



Illinois Department of Transportation

Memorandum

To: ALL BRIDGE DESIGNERS
From: D. Carl Puzey  15.5
Subject: Revised Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges
Date: October 6, 2015

Based on the research findings of the National Cooperative Highway Research Program (NCHRP) Report 12-84 along with the Transportation Research Board (TRB) Report w197, the American Association of State Highway and Transportation Officials (AASHTO) has updated the Manual for Bridge Evaluation (MBE) with the 2014 and 2015 Interims. These MBE Interims also incorporated and superseded the Federal Highway Administration (FHWA) Publication No. FHWA-IF-09-014 titled "*Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges*" dated February 2009. Based on these changes, the Department found it necessary to supersede our original ABD Memo 10.2, "*Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges*".

To assist with determining gusset plate capacities and ratings, the Department has updated the attached guidelines. These guidelines are intended to be used with the 2014 and 2015 MBE Interims. Updates to this guidance will be revisited and updated if required due to future releases of the MBE.

All Department staff and consultants who are load rating trusses with gusset plates shall use the most recent version of the MBE along with the attached guidelines for determining the capacities and ratings of gusset plates for structure ratings initiated after the date of this memorandum. Currently, the Department does not see a need to update previous gusset plate ratings solely due to these updates. However, more favorable ratings may be attainable using these updates.

Further guidance regarding load rating implementation for Local Public Agency (LPA) maintained trusses with gusset plates will be forthcoming in the near future.

Questions regarding these documents may be directed to Carl Puzey at (217) 782-2124.

Attachment

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Guidelines for Rating Gusset Plates

Introduction

Gusset plate ratings have been included in the 2014 Interim and 2015 Interim of the American Association of State Highway and Transportation Officials (AASHTO) Manual for Bridge Evaluation (MBE). Therefore, bridge owners should check the capacity and load rating of gusset plates on steel truss bridges as part of the load rating calculations.

This guideline is intended for use with the 2014 and 2015 Interims of the MBE. Updates to this guidance will be revisited and updated if required due to future releases of the MBE.

FHWA Resources

The previous Federal Highway Administration (FHWA) document “*Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges*” (Publication Number FHWA-IF-09-014) has been incorporated into and superseded by the 2014 Interims of the MBE and is no longer a current gusset plate rating document. The research results from the FHWA National Cooperative Highway Research Program (NCHRP) Project 12-84 along with Transportation Research Board (TRB) Report w197, as well as reference to the Illinois Department of Transportation (IDOT) sponsored “*Gusset Plate Evaluation Guide*”, have also been incorporated into the 2014 and 2015 Interims of the MBE.

IDOT Bureau of Bridges and Structures (BBS) Gusset Plate Rating Guidelines

The BBS has developed these guidelines for rating gusset plates for Illinois. These recommendations shall take precedence over the current MBE if in conflict.

Rating Method

Currently the main load rating method for the BBS is Load Factor Rating (LFR). Rating methods other than LFR are allowed but should be brought to the attention of the owner.

Refined Analysis Ratings

Where results of a load rating analysis produce substandard controlling ratings, a more refined analysis should be performed consistent with the 2014 and 2015 Interims of the MBE. If using a refined rating analysis method, it should be brought to the attention of the owner.

The “*Gusset Plate Evaluation Guide*” prepared by Wiss, Janney, Elstner Associates, Inc. (WJE) for the Department provides examples to assist raters with the refined analysis of gusset plates. This guide is available at the IDOT website at the following link (<http://www.idot.illinois.gov/doing-business/procurements/engineering-architectural-professional-services/Consultants-Resources/index> under the “Bridges & Structures” tab and “Ratings” tab). Other refined analysis approaches, including the Truncated Whitmore Section method, are also acceptable.

Dead Load Forces

The BBS recommends using a minimum dead load factor of 0.90 when the dead load acts to reduce the overall loading (i.e.: the dead load and live load are acting in opposite directions). The maximum dead load factors shall be as defined per the MBE.

Live Load Forces

Live load forces may be determined by using the maximum envelope forces or by the concurrent forces. The maximum envelope forces should be used for the individual member rating checks. However, using the maximum envelope forces for the overall gusset plate shear checks may be un-conservative. Therefore, the BBS recommends using the controlling concurrent forces for the overall gusset plate shear rating checks.

Both maximum enveloped forces and concurrent forces can be attained using the AASHTOWare Bridge Design and Rating (BrDR) software (formerly Virtis software).

Effective Length Factor, K

For the effective length factor, K, the BBS recommends using $K = 0.5$ (MBE L6B.2.6.4) for all typical cases when evaluating the column model for gusset plates. If a rater uses a K factor other than 0.5, it should be brought to the attention of the owner.

Shear Reduction Factor, Ω

For the Shear Reduction Factor, Ω , the BBS recommends $\Omega = 0.88$ (MBE L6B.2.6.3) be used for typical cases. The Shear Reduction Factor, Ω , can vary from 0.74 to 1.00. Therefore, it is possible that a more refined analysis of this factor may provide more favorable results. Thus, if the rater uses an Omega Factor other than $\Omega = 0.88$, it should be brought to the attention of the owner

Slip Critical Considerations

Slip critical connections do not need to be considered for the gusset plate rating.

Load Distribution between Gusset Plates

There are typically two gusset plates at each panel point node location, an inside gusset plate and an outside gusset plate. Sometimes there are multiple gusset plates on each side. Generally, half the loads shall be distributed to the inside gusset plate(s) and half to the outside gusset plate(s). However, for gusset plates with resulting substandard load ratings, load redistribution between inside and outside gusset plates at a given node may be based on the remaining capacity of each gusset plate(s).

Currently, the BBS recommends a maximum redistribution of 30% of the load carried by the gusset plate(s) on one side of the member, to the gusset plate(s) on the other side of the member. Under the design assumption of the gusset plate(s) on one side carrying 50% of the load, the maximum redistribution would result in the gusset plate(s) on the one (strong) side carrying a maximum of 65% of the total load and the gusset plate(s) on the other (weak) side carrying a minimum of 35% of the total load. If this load redistribution technique is utilized, it should be brought to the attention of the owner.

Please also see the section below on Section Loss.

Capacity Reduction Factor

The previous capacity reduction factor of the 2009 FHWA Guidance is now included in the LRFD system factor within the current MBE. This factor has been removed for the LFR gusset plate ratings in the current MBE.

Section Loss

Rating of the gusset plates for section loss shall be based on the current MBE (see MBE Article 6A.6.5). However, where the MBE procedures produce a rating that controls the overall structure rating, a more refined analysis is recommended. Procedures for the refined section loss calculations are outlined in the "*Gusset Plate Evaluation Guide*". If this refined section loss method is utilized, it should be brought to the attention of the owner.

If there is no recorded corrosion of the gusset plates, the splice plates or the fasteners, raters need not consider section loss. If there is recorded corrosion of the gusset plates, splice plates and/or fasteners, raters should reduce the areas and capacities of the affected members to account for the greater of:

- The actual section loss based on the detailed measurements (from the inspection records).
- An assumed minimum section loss of 10%.

If the member section loss is not proportional between the inside plate(s) and the outside plate(s), the load distribution between the plates should be verified (see Load Distribution between Gusset Plates above).

Partial Shear Planes

The 2014 MBE Interims added a new Partial Shear Plane check for gusset plates. Based on research conducted on behalf of the Department, the Partial Shear Plane checks within the 2014 MBE Interims may be overly conservative in some incidences. Therefore, if the rating of a Partial Shear Plane is controlling the rating of the structure, the BBS recommends that a more refined analysis be performed to possibly improve the overall structure rating.