Project Summary

Texas Department of Transportation

9-1502-01: Model Calibrations with Local APT Data and Implementation for Focused Solutions to NAFTA

Background

The implementation of the North American Free Trade Agreement (NAFTA) among Canada, Mexico, and the United States, has re-focused the attention of state departments of transportation (DOTs) on the need to understand the impact of heavier axle loads and new axle configurations on state highway networks. With increased trade, highways designed to carry vehicle loads of 80,000 lbs. could be trafficked with gross loads of over 120,000 lbs.

Specialized haulage vehicles in Mexico are equipped with "super-single" tires, and in Canada tridem-axles and triple trailers are used on many long-haul routes. The use of these heavy loads and different vehicle configurations will have a major impact on the performance of highway networks. There is an urgent need for defensible systems to predict the additional pavement damage and economic impacts, a goal of this project.

The work-horse of this effort was the VESYS5 pavement distress prediction model that can be calibrated with local materials and performance data. This latest version of the program includes the capability to handle both tandem and tridem-axles and predict rutting within each pavement layer. The objective of this project was to integrate the accelerated pavement test technologies of Texas, Louisiana, and other participating states with VESYS5 developed by the Federal Highway Administration (FHWA).

What the Researchers Did

Researchers evaluated existing laboratory test procedures for characterizing rutting resistance using the cores with variable rut depth. These cores were taken from seven specific pavement sections on US 281 in south Texas. Seven laboratory test procedures were evaluated: repeated load test (or VESYS rutting test), repeated shear test at constant height, Hamburg wheel tracking test, Hveem stability, Asphalt Pavement Analyzer (APA), resilient modulus, and dynamic modulus test.

Researchers also developed a procedure to calibrate the performance model using accelerated pavement test (APT) data. Utilizing this proposed calibration procedure, the VESYS5 rutting model was calibrated applying Texas Mobile Load Simulator rutting data from US 175.

Researchers upgraded VESYS5, originally a DOS program, to a more user-friendly Windows-based program: TTI VESYS5W.

The Mechanistic-Empirical Pavement Design Guide (MEPDG) fatigue cracking model is composed of the fatigue life model, fatigue damage model, and fatigue crack area model.

Research Performed by:

Texas Transportation Institute (TTI), The Texas A&M University System

Center for Transportation Infrastructure Systems, The University of Texas at El Paso (UTEP)

Research Supervisor:
Tom Scullion, TTI

Researchers:
Sheng Hu, TTI
Fujie Zhou, TTI
Cesar Carrasco, UTEP
Soheil Nazarian, UTEP
Roberto Osegueda, UTEP

Project Completed:
8-31-06

To verify the accuracy of these models, the researchers analyzed the FHWA accelerated load facility (ALF) fatigue data for five test lanes where both conventional and modified asphalt binders were used in the asphalt layer.

Recognizing the inaccurate prediction results from the MEPDG fatigue cracking model, the researchers developed an overlay tester-based fatigue cracking prediction approach in which the overlay tester was used to characterize fracture properties of asphalt mixes (A and n). A and n valves can be used in VESYS5W to predict fatigue performance of the flexible pavement.

Based on laboratory tests, a series of laboratory test protocols were developed or standardized under this project. These test protocols include repeated load test protocols for asphalt mixes, granular base, subgrade, and overlay tester for fatigue cracking.

What They Found

The major findings from this project are:

- When compared to field rutting performance, both the repeated load test, and the repeated shear test at constant height, were ranked the top two tests for characterizing rutting resistance of asphalt mixes, which provides users the confidence to use VESYS5 for rutting prediction.
- Results from the FHWA-ALF fatigue test proved the overlay tester to be a valid simple performance test for fatigue cracking. In addition, a relationship between the traditional bending beam fatigue test and the overlay tester was developed based on massive historic bending beam fatigue test results and a strong theoretical background.
- TTI VESYS5W provides a user-friendly input and visualized output interface and significantly improves the usability of the existing VESYS5 program. One of the special features of the TTI VESYS5W program is that the default values of material properties have been built into the program.
- The current MEPDG fatigue cracking model was found to over-predict the fatigue life of asphalt pavements with conventional asphalt binders, but under-predict the fatigue life of asphalt pavements with modified asphalt binders. To match field performance, a large shift factor was required.
- The overlay tester-based fatigue cracking prediction approach developed in this study differs from traditional approaches (such as the MEPDG). In this study, fracture mechanics principles were applied which consider both crack initiation and propagation.

What This Means

As discussed above, significant progress has been made in both laboratory characterization of pavement materials and associated pavement performance prediction under this project. The researchers highly recommend that these findings from this research project be implemented in the Texas mechanistic-empirical asphalt pavement structural design program.

For More Information:
Research Engineer - German Claros, TxDOT, 512-465-7403
Project Director - Dar-Hao Chen, TxDOT, 512-467-3963
Research Supervisor - Tom Scullion, TTI, 979-845-9913

Technical reports when published are available at:
http://library.ctr.utexas.edu/index.htm

WWW.txdot.gov
keyword: research

Texas Department of Transportation
Research and Technology Implementation Office
P.O. Box 5080
Austin, Texas 78763-5080
512-465-7403