

5.16.50 UNCOMPACTED VOID CONTENT OF FINE AGGREGATE (Kansas Test Method KT-50)

a. SCOPE

This method of test covers the determination of the uncompact void content of a sample of aggregate based on a given gradation. It provides a measure of aggregate angularity and texture compared to other fine aggregates tested.

b. REFERENCED DOCUMENTS

b.1. KT-3; Material Passing No. 200 (75 μ m) Sieve by the Wash Method

b.2. KT-15; Bulk Specific Gravity and Unit Weight of Compacted Asphalt Mixtures

b.3. AASHTO M 231; Balances Used in Testing of Materials

b.4. AASHTO T 304; Uncompact Void Content of Fine Aggregate

b.5. ASTM B 88; Specification for Seamless Copper Water Tube

c. APPARATUS

c.1. Funnel - The lateral surface of the right frustum of a cone sloped 60 ± 4 degrees from the horizontal with an opening of 0.50 ± 0.024 in (12.7 ± 0.6 mm) diameter. The funnel shall be smooth on the inside and at least 1.5 in (38 mm) high. It shall have a volume of at least 200 mL or shall be provided with a supplemental container to provide the required volume. The funnel and supplemental container shall comply with the apparatus shown in Figure 5.16.50-1.

c.2. Funnel Stand - A support capable of holding the funnel firmly in position with its axis collinear with the axis of the measure and funnel opening 4.5 ± 0.1 in (115 ± 2 mm) above the top of the cylinder. A suitable arrangement is shown in Figure 5.16.50-1.

c.3. Measure - A right angle cylinder of approximately 6.1 in³ (100 mL) capacity having an inside diameter of 1.53 ± 0.05 in (39 ± 1.3 mm), and an inside height of approximately 3.37 in (86 mm), made of drawn copper water tube meeting ASTM B 88, Type M or equally rigid material. The bottom of the measure shall be at least 0.24 in (6 mm) thick, shall be firmly sealed to the tubing, and shall be provided with means for aligning the axis of the cylinder with that of the funnel. See Figure 5.16.50-2.

Apply a light coat of grease to the top edge of the dry, empty measure. Weigh the measure, grease, and a flat, glass plate slightly larger than the diameter of the measure. Fill the measure with water at a temperature of $77 \pm 5^{\circ}$ F ($25 \pm 3^{\circ}$ C). 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 mass of measure, glass plate, grease, and water by weighing. This procedure should be done at least once a year.

Calculate the volume of the measure as follows:

$$V_c = \frac{W}{\text{density of water}^a}$$

where: V_c = volume of cylinder, mL

$W = d - c$ = net mass of water, g

where: c = cylinder + glass + grease, g

d = cylinder + glass + grease + water, g

NOTE a: Density of water varies based on temperature. Determine the temperature and select the proper density for water from KT-15, Table 5.16.15-1.

c.4. 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 aggregate grains that overflow the measure during filling or strike off.

c.5. Metal spatula about 4 in (100 mm) long with sharp straight edges. The straight edge of the spatula is used to strike off the fine aggregate.

c.6. The balance shall conform to the requirements of AASHTO M 231 for the class of general purpose balance required for the principal sample mass of the sample being tested.

c.7. 200 mL Volumetric flasks TC at 68°F (20°C) accurate and readable to ± 0.10 mL.

c.8. Brush - A brush small enough to use to dislodge aggregate from the measure's base while inside the funnel stand.

c.9. Utility funnel - A small plastic or metal or glass funnel with a neck small enough to insert into the 200 mL volumetric flasks but sufficiently large enough in inside diameter to transfer all the contents of the measure to the flask.

d. SAMPLE PREPARATION

d.1. Wash the sample over the No. 200 (75 μm) sieve using the equipment and procedures listed in KT-3. Dry the plus No. 200 (75 μm) material to a constant mass. Sieve the dry aggregate over the No. 8 (2.36 mm), No. 16 (1.18 mm), No. 30 (600 μm), No. 50 (300 μm), and No. 100 (150 μm) sieves. Discard all material retained on the No. 8 (2.36 mm) and passed through the No. 100 (150 μm).

d.2. Weigh out and combine the following quantities of dry aggregate from each of the sizes:

<u>Individual Size Fraction</u>	<u>Mass, g</u>
No. 8 (2.36 mm) to No. 16 (1.18 mm)	44
No. 16 (1.18 mm) to No. 30 (600 μm)	57
No. 30 (600 μm) to No. 50 (300 μm)	72
No. 50 (300 μm) to No. 100 (150 μm)	<u>17</u>
	190 total

The tolerance on each of these amounts is ± 0.2 g. Mix the test sample until it is homogenous.

d.3. Prepare two test samples of the above recipe.

Note: If U_k values below the specified (full pay) value have been obtained from previous tests on this project, the Engineer may increase the number of test samples from two to four, and go directly to the U_k determination specified in paragraph **g.2**. This is in lieu of performing a two sample test, discarding a failed result, and retesting with four samples.

e. TEST PROCEDURE

e.1. Mix the test sample until it is homogenous. Using a finger to block the opening of the funnel, pour the test sample into the funnel. Level the material in the funnel with the spatula. Center the measure under the funnel, remove the finger, and allow the sample to fall freely into the measure.

e.2. After the funnel empties, remove excess heaped aggregate from the measure by a single pass of the spatula with the blade vertical using the straight part of its edge in light contact with the top of the measure. Until this operation is complete, exercise care to avoid vibration or disturbance that could cause compaction of the fine aggregate in the measure. After strike-off the measure may be tapped lightly to compact the sample to make it easier to transfer the measure. Brush adhering grains from the outside of the measure.

e.3. Pour contents of cylinder into 200 mL volumetric flask using a funnel to assure total transfer of aggregate.

e.4. Weigh the flask and sample, record as A.

e.5. Add distilled water (deionized water can be substituted) and removed trapped air by slowly turning the flask at an angle along it's base. Do not shake. Allow the flask to sit for several minutes then roll flask again. Continue the process until there are no visible air bubbles present or for a maximum of 15 minutes, whichever comes first. Distilled water (and entire test) should be at room temperature, $77 \pm 5^\circ\text{F}$ (25 to 3°C).

e.6. Adjust distilled water to the calibrated volume mark on the neck of the flask.

e.7. Weigh flask and contents, record as B.

d.8. Repeat procedure for the second test sample and record results.

f. CALCULATIONS

The uncompacted void content (U_k) in 0.01 percent, is calculated by this method:

$$U_k = \frac{U_1 + U_2}{2}$$

Where U_1 and U_2 are the uncompacted void content for Trial No. 1 and Trial No. 2 respectively, and are determined by:

$$U_{1,2} = \frac{100 [W_w - (V_f - V_c)]}{V_c}$$

Where: W_w = Mass of the water = $B - A$, g

B = mass of flask, water and aggregate, g

A = mass of flask and aggregate, g

V_f = Volume of the flask (normally 200 mL as specified), mL.

V_c = Calibrated volume of cylinder, mL.

g. CONFIRMATION OF TEST VALUES

g.1. If two samples are prepared in **d.3.**, and the raw values of U_1 and U_2 differ by more than 1.0, discard those U_1 and U_2 values and rerun the full test. Prepare four trial samples instead of two, as specified in **d.3.** Determine the four trial values, U_1 , U_2 , U_3 and U_4 , and calculate U_k using the following formula:

$$U_k = \frac{U_1 + U_2 + U_3 + U_4}{4}$$

Use this four test value for determining the pay factor.

g.2. If the U_k value is below the specified (full pay) value and based on only two values (U_1 and U_2), discard those values and rerun the full test. Prepare four trial samples in step **d.3.** and proceed

with the testing. Calculate U_k using the four test results as shown in **g.1**. Use this U_k value for determining the pay factor.

h. PRECISION AND BIAS¹

h.1. Precision:

h.1.a. The single-operator standard deviation has been found to be 0.13 % voids (1s), using the graded standard silica sand as described in ASTM Specification C 778. Therefore, results of two properly conducted tests by the same operator on similar samples should not differ by more than 0.37 % (d2s).

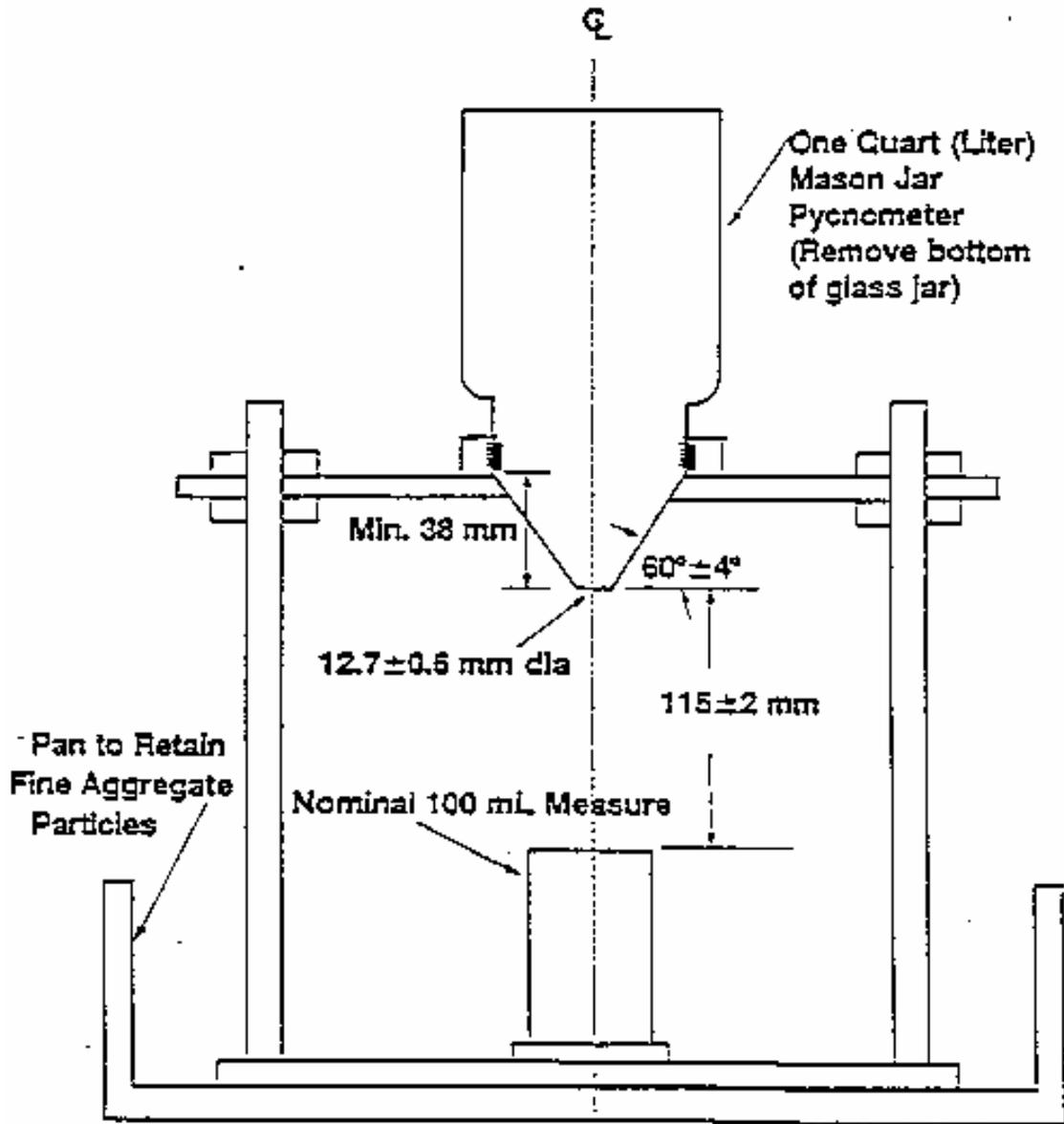
h.1.b. The multilaboratory standard deviation has been found to be 0.33 % (1s) using the standard fine aggregate as described in ASTM Specification C 778. Therefore, results of two properly conducted tests by laboratories on similar samples should not differ by more than 0.93 % (d2s).

h.1.c. The above statements pertain to void contents determined on “graded standard sand” as described in ASTM Specification C 778, which is considered rounded, and is graded from No. 30 (600 μm) to No. 100 (150 μm), and may not be typical of other fine aggregates. Additional precision data are needed for tests of fine aggregates having different levels of angularity and texture in accordance with these test methods.

h.2. Bias--Since there are no accepted reference material suitable for determining the bias for the procedures in these test methods, bias has not been determined.

¹ Precision and Bias Statement is taken directly from AASHTO T 304, **13**.

Figure 5.16.50-1
Suitable Funnel Stand Apparatus with Cylindrical Measure in Place



Section Through Center of Apparatus

Figure 5.16.50-2
Nominal 100 mL Cylindrical Measure

