# Designing for Corrosion Control in Marine Structures: A Sustainable and Cost-Effective Treatment for Accelerated Low Water Corrosion

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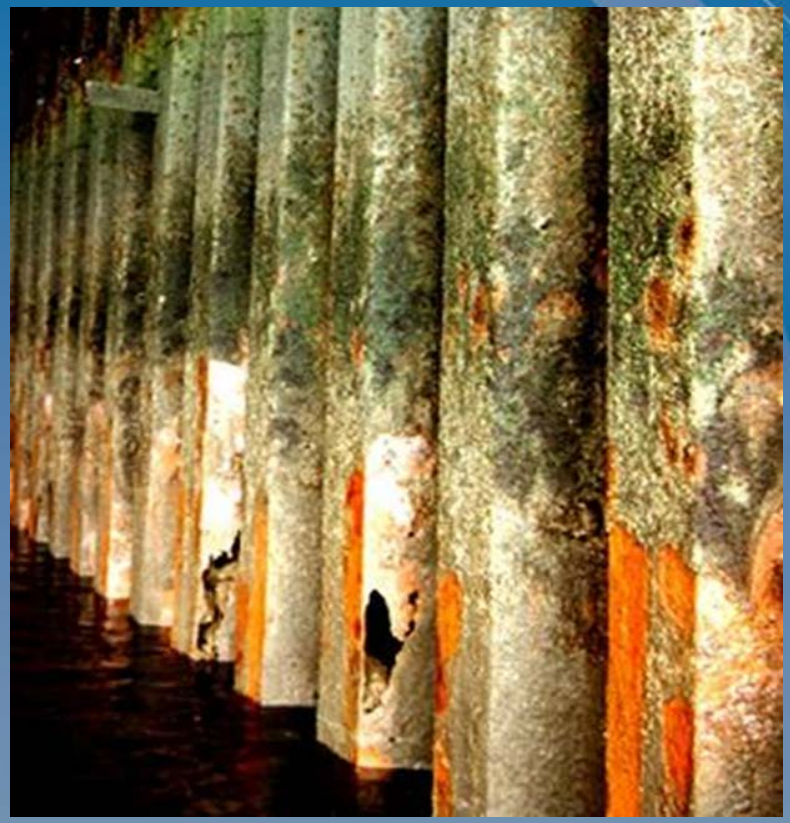
# Agenda

- The Challenge
- Technical Approach:
  - Cathodic Protection
  - LATreat
- Results
- Summary
- Discussion and Questions

# The Challenge

Client issue:

- Microbiologically induced corrosion (MIC)
- Localised, severe corrosion (up to 2mm per year)
- Rapid and local metal thinning
- Perforations/holing
- Loss of stability and strength



# The Challenge

Client Need:

- Something that works (specific to ALWC)
- Minimal disruption to operation
- Reduce maintenance costs
- Environmentally-friendly

# The Challenge

Current protection approaches:

- Coatings
  - Barrier to environment
- Cathodic protection
  - Galvanic
  - Impressed

# Technical Approach

- Cathodic Protection e.g. Rehab of seawall, Florida; tailored galvanic CP design, saved client $0.5 mil.


# Technical Approach

- Cathodic Protection e.g. Rehab of reinforced concrete pier, Jersey; impressed current system based on an innovative ribbon anode design.

# Developing the Concept

- 4.5 yr R&D project
- University of Manchester
- Industrial partners
- End users – 4 UK ports
- $800k funding

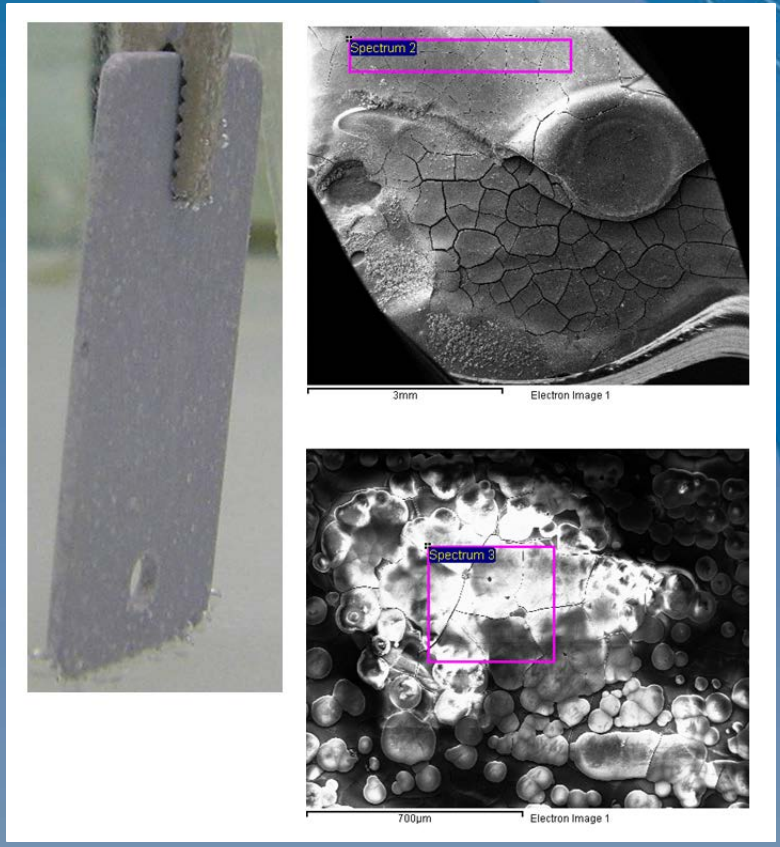






# Developing the Concept

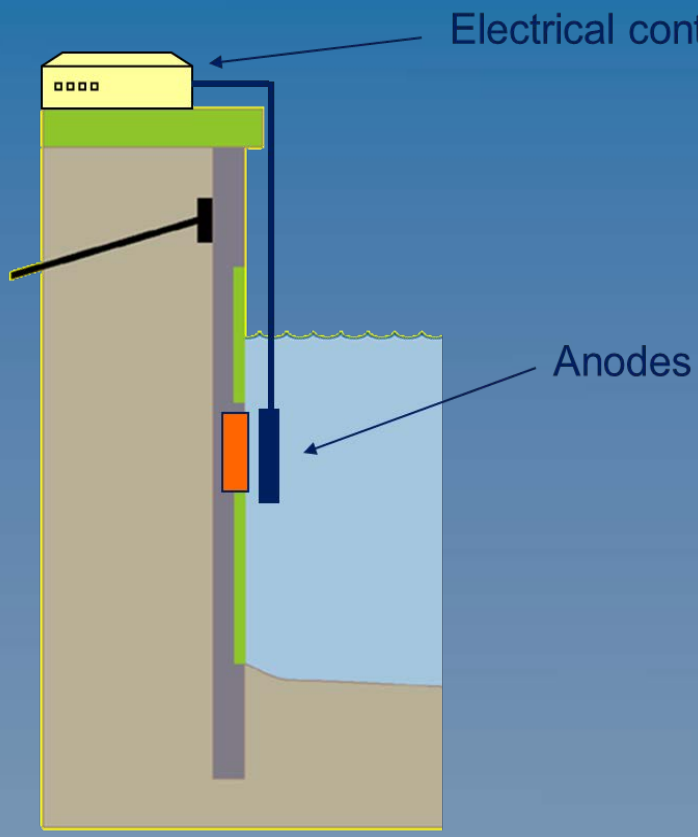
- Fundamental understanding
- Optimise and improve
- Robustness and reliability
- Onsite validation
- Confirm commercial viability



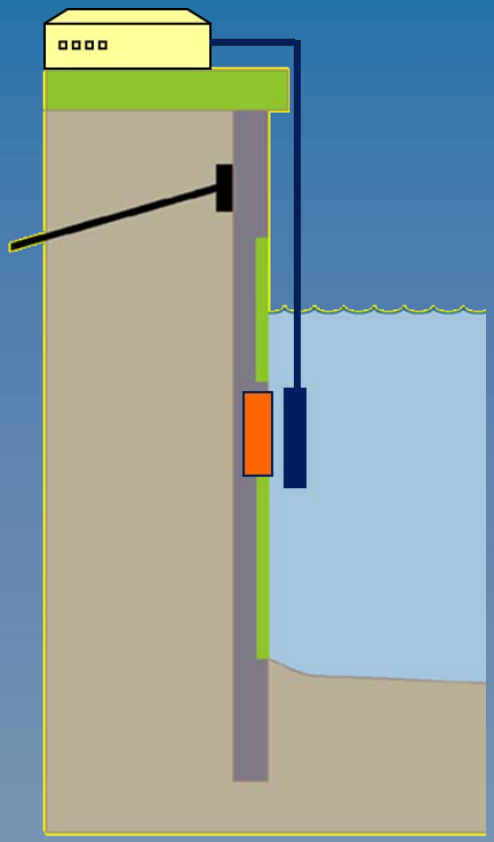
# Technical Approach

- Galvanics:
  - Replacement of anodes typically at 10-15 yrs
  - Lower driving force for protection
  - Cost ~$180/linear m
- Impressed:
  - Typically tubular anodes, replaced after 50 yrs
  - Replace power supply at 10-20 yrs
  - Cost ~$350-400/linear m
  - Operating cost ~$1.25/m2/yr
- LATreat:
  - ~$350-400/linear m
  - Operation costs  - zero
  - Re-coating required 10 – 15+ yrs

# Technical Approach: LATreat



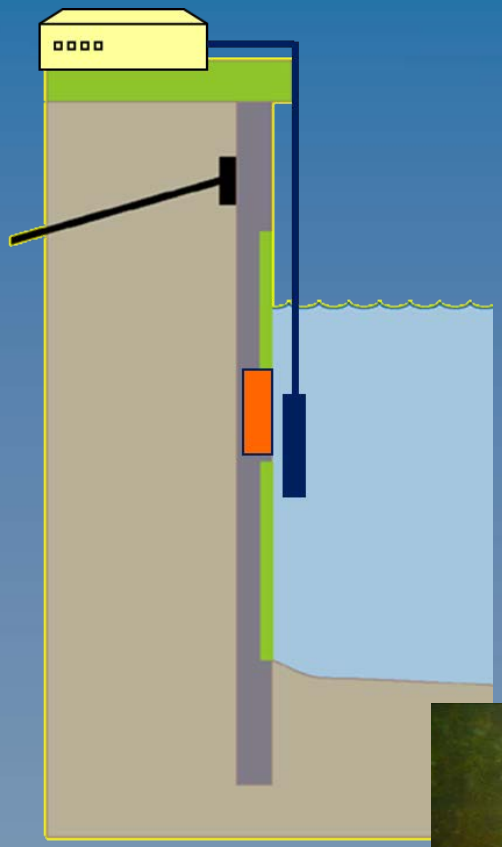

# Technical Approach: LATreat



## Stage 1 – cleaning

- Cathodically generated hydrogen removes aggressive surface foulant
- $2H_2O + 2e^- \rightarrow 2OH^- + H_2\uparrow$ hydrogen evolution

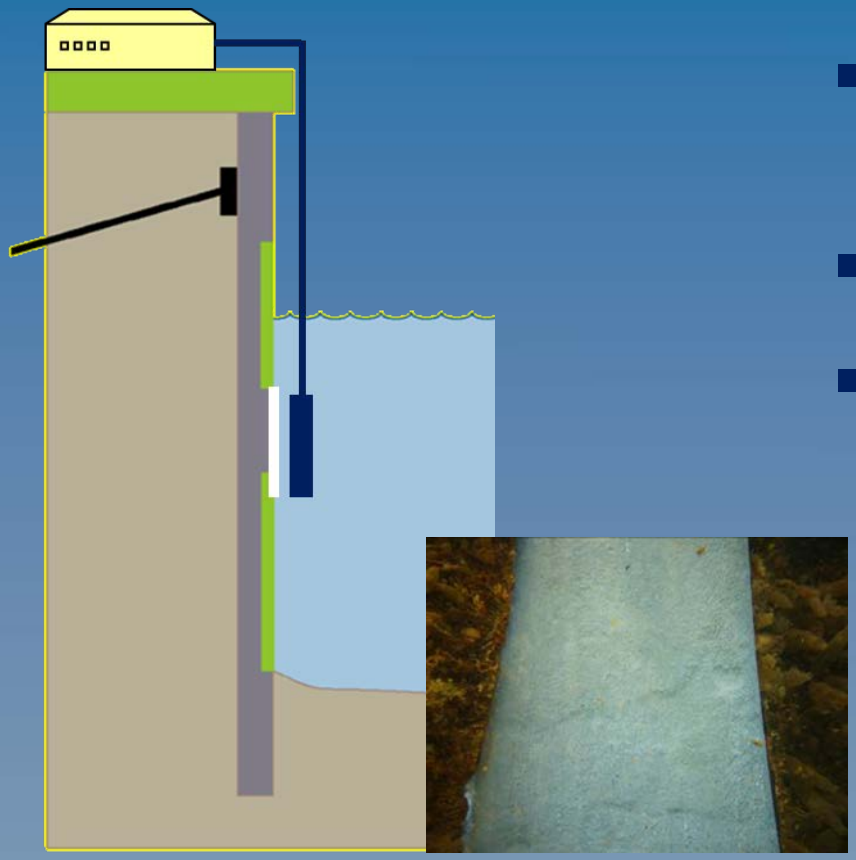
# Technical Approach: LATreat



**Stage 2 – sterilization**

- Anodically generated chlorine, a known biocide, is used to kill bacterial species
- Short, controlled bursts – not a health hazard
- $2Cl^- + 2e^- \rightarrow Cl_2\uparrow$ chlorine evolution
- Typically a 24 hour cycle

# Technical Approach: LATreat



## Stage 3 – coating

- Alkaline coating deposited from seawater dissolved salts
- Pulsed current technique
- Deposition over 3 to 4 days

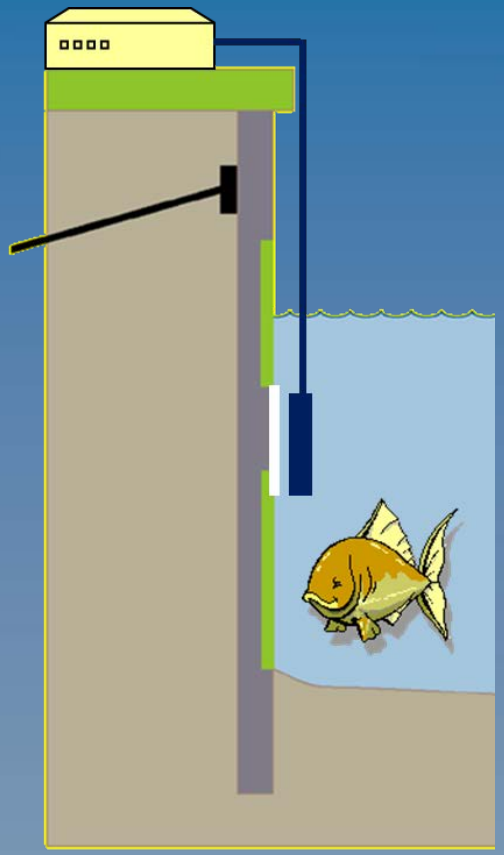
$$HCO_3^- + OH^- \leftrightarrow H_2O + CO_3^{2-}$$

$$CO_2 + OH^- \leftrightarrow H_2O + HCO_3^-$$

$$Ca_2+ + CO_3^{2-} \rightarrow \mathbf{CaCO_3}\downarrow$$

$$Mg^{2+} + 2OH^- \rightarrow Mg(OH)_2\downarrow$$

# Technical Approach: LATreat



- Completed in 5 days
- No external materials
- Creates no waste
- All equipment removed on completion
- No costly ongoing maintenance

# Moving Forward

- First commercial project at Shoreham Port: 110m of sheet piled wall which requires protection from identified ALWC.  January 2014.

# Summary

Traditional corrosion management methods can be combined with new technology to specifically address ALWC, and reduce risk from:

Failures
Reduced availability of assets
Maintenance efforts
Operational Costs

# At Your Service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