POST-FAILURE CAPACITY OF BUILT-UP STEEL MEMBERS

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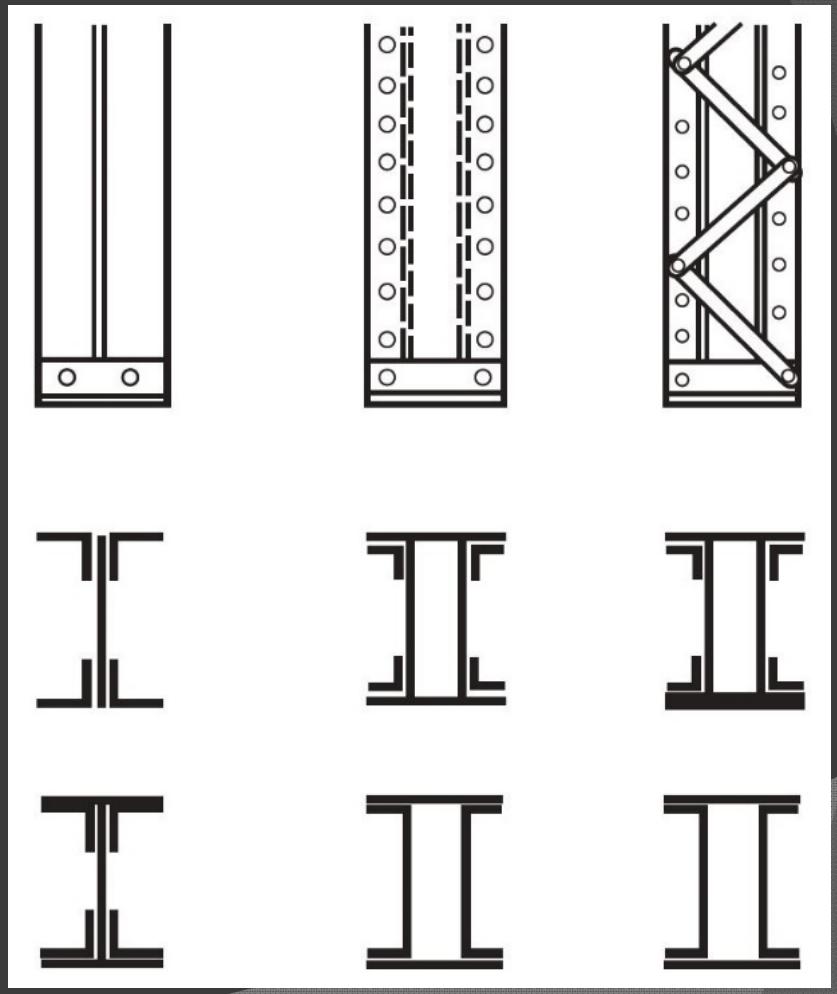
Road School
2014

Built-up Steel Sections

- Used up until early 1960's
- Fabricated from smaller, readily available shapes
  - Plates, angles, channels, etc.
- Hot riveted components together



Friedman, 2009

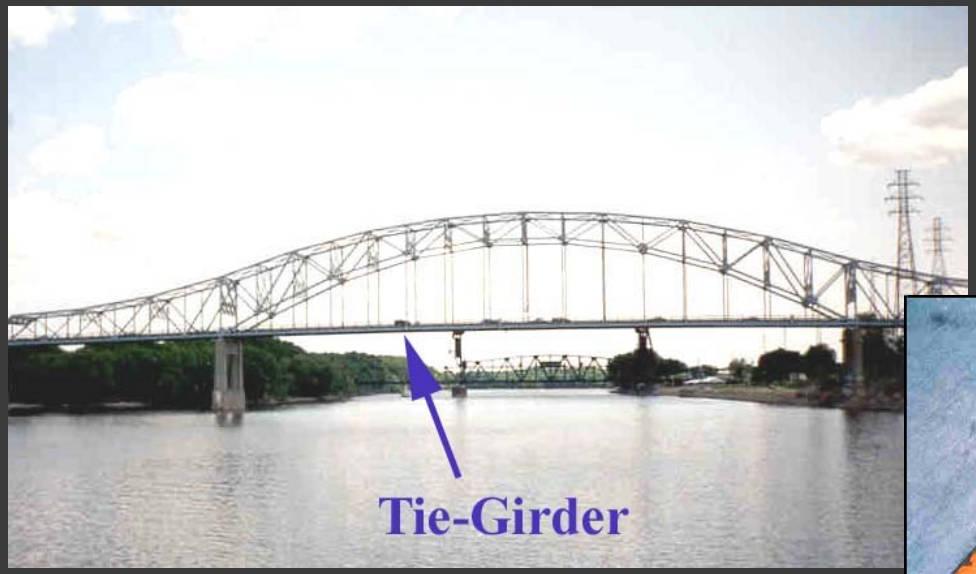
Fracture-Critical Members

"Steel tension members or steel components of members whose failure would be expected to result in collapse of the bridge"

– AASHTO Manual for Bridge Evaluation

Built-up Member Fracture

- Hastings Bridge, MN
  - Fracture in web plate of riveted built-up tie-girder



Neimann, 1999

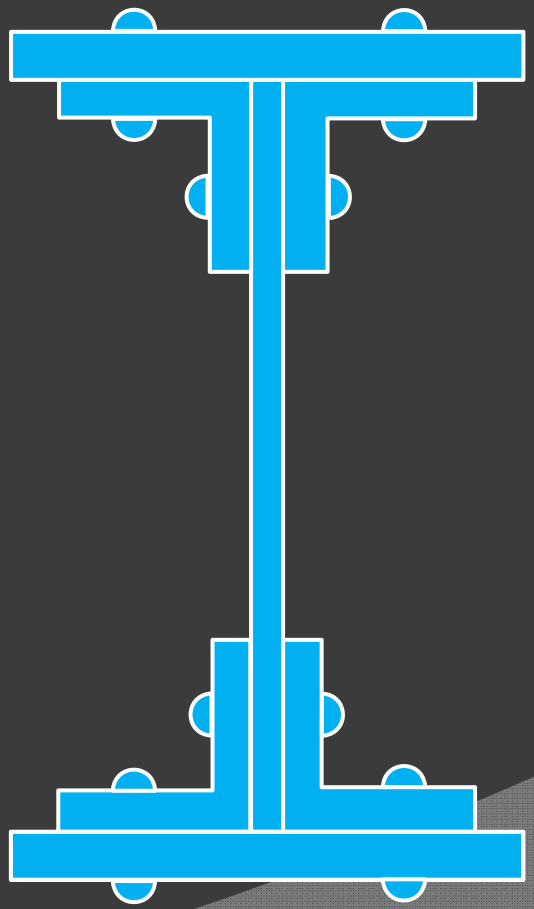
Built-up Member Fracture

- North Fork Mollala River Bridge, OR
  - Fracture in bottom flange of riveted built-up two-girder bridge

Lovejoy, 2001

Research Objective

- Determine whether built-up sections are fracture-critical
- Determine after-fracture load capacity of ‘failed’ built-up sections
- Evaluate effect on remaining fatigue life in ‘failed’ state
  - How long until next component fails?

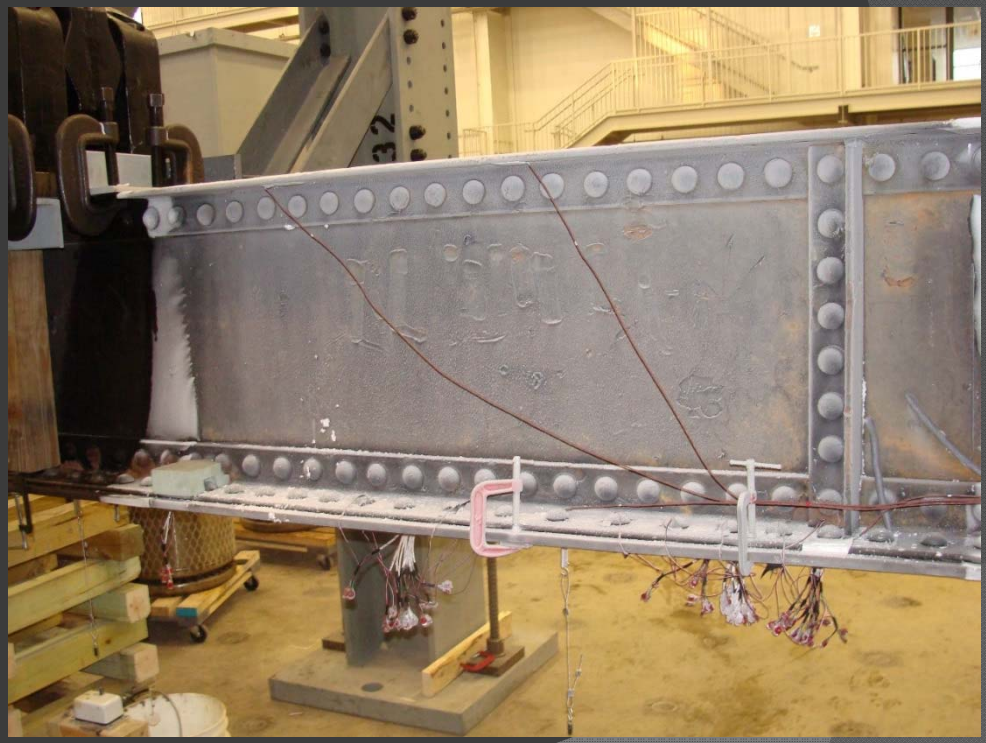


Specimen Selection

- Full scale experiments
  - Riveted vs. HS bolted
  - Historical specimens vs. new fabrication

Test Procedure

- Induce fracture at controlled location
- Load test to determine stress redistribution
- Apply cyclic loading to find fatigue life in the ‘failed’ state

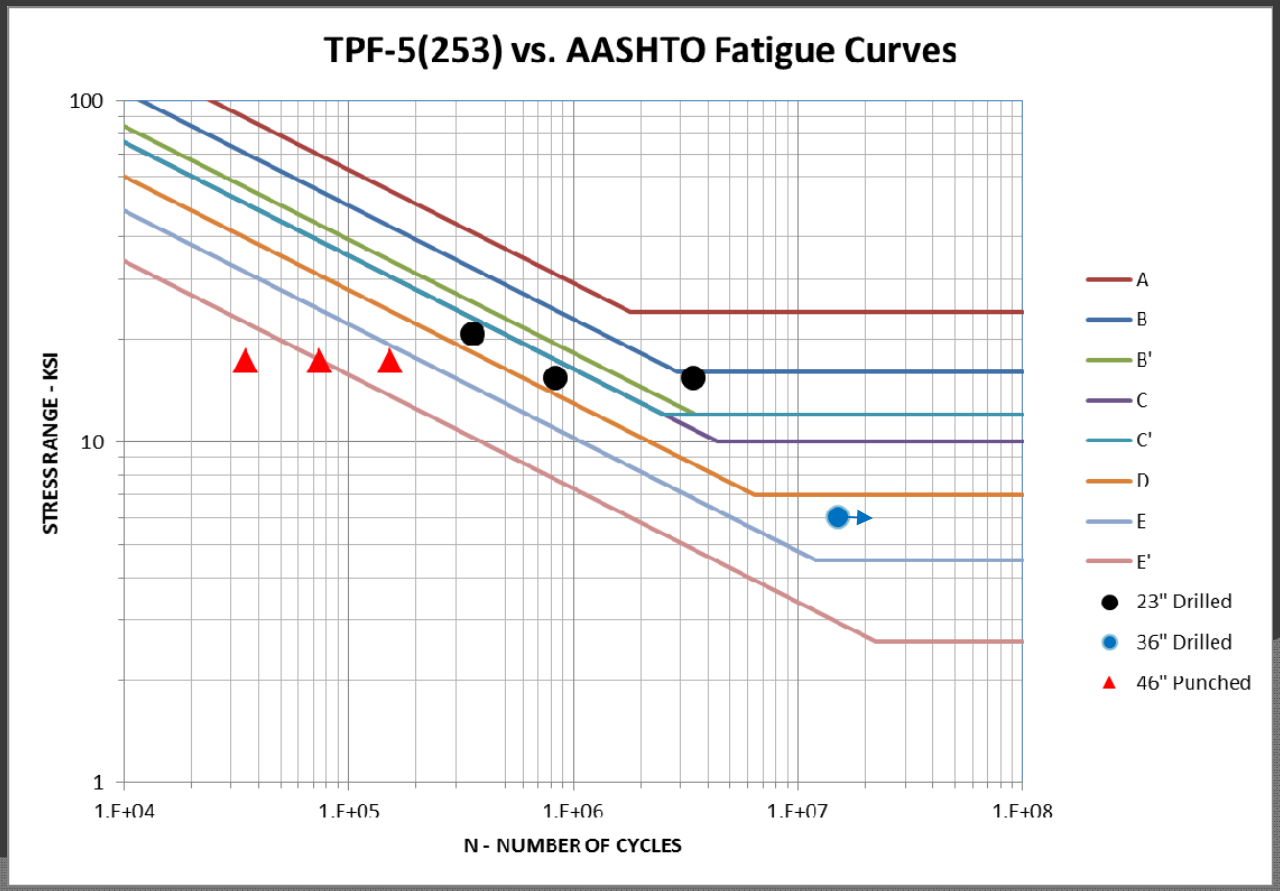


Fracture Test Results

- Only 1 of 7 specimens fractured
- All other specimens failed in fatigue

Fatigue Test Results

- Net section stress AFTER 1st component failure
- N is measured only AFTER 1st component failure



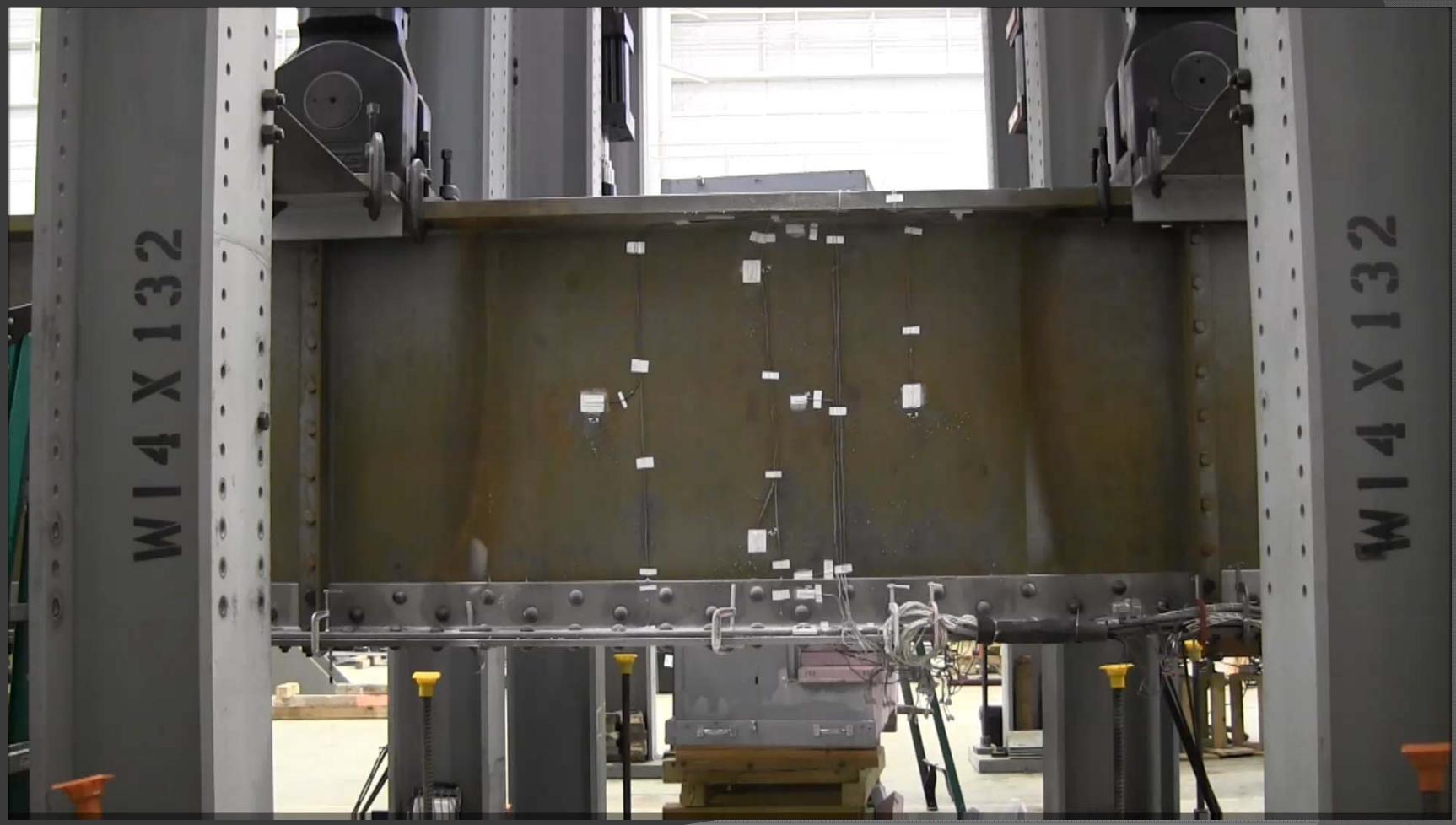
Fracture Video

46” Specimen

- 46” web plate
- 40’ span length
- Single cover plate
  - Initially notched
  - Fatigue crack growth to critical crack length
- Fracture Load
  - 180 kips per actuator
  - 0.55Fy of net section

Fracture Video

46” Specimen



Fracture Video

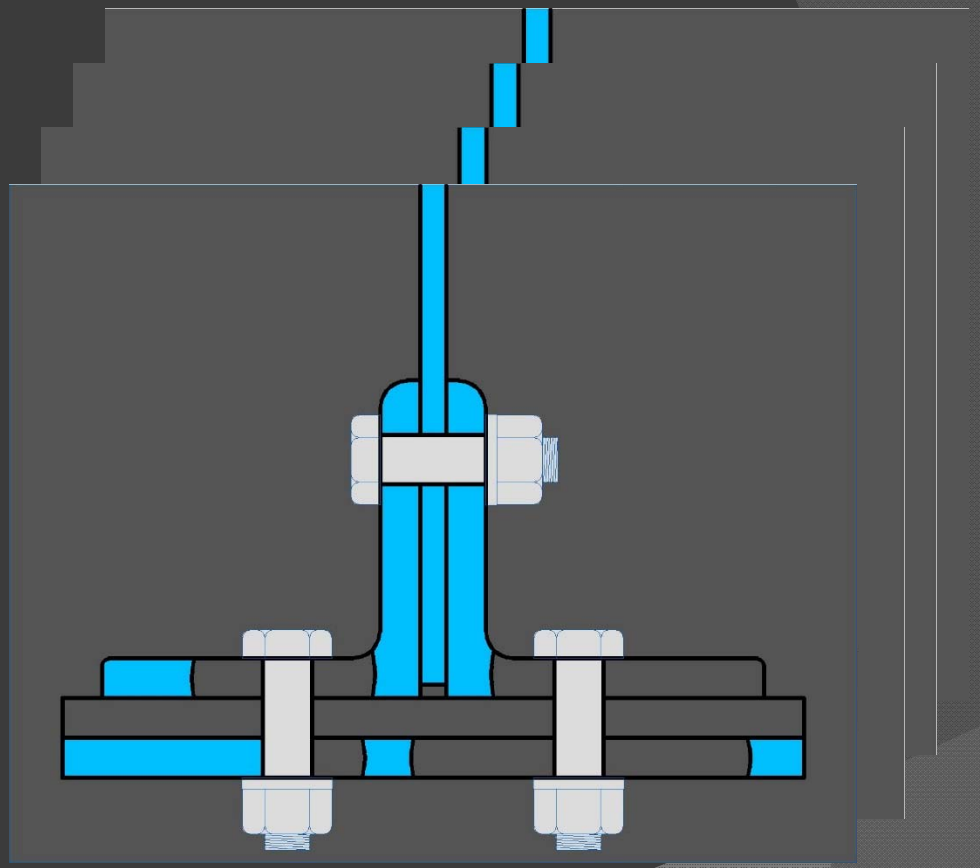
36” Specimen

- 36” web plate
- 40’ span length
- Double cover plate
- Upper cover plate
  - Initially notched
  - Fatigue crack growth to critical crack length
- Fracture Load
  - 200 kips per actuator
  - 0.55Fy of net section

Fracture Video

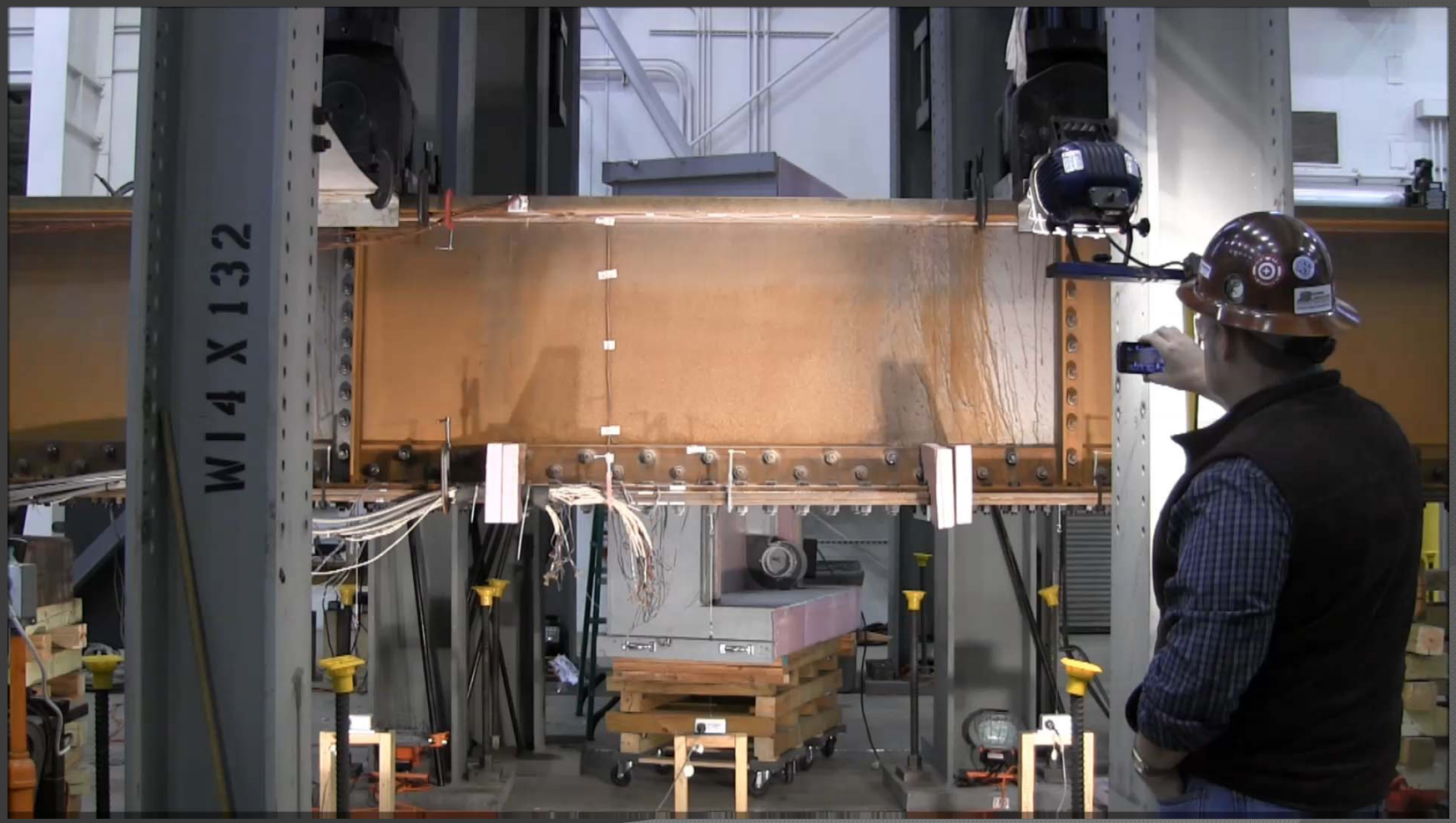
36” Specimen

- 4 fracture attempts beyond ‘critical crack length’
- Only 28% of tension flange remaining
  - Applied load greater than yield capacity of net section



Fracture Video

36” Specimen



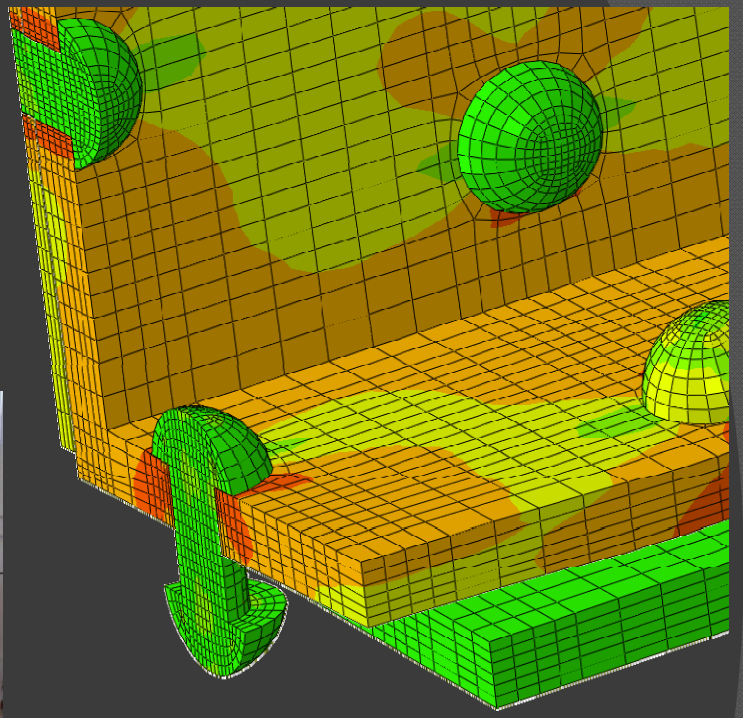
Results (ongoing)

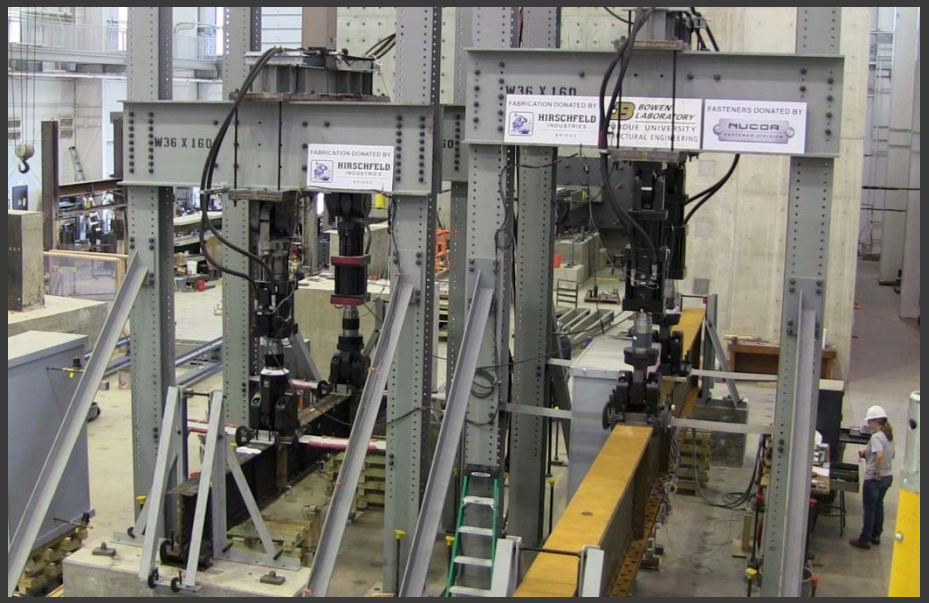
- Built-up sections do not appear fracture-critical
  - Possess member-level redundancy
  - Fracture propagation to adjacent components in built-up members appears unlikely
  - Can built-up sections be declassified?
- Substantial fatigue life of built-up sections with failed component
  - AASHTO fatigue category D
  - Can rationally based inspection intervals be set?

Impact

- Over 13,000 steel bridges in the U.S. are classified as fracture critical with built-up sections
  - 6-7% of steel bridge inventory

Questions





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