Test Procedure for

PREDICTION OF MOISTURE-INDUCED DAMAGE TO BITUMINOUS PAVING MATERIALS USING MOLDED SPECIMENS

TxDOT Designation: Tex-531-C

Effective Date: August 1999

1. SCOPE

1.1 Use this procedure to evaluate potential for stripping using molded specimens of mix. The procedure will subject some molded specimens to moisture conditioning and will compare them by indirect tensile strength to unconditioned specimens.

1.2 Calculate the tensile strength ratio (TSR) of a mix as the indirect tensile strength of the moisture-conditioned specimens divided by the indirect tensile strength of unconditioned specimens. The TSR is, therefore, an indication of loss of strength caused by the moisture conditioning (stripping). Use this procedure to evaluate untreated mixes or evaluate the effectiveness of anti-strip additives.

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. APPARATUS

2.1 *Bituminous mixing equipment,* meeting the requirements of Tex-205-F.

2.2 *Gyratory molding press,* meeting the requirements of Tex-206-F.

2.3 *Density measurement equipment,* meeting the requirements of Tex-207-F.

2.4 *Desiccator,* to hold a minimum of four specimens.

2.5 *Vacuum chamber,* sized to hold a minimum of four specimens submerged under water.

2.6 *Vacuum pump.*

2.7 *Vacuum gauge or manometer.*

2.8 *Plastic bags,* sized to hold a minimum of one specimen.

2.9 *Leak-proof, submergible containers,* for dry specimens (e.g., plastic containers or bags).

2.10 *Freezer,* capable of maintaining -18 ± 3°C (0 ± 5°F).

2.11 *Water bath,* capable of maintaining 60 ± 1°C (140 ± 1.8°F).

2.12 *Water bath,* capable of maintaining 25 ± 0.5°C (77 ± 1°F).

2.13 *Indirect tensile strength apparatus,* meeting the requirements of Tex-226-F.

3. PROCEDURE

Note 1—This procedure involves the preparation of eight molded specimens. If evaluating additives, incorporate them into the specimens either by addition to the asphalt or the aggregate, as required for the specific additive.

3.1 *Adding Anti-Strip Additives:*

3.1.1 Blend commercial anti-strip agent with the asphaltic material.

3.1.2 Preheat the asphaltic material to the minimum asphaltic material temperature shown in Tex-205-F, Table 1.

3.1.3 Weigh an amount of asphaltic material and anti-strip agent into a metal can to yield enough treated asphalt to prepare at least 12 molded specimens. (See Sections 3.3 and 5.1.)

3.1.4 Immediately mix the two materials by stirring with a spatula for a minimum of 2 min.

3.1.5 Express the concentration of anti-strip agent as a percent of the treated asphaltic material.

3.2 *Adding Lime or Lime Slurry:*

3.2.1 Blend lime or lime slurry and mix well with the pre-weighed aggregate used to make individual specimens. Method of lime application must simulate the method used in field.

3.2.2 Oven dry lime slurry-aggregate blends at the temperature shown for mixing in Tex-205-F, Table 1.

3.2.3 Express the concentration of lime as a percent of the aggregate.

3.3 *Mixing:*

3.3.1 Mix a minimum of eight specimens in accordance with Tex-205-F using the design aggregates and asphalt. Additional specimens may be necessary, as described in Section 5.1, to determine the compactive effort necessary to achieve the percent density required for the eight specimens to be tested.

3.3.2 Cool mixture specimens for a minimum of 2-1/2 hr. at room temperature.

3.3.3 Cure mixture specimens at 60°C (140°F) for 15 hr. ± 30 min.

3.4 *Molding:*

3.4.1 Heat mixture specimens at 121°C (250°F) for 2 hr. ± 15 min.

3.4.2 Mold specimens in accordance with Tex-206-F, except compact specimens to 93 ± 1% of theoretical maximum specific gravity in accordance with Tex-207-F. This involves an initial trial-and-error procedure to determine the proper compactive effort to achieve the density range desired. (See Section 5.1.)

3.4.3 Cool the specimens to room temperature.

3.5 *Density Determination:*

3.5.1 Calculate the percent density for each of the eight specimens in accordance with Tex-207-F and Tex-227-F.

3.5.2 Allow molded specimens to stand at room temperature for a minimum of 24 hr.

3.5.3 Divide the eight molded specimens into two groups of four specimens.

3.5.3.1 Base this division on achieving approximately the same average percent of density in both groups.

3.5.3.2 Measure the height of each specimen for future use.

3.6 *Specimen Conditioning:*

3.6.1 Place one of the groups of four specimens in a desiccator and store until ready to determine the indirect tensile strength.

3.6.2 Subject the second group of four specimens to moisture conditioning in an attempt to induce moisture-related damage (stripping).

3.6.3 Accomplish moisture conditioning as follows:

3.6.3.1 Place the specimens in a vacuum chamber and fill the chamber with enough water to submerge the molded specimens. Vacuum saturate specimens for 30 min. at a residual pressure of 50 mm (2 in.) Hg. (See Section 5.4.)

3.6.3.2 Place the four saturated specimens in plastic bags (maximum of two specimens per bag) along with approximately 10 mL (0.3 oz.) of additional water.

3.6.3.3 Fold or seal the bags to prevent the loss of water, and place in a freezer at -18 ± 3°C (0 ± 5°F) for a minimum of 15 hr.

3.6.3.4 Take the specimens from the bags and place in a 60 ± 3°C (140 ± 1.8°F) water bath for 24 ± 2 hr.

3.7 *Indirect Tensile Testing:*

3.7.1 Remove moisture-conditioned specimens from 60°C (140°F) water bath and place them in a 25 ± 0.5°C (77 ± 1°F) water bath.

3.7.2 Remove the dry specimens from the desiccator, put them into leak-proof submergible containers, and place these containers in the 25°C (77°F) water bath.

Note 2—The containers must allow the dry specimens to remain dry, but still allow them to attain the temperature of the 25 C (77°F) water bath.

3.7.3 After the specimens have been in the 25°C (77°F) water bath for 3–4 hr. (to ensure 25 ± 0.5°C [77 ± 1°F] has been obtained), remove and immediately test them all to failure by indirect tensile loading, as described in Tex-226-F.

4. CALCULATIONS

4.1 Calculate the tensile strength ratio:

$$TSR = \frac{Average\ Indirect\ Tensile\ Strength\ of\ \ Conditioned\ Specimens}{Average\ Indirect\ Tensile\ Strength\ of\ \ Dry\ Specimens}$$

4.2 Use the tensile strength ratio as a measure of stripping susceptibility.

4.3 The sample data and calculation sheets are included in this test method.

5. NOTES

5.1 *Compactive Effort Determination Procedure:*

5.1.1 Mix four trial specimens.

5.1.2 Mold the four specimens using two, four, six, and eight sets of gyrations at 345 kPa (50 psi) loading and a 6895 kPa (1,000 psi) level-up load.

5.1.3 Determine the density of these trial specimens and determine the compactive effort (i.e., number of gyrations at 345 kPa [50 psi] with a 6895 kPa [1,000 psi] level-up load) needed to achieve 93 ± 1% density for the test specimens.

5.2 *Hot-Mix, Cold-Laid (HMCL) Material Procedure:*

5.2.1 Amend the mixing and molding procedures by mixing the design aggregates and the asphaltic material (asphalt-primer blend [no water], emulsion, or cutback asphalt) in accordance with Tex-205-F.

5.2.2 Cool at room temperature for 2-1/2 hr.

5.2.3 Cure mix a minimum of 15 hr. at 60°C (140°F) or until attaining constant weight.

5.2.4 Heat the mix specimens at 38 ± 2°C (100 ± 5°F) for two hr.

5.2.5 Mold at 38 ± 2°C (100 ± 5°F).

5.2.6 Test plant mixes by the modified procedure starting with the curing step.

5.3 *Hot-Mix, Hot-Laid (HMHL) Plant Mix Procedure:*

5.4 Start at Section 3.4, providing that representative samples of the plant mix are weighed to produce mix specimens. The specification acceptance criteria are based on laboratory mixtures; plant mixes generally yield a higher TSR than laboratory-produced mixes.

5.5 The vacuum pump or water aspirator must be able to reduce the residual pressure in the system to 50 mm (2 in.) Hg or less before the completion of the air evacuation process of the procedure. This equates to a vacuum gauge reading (absolute vacuum) of 710 mm (27.9 in.) Hg or more at normal sea level atmospheric pressure. In locations that are significantly higher than sea level, it may be necessary to use a mercury manometer to establish the point on a vacuum gauge that equates to 50 mm (2 in.) Hg of residual pressure. Accomplish this by pulling a residual vacuum of 50 mm (2 in.) Hg as read on a mercury manometer placed in line with the vacuum gauge. At this point, make a mark on the vacuum gauge and use this point as the minimum vacuum to pull. Vacuum gauges are not as precise as manometers, so calibrate the vacuum gauge with a manometer on a regular basis.