

Recommended Performance Guideline For Micro Surfacing

**A143
(Revised February 2010)**



NOTICE

It is not intended or recommended that this guideline be used as a verbatim specification. It should be used as an outline, helping user agencies establish their particular project specification. Users should understand that almost all geographical areas vary as to the availability of materials. An effort should be made to determine what materials are reasonably available, keeping in mind system compatibility and specific job requirements. Contact the ISSA for answers to questions and for a list of ISSA member contractors and companies.

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RECOMMENDED PERFORMANCE GUIDELINE FOR MICRO SURFACING

1. SCOPE

The intent of this guideline is to aid in the design, testing, quality control, measurement and payment procedures for the application of micro surfacing.

2. DESCRIPTION

Micro surfacing shall consist of a mixture of polymer-modified emulsified asphalt, mineral aggregate, water, and additives, proportioned, mixed and uniformly spread over a properly prepared surface as directed by the Buyer's Authorized Representative (B.A.R.). Micro surfacing should be capable of performing in variable thickness cross-sections such as ruts, scratch courses and milled surfaces. After curing and initial traffic consolidation, it should resist further compaction.

The micro surfacing shall be applied as a homogeneous mat, adhere firmly to the prepared surface, and have a skid-resistant texture throughout its service life.

Micro surfacing is a quick-traffic system that allows traffic to return shortly after placement. Normally, these systems are required to accept straight, rolling traffic on a 0.5 in (12.7 mm) thick surface within one hour after placement in specific application conditions. Stopping and starting traffic may require additional curing time.

3. SPECIFICATIONS

It is normally not required to specify all tests for every project. A compilation of the results from the listed tests should be indicative of system performance. Failure to meet requirements for an individual test does not necessarily disqualify the system. If, for example, the system to be used on the project has a record of good performance, an individual test result may be waived. Agency and testing methods are listed in the appendix (see Appendix A) and form a part of this guideline.

4. MATERIALS

4.1 EMULSIFIED ASPHALT

4.1.1 GENERAL

The emulsified asphalt shall be polymer modified. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. In general, a three percent (3%) polymer solids, based on asphalt weight, is considered minimum.

4.1.2 QUALITY TESTS

The emulsified asphalt, and emulsified asphalt residue, shall meet the requirements of AASHTO M 208 or ASTM D 2397 for CQS-1h, with the following exceptions:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Settlement and Storage Stability of Emulsified Asphalts, 24-h	T 59	D 6930	1% Maximum
Distillation of Emulsified Asphalt ¹	T 59	D 6997	62% Minimum
Tests on Emulsified Asphalt Residue			
Softening Point of Bitumen (Ring-and-Ball Apparatus)	T 53	D 36	135°F (57°C) Minimum
Penetration of Bituminous Materials at 77°F (25°C)	T 49	D 5	40-90 ²

¹ The temperature for this test should be held at 350°F (177°C) for 20 minutes.

² The climatic conditions should be considered when establishing this range.

The solubility test, if required, should be evaluated on the base asphalt.

Each load of emulsified asphalt shall be accompanied with a Certificate of Analysis/Compliance to indicate that the emulsion meets specification.

4.2 AGGREGATE

4.2.1 GENERAL

The mineral aggregate used shall be the type specified for the particular application requirements of the micro surfacing. The aggregate shall be a crushed stone such as granite, slag, limestone, chat, or other high-quality aggregate, or combination thereof. To assure the material is 100 percent crushed, the parent aggregate will be larger than the largest stone in the gradation used.

4.2.2 QUALITY TESTS

The aggregate should meet agency specified polishing values and these minimum requirements:

TEST	TEST METHOD		SPECIFICATION
	AASHTO	ASTM	
Sand Equivalent Value of Soils and Fine Aggregate	T 176	D 2419	65 Minimum
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate	T 104	C 88	15% Maximum w/Na ₂ SO ₄ 25% Maximum w/MgSO ₄
Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine ¹	T 96	C 131	30% Maximum

¹The abrasion test is run on the parent aggregate.

4.2.3 GRADATION

When tested in accordance with AASHTO T 27 (ASTM C 136) and AASHTO T 11 (ASTM C 117), the mix design aggregate gradation shall be within one of the following bands (or one recognized by the local paving authority).

SIEVE SIZE	TYPE II PERCENT PASSING	TYPE III PERCENT PASSING	STOCKPILE TOLERANCE
3/8 (9.5 mm)	100	100	
# 4 (4.75 mm)	90 - 100	70 - 90	± 5%
# 8 (2.36 mm)	65 - 90	45 - 70	± 5%
# 16 (1.18 mm)	45 - 70	28 - 50	± 5%
# 30 (600 um)	30 - 50	19 - 34	± 5%
# 50 (330 um)	18 - 30	12 - 25	± 4%
#100 (150 um)	10 - 21	7 - 18	± 3%
#200 (75 um)	5 - 15	5 - 15	± 2%

The gradation of the aggregate stockpile shall not vary by more than the stockpile tolerance from the mix design gradation (indicated in the table above) while also remaining within the specification gradation band. The percentage of aggregate passing any two successive sieves shall not change from one end of the specified range to the other end.

The aggregate will be accepted at the job location or stockpile based on five gradation tests sampled according to AASHTO T 2 (ASTM D 75). If the average of the five tests is within the stockpile tolerance from the mix design gradation, the material will be accepted. If the average of those test results is out of specification or tolerance, the contractor will be given the choice to either remove the material or blend additional aggregate with the stockpile material to bring it into compliance. Materials used in blending must meet the required aggregate quality test specifications in Section 4.2.2 before blending and must be blended in a manner to produce a consistent gradation. Aggregate blending may require a new mix design.

Screening shall be required at the stockpile if there are any problems created by oversized materials in the mix.

Type II. This aggregate gradation is used to fill surface voids, address surface distresses, seal, and provide a durable wearing surface.

Type III. This aggregate gradation provides maximum skid resistance and an improved wearing surface. This type of micro surfacing surface is appropriate for heavily traveled pavements, rut filling, or for placement on highly textured surfaces requiring larger size aggregate to fill voids.

4.3 MINERAL FILLER

Mineral filler may be used to improve mixture consistency and to adjust mixture breaking and curing properties. Portland cement, hydrated lime, limestone dust, fly ash, or other approved filler meeting the requirements of ASTM D 242 shall be used if required by the mix design. Typical use levels are normally 0.0 - 3.0 percent and may be considered part of the aggregate gradation.

4.4 WATER

The water shall be free of harmful salts and contaminants. If the quality of the water is in question, it should be submitted to the laboratory with the other raw materials for the mix design.

4.5 ADDITIVES

Additives may be used to accelerate or retard the break/set of the micro surfacing. Appropriate additives, and their applicable use range, should be approved by the laboratory as part of the mix design.

5. LABORATORY EVALUATION

5.1 GENERAL

Before the work begins, the contractor shall submit a signed mix design covering the specific materials to be used on the project. This design will be performed by a laboratory which has experience in designing micro surfacing. After the mix design has been approved, no material substitution will be permitted unless approved by the B.A.R.

ISSA can provide a list of laboratories experienced in micro surfacing design.

5.2 MIX DESIGN

Compatibility of the aggregate, polymer-modified emulsified asphalt, water, mineral filler, and other additives shall be evaluated in the mix design. The mix design shall be completed using materials consistent with those supplied by the contractor for the project. Recommended tests and values are as follows:

TEST	ISSA TB NO.	SPECIFICATION
Mix Time @ 77°F (25°C)	TB 113	Controllable to 120 Seconds Minimum
Wet Cohesion		
@ 30 Minutes Minimum (Set)	TB 139	12 kg-cm Minimum
@ 60 Minutes Minimum (Traffic)		20 kg-cm or Near Spin Minimum
Wet Stripping	TB 114	Pass (90% Minimum)
Wet-Track Abrasion Loss		
One-hour Soak	TB 100	50 g/ft ² (538 g/m ²) Maximum
Six-day Soak		75 g/ft ² (807 g/m ²) Maximum
Lateral Displacement		5% Maximum
Specific Gravity after 1,000 Cycles of 125 lb (56.71 kg)	TB 147	2.10 Maximum
Excess Asphalt by LWT Sand Adhesion	TB 109	50 g/ft ² (538 g/m ²) Maximum
Classification Compatibility	TB 144	11 Grade Points Minimum (AAA, BAA)

The Wet Track Abrasion Test is performed under laboratory conditions as a component of the mix design process. The purpose of this test is to determine the minimum asphalt content required in a micro surfacing system. The Wet Track Abrasion Test is not recommended as a field quality control or acceptance test. ISSA TB 136 describes potential causes for inconsistent results of the Wet Track Abrasion Test.

The mixing test is used to predict the length of time the material can be mixed before it begins to break. It can be a good reference check to verify consistent sources of material. The laboratory should verify that mix and set times are appropriate for the climatic conditions expected during the project.

The laboratory shall also report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect) according to AASHTO T19 (ASTM C29).

The percentage of each individual material required shall be shown in the laboratory report. Based on field conditions, adjustments within the specific ranges of the mix design may be required.

The component materials shall be designed within the following limits:

COMPONENT MATERIALS	SUGGESTED LIMITS
Residual Asphalt	5.5 - 10.5% by dry weight of aggregate
Mineral Filler	0.0 - 3.0% by dry weight of aggregate
Polymer Content	Minimum of 3.0% solids based on bitumen weight content
Additives	As needed
Water	As required to produce proper mix consistency

6. EQUIPMENT

6.1 GENERAL

All equipment, tools, and machines used in the application of micro surfacing shall be maintained in satisfactory working condition at all times.

6.2 MIXING EQUIPMENT

The machine shall be specifically designed and manufactured to apply micro surfacing. The material shall be mixed by an automatic-sequenced, self-propelled micro surfacing mixing machine. It shall be a continuous-flow mixing unit that accurately delivers and proportions the mix components through a revolving multi-blade, double-shafted mixer. Sufficient storage capacity for all mix components is required to maintain an adequate supply to the proportioning controls.

When specifying continuous machinery to minimize transverse joints, the specified machine must be capable of loading materials while continuing to apply micro surfacing. The continuous-run machine shall be equipped to provide the operator with full control of the forward and reverse speeds during application. It shall be equipped with opposite-side driver stations to assist in alignment. The self-loading device, opposite-side driver stations, and forward and reverse speed controls shall be of original-equipment-manufacturer design.

6.3 PROPORTIONING DEVICES

Individual volume or weight controls for proportioning mix components shall be provided and properly labeled. These proportioning devices are used in material calibration to determine the material output at any time.

6.4 SPREADING EQUIPMENT

The mixture shall be agitated and spread uniformly in the surfacing box by means of twin-shafted paddles or spiral augers fixed in the spreader box. A front seal shall be provided to insure no loss of the mixture at the road contact point. The rear seal shall act as a final strike-off and shall be adjustable. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved and a free flow of material is provided to the rear strike-off. The spreader box shall have suitable means provided to side shift the box to compensate for variations in the pavement geometry.

6.4.1 SECONDARY STRIKE-OFF

A secondary strike-off shall be provided to improve surface texture. The secondary strike-off shall be adjustable to match the width of the spreader box and allow for varying pressures to control the surface texture.

6.4.2 RUT-FILLING EQUIPMENT

When project plans require, Micro Surfacing material may be used to fill ruts, utility cuts, depressions in the existing surface, etc. Ruts of 0.5 in (12.7 mm), or greater in depth, shall be filled independently with a rut-filling box, either 5 ft (1.5 m) or 6 ft (1.8 m) in width. Ruts that are in excess of 1.5 in (38.1 mm) in depth may require multiple applications with the rut-filling box to restore the cross-section. When rutting or deformation is less than 0.5 in (12.7mm), a full width scratch course may be applied with the spreader box using a metal or stiff rubber strike-off. Apply at a sufficient rate to level the pavement surface. The leveling course may, or may not, meet the suggested application rate in the table in Section 11.2. All rut-filling and level-up material should cure under traffic for at least twenty-four (24) hours before additional material is placed.

6.5 AUXILIARY EQUIPMENT

Suitable surface preparation equipment, traffic control equipment, hand tools, and other support and safety equipment necessary to perform the work shall be provided by the contractor.

7. CALIBRATION

Each mixing unit to be used in the performance of the work shall be calibrated in the presence of the B.A.R. prior to the start of the project. Previous calibration documentation covering the exact materials to be used may be acceptable, provided that no more than 60 days have lapsed. The documentation shall include an individual calibration of each material at various settings that can be related to the machine metering devices. Any component replacement affecting material proportioning requires that the machine be recalibrated. No machine will be allowed to work on the project until the calibration has been completed and/or accepted. ISSA *Inspector's Manual* describes a method of machine calibration. ISSA contractors and/or machine manufacturers may also provide methods of machine calibration.

8. WEATHER LIMITATIONS

Micro surfacing shall not be applied if either the pavement or air temperature is below 50°F (10°C) and falling, but may be applied when both pavement and air temperatures are above 45°F (7°C) and rising. No micro surfacing shall be applied when there is the possibility of freezing temperatures at the project location within 24 hours after application. The micro surfacing shall not be applied when weather conditions prolong opening to traffic beyond a reasonable time.

9. NOTIFICATION AND TRAFFIC CONTROL

9.1 NOTIFICATION

Homeowners and businesses affected by the construction shall be notified at least one day in advance of the surfacing. Should work not occur on the specified day, a new notification will be distributed. The notification shall be in the form of a written posting, stating the time and date that the surfacing will take place. If necessary, signage alerting traffic to the intended project should be posted.

9.2 TRAFFIC CONTROL

Traffic control devices shall be in accordance with agency requirements and, if necessary, conform to the requirements of the Manual on Uniform Traffic Control Devices. Opening to traffic does not constitute acceptance of the work

10. SURFACE PREPARATION

10.1 GENERAL

Immediately prior to applying the micro surfacing, the surface shall be cleared of all loose material, silt spots, vegetation, and other objectionable material. Any standard cleaning method will be acceptable. If water is used, cracks shall be allowed to dry thoroughly before applying micro surfacing. Manholes, valve boxes, drop inlets and other service entrances shall be protected from the micro surfacing by a suitable method. The B.A.R. shall approve the surface preparation prior to surfacing.

10.2 TACK COAT

Normally, tack coat is not required unless the surface to be covered is extremely dry and raveled or is concrete or brick. If required, the emulsified asphalt should be SS, CSS, or the micro surfacing emulsion. Consult with the micro surfacing emulsion supplier to determine dilution stability. The tack coat may consist of one part emulsified asphalt/three parts water and should be applied with a standard distributor. The distributor shall be capable of applying the dilution evenly at a rate of 0.05-0.15 gal/yd² (0.23-0.68 l/m²). The tack coat shall be allowed to cure sufficiently before the application of micro surfacing. If a tack coat is to be required, it must be noted in the project plans.

10.3 CRACKS

It is recommended to treat cracks wider than 0.25" (0.64cm) in the pavement surface with an approved crack sealer prior to application of the slurry seal.

11. APPLICATION

11.1 GENERAL

If required, a test strip should be placed in conditions similar to those expected to be encountered during the project.

When local conditions warrant, the surface shall be fogged with water ahead of the spreader box. The rate of application of the fog spray may be adjusted as the temperature, surface texture, humidity, and dryness of the pavement change.

The micro surfacing shall be of the appropriate consistency upon leaving the mixer. A sufficient amount of material shall be carried in all parts of the spreader at all times so that complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumps or unmixed aggregate shall be permitted. No dry aggregate either spilled from the lay-down machine or existing on the road, will be permitted.

No streaks, such as those caused by oversized aggregate or broken mix, shall be left in the finished surface. If excessive streaking develops, the job will be stopped until the contractor proves to the B.A.R. that the situation has been corrected. Excessive streaking is defined as more than four drag marks greater than 0.5 in (12.7 mm) wide and 4.0 in (101 mm) long, or 1.0 in (25.4 mm) wide and 3.0 in (76.2 mm) long, in any 29.9 yd² (25 m²) area. No transverse ripples or longitudinal streaks of 0.25 in (6.4 mm) in depth will be permitted, when measured by placing a 10 ft (3 m) straight edge over the surface.

11.2 RATE OF APPLICATION

The micro surfacing mixture shall be of the proper consistency at all times so as to provide the application rate required by the surface condition. The application rate shall be in accordance with the table below.

AGGREGATE TYPE	LOCATION	SUGGESTED APPLICATION RATE
Type II	Urban and Residential Streets Airport Runways Scratch or Leveling Course	10 - 20 lb/yd ² (5.4 - 10.8 kg/m ²) As Required
Type III	Primary and Interstate Routes Wheel Ruts Scratch or Leveling Course	15 - 30 lb/yd ² (8.1 - 16.3 kg/m ²) As Required (See Appendix B) As Required

Suggested application rates are based upon the weight of dry aggregate in the mixture. Application rates are affected by the unit weight and gradation of the aggregate and the demand of the surface to which the micro surfacing is being applied.

11.3 JOINTS

No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The contractor shall provide suitable width spreading equipment to produce a minimum number of longitudinal joints throughout the project. When possible, longitudinal joints shall be placed on lane lines. Partial width passes will only be used when necessary and shall not be the last pass of any paved area. A maximum of 3.0 in (76.2 mm) shall be allowed for overlap of longitudinal joints. Also, the joint shall have no more than a 0.25 in (6.4 mm) difference in elevation when measured by placing a 10 ft (3 m) straight edge over the joint and measuring the elevation difference.

11.4 MIXTURE

The micro surfacing shall possess sufficient stability so that premature breaking of the material in the spreader box does not occur. The mixture shall be homogeneous during and following mixing and spreading. It shall be free of excess liquids which create segregation of the aggregate. Spraying of additional water into the spreader box will not be permitted.

11.5 HANDWORK

Areas which cannot be accessed by the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. If necessary, the area to be hand worked shall be lightly dampened prior to mix placement. As much as possible, handwork shall exhibit the same finish as that applied by the spreader box. All handwork shall be completed prior to final surfacing.

11.6 LINES

Lines at intersections, curbs, and shoulders will be kept straight to provide a good appearance. If necessary, a suitable material will be used to mask off the end of streets to provide straight lines. Longitudinal edge lines shall not vary by more than ± 2 in (± 51 mm) horizontal variance in any 96 ft (29 m) of length.

11.7 ROLLING

Rolling is usually not necessary for micro surfacing on roadways. Airports and parking areas should be rolled by a self-propelled, 10-ton (maximum) pneumatic tire roller equipped with a water spray system. All tires should be inflated per manufacturer's specifications. Rolling shall not start until the micro surfacing has cured sufficiently to avoid damage by the roller. Areas which require rolling shall receive a minimum of two (2) full coverage passes.

11.8 CLEAN UP

All utility access areas, gutters and intersections, shall have the micro surfacing removed as specified by the B.A.R. The contractor shall remove any debris associated with the performance of the work on a daily basis.

12. QUALITY CONTROL

12.1 INSPECTION

Inspectors assigned to projects must be familiar with the materials, equipment and application of micro surfacing. Local conditions and specific project requirements should be considered when determining the parameters of field inspection.

Proper mix consistency should be one of the major areas of inspector concern. If mixes are too dry, streaking, lumping and roughness will be present in the mat surface. Mixes applied too wet will flow excessively and not hold straight lane lines. Excessive liquids may also cause an asphalt-rich surface with segregation.

12.2 MATERIALS

To account for aggregate bulking, it is the responsibility of the contractor to check stockpile moisture content and to set the machine accordingly. At the B.A.R.'s discretion, material tests may be run on representative samples of the aggregate and emulsion. Tests will be run at the expense of the buyer. The buyer must notify the contractor immediately if any test fails to meet the specifications.

12.3 MICRO SURFACING

If required, representative samples of the micro surfacing may be taken directly from the micro surfacing machine. Residual asphalt content (ASTM D2172) tests may be run on the samples at the expense of the buyer. The buyer must notify the contractor immediately if any test fails to meet specifications. Data obtained from the proportioning devices on the micro surfacing machine may be used to determine individual material quantities and application rate.

12.4 NON-COMPLIANCE

If any two successive tests fail on the stockpile aggregate, the job shall be stopped. If any two successive tests on the mix from the same machine fail, the use of the machine shall be suspended. It will be the responsibility of the contractor, at his expense, to prove to the B.A.R. that the problems have been corrected.

13. METHOD OF MEASUREMENT

13.1 AREA

On smaller projects, the method of measurement and payment is usually based on the area covered, measured in square feet, square yards, or square meters.

13.2 TONS AND GALLONS

On larger projects of over 50,000 yd (41,806 m³) measurement and payment are usually based on the tons of aggregate and the gallons (liters) of emulsified asphalt used.

Aggregate delivery tickets or printed tickets from certified scales at the staging area shall be used for measurement. The emulsified asphalt used on the project will be measured by the certified tickets for each load delivered. Emulsified asphalt not used shall be deducted from the job total.

14. PAYMENT

The micro surfacing shall be paid for by the unit area or the weight of the aggregate and the emulsified asphalt used on the project and accepted by the B.A.R. Payment shall be full compensation for all preparation, mixing and application of materials, and for all labor, equipment, tools, testing, cleaning, and incidentals necessary to complete the job as specified herein.

APPENDIX A

TEST METHODS (CONTINUED)

AGGREGATE AND MINERAL FILLER

AASHTO TEST NO.	ASTM TEST NO.	TEST
T 176	D 2419	Sand Equivalent Value of Soils and Fine Aggregate
T 104	C 88	Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
T 96	C 131	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine (This test should be performed on the parent rock that is used for crushing the finer gradation Micro Surfacing material.)
T 27	C 136	Sieve Analysis of Fine and Coarse Aggregates
T 11	C 117	Test Method for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing
T 2	D 75	Sampling Aggregates
	D 242	Mineral Filler for Bituminous Paving Mixtures
T 19	C 29	Bulk Density ("Unit Weight") and Voids in Aggregate

MIX DESIGN

ISSA TEST NO.	TEST
A143	Standard Design, Testing and Construction of Micro Surfacing
TB 100	Wet Track Abrasion of Slurry Seals
TB 109	Excess Asphalt by LWT Sand Adhesion
TB 113	Mix Time
TB 114	Wet Stripping Test for Cured Slurry Seal Mixes
TB 136	Causes of Inconsistency of Wet Track Abrasion Test (WTAT) Results
TB 144	Classification Compatibility by Use of the Schulze-Breuer and Ruck Procedure

NOTES:

ASTM D 6372, Standard Practice for Design, Testing, and Construction of Micro Surfacing, is a combined reference of the ISSA Test Bulletins listed above.

ASTM D 2172, Standard Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures, is referenced in Section 12.3.

APPENDIX A

TEST METHODS (CONTINUED)

AGGREGATE AND MINERAL FILLER

AASHTO TEST NO.	ASTM TEST NO.	TEST
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T 27	C 136	Sieve Analysis of Fine and Coarse Aggregates
T 11	C 117	Test Method for Materials Finer than 75µm (No. 200) Sieve in Mineral Aggregates by Washing
T 2	D 75	Sampling Aggregates
	D 242	Mineral Filler for Bituminous Paving Mixtures
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NOTES:

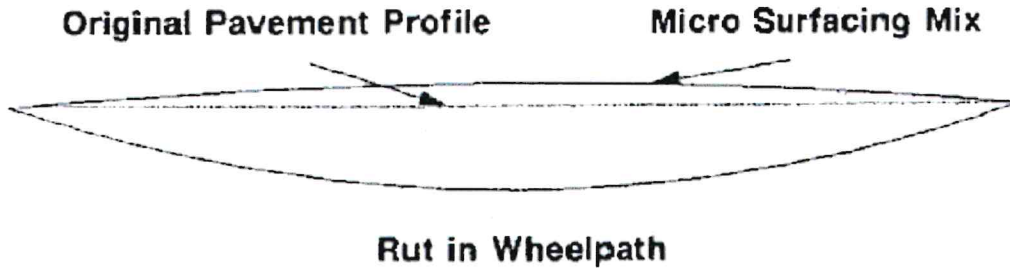
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ASTM D 2172, Standard Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures, is referenced in Section 12.3.

APPENDIX B
REPROFILING RUTTED WHEELPATHS
WITH MICRO SURFACING

Rule of Thumb

For every inch (mm) of micro surfacing mix, add 0.125 in (3.2 mm) to 0.25 in (6.4 mm) as a crown to allow for compaction under traffic.



Rut Depth		Micro Surfacing Quantity Needed	
0.5 - 0.75"	(12.7 - 19.1 mm)	20 - 30 lb/yd ²	(10.8 - 16.3 kg/m ²)
0.75 - 1.00"	(19.1 - 25.4 mm)	25 - 35 lb/yd ²	(13.6 - 19.0 kg/m ²)
1.00 - 1.25"	(25.4 - 31.75 mm)	28 - 38 lb/yd ²	(15.2 - 20.6 kg/m ²)
1.25 - 1.50"	(31.75 - 38.1 mm)	32 - 40 lb/yd ²	(17.4 - 21.7 kg/m ²)

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