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 traff c 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 f bers to the concrete mix. However, except for bridge deck applications, there is no standard specif cation for the use of f ber reinforced concrete (FRC) in the construction of concrete roadways.

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

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 f bers are the four main f bers currently used in FRC. Steel f bers are used most often but corrode if exposed. Glass f bers improve fracture toughness but do not enhance ductility. During mixing, all of the f bers 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 f bers. 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 f exural 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 def ection data and used Smartstrain software to interface the instruments with the data acquisition system.

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

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