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Evaluation of Current Louisiana Flexible Pavement Structures Using PMS Data and New Mechanistic-Empirical Pavement Design Guide

INTRODUCTION

The new Mechanistic-Empirical Pavement Design Guide (MEPDG) developed under the National Cooperative Highway Research Program (NCHRP) Project 1-37A represents a major change as compared to the 1993 AASHTO Pavement Design Guide. MEPDG provides a rational pavement design framework based on the mechanistic-empirical principles to characterize the impacts of traffic, climate, and material properties on the pavement performance. Before replacing the 1993 Pavement Design Guide (and its accompanying DARWin 3.1 design software) currently used by Louisiana Department of Transportation and Development (LADOTD), the nationally calibrated MEPDG design models need to be further validated and calibrated against the local conditions in Louisiana.

OBJECTIVE

The objectives of this study were to use MEPDG 1.1 software evaluating the performance of typical Louisiana flexible pavement types, materials, and structures as compared with Louisiana pavement management system (PMS) performance data and identify the areas for further local calibration of the MEPDG in Louisiana. Only new and full-depth rehabilitated (with a reconstruction of base) flexible pavements were investigated. The selected projects for analysis included five typical Louisiana flexible pavement structure types: asphalt concrete (AC) over AC base, AC over rubblized portland cement concrete (RPCC) base, AC over crushed stone, AC over soil cement, and AC over stone interlayer. Network-level pavement condition data from the Louisiana pavement management system were used to compare with the MEPDG predicted pavement performance.

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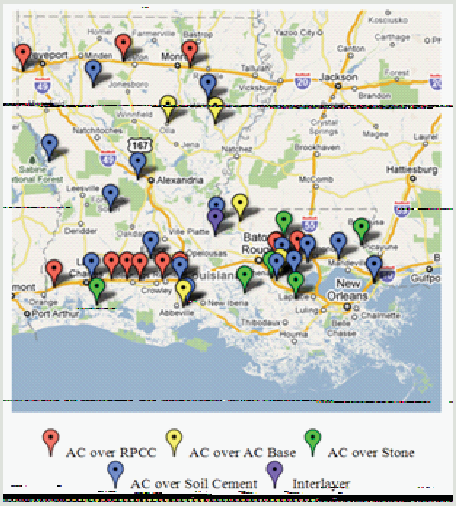
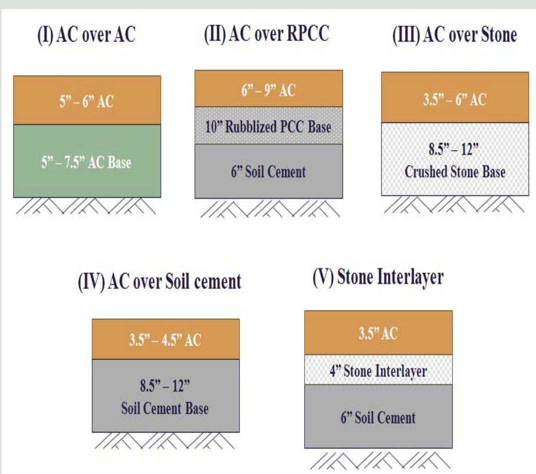
METHODOLOGY

In this study, a total of 40 AC pavement projects were strategically selected throughout Louisiana with various traffic volume and subgrade stiffness. The original pavement structural design information as well as the network-level pavement performance data for the selected projects were retrieved from multiple LADOTD data sources including the PMS and other project tracking databases and used to evaluate the implementation of MEPDG for flexible pavement design in Louisiana. Based on the sensitivity analyses and available pavement design information, a set of Louisiana condition based level-3 design inputs (i.e., material, climate, and traffic inputs) for MEPDG flexible pavement design was developed. The MEPDG design software version 1.1 was then used to predict the pavement performance of the selected projects. In addition, to facilitate the data analysis and further provide a data source for further local calibration of MEPDG in Louisiana, a database named LA-MEPDG was developed, which contains all MEPDG required inputs and LA-PMS retrieved pavement performance data for all projects evaluated in this study. By comparing the MEPDG predicted and LA-PMS measured distresses, the suitability of the MEPDG design model for Louisiana conditions was evaluated. Statistical analyses were performed to investigate potential influence factors on the prediction error of the MEPDG models. Finally, a MEPDG design example for an AC over AC base pavement structure was presented and compared to the design results form the 1993 AASHTO Pavement Design Guide.





Project location and pavement structures

CONCLUSIONS

The comparison between LA-PMS measured and MEPDG predicted pavement performance results indicated that MEPDG generally over-predicts the total rutting for all projects evaluated, except some pavements with AC bases. The MEPDG rutting models appeared to be adequate only for the AC over AC base pavements in Louisiana. The MEPDG fatigue cracking models (combining both the alligator and longitudinal cracking models) were found somewhat suitable to be used in the surface cracking prediction for the AC over AC base and AC over RPCC pavements in Louisiana, even without further local calibration. This observation may result from the fact that the fatigue cracking during the first 10 years of pavement service was not the major distress type for those pavements. On the other hand, the MEPDG fatigue models were found to significantly under predict field cracking for both the AC over soil cement and AC over stone pavements. The possible explanation is because the current MEPDG software cannot correctly predict any shrinkage and reflective cracking due to a software bug. The predicted International Roughness Index (IRI) by MEPDG was found to compare well with the LA-PMS data for most pavement projects evaluated. The predicted IRIs at the design reliability level are often larger than or equal to the field IRIs at the mean-plus-one-standard-deviation level for different pavement types, except the AC over soil cement pavement type. Further statistical analyses using multiple comparison and the Analysis of Variance (ANOVA) procedures were performed on the MEPDG prediction errors. The results generally indicated that the MEPDG predicted errors for both the rutting and fatigue cracking models could be significantly influenced by pavement type, traffic volume, subgrade modulus and project location. Based on the available data, a preliminary local calibration of the MEPDG rutting models was conducted for AC over RPCC and AC over soil cement pavements in Louisiana.

RECOMMENDATIONS

LADOTD pavement design engineers may start to use the current version MEPDG software (version 1.1) as a design comparison tool to LADOTD's currently-used DARWin 3.1 design method until further improvement can be made to the MEPDG prediction models and input data based on the results of several national on-going research studies as well as research projects currently conducted by LTRC. The input data developed by this study, such as the E* master curves for typical Louisiana HMA mixtures and the various calibration factors of rutting models for different pavement types and materials, can be used as initial MEPDG input trials (or Level-3 inputs) in Louisiana. MEPDG fatigue models need to be further calibrated based on different flexible pavement types and the developed rutting calibration factors should be further validated based on trench test results on typical pavement structures. LADOTD needs to start developing a calibration database by monitoring newly constructed pavements and expand the database (LA-MEPDG) developed.