

# **IMPLEMENTATION OF THE FLORIDA CRACKING MODEL INTO MECHANISTIC-EMPIRICAL PAVEMENT DESIGN**

## **PROBLEM STATEMENT**

The new NCHRP Mechanistic-Empirical Pavement Design Guide (ME-PDG) for flexible pavements combines the elements of mechanical modeling and performance observations in analyzing the pavement life for a set of design conditions. The evaluation of pavement life based on stresses and strains requires the ability to account for changes in loads, environmental and temperature effects and to track changes and damage in the material over the projected life span of a pavement. Empirical and/or mechanical performance models that relate predicted stresses or strains for given combinations of loads, structure, and environmental conditions to rutting and cracking are also required in M-E design.

The new NCHRP ME-PDG framework includes empirical performance models for the prediction of rutting, traditional fatigue cracking, and low temperature cracking. Due to the relatively recent recognition of top-down cracking as a major pavement distress mechanism, the new NCHRP ME-PDG framework does not include the most recent findings from research on the factors and mechanisms controlling top-down cracking in pavements. In addition, the NCHRP ME-PDG framework does not allow for the optimization of design pavement thickness. Rather, it only allows the analysis of pavement life for a given pavement structure. In Florida, top-down cracking has been found to be a predominant mode of distresses of flexible pavements. After a multi-year study on top-down cracking supported by the Florida Department of Transportation (FDOT), the University of Florida has developed a top-down cracking model based on fracture mechanics.

## **OBJECTIVES**

The objectives of the implementation of this project include the following:

- Develop a pavement cracking analysis framework for evaluating the top-down cracking performance of mixtures. This framework is compatible with the new NCHRP ME-PDG framework. In addition, it includes a suitable material model based on Hot Mix Asphalt (HMA) fracture mechanics for implementation into an M-E design framework.
- Develop an interactive Windows-based M-E pavement design tool for use by pavement engineers in Florida. The pavement thickness design is fully integrated with key mixture cracking properties. Due to the full integration of mixture specification and pavement thickness design, the design tool developed is independent of the NCHRP ME-PDG software, even though the essential features of the current ME-PDG approach are included.

## **FINDINGS AND CONCLUSIONS**

This report presents the implementation of the Florida cracking model into a mechanistic-empirical (ME) flexible pavement design framework that integrates mixture properties with pavement thickness design. Researchers developed a new Mechanistic-Empirical pavement design tool for top-down cracking has been developed. A series of material models were developed for estimation of the time-, temperature-, and age-dependent asphalt material properties. With incorporation of the material properties models, the design tool is capable of performing pavement thickness design as well as pavement life prediction for top-down cracking in Florida. The thickness design is optimized for different traffic levels, design reliabilities, mixture types, and binder types, including polymer modified binders. The asphalt pavement layer thickness determination is an automated process, in contrast with the NCHRP ME-PDG design approach. This design tool has been developed and implemented into an interactive Windows-based software, making it convenient to use for Florida pavement design engineers. Further calibration and more continuum output are needed to refine the tool.

## **BENEFITS**

The benefits to the State of Florida from this research project include (1) the development of a new mechanistic-empirical flexible pavement design framework that combines both asphalt mixture material properties and pavement thickness design to determine optimal combinations of materials and asphalt layer thickness to minimize top-down cracking of Florida's pavements, (2) the implementation of the new design framework into a fast, interactive Windows-based pavement design tool tailored for Florida conditions and materials, and (3) the first integrated pavement evaluation and design tool that allows for the quantification of the benefits of polymer modification in the State of Florida in terms of either increased pavement life or reduced pavement thickness.

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