I-35 BRIDGE COLLAPSE

How an Unchecked Assumption Brought Down a Bridge

Assumptions are made to simplify analyses. When these assumptions aren’t verified, they can result in a compounded error. In this case, an assumption of a part’s strength meant it was never rechecked or inspected, and resulted in the collapse of the bridge.

“Bridge designers, builders, owners, and inspectors will never look at gusset plates quite the same again”                             - NTSB Acting Chairman Mark V. Rosenker

1. Problem
   What: Problem(s) - Bridge collapse
   When: Date - August 1, 2007
   Time - 6:02 p.m.
   Differentials - Evening rush hour, roadwork underway
   Where: Physical location - Minneapolis, Minnesota

2. Analysis
   Basic Cause-and-Effect
   - Safety Goal: Impact to Goals
     - 13 people killed
     - 145 people injured
   - Service Goal: Impact to Goals
     - Loss of major transportation route
   - Property Goal: Impact to Goals
     - Replacement of bridge (~$234 M)

   Basic Cause Map
   - Started with simple Why questions.
   - Safety Goal Impacted: 13 people killed
   - Safety Goal Impacted: Fracture of gusset plate
   - Safety Goal Impacted: Insufficient load capacity of gusset plate
   - Service Goal Impacted: Main span of bridge collapsed
   - Property Goal Impacted: Main span of bridge collapsed

   More Detailed Cause Map
   - Safety Goal Impacted: 13 people killed
   - Safety Goal Impacted: Fracture of gusset plate
   - Safety Goal Impacted: Insufficient load capacity of gusset plate
   - Service Goal Impacted: Main span of bridge collapsed
   - Property Goal Impacted: Main span of bridge collapsed

3. Solutions
   - Solution 1: Mark preliminary designs clearly.
   - Solution 2: Checklist to make sure all calculations have been performed.
   - Solution 3: Add gusset plates to design review.
   - Solution 4: Analyze capacity of gusset plates.
   - Solution 5: Educate on the importance of gusset plates.
   - Solution 6: Verify strength of gusset plates is greater than strength of members.
   - Solution 7: List gusset plates as a specific, separate inspection element.
   - Solution 8: Add specific training on gusset plate inspections.
   - Solution 9: Add written permission for staging materials on bridges.
   - Solution 10: Require written permission for staging materials on bridges.

   More Detail
   - The gusset plate was under-designed because shear calculations were not performed. The error wasn’t noticed during the firm’s review process, by the government, or during load rating evaluations and inspections over the service of the bridge. Why? Because gusset plates just weren’t considered to be that important. When correctly designed, they are stronger than the members they connect and so can be omitted from the analysis.

   - Solution 11: Limit weight concentration of construction materials.
   - Solution 12: Recheck strength analyses after dead weight increases.
   - Solution 13: Review strength analyses after dead weight increases.

   More Detail
   - The gusset plate had been under-designed since it opened in 2007. The volume of traffic had increased greatly since the bridge opened, and traffic was particularly heavy at the time of the collapse thanks to rush hour and roadwork. The construction materials for the road work were concentrated over the gusset plate, with no oversight. On top of all this, the dead load, or weight of the bridge, had increased by more than 4 million pounds from roadway improvements.