Rehabilitating Bridge Substructures with FRP Materials

Midwest Bridge Preservation Partnership

2010 Annual Meeting, Detroit, MI

Presented by:

William J. Gold, P.E.

Engineering Services Manager
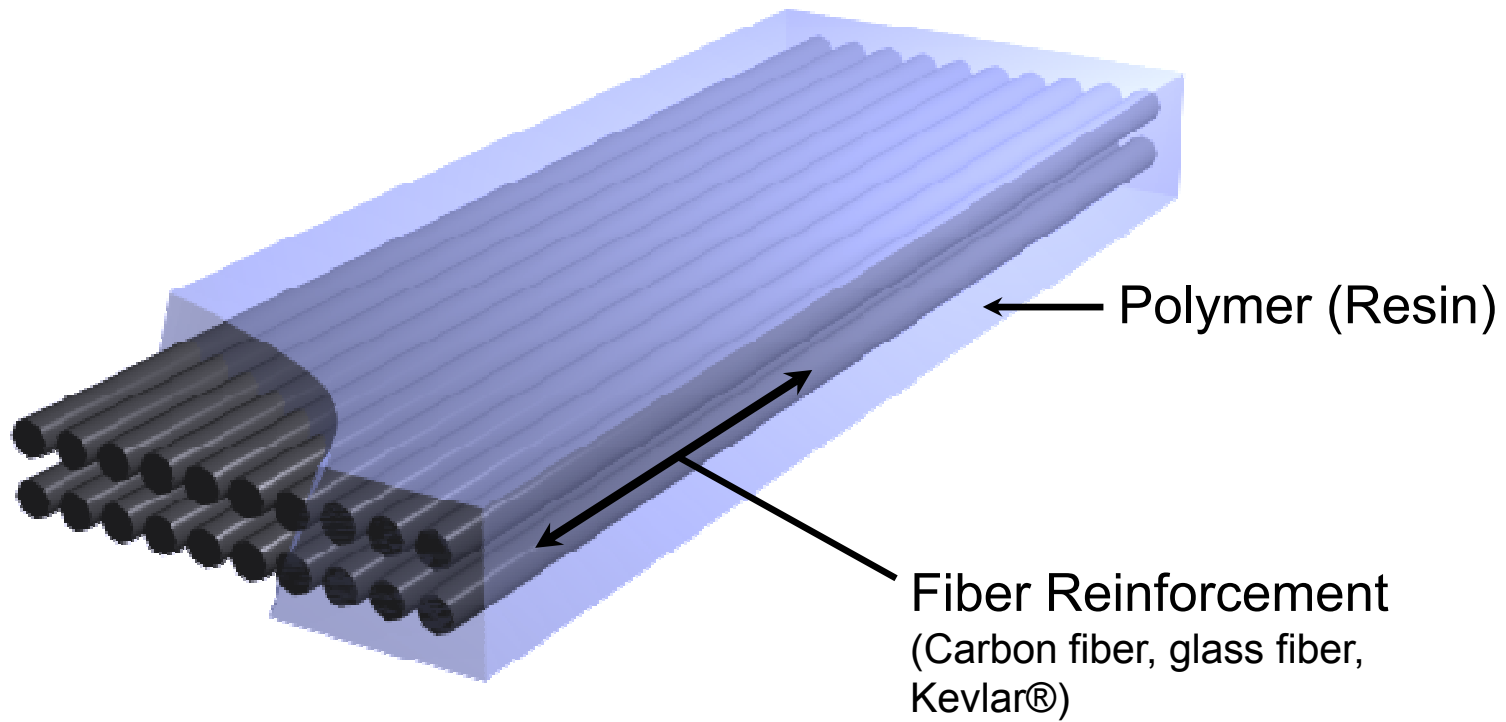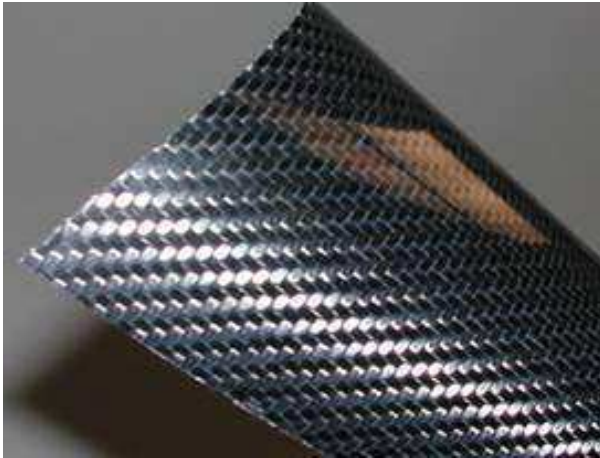
BASF Corporation

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The Chemical Company

Fiber Reinforced Polymers (FRP)

Polymer (Resin)

Fiber Reinforcement
(Carbon fiber, glass fiber, Kevlar®)

FRP Materials

Material Characteristics

- Very High Strength
- Light weight
- Non-corrosive
- Non-magnetic

Uses

- Aerospace (aircraft and satellite structures)
- Shipbuilding (ship hulls, masts)
- Automotive (car frame and body parts)
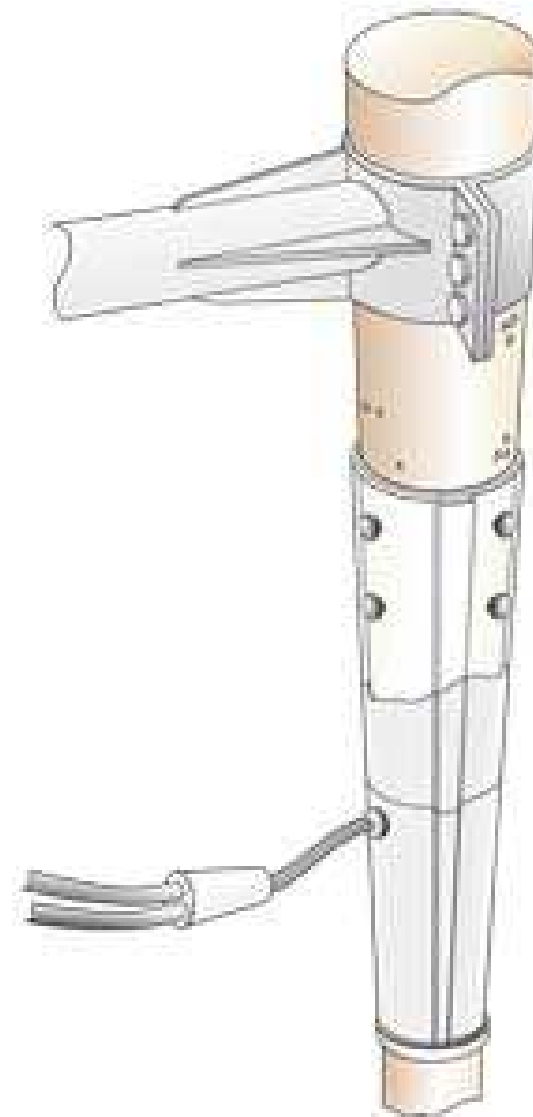- Sporting goods (fishing rods, skis, bicycles and bicycle parts)

FRP in Construction

FRP Strengthening Systems

FRP Encapsulation Systems
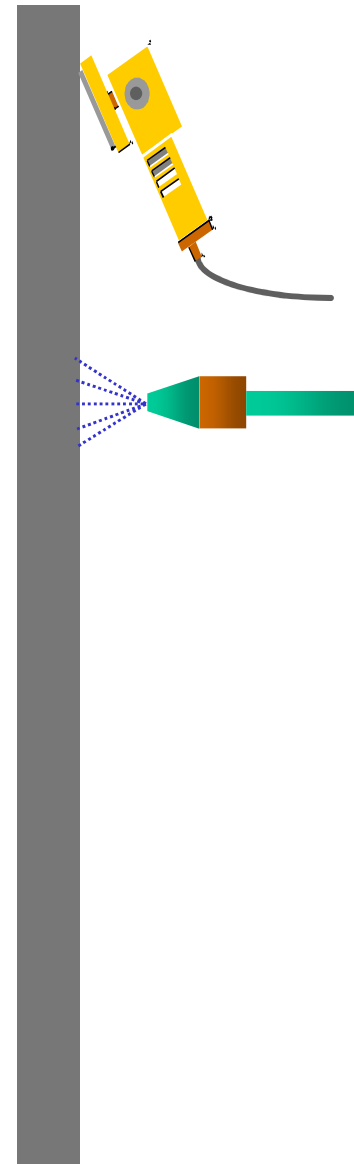
FRP Encapsulation

- GFRP jackets placed around an existing structure

- Annular space btwn jacket and structure filled with an epoxy grout

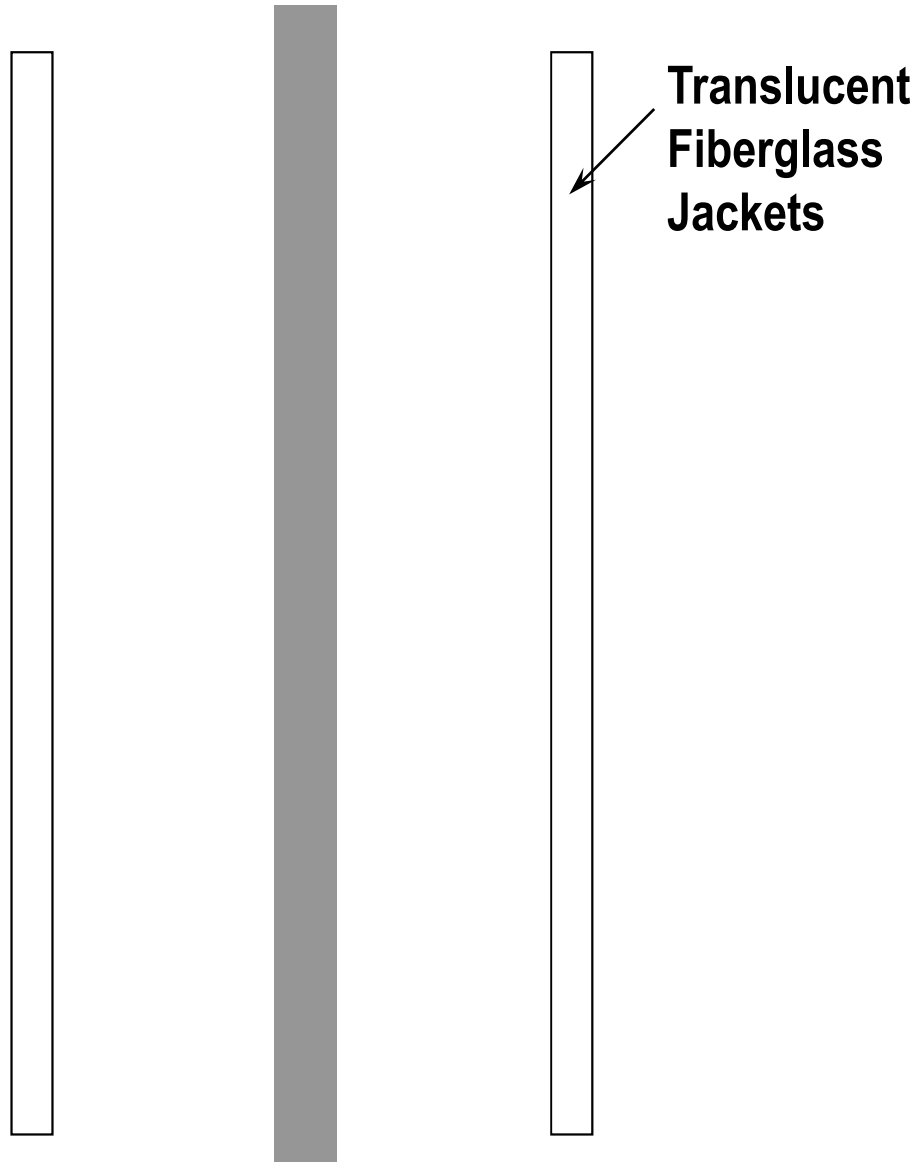- Grout pumped under pressure from the bottom of the jacket up

Encapsulation Process

Step 1

- Surface preparation

- Remove damaged/delaminated sections

- Profile substrate
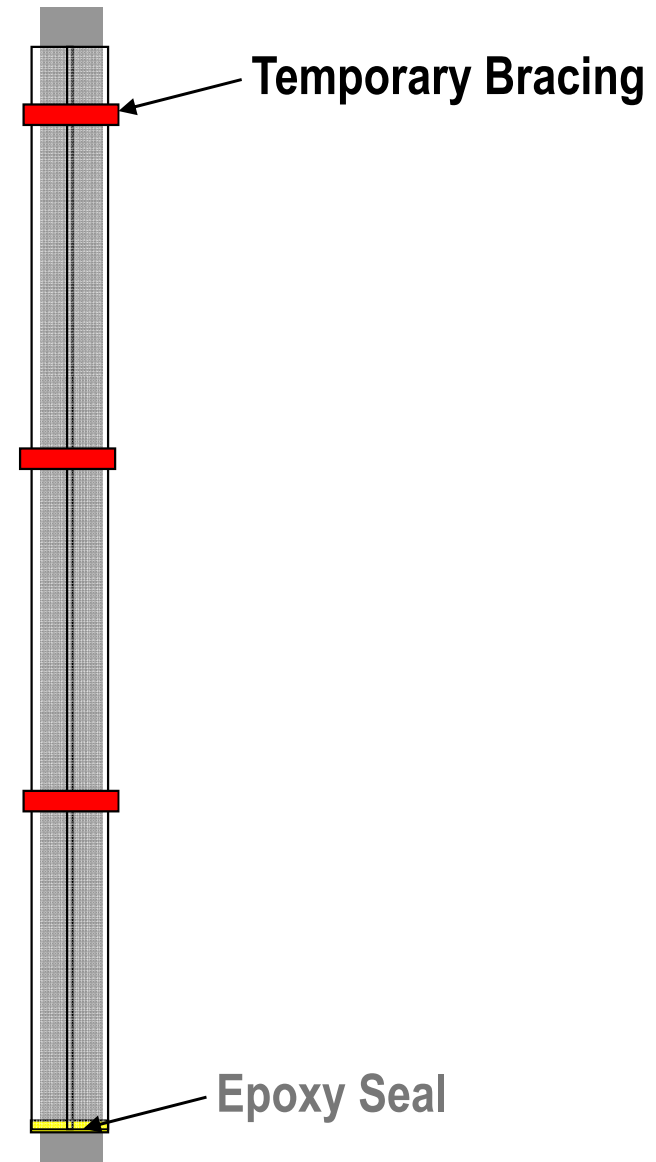
Encapsulation Process

Step 2

- Fiberglass Jackets Placed Around Structure

- Leaving 3/8" to 1/2" Annulus between Jacket and Structure

- Seams are sealed with epoxy

Translucent Fiberglass Jackets

Encapsulation Process

Step 3

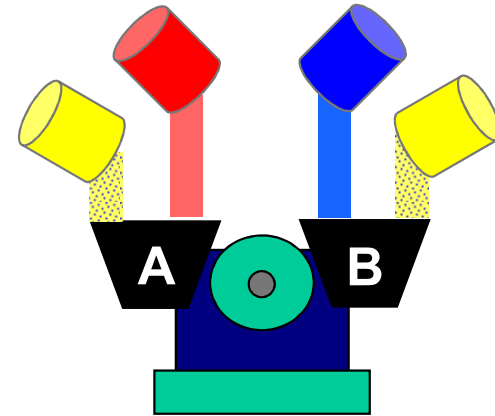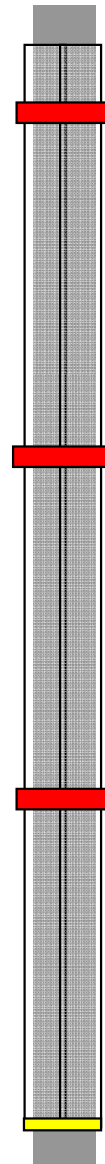- Seams are riveted in place

- Temporary bracing is installed

- Bottom of Jacket is sealed w/ epoxy coated backer rod

Temporary Bracing

Epoxy Seal
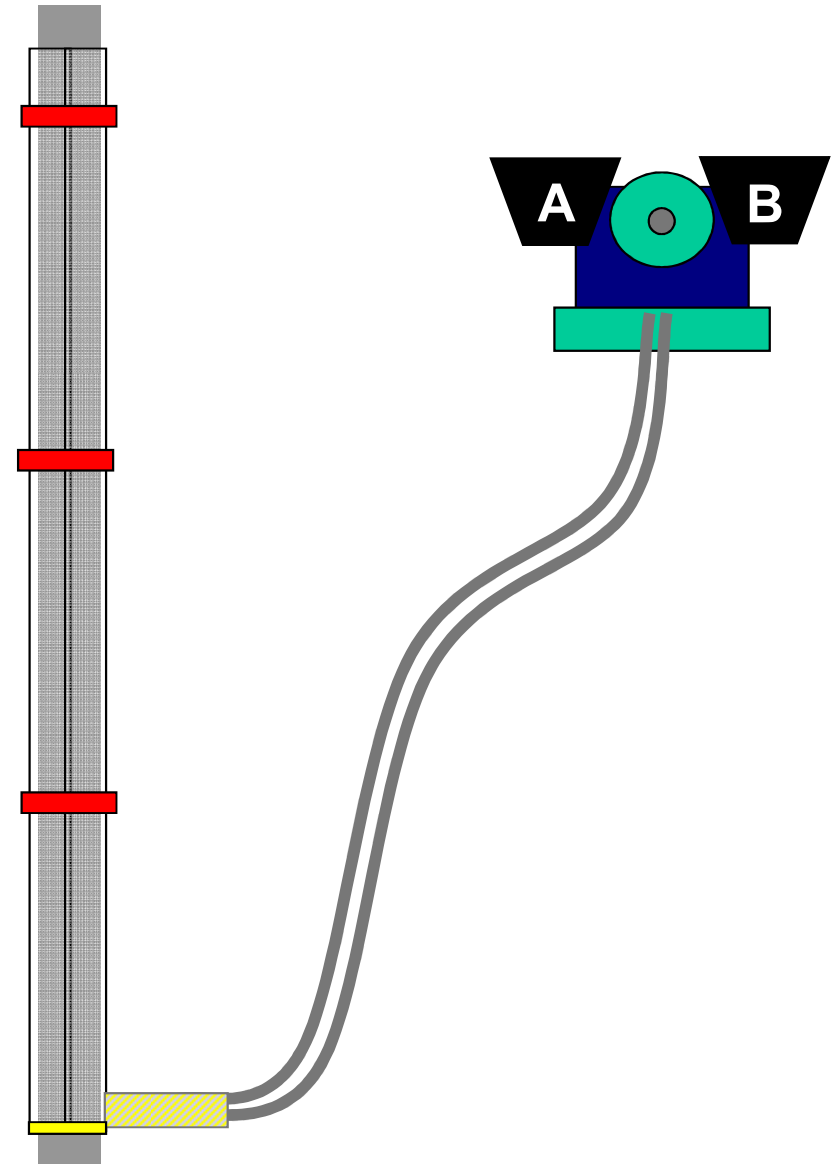
Encapsulation Process

Step 4

Each component of a two-component marine grade epoxy is mixed with sand

Encapsulation Process

Step 5
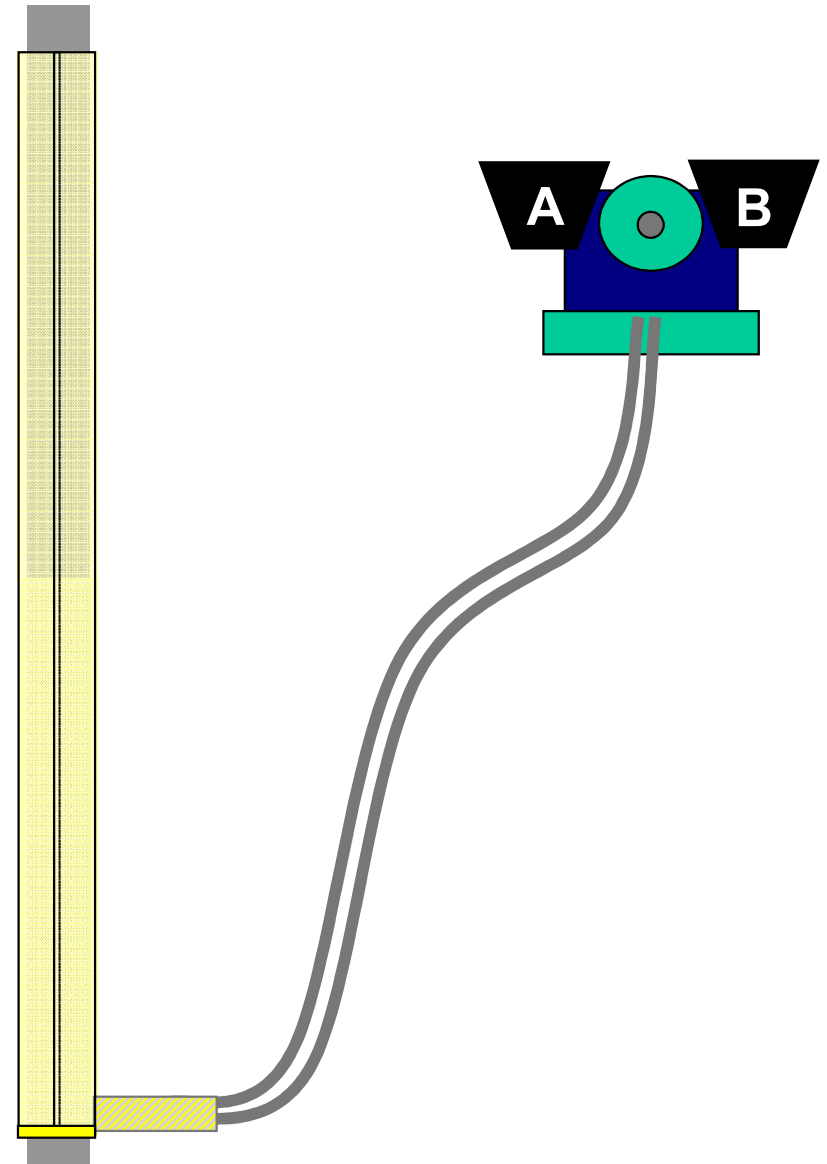
- Grout plant is attached to injection port in fiberglass jacket

- Dual-umbilical hose w/ static mixer at injection site

Encapsulation Process

Step 6

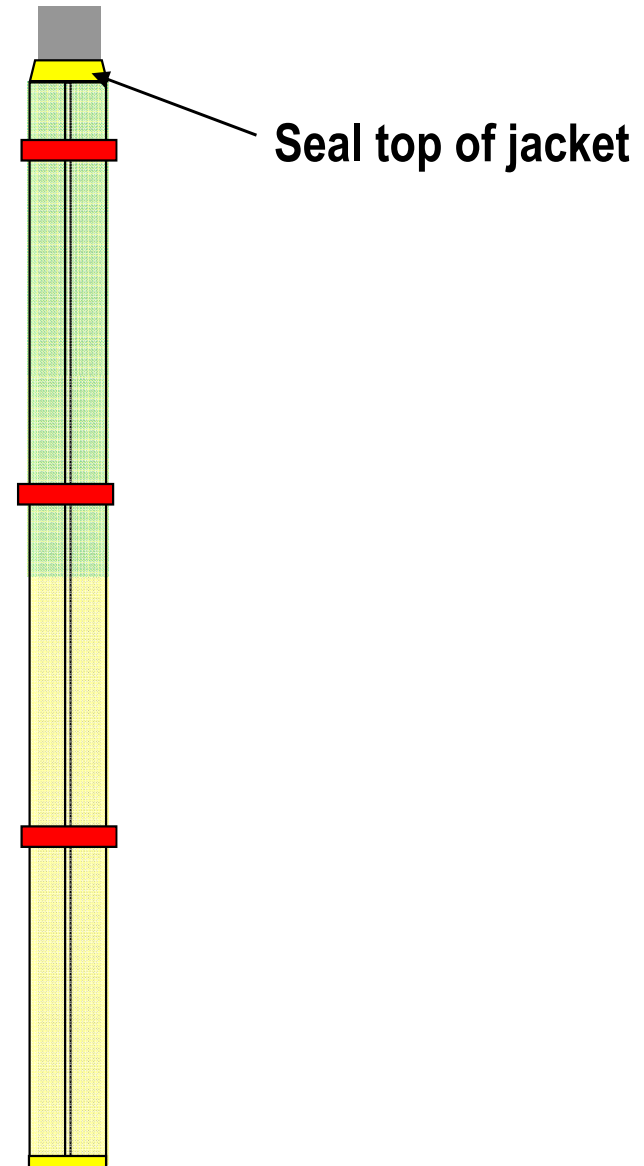- Epoxy grout is pumped into annulus

- Water in the annulus is displaced and expunged out of the top of the jacket

Encapsulation Process

Step 7

- Top of jacket is sealed with epoxy

- Bracing is removed

Seal top of jacket

Encapsulation Process

Encapsulation is
complete!
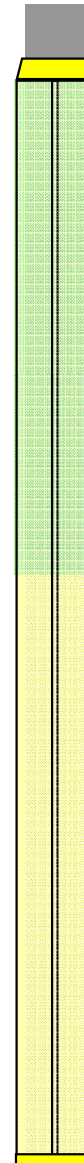
Complete Encapsulation

FRP Jacket

Epoxy Grout Infill

Complete Coverage of Grout

Well Bonded to the Pile

Complete Encapsulation

Epoxy Grout is pumped under pressure

Grout penetrates into cracks and voids in the substrate

Purpose Designed FRP Jackets

- Appropriately sized FRP Jackets Delivered to Site

- Polymer Stand-offs

- Seam adhesive applied on deck

Epoxy Grout Infill Properly Placed

- Grout is pumped into the annulus from the bottom up

- Grout progress is monitored

Epoxy Grout Infill Properly Placed

- Plural component grout plant

- Part A & Part B mixed with sand in each hopper

Epoxy Grout Infill Properly Placed

- Downstream mixer

Epoxy Grout Infill Properly Placed

- Fluid sand-filled epoxy grout is dispensed out of the mixer

Lake Pontchartrain Causeway, New Orleans, Louisiana

Pile Encapsulation

- Started in 1988 – still ongoing

- 26 mile long bridge

- 54" diameter concrete cylinder piles

Lake Pontchartrain Causeway, New Orleans, Louisiana

Pile Encapsulation

- Encapsulations soon after completion in 1989

Lake Pontchartrain Causeway, New Orleans, Louisiana

Pile Encapsulation

- Encapsulations in 2002

Lake Pontchartrain Causeway, New Orleans, Louisiana

Coring 13-year old encapsulations

Lake Pontchartrain Causeway, New Orleans, Louisiana

Core sample

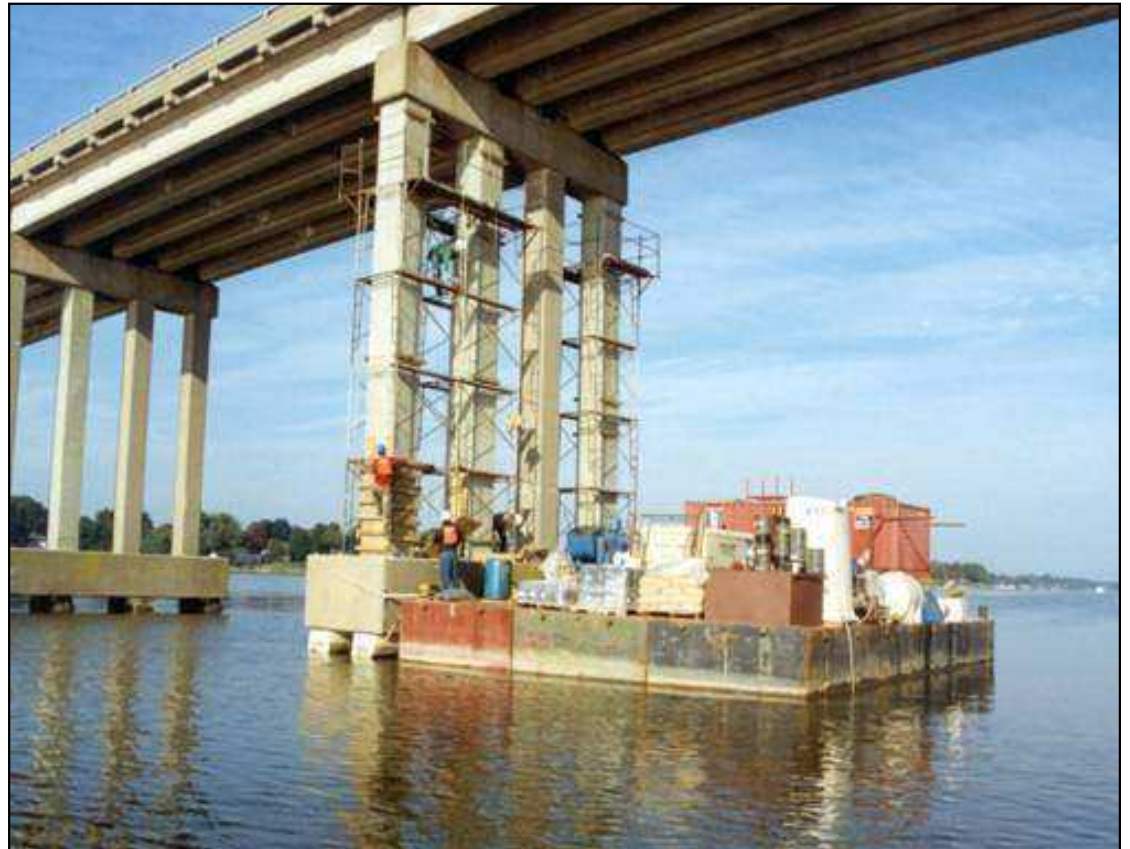# Lake Pontchartrain Causeway, New Orleans, Louisiana

Bond testing 13-year old encapsulations

Rappahannock River Bridge, Tappahannock, Virginia

1993

RC Piers Showing Corrosion and Spalling

Rappahannock River Bridge, Tappahannock, Virginia

1993

RC Piers Showing Corrosion and Spalling

Encapsulations all Above Water

Rappahannock River Bridge, Tappahannock, Virginia

Jackets placed over spalled areas

No patching was done

Rappahannock River Bridge, Tappahannock, Virginia

Completed Encapsulation

Stockton California Bridge

Encapsulation of
timber piles

Stockton California Bridge

FRP Jackets with adjustable standoffs

Stockton California Bridge

Encapsulated pile

Warren Road Bridge, Baltimore, Maryland

Deteriorated piers

- Large concrete pier

Warren Road Bridge, Baltimore, Maryland

Pier Encapsulation:

- Large concrete pier

- Jacket Fabrication

Warren Road Bridge, Baltimore, Maryland

Pier Encapsulation:

- Large concrete pier

Thank You!

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