LABORATORY TESTING OF RAILROAD FLATCARS TO DETERMINE ULTIMATE STRENGTH AND REDUNDANCY

Teresa L. Washeleski
Jason Lloyd
Robert J. Connor
**PHASE I:** Field Testing of 7 RRFCs to develop load rating procedures

**PHASE II:** Laboratory Testing of RRFCs to refine rating procedures and evaluate redundancy
Research Plan

- Load RRFCs individually
  - Load distribution within RRFC
- Timber and Concrete decks
  - Load distribution within and between RRFCs
  - Composite action (Concrete Deck)
- Investigate after-fracture capacity
  - Two girder system = fracture critical
  - Becomes less economical for counties
    - $$$ inspection
  - Simulate fracture to investigate redundancy
Installed Timber Deck
Concrete Deck

- Detailed to be composite
  - ~600 studs throughout entire bridge
  - Designed per AASHTO

- Rebar
  - #5’s spaced at 10” on top
  - #5’s spaced at 12” on bottom
  - Typical INDOT Design

- Concrete
  - INDOT Class C Concrete (6000 psi)
Concrete Deck
Concrete Deck

https://www.youtube.com/watch?v=RumXqSG-HC4
Search for : Bowen lab channel
Concrete Deck

West Car

East Car
With Timber and Concrete Decks

- Series of load tests conducted
  - Single patch load
  - Axle load (2 patch/wheel loads)
- Establish load distribution
  - Within car
  - Between cars
Should they be Classified as Fracture Critical?

- Simulated fracture of main girders
  - Cut portion of girder
  - Cooled with liquid nitrogen and loaded
East RRFC Fracture Test

- 11 in. initial “crack”
- Difficulty fracturing
  - Cut 3 in. into edges of flange
  - Cut 15 in. up both webs
East RRFC Fracture Test
Results of East Car Fracture

- Bridge carried self weight
- Sustained 150 kip patch load over fracture
  - Test stopped…ran out of stroke
  - Deflection about 3 inches
  - Very detectable crack and sag

- Of course question remains…
  - If off “FC” list, no detailed inspection. What if one car failed and no one knew…
    - Left with “one girder bridge”
    - What if other car fails…tragedy
Therefore conducted Fracture Test on West RRFC

- 11 in. initial center cut
- Cooled with liquid nitrogen
- Applied load...bang!
West RRFC Fracture Test
Performance with Both Main Girders Fractured

- With East and West box girders fractured
  - System sustained 190 kip point load over west car
  - Deflection about 8 inches
    - Very detectable crack and sag
Conclusions

- Phase I rating procedures appear reasonable
  - Compare well with lab results for this car
- Timber deck offered little load distribution within car
  - Negligible between cars (based on field data)
- Concrete deck offered excellent distribution within and between cars
- **These cars demonstrated excellent reserve strength...even when severely damaged**
  - Makes sense – Designed for much higher loads
<table>
<thead>
<tr>
<th>Live Load Limit</th>
<th>Gross Rail Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>kips (tons)</td>
<td>kips (tons)</td>
</tr>
<tr>
<td>140 (70)</td>
<td>220 (110)</td>
</tr>
<tr>
<td>200 (100)</td>
<td>263 (131.5)</td>
</tr>
<tr>
<td>220 (110)</td>
<td>286 (143)</td>
</tr>
</tbody>
</table>

AAR Design Specifications have existed since 1964

100 ton cars since mid 1960s

Load uniformly distributed across car
Conclusions

- A single RRFC is not a single beam
  - Comprised of multiple longitudinal and transverse components
Conclusions

- Encourage owners to consider composite concrete deck
  - Concrete Deck $9,300
  - Timber Deck $12,300
    - Estimated from partial timber decking installed
  - Labor likely greater for timber
  - Concrete lasts 30+ years on low volume
  - Allows more robust parapet connection

- These are typical RRFC bridge X-Sections
  - Hard to justify classifying as FC with composite deck
Questions?