

CRD-C 119-53

## METHOD OF TEST FOR FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE

### Scope

1. This method of test outlines procedures for the determination of flat and elongated particles in coarse aggregate for concrete.

### Definitions

2. (a) Flat Particle.- A flat particle is one having a ratio of width to thickness greater than three (Note).

(b) Elongated Particle.- An elongated particle is one having a ratio of length to width greater than three (Note).

Note.- Length (L), width (W), and thickness (T) are, respectively, the greatest, intermediate, and least dimensions of any particle, as measured along mutually perpendicular directions. Strictly they should be considered as the principal dimensions of the circumscribing rectangular prism. The definitions give the criterion of a ratio of three. One type of apparatus described below enables detection of greater or lesser degrees of flatness and elongation to be made by permitting determinations of whether particles have width:thickness or length:width ratios greater than two and five. These definitions are based on those given in A.S.T.M. Designation: C 125.

### Apparatus

3. (a) The apparatus used in this test shall consist of any suitable equipment, by means of which aggregate particles may be tested for compliance with the definitions given in Sec. 2 above. One type of apparatus is described below.

(b) Proportional Caliper Device<sup>1</sup>.- The proportional caliper device is illustrated in Figs. 1 and 2. It consists

<sup>1</sup>Developed by the Concrete Research Division, Waterways Experiment Station, Corps of Engineers, Jackson, Mississippi.

of a base with two fixed posts and a swinging arm between them. The axis (thumbscrew) on which the arm swings is positioned so that the openings between the ends of the arms and the fixed posts maintain a constant ratio. The model illustrated has three axis positions, by the use of which openings in the ratios of 1:2, 1:3, and 1:5, respectively, may be obtained.

(c) Balance.- A balance or scales sensitive to 0.5 per cent of the weight of the sample to be weighed (Note).

Note.- A balance will not be required when percentages are to be based on count as described in Sec. 4(d).

### Procedure

4. (a) A representative sample of the supply of each size of coarse aggregate to be tested shall be selected, sieved, and reduced by quartering and/or splitting until approximately 100 particles are obtained (Note) of each sieve size larger than the 3/8-in. sieve present in the amount of 10 per cent or more of the sample.

Note.- Larger samples consisting of approximately 300 particles may be used when more precise data are required.

(b) Each of the particles in the sieve-size sample shall be tested, using the testing device, and segregated into one of three groups: (1) Flat, (2) Elongated, (3) Not flat or elongated (Note).

Note.- If desired, a fourth group, comprising particles that are both flat and elongated, may be separated. When apparatus of the proportional caliper type is used, the particles that are found to be flat or elongated, using a ratio of three, may be retested at a ratio of five, and the particles that are found to be not flat or elongated may be retested at a ratio of two, thus permitting the segregation of four degrees each of flatness and elongation.

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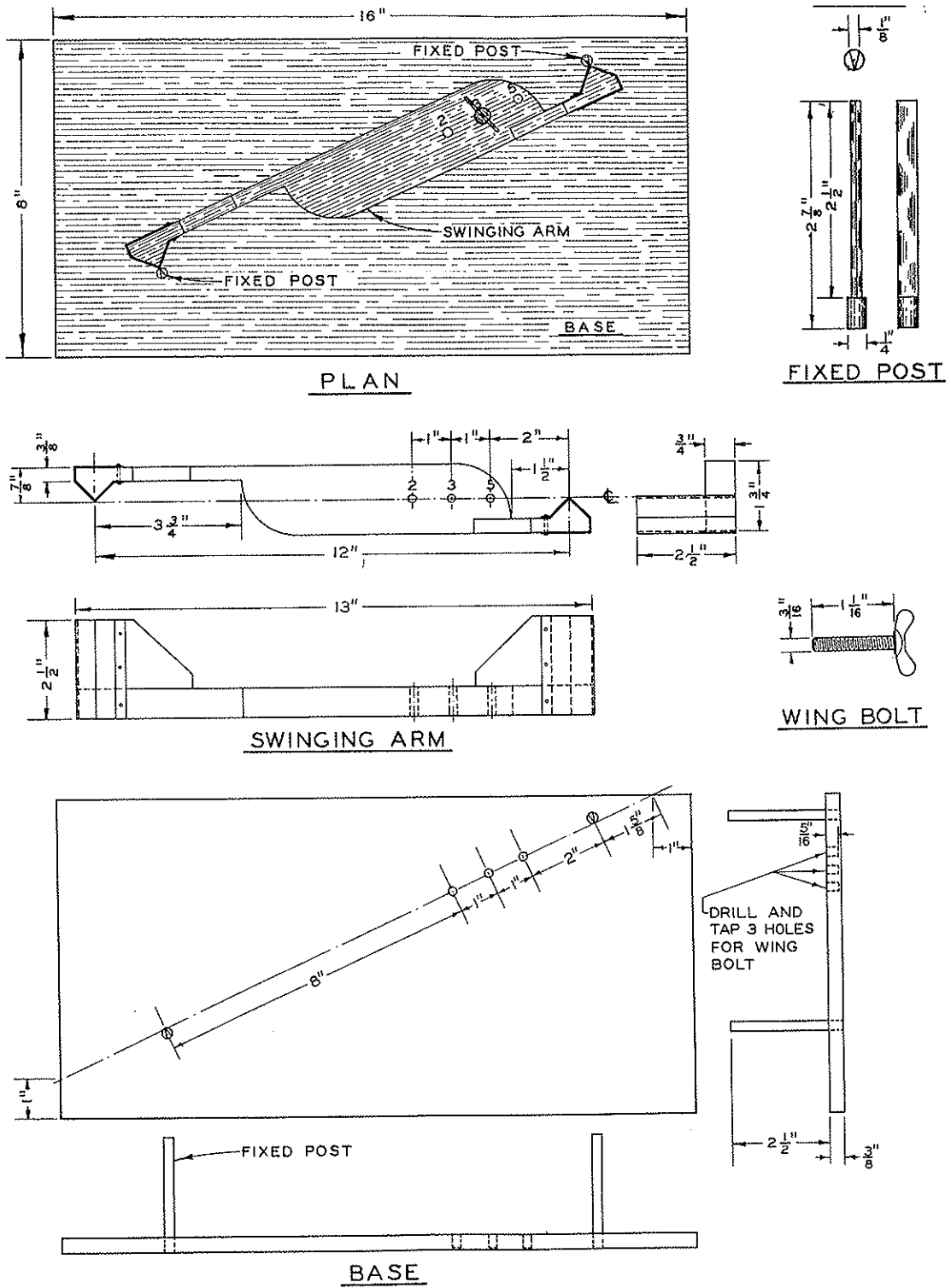
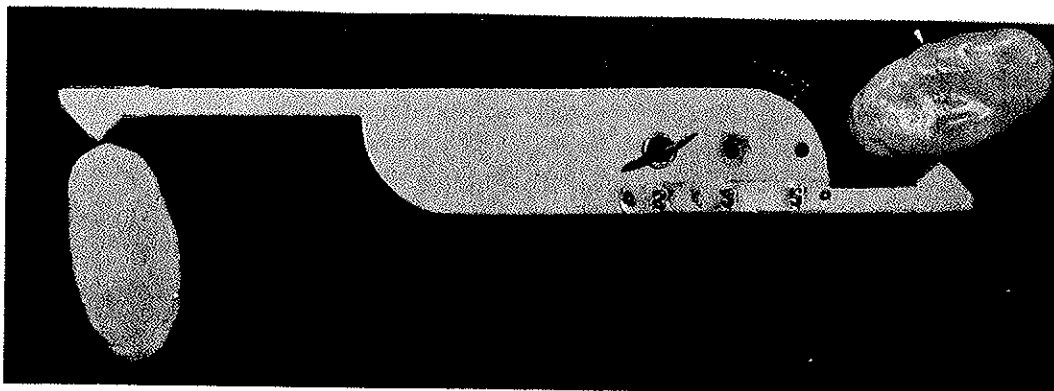
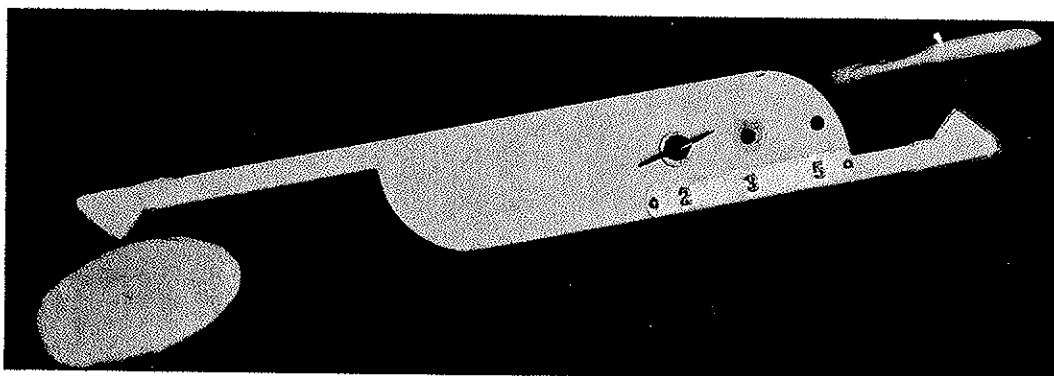


Fig. 1. Proportional caliper

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a. Test for elongation.



b. Test for flatness

Fig. 2. Use of proportional caliper

(c) The specific procedure for use with the proportional caliper device shall be as follows:

(1) **Test for Elongation.**- Set the larger opening equal to the length of the particle. If the width of the particle can be placed within the smaller opening, the particle is elongated.

(2) **Test for Flatness.**- Set the larger opening equal to the width of the particle. If the thickness of the particle can be placed within the smaller opening, the particle is flat.

(d) When the particles in the sample have been classified into groups listed in subparagraph (b) above, the portion of the sample in each group shall be determined by count or by weight (Note).

**Note.**- For use in the field it is believed that a count of the number of particles in each category will provide adequate information and the necessity of providing facilities for weighing will be avoided. For laboratory testing, determinations by weight may be made if desired.

#### Calculation

5. (a) The results of the test shall be calculated as indicated in the following examples. Results in per cent shall be reported to the nearest 1.0 per cent. When weighted averages are calculated, based on actual or assumed proportions of the several sieve sizes in a size range, sieve sizes not tested shall be assumed to have the same percentages of flat and elongated particles as the average of the next smaller and the next

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larger sizes, or, if one of these sizes is absent, it shall be considered to have the same percentage as the next larger or next smaller size, whichever is present. Gradations used for calculating weighted averages shall be computed omitting material finer than the 3/8-in. sieve.

(b) The following example represents the calculations when the test is made by number and weighted averages are not required:

aggregate tested.

(2) Percentages, given to the nearest 1.0 per cent, for (a) Flat particles, (b) Elongated particles, (c) Total flat and elongated particles; in each sieve size tested, calculated by weight or by number or both.

(3) The number of particles of each sieve size tested.

(4) The criterion or criteria used if other than 3:1.

(5) When required, weighted aver-

Sieve	Grading, Individual % Retained	Material Tested, No.	Results of Test							
			Flat		Elongated		Not Flat or Elongated		Total Flat or Elongated	
			No.	%	No.	%	No.	%	No.	%
1 in.	0	--	--	--	--	--	--	--	--	--
3/4 in.	5	--	--	--	--	--	--	--	--	--
1/2 in.	28	124	20	16	2	2	102	82	22	18
3/8 in.	24	114	26	23	1	1	87	76	27	24
No. 4	40	--	--	--	--	--	--	--	--	--
Passing No. 4	3	--	--	--	--	--	--	--	--	--

(c) The following example represents the complete calculations required when the test is made both by number and by weight and when weighted averages are required.

age percentages based on the actual or assumed proportions of the several sieve sizes in a size range.

(b) When values for percentage of flat and elongated particles have been calculated both by number and by weight and a single value is required, as for determination of compliance with a specification limit; or in case of dispute, the percentage by weight shall be the value taken.

Report

6. (a) The report shall include: (1) Adequate identification of the coarse

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Sieve, in.	Sam- ple as Rec'd for Test on 3/8 in.	Calcu- lated on Portion Retained on 3/8 in.	Material Tested No. of Wt, Par- ticles	Results of Test						Weighted Avg Percentages			Total Flat or Elongated Per Cent													
				By Weight		By Number		By Weight		Flat or Elongated		Not Flat or Elongated														
				Flat g	Elon- gated g	%	Flat g	Elon- gated g	%	Flat g	Elon- gated g	%	Flat g	Elon- gated g	%	No. by Weight	No. by Weight	No. by Weight								
1	0	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---							
3/4	5	8.8*	---	---	(49.4)	---	(3.8)	---	(46.8)	---	(58.0)	---	(3.0)	---	(39.0)	4	5	4	5							
1/2	28	49.1	485	239.8	49.4	18.4	3.8	226.8	46.8	58	58.0	3	3.0	39	39.0	24	29	2	1	23	19	53	61	26	30	
3/8	24	42.1	628	320.8	51.1	134.5	21.4	172.7	27.5	186	62.0	38	12.7	76	25.3	21	26	9	5	12	11	72	75	30	31	
No. 4	40	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
-No. 4	3	0.0	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	100	100.0																								

\* This size not tested since it included less than 10 per cent of the sample; assumed to have the same percentages of flat and elongated particles as next smaller size, as indicated by values in parentheses.

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