Designation: D 5821 – ~~95~~01

Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate[1]

This standard is issued under the fixed designation D 5821; 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:*

[1] This test method is under the jurisdiction of ASTM Committee ~~D-4~~ D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

Current edition approved ~~Nov.~~ Aug. 10, ~~1995.~~ 2001. Published ~~January 1996.~~ October 2001. Originally published as D 5821 - 95. Last previous edition D 5821 - 95.

C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates[2]
C 702 Practice for Reducing Field Samples of Aggregate to Testing Size[2]
D 8 Terminology Relating to Materials for Roads and Pavements[3]
D 75 Practice for Sampling Aggregates[3]
E 11 Specification for Wire-Cloth Sieves for Testing Purposes[4]

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 D 8).

3.1.~~2~~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 ~~and the face has sharp and well defined edges; this~~ (this excludes small nicks~~. S~~, see Fig. 1) and the face has sharp or slightly blunt edges.

3.1.~~3~~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 E 11.

5.3 *Splitter*—A sample splitter suitable for dividing field samples into test portion sizes in accordance with Practice C 702.

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 D 75.

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

[2] *Annual Book of ASTM Standards,* Vol 04.02.
[3] *Annual Book of ASTM Standards,* Vol 04.03.
[4] *Annual Book of ASTM Standards,* Vol 14.02.

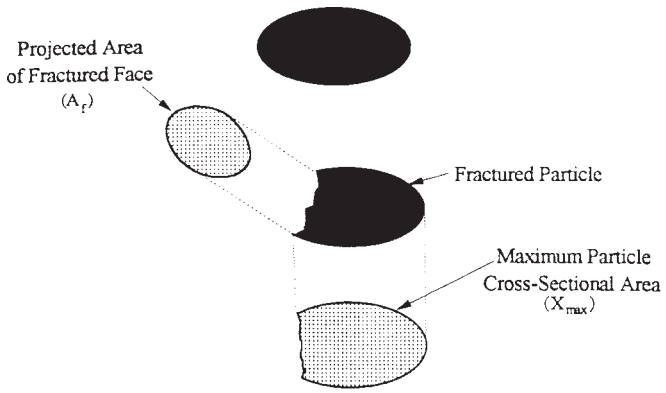

FIG. 1 Schematic of a Fractured Particle with One Fractured Face

over the 4.75-mm (No. 4) sieve, or other specified sieve for retaining material for this test, in accordance with Test Method C 136 and then reduce the portion retained on the sieve using a splitter in accordance with Practice C 702 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 (⅜)	200 (0.5)
12.5 (½)	500 (1)
19.0 (¾)	1500 (3)
25.0 (1)	3000 (6.5)
37.5 (1½)	7500 (16.5)
50.0 (2)	15 000 (33)
63.0 (2½)	30 000 (66)
75.0 (3)	60 000 (132)
90.0 (3½)	90 000 (198)

7.3 For aggregate with a nominal maximum size of 19.0 mm (¾ 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 (⅜-in.) sieve. The portion passing the 9.5-mm (⅜-in.) sieve may then be further reduced, in accordance with Practice C 702, 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 calculated 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 ~~three~~ 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, and (*3*) questionable or borderline particles.~~ 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, the mass or count of the questionable particles,~~ 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 % with two or more fractured faces), repeat the procedure on the same sample for each requirement.

~~8.6 If on any of the determinations, more than 15 % of the total is placed in the questionable pile, repeat the determination until no more than 15 % is present in that category. Use percent based on mass for this determination unless percent by particle count~~

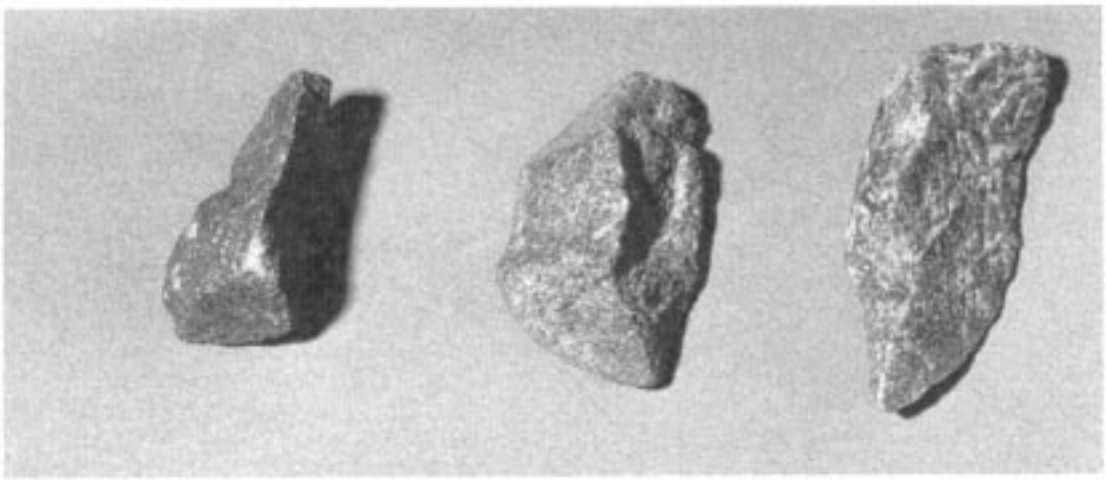

FIG. 2 Fractured Particle (Sharp Edges, Rough Surfaces)

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

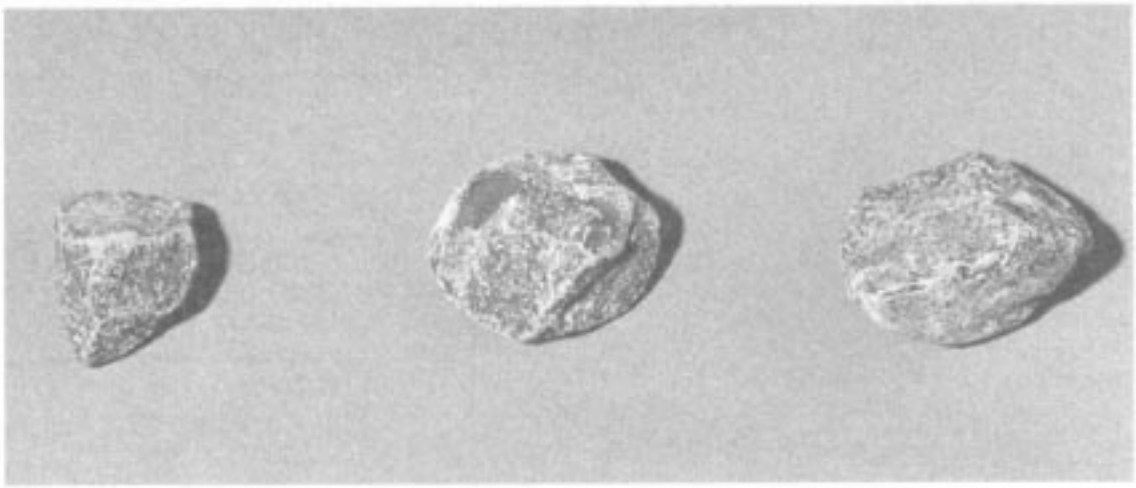

FIG. 4 Fractured Particle (Round Edges, Rough Surfaces)

~~is specified. Also, if the sample has been divided into two test portions (see 7.3) the 15 % criteria shall apply to each.~~

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:

~~$$P = [(F + Q/2)/(F + Q + N)] \times 100 \quad (1)$$~~

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

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
~~Q = mass or count of particles in the questionable or borderline category, and~~
N = mass or count of particles in the ~~uncrushed~~ 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.

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

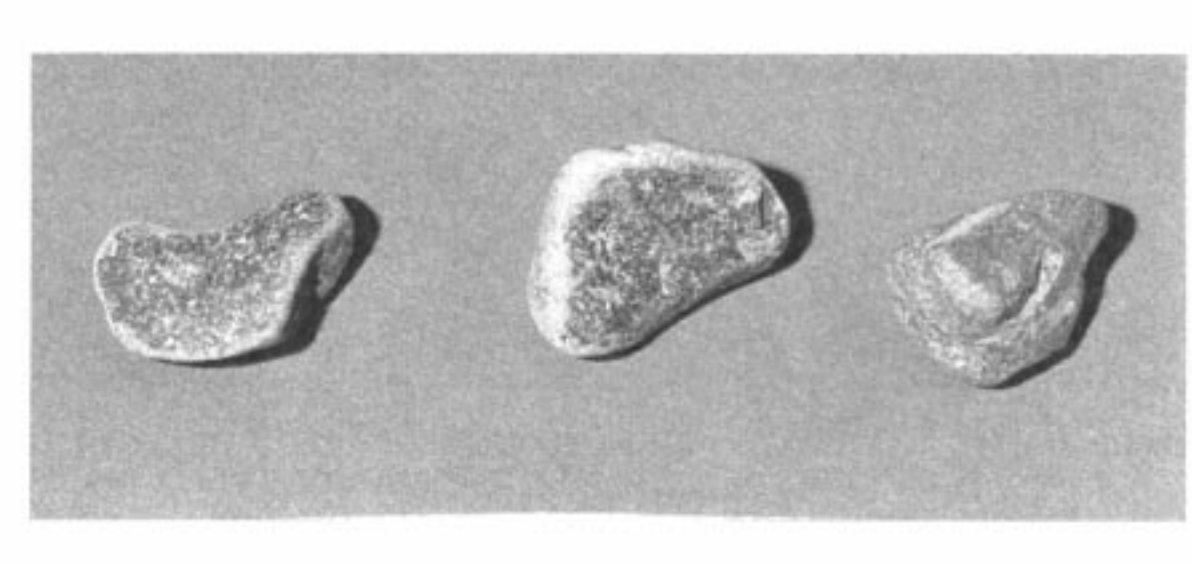

FIG. 6 Non-Fractured Particle (Round Edges, Smooth Surfaces)

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

10. Precision and Bias

10.1 *Precision*—~~No precision data are available using this method. Data from separate studies by the California Department~~—The Ontario Ministry of Transportation ~~and the Arizona Department of Transportation, using their DOT methods, on material~~ reported that ~~averaged about 80 % crushed particles showed similar precision. The multi-laboratory precision~~ in ~~California and the multi-operator precision in Arizona (many~~ a formal study of ~~which operators were in different laboratories) were both about 10 %~~ 34 well-trained observers of two samples of partly-fractured gravel (proportion of fractured particles = 76 %) the average standard deviation ~~(1s). At this level of precision, a~~ was found to be 5.2 %. Therefore, the difference in results between ~~operators from~~ two ~~different laboratories would~~ well-trained observers, on samples of the same material should not ~~be expected to~~ exceed ~~28 %, 95 %~~ 14.7 % of their average, nineteen times in twenty.

NOTE 1—When a mixture of trained and untrained observers conducted this test, the ~~time (d2s).~~ average multi-operator standard deviation increased to about 7.6 %.

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

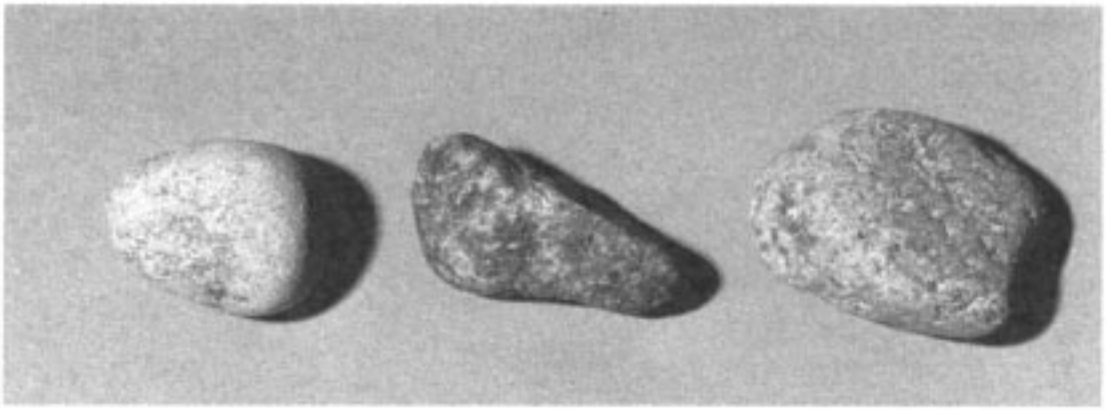

FIG. 7 Non-Fractured Particle (Rounded Particles, Smooth Surfaces)