Tran-SET
Transportation Consortium of South-Central States

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Key Points

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$305,000

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Tran-SET
Louisiana State University
Louisiana Transportation Research Center
University of New Mexico

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$610,480

Application of Engineered Cementitious Composites (ECC) for Jointless Ultrathin Whitetopping Overlay

Brief Project Description

The objective of this study is to evaluate Engineered Cementitious Composites (ECC) in Jointless Ultrathin Whitetopping (UTW) overlay application. An ECC material will be specifically designed for UTW application based on locally available materials. Fatigue evaluation of the UTW-ECC material will be performed to produce a σ-N relation (flexural stress vs. cycles to failure). Moreover, finite element analysis (FEA) and fatigue performance data of the UTW-ECC material (σ-N relation) will be integrated to produce an UTW-ECC overlay performance prediction model (overlay thickness vs. cycles to failure, H-N relation). To validate the developed model, a full-scale experiment of an UTW-ECC overlay system will be performed at the Louisiana Transportation Research Center (LTRC) Pavement Research Facility. Finally, a cost-analysis of the construction of jointless UTW-ECC compared to traditional jointed UTW will be conducted.

Problem Statement

Whitetoppings are concrete overlays on top of HMA pavement structures. Whitetoppings are divided in two categories, thin whitetoppings (TWT) and ultrathin whitetoppings (UTW), where the thickness of TWT and UTW ranges between 4 to 8 inches and 2 to 4 inches, respectively. UTW are used to rehabilitate distressed HMA pavement structures, which may have failed from rutting, local surface distresses, fatigue cracking, and low-temperature cracking. Commonly observed distresses in whitetoppings include, corner, reflective and load related cracking; yet, corner cracking appears to be the primary distress observed in UTW when joints coincide with the wheel path.

While using smaller joint spacing allows for the utilization of UTW in whitetopping projects, it is usually more economical to utilize TWT with larger joint spacing, since the cost of concrete is relatively low compared to saw cutting and the performance of the overlay is not compromised due to the coincidence of joints with the wheel passing. Therefore, enhancements in the properties of concrete materials could allow for the utilization of ultra-thin overlays with large joint spacing that would mitigate joint related distresses, increase construction speed, and be more cost-effective.

Objectives

The main objectives of this study are the following:

- To develop an ECC material for specific UTW overlay application utilizing local materials.
- To evaluate the fatigue performance of the UTW-ECC material produced.
- To produce an UTW-ECC overlay performance prediction model based on the integration of fatigue performance data and finite element analysis (FEA).
- To validate the UTW-ECC overlay performance prediction model by means of a fullscale test of an UTW-ECC overlay system on the Louisiana Transportation Research Center (LTRC) Pavement Research Facility.
- To conduct a cost analysis of the construction of jointless UTW-ECC compared to traditional jointed UTW.
- To develop preliminary guidelines for a specification on UTW-ECC overlays in the state of Louisiana.

Intended Implementation of Research

Workforce Development

This study will provide funding to one PhD student at Louisiana State University (LSU). The research team will prepare educational materials on UTW-ECC systems to be incorporated in transportation courses at LSU. The educational materials will also be summarized in the form of YouTube videos for dissemination to DOT and the transportation industry. Findings will be also disseminated at national conferences such as TRB and ASCE.

Education

This study will produce knowledge about UTW-ECC systems, which may be implemented in courses in pavement design at LSU and other universities in Tran-SET.

Outreach

This study will offer two internships for undergraduate students to introduce them to research in transportation. In addition, seminars and webinars explaining findings on UTW-ECC overlay systems will be offered to concrete research institutes and companies interested in emerging innovative technologies for the Transportation Sector in collaboration with the highway agencies in Region 6.

Anticipated Impacts/Benefits of Implementation

Engineered Cementitious Composites (ECC) are proposed as a novel alternative for UTW application since its outstanding mechanical properties (extreme ductility and superior flexural strength) have the potential to allow for jointless (or significantly large joint spacing) UTW systems at reduced thicknesses. This could lead to a new generation of UTW that could be faster to build, more cost effective and more sustainable.

Weblinks:

- Tran-SET's website (http://transet.lsu.edu/research-in-progress/)
- TRB's Research in Progress (RIP) database (https://trid.trb.org/View/1505362)