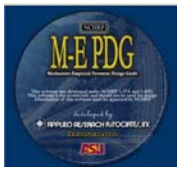
MEPDG Implementation in Arkansas



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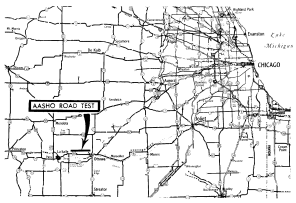
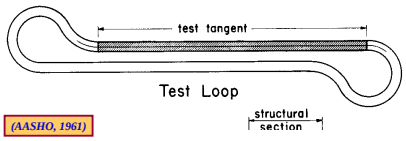
Southeastern Asphalt User-Producer Group Annual Meeting
Birmingham, Alabama
19 November 2008

The Plan for Today…

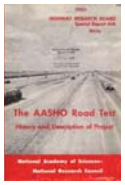
- A short stroll down memory lane
  (where we've been)
- A look up the road
  (where we're going)
- A peek at Arkansas' plan for implementation
  (how we are going to get there)

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





(AASHO, 1961)



AASHTO Pavement Design *(current)*

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

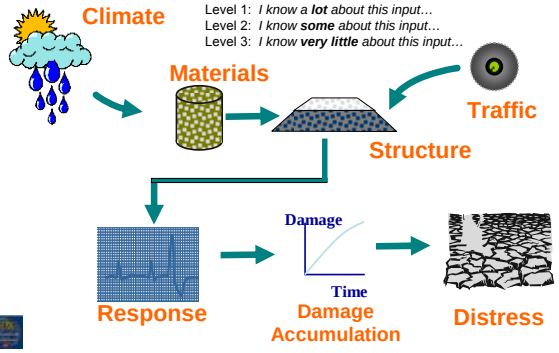
Flexible pavement design:
the ***answer*** is structural number (SN)

Then you break SN into layers:

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

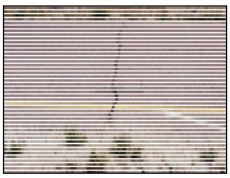
The ***design*** is layer thickness

Mechanistic-Empirical Design/Analysis



MEPDG: Flexible Pavements

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



National Perspective

- FHWA Design Guide Implementation Team (DGIT)
- NCHRP
  - 1-37: Development of M-E Design Guide
  - 1-39: Traffic Data Collection, Analysis, and Forecasting
  - 1-40A: Independent Review of MEPDG
  - 1-40B: User Manual and Local Calibration Guide
  - 1-40D: Technical Assistance to NCHRP 1-40A
  - 1-41: Models for Predicting Reflection Cracking of HMA Overlays
  - 1-42A: Models for Predicting Top-Down Cracking of HMA
  - 1-47: Sensitivity Analysis of the MEPDG
  - 9-30: Experimental Plan for Calibration & Validation of HMA Performance Models
  - 9-30A: Calibration of Rutting Models for HMA
  - 9-44: Development of Work Plan for Validating Endurance Limit for HMA
- "Lead States" activities

A Quick Peek at Arkansas' Efforts

- Sensitivity Analyses ✓
- Materials Inputs ✓
  - HMA Dynamic Modulus
  - PCC Coefficient of Thermal Expansion & Poisson's Ratio
  - Unbound (Soil & Aggregate) Resilient Modulus
- Traffic Inputs ✓
- Design Studies
- Local Calibration
  - Database Development ✓
  - Section I.D.
  - Data Collection
  - Analysis

NCHRP 1-40

Recommended Practice for Local Calibration of the Mechanistic-Empirical Pavement Design Guide

"The calibration and validation of the performance prediction model is a mandatory step…to establish confidence in the design and analysis procedure and facilitate its acceptance and use."

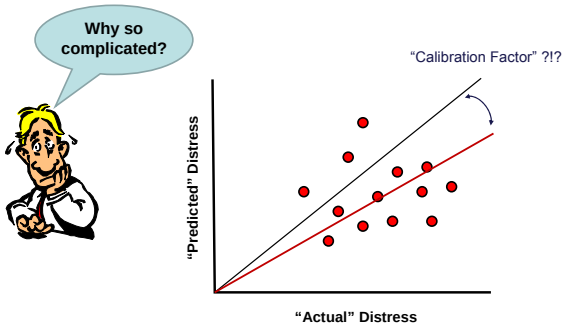
Calibration: the mathematical process through which total (residual) error – the difference between observed and predicted values of distress – is minimized.

Validation: the process to confirm that the calibrated model can produce robust and accurate predictions for cases other than those used for model calibration.

NCHRP 1-40: 11-Step Process

1. Select Hierarchical Input Level for Each Input Parameter
2. Develop Experimental Design and Matrix
3. Estimate Sample Size for Each Distress Model
4. Select Roadway Segments
5. Extract and Evaluate Roadway Segment/Test Section Data
6. Conduct Field Investigations of Test Sections to Define Missing Data
7. Assess Bias for the Experimental Matrix
8. Determine Local Calibration Coefficient to Eliminate Bias of Transfer Function
9. Assess Standard Error for Transfer Function
10. Improve Precision of Model: *modify coefficients and exponents of transfer functions*
11. Interpretation of Results: *decide on adequacy of calibration coefficients*

Now, wait just a minute here...



Bias and Error

What is ERROR?

$$(V_{total})^2 = (V_m)^2 + (V_{input})^2 + (V_l)^2 + (V_{pure})^2$$

V_{total}	=	total variance of the residual error – associated with "actual" versus "predicted"
V_{input}	=	variance caused by errors in lab and field measurements to estimate model inputs
V_m	=	variance caused by inaccuracies in measuring distress along the test section used for calibration
V_{pure}	=	variance due to replication ("pure" error)
V_l	=	variance caused by inadequate theory and/or model forms (typically called 'lack-of-fit' or model variance)

ATTACK WHAT YOU CAN CONTROL

NCHRP 1-40: 11-Step Process

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Calibration Effort "Snapshots"

- Sample size (minimum)
  - Distortion (total rutting or faulting) — 20 roadway segments
  - Load-related cracking — 30 roadway segments
  - Non-load-related cracking — 25 roadway segments
  - Reflection cracking (HMA only) — 15 roadway segments
- Roadway Segment / Condition Surveys
  - At least 3 condition surveys available for a roadway segment
  - Condition surveys cover at least 10 years
  - Increased number of surveys for higher levels of distress
  - Range of distress magnitudes – minor to "close to" design criteria
  - Distress definitions/measurements consistent with MEPDG *(Data Collection Guide for Long Term Pavement Performance)*

Arkansas: Progress & Plan

1. Select Hierarchical Input Level for Each Input Parameter
2. Develop Experimental Design and Matrix
3. Estimate Sample Size for Each Distress Model
4. Select Roadway Segments
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Future

Final Thoughts...

- Local calibration may be a long-term process; in the meantime…
  - Models within the Guide may change; new models may be added
  - The software may change
- It is ***imperative*** that the entire agency 'buy in' to this effort!
  - Tech services
  - Roadway Design
  - Materials
  - Construction

  Many agencies have formed a "M-E Guide Implementation Team" to coordinate and communicate the effort
- You can't fully implement a *locally calibrated* ME Design Guide haphazardly – it takes careful planning to do it right.

A Long-Term Effort?

THANK YOU !!!