Florida Department of Transportation Research

Durability of Fiber-Reinforced Concrete Pipe Exposed to Florida Aggressive Environments

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Current Situation

The addition of fiber to concrete can improve the strength of concrete, reduce cracking due to shrinkage while drying, and reduce the permeability of concrete. All of these improvements are desirable for concrete pipe, but the type of fiber and the amount to add for optimum performance are a matter of continuing research. This is especially true for dry-cast concrete, a method typically used for making concrete pipe in which the dry components of concrete are mixed with little or no water and then placed in molds. The molded concrete is then infused with water. Vibration causes compaction of the concrete. This method allows for more precise casting and rapid curing and unmolding.

Cast concrete pipe awaits installation at a Florida construction site.

Research Objectives

Florida Atlantic University researchers investigated the use of four synthetic fibers as reinforcement in dry-cast concrete.

Project Activities

Dry-cast concrete mixes were prepared with four synthetic fibers types: (1) a blend of polypropylene and polyethylene (51 mm long), (2) polyvinyl alcohol (30 mm), (3) polypropylene (50 mm), and (4) polypropylene (50 mm) treated to enhance the chemical bonding. The amount of fiber used in the mixes ranged from 9 to 15 lb/yd^3. Mixes were prepared with each of the four fibers, including two fibers at a higher amount, for a total of six mixes. The mixes were molded into two sizes of blocks from which samples – either cylindrical cores or square beams – were cut.

Samples cut from the cores and beams were exposed to various environments. Control samples that were exposed to high humidity for over a year were tested for properties related to the transport of ions, including surface resistivity, sorptivity, porosity, and non-steady state migration coefficients. Fiber presence did not seem to significantly affect the obtained values, compared to fiber-free concrete prepared in a previous project.

Beams, 1" to 3" thick slices, and core samples were subjected to five environmental exposures: (1) immersion in seawater with wet and dry cycles; (2) the same as 1, but at low pH; (3) immersion in the low salinity Intracoastal Waterway; (4) immersion in calcium hydroxide; and (5) room temperature and high humidity. Compression, split tensile test, and residual strength testing took place after 8 and 16.5 months of exposure. No significant degradation was observed. A modified split tensile test was performed on square and round samples after 8, 16.5, and 20 to 24 months of exposure. A few samples immersed in intracoastal waters appeared to suffer degradation. A few samples immersed in seawater adjusted to low pH also appeared to degrade. Visual inspection took place after splitting open the samples. Results indicated that fiber reinforcement for dry-cast concrete pipe merits further investigation.

Project Benefits

This project demonstrates the potential advantages of dry-cast concrete reinforced with synthetic fiber for use in Florida environments, leading to more durable concrete pipe installations.

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