Technologies to Identify, Treat and Prevent Corrosion

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Vector Corrosion Technologies
Outline

• Define Corrosion for the Purpose of this Presentation
• Technologies to Identify Corrosion
• Technologies to Treat Corrosion
• Technologies to Prevent Corrosion
• Conclusions (all in 30 minutes)
Corrosion

- Corrosion for the Purpose of this Presentation is intended to include:
  - Corrosion of steel in concrete
    - Reinforcing steel
    - Post-tensioning steel

- This presentation does not cover:
  - Corrosion of exposed steel members
Technologies to Identify Corrosion

• Reinforcing Steel in Concrete
  – Concrete Defects
    • Cracks and Delaminations
  – Concrete Chemistry
    • Chlorides, pH and Cover
  – Electrochemistry
    • Corrosion Potentials and Corrosion Rate
Technologies to Identify Corrosion

• Bonded Post-Tensioning Steel
  – Grout Composition
  – Void Detection
  – Corrosion Evaluation
Void Detection using Ultrasonic Tomography
Ultrasonic Tomography Results
Fully Grouted Duct “A”
Poorly Grouted Duct "B"
PT Corrosion Evaluation

POST-TENSION CABLE

IN PORT

FLOW METER

DRY GAS SUPPLY

OUT PORT

FLOW METER

SAMPLING/MEASUREMENT STATION
Moisture and Corrosion

- W Vernon was the first to realize the importance of moisture to the rate at which metals corrode in the early 1900’s
- Vernon discovered critical relative humidity, (60% to 70% RH for steel at room temp) below which the rate of corrosion is low
- Litvan, (NRC) determined that under normal conditions corrosion of steel is negligible below 45% RH
PT Corrosion Evaluation Grading Chart

- **700 ppm**
- **300 ppm**
- "WET" CABLES
- "MOIST" CABLES
- "DRY" CABLES
Technologies to Treat Corrosion

- Reinforcing Steel in Concrete
  - Replace Contaminated Concrete
  - Overlay / Waterproof
  - Electrochemical Techniques
    - Galvanic Protection
    - Impressed Current CP
    - Electrochemical Treatments (ECE / Realk)
Electrochemical Techniques
Technologies to Treat Corrosion

- Bonded Post-Tensioning Steel
  - Voids in Grout
    - Re-Grout
    - Dry
    - Coat steel (exposed and embedded)
  - Grout Issues (Corrosive: Cl\(^-\), SO\(_4^{2-}\), low pH)
    - Remove Grout
    - Impregnate Grout
Cable Impregnation

- Corrosion protection for bonded post-tension and pre-stressed cables
- Uses corrosion inhibiting impregnation material
  - Makes grout / concrete corrosion resistant
  - Coats exposed steel in voids to prevent corrosion
Impregnation Principle
Impregnation of Beam End
Impregnation Pattern
Corrosion Testing of Impregnation Material on Exposed Steel
Technologies to Prevent Corrosion

• Reinforcing Steel in Concrete
  – Prevent Contamination / Delay Corrosion
  – Cathodic Prevention
Saudi Arabia Naval Base

New Construction
Galvanic Corrosion Prevention
Saudi Arabia Naval Base

Jetty: New Construction
Galvanic Corrosion Prevention
Technologies to Prevent Corrosion

• Bonded Post-Tensioning Steel
  – Resolve Grout Issues (Cl\(^-\), SO\(_4\)^{2-}\), low pH)
  – Ensure no Voids
  – Treat Grouted Tendons
    • End Sections / High Points
Treat End Sections of Tendons
Conclusions

- Evaluation techniques can be used to identify corrosion problems before they affect structure safety and service life of concrete structures.
- A range of corrosion mitigation techniques are available to address corrosion of conventionally reinforced and post-tensioned structures.
- Preventing corrosion is the preferred option and should be considered in the design, construction and maintenance of concrete structures.
Thank You