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# Technologies to Identify, Treat and Prevent Corrosion

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Vector Corrosion Technologies





# Outline

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- 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

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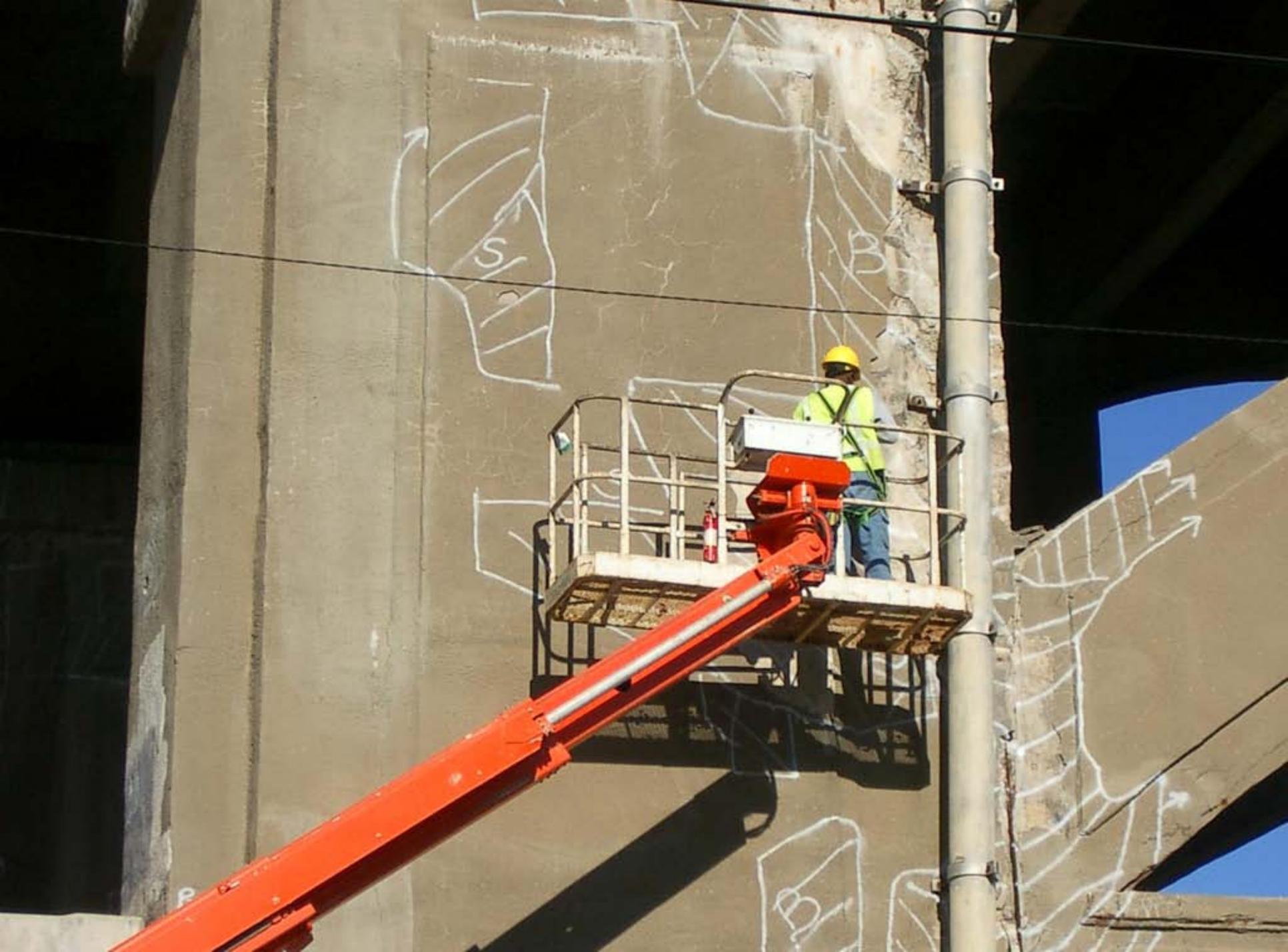
- Corrosion for the Purpose of this Presentation is intended to include:
  - Corrosion of steel in concrete
    - Reinforcing steel
    - Post-tensioning steel
- This presentation does not cover:
  - Corrosion of exposed steel members



# Technologies to Identify Corrosion

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- 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

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- Bonded Post-Tensioning Steel
  - Grout Composition
  - Void Detection
  - Corrosion Evaluation

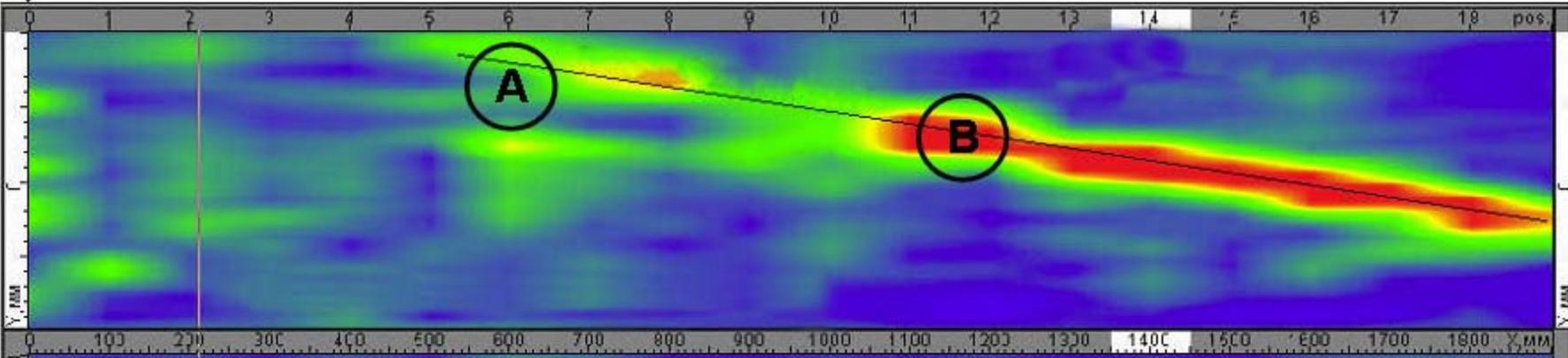
# Void Detection using Ultrasonic Tomography

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# Ultrasonic Tomography Results

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# Fully Grouted Duct "A"

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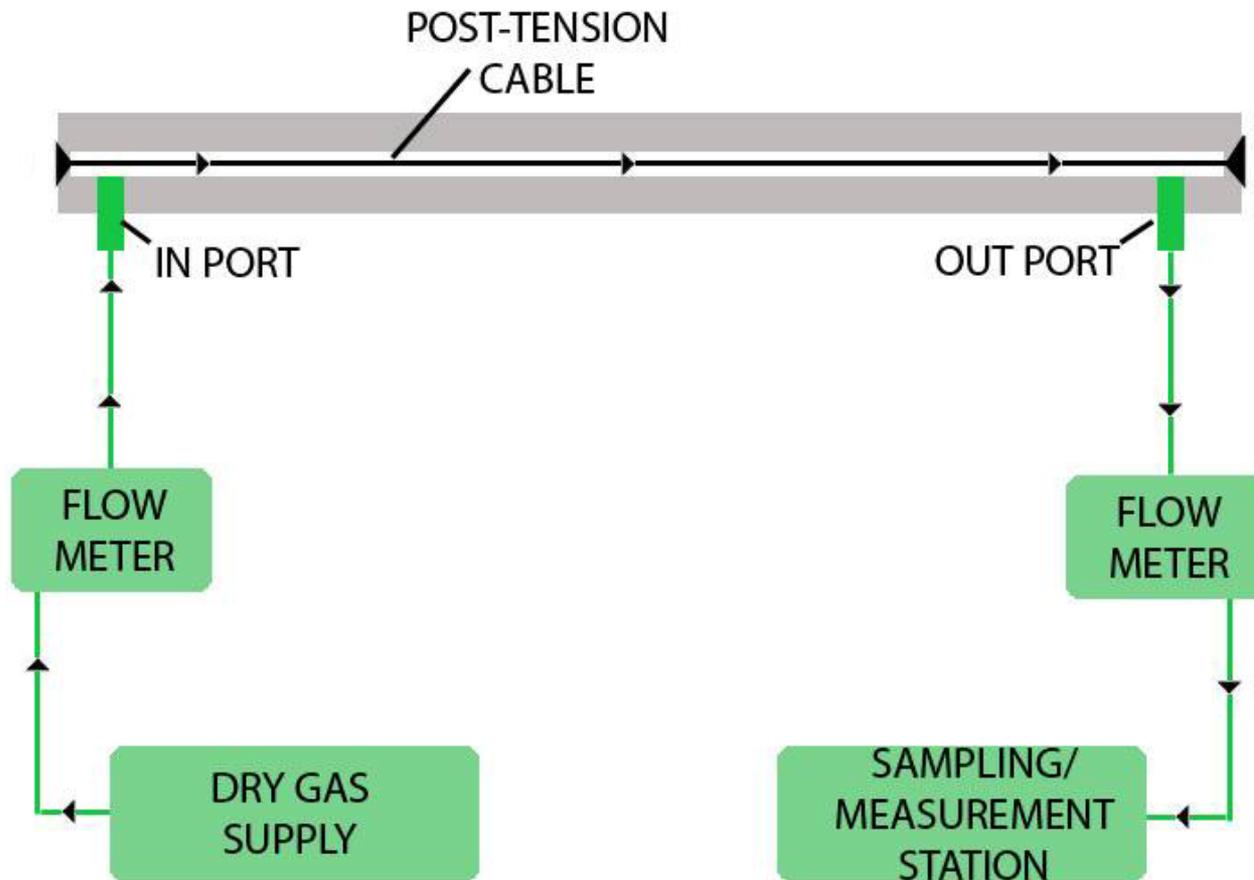
# Poorly Grouted Duct "B"

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# PT Corrosion Evaluation

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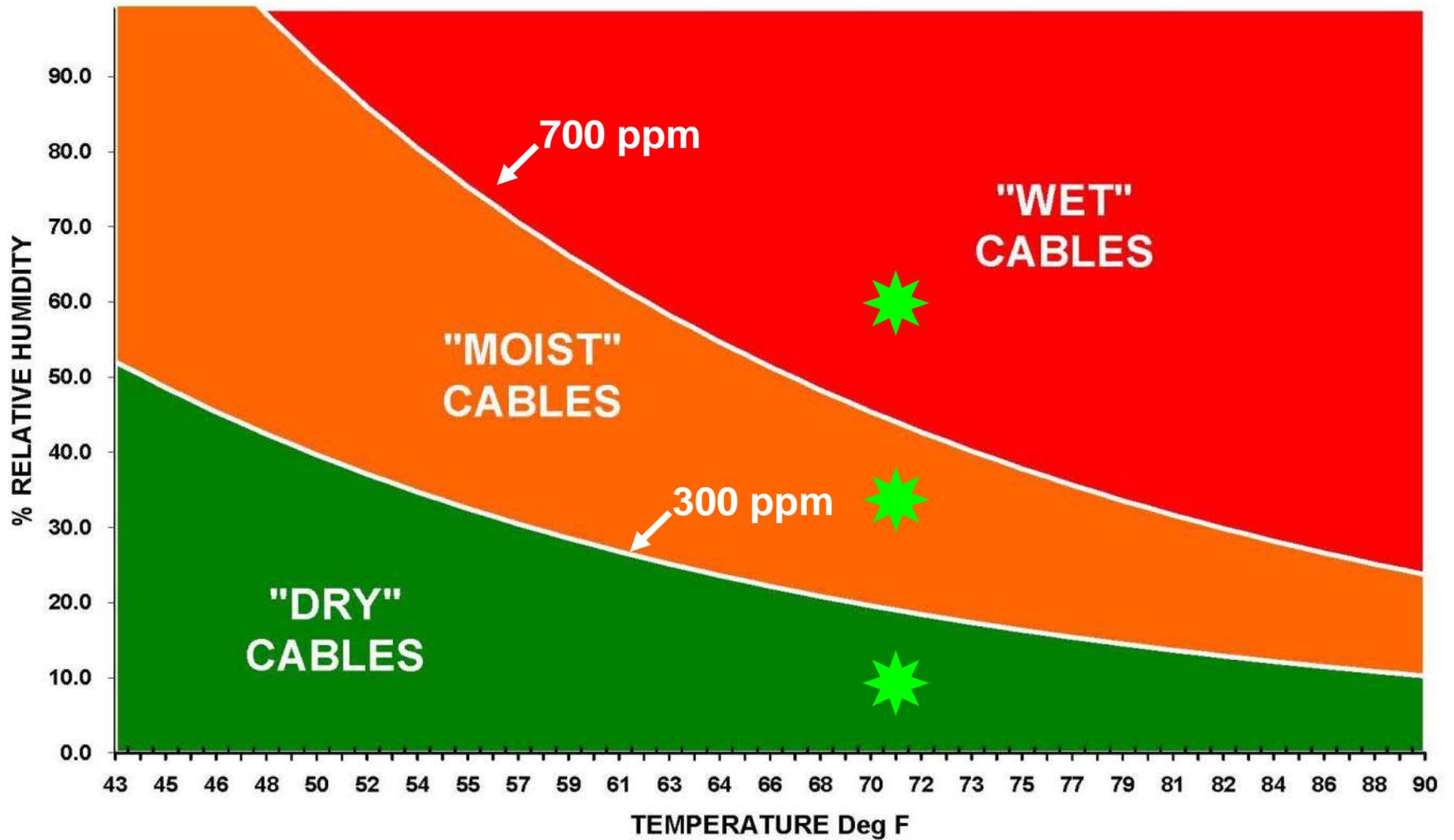


# Moisture and Corrosion

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- 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





















# Technologies to Treat Corrosion

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- 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

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





ICES LLC 1.5" SCH 40 ASTM D2661-02 B13E1 B-AB

VECTOR

ASTM D2661-02 B13E1 B-AB







# Cable Impregnation

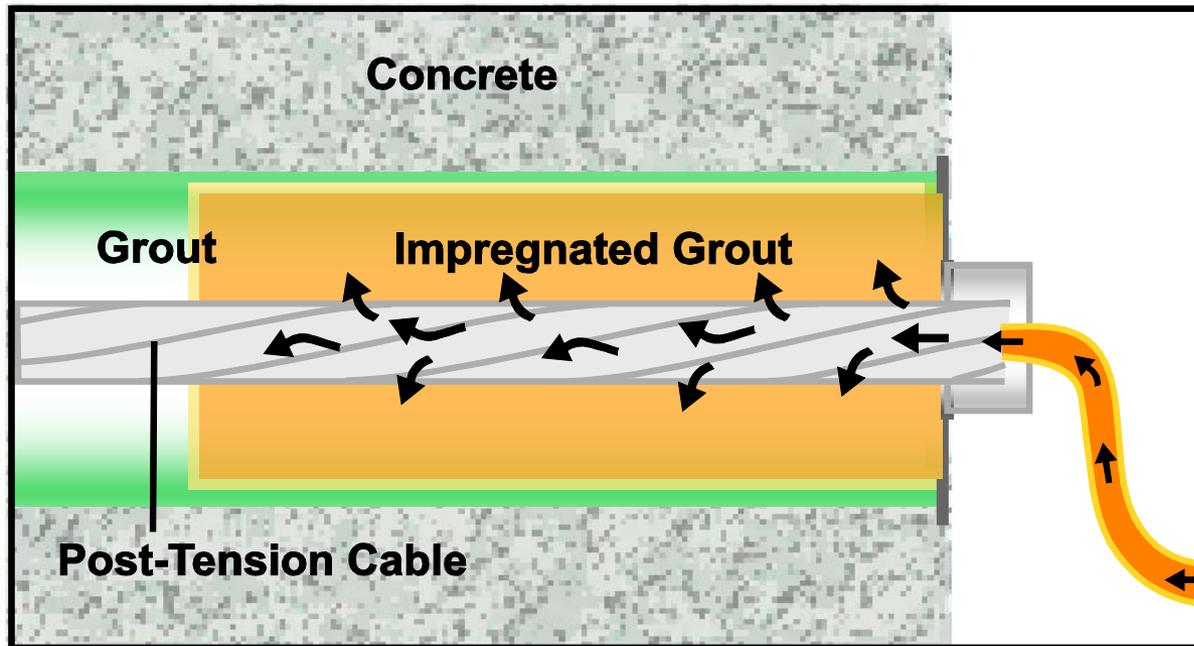
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- Corrosion protection for bonded post-tension and pre-stressed cables
- Uses corrosion inhibiting impregnation material
  - Makes grout / concrete corrosion resistant
  - Coats exposed steel in voids to prevent corrosion



# Impregnation Principle

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# Impregnation of Beam End

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# Impregnation Pattern

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# Corrosion Testing of Impregnation Material on Exposed Steel

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# Technologies to Prevent Corrosion

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- Reinforcing Steel in Concrete
  - Prevent Contamination / Delay Corrosion
  - Cathodic Prevention

# Saudi Arabia Naval Base



**New Construction  
Galvanic Corrosion Prevention**

# Saudi Arabia Naval Base

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**Jetty: New Construction  
Galvanic Corrosion Prevention**



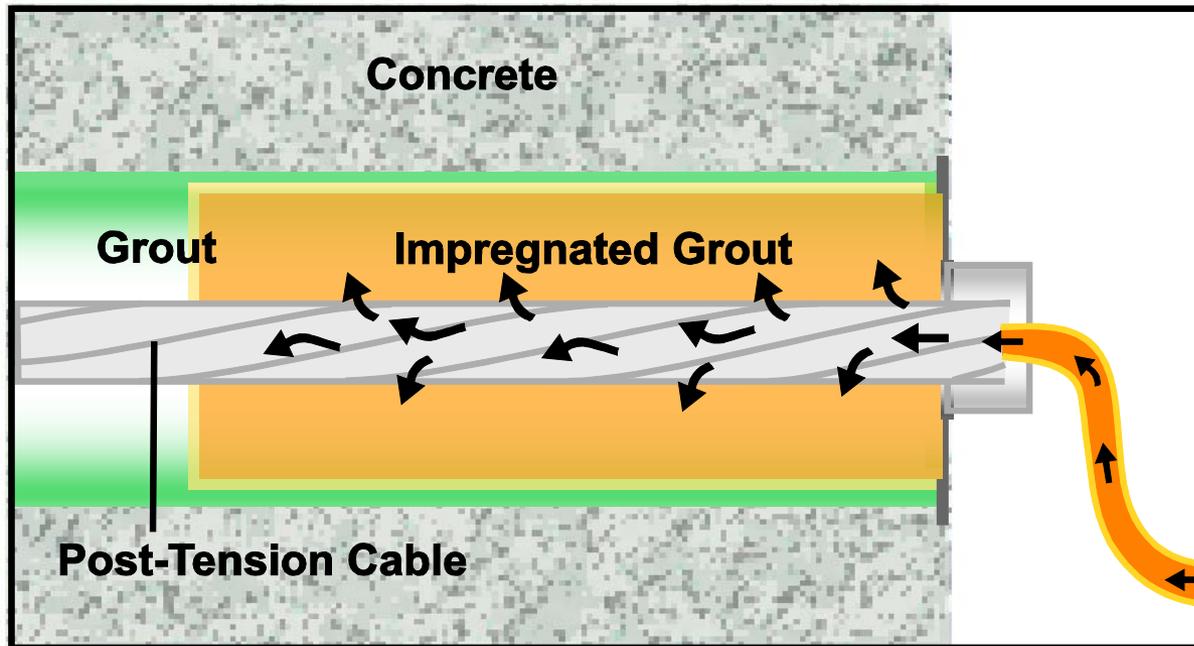
# Technologies to Prevent Corrosion

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

# Treat End Sections of Tendons

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# Conclusions

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- 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

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