RESEARCH
PROJECT CAPSULE
July 2014
[14-5C]
TECHNOLOGY TRANSFER PROGRAM

DOTD Support for UTC Project: Development of Rapid PCC Pavement Repair Materials and Construction Techniques

JUST THE FACTS:

Start Date:
July 1, 2014

Duration:
24 months

End Date:
June 30, 2016

Funding:
SPR: TT-Fed/TT-Reg

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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

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The purpose of this project is to provide DOTD match funding for the proposed research. This project is associated with the LTRC/Southern partnership with Research on Concrete Applications for Sustainable Transportation (RE-CAST) Rapid Pavement Construction and Repair housed at Missouri S&T funded by the Office for the Assistant Secretary for Transportation Research (OAST-R) of the U.S. Department of Transportation.

PROBLEM

With over 4 million miles of roadways in the U.S., pavement maintenance and construction represents a significant portion of federal and state funding for infrastructure. Compounding these financial burdens are the significant indirect costs to users during construction. The present study aims at developing cost-effective concrete materials for pavement repair. The main idea is to produce high performance concrete materials, reduce the cost, and produce durable material.

An additional need exists for a more crack-resistant rapid repair material. Current materials and methods produce rapid patches that tend to exhibit moderate to severe cracking, sometimes within weeks after placement. This method tends to lead to repairing patches much earlier than intended. Several methods exist that may decrease the severity of cracking and lead to longer, more durable concrete patches, which include the use of shrinkage reducing or compensating methods, fibers and recycled materials, and the use of internal curing.

The proposed project will investigate cost-effective, rapid pavement repair techniques that can reduce cost and duration. Two types of concrete materials are proposed for investigation in this project, including adaptive rheology concrete and crack-free early strength concrete for rapid pavement repair. Reducing the construction duration, and enhancing early age and long-term performance, is the key solution for decreasing both the direct and indirect costs.

The first approach to developing cost-effective concrete mixtures to be used in accelerated pavement repair is to develop flowable concrete with adaptive rheological properties to be used in repair patching. The main problems associated with repair work are bonding between the repair material and the substrate and differences in shrinkage or thermal changes, leading to cracks and preferential paths for water intrusion. Based on the above methodology, the use of shrinkage reducing admixtures (SRAs), expansive agents, and fibers in self-consolidating concrete (SCC) can be investigated. The advantage of the expansive agents is that shrinkage is fully compensated, while the flowability of SCC result in a better bonding with the substrate, as no air gets trapped between the two layers. The absence of consolidation can further enhance the bonding between the substrate and the repair material. Due to vibration, water is drawn near the interface, creating a weaker bond, similar to the interface transition zone (ITZ) for coarse aggregates in concrete.

Due to the increasing amount of paste and the cementitious materials content in SCC mixtures, shrinkage and cracking potential will be an issue compared to the conventional concrete mixtures (Lomboy et al. 2011). It is required to focus on optimization of mix design in terms of the paste content, Portland cement content, w/cm, and incorporation of proper types and amounts of SRAs and fibers to decrease the shrinkage and control the cracking potential in hardened concrete.

The cost-effectiveness will be achieved by optimizing the SCC mix design. One key component in this optimization procedure is the granular skeleton formed by the aggregates. Cost-effective SCC requires an appropriate aggregate grain size distribution to minimize paste content. With this appropriate grain size distribution, the cost of the concrete can be reduced, as well as the shrinkage potential. Based on developed theories on particle packing in concrete, optimized grain size distributions can be created with locally available materials.

OBJECTIVE

The main objective of the proposed research is to determine the feasibility of producing cost effective materials for rapid pavement repair. The study will include mixture optimization as well as evaluating fresh and hardened properties and durability aspects of such novel materials through laboratory tests.

Two types of pavement technologies will be applied in this project: (1) self-consolidating concrete mixture for repair and slip form paving and (2) crack-free early strength concrete.

METHODOLOGY

Laboratory mixtures will be prepared using several different methods to control early age cracking. Mixtures will be tested for strength, shrinkage, and workability. Full-scale field sections will also be constructed with promising laboratory results in MO and LA.

IMPLEMENTATION POTENTIAL

The results of this project will enable the Department to produce a more durable, cost effective, patching program. The resulting patching material(s) and construction techniques(s) should result in a lower life-cycle cost repair.