RESEARCH
PROJECT CAPSULE [14-3C]
September 2013
TECHNOLOGY TRANSFER PROGRAM

Laboratory Fatigue Evaluation of Continuously Fiber-Reinforced Concrete Pavement

JUST THE FACTS:

Start Date:
September 1, 2013

Duration:
18 months

End Date:
February 28, 2015

Funding:
SPR: TT-Fed/TT-Reg

Principal Investigator:
Tyson D. Rupnow, Ph.D., P.E.
Senior Concrete Research Engineer

Administrative Contact:
Mark Morvant, P.E.
Associate Director, Research
225-767-9124

Technical Contact:
William "Bill" King, Jr., P.E.
Materials Research Administrator
225-767-9129

Louisiana Transportation
Research Center
4101 Gourrier Ave
Baton Rouge, LA 70808

Sponsored jointly by the Louisiana Department of Transportation and Development and Louisiana State University

POINTS OF INTEREST:

Problem Addressed / Objective of Research / Methodology Used Implementation Potential

PROBLEM

Portland cement concrete (PCC) is the world's most versatile construction material. PCC has been in use in the United States for over 100 years. PCC pavement is generally constructed as either continually reinforced concrete pavement (CRCP) or jointed plain concrete pavement (JPCP). CRCP is constructed with steel reinforcing totaling about 0.7 percent that is intended for crack control and to provide load transfer once cracks have formed by keeping crack faces in close contact. JPCP is constructed from unreinforced concrete with steel dowel bars over the saw-cut joints to provide load transfer between slabs. CRCP has the advantage of not having joints, which leads to better ride quality and generally longer life, if constructed properly. JPCP is advantageous because it generally costs about 20 percent less than a comparable CRCP section. The major drawback to JPCP is the joints. The relatively large saw-cut joints produce more noise generation than CRCP, and create points for water movement into the pavement structure. Recently, it has been noticed on a wide scale within the United States that a great number of JPCPs in the 15-25 year age range are exhibiting spalling and severe deterioration at the joints. Various theories are being explored nationally to explain the causes of premature joint deterioration, but all fall into the categories of unwanted moisture at the joint locations or damage caused in the sawing process. Concrete is durable and premature joint deterioration is unacceptable, as the intended design life of many of these pavement structures is 30-40 years. A need exists to produce a jointless pavement with the high cost of CRCP.

This project aims to prove a new pavement type encompassing the cost effectiveness of the JPCP with the structure of the CRCP through the use of fibers. The use of fibers is not novel in concrete as fibers are routinely used in residential concrete, decorative concrete, jointless warehouse floors, and at high dosages in blast and impact resistant concrete. This project will explore the feasibility of a continuously fiber reinforced concrete pavement structure (CFRCP). The CFRCP concept will first be explored on small specimens in a laboratory setting with the fatigue behavior of several fiber types and combinations being of the greatest interest. The results of this project will guide a roadmap of future research into the failure mechanisms of CFRCP, possible rehabilitation techniques, and fiber dosage rates and combinations, as well as a possible full-scale loading program.

OBJECTIVE

This study presents the first approach to develop a new concrete pavement structure reinforced only with fibers. This research will identify probable combinations of fibers (dosage and length combinations) that will adequately perform repeated load fatigue tests. While fibers and high dosage fiber combinations have been previously used in concrete, these combinations have never before been used in a DOT pavement structure. The major difference between previous applications and the current objective is the number and level of load applications. The fundamental objective of this research is to determine how CFRCPs behave under highway-type loading.

The specific objectives of this study are to characterize the fresh and hardened properties of CFRCP concrete, determine the comparative fatigue resistance of different fibers and differing fiber blends and dosage rates, perform a detailed economic analysis of all pavement types through a cost-benefit analysis, and provide recommendations for future research, including full scale loading and possible field implementation sites.

METHODOLOGY

The proposed work is to develop a new pavement type. This method is novel because the current pavements, such as CRCP and JPCP, have limitations as previously noted. This new pavement type will attempt to remove the limitations associated with each pavement type, leading to a longer-lasting, more durable, and more cost-effective concrete pavement. Within the scope of Phase 1, six tasks have been outlined to achieve the project goals: literature review, testing program design, laboratory testing, data analysis, implementation plan, and final report preparation. To ensure applicability and immediate benefit to DOTs, a project oversight panel will be assembled. Members of the oversight panel will include representatives from both fiber companies, DOT members, and several contractor/producers. All task results will be reviewed by the project oversight panel before release and to help guide subsequent research. Routine conference call meetings will be held quarterly.

IMPLEMENTATION POTENTIAL

The results of this study will most likely be used in developing a large, full-scale experimental program, and will greatly increase the body of knowledge pertaining to fiber reinforced concrete pavements and their behavior. It is anticipated that once the project is fully completed, the Department will benefit from CFRCP. The implementation plan will detail the cost and benefits of each pavement type and provide recommendations to the Department for implementation of CFRCP.