Asphalt Mixture ETG - Activities

- Asphalt Mixture Performance Tester
- RAP & RAS Technology Deployment
- WMA Technology Deployment
- Revise & Update AASHTO Test Standards
- Mix Design Manual  NCHRP 9-33
Asphalt Mix Performance Tester (AMPT)

- Refined under NCHRP 9-29 (AAT)
- Input AASHTOware® Pavement™ ME Design
- Dynamic Modulus $/E^*/$ and Flow ($F_n$)
- AASHTO Standards: PP 60, TP 79, & PP 61
- New: Flow Number standardization
- Specimen air void tolerance
- New: Fatigue testing protocols
AMPT Flow Number standardization

Published as Appendix within AASHTO TP 79-13

X1. EVALUATE RUTTING RESISTANCE USING THE FLOW NUMBER TEST

X1.1 Scope:

X1.1.1 This procedure establishes a method to evaluate the rutting resistance of asphalt paving mixtures using the TP 79, Flow Number test in the AMPT.

X1.2 Procedure:

X1.2.1 Input the test parameters listed in Table X1.2.1.1 to the AMPT control software for the Flow Number test.

Table X1.2.1 – TP 79 Flow Number Test Conditions

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>HMA</th>
<th>WMA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Temperature</td>
<td>1- (600 kPa)</td>
<td>1- (600 kPa)</td>
</tr>
<tr>
<td>Deviator Stress</td>
<td>87 psi (600 kPa)</td>
<td>87 psi (600 kPa)</td>
</tr>
<tr>
<td>Contact Stress</td>
<td>5% of deviator stress</td>
<td>5% of deviator stress</td>
</tr>
<tr>
<td>Confining Stress</td>
<td>0 psi (0 kPa)</td>
<td>0 psi (0 kPa)</td>
</tr>
</tbody>
</table>

1- Determine the project design temperature using LTTPBind version 3.1; computed using 50% reliability, at a 20 mm depth for surface courses and the top of the pavement layer for intermediate and base courses.

X1.2.2 Determine the flow number for each specimen, and average the results. Compare the average flow number with the criteria in Table X1.2.2.

Table X1.2.2 – Minimum Flow Number Requirements

<table>
<thead>
<tr>
<th>Traffic Level, million ESAL's</th>
<th>HMA, minimum Flow Number</th>
<th>WMA, minimum Flow Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>3 to &lt; 10</td>
<td>50</td>
<td>30</td>
</tr>
<tr>
<td>10 to &lt; 30</td>
<td>190</td>
<td>105</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>740</td>
<td>415</td>
</tr>
</tbody>
</table>
# NCHRP 9-47A – HMA Flow Number ($F_n$) Results

<table>
<thead>
<tr>
<th>Project</th>
<th>Route</th>
<th>Mix Heating</th>
<th>$F_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker, MT</td>
<td>Route 322</td>
<td>Reheated</td>
<td>98</td>
</tr>
<tr>
<td>Rapid River, MI</td>
<td>CR-513</td>
<td>Reheated</td>
<td>199</td>
</tr>
<tr>
<td>Casa Grande, AZ</td>
<td>SR 84</td>
<td>No</td>
<td>61</td>
</tr>
<tr>
<td>Jefferson Co., FL</td>
<td>SR 30</td>
<td>No</td>
<td>414</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reheated</td>
<td>231</td>
</tr>
<tr>
<td>Queens, NY</td>
<td>Little Neck Pkwy</td>
<td>No</td>
<td>291</td>
</tr>
<tr>
<td>Munster, IN</td>
<td>Calumet Ave.</td>
<td>No</td>
<td>561</td>
</tr>
<tr>
<td>Walla Walla, WA</td>
<td>US-12</td>
<td>No</td>
<td>332</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reheated</td>
<td>426</td>
</tr>
<tr>
<td>Centreville, VA</td>
<td>I-66</td>
<td>Reheated</td>
<td>1,855</td>
</tr>
</tbody>
</table>

### HMA $F_n$ Criteria

<table>
<thead>
<tr>
<th>Traffic, MESALs</th>
<th>$F_n$ Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>n/a</td>
</tr>
<tr>
<td>3 to &lt;10</td>
<td>50</td>
</tr>
<tr>
<td>10 to &lt;30</td>
<td>190</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>740</td>
</tr>
</tbody>
</table>

---

U.S. Department of Transportation
Federal Highway Administration
### NCHRP 9-47A – WMA Flow Number ($F_n$) Results

<table>
<thead>
<tr>
<th>Project</th>
<th>Route</th>
<th>Mix Heating</th>
<th>WMA Technology</th>
<th>$F_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baker, MT</td>
<td>Route 322</td>
<td>RH</td>
<td>Evotherm DAT</td>
<td>58</td>
</tr>
<tr>
<td>Rapid River, MI</td>
<td>CR-513</td>
<td>RH</td>
<td>Advera</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RH</td>
<td>Evotherm 3G</td>
<td>65</td>
</tr>
<tr>
<td>Casa Grande, AZ</td>
<td>SR 84</td>
<td>No</td>
<td>Sasobit</td>
<td>46</td>
</tr>
<tr>
<td>Jefferson Co., FL</td>
<td>SR 30</td>
<td>RH</td>
<td>Terex Foam</td>
<td>127</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Terex Foam</td>
<td>157</td>
</tr>
<tr>
<td>Queens, NY</td>
<td>Little Neck Pkwy</td>
<td>No</td>
<td>Cecabase</td>
<td>115</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>SonneWarmix</td>
<td>123</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>BituTech PER</td>
<td>128</td>
</tr>
<tr>
<td>Munster, IN</td>
<td>Calumet Ave.</td>
<td>No</td>
<td>Evotherm 3G</td>
<td>177</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Gencor Foam</td>
<td>217</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No</td>
<td>Heritage Wax</td>
<td>314</td>
</tr>
<tr>
<td>Walla Walla, WA</td>
<td>US-12</td>
<td>No</td>
<td>Maxam Aquablack</td>
<td>200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RH</td>
<td>Maxam Aquablack</td>
<td>227</td>
</tr>
<tr>
<td>Centreville, VA</td>
<td>I-66</td>
<td>RH</td>
<td>Astec DBG</td>
<td>439</td>
</tr>
</tbody>
</table>

### Traffic, MESALs

<table>
<thead>
<tr>
<th>Traffic, MESALs</th>
<th>Min. $F_n$</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 3</td>
<td>n/a</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>&gt; 30</td>
<td>415</td>
</tr>
</tbody>
</table>

**WMA $F_n$ criteria**

AASHTO TP-79 Appendix 2

Federal Highway Administration
Recycled Asphalt Pavement (RAP)

• NCHRP 9-46 “Mix Design and Evaluation Procedure for High Reclaimed Asphalt Pavement Content in HMA”

• Completed
  – published as NCHRP Report No. 752

• Report recommendations are under review by ETG
  – Potential changes to M323 and R35?
### RAP Usage in HMA/WMA

#### Percentage of Total Mix Production in USA

<table>
<thead>
<tr>
<th>Year</th>
<th>Total HMA/WMA Mix (million tons)</th>
<th>RAP Utilized (million tons)</th>
<th>Percentage Utilized</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>358.4</td>
<td>67.2</td>
<td>16%</td>
</tr>
<tr>
<td>2010</td>
<td>359.8</td>
<td>73.5</td>
<td>20%</td>
</tr>
<tr>
<td>2011</td>
<td>366.0</td>
<td>79.1</td>
<td>20%</td>
</tr>
<tr>
<td>2012</td>
<td>356.6</td>
<td>70.4</td>
<td>20%</td>
</tr>
</tbody>
</table>

*Percentages are based on RAP utilized for new asphalt mixtures only.*
Recycled Asphalt Shingles (RAS)

- Current AASHTO PP 53 and MP 15 Standards about to “expire”
- ETG Taskforce recommendations for draft revisions to AASHTO Standards PP 53 and MP 15
- Revisions forwarded on to AASHTO Subcommittee on Materials (SOM) for their consideration and balloting
**RAS Usage in HMA/WMA**

**Total** RAS tons used for mix production in USA

<table>
<thead>
<tr>
<th>Year</th>
<th>Total asphalt mix (million tons)</th>
<th>2009 RAS tons</th>
<th>2010 RAS tons</th>
<th>2011 RAS tons</th>
<th>2012 RAS tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009</td>
<td>358.4</td>
<td>702 thousand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>359.8</td>
<td>1,100 thousand</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>366.0</td>
<td></td>
<td>1,192 thousand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>356.6</td>
<td></td>
<td></td>
<td>1,861 thousand</td>
<td></td>
</tr>
</tbody>
</table>

Total RAS tons used for mix production in USA:
### NCHRP Projects funded as a result of WMA TWG efforts:

<table>
<thead>
<tr>
<th>Project Code</th>
<th>Description</th>
<th>Cost</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-43</td>
<td>- Mix Design Practices for WMA</td>
<td>$522,501</td>
<td>completed</td>
</tr>
<tr>
<td>9-47</td>
<td>- Engineering Properties, Emissions, and Field Performance of WMA Technologies</td>
<td>$79,000</td>
<td>completed</td>
</tr>
<tr>
<td>9-47A</td>
<td>- Properties and Performance of WMA Technologies</td>
<td>$1,121,000</td>
<td>Jun 2013</td>
</tr>
<tr>
<td>9-49</td>
<td>- Performance of WMA</td>
<td>$450,000</td>
<td>completed</td>
</tr>
<tr>
<td>9-49A</td>
<td>- Performance of WMA Stage I--Moisture Susceptibility</td>
<td>$900,000</td>
<td>Jul 2016</td>
</tr>
<tr>
<td>9-52</td>
<td>- Performance of WMA Stage II--Long-Term Field Performance</td>
<td>$800,000</td>
<td>Nov 2014</td>
</tr>
<tr>
<td>9-53</td>
<td>- Properties of Foamed Asphalt for Warm Mix Asphalt Applications</td>
<td>$700,000</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>9-54</td>
<td>- Long-Term Aging of Asphalt Mixtures for Performance Testing and Prediction</td>
<td>$800,000</td>
<td>May 2016</td>
</tr>
<tr>
<td>9-55</td>
<td>- Recycled Asphalt Shingles in Asphalt Mixtures with WMA Technologies</td>
<td>$600,000</td>
<td>Sept 2016</td>
</tr>
<tr>
<td>9-58</td>
<td>- Effects of Recycling Agents on Asphalt Mixtures w/High RAS &amp; RAP Binder Ratios</td>
<td>$1,500,000</td>
<td>July 2017 est.</td>
</tr>
<tr>
<td>20-07 (311)</td>
<td>- Development of a WMA Tech. Evaluation Program</td>
<td>$50,000</td>
<td>completed</td>
</tr>
</tbody>
</table>

**Total**: $7,522,501
Objectives:

(1) Evaluate the effectiveness of recycling agents in HMA and WMA mixtures with high RAS, RAP, or combined RAS/RAP binder ratios through a coordinated program of laboratory and field experiments;

(2) Propose revisions to several relevant AASHTO specifications and test methods;

(3) Develop training and workshop materials and deliver one workshop.
WMA Usage in HMA/WMA

Percentage of **Total** Mix Production in USA

<table>
<thead>
<tr>
<th>Year</th>
<th>Total HMA/WMA mix: (million tons)</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>16.8</td>
<td>41.1</td>
<td>68.7</td>
<td>85</td>
</tr>
<tr>
<td>2009</td>
<td>358.4</td>
<td>5%</td>
<td>11%</td>
<td>19%</td>
<td>24%</td>
</tr>
<tr>
<td>2010</td>
<td>359.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>366.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>356.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2006 WMA trials begin
WMA Usage by Technology

Percent of market for WMA production in USA
• Road Science™ division of ArrMaz
  – AD-here® with CECABASE™ RT 945*
• Engineered Additives LLC
  – BituTech RAP, BituTech PER, BituTech WA1, BituTech VPW (products also listed as recycling/rejuvenating agents)
• GreenMantra Technologies**
  – Synthetic wax derived from recycled plastics

*CECA, a subsidiary of the Arkema Group in France, through its affiliate, Arkema Inc., and Road Science, a division of ArrMaz, Inc., announced they have signed a distribution agreement in which Road Science will be the exclusive USA distributor of CECA’s warm mix asphalt additive, CECABASE™ RT.

**GreenMantra Technologies announced that Paul Veillette, former President & CEO of Sasol Wax Americas, has joined GreenMantra as Vice President of Sales.
Expansion of NCHRP 9-43 Mix Design Study on Higher Absorption Mixtures

• Original Project 9-43
  – Binder Absorption limited to 0.5 - 1.0 %

• ETG Work Item: Expansion to Higher Absorption Mixtures ≥ 2.0%
  – Includes High Absorption Laboratory Foamed Mixtures

• Dr. Ray Bonaquist, AAT
  – Scheduled for completion Jan – Feb 2014
• Report:
  http://www.trb.org/Main/Blurbs/165467.aspx
  • A Manual for Design of Hot-Mix Asphalt with Commentary
  • Adapting Specification Criteria for Simple Performance Tests to HMA Mix Design

• Performance Test Criteria

• NCHRP 9-33 maintain existing $N_{\text{design}}$ criteria

• Proposed Specification: to be used as a preliminary selection of mix parameters as a starting point for mix testing...
Multiple Stress Creep Recovery (MSCR)
  - TP 70 MSCR Test of Asphalt Binder Using DSR
  - MP 19 MSCR Performance Graded Asphalt Binder
Ground Tire Rubber Implementation
Revise & Update AASHTO Test Standards
FHWA is working with the Asphalt Institute to assist States to effectively understand and implement MSCR & also better understand successful GTR utilization.

• Technical Brief FHWA-HIF-11-038

• Resources posted on AI’s website
• MSCR – AASHTO TP 70 Revisions
  – Recommendations from ETG (May 2013 Corrigan & D’Angelo) on equipment tolerance for extrapolating creep and recovery data at 1 sec and 10 sec for each cycle local time within TP 70
  – Revise section 7.3 and add 7.4 to clarify wording and ensure critical data are obtained. Also add a note regarding negative percent recovery
  – SOM TS 2b motion was made to move these changes to concurrent ballot
• MSCR – AASHTO MP 19
  – Recommendations from ETG on maximum $J_{nr}$ for Standard Grade moved from 4.0 to 4.5 kPa$^{-1}$
  – SOM TS 2b motion was made to move these changes to concurrent ballot
MSCR – AASHTO TP 70 & MP 19

- NEAUPG asked the TS to consider moving TP 70 and MP 19 to full standards.
  - Plans to adopt MP 19 for specifying modified binders starting in 2014
  - Recommended changes
    - “PG 64-22, Grade V” to “PG 64V-22” designation
    - Move Elastic Response Appendix X2 from TP 70 to MP 19 Appendix X1
  - SOM TS 2b motion to send these changes to concurrent ballot and also ballot to move TP 70 and MP 19 to “full standards”
“Standard Practice for Evaluating the Elastic Behavior of Asphalt Binders Using the Multiple Stress Creep Recovery (MSCR) Test”

Background and work elements provided by Mike Anderson (May 2013 & Sept 2013 ETG)
Includes FIGURE 1: Comparison of MSCR Jnr-3.2 and Rec-3.2 to Assess Elastic Response

The curve stops at Jnr-3.2 = 2.00 kPa⁻¹ and 0.1 kPa⁻¹. Jnr-3.2 values greater than 2.00 kPa⁻¹ are not required to have any minimum Rec-3.2 value. Jnr-3.2 values less than 0.10 kPa⁻¹ are required to have a minimum Rec-3.2 value of 55%.
• New Task Force
  – MSCR Temperature task force consisting of Matthew Corrigan- FHWA (lead), John D’Angelo, Darren Hazlett (TX), Lyndi Blackburn (Alabama), Mike Anderson (Asphalt Institute), Chris Abadie (LA), and Eileen Sheehy (NJ) was put together to develop further guidance on temperature selection for TP 70
Ground Tire Rubber (GTR)

Testing Challenges

Equipment Limitations

Potential Solutions

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

- **Solubility limitations**
  - Current AASHTO M 320 requires the asphalt binder shall be at least 99.0 percent soluble as determined by T 44 or ASTM D 5546.

- **Handling/re-heating of AR binders**
  - Impact on test results due to additional reaction or additional degradation of GTR
Can it fit within existing PG grading system?

- **RTFO limitations**
  - Cannot achieve coating at higher GTR concentrations
  - In order to mainstream GTR in PG system, we may need to use softer base binders or target a lower percent GTR needed in order to achieve a reacted PG 70, 76 or 82?
Can it fit within existing PG grading system?

- Impact of binder crude source compatibility with GTR source?
  - Some binder/GTR source combinations react well, while others do not react
  - Impact on percent GTR required/allowed to meet PG grade or rotational viscosity requirements
Can it fit within existing PG grading system?

- **DSR Parallel Plate Geometry**
  - 2 mm, 3 mm, & 4 mm gap considered

- **GTR particle size & concentration limitations**
  - DSR currently limited to a max. of 25% of gap size
  - Size of non-reacted GTR vs reacted GTR in binder
    - GTR particle size increases with reaction (it can double)
  - Particle influence with increased concentrations
    - Non-homogenous or mastic behavior?
Ground Tire Rubber (GTR)

- DSR Cup & Bob Geometry is being explored
- GTR blending study – size, source, %
- Evaluate GTR modified binders to PG and MSCR specifications
- Potential crude source dependency
- GTR size will effect test results
- Careful formulation is needed to meet all MSCR J_{nr} specifications
Mobile Asphalt Pavement Materials Lab
  – Site Visit
  – Field Data/Testing
  – Use/Demo Emerging Test Devices
  – POC: Matthew Corrigan, P.E.
Asphalt Pavements

Current Projects and Activities

- Asphalt Pavement Recycling with Reclaimed Asphalt Pavement (RAP)
- Asphalt Mixture Performance Tester (AMPT)
- Expert Task Group on Asphalt Mixtures & Construction: Asphalt Binders; and Models Technology
- Mobile Asphalt Pavement Mixture Laboratory
- Foamed Recycled Asphalt Pavement The Louisiana Experience
- Slurry/Micro-Surface Mix Design Procedure Project
- Superpave Regional Centers
- Superpave Implementation Update
- Recycling Team activities
- RD&T Recycling Information
- Warm Mix Asphalt Technologies and Research
- Crumb Rubber
- NIOSH Activities

Research

- Asphalt Research

Techbriefs

- TechBrief: Asphalt Mixture Performance Tester (AMPT), FHWA-HIF-13-005 2013
- Construction Quality Assurance for Design-Build Highway Projects, FHWA-HIF-13-014 2013
- More Information
  - Pavement Materials
  - Pavement Publications
  - Percent Within Limits

Contacts

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E-mail Jack

Tom Harman
Resource Center (Baltimore)
410-962-0134
E-mail Tom

Katherine Petros
Turner Fairbank (Modeling)
202-493-3154
E-mail Katherine
• Asphalt Material Characterization for AASHTOWare® Pavement ME Design Using an Asphalt Mixture Performance Tester (AMPT), FHWA-HIF-13-060 2013
• TechBrief: Asphalt Mixture Performance Tester (AMPT), FHWA-HIF-13-005 2013
• Construction Quality Assurance for Design-Build Highway Projects, FHWA-HRT-12-039 2012
• TechBrief: An Alternative Asphalt Binder, Sulfur-Extended Asphalt (SEA), FHWA-HIF-12-037 2012
• The Use and Performance of Asphalt Binder Modified with Polyphosphoric Acid (PPA), FHWA-HIF-12-030 2012
• Techbrief: Independent Assurance Program, FHWA-HIF-12-001 2012
• Identifying Existing/Emerging Technologies in the Area of Intelligent Construction, FHWA-HIF-12-014 2011
• **The Multiple Stress Creep Recovery (MSCR) Procedure**, FHWA-HIF-11-038 2011
• **A Review of Aggregate and Asphalt Mixture Specific Gravity Measurements and Their Impacts on Asphalt Mix Design Properties and Mix Acceptance**, FHWA-HIF-11-033 2011
• **Superpave Gyratory Compactors**, FHWA-HIF-11-032 2011
• **Superpave Mix Design and Gyratory Compaction Levels**, FHWA-HIF-11-031 2011
• **TechBrief: Intelligent Compaction for Asphalt Materials**, 2010
• **TechBrief: Phosphoric Acid as an Asphalt Modifier Guidelines for Use: Acid Type**, FHWA-HRT-08-061 2008
• ... and many more!!
New 2013 FHWA Initiative

“Advancement of Innovative Asphalt Technology”

Contractor: NAPA (Dr. Audrey Copeland & Kent Hansen)
Period: 5-years (Starting October 2013)
Effort: Conferences, Seminars, Webinars, FHWA Technical Information, Best Practice Guides, News Articles, etc.
Scope: RAP, RAS, GTR, In-Place Recycling, SMA, Designs and Construction, Longitudinal Joints, etc.
Thank you!