 Truss Axial Tension and Compression Rating		N/A	Passed
L2	6A.6.8 Truss Combined Axial and Flexure Rating		N/A	Not Applicable
L3	APPD6.2 Yield Moment		N/A	General Comp.
L4	APPD6.3.1 In the Elastic Range (Dc)		N/A	General Comp.
U0	Plastic Moment (Mp) for Steel Noncomposite Sections Plastic Momen		N/A	General Comp.
U2	Steel Elastic Section Properties		N/A	General Comp.
U4				
U6				

## TPG1-Truss Gusset Plate Example

The following list of LRFR specification articles will be checked for gusset plates. The implementation of these articles is described in detail in the **AASHTO LRFR Truss Method of Solution Manual's** Appendix B.

MBE 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.6.12.6.7a	Gusset Plate Compressive Resistance – Partial Shear Plane
6A.6.12.6.7a	Gusset Plate Compressive Resistance – Whitmore Section
6A.6.12.6.7a	Gusset Plate Compressive Resistance – Truncated Whitmore Section
6A.6.12.6.7b	Gusset Plate Compressive Resistance – Basic Corner Check
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

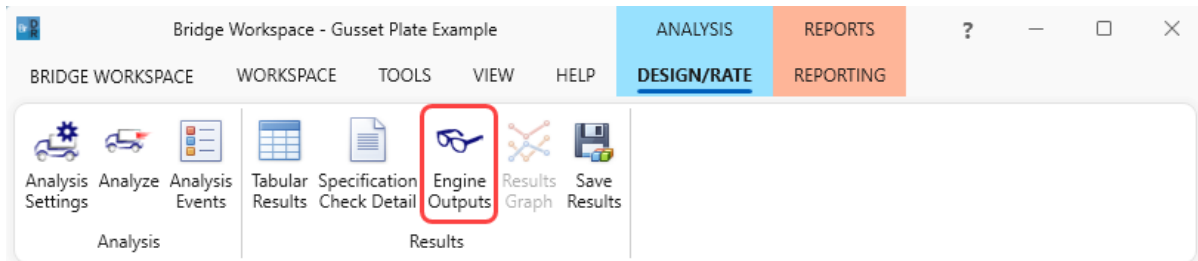
The following list of LFR specification articles will be checked for gusset plates. The implementation of these articles is described in detail in the **AASHTO LFD Truss Method of Solution Manual's** Appendix A.

MBE 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

## TPG1-Truss Gusset Plate Example

### Engine Outputs

After the analysis is complete, the output files can be viewed by clicking the **Engine Outputs** button on the **Results** group of the ribbon.



The **Gusset Plate Section Property Report** contains a listing of the gusset plate data. In the **Rating Results Report**, the **Overall Rating Summary** lists the critical rating results considering the truss member and panel point rating results. For each live load type, the detail truss member rating results, detail panel point rating results, panel point shear action, panel point chord splice action, and panel point shear and chord splice rating results are listed.

