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METHOD OF TEST FOR EVALUATING CLEANNESS OF COARSE AGGREGATE

A. SCOPE

The cleanness test provides an indication of the relative proportions of clay-sized material clinging to coarse aggregates or screenings.

B. REFERENCES

California Test 202 - Sieve Analysis of Fine and Coarse Aggregates
California Test 226 - Moisture Content of Soils and Aggregates by Oven Drying
California Test 217 - Sand Equivalent

C. APPARATUS

1. Agitator: a mechanical device designed to hold the wash vessel in an upright position while subjecting it to a lateral reciprocating motion at a rate of 285 cycles per minute (cpm) \pm 10 cpm. The reciprocating motion must be produced by means of an eccentric located in the base of the carrier, and the length of the stroke must be 1.75 in. \pm 0.25 in. The clearance between the cam and follower of the eccentric must be between 0.001 and 0.004 in. Other types of agitators may be used provided the length of time and other factors are adjusted to produce the same results as those obtained using the agitator described above (Figure 1).
2. Wash Vessel: a flat-bottom, straight-sided, cylindrical vessel conforming to the specifications and dimensions shown in Figure 2.
3. Washing Pan: a pan of convenient size to submerge and scrub individual aggregate particles up to 2½ in. in size.
4. Collection Pot: a round pan or container with vertical or nearly vertical sides and equipped as necessary to hold the wire mesh of a standard 8 in. diameter sieve at least 3 in. above the bottom of the collection pot.

An adapter that will not allow loss of fines or wash water may be used to nest the sieve with the container, or the sieve may be nested with a blank sieve frame resting in the bottom of the pan.

5. Graduated Cylinder: a cylinder with a capacity of 1000 mL to 1500 mL.
6. Graduated Plastic Cylinder: a sand equivalent test cylinder specified in California Test 217.
7. Rubber stopper: a stopper to fit the plastic cylinder.
8. Funnel: a wide-mouth funnel suitable for directing water into the plastic cylinder.

9. Sieves: U.S. Standard Sieves No. 8 and No. 200, standard 8 in. diameter, full height.
10. Box Sieve Assembly: a rocker and box sieve assembly conforming to the design shown in TL drawing No. D-574 (Figure 3). The screen must be U.S. Standard Sieves No. 4 and 1 in.
11. Balance: a balance or scale accurate to 0.2 % of the weight of the sample to be tested.
12. Oven: a drying oven set to operate at $230^{\circ}\text{F} \pm 9^{\circ}\text{F}$.
13. Timer: a clock or watch graduated in minutes and seconds.
14. Stiff fiber brush.

D. MATERIALS

1. Stock calcium chloride solution:
 - a. “Sand Equivalent Stock Solution” may be purchased and used in accordance with manufacture’s guidelines, or
 - b. “Sand Equivalent Stock Solution” may be prepared from the following:
 - 120 g tech. grade anhydrous calcium chloride
 - 542 g (434 mL) USP glycerin (95 %)

Dissolve the calcium chloride in 1 pint of distilled or deionized water. Cool the solution to room temperature, then filter it through Whatman No. 2V or equivalent filter paper. Add the glycerin to the filtered solution, mix well, and dilute to $\frac{1}{4}$ gal with distilled or deionized water.

2. Water: use distilled or deionized water for the normal performance of this test.

E. CONTROLS

The temperature of the testing water should be maintained at $72^{\circ}\text{F} \pm 5^{\circ}\text{F}$. If this is impractical, it is necessary to establish temperature correction factors for each material being tested in accordance with Section E of California Test 217.

F. PREPARATION OF TEST SPECIMENS

1. Split or quarter the material to obtain a test specimen conforming to the weight specified in Table 1 for various primary aggregate nominal sizes.

TABLE 1

Specified weight for various aggregate nominal sizes

Primary Aggregate Nominal Size	Oven-Dry Weight (g)	Volume of Wash Water (mL)
2 ½ in. × 1 ½ in.	20 000 ± 1000	1500 ± 15
1 ½ in. × ¾ in.	10 000 ± 500	1250 ± 12
1 in. × No. 4	2500 ± 125	1000 ± 5
½ in. Max.	1000 ± 50	500 ± 3

- a. If the material representing a primary aggregate nominal size for use in portland cement concrete has been separated into two or more bin sizes, prepare a combined sample representing the primary aggregate nominal size from representative portions of material from each bin. When preparing the combined sample, use the same proportions of material from each bin as is used in the mix.
 - b. Pit-run aggregates such as used for sacked concrete slope protection must be oven dried and processed according to the instructions in Section F.4.c prior to splitting out the test specimen.
2. Dry to constant weight at 230°F ± 9°F.
 - a. When testing aggregate samples containing reclaimed asphalt pavement (RAP), the oven drying temperature must not exceed 100°F.
 - b. Aggregates, which are sampled immediately after being dried in an asphalt plant dryer, may be tested without additional drying provided they are not exposed to moisture prior to testing. Aggregates that are not tested on the same day they are sampled must be oven-dried prior to testing unless they have been stored in moisture-proof containers.
 - c. As a time-saving expedient in routine work, it is permissible to test materials in an air-dried condition. Air-dried materials that do not meet minimum requirements must be retested in an oven-dried condition and the results of the oven-dried sample will control.
 3. Cool to room temperature.
 4. Complete the sample preparation according to the following instructions for various materials.
 - a. 2½ in. × 1½ in. and 1½ in. × ¾ in. aggregate.
 - (1) Separate the material on the No. 4 box sieve (Figure 3) using the following procedure:
 - (a) Divide the sample into portions weighing approximately 2500 g each.
 - (b) Place 1 of the portions on the No. 4 box sieve and “rock” the assembly 10 complete cycles in approximately 12 s.

One complete cycle is a back and forth motion with the stops on each end of the rocker assembly bumping the floor before the motion is reversed.

- (c) Repeat this sieving operation on each portion of the sample.
 - (d) Discard the material that passes the No. 4 sieve.
 - (e) Save the material retained on the No. 4 sieve for determining the cleanness value.
- (2) Recombine all of the portions of the 2½ in. × 1½ in. test specimen.
- (3) Retain each of the 4 portions of the 1½ in. × ¾ in. test specimen in separate containers.
- b. 1 in. × No. 4 aggregate.
- No further preparation is required.
- c. Pit-Run Aggregate.
- (1) Dry the entire sample to constant weight at 230°F ± 9°F in accordance with California Test 226 and cool to room temperature.
 - (2) Separate the entire sample on the 1-in. and No. 4 box sieves using the following procedure.
 - (a) Place the material on the nested 1 in. and No. 4 box sieves and rock the assembly 10 complete cycles in approximately 12 s. Divide the sample into as many portions as necessary to avoid overloading the sieves.
 - (b) Discard the portion retained on the 1 in. sieve.
 - (c) Save the portion retained on the No. 4 sieve for determining the cleanness value.
 - (d) Split or quarter out a test specimen conforming to the weight requirements for 1 in. × No. 4 aggregate.
 - (e) Save the portion passing the No. 4 sieve for determining the sand equivalent.
- d. ½ in. maximum size aggregates (screenings, chips, pea gravel, etc.).
- No further preparation is required.

G. TESTING PROCEDURES

1. Measure out the appropriate volume of water for the test specimen according to Table 1.
2. Wash the prepared test specimen according to the appropriate procedure below:
 - a. $2\frac{1}{2}$ in. \times $1\frac{1}{2}$ in. aggregate.
 - (1) Pour the wash water into the washing pan.
 - (2) Submerge each aggregate particle individually in the wash water and remove the fines by scrubbing with a stiff fiber brush.
 - (3) Discard the washed particle and repeat the procedure until all particles have been washed. Take care to avoid loss of wash water or fines.
 - (4) Pour the dirty wash water and accumulated fines through the No. 200 sieve into the collection pot.
 - (a) Prior to pouring, stir the water vigorously to bring the fines into suspension.
 - (b) Use a small amount of fresh water, as necessary, to rinse any remaining fines from the washing pan.
 - (5) Pour the wash water into a graduated cylinder and adjust the volume to $1500\text{ mL} \pm 15\text{ mL}$ with fresh water. Return the wash water to the collection pot taking care to include all water and fines.
 - b. $1\frac{1}{2}$ in. \times $\frac{3}{4}$ in. aggregate.
 - (1) Place 1 of the 2500 g portions of the test specimen in the wash vessel.
 - (2) Add the wash water, clamp the lid in place, and secure the vessel in the agitator.
 - (3) At $1\text{ min} \pm 10\text{ s}$ after adding the wash water, start the agitator, and agitate the vessel for a period of $1\text{ min} \pm 5\text{ s}$.
 - (4) Immediately following the agitation period, take the vessel from the agitator and remove the lid.
 - (5) Bring the fines into suspension by holding the vessel in an upright position and moving it vigorously in a horizontal circular motion 5 or 6 times to cause the contents to swirl inside.
 - (6) Immediately pour all of the contents of the vessel into the No. 8 and No. 200 sieves nested over the collection pot.

- (7) Discard the material retained on the No. 8 sieve.
 - (8) Pour the wash water from the collection pot into a graduated cylinder and adjust the volume to $1250 \text{ mL} \pm 12 \text{ mL}$ with fresh water.
 - (9) Place the second portion of the test specimen in the washing vessel, add the same wash water, and wash according to the above procedures.
 - (10) Repeat this procedure with each of the 4 portions of the test specimen.
 - (11) After washing the last portion and pouring it into the nested sieves, use a small amount of fresh water to rinse the remaining fines from the washing vessel.
 - (12) Adjust the volume of water to $1250 \text{ mL} \pm 12 \text{ mL}$ with fresh water. Return the wash water to the collection pot taking care to include all water and fines.
- c. Aggregates having maximum nominal size of 1 in. or less.
- (1) Place the test specimen in the washing vessel.
 - (2) Add the specified volume of wash water, clamp the lid in place, and secure the vessel in the agitator.
 - (3) At $1 \text{ min} \pm 10 \text{ s}$ after adding the wash water, start the agitator, and agitate the vessel for a period of $2 \text{ min} \pm 5 \text{ s}$.
 - (4) Immediately following the agitation period take the vessel from the agitator and remove the lid.
 - (5) Bring the fines into suspension by holding the vessel in an upright position and moving it in a horizontal circular motion 5 or 6 times to cause the contents to swirl inside.
 - (6) Immediately pour all of the contents of the vessel into the No. 8 and No. 200 sieves nested over the collection pot.
 - (7) Use a small amount of fresh water to rinse the remaining fines from the washing vessel.
 - (8) Discard the material retained on the No. 8 sieve.
 - (9) If a concentration of material is retained on the No. 200 sieve, re-rinse the fine material by pouring the wash water through the sieve again using the following procedure:
 - (a) Allow the wash water to stand undisturbed in the collection pot for a few moments to permit the heavier particles to settle to the bottom.

- (b) Set the No. 200 sieve aside and pour the upper portion of the wash water into a separate container.
 - (c) Place the No. 200 sieve back on the collection pot and pour the water back through the material on the No. 200 sieve. (If two collection pots are available, the specimen may be rinsed by alternately placing the sieve on one and then the other while pouring the wash water through the material on the sieve. Before each rinsing, allow the heavier particles to settle to the bottom and pour only the upper portion of the water through the material.)
 - (d) Repeat this procedure as necessary until all of the minus No. 200 material has been washed through the sieve. When the material has been rinsed sufficiently, the material on the sieve will be free of visible streaks of clay, and the wash water will flow freely through the sieve and accumulated material.
- (10) Discard the material retained on the No. 200 sieve.
 - (11) Pour the wash water into a graduated cylinder and adjust the volume to the original amount with fresh water. Return the wash water to the collection pot taking care to include all water and fines.
3. Fill the graduated plastic cylinder to the 0.3 in. mark with stock calcium chloride solution and place the funnel on the cylinder.
 4. Stir the wash water vigorously with 1 hand until all fines are in suspension. Use a circular motion allowing the fingers to rub the sides and bottom of the collection pot.
 5. Immediately fill the graduated plastic cylinder to the 15 in. mark with the turbulent wash water.
 6. Stopper the cylinder and thoroughly mix the wash water and calcium chloride solution by inverting the cylinder 20 times in approximately 35 s. Allow the air bubble to completely traverse the length of the cylinder each time.
 7. Immediately place the cylinder on a work bench or table free of vibrations, remove the stopper, and allow it to stand undisturbed for 20 min \pm 15 s.
 8. At the end of the 20 min period, read the top of the sediment column to the nearest 0.1 in. mark.
 - a. If a clearly defined line of demarcation does not form between the sediment and the liquid above it in the specified 20 min period, allow the cylinder to stand undisturbed until the clear line of demarcation does form, then immediately read and record the time and the height of the column.

- b. If the liquid immediately above the line of demarcation is still darkly clouded at the end of 20 min and the line of demarcation (although distinct) appears to be in the sediment column itself, read and record the level of this line at the end of the specified 20-min period.

H. CLEANNES VALUE DETERMINATION

1. Determine the Cleanness Value of individual test specimens from Table 2.

This table is derived from the formula:

$$CV = \frac{(3.214 - 0.214 \cdot H)}{(3.214 + 0.786 \cdot H)} \times 100$$

Where:

CV = Cleanness value

H = Height of sediment, in.

2. When 2 or more primary sizes of coarse aggregate are combined in a mix, determine the weighted-average Cleanness Value for the mix. For portland cement concrete mixes, calculate the weighted-average Cleanness Value using the combinations shown below regardless of the actual proportions to be used on the project.

- a. 1½ in. Maximum aggregate mix

1½ in.	×	¾ in.		40%
1 in.	×	No. 4		60%

- b. 2½ in. Maximum aggregate mix

2½ in.	×	1½ in.	..	30%
1½ in.	×	¾ in.	..	30%
1 in.	×	No. 4	..	40%

I. REPORTING OF RESULTS

1. Report the Cleanness Value to the nearest whole number.
2. The reported Cleanness Value must be indicative of all the coarse aggregate in a product.
- a. When only 1 primary size of coarse aggregate is represented in a product, report the Cleanness Value determined for the sample. No additional remarks are necessary.
- b. When a product is composed of more than 1 primary size aggregate, or when aggregates from more than 1 bin are combined to make a product, report the Cleanness Value calculated by averaging, on the weighted-average basis, the results of the individual samples. Also note the Cleanness Value of each sample used in the computation.

- c. When more than 1 primary size of aggregate is being combined in a product, but only one size is tested, report the Cleanness Value of the tested sample and indicate that the reported value is for a primary aggregate size only and that this value may not be used for determining compliance with the specified cleanness value.

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 227 contains 13 pages)

TABLE 2
Cleanness Values (CV) for 0.0 to 15.0 in. Sediment Height Readings (H)

Sediment Height (in.)	C.V.								
0.0	100	3.0	46	6.0	24	9.0	13	12.0	5
0.1	97	3.1	45	6.1	24	9.1	12	12.1	5
0.2	94	3.2	44	6.2	23	9.2	12	12.2	5
0.3	91	3.3	43	6.3	23	9.3	12	12.3	5
0.4	89	3.4	42	6.4	22	9.4	11	12.4	4
0.5	86	3.5	41	6.5	22	9.5	11	12.5	4
0.6	84	3.6	40	6.6	21	9.6	11	12.6	4
0.7	81	3.7	40	6.7	21	9.7	11	12.7	4
0.8	79	3.8	39	6.8	21	9.8	10	12.8	4
0.9	77	3.9	38	6.9	20	9.9	10	12.9	3
1.0	75	4.0	37	7.0	20	10.0	10	13.0	3
1.1	73	4.1	36	7.1	19	10.1	9	13.1	3
1.2	71	4.2	36	7.2	19	10.2	9	13.2	3
1.3	69	4.3	35	7.3	18	10.3	9	13.3	3
1.4	68	4.4	34	7.4	18	10.4	9	13.4	3
1.5	66	4.5	33	7.5	18	10.5	8	13.5	2
1.6	64	4.6	33	7.6	17	10.6	8	13.6	2
1.7	63	4.7	32	7.7	17	10.7	8	13.7	2
1.8	61	4.8	32	7.8	17	10.8	8	13.8	2
1.9	60	4.9	31	7.9	16	10.9	7	13.9	2
2.0	58	5.0	30	8.0	16	11.0	7	14.0	2
2.1	57	5.1	29	8.1	15	11.1	7	14.1	1
2.2	56	5.2	29	8.2	15	11.2	7	14.2	1
2.3	54	5.3	28	8.3	15	11.3	7	14.3	1
2.4	53	5.4	28	8.4	14	11.4	6	14.4	1
2.5	52	5.5	27	8.5	14	11.5	6	14.5	1
2.6	51	5.6	26	8.6	14	11.6	6	14.6	1
2.7	49	5.7	26	8.7	13	11.7	6	14.7	0
2.8	48	5.8	25	8.8	13	11.8	6	14.8	0
2.9	47	5.9	25	8.9	13	11.9	5	14.9	0
								15.0	0

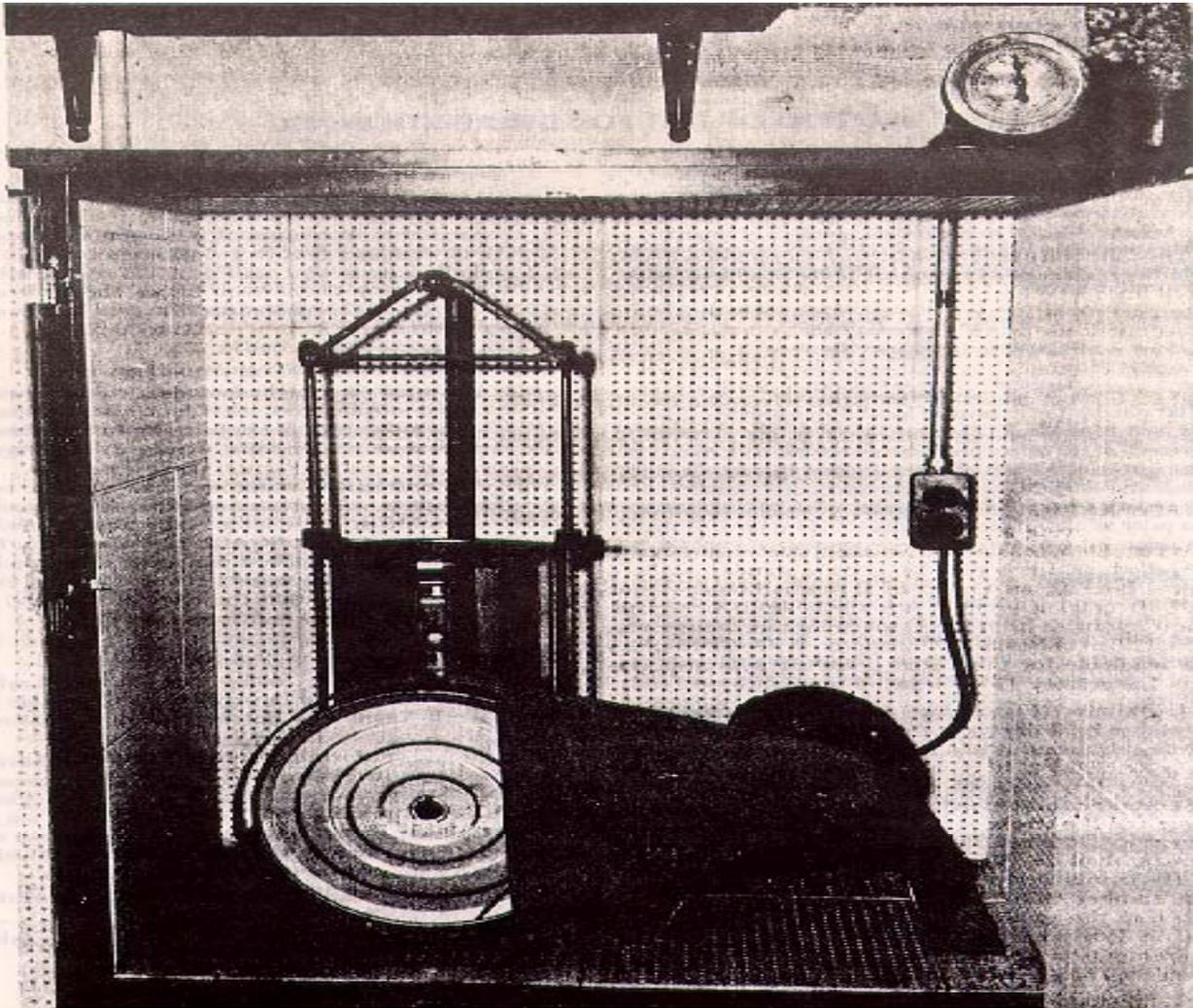
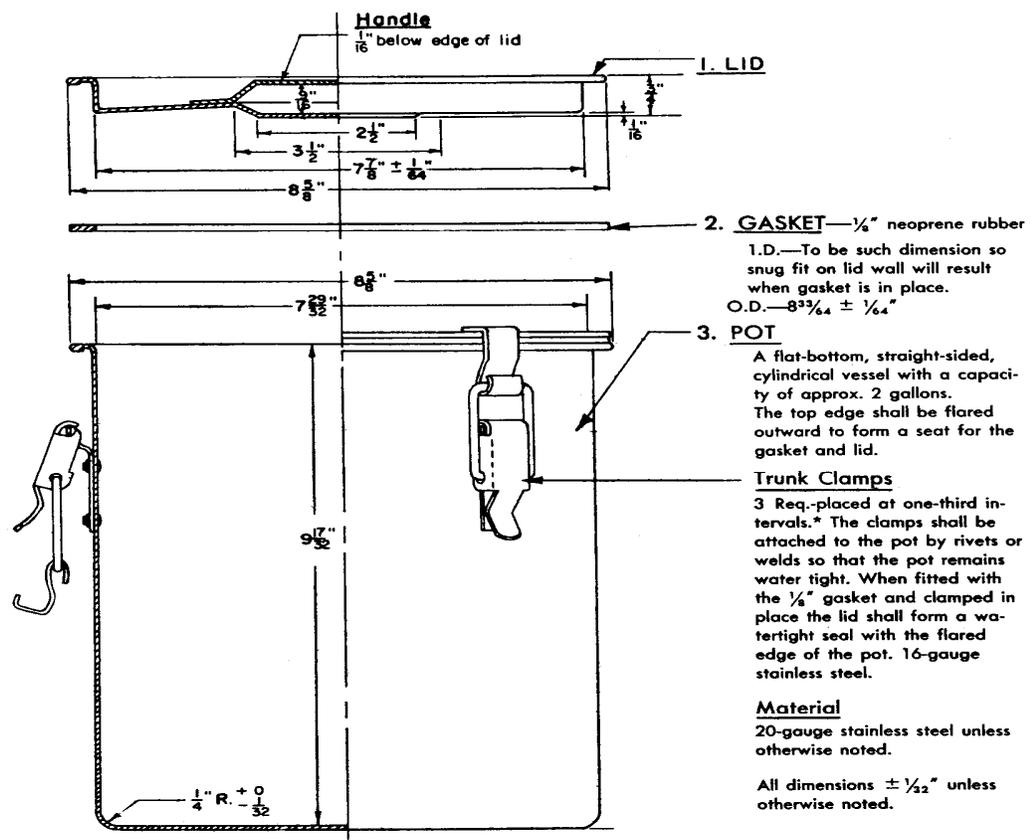


FIGURE 1. Agitator



* at intervals of one-third of the circumference or at 120-degree intervals.

FIGURE 2. Mechanical Washing Vessel

