RESISTANCE OF COMPACTED ASPHALT MIXTURES TO MOISTURE-INDUCED DAMAGE

AASHTO T 283

GLOSSARY

Tensile strength -- a measure of the force required to pull apart a material.

SCOPE

HMA made from certain materials may be sensitive to the presence of water in the finished pavement. Water will cause the binder to not adhere to the aggregate. Since the binder is the "glue" that holds the pavement together, rapid failure of the pavement can be expected if the binder cannot adhere to the aggregate. This is often referred to as stripping. To help prevent stripping, additives such as hydrated lime or liquid anti-stripping chemicals may be required. AASHTO T 283 is a test method that can be used to determine if the materials may be subject to stripping and also to measure the effectiveness of additives.

The test is performed by compacting specimens to an air void level of six to eight percent. Three specimens are selected as a control and tested without moisture conditioning, and three more specim,ens are selected to be conditioned by saturating with water undergoing a freeze cycle, and subsequently having a warm-water soaking cycle. The specimens are then tested for indirect tensile strength by loading the specimens at a constant rate and measuring the force required to break the specimen. The tensile strength of the conditioned specimens is compared to the control specimens to determine the tensile strength ratio (TSR). This test may also be performed on cores taken from the finished pavement.

SUMMARY OF TEST

Apparatus

Vacuum container for saturating specimens

Balance, general purpose class G_2 (AASHTO M 231)

Water bath, capable of maintaining a temperature of 140 ± 2°F (60 ± 1°C)

Pans, having a surface area of 75-200 in^2 (48,400 – 129,000) mm^2 in the bottom and a depth of approximately 1 in. (25 mm)

Loading jack and force measuring device

Loading strips with a curved face to match the side of the specimen

Forced-draft oven, capable of maintaining a temperature from room temperature to 350 ± 15°F (176 ± 3°C)

Freezer, capable of maintaining a temperature of 0 ± 5°F (-18 ± 3°C)

Plastic wrap and heavy-duty leak proof plastic bags

10 mL graduated cylinder

Sample Preparation

For laboratory-batched mixtures, 6 in. (150 mm) diameter and 2.5 in. (63.5 mm) thick specimens are normally used. Enough material is mixed to produce at least eight specimens at the binder content recommended for the mixture. Extra mixture will be needed for trials to establish the compaction required and for determining the maximum specific gravity of the mixture, if these values are not known.

After mixing, the mixture is placed in the pans and spread to about 1 in. (25 mm) thick. The mix is then cooled to room temperature for 2 ± 0.5 hours. The mixture is placed in the oven for 2 hours at 275 ± 5°F (135 ± 3°C), and stirred every 60 ± 5 minutes to maintain conditioning.

Some experimentation will be needed to find the correct compactive effort that will yield 7 ± 0.5 percent air voids. The specimens are required to be compacted in accordance with AASHTO T 312. After the specimens are removed from the molds, they are stored at room temperature for 24 ± 3 hours.

Evaluating and Grouping of Specimens

After curing, the following tests and measurements of each specimen are done:

1. The maximum specific gravity (G_{mm}) in accordance with AASHTO T 209

2. The thickness (t) and diameter (D)

3. The bulk specific gravity (G_{mb}) in accordance with AASHTOT 166. The volume (E) of the specimens is determined by subtracting the specimen weight in water from the saturated, surface-dry weight.

The percentage of air voids (P_a) is determined in accordance with AASHTO T 269. Once determined, the specimens are separated into two subsets, of at least three specimens each, so that the average air voids of the two subsets are approximately equal.

For those specimens to be subjected to vacuum saturation, a freeze cycle, and a warm-water soaking cycle, the volume of the air voids (V_a) in cubic centimeters is calculated as follows:

$$V_a = \frac{P_a E}{100}$$

where:

V_a = volume of air voids, cubic centimeters
P_a = air voids, percent
E = volume of the specimen, cubic centimeters

Reconditioning of Specimens

At the end of the curing period, the dry subset is wrapped with plastic in a heavy duty, leak proof plastic bag. The specimens are then placed in a 77 ± 1°F (25 ± 0.5°C) water bath for 2 hours ± 10 minutes with a minimum of 1 in. (25 mm) of water above their surface. (Figure 1)

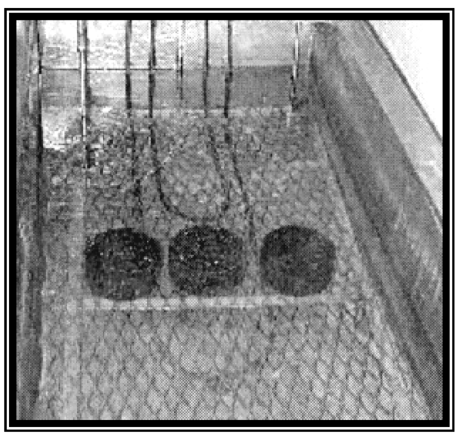

Figure 1
Specimens in Water Bath

The other subset is conditioned as follows:

1. The specimens are placed in a vacuum container supported a minimum of 1 in. (25 mm) above the container bottom (figure 2

2. The container is filled with potable water at room temperature so that the specimens have at least 1 in. (25 mm) of water above their surface.

3. A vacuum of 10-26 in. Hg partial pressure (13-67 kPa absolute pressure) is applied for approximately 5 to 10 minutes.

4. The vacuum is removed and the specimen is left submerged in water for approximately 5 to 10 minutes. (Figure 2)

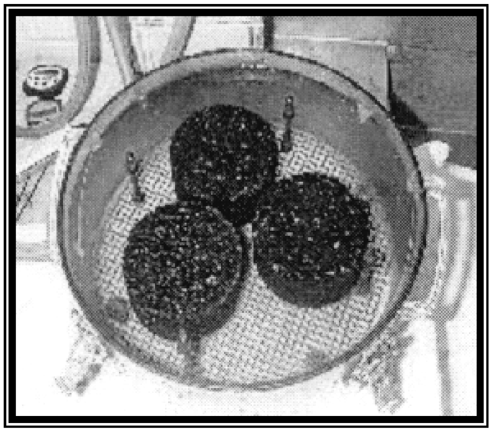

Figure 2
Specimens in Vacuum Container

The weight of the saturated, surface-dry specimen after partial vacuum saturation (B^1) is determined by Method A of AASHTO T 166.

The volume of absorbed water (J^1) in cubic centimeters is determined by the following equation

$$J^1 = B^1 - A$$

where:

J^1 = volume of absorbed water, cubic centimeters
B^1 = weight of the saturated, surface-dry specimen after partial vacuum saturation, g
A = weight of the dry specimen in air, g

The degree of saturation (S^1) is determined by comparing the volume of absorbed water (J^1) with the volume of air voids (V_a) using the following equation:

$$S^1 = \frac{100\, J^1}{V_a}$$

where:

S^1 = degree of saturation, percent

If the degree of saturation is between 70 and 80 percent, the conditioning by freezing may continue. If the degree of saturation is less than 70 percent, the vacuum procedure using more vacuum and/or time is repeated. If the degree of saturation is more than 80 percent, the specimen is considered damaged and is discarded.

For specimens with 70 to 80 percent saturation, the samples are each wrapped with a plastic film such as Saran Wrap and placed in a plastic bag containing 10 ± 0.5 mL of water and sealed. The plastic bags are placed in a freezer at a temperature of 0 ± 5°F (-18 ± 3°C) for 24 ± 1 hours. The specimens should have a minimum of 1 in. (25 mm) of water above their surface. As soon as the specimens are placed in the water bath, the plastic bag and film is removed from each specimen.

After 24 ± 1 hours in the water bath, the specimens are removed and placed in a water bath at 77 ± 1°F (25 ± 0.5°C) for 2 hours ± 10 minutes. The specimens should have a minimum of 1 in. (25 mm) of water above their surface.

Testing

The specimen is removed from the bath, the thickness (t^1) determined, and then placed on its side between the bearing plates of the testing machine (Figure 3). Steel loading strips are placed between the specimen and the bearing plates. A load is applied to the specimen by forcing the bearing plates together at a constant rate of 2 in. (50 mm) per minute.

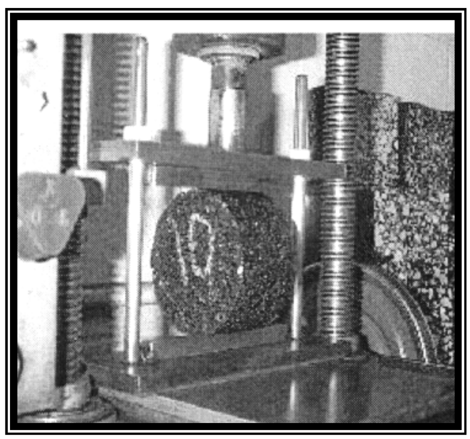

Figure 3
Specimen in Testing Machine

The maximum load is recorded, and the load continued until the specimen cracks. The machine is stopped and the specimen broken apart at the crack for observation (Figure 4). The approximate degree of moisture damage is estimated on a scale from 0 to 5, with 5 being the most stripped.

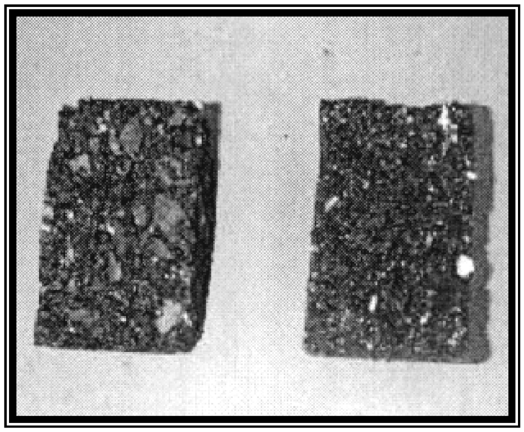

Figure 4
Specimen Broken for Observation

Calculations

The tensile strength is calculated using the following equation:

English units:

$$S_t = \frac{2P}{\pi t D}$$

where:
S_t = tensile strength, psi
P = maximum load, lbs
t = specimen thickness, in.
D = specimen diameter, in.

SI units:

$$S_t = \frac{2000P}{\pi t D}$$

where:
S_t = tensile strength, kPa
P = maximum load, Newtons
t = specimen thickness, mm
D = specimen diameter, mm

The tensile strength ratio is calculated as follows:

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

where:
S_1 = average tensile strength of the dry subset, psi (kPa)
S_2 = average tensile strength of the conditioned subset, psi (kPa)