National Center for Asphalt Technology NCAT at AUBURN UNIVERSITY

Pavement ME Design - Impact of Local Calibration, Foundation Support, and Design and Reliability Thresholds

RESEARCH SYNOPSIS 17-08

Objectives

The Mechanistic-Empirical Pavement Design Guide (MEPDG) and the accompanying AASHTOWare Pavement ME Design software were developed to replace the empirical AASHTO Pavement Design Guide. Properly conducting local calibration, selecting design thresholds, and selecting reliability levels for acceptable pavement designs are important steps in the successful adoption and use of the MEPDG. The importance of these steps is illustrated in (1) two case studies to show the effect of global and local calibration coefficients; and (2) a sensitivity analysis to show the impact of performance criteria and reliability levels on flexible pavement design.

Case Studies

Case studies include Missouri and Colorado. These two states completed their local calibration processes and use the Pavement ME Design software for routine pavement design.

For local calibration of the MEPDG for flexible pavement design, Colorado utilized more Level 1 inputs and evaluated more pavement sites than Missouri. Both states changed local calibration coefficients for models to predict asphalt rutting, unbound-material rutting, transverse cracking, and International Roughness Index (IRI). Colorado also changed local calibration coefficients for the fatigue cracking model while Missouri did not, as this model was found to be appropriate for local materials and conditions.

Missouri currently designs flexible pavements based only on fatigue cracking and rutting in asphalt layers even though other models were also locally calibrated. The performance criteria were selected to minimize or eliminate bottom-up fatigue cracking in asphalt layers and to control total rutting due to the potential for hydroplaning. Missouri conducts all flexible pavement designs at a 50% reliability level.

Colorado selected design criteria and reliability levels similar to recommendations in the Manual of Practice (*1*). Criteria vary based on functional classification with more stringent thresholds for higher traffic roadways. Designs for new pavement or overlays use different criteria. For new flexible pavements, thresholds for IRI, total rutting, asphalt rutting, and top-down fatigue cracking apply to time of the first rehabilitation whereas criteria for bottom-up fatigue cracking and thermal cracking apply to the entire design life. For overlays, criteria are selected for the end of the overlay design life.

For the case studies, new flexible pavement designs were conducted for one pavement section in each state using both global and local calibration coefficients. Jointed plain concrete pavement (JPCP) designs were also conducted for comparison. Key findings are as follows:

- In Missouri, new flexible pavement designs were governed by bottom-up fatigue cracking. Since the coefficients (globally calibrated) in the fatigue cracking model were not adjusted during local verification, the final thickness (8 inches of asphalt and 18 inches of aggregate) was the same for the flexible pavement designs using global and local calibration coefficients. For new JPCP designs, the global calibration coefficients produced a design (8.5 inches of concrete and 18 inches of aggregate) 0.5 inches thicker than local calibration coefficients (8 inches of concrete and 18 inches of aggregate).
- In Colorado, local calibration coefficients yielded an asphalt structure (11.5 inches of asphalt and 6 inches of aggregate) 1-inch thinner than global coefficients (10.5 inches of asphalt and 6 inches of aggregate). The designs were controlled by bottom-up cracking. These designs failed the asphalt rutting criteria. However, the agency recognized that the locally calibrated model was over-predicting rutting in the asphalt layer, as rutting was not a performance issue for similar pavements in the area. Thus, the designs were accepted. For JPCP, thickness was the same for local and global calibration coefficients (7.5 inches of concrete and 6 inches of aggregate).

Both states still plan to adjust their MEPDG procedures as more information becomes available. Missouri is recalibrating the models with more Level 1 inputs and field performance information while Colorado is adjusting the asphalt rutting model based on more field rutting data.

Selection of Performance Criteria and Reliability Levels

MEPDG allows performance criteria and reliability levels to be set by state highway agencies. Reliability is the probability that each distress will be lower than its design threshold (i.e., performance criterion) at the end of the design life.

A sensitivity analysis was conducted using the flexible pavement designed with local calibration coefficients in the Colorado case study as the reference structure. This design consists of a 10.5-inch asphalt layer and a 6-inch crushed gravel base on top of Class A-2-4 subgrade.

The analysis was conducted for four roadway classifications including interstate, principal arterial, minor arterial, and major collector. For each roadway classification, the performance criteria were selected as recommended in the Manual of Practice (*1*). The analysis was conducted by determining the design reliability level when the asphalt thickness was varied for each roadway classification. Permanent deformation in the unbound layers and bottom-up fatigue cracking of the asphalt layers were found to be more sensitive to asphalt thickness, with bottom-up fatigue cracking being the most sensitive. The impact of reliability level on asphalt thickness designed at the recommended performance criteria for each roadway classification is shown in Figure 1.

Proposed performance criteria (i.e., maximum value at the end of the design life) and reliability levels are shown in Table 1 based on the sensitivity analysis results, values recommended in the Manual of Practice (*1*), and those adopted in Colorado.

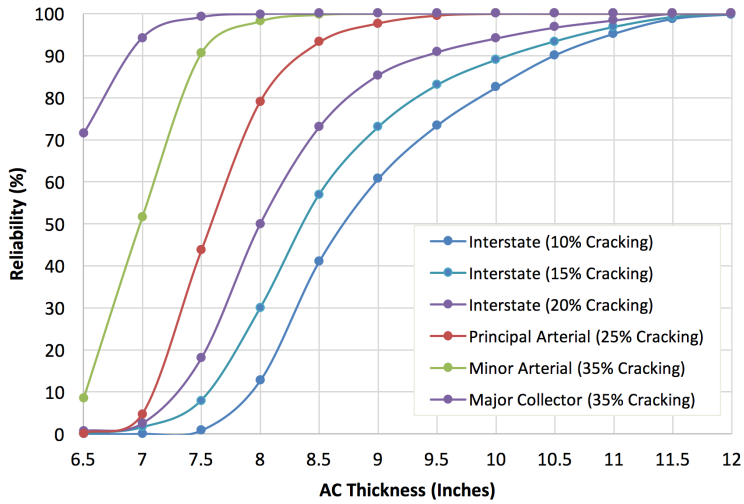

Figure 1. Reliability Level versus AC Thickness at Selected Performance Criteria

Summary

Local calibration and selection of design thresholds and reliability levels are important steps in the successful adoption and use of the MEPDG. Design thickness of asphalt layers is affected when the coefficients of models to predict bottom-up cracking and rutting in unbound layers are adjusted during local calibration. Design thresholds and reliability levels are proposed for each roadway classification based on results of the sensitivity analysis and values recommended in the Manual of Practice and adopted by states.

References

1. *Mechanistic–Empirical Pavement Design Guide, Interim Edition: A Manual of Practice*. AASHTO, Washington, D.C., 2008.

Table 1. Proposed Performance Criteria and Reliability Levels for Future Design

Classification	Reliability (%)	Performance Criteria					
		Terminal IRI (in/mi)	Rutting Total (in)	Rutting AC (in)	Top-Down Cracking (ft/mi)	Bottom-Up Cracking (% lane)	Thermal Cracking (ft/mi)
Interstate	80-90	160	0.5	0.35	2,000	10-20[1]	1,500
Principal Arterials	75-90	200	0.5	0.35	2,500	25	1,500
Minor Arterial	75-90	200	0.65	0.5	3,000	35	1,500
Major Collectors	70-90	200	0.65	0.5	3,000	35	1,500

[1]A sensitivity analysis may be conducted to select an appropriate criterion within this range based on the accuracy and precision of the locally-calibrated bottom-up cracking model.

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