

**HUB FOUNDATION**

**PENETRATES SLURRY WALL MARKET WITH BAUER EQUIPMENT**

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# PILEBUCK

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# DREDGING

**AND DREDGED MATERIAL DISPOSAL**

**PLUS**

**DRILLED SHAFTS**

Concrete Placement and Design

**HONG KONG HOUSING PROJECT**

3 Liebherr Cranes Used for Foundation Work

**COMPACTION GROUTING**

CGS Stabilizes Sinkhole-Prone Site

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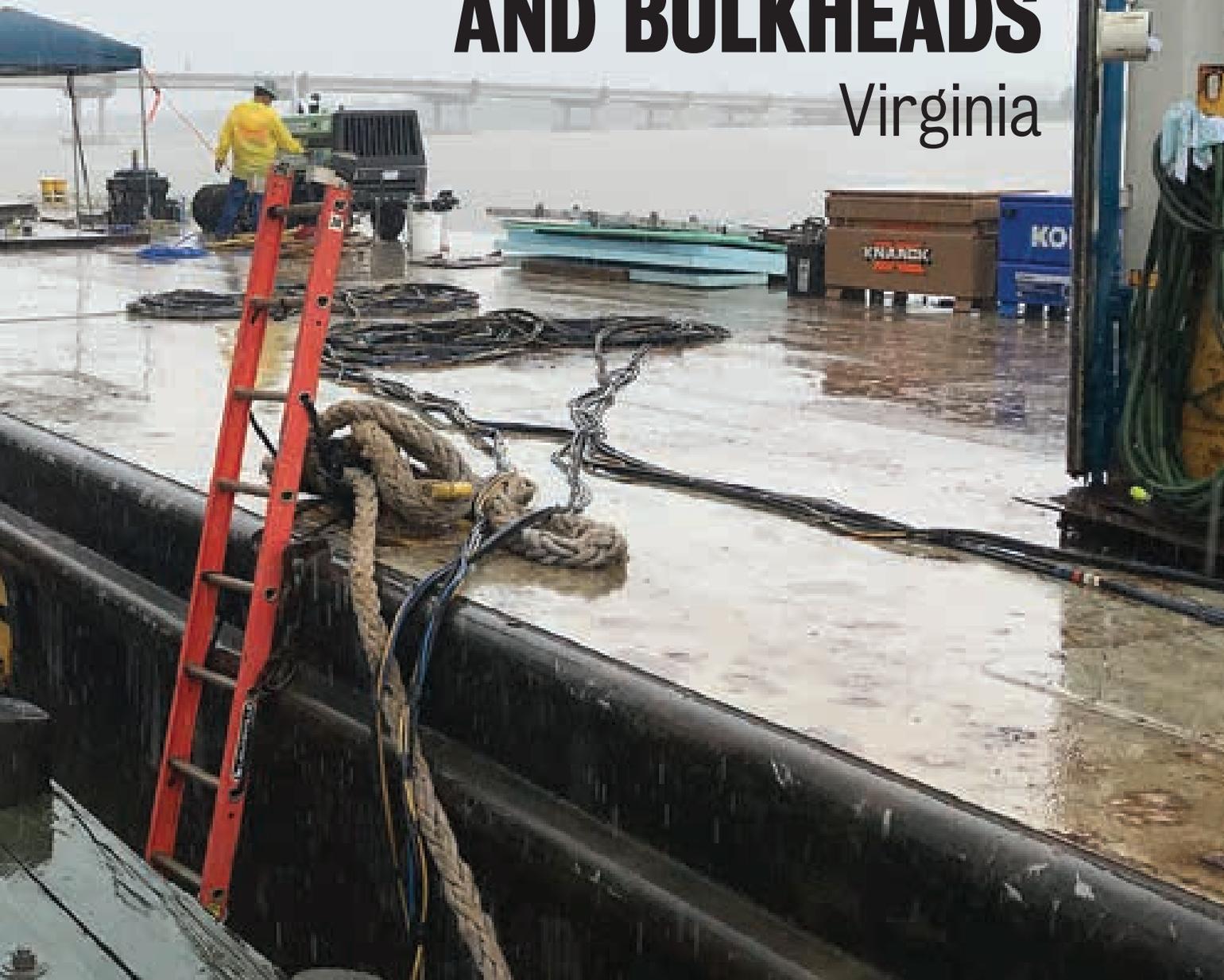
The SPiRe® sheet pile repair system replaces a corroded steel bulkhead at an industrial plant in Virginia. Photo courtesy QuakeWrap Inc./FRP Construction.



By Prof. Mo Ehsani, PhD, PE, SE

# COMPOSITES SOLVE CORROSION ISSUES FOR SHEET PILES AND BULKHEADS

Virginia



**S**heet piles and bulkheads constitute a major part of the U.S. waterfront infrastructure that extends far beyond ports and harbors. After many years of service, the dry wet cycle in the splash zone of these protective, shallow water structures results in deterioration and loss of structural capacity for sea walls and industrial bulkheads.

Few cost-effective repair options are available, and our interaction with the commercial ports industry indicates that there is great interest for a solution to this ever-growing marine infrastructure and potentially environmental problem.

The compromise of this critical component of infrastructure gets little mention in national dialog, but is of equal or greater importance to U.S. commerce and transportation.

## **BULKHEADS WITH WATERLINES REPAIRED**

One example of this type of wear and tear often happens at industrial plants. Industrial plants located near a commercial waterway will typically use a retention pond or designated area to keep chemicals separated from nearby rivers or channels. These bulkheads have been traditionally constructed using steel sheet piles at lengths from a few hundred feet to the thousands. Water lines running along these walls — including the splash zones — can also vary from a few feet to dozens of feet.

Our company has a newly-developed, patent-pending composite system that can



Engineered SPIRe® FRP panels repair a waterfront industrial bulkhead. The sheet pile replacement system forms a corrosion-halting barrier between the plant and the open water. Photo courtesy QuakeWrap Inc./FRP Construction.

## BULKHEAD REPAIR FAST FACTS

**Original bulkhead construction:**

PZ-35 or Frodingham 4N steel sheet piles

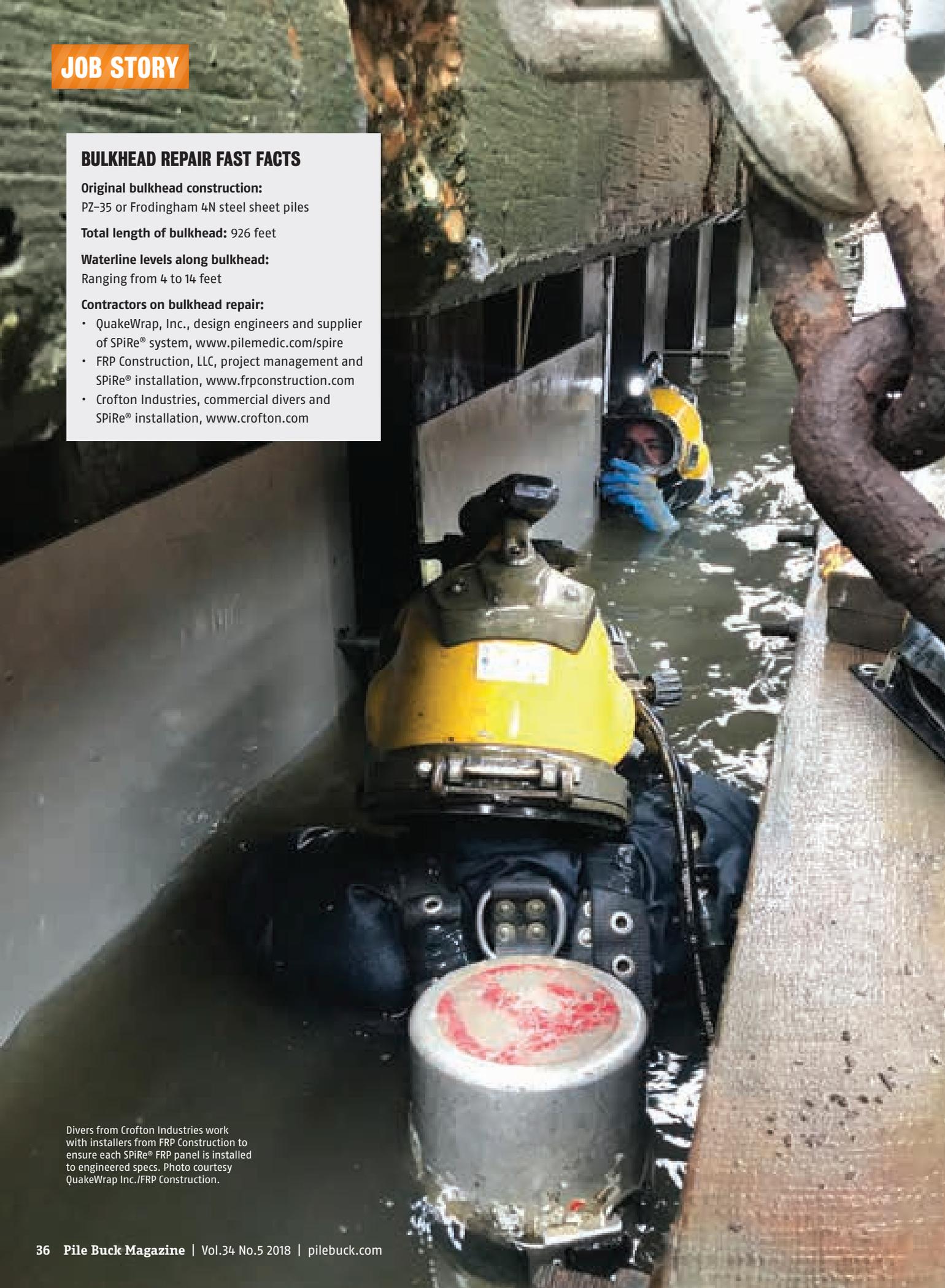
**Total length of bulkhead:** 926 feet

**Waterline levels along bulkhead:**

Ranging from 4 to 14 feet

**Contractors on bulkhead repair:**

- QuakeWrap, Inc., design engineers and supplier of SPiRe® system, [www.pilemedic.com/spire](http://www.pilemedic.com/spire)
- FRP Construction, LLC, project management and SPiRe® installation, [www.frpconstruction.com](http://www.frpconstruction.com)
- Crofton Industries, commercial divers and SPiRe® installation, [www.crofton.com](http://www.crofton.com)



Divers from Crofton Industries work with installers from FRP Construction to ensure each SPiRe® FRP panel is installed to engineered specs. Photo courtesy QuakeWrap Inc./FRP Construction.



Crofton Industries diver maneuvers the composite, impermeable SPiRe FRP panel into place. Divers working directly with installers from FRP Construction to ensure each SPiRe® panel is installed to design specs. Photo courtesy QuakeWrap Inc./FRP Construction.

be used to repair these critical structures. The system is lightweight, highly corrosion resistant, and is installed onsite with minimal service interruption to plant operations.

## **SHEET PILE REPAIR USING FRP**

The new sheet pile repair system, called SPiRe®, consists of engineered panels made with fiber reinforced polymer (FRP) products. A 1/4-inch thick core material is sandwiched between various layers of uniaxial or biaxial glass or carbon fabric saturated with resin to create a rigid panel. The panels are four feet wide and their length varies depending on the location of installation.

The panels are custom-built at the manufacturer's facility in Tucson, Ariz.,

and shipped to the jobsite. In the field, the edges of the panels are epoxied together to create an FRP wall of desired height and length. The bottom of the panels extend a minimum of six inches below the mudline. The panels are also secured to the steel sheet piles using steel J-bolts. Reinforcing cages made with glass FRP bars were placed within the annular space between the SPiRe® panels and the steel bulkhead before the annular space was filled with concrete.

## **CORROSION-RESISTANT BARRIER**

The SPiRe® system serves as a durable, chemical resistant, stay-in-place form that prevents leakage of chemicals from the containment area or retention pond into

# JOB STORY

the river. The SPiRe® wall itself is made of non-corroding FRP materials. Furthermore, these impervious layers prevent moisture and oxygen from coming in contact with the existing sheet piles and the newly cast concrete. Since oxygen is the fuel to the corrosion process, this design significantly reduces the future corrosion rate of the structure, providing a long-lasting repair and many years of maintenance-free service.

## FRP ENGINEERING, FIELD APPLIED

This patent-pending system was first developed by structural FRP pioneer and Civil Engineering Professor Emeritus Dr. Mo Ehsani.

## THIS PATENT-PENDING SYSTEM WAS FIRST DEVELOPED BY STRUCTURAL FRP PIONEER AND CIVIL ENGINEERING PROFESSOR EMERITUS DR. MO EHSANI.

Both the design and construction of the FRP panels — and their installation in the field — offer numerous challenges.

Sample wall panels need to be constructed and tested to ensure that they meet the design strength and stiffness requirements. These tests were first completed at the QuakeWrap Inc. headquarters, then conducted again by the diving subcontractor, Portsmouth, Va.-based Crofton Industries. Crofton assembled mock-up

installations directly on their property to calculate productivity rates and to ensure that no surprises occur during installation in the field.

David Mrowiec, P.E., principal engineer at Crofton Industries, shared that “as a result of the field mock ups, we were able to collaborate with FRP Construction to develop an innovative custom diver tooling which ultimately increased production rates.”

Thanks to the design,

engineering and precautions exercised by the on-site installation crew of FRP Construction, LLC, and Crofton Industries, the project is nearly complete for 2018 and there is already growing interest from others seeking a similar solution.

This attests to the timeliness of the solution, and the industry’s need for economical techniques that address an oft-forgotten major infrastructure renewal concern, our intercoastal waterways. ■