



Designation: D5444 – 23

Standard Test Method for Mechanical Size Analysis of Extracted Aggregate¹

This standard is issued under the fixed designation D5444; 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 covers a procedure for determination of the particle size distribution of fine and coarse aggregates extracted from asphalt mixtures using sieves with square openings.

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

1.3 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*²

C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

D2172/D2172M Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D6307 Test Method for Asphalt Content of Asphalt Mixture by Ignition Method

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

¹ This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

Current edition approved May 1, 2023. Published May 2023. Originally approved in 1993. Last previous edition approved in 2015 as D5444 – 15. DOI: 10.1520/D5444-23.

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.

2.2 *AASHTO Standard:*³

AASHTO Test Method T 30 Mechanical Analysis of Extracted Aggregate

3. Significance and Use

3.1 This test method is used to determine the grading of aggregates extracted from asphalt mixtures. The results are used to determine compliance of the particle size distribution with applicable specifications requirements, and to provide necessary data for control of the production of various aggregates to be used in asphalt mixtures.

NOTE 1—The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this standard are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

4. Apparatus

4.1 *Balances*, or scales, readable to 0.1 g and accurate to 0.1 g or 0.1 % of the test load, whichever is greater, at any point within the range of use.

4.2 *Sieves*, with square openings, mounted on substantial frames constructed in a manner that will prevent the loss of materials during sieving. Suitable sieve sizes shall be selected to furnish the information required by the specifications covering the material to be tested. The woven wire cloth sieves shall conform to the requirements of Specification E11.

4.3 *Mechanical Sieve Shaker*—If used, it shall impart a vertical, or lateral and vertical, motion to the sieve, causing the particles thereon to bounce and turn so as to present different orientations to the sieving surface. The sieving action shall be such that the criterion for adequacy of sieving described in 6.8 is met in a reasonable time period.

4.4 *Oven*, of appropriate size, capable of maintaining a uniform temperature of 110 ± 5 °C.

³ Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, <http://www.transportation.org>.

4.5 *Container*—A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of any of the sample or water.

5. Sample

5.1 The sample shall consist of the entire sample of aggregate from Test Method **D2172/D2172M** or Test Method **D6307**.

5.1.1 Aggregate extracted by the ignition method in Test Method **D6307** shall not be used for gradation analysis if the correction factor obtained in Test Method **D6307** is greater than 1.0 (see **Note 2**).

5.2 The size of the test sample shall be governed by the nominal maximum aggregate size and shall conform to the mass requirements shown in **Table 1**.

NOTE 2—The temperatures used during the ignition method of asphalt content determination can cause temperature-related deterioration, such as calcination of some carbonate minerals, and quartz phase transitions.⁴ These reactions can result in particle breakdown, which will yield gradation results that are finer than the actual material that was used in the mixture.

6. Procedure

6.1 Dry the sample at $110 \pm 5^\circ\text{C}$ to constant weight. Determine the weight to the nearest 0.1 % of the sample weight. The total weight of aggregate in the asphalt mixture being tested is the sum of the weights of the dried aggregates and the mineral matter contained in the extracted bitumen. When using Test Method **D2172/D2172M**, the latter is to be taken as the sum of the weight of ash in the extract and the increase in weight of the filter element as determined in the test method.

6.2 After drying and weighing the test sample, place it in a container and cover it with water. Add a sufficient amount of wetting agent to ensure a thorough separation of the material finer than the 75 μm sieve from the coarser particles (see **Note 3**). The contents of the container shall be agitated vigorously and the washwater poured immediately over a nest of two sieves consisting of a 2.00 or 1.18 mm sieve superimposed on a 75 μm sieve. The use of a large spoon to stir and agitate the aggregate in the washwater has been found satisfactory.

NOTE 3—Wetting agents may include any dispersing agent such as a liquid detergent, or a soap, that will promote the separation of fine material. There should be enough wetting agent to produce a small amount of suds when the sample is agitated. The quantity of wetting agent will depend on the hardness of the water and quality of the agent. Excessive

⁴ Information presented by Chris Rogers at the Annual Symposium of the “International Center for Aggregate Research,” April 2004, Denver, CO.

TABLE 1 Size of Sample

Nominal Maximum Aggregate Size	Minimum Mass of Sample, kg
4.75 mm (No. 4)	0.5
9.5 mm	1
12.5 mm	1.5
19.0 mm	2
25.0 mm	3
37.5 mm	4

suds may overflow the sieves and carry some material with them.

6.3 The agitation shall be sufficiently vigorous to result in complete separation from the coarse particles of all particles finer than the 75 μm sieve and to bring them into suspension so that they may be removed by decantation of the washwater. Take care to avoid decantation of the coarse particles of the sample as much as possible. Repeat the operation until any wetting agent used is removed and the washwater is clear.

6.4 Return all material retained on the nested sieves to the container. Dry the washed aggregate in the container to constant weight at a temperature not to exceed the mixture laboratory compaction temperature $+5^\circ\text{C}$ and not less than 105°C , and weigh to the nearest 0.1 % of the original dry weight of the sample.

6.5 Then sieve the aggregate over sieves of the various sizes required by the specification covering the mixture, including the 75 μm sieve. Record the weight of material passing each sieve and retained on the next and the amount passing the 75 μm sieve. The summation of these various weights must check the dried weight after washing within 0.2 % of the total weight. Add the weight of dry material passing the 75 μm sieve by dry sieving to the weight of mineral matter in the bitumen and the weight removed by washing in order to obtain the total passing the 75 μm sieve. If it is desired to check the weight of material washed through the 75 μm sieve, the washwater may be evaporated to dryness or filtered through a tared filter paper that is dried and weighed subsequently. Convert the weights of fractions retained on the various sieves and the total passing the 75 μm sieve to percentages by dividing each by the total weight of aggregate in the asphalt mixture from **6.1**.

6.6 Nest the sieves in order of decreasing size of opening from top to bottom, and place the sample on the top sieve. Agitate the sieves by hand or by mechanical apparatus for a sufficient period, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving described in **6.7**.

6.7 Limit the quantity of material on a given sieve so that all particles have the opportunity to reach sieve openings a number of times during the sieving operation. For sieves with openings smaller than 4.75 mm (No. 4), the weight retained on any sieve at the completion of the sieving operation shall not exceed 6 kg/m^2 of sieving surface. For sieves with openings 4.75 mm (No. 4) and larger, the weight in kg/m^2 of sieving surface shall not exceed the product of $2.5 \times$ (sieve opening in mm). In no case shall the weight be so great as to cause permanent deformation of the sieve cloth.

6.8 Continue sieving for a sufficient period and in such manner that, after completion, not more than 0.5 % by weight of the total sample passes any sieve during 1 min of continuous hand sieving performed as follows: hold the individual sieve, provided with a snug-fitting pan and cover, in a slightly inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the inclined position in one hand. Strike the side of the sieve sharply and with an upward motion against the heel of the other hand at a rate of approximately 150 times per minute, turning the sieve