Underwater Pile Repair and Protection of Marine Structures

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Objectives

- What is Pile Encapsulation?
- Why Do Piles Fail?
- Pile Jacket Installation
- Future Trends

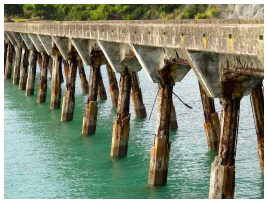
Marine Infrastructure Overview

- Bridges
- Wharfs
- Piers
- Jetties
- Dolphins
- Transmission Towers
- Sea Walls

Marine Applications

Deterioration in Marine Environments

- Marine organisms
- Chemical attack
- Corrosion
- Mechanical damage
- Freezing and thawing damage
- Salt Scaling



Repair Zones for Typical Pile Repair

Tidal Zone
- Corrosion
- Biological/chemical attack
- Mechanical damage

Splash Zone
- Corrosion
- Biological/chemical attack
- Mechanical damage

Mudline
- Corrosion
- Mechanical damage

Pile Caps
- Corrosion
- Mechanical damage

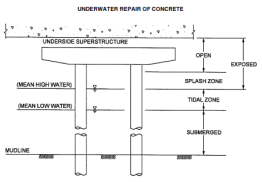


Fig. 1.1—Repair zones: submerged, tidal, and exposed.

Prior to Pile Encapsulation Systems

Complete replacement – or – Repair in-place

In-place repairs were made using the same materials used in original construction

Drawbacks to this type of repair:
- Subject to same issues that caused deterioration = unending repair cycle
- Costs:
  - Coffer dams are often required to dewater the repair area
  - Lengthy repair times
  - Loss of structure function during repair

Composite Systems for Pile Encapsulation

System to *Repair* and *Protect* damaged and deteriorated piles

Provides an "in-place" repair
- No dewatering
- No loss of service

Impervious repair
- Suffocates the splash zone
- Improves resistance
  - Chemical
  - Biological
  - Freeze thaw

Proven technology for over 40 years

Advantages of Pile Encapsulation

Components are Underwater & Marine-Grade

- Effective above and below waterline
- Effective in salt water, fresh water, and brackish water
- Jacket and fillers can be placed and cure underwater
- No dewatering required
- Environmentally safe to marine life
- Cost effective!

Advantages of Pile Encapsulation

Benefits to contractors, owners & engineers

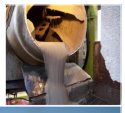
- User friendly; can be modified in field; maintenance free
- Jackets are manufactured per project needs
- Epoxy is both pourable and pumpable, fills all voids
- Epoxy grout bonds tenaciously to jacket
- Complete barrier system protects against additional corrosion and deterioration
- Restores structural integrity
- No need to shut down structure during installation

Components of a Jacketing System

Stay in Place Form
- Fiberglass jacket

Filler
- High-strength grouting materials
- Marine epoxy grout
- Underwater cementitious grout

Accessories
- Forming hardware
- Temporary bottom seals
- Pumping ports
- Stainless steel screws



Components of a Jacketing System

Made from fiberglass fabric and polymer resin

Shape and size made per project

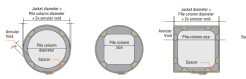
Jackets are 1/8" to ½" thick

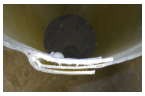
Integral tongue & groove joint

Spacers added to maintain annulus

Bottom Seal

Self-tapping screws



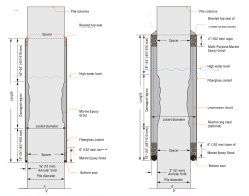


Type of Filler Material

Depends on Section Loss

Less than 25% Epoxy grout

Greater than 25% Epoxy & cement grout



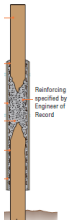
What About Complete Pile Section Loss?

Jackets may still provide solution

Engineer-of-record to determine

Additional repair material may be appropriate

- Rebar cage (wood or concrete piles)
- Welded steel plates (steel piles)



Surface Preparation

Clean existing surface from loose debris

Prepare surface

- **Concrete:** Mechanically remove unsound concrete in the damaged area per ICRI Guideline 310.1R providing a minimum concrete surface profile CSP 6, per ICRI Guideline 310.2R. Prepare remaining surfaces by high-pressure water blasting or other mechanical means to achieve ICRI 310.2 CSP 3-6.
- **Steel:** Prepare surface by high-pressure water jetting or other mechanical means necessary to achieve SSPC-SP12/NACE 5 WJ-4.
- **Fiberglass Jacket:** Fiberglass surfaces must be sound, clean, and free of all contaminants that could impair product adhesion or performance.

Means & Methods

- Mechanical (brushing)
- Air pressure
- Water Blasting
- Sandblast

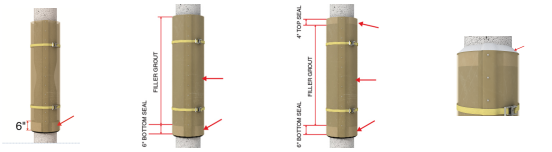
Installation Procedure

Gun epoxy into T&G joint
Place jacket around pile

Close jacket
Position 18"-24" beyond repair area

Attach external bracing
Attach screws to secure T&G joint

Installation Procedure



Bottom seal
Install epoxy grout

All epoxy systems
Fill jacket full with epoxy grout

Epoxy/cement system
Fill jacket with cement grout
Fill remainder with epoxy grout

Top Seal
Apply epoxy mortar cant

Installation Details

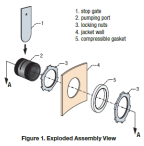


Figure 1. Exploded Assembly View

Grout Port

Bell Joint

Jacket formwork

Future Trends with Jacketing Systems

Stay in Place Forms
Strengthening Applications
Passive Cathodic Protection Systems
Active Cathodic Protection Systems

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Thank You!

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