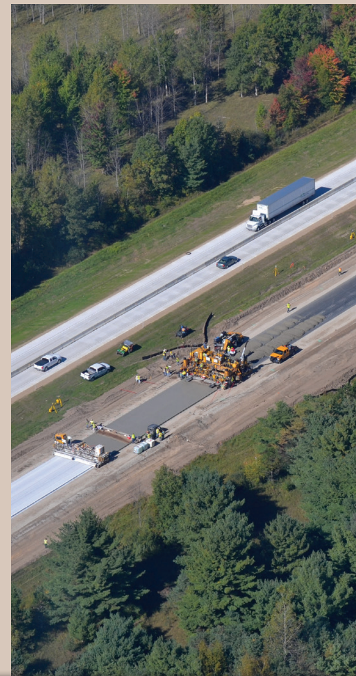
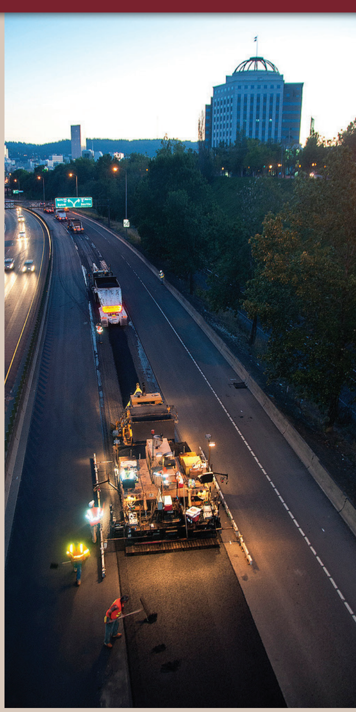
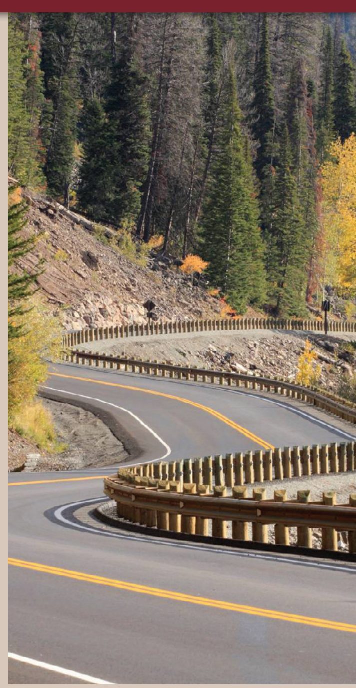
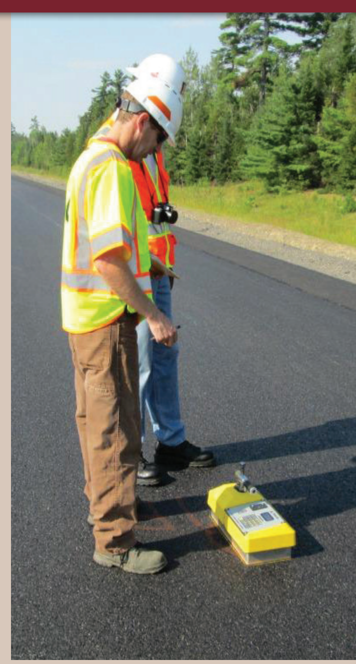


Mechanistic-Empirical Pavement Design Guide

~ A Manual of Practice ~







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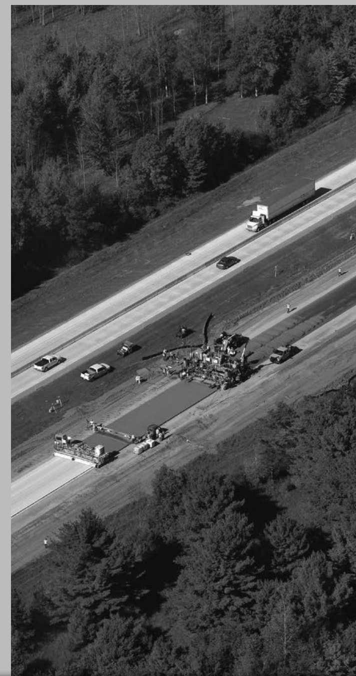
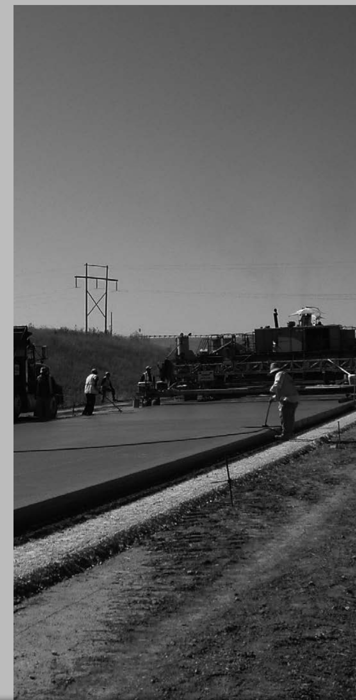

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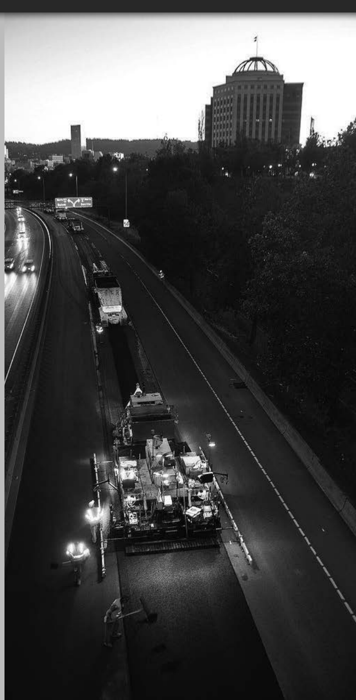


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Preface

This document or manual of practice describes a pavement design methodology that is based on engineering mechanics and has been validated with extensive road test performance data. This methodology is termed mechanistic-empirical (ME) pavement design, and it represents a major change from the pavement design methods in practice today.

Interested agencies have already begun implementation activities through staff training, collection of input data (materials library, traffic library, etc.), acquiring of test equipment, and preparation of field sections for local calibration. This manual, referred to as the Mechanistic-Empirical Pavement Design Guide (MEPDG), presents the information necessary for pavement design engineers to start using the ME-based design and analysis method. The software supporting this method is called Pavement ME Design® and is commercially available through AASHTOWare. The software is referred to in this document as PMED.

Multiple enhancements have been made to the AASHTOWare PMED based on completed research projects sponsored by the National Cooperative Highway Research Program (NCHRP) and the Federal Highway Administration (FHWA). In addition, revisions to the software were based on evaluations performed by State Highway Agencies and others in the Community of Practice. The third edition of the MEPDG Manual of Practice was prepared so the manual was consistent with the enhanced features and models included in the software through 2018.

The following table (Table P-1) summarizes the key differences noted between the format and calibration factors used in the MEPDG version 1.1 software, the AASHTOWare Pavement ME Design software version 2.3.1, and version 2.5.3 software.

Table P-1. Summary of Key Differences in Software Format and Calibration Factors

<table>
<tr><th colspan="2">Format, Transfer Functions, and Calibration Coefficients</th><th>MEPDG version 1.1</th><th>AASHTOWare Pavement ME Design version 2.3.1</th><th>AASHTOWare Pavement ME Design version 2.5.3</th></tr>
<tr><td colspan="2">Output Format</td><td>Excel-based</td><td>PDF- and Excel-based</td><td>PDF- and Excel-based</td></tr>
<tr><td colspan="2">Climatic Input Data and if Included in Output Summary</td><td>Data from Ground-Based Weather Stations; output summary not included</td><td>Data from NARR database for rigid and flexible pavements; output summary included</td><td>Data from NARR database for rigid pavements and MERRA2 database for flexible and semi-rigid pavements; output summary included</td></tr>
<tr><td colspan="2">Axle Configuration Data in Output Summary</td><td>Not included</td><td>Included</td><td>Included</td></tr>
<tr><td colspan="2">Special Axle Load Configuration</td><td>Included</td><td>Not included</td><td>Not included</td></tr>
<tr><td colspan="2">Reflection Cracking Transfer Function</td><td>Empirical regression equation included</td><td>ME-based fracture mechanics model included</td><td>ME-based fracture mechanics model included</td></tr>
<tr><td colspan="2">Coefficient of Thermal Expansion (CTE)</td><td>CTE for Basalt of 4.6</td><td>CTE for Basalt of 5.2</td><td>CTE for Basalt of 5.2</td></tr>
<tr><td colspan="2">PCC Zero Stress Temperature</td><td>PCC Zero Stress Temperature (60°–120°F)</td><td>PCC Set Temperature (70°–212°F)</td><td>PCC Set Temperature (70°–212°F)</td></tr>
<tr><td colspan="2">Heat Capacity of Asphalt Pavement</td><td>Default value of 0.23 BTU/lb-°F</td><td>Default value of 0.28 BTU/lb-°F</td><td>Default value of 0.28 BTU/lb-°F</td></tr>
<tr><td colspan="2">Thermal Conductivity of Asphalt Pavement</td><td>Default value of 0.67 BTU/(ft)(hr)(F)</td><td>Default value of 1.25 BTU/(ft)(hr)(F)</td><td>Default value of 1.25 BTU/(ft)(hr)(F)</td></tr>
<tr><td colspan="2">Surface Shortwave Absorptivity</td><td>Default value of 0.95</td><td>Default value of 0.85</td><td>Default value of 0.85</td></tr>
<tr><td rowspan="4">Global Model Coefficient for Unbound Materials and Soils in Flexible Pavement Subgrade Rutting Model</td><td>Aggregate Base</td><td rowspan="3">k_{s1} of 1.673</td><td rowspan="3">k_{s1} of 2.03</td><td>k_{s1} of 0.965</td></tr>
<tr><td>Coarse-Grained Soil</td><td>k_{s1} of 0.965</td></tr>
<tr><td>Sand Soil</td><td>k_{s1} of 0.635</td></tr>
<tr><td>Fine-Grained Soil</td><td>k_{s1} of 1.35</td><td>k_{s1} of 1.35</td><td>k_{s1} of 0.675</td></tr>
</table>

Continued on next page.

Table P-1. Summary of Key Differences in Software Format and Calibration Factors, *continued*

Format, Transfer Functions, and Calibration Coefficients		MEPDG version 1.1	AASHTOWare Pavement ME Design version 2.3.1	AASHTOWare Pavement ME Design version 2.5.3
Global Local Calibration or Field Adjustment Constant for Unbound Materials and Soils in Flexible Pavement Subgrade Rutting Model	Aggregate Base	1.0	1.0	1.0
	Coarse-Grained Soil			1.0
	Sand Soil			1.0
	Fine-Grained Soil			1.0
Global Laboratory-Derived Model Coefficients in the Fatigue Cracking Prediction Model in Flexible Pavement		k_{s1} of 0.007566	k_{s1} of 0.007566	k_{s1} of 3.75
		k_{s2} of -3.9492	k_{s2} of 3.9492	k_{s2} of 2.87
		k_{s3} of -1.281	k_{s3} of 1.281	k_{s3} of 1.46
Global Local Calibration or Field-Adjustment Constants for Fatigue Cracking Prediction Model in Flexible Pavement		β_1 of 1.0	β_1 of 1.0	AC thickness dependent; see Chapter 5
		β_2 of 1.0	β_2 of 1.0	β_2 of 1.38
		β_3 of 1.0	β_3 of 1.0	β_3 of 0.88
Global Bottom-Up Alligator Cracking Transfer Function Coefficients		C_1 of 1.0	C_1 of 1.0	1.31
		C_2 of 1.0	C_2 of 1.0	AC thickness dependent; see Chapter 5
Global Calibration or Field-Adjustment Coefficient in the Transverse Cracking Model for AC		k_t (Level 1) of 5.0	k_t (Level 1) of 1.5	k_s (Level 1) is Mean Annual Air Temperature (MAAT) dependent; see Chapter 5.
		k_t (Level 2) of 1.5	k_t (Level 2) of 0.5	k_s (Level 2) is MAAT dependent; see Chapter 5.
		k_t (Level 3) of 3.0	k_t (Level 3) of 1.5	k_s (Level 3) is MAAT dependent; see Chapter 5.
Global Laboratory Derived Model Coefficients in the Rut Depth Prediction Model		k_1 of -3.35412	k_1 of -3.35412	k_1 of -2.45
		k_{2r} of 0.4791	k_2 of 1.5606	k_2 of 3.01
		k_{3r} of 1.5606	k_3 of 0.4791	k_3 of 0.22

Continued on next page.

Table P-1. Summary of Key Differences in Software Format and Calibration Factors, *continued*

Format, Transfer Functions, and Calibration Coefficients	MEPDG version 1.1	AASHTOWare Pavement ME Design version 2.3.1	AASHTOWare Pavement ME Design version 2.5.3
Global Local Calibration or Field Adjustment Coefficients in the Rut Depth Prediction Model	β_1 of 1.0	β_1 of 1.0	β_1 of 0.40
	β_2 of 1.0	β_2 of 1.0	β_2 of 0.52
	β_3 of 1.0	β_3 of 1.0	β_3 of 1.36
Calibration Coefficients in the Rigid Pavement Cracking Prediction Model	C_4 of 1.0	C_4 of 0.52	C_4 of 0.52
	C_5 of -1.98	C_5 of -2.17	C_5 of -2.17
Calibration Coefficients in the Rigid Pavement Faulting Prediction Model	C_1 of 1.29	C_1 of 1.0184	C_1 of 0.595
	C_2 of 1.1	C_2 of 0.91656	C_2 of 1.636
	C_3 of 0.001725	C_3 of 0.0021848	C_3 of 0.00217
	C_4 of 0.0008	C_4 of 0.0008837	C_4 of 0.00444
	C_6 of 0.4	C_6 of 0.47	C_6 of 0.47
	C_7 of 1.2	C_7 of 1.83312	C_7 of 7.3
Calibration Coefficient in the Rigid Pavement Punchout Prediction Model	APO of 195.789	C_3 of 107.73	C_3 of 107.73
	αPO of 19.8947	C_4 of 2.476	C_4 of 2.475
	βPO of -0.526316	C_5 of -0.785	C_5 of -0.785
Calibration Coefficients in the Short JPCP Overlay Longitudinal Cracking Prediction Model	Excluded	C_4 of 0.4	C_4 of 0.4
		C_5 of -2.21	C_5 of -2.21

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CHAPTER 1

Introduction

The overall objective of the Mechanistic-Empirical Pavement Design Guide (MEPDG) is to provide the highway community with a state-of-the-practice method for the design and analysis of new and rehabilitated pavement structures, based on mechanistic-empirical (ME) principles. This means that the design/analysis procedure calculates pavement responses (stresses, strains, and deflections) and uses those responses to compute incremental damage over time. The procedure empirically relates the cumulative damage to observed pavement distresses. The flowchart in Figure 1-1 illustrates this ME-based procedure. The AASHTOWare Pavement ME Design® is the commercially available software tool. The AASHTOWare software is referred to in this manual as PMED.

The AASHTOWare PMED represents a major change in the way pavement design is performed. AASHTOWare PMED predicts multiple performance indicators (refer to Figure 1-1) and it provides a direct tie between materials, structural design, construction, climate, traffic, and pavement management systems. Figures 1-2 and 1-3 are examples of the interrelationship between these activities for asphalt concrete (AC) and Portland cement concrete (PCC) materials.

1.1 Purpose of Manual

This manual of practice presents information to guide pavement design engineers in making decisions and using AASHTOWare PMED for new pavement and rehabilitation design. The manual does not provide guidance on developing regional or local calibration factors for predicting pavement distress and smoothness. A separate document, *Guide for the Local Calibration of the Mechanistic-Empirical Pavement Design Guide*, provides guidance for determining the local calibration factors for both AC and PCC pavement types (2).

1.2 Overview of the Design Procedure

AASHTOWare PMED is a production-ready design tool to support the day-to-day operations of public and private pavement engineers. When analyzing a pavement design project using