

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Transportation Laboratory
5900 Folsom Blvd.
Sacramento, California 95819-4612



METHOD OF TEST FOR PERCENTAGE OF CRUSHED PARTICLES

A. SCOPE

This test describes a procedure for determining the percent, by weight, of particles that by visual inspection have the characteristics of crushed aggregate.

B. REFERENCES

California Test 201 – Soil Aggregate Sample Preparation
California Test 202 – Sieve Analysis of Fine and Coarse Aggregates
California Test 226 – Determination of Moisture Content by Oven Drying
AASHTO M 92 – Standard Specification for Wire-Cloth Sieves for Testing Purposes
ASTM D 5821 – Percentage of Fractured Particles in Coarse Aggregate

C. APPARATUS

1. Balance: a balance or scale with a capacity of at least 6000 g and sensitive to 0.1 g or less.
2. Sample Splitting Device: a device that will produce a representative split sample and that will not alter the aggregates from their original shape. Riffle splitters are the preferred devices.
3. Sieves: standard sieves of the woven-wire type with square openings and conforming to AASHTO Designation: M 92
4. Fan, Forced Air Heater, or Oven: to remove moisture from wet samples. When air drying is not practical, typical equipment may be fans with or without heating coils or a vented, forced draft oven capable of maintaining a temperature of $140^{\circ}\text{F} \pm 9^{\circ}\text{F}$ or $230^{\circ}\text{F} \pm 9^{\circ}\text{F}$.

D. TERMINOLOGY

1. Crushed Particle: Any particle having 1 or more fractured faces. A crushed particle is an angular, rough, or broken surface of an aggregate particle created by crushing or by other mechanical means. The face must have sharp and well-defined edges, excluding small nicks.
2. Fractured Face: A face is determined to be “fractured” only if the projected surface area of the face is at least 25 % of the largest cross-sectional area of the aggregate.

E. SAMPLE PREPARATION

1. Prepare the sample in accordance with California Test 201. From each aggregate fraction representing 5 % or more of the submitted sample, split a representative portion to within 10 % of the weight specified in Table 1.

2. Separate the sample into a series of sizes in accordance with California Test 202. Use such sieves as are necessary to determine compliance with the specification for the material being tested.

TABLE 1

Aggregate Fraction (Passing × Retained)	Test Sample Weight g (± 10 %)
2 in. × 1½ in.	6000
1½ in. × 1 in.	3000
1 in. × ¾ in.	1500
¾ in. × ½ in.	1000
½ in. × ⅜ in.	500
⅜ in. × ¼ in.	300
¼ in. × No. 4	100
No. 4 × No. 8	100

Aggregates that have an accumulation of fines should be carefully washed by hand on the No. 8 sieve and then dried to a constant weight in accordance with California Test 226 before performing this test. If the sample to be washed is too large for the sieve, wash it in separate small portions then recombine them to get a constant weight.

F. TEST PROCEDURE

1. Weigh each sample to the nearest gram and record as “Test Sample Weight.”
2. Spread each aggregate fraction individually on a clean, flat surface in a well-lit area. The surface must be large enough to permit the material to be spread thinly for inspection.
3. Use the knife-edge of a spatula or similar tool to separate uncrushed particles from crushed particles.
4. When the separation is complete, weigh the crushed particles and record as “Weight of Crushed Particles.”
5. Repeat the above procedure on each individual sieve size fraction.

G. CALCULATIONS

1. Calculate the percent of crushed particles in each respective test sample using the following formula:

$$\text{Percent of Crushed Particles} = \frac{\text{Weight of Crushed Particles}}{\text{Test Sample Weight}} \times 100$$

Table 2 is an example illustrating a typical calculation.

2. Calculate the percent of crushed particles in the whole sample or in the coarse portion of the as-received sample by the weighted average method as follows:
 - a. Multiply the percent of each size fraction to be included in the weighted average by its respective percent of crushed particles (use the total weight of the as-received sample).

- b. The sum of these products divided by the sum of the percent of each of the included size fractions (based on the total weight of the as-received sample) gives the weighted average percent of crushed particles for that group of fractions included in the calculation.

H. REPORTING OF RESULTS

Report the weighted percent of crushed particles to the nearest 1 % (Figure 1).

TABLE 2

Example Calculation – Percentage of Crushed Particles for Coarse Aggregate

Percent of Coarse Crushed Particles						
Size Fractions (Pass × Retain)	A Cumulative Percent Passing	B Individual Percent Retained	C Weight of Sample (from Table 1)	D Weight of Crushed Particles	E Percent Crushed Particles $\left(\frac{D}{C} \times 100\right)$	F Individual Percentage Crushed Particles (B × E)
3 in. × 2 in.	100	0	-	-	-	-
1 in. × 1½ in.	97	100-97 = 3	-	-	-	-
1½ in. × 1 in.	77	97-77 = 20	3000	2610	87	17.40
1 in. × ¾ in.	70	77-70 = 7	1500	1335	89	6.23
¾ in. × ½ in.	62	70-62 = 8	1000	930	93	7.44
½ in. × ⅜ in.	51	62-51 = 11	500	470	94	10.34
⅜ in. × No. 4	35	51-35 = 16	300	285	95	15.20
Total of Column B =		62	Total of Column F =		56.61	
Percent of Coarse Crushed Particles = $\frac{\text{Total of F}}{\text{Total of B}} = \frac{56.61\%}{62\%} = 91\%$						
Percent of Fine Crushed Particles						
No. 4 by No. 8	-	-	100	80	80	-
Percent of Fine Crushed Particles = 80 %						

I. PRECAUTIONS

1. It is the tester's responsibility to review the specification requirement so that the results will be reported correctly and in conformance with the requirements of the specification involved.
2. It is the intent of this test method to only determine the percent of crushed particles created by crushing or other mechanical means and not the additional crushed/fractured aggregates created by laboratory processes. With this in mind, it is important that the tester handle aggregates for this test carefully.

J. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

**End of Text
(California Test 205 contains 6 pages)**

California Test 205
Calculation Sheet for Percentage of Crushed Particles

Percentage of Coarse Crushed Particles						
	A	B	C	D	E	F
Size Fractions (Pass × Retain)	Cumulative Percent Passing	Individual Percent Retained	Weight of Sample (from Table 1)	Weight of Crushed Particles	Percent Crushed Particles $\left(\frac{D}{C} \times 100\right)$	Individual Percentages of Crushed Particles (B × E)
3 in. × 2 in.						
1 in. × 1½ in.						
1½ in. × 1 in.						
1 in. × ¾ in.						
¾ in. × ½ in.						
½ in. × 3/8 in.						
3/8 in. × No. 4						
Total of Column B =			Total of Column F =			
Percentage of Coarse Crushed Particles = $\frac{\text{Total of F}}{\text{Total of B}} = \text{_____} = \text{_____} \%$						
Percentage of Fine Crushed Particles						
No. 4 by No. 8	-	-				-
Percentage of Fine Crushed Particles = _____ %						

FIGURE 1. Calculation Sheet for percentage of Crushed Particles



Figure 2. Crushed Particles
(Fractured face is greater than 25 % of largest cross-sectional area of the aggregate)



Figure 3. Not Crushed Particles