



Standard Practice for Preparation of Test Specimens of Bituminous Mixtures by Means of Gyrotory Shear Compactor¹

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1. Scope

1.1 This practice covers the preparation of 10-cm or 4-in. diameter test specimens of bituminous mixtures containing – 22.4-mm ($-\frac{7}{8}$ -in.) aggregate.

1.2 The values stated in SI units are to be regarded as standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

E 4 Practices for Load Verification of Testing Machines²

3. Summary of Practice

3.1 This practice employs gyrotory-shearing action of the mixture at low initial pressures, allowing orientation of the aggregate particles to aid compaction, and then nongyrotory compression at high pressure for consolidation and shaping.

4. Significance and Use

4.1 The specimens are compacted to simulate the density, aggregate degradation, and structural characteristics possible in the actual road surface when proper construction procedure is used in the placement of the material. The specimens may be used to determine stability, density, strength, water susceptibility, etc., of bituminous mixtures by specified test methods.

5. Apparatus

5.1 *Gyrotory-Shear Molding Press:*

5.1.1 *Press Platen*, which is hardened and ground flat.

5.1.2 *Hydraulic Compaction Ram*, with nonrotating metal face as shown in Fig. 1 and Fig. 2. The ram face is hardened and ground flat. The ram varies the vertical opening between the ram face and the press platen from + 11 cm (4.5 in.) down to less than 2.5 cm (1.0 in.).

5.1.3 *Low-Pressure Gage*, with automatic valve for high pressure protection and with a capability of indicating within ± 2 kPa (± 0.3 psi) the following: (See Note 1):

5.1.3.1 *Pregyration Stress*—219 kPa (31.8 psi), which is 1779 N (400 lbf) total for 10-cm or 4-in. diameter specimens.

5.1.3.2 *End Point Stress*— 657 kPa (95.3 psi), which is 5338 N (1200 lbf) total for 10-cm or 4-in. diameter specimens.

5.1.4 *High-Pressure Gage*, with capability of indicating within ± 110 kPa (± 16 psi) the following: (See Note 1):

5.1.4.1 *Consolidation Stress*—11.0 MPa (1590 psi), which is 89 kN (20 000 lbf) total for 10-cm or 4-in. diameter specimens.

5.1.5 *Tilt Mechanism*, to cock the mold 6° while the specimen is under pregyration stress (see 5.1.3.1). In reverse manner, it squares the mold axially against the press platen, with a smooth quick motion.

5.1.6 *Gyration Mechanism*, to move the mold about the ram face 12° total angle and produce gyrotory shear compaction of the specimen. An electric motor drives the gyration mechanism at approximately 1 s/cycle.

5.1.7 *Count Mechanism*, to shut the gyration motor off after three complete cycles and to stop it in the loading position with an electric brake.

5.1.8 *Hydraulic Hand Pump*, which meters 0.51-mm (0.020-in.) ram movement, with a smooth quick motion.

5.2 *Gyrotory Mold*— Rigid metal mold as shown in Fig. 1 and Fig. 3, with a concentric hardened ring for manipulating gyrotory action, and hardened to at least 55 HRC honed and hard-plated interior.

5.3 *Base Plate*—Solid metal plate as shown in Fig. 1 and Fig. 2. Top and bottom surfaces are hardened and ground flat. (See Table 1 for a comparison of dimensions.)

5.4 *Wide-Mouth Funnel*, with mouth that fits inside mold.

5.5 *Scale or Balance*, having at least 4500-g capacity, sensitive to 0.1 g.

5.6 *Sieve or Screen*— A 25-mm (1-in.) screen or 22.4-mm ($\frac{7}{8}$ -in.) sieve.

5.7 *Spatula*—A flexible spatula having a blade about 100 mm (4 in.) long and 20 mm ($\frac{3}{4}$ in.) wide.

5.8 *Spoon*—A large spoon with a right angle bend between the bowl and handle.

5.9 *Measuring Device*— A micrometer dial assembly or calipers for determining the height of the specimens is suitable for this purpose.

¹ This practice is under the jurisdiction of ASTM Committee D-4 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.26 on Fundamental/Mechanistic Tests.

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² *Annual Book of ASTM Standards*, Vol 03.01.

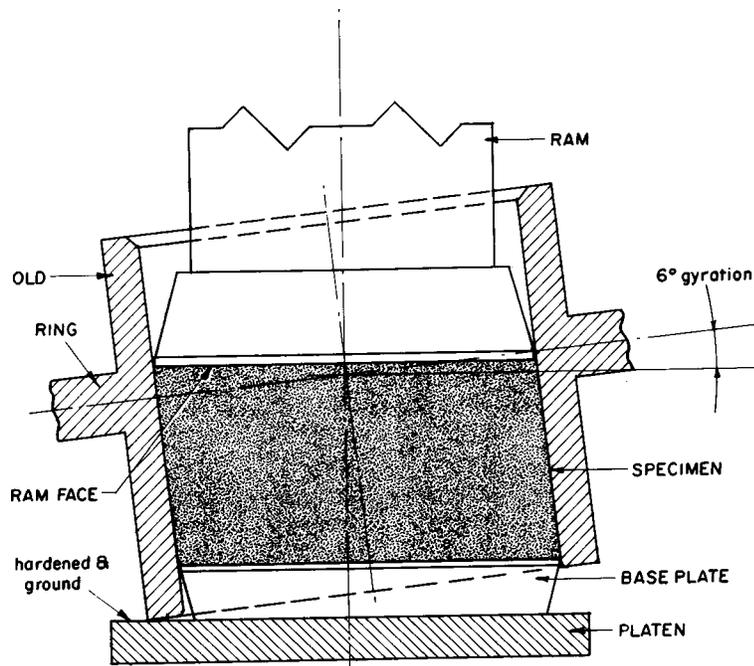


FIG. 1 Mold Assembly

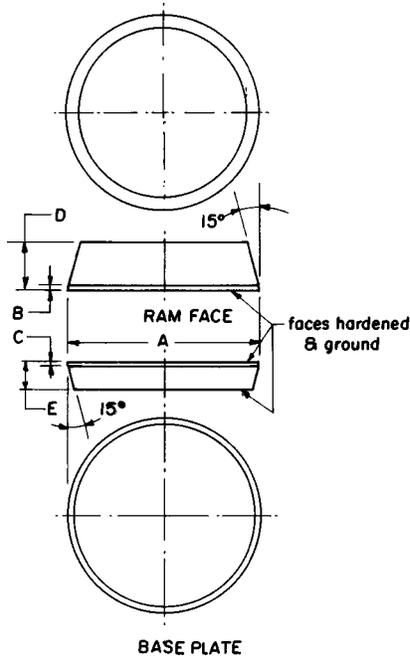


FIG. 2 Ram Face and Base Plate

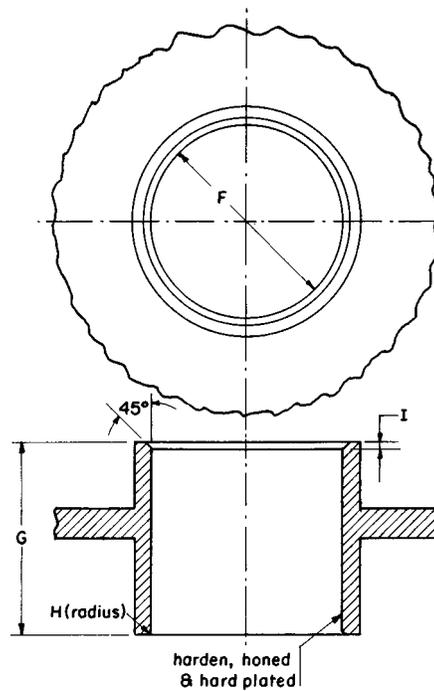


FIG. 3 Mold

5.10 *Specimen Extrusion Device*—A rigid right cylinder, having a minimum height of 115 mm (4½ in.), and a diameter of approximately 98 mm (3⅞ in.) to be used as a pedestal with a converted arbor press or some similar device. Other methods of specimen extrusion that do not damage the specimen may be used.

5.11 *Oven*, for specimen mixtures and mold assemblies having a range from 38 to 150°C (100 to 300°F) and thermostatically controlled to within ±3°C (±5°F).

5.12 *Miscellaneous*—Thermometers, trowels, gloves, and mixing pans.

NOTE 1—Because the effective diameter of the ram is different than the nominal inside diameter of the mold, the hydraulic pressure on the ram is not the same as the stress on the specimen. (The hydraulic pressure on the ram for many presses is equal to 50 psi, 150 psi and 2500 psi for Pregyration Stress, End Point Stress, and Consolidation Stress, respectively.)

6. Materials

- 6.1 *Kerosine*.
- 6.2 *Lubricating Oil*, lightweight grade.
- 6.3 *Paper Disks*, 10-cm or 4-in. diameter.

TABLE 1 Dimensions of Fig. 2 and Fig. 3

Dimension	Preferred		Alternative	
	mm	Tolerance	mm	Tolerance
A	100.00	+0.00 -0.05	101.60	+0.00 -0.05
B	2.54	+0.00 -0.25	2.54	+0.00 -0.25
C	1.57	±0.25	1.57	±0.25
D	25.40	±0.38	25.40	±0.38
E	14.27	±0.38	14.27	±0.38
F	100.25	±0.05	101.85	±0.05
G	100.00	+0.00 -0.13	101.60	+0.00 -0.13
H	1.57	±0.13	1.57	±0.13
I	3.18	±0.25	3.18	±0.25

7. Test Specimen

7.1 *Preparation of Mixture*—Prepare the bituminous mixture in accordance with the specified test method.

7.2 *Amount of Mixture*—Prepare constant-weighed amounts of bituminous mixture such that the compacted specimen heights are within the tolerances of the specified test method. If an initial specimen height is not within tolerances, revise the constant weight of subsequent specimens by multiplying the initial constant weight by the optimum height and dividing by the initial height as follows:

$$\text{Revised constant weight} = \frac{(\text{initial constant weight}) \times (\text{optimum height})}{\text{initial height}} \quad (1)$$

7.2.1 *Example*—The specified height is 2.00 ± 0.25 in. The weight of the initial specimen is selected to be 2500.0 g, and it is compacted to 2.32 in. The constant weight for the next and subsequent specimens of this mixture should be $(2500.0 \text{ g} \times 2.00 \text{ in.})/2.32 \text{ in.}$; or 2155.2 g.

8. Calibration

8.1 *Gage Scales*, The scales on the low- and high-pressure gages may indicate the pressure of the hydraulic system or the force of the ram. Distinct points on the low pressure gage must be determined for pregyration stress (5.1.3.1) and end point stress (5.1.3.2), and one point on the high pressure gage for the consolidation stress (5.1.4.1).³

8.2 *Verification*— The low- and high-pressure gages should be verified on the gyratory-shear molding press at the points determined in 8.1, in accordance with Method E 4.

9. Preparation for Test and Compaction Temperatures

9.1 Mix hot-mix asphaltic concrete mixtures that contain asphalt cement and compact into test specimens at a temperature of $121 \pm 3^\circ\text{C}$ ($250 \pm 5^\circ\text{F}$).

9.2 Place hot-mix, cold-laid mixtures and rock asphalt mixtures in an oven, cure to constant weight at a temperature of $60 \pm 6^\circ\text{C}$ ($140 \pm 10^\circ\text{F}$) to remove moisture or hydrocarbon

volatiles, and mold at a temperature of $38 \pm 3^\circ\text{C}$ ($100 \pm 5^\circ\text{F}$). Curing to a “constant weight” may be accomplished by drying for a specific period of time that has proven by experiment to be adequate or drying to the point that by observation, based on experience, the material is sufficiently dry for testing. Drying should be accompanied by frequent stirring.

9.3 If the mixture (such as one obtained from an asphaltic concrete plant) contains aggregate larger than 22.4 mm ($7/8$ in.), separate the large size aggregate from the sample by means of a 22.4-mm sieve (or a 25.0-mm (1-in.) round opening screen). Use the trowel to rub the material through the sieve, scrape off, and recover as much of the fines clinging to oversize particles as possible.

9.4 Preheat the mold and base plate in an oven to approximately 60 to 93°C (140 to 200°F). For hot-mix, cold-laid mixtures and rock asphalt mixtures, heat to 38°C (100°F). Make certain that the gyratory mechanism is in proper working order and in the loading position. Connect the motorized gyratory-shear molding press to its electrical outlet, and switch on the gyration mechanism, allowing the press to go through one set of gyrations.

9.5 Place a small amount of lightweight oil in the center of the motorized press platen and a drop or two on the surfaces of the lower bearing. (This is the bearing that “cocks” the mold and gives or creates the gyratory action.) Squirt a small ring of oil around the periphery of the top surface of the mold’s ring, in the path that the upper bearing will follow during the gyration. Do not use an excessive amount. When molding a number of specimens, this step should be repeated as appears necessary for adequate lubrication.

9.6 Remove the mold and base plate from the oven and wipe the inside of the mold with a rag lightly moistened with kerosene or light lubricating oil. Insert the base plate into the mold with the large diameter up, and cover with a paper disk. Using the bent spoon and wide-mouthed funnel, transfer the laboratory mixtures, or a weighed quantity of plantmixed material, heated to proper molding temperature, in two approximately equal layers, into the mold. Use the small spatula to move any large aggregate a small distance away from any surface that must be molded smooth. Level the top of each layer while pressing the material downward with the spoon. Place a paper disk on top of the mixture. Be careful to avoid loss of material and segregation of particles.

9.7 Slide the hot mold and contents to the edge of the work table, and with a gloved hand holding the base plate in place, transport the mold to the platen of the press. Slide the mold onto the platen and center it in the molding position beneath the ram of the press. Pump the ram down into the center of the mold. Continue pumping until the low pressure gage reaches the pregyration stress point (5.1.3.1).

10. Gyratory-Shear Compaction

10.1 Immediately tilt the mold to the specified angle of gyration. Be certain that the mold is tilted all the way. The metering pump should be completely full, accomplished by lifting its handle all the way up.

10.2 Switch on the gyrating mechanism. The mold is automatically gyrated three times and stopped.

³ Original presses had 3.19-in. diameter jack cylinders such that the three stress points on the gage were 50, 150, and 2500-psi (345, 1034, and 17 237-kPa) hydraulic pressures, respectively.

NOTE 2—Experience has revealed that the smoothest operating procedure, and certainly the *safest*, is for the operator to keep one hand on the pump handle at all times while operating the controls with the other hand.

11. End Point Trial

11.1 As soon as the mold stops gyrating, reverse the tilt mechanism to square the mold, and immediately follow with *one full stroke* of the metering pump. Squaring the mold and the test pump stroke must be two smooth, complete, and consecutive motions. (The speed of the full stroke of the pump is important because this serves as the end point criteria for the procedure. The proper pumping speed is one full stroke in approximately one second.) Observe the low-pressure gage during the one full stroke of the metering pump; this is important because it checks for the end point of gyratory-shear compaction.

11.2 If the low-pressure gage does not reach end point stress (5.1.3.2), adjust the pressure to pregyration stress (5.1.3.1), and repeat the procedure in Section 10. During molding when the gage comes to rest between pregyration stress and end point stress, drop the pressure below pregyration stress and pump back up to it:

11.2.1 *Example*—Suppose the pregyration stress is 345 kPa (50 psi) on the low-pressure gage and the end point stress is 1034 kPa (150 psi). If the mold is squared and the test pump stroked once, three types of conditions are possible:

11.2.1.1 The low-pressure gage goes to 414 kPa (60 psi) and drops to 310 kPa (45 psi); pump to 345 kPa and repeat the procedure in Section 10.

11.2.1.2 The low-pressure gage reaches 965 kPa (140 psi) and drops to 793 kPa (115 psi); release the pressure to approximately 276 kPa (40 psi), pump to 345 kPa (50 psi), and repeat the procedure in Section 10.

11.2.1.3 The low-pressure gage reaches 1048 kPa (152 psi) and drops, which indicates that compaction is completed in accordance with 12.1; proceed as described in 12.2 through 12.6.

12. Completion of Test

12.1 The gyratory-shear compaction and the end point trial

are repeated alternately until one nonviolent stroke of the metering pump causes the gage to surge to end point stress (5.1.3.2) or higher, thus indicating completion of the gyratory-shear portion.

12.2 Pump slowly until the automatic gage protector valve cuts the low-pressure gage out of the system. Then, at approximately one stroke per second, pump the pressure up to consolidation stress (5.1.4.1), as measured by the high-pressure gage.

12.3 As soon as the gage registers consolidation stress, stop pumping with the one hand, and with the other very *carefully* bleed-off the pressure, watching the descent of the high-pressure gage when releasing stress so as to prevent damage to the gage.

12.4 Pump the ram up and out of the mold. Slide the mold out of the press, remembering to place a gloved hand beneath the mold to keep the base plate from falling out. Remove the specimen from the mold by placing the assembly on the extrusion pedestal and, with the aid of a converted arbor press or some similar device, force the mold off the specimen. (Other methods of specimen extrusion that do not damage the specimen may be used.)

12.5 Measure the height of the specimen for conformity to the specified test method (see 7.2), and log it in if satisfactory.

12.6 Clean the mold on the inside with a kerosine rag before molding another specimen.

NOTE 3—It should be emphasized that this motorized press *must* be kept clean. If dirt and grit collect on the platen, ram face, or hardened steel ring, wipe it off and re-oil before molding the next specimen. Attention *must* be given to cleanliness during and after molding.

NOTE 4—When all the molding is completed, disconnect the press from the electrical outlet, clean the unpainted parts of the press, platen, ram face, mold, and base plate with a lightly moistened kerosine rag, and coat with a thin coat of light-weight oil. Wipe the painted parts of the press with a clean, dry rag. This cleaning and oiling is necessary if the press is to function properly and deliver a long useful life.

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