TP 61

DETERMINING THE PERCENTAGE OF FRACTURE IN COARSE AGGREGATE

FOP FOR AASHTO TP 61

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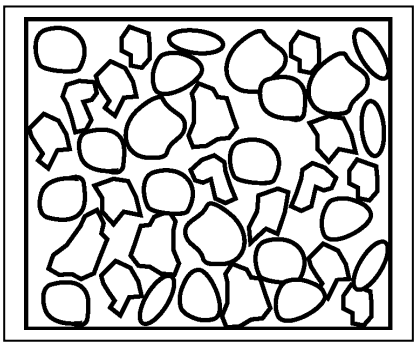

Fractured and unfractured

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Significance

Aggregate particles can be round or smooth, as is often the case for material mined from the bottom of a river. This material has been rounded or smoothed as the stone has been transported downstream through the years. Aggregate can also be fractured, exhibiting a rough surface. Material that has been mechanically crushed has at least one fractured, rough surface per particle.

Fractured material often exhibits better interlocking between particles than smooth material does. This improved interlocking results in stronger material from the standpoint of supporting a load in a road base. Using stronger material results in a lesser depth of material being used. Fractured material may also be used in Portland cement (PCC) or asphalt cement concretes (ACC) to obtain a better bond between aggregate particles and the cement. Again, a stronger structure results.

Scope

04 This procedure covers the determination of the percentage, by mass, of a coarse aggregate (CA) sample that consists of fractured particles meeting specified requirements in accordance with AASHTO TP 61.

In this procedure, a sample of aggregate is screened on the sieve separating CA and fine aggregate (FA). This sieve will be identified in the agency's specifications, but might be the No. 4 sieve. CA particles are visually evaluated to determine conformance to the specified fracture. The percentage of conforming particles, by mass, is calculated for comparison to the specifications.

Apparatus

- Balance or scale: Capacity sufficient for the principle sample mass, accurate to 0.1 percent of the sample mass or readable to 0.1 g. Meets the requirements of AASHTO M 231

- Sieves, meeting requirements of AASHTO M 92.
- Splitter, meeting the requirements of the FOP for AASHTO T 248.

Terminology

Fractured aggregate

1. Fractured Face – An angular, rough, or broken surface of an aggregate particle created by crushing, or other means. A face is considered a "Fractured Face" whenever one-half or more of the projected area, when viewed normal to that face, is fractured with sharp and well defined edges. This excludes small nicks.
2. Fractured particle – A particle of aggregate having at least the minimum number of fractured faces specified. (This is usually one or two.)

Sampling and Sample Preparation

1. Sample and reduce the aggregate in accordance with the FOP's for AASHTO T 2 and T 248.
2. When the specifications list only a total fracture percentage, the sample shall be prepared in accordance with Method 1. When the specifications require that the fracture be counted and reported on each sieve, the sample shall be prepared in accordance with Method 2.
3. Method 1 - Combined Fracture Determination
   a. Dry the sample sufficiently to obtain a clean separation of CA and FA material in the sieving operation.
   b. Sieve the sample in accordance with the FOP for AASHTO T 27/ T 11 over the No. 4 sieve, or the appropriate sieve listed in the agency's specifications for this material.

Note 1: Where necessary wash the sample over the sieve or sieves designated for the determination of fractured particles to remove any remaining fine material, and dry to a constant mass in accordance with FOP for AASHTO T 255.

c. Reduce the sample using Method A, Mechanical Splitter, in accordance with the FOP for AASHTO T 248 to the appropriate test size. This test size should be slightly larger than shown in Table 1, to account for loss of fines through washing, if necessary.

TABLE 1
Sample Size
Method 1 (Combined Sieve Fracture)

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Nominal Maximum Size* (in.)	Minimum Sample Mass Retained on 4.75 mm (No. 4) Sieve g (lb)
1½	2500 (6)
1	1500 (3.5
3/4	1000 (2.5)
1/2	700 (1.5)
3/8	400 (0.9)
No. 4	200 (0.4)

* One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

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4. Method 2 – Individual Sieve Fracture Determination

   a. Dry the sample sufficiently to obtain a clean separation of CA and FA material in the sieving operation. A washed sample from the gradation determination (FOP for T 27/T 11) may be used.

   b. If not, sieve the sample in accordance with FOP for AASHTO T 27 over the sieves listed in the specifications for this material.

***Note 2*:** If overload (buffer) sieves are used the material from that sieve must be added to the next specification sieve.

c. The size of test sample for each sieve shall meet the minimum size shown in Table 2. Utilize the total retained sieve mass or select a representative portion from each sieve mass by splitting or quartering in accordance with the FOP for AASHTO T 248.

Note 1: Where necessary wash the sample over the sieve or sieves designated for the determination of fractured particles to remove any remaining fine material, and dry to a constant mass in accordance with FOP for AASHTO T 255.

13 **TABLE 2**
Sample Size
Method 2 (Individual Sieve Fracture)

Sieve Size (in.)	Minimum Sample Mass g (lb)
1¼	1500 (3.5)
1	1000 (2.2)
3/4	700 (1.5)
5/8	500 (1.0)
1/2	300 (0.7)
3/8	200 (0.5)
1/4	100 (0.2)
No. 4	100 (0.2)
No. 8	25 (0.1)
No. 10	25 (0.1)

14 ***Note 3:*** If fracture is determined on a sample obtained for gradation, use the mass retained on the individual sieves, even if it is less than the minimum listed in Table 2. If less than 5 percent of the total mass is retained on a single specification sieve, include that material on the next smaller specification sieve. If a smaller specification sieve does not exist this
15 material shall not be included in the fracture determination.

16 **Procedure**

1. After cooling, spread the dried 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.

17 2. To aid in making the fracture determination separate the sample into three categories:

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- fractured particles meeting the criteria
- particles not meeting the criteria
- questionable or borderline particles

3. Determine the dry mass of particles in each category to the nearest 0.1 g.

19 ***Note 4:*** If, on any determination, more than 15 percent of the total mass of the sample is placed in the questionable category, repeat the sorting procedure until no more than 15 percent is present in that category.

Calculation

Calculate the mass percentage of fractured faces to the nearest 1 percent using the following formula:

$$P = \frac{\left(\frac{Q}{2} + F\right)}{(F + Q + N)} \times 100$$ 20

where:

P = Percent of fracture

F = Mass of fractured particles

Q = Mass of questionable or borderline particles.

N = Mass of unfractured particles

Example:

F = 632.6 g, Q = 97.6 g, N = 352.3 g

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$$\frac{\left(\frac{97.6}{2}+632.6\right)}{(632.6+97.6+352.6)}\times 100 = 62.9 \qquad \textbf{P= 63\%}$$

Questionable:

Calculate the mass percentage of questionable fractured particles to the nearest 1 percent using the following formula:

$$\%Q = \frac{Q}{(F+Q+N)}\times 100$$

where:

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%Q = Percent of questionable fractured particles

F = Mass of fractured particles

Q = Mass of questionable or borderline particles.

N = Mass of unfractured particles

Example:

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F = 632.6 g, Q = 97.6 g, N = 352.6 g

$$\%Q = \frac{97.6}{(632.6+97.6+352.6)}\times 100 = 9.0 \qquad \%Q = \textbf{9\%}$$

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Report

Results shall be reported on standard forms approved for use by the agency. Report fracture to the nearest 1 percent.

REVIEW QUESTIONS

1. Describe a fractured face.

2. Describe a fractured particle.

3. Is washing of the sample always required?

4. What is the difference between Method 1 and Method 2?

PERFORMANCE EXAM CHECKLIST

DETERMINING THE PERCENTAGE OF FRACTURE IN COARSE AGGREGATE FOP FOR AASHTO TP 61

Participant Name _____ Exam Date _____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Sample properly sieved through specified sieve(s)?	_____	_____
2. Sample reduced to correct size?	_____	_____
3. Sample dried and cooled, if necessary?	_____	_____
4. Particles separated into fractured, unfractured, and questionable categories?	_____	_____
5. Dry mass of each category determined to nearest 0.1 g?	_____	_____
6. Procedure repeated if more than 15 percent of total mass falls into the questionable category?	_____	_____
7. Fracture calculation performed correctly?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

_____

Examiner Signature _____ WAQTC #:_____