Idaho Standard Method of Test for

Specific Gravity and Absorption of Fine Aggregate Using Automatic Vacuum Sealing (CoreLok) Method

Idaho IT-144-08

1 Scope

1.1 This standard covers the determination of specific gravity and absorption of fine aggregates.

1.2 The values are stated in SI units and are regarded as the standard units.

1.3 This standard may involve hazardous materials, operations and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2 Referenced Documents

2.1 AASHTO Standards:

- M 132, Terms Relating to Density and Specific Gravity of Solids, Liquids and Gases
- M 231, Weighing Devices Used in the Testing of Materials
- T 2, Standard Practice for Sampling of aggregates
- T 19, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
- T 248, Standard Practice for Reducing Samples of Aggregate to Testing Size
- T255, Total Evaporable Moisture Content of Aggregate by Drying

2.2 Other Standards

- CoreLok Operational Instructions (InstroTek, Inc.)

3 Terminology

3.1 absorption—the increase in the mass of aggregate due to water in 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 ± 5ºC for sufficient time to remove all uncombined water.

3.2 specific gravity—the ratio of the mass (or weight in air) of a unit volume of a material to the mass of the same volume of water at stated temperatures. Values are dimensionless.

3.3 apparent specific gravity—the ratio of the weight in air of a unit volume of the impermeable portion of aggregate at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.4 bulk specific gravity—the ratio of the weight in air of a unit volume of aggregate (including the permeable and impermeable voids in the particles, but not including the voids between particles) at a stated temperature to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

3.5 bulk specific gravity (SSD)—the ratio of the mass in air of a unit volume of aggregate, including the mass of water within the voids filled to the extent achieved by vacuum saturating (but not including the voids between particles) at a stated temperature, compared to the weight in air of an equal volume of gas-free distilled water at a stated temperature.

4 Summary Of Method

4.1 Sufficient fine aggregate sample is dried to constant mass and representative dry fine aggregate samples of the same material are selected for testing. One sample is sealed in a vacuum chamber inside a plastic bag and opened under water for rapid saturation of the aggregate. The dry mass and submerged mass of the sample is used for calculation of apparent specific gravity. Other samples of the same aggregate are tested in a known volume metal pycnometer. The known mass of the pycnometer with water, mass of the dry aggregate, and mass of the dry aggregate and pycnometer filled with water is averaged and used for calculation of bulk specific gravity oven dry (OD.) The results from the samples tested are used to calculate absorption, and bulk specific gravity saturated-surface-dry (SSD).

5 Apparatus

5.1 Balance—A balance that conforms to AASHTO M231. The balance shall be sensitive, readable and accurate to 0.1% of the test sample mass. The balance shall be equipped with suitable apparatus for suspending the sample in water.

5.2 Water Bath—A large container that will allow for completely submerging the sample in water while suspended, equipped with an overflow outlet for maintaining a constant water level. Temperature controls may be used to maintain the water temperature at 25 ± 1° C (77 ± 2 °F).

Note 1—It is preferable to keep the water temperature constant by using a temperature controlled heater. Also, to reduce the chance for the bag to touch the sides of the water tank, it is preferable to elevate the water tank to a level at which the sample can be placed on the weighing mechanism while the operator is standing up (waist height), and the placement of the sample and the bag in the water tank can easily be inspected.

5.3 Sample holder for water displacement of the sample, having no sharp edges.

5.4 Vacuum Chamber—with a pump capable of evacuating a sealed and enclosed chamber to a pressure of 6 mm Hg, when at sea level. The device shall automatically seal the plastic bag and exhaust air back into the chamber in a controlled manner to ensure proper conformance of the plastic to the specimen. The air exhaust and vacuum operation time shall be set at the factory so that the chamber is brought to atmospheric pressure in 80 to 125 seconds, after the completion of the vacuum operations.

5.5 A Vacuum Measurement Gauge, independent of the vacuum sealing device, that could be placed directly inside the chamber to verify vacuum performance and the chamber door sealing condition of the unit. The gauge shall be capable of reading down to 3 mm Hg and readable to ± 1 mm Hg. The gauge shall be NIST traceable.

5.6 Plastic Bags, used with the vacuum device, shall have a minimum opening of 235 mm (9.25 in.) and maximum opening of 260 mm (10.25 in.). The bags shall be of plastic material, shall be puncture resistant, and shall be impermeable to water. The bags shall have a minimum thickness of 0.127mm (0.005 in.). The manufacturer shall provide the apparent specific gravity for the bags.

5.7 Metal pycnometer and lid, with 137 ± 0.13 mm (5.375 ± 0.005 in.) inside diameter (ID) and 89 ± 0.41 mm (3.5 ± 0.016 in.) height, for testing fine aggregates. The pycnometer shall be machined to be smooth on all surfaces. The inside of the lid shall be machined at a 5° angle to create an inverted conical surface.

5.8 Pycnometer clamping device to hold and secure the lid on the metal pycnometer from lifting during fine aggregate tests. The device shall be provided with a level indicator.

5.9 Syringe with a needle no larger in diameter than 3 mm (0.125 in.)

5.10 Thermometer or other temperature device with range to 40ºC (100ºF) accurate to ±1º.

5.11 Isopropyl alcohol – Technical Grade

5.12 Accessories— A bag cutting knife or scissors, spray bottle for the isopropyl alcohol, a bucket large enough to allow the pycnometer to be fully submerged in water, water containers to dispense water into pycnometer during testing, small paint brush and 25 mm (1 in.) wide aluminum spatula.

6 Verification

6.1 System Verification: The vacuum settings of the vacuum chamber shall be verified once every 12 months and after major repairs and after each shipment or relocation.

6.1.1 Place the gauge inside the vacuum chamber and record the setting, while the vacuum unit is operating. The gauge should indicate a pressure of 6 mm Hg or less. The unit shall not be used if the gauge reading is above 6 mm Hg.

> **Note 2**— In line vacuum gauges, while capable of indicating vacuum performance of the pump, are not suitable for use in enclosed vacuum chambers and cannot accurately measure vacuum levels.

6.2 Calibration of Pycnometer:

6.2.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F). Place the pycnometer clamping device on a level surface. Use a level indicator or the provided level to level the device.

> **Note 3 –** The clamping device must be protected from hot or cold ambient laboratory temperatures that are more or less than 25 ± 1°C (77 ± 2°F).

6.2.2 Remove the pycnometer from the water bucket and dry it with a towel. Place the pycnometer in the device and push it back until it makes contact with the stops.

6.2.3 Fill the pycnometer with 25 ± 1°C (77 ± 2°F) water to approximately 10 mm (0.375 in.) from the top. Using the alcohol spray bottle, spray the surface of the water to remove bubbles.

6.2.4 Gently place the lid on the pycnometer and close the clamps on the device.

6.2.5 Using a syringe filled with 25 ± 1°C (77 ± 2°F) water, slowly fill the pycnometer through the large fill hole on the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step prevents formation of air bubbles inside the pycnometer.

6.2.6 Fill the pycnometer until water comes out of the 3 mm (1/8-in.) hole on the surface of the lid.

6.2.7 Wipe any remaining water from the top of the lid with a towel.

6.2.8 Place the entire device with the pycnometer on the scale and record the mass. Record the mass to 0.1 in the top portion of the Aggregate Worksheet. (See Appendix 1)

6.2.9 Clean the pycnometer and repeat steps 6.2.1 to 6.2.8 two more times and average the calibration masses obtained in 6.2.8.

6.2.10 If the range for the 3 calibration masses is larger than 0.5 grams, then the test is not being run correctly. Check to see if the device is level. Make certain the water injection with the syringe is done below the pycnometer water surface and is applied gently. Check the water temperature. Check the pycnometer temperature. Repeat the above procedure until you have three masses that are within a 0.5 gram range.

6.2.11 The pycnometer must be re-calibrated daily prior to testing.

7 Sampling

7.1 Sampling shall be performed in accordance with AASHTO T 2.

7.2 Samples shall be dried to constant mass in accordance with AASHTO T255.

7.3 Samples shall be reduced in accordance with AASHTO T 248.

8 Procedures

8.1 Equipment Preparation:

Note 4 – Make certain water temperature used for this test remains at 25 ± 1°C (77 ± 2°F).

8.1.1 Prior to testing, condition the pycnometer to 25 ± 1°C (77 ± 2°F) by placing it inside a bucket of water that is maintained at 25 ± 1°C (77 ± 2°F).

8.1.2 Remove the pycnometer from the water bucket and dry thoroughly with a towel.

8.1.3 Place the pycnometer clamping device on a level surface. Use a level indicator or the provided level to level the device.

8.1.4 Place the empty pycnometer in the pycnometer clamping device and push it back until it makes contact with the stops.

8.2 Determine Bulk Specific Gravity:

8.2.1 Oven dry to constant mass according to AASHTO T255, enough fine aggregate to obtain three 500 gram samples and one 1000 gram sample, reduced according to AASHTO T248..

8.2.2 Allow the sample to cool to 25 ± 1°C (77 ± 2°F).

8.2.3 Determine the mass of a 500 ± 1 gram dry sample, Trial 1, that is at 25 ± 1°C (77 ± 2°F) and record to 0.1 on the Aggregate Worksheet.

8.2.4 Steps 8.2.5 to 8.2.13 shall be completed in less than 2 minutes.

8.2.5 Place approximately 500 ml of 25 ± 1°C (77 ± 2°F) water in the pycnometer (halfway full).

8.2.6 Slowly and evenly pour the sample into the pycnometer. Make certain aggregate is not lost in the process of filling the pycnometer. Use a brush if necessary to sweep any remaining fines into the pycnometer. If any aggregate is lost during the process of filling the pycnometer, start the test over.

8.2.7 Use a metal spatula and push it to the bottom of the pycnometer against the inside circumference. Slowly and gently drag the spatula to the center of the pycnometer, removing the spatula after reaching the center. Repeat this procedure in eight equal increments until the entire circumference is covered. If necessary, use a squeeze water bottle to rinse any sample residue off the spatula into the pycnometer.

8.2.8 Fill the pycnometer with 25 ± 1°C (77 ± 2 °F) water to approximately 10 mm (0.375 in.) of the pycnometer rim. It is important the water level be kept at or below the 10 mm line to avoid spills during lid placement.

8.2.9 Use the spray bottle filled with isopropyl alcohol to spray the top of the water to remove air bubbles.

8.2.10 Gently place the lid on the pycnometer and lock the clamping device. Using the syringe, slowly fill the pycnometer through the center hole on top of the lid post. Make sure the syringe tip is far enough in the pycnometer to be below the water level. Gentle application in this step will prevent formation of air bubbles inside the pycnometer.

8.2.11 Fill the pycnometer until water comes out of the 3 mm (1/8-in.) hole on the surface of the lid.

8.2.12 Wipe any remaining water from around the 3 mm (1/8-in.) hole with a towel.

> **Note 5 –** Do not wipe water from the rim of the pycnometer if it seeps between the lid and the pycnometer. Allow this water to remain.

8.2.13 Determine the mass of the sample, the pycnometer and the device. Record the mass to 0.1 in B of the Aggregate Worksheet.

8.2.14 Discard the sample and prepare the equipment according to step 8.1.1 to 8.1.4.

8.2.15 Repeat steps 8.2.3 to 8.2.13 for another 500 ± 1 gram sample, Trial 2.

8.2.15.1 The difference in the mass of Trial 1 and Trial 2 recorded in B must be 1.0 gram or less. If the difference is greater than 1.0, then repeat steps 8.2.14 and 8.2.15 using another 500 ±1 gram dry sample.

8.2.16 Calculate the average mass for the two trials that are within 1 gram; record to 0.1 on Aggregate Worksheet.

8.2.17 Record the average weight of the pycnometer from section 6.2.9 on Aggregate Worksheet.

8.3 Determine Apparent Specific Gravity:

8.3.1 Set the vacuum device according to manufacturer's recommendation.

8.3.2 Tare the immersed weighing basket in the water bath.

8.3.3 Use a small plastic bag and inspect the bag to make sure there are no holes, stress points or side seal discontinuities in the bag. If any of the above conditions are noticed, use another bag.

8.3.4 Determine the mass of the bag and record to 0.1 on Aggregate Worksheet.

> **Note 6**—Always handle the bag with care to avoid creating weak points and punctures.

8.3.5 Determine the mass of a 1000 ± 1 gram sample of oven dry aggregate and record 0.1 at E on Aggregate Worksheet.

8.3.6 Place the sample in the bag. Support the bottom of the bag on a smooth tabletop when pouring the aggregate to protect against punctures and impact points.

8.3.7 Place the bag containing the sample inside the vacuum chamber.

8.3.8 Grab the two sides of the bag and spread the sample flat by gently shaking the bag side to side. Do not press down or spread the sample from outside the bag. Pressing down on the sample from outside the bag will cause the bag to puncture and will negatively impact the results. Lightly spray mist aggregates with high minus 75-µm (No. 200) sieve material to hold down dust prior to sealing.

8.3.9 Place the open end of the bag over the seal bar and close the chamber door. The unit will draw a vacuum and seal the bag, before the chamber door opens.

8.3.10 Gently remove the sample from the chamber and immediately (within 5 seconds) submerge the sample in the water bath equipped with a balance for water displacement analysis.

> **Note 7 -** It is extremely important the bag be removed from the vacuum chamber and immediately placed in the water bath. Leaving the bag in the vacuum chamber or on a bench top after sealing can cause air to slowly enter the bag and can result in low apparent specific gravity results.

8.3.11 Completely submerge the bag at least 2-inches below the surface of the water during cutting.

8.3.12 Make a small cut across the top edge of the immersed bag approximately 25 to 50 mm (1 to 2 in.).

8.3.13 Hold the immersed bag open at the cut for approximately 45 seconds allowing the water to freely flow into the bag. Allow any small residual air bubbles to escape. Do not shake or squeeze the sample, as these actions will cause the fines to escape from the bag.

8.3.14 After water has filled in, make another cut on the opposite side of the immersed bag approximately 25 to 50 mm (1 to 2 in.). Squeeze any residual air bubbles on top portion of the bag through the openings by running your fingers across the top of the bag. Do not completely remove any portion from the bag nor allow any portion of the bag to reach the surface of the water. Keep the sample and bag at least 2-inches below the surface of the water at all times.

8.3.15 Place the bag containing the sample in the immersed weighing basket to obtain the under water mass. Allow water to freely flow into the bag. Make certain the bag or the sample are not touching the bottom, the sides, or floating out of the water bath.

8.3.16 Allow the sample to stay in the water bath for a minimum of fifteen (15) minutes but not more than 20 minutes.

8.3.17 Record the submerged mass on the Aggregate Worksheet and wait one minute. If after this time the mass increases by more than one-gram, wait an additional five minutes. Record the mass and continue this process until the mass stops increasing.

9 Calculations

9.1 Test result calculations for percent absorption, apparent specific gravity and bulk specific gravity will be obtained from the software supplied by the manufacturer. Use the data from the Aggregate Worksheet. The software will provide a report of the test results.

9.2 The final test result will be determined from an average of two laboratory specimens.

Appendix 1
Aggregate Worksheet

Weight of pycnometer and clamping device filled with water.					1.	2.	3.	Avg.
Sample Number or Label	Trial Number		**A** Dry Sample Mass (500 g)	**B** Mass of pycnometer with sample and water (g)	**C** Plastic bag mass (g)	**D** Mass of two rubber sheets (g)	**E** Dry Sample Mass (1000 g)	**F** Mass of Sealed sample opened under water
	1							
	2							
	3*							
	Avg							
	1							
	2							
	3*							
	Avg							
	1							
	2							
	3*							
	Avg							

* Trial 3 is only necessary if the mass in B for the first 2 trials is larger than 1.0 grams.

PERFORMANCE EXAM CHECKLIST

SPECIFIC GRAVITY AND ABSORPTION OF FINE AGGREGATE USING AUTOMATIC VACUUM SEALING (CORELOK) METHOD IDAHO IT-144-08

Participant Name_____ Exam Date_____

Record 'P' For Passing "F" for failing each step of the checklist.

Verification Element	**Trial 1**	**Trial 2**
1. Pycnometer and lid placed inside a bucket of water at 25°± 1C (77°± 2F)?	_____	_____
2. Pycnometer and lid removed from water dried well and placed on clamping device until it makes contact with stops?	_____	_____
3. Pycnometer filled with 25°± 1C (77°± 2F) water to 10mm (3/8") of top, sprayed with Isopropyl alcohol to remove air?	_____	_____
4. Lid gently placed on Pycnometer and clamped?	_____	_____
5. A syringe filled with 25°± 1C (77°± 2F) inserted in top of lid and gently added until water is expelled through the 3mm (1/8") hole?	_____	_____
6. Water wiped from lid, device water and pycnometer weighed and recorded to 0.1 g?	_____	_____
7. Procedure repeated two additional times (no greater than 0.5 g difference) recorded to work sheet and averaged?	_____	_____

Procedure Element	**Trial 1**	**Trial 2**
8. Representative samples obtained per FOP for AASHTO T 2?	_____	_____
9. Reduced per FOP for AASHTO T 248?	_____	_____
10. Dried per FOP for AASHTO T 255?	_____	_____
11. Samples cooled to 25°±1C (77°± 2F)?	_____	_____
12. Three samples obtained @ 500g ±1g and one @ 1000g ± 1g?	_____	_____
13. Pycnometer and lid removed from water, dried and pycnometer placed on clamping device until it makes contact with stops?	_____	_____
14. Water added to pycnometer (at 25°± 1C, 77°± 2F) to approximately half full?	_____	_____

Procedure Element	**Trial 1**	**Trial 2**
15. Sample at 500 g ± 1g slowly added to pycnometer?	_____	_____
16. Metal spatula inserted against side of pycnometer and slowly pushed to center removed, repeated in eight equal increments?	_____	_____
17. Water added at 25°± 1C (77°± 2F) to within 10mm (3/8") of rim?	_____	_____
18. Sprayed with isopropyl alcohol to remove air?	_____	_____
19. Lid gently placed on pycnometer with 3mm (1/8") hole to the front and clamped?	_____	_____
20. Syringe filled with 25°± 1C (77°± 2F) water inserted in top of lid and water slowly added until it is expelled through 3mm (1/8") hole?	_____	_____
21. Excess water wiped from lid?	_____	_____
22. Clamping device, pycnometer and sample mass recorded to 0.1 g?	_____	_____
23. Clamping device, pycnometer and sample mass determined no more than 2 minutes from time sample was submerged?	_____	_____
24. Second 500g ±1 g sample tested and mass recorded?	_____	_____
25. If recorded mass of first and second sample greater than 1 g, was a third 500 g ± 1 g sample tested?	_____	_____
26. Vacuum device set at manufacture's recommended setting?	_____	_____
27. Small plastic bag inspected and mass determined to 0.1 g and recorded?	_____	_____
28. 1000 g ±1 g sample mass determined and recorded?	_____	_____
29. 1000 g ±1 g sample placed in the bag, supported by a smooth surface to prevent punctures?	_____	_____
30. Sample placed in vacuum device and spread flat by grasping both sides of bag and gently shaking?	_____	_____
31. Open end of bag placed over seal bar and closed?	_____	_____
32. Sample removed from vacuum chamber when door opens and submerged in 25°± 1C (77°± 2F) water bath within 5 seconds?	_____	_____
33. Bag maintained at a minimum depth of two inches?	_____	_____
34. A small cut made at corner of bag approximately 25 to 50mm (1" to 2")?	_____	_____
35. Submerged bag held open until water flows freely into bag (approximately 45 seconds)	_____	_____

Procedure Element	**Trial 1**	**Trial 2**
36. A second cut approximately 25 to 50mm (1" to 2") made to opposite side of bag?	_____	_____
37. Residual air removed from bag by running fingers across top of submerged bag?	_____	_____
38. Bag placed in weighing basket and water allowed to flow freely into bag?	_____	_____
39. Sample mass determined and recorded after 15 minutes but not more than 20 minutes and recorded to 0.1g?	_____	_____
40. Test data entered into manufacture's software to obtain test results?	_____	_____

COMMENTS: First Attempt : Pass ☐ Fail ☐ Second Attempt: Pass ☐ Fail ☐

Examiner Signature:_____ Sampler / Tester Qualification # _____

Examiner Signature:_____ Sampler / Tester Qualification # _____