Emergency Repair to the Delaware River Turnpike Bridge

GENERAL INFORMATION:

Year Built: 1956

Designer: George S. Richardson

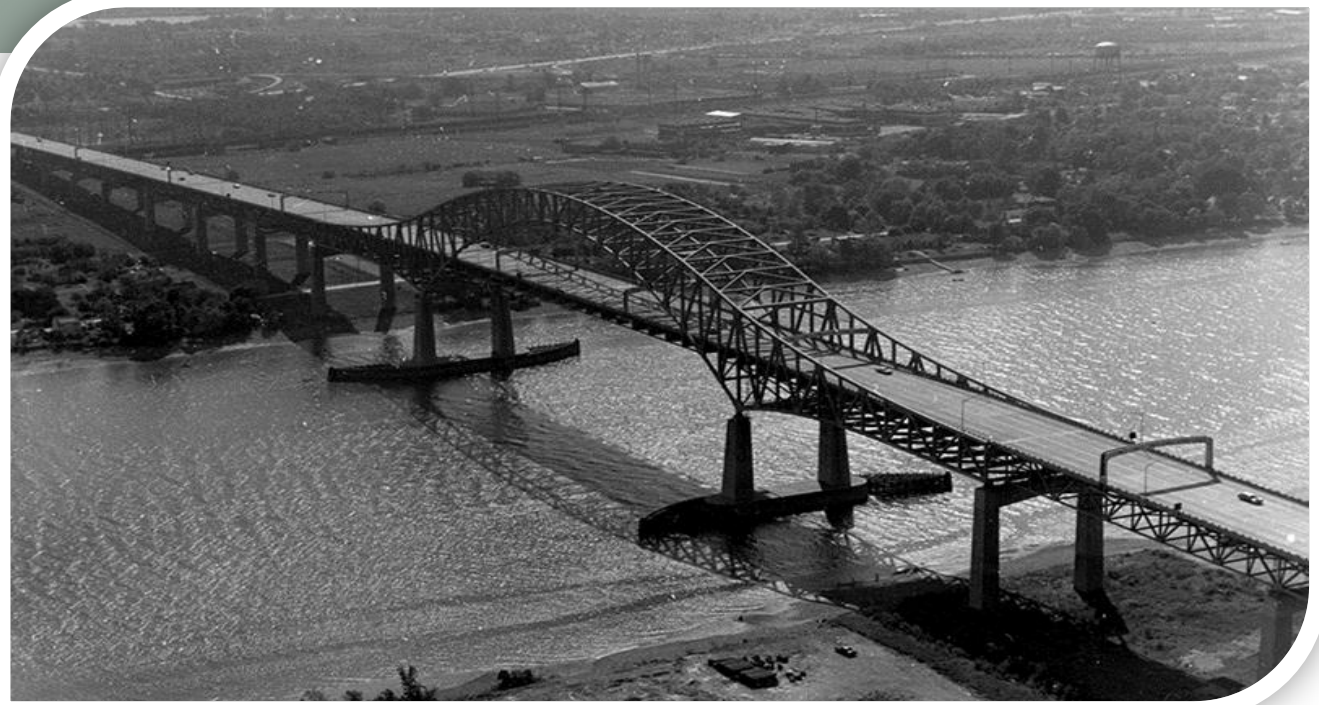
Contractor: American Bridge

Structure Type: 6,571’, 31 Spans

Main Span – Continuous Arch Truss (682’ Main/341’ anchor)

Approach – 3/4 Span Continuous Deck Truss, girder/floorbeam

Over: PA US Route 13, Amtrak Mainline, 3 Local Roads in PA, Delaware River, River Road in NJ

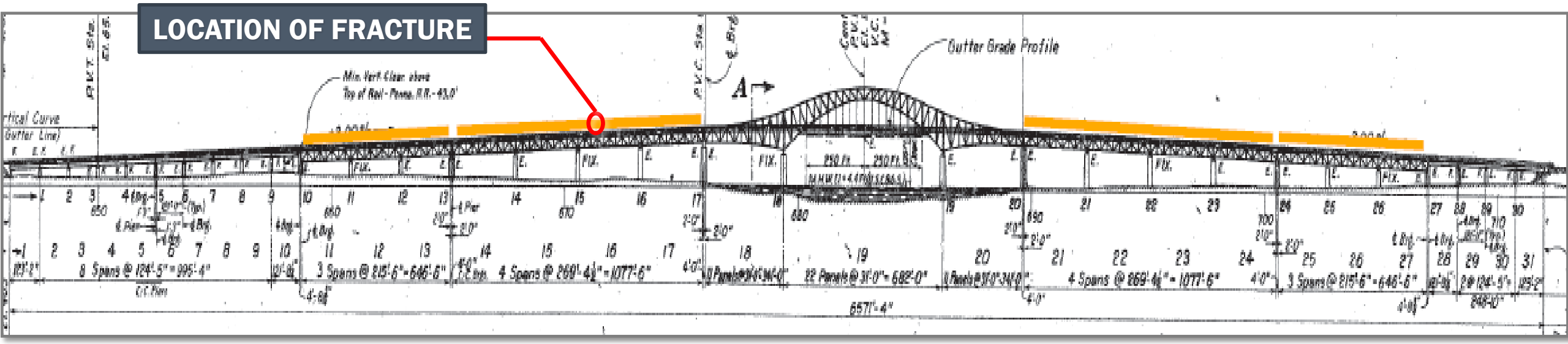


ADDITIONAL INFORMATION:

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

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’

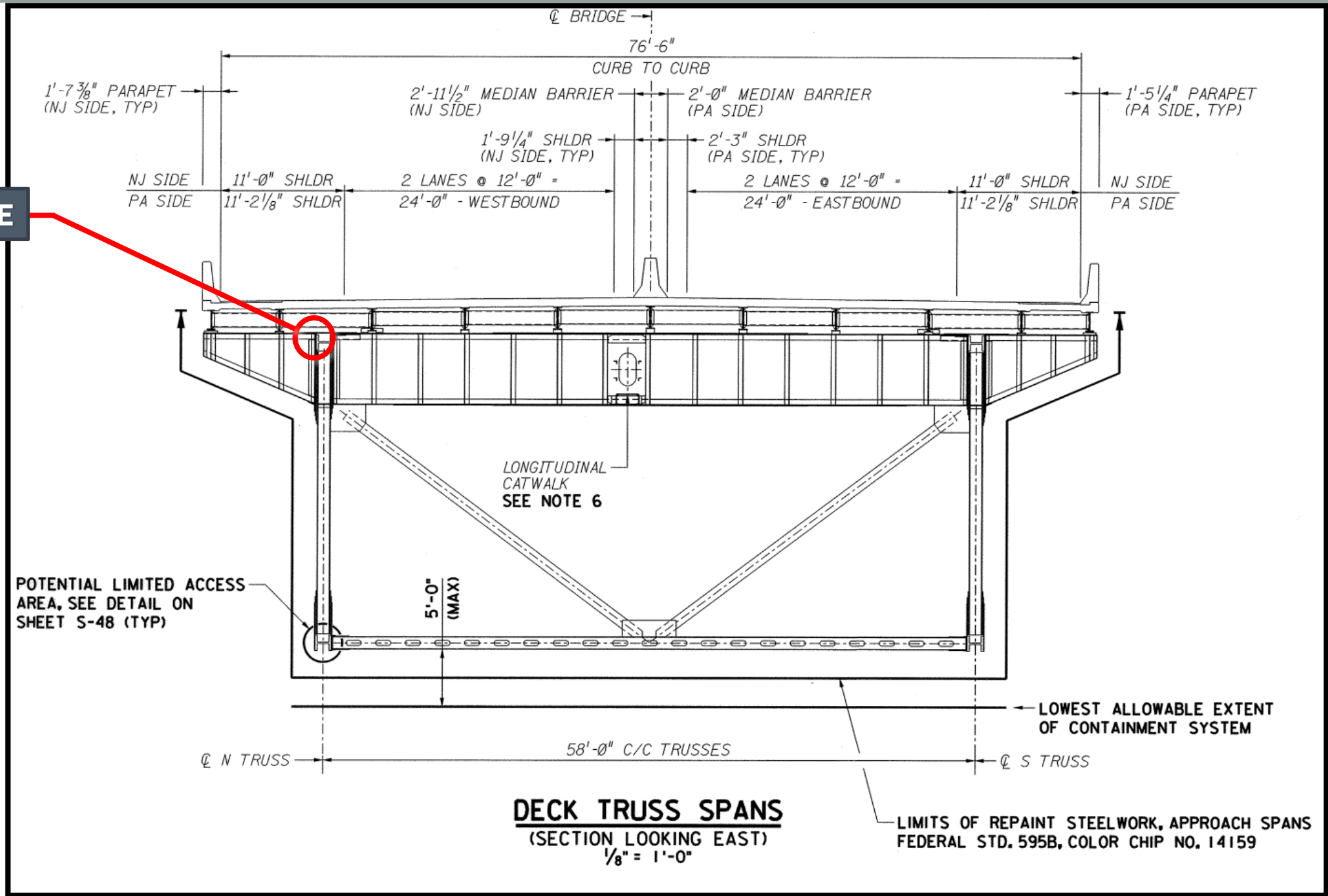
NJ Cont. Deck Truss Spans:

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


LOCATION OF FRACTURE
I-276 Eastbound Traffic
I-276 Westbound Traffic
Palmer Ave
Wood Ave

LOCATION OF FRACTURE

4 Span Continuous Deck Truss Unit (Spans 14 to 17)




INCHES 1 2 3 Lufkin 4 UNIVERSAL 5 6 7 8 P.R. APP'D. 9 212 Tb 10 11 12 13 14 OIL 15 ALL 16 JOINTS 17 18

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
- Utilize Agencies' General Consultant Engineers
  (Michael Baker, HNTB)
- Utilize Resources Already on Site or in Area
  (Allied Painting, Cornell, STV, Urban, PKF)
- PTC Presence on Site

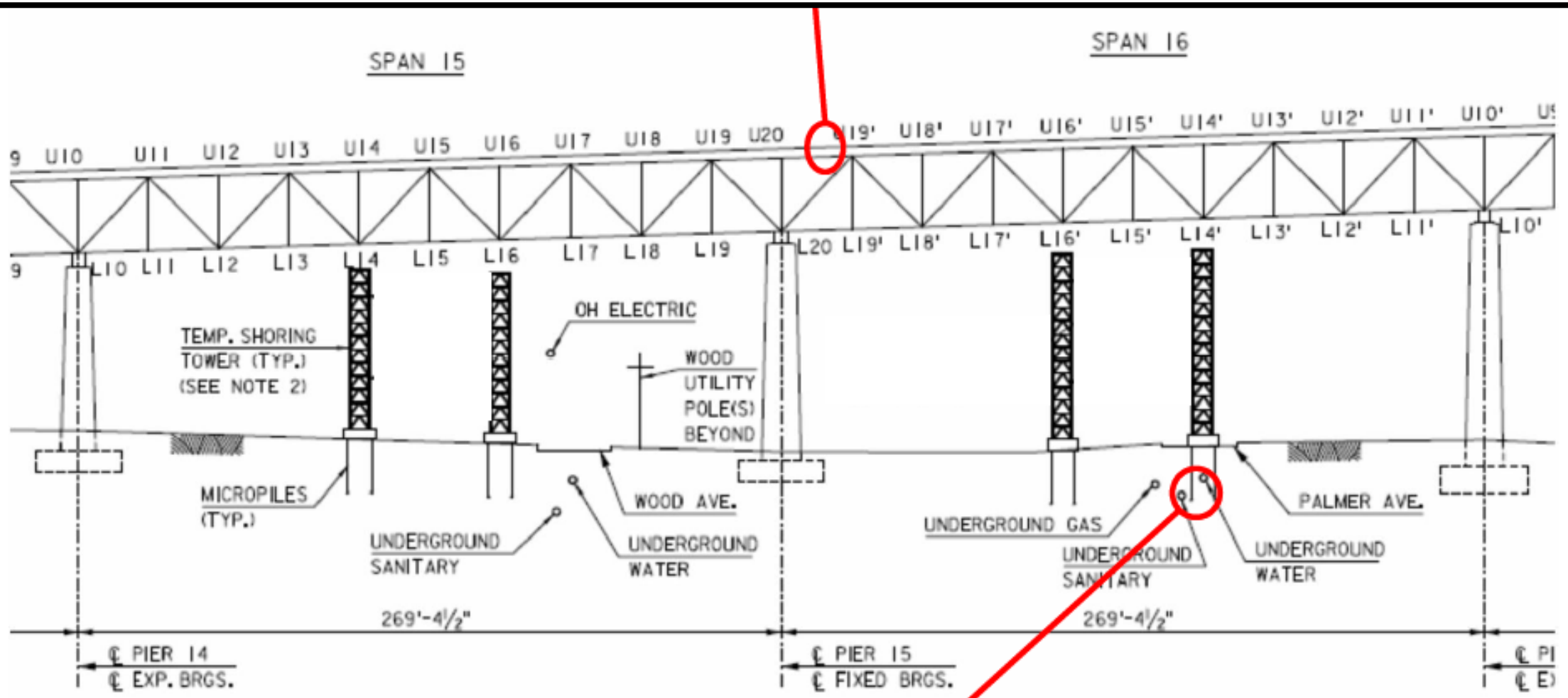

1"x11" WEB SPLICE
PLATE (TYP.)
EXIST. 14WF314

Temporary Splice

STABILIZE TRUSS

Install Temporary Support Towers

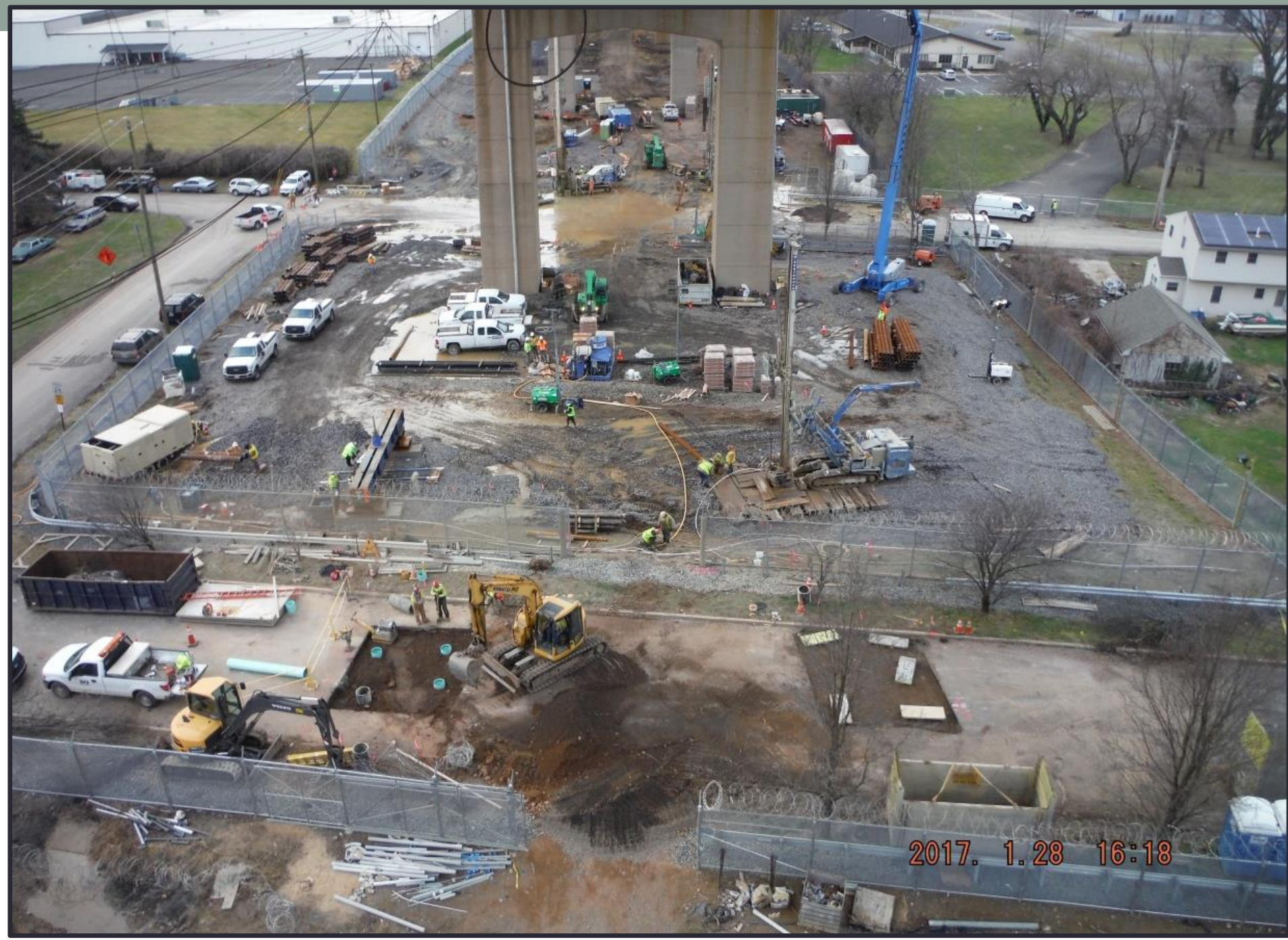
Temporary Support/Jacking Towers



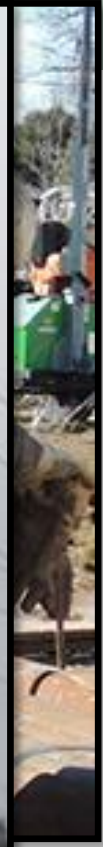
Utilities were avoided during drilling


Palmer Ave

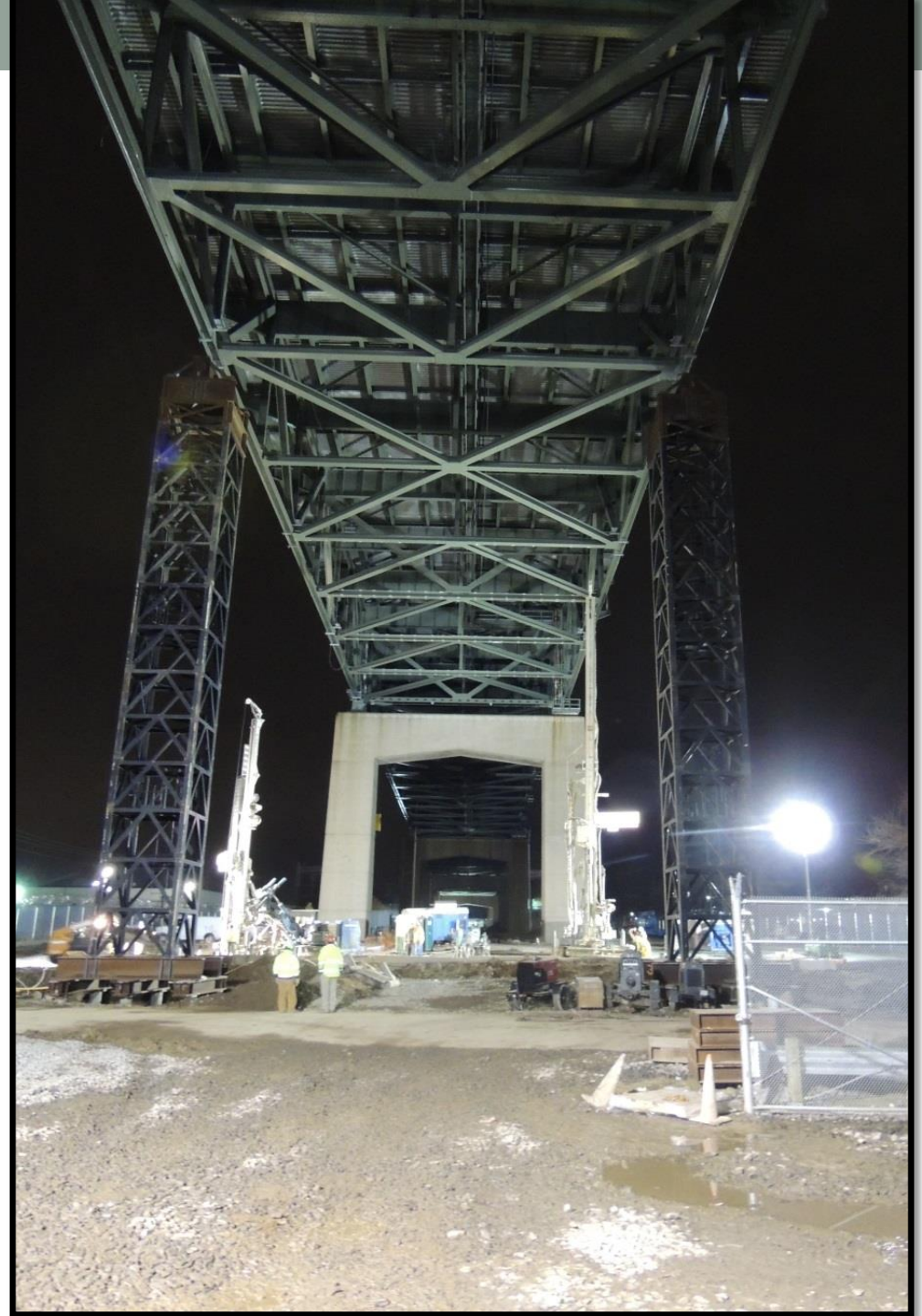
Micropile Foundations



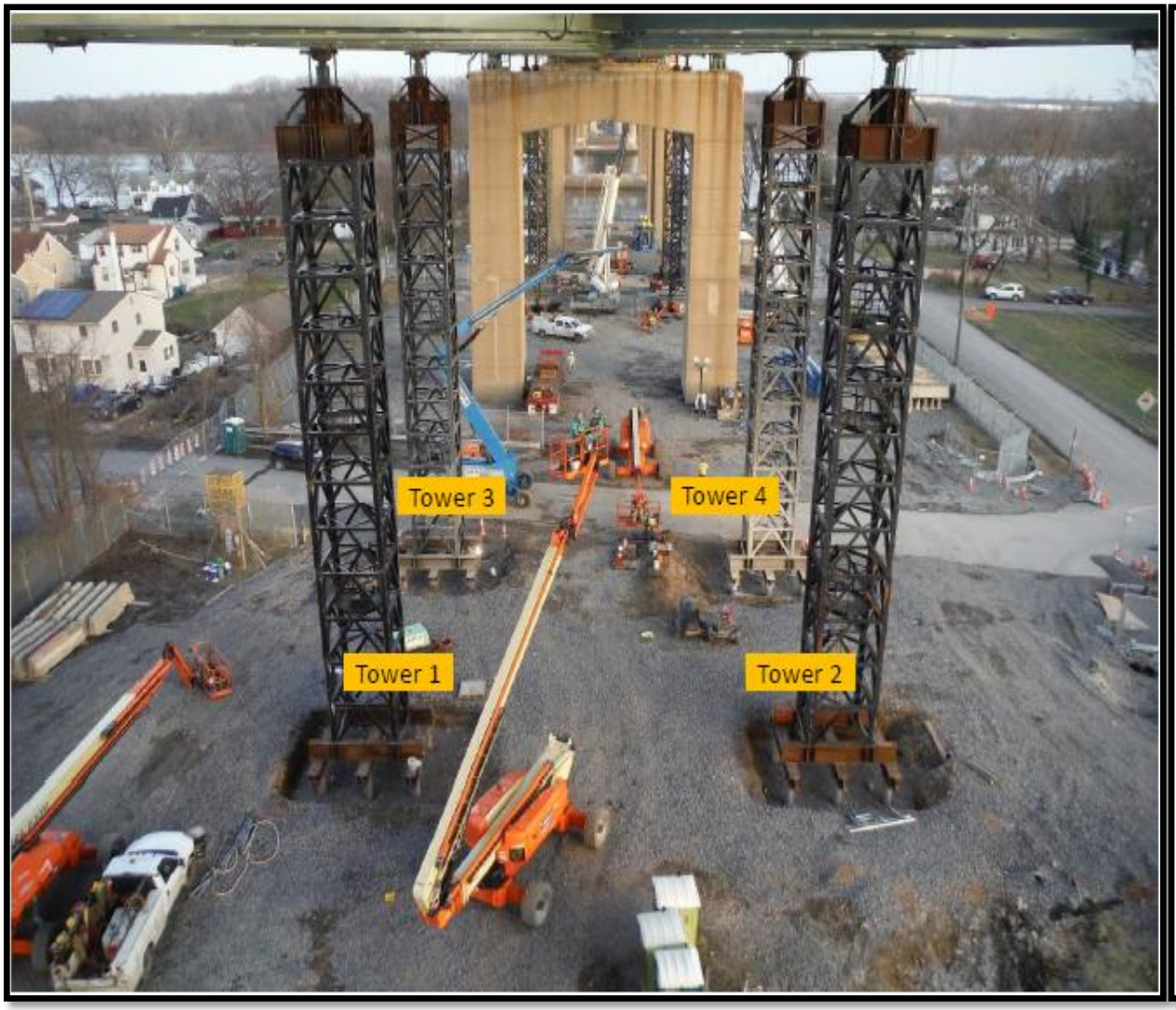
Micropile Foundations

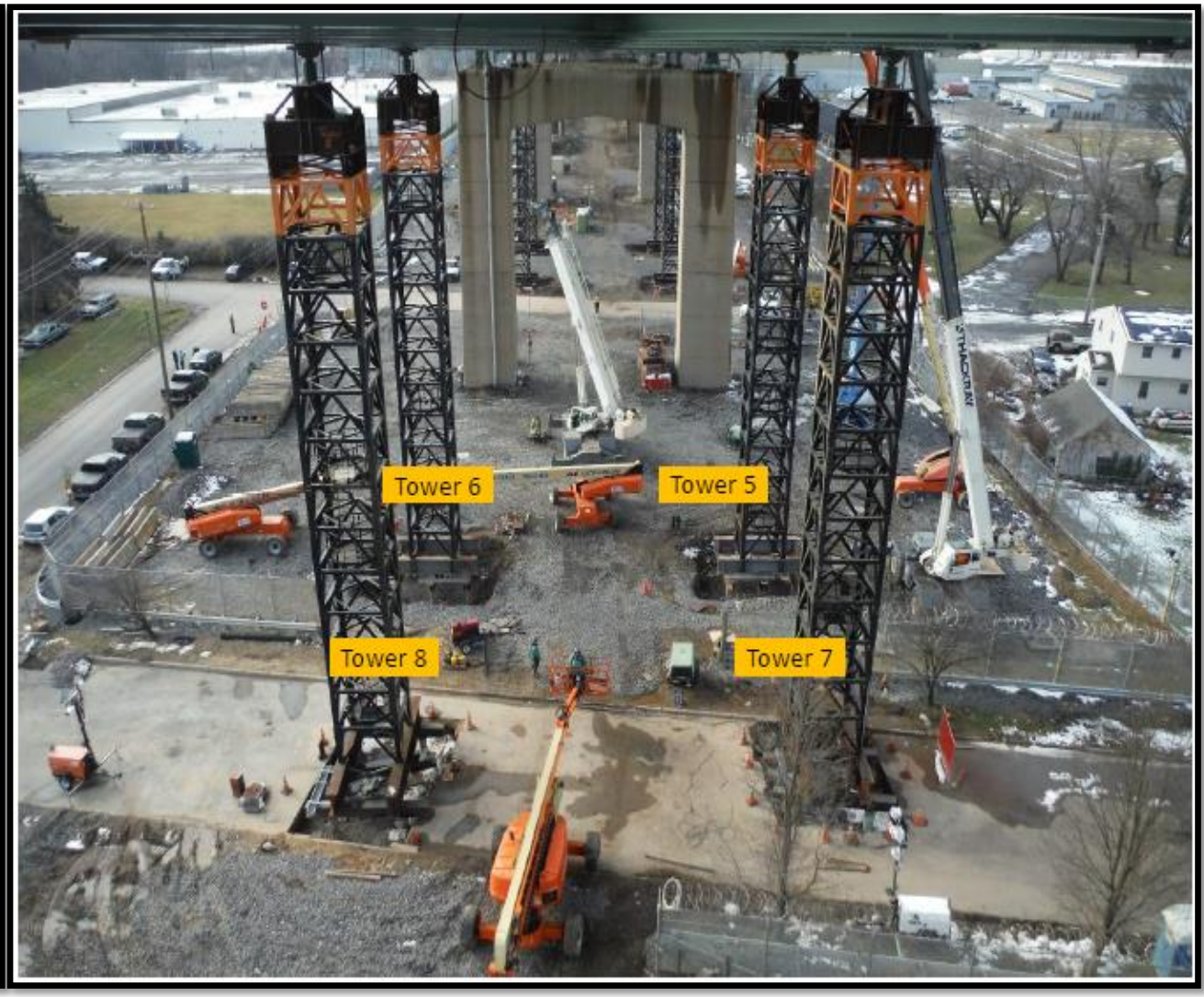


Micropile Foundations
Utility Impacts

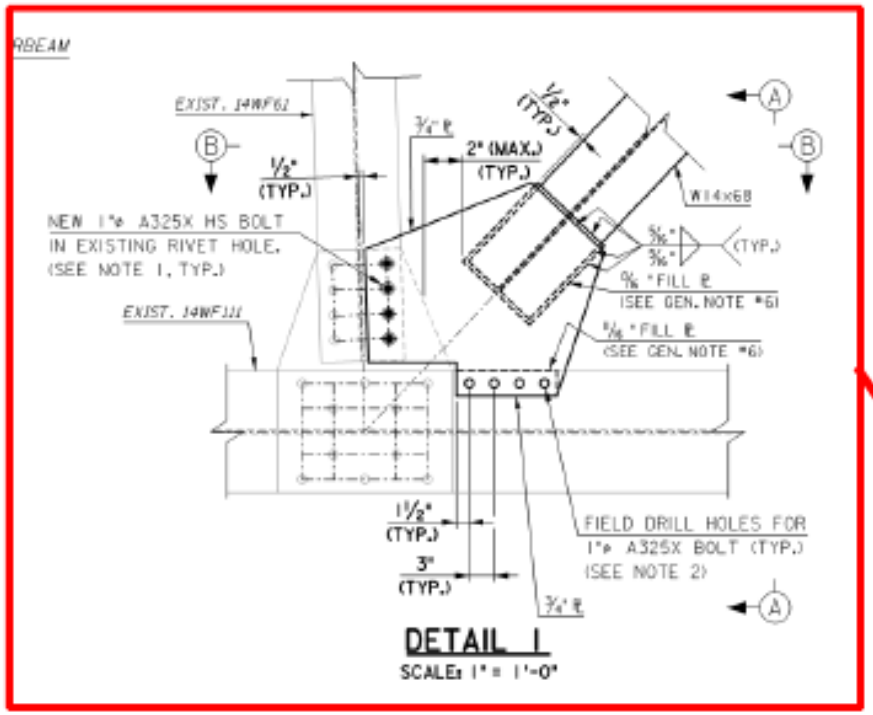


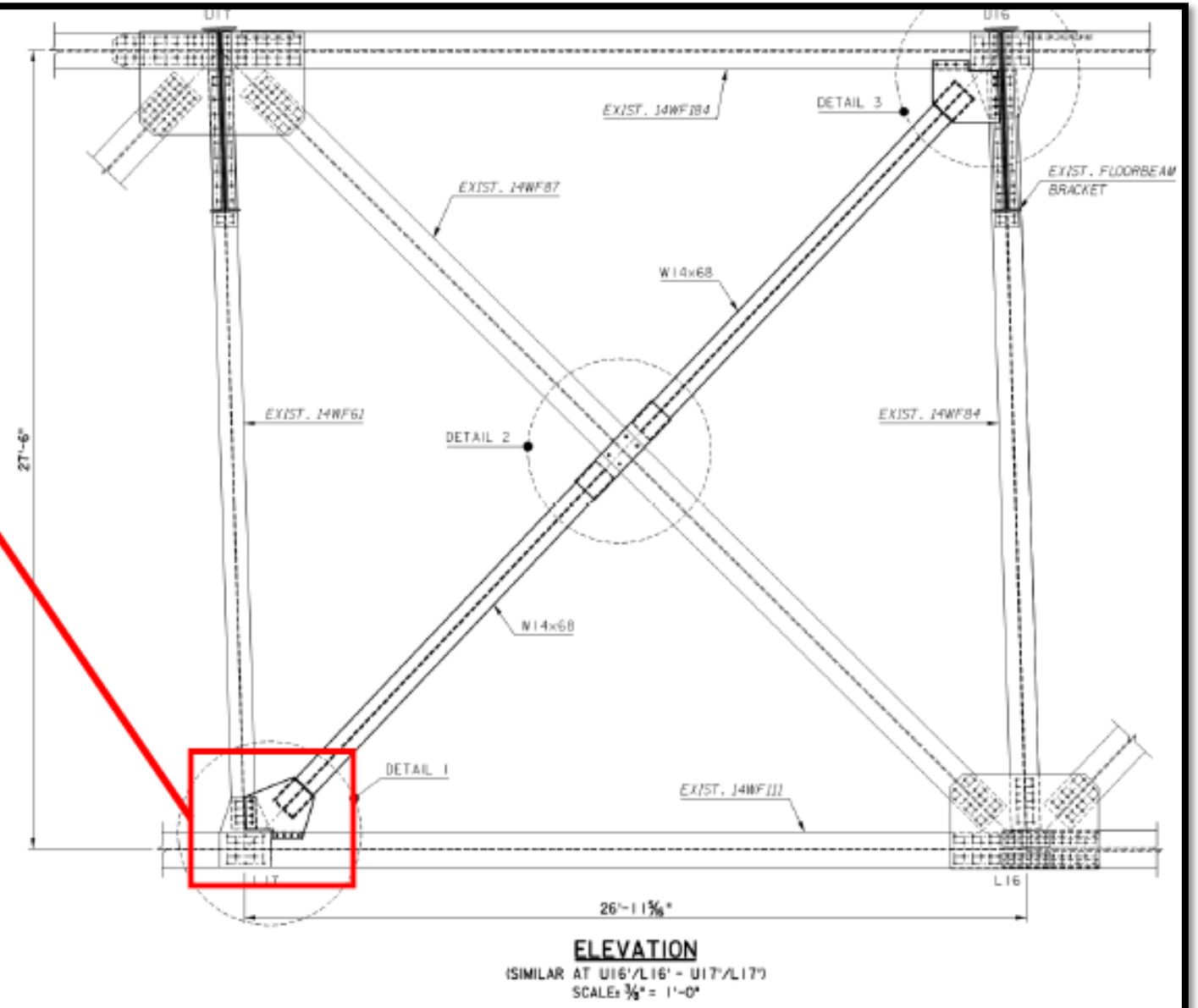
Temporary Support/Jacking Towers



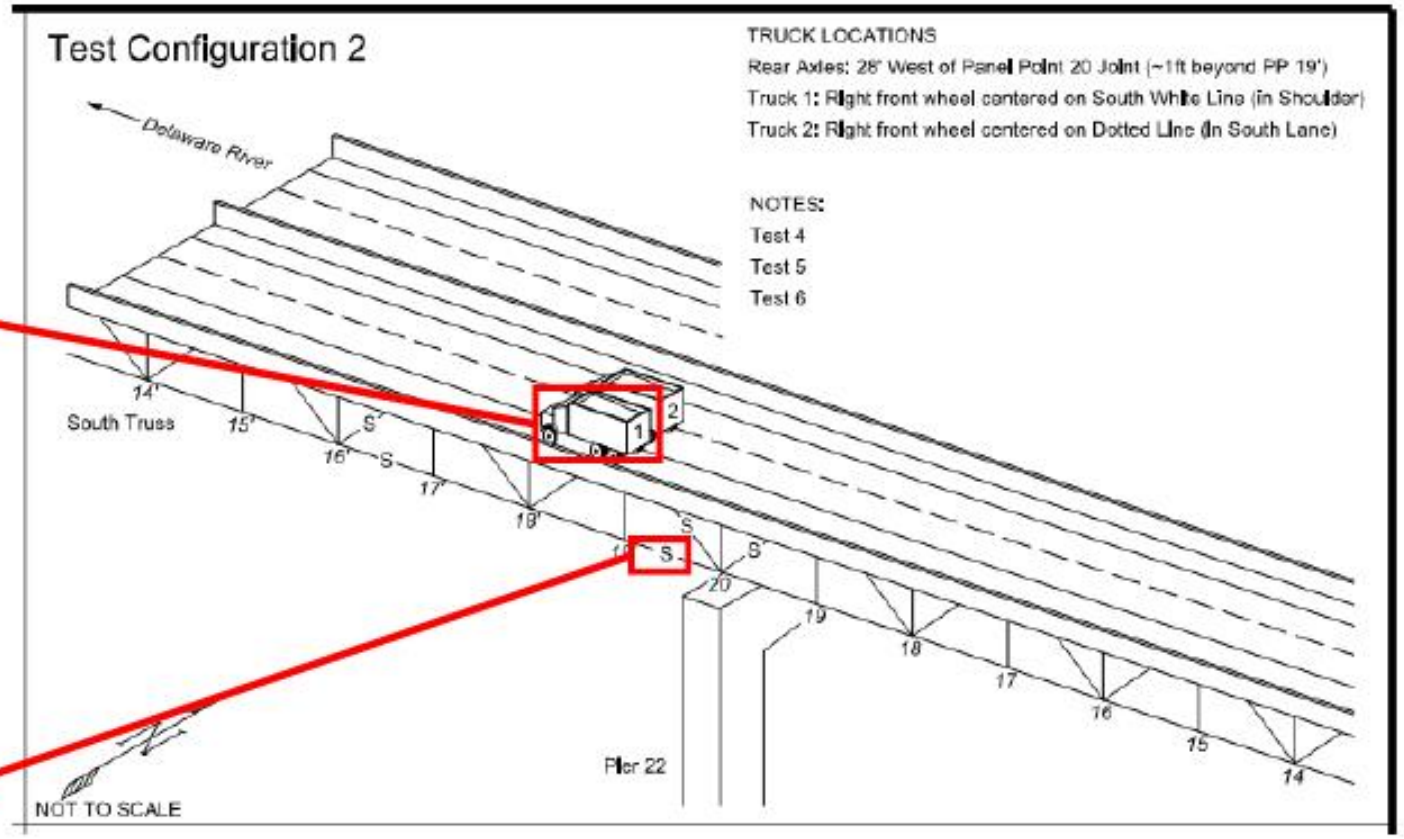


Truss Strengthening





Instrumentation and Load Testing



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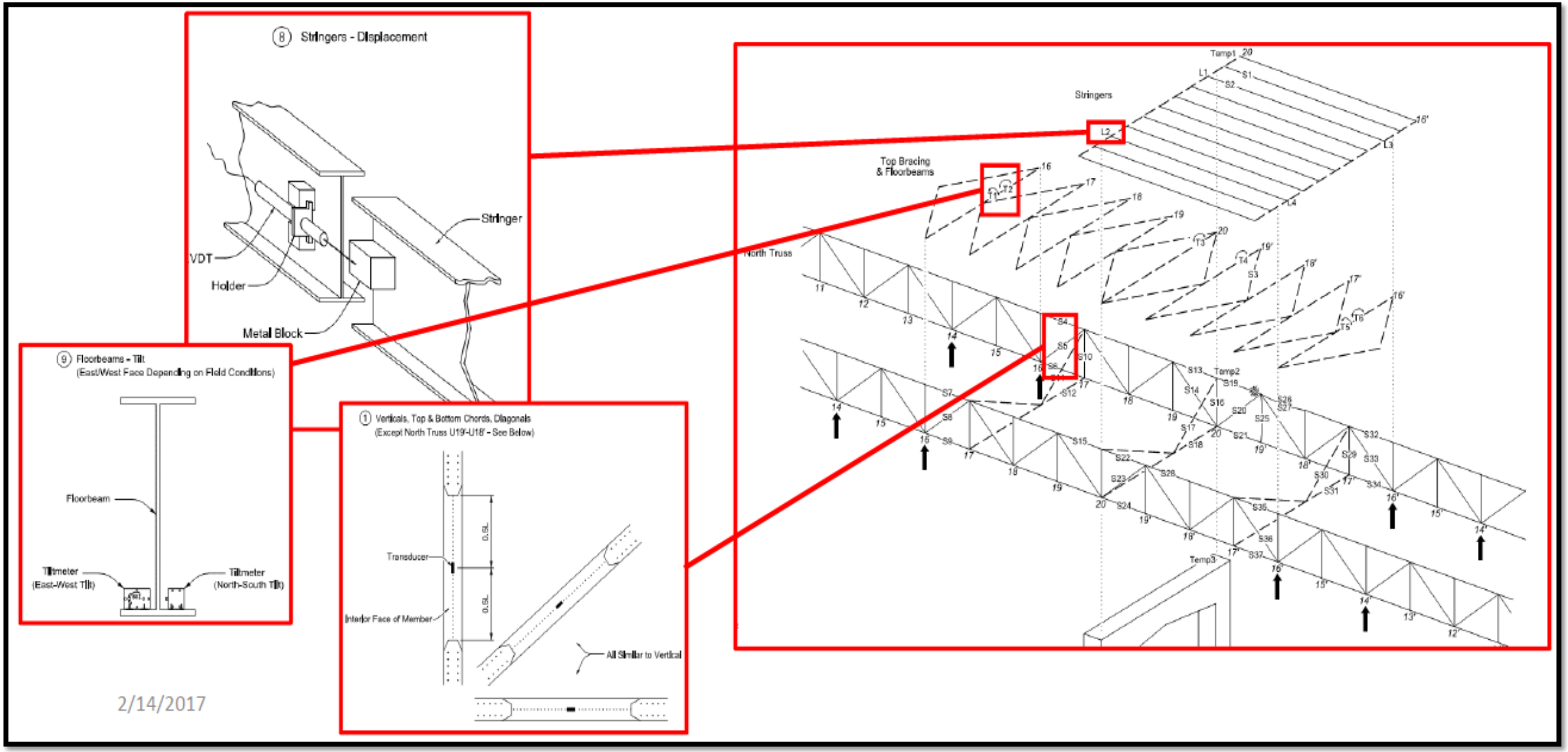
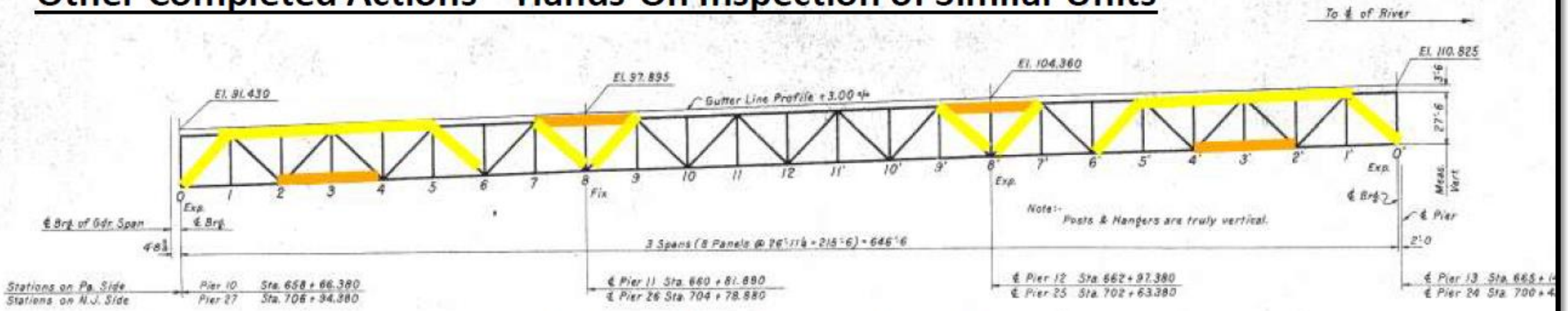


Hands-On Inspection

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

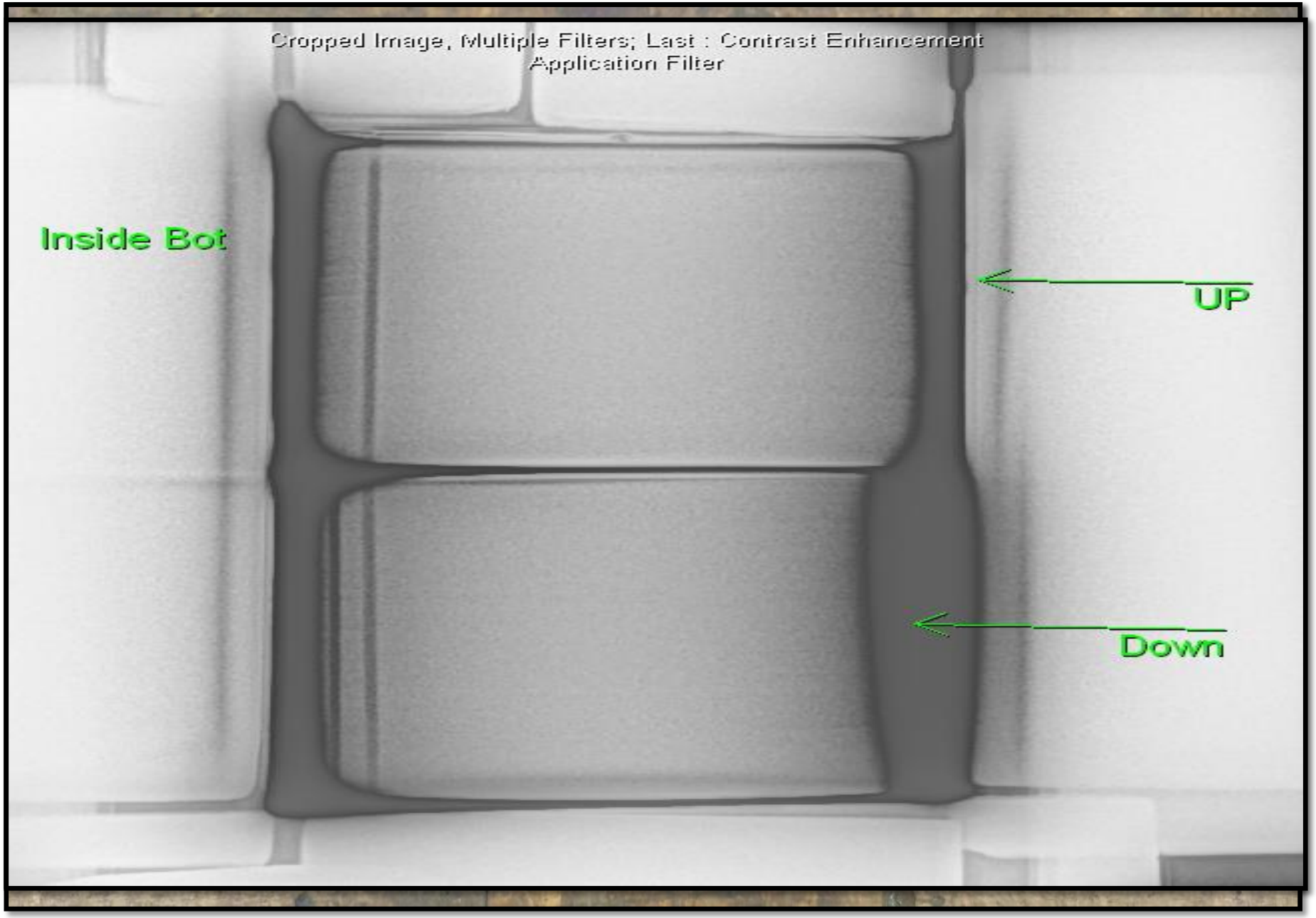
PA 3-Span Continuous Deck Truss Unit on 2/3/2017

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

Ultrasonic Testing

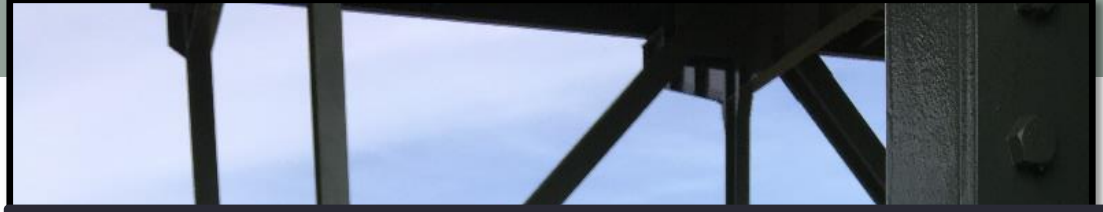
Ultrasonic Testing

U7-U9 Finding



Ultrasonic Testing

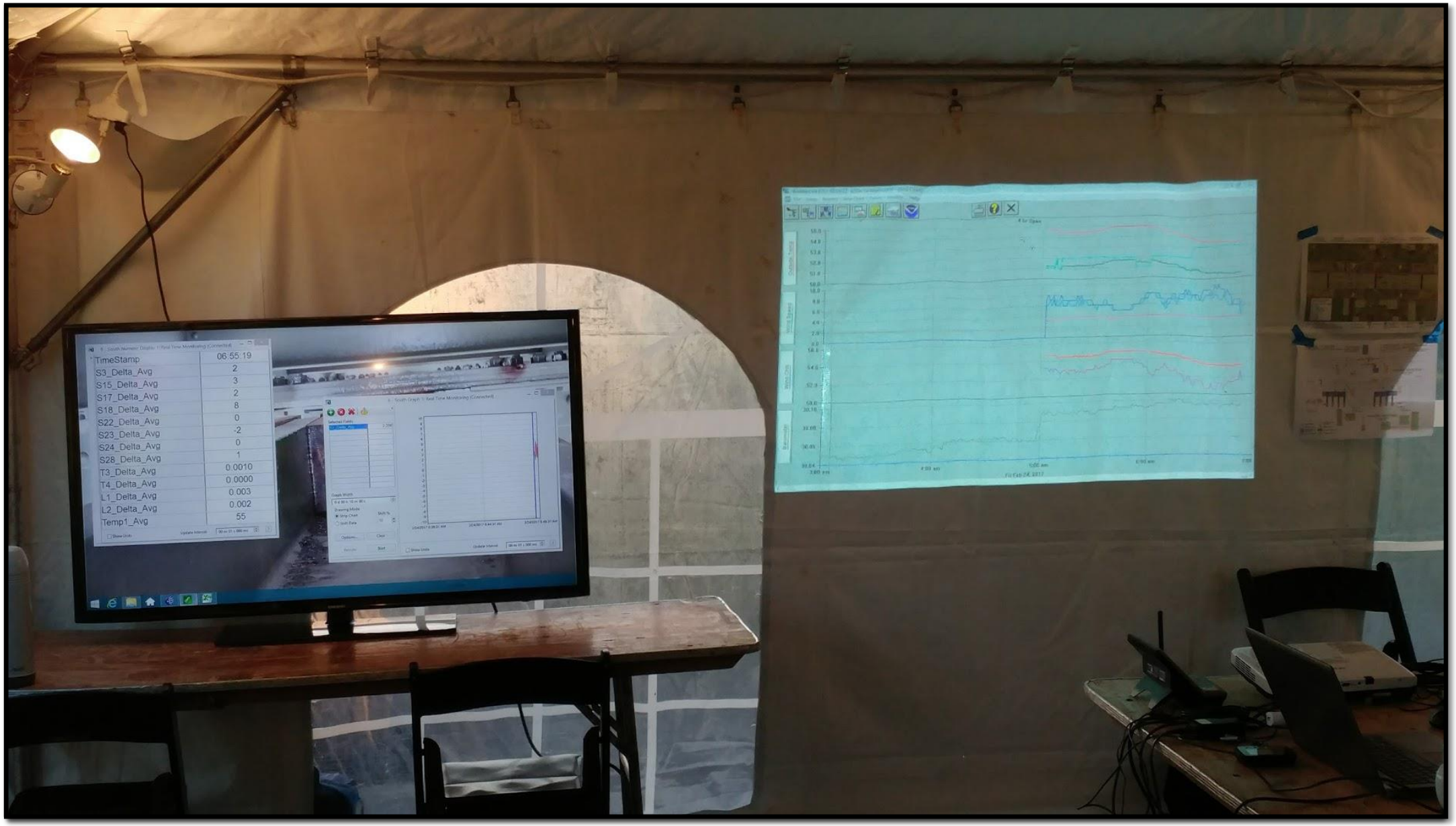
U7-U9 Finding



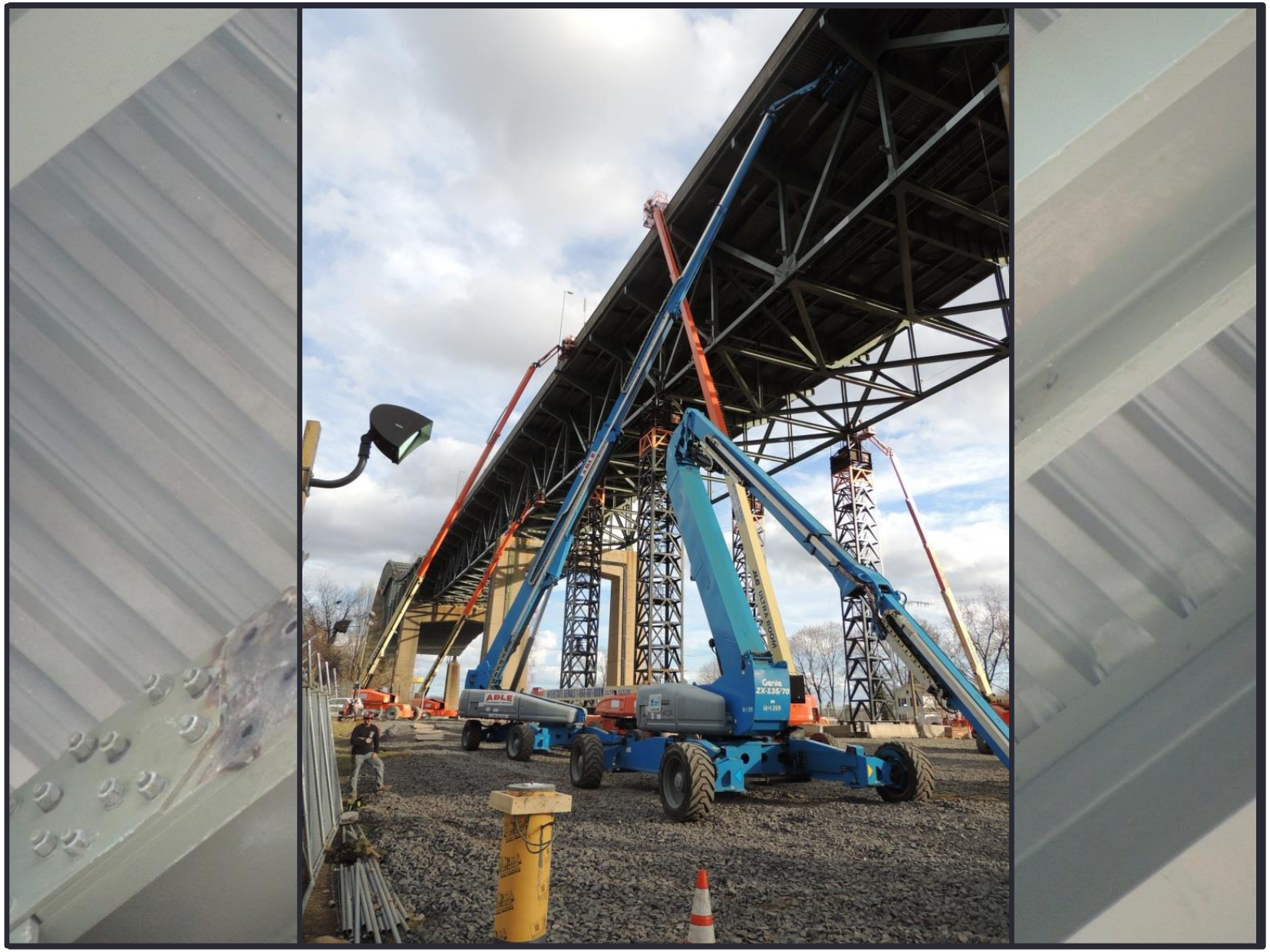
Summary of UT

- 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

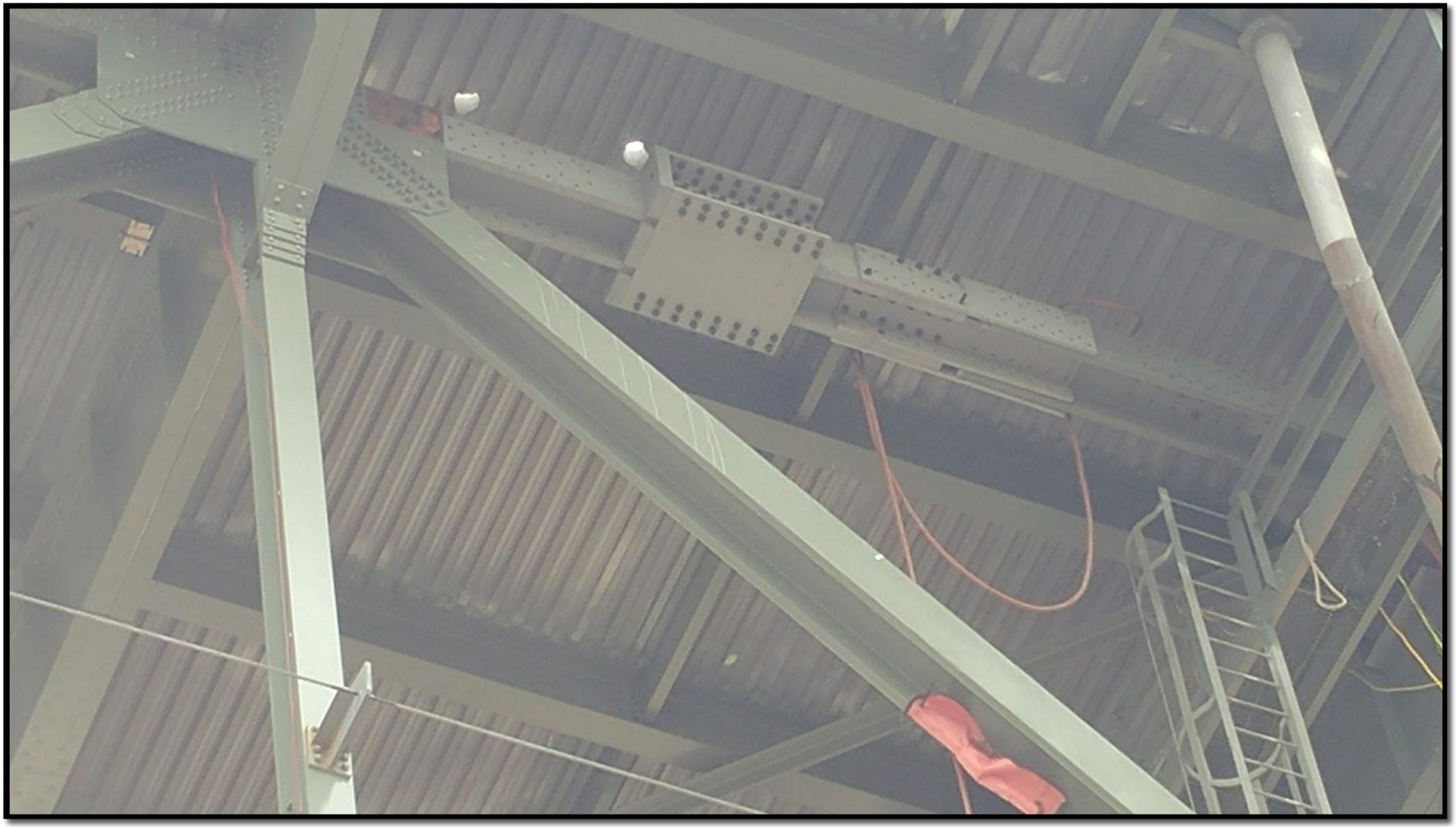


Vertical Jacking Operations



Removal of Fractured Member

Post Tensioning



Post Tensioning

Final Splice

PP U19' N
2017. 3. 13 11:41

Delaware River Turnpike Bridge

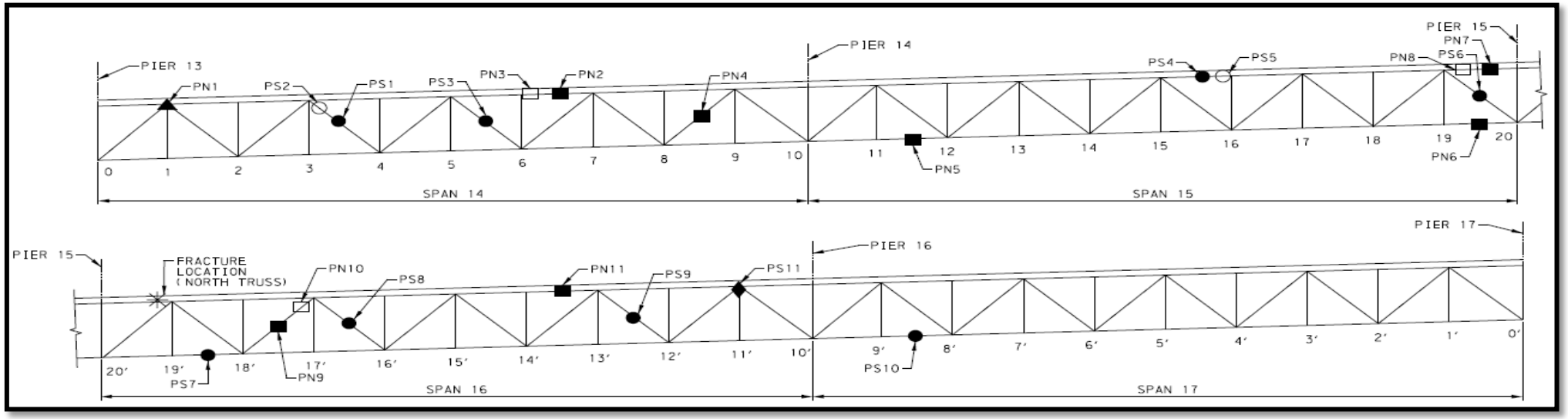
CHECKLIST TO OPEN:

- ✓ 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

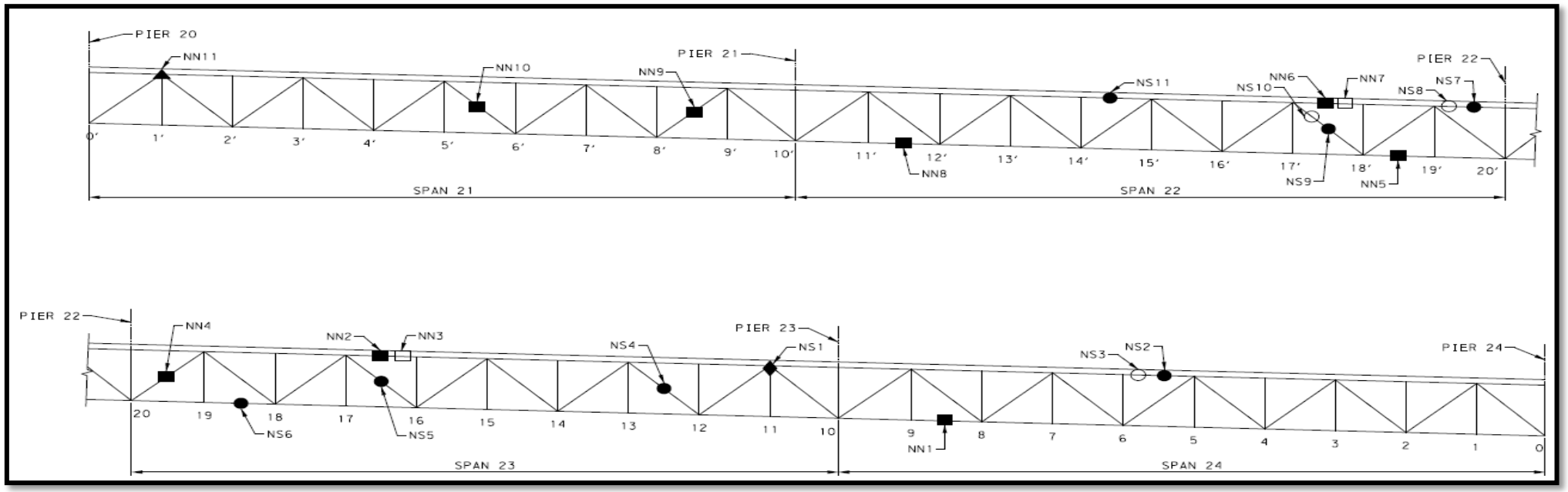
Going Forward

- Restoration of Site
- Forensic Analysis
- Long Term Health Monitoring
- Bridge Replacement
- Challenges and Positives

Purdue - Material Testing

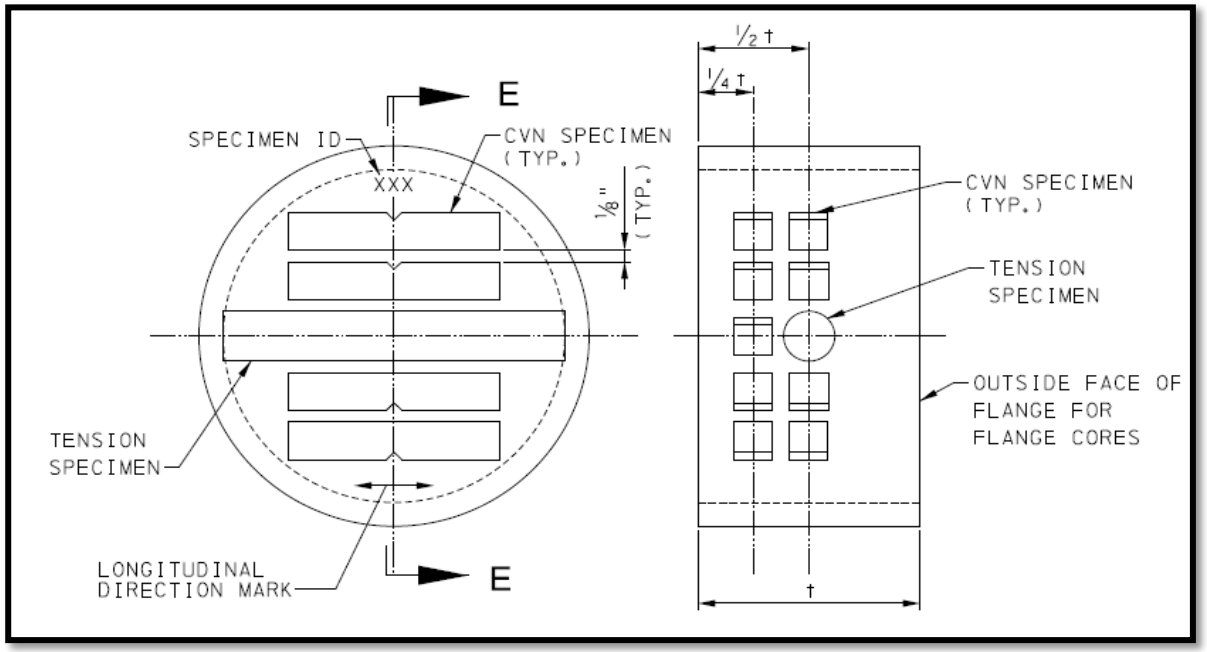


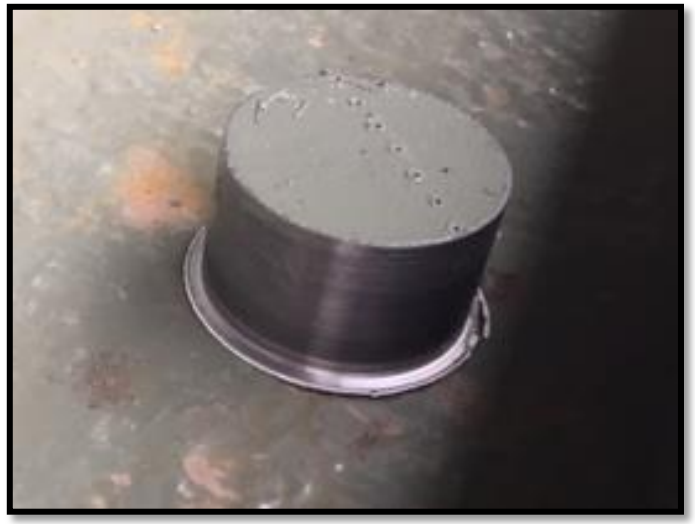
PA 4-span

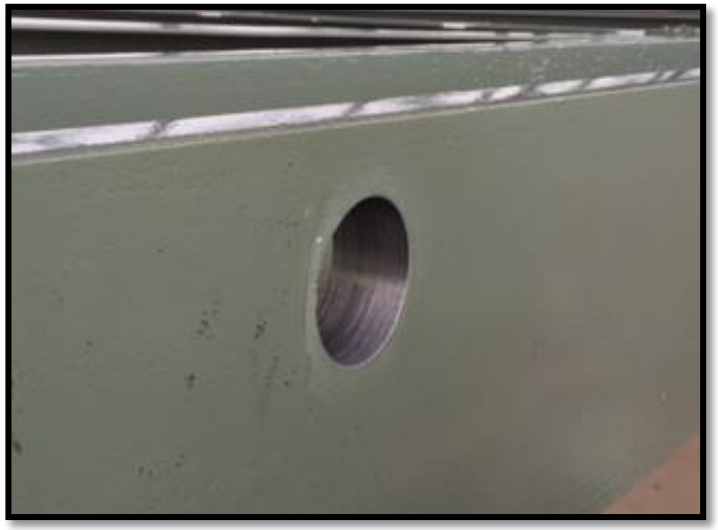


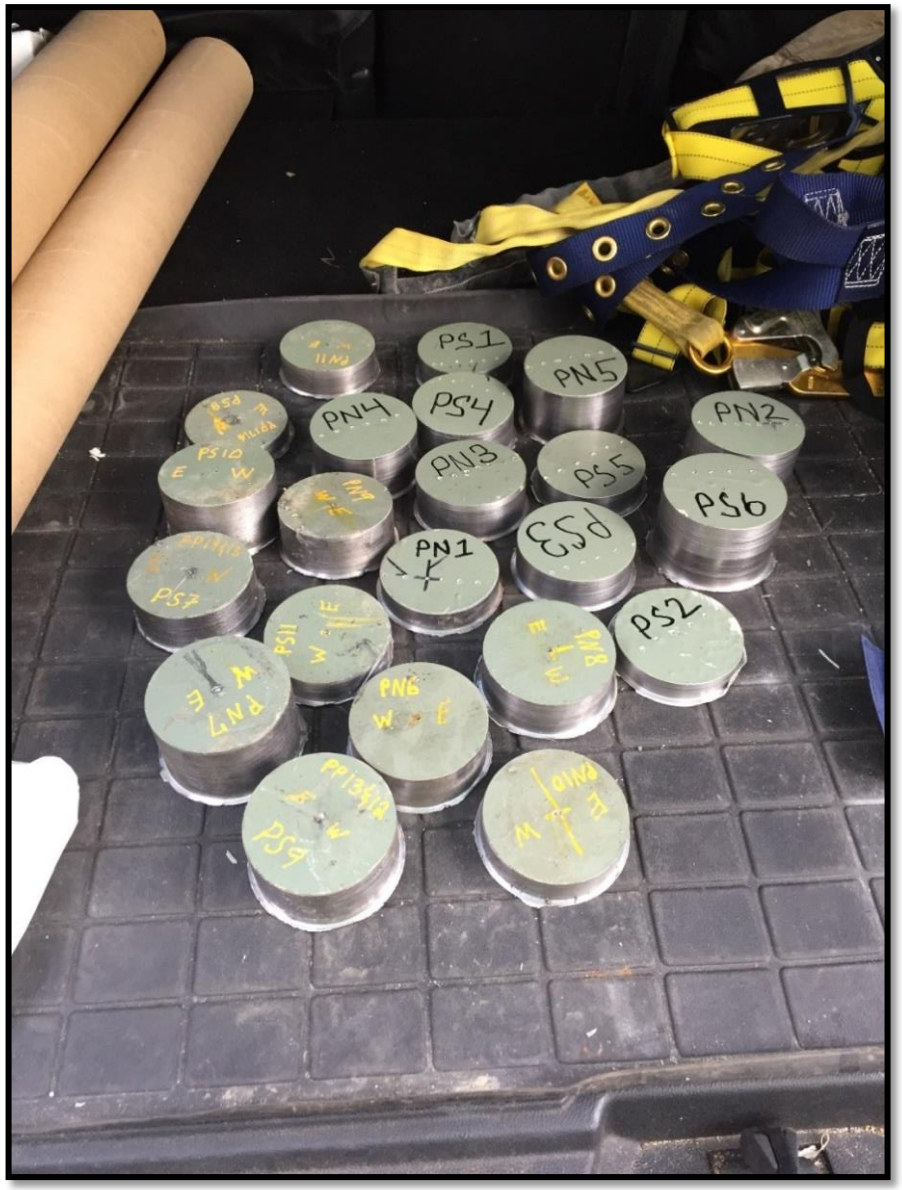
NJ 4-span

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?