


The New Mechanistic-Empirical Pavement Design Guide: Implementation and Other Issues...or


What in the world is going on?



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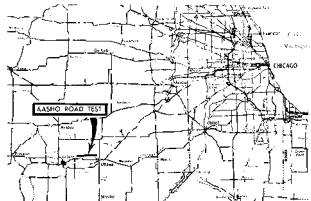

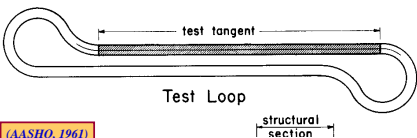
Southeastern Asphalt User-Producer Group
Nashville, Tennessee – December 2005

First things first...



- What is the mechanistic-empirical pavement design guide (MEPDG)?
 - A product of NCHRP 1-37a
 - With refinements under NCHRP 1-40
 - A pavement *analysis* tool
 - Provides predictions of pavement distress, given a trial structural pavement section
- What is it NOT?
 - An official AASHTO product (yet)
 - A traditional “design” program (yet?)
 - (likely) in its final form


Memory Lane: the AASHTO Road Test (late 1950's)

(AASHTO, 1961)

The AASHTO Road Test
History and Description of Project
National Academy of Sciences
National Research Council

AASHTO Pavement Design (current)



$$\log_{10} W_{18} = Z_r * S_w + 9.36 * \log_{10} (SN + 1) - 0.20 + \frac{\log_{10} \left[\frac{\Delta PSI}{4.2 - 1.5} \right]}{0.40 + \frac{1094}{(SN + 1)^{5.19}}} + 2.32 * \log_{10} M_r - 8.07$$


Flexible pavement design:
the *answer* is structural number (SN)

Then you break SN into layers:




$$SN \leq (a_{ACHM} * d_{ACHM}) + (a_{base} * d_{base})$$

The *design* is layer thickness


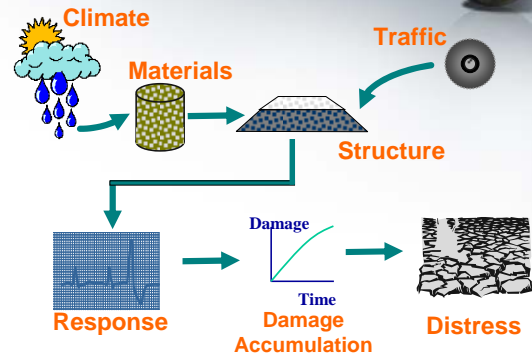
MEPDG: Flexible Pavements



- Distress Models
 - Fatigue Cracking (bottom up)
 - Rutting
 - Thermal Cracking
 - Roughness (IRI)

Mechanistic-Empirical Design/Analysis: The “nickel tour”

Climate → Materials → Structure → Response → Damage Accumulation → Distress

Traffic → Structure

Response → Damage Accumulation → Distress

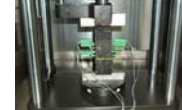
**MEPDG:
Materials Inputs**

- Complicating Factors
 - LOTS MORE!!!!
 - Some inputs not currently measured/tracked
- “Levels” of inputs
 - Level 3: I don't know much about the input...
 - Level 2: I know “some” about the input...
 - Level 1: I know a lot about the input...
- Typical Approaches
 - catalogs/libraries
 - correlations

Asphalt Materials Properties



Parameter	Level 1	Level 2	Level 3
Dynamic Modulus, E*	Lab: simple performance test	Mix volumetric properties	Mix volumetric properties
Tensile strength & Creep compliance	Lab: indirect tension test	Lab: IDT at 1 temperature	Default data calculated



Level: 1

Asphalt material type: Asphalt concrete

Layer thickness (in): 4

Options - At Short Term Aging - RTFD

Superpave binder test data

Conventional binder test data

Temperature (°F)	Angular frequency = 10 rad/sec	G' (Pa)	Delta (°)
40		1.79E7	37.4
55		4.98e6	46.9
77		8.14e5	56.5
113		4.1e4	66

Superpave binder test

Level: 3

Asphalt material type: Asphalt concrete

Layer thickness (in): 4

Options

Superpave binder grading

Conventional viscosity grade

Conventional penetration grade

High Temp (°C)	Low Temp (°C)					
	-10	-16	-22	-28	-34	-40
46						
52						
58						
64						
70						
76						
82						

Superpave binder grade

Level: 3

Asphalt material type: Asphalt concrete

Layer thickness (in): 4

Poisson's ratio: 0.3

Reference temperature (°F): 70

Effective binder content (%): 8.6

Air voids (%): 7

Total unit weight (pcf): 148

Thermal conductivity asphalt (BTU/hr-R-F): 0.67

Heat capacity asphalt (BTU/lb-F): 0.23

Level: 1

Asphalt material type: Asphalt concrete

Layer thickness (in): 4

Dynamic Modulus Table

Temperature (°F)	Mixture E' (psi)			
	0.1	1	10	25
10	1807698	2214499	2509367	2598853
40	789187	1227495	1654832	1734659
70	226939	440246	781182	957396
100	49488	107164	232124	324039
130	16160	32519	68538	105721

SEAUPG 2005 Conference - Nashville, TN

Asphalt Material Properties

Level: 3

Asphalt material type: Asphalt concrete

Layer thickness (in): 4

Aggregate Gradation

Cumulative % Retained 3/4 inch sieve: 0

Cumulative % Retained 3/8 inch sieve: 11

Cumulative % Retained #4 sieve: 46

% Passing #200 sieve: 2.5

Levels 2 & 3 Input aggregate gradation

Thermal Cracking

Level 1

Level 2

Level 3

Average tensile strength at 14 °F (psi): 444

Creep test duration (sec): 100

Import/export already-created thermal cracking files

Input or default coefficient of thermal contraction

For Level 1, Tensile Strength and Creep Compliance at three temperatures are needed to determine thermal cracking

Loading Time sec	Creep Compliance (1/psi)		
	Low Temp (°F)	Mid Temp (°F)	High Temp (°F)
	-4	14	32
1	2.827e-007	4.137e-007	5.309e-007
2	2.965e-007	4.206e-007	6.205e-007
5	3.309e-007	5.34e-007	7.791e-007
10	3.378e-007	5.86e-007	8.756e-007
20	3.654e-007	6.481e-007	1.049e-006
50	3.792e-007	7.996e-007	1.358e-006
100	3.999e-007	9.101e-007	1.696e-006

Thermal Cracking - Level 2

Level 2

Level 1

Level 2

Level 3

Average tensile strength at 14 °F (psi): 444

Creep test duration (sec): 100

Input tensile strength and creep compliance data at one temperature

Loading Time sec	Creep Compliance (1/psi)		
	Mid Temp (°F)	Low Temp (°F)	High Temp (°F)
	14	-4	32
1	4.137e-007	2.827e-007	5.309e-007
2	4.206e-007	2.965e-007	6.205e-007
5	5.24e-007	3.309e-007	7.791e-007
10	5.86e-007	3.378e-007	8.756e-007
20	6.481e-007	3.654e-007	1.049e-006
50	7.996e-007	3.792e-007	1.358e-006
100	9.101e-007	3.999e-007	1.696e-006

Thermal Cracking - Level 3

Level 3

Level 1

Level 2

Level 3

Average tensile strength at 14 °F (psi): 438.88

Creep test duration (sec): 100

Level 3 Tensile Strength and Creep Compliance default values will be generated as a function of volumetric properties and binder type

Loading Time sec	Creep Compliance (1/psi)		
	Low Temp (°F)	Mid Temp (°F)	High Temp (°F)
	-4	14	32
1	2.84235e-007	3.88756e-007	5.31713e-007
2	3.14314e-007	4.54281e-007	6.88031e-007
5	3.59017e-007	5.58147e-007	9.67326e-007
10	3.97011e-007	6.52223e-007	1.25171e-006
20	4.39026e-007	7.62155e-007	1.6197e-006
50	5.01466e-007	9.36415e-007	2.27719e-006
100	5.54534e-007	1.09425e-006	2.94666e-006

MEPDG: Pavement Responses

- Ties to materials inputs
- Typical Approach: **Sensitivity Analysis**
 - Identifies “critical” inputs
 - “Where do I need to spend my money?”
 - Provides an assessment of the suitability of using default values
 - Allows designers to focus on topics most affecting design
 - Gives designers tools to affect one distress without affecting others

MEPDG: Local Calibration

- This is where the “empirical” of M-E comes in...
- Compare predicted distress versus real life
- Adjust distress prediction models to “fit”
 - Current calibration is *national*
- Typical Approach
 - Start with LTPP sections
 - Add existing sections (PMS??)
 - Plan new sections
 - DATA QUALITY IS KEY
- This could be a long-term effort!!!

To Sum Up...



- Materials and traffic inputs have gotten intense
 - Catalog and document past & future testing efforts
- Pavement responses must be understood
 - Sensitivity analyses – R – us
- Make it real – but make sure it's complete
 - Local calibration makes the MEPDG work for you

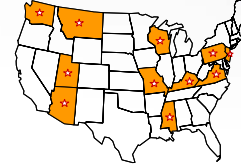
A final thought: you are not alone!



- FHWA Design Guide Implementation Team (DGIT)



- Lead States



- Technology Transfer

THANK YOU

QUESTIONS?

