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

METHOD OF TEST FOR UNCOMPACTED VOID CONTENT OF FINE AGGREGATE

A. SCOPE

This test method describes the procedure for determining the loose uncompacted void content of a sample of fine aggregate. When measured on any aggregate of known grading, void content provides an indication of that aggregate's angularity, sphericity, and surface texture compared to other fine aggregates tested in the same grading.

This method uses a standard fine aggregate grading that is obtained by combining individual sieve fractions from a typical fine aggregate sieve analysis.

B. REFERENCES

California Test 125 – Sampling Highway Materials and Products Used in the Roadway Structural Sections
California Test 202 – Sieve Analysis of Fine and Coarse Aggregates
California Test 207 – Specific Gravity and Absorption of Fine Aggregate
AASHTO T 304 – Uncompacted Void Content of Fine Aggregate
ASTM B 88 – Seamless Copper Water Tube

C. SIGNIFICANCE AND USE

This procedure calculates percent void content determined under standardized conditions that depend on the particle shape and texture of a fine aggregate. A larger void content determined by this procedure indicates greater angularity, less sphericity, or rougher surface texture (or some combination of the three factors). A lower void content result is associated with more rounded, spherical, smooth surfaced fine aggregate, or a combination of these factors.

The bulk dry specific gravity (based on California Test 207) of the fine aggregate is used in calculating the void content.

Void content information is useful as an indicator of properties such as: the mixing water demand of hydraulic cement concrete; flowability, pumpability, or workability factors when formulating grouts or mortars; the effect of the fine aggregate on stability and voids in the mineral aggregate in hot mix asphalt; or the stability of the fine aggregate portion of a base course aggregate.

D. APPARATUS

1. Cylindrical Measure: a right cylinder of approximately 100 mL capacity having an inside diameter of approximately 39 mm and an inside height of approximately 86 mm made of drawn copper water tube meeting ASTM Specification B 88 Type M, or B 88 M Type C.

The bottom of the measure must be metal at least 6 mm thick, must be firmly sealed to the tubing, and must be provided with means for aligning the axis of the cylinder with that of the funnel (Figure 1).

2. Funnel: the lateral surface of the right frustum of a cone sloped 60° ± 4° from the horizontal with an opening of 12.7 mm ± 0.6 mm diameter. The funnel section must be a piece of metal, smooth on the inside and at least 38 mm high. It must have a volume of at least 200 mL or must be provided with a supplemental glass or metal container to provide the required volume (Figure 2).

3. Funnel Stand: a three or four-legged support capable of holding the funnel firmly in position with the axis of the funnel collinear (within a 4° angle and a displacement of 2 mm) with the axis of the cylindrical measure. The funnel opening must be 115 mm ± 2 mm above the top of the cylinder. A suitable arrangement is shown in Figure 2.

4. Glass Plate: a square glass plate approximately 60 mm × 60 mm with a minimum 4 mm thickness used to calibrate the cylindrical measure.

5. Pan: a metal or plastic pan of sufficient size to contain the funnel stand and to prevent loss of material. The purpose of the pan is to catch and retain fine aggregate particles that overflow the measure during filling and strike off.

6. Metal Spatula: a spatula with a blade approximately 100 mm in length and at least 20 mm wide with straight edges. The end must be cut at a right angle to the edges.

7. Balance: balance or scale accurate and readable to ± 0.1 g within the range of use, capable of weighing the cylindrical measure and its contents.

E. SAMPLING

Obtain the sample(s) for this test from cold feeds or stock piles and prior to lime treatment in accordance with California Test 125. Wash the sample(s) over a No. 200 sieve and then dry and sieve into separate size fractions in accordance with California Test 202. Maintain the necessary size fractions obtained from 1 (or more) sieve analysis in a dry condition in separate containers for each size.

F. CALIBRATION OF CYLINDRICAL MEASURE

1. Apply a light coat of grease to the top edge of the dry, empty cylindrical measure. Weigh the measure, grease, and glass plate. Fill the measure with deionized or distilled water at a temperature of 65° to 75°F. Record the temperature of the water. Place the glass plate on the measure being sure that no air bubbles remain. Dry the outer surfaces of the measure and determine the combined weight of measure, glass plate, grease, and water by weighing.

   Following the final weighing, remove the grease and determine the weight of the clean, dry, empty measure for subsequent tests.

2. Calculate the volume of the measure as follows:

$$V = 1000\frac{M}{D}$$

Where: V = Volume of cylinder (mL)
M = Net weight of water (g)
D = Density of water (kg/m³)
(See Table 1 for density at the temperature used and interpolate if necessary.)

Determine the volume to the nearest 0.1 mL.

NOTE: If the volume of the measure is greater than 100.0 mL, it may be worthwhile to grind the upper edge of the cylinder until the volume is exactly 100.0 mL in order to simplify subsequent calculations.

TABLE 1.
Water Density

Temperature		kg/m³	lb/ft³
°C	°F		
15.6	60	999.01	62.366
18.3	65	998.54	62.336
21.1	70	997.97	62.301
(23.0)	(73.4)	(997.54)	(62.274)
23.9	75	997.32	62.261
26.7	80	996.59	62.216
29.4	85	995.83	62.166

G. PREPARATION OF SAMPLES

1. Weigh out as specified in Table 2 and combine quantities of fine aggregate which has been dried and sieved in accordance with California Test 202. The tolerance on each of these amounts is ± 0.2 g.

TABLE 2.
Combined Quantities of Fine Aggregate

Individual Size Fraction		Weight
Passing	Retained	(g)
No. 8	No. 16	44
No. 16	No. 30	57
No. 30	No. 50	72
No. 50	No. 100	17
Total weight		190

2. Specific Gravity of Fine Aggregate: If the bulk dry specific gravity of fine aggregate from the source is unknown, determine it on the minus No. 4 material in accordance with California Test 207. Use this value in subsequent calculations.

H. PROCEDURE

1. Mix each sample with the spatula until it appears to be homogeneous. Position the jar and funnel section in the stand and center the cylindrical measure as shown in Figure 2. Use a finger to block the opening of the funnel. Pour the sample into the funnel. Level the material in the funnel by over filling and striking off the excess with the straight edge of the spatula. Remove the finger and allow the sample to fall freely into the cylindrical measure.

   NOTE: Use of a torpedo level is recommended to verify that the funnel and stand are level.

2. After the funnel empties, strike-off excess heaped fine aggregate from the cylindrical measure by a rapid single pass of the spatula with the width of the blade vertical, keeping the straight part of its edge horizontal and in light contact with the top of the measure. Until this operation is complete, exercise care to avoid vibration or any disturbance that could cause compaction of the fine aggregate in the cylindrical measure. After strike-off, tap the cylindrical measure lightly to compact the sample to make it easier to transfer the container to scale or balance without spilling any of the sample. Brush adhering grains from the outside of the container and determine the weight of the cylindrical measure and contents to the nearest 0.1 g. Retain all fine aggregate particles for a second test run.

3. Recombine the sample from the retaining pan and cylindrical measure and repeat the procedure. The results of 2 runs are averaged. See Section J.

4. Record the weight of the empty cylindrical measure. Also, for each run, record the weight of the cylindrical measure and fine aggregate.

I. CALCULATION

1. Calculate the uncompacted voids for each determination as follows:

$$U = \frac{V - \left(\frac{F}{G}\right)}{V} \times 100$$

   V = Volume of cylindrical measure, mL
   F = Net weight of fine aggregate in cylindrical measure (gross weight minus the weight of the empty cylindrical measure), g
   G = Bulk specific gravity (oven dry) of fine aggregate
   U = Uncompacted voids, in the material, percent

2. Calculate the average uncompacted voids for the 2 determinations and report the result as U_A.

J. REPORT

1. The Uncompacted Voids (U_A) in percent to the nearest one-tenth of a percent (0.1 %).

2. The bulk specific gravity (oven dry) value used in the calculations.

K. 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

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(California Test 234 contains 6 pages)

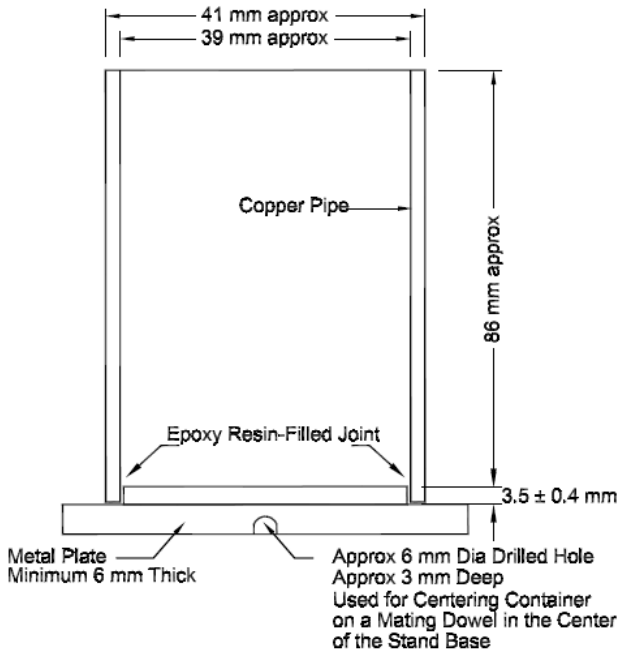

FIGURE 1—Nominal 100-mL Cylindrical Measure

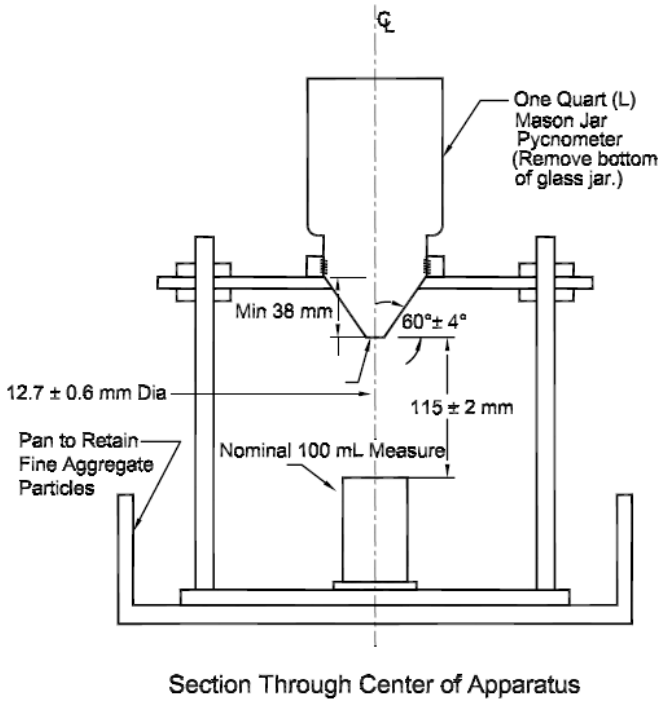

FIGURE 2—Suitable Funnel Stand Apparatus with Cylindrical Measure in Place (supplemental glass or metal container is optional)