Technical Paper

ISSN 1997-1400 Int. J. Pavement Res. Technol. 5(6):386-394

Traffic Characteristics and Their Impact on Pavement Performance for the Implementation of the Mechanistic-Empirical Pavement Design Guide in Idaho

Sherif M. El-Badawy[1+], Fouad M. Bayomy[2], and Scott W. Fugit[3]

Abstract: This study addresses the development of traffic characteristics to facilitate the implementation of the Mechanistic-Empirical Pavement Design Guide (MEPDG) in Idaho. Classification and weight data collected at 25 weigh-in-motion (WIM) sites were procured from Idaho Transportation Department (ITD). Among these 25 sites, only 12 sites were found to have complete and accurate data. Site-specific axle load spectra (ALS), monthly adjustment factors (MAF), vehicle class distribution factors (VCD), and number of axles per truck type were developed. Predicted distresses and International Roughness Index (IRI) based on a typical pavement section and traffic data obtained at the investigated WIM sites (level 1) were compared to predicted distresses/IRI using statewide/national (level 3) default traffic inputs. This comparison revealed that ALS, VCD, and MAF input level have significant impact on longitudinal cracking. Statewide ALS yielded high differences in alligator cracking predictions while MAF and VCD yielded only moderate differences compared to site-specific ALS. Very low prediction differences occurred in rutting when statewide/national default ALS, MAF, and VCD were used as opposed to site-specific data. The level of input of the investigated traffic parameters did not affect IRI. Finally, it was found that statewide/national number of axles per truck can be used instead of site-specific values without sacrificing accuracy of pavement performance predictions.

***Key words**: Axle load spectra; MEPDG; Performance; Weigh-in-motion (WIM).*

Introduction

Traffic data is one of the most important inputs for any pavement design procedure. It is required for estimating the frequency and magnitude of loads that are applied to a pavement throughout its design life. However, traffic data is often associated with the highest level of uncertainty. Unlike AASHTO 1993 design methodology that requires the number of 18-kips Equivalent Single Axle Load (ESAL) as the only traffic input, the Mechanistic-Empirical Pavement Design Guide (MEPDG) requires an extensive amount of traffic inputs for design/analysis of pavement systems [1, 2]. MEPDG requires four main traffic input categories: a) base year truck traffic volume, b) traffic volume adjustment factors, c) axle load distribution factors, and d) general traffic inputs [2]. The traffic volume adjustment factors are used to adjust the base year traffic volume. These adjustment factors are the monthly adjustment factors (MAF), vehicle class distribution (VCD), hourly truck distribution (HTD), and traffic growth factors. The general traffic input data includes number of axles per truck, axle configuration, tire pressure, traffic wander, and wheel base.

MEPDG required traffic data can be obtained through weigh-in-motion (WIM), automatic vehicle classification (AVC), and classified vehicle counts. The base year truck traffic volume and traffic volume adjustment factors can be obtained from WIM, AVC, and vehicle counts. Axle load distribution factors or spectra (ALS) can only be determined from WIM data.

MEPDG offers three hierarchical traffic input levels based on the amount of traffic data available [2, 3]. Level 1 is considered the most accurate and it requires detailed knowledge of historical load, volume, and classification data at or near the project location. Level 2 is moderately accurate and it requires modest knowledge of traffic characteristics. It requires regional ALS instead of site-specific data. Level 3 is the least accurate as it only requires estimates of truck traffic volume data and statewide default ALS with no site-specific knowledge of traffic characteristics at the project site. An estimate of traffic inputs based on local experience is also considered level 3.

Various literature studies investigated the sensitivity of MEPDG predicted performance to key design inputs including traffic parameters. In a recent study, Ahn *et al.* [4] assessed the impact of traffic data from Long Term Pavement Performance (LTPP) sites in Arizona and typical default values on MEPDG predicted distresses. This study showed large prediction differences particularly in longitudinal cracking resulted from using default VCD and annual average daily truck traffic (AADTT) instead of actual values. Moderate prediction differences in cracking and little prediction differences in rutting and roughness resulted from using default ALS instead of ALS from LTPP database. MAF had little impact on all predicted distresses except for one location. Based on South Dakota typical conditions, Hoerner *et al* [5] reported that load-associated cracking, and Asphalt Concrete (AC) layer rutting are highly sensitive to AADTT, moderately sensitive to traffic growth rate, VCD, and not sensitive to HTD. The total rutting was

[1] Mansoura University, Public Works Engineering Department, Faculty of Engineering, Mansoura University, Mansoura 35516, Egypt; and Department of Civil Engineering, University of Idaho, Moscow, Idaho, USA.
[2] Department of Civil Engineering, University of Idaho, P.O. Box 441022, Moscow, Idaho 83844-1022, USA.
[3] Roadway Data Section, Idaho Transportation Department, P.O. Box 7129 Boise, Idaho 83707-1129, USA.
[+] Corresponding Author: E-mail sbadawy@mans.edu.eg
Note: Submitted December 3, 2011; Revised June 7, 2012; Accepted June 19, 2012.

Table 1. WIM Sites with Traffic Data Complying with the FHWA Quality Control Checks**.**

WIM Site ID	Functional Classification	Route	Mile Post	Nearest City
79	Principal Arterial -Interstate (Rural)	I-15	27.7	Downey
93	Principal Arterial -Interstate (Rural)	I-86	25.05	Massacre Rocks
96	Principal Arterial -Other (Rural)	US-20	319.2	Rigby
117	Principal Arterial -Interstate (Rural)	I-84	231.7	Cottrell
134	Principal Arterial -Other (Rural)	US-30	425.785	Georgetown
135	Principal Arterial -Other (Rural)	US-95	127.7	Mesa
137	Principal Arterial -Other (Rural)	US-95	37.075	Homedale
138	Principal Arterial -Other (Rural)	US-95	22.72	Marsing
148	Principal Arterial -Other (Rural)	US-95	363.98	Potlatch
155	Minor Arterial (Rural)	US-30	229.62	Hansen
156	Minor Arterial (Rural)	SH-33	21.94	Howe
185	Principal Arterial-Other (Rural)	US-12	163.01	Powell
192	Principal Arterial-Other (Rural)	US-93	16.724	Rogerson

found highly sensitive to AADTT, moderately sensitive to traffic growth rate, and not sensitive to VCD and HTD. However, this study did not investigate the sensitivity of MEPDG predicted distresses to ALS. Tran and Hall [6, 7] developed statewide ALS and traffic volume adjustment factors for the state of Arkansas and evaluated their impact on pavement performance. They found significant differences in predicted distresses from statewide as opposed to national default ALS. In addition, they reported that pavement performance was not sensitive to MAF and HTD while sensitive to VCD. Swan *et al*. [8] reported insignificant change in the predicted pavement lifespan (less than 0.5 years) when MEPDG national default ALS was used rather than regional ALS developed for Ontario.

Because many states, including Idaho, do not always have the capability to collect site-specific traffic data for each project of interest, it is important to study the impact of the traffic input level on pavement performance as predicted by MEPDG based on Idaho data. This study reports the development of traffic characterization inputs to facilitate MEPDG implementation in Idaho. It also investigates the impact of traffic input level on MEPDG predicted distresses and roughness.

Traffic Data Collection

Traffic data was collected at 25 WIM sites maintained by Idaho Transportation Department (ITD) [9]. Most of the traffic data was collected in 2009 with few sites had data for 2008 and 2009. WIM data is divided into two types; vehicle classification data and vehicle weight data. The vehicle classification data contains hourly truck traffic volume by truck class while the weight data contains hourly weights for each truck class and axle type as well as axle spacing. The format of the classification and weight data follows the FHWA C-card and W-card formats, respectively. More details regarding the C-cards and W-cards format can be found in the FHWA's Traffic Monitoring Guide [10].

Generating MEPDG Traffic Inputs

Generating MEPDG traffic inputs from WIM data requires an extensive effort. The TrafLoad software developed as part of the NCHRP Project 1-39 was used to process and generate the required MEPDG traffic inputs for Idaho WIM sites [11]. In order to process the classification data using TrafLoad to generate MEPDG traffic volume related data, continuous classification data for 12 consecutive months must be available. Analysis of the provided data showed that some sites were missing sufficient classification data for at least 12 consecutive months. Classification and weight data at the 25 WIM sites were processed by the TrafLoad software and site-specific (level 1) traffic inputs were generated. For the weight data, quality control checks recommended by FHWA were applied to the data processed by TrafLoad [10, 12]. Only 12 out of the 25 WIM sites were found to pass these quality checks. These sites are shown in Table 1. For each of these 12 sites, traffic data required by MEPDG were generated. This data is explained in the subsequent sections.

Base Year Truck Traffic Volume and Directional and Lane Factors

Level 1 MEPDG traffic volume inputs at the 12 analyzed WIM sites are summarized in Table 2. This table shows the location information of the analyzed sites along with the number of lanes in design direction, AADTT, and percentage of trucks in the design direction and lane. The directional distribution factors of the trucks ranged from 0.51 to 0.65 with an average of 0.56 and a standard deviation of 0.05. This value is very close the MEPDG default value of 0.55. The design lane factor for the two-lane roads (in each direction) ranged from 0.89 to 0.97 with an average of 0.94 and a standard deviation of 0.03. Again, this value agrees quite well with the MEPDG default value for the two-lane roadways, which is 0.90. For the roads with one-lane in each direction, the lane distribution factors are equal to 1.0.

Vehicle Class Distribution (VCD)

Vehicle class distribution represents the percent of truck volume by truck class within the base year AADTT. Table 3 summarizes the site-specific (MEPDG level 1) VCD. Data in this table shows that at the majority of the investigated sites the predominant truck class is class 9 followed by class 5 trucks. In case of the absence of accurate truck traffic classification, there are 17 Truck Traffic Classification

Table 2. Traffic Volume Characteristics.

WIM Site ID	No. of Lanes in Design Direction	AADTT	Travel Direction	Percent Trucks in Design Direction	Percent Trucks in Design Lane
79	2	1917	NB/SB	55/45	97
93	2	912	EB/WB	54/46	97
96	2	2213	NEB/SWB	51/49	89
117	2	2449	SEB/NWB	65/35	95
134	1	863	EB/WB	45/55	100
137	1	413	EB/WB	51/49	100
138	1	377	SEB/NWB	54/46	100
148	1	290	EB/WB	54/46	100
155	1	302	NB/SB	50/50	100
156	1	93	NB/SB	43/57	100
185	1	75	NB/SB	45/55	100
192	2	541	NB/SB	54/46	93

NB = North Bound, SB = South Bound, EB = East Bound, WB = West Bound, NEB = North East Bound,
NWB = North West Bound, SEB = South East Bound, SWB = South West Bound

Table 3. Percentage Vehicle Class Distribution.

WWIM Site ID	Vehicle Class										TTC
	4	5	6	7	8	9	10	11	12	13	Group
79	1.77	21.20	2.13	0.50	8.35	49.07	5.19	1.11	1.01	9.67	7
93	0.99	11.21	1.31	0.11	4.09	52.90	12.73	0.76	0.59	15.33	5
96	1.94	45.59	6.60	0.95	7.64	27.43	6.73	0.18	0.32	2.62	12
117	1.03	5.96	3.86	7.20	4.56	52.35	15.06	1.45	1.33	7.20	NA
134	2.15	21.28	1.90	0.36	5.51	61.01	3.43	0.19	0.27	3.91	3
137	5.37	8.56	10.73	0.32	6.94	52.33	8.71	0.61	0.18	6.26	4
138	1.14	3.82	2.39	0.03	5.18	72.76	6.35	2.23	0.58	5.54	NA
148	2.11	7.69	13.66	1.16	5.02	24.87	41.78	0.00	0.12	3.59	NA
155	17.94	7.73	11.46	3.10	8.46	16.75	15.21	2.07	2.33	14.95	NA
156	1.01	4.00	5.12	0.00	4.96	39.99	12.72	0.00	0.08	32.12	NA
185	0.26	4.77	9.10	0.45	8.05	46.29	21.53	0.00	0.00	9.55	NA
192	3.40	4.90	2.18	0.60	7.24	75.47	3.68	0.50	0.26	1.78	1

NA = Not Applicable

(TTC) groups in MEPDG that can be used based on the user's selection. These TTC groups represent default (level 3) truck traffic combinations based on the analysis of traffic data from 133 LTPP sites [2]. These 17 TTC groups were developed based on the distribution of class 4, 5, 9, and 13 trucks. Table 3 shows that 6 out of the 12 sites did not follow any of the 17 MEPDG TTC groups.

Monthly Adjustment Factors (MAF)

The normalized vehicle class distribution at WIM site 79 is shown in Fig. 1. The figure shows that monthly variation in truck traffic is expected to occur. Thus, MEPDG uses monthly adjustment factors (MAF) to proportion the annual truck traffic for each month of the year per truck class. For each truck class the sum of MAF should be 12, while for all truck classes the average should be 1.0. For the investigated sites, MAF were developed using TrafLoad. The developed factors show that truck volumes vary from month to month, with MAF generally between 0 and 4. As an example, MAF for all truck classes at WIM site 79 is shown in Fig. 2. Fig. 3 depicts MAF for class 9 truck at the investigated WIM sites. In MEPDG, a typical default (level 3) MAF value of 1.0 is suggested for all truck classes and all months.

Hourly Truck Distribution (HTD)

Hourly truck distribution (HTD) factors represent the percentage of truck traffic for each hour of the day. This parameter is only required for the analysis of rigid pavements. For flexible pavements, it has negligible impact on the predicted distress and roughness [3]. This is because analysis of flexible pavement is related to temperature which is processed monthly.

Axle Load Spectra (ALS)

ALS presents the percentage of the total axle applications within a specific load interval for each axle type (single, tandem, tridem, and quad) and truck class (classes 4 to 13) [2]. The load intervals for each axle type are defined as follows: single axles (3,000 lb to 40,000 lb at 1,000 lb intervals), tandem axles: (6,000 lb to 80,000 lb at 2,000 lb intervals), and tridem and quad axles (12,000 lb to 102,000 lb at 3,000 lb intervals).

For each of the investigated sites, level 1 ALS data was

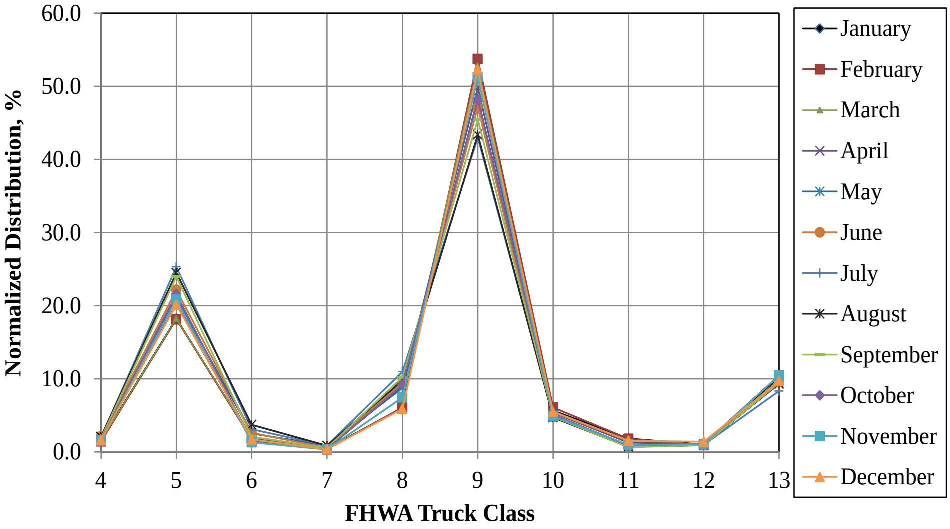

Fig. 1. Normalized Monthly Vehicle Class Distribution at WIM Site 79.

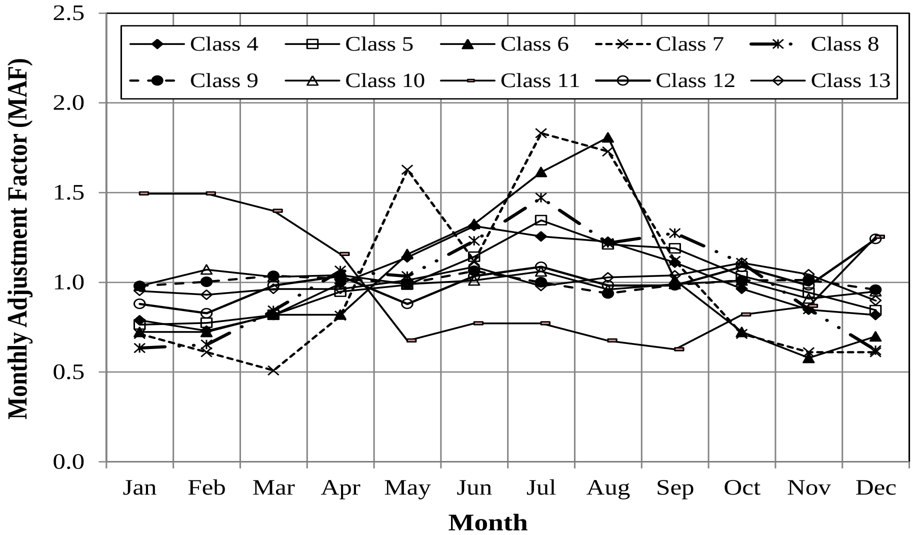

Fig. 2. Monthly Adjustment Factors for all Truck Classes at WIM Site 79.

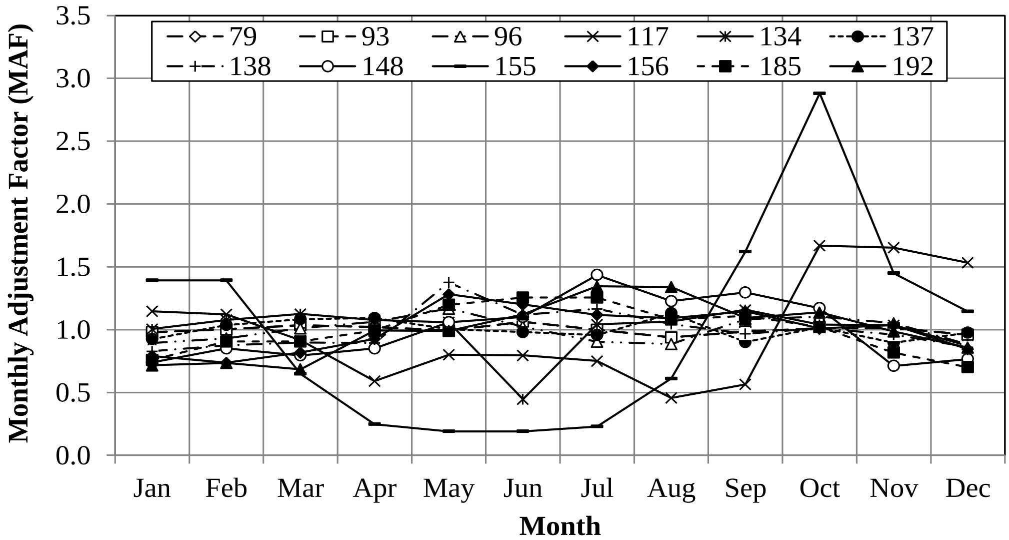

Fig. 3. Monthly Adjustment Factors for Class 9 Trucks at the Investigated WIM Sites.

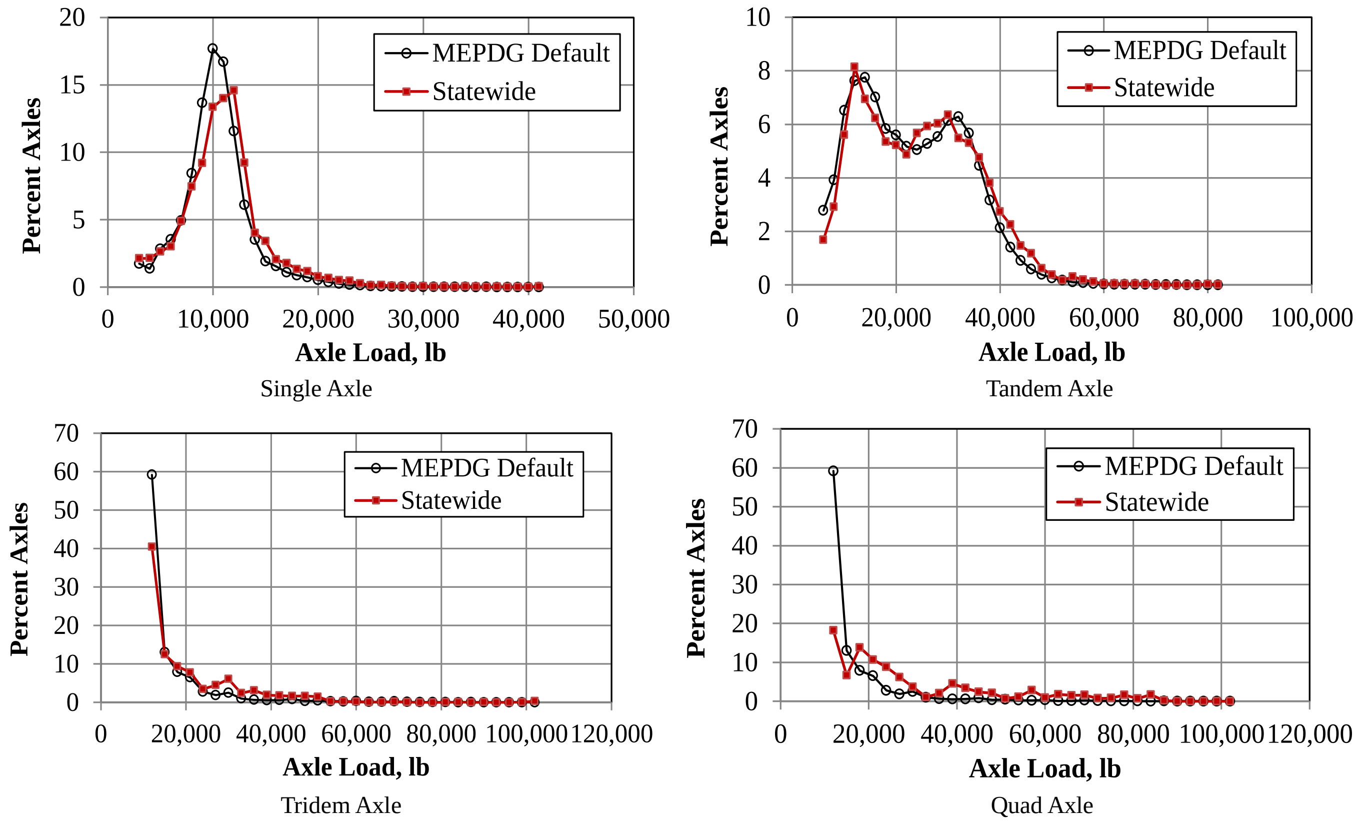

Fig. 4. Comparison of MEPDG and Developed Statewide Axle Load Spectra of Class 9.

developed with the help of TrafLoad. All axle weight data for each axle type and truck class at the 12 sites with valid data were combined together in one database. Statewide ALS was then determined by averaging the normalized axle load spectra for each axle type and truck class at all sites. This is considered level 3 inputs in MEPDG. Comparison of the developed statewide and MEPDG default ALS show fairly similar peak locations for most of the truck classes and axle types. However, the percentages of axles within these peaks were different, especially for the tridem and quad axles. A comparison of the developed statewide and MEPDG default ALS for class 9 truck is shown in Fig. 4.

Number of Axles per Truck Type

Number of axles per truck represents the total number of each axle type (single, tandem, tridem, and quad) divided by the total number of trucks. Site-specific (level 1) number of axles per truck was developed for the investigated WIM sites. Statewide number of axles per truck type data was also developed. Comparison of the developed statewide and MEPDG default number of axles per truck is shown in Fig. 5. The figure shows that, for all practical purposes, there is no significant difference in the number of single, tandem, and tridem axles per truck for all truck classes. ITD data showed few quad axles for vehicle classes 7, 10, 11, and 13 while MEPDG has zero percent quad axles for all truck types.

Impact of Traffic Input Level on MEPDG Predicted Performance

It is important to study the significance of the level of traffic inputs on MEPDG predicted performance. A sensitivity study is conducted using a typical Idaho pavement section with level 1 (site-specific) versus level 3 (statewide/national or default) traffic data. The traffic data included in the study are ALS, VCD, MAF, and number of axles per truck class. The pavement section properties and primary inputs used for this study are illustrated in Table 4. All other MEPDG inputs used in this analysis were taken as the MEPDG default values. Since low traffic volume was used in the sensitivity analyses, the results are only limited to low-volume roads. The differences between predicted performance based on levels 1 and 3 inputs were normalized using Eq. (1) as follows:

$$ND = \left(\frac{|X_{level\,1} - X_{level\,3}|}{X_{level\,1}}\right)(100) \quad (1)$$

where:
ND = Absolute value of the normalized difference
$X_{level\,1}$ = Predicted distress/IRI based on site-specific (level 1) inputs
$X_{level\,3}$ = Predicted distress/IRI based on statewide/national (level 3) inputs

Performance Prediction for Statewide ALS versus MEPDG National Defaults

The developed statewide ALS was compared to the default ALS in MEPDG, which was based on the nationwide LTPP database. A typical pavement section was selected for this comparative study. MEPDG software was run using the typical inputs shown in Table 4

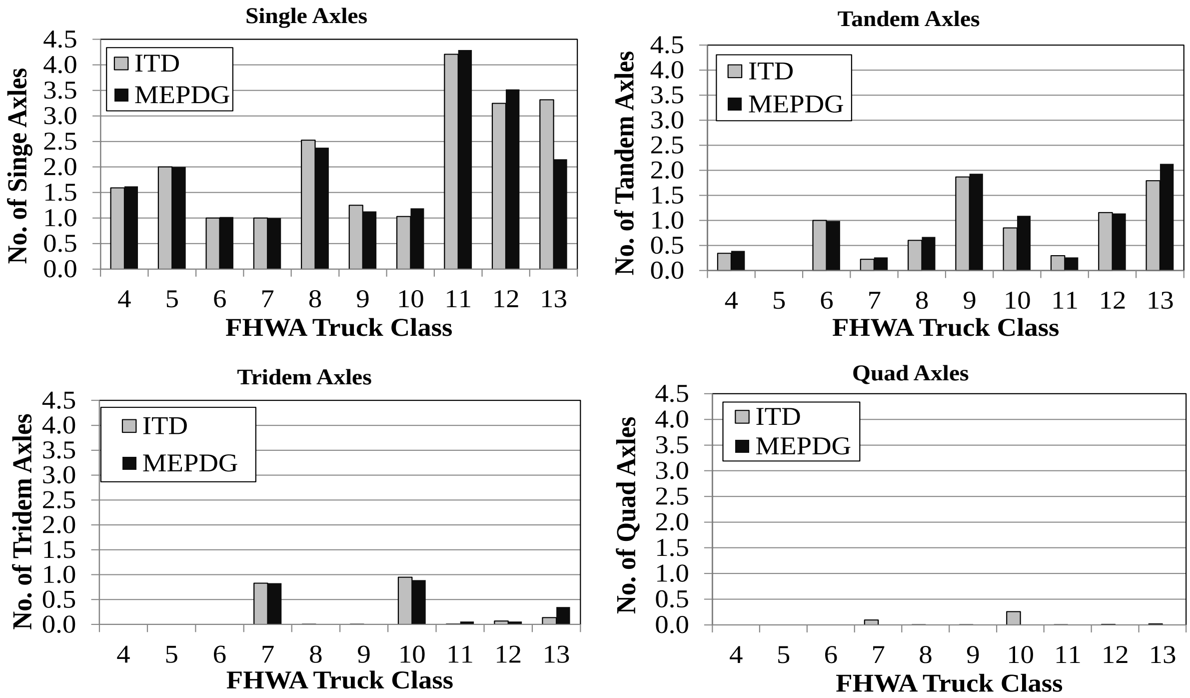

Fig. 5. Comparison of Statewide and MEPDG Default Number of Axles Per Truck for Vehicle Classes 4 to 13.

Table 4. Typical Design Inputs used in the Analysis.

Parameter	Input
General Information:	
Type of Design	Flexible
Reliability	50%
Design Life	20 years
AADTT (design lane)	150
Axle Load Spectra (ALS)	Variable
Vehicle Class Distribution (VCD)	Variable
Monthly Adjustment Factors (MAF)	Variable
No. of Axles per Truck	Variable
Operational Speed, mph	60
Climate	**Pullman/Moscow**
AC Layer	
Thickness, in. (cm)	6 (15)
Cumulative % Retained ¾″ Sieve	0
Cumulative % Retained 3/8″ Sieve	15
Cumulative % Retained #4 Sieve	45
% Passing #200 Sieve	8.2
Binder Type	PG 58-28
Effective Binder Content, %	11.0
In-Situ Air Voids, %	7.0
Granular Base:	
Thickness, in.(cm)	8 (20)
Modulus, psi (MPa)	40,000 (276)
Subgrade:	
Type	CL
Modulus, psi (MPa)	5,600 (39)

with all inputs kept constant except for the ALS. Comparisons of the absolute normalized differences in predicted performance based on statewide versus MEPDG default ALS is shown in Fig. 6. The figure shows that the developed statewide ALS yielded significantly

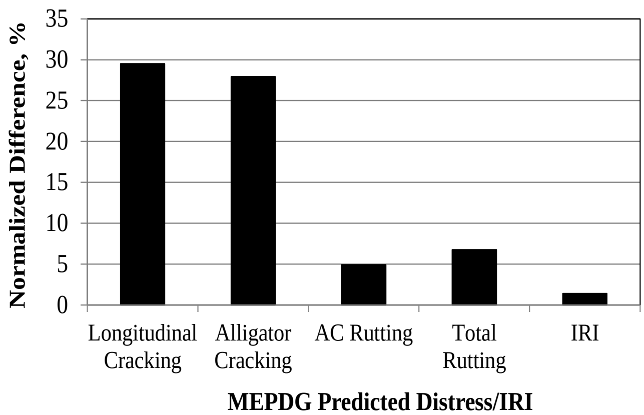

Fig. 6. Influence of Statewide and MEPDG Default ALS on Predicted Performance

higher longitudinal and alligator cracking compared to MEPDG default ALS. This figure also shows that both AC rutting and total rutting, in general, are not as sensitive to ALS as cracking. It can be inferred from these results that the tensile strain either at the bottom or top of the AC layers (alligator and longitudinal) cracking is more sensitive to the axle load spectra (ALS) compared to the compressive strain at the mid-depth of each layer (total rutting). Finally, it can be inferred from this figure that there is no significant difference in predicted IRI based on statewide and MEPDG default ALS. This can be explained by the MEPDG IRI prediction model. This is not surprising as the IRI prediction model, in MEPDG, is a function of the predicted cracking, rutting, as well as site factors. This model is shown in Eqs. (2) and (3) [3]. By examining the coefficients of this model one can surmise that IRI is more sensitive to rutting compared to cracking (100% cracked area will lead only to IRI of 4 in/mi while 0.5 in rutting will lead to 20 in/mi IRI). Since ALS significantly affected cracking rather than rutting, this explains

Table 5. Influence of Site-Specific versus MEPDG Default ALS on MEPDG Predicted Distresses and IRI.

WIM Site ID	Absolute Normalized Difference (ND), %				
	Longitudinal Cracking	Alligator Cracking	AC Rutting	Total Rutting	IRI
79	11.0	4.8	2.1	1.2	0.3
93	48.3	44.3	2.2	10.1	1.9
96	32.0	2.4	3.4	1.0	0.2
117	55.7	34.0	8.4	11.0	2.3
134	49.4	21.7	11.8	5.8	1.2
137	23.8	24.5	3.6	4.6	0.9
138	52.3	43.1	2.2	10.1	1.8
148	63.3	43.1	9.2	8.2	1.5
155	50.4	62.3	9.6	16.9	4.2
156	10.6	3.8	0.7	1.2	0.3
185	130.0	88.4	10.9	17.5	3.0
192	5.2	0.0	2.1	1.8	0.4
Average	44.3	31.0	5.5	7.4	1.5
Standard Deviation	32.0	26.0	3.9	5.6	1.2

Table 6. Influence of Site-Specific VCD versus Equivalent MEPDG TTC Group Distribution on MEPDG Predicted Distresses and IRI.

WIM Site ID	Absolute Normalized Difference (ND), %				
	Longitudinal Cracking	Alligator Cracking	AC Rutting	Total Rutting	IRI
79	14.5	6.7	3.6	2.1	0.4
93	34.5	6.1	4.1	3.6	0.6
96	18.8	14.7	5.1	2.9	0.5
134	9.9	3.4	2.6	1.1	0.2
137	32.8	8.1	5.9	4.3	0.8
192	14.6	3.7	1.9	1.6	0.3
Average	20.9	7.1	3.9	2.6	0.5
Standard Deviation	10.3	4.2	1.5	1.2	0.2

why the ALS did not affect the IRI.

$$\mathrm{IRI} = \mathrm{IRI_o} + 0.0150(\mathrm{SF}) + 0.400(\mathrm{FC_{Total}}) + 0.0080(\mathrm{TC}) + 40.0(\mathrm{RD}) \quad (2)$$

$$\mathrm{SF} = \mathrm{Age}\begin{pmatrix} 0.02003(\mathrm{PI}+1) + 0.007947(\mathrm{Precip}+1) \\ +0.000636(\mathrm{FI}+1) \end{pmatrix} \quad (3)$$

where:

$\mathrm{IRI_o}$ = Initial IRI after construction, in/mi.

SF = Site factor.

$\mathrm{FC_{Total}}$ = Area of fatigue cracking (combined alligator, longitudinal, and reflection cracking in the wheel path), percent of total lane area. All load related cracks are combined on an area basis – length of cracks is multiplied by 1 foot to convert length into an area basis.

TC = Length of transverse cracking (including the reflection of transverse cracks in existing HMA pavements), ft/mi.

RD = Average rut depth, in.

Age = Pavement age, years.

PI = Percent plasticity index of the soil.

FI = Average annual freezing index, degree F days.

Precip = Average annual precipitation or rainfall, in.

Predicted Performance based on Site-Specific versus Developed Statewide ALS

The absolute normalized difference values computed for MEPDG predicted longitudinal cracking, alligator cracking, AC rutting, total rutting, and IRI based on site-specific and developed statewide ALS are shown in Table 5. Large differences in predicted longitudinal cracking occurred as a result of using statewide ALS instead of site-specific ALS. The absolute normalized difference (ND) for longitudinal cracking ranged from 5% to more than 100% with an average value exceeding 40%. For alligator cracking the normalized difference was also high (0 to 88%) with an average value of 31%. The average ND values for AC rutting, total rutting and IRI were generally very small especially for IRI. This data indicates that ALS has a significant influence on load-associated cracking and minor to negligible influence on rutting and IRI.

Predicted Performance based on Site-Specific versus National Default VCD

To investigate the influence of site-specific (level 1) VCD versus equivalent MEPDG TTC group distribution (level 3), the WIM sites with VCD that matches any of the MEPDG 17 TTC groups were identified (Table 3). For each WIM site data, one run was conducted using actual site-specific traffic data related to ALS, MAF, number of axles per truck, and VCD while the other run used the equivalent MEPDG TTC distribution instead of actual VCD.

Table 6 summarizes the computed normalized differences. The average difference values shown in this table indicate that using the appropriate MEPDG TTC group may lead to satisfactory results in

Table 7. Influence of Site-Specific versus MEPDG Default MAF on MEPDG Predicted Distresses and IRI.

WIM Site ID	Absolute Normalized Difference (ND), %				
	Longitudinal Cracking	Alligator Cracking	AC Rutting	Total Rutting	IRI
79	0.0	0.6	0.7	0.2	0.0
93	0.9	1.0	0.7	0.2	0.1
96	5.3	1.6	3.5	1.0	0.2
117	73.4	34.2	21.1	7.6	1.6
134	4.4	0.8	0.0	0.0	0.0
137	2.8	0.6	0.0	0.0	0.0
138	26.7	10.7	6.7	3.8	0.6
148	29.1	16.8	12.2	5.1	1.0
155	111.0	8.5	16.3	4.9	1.1
156	15.6	1.9	4.0	0.6	0.2
185	20.6	14.4	9.9	4.1	0.8
192	25.8	14.6	10.4	4.6	0.8
Average	26.3	8.8	7.1	2.7	0.5
Standard Deviation	33.5	10.2	6.9	2.6	0.5

Table 8. Influence of Site-Specific versus MEPDG Default MAF on MEPDG Predicted Distresses and IRI.

WIM Site ID	Absolute Normalized Difference (ND), %				
	Longitudinal Cracking	Alligator Cracking	AC Rutting	Total Rutting	IRI
79	0.0	0.6	0.0	0.0	0.0
93	0.9	1.1	0.7	0.2	0.1
96	5.0	2.3	0.7	0.6	0.2
117	1.9	1.3	0.6	0.4	0.0
134	1.1	0.8	0.0	0.0	0.0
137	1.6	0.5	0.0	0.0	0.0
138	3.7	0.8	0.0	0.0	0.1
148	0.7	0.0	0.0	0.0	0.0
155	6.8	1.1	0.0	0.3	0.0
156	5.6	1.0	0.0	0.6	0.1
185	0.0	0.0	0.0	0.0	0.0
192	16.2	4.0	0.0	0.8	0.1
Average	3.6	1.1	0.2	0.2	0.0
Standard Deviation	4.4	1.0	0.3	0.3	0.1

regard to alligator cracking, AC rutting, total rutting, and IRI (average percent ND of 7.1, 3.9, 2.6, and 0.5, respectively). On the other hand, higher average ND percent (20.9) occurred with respect to longitudinal cracking if MEPDG TTC group is used instead of actual VCD.

Predicted Performance based on Site-Specific versus National Default MAF

Table 7 shows the comparison results of the computed absolute normalized difference values for MEPDG predicted distresses and roughness when level 1 and level 3 MAF were used. This data shows a high average normalized difference of 26.3 percent in longitudinal cracking predictions. The differences in predictions ranged from 0 percent to more than 100 percent. Alligator cracking and AC rutting show relatively small average absolute percent differences (8.8 and 7.1). Total rutting and IRI show very small average ND of only 2.7 and 0.5 percent, respectively.

Predicted Performance based on Site-Specific versus Statewide Number of Axles per Truck

Table 8 shows the comparison results of the computed absolute normalized difference values for MEPDG predicted distresses and roughness when site-specific and the developed statewide MAF were used. This data indicates that, for all practical purposes, there is no significant difference in predicted distresses and IRI based on level 1and level 3 average number of axles per truck. Thus, statewide/national number of axles per truck can be used without sacrificing accuracy of pavement performance predictions.

Summary and Conclusions

As part of MEPDG implementation effort in Idaho, site-specific traffic inputs were developed based on the analyses of traffic data from 12 out of 25 WIM sites in Idaho. The other sites did not have complete and/or accurate data to enable the analysis. Statewide axle load spectra and average number of axles per truck were established.

Significance of MEPDG predicted performance in relation to axle load spectra, vehicle class distribution, monthly adjustment factors and average number of axle per truck was also investigated. Based on the results and analyses performed in this study the following observations and conclusions are found:

a) Traffic characterization revealed that:

1. The investigated data showed an average directional distribution and lane factors of 0.56±0.05 and 0.94±0.03 for the 4-lane roadways. These values agree quite well with the MEPDG recommended default values.
2. In general, class 9 followed by class 5 trucks represented the majority of the trucks travelling on Idaho roads. The vehicle class distribution factors at 6 out of 12 investigated WIM sites did not match any of the MEPDG recommended TTC groups.
3. The developed MAF ranged between 0 and 4 indicating that truck volumes vary from month to month.
4. The peak locations of the developed statewide and MEPDG default ALS were fairly similar for the majority of the truck classes and axle types. However, the percentages of axles within these peaks were different, especially for the tridem and quad axles.
5. The number of single, tandem, and tridem axles per truck for all truck classes based on Idaho data was found quite similar to MEPDG default values. Idaho data showed few percentages of quad axles for truck classes 7, 10, 11, and 13 compared to MEPDG default values which are all zero.

b) MEPDG predicted performance indicated the following:

1. The developed statewide axle load spectra yielded significantly higher longitudinal and alligator cracking compared to MEPDG default spectra. No significant difference was found in predicted AC rutting, total rutting, and IRI based on statewide and MEPDG default spectra.
2. High prediction differences were found for longitudinal cracking when statewide/national (level 3) axle load spectra, vehicle class distribution, or monthly adjustment factors were used instead of site-specific (level 1) data.
3. Large prediction differences in alligator cracking were only found when statewide default axle load spectra were used compared to site-specific spectra. Moderate differences were found when MEPDG typical default monthly adjustment factors or vehicle class distribution were used instead of site-specific values.
4. The input level of the axle load spectra, monthly adjustment factors, vehicle class distribution, and number of axles per truck had very low impact on predicted AC rutting and negligible impact on total rutting and IRI.
5. The input level of the number of axles per truck had negligible influence on MEPDG predicted performance.

Acknowledgement

Funding for this study was partially provided by Idaho Transportation Department (ITD) and the Federal Highway Administration (FHWA) under contract with the National Institute for Advanced Transportation Technology (NIATT) at the University of Idaho. Authors acknowledge the technical and financial support provided by these organizations.

References

1. AASHTO (1993). *Guide for Design of Pavement Structures*, American Association of State Highways and Transportation Officials (AASHTO), Washington, DC, USA.
2. ARA, Inc., ERES Consultants Division (2004). Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures, *NCHRP 1-37A Final Report*, Transportation Research Board, National Research Council, Washington, DC, USA.
3. AASHTO (2008). Mechanistic-Empirical Pavement Design Guide: A Manual of Practice, Interim Edition, American Association of Highways and Transportation Officials, Washington, DC, USA.
4. Ahn, S., Kandala, S., Uzan, J., and El-Basyouny M. (2011). Impact of Traffic Data on the Pavement Distress Predictions using the Mechanistic Empirical Pavement Design Guide (MEPDG), *Road Materials and Pavement Design*, 12(1), pp. 195-216.
5. Hoerner, T., Zimmerman, K., Smith, K., and Cooley, L. (2007). Mechanistic-Empirical pavement Design guide Implementation Plan, *Report No. SD2005-01*, Applied Pavement Technology, Inc., Urbana, Illinois, USA.
6. Tran, N. and Hall, K. (2007). Development and Influence of Statewide Axle Load Spectra on Flexible Pavement Performance, *Transportation Research Record*, No. 2037, pp. 106-114.
7. Tran, N. and Hall, K. (2007). Development and Significance of Statewide Volume Adjustment Factors in Mechanistic Pavement Design Guide, *Transportation Research Record*, No. 2037, pp. 97-105.
8. Swan, D.J., Tardif, R., Hajek, J., and Hein D. K. (2008). Development of Regional Traffic Data for the Mechanistic-Empirical Pavement Design Guide, *Transportation Research Record*, No. 2049, pp. 54-62.
9. Bayomy, F., El-Badawy, S., and Awed, A. (2012). Implementation of the MEPDG for Flexible Pavements in Idaho, *Report No. FHWA-ID-11-193*, National Institute for Advanced Transportation Technology (NIATT), University of Idaho, Moscow, Idaho, USA.
10. FHWA (2001). *Traffic Monitoring Guide*, U.S. Department of Transportation, Federal Highway Administration, Office of Highway Policy Information, Washington, DC, USA.
11. NCHRP (2005). Traffic Data Collection, Analysis, and Forecasting for Mechanistic Pavement Design, *NCHRP Report 538*, National Cooperative Highway Research Program, Transportation Research Board of the National Academies, Washington, DC, USA.
12. FHWA (2001). Guide to LTPP Traffic Data Collection and Processing, Federal Highway Administration, Washington, DC, USA.