LTRC RESEARCH PROJECT CAPSULE

DECEMBER 2008

07-1P

TECHNOLOGY TRANSFER PROGRAM

Finite Element Simulation of Structural Performance on Flexible Pavements with Stabilized Base/Treated Sub-base Materials under Accelerated Loading

JUST THE FACTS

Start Date:
November 1, 2006

Duration:
24 months

End Date:
June 30, 2009

Funding:
State

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SPECIAL POINTS OF INTEREST:

- Problem Addressed
- Objectives of Research
- Methodology Used
- Implementation Potential

PROBLEM

The full-scale accelerated pavement testing (APT) provides a unique tool for pavement engineers to directly collect pavement performance and failure data under heavy wheel loading. However, running a full-scale APT experiment is very expensive. Only a few selected pavement structures/materials can be tested using APT. Therefore, computer simulation of APT becomes a logical direction to expand the benefit from an APT study.

Currently, no computer programs in the literature are able (or suitable) to predict the pavement rutting performance developed in a pavement structure containing chemically stabilized base or sub-base layers, such as cement treated or stabilized soils, slag or fly-ash treated BCS materials, and lime-treated soils as investigated currently at the Louisiana Transportation Research Center (LTRC).

OBJECTIVES

The objective of this research is to develop a finite element (FE) model to simulate performance of pavement structures, specifically for rutting performance of the chemically stabilized base/sub-base materials, under accelerated loading. Initial validation of the model will be performed using results from a current LTRC study: Accelerated Loading Evaluation of a Sub-base Layer on Pavement Performance (ALF Experiment 4).

METHODOLOGY

First, a comprehensive literature review will be conducted on numerical modeling of asphalt pavements. Based on the results of the literature review, potential material models will be investigated, and a permanent deformation model with simple mathematical form will be proposed in this study. Parameters for the selected material model may be determined from the permanent deformation tests.

A commercial finite element program, ABAQUS, will be chosen for the FE analysis. The linear elastic FE (both two-dimensional and three-dimensional) analysis will be performed on the pavement structures of ALF Experiment 4. Pavement structural responses (vertical stresses and elastic deformations) measured from ALF Experiment 4 will be utilized in choosing, calibrating, and verifying the most representative loading scheme for the FE analysis. In addition, non-linear FE models will be developed with the optimal FE meshes and loading scheme obtained from the linear elastic analysis.

A sensitivity analysis of two-dimensional non-linear FE models will be conducted to assess the effects of material model parameters, wheel load configurations and loading schemes, and pavement structure characteristics (e.g., modulus, thickness, and etc.). A three-dimensional non-linear FE model will then be developed based on the two-dimensional analysis, calibrated, and finalized by the pavement responses

measured from ALF Experiment 4. Finally, the developed FE model will be used to predict the permanent deformation performance of typical flexible pavements with stabilized base and/or treated sub-base materials currently implemented by LADOTD.

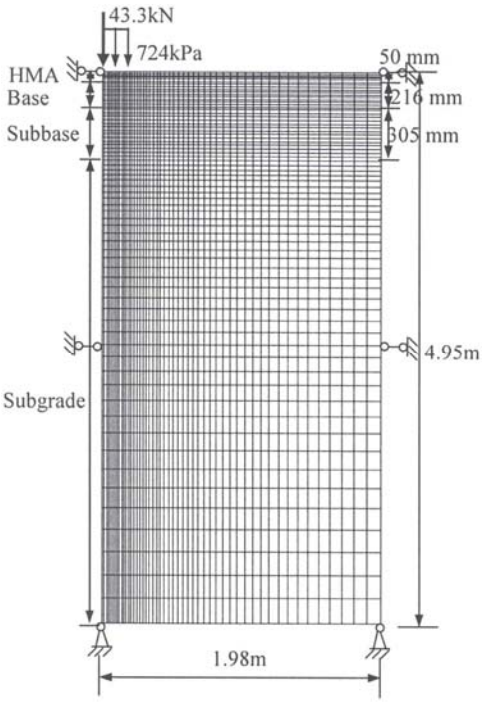

Figure 1
2-D Axisymmetric FE Model

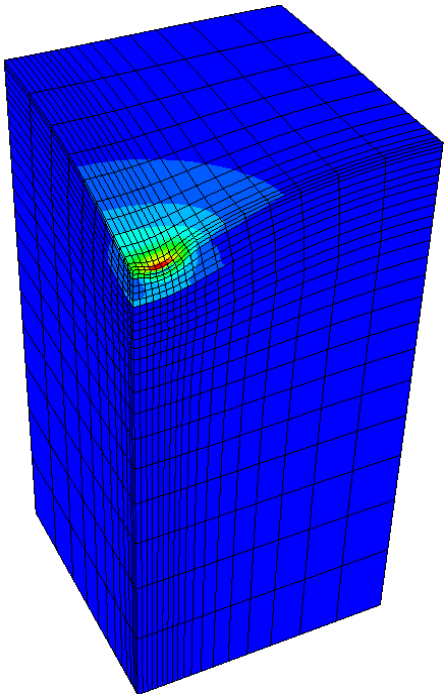

Figure 2
3-D Quarter Symmetric FE Model

IMPLEMENTATION POTENTIAL

The calibrated and verified numerical simulation models may be implemented to simulate the accelerated-loading performance of flexible pavements with different base and sub-base configurations without actually conducting an APT experiment.

Louisiana Transportation Research Center *sponsored jointly by the*
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