

NCHRP 9-43

Mix Design Practices

for Warm Mix Asphalt

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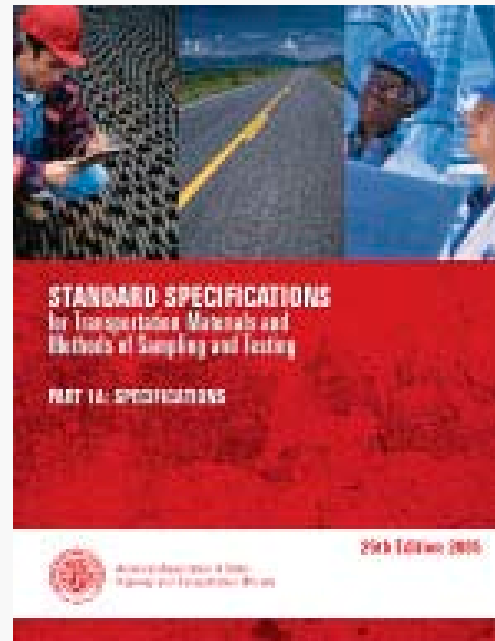
Outline

- Objective and Approach
- Experiments
- Conclusions
- Products
- Remaining Work
- Recommended Additional Research



Objective

- To adapt laboratory mixture design and analysis procedures to WMA
 - Compatible with HMA procedures
 - Address wide range of warm mix processes
 - Current
 - Future



Approach

- Preliminary Procedure
 - ✓ Focus Experimental Work
- Phase I Experiments
 - ✓ Reheating
 - ✓ Binder Grade
 - ✓ RAP
 - ✓ Short-Term Conditioning
 - ✓ Workability



Approach (Continued)

- Revised Preliminary Procedure
- Phase II Experiments
 - ✓ Expanded RAP Mixing
 - ✓ Laboratory Mix Design
 - ✓ Field Validation
 - ✓ Limited Fatigue Study
- Final Draft Procedures
- Documentation



Focus on Key Differences

- Preliminary

- Binder Grade Changes
- Limits on RAP
- Specimen Fabrication
- Coating, Workability & Compactability
- Evaluation of Rutting Resistance
- Optional Performance Tests

- Draft Final

- Specimen Fabrication
- Coating & Compactability
- Evaluation of Rutting Resistance
- Optional Performance Tests

Experiments

1. Reheating
2. Binder Grade Selection
3. RAP
4. Short Term Conditioning
5. Workability
6. Laboratory Mix Design
7. Fatigue
8. Field Validation



Conclusions

- 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
- WMA design is challenging for plant foaming process
 - Laboratory foaming devices need improvement



Conclusions

- For mixtures using the same aggregates and binders and having binder absorption 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
 - Supports need for design procedure



Products

- Draft Appendix to AASHTO R35, *Special Mixture Design Considerations and Methods for Warm Mix Asphalt (WMA)*
- Commentary to Draft Appendix
- Training Materials for Draft Appendix
- Draft Standard Practice, *Standard Practice For Measuring Properties of Warm Mix Asphalt (WMA) for Performance Analysis Using the AASHTO MEPDG*



Remaining Work

- Complete Revision of Final Report and Procedures Based on Panel Comments
- Prepare a Chapter on WMA Design for the NCHRP Project 9-33 Mix Design Manual
 - Chapter
 - Commentary
 - HMA Tools Revisions
 - Revised Training Materials
 - Revised CD ROM



Additional Research

- Many issues identified in Project 9-43 will be addressed by
 - NCHRP 9-47A, *Properties and Performance of Warm Mix Asphalt Technologies*
 - NCHRP 9-49, *Performance of WMA Technologies: Stage I--Moisture Susceptibility*
 - NCHRP 9-49A, *Performance of WMA Technologies: Stage II--Long-Term Field Performance*



Additional Research

- Two mixture design issues may not be addressed
 - WMA mixing procedures for bucket mixers
 - STOA for Moisture Sensitivity and Rutting Resistance



Mixing Procedures for Bucket Mixers

- Mixing times included in Draft Appendix to R35 are based on a planetary mixer
- Bucket mixers are less efficient, but more readily available
- Establish mixing times for bucket mixers
 - Coating as a function of mixing time
 - HMA
 - WMA



Two Step Short-Term Conditioning

- AASHTO R30 for performance testing (4 hours at 135 °C) includes construction aging plus some time in service
 - Basis for many performance test criteria for HMA (flow number, Hamburg, etc)
- Two Step short-term conditioning is needed to use the same criteria for WMA
 - 2 hours at compaction temperature to simulate construction
 - Extended time at service temperature to simulate early aging



Two Step Short-Term Conditioning

- Establish service temperatures
 - LTPPBind
- Establish service aging time
 - Two step process should provide same aging as 4 hours at 135 °C for HMA
- Evaluate similar HMA and WMA mixtures using the two step aging process
 - Moisture sensitivity
 - Flow number

