



Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate¹

This standard is issued under the fixed designation D 4791; 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.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This test method covers the determination of the percentages of flat particles, elongated particles, or flat and elongated particles in coarse aggregates.

1.2 The values stated in inch-pound units are to be regarded as the standard except in regard to sieve size and the size of aggregate, which are given in SI units in accordance with Specification E 11. The SI units in parentheses are for information purposes 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:

C 125 Terminology Relating to Concrete and Concrete Aggregates²

C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates²

C 702 Practice for Reducing Samples of Aggregate to Testing Size²

D 75 Practice for Sampling Aggregates³

E 11 Specification for Wire-Cloth and Sieves for Testing Purposes⁴

3. Terminology

3.1 Definitions:

3.1.1 *flat or elongated particles of aggregate*—those particles of aggregate having a ratio of width to thickness or length to width greater than a specified value (see Terminology C 125).

3.1.2 *flat and elongated particles of aggregate*—those particles having a ratio of length to thickness greater than a specified value.

3.1.3 *length*—maximum dimension of the particle.

3.1.4 *width*—maximum dimension in the plane perpendicular to the length

3.1.5 *thickness*—maximum dimension perpendicular to the length and width.

4. Summary of Test Method

4.1 Individual particles of aggregate of specific sieve sizes are measured to determine the ratios of width to thickness, length to width, or length to thickness.

5. Significance and Use

5.1 Flat or elongated particles of aggregates, for some construction uses, may interfere with consolidation and result in harsh, difficult to place materials.

5.2 This test method provides a means for checking compliance with specifications that limit such particles or to determine the relative shape characteristics of coarse aggregates.

6. Apparatus

6.1 The apparatus used shall be equipment suitable for testing aggregate particles for compliance with the definitions in 3.1, at the dimensional ratios desired.

6.1.1 *Proportional Caliper Device*—The proportional caliper devices illustrated in Fig. 1, Fig. 2, and Fig. 3 are examples of devices suitable for this test method. The device illustrated in Fig. 1 and Fig. 2 consists of a base plate with two fixed posts and a swinging arm mounted between them so that the openings between the arms and the posts maintain a constant ratio. The axis position can be adjusted to provide the desired ratio of opening dimensions. Fig. 1 illustrates a device on which ratios of 1:2, 1:3, 1:4, and 1:5 may be set. The device illustrated in Fig. 3 contains several fixed posts and has the capability of measuring various ratios simultaneously.

6.1.1.1 *Verification of Ratio*—The ratio settings on the proportional caliper device shall be verified by the use of a machined block, micrometer, or other appropriate device.

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

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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.

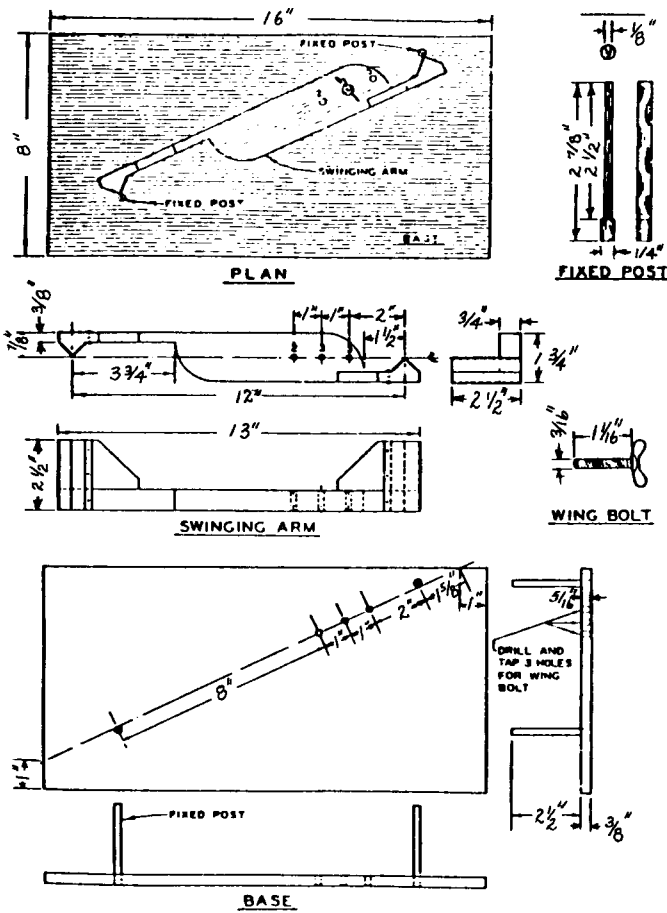


FIG. 1 Proportional Caliper

6.1.2 *Balance*—The balance or scales used shall be accurate to 0.5 % of the mass of the sample.

7. Sampling

7.1 Sample the coarse aggregate in accordance with Practice D 75. The mass of the field sample shall be the mass shown in Practice D 75.

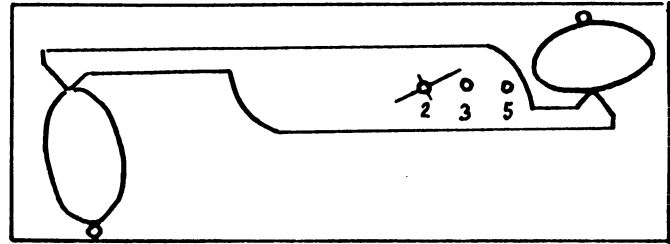
7.2 Thoroughly mix the sample and reduce it to an amount suitable for testing using the applicable procedures described in Practice C 702. The sample for test shall be approximately the mass desired when dry and shall be the end result of the reduction. Reduction to an exact predetermined mass shall not be permitted. The mass of the test sample shall conform to the following:

Nominal Maximum Size Square Openings, mm (in.)	Minimum Mass of Test Sample, kg. (lb)
9.5 (3/8)	1 (2)
12.5 (1/2)	2 (4)
19.0 (3/4)	5 (11)
25.0 (1)	10 (22)
37.5 (1 1/2)	15 (33)
50 (2)	20 (44)
63 (2 1/2)	35 (77)
75 (3)	60 (130)
90 (3 1/2)	100 (220)
100 (4)	150 (330)
112 (4 1/2)	200 (440)
125 (5)	300 (660)
150 (6)	500 (1100)

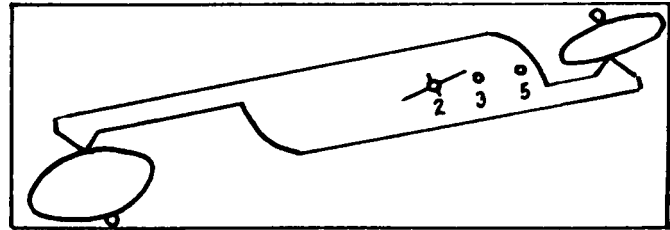
8. Procedure

8.1 If determination by mass is required, oven dry the

TABLE 2



a. Test for elongation



b. Test for flatness

Metric Equivalents					
in.	mm	in.	mm	in.	mm
1/8	3.2	7/8	21.2	2 1/2	64.0
3/16	4.8	1	25.4	2 7/8	72.0
1/4	6.3	1 1/16	27.0	3 3/4	96.0
5/16	7.9	1 1/2	38.0	8	207.0
3/8	9.5	1 5/8	41.0	16	414.0

FIG. 2 Use of Proportional Caliper

sample to constant mass at a temperature of 230 ± 9°F (110 ± 5°C). If determination is by particle count, drying is not necessary.

8.2 Sieve the sample to be tested in accordance with Test Method C 136. Using the material retained on the 9.5 mm (3/8 in.) or 4.75 mm (No. 4), as required by the specification being used, reduce each size fraction present in the amount of 10 % or more of the original sample in accordance with Practice C 702 until approximately 100 particles are obtained for each size fraction required.

8.3 *Flat Particle Test and Elongated Particle Test*—Test each of the particles in each size fraction, and place in one of three groups: (1) flat, (2) elongated, (3) neither flat nor elongated.

8.3.1 Use the proportional caliper device, positioned at the proper ratio, shown in Fig. 2, as follows:

8.3.1.1 *Flat Particle Test*—Set the larger opening equal to the particle width. The particle is flat if the thickness can be placed in the smaller opening.

8.3.1.2 *Elongated Particle Test*—Set the larger opening equal to the particle length. The particle is elongated if the width can be placed within the smaller opening.

8.3.2 After the particles have been classified into the group described in 8.3, determine the proportion of the sample in each group by either count or by mass, as required.

8.4 *Flat and Elongated Particle Test*—Test each of the particles in each size fraction and place in one of two groups: (1) flat and elongated or (2) not flat and elongated.

8.4.1 Use the proportional caliper device, set at the desired ratio.

8.4.2 *Measurement:*

8.4.2.1 On proportional caliper devices similar to the devices shown in Fig. 1 and Fig. 2, set the larger opening equal

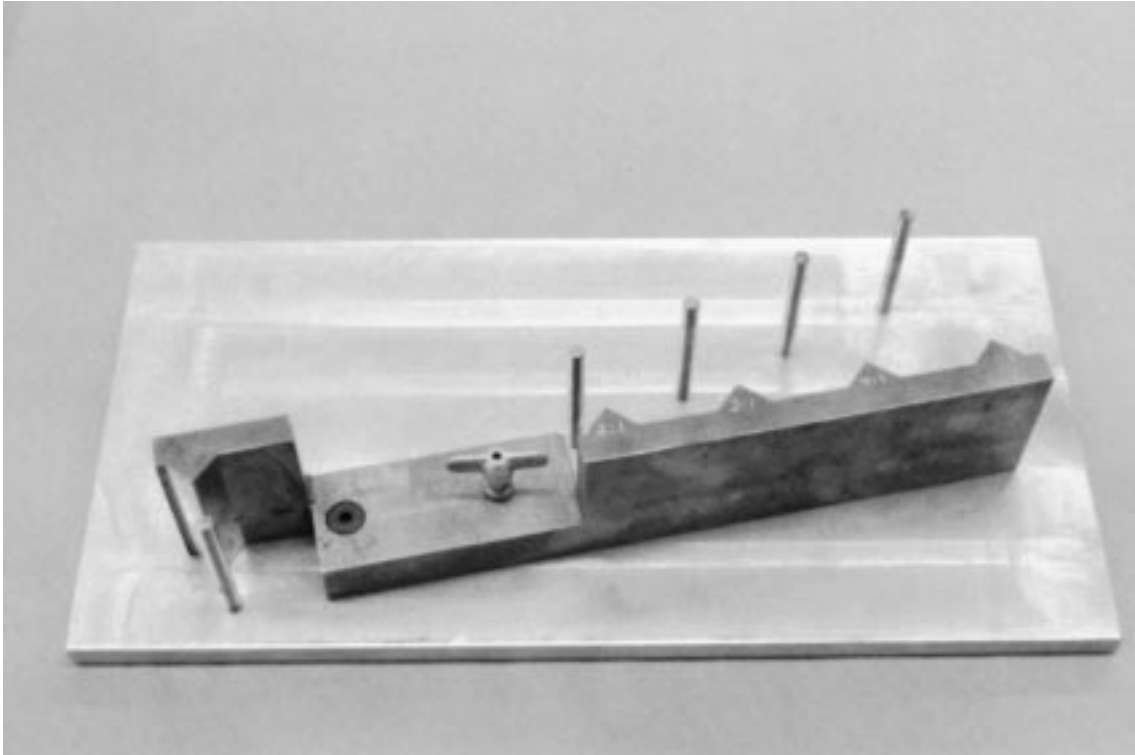


FIG. 3 Proportional Caliper

to the length of the particle. The particle is flat and elongated if the particle, when oriented to measure its thickness, can pass completely through the smaller opening of the caliper.

8.4.2.2 On calipers similar to the one described in Fig. 3, set the minimum dimension of the proportional caliper device such that the particle, when oriented to measure its thickness, passes snugly between the post and swing arm. The particle is flat and elongated if the particle, when oriented to measure its length, fails to pass the desired large opening of the proportional caliper device.

8.4.3 After the particles have been classified into the groups described in 8.4, determine the proportion of the sample in each group by count or mass, as required.

9. Calculation

9.1 Calculate the percentage of flat and elongated particles to the nearest 1 % for each sieve size greater than 9.5 mm ($\frac{3}{8}$ in.) or 4.75 (No. 4), as required.

10. Report

10.1 Include the following information in the report:

- 10.1.1 Identification of the coarse aggregate tested, and
- 10.1.2 Grading of the aggregate sample, showing percentage retained on each sieve.
- 10.1.3 For flat particle tests and elongated particle tests:

10.1.3.1 Number of particles in each sieve size tested,

10.1.3.2 Percentages, calculated by number or by mass, or both, for: (1) flat particles, (2) elongated particles, and (3) total flat particles and elongated particles for each sieve size tested, and

10.1.3.3 The dimensional ratios used in the tests.

10.1.4 For flat and elongated particle tests:

- 10.1.4.1 Number of particles in each sieve size tested,
- 10.1.4.2 Percentages, calculated by number or by mass, or both, for flat and elongated particles for each sieve size tested,
- 10.1.4.3 The dimensional ratio used in the tests, and

10.1.5 When required, weighted average percentages based on the actual or assumed proportions of the various sieve sizes tested. Report the grading used for the weighted average if different from that in 10.1.2.

11. Precision and Bias

11.1 *Precision*—The precision of this test method is being determined.

11.2 *Bias*—Since there is no accepted reference material suitable for determining the bias for this test method, no statement on bias is being made.

12. Keywords

- 12.1 aggregates; coarse aggregates; particle shape

 **D 4791**

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