

## **SPECIFIC GRAVITY AND ABSORPTION OF COARSE AGGREGATE FOP FOR AASHTO T 85 (09)**

### **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 ( $G_{sb}$ ), bulk specific gravity, saturated surface dry ( $G_{sb}$  SSD), or apparent specific gravity ( $G_{sa}$ ).  $G_{sb}$  and absorption are based on aggregate after soaking in water. This procedure is not intended to be used with lightweight aggregates.

### **Terminology**

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  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ) for sufficient time to remove all uncombined water.

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.

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.

Bulk Specific Gravity ( $G_{sb}$ )– the ratio of the 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 15 to 19 hours (but not including the voids between particles), to the mass of an equal volume of gas-free distilled water at a stated temperature.

### **Apparatus**

- Balance or scale: with a capacity of 5 kg, sensitive to 1 g. Meeting the requirements of AASHTO M 231.
- Sample container: a wire basket of 3.35 mm (No. 6) or smaller mesh, with a capacity of 4 to 7 L (1 to 2 gal) to contain aggregate with a nominal maximum size of 37.5 mm (1 1/2 in.) or smaller; and/or a 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 the smallest practical diameter.

- Sieves 4.75 mm (No. 4) or other sizes as needed, conforming to AASHTO M 92.
- Large absorbent towel

**Sample Preparation**

1. Obtain the sample in accordance with the FOP for AASHTO T 2 (see Note 1).
2. Mix the sample thoroughly and reduce it to the approximate sample size required by Table 1 in accordance with the FOP for AASHTO T 248.
3. Reject all material passing the appropriate sieve by dry sieving.
4. Thoroughly wash sample to remove dust or other coatings from the surface and re-screen the washed dry sample over the appropriate sieve. Reject all material passing that sieve.
5. The sample shall meet or exceed the minimum mass given in Table 1.

*Note 1:* If this procedure is used only to determine the Bulk  $G_{sb}$  of oversized material for the FOP for AASHTO T 99 / T 180 and in the calculations for the FOP for AASHTO T 224, the material can be rejected over the appropriate sieve. For T 99 / T 180 Methods A & B, use the 4.75 mm (No.4) sieve; T 99 / T 180 Methods C & D use the 19 mm (3/4 in).

**Table 1**

Nominal Maximum Size mm (in.)	Minimum Mass of Test Sample, g (lb)
12.5 (1/2) or less	2000 (4.4)
19.0 (3/4)	3000 (6.6)
25.0 (1)	4000 (8.8)
37.5 (1 1/2)	5000 (11)
50 (2)	8000 (18)
63 (2 1/2)	12,000 (26)
75 (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**

1. Dry the test sample to constant mass at a temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ) 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-to-19 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 the values obtained.

3. Place the empty basket into the water bath and attach to the balance. Inspect the immersion tank to ensure the water level is at the overflow outlet height. Tare the balance with the empty basket attached in the water bath.
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.  
*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  $23.0 \pm 1.7^{\circ}\text{C}$  ( $73.4 \pm 3^{\circ}\text{F}$ ). 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. 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 section) 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 ( $G_{sb}$ )

$$G_{sb} = A / (B - C)$$

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

$$G_{sb} \text{ SSD} = B / (B - C)$$

Apparent specific gravity ( $G_{sa}$ )

$$G_{sa} = A / (A - C)$$

Absorption

$$\text{Absorption} = [(B - A) / A] \times 100$$

**Sample Calculations**

<b>Sample</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>B - C</b>	<b>A - C</b>	<b>B - A</b>
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

<b>Sample</b>	<b>G<sub>sb</sub></b>	<b>G<sub>sb</sub> SSD</b>	<b>G<sub>sa</sub></b>	<b>Absorption</b>	<b>Reported</b>
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  $G_{sb}$ ,  $G_{sb}$  SSD, and  $G_{sa}$ .  $G_{sb}$  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.

**Report**

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

**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.**

<b>Procedure Element</b>	<b>Trial 1</b>	<b>Trial 2</b>
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 $110 \pm 5^{\circ}\text{C}$ ( $230 \pm 9^{\circ}\text{F}$ ) 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 $23.0 \pm 1.7^{\circ}\text{C}$ ( $73.4 \pm 3^{\circ}\text{F}$ )?	_____	_____
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?

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20. Proper formulas used in calculations?

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

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Examiner Signature \_\_\_\_\_ WAQTC #: \_\_\_\_\_