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EVALUATION OF SHRINKAGE CRACKING POTENTIAL OF CONCRETE USED IN BRIDGE DECKS IN FLORIDA

PROBLEM STATEMENT

Shrinkage cracking of concrete bridge decks is a critical problem in Florida. Many concrete bridge decks have been observed to develop plastic shrinkage cracks soon after construction. These cracks shorten the service lives of the decks and increase the cost for maintenance and repairs. One of the possible solutions to this problem is to modify the concrete mix designs such that the concretes could be less susceptible to shrinkage cracking while maintaining their other high-performance properties. There is a need to have an effective testing and analysis method to evaluate the shrinkage cracking resistance of concrete in service so that a concrete mixture can be properly designed to minimize shrinkage cracking potential in service. In a prior research project sponsored by the FDOT, a very promising testing and analysis method was developed for evaluation of concrete mixes for resistance to shrinkage cracking. This testing and analysis method needs to be further evaluated, refined, and implemented as a standard procedure for evaluating shrinkage cracking resistance of concrete used by FDOT.

OBJECTIVES

The main objectives of this research are (1) to develop an effective and convenient laboratory set-up and procedure for evaluating concrete mixtures for their resistance to shrinkage cracking in service of bridge decks in Florida, (2) to evaluate the different concrete mixtures that have various different admixtures added for reducing the shrinkage in the concrete, and (3) to make recommendations for concrete mix designs for improved resistance to shrinkage cracking in service.

FINDINGS AND CONCLUSIONS

The constrained long specimen apparatus, which was previously developed for the FDOT by the University of Florida to evaluate resistance to shrinkage cracking of concrete, was further refined and evaluated. The major refinements included (1) using a load cell to measure the induced force in the constrained long specimen, (2) using an embedment strain gage to measure the strain of the long specimen, (3) using an automatic data acquisition system to collect the load and strain data continuously, and (4) using a water-resistant and low-friction Teflon sheet as a base plate to minimize the friction between the concrete specimen and its supporting base.

One observed problem with the long specimen apparatus was that it was not able to provide complete restraint to the concrete specimen to keep it from contracting during the constrained shrinkage test. The test procedure was modified to correct the specimen contraction, i.e., manually turning a nut on a threaded rod on the test apparatus during the test such that the strain in the specimen would be kept as close to zero as possible. This manual method of correcting the

contraction strains in the constrained long specimen appeared to give acceptable results, and was adopted for use in the laboratory testing program of this study. However, to improve the efficiency in the running of this test, the apparatus should be further refined such that the correction for the contraction strains can be done automatically by means of a servo-hydraulic actuator rather than manually. .

The results of the laboratory testing program indicated that the use of a shrinkage reducing admixture was effective in reducing the free shrinkage strains and shrinkage induced stresses of all the concrete mixtures tested, while the compressive strength, splitting tensile strength and elastic modulus of the concrete were not significantly affected. The addition of fly ash as a mineral admixture was found to be effective in reducing the free shrinkage strain and shrinkage induced stresses of all the concrete.

BENEFITS

An effective testing and analysis method for evaluating the shrinkage cracking resistance of concrete in service was developed as a result of this study. The results from the laboratory testing program pointed to the possible benefits of using a shrinkage reducing admixture and fly ash as a mineral admixture for improving the resistance to shrinkage cracking of concrete. This test method may reasonably be expected to lead to the design of concrete mixtures with improved resistance to shrinkage cracking in service.

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