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
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 between 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
Encapsulation Process

**Step 3**

- Seams are riveted in place
- Temporary bracing is installed
- Bottom of Jacket is sealed with epoxy coated backer rod
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
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
Pier Encapsulation:
- Large concrete pier
- Jacket Fabrication
Warren Road Bridge, Baltimore, Maryland

Pier Encapsulation:
- Large concrete pier
Thank You!

Presented by:
William J. Gold, P.E.
Engineering Services Manager
BASF Corporation
23700 Chagrin Boulevard
Cleveland, OH 44122
Phone: (216) 839-7408
Fax: (216) 839-8822
e-mail: will.gold@basf.com