Florida Method of Test for Laboratory Testing the Effectiveness of Anti-Strip Additives

Designation: FM 5-508

1. SCOPE

This test method contains procedures for preparing and testing asphalt mixture specimens for the purpose of measuring the effectiveness of anti-stripping additives on the indirect tensile strength of the asphalt mixture. One asphalt mixture with known stripping characteristics is used to evaluate the anti-strip additive.

This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, and health practices and determine the applicability of regulatory limitations prior to use.

2. APPLICABLE DOCUMENTS

Florida Test Methods:

FM 1-T 166, Bulk Specific Gravity of Compacted Bituminous Mixtures
FM 1-T 209, Maximum Specific Gravity of Bituminous Paving Mixtures

AASHTO Test Methods:

M 231, Standard Specification for Weighing Devices Used in the Testing of Materials
T 312, Method for Preparing and Determining the Density of Hot-Mix Asphalt (HMA) Specimens by Means of the Superpave Gyratory Compactor
T 167 Compressive Strength of Bituminous Mixtures
T 245, Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus

3. SUMMARY OF TEST METHOD

One standard laboratory mixture with known stripping properties composed of Georgia granite is tested for indirect tensile strength in an unconditioned and conditioned state. Samples of the mixture are then prepared with the anti-strip additive and tested for indirect tensile strength in a conditioned state.

4. SIGNIFICANCE AND USE

This test method provides a means for determining if an anti-strip additive is effective at minimizing the effect of moisture damage as measured by indirect tensile strength for a standard laboratory mixture. It does not guarantee that the anti-strip additive will work on all mixtures. Moisture sensitivity testing for each individual mixture will typically be required at the mix design stage.

5. APPARATUS

5.1 Vacuum container - A container of sufficient size to vacuum saturate at least one specimen while maintaining at least one inch of deionized water above the specimen.

5.2 Vacuum pump and gauge - Capable of maintaining a vacuum of at least 25 inches of mercury (gauge pressure).

5.3 Temperature measuring device - A mercury thermometer or thermocouple device capable of measuring the temperature of water to the nearest 0.2 ºF.

5.4 Water baths – Two separate baths containing deionized water. One capable of maintaining a temperature of 77 ± 1.0 ºF and the other capable of maintaining a temperature of 140 ± 2.0 ºF. Ideally, the baths would hold at least six specimens each, but they shall hold at least a minimum of three specimens each.

5.5 Loading device - A mechanical or hydraulic testing machine meeting the requirements of AASHTO T 245 or AASHTO T 167. In either case, the device shall be capable of applying a load of 2.0 inches per minute. Use steel loading strips with a concave surface having a radius of curvature equal to the nominal radius of the test specimen. For four-inch nominal diameter specimens, the loading strips shall be 0.5 inches wide. The length of the strips shall exceed the thickness of the specimens.

5.6 Measuring device - Capable of measuring the dimensions of the compacted specimen to the nearest 0.001 in.

5.7 Electric drill and paddle bit - A hand-held electric drill and a paddle bit designed for mixing liquids.

5.8 Balance – A balance conforming to the requirements of AASHTO M 231, Class G2.

6. PREPARATION OF TEST SAMPLES

6.1 Nine specimens will be needed to evaluate one anti-strip additive. Typically, more than nine specimens are made in order to obtain nine specimens within the target air void range. Six specimens without anti-strip additive and three specimens with anti-strip additive are fabricated. Additional maximum specific gravity (G_{mm}) specimens will need to be fabricated and tested when there is a change in aggregate materials.

6.2 Prepare the asphalt binder with anti-strip additive as follows: add 0.5% anti-strip additive (by total weight of the binder) to preheated (300 ± 5 ºF) unmodified PG 67-22 binder in a quart or gallon metal can. For example, if the total weight of binder is 1000 grams, then add 5 grams of anti-strip additive to 995 grams of unmodified binder. Mix the anti-strip additive and unmodified binder thoroughly with a paddle-mixing bit attached to an electric drill. Heat the modified binder in a covered can in an oven at 300 ± 5 ºF for a minimum of 12 hours, but no more than 24 hours. An additional can of unmodified binder shall also be heated in the oven for the same time period to produce similar aging effects on both binders.

NOTE 1: A small hole should be made in the lids of the cans to prevent excessive pressure buildup.

6.3 Batch the aggregate components for at least nine specimens. A batch sheet for the granite mixture is shown in Figure 1. The batch size should produce specimens approximately 4 inches in diameter by 2.5 inches thick. If maximum specific gravity specimens are needed, two additional samples should also be batched. Heat the aggregates in a forced draft oven at 300 ± 5 ºF for a minimum of two hours.

6.4 Mix at least nine specimens (six without anti-strip agent and three with anti-strip agent) and place the specimens back in the oven for only the time period necessary to bring the specimens to the compaction temperature, 295 ± 5 ºF. If maximum specific gravity samples were mixed, they can be broken down without additional heating and subsequently tested per FM 1-T 209.

6.5 Compact the specimens in the Superpave gyratory compactor per AASHTO T 312. Compact the specimens to the height listed in Figure 1. Extrude the specimens immediately after compaction. No further cooling in the compaction mold is necessary.

NOTE 2: The gyratory compactor height may need to be adjusted slightly to obtain the proper air void content depending on the gyratory compactor used.

6.6 After the specimens have cooled to room temperature, measure and record, to the nearest 0.001 inches, the height and diameter of the sample at three different locations 120º apart. Average the three height dimensions and the three diameter dimensions.

6.7 Determine the bulk specific gravity of the specimens per Method B of FM 1-T 166.

6.8 Calculate the percent air voids of the specimens as follows: percent air voids = $((G_{mm}-G_{mb})/G_{mm})*100$. The specimens should have an air void content in the range of 7.0 ± 1.0%. If this range is not met, then more specimens will have to be fabricated.

6.9 Once enough specimens have been fabricated within the proper air void range, group the six specimens without anti-strip additive into two subsets so that the average air void content of the two subsets are approximately equal. If more than three specimens with anti-strip additive were fabricated, use the three specimens that meet the air void requirements of Section 6.8 and whose average air void content is closest to the average air void content of the unconditioned specimens.

7. CONDITIONING OF TEST SPECIMENS

7.1 Three specimens without anti-strip additive and three specimens with anti-strip additive are conditioned by vacuum saturation and a hot-water soak prior to testing.

7.2 Place the specimen(s) in the vacuum container so that they are standing on end and are covered by at least one inch of room temperature deionized water.

7.3 Start the vacuum pump and gradually increase the vacuum to 20 inches gauge pressure (relative to atmospheric pressure). Apply the vacuum for several minutes and then turn off the vacuum pump and slowly allow the interior of the container to reach atmospheric pressure (approximately one minute). Remove the specimen and determine the saturated surface dry mass per Method B of FM 1-T 166.

7.4 Calculate the volume of absorbed water as the difference between the saturated surface dry mass determined in Section 7.3 and the original dry mass determined in Section 6.7.

7.5 Calculate the volume of air voids by multiplying the percentage of air voids, expressed as a decimal, determined in Section 6.8, by the volume of the specimen determined in Section 6.7.

7.6 Calculate the percentage of saturation by dividing the volume of absorbed water determined in Section 7.4 by the volume of air voids determined in Section 7.5 and multiplying by 100. The target percent saturation ranges from 70% to 75%. If the target percent saturation has not been reached, repeat Section 7.3 while slightly increasing the vacuum pressure and/or time of vacuum.

NOTE 3: A computer spreadsheet should be used for the calculations and can be programmed to provide a target saturated surface dry mass for Section 7.3, which will provide the specified percent saturation.

7.7 Immediately after the specimens have been saturated to the target saturation level, place them in a water bath containing deionized water at 140 ± 2.0 ºF for 24 ± 1.0 hours.

7.8 After the completion of Section 7.7, place the conditioned specimens in a 77 ± 1.0 ºF water bath for 2 ± 1.0 hours.

8. TESTING

8.1 All specimens must be at 77 ± 1.0 ºF at the time of testing. Place the conditioned specimens in a 77 ± 1.0 ºF water bath for 2 ± 1.0 hours as mentioned in Section 7.8. The unconditioned specimens should be placed in a thermostatically controlled air chamber, if available, at 77 ± 1.0 ºF for a minimum of one hour. If an air chamber is not available, the specimens should be wrapped in plastic and put in a leak proof plastic bag, then placed in a 77 ± 1.0 ºF water bath for 2 ± 1.0 hours. All specimens should then be tested immediately since small temperature variations can have significant effects on test results.

8.2 Place the specimen in the testing apparatus per AASHTO T 245-14 or AASHTO T 167. Use the Lottman breaking head, not the standard semi-circular head used for determining stability and flow. Position the specimen between the two loading strips. Align the loading strips so that they are parallel and centered over the vertical diametral plane. Apply the load at a rate of 2.0 inches per minute until the maximum load is achieved. Record the maximum load in pounds.

9. CALCULATIONS

9.1 Calculate the tensile strength (S_t) as follows:

$$S_t = 2P/\pi td$$

where:

S_t = tensile strength of individual specimen, psi
P = maximum applied load, lb.
t = average specimen thickness, in.
d = average specimen diameter, in.

9.2 Calculate the tensile strength ratio (TSR) as follows::

$$TSR = S_{tc}/S_{tu}$$

where:

TSR = tensile strength ratio
S_{tc} = average tensile strength of three conditioned specimens, psi
S_{tu} = average tensile strength of three unconditioned specimens, psi

10. PRECISION

10.1 Precision values for both unconditioned and conditioned samples are for single operator, within-laboratory only. Precision values for multi-operator, multi-laboratory have not been established.

10.2 Unconditioned specimens: the maximum difference in tensile strength between the highest and lowest value in a set of three test specimens shall not exceed 26 psi.

10.3 Conditioned specimens: the maximum difference in tensile strength between the highest and lowest value in a set of three test specimens shall not exceed 29 psi.

Batch Sheet

	Aggregate Type			
	#7 (52) GA-185	#89 (51) GA-185	W-10 Scrns (20) GA-185	Marble Dust
Blend %	15.0	20.0	60.0	5.0
Sieve Size	Cumulative aggregate weights (g)			
+ 3/8"	78			
+ No. 4	178	291	302	
+ No. 8	305	417	563	
- No. 8		577	1140	1200
			Asphalt Binder @ 6.0%	77
			Total sample weight	1277 g

Notes:
1. Set the gyratory compactor height to 71.5 mm.
2. Georgia granite is from Martin Marietta.
3. Marble dust is from Imerys.

Figure 1 – Batch Sheet for Granite Mixture