RESEARCH
PROJECT CAPSULE [12-3P]
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TECHNOLOGY TRANSFER PROGRAM

Minimizing Shrinkage Cracking in Cement-Stabilized Bases Through the Use of Micro-cracking

JUST THE FACTS:

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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

PROBLEM

The Louisiana Department of Transportation and Development (DOTD) has been using cement stabilized base course (soil cement) in flexible pavement construction for more than 50 years. This type of base course, although known for having an excellent loading carrying capacity and durability, is also well-known for developing shrinkage cracks, which can reflect through the asphalt concrete surface and accelerate the deterioration of the pavement. Micro-cracking is a special reflective-cracking mitigation technique that produces a fine network of hairline cracks through vibratory roller compaction on the cement stabilized base shortly after the base construction. The micro-cracks will help relieve the contracting stress of the cement stabilized layer during its drying process, thus preventing it from forming wider shrinkage cracks, which are more likely to be reflected to the pavement surface. Several recent research studies have reported that micro-cracking did improve the field performance of reflective cracking for asphalt pavements with cement stabilized bases by reducing the crack width, crack length, or both, indicating a great potential of applying this technique on the soil cement pavement construction in Louisiana.

OBJECTIVE

The objectives of this research study are: (1) to determine if the micro-cracking technique is suitable for implementing on soil cement pavements in Louisiana and (2) to evaluate the effectiveness of micro-cracking on reducing the shrinkage/reflective cracking on soil cement pavements.

METHODOLOGY

To achieve the objectives, micro-cracking test sections will be constructed on both the accelerated loading facility (ALF) site and selected in-situ pavement project sites. Figure 1 presents the layout of six micro-cracking test sections to be constructed at the ALF. As shown in Figure 1, the six ALF test sections will be constructed with soil cement or cement treated soil according to current DOTD's specifications, but without any asphalt surface layer. The purpose is to directly evaluate the shrinkage cracking performance of cement stabilized or treated base layers w/o the use of micro-cracking. Non-destructive tests including falling weight deflectometer (FWD), light FWD (LFWD) and Geogauge will be used to determine the required micro-cracking roller passes during the construction. After the construction, the development of shrinkage cracking will be continuously monitored on each of ALF test sections for up to one year.

Three to five field pavement projects will be selected with the assistance of DOTD district project engineers. The selected projects will be distributed within different Louisiana geographic locations and have either a Class II soil cement base (Item 302) or an in-place cement stabilized or treated base (Item 303 or 308). On each selected pavement site, five 1000-ft. long test sections

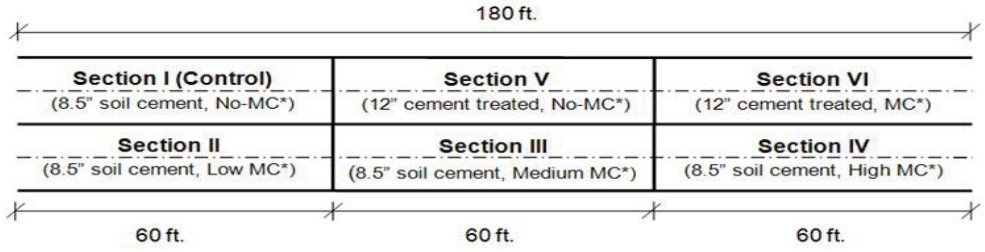
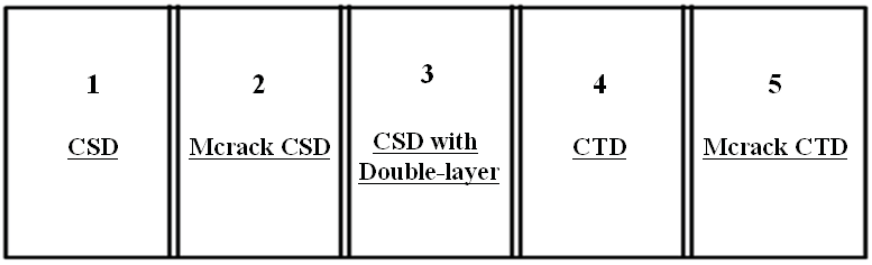


Figure 1
Layout of proposed ALF micro-cracking test sections
(*MC = micro-cracking, *No-MC = no micro-cracking)

of different surface treatments, as outlined in Figure 2, will be constructed. Noted that the following terminologies are used in the section plan shown in Figure 2: (1) 8.5-in. thick cement stabilized design (CSD): 300 psi unconfined compressive strength (UCS) at 7 days; (2)8.5-in. thick CSD with Micro-cracking (Mcrack); (3) 8.5-in. thick CSD with double-layer asphalt surface treatment (AST); (4) 12-in. thick cement treated design (CTD): 150 psi UCS at 7 days; and (5) 12-in. thick CTD with Mcrack.



1- Control section: CSD
2- Treatment section 1: Mcrack CSD
3- Treatment section 2: CSD with double-layer AST
4- Treatment section 3: CTD
5- Treatment section 4: Mcrack CTD

Figure 2
Typical test section layout of one selected field project

All field test sections shall be constructed according to the Louisiana standard construction procedure. For the micro-cracking test sections (i.e., section 2 and 5 in Figure 2), initial FWD deflection data will be collected on the left and right sides of the test section at intervals of 100 ft. after 48 to 72 hours of dry curing immediately before micro-cracking. Micro-cracking will be conducted using a 12-ton vibratory roller compactor operated at a low speed (2–3 mph) and a high vibration amplitude. After three passes of roller compaction, FWD tests will be conducted on those previously tested spots to check the reduction of base modulus. More roller compaction will be applied until a 50% reduction of back-calculated modulus is achieved. At one of the selected projects, LFWD and geogauge tests will be conducted at each FWD test spot. After micro-cracking, all micro-cracking sections will need to be cured by curing membranes for 48 to 72 hours until the asphalt concrete layer is placed. Pavement condition surveys will be carried out at 28-day, 180-day, 1-year, and 2-year intervals after the construction. The pavement rutting, cracking, and IRI data will be collected. FWD tests will be conducted at those previously tested spots during the pavement condition survey. Test results from field test sections will be used to determine the effectiveness of micro-cracking in reducing the reflective cracking of soil cement pavements.

To better understand the mechanism of micro-cracking, a prediction model will be developed to estimate the effect of micro-cracking in reducing shrinkage/reflective cracking. The prediction model may be developed based on Geomechanics and finite element analysis (FEA) and calibrated using the field test results. The calibrated prediction model will be used in the cost benefit analysis. The following are the specific tasks involved in this study:

Task 1 *– Review literature and gather facts*
Task 2 *– Construct test sections* | ***2a*** *– PRF test sections* | ***2b*** *– field project test sections*
Task 3 *– Monitor the stiffness and cracking performance*
Task 4 *– Analyze the test data*
Task 5 *– Develop a recommended micro-cracking procedure*
Task 6 *– Prepare the final report*

IMPLEMENTATION POTENTIAL

Micro-cracking, as demonstrated by several other states, is potentially a cost-effective solution to the shrinkage and reflective cracking problems for Louisiana's soil cement pavements. Field tests conducted in this study will explore how to perform micro-cracking on typical Louisiana cement stabilized materials. DOTD can implement the recommended micro-cracking procedure in construction of pavements with cement stabilized bases.