

Appendix F

Proposed revision to Tex-248-F: Overlay Test

Test Procedure for

OVERLAY TEST

TxDOT Designation: Tex-248-F

Effective Date: July 2019



1. SCOPE

- 1.1 This test method determines the susceptibility of bituminous mixtures to fatigue or reflective cracking.
 - 1.2 Critical fracture energy and crack progression rate are performance indices that characterize the bituminous mixtures resistance to cracking.
 - 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.
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2. DEFINITIONS

- 2.1 *Critical Fracture Energy (G_c)*—the energy required to initiate a crack on the bottom of the specimen at the first loading cycle of the overlay test (OT). This parameter characterizes the fracture properties of the specimen during the crack initiation phase.
 - 2.2 *Crack Progression Rate (CPR)*—the reduction in load required to propagate cracking under the cyclic loading conditions of the OT. This parameter characterizes the flexibility and fatigue properties of specimens during the crack propagation phase.
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3. APPARATUS

- 3.1 *Overlay Tester (OT)*—an electro-hydraulic system that applies repeated direct tension loads to specimens. The device automatically measures and records load, displacement, and temperature every 0.1 sec.
 - 3.1.1 The machine features two blocks: one is fixed, and the other slides horizontally. The sliding block applies tension in a cyclic triangular waveform to a constant maximum displacement of 0.025 ± 0.001 in. (0.64 ± 0.02 mm). The sliding block reaches the maximum displacement and then returns to its initial position in 10 ± 1 sec. (one cycle).
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- 3.1.2 Additionally, the device includes:
- a controlled temperature chamber,
 - a linear variable differential transducer (LVDT) to measure the displacement of the block,
 - an electronic load cell to measure the load resulting from the displacement,
 - aluminum or steel base plates to restrict shifting of the specimen during testing,
 - a mounting jig to align the two base plates for specimen preparation, and
 - a 4.2-mm thick spacer bar.
- 3.1.3 Refer to the manufacturer's specifications for equipment range and accuracy of the LVDT and load cell.
- 3.2 *Single- or Double-Blade Saw.*
- 3.3 *Cutting Template*, used to facilitate specimen trimming, as shown in Figure 1.
- Note 1**—This is not required when using a double-blade saw.



Figure 1—Cutting Template

- 3.4 *Apparatus* used in Tex-207-F for determining density of compacted bituminous mixtures.
- 3.5 *Temperature Chamber or Heating Oven* (optional), capable of maintaining a temperature of $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$).
- 3.6 *Vacuum Device* (optional), such as CoreDry.
- 3.7 *Spatula and Dish*, disposable, for mixing epoxy.
- 3.8 *Weights*, 5 to 10 lb. (2.25 to 4.50 kg) each.
- Note 2**—As shown in Figure 2, one weight must rest on top of each specimen without overlapping the sides.
- 3.9 *3/8-in. Socket Drive Torque Wrench*, with a 3-in. extension, capable of applying a 15 lb.-ft. torque.



Figure 2—Weighted Specimens

4. MATERIALS

4.1 *Two-Part Epoxy*, with a minimum 24-hr. tensile strength of 4.1 MPa (600 psi) and 24-hr. shear strength of 13.8 MPa (2,000 psi) when tested in accordance with Tex-614-J.

Note 3—Expired epoxy will affect test results. Use epoxy before the expiration date or approximately 6 months after purchase. Cloudiness in color can be an indication of expired epoxy.

4.2 *Paint or Permanent Marker*.

4.3 *Lubricant (optional)*, such as grease or oil.

4.4 *Tape*, 4 mm wide.

4.5 *Utility razor blade*.

5. SPECIMENS

5.1 *Laboratory-Molded Specimens*—Prepare three specimens in accordance with Tex-241-F. Specimen diameter must be 6 in. (150 mm), and height must be 4.5 ± 0.2 in. (115 ± 5 mm). Test specimens within 5 days of molding.

Note 4—Cure warm-mix asphalt (WMA) mixtures at 275°F for 4 hr. \pm 5 min. before molding. WMA is defined as HMA that is produced within a target temperature discharge range of 215°F and 275°F using WMA additives or processes.

5.1.1 Density of the trimmed test specimen must be $93 \pm 0.5\%$, except for Permeable Friction Course (PFC) mixtures.

Note 5—Laboratory-molded specimens with $91 \pm 1\%$ density usually result in trimmed test specimens that meet the $93 \pm 0.5\%$ density requirement. This is only a guide; use prior experience and knowledge of the specific materials.

Note 6—Mixture weights for laboratory-molded specimens that achieve the density requirement typically vary between 4200 and 4500 g.

- 5.1.2 For PFC mixtures, mold test specimens to 50 gyrations (Ndesign).
Note 7—PFC mixture weights for specimens prepared in the laboratory typically vary between 3800 and 4100 g. Select the mixture weight for the molded PFC specimen based on the weights used in the mix design.
- 5.2 *Core Specimens*—Specimen diameter must be 6 ± 0.1 in. (150 ± 2 mm), and height must be a minimum of 1.5 in. (38 mm). There is not a specific density requirement for core specimens.
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6. PROCEDURE

- 6.1 *Preparing Specimens:*
- 6.1.1 Obtain three cylindrical specimens meeting the requirements of Section 5.
Note 8—Test roadway cores for informational purposes only.
- 6.1.2 Refer to the sawing device manufacturer's instructions for trimming specimens.
- 6.1.3 Cutting the specimens perpendicular to the top surface, trim the sides to produce specimens 3 ± 0.08 in. (76 ± 2.0 mm) wide, as shown in Figure 3. When using a single blade saw, follow the lines traced using the template. Discard the cuttings.
- 6.1.4 Trim the top and bottom of each specimen to produce a sample with a height of 1.5 ± 0.02 in. (38 ± 0.5 mm), as shown in Figure 4. Discard the cuttings.



Figure 3—Trimmed Specimen (Top View)

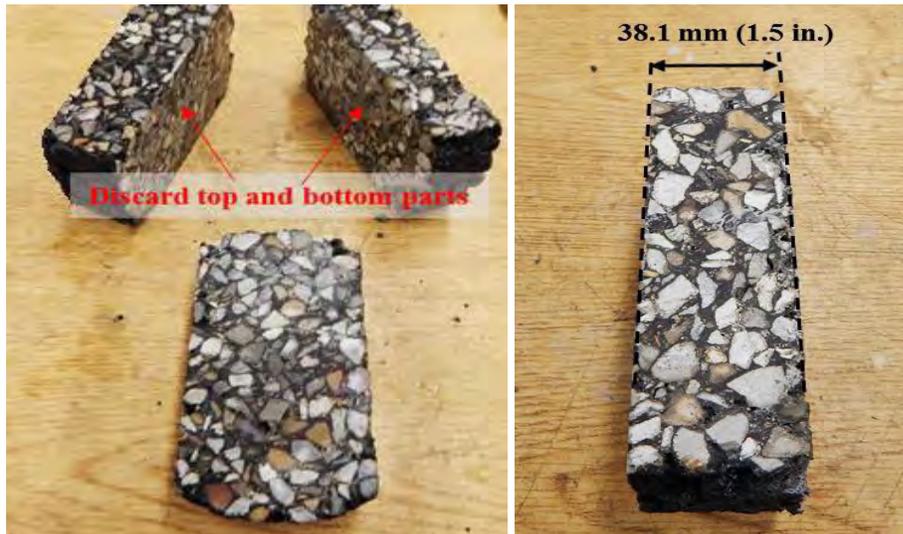


Figure 4—Trimmed Specimen (Side View)

6.1.5 Calculate the density of the trimmed laboratory-molded specimens in accordance with Tex-207-F, in the following order.

Note 9—Do not measure the density of trimmed PFC specimens.

6.1.5.1 Calculate the weight of the specimens in water.

6.1.5.2 Calculate the saturated surface dry (SSD) weight of the specimens in air.

6.1.5.3 Dry the trimmed specimens using one of the following methods.

- Air dry to remove excess moisture, and then use a vacuum device to dry the specimens to constant weight.
- Oven dry at $104 \pm 5^{\circ}\text{F}$ ($40 \pm 3^{\circ}\text{C}$) to constant weight.

Note 10—Specimens take approximately 8 hr. to oven dry. Do not oven dry for more than 24 hr. Constant weight is defined as the weight at which further oven drying does not alter the weight by more than 0.05% in a 2-hr. or longer drying interval

6.1.5.4 Relative density must be $93 \pm 0.5\%$. Discard and prepare a new specimen if the trimmed specimen does not meet the density requirement.

Note 11—The relative density of CAM specimens must be $95 \pm 0.5\%$.

Note 12—The density for specimens trimmed from roadway cores is for informational purposes only. Trimmed PFC specimens do not have a density requirement.

6.2 *Mounting and Conditioning Specimens:*

6.2.1 Prepare the materials required to mount the specimen. Follow the gluing process for each specimen individually.

6.2.2 Ensure the base plates and spacer bar are clean, removing any dirt or epoxy from previous samples.

6.2.3 Mount and secure the base plates to the mounting jig. Insert the spacer bar between the plates as shown in Figure 5.

Note 13—If desired, apply a small amount of lubricant on the spacer bar to facilitate its removal.

Note 14—The gap between the two base plates is 4.2 mm.



Figure 5—Mounting Jig, Base Plates, and Spacer Bar

6.2.4 Draw a line along the middle of the trimmed specimen to guide the placement of the tape, as shown in Figure 6.



Figure 6—Middle Line Drawn with Permanent Marker

- 6.2.5 Apply a small amount of petroleum jelly along the line, as shown in Figure 7, and then place a piece of 4-mm wide tape along the line, over the petroleum jelly to facilitate removal once the specimen is mounted onto the base plates.



Figure 7—Applying Petroleum Jelly to Specimen

- 6.2.6 Prepare approximately 16 g of the two-part epoxy for each test specimen following the manufacturer's instructions. Do not prepare epoxy for more than three specimens in one batch.
- 6.2.7 Pour the mixed epoxy on each half of the specimen and spread evenly, avoiding the tape, as shown in Figure 8.



Figure 8—Pouring and Spreading Epoxy

- 6.2.8 Mount the specimen on the base plates, ensuring that the specimen is centered and aligned with the edges, as shown in Figure 9.



Figure 9—Centering and Alignment of the Specimen

6.2.9 Place a 5- to 10-lb. weight on top of the specimens to ensure full contact with the base plates. See Figure 10.



Figure 10—Weighted Specimen

6.2.10 Remove any epoxy accumulated on the sides of the mounted specimen or the plates by scraping it away from the specimen with a razor. See Figure 11.

Note 15—Be careful not to scrape any epoxy onto the specimen, as this could affect results.



Figure 11—Removing Excess Epoxy

6.2.11 Carefully remove the tape and the spacer bar while preventing the specimen from moving, as shown in Figure 12.

Note 16—No more than 2 minutes should pass from spreading the epoxy onto the specimen to removing the tape and spacer bar.

Note 17—If using mounting plates that accommodate multiple samples, be careful to not drag epoxy from one sample to the next when removing the spacer bar.



Figure 12—Tape and Spacer Bar Removal

6.2.12 For sufficient bonding strength, allow the epoxy to cure per the manufacturer's recommendations. Figure 13 shows the final mounted specimen.

Note 18—A minimum of 24 hours is recommended to ensure adequate curing.

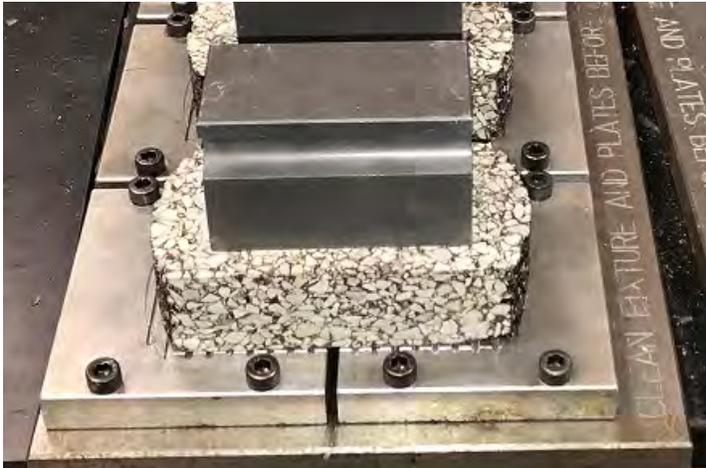


Figure 13—Mounted Specimen Prepared for Testing

- 6.2.13 Remove the weights from the specimens.
- 6.2.14 Place the test sample assembly (specimens and base plates) in the OT temperature chamber or an oven at $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) for a minimum of 1 hr. before testing.
- 6.3 *Starting Testing Device:*
- 6.3.1 Turn on the OT. Turn on the computer and wait at least 5 min. to establish communication with the OT before starting the OT software.
- 6.3.2 Turn on the hydraulic pump using the OT software.
- 6.4 *Mounting Specimen Assembly to Testing Device:*
- 6.4.1 Enter the required test information into the OT software.
- 6.4.1.1 Clean the bottom of the base plates and the top of the testing machine blocks before placing the specimen assembly into the blocks.
Note 19—The machine, specimen, or base plates may become damaged when tightening the base plates if all surfaces are not clean.
- 6.4.2 Mount the specimen assembly onto the machine according to the manufacturer's instructions, with the following additional steps.
- 6.4.2.1 While placing the assembly into the machine, ensure the device is in load mode to minimize stress to the specimen.
- 6.4.2.2 Use the torque wrench to apply 15 lb.-ft. of torque to each bolt to fasten the base plates to the machine. Use a similar torqueing pattern for the replicate specimens. Figure 14 shows the recommended pattern.

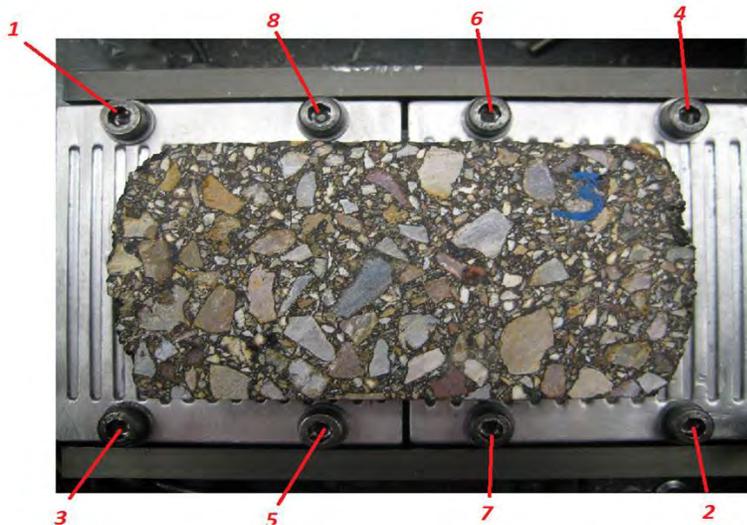


Figure 14—Suggested Pattern for Tightening Bolts

6.5 *Testing Specimens:*

6.5.1 Test all replicate specimens within the same day to minimize the variability in the test results. Test specimens within 5 days of molding.

6.5.2 Perform testing at a constant temperature of $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$).

6.5.3 Start the test using the program’s start button.

Note 20—Add a minimum 10-min. relaxation period prior to testing. The test will automatically start after the specimen relaxation and temperature stabilization sequence is completed.

Note 21—The test will run until a 93% reduction of the maximum load occurs, when measured from the first opening cycle. If a 93% reduction is not reached within 1,000 cycles, the OT will stop the test.

6.5.4 Remove the specimen assembly upon completion of the test. Turn off the OT if needed.

6.5.5 Visually count the number of cracks at the top of the specimens. Record zero, single, or multiple cracks in the comments section of the test report.

7. CALCULATIONS

7.1 Calculate critical fracture energy at the maximum peak load:

$$G_c = \frac{W_c}{b * h}$$

Where:

G_c = critical fracture energy, lb.-in./in.² (kN-mm²)

W_c = fracture area, lb.-in. (kN-mm)

b = specimen width: 3 in. (76.2 mm)
 h = specimen height: 1.5 in. (38.1 mm)

Note 22—Figure 15 illustrates a graphical representation of the critical fracture energy of the first cycle.

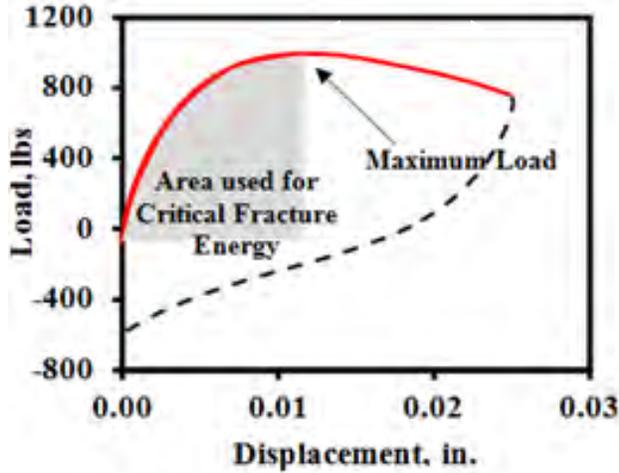


Figure 15—Area Used for Calculation of Critical fracture Energy

7.2 Calculate the Crack Progression Rate by fitting a power equation to the peak load versus number of cycles curve as depicted in Figure 16.

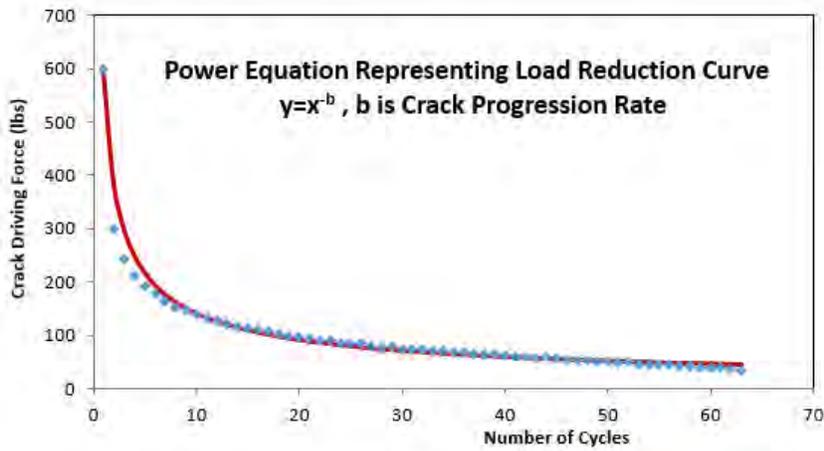


Figure 16—Calculation of Crack Resistance Index

7.3 Extrapolate the number of cycles that the test will have to run until a 93% reduction of the maximum load occurs, when measured from the first opening cycle. This estimation is only for informational purposes.

8. REPORT

8.1 Report the following for each specimen:

- trimmed density,
- maximum load,
- critical fracture energy,
- crack progression rate,
- number of cycles to failure (informational), and
- additional comments.

9. ARCHIVED VERIONS

9.1 Archived versions are available.