PROJECT SUMMARY

Texas Department of Transportation

0-6812: Updated Testing Procedures for Long Life Heavy Duty Stabilized Bases

Background

Fatigue cracking is one of the major distresses observed in pavement structures due to repeated traffic loads. Current performance models in mechanistic empirical pavement design approaches such as Texas-ME, consider the modulus of rupture of treated materials as the main influencing factor for the fatigue life of pavements with cementitously treated layers. There are several systematic errors and practical concerns associated with the conventional bending beam test for the estimation of the modulus of rupture of stabilized materials. In Project 0-6812 our research team elaborated on the practical and theoretical issues pertaining to traditional bending beam test, and developed an alternative approach, based on modified split tension test for the determination of the tensile strength properties of the stabilized materials.

What the Researchers Did

The primary goal of this project was to develop a reliable and repeatable laboratory testing protocol to assess the tensile strength properties and tensile fracture potential of cement treated base materials in the laboratory.

To achieve this goal, the research team performed a thorough study of the available test methods in the US and abroad for proper characterization of the stabilized materials in the laboratory. Additionally, a survey was designed and distributed among the districts to collect relevant data to document the challenges associated with the mixture design of cement treated aggregates in the laboratory.

In this project, the research team developed a comprehensive experiment matrix complimented by numerical simulations to fully characterize the mechanical behavior of the stabilized materials in the laboratory. Parameters and properties such as compressive and tensile strength, deformation potential at various strength ratios, resilient properties, and moisture adsorption potential for four different materials sourced from El Paso, Pharr, Paris, and San Antonio districts were determined in this project. Figure 1 shows the laboratory tests performed as part of the experimental efforts in this project. Subsequently, 10-day capillary soak protocol was followed to study the influence of moisture ingress in de-bonding and loss of compressive and tensile strength properties of cement treated materials compared to 7-day moist cured control specimen in the laboratory.

Ultimately, a series of numerical simulations using finite element approach were performed on prismatic beams in bending beam test and cylindrical specimens in split tension test under various loading conditions, and the results were compared to the modified Indirect Diametrical Tension (IDT) test results from our laboratory efforts for cross validation.

What They Found

Initially, the research team itemized the issues pertaining to the use of bending beam test for laboratory characterization of the tensile properties of the cement treated base materials in the laboratory. Based on laboratory testing and numerical simulations, the major sources of inaccuracies were:

a. Practicality issues associated with specimen de-molding and handling of large beams in the laboratory for lightly stabilized materials.
b. Large sample size for bending beam test 6 x 6 x 20 in. and the issues associated with the heavy weight of the beam for handling.
c. Issues associated with the uniformity of compaction of cement treated materials in the

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large beam specimen. Specifically in mixtures with large aggregates, there were large pockets of air voids trapped adjacent to the rigid mold.

d. Systematic errors associated with the linear stress distribution assumption in the bending beam test. As it is displayed in Figure 2, approximately 60% of the beam is in compression due to the pure bending loading scenario; while uniform tension along the axis of loading is induced to the specimen during the indirect diametrical tensile (IDT) test.

Due to the practicality and theoretical issues pertaining to the bending beam test for cement treated base and subbase materials, the research team developed a modified IDT test, with external deformation measurement capabilities from the outside perimeter, to characterize the tensile strength for mixture design of the cementitiouly treated materials in the laboratory in lieu of traditional modulus of rupture test.

The research team developed two protocols, static IDT procedure, and dynamic IDT procedure in this project. The results for the dynamic IDT procedure showed promising potential for the modified approach to capture the loss of strength due to repeated loading for lightly cement treated base materials in the laboratory.

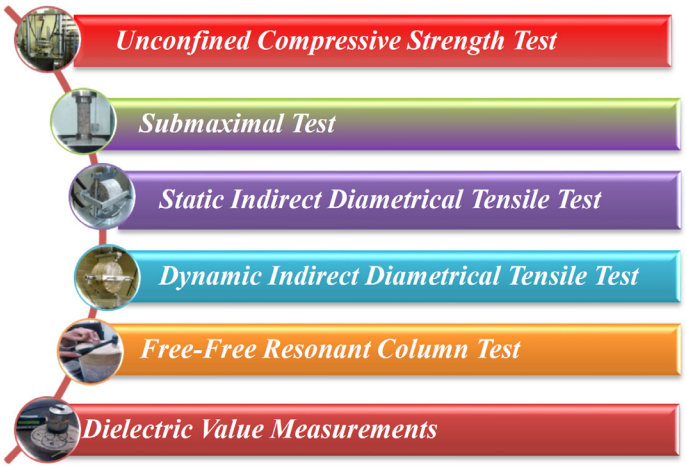

Figure 1. Laboratory Tests Envisioned in the Experiment Design

What This Means

This project provided an alternative practical approach for the estimation of the tensile properties of the cement-treated base materials. This allows the districts to incorporate IDT strength in combination with UCS for improved laboratory mixture design of cement-treated materials.

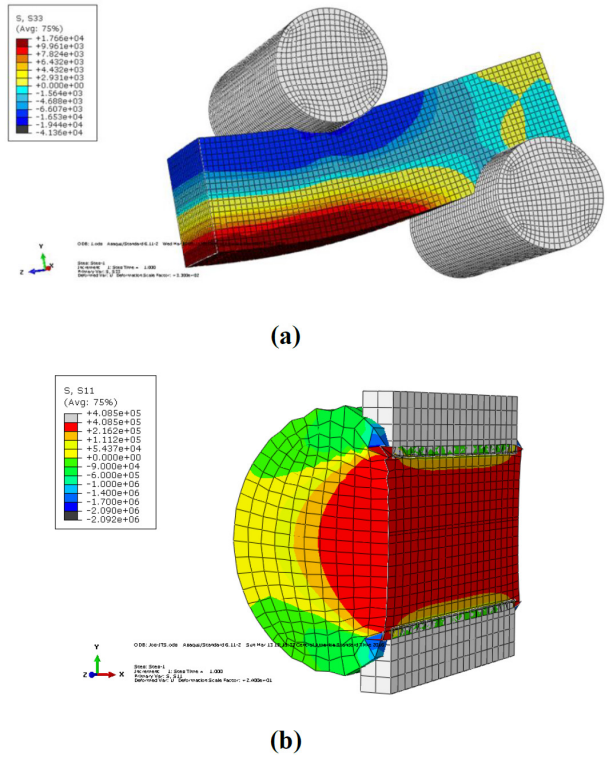

Figure 2. Stress Distributions on the (a) Bending Beam Test and (b) IDT Test

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