



Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate¹

This standard is issued under the fixed designation D5821; 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 the determination of the percentage, by mass or by count, of a coarse aggregate sample that consists of fractured particles meeting specified requirements.

1.2 The values stated in SI units are to be regarded as the standard. The values in parentheses are provided 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:*²

C136 Test Method for Sieve Analysis of Fine and Coarse Aggregates

C702 Practice for Reducing Samples of Aggregate to Testing Size

D8 Terminology Relating to Materials for Roads and Pavements

D75 Practice for Sampling Aggregates

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Terminology

3.1 *Definitions:*

3.1.1 *fractured face, n*—an angular, rough, or broken surface of an aggregate particle created by crushing, by other artificial means, or by nature (see Terminology **D8**).

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.

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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.

3.1.1.1 *Discussion*—for this standard, a face will be considered a “fractured face” only if it has a projected area at least as large as one quarter of the maximum projected area (maximum cross-sectional area) of the particle (this excludes small nicks, see **Fig. 1**) and the face has sharp or slightly blunt edges.

3.1.2 *fractured particle, n*—a particle of aggregate having at least the minimum number of fractured faces specified (usually one or two).

4. Significance and Use

4.1 Some specifications contain requirements relating to percentage of fractured particles in coarse aggregates. One purpose of such requirements is to maximize shear strength by increasing inter-particle friction in either bound or unbound aggregate mixtures. Another purpose is to provide stability for surface treatment aggregates and to provide increased friction and texture for aggregates used in pavement surface courses. This test method provides a standard procedure for determining the acceptability of coarse aggregate with respect to such requirements.

4.2 Specifications differ as to the number of fractured faces required on a fractured particle, and they also differ as to whether percentage by mass or percentage by particle count shall be used. If the specification does not specify, use the criterion of at least one fractured face and calculate percentage by mass.

5. Apparatus

5.1 *Balance*—A balance or scale accurate and readable to within 0.1 % of the test sample mass at any point within the range of use.

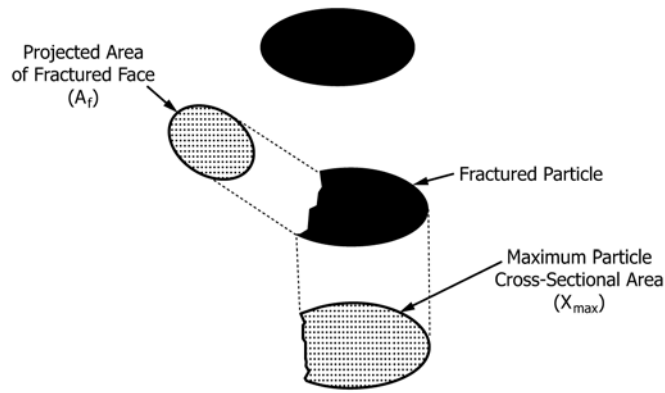
5.2 *Sieves*—Sieves conforming to Specification **E11**.

5.3 *Splitter*—A sample splitter suitable for dividing field samples into test portion sizes in accordance with Practice **C702**.

5.4 *Spatula*—A spatula or similar tool to aid in sorting aggregate particles.

6. Sampling

6.1 Sample the aggregate in accordance with Practice **D75**.



A face will be considered a "Fractured Face" only if it has : $A_f \geq 0.25 X_{max}$

FIG. 1 Schematic of a Fractured Particle with One Fractured Face

7. Sample Preparation

7.1 Dry the sample sufficiently to obtain a clean separation of fine and coarse material in the sieving operation. Sieve the sample over the 4.75-mm (No. 4) sieve, or other specified sieve for retaining material for this test, in accordance with Test Method C136 and then reduce the portion retained on the sieve using a splitter in accordance with Practice C702 to appropriate size for test.

7.2 The mass of the test sample shall be at least large enough so that the largest particle is not more than 1 % of the sample mass; or the test sample shall be at least as large as indicated below, whichever is smaller:

Nominal Maximum Size Square Openings, mm (in.)	Minimum Test Sample Mass, g (Approx. lb)
9.5 (3/8)	200 (0.5)
12.5 (1/2)	500 (1)
19.0 (3/4)	1500 (3)
25.0 (1)	3000 (6.5)
37.5 (1 1/2)	7500 (16.5)
50.0 (2)	15 000 (33)
63.0 (2 1/2)	30 000 (66)
75.0 (3)	60 000 (132)
90.0 (3 1/2)	90 000 (198)

7.3 For aggregate with a nominal maximum size of 19.0 mm (3/4 in.) or larger, where the fracture particle content is to be determined for material retained on the 4.75-mm (No. 4) or smaller sieve, the test sample may be separated on the 9.5-mm (3/8-in.) sieve. The portion passing the 9.5-mm (3/8-in.) sieve may then be further reduced, in accordance with Practice C702, to a minimum of 200 g (0.5 lb). This will reduce the number of particles to be separated during the procedure. In this case, percent fractured particles is determined on each portion; and a weighted average percentage of fractured particles is calcu-

lated based on the mass of each of the portions to reflect the total percentage of fractured particles in the entire sample.

8. Procedure

8.1 Wash the sample over the sieve designated for determination of fractured particles to remove any remaining fine material, and dry to constant mass. Determine the mass of the test sample, and any subsequent determinations of mass, to the nearest 0.1 % of the original dry sample mass.

8.2 Spread the dried test sample on a clean flat surface large enough to permit careful inspection of each particle. To verify that a particle meets the fracture criteria, hold the aggregate particle so that the face is viewed directly. If the face constitutes at least one quarter of the maximum cross-sectional area of the rock particle, consider it a fractured face.

8.3 Using the spatula or similar tool separate into two categories: (1) fractured particles based on whether the particle has the required number of fractured faces, and (2) particles not meeting the specified criteria. Use Figs. 2-7 to aid in this determination. Be aware that some of the particles in Figs. 2-4 do show more than one fractured face. If the required number of fractured faces is not given in the applicable specifications, the determination will be made on the basis of a minimum of one fractured face.

8.4 Determine the mass or count of particles in the fractured particle category and the mass or count of the particles not meeting the specified fracture criteria. Use mass to calculate percent fractured particles unless percentage by particle count is specified.

8.5 If more than one number of fractured faces is specified (for example, 70 % with one or more fractured faces and 40 %

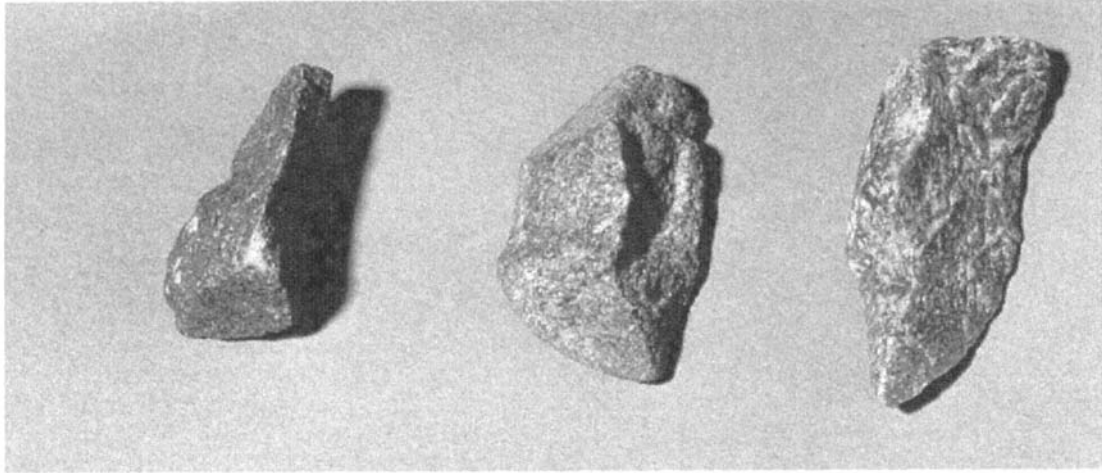


FIG. 2 Fractured Particle (Sharp Edges, Rough Surfaces)



FIG. 3 Fractured Particle (Sharp Edges, Smooth Surfaces)

with two or more fractured faces), repeat the procedure on the same sample for each requirement.

9. Report

9.1 Report the mass percentage or count percentage of particles with the specified number(s) of fractured faces to the nearest 1 % in accordance with the following:

$$P = [F/(F+N)] \times 100 \quad (1)$$

where:

- P = percentage of particles with the specified number of fractured faces,
- F = mass or count of fractured particles with at least the specified number of fractured faces, and
- N = mass or count of particles in the non-fractured category not meeting the fractured particle criteria.

9.2 Report the specified fracture criteria against which the sample was evaluated.

9.3 Report the total mass in grams of the coarse aggregate sample tested.

9.4 Report the sieve on which the test sample was retained at the start of the test.

9.5 Report whether the percentage of fractured particles was determined by mass or by particle count.

10. Precision and Bias

10.1 *Precision*—The Ontario Ministry of Transportation reported that in a formal study of 34 well-trained observers of two samples of partly-fractured gravel (proportion of fractured particles = 76 %) the average standard deviation was found to be 5.2 %. Therefore, the difference in results between two well-trained observers, on samples of the same material should not exceed 14.7 % of their average, nineteen times in twenty.

NOTE 1—When a mixture of trained and untrained observers conducted this test, the average multi-operator standard deviation increased to about 7.6 %.

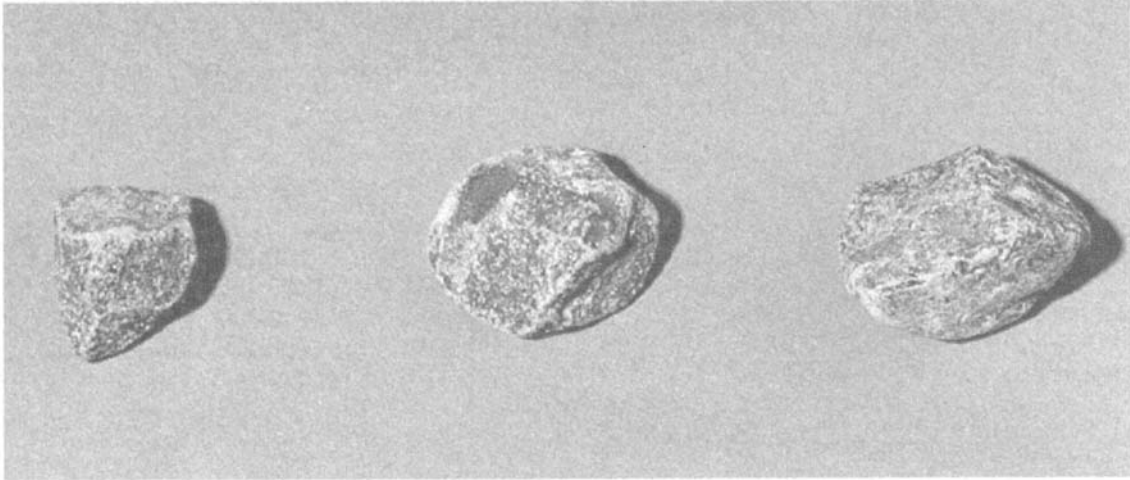


FIG. 4 a) Fractured Particle (Round Edges, Rough Surfaces)



FIG. 4 b) Fractured Particle (Round Edges, Rough Surfaces) (continued)



FIG. 4 c) Fractured Particle (Round Edges, Rough Surfaces) (continued)

10.2 *Bias*—This test method has no bias because the values determined can be defined only in terms of the test method.

11. Keywords

11.1 aggregate; crushed aggregate; crushed gravel; crushed particles; fractured faces; fractured particles

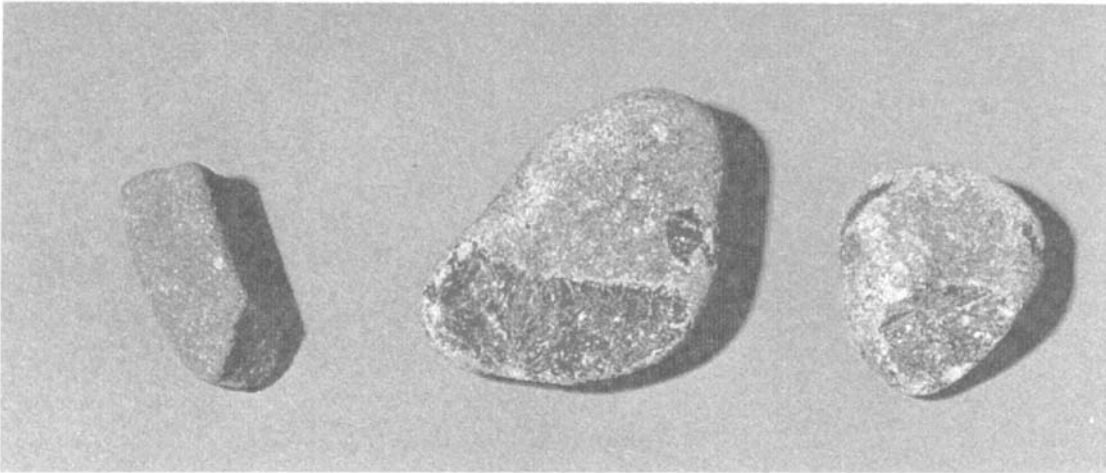


FIG. 5 Fractured Particle (Center) Flanked by Two Non-Fractured Particles (Chipped Only)

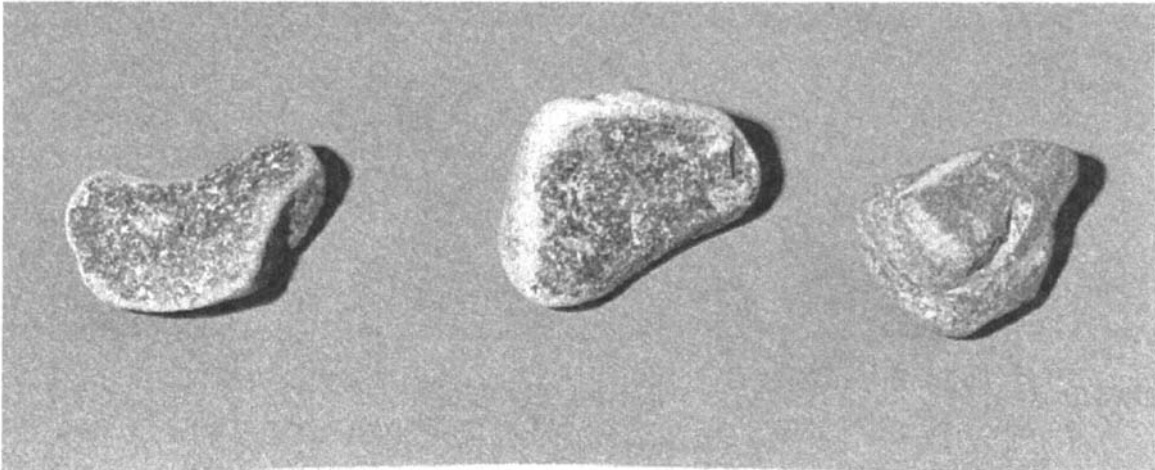


FIG. 6 Non-Fractured Particle (Round Edges, Smooth Surfaces)

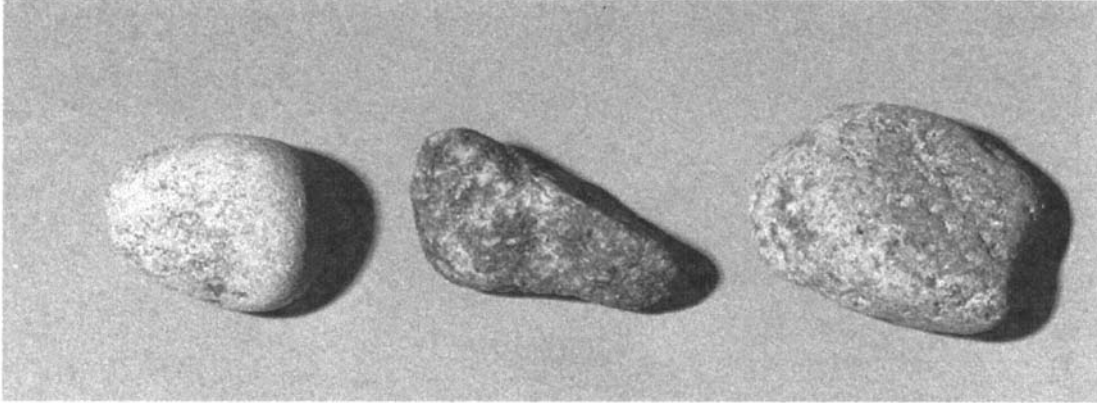


FIG. 7 Non-Fractured Particle (Rounded Particles, Smooth Surfaces)

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