



Designation: D3744 – 03

## Standard Test Method for Aggregate Durability Index<sup>1</sup>

This standard is issued under the fixed designation D3744; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This test method covers the determination of a durability index of an aggregate. The calculated durability index is a value indicating the relative resistance of an aggregate to production of detrimental clay-like fines when subjected to the prescribed mechanical methods of degradation.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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

### 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

**C136** Test Method for Sieve Analysis of Fine and Coarse Aggregates<sup>3</sup>

**D75** Practice for Sampling Aggregates<sup>3</sup>

**D2419** Test Method for Sand Equivalent Value of Soils and Fine Aggregate<sup>4</sup>

**D4753** Guide for Evaluating, Selecting, and Specifying Balances and Standard Masses for Use in Soil, Rock, and Construction Materials Testing<sup>5</sup>

**E11** Specification for Woven Wire Test Sieve Cloth and Test Sieves

### 3. Summary of Test Method

3.1 This test method was developed to permit prequalification of aggregates proposed for use in the construction of

transportation facilities. Basically, the test establishes an aggregate's resistance to generating fines when agitated in the presence of water. Separate and different test procedures are used to evaluate the coarse and the fine portions of a material.

3.2 A sample of coarse aggregate is prepared to a specific grading and then washed in a mechanical washing vessel for a 2-min agitation time. After discarding the minus 4.75-mm (No. 4) material, dry the washed test sample.

3.3 The coarse aggregate test sample is then agitated in the mechanical washing vessel for a period of 10 min. A representative portion of the resulting wash water and minus 75- $\mu$ m (No. 200) size fines is collected and mixed with a stock calcium chloride solution and placed in a plastic cylinder. After a 20-min sedimentation time, the level of the sediment column is read. The height of the sediment value is then used to calculate the durability index of the coarse aggregate ( $D_c$ ).

3.4 The fine aggregate sample is prepared by washing a specific quantity of the material in the mechanical washing vessel for a 2-min agitation period. All minus 75- $\mu$ m (No. 200) size material is washed from the sample through a 75- $\mu$ m (No. 200) sieve and discarded. The plus 75- $\mu$ m (No. 200) fraction is dried.

3.5 The fine aggregate test sample is tested by the Standard Sand Equivalent Test Method (Test Method **D2419**) except for modifications to the test sample preparation and duration of the shaking time. The mechanical shaker method is required. A shaking time of 10 min instead of 45 s is used.

3.6 This test method includes procedures for testing aggregates exhibiting a wide range in specific gravity, including lightweight and porous coarse aggregates, and also procedures for testing small maximum size aggregate which is too fine to test as a coarse aggregate and too coarse to consider as a fine aggregate, such as a pea gravel or a very coarse sand.

3.7 The durability index for coarse aggregate ( $D_c$ ) or for fine aggregate ( $D_f$ ) is calculated, as applicable, by appropriate equations presented in the method. The durability index of a well-graded aggregate containing both coarse and fine fractions is defined as the lowest of the two values,  $D_c$  or  $D_f$ , obtained by the test. This value is recommended to be the controlling value for specification purposes.

<sup>1</sup> 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 July 10, 2003. Published September 2003. Originally approved in 1979. Last previous edition approved in 1997 as D3744 – 97. DOI: 10.1520/D3744-03.

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 04.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 04.03.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 04.08.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

#### 4. Significance and Use

4.1 This test method assigns an empirical value to the relative amount, fineness, and character of clay-like material that may be generated in an aggregate when subjected to mechanical degradation.

4.2 The procedure has been used in limited geographical areas of the United States and the results have been correlated with aggregate performance in various construction applications, including: aggregate base, permeable material for back-fill, fine concrete aggregate, and riprap for rock slope protection.<sup>6,7</sup>

4.3 A minimum durability index is permitted to be specified to prohibit the use of an aggregate in various construction applications that is prone to degradation, resulting in generation of clay-like fines.

4.4 This test method provides a rapid test for evaluation of the quality of a new aggregate source. Research has indicated it may also be suitable for use instead of the sodium sulfate soundness test for evaluating the durability characteristics of fine aggregate for use in portland-cement concrete, thereby reducing the need for time-consuming and expensive soundness tests.<sup>6</sup>

4.5 Although the application of this method has been limited to aggregates for specific construction uses, the possibility exists for expanding the application of this method to control the quality of aggregates used in other areas of construction, such as aggregates for use in bituminous paving mixtures, coarse aggregate for use in portland-cement concrete, and aggregate for use as railroad ballast.

#### 5. Apparatus

5.1 *Mechanical Washing Vessel (Pot)*—A flat-bottomed, straight-sided cylindrical vessel conforming to the specifications and dimensions shown in Fig. 1.

5.2 *Collection Pan*—A round pan (at least 230 mm (9 in.) in diameter and approximately 100 mm (4 in.) deep), suitable to collect the wash water from the washed sample. The pan shall have vertical or nearly vertical sides and shall be equipped as necessary to hold the wire mesh of an 203-mm (8-in.) diameter sieve at least 75 mm (3 in.) above the bottom. An adaptor that will not allow loss of fines or wash water may be used to nest the sieve with the container, or the sieve may be nested with a blank sieve frame resting in the bottom of the pan.

5.3 *Agitator*—A mechanical device designed to hold the wash vessel in an upright position while subjecting it to a lateral reciprocating motion at a rate of  $285 \pm 10$  complete cycles per minute. The reciprocating motion shall be produced by means of an eccentric in the base of the carrier and the length of the stroke shall be  $44.5 \pm 0.6$  mm ( $1.75 \pm 0.025$  in.). The clearance between the cam and follower of the eccentric

shall be 0.25 to 1.02 mm (0.001 to 0.004 in.). Fig. 2 shows a Tyler portable sieve shaker modified to meet these requirements.

5.4 All equipment required to perform the Test for Sand Equivalent Value of Soils and Fine Aggregate (Test Method D2419).

5.5 *Sieves*—The sieves shall conform to Specification E11.

5.6 *Balance*—A balance having a minimum capacity of 500 g and meeting the requirements of Guide D4753, Class GP5.

#### 6. Reagents and Materials

6.1 *Calcium Chloride Solutions*—Use stock and working calcium chloride solutions as specified in the Reagents and Materials section of Test Method D2419.

6.2 *Water*—Use distilled or demineralized water for the normal performance of this test method. The test results are likely to be affected by certain minerals dissolved in water. However, if it is determined that local tap water is of such purity that it does not affect the test results, the use of tap water is permissible in place of distilled or demineralized water. For referee purposes, distilled or demineralized water shall be used for all steps in the test.

#### 7. Temperature Control

7.1 This test method is normally performed without strict temperature control; however, for referee purposes, retest the material with the temperature of the distilled or demineralized water and the working calcium chloride solution at  $22 \pm 3^\circ\text{C}$  ( $72 \pm 5^\circ\text{F}$ ).

#### 8. Sampling

8.1 Obtain samples of the aggregate to be tested in accordance with Practice D75.

#### 9. Initial Sample Preparation

9.1 Dry aggregate samples sufficiently to permit a complete separation on the 4.75-mm (No. 4) sieve and to develop a free-flowing condition in the portion passing the sieve. Perform drying by any method that does not heat the aggregate in excess of  $60^\circ\text{C}$  ( $140^\circ\text{F}$ ) or cause degradation of the particles. The use of sunlight, ovens, or forced drafts of warm air are the most common drying methods.

9.2 If the sample contains an appreciable amount of clay, turn the aggregate frequently during the drying process to obtain even drying throughout and prevent the formation of hard clay lumps.

9.3 Break up any hard clods and remove coatings of fines from the coarse aggregate particles by any means that will not appreciably reduce the natural individual particle sizes.

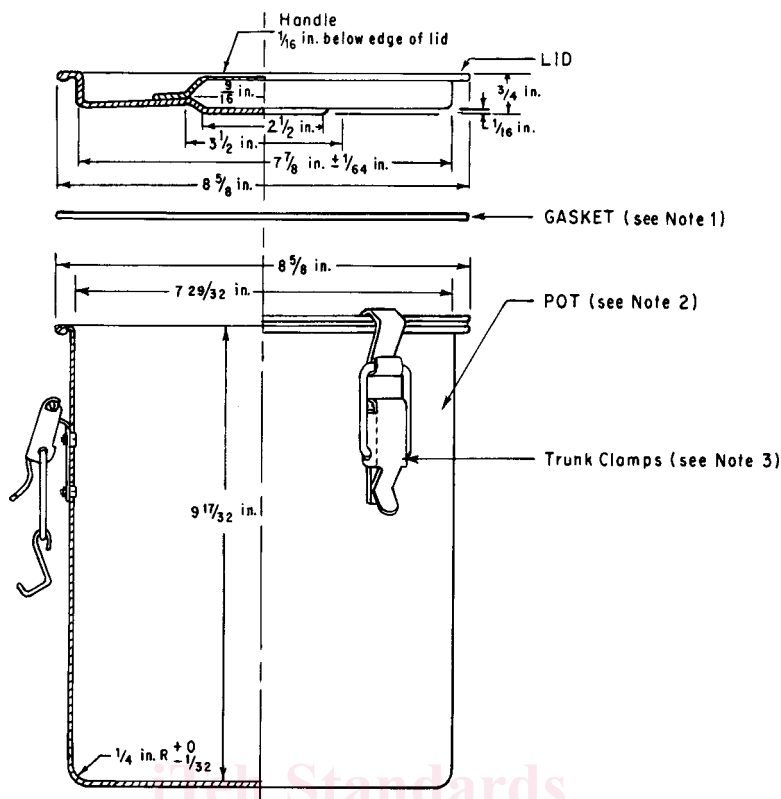
9.4 Determine the sample grading by sieving in accordance with Test Method C136 on the 19.0, 12.5, 9.5, 4.75, 2.36, and 1.18-mm ( $\frac{3}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{8}$ -in. and Nos. 4, 8, and 16) sieves. Discard any material that is retained on the 19.0-mm ( $\frac{3}{4}$ -in.) sieve.

9.5 Determine the test procedures to be used for establishing the durability index of the aggregate based upon the grading of the aggregate as determined in 9.4.

9.5.1 If less than 10 % of the aggregate passes the 4.75-mm (No. 4) sieve, test coarse aggregate (Procedure A) only.

<sup>6</sup> Hamilton, R. D., Smith, R. E., and Sherman, G. B., "Factors Influencing the Durability of Aggregates," Research Report 633476, State of California, Division of Highways, Materials and Research Department, June 1971.

<sup>7</sup> Hveem, F. N., and Smith, T. N., "Durability of Aggregates," Research Report, State of California, Division of Highways, Materials and Research Department, January 1964.



SI Equivalent

in.	mm	in.	mm	in.	mm
9 <sup>17</sup> / <sub>32</sub>	242.1	7 <sup>5</sup> / <sub>8</sub>	193.7	1/4	6.4
8 <sup>5</sup> / <sub>8</sub>	219.1	3 <sup>1</sup> / <sub>2</sub>	88.9	1/16	1.6
8 <sup>33</sup> / <sub>64</sub>	216.3	2 <sup>1</sup> / <sub>2</sub>	64.8	1/32	0.79
7 <sup>29</sup> / <sub>32</sub>	200.8	3/4	19.0	1/64	0.40
7 <sup>27</sup> / <sub>32</sub>	199.2				

NOTE 1—The gasket shall be 1/8 in. neoprene rubber, having an inside diameter of 7 27/32 ± 1/64 in. and an outside diameter of 8 33/64 ± 1/64 in.

NOTE 2—The pot shall be a flat bottom, straight-sided, cylindrical vessel with a capacity of approximately 2 gal. The top edge shall be flared outward to form a seat for the gasket and lid.

NOTE 3—Three trunk clamps are required and shall be placed at one-third intervals. The clamps shall be attached to the pot by rivets or welds so that the pot remains watertight. When fitted with the 1/8-in. gasket and clamped in place, the lid shall form a watertight seal with the flared edge of the pot.

NOTE 4—The vessel shall be 20-gage stainless steel, unless otherwise noted. All dimensions shall be within ± 1/32 in., unless otherwise noted.

FIG. 1 Mechanical Washing Vessel

9.5.2 If less than 10 % of the aggregate is coarser than the 4.75-mm (No. 4) sieve, test fine aggregate (Procedure B) only.

9.5.3 When both coarse and fine aggregate fractions are each present in quantities equal to or greater than 10 % and if the percent passing the 1.18-mm (No. 16) sieve is greater than 10 %, use both Procedures A and B on the appropriate aggregate sizes. If the percent passing the 1.18-mm (No. 16) sieve is less than or equal to 10 %, use Procedure A or Procedure C.

9.5.4 If most of the aggregate (75 to 80 %) is retained between the 9.5 and 1.18-mm (3/8-in. and No. 16) sieves, use Procedure C only.

PROCEDURE A—COARSE AGGREGATE

10. Test Sample Preparation

10.1 Prepare a 2550 ± 25-g (air-dry) preliminary test sample using the grading given below:

Aggregate Size	Air Dry Mass, g
19.0 to 12.5 mm (3/4 to 1/2 in.)	1070 ± 10
12.5 to 9.5 mm (1/2 to 3/8 in.)	570 ± 10
9.5 to 4.75 mm (3/8 in. to No. 4 )	910 ± 5
	2550 ± 25

For materials with less than 10 % in any of the size fractions given in 10.1, prepare the test sample using the actual

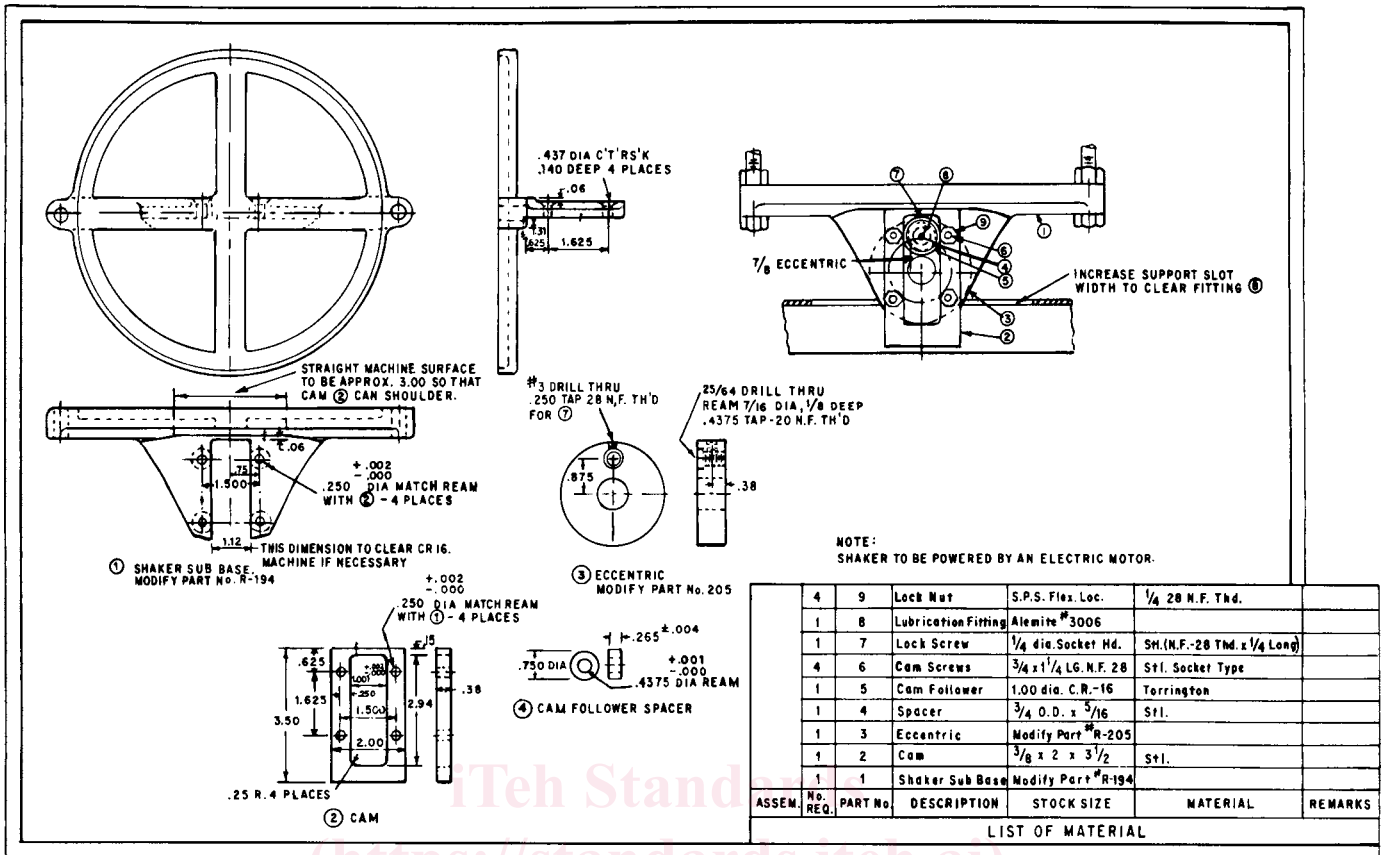


FIG. 2 Modification of Tyler Portable Sieve Shaker

percentage for the deficient fraction and proportionally increase the mass of the remaining fractions to obtain the 2550 g test sample. Two examples follow.

Example 1—Less than 10 % in 19.0 to 12.5 mm (3/4 to 1/2 in.) fraction

Aggregate Size	Percent	Calculation	Air Dry Mass, g
19.0 to 12.5 mm (3/4 to 1/2 in.)	6	0.06 × 2550	153 ± 10
12.5 to 9.5 mm (1/2 to 3/8 in.)	26	570 (2550 - 153)	923 ± 10
		570 + 910	
9.5 to 4.75 mm (3/8 to No. 4)	68	910 (2550 - 153)	1474 ± 5
		570 + 910	
Totals	100		2550 ± 25

Example 2—Less than 10 % in two fractions

Aggregate Size	Percent	Calculation	Air Dry Mass, g
19.0 to 12.5 mm (3/4 to 1/2 in.)	4	0.04 × 2550	102 ± 10
12.5 to 9.5 mm (1/2 to 3/8 in.)	7	0.07 × 2550	179 ± 10
9.5 to 4.75 mm (3/8 to No. 4)	89	2550 - (102 + 179)	2269 ± 5
Totals	100		2550 ± 25

10.2 Place the preliminary test sample in the mechanical washing vessel and add 1000 ± 5 ml of distilled or demineralized water.

10.3 Because of the low specific gravity or high absorption rate, or both, of some aggregates, the proportions of aggregate to water will not provide the intended interparticle abrasion. Testing of these materials will require adjustment of the test specimen mass or volume of both wash and test water, or both.

10.3.1 Wash all materials that are not completely inundated when 1000 ml of water are added to the test sample and test with adjusted sample masses and water volumes.

10.3.2 Determine the bulk, oven-dry specific gravity, and percentage of absorption of the aggregate in accordance with Test Method C127.

10.3.3 Adjust the total mass of the test sample using the following equation:

$$\text{Adjusted sample mass, g} = \frac{\text{specific gravity of aggregate}}{2.65} \times W \quad (1)$$

where:

W = mass of oven-dried test sample, g.

Adjust the mass of material in each size fraction proportionally to the masses specified in 10.1.

10.3.4 Adjust the volume of test water using the following equation:

$$\text{Adjusted water} = 1000 + (A \times W) - 50 \quad (2)$$

where:

A = absorption of aggregate, % (expressed as a decimal fraction), and

W = mass of oven-dried test sample, g.

10.4 Clamp the vessel lid in place, and secure the vessel in the sieve shaker. Begin agitation after a time of 60 ± 10 s has elapsed from the introduction of the wash water. Agitate the vessel in the sieve shaker for 120 ± 5 s.

10.5 After the 2-min agitation time is completed, remove the vessel from the shaker, unclamp the lid and pour the contents onto a 4.75-mm (No. 4) sieve. Rinse any remaining fines from the vessel onto the sieve and direct water (from a