Mix Design Practices for Warm Mix Asphalt
Presentations

• Ramon Bonaquist
  - Overview of Proposed Appendix to AASHTO R35 for WMA

• Brian Prowell
  - Data from NCHRP Project 9-47A evaluating the Proposed Appendix

• Rick Harvey
  - Efforts to incorporate the Proposed Appendix into the AASHTO Standard Methods of Test.
Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)

An Appendix to AASHTO R35
Standard Practice for Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
Outline

- Brief Overview of NCHRP Project 9-43
- NCHRP Project 9-43 Conclusions
- NCHRP Project 9-43 Products
- Review of the Proposed Appendix to AASHTO R35
  - Major Sections
  - NCHRP 9-43 Research
- What to Expect When Using the Appendix
NCHRP 9-43

- Mix Design Practices for Warm Mix Asphalt
- Objective
  - To adapt laboratory mixture design and analysis procedures to WMA
    - Compatible with HMA procedures
    - Address wide range of warm mix processes
NCHRP 9-43 Approach

Preliminary Procedure
- Focus

Phase I Experiments
- Reheating
- Binder Grade
- RAP
- Short-Term Conditioning
- Workability

Revised Procedure

Phase II Experiments
- Expanded RAP Mixing
- Laboratory Mix Design
- Field Validation
- Limited Fatigue

Final Procedure
- Draft Appendix to AASHTO R35

Special Mixture Design Considerations and Methods for WMA
NCHRP 9-43 Conclusion 1

- WMA can be designed with only minor changes to AASHTO R35
  - Specimen fabrication procedures
  - Coating and compactability in lieu of viscosity based mixing and compaction temperatures
NCHRP 9-43 Conclusion 2

- For mixtures using the same aggregates and binders and having binder absorption equal to or less than 1 percent
  - Volumetric properties of WMA and HMA are very similar
  - Compactability, moisture sensitivity, and rutting resistance may be different when designed as WMA compared to HMA
NCHRP 9-43 Conclusion 3

- Fatigue properties of HMA and WMA are very similar
NCHRP 9-43 Products

• NCHRP Report 691
• Recommended Draft Appendix to AASHTO R35, *Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)*
• Commentary to the Draft Appendix
• Training Materials for the Draft Appendix
  - NHI Web-Course ~ September 2011
1. Equipment for Designing WMA,
2. WMA Process Selection,
3. Binder Grade Selection,
4. RAP in WMA,
5. Process Specific Specimen Fabrication Procedures,
6. Evaluation of Coating
7. Evaluation of Compactability,
8. Evaluation of Moisture Sensitivity,
9. Evaluation of Rutting Resistance, and
10. Adjusting the Mixture to Meet Specification Requirements.

Proposed Appendix to AASHTO R35

Appendix: Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)

1. PURPOSE
1.1. This appendix presents special mixture design considerations and methods for designing warm mix asphalt (WMA) using AASHTO R35. WMA refers to asphalt concrete mixtures that are produced at temperatures approximately 50 °F (28 °C) or more cooler than typically used in the production of HMA. The goal with WMA is to produce mixtures with similar strength, durability, and performance characteristics as HMA using substantially reduced production temperatures.
1.2. The methods in this appendix are applicable to a wide range of WMA processes including:
   - WMA additives that are added to the asphalt binder,
   - WMA additives that are added to the mixture during production,
   - Sequential mixing processes, and
   - Plant foaming processes.
1.3. The information in this appendix supplements the standard procedures contained in AASHTO R35. This appendix assumes the user is proficient with the standard procedures contained in AASHTO R35.

2. SUMMARY
2.1. This appendix includes separate sections addressing the following aspects of WMA mixture design:
   - Equipment for designing WMA,
   - WMA Process Selection,
   - Binder Grade Selection,
   - RAP in WMA,
   - Process Specific Specimen Fabrication Procedures,
   - Evaluation of Coating
   - Evaluation of Compactability,
   - Evaluation of Moisture Sensitivity,
   - Evaluation of Rutting Resistance, and
   - Adjusting the Mixture to Meet Specification Requirements.
2.2. In each section, reference is made to the applicable section of AASHTO R35.
1 Additional Equipment

Low Shear Mixer to Blend Additive into Binder
1 Additional Equipment

Mechanical Mixer Needed of All WMA Designs
1 Additional Equipment

Laboratory Foaming Device Needed for Plane Foaming Processes
2 WMA Process Selection

• WMA mix design requires the producer to select
  - WMA process
  - Planned production temperature
  - Planned compaction temperature

• Laboratory specimen fabrication
2 WMA Process Selection

- Producer should consider
  - Agency specifications
  - Past performance and technical support
  - Cost
  - Useful temperature range
  - Production rates
  - Modifications
3 Binder Grade Selection

- Use same grade as HMA

Low Temperature Grades:
- Sasobit -47 F
- LEA -100 F
- Plant Foam -60 F
- Evotherm -50 F
- Advera -47 F

High Temperature Grades:

Change in Grade (HMA Control - WMA), °C
4 RAP

• RAP Does Mix at WMA Temperatures
  - Atomic Force Microscope Interfacial Mixing Study
  - Laboratory Blending Studies
    • Measured Dynamic Modulus to Estimated Dynamic Modulus for Fully Blended Condition

• Mechanism
  - New Coats RAP, Then Continues to Mix While Held at Elevated Temperature
Special Mixture Design Considerations and Methods for WMA

4 RAP

<table>
<thead>
<tr>
<th>Measured to Hirsch Estimated Fully Blended Dynamic Modulus, 68 F, 1.0 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-Term Conditioning Time, hr</td>
</tr>
</tbody>
</table>

- HMA 280/255
- HMA 248/230
- WMA 248/230
- WMA 230/212
- No RAP
4 RAP

- To Ensure Adequate Mixing
  - High temperature grade of RAP $\leq$ planned compaction temperature
Special Mixture Design Considerations and Methods for WMA
Special Mixture Design Considerations and Methods for WMA

4 RAP

Change in Grade (HMA Control - WMA), °C

-6.0

0.0

6.0

Low Temperature Grade

High Temperature Grade

Sasobit -47 F

LEA -100 F

Plant Foam -60 F

Evotherm -50 F

Advera -47 F
4 RAP

Special Mixture Design Considerations and Methods for WMA
5 Specimen Fabrication

Additive Added to the Binder
5 Specimen Fabrication

Additive Added to the Mixture
5 Specimen Fabrication

Wet Aggregate Mixtures
5 Specimen Fabrication

Foamed Asphalt Mixtures
5 Specimen Fabrication

- Short-Term Conditioning
  - 2 hours at Planned Compaction Temperature

- Compactive Effort and Volumetric Criteria
  - Same as HMA
6 Coating

- Separate coarse aggregates
  - 9.5 mm sieve for NMAS 12.5 mm and larger
  - 4.75 mm sieve for NMAS 9.5 and smaller
  - Min 200 particles

\[
\% \text{ Coated Particles} = \left( \frac{\# \text{ of Fully Coated Particles}}{\text{Total \# of Particles}} \right) \times 100\%
\]

- >= 95 percent
6 Coating

- Differences Observed for Planetary vs Bucket Mixers
- Mixing Times in Appendix Based on Planetary Mixer
- May Require Adjustment for Bucket Mixers
7 Compactability

- Compact 2 specimens to $N_{\text{design}}$ at the planned compaction temperature
  - Compute gyrations to 92% of Gmm
- Compact 2 specimens to $N_{\text{design}}$ at 30 °C below the planned compaction temperature
  - Compute gyrations to 92% of Gmm

\[
\text{Ratio} = \frac{(N_{92})_{T-30}}{(N_{92})_{T}} \leq 1.25
\]
7 Compactability

% Increase in Gyrations to 92% of Gmm for 30 °C Reduction in Temperature

Mixture Type

- HMA
- Advera
- Sasobit
8 Moisture Sensitivity

- AASHTO T283
  - Short-Term Condition 2 hours at Compaction Temperature
  - TSR >= 0.80 with no visual stripping
9 Rutting Resistance

- Flow Number AASHTO TP 79
  - Short-Term Condition 2 hours at Compaction Temperature

<table>
<thead>
<tr>
<th>Traffic Level, Million ESALs</th>
<th>Minimum Flow Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;3</td>
<td>NA</td>
</tr>
<tr>
<td>3 to &lt; 10</td>
<td>30</td>
</tr>
<tr>
<td>10 to &lt; 30</td>
<td>105</td>
</tr>
<tr>
<td>≥ 30</td>
<td>415</td>
</tr>
</tbody>
</table>
9 Rutting Resistance

• Testing Conditions
  - Air Voids = 7.0 +/- 0.5 percent
  - Temperature = 50 % reliability high pavement temperature from LTPPBind 3.1
    • Depth of 20 mm for surface courses, top of layer for intermediate and base courses
    • No adjustments for traffic or speed
  - Unconfined
  - 600 kPa repeated deviator stress, 30 kPa contact deviator stress
10 Adjustments

- Coating
- Compactability
- Moisture Sensitivity
- Rutting Resistance
  - Change binder grade
  - Add RAP
  - Increase filler content
  - Decrease VMA
  - Increase $N_{\text{design}}$

Consult WMA Technology Supplier
# Converting HMA Designs to WMA

## Mixture Identification Process

<table>
<thead>
<tr>
<th>No.</th>
<th>$N_{\text{design}}$</th>
<th>Aggregate Absorption</th>
<th>RAP</th>
<th>HMA</th>
<th>WMA A</th>
<th>WMA B</th>
<th>WMA C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50</td>
<td>High</td>
<td>Yes</td>
<td>320/310</td>
<td>270/260</td>
<td>225/215</td>
<td>225/215</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>Low</td>
<td>No</td>
<td>320/310</td>
<td>225/215</td>
<td>270/260</td>
<td>270/260</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>Low</td>
<td>Yes</td>
<td>320/310</td>
<td>270/260</td>
<td>270/260</td>
<td>225/215</td>
</tr>
<tr>
<td>4</td>
<td>75</td>
<td>High</td>
<td>No</td>
<td>320/310</td>
<td>225/215</td>
<td>225/215</td>
<td>270/260</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>High</td>
<td>Yes</td>
<td>320/310</td>
<td>225/215</td>
<td>270/260</td>
<td>270/260</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>Low</td>
<td>No</td>
<td>320/310</td>
<td>270/260</td>
<td>225/215</td>
<td>225/215</td>
</tr>
</tbody>
</table>

Paired t-test WMA-HMA
Design Binder Content

Average Difference in Design Binder Content, wt. %

WMA Process A  WMA Process B  WMA Process C

Binder Absorption 0.5 to 1.0 %

Special Mixture Design Considerations and Methods for WMA
Special Mixture Design Considerations and Methods for WMA

Graph: Binder Absorption

Average Difference in Binder Absorption, wt %

WMA Process A: 
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35

WMA Process B: 
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35

WMA Process C: 
-0.35
-0.30
-0.25
-0.20
-0.15
-0.10
-0.05
-0.00
-0.05
-0.10
-0.15
-0.20
-0.25
-0.30
-0.35
Compactability

Average Difference in Gyration Ratio, %

WMA Process A  WMA Process B  WMA Process C

Without RAP  25 Percent RAP

Special Mixture Design Considerations and Methods for WMA
Moisture Sensitivity

Average Difference in Tensile Strength Ratio, %

<table>
<thead>
<tr>
<th>WMA Process A</th>
<th>WMA Process B</th>
<th>WMA Process C</th>
</tr>
</thead>
<tbody>
<tr>
<td>-20</td>
<td>-10</td>
<td>-20</td>
</tr>
</tbody>
</table>

Special Mixture Design Considerations and Methods for WMA
Flow Number

Average Difference in Flow Number, %

WMA Process A  WMA Process B  WMA Process C

-80.0  -70.0  -60.0  -50.0  -40.0  -30.0  -20.0  -10.0  0.0
Additional Information

NCHRP Report 691
http://www.trb.org/Main/Blurbs/165013.aspx

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Appendix to AASHTO R35
Special Mixture Design
Considerations and Methods for
Warm Mix Asphalt:
How the Appendix Works

Brian D. Prowell, Ph.D., P.E.
Advanced Materials Services, LLC
NCHRP 9-47A: Properties and Performance of Warm Mix Asphalt Technologies

Team: National Center for Asphalt Technology, AMS, Heritage Research, and Bob Frank

Objectives:

• Establish Relationships among engineering properties of WMA and field performance,
• Determine relative performance between WMA and HMA,
• Compare production and lay down practices, and
• Provide relative emissions measurement of WMA compared to HMA.

One of the deliverables is recommended modifications to AASHTO R35
Research Plan Related to R35 Appendix

• Sample 8 projects
• Perform Mix verification of three multi-technology sites (IN, MI, and NY) and two additional single technology sites
• Match measured field gradation when performing verification to allow comparison between field-produced and lab-produced material
• Note: for the seven sites tested to date, WMA mix designs were not performed by the contractor, rather the HMA design was used.
First Step: Selection of a WMA Technology

• Which WMA technology is best?
• It depends, considerations:
  – How many tons of WMA do you expect to produce?
  – Some processes have higher upfront equipment costs, others have higher additive costs, included in every ton
  – What sort of temperature reduction do you want?
  – Is binder modification a concern?
Producing WMA in the Lab
No Hand Mixing!

R35 Appendix recommendations based on a planetary mixer.

NCHRP 9-47A investigating bucket mixer. If laboratory coating matches field coating, 90-second mixing time adequate.

C/o AAT
Preparing WMA in Laboratory

- Binder additives, mix additives, and mixtures with wet aggregate fraction relatively easy
- Foamed asphalt mixes require specialized equipment

Low-cost method for blending binder additives
# Free-Water or Mechanical Foaming Systems

<table>
<thead>
<tr>
<th>System</th>
<th>Manufacturer</th>
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<tbody>
<tr>
<td>Accu-Shear™</td>
<td>StanSteel®</td>
</tr>
<tr>
<td>AQUABlack™ WMA System</td>
<td>Maxam Equipment, Inc</td>
</tr>
<tr>
<td>AquaFoam</td>
<td>AquaFoam, LLC</td>
</tr>
<tr>
<td>Double Barrel® Green</td>
<td>Astec</td>
</tr>
<tr>
<td>Eco-Foam II</td>
<td>AESCO/MADSEN</td>
</tr>
<tr>
<td>Meeker Warm Mix</td>
<td>Meeker Equipment</td>
</tr>
<tr>
<td>Terex® WMA System</td>
<td>Terex® Roadbuilding</td>
</tr>
<tr>
<td>Tri-Mix Warm Mix Injection System</td>
<td>Tarmac International, Inc.</td>
</tr>
<tr>
<td>Ultrafoam GX2™</td>
<td>Gencor Industries, Inc.</td>
</tr>
</tbody>
</table>
How much water is added?

- Zeolite – approx. 1.25 lbs/ton
- Free water systems - approx. 2 lbs/ton
- LEA – approx. 28 lbs/ton
- Evotherm emulsion – approx. 55 lbs/ton
Laboratory Foaming Devices

Wirtgen

Kolo Veidekke

These devices can be as expensive, or more expensive than their field counterparts.
Selecting Mixing and Compaction Temperatures
What Controls Minimum Production Temperature? Coating?
What Controls Minimum Production Temperature?

Amperage or Flow?

Coater
What Controls Minimum Production Temperature?

Compaction or Workability?
Selecting Mixing and Compaction Temperatures

• Are you trying to produce WMA or are you trying to use a WMA technology as a compaction aid to address long-haul distances or cold-weather paving?

• Technology supplier’s recommendation

• For volumetric properties, can probably error towards lower temperatures

• Higher temperatures may be beneficial for moisture sensitivity and flow number due to increased binder aging

• Using observed field mixing and compaction temperatures for NCHRP 9-47A
Selecting Mixing and Compaction Temperatures

• The Draft Appendix for R35 does not recommend mixing and compaction temperatures, rather it provides tools to evaluate the selected temperatures
  – Coating – Ross Count – AASHTO T195
  – Compactability – Ratio of gyrations to 92% relative density at proposed compaction temperature and 30°F lower.
## Coating

<table>
<thead>
<tr>
<th>Project</th>
<th>Mix Type</th>
<th>Asphalt Content, %</th>
<th>Mixing Temp., °F</th>
<th>Lab Coating, %</th>
<th>Field Coating, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>Mixture Additive A</td>
<td>5.34</td>
<td>275</td>
<td>98.5</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>Binder Additive A</td>
<td>5.00</td>
<td>275</td>
<td>100.0</td>
<td>99.6</td>
</tr>
<tr>
<td>Montana</td>
<td>Mixture Additive B</td>
<td>5.80</td>
<td>250</td>
<td>98.5</td>
<td>98.8</td>
</tr>
</tbody>
</table>

Laboratory Ross Count samples prepared with bucket mixer with 90 second mixing time.
## Compactability

<table>
<thead>
<tr>
<th>Project</th>
<th>Mix Type</th>
<th>Asphalt Content, %</th>
<th>Compaction Temperature, °F</th>
<th>Compactability Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Design</td>
<td>Design - 54 °F</td>
</tr>
<tr>
<td>Michigan</td>
<td>Mixture</td>
<td>5.34</td>
<td>250</td>
<td>196</td>
</tr>
<tr>
<td></td>
<td>Additive A</td>
<td>Binder Additive A</td>
<td>5.00</td>
<td>250</td>
</tr>
<tr>
<td>Montana</td>
<td>Mixture</td>
<td>5.76</td>
<td>235</td>
<td>181</td>
</tr>
<tr>
<td></td>
<td>Additive B</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: R35 Appendix specifies Compactability Ratio < 1.25
Determine Optimum Asphalt Content
## Michigan Optimum AC%

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Compaction Temperature, °F</th>
<th>Asphalt Content, %</th>
<th>JMF</th>
<th>Production</th>
<th>Lab Verified</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMA</td>
<td>300 (255)$^1$</td>
<td></td>
<td>5.30</td>
<td>5.26</td>
<td>5.32</td>
</tr>
<tr>
<td>Mix Additive A</td>
<td>250 (230)</td>
<td></td>
<td>5.34</td>
<td>4.95</td>
<td></td>
</tr>
<tr>
<td>Binder Additive A</td>
<td>250 (240)</td>
<td></td>
<td>5.00</td>
<td>4.83</td>
<td></td>
</tr>
</tbody>
</table>

$^1$Temperature in () is average temperature observed behind screed.
Michigan - VMA

![Graph showing VMA (%) vs. AC% for different mixtures: HMA, Mix Additive A, Binder Additive A.](image-url)
## Montana Optimum AC%

<table>
<thead>
<tr>
<th>Mix Type</th>
<th>Compaction Temperature, °F</th>
<th>Asphalt Content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>270</td>
<td>5.80</td>
</tr>
<tr>
<td>HMA Control</td>
<td>270</td>
<td>5.69</td>
</tr>
<tr>
<td>Additive B</td>
<td>235</td>
<td>5.76</td>
</tr>
</tbody>
</table>
Montana

![Montana Graph]

- **VMA, %**
- **AC, %**

- **Mixture Additive B**
- **HMA**
# Tensile Strength Ratio (TSR)  
**AASHTO T283**

<table>
<thead>
<tr>
<th>Project</th>
<th>Mix Type</th>
<th>Lab or Field</th>
<th>Conditioned Tensile Strength, psi</th>
<th>Unconditioned Tensile Strength, psi</th>
<th>TSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>MI</td>
<td>Mix</td>
<td>Field</td>
<td>30.8</td>
<td>35.1</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>Additive A</td>
<td>Lab</td>
<td>37.0</td>
<td>57.7</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>Binder</td>
<td>Field</td>
<td>36.6</td>
<td>36.6</td>
<td>1.00</td>
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<tr>
<td></td>
<td>Additive A</td>
<td>Lab</td>
<td>43.1</td>
<td>51.4</td>
<td>0.84</td>
</tr>
<tr>
<td>MT</td>
<td>Mix</td>
<td>Field</td>
<td>63.5</td>
<td>67.3</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>Additive B</td>
<td>Lab</td>
<td>60.7</td>
<td>62.8</td>
<td>0.97</td>
</tr>
</tbody>
</table>
## Unconfined Flow Number

<table>
<thead>
<tr>
<th>Project</th>
<th>Mix Type</th>
<th>Test Temperature, °C</th>
<th>Flow Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michigan</td>
<td>Mix Additive A</td>
<td>42</td>
<td>78&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Binder Additive A</td>
<td>42</td>
<td>66&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>1</sup>Exceeds requirement for >3 to 10 million ESALs
Thanks

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AASHTO Subcommittee on Materials

- Responsible for AASHTO Materials Standards:
  - Specifications
  - Test Methods
  - Practices
NCHRP Research

- Research of Interest to State DOTs

- Draft Standards Developed as Part of NCHRP Reports
  - New Standards
  - Revisions
  - Additions
11/10/10 DRAFT

Proposed Appendix to AASHTO R35

Appendix: Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)

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1.3. The information in this appendix supplements the standard procedures contained in AASHTO R35. This appendix assumes the user is proficient with the standard procedures contained in AASHTO R35.

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   - Evaluation of Coating
   - Evaluation of Compactability,
   - Evaluation of Moisture Sensitivity,
   - Evaluation of Rutting Resistance, and
   - Adjusting the Mixture to Meet Specification Requirements.

2.2. In each section, reference is made to the applicable section of AASHTO R35.
Informative Strive to Adopt “Best Practice” Supported by Research
AASHTO Subcommittee on Materials Approval Process

- Technical Section Ballot – Pass by 2/3 Vote
- Subcommittee Ballot – Pass by 2/3 Vote
- Address Negative Votes and Comments
Status of WMA Appendix for R 35

- Technical Section 2d – Proportioning of Asphalt-Aggregate Mixtures
- 37 States - Voting Members on Technical Section
- Technical Section Ballot Issued – July 2011
- There were No Negative Votes
- Comments Addressed at SOM Meeting – Aug. 2011

- Moved to Subcommittee Ballot - Nov. 2011
<table>
<thead>
<tr>
<th>Concern</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Concurred with Non-Mandatory Appendix</td>
<td>• Apply when WMA Process is Used.</td>
</tr>
<tr>
<td>• Should Appendix only address -50°F WMA?</td>
<td>• Yes, to check Performance Properties</td>
</tr>
<tr>
<td>• Is laboratory foamer necessary?</td>
<td></td>
</tr>
</tbody>
</table>
Technical Section Comments

Concern

• Does laboratory foaming correlate with field foaming?

• Does laboratory curing represent WMA in pavement applications?

Response

• NCHRP 9-53 “Asphalt Foaming Characteristics for WMA Applications

• NCHRP 9-52 “Short-Term Laboratory Conditioning of WMA Mixtures for Mix Design and Performance Testing”
## Technical Section Comments

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>Susceptibility of WMA to Moisture Damage?</td>
<td>NCHRP 9-49 “Performance of WMA Technologies: Stage I-Moisture Susceptibility</td>
</tr>
<tr>
<td>Is TP 79 (AMPT) the only method to evaluate rutting performance?</td>
<td>A Note will be included to mention the use of other methods (APA and Hamburg)</td>
</tr>
</tbody>
</table>
## Technical Section Comments

<table>
<thead>
<tr>
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<tr>
<td>• There needs to be more direction on the use of RAS.</td>
<td>• SOM endorsed an NCHRP Problem Statement to further explore the use of RAP, RAS, and RAP/RAS combinations in WMA</td>
</tr>
<tr>
<td>• Some clarification and examples are needed.</td>
<td>• Changes will be made to Appendix for SOM Ballot</td>
</tr>
</tbody>
</table>
What’s Next

• SOM Ballot – Nov. 2011
• If Approved – Published as an Appendix to R 35 in the 2012 Edition of the AASHTO Materials Standards
• Available August 2012
• Revised as Needed as Research is Completed
  – FHWA Warm Mix and Asphalt Mixture ETG review