Pile Repair Sleeves for Challenging Substructure Repairs

As the Hudson River becomes cleaner, wood-boring marine worms have returned to erode timber piles.

A cleaner Hudson River is in everyone's best interest; just not the piles supporting the New York City Passenger Ship Terminal (PST) at the Port of New York. In recent years the pollution-laden waters of the Hudson have become cleaner, which has invited the return of wood-boring marine worms that have infiltrated and eroded the timber piles of the PST's three finger piers, each about 1,000-ft long and 125-ft wide.

As part of the New York City Economic Development Corporation's $50-million PST improvement plan, one segment of a master plan to advance the city's $20-billion-plus tourism industry and accommodate the growing cruise segment, stabilizing the facilities' infrastructure and restoring its structural integrity was essential to the world-class terminals' trade and transport capabilities. As severe structural infrastructure deterioration caused by corrosion exists in concrete, steel, and wood all over the world, finding restoration versus replacement solutions is vital to economic growth and stability. Each year nearly one million passengers pass through the PST, located a few blocks west of Times Square in the heart of Manhattan. Finding the best pile restoration solution versus replacing the PST's deteriorating piles (which would mean an extremely costly, extended shutdown) was the project's goal.

Source Selection

Bidding and selection of the project's partners was done to ensure cost-efficiency/quality mix optimization for the two-phase PST pile job. An FRP (fiber-glass reinforced plastic) pile encapsulation system was chosen as the project's pile restoration/protection solution. The encapsulation system is comprised of a molded FRP jacket, epoxy grout, and aggregate mix. In Phase I, divers abrade and clean each pile. In Phase II, jackets are placed around each pile. Epoxy grout and aggregate mix is then pumped by the divers from the bottom up, displacing the seawater. The aggregate mix enhances the bond as it scours the substrate further. Durable in seawater, lightweight, and relatively easy to install, the FRP jackets then provide maintenance free protection for long periods of time.

To solve the marine worm problem, an FRP pile encapsulation system was selected.

Phase II of the project was awarded to Trevcon Construction Company, Inc. (www.trevcon.com), which had extensive marine construction experience and knowledge of underwater environments. In Phase II Trevcon evaluated the condition of the pilings and decided to experiment with different epoxies and pile sleeves to maximize savings, assembly time, and seam strength.

MFG Construction Products Company (www.mfgcp.com) was select-

New York City's Passenger Ship Terminal timber piles are being attacked by wood-boring marine worms.

FRP sleeves come with a slip-joint closure to make underwater assembly easier.

ed as the FRP pile sleeve source because the company provided a single tube solution, which meant less assembly time and a single seam that was stronger. The pile sleeve also offered a more flexible, peal-away liner design seam and a resin bond finish to the jacket that eliminated the need to sand-blast for chemical adhesion to work in conjunction with the epoxy selected for the project.

According to Trevcon president Ron Treveloni, "MFG was recommended and chosen based upon service and the fact that they could provide the required length and diameter of pile sleeves needed for the project; thus, avoiding costly custom-built sleeves." Additionally, Treveloni noted, "The MFG jackets' rough finish also strengthened the bonding epoxy, which was supplied by Sika Corporation (www.sika.com), to the shell."

After testing concrete epoxy solutions, which were too heavy and would result in unnecessary weight added to the piers, Sika devised an epoxy resin solution. In combination with the sleeve design, the solution provided a smaller annulus (space between existing pile and the interior of the jacket) at a weight that was lighter than the cement filler.

Pile Sleeve Solution

To help restore the structural integrity to the deteriorating piles, MFG provided its one-piece FRP pile repair sleeve. Designed to leave in place, the sleeves are chemically resistant to acids, alkalis, and most solvents, thus providing long-lasting, reliable protection.

Made from chop strand mat and woven roving, the two materials provide better physical properties so the jackets meet or exceed specifications versus gun-roving/chopper gun applied, which is not as strong. This result is resistance to abrasion and impact when concrete or grout is properly placed in the form.

For underwater assembly, the sleeves offer a slip joint closure that makes divers' jobs easier. Standard diameters are available in 12-in to 36-in., and custom sizes can be accommodated. Lengths are produced to specifications and ultraviolet resistance accommodations are available.

Combined with the correct epoxy bond, the sleeves are able to refurbish the existing timber piles and strengthen them to their original strength or better. The sleeves can also be used on steel or concrete piles. In addition to replacement savings, sleeve installation did not require shut downs of the terminal.

Epoxy Solution

SIKA utilized its Sikadur 35, Hi-Mod LV/LTL, which is a two-component 100 percent solids, moisture-tolerant, low-viscosity, high-strength, multi-purpose epoxy resin adhesive. Conforming to the current ASTMC-881 and AASHTOM-235 specifications, the epoxy is an aliphatic amine blend offering low viscosity-long pot life, which increases the materials working time. Bob Wallace, Sika's senior project sales manager, noted that "This was essential since the pre-blended mixture was entered hot into a single pump/hose (versus individual A/B lines), thus lessening the divers reaction/working time with the material."

Conclusion

According to Trevcon Project Manager Dennis Mullins, "Not only did MFG provide pile jackets that met the standard criteria for the project, they responded quickly to field modifications that needed to be made based on the pumping applications required by the divers after pile cleaning and measurement analysis of the diameter of the annular space with relation to the Sika epoxy infusion. MFG made these modifications to achieve the maximum savings on each pile filled."

MFG also provided a prototype sleeve that was tested by Trevcon divers. According to Jim Williams, MFG Construction Products' plant manager/project leader, "After the test they requested a design change: increase dimension by 1/4 in. between the tongue and grove. The additional space was needed because of the limited sight issues posed by the Hudson River during installation."

After MFG modified its design, a total of 1,500 to 2,000 jackets were produced for the project, which began in 2004 and is scheduled to be completed by the end of 2006.

Finally, Treveloni noted that the encapsulation partners shared a combined goal to run seamless construction operations while active shipping was taking place, "Making this more vital was the fact that the first pier construction began approximately one month after the events of 9/11 and was the housing center of the Joint Task Force Offices; including those of Rudi Guilliani, then mayor of New York City. Additionally, the second pier was set up as a control strategy center for FEMA and therefore security considerations around the construction sites had to be made to ensure seamless construction." GE

Refurbished wooden piles are now returned to their original strength or better.