



NTSB National Transportation Safety Board

Office of Highway Safety

Gusset Plate Inspection Issues

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Presentations

1. Bridge description and collapse
2. Construction activities on bridge at time of collapse
3. Gusset plate inadequacy
4. Finite Element Analysis
5. Design and review process
6. Bridge load rating and bridge load analysis
7. Bridge inspections
8. Gusset plate inspections

Issue Areas

- Visual inspections may not detect or accurately quantify corrosion on gusset plates
- Lack of guidance for inspecting and evaluating gusset plates for distortion (bowing)

Gusset Plate Corrosion

- Corrosion not a factor in I-35W bridge collapse
 - Amount of corrosion on node L11 East under-reported
 - Corrosion on gusset plate at L11 first reported in 1993
 - Amount of reported corrosion unchanged from 1994 — 2006

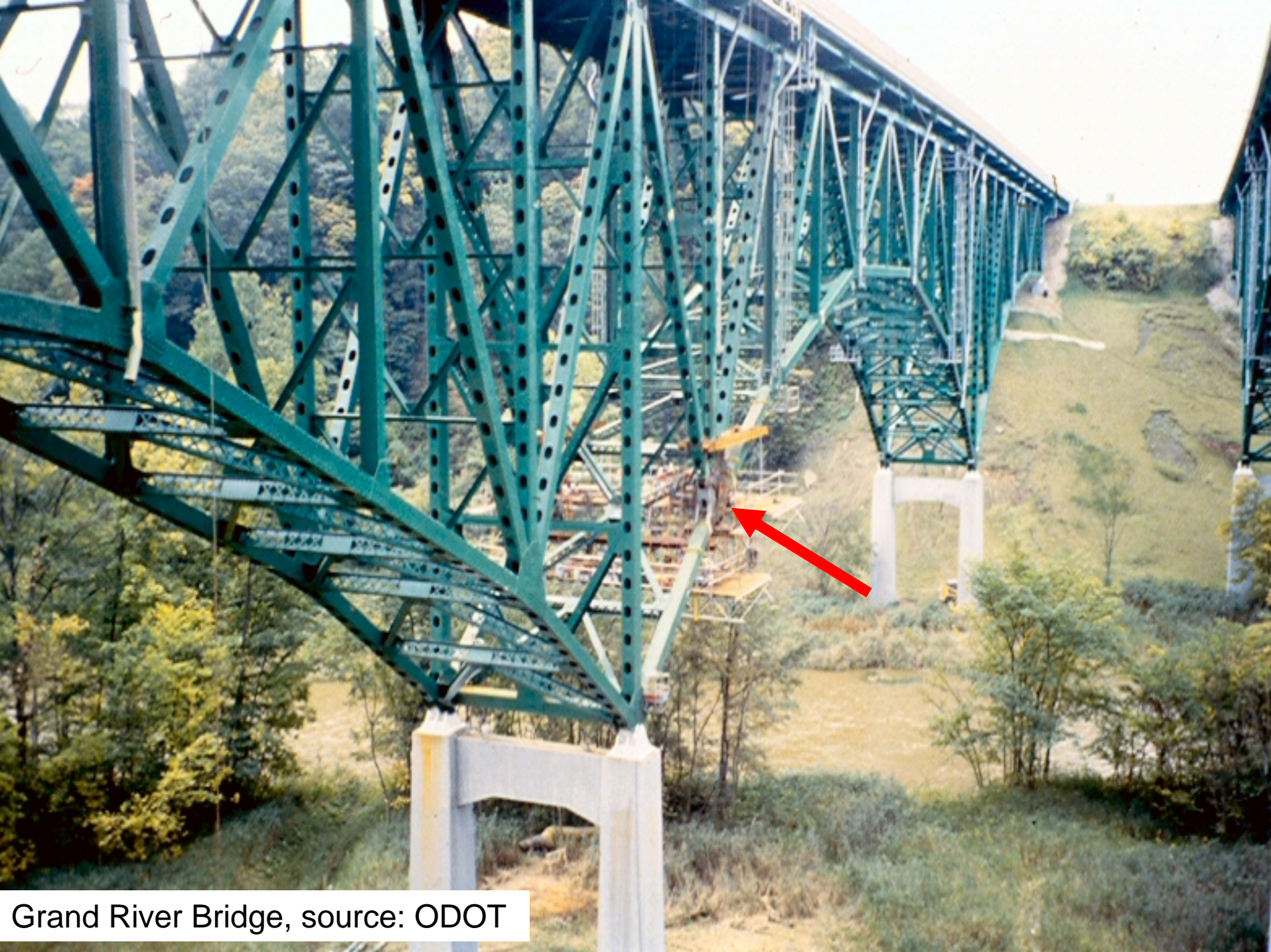


Corrosion on Ohio Bridges

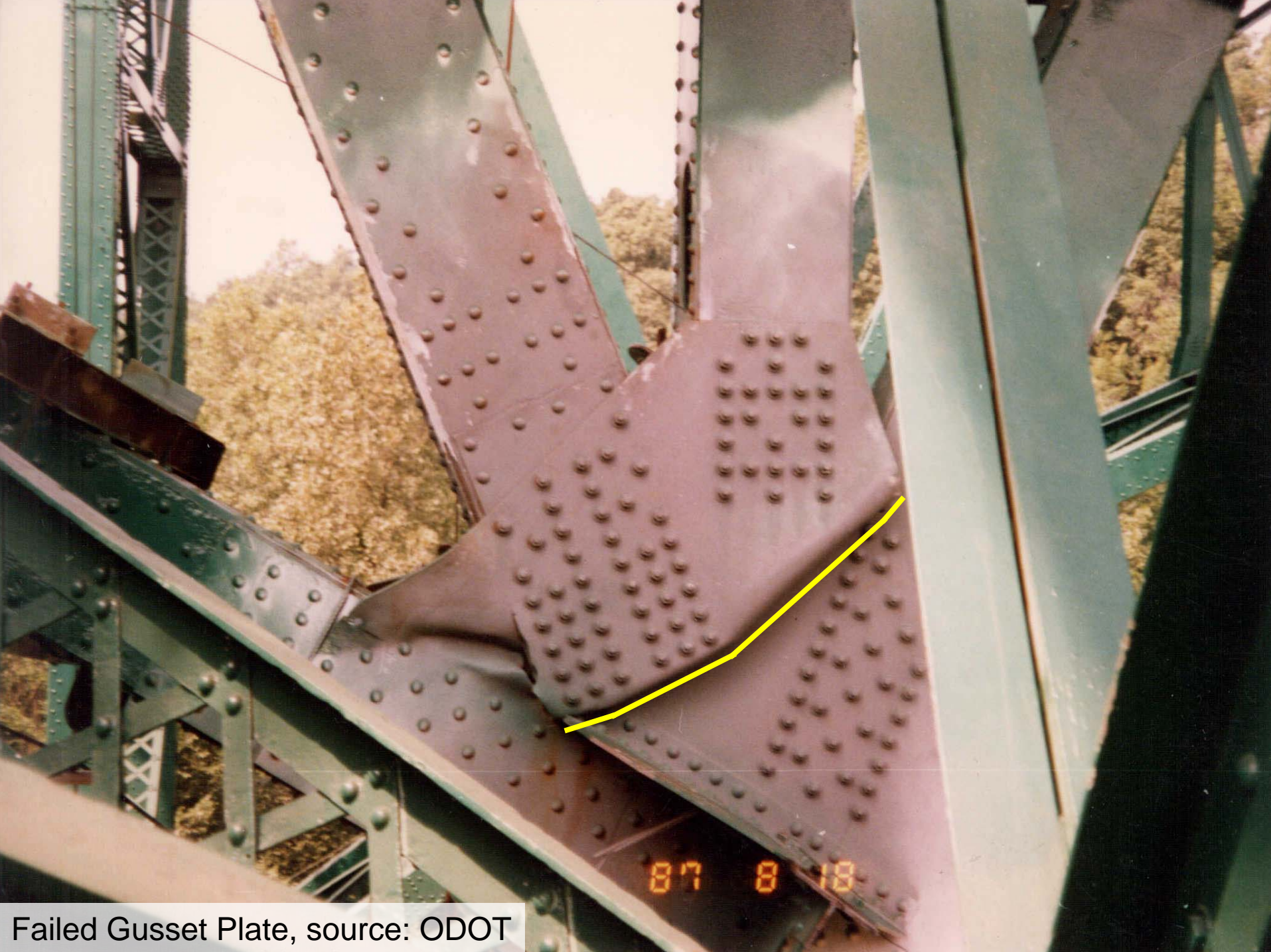
- Gusset plate failure of Grand River bridge in May 1996
 - Right lane and shoulder closed to traffic for repainting project
 - Maintenance vehicles and equipment parked in closed traffic lane
 - Truck traversing bridge in open traffic lane caused buckling of several gusset plates below work zone

Corrosion on Ohio Bridges

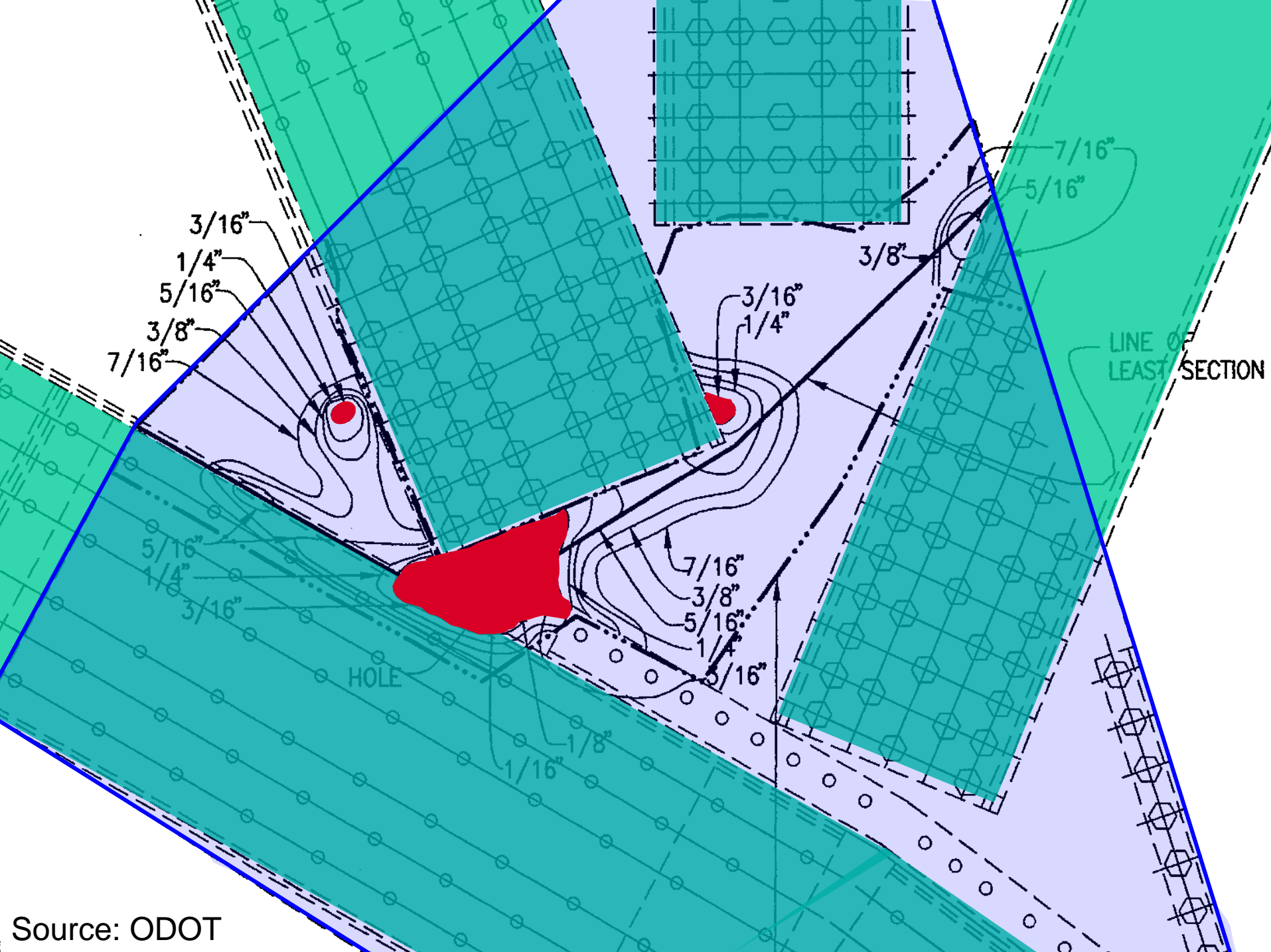
- Gusset plate failure did not result in collapse of bridge
- Significant displacement of some superstructure members
- Failure attributed to corrosion and significant section loss



Grand River Bridge, source: ODOT



Failed Gusset Plate, source: ODOT





Innerbelt Bridge, source: ODOT

Corrosion on Ohio Bridges

- Gusset plate corrosion on Innerbelt bridge reported during October 2007 inspection
- Follow-up evaluation used NDE methods
 - Original visual inspections grossly underestimated section loss

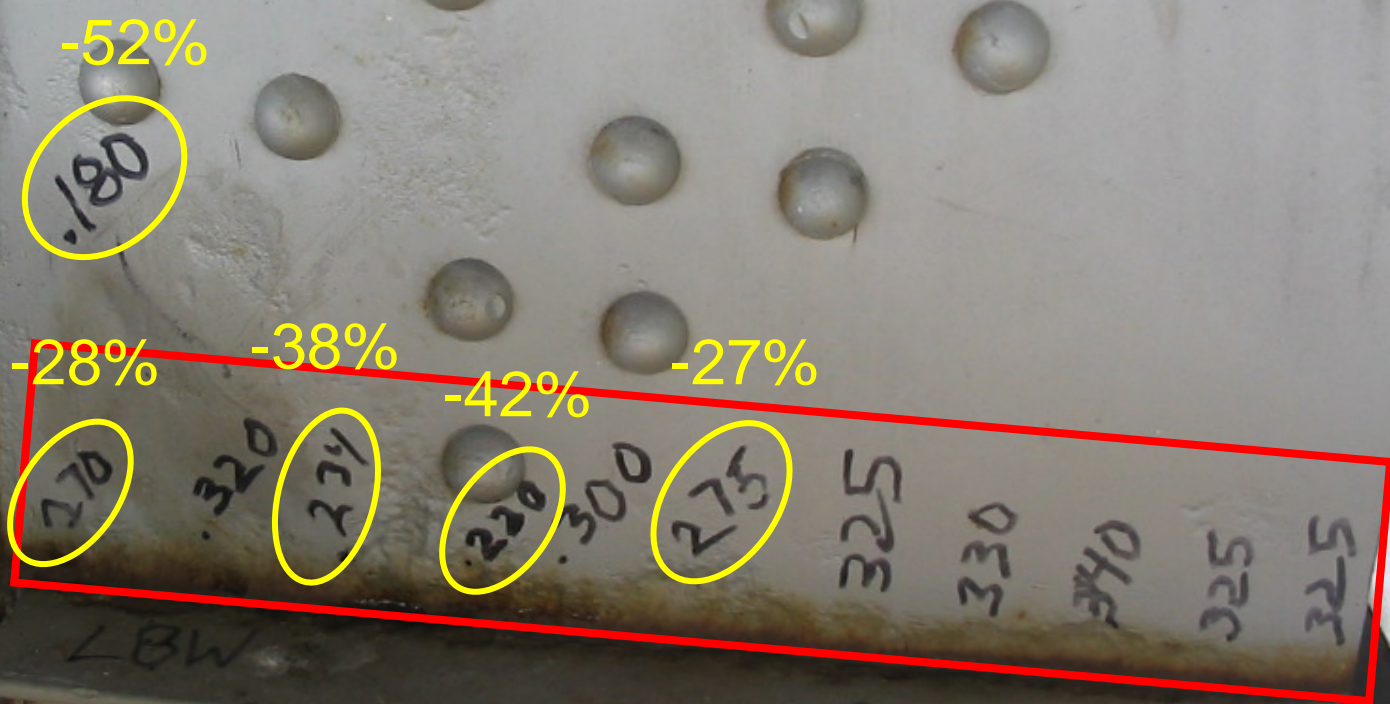


3/8-inch

Corrosion on Minnesota Bridges

- Mn/DOT initiated gusset plate reviews of other steel truss bridges
- Review included June 2008 inspection of Highway 43 bridge in Winona
 - Ultrasonic thickness measurements revealed significant section loss in some gusset plates

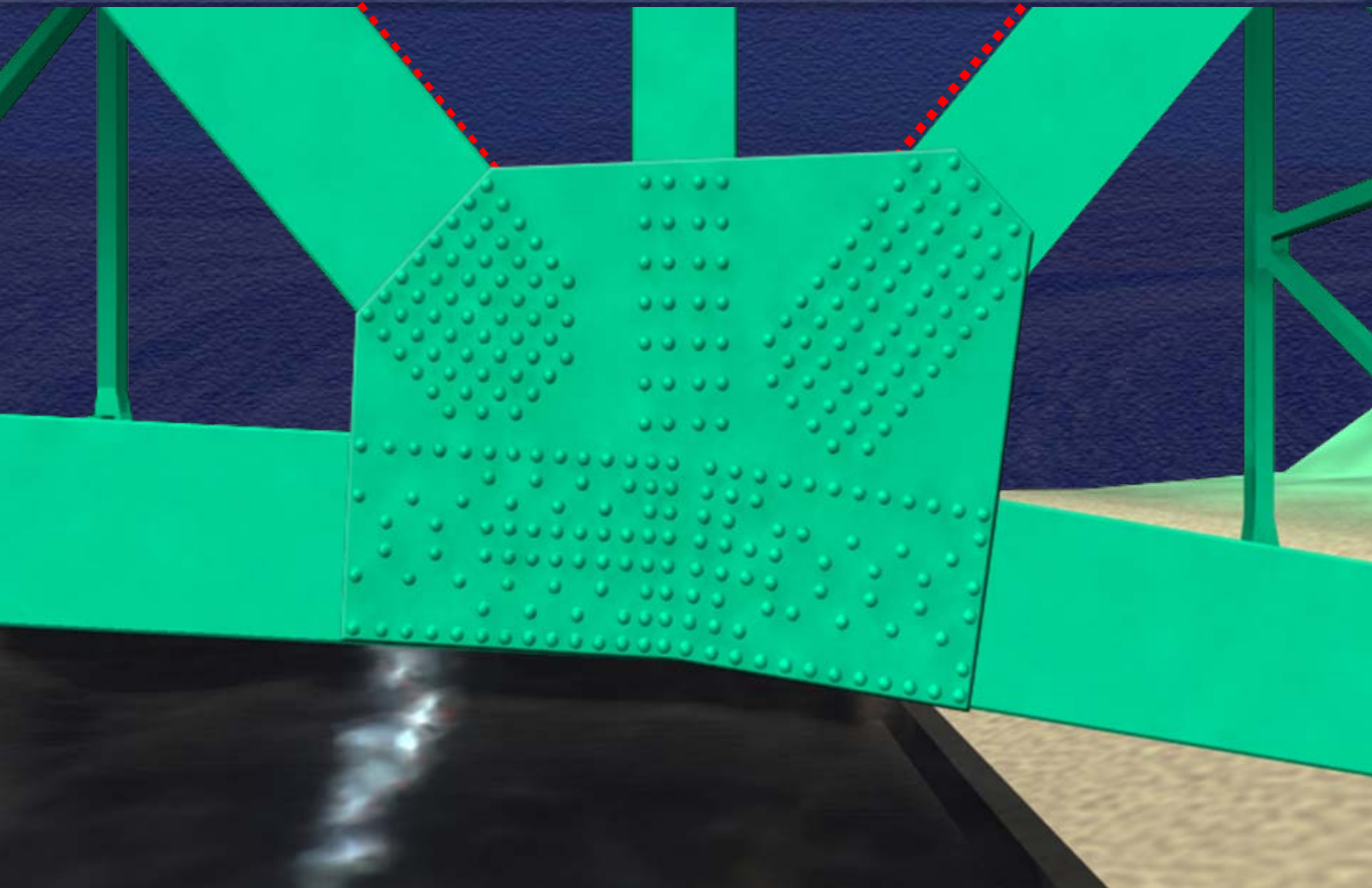
Original gusset plate thickness = 0.375"



Corrosion on Minnesota Bridges

- Highway 43 bridge previously inspected in April 2007
- Fracture critical inspection conducted July 30 — August 1, 2007
- No ultrasonic measurements taken during those inspections
- Significance of visible corrosion not recognized

Why Corrosion May Go Undetected



FHWA Technology Initiative

- Bridge Inspector's NDE Showcase (BINS)
- One-day training program demonstrating advanced tools
- FHWA was concerned that commercially available technology may be under-utilized
- BINS is positive step toward better use of technology

Summary of Corrosion Issue

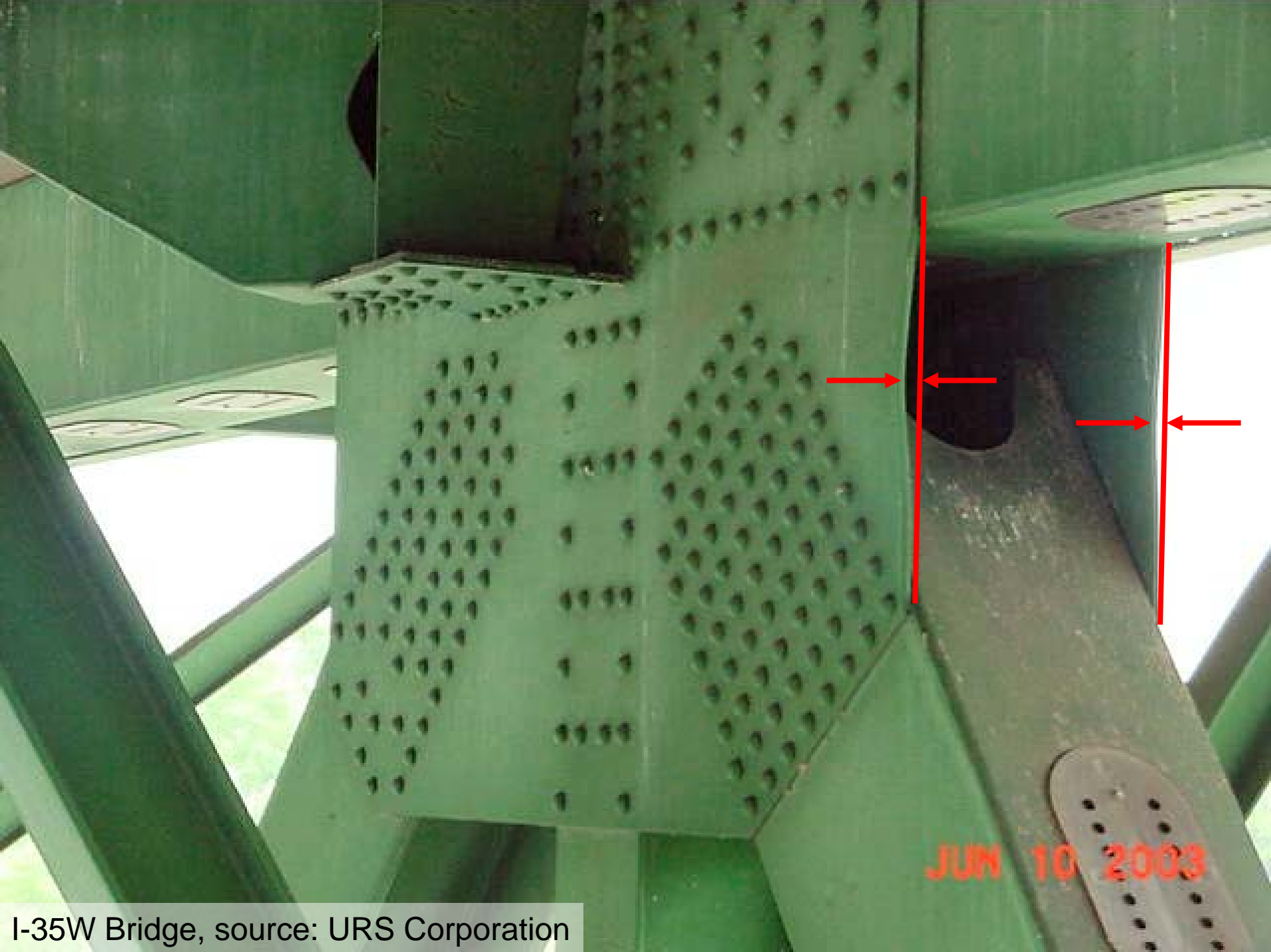
- Corrosion not a factor in I-35W bridge collapse
- Visual inspections alone inadequate to detect or quantify gusset plate corrosion
- NDE can greatly enhance accuracy of inspections
- Use NDE when appropriate to evaluate gusset plates

Gusset Plate Distortion

- Fatigue crack studies of I-35W bridge
 - University of Minnesota, 1999, no reference to bowing
 - URS Corporation, 2003, no reference to bowing
- Reviews of state bridge inspection reports found no entries for bowed gusset plates



I-35W Bridge, source: UMN



JUN 10 2003

I-35W Bridge, source: URS Corporation

Gusset Plate Distortion

- At least one Mn/DOT inspector had observed bowing
- He concluded bowing resulted from original construction
- Because of his training, he believed gusset plates were oversized

Gusset Plate Distortion

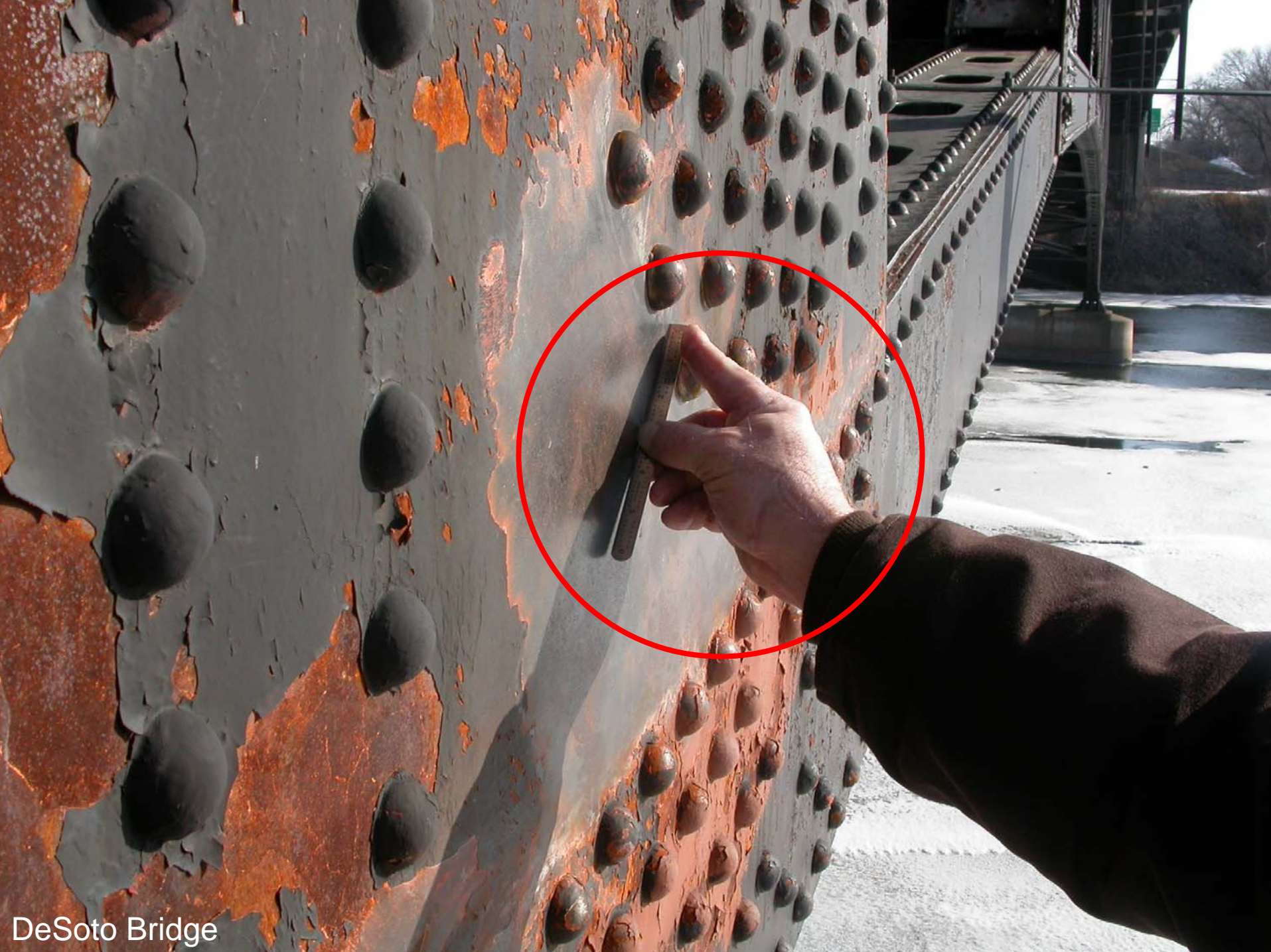
- Connection did not have other signs of distress
 - Peeling paint
 - Elongation of rivet holes
 - Cracked tack welds
 - Cracking or crushing of bridge deck
- Inspections addressed deteriorations, not construction or design problems



1/4-inch

Gusset Plate Distortion

- Gusset plate distortion found on DeSoto bridge in Saint Cloud, MN
 - Distortion believed to have occurred during original construction in 1957
 - Distortion not discovered for 50 years
 - Discovered only with inspections that emphasized condition of gusset plates



DeSoto Bridge

FHWA Training Material

- Bridge Inspector's Reference Manual (BIRM)
- BIRM references topics related to inspections of steel truss bridges
- No references to distortion of gusset plates on main truss members

FHWA Training Material

- The BIRM used in training provided by the National Highway Institute
- NHI training courses were reviewed
- Information provides only general references to gusset plates
- No emphasis on conditions such as distortion

Summary of Distortion Issue

- Bowed gusset plates on I-35W bridge were not addressed through inspections
- Bowing may indicate out-of-design condition and should be subjected to further engineering analysis
- Lack of specific training references to bowing could cause bridge inspectors to give inadequate attention to this condition

