Florida Department of Transportation Research

Epoxy Dowel Pile Splice Evaluation

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Current Situation

Because of Florida's varied soils, establishing bridge foundation pile lengths can be difficult. Many times, piles must be driven very deep to secure them. Because there are limits on the length of piles that can be shipped to a work site, pile segments are usually connected onsite using dowels to make them longer.

To connect pile segments, holes are cast or drilled into the top of the lower pile segment to receive dowel rebars protruding from the upper segment. However, traditional steel dowel materials are prone to corrosion, especially in a marine environment.

Research has been done to test the strength of a more cost effective material for dowels. Here, Glass Fiber-Reinforced Polymer dowels are being tested.

For extremely aggressive environments, FDOT specifies dowel materials that resist corrosion (stainless-steel and carbon fiber-reinforced polymer), but they can be expensive and difficult to procure. Glass fiber-reinforced polymer (GFRP) reinforcing bars have been proposed as an alternate dowel bar material. However, at the time of this study, no design framework had been developed for GFRP dowel connections in prestressed-precast concrete pile (PPCP) splices.

Research Objectives

The objective of this study was to investigate the effectiveness of GFRP dowels for PPCPs as an economical alternative to carbon FRP and stainless-steel dowels. The study also sought to develop a design procedure and tool to allow engineers to design pile splices of different materials with various sizes and configurations.

Project Activities

After a literature review, the Florida International University research team used existing guidelines to develop a design procedure, details for GFRP epoxy dowel splices, design drawings for the recommended details, and recommended refinements to current designs. The team then developed designs for a series of 10 test specimens using various combinations of dowel and strand types for validation. The 10 full-scale PPCP specimens were constructed, spliced, and tested in flexure to verify the newly developed procedures and details.

The team then developed a Mathcad design tool using the validated design procedures that can be used for designing future variations of pile and splice systems. This design tool was used to design GFRP dowel splices for all FDOT standard square cross-section pile sizes.

Project Conclusions and Benefits

The team successfully developed designs for GFRP dowel splices of all standard square pile sizes to be considered for FDOT standards. Given the relatively low stiffness of GFRP reinforcing bars and conservative AASHTO design parameters for GFRP reinforcing, these splice designs are not able to meet the full strength of current FDOT standard pile splices but could be used in less structurally demanding locations. The team also recommended several methods to improve performance of epoxy-bonded dowel splices based on eight aspects of design, material, and implementation. These recommendations can help reduce cracking and other failures in pile splices as well as create control for variables during splicing that can improve the quality and durability of the splices.

For more information, please see fdot.gov/research.