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MaineDOT

Transportation Research Division

Construction Report 17-10

Underwater Fiber Reinforced Polymer (FRP) Wrap Experimental Project

1/30/18

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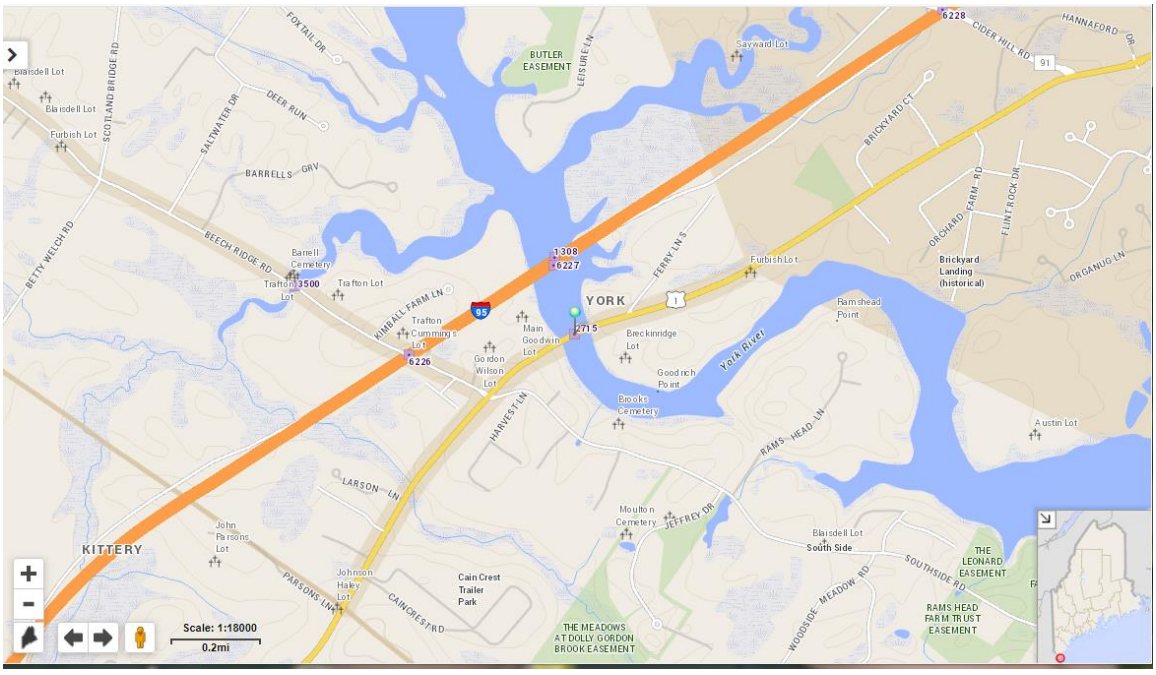
Introduction

In 2017, The Maine Department of Transportation in collaboration with the Kenway Corporation and Construction Divers Inc.(CDI), completed a rehabilitation project on the Rices Bridge (#2715) over the York River in York, Maine. The project was to address the premature failure, after only 12 years, of the fusion bonded epoxy protective coatings on the exterior pier piles of the bridge, the primary layer to deter corrosion (figures 1). Rices Bridge in York is one of over 30 bridges in the Maine Department of Transportation (MaineDOT) inventory that use pipe piles in their substructure. The problem is not exclusive to this bridge as many of this type are experiencing the same premature failure of the fusion-bonded epoxy coating (FBE).

Project Location

Rices Bridge (#2715) over the York River

York, Maine



Project Scope

The goal of the project was to gather data and information to assist the Department in making an objective decision regarding the performance and viability of the underwater FRP wrap system. The analysis of the construction aspects of the project will include the debris containment system, ease of construction underwater and time to construct. Performance will involve measuring the durability, bond force, and water intrusion. With the intent to use the data gained from this project to facilitate the development of a draft design guidance and specifications for FRP wraps.

Cost Considerations

The monetary cost of the experimental product was considerably lower when compared to the cost of the traditional technologies such as FRP/HDPE (high density polyethylene) shell and grout cement repair. Traditional technologies cost approximately $\$140/ft^2$ while the cost of the FRP wrap was significantly less at approximately $\$60/ ft^2$. These figures do not include the repairs to the current FBE coating that needs to be repaired anytime it is hit with ice or other waterborne hazard impacts. The environmental costs of the wrap were significantly less than the FRP/HDPE as there were no piles to drive or cofferdams and no potential concrete seepage from the incomplete sealing of the shell. The FRP wrap process did not include either of these environmental risks/costs.

Materials

Partnering with Kenway Corporation the material selected for the project was DowAska CarbonBond™ 300-UW, a two-ply system with a UV protective additive which has been used by the petroleum industry for underwater pipe repairs. The material requires a minimal cure time of 14 days at 50°F during which time it was wrapped with plastic and tape to hold the plastic in place. This process also required removal of only the loose debris for proper adhesion and divers and barges for installation.

Construction

Representatives from Kenway Corporation, Construction Divers of Westbrook, Me. and MaineDOT personnel worked in collaboration on this project. Mock-ups on a small scale were done prior to starting the project to ensure that materials performed as expected (figure 2). Wireless RFID sensors were installed on the mock up and on the final project. The wrap

installation procedure caused the wrap to force resin in to the sensor rendering it inoperable. Further testing with different metrology is needed to fully test the wireless moisture sensor system. In cooperation with The University of Maine, custom load cells were used during the mock-up to measure the confinement pressures during curing as part of a larger study to assess constructability and performance of wrap systems for bridge repair (see Appendix A).

Construction started with setting up barges to serve as work areas and environmental containment (figures 3 & 4). A boat was also needed to get back and forth to the barges and serve as a rescue boat, should the need arise.

Removal of the flaking, loose debris and organics on the piles was necessary to achieve proper adhesion between the wrap and the piles. Kenway worked on the removal above the water line while the divers worked below the waterline (figures 5 & 6). Kenway was on hand to give guidance on what and how much needed to be removed (figures 7 & 8: before & after removal).

Preparing the wrap could be done on site and on the barges, this was a significant decrease in prep time compared to traditional methods. Kenway representatives used their expertise to work in conjunction with the divers to assure the wrap was properly prepared (figures 9 & 10). To accommodate the tides, some of the work had to be done early in the morning or into the later hours of the day as evidenced in some of the figures.

Each piece of wrap was applied as soon as they were prepared. This was done in pairs to handing the wrap back and forth around the pile. This was done in the same way as the removal process with the divers handling the application in the water (figures 11-14). The pieces of FRP wrap were overlapped approximately 4 – 6 inches and smoothed out as they were applied (figures 15 & 16). As FRP wrap pieces were added the previous ones were wrapped in plastic wrap for curing (figures 17 & 18) and held in place with a 3M™ black duct tape that works underwater as well as in air.

Figures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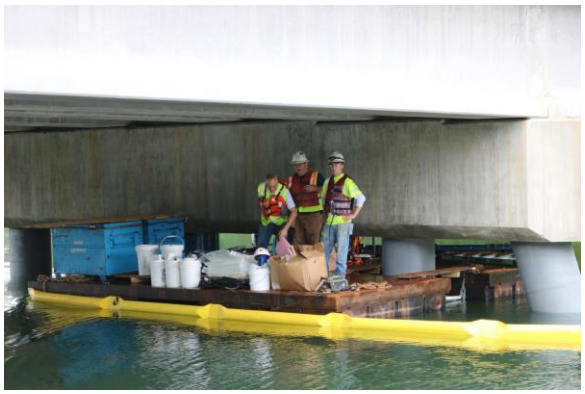
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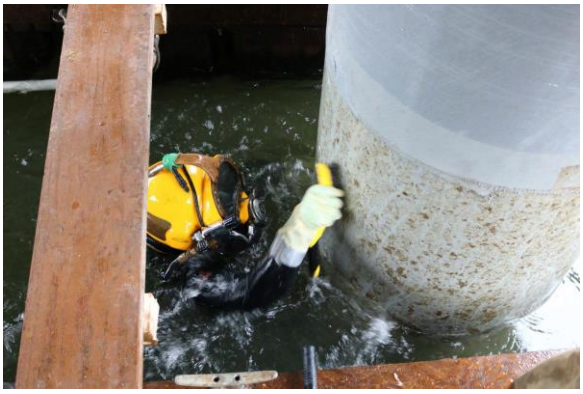
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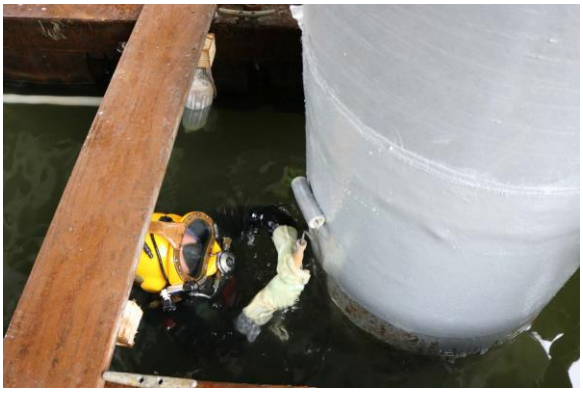

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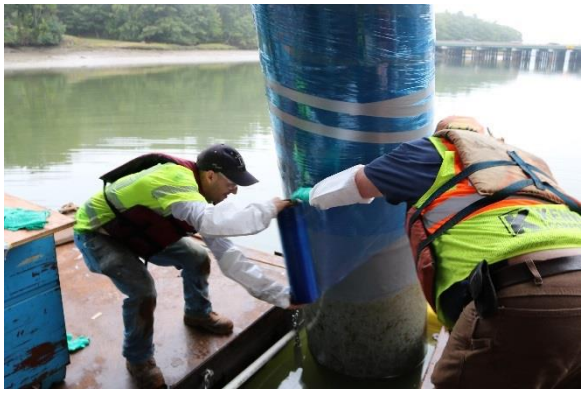

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Conclusions

Once the preliminary research was completed, the project took 15 days to complete the 14 piles identified for repair (figures 19 & 20: before & after application). The curing times were significantly less than the 14 days due to the higher water and ambient temperatures. All those involved agreed that it was an easier installation when compared to traditional repair methods. There was less chance of environmental impacts from the process and the containment was easily installed although, the currents in the area did impact positioning of the containment at time. The project used the tides to their advantage as much as possible working up or down the piles with the tides. These advantages, in combination with the significant cost savings, has led MaineDOT to use this on other bridges throughout the State. All projects will be inspected on a regular basis to assess the viability of the FRP wrap as a long-term solution to the premature failure of the FBE coatings on bridge piles.

Special Thanks

We would like to everyone who worked on this project and contributed to its success.

We would like to give a special thank you to the following people for their contributions to this project:

Joseph Stilwell – MaineDOT Project Manager

Kenway Corporation – John Rand & Alex Thibodeau

Construction Divers – Westbrook Maine

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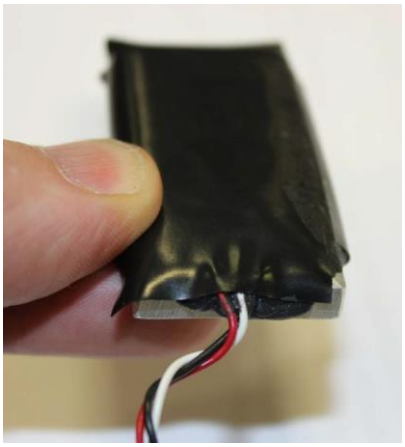
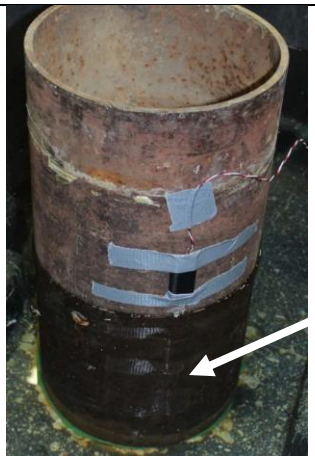
Appendix A



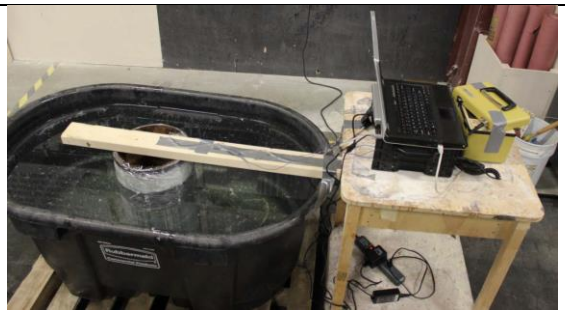
Custom load-cell



Load-cell location

Teflon Sheet

Installation of FRP Wrap



Mock-up after installation complete with thermocouples to monitor temperatures and load-cell

Instrumented mock-up after starting the data acquisition.