Summary

1. What is Warm Mix Asphalt (WMA)?
2. Why are we shifting to WMA?
3. How do we produce WMA?
4. Implementation
5. WMA/RAP/RAS
What is WMA

Asphalt mix that includes a technology which improves the production and placement of conventional asphalt mix at significantly lower temperatures.

What is “significant”? 
275 F (Production)

or

235 F (Screed)

Why are we shifting to WMA
FHWA: Every Day Counts

Identify and Deploy Innovation that:

- Shortens Project Delivery
- Enhances Roadway Safety
- Protects the Environment

WMA identified as an effective, proven, and market ready technology that the FHWA is prioritizing for accelerated use

WMA Production Temperature Range

Every 10° degrees increase of temperature doubles exposure to asphalt fumes – BP
PERFORMANCE!!!

Improvements in mix performance
- Increase use of modified binders
- Increase use of coarse mixes
- Required density

Changes in lane closure requirements
- Night Paving
- Take a chance in cool temps

Improved Compaction = Improved Performance !!!

Constructability

Utilizes exiting asphalt paving equipment and methods

Improved Compaction

Improved Workability

Reducing RISK!!!
Cold Weather Paving

New York City,
8 Dec. 08,
40% RAP PG 64-22

How do we produce WMA
Production BMPs

Dry the Rock!!!

To maximize energy savings:
  • Tune burner and adjust drum flights to efficiently operate at lower temperatures
  • Maintain baghouse temperature above condensation point

Warm Mix, 2012

30+ Warm Mix Technologies
  - Foam warm mixes
  - Wax warm mixes
  - Chemical (surfactant) warm mixes

Differences
  - WMA Mechanism
  - Effective temperature range
  - Track record of performance

How many can you name? 🤔
WMA Implementation

In the Beginning…

Existing HMA mix designs (drop-in technology)

What can WMA do?

How do we evaluate WMA?

Can we utilize existing specs and tests?
NCHRP Projects Results in WMA Design Considerations

Appendix to AASHTO R35 with commentary “Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)”

HMA – WMA Comparison

<table>
<thead>
<tr>
<th>ITEM</th>
<th>HMA</th>
<th>WMA</th>
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<tbody>
<tr>
<td>OBC</td>
<td>AASHTO M323</td>
<td>AASHTO M323</td>
</tr>
<tr>
<td>Gradation</td>
<td>Std Spec</td>
<td>Std Spec</td>
</tr>
<tr>
<td>Aggregate</td>
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<td>Std Spec</td>
</tr>
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<td>Binder Type</td>
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<tr>
<td>Specimen Prep</td>
<td>Std Spec</td>
<td>Technology Specific</td>
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<tr>
<td>Mixing Compaction</td>
<td>Viscosity/Binder</td>
<td>Field Targets, Coating, &amp; Compactability</td>
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<tr>
<td>Temperature</td>
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<tr>
<td>Moisture Sensitivity</td>
<td>Std Spec</td>
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<tr>
<td>Rutting</td>
<td>APA, Hamburg, Flow</td>
<td>APA, Hamburg, Flow</td>
</tr>
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</table>
WMA Technology – Which One?

Contractor Selection
“Approved” Technology Lists?
Technology capabilities (target production and compaction temperatures)

• Categories:
  • By Process:
    – Additive to Binder
    – Additive to Mix
    – Wet Aggregate
    – Foam Asphalt
  • By Type
    – Chemical Additive
    – Wax Additive
    – Mineral Additive
    – Mechanical Foam

Mixing/Compaction/Conditioning

Mixing Temperature: Use anticipated field production temperature

Compaction Temperature: Use anticipated field compaction temperature

Conditioning: 2 hours at compaction temp
Compactability

Compact specimens to $N_{des}$ (1) at field compaction temperature and (2) at 54F (30C) below field compaction temperature

Determine number of gyrations for 92% relative density

OK if $\frac{N_{92(t-30)}}{N_{92t}} < 1.25$
**WMA and RAP/RAS**

Does RAP/RAS binders blend with virgin binders at WMA temperatures?  

Is it necessary to adjust the virgin binder grade when WMA includes high percentages (>25%) RAP?

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**RAP Binders**

NCHRP 9-43 findings

Binder grading  
- PG82-xx to PG100-xx  
Field compaction temps  
- 180F to 212F  
within WMA ranges
WMA Helps Increase in RAP Percentage

<table>
<thead>
<tr>
<th></th>
<th>WMA 35% RAP</th>
<th>HMA 20% RAP</th>
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<tbody>
<tr>
<td>Penetration</td>
<td>28</td>
<td>29</td>
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<tr>
<td>Viscosity</td>
<td>23,500</td>
<td>25,900</td>
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<tr>
<td>Ductility</td>
<td>42</td>
<td>38</td>
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<tr>
<td>DSR @ 64 C</td>
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<td>7.35</td>
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<tr>
<td>MSCR</td>
<td>32</td>
<td>26</td>
</tr>
<tr>
<td>DSR @ 70 C</td>
<td>3.49</td>
<td>3.48</td>
</tr>
</tbody>
</table>

I-44 in Eureka, MO near St. Louis
12.5-mm Superpave mix with PG70-22 binder
Increased RAP content while maintaining mix properties.
Excellent workability in the lab and in the field.
Blending of RAP and Virgin Asphalt

Thorough blending of virgin and RAP binders is important, especially when high levels of RAP are used.

WMA mix formulations containing various high percentages of RAP were evaluated in MWV's Asphalt Innovations laboratory.

- Dynamic moduli were measured with an AMPT and calculated using the Hirsch model protocol.
- Thorough blending of the RAP binder and virgin binder was observed.
- Excellent correlation between measured and calculated values was shown.

Asphalt Mixture Performance Tester (AMPT)

AKA the “Simple Performance Tester”

- Product development
  - High RAP/RAS chemistries
  - Processing aides (rubberized mixes)
- Added value to contractor
  - Increase RAP without grade-dump using warm-mix
  - Prove effective blending at lower temperatures
- Sample prep per AASHTO PP60
- Tested per AASHTO PP61
Hirsch Equation

\[ |E^*| = f( \text{VMA}, \text{VFA}, G^*) \]

Maryland Example: RAP Blending?

MixType:
- AC: 5.3%
- RAP: 32%
- PG 64-22

PG64-28

PG64-22 EVT
Master Curve Comparison

![Graph showing Master Curve Comparison for 32% RAP with reduced frequency (Hz) on the x-axis and |E*| (ksi) on the y-axis. Two lines are plotted: one for PG 64-22+Evotherm and one for PG 64-28 HMA.]

Binder Grade Check

![Graph showing Low Temperature Profile for Newark, DE with 98% Reliability. The x-axis represents Temperature (°C) ranging from -28.0 to -6.0, and the y-axis represents Depth (mm) ranging from 0 to 200. Three lines are plotted: LTTP Bind, PG 64-28 HMA, and PG 64-22+Evotherm. The recovered binder is evaluated per AASHTO R29.]

52nd Idaho Asphalt Conference, 10/25/2012
Conclusion

Conclusions

The future of asphalt paving is available TODAY!!!
Properly condition materials prior to testing
Adequate binder blending occurs at WMA temperatures
High RAP mixes produced at WMA temperatures do not require a change in virgin binder grade
Thank you!

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