

U.S. Department of Transportation
Federal Highway Administration

Federal Highway Administration
RESOURCE CENTER

MEPDG Darwin-ME Status and Implementation Efforts

Idaho Asphalt Conference
October 22, 2009

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What's Being Used (2007 survey)

Asphalt Design:

	Response Total	Response Percent
AASHTO 1972	6	12%
AASHTO 1981	0	0%
AASHTO 1986	0	0%
AASHTO 1993	33	63%
Individual State design procedure	7	13%
Combination of AASHTO & State procedure	4	8%
Other	2	4%
Total Respondents	52	

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Does SHA Use or Plan to Use **MEPDG DARWIN-ME**?

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■ NO - 12
■ YES - 40

Alaska
Hawaii

2007 Survey

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Timeframe for Implementation

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■ Using 3
Delaware: Project Analysis

Alaska
Hawaii

2007 Survey

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Why change ??

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AASHO Road Test (late 1950s)

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1950s Construction Methods...

Figure 57. Compacting subbase.

Figure 29. Bituminous concrete construction.

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(AASHO, 1961)

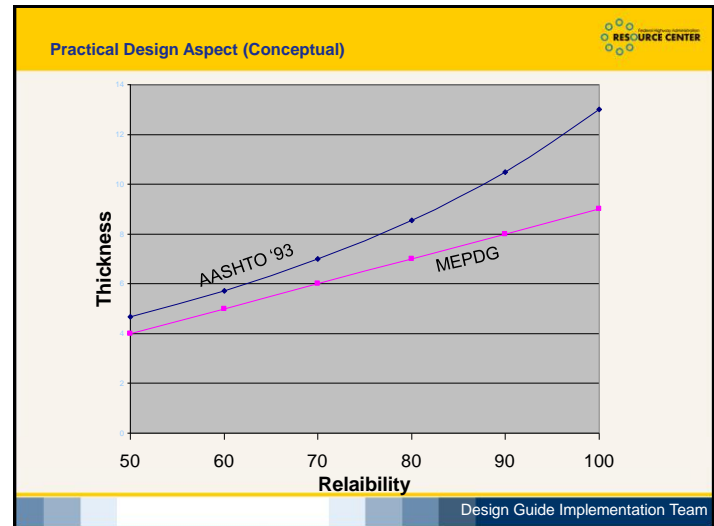
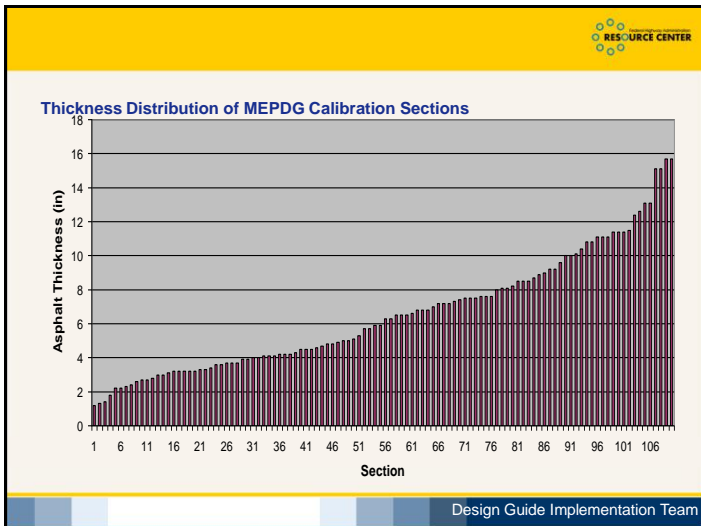
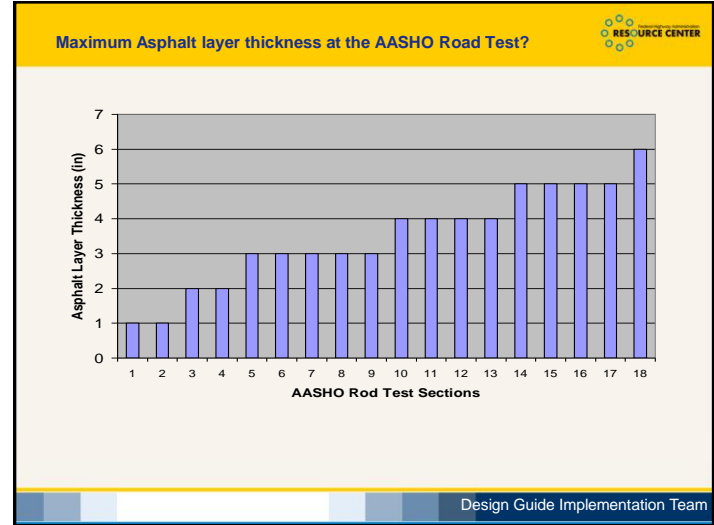
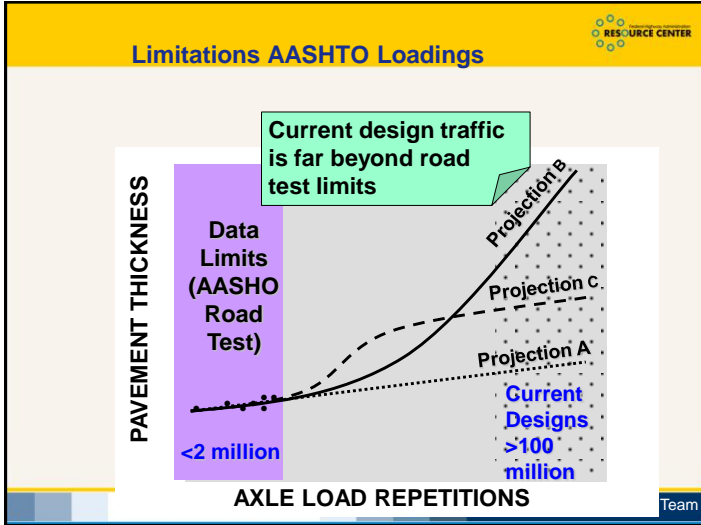
1950s Vehicle Loads...

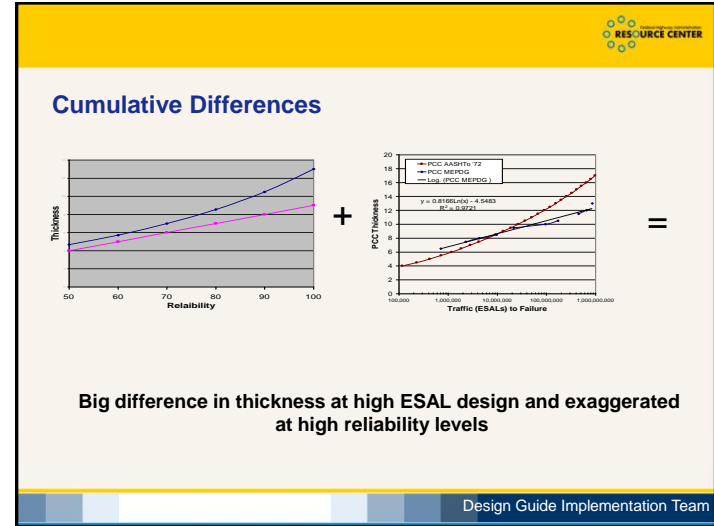
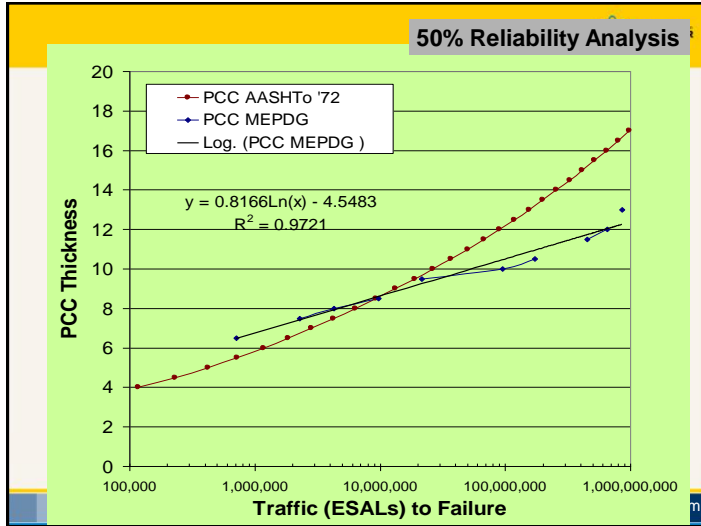
Figure 23. Test vehicles, showing typical axle arrangements and loadings.

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Design Guide Implementation Team (AASHO, 1961)

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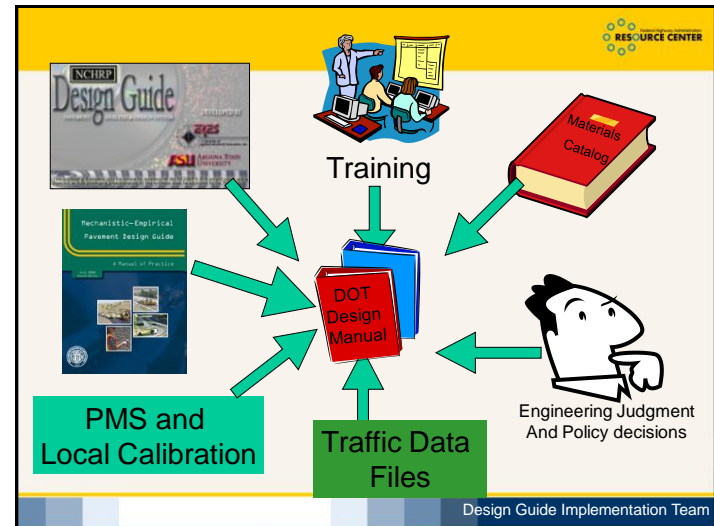
MEPDG DARWIN-ME from Research to Reality

DARWIN -ME

“The ~~MEPDG~~ is an analysis tool, not a pavement design program.”

– Various Unnamed Sources

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Prep-ME Arkansas Software Capabilities:

- Import Raw Data**
- Traffic Data Check**
- Interpolate Climate and Traffic Data**
- Retrieve Material Data**
 - Dynamic Modulus
 - CTE
 - M_r

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Software Capabilities-Import Raw Data

Generate MEPDG Supporting Database

Arkansas

Import Climate Data: C:\Documents and Settings\jdi.GAL\Desktop\weigu

Import Traffic Data: C:\Documents and Settings\jdi.GAL\Desktop\weigu

SaveDB to: C:\Documents and Settings\jdi.GAL\Desktop\weigu

Processing completed 88%

Importing C:\Documents and Settings\jdi.GAL\Desktop\weigu\CD Files, AHTD May Conference_05-16-2007\In Wang_Mar 17 2008\IRC-0702 Software\Arch_Demo_IRC0702\Climate\WTD_3.mxd.z

- Climate: icm files**
- Traffic: AHTD Traffic Monitoring Data**

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Software Capabilities-Traffic Data Check

Traffic Data Check

MEPDG Supporting Database File for Quality Control

C:\Documents and Settings\jdi.GAL\Desktop\weigu\CD Files, AHTD May Conference_05-16-2007\In Wang_Mar 17 2008\IRC-0702 Software\April 1st 2008, De

Weight Data Check

Vehicle Class Distribution by Month

Accepted/Not Accepted/Partially Accepted/Not Accepted

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Software Capabilities-Materials E*

Dynamic Modulus Report

Accepted Parameters

Blender Grade: PG19-22

Design Air Void Level (%): High (7.0%)

Nominal Aggregate Size (mm): 12.5 mm

Aggregate Type: Limestone

Material Gradients

Sieve Size: 37.5 - 1-1/2"

25.0 - 1"

19.0 - 3/4"

12.5 - 1/2"

9.5 - 3/8"

4.75 - #4

2.36 - #6

1.18 - #16

0.6 - #30

0.3 - #60

0.15 - #100

0.075 - #200

Dynamic Modulus E* Data

Temperature (F degree)	0.1	0.5	1.0	5.0	10.0	25.0
14	1826.77	1186.52	2336.96	3669.61	2776.7	3038.62
40	1288.39	8676.39	1771.18	2230.07	2425.92	2691.76
70	270.52	936.58	520.74	768.28	824.71	1114.98
100	72.99	113.63	141.69	249.08	318.81	432.42
130	30.29	60.13	67.03	76.35	98.34	141.85

Phase Angle (degree)

Temperature (F degree)	0.1	0.5	1.0	5.0	10.0	25.0
14	11.47	9.49	9	6.61	9.56	13.37
40	15.19	11.55	10.88	10	10.7	13.18
70	26.43	25.37	24.61	22.4	22.26	23.91
100	24.44	29.06	30.7	32.73	33.04	35.87
130	18.62	23.59	25.26	32.45	35.75	41.2

Dynamic Shear Rheometer (DSR) with Angular Frequency = 10 rad/sec

Temperature (F degree)	60	96	122	149
G* (kPa)	194673.58	159402.52	20226.94	3765.7
Delta (degree)	55.25	67.28	67.13	68.34

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Software Capabilities- Retrieving Data

Retrieve Material Parameters

MEPDG Supporting Database File

Export to MEPDG Input Files

Rigid Pavement Flexible Pavement

Retrieving Coefficient of Thermal Expansion Data Based On

Coarse Aggregate Type

Age

Cementitious Paste Type

Retrieving Dynamic Modulus & Dynamic Shear Rheometer Based On

Binder Grade

Design Air Void Level

Nominal Max Aggregate Size

Coarse Aggregate Type

NMA

Asphalt Content

Aggregate Gradation

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Software Capabilities-Geo-Mapping Utility

PvmtDesigner - [PvmtDesigner]

For Arkansas Highway Transportation Department Use only (TRC/82)

Ready 10:04

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Software Capabilities-Generated Files

Interpolation Result

Address C:\Documents and Settings\jlg.GACL\Desktop\weiguoc\CD Files, AHTD May Conference, 05-16-2007\D

1540 4/25/2008 9:01 AM Climate ALF File	quad 4/25/2008 9:01 AM ALF File
Single 4/25/2008 9:01 AM ALF File	tandem 4/25/2008 9:01 AM ALF File
tridem 4/25/2008 9:01 AM ALF File	HourlyTrafficPerc 4/25/2008 9:01 AM Text Document
AxesPerTraffic 4/25/2008 9:01 AM Text Document	GeneralTraffic 4/25/2008 9:01 AM Text Document
MonthlyAdjustmentFactor 4/25/2008 9:01 AM Text Document	Traffic 4/25/2008 9:01 AM Text Document
TrafficGrowth 4/25/2008 9:01 AM Text Document	VehicleClassDistribution 4/25/2008 9:01 AM Text Document
DSR 4/25/2008 9:14 AM BIF File	E_Modulus 4/25/2008 9:14 AM DWN File
Material_Report 4/25/2008 9:23 AM Microsoft Office Access Application	

Climate (highlighted)

Traffic Files: 11 in total (highlighted)

Materials (highlighted)

Summary Report (highlighted)

Can be imported to MEPDG software (highlighted)

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Use the experts in your Backyard.....


**Arkansas DOT contracted with University of Arkansas
Dr. Kevin Hall**

**Indiana DOT contracted with INDOT Research / Purdue University
Dr. Tommy Nantung**

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Indiana DOT HMA Materials Characterization

- Dynamic Modulus**
 - District - 6
 - Nom Max Aggregate Size - 3
 - Binder Type – 3
- Binder Characterization**
 - 3 Binders DSR data
- Traffic Data**
 - WIM Station Data Analyzed
 - Load Spectra defined by Volume



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What to Change for Design?

Sensitivity of Inputs for Concrete

Parameter	Roughness	Faulting	Percent Slabs Cracked
Permanent Curl/Warp Effective Temperature Difference	VS	VS	VS
Joint Spacing	VS	VS	VS
Dowel Bar Diameter	MS	MS	NS
Pavement Thickness	S	MS	VS
Modulus of Rupture	S	NS	VS
Modulus of Elasticity	S	NS	VS
20-year/28-day Ratio	S	NS	VS

Indiana DOT: MEPDG Guide for Designers

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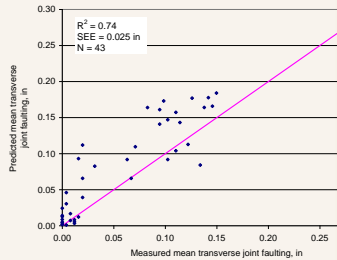
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Local Calibration Potential

All models can be adjusted (**Tools, Calibration, Coefs.**)

Key effect: **Eliminate “bias” of prediction (significant over prediction or under prediction of distress).**

Possible effect: **Reduce residual of prediction (depends on quality of data).**



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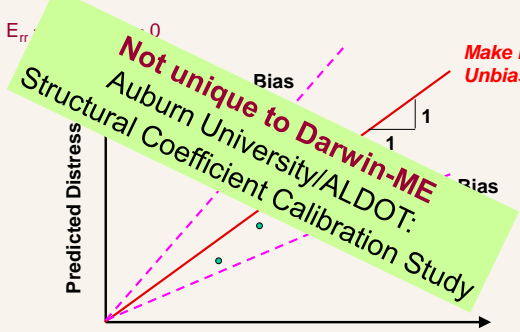
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Statistical Optimization

$\sum E_{it}$

Not unique to Darwin-ME
Auburn University/ALDOT:
Structural Coefficient Calibration Study

Make Model Unbiased



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A few thoughts on calibration:

- **Step 1: Become comfortable with MEPDG as it stands**
- **Step 2: Does it reflect current pavement performance?**
 - Use actual performance data & engineering experience
 - Results from MEPDG will be different than AASHTO 93
- **Step 3: Is there a bias in MEPDG prediction?**
- **Step 4: Does the MEPDG capture special material properties?**
 - OGFC, SMA, Polymer, WMA, Rubber Asphalt, etc...
 - Unique Structural Design

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Good Calibration and Implementation Document

Montana DOT
http://www.mdt.mt.gov/research/projects/pave/pave_model.shtml

Major Findings:

- Preservation Practice Extend Performance
- Most models adequate for design
- Re-calibrate unbound materials rutting

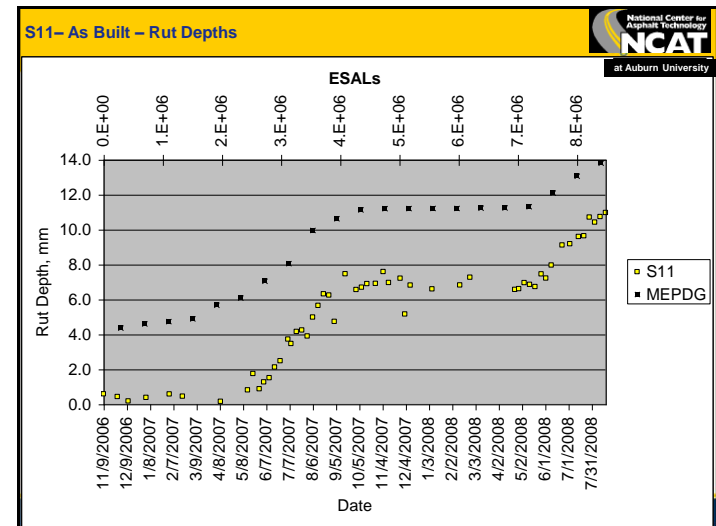
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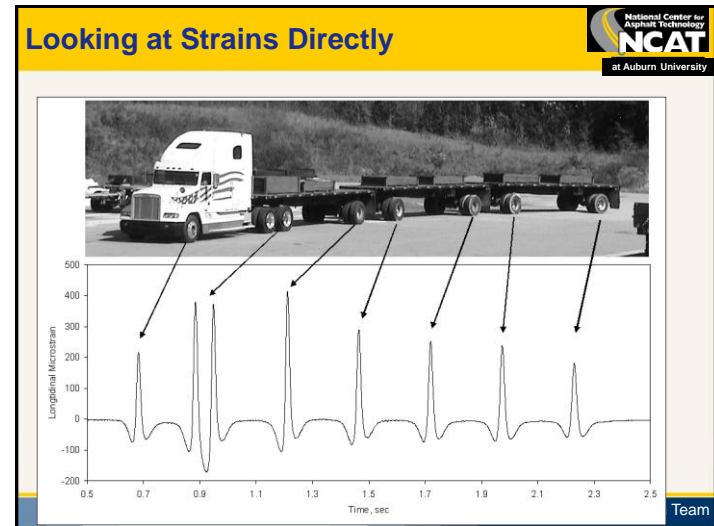
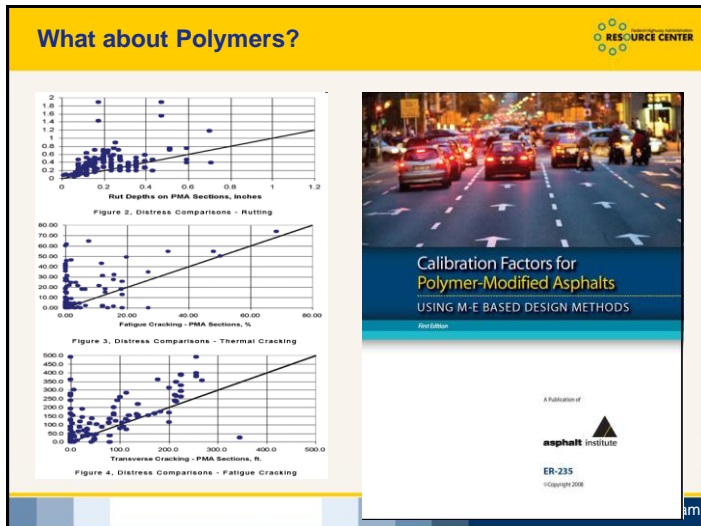
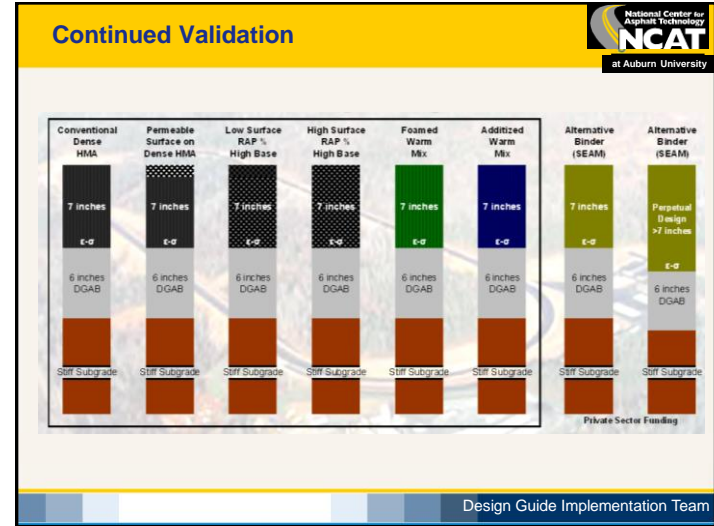
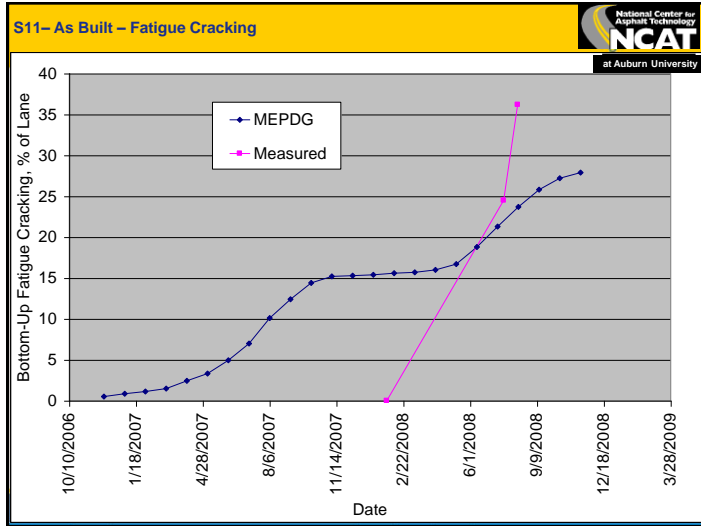
Continual Improvement

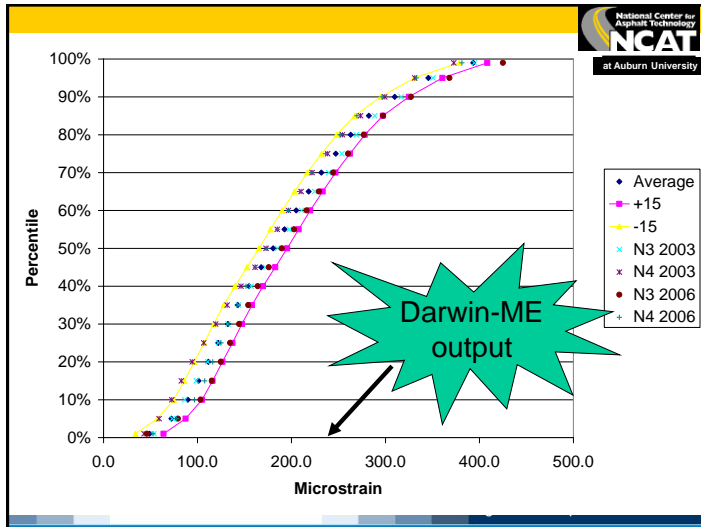
- **Continued MEPDG Validation**

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Training Opportunities



NHI #131064 – Introduction to Mechanistic Design

NHI #131109 - Using Mechanistic-Empirical Pavement Design Guide Software

NHI #132040 – Geotechnical Aspects of Pavements

NHI #151018 – Application of Traffic Monitoring Guide

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Training / Collaboration Opportunities

FHWA Regional WIM/Traffic Workshop
– Boise, Idaho Sept 2009

FHWA Resource Center on request training

MEPDG Regional Meetings

Look out for DARWIN- ME roll out
Summer 2010



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Previous & On-Going Studies



NCHRP 1-41 – Models for Predicting Reflection Cracking of HMA Overlays (2008)

NCHRP 1-42A – Models for Predicting Top-Down Cracking of HMA Layers (2008)

NCHRP 9-29 – Simple Performance Tester for Superpave Mix Design (2008)

NCHRP 9-38 – Endurance Limit of HMA Mixtures to Prevent Fatigue Cracking (2008)

NCHRP 9-44 – Develop Plan for Validating an Endurance Limit for HMA (2008)

NCHRP 9-44A – Validating an Endurance Limit for HMA

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Previous & On-Going Studies

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- SHRP 2 Project R-21 – *Composite Pavement Systems*
- NCHRP 1-46 – *Development of AASHTO Pavement Handbook (2008)*
- NCHRP 1-47 – *Sensitivity Analysis of MEPDG (2011)*
- NCHRP 4-36 – *Characterization of Cementitious Stabilized Layers for Use in Pavement Design and Analysis (not awarded)*

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Previous & On-Going Studies

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Calibration Documents:

- **NCHRP Digest 284**, December 2003; *Refining the Calibration & Validation of HMA Performance Models: An Experimental Plan and Database.*
- **NCHRP Digest 283**, December 2003; *Jackknife Testing – An Experimental Approach to Refine Model Calibration and Validation.*

FHWA: Use of PMS data for local calibration.

FHWA: Use of deflection basin data in the MEPDG.

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What is DARWin ME going to look like?

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- **Runtime Improvement**
 - 35-45 minutes to less than 15 minutes
- **Thickness Optimization**
- **Database Structure**
- **New GUI Interface**
- **Backwards Compatible with earlier MEPDG versions**
- **Stand Alone EICM**
- **Sensitivity Analysis**
- **Enhanced Batch Mode features**
- **Structural response output**
- **SI Units**

No Fundamental Theory Changes

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Perspective

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Darwin-ME Coming to a computer near you: January 2011

- 1960 – Cor
- 1961-62 A
- 1972 AAS
- 1981 Revis
- 1986 Guid
- 1993

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