

S-1 (2356) MICRO-SURFACING
REVISED 1/12/04

Mn/DOT Standard Specification for Construction 2356 is deleted and replaced with the following.

S-1.1 DESCRIPTION

This work is the construction of micro-surfacing on a prepared pavement. Micro-surfacing is a mixture of: polymer modified asphalt emulsion, well-graded crushed mineral aggregate, mineral filler, water and other additives.

S-1.2 MATERIALS

A. Asphalt Emulsion

Provide a polymer modified, CSS-1h bituminous material as specified in Mn/DOT 3151, and the following:

<u>Quality (on emulsion)</u>	<u>Test</u>	<u>Requirement:</u>
Residue after Distillation ¹	AASHTO T59	62%, min
<u>Quality (on residue)</u>	<u>Test</u>	<u>Requirement:</u>
Softening Point	AASHTO T53	57 °C [135 °F], min
Penetration at 25 °C [77 °F]	AASHTO T49	40 – 90
Absolute Viscosity at 60 °C	ASTM D 2171	800 Pa-s, min

Use only natural latex polymers.

Use a minimum of 3% polymer solids.

¹ The temperature for the distillation procedure shall be held at 177±5 °C [350 °F±9 °F] for 20 minutes. Complete the entire distillation procedure within 60 minutes from the first application of heat. The cement mixing test shall be waived.

B. Aggregate

Provide a Class A, or a blend of Class A and Class B aggregate, or Taconite Tailings, as specified in Mn/DOT 3139. When blending aggregate types, material passing the 3/8 inch sieve and retained on #16 shall not have less than 90 percent Class A and/or Taconite Tailings, by weight. Also, meet the following requirements:

<u>Tests on Aggregate:</u>	<u>Requirement:</u>
Sand Equivalent	AASHTO T176 60 percent, min
Abrasion Resistance ¹	AASHTO T96 40 percent, max
Soundness (using MgSO ₄) ²	AASHTO T104 25 percent, max

¹ Use grading C for Type 3 material. Use grading D for Type 2 material.

² The Soundness test shall be done on the Class B aggregate component of the blend, if applicable.

TABLE 1 (AASHTO T11, AASHTO T27).

Sieve Size	Mn/DOT Type 1	Mn/DOT Type 2 (ISSA Type II)	Mn/DOT Type 3 ISSA Type III	QC TOLERANCES Percent in JMF for each sieve size
3/8 (9.5mm)	100	100	100	
# 4 (4.75mm)	100	90 – 100	70 – 90	±5
# 8 (2.38mm)	85-100	65 – 90	45 – 70	±5
# 16 (1.18mm)	72-92	45 – 70	28 – 50	±5
# 30 (600µm)	50-75	30 – 50	19 – 34	±5
#50 (300 µm)	35-55	18 – 30	12 – 25	±4
#100 (150 µm)	15-35	10 – 21	7 – 18	±3
#200 (75 µm)	5-15	5 – 15	5 – 15	±2

C. Mineral Filler

Provide Portland cement or Hydrated lime, free of clumps, based on the mix design results.
Portland cement, type I as specified in Mn/DOT 3101.
Hydrated lime as specified in Mn/DOT 3106.

D. Water

Provide water as specified in Mn/DOT 3906.

2356.3 MIXTURE REQUIREMENTS

A. Mix Design

Submit a complete mix design, prepared by a qualified laboratory experienced in micro-surfacing technology, ten working days prior to the start of production. List the source of all materials used for the mix design. Show that the individual proportions of each of the materials when combined will meet the following mix design requirements:

<u>Test</u>	<u>Description</u>	<u>Specification</u>
ISSA TB-114	Wet Stripping	90 percent, min
ISSA TB-100	Wet Track Abrasion Loss	
	- One Hour Soak	538 g/m ² max
	- Six Day Soak	807 g/m ² max
ISSA TB-144	Saturated Abrasion Compatibility	3 g loss, max
ISSA TB-113	Mix Time at 25 °C	Controllable to 120 sec., min
	Mix Time at 37.4 °C	Controllable to 35 sec., min

The Job Mix Formula (JMF) shall be within the following limits:

Residual Asphalt: 5.5 – 11.5 percent, by dry weight of aggregate.
Mineral Filler: 0.25 - 3.0 percent, by dry weight, of aggregate.

A change in aggregate, aggregate blend, or asphalt emulsion source will require a new mix design.

C. Mix Design Format

Submit the final mix design in the following format.

- a. Source of each individual material.
- b. Aggregate:
 1. Gradation
 2. Sand Equivalent
 3. Abrasion Resistance
 4. Soundness
- c. Field Simulation Tests:
 1. Wet Stripping Test
 2. Wet Track Abrasion Loss
 3. Saturated Abrasion Compatibility
 4. Trial Mix Time @ 77 °F and 100 °F.
- d. Interpretation of Results and the Determination of a Job Mix Formula (JMF):
 1. Percentage of Mineral Filler (minimum and maximum)
 2. Percentage of Water, including aggregate moisture (minimum and maximum)
 3. Percentage of Mix Set Additive (if required)
 4. Percentage of Modified Emulsion
 5. Residual Content of Modified Emulsion
 6. Percentage of Residual Asphalt
- e. Signature and Date

2356.4 CONSTRUCTION REQUIREMENTS

A. Equipment

Maintain equipment in satisfactory working condition to ensure a high quality product.

A1. Mixing Machine

Provide a continuous micro-surfacing lay down machine. Provide a positive connection conveyer belt aggregate delivery system and an inter-connected positive displacement, water-jacketed gear pump to accurately proportion aggregate and asphalt emulsion. Locate the mineral filler feed so the proper amount of mineral filler is dropped on the aggregate before discharging into the pugmill. The pugmill must be a continuous flow twin shaft multi-blade type and a minimum of 4 feet long. The blade size and side clearance must meet the equipment manufacturer's recommendations. Introduce the asphalt emulsion within the first one-third of the mixer length to ensure proper mixing of all materials prior to exit from the pugmill.

Use a self propelled, front feed and continuous loading machine. Provide opposite side driving stations on the front to optimize longitudinal alignment during placement. Provide a remote forward speed control at the back mixing platform so that the back operator can control forward speed and the level of mixture in the spreader box. Use sufficient transport units to assure a continuous operation during mix production and application.

Provided individual volume or weight controls for proportioning each material. Position the controls to be accessible at any time. Use the controls to calibrate the operation prior to production and to determine the amount of each material used at any time.

Provide a water pressure system and nozzle type spray bar to spray water ahead of and outside the spreader box when required. Apply water at a rate to uniformly dampen the surface, but not to create free flowing water, ahead of the spreader box.

A2. Spreader Box

Spread the mix uniformly, using a mechanical type spreader box, attached to the mixer and equipped with **spiral augers** mounted on adjustable shafts. Continually agitate and distribute the mixture. Provide sufficient agitation to prevent stagnation, excessive build-up, or lumps. Equip the spreader box with front and rear flexible seals to achieve direct contact with the road. Use a secondary strikeoff attached to the spreader box to provide a smooth finished surface texture.

A3. Rut Filling Box

Provide a steel V-configuration screed rut box commercially designed and manufactured to fill ruts. The rut box shall achieve a mixture spread width of five to six foot and have a strikeoff to control crown.

A4. Weighting Equipment

Use of portable scales to weight material must be certified as specified in Mn/DOT 1901.8, and as modified as follows. Re-certified the scale after any change in location. Randomly spot check the scale at a rate of once per week or one per project, which ever is greater.

A5. Miscellaneous Equipment

Provide hand squeegees, shovels and other equipment necessary to perform the work. Cleaning equipment such as power brooms, air compressors, water flushing equipment, and hand brooms shall be adequate for surface preparation.

B. Operations

B1. Micro-surfacing Types

1. Rut Fill Use Mn/DOT Type 3

Rut fill pavement segments greater than 1000 feet length, when the average rut depth exceeds 1/2 inch. Provide a rut box for each designated wheel track. A clean overlap and straight edges shall be required between wheel tracks. Construct each rutted wheel track with a crown to allow for proper consolidation by traffic.

2. Scratch Course Use Mn/DOT Type (2 or 3, selected by designer)

Apply full lane width in one course, where rutting is $> \frac{1}{4}$ -in. and $< \frac{1}{2}$ -in.. *Use a metal strike off bar on the spreader box.* There shall be no excess buildup or uncovered areas.

3. Surface Course Use Mn/DOT Type 2

Apply full lane width in one course. There shall be no excess buildup or uncovered areas.

B2. Pre-Paving Meeting

A pre-paving meeting between the Contractor and Engineer will be held on-site prior to beginning work. The agenda for this meeting will include: Job Mix Formula, condition of all equipment, calibration of equipment, test strip(s), detailed work schedule, and traffic control plan.

B3. Calibration

Calibrate each mixing machine prior to use. Maintain documentation showing individual calibrations of each material at various settings, which relate to the machine's metering devices. Supply all materials and equipment, including scales and containers necessary for calibration. A change in aggregate or asphalt emulsion source will require recalibration. Calibration procedures are available from the equipment manufacturer.

B4. Test Strip

Construct a 1000 foot long, one lane wide test strip, for each machine used on the project. Begin construction after dark, no sooner than one hour after sunset and no later than one hour before sunrise. Compare the machines for variances in surface texture and appearance.

The emulsion shall not exceed 50 °C [122 °F]. Postpone the construction of the test strip until the emulsion temperature is under 50 °C [122 °F].

Construct a new test strip when the system used in job mix changes or there is field evidence that the system is out of control. The system includes the following: emulsion, aggregate supplier, type of mineral filler, and the lay down machine.

In place of construction of a test strip, a contractor may submit evidence of a successful construction of a test strip on another State project using the same mix designs. The project must have been constructed in same construction season. The system used for the test strip must be identical to all parts of the proposed system.

Carry normal traffic on the test strip within one hour after application, without any damage occurring. The Engineer will inspect the completed test strip after 12 hours of traffic to determine if the mix design is acceptable. Full production may begin after the Engineer accepts a test strip. The Engineer shall approve the location of the test strip.

B5. Surface Preparation

Prepare and maintain a clean surface immediately prior to placement of the micro-surfacing. Clean the surface of all loose material, vegetation, plastic markings, and other objectionable material. Cleaning the roadway surface is incidental to the cost of the Micro-surfacing.

B5. Tack Coat

Apply tack coat to all portland cement concrete surfaces. Only apply tack coat to hot mix asphalt pavements, if specified in the plan or if directed by the Engineer. Provide a CSS-1 or CSS-1h as specified in Mn/DOT standard specification 3151. Apply the material as specified in Mn/DOT 2357, and the following. Use one part emulsion to one part water. Apply the diluted emulsion at .05-.10 gal/y². Payment for the tack coat will be made under 2357.502 (Bituminous Material for Tack Coat).

Protect drainage structures, monument boxes, water shut-offs, etc., during application of the tack coat.

B8. Surface Quality

The restored transverse pavement cross section as measured using a 10 foot straight edge shall not exceed 3/8 inch, or 3/16 inch when measured with a 6 foot straight edge. The preceding shall not apply to any area within 12 inches of the edge line, lane line or center line.

Construct the surface course without excessive scratch marks, tears, rippling, or other surface irregularities. Repair tear marks greater than 1/2 inch wide and 4 inches long, and marks greater than 1 inch wide and 1 inch long. Repair transverse ripples or streaks greater than 1/4 inch in depth as measured by a 10 foot straight edge.

Construct longitudinal joints, with no more than 1/4 inch overlap thickness as measured with a 10 foot straight edge, and less than a 3 inch overlap on adjacent passes. Longitudinal construction joints and lane edges shall coincide with the proposed painted lane lines. Place overlapping passes, on the uphill side, to prevent ponding of water.

Construct transverse joints, with no more than 1/8 inch difference in elevation across the joint as measured with a 10 foot straight edge.

Construct edge lines along curbs and shoulders, with no more than 2 inches of horizontal variance in any 100 foot location. No runoff in these areas will be permitted.

If the micro-surfacing surface course cannot meet these requirements, stop the job until the problem is corrected.

Protect drainage structures, monument boxes, water shut-offs, etc.

B11. Open to Traffic

The micro-surface must cure sufficiently to prevent pickup by vehicle tires, before it is open to traffic. Micro-surface carries normal traffic within one hour after application, without any damage occurring. Protect the new surface from potential damage at intersections and driveways. Repair any damage to the surface, by traffic, at the Contractor's expense.

Confirm that the one hour cure is achieved on the first day of production, after construction of the test strip. Conduct three, one hour spot checks, by the Engineer. If any spot check fails, stop construction and deduct \$5,000 from the contract amount for each failure. Construct a new test strip. If the test strip fails, deduct \$5,000. After completion of three, one hour spot checks on the first day of production, the rate of one hour spot checks will be reduced to one per day, randomly picked by the Engineer. Additional spot checks may be taken at any time. Any failure of a one hour spot checks will result in a \$5,000 deduction and construction of a new test strip. After a test strip, the one hour spot check rate will revert to the first day of production procedure.

B12. Weather Limitations

Begin construction when the air and pavement surface temperature are **50 °F**, or above and rising. Placement is not permitted if it is raining. Do not work if the temperature is forecasted to be below **32 °F** within 48 hours. Complete all work by September 15.

S-1.5

QUALITY CONTROL

The Contractor is responsible for quality control (QC) sampling and testing.

A. Emulsion

Only emulsion from Certified Sources is allowed for use.

Provide material certification and quality control test results for each batch of emulsion used on the project. Include the supplier name, plant location, emulsion grade, and batch number on all reports. The emulsion must meet all requirements in this specification.

B. Aggregate

1. Stockpile production.

Provide material gradation and sand equivalence quality test results taken during production.

The testing rate is a minimum of one per day, or one per 1360t [1500 tons], whichever is greater for gradation, and one per source for sand equivalence.

The Contractor may also test at the stockpile location.

2. Construction.

Determine the gradation, sand equivalence, and moisture content.

Sample from the micro-surfacing machine. Sample at a rate of one per 500 tons, or a minimum of one per day of mixture production.

B1. Gradation and JMF Tolerance

Run gradation tests according to AASHTO T11 and AASHTO T27 at the stockpile site.

Report results to the Engineer, the same day as sample is taken. Provide companion samples if requested by the Engineer. The quality control tolerances for the JMF are listed in TABLE 1. The tolerance range does not extend the specification limits set in Table 1.

Schedule of Price Reduction for Micro-surfacing Construction.

Payment for micro-surfacing aggregate by the ton for failing gradation are based on a 2 percent price reduction for each 1 percent passing outside of either a QC tolerance requirements or a gradation range, for all sieves. This Schedule of Price Reduction for Micro Surfacing Construction only applies to non warranty work.

B2. Sand Equivalent Test

Determine the Sand Equivalent (AASHTO T176) for each aggregate gradation test.

Quality control tolerance is ± 7 percent, of the value established in the mix design (60% minimum). Run the sand equivalent test at the stockpile site. Report results to the Engineer, the same day as sample is taken.

B3. Moisture Content

Determine the moisture content. Visible changes in moisture require additional testing.

An average daily moisture will be used to calculate the oven dry weight of the aggregate. Handle the stockpile material to provide a uniformly damp material.

B4. Test Results

The tests results for B1, B2, and B3 must be reported daily. If construction on a new day begins without reporting the previous days test results, a \$500.00 penalty will be applied to the contractor.

C. Asphalt Content

Calculate and record the percent asphalt content of the mixture from the equipment counter readings, randomly, a minimum of three times a day. The quality control tolerance is ± 0.5 percent for a single test and the average daily asphalt content is ± 0.2 percent from the JMF.

D. Application Rate

The design application rate shall be the total amount of micro-surfacing material placed to meet the requirements for cross section, and surfacing. This amount will be the combination of all courses placed.

E. Documentation

Provide a daily report to the Engineer within one working day with the following information:

- Date, Air Temperature at start up.
- Beginning and Ending locations for the days work.
- Length, Width, Total Area (y^2) covered for the day.
- Application Rate (lbs/y^2), lbs of aggregate.
- Daily asphalt spot check reports, gal of emulsion, unit weight of emulsion (lbs/gal).

- Asphalt Emulsion Bill of Lading.
- Counter Readings (and Beginning, and Ending, and Total).
- Control Settings, Calibration Values, Percent Residue in Emulsion.
- Percent of Each Material, Percent of Asphalt Cement.
- Calibration Forms
- Aggregate Certification or Shipment of Tested Stock Report
- Contractor's Authorized Signature

The Contractor shall sample and test the material in the stockpile to assure the correct passing material is provided prior to starting micro-surfacing production. Contractor shall perform all tests according to referenced standards and maintain all quality control documentation and make them available to the Engineer upon request or at completion of work.

S-1.6 QUALITY ASSURANCE

Mn/DOT is responsible for quality assurance (QA) sampling and testing.

A. Asphalt Emulsion

Only material from a Certified Source is allowed for use.

Sample the first shipment. Also, provide one sample for every 200 m³ (**50,000 gallons**) (approx 200 ton).

B. Aggregate

Determine the gradation. Sample at a rate of one per 1500 tons of aggregate used, or a minimum of one sample per project, which ever is greater.

Determine the moisture content. Sample at a minimum rate of once per day.

S-1.7 METHOD OF MEASUREMENT

A. Bituminous Material

Measure the Bituminous Material for Micro-surfacing by volume, at 15 °C [**60 °F**].

B. Micro-surfacing Rut Fill

Measure the Micro-surfacing Rut Fill by mass, of **oven dry weight of aggregate**.

C. Micro-surfacing Scratch Course

Measure the Micro-surfacing Scratch Course by mass, of **oven dry weight of aggregate**.

D. Micro-surfacing Surface Course

Measure the Micro-surfacing Surface Course by mass, of **oven dry weight of aggregate**.

E. Bituminous Material for Tack Coat

Measure the bituminous material for tack coat by volume, **undiluted**, at 15 °C [**60 °F**].

S-1.8 BASIS OF PAYMENT

A. Payment for the accepted quantity of Bituminous Material for Micro-surfacing (including any required additives) at the Contract price of measure will be compensation in full for all cost of constructing the micro-surfacing as specified

B. Payment for the accepted quantity of Micro-surfacing Rut Fill at the Contract price of measure will be compensation in full for all cost of constructing the micro-surfacing rut fill as specified.

C. Payment for the accepted quantity of Micro-surfacing Scratch Course at the Contract price of measure will be compensation in full for all cost of constructing the micro-surfacing scratch course as specified.

D. Payment for the accepted quantity of Micro-surfacing Surface Course at the Contract price of measure will be compensation in full for all cost of constructing the micro-surfacing surface course as specified.

E. Payment for Bituminous Material for Tack Coat, as specified in Mn/DOT 2357.

<u>Item No.</u>	<u>Item</u>	<u>Unit</u>
2356.606	Bituminous Material for Micro-Surfacing.....	Liter [Gallon]
2356.609	Micro-surfacing Rut Fill.....	Ton
2356.609	Micro-surfacing Scratch Course.....	Ton
2356.609	Micro-surfacing Surface Course.....	Ton
2357.502	Bituminous Material for Tack Coat.....	Liter [Gallon]