

**1816 Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using an Automatic Vacuum Sealing Method – (Corelok System) ASTM D6752-02 (Mn/DOT Modified)**

**1816.1 SCOPE**

This test method covers the determination of the bulk specific gravity of compacted bituminous mixtures and/or of bituminous cores used for pavement density determination. This test method should be used with samples that contain open or interconnecting voids. Mixes such as Stone Matrix Asphalt (SMA), open graded friction courses (PASB, PASSRC), and SuperPave coarse graded mixtures with significant surface texture should be sealed for accurate bulk specific density results.

**Note 1:** This method differs from the ASTM procedure in that Mn/Dot requires a moisture correction for field cores.

**1816.2 SUMMARY OF METHOD**

Lab compacted specimens or field cores are placed into puncture resistant polymer bags. The specimen and bag are then placed inside a vacuum chamber, which is completely evacuated of air before the bag is automatically sealed. The bag tightly conforms to the specimen's surface and prevents the infiltration of water into the specimen. Then the specimen's density is measured by performing the water displacement method. Results are corrected for bag density and displaced bag volume.

**1816.3 APPARATUS**

- A. Balance** - Conforming to the requirements of AASHTO M 231 having a readability and sensitivity of 0.1 grams and an accuracy of grams or 0.1% and having a minimum capacity of 5000g. The balance shall be equipped with a suitable apparatus to permit weighing the specimen while it is suspended in water.
- B. Water Tank** - A watertight tank with minimum dimensions (Length x Width x Depth) of 610 x 460 x 460 mm (24" x 18" x 18") or a large cylindrical container, for completely submerging the specimen in water. The tank shall be equipped with an overflow outlet for maintaining a constant water level.

**Note 2:** Since the water in the tank must be maintained at  $25 \pm 1^\circ\text{C}$  ( $77 \pm 1.8^\circ\text{F}$ ) it is recommended that it be equipped with an immersion heater/circulator capable of maintaining that temperature.

- C. Cushioned Holder** - for water displacement of the sample, having no sharp edges.

**Note 3:** To avoid accidental punctures of the plastic bags in the water bath, plastic coated holders have been found to work well.

- D. Corelok** - Vacuum chamber and system that conforms to ASTM D 6752.

- E. Polymer Bags** - Shall be one of the two following sizes. The smaller bags shall have a minimum opening of 235 mm (9.25”) and a maximum opening of 260 mm (10.25”). The larger bags shall have a minimum opening of 375 mm (14.75”) and a maximum opening of 394 mm (15.5”). The bags shall have a thickness of 0.100 mm (0.004”) to 0.152mm (0.006”). The bags shall be of plastic material that will not adhere to asphalt film, puncture resistant, capable of withstanding sample temperatures to 70 °C (158 °F), is impermeable to water, containing no air channels for evacuation of air from the bag. The manufacturer for each bag shipment shall provide the apparent gravity for the bags. The specific gravity provided for each size bag shall account for the different sample weights and bag weight used during testing.

**NOTE 4:** Use only the plastic bags that are recommended by Corelok’s manufacturer.

- F. Specimen sliding plate** - Used within the vacuum chamber to reduce friction on the plastic bags.
- G. Oven** - Capable of maintaining a temperature of  $110 \pm 5^{\circ}\text{C}$  ( $230 \pm 9^{\circ}\text{F}$ ).
- H. Alternate vacuum pump/system with regulating capabilities** – Refer to the “Rice” apparatus (Section 1807) and/or the “Lottman” (Section 1813) test method for vacuum system. This additional equipment is needed for specimens that contain water (i.e. cores).

#### 1816.4 TEST SPECIMENS

Test specimens may be molded from laboratory mixtures or taken from bituminous pavement (cores).

Laboratory compacted specimens shall be cooled to room temperature and are considered moisture free.

Cores - Care shall be taken to avoid distortion, bending or cracking of the core specimen during and after the removal from the pavement. Specimens shall be free from foreign matter such as tack coats, seal coats, foundation material, soil, paper, or other similar material. When any of these are visually evident they shall be removed. Seal coats and tack may be removed by sawing.

Clean any debris from specimen surfaces. Loose debris may cause punctures in the bag during the vacuum process.

#### 1816.5 CORELOK SETUP

- A.** Turn on the device. (The actual vacuum operation begins when the lid is closed.) For newer models the display should read “program #1”.
- B.** Check to see if the vacuum setting is correct. On newer models this setting should be 99% (press the menu key to check it). On older machines, check the vacuum timer. Set the timer to the maximum setting of 45 seconds (the #10 setting). The “Corelok’s” pump is designed to run for the 45 seconds.

- C. Turn On newer models the dwell and seal times are preset. For older models, set the sealing bar timer between 3 and 4. After the sealing operation you can check the seal quality. If there's an indication of stretching or burning of the plastic, then reduce the setting. However if there's an incomplete seal or the seal easily separates, then increase the setting. A timer setting that's too short will result in an incomplete seal, which will cause the bag to leak within a short time.

## 1816.6 PROCEDURE for DETERMINATION of BULK SPECIFIC GRAVITY

- A. Select the appropriate bag size & record the bag weight to the nearest 0.1g as (A).
1. For gyratory specimens and/or for 150mm (6 in) diameter samples with greater than 50mm (2 in) thickness use the larger opening size bags as specified in section 1816.3E
  2. For all 100 mm (4 in) diameter specimens (cores) and for specimens with 150mm (6 in) diameter and less than 50mm (2 in) thickness use the bag with the smaller opening as specified in section 1816.3E
- B. Determine the dry weight of the specimen.
1. For laboratory compacted specimens (free from moisture)
    - a. Cool to room temperature  $25 \pm 5$  °C ( $77 \pm 9$  °F),
    - b. Weigh in air to the nearest 0.1g
    - c. Record the dry weight as (B).
  2. For cores and specimens containing moisture. It's recommended that as much entrapped moisture as possible should to be removed before testing continue in the Corelok.

**Note 5:** Moisture if not removed from the cut cores will become a contaminate to the "Corelok's" vacuum oil. Excessive moisture in the oil will cause a low vacuum and may lead to premature pump failure. It's important to remove as much moisture from the field cores as possible before testing.

- a. Air dry the specimens to a constant weight. To assist in attaining this condition, place the specimen in front of a fan for at least 30 minutes.
- b. Then remove any remaining water by using a rapid vacuum drying device like the "CoreDry" or by placing the specimen inside a another vacuum chamber (other than the Corelok) capable of evacuating and sustaining a partial vacuum to a residual pressure of 254 mm. Hg (254 Torr).

**Note 6:** Either vacuum system used in the "Rice" or in the Lottman testing will work as long as you are able to adjust the pressure. For the "CoreDry" device refer to ASTM D 7227.

- c. Apply a vacuum of approximately 254 mm HG for a period of 4-5 minutes. As the vacuum is applied the entrapped moisture will be drawn out of the specimen.
- d. Remove the specimen from vacuum and then take a cloth towel and dry off any moisture that's on the surface.
- e. Repeat steps if necessary.
- f. Weigh to the nearest 0.1g and record this weight as **(B)**.
- C. Place the appropriate size bag, with the open end facing the front, inside the vacuum chamber, and on top of the specimen sliding plate. The smooth side of the sliding mechanism needs to rest on top of the filler plate(s).

**Note 7:** Fill the chamber with as many filler plates as needed. The idea is to keep the bag and specimen as close to the same plane as possible. For standard size gyratory samples, a single filler plate should suffice.

- D. Open the bag and carefully place the specimen inside. When placing the specimen into the bag, grip the specimen in one hand and the bag in the other. Handle the bag with care; avoid any possibilities of a puncture. The sliding plate should be placed towards the back of the chamber. Center the specimen toward the backside of the bag leaving approximately one inch of slack on the backside.
- E. Align the bag and specimen in the vacuum chamber in such a manner that approximately one inch of the open end is resting over the sealing bar. Check for wrinkles.
- F. Close the "Corelok's" lid and hold it down for a couple of seconds. You should hear the vacuum pump start and as the vacuum builds the lid will stay closed on it's own.
- G. The vacuum operation begins when the lid is closed. Allow the vacuum chamber to remove the air from the bag and chamber. After a short period of time the bag will appear to "puff up". The bag is then automatically heat -sealed. Once sealed, air is exhausted back into the chamber until atmospheric pressure is attained. Since the inside of the bag is still evacuated, the pressure outside of the bag will collapse it tightly around the specimen. The chamber door will automatically open when the operation is completed.

**Note 8:** CAUTION! The seal bar will still be hot. DO NOT TOUCH!

- H. Carefully remove the sealed sample from the chamber. Rest the specimen and bag on top of your hand. **Do not carry by grabbing the empty end of the bag!** Always support the bag and specimen with your hands.
- I. Examine the bag to ensure that it's tightly conformed to the specimen. A loose bag indicates a leak. If a leak is detected repeat the process. If there's a bad seal refer to Section 1816.5C.

- J.** Immediately determine the weight of the sealed specimen in air to the nearest 0.1g and record this weight as (C).

**Note 9:** A cloth towel or foam pad placed on top of the balance platform will aid in preventing unwanted punctures to the bag.

- K.** Within two (2) minutes after being sealed, submerge the sealed specimen in the  $25 \pm 1.0$  °C ( $77 \pm 1.8$  °F) water bath. Place the sample on top of the cushioned holder. Let the sealed sample remain submerged for 3 to 5 minutes. Then determine the sealed weight in water. Weigh to the nearest 0.1g and record as (D).

**Note 10:** During the immersed step, you may observe darker color areas appearing on the specimen's surface. This is an indication that water has penetrated the bag and specimen. Abort the testing, there's a leak in the bag.

- L.** Remove the sealed specimen from the bath and cut open the bag.
- M.** Determine the dry weight of the specimen after immersion.
- 1.** For laboratory compacted specimens (free from moisture).
- a.** Take the specimen out of the bag and weigh in air to the nearest 0.1g.
- b.** Record this weight as (E). If this weight is higher than the initial dry weight (B), then the bag has been punctured. Repeat the test after drying the specimen.
- 2.** The following steps are for the cores and specimens that contained moisture.
- a.** Remove the specimen from the bag and place it in a drying pan of known weight.
- b.** Place the pan and specimen in a  $110 \pm 5$  °C ( $230 \pm 9$  °F) oven until it can be separated easily (a minimum of 3 hours).
- c.** After three hours chop the sample carefully with a spatula or knife and take an initial oven-dry weight.
- d.** Return the sample to the oven and continue drying for at least 15 additional minutes.
- e.** Check the weight at 15-minute intervals until further drying does not alter the weight by more than 0.05 percent.
- f.** Within 20 minutes of determining a constant dry weight, record this weight minus the pan weight as "F".

**1816.7 CALCULATIONS**

- A.** Determine each Corelok's individual bag specific gravity (bag volume correction factor or  $V_c$ ) as follows:

For Corelok's Large Bags (14.75 x 18") the calculation is:

$$V_c = (-0.00166 \times R) + 0.8596 \text{ or}$$

For Corlok's Small Bags (10 x 14") the calculation is:

$$V_c = (-0.000566 \times R) + 0.8121$$

where:  $R$  = ratio of  $E / A$

$A$  = bag weight, g

$E$  = dry specimen wt after submersion

- B.** Calculate the bulk specific gravity ( $G_{mb}$ ) at  $25 \pm 1.0$  °C ( $77^\circ\text{F} \pm 1.8$  °F) of the sealed specimen as follows:

- 1.** For laboratory compacted specimens (free from moisture).

$$G_{mb} = \frac{B}{(C - D) - \frac{A}{V_c}}$$

- 2.** For cores and specimens containing moisture.

$$G_{mb} = \frac{F}{(C - D) - \frac{A}{V_c}}$$

Where:  $A$  = Bag weight

$B$  = Dry specimen wt before sealing, g

$C$  = Sealed specimen wt, g

$D$  = Sealed specimen wt in water, g

$E$  = Dry specimen wt after submersion, g

$F$  = Oven dried weight, g

$V_c$  = Specific gravity of the bag (bag volume correction factor) - See Step A above.

**Note 9:** For water temperature differences greater than 1.0°C (1.8°F) refer to ASTM D 6752 section 8 for corrections to the density.

**1816.8 Worksheets****CORELOK BULK GRAVITY WORKSHEET for COMPACTED SPECIMENS**

<b>Specimen ID</b>				
Bag weight ( <b>A</b> )				
Specimen dry weight ( <b>B</b> )				
Sealed specimen weight ( <b>C</b> )				
Sealed specimen weight in water ( <b>D</b> )				
Specimen dry wt. after submersion ( <b>E</b> )				
Bag volume correlation ( <b>V<sub>c</sub></b> )				
Bulk gravity $B/[C-D-(A/V_c)]$				

**CORELOK BULK GRAVITY WORKSHEET for CORES**

<b>Specimen ID</b>				
Bag weight ( <b>A</b> )				
Specimen dry weight ( <b>B</b> )				
Sealed specimen weight ( <b>C</b> )				
Sealed specimen weight in water ( <b>D</b> )				
Specimen dry wt. after submersion ( <b>E</b> )				
Oven dried weight ( <b>F</b> )				
Bag volume correlation ( <b>V<sub>c</sub></b> )				
Bulk gravity $F/[C-D-(A/V_c)]$				