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Standard Test Method for Preparation and Determination of Bulk Specific Gravity of Dense-Graded Cold Mix Asphalt (CMA) Specimens by Means of Superpave Gyratory Compactor[1]

This standard is issued under the fixed designation D7229; 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.

ε[1] NOTE—Editorially corrected 9.1 in December 2013.

1. Scope

1.1 This test method concerns the preparation and compaction of cylindrical specimens of dense-graded cold mix asphalt (CMA) using the Superpave gyratory compactor (SGC).

1.2 This test method is applicable for road mixes or plant mixes prepared at ambient temperatures.

1.3 This test method also refers to the determination of the bulk specific gravity of the compacted CMA.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 A precision and bias statement for this test method has not been developed at this time. Therefore, this test method should not be used for acceptance or rejection of a material for purchasing purposes.

1.6 *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]

C566 Test Method for Total Evaporable Moisture Content of Aggregate by Drying

D8 Terminology Relating to Materials for Roads and Pavements

D977 Specification for Emulsified Asphalt

D1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Coated Samples

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

D2397 Specification for Cationic Emulsified Asphalt

D2489 Practice for Estimating Degree of Particle Coating of Bituminous-Aggregate Mixtures

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

D3203 Test Method for Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures

D3628 Practice for Selection and Use of Emulsified Asphalts

D4215 Specification for Cold-Mixed, Cold-Laid Bituminous Paving Mixtures

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

D6925 Test Method for Preparation and Determination of the Relative Density of Hot Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

D6934 Test Method for Residue by Evaporation of Emulsified Asphalt

D6998 Practice for Evaluating Aggregate Coating using Emulsified Asphalts

3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *dense-graded aggregate emulsified asphalt cold mixtures*—mixtures of dense-graded aggregate and emulsified asphalt uniformly mixed at or near ambient temperature.

3.2.2 *dense-graded cold mix asphalt (CMA)*—emulsified asphalt that has been mixed with aggregate, dry, and compacted by a suitable compacting device.

3.2.3 *nominal maximum aggregate/sieve size*—one sieve size larger than the first sieve to retain more than 10 %.

[1] This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.27 on Cold Mix Asphalts.

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[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.

4. Significance and Use

4.1 This test method is used to prepare specimens for determination of the bulk specific gravity of a cured compacted specimen. It covers modifications to Test Method D6925 for preparation of CMA by means of the SGC.

4.2 This test method is useful for monitoring the density of the specimen during the compaction process. It is suitable for laboratory design and field control of CMA.

4.3 Local end-use specifications should be developed to establish conformance to the job and user requirements.

5. Apparatus

5.1 *Superpave Gyratory Compactor*—An electrohydyaulic or electromechanical compactor with a ram and ram heads as described in Test Method D6925.

6. Materials

6.1 *Aggregates*[3]—Dense-graded aggregates meeting the requirements of Specification D4215 are among those suitable for emulsified asphalt cold mixtures or further guidance should be obtained from the Cold Mix Manual.

6.2 *Emulsions*—Two types of emulsified asphalt are used for producing dense-graded emulsified asphalt cold mixtures and their selection are described in Practice D3628. These are designated as slow-setting and medium-setting emulsions. Medium-setting emulsions are used with aggregates that do not have excessive amounts passing the 0.075-mm sieve. Slow-setting emulsions are normally used with the more dense aggregates with larger amounts passing the 0.075-mm sieve. Specifications for these emulsions are given in Specifications D977 and D2397.

7. Procedure

7.1 *Determination of Trial Emulsion Content*—If needed, a simple formula for base mixtures and one for surface mixtures is used. These formulas are based on the percentage of aggregate passing the 4.75-mm sieve and, in most cases, give a satisfactory starting point.

7.1.1 Determine the residue content of the emulsion to be used by Test Method D6934 or another suitable acceptable procedure.

7.1.2 Estimate the initial emulsified asphalt content based on the dry weight of aggregate as follows:[4]

7.1.2.1 *Base Mixtures:*

$$E = \frac{(0.06B + 0.01C) \times 100}{A} \quad (1)$$

7.1.2.2 *Surface Mixtures:*

$$E = \frac{(0.07B + 0.03C) \times 100}{A} \quad (2)$$

where:

A = percent residue of the emulsion by distillation or other suitable procedure (see 7.1.1),
B = percent of dry aggregate passing the 4.75-mm sieve,
C = 100 – B (dry aggregate retained on the 4.75-mm sieve and above), and
E = percent emulsified asphalt based on dry weight of aggregate.

7.2 *Coating Test*—Preliminary evaluation of the emulsified asphalt selected for mixture preparation is accomplished through a coating test. The trial emulsion content as determined in 7.1 is combined with the wet job aggregate corrected to dry weight. Coating is visually estimated by the user as satisfactory or unsatisfactory for the intended use of the mix (surface mixtures require a greater degree of coating than do base mixtures). Local end-use specifications or agreement between user and supplier should be developed to determine the degree of coating. If the degree of coating is considered satisfactory, proceed to making the mix. If the coating is considered unsatisfactory, select another grade of emulsion as described in Practice D3628 and start over from 7.1.

NOTE 1—As a general guideline, aggregates not exceeding 20 % passing the 0.075-mm sieve can be used for the slow-setting emulsions, and aggregates with less than 10 % passing the 0.075-mm sieve are used for the medium-setting emulsions. Local end-use specifications should be developed to finalize these requirements since aggregates vary from region to region.

NOTE 2—Coating may be quantitatively calculated by using the procedure described in Practice D2489.

NOTE 3—The emulsified asphalt/job aggregate coating test in Test Method D6998 can be used for this screening process.

7.3 *Preparation of Test Specimens*—Prepare a specimen using the emulsion content determined in 7.1. If the mixture in the coating tests (7.2) appears to be dry, start with the trial emulsion content (7.1). Conversely, if the mixture appears rich, reduce the emulsion content.

NOTE 4—A trial emulsion content of 8 % emulsion is a good starting point. Other trial blends can be 1 % higher or 1 % lower. Other trial blends would then be 9, 8, and 7 % of emulsion content, respectively. A normal difference between the emulsion content levels is 1 %, which is a residual difference of 0.65 % for an emulsion with a 65 % residue content.

7.4 *Preparation of Aggregates:*

7.4.1 Determine the moisture content of the aggregate following Test Method C566.

7.4.2 Weigh the appropriate amount of wet job aggregate, corrected to dry aggregate weight to obtain a compacted specimen height of 115 ± 5 mm, into suitable mixing bowls for each individual batch. Care must be taken so that the aggregate for each batch is representative of the project aggregate. If necessary, the aggregate maybe dried and separated into sizes then reblended into individual batch sizes. If this is done, water equivalent to stockpile moisture must be added to each batch and the mixture covered to prevent loss of moisture for about 24 h before mixing with emulsion.

NOTE 5—It may be necessary to produce a trial specimen to achieve this height requirement. Generally, 4500 to 4700 g of aggregate are required.

7.4.3 If premixing water is required, pour the predetermined amount (from section 7.2) onto the aggregate and hand mix for 60 s or until uniform. As an option, mechanical mixing may be

[3] *Asphalt Cold Mix Manual*, Asphalt Institute, Manual Series No. 14 (MS-14), 3rd Edition, 1997.

[4] *A Basic Asphalt Emulsion Manual*, Asphalt Institute, Asphalt Emulsion Manufactures Association, Manual Series No. 19 (MS- 9), 3rd Edition.

used. This must be done just before the addition and mixing with the emulsified asphalt.

7.4.4 Weigh a predetermined amount of emulsion (from section 7.2) and add to the wet aggregate. Mix thoroughly for 60 s until the aggregates are coated. As an option, mechanical mixing may be used. Excessive mixing will cause the mix to strip.

7.4.5 Place the emulsion mix in a pan and dry in a forced-draft oven for 3.0 ± 0.1 h at 30 ± 0.1°C.

7.5 *Compaction:*

7.5.1 Prepare the sample for compaction as described in this procedure and follow the densification procedure of Section 8 of Test Method D6925.

7.5.2 Place the base plate and a paper disk in the bottom of the mold.

7.5.3 Place the mixture into the mold in one lift. Care should be taken to avoid segregation in the mold. After all the mix is in the mold, level the mix, and place another paper disk and upper plate (if required) on top of the leveled material.

7.5.4 Load the charged mold into the compactor and center the loading ram.

7.5.5 Apply a constant vertical pressure of 600 ± 60 kPa for the first five gyrations and 600 ± 18 kPa during the remainder of the compaction process as described in Test Method D6925.

7.5.6 Allow the compaction to proceed to the desired number of gyrations based on end-use requirement.

NOTE 6—Note that this process of loading, densification, and unloading of the CMA is similar to the HMA process described in sections 6.1 through 6.11 of Test Method D6925, except temperatures, handling times, and aging requirements are different.

NOTE 7—Present practice is to use 33 ± 3 gyrations. Previous round robin between five laboratories indicated that above 40 gyrations no further height reduction of the compacted mix was observed.

7.5.7 Extrude the sample from the mold and weigh. Place the compacted specimen in the forced air-draft oven set at 30 ± 1°C and cure for 20 ± 0.1 h.

NOTE 8—The curing protocol in this standard represents only a practice being followed by some practitioners and was used in a round-robin encompassing five laboratories. It is not intended to cover or simulate the large spectrum of varying field practices and pavement performance conditions. In the application of this standard the user may define a different curing protocol that better represents the local field practice; one that better simulates the expected short and long term conditions affecting the mixture properties.

7.6 *Densification:*

7.6.1 Determine the bulk specific gravity of the extruded specimen as described in Test Methods D1188, D2726 or D6752.

7.6.2 Determine the bulk density by dividing the weight of the specimen in air by its calculated volume, determined based on geometric measurements (height and mold diameter).

$$D_b = \frac{W_a}{HA}; \quad A = \pi \times D^2/4 \tag{3}$$

where:

D_b = measured bulk density of a compacted mixture specimen,
D = diameter of specimen,
W_a = specimen weight in air,
H = height of compacted specimen, and
A = area of cylindrical specimen.

7.6.3 Other volumetric properties such as voids, voids filled, and voids in the mineral aggregate are determined following the appropriate Test Methods D2041 and D3203 and the calculations described in Asphalt Institute Manual MS-2.[5]

8. Report

8.1 Report the following information:

8.1.1 Date and time of specimen preparation;

8.1.2 Specimen identification including grade of emulsion;

8.1.3 Percentage of emulsified asphalt in specimen to the nearest 0.1 %;

8.1.4 Mass of the specimen to the nearest 0.1 g;

8.1.5 Bulk specific gravity of the compacted specimen (G_{mb}) by Test Methods D1188, D2726, or D6752 to the nearest 0.001; and

8.1.6 Height of the compacted specimen after each gyration (h_x) to the nearest 0.1 mm if required.

9. Precision and Bias

9.1 The between-laboratory reproducibility of this test method is underway and will be available on or before December 1, 2017. A preliminary study between five laboratories, using one emulsion and one set of aggregates and three emulsion content of a single mix and two replicates, indicated that a single-operator precision greater than 1 % of the mean should be considered suspect and for between-laboratory precision greater than 3 % of the mean should be considered suspect. This test method should not be used for acceptance or rejection of a material for purchasing purposes.

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

10. Keywords

10.1 aggregates; cold mix asphalt; compaction; emulsified asphalt; emulsions; gyratory; medium-setting emulsions; slow-setting emulsions

[5] *Mix Design Methods for Asphalt Concrete and other Hot-mix types*, Asphalt Institute, Manual Series No. 2 (MS-2) 6th Edition, 1995.