TECHSUMMARY April 2014
SIO No. 30000115 / LTRC Project No. 04-6B

Characterization of Louisiana Asphalt Mixtures Using Simple Performance Tests and MEPDG

INTRODUCTION

The Federal Highway Administration's 1995-1997 National Pavement Design Review found that nearly 80 percent of states use the 1972, 1986, or 1993 AASHTO Design Guides. These design guides are relying on empirical relationships between paving material properties and structural performance of pavement layers developed mainly based on the AASHO Road Test data (1956-1962). In recognition of the limitations of these older AASHTO Design Guides, the Joint Task Force on Pavements (JTFP) initiated an effort to develop an improved design guide based as fully as possible on mechanistic principles. The FHWA's Mechanistic-Empirical Pavement Design Guide (MEPDG) is the recently released result of such an effort. An integrated hierarchical approach was elected as the main framework of the new MEPDG in such a way that the input items are classified as Level 1, Level 2, and Level 3 from the most to least accurate values depending on the importance of projects in concern. Four broad categories of inputs are required in the MEPDG analysis: namely, general, traffic, climate, and structure where the paving materials' mechanical properties are fed under the category of structure.

The dynamic modulus, $|E^*|$, is the most important MEPDG input for the asphalt layers in a pavement structure. The $|E^*|$ test is a part of the Asphalt Mixture Performance Tests (AMPTs) (formerly termed Simple Performance Tests), which includes flow number (F_N), and flow time (F_T) tests, which were recommended by NCHRP Project 9-19, Superpave Support and Performance Models Management. In order to fully implement the new MEPDG on the Louisiana pavement design practice, it was necessary to characterize typical Louisiana asphalt mixtures using the latest AMPT protocols and to develop a database of $|E^*|$ for the Level 1 MEPDG input.

OBJECTIVE

The objective of this research was to characterize common Louisiana asphalt mixtures and to develop a catalog for dynamic modulus value inputs in the MEPDG software using the Asphalt Mixture Performance Tester.

SCOPE

A total of 14 rehabilitation projects across Louisiana were selected to provide 28 asphalt mixtures as shown in the map in Figure 1. The experimental factorial included two mixture production methods [hot-mix asphalt (HMA) and warm-mix asphalt (WMA)]; three design traffic levels [Level 1, 2, and 3 for less than 3 million, 3 to 30 million, and more than 30 million equivalent single axle loads (ESALs), respectively]; three nominal maximum aggregate sizes (12.5, 19, and 25 mm); and four asphalt binder grades (PG64-22, PG70-22, PG76-22, and PG82-22). Laboratory mechanistic tests performed included the $|E^*|$, F_N, F_T, and loaded wheel tracking (LWT) tests.

LTRC Report 499

Read online summary or final report:
www.ltrc.lsu.edu/publications.html

PRINCIPAL INVESTIGATOR:
Louay Mohammad, Ph.D.
225.767.9126

LTRC CONTACT:
Bill King, P.E.
225.767.9129

FUNDING:
SPR: TT-Fed/TT-Reg

Louisiana Transportation Research Center

4101 Gourrier Ave
Baton Rouge, LA 70808-4443

www.ltrc.lsu.edu

METHODOLOGY

Mechanical characterization testing on 28 typical Louisiana asphalt mixtures was conducted on 14 field projects, which include design traffic levels 1, 2, and 3. Test methods performed in this study include dynamic modulus ($|E^*|$), flow number (F_N), flow time (F_T), and loaded wheel tracker (LWT) tests. The $|E^*|$ test results were used to develop a catalog of typical dynamic modulus values for Level 1 input in the new MEPDG. In addition, validation of Witczak and Hirsch's $|E^*|$ prediction equations, sensitivity analysis of MEPDG rutting prediction model, preliminary calibration of MEPDG rutting prediction model for use in Louisiana, comparison between uniaxial and indirect tension (IDT) $|E^*|$, and correlation analysis between the LWT and other AMPT (asphalt mixture performance test) methods were conducted.

CONCLUSIONS

A catalog of $|E^*|$ values of typical Louisiana asphalt mixtures was created for the Level 1 and Level 2 traffic categories per the Louisiana specification. It is expected that this catalog of dynamic modulus could be used for Level 1 input in the MEPDG simulations.

Other significant findings included:

- Dynamic modulus ($|E^*|$) appeared to be dependent on the design traffic level, nominal maximum aggregate size (NMAS), and the asphalt binder's high temperature PG grade. Mixtures designed for high-volume traffic roads with larger aggregate size and higher asphalt binder grade resulted in higher $|E^*|$ values at higher temperatures.
- The rutting factor, $|E^*|/\sin(\delta)$ was found to distinguish the Level 1 traffic mixtures from the Level 2 and Level 3 mixtures for their potential rutting resistance.
- Both Witczak and Hirsch models predicted the dynamic modulus ($|E^*|$) values with reasonable accuracy.
- The MEPDG rut prediction was sensitive to changes in the dynamic modulus input values. The pavement structure with the thicker asphalt layer was more sensitive as compared to the structure with the thinner asphalt layer.
- A local calibration on the rutting prediction model of the MEPDG was conducted and preliminary ranges of calibration factors were presented.
- Dynamic modulus test results obtained in the axial and IDT modes showed no statistical differences for the majority of the mixtures tested.
- Correlations between the LWT rut depth and $|E^*|$, $|E^*|/\sin(\delta)$, and Fn were not strong.

RECOMMENDATIONS

This research project generated a catalog of dynamic moduli values for various asphalt mixture types. This catalog includes dynamic modulus test results at five temperatures and six loading frequencies. The dynamic modulus values were grouped by Design Levels 1 and 2, as defined in the 2006 Edition of the Louisiana Specifications for Roads and Bridges. The dynamic modulus values are further grouped by NMAS within each level. This catalog was also created as a user-friendly spreadsheet and Microsoft Access based database, which is submitted as a separate CD. It is recommended that LADOTD design engineers use this catalog as the asphalt mixtures materials input during the implementation of the MEPDG (known as Pavement-ME) design guide in Louisiana.

In addition, the rutting prediction model used in the MEPDG was calibrated based on limited number of projects. The local calibration coefficients developed in this study are recommended during the implementation of the MEPDG design guide in Louisiana.

Furthermore, it is recommended that field rut depth studies should be pursued to collect longterm rutting performance of actual field mixtures to improve MEPDG rutting predictions.

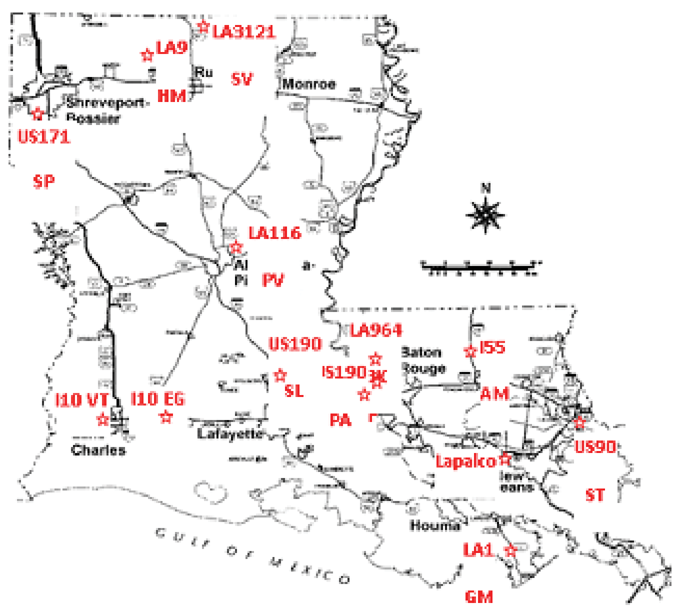

Figure 1
14 field project locations