



Florida Department of Transportation Research

Use of Fiber Reinforced Concrete for Pavement Slab Replacement

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Replacing cracked concrete in roadways requires lanes to be closed and traffic disrupted. One way to reduce road closure time is to reduce concrete curing time. To accelerate curing time, pavement engineers mix a very low water-cement ratio with a large amount of Portland cement. While the mixture dries quickly, the replacement slabs are susceptible to early-age drying shrinkage, which can potentially cause the replacement slabs to crack. One way to lessen the risk of cracking and to strengthen concrete is to add fibers to the concrete mix. However, except for bridge deck applications, there is no standard specification for the use of fiber reinforced concrete (FRC) in the construction of concrete roadways.

Researchers at Florida International University recently explored FRC mixtures for replacement slab applications. They conducted a literature review to understand the current industry use of FRC. Steel, glass, synthetic, and basalt fibers are the four main fibers currently used in FRC. Steel fibers are used most often but corrode if exposed. Glass fibers improve fracture toughness but do not enhance ductility. During mixing, all of the fibers have a tendency to ball and clump, causing voids and potential slab failure.

In this study, researchers tested 10 concrete mixtures, one of which was a control mixture commonly used by FDOT in replacement projects. The other nine were made by modifying the control mixtures with various fibers. All mixtures were required to have a minimum six-hour compressive strength of 2,200 psi and a minimum 24-hour compressive strength of 3,000 psi. A set of two or three specimens per testing sequence was prepared for all tests and mixtures.

Researchers conducted flexural and residual shrinkage tests and evaluated the mixtures for their plastic properties, mechanical properties and cracking performance. They collected data using a Vishay data acquisition system to collect and process load and deflection data and used



Concrete failure after compressive strength tests. Left: plain concrete. Right: Fiber reinforced concrete.

Smartstrain software to interface the instruments with the data acquisition system.

Researchers found that adding fibers to concrete mixtures increased the age at which cracking occurs in concrete and reduced crack width. Regarding shrinkage, they found that stiff fibers like steel, glass and 1.5"-long polypropylene fibers tend to provide good flexural strength, but are relatively poor in restraining cracking caused by shrinkage. Researchers do not recommend steel, glass, basalt, and 1.5"-long polypropylene fibers be used for restraining early age cracking because the fibers were found to decrease the age at which concrete cracks occur and increase the crack width. Researchers found that nylon fibers can be used to restrain early age cracking, but care must be taken when mixing because nylon fibers are prone to balling during mixing. Researchers concluded that short (0.5" and 1") polypropylene fibers are superior at restraining early age cracking and are recommended for use in concrete pavement replacement slab mixtures.

Understanding the properties of FRC enables roadway engineers to make better decisions about the types of materials to use when replacing concrete slabs, resulting in the least amount of traffic disruption.

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For more information, visit <http://www.dot.state.fl.us/research-center>