

FACTUAL SUMMARY OF FINDINGS FROM OTHER BRIDGES
IN THE MINNESOTA DOT INVENTORY
(6 pages including this cover sheet)



**NATIONAL TRANSPORTATION SAFETY BOARD
OFFICE OF HIGHWAY SAFETY
WASHINGTON, D.C. 20594**

**FACTUAL SUMMARY OF FINDINGS FROM OTHER BRIDGES
IN THE MINNESOTA DOT INVENTORY**

A. ACCIDENT

NTSB #: HWY-07-MH-024

Date and Time: August 1, 2007 at 6:05 p.m.

Description: Interstate 35W Bridge collapse

Location: Interstate Highway 35W Bridge over the Mississippi River, Minneapolis, Hennepin County, MN.

Fatalities: 13

Injuries: 145

B. REPORT GROUP

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C. ACCIDENT SUMMARY

About 6:05 p.m. (CDT), on Wednesday, August 1, 2007, the 35W Interstate Highway Bridge over the Mississippi River, in Minneapolis, Minnesota experienced a catastrophic failure in the main span of the deck truss portion of the 1907-foot-long bridge. As a result, approximately 1,000 feet of the deck truss collapsed with about 456 feet of the main span falling into the river. An assessment of the gusset plates within the deck truss revealed that the connections at U10, U10 prime, L11 and L11 prime were under-designed. The bridge was comprised of eight traffic lanes, with four lanes in each direction. At the time of the collapse, a roadway construction project was underway that resulted in the closure of two northbound and two southbound traffic lanes causing traffic queues on the bridge. A total of 111 vehicles were documented as being on the portion of the bridge that collapsed. Of these, 17 vehicles were recovered from the water. As a result of the bridge collapse, 13 people died and 145 people were injured.

D. DETAILS OF THE REPORT

Following the collapse of the I-35W Bridge, the Minnesota Department of Transportation (MnDOT) initiated a review to examine the condition and design adequacy of the gusset plates for the other 25 steel truss bridges identified on the state's highway system. A design review was conducted to assess whether the gusset plates were adequate for each structure. The review process included physical inspections that allowed MnDOT to confirm the condition of the gusset plates and incorporate any condition changes in the capacity calculations.

This gusset plate review and inspection process was developed, in part, because of the interim safety recommendation¹ and subsequent information released by the National Transportation Safety Board on January 15, 2008. The recommendation presented information to bridge owners that the original design of some gusset plates on the I-35W Bridge was inadequate. Immediately following the issuance of the safety recommendation, the Federal Highway Administration (FHWA) released a technical advisory² directing state DOT's to recalculate the load bearing capacity of their truss bridges whenever major work was planned.

The review of these 25 bridges was completed mid-way through 2008, and a final update regarding MnDOT's findings was released on July 31, 2008. This report will examine the findings for the four truss bridges that were determined to have deficiencies associated with their gusset plates. The remaining 21 bridges that had been reviewed and inspected did not require any repairs to remain open to their previously assigned legal loads.

1. Highway 23 - Division Street (DeSoto) Bridge over the Mississippi River in St. Cloud, MN

The DeSoto Bridge was identified in the MnDOT inventory as bridge number 6748. The bridge was designed by Sverdrup and Parcel and was constructed in 1957. The design was a continuous steel deck truss bridge that was comprised of seven spans and had a maximum span length of 291 feet. The bridge was approximately 890 feet long and 70 feet wide and carried four-traffic lanes, two lanes in each direction.

The Average Daily Traffic (ADT) volume was reported at 31,000 vehicles and the Average Daily Heavy Commercial Traffic volume was listed as 930 vehicles³. The DeSoto Bridge was last painted in 1973, and a deck overlay project had been completed in 1978. Previous bridge Inspections included an underwater inspection in September of 2004 and an In-Depth Fracture Critical Inspection had been performed in August of 2007⁴.

¹ Safety Recommendation H-08-1

² Technical Advisory T 5140.29: Load-carrying Capacity Considerations of Gusset Plates in Non-load-path-redundant Steel Truss Bridges, issued on January 15, 2008.

³ Both reports were from the 2004 reporting period.

⁴ This inspection resulted from the guidance provided by the FHWA following the I-35W bridge collapse.

In March of 2008, MnDOT inspected the bridge as part of their review of all truss bridges on the state's highway system. This inspection was specifically directed at evaluating the gusset plates to confirming the adequacy their design, measure for distortion, and thoroughly record any corrosion and related section loss.

During the March 20, inspection, distortion was found on both L11 gusset plates on the south truss. The unsupported edge of the gussets had bow of approximately 0.25-inch. The L11 connection had been determined as one having the highest loads on the gusset plates. No similar distortion was found at any of the other connections, resulting in a decision to close the bridge due to concern that the distortion was load induced. A subsequent engineering analysis determined the distortion was due to original fit up issues including an imperfect match of member depths, slight misalignment of members, and possibly typical stresses that may have been encountered during the construction and erection process.

Initially, MnDOT considered repairing and reopening the bridge. The repair would have added angles (edge stiffeners) to the unsupported edges of several gusset plates that were found not to meet code requirements. However, due to increased transportation funds, replacement of the bridge was already being considered and allowed for an accelerated replacement schedule that was planned for 2010. MnDOT chose not to reopen the bridge and instead let a contract for its replacement. Construction on the new bridge began in 2008.

2. Interstate 535 - John A. Blatnik Bridge between Duluth, MN and Superior, WI

The Blatnik Bridge was co-owned by Minnesota and Wisconsin and was identified in the MnDOT inventory as bridge number 9030. Howard, Needles, Tammen & Bergendoff (HNTB) designed the bridge and construction on the bridge began in 1958. The bridge was opened to traffic in 1961. The design of the bridge's main spans was a continuous steel high truss and the approach spans were comprised of continuous steel girders. The Blatnik Bridge had a total of 52 spans and had a main span length of 600 feet. The bridge was approximately 7,980 feet long and 58 feet and carried four lanes of traffic, two lanes in each direction.

The Average daily Traffic (ADT) volume was reported at 28,000 vehicles and the Average Daily Heavy Commercial Traffic volume was listed as 1,960 vehicles⁵. The Blatnik Bridge had last been repainted in 1998, and in 1993, the approach spans were widened and the deck was replaced. Previous bridge inspections included an underwater inspection in August of 2004 and an In-Depth Fracture Critical Inspection in August of 2007⁶.

⁵ Both reports were from the 2004 reporting period.

⁶ Originally, this inspection had been scheduled prior to the I-35W collapse and began on August 6, 2007. PB Americas conducted the inspection and this was their first Minnesota bridge inspection performed in through their contract to assist MnDOT in the inspection of all state owned bridges by December 2007.

In April of 2008, MnDOT inspected the Blatnik Bridge to verify the condition of the gusset plates. An engineering analysis of gusset plate capacities was also being performed. This analysis determined the capacity of the gusset plates at U1 and L0 did not have the full safety factor MnDOT desired. The gusset plates were reported to have been adequate in the original design, but the increases in the structure's dead load from the 1993 maintenance projects had reduced their safety factor. As a result, on May 6, 2008, MnDOT restricted traffic to one lane in each direction.

MnDOT devised a repair plan to reinforce the gusset plates by adding members to stiffen them at the ends of the compression diagonals. This was done to meet buckling requirements and to restore the full safety factor back to the gusset plates. The plan also included the addition of edge stiffeners to gusset plates identified as having unbraced edge lengths exceeding code requirements. Following the completion of these modifications, the previously closed traffic lanes were opened on July 21, 2008.

3. Minnesota Highway 43 - Wisconsin Highway 54 Bridge over the Mississippi River in Winona, MN

The Minnesota Highway 43 Bridge was identified in the MnDOT inventory as bridge number 5900. Unlike the other bridge's this bridge was not designed by a private consulting firm, and was designed by the Minnesota Department of Highways. The bridge was constructed in 1941, and consisted of continuous high trusses for the main spans, while the approach spans incorporated a variety of under deck truss spans and girder spans. The main span was 450 feet and the bridge was approximately 2,289 feet long with a deck width of about 34.4 feet. The bridge carried two lanes of traffic, one lane in each direction.

The Average Daily Traffic (ADT) volume was reported at 11,900 vehicles and the Average Daily Heavy Commercial Traffic volume was 476 vehicles⁷. In 1985, the bridge deck was replaced and the sidewalk was relocated at that time. Previous bridge Inspections included a Routine inspection that was conducted in April of 2007 and a Fracture Critical inspection had been preformed from July 30 to August 1 of 2007⁸. These 2007 inspections had noted corrosion in several of the gusset plates. However, no additional inspections utilizing any non-destructive evaluation methods such as ultrasonic testing were conducted at that time. MnDOT reported that while the inspections in 2007 noted corrosion, the significance was not recognized and was viewed as corrosion in a limited area over a large plate.

An In-depth Fracture Critical inspection was conducted on June 2, 2008. This inspection was part of MnDOT's review of all truss bridges and included a detailed inspection of the gusset plates. As such, inspectors were directed to measure for distortion and thoroughly record any corrosion and resulting section loss. This inspection found that numerous gusset plates located at the piers of the deck truss spans exhibited convex bulging distortion in the unbraced compression zones. Additionally, significant section loss in these areas was also detected by ultrasonic thickness testing measurements, which revealed a loss in plate thickness by as much as 52-percent.

⁷ Both reports were from the 2004 reporting period.

⁸ This inspection had been scheduled prior to the collapse of the I-35W Bridge, and the start of the inspection predated the event.

Following these findings, the bridge was closed on June 3, 2008, and the remaining gusset plate inspections were completed by June 5, 2008. The bridge was reopened to traffic on June 14, 2008, but based on their analysis of the gusset plates; MnDOT restricted the traffic loads and prohibited trucks from using the bridge. The bridge was reopened to all traffic on July 21, 2008, following repairs to the gusset plates.

4. Highway 61 Bridge over the Mississippi River at Hastings, MN

The Highway 61 Bridge was identified in the MnDOT inventory as bridge number 5895. The design was a steel high through-truss that incorporated 3 main spans and 10 approach spans. The bridge was constructed in 1950. The main river span was 514 feet long and the bridge was approximately 1,857 feet long. The bridge carried two lanes of traffic, one lane in each direction.

The Average daily Traffic (ADT) volume was reported at 32,000⁹. An In-Depth Fracture Critical Inspection was performed in August of 2007. As part of their review process to verify the condition of the gusset plates, MnDOT inspected the Highway 61 Bridge between April 7 and April 18, 2008. Their report indicated that the overall structural condition for the bridge was unchanged from the August 2007 inspection.

As part of the April inspection, the gusset plates on the lower chords of the truss were inspected. The plates were examined for distortion, corrosion and section loss. Some of these gusset plates exhibited some degree of distortion. However, this distortion was attributed to pack rust. Despite these findings, MnDOT planned to add bracing to gusset plates at eight locations on the bridge. Additionally, section loss was noted on some gusset plates, but the amounts were within the levels previously determined at the time the capacity rating calculations had been performed.

The Highway 61 Bridge was rated as Structurally Deficient. Originally, MnDOT had planned a 2008 rehabilitation project to address issues found during the previous inspections. However, MnDOT developed a plan to begin replacement of the bridge in 2010. Because of the accelerated replacement, MnDOT reduced the amount of 2008 rehabilitation originally planned for the bridge, but will continue the repair of such items as the bridge bearings and deck.

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⁹ As indicated during the 2006 reporting period.