Mitigating Grouted Post-Tension Strand Corrosion on Bridges

David Whitmore, P.Eng.
Vector Corrosion Technologies

VECTOR CORROSION TECHNOLOGIES

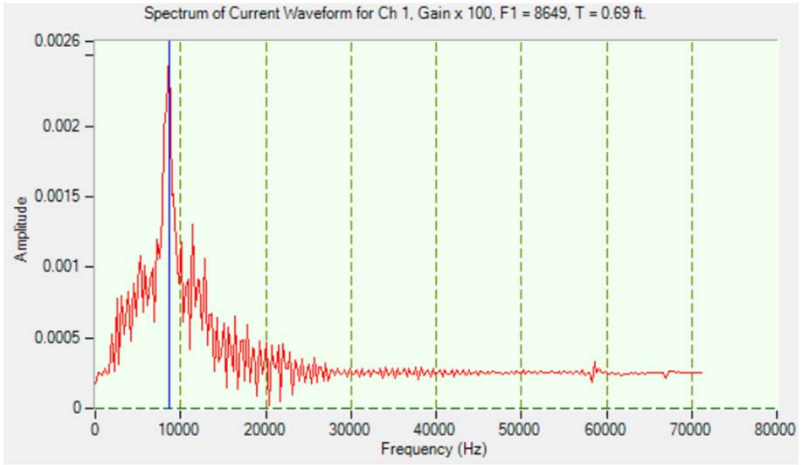
Grout Issues which can lead to Corrosion

- **Voids**
    1. Bleed Water
    2. Grouting Problems
- **Defective Grout**
    1. Segregated
    2. Chloride Contaminated
    3. Carbonated

Identification of PT Grout / Corrosion Issues

- Sonic / Ultrasonic Methods
- Borescope
- Magnetic

Impact Echo – Rogers Overpass



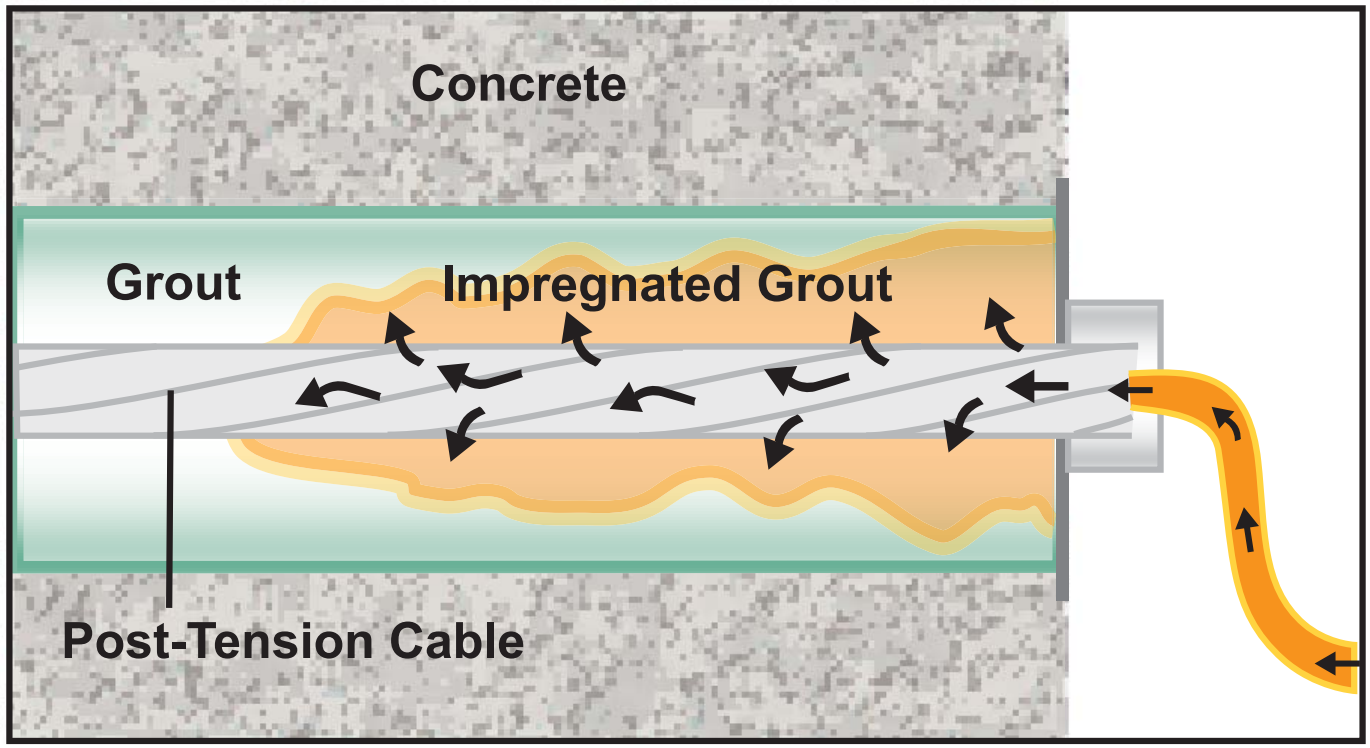
Borescope Inspection

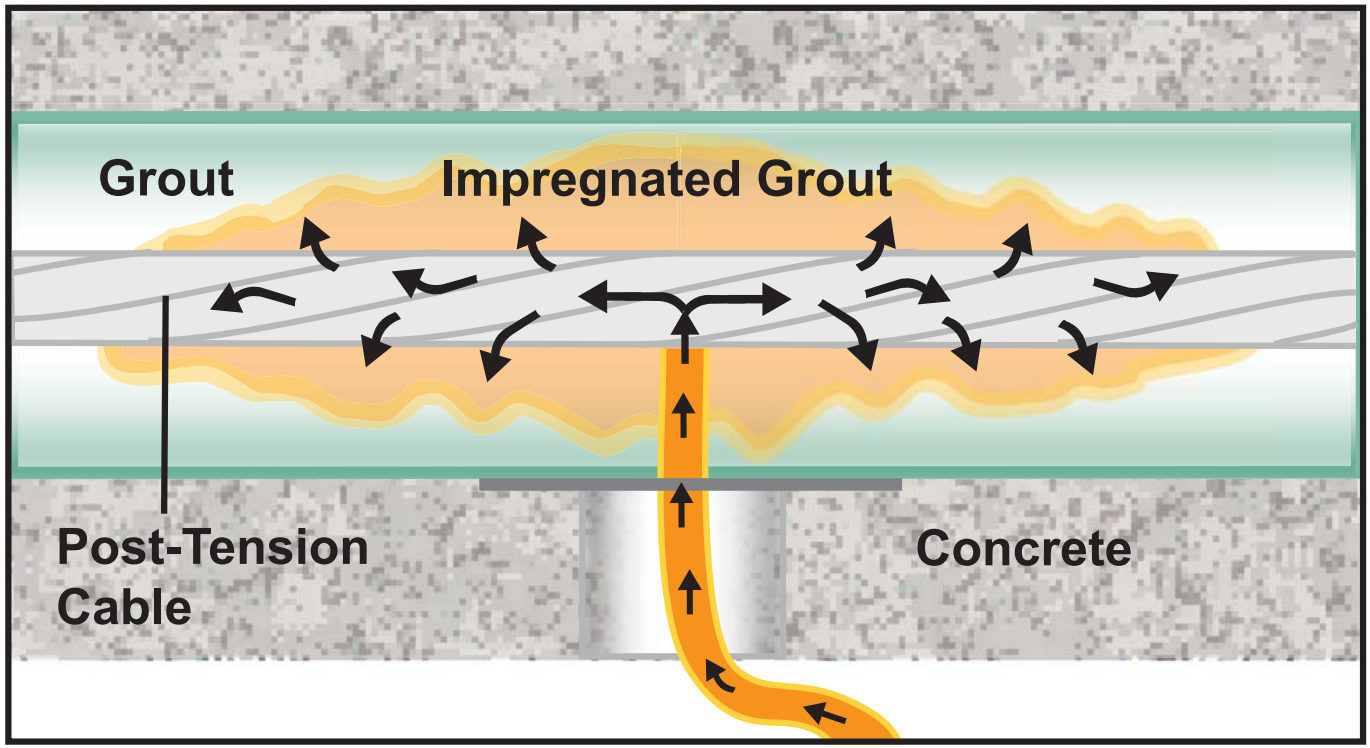
- Visual inspection of voids with minor physical impact
  - Borescope Diam. = 4 mm

Magnetic Flux – Champlain Bridge / Sunshine Skyway

Post-Tension Tendon Impregnation Process

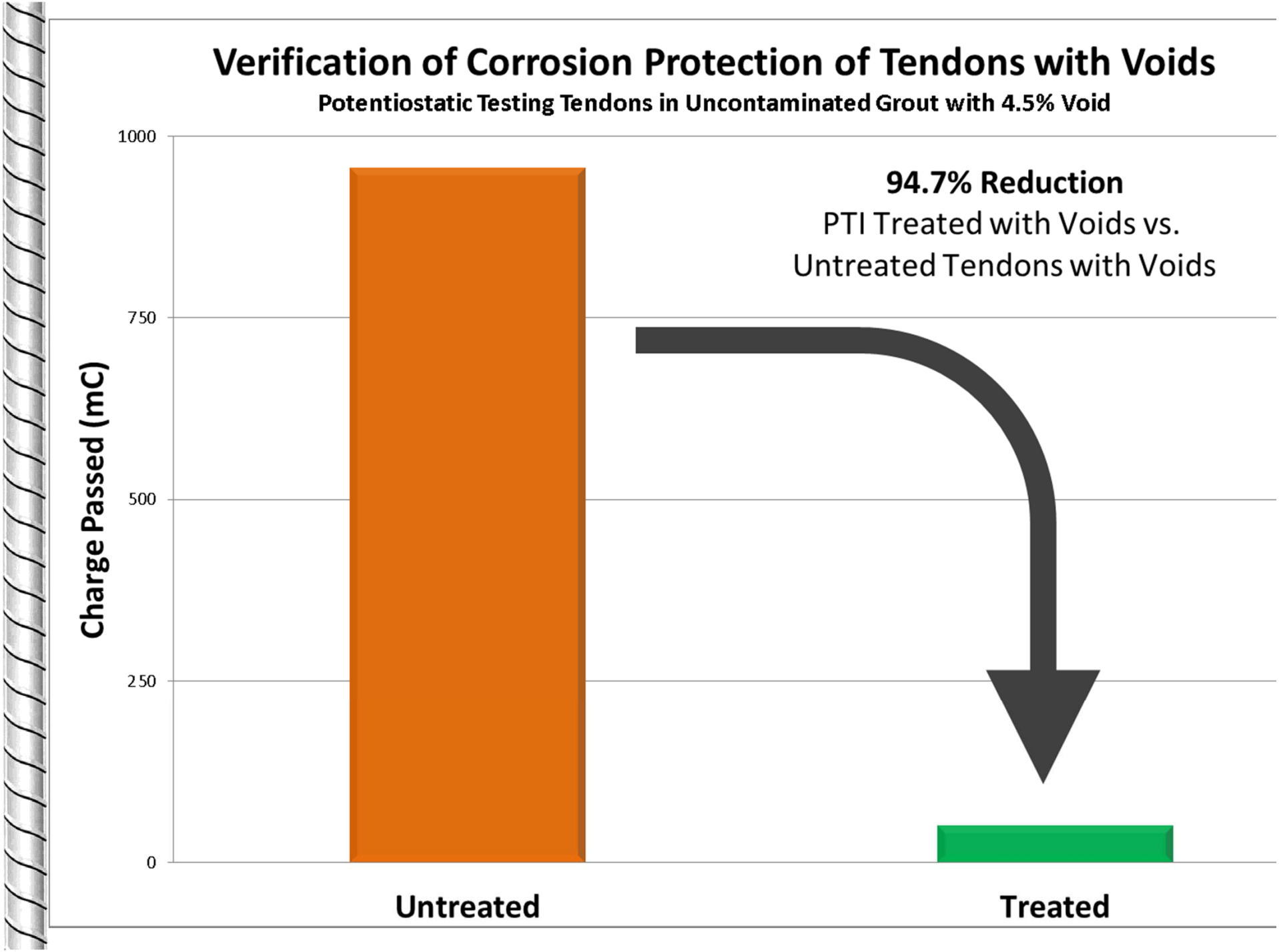
- Corrosion protection process
- Impregnation material transported inside strands full length of tendon
- Impregnation material reduces corrosion by:
  - Coating exposed steel in voids
  - Improving corrosion resistance of grout

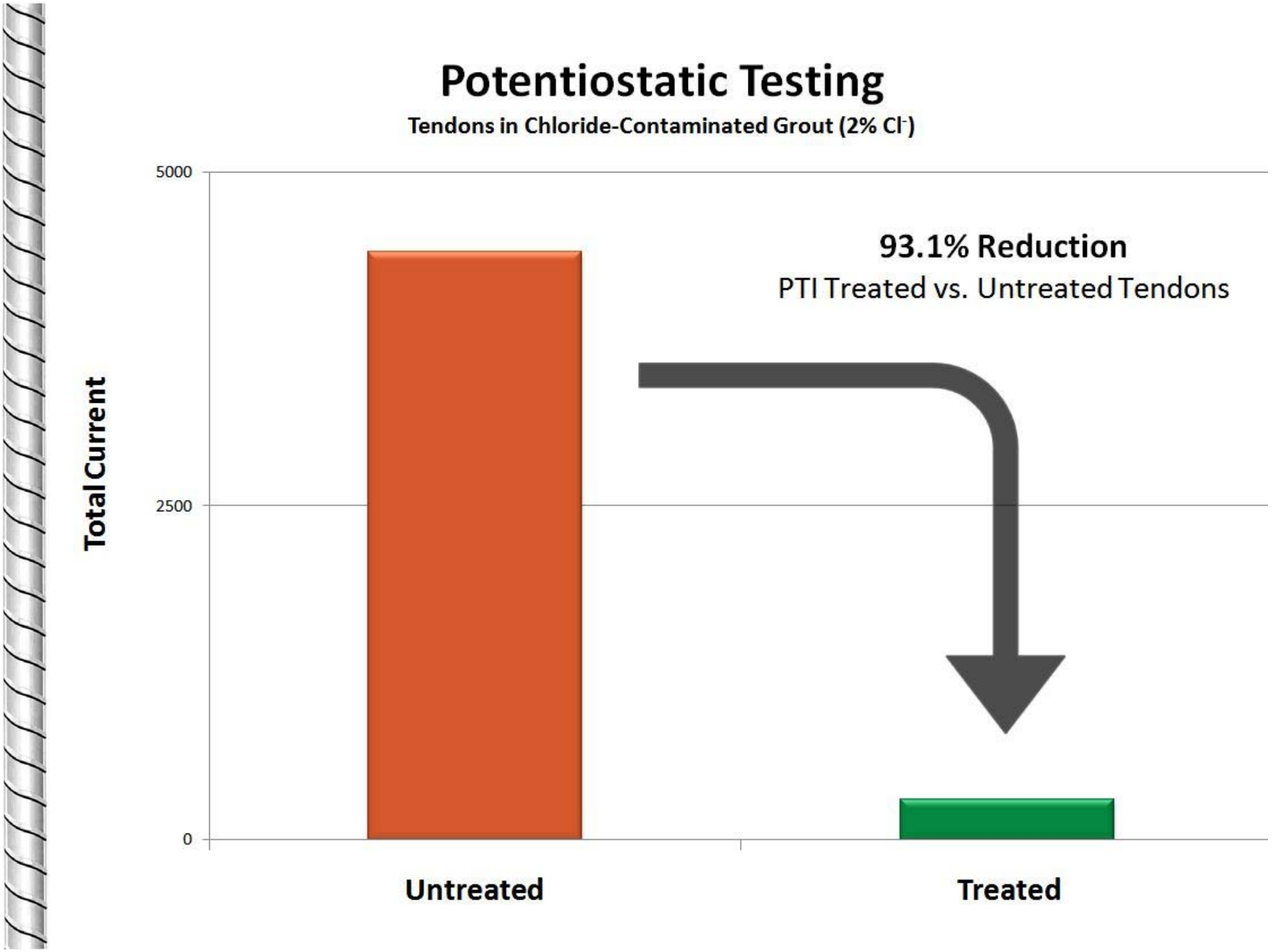

Concrete
Grout
Impregnated Grout
Post-Tension Cable


Grout
Impregnated Grout
Post-Tension
Cable
Concrete

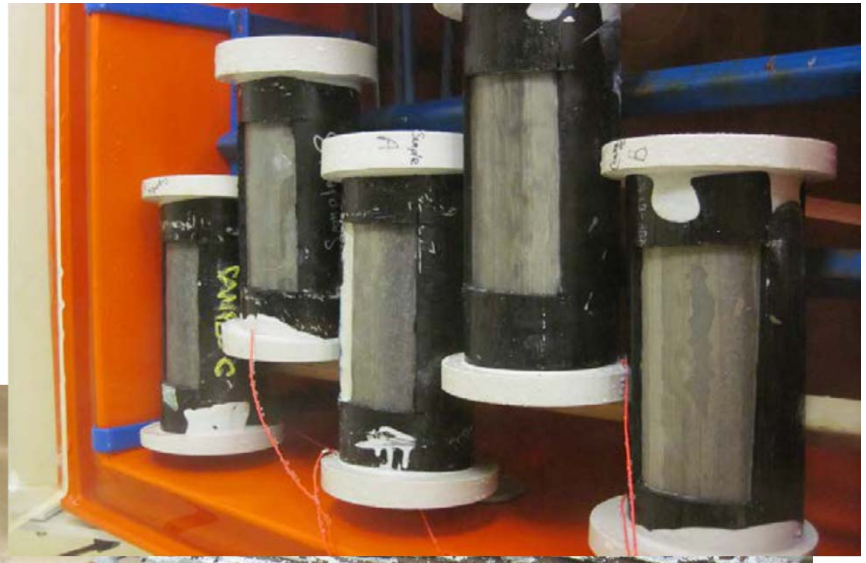
Untreated and Treated Strand Samples

Test Specimen Undergoing Galvanostatic Testing


Verification of Corrosion Protection of Tendons with Voids
Potentiostatic Testing Tendons in Uncontaminated Grout with 4.5% Void
Charge Passed (mC)
1000
750
500
250
0
94.7% Reduction
PTI Treated with Voids vs.
Untreated Tendons with Voids
Untreated
Treated


Potentiostatic Testing
Tendons in Chloride-Contaminated Grout (2% Cl-)
Total Current
5000
2500
0
93.1% Reduction
PTI Treated vs. Untreated Tendons
Untreated
Treated

FDOT Testing



FDOT Florida Department of Transportation - Corrosion Research Laboratory

Interim Report:

Evaluation of a Silicon Based Polymer Corrosion Inhibitor for Post-Tensioned Tendons

K. Bergum
T. Risher
State Materials Office
Corrosion/Durability Laboratory
March 1, 2017

FDOT Jacksonville Bridge

Removal of Anchorage Caps and Grout


S2-E2L-US

Summary

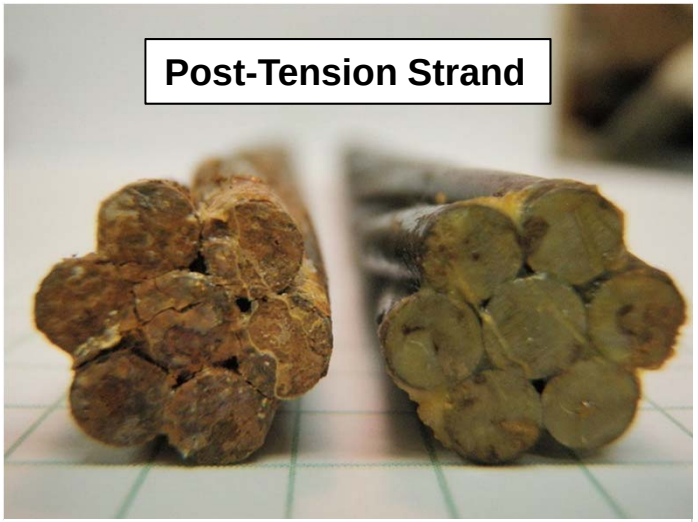
- Impregnation is a corrosion protection process for tendons with grout defects
- Corrosion resistance of treated tendons is improved
- Impregnation may also be suitable for new structures where long service life is desired and the use of bonded tendons is preferred

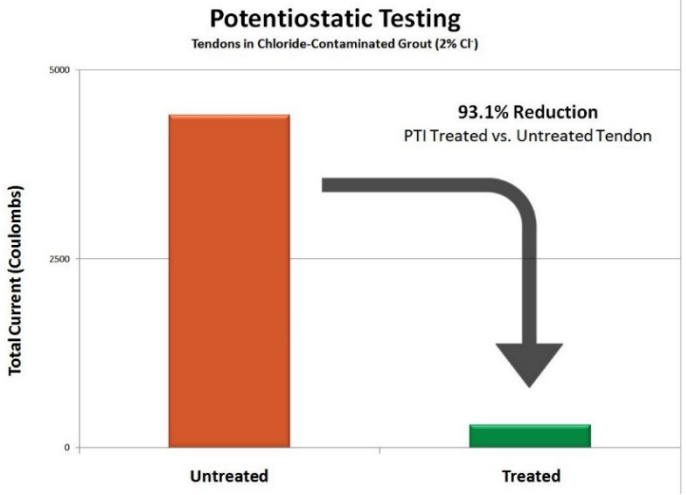
Questions

VECTOR CORROSION TECHNOLOGIES

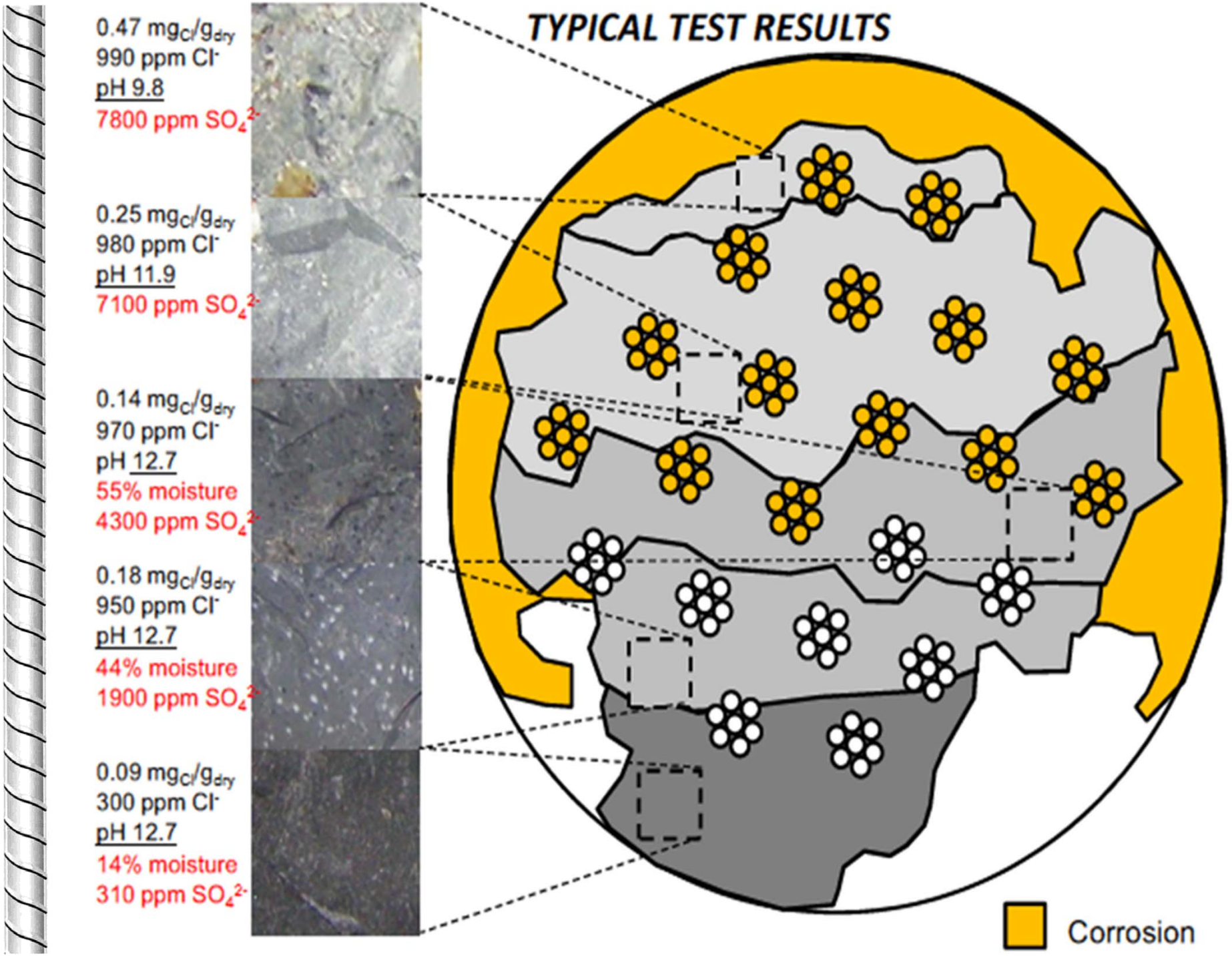
Post-Tech PTI Impregnation

Verification of Corrosion Protection



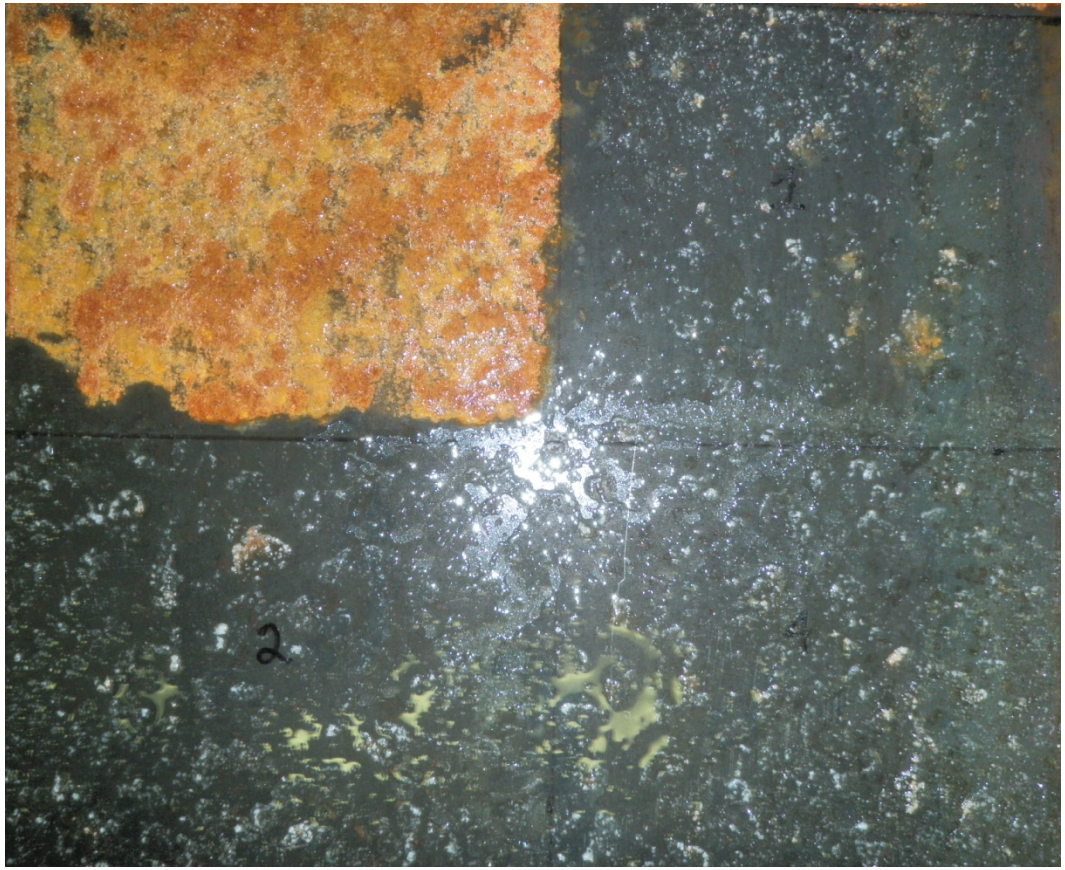


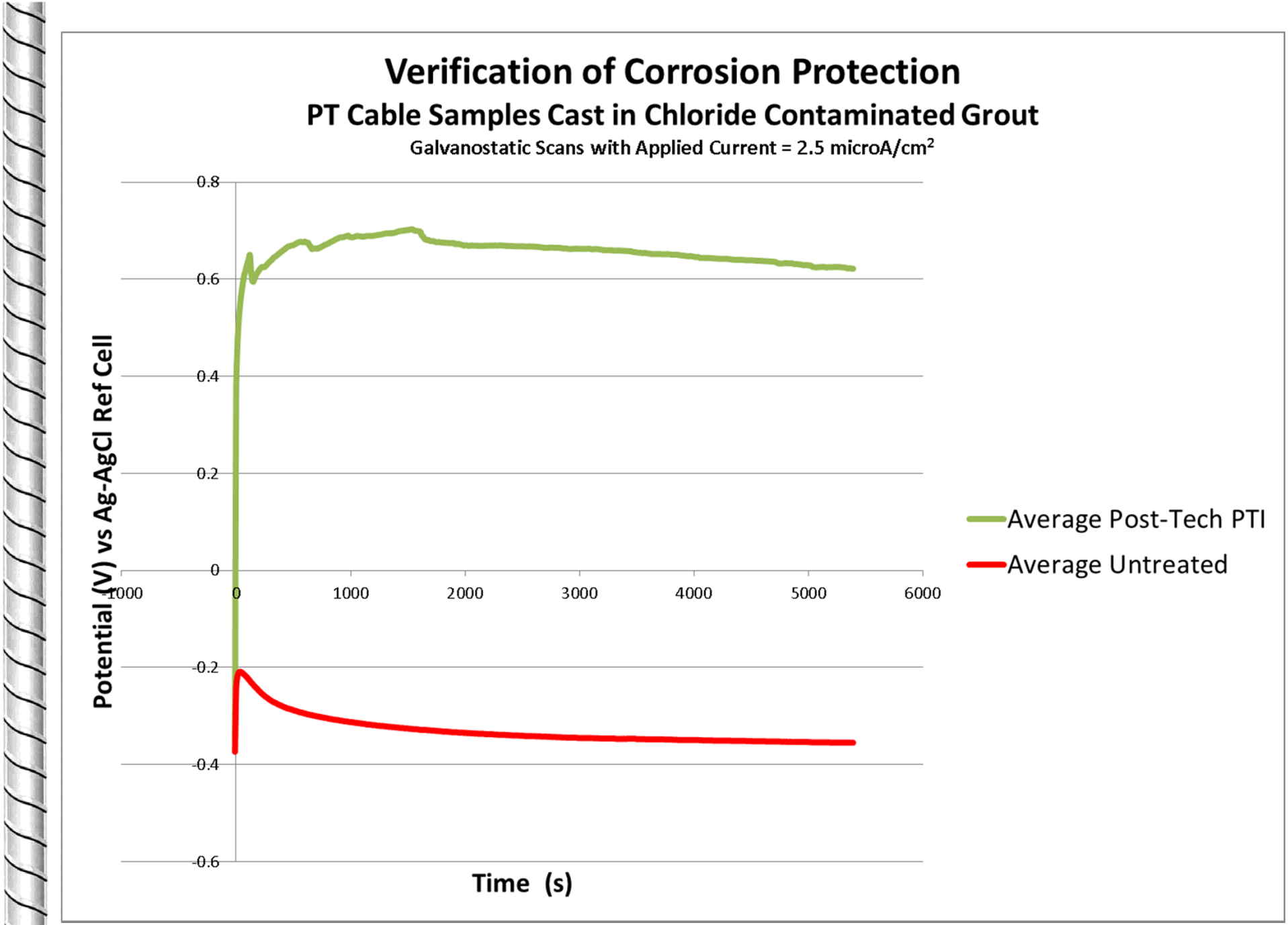
Wick-induced bleed test by American Segmental Bridge Institute in April 2012 showing portland cement grout with about 4% bleeding after 24 hours of grouting operation

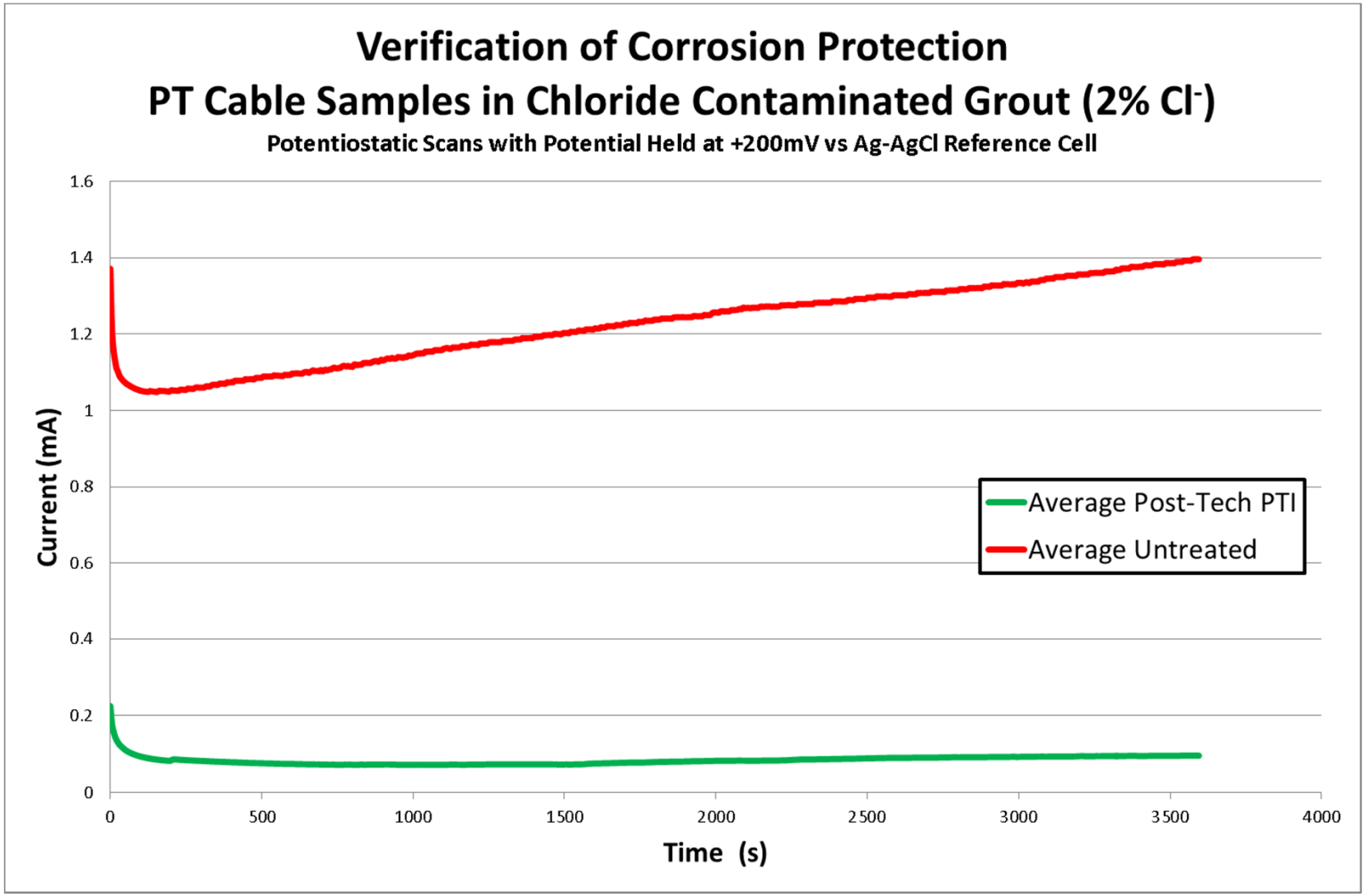

TYPICAL TEST RESULTS
0.47 mg$_{Cl}$/g$_{dry}$
990 ppm Cl$^-$
pH 9.8
7800 ppm SO_4^{2-}
0.25 mg$_{Cl}$/g$_{dry}$
980 ppm Cl$^-$
pH 11.9
7100 ppm SO_4^{2-}
0.14 mg$_{Cl}$/g$_{dry}$
970 ppm Cl$^-$
pH 12.7
55% moisture
4300 ppm SO_4^{2-}
0.18 mg$_{Cl}$/g$_{dry}$
950 ppm Cl$^-$
pH 12.7
44% moisture
1900 ppm SO_4^{2-}
0.09 mg$_{Cl}$/g$_{dry}$
300 ppm Cl$^-$
pH 12.7
14% moisture
310 ppm SO_4^{2-}
Corrosion

Impregnation of Strands in Prestressed Concrete

Corrosion Testing of Impregnation Material Applied to Unprepared Steel




Verification of Corrosion Protection
PT Cable Samples Cast in Chloride Contaminated Grout
Galvanostatic Scans with Applied Current = 2.5 microA/cm2
Potential (V) vs Ag-AgCl Ref Cell
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-1000
0
1000
2000
3000
4000
5000
6000
Time (s)
Average Post-Tech PTI
Average Untreated


Verification of Corrosion Protection
PT Cable Samples in Chloride Contaminated Grout (2% Cl-)
Potentiostatic Scans with Potential Held at +200mV vs Ag-AgCl Reference Cell
Current (mA)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
500
1000
1500
2000
2500
3000
3500
4000
Time (s)
Average Post-Tech PTI
Average Untreated