T 85

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE

FOP FOR AASHTO

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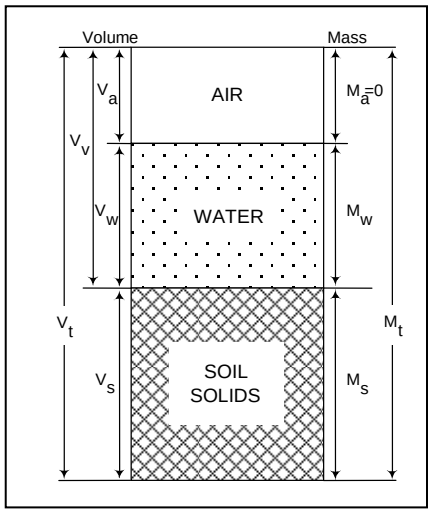

Phase diagram

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Significance

Bulk specific gravity is a characteristic used for calculating the volume occupied by the aggregate or various mixtures containing aggregate, including portland cement concrete, bituminous mixes, and other materials that are proportioned or analyzed on an absolute volume basis. Specific gravity is the ratio of the mass of a material to the mass of an equal volume of water. Several categories of specific gravity are used relative to aggregate.

Bulk specific gravity (oven-dry), G_{sb}(OD), is used for computations when the aggregate is dry. Bulk specific gravity (saturated surface dry), G_{sb}(SSD), is used if the aggregate is wet. Apparent specific gravity, G_{sa}, is based solely on the solid material making up the constituent particles and does not include the pore space within the particles that is accessible to water.

Absorption values are used to calculate the change in the mass of an aggregate due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition, when it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential.

The laboratory standard for absorption is that obtained after submerging dry aggregate for approximately 15 hours in water. Aggregates mined from below the water table may have a higher absorption, when used, if not allowed to dry. Conversely, some aggregates, when used, may contain an amount of absorbed moisture less than the 15 hours soaked condition. For an aggregate that has been in contact with water and that has free moisture on the particle surfaces, the percentage of free moisture can be determined by deducting the absorption from the total moisture content.

The pores in lightweight aggregates may or may not become filled with water after immersion for 15 hours. In fact, many such aggregates can remain immersed in water for several days without satisfying most of the aggregates' absorption potential. Therefore, this method is not intended for use with lightweight aggregate.

Scope

This procedure covers the determination of specific gravity and absorption of coarse aggregate in accordance with AASHTO T 85. Specific gravity may be expressed as bulk specific gravity, oven dry (G_{sb} OD), bulk specific gravity, saturated surface dry (G_{sb} SSD), or apparent specific gravity (G_{sa}). G_{sb} and absorption are based on aggregate after 15 to 19 hours soaking in water.

Terminology

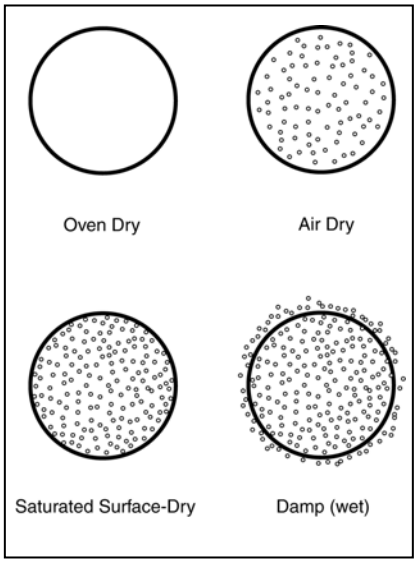
Saturated surface dry (SSD) – condition of an aggregate particle when the permeable voids are filled with water, but no water is present on exposed surfaces.

Specific Gravity – the ratio of the mass, in air, of a volume of a material to the mass of the same volume of gas-free distilled water at a stated temperature.

Bulk Specific Gravity (Oven Dry) (G_{sb} OD) – the ratio of the dry mass, in air, of a volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) to the mass of an equal volume of gas-free distilled water at a stated temperature.

Bulk Specific Gravity (SSD) (G_{sb} SSD) – the ratio of the mass, in air, of a volume of aggregate, including the mass of water within the voids filled to the extent achieved by submerging in water for approximately 15 hours (but not including the voids between particles), to the mass of an equal volume of gas-free distilled water at a stated temperature.

Apparent Specific Gravity (G_{sa}) – the ratio of the mass, in air, of a volume of the impermeable portion of aggregate to the mass of an equal volume of gas-free distilled water at a stated temperature.



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Moisture conditions

Definition: (Specific Gravity Symbols)

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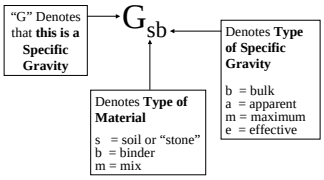

07 Absorption – the increase in the mass of aggregate due to water being absorbed into the pores of the material, but not including water adhering to the outside surface of the particles, expressed as a percentage of the dry mass. The aggregate is considered "dry" when it has been maintained at a temperature of 230 ±9°F for sufficient time to remove all uncombined water.

Apparatus

Sample container and scale

08 • Balance or scale: Sufficient capacity for the principal sample mass, sensitive to 1 g., meeting the requirements of AASHTO M 231.

09 • Sample container: Wire basket of No. 6 or smaller mesh, with a capacity of 1 to 2 gal to contain aggregate with a nominal maximum size of 1½ in. or smaller; larger basket for larger aggregates.

- Water tank: Watertight and large enough to completely immerse aggregate and basket, equipped with an overflow valve to keep water level constant.
- Suspension apparatus: Wire used to suspend apparatus shall be of smallest practical diameter.
- Sieves: No. 4, or other sizes as needed, conforming to AASHTO M 92.

Sample Preparation

10 1. Obtain the sample in accordance with the FOP for AASHTO T 2 (see Note 1).
2. Mix the sample thoroughly and reduce it in accordance with the FOP for AASHTO T 248.
3. Reject all material passing the appropriate sieve by dry sieving and thoroughly washing to remove dust or other coatings from the surface. The minimum mass is given in Table 1.

Note 1: If this procedure is used only to determine the G_{sb} of oversized material for the FOP for AASHTO T 99 or T 180 and in the calculations for the FOP for AASHTO T 224, the material can be rejected over the appropriate sieve (T 99 / T 180 methods A & B the No.4; T 99 / T 180 methods C & D the 3/4 in.).

11 **Table 1**

Nominal Maximum Size*, (in.)	Minimum Mass of Test Sample, g (lb)
1/2" or less	2000 (4.4)
3/4"	3000 (6.6)
1”	4000 (8.8)
1½”	5000 (11)
2”	8000 (18)
2½”	12,000 (26)
3”	18,000 (40)

***** One sieve larger than the first sieve to retain more than 10 percent of the material using an agency specified set of sieves based on cumulative percent retained. Where large gaps in specification sieves exist, intermediate sieve(s) may be inserted to determine nominal maximum size.

Procedure

12 1. Dry the test sample to constant mass at a temperature of 230 ±9°F and cool in air at room temperature for 1 to 3 hours.

Note 2: Where the absorption and specific gravity values are to be used in proportioning concrete mixtures in which the aggregates will be in their naturally moist condition, the requirement for initial drying to constant mass may be eliminated; and, if the surfaces of the particles in the sample have been kept continuously wet until test, the 15-hour soaking may also be eliminated.

2. Immerse the aggregate in water at room temperature for a period of 15 to 19 hours.

Note 3: When testing coarse aggregate of large nominal maximum size requiring large test samples, it may be more convenient to perform the test on two or more subsamples, and then combine values obtained.

3. Place the empty basket into the water bath and attach to the balance. Inspect the immersion tank to insure the water level is at the overflow outlet height. Tare the balance with the empty basket attached in the water bath, and with an empty pan on the balance.

4. Remove the test sample from the water and roll it in a large absorbent cloth until all visible films of water are removed. Wipe the larger particles individually.

13

Submerged container

Note 4: A moving stream of air may be used to assist in the drying operation, but take care to avoid evaporation of water from aggregate pores.

5. Determine the SSD mass of the sample, and record this and all subsequent masses to the nearest 0.1 g or 0.1 percent of the sample mass, whichever is greater. Designate this mass as "B"
6. Re-inspect the immersion tank to insure the water level is at the overflow outlet height. Immediately place the SSD test sample in the sample container and weigh it in water maintained at 73.4 ±3°F. Shake the container to release entrapped air before recording the weight. Designate this submerged weight as "C"

Note 5: The container should be immersed to a depth sufficient to cover it and the test sample during mass determination. Wire suspending the container should be of the smallest practical size to minimize any possible effects of a variable immersed length.

7. Remove the sample from the basket. Ensure all material has been removed and place in a container of known mass.
8. Dry the test sample to constant mass in accordance with the FOP for AASHTO T 255/T 265 (Aggregate) and cool in air at room temperature for 1 to 3 hours. Designate this mass as "A"

Calculations

Perform calculations and determine values using the appropriate formula below. In these formulas, A = oven dry mass, B = SSD mass, and C = weight in water.

Bulk specific gravity, G_{sb}(OD)

$$G_{sb}(OD) = \frac{A}{B - C} \quad (14)$$

Bulk specific gravity SSD, G_{sb}(SSD)

$$G_{sb}(SSD) = \frac{B}{B - C} \quad (15)$$

Apparent specific gravity, G_{sa}

$$G_{sa} = \frac{A}{A - C} \quad (16)$$

Absorption %

$$\text{Absorption} = \frac{B - A}{A} \times 100 \quad (17)$$

Sample Calculations

Sample	A	B	C	B - C	A - C	B - A
1	2030.9	2044.9	1304.3	740.6	726.6	14.0

2	1820.0	1832.5	1168.1	664.4	651.9	12.5
3	2035.2	2049.4	1303.9	745.5	731.3	14.2

Sample	G_{sb}(OD)	G_{sb}(SSD)	G_{sa}	Absorption	Reported
1	2.742	2.761	2.795	0.689	0.7
2	2.739	2.758	2.792	0.687	0.7
3	2.730	2.749	2.783	0.698	0.7
Average	2.737	2.756	2.790	0.691	0.7

These calculations demonstrate the relationship between G_{sb}(OD), G_{sb}(SSD), and G_{sa}. G_{sb}(OD) is always lowest, since the volume includes voids permeable to water. G_{sb}(SSD) is always intermediate. G_{sa} is always highest, since the volume does not include voids permeable to water. When running this test, check to make sure the values calculated make sense in relation to one another.

18

Report

- Results shall be reported on standard forms approved by the agency.
- Report specific gravity values to 3 decimal places.
- Report absorption to 0.1 percent.

19

Tips!

- Shake the container and sample when weighing in water to release entrapped air.
- Compare G_{sb}(OD), G_{sb}(SSD), and G_{sa} to see if they make sense.

REVIEW QUESTIONS

1. What size sample is required for aggregate with a nominal maximum size of 1 in.?

2. When is soaking required? For how long must material be soaked?

3. When, in the process, are dry and SSD masses determined?

PERFORMANCE EXAM CHECKLIST

SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE FOP FOR AASHTO T 85

Participant Name _____ Exam Date _____

Record the symbols "P" for passing or "F" for failing on each step of the checklist.

Procedure Element	Trial 1	Trial 2
1. Sample obtained by FOP for AASHTO T 2 and reduced by FOP for AASHTO T 248 or from FOP for AASHTO T 99 / T 180?	_____	_____
2. Screened on the appropriate size sieve?	_____	_____
3. Sample mass appropriate?	_____	_____
4. Particle surfaces clean?	_____	_____
5. Dried to constant mass 230 ±9°F and cooled to room temperature?	_____	_____
6. Covered with water for 15 to 19 hours?	_____	_____
7. Basket placed into immersion tank and attached to balance?	_____	_____
8. Immersion tank inspected for proper water height?	_____	_____
9. Balance tared with basket in tank and temperature checked 73.4 ±3°F?	_____	_____
10. Sample removed from water and rolled in cloth to remove visible films of water?	_____	_____
11. Larger particles wiped individually?	_____	_____
12. Evaporation avoided?	_____	_____
13. Sample mass determined to 0.1 g?	_____	_____
14. Sample immediately placed in basket, in immersion tank?	_____	_____
15. Entrapped air removed before weighing by shaking basket while immersed?	_____	_____
16. Immersed sample weight determined to 0.1 g?	_____	_____
17. All the sample removed from basket?	_____	_____
18. Sample dried to constant mass and cooled to room temperature?	_____	_____

OVER

Procedure Element	**Trial 1**	**Trial 2**
19. Sample mass determined to 0.1 g?	_____	_____
20. Proper formulas used in calculations?	_____	_____

Comments: First attempt: Pass ☐ Fail ☐ Second attempt: Pass ☐ Fail ☐

_____
_____
_____
_____
_____
_____

Examiner Signature _____WAQTC #:_____