


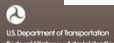








### Challenges with PRS

- Testing efficiency and simplicity
  - Completed/Continuous
- Standardization of test methods
  - Ongoing
- Reliability of performance prediction models
  - Complete
- Performance volumetric relationships
  - Ongoing
- Same principles and methods between mix design and PRS
  - Ongoing


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### Standardization of Test Methods

FULL SIZE SPECIMEN	SMALL SIZE SPECIMEN
Specimen Prep AASHTO R 83	Specimen Prep AASHTO PP XXX
Dynamic Modulus AASHTO T 378	Dynamic Modulus AASHTO TP XXX
Cyclic Fatigue AASHTO TP 107	Cyclic Fatigue AASHTO TP XXX
Stress Sweep Rutting AASHTO TP XXX	

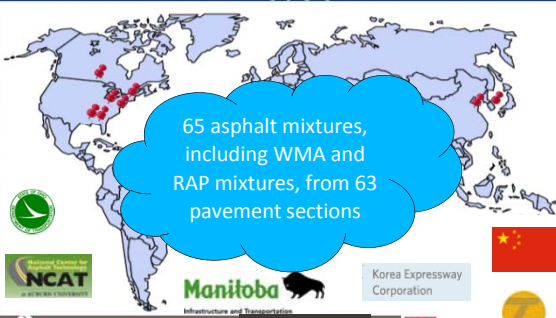






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### Reliability of Performance Prediction Models

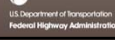


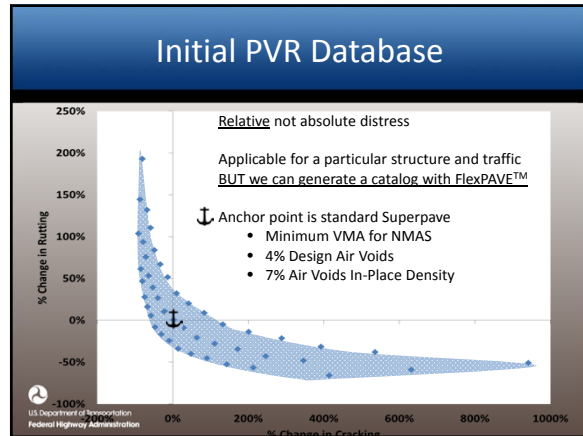







### Performance Volumetric Relationships (PVR)

- Predict as-built performance
  - Without performance testing
- Database developed at TFHRC
- Expansion underway in shadow projects
  - Will use plant-produced variations
- Agency and contractor guidance for planning purposes





- ### AASHTOWare Pavement ME-FlexPAVE™ Compatibility
- Graphical user interfaces similar
  - Same climate, traffic inputs
  - AASHTO TP 107 results proven to be compatible with K1, K2, K3 fatigue coefficients
  - AASHTO T 378 ( $|E^*|$ ) remains critical input
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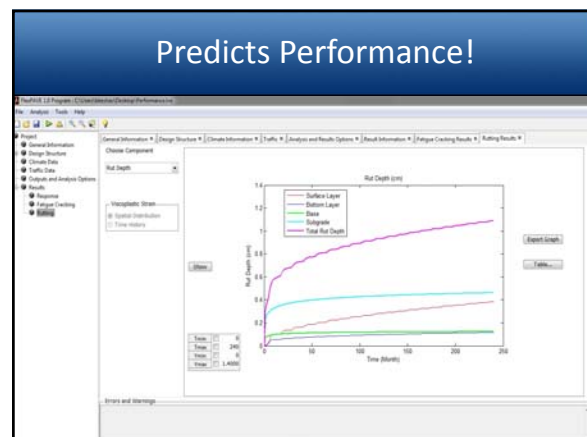
- ### FlexMAT™ and FlexPAVE™ Available
- FlexMAT™ – Excel spreadsheet
    - Analyzes cyclic fatigue,  $|E^*|$ , and SSR data
    - Import files directly
    - Output → FlexPAVE™
  - FlexPAVE™ – performance prediction tool
    - PEMD through acceptance
    - Simulate as-design and as-built performance
- US Department of Transportation  
Federal Highway Administration

### FlexMAT™

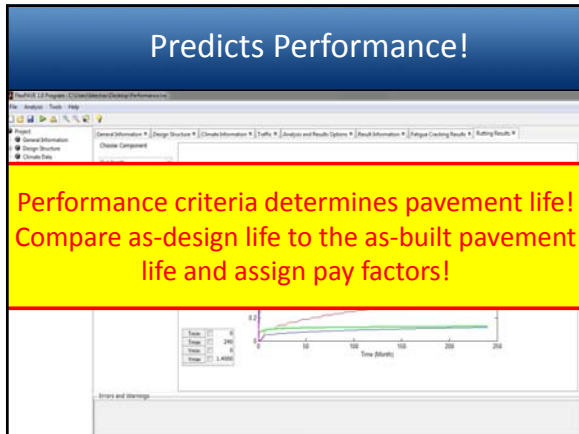
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### FlexPAVE™

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### Predicts Performance!



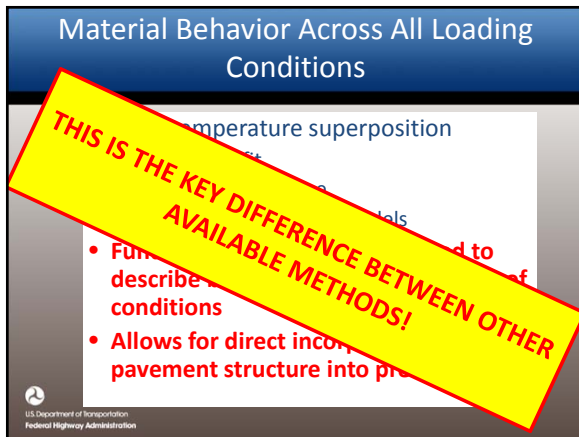
**Performance criteria determines pavement life!  
Compare as-design life to the as-built pavement life and assign pay factors!**

### Material Behavior Across All Loading Conditions

- Time-temperature superposition
  - Major benefit
  - Reduces testing time/specimens
  - Enables robustness of models
- **Fundamental properties required to describe behavior across wide-range of conditions**
- **Allows for direct incorporation of pavement structure into predictions**

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### Material Behavior Across All Loading Conditions



**THIS IS THE KEY DIFFERENCE BETWEEN OTHER AVAILABLE METHODS!**

- **Fundamental properties required to describe behavior across wide-range of conditions**
- **Allows for direct incorporation of pavement structure into predictions**

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### FHWA Shadow PRS Program

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### How Will This All Work?

- DOT determines project(s)
- Develop sampling plan with FHWA, NC St., ARA
  - 10 plant-produced samples (only in shadow)
  - Proficiency sample (1 project only)
  - Mix design replication sample
- Training before AMPT testing begins
- Volumetric testing as normally done
- AMPT testing whenever DOT has time

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### Shadow PRS Status


- Maryland SHA – Underway (10 projects)
- Maine DOT – Sampled
- Missouri DOT – Sampled 3 projects
- Ontario MOT – Sampled
- Western Federal Lands – 1<sup>st</sup> project complete, 2<sup>nd</sup> ongoing
  - “Desktop study” also complete

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Office of Asset Management,  
Pavements, & Construction

### Asphalt Technology Guidance Program (ATGP)



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*Long-Life Asphalt Pavement for the 21<sup>st</sup> Century*

## Thank you!

- Questions?
- Contact information
  - 202.366.1286
  - [david.mensching@dot.gov](mailto:david.mensching@dot.gov)

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### Same Principles and Methods in Design and PRS

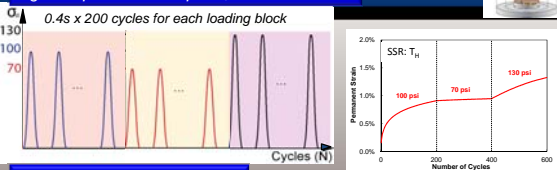
- Testing is conducted at mix design phase
- Run predictions to establish as-design pavement life
- Same principles present
  - Prediction using cyclic fatigue and shift models
  - Pay factors assigned on a life difference

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### Stress Sweep Rutting (SSR) Test

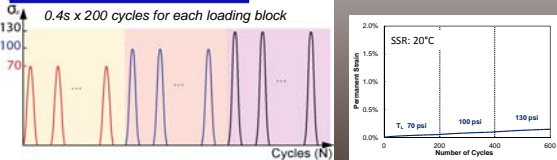
High Temperature: 0.4s pulse, 3.6s rest

0.4s x 200 cycles for each loading block



20°C: 0.4s pulse, 1.6s rest

0.4s x 200 cycles for each loading block



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### SSR Test

- Draft procedure ready for consideration by AASHTO
- FlexMAT™-Rutting available
  - Single tab spreadsheet
- Confined testing (10 psi)
- 1 day to complete all replicates
- **Model predicts permanent deformation at all loading conditions!**

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### AMPT Cyclic Fatigue

- Fundamental, repeated loading test
- Direct tension (pull-pull)
- Small-specimen testing available (AASHTO TP xxx)
- AASHTO TP 107 – revisions out for ballot!
- **Material behavior across all possible loading conditions!**

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### Field Validation of AMPT Cyclic Fatigue

- Pavement prediction software built from models
- Field validation
  - 59 mixtures
  - 55 different pavement structures
- Develop laboratory-to-field transfer functions
- **Volumetrics have a seat at the table!**

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### Ruggedness, Precision, and Bias

- AASHTO T 378 |E\*| – Complete!
- AASHTO TP 107 – Ruggedness and precision and bias underway
- Small-specimen cyclic fatigue – Ruggedness and precision and bias underway
- Small-specimen |E\*| – coming soon

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### Standard Sample Preparation

- Cylindrical specimens
  - AASHTO R 83 for full-size
  - Draft procedure ready for small-size
- Equipment required
  - Superpave gyratory compactor and molds
  - Core drill (bits depend on specimen size)
  - Wet saw
  - Water bath or other device (for Gmb)
  - Engineering square, piano wire

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### AMPT + Performance Prediction

✓ Structure ✓ Traffic ✓ Climate

Predicted Rutting  
Predicted Cracking

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### AMPT Cyclic Fatigue Process

**Preparation**

- Cylindrical specimen - 100 mm x 130 mm
- Small-specimen: 38 mm x 110 mm
- End plate gluing, clamp system being explored
- 2-3 days for mix

**Testing**

- Dynamic modulus fingerprint for specimen variability
- Pull-pull fatigue test
- Strain level based on TFHRC database
- Test temperature based on location of interest
- Load until crack forms
- 1-2 days for mix

**Analysis**

- AMPT automatically captures data for analysis
- Calculate damage via FlexMAT or FlexPAVE
- Assign mixture rankings or use FlexPAVE
- 1-2 hours for mix

About one week per mixture...worth it when considering the cost of premature failure?

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### Advantages of AMPT Cyclic Fatigue

- Standard sample preparation
- AASHTOWare Pavement ME compatible
- Ruggedness, precision and bias underway
- FlexMAT™ & FlexPAVE™ available
- Predicts performance!
- **Material behavior across all possible loading/temperature conditions!**

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## Two Major Tasks for DOT

- Accept 'shadow' mixtures based on the performance engineered mix design (PEMD) approach
- Collect volumetric-based acceptance quality characteristics (AQC's) during construction (PASSFlex™)
  - These would be used to determine hypothetical contractor pay



## Material Testing

- Proficiency Testing
  - Ensure repeatable results with separate laboratory AMPT
  - Only done on first shadow project
- PEMD Testing
  - Baseline for the as-designed condition
  - Needed in design phase of each project
- Production Testing with AMPT (Shadow only)
  - Establish PVR
- Production Testing with Volumetrics



## What Will a DOT Get Out of Shadow Project Participation?

- Understanding concept of PRS
  - Understanding pavement fatigue and rutting using fundamental test procedures
  - Pavement performance as function of AQC's
  - Construction Acceptance
- AMPT training
  - ARA, NCSU, & FHWA will work with State Agency to determine the best solution for training. The FHWA-MATT provides opportunities for DOTs to look over the shoulder of its personnel when testing for performance.
- PRS Software training and analysis support
- Potential for FHWA project funding support
- Potential for Mobile Asphalt Testing Trailer support

