I-35W Bridge Collapse

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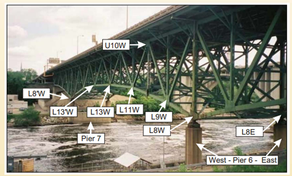
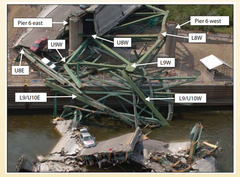
The I-35W Bridge collapse lasted only a few minutes, but the consequences were heavy. 1000 ft of the deck truss had collapsed with 456 ft of that being the main span falling 108 ft into the 15 ft deep river below. On that day, the bridge deck was being repaved with new concrete when the collapse happened. Four of the eight travel lanes were closed due to construction. At the time of the collapse, two of the lanes had heavy construction equipment and materials on them. The other four lanes had bumper to bumper traffic. The last two lanes were empty.

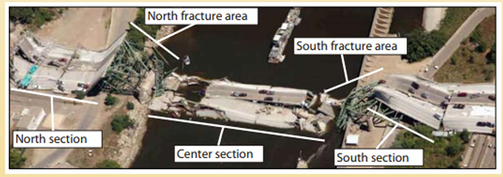


Side view of the bridge before the collapse. [1]



North end of the bridge after the colapse. [1]

Aerial view of the bridge before the collapse. [1]



Top view of the bridge after the collapse. [1]

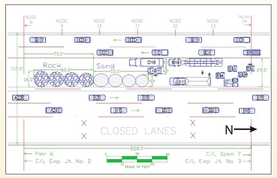
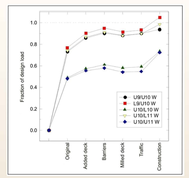
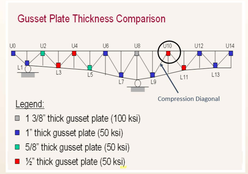


Illustration of closed lanes and open lanes during bridge repaving. [1]

Name: I-35W Bridge
Date: August 1, 2007
Time: 6:05 pm Central Time
Location: Minneapolis, Minnesota, over the Mississippi River
Deaths: 13
Injuries: 145

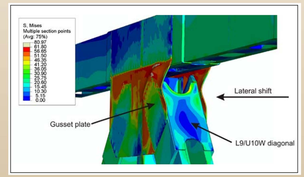


Dead loads progressively increased throughout the life of the bridge due to subsequent renovations. Additionally, a high level of live load was present on the bridge the day of the collapse, caused by construction equipment and bumper-to-bumper traffic. [1]

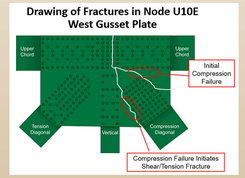


The U10 node gussets were originally 0.5" T-1 steel (100 ksi). After T-1 steel was removed from the bridge, the gussets were changed to A441 steel (50 ksi), but remained at the same thickness. [3]

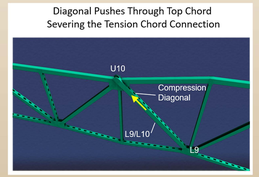
The four U10 node gussets deformed and bowed out. The thickness of these gusset plates was not increased after the material changed. [1]



With the gussets bowed, the L9/U10 member was more susceptible to lateral shifting. [1]



The lateral shifting of the L9/U10 member introduced eccentric loading in the gusset plate that led to its rupture. [3]



Once the gusset plate ruptured, the L9/U10 member punched through the top chord, severing the tension chord connection. [3]

The bridge then collapsed since the deck truss did not have redundancy against the failure of gusset plate U10. [1]

1962

Oct. 1962: Sverdrup & Parcel began designing the bridge after MnDOT awarded them the contract. The original design used mostly T-1 Steel.

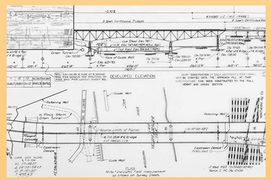
1967

March 1964: MnDOT required the replacement of the T-1 steel in all of the members some of the gussets with A441 and A242 steel.

March 1965: Final plans were certified.
June 1965: MnDOT approved the plans.

1972

Picture of the bridge in the 1970's. [2]



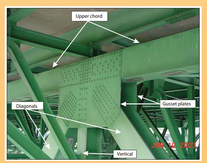
Drawing from the final plans. [2]

1977: First major renovation of the bridge. The deck was milled to 1/4" thick, and a 2" thick wearing coarse low slump concrete was added on top. This added more than 3 milion lbs of dead load to the bridge

1991: The bridge was officially deemed as "Structurally Deficient". This label would stay until the bridge's collapse.

1992

Picture of the bridge in the 2000's. [1]



Picture of one of the gusset plates. [1]

1993: An inspector noted that there was a loss of metal in at least one gusset plate and horizontal brace due to corrosion. Major corrosion would continue to be a concern up until the collapse.

1997

An inspector inspecting the bridge. [1]

1998: A construction renovation replaced the median barrier, upgraded the concrete traffic railings, installed an anti-icing system, repaired concrete slab and piers, replaced girders. This renovation added 1.13 million pounds of dead load to the bridge, a 6.1% increase.

1999: A fatigue study was conducted on the bridge, including a finite element model of the bridge. Gusset plates were not modeled in detail. The final conclusion drawn was that deck truss fatigue was unlikely, so expensive replacement of the bridge could be deferred.

2002

2003: Photographs were taken of the bridge, showing the 4 gusset plates at the two U10 nodes were visibly bowed.

2006: Numerous concerning weld details and significant surface rust corrosion were reported on many of the main truss and floor members. Several gusset plates had significant section loss. The report recommended "eventual replacement of the bridge would be preferrable".

2006: A retrofit project for the bridge began. The project contract was to be let in October 2007 and was allocated $1.5 million.

2007

May 2007: In-depth and non-destructive inspections of half of the critical structural members took place. No significant cracks were found. A meeting to discuss the inspection results was planned for August 20, 2007.

June 2007: A third major renovation started. A part of the renovation was replacing the concrete wearing course with a new 2" thick concrete overlay.

August 1, 2007: The bridge collapsed.

2012

Photos of the bowed U10 gussets. [1]

References

[1] National Transportation Safety Board. (November 2008). Collapse of I-35W Highway Bridge Accident Report. Retrieved from https://www.ntsb.gov/investigations/AccidentReports/Reports/HAR0803.pdf
[2] Minnesota Historical Society. Bridge Resources. Retrieved from http://www.mnhs.org/library/bridge/
[3] Frank, K. I-35W Slides.