

**RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE**

LS-604 R33/C127-15/T85-14(2018)

**3. DEFINITION**

3.1 Coarse aggregate: For the purpose of this test, coarse aggregate is all aggregate material retained on the 4.75 mm sieve..... \_\_\_\_\_

**4. PROCEDURE**

4.1 Procedures of ASTM C127 (concrete aggregate) and AASHTO T 85 (asphalt aggregate) shall be followed, except as noted below, for the determination of relative density at 23°C and absorption of coarse aggregate..... \_\_\_\_\_  
 When the amount of material passing the 4.75 mm sieve in coarse aggregate exceeds 5% by mass of the sample, the fraction passing the 4.75 mm sieve shall be tested in LS-605..... \_\_\_\_\_

**5. EXCEPTIONS**

**5.1 Individual coarse aggregates for hot mix asphalt mixture design process.**

- 5.1.1 Obtain two representative sub-sample of approximately 3000 g of oven-dried coarse aggregate by use of a sample splitter or by quartering..... \_\_\_\_\_
- 5.1.2 Remove all material finer than 4.75 mm by dry sieving..... \_\_\_\_\_  
 Remove all dust or other coatings by thorough washing. In the case of RAP, use a wetting agent \_\_\_\_\_
- 5.1.3 Saturate the samples in water by immersion for 15-19 hours..... \_\_\_\_\_
- 5.1.4 Test the 2 sub-samples..... \_\_\_\_\_
- 5.1.5 If duplicate tests of relative density differ by more than 0.020, the material shall be retested \_\_\_\_\_
- 5.1.6 If duplicate tests of absorption differ by more than 0.20%, the material shall be retested.... \_\_\_\_\_

**5.2 Blended coarse aggregates for hot mix asphalt mixture design process (Note 1).**

- 5.2.1 Prepare two 3-kg sub-samples and perform the test on each. Sample preparation for hot mix asphalt coarse aggregates shall follow LS-600 Part B..... \_\_\_\_\_  
Note 1: Testing of blended coarse aggregates components is carried out only when specified by the owner..... \_\_\_\_\_
- 5.2.2 If duplicate tests of relative density differ by more than 0.020, the material shall be retested \_\_\_\_\_
- 5.2.3 If duplicate tests of absorption differ by more than 0.20%, the material shall be retested.... \_\_\_\_\_

**5.3 Coarse aggregates extracted from RAP for both Marshall and Superpave mix design.**

- 5.3.1 Obtain a sample of RAP following LS-312..... \_\_\_\_\_
- 5.3.2 Remove the asphalt from the RAP, wash and oven-dry the extracted aggregates according to LS-282..... \_\_\_\_\_
- 5.3.3 Separate the extracted aggregates on a 4.75 mm sieve into coarse and fine aggregate fractions. Do not sieve so thoroughly as to significantly change the shape of the aggregate particles..... \_\_\_\_\_  
 Determine the density of the fine aggregate following LS-605, and density and absorption of coarse aggregate following 4.1..... \_\_\_\_\_

**5.4 Combinations of virgin coarse aggregate and RAP for Marshall mix design process.**

- 5.4.1 Determine the density of the coarse aggregate extracted from the RAP using duplicate samples..... \_\_\_\_\_

**RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE**

LS-604 R33/C127-15/T85-14(2018)

Calculate the density of the coarse aggregate in the asphalt mixture by using a calculation based on the density of the virgin coarse aggregate determined following 5.1 or 5.2 and the density of the RAP coarse aggregate..... \_\_\_\_\_

The calculation shall be based on the mass proportions of virgin coarse aggregate to the mass proportion of coarse aggregate contributed to the mixture by the RAP after subtracting the amount of asphalt contributed by the RAP..... \_\_\_\_\_

**5.5 Combinations of virgin coarse aggregate and RAP for Superpave mix design process.**

5.5.1 Mix the coarse aggregate, following extraction, with virgin coarse aggregate in the mass proportions in which the materials will be used in the mixture design, according to LS-600 Part B \_\_\_\_\_  
 Determine the density and absorption on duplicate samples of the combination following 4.1.... \_\_\_\_\_

**5.6 Coarse aggregate which have been previously treated with a hydrated lime anti-stripping agent.**

5.6.1 Obtain and test samples prior to the addition of hydrated lime when both the coarse and the fine aggregate have been treated (Note 2). If only the coarse aggregate has been treated, samples may be obtained after treatment but must be thoroughly washed prior to testing..... \_\_\_\_\_

Note 2: Hydrated lime cannot be completely removed by washing even with wetting agents. The presence of lime gives fine aggregates lower BRD and higher absorption values. For this reason, testing should be conducted prior to the addition of lime. Coarse aggregate density and absorption values are not significantly affected by the presence of hydrated lime and, in this case, may be obtained after addition of lime, but it is preferable to obtain samples prior to addition of lime if at all possible.. \_\_\_\_\_

**6. USE OF LABORATORY CONTROL AGGREGATE**

6.1 Every ten samples, but at least every week in which a sample is tested, a sample of the standard reference aggregate shall also be tested..... \_\_\_\_\_

Material shall be taken from a stock supply of Stoney Lake Brothers Quarry stone maintained by the Soils and Aggregates Section, Ministry of Transportation, 145 Sir William Hearst Avenue, Toronto, Ontario M3M 0B6, Email [Soils-Aggregates@ontario.ca](mailto:Soils-Aggregates@ontario.ca), Tel (416) 235-3698 and Fax (416) 235-4101 \_\_\_\_\_

Only the material retained 4.75 mm and coarser shall be tested..... \_\_\_\_\_

It is permissible to re-use the reference material provided it does not degrade due to multiple wetting and drying cycles..... \_\_\_\_\_

6.2 Control Chart Use: The relative density and absorption of the last twenty samples of reference material shall be plotted on a control chart in order to monitor the performance of the laboratory \_\_\_\_\_

6.3 The mean absorption of the Drain Brothers Stoney Lake Quarry standard reference aggregate is 0.39% (MERO-036) ..... \_\_\_\_\_

Individual test data should not normally be greater than 0.49% or less than 0.29%..... \_\_\_\_\_

6.3.1 The mean relative density (oven-dry) of the Drain Brothers Stoney Lake Quarry standard reference aggregate is 2.690..... \_\_\_\_\_

Individual test data should not normally be greater than 2.699 or less than 2.681..... \_\_\_\_\_

## RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE

LS-604 R33/C127-15/T85-14(2018)

### ASTM C127 (Concrete Aggregate)

#### 6. Apparatus

6.1 Balance—A device for determining mass that is sensitive, readable, and accurate to 0.05 % of the sample mass at any point within the range used for this test, or 0.5 g, whichever is greater..... \_\_\_\_\_

The balance shall be equipped with suitable apparatus for suspending the sample container in water from the center of the platform or pan of the balance..... \_\_\_\_\_

6.2 Sample Container—A wire basket of 3.35mm (No.6) or finer mesh, or a bucket of approximately equal breadth and height, with a capacity of 4 to 7 L for 37.5-mm (1 1/2-in.) nominal maximum size aggregate or smaller, and a larger container as needed for testing larger maximum size aggregate\_\_\_\_\_

The container shall be constructed so as to prevent trapping air when the container is submerged\_\_\_\_\_

6.3 Water Tank—A watertight tank into which the sample container is placed while suspended below the balance..... \_\_\_\_\_

6.4 Sieves—A 4.75-mm (No. 4) sieve or other sizes as needed (see 7.2 – 7.4), conforming to Specification E11..... \_\_\_\_\_

6.5 Oven—An oven of sufficient size, capable of maintaining a uniform temperature of  $110 \pm 5$  °C ( $230 \pm 9$  °F) ..... \_\_\_\_\_

#### 7. Sampling

7.1 Sample the aggregate in accordance with Practice D75..... \_\_\_\_\_

7.2 Thoroughly mix the sample of aggregate and reduce it to the approximate quantity needed using the applicable procedures in Practice C702..... \_\_\_\_\_

Reject all material passing a 4.75-mm (No. 4) sieve by dry sieving and thoroughly washing to remove dust or other coatings from the surface..... \_\_\_\_\_

If the coarse aggregate contains a substantial quantity of material finer than the 4.75-mm sieve (such as for Size No. 8 and 9 aggregates in Classification D448), use the 2.36-mm (No. 8) sieve in place of the 4.75-mm sieve. Alternatively, separate the material finer than the 4.75-mm sieve and test the finer material according to Test Method C128..... \_\_\_\_\_

NOTE 1—If aggregates smaller than 4.75 mm (No. 4) are used in the sample, check to ensure that the size of the openings in the sample container is smaller than the minimum size aggregate..... \_\_\_\_\_

7.3 The minimum mass of test sample to be used is given as follows..... \_\_\_\_\_

Testing the coarse aggregate in several size fractions is permitted..... \_\_\_\_\_

If the sample contains more than 15 % retained on the 37.5-mm (1 1/2-in.) sieve, test the material larger than 37.5 mm in one or more size fractions separately from the smaller size fractions..... \_\_\_\_\_

When an aggregate is tested in separate size fractions, the minimum mass of test sample for each fraction shall be the difference between the masses prescribed for the maximum and minimum sizes of the fraction..... \_\_\_\_\_

## RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE

LS-604 R33/C127-15/T85-14(2018)

Nominal Maximum Size, mm (in.)	Minimum Mass of Test Sample, kg (lb)
12.5 (1/2) or less	2 (4.4)
19.0 (3/4)	3 (6.6)
25.0 (1)	4 (8.8)
37.5 (1 1/2)	5 (11)
50 (2)	8 (18)
63 (2 1/2)	12 (26)
75 (3)	18 (40)
90 (3 1/2)	25 (55)
100 (4)	40 (88)
125 (5)	75 (165)

7.4 If the sample is tested in two or more size fractions, determine the grading of the sample in accordance with Test Method C136, including the sieves used for separating the size fractions for the determinations in this method..... \_\_\_\_\_

In calculating the percentage of material in each size fraction, ignore the quantity of material finer than the 4.75-mm (No. 4) sieve (or 2.36-mm (No. 8) sieve when that sieve is used in accordance with 7.2) .....

NOTE 2—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 the values obtained combined for the computations described in Section 9..... \_\_\_\_\_

### 8. Procedure

8.1 Dry the test sample in the oven to constant mass at a temperature of  $110 \pm 5$  °C..... \_\_\_\_\_  
 Cool in air at room temperature for 1 to 3 h for test samples of 37.5-mm (1 1/2-in.) nominal maximum size, or longer for larger sizes until the aggregate has cooled to a temperature that is comfortable to handle (approximately 50 °C) .....

Subsequently immerse the aggregate in water at room temperature for a period of  $24 \pm 4$  h..... \_\_\_\_\_  
 When Specification C330 or Specification C332 Group II lightweight aggregates are used, immerse the aggregate in water at room temperature for a period of  $72 \pm 4$  h, stirring for at least one minute every 24 h..... \_\_\_\_\_

8.2 When the absorption and relative density (specific gravity) values are to be used in proportioning concrete mixtures in which the aggregates will be in their naturally moist condition, the requirement in 8.1 for initial drying is optional..... \_\_\_\_\_

And, if the surfaces of the particles in the sample have been kept continuously wet until tested, the requirement in 8.1 for  $24 \pm 4$  h or  $72 \pm 4$  h soaking is also optional..... \_\_\_\_\_

NOTE 3—Values for absorption and relative density (specific gravity) (SSD) may be significantly higher for aggregate not oven dried before soaking than for the same aggregate treated in accordance with 8.1. This is especially true of particles larger than 75 mm since the water may not be able to penetrate the pores to the center of the particle in the prescribed soaking period..... \_\_\_\_\_

## RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE

LS-604 R33/C127-15/T85-14(2018)

- 8.3 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..... \_\_\_\_\_
- A moving stream of air is permitted to assist in the drying operation..... \_\_\_\_\_
- Take care to avoid evaporation of water from aggregate pores during the surface-drying operation \_\_\_\_\_
- Determine the mass of the test sample in the saturated surface-dry condition..... \_\_\_\_\_
- Record this and all subsequent masses to the nearest 0.5 g or 0.05 % of the sample mass, whichever is greater..... \_\_\_\_\_
- 8.4 After determining the mass in air, immediately place the saturated-surface-dry test sample in the sample container and determine its apparent mass in water at  $23 \pm 2.0$  °C..... \_\_\_\_\_
- Take care to remove all entrapped air before determining its mass by shaking the container while immersed..... \_\_\_\_\_
- NOTE 4—The difference between the mass in air and the mass when the sample is submerged in water equals the mass of water displaced by the sample..... \_\_\_\_\_
- NOTE 5—The container should be immersed to a depth sufficient to cover it and the test sample while determining the apparent mass in water. Wire suspending the container should be of the smallest practical size to minimize any possible effects of a variable immersed length..... \_\_\_\_\_
- 8.5 Dry the test sample in the oven to constant mass at a temperature of  $110 \pm 5$  °C..... \_\_\_\_\_
- Cool in air at room temperature 1 to 3 h, or until the aggregate has cooled to a temperature that is comfortable to handle (approximately 50 °C), and determine the mass..... \_\_\_\_\_

### 9. Calculations

9.1 Relative Density (Specific Gravity):

9.1.1 Relative Density (Specific Gravity) (OD)—Calculate the relative density (specific gravity) on the basis of oven-dry aggregate as follows: .....

$$\text{Relative density (specific gravity) (OD)} = A/(B - C) \quad (1)$$

where:

A = mass of oven-dry test sample in air, g,

B = mass of saturated-surface-dry test sample in air, g, and

C = apparent mass of saturated test sample in water, g.

9.1.2 Relative Density (Specific Gravity) (SSD)—Calculate the relative density (specific gravity) on the basis of saturated surface-dry aggregate as follows: .....

$$\text{Relative density (specific gravity) (SSD)} = B/(B - C) \quad (2)$$

9.1.3 Apparent Relative Density (Specific Gravity)— Calculate the apparent relative density (specific gravity) as follows: .....

$$\text{Apparent relative density (specific gravity)} = A/(A - C) \quad (3)$$

## RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE

LS-604 R33/C127-15/T85-14(2018)

9.2 Average Relative Density (Specific Gravity) Values—If the sample is tested in separate size fractions, compute the average values for relative density (specific gravity) of the size fraction computed in accordance with 9.1 using the following equation: .....

$$G = \frac{1}{\frac{P_1}{100 G_1} + \frac{P_2}{100 G_2} + \dots + \frac{P_n}{100 G_n}} \quad \text{(see Appendix X1)} \quad (4)$$

where:

G = average relative density (specific gravity). All forms of expression of relative density (specific gravity) can be averaged in this manner,  
 G<sub>1</sub>, G<sub>2</sub> ... G<sub>n</sub> = appropriate average relative density (specific gravity) values for each size fraction depending on the type of relative density (specific gravity) being averaged, and  
 P<sub>1</sub>, P<sub>2</sub>, ... P<sub>n</sub> = mass percentages of each size fraction present in the original sample (not including finer material—see 7.4).

9.3 Absorption—Calculate the percentage of absorption, as follows: .....

$$\text{Absorption, \%} = [(B - A)/A] \times 100 \quad (5)$$

9.4 Average Absorption Value—If the sample is tested in separate size fractions, the average absorption value is the average of the values as computed in 9.3, weighted in proportion to the mass percentages of each size fraction present in the original sample (not including finer material—see 7.4) as follows: \_\_\_\_\_

$$A = (P_1 A_1 / 100) + (P_2 A_2 / 100) + \dots + (P_n A_n / 100) \quad (6)$$

where:

A = average absorption, %,  
 A<sub>1</sub>, A<sub>2</sub> ... A<sub>n</sub> = absorption percentages for each size fraction, and  
 P<sub>1</sub>, P<sub>2</sub>, ... P<sub>n</sub> = mass percentages of each size fraction present in the original sample.

### AASHTO T 85 (Asphalt Aggregate)

#### 6. APPARATUS

Note: Very similar to ASTM C127 with the addition of AASHTO test designations instead of ASTM test designations.....

#### 7. SAMPLING

Note: Very similar to ASTM C127 with the addition of AASHTO test designations instead of ASTM test designations.....

#### 8. PROCEDURE

8.1 Note: Very similar to ASTM C127 with the following exception.  
 Subsequently immerse the aggregate in water at room temperature for a period of 15 ± 19 h.....

**Note 1** – See ASTM NOTE 2.....

**RELATIVE DENSITY AND ABSORPTION OF COARSE AGGREGATE**

LS-604 R33/C127-15/T85-14(2018)

- 8.2 Note: Very similar to ASTM C127..... \_\_\_\_\_
- 8.3 Note: Very similar to ASTM C127 with the following exception..... \_\_\_\_\_  
 If the test sample dries past the SSD condition, immerse in water for 30 min, then resume the process of surface-drying. .... \_\_\_\_\_
- Determine the mass of the test sample in the saturated surface-dry condition..... \_\_\_\_\_
- Record this and all subsequent masses to the nearest 1.0 g or 0.1 % of the sample mass, whichever is greater..... \_\_\_\_\_
- 8.4 Note: Very similar to ASTM C127 with the following exception..... \_\_\_\_\_  
 After determining the mass in air, immediately place the saturated-surface-dry test sample in the sample container and determine its apparent mass in water at  $23 \pm 1.7$  °C ( $73.4 \pm 3$  °F), having a density of  $997 \pm 2$  kg/m<sup>3</sup>..... \_\_\_\_\_
- 8.5 Note: Very similar to ASTM C127..... \_\_\_\_\_

**9. CALCULATIONS**

Section 9 Note: Very similar to ASTM C127..... \_\_\_\_\_

**LS 7. REPORT**

The report shall include the following:

- 7.1 If duplicate tests of absorption and relative density are made, the mean of the results shall be reported as the final "test result"..... \_\_\_\_\_
- 7.2 If more than one aggregate is tested, report the density and absorption of each and the weighted average of the combination..... \_\_\_\_\_
- 7.3 The percent absorption to the nearest 0.01%, and relative densities to the nearest 0.001 of the reference sample, tested closest to the time at which the aggregate sample was tested..... \_\_\_\_\_
- 7.4 The percent absorption and relative density of the last 20 samples of reference material on control charts..... \_\_\_\_\_

**ASTM 10. Report**

- 10.1 Report relative density (specific gravity) results to the nearest 0.01 and indicate the basis for relative density (specific gravity) as either (OD), (SSD), or apparent..... \_\_\_\_\_
- 10.2 Report the absorption result to the nearest 0.1 %..... \_\_\_\_\_
- 10.3 If the relative density (specific gravity) and absorption values were determined without first drying the aggregate, as permitted in 8.2, note that fact in the report..... \_\_\_\_\_

**AASHTO 10. Report**

- 10.1. Report specific gravity results to the nearest 0.001 (Coarse Aggregate meeting M 80 requirements may be reported to the nearest 0.01), and indicate the type of specific gravity, whether bulk, bulk (saturated surface-dry), or apparent..... \_\_\_\_\_
- 10.2. & 10.3. Very similar to ASTM C127..... \_\_\_\_\_

**COMMENTS**