Performance-Related Specifications: Integration of the Asphalt Mixture Performance Tester (AMPT)
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
• 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!
“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”
How PRS Works

1. Establish Performance Criteria
2. Identify AQC's and Target Values
3. Compare As-Built and As-Designed
4. Pay Factor

How PRS Works:
- Planning
- Design AQC vs. As-Constructed AQC
- 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
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

**FULL SIZE SPECIMEN**
- Specimen Prep
  - AASHTO PP 60
- Dynamic Modulus
  - AASHTO TP 79
- Cyclic Fatigue
  - AASHTO TP 107
- Stress Sweep Rutting
  - AASHTO TP XXX

**SMALL SIZE SPECIMEN**
- Specimen Prep
  - AASHTO PP XXX
- Dynamic Modulus
  - AASHTO TP XXX
- Cyclic Fatigue
  - AASHTO TP XXX

**Performance-Related Specification**
- PASSFlex™
Testing Efficiency and Simplicity

Large Specimen

|E*| Tests

Fatigue Tests

Small Specimen

|E*| Tests

Fatigue Tests
## Testing Efficiency and Simplicity (2)

<table>
<thead>
<tr>
<th></th>
<th>Large Specimen</th>
<th>Small Specimen</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Steel Putty</strong></td>
<td>Devcon 10110</td>
<td>Devcon 10240</td>
</tr>
<tr>
<td><strong>Working Time</strong></td>
<td>10 – 20 min.</td>
<td>5 min.</td>
</tr>
<tr>
<td><strong>Functional Cure</strong></td>
<td>16 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td><strong>Amount of Putty (per specimen)</strong></td>
<td>100 g</td>
<td>6 g</td>
</tr>
</tbody>
</table>
Asphalt concrete layers are generally thinner than 100 mm. Allow for performance testing individual layers of as-built pavement.
• 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

- 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
- Structural response model (stresses and strains)
- Performance volumetric relationships used 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
- 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

Computer Control and Data Acquisition System

Specimen Mounted Deformation Measuring System, Hydraulic Loading System (Under chamber in enclosure)

Temperature Control System
AMPT + Performance Prediction

- Predicted Rutting
- Predicted Cracking

✓ 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
• 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
Asphalt Technology Guidance Program (ATGP)

Long-Life Asphalt Pavement for the 21st Century
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
Questions?

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