CRD-C 120-94

Test Method for Flat and Elongated Particles in Fine Aggregate

1. Scope

1.1 This test method outlines a procedure for the determination of flat and elongated particles in fine aggregate for concrete.

2. Classification of Shapes

2.1 For this test method flat and elongated particles are defined as particles having a ratio of width to thickness or length to width, respectively, greater than three.

3. Apparatus

3.1 The apparatus consists of:

3.1.1 Microscope. A stereoscopic microscope equipped with a 10X ocular and 0.66X and 2.0X objectives to give magnifications of 6.6 and 20 diameters. (Note)

Note: Any magnification in the range 5 to 15 diameters may be used in lieu of the 6.6 diameters specified, and any magnification in the range 15 to 30 diameters may be used in lieu of the 20 diameters specified. Seven and twenty diameters have however been found convenient for use in this test. If desired, a micrometer disc with a scale division of 0.1 mm fitted in one of the microscope oculars may be used as a measuuring device for determining the dimensions of the aggregate particles.

3.1.2 Manipulation Tools. Dissecting needles and sharp-nosed forceps for use in turning and picking up fine aggregate grains.

4. Preparation of Sample

4.1 Select a representative portion of the material to be tested to produce a quantity of each of the following size ranges which is present in the material to the extent of five percent or more:

Size Range	
Sieve Passing	Sieve Retained on
4.75 mm	2.36 mm
2.36 mm	1.18 mm
1.18 mm	600 μm
600 μm	300 μm
300 μm	150 μm

Each size range sample shall be subdivided until a fraction consisting of at least 300 particles has been selected.

5. Procedure

5.1 Magnification and Illumination. The largest size, passing the 4.75-mm and retained on the 2.36-mm sieve, may be counted without magnification or with low magnification with equal ease and accuracy. In either case, adequate glare-free illumination is necessary. When no magnification is used, daylight from a north window on a sunny day or a reading lamp with a 100-watt bulb will give satisfactory light. Any lamp can be used with the stereoscopic microscope if it provides illumination satisfactory to the operator. A focusing or spotlight lamp is suggested. The ocular-objective combinations and magnification used for counting each size are shown below.

Sieve Size				
Passing	Retained	Ocular	Objective	Magnification
4.75 mm	2.36 mm	10X	0.66X	6.6X
2.36 mm	1.18 mm	10X	0.66X	6.6X
1.18 mm	600 μm	10X	0.66X	6.6X
600 μm	300 μm	10X	2.0X	20X
300 μm	150 μm	10X	2.0X	20X

If the size of field and depth of focus achieved by the optical combination are convenient, use any magnification in the range 5X to 15X for the three larger sizes, and any magnification from 20X to 30X for the two smaller sizes.

5.2 Shape Count. Examine each particle and assign it by inspection to the category of flat, elongated, or not flat or elongated. Assign particles which fall on the border line between two categories half to each category.

6. Calculation, Report, Reproducibility of Results

6.1 Calculate results as percentage of flat and elongated particles in each size range examined and as a weighted average. Base the weighted average calculated to the nearest 1% on a recalculated grading including only that portion of the sample passing the 4.75-mm and retained on the 150-μm sieve. Include in the report the results of these calculations and the grading on which the weighted average was based. Repeated counts by separate operators of comparable skill should check within one percent. An example of the calculations is given below.

Calculation of Percentage of Flat and Elongated Particles in Fine Aggregate				
(1)	(2)	(3)	(4)	(5)
Sieve	Grading of Sample as Received, Individual % Retained	Grading Recalculated Omitting Sizes Not Counted, Individual % Retained	Flat and Elongated % of Size Range	Flat and Elongated % of Recalculated Grading (3) × (4)
4.75 mm	0	—	—	—
2.36 mm	10	10.5	5	0.5
1.18 mm	20	21.0	10	2.1
600 μm	20	21.0	2	0.4
300 μm	20	21.0	4	0.8
150 μm	25	26.5	10	2.6
75 μm	3	—	—	—
-75 μm	2	—	—	—
Total	100	100	—	6.4

Total flat and elongated, as percentage of recalculated grading: 6.4.
Value to be reported: 6 percent.

7. Supplementary Examination

7.1 A more detailed classification of the particles in a sample may in certain cases be desirable. This supplementary work may include either the subdivision of the flat and elongated categories or the subdividion of the not flat or elongated category, or both.

7.1.1 The particles in the flat and in the elongated categories may be reexamined and sorted into those having a ratio of width to thickness or length to width, respectively, greater than five; and those for which the ratio is greater than three but less than five. This procedure will yield data on the degree of excessive flatness and elongation of the flat and elongated particles.

7.1.2 The particles in the not flat or elongated category may be reexamined and sorted in either or both of two ways:

7.1.2.1 They may be sorted into those having a ratio of width to thickness or length to width, respectively, greater than two but less than three; and those for which the ratio is less than two.

7.1.2.2 They may be sorted into shape categories as follows:

7.1.2.2.1 Round: Approximately spherical, rounded particles.

7.1.2.2.2 Cubic: Angular particles, approximating cubic shape, ratio of length to thickness less than two.

7.1.2.2.3 Pyramidal: Angular particles, approximating a pyramid, characteristically possessing triangular faces, ratio of length to thickness less than 3.

7.1.2.2.4 Tabular: Particles intermediate between round or cubic and flat.

7.1.2.2.5 Prismatic: Particles intermediate between round, cubic, or pyramidal; and elongated.