AASHTOWare BrR 6.8

Truss Tutorial

Truss Gusset Plate Example
AASHTOWare Bridge Rating Training

TGP1 – Truss Gusset Plate Example

Topics Covered

- Gusset plate LRFR Factors and LFD Factors
- Enter Gusset Plate Definition
- Assign Gusset Plate Definition at Panel Point
- Perform truss rating with gusset plates and review results

Start BrDR or BrR and open the Library Explorer, expand the Factors library item’s LRFR folder and select the Standard folder.
Open the 2011 (2016 Interim) AASHTO LRFR Spec. LRFR Factors and select the Steel tab. The gusset plate LRFR resistance factors are listed at the bottom of table.

Close the LRFR Factors window.
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Expand the Factors library item’s LFD folder and select the Standard folder. Open the 2002 AASHTO Std. Specifications LFD Factors and select the Phi Factors tab. The gusset plate LFD strength reduction factors are listed at the bottom of table.

Close the LFD Factors window and the Library Explorer.
From the Bridge Explorer, open the Bridge Workspace for BID 28 (Gusset Plate Example). Expand the Bolts Superstructure Definition and the Gusset Plate Definitions folder. The Bridge Workspace for BID 28 (Gusset Plate Example) is shown below.
Open the L2 GP (L4 Mathcad) Gusset Plate Definition. 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.
Select the Panel Point tab. 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.
Select the Fasteners tab. Only truss members present in this Gusset Plate 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.
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 NLxNT 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.
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Select the Plate Tension tab. T, Ttension and Tshear are disabled and defaulted to the As-built plate thickness when Contains corrosion is not checked in the Description tab.

Yielding and Net Fracture:
Whitmore Width = Width of the Whitmore section. If left blank, computed as W + 2L x tan30° where W is the transverse width between extreme fasteners. Refer to MBE Figure 6A.6.12.6.8-1. The user should verify that the computed Whitmore Width cannot be truncated due to the edge of the gusset plate.
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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.

Block Shear:

Ltension = Length of the tension plane.
Ttension = Thickness of the gusset plate along the tension plane.
NTfasteners = Number of fasteners along the tension plane.
Lshear = Length of the shear plane.
Tshear = Thickness of the gusset plate along the shear plane.
NVfasteners = Number of fasteners along the shear plane.
Nshear = Number of shear planes

Nshear = 2 for this example
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Select the Plate Compression tab. T is disabled and defaulted to the As-built plate thickness when Contains corrosion is not checked in the Description tab.

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

$T$ = 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.
Select the Plate Shear tab. 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.

![Gusset Plate Definition](image)

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.

**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.

Select the Chord Splice tab.
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, Ag, of all plates in the cross-section intersecting the spliced plane.
Gross section modulus = Gross section modulus, Sg, 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.
epg = 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.

Fcr = If the computed slenderness ratio is less than 25 as per MBE 6A.6.12.6.9-2, the Fcr is set to Fy.

**Tension Splice:**

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

Net section modulus = Net section modulus, Sn, 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.

epn = Distance between the centroid of the net cross-section and the resultant force perpendicular to the spliced plane.

Select the Load Transfer tab.

% 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.
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Expand the TRUSSES folder in the Bridge Workspace tree. Open the Truss 1 and select 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 Definition Flipped? 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.
Select the Factors tab. The Gusset Plate System Factor is defaulted to Riveted and Bolted Gusset Plates.

Close the Truss 1.
Open the Truss 1 schematic. The Panel Point is labeled with the assigned Gusset Plate Definition. Close the Truss 1 schematic.
Open the Analysis Settings window and select the LRFR Design Load Rating template.

Select the Output tab and select the Truss Panel Point Concurrent Forces Report and the Truss Panel Point Maximum Forces Report. Click OK to save the analysis settings and close the window.
With Truss 1 selected in the Bridge Workspace tree, click on the Analyze button on the Bridge Workspace toolbar to start the truss rating analysis. The Analysis Progress window will appear showing the progress. Click Ok to close the Analysis Progress window after the analysis is completed.

Open the Analysis Results window. 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. Rating Results Summary is the only report type available.
Open the Specification Checks window. Gusset plate specification articles specific to a member and the member loads (like fasteners, tension and compression) is 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.
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.

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<tr>
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<th>Description</th>
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<td>6A.6.12.6.8</td>
<td>Gusset Plate Tensile Resistance – Block Shear Rupture</td>
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<td>6A.6.12.6.8</td>
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<td>6A.6.12.6.9</td>
<td>Chord Splices – Compressive Resistance</td>
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<td>6A.6.12.6.9</td>
<td>Chord Splices – Tensile Resistance</td>
</tr>
<tr>
<td>6A.6.12.6.1</td>
<td>Resistance Reduction for DL/LL Ratio</td>
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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.

<table>
<thead>
<tr>
<th>MBE Article</th>
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<td>L6B.2.6.1</td>
<td>Fasteners – Shear</td>
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<tr>
<td>L6B.2.6.1</td>
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<td>L6B5.3.1</td>
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<tr>
<td>L6B.2.6.1</td>
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<td>Gusset Plate Compressive Resistance</td>
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<td>L6B.2.6.5</td>
<td>Gusset Plate Tensile Resistance – Block Shear Rupture</td>
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<td>L6B.2.6.6</td>
<td>Chord Splices – Tensile Resistance</td>
</tr>
</tbody>
</table>
Open the Analysis Output window. 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.