Binder and Mixture ETG Update
Binders
High Temperature Binder Criteria

- Study
  - Refine the Multi-Stress Creep and Recovery Test
  - Evaluate multiple binders
  - Evaluate binder and mix properties to develop specification criteria.
NCHRP 9-10 Rutting Test
Repeated Creep Recovery Test

Shear Stress, 68

Shear Stain, mm/mm  Accumulated Strain

1 10 20

1 10 20
MI NN Road 58-XX binders

Depending on base AC and stress level there is reversal of performance
Hamburg Rut testing  MI NN Road mixes

\[ y = 0.0329x \]
\[ R^2 = 0.8048 \]
Hamburg Rut testing  MN NN Road mixes

Jnr 6400

\[ y = 0.0341x - 0.0611 \]

\[ R^2 = 0.9163 \]
<p>| | | | | | | |</p>
<table>
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</tbody>
</table>

As-Built Pavement Lanes

- CR-AZ
- PG 70-22 Control
- Air Blown
- SBS LG
- CR-TB
- TP
- PG 70-22 + Fibers
- PG 70-2264-40 Blown
- SBS LG
- TP
Jnr ALF binder 64C

Stress Pa

64-40 64C
AB 64C
SBS LG
control 64C
Elvaloy 64C
TBCR 64C
$y = -7.4519x + 10.956$

$R^2 = 0.1261$
$y = 0.5011x - 0.1194$

$R^2 = 0.7577$
Ongoing work

- Define Jnr based on neat binders.
- Evaluate SPT creep and recovery testing to relate stress level in binder to mix.
- Evaluate test sections with known performance.
Evaluation of the Repeated Creep and Recovery Test Method as an Alternative SHRP + Requirement
No ER So What Do We Do? – Use DSR Approach

- Use DSR
  - Multi Stress Creep Recovery Test
    - Two creep stress levels
    - Ten cycles per stress level
    - For Elastomeric modifiers Specify:
      - % strain recovery > 15% or 20%
      - Overall change between stress levels
  - Run on the RTFOT
  - Run on the same sample as RTFOT grading
Proposed MSCR TEST Protocol

- Creep Stress
  - 100 Pa
  - 3200 Pa

- Creep Strain

- Time
What criteria? % recovered strain

Creep 1st cycle 70C 1000 Pa

(Peak Strain - recovered Strain)/Peak Strain

control
Elvaloy
Stylink
AB
Two 70-22’s with SBS. Not all binders are the same.
MSCR selection of stress levels

- poor structure
- good structure

Stress Pa

Jnr

10 100 1000 10000 100000
Comparison of MSCR-3200 Recovery and Elastic Recovery

MSCR

\[ y = 0.83x - 32.88 \]

\[ R^2 = 0.21 \]
## Multi-Lab Reproducibility: 100 Pa

<table>
<thead>
<tr>
<th>Grade</th>
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<tr>
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<td>-1.8</td>
<td>4.5</td>
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<td>2.0</td>
<td>3.2</td>
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<tr>
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<td>36.7</td>
<td>42.4</td>
<td>41.9</td>
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<td>PG 70-28</td>
<td>59.0</td>
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<td>60.2</td>
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<td>13%</td>
</tr>
<tr>
<td>PG 76-22</td>
<td>59.1</td>
<td>64.4</td>
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<td>67.4</td>
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## Multi-Lab Reproducibility: 3200 Pa

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<td>-2.3</td>
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## Effect of RTFO Aging

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## Effect of RTFO Aging

### Lab-Aged

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#### Recovery - 100 Pa

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### MTE RTFO-Aged

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#### Recovery - 100 Pa

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#### Recovery - 3200 Pa

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Phosphoric Acid
Modified Asphalt

FHWA Study
## Four SHRP Asphalts

<table>
<thead>
<tr>
<th>Origin</th>
<th>Grade</th>
<th>Asphaltene %</th>
<th>Polar Aromatics</th>
<th>Napthenic Aromatics</th>
<th>Saturates</th>
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<tr>
<td>AAD-1</td>
<td>CA Coastal</td>
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<td>AAM-1</td>
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<td>ABM-1</td>
<td>CA Valley</td>
<td>PG 58-10</td>
<td>7.1</td>
<td>52.4</td>
<td>29.6</td>
</tr>
</tbody>
</table>
PAV Aging 100°C, AAM-1 Under Air 1% Phosphoric Acid

Stiffness $G'/\sin\delta$/kPa

- Control
- 105%
- 115%
- P2O5

Hours

0 50 100 150 200 250 300

0 5 10 15 20 25 30 35 40
PAV Aging 100°C, ABM-1 Under Air 1% Phosphoric Acid

Stiffness G'/Sin δ/kPa

Control 105% 115% P2O5

Hours
Effect of 115% PPA Acid Modification on Original PG Grade
Conclusion – Based on 24 Hour Stiffness

- Any of the Phosphoric Acid Grades can be used
- Acids Containing Water Cause Foaming
- Green Acid is Likely to Cause Corrosion
- Stiffness is Asphalt Dependant
- AAK-1 (Boscan) is the Most Responsive
- ABM-1 (CA Valley) Showed No Stiffness Increase
Effect of Water on Gyratory Cores - ALF Mix no lime
Conclusion Effect of Water on Gyratory Cores

- PPA does not seem to be leaching out.
Proposed Work Plan

• Three binders with different sensitivities to PPA
• Two aggregates, non stripping and stripping;
• Amine anti- strip additives and lime
• Four stripping tests
• Effect of Polymer Modification with SBS
Mixture Issues
Superpave Gyratory Compactor Calibration

Making Superpave Mixtures Consistent
AASHTO Designation: T 312-03

Preparing ... Specimens by ... SGC

4.1

*Superpave Gyratory Compactor* – ... an average internal angle of 1.16° ± 0.02°

.....

*(only internal angle with simulated mix measurement)*
Specification Recommendations

• **Drop procedures related to use of HMA**
  - drop reference in T312; eliminate TP48

• **Implement new TP for simulated loading**
  - add reference in T312
  - Precision: Troxler 4140 NOT INCLUDED
  - Refer to “manufacturers’ recommendations”
    • Applies to specific procedures for using various devices
    • Applies to hot-versus-cold question(s).
  - Inform users that RAM ≠ DAV2/HMS

• **Angle tolerance:** move to +/- 0.03 deg
Internal Angle of Gyration

- Mixless measuring devices
- AASHTO provisional procedures for mix simulation
- SGC guidance/rationale document
TP-62 Determination of Dynamic Modulus

- 9-29: Superpave Performance Tester for dynamic modulus
- **TP 62 Dynamic Modulus E***
  - Accommodate Superpave Performance Tester
  - Separate Std for sample preparation
  - Separate Std. for master curve
Fine Aggregate Specific Gravity Issues

Task Group Objectives:

• Identify problems/issues with current standard AASHTO T 84
• Evaluate alternate methods
• Make recommendations regarding changes and/or new methods
• Additional scope -- Mixture gravity determination issues T 209
9-33: A Mix Design Manual for Hot Mix Asphalt

Final draft end of 2006 will modify build upon Superpave method to Asphalt Institute Manual SP-02:

- New volumetric criteria.
- N-design
- Simple performance test(s).
- Criteria developed with M-E design guide performance models and software.
- Framework for integrated mix and structural design.

*Advanced Asphalt Technologies (August 2006)*
Other NCHRP Projects

- **9-34**: Improved Conditioning Procedure for Moisture Susceptibility
- **9-38**: Endurance Limit of HMA Mixtures to Prevent Fatigue Cracking
- **9-39**: Determining Mixing and Compaction Temperatures of PG Binders in HMA
- **9-45**: Development of Specification Criteria for Mineral Fines Used in HMA
AASHTO M 323 Design Guidance

- Combined New and RAP Aggregates
  - Gradation
  - Angularity
  - Flat and Elongated
  - Other Tests ??

- Binder Grade Changes ??
  - < 15 % RAP, no grade change
  - 15 - 25 % RAP, use one grade softer
  - > 25 % RAP, use blending chart
Thank You........

http://www.fhwa.dot.gov/pavements