

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



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 217 - Sand Equivalent

C. APPARATUS

The following equipment is required to perform this test. Detailed descriptions and specifications are included as necessary to ensure standardization.

1. Agitator (Figure 1): 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 ± 10 complete cycles per min. The reciprocating motion shall be produced by means of an eccentric located in the base of the carrier, and the length of the stroke shall be 1.75 in. \pm 0.025 in. The clearance between the cam and follower of the eccentric shall be between 0.001 in. 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.
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.

An adapter, which 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 graduated cylinder with a capacity of 1000 mL to 1500 mL.
6. Graduated plastic cylinder: A sand equivalent test cylinder, Assembly B, specified in Transportation Laboratory drawing No. C 218.
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 sieves assembly conforming to the design shown in Transportation Laboratory drawing No. D-574 (Figure 3). The screen shall be U.S. Standard Sieves, No. 4 and 1 in.
11. Balance: A balance or scale accurate to 0.2 % of the mass 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. Calcium chloride solution.
 - a. "Sand Equivalent Stock Solution" Division of Procurement and Contracts – Materials and Storage Warehouse catalog No. 6810-0090-3 or 6810-0100-6.
 - b. May be prepared from the following:

120 g - (1/4 lb) technical grade anhydrous calcium chloride.

542 g - (434 mL) USP glycerin (95 %).

Dissolve the calcium chloride in one pint (500 mL) 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 1/4 gal with distilled or deionized water.
2. Water.

Use distilled or deionized water for the normal performance of this test. If it is determined, however, that the local tap water is of such quality that it does not affect the test results, it is permissible to use it in lieu of distilled or deionized water.

E. CONTROL

The temperature of the testing water should be maintained at $72^{\circ}\text{F} \pm 5^{\circ}\text{F}$. If the temperature is below the recommended range, test results that meet the specified requirement are valid.

F. PREPARATION OF TEST SPECIMENS

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

**TABLE 1
Gradation of Test Specimens**

| Primary Aggregate Nominal Size | Oven-Dry Mass (g) | Volume of Wash Water (mL) |
|--------------------------------|-------------------|---------------------------|
| 2½ in. × 1½ in. | 20000 ± 1000 | 1500 ± 15 |
| 1½ in. × ¾ in. | 10000 ± 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, shall 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 mass at 230°F ± 9°F.
 - a. When testing reclaimed aggregates containing traces of asphalt or asphalt concrete, the oven drying temperature shall not exceed 100°F.
 - b. Aggregates, which are sampled immediately after being dried in an asphalt plant drier, may be tested without additional drying provided they are not exposed to dampness prior to testing. Aggregates that are not tested on the same day they are sampled shall 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 shall 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 test 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 one 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 test 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 four 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 mass at 230°F ± 9°F and cool it 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 mass 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. 2½ in. × 1½ 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 mL ± 15 mL with fresh water. Return the wash water to the collection pot taking care to include all water and fines.
 - b. 1½ in. × ¾ in. aggregate.
 - (1) Place one 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 min ± 10 s after adding the wash water, start the agitator and agitate the vessel for a period of 1 min ± 5 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 four 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 one 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 15.0 in. mark with the turbulent wash water.
 6. Plug 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 and the test is being made with distilled or deionized water, 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. If tap water was used, retest an untested portion of the same material using distilled or deionized water.

- 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. If tap water was used, retest an untested portion of the sample using distilled or deionized water.

H. CLEANNES VALUE DETERMINATION

- 1. Determine the Cleanness Value of individual test specimens from Table 2.
 - a. This table is derived from the formula:

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

where: CV = Cleanness Value
H = Height of sediment in inches.

- 2. When two 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 shall be indicative of all the coarse aggregate in a product.
 - a. When only one primary size of coarse aggregate is represented in a product, report the Cleanness Value determined for the test sample. No additional remarks are necessary.
 - b. When a product is composed of more than one primary size aggregate, or when aggregates from more than one 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 test sample used in the computation.

- c. When more than one 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

Soils and aggregates may contain bacteria and/or organisms that can be harmful to your health. Wearing dust masks and protective gloves when handling materials is advised.

The use of heat resistant gloves/mitts or potholders to remove samples from the ovens is required.

When preparing stock solution, protective eyewear, an approved respirator, protective gloves, and apron shall be worn.

The requirements listed for preparing stock solution should be considered for use when performing the evaluating cleanness of coarse aggregate test.

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

Users of this method do so at their own risk.

**End of Text
(California Test 227 contains 13 pages)**

TABLE 2

Cleanness Values (C.V.) For 0.0 to 15.0 Inch Sediment Height Readings (H)

| Sediment Height (inches) | C.V. | Sediment Height (inches) | C.V. | Sediment Height (inches) | C.V. | Sediment Height (inches) | C.V. | Sediment Height (inches) | 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 |

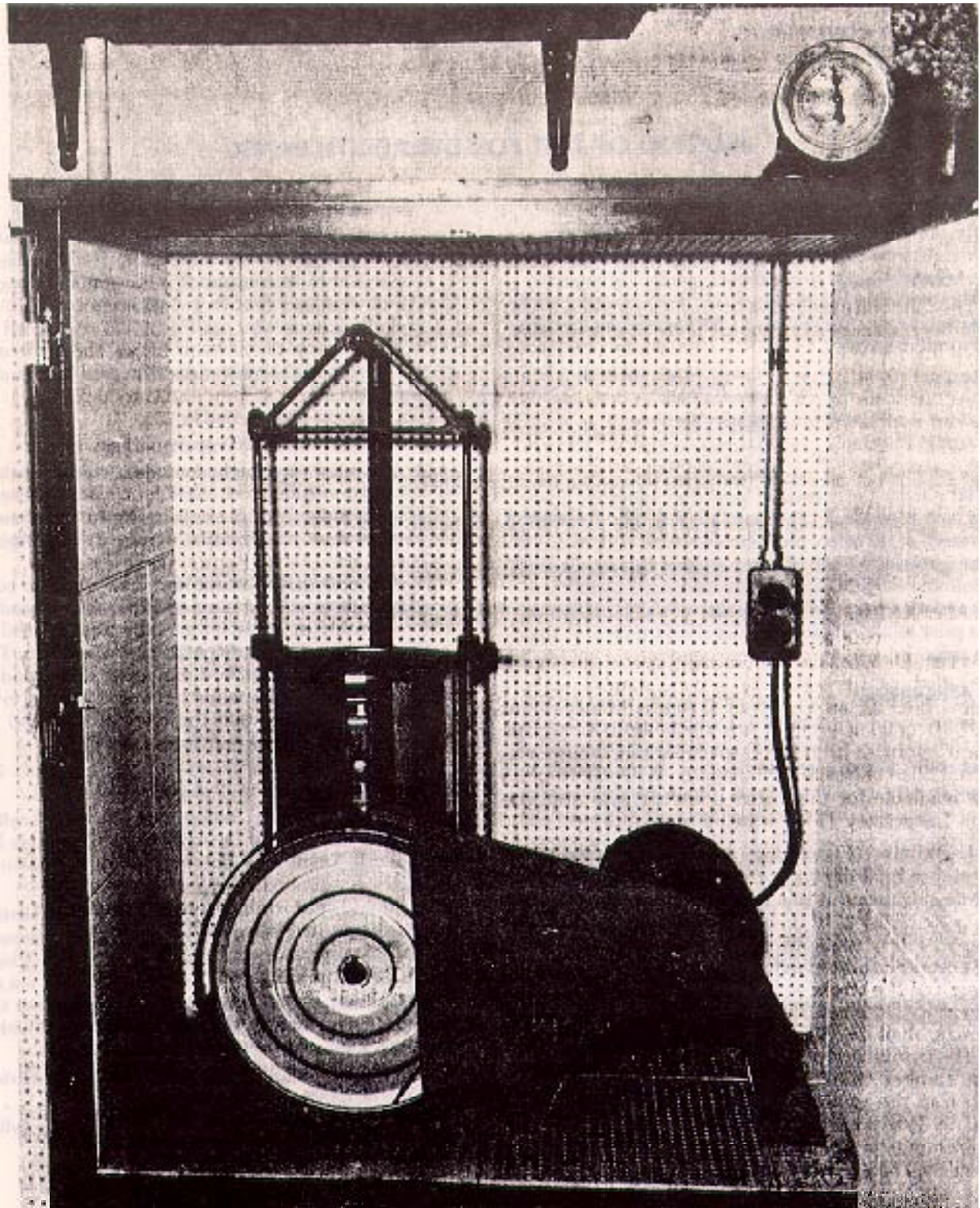
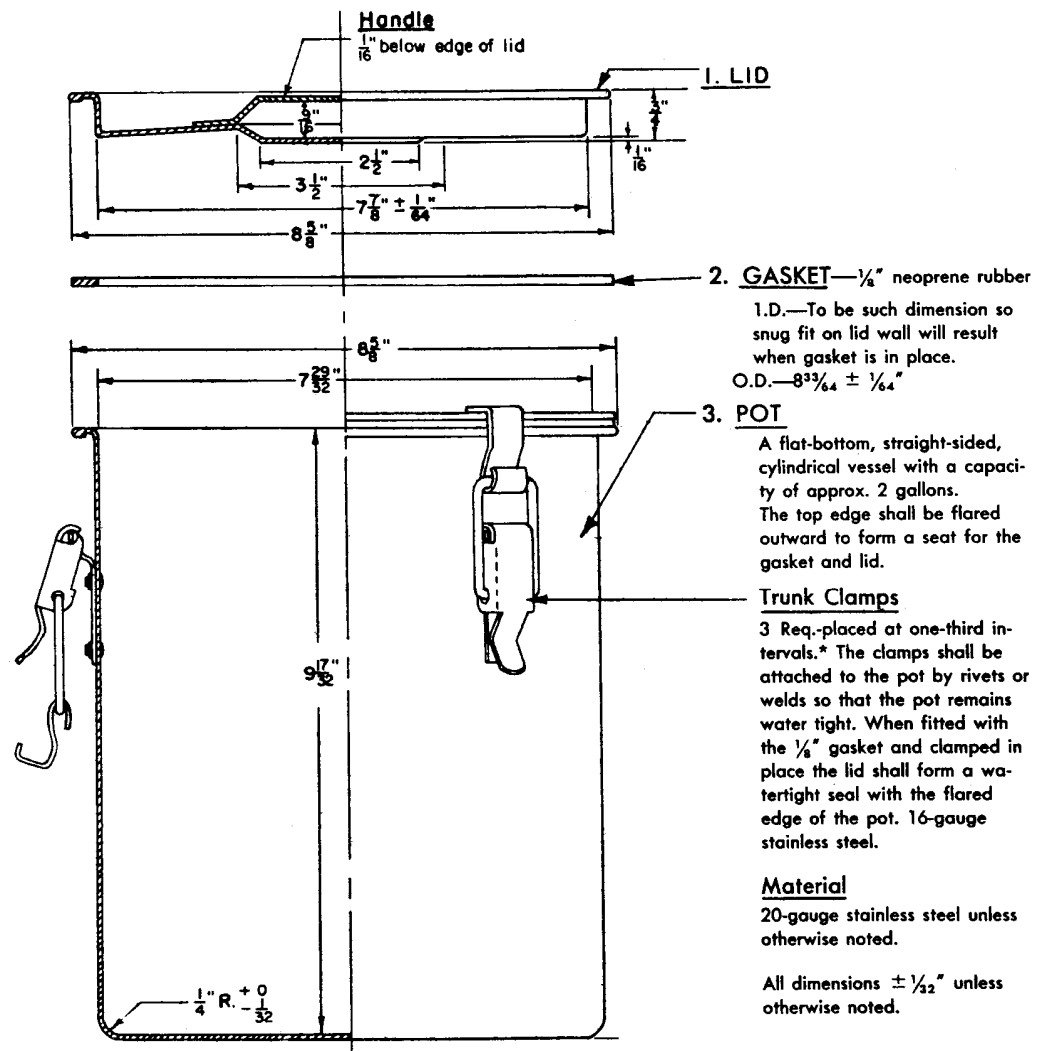


FIGURE 1. Agitator



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

FIGURE 2. Mechanical Washing Vessel

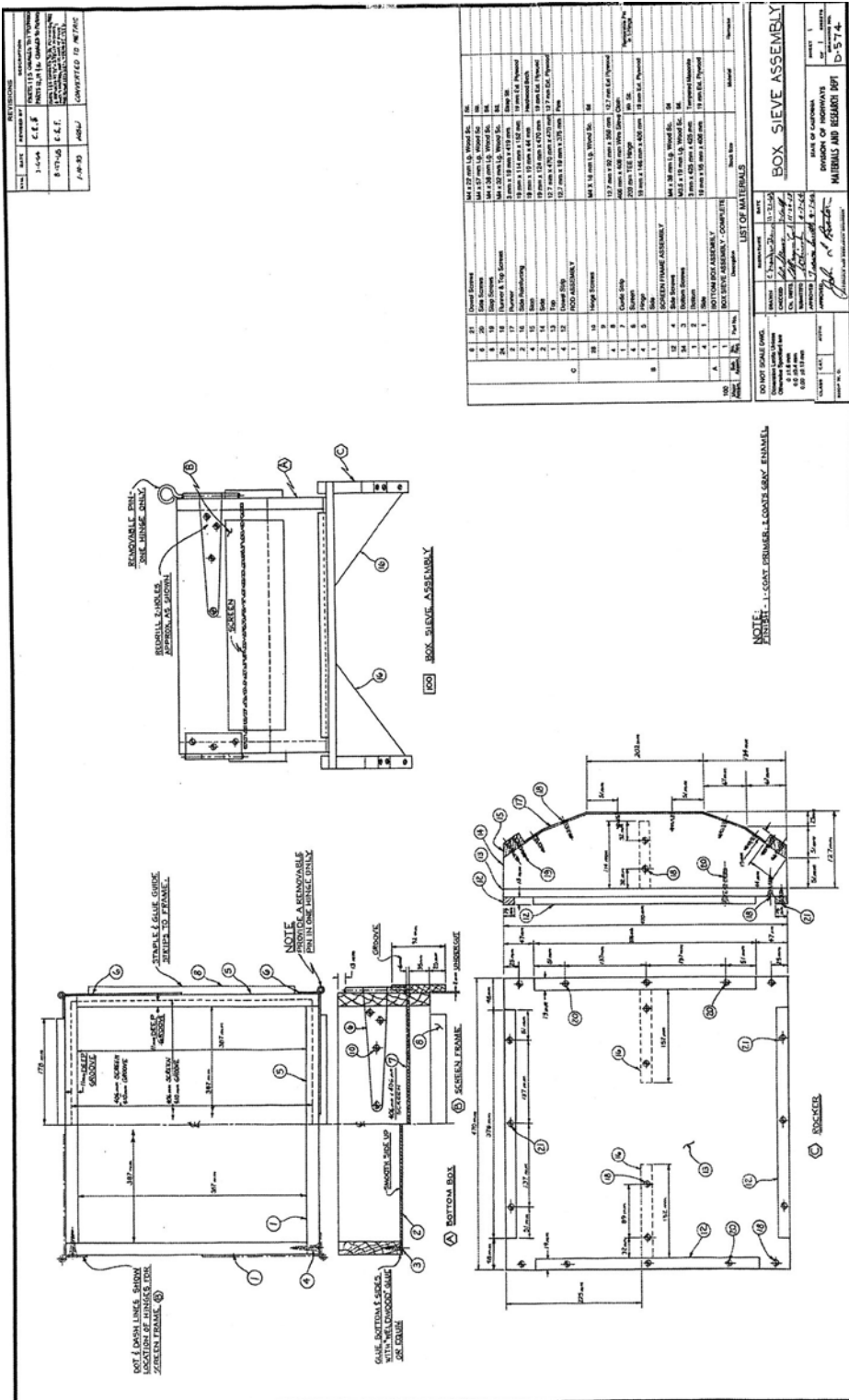


FIGURE 3. Box Sieve Assembly