Method of Test for

DETERMINING THE RELATIVE DENSITY (SPECIFIC GRAVITY), MOISTURE CONTENT, AND ABSORPTION OF LIGHTWEIGHT AGGREGATE

DOTD Designation: TR 123

I. Scope

A. This test method covers the determination of the relative density (specific gravity), surface moisture, and absorption properties of lightweight fine aggregate in the field or laboratory. The specific gravity, surface moisture, and absorption values calculated in this test method are used for the design of internally-cured concrete mixtures.

B. Referenced Documents

1. ASTM Standard C 1761 - Lightweight Aggregate for Internal Curing of Concrete
2. DOTD TR 113 – Sieve Analysis of Fine and Coarse Aggregates
3. AASHTO M 231 - Standard Specification for Weighing Devices Used in the Testing of Materials
4. AASHTO T 2 - Standard Method of Test for Sampling of Aggregates
5. AASHTO T 84 - Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate
6. AASHTO T 164 - Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA)
7. AASHTO T 248 - Reducing Samples of Aggregate to Testing Size

II. Terminology

A. Absorption – The increase in the mass of aggregate due to water in the pores of the aggregate material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass.

B. Specific gravity – The ratio of mass of a volume of a material at a stated temperature to the mass of the same volume of distilled water at the same temperature.

C. Internal curing – The process in which pre-wetted lightweight aggregates, or other materials that readily release water from within the particles, supply water within a cementitious matrix, thereby mitigating self-desiccation and sustaining hydration.

D. Self-desiccation – Reduction in the internal relative humidity of a sealed cementitious mixture, due to chemical shrinkage, that may reduce the rate of hydration or stop hydration.

E. Chemical shrinkage – The reduction in volume of cementitious paste that occurs during hydration, since the hydration products occupy less volume than the volume occupied originally by the water and unhydrated cementitious materials.

III. Apparatus

A. Centrifuge – Extraction apparatus conforming to AASHTO T 164, method A.
B. Filter ring – Felt or paper, to fit the rim of the bowl, conforming to AASHTO T 164.
C. Pycnometer – A two-quart flask as specified in AASHTO T 84. The pycnometer should have a capacity at least 50 percent more than the volume needed to accommodate the test sample.
D. Oven – The drying apparatus capable of drying the test specimen at 110 ± 5°C.
E. Balance – A scale as specified in AASHTO M 231, class G2.
F. Miscellaneous – Spatulas and brushes, as needed.

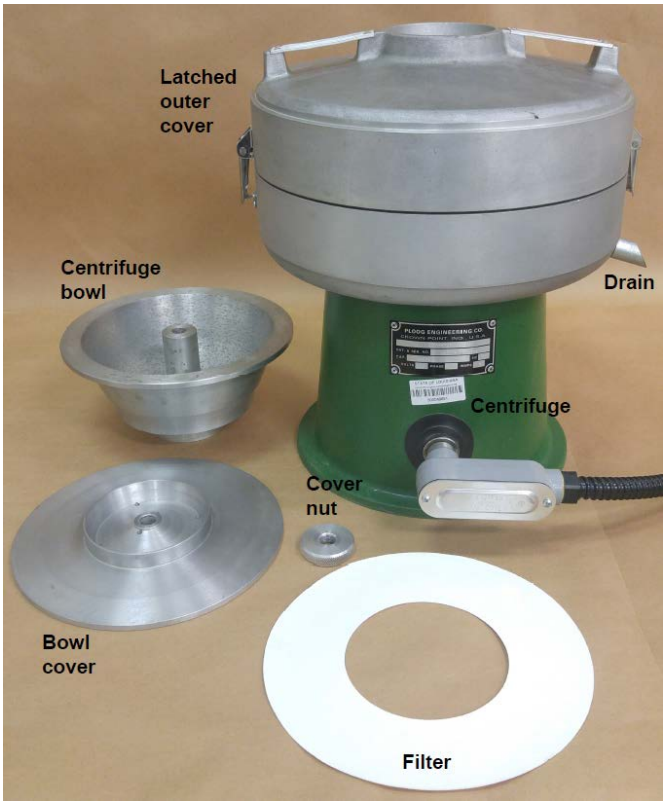

Figure 1. Centrifuge apparatus.

IV. Health Precautions

Standard laboratory safety precautions must be observed when preparing and handling the test specimens.

V. Samples, Test Specimens, Test Locations, etc.

A. Obtain approximately 1000 g of the lightweight aggregate using the AASHTO T 248 procedure and oven-dry it at 110 ± 5°C to a constant mass.

Note 1: *Constant mass is obtained when the weight of the test specimen does not change by more than 0.1 percent of its original weight after a 15-minute interval.*

B. After constant mass is obtained, cool the specimen to room temperature.
C. Submerge the specimen in water for 72 ± 4 hours. For field testing, omit oven drying and soaking (steps A and B).
D. Decant excess water with care to avoid the loss of fines.

VI. Procedure

Absorption, Surface Moisture, and Total Moisture

A. Measure 600 ± 10g of pre-wetted lightweight aggregate into the centrifuge bowl. For field testing, record the mass as M_W.
B. Place the filter ring on the bowl, clamp on the cover, and start the centrifuge. Adjust the rotation speed to 2000 ± 20 rpm. Maintain the rotational speed for 3 minutes ± 15 seconds and then turn off the centrifuge.
C. After the centrifuge has come to a stop, remove the latched outer cover. Remove the inner cover nut and filter paper. Scrape the sides of the bowl and use a brush to remove aggregate from the filter paper. The test specimen is now in the wetted surface-dry condition.
D. Weigh the pre-wetted surface-dry aggregate test sample and record this mass to the nearest 0.1 g (A).
E. Measure the mass of an empty pan that will be used to oven-dry the pre-wetted surface-dry aggregate.
F. Place the aggregate in the pan and dry the test specimen in an oven at 110 ± 5°C to a constant mass. Cool the specimen to room temperature and record the mass to the nearest 0.1 g (B).

Relative Density (Specific Gravity)

G. Fill an empty pycnometer with water to its calibrated mark. Weigh and record this mass to the nearest 0.1 g (C).
H. Remove the water from the pycnometer.
I. Repeat steps A to D to obtain lightweight aggregate in its pre-wetted surface-dry condition.
J. Partially fill the pycnometer with water and introduce 300 ± 10g of pre-wetted surface-dry lightweight aggregate into the pycnometer. Add water to fill to approximately 90 percent of capacity of the pycnometer.
K. Roll and agitate the pycnometer to remove air bubbles. It takes approximately 15-20 minutes to eliminate air bubbles.
L. Adjust the water temperature to 23 ± 1.7°C (73.4 ± 3°F) and bring the level of the water to the calibration mark of the pycnometer. Determine the mass of the pycnometer, specimen, and water and record it to the nearest 0.1 g (D).
M. Decant excess water with care to avoid loss of fines. Transfer the test specimen to an appropriate vessel for oven-drying. Rinse the flask until all material has been transferred.
N. Measure the mass of an empty pan that will be used to oven-dry the contents of the pycnometer.
O. Place the aggregate in the pan, and dry the test specimen in an oven at 110 ± 5°C to a constant mass. Cool the specimen to room temperature and record the mass to

the nearest 0.1 g (E).

VII. Calculation and Interpretation of Results

A. The surface moisture of the lightweight aggregate is calculated as follows:

$$\mathrm{Ws}\ (\%) = \frac{\mathrm{Mw} - \mathrm{A}}{\mathrm{A}} \times 100$$

Where:
W_S = the surface moisture in the lightweight aggregate, percent
M_W = Mass of the pre-wetted lightweight aggregate, g
A = Mass of the wetted surface-dry aggregate test sample, g

B. The 72-hour absorption of the lightweight aggregate is calculated as follows:

$$A_{72}(\%) = \frac{\mathrm{A} - \mathrm{B}}{\mathrm{B}} \times 100$$

Where:
A_{72} = the 72-h absorption, percent
A = Mass of the wetted surface-dry test specimen, g
B = Mass of the oven-dry aggregate, g

C. The total moisture of the lightweight aggregate is calculated as follows:

$$\mathrm{MC_T}(\%) = \frac{\mathrm{M_W} - \mathrm{B}}{\mathrm{B}} \times 100$$

Where:
MC_T = the total moisture of the lightweight aggregate, percent
M_W = Mass of the pre-wetted lightweight aggregate (~600 g), g
B = Mass of the oven-dry aggregate, g

D. The pre-wetted surface-dry specific gravity of the lightweight aggregate is calculated as follows:

$$\mathrm{G_{WSD}} = \frac{M_{PSD}}{M_{PSD} + \mathrm{C} - \mathrm{D}}$$

Where:
G_{WSD} = Wetted surface-dry specific gravity
M_{PSD} = Mass of the wetted surface-dry test specimen (~300 g), g
C = Mass of the pycnometer filled with water, g
D = Mass of the pycnometer containing the specimen and water, g

E. The oven-dry specific gravity of the lightweight aggregate is calculated as follows:

$$G_{OD} = \frac{E}{M_{PSD} + C - D}$$

Where:
G_{OD} = Oven-dry specific gravity
M_{PSD} = Mass of the wetted surface-dry test specimen (~300 g), g
C = Mass of the pycnometer filled with water, g
D = Mass of the pycnometer containing the specimen and water, g
E = Mass of the oven-dry aggregate, g

VIII. Report

A. Maximum size of the lightweight aggregate.
B. Source of the lightweight aggregate.
C. Test results reported as the surface moisture (to the nearest 0.1%), 72-hour absorption (to the nearest 0.1%), total moisture (to the nearest 0.1%), and specific gravity (to the nearest 0.001) of the lightweight aggregate.
D. Test date.

IX. Normal Test Reporting Time

The lightweight aggregate shall be first submerged in water for 72 ± 4 hours. Next, normal test reporting time is 24 hours.

X. Illustrations and Tables, etc.

M_B	Mass of Empty Centrifuge Bowl	g
M_W	Mass of Pre-Wetted Aggregate Added to Tared Empty Centrifuge Bowl, 600 ± 10g	g
M_{BD}	Mass of Bowl and Surface-Dry Aggregate	g
A	Mass of the Wetted Surface-Dry Test Specimen ($A = M_{BD} - M_B$)	g
Ws	**Surface Moisture in Lightweight Aggregate** $Ws\ (\%) = \frac{Mw - A}{A} \times 100$	**%**
M_{P1}	Mass of Empty Pan for Drying	g
M_{PD1}	Mass of Pan and Oven-Dried Aggregate	g
B	Mass of the Oven-Dry Aggregate ($B = M_{PD1} - M_{P1}$)	g
A_{72}	**The 72-hour Absorption of Lightweight Aggregate** $A_{72}(\%) = \frac{A - B}{B} \times 100$	**%**

MC_T	**Total Moisture in Lightweight Aggregate** $MC_T(\%) = \frac{M_W - B}{B} \times 100$	**%**
M_{PE}	Mass of Empty Pycnometer	g
C	Mass of Pycnometer filled to Calibration Mark	g
M_{PSD}	Mass of Pre-Wetted Surface-Dry Aggregate Added to Tared Empty Pycnometer, 300 ± 10g	g
D	Mass of the Pycnometer, Pre-Wetted Surface-Dry Aggregate and Water to Calibration Mark	g
M_{P2}	Mass of Empty Pan for Drying	g
M_{PD2}	Mass of Pan and Oven-Dried Aggregate	g
E	Mass of the Oven-Dry Aggregate ($E = M_{PD2} - M_{P2}$)	g
G_{WSD}	**Pre-Wetted Surface-Dry Relative Density** $G_{WSD} = \frac{M_{PSD}}{M_{PSD} + C - D}$	
G_{OD}	**Oven-Dry Relative Density** $G_{OD} = \frac{E}{M_{PSD} + C - D}$	