Performance-Related Specifications: Integration of the Asphalt Mixture Performance Tester (AMPT)

U.S. Department of Transportation
Federal Highway Administration

Acknowledgements

- Headquarters - Office of Asset Management, Pavement, and Construction
- Turner-Fairbank Highway Research Center - Office of Infrastructure Research and Development
- Resource Center - Office of Technical Services

Background

- Owner agencies short on funding
  - Need more pavement life
  - Less rehab
  - More “bang for buck”
- MAP-21 introduced performance-based administering of federal funds
  - FHWA established measures for States to set own targets

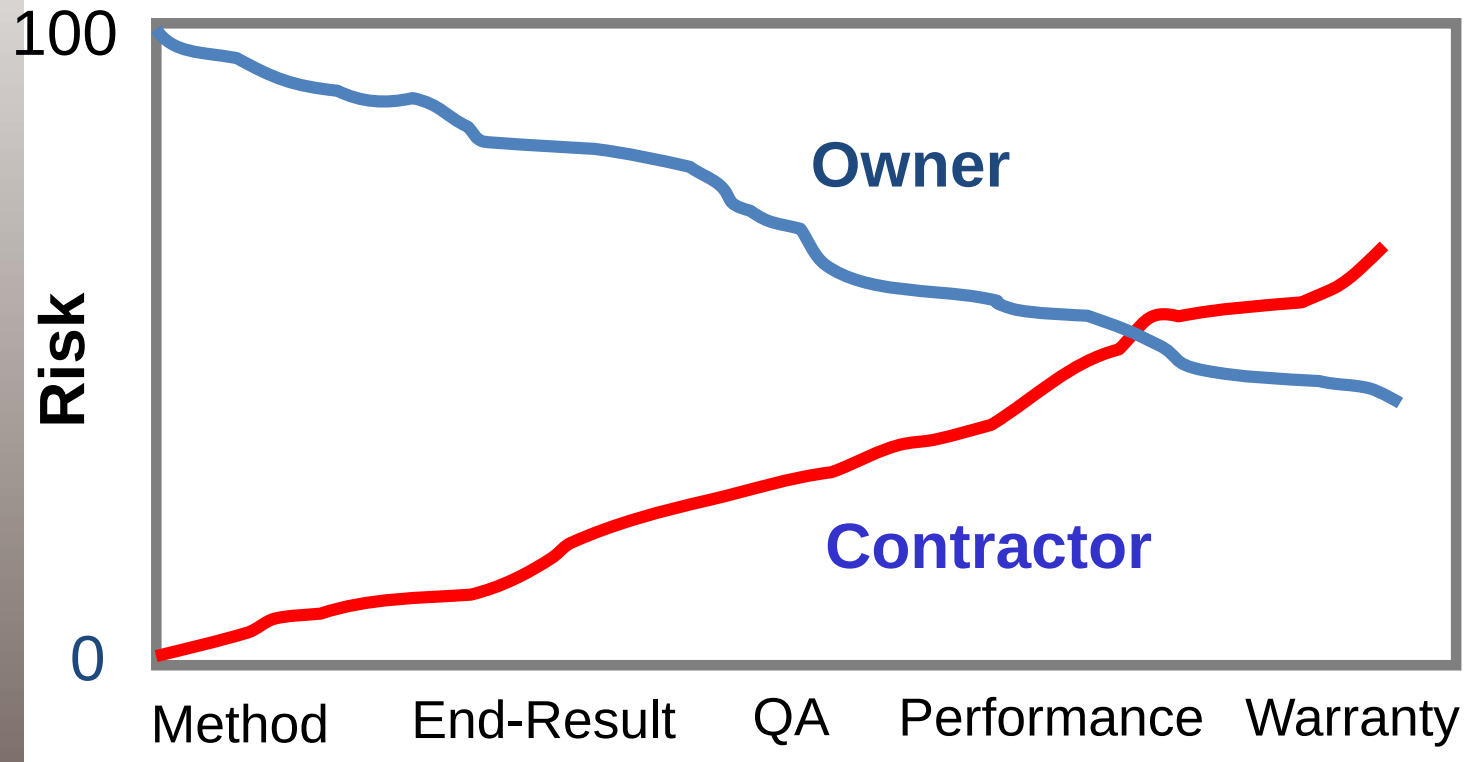
Two Questions

- How can I extend pavement life?
  - Specification development/targets
  - Exceeding performance thresholds
  - Optimizing asset management plan
- How can I measure performance upfront?
  - Effect of RAP, WMA, etc., and pavement structure
  - Laboratory testing and conditioning
    - Fundamental
    - Index-based

AMPT – Addressing a Need

- Late 1980s-Early 1990s: Strategic Highway Research Program
  - Superpave mixture design approach
  - Performance grade binders
  - But no viable performance tests for mixture
- National Cooperative Highway Research Program
  - 9-19: Identify simple performance tests for Superpave (rutting, fatigue)
    - Dynamic modulus, flow number, flow time
  - 9-29: Produce test methods and prototype, conduct ruggedness and interlaboratory studies
    - Simple Performance Tester (now known as AMPT) was born!

Continuum of Specifications



Performance-Related Specifications (PRS)

"QA specifications that describe the desired levels of key materials and construction quality characteristics that have been found to ***correlate with fundamental engineering properties that predict performance****"*

Transportation Research Circular Number E-C137
Glossary of Highway Quality Assurance Terms

How PRS Works

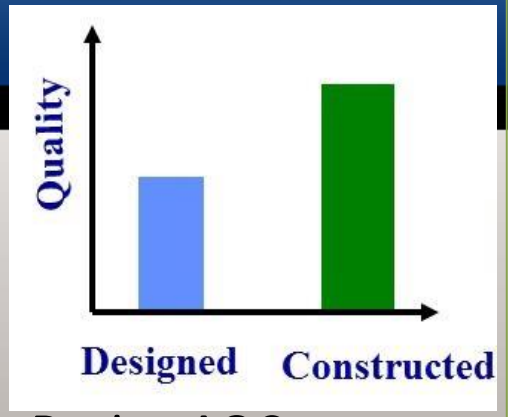
Pavement Design

Planning

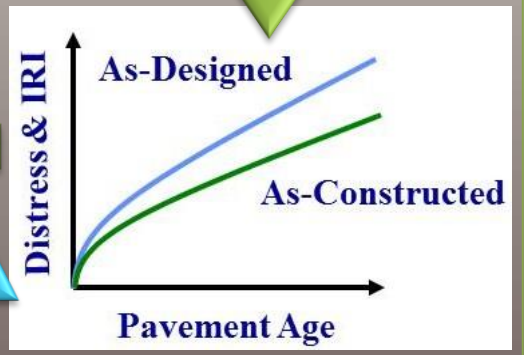
Establish Performance Criteria

Identify AQCs and Target Values

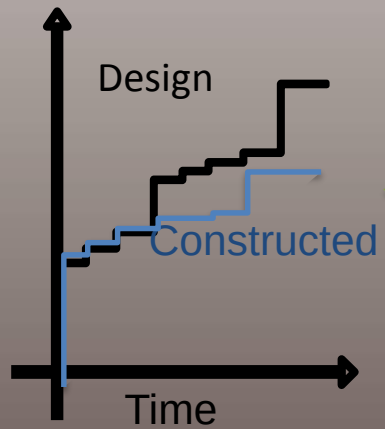
SOFTWARE



Design AQC vs. As-Constructed AQC



Model Performance



Compare As-Built and As-Designed

Pay Factor

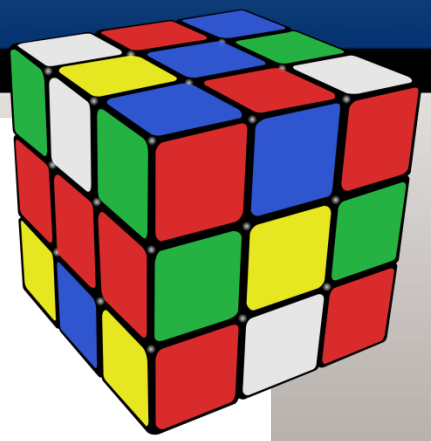
Value of Performance?

Benefits of PRS

- Long term pavement performance predicted from fundamental engineering properties
- Incentives and disincentives justified through reduction or increase in pavement life
- Allow contractors to be more innovative and more competitive

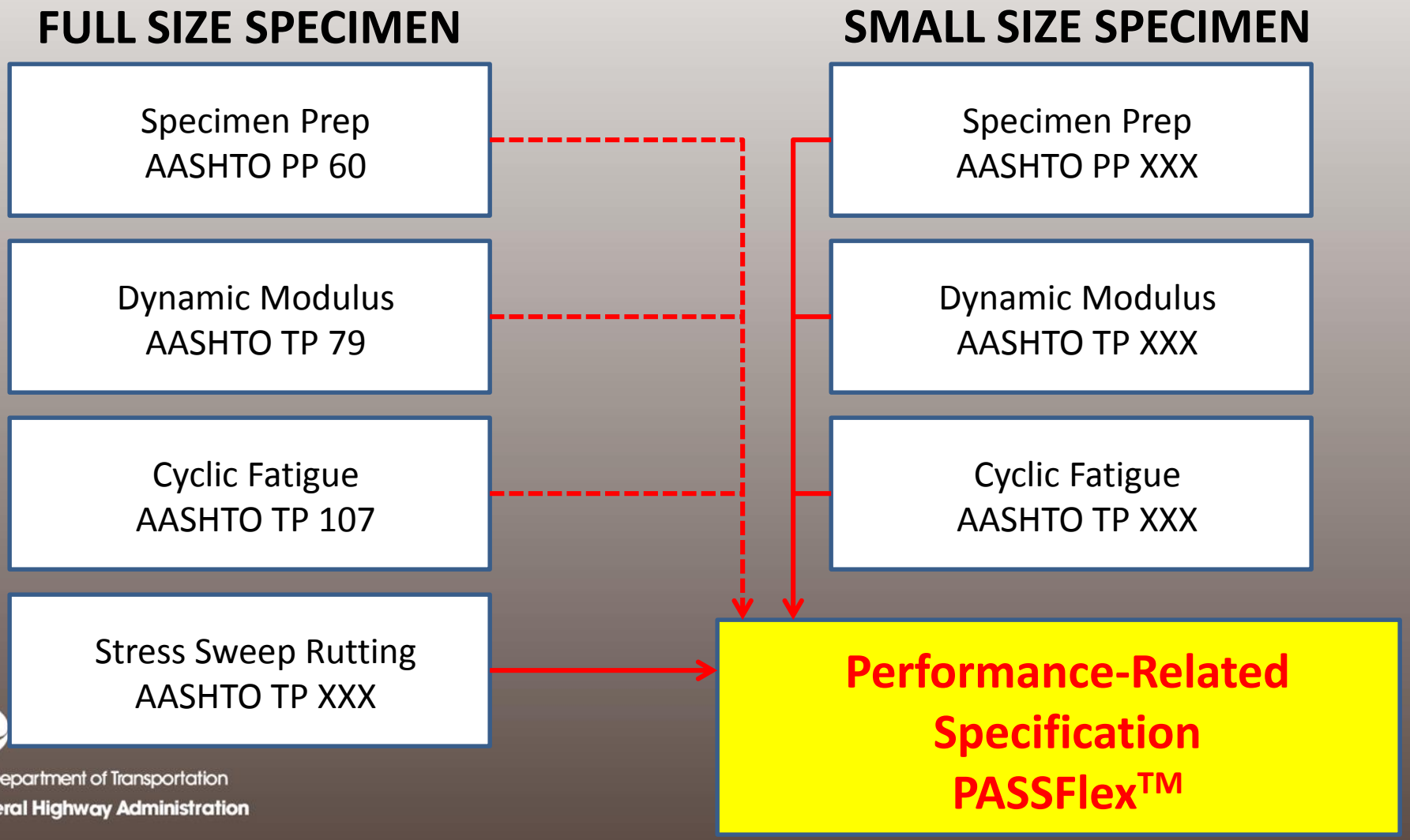
YES!

Challenges with PRS

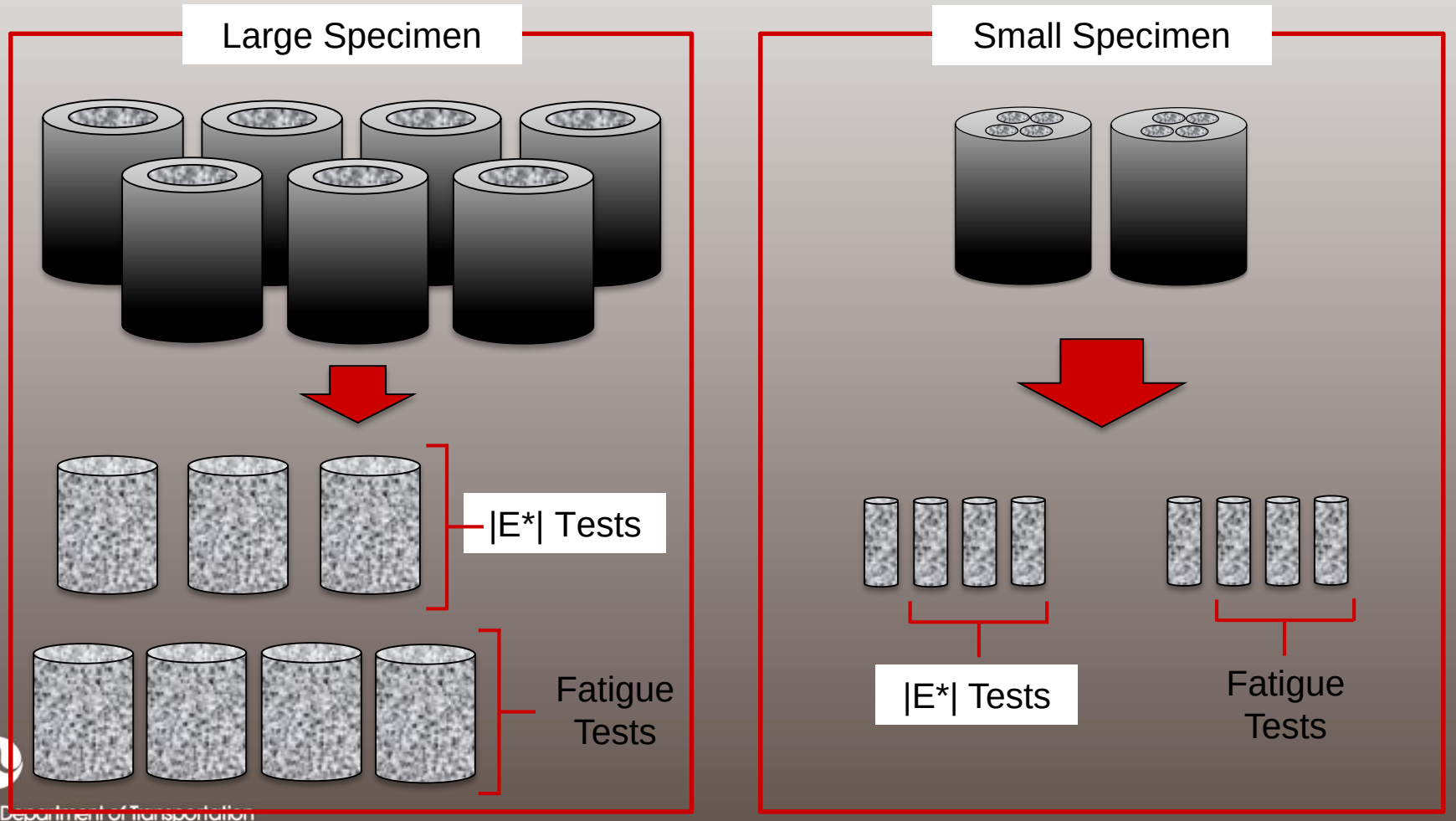


- Testing efficiency and simplicity
  - Completed/Continuous
- Standardization of test methods
  - Ongoing
- Reliability of performance prediction models
  - Complete
- Performance volumetric relationships
  - Ongoing
- Same principles and methods between mix design and PRS
  - Ongoing

Standardization of Test Methods



Testing Efficiency and Simplicity

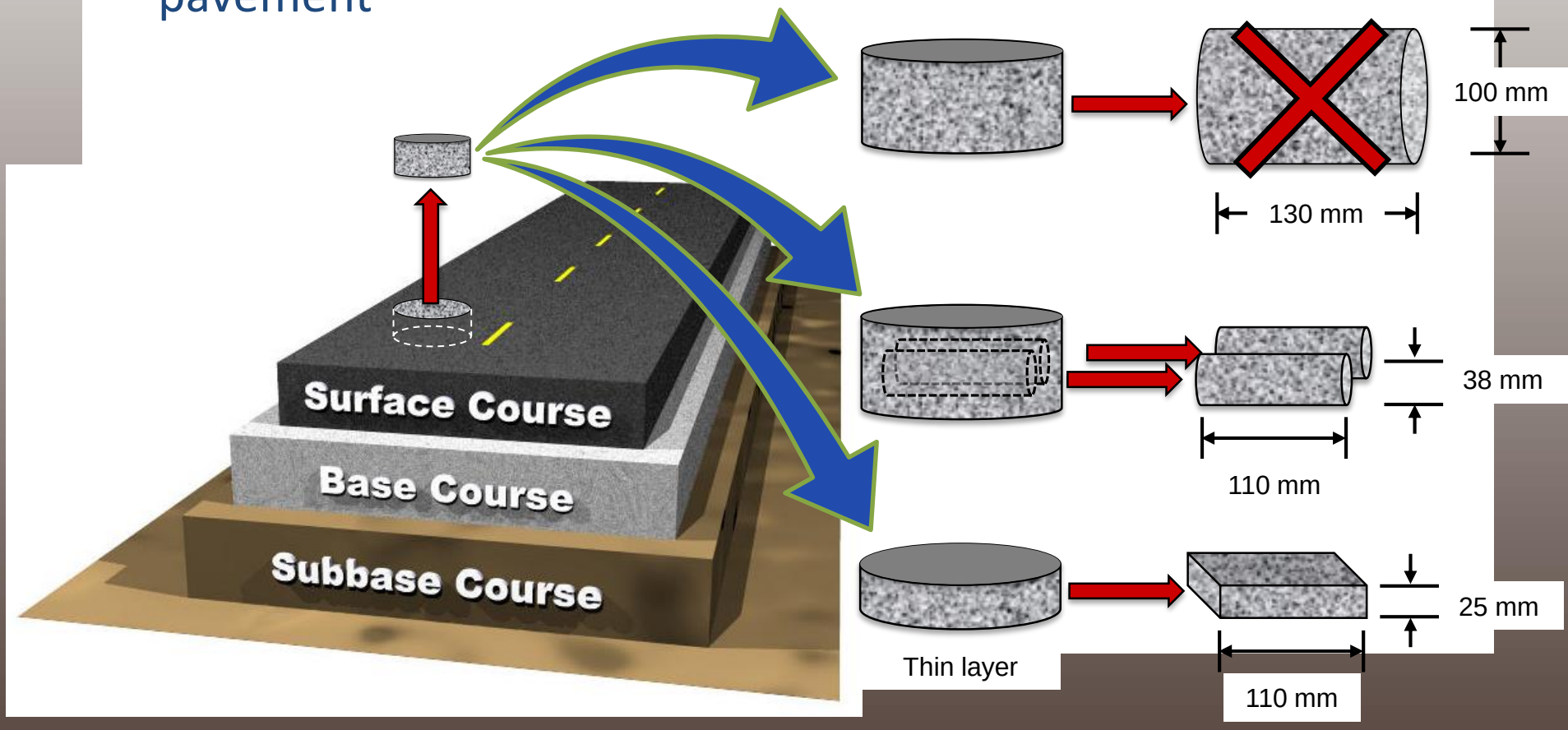


Testing Efficiency and Simplicity (2)

	Large Specimen	Small Specimen
Steel Putty	Devcon 10110	Devcon 10240
Working Time	10 – 20 min.	5 min.
Functional Cure	16 hours	1 hour
Amount of Putty (per specimen)	100 g	6 g

Testing Specimen from Field Cores

- Asphalt concrete layers are generally thinner than 100 mm
- Allow for performance testing individual layers of as-built pavement



FHWA PRS Initiative

- Use of fundamental tests to capture variance between as-designed and as-built AQCs
- Asphalt Mixture Performance Tester (AMPT) used in performance balanced mixture design (PBMD → PEMD)
- Structural response model (stresses and strains)
- Performance volumetric relationships used in construction

FHWA PRS Initiative

- f fundamental tests to capture
  ween as-designed and as-built
- As ance Tester (AMPT), alanced mixture desig
- Structural response strains)
- Performance volumetric relation in construction

PERFORMANCE TESTING ONLY IN DESIGN PHASE!!!

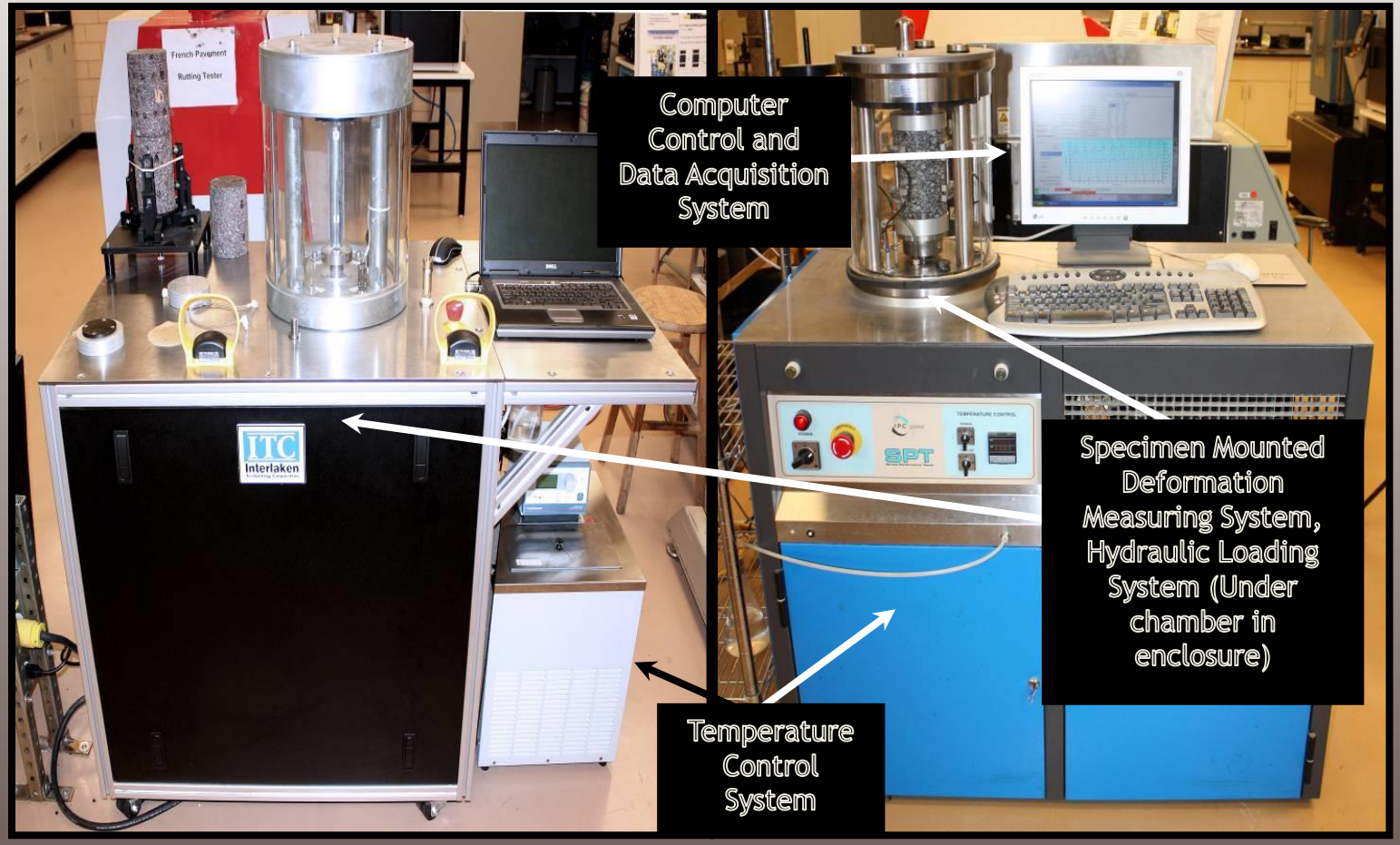
Performance-engineered mixture design (balanced mixture design)

- Fundamental
  - How much distress? How much life?
  - Stresses and strains
  - Material properties (i.e., modulus)
  - Use with structural response model (FlexPAVE™)
  - Many temperature/loading conditions represented
- Index-Based
  - Go/no-go: correlation-based
  - Some engineering properties, some empirical
    - More tied to a material database
  - Not used with structural response model
  - Only a few temperature/loading conditions represented

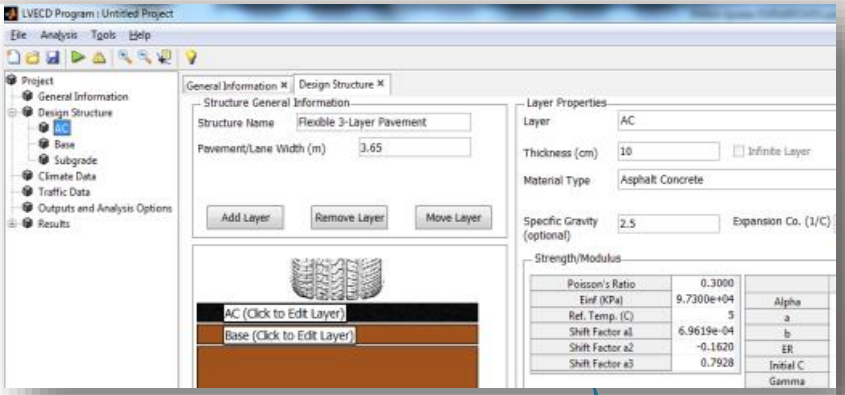
AMPT

- Temperature range from about 4° to 70°C
- Computer-controlled device
  - Software built-in for various test procedures
- Fundamental tests
  - Stress and strain modeling
  - "Bulk testing"
  - Pavement ME or FlexPAVE™
- Kits available for other tests

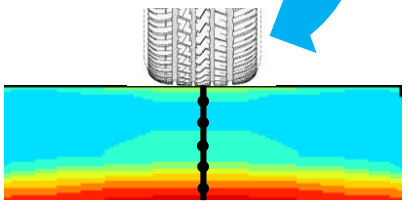
AMPT Overview



AMPT + Performance Prediction



✓ Structure ✓ Traffic ✓ Climate



Predicted Rutting
Predicted Cracking

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!

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?

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!**

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 wide range of loading/temperature conditions!**

AMPT Implementation

- Transportation Pooled Fund Study (TPF(5)-178)
  - Purchase, installation of 29 AMPTs
  - NHI Course (over 80 trainees)
  - Interlaboratory study on effect of air voids
  - National workshop
  - Equipment specification, and others!
- Test standard development, improvement, and revision
- Instructional videos, TechBriefs
- PRS shadow implementation (TFHRC-led)
- MATT projects/training
- User Groups at TRB and regional meetings

AMPT Users Group

- National/International
  - TRB Annual Meeting
  - Discussion of issues, best practices, future efforts
  - 70 attendees, 10 DOTs present
- Regional
  - User-Producer Groups
  - State Asphalt Paving Assoc. meetings

AMPT Users Group

- National/International
  - TRB Annual Meeting

NEXT AMPT USERS GROUP MEETING
JULY 25, 2017 AT 1 PM EASTERN

- Regional
  - User-Producer Groups
  - State Asphalt Paving Assoc. meetings

Shadow PRS status

- Maine DOT – SHRP2 R07
- Western Federal Lands – SHRP2 R07
- Missouri DOT – 2 projects (3 total mixtures)
- North Carolina DOT – SHRP2 R07
- Oklahoma DOT – SHRP2 R07
- MATT support
- Marketing of success stories
- **SEEKING ADDITIONAL SHADOW PROJECTS WITH DOTs**

U.S. Department of Transportation
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Office of Asset Management,
Pavements, & Construction

Asphalt Technology Guidance Program (ATGP)

Long-Life Asphalt Pavement for the 21st Century

U.S. Department of Transportation
Federal Highway Administration

Program Objectives

- Advance Performance
- Advance Quality Assurance
- Advance Innovation

Courtesy of Anton Paar

Program Focus Areas

- Provide Support to National Initiatives
  - Increased Pavement Density
  - Increased RAP/RAS Usage
  - Understanding GTR Testing
  - Mixture Performance Testing and the AMPT
  - Stone Matrix Asphalt
  - Binder Performance Testing
  - Long-Term Aging

Program Focus Areas (2)

- Equipment Development & Refinement
  - Asphalt Mixture Performance Tester (AMPT)
    - Standardization of Equipment, Test Methods
  - Binder Performance Testing
- Development of New QA Concepts for HMA
  - Performance-Based/Related and Risk-Based Acceptance
- Advanced Rapid Test Tools
  - AIMS, CoreLok, CoreDry, Small-Scale Geometry

Solutions to Agency Needs

- Project-Specific Workplans
  - Material Characterization
    - High RAP/RAS, GTR, SMA, PRS…
  - Mix Design Replication and Testing
  - Mix Production Testing
  - Performance Prediction
  - Training and Demonstration

Thank you!

- Questions?
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