I-35W Bridge Collapse Investigation

Tom Everett, P.E.
Principal Bridge Engineer
FHWA Office of Bridge Technology
FHWA Role

- Investigation
- Testing
- Analysis
DOT Secretary Mary Peters offered…
August 2

- Full financial and technical support
- Administrator Rick Capka to stay in MN
- Bridge and Engineering Staff
- Initial Distribution of $5.0M
  - restore traffic
  - clear debris
  - set up detours
  - begin repair work
Failure Investigation
August 2

- NTSB requested FHWA’s help:
  - Drs. Joey Hartmann & Bill Wright
- FHWA Roles:
  - Provide engineering expertise
  - Assist in field investigation
  - Assist in recovery operations
  - Analyze structures, fracture surfaces and failure mechanism
I-35W Investigation

- NTSB has lead and controlling role
- FHWA was leveraged by NTSB for bridge expertise
- Mn/DOT has engaged WJE to perform an independent investigation
- 3 times lucky!
Lucky #1
Technical Advisory 5140.27
August 2, 2007

• Strongly advise immediate re-inspection of all fracture critical deck truss bridges.

• At a minimum, owners should review inspection reports to determine if more detailed inspections are warranted.
Figure 1a - Scale Diagram of Pre-Collapse Bridge
Construction Material Staging on Center Span Truss

4 Loads of Rock (184,380 lbs) 4 Loads of Sand (198,820 lbs) = 383,200 lbs
3 Loaded Commercial Construction Vehicles, Water Truck D16 (48,200 lbs), Cement Tanker B16 (72,780 lbs), and Concrete Mixer B15 (51,400 lbs) = 172,380 lbs
1 Skidsteer and 5 Scootcretes with associated material and workers = approximately 21,655 lbs

Total Load = 577,235 lbs
Technical Advisory 5140.28
August 8, 2007

- Construction loads were present on I-35W but the significance of these loads is not yet known.

- Strongly advise that bridge owners who are engaged in or contemplating any construction operation ensure that any construction loading does not overload bridge members.
“Adequacy of the U10 & L11 Gusset Plate Designs for the Minnesota Bridge No. 9340”

- Holt and Hartmann
- “Forensic” design of primary truss gusset plates
- Not intended to provide a procedure for rating (Guidance from Dr. Ibrahim at HIBT)

- Gusset plates shall be of ample thickness to resist shear, direct stress, and flexure, acting on the weakest or critical section of maximum stress.
- If the length of an unsupported edge ... exceeds 48 times its thickness, the edge shall be stiffened.
U10 Gusset Design Checks

Section A-A

2,288 k
540 k
1,975 k

Section B-B

2,147 k
2,288 k

16 Rivets
Gusset Plate Shear across Section A-A

- **Demand**
- **Capacity**

Gusset Plate Number:
- U2
- U4
- U6
- U8
- U10
- U12
- U14

D/C = 1.81
Load ratings required according to the AASHTO Manual for Condition Evaluation of Bridges. The following supplemental actions are recommended:

- **New or replaced truss bridges** – check gusset plate capacity as part of the initial load rating.
- **Existing truss bridges** – check gusset plate capacity when load rating after condition or load changes of the structure.
- Review previous load rating calculations for truss bridges that have undergone significant changes in their service life.
Recovery, Assessment and Evaluation
Recovery
Assessment
Evaluation
Material Properties Testing

- **Tension Testing**
  - Modulus
  - Yield Strength
  - Ultimate Strength
  - Strain Capacity

- **Charpy Testing**
  - CVN Energy

- **Compact Tension Testing**
  - Fracture Toughness
Lucky #3

72”
½” thick
Amplitude of “buckle” estimated at 0.70” +/- 0.15”
Significant Causal Factor...DESIGN ERROR

- Design did not meet strength limit state and was not detailed properly for stability.
- Construction loading
- Deformed (‘buckled’) gusset plate
Non-factors (NTSB to date)

- Material
- Deterioration...maintenance, aging infrastructure
- Fatigue
- Traditional Rating
- Inspection
Isolated Incident

- Ohio bridges
- Additional Minnesota bridges
Questions?