Mechanistic-Empirical Design Implementation

John D'Angelo
Federal Highway Administration
Office of Pavement Technology

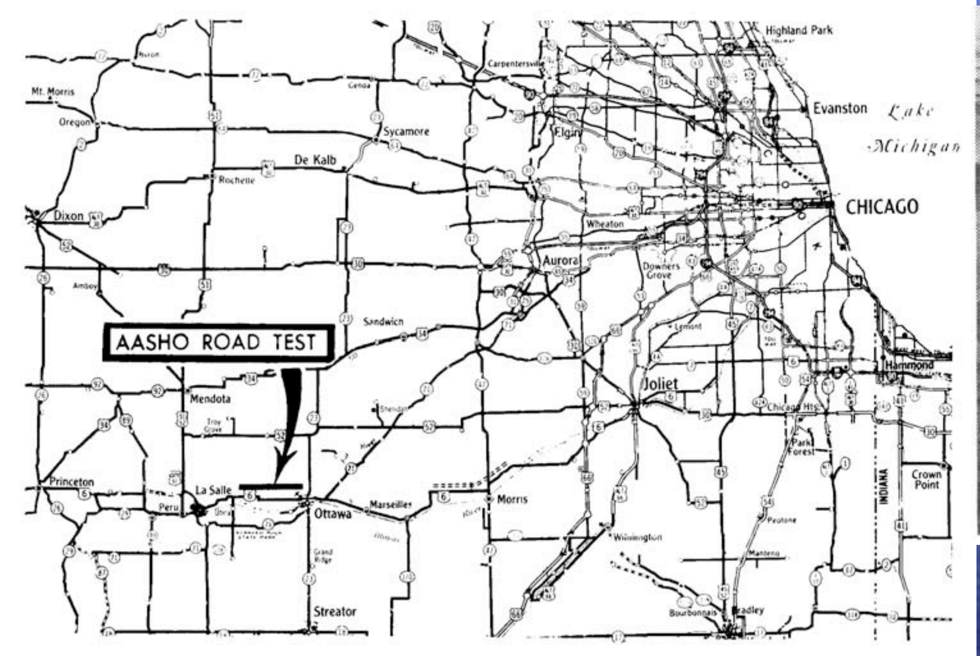
Design of New Flexible Pavements

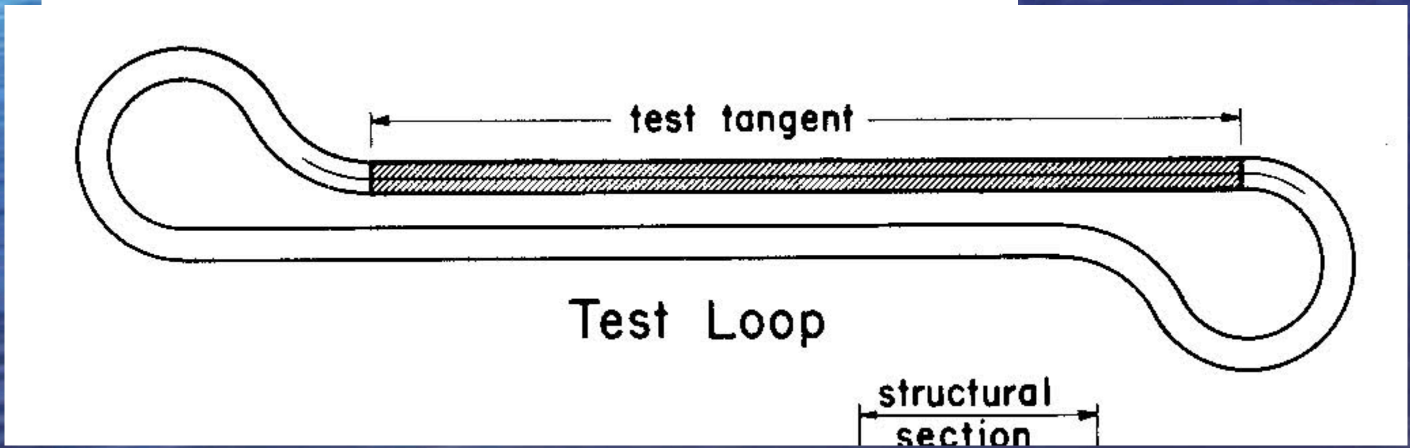
Mechanistic-Empirical Methodology

Existing AASHTO Pavement Design Guide

- Empirical design methodology based on AASHO Road Test in the late 1950s
- Several editions:
  - 1961 Interim Guide
  - 1972
  - 1986
    - Resilient modulus, rehabilitation, reliability
  - 1993
    - Improved rehabilitation
    - Current version

AASHO Road Test (late 1950s)





(AASHO, 1961)

1950s Vehicle Loads…

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

(AASHO, 1961)

Mechanistic-Empirical Design

- *Mechanistically* calculate pavement response (i.e., stresses, strains, and deflections) due to:
  - Traffic loading
  - Environmental conditions
- Accumulate *damage* over time
- *Empirically* relate damage over time to pavement distresses, e.g.:
  - Cracking
  - Rutting
  - Faulting
- *Calibrate* predictions to observed field performance

Mechanistic-Empirical Pavement Design Software (NCHRP 1-37A)

- Software & guide available online to download.
- Each SHA and FHWA Division received copies.
- Limited tech support through NCHRP.
- Guide currently under independent review through NCHRP 1-40 project.

Benefits

- Compatible with Superpave system
- Major Improvement for Flexible Pavement Design
- Most Comprehensive Approach for Structural Design
- Provides Link Between -
  - Structural Design
  - Asphalt Mixture Design

Benefits

- Wide Range of Pavement Structures
  - New
  - Rehabilitated
- Direct Consideration of Major Factors
  - Traffic – Direct Consideration of Over-Weight Trucks
  - Climate
  - Materials – Different HMA/Aggregate Materials
  - Support – Foundation & Existing Pavement
- Multiple Acceptance Criteria
  - Distress, smoothness

Benefits

- Uses Best Available Mechanistic-Empirical Models
  - Rutting, Fatigue Cracking, Thermal Cracking, Smoothness
- Models Calibrated Using LTPP Data
- Includes Method for Local Calibration

FHWA Design Guide Implementation Team DGIT

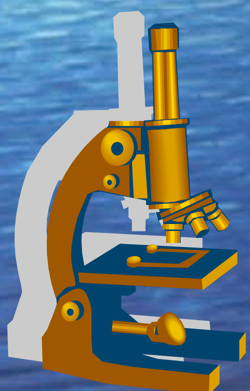
- **Office of Pavement Technology**
  - **Leslie Myers – Asphalt Team**
  - **Sam Tyson – Concrete Team**

- **Turner-Fairbank Highway Research Center**
  - **Katherine Petros – Advanced Models Team**

- **Resource Center**
  - **Monte Symons – TST Team**
  - **Timothy Barkley - Communications Specialist**
- **Division Office**
  - **John Sullivan – Division Administrator**

PURPOSE

To support & educate State highway agencies and industry in development & implementation of Mechanistic-Empirical Pavement Design



Facilitating Implementation of Mechanistic-Empirical Pavement Design

1-Day Workshops

Facilitating Implementation of Mechanistic-Empirical Pavement Design

Eight workshops throughout US in 2004

Participants from:

35 States
5 local highway agencies
20 universities
HMA and PCC industry
Consultants

Approximately 800 people will have attended by close of workshop program in the end of October 2004

Increase Understanding: NHI Course

NHI Course

Introduction to Using M-E Pavement Design Guide & Software

- Hands-on format with computers loaded with software
- Focus on user, not theory
  - **Pre-req NHI #131064 or similar training**
- Objective is for audience to be capable of performing flexible, rigid, rehab designs

STATUS: preparing RFP

Increase Understanding: Materials Characterization

Materials/Design Engineers 3-day Workshops

- **Objective: Educate M/D engineers on what is required for obtaining Level 1 materials inputs to design guide**
  - **Asphalt materials inputs**
  - **Concrete materials inputs**
  - **Soils/Unbound Granular materials inputs**

- Workshop, Laboratory and Software Modules

DGIT 3-day Workshops

- Pilot in January 2005
  - Additional 3 - 4 in FY 2005
    - **Max Attendance:** **40 participants / session**
    - **Location:** **State materials laboratory**
    - **Audience:** **State DOT Materials Engineers, Design Engineers, Senior test technicians from State labs, industry reps, State design consultants**

- Delivery by DGIT-HQ and RC staff
    - Lab module supported by HQ mobile labs

Utah, Missouri, Connecticut, Virginia

Support of AASHTO & NCHRP 1-40

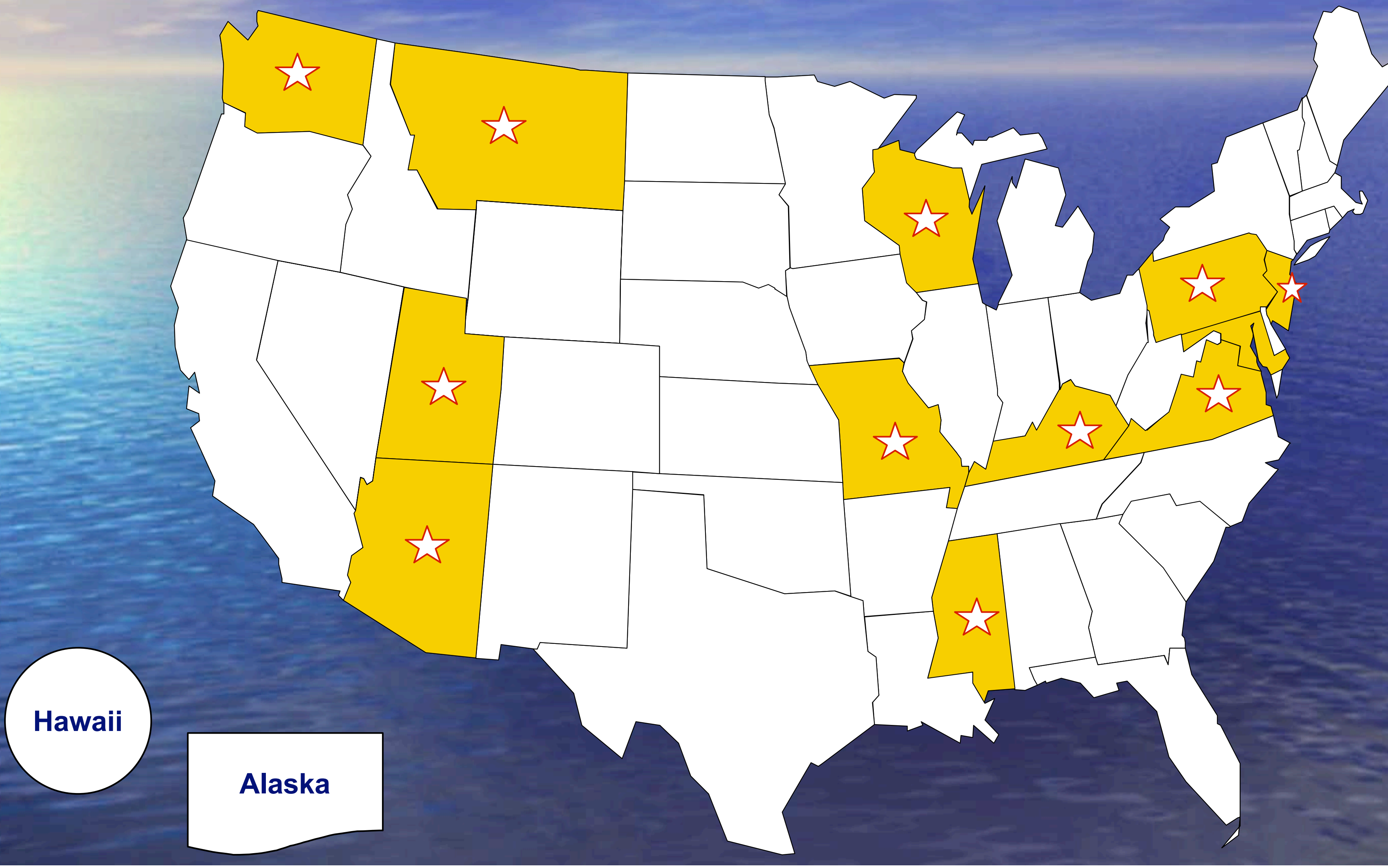
Lead States Group

- Identify States who have implementation plans
- Invite DOTs for First Lead States Group meeting
    - December 13-14, 2004 at TFHRC
    - First topic: implementation plans
- Coordinate with NCHRP/JTF
- DG User Group national meeting planned in March 05

Pooled-Fund Studies

- Budgetary issues

Lead States (based on FHWA Division Office 2003 questionnaire)



Additional Information

NCHRP 1-37A Design Guide User Comments database

http://www.fhwa.dot.gov/pavement/dgitdata.htm

Design Guide Implementation Team

dgit@fhwa.dot.gov

www.fhwa.dot.gov/pavement/dgit.htm

Local Calibration Example for Flexible Pavements

PENNSYLVANIA

Pennsylvania Department of Transportation

PENNDOT

Pennsylvania DOT

Contracted with Pennsylvania Transportation Institute

Collaboration of traffic, materials, & design engineers

Flexible pavement sections constructed in 2001 - 2003

SISSI Project

Long-Range Plan for Using Results from Superpave In-Situ Stress/Strain Investigation for Validation of Mechanistic-Empirical Pavement Design Guide

- Planned budget: $2.4 million
- Life of project: 5 years
  - Renewable for additional 5 years

Cooperation between PennDOT Research & Maintenance/Operations departments

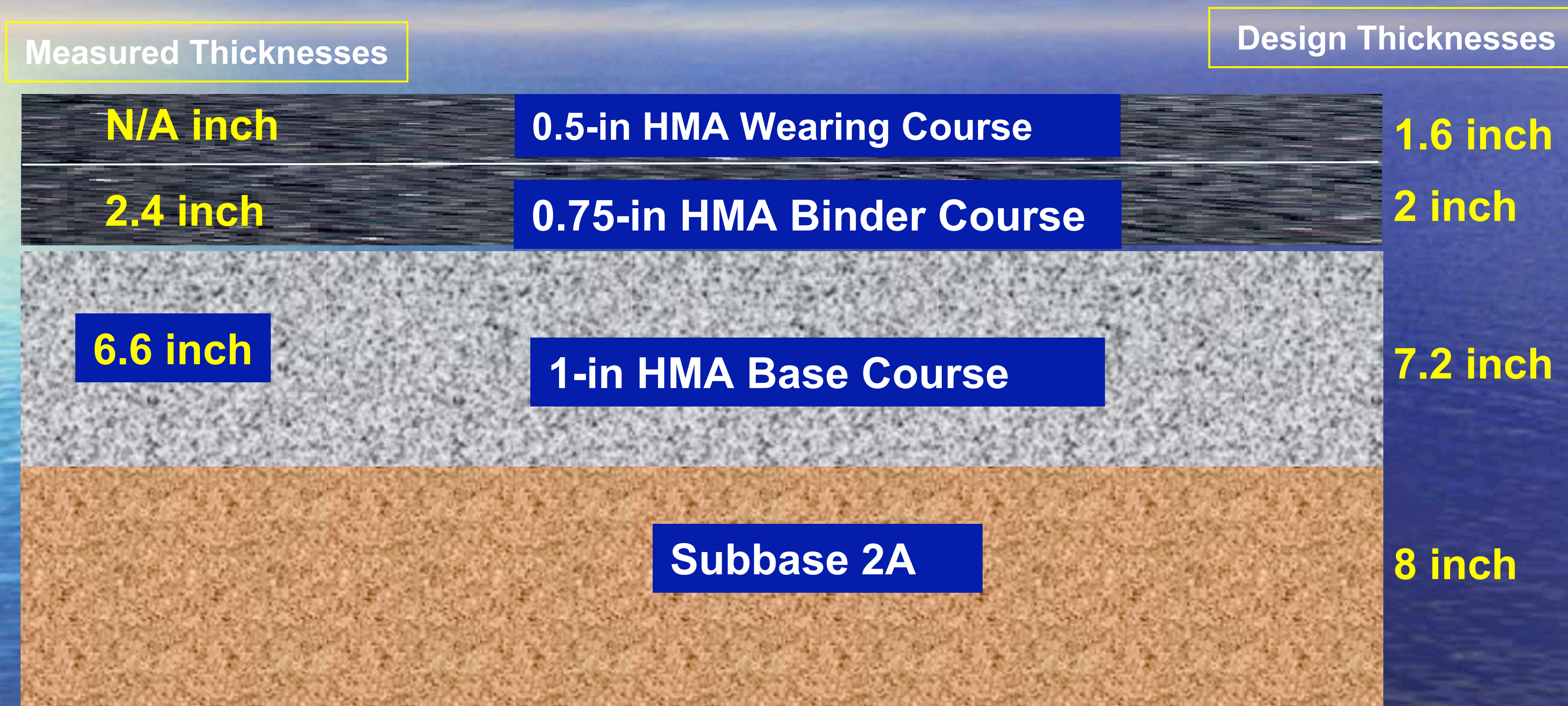
SISSI Project

Objective:

To provide data for validation & regional calibration of new M-E models

- Materials characterization
- Load-response information
- Traffic & environmental data
- Performance measures from Superpave sections

Typical Calibration Section



SISSI
Layer Thicknesses for Blair Plank Road Site

Instrumentation

- Tranducers
  - Temperature profiles, frost depth, moisture
- Pressure cells, Strain gauges, Deflectometers
  - Traffic loading response
  - Pressure on subgrade & subbase layers
  - Tensile strain at bottom of each HMA layer
  - Deflection of each layer
- Data collection stations
  - Weather station → environmental data
  - Weigh-in-motion station → traffic information

Testing for Materials Characterization

Subgrade and Unbound Subbase

Asphalt Binders

Asphalt Mixture

- Volumetric tests
- Mechanistic characterization

Testing for Pavement Response

Falling Weight Deflectometer

Coring

Trench Sections

Weigh-in-Motion

Climatic Database

New Mechanistic Empirical Design Guide

The Pavement designers can

- Create more efficient and cost-effective designs
- Improve design reliability
- Improve rehabilitation design
- Reduce life cycle costs
- Increase support for cost allocation

Thanks!