5.16.05 UNIT WEIGHT OF AGGREGATE (Kansas Test Method KT-5)

a. SCOPE

This method of test covers the procedures for determining the unit weight[a] of fine, coarse, or mixed aggregates. The method is applicable to aggregates not exceeding 1 1/2 in (37.5 mm) in nominal maximum size[1]. KT-5 reflects testing procedures found in AASHTO T 19.

NOTE **a**: Unit weight is the traditional terminology used to describe the property determined by this test method. Some believe the proper term is unit mass or density or bulk density, but consensus on this alternate terminology has not been obtained.

b. REFERENCED DOCUMENTS

b.1. KT-20; Weight per Cubic Meter (Foot), Yield Cement Factor and Air Content (Gravimetric) of Fresh Concrete

b.2. AASHTO M 231; Balances Used in the Testing of Materials

b.3. AASHTO T 19; Unit Weight and Voids in Aggregate

c. APPARATUS

c.1. 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.2. Tamping Rod: A straight steel rod, 5/8 in (16 mm) in diameter and approximately 24 in (600 mm) in length, having the tamping end rounded to a hemispherical tip.

c.3. Cylindrical measure shall be provided with a handle and be water tight. The top rim shall be smooth and plane within 0.01 in (0.25 mm) and shall be parallel to the bottom within 0.5 degrees (0.1592 rads)[b]. The 0.5 ft^3 (0.014 m^3) measure shall be reinforced around the top with a band or rim and shall conform to the following dimensional requirements:

[1]AASHTO T 19 provides for aggregates up to 6 in (150 mm) in Table 1. Under KDOT aggregate specifications, 1 1/2 in (37.5 mm) represents the maximum size aggregate permitted.

TABLE 5.16.05-1
Cylindrical Measure Requirements for Unit Weight

Overall Measurements		Wall Thickness of Measure	
Capacity	0.5 ft^3 (0.014 m^3)	Bottom	0.20 in (5.0 mm)
Inside Diameter	10.0 in (254 mm)	Side	0.12 in (3.0 mm)
Inside Height	11.0 in (280 mm)	Top Rim	0.20 in (5.0 mm)

NOTE **b**: The top rim is satisfactorily plane if a 0.01 in (0.25 mm) feeler gage cannot be inserted between the rim and a piece 1/4 in (6 mm) or thicker plate glass laid over the measure. The top and bottom are satisfactorily parallel if the slope between pieces of plate glass in contact with the top and bottom does not exceed 0.87 percent in any direction.

d. CALIBRATION OF MEASURE

Calibrate the measure as set forth in **KT-20**. Obtain the factor for any unit by dividing the unit weight of water 62.4 lb/ft^3 (1,000 kg/m^3) by the mass of water required to fill the measure.

e. SAMPLE

The size of sample shall be approximately 125 to 200 percent of the quantity required to fill the measure, and shall be handled in a manner to avoid segregation. Dry the sample of aggregate to essentially constant mass, preferably in an oven 230 ± 9°F (110 ± 5°C).

f. TEST PROCEDURE (RODDED WEIGHT)[2]

f.1. Fill the measure one-third full and level the top of the sample with the fingers. Rod the layer with 25 strokes of the tamping rod evenly distributed over the surface. Fill the measure to two-thirds full, level and rod with 25 strokes. Fill the measure to overflowing, rod 25 times, and strike off the surplus aggregate using the tamping rod as a straight edge in such a way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the measure. In rodding the first layer, do not permit the rod to forcibly strike the bottom of the measure. In rodding the second and final layers use only enough force to cause the tamping rod to penetrate the last layer of the aggregate placed in the measure.

f.2. Determine the net mass of the aggregate in the measure to the nearest 0.1 lb (50 g).

f.3. Calculate the unit weight of the aggregate by multiplying the net mass of the aggregate by the factor found as described in **d.**

[2]AASHTO T 19 also has jigging and shoveling procedures to determine the unit weight of the aggregate. These procedures are not permitted under KT-5.

g. TEST PROCEDURE (LOOSE MASS FOR LIGHT WEIGHT AGGREGATE)

g.1. Fill the calibrated measure to overflowing by means of a shovel or scoop, discharging the aggregate from a height not to exceed 2 in (50 mm) above the top of the measure. Exercise care to prevent, so far as possible, segregation of the particle sizes of which the sample is composed. Level the surface of the aggregate with the fingers or a straightedge in such a way that any slight projections of the larger pieces of the coarse aggregate approximately balance the larger voids in the surface below the top of the measure.

g.2. Determine the mass of the measure and its contents and record the net mass of the aggregate to the nearest 0.1 percent. Using the calibration factor of the measure, determine the loose unit mass of the aggregate.

h. AIR VOIDS CALCULATIONS

h.1. Bulk Density-Calculate the bulk density as follows:

$M = (G-T)/V$
Or,
$M = (G-T) \times F$

Where:
M = bulk density of aggregate, lb/ft^3 (kg/m^3).
G = mass of aggregate plus the measure, lb (kg).
T = mass of the measure, lb (kg).
V = volume of measure, ft^3 (m^3).
F = factor for measure, ft^{-3} (m^{-3}).

h.2. The bulk density determined by this method is for aggregate in an oven-dry condition. If the bulk density in terms of saturated-surface-dry (SSD) condition is desired, use the exact procedure in this method, and then calculate the SSD bulk density by the following formula:

$M_{SSD} = M[1+(A/100)]$

Where:

M_{SSD} = bulk density in SSD condition, lb/ft^3 (kg/m^3); and
A = absorption, percent, determined in accordance with KT-6.

h.3. Void Content - Calculate the void content in the aggregate using the bulk density as follows:

$$\text{Voids \%} = \frac{100[(SxW) - M]}{SxW}$$

Where:

M = bulk density of aggregate, lb/ft^3 (kg/m^3)
S = bulk specific gravity (dry basis) as determined in accordance with KT-6: and
W = density of water 62.3 lb/ft^3 (998 kg/m^3).

i. REPORT

Report the results for unit weight to the nearest 1 lb/ft^3 (10 kg/m^3).

j. PRECISION

The following estimates of precision for this method are based on results from the AASHTO Materials Reference Laboratory (AMRL) Reference Sample Program (AASHTO T 19, **15. Precision and Bias**):

TABLE 5.16.05-2
Precision for Unit Weight Test Procedure

Coarse Aggregate	1S kg/m^3 (lb/ft^3)	D2S kg/m^3 (lb/ft^3)	Fine Aggregate	1S kg/m^3 (lb/ft^3)	D2S kg/m^3 (lb/ft^3)
Single Operator Precision	14 (0.88)	40 (2.5)	Single Operator Precision	14 (0.88)	40 (2.5)
Multilaboratory Precision	30 (1.87)	85 (5.3)	Multilaboratory Precision	44 (2.76)	125 (7.8)