INDIANA DEPARTMENT OF TRANSPORTATION
Division of Materials and Tests

Directive 306

Specific Gravity of Fine Aggregate from Extracted Samples

This directive details the procedure INDOT labs and INDOT's consultants will use to determine fine aggregate specific gravity and absorption of an extracted sample. This method adds detail to AASHTO T 84 to promote uniformity of method. The procedure in this Directive is in compliance with T 84.

Apparatus

Balance, conforming to the requirements of M 231, Class G 2

Flask, Two plastic or glass volumetric flasks of 500 mL capacity. DO NOT USE a fruit jar, Le Chatelier flask, or other sizes of volumetric flask. (Figure 1)

Figure 1: Plastic 500mL volumetric flask

Cone Mold, A metal mold in the form of a frustum of a cone with dimensions as follows: 40 ± 3 mm inside diameter at the top, 90 ± 3 mm inside diameter at the bottom, and 75 ± 3 mm in height, with the metal having a minimum thickness of 0.8 mm. (Figure 2)

Tamper, A metal tamper having a mass of 340 ± 15 g and having a flat circular tamping face 25 ± 3 mm in diameter. (Figure 2)

Figure 2: Cone Mold and Tamper

Fine aggregate splitter, in accordance with AASHTO R 76. (Figure 3)

Figure 3: Fine Aggregate Splitter

Flat, non-absorbent pan, and two smaller pans. (Figures 4 and 5)

Figure 4: Flat, non-absorbent pan

Figure 5: Two smaller pans

Small space heater, similar to type shown in Figure 6.

Figure 6: Small heater

Brush, Figure 7.

Figure 7: Brush

Funnel, Figure 8.

Figure 8: Funnel

Trowel, Figure 9.

Figure 9: Trowel

Squeeze bottle, Figure 10.

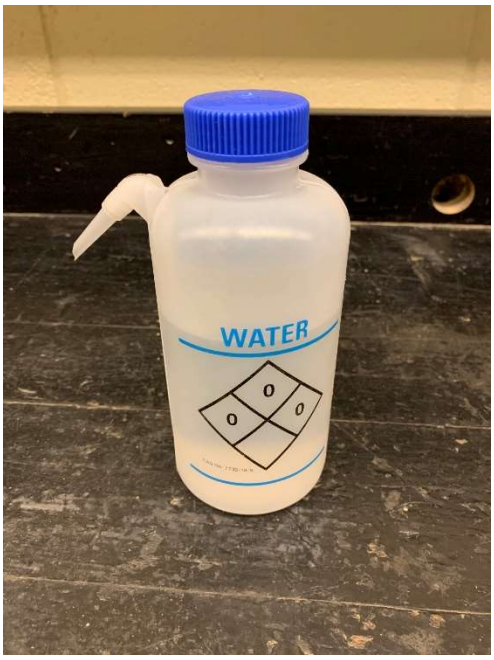


Figure 10: Squeeze Bottle

#200 sieve, Figure 11.

Figure 11: #200 Sieve

Thermometer, readable to 0.1 °F. (Figure 12)

Figure 12: Thermometer

Sample Preparation

1. Perform a gradation analysis by AASHTO T 27 or T 30, and retain all material passing the #4 sieve.

2. Combine and blend the fine aggregate.

3. Reduce the fine aggregate in accordance with AASHTO R 76, Method A. This method requires the use of a fine aggregate splitter (Figure 3). Obtain a weight of approximately 1200g ± 100g.

Soaking Procedure

1. Place the entire 1200 g ± 100g sample in a flat, nonabsorbent pan.

2. Cover the sample with water to at least 1 inch above the sample.

3. Immediately after submerging the sample, stir the sample for several minutes to ensure total saturation. The sample should look completely "wet" after stirring. There may be some "floaters" on top of the water. (Figure 13)

Figure 13: Submerged sample after manual agitation (left) and floaters (right)

4. Allow the sample to soak for 15 to 19 hours.

5. After the soaking period, pour the excess water over a #200 sieve with care to avoid loss of fines.

6. Rinse the fines and foam retained on the #200 sieve back into the pan with the sample.

Achieving SSD

- The purpose of this section is to use slow, uniform drying to bring the sample to a saturated, surface dry (SSD) condition. In this condition, moisture fills the pores of each particle while the surface of the particle is dry. If non-uniform drying occurs, errors in testing will result.

1. Place the sample and large pan in front of the small heater (Figure 14). Use an empty small bread loaf pan upside down under one end of the large pan to assist in even drying of the sample.

Figure 14: Sample and pan in front of small heater

2. Periodically stir the sample in the pan and rotate the pan 180° to assist in homogenous drying of the sample

3. Continue this process until the test specimen reaches a free-flowing condition. If the sample is able to compact into your hand, the sample has not yet reached free-flowing condition.

4. The sample is now ready to continue to the cone test.

Cone Test

- The surface for this test shall be a flat, level, stable area free from vibration or gusts of air. If at any point during the cone test, the surface is vibrated or impacted, the test shall be restarted.

- The first cone test must be made with some surface moisture remaining in the sample allowing it to retain its molded shape (fails to slump).

1. Using your hand, hold the cone firmly with the large diameter resting on the pan. Using your other hand, begin filling the cone with the sample. Continue filling until the cone is overflowing. The cone shall be held throughout the cone test.

2. Starting at the level of the top of the fine aggregate, drop the tamper a total of 5 mm (0.2 inches) in the small opening of the cone mold (Figure 15)

Figure 15: Tamping in a circular motion

3. Continue dropping the tamper in the same manner in a circular pattern until 25 drops of the tamper have been completed. Adjust the starting height of each drop to the current surface elevation of the fine aggregate. The tamper shall be kept vertical throughout the process.

4. Remove excess fine aggregate from the base of the cone. This may be achieved using your hand or a brush. Continue holding the cone with one hand throughout this process, and take care to not impact the cone with the brush or your hand. (Figure 16)

Figure 16: Excess aggregate brushed from the base

5. Lift the cone vertically from the pan and set aside. Do not tap or strike the pan.

6. If surface moisture is still present, the sample will retain its molded shape (Figure 17). Return to Step 1 of Cone Test.
Tip: If the sample has retained its molded shape, the technician may tap the pan to determine how close the sample is to partial slump. The cone test may be restarted immediately if partial slump appears imminent.

Figure 17: Sample retaining its molded shape

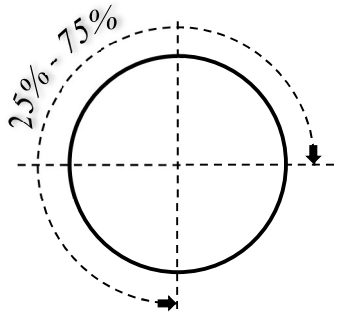
7. If a small portion of the fine aggregate falls out of its molded condition (*known as partial slump*), the test is complete and the SSD condition is achieved (Figure 18).

Mandatory Information: If the first cone test displays partial slump, or if any cone test displays total slump, the sample has been dried past the SSD condition. If this occurs, thoroughly mix 2-4 mL of water with the fine aggregate and cover

the sample pan with another pan for 30±1 minutes. Return to Step 1 of cone test.

Figure 18: Sample displaying partial slump

Tip: Partial slump occurs when 25% - 75% of the top diameter of the cone "falls", moves, or is otherwise disturbed after lifting the cone. Any less than that is not considered partial slump, and any more than that is considered total slump.



Tip: Partial slump is not typically an "apple core" or "dime size" area remaining in the center. This is typically considered total slump. However, these can be considered partial slump if they occur immediately (within a minute or two) after a test where the sample retained its molded shape. All fine aggregate samples are different and slumps can be different from sample to sample. A complete "pancake" of the sample is always considered total slump.

Determining Bulk Specific Gravity

Once partial slump has been achieved in the previous section, immediately prepare two fine aggregate samples for testing as follows:

1. Using a trowel, measure 500.0 ± 1.0 g of the sample into a small bread pan. Ensure a homogenous blend of the sample is represented in the 500g of material. Repeat for a second pan. ***Record as S***
   Tip: The use of your fingers for "pinches" of material is acceptable to reach the prescribed weight.

2. Partially fill each flask with approximately an inch of water.

3. Place one flask in a large pan and add the first 500.0 g sample ("Sample 1") using a funnel. Repeat for second sample ("Sample 2").

4. Inspect the pan and funnel for any material that did not go into the flask. Ensure that any material that did not make it into the flask is added. Tap the funnel or the pan, or use a small brush to add any remaining material to the flask.

5. Add additional water to approximately halfway between the calibration line and the bottom of the neck of the flask.

6. Shake, twist, or otherwise agitate the flask by hand until all air bubbles are released. Do not invert the flask. This may reintroduce air bubbles in to the sample.
   Tip: This may take longer than 15-20 minutes.

7. If at any point the water level goes below the base of the neck of the flask during agitation, this may reintroduce air bubbles into the sample. Refill the flask to halfway between the calibration line and the bottom of the neck of the flask and continue agitation.

8. Once air bubbles are no longer visible, add more water to push any foam to the top of the flask.

9. Using a folded paper towel, remove the foam and any contaminants.

10. Using a squeeze bottle, fill the flask with additional water up to the calibrated line of 500 mL on the flask.
    Tip: If there is a meniscus, read the bottom of the meniscus.

11. Verify the temperature of the water is 73.4 ± 3 °F, and adjust the temperature of the water if necessary.
    Tip: Partially immersing in a water bath at approximately 73°F is one way achieve this temperature.

12. With the cap off, record the mass of the flask and its contents for Sample 1. ***Record as C.*** Repeat for Sample 2.

13. Empty the contents of the flask into a small bread pan.
Tip: This is best achieved by holding the flask at a downward angle, using a fast, continuous, shaking method to minimize material left in the flask.

14. Using the squeeze bottle, rinse out the flask, ensuring all material has been emptied into the pan.

15. Dry the sample to constant mass at a temperature of 230 ± 9°F.

16. Cool the sample to room temperature for 1.0 ± 0.5 hour and record the mass. ***Record as A***. Repeat for Sample 2.

17. Determine the mass of each flask filled to 500 mL with water at 73.4 ± 3 °F. ***Record as B.***
Tip: This step can be done once per year for each individual flask. The yearly calibrated mass is then used as mass B.

Calculations

Bulk Specific Gravity (Gsb)

$$Gsb = \frac{A}{(B + S - C)}$$

A = mass of oven-dry specimen in air
B = mass of pycnometer filled with water to calibration mark
S = mass of SSD specimen
C = mass of pycnometer with specimen and water to calibration mark

Absorption

$$Abs = \frac{(S - A)}{A} x100$$

A = mass of oven-dry specimen in air
S = mass of SSD specimen

Report

Report specific gravity values to the nearest 0.001 and absorption to the nearest 0.1 percent