Development and Application of the Asphalt Mix Performance Tester

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Advanced Asphalt Technologies, LLC
Outline

- What is the Asphalt Mixture Performance Tester?
- Why was it developed?
- What tests can be conducted?
- How can I use the data?
- What’s next?
What is the AMPT?

- NCHRP 9-29
- Servo-Hydraulic Machine
- HMA Testing
  - Mix Design
  - Structural Design
  - Evaluation
AMPT Capabilities

- Three Performance Related Tests
  - Dynamic Modulus
  - Repeated Load
  - Creep
- Temperature Control
  - 4 to 60 °C
- With and Without Confinement
  - 210 kPa Max
- Fatigue Test Under Development
Key AMPT Features

• Rugged
  – Proven Hydraulic System
• Automated Testing Cell
  – Temperature
  – Confining Pressure
• Easy to Install Instrumentation
• Standard Software
  – Testing and Analysis
  – Data Quality
• Technician Friendly
Why Do We Need the AMPT?

- Test to Indicate How a Mix Will Perform
  - Rutting
  - Cracking

- Uses
  - Identify Inferior Mixtures
  - Structural Design
  - Evaluations
SHRP Mixture Tests

- **Shear Test AASHTO TP7**
  - Modulus
  - Permanent Deformation
- **Flexural Fatigue AASHTO TP8**
  - Fatigue Cracking
- **Indirect Tensile Test AASHTO TP9**
  - Thermal Cracking
Issues With SHRP Products

• High Costs
  – Equipment
  – Training

• Used With Performance Models
  – Errors
  – Not Calibrated
  – Not User Friendly
Post SHRP

- National Cooperative Highway Research Program (NCHRP)
- Considered
  - Gyratory Compactor
  - Asphalt Pavement Analyzer
  - Fundamental Tests
Recommended Tests

• Dynamic Modulus
  – Rutting
  – Cracking

• Repeated Load Test
  – Rutting

• Creep Test
  – Rutting
Dynamic Modulus Test

- Rutting
  - Min $|E^*|$ at High Temp
- Fatigue Cracking
  - Max $|E^*|$ at Intermediate Temp

$|E^*| = \frac{\sigma_0}{\varepsilon_0}$
Repeated Load Test

- Rutting
  - Min FN at High Temp
Creep Test

- Rutting
  - Min FT at High Temp
SPT Uses

- Dynamic Modulus Master Curve for Structural Design
  - AASHTO MEPDG
- Mixture Design
  - NCHRP Project 9-33 “Mix Design Manual for Hot Mix Asphalt”
- Material Evaluations
  - Homogenity of RAP Mixtures
Pavement Structural Design

- AASHTO Mechanistic-Empirical Pavement Design Guide
  - HMA Characterized by a Dynamic Modulus Master Curve
    - Plant Aged Conditions
  - Modulus Needed
    - Stress-Strain Analysis
    - Rutting Model
    - Fatigue Cracking Model
Temperature and Loading Rate Effects

Dynamic Modulus, ksi

- 4 C
- 20 C
- 40 C

|E*| Master Curve

<table>
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<th>Reduced Frequency, Hz</th>
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Temperature, C

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Shift Factor vs Temperature, C
NCHRP 9-29 Draft Practice

• Developing Dynamic Modulus Master Curves for Hot-Mix Asphalt Concrete Using the Asphalt Mixture Performance Tester
  – Testing Conditions
    • Temperature
    • Frequency
  – Replicates
  – Data Analysis
    • Excel Spreadsheet
Rutting Resistance

Rutting Mechanism

• Shear Deformation - Major
• Densification - Minor
• High Temperatures
• Early in Pavement Life

2-3 in
NCHRP 9-33 Tentative Criteria

• Stress Level
  – 600 kPa (87 psi)
  – Database of Mixtures Tested by FHWA

• Temperature
  – 50 % Reliability Design Temperature From LTPPBind 3.1

• Short Testing Time
Mixture Homogenity

• How Well Does the RAP/RAS Binder Mix with the New Binder?
  – Black Rock
  – Complete Mixing

• Process Specific
  – Plant Type
  – Plant Operations
  – RAP/RAS Processing
One Tool

• Dynamic Modulus
  – Test Is Highly Sensitive to Binder Stiffness
    • Assess Degree of Mixing of New and Recycled Binders
  – Relatively Easy to Perform with the AMPT
How?

• Perform Dynamic Modulus Tests on Plant Produced Mixture
  – Plant Mixed Condition

• Recover Binder, Test and Estimate Dynamic Modulus Using Predictive Model
  – Fully Blended Condition

• Compare Measured and Estimated
Good Mixing

Dynamic Modulus, ksi

Testing Condition

- 4 C, 10 Hz
- 4 C, 1 Hz
- 4 C, 0.1 Hz
- 20 C, 10 Hz
- 20 C, 1 Hz
- 20 C, 0.1 Hz
- 40 C, 10 Hz
- 40 C, 1 Hz
- 40 C, 0.1 Hz

Measured
Estimated for Complete Mixing
Poor Mixing

Testing Condition

Dynamic Modulus, ksi

- Measured
- Estimated for Complete Mixing

Conditions:
- 4 °C, 10 Hz
- 4 °C, 1 Hz
- 4 °C, 0.1 Hz
- 20 °C, 10 Hz
- 20 °C, 1 Hz
- 20 °C, 0.1 Hz
- 40 °C, 10 Hz
- 40 °C, 1 Hz
- 40 °C, 0.1 Hz

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"Engineering Services for the Asphalt Industry"
Implementation

• Interlaboratory Study
  – NCHRP 9-29

• Pooled Fund Study 5(178)
  – Purchase Equipment for Interested Agencies
  – 2 Day Training Course
  – Coordinated Studies
    • Improve Criteria
AMPT Summary

• Specifically for HMA Testing
• Three Performance Related Tests
  – Dynamic Modulus
  – Repeated Load
  – Creep
  – Fatigue Test Under Development
• User Friendly, Second Generation Mixture Performance Testing Equipment
• Extensive National Efforts to Develop and Implement
AMPT Uses

- Dynamic Modulus Master Curve for Structural Design
  - AASHTO MEPDG

- Mixture Design
  - NCHRP Project 9-33 “Mix Design Manual for Hot Mix Asphalt”

- Material Evaluations
  - Homogenity of RAP Mixtures
  - Forensics
  - Others
Questions

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