ITD Implementation Plan for MEPDG

50th Annual Idaho Asphalt Conference

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Moscow, Idaho
Thursday, October 28, 2010

Objectives

- **Implementation of the MEPDG for flexible pavements in Idaho.**
- **Develop a plan for local calibration and Validation of MEPDG.**

NCHRP

M-E PDG

Mechanistic-Empirical Pavement Design Guide

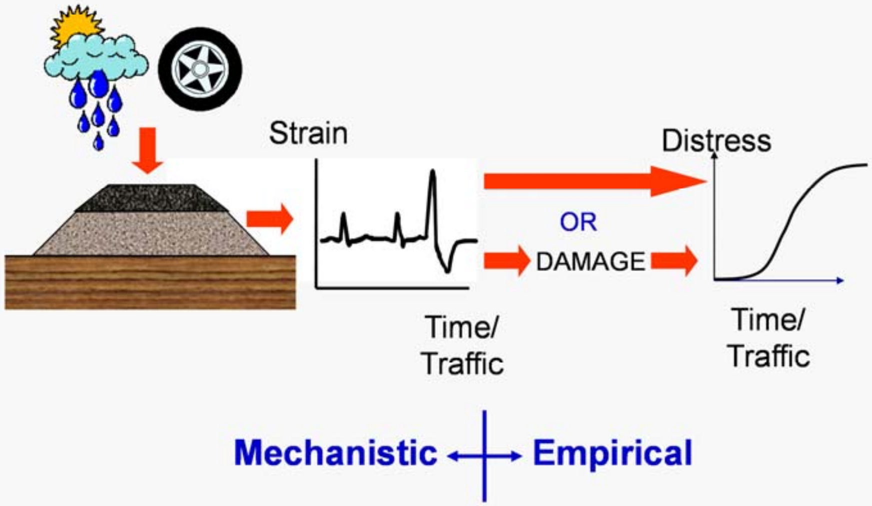
This software is for review only and should not be used for design.
This software was developed under NCHRP 1-37A and 1-40D.
Distribution of this software must be approved by NCHRP.

developed by
APPLIED RESEARCH ASSOCIATES, INC
TRANSPORTATION
ASU

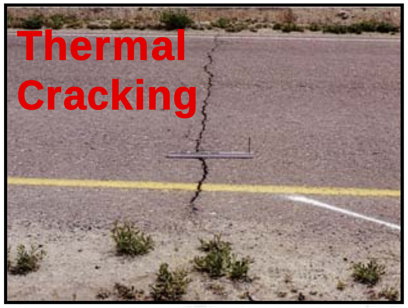
Version 1.100

Last Build: August 31, 2009

Mechanistic-Empirical Pavement Design Guide



MEPDG Predicted Distresses



MEPDG Hierarchical Input Levels

- **Level 1:** Highest level of accuracy. Laboratory or field measured data.
  - EX: laboratory E* for HMA, G*&δ for binder, Mr for Base/SG.
- **Level 2:** Intermediate level of accuracy. Correlations with other properties.
  - EX: Mr = 1155 +555*R
- **Level 3:** Lowest level of accuracy. Typical default values (best estimates).
  - EX: for A-1-a soil Mr = 38,000 psi

Main Project Tasks

1. Study the Latest Version of the MEPDG Software
2. Review of Other State Agencies Implementation Efforts
3. Material Database:
   - Binder
   - HMA
   - Unbound base/Subbase layers
   - Subgrade
4. Develop Traffic Load Spectra
5. Establish climatic factors for the various regions
6. MEPDG sensitivity analysis
7. Performance and reliability
8. Develop plan for local calibration and validation

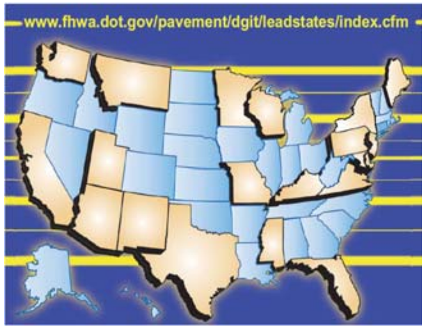
Task 1

- **Study the Latest Version of the MEPDG Software**
  - Overview of the **MEPDG**.
  - Comparison of **MEPDG** and **AASHTO 1993** Guide.
  - Flexible Pavement **Design/Analysis** Procedure in the **MEPDG**.
  - MEPDG **Distress Prediction Models** for Flexible Pavements.
  - MEPDG Software Evolution and Improvements **(Ver 0.70 to Ver 1.10).**
  - MEPDG **Version 1.100 (August 2009)** Software Capabilities and Limitations.

Lead States

- A group of **19 states** was formed to facilitate the refinement, Implementation, and evolution of the MEPDG
- The lead states are:

Arizona	**California**	**Florida**
Kentucky	**Main**	**Missouri**
Montana	**Maryland**	**Minnesota**
Mississippi	**Pennsylvania**	**Texas**
Wisconsin	**New Jersey**	**New Mexico**
New York	**Utah**	**Virginia**
Washington		



Task 2

- **Review of Other State Agencies Implementation Efforts**

☐ Utah
☐ Montana
☐ Washington
☐ Arizona
☐ Arkansas
☐ Oregon
☐ North Carolina
☐ Kansas
☐ Iowa
☐ South Dakota
☐ California
☐ Minnesota

– ***With the Focus on Idaho Adjacent States***

MEPDG States Implementation Summary

For successful MEPDG implementation:

- A comprehensive database for MEPDG inputs (input libraries) for material characterization, traffic, and climate should be established.
- Distress prediction models should be locally calibrated.
- The sensitivity of each input should be defined.
- Establishing reasonable ranges for each key design input based on local conditions.
- Train the staff on the software.

MEPDG States Implementation Summary (Cont'd)

Issues Related to Traffic are also highlighted:

- Traffic axle load spectra can be characterized using data from WIM stations.
- The quality of the data should be assessed and the WIM stations should be calibrated regularly.
- Some SHA used the ***TrafLoad*** software (NCHRP project 1-39) for processing the WIM data to be used with the MEPDG.
- Other states reported problems opening the WIM data files with this software and developed their own software for WIM traffic data processing for the MEPDG.

MEPDG States Implementation Summary (Cont'd)

Material and Climate:

- Although level input 1 is the most accurate input data level, many of the SHA used levels 2 and 3 data inputs for traffic and material characterization as this is the level of data usually available.
- Almost all SHA used the default weather station climatic database that comes with the software for climatic characterization.

Summary of Very Significant to Significant Key Design Input Parameters for New Flexible Pavements based on Literature

Performance Indicator	Input Parameter/Predictor
Top-down fatigue (longitudinal cracking)	☐ AADTT ☐ AC layer thickness ☐ AC binder grade ☐ Effective asphalt content ☐ AC mixture in-situ air voids ☐ AC mixture stiffness ☐ Foundation quality ☐ Environmental location
Bottom-up fatigue (alligator cracking)	☐ AADTT ☐ AC binder grade ☐ Effective asphalt content ☐ AC mixture in-situ air voids ☐ AC layer thickness ☐ AC Mixture Stiffness (insignificant at very thick AC layers) ☐ Foundation quality ☐ Environmental location
Transverse cracking	☐ AC thickness ☐ AC binder grade ☐ AC mixture in-situ air voids ☐ AC mixture tensile strength ☐ Environmental location

Summary of Very Significant to Significant Key Design Input Parameters for New Flexible Pavements (Cont'd)

Performance Indicator	Input Parameter/Predictor
HMA Rutting	☐ AADTT ☐ AC mixture stiffness ☐ AC layer thickness ☐ AC binder grade ☐ AC mixture in-situ air voids ☐ Environmental location
Total Rutting	☐ AADTT ☐ Total pavement thickness ☐ Depth of water table ☐ AC binder grade ☐ Subgrade resilient modulus ☐ Base resilient modulus ☐ Climatic location
Smoothness (IRI)	☐ Bottom-up fatigue (alligator cracking) ☐ Total permanent deformation (rutting) ☐ Environmental location ☐ Initial IRI

Task 3

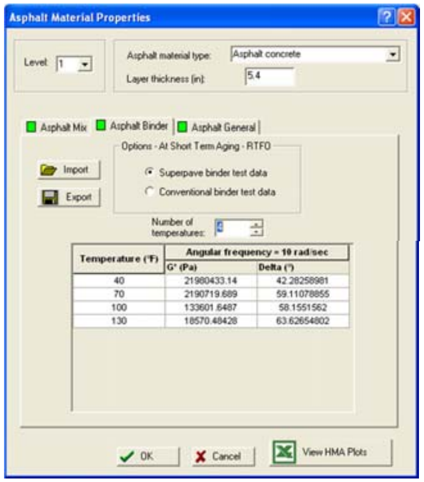
- **MEPDG Material Characterization**
  - **Binder: G* and δ**
  - **HMA Materials: Dynamic Modulus (E*)**
  - **Unbound Base / Subgrade Layers:**
    - **R-Value / Mr, PI, Gradation.**

MEPDG Binder Characterization

- **Levels 1 and 2:** **G* and δ at 10 rad/sec**
- **Level 3:** **choose binder grade**

Idaho Binder Characterization (MEPDG Level 1)

	G*,δ @ 10 Hz		
	Temp., °F	G*, Psi	δ, degrees
PG 58-28	40	3.56E+03	57.96
	70	2.03E+02	60.92
	100	9.92E+00	73.70
	130	8.38E-01	82.02
PG 58-34	40	6.52E+02	56.13
	70	3.31E+01	63.32
	100	3.65E+00	68.09
	130	5.06E-01	70.34
PG 64-22	40	4.66E+03	52.79
	70	4.78E+02	57.38
	100	2.84E+01	73.98
	130	2.06E+00	82.12
PG 64-28	40	8.55E+02	58.87
	70	2.35E+02	60.97
	100	1.51E+01	66.79
	130	1.56E+00	73.77
PG 64-34	40	1.22E+03	46.93
	70	7.32E+01	60.75
	100	5.67E+00	66.87
	130	8.62E-01	61.47



Level: 1

Asphalt material type: Asphalt concrete

Layer thickness (in): 5.4

Options - At Short Term Aging - RTFO

● Superpave binder test data
○ Conventional binder test data

Number of temperatures: 4

Temperature (°F)	Angular frequency = 10 rad/sec	
	G* (Pa)	Delta (°)
40	21980433.14	42.28258981
70	2190719.689	59.11078855
100	133601.6487	58.1551562
130	18570.48428	63.62654802

Tested by Idaho Asphalt Supply

HMA Material Characterization

ITD Field Mixes Investigated

Mixture Type						
SP1	SP2	SP3		SP4	SP5	SP6
SP1-1	SP 2-1	SP 3-1	SP 3-5-4	SP 4-1	SP 5-1	SP 6-1
	SP 2-2 *	SP 3-2	SP 3-5-5	SP 4-2	SP 5-2	SP6-2
		SP 3-3	SP 3-6 *	SP 4-3	SP 5-3	SP6-3
		SP 3-4	SP 3-7 *	SP 4-4 *	SP 5-4	
		SP 3-5-1	SP 3-8 *			
		SP 3-5-2	SP 3-9 *			
		SP 3-5-3	SP3-10 *			
1	2	14		4	4	3
Total Number of Mixtures = 28 Mixtures						

**** From ITD Project No. RP 181 "Development and Evaluation of Performance Tests to Enhance Superpave Mix Design and its Implementation in Idaho"***

Experimental Work

GS Determination from Servopac Gyratory Compactor data

E* Testing using SPT Machine

E* Sample Preparation

Cutting and Coring

E* Sample Preparation (Cont'd)

Attaching Gauge Point Fixing System & Strain Transducer Mounts

E* Testing Data (MEPDG level 1)

Temperatures	Frequency, Hz
40°F (4.4°C) 70°F (21.1°C) 100°F (37.8°C) 130°F (54.4°C)	25 10 5 1.0 0.5 0.1

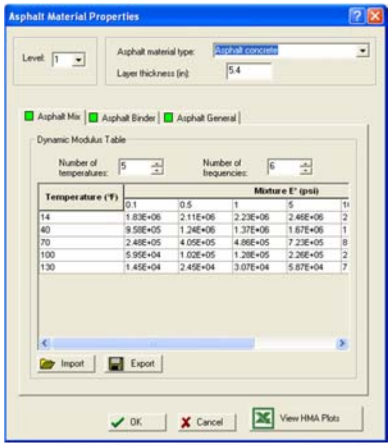
***4** Temperatures & **6** Frequencies*

Example of MEPDG level 1 input data of SP4-2 mixture

Asphalt Mix Dynamic Modulus

Temp (°F)	Mixture E* (psi)					
	0.1	0.5	1	5	10	25
14	1.83E+06	2.11E+06	2.23E+06	2.46E+06	2.55E+06	2.66E+06
40	9.58E+05	1.24E+06	1.37E+06	1.67E+06	1.80E+06	1.93E+06
70	2.48E+05	4.05E+05	4.86E+05	7.23E+05	8.39E+05	1.00E+06
100	5.95E+04	1.02E+05	1.28E+05	2.26E+05	2.84E+05	3.77E+05
130	1.45E+04	2.45E+04	3.07E+04	5.87E+04	7.72E+04	1.17E+05

- ✓ Minimum temperature within 10 to 20 °F
- ✓ Maximum temperature within 125 to 135°F.
- ✓ At least E* matrix (3-temperatures * 3-frequencies).
- ✓ E-values = 10,000 to 5,000,000 psi.



Level: 1

Asphalt material type: Asphalt concrete

Layer thickness (in): 5.4

Dynamic Modulus Table

Number of temperatures: 5

Number of frequencies: 6

Temperature (°F)	Mixture E* (psi)				
	0.1	0.5	1	5	1
14	1.83E+06	2.11E+06	2.23E+06	2.46E+06	2
40	9.58E+05	1.24E+06	1.37E+06	1.67E+06	1
70	2.48E+05	4.05E+05	4.86E+05	7.23E+05	8
100	5.95E+04	1.02E+05	1.28E+05	2.26E+05	2
130	1.45E+04	2.45E+04	3.07E+04	5.87E+04	7

E* Data (MEPDG Levels 2 & 3)

- Cumulative % Retained 3/4 inch sieve
- Cumulative % Retained 3/8 inch sieve
- Cumulative % Retained #4 sieve
- % Passing # 200 sieve
- % Effective Binder Content by Volume
- % Air Voids
- Binder stiffness or grade


Asphalt Material Properties

Level: 3

Asphalt material type: Asphalt concrete

Layer thickness (in): 3

Aggregate Gradation

Cumulative % Retained 3/4 inch sieve: 0

Cumulative % Retained 3/8 inch sieve: 25

Cumulative % Retained #4 sieve: 55

% Passing #200 sieve: 5

NCHRP 1-37A η*-based Model

(Andrei, Witczak and Mirza's Revised Model, 1999)

$$\log_{10} E^* = -1.249937 + 0.02923\rho_{200} - 0.001767(\rho_{200})^2 - 0.002841\rho_4 - 0.058097V_a - 0.82208\frac{V_{beff}}{V_{beff}+V_a} + \frac{3.871977 - 0.0021\rho_4 + 0.003958\rho_{38} - 0.000017(\rho_{38})^2 + 0.00547\rho_{34}}{1+e^{(-0.603313-0.313351\log f-0.393532\log\boxed{\eta})}}$$

Where,

E^* = HMA dynamic modulus, in 10^5 psi;

η = binder viscosity, in 10^6 poise;

f = loading frequency, in Hz;

V_a = % air voids in the mix, by volume;

V_{beff} = % effective binder content, by volume;

ρ_{34} = cumulative % retained on the 3/4 in sieve,;

ρ_{38} = cumulative % retained on the 3/8 in sieve,;

ρ_4 = cumulative % retained on the No. 4in sieve,; and

ρ_{200} = % passing the No. 200 sieve

NCHRP 1-40D *G**-based Model

(Witczak, El-Basyouny & El-Badawy Revised from Bari's Model, 2007)

$$\log_{10} E^* = 0.02 + 0.758\left(\left|\boxed{G_b^*}\right|^{-0.0009}\right)\times\left(\begin{array}{l}6.8232 - 0.03274\rho_{200} + 0.00431\rho_{200}^2 + 0.0104\rho_4 - 0.00012\rho_4^2 \\ + 0.00678\rho_{38} - 0.00016\rho_{38}^2 - 0.0796V_a - 1.1689\left(\frac{V_{beff}}{V_a+V_{beff}}\right)\end{array}\right) + \frac{1.437 + 0.03313V_a + 0.6926\left(\frac{V_{beff}}{V_a+V_{beff}}\right) + 0.00891\rho_{38} - 0.00007\rho_{38}^2 - 0.0081\rho_{34}}{1+e^{(-4.5868-0.8176\log\boxed{G^*}+3.2738\log\boxed{\delta})}}$$

Where,

E^* = HMA dynamic modulus, psi,

$|G_b^*|$ = dynamic shear modulus of binder, psi,

δ_b = phase angle, degrees,

V_a = air voids in the mix, %,

V_{beff} = effective binder content, by volume, %,

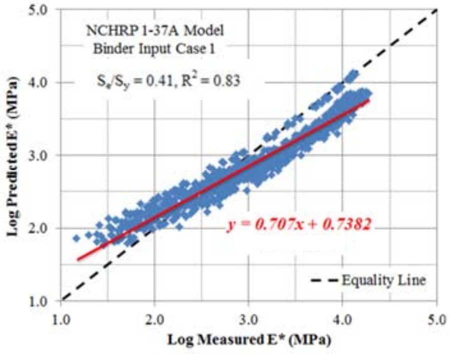
ρ_{34} = cumulative % retained on the 3/4 in sieve,

ρ_{38} = cumulative % retained on the 3/8 in sieve,

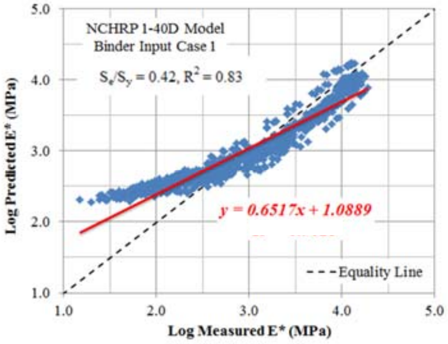
ρ_4 = cumulative % retained on the No. 4 sieve, and

ρ_{200} = % passing the No. 200 sieve.

Comparison of MEPDG 1-37A Model and 1-40D E* Predictive Model @ Level 1 Binder Data

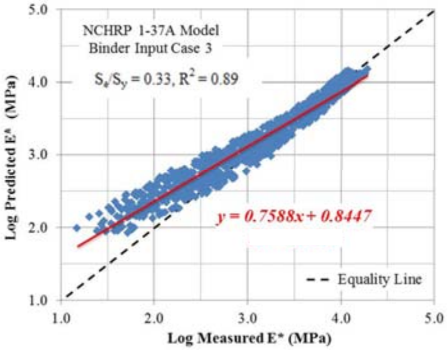


NCHRP 1-37A Model (Binder Input Level 1)

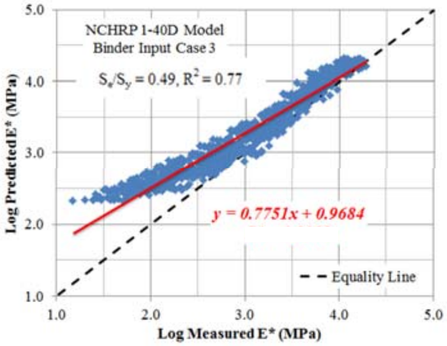


NCHRP 1-40D Model (Binder Input Level 1)

Comparison of MEPDG 1-37A Model and 1-40D E* Predictive Model @ Level 3 Binder Data



NCHRP 1-37A Model (Binder Input Level 3)



NCHRP 1-40D Model (Binder Input Level 3)

Evaluation of the MEPDG Dynamic Modulus Prediction Models for Asphalt Concrete Mixtures

S. M. El-Badawy, A. Awed, and F. M. Bayomy

Idaho GS-based E* Model

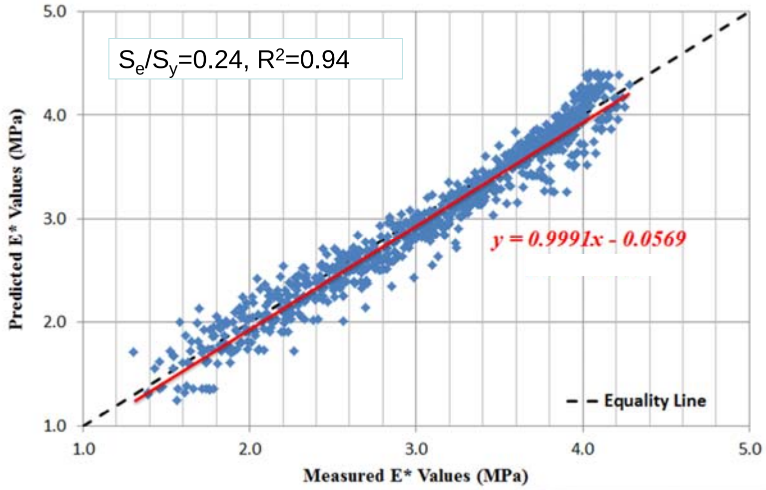
(Bayomy & Abu Abdo 2009)

$$E^* = 1.08\left(\frac{\rho_w . G^* . GS . G_{mb}}{P_b\left(1 - P_b\right)}\right)^{0.558}$$

where,

E^* = dynamic modulus of the mixture, MPa
G^* = dynamic shear modulus for RTFO aged binder, MPa
P_b = binder content by mix weight
GS = Gyratory Stability, kN.m
G_{mb} = bulk specific gravity of the mix
ρ_w = Density of water, kg/m^3

Measured Vs. Predicted E* using Idaho – GS-based Model



HMA Material Characterization

ITD Field Mixes Investigated

Mixture Type						
SP1	SP2	SP3		SP4	SP5	SP6
SP6-1	SP 2-1	SP 3-1	SP 3-5-4	SP 4-1	SP 5-1	SP 6-1
	SP 2-2 *	SP 3-2	SP 3-5-5	SP 4-2	SP 5-2	SP6-2
		SP 3-3	SP 3-6 *	SP 4-3	SP 5-3	SP6-3
1	2	14		4	4	3
Total Number of Mixtures = 28 Mixtures						

HMA Material Database
28 Mixes

** From ITD Project No. RP 181 "Development and Evaluation of Performance Tests to Enhance Superpave Mix Design and its Implementation in Idaho"*

G-Stab 2010 and *E-Star2010*

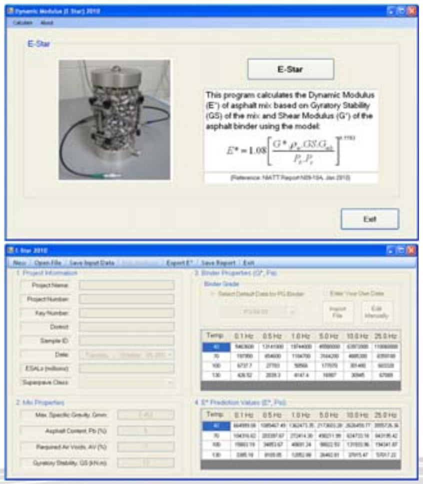
G-Stab 2010 Software

G-Stab

This program calculates the Gyratory Stability of asphalt mix based on compaction volumetric and shear data using the model:

$$GS = \sum_{N_{ini}}^{N_{design}} S_{ave} \Delta d_i$$

E-Star 2010 Software



E-Star

This program calculates the Dynamic Modulus (E*) of asphalt mix based on Gyratory Stability (GS) of the mix and Shear Modulus (G*) of the asphalt binder using the model:

$$E^* = 1.08\left[\frac{G^* \rho_a GS G_{sb}}{P_b P_a}\right]^{0.7783}$$

(Reference: NIATT Report N09-19A, Jan 2010)

ITD Unbound/Subgrade Material Characterization (MEPDG Level 2 inputs)

Two Models Developed:

- R-Value Models based on ITD Database
- Mr-R-Value Model based on literature Mr-Data

R-Value Model:

- Historical ITD R-Values database **(from 1953 to 2008).**
- **8233** points with soil classification, P200 and PI.
- Collected by Dr. Stanley Miller (UI)
- ITD-PR 185, NIATT KLK 553: Developing Statistical Correlations of Soil Properties with R-Value for Idaho Pavement Design

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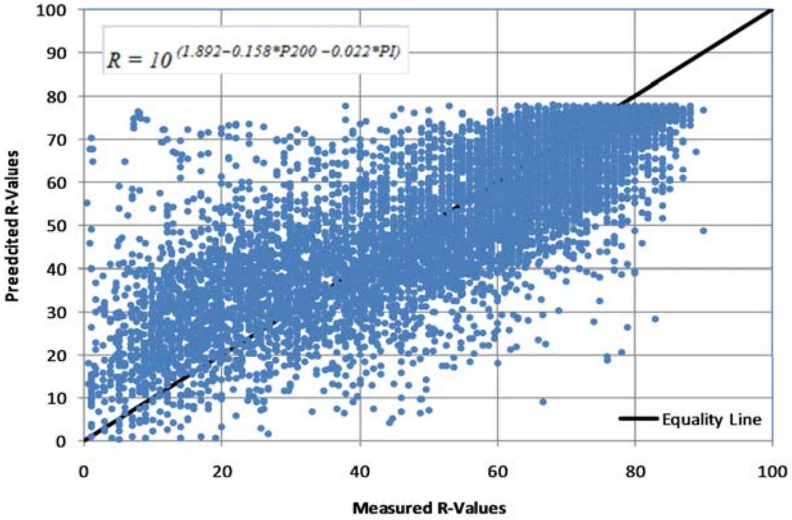
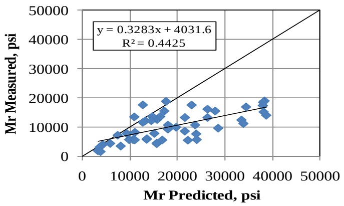
Unbound/SG Material Characterization (Cont'd)

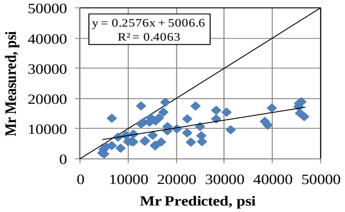
Measured versus Predicted R-Values (ITD Model, 2010)



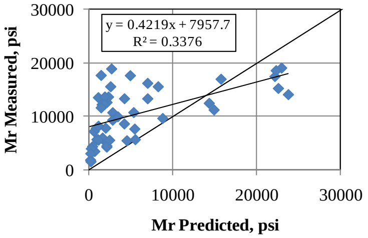
Comparison of Different Mr-R-Value Models based on Mr Literature Data



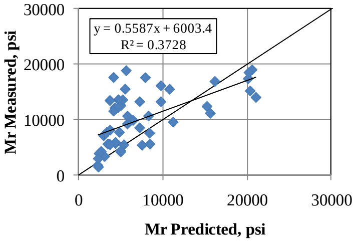
Asphalt Institute Model (Mr=1155+555*R)



ADOT Model: $Mr = \frac{1815 + 225(Rmean) + 2.40(Rmean)^2}{0.6(SVF)^{0.6}}$



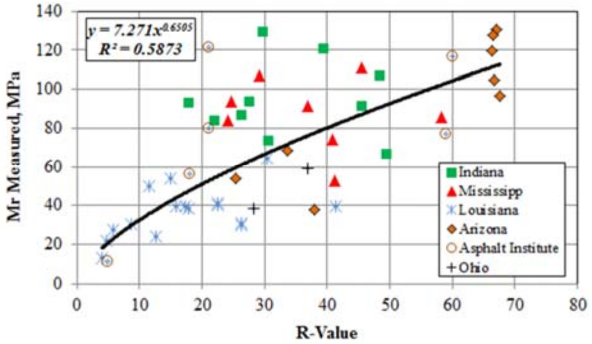
WSDOT Model [Mr = 720.5 ($e^{(0.0521*R)}$-1)]



ITD Model (Log Mr = (222+R)/67)

2010 MR-R-Value Model

$$M_r\ (psi) = 1054.6\ (R)^{0.6505} \quad (9)$$



"Prediction of the Subgrade Resilient Modulus for the Implementation of the MEPDG in Idaho" *El-Badawy, Bayomy, and Miller, Accepted for Presentation and Publication in the Geo-Frontiers 2011 Conference.*

Prediction of the Subgrade Resilient Modulus for the Implementation of the MEPDG in Idaho

S. M. El-Badawy, F. M. Bayomy, and S. M. Miller

Recommend Default R-Values and Ranges for Unbound Granular Materials and Subgrade Soils for MEPDG Level 3 for Idaho

Unified Soil Classification	ITD Recommended R-Value	ITD Recommended R-Value Range	
		Lower bound	Upper bound
OH	32	15	49
OL	44	30	58
CH	15	3	26
MH	28	12	45
CL	27	12	41
CL-ML	45	31	60
ML	60	47	73
SC	35	17	54
GC	38	20	56
SC-SM	53	35	70

Traffic inputs for MEPDG

Task 4 - MEPDG Traffic Inputs

- Traffic inputs in the MEPDG are very **comprehensive** and more **sophisticated** compared to older design methodologies.
- It relies on the traffic axle load spectra data which requires continuous WIM data measurements.
- 3 hierarchical input levels

MEPDG Major Traffic Inputs

Four basic traffic input categories are required by MEPDG as follows:

- Volume
- Classification
- Weight
- General

MEPDG Traffic Input Levels

Input Level	Understanding of Traffic	Classification Data	Weight Data
Level 1	Good	Site Specific, Continuous	Site Specific
Level 2	Fair	Site Specific, short	Regional Average (TWRGs)
Level 3	Poor	No Actual Class Data	Statewide Average

Idaho WIM Stations

Hammett WIM
I-84 @ MP 114.500
0.5 Mi. E of Jct I84B, E Hammett IC
Segment Code 001010

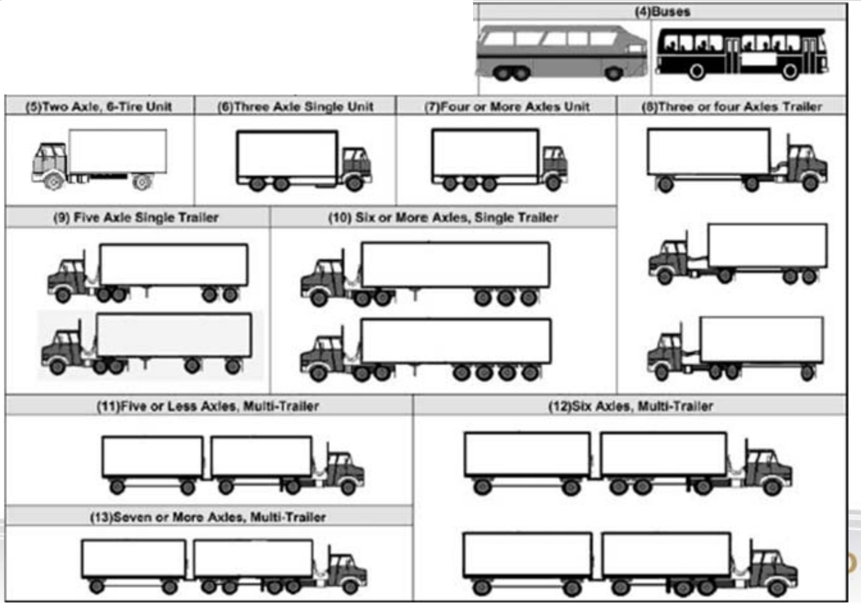
ID	Functional Classification	Rout	Mile post	City
79	Principal Arterial -Interstate (Rural)	I-15	27.7	Downey
93	Principal Arterial -Interstate (Rural)	I-86	25.05	Massacre Rocks
96	Principal Arterial -Other (Rural)	US-20	319.2	Rigby
115	Principal Arterial -Interstate (Rural)	I-90	23.37	Wolf Lodge
117	Principal Arterial -Interstate (Rural)	I-84	231.7	Cottrell
118	Principal Arterial-Other (Rural)	US-95	24.1	Mica
119	Principal Arterial-Other (Rural)	US-95	85.2	Samuels
128	Principal Arterial -Interstate (Rural)	I-84	15.1	Black canyon
129	Principal Arterial-Other (Rural)	US-93	59.8	Flattop
133	Minor Arterial (Rural)	US-30	205.5	Filer
134	Principal Arterial -Interstate (Rural)	US-30	425.785	Georgetown
135	Principal Arterial -Interstate (Rural)	US-95	127.7	Mesa
137	Principal Arterial -Interstate (Rural)	US-95	37.075	Homedale
138	Principal Arterial -Interstate (Rural)	US-95	22.72	Marsing
148	Principal Arterial -Interstate (Rural)	US-95	363.98	Potlatch
155	Minor Arterial (Rural)	US-30	229.62	Hansen
156	Minor Arterial (Rural)	SH-33	21.94	Howe
166	Principal Arterial -Interstate (Rural)	I-84		
169	Principal Arterial -Other (Rural)	US-95	56.002	Parma
171	Principal Arterial -Interstate (Rural)	I-84	114.5	Hammett
173	Principal Arterial -Interstate (Rural)	I-15	177.86	Dubois
179	Principal Arterial -Interstate (Rural)	I-86B	101.275	American Falls
185	Principal Arterial-Other (Rural)	US-12	163.01	Powell

Idaho WIM Sites

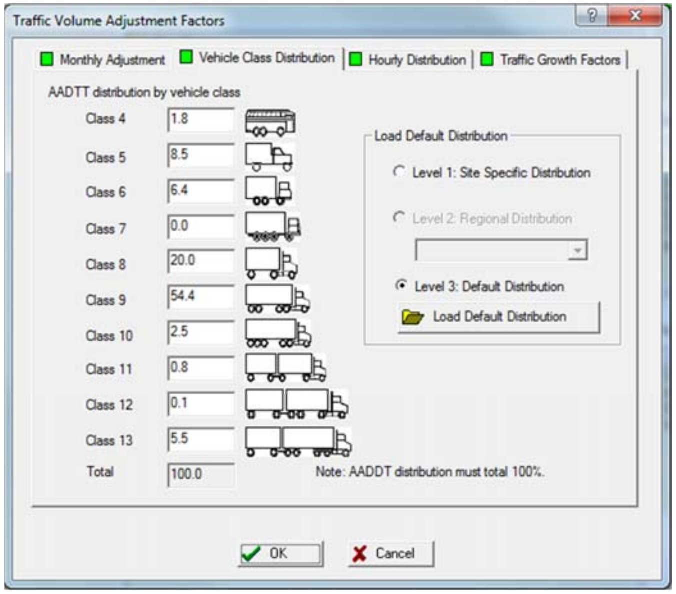
Idaho MEPDG Traffic Characterization

- ❑ *WIM Data: Classification Data (C-Cards), Weight Data (W-Cards).*
- ❑ ***TrafLoad*** software (NCHRP project 1-39) was used for processing the WIM data to generate MEPDG traffic inputs.
- ❑ *25 WIM Station Data for year 2009 and some WIM station Data for 2008.*
- ❑ Only 21 WIM sites → continuous classification data.
- ❑ 23 WIM sites were successfully analyzed by the TrafLoad for the weight data.
- ❑ Only 14 WIM sites → good quality weight data.

MEDPG Truck Classes



MEPDG Vehicle Class Distribution



AADTT distribution by vehicle class

Class 4	1.8
Class 5	8.5
Class 6	6.4
Class 7	0.0
Class 8	20.0
Class 9	54.4
Class 10	2.5
Class 11	0.8
Class 12	0.1
Class 13	5.5
Total	100.0

Load Default Distribution

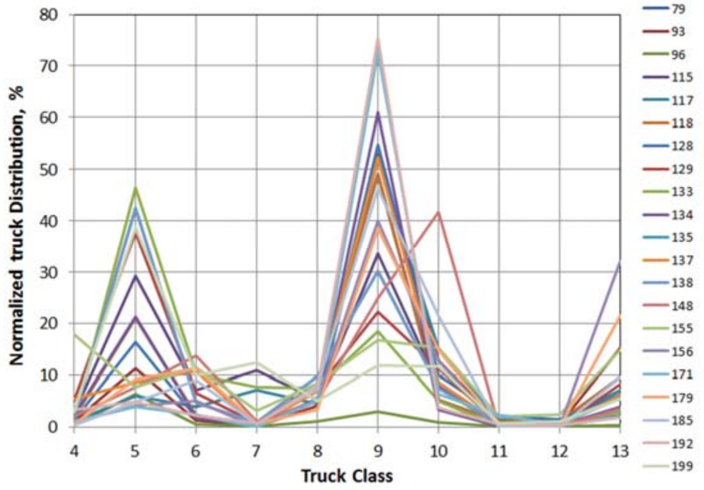
○ Level 1: Site Specific Distribution

○ Level 2: Regional Distribution

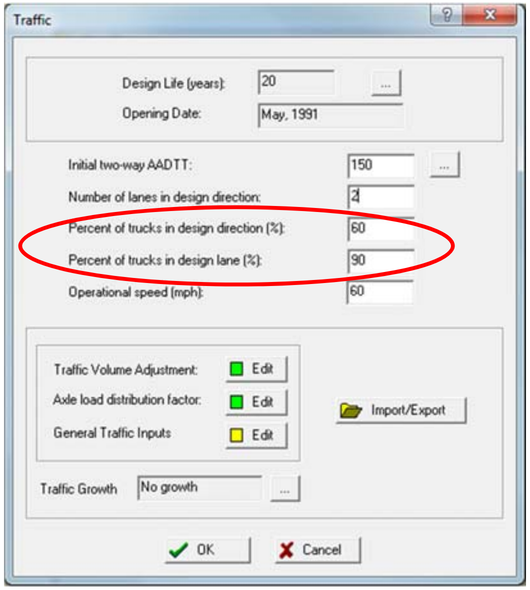
● Level 3: Default Distribution

Note: AADTT distribution must total 100%.

Normalized Truck Distribution by Truck Class



MEPDG Lane and Directional Distribution Factors



Design Life (years): 20

Opening Date: May, 1991

Initial two-way AADTT: 150

Number of lanes in design direction: 2

Percent of trucks in design direction (%): 60

Percent of trucks in design lane (%): 90

Operational speed (mph): 60

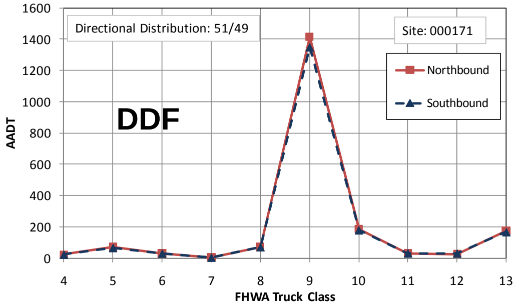
Traffic Volume Adjustment: 🟩 Edit

Axle load distribution factor: 🟩 Edit

General Traffic Inputs: 🟨 Edit

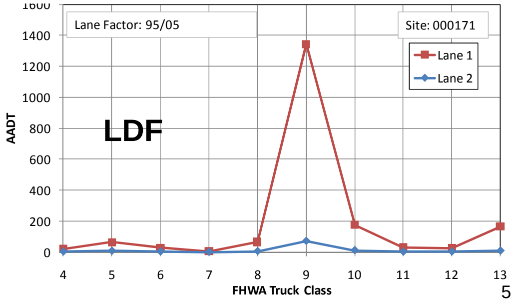
Traffic Growth: No growth

Lane and Directional Distribution Factors

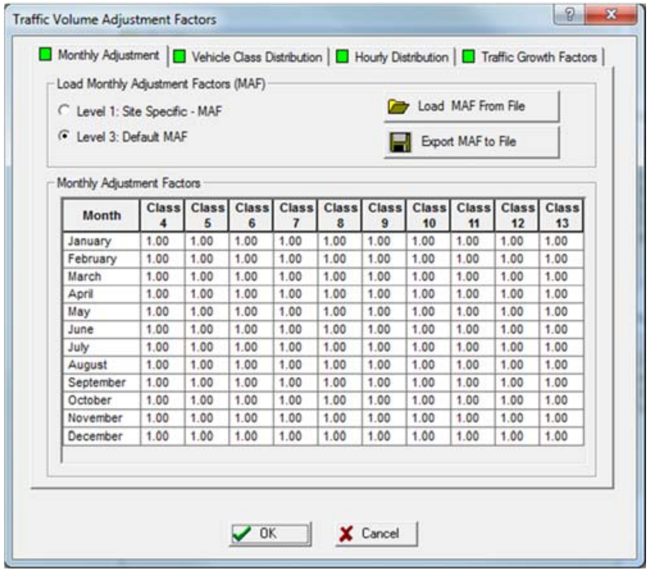


Statewide

	Mean	Std. Dev.
DDF	0.56	0.077
LDF	0.94	0.032



MEPDG Default MAF



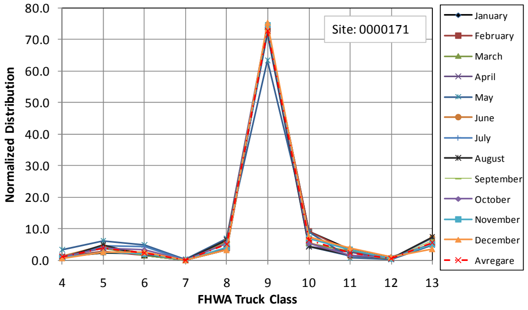
Load Monthly Adjustment Factors (MAF)

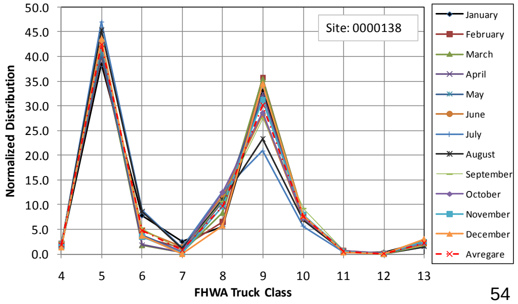
○ Level 1: Site Specific - MAF
● Level 3: Default MAF

Monthly Adjustment Factors

Month	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13
January	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
February	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
March	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
April	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
May	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
June	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
July	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
August	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
September	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
October	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
November	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
December	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Monthly Normalized Truck Distribution by Class

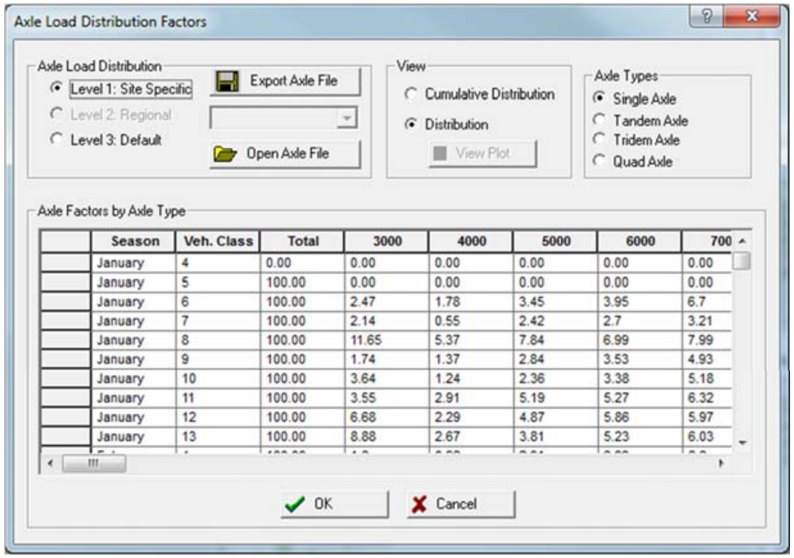




MAF for WIM Site 000118

Vehicle class:	4	5	6	7	8	9	10	11	12	13
January	0.788	0.764	0.723	0.712	0.634	0.979	0.980	1.494	0.879	0.952
February	0.730	0.774	0.723	0.610	0.652	1.003	1.071	1.494	0.828	0.930
March	0.818	0.818	0.819	0.508	0.843	1.036	1.030	1.398	0.983	0.963
April	0.993	0.947	0.819	0.814	1.065	1.021	1.040	1.157	1.034	0.963
May	1.139	0.986	1.157	1.627	1.034	0.993	0.990	0.675	0.879	1.011
June	1.314	1.143	1.325	1.119	1.231	1.064	1.010	0.771	1.034	1.087
July	1.255	1.345	1.614	1.831	1.471	0.999	1.061	0.771	1.086	0.979
August	1.226	1.211	1.807	1.729	1.218	0.938	0.960	0.675	0.983	1.027
September	1.109	1.189	1.012	1.119	1.274	0.986	0.990	0.627	0.983	1.038
October	0.964	1.035	0.723	0.712	1.108	1.010	1.010	0.819	1.086	1.109
November	0.847	0.942	0.578	0.610	0.849	1.013	0.909	0.867	0.983	1.044
December	0.818	0.845	0.699	0.610	0.622	0.959	0.949	1.253	1.241	0.898

MEPDG Axle Load Distribution Factors (Spectra)



Axle Load Distribution

● Level 1: Site Specific
○ Level 2: Regional
○ Level 3: Default

View

○ Cumulative Distribution
● Distribution

Axle Types

● Single Axle
○ Tandem Axle
○ Tridem Axle
○ Quad Axle

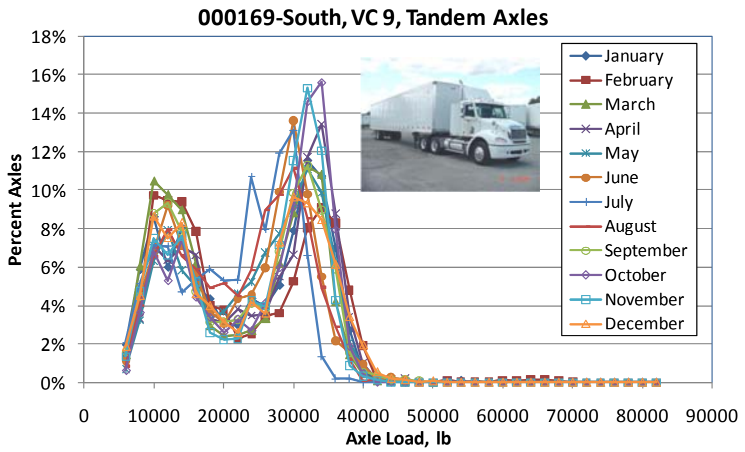
Axle Factors by Axle Type

Season	Veh. Class	Total	3000	4000	5000	6000	700
January	4	0.00	0.00	0.00	0.00	0.00	0.00
January	5	100.00	0.00	0.00	0.00	0.00	0.00
January	6	100.00	2.47	1.78	3.45	3.95	6.7
January	7	100.00	2.14	0.55	2.42	2.7	3.21
January	8	100.00	11.65	5.37	7.84	6.99	7.99
January	9	100.00	1.74	1.37	2.84	3.53	4.93
January	10	100.00	3.64	1.24	2.36	3.38	5.18
January	11	100.00	3.55	2.91	5.19	5.27	6.32
January	12	100.00	6.68	2.29	4.87	5.86	5.97
January	13	100.00	8.88	2.67	3.81	5.23	6.03

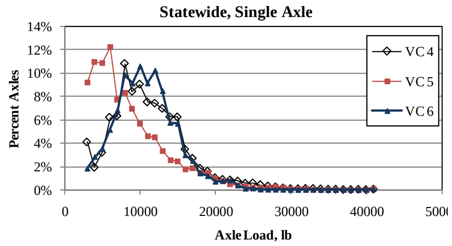
Axle Load Spectra for MEPDG

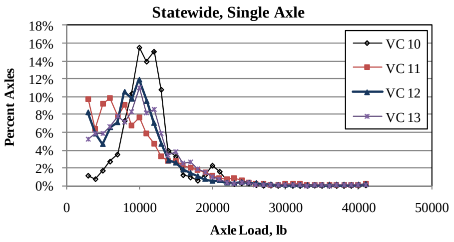
- Site-Specific Axle Load Spectra, ***(Level 1)***.
- Truck Wight Road Groups (TWRGs), ***(Level 2).***
- State Wide Axle Load Spectra ***(Level 3).***

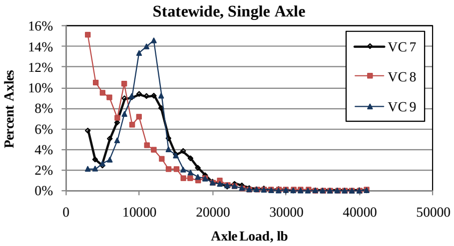
Axle Load Spectra



Statewide Single Axle Load Spectra by Truck Class



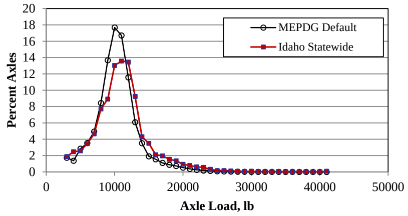




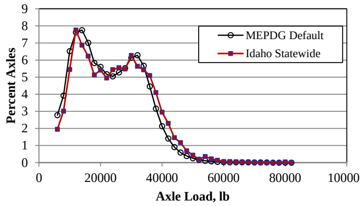
Statewide Single Axle Load Spectra

Axle Load (lb)	Vehicle Class									
	4	5	6	7	8	9	10	11	12	13
3000	4.40	10.58	1.99	5.76	15.00	1.88	1.20	10.08	8.78	5.79
4000	2.06	10.99	3.02	3.29	8.67	2.48	0.86	6.93	6.25	5.31
5000	3.29	9.35	3.85	2.46	10.39	2.58	1.90	9.88	4.80	5.14
6000	6.50	11.05	5.20	5.38	9.13	3.46	2.25	10.27	6.26	7.41
7000	6.58	7.46	6.02	6.61	6.95	4.66	3.55	7.85	7.29	7.33
8000	10.89	8.11	8.69	8.35	9.34	7.71	7.86	8.48	10.70	7.14
9000	8.14	6.70	7.98	8.28	6.56	8.92	10.32	5.95	9.67	8.58
10000	8.53	5.92	10.44	8.77	7.25	13.03	15.39	7.08	12.07	10.78
11000	6.95	4.24	9.29	8.39	4.66	13.57	13.75	5.42	9.28	7.93
12000	6.88	3.90	10.57	9.38	4.31	13.45	13.89	4.32	6.91	8.07
13000	6.71	3.46	8.92	8.72	3.36	9.24	9.66	3.20	4.54	5.83
14000	6.33	2.78	6.19	5.34	2.28	4.31	4.22	2.69	2.50	3.89
15000	6.27	2.63	6.14	3.27	2.31	3.50	3.71	2.86	2.45	4.08

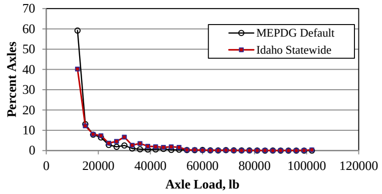
Comparison of MEPDG and Statewide Axle Load Spectra for VC 9



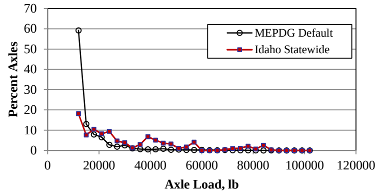
Single Axle



Tandem Axle

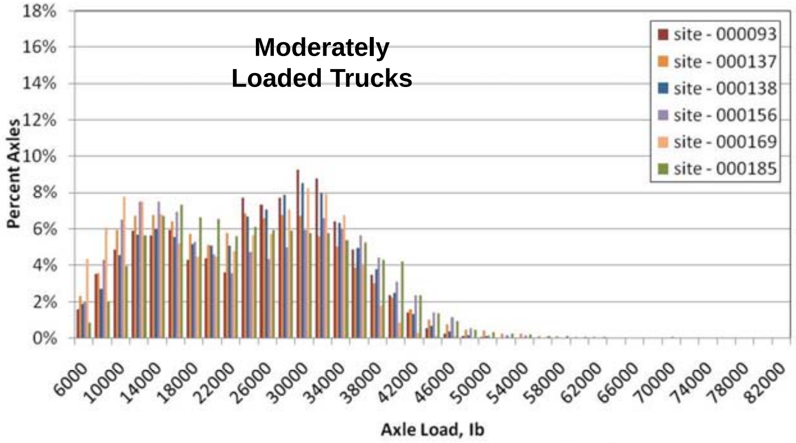


Tridem Axle

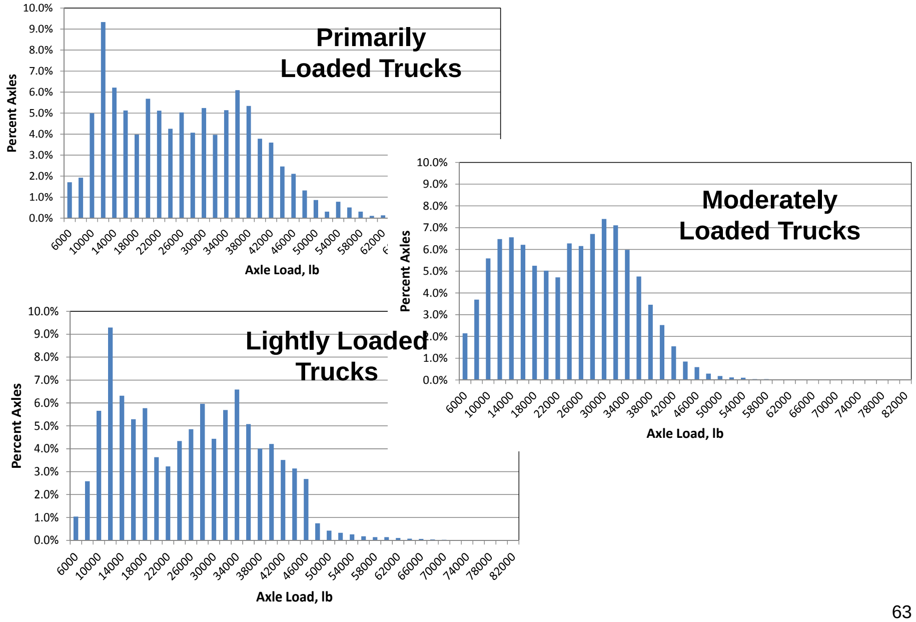


Quad Axle

Idaho TWRGs (level 2)

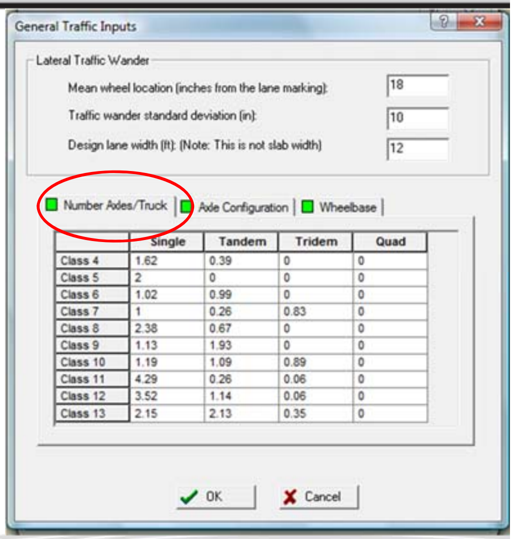


Idaho TWRGs



General Traffic Inputs

- Wander (Default)
- No of axles per truck category
- Axle configuration (Default)
- Wheelbase (Default)



General Traffic Inputs

Lateral Traffic Wander

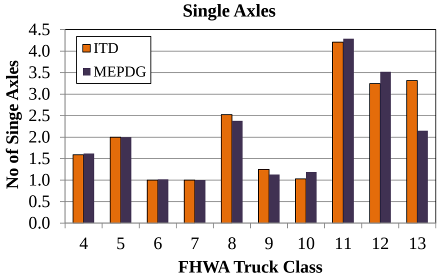
Mean wheel location (inches from the lane marking): 18

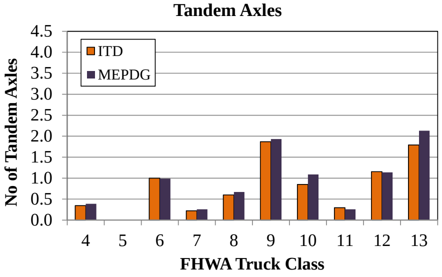
Traffic wander standard deviation (in): 10

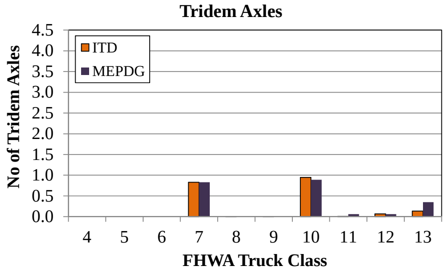
Design lane width (ft): (Note: This is not slab width) 12

	Single	Tandem	Tridem	Quad
Class 4	1.62	0.39	0	0
Class 5	2	0	0	0
Class 6	1.02	0.99	0	0
Class 7	1	0.26	0.83	0
Class 8	2.38	0.67	0	0
Class 9	1.13	1.93	0	0
Class 10	1.19	1.09	0.89	0
Class 11	4.29	0.26	0.06	0
Class 12	3.52	1.14	0.06	0
Class 13	2.15	2.13	0.35	0

General Traffic Inputs
Number of Axles Per Truck

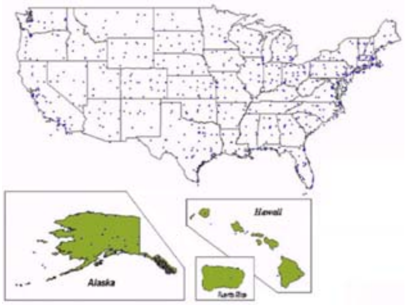






Task 5 - Climatic Database for Idaho

- MEPDG Requires the Following
  - Hourly air temperature
  - Hourly precipitation
  - Hourly wind speed
  - Hourly percentage sunshine
  - Hourly relative humidity
  - Ground water depth



Task 5: Climatic Database for Idaho (Cont'd)

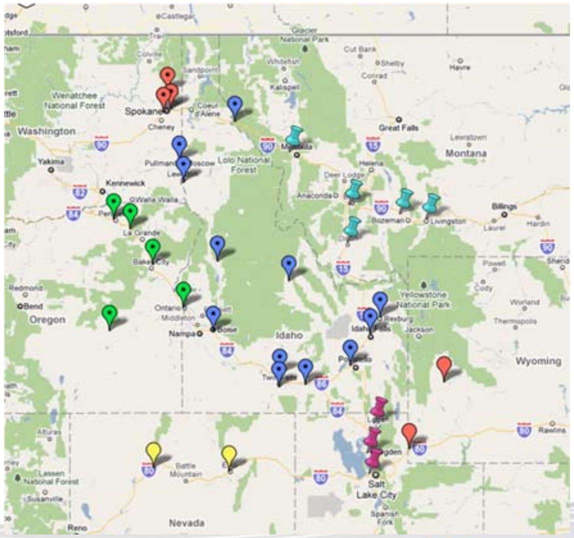
Idaho Weather Stations Currently Available in the MEPDG Software Version 1.100

Weather Station	Station Location	Latitude (Degree.Minutes)	Longitude (Degree.Minutes)	Elevation (ft)	Months of Available Data	Months Missing in File
Boise	Boise Air Trml/Gowen FD AP	43.34	-116.13	2861	116	0
Burley	Burley Municipal Airport	42.32	-113.46	4151	64	0
Challis	Challis Airport	41.31*	-114.13	5042	90	0
Idaho Falls	Idaho Falls Regional Airport	43.31	-112.04	4768	97	0
Jerome	Jerome County Airport	42.44	-114.28	4012	109	4*
Lewiston	Lewiston-Nez-Perce co airport	46.22	-117.01	1447	116	0
MC Call	MC Call Municipal Airport	44.53	-116.06	5032	101	0
Mullan Pass	Mullan Pass	47.28	-115.38	6074	116	0
Pocatello	Pocatello Regional Airport	42.55	-112.34	4454	116	0
Rexburg	Rexburg-Madison County Airport	43.5	-111.53	4875	97	1*
Twin Falls	Jsin Fld-Magic Vly Regional Airport	42.29	-114.29	4148	105	1*
Pullman/ Moscow	Pullman/Moscow Regional Airport	46.44	-117.07	2540	93	0

Weather Stations Located in Idaho Adjacent States Close to Idaho Borders

Weather Station	Station Location	State	Latitude (Degree.Minutes)	Longitude (Degree.Minutes)	Elevation (ft)	Months of Available Data	Months Missing in File
Baker City	Backer City Municipal Airport	Oregon	44.5	-117.49	3363	52	0
Burns	Burns Municipal Airport	Oregon	43.35	-118.57	4148	116	0
Meacham	Meacham	Oregon	45.31	-118.25	3729	94	0
Pendleton	Eastern Oregon Regional Airport	Oregon	45.42	-118.5	1516	116	1*
Ontario	Ontario Municipal Airport	Oregon	44.01	-117.01	2192	104	0
Deer Park	Deer Park Airport	Washington	47.58	-117.25	2196	88	1*
Spokane	Spokane International Airport	Washington	47.37	-117.32	2384	116	0
Spokane	Felts Field Airport	Washington	47.41	-117.19	1979	89	0
Bozeman	Gallatin Field Airport	Montana	45.47	-111.09	4468	116	0
Butte	Bert Mooney Airport	Montana	45.58	-112.3	5539	64	0
Dillon	Dillon Airport	Montana	45.16	-112.33	5221	105	0

Weather Stations Located in Idaho and Idaho Adjacent States Close to Idaho Borders



Recommended Weather Stations for Each Idaho County

Idaho County	MEPDG Weather Station
Boundary	Deer Park, Spokane Felts Field, Spokane International Airport, Mullan Pass
Bonner	Deer Park, Spokane Felts Field, Spokane International Airport, Mullan Pass, Pullman-Moscow
Kootenai	Deer Park, Spokane Felts Field, Spokane International Airport, Mullan Pass, Pullman/Moscow, Lewiston
Benewah	Deer Park, Spokane Felts Field, Spokane International Airport, Mullan Pass, Pullman/Moscow, Lewiston
Shoshone	Deer Park, Spokane Felts Field, Spokane International Airport, Mullan Pass, Pullman/Moscow, Lewiston, Missoula
Latah	Deer Park, Spokane Felts Field, Spokane International Airport, Mullan Pass, Pullman/Moscow, Lewiston
Clearwater	Spokane Felts Field, Spokane International Airport, Mullan Pass, Pullman/Moscow, Lewiston, Missoula
Nez Perce	Lewiston, Pullman/Moscow, Meacham

GWT Depth

- Seasonal water table depth variations have a great impact on the in-situ moisture of the unbound base/subbase and subgrade materials.
- For the State of Idaho, GWT depth can be obtained either form geotechnical investigation reports done at the project site.
- Other source for GWT depth are:
  - **Idaho Department of Water Resources** (**IDWR**). ttp://www.idwr.idaho.gov/WaterInformation/GWLevels.
  - **The U.S. Geological Survey (USGS) website**: http://groundwaterwatch.usgs.gov/default.asp

Thank you