



**COMPACTING ASPHALT CONCRETE
BY THE MARSHALL METHOD****SCOPE**

This method of test covers the procedures to be used in compacting asphaltic concrete utilizing the Marshall apparatus.

PROCEDURE**A. Apparatus**

1. Specimen mold assembly consisting of a base plate, forming mold and collar extension. The forming mold shall have an inside diameter of $4.0 \pm .005$ in. (101.6 ± 0.127 mm) and a height of approximately 3 in. (75 mm); the base plate and collar extension are designed to be interchangeable with either end of the forming mold.
 2. A specimen extractor for extracting the compacted specimen from the specimen mold.
 3. A mechanical compaction apparatus designed to drop a 10 ± 0.02 lb. ($4,536 \pm 9$ g) weight a distance of 18 ± 0.06 in. (457.2 ± 1.524 mm) and strike a $3\frac{7}{8}$ in. (98.425 mm) diameter compaction plate 50 times in a period of 60 ± 10 seconds.
 4. A compaction pedestal consisting of either:
 - a. An 8 x 8 x 18 in. (200 mm x 200 mm x 450 mm) wooden post capped with a 12 x 12 x 1 in. (300 mm x 300 mm x 25 mm) steel plate. The wood post shall have a dry weight of 42 to 48 lb./ft.³ (672.8 kg/m³ to 769.0 kg/m³) and shall be securely fastened to a solid concrete slab. The steel cap shall be firmly fastened to the post. The assembly shall be installed so that the post is plumb and the cap is level.
 - b. A massive concrete pedestal upon which has been mounted a 1 in. (25 mm) thick neoprene pad capped with a 1 in. (25 mm) thick steel plate.
 5. An oven capable of maintaining a constant temperature of $275 \pm 5^\circ\text{F}$ ($135 \pm 2.8^\circ\text{C}$).
 6. Thermometers [100°F - 400°F (38°C to 204°C) range].
 7. Balance having a capacity of at least 1500 grams and accurate to at least 1 gram.
 8. Funnel with protruding prongs, approximately 2 in. (50 mm) in length, which fit inside the collar of the mold.
 9. Suitable pans for heating the mixture
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10. Specimen height indicator
 11. Paper discs [4 in. (100 mm) diameter]

B. Test Procedure

1. Obtain the material for the test specimen by following the procedure described in IM 357, "Preparation of Hot Mix Asphalt (HMA) Mix Sample for Test Specimens."
2. Weigh into separate pans for each specimen the amount of asphaltic concrete required which will result in a compacted specimen 2.5 ± 0.05 in. (63.5 ± 1.27 mm) in height. This will normally be about 1200 grams. It is generally desirable to prepare a trial specimen prior to weighing in each pan. If the trial specimen height falls outside the limits, the amount of mixture used for the specimen may be adjusted as follows:

$$\text{Adjusted weight of mixture} = \frac{63.5 * (\text{weight of mixture used})}{\text{specimen height obtained}}$$

*Use a factor of 2.5 when working with English units

NOTE: The mixture may be weighed directly into the molds with care to avoid segregation of coarse material. The appropriate portions of steps 2 through 8 should be performed prior to placing the filled molds in the oven for heating to compaction temperature so that the specimens can be compacted immediately upon removal from the oven.

3. Heat the pans of mixture in the oven to a temperature of $275^{\circ}\text{F} \pm 5^{\circ}\text{F}$ ($135^{\circ}\text{C} \pm 3^{\circ}\text{C}$) as checked by a thermometer with the bulb in the center of the mixture sample.
 - a. When molding is in progress, check the temperature at least once for each three pans of mixture.
 - b. Heat the mold, base, funnel, and compaction plate in the oven for each specimen compacted.
 4. Place a paper disc in the bottom of the mold.
 5. Place all of the mixture that has been weighed out in one pan into the mold at one time by quickly inverting the pan into the funnel, which has been placed in the mold.
 6. Remove the funnel and spade the mixture with a heated spatula 15 times around the perimeter and 10 times over the interior. If mix segregation is occurring as a result of the spading process, reduce the spading effort to 10 times around the perimeter and 5 times over the interior.
 7. Smooth the surface of the mix to a slightly rounded shape and make sure there is no excess of coarse particles lying on the surface.
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8. Place a paper disc on the mixture.
9. Place the compaction plate in the mold and position the hammer guide rod.
10. Unless otherwise specified, apply 50 blows of the compaction hammer. Remove the base plate, collar, and compaction plate; reverse and reassemble the mold.
11. Unless otherwise specified, apply 50 blows to the face of the reversed specimen.
12. Compaction of specimens shall be completed within six minutes from the time the mixture is taken from the oven. Reheating of specimen in the mold prior to compacting is allowed and may be required if compaction cannot be completed within 6 minutes.
13. Place the mold in the specimen extractor and press out the finished specimen. Specimens, which cannot be removed without distortion, may be cooled in the mold until sufficient cohesion has developed to allow a specimen of the proper cylindrical shape to be obtained upon removal.

NOTE: For mixes containing crumb rubber, the compacted specimens must be cooled in the molds and kept fully confined on both the top and the bottom until cool enough to handle with bare hands. Carefully removing the paper disks before confining the specimens is recommended. This procedure will prevent swelling of rubber-modified specimens, which results in incorrect density and stability results.

14. Allow the specimens to cool to room temperature [approximately 77°F (25°C)] before further testing. Fans may be used for more rapid cooling but not immersion in water.

C. Number of Specimens

1. Prepare at least three specimens for each asphaltic concrete mixture.