Florida Department of Transportation Research

Mitigation of Cracking in Florida Structural Concrete

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Current Situation

High-performance concrete (HPC) became available in the U.S. in the early 2000s, and since that time, it has found wide use in transportation. HPC is more expensive than ordinary concrete, but it is stronger, and the extra expense is offset by reduction of steel reinforcement. HPC concrete can have higher drying shrinkage due to its higher cement content and a possibility of cracking, which compromises the increased durability of HPC. Internal curing, in which porous aggregates such as expanded shale or clay are added to concrete in place of some of the regular fine aggregate as a source of internal moisture, causes the concrete to cure more effectively and helps reduce shrinkage and prevent cracking.

The heavy vehicle simulator can simulate up to 20 years of pavement wear in about three months.

Research Objectives

University of Florida researchers tested the ability of three admixtures to enhance the cracking mitigation potential of internally cured HPC when used for bridge decks and pavements: shrinkage-reducing admixture (SRA), polymeric microfibers (PMF), and optimized aggregate gradation (OAG).

Project Activities

The three admixtures were tested in the laboratory and in the field in a series of 66 mixes that covered three classes of concrete specified by the Florida Department of Transportation (FDOT) in 11 mixes that contained various admixtures and their controls. Smaller size trial mixes were tested to make sure they met FDOT specifications; they were then tested at batch scale to evaluate various strength and durability properties. Some adjustments were needed in admixture amounts, but the water-to-cementitious ratio (w/cm) and the total cementitious content all conformed to the mix designs. Fresh concrete was tested for slump, air content, density, temperature, time of set, and bleeding. Hardened concrete was subjected to 12 tests, including compressive strength, flexural strength, surface resistivity, and others.

Based on the lab studies, concrete mixes with properties desirable for pavement were chosen for further study in 12-foot by 15-foot slabs. The slabs were tested for basic properties and tested under load with the heavy vehicle simulator at FDOT's State Materials Office. Three-dimensional finite element method models were calibrated to the results of concrete testing. Two rounds of testing were conducted to cover a wider range of mixes.

Generally, SRA and PMF admixtures were not found to improve expected service life enough to justify the additional costs. However, OAG was found to have advantages that warrant full-scale, in-service field testing.

Project Benefits

The refinement of concrete mixes can lead to increased strength and durability of concrete transportation structures, with corresponding reductions in maintenance and replacement costs.

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