GDT 66

A. Scope

For a complete list of GDTs, see the Table of Contents.

Use this test method to compare the Diametral Tensile Strength of bituminous mixtures on dry and wet specimens.

Internal water pressures in the mixtures are produced by vacuum saturation followed by a freeze and a warm-water soaking cycle. By comparing the properties of dry specimens with accelerated, water-conditioned specimens, you get the percentage of retained strength.

Use this method, along with GDT 56, to determine acceptability of liquid anti-stripping agents.

B. Apparatus

The apparatus outlined in AASHTO T 245 or T 312 is needed along with the following:

1. Vacuum Pump: Use a pump that can produce a pressure drop of 26 in (660.4 mm) of mercury (a gauge vacuum of 26 in (660.4 mm) Hg) for use in water-saturating the test specimen (WV-E-02).
2. Vacuum Chamber: Use Nalgene or equivalent vacuum jars, at least 6 in (152.4 mm) diameter and 8 in (203.2 mm) high, with smooth-fired edges. The chamber also includes:
    - A flat rubber gasket
    - A stiff, round plate greater than 6 in (152.4 mm) diameter, with a vacuum hose receptacle, having holes bored through the plate thickness
    - A vacuum hose attached between the receptacle fitting and vacuum pump
    - A 6 in (152.4 mm) diameter screen-type or highly porous specimen spacer approximately 0.25 in (6 mm) high
3. Freezer: Use a freezer that can maintain a temperature of –0.4 ° ± 3.6 °F (–18 ° ± 2 °C) and is big enough to contain the Marshall specimens to be frozen.
4. Warm Water Bath: Use the same as in AASHTO T 245.
5. Refrigerator or Cool Water Bath: Use equipment that cools specimens to a constant temperature of 55 °, ± 3.6 °F (12.8 °, ± 2 °C). If you use a bath, it must be made of stainless steel or non-corrosive metal. Use clean tap water in the bath. Periodically empty, clean, and refill the bath with fresh water.
6. Compression Testing Machine: Use one that conforms to ASTM D 1074, and can control deformation at a rate of 0.065 in/minute (1.651 mm/minute).
7. Loading Apparatus: Use a loading apparatus equipped with loading strips as shown in ASTM D 4123. The strips are attached to the loading apparatus to be parallel and centered on the vertical diametral plane.
8. Measuring Device: Use one graduated so that the height of the specimens can be determined to the nearest 0.05 in (1.27 mm).
9. Plastic Bag: Use a bag measuring 5 x 3 x 15 in (127 x 76.2 x 381 mm) (WB-01).

C. Sample Size and Preparation

1. Treating the Mixture with Additives
    a. Liquid Anti-Stripping Additive. When liquid anti-stripping additive is used in the mixture:
        1) Place a covered container of asphalt cement into an oven and heat it to 325 °F (162.8 °C).
        2) Weigh the appropriate amount of additive into the container of asphalt cement.
        3) Immediately lower a mechanical stirrer to within 1 in (25.4 mm) of the bottom of the container.
        4) Mix the contents for 2 minutes.
    b. To evaluate a liquid anti-stripping additive for the Qualified Product List:
        1) Place a covered container of asphalt cement into an oven and heat it to 325 °F (162.8 °C).

2) Maintain the temperature for 96 hours (as outlined in GDT 56) before preparing the specimens.

c. For routine design work:
   1) Discard the treated asphalt cement if you do not use it on the same day or if you have to reheat it.

d. Hydrated lime:
   1) When using hydrated lime in the mixture, dry-mix the lime into the hot aggregate immediately before adding and mixing the asphalt cement into the mixture.
   2) When the evaluation of new sources is for inclusion into QPL-41, the percentage of retained strength for the 3 cycles, as required in sub-section g, must meet the requirements of Section 828 of the Standard Specifications.

e. Prepare all specimens in accordance to AASHTO T 245 or T 312 except for the following modifications:
   1) Fabricate 6 specimens at optimum asphalt content. Adjust the number of gyrations or hammer blows in order to fabricate specimens with air voids that fall within a range of 6.0 ± 1.0 percent for Stone Matrix Asphalt Mixes (SMA), and a range of 7.0 ± 1.0 percent for all other mixes. Determine the air voids of the specimens according to AASHTO T 269.
   3) Determine the bulk density of the specimens according to AASHTO T 166. AASHTO T 331 can be used as an alternative to AASHTO T 275 for specimens with water absorbed that exceeds 2.0 percent of water by volume.
   4) Separate the specimens into two groups so that both groups have as nearly as possible the same average mix bulk density.
   5) Make sure the average air voids for the two groups are within the established limits.
   6) Use one group for accelerated conditioning and the other for "control" specimens.

f. To predict moisture-induced damage to an asphaltic concrete mix:
   1) Prepare specimens for the specific mix in question with an approved asphalt cement and an approved liquid additive (where applicable) or an approved hydrated lime (where applicable).
   2) When using a liquid anti-stripping additive, treat the asphalt cement as outlined in Sample Size and Preparation, step 1.a at the rate required by the Standard Specifications.
   3) When using hydrated lime, add the lime to the hot aggregate as outlined in Sample Size and Preparation, step 1.d at the rate required by the Standard Specifications.

g. To evaluate liquid anti-stripping additive for approval:
   1) Prepare 12 batches using laboratory standard aggregate to the following mix gradation:

Sieve Size	Percent Passing
1/2" (12.5 mm)	100
3/8" (9.5 mm)	95-100
No. 4 (4.75 mm)	60-70
No. 8 (2.36 mm)	44-46
No. 50 (300 µm)	18-22
No. 200 (75 µm)	5.5-6.5
% AC	5.25-7.0

NOTE: The laboratory-standard aggregate has a known history of stripping problems, and the laboratory-standard asphalt is a PG-67-22 normally used in the laboratory for mix design purposes.

   2) Mix the specimens with asphalt cement prepared according to Sample Size and Preparation , step 1.b at the rate required by the Standard Specifications. (NOTE: Hydrated Lime is not used for this additive evaluation)

3) Fabricate the 12 specimens using the optimum asphalt content. Adjust the number of gyrations or hammer blows in order to fabricate specimens with air voids that fall within a range of 7.0 ± 1.0 percent. Determine the bulk density of the specimens according to AASHTO T 166. AASHTO T 331 can be used as an alternative to AASHTO T 275 for specimens with water absorbed that exceeds 2.0 percent of water by volume. Determine the air voids of the specimens according to AASHTO T 269.
4) Separate the specimens into four groups so that all groups have as nearly as possible the same average mix bulk density.
5) Three groups are subjected to accelerated conditioning for one, three, and six freeze-thaw cycles respectively. The fourth group is used for "control" specimens.

h. When using cores from the roadway to determine moisture-induced damage:
1) Take 6 cores from within a few feet of each other along the same longitudinal alignment.
2) Make sure the cores are at least 1 in (25.4 mm) thick for mechanical testing.
3) Blot all samples free of moisture and desiccate them for 24 hours before starting the test.
4) Separate the cores into two groups based on mix bulk density so that each group is about equal. Determine bulk density as outlined in AASHTO T 166.

Note: For cores cut from a roadway that has gone through a freeze-thaw cycle, take only three cores and omit the grouping based on mix bulk density.

5) You may break apart cores less than 1 in (25.4 mm) thick to visually examine them and give a stripping rating.

i. Measure and record the height of each of the specimens.

Note: For cores cut from a roadway that has gone through a freeze-thaw cycle, prepare the cores as accelerated conditioned specimens in step j. After step j, skip to step s.1 and immediately place the cores in 55 ° F (12.8 °C) water. Test the cores as accelerated conditioned specimens.

j. Take the specimens for accelerated conditioning and vacuum saturate them.
1) Place the specimen in the vacuum chamber.
2) Cover the specimen with at least 1 in (25.4 mm) of tap water.
3) Drop the pressure in the chamber by 26 in (560.4 mm) of mercury for 30 minutes.
4) While the pressure drops, frequently tap or gently shake the chamber to dislodge trapped bubbles.
5) Release the vacuum and let the specimens remain in the water undisturbed for another 30 minutes.
6) After 30 minutes, determine the percent saturation:

$$\% \text{ Saturation} = \frac{100\,(D - A)}{(C - B)\,(E)}$$

where:

A = Air weight (dry)

B = Weight in water before vacuum

C = SSD weight before vacuum

D = SSD weight after vacuum

E = Percent of air voids in specimen

k. Place each vacuum-saturated specimen into a plastic bag with approximately 10 cm^3 of extra water.

l. Squeeze most of the air out of the bag and draw it snugly around the specimen. Secure the top of the bag.

m. Freeze the vacuum-saturated specimens for at least 15 hours.

n. Remove the specimens from the freezer and place immediately into a warm water bath. Maintain the bath temperature at 140 °, ± 3.6 °F (60 °, ± 2 °C).

o. Leave the specimens undisturbed for 30 minutes.

p. After 30 minutes, carefully cut a small opening in the plastic bags.

q. Leave the specimens and bags undisturbed for 24 hours.

r. Carefully remove the specimens from the warm water bath, taking care to avoid damage in handling.

s. Prepare both accelerated conditioned and control specimens for mechanical testing as follows:

1) Accelerated Conditioned Specimens:

a. Allow specimens just removed from the warm water bath to remain undisturbed for about 1 hour, or until the specimens reach ambient temperature.

b. Place each specimen into a beaker, plastic bucket, or corrosion-proof container.

c. Cover with about 1 in (25 mm) of 55 °F (12.8 °C) water.

d. Place the specimens into a refrigerator at 55 °, ± 3.6 °F (12.8 °, ± 2 °C) for 3 hours. You may also use a corrosion-proof water bath controlled within this temperature range.

e. Remove one specimen at a time, blot the surface dry, and perform the mechanical testing.

2) Control Specimens:

a. Place each control specimen into the refrigerator at 55 °, ± 3.6 °F (12.8 °, ± 2 °C) for 3 hours. You may also use a corrosion-proof water bath controlled within this temperature range provided the specimens are kept dry sealed in a plastic bag or other suitable container.

b. Remove one specimen at a time and perform the mechanical testing.

D. Procedures

1. Immediately after removing each specimen from the refrigerator (or cool water bath), remove surface water by blotting and place the specimen into the loading apparatus.
2. Place the loading apparatus and the specimen under the breaking head of the testing machine.
3. Apply load at a rate of 0.065 in/minute (1.65 mm/minute).
4. Immediately release the load whenever you note a load drop or when the load has remained constant for 15 seconds.
5. Record the maximum load reached.
6. Place conditioned specimens back under the breaking head of the testing machine and apply a load until a vertical crack appears.
7. Pull the specimen apart and inspect for stripped particles.
8. Record the rate of stripping according to the following table:

Stripping Code	Degree of Stripping
0	None (No evidence of stripping)
1	Slight (Some stripping, primarily on coarse particles)
2	Moderate (Considerable stripping on coarse particles; moderate stripping on fine particles)
3	Severe (Severe stripping on fine and coarse particles)

E. Calculations

1. Calculate the diametral tensile strength of each specimen as follows:

$$S = 2P \div (\pi t D)$$

where:

S = tensile strength, psi (kPa)

P = maximum load, pounds (kN)

t = specimen height immediately before tensile test, inches (meters)

D = specimen diameter, inches (meters)

2. Calculate the percent retained stability as follows:

$$RS = Sa \div Sc$$

where:

RS = percent retained strength

Sa = average tensile strength of accelerated conditioned subset, psi (kPa)

Sc = average tensile strength of control subset, psi (kPa)

F. Report

1. Report the average retained stability to the nearest 0.1 percent on Form 159-5.
2. Show the percent liquid additive or hydrated lime (as appropriate) used in the test specimens.