Test Procedure for

OVERLAY TEST

TxDOT Designation: Tex-248-F

Effective Date: April 2025

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.

2. DEFINITIONS

2.1 *Critical Fracture Energy (CFE)*—the cracking response of a specimen to initiate a crack on the bottom of the specimen at the first loading cycle of the overlay test. This index characterizes the cracking 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 overlay test. This index characterizes the flexibility and fatigue properties of specimens during the crack propagation phase.

3. APPARATUS

3.1 *Overlay Tester (OT)*—an electro-hydraulic or electro-mechanical 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 block is fixed, and the other block moves in the horizontal axis in which tension is applied to the specimen. The sliding block applies tension in a cyclic triangular waveform to a constant maximum displacement of 0.635 mm (0.025 in.). The sliding block reaches its maximum displacement after 5 sec., and then returns to its initial position after a full cycle of 10 sec.

3.1.2 Additionally, the device includes:

- internal software capable of calculating CFE, CPR, and number of cycles to failure,
- a controlled temperature chamber,
- linear variable differential transducers (LVDTs) to measure the displacement of the block,
- an electronic load cell to measure the load resulting from the displacement,

- aluminum or steel base plates are designed to restrict shifting of the specimen during testing as shown in Figure 1. The difference between the shoulder of the bolt and the hole diameter must not be greater than 0.2 mm (0.008 in.).
- a mounting jig to align the two base plates for specimen preparation, and
- a 4.2 ± 0.3 mm (0.17 ± 0.01 in.) thick spacer bar.

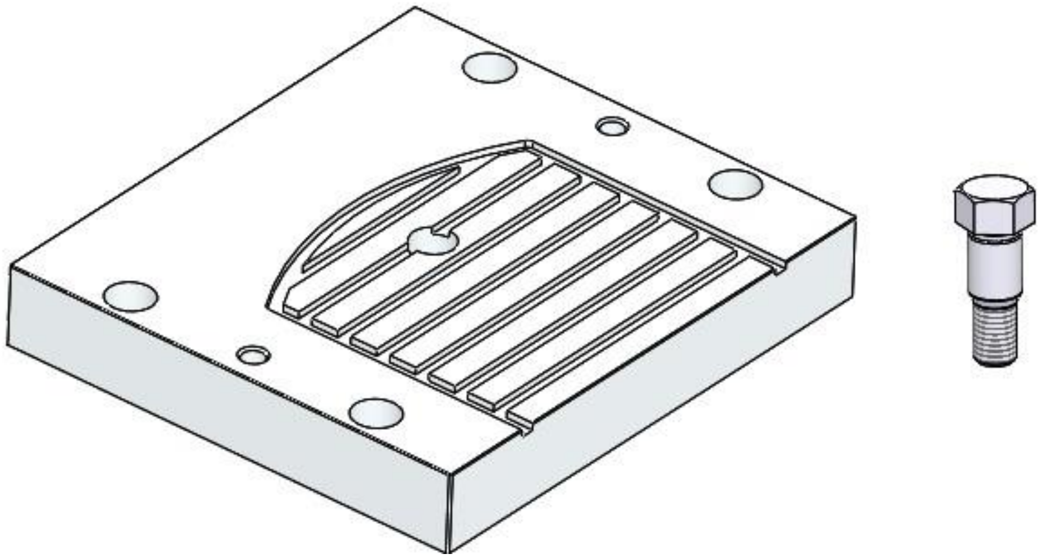

Figure 1—Base Plate and Shoulder Bolt

3.1.3 Refer to Tex-237-F for the range and accuracy of the LVDTs and load cell.

3.2 *Single- or Double-Blade Saw*.

3.3 *Cutting Template,* used to facilitate specimen trimming as shown in Figure 2.

Note 1—This is not required when using a double-blade saw.

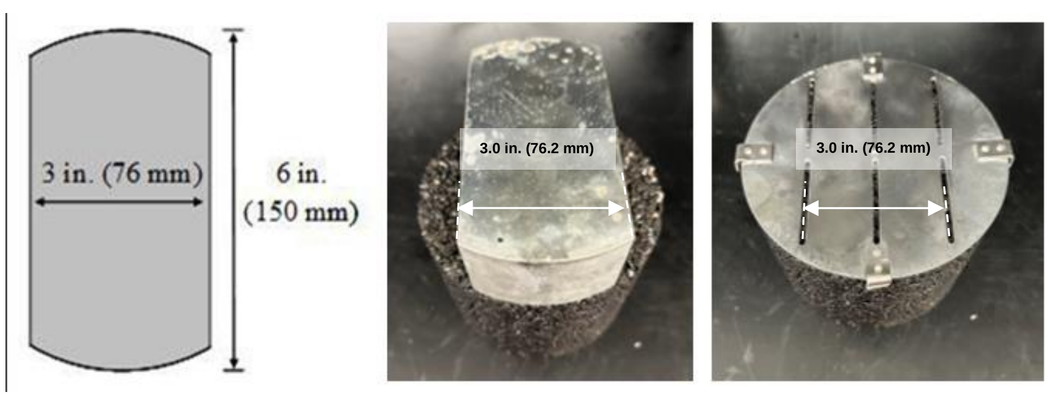

Figure 2—Cutting Template

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 attaining a temperature of 25°C (77°F) with a temperature stability of 1°C (2°F).

3.6 *Vacuum Drying Device* (*optional*), such as CoreDry.

3.7 *Spatula and Dish,* disposable, for mixing epoxy.

3.8 *3/8-in. Socket Drive Torque Wrench,* with a 3-in. extension, capable of applying a 34 Nm (25 ft.-lb.) torque.

3.9 *Weights,* 5 lb. (2.25 kg) each.

Note 2—The weight must be placed onto and rest on top of each specimen without overhanging from the sides as shown in Figure 3.

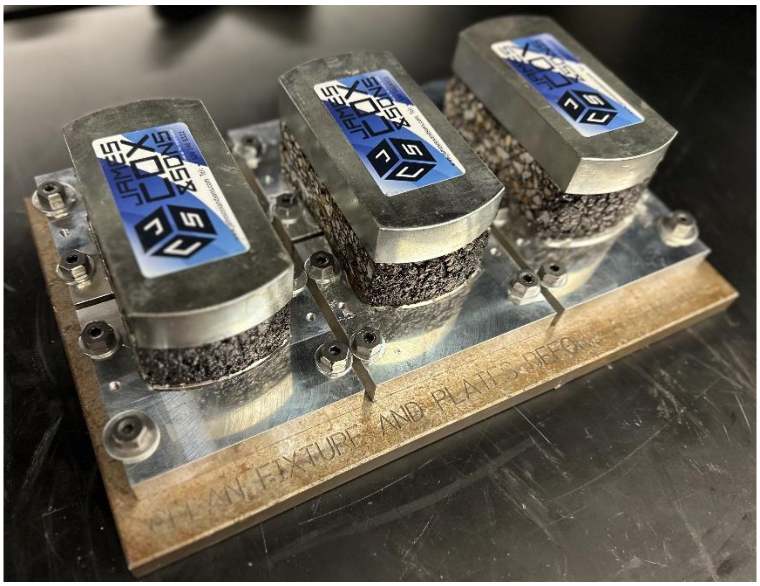

Figure 3—Weighted Specimens

4. MATERIALS

4.1 *Two-Part Epoxy,* with a minimum 24-hr. tensile strength of 600 psi (4.14 MPa) and 24-hr. shear strength of 2,000 psi (13.79 MPa) when tested in accordance with Tex-614-J.

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

Note 4—Recommended epoxies include Gorilla 3,300 psi Clear Epoxy, JB Weld 4,400 psi Quick Set Epoxy, or an equivalent. Do not use gel epoxies, as they tend to break free from the specimen during the testing.

4.2 *Paint or Permanent Marker.*

4.3 *Lubricant* (optional), such as Petroleum Jelly, 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 150 mm (5.9 in.), and height must be 115 ± 5 mm (4.5 ± 0.2 in.). Test specimens within 5 days after molding.

5.1.1 Density of the trimmed test specimen must be 93 ± 1%, except for Permeable Friction Course (PFC) mixtures or Crack Attenuating Mix (CAM).

Note 5—Laboratory-molded specimens with 91 ± 1% density usually result in trimmed test specimens that meet the 93 ± 1% 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 4,200 and 4,500 g.

5.1.2 For PFC mixtures, mold test specimens to 50 gyrations (N_{design}).

Note 7—PFC mixture weights for laboratory-molded specimens typically vary between 3,800 and 4,100 g. Select the mixture weight for the molded PFC specimen based on the weights used in the mix design.

5.1.3 Density of the trimmed test specimen must be 95 ± 1% for CAM mixtures.

5.2 *Core Specimens*—Specimen diameter must be 145 ± 5 mm (5.7 ± 0.2 in.), and height must be a minimum of 38.1 mm (1.5 in.). There are no specific density requirements for core specimens.

Note 8—Test roadway cores for informational purposes only.

6. PROCEDURE

6.1 *Preparing Specimens:*

6.1.1 Obtain three cylindrical specimens meeting the requirements in Section 5.

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 ± 0.02 in. (76.2 ± 0.5 mm) in width as shown in Figure 4. Discard the cuttings.

Note 9—If using a single-blade saw, a cutting template must be used to mark the specimens with the cutting lines. Follow the traced lines when cutting the specimen.

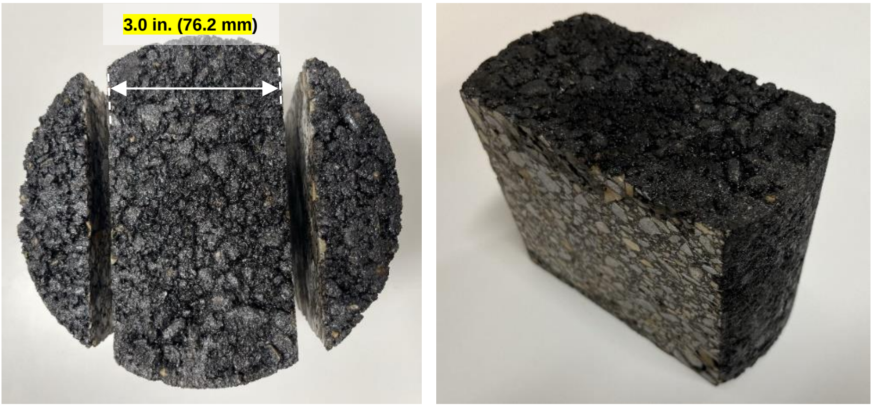

Figure 4—Trimmed Specimen (Top View)

6.1.4 Trim the top and bottom of each specimen to produce a sample 1.5 ± 0.02 in. (38.1 ± 0.5 mm) in height as shown in Figure 5. Discard the cuttings.

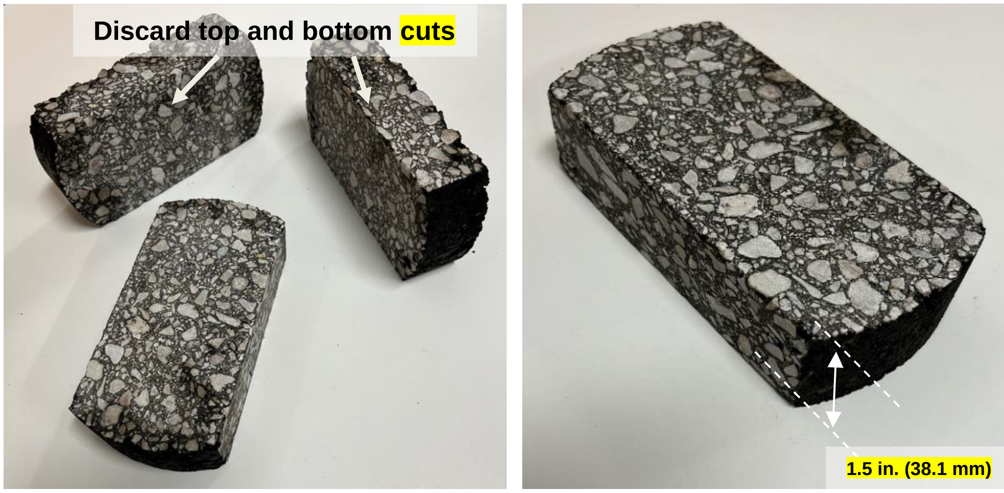

Figure 5—Trimmed Specimen (Side View)

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

- Air dry to remove excess moisture. Then use a vacuum device to dry the specimens to constant weight.
- Oven dry at 115 ± 5°F (46 ± 3°C) to constant weight.

6.1.6 Calculate the density of the trimmed laboratory-molded specimens in accordance with Tex-207-F.

Note 10—Do not calculate the density of trimmed PFC specimens.

Note 11— 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.

6.1.6.1 Discard and prepare a new specimen if the trimmed specimen does not meet the density requirement in Section 5.

6.2 *Mounting and Conditioning Specimens:*

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

6.2.2 Remove any dirt or epoxy residue from previously tested samples to ensure the base plates and spacer bar are clean.

6.2.3 Mount and secure the base plates to the assembly jig. Insert the spacer bar between the base plates as shown in Figure 6.

Note 12—If desired, apply a small amount of lubricant on the spacer bar to facilitate removal.

Note 13—The gap between the two base plates is 4.2 mm.

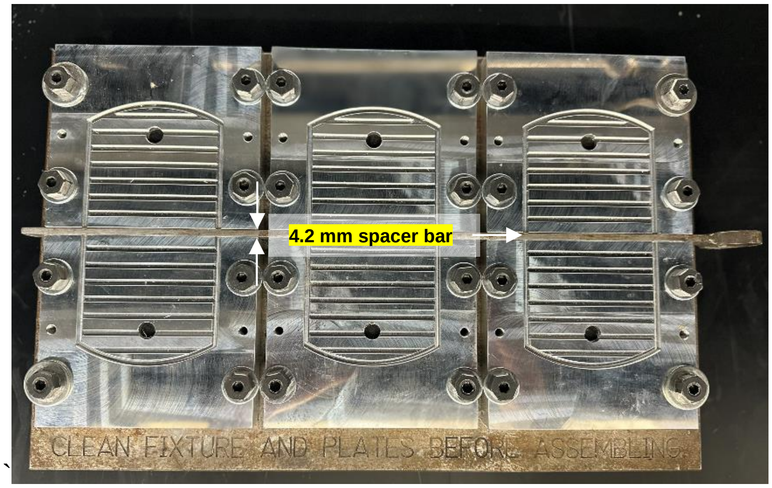

Figure 6—Assembly Jig, Base Plates, and Spacer Bar

6.2.4 Draw a line along the middle of the trimmed specimen to guide the placement of the tape as shown in Figure 7.

Note 14—It is recommended to mark a diagonal line from corner to corner and then mark the center line by using a rafter square positioned 90° to the point the diagonals cross.

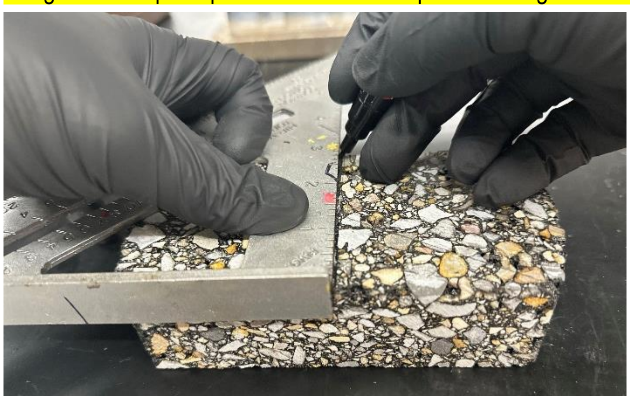

Figure 7—Middle Line Drawn with Permanent Marker

6.2.5 Apply a small amount of petroleum jelly along the line as shown in Figure 8. Place a piece of 4-mm wide tape over the petroleum jelly to facilitate removal once the specimen is mounted onto the base plates.

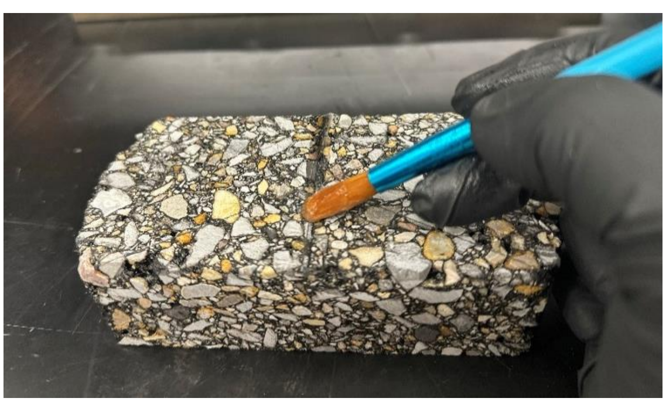

Figure 8—Applying Petroleum Jelly to Specimen

6.2.6 Prepare approximately 16 g of the two-part epoxy for each 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 as shown in Figure 9. Avoid spreading epoxy over the tape.

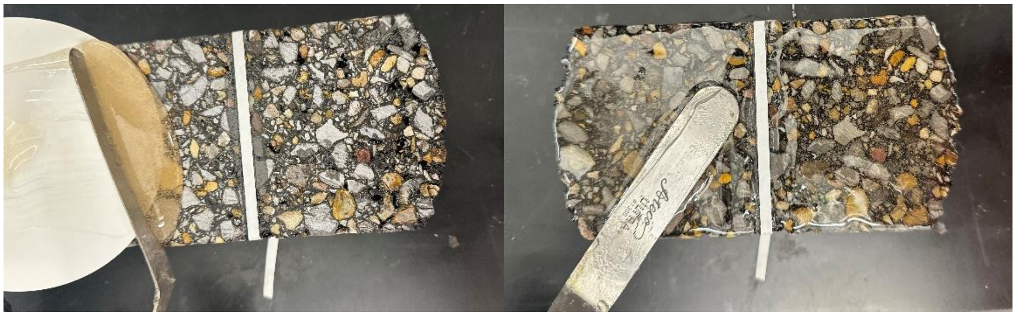

Figure 9—Pouring and Spreading Epoxy

6.2.8 Mount the specimen onto the base plates. Ensure that the specimen is centered and aligned with the edges as shown in Figure 10.

Figure 10—Centering and Alignment of the Specimen

6.2.9 Place a 5-lb. weight on top of the specimen to ensure full contact with the base plates as shown in Figure 11.

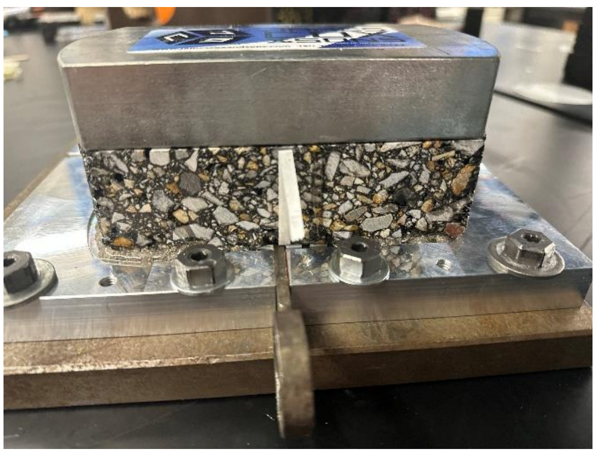

Figure 11—Weighted Specimen

6.2.10 Remove excess epoxy from the sides of the mounted specimen and the base plates by scraping it away from the specimen with a razor as shown in Figure 12.

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

Figure 12—Removing Excess Epoxy

6.2.11 Carefully remove the tape and the spacer bar while preventing the specimen from moving as shown in Figure 13.

Note 16—No more than two minutes should pass from spreading the epoxy onto the specimen to removing the tape.

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

Figure 13 —Tape and Spacer Bar Removal

6.2.12 Allow the epoxy to cure per the manufacturer's instructions to ensure adequate bonding strength. The final mounted specimen is shown in Figure 14.

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

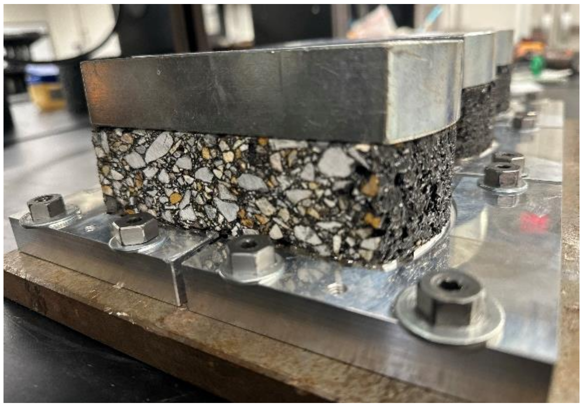

Figure 14—Mounted Specimen Prepared for Testing

6.2.13 Remove the weight from the specimen.

6.2.14 Remove the base plates from the mounting jig.

6.2.15 Place the assembly (specimens and base plates) in the OT temperature chamber or an oven at 25 ± 1°C (77 ± 2°F) for a minimum of 1 hr. before testing.

6.3 *Starting the Testing Device:*

6.3.1 Turn on the OT.

6.3.2 Follow the on-screen instructions from the OT software.

6.3.3 Enter the required test information into the OT software.

6.4 Mounting the Assembly to the OT:

6.4.1 Clean the bottom of the base plates and the top of the testing machine blocks before placing the assembly onto the blocks.

Note 19—Tightening the base plates onto unclean surfaces may damage the OT, specimen, or base plates.

6.4.2 Mount the assembly onto the OT in accordance with the manufacturer's instructions, observing the following steps:

6.4.2.1 While placing the assembly into the OT, ensure the device is at the sample detecting mode to minimize stress to the specimen.

6.4.2.2 Fasten the base plates to the OT evenly and progressively tightening the bolts using the torque wrench. Apply 34 Nm (25 ft.-lb.) of torque to each bolt. Use a similar torquing pattern for the replicate specimens. The recommended pattern is shown in Figure 15.

Figure 15—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 25 ± 1°C (77 ± 2°F).

6.5.3 Press the OT start button to start the test.

Note 20—Add a 1-min. relaxation period before 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 after 1,000 cycles, the OT will stop the test.

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

7. CALCULATIONS

7.1 Calculate CFE at the maximum peak load:

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

Where:

CFE = critical fracture energy, lb.-in./in.^{2} (J/m^2)

W_c = fracture area, lb.-in. (J)

b = specimen width: 3 in. (0.0762 m)

h = specimen height: 1.5 in. (0.0381 m)

Note 22—Figure 16 illustrates a graphical representation of the CFE from the first cycle. For practical purposes, the cracked cross-sectional area of the specimen is assumed to be the total cross-sectional area of the specimen (specimen width x height).

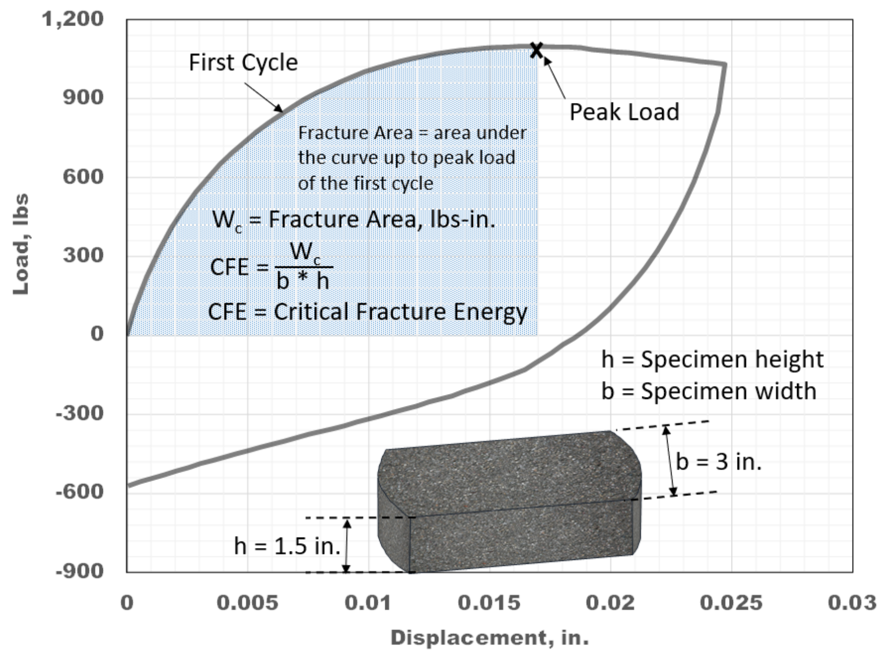

Figure 16—Area Used for Calculation of the CFE

7.2 Calculate the CPR by fitting a power equation to the normalized peak load versus number of cycles curve as shown in Figure 17. The curve for peak load versus number of cycles must be first normalized by the peak of the first cycle. The power equation is fitted, with the constraint that the 'a' coefficient equals unity.

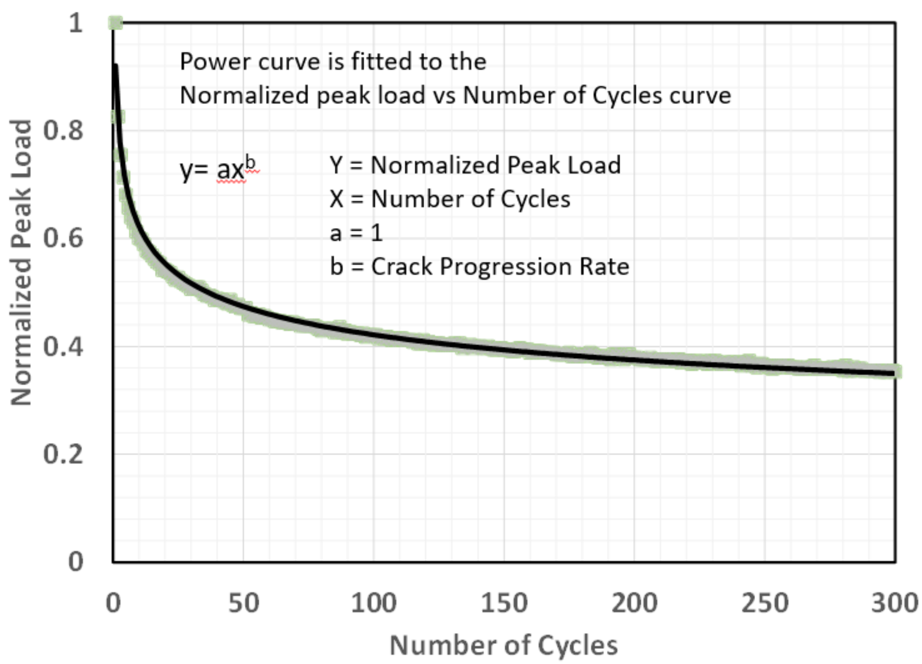

Figure 17—Calculation of the CPR

8. REPORT

8.1 Report the following for each specimen:

- displacement rate,
- trimmed density, %,
- CFE, lb.-in./in.^{2},
- CPR,
- number of cycles to failure (informational), and
- additional comments.

9. ARCHIVED VERIONS

9.1 Archived versions are available.