Test Procedure for

MOLDING, TESTING, AND EVALUATING BITUMINOUS BLACK BASE MATERIALS

TxDOT Designation: Tex-126-E

Effective Date: August 1999–May 2013.

1. SCOPE

1.1 Use this method to mold an asphalt stabilized (black base) material, and determine the relationship between the percent compacted density and percent asphalt in the material. The method is also the means to test specimens unconfined in slow and fast deformation rates.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. DEFINITIONS

2.1 Maximum Density—Maximum density is the highest density calculated based on dry weight of material per cubic foot.

2.2 Minimum Allowable Percent Density—Minimum allowable percent density is the density allowed on a given black base material based on a sample of freshly gyrated road mix.

2.3 Actual Percent Density—Actual percent density is the quotient obtained from the nuclear gauge density of a roadway core divided by the density of the same roadway mix compacted in the gyratory press times 100.

2.4 Optimum Asphalt Content—Optimum asphalt content is the recommended percent asphalt taken as the percent asphalt that will produce the maximum density under a fixed compacted effort, and the compacted specimens must satisfy the specified unconfined compressive strength requirements.

3. APPARATUS

3.1 Apparatus, required to perform Tex-101-E, Part II

3.2 Motorized gyratory press, calibrated in accordance with Tex-916-K.
3.3 Compaction mold, 152.4 ± 1 mm (6 ± 0.030 in.) I.D. and 305 ± 2 mm (12 ± 1/16 in.) high-forming mold with gyratory flange collar and mold base plate. It is preferable, but not necessary, that the mold be chromium plated.

3.4 Spacer block, approximately 200 mm (8 in.) high.

3.5 Press, to eject specimen from the mold.

3.6 Mechanical mixer.

3.7 Ovens, able to heat to 143°C (290°F), 121°C (250°F), and 60°C (140°F), and maintain those temperatures to within ± 3°C (± 5°F).

3.8 Electric hot plate.

3.9 Dolly, caster mounted, made to same height as compactor platen and extrusion press platen.

3.10 Metal pans, approximately 530 × 38 × 100 mm (21 × 15 × 4 in.)

3.11 Circular porous stones, slightly less than 152.4 mm (6 in.) in diameter and 51 mm (2 in.) high.

3.12 Metal disks, 152.4 mm (6 in.) in diameter by approximately 1 mm (0.030 in.) thick (No. 18 gauge sheet metal).

3.13 Filter paper, 152.4 mm (6 in.) in diameter.

3.14 Supply of small tools, trowels, plastic mallet, etc.

3.15 Asphalt, sufficient for molding specimens.

3.16 Fine soil pans, round pans approximately 200 mm (8 in.) in diameter.

3.17 Gloves, heat-resistant.

3.18 Standard U.S. sieves, meeting the requirements of Tex-907-K, in the following sizes:
   - 50 mm (2 in.)
   - 45 mm (1 3/4 in.)
   - 31.5 mm (1 1/4 in.)
   - 22.4 mm (7/8 in.)
   - 16.0 mm (5/8 in.)
   - 12.5 mm (1/2 in.)
   - 9.5 mm (3/8 in.)
   - 4.75 mm (No. 4)
   - 2.00 mm (No. 10)
4.25 μm (No. 40).

3.19 Sample pans.

3.20 Screw jack press, from Tex-117-E, unless gyratory compactor is equipped for compression testing.

4. TEST REPORT FORMS

4.1 Gyratory Worksheet

4.2 Black Base Testing Data Worksheet

5. CALIBRATING EQUIPMENT

5.1 Compact specimens approximately 152.4 mm (6 in.) in diameter and 203.2 mm (8 in.) in height in the 152.4 mm (6 in.) mold. Since some of the compacted specimens do not completely fill the mold, it is necessary to determine the volume per linear millimeter (inch) of the height of the mold.

5.2 Measure the diameter of the mold, by means of the micrometer dial, at the ends and several intermediate points to obtain an average value for the diameter.

5.3 Use the average diameter to calculate a mean cross sectional area of the mold.

5.4 Use the equation under Section 6, then:

5.4.1 Use the micrometer dial assembly and an appropriate 200 mm (8 in.) spacer block.

5.4.2 Place the mold base plate in position on the gyratory platen.

5.5 Bring the top gyratory head down on the spacer and determine the dial setting for a specimen of 200 mm (8 in.) height.

5.6 Set the dial face to read zero. Specimens taller than 200 mm (8 in.) will read greater than the “zero” reading; shorter specimens will read less.

6. CALCULATIONS

6.1 Calculate the volume per unit of height of the mold:

\[
\text{volume of mold (m}^3 / \text{mm}) = \frac{(Area \text{ mm}^2)}{1,000,000} \times (1 \text{ mm})
\]
Or:

\[
\text{Volume of mold (ft}^2/\text{in.}) = \frac{(Area, \text{in}^2) \times (1 \text{ in.})}{1,728}
\]

7. PREPARING SAMPLE

7.1 Select a 130 kg (300 lb.) representative sample. Check specifications for maximum size aggregate.

7.2 The material must be prepared in accordance with Tex-101-E, Part II.

7.3 When recycled asphalt pavement (RAP) material is used, the percent asphalt content must be determined in accordance with Tex-210-F.

8. PROCEDURES

8.1 Weight Batching Materials to be Mixed:

8.1.1 Place a supply of asphalt to be used in the oven and heat to 140 ± 3°C (290 ± 5°F).

8.1.2 Estimate the weight of material that, when heated, mixed with the intended asphalt and gyratory molded, will fill the gyratory mold to a specimen height of 200 ± 6 mm (8 ± 0.25 in.) In case the estimated weight for the first specimen is not in keeping with this tolerance after molding, adjust weight to meet height tolerance before weighing out other specimens.

8.1.3 Using this weight and the percentages of the various sizes of particles obtained in preparation of the large sample, calculate the cumulative weights of each size to combine to make a specimen.

8.1.4 Weigh the specimen as calculated in Step 3, separating the virgin aggregate on a 2.00 mm (No. 10) sieve. All RAP material must be kept separate from the virgin material.

8.1.5 Place the plus 2.00 mm (No. 10) fraction of the virgin aggregate in a tared mixing pan and the passing 2.00 mm (No. 10) portion of the virgin aggregate in a smaller tared pan. Place both pans in the oven for heating. If all the material is passing 2.00 mm (No. 10), the larger mixing pan only must be used. Heat the virgin material and RAP to 140 ± 3°C (290 ± 5°F).

8.2 Mixing and Molding Black Base Specimens:

Note 1—Preheat the mold and base plate in the 121°C (250°F) oven to help retain the heat of the mixture during loading and gyration. Proceed to mix and mold the first specimen on the Asphalt-Density curve.
8.2.1 Remove the pans of material from the oven and weigh. Perform this step when the material reaches approximately 143°C (290°F), and is ready for mixing. Subtract the sum of the tares of the pans and obtain the dry weight of aggregates.

8.2.2 Place the pan containing the virgin passing 2.00 mm (No. 10) portion back in the hot oven, and place the mixing pan and its contents on the preheated hot plate for temperature retention.

8.2.3 Calculate the weight of asphalt required in the specimen, then place the mixing pan back on the scales and accurately weigh in the hot asphalt from the oven.

8.2.4 Return the mixing pan to the hot plate.

8.2.5 Using a trowel or other convenient mixing tool, mix and turn the hot mixture of asphalt and retained on 2.00 mm (No. 10) virgin material until it appears to be as well coated as it can be using that particular percentage of asphalt. This may require several minutes.

8.2.6 When the mixing of the aggregate particles is completed, add in the passing 2.00 mm (No. 10) portion from the oven and continue mixing.

8.2.7 When dealing with RAP, add the RAP last and complete the mixing.

8.2.8 When using a mechanical mixer is used, place the material and mix in the mixer following the same sequence described in Sections 8.2.4–8.2.6.

8.2.9 Put the mixed materials in a large pan and place it in the oven at 121 ± 3°C (250 ± 5°F) for two hours prior to molding.

8.2.10 Remove the base plate from the oven and place it on the loading dolly.

8.2.11 Place the hot mold on the base plate and insert one of the thin 152.4 mm (6 in.) metal disks in the mold on top of the base plate.

8.2.12 Place one piece of the round 152.4 mm (6 in.) filter paper on the metal disk.

8.2.13 Load the hot mixture into the mold in accordance with Section 8.3.

8.2.14 When the mold has been loaded, level the fines on top with a hand tool.

8.2.15 Place another filter paper on top of the mix, then a thin metal disk and move the dolly, with the mold on it, to the gyratory press.

8.2.16 Slide the mold, with base plate, onto the platen of the compactor. The platen must have a generous coat of good lubricant or the platen and base plate can be damaged.

8.2.17 Center the mold, lower the compactor head on the specimen, and turn the lift cam down to give the mold its 5-degree lift angle.

8.2.18 Using the machine controls, place a load of 241 kPa (35 psi) gauge 138 kPa (20 psi) specimen with the loading ram on the specimen, and turn on the machine.
8.2.19 Gyrate the specimen for two minutes at 241 kPa (35 psi) gauge loading.
8.2.20 At the end of two minutes, increase the load to 476 kPa (69 psi) gauge 276 kPa (40 psi) specimen and continue gyrating two minutes.
8.2.21 Increase the load on the ram to 717 kPa (104 psi) gauge 414 kPa (60 psi) specimen and continue gyration until the gauge needle will stand steady for five revolutions of the platen. This means that there has been no appreciable shortening or densification in the five revolutions.
8.2.22 Turn the gyratory press off.
8.2.23 Slightly release the pressure from the top of the specimen, and, using the handle provided, return the cam lift to its original position. Reduce the angle of lift to zero.
8.2.24 Place 241 kPa (35 psi) gauge pressure on the specimen, and turn the machine on for a few revolutions. This tends to square up the specimen.
8.2.25 Turn the machine off.
8.2.26 Wipe off any oil on the platen, and place 5964 kPa (865 psi) gauge pressure on the specimen. This is 3447 kPa (500 psi) on the cross-section of the specimen.
8.2.27 Place the pre-set measuring stand in position to measure the height of specimen.
8.2.28 Hold the load on the specimen until the rate of consolidation is 0.13 mm (0.005 in.) or less in five minutes. The consolidation rate must be measured in five-minute increments.
8.2.29 Observe the dial reading, and record the net height of specimen only, making allowance for thickness of the metal disks.
8.2.30 Remove the measuring device, and then the load on the specimen.
8.2.31 Raise the ram out of the mold and remove the mold from the machine platen to the dolly.
8.2.32 Slide the mold with base plate on the platen of the ejection press and eject the specimen up and out of the mold.
8.2.33 Remove the top and bottom metal disks and weigh the specimen to the nearest 0.5 g. Clean any material adhering to the disks that was included in the measured height, and weigh this with the specimen.
8.2.34 Put the specimen with a 152.4 mm (6 in.) porous stone on the bottom and place in the 60°C (140°F) oven for storage if further testing for strengths is desired. Use two or more molds to minimize time lost for heating the molds, using one and then the other. However, use only one base plate, unless they are identical in height.
8.2.35 Calculate the volume and the density of specimen according to the equation under Section 8.4.
8.2.36  Begin to construct the Asphalt-Density Curve by plotting the first point for this specimen on Figure 1.

8.2.37  Vary the percent asphalt in the mix, and mix, mold, and plot the results from enough specimens to clearly define the Asphalt-Density Curve, especially in the break of the curve. Take the break of the curve as the optimum asphalt content, and use this as the starting point for the field mix.

8.2.38  Mold duplicate specimens for each point. Where points are made with extremely low asphalt content and several other percentages of asphalt are molded prior to the break in the curve, then if possible, omit that duplication.

8.2.39  Store the fresh, hot molded specimen in the 60°C (140°F) oven to await further testing or cooling in the case of just molded specimens. A supply of top porous stones must be kept in the oven, but must not be placed on the specimens because of a tendency to cause slumping. Very rich specimens must be spaced about 51 mm (2 in.) away from other specimens to prevent damage in the case of slumping.

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**Figure 1**—Percent Asphalt in Mix vs. Total Density Graph

8.3  **Loading Hot Mixture into Mold:**

8.3.1  After mixing and the two-hour curing in the 121°C (250°F) oven, but before removal of the mold from the oven, separate the larger aggregates equally, as judged by eye, in the corners of the mixing pan.

8.3.2  Bring the dolly and mold assembly to the mixing pan, placing the hot plate and mixing pan near the mold.
8.3.3 Begin loading by placing about 13 mm (0.5 in.) loose thickness of the finer sizes of the mixture on top of the filter paper.

8.3.4 With a spatula or any convenient tool, level these fines out in the mold.

8.3.5 Place one quadrant of the larger aggregates, from one of the corners, into the mold, and level as above.

8.3.6 Place the remaining intermediate sizes and fines, from the same quadrant of the pan, on top of the larger aggregates and spade well around the sides of the mold and in the layer as well. Do not allow the larger aggregates to come to the top of the loose layer.

8.3.7 Load in the second, third, and fourth quadrants of the mixture in the same manner except that about 6 mm (0.25 in.) of loose fines at the beginning is sufficient. Spade well around the sides after the addition of each quadrant of the mixture.

8.3.8 After loading the fourth quadrant, top off the layer with about 6 mm (1/4 in.) of fines. Using a wide-blade putty knife or similar tool, scrape out the remaining contents of the pan and place in the mold.

8.3.9 Place all the contents of the pan in the mold for gyration for one specimen. The intent of this technique is to load the mold each time for maximum density. This reduces time of gyration and produces more uniform, repeatable specimens.

8.3.10 In loading hot sand and asphalt mixes, or any fine-sized fluffy material, the amount of mixture that will gyrate into a specimen may exceed the volume of a mold. In this case, after the addition of each quadrant, push the material down using any convenient tool. Use a finishing tool that covers the cross section of the mold.

8.3.11 Tamp the loose mixture, using a plastic or rawhide hammer.

8.4 Calculation:

8.4.1 Calculate the volume and the density of specimen as follows:

\[
\text{Specimen Volume} m^3 (ft^3) = (\text{Height of Specimen} \text{in mm}[in.] \times \text{(Calibration Factor of Mold)})
\]

\[
\text{Density of Specimen} \text{kg/m}^3 (\text{lbs./ft}^3) = \frac{\text{Weight of Specimen}}{\text{Volume of Specimen}}
\]

8.5 Testing Black Base Specimens in Unconfined Compression:

8.5.1 Test the compacted black base specimens made in duplicate for its unconfined compressive strength at 60°C (140°F). Test one specimen at the slow deformation rate of 3.8 mm (0.15 in.) per minute, and the other at the fast rate of 250 mm (10 in.) per minute deformation. Use the triaxial testing press to perform the slow test. The gyratory compactor has the capacity to perform both the slow and fast tests. However, use any testing press meeting ASTM D 1663 (superseded by ASTM D 3515) and the deformation rate requirements.
8.5.2 When the triaxial press is used to determine the strength at the slow rate of deformation, use the procedure described in Tex-117-E for the unconfined compression test.

8.5.3 Remove the specimen from the 60°C (140°F) oven, measure the circumference, and calculate the cross-section area of the test specimen.

8.5.4 Record these data on the “Black Base Testing Data Worksheet.”

8.5.5 Set up the unconfined specimen for testing as described in Tex-117-E, and test. It will not be necessary to take any readings on the proving ring except the maximum readings. There is no need to make area corrections.

8.5.6 When the test is completed, remove the specimen for the press and calculate the strength of the material according to equation under calculations following this table.

8.5.7 Record this strength on the data sheet in Section 8.5.3, under slow strength.

8.5.8 Most large gyratory soil compactors have the capability of performing both the slow and fast tests. When this machine is used for testing, proceed as follows:

8.5.8.1 Prepare the specimens for testing as described in Section 8.5.3.

8.5.8.2 Place one of the metal disks on the platen to protect the surface from abrasion.

8.5.8.3 Center the specimen, with top and bottom porous stones in place, on the disk in the machine.

8.5.8.4 Place thin metal disk on the top of the top stone.

8.5.8.5 Using the controls on the machine, bring the top head down to just make contact with the specimen.

8.5.8.6 Turn the machine off.

8.5.8.7 Set the controls on the machine for the speed desired.

8.5.8.8 Check the drag hands on the pressure gauge to see that they are at zero.

8.5.8.9 Start the machine and read the maximum reading on the gauge at failure. Watch this reading to insure against overthrow of the follower by the gauge needle.

8.5.8.10 Record this value on the “Black Base Testing Data Worksheet.”

8.5.8.11 Since the ratio of the area of the specimen to the ram of the pump is 1.73 to 1 for a 150 mm (6 in.) diameter specimen, calculate the strength of the specimen in accordance with Section 8.6.

8.5.8.12 The specimens are tested at 60°C (140°F). Record all data on the data sheet.
8.6 Calculations:

8.6.1 Strength of the material:

\[
\text{Unconfined Compressive Strength} = \frac{\text{Total Load}}{\text{Cross - Section Area}}
\]

8.6.2 Strength of the specimen:

\[
\text{Strength, kPa} = \text{Strength, psi} \times 6.895
\]

\[
\text{Strength, psi} = \frac{\text{Gauge Reading, psi}}{1.73}
\]

8.7 Determining Field Density, Minimum Percent Density and Actual Percent Density for Field Control:

8.7.1 Field densities may be determined from core samples or nuclear gauge readings in accordance with Tex-207-F. When cores are taken from a mixture containing maximum aggregate size of 22.2 mm (7/8 in.) or larger, the cores must be 150 mm (6 in.) in diameter.

8.7.2 Use the nuclear density gauge or other methods, which are well correlated with the core densities, on the roadway during rolling as a rapid check on field density and actual percent density, while the mix is still hot and can be further densified as needed. The method used must be verified by coring once per lane mile.

8.7.3 The minimum percent density must be obtained from the density-unconfined compressive strength curve, which must be obtained as follows: obtain a sufficient amount of fresh field mix to make at least four specimens.

8.7.4 Place the material in heat retention containers during transit and in a 121°C (250°F) oven after arrival at the laboratory.

8.7.5 Using a sample splitter or other accepted methods, cut out enough fresh mix for one specimen in a mixing pan and place the pan in the small electric drying oven and raise the temperature to 121 ± 3°C (250 ± 5°F).

8.7.6 Using the procedures described in Sections 8.2.9 through 8.2.33, compact the material into a specimen and obtain the maximum gyrated density.

8.7.7 Repeat the same procedures and obtain a duplicate specimen.

8.7.8 Repeat Sections 8.8.5 through 8.8.7, mold one more pair of duplicate specimens, and mold the specimens by gyrating at 241 to 476 kPa (35 to 69 psi) gauge pressure only.
8.7.9 Skip the step that requires gyrating the specimen at 717 kPa (104 psi) gauge pressure. This exception is intended to mold specimens with lower densities and unconfined compressive strength.

8.7.10 Test the unconfined compressive strength on one of the duplicate specimens of each pair using a fast deformation rate, and test the other using a slow deformation rate.

8.7.11 Plot the unconfined compressive strength against the molded densities as shown in Figure 1.

8.7.12 From the density-unconfined compressive strength relationship, linearly extrapolate the minimum density that would satisfy the unconfined strength (both fast and slow) requirements called for in the specification, and this must be taken as the minimum allowable density. Calculate the minimum percent density according to the equation under Section 8.8.

8.7.13 Calculate Percent Actual Density of a compacted field mix according to the equation under Section 8.8.

8.8 Calculations

8.8.1 Calculate minimum percent density:

\[
\text{Maximum Percent Density} = \frac{\text{Minimum Allowable Density}}{\text{Maximum Gyrated Density}} \times 100
\]

EXAMPLE: From Figure 1 the maximum gyrated density of the field mix is 146 pcf and the field mix needs to be compacted to at least 141.5 pcf to meet the Grade 1 unconfined compressive strength requirements. With a minimum allowable density of 141.5 pcf, the minimum percent density can be calculated as:

\[
\frac{141.5 \text{ pcf}}{146 \text{ pcf}} \times 100 = 97\%
\]

8.8.2 Calculate percent actual density of a compacted field mix:

\[
\text{Percent Actual Density in Field} = \frac{\text{Density of Core}}{\text{Gyrated Maximum Density}} \times 100
\]

or

\[
\text{Percent Actual Density in Field} = \frac{\text{Nuclear Density}}{\text{Gyrated Maximum Density}} \times 100
\]

9. GENERAL NOTES

9.1 Occasionally, when first beginning to gyrate some black base materials (usually made from fine grain soils), the mold may turn instead of gyrating when 241 kPa (35 psi) gauge
pressure is applied. If this occurs, immediately increase the gauge pressure to 476 kPa (69 psi), rather than letting the mold turn for 2 minutes. If the mold continues to turn at 476 kPa (69 psi) gauge pressure, increase the gauge pressure to 717 kPa (104 psi) and complete gyration at this pressure. If the mold will not gyrate at 717 kPa (104 psi) gauge pressure, and will only turn, the operator must discard the specimen and remake the mixture using a greater amount of soil. This suggests that the amount of soil in the mold is so loose that it will not gyrate at 717 kPa (104 psi) gauge pressure. Mold a specimen much shorter than 200 mm (8 in.) if gyration can be accomplished.

9.2 Some of the large gyratory compactors have been modified with a different height-measuring device. This device is front-mounted at the bottom of the cover bonnet and has a steel strap mounted perpendicular to the machine platen to support the measuring dial. The magnetic height measuring yoke is provided with a flat smooth surface to make contact with the dial stem when the yoke is in position. The “zero” setting for this new device is the same as that described under Section 5. The advantage of the new device is that it is placed in position as soon as the loose material has been shortened enough by gyration to place the measuring yoke on top of the top gyrating head. This is usually no later than the end of the first 2 minutes of gyration at 241 kPa (35 psi) gauge pressure.

9.3 Read the height of specimen directly at any desired time and, if desired, calculate and plot a time-density curve. The procedure for gyration is the same except that the new measuring device is placed in position as described above, and the end point is reached when the rate of dial decrease is not greater than one division 0.025 mm (.001 in.) in five revolutions of the platen. From the beginning, all dial readings are decreasing values until the end point is reached. It must be noted that during gyration the needle will fluctuate some 5 to 10 points on the dial during the latter stages of gyration but as the gyration nears the end (density nearing the maximum), the minimum reading of the needle approaches the same reading.

10. GAUGE CHECK VALVE

10.1 A new accuracy feature, a gauge check valve, has been approved and recommended for use on all large gyratory soil presses. This valve is particularly useful in that the follower hand is not used, and, when the gauge check valve operates, it keeps the gauge needle at the indicated pressure until released.

10.2 To operate:

10.2.1 For gyrating purposes, turn the gauge check valve all the way in (clockwise). This allows a free flow of oil to and from the gauges.

10.2.2 For testing purposes, turn the gauge check valve all the way out (counter-clockwise). This allows oil to enter the gauge, register the pressure, and hold it until released by turning the valve all the way in.