Florida Department of Transportation Research

BFRP Rebar Characterization and Performance

August 2023

Project Number
BE694

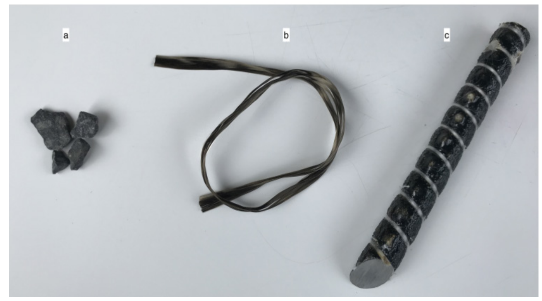
Project Manager
Steven Nolan, P.E.
Structures Design Office

Principal Investigator
Raphael Kampmann, Ph.D.
Florida Agricultural and Mechanical University-Florida State University

Current Situation

Florida is a state with the long inhabited coastal shoreline in the North America which exposes bridge infrastructure extremely aggressive environments—including acidic and marine waters. This exposure causes conventional steel reinforcement to corrode prematurely, resulting in early structural deterioration, which may cause large financial liabilities for maintenance and potential tragedy for the public in the case of a bridge collapse.

Reinforcing bars (rebars) made from fiber-reinforced polymers (FRP) were developed to eliminate this type of corrosion. FRP rebar can be made of different fiber types; the most common and economical in the U.S. is glass fiber. However, continuous basalt fibers (CBF) are a viable alternative to glass fibers and currently used to produce basalt fiber-reinforced polymers (BFRP) in rebar in several countries. Various types of BFRP rebars with dissimilar sizes, strength, and physical properties, are used for civil engineering construction, which is best for use by the Florida Department of Transportation (FDOT)?



In a recent study, an FDOT research team evaluated basalt fiber reinforced polymers (BFRP) to be used in bridge infrastructure. Pictured l-r: basalt rock, basalt fiber, and BFRP.

At the time of this project, these BFRP rebars were not considered under the FDOT Specifications Section 932 and there were no nationally accepted standards available for design and manufacturing guidance, despite the possible benefits they could realize.

Research Objectives

This research was conducted to evaluate the performance of three commercially available BFRP rebar products, before and after exposure to nine different aggressive environments, to develop acceptance criteria specifically for basalt-based fiber-reinforced polymer (BFRP) reinforcing bars.

Project Activities

After a literature review, the Florida A&M University-Florida State University research team tested representative and commonly available BRFP rebars to evaluate five physical properties and four strength characteristics according to ASTM standards.

Rebars from three manufacturers, two different production lots, and two commonly used sizes were included in the study. Because acceptance criteria for basalt FRP rebars are not well established in the U.S., the findings were compared to the prevalent minimum criteria for glass FRP rebars to evaluate performance. The team also developed a long-term strength prediction model for FRP bars, regardless of exposure environment, which took into account new degradation terms.

Finally, the team proposed an interim approach for acceptance of BFRP reinforcing using the current environmental exposure factor in design, and a modified Alkaline Resistance test.

Project Conclusions and Benefits

BFRP rebar is stronger and more durable than the minimum criteria set for GFRP bars and appears to be a viable alternative as a non-corrosive rebar option. They should be considered for FDOT Specification 932.

In addition to the recommended acceptance criteria proposed, more critical BFRP-specific performance criteria can be developed in future projects to further differentiate the various fiber types and to take full advantage of the available material characteristics.

Since completion of testing for this project, national standards for manufacturing of basalt fiber and straight BFRP rebars have been adopted by ASTM with similar criteria as recommended by the research team. These specifications are published under ASTM D8448-22 and D8505-23 respectively, but do not include the addition of high concentration chlorides or saltwater to the Alkaline Resistance test. This accelerated durability evaluation test along with increasing endurance design limits for sustained and fatigue loads, remain outstanding topics of discussion and further research need.

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