Emergency Repair to the Delaware River Turnpike Bridge

GENERAL INFORMATION:

Year Built:	1956
Designer:	George S. Richardson
Contractor:	American Bridge
Structure Type:	6,571', 31 Spans
	Main Span – Continuous Arch Truss (682' Main/341' anchor)
	Approach – 3 & 4 Span Continuous Deck Truss, girder/floorbeam spans
Over:	PA US Route 13, Amtrak Mainline, 3 Local Roads IN PA, Delaware River, River Road in NJ

ADDITIONAL INFORMATION:

- ADT (2014) = 41,551
- Ownership/Maintenance: Jointly Owned by New Jersey Turnpike Authority and Pennsylvania Turnpike Commission
- Last Inspection: 2014
- 2016 Inspection currently in progress.
- Structure Painting Contract Currently in Progress.

14 Similar Deck Truss Spans of 31 Total Spans

Bridge Length Potentially Affected: ⅔ Mile of 1¼ Miles

PA Cont. Deck Truss Spans:

- 3 Span Continuous Unit: Piers 10 – 13
  Total Length ≈ 647'
- 4 Span Continuous Unit: Piers 13 – 17
  Total Length ≈ 1078'

NJ Cont. Deck Truss Spans:

- 3 Span Continuous Unit: Piers 24 – 27
  Total Length ≈ 647'
- 4 Span Continuous Unit: Piers 20 – 24
  Total Length ≈ 1078'

LOCATION OF FRACTURE
4 Span Continuous Deck Truss Unit (Spans 14 to 17)
DECK TRUSS SPANS

Fractured Member

Day 1: January 20

- On-Going Paint Contract – Discovered by Contractor
- Immediate Action
  - Remove Traffic on and below bridge.
  - Clearing the Unit of Contractor Material
  - Stabilize Truss
- Alternatives
- Organize Teams/Resources

Organize Teams/Resources

- Set Up War Rooms at Site as Well as PTC Central Office
- Communications – Daily Meetings/Calls – Multiple Times a Day
- Utilize Agencies' General Consultant Engineers
- Utilize Resources Already on Site or in Area
  - Allied Painting
  - Cornell and Co.
  - STV
  - Urban
  - PKF
- PTC Presence on Site

Stabilize Truss – Temporary Splice

Temporary Splice

STABILIZE TRUSS

Install Temporary Support Towers

Temporary Support/Jacking Towers

Utilities were avoided during drilling

2/14/2017

Micropile Foundations

Micropile Foundations

Micropile Foundations- Utility Impacts

Temporary Support/Jacking Towers

Hydraulic Jacks Installed at Towers 1, 2, 3 & 4 on 2/8/2017

Hydraulic Jacks Installed at Towers 5, 6, 7 & 8 on 2/11/2017

Truss Strengthening

Instrumentation and Load Testing

Instrumentation and Load Testing

Hands-On Inspection

Other Completed Actions – Hands-On Inspection of Similar Units

3-Span Continuous Deck Truss

NJ 4-Span Continuous Deck Truss Unit on 1/27/2017

NJ 3-Span Continuous Deck Truss Unit on 1/30/2017

PA 3-Span Continuous Deck Truss Unit on 2/3/2017

Legend: Inspection Focus — "Jumbo" Tension Member (Flange Thickness ≥ 1 ½") — "Jumbo" Compression Member (Flange Thickness ≥ 1 ½")

Ultrasonic Testing (UT)

Ultrasonic Testing (UT)

U7-U9 Finding

Ultrasonic Testing (UT)

Summary of UT

- 277 members tested. 3 ft. limits each end
  - Zero plug weld indications
  - Removed chord scanned prior to delivery to Lehigh. No other plugs present
- 53 additional members identified for full length testing. No defects found.
- Suspected "mechanically filled holes" confirmed that "no welds" present.
- U7-U9 cores tested multiple ways. No evidence of any rejectable defects

Vertical Jacking Operations

Removal of Fractured Member/Post Tensioning

Post Tensioning

Additional Repairs

Final Splice

Delaware River Turnpike Bridge

BEST SCENARIO:

- ✓ Confirmation that this is an isolated finding
- ✓ Material testing across entire structure does not show global issue
- ✓ The structural members move as predicted during slow, regulated jacking
- ✓ Sensors installed during instrumentation and analysis show that stresses shift in existing members to acceptable levels during jacking
- ✓ Permanent splice is installed
- ✓ Complete repairs; load test
- ✓ Open the bridge to traffic

Going Forward

- On-going Repairs
- Restoration of Site
  - Removal of Towers
  - Recreation of Basins
- Forensic Analysis
- Long Term Health Monitoring
- Bridge Replacement
- Challenges and Positives

Purdue - Material Testing

PA 4-span

NJ 4-span

Purdue – Material Testing

Lehigh – Material Testing of Fractured Member

INITIAL CONCLUSIONS

- Brittle fracture initiated and propagated from holes repaired/partially filled with weld material.
- No evidence of fatigue damage observed in initiation areas.
- The weld HAZ may have increased the susceptibility to brittle crack initiation.
- Five of six samples tested met the yield and tensile strength requirements.
- Test results indicate the material is as-expected for the era of construction
- Cracking observed along inclusions near the mid-surface of the flange:
  - May have formed during welding or fracture.
  - Oriented perpendicular to the fracture.

Conclusions Based on Results To-Date

- CVN values, when taken per the A673 specifications, appear more than adequate for steels of the era.
- CVN values can vary depending on where they were taken: those near the surface tend to have higher toughness than those near mid-thickness.
- Test results indicate the material is as-expected for the era of construction.
- Chemical composition and mechanical properties closest to MAN-TEN (A242) outlined in USS Design Manual (1954).
- Appropriate yield stress to use based on the material tests to date would be 42 ksi.
- Material shows good ductility.

Delaware River Turnpike Bridge

New Jersey Turnpike Authority (NJTA)

- Allied Painting Inc.
- Cornell & Company Inc.
- Federal Highway Administration (FHWA)
- Greenman-Pedersen Inc. (GPI)
- HNTB Corp. - GCE
- Lehigh University
- MoreTrench American Corp.
- NJ Department of Transportation
- NJ State Police
- NJ Turnpike Authority (NJTA)
- Notre Dame
- PB Americas Inc.
- STV Inc.
- WSP/Parsons Brinckerhoff

PA Turnpike Commission (PTC)

- Federal Highway Administration (FHWA)
- Laboratory Testing Inc. (LTI)
- Michael Baker International (MBI) - GCE
- Modjeski & Masters Inc. (M&M)
- PA Department of Transportation (PennDOT)
- PA Emergency Management Association (PEMA)
- PA State Police (PSP)
- PA Turnpike Commission (PTC)
- Pennoni Consulting Engineers
- PKF Construction
- Purdue
- Urban Engineers

Questions?
INTERSTATE
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BRIDGE TO NJ
NOW OPEN