AASHTOWare Pavement ME Design™ Update

Linda Pierce, NCE
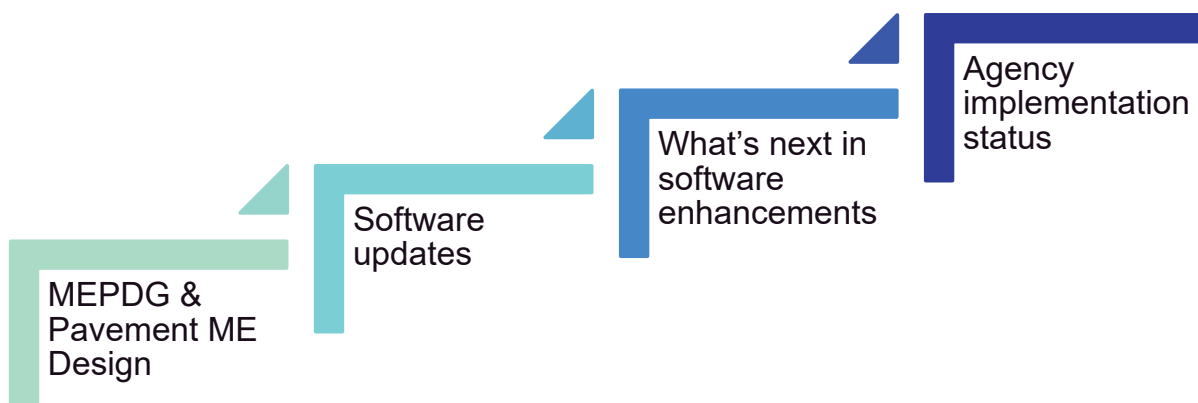
57th Annual Idaho Asphalt Conference

Moscow, ID
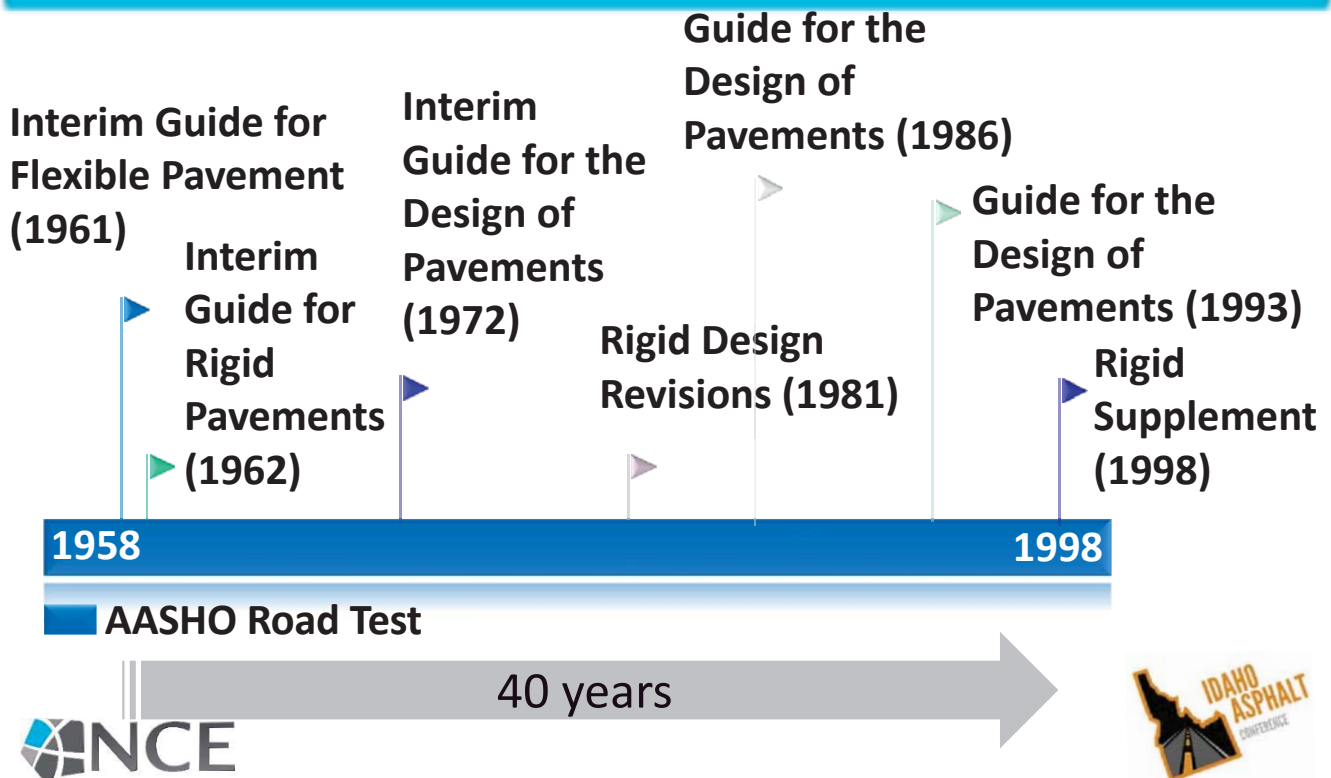
October 26, 2017

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Discussion Topics

MEPDG & Pavement ME Design

Software updates

What's next in software enhancements

Agency implementation status

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AASHO/AASHTO Pavement Design

Interim Guide for Flexible Pavement (1961)

Interim Guide for Rigid Pavements (1962)

Interim Guide for the Design of Pavements (1972)

Guide for the Design of Pavements (1986)

Rigid Design Revisions (1981)

Guide for the Design of Pavements (1993)

Rigid Supplement (1998)

1958   1998

■ AASHO Road Test

40 years
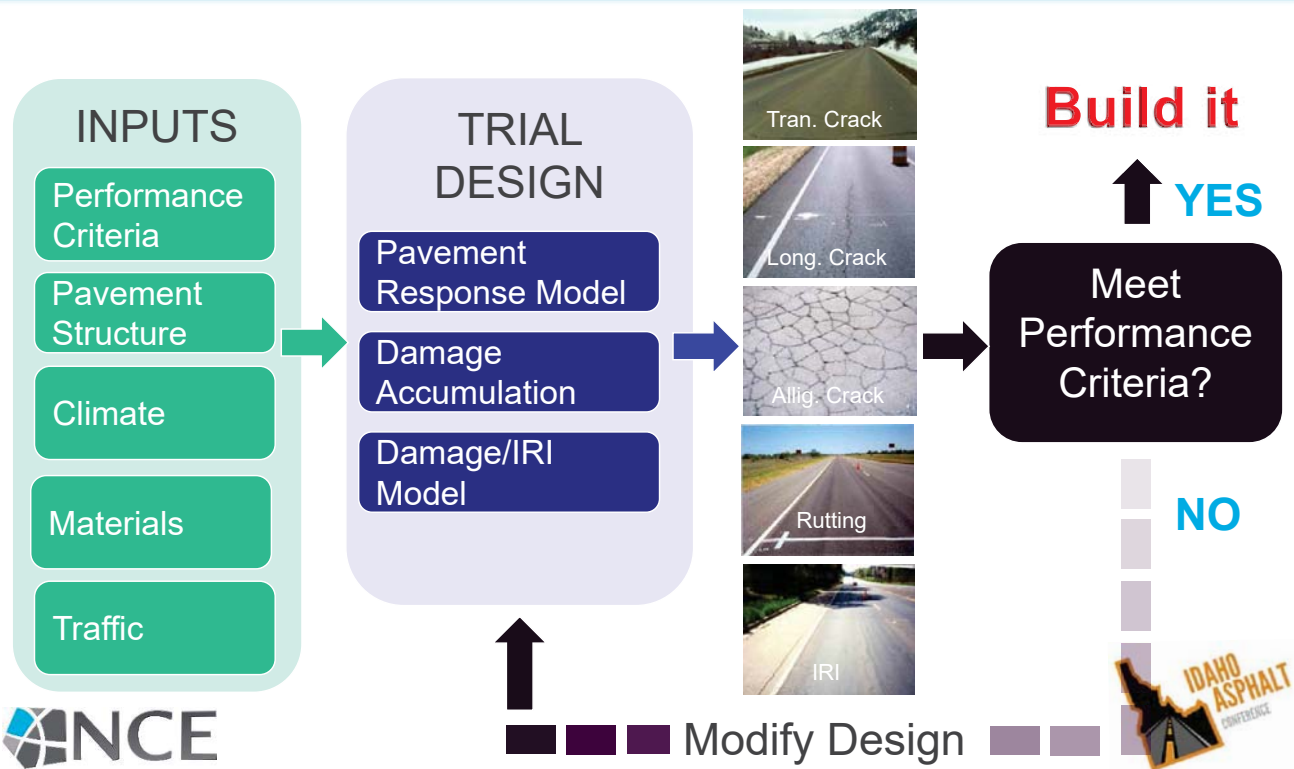
NCHRP 1-37A

- 1998-2004
- Develop guide & software
- New & rehabilitated pavements
- Mechanistic-empirical based models
- Similar inputs
  - Traffic
  - Climate
  - Materials

➡ Estimate damage & predict performance

Design/Analysis Overview

Pavement Types

- Asphalt
  - New construction
  - Asphalt overlay
  - Concrete overlay
- Semi-Rigid
  - New asphalt over chemically stabilized base
  - Asphalt overlay

- Rigid
  - New jointed plain
  - New continuously reinforced
  - Asphalt overlay
  - Concrete overlay
    - o Bonded
    - o Unbonded
    - o Short jointed

Hierarchical Input Levels

- ## Level 1
  - Based on measured values
- ## Level 2
  - Limited test results & correlations
- ## Level 3
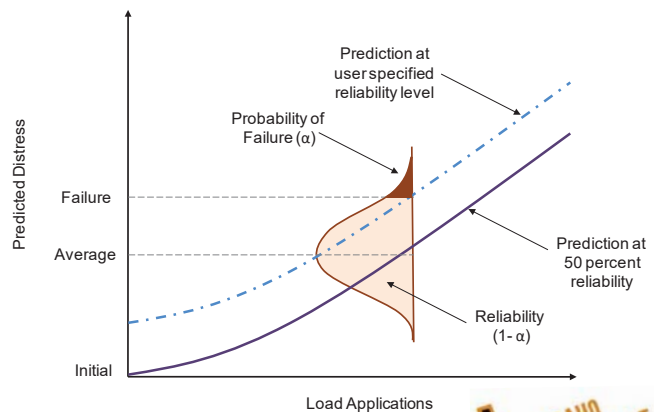 - Regional averages or expert opinion

**Analysis is the same
regardless of input level**

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Reliability

Probability that the predicted distress will be less than the critical distress over the design period

Functional Class	Urban	Rural
Interstate	95	95
Principal Arterial	90	85
Collector	80	75
Local	75	70

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Traffic Characterization

- Axle load spectra
  - Class 4+ vehicles
  - Axle configuration
  - Axle weight
- Data collection
  - Weigh-in-Motion
  - Automated Vehicle Classification
  - Vehicle Count

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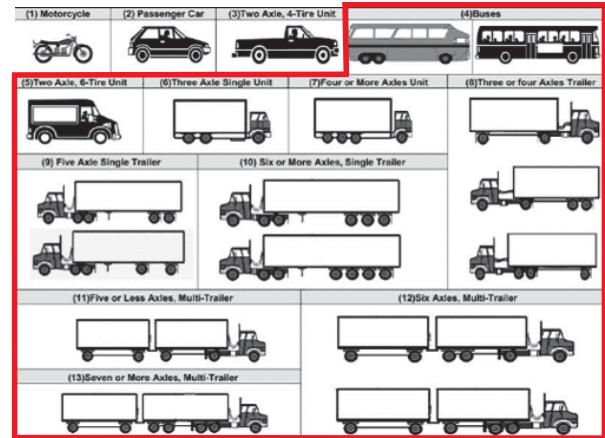
Asphalt Materials

- Layer thickness
- Air voids
- Effective binder content
- Poisson's ratio
- Unit weight
- Binder type
  - PG, viscosity, or penetration grade

- Creep compliance
- Dynamic modulus
- Reference temperature
- Indirect tensile strength
  - Correlated (level 3)
- Heat capacity
- Thermal conductivity

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Input Levels 1-3

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Concrete Materials

- Thickness
- Poisson's ratio
- Unit weight
- Coefficient of thermal expansion
- Heat capacity
- Thermal conductivity
- Aggregate type

- Cementitious content
- Cement type
- Water/cement ratio
- Curing method
- Reversible shrinkage
- Zero-stress temp.
- Time 50% shrinkage
- Ultimate shrinkage
- Strength

  Input Levels 1-3

Base Material Types

- Asphalt
- Concrete
- Chemically stabilized
  - Cement
  - Lime cement
  - Lime fly ash
  - Lime stabilized
  - Soil cement

- Sandwiched granular
- Non-stabilized
  - A-1-a to A-3
  - RAP (plant & in-place)
  - Crushed gravel
  - Crushed stone
  - Permeable aggregate
  - River-run gravel

Base Materials

- Thickness
- Poisson's ratio
- Coefficient of lateral earth pressure
- Resilient modulus
- Gradation
- Plasticity Index
- Liquid Limit

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Foundation

Type

- Subgrade
  - A-1-a to A-7-6
- Bedrock
  - Highly fractured & weathered
  - Massive continuous

Inputs

- Thickness
- Poisson's ratio
- Coefficient of lateral earth pressure
- Resilient modulus
- Gradation, PI, PL

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Climate

- Temperature
  - Asphalt
    - o Fatigue cracking, thermal cracking, & rutting
  - Concrete
    - o Slab cracking & faulting (JPCP) & punchouts (CRCP)
- Freeze/Thaw
  - JPCP performance

- Relative Humidity
  - Moisture gradients JPCP & CRCP
- Seasonal Variation
  - Resilient modulus
- Moisture Content
  - Rutting unbound layers

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Performance Prediction

- Predict performance at any point in time

- Asphalt
  - IRI
  - Rutting
  - Cracking
- Semi-Rigid
  - IRI
  - Rutting
  - Cracking

Top down
Fatigue
Thermal
Reflection

- Plain Jointed Concrete
  - IRI
  - Slab cracking
  - Faulting
- Continuously Reinforced Concrete
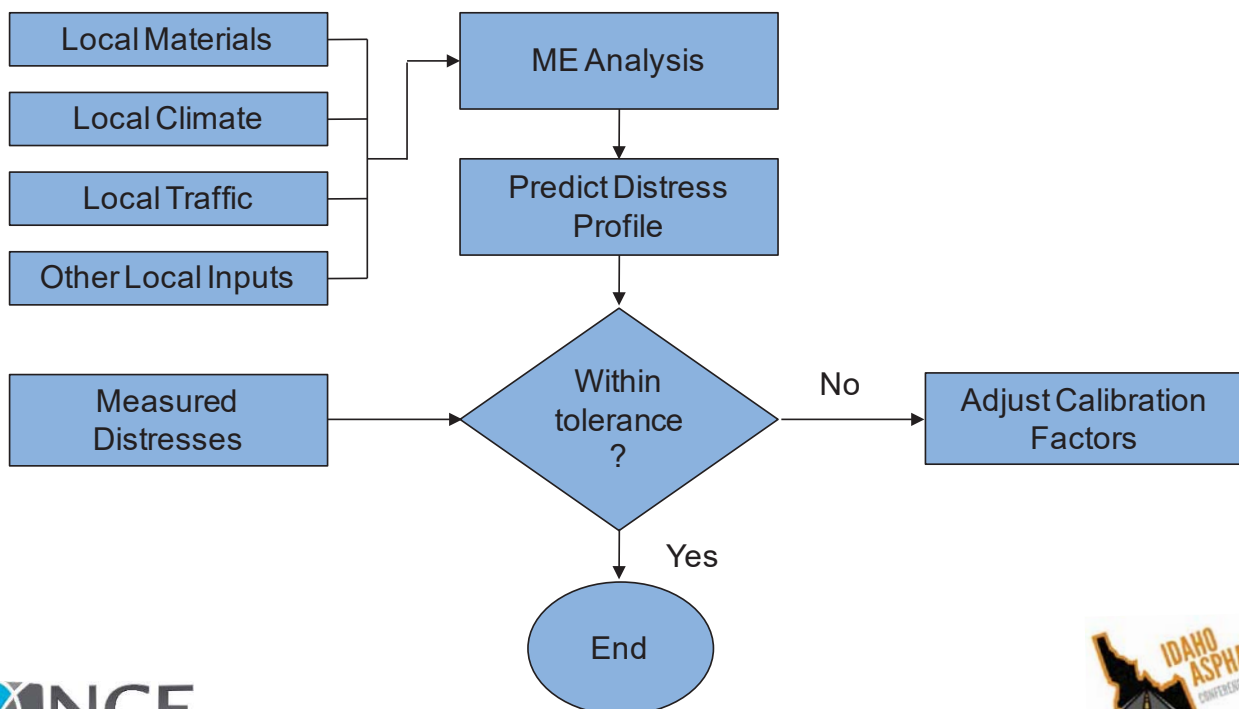 - IRI
  - Punchouts

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Characterizing Existing

- Pavement condition surveys
- Core samples
    - condition, thickness, material testing
- Soil borings
    - Subgrade modulus, depth to stiff layer
- Other
    - Ground penetrating radar, seismic analysis of surface waves, impact echo
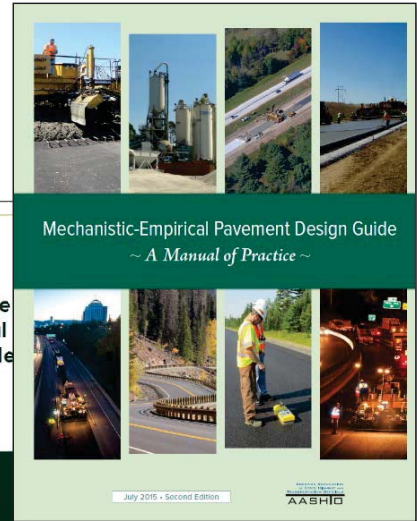
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Local Calibration

AASHTO Products

- Manual of Practice
- Calibration Guide
- Software

Software Updates

- 2015 (v2.2)
  - **D**rainage **R**equirements **i**n **P**avements
  - MapME
  - Level 1, 2, & 3 inputs applicable for PCC & AC overlays of asphalt pavements
  - Reflection cracking model
  - Concrete pavement global re-calibration
  - Plastic deformation for each asphalt layer

Software Updates (continued)

- 2016 (v2.3)
    - Code modernization & review
    - Technical audit
    - Bonded concrete overlay design
    - **N**orth **A**merican **R**egional **R**e-analysis climate database
        o 1083 locations
        o 37 years continuous data

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Software Updates (continued)

- 2017 (v2.4)
    - Correct unbound layer rutting model
    - Backcalculation tool
        o Pre-processing
        o Stiffness value determination
        o Post processing results
    - Revisions based on technical audit

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Software Updates (continued)

- January 2018 (v2.5)
  - *Manual of Practice* integration
  - Tran. crack access to inputs/outputs
  - Access to dynamic modulus calculations
  - **M**odern-**E**ra **R**etrospective **A**nalysis for **R**esearch & **A**pplications data
    - ○ Continuous hourly estimate of all climate-related data (NASA)
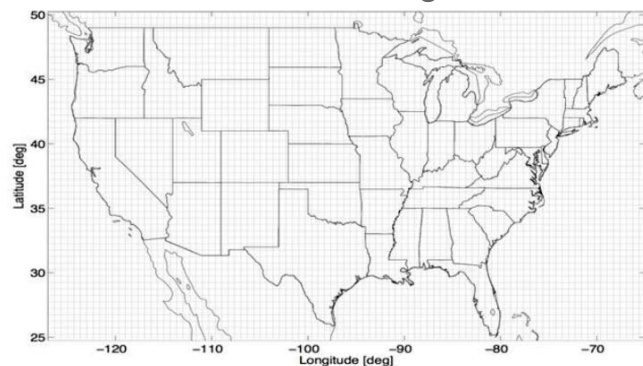 - Re-calibrate flexible & semi-rigid models

LTPP vs MERRA

PaveME weather database

MERRA grid points
31 mi x 37 mi grid

Software Updates *(continued)*

- July 2018 (v2.6)
  - Report customization
  - Input comparison filter tool
  - Maintenance strategy tool
  - Level 1 tensile strength
    - Transverse crack prediction

Asphalt Pavements
Cold milling
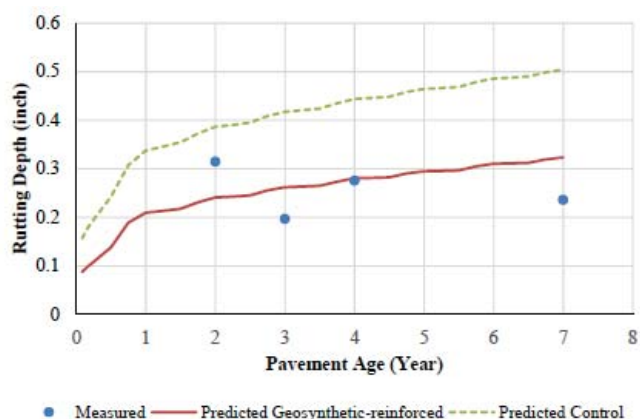Microsurfacing
Thin/ultra thin overlays
Hot in-place recycling

Concrete Pavements
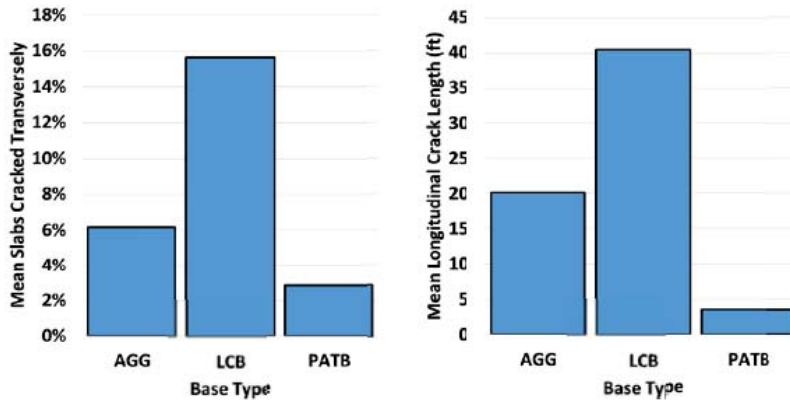Diamond grinding
Thin/ultra thin overlays

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What's Next?

- Influence of Geosynthetics on Pavement Performance (NCHRP 1-50)
  - Unbound base layers
  - Planned for **FY 2019**

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What's Next? *(continued)*

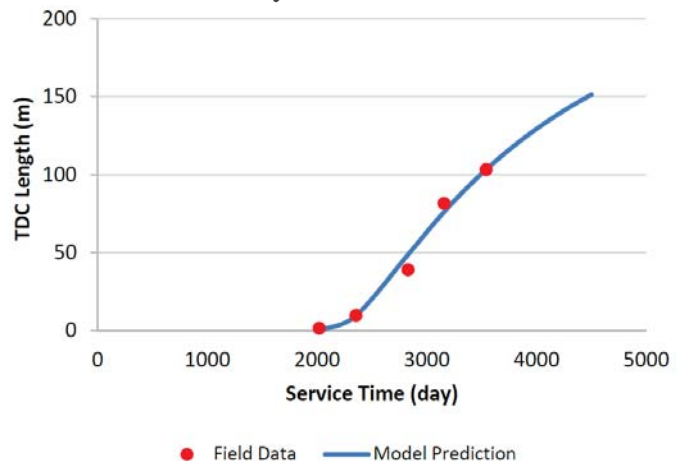- Slab/Underlying Layer Interaction in Concrete Pavements (NCHRP 1-51)

  – Planned for **FY 2019**
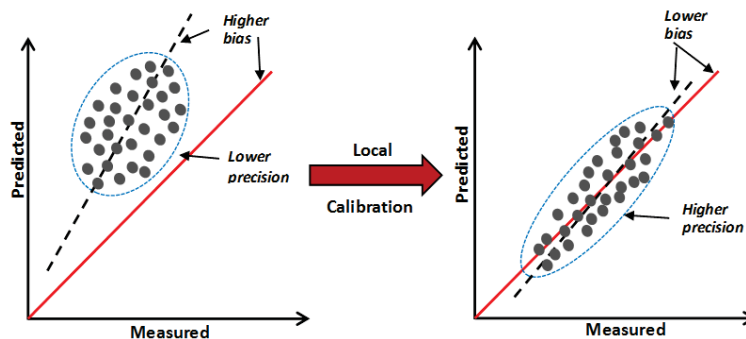
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What's Next? *(continued)*

- Top-Down Cracking in Asphalt Pavements (NCHRP 1-52)

  – Anticipated completion by end of 2017
  – Planned for **FY 2019**

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What's Next? (continued)

- ## Automated Local Calibration Tool
  - ### Significant agency challenge (time & $)
    - ○ Section selection and data assembly
    - ○ Potentially thousands of software iterations
  - ### Planned for **FY 2019**

What's Next? (continued)

- ## Material Properties of CIP & Full-Depth Reclamation (NCHRP 9-51)
  - ### Software **Addendum** planned after release of final report
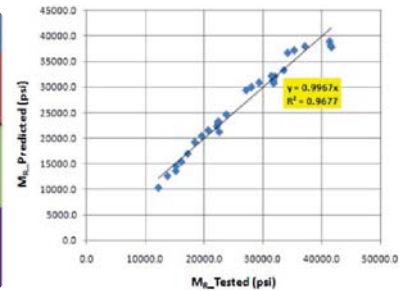

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What's Next? *(continued)*

- Influence of Subgrade/Unbound Layers (NCHRP 1-53)
  - Anticipated completion June 2018
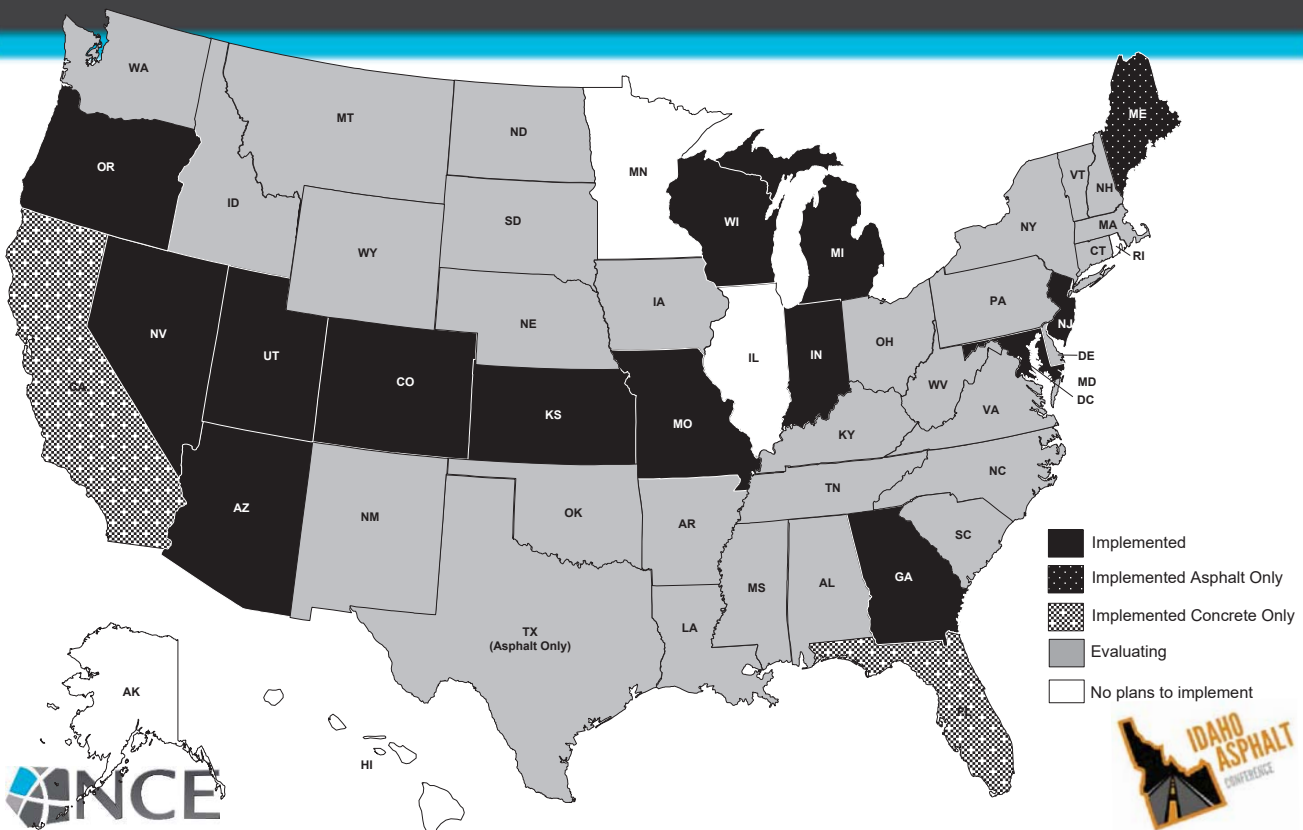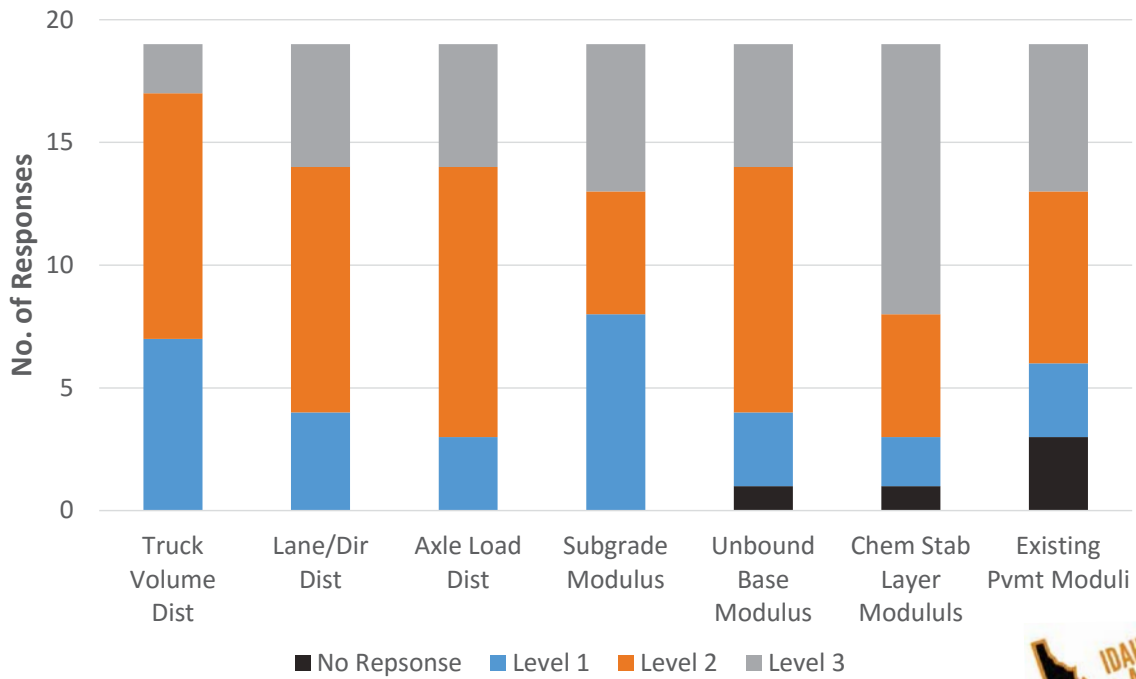 - Planned for **FY 2020**

Testing

Existing Pavements

Property

Implementation Status

Implemented
Implemented Asphalt Only
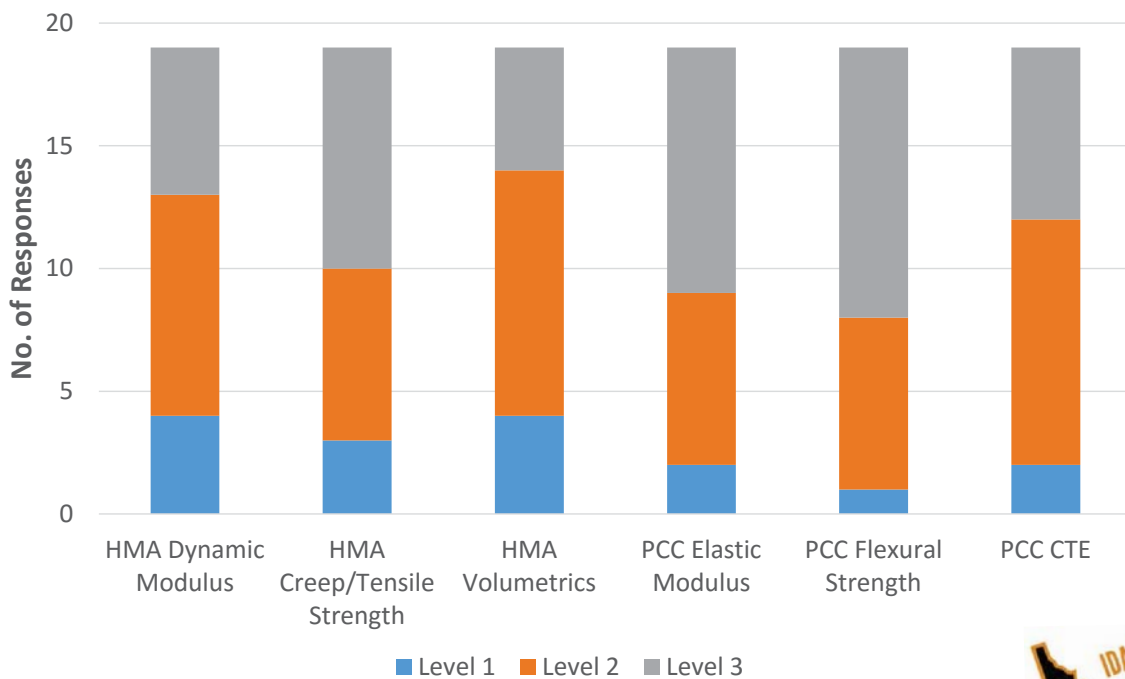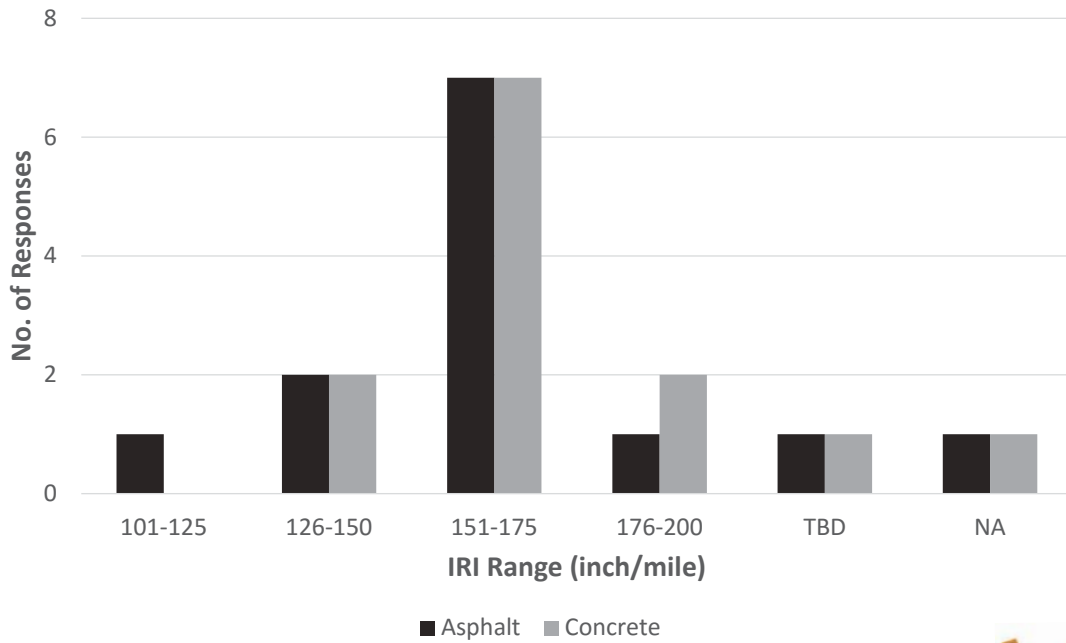Implemented Concrete Only
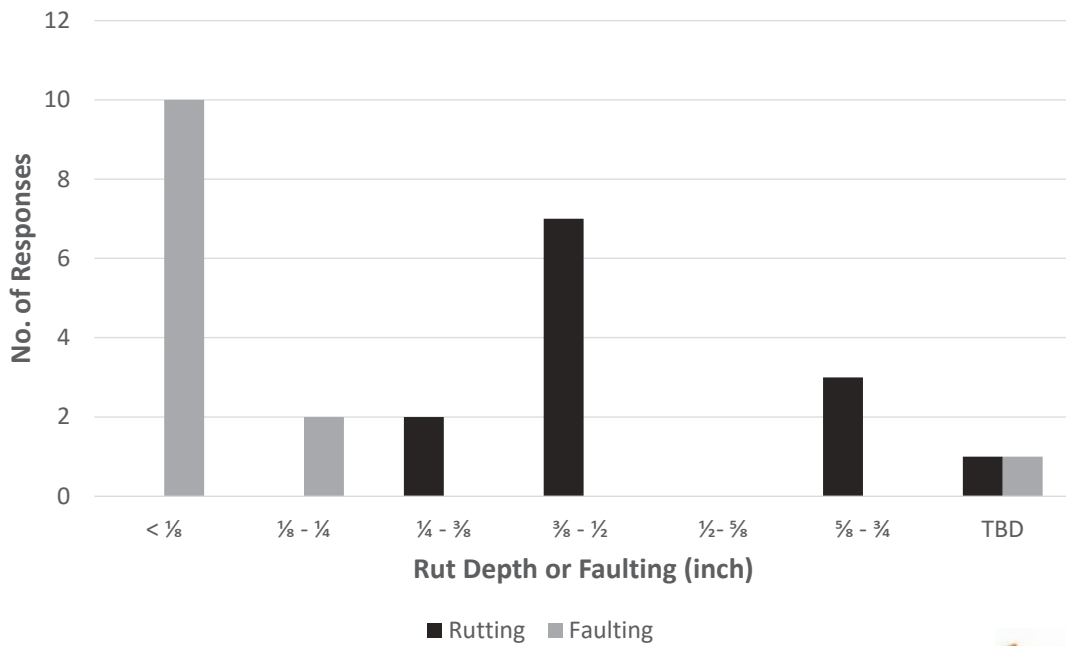Evaluating
No plans to implement

Input Levels

Input Levels *(continued)*

Performance Thresholds

Thresholds (continued)

Thresholds *(continued)*

Bar chart: No. of Responses vs Rut Depth or Faulting (inch). Legend: Rutting (black), Faulting (gray).

- < ⅛: Faulting 10
- ⅛ - ¼: Faulting 2
- ¼ - ⅜: Rutting 2
- ⅜ - ½: Rutting 7
- ½ - ⅝: (none)
- ⅝ - ¾: Rutting 3
- TBD: Rutting 1, Faulting 1

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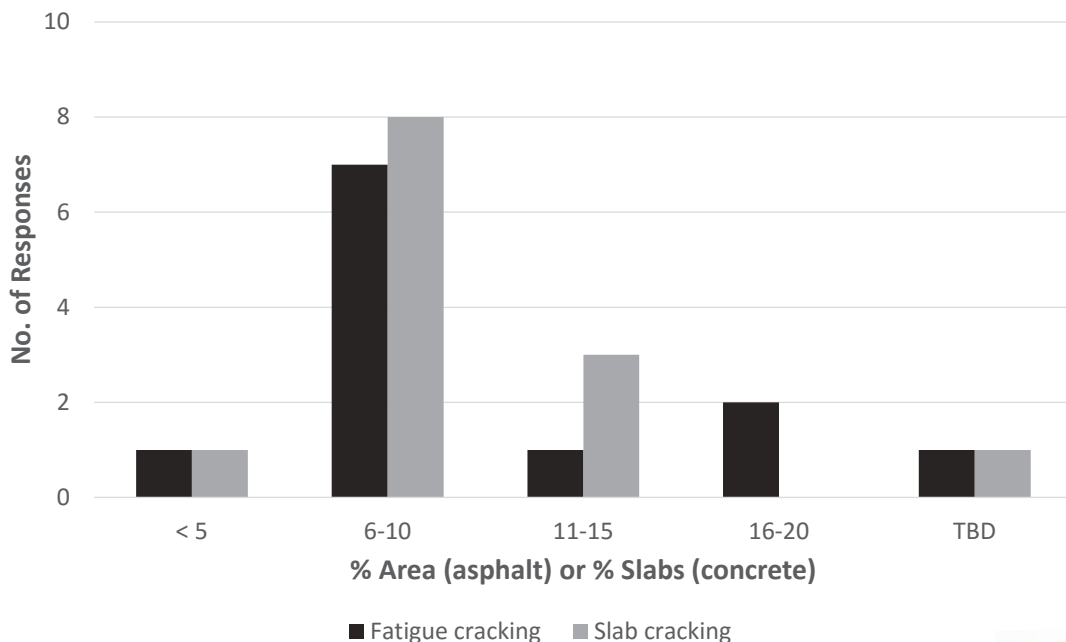
Implementation Challenges

- Local calibration
- Designing pavements with features not included or have not been calibrated
- Material characterization (all layers)
- Traffic characterization
- Availability of performance data to verify/calibrate prediction models

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User Group Meeting

- FHWA Transportation Pooled Fund
  - Conduct meetings
    - o Information sharing
    - o Identify implementation issues
    - o Identify research needs
    - o Organize regional/national implementation efforts

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User Group Meeting (continued)

- Annual Meeting Dates
  1. December 14-15, 2016 - Indianapolis
  2. October 11-12, 2017 - Denver
  3. Sep/Oct/Nov 2018 - Nashville

  http://www.pooledfund.org/
  Details/Study/549

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Questions?

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