

**METHODS OF SAMPLING AND TESTING**  
**MT 217-04**  
**METHOD OF TEST FOR DETERMINING**  
**PERCENTAGE OF MECHANICALLY FRACTURED PARTICLES**

**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.

**2 Referenced Documents:**

**2.1 ASTM:**

D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

**MT Manual:**

MT 201 Sampling Roadway Materials

MT 202 Sieve Analysis for Coarse and Fine Aggregate

MT 405 Wire Cloth Sieves for Testing Purposes

MT 607 Procedure for Reducing Field Samples to Testing Size

**WAQTC:**

TM-1 Determining the Percentage of Fractured Particles in Coarse Aggregate

**3 Terminology:**

- 3.1 *Fractured face, n* – an angular, rough, or broken surface of an aggregate particle created by crushing, by other artificial means, or by nature.
- 3.2 *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 excludes small nicks
- 3.3 *Fractured particle, n* – a particle of aggregate having at least the minimum number of fractured faced specified (usually one or two).
- 3.4 *Nominal Maximum Size* – One sieve size larger than the first sieve to retain more than 10 percent.

**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 Significance and Use: (continued)**

- 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 shall be of the woven wire type with square openings and shall conform to MT 405.
- 5.3** *Splitter* - A sample splitter suitable for dividing field samples into test portion sizes according to MT 607.
- 5.4** *Spatula* - A spatula or similar tool to aid in sorting aggregate particles.

**6 Sampling:**

- 6.1** Sample and reduce the aggregate in accordance with MT 201 and MT 607.

**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 in accordance with MT 202 over the 4.75 mm (No. 4) sieve, or other specified sieve for retaining material for this test, and reduce the portion retained on the sieve using a splitter in accordance with MT 607 to the appropriate size for test. This test size should be slightly larger than shown in Table 1 to account for loss of fines through washing, if necessary.

*Note - When individual sieve fracture determination is required, such as in the Special Provisions for a Grade "S" mix design, the test sample size will be determined using Table 2.*

- 7.2** 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 MT 607, to a minimum of 200 g (0.5 lbs.). 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 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.

## Combined Fracture Determination

TABLE 1

Nominal Maximum Size Square Openings, mm (in.)	Minimum Test Sample Mass, grams (Approx. lb.)
4.75 (No.4)	200 (0.4)
9.5 (3/8)	400 (0.9)
12.5 (1/2)	700 (1.5)
19.0 (3/4)	1,000 (2.5)
25.0 (1)	1,500 (3.5)
37.5 (1 1/2)	2,500 (6)
50.0 (2)	4,000 (8.8)
63.0 (2 1/2)	7,500 (16.5)
75.0 (3)	10,000 (27)
90.0 (3 1/2)	15,000 (33)

Note - Nominal maximum size is one sieve size larger than the first sieve to retain more than 10 percent of the material.

## Individual Sieve Fracture Determination

TABLE 2

Nominal Maximum Size Square Openings, mm (in.)	Minimum Test Sample Mass, grams (Approx. lb.)
2.00 (No.10)	25 (0.1)
2.36 (No.8)	25 (0.1)
4.75 (No.4)	100 (0.4)
6.3 (1/4)	100 (0.2)
9.5 (3/8)	200 (0.5)
12.5 (1/2)	300 (0.7)
16.0 (5/8)	500 (1)
19.0 (3/4)	700 (1.5)
25.0 (1)	1,000 (2.2)
31.5 (1 1/4)	1,500 (3.5)

**8 Procedure:**

- 8.1** Wash the sample, when necessary, over the sieve designated for determination of fractured particles to remove any remaining fine material, and dry to a constant mass in accordance with MT 202. Determine the mass of the test sample, and any subsequent determination 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 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 the test sample into three categories: (1) fractured particle based on whether the particle has the required number of fractured faces, (2) particles not meeting the specified criteria, and (3) questionable or borderline particles. 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 Procedure: (continued)**

- 8.4** To aid in making the fracture determination, separate the sample into three categories. Determine the mass or count of particle in the fractured particle category, the mass or count of the questionable particles, and the mass or count of the particle 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, 90% with one or more fractured faces and 60% 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 is specified. Also, if the sample has been divided into two test portions, the 15% criteria shall apply to each.

**9 Report:**

- 9.1** Report the mass percentage of fractured faces to the nearest 1% in accordance with the following:

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

P = percentage of particle with the specified number of fractured faces,

F = mass or, count of fractured particles with at least the specified number of fractured faces,

Q = mass or count of particles in the questionable or borderline category, and

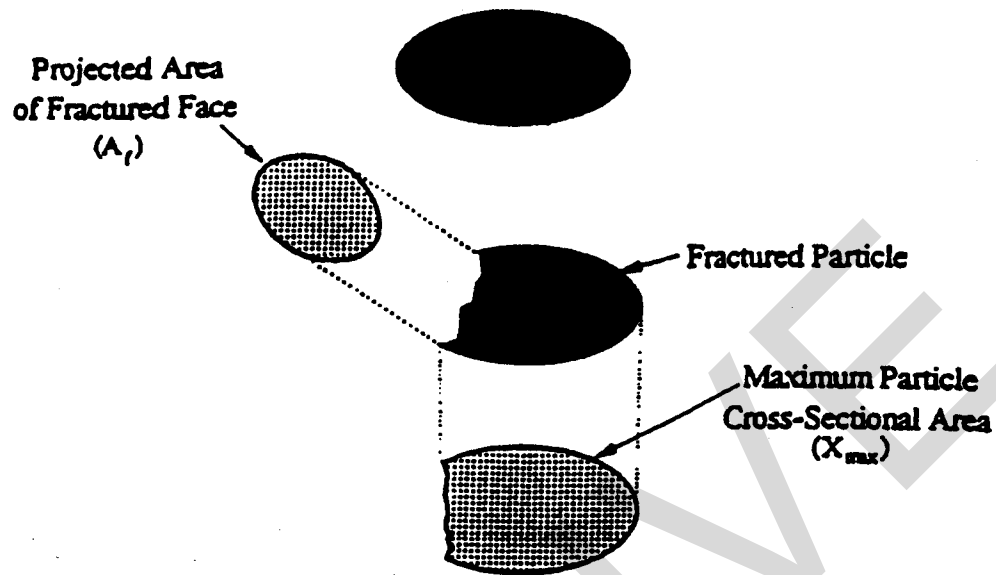
N = mass or count of particles in the uncrushed category not meeting the fractured particle criteria.

Example:

$$F = 632.6 \text{ g}, Q = 97.6 \text{ g}, N = 352.3 \text{ g}$$

$$P = [(632.6 \text{ g} + 97.6 \text{ g}/2)/(632.6 \text{ g} + 97.6 \text{ g} + 352.3 \text{ g})] \times 100 = 62.9\%$$

- 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.



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**

Fig. 1 reprinted with the permission of the American Society for Testing Materials