PRACTICE FOR SUPERPAVE WARM MIX ASPHALT (WMA) MIX DESIGN

1. SCOPE

1.1 This standard provides special mixture design considerations and mix design procedures for designing Warm Mix Asphalt (WMA). WMA represents technologies which allow a reduction in the temperature at which asphalt mixtures are produced and placed.

1.2 The intent of this standard is to ensure that the WMA mix design meets the volumetrics and other requirements stated here-in.

1.3 This standard is applicable to a number of WMA processes including those in which the additive is mixed with the asphalt cement or added to the mixture during production, and to plant foaming processes.

***Note 1**: The laboratory modification of the asphalt cement either using additives or by foaming shall be in accordance with the written recommendations of the manufacturer and/or proponent of the WMA technology. The WMA technology manufacturer/proponent shall provide the laboratory mixing/compaction temperature for mix design and for the testing of plant produced mix.*

2. REFERENCES

2.1 MTO Test Methods

- LS-306 Bulk Relative Density of Compacted Bituminous Mixtures Using Paraffin Coated Specimens
- LS-307 Recycled Hot Mix Asphalt
- LS-309 Practice for Superpave Mix Design
- LS-312 Method for the Fractionation of Unextracted Reclaimed Asphalt Pavement (RAP) for Testing and For Incorporating in Other Test Samples
- LS-313 Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
- LS-604 Relative Density and Absorption of Coarse Aggregate
- LS-605 Relative Density and Absorption of Fine Aggregate

2.2 AASHTO Standards

- M320-10 Performance-Graded Asphalt Binder
- M323-12 Superpave Volumetric Mix Design
- T 283-07 Resistance of Compacted Asphalt Mixture to Moisture-Induced Damage
- T195-11 Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures

TP 79-12 Determining the Dynamic Modulus and Flow Number of Hot Mix Asphalt Using the Asphalt Mixture Performance Tester (AMPT)

R 30-02 (2010) Mixture Conditioning of Hot Mix Asphalt (HMA)

R 35-12 Superpave Volumetric Design for Hot Mix Asphalt (HMA)

2.3 ASTM Standards

D6752-11 Standard Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Automatic Vacuum Sealing Method

3. EQUIPMENT

3.1 For all WMA processes: a mechanical mixer (planetary mixer) of sufficient capacity to adequately mix the aggregates and modified asphalt cement. Mix until fully coated (the recommended mixing time for planetary mixer is about 90 sec to get full coating).

3.2 For processes requiring that additives be blended into the AC: a low shear mechanical stirrer with appropriate impeller to uniformly blend the AC and the additive.

3.3 For foaming processes: a laboratory scale foamed asphalt unit capable of producing consistent foamed AC at a water content to be used in the plant during mix production. The unit shall be calibrated to ensure that the design AC content is achieved in the foamed warm mix.

4. PROCEDURE

WMA mix design procedures and tests shall be in accordance with AASHTO R 35-12 Appendix X2 except as noted below.

5. EXCEPTIONS

5.1 Superpave warm mix designed with a content of Reclaimed Asphalt Pavement shall be designed in conjunction with LS-307.

5.2 All references to AASHTO M 323, with the exception of Appendixes, are deleted and replaced by “the Owner”. The PGAC grade shall be provided by the owner. The aggregate selection shall be based on the traffic category provided by the owner. The mix shall be designed based on the number of gyrations determined from Table 1 based on the traffic category provided by the owner. The design aggregate structure and asphalt cement content shall be selected to conform to the requirements provided by the owner. The design shall meet the owner’s requirements.

5.3 References to AASHTO T 84 and AASHTO T 85 are deleted and replaced with LS-605 and LS-604, respectively. Additionally, determine the bulk specific gravity of the blended coarse aggregate and the blended fine aggregate using LS-604 and LS-605, respectively.

5.4 The calculation of the voids in mineral aggregate shall be based on the densities of the blended coarse and blended fine aggregates.

5.5 References to AASHTO T 275 are deleted and replaced with LS-306 or ASTM D6752.

5.6 References to AASHTO T 312 are deleted and replaced with LS-313.

6. EVALUATIING WMA MIXTRE

The following testing shall be carried out on WMA samples prepared in accordance with AASHTO R35-12 Appendix X2, and test results shall meet the requirements as described here-in.

6.1 Coating

For Coating test, prepare sufficient WMA mixture at the design AC content using the procedure described in R35 Appendix X2.8.2. The requirement is that minimum 95% of the coarse aggregate particles shall be fully coated.

6.2 Compactability

For Compactability test, prepare sufficient WMA mixture at the design AC content using the procedure described in R35 Appendix X2.8.3. The requirement is that the compactability is acceptable if the gyration ratio is less than or equal to 1.25.

6.3 Moisture Sensitivity

For moisture sensitivity test, prepare sufficient WMA mixture at the design AC content using the procedure described in R35 Appendix X2.8.4. The requirement is that the Tensile Strength Ratio (TSR) shall meet minimum value of 0.8 and there is no visual evidence of stripping.

6.3 Rutting Resistance (for information purposes only)

For evaluating the rutting resistance of WMA mixture, Flow Number tesing shall be carried our in accordance with AASHTO TP 79-12. For this purpose, prepare sufficient WMA mixture at the design AC content using the procedure described in R35 Appendix X2.8.5. The Flow Number test results shall be provided for information purposes only.

Perform the Flow Number Test at the design high temperature corresponding to the 50 percent reliability using the LTPP Bind Version 3.1 with no traffic adjustment for traffic and speed. The temperature is computed at 20 mm depth for surface course mixes and at the top of any pavement layer below the surface course (**Note 2**).

***Note 2**: LTPP Bind is software that is downloadable free of charge from the U.S. Federal Highway Administration website (*http://ltpp-products.com/OtherProducts.asp).

7. REPORTING REQUIRMENTS

Information shall be provided in a legible manner. The documentation required with the WMA mix design submission is covered by AASHTO R 35-12. The documents shall include, but are not limited to, the following information:

7.1 WMA mix design and JMF documents that are signed, dated, and certified correct by the person accountable for the engineering and management responsibility for the laboratory that conducted the work.

7.2 Contract number, item number, and mix type for which the WMA mix design and JMF were completed and a description of the usage of the mix on the contract.

7.3 All material proportions and sources for aggregates, including the owner's Mineral Aggregate Inventory for the aggregate sources, asphalt cement, mineral fillers, fibres, and the name of each product, its manufacturer, and the manufacturer's data sheet. Information provided for fibres shall include test results for all the owner's fibre requirements. The amount of RAP in percent by mass and volumetric data shall also be included.

7.4 PGAC and source and percent by mass of the required new asphalt cement. Information on asphalt cement modifiers or any other additives, including name, source, type, manufacturer, its manufacturer's data sheet, and percent by mass of asphalt cement.

A graph of the temperature-viscosity relationship for the PGAC that is to be used in the WMA mix and will indicate the recommended mixing and compaction temperatures. Mixing and compaction temperature used in the WMA mix design and the compaction temperature of the reheated WMA mixture to be employed in the testing of the production WMA mix. (**Note 3**)

Note 3: For some WMA processes, the recompaction temperature may be different from lab design compaction temperature.

7.5 Information regarding fines that are returned to the mix, aggregate breakdown during production, and the resultant change in the aggregate gradations.

7.6 Complete gradations for all coarse and fine aggregates, aggregate absorptions, and bulk specific gravity and saturated surface dry density for each aggregate, the blended coarse aggregate, the blended fine aggregate, and the combined aggregate density along with information on the test method used.

7.7 Volumetric properties for the WMA mixture selected. The percent air voids, voids in mineral aggregate, compared with the requirements for air voids and voids in mineral

aggregate. Graphs shall be reported for the air voids, voids in mineral aggregate, voids filled with asphalt, dust-to-asphalt ratio, bulk relative density (G_{mb} @ N_{ini}), maximum relative density (G_{mm}), and the gyratory curves of the mixture plotted against asphalt cement content.

Using a four-point mix design, graphs of air voids, voids in mineral aggregate plotted against asphalt cement content at N_{des}. Mix bulk specific gravity and percentage absorption by volume and the method used to determine it shall be clearly identified. Theoretical maximum specific gravity.

7.8 Extracted bulk relative density, percentage asphalt cement, and gradation for the RAP if included in the WMA mix.

7.9 Typical mix weight to produce a gyratory specimen with a height of 115 ± 5 mm.

7.10 TSR test results as per AASHTO T283.

7.11 The coating at the design AC content.

7.12 Gyrations to 92 percent G_{mm} at the proposed compaction temperature and 30° C below the compaction temperature, as well as the gyration ratio.

7.13 The Flow Number test temperature, specimen air voids and Flow Number at the design AC content.

7.14 Name and percent of the additive by weight of AC, added to the AC for WMA process.

7.15 The WMA process description, the WMA technology supplier's recommended production and compaction temperatures.

Table 1 - Superpave Compactive Effort

Ontario Traffic Category (see Note 4)	Number of Gyrations (see Note 5)		
	N_{ini}	N_{des}	N_{max}
A	6	50	75
B and C	7	75	115
D	8	100	160
E	9	125	205

Notes:

4. The Traffic Category shall be provided by the owner.
5. Where:
   - N_{ini} means initial number of gyrations.
   - N_{des} means design number of gyrations.
   - N_{max} means maximum number of gyrations.

8. ADDITIONAL REFERENCE

Additional information regarding the WMA mix design practices can be obtained from the following NCHRP Reports:

NCHRP Report 691 Mix Design Practices for Warm Mix Asphalt.

NCHRP Report 714 Special Mixture Design Considerations and Methods for Warm Mix Asphalt: A Supplement to NCHRP Report 673: A Manual for Design of Hot Mix Asphalt with Commentary