1214   **DETERMINATION PERCENTAGE OF CRUSHED
                    PARTICLES IN AGGREGATES**
                          ASTM D 5821

1214.1   SCOPE

This test method covers the determination of percent of particles which, by visual inspection, have the essential characteristics of crushed aggregates.

1214.2   SIGNIFICANCE and USE

The specifications and special provisions contain requirements for percentage of crushed particles, with the purpose of maximizing shear strength in either bound or unbound aggregate mixtures. This method can be used in determining the acceptability of coarse, dense-graded, and open-graded aggregates with respect to such requirements. This procedure is used for bituminous aggregates and grading and base gravels.

NOTE 1: The intended purpose of determining percent of crushed particles is to indicate a degree of internal friction between particles.

NOTE 2: The intended purpose of crushing aggregates is to change the particle surface texture from smooth to rough and the particle shape from round to angular. These alterations in characteristics will aid in the aggregate particles interlocking and adhesion.

1214.3

TERMINOLOGY

Fractured Face - Broken surface constituting an area equal to at least 25% of the maximum projected area (maximum cross-sectional area) of the particle, as viewed perpendicular to (looking directly at) the fractured face.

NOTE 3: A fractured face is defined as being caused either by mechanical means or by nature. Natural fractures, to be accepted, must be similar to fractures produced by a crusher. The fractured face should have sharp or slightly blunted edges.

Crushed Particle - A particle of aggregate having at least one fractured face, or two fractured faces, as required for that class/type of aggregate in the specifications and/or special provisions.

NOTE 4: The following three statements on "Angle at Edge of Fractured Face", "Edge Condition" and "Surface Condition" are intended to convey the intent of this method with regard to the description of crushed particles. The three statements are for **general guidance** and are **not to define rigidly enforced limits. See Fig 1214.12 for visual reference.**

Angle at Edge of Fractured Face - The angle between the two fractured faces, or between a fractured face and the remaining surface of the particle should be moderately abrupt, approximately 60° minimum from the plane of the fractured face.

Edge Condition - The edge of a fractured face should be sharp or only slightly blunted. For example, a piece of crushed limestone in handling may have a small amount abraded from the sharp edge, making it slightly rounded.

Surface Condition - The surface of the fractured face should be rough (not smooth or polished) in texture.

NOTE 5: All quarried aggregate is considered 100% crushed (i.e. 2 or more faces). Sandstone is also considered 100% crushed.

1214.4   APPARATUS

A.   Sieves - A set of sieves, appropriate for the sample type, conforming to the requirements of ASTM E 11.

B.   Balances - **For Sieving**, . balance or scale accurate and readable to within 0.1% of the test sample mass at any point within the range of use.   **For Crushed Particle Determination**, with readability, sensitivity and accuracy of 0.1g.

C.   Spatula - A spatula or similar tool to aid in sorting the aggregate particles.

D.   Test sample Containers.

1214.5   SAMPLING

Obtain a representative sample from the coarse gradation using the same setup procedure used for Lithological test pans. (See Sections 1002, 1201 and 1202.)

TEST SAMPLE SIZES

AGGREGATE SIZE (mm)	AGGREGATE SIZE	SAMPLE SIZE (g)
4.75 - 12.5 12.5 - 25.0	#4 - 1/2" 1/2 - 1"	900 - 1100 1500 - 3000

NOTE 6: Weights are for guidance <u>only</u>. In no case shall the number of particles examined in any fraction be less than 150. For pea-rock (3/8"-) sample sizes shall be approximately 300g.

1214.6   PROCEDURE

A.   Wash and then dry to a constant weight. Weigh the test sample to the nearest 0.1g and record as "Test Sample Weight".

B.   Spread the test sample on a clean, flat surface large enough to permit the material to be spread thinly for careful inspection and evaluation.

C.   Using the spatula or a similar tool separate the particles into one of the following categories.

      1.   **Crushed Particles**, using the criteria of "one or more fractured faces" or "two or more fractured faces" as is consistent with the requirements in the specifications and/or special provisions.

      2.   **Non-Crushed Particles**

D.   Determine the weight of the "Crushed Particles" according to the applicable specification and Non-Crushed separately and record the weights.

1214.7   BITUMINOUS AGGREGATE (BA) CALCULATION

A.   Calculate the percentage of crushed particles for each separate fraction as follows:

One Faced Percent Crushed Particles (1**F**) **=** (1F + 2F)/Total **X** 100.

Where: 1F = Weight of crushed particles with at least one fractured face, in grams.

2F = Weight of crushed particles with at least 2 fractured faces , in grams.

Total = Weight of the total test sample, in grams including Non-Crushed

In the example, 12.5 to 4.75mm (1/2 to #4) size:

1F =   200g(1F) + 530g(2F) = 730g
Total   = 1000

1F = 730g/1000g **X** 100 **=** 73%
2F=   530g/1000g **X** 100 = 53%

In the example, 12.5 to 25.0mm (1/2" to 1") size:

1F = 350g(1F) + 1260g(2F) = 1610g
Total   = 2250

1F = 1610g/2250g **X** 100 **=** 71.6%
2F = 1260g/2250 X 100 = 56.0%

See 1209.6 Litho Calculations for weighted average determination.

1214.8　　　BITUMINOUS MIXTURE

A.　　The typical Bituminous Mixture (BM) sample is approximately 2000 grams. After asphalt removal , the Bituminous Engineering Unit has altered this procedure for BM samples as follows:

1.　　Use all the material retained on all the 4.75mm (#4) and larger sieves.

2.　　Perform the procedure in accordance with Sections 1214.3, 1214.4 and 1214.6.

CALCULATION

B.　　Calculate the percentage of crushed particles as follows:

Percent 2 or more face crushed = $\% \, 2 \, face = \left(\frac{A}{C}\right) \times 100$

A = The weight of crushed particles with two or more fractured faces

C = Weight of test sample, in grams

Percent 1 face crushed $= \left(\frac{A+B}{C}\right) \times 100$

A = The weight of crushed particles with two or more fractured faces

B = The weight of crushed particles with only one fractured face

C = Weight of test sample, in grams

NOTE 7: This procedure is not to be used for any other type of sample.

1214.9   GRADING & BASE MATERIALS

Specification 3138, Classes 5 and 6, OGAB Open Graded Aggregate Base and DSB Drainable Stable Base, have a required minimum percent crushing. For Class 5 & 6, the requirements are crushed or non-crushed. OGAB & DSB require minimum 2 faced crushing. Perform the procedure in accordance with 1214.3, 1214.4, 1214.5 and 1214.6.

1214.10   SAMPLING

Obtain a representative sample from the coarse gradation using the same setup procedure used for Lithological test pans. (See Sections 1002, 1201 and 1202.)

1214.11   PROCEDURE

Follow procedure as detailed in 1214.6.

1. Add the WA% of all crush types together. The total should equal 100%

$$CRUSH\% = \left(\frac{f}{(f + N)}\right) * 100$$

Where f = mass of minimum required amount of fractured faces

Where N = the weight in grams of non-crushed material

Where $(f + N)$ = the total sample weight in grams

$WA\%\ crushed = (C\%[1"\text{-}1/2"])*(\%\ \text{Retained } [1" - 1/2"])$

$WA\%\ crushed = (C\%[1/2"\text{-}\#4])*(\%\ \text{Retained } [1/2"\text{-}\#4])$

Report to the nearest 0.1 percent

CRUSHED PARTICLES – SHARP EDGES, ROUGH SURFACES

CRUSHED PARTICLES – SHARP EDGES, SMOOTH SURFACES

CRUSHED PARTICLES – BLUNT EDGES, ROUGH SURFACES

NON CRUSHED PARTICLES – ROUND EDGES, SMOOTH SURFACES

ROUNDED PARTICLES – SMOOTH SURFACES