Use of Modified Asphalt in Thin Lift HMA Applications

Presented By:
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University of Massachusetts Dartmouth

2007 Annual Conference
Mystic, Connecticut
October 17th, 2007
Evaluation of Modified Performance Grade Binders in Thin Lift Maintenance Mixes, Surface Mix, and a Reflective Crack Relief Layer Mix.
Participating States

Massachusetts

New York

New Hampshire

Connecticut

New Jersey

Rhode Island

NEAUPG

PRISM

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<table>
<thead>
<tr>
<th>Name</th>
<th>State</th>
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<tbody>
<tr>
<td>Matthew Turo - Chair</td>
<td>Massachusetts</td>
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<tr>
<td>Zoeb Zavery</td>
<td>New York</td>
</tr>
<tr>
<td>Colin Franco</td>
<td>Rhode Island</td>
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<tr>
<td>Allen Rawson</td>
<td>New Hampshire</td>
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<td>Nelio Rodrigues</td>
<td>Connecticut</td>
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<tr>
<td>Ed Kondrath</td>
<td>New Jersey</td>
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UMass Dartmouth PRISM

Professor Walaa Mogawer, P.E. – Principal Investigator
Alexander J. Austerman – Research Engineer
Graduate Students
Undergraduate Research Assistants

Consultants
Professor Jo Daniel – University of New Hampshire
Mr. Kevin Stuart
Advanced Asphalt Technologies, LLC
Project Objectives

Develop thin lift HMA mixes for maintenance and rehabilitation purposes using different modified binders typically specified in the Northeast.

Develop a Reflective Crack Relief Layer (RCRL) mix.

Evaluate the performance of these mixes.
Definition of Thin Lift Mixes

Mixes that are placed at thicknesses greater than \(\frac{3}{4}\) inch and less than or equal to 1\(\frac{1}{2}\) inches.
Literature Review

- Review development of maintenance and rehabilitation mixes prepared with polymer modified binders using Superpave design methodology.

- Review differences between different types of polymer modifiers.

- Conduct survey to quantify State DOT experiences with using PMA in thin lift maintenance or rehabilitation mixes.

- Review of design and test methods for PMA mixes as well as methods for placement.
Survey

Internet (web) based survey.

Attempted to solicit responses from over 100 Federal, State, and select Local agency representatives.
Does your agency use or specify any thin lift HMA overlay maintenance mixes?

- Yes: 71%
- No: 29%
What distresses does your agency hope to resolve using thin lift HMA overlay mixes?

- Raveling: 50%
- Oxidation: 50%
- Cracking: 79%
- Rutting: 36%
- Surface Friction: 71%
- Moisture: 64%
- Other: 29%
What types of thin mixes does your agency use?

- Dense Graded: 71%
- Coarse Graded: 50%
- OGFC: 29%
- SMA: 29%
- Sand Mix: 29%
- Others: 21%

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What polymers does your agency use for thin lift HMA overlays?
1. PG 64-28 without modification (Control)

2. PG 64-28 Poly-Phosphoric Acid (PPA) Modified

3. PG 64-28 SBR (Styrene-Butadiene Rubber) Latex Modified

4. PG 76-22 SBS (Styrene-Butadiene-Styrene) Modified

5. PG 76-34 Chemically Modified Crumb Rubber

6. PG 64-34 SBS (Styrene-Butadiene-Styrene) Modified
Aggregates

**Crushed Stone Source – Wrentham, Massachusetts**

- 9.5mm Crushed Stone
- Natural Sand

**Gravel Stone Source – Farmington, New Hampshire**

- 9.5mm Gravel Stone
- Washed Sand
- Stone Dust
### Mix Designs

<table>
<thead>
<tr>
<th></th>
<th>PG64-28 Neat</th>
<th>PG 64-28 PPA</th>
<th>PG64-28 SBR (Latex)</th>
<th>PG 76-22 SBS</th>
<th>PG 76-34 CMCR</th>
<th>PG 64-34 SBS</th>
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<tbody>
<tr>
<td><strong>SP 4.75 mm –</strong></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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<tr>
<td><strong>Crushed Stone</strong></td>
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<td><strong>Source</strong></td>
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<tr>
<td><strong>Gravel Stone Source</strong></td>
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<tr>
<td><strong>SP 9.5 mm –</strong></td>
<td>✔️</td>
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<td><strong>Crushed Stone</strong></td>
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<tr>
<td>RCRL</td>
<td></td>
<td></td>
<td></td>
<td>✔️</td>
<td>✔️</td>
<td>✔️</td>
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SP = Superpave  RCRL = Reflective Crack Relief Layer
Binder Testing

Verification of Performance Grade (PG) of each binder in accordance with AASHTO and Superpave specifications.

Determine elastic recovery of each binder per AASHTO T301.

Perform Multi-Stress Creep Recovery Test (MSCRT) on each binder.
Performance Testing

Thin Lift Mixes:
Dynamic Modulus (E*)
Accelerated Pavement Testing
Beam Fatigue

RCRL:
Accelerated Pavement Testing
Beam Fatigue
## Dynamic Modulus Testing

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<th>Temperature</th>
<th>Frequency</th>
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<tr>
<td>4°C</td>
<td>10 Hz, 1Hz, 0.1Hz</td>
</tr>
<tr>
<td>20°C</td>
<td>10 Hz, 1Hz, 0.1Hz</td>
</tr>
<tr>
<td>40°C</td>
<td>10 Hz, 1Hz, 0.1Hz, 0.01Hz</td>
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Simple Performance Test Device

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Master Curve Example Courtesy Advanced Asphalt Technologies, LLC.
Accelerated Pavement Testing

Model Mobile Load Simulator (MMLS3)
## Preliminary RCRL Development

<table>
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<tr>
<th>Sieve Size</th>
<th>Trial Gradation</th>
<th>Koch Specification</th>
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<tbody>
<tr>
<td>1/2”</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>3/8”</td>
<td>99.5</td>
<td>100</td>
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<tr>
<td>No.4</td>
<td>86.1</td>
<td>80-100</td>
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<tr>
<td>No.8</td>
<td>70.9</td>
<td>60-85</td>
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<tr>
<td>No.16</td>
<td>55.5</td>
<td>40-70</td>
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<tr>
<td>No.30</td>
<td>39.3</td>
<td>25-50</td>
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<tr>
<td>No.50</td>
<td>25.2</td>
<td>15-35</td>
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<tr>
<td>No.100</td>
<td>19.3</td>
<td>8-20</td>
</tr>
<tr>
<td>No.200</td>
<td>13.9</td>
<td>6-14</td>
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<tr>
<td>% Binder (PG76-34)</td>
<td>10%</td>
<td>-</td>
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<tr>
<td>% Air Voids</td>
<td>1.1%</td>
<td>0.5 – 2.5%</td>
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<tr>
<td>%VMA</td>
<td>16.0%</td>
<td>&gt;16%</td>
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</tbody>
</table>
Acknowledgements

TPF-5(146) Technical Committee

Stephen Pepin – Massachusetts Executive Office of Transportation (EOT)

Patrick McMahon – Massachusetts Executive Office of Transportation (EOT)

Dr. Ramon Bonaquist – Advanced Asphalt Technologies, LLC.

Mr. Frank Fee – Citgo

Mr. Michael Worden - SemMaterials

Mr. Dave Duncan – Pike Industries

Mr. Mike Nichols – Aggregate Industries

Mr. Alexander Austerman – Research Engineer at PRISM

Mr. Bryan Engstrom – Graduate Student UMass Dartmouth
Thank You!