Technical Advisory

U.S. DEPARTMENT OF TRANSPORTATION

Federal Highway Administration

Subject

Inspection of Gusset Plates Using Non-Destructive Evaluation Technologies

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Par.

1. **What is the purpose of this Technical Advisory?** The purpose of this Technical Advisory is to provide recommendations for the use of NDE technologies to supplement gusset plate inspection when visual techniques are inadequate to determine the extent of deterioration due to corrosion.

2. **Does this Technical Advisory supersede another Technical Advisory?** No. This is a new Technical Advisory.

3. **What is this background of this Technical Advisory?**

   a. On August 1, 2007, the eight-lane, 1,907-foot-long I-35W highway bridge over the Mississippi River in Minneapolis, Minnesota, experienced a catastrophic failure in the main span of the deck truss. As a result, 1,000 feet of the deck truss collapsed, with about 456 feet of the main span falling 108 feet into the 15-foot-deep river. A total of 111 vehicles were on the portion of the bridge that collapsed. Of these, 17 were recovered from the water. As a result of the bridge collapse, 13 people died, and 145 people were injured. On the day of the collapse, construction work was underway on the I-35W bridge.

   b. The National Transportation Safety Board (NTSB) investigation determined that the probable cause of the collapse was the inadequate load capacity of the U10 nodes due to a design error of the gusset plates which failed under a combination of (1) substantial increases in the weight of the bridge, which resulted from previous bridge modifications, and (2)

the traffic and concentrated construction loads on the bridge the day of the collapse.

c. The NTSB investigation also revealed that corrosion documented on the gusset plates at the L11 nodes had been overlooked or underestimated by bridge inspectors using visual inspection methods. These inaccuracies were attributed to the limited access inspectors had to the gusset plates between the diagonal and vertical members of the primary truss. Similar underestimates of corrosion loss using visual inspection on primary truss gusset plates were identified in other States. As a result, NTSB concluded that visual methods alone were not always capable of adequately evaluating the condition of gusset plates with section loss due to corrosion in tightly configured connections or those where the members framing into the gusset plates are closely spaced.

d. Based on that conclusion, the NTSB made safety recommendation H-08-18 which asked FHWA to require that bridge owners assess the truss bridges in their inventories to identify locations where visual inspections may not detect gusset plate corrosion and where, therefore, appropriate NDE technologies should be used to assess gusset plate condition.

4. **What are the recommendations for using Nondestructive Evaluation (NDE) technologies for inspecting gusset plates?**

FHWA agrees with the NTSB on the importance of accurate gusset plate inspections. The American Association of State and Highway Officials (AASHTO) has also recently expressed concurrence with the revisions to Section C4.8.3.6 of the AASHTO Manual for Bridge Evaluation (MBE) approved during the 2009 Annual Meeting of the Highway Subcommittee on Bridges and Structures. The following recommendations are consistent with the changes made to the MBE.

a. This Technical Advisory recommends that prior to or during the next scheduled inspection, but not later than 36 months from the issuance date of the Advisory, that bridge owners identify primary truss gusset plates within their inventories where corrosion is evident and visual inspections with traditional measurement devices (calipers, depth probe, tape-measure, etc.) may not detect or adequately quantify section loss due to corrosion for the entire plate. These locations should be documented and retained in the bridge file for reference in planning and conducting future inspections.

b. At the locations identified in (a), this Technical Advisory recommends that during the next scheduled inspection but not later than 36 months from the issuance date of the Advisory, and for all subsequent future inspections, that bridge owners use an appropriate NDE technology to assess gusset plate condition (quantify gusset plate thickness). The measurement location and dimension from each inspection when NDE is employed should be

documented and retained in the bridge file for reference by the owner/engineer. It is important that all measurement locations be identified and located from reference points that are readily reestablished.

c. This Technical Advisory recommends ultrasonic testing (UT) methods for thickness measurement as the most appropriate NDE technology to assess gusset plate condition when corrosion is evident. Ultrasonic testing is a proven field ready technology suitable for measuring thickness in single plate gusseted connections.

d. Research is underway to identify suitable advanced technology for multi-plate gusseted connections. Until suitable technology is available, this Technical Advisory recommends a combination of visual and UT inspection to best evaluate multi-plate gusseted connections.

e. This Technical Advisory also recommends that UT inspections be performed by trained technicians concurrently with or soon after a visual inspection. The level of training required is to be commensurate with the complexity of the connection, ease of use of the equipment, and acceptance by the owner.

Given the many configurations and geometries associated with gusset plate connections on primary trusses, each individual situation necessitates that the bridge owner assess NDE methods available, recognize the limitations of the methods for the given application, and ascertain which method of measurement and quantification is best suited for their particular situation. The inspection procedures for each bridge with gusset plates should clearly indicate the selected methods of measurement and quantification and which gusset plates are covered by each method.

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