

METHODS OF SAMPLING AND TESTING
MT 330-04
RESISTANCE OF COMPACTED BITUMINOUS MIXTURE
TO MOISTURE INDUCED DAMAGE
(Modified AASHTO T 283)

1 Scope:

- 1.1 This method is intended to evaluate the effects of saturation and accelerated water conditioning of compacted bituminous mixtures in the laboratory.

2 Referenced Documents:**2.1 AASHTO:**

- T 166 Bulk Specific Gravity of Compacted Bituminous Mixtures Using Saturated Surface-Dry Specimens
- T 167 Compressive Strength of Bituminous Mixtures
- T 209 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
- T 245 Resistance of Plastic Flow of Bituminous Mixtures by Means of Hveem Apparatus
- T 247 Preparation of Test Specimens of Bituminous Mixtures by Means of California Kneading Compactor
- T 269 Percent Air Voids in Compacted Dense and Open Bituminous Paving Mixtures
- T 312 Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor

ASTM:

- D 2041 Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
- D 3549 Thickness or Height of Compacted Bituminous Paving Mixture Specimens

3 Apparatus:

- 3.1 Equipment for preparing and compacting specimens from one of the following AASHTO Methods: T-245 and T-247, or ASTM Method D 3387.
- 3.2 *Vacuum container* - preferably Type D, and vacuum pump or water aspirator from ASTM D 2041, including manometer or vacuum gauge.
- 3.3 *Balance* - and water bath from AASHTO T 166.
- 3.4 *Water bath* - capable of maintaining a temperature of $140 \pm 1.8^{\circ}\text{F}$ ($60 \pm 1^{\circ}\text{C}$).
- 3.5 *Freezer* - maintained at $0 \pm 5^{\circ}\text{F}$ ($-18 \pm 3^{\circ}\text{C}$).
- 3.6 A supply of plastic film for wrapping, heavy-duty leak proof plastic bags to enclose the saturated specimens and masking tape.
- 3.7 10 ml graduated cylinder.
- 3.8 *Aluminum pans* - having a surface area of 75-100 square inches in the bottom and a depth of approximately 1 inch.
- 3.9 *Forced air draft oven* - capable of maintaining a temperature of $140 \pm 1.8^{\circ}\text{F}$ ($60 \pm 1^{\circ}\text{C}$).
- 3.10 *Loading jack and ring dynamometer from AASHTO T 245* - or a mechanical or hydraulic testing machine from AASHTO T167 to provide a range of accurately controllable rates of vertical deformation in 2 in. per minute (50.8 per minute).

3 Apparatus: (continued)

- 3.11** *Loading Strips* - If used, steel loading strips with a concave surface having a radius of the test specimen. For specimens 4 inches (102mm) in diameter the loading strips shall be 0.5 inches (12.7mm) wide, and for specimens 6 inches (152.4mm) in diameter the loading strips shall be 0.75 in. (19.05mm) wide. The length of the loading strips shall exceed the thickness of the specimens. The edges of the loading strips shall be rounded by grinding.

4 Preparation of Laboratory Test Specimens:

- 4.1** Specimens 4 inches (100 mm) in diameter and 2.5 inches (63.5 mm) thick are usually used. Specimens of other dimensions may be used if desired and should be used if aggregate larger and 1 inch (25.4 mm) is present in the mixture and/or is not permitted to be scalped out.
- 4.2** After mixing, the mixture shall be placed in an aluminum pan having a surface area of 75-100 square inches in the bottom and a depth of approximately 1 inch (25.4 mm) and cooled at room temperature for 2 ± 0.5 hours. Then the mixture shall be placed in a 140°F (60°C) oven for 16 ± 1 hour for curing. The pans should be placed on spacers to allow air circulation under the pan if the shelves are not perforated.
- 4.3** After curing, place the mixture in an oven at 275°F (135°C) for 2 hours prior to compaction. The mixture shall be compacted to 7 ± 0.5 percent air voids or void level expected in the field. This level of voids can be obtained by adjusting the number of blows in AASHTO T 245; adjusting foot pressure, number of tamps, leveling load, or some combination in AASHTO T 247; and adjusting the number of revolutions in ASTM D 3387. The exact procedure must be determined experimentally for each mixture before compacting the specimens for each set.
- 4.4** After extraction from the molds, the test specimens shall be stored for 24 ± 1 hour at room temperature.

5 Preparation of Core Test Specimens:

- 5.1** Select locations on the completed pavement to be sampled, and obtain cores. The number of cores shall be at least 6 for each set of mix conditions.
- 5.2** Separate core layers as necessary by sawing or other suitable means, and store layers to be tested at room temperature.

6 Evaluation of Test Specimens and Grouping:

- 6.1** Determine theoretical maximum specific gravity of mixture by AASHTO T 209.
- 6.2** Determine specimen thickness by ASTM D 3549.
- 6.3** Determine bulk specific gravity by AASHTO T 166. Express volume of specimens in cubic centimeters.
- 6.4** Calculate air voids by AASHTO T 269.
- 6.5** Sort specimens into two subsets of three specimens each so that average air voids of the two subsets are approximately equal.

7 Preconditioning of Test Specimens:

- 7.1** One subset will be tested dry and the other will be preconditioned before testing.
- 7.2** The dry subset will be stored at room temperature until testing. The specimens shall be wrapped with plastic or placed in a heavy duty leak proof plastic bag. The specimens shall then be placed in a $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) water bath for a minimum of 2 hours \pm 10 minutes and then tested as described in Section 7.

7 Preconditioning of Test Specimens: (continued)

7.3 The other subset shall be conditioned as follows:

- 7.3.1** Place the specimen in the vacuum container supported above the container bottom by a spacer. Fill the container with distilled water at room temperature so that the specimens have at least one inch of water above their surface. Apply partial vacuum, such as 10 to 26 inches Hg for a short time, such as five minutes. Remove the vacuum and leave the specimen submerged in water for 5 to 10 minutes.
- 7.3.2** Determine bulk specific gravity by AASHTO T 166. Compare saturated surface-dry weight with saturated surface-dry weight determined in Section 5.3. Calculate volume of absorbed water.
- 7.3.3** Determine degree of saturation by comparing volume of absorbed water with volume of air voids from Section 5.4. If the volume of water is between 70% and 80% of the volume of air, proceed to Section 6.3.4. If the volume of water is less than 70%, repeat the procedure beginning with Section 6.3.1 using more vacuum and/or time. If volume of water is more than 80%, specimen has been damaged and is discarded. Repeat the procedure beginning with Section 6.3.1, using less vacuum and/or time.
- 7.3.4** Cover the vacuum saturated specimens tightly with a plastic film (saran wrap or equivalent). Place each wrapped specimen in a plastic bag containing 10 ml of water and seal the bag.
- 7.3.5** Place the plastic bag containing specimen in a freezer at $0 \pm 5^{\circ}\text{F}$ ($-18 \pm 3^{\circ}\text{C}$) for a minimum of 16 ± 1 hour.
- 7.3.6** After removal from the freezer, place the specimens into a $140 \pm 1.8^{\circ}\text{F}$ ($60 \pm 0.9^{\circ}\text{C}$) water bath for 24 ± 1 hours. As soon as possible after placement in the water bath, remove the plastic bag and film from the specimens.
- 7.3.7** After 24 ± 1 hours in the 140°F (60°C) water bath, remove the specimens and place them in a water bath already at $77 \pm 1^{\circ}\text{F}$ ($25 \pm 0.5^{\circ}\text{C}$) for 2 hours \pm 10 minutes. It may be necessary to add ice to the water bath to prevent the water temperature from rising above 77°F (25°C). Not more than 15 minutes should be required for the water bath to reach 77°F (25°C). Test the specimens as described in Section 7.

8 Testing:

- 8.1** Determine the indirect tensile strength of dry and conditioned specimens at 77°F (25°C).
- 8.2** Remove the specimen from 77°F (25°C) water bath and place between the two bearing plates in the testing machine. Apply the load to the specimen by means of the constant rate of movement of the testing machine head of 2 inches (50.8 mm) per minute.

Note - When reviewing a failure or stripped pavement, the temperature of the conditioned specimens in 7.1 and 7.2 of 77°F (25°C) should be changed to 55°F (13°C).

- 8.3** If steel loading strips are used, record the maximum compressive strength noted on the testing machine and continue loading until a vertical crack appears. Remove the specimen from the machine and pull apart at the crack. Inspect the interior surface for stripping and record the observations.
- 8.4** If steel loading strips are not used, stop loading as soon as the maximum compressive load is reached. Record the maximum compressive load. Remove the specimen, measure and record the side (edge) flattening to the nearest 0.1 inch. The flattening may be easier to measure if the flattened edge is rubbed with the lengthwise edge of a piece of chalk. After recording the flattening, replace the specimen in the compression machine and compress until a vertical crack appears. Remove the specimen from the machine and pull apart at the crack. Inspect the interior surface for stripping and record the observations.

9 Calculations:

9.1 If steel loading strips are used, calculate the tensile strength as follows:

$$S_t = \frac{2P}{\pi tD}$$

where:

S_t = tensile strength, psi

P = maximum load, pounds

t = specimen thickness, inches

s = specimen diameter, inches

9.2 If steel loading strips are not used, calculate the tensile strength of a 4-inch (102mm)-diameter specimen as follows:

$$S_t = \frac{S_{10}P}{10,000 t}$$

where:

S_t = tensile strength, psi

S_{10} = maximum tensile stress corresponding to the width of flattened area from Table 1

P = maximum load, pounds

t = specimen thickness, inches

9.3 Express the numerical index of resistance of asphalt mixtures to the detrimental effect of water as the ratio of the original strength that is retained after the freeze-warm water conditioning.

$$\text{Tensile Strength Ratio (TSR)} = \frac{S_2}{S_1}$$

where:

S_1 = average tensile strength of dry subset, and

S_2 = average tensile strength of conditioned subset.

TABLE 1

Maximum Tensile Stress (S) for a base index of a 10,000 lb. Load, 4" diameter specimen, 1 inch in length

Width of Flattened Area, In Inches	Maximum Tensile Stress, S, PSI
0.0	1640
0.1	1629
0.2	1619
0.3	1606
0.4	1595
0.5	1571
0.6	1540
0.7	1508
0.8	1470
0.9	1438
1.0	1405