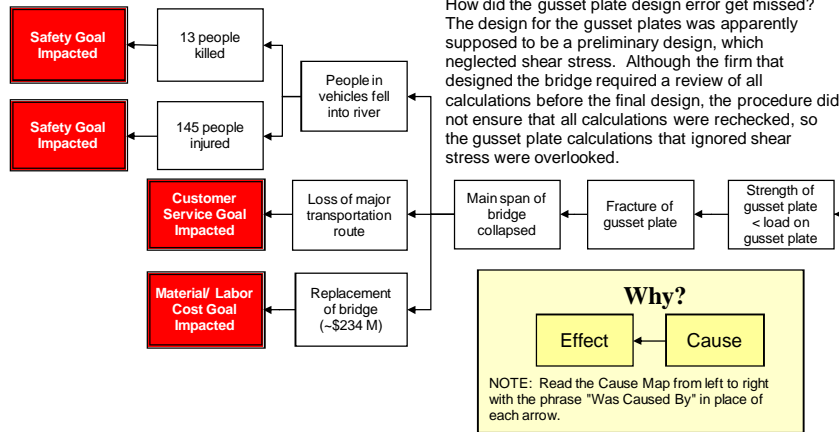


How an Unchecked Assumption Brought Down a Bridge (The Collapse of the I-35 Bridge in Minneapolis)

On August 1, 2007, the I-35 bridge over the Mississippi River in Minneapolis, Minnesota collapsed during evening rush hour, killing 13 and injuring at least 145. During the National Transportation Safety Board's investigation, it was discovered that the gusset plates (the riveted metal plate that joins several structural members) were designed with inadequate load capacity. At the time of the bridge collapse, the load on the gusset plate that failed was higher than usual, due to construction materials and equipment concentrated on the deck over the location of the gusset plate and rush hour traffic slowed by the construction. In addition to these weights, the dead load (weight of the bridge structure) had increased by more than four million pounds due to improvements made to



How did the gusset plate design error get missed? The design for the gusset plates was apparently supposed to be a preliminary design, which neglected shear stress. Although the firm that designed the bridge required a review of all calculations before the final design, the procedure did not ensure that all calculations were rechecked, so the gusset plate calculations that ignored shear stress were overlooked.

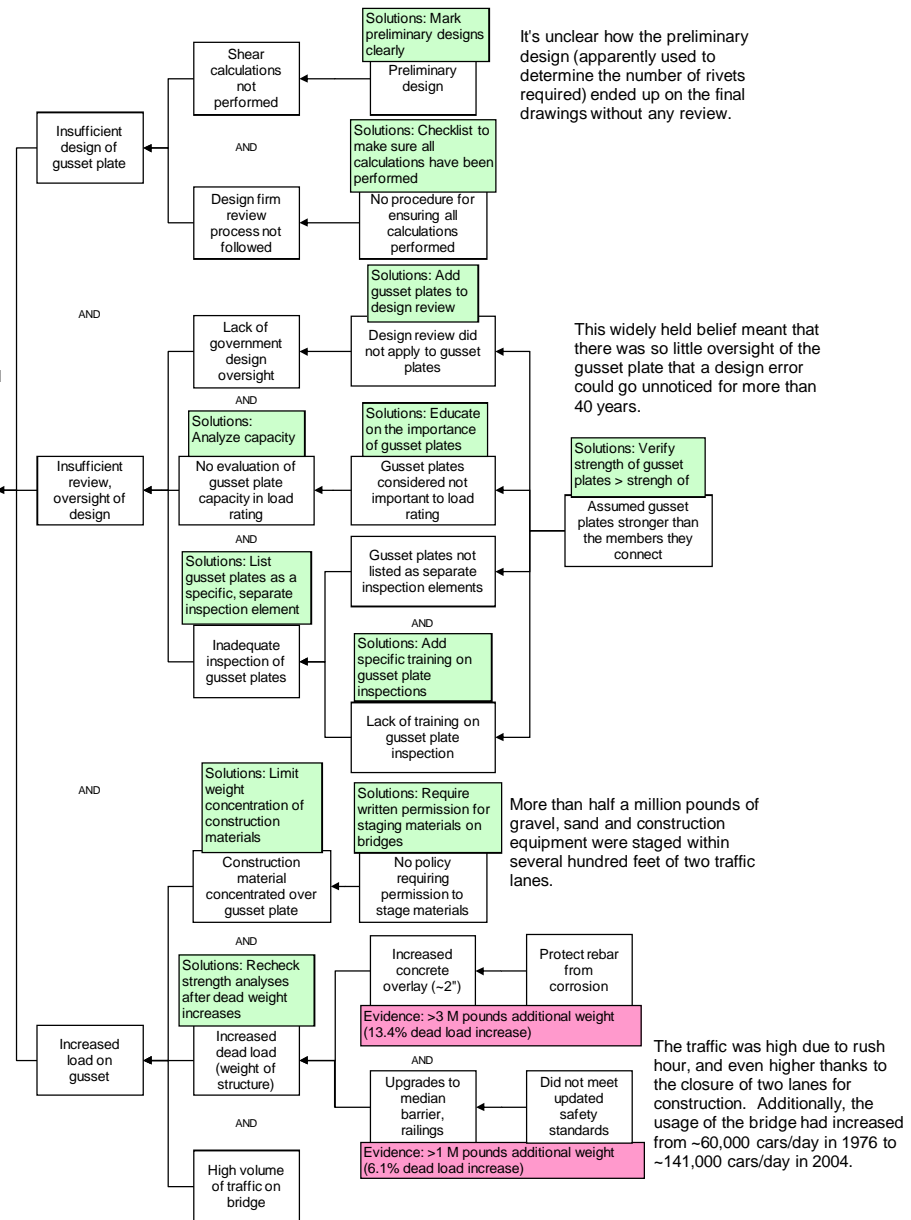
The design was reviewed by the government, but their design review did not apply to gusset plates. The gusset plate capacity was not calculated as part of the load rating calculations. Gusset plates were not listed as a separate element to be inspected during a bridge inspection. And, the training for bridge inspectors continued very little information about gusset plates. Why? Because it was widely assumed that gusset plates are stronger than the members they join and so can be neglected in calculations in order to simplify the analysis. In most cases, this assumption is true. However, since the gusset plates were designed incorrectly, and so were much weaker than typical, allowing this assumption to go unchecked, on several different occasions, proved disastrous.

Thanks to this tragedy, it's unlikely the same problem will happen again. Structural design and bridge inspection training material is being rewritten to include the lessons learned from this bridge collapse, and inspections are now considering the strength of gusset plates as part of their evaluation. Assumptions are made all the time, but these assumptions need to be verified.

This is a very high level of the root cause analysis investigation into the bridge collapse. As with any investigation the level of detail in the analysis is based on the impact of the incident on the organization's overall goals.



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It's unclear how the preliminary design (apparently used to determine the number of rivets required) ended up on the final drawings without any review.

This widely held belief meant that there was so little oversight of the gusset plate that a design error could go unnoticed for more than 40 years.

More than half a million pounds of gravel, sand and construction equipment were staged within several hundred feet of two traffic lanes.

The traffic was high due to rush hour, and even higher thanks to the closure of two lanes for construction. Additionally, the usage of the bridge had increased from ~60,000 cars/day in 1976 to ~141,000 cars/day in 2004.