Florida Department of Transportation Research

Degradation Assessment of Internal Continuous Reinforcement in Concrete Environment
BDK82-977-05

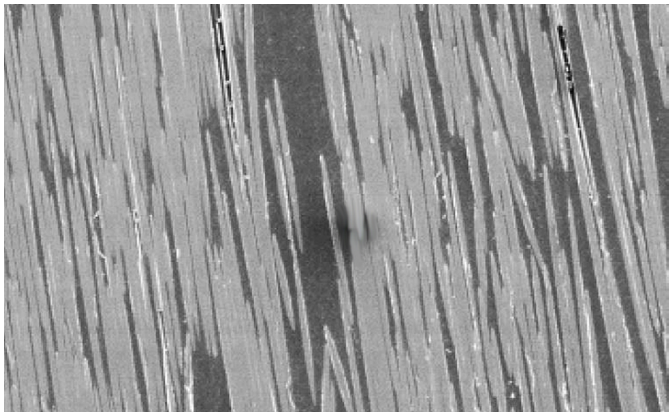
The use of continuous basalt, glass, and carbon fiber reinforcement in concrete structural applications seems to be promising for reinforcing new concrete structures and strengthening existing structures. Fiber-reinforced polymer (FRP) bars are starting to replace conventional steel bars due to their resistance to corrosion in many applications, such as bridge decks.

In this project, researchers from the University of North Florida, the University of Sherbrooke (Quebec), and North Carolina State University studied three types of FRP bars in one or more applications: basalt-fiber-reinforced polymer (BFRP) reinforcing and prestressing bars; glass-fiber-reinforced polymer (GFRP) bars; and carbon-fiber prestressing bars. The researchers measured physical and mechanical properties, durability, and FRP-to-concrete bond strength.

For GFRP, the research team used sand-coated GFRP bars of low, standard, and high modulus in several sizes. For each of eight bar types, the researchers determined fiber content, transverse and longitudinal coefficient of thermal expansion, void content, water/moisture absorption, cure ratio, and glass transition temperature. Tensile properties of sand-coated GFRP bars rated 40 to 60 GPa were determined using a Baldwin testing machine. The same type of bars were tested for alkali resistance in high pH solutions.

The carbon FRP material investigated in this project was the CFCC 1X7 cable. Material of this type has found wide application in construction in Japan and Europe because of its strength, durability, resistance to corrosion, and versatility of fabrication. CFCC was tested for fiber content, water absorption, cure ratio, glass transition temperature, and long-term durability by alkaline conditioning up to 7,000 hr. CFCC was imaged with optical and scanning electron microscopy.

Because of its more recent introduction to the marketplace, BFRP has been researched less than



In this scanning electron micrograph of BFRP, the basalt fibers are the lighter colored objects in the darker polymer matrix.

the other FRP types for structural applications, so the BFRP test program was more extensive than for the other FRPs in the study. A variety of BFRP bars and concrete beams and slabs reinforced with the bars were also tested.

For BFRP prestressing and reinforcing bars, the researchers conducted physical characterization, scanning electronic microscopy, and tests for tensile properties, shear strength in high pH under load and without load, and other tests for different types of BFRP. The investigators tested concrete beams reinforced with BFRP rebar and investigated the bond-dependent coefficient. In addition, the research team investigated flexural behavior of slabs reinforced with BFRP. Predicted and experimental results, such as ultimate load, strains, and deflection, were compared.

The extensive test program in this project produced a significant amount of information. The detailed characterization of the FRP bars studied will promote their use in designs for new structures as well as rehabilitations. FRPs are valuable for reducing the weight of structures and for their durability and longevity, yielding structures that are more economical to build and need less maintenance over a longer service life.

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