Use of Pavement Management Information System for Verification of *Mechanistic–Empirical Pavement Design Guide* Performance Predictions

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The performance models used in the *Mechanistic–Empirical Pavement Design Guide* (MEPDG) are nationally calibrated with design inputs and performance data obtained primarily from the national Long-Term Pavement Performance database. It is necessary to verify and calibrate MEPDG performance models for local highway agencies' implementation by taking into account local materials, traffic information, and environmental conditions. This paper discusses the existing pavement management information system (PMIS) with respect to the MEPDG and the accuracy of the nationally calibrated MEPDG prediction models for Iowa highway conditions. All the available PMIS data for Interstate and primary road systems in Iowa were retrieved from the Iowa Department of Transportation (DOT) PMIS. The retrieved databases were then compared and evaluated with respect to the input requirements and outputs for Version 1.0 of the MEPDG software. Using Iowa DOT's comprehensive PMIS database, researchers selected 16 types of pavement sections across Iowa (not used for national calibration in the NCHRP 1-37A study). A database of MEPDG inputs and the actual pavement performance measures for the selected pavement sites were prepared for verification. The accuracy of the MEPDG performance models for Iowa conditions was statistically evaluated. The verification testing showed promising results in terms of MEPDG's performance prediction accuracy for Iowa conditions. Recalibrating the MEPDG performance models for Iowa conditions is recommended to improve the accuracy of pavement performance predictions.

The current AASHTO Design Guide is based on methods that have evolved from the AASHO Road Test (1958–1961) (*1*). Through a number of editions from the initial publication in 1962, the interim guide in 1972 (*2*) and later editions (*3, 4*), minor changes and improvements have been made. Nonetheless, these later modifications have not significantly altered the original methods, which are based on empirical regression techniques relating simple material characterizations, traffic characterization, and measures of performance.

In recognition of the limitations of the current AASHTO guide, the new *Mechanistic–Empirical Pavement Design Guide* (MEPDG) and its software were developed through NCHRP Project 1-37A (*5*). The mechanistic part of MEPDG is the application of the principles of engineering mechanics to calculate pavement responses (stresses, strains, and deflection) under loads for the predictions of the pavement performance history. The empirical nature of the MEPDG stems from the laboratory-developed pavement performance models being adjusted or calibrated to the observed performance measurements (distresses) from the actual pavements. The MEPDG's mechanistic–empirical procedure will require an even greater effort to successfully implement a useful design procedure. Without calibration, the results of mechanistic calculations cannot be used to predict rutting, cracking, and faulting with any degree of confidence. The distress mechanisms are far more complex than can be practically modeled; therefore, the use of empirical factors and calibration is necessary to obtain realistic performance predictions.

The MEPDG does not provide a design thickness as the end products; instead, it provides the pavement performance throughout its design life. The design thickness can be determined by modifying design inputs and obtaining the best performance with an iterative procedure. The performance models used in the MEPDG are nationally calibrated using design inputs and performance data largely from the national Long-Term Pavement Performance (LTPP) database. The LTPP database used for national (global) calibration of MEPDG includes no hot-mix asphalt (HMA) sections and only one portland cement concrete (PCC) pavement section in Iowa (*5*). Thus, it is necessary to calibrate MEPDG performance models for local highway agencies' use by taking into account local materials, traffic information, and environmental conditions.

The local calibration process involves three important steps: verification, calibration, and validation (*6*). Verification refers to assessing the accuracy of the nationally (globally) calibrated prediction models for local conditions. Calibration refers to the mathematical process through which the total error or difference between observed and predicted values of distress is minimized. Validation refers to the process to confirm that the calibrated model can produce robust and accurate predictions for cases other than those used for model calibration.

The first step of the local calibration plan is to perform verification runs on the pavement sections using the nationally calibrated MEPDG performance models (*6*). The MEPDG (*5*) recommends

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that a verification database be developed to confirm that the national calibration factors or functions of performance models are adequate and appropriate for the construction, materials, climate, traffic, and other local conditions.

The input data types required for analysis using the MEPDG software range from simple data, such as the pavement design features and pavement geometrics, to detailed data obtained from destructive testing (e.g., HMA dynamic modulus and PCC elastic modulus), nondestructive testing (e.g., falling weight deflectometer testing), and drainage surveys. The performance measures projected from MEPDG include longitudinal cracking, rutting, fatigue cracking, and thermal cracking for HMA pavements, and jointed plain concrete pavement (JPCP) joint faulting, JPCP transverse cracking, and continuously reinforced concrete pavement (CRCP) punch-outs (with limited crack width calibration) for PCC pavements. International Roughness Index (IRI) is also projected for new and rehabilitated pavement systems. Many of this information actually measured can be obtained from the local agency's pavement management information system (PMIS). However, it is also needed to systematically evaluate the existing PMIS with respect to the MEPDG input parameters and projected performance measure results for local calibration.

SCOPE AND OBJECTIVES

Scope

To effectively and efficiently transition from current pavement design methodology to the MEPDG, the Iowa Department of Transportation (DOT) developed a strategic plan for implementing the MEPDG through research projects with Iowa State University in 2005. An implementation plan consists of general implementation and full implementation efforts (*7*). The general implementation efforts are high-priority research activities to demonstrate the benefits of MEPDG in Iowa. These activities include sensitivity analyses; examination of MEPDG design components related to traffic, climate, structural and nonstructural elements; and verification of the nationally calibrated MEPDG performance models using available data from the Iowa DOT's PMIS. On the basis of the findings from the general implementation efforts, Iowa DOT has developed a plan for full implementation focusing mainly on local calibration of MEPDG in Iowa.

The research described in this paper was conducted as part of the general MEPDG implementation for Iowa DOT. The scope of this paper includes the evaluation of the existing PMIS with respect to the MEPDG input and output information and the verification of the nationally calibrated MEPDG performance models using available data from Iowa DOT's PMIS. Level 3 inputs were selected for verification of MEPDG.

Objectives

The primary objectives of this research are to (*a*) to evaluate the type, accuracy, and timeliness of information collected in the Iowa DOT's PMIS regarding the MEPDG input and output information; (*b*) determine whether the nationally calibrated performance models used in the MEPDG provide a reasonable prediction of actual performance; and (*c*) to examine if desired accuracy or correspondence exists between predicted and monitored performance for Iowa highway conditions.

To accomplish these objectives, all the available PMIS data for Interstate and primary road systems in Iowa were retrieved from the Iowa DOT's PMIS. The retrieved databases were then compared and evaluated with respect to the input requirements and outputs for Version 1.0 of the MEPDG software. Using Iowa DOT's comprehensive PMIS database, researchers selected 16 different types of pavement sections across Iowa, not used for national calibration in NCHRP Project 1-37A. The MEPDG input parameter database for the selected pavements was prepared primarily from Iowa DOT's PMIS. A database of the actual pavement performance measures available was also prepared. The accuracy of the MEPDG performance predictions for Iowa conditions was statistically evaluated. On the basis of the findings of this research, recommendations are made for future MEPDG local calibration efforts for Iowa conditions.

EVALUATION OF IOWA DOT's PMIS FOR MEPDG

Each year, the Iowa PMIS database contains more than 3,000 data records, including detailed information for HMA, JPCP, CRCP, and overlaid (composite) pavement systems. Each data record includes traffic volumes, pavement material and structure related information, and distress survey results that use about 270 columns when the database is formatted in an Excel spreadsheet. However, Iowa DOT's PMIS does not have detailed material property inputs (subgrade resilient modulus, HMA dynamic modulus, PCC elastic modulus, etc.) and detailed traffic characterization inputs (vehicle class distribution, hourly traffic distribution, etc.). The available information from Iowa DOT's PMIS was also compared with the rehabilitation information required for running Version 1.0 of the MEPDG software. These comparisons for HMA and PCC rehabilitation design are summarized in Table 1. Only four of nine input parameters of

TABLE 1 Input Requirements for MEPDG Flexible and Rigid Pavement Rehabilitation

Type of Rehabilitation	Input Variable Available in Iowa PMIS	Input Variable Not Available in Iowa PMIS
HMA rehabilitation		
Rehabilitation for existing PCC pavement	Modulus of subgrade reaction	Before restoration, percent slabs with transverse cracks plus percent previously replaced or repaired slabs After restoration, total percent replaced or repaired slabs CRCP punch-out (per mile) Month modulus of subgrade reaction measured
Rehabilitation for existing HMA pavement	Total rutting Milled thickness Existing pavement condition	Placement of geotextile prior to overlay
PCC rehabilitation: rehabilitation for existing PCC or HMA pavement	Modulus of subgrade reaction Milled thickness Existing pavement condition	Before restoration, percent slabs with transverse cracks plus percent previously replaced or repaired slabs After restoration, total percent replaced or repaired slabs CRCP punch-out (per mile) Monthly modulus of subgrade reaction measured

TABLE 2 Comparison of MEPDG Output Metrics to Metrics Adopted by Iowa DOT's PMIS

Type of Pavement	Performance Model	MEPDG	Iowa PMIS
HMA	Longitudinal cracking	Feet per mile	Meters per kilometer
	Alligator cracking[a]	Percentage of total lane area	Square meters per kilometer
	Thermal cracking[a]	Feet per mile	Number per kilometer
	Rutting	Inches	Millimeters
	Smoothness	Inches per mile	Meters per kilometer
PCC			
JPCP	Faulting	Inches	Millimeters
	Transverse cracking[a]	Percentage of slabs cracked	Number per kilometer
	Smoothness	Inches per mile	Meters per kilometer
CRCP	Punch-out[a]	Number per mile	N/A
	Maximum crack width[b]	Mils	N/A
	Minimum crack LTE[b]	Percentage	N/A
	Smoothness	Inches per mile	Meters per kilometer

NOTE: N/A = not available.
[a]Measurement units of performance predictors reported by MEPDG differ from those of Iowa DOT's PMIS.
[b]Performance measures reported by MEPDG are not available in Iowa DOT's PMIS.

MEPDG HMA rehabilitation and only three of seven input parameters of MEPDG PCC rehabilitation are available in the current PMIS. These results indicate that the Iowa DOT PMIS should be revised to incorporate periodically collected data for the identified unavailable parameters for successful implementation of the MEPDG in Iowa.

The pavement distress types and units of distresses collected from distress survey results and the recorded data in Iowa DOT's PMIS were also compared with those of MEPDG performance predictions (see Table 2). In general, most of the MEPDG performance measures are available in Iowa DOT's PMIS. However, three performance measures for CRCP, punch-out, maximum crack width, and minimum crack load transfer efficiency (LTE) are not available. Also, the measurement units for JPCP transverse cracking as well as HMA alligator and thermal (transverse) cracking reported by MEPDG cannot be compared with those of Iowa DOT's PMIS. These results indicate that the proper conversion methods of pavement distress measurement units from PMIS to MEPDG should be developed for the future local calibration of MEPDG for Iowa conditions. Iowa DOT's PMIS provides only accumulated (total) surface rutting values observed in the pavement systems, whereas MEPDG provides individual pavement layer rutting predictions. This difference can lead to difficulties in the local calibration of MEPDG rutting models because pavement sublayers below the surface layer contribute to total rutting value. The PMIS data are reported in the International System of Units units, whereas U.S. customary units are used in MEPDG, although this is not a big concern.

DATA COLLECTION

To develop the required database needed for MEPDG verification testing, researchers selected, in consultation with Iowa DOT engineers, representative pavement sections across Iowa for different pavement types (flexible, rigid, and overlaid/composite), geographical locations, and traffic levels.

Five HMA and five JPCP sections were selected under flexible and rigid pavement categories, respectively. These pavements were not used for national calibration through NCHRP Project 1-37A. Six overlaid (composite) pavement sections—three HMA over JPCP, and three HMA over HMA sections—were also selected. Table 3 summarizes the pavement sections selected for this study. Among the selected pavement sections, Highway US-18 in Clayton County was originally constructed as JPCP in 1967 and overlaid with HMA in 1992. This section was again resurfaced with HMA in 2006. However, this study did not consider the pavement performance data after HMA resurfacing in 2006 to avoid irregularity of data.

The MEPDG pavement inputs related to the selected sections were obtained primarily from the Iowa DOT's PMIS. Other major sources of the data include online project reports relevant to MEPDG implementation in Iowa (*8, 9*). If specific input data were not available, the best estimated typical value in Iowa conditions was used, considering its level of sensitivity with respect to MEPDG predicted performance. Level 3 inputs were selected because most data used in this study are typical Iowa values. A detailed database was prepared and formatted in a manner suitable for input to the MEPDG software. The descriptions of the input data and sources are presented next.

General Project Inputs

The general project inputs section of the MEPDG is categorized into general information, site/project identification information, and analysis parameters. General information consists of information about the pavement type, design life, and time of construction. Site/project identification information includes pavement location and construction project identification. The analysis parameters require initial smoothness (IRI), distress limit criteria, and reliability values. Most of the information required, except distress limit criteria, can be obtained from Iowa DOT's PMIS. The MEPDG software default values were applied to distress limit criteria.

Traffic Inputs

The base year for the traffic inputs is defined as the first calendar year that the roadway segment under design is opened to traffic. Four basic types of traffic data for the base year are required for the MEPDG: traffic volume, traffic volume adjustment factors, axle load distribution factors, and general traffic inputs. Iowa DOT's PMIS provides annual average daily truck traffic for the base year under

TABLE 3 Summary Information for Selected Iowa Pavement Sections

Type	Route	Direction[a]	County	Beginning Mile Post	End Mile Post	Construction Year	Resurface Year	AADTT[b]
Flexible (HMA)	US-218	1	Bremer	198.95	202.57	1998	N/R	349
	US-30	1	Carroll	69.94	80.46	1998	N/R	562
	US-61[c]	1	Lee	25.40	30.32	1993	N/R	697
	US-18	1	Kossuth	119.61	130.08	1994	N/R	208
	IA-141	2	Dallas	137.60	139.27	1997	N/R	647
Rigid (JPCP)	US-65[c]	1	Polk	82.40	83.10	1994	N/R	472
	US-75	2	Woodbury	96.53	99.93	2001	N/R	330
	I-80	1	Cedar	275.34	278.10	1991	N/R	7,525
	US-151	2	Linn	40.04	45.14	1992	N/R	496
	US-30	2	Story	151.92	158.80	1992	N/R	886
Overlaid (composite)								
HMA over JPCP	IA-9	1	Howard	240.44	241.48	1973	1992	510
	US-18[d]	1	Clayton	285.82	295.74	1967	1992	555
	US-65	1	Warren	59.74	69.16	1972	1991	736
HMA over HMA	US-18	1	Fayette	273.05	274.96	1977	1991	2,150
	US-59	1	Shelby	69.73	70.63	1970	1993	3,430
	IA-76	1	Allamakee	19.78	24.82	1964	1994	1,340

NOTE: N/R = not required.
[a]Direction 1 = northbound or eastbound and Direction 2 = southbound or westbound.
[b]Annual average daily truck traffic at construction year.
[c]LTPP sites in Iowa.
[d]Resurfaced again with HMA in 2006.

traffic volume. Because the other traffic input data required were not available in both of Iowa DOT's PMIS and previous project reports reviewed, the traffic input values of this case are the best estimated typical values using the sensitivity analysis results and the recommendations made by NCHRP Project 1-37A reports.

Climate Inputs

The MEPDG software includes climate data at weather stations in each state. The MEPDG software can also generate climate data by extrapolating nearby weather stations if the latitude and longitude values are known. The specific location information of selected sections obtained from Iowa DOT's PMIS was input and then the climate data of each section was generated.

Pavement Structure and Materials Inputs

The MEPDG pavement structure inputs include types of layer material and layer thicknesses. This information can be obtained from Iowa DOT's PMIS. For selected HMA over PCC and HMA over HMA pavements in the overlaid pavement category, additional MEPDG input parameters are required for rehabilitation design (see Table 1). Iowa DOT's PMIS can provide some of this information, including milled thickness, total rutting of existing pavement, and subjective rating of pavement condition.

Detailed material properties were difficult to obtain from Iowa DOT's PMIS, especially for older pavement sections. It is difficult to ascertain if the MEPDG default values are applicable to Iowa conditions. Examinations of typical Iowa pavement material properties were conducted for projects related to MEPDG implementation (*7*). These material properties include PCC elastic modulus, asphalt binder and aggregate properties, HMA volumetric properties, thermal properties of HMA and PCC, unbound materials resilient modulus, and so forth. Recently completed project reports related to MEPDG implementation in Iowa were reviewed. Typical pavement material properties for Iowa roadway systems could be obtained from these project reports (*10–13*).

PMIS Performance Data

A database of historical performance data for the selected sections was prepared from Iowa DOT's PMIS. Most of MEPDG performance prediction indicators are available in Iowa DOT's PMIS. However, the units reported in PMIS for some pavement performance measures (JPCP transverse cracking, and alligator and thermal (transverse) cracking of HMA and HMA overlaid pavements) are different from those used in MEPDG (see Table 3). These pavement performance data were not used for verification. Even though MEPDG provides rutting predictions for individual pavement layers, Iowa DOT's PMIS provides only accumulated (total) rutting observed in the HMA surface. This difference can lead to difficulties in the calibration of individual pavement layer rutting models.

Additionally, some irregularities in distress measures were identified in Iowa DOT's PMIS. Occasionally, as shown in Figure 1, distress magnitudes appear to decrease with time or show erratic patterns without explanation.

Such irregularities in observed distresses were also reported by recent studies by Wisconsin DOT (*14*) and Washington DOT (*15*). The Wisconsin study (*14*) suggested two possible explanations. First, minor maintenance may have been applied to improve pavement performance. Minor maintenance activities are not categorized as restoration or reconstruction that can be considered by the MEPDG and are not recorded in detail by DOT's PMIS. Second, the irregularity may be due to human factors and measurement location arising from distress surveys.

NCHRP Project 1-40 B (*6, 16*) recommends that all data be evaluated for reasonableness check, and any irrational trends or outliers in the data be removed before evaluating the accuracy of MEPDG performance predictions. Comparisons of performance measures (MEPDG versus actual) were conducted for this purpose.

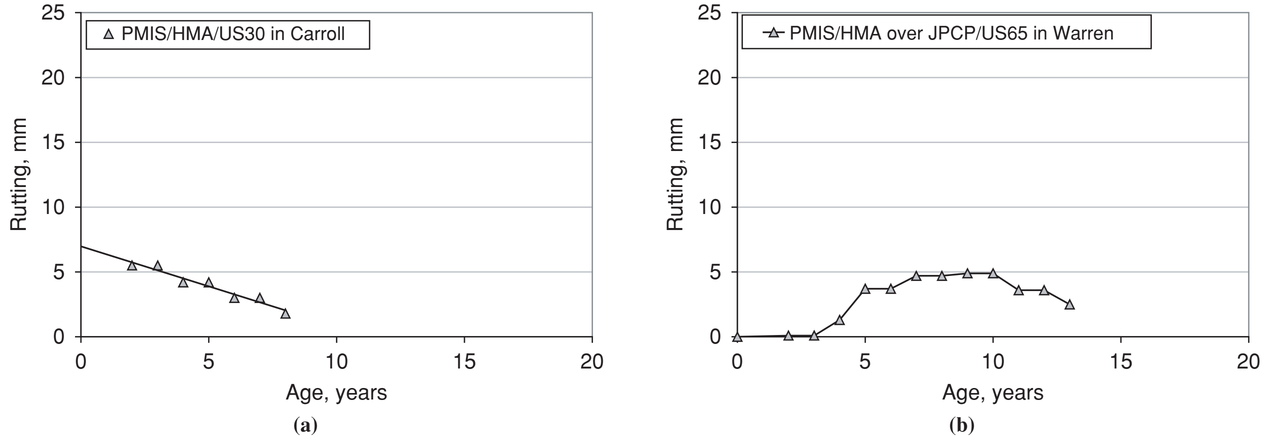

FIGURE 1 Irregularities observed in progression of pavement distresses: (*a*) decrease of distress with time and (*b*) erratic patterns.

VERIFICATION OF MEPDG PERFORMANCE PREDICTIONS FOR IOWA PAVEMENTS

Comparisons of Pavement Performance Measures

A number of MEPDG simulations were run using the prepared MEPDG input database. The MEPDG pavement performance predictions for all of 16 of pavement sections are compared with actual performance data from PMIS as shown in Figures 2–5. Figure 2 presents these comparisons for HMA pavement of US-218 in Bremer County. As seen in Figure 2, the predicted longitudinal cracking, rutting, and IRI trends show a good agreement with the PMIS observations. Figure 3 presents the comparisons for JPCP of US-65 in Polk County. The predicted IRI trend shows good agreement with the PMIS observations, but the predicted faulting trend does not. Figures 4 and 5 present the comparisons for HMA over JPCP of US-18 in Clayton

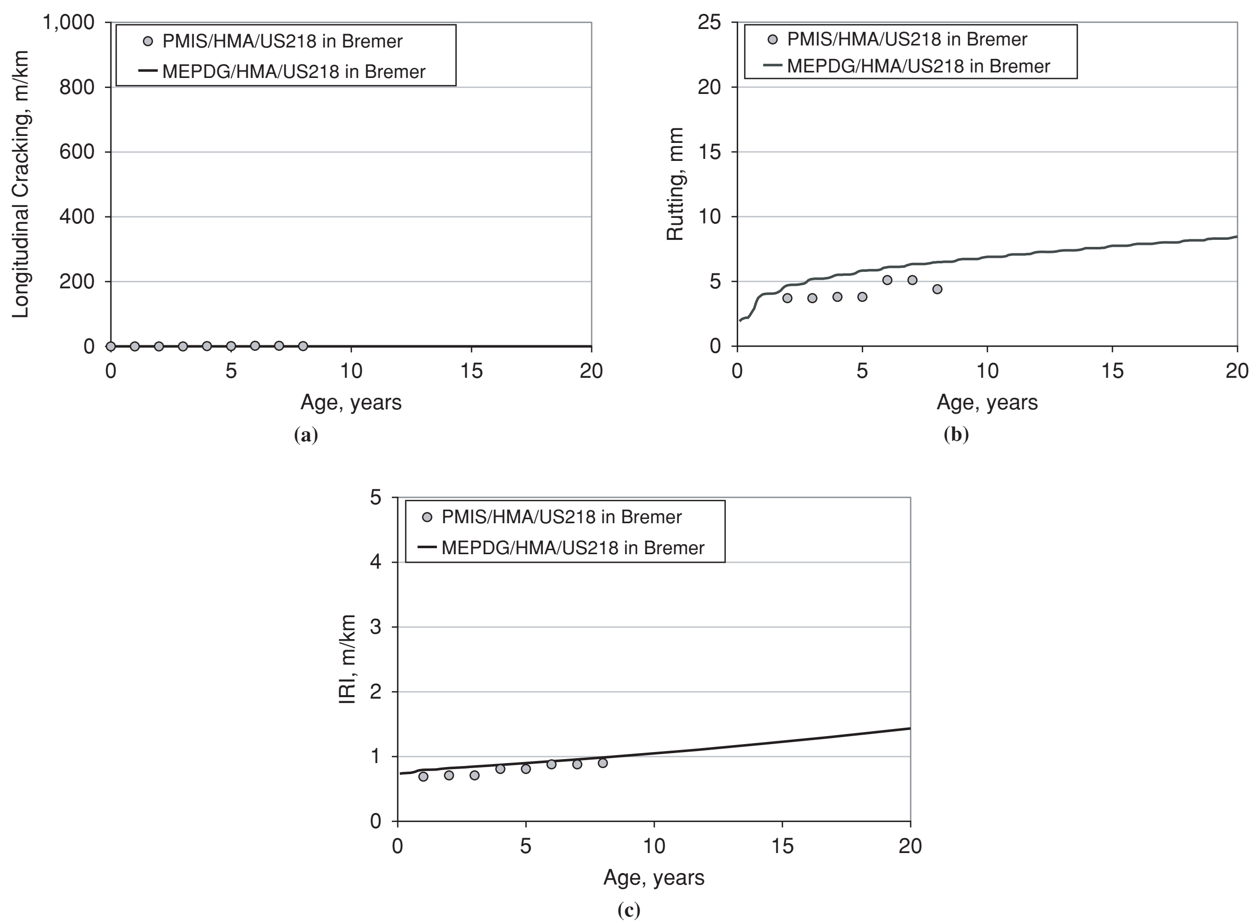

FIGURE 2 Predicted versus actual pavement distresses for HMA pavement of US-218 in Bremer County: (*a*) longitudinal cracking, (*b*) rutting, and (*c*) IRI.

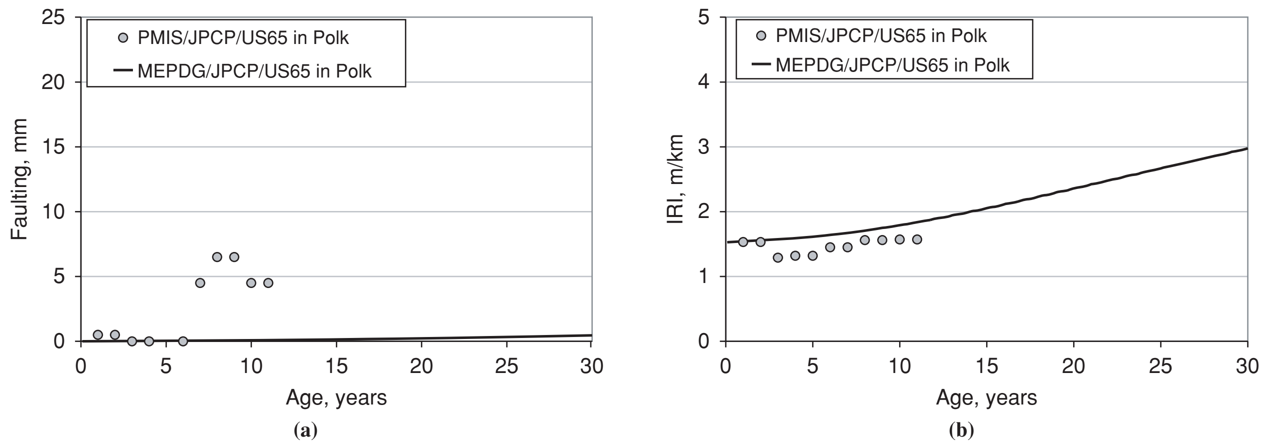

FIGURE 3 Predicted versus actual pavement distresses for JPCP of US-65 in Polk County: (*a*) faulting and (*b*) IRI.

County and HMA over HMA composite pavement of US-18 in Fayette County. As seen in these figures (other comparisons are not presented here because of space limitations), there are differences between the MEPDG model predictions and the actual longitudinal cracking values observed in HMA overlaid pavement sections. Compared with actual observed field rutting predictions, MEPDG model underestimates rutting in HMA over JPCP, as shown in Figure 4*b*, while overestimating rutting in HMA over HMA sections, as shown in Figure 5*b*. IRI predictions in Figures 4*c* and 5*c* illustrate that MEPDG model provides good predictions compared with actual IRI data in HMA overlaid pavement sections. Some portions of the PMIS performance data showed irrational trends. These data were not used to evaluate the accuracy of MEPDG predictions.

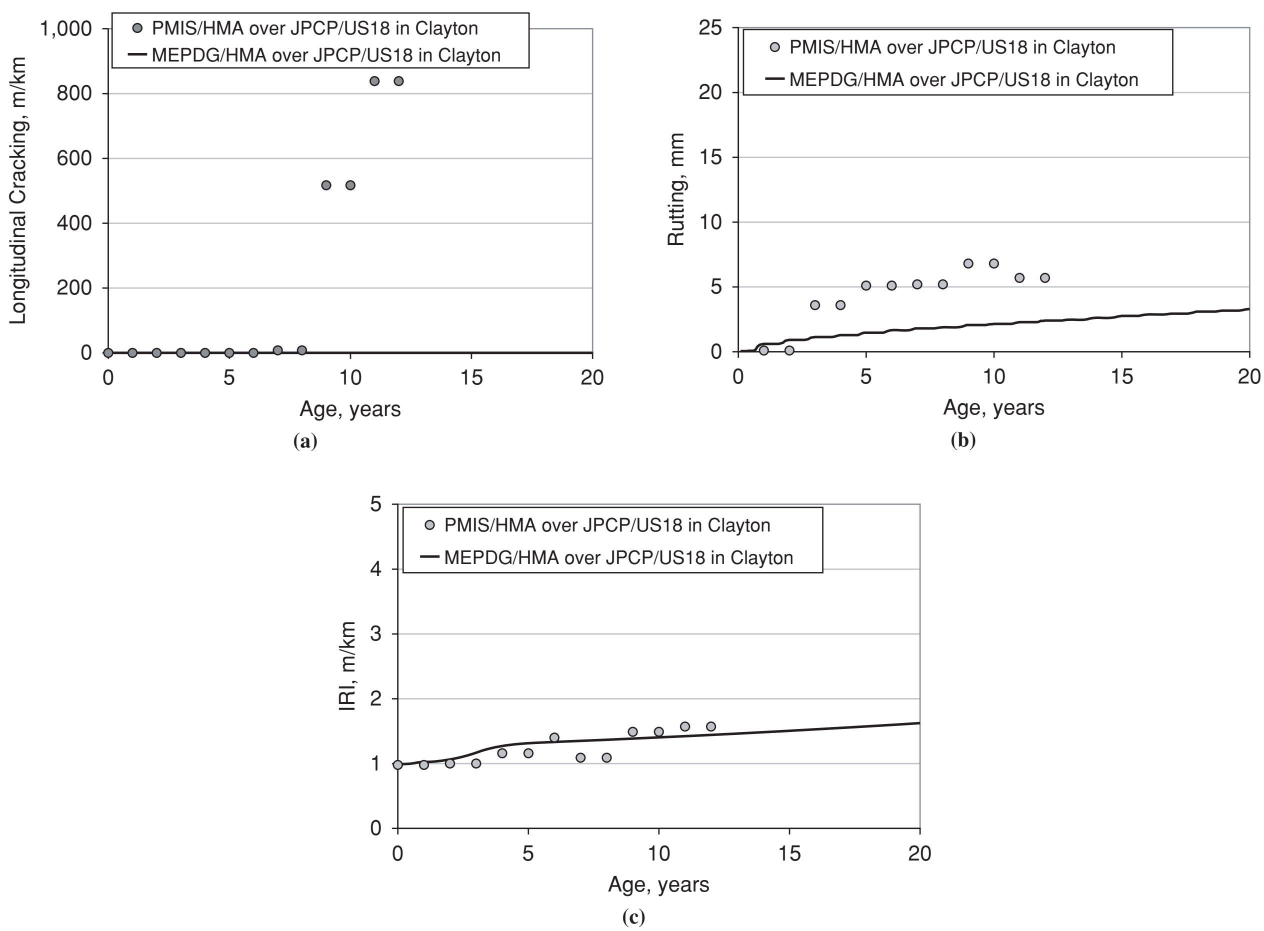

FIGURE 4 Predicted versus actual pavement distresses for HMA over JPCP of US-18 in Clayton County: (*a*) longitudinal cracking, (*b*) rutting, and (*c*) IRI.

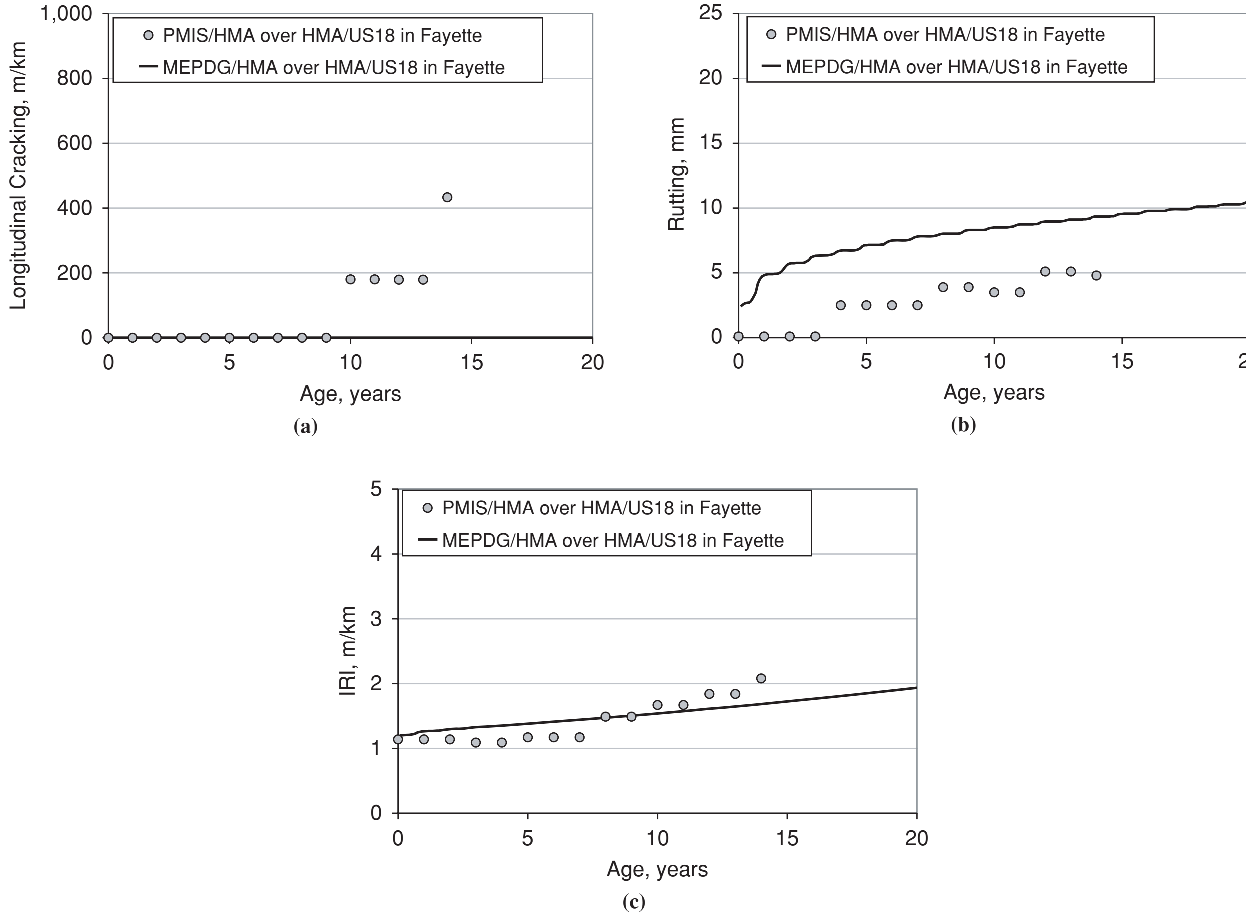

FIGURE 5 Predicted versus actual pavement distresses for HMA over HMA pavement of US-18 in Fayette County: (*a*) longitudinal cracking, (*b*) rutting, and (*c*) IRI.

Accuracy of Performance Predictions

Some NCHRP research projects are closely related to local verification and calibration of MEPDG performance predictions (*6, 16–19*). These studies recommend using the goodness-of-fit statistics and null hypothesis test to assess if there is any systematic difference between the measured and predicted distress values. The goodness-of-fit statistics includes bias or residual error (e_r), standard error of estimation (S_e), standard deviations (S_y), and coefficient of determination (R^2). These studies also recommend calibrating the MEPDG performance models to local conditions if there are significant systematic differences.

Following the NCHRP studies recommendations, the current study also adopted the goodness-of-fit statistics and null hypothesis test (a paired *t*-test) to check the accuracy of the MEPDG performance prediction models with national calibration factors for Iowa conditions. The accuracy of longitudinal cracking was not evaluated because it was later recommended by NCHRP Project 1-40B (*20*) that the longitudinal cracking model be dropped from the local calibration guide development because of lack of accuracy in the predictions. Table 4 includes the goodness-of-fit statistics results for Iowa pavements selected in this study. It also includes the goodness-of-fit statistics results obtained from national calibration using LTPP data. It is observed that the goodness-of-fit statistics results for IRI of Iowa HMA and overlaid pavement sections are comparable to those obtained from national calibration.

The null hypothesis test results for the HMA and JPCP pavements are presented in Figure 6 and those for the overlaid pavement systems are presented in Figure 7. The hypothesis here is that no significant differences exist between the measured and predicted values. A *p*-value greater than .05 (alpha) signifies that no significant difference exists between the measured and predicted values and, hence, the hypothesis is accepted. As shown in these figures, it can be observed that all *p*-values except IRI of HMA over JPCP are less than .05 (alpha), signifying that systematic difference (bias or residual error) exists between the measured and predicted values. Only IRI values for HMA over JPCP do not have any systematic difference. Even though *p*-values for IRI of HMA and HMA over HMA pavements are less than .05 (alpha), the values of IRI at these pavements as shown in Figures 6*b* and 7*d* are close to line of equality, signifying good agreement between the actual values and predictions. These results indicate that systematic difference needs to be eliminated by recalibrating the MEPDG performance models to local conditions and materials.

SUMMARY

As part of the MEPDG implementation efforts in Iowa, the existing PMIS with respect to the MEPDG and the accuracy of the nationally calibrated MEPDG prediction models for Iowa conditions have been

TABLE 4 Goodness-of-Fit Statistics Results for Iowa Pavements

Type	Performance Measure	N^a	Goodness-of-Fit Statistics $e_{r(\text{Mean})}$	S_e	S_e/S_y	R^2
HMA	Rutting (mm)	27		2.16	1.51	Poor[c]
		(387)[b]	−1.86	(3.07)	(0.82)	(.40)
	IRI (m/km)	52		0.25	0.68	.54
		(353)	−0.06	(0.39)	(0.75)	(.62)
JPCP	Faulting (mm)	53		3.26		Poor[c]
		(564)	1.88	(0.74)	1.16	(.71)
	IRI (m/km)	32		0.45		Poor[c]
		(183)	−0.29	(0.01)	4.71	(.60)
HMA over JPCP	Rutting (mm)	35		2.34	1.13	Poor[c]
		(387)	1.60	(3.07)	(0.82)	(.40)
	IRI (m/km)	40		0.21		.34
		(367)	0.03	(0.20)	0.82	(.54)
HMA over HMA	Rutting (mm)	34		4.01	2.41	Poor[c]
		(387)	−2.74	(3.07)	(0.82)	(.40)
	IRI (m/km)	41		0.19		.60
		(797)	0.05	(0.18)	0.64	(.70)

[a]Number of data points.
[b]National calibration (*5*).
[c]Model did not explain variation in the measured data within and between pavement sections.

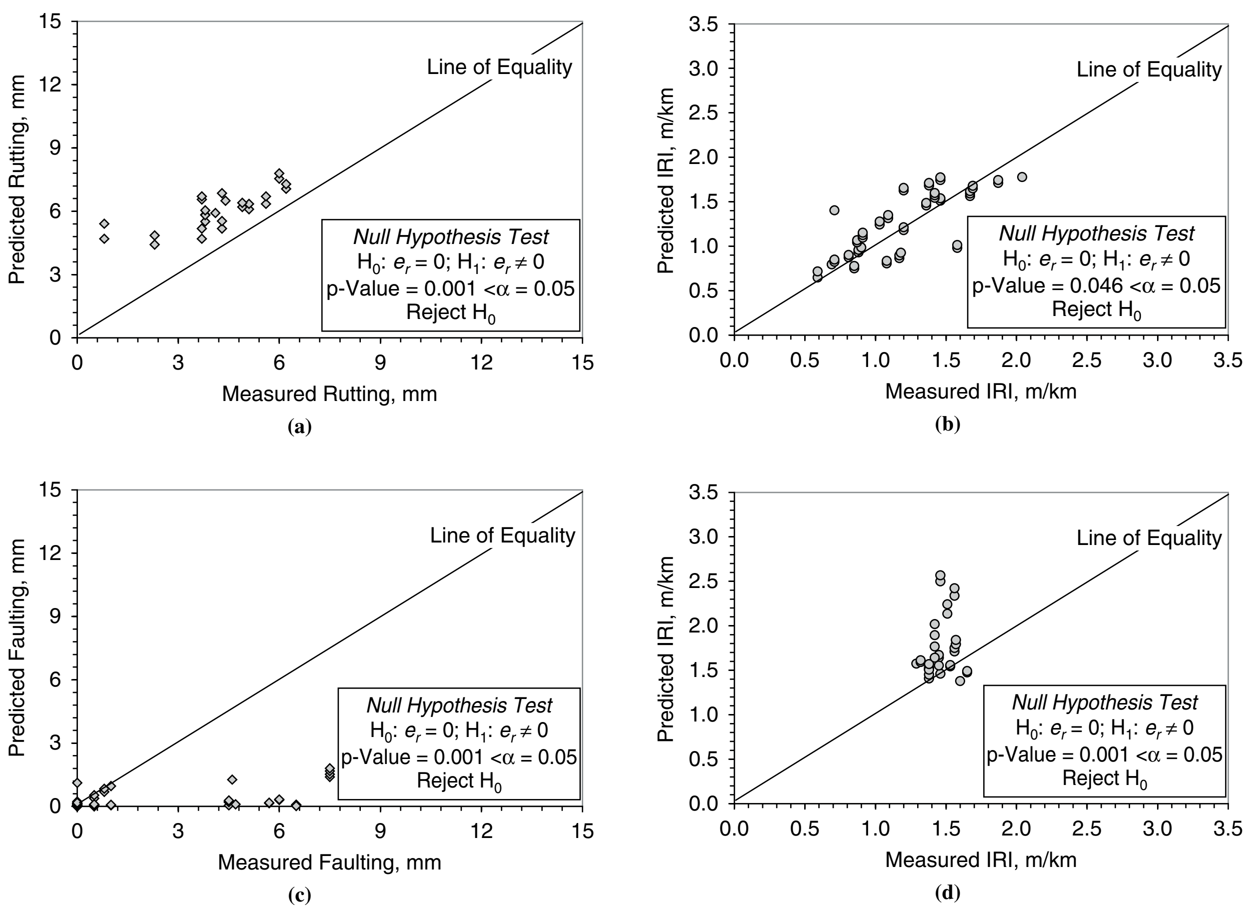

FIGURE 6 Null hypothesis test results for Iowa flexible and rigid pavement systems: (*a*) rutting for HMA, (*b*) IRI for HMA, (*c*) faulting for JPCP, and (*d*) IRI for JPCP.

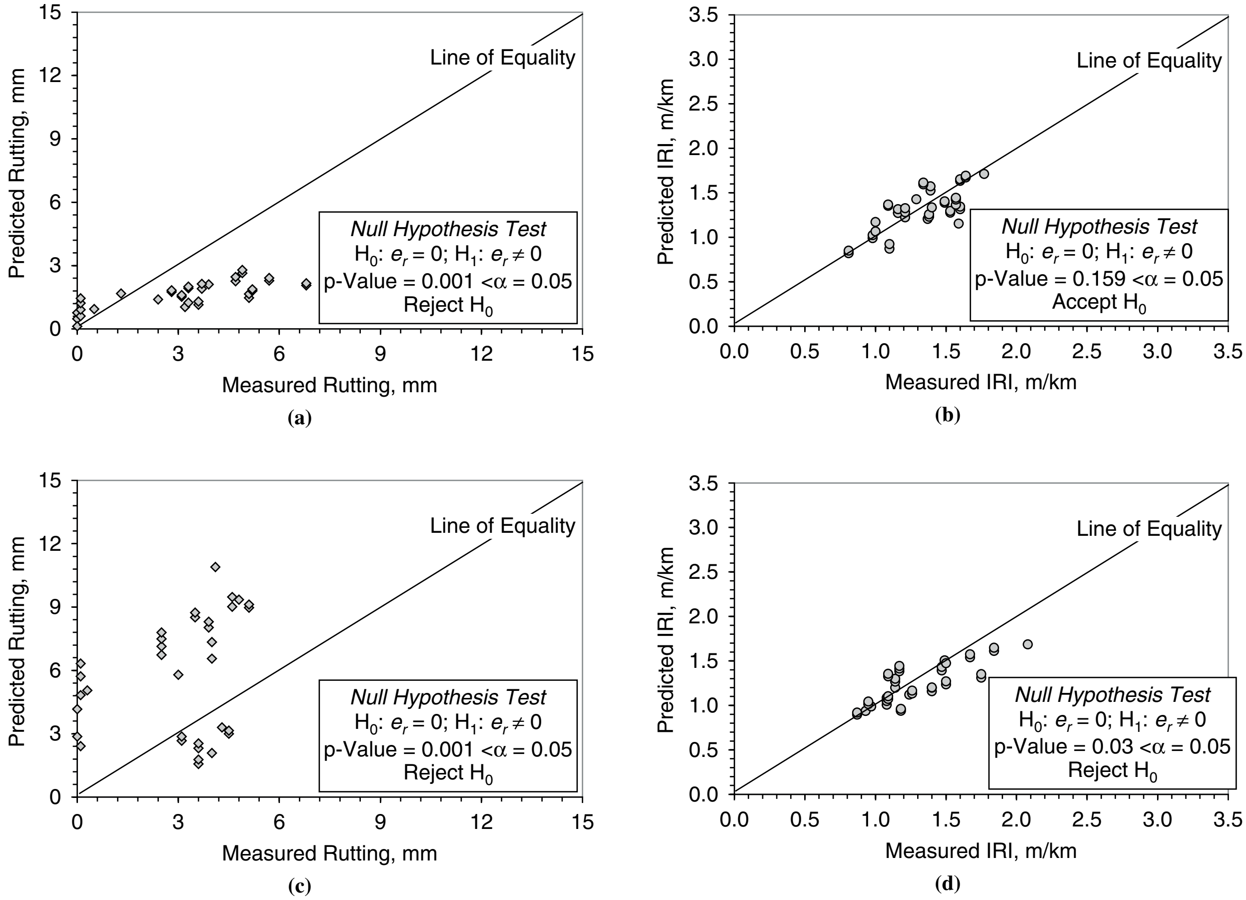

FIGURE 7 Null hypothesis test results for Iowa composite pavement sections: (*a*) rutting for HMA over JPCP, (*b*) IRI for HMA over JPCP, (*c*) rutting for HMA over HMA, and (*d*) IRI for HMA over HMA.

evaluated and discussed. Based on this study, the following conclusions and recommendations were made to improve the accuracy of MEPDG predictions under Iowa conditions.

Conclusions

- The MEPDG-predicted IRI values are in good agreement with the actual IRI values obtained from Iowa DOT's PMIS for flexible and HMA overlaid composite pavement systems.
- Systematic difference (bias or residual error) was found for MEPDG rutting and faulting model predictions for Iowa highway conditions and materials.
- The HMA alligator and thermal (transverse) cracking and the JPCP transverse cracking in Iowa DOT's PMIS are differently measured compared with MEPDG measurement metrics.
- MEPDG provides individual pavement layer rutting predictions, whereas Iowa DOT's PMIS provides only accumulated (total) surface rutting observed in the pavement systems. This difference can lead to difficulties in the local calibration of MEPDG rutting models for pavement sublayers.
- Irregularity trends in some of the pavement distress measures recorded in Iowa DOT's PMIS for certain pavement sections are observed. These may need to be removed from the PMIS for successful verification and local calibration of the MEPDG models.

Recommendations for Local Calibrations

- Recalibrating the MEPDG performance models to Iowa conditions is recommended to improve the accuracy of predictions.
- Increased number of pavement sections with more reliable data from Iowa DOT's PMIS and the LTPP database should be included for successful local calibration.
- All the actual performance data should be subjected to reasonableness check, and any presence of irrational trends or outliers in the data should be removed before performing local calibration.
- Local calibration of HMA longitudinal cracking model included in the MEPDG should not be performed before it is refined further and released by the MEPDG research team.
- A field investigation of trenches on HMA pavements with rutting should be conducted to determine the amount of rutting contributed by each pavement sublayer to the accumulated (total) surface rutting observed in Iowa pavements. This can help determine the selection of different MEPDG rutting models (HMA and unbound materials) associated with pavement component layers for local calibration.
- Before performing local calibration, it should be ensured that pavement distress measurement units between PMIS and MEPDG match. The PMIS records both severity and density of cracks, whereas the MEPDG models predict only the density of cracking.

Considering this, the following conversion equations are proposed for both flexible and rigid pavement systems:

$$\text{FC} = \left(\frac{\text{FC}_h\left(W_h\right) + \text{FC}_m\left(W_m\right) + \text{FC}_l\left(W_l\right)}{\text{LW}} \right) \times C_1 \times 100 \quad (1)$$

where

FC = converted fatigue cracking measurements in HMA pavement (%);
FC_h, FC_m, FC_l = high, moderate, and low fatigue cracking measurements (m^2/km) recorded in Iowa DOT PMIS;
W_h, W_m, W_l = weight of severity, with recommended values being 1.5 for high, 1 for moderate, and 0.5 for low severity;
LW = lane width (m), with the value of 3.66 m (12 ft) being the typical lane width; and
C_1 = unit conversion factor from m^2/km^2 to m^2/m^2 or $km^2/km^2 = 0.0001$.

$$\text{THC} = \text{LW} \times \sum_{i=h,m,i} \text{THC}_i \times C_2 \quad (2)$$

where

THC = converted thermal cracking measurements in HMA pavement (ft/mi);
THC_i = count number of thermal cracking with high, moderate, and low severity (number/km) recorded in Iowa DOT PMIS; and
C_2 = unit conversion factor from m/km to ft/mi = 5.3.

$$\text{TRC} = \left(\frac{\sum_{i=h,m,n} \text{TRC}_i}{\frac{\text{LW}}{\text{SA}}} \times \frac{1}{C_3} \right) \times 100 \quad (3)$$

where

TRC = converted transverse cracking measurements in JPCP pavement = percentage of all slabs with midpanel transverse cracking (%);
TRC_i = count number of transverse cracking with high, moderate, and low severity (number/km) recorded in Iowa DOT PMIS;
SA = slab area (km^2); and
C_3 = number of transverse cracks per slab.

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