Designation: D6995 – 05 (Reapproved 2013)

Standard Test Method for Determining Field VMA based on the Maximum Specific Gravity of the Mix (G_{mm})[1]

This standard is issued under the fixed designation D6995; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method is intended to be used for a rapid field determination of voids in mineral aggregate (VMA) of hot mix asphalt (HMA). It provides equations for calculating the VMA based on the asphalt content of the mix and its maximum specific gravity (G_{mm}). It is intended that this should be used for the rapid "field" determination of VMA during Quality Control (QC) operations at HMA plants, particularly where the specific gravity of the aggregate is highly variable.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C127 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate

C128 Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate

D70 Test Method for Density of Semi-Solid Bituminous Materials (Pycnometer Method)

D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

D2041 Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures

D2172 Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures

D2726 Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures

D6307 Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method

3. Summary of Test Method

3.1 The percent of (field) VMA in the mix can be calculated by means of equations in which measured values for the theoretical maximum specific gravity, the asphalt content, the specific gravity of the asphalt, and the average bulk specific gravity of the total aggregate and the compacted mix are known.

4. Significance and Use

4.1 Various users desire indication of compliance with VMA specifications for hot mix asphalt (HMA) during production.

4.2 The standard practice for determining VMA requires that the bulk specific gravity of the aggregate components be determined. This is a very time consuming test, which is not suitable for routine QC procedures.

4.3 When an aggregate source used in the mix has a highly variable bulk specific gravity and a reference average bulk specific gravity (G_{sb}) (for example, as established in the mix design) is used to calculate VMA during HMA production, erroneous values may occur.

4.4 The test for maximum specific gravity of the mix (G_{mm}) is a routine QC test at HMA plants. The effective specific gravity of the aggregate components (G_{se}) can be easily calculated from this test. However the G_{se} does not take into account the amount of asphalt absorbed, which is required for accurate VMA determination. This method provides a means to correct the G_{se} to account for the average absorbed asphalt. This procedure should not be used if the percent water absorption of the total (combined) aggregates varies between four tests, randomly obtained over a 30 day period, by more than 0.4 %.

5. Procedure

5.1 Determine the percent of field VMA in a compacted mix sample by first obtaining the following information and then calculating the value.

5.2 *Tests Run During the HMA Mix Design Procedure*

5.2.1 *Test Method* C127*,* C128*, and* D854—Determine the average bulk specific gravity (G_{sb}) of the fine and coarse aggregates, and mineral filler if applicable. Once this value is

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.21 on Specific Gravity and Density of Bituminous Mixtures.

Current edition approved June 1, 2013. Published September 2013. Originally approved in 2005. Last previous edition approved in 2005 as D6995 – 05. DOI: 10.1520/D6995-05R13.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

determined it should be used in the calculations in section 6.1.1 until a change in the plant produced mix occurs.

NOTE 1—It is recommended that a minimum of three sets of tests (one for each aggregate) should be averaged to establish this bulk specific gravity.

5.2.2 Use the percent by weight of each aggregate established in the mix design in the calculation in section 6.1.1. If the percent of individual aggregates in the mix is changed during production a new G_{sb}(comb) should be calculated per section 6.1.1, using the new percentages.

5.2.3 *Test Method D70*—Determine the specific gravity of the asphalt binder (G_b)

5.2.4 Determine the bulk specific gravity of the combined aggregates in the mix (G_{sb}(comb) in accordance with the formula in section 6.1.1, using the values established above.

5.2.5 Prepare a lab mix according to the mix design, at optimum asphalt content. Use this mix to establish a correction factor (C_f) for asphalt absorption, with the formula in section 6.1.3. It is intended that this C_f will remain constant until subsequent testing indicates a change is appropriate.

NOTE 2—It is recommended that a corresponding lab mix be prepared and tested in accordance with Note 1. The correction factors that are determined should be averaged and used in section 5.3.5.

5.3 *QC Tests Run During HMA Production*

5.3.1 *Test method D6307 or D2172*—Determine the percent of asphalt binder in the plant produced mix.

5.3.2 *Test method D2726*—Determine the bulk specific gravity of the compacted mix (G_{mb}).

5.3.3 *Test Method D2041*—Determine the maximum specific gravity of the mix (G_{mm}). An appropriate mix short term aging procedure must be defined by the user of this standard.

NOTE 3—Since the amount of asphalt absorbed is affected by the length of the short term aging of the mix, it is recommended that the same procedure used in the mix design also be used in the field, unless it can be demonstrated that another aging period is more appropriate.

5.3.4 Determine the effective specific gravity (G_{se}) of the plant mix sample in accordance with the formula in section 6.1.2, using the appropriately adjusted values from sections 5.2.3, 5.3.1, and 5.3.3.

5.3.5 Use the correction factor (C_f) established in the mix design (see section 5.2.5) to determine the field VMA. This factor may need periodic adjustment based on plant production (see sections 5.2.2 and Note 4). If the (C_f) varies by more than 10 %, it should be re-verified in accordance with section 5.2.5.

NOTE 4—Verification testing – Since this method depends on the asphalt absorption remaining constant, it is recommended that the bulk specific gravity of each aggregate be tested approximately once per month during production and the G_{sb} (comb) revised if there is a change of >0.015 in any aggregate G_{sb}. A corresponding sample of plant mix should be obtained in conjunction with this testing and the C_f verified.

5.3.6 Determine the field VMA in accordance with section 6.2 using the values from section 5.3.2, 5.3.4, and 5.3.5.

6. Calculation

6.1 Determine the laboratory correction factor as follows:

6.1.1 Determine the average bulk specific gravity of the combined aggregate (G_{sb}) as follows:

$$G_{sb}\,(\text{comb}) = \frac{100}{\frac{\%\text{ of aggregate \#1}}{\text{bulk specific gravity}(G_{sb1})} + \frac{\%\text{ of aggregate \#2}}{\text{bulk specific gravity}(G_{sb2})} + \ldots} \quad (1)$$

6.1.2 Determine the effective specific gravity (G_{se}) of the aggregate in the mix as follows:

$$G_{se} = \frac{100.0 - \%\text{ asphalt binder}}{\frac{100.0}{G_{mm}} - \frac{\%\text{ asphalt binder}}{\text{specific gravity of asphalt }(G_b)}} \quad (2)$$

6.1.3 Establish a correction factor for asphalt absorption as follows :

$$C_f = G_{se} - G_{sb\ (comb)} \quad (3)$$

6.2 Determine the field VMA as follows:

$$VMA_{\ (field)} = 100.0 - [(G_{mb} * Ps)/(G_{se} - C_f)] \quad (4)$$

Where:

G_{mb} = Bulk specific gravity of compacted mix
P_s = Percent aggregate in the mix (100.0 - % asphalt binder)
G_{se} = Effective specific gravity of the aggregate
C_f = Correction factor for asphalt absorption

NOTE 5—The percent aggregate in the mix should be based on actual asphalt content of the mix as determined in section 5.

NOTE 6—The field VMA may yield a different value than the traditional method of calculation described in sec.4.10 of the Asphalt Institute MS-2.

7. Report

7.1 Report the test values as follows:

7.1.1 Report the field VMA to the nearest 0.1 %

7.1.2 Report the G_{se}, individual G_{sb} , G_{sb}(comb), G_b, G_{mm}, and C_f to the nearest 0.001

7.1.3 Report the percent asphalt binder to the nearest 0.1 %

8. Precision and Bias

8.1 *Precision*

8.1.1 *Single Operator Precision*—

Method to determine % AC	G_{se} within lab STD
Test Method D2172	0.008
Test Method D6307	0.014

8.1.2 *Multilaboratory Precision*

Method to determine % AC	G_{se} between lab STD
Test Method D2172	0.024
Test Method D6307	0.026

NOTE 7—The precision estimates were obtained from a Monte Carlo Simulation of input data used to calculated the G_{se}.

8.2 *Bias*

No information can be presented on the bias of the procedure because no material having an accepted reference value is available.

9. Keywords

9.1 HMA; Field VMA; QC