Design and Evaluation of WMA

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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

MWV EVOTHERM WARM MIX ASPHALT TECHNOLOGY

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


Federal Highway Administration

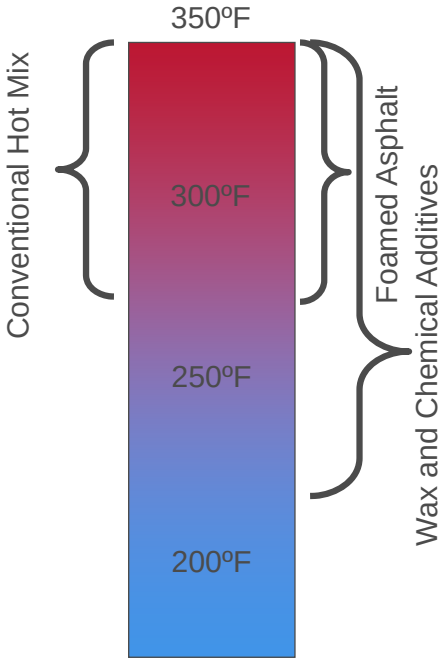
Every Day Counts

Innovation Initiative

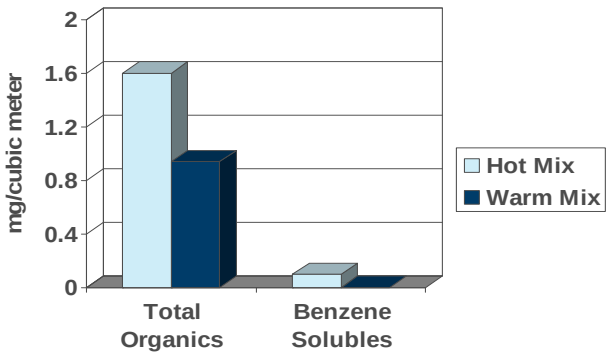
Message from the Administrator

EDC Initiatives

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

MWV EVOTHERM WARM MIX ASPHALT TECHNOLOGY

In the Beginning…

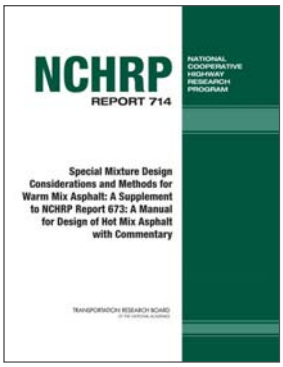
Exisiting HMA mix designs (drop-in technology)

What can WMA do?

How do we evaluate WMA?

Can we utilize existing specs and tests?

NCHRP Projects Results in WMA Design Considerations



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

HMA – WMA Comparison

ITEM	HMA	WMA
OBC	AASHTO M323	AASHTO M323
Gradation	Std Spec	Std Spec
Aggregate	Std Spec	Std Spec
Binder Type	Std Spec	Std Spec
Specimen Prep	Std Spec	Technology Specific
Mixing Compaction Temperature	Viscosity/Binder	Field Targets, Coating, & Compactability
Moisture Sensitivity	Std Spec	Std Spec
Rutting	APA, Hamburg, Flow	APA, Hamburg, Flow

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 $N_{92(t-30)} / N_{92t} < 1.25$

WMA/RAP/RAS

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?

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

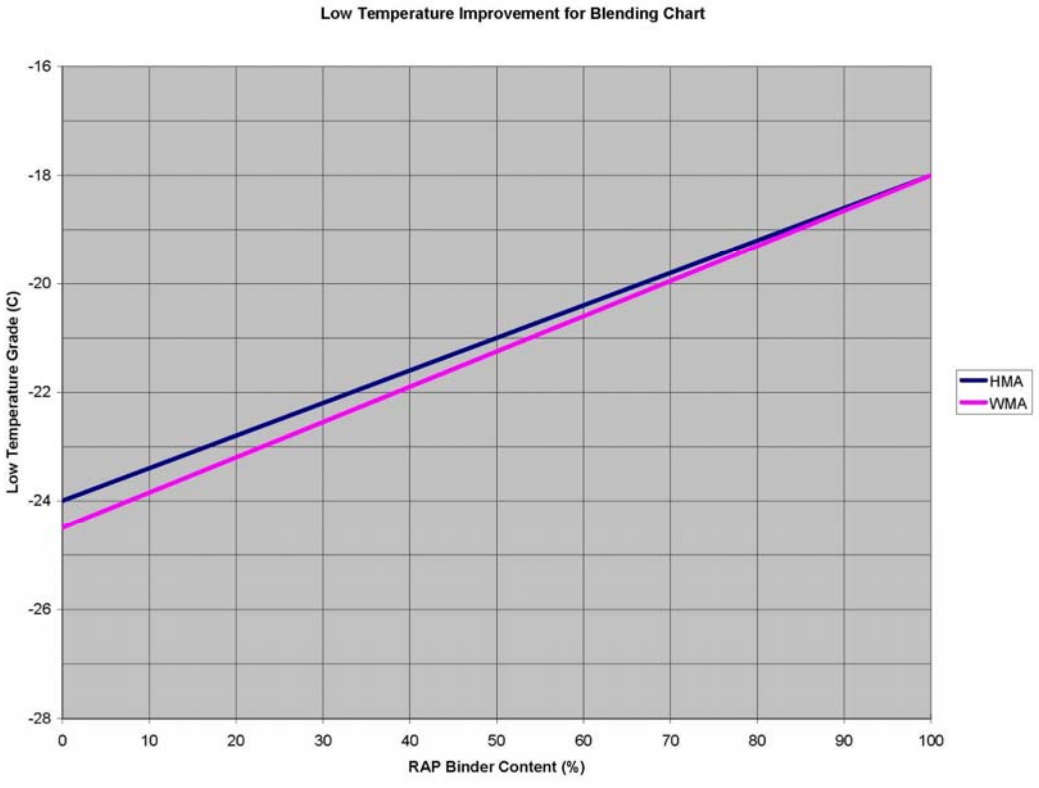
	WMA 35% RAP	HMA 20% RAP
Penetration	**28**	**29**
Viscosity	**23,500**	**25,900**
Ductility	**42**	**38**
DSR @ 64 C	**7.56**	**7.35**
MSCR	**32**	**26**
DSR @ 70 C	**3.49**	**3.48**

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.

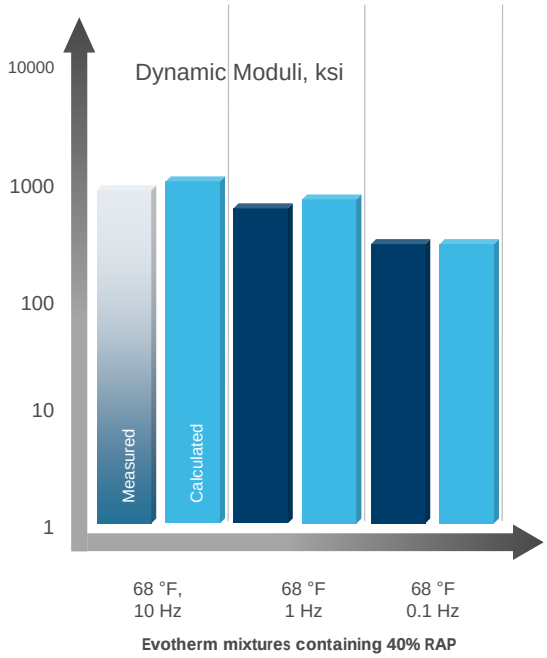


Blending of RAP and Virgin Asphalt

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.**



Evotherm mixtures containing 40% RAP

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

$$|E^*| = f(\ VMA,\ VFA,\ G^*)$$

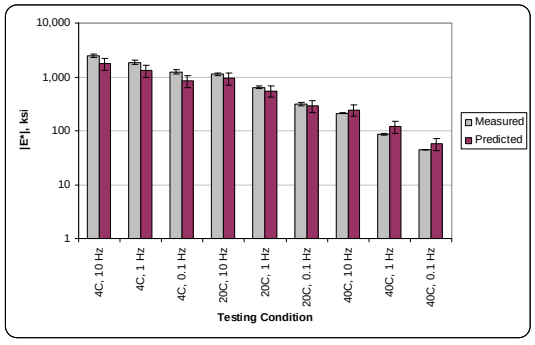
Maryland Example: RAP Blending?

MixType:

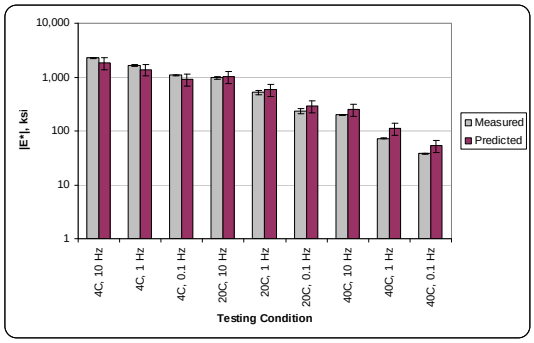
AC: 5.3%

RAP: 32%

PG 64-22

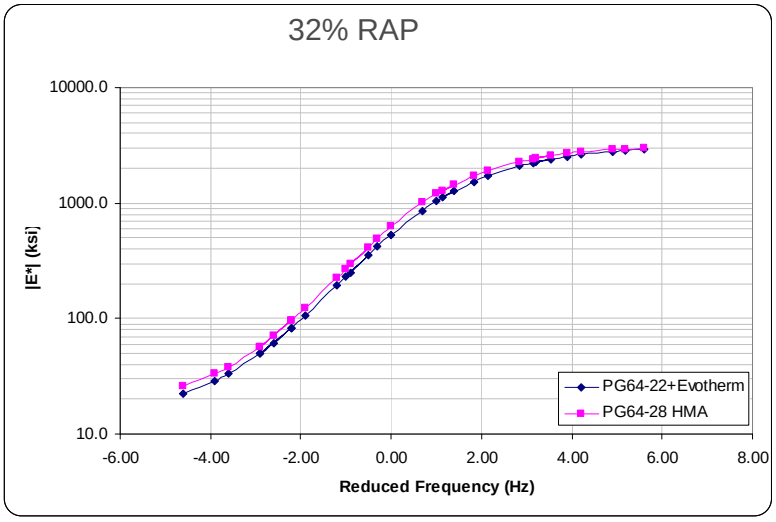


PG64-28

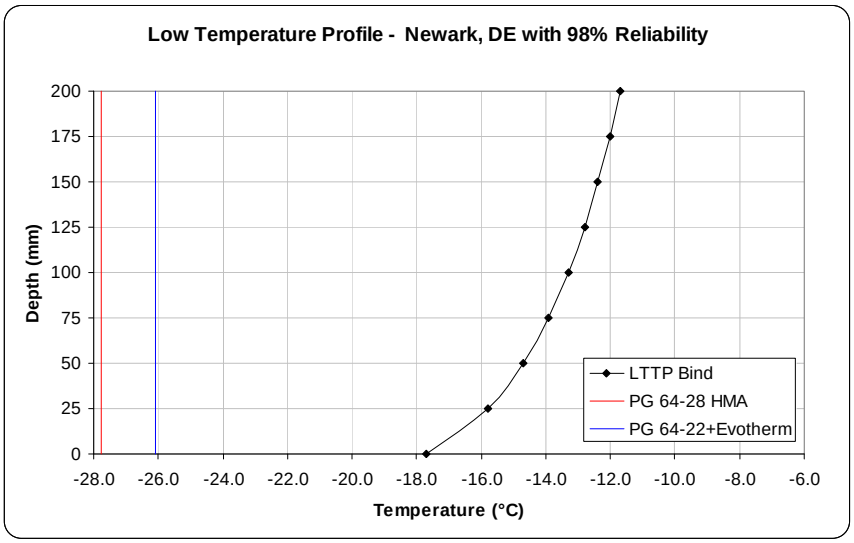


PG64-22 EVT

Master Curve Comparison



Binder Grade Check



Recovered binder evaluated per AASHTO R29

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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