HIGH PERFORMANCE PORTLAND CEMENT CONCRETE PAVEMENT

Problem
Under TE -30 High Performance Concrete Pavement program, several states are undertaking a variety of innovative research in high performance concrete pavement materials and innovative design/construction features. This project addressed the needs of Maryland State Highway Administration in exploring the use of fiber reinforced and low shrinkage concrete in pavements.

Objectives
The objective of this study was to examine the design and performance of these materials for Maryland conditions, monitor their lab and field performance, and quantify potential benefits. The results of the study were documented in two research reports. The first one was related to the field instrumentation identifying pavement instrumentation, installation guidelines and testing. The second report, the final report for the study, includes the lab and field data analysis and findings, and the analytical evaluation.

Description
In the laboratory, testing the MD Mix 7 was the control mix. This study examined the effects of fiber content (ranging from 0.1% - to 0.4%) on concrete properties. The research team selected a candidate polypropylene fiber for the laboratory testing. According to the recommendations of the industry and the project advisory panel, the low shrinkage concrete was based on the use of MD #357 aggregate in place of the #57 aggregate, and /or modifying the w/c ratio. The field testing included pavement instrumentation for the control, fiber reinforced and low shrinkage concrete test sections on US 50. The objective of the instrumentation was to monitor and compare the structural response and behavior of the control and modified concrete slabs. The instrumentation was placed in key locations of the concrete slabs for evaluating both loading and climatic effects on slab behavior. The instrumentation plan was fine tuned during the project meetings and based on the input of the project advisory panel and the CTL engineers. Field testing included several runs of loading the test sections with two MSHA trucks (with 18 kip and 32 kip axles). The data were used for analytical evaluation of the response and behavior of the test sections. Further more, condition surveys / profile measurements were conducted using a dipstick device. The data were used for 1) monitoring any slab shape changes and 2) as a base line for the concrete slab analysis. Non destructive testing was also conducted using an ultrasound device and for relating lab and field mixture properties.
Results

The lab results indicated that toughness of concrete increased with increasing fiber content. In terms of shrinkage, there were small differences in unrestrained shrinkage for the control and the two low shrinkage mixtures. However, fiber reinforced concrete mixtures exhibited higher levels of shrinkage. The fatigue analysis indicated that the addition of polypropylene fibers resulted in higher fatigue strengths. Overall, the best fatigue performance was obtained with the 0.1 fiber content. SN curves were developed from the fatigue analysis to be used in pavement design, see figure below.

The pre-construction predictions of pavement response carried out through the finite element analysis provided the expected response for each of the field instrumentation devices. The field data collected from the in-situ instrumentation indicated that overall, the sections had acceptable variability in deflections. The back calculation analysis using the deflection and strain data indicated that the best estimates of k and Ec are k of 350 pci and Ec of 5,000,000 psi. These are both reasonable values for the embankment soils and concrete conditions at the site at the time of the load tests. These values could be used for future analysis of the behavior and performance of the three test sections using the field instrumentation installed.

SN Curves from Fatigue Analysis

Report Information

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