Test Procedure for

DETERMINING UNIT MASS (WEIGHT) OF AGGREGATES

TxDOT Designation: Tex-404-A

Effective Date: August 1999

1. SCOPE

1.1 This method describes the determination of the loose mass per m^3 ($ft.^3$) of both fine and coarse aggregates.

1.1.1 The unit mass of aggregate in a saturated surface-dry (SSD) condition is intended for use in portland cement concrete mix design.

1.1.2 The dry rodded condition is intended for use in the American Concrete Institute (ACI) design procedure.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. APPARATUS

2.1 *Scoops,* one medium, one small, having square points.

2.2 *Quartering cloth or large flat metal pan.*

2.3 *Balance,* accurate within 0.1% of the mass of the test sample, readable to 5 g for aggregate passing the No. 4 sieve, and readable to 10 g for aggregate retained on the No. 4 sieve.

2.4 *Metal straightedge.*

2.5 *Volume measures,* calibrated in accordance with Tex-905-K, with volumes of 0.003 m^3 (0.1 $ft.^3$) and 0.01 m^3 (0.5 $ft.^3$).

2.6 *Denim cloth sleeve,* approximately 216 × 762 mm (8.5 × 30 in.) long (flat measure).

2.7 *Tamping rod,* a round straight steel rod, 16 mm (5/8 in.) diameter, approximately 600 mm (24 in.) in length, having one end rounded to a hemispherical tip of the same diameter as the rod.

3. PREPARING SAMPLE

3.1 Secure a field sample in accordance with Tex-400-A, obtaining a representative test sample of more than sufficient quantity to fill the measure.

3.2 The test may be performed on material at various uniform moisture conditions (including stockpile condition); however, the water content of the sample at the time of the test needs to be in the SSD condition.

3.3 Do not test fine aggregate at water content wetter than SSD condition, since this may cause bulking or bridging of the wet sand.

3.4 If oven dry condition is desired, place the sample in a 110 ± 5°C (230 ± 9°F) oven until constant mass is obtained. Cool to room temperature.

3.5 If SSD condition is desired, air dry at room temperature to the SSD condition.

4. PROCEDURES

4.1 *Determining Unit Mass (Weight)—Loose Method:*

4.1.1 *Coarse Aggregate:*

4.1.1.1 Place the sample on a smooth, flat surface and mix thoroughly.

4.1.1.2 Place the 0.01 m^3 (0.5 $ft.^3$) measure on a level surface near the sample.

4.1.1.3 Take a medium scoop of the aggregate from the thoroughly mixed sample pile.

4.1.1.4 Hold the scoop 51 mm (2 in.) above the measure.

4.1.1.5 Pour the material uniformly over the entire area in such a manner that each layer placed is nearly level and such that the surface of the material when the measure is full will be level with the rim of the measure.

4.1.1.6 While taking care not to jar the measure, level off the surface of the aggregate with the fingers in such a way that slight projections of the larger particles above the rim balance the larger voids in the surface below the top of the measure.

4.1.1.7 Weigh measure to nearest 10 g (0.02 lb.) and subtract the calibrated tare mass of the measure to obtain the net mass of the material.

4.1.1.8 Repeat above step to obtain a second determination. If two determinations are not within 1% for the same operator, run additional unit mass determinations until two non-consecutive unit masses vary by less than 1%.

4.1.1.9 Record the average mass of the aggregate as W_{SSD} if aggregate was tested at SSD or as X if the aggregates were dried to constant weight before testing, under Section 5.

4.1.2 *Fine Aggregate:*

4.1.2.1 The fine aggregate sample should be large enough (after drying) to fill the 0.003 m^3 (0.1 $ft.^3$) measure to overflowing. Use a small scoop to place the sample of sand into the denim sleeve.

4.1.2.2 Place the 0.003 m^3 (0.1 $ft.^3$) measure in a large flat pan so that excess material may be recovered for check tests.

4.1.2.3 Thoroughly mix the fine aggregate in the sleeve by closing the ends with both hands and then alternately raising and lowering one end and then the other.

4.1.2.4 Close the open end of the sleeve with one hand, allowing several millimeters (inches) of the empty part of the sleeve to extend beyond the hand.

4.1.2.5 Place this end on the bottom of the measure and release it.

4.1.2.6 Hold the measure firmly with one hand while steadily withdrawing the sleeve with the other.

4.1.2.7 Use a straightedge to strike off excess material even with the top of the measure.

4.1.2.8 Tap the side of the measure lightly to slightly settle the material and prevent material loss when weighing.

4.1.2.9 Weigh the measure full of aggregate to the nearest 5 g (0.01 lb.) and subtract the tare mass of the empty measure to obtain net mass of material required to fill the measure.

4.1.2.10 Repeat above step to obtain a second determination. If the two mass determinations are not within 1% for the same operator, run additional unit mass determinations until two non-consecutive unit masses vary by less than 1%.

4.1.2.11 Record the average net mass of aggregate as *X* under Section 5.

4.1.3 *Coarse Lightweight Aggregate:*

4.1.3.1 Standardize the gradation on which the dry loose unit mass determination is made when this unit mass is used as a quality acceptance criterion, as noted under the Materials article in the governing Department *Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.*

4.1.3.2 When used as a volume measure for mass volume conversion, distribution rate, or pay item, make the dry loose unit mass determination on the total sample.

4.1.3.3 Dry the material to a constant mass at approximately 110°C (230°F). Cool to room temperature.

4.1.3.4 Sieve enough material to fill the 0.01 m^3 (0.5 $ft.^3$) measure into the percentages specified in Table 1.

Note 1—Use standard gradation when dry loose unit mass fails the specification requirement at received gradation, and note this on the test report.

4.1.3.5 Place the sample on a smooth, flat surface and mix thoroughly.

4.1.3.6 Place the 0.01 m^3 (0.5 $ft.^3$) measure on a level surface near the aggregate sample.

4.1.3.7 Take a medium scoop full of the aggregate from the thoroughly mixed sample pile.

4.1.3.8 Hold the scoop 51 mm (2 in.) above the measure.

4.1.3.9 Pour the aggregate into the measure.

4.1.3.10 Pour the material uniformly over the entire area in such a manner that each layer placed is nearly level and such that the surface of the material when the measure is full will be level with the rim of the measure.

4.1.3.11 Taking care not to jar the measure, level off the surface of the aggregate with the fingers in such a way that slight projections of the larger particles above the rim balance the larger voids in the surface below the top of the measure.

4.1.3.12 Weigh measure to nearest 10 g (0.02 lb.) and subtract the calibrated tare mass of the measure to obtain the net mass of the material.

4.1.3.13 Repeat Steps 4.1.3.6–4.1.3.12 to obtain a second determination.

4.1.3.14 If the two determinations are not within 1% for the same operator, run additional unit mass determinations until two non-consecutive unit masses vary by less than 1%.

4.1.3.15 Record average net mass of aggregate of the satisfactory determinations as *W* under Section 5.

Note 2—Mix the aggregates thoroughly and take precautions to prevent segregation of the particles when filling the unit mass measures.

Table 1—Size of Material by % Retained by Mass

Size	% Retained by Mass
12.5 mm (1/2 in.)	0
9.5 mm (3/8 in.)	40–60
4.75 mm (No. 4)	100

4.2 *Determining Unit Mass (Weight)—Rodded Method:*

4.2.1 *Coarse or Fine Aggregate:*

4.2.1.1 Dry the sample to constant mass.

4.2.1.2 Place the dry sample on a smooth, flat surface and mix thoroughly. Use the 0.01 m^3 (0.5 $ft.^3$) measure for coarse and the 0.03 m^3 (0.1 $ft.^3$) for fine aggregate.

4.2.1.3 Fill the measure one-third full with a scoop and level the surface with the fingers.

4.2.1.4 Rod the layer of aggregate with 25 strokes of the tamping rod so the aggregate distributes evenly over the surface. Do not allow the rod to strike the bottom of the measure forcibly.

4.2.1.5 Fill the measure two-thirds full and again level and rod as in Section 4.2.1.4. The rod should not penetrate into the first layer.

4.2.1.6 Fill the measure to overflowing and rod again. The rod should not penetrate into the middle layer.

Note 3—In rodding the larger sizes of coarse aggregate, it may not be possible to penetrate through the layer being consolidated to the lower level, especially with angular aggregates. Nevertheless, the intent of the procedure will be accomplished as long as vigorous effort to penetrate is used.

4.2.1.7 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.

4.2.1.8 Weigh the full measure to the nearest 10g (0.02 lb.) for coarse aggregate and 5g (0.01 lb.) for fine aggregate. Subtract the calibrated tare mass to obtain net mass of the material.

4.2.1.9 Repeat Sections 4.2.1.3–4.1.2.8 to obtain a second determination. If two determinations are not within 1% for the same operator, then run additional unit mass determinations until two non-consecutive unit masses vary by less than 1%.

4.2.1.10 Record average net mass of aggregate as *X* under Section 5.

5. CALCULATIONS

5.1 Calculate Rodded U_{dry}:

$$U_{DRY} = X / V$$

5.2 If the aggregate was dried to a constant mass when tested, calculate W as:

$$W = X\,[(100 + A) / 100\,]$$

5.3 If aggregate is less than SSD, calculate W as:

$$W = X_1\,[(100 + A - A_1\,) / 100\,]$$

-OR-

$$W = X_1\,[(100 + A_2\,) / 100\,]$$

5.4 If the free moisture has been removed but the aggregate still contains some absorbed moisture when tested and the oven-dry mass is desired, then calculate W_{dry} as:

$$W_{DRY} = 100[\,X_1 / (100 + A_1)]$$

5.5 For coarse aggregate only, if the moisture content at the test condition of the aggregate is greater than SSD and the SSD mass is desired, calculate W_{SSD} as:

$$W_{SSD} = X_2[(100 - M)/100]$$

5.6 Calculate the unit mass (U):

$$U = W / V, in\ kg / m^3\ (lb./ ft^3)$$

-OR-

$$U = X / V, kg / m^3\ (lb./ ft^3)$$

Where:

A = percent absorption as determined in Tex-403-A.

A_1 = percent absorbed moisture at the test condition of the aggregate

A_2 = percent absorption based on stockpile condition mass as determined in Part II of Tex-409-A

M = percent free moisture as determined in Part I of Tex-409-A

V = Volume of the measure; either 0.01 or 0.003 m^3 (0.5 or 0.1 $ft.^3$)

W = average net mass of saturated surface-dry (SSD) aggregate to fill the measure

X = mass of aggregate (oven dry) in the container, kg (lb.)

X_1 = mass of aggregate (less than SSD) in the container, kg (lb.)

X_2 = mass of aggregate (greater than SSD) in the 0.01 m^3 (0.5 $ft.^3$) container, kg (lb.)

Note 4—Avoid unnecessary delays when testing saturated surface-dry material to prevent excessive loss of moisture by evaporation.

6. REPORT

6.1 Report the unit mass to the nearest kg/m^3 (0.1 lb./$ft.^3$) using the Unit Weight of Lightweight Surface Treatments Aggregates worksheet.