Florida Department of Transportation Research

Performance Evaluation of Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars Embedded in Concrete under Aggressive Environments

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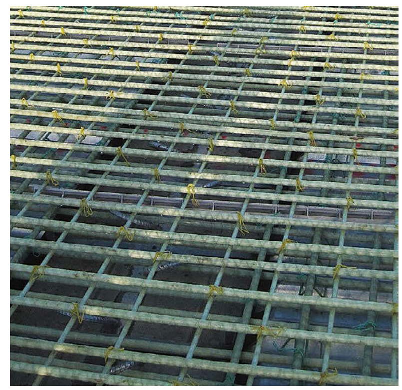
Project Manager
Chase Knight
FDOT Materials Office

Principal Investigators
Raphael Kampmann
Michelle Roddenberry
Florida State University

Current Situation

Many concrete structures in Florida are reinforced with steel bars. Combining concrete and steel produces extremely strong structures that would not be possible with concrete alone. However, in Florida's humid environments, moisture or salt can penetrate the concrete over a number of years and cause the steel to corrode. This can cause the concrete to crack or reduce the strength of the steel, weakening the structure. Regular inspection prevents this situation from leading to structural failure, but annual maintenance and repair costs are significant across the many structures for which the Florida Department of Transportation (FDOT) is responsible.

It is possible to use glass-fiber-reinforced polymer (GFRP) reinforcing bars instead of steel in concrete construction. GFRP does not corrode. The critical question is whether GFRP performs as well as steel over time.



Tied grids of GFRP rebar prior to concrete pouring at the Halls River Bridge, Homosassa Springs, FL.

Research Objectives

Florida State University researchers reviewed current GFRP technologies and tested GFRP products in order to provide additional guidance for integrating GFRP technology into existing design guidelines.

Project Activities

The researchers developed extensive background information about GFRP rebar technology, describing raw materials, production processes, and various properties of composite material. They reviewed studies that evaluated the strength and durability behavior of GFRP bars and conducted a market analysis of worldwide production and use of GFRP bars.

GFRP bar samples were obtained in three thicknesses from each of three manufacturers. The bars varied in shape and surface characteristics. They were subjected to a variety of conditions designed to simulate different periods of exposure to salt water. Three temperatures, 74°F, 104°F, and 140°F, were used for each of the four exposure periods, 60, 120, 210, and 360 days.

After exposure, the bars were examined microscopically, by physical measurement and by weight. They were also subjected to strength testing, including transverse and horizontal shear, tensile strength, the strength of their bond to concrete, and others. Data from these measurements were used with computer models to estimate the long-term durability of the bars in aggressive environments. Models were based on chemical reaction and degradation models with the goal of developing predictions of long-term behavior based on the measured strength values.

Based on this wide-ranging study of GFRP reinforcement, the researchers provided many detailed observations and recommendations, including recommendations for testing protocols that will yield better predictions of long-term GFRP performancee.

Project Benefits

Methods that allow designers to use GFRP reinforcement with more confidence about their appropriate application and long-term performance will increase the benefits of GFRP use: reduced maintenance and increased service life – to structures in the FDOT inventory.

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