Chapter 36

Tex-240-F, Determining Optimum Residual Asphalt Content (RAC) for Micro-surfacing Systems

Contents:

Section 1
Overview

Effective Dates: August 1999 to November 2004.

Use this mixture design procedure to determine optimum residual asphalt content (RAC) for micro-surfacing systems.

Conduct tests on the mixture of polymer modified asphalt cement, aggregate, Portland cement, water, and set retarding additive.

Establish the water content using the mixing test and the modified cone test.

Establish the cement content using the cohesion test.

Establish the optimum RAC of cement using the wet track abrasion test.

Units of Measurement

The values given in parentheses (if provided) are not considered to be standard and may not be exact mathematical conversions. Each system of units shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

Section 2
Procedure

Use this procedure to determine the proper proportion of approved aggregate, mineral filler, water, asphalt emulsion and additive to produce a mix that meets specification requirements.

Determining Asphalt Additive Proportion

Step	Action
1	Obtain a representative sample of aggregate, mineral filler (Portland cement) and emulsion. The following quantities are required: 45 kg (100 lb.) of aggregate 1 L (1 qt.) of Portland cement 5 L (2 gal.) of emulsion.
2	Dry the aggregate to a constant weight.
3	Determine: the sieve analysis as outlined in Test Method "Tex-200-F, Sieve Analysis of Fine and Coarse Aggregates," and bulk or apparent specific gravity as outlined in test methods "Tex-201-F, Bulk Specific Gravity and Water Absorption of Aggregate," and "Tex-202-F, Apparent Specific Gravity of Material Finer than 180 µm (No. 80) Sieve."
4	Separate the aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4) and 2.36 mm (No. 8) sieves. A large number of small aggregate samples is required to reduce segregation.
5	Recombine the aggregate to obtain samples with the proper gradation.
6	Determine percent residual asphalt cement content of emulsion as outlined in AASHTO T 59.
7	Select five trial asphalt contents. The trial asphalt contents must be in 0.5% increments.
8	Perform 'Part I, Mixing Time Test' at each RAC with 0.5, 1.0, 1.5 and 2.0% Portland cement to ensure there is adequate time to mix and apply the slurry. Start with a creamy mixture and decrease, at 1% increments, the water content. The minimum water content is the water content that has a 120 second mixing time.
9	Select the optimum water content using 'Part II, Water Content Selection Using Modified Cup Flow Test,' of this test procedure. Perform this test at each RAC and with the following cement contents: 0.5, 1.0, 1.5, and 2.0%.
10	Select optimum water content for each combination of RAC and Portland cement. Select the optimum water content at 2% below the water content that gives equal to or greater than 5 mm (0.2 in) separation of fluids and solids. The optimum water contents selected in this step must be greater than the minimum water content from Step 6. (Stop testing and develop a new mixture if the optimum water content is less than the minimum water content.)
11	Perform 'Part III, Wet Cohesion Test' for each RAC and the amount of water and additive selected in Steps 7-10 and the following Portland cement contents: 0.25, 0.5, 0.75, 1.0, 1.5, 2.0 and 2.5%. For each RAC, select the lowest Portland cement content that provides the minimum torque of 12 kg-cm at 30 minutes and 20 kg-cm at 60 minutes. Perform all subsequent testing at the Portland cement contents selected in this step.
12	Conduct 'Part IV, Wet Track Abrasion Test (WTAT)' for each RAC with the appropriate water, Portland cement and additive contents. Select the minimum acceptable RAC that passes the WTAT with an abrasion loss less than 75

Determining Asphalt Additive Proportion	
Step	**Action**
	g/ft^2 (806 g/m^2) for a 6 day soak.
13	Select the optimum RAC at 0.5% above the minimum RAC that passes the WTAT.

Section 3
Reporting

Report the optimum RAC, the corresponding emulsion content, the required minimum Portland cement content selected in Step 8 of 'Determining Asphalt Additive Proportion' for the optimum RAC, the minimum water content for the optimum RAC, the optimum water content for the optimum RAC, and the aggregate gradation. All content values must be in percent of weight of dry aggregate.

The results of each test will be provided with the final mixture design results, which must become the job mixture formula when approved.

Section 4
Part I, Mixing Time Test

This test determines the minimum water content that gives 120 seconds mix time. The 120 second mix time insures adequate time to mix and place the slurry.

Apparatus

The following apparatus is required:

mixing container – a 500 mL (16 oz.) plastic drinking cup

mixing blade – a 150 mm (6 in.) tongue depressor

stop watch

balance capable of weighing 600 ± 0.1 g.

Preparing Sample

Follow these steps to prepare samples for mixing time test.

Preparing Mixing Time Test Sample

Step	Action
1	Carry out the test with all ingredients and room at 25 ± 1.1 °C (77 ± 2 °F).
2	Oven dry the aggregate to a constant weight.
3	Sieve the oven dry aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4) and 2.36 mm (No. 8) sieves.
4	Recombine the aggregate to obtain a 200 g aggregate sample.
5	Weigh 200 g of aggregate into a 500 mL (16 oz.) plastic cup.
6	Add the appropriate amount of cement and dry mix into the aggregate for 60 seconds.
7	Weigh in the desired amount of water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wetted.
8	Add the required amount of emulsion.

Procedure

Follow these steps to perform mixing time test.

Mixing Time Test

Step	Action
1	After the emulsion has been added, start the timer and mix the slurry at 60-70 rpm. Continue mixing until the emulsion has broken.
2	Record the time when the emulsion breaks.

Report

Report the time at which the emulsion breaks with the percent Portland cement, water, emulsion and additive, if used.

Section 5

Part II, Water Content Selection Using Modified Cup Flow Test

Use this test method to measure the water content where separation of fluids and solids occur on a 15° inclined plane. Select the optimum water content for the micro-surfacing system at 2% below the water content where separation occurs at a point equal to or greater than 5 mm (0.2 in.).

Apparatus

The following apparatus is required:

mixing container – a 500 mL (16 oz.) plastic drinking cup

mixing blade – a 150 mm (6 in.) tongue depressor

stop watch

balance capable of weighing 600 ± 0.1 g

stainless steel or aluminum inclined plane. The inclined plane must be 300 mm wide x 600 mm long (12 x 24 in.) and at a 15° angle.

Preparing Sample

Follow these steps to prepare water content selection using the Modified Cup Flow test sample.

Preparing Cup Flow Test Sample

Step	Action
1	The 'Mixing Time Test' must be performed to determine the amount of additive required to obtain a mixing time equal to or greater than 240 seconds. The 'Modified Cup Flow Test' must be performed at this amount of additive.
2	Carry out the test with all ingredients and room at 25 ± 1.1 °C (77 ± 2 °F).
3	Oven-dry the aggregate to a constant weight.
4	Sieve the oven-dry aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4) and 2.36 mm (No. 8) sieves.
5	Recombine the aggregate to obtain a 200 g aggregate sample.
6	Weigh 200 g of aggregate into a 590 mL (20 oz.) plastic cup.
7	Add the appropriate amount of cement and dry mix into the aggregate for 60 seconds.
8	Weigh in the desired amount of water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wetted.
9	Add the required amount of emulsion.
10	The emulsion must be mixed for 30 seconds.

Procedure

Follow these steps for water content selection using the Modified Cup Flow test.

Modified Cup Flow Test	
Step	**Action**
1	Place the inclined plane on top of cup.
2	Invert the cup and inclined plane. Hold the cup to the inclined plane securely to prevent loss of fluids.
3	Place the inclined plane on a level surface.
4	Tap lightly on the bottom of the cup 2 times.
5	Remove the cup vertically and start the timer.
6	After 120 seconds, observe the slurry and record if separation of fluids and solids is equal to or greater than 5 mm (0.2 in.).

Report

Report the water content that gives a separation of fluids and solids equal to or greater than 5 mm (0.2 in.). Also report the percentages of water, Portland cement, emulsion and additives used.

Section 6
Part III, Wet Cohesion Test

This procedure, which is a modification of ASTM D 3910, is used to select the percent Portland cement for a given micro-surfacing system.

Apparatus

The following apparatus is required:

modified cohesion tester, similar to the ASTM D 3910, with the following modifications:

28.5 mm (1-1/8 in.) double rod air cylinder with 8 mm (5/16 in.) rods and 75 mm (3 in.) stroke

6 x 28.5 mm (1/4 x 1-1/8 in.) 60 durometer neoprene rubber foot

Air pressure regulator with a variable down stream bleed valve with exhaust port regulating valves

Four-way directional control valve with exhaust port regulating valves

Air pressure gauge with a 0 to 700 kPa (0 to 100 psi) pressure gauge

700 kPa (100 psi) air supply

Torque meter capable of measuring and marking at least 35 kg-cm torque.

100 x 100 mm (4 x 4 in.) square cut from 14 kg (30 lb.) saturated roofing felt to be used as sample mounting pads

6 x 60 mm (0.24 x 2.4 in.) diameter and 10 x 60 mm (0.4 x 2.4 in.) diameter specimen molds

4.75 mm (No. 4) and 9.5 mm (3/8 in.) ASTM E 11 sieves

plastic, 590 mL (20 oz.) cups for mixing

steel spatula for mixing and for scraping off neoprene foot

scale capable of weighing 600 ± 0.1 g

wash bottle with a very fine spout

forced draft oven controlled at 60 ± 3 °C (140 ± 5 °F)

for calibration:

20-30 mesh standard ASTM C 190 Ottawa Sand

220 grit silicon carbide '3-M' brand sand paper

100 grit silicon carbide 'Carborundum' brand sand paper

load cell to periodically check the cohesion meter pressure.

Calibration

Follow these steps to calibrate the testing apparatus.

Calibrating Testing Apparatus	
Step	Action
1	Make a series of tests with 220 grit sand paper until a series of 10 tests read a constant average within a 0.3 kg-cm (0.66 lb.-in.) range.
2	After the rubber disc is 'polished' with the 220 grit sand paper to a constant reading and the 20-30 mesh Ottawa sand (ASTM C190) contained in a 1 cm (0.4 in.) mold, test the 100 grit sand paper and record the calibration readings
3	Test the dry aggregate used for the test mix as in Step 2 and record on the cohesion graph.

Preparing Sample

Follow these steps to prepare samples for the wet cohesion test.

Preparing Sample for Wet Cohesion Test	
Step	**Action**
1	Oven-dry the aggregate to a constant weight.
2	Sieve the oven dry aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4) and 2.36 mm (No. 8) sieves.
3	Recombine the aggregate using the material passing the 4.75 (No. 4) sieve for grade I and the 9.5 mm (3/8 in.) sieve for grade II to obtain a 200 g aggregate sample.
4	Weigh 200 g of aggregate into the plastic cup.
5	Add the appropriate amount of cement and dry mix into the aggregate for 60 seconds.
6	Add the desired water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wetted.
7	Add the required amount of emulsion and mix for 30 seconds.
8	Center the 6 mm (0.24 in.) mold for grade I or 10 mm (0.4 in.) mold for grade II on the 10 x 10 cm (4 x 4 in.) roofing felt disc.
9	Pour the slurry into one side of the mold.
10	Level off the sample with the spatula blade held perpendicular to the mold surface. Level the sample in one pass using a 'sawing' motion to avoid segregation. Complete this step within 45 seconds of the addition of the emulsion.
11	Remove the mold and allow the sample to cure for 30 minutes and/or 60 minutes at room temperature (25 °C). For 24 hour cured samples, place the sample in a 60 °C (140 °F) oven for 24 hours.

Procedure

Follow these steps to perform the wet cohesion test.

Wet Cohesion Test	
Step	**Action**
1	Center the sample under the neoprene foot.
2	Set the air pressure at 200 kPa (29 psi).

Wet Cohesion Test	
Step	**Action**
3	Zero the torque wrench and place it on top of the cylinder rod.
4	Lower the foot against the sample at a rate of 8 to 10 cm/sec (3.2 to 4 in/sec).
5	After 5 to 6 seconds of compaction, twist the torque wrench in a smooth, firm, horizontal motion through a 90 to 120° arc within 0.5 to 0.7 seconds.
6	Take care to prevent pressing down on the rod when using the torque wrench.
7	Note the mode of rupture of the sample. NOTE: The modes of rupture are described under 'Report.'

Report

Report a torque reading for 30 minutes and one for 60 minutes. Include the 'mode of rupture.'

Report the mode of rupture as 'normal' when the specimen falls apart under torque.

Report the mode of rupture as 'solid spin' when the specimen does not fall apart under torque and the neoprene foot spins on the specimen without any visible damage to the specimen.

Report the mode of rupture as 'near spin' when the foot spins but leaves an indentation on the specimen.

Section 7
Part IV, Wet Track Abrasion Test (WTAT)

Use this procedure, which is a modification of ASTM D 3910, for determining the minimum asphalt content for a given micro-surfacing system.

Apparatus

The following apparatus is required:

balance capable of weighing 5000 ± 0.1 g

planetary type mechanical mixer such as Hobart C-100, N-50, or A-120

a 2.27 kg (5 lbs.) abrasion head, a 300 mm (12 in.) diameter rust resistant flat bottom pan and quick clamp mounting plate

300 x 300 mm (12 x 12 in.) square cut from 14 kg (30 lb.) saturated roofing felt

rust resistant round bottom bowl for mixing slurry

a raised lip sample mold of the following dimensions: a depth of 6.35 mm (1/4 in.) and a diameter of 279 mm (11 in) for the C-100 and A-120 mixers and 254 mm (10 in) for the N-50 mixer

a strike-off wooden dowel rod that is 25 mm (1 in.) diameter by 400 mm (15.7 in.) long

forced draft oven controlled at 60 ± 3 °C (140 ± 5 °F)

constant temperature water bath controlled at 25 ± 1 °C (77 ± 2 °F)

a 127 mm (5 in.) length of reinforced rubber hose equivalent to Parker 290 Ozex General Purpose Hose with 19 mm (3/4 in.) inside diameter with 6.25 mm (1/4 in.) wall thickness

a wooden block to support the mounting plate during testing.

Preparing Sample

Follow these steps to prepare samples for WTAT.

Preparing Sample for Wet Track Abrasion Test (WTAT)

Step	Action
1	Sieve the oven dry aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4), and 2.36 mm (No. 8) sieves.
2	Using only the material passing the 4.75 mm (No. 4) sieve, recombine the aggregate in proper proportions to maintain desired gradation and to obtain an 800 g sample (700 g using the N-50 machine).
3	Weigh the 800 g of aggregate into the mixing bowl.
4	Add the Portland cement and dry mix for 60 seconds or until uniformly distributed.
5	Add the desired water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wetted.

Preparing Sample for Wet Track Abrasion Test (WTAT)	
Step	**Action**
6	Add the required amount of emulsion and mix for 30 seconds.
7	Center the mold on the 300 x 300 mm (12 x 12 in.) square disc roofing felt.
8	Immediately pour the slurry into one side of the mold.
9	Level off the sample with the wooden dowel rod using a sawing motion. The sample must be leveled off in one pass to avoid segregation. This step must be completed within 45 seconds of the addition of the emulsion.
10	Remove the mold and place sample in the 60 °C (140 °F) oven and dry to constant weight (a minimum of 15 hours drying time).

Procedure

Follow these steps for WTAT.

Wet Track Abrasion Test (WTAT)	
Step	**Action**
1	Remove the dried sample from the 60 °C (140 °F) oven and allow to cool to room temperature.
2	Remove excessive felt by cutting around the sample, staying at least 10 mm (0.4 in.) away from the edge of the sample.
3	Weigh the sample and place in a 25 °C (77 °F) water bath filled with distilled water for 6 days.
4	Remove the sample and place in flat bottom pan.
5	Clamp sample to mounting plate using the quick connection clamp.
6	Cover the sample with 6 ± 0.5 mm (0.25 ± 0.02 in.) of 25 °C (77 °F) distilled water.
7	Place fresh hose onto the abrasion head. An option is to use a hose section 4 times by rotating the hose 90° after each test to have a new section of hose in contact with the sample.
8	Lock the abrasion head on the shaft of the mixer.
9	Raise the mounting plate until the rubber hose is floating freely in contact with the sample surface.
10	Insert the wooden support block under the platform.
11	Switch the mixer on low speed for the time given in the 'Correction Factors to Correlate all Results to the C-100 Abrasion Loss' table for the machine being used.
12	Remove the sample and wash off loose debris with slow-running, room temperature water.
13	Place the washed sample in 60 °C (140 °F) oven and dry to constant weight.
14	Remove the dry sample and allow to cool to room temperature.
15	Weigh dry sample and calculate loss.

Use following correction factors to correlate results.

Correction Factors to Correlate all Results to the C-100 Abrasion Loss				
Model	**Running Time**	**Conversion Constant g/ft^2**	**Conversion Constant g/m^2**	**C-100 Correction Factor**
C-100	5 min ± 2 sec	3.06	32.9	1.00
A-120	6 min, 45 sec ± 2 sec	2.78	29.9	1.17

Correction Factors to Correlate all Results to the C-100 Abrasion Loss				
Model	**Running Time**	**Conversion Constant g/ft^2**	**Conversion Constant g/m^2**	**C-100 Correction Factor**
N-50	5 min, 15 sec ± 2 sec	3.48	37.5	0.78
Modified N-50	5 min, 15 sec ± 2 sec	3.06	32.9	0.78

Calculation

Calculate the loss of material abraded in g/ft^2 or g/m^2 (wear value):

$$wear\ value = (A - B) \bullet C \bullet D$$

Where:

A = Initial dry specimen weight

B = Abraded dry specimen weight

C = Conversion constant from the 'Correction Factors to Correlate all Results to the C-100 Abrasion Loss' table

D = C-100 correction factor from the 'Correction Factors to Correlate all Results to the C-100 Abrasion Loss' table.

Report

Report the wear value in g/m^2 (or g/ft^2), machine used, running time and soaking period.

EXAMPLE: The 6-day soak, wet track abrasion wear value is 644 g/m^2 (59.8 g/ft^2), using a N-50 machine for 5 minutes and 15 seconds.