

Standard Specification for Superpave Volumetric Mix Design

AASHTO Designation: MP2-01^{1,2}

1. Scope

1.1 This specification for Superpave volumetric mix design uses aggregate and mixture properties to produce a hot-mix asphalt (HMA) job-mix formula.

1.2 This standard specifies minimum quality requirements for binder, aggregate, and HMA for Superpave volumetric mix designs.

1.3 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 AASHTO Standards:

- T11 Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
- T27 Sieve Analysis of Fine and Coarse Aggregates
- T176 Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
- T283 Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
- T304 Uncompacted Void Content of Fine Aggregate
- MP1 Performance Graded Asphalt Binder
- PP28 Superpave Volumetric Design for Hot-Mix Asphalt (HMA)
- TP2 Quantitative Extraction and Recovery of Asphalt Binder from Asphalt Mixtures
- TP4 Preparing and Determining the Density of Hot-Mix Asphalt Specimens by Means of the Superpave Gyratory Compactor

2.2 ASTM Standards:

- D4791 Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- D5821 Determining the Percentage of Fractured Particles in Coarse Aggregate

2.3 Other References:

"LTPP Seasonal Asphalt Concrete Pavement Temperature Models, FHWA-RD-97-103," September, 1998.

The Asphalt Institute Manual MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

3. Terminology

3.1 HMA - Hot-Mix Asphalt

3.2 Design ESALs - Design equivalent (80kN) single-axle loads

Discussion - Design ESALs are the anticipated project traffic level expected on the design lane over a 20-year period. For pavements designed for more or less than 20 years, determine the design ESALs for 20 years when using this standard.

3.3 Air voids (V_a) - The total volume of the small pockets of air between the coated aggregate particles throughout a compacted paving mixture, expressed as a percent of the bulk volume of the compacted paving mixture (Note 1).

Note 1 - Term defined in the Asphalt Institute Manual MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types."

¹ This standard is based on SHRP Product M001.

² Approved in December 1995, this provisional standard was first published in June 1996. The 2001 publication includes major changes primarily resulting from NCHRP 9-12 Project.

3.4 Voids in the Mineral Aggregate (VMA) - The volume of the intergranular void space between the aggregate particles of a compacted paving mixture that includes the air voids and the effective binder content, expressed as a percent of the total volume of the specimen (Note 1).

3.5 Voids Filled With Asphalt (VFA) - The percentage of the VMA filled with binder (the effective binder volume divided by the VMA).

3.6 Dust-to-Binder Ratio ($P_{0.075}/P_{be}$) - By mass, the ratio between the percent of aggregate passing the 0.075 mm (#200) sieve ($P_{0.075}$) and the effective binder content (P_{be}).

3.7 Nominal Maximum Aggregate Size - One size larger than the first sieve that retains more than 10 percent aggregate (Note 2).

3.8 Maximum Aggregate Size - One size larger than the nominal maximum aggregate size (Note 2).

Note 2 - The definitions given in Subsections 3.7 and 3.8 apply to Superpave mixes only and differ from the definitions published in other AASHTO standards.

3.9 Reclaimed Asphalt Pavement (RAP) - removed and/or processed pavement materials containing asphalt binder and aggregate.

4. **Significance and Use** - This standard may be used to select and evaluate materials for Superpave volumetric mix designs.

5. Binder Requirements

5.1 The binder shall be a performance-graded (PG) binder, meeting the requirements of MP1, which is appropriate for the climate and traffic-loading conditions at the site of the paving project or as specified by the contract documents.

5.1.1 Determine the mean and the standard deviation of the yearly, 7-day-average, maximum pavement temperature, measured 20 mm below the pavement surface, and the mean and the standard deviation of the yearly, 1-day-minimum pavement temperature, measured at the pavement surface, at the site of the paving project. These temperatures can be determined by use of the LTPPBind software or be supplied by the specifying agency. If the LTPPBind software is

used, the LTPP high and low temperature models should be selected in the software when determining the binder grade. Often, actual site data is not available, and representative data from the nearest weather station will have to be used.

5.1.2 Select the design reliability for the high and low temperature performance desired. The design reliability required is established by agency policy.

Note 3 - The selection of design reliability may be influenced by the initial cost of the materials and the subsequent maintenance costs.

5.1.3 Using the pavement temperature data determined, select the minimum required PG binder that satisfies the required design reliability.

5.2 If traffic speed or the design ESALs warrant, increase the high temperature grade by the number of grade equivalents indicated in Table 1 to account for the anticipated traffic conditions at the project site.

5.3 If RAP is to be used in the mixture, adjust the binder grade selected in 5.1.3 and 5.2 according to Table 2 to account for the RAP binder stiffness and amount. Procedures for developing a blending chart are included in the Appendix.

6. Combined Aggregate Requirements

6.1 Size Requirements

6.1.1 Nominal Maximum Size - The combined aggregate shall have a nominal maximum aggregate size of 9.5 to 19.0 mm for HMA surface course and no larger than 37.5 mm for HMA subsurface courses.

6.1.2 Gradation Control Points - The combined aggregate shall conform to the gradation requirements specified in Table 3 when tested according to T11 and T27.

6.1.3 Gradation Restricted Zones - It is recommended that the selected combined aggregate gradation does not pass through the restricted zones specified in Table 4. See Figure 1 for an example of a graph showing the gradation control points and the restricted zone.

6.2 Coarse Aggregate Angularity Requirements - The aggregate shall meet the percentage of fractured faces requirements, specified in Table 5, measured

according to D5821.

6.3 Fine Aggregate Angularity Requirements - The aggregate shall meet the uncompacted void content of fine aggregate requirements, specified in Table 5, measured according to T304, Method A.

6.4 Sand Equivalent Requirements - The aggregate shall meet the sand equivalent (clay content) requirements, specified in Table 5, measured according to T176.

6.5 Flat-and-Elongated Requirements - The aggregate shall meet the flat-and-elongated requirements, specified in Table 5, measured according to D4791, with the exception that the material passing the 9.5 mm sieve and retained on the 4.75 mm sieve shall be included. The aggregate shall be measured using the ratio of 5:1, comparing the length (longest dimension) to the thickness (smallest dimension) of the aggregate particles.

6.6 When RAP is used in the mixture, the RAP aggregate shall be extracted from the RAP using a solvent extraction or ignition oven as specified by the Agency. The RAP aggregate shall be included in determinations of gradation, coarse aggregate angularity, fine aggregate angularity and flat-and-elongated particles. The sand equivalent requirements shall be waived for the RAP aggregate but shall apply to the remainder of the aggregate blend.

7. HMA Design Requirements

7.1 The binder and aggregate in the HMA shall conform to the requirements of Sections 5 and 6.

7.2 The HMA design, when compacted in accordance with TP4, shall meet the relative density, VMA, VFA, and dust-to-binder ratio requirements specified in Table 6. The initial, design, and maximum number of gyrations are specified in PP28.

7.3 The HMA design, when compacted according to TP4 at 7.0 ± 1.0 percent air voids and tested in accordance with T283 shall have a tensile strength ratio of at least 0.80.