POLYMER MODIFIED ASPHALT EMULSIONS

Composition, Uses & Specifications for Surface Treatments
Acknowledgements

- **Sponsored by:**
  - Central Federal Highway Lands Division
    Federal Highway Administration
    - Mike Voth, James Sorenson

- **Investigators:**
  - National Center for Pavement Preservation
    - Larry Galehouse, John Johnston
    - GHK, Inc.
      - Gayle King, Helen King
    - Industry volunteers
      - BASF, PRI, Paragon, SemMaterials, UW, others
The Problem

- Experience: polymer modification results in better short- and long-term performance
- No definitive guide
  - For selecting, specifying & using polymer emulsions
- Areas of interest
  - Use of PMEs vs. conventional emulsions
  - Optimal % polymer
  - Use on non-roadway applications (parking lots, trails, bike paths)
The Project

- Literature review & knowledge gathering sessions
  - Industry, academic, federal & local government agencies
  - On-line user/producer survey
  - Presentations & input: AEMA/ARRA/ISSA, TRB, ETGs, AASHTO
- Draft performance spec
- Field trials
- Field guide
Findings - What Are PMEs?

- Water based, emulsified asphalt & polymer
- Performance depends on:
  - Type of polymer
  - Compatibility of polymer & asphalt

PME Chip Seal
Findings – What Are PMEs?

✓ Typically 1-5% polymer based on asphalt

✓ Polymers

- Elastomers - elastic
  - SBR latex (random)
  - SBS block copolymers
  - Natural rubber latex

- Plastomers - high modulus (stiffness)
  - EVA

✓ Recommend - preblend prior to emulsifying
PME recommended for all emulsion applications

- Improve performance
  - Stiffer at high temperatures (bleeding, rutting)
  - Less brittle at low temperatures (shelling, cracking)
  - More adhesive (early chip loss, raveling, delamination)
  - Less susceptible to moisture damage
  - Less susceptible to oxidative aging (raveling, cracking)
  - More elastic – fatigue resistant (chip loss, cracking)
Findings - When & Why PME?

✓ PME recommended for all emulsion applications

- Caution: avoid sealing in moisture
  - Insufficient drainage
  - Saturated pavement at time of construction
  - Insufficient curing (late season application)
Findings - When & Why PME?

- Increase service life
- Prevent early failures
- Cost differentials vs. no polymer
  - Mn/DOT: total project cost ≈7% higher
  - 2008 study field projects: 4-11% higher
  - Right treatment - Right road - Right time

www.pavementpreservation.org/toolbox/guidelines.html
Findings - When & Why PME?

✓ Chip seals
  - Early & long term stone retention
  - Quicker traffic return
  - Fewer broken windshields
  - Reduced flushing & bleeding
  - Greater tolerance for quantities & aggregate embedment factor
  - Increased durability
    • Better performance on high volume roads
Findings – When & Why PME?

✓ Slurry Seals & Microsurfacing
  ▪ Quicker traffic return
  ▪ Increased durability
  ▪ PME slurry for <1000 ADT
  ▪ PME microsurfacing for
    ▪ >1000 ADT
    ▪ Rut filling
    ▪ Minimizing user delay

✓ Non-roadway applications - similar benefits
Findings – How to Specify PME

- Current specs don't correlate with performance
- Recommendation: don't specify % polymer
Recommendations:

- Update ASTM D-244 with performance-related tests
  - Low temp residue recovery method
  - Superpave binder tools preferred (rheometry)
    - Sample prep & tests adapted for emulsion treatments
  - Aging procedure for residues
  - Revise emulsion viscosity method
    - Field viscosity test

- Develop Approved Supplier Certification program
  - To prevent shipping & construction delays
## Sample Proposed Performance Tests

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Test</th>
<th>Conditions</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residue Recovery</td>
<td>Forced Draft Oven</td>
<td>24 hrs @ambient + 24 hrs @60°C</td>
<td>✓% Residue</td>
</tr>
</tbody>
</table>

### Tests on Residue from Forced Draft Oven

<table>
<thead>
<tr>
<th>High Temperature (Rutting/Bleeding)</th>
<th>Test</th>
<th>Conditions</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSR-MSHR</td>
<td>DSR freq sweep</td>
<td>$T_h$</td>
<td>✓$J_{nr}$ ✓$G^*$ &amp; phase angle</td>
</tr>
<tr>
<td>Polymer Identifier (Elasticity/Durability)</td>
<td>DSR-MSHR</td>
<td>$T_h$ @3200 Pa</td>
<td>✓% Recoverable Strain</td>
</tr>
<tr>
<td>High Float Identifier (Bleeding)</td>
<td>DSR - non-linearity</td>
<td>$T_h$</td>
<td>✓Test to be developed</td>
</tr>
</tbody>
</table>

### Tests on PAV after Forced Draft Oven Residue

<table>
<thead>
<tr>
<th>Low Temperature (Aged Britteness)</th>
<th>Test</th>
<th>Conditions</th>
<th>Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSR freq sweep</td>
<td>10 &amp; 20° C Model low T</td>
<td>$G^*$</td>
<td>✓Phase Angle</td>
</tr>
<tr>
<td>Polymer Degradation (Before/After PAV)</td>
<td>DSR-MSHR</td>
<td>$T_h$ @3200 Pa</td>
<td>✓Recoverable Strain Ratio</td>
</tr>
</tbody>
</table>

$T_h = $ high pavement temp; DSR = dynamic shear rheometer; MSCR = multiple stress creep recovery
Field Projects

- Field projects - 2008 & 2009
- Tested with proposed performance tests
  - Results currently being analyzed
Utah Parks - Construction

- 90 miles total 9/6/08 – 10/17/08
  - Arches & Canyonlands Nat’l Parks,
  - Natural Bridges & Hovenweep Nat’l Monuments
- Chip Seal – 1,140,000 sy (fogged)
  - SBR latex modified CRS-2LM
- Microsurfacing – 60,000 sy
  - Natural latex modified Ralumac®
Utah Parks – Testing Plan

✓ PRI: Testing both chip & micro emulsion & aggregates
✓ Paragon: chip emulsion & aggregates
✓ BASF: chip emulsion & aggregates
✓ SemMaterials: micro emulsion
✓ NCHRP study (Shuler): chip emulsion & aggregates
✓ CFLHD Lab: acceptance testing only
Death Valley National Park

✓ 13 miles – 11/11/08 – 11/14/08
✓ Chip seal – 161,400 sy
  ▪ SBR latex modified CRS-LM

✓ Test plan:
  ▪ PRI: emulsion & aggregates
  ▪ Paragon: emulsion & aggregates
  ▪ BASF: emulsion & aggregates
  ▪ CFLHD Lab: acceptance testing only
Dinosaur National Monument

✓ 11.4 miles – 9/23/08 – 9/30/08
✓ Chip seal – 135,000 sy
  ▪ Neoprene modified PASS®

✓ Test plan:
  ▪ PRI: emulsion & aggregates
  ▪ CFLHD Lab: acceptance testing only
Crater Lake National Park

✓ 23 miles chip seal
  ▪ Planned for late spring 2009
  ▪ 367,000 sy

✓ Hope: SBS modified CRS-2P

✓ Testing to be determined
PME Project Status

✓ Preliminary report under review
  - Final report after results of 2009 project
  - Will be posted on NCPP website
✓ Field Guide written, published soon
✓ Full data available at
  www.pavementpreservation.org
Recommendations for Further Study

- Continue development work on performance specs for emulsions
- Include testing of unmodified emulsion
- Continue knowledge sharing of related projects
  - Coordinated by Emulsion Task Force (Pavement Preservation Expert Task Group)
**Related Projects**

- **ASTM – Committee D 4.42,**
  - Low temperature recovery of emulsion residue & emulsion viscosity.
- **Manual for Emulsion-Based Chip Seals for Pavement Preservation (NCHRP 14-17)**
  - Scott Shuler, Colorado State University, and Amy Epps Martin, Texas A&M University.
- **Emulsion Cold Mix (Asphalt Research Consortium)**
  - Husain Bahia, University of Wisconsin, and Peter Sebaaly, University of Nevada at Reno.
- **“Chip Seal Design and Performance” North Carolina DOT Project HWY 2004-04**
  - Richard Kim, North Carolina State University.
- **“Using DSR and Rheological Modeling to Characterize Binders at Low Temp”**
  - Fred Turner and Mike Harnsberger, Western Research Institute.
- **“Slurry/Micro-Surface Mix Design Procedure” Caltrans Contract 65A0151**
  - Jim Moulthrop, Fugro, and Gary Hicks.
Envisioned next steps:

- May 14-15, 2009: ETG/ETF Meeting
- August 3-7, 2009: AASHTO SOM - Study results discussed with emulsion subsection
- September, 2009: Testing completed
- October, 2009: Report finalized
- November, 2009: Begin study to develop specification for AASHTO provisional adoption
- August, 2010: Provisional specification presented to AASHTO SOM for adoption
Summary

✓ PME should be used for all emulsion applications
  ▪ <10% increase in cost offset by increased reliability & performance
✓ Field Guide to be published soon
✓ Current specs need improvement
  ▪ Efforts underway to develop & implement performance related specs
  ▪ Stay tuned - www.pavementpreservation.org
Thank You.