

FLAT AND ELONGATED PARTICLES IN COARSE AGGREGATE FOP FOR ASTM D 4791

Scope

This FOP covers the determination of the percentage, by mass, of flat and elongated particles in coarse aggregates for comparison with specification limits.

This FOP can be performed in conjunction with AASHTO T 27/T 11.

Flat and elongated particles of aggregates, for some construction applications, may interfere with consolidation and result in harsh, difficult to place materials and a potentially unstable mixture.

Apparatus

- Balance or scale: Capacity sufficient for the principal 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.
- Proportional Caliper Device, meeting the requirements of ASTM D 4791. The device typically consists of a base plate with two fixed posts and a swinging arm mounted between them so that the openings between the arm and the posts maintain a constant ratio. The numbers on the arm represent the ratios for which the apparatus can be set. For example, the number 5 represents the 5:1 ratio.

Terminology

Flat and elongated particles are defined as those coarse aggregate particles that have a ratio of length to thickness equal to or greater than a specified value such as 5:1.

Sample and Sample Preparation

1. Sample the aggregate in accordance with the FOP for AASHTO T 2. When the sample contains both coarse (+ #4) and fine (- #4) material, the fine portion must be removed to determine the minimum sample size from Table 1.
2. Mix the sample and reduce to sample size in accordance with the FOP for AASHTO T 248. See Table 1 for minimum required sample mass.

Table 1 Coarse Sample Size

Nominal Maximum Size	Coarse Sample Mass, min.	
	kg	lb
3/8"	1	2
1/2"	2	4
3/4"	5	11
1"	10	22
1½"	15	33

3. Dry the sample to constant mass.
4. Sieve the aggregate according to the FOP for AASHTO T 27/11.
5. If an individual sieve size fraction is not represented by at least 10% of the coarse portion (+No. 4) aggregate material, combine that sieve size fraction with the next smaller fraction for all sieves except the 3/8" sieve. If the 3/8" sieve is not represented by at least 10% of the coarse portion (+No. 4), combine the 3/8" sieve material with the next larger sieve size material.
6. Reduce each individual sieve size fraction through and including the 3/8" sieve to approximately 100 particles per T-248 (Reduction to an exact amount is not permitted).

Procedure

From Step 6, perform the following for each sieve size fraction:

1. Determine the total dry mass of each fraction to the nearest 0.1 g. This mass is designated as **T** in the calculation.
2. Set the proportional caliper device to the ratio required in the contract specifications: (2:1, 3:1, or 5:1).
3. Expedite testing through preliminary visual separation of all material which obviously is not flat and elongated.
4. Test each questionable particle by setting the larger opening of the proportional caliper device equal to the maximum dimension of the particle's length. Determine the dimension which represents the particle thickness (the smallest dimension). Pull the particle horizontally through the smaller opening without rotating, maintaining contact of the particle with the fixed post at all times. If the entire particle thickness can be pulled through the smaller opening, the particle is flat and elongated. Develop two categories of aggregate for each size fraction, flat and elongated and not flat and elongated.
5. Determine the dry mass of the flat and elongated particles in each size fraction to the nearest 0.1 g. This mass is designated as **F** in the calculation.

Calculations

1. Calculate the percentage of flat and elongated particles in each size fraction to the nearest 0.1% according to the equation shown below.

$$P_i = \frac{F}{T} \times 100$$

where:

P_i = percent flat & elongated of individual size fraction

F = mass of flat and elongated particles in fraction

T = total mass of particles in fraction

Example –

- **Individual Percent Flat & Elongated for 3/4" Sieve Size Fraction:**

$$P = \frac{196.4}{1178.0} \times 100 = 16.7, \text{ report } 17\%$$

Sample Report

Sieve Size	Total Mass in Size Fraction (Mass)	Mass of Flat & Elongated Particles (Mass)	Flat & Elongated (Percent) *
1"	1640.9	589.2	36
3/4"	1178.0	196.4	17
1/2"	825.7	70.1	8
3/8"	277.0	23.3	8

* Report to the nearest 1 percent.

PERFORMANCE EXAM CHECKLIST

Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate Fop for ASTM D 4791

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
<i>Sample Preparation</i>		
1. Sample obtained, mixed and reduced in accordance with AASHTO T 2 and AASHTO T 248 to approximately the amount required for testing? For combined samples fine portion (- # 4) removed?	_____	_____
2. Minimum dry sample mass meets requirements of Table 1?	_____	_____
<i>Procedure</i>		
1. Sample sieved according to AASHTO T 27?	_____	_____
2. Each coarse aggregate size fraction present in amount of 10% or more of original coarse sample reduced according to T 248 until approximately 100 particles obtained?	_____	_____
Flat and Elongated Particle Test:		
3. Each particle in each size fraction tested and placed into one of two groups: (1) flat and elongated or (2) not flat and elongated?	_____	_____
4. Proportional caliper device positioned at proper ratio?	_____	_____
5. Larger opening set equal to particle <u>length</u> ?	_____	_____
6. Particle is <u>flat and elongated</u> if the <u>thickness</u> can be placed in the smaller opening?	_____	_____
8. Proportion of sample in each group determined by count or by mass, as required?	_____	_____
<i>Calculation</i>		
1. Percentage of flat and elongated particles calculated to nearest 1% for each sieve size greater than No. 4?	_____	_____
2. When weighted average for sample is required, sieve sizes not tested (those representing less than 10% of sample) assumed to have same percentage of flat particles, elongated particles, or flat and elongated particles as the next smaller or the next larger size? Or if both are present, is average for next smaller and larger sizes used?	_____	_____

Comments and Score: First Attempt: Pass Fail Second Attempt: Pass Fail

Signature of Examiner: _____