

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Transportation Laboratory
5900 Folsom Blvd.
Sacramento, California 95819-4612



METHOD OF TEST FOR DETERMINING BULK SPECIFIC GRAVITY AND DENSITY OF COMPACTED HOT MIX ASPHALT

A. SCOPE

This test provides three methods for determining the bulk specific gravity and density of compacted hot mix asphalt (HMA).

Method A measures the bulk specific gravity using paraffin coated briquettes and is used for specimens compacted during the mix design and job mix formula (JMF) verification processes for laboratory-mixed / laboratory-compacted and field-mixed / laboratory-compacted specimens; for dense graded and rubberized hot mix asphalt (Type G) (RHMA-G) specimens; for HMA briquettes that contain open or interconnected voids or that absorb more than 2.0 % of water by volume. Method A is also used for field-compacted samples cut from the pavement (field-mixed / field-compacted specimens).

Method B measures the bulk specific gravity of open graded friction course (OGFC) using a fixed amount of laboratory-mixed or field-mixed specimens to determine the density of OGFC for estimating construction quantities only.

Method C measures the bulk specific gravity on a saturated surface dry basis and is used for laboratory-mixed / laboratory-compacted and field-mixed / laboratory-compacted specimens that absorb 2.0 % or less of water by volume.

B. REFERENCED DOCUMENTS

- California Test 226 – Moisture Content by Oven Drying
- California Test 304M – Preparation of Hot Mix Asphalt for Test Specimens
- California Test 304C – Compaction of Hot Mix Asphalt Using the California Kneading Compactor
- California Test 367 – Optimum Binder Content (OBC) for Hot Mix Asphalt Types A, B, and C and Rubberized Hot Mix Asphalt (Type G)
- California Test 368 – Optimum Bitumen Content (OBC) for Open Graded Friction Course

C. APPARATUS

1. Balance: a balance or scale having a minimum capacity of 5 kg capacity, accurate to 0.1 g, fitted with a suitable suspension apparatus and basket to permit weighing briquettes immersed in water (Methods A and C).
2. Water Bath: a water bath of sufficient size for immersing briquettes (Methods A and C). The water bath must be maintained at $77^{\circ}\text{F} \pm 2^{\circ}\text{F}$ by suitable methods, and have an overflow system for maintaining a constant water level during briquette immersion.
3. Oven: an oven with free circulation of air capable of maintaining a temperature required for different types of HMA in testing (Method B).
4. Paraffin and a device for heating the paraffin (Method A).
5. Device for measuring the height of briquettes to the nearest 0.01 in. (Method B).

D. BRIQUETTE PREPARATION

1. For dense graded HMA and RHMA-G, prepare HMA in accordance with California Test 367 and prepare briquettes in accordance with California Test 304M and California Test 304C.
2. For OGFC, prepare HMA in accordance with California Test 368 and prepare briquettes as follows:
 - a. Weigh out the appropriate amount of OGFC to the nearest 1 g.

Maximum Nominal Aggregate Size	Weight of OGFC
≤ ¾ in.	400 g
> ¾ in.	800 g

- b. Heat the OGFC and molds to the temperatures given below.

HMA Type	HMA and Mold Temperatures
OGFC (PG and PG__ - __PM)	220 to 230°F
PG__ - __TR	230 to 240°F
RHMA-O (and O-HB)	300 to 310°F

- c. Place the heated OGFC in a 4 in. diameter heated mold.
 - d. Apply a 2,000 psi static load in a compression testing machine. Use a testing machine head or platen speed of 0.25 in ± 0.01 in/min. Apply the load by the double plunger method in which a free-fitting metal plunger is placed on the top and bottom of the briquette.

NOTE: If the testing machine has a spherically seated type of upper head, use the proper shims to lock it in such a manner that the contact face is fixed in a horizontal plane.

3. Oven-dry briquettes to a constant mass in accordance with California Test 226, except the temperature shall not exceed 100°F. Newly compacted (within 3 days) briquettes which have not been exposed to moisture do not require drying.
4. Cool the briquette to room temperature (77°F ± 9°F) prior to testing. Take care to avoid distortion, bending, or cracking of briquettes during preparation. Store specimens in a safe, cool place.

E. PREPARATION OF FIELD-COMPACTED SAMPLES

1. Take specimens from pavements with a core drill, diamond or carborundum saw, or by other suitable means.

Note: It is recommended that:

- a. The diameter of cylindrically compacted or cored specimens or the length of the sides of sawed specimens be at least equal to 4 times the maximum size of the aggregate; and,

- b. The thickness of specimens should be at least 1½ times the maximum size of the aggregate.
2. Specimens must be free from foreign materials such as seal coat, tack coat, foundation material, soil, paper, or foil.
3. Specimens may be separated from other pavement layers by sawing or other suitable means. Ensure sawing does not damage the specimens.
4. Take care to avoid distortion, bending, or cracking of specimens during and after the removal from the pavement. Store specimens in a safe, cool place.
5. Oven-dry specimens to a constant mass in accordance with California Test 226, except the temperature shall not exceed 100°F. Cool the specimens to room temperature (77°F ± 9°F) prior to testing.

F. PROCEDURES AND CALCULATIONS

1. Method A – This method measures bulk specific gravity of HMA and RHMA-G using paraffin coated briquettes or field-compacted samples.
 - a. Weigh the briquette in air to the nearest 0.1 g. Designate this weight as A.
 - b. Coat all surfaces of the briquette or field-compacted sample with melted paraffin sufficiently thick to seal all surface voids. Allow the coating to cool in air at room temperature for at least 30 min.

NOTE: Heat the paraffin to melt (not to exceed 165°F) under an operating fume hood or in a well ventilated area.

- c. Weigh the paraffin coated briquette or field-compacted sample in air to the nearest 0.1 g. Designate this weight as D.
- d. Weigh the paraffin coated briquette or field-compacted sample in a water bath at 77°F ± 2°F to the nearest 0.1 g. Designate this weight as E.
- e. Use the specific gravity of paraffin provided by the supplier or, if unavailable, use 0.90. Designate this as F.
- f. Calculate the bulk specific gravity of the briquette or field-compacted sample as follows:

$$\text{Bulk Specific Gravity} = \frac{A}{D - E - \left(\frac{D - A}{F}\right)}$$

Where: A = Weight of the dry specimen in air
D = Weight of the paraffin coated briquette or field-compacted sample in air
E = Weight of the paraffin coated briquette or field-compacted sample in water
F = Specific gravity of the paraffin at 77°F ± 2°F

2. Method B – This method measures bulk specific gravity of OGFC.

- a. Measure the height of briquette to the nearest 0.01 in.
- b. Use the following chart to convert the height of a compacted OGFC briquette to bulk specific gravity or calculate the values as follows:

$$\text{For 400 g samples: Bulk specific gravity} = \frac{1.9424}{\text{Height of Briquette}}$$

$$\text{For 800 g samples: Bulk specific gravity} = \frac{3.8848}{\text{Height of Briquette}}$$

Height of Briquette (in.)		Bulk Specific Gravity
400 g Sample	800 g Sample	
0.90	1.80	2.150
0.91	1.82	2.130
0.92	1.84	2.110
0.93	1.86	2.090
0.94	1.88	2.060
0.95	1.90	2.040
0.96	1.92	2.020
0.97	1.94	2.000
0.98	1.96	1.980
0.99	1.98	1.960
1.00	2.00	1.940
1.01	2.02	1.920
1.02	2.04	1.900
1.03	2.06	1.880
1.04	2.08	1.860
1.05	2.10	1.850
1.06	2.12	1.830
1.07	2.14	1.810
1.08	2.16	1.800

3. Method C – This method measures bulk specific gravity of HMA on a saturated surface dry (SSD) basis.

- a. Weigh the briquette in air to the nearest 0.1 g. Designate this weight as A.
- b. Immerse the briquette in a water bath at 77°F ± 2°F for 3 to 5 min. Weigh the briquette in the water bath to the nearest 0.1 g. Designate this weight as C.
- c. Remove the briquette from the water, damp-dry the briquette by blotting with an absorbent damp towel as quickly as possible (not to exceed 5 s) and determine the weight to the nearest 0.1 g. Designate this weight as B.

NOTE: A terry cloth towel has been found to work well. Damp is considered to be when no water can be wrung from the towel.

- d. Calculate the bulk specific gravity as follows:

$$\text{Bulk Specific Gravity} = \frac{A}{B - C}$$

Where: A = Weight of the briquette in air
B = Weight of the SSD briquette in air
C = Weight of the briquette in water

- e. Calculate the percent water absorbed by the briquette by volume as follows:

$$\text{Percent Water Absorbed} = \frac{B - A}{B - C} \times 100$$

NOTE: If the percent of water absorbed by the briquette exceeds 2.0 %, use Method A to determine the bulk specific gravity. Briquettes may be oven dried in accordance with California Test 226 and retested per Method A.

G. REPORTING OF RESULTS

1. Report bulk specific gravity to the nearest 0.001.
2. Calculate and report HMA density as follows:

$$\text{Density (lb/ft}^3\text{)} = \text{Bulk Specific Gravity} \times 62.245 \text{ lb/ft}^3$$

H. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

End of Text
(California Test 308 contains 5 pages)