Presentation of recommendations and tool to help Ports to assess impacts of quay protection

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L. Walle - TLA
Presentation overview

• Corrosion issues
• Rehabilitation & protection techniques
  – Rehabilitation
  – Coatings
  – Sacrificial anode Cathodic protection
  – Impressed current Cathodic protection
• Assessment of techniques
• Tool
• Recommendations
Corrosion issues – elements

- Elements subjects to corrosion:
  - Steel structures: Piles, Sheet piles
  - Reinforced or pre-stressed concrete (reinforcing steel): piles, beams, quays…
  - Mobile parts: gates…
Corrosion issues – zones & pathologies

- Pathologies:
  - Atmospheric zone: general corrosion (oxide layer on whole surface)
  - z3: localized corrosion (craters, cracks, holes)
  - z2: combination of atmospheric corrosion and erosion, abrasion, fouling, ...
  - LAT: differential aeration cell
  - Mud line: bacterial corrosion
  - Any zone: galvanic corrosion
Corrosion issues – different forms

Group I: Identifiable by visual inspection
- Uniform Corrosion
- Pitting
- Crevice Corrosion
- Galvanic Corrosion

Group II: Identifiable with special inspection tools
- Erosion
- Cavitation
- Fretting
- Intergranular

Group III: Identifiable by microscopic examination
- Exfoliation
- De-Alloying
- Stress Corrosion Cracking
- Corrosion Fatigue
Rehabilitation techniques

• Concrete structure with metallic frames
  – Reinforcement with shotcrete
  – Reinforcement with metal sheets
  – Repair with injection of epoxy resins
  – Realkalisation, dechlorination

• Metallic elements
  – Dual shell system
  – Pile shielding
Protection techniques - coatings

- Most commonly used method, cost being the key factor
- Number of concepts, 2 main families:
  - Barrier protection (physical: coatings)
  - Galvanic protection (electrochemical barrier…)
- Organic coating: 15 to 20 ingredients, typical 3 layers 300µm total thickness (primer, barrier, finish)
- Metallic coating by electroplating, hot dipping,… using Cadmium, chromium, nickel, aluminium or zinc
- Inhibitor, chemical substance (added to primer), many types
Protection techniques - Sacrificial anode Cathodic protection
Protection techniques – Impressed current CP
## WP 2.2.2 – Water quality in port

### Assessment of techniques

<table>
<thead>
<tr>
<th></th>
<th>Coating</th>
<th>Electrochemical protection</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Organic coating</td>
<td>Metallic coating</td>
</tr>
<tr>
<td><strong>Application domain</strong></td>
<td>Sheet pile, pile, moving element</td>
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</tr>
<tr>
<td><strong>Main advantage</strong></td>
<td>Preventive</td>
<td>Curative</td>
</tr>
<tr>
<td><strong>Risks / Limitations</strong></td>
<td>Adherence, quality of painting</td>
<td>Galvanization, non uniform corrosion</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>~5 y</td>
<td>~10 y</td>
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<tr>
<td><strong>Control mean</strong></td>
<td>Aspect, presence of mini-holes</td>
<td>Welding state, corrosion process</td>
</tr>
<tr>
<td><strong>Technical</strong></td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Ease of application / installation</strong></td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Exploitation</strong></td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Maintenance constraints</strong></td>
<td>Duration 5 years max</td>
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</tr>
<tr>
<td><strong>Environmental</strong></td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Toxicity</strong></td>
<td>- Caution to components in painting</td>
<td>Nature of metal n</td>
</tr>
<tr>
<td><strong>Economical</strong></td>
<td>+</td>
<td>+++</td>
</tr>
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<td><strong>Installation &amp; investment</strong></td>
<td>+</td>
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**Corrosion quay protection decision tool**

**Infrastructure considerations**
- Length of berth: 500 m
- Width of berth: 20 m
- Number of piles: 1112 (approx.)
- Draught: 6 m
- Piles inter space: 3 m
- Basin dredging frequency: 2 / year
- Steel sheetpiles presence: 

**Environmental considerations**
- Water pH (1 to 14: acidic to basic): 7.5 (7: neutral)
- Chemical industries neighborhood: 

**Overall considerations**
- Most important factor(s):
  - 
- Estimation: 15 years

Given your data, the best solution is: **Sacrificial Anode: Al**

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**Technical**
- Installation
- Exploitation
- Maintenance

**Environmental**
- Risk
- Toxicity

**Economical**
- Installation
- Exploitation
- Maintenance

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**Overall results**

**Comparison of techniques**

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<tr>
<th>Coating</th>
<th>Orga</th>
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<th>Zn</th>
<th>Al</th>
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**Technical Result**

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**Environmental Result**

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**Most important factor(s):**
- Press
- Environment
- Reduced maintenance

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**Price**
- Environment
- Reduced maintenance

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**Environment**
- Reduced maintenance: 15
Recommendations

- Plan protection when building installation
- To protect, think about technical feasibility, costs, and environment
- **For a better choice, take into account:**
  - *Dimensions of basin*
  - *Water draught*
  - *Dredging frequency*
  - *Sediments use*
  - *Neighborhood*
  - *Water pH*
  - *Horizon of depreciation*
  - *Main factor considered (technical, environmental, economical)*