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Analysis of Virginia-Specific Traffic Data Inputs for Use with the Mechanistic-Empirical Pavement Design Guide

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Abstract:

This study developed traffic inputs for use with the *Guide for the Mechanistic-Empirical Design of New & Rehabilitated Pavement Structures* (MEPDG) in Virginia and sought to determine if the predicted distresses showed differences between site-specific and default traffic inputs for flexible and rigid pavements. The axle-load spectra, monthly adjustment factors, vehicle class distribution factors, and number of axles per truck inputs were considered. The predicted distresses based on site-specific traffic inputs from eight interstate and seven primary route weigh-in-motion sites in Virginia were compared to predicted distresses using MEPDG default traffic inputs. These comparisons were performed by use of a normalized difference statistic for each site-specific traffic input and the coefficient of variation for each pavement distress model. In addition, the practical significance for flexible pavements was considered from the difference in the predicted time to failure between site-specific and default traffic inputs.

The analysis showed that the effect of the site-specific traffic inputs was generally not statistically significant when the uncertainty of the distress models was considered. However, the site-specific axle-load spectra and vehicle class distribution inputs showed a statistically significant effect on certain predicted distresses for flexible and rigid pavements, respectively.

The study recommends that site-specific axle-load spectra data be considered for analysis of flexible pavements. Alternatively, summary (statewide average) axle-load spectra data for analysis of interstate and primary flexible pavements should be considered preferentially over default axle-load spectra. Site-specific vehicle class distribution factors should be considered for analysis of rigid pavements on the interstate system. Alternatively, summary (statewide average) vehicle class distribution factors for analysis of interstate rigid pavements should be considered preferentially over default vehicle class distribution data. Default traffic data are recommended for analysis of primary rigid pavements. This study also recommends that a local calibration process be completed to determine if the predictive models accurately predict the conditions found on Virginia's roadways. If the predictive models are modified, the results may impact the recommendations resulting from this study.

The implementation of the recommendations of this study and the use of the MEPDG in general will provide the Virginia Department of Transportation with a more advanced means of designing and analyzing pavements. This should result in optimal designs that are more efficient in terms of initial construction and future maintenance costs.

FINAL REPORT

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and the University of Virginia since 1948)

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DISCLAIMER

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INTRODUCTION

The Virginia Department of Transportation (VDOT) currently follows the 1993 American Association of State Highway and Transportation Officials (AASHTO) *Guide for Design of Pavement Structures* for all new and rehabilitation pavement designs (AASHTO, 1993). This design methodology is based on the results of the American Association of State Highway Officials (AASHO) Road Test of the late 1950s through early 1960s in which designed pavement thickness is primarily a function of the anticipated service life, serviceability of the pavement, and number of equivalent loads applied (Highway Research Board, 1962).

The next generation, nationally, of pavement design methodologies is the *Guide for the Mechanistic-Empirical Design of New & Rehabilitated Pavement Structures* (MEPDG). It is expected that VDOT will ultimately transition to this design methodology (VDOT, 2007b). The MEPDG was developed under National Cooperative Highway Research Program (NCHRP) Project 1-37A (ARA, Inc., 2004) and NCHRP Project 1-40D (NCHRP, 2006) and consists of a software package that analyzes a user-provided pavement design and provides a prediction of the future pavement condition (in terms of smoothness and levels of typical distresses). The MEPDG uses mechanistic pavement analysis procedures to determine the physical response of the pavement to traffic and environmental loading. From this, the pavement condition is predicted through the use of nationally calibrated empirical transfer functions.

To implement the MEPDG fully, users will need to develop databases of the required inputs and determine whether or not their usage results in a significant difference in the predicted condition as compared to default values. Users will also have to determine how the significance is determined. In addition, users will need to evaluate whether the nationally calibrated transfer functions used to predict future pavement condition accurately do so for their local conditions.

Traffic data inputs represent one of the layers of required information to use the MEPDG. Weigh-in-motion (WIM) sensors are useful for collecting the large amount of traffic data necessary to develop inputs for the MEPDG design methodology. VDOT and Virginia‘s Department of Motor Vehicles employ WIM sensors located in the travel lane and passing lane (at select locations) at 15 sites to provide information on the axle loading applied to the pavement on interstate and primary roadways.

AASHTO (2008) lists the following traffic inputs as being those available from WIM data: axle load distribution, truck-volume distribution, number of axles per truck, monthly distribution factors, and hourly distribution factors. According to AASHTO (2008), the number of axles per truck is relatively constant and the hourly distribution factors are significant only for the analysis of rigid pavements where thermal gradients within the rigid slab must be considered. As these inputs require separate factors for each truck type, the MEPDG uses the Federal Highway Administration (FHWA) grouping system, which divides vehicles into 13 vehicle classes (FHWA, 2001a).

Previous studies have investigated the traffic data inputs for use with the MEPDG in other states (Haider and Harichandran, 2009; Li et al., 2007; Li et al., 2009; Timm et al., 2006; Tran and Hall, 2007). The results are mixed, however, with some studies reporting similar predicted pavement distresses using default versus site-specific traffic inputs and others reporting a significant difference. In addition, a variety of methods of determining the significance of these differences is presented.

PURPOSE AND SCOPE

The purpose of this study was twofold: (1) develop site-specific traffic data inputs for the MEPDG pavement design methodology using Virginia WIM data, and (2) compare the predicted distresses for pavement designs representing typical flexible and rigid pavements used on interstate and primary highways. The traffic inputs considered were axle-load spectra, monthly adjustment factors (MAF), vehicle class distribution factors, and number of axles per truck.

Site-specific traffic data inputs were developed from the 15 WIM sites in Virginia. In addition, weighted average values from all interstate WIM sites, primary sites, and statewide WIM data were developed. The WIM data were collected over 12 consecutive months from June 2007 through May 2008.

METHODS

Four tasks were conducted to fulfill the purpose of the study:

1. Conduct a literature review to document the experiences of other state and provincial departments of transportation in developing site-specific traffic data for the MEPDG.

2. Develop a method to calculate MEPDG traffic inputs from Virginia WIM data.

3. Use the MEPDG to develop predicted distresses using both site-specific and default traffic data input values.

4. Evaluate the differences in the MEPDG-predicted pavement condition between site-specific and default traffic input values.

Literature Review

The literature review was conducted by searching various databases such as the Transportation Research Information Services (TRIS) bibliographic database, the Catalog of Transportation Libraries (TLCat), the Catalog of Worldwide Libraries (WorldCat), and the Transportation Research Board's Research in Progress (RiP) and Research Needs Statements (RNS) databases.

Development of Method to Calculate MEPDG Traffic Inputs from WIM Data

Data Used

The data used for this study came from WIM stations around Virginia and were provided by VDOT's Traffic Engineering Division. The locations of the 15 WIM sites considered in this study are shown in Table 1: 8 of the sites are on interstate highways and 7 are on primary highways. In general, data from each direction on an interstate route are considered to be from a single site whereas multidirectional data on a primary route are considered to be from one site. The WIM data for each truck include a site identification number, a vehicle identification number, the lane of travel, the date and time, the FHWA vehicle classification number, the vehicle speed, the gross vehicle weight, the number of axles, the weight of each axle, and the distance between the axles.

The WIM stations are calibrated as needed to ensure they comply with the requirements specified in ASTM E 1318-02 (American Society of Testing and Materials [ASTM], 2002) for a Type I WIM system (95% of axle loads within 20% of actual axle weight). Calibration is performed by running a vehicle with a known weight over the WIM sensor 20 times and measuring the percent error of the gross vehicle weight. The accuracy of the individual WIM records is also evaluated in accordance with the procedures outlined in FHWA's *Traffic*

Table 1. Virginia Weigh-in-Motion (WIM) Sites

Route	Direction	No. of Lanes with WIM Sensor	Location	No. of Months of WIM Data (June 2007-May 2008)
I-66	West	2	Fauquier County	10
I-81	North	1	Stephens City	12
I-81	South	1	Stephens City	12
I-81	North	1	Troutville	8
I-81	South	1	Troutville	12
I-95	North	1	Dumfries	12
I-95	South	1	Dumfries	8
I-95	North	2	Sussex County	11
SR 164	East, West	2, 2	Portsmouth	12
SR 234	North, South	2, 2	Prince William County	12
SR 288	North, South	2, 2	Midlothian	10
US 17	North, South	2, 2	Fauquier County	12
US 29	South	2	Danville	12
US 58	East, West	2, 2	Lee County	10
US 60	East, West	1, 1	Cumberland County	11

Monitoring Guide (FHWA, 2001b) during data processing, and any records that are marked as "low quality" are removed; a low-quality record is typically attributable to the sensor not reading all of the wheel loads. If the accuracy of any data was questionable, the data were not used until the site's calibration was checked. The WIM stations are maintained by VDOT's Traffic Engineering Division and Virginia's Department of Motor Vehicles.

The data considered for this study consisted of WIM data for a continuous 1-week period, Sunday through Saturday, each month for 12 months. Weeks were randomly selected, but the selection was done so as to ensure that no state or national holidays were included. Using 1 week of data to represent an entire month has been shown to provide accurate data for pavement design (Hong et al., 2008). A 12-month period of data from June 2007 through May 2008 was used to develop the traffic loading inputs. Of a possible 180 records (12 months for each of 15 sites), a total of 164 records were captured (91.1%). The remaining months were not included because of potential sources of error within the data or non-functioning equipment during the time period sampled. The I81-N (Stephens City), I95-S (Dumfries), I95-N (Sussex), I66-W (Fauquier), US58 (Lee County), US60 (Cumberland), and SR288 (Chesterfield) sites were missing some portion of the 12-month data, as indicated in Table 1. The researchers' perspectives regarding the degree of significance of the missing data for each input are provided later in this report. The MEPDG provides estimates for the accuracy of the site-specific axle-load spectra inputs based on the amount of data collected; these accuracy estimates are shown in Table 2. Based on the information in this table, the axle-load spectra developed in this study would have an expected error of 2% with greater than a 97.5% level of confidence (ARA, Inc., 2004).

Table 2. Minimum Sample Size (Number of Days per Year) to Estimate Normalized Axle Load Distribution from WIM Data (ARA, Inc., 2004)

Expected Error (± %)	**Level of Confidence or Significance, %**				
	80	**90**	**95**	**97.5**	**99**
20	1	1	1	1	1
10	1	1	2	2	3
5	2	3	5	7	10
2	8	19	30	43	61
1	32	74	122	172	242

WIM Data Processing

A MATLAB program was developed to process the raw data files provided by VDOT's Traffic Engineering Division; the program, 'axleld,' is available from the authors. This program requires the user to indicate the site identification number and date range for the WIM data that are to be evaluated. The program then opens the appropriate WIM data files and identifies the axle type and axle weight for each axle group on every vehicle. The axle type is determined by the axle spacing, as defined by AASHTO (2001). The axle groups considered were:

- a *single axle,* defined as an axle located at a distance greater than 8 ft or at a distance less than 3.33 ft from an adjacent axle

- a *tandem axle,* defined as two adjacent axles with a spacing of 3.33 to 8 ft

- a *tridem axle,* defined as three axles with a spacing of less than 12 ft from the first to the third axle

- a *quad axle,* defined as four axles with a spacing of less than 16 ft from the first to the fourth axle.

The output of the ‘axleld’ program is a separate set of histograms for each month and WIM site of the axle weights for each axle group and for each FHWA vehicle classification. Three summary datasets were developed for the interstate and primary highways, and a statewide average (including interstate and primary), by summing the histogram counts from the appropriate WIM sites. The bin ranges and intervals used to develop the histograms were recommended by the MEPDG (ARA, Inc., 2004); these bin intervals are as follows:

- *steering axles:* 1,000-lb intervals from 3,000 to 40,000 lb
- *single axles:* 1,000-lb intervals from 3,000 to 40,000 lb
- *tandem axles:* 2,000-lb intervals from 6,000 to 80,000 lb
- *tridem axles:* 3,000-lb intervals from 12,000 to 102,000 lb
- *quad axles:* 3,000-lb intervals from 12,000 to 102,000 lb.

MEPDG Comparison of Site-Specific and Default Traffic Inputs

The MEPDG software analyzes a pavement based on inputs describing the materials, traffic, climate, and pavement structure and outputs the predicted pavement condition over the design life of the pavement. This study used the predicted pavement condition to evaluate the differences between the site-specific traffic inputs developed at each WIM site and the default MEPDG traffic input values. This required a trial pavement section that could be used to compare the resultant predicted pavement condition from the different inputs. Two pavement sections and traffic levels were used to represent interstate and primary highways for this study. The traffic volumes from the interstate and primary highway locations with the highest truck traffic volumes were selected as the traffic levels for this study to amplify the amount of load-related distresses that would be predicted during the analysis; the locations selected were I-81 in Augusta County and US 17 in Stafford County.

The default MEPDG traffic and climate inputs are shown in Table 3. The input values were based on either the default MEPDG values or recommended VDOT values for pavement design (VDOT, 2008). The weather station location was chosen for simplicity so that the same site could be used during all analyses. Different average daily truck traffic (ADTT) and default vehicle class distribution sets were used for the interstate and primary highways. The values used for these inputs are shown in Table 4. The ADTT values are based on VDOT traffic volume estimates (VDOT, 2007a). Different vehicle class distribution factors were chosen from the MEPDG-provided default distributions to represent best the distribution at the interstate and primary WIM sites. A 95% reliability input was used for interstate MEPDG trials and 90% reliability was used for the primary trials, but all predicted pavement condition values were considered at the 50% (default) reliability level at the end of the pavement design life.

Table 3. Default MEPDG Test Section Traffic and Climate Inputs

Traffic	
Lanes in design direction	2
Trucks in design direction (%)	50
Trucks in design lane (%)	95
Operational speed (mph)	60
Monthly adjustment factors	Default
Hourly truck traffic distribution	Default
Traffic growth factor	3% Compound
Axle load distribution factors	Default
Axles per truck	Default
Mean wheel location (inches from the lane marking)	18
Traffic wander standard deviation (in)	10
Design lane width (ft)	12
Average axle width (ft)	8.5
Dual tire spacing (in)	12
Tire pressure (psi)	120
Average tandem axle spacing (in)	51.6
Average tridem axle spacing (in)	49.2
Average quad axle spacing (in)	49.2
Climate	
Weather station location	Charlottesville, Virginia
Depth of water table (ft)	5

Table 4. MEPDG Interstate and Primary Traffic Inputs

MEPDG Input	Interstate Section	Primary Section
Two-way ADTT	19,470	8,170
Vehicle Class Distribution	Default–TTC Group 1	Default–TTC Group 2
Reliability Input	95%	90%

TTC = Truck Traffic Classification.

Flexible Pavement MEPDG Analysis

Two trial flexible pavement structures were analyzed to represent interstate and primary highways. The interstate trial pavement structure is described in Table 5, and the primary in Table 6. These trial pavement sections were designed based on layer properties and thicknesses typical of Virginia highways. One trial structure for each administrative classification was considered to simplify the analysis. The modulus values for Layers 4, 5, and 6 are assumed values. The subgrade was subdivided into two layers (Layers 5 and 6) to represent compacted subgrade and natural subgrade. The interstate highway trial structure was designed for a structural number of 6.2, and the primary highway trial structure for a structural number of 4.75; these values represent average structural numbers for interstate and primary highways based on the recommendations of VDOT pavement engineers. A 20-year design life was used during the flexible pavement analysis to make the MEPDG analysis more computationally efficient. The VDOT-recommended design life for a new flexible interstate or primary highway is 30 years (VDOT, 2008).

Table 5. Flexible Interstate Trial Pavement Structure

Layer No.	Material	Binder PG	Thickness (in)	Air Void (%)	Effective Binder Content, vol. (%)	Unit Weight, lb/ft^3	% Retained			% Passing No. 200	Modulus (psi)
							3/4 in	3/8 in	No. 4		
1	SM 12.5	70-22	2	6	16.1	152	0	38.1	68.9	11.7	
2	IM 19.0	64-22	2.5	6	10.3	152	1.1	25	49	6	
3	BM 25.0	64-22	7	6	11.3	148	14.9	35	57	5.2	
4	21-B		12								42,000
5	A-7-6		12								12,000
6	A-7-6		Infinite								8,000

Table 6. Flexible Primary Trial Pavement Structure

Layer No.	Material	Binder PG	Thickness (in)	Air Void (%)	Effective Binder Content, vol. (%)	Unit Weight, lb/ft^3	% Retained			% Passing No. 200	Modulus (psi)
							3/4 in	3/8 in	No. 4		
1	SM 12.5	70-22	2	6	16.1	152	0	38.1	68.9	11.7	
3	BM 25.0	64-22	6	6	11.3	148	14.9	35	57	5.2	
4	21-B		10								42,000
5	A-7-6		12								12,000
6	A-7-6		Infinite								8,000

The predicted pavement condition from the flexible pavement analysis include the following parameters: international roughness index (IRI), surface down asphalt cracking, bottom up asphalt cracking, asphalt thermal fracture, fatigue fracture of chemically stabilized layer, asphalt layer(s) rutting, and total pavement rutting. This study used the default, nationally calibrated, transfer functions to calculate the predicted pavement condition without any local calibration. The two cracking and rutting distresses were the main load-related distresses considered in this study.

Surface down cracking in the asphalt is also referred to as longitudinal cracking; these longitudinal cracks are explained by high stresses at the pavement surface (Myers et al., 1998). Longitudinal cracking is measured in feet of cracking per mile. Bottom up asphalt cracking is referred to as fatigue or alligator cracking; this distress also occurs in the wheelpath after repeated traffic loading (Strategic Highway Research Program, 1993).

Two rutting distress outputs describe the amount of permanent deformation that occurs within the pavement structure: asphalt layer(s) rutting is the deformation within the bound layers of a flexible pavement, and the total pavement rutting also includes the deformation of the base and subgrade materials. Although material properties influence the amount of rutting in a pavement, traffic loading also has a large effect.

The IRI gives an assessment of the roughness of the pavement. A smoother pavement provides a more comfortable ride for the user and causes less wear on vehicles. Although the IRI tends to increase faster with higher traffic loading, it is also a function of the cracking and rutting distress levels. Therefore, the IRI was not a main focus in this analysis, but the predicted IRI value for each trial is provided herein for informational purposes along with the predicted cracking and rutting distresses.

The asphalt thermal fracture and fatigue fracture of chemically stabilized layer distresses are related more to the environmental conditions than traffic loading. This was confirmed with the output from the MEPDG trials, which consistently showed negligible predicted distress values. Therefore, the predicted distress outputs for these two distresses are not provided herein.

Rigid Pavement Analysis

One trial rigid pavement structure, a continuously reinforced concrete pavement (CRCP), was used to represent both interstate and primary highways; this pavement structure is described in Tables 7 and 8. A CRCP was chosen since the most recently constructed rigid pavements in Virginia are of this type. The material properties for the CRCP were based on a recently constructed CRCP on I-64 in VDOT's Hampton Roads District. A slab thickness of 12 in was used to represent the average slab thickness for rigid pavements in Virginia; this value was chosen since it is representative of the most recently constructed CRCPs (although it is likely to be on the upper end of typical thicknesses). The rigid MEPDG analysis was performed with a 30-year design life as recommended for rigid pavement design in Virginia (VDOT, 2008).

The MEPDG output for rigid CRCP pavement analysis predicts the IRI, number of punchouts per mile, crack width, and load transfer efficiency (LTE). The IRI is the same measure of roughness for a rigid pavement that was discussed for the flexible pavement analysis. A punchout is caused by a loss of aggregate interlock at closely spaced cracks; after repeated loading the reinforcing steel will rupture and a piece of the concrete will punch downward into the lower pavement layers (Huang, 2004). The MEPDG predicts the maximum crack width that is expected during the pavement design life. Cracks are expected to be wider during winter months when the pavement material contracts because of cooler weather. The LTE for a CRCP pavement refers to the ability to transfer loads at the cracked locations; it is reported as the percentage of the load transferred. The higher the LTE (up to 100%), the better the pavement is performing; lower LTE values indicate a poorer performing pavement.

The IRI and distresses considered by the MEPDG for CRCPs are interrelated; a large crack width can cause poor LTE in a pavement, which, in turn, leads to punchouts and ultimately

Table 7. Rigid Pavement Structure for Interstate and Primary MEPDG Test Sections

Layer No.	Material	Thickness (in)	Unit Weight (lb/ft^3)	% Steel	Modulus (psi)
1	Continuously reinforced concrete pavement	12	147.2	0.70	5,880,000
2	Cement-treated aggregate layer	6	150		70,000
3	A-7-6	12			12,000
4	A-7-6	Infinite			8,000

Table 8. Strength Properties of Continuously Reinforced Concrete Pavement Material

Time	Modulus of Elasticity (psi)	Modulus of Rupture (psi)	Splitting Tensile Strength (psi)
7 day	4,950,000	769	323
14 day	5,200,000	937	397
28 day	5,880,000	940	402
90 day	5,920,000	950	405
20 year / 28 day ratio	1.2	1.2	1.2

a rougher pavement. Although it is expected that the progression of the IRI and distresses will coincide, all the pavement condition outputs were still considered in this study as the researchers considered the functional condition of a rigid pavement to be a predominant driver of rehabilitation.

RESULTS AND DISCUSSION

Literature Review

Previous studies have investigated the traffic data inputs for use with the MEPDG in other states. The results, however, are mixed, with some studies reporting similar predicted pavement conditions using global versus site-specific traffic inputs and others reporting a significant difference.

Li et al. (2009) studied axle-load spectra inputs and found minimal differences in the MEPDG-predicted distress values for different levels of axle-load spectra. In addition, Timm et al. (2006) studied the traffic data inputs using data from Alabama and reported that 86% of the site-specific axle-load spectra factors investigated resulted in a pavement design that was within 0.5 in of the default values. However, Tran and Hall (2007) studied traffic data from Arkansas and found that the predicted pavement life differed by 25% when comparing state-specific and global (or default) axle-load spectra data. Li et al. (2007) investigated other traffic inputs into the MEPDG and found vehicle class distributions and MAF to affect the predicted amounts rutting and cracking, with no effects on IRI. Hourly distribution factors and axles per truck had no effect on the predicted pavement distresses.

The previously mentioned studies focused on flexible pavement design; a study by Khanum et al. (2006) investigated traffic data inputs for rigid pavements. When simulating a concrete pavement in Kansas, the default traffic inputs were found to predict higher distress levels than the site-specific traffic data. In addition, the authors found that the use of site-specific MAF inputs resulted in greater predicted distresses than when default MAF were used.

Calculation of MEPDG Traffic Inputs from WIM Data

The traffic inputs developed for analysis in the MEPDG include the following: axle-load spectra, MAF, vehicle class distribution factors, and number of axles per truck. Details on how each was calculated from the WIM data are presented here.

Axle-load Spectra

The axle-load spectra input in the MEPDG requires a relative frequency distribution for single, tandem, tridem, and quad axles over the previously mentioned intervals for each vehicle classification and for each month of the year. The output provided by the developed MATLAB program separated the data into steering axles in addition to the four axle types. Therefore, the histogram data were developed by combining the steering axle counts into the single-axle data. Relative frequencies were then calculated by dividing the axle counts at each interval by the total number of axles for that particular axle type, vehicle classification, and month. Figure 3 shows the relative frequency for the four axle types (single, tandem, tridem, and quad) based on the combined data from all 15 WIM sites and all vehicle classes. The axle-load spectra from each WIM site and interstate, primary, and statewide summaries are available from the authors.

For those sites that were missing a portion of the 12-month WIM data, the site-specific axle-load spectra input was determined by substituting the weighted average (weighted by the number of observations at each load level) of the available data for those dates that were missing. The average value from all observations (existent and substituted) was then calculated for each site. Summary values (interstate, primary, and statewide averages) were calculated as the average of all existent data (i.e., no values were substituted for those sites missing portions of the 12-month WIM data).

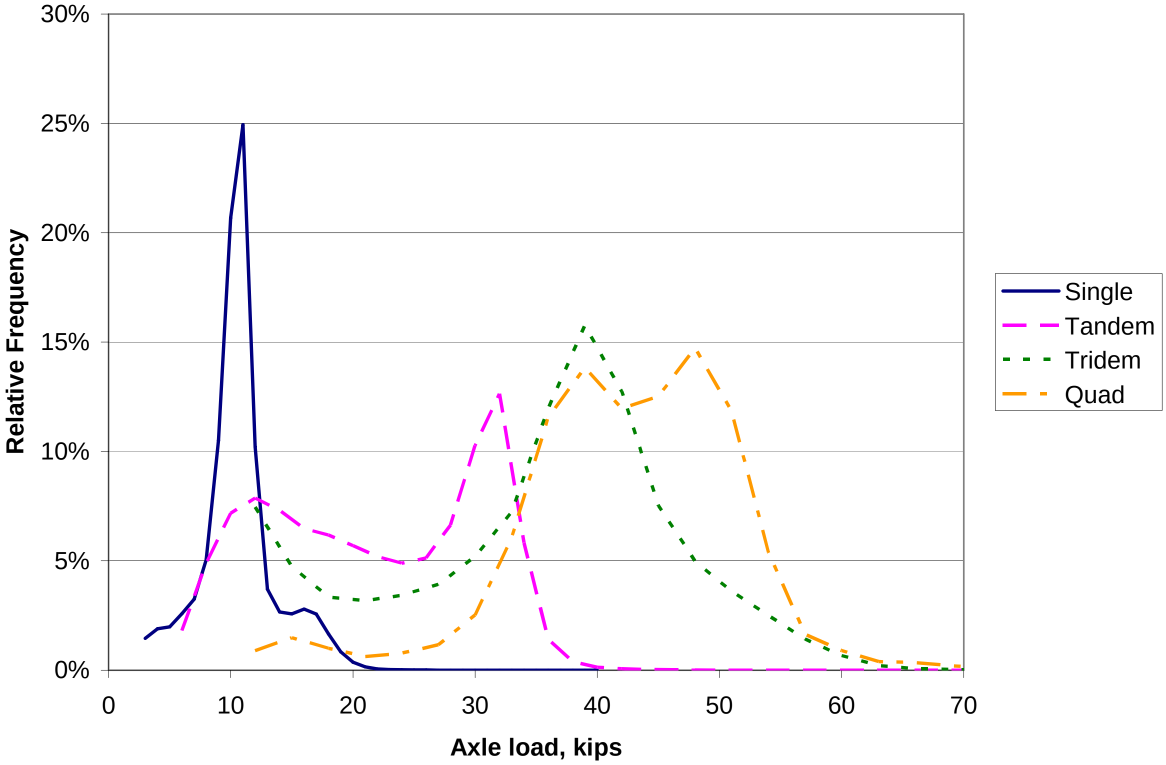

Figure 3. Statewide Axle-load spectra from All Vehicle Classifications

Monthly Adjustment Factors

Site-specific MAF for input into the MEPDG were also developed based on the WIM data. Separate MAF were used for each month, and the sum of the monthly MAF had to be 12 for each vehicle classification. The default MAF were 1.00 for all months and vehicle classes. The MEPDG provides a formula to calculate the MAF input values from traffic count data; this formula is shown as Equation 1 (ARA, Inc., 2004).

$$MAF_i = \frac{AMDTT_i}{\sum_{i=1}^{12} AMDTT_i} \times 12 \qquad \text{[Eq. 1]}$$

where

MAF_i = monthly adjustment factor for month i
$AMDTT_i$ = average monthly daily truck traffic for month i.

The output of the 'axleld' MATLAB program was used to determine the site-specific MAF input values. The sum of the steering axle counts from the histogram for each vehicle classification was used as the $AMDTT_i$ value for that month. This method excluded any vehicles that may have had a steering axle below the histogram range of 3,000 lb. The MAF that were determined based on the collection of statewide WIM data (including WIM data from interstate and primary roadways) are shown in Table 9; the MAF inputs from each WIM site and interstate, primary, and statewide summaries are available from the authors.

For those sites missing some portion of the 12-month WIM data, the site-specific MAF were calculated as the average of the existent data and a value of 1.00 assigned to those months that were missing (making the total MAF for all sites for the year equal to 12). The MAF inputs from the interstate, primary, and statewide summaries were not adjusted to correct for the sites with missing WIM data. Table 9 shows the unadjusted statewide MAF values to indicate decreased truck traffic for the months of June through September attributable to the missing data; therefore, the rest of the months have higher MAF. The researchers do not consider the effect of the missing data to be significant; however, the summary data could be influential if they under- or over-predict certain types of damage that may predominantly occur at certain times of the year (e.g., asphalt rutting and summer months).

Table 9. Monthly Adjustment Factors from Statewide WIM Data

Month	FHWA Vehicle Classification									
	4	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
January	0.95	0.88	0.83	0.54	0.99	1.05	0.93	1.01	0.99	1.02
February	1.01	0.94	0.98	0.70	1.01	1.04	1.00	1.02	1.04	0.69
March	1.15	1.16	1.11	1.06	1.14	1.14	1.16	1.09	1.09	1.34
April	1.18	1.23	0.93	0.76	1.10	1.12	1.23	1.13	1.10	1.71
May	1.11	1.07	0.94	0.76	1.10	1.13	1.10	1.13	1.13	1.11
June	0.80	0.82	0.98	1.46	0.84	0.80	0.85	0.84	0.79	1.11
July	0.78	0.89	0.96	1.28	0.80	0.73	0.83	0.79	0.72	0.78
August	0.83	0.89	1.01	1.23	0.82	0.76	0.78	0.77	0.75	0.65
September	0.83	0.93	1.03	1.13	0.85	0.78	0.82	0.80	0.83	0.97
October	1.12	1.19	1.12	1.13	1.09	1.10	1.03	1.12	1.10	1.02
November	1.14	1.05	1.06	0.98	1.13	1.18	1.13	1.18	1.18	0.92
December	1.09	0.95	1.04	0.98	1.13	1.17	1.14	1.11	1.27	0.69

Vehicle Class Distribution Factors

Vehicle class distribution factors were also determined from the WIM data. A factor was given to each FHWA Truck Class 4 through 13, with the total equaling 100%. These factors were based on the number of steering axle loads recorded for each vehicle classification. Table 10 shows the interstate, primary, and statewide average WIM vehicle class distributions and the two default MEPDG distributions that best corresponded to data from interstate and primary WIM sites: Truck Traffic Classification (TTC) Groups 1 and 2 (ARA, Inc., 2004). The vehicle class distribution factors from each WIM site and interstate, primary, and statewide summaries are available from the authors.

The vehicle class distribution factor for those sites missing a portion of the 12-month WIM data was calculated as an average of the existent data. The researchers assumed the vehicle class distribution data for those missing dates did not vary considerably from that for the remainder of the year.

Table 10. Default and Average Vehicle Class Distribution Factor Inputs

FHWA Vehicle Classification	Primary Average	Interstate Average	Statewide Average	Default TTC 1	Default TTC 2
4	5.4%	3.0%	3.5%	1.3%	2.4%
5	10.9%	3.2%	4.9%	8.5%	14.1%
6	12.9%	2.5%	4.8%	2.8%	4.5%
7	3.2%	0.1%	0.8%	0.3%	0.7%
8	4.5%	2.4%	2.9%	7.6%	0.8%
9	59.2%	82.4%	77.3%	74.0%	66.3%
10	1.8%	0.7%	0.9%	1.2%	1.4%
11	1.7%	4.1%	3.6%	3.4%	2.2%
12	0.4%	1.6%	1.3%	0.6%	0.3%
13	0.0%	0.0%	0.0%	0.3%	0.2%

TTC = Truck Traffic Classification.

Number of Axles per Truck

The number of axles per truck input values were calculated from the ‘axleld’ MATLAB output for each site by dividing the total number of axle load counts for each axle type by the total number of steering axle load counts for each of the truck classification groups. The steering and single axles were again combined into the same group to correspond with the MEPDG input format. The default MEPDG inputs are shown in Table 11 along with the statewide WIM average axles per truck. The site-specific axles per truck factors for each WIM site and interstate, primary, and statewide summaries are available from the authors.

Table 11. Default and Statewide Average Number of Axles per Truck MEPDG Inputs

FHWA Vehicle Classification	MEPDG Default Axles per Truck				Statewide WIM Average Axles per Truck			
	Single	Tandem	Tridem	Quad	Single	Tandem	Tridem	Quad
4	1.62	0.39	0.00	0.00	1.91	0.09	0.00	0.00
5	2.00	0.00	0.00	0.00	2.05	0.00	0.00	0.00
6	1.02	0.99	0.00	0.00	1.05	0.97	0.00	0.00
7	1.00	0.26	0.83	0.00	1.25	0.04	0.41	0.55
8	2.38	0.67	0.00	0.00	2.21	0.72	0.00	0.00
9	1.13	1.93	0.00	0.00	1.23	1.87	0.00	0.00
10	1.19	1.09	0.89	0.00	1.05	0.92	0.87	0.10
11	4.29	0.26	0.06	0.00	5.00	0.00	0.00	0.00
12	3.52	1.14	0.06	0.00	4.00	1.00	0.00	0.00
13	2.15	2.13	0.35	0.00	1.57	2.61	0.07	0.00

The MEPDG default axles per truck did not include any quad axles because too few were observed in the Long Term Pavement Performance (LTPP) traffic database from which the MEPDG default values were developed. Quad axles were observed in the Virginia WIM data; they accounted for approximately 0.2% of the axles recorded. Because the vehicle counts used to determine the statewide average axles per truck factors were based on the histogram counts, any axles that had a loading outside the histogram range were not counted. The number of axles per truck for those sites missing a portion of the 12-month data was calculated as an average of the existent data. The researchers assumed the distribution of the number of axles per truck did not vary significantly during the course of a year.

Comparison of Site-Specific Versus Default Traffic Inputs

To evaluate the influence of site-specific versus default traffic inputs, the predicted pavement distresses using a trial pavement structure and the two sets of traffic inputs, site-specific and default, were compared in an MEPDG analysis. A series of separate MEPDG runs was performed for each group of site-specific traffic input factors (e.g., axle-load spectra, MAF, etc.), and default inputs were used for the other factors. This allowed a separate comparison of each traffic input factor.

The differences between the predicted pavement conditions using site-specific versus default traffic inputs were compared by difference normalization. This was accomplished by dividing the difference in predicted condition by the user-defined performance criteria for each condition (found under the analysis parameters menu at the MEPDG project input screen); this normalization procedure is shown in Equation 2.

$$ND = \frac{x_{default} - x_{site}}{x_{perf}} \times 100 \qquad \text{[Eq. 2]}$$

where

ND = normalized difference
$x_{default}$ = predicted condition using default traffic data inputs
x_{site} = predicted condition using site-specific traffic data inputs
x_{perf} = user-defined performance criteria.

Normalization has been used previously to allow for comparison among the different distresses (Tran and Hall, 2007). The user-defined performance criteria were used as limiting values so changes in predicted condition could be compared with respect to the magnitude of the performance criteria. For example, site-specific traffic inputs may show twice the predicted deterioration of that obtained using default traffic inputs, but if they are each only a fraction of the limiting performance criteria, their difference would be considered negligible.

Flexible Pavement Analysis

The predicted pavement condition for the interstate and primary flexible pavement trial structures using the default traffic inputs is shown in Table 12. These values were used to compare the predicted pavement condition using site-specific traffic inputs. Table 12 also shows the user-defined performance criteria for IRI and the load-related distress values (the user-defined performance criteria values were unchanged from the MEPDG defaults).

Table 12. Predicted Pavement Condition for Flexible Trial Structures Using Default Traffic Inputs and User-Defined Performance Criteria

Condition	Predicted Condition		User-Defined Performance Criteria
	Interstate	**Primary**	
IRI (in/mi)	146.5	143.7	172
Longitudinal Cracking (ft/mi)	0	0.85	2,000
Fatigue Cracking (%)	1.22	3.36	25
Asphalt Rutting (in)	0.81	0.65	0.25
Total Rutting (in)	1.22	1.12	0.75

IRI = international roughness index.

To determine if the differences in predicted pavement condition using site-specific and default traffic inputs were significant, statistical and practical approaches were considered. To determine statistical significance, the normalized difference values for each predicted condition were evaluated with respect to the coefficient of variation (standard deviation divided by the mean) for each predicted condition. This was done to compare the changes in predicted pavement condition attributable to site-specific traffic inputs to the variation attributable to uncertainty in the predictive model. The MEPDG includes formulas that describe the standard deviation of each predicted pavement condition. Because the predicted distresses do not follow a standard distribution format, the standard deviation changes as the distress value changes. Therefore, equations are necessary to determine the standard deviation at a specific distress level.

Equations 3 through 7 were used to calculate the standard deviation of the flexible pavement cracking and rutting distresses (ARA, Inc., 2004). The calculation to determine the standard deviation of the flexible pavement IRI value was not shown; therefore, the standard deviation value was determined from the IRI at reliability values that are included in the MEPDG output; the formula used for this calculation is shown as Equation 8.

$$SD_{TopDown} = 200 + \frac{2300}{(1 + e^{(1.072 - 2.1654 \times \log(TOP + .0001))})} \quad \text{[Eq. 3]}$$

$$SD_{BottomUp} = 1.13 + \frac{13}{(1 + e^{-7.57 - 15.5 \times \log(BOTTOM + 0.0001)})} \quad \text{[Eq. 4]}$$

$$SD_{ACRutting} = 0.24 \times ACRut^{0.8206} + 0.001 \quad \text{[Eq. 5]}$$

$$SD_{BaseRutting} = 0.1477 \times BaseRut^{0.6711} + 0.001 \quad \text{[Eq. 6]}$$

$$SD_{SubgradeRutting} = 0.1235 \times SubRut^{0.5012} + 0.0001 \quad \text{[Eq. 7]}$$

$$SD_{IRI} = \frac{IRI_R - IRI_{50\%}}{Z(R)} \quad \text{[Eq. 8]}$$

where

$SD_{TopDown}$ = standard deviation of longitudinal cracking (ft/mi)
TOP = predicted damage for longitudinal cracking (%)
$SD_{BottomUp}$ = standard deviation of fatigue cracking (%)
BOTTOM = predicted damage for fatigue cracking (%)
$SD_{ACRutting}$ = standard deviation of asphalt layer(s) rutting (in)
ACRut = predicted amount of asphalt permanent deformation (in)
$SD_{BaseRutting}$ = standard deviation of base layer permanent deformation (in)
BaseRut = predicted amount of base permanent deformation (in)
$SD_{SubgradeRutting}$ = standard deviation of subgrade layer permanent deformation (in)
SubRut = predicted amount of subgrade permanent deformation (in)
SD_{IRI} = standard deviation of IRI (in/mi)
IRI_R = IRI at reliability (95% for interstate and 90% for primary trials)
$IRI_{50\%}$ = predicted IRI for a 50% reliability level
Z(R) = z-score for reliability level (1.645 for interstate [assuming 95% reliability] and 1.28 for primary [assuming 90% reliability] trials).

The standard deviation values for the four flexible distresses were calculated at the point where the predicted distress met the corresponding user-defined performance criteria. This way each standard deviation represents the amount of variation at the point of failure for that specific distress. Because the two cracking distresses and IRI values did not reach the limiting distress criterion values, the standard deviation for these conditions was calculated using the predicted condition at the end of the 20-year service life. The coefficient of variation for each predicted pavement condition was then determined by dividing the calculated standard deviation by the user-defined performance criteria. The standard deviation and coefficient of variation values that were calculated for the IRI and four flexible pavement distresses for the interstate and primary trial structures using default traffic inputs are shown in Table 13.

To determine if the differences in predicted pavement condition using site-specific and default traffic inputs were practically significant, the predicted time to failure for each pavement condition using site-specific traffic data inputs was compared to the predicted time to failure for each pavement condition using the default traffic data inputs. The predicted number of months

Table 13. Calculated Standard Deviation and Coefficient of Variation for Predicted Pavement Condition for Flexible Trial Structures Using Default Traffic Inputs

Condition	Interstate		Primary	
	Standard Deviation	**Coefficient of Variation**	**Standard Deviation**	**Coefficient of Variation**
IRI	32.4	18.8%	34.4	20.0%
Longitudinal Cracking	206.1	10.3%	363.4	18.2%
Fatigue Cracking	1.27	5.1%	13.11	52.4%
Asphalt Rutting	0.078[a]	31.2%	0.078[a]	31.2%
Total Rutting	0.205[b]	27.3%	0.198[c]	26.5%

IRI = international roughness index.
[a] Calculated at an asphalt layers rut depth of 0.25 in.
[b] Calculated at a total layers rut depth of 0.7514 in.
[c] Calculated at a total layers rut depth of 0.7453 in.

until each distress reached the user-defined performance criteria was used as the time until failure for the pavement. Because the flexible pavement trials all showed low fatigue and longitudinal cracking distresses, only the rutting distress (both asphalt layers and total pavement rutting) predictions reached this definition of failure and were thus the only conditions considered (the predicted IRI condition is largely based on these four distresses so it was not considered separately).

Axle-load Spectra

The axle load distribution factors for each site were converted to an axle load file that could be imported into the MEPDG software. If no vehicles were observed at a site for a vehicle class in a given month for an axle group, a zero was entered into the file for the MEPDG calculations. For those sites that were missing a portion of the 12-month WIM data, the missing values were substituted with the weighted average of the axle-load spectra from the months with available data for that site. The interstate, primary, and statewide summary axle-load spectra were developed from the existent WIM data. Although using monthly axle-load spectra is preferred, the monthly variation of the axle-load spectra is not typically significant for MEPDG analysis (ARA, Inc., 2004).

The predicted pavement condition and normalized difference for the site-specific axle-load spectra input trials using the flexible interstate trial structure are shown in Table 14. The predicted condition and normalized difference using the interstate trial structure and the average axle-load spectra from the interstate WIM sites (interstate average) and all WIM sites (statewide average) are also shown. The predicted pavement condition and normalized difference for the site-specific axle-load spectra input trials using the flexible primary trial structure are shown in Table 15. As discussed previously, the site-specific values for those sites missing a portion of the WIM data were developed from weighted averages, these locations are marked with an asterisk in Tables 14 and 15. The predicted condition and normalized difference using the primary trial structure and the average axle-load spectra from the primary WIM sites (primary average) and all WIM sites (statewide average) are also shown.

Table 14. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Interstate MEPDG Axle-Load Spectra Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
I81-N Stephens City	143.2	1.9%	0	0.0%	0.9	1.3%	0.81	0.0%	1.14	10.7%
I81-S Stephens City	141.7	2.8%	0	0.0%	0.8	1.7%	0.78	12.0%	1.1	16.0%
I81-N Troutville[a]	142.4	2.4%	0	0.0%	0.9	1.3%	0.79	8.0%	1.12	13.3%
I81-S Troutville	141.7	2.8%	0	0.0%	0.8	1.7%	0.77	16.0%	1.1	16.0%
I95-N Dumfries	142.9	2.1%	0	0.0%	0.9	1.3%	0.8	4.0%	1.13	12.0%
I95-S Dumfries[a]	140.5	3.5%	0	0.0%	0.8	1.7%	0.75	24.0%	1.07	20.0%
I95-N Sussex[a]	143.4	1.8%	0	0.0%	0.9	1.3%	0.81	0.0%	1.14	10.7%
I66-W Fauquier[a]	139.1	4.3%	0	0.0%	0.7	2.1%	0.72	**36.0%**	1.04	24.0%
Interstate Average[b]	142.3	2.4%	0	0.0%	0.9	1.3%	0.79	8.0%	1.12	13.3%
Statewide Average[b]	142	2.6%	0	0.0%	0.9	1.3%	0.78	12.0%	1.11	14.7%

IRI = international roughness index.

Significant normalized difference values are shown in bold.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

Table 15. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Primary MEPDG Axle-Load Spectra Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
US29 Danville	137.9	3.4%	0.4	0.0%	2.3	4.2%	0.6	20.0%	0.99	17.3%
US58 Lee County[a]	137.1	3.8%	0.5	0.0%	2	5.4%	0.56	**36.0%**	0.97	20.0%
US60 Cumberland[a]	137.7	3.5%	0.5	0.0%	2.1	5.0%	0.58	28.0%	0.98	18.7%
SR288 Chesterfield[a]	138	3.3%	0.4	0.0%	2.2	4.6%	0.6	20.0%	0.99	17.3%
US17 Fauquier	138.3	3.1%	0.4	0.0%	2.3	4.2%	0.61	16.0%	1	16.0%
SR234 Prince William	136.6	4.1%	0.3	0.0%	2	5.4%	0.58	28.0%	0.96	21.3%
SR164 Portsmouth	134.8	5.2%	0.3	0.0%	1.5	7.4%	0.54	**44.0%**	0.92	**26.7%**
Primary Average[b]	138.5	3.0%	0.4	0.0%	2.3	4.2%	0.61	16.0%	1	16.0%
Statewide Average[b]	139.6	2.4%	0.5	0.0%	2.5	3.4%	0.64	4.0%	1.03	12.0%

IRI = international roughness index.
Significant normalized difference values are shown in bold.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

The axle-load spectra trials predicted low levels of longitudinal and fatigue cracking and the normalized difference values were well below the coefficient of variation shown in Table 13. The predicted asphalt and total rutting showed more variation in terms of the normalized difference between site-specific and default inputs. However, the normalized difference was still less than the coefficient of variation for each distress in all cases except for the asphalt rutting at one interstate site, the asphalt rutting at two primary sites, and total rutting at one primary site. Overall, the predicted pavement distresses using the site-specific load spectra were found to be similar to those predicted using the default traffic data inputs for all cases but four.

Monthly Adjustment Factors

Tables 15 and 16 show the MEPDG-predicted pavement condition and normalized difference for the flexible interstate and primary site-specific MAF input trials, respectively. As discussed previously, site-specific data from those sites missing portions of the 12-month WIM data were substituted with MAF values of 1.00. The interstate, primary, and statewide summary inputs for MAF were developed from the existent WIM data and may be influenced by lesser vehicle counts from those months and sites with incomplete data.

The MAF trials show that there is almost no difference in predicted longitudinal cracking and fatigue cracking between the site-specific and default MAF. The predicted asphalt rutting and total rutting using site-specific data were found to vary more from the distress quantities predicted using default traffic inputs but were all less than the coefficient of variation values shown in Table 13 except for the asphalt rutting from the interstate average data. Overall, the predicted pavement distresses using the site-specific MAF were the same as those predicted using the default traffic data inputs for all cases but one.

Table 16. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Interstate MEPDG MAF Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
I81-N Stephens City	146.9	-0.2%	0	0.0%	1.2	0.1%	0.82	-4.0%	1.23	-1.3%
I81-S Stephens City	146.9	-0.2%	0	0.0%	1.2	0.1%	0.82	-4.0%	1.23	-1.3%
I81-N Troutville[a]	146.6	-0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.22	0.0%
I81-S Troutville	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I95-N Dumfries	145	0.9%	0	0.0%	1.2	0.1%	0.78	12.0%	1.18	5.3%
I95-S Dumfries[a]	146.7	-0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.22	0.0%
I95-N Sussex[a]	144.6	1.1%	0	0.0%	1.2	0.1%	0.77	16.0%	1.17	6.7%
I66-W Fauquier[a]	147.2	-0.4%	0	0.0%	1.3	-0.3%	0.83	-8.0%	1.24	-2.7%
Interstate Average[b]	142.5	2.3%	0	0.0%	1.1	0.5%	0.72	**36.0%**	1.12	13.3%
Statewide Average[b]	143.2	1.9%	0	0.0%	1.1	0.5%	0.74	28.0%	1.14	10.7%

MAF = monthly adjustment factors; IRI = international roughness index.
Significant normalized difference values are shown in bold.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Table 17. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Primary MEPDG MAF Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
US29 Danville	140.7	1.7%	0.6	0.0%	3.1	1.0%	0.59	24.0%	1.05	9.3%
US58 Lee County[a]	143.3	0.2%	0.8	0.0%	3.2	0.6%	0.65	0.0%	1.11	1.3%
US60 Cumberland[a]	142.4	0.8%	0.9	0.0%	3.2	0.6%	0.62	12.0%	1.09	4.0%
SR288 Chesterfield[a]	143.9	-0.1%	0.9	0.0%	3.4	-0.2%	0.66	-4.0%	1.12	0.0%
US17 Fauquier	143.6	0.1%	0.9	0.0%	3.4	-0.2%	0.65	0.0%	1.12	0.0%
SR234 Prince William	144.9	-0.7%	1.1	0.0%	3.5	-0.6%	0.68	-12.0%	1.15	-4.0%
SR164 Portsmouth	142.6	0.6%	0.9	0.0%	3.3	0.2%	0.63	8.0%	1.09	4.0%
Primary Average[b]	143	0.4%	0.9	0.0%	3.3	0.2%	0.64	4.0%	1.1	2.7%
Statewide Average[b]	140.9	1.6%	0.7	0.0%	3.1	1.0%	0.59	24.0%	1.05	9.3%

MAF = monthly adjustment factors; IRI = international roughness index.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Vehicle Class Distribution Factors

Tables 18 and 19 show the MEPDG-predicted pavement condition and normalized difference for the flexible interstate and primary site-specific vehicle class distribution factor input trials, respectively. As discussed previously, site-specific distribution factors from those sites missing portions of the 12-month WIM data were calculated using only the existent data. The interstate, primary, and statewide summary vehicle class distribution inputs were also developed from the existent WIM data.

The trials show that there is almost no difference in predicted longitudinal cracking and fatigue cracking between the site-specific and default vehicle class distribution factors. The predicted asphalt rutting and total rutting using site-specific data were found to vary more from the control distress values than the cracking distresses but were all less than the coefficient of

Table 18. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Interstate MEPDG Vehicle Class Distribution Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
I81-N Stephens City	148	-0.9%	0	0.0%	1.3	-0.3%	0.85	-16.0%	1.25	-4.0%
I81-S Stephens City	147.9	-0.8%	0	0.0%	1.3	-0.3%	0.84	-12.0%	1.25	-4.0%
I81-N Troutville[a]	148	-0.9%	0	0.0%	1.3	-0.3%	0.85	-16.0%	1.25	-4.0%
I81-S Troutville	147.7	-0.7%	0	0.0%	1.3	-0.3%	0.84	-12.0%	1.25	-4.0%
I95-N Dumfries	147.3	-0.5%	0	0.0%	1.3	-0.3%	0.83	-8.0%	1.24	-2.7%
I95-S Dumfries[a]	147.5	-0.6%	0	0.0%	1.3	-0.3%	0.83	-8.0%	1.24	-2.7%
I95-N Sussex[a]	147.3	-0.5%	0	0.0%	1.2	0.1%	0.83	-8.0%	1.24	-2.7%
I66-W Fauquier[a]	147.1	-0.3%	0	0.0%	1.2	0.1%	0.83	-8.0%	1.23	-1.3%
Interstate Average[b]	147.7	-0.7%	0	0.0%	1.3	-0.3%	0.84	-12.0%	1.25	-4.0%
Statewide Average[b]	147.2	-0.4%	0	0.0%	1.3	-0.3%	0.83	-8.0%	1.24	-2.7%

IRI = international roughness index.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

Table 19. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Primary MEPDG Vehicle Class Distribution Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
US29 Danville	145	-0.8%	1.1	0.0%	3.6	-1.0%	0.68	-12.0%	1.15	-4.0%
US58 Lee County[a]	142.5	0.7%	1.1	0.0%	3.1	1.0%	0.63	8.0%	1.09	4.0%
US60 Cumberland[a]	143.5	0.1%	1.8	0.0%	3.2	0.6%	0.64	4.0%	1.12	0.0%
SR288 Chesterfield[a]	144.1	-0.2%	2.3	-0.1%	3.3	0.2%	0.64	4.0%	1.13	-1.3%
US17 Fauquier	145.4	-1.0%	1.5	0.0%	3.6	-1.0%	0.68	-12.0%	1.16	-5.3%
SR234 Prince William	140.7	1.7%	1.7	0.0%	2.8	2.2%	0.58	28.0%	1.05	9.3%
SR164 Portsmouth	144	-0.2%	1.3	0.0%	3.3	0.2%	0.65	0.0%	1.13	-1.3%
Primary Average[b]	144	-0.2%	1.6	0.0%	3.4	-0.2%	0.65	0.0%	1.13	-1.3%
Statewide Average[b]	145.5	-1.0%	1	0.0%	3.7	-1.4%	0.69	-16.0%	1.16	-5.3%

IRI = international roughness index.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

variation values shown in Table 13. Overall, the predicted pavement distresses using the site-specific vehicle class distribution factors were found to be the same as those predicted using the default traffic data inputs for all cases.

Number of Axles per Truck

The MEPDG-predicted pavement condition and normalized difference for the flexible interstate and primary site-specific number of axles per truck input trials are shown in Tables 20 and 21, respectively. As discussed previously, site-specific axles per truck factors from those sites missing portions of the 12-month WIM data were developed using only the existent data. The interstate, primary, and statewide summary axles per truck factors were also developed from the existent WIM data.

Table 20. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Interstate MEPDG Number of Axles per Truck Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
I81-N Stephens City	146.4	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I81-S Stephens City	146.5	0.0%	0	0.0%	1.2	0.1%	0.81	0.0%	1.22	0.0%
I81-N Troutville[a]	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I81-S Troutville	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I95-N Dumfries[a]	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I95-S Dumfries	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I95-N Sussex[a]	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
I66-W Fauquier[a]	146.2	0.2%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
Interstate Average[b]	146.4	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%
Statewide Average[b]	146.3	0.1%	0	0.0%	1.2	0.1%	0.81	0.0%	1.21	1.3%

IRI = international roughness index.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

Table 21. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Flexible Primary MEPDG Number of Axles per Truck Trials

Input	IRI (in/mi)		Longitudinal Cracking (ft/mi)		Fatigue Cracking (%)		Asphalt Rutting (in)		Total Rutting (in)	
US29 Danville	143.4	0.2%	1.2	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%
US58 Lee County[a]	142.8	0.5%	0.9	0.0%	3.1	1.0%	0.64	4.0%	1.1	2.7%
US60 Cumberland[a]	144.3	-0.3%	1.6	0.0%	3.5	-0.6%	0.67	-8.0%	1.13	-1.3%
SR288 Chesterfield[a]	143.4	0.2%	1.4	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%
US17 Fauquier	143.2	0.3%	1.4	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%
SR234 Prince William	143.3	0.2%	1.3	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%
SR164 Portsmouth	143.3	0.2%	1.2	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%
Primary Average[b]	143.3	0.2%	1.3	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%
Statewide Average[b]	143.4	0.2%	1.3	0.0%	3.3	0.2%	0.65	0.0%	1.11	1.3%

IRI = international roughness index.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

The axles per truck trials show no difference in predicted longitudinal cracking and fatigue cracking between the site-specific and default number of axles per truck values. The predicted asphalt rutting and total rutting show no difference in site-specific and default number of axles per truck values. Overall, the predicted pavement distresses using the site-specific number of axles per truck factors were found to be the same as those predicted using the default traffic data inputs for all cases.

Evaluation for Practical Significance

The MEPDG-predicted time to failure was used to compare the different site-specific inputs in practical terms. Since only the rutting distresses (both asphalt and total rutting) were found to exceed the definition of failure prior to the end of the 20-year analysis period, only these distresses were considered. Tables 22 and 23 show the number of months until the limiting pavement condition criterion (asphalt rutting = 0.25 in or total rutting = 0.75 in) was reached for the four traffic factors (axle-load spectra, monthly adjustment factor, vehicle class distribution,

Table 22. Number of Months to Failure for Interstate MEPDG Trials

Site	Asphalt Rutting = 0.25 in				Total Rutting = 0.75 in			
	Axle-load Spectra	Monthly Adjustment Factors	Vehicle Class Distribution	Axles per Truck	Axle-load Spectra	Monthly Adjustment Factors	Vehicle Class Distribution	Axles per Truck
Interstate Default	33	33	33	33	70	70	70	70
I81-N Stephens City	33	33	33	33	**93**	70	70	71
I81-S Stephens City	34	33	33	33	**97**	70	70	70
I81-N Troutville[a]	34	33	33	33	**99**	70	70	71
I81-S Troutville	34	33	33	33	**103**	70	70	71
I95-N Dumfries	34	34	33	33	**93**	80	70	71
I95-S Dumfries[a]	34	33	33	33	**106**	70	70	71
I95-N Sussex[a]	33	34	33	33	**93**	80	70	71
I66-W Fauquier[a]	35	33	33	33	**108**	70	70	71
Interstate Average[b]	34	34	33	33	**95**	**92**	70	71
Statewide Average[b]	34	34	33	33	**95**	**83**	70	71

Significant normalized difference values are shown in bold.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

Table 23. Number of Months to Failure for Primary MEPDG Trials

Site	Asphalt Rutting = 0.25 in				Total Rutting = 0.75 in			
	Axle-load Spectra	Monthly Adjustment Factors	Vehicle Class Distribution	Axles per Truck	Axle-load Spectra	Monthly Adjustment Factors	Vehicle Class Distribution	Axles per Truck
Primary Default	45	45	45	45	82	82	82	82
US29 Danville	47	48	35	45	**119**	**100**	73	83
US58 Lee County[a]	**58**	45	46	45	**128**	83	91	85
US60 Cumberland[a]	**57**	46	46	36	**119**	92	82	81
SR288 Chesterfield[a]	47	44	45	45	**118**	82	81	83
US17 Fauquier	46	45	35	45	**118**	82	71	83
SR234 Prince William	**57**	35	**57**	45	**130**	80	**96**	83
SR164 Portsmouth	**59**	46	45	45	**142**	91	81	83
Primary Average[b]	47	46	45	45	**117**	84	81	83
Statewide Average[b]	45	48	35	45	**107**	**96**	71	83

Significant normalized difference values are shown in bold.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

and number of axles per truck inputs) for interstate and primary trials, respectively. The tables also indicate those site-specific traffic factors found to have a difference greater than 12 months from the default traffic data.

From Table 22, it can be seen that the predicted time to failure for the asphalt rutting deterioration (with failure defined at 0.25 in) using the various site-specific traffic inputs was not significant when compared to the predicted time to failure using the default traffic inputs. Conversely, when total rutting was considered (with failure defined at 0.75 in), the predicted time to failure using site-specific axle-load spectra was found to be significant for all sites when compared to the default axle-load spectra. In addition, the time to failure considering total rutting using the site-specific MAF was found to be significant for the interstate and statewide average traffic inputs.

From Table 23 it can be seen that the predicted time to failure for the asphalt rutting deterioration (with failure defined at 0.25 in) using the site-specific axle-load spectra and vehicle class distribution factors was found to be significant when compared to the predicted time to failure using the default traffic inputs for four sites and one site, respectively. In addition, when total rutting was considered (with failure defined at 0.75 in), the predicted time to failure using site-specific axle-load spectra was found to be significant for all sites when compared to the default axle-load spectra. In addition, the time to failure considering total rutting using the site-specific MAF was found to be significant for one site and the statewide average. The time to failure considering total rutting using the site-specific vehicle class distribution factors was found to be significant for one site.

Rigid Pavement Analysis

The predicted pavement condition for the interstate and primary rigid trials using the default traffic inputs is shown in Table 24. These values were used to compare the predicted pavement condition using site-specific traffic inputs. Table 24 also shows the user-defined performance criteria for IRI and the load-related distress values (the user-defined performance criteria values were unchanged from the MEPDG defaults).

The reliability for IRI and punchouts for the two test sections was determined to be approximately 100%, indicating that very low levels of distress were predicted, even after a 30-year design life. Low quantities of pavement distresses were predicted until a critical amount of traffic loading was reached, and then the predicted distresses began to increase quickly. The predicted distresses for the test sections were low throughout the 30-year life span. As with the flexible pavement distress predictions, the predicted distresses could change from what was found in this study if a local calibration process is completed for Virginia.

Because of the low levels of distress for these pavement sections, the standard deviation formulas were considered to be inappropriate. Thus, estimates of the coefficient of variation

Table 24. Predicted Pavement Condition for Rigid Trial Structure Using Default Traffic Inputs and User-Defined Performance Criteria

Condition	Predicted Condition		User-Defined Performance Criteria
	Interstate	Primary	
IRI (in/mi)	68.7	68.6	172
Punchouts (per mi)	0	0	10
Maximum Crack Width (in)	0.0143	0.0143	0.02
Minimum LTE (%)	78.4	98.9	75

IRI = international roughness index; LTE = load transfer efficiency.

values were not calculated. In addition, a measure of significance by evaluating the predicted time to failure for the various distresses was not performed. The results are discussed with respect to what the researchers considered to be a practically significant difference of 10% in the calculated normalized difference.

Axle-load Spectra

The MEPDG-predicted pavement condition and normalized difference for the rigid interstate site-specific axle-load spectra input trials are shown in Table 25 and the rigid primary trials are shown in Table 26; the normalized difference values were calculated with Equation 2 using values from Table 24 for the limiting distress criteria and default values. The sites with missing data were treated the same as in the flexible analysis described previously. The summary axle-load spectra were also developed in the same manner as for the flexible analysis.

Table 25. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Interstate MEPDG Axle-load Spectra Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
I81-N Stephens City	68.6	0.1%	0	0.0%	0.0143	0.0%	76.4	2.7%
I81-S Stephens City	68.6	0.1%	0	0.0%	0.0143	0.0%	79.6	-1.6%
I81-N Troutville[a]	68.6	0.1%	0	0.0%	0.0143	0.0%	77.7	0.9%
I81-S Troutville	68.6	0.1%	0	0.0%	0.0143	0.0%	80.9	-3.3%
I95-N Dumfries	68.6	0.1%	0	0.0%	0.0143	0.0%	79.6	-1.6%
I95-S Dumfries[a]	68.6	0.1%	0	0.0%	0.0143	0.0%	84.5	-8.1%
I95-N Sussex[a]	68.6	0.1%	0	0.0%	0.0143	0.0%	72.9	7.3%
I66-W Fauquier[a]	68.6	0.1%	0	0.0%	0.0143	0.0%	87.1	**-11.6%**
Interstate Average[b]	68.6	0.1%	0	0.0%	0.0143	0.0%	79.3	-1.2%
Statewide Average[b]	68.6	0.1%	0	0.0%	0.0143	0.0%	80.2	-2.4%

IRI = international roughness index; LTE = load transfer efficiency.
Significant normalized difference values are shown in bold.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Table 26. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Primary MEPDG Axle-load Spectra Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
US29 Danville	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
US58 Lee County[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	99.1	-0.3%
US60 Cumberland[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	99.1	-0.3%
SR288 Chesterfield[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
US17 Fauquier	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
SR234 Prince William	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
SR164 Portsmouth	68.6	0.0%	0	0.0%	0.0143	0.0%	99.1	-0.3%
Primary Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
Statewide Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%

IRI = international roughness index; LTE = load transfer efficiency.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data

Tables 25 and 26 show that very little change was observed in the MEPDG-predicted pavement condition when site-specific axle-load spectra were used in place of the default load spectra. Only the load transfer efficiency from one site during the interstate trials showed a predicted load transfer efficiency with a practically significant difference from that predicted using default data.

Monthly Adjustment Factors

The MEPDG-predicted pavement condition and normalized difference for the rigid interstate site-specific MAF input trials are shown in Table 27, and the rigid primary MAF input trials are shown in Table 28. The sites with missing data were treated the same as in the flexible analysis described previously. The summary MAF were also developed in the same manner as for the flexible analysis.

Table 27. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Interstate MEPDG Monthly Adjustment Factor Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
I81-N Stephens City	68.6	0.1%	0	0.0%	0.0143	0.0%	81.2	-3.7%
I81-S Stephens City	68.7	0.0%	0	0.0%	0.0143	0.0%	80.9	-3.3%
I81-N Troutville[a]	68.7	0.0%	0	0.0%	0.0143	0.0%	79.9	-2.0%
I81-S Troutville	68.7	0.0%	0	0.0%	0.0143	0.0%	77	1.9%
I95-N Dumfries	68.7	0.0%	0	0.0%	0.0143	0.0%	77	1.9%
I95-S Dumfries[a]	68.7	0.0%	0	0.0%	0.0143	0.0%	76.9	2.0%
I95-N Sussex[a]	68.8	-0.1%	0.1	-1.0%	0.0143	0.0%	73.4	6.7%
I66-W Fauquier[a]	68.6	0.1%	0	0.0%	0.0143	0.0%	81.7	-4.4%
Interstate Average[b]	69.1	-0.2%	0.3	-3.0%	0.0143	0.0%	**63.5**	19.9%
Statewide Average[b]	69	-0.2%	0.2	-2.0%	0.0143	0.0%	**66.5**	15.9%

IRI = international roughness index; LTE = load transfer efficiency.
Significant normalized difference values are shown in bold.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Table 28. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Primary MEPDG Monthly Adjustment Factor Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
US29 Danville	68.6	0.0%	0	0.0%	0.0143	0.0%	98.7	0.3%
US58 Lee County[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
US60 Cumberland[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.8	0.1%
SR288 Chesterfield[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
US17 Fauquier	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
SR234 Prince William	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
SR164 Portsmouth	68.6	0.0%	0	0.0%	0.0143	0.0%	98.8	0.1%
Primary Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.8	0.1%
Statewide Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.7	0.3%

[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Tables 27 and 28 show that very little change was observed in the MEPDG-predicted pavement condition when site-specific MAF were used in place of the default adjustment factors. The only changes noted were in the predicted load transfer efficiency. Table 27 shows only the differences arising from using the two summary inputs would be considered to be practically significant (normalized difference greater than 10%). As discussed in the "Methods" section, this could be a result of using summary adjustment factors developed from traffic data that are missing during critical times of the year for this distress.

Vehicle Class Distribution Factors

The MEPDG-predicted pavement condition and normalized difference for the rigid interstate and primary site-specific vehicle class distribution input trials are shown in Tables 29 and 30, respectively. The sites with missing data were treated the same as in the flexible analysis described previously. The summary vehicle class distribution factors were also developed in the same manner as for the flexible analysis.

Table 29. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Interstate MEPDG Vehicle Class Distribution Factor Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
I81-N Stephens City	68.9	-0.1%	0.1	-1.0%	0.0143	0.0%	**68.3**	13.5%
I81-S Stephens City	68.9	-0.1%	0.1	-1.0%	0.0143	0.0%	**69**	12.5%
I81-N Troutville[a]	68.9	-0.1%	0.1	-1.0%	0.0143	0.0%	**68.1**	13.7%
I81-S Troutville	68.8	-0.1%	0.1	-1.0%	0.0143	0.0%	**70.8**	10.1%
I95-N Dumfries	68.7	0.0%	0.1	-1.0%	0.0143	0.0%	73.5	6.5%
I95-S Dumfries[a]	68.8	-0.1%	0.1	-1.0%	0.0143	0.0%	72.8	7.5%
I95-N Sussex[a]	68.8	-0.1%	0.1	-1.0%	0.0143	0.0%	72.5	7.9%
I66-W Fauquier[a]	68.7	0.0%	0.1	-1.0%	0.0143	0.0%	74.6	5.1%
Interstate Average[b]	68.8	-0.1%	0.1	-1.0%	0.0143	0.0%	**70.8**	10.1%
Statewide Average[b]	68.7	0.0%	0.1	-1.0%	0.0143	0.0%	74.9	4.7%

IRI = international roughness index; LTE = load transfer efficiency.
Significant normalized difference values are shown in bold.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Table 30. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Primary MEPDG Vehicle Class Distribution Factor Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
US29 Danville	68.6	0.0%	0	0.0%	0.0143	0.0%	98.7	0.3%
US58 Lee County[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
US60 Cumberland[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
SR288 Chesterfield[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
US17 Fauquier	68.6	0.0%	0	0.0%	0.0143	0.0%	98.7	0.3%
SR234 Prince William	68.6	0.0%	0	0.0%	0.0143	0.0%	99.2	-0.4%
SR164 Portsmouth	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
Primary Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
Statewide Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.6	0.4%

IRI = international roughness index; LTE = load transfer efficiency.
[a] Sites with incomplete WIM data.
[b] Summary inputs developed from sites with incomplete data.

Tables 29 and 30 show that very little change was observed in the MEPDG-predicted pavement condition when site-specific vehicle class distribution factors were used in place of the default distribution factors with the exception of the predicted load transfer efficiency. Table 29 shows that the predicted load transfer efficiency using site-specific data for four sites and the interstate average data during the interstate trials showed a normalized difference greater than 10%, which could be considered to be practically significant.

Number of Axles per Truck

The MEPDG-predicted pavement condition and normalized difference for the rigid interstate and primary site-specific number of axles per truck input trials are shown in Tables 31 and 32, respectively. The sites with missing data were treated the same as in the flexible analysis described previously. The summary number of axles per truck factors was also developed in the same manner as for the flexible analysis.

Table 31. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Interstate MEPDG Number of Axles per Truck Input Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
I81-N Stephens City	68.7	0.0%	0	0.0%	0.0143	0.0%	79.3	-1.2%
I81-S Stephens City	68.7	0.0%	0	0.0%	0.0143	0.0%	78.6	-0.3%
I81-N Troutville[a]	68.7	0.0%	0	0.0%	0.0143	0.0%	79.7	-1.7%
I81-S Troutville	68.7	0.0%	0	0.0%	0.0143	0.0%	79.4	-1.3%
I95-N Dumfries	68.7	0.0%	0	0.0%	0.0143	0.0%	79.5	-1.5%
I95-S Dumfries[a]	68.7	0.0%	0	0.0%	0.0143	0.0%	79.9	-2.0%
I95-N Sussex[a]	68.7	0.0%	0	0.0%	0.0143	0.0%	79.8	-1.9%
I66-W Fauquier[a]	68.7	0.0%	0	0.0%	0.0143	0.0%	80.1	-2.3%
Interstate Average[b]	68.7	0.0%	0	0.0%	0.0143	0.0%	79.3	-1.2%
Statewide Average[b]	68.7	0.0%	0	0.0%	0.0143	0.0%	79.8	-1.9%

IRI = international roughness index; LTE = load transfer efficiency.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

Table 32. Predicted Pavement Condition and Normalized Difference (%) for Site-Specific Rigid Primary MEPDG Number of Axles per Truck Input Trials

Input	IRI (in/mi)		Punchouts (per mi)		Maximum Crack Width (in)		Minimum LTE (%)	
US29 Danville	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
US58 Lee County[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	99	-0.1%
US60 Cumberland[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
SR288 Chesterfield[a]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
US17 Fauquier	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
SR234 Prince William	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
SR164 Portsmouth	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
Primary Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%
Statewide Average[b]	68.6	0.0%	0	0.0%	0.0143	0.0%	98.9	0.0%

IRI = international roughness index; LTE = load transfer efficiency.

[a] Sites with incomplete WIM data.

[b] Summary inputs developed from sites with incomplete data.

Tables 31 and 32 show that very little change was observed in the MEPDG-predicted pavement condition when site-specific number of axles per truck factors were used in place of the default axles per truck factors. This shows that the use of site-specific number of axles per truck factors was not found to be significant.

Local Calibration

As noted in the tables previously provided, the distress limits were seen, in some cases, to over- or underestimate the severity of deterioration that might be expected based on local experience. In these cases, the need for a local calibration procedure to adjust the distress prediction models was shown. Following a local calibration procedure, this study may need to be repeated to determine if the findings remain the same.

SUMMARY OF FINDINGS

Flexible Pavement Analysis

Axle-load Spectra

- The predicted asphalt rutting using site-specific axle-load spectra was significantly different for one and two sites during the interstate and primary structure trials, respectively.
- The predicted total rutting using site-specific axle-load spectra was significantly different for one site during the primary structure trial.
- The predicted time to failure by asphalt rutting using site-specific axle-load spectra was significantly different for four sites during the primary structure trial.
- The predicted time to failure by total rutting using site-specific axle-load spectra was significantly different for all sites during the interstate and primary structure trials.

Monthly Adjustment Factor

- The predicted asphalt rutting using site-specific MAF was significantly different for the interstate average data during the interstate structure trial.
- The predicted time to failure by total rutting using site-specific MAF was significantly different for the interstate and statewide average data during the interstate structure trial and for one site and the statewide average data during the primary structure trial.

Vehicle Class Distribution Factor

- No predicted distresses using site-specific vehicle class distribution factors were significantly different in either the interstate or primary structure trials.

- The predicted time to failure by asphalt rutting using site-specific vehicle class distribution factors was significantly different for one site during the primary structure trial.

- The predicted time to failure by total rutting using site-specific vehicle class distribution factors was significantly different for the same site during the primary structure trial.

Number of Axles per Truck

- No predicted distresses using site-specific number of axles per truck were significantly different.

- The predicted time to failure using site-specific number of axles per truck was not significantly different.

Rigid Pavement Analysis (Continuously Reinforced)

Axle-load Spectra

- The predicted load transfer efficiency using site-specific axle-load spectra was significantly different for one site during the interstate trial.

Monthly Adjustment Factor

- The predicted load transfer efficiency using site-specific MAF was significantly different for the interstate and statewide average data during the interstate trial. These results may have been influenced by incomplete data from the WIM sites.

Vehicle Class Distribution Factor

- The predicted load transfer efficiency using site-specific vehicle class distribution factors was significantly different for four sites and the interstate average data during the interstate trial.

Number of Axles per Truck

- No predicted distresses using site-specific number-of-axles-per-truck data were significantly different.

CONCLUSIONS

- *For the flexible pavements considered in this study, the MEPDG predicts statistically significant differences in predicted pavement condition when site-specific versus default axle-load spectra traffic data inputs are used.*

- *For the rigid pavements considered in this study that would likely be used on the interstate system, the MEPDG predicts statistically significant differences in predicted pavement condition when site-specific versus default vehicle class distribution factors are used.*

RECOMMENDATIONS

1. *VDOT's Materials Division should consider using site-specific axle-load spectra for analysis of both interstate and primary flexible pavements.* If site-specific traffic data are desired but no nearby WIM data are available, the installation of a WIM station at the project site will be necessary; this will incur additional expense. If installation of a WIM station is not practical and/or these data are not available, statewide or administrative-classification-specific average axle-load spectra should be used as an alternative to the default axle-load spectra. These data may be current data or those data developed in this study, available from the authors.

2. *VDOT's Materials Division should consider using default MAF, vehicle class distribution factors, and number of axles per truck factors for analysis of both interstate and primary flexible pavements.*

3. *VDOT's Materials Division should consider current site-specific vehicle class distribution factors for analysis of interstate rigid pavements.* If these data are not available, the statewide or interstate average vehicle class distribution factors (either those that are current or those developed in this study, available from the authors) should be used as an alternative to the default class distribution data.

4. *VDOT's Materials Division should consider using default vehicle class distribution factors for analysis of primary rigid pavements.*

5. *VDOT's Materials Division should consider using default axle-load spectra, MAF, and number of axles per truck factors for analysis of both interstate and primary rigid pavements.*

6. *VDOT's Materials Division should consider using Truck Traffic Classification Groups 1 and 2 as the default vehicle classification data for interstate and primary pavement analysis, respectively, if site-specific data are not used.*

7. *VDOT's Materials Division and the Virginia Transportation Research Council should complete a local calibration process to determine if the predictive models accurately predict the conditions found on Virginia's roadways.* If the predictive models are modified, the results may impact the recommendations resulting from this study.

BENEFITS AND IMPLEMENTATION PROSPECTS

Using the site-specific traffic data as recommended in this study will allow for pavement designs that more accurately reflect the current traffic loading on roadways in Virginia. The results of the MEPDG analysis (predicted pavement condition) are only as reliable as the quality of the input data. Thus, the various input factors are critical components to consider in the analysis.

The implementation of the recommendations in this study and the use of the MEPDG in general will provide VDOT with a more advanced means of designing and analyzing pavements. This should provide optimal designs that are more efficient in terms of initial construction and future maintenance costs.

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