



2024 SPRING CONVENTION



APRIL 21-24, 2024
ICRI.ORG

➤ Holistic Repair Strategy Wando River Viaduct

Mt. Pleasant, SC



Daniel Island, SC

APRIL 21-24, 2024

ICRI.ORG

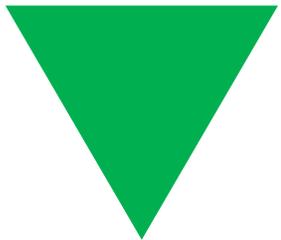
➤ Introduction

Evaluation, design and implementation of a holistic repair strategy to extend the service life of the post-tensioned I-526 Wando River Viaduct

- Background
 - Construction History
 - Challenges & Successes
 - Investigation

➤ Objectives

- The Story of Success When You Have a Plan
- The Steps Required & The Challenges
- Intro to Segmental Box Girder Bridges



➤ Background

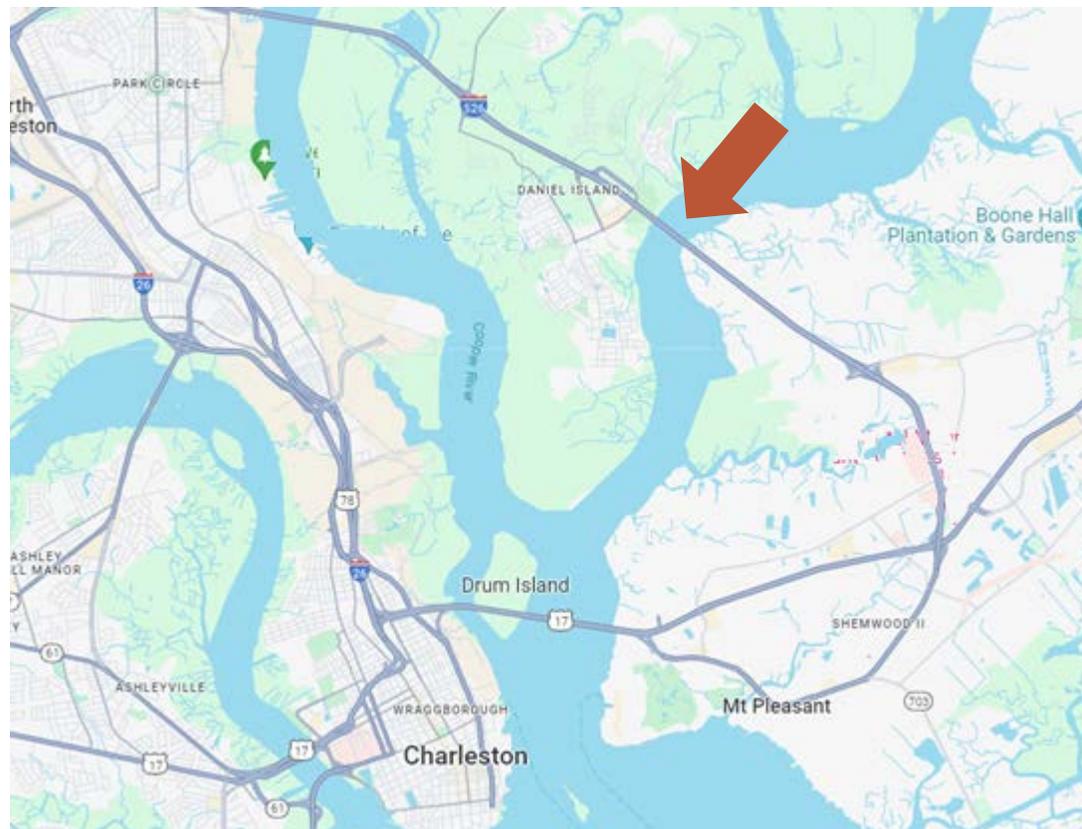
- James B. Edwards Bridge
- aka “Wando River Bridge”
- I-526 between Daniel Island and
Mt. Pleasant, SC



1981

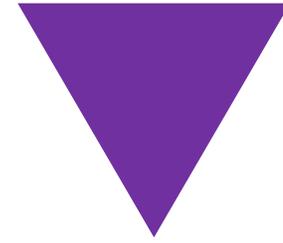
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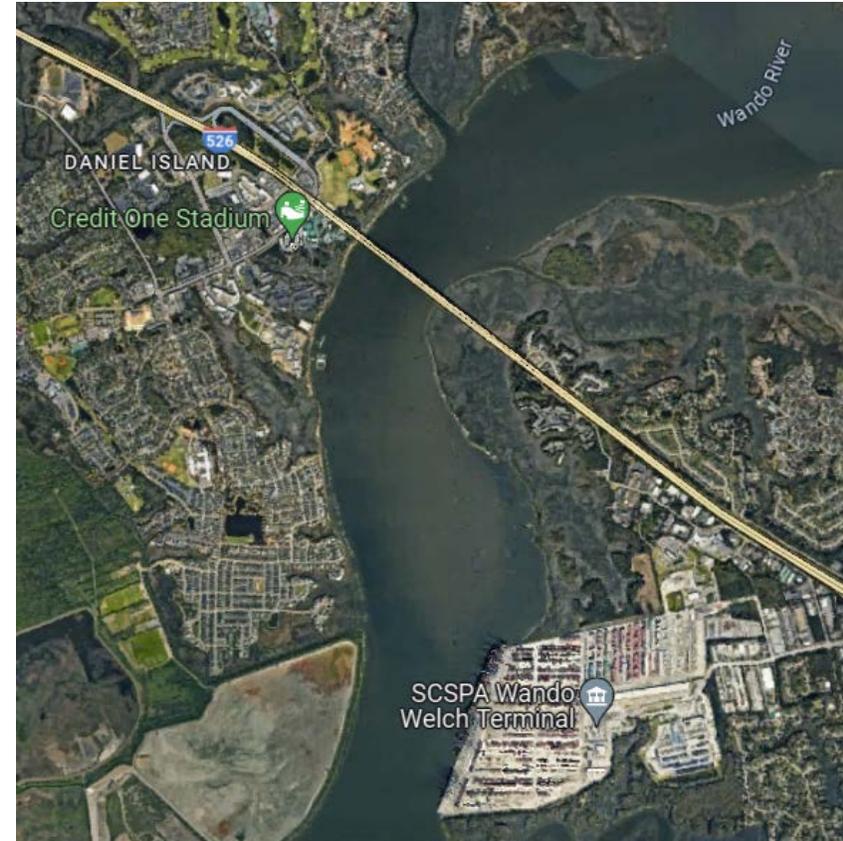


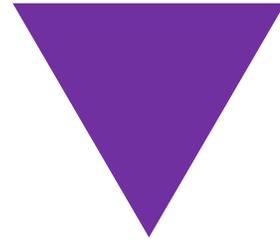
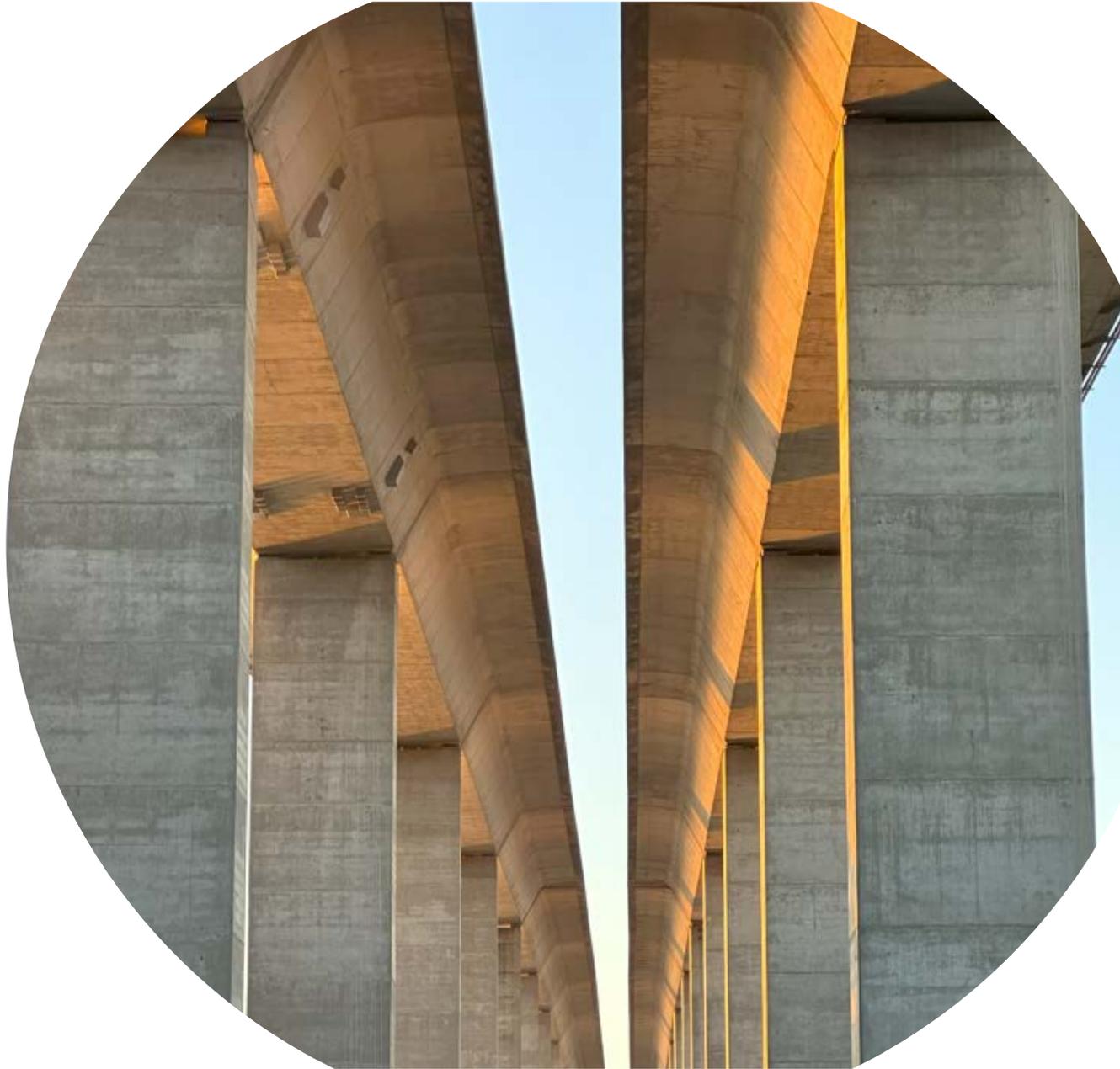


Critical Infrastructure



- Projected AADT **32,800**
- Actual AADT **71,800** in 2023
- Main artery to SC largest port
- Critical link to Daniel Island





APRIL 21-24, 2024

[ICRI.ORG](https://www.icri.org)

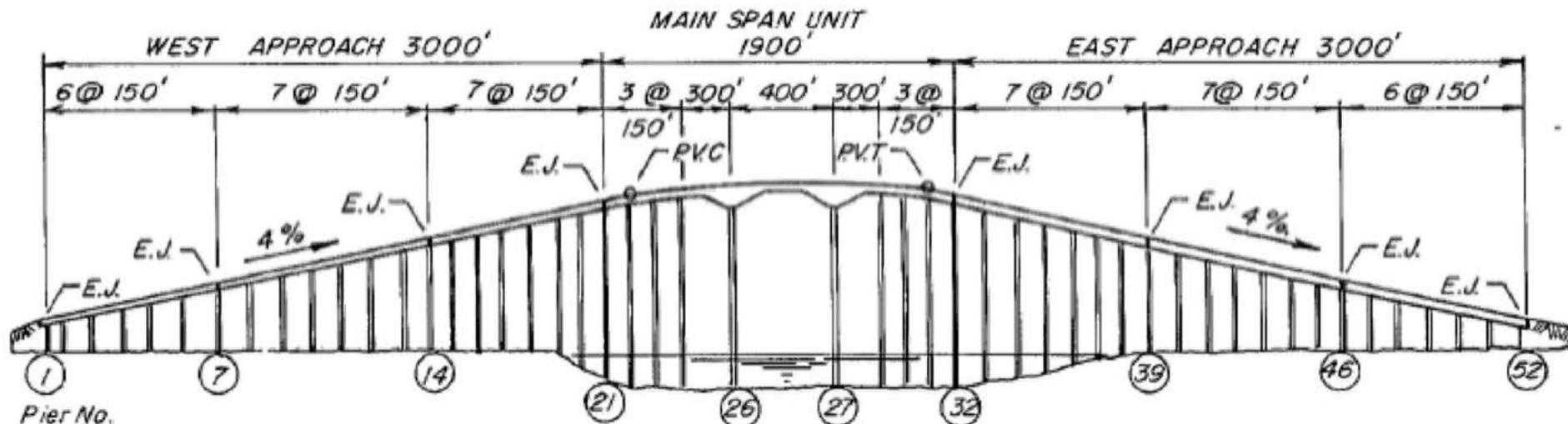
➤ Construction

- T. L. James Associates \$34m
- Figg and Muller Engineers
- Construction 1985 - 1989
- Opened to traffic 1991



➤ Segmental Construction

- Approach Span 3,000 ft each
- East Approach Mt. Pleasant Marsh
- West Approach Daniel Island Pro-Level Tennis Complex
- Each Structure Length 7,900



➤ Great Deal for SC

- \$34 Million in 1991 = \$78 Million in 2024
- \$1.5M per Span or \$10,400 LF
- The New Chain of Rocks Bridge over the Mississippi
- \$12.65M per span or \$97,500 LF

Gov. Pritzker Joins Missouri Officials to Celebrate Start of New I-270 Chain of Rocks Bridge

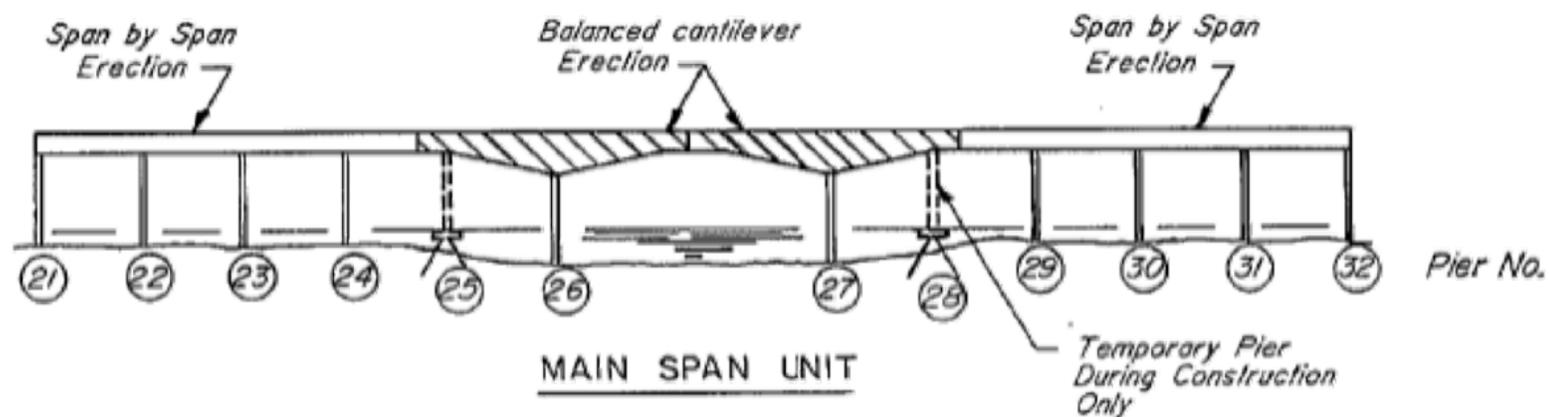
Press Release - Tuesday, June 13, 2023

 PRINT  EMAIL

Joint \$531.6 million project will improve safety and mobility along major freight, travel corridor

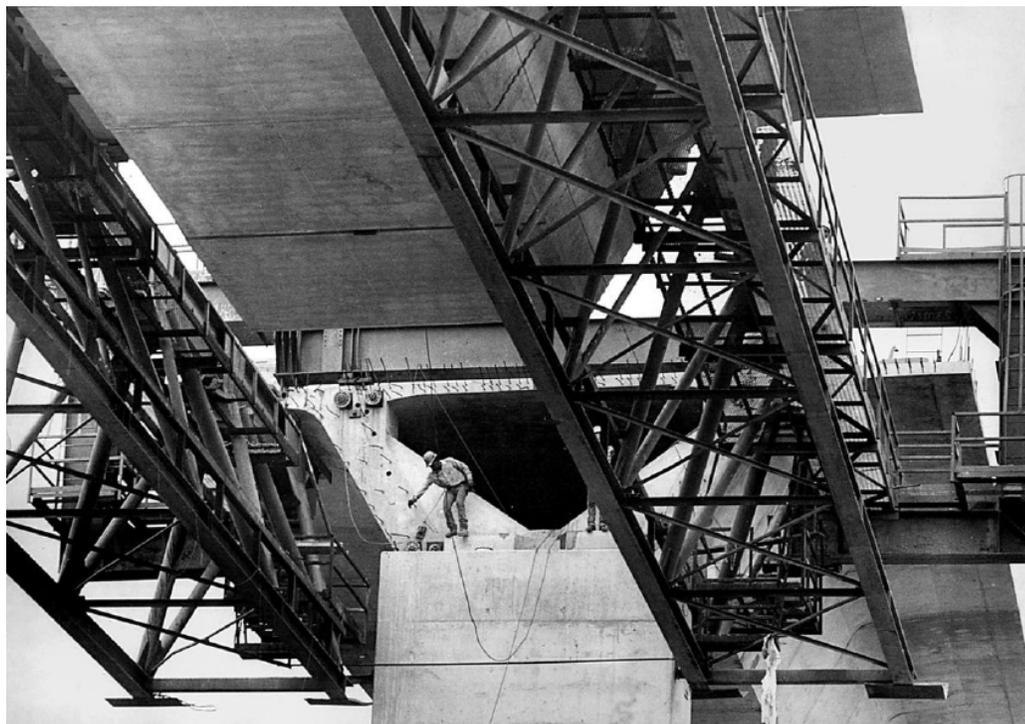
➤ Segmental Construction

- Twin Structures; Precast, Post-Tensioned Segments
- Cantilever Main Spans, 1,900 feet in length

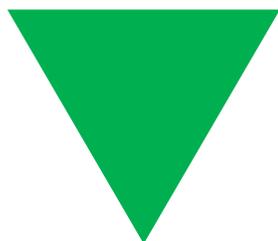


➤ Key Structure Elements

- Approach Spans constructed using Span-by-Span Method
- Combination of Internal and External Post-Tensioned Tendons
 - 600 External Draped and 792 Internal Longitudinal



➤ Approach Span Construction



➤ External Draped Tendons



➤ Challenges

- Not unique to Wando
- Every technology has its challenges
- **2010** Visual evidence water intrusion
- Triggers Investigation
 - Corrosion Potential
 - Impact Echo
 - Borescope
 - Chlorides
 - Sulfates



➤ Investigation

- Corrosion Potential



Table 4.2-2. Corrosion potential measurements.

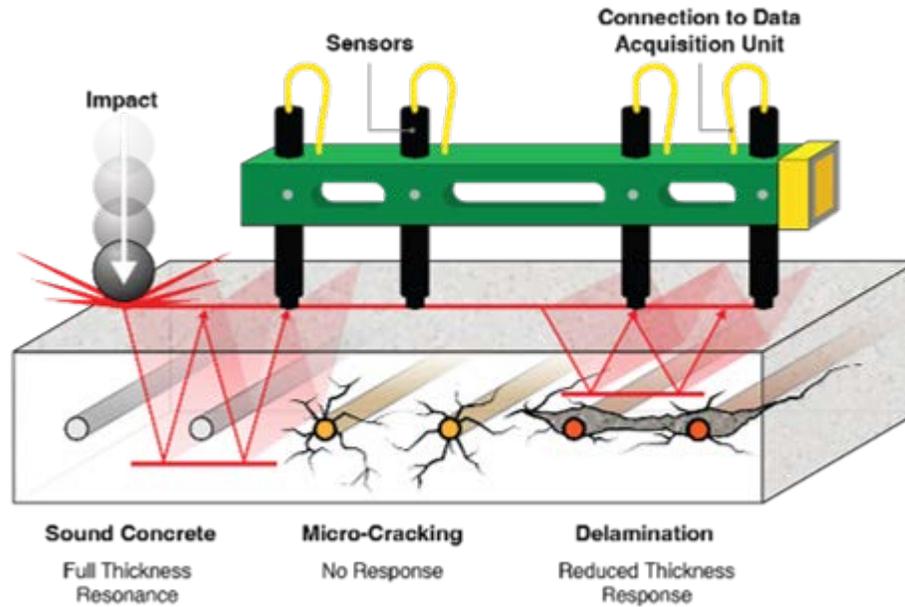
Location	Corrosion Potentials, mV CSE									
1A	-160	-172	-174	-158						
3	-139	-150	-151	-152	-140	-147	-169	-161		
5A	-182	-182	-181	-214	-231	-161				
7	-195	-180	-190	-196	-195	-194	-194	-194	-195	-195
	-196	-195	-196	-197	-196					
9B	-164	-144	-157	-165	-163	-168	-168	-175		
11	-175	-175	-169	-173	-177	-165	-169	-178	-171	-170
13	-159	-113	-160	-162	-160	-162	-157	-156	-160	
13A	-131	-136	-135	-135	-115	-138				
15A	-173	-173	-172	-172	-172	-171	-173			
18B	-149	-149	-150	-151	-148	-148				
24C	-160	-170	-174	-175	-172	-173	-175			

No corrosion activity.
 Corrosion activity is uncertain.
 Active corrosion.

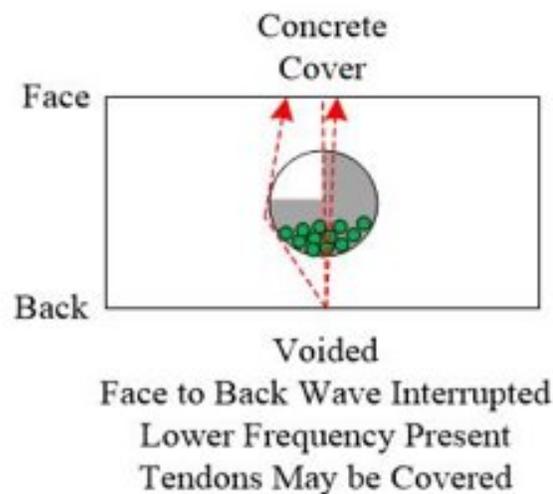
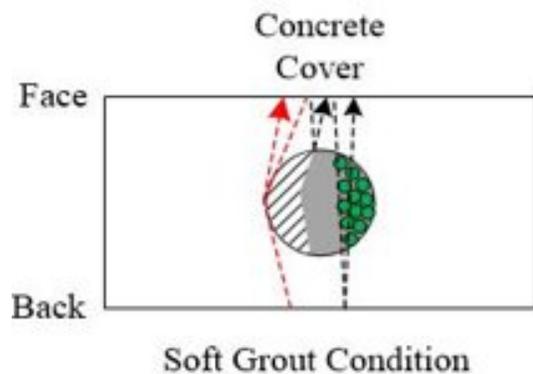
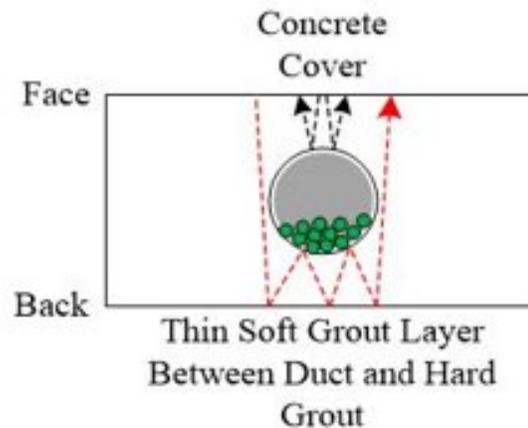
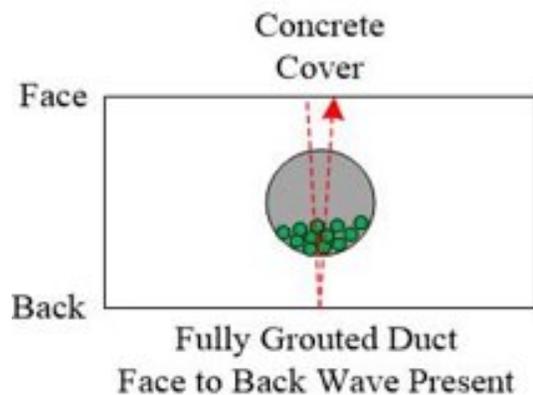


Investigation

- Impact Echo/Pulse Velocity Testing



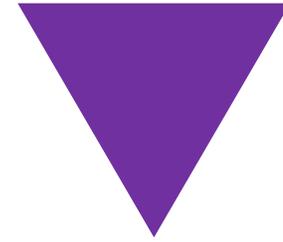
➤ Investigation



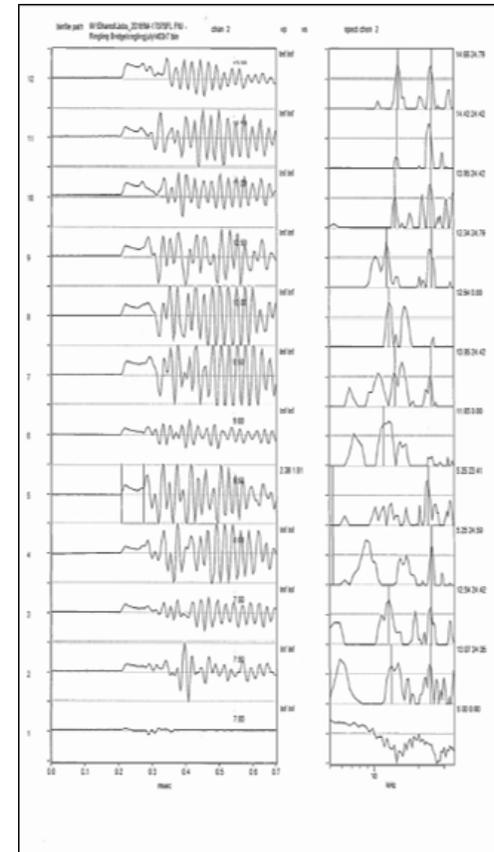
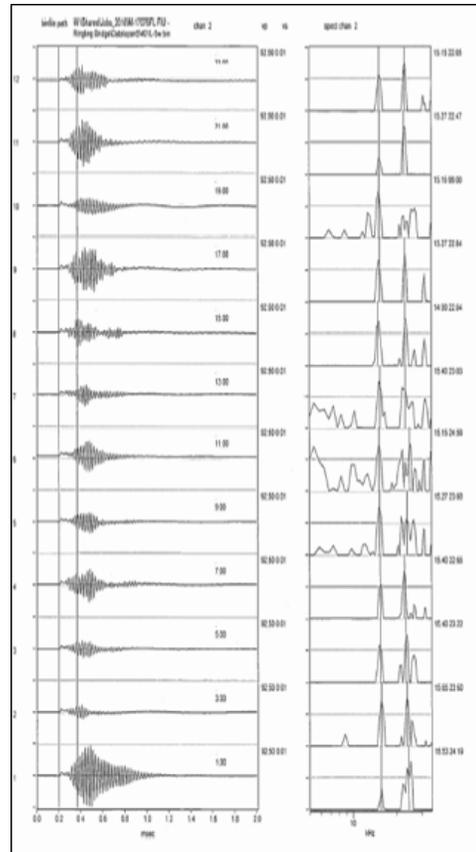
- Impact Echo/Pulse Velocity Testing – Bonded Internal Ducts



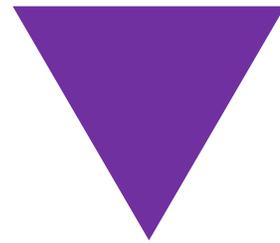
Investigation



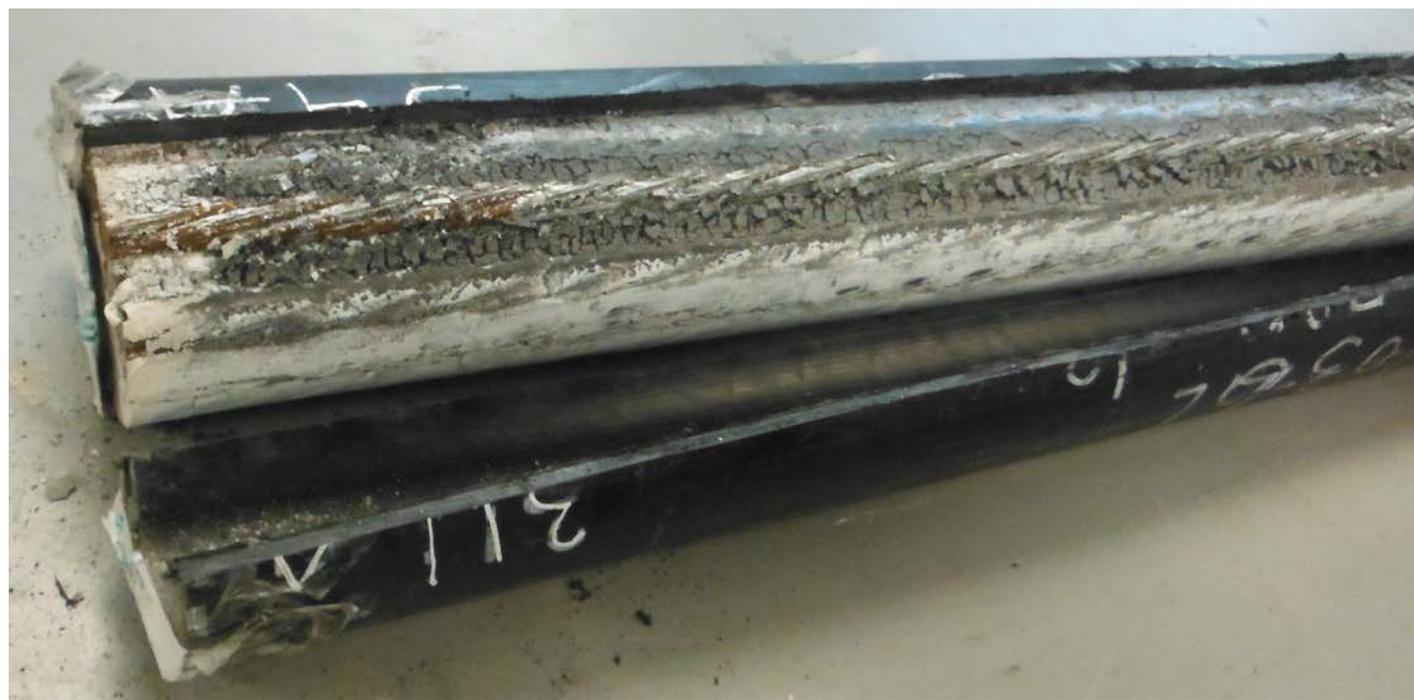
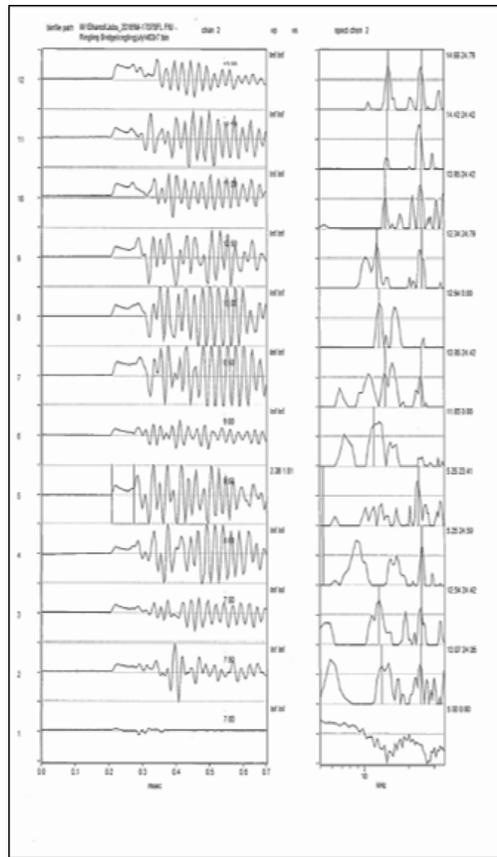
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➤ Investigation



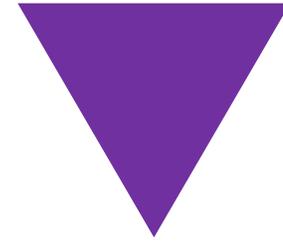
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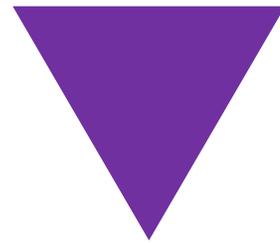


Investigation

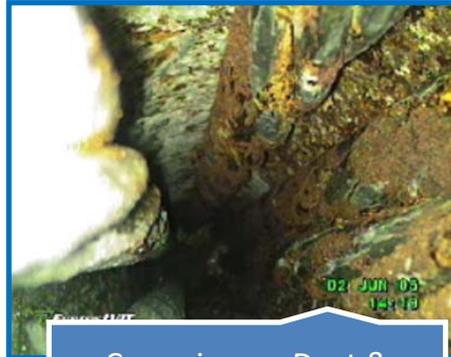
- Borescope



Investigation



Void Bottom Corrosion on Duct & Tendons



Corrosion on Duct & Tendon



Void in Pier With Dywidag Bar Instead of Tendons



Corrosion on Duct



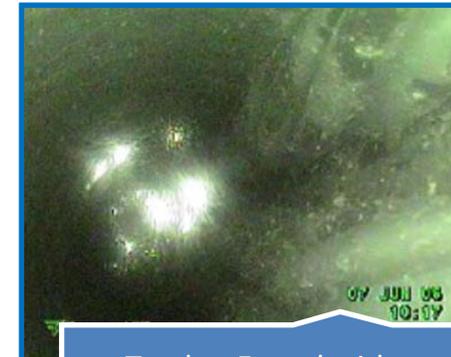
Void With Tendon Corrosion



Anchor Plate, Tendons & Duct are Grout Coated



Anchor Close-Up, Top of Tendons Show Corrosion



Tendon Found with Standing Water Inside

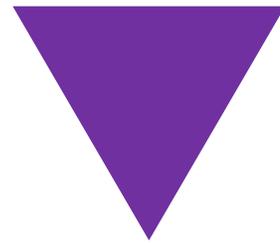




Same wire as above, but deeper into the void.



Examples of corrosion products oozing out of crevices between individual wires.



➤ 2010 Investigation Summary

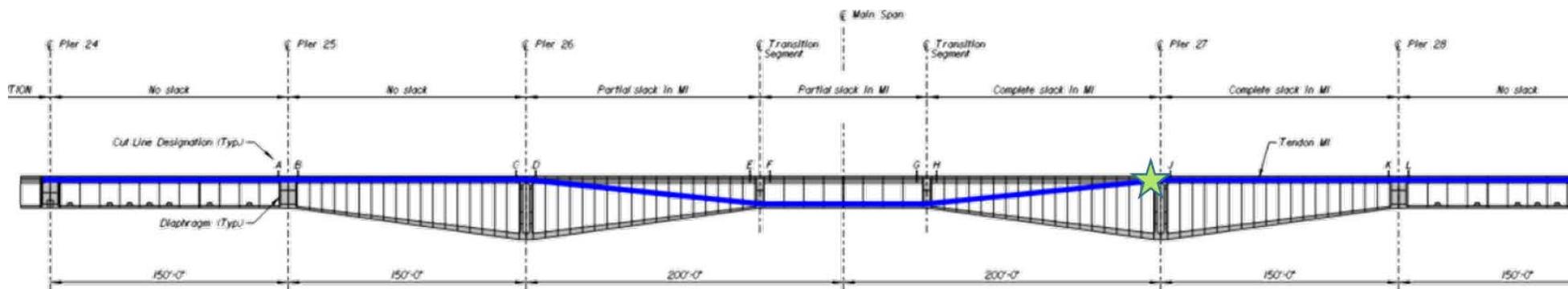
- Root Causes
 - Water intrusion from the deck
 - Some Voiding
- Some Corrosion but high potential for future corrosion events
- Common issues for that vintage

Grout vent tube open to the top of the deck.

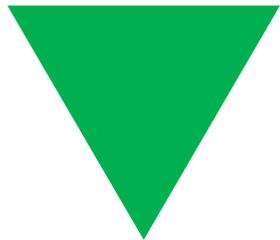


➤ 2016 M1 Tendon Failure

- M1 = Main Span; Continuous between Piers 24-29
- External Tendon 1,010 ft in length
- 19 stand tendon
- Tendon removed and replacement installed
- Supplemental tendon installed



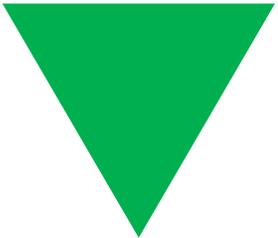
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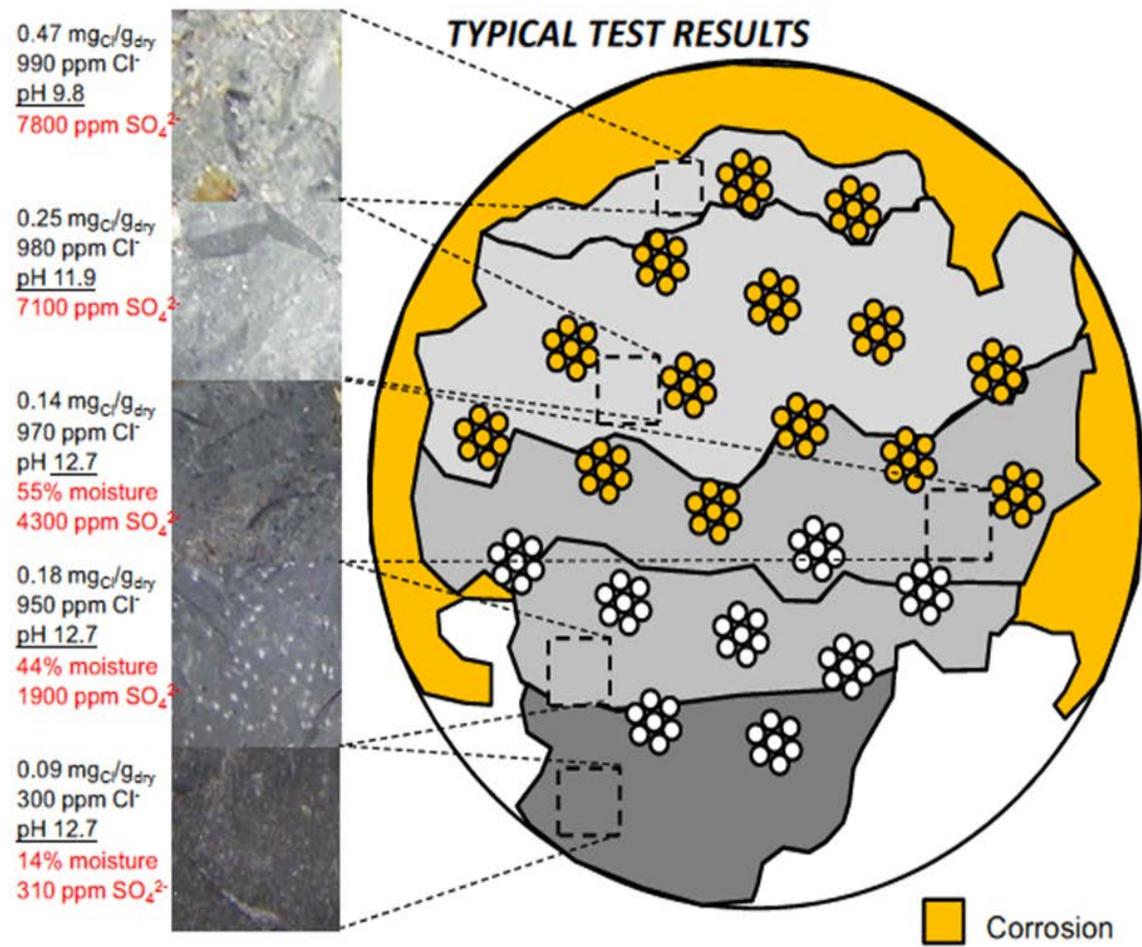
➤ 2016 M1 Tendon Failure



➤ 2016 M1 Tendon Failure



➤ Grout Segregation



➤ Bleed Water Separation 4%



➤ Bleed Water Separation

Straight Tendon



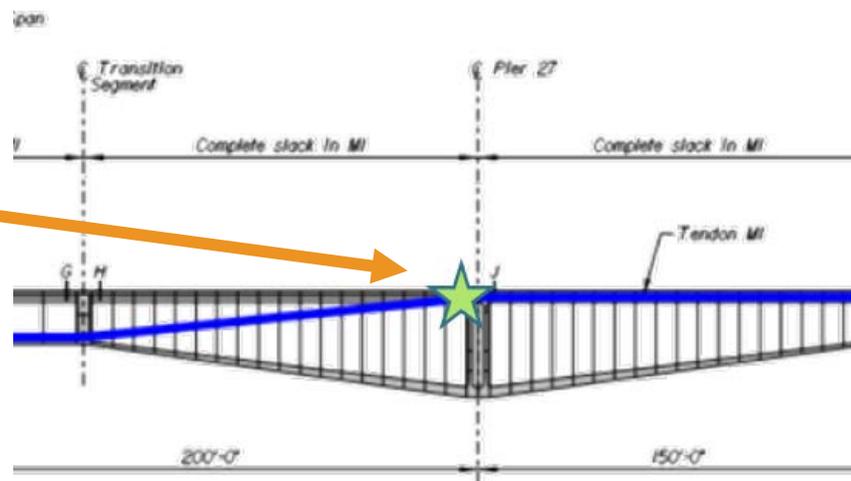
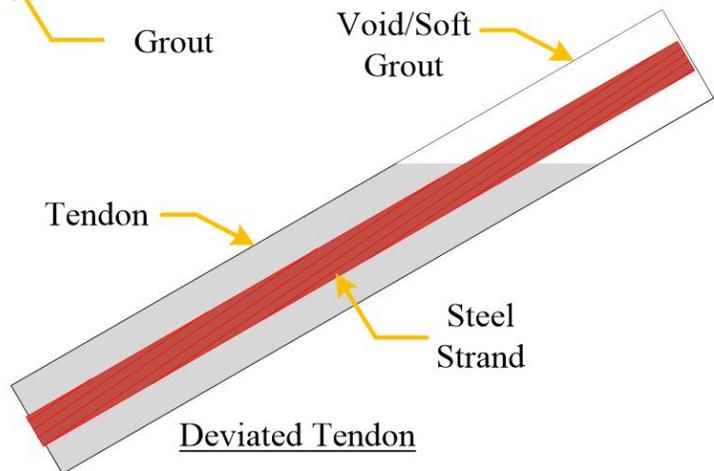
Grout

Void/Soft Grout

Tendon

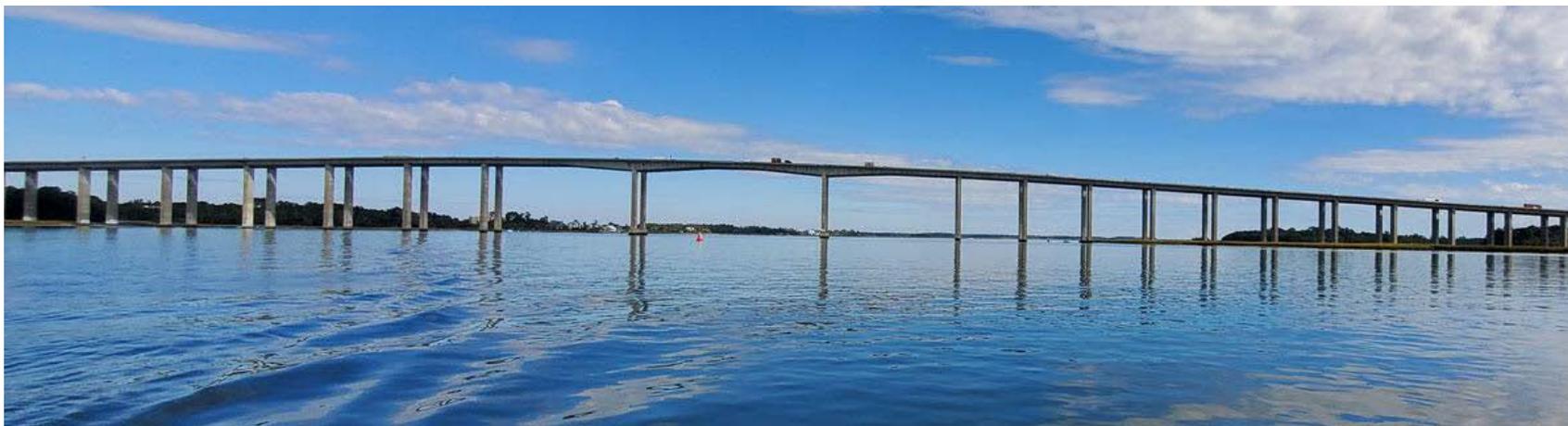
Steel Strand

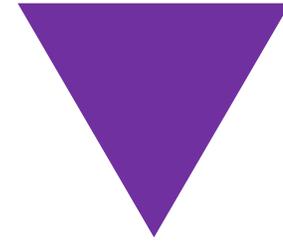
Deviated Tendon



➤ Further Assessment

- Keep in mind the scope
 - +1,300 tendons over
 - 2 miles of structure
- Confirmed what was already known





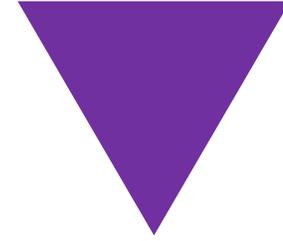
➤ May 2018 WB M Tendon Fails

- Rupture at same location as M1
- SCDOT closed WB bridge

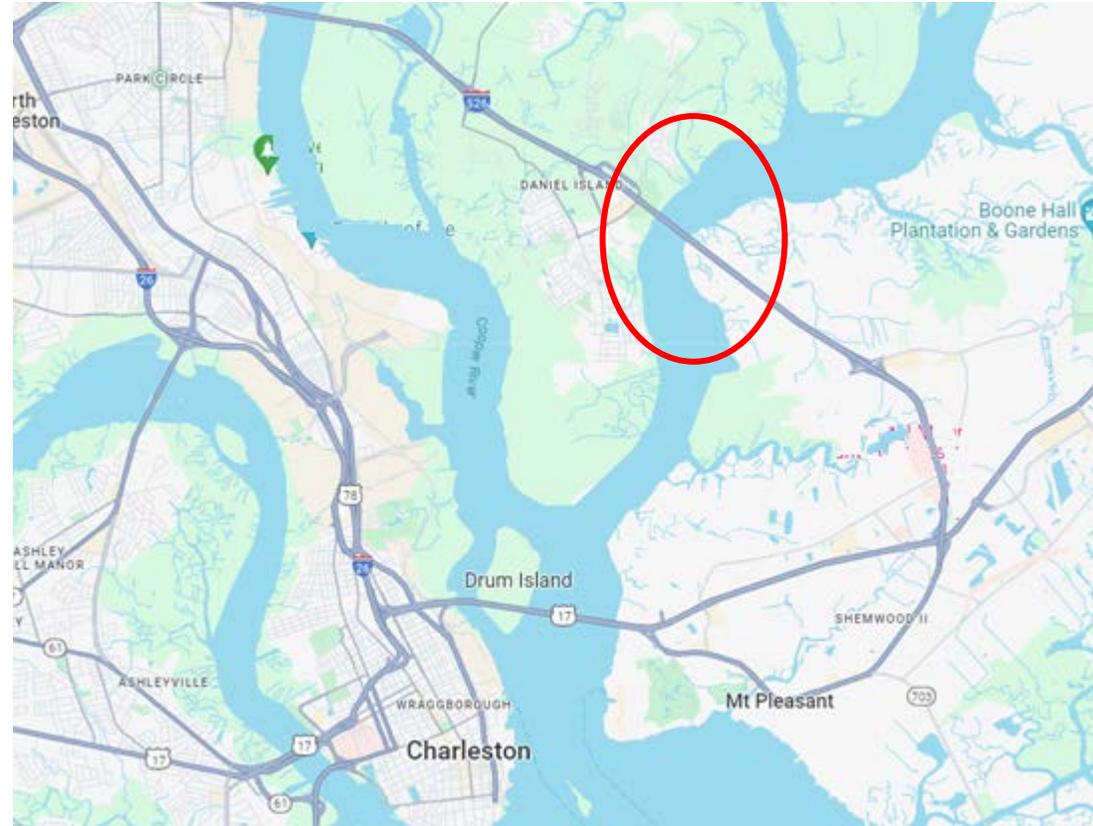


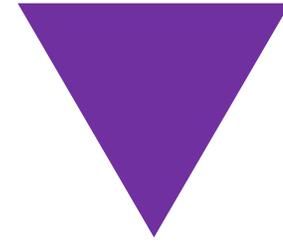


Critical Infrastructure



- Actual AADT **71,800** in 2023
- Main artery to SC largest port
- Critical link to Daniel Island





➤ May 2018 WB M Tendon Fails

- Two supplemental tendons installed in both structures
- Excellent execution; **bridge reopened after 19 days**



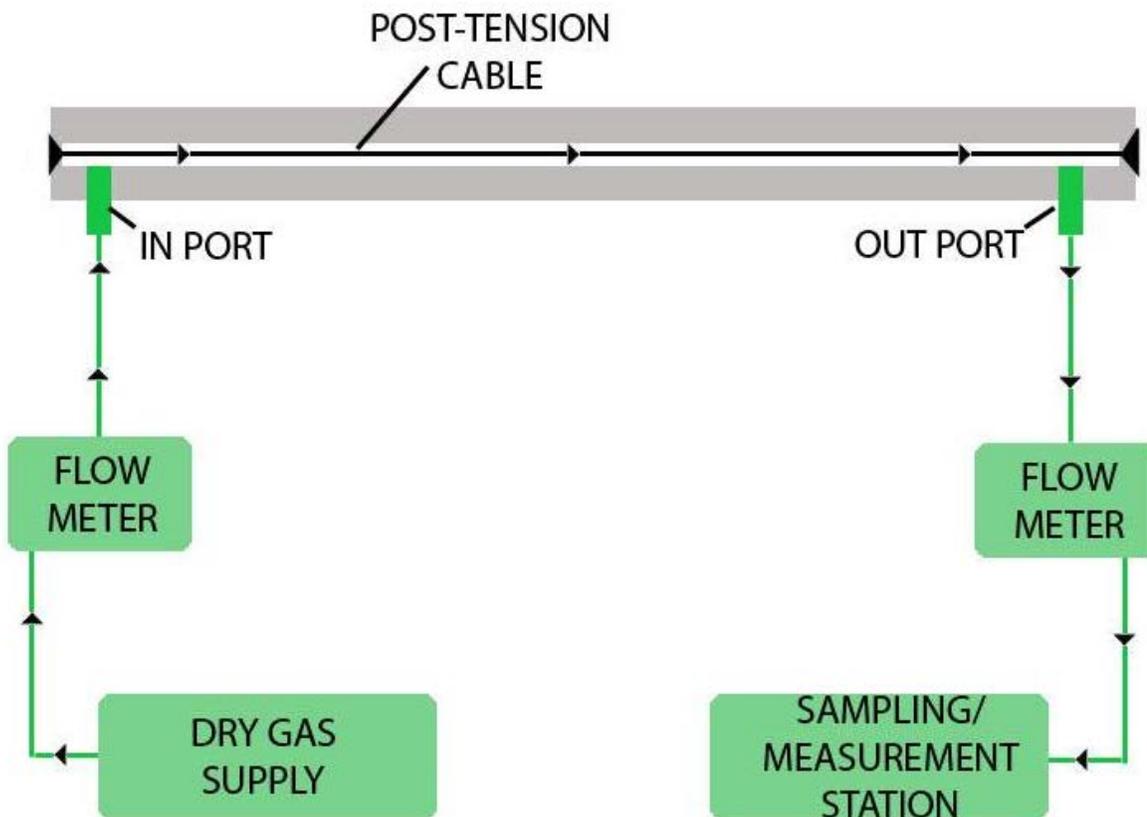
➤ Additional Steps Taken

- Two WB M2 tendons detensioned and replaced
- Pier 24 Segment Joint Repair – differential displacement from truck loads
- WB Span 16 supplemental tendons
- Deck Overlay Installed
- **Specific repairs completed but how do you address the other known issues?**



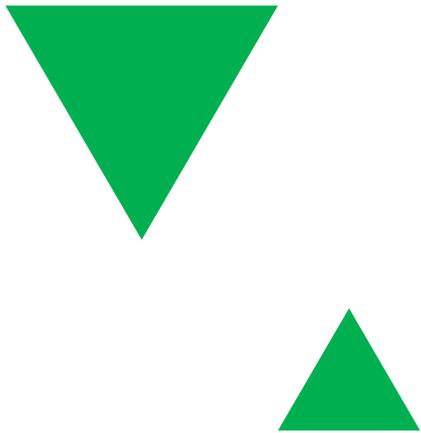
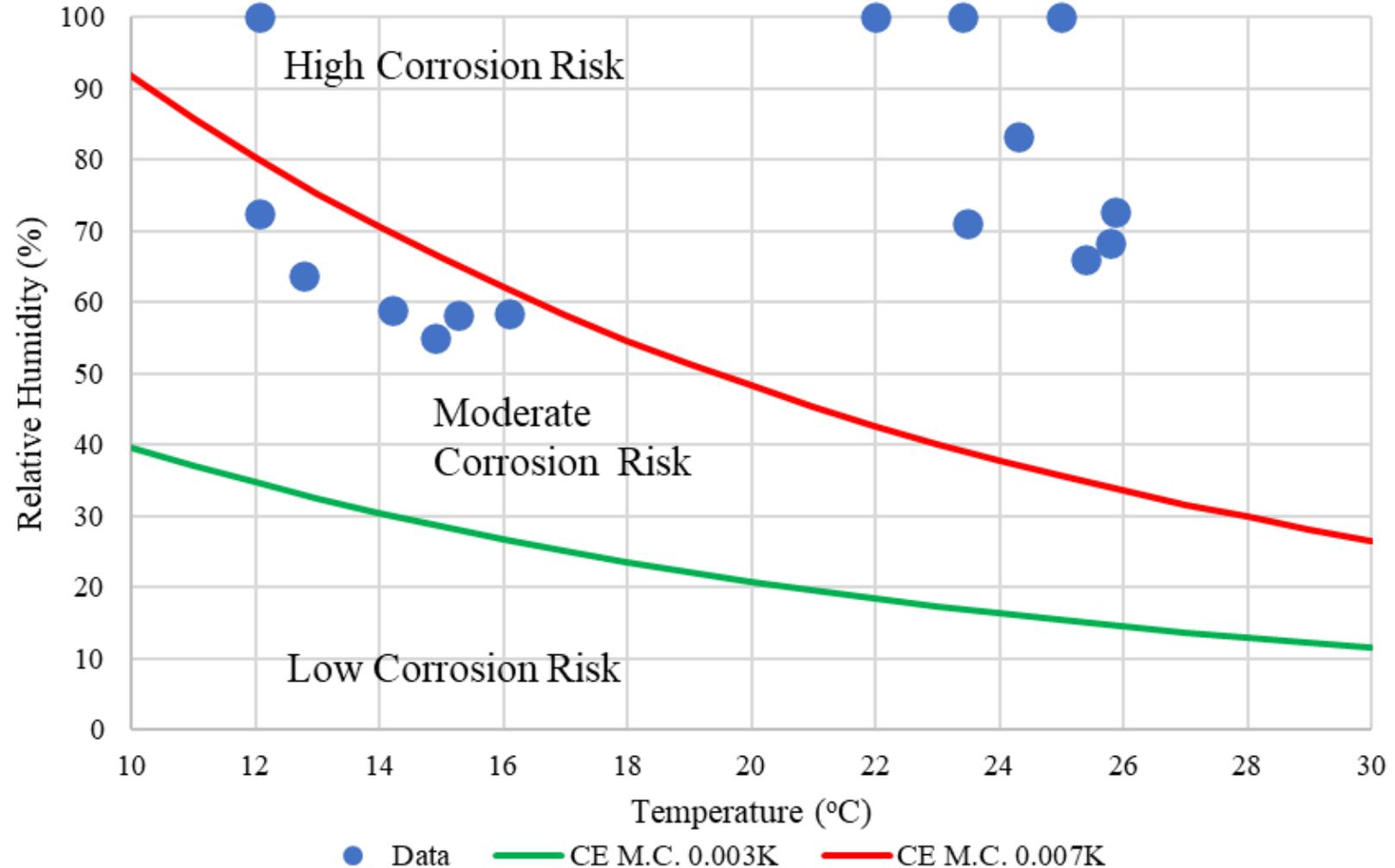
➤ Identify Tendons at Risk

- Post-Tech Corrosion Evaluation
- Correlates tendon moisture level with corrosion risk

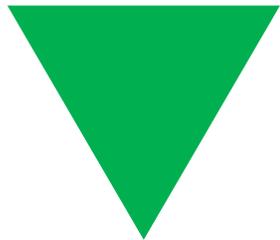
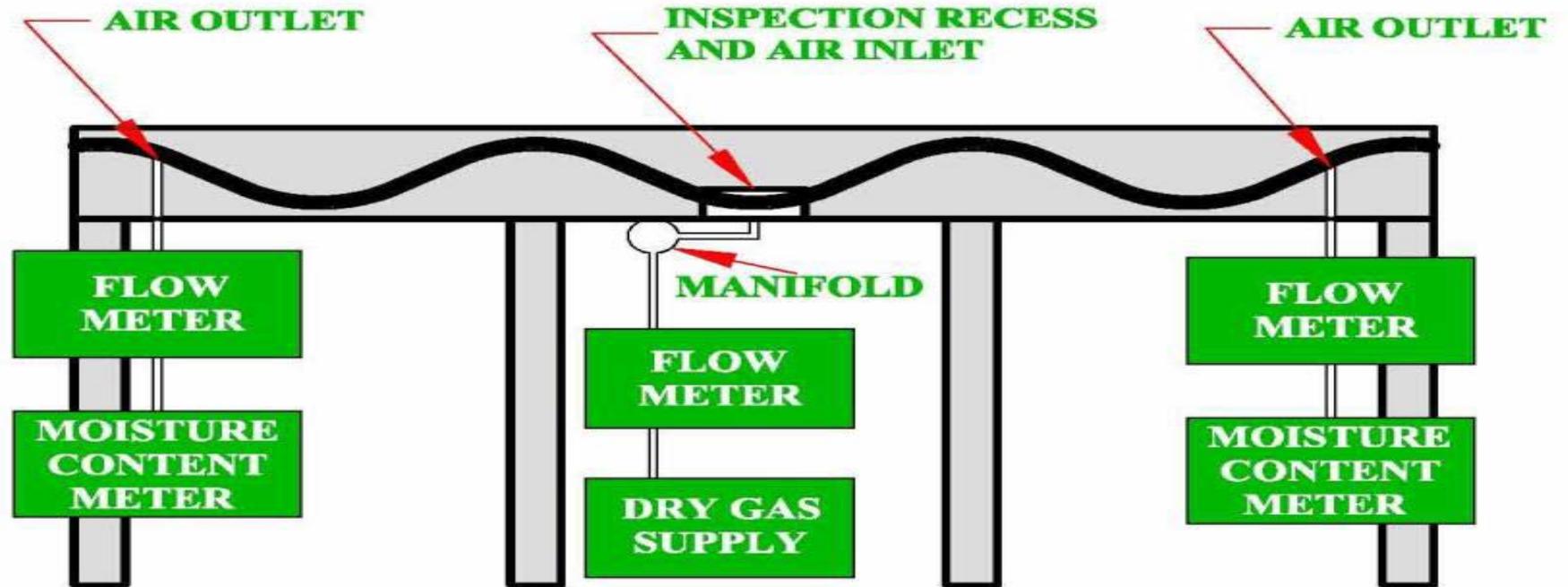




Post-Tech Corrosion Evaluation

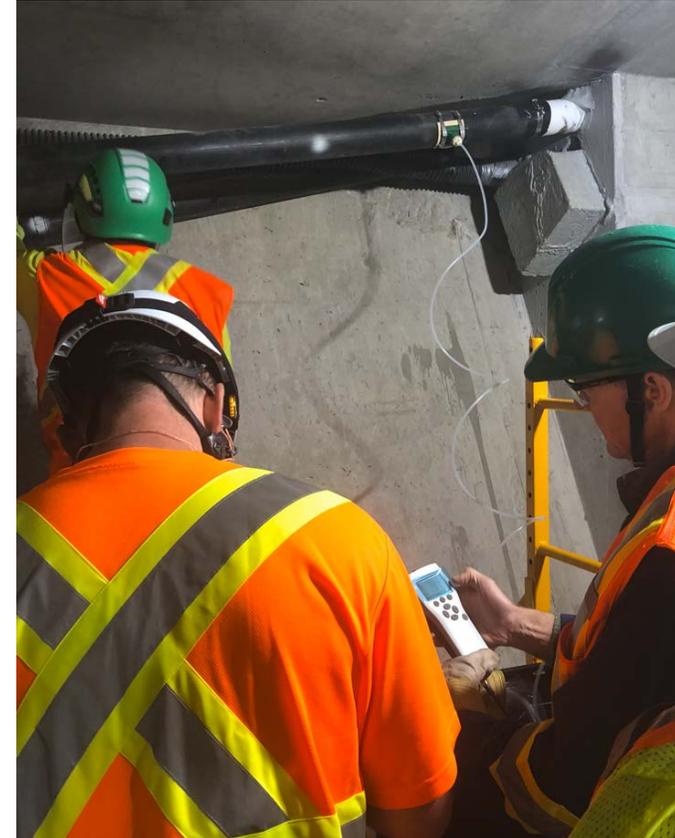


➤ Solution: PT Tendon Drying



➤ PT Tendon Drying

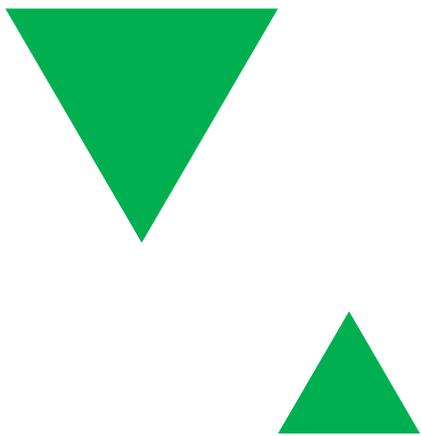
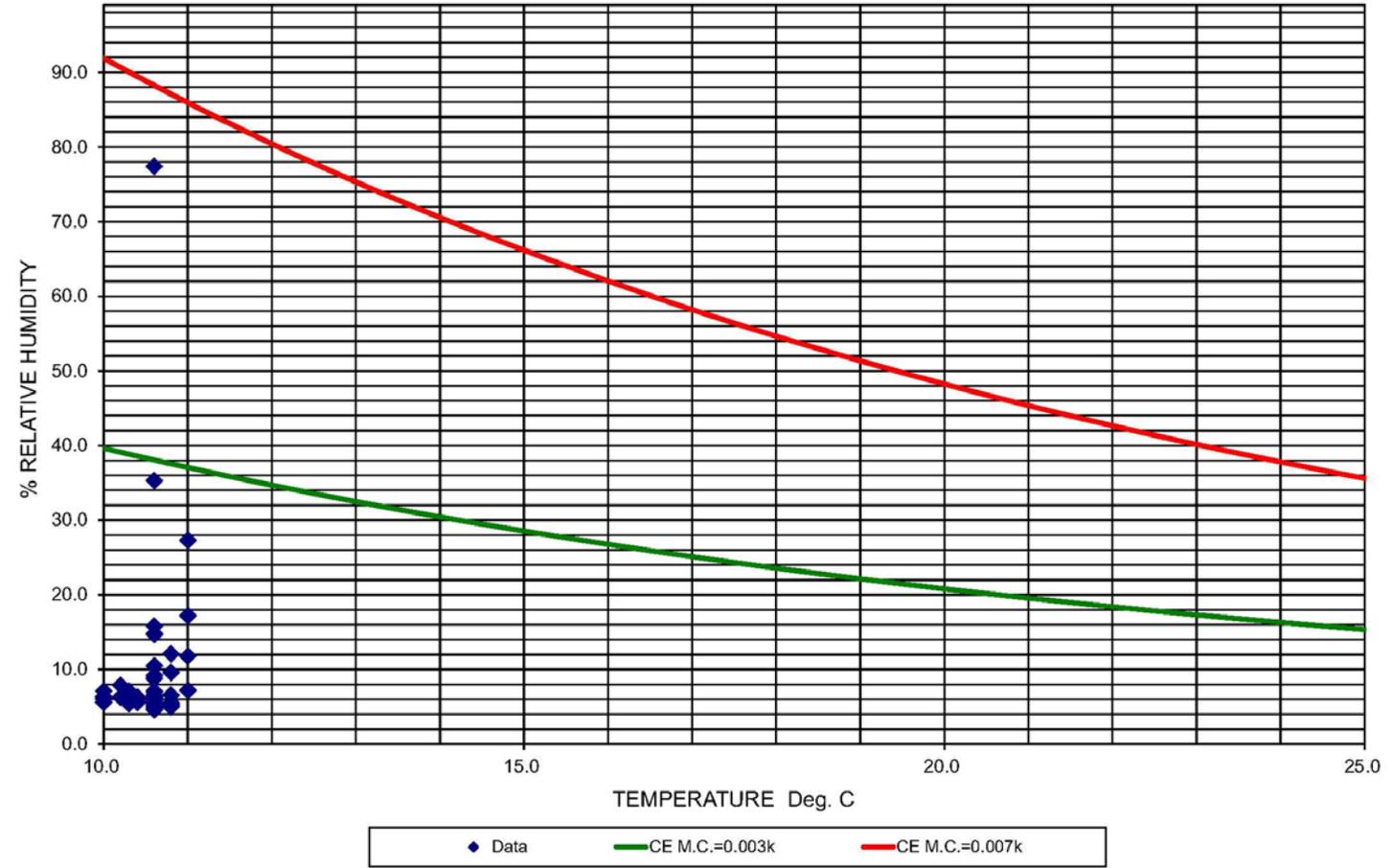
Dry air injection ports



Monitoring output ports



PT Tendon Drying Outcome

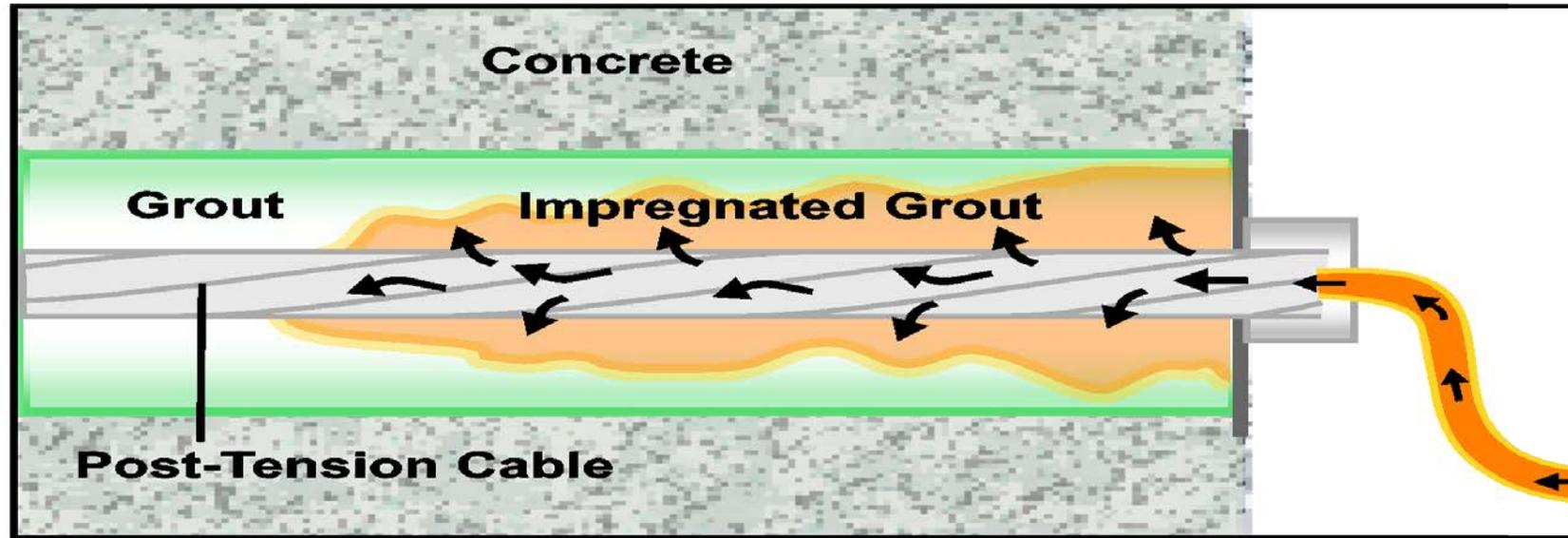


➤ Post Tension Impregnation

- Corrosion protection process for grouted PT tendons with voids or defective grout
- Impregnation material transported inside strands full length of tendon
- Impregnation material reduces corrosion by:
 - Coating exposed steel in voids
 - Improving corrosion resistance of grout



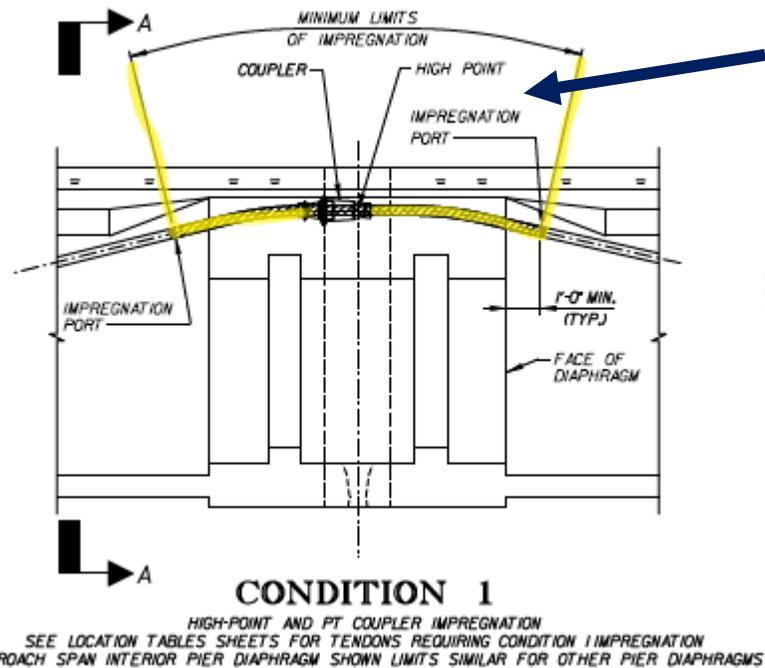
➤ Post Tension Impregnation



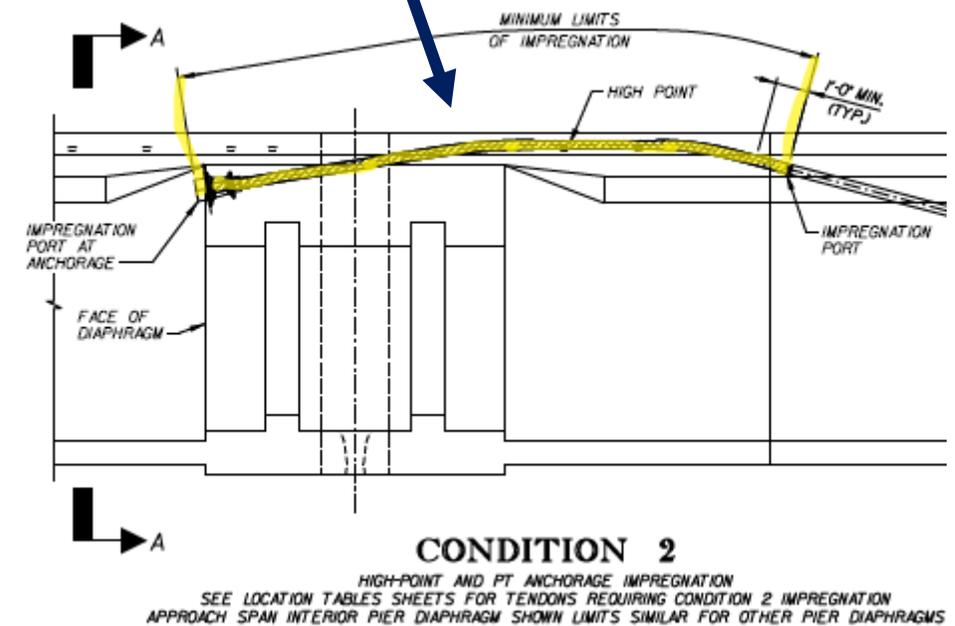
➤ Post Tension Impregnation

- Scope of PTI Treatment at Wando:
 - **470 Tendons + 1,400 gallons of PTI**
 - Focus on High Points near anchorages and Couplers
 - Select full-length Main span "M" tendons (1,000+ feet)
 - Select full-length approach tendons based on testing
 - Anchorage Protection
 - Post-Tech Corrosion Evaluation
 - Tendon Drying – morphed into targeted micro-dryig

➤ Post Tension Impregnation



Higher Probability for Voids



➤ PTI Steps: Prep Grout Cap

Remove
Blockout



Remove
Cap



Expose
Tendon Tails



Port cap
Reinstall



➤ Injection Along Duct

- Low-pressure installation
- Injecting "High Point" until material communicates down the duct to the verification port



➤ Communication Verified



➤ Communication Verified

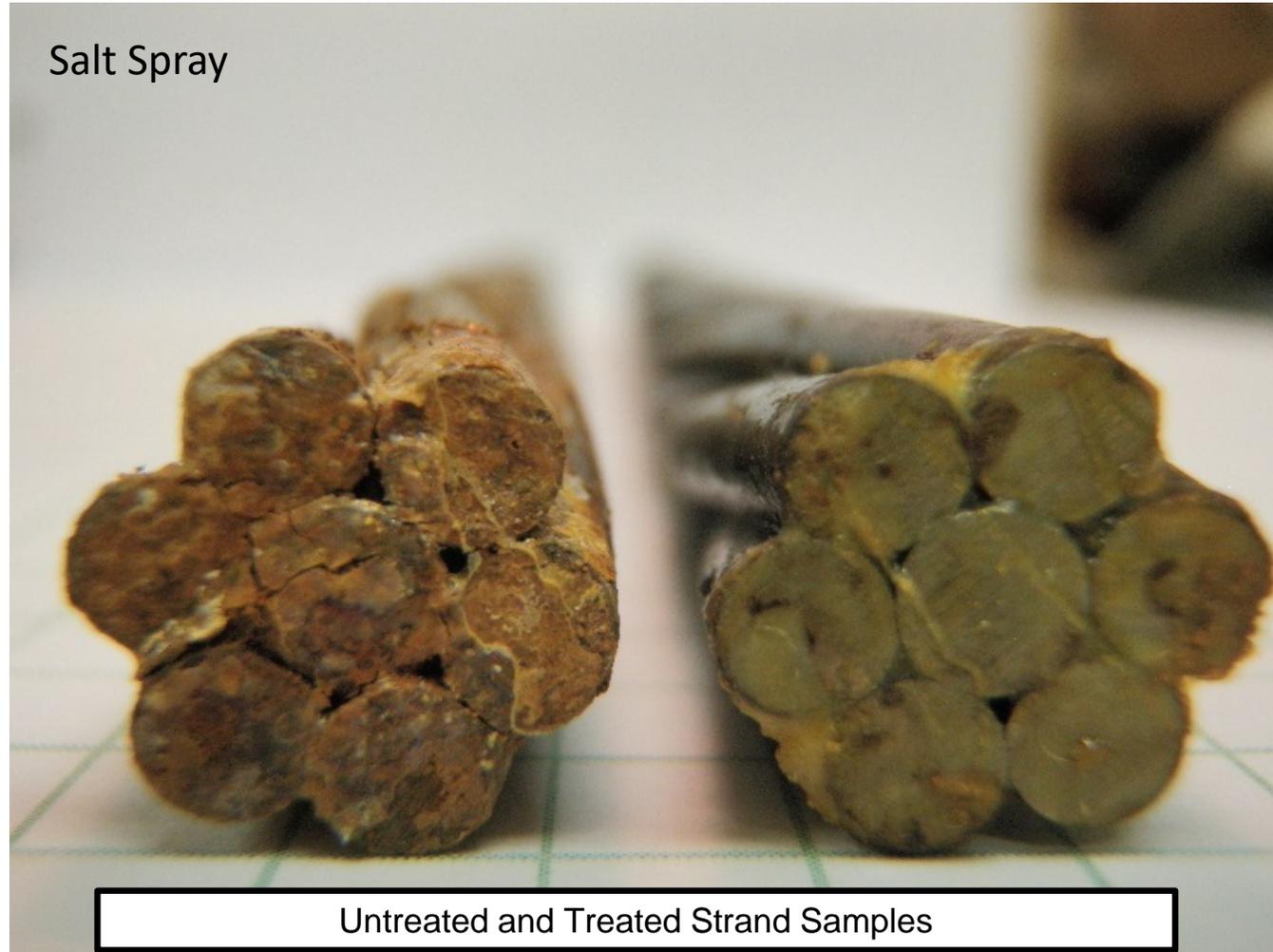


➤ Communication Verified

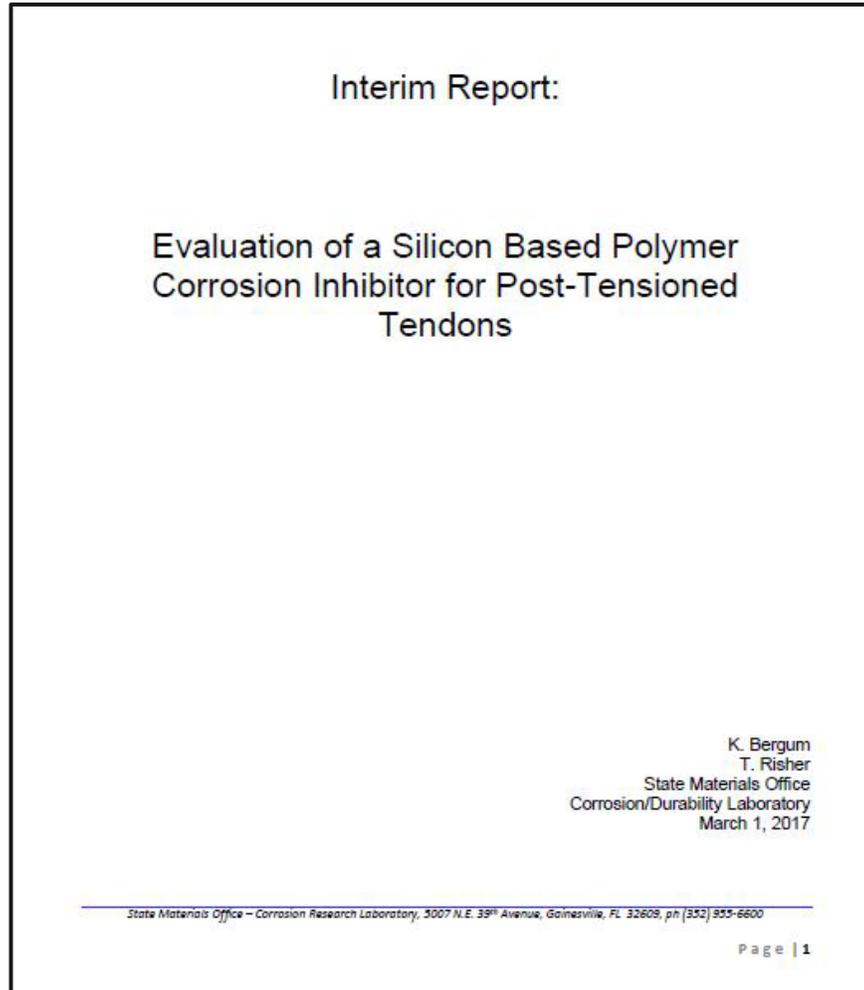


Grout Saturated

➤ Performance Validation



➤ Performance Validation



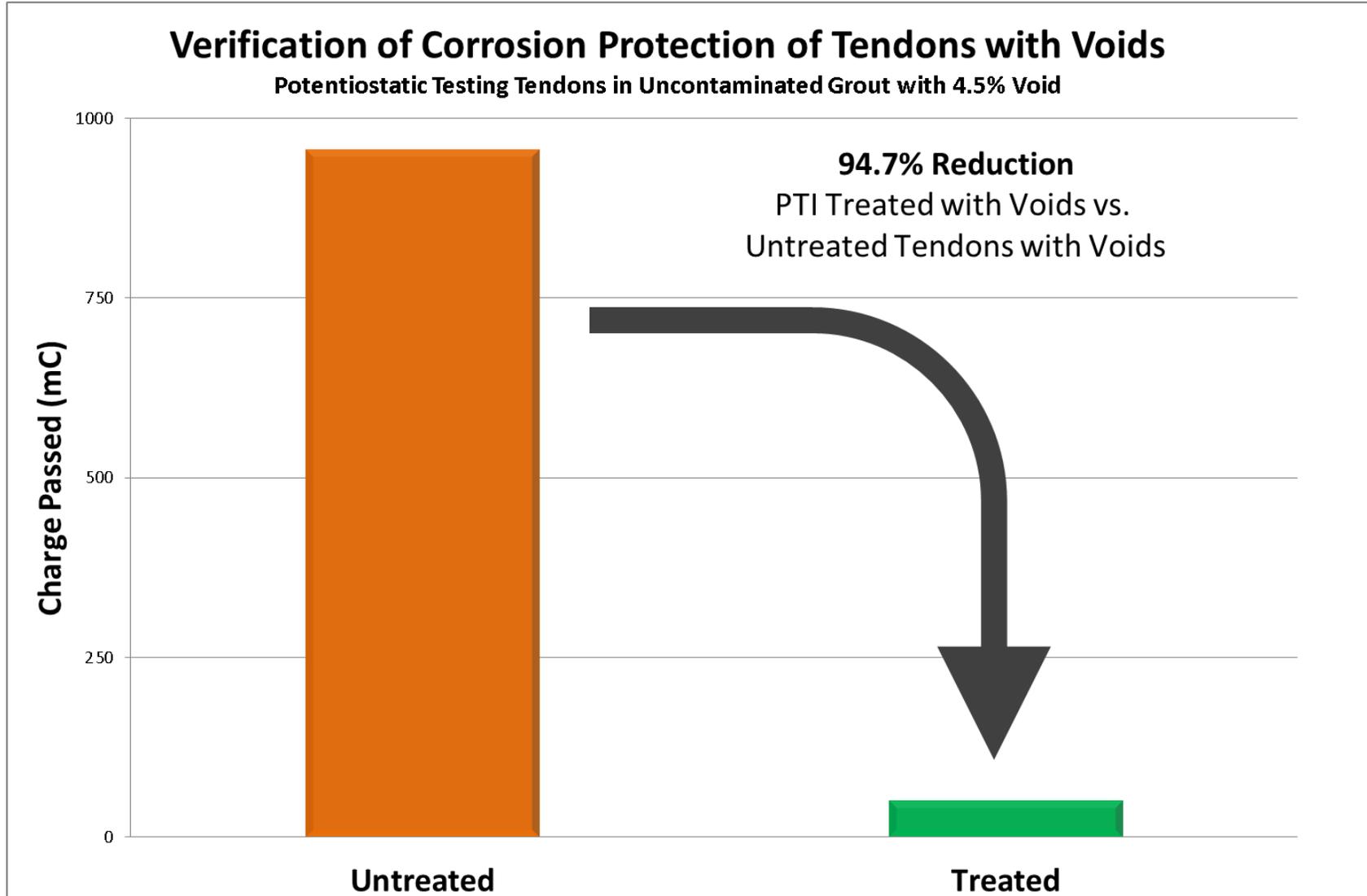
**Treated
Sample**



Untreated Control



Performance Validation



➤ PTI Impregnation Results

➤ Proactive Corrosion Mitigation using PTI

- Ahead of schedule to finish in April 2024
- Successful communication of all tendons
- Deck waterproofing created a challenge
 - PTI fluid saturated grout and protection against future water intrusion
 - Coated tendons reduce corrosion risk
 - Completed with minimal lane closures or public impact

➤ Conclusion

- Amazing results with a proactive and collaborative team dedicated to the traveling public safety
- Special Thanks to:



- Vector Construction
- VCS Engineering
- Freyssinet
- Sixense
- Siva Corrosion Services

- **Nick Amico - HDR**
- **Kevin Turner - SCDOT**
- Infrastructure Corp
- Infrastructure Preservation
- Structural / VSL



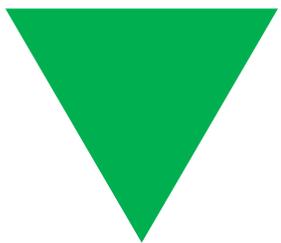
Conclusion

Travis Marman

Project Development

Vector Construction

travism@vector-construction.com



Mike Kernan

Division Manager

Vector Construction

217-619-3650



michaelk@vector-construction.com

