

# Resisting Corrosion to Extend Service Life of Port Infrastructure

Brian Pailes, PhD, PE, NACE CP-4

Principal Engineer

Vector Corrosion Services



# Corrosion

- Corrosion damage costs waterways and ports over \$300,000,000 USD each year



# How do we protect infrastructure from corrosion?

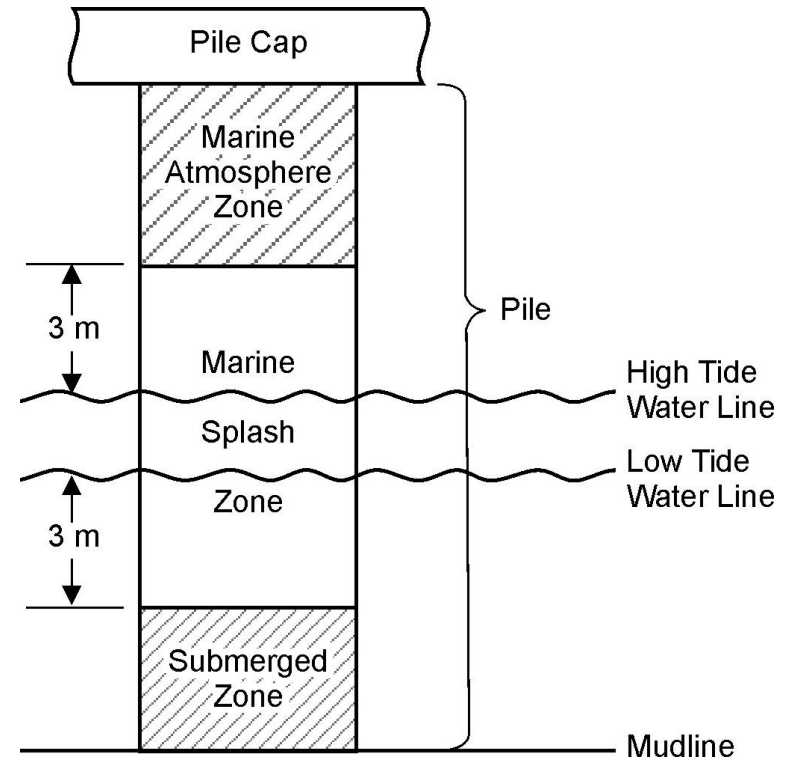
- Barriers
  - Coatings
  - Concrete
- Cathodic protection
  - Galvanic and impressed current
- Corrosion resistant construction materials
  - Improved steel grades or composite materials
- Reduce exposure to contaminants
- Regular maintenance



# Environment

- Most severe environment for ports?
  - **Tidal splash zone**
  - Repeated wet/drying cycles
  - High oxygen availability
  - Exposure to chlorides in salt and brackish water ways

**What do we typically see in the tidal/splash zone of Ports?**



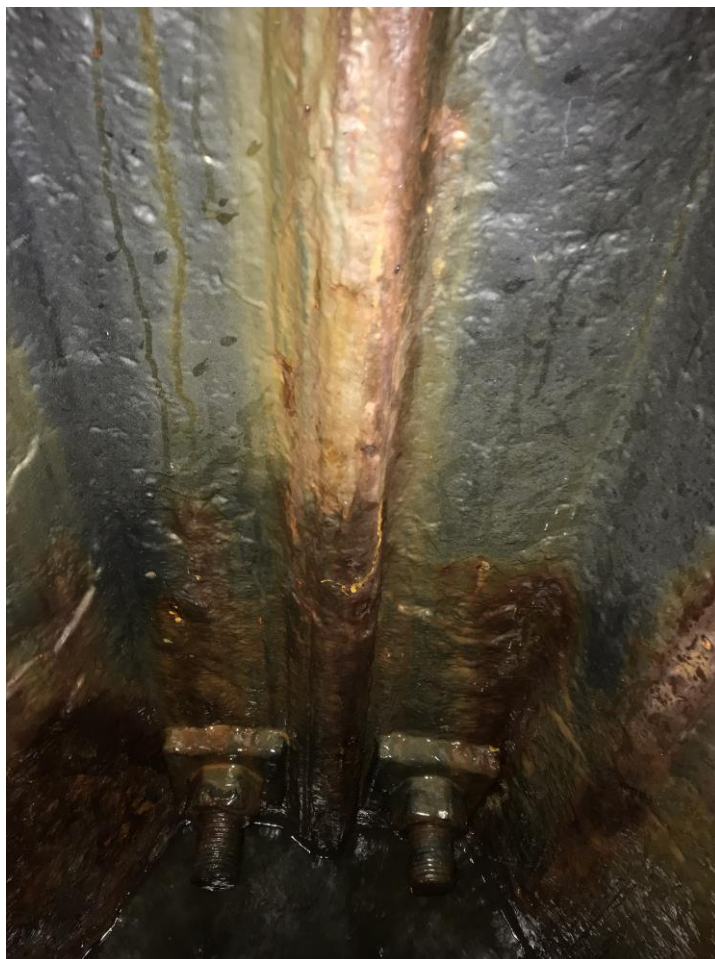
# Steel



# Steel



# Coatings don't last for ever



# Why are we putting our most corrosion susceptible material in the most severe environment using a short term barrier for protection?

Design decisions have a significant impact on the future of a structure



# Most common question I get as a corrosion engineer

- What can you do to protect my exposed steel sheet pile wall from continued corrosion in the tidal/splash zone?
  - Coat it...
  - More importantly Keep up with the coating...
  - Encase it in concrete.....
- Cathodic protection will not work above the water line
  - Unless its encased in concrete



# Barriers

- Coatings
  - Provides barrier to contamination
  - Surface prep, surface prep, surface prep
    - Can't say it enough!!
- Concrete
  - Provides a high pH barrier for steel
  - High pH passivates steel
  - Must control cracking

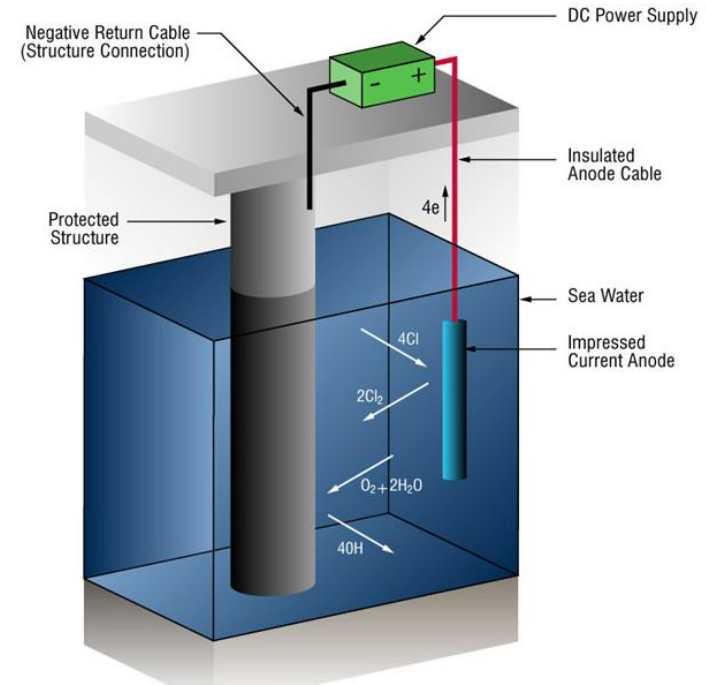
# Cathodic Protection

- Will work on steel
  - Submerged in Water
  - Embedded in Soil and
  - Embedded in Concrete
- Galvanic
  - Set and “forget”
    - Don’t really forget about them!
  - Typically more durably
  - Typically higher cost



# Cathodic Protection

- Impressed current
  - Typically cheaper to install
  - More control over protective current
  - **Requires maintenance and monitoring to be effective over long term**



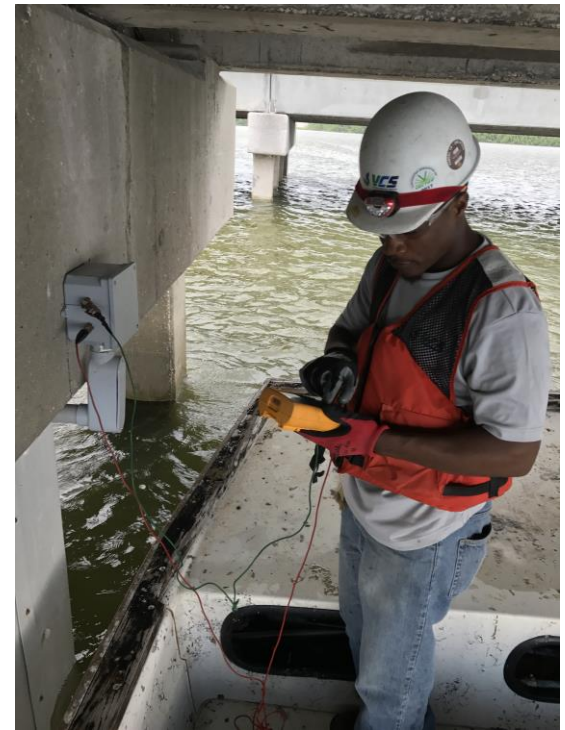
# Better Construction Materials

- Steel structures
  - Higher grade alloys
  - Can be extremely expensive
- Concrete structures
  - Corrosion resistant reinforcing becoming more available
  - Stainless, galvanized, stainless clad, GFRP, Carbon Fiber, MMFX and others
  - More expensive than conventional reinforced concrete
    - But much more cost effective to implement than a high grade steel structure



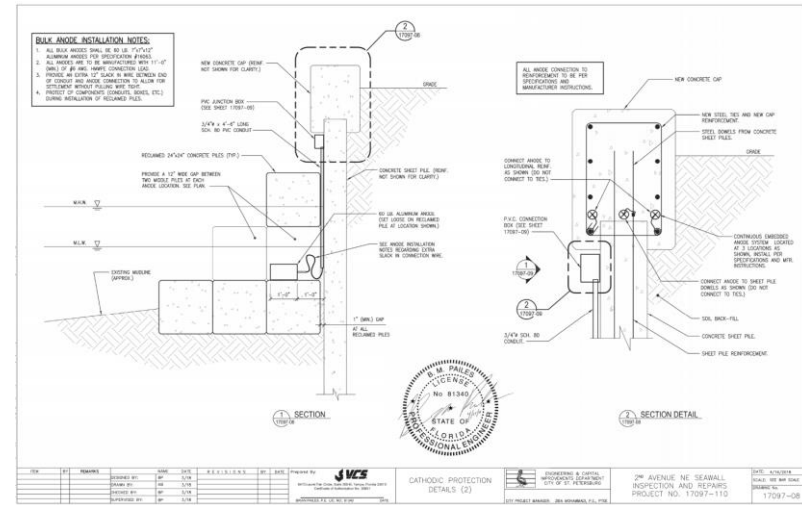
# Asset Management

- Key to the effective service life of any infrastructure
  - Regular inspections
  - Effective maintenance with standardized high-quality repair procedures and materials
  - Transfer knowledge



# Design Phase

- Have a material engineer perform a durability review
  - Can have a long lasting impact on structure's service life
  - How can we design a concrete mix to limit cracking and chloride ingress?
  - Where are the best places for steel structures verses concrete?
  - How can we limit construction defects in barrier coatings?



Thank you!

Questions?