

---

## Test Procedure for

# DETERMINING OPTIMUM RESIDUAL ASPHALT CONTENT (RAC) FOR POLYMER-MODIFIED SLURRY SEAL (MICROSURFACING) MIXTURES



## TxDOT Designation: Tex-240-F

**Effective Date: December 2004**

---

### 1. SCOPE

- 1.1 Use this test method to determine the optimum residual asphalt content (RAC) for microsurfacing systems. Conduct tests on the mixture of polymer modified asphalt cement, aggregate, mineral filler, water, and set retarding additive.
  - 1.1.1 Part I outlines the mixture design procedure for microsurfacing mixtures.
  - 1.1.2 Part II and Part III establish the minimum and optimum water content using the mixing test and the modified cone test.
  - 1.1.3 Part IV establishes the cement content using the wet cohesion test.
  - 1.1.4 Part V establishes the optimum RAC of cement using the wet track abrasion test (WTAT).
- 1.2 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.

---

## PART I—MIX DESIGN PROCEDURE

---

### 2. SCOPE

- 2.1 Follow these steps to determine the proper proportion of approved aggregate, mineral filler, water, asphalt emulsion, and additive to produce a mix that meets specification requirements.

---

### 3. PROCEDURE

- 3.1 Obtain a representative sample of aggregate, mineral filler, and emulsion. The following quantities are required:
  - 45 kg (100 lb.) of aggregate

- 1 L (1 qt.) of mineral filler
  - 5 L (2 gal.) of emulsion.
- 3.2 Oven-dry the aggregate to a constant weight at a temperature between 38 and 150°C (100 and 302°F). Cool to 25 ± 3°C (77 ± 5°F).
- 3.3 Determine the sieve analysis in accordance with Tex-200-F and the bulk or apparent specific gravity in accordance with Tex-202-F and Tex-202-F.
- 3.4 Separate the aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4), and 2.36 mm (No. 8) sieves.
- Note 1**—A large number of small aggregate samples are required to reduce segregation.
- 3.5 Recombine the aggregate to obtain samples with the proper gradation.
- 3.6 Determine percent residual asphalt cement content of emulsion as outlined in AASHTO T 59.
- 3.7 Select three or five trial asphalt contents, depending on experience and knowledge of materials used.
- Note 2**—The trial asphalt contents must be in 0.5% increments.
- 3.8 Perform Part II at each RAC with 0.5, 1.0, 1.5, and 2.0% mineral filler to ensure there is adequate time to mix and apply the slurry. Start with a creamy mixture and decrease the water content at 1% increments.
- Note 3**—The minimum water content is the water content that has a 120-second mixing time.
- 3.9 Select the optimum water content using Part III. Perform this test at each RAC and with the following mineral filler contents: 0.5, 1.0, 1.5, and 2.0%.
- 3.10 Select optimum water content for each combination of RAC and mineral filler. 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.
- Note 4**—The optimum water contents selected in this step must be greater than the minimum water content from Section 3.8. Stop testing and develop a new mixture if the optimum water content is less than the minimum water content.)
- 3.11 Perform Part IV for each RAC, the amount of water and additive selected in Sections 3.7–3.10, and the following mineral filler contents: 0.25, 0.5, 0.75, 1.0, 1.5, 2.0, and 2.5%. For each RAC, select the lowest mineral filler content that provides the minimum torque of 12 kg-cm at 30 min. and 20 kg-cm at 60 min. Perform all subsequent testing at the mineral filler contents selected in this step.
- 3.12 Conduct Part V for each RAC with the appropriate water, mineral filler, and additive contents. Select the minimum acceptable RAC that passes the WTAT with an abrasion loss less than 75 g/ft.<sup>2</sup> (806 g/m<sup>2</sup>), for a 6-day soak.
- 3.13 Select the optimum RAC at 0.5% above the minimum RAC that passes the WTAT.

---

## 4. REPORTING

- 4.1 Report the optimum RAC, the corresponding emulsion content, the required minimum mineral filler content selected in Section 3.11 for the optimum RAC, the minimum water content for the optimum RAC, the optimum water content for the optimum RAC, and the aggregate gradation. Report all content values in percent of weight of dry aggregate.
- 4.2 Provide the result of each test with the final mixture design results. This is the job-mix formula when approved.

---

## PART II—MIXING TIME TEST

---

### 5. SCOPE

- 5.1 Use this procedure to determine the minimum water content that gives 120-sec. mix time. The 120-sec. mix time ensures adequate time to mix and place the slurry.

---

### 6. APPARATUS

- 6.1 *Plastic cup, 500 mL (16 oz.), for mixing.*
- 6.2 *Tongue depressor, 150 mm (6 in.), for mixing.*
- 6.3 *Stop watch or timer.*
- 6.4 *Balance, Class G2 in accordance with Tex-901-K, capable of weighing  $600 \pm 0.1$  g.*

---

### 7. PREPARING SAMPLE

- 7.1 Perform the test with all ingredients and room at  $25 \pm 1.1^\circ\text{C}$  ( $77 \pm 2^\circ\text{F}$ ).
- 7.2 When evaluating the mixing time in determining the optimum RAC, oven-dry the aggregate to a constant weight in an oven at a temperature between  $38$  and  $150^\circ\text{C}$  ( $100$  and  $302^\circ\text{F}$ ). Cool to  $25 \pm 3^\circ\text{C}$  ( $77 \pm 5^\circ\text{F}$ ).
- 7.2.1 When verifying the mixing time for a mixture design or when evaluating the mixing time during production, air-dry the aggregate.
- 7.3 Sieve the oven-dry aggregate using  $9.5$  mm ( $3/8$  in.),  $4.75$  mm (No. 4) and  $2.36$  mm (No. 8) sieves.
- 7.4 Let the aggregate cool to the required testing temperature and recombine to obtain a  $200$  g aggregate sample.
- 7.5 Determine the weight of mineral filler, water, additives, and emulsion in accordance with Tex-230-F, Section 6.

- 7.6 Place 200 g of aggregate into a plastic cup.
- 7.7 Add the appropriate amount of mineral filler and dry mix into the aggregate for 60 seconds.
- 7.8 Weigh in the desired amount of water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wetted.
- 7.9 Add the required amount of emulsion.
- 

## 8. PROCEDURE

- 8.1 After adding the emulsion, start the timer and mix the slurry at 60–70 rpm.
- 8.2 Continue mixing until the emulsion has broken. Color change is the primary indication that an emulsion has broken. It normally changes to a black or dark color.
- 8.3 Record the time in seconds when the emulsion breaks.
- 

## 9. REPORT

- 9.1 Report the time in seconds at which the emulsion breaks with the percent mineral filler, water, emulsion, and additive, if used.
- 

## PART III—WATER CONTENT SELECTION USING MODIFIED CUP FLOW TEST

---

## 10. SCOPE

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

## 11. APPARATUS

- 11.1 *Plastic cup*, 590 mL (20 oz.), for mixing.
- 11.2 *Tongue depressor*, 150 mm (6 in.), for mixing.
- 11.3 *Stop watch or timer*.
- 11.4 *Balance*, capable of weighing  $600 \pm 0.1$  g.
- 11.5 *Stainless steel or aluminum inclined plane*, 300 mm wide  $\times$  600 mm long (12  $\times$  24 in.) and at a 15° angle.
-

---

## 12. PREPARING SAMPLE

- 12.1 Perform Section 8 to determine the amount of additive required to obtain a mixing time equal to or greater than 120 seconds. Perform Section 12 at this amount of additive.
- 12.2 Perform the test with all ingredients and room at  $25 \pm 1.1^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ ).
- 12.3 Oven-dry the aggregate to a constant weight in an oven at a temperature between 38 and  $150^{\circ}\text{C}$  (100 and  $302^{\circ}\text{F}$ ) when evaluating the water content for determining the optimum RAC. Cool to  $25 \pm 3^{\circ}\text{C}$  ( $77 \pm 5^{\circ}\text{F}$ ).
- 12.3.1 Air-dry the aggregate when verifying the mixing time for a mixture design or when evaluating the mixing time during production.
- 12.4 Sieve the oven-dry aggregate using 9.5 mm (3/8-in.), 4.75 mm (No. 4), and 2.36 mm (No. 8) sieves.
- 12.5 Let the aggregate cool to the required testing temperature and recombine to obtain a 200 g aggregate sample.
- 12.6 Weigh 200 g of aggregate into a plastic cup.
- 12.7 Determine the weight of mineral filler, water, additives, and emulsion in accordance with Tex-230-F, Section 6.
- 12.8 Add the appropriate amount of mineral filler and dry mix into the aggregate for 60 seconds.
- 12.9 Weigh in the desired amount of water and any liquid additive and mix for 60 sec. or until the aggregate is uniformly wetted.
- 12.10 Add the required amount of emulsion.
- 12.11 Mix the emulsion for a minimum of 30 seconds.

---

## 13. PROCEDURE

- 13.1 Place the inclined plane on top of cup.
- 13.2 Invert the cup and inclined plane. Hold the cup to the inclined plane securely to prevent loss of fluids.
- 13.3 Place the inclined plane on a level surface.
- 13.4 Tap lightly on the bottom of the cup two times.
- 13.5 Remove the cup vertically and start the timer.

- 13.6 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.)
- 

## 14. REPORT

- 14.1 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, mineral filler, emulsion, and additives used.
- 

## PART IV—WET COHESION TEST

---

### 15. SCOPE

- 15.1 Use this procedure, a modification of ASTM D 3910, to select the percent mineral filler for a given microsurfacing system.
- 

### 16. APPARATUS

- 16.1 *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 × 28.5 mm (1/4 × 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 0–700-kPa (0–100-psi) pressure gauge
  - 700 kPa (100 psi) air supply
  - Torque meter, capable of measuring and marking at least 35 kg-cm torque.
- 16.2 *100 × 100 mm (4 × 4 in.) square cut from 14-kg (30-lb.) saturated roofing felt*, to be used as sample mounting pads.
- 16.3 *Specimen molds*, 10 × 60-mm (0.4 × 2.4-in.) diameter.
- 16.4 *ASTM E 11 sieves*, 4.75 mm (No. 4) and 9.5 mm (3/8 in.)
- 16.5 *Plastic cups*, 590 mL (20 oz.), for mixing.
- 16.6 *Steel spatula*, for mixing and for scraping off neoprene foot.
- 16.7 *Scale*, Class G2 in accordance with Tex-901-K, capable of weighing 600.
- 16.8 *Wash bottle*, with a very fine spout.
-

- 16.9 *Forced draft oven, controlled at  $60 \pm 3^{\circ}\text{C}$  ( $140 \pm 5^{\circ}\text{F}$ ).*
  - 16.10 For calibration:
    - 16.10.1 *ASTM C 190 Ottawa Sand, 20–30 mesh standard.*
    - 16.10.2 *Silicon carbide 3M™ sand paper, 220 grit.*
    - 16.10.3 *Silicon carbide Carborundum brand sand paper, 100 grit.*
    - 16.10.4 *Load cell, to check the cohesion meter pressure periodically.*
- 

## 17. CALIBRATION

- 17.1 Make a series of tests with 220 grit sand paper until a series of ten tests reads a constant average within a 0.3 kg-cm (0.66 lb.-in.) range.
  - 17.2 After the rubber disc is polished with the 220 grit sand paper to a constant reading and the 20–30 mesh Ottawa sand (ASTM C 190) contained in a 1 cm (0.4 in.) mold, test the 100 grit sand paper and record the calibration readings.
  - 17.3 Test the dry aggregate used for the test mix as in Section 17.2 and record on the cohesion graph.
- 

## 18. PREPARING SAMPLE

- 18.1 Oven-dry the aggregate to a constant weight in an oven at a temperature between 38 and 150°C (100 and 302°F) when evaluating the wet cohesion for determining the optimum RAC. Cool to  $25 \pm 3^{\circ}\text{C}$  ( $77 \pm 5^{\circ}\text{F}$ ).
    - 18.1.1 Air-dry the aggregate when verifying the wet cohesion for a mixture design or when evaluating the mixing time during production.
  - 18.2 Sieve the oven dry aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4), and 2.36 mm (No. 8) sieves.
  - 18.3 Recombine the aggregate using the material passing the 4.75 (No. 4) sieve to obtain a 200 g sample. Prepare two test specimens for each curing time.
  - 18.4 Weigh 200 g of aggregate into the plastic cup.
  - 18.5 Determine the weight of mineral filler, water, additives, and emulsion in accordance with Tex-230-F, Section 6.
  - 18.6 Add the appropriate amount of mineral filler and dry mix into the aggregate for 60 seconds.
  - 18.7 Add the desired water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wet.
-

- 18.8 Add the required amount of emulsion and mix for 30 seconds.
  - 18.9 Center the 10 × 10 cm (4 × 4 in.) roofing felt disc.
  - 18.10 Pour the slurry into one side of the mold.
  - 18.11 Level off the sample with the spatula blade held perpendicular to the mold surface.
  - 18.11.1 Level the sample in one pass using a sawing motion to avoid segregation.
  - 18.11.2 Complete this step within 45 seconds of the addition of the emulsion.
  - 18.12 Remove the mold and allow the sample to cure at the required curing time. Cure test specimen for 30–60 minutes at room temperature 25°C (77°F).
- 

## 19. PROCEDURE

- 19.1 Center the sample under the neoprene foot.
- 19.2 Set the air pressure at 200 kPa (29 psi).
- 19.3 Zero the torque wrench and place it on top of the cylinder rod.
- 19.4 Lower the foot against the sample at a rate of 8–10 cm/sec. (3.2–4 in./sec.)
- 19.5 After 5–6 seconds of compaction, twist the torque wrench in a smooth, firm, horizontal motion through a 90–120° arc within 0.5–0.7 seconds.
- 19.6 Take care to prevent pressing down on the rod when using the torque wrench.
- 19.7 Note the mode of rupture of the sample.

**Note 5**—The modes of rupture are described under Section 20.

---

## 20. REPORT

- 20.1 Report an average torque reading for the samples cured for 30 min. and for the samples cured for 60 min.; include the mode of rupture.
- 20.2 Report the mode of rupture as “normal” when the specimen falls apart under torque.
- 20.3 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.
- 20.4 Report the mode of rupture as “near spin” when the foot spins but leaves an indentation on the specimen.

---

## PART V—WET TRACK ABRASION TEST (WTAT)

---

### 21. SCOPE

- 21.1 Use this procedure, a modification of ASTM D 3910, to determine the minimum asphalt content for a given micro surfacing system.

---

### 22. APPARATUS

- 22.1 *Balance*, Class G2 in accordance with Tex-901-K, capable of weighing 5000 g.
- 22.2 *Planetary type mechanical mixer*, such as Hobart C-100, N-50 or A-120.
- 22.3 *2.27-kg (5-lb.) abrasion head, 300-mm (12-in.) diameter rust resistant flat bottom pan and quick clamp mounting plate.*
- 22.4 *300 × 300-mm (12 × 12-in.) square cut from 14-kg (30-lb.) saturated roofing felt.*
- 22.5 *Rust-resistant round bottom bowl*, for mixing slurry.
- 22.6 *Raised lip sample mold*, with a depth of 6.35 mm (1/4 in.), 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.
- 22.7 *Strike-off wooden dowel rod*, 25-mm (1-in.) diameter by 400 mm (15.7 in.) long.
- 22.8 *Forced draft oven*, controlled at  $60 \pm 3^{\circ}\text{C}$  ( $140 \pm 5^{\circ}\text{F}$ ).
- 22.9 *Constant temperature water bath*, controlled at  $25 \pm 1^{\circ}\text{C}$  ( $77 \pm 2^{\circ}\text{F}$ ).
- 22.10 *Reinforced rubber hose*, equivalent to Parker 290 Ozex General Purpose Hose, with 127 mm (5 in.) length, 19 mm (3/4 in.) inside diameter and 6.25 mm (1/4 in.) wall thickness.
- 22.11 *Wooden block*, to support the mounting plate during testing.

---

### 23. PREPARING SAMPLE

- 23.1 Oven-dry the aggregate to a constant weight in an oven at a temperature between 38 and 150°C (100 and 302°F) when evaluating the wet track abrasion for determining the optimum RAC. Cool to  $25 \pm 3^{\circ}\text{C}$  ( $77 \pm 5^{\circ}\text{F}$ ).
- 23.1.1 Air-dry the aggregate when verifying the wet track abrasion for a mixture design or when evaluating the wet track abrasion during production.
- 23.2 Sieve the dry aggregate using 9.5 mm (3/8 in.), 4.75 mm (No. 4), and 2.36 mm (No.8) sieves.

- 23.3 Use only the material passing the 4.75 mm (No. 4) sieve, and recombine the aggregate in proper proportions to maintain desired gradation and to obtain 800 g sample (700 g using the N-50 machine).
- 23.4 Weigh the 800 g of aggregate into the mixing bowl.
- 23.5 Determine the weight of mineral filler, water, additives, and emulsion in accordance with Tex-230-F, Section 6.
- 23.6 Add the mineral filler and dry mix for 60 seconds or until uniformly distributed.
- 23.7 Add the desired water and any liquid additive and mix for 60 seconds or until the aggregate is uniformly wetted.
- 23.8 Add the required amount of emulsion and mix for 30 seconds.
- 23.9 Center the mold on the 300 × 300-mm (12 × 12-in.) square disc roofing felt.
- 23.10 Immediately pour the slurry into one side of the mold.
- 23.11 Level off the sample with the wooden dowel rod held parallel to the mold surface.
- 23.11.1 Level the sample in one pass using a sawing motion to avoid segregation.
- 23.11.2 Complete this step within 45 seconds of the addition of the emulsion.
- 23.12 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).

---

## 24. PROCEDURE

- 24.1 Remove the dried sample from the 60°C (140°F) oven and allow it to cool to room temperature.
- 24.2 Remove excessive felt by cutting around the sample, staying at least 10 mm (0.4 in.) away from the edge of the sample.
- 24.3 Weigh the sample and place in a 25°C (77°F) water bath filled with distilled water for six days
- 24.4 Remove the sample and place in flat bottom pan.
- 24.5 Clamp sample to mounting plate using the quick connection clamp.
- 24.6 Cover the sample with  $6 \pm 0.5$  mm ( $0.25 \pm 0.02$  in.) of 25°C (77°F) distilled water.
- 24.7 Place fresh hose onto the abrasion head. An option is to use a hose section four times by rotating the hose 90° after each test to have a new section of hose in contact with the sample.

- 24.8 Lock the abrasion head on the shaft of the mixer.
- 24.9 Raise the mounting plate until the rubber hose is floating freely in contact with the sample surface.
- 24.10 Insert the wooden support block under the platform.
- 24.11 Switch the mixer on low speed for the time given in Table 1 for the machine being used.
- 24.12 Remove the sample and wash off loose debris with slow-running, room temperature water.
- 24.13 Place the washed sample in 60°C (140°F) oven and dry to constant weight.
- 24.14 Remove the dry sample and allow it to cool to room temperature.
- 24.15 Weigh dry sample and calculate loss.

**Table 1—Correction Factors to Correlate All Results to the C-100 Abrasion Loss**

Model	Running Time	Conversion Constant - g/ft. <sup>2</sup>	Conversion Constant - g/m <sup>2</sup>	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
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

## 25. CALCULATION

- 25.1 Calculate the loss of material abraded in g/ft.<sup>2</sup> or g/m<sup>2</sup> (wear value):

$$\text{wear value} = (A - B) \cdot C \cdot D$$

Where:

*A* = Initial dry specimen weight

*B* = Abraded dry specimen weight

*C* = Conversion constant from Table 1

*D* = C-100 correction factor from Table 1.

## 26. REPORT

- 26.1 Report the wear value in g/ft.<sup>2</sup> (g/m<sup>2</sup>), machine used, running time, and soaking period.

*EXAMPLE:* The six-day soak, wet track abrasion wear value is 59.8 g/ft.<sup>2</sup> (644 g/m<sup>2</sup>), using an N-50 machine for 5 min. and 15 sec.

**27. ARCHIVED VERSIONS**

27.1 Archived versions are available.