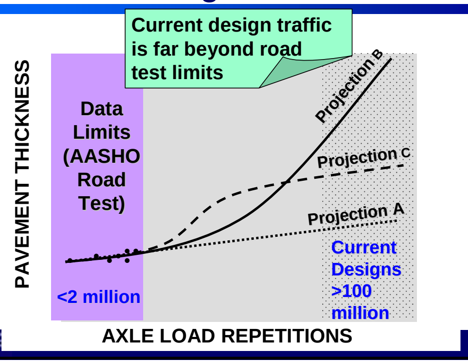
2007 Virginia Concrete Conference

Highlights of the new ME Design Procedure for Concrete Pavements

Mechanistic-Empirical Pavement Design Guide??

- The Design Guide represents a major change in the way we do design. It brings the designer closer to reality and considers traffic, structural features, materials, construction, and climate far more than ever before.
- This means the designer now will be more involved in the design and expected performance of pavements.

Limitations AASHTO Loadings



1972 AASHTO Interim Guide for the Design of Pavement Structures

- *"While the Guides were under evaluation, AASHO initiated research studies within NCHRP for the purpose of developing a more **theoretical or "rational"** method for structural design of highway pavements."*

What's Being Used (2003 survey)

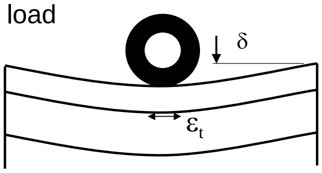
Design Procedures	DOTs
1972 AASHTO Guide	3
1986 AASHTO Guide	2
1993 AASHTO Guide	26
Agency's own pavement design guide or combination of AASHTO/Agency design procedures	17

The "Rational Method" gets a push

- Process initiated by Joint Task Force on Pavements
  - Irvine, California : March 1996
- Development of the 2002 Guide for Design of New and Rehabilitated Pavement Structures
  - NCHRP 1-37A
  - Awarded to ARA : February 1998
  - Product Submitted : February 2004
  - Cost $7 million

What is Mechanistic Design?

- Fundamental Engineering Theories and Material Properties used to calculate critical strains in the pavement due to traffic load



NCHRP 1-37a Product Includes:

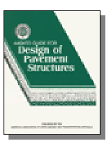
Comprehensive Pavement Design Procedure

Available at:
www.trb.org/mepdg/

Structural Analysis Software

Major Advantages of MEPDG

- Improved traffic characterization
- Ability to deal with changing load types



$ESAL_{18k}$

Load Spectra

Materials

- Enhanced definition of material properties
- Relate material properties to performance
- Material Aging

Layer Coefficient

Modulus

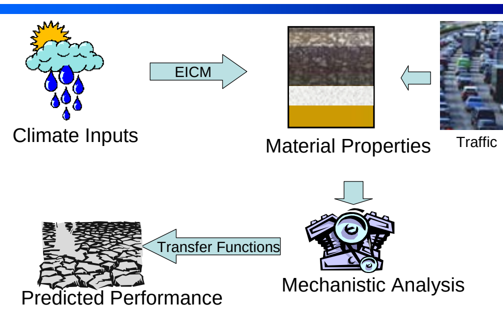
Climate

- Site specific climate considerations
  - Material properties effected by climate
  - PCC Joint openings, Curling / Warping

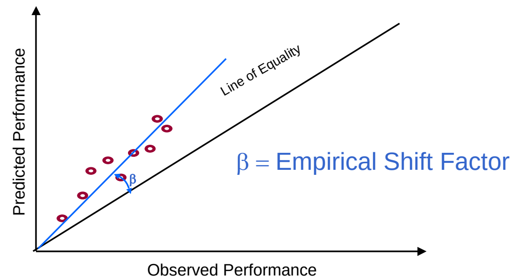
Extrapolated from Ottawa, IL

800 Weather Sites

The Big Picture



Empirical Portion of MEPDG



PCC Pavement Design Types

Design Types	Pavement Types	PCC Property Inputs
New Construction	JPCP, CRCP	New PCC
Restoration	JPCP	Existing PCC
Rehabilitation (BCO/ UBCO)[1]	JPCP, CRCP	New and existing PCC

[1] Bonded Concrete Overlay / Unbonded Concrete Overlay

PCC Rehabilitation

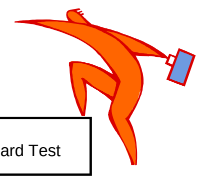
- **Not included in DG**
- CRCP Restoration
- JRCP
- Ultra-thin whitetopping

Levels of Input

Level 1: Project Level Direct Testing

Level 2: Correlation w/ Standard Test

Level 3: Default Data



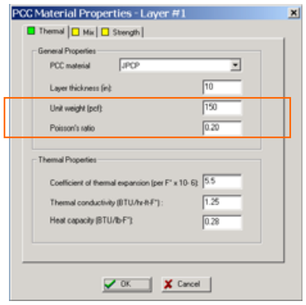
M-E Guide Outputs: Rigid

PCC Material Properties for Design Inputs

- Design Guide requires inputs for PCC material properties in 4 groups
  - General Properties
  - Structural Properties
  - Thermal Properties
  - Shrinkage Properties
- **Input requirements vary with pavement types and design input levels**

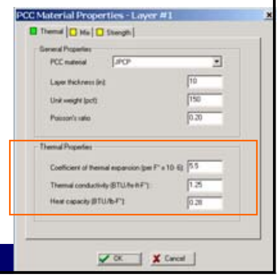
General Properties

- PCC Unit Weight (ρ)
- Poisson's Ratio (ν)



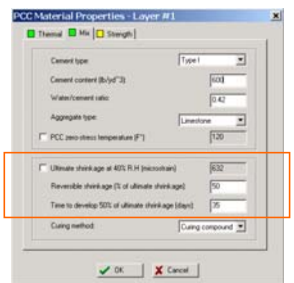
Thermal Properties

- **Coefficient of Thermal Expansion**
- **Other Thermal Properties**
  - **Surface Short-Wave Absorptivity**
  - **Thermal Conductivity**
  - **Heat Capacity**

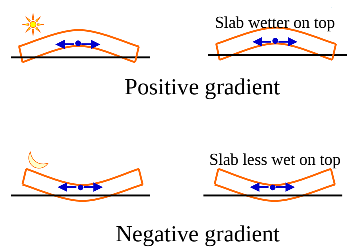


Shrinkage Properties

- **Ultimate Shrinkage**
- **Reversible Shrinkage**
- **Time to develop 50% of Ultimate Shrinkage**

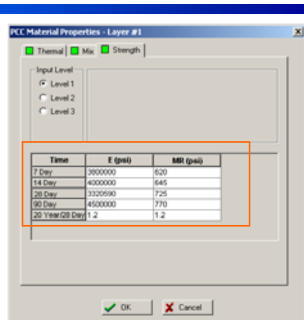


Slab Curling and Warping



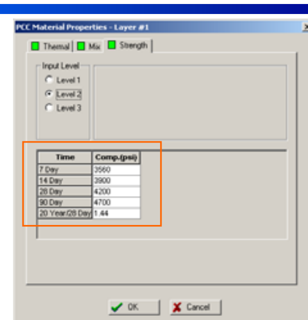
Strength Properties

- **Modulus of Elasticity**
- **Modulus of Rupture**



Strength Properties

- **Compressive Strength**



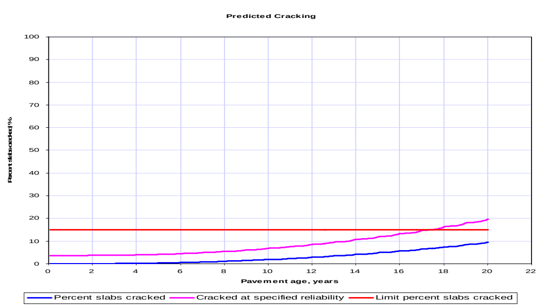
Strength Properties

- **Modulus of Rupture or Compressive Strength to predict Elastic Modulus**

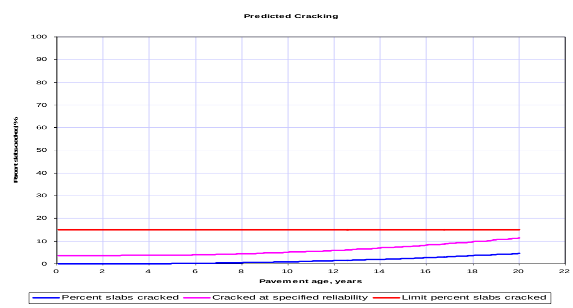
Using MEPDG for Design

- Iterative Process
- Use one or more distress predictions for failure criteria
- State specific guidance is necessary
  - Pavement Design Manual
  - Distress criteria and limits
  - Design parameters to change
- Do not throw out past experience

Inadequate Design



Adequate Design



Local Calibration for States

Do standards & materials differ from LTPP?

- Yes – Re-calibrate
- No – Confirm national results

How?

- Database of materials properties (confirm level 2 inputs)
- Database of default values (confirm level 3 inputs)
- Use LTPP as a starting point
- Add performance data available in the local area

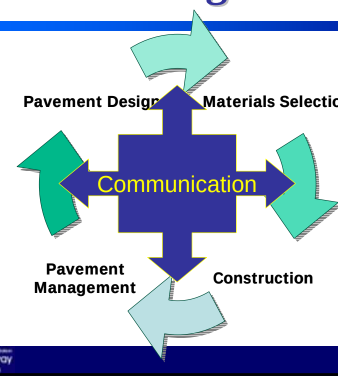
Using MEPDG for Design

- Develop catalog of input values or files
- Guidance on use of Default values
  - Is it important ?
  - Can I test it ?
  - Will I test it ?
- Design catalogs are an option
- Have a in-house expert

Major Advantages

- Modular system that allows for incremental enhancement
- Produces a more reliable design
- No longer dependent on the extrapolation of out-dated empirical relationships
- Excellent for forensic analysis
  - Answers “What if….” questions

Integration



Connection to Innovative Contracting

- Warranty
- Performance Related Specifications
- LCCA
- Design / Build
- Dispute Resolution Analysis

Longer Term Goals

Things to remember

- All pavement design systems need:
  - Quality Materials Characterization
  - Quality Traffic Data
  - Calibrated to local conditions
- The MEPDG is one tool for a designer
  - Focused on the structural design aspects
  - Has limitations

Questions

- www.trb.org/mepdg
- www.fhwa.dot.gov/pavement

Gary Crawford

Federal Highway Administration

(202) 366-1286

gary.crawford@dot.gov