METHOD OF TEST
FOR
STRIPPING BY STATIC IMMERSION

1. SCOPE

1.1 Aggregate is prepared and coated with asphalt cement that has been combined with an anti-stripping additive. Various percentages of the additive are compared. The samples are immersed in distilled water and the retained coating is visually evaluated.

2. REFERENCES

2.1 MTO Manual of Designated Sources for Materials

2.2 ASTM E11, Standard Specification for Wire Cloth and Sieves for Testing Purposes

2.2 OPSS 1102, Material Specification for Liquid Asphalt

3. APPARATUS

3.1 BALANCE: Capable of weighing 1000 g to within 0.1 g accuracy.

3.2 CONTAINER FOR MIXING: An enamelled ware dish, approximately 140 mm in diameter and 70 mm in depth, must be suitable to withstand heat. Used to hold aggregate and asphalt cement with anti-stripping additive for thorough mixing.

3.3 SPATULA: With a metal blade approximately 100 mm long and 20 mm wide. Used for mixing aggregate and anti-stripping additive together to achieve a complete coating.

3.4 OVEN: Capable of maintaining temperatures between 121° and 177°C to within 2°C.

3.5 WATER BATH: Capable of maintaining a temperature of 49°C to within 0.5°C accuracy.

3.6 QUICK HEAT OVEN: Capable of rapidly heating aggregate to high temperatures.

3.7 FLAT METAL PAN: Suitable for containing aggregate to be quick heated. A thin film oven dish that can no longer be used for testing is convenient.

3.8 BEAKER: 600 ml, Pyrex.

3.9 SQUARES: (Approximately 200 mm) of polyethylene paper.

3.10 POLYETHYLENE DISH: Approximately 120 mm square by 40 mm deep.

3.11 CONTAINER (1 L): Triple tight lid, screw cap, to hold 800 g of asphalt cement with different percentages of anti-stripping additives in them.

3.12 HOT PLATE: To heat asphalt cement before anti-stripping additive has been added, then to heat 250 ml cans with asphalt cement and various percentages of anti-stripping additives to 143°C.

3.13 CONTAINER (250 ml ointment cans): Used to pour asphalt cement and various percentages of anti-stropping additive into bowls of aggregate and also to hold 100 g of aggregate that has been mixed in proportions.

3.14 BATH (ultrasonic): Used for cleaning of beakers and enamelled ware dishes.

3.15 LIGHT (with magnifier): Used to illuminate the surface of the water, to aid in the evaluation of the percentage retained coating.

3.16 THERMOMETER: Needed to read temperature of asphalt cements and anti-stripping additives being heated to 143°C for addition to the aggregate.

3.17 SIEVES: Standard, woven-wire, square-hole of 6.3 mm and 9.5 mm size, in accordance with ASTM E11.

3.18 DISTILLED WATER: Used to cover the coated aggregate in the beaker.

4. PREPARATION

4.1 The aggregate is dried for 24 h in an oven maintained at about 141°C. The cooled aggregate is sieved and its gradation is determined. The material passing the 13.2 mm sieve and retained on the 4.75 mm (No. 4) sieve is used with asphalt cements. The aggregate passing the 9.5 mm sieve and retained on the 4.75 mm (No. 4) sieve is used for cut-back asphalts. Each sieve size is stored in a separate container until ready for use.

4.2 If washed aggregate is to be used, the aggregate is dried and sieved as in 4.1. The aggregate is then washed thoroughly with tap water and rinsed with distilled water. (It is convenient to wash each sieve size to be used separately.) The aggregate is surface-dried and placed in an oven maintained at 141°C for a period of 24 h.

4.3 After the 24 h drying period, the cooled aggregate is stored (according to sieve size) in suitable containers. The container must have a lid and be air tight, in order to protect the aggregate from the surrounding air conditions until ready to be used.

4.4 Prepare and weigh the aggregate before the start of a test. Each sample to be tested requires 100 g of aggregate, composed of 50 g of the 9.5 mm sieve designation, 35 g of the 6.7 mm sieve designation, and 15 g of the 4.75 mm sieve designation. Once the aggregate has been weighed, it may be stored in 250 ml cans with lids. The cans will hold the pre-weighed, proportioned aggregate until ready for use.

4.5 For a single grade of asphalt cement being tested and a single anti-stripping additive, 10 cans of aggregate will be required for each day. All tests must be done in duplicate and 2 cans are required for each percentage of additive, in addition to the 2 cans for a control sample. Any subsequent days of testing may be completed without the control and thus will only require 8 cans of aggregate.

5. PROCEDURE

5.1 Method A: Asphalt Cements

5.1.1 If an anti-stripping additive is being tested, refer to Method D (section 5.4) for the asphalt/ additive preparation procedures. Otherwise, proceed with step 5.1.2.

5.1.2 The oven is adjusted to a temperature of 143 ± 2°C (or the mixing temperature recommended by the asphalt cement supplier). The enamelled ware dishes are preheated in this oven and the quick heat oven is allowed to come back up to temperature.

5.1.3 100 g of the pre-weighed aggregate is placed into the flat metal pan. The pan and its contents are placed into the quick heat oven for 10 min. Upon completion of the 10 min heating period, the surface temperature of the aggregate should be between 149° and 177°C.

5.1.4 The aggregate is transferred from the flat metal pan to the preheated enamelled ware dish in the oven. The heating process is continued at 143°C for an additional 15 min to stabilize the temperature of the aggregate.

5.1.5 At the completion of the 15 min stabilizing 5.1.4, the dish and contents are removed from the oven. 4.0 ± 0.1 g of asphalt cement heated to a temperature of 143°C is quickly added to the aggregate. Using the metal spatula, the aggregate is mixed until it is completely coated. The coated aggregate is immediately transferred to a 600 ml beaker. The beaker may be shaken to keep the mixture even. The mixture is allowed to cool to room temperature.

5.1.6 Once cooled, the aggregate is submersed in distilled water, filling the beaker to about the 3/4 full mark without pouring the distilled water directly onto the aggregate. The distilled water shall instead be poured in gently along the side of the beaker. The beaker is covered with a square of polyethylene, which is secured with an elastic band. This is to prevent evaporation of the water. The beaker and its contents are placed into the water bath at 49 ± 0.5°C for 24 h.

5.1.7 After the 24 h period, the beaker and its contents are removed from the water bath. Do not pour out the water from the beaker. The surface of the water is illuminated by means of a shaded lamp, and the percentage of total visible area of aggregate that has remained coated is evaluated.

5.1.8 If the retained coating is less than 65%, proceed with Method C (section 5.3).

5.2 Method B: Liquid Asphalts

5.2.1 100 g of the aggregate as per step 4.1 is placed into a 600 ml beaker. 6.0 ± 0.1 g of the asphalt cement which has been brought to the minimum mixing temperature as recommended in MTO Specification No. 1102 - Table 5, “Temperature Range of Liquid Asphalts for Spraying and Mixing”, is added to the beaker with the aggregate. Using the metal spatula, the asphalt cement and aggregate are mixed for 3 min.

5.2.2 Using the spatula, the coated aggregate is transferred to the polyethylene dish. The mix is allowed to cure for 1 h at room temperature.

5.2.3 At the end of the curing period, the per cent coated is visually evaluated. The dish is filled with distilled water and allowed to stand for 24 h at room temperature.

5.2.4 After 24 h, without disturbing the coated aggregate, any film floating on the surface of the water is removed. The per cent coating, using the lamp to illuminate the water surface, is evaluated. Any thin, brownish, translucent areas are to be considered as coated.

5.2.5 If the retained coating is less than 65%, proceed with Method C (section 5.3), except aggregate is not heated.

5.3 Method C: Aggregate Evaluation

5.3.1 The oven is adjusted to a temperature of 143 ± 2°C, the mixing pan is preheated in this oven, and the quick heat oven allowed to come back up to temperature.

5.3.2 100 g of the test aggregate is weighed using the standard gradation of:

Ministry Sieve Designation (mm)	% Passing
12.5	100
9.5	50
6.7	15
4.75	0

5.3.3 The aggregate is put into a flat metal pan and the pan and contents placed into the quick heat oven for 10 min. After the 10 min has elapsed, the surface temperature of the aggregate should be between 149° and 177°C.

5.3.4 At the end of this 10 min heating period, the aggregate is transferred from the flat metal pan to the preheated enamelled ware dish and placed in the conventional oven. The heating is continued at 143°C for an additional 15 min to stabilize the temperatures of the aggregate.

5.3.5 Asphalt cements and additives are selected by considering one of the following:

a) An asphalt cement that is representative of the bituminous material to be used on a contract with the aggregate in question is selected.

b) A source and grade of asphalt cement(s) that is representative of the area where the aggregate may be used is selected.

c) MTO Designated Sources List #3.05.10 for the current listing of approved anti-stripping additives may be referred to, or a pre-selected additive may be used.

5.3.6 Additives are usually added to the asphalt cement in the following increments, 0.5%, 0.75%, 1.00%, and 1.25% by weight of asphalt cement.

5.3.7 A minimum of 100 g of asphalt cement is heated in a suitable metal container and the required amount of additive is weighed to 0.1 g accuracy and added into the heated asphalt cement. Using a spatula, the additive is stirred thoroughly into the asphalt. The test procedure is continued as in 5.1.5 to 5.1.7.

5.4 Method D: Additive Evaluation

5.4.1 Aggregate(s), freshly crushed from boulders (crushed a maximum of 30 days prior to testing of anti-stripping additive) with known stripping characteristics such as dolomitic sandstone, granite-gneiss, and/or quartzite, are used.

5.4.2 The aggregate is prepared according to 5.3.1 to 5.3.4.

5.4.3 Asphalt cements are selected in the following manner:

a) An asphalt cement that is representative of the bituminous material used in the province.
b) A source and grade of asphalt cement(s) that is representative of the area where the aggregate may be used is selected.
c) The asphalt cement(s) specified by the owner.

Note: MTO has been evaluating anti-stripping additives using all nine combinations of the three freshly crushed dolomitic sandstone, granite gneiss, and quartzite with PG 58-28, PG 52-34, and PG 52-40.

5.4.4 Additives are usually added to the asphalt in the following increments: 0.5%, 0.75%, 1.0%, and 1.25% by weight of asphalt.

5.4.5 Approximately 800 g of asphalt cement is heated in a suitable metal container (1 L capacity, triple tight lid with screw cap), and the required amount of additive is weighed to 0.1 g accuracy into the heated asphalt. Using a spatula, the additive is thoroughly stirred into the asphalt. 30 to 50 g of the mixture is poured off. This asphalt/additive mixture is now ready for the initial day of testing. To coat aggregate, add asphalt binder follow steps 5.1.5 to 5.1.7.

5.4.6 When a heat stability cycle is included in the elevations, the additive-asphalt mixtures are placed in an oven at 177°C for a period of 1 d (24 h), 2 d, 3 d, and 4 d (or other specified periods). After each 24 h period has elapsed, another 30 to 50 g of asphalt is poured of for the completion of that particular day of testing.

When required for use, the additive-asphalt mixtures are brought up to mixing temperature (143°C or as recommended by the particular asphalt cement supplier, see step 7.8).

6. REPORT

6.1 The sample number and the per cent coating of the aggregate for initial and all other required cycles (24 h for Methods A, B, and C, and for Method D 1, 2, 3, and 4 d) for each increment of additive (0.5%, 0.75%, 1.0%, and 1.25%) are to be reported on a form sheet for each PGAC and aggregate combination. Refer to Figure 1 for an example form sheet for Static Immersion Stripping Results (Additive Evaluation).

7. NOTES

7.1 If the initial coating of aggregate is less than 90%, experience has shown that the combination of additive/asphalt's being evaluated has a lower chance of meeting the minimum coating requirements of 65% after 4 d of exposure in the oven.

7.2 When specified by the owner, the test may include immersing the aggregate in a 0.5% solution of NaCl in distilled water.

7.3 All tests are to be performed in duplicate.

7.4 With some very angular aggregates, it may be necessary to add more than 4.0 g of asphalt cement to obtain complete initial coating.

7.5 Use heat resistant gloves when handling hot aggregate and equipment.

7.6 If it is necessary to remove the mixing dish from the oven in order to add the aggregate from the quick heat oven, this operation must be quickly performed to keep heat loss to a minimum.

7.7 Refer to the chart provided in Figure 2 for visual percentage estimation.

7.8 When the asphalt cement supplier recommends a mixing temperature higher than the 143^{o}C used in this test procedure, the operator shall adjust the procedure to heat materials to within 2^{o}C of the asphalt cement supplier's recommended mixing temperature.

Figure 1: Example of Reporting Sheet

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Static Immersion Stripping Results
(Additive Evaluation)

Project: Additive Used:
Date: Aggregate Used:

Asphalt Binder	% Retained Coating															
	Heat Stability at 177oC															
	Initial				1 Day				2 Day				3 Day				4 Day			
	Control	0.50%	0.75%	1.00%	1.25%	Control	0.50%	0.75%	1.00%	1.25%	Control	0.50%	0.75%	1.00%	1.25%	Control	0.50%	0.75%	1.00%	1.25%
1																				
2																				
3																				

	Source and Grade of Asphalt Binder Use
1	1. _____
2	2. _____
3	3. _____

Remarks: _____
_____
_____

Figure 2: Chart for Visual Percentage Estimation