Designation:D4013–09

Standard Practice for Preparation of Test Specimens of Bituminous Mixtures by Means of Gyratory Shear Compactor [1]

This standard is issued under the fixed designation D4013; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the preparation of 4-in. (101.6 mm) diameter test specimens of bituminous mixtures containing –7⁄8-in. (–22.4-mm) aggregate.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered 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:* [2]

E 4 Practices for Force Verification of Testing Machines

3. Summary of Practice

3.1 This practice employs gyratory-shearing action of the mixture at low initial pressures, allowing orientation of the aggregate particles to aid compaction, and then nongyratory 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 *Gyratory-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 4.5 in. (114.3 mm) down to less than 1.0 in. (25.4 mm).

5.1.3 *Low-Pressure Gauge* , 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* —31.8 psi (219 kPa) , which is 400 lbf (1779 N) total for diameter specimens.

5.1.3.2 *End Point Stress* —95.3 psi (657 kPa), which is 1200 lbf (5338 N) total for 4-in. (101.6-mm) diameter specimens.

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

5.1.4.1 *Consolidation Stress* —1590 psi (11.0 MPa), which is 20 000 lbf (89 kN) total for 4-in. (101.6-mm) 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 gyratory 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 0.020-in. (0.508-mm) ram movement, with a smooth quick motion.

5.2 *Gyratory Mold* —Rigid metal mold as shown in Fig. 1 and Fig. 3, with a concentric hardened ring for manipulating gyratory 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 1-in. (25-mm) screen or 7⁄8-in. (22.4-mm) sieve.

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[1] This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.20 on Mechanical Tests of Bituminous Mixtures.

Current edition approved July 1, 2009. Published August 2009. Originally approved in 1981. Last previous edition approved in 2005 as D4013–98 (2005).

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

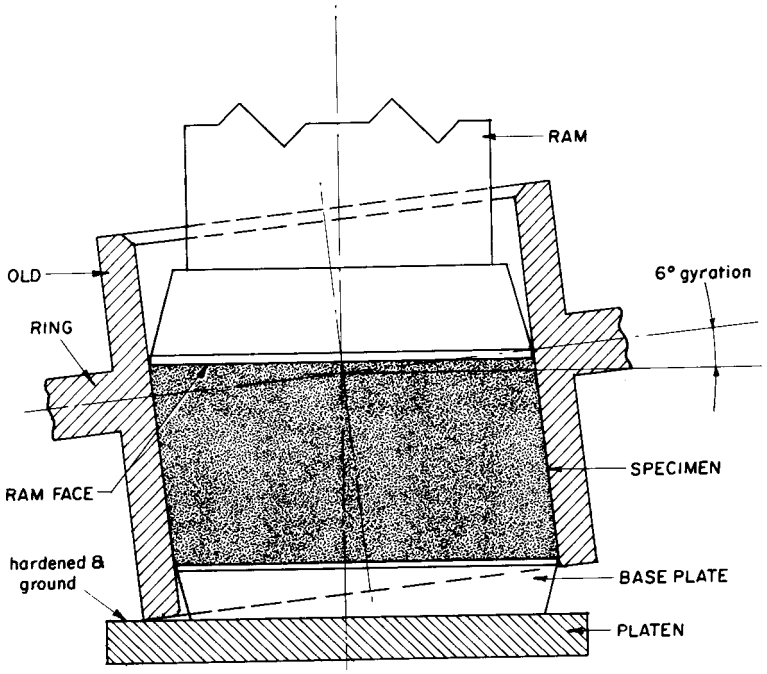

FIG. 1 Mold Assembly

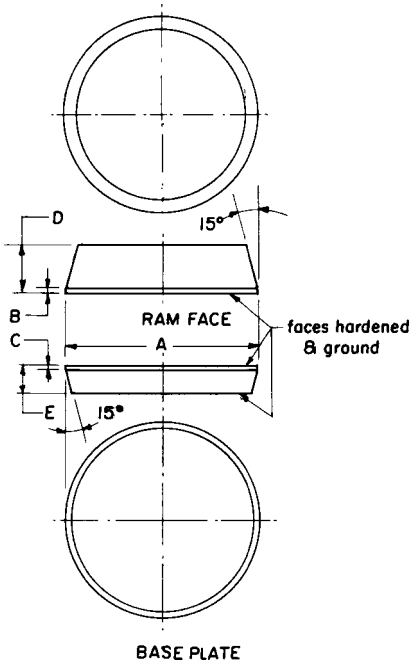

FIG. 2 Ram Face and Base Plate

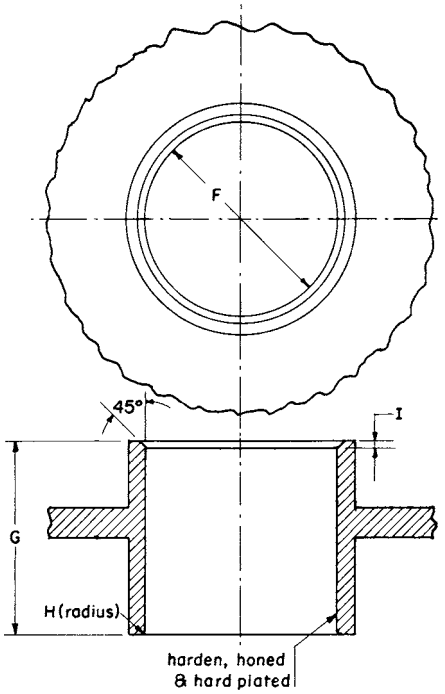

FIG. 3 Mold

5.7 *Spatula*—A flexible spatula having a blade about 4 in. (101.6 mm) long and ¾ in. (19.1 mm) 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.

5.10 *Specimen Extrusion Device* —A rigid right cylinder, having a minimum height of 4 ½ in. (114.3 mm), and a diameter of approximately 3 ⅞ in. (98.4 mm) 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 100 to 300°F (37.8 to 148.9°C) and thermostatically controlled to within ±5°F (±3°C).

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

NOTE 1—Because the effective diameter of the ram is different than the

TABLE 1 Dimensions of Fig. 2 and Fig. 3

Dimension	in. (mm)	Tolerance, in (mm)
A	4.000 (101.60)	+0.00 (0.000) –0.05 (0.002)
B	0.1 (2.54)	+0.00 (0.000) –0.25 (0.010)
C	0.062 (1.57)	±0.25 (0.010)
D	1.000 (25.40)	±0.38 (0.015)
E	0.562 (14.27)	±0.38 (0.015)
F	4.010 (101.85)	±0.05 (0.002)
G	4.000 (101.60)	+0.00 (0.000) –0.13 (0.005)
H	0.062 (1.570)	±0.13 (0.005)
I	0.125 (3.18)	±0.25 (0.010)

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 (345 kPa, 1034 kPa and 2500 kPa) 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*, 4-in. (101.6-mm) diameter.

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. (50.80 ± 6.35 mm). The weight of the initial specimen is selected to be 2500.0 g, and it is compacted to 2.32 in. (58.93 mm). The constant weight for the next and subsequent specimens of this mixture should be [2500.0 × 2.00 in.]/2.32 in. or 2155.2 g ([2500.0 g × 50.80 mm]/58.93 mm or 2156.1 g).

8. Calibration

8.1 *Gauge Scales*, The scales on the low- and high-pressure gauges may indicate the pressure of the hydraulic system or the force of the ram. Distinct points on the low pressure gauge 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 gauge for the consolidation stress (5.1.4.1).[3]

[3] Original presses had 3.19-in. (8.10 cm) diameter jack cylinders such that the three stress points on the gauge were 50, 150, and 2500-psi (345, 1034, and 17 237-kPa) hydraulic pressures, respectively.

8.2 *Verification*—The low- and high-pressure gauges 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 250 ± 5°F (121 ± 3°C).

9.2 Place hot-mix, cold-laid mixtures and rock asphalt mixtures in an oven, cure to constant weight at a temperature of 140 ± 10°F (60 ± 6°C) to remove moisture or hydrocarbon volatiles, and mold at a temperature of 100 ± 5°F (38 ± 3°C). 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 ⅞ in. (22.4 mm), separate the large size aggregate from the sample by means of a ⅞ in. (22.4-mm) sieve (or a 1-in. (25.0-mm) 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 140 to 200°F (60 to 93°C). For hot-mix, cold-laid mixtures and rock asphalt mixtures, heat to 100°F (38°C). 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 plant-mixed 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 gauge 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.

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

11.2.1.1 The low-pressure gauge goes to 60 psi (414 kPa) and drops to 45 psi (310 kPa); pump to 50 psi (345 kPa) and repeat the procedure in Section 10.

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

11.2.1.3 The low-pressure gauge reaches 152 psi (1048 kPa) 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 gauge 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 gauge protector valve cuts the low-pressure gauge 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 gauge.

12.3 As soon as the gauge 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 gauge when releasing stress so as to prevent damage to the gauge.

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.