Asphalt Technology Guidance Program (ATGP)

Nebraska Asphalt Paving Conference
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Long-Life Asphalt Pavement for the 21st Century

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Pavement & Materials Discipline
• Program Office
  – Office of Asset Management, Pavements, and Construction (FHWA HQ, Washington, DC)
    • ATGP: Mobile Asphalt Testing Trailer (MATT) and Asphalt Binder Testing Laboratory (ABTL)

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- Technical Services (Resource Centers)
  - Atlanta, Baltimore, Chicago, Denver

MATT Program History

- Projects began in 1988
  - DP 74: Field Management of Asphalt Mixes Using Volumetric Quality Control
- Transition to Superpave implementation
  - Early-1990s
  - Classroom and hands-on training
- Transition to performance-related specifications
  - Shadow testing
  - AMPT user since 2003!
- Innovative materials and practices
  - WMA, GTR, RAP/RAS, increased density

MATT in Nebraska

- 1992 – Omni Engineering, Weston
  - DP 74: Field Management of Asphalt Mixes Using Volumetric Quality Control
- 1998 – Werner Construction, Aurora
  - Level 1 Superpave
- 2005 – Werner Construction, Pierce
  - MEPDG Workshop
  - Level 1 inputs from paving sites
- 2017 – Here and now!
**Program Objective**

- Provide Support to National Initiatives
  - Increased Pavement Density
  - Increased Usage of Recycled Materials
  - Understanding Ground Tire Rubber-Modified (GTR) Asphalt Testing
  - Mixture Performance Testing and the AMPT
  - Stone Matrix Asphalt
  - Binder Performance Testing
  - Long-Term Aging

**MATT Technology**

- Equipment Development & Refinement
  - Simple Performance Tester (SPT)
- Evaluation and Refinement of Innovative Contracting Concepts
- Development of New QA Concepts for HMA
- Advanced Rapid Test Tools
  - AIMS, CoreLok, CoreDry

**Routine Project Site Activities**

- Material Characterization
- Mix Design Replication and Testing
- Mix Production Testing

**Binder Tests and Analysis**
**Binder Characterization**

**TEST PROCEDURES**
- Performance Grading
  - AASHTO M 320
  - AASHTO M 332 (MSCR)
  - AASHTO R 49 (Low Temperature PG)
- Solubility & Separation
  - AASHTO T 44
  - ASTM D7173

**EQUIPMENT**
- RV
- DSR
- RTFO
- PAV
- Vacuum Degassing Oven
- BBR
- DTT
- ABCD
- Torsional bar testing

**Additional DSR Testing**

**Parallel Plate (PP) Geometry**
- Frequency Sweep (Master Curve)
- Linear Amplitude Sweep (AASHTO TP 101)
- 4mm test

**Cylindrical Geometry**
- Viscosity: AASHTO T 316
- GTR-Modified Asphalt Testing

**DSR Testing Alternative:**

**GTR-modified Binder**

**Can it fit within existing PG grading system?**

- DSR Testing Geometry
  - Caltrans, University of California Pavement Research Center, Anton Paar
  - Concentric Cylinder (CC) development testing evaluation looks promising
  - CC test geometry may overcome specimen preparation limitations of PP geometry
  - Draft AASHTO standard in development

**Concentric Cylinder Geometry**

**Advantage**
- GTR-modified asphalt can be measured with particle sizes up to 2 mm
- No trimming problems and filling problems
- No edge effects

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Rheological Properties: Master Curve

- **Rheological parameter:**
  - Rheological index (R value)
  - Crossover frequency (ω_c)
  - Glover-Rowe (G-R)

- These parameters can be interrelated from understanding the relationship between loading time (or frequency) and temperature.

Extended Aging

Do current procedures provide similarly aged material compared to long term aging in the field?

- **Binder:** PAV procedure (AASHTO R 28)
  - ETG task force evaluating 40 h PAV
  - Rheological parameters are used to assess

- **Mixture:** Oven aging (AASHTO R 30)
  - NCHRP 9-54 is underway to investigate the need for extended aging

Long Term Conditioning: Master Curve - PG 76-22 Asphalt Rubber

- More conditioning causes the master curves to become flatter with R increasing and ω_c decreasing.

Low Temperature BBR Test: Binder New Parameter (ΔT_c)

- ΔT_c is the difference between the critical low temperature determined by stiffness and relaxation criteria from BBR test
  - ΔT_c = S critical temp - m critical temp

- As an asphalt binder ages, ΔT_c becomes more negative
  - Indicating a loss of relaxation properties

- Important parameter related to asphalt binder durability

- Threshold of -5°C being evaluated
Low Temperature ABCD Test:
AASHTO TP 92

- Asphalt Binder Cracking Device (ABCD)
  - Cracking Temperature
  - Fracture Stress
  - Low Temperature Grade

Long Term Conditioning:
Low Temperature - PG 76-22 Asphalt Rubber

- Reasonable agreement between the three measurements for 20 hours PAV conditioning
- Doubling PAV time:
  - 1.1 °C ↑ of cracking temp (ABCD)
  - 3.2 °C ↑ of cracking temp (Table 1)
  - 1.9 °C ↑ of cracking temp (Table 2)

Aggregate Characterization

- Physical Properties, AASHTO M-323
  - Sieve Analysis – AASHTO T 11 & T 27
  - Specific Gravity & Absorption – AASHTO T 84 & T 85
  - Flat & Elongation – ASTM D4791
  - CA Angularity – AASHTO T 335
  - FA Angularity – AASHTO T 308
  - Sand Equivalent – AASHTO T 176
  - Shape & Texture (AIMS) – AASHTO PP 64 & TP 81
    - Angularity
    - Shape
    - Texture
AIMS

Masad et al. (2003)

TP 81-12

AIMS Output - Example

Elongation vs Flatness

FAA

Birdseye

#7

3099

4

44.8

4

#8

2899

5

45.1

3

#10 Wash

3162

4

50.6

1

RAP

3017

3

46.5

2

CAAs

Rank

FAA

FAA

Rank

F&E (3:1 & 5:1)

Birdseye

3166

1

44.5

5

#10 Wash

3164

2

50.6

1

RAP

2585

5

98

2

CAAs

Rank

F&E (3:1)

Rank

F&E (5:1)

Rank

ASTM D 4791

FAA

Rank

FAA

Rank

F&E (3:1)

Rank

F&E (5:1)

Rank

ASTM D 5821

FAA

Rank

FAA

Rank

CAAs

Rank

CAAs

Rank

CAAs

Rank

CAAs

Rank
Mix Design Replication

- Use Plant Site Materials

Mix Design Replication

- Mixing, Aging, Compacting

Mixture Production Testing

- Asphalt Mixture Sample
  - Volumetric Properties
    - Ps – Ignition (T 308)
    - Gradation – (T 30)
  - Gradation – (T 166)
    - Corelok (T 331)
    - Gilson SG 4 (TP 82)
- Performance Testing
  - Dynamic Modulus (TP 79)
    - Unconfined
  - Flow Number (TP 79)
  - Confined
  - Unconfined
  - Cyclic Fatigue (TP 107)

Gilson SG-4

- AASHTO TP 82 “Bulk Specific Gravity of Compacted Bituminous Mixtures Using Water Displacement Measured by Pressure Sensor”

Courtesy of Gilson Company, Inc.
Corelok

AASHTO T 331 – “Bulk Specific Gravity ($G_{mb}$) and Density of Compacted Hot Mix Asphalt (HMA) Using Automatic Vacuum Sealing Method”

Rapid Test Tools

CoreDry

- ASTM D7227
  - "Standard Practice for Rapid Drying of Compacted Asphalt Specimens by Using Vacuum Drying Apparatus"
- Rapid Vacuum Drying
  - Alternating cycles of Vacuum and Heating
- Maintains Sample at Room Temperature

Performance Characteristics

- Asphalt Mixture Performance Tester

Mixture Performance Testing and Analysis
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!

AMPT

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

AMPT Overview

Gauge Point Gluing System
**Dynamic Modulus Test**

- Mixture Stiffness
- Rutting
- Fatigue Cracking

\[ E^* = \frac{\sigma_0}{\varepsilon_0} \]

\[ \phi = \frac{T_1}{T_p} \] (360)

**AMPT Cyclic Fatigue**

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

**AMPT Cyclic Fatigue Process**

**Preparation**
- Cylindrical specimen
- 100 mm x 130 mm
- Small-specimen: 38 mm x 115 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 spreadsheet or software
- Assign mixture rankings or use pavement prediction software
- 1-2 hours for mix
AMPT Cyclic Fatigue Field Validation

- Pavement prediction software built from models
- Field validation
  - 59 mixtures
  - 55 different pavement structures
- Develop laboratory-to-field transfer functions
- Built for use in a PRS framework...

AMPT Cyclic Fatigue Advantages

- Standard sample preparation
- AASHTOWare Pavement ME compatible
- Ruggedness, precision and bias underway
- Commercial analysis software available
- Spreadsheet analysis & formulation available
- Predicts performance!
- **Material behavior across all possible 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 Groups

- 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
Technical assistance

- If you have upcoming projects where you’d like MATT technical assistance, contact:
  - Dave Mensching, david.mensching@dot.gov, 202.366.1286
  - Chuck Paugh, chuck.paugh.ctr@dot.gov, 202.366.6640

Closing notes

- Trailer is parked outside!
- Come in for a tour!
- We’re here to assist! Please stop by anytime for more discussion.
- Questions?