Test Procedure for

COMPACTING SPECIMENS USING THE TEXAS GYRATORY COMPACTOR (TGC)

Texas Department of Transportation

TxDOT Designation: Tex-206-F

Effective Date: August 2009

1. SCOPE

1.1 Use Part I of this test method to compact specimens of bituminous mixtures using a TGC or replicate model type.

1.2 Use Part II to determine the correlation factor between two or more TGCs or Superpave Gyratory Compactors (SGCs) or replicate model types.

1.3 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.

PART I—COMPACTING SPECIMENS USING THE TGC

2. SCOPE

2.1 Use this procedure to properly compact specimens of bituminous mixtures using the TGC or a replicate model type.

3. APPARATUS

3.1 *Motorized gyratory-shear molding press,* calibrated in accordance with Tex-914-K (See Figure 1).

3.2 *Molding assembly,* consisting of gyratory-shear mold, base plate, and wide-mouthed funnel.

3.3 *Balance,* Class G2, in accordance with Tex-901-K, with a minimum capacity of 10,000 g.

3.4 *Heating oven,* capable of attaining a temperature of at least 325 ± 5ºF (163 ± 3ºC).

3.5 *Mercury thermometer,* marked in 5ºF (3ºC) divisions or less, or digital thermometer, capable of measuring the temperature specified in the test procedure.

3.6 *Sieve,* 3/4 in. (19.0 mm), when required.

3.7 *Flexible spatula*, with a blade 4 in. (100 mm) long and 0.75 in. (20 mm) wide.

3.8 *Large, bent spoon.*

3.9 *Micrometer dial assembly or calipers*, capable of measuring a height of at least 2 ± 0.06 in. (50.8 ± 1.5 mm).

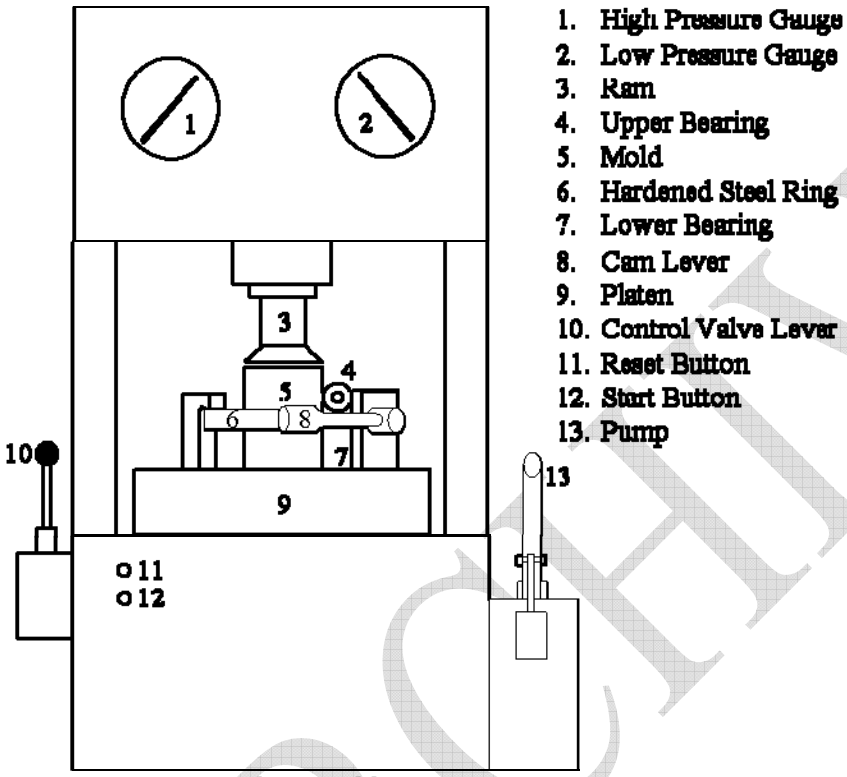

Figure 1—Gyratory Shear Molding Press

4. MIXTURE PREPARATION

4.1 For hot mix asphalt concrete (HMAC) laboratory-produced mixtures, proceed to Section 4.2. For HMAC plant-produced mixtures, proceed to Section 4.3. For laboratory or plant mixtures produced with Warm Mix Asphalt (WMA) additives or processes, proceed to Section 4.4. For other types of bituminous mixtures, proceed to Section 4.5.

4.2 *HMAC Laboratory-Produced Mixtures:*

4.2.1 Combine aggregates and prepare laboratory bituminous mixture in accordance with Tex-205-F.

4.2.2 Select a compaction temperature from Table 1 based on the asphalt binder used in the mixture design.

4.2.3 Oven-cure the mixture at the compaction temperature selected in Section 4.2.2 for two hours prior to molding.

4.2.4 Proceed to Section 4.6.

4.3 *HMAC Plant-Produced Mixtures:*

4.3.1 Sample the plant-produced mixture in accordance with Tex-222-F.

4.3.2 Select a compaction temperature from Table 1 based on the asphalt binder used in the mixture design.

4.3.3 Oven-cure the mixture at the compaction temperature selected in Section 4.3.2 for a maximum of 2 hours prior to molding.

Note 1—Reduce or eliminate the two-hour curing when testing shows that it does not affect the material properties and the laboratory-molded density.

4.3.4 Proceed to Section 4.6.

4.4 *WMA Laboratory or WMA Plant-Produced Mixtures:*

4.4.1 Prepare the laboratory bituminous mixture in accordance with Tex-205-F or sample the plant-produced mixture in accordance with Tex-222-F.

4.4.2 Select a compaction temperature.

4.4.2.1 When WMA additives or processes are allowed, select the compaction temperature from Table 1 based on the asphalt binder used in the mixture design, unless otherwise recommended by the WMA material supplier and allowed by the Engineer.

Note 2—The compaction temperature may be reduced to the anticipated production temperature when allowed by the Engineer.

4.4.2.2 When WMA additives or processes are required, select a compaction temperature between 215°F and 275°F, as recommended by the WMA material supplier.

4.4.2.3 When compacting WMA mixtures for mechanical property testing, compact the specimens at 275ºF ±5ºF.

Note 3—Mechanical property testing includes the Indirect Tensile Strength Test (Tex-226-F) as well as any other laboratory test used to measure and predict performance.

4.4.3 Oven-cure the WMA mixture at the temperature selected in Section 4.4.2.1 or 4.4.2.2 for 2 hours, except when molding specimens for mechanical property testing.

4.4.3.1 Oven-cure the WMA mixture intended for preparing specimens for mechanical property testing at 275ºF ±5ºF for 4 hours prior to molding.

4.4.4 Proceed to Section 4.6.

4.5 *Other Types of Bituminous Mixtures:*

4.5.1 Place hot-mix, cold-laid mixtures in an oven and cure to constant weight at a minimum temperature of 140°F (60°C) to remove moisture and/or hydrocarbon volatiles.

4.5.2 Oven-cure and dry limestone rock asphalt mixtures to constant weight at a temperature of 190 ± 10°F (88 ± 5°C) with frequent stirring.

Note 4—Constant weight is the weight at which further oven drying does not alter the weight by more than 0.05% in a 2-hour or longer drying interval in accordance with Section 9.1.

4.5.3 Mold specimens of hot-mix, cold-laid mixtures and limestone rock asphalt mixtures after cooling to a temperature of 100 ± 5°F (38 ± 3°C).

4.5.4 Proceed to Section 4.6.

4.6 Select a mixture weight that will yield a 2 ± 0.06 in. (50.8 ± 1.5 mm) high specimen when molded.

4.7 If the mixture prepared in the laboratory or obtained from an asphaltic concrete plant contains aggregate larger than 3/4 in. (19.0 mm), remove the large aggregate using a 19 mm (3/4 in.) sieve.

4.8 Use the trowel to rub the material through the sieve and scrape off as much of the fines clinging to oversize particles as possible.

4.9 Preheat the mold and base plate in an oven at the selected compaction temperature for 15 ± 2 min. or for a minimum of 4 hr. at 140°F (60°C).

4.10 For hot-mix, cold-laid, heat the mold and base plate in an oven at the curing temperature for 3 to 4 min.

5. PREPARATION OF THE TGC

5.1 Make certain that the platen is free to turn.

5.2 Connect the motorized TGC to an appropriate AC outlet, and push the reset and start buttons.

5.3 Allow the TGC to go through one set of gyrations.

5.4 Place a small amount of lightweight oil in the center of the motorized platen and a drop or two on the surface of the lower bearing.

Note 5—This is the bearing that 'cocks' the mold and creates the gyratory action.

5.5 Squirt a small ring of oil around the periphery of the mold on the top surface of the hardened steel ring. This ring of oil must be in the path that the upper bearing will follow during gyration. Do not use an excessive amount of oil in making this ring.

5.6 When molding a large number of specimens, repeat Sections 5.4 and 5.5 every ten to fifteen specimens, or as appears necessary when wearing surfaces become dry.

6. COMPACTION PROCEDURE

6.1 Remove the mold from the oven and wipe the inside lightly with a damp rag moistened with kerosene or light lube oil.

6.2 Insert base plate into mold with large diameter up, and place a paper gasket over base plate.

6.3 Place approximately 1/3 of the mixture into the mold, taking care not to segregate the mixture. Use the bent spoon and wide-mouthed funnel to transfer the mixture into the mold. If testing the specimen for Hveem stability, the vertical side of the specimen must be smooth to prevent damage to diaphragm of the stabilometer. Since the top and bottom surface need not be exceptionally smooth, do not arbitrarily place fine material on the bottom or top of the sample.

6.4 With a sawing motion, move the small spatula around the inside of the mold to the bottom of the recently placed 1/3 lift, and then use the spoon to lightly press the material down.

6.5 Add another 1/3 of the material, using the spatula and pressing down with the spoon as before.

6.6 Place the remainder of the sample into the mold, again using the spatula, and level the surface of the specimen while pressing the material down.

6.7 Place a paper gasket on top of the mixture. Avoid loss of material and segregation of particles while placing the mixture into the mold.

6.8 Slide the hot mold and contents to the edge of the worktable, and with a gloved hand holding the base plate in place, transport the mold to the platen of the TGC.

6.9 Slide the mold onto the platen and center it beneath the ram of the TGC.

6.10 Move the lever on the control valve to the forward or positive position, and pump the ram down into the center of the mold.

6.11 Continue pumping until the low pressure gauge first registers 50 psi (345 kPa). It is normal for the pressure to immediately fall below 50 psi (345 kPa). Do not continue to apply pressure after the gauge has first registered 50 psi (345 kPa). No more than 3 min. should pass from the time the mixture is removed from the oven to the time the initial 50 psi (345 kPa) is placed on the mixture.

6.12 Immediately pull the handle of the cam-lever down to the horizontal position, cocking the mold to the proper angle of gyration. Be certain that the cam-lever is pulled all the way down. The pump handle must be all the way up.

6.13 Push the reset button, then press and hold the start button. The mold will gyrate three times and stop. Hold the start button with the left hand while holding the pump handle in the uppermost position with the right hand. Should the start button be disengaged,

molding press gyrations will cease. Press the start button again to complete the three-gyration cycle. Keep hands away from the gyrating platen while in motion.

6.14 As soon as the mold stops gyrating, immediately level the mold by raising the cam-lever handle to the vertical position with the left hand while making one full stroke of the pump handle with the right hand. These must be two smooth, consecutive motions. The speed of the full stroke of the pump is important, for it serves as an endpoint for the procedure. The proper speed of pump stroke is one stroke per second.

6.15 Once again, apply pressure using the pump until the low pressure gauge first registers 50 psi (345 kPa), lower the cam-lever to the horizontal position, push the reset button, and then push and hold the start button.

6.16 During molding, when one stroke of the pump handle causes the gauge to come to rest between 50 to 150 psi (345 to 1,034 kPa), drop the pressure below 50 psi (345 kPa) by shifting the lever on the control valve to the unloading position and immediately returning it to the loading position.

6.17 Pump the pressure back to 50 psi (345 kPa). Experience reveals that the smoothest operating procedure, and certainly the safest, is for the operator to keep the right hand on the pump handle at all times. Use the left hand to operate the cam-level, the reset button, the start button, and the control valve.

6.18 Repeat Sections 6.13 through 6.17 until one smooth stroke of the pump handle, as described above, will cause the low pressure gauge to indicate a pressure of 150 psi (1,034 kPa) or more.

6.19 When one full stroke of the pump causes the low pressure gauge to indicate to 150 psi (1,034 kPa) or more, the gyrating portion of the molding procedure is complete.

6.20 At this endpoint of 150 psi (1,034 kPa), bring the pump handle down slowly until the automatic gauge protector valve cuts the low pressure gauge out of the system.

6.21 At approximately one stroke per second, pump the pressure up to 2,500 psi (17,238 kPa), as measured on the high pressure gauge.

6.22 As soon as the gauge registers 2,500 psi (17,238 kPa), stop pumping with the right hand, and with the left hand, very carefully release the pressure by slowly reversing the lever on the control valve to the backward position. Watch the large capacity gauge when releasing pressure to prevent damage to the low pressure gauge due to sudden, violent release of pressure.

6.23 Pump the ram up and out of the mold.

6.24 Slide the mold out of the TGC, remembering to place a gloved hand beneath the mold to keep the base plate from falling out.

6.25 Allow the base plate to drop out of the mold onto the worktable. Invert the mold and remove the specimen from the mold with a converted arbor press or similar device.

6.26 Measure the height of the specimen. If testing the specimen for Hveem Stability, the height must be 2 ± 0.06 in. (50.8 ± 1.5 mm). If the height is not within this tolerance, discard the specimen and mold another specimen using the weight calculated from the formula in Section 9.2.

6.27 Clean the inside of the mold with a rag lightly moistened with kerosene or light lube oil before molding another specimen. It is critical to keep the TGC clean. If dirt or grit collects on the platen or hardened steel ring, wipe it off and re-oil it before molding the next specimen.

6.28 When all the molding is complete, disconnect the TGC from the electric outlet. Clean the unpainted parts of the TGC, the mold, and the base plate with a lightly moistened kerosene rag and coat with a thin coating of lightweight oil. This cleaning and oiling is an absolute necessity if the TGC is to continue functioning properly. Wipe the painted parts of the TGC with a clean, dry rag.

7. TGC LUBRICATION

7.1 Remove the setscrew from the center of the platen spindle top every three months and fill the reservoir with high-quality S.A.E. 30 weight hydraulic oil.

7.2 Periodically put several drops of high-quality S.A.E. 30 weight hydraulic oil in the two oil holes of the elevating roller.

7.3 Follow the lubrication instructions on the plate attached to the end of the electric motor.

8. MIXING AND COMPACTION TEMPERATURES

8.1 Use the mixing and compaction temperatures in Table 1 when preparing samples for curing and compaction. Use the same temperature for both curing and compacting of these mixtures.

8.2 Mixtures containing asphalt materials not listed in Table 1, or those containing viscosity-modifying additives, may require considerably varied mixing temperatures from those listed. For guidance, consult the binder supplier or the Flexible Pavements Branch of the Materials and Pavements Section of the Construction Division.

8.3 The Engineer must approve the use of mixing and compaction temperatures different from those listed.

Table 1—Mixing and Compaction Temperatures		
PG Grade	**Mixing °F (°C)**	**Compaction °F (°C)**
76-16, 76-22; 70-28	325 (163)	300 (149)
70-22; 64-28	300 (149)	275 (135)
64-16, 64-22	290 (143)	250 (121)
58-22, 58-28	275 (135)	250 (121)
Asphalt-Rubber (A-R) Binder	325 (163)	300 (149)

Note 6—Mixtures must be compacted at the selected compaction temperature within a tolerance of ±5°F (±3°C).

9. CALCULATIONS

9.1 Calculate the percent difference in weight:

$$PercentDifference = \left(\frac{InitialWeight - FinalWeight}{InitialWeight} \right) * 100$$

9.2 Calculate height adjustment:

$$\text{Re}\,quired\ Weight\ (grams) = \frac{DW}{H}$$

Where:

D = desired height of specimen, 2.0 in. or 50.8 mm

W = weight of existing molded specimen, g

H = height of existing molded specimen, in or mm.

PART II—CORRELATING GYRATORY COMPACTORS

10. SCOPE

10.1 Use this procedure to minimize the variability of the bulk specific gravity (G_a) of compacted bituminous specimens between two different Texas Gyratory Compactors (TGCs) or Superpave Gyratory Compactors (SGCs).

11. APPARATUS

11.1 *Motorized gyratory-shear molding press,* calibrated in accordance with Tex-914-K or as per manufacturer's recommendations.

11.2 *Molding assembly*, consisting of gyratory-shear mold, base plate, and wide-mouthed funnel.

11.3 *Balance*, Class G2, in accordance with Tex-901-K, with a minimum capacity of 10,000 g.

11.4 *Mercury thermometer*, marked in 5°F (3°C) divisions or less, or digital thermometer, capable of measuring the temperature specified in the test procedure.

11.5 *Sieve*, 3/4 in. (19.0 mm), when required.

11.6 *Flexible spatula*, with a blade 4 in. (100 mm) long and 0.75 in. (20 mm) wide.

11.7 *Large, bent spoon.*

11.8 *Micrometer dial assembly or calipers*, capable of measuring a height of at least 2 ± 0.06 in. (50.8 ± 1.5 mm).

11.9 *Heating oven*, capable of attaining a temperature of at least 325 ± 5ºF (163 ± 3ºC).

12. PROCEDURE

12.1 Reference the most current Flexible Pavements Branch Statewide Proficiency Report for correlation of the gyratory compactors.

Note 7–Reference the proficiency report for all technicians who use the gyratory compactor.

12.1.1 Perform a two-press correlation among the presses if the rating for the bulk specific gravity (G_a) of the gyratory compactor to be correlated to was two standard deviations or less of the Statewide average G_a.

12.1.2 Perform a three-press correlation of the two presses to the Referee gyratory compactor of CST/M&P's Flexible Pavements Branch if the G_a of the gyratory compactor to be originally correlated to was more than two standard deviations of the Statewide average G_a.

12.2 Obtain a representative sample of bituminous mixture using one of the following methods for either a two- or three-press correlation:

- Obtain a sample from the plant in accordance with Tex-222-F.
- Prepare a laboratory sample (minimum size of 20,000 g for a two-press correlation and a minimum 30,000 g for a three-press correlation) in accordance with Tex-205-F for TGC.
- Prepare a laboratory sample (minimum size of 60,000 g for a two-press correlation and a minimum 90,000 g for a three-press correlation) in accordance with Tex-241-F for SGC.

12.3 Use sample weights that are 1,000 ± 1 g or allow a specimen height of 2 ± 0.06 in. (50.8 ± 1.5 mm) when correlating TGCs. Combine at least nine samples for each press to correlate.

12.4 Use sample weights that are 4,500 ± 10 g or allow a specimen height of 115 ± 5 mm (4.5 ± 0.2 in.) when correlating SGCs. Combine at least six samples for each press to correlate.

12.5 Thoroughly blend the material and take small portions from several places throughout the entire area of the pan.

12.6 Give the samples to the operator of each gyratory compactor to correlate. The same operator on the given gyratory compactor must mold all the samples.

12.7 Cure the samples in accordance with Part I. Handle all samples identically. This will require coordination between the operators of all gyratory compactors to be correlated. Stagger placement of samples into the oven so they will all receive the same amount of cure time. If not molding all samples immediately, allow all samples to cool to room temperature before placing in the oven to cure.

12.8 Mold the samples in accordance with Part I.

12.9 Determine the G_a of the molded specimens in accordance with Tex-207-F, Part I.

12.10 Calculate the average G_a of the samples molded on each TGC in accordance with Section 13.2.

12.11 Subtract the average G_a of the samples molded on the Contractor's gyratory compactor from the average G_a of the samples molded on the Department's gyratory compactor for a two-press correlation. This is the correlation factor for the Contractor's gyratory compactor.

12.12 Subtract the average G_a of the samples molded on the Department and Contractor's gyrator compactors from the average G_a of the samples molded on the Referee gyratory compactor for a three-press correlation. These are the correlation factors for the Department's and the Contractor's gyratory compactors.

12.13 Add this factor to the average G_a for each set of specimens molded on the gyratory compactor if it positive. Subtract this factor from the average G_a for each set of specimens molded on the gyratory compactor if it is negative.

Note 8–Do not apply a correlation factor to the Ga of molded specimens if it is 0 ± 0.010.

12.14 Record the following information:

- Correlation factor
- Date of correlation
- Type of mix used for correlation
- Serial number of TGCs used in correlation.

13. CALCULATIONS

13.1 Calculate bulk specific gravity:

$$G_a = \frac{DryWt.}{(SSDWt. - Wt.inWater)}$$

Where:
G_a = bulk specific gravity
DryWt. = weight of dry specimen in air, g
SSDWt. = weight of the SSD specimen in air, g
Wt.inWater = weight of the specimen in water, g.

13.2 Calculate the average G_a for each TGC:

$$Avg = \frac{\sum G_a}{N}$$

Where:
N = number of trial samples.

14. EXAMPLE

14.1 Use the following example to correctly calculate and apply the TGC correlation for a two-press correlation.

14.1.1 Results from Department TGC and Contractor TGC are shown in Tables 2 and 3.

Table 2—Results from Department TGC

Mixture Property	Trial Specimen								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Dry Wt.	999.3	998.2	999.7	998.7	999.1	999.5	998.4	998.8	997.8
SSD Wt.	999.7	998.9	1000.4	999.5	999.9	1000.4	999.3	999.7	998.8
Wt. in Water	574.6	575.3	575.6	576	576.2	577.2	574.9	576.1	575.9
G_a	2.351	2.356	2.353	2.358	2.358	2.362	2.352	2.358	2.359

Table 3—Results from Contractor TGC

Mixture Property	Trial Specimen								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Dry Wt.	996.4	998.2	999.5	998.9	999.7	998.2	997.6	998.7	999.1
SSD Wt.	997.6	999.5	1000.7	999.8	1000.9	999.6	998.8	999.6	1000.2
Wt. in Water	573.1	574.1	573.9	573.4	574.1	572.9	571.7	572.9	573.8
G_a	2.347	2.346	2.342	2.343	2.342	2.339	2.336	2.341	2.343

14.2 The calculated average G_a is:

- Department = 2.356
- Contractor = 2.342.

14.3 Subtract the Contractor average from the Department average:

- 2.356 – 2.342 = 0.014, which is greater than 0.010.

14.4 Add the 0.014 to the average G_a for each set of specimens molded on the Contractor's TGC.

15. NOTES

15.1 Each gyratory compactor used for molding must be correlated to the verification gyratory compactor. A new correlation must be obtained if a different gyratory compactor is used, if the gyratory compactor has to be repaired, or if the operating tolerance is exceeded.

15.2 Use historical data that may be available for two gyratory compactors in lieu of molding a minimum of nine or six specimens, provided that historical data is representative of the mix being produced and the presses have not been moved, adjusted, or repaired since the historical data was collected.

15.3 As a tool, use test results from statewide proficiency samples, when available, to judge the accuracy of the gyratory compactors used in correlation testing.

15.4 If for any reason, a correlation factor cannot be agreed upon, submit representative samples of the mix for referee testing.

16. ARCHIVED VERIONS

16.1 Archived versions are available.