# Illinois Department of Transportation

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| To: | ALL BRIDGE DESIGNERS | 10.2 |
| From: | Ralph E. Anderson | Ralph E. Anderson |
| Subject: | Load Rating Guidance for Bolted and Riveted Gusset Plates in Steel Truss Bridges | |
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In response to the collapse of the I-35W Interstate highway bridge over the Mississippi River in Minneapolis on August 1, 2007, the Federal Highway Administration (FHWA) issued Technical Advisory T5140.29. The technical advisory requires load capacity checks of gusset plates as part of load ratings of non-load-path-redundant steel truss bridges.

To assist with determining gusset plate capacities, the FHWA developed Publication No. FHWA-IF-09-014 titled "Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges" dated February 2009. The FHWA publication is available from the FHWA Research and Technology Reports Center by calling 814-239-1160 or by e-mail to report.center@dot.gov. To further assist with determination of gusset plate capacities and use of the FHWA document, the Department has developed the attached guidelines.

The Department is currently in the process of load rating state maintained steel trusses with gusset plates. Department staff and consultants assigned the task of load rating trusses with gusset plates shall use these documents as guidance for determining the capacities of gusset plates.

Further guidance regarding load rating implementation for local agency maintained trusses with gusset plates will be forthcoming in the near future.

Questions regarding these documents may be directed to Tim Armbrecht, Structural Ratings and Permits Unit Chief, at 217-782-6266.

attachment

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# Guidelines for Rating Gusset Plates by the Load Factor Method

## Introduction

In FHWA Technical Advisory T5140.29, issued January 15, 2008, the National Transportation Safety Board recommends that bridge owners check the capacity of gusset plates on non-load-path-redundant steel truss bridges as part of the load rating calculations.

## FHWA Resources

The FHWA has published a document for rating gusset plates titled *"Load Rating Guidance and Examples for Bolted and Riveted Gusset Plates in Truss Bridges"* (Publication No. FHWA-IF-09-014, dated February 2009), hereinafter called the 2009 FHWA Guidance.

The FHWA is also involved with NCHRP Project 12-84, which is currently underway and is due to finish at the end of 2010. This project is researching methods for designing and rating gusset plates. Depending on the results of this project, the gusset plate rating procedures may eventually be revised.

## IDOT Bureau of Bridges and Structures (BBS) Guidelines

The BBS has developed the guidelines below for rating gusset plates for Illinois. These recommendations shall take precedence over recommendations in the 2009 FHWA Guidance.

### Live Load Forces

The BBS recommends determining gusset plate load ratings based on the maximum envelope live load forces. The results should be used as a filter to determine any rating factors that are below 1.0. If any gusset plate load rating factors are determined to be below 1.0, load ratings should be re-calculated based on concurrent forces in the members, which can be determined using the Virtis software.

### Effective Length Factor, K

For the effective length factor, K, the BBS recommends K = 1.2 be used for all typical cases when evaluating the column model for gusset plates. For these cases, raters do not need to determine whether lateral sway is possible or what the end conditions are for each gusset plate. FHWA has indicated there could be "unique connections (i.e., unsymmetrical, large unbraced length, etc.)" where a different K value may be more appropriate. If a rater uses a K factor other than 1.2, it should be brought to the attention of the owner.

### Shear Reduction Factor, Ω

According to the 2009 FHWA Guidance, the options for Ω are either 1.00 or 0.74. FHWA has indicated "Until current research demonstrates the proper value of Omega, we recommend using a value of 0.74." Part of the NCHRP 12-84 project will be to research whether Ω should be 0.74 or some other value.

For the Shear Reduction Factor, Ω, the BBS recommends Ω = 0.74 be used at this time.

### Slip Critical Considerations

The 2009 FHWA Guidance does not consider slip. The BBS concurs that raters need not determine a rating based on slip resistance.

Chord Splices

Sometimes there are chord splice plates at a gusset location. These splice plates may carry part of the load along with the gusset plates. FHWA has pointed out that a short splice plate may not carry much load at a given section. The amount of load that a splice plate may carry depends on the splice plate capacity that has developed on each side of the section which is being analyzed.

At a given section, the BBS recommends that raters distribute loads proportionally between the gusset plates and the splice plates according to their respective areas and while considering the developed capacity of the splice plates. Recorded corrosion shall be considered in proportioning the loads. Please see the item below on Section Loss.

Load Distribution between Gusset Plates

There is typically a gusset plate on each side of a chord member – an inside gusset plate and an outside gusset plate. Sometimes there are multiple gusset plates on each side of a chord member. Generally, half the loads shall be distributed to the inside gusset plate(s) and half to the outside gusset plate(s). For gusset plates with resulting substandard load ratings, load redistribution between inside and outside gusset plates at a given node, based on remaining thickness of each plate, may be acceptable.

At this time, the BBS recommends a maximum redistribution of 30% of the force carried by the gusset plate(s) on one side of the chord member, to the gusset plate(s) on the other side of the chord member. Under the original assumption of the gusset plate(s) on one side carrying 50% of the load, this maximum redistribution would result in the gusset plate(s) on one side carrying 65% of the total load and the gusset plate(s) on the other side carrying 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 2009 FHWA Guidance applies a 10% reduction in capacity (for Load Factor ratings) based on the following statement: "Since the failure of gusset plates in non-redundant structures may result in the collapse of the bridge, the capacity is therefore reduced by 10% to increase the margin of safety."

For Illinois structures, the BBS does not believe it is necessary to use a capacity reduction factor to increase the margin of safety for non-redundant structures. However, a capacity reduction factor approach should be used to account for section loss due to corrosion. Please see the item below on Section Loss.

Section Loss

The 2009 FHWA Guidance does not provide direction on how to account for section loss due to corrosion. Research is underway by NCHRP 12-84 to determine appropriate methods of accounting for section loss.

For Illinois structures, raters may utilize a capacity reduction factor approach (discussed above) to account for section loss. 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 plate thicknesses and the fastener areas to account for the greater of:

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

This decrease in material area acts as a capacity reduction factor.