



SECTION 413

SURFACE TREATMENTS

SECTION 413.10 MICRO-SURFACING.

413.10.1 Description. This work shall consist of producing and placing a mixture of cationic polymer-modified asphalt emulsions, mineral aggregate, mineral filler, water, and other additives as needed at locations shown on the plans or as directed by the engineer.

413.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Emulsified Asphalt	1015
Aggregate	1002

413.10.2.1 Aggregate.

413.10.2.1.1 The mineral aggregate shall be flint chat from the Joplin area, an approved crushed porphyry or an approved crushed steel slag. Blast furnace slag may be used from sources with a documented history of satisfactory use and that have been previously approved by MoDOT for use in micro-surfacing. For non-traffic areas such as shoulders, the mineral aggregate may be crushed limestone or crushed gravel in accordance with [Sec 1002.1](#). The aggregate shall be free of cemented or conglomerated material and shall not have any coating or detrimental material.

413.10.2.1.2 Blends of approved aggregate may be supplied provided:

- (a) The individual aggregates are reasonably uniform in gradation and other qualities.
- (b) The aggregates are uniformly blended with designated proportions into a separate stockpile prior to use. Aggregate may be blended directly into the supply truck provided the blending device has been calibrated, gate settings are unchanged, and belt samples indicate material gradation compliance.
- (c) The proportion is not changed from the job mix formula during the course of placement.

413.10.2.1.3 The final aggregate, or blend of aggregates, shall be in accordance with one of the following gradations. In addition, the aggregate shall be ± 5 percent of the designated job mix gradation for all plus No. 200 material and within ± 2 percent for the minus No. 200 material.

Aggregate Gradation Requirements			
Type II		Type III/Type IIIR	
Sieve	Percent Passing	Sieve	Percent Passing
3/8 inch	100	3/8 inch	100
No. 4	90 - 100	No. 4	70 - 90

No. 8	65 - 90	No. 8	45 - 70
No. 16	45 - 70	No. 16	28 - 50
No. 30	30 - 50	No. 30	19 - 34
No. 50	18 - 30	No. 50	12 - 25
No. 100	10 - 21	No. 100	7 - 18
No. 200	5 - 15	No. 200	5 - 15

413.10.2.1.4 The final aggregate mixture shall have no oversize material when deposited at the stockpile site. If the stockpile area contains any particles exceeding the specified maximum sieve, all aggregate shall be screened again as the aggregate is loaded into the final placement machine.

413.10.2.2 Mineral Filler. Mineral filler shall be Type 1 Portland cement or hydrated lime, and shall be free of lumps or any other deleterious material.

413.10.2.3 Water. Water shall be potable and free of harmful soluble salts.

413.10.2.4 Additives. Any other material added to the mixture or to any of the component materials to provide the required properties shall be supplied by the emulsion manufacturer.

413.10.2.5. Material Acceptance. All aggregate shall be sampled, tested and approved by the engineer prior to use. Portland cement and hydrated lime may be accepted for use based on visual examination.

413.10.3 Job Mix Formula. The manufacturer of the emulsion shall develop the job mix formula and shall present certified test results for the engineer's approval. The job mix formula shall be designed in accordance with the International Slurry Surfacing Association (ISSA) recommended standards by an ISSA recognized laboratory. Mix acceptance will be subject to satisfactory field performance. The job mix formula, all material, the methods and the proportions shall be submitted for approval prior to use. Proportions to be used shall be within the limits provided in the table below. If more than one aggregate is used, the aggregates shall be blended in designated proportions as indicated in the job mix formula, and those proportions shall be maintained throughout the placement process. If aggregate proportions are changed, a new job mix formula shall be submitted for approval.

Material	Requirement
Type II Mineral aggregate, lbs/yd ² dry mass, min.	10 - 20
Type III Mineral aggregate, lbs/ yd ² dry mass, min.	15 - 30
Type IIIR	As necessary
Polymer Modified Emulsion (residual), percent	5.5 to 10.5 by dry weight of aggregate
Mineral Filler, percent by mass of dry aggregate	0.0 to 3.0 by dry weight of aggregate
Additive	As required

413.10.3.1 All Types. The minimum dry mass per unit area will be based on a bulk specific gravity (BSG) of 2.65. In the event that crushed steel slag aggregate is used as a part of the blended aggregate or as the entire aggregate, the BSG of the final aggregate blend shall be determined and shown as part of the job mix formula criteria. If the BSG is different from 2.65 by more than 0.05, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiplying by the new BSG. (For example, for a new BSG = 3.15, the

new minimum would be $3.15(10.8/2.65) = 23.8$ lbs./sy). These adjusted values shall be designated on the job mix formula and will apply in the field.

413.10.3.2 Type II. For Type II, if a specified thickness will be required, the amount of mineral aggregate per square yard shall be increased as necessary to obtain the thickness.

413.10.3.3 Type III. When specified, Type III shall be applied in two passes of approximately equal quantities, the first of which shall be to fill depressions and level the surface for the final pass.

413.10.3.4 Type IIIR. For Type IIIR mixes, there will be no minimum or maximum unit quantities. The contractor shall make the determination as to the amount necessary, except all depressed areas shall be filled level as specified. Type IIIR may be applied in more than one pass at the contractor's expense. Type IIIR shall not be added to Type II or Type III applications in the field, but shall be a separate application.

413.10.4 Equipment.

413.10.4.1 Mixing Equipment. The micro-surfacing mixture shall be mixed and laid by a self-propelled mixing machine. The mixing machine shall be able to accurately deliver and proportion the aggregate, mineral filler, water, additive and emulsion to a revolving multi-blade dual mixer and to discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for all components to maintain an adequate supply to the proportioning controls.

413.10.4.1.1 Individual volume or weight controls for proportioning each item to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked. The calibration shall be approved by the engineer prior to proportion. Each device shall be accessible for ready calibration and placed such that the engineer may determine the amount of each material used at the time.

413.10.4.1.2 The mixing machine shall be equipped with a water pressure system and nozzle-type spray bar to provide a water spray to dampen the surface when required immediately ahead of and outside the spreader box as required. No free flowing water shall be present.

413.10.4.2 Spreading Equipment. The micro-surfacing mixture shall be spread uniformly by means of a mechanical-type spreader box attached to the mixer. The spreader box shall be equipped with paddles or augers to agitate and spread the material uniformly throughout the box. The paddles or augers shall be designed and operated so all the fresh mix will be agitated to prevent the mixture from setting up in the box, causing side buildup and lumps.

413.10.4.2.1 The spreader box used for surface course construction shall be equipped with flexible seals in contact with the road to prevent loss of mixture from the box. The box shall be equipped with devices to adjust the thickness or grade of the surface and shall have a squeegee strike-off rear plate.

413.10.4.2.2 A secondary strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same adjustments as the spreader box.

413.10.4.2.3 The spreader box used for rut-filling shall have two metal strike-offs, angled from each side toward the center at approximately 45 degrees. Interrupted flight augers shall be used ahead of the first strike-off plate to spread the mix and maintain laminar flow. The second strike-off plate shall be adjusted to produce the desired grade and depth. The first strike-off and augers shall be adjustable up and down in order to maintain a fairly uniform

flow or roll of material in front of the second strike-off. A rubber squeegee shall be attached to the adjustable metal plate at the rear of the spreader box, behind the second strike-off, to texture the surface. The adjustable metal plate shall have sufficient clearance not to affect the grade established by the second strike-off.

413.10.5 Construction Requirements.

413.10.5.1 Test Strip. A test strip 500 feet long and the width of one lane shall be provided. The test strip will be evaluated for 24 hours after placement and will be subject to approval from the engineer before any further production. If unsatisfactory, the test strip shall be removed and another strip placed for evaluation at the contractor's expense.

413.10.5.2 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud, and other objectionable material and shall be pre-wetted as required immediately prior to application of the micro-surfacing. All pavement marking shall be removed, maintained, and compensated for in accordance to [Sec 620](#).

413.10.5.3 Application. The micro-surfacing mixture shall be spread to fill cracks and minor surface irregularities, and shall leave a uniform surface. No lumping, balling or unmixed aggregate will be permitted. Longitudinal joints shall be placed on lane lines. Excessive overlap will not be permitted. The finished micro-surfacing shall have a uniform texture free of scratches, tears and other surface irregularities. The contractor shall repair the surface if any of the following conditions exist:

(a) More than one surface irregularity that is 1/4 inch or wider and 10 feet or longer in any 100-foot section of the micro-surfacing.

(b) More than three surface irregularities that are 1/2 inch or wider and more than 6 inches long in any 100-foot section of the micro-surfacing.

(c) Any surface irregularity that is one inch or wider and more than 4 inches long. The finished longitudinal and transverse joints in the micro-surfacing shall be complete and uniform.

413.10.5.3.1 The contractor shall repair joints if any of these conditions exist:

(a) Build-up of micro-surfacing material at the joints.

(b) Uncovered areas at the joints.

(c) Longitudinal joints with more than 1/2 inch vertical space between the surface and a 4-foot straightedge placed perpendicular to the joint.

(d) Transverse joints with more than 1/4 inch vertical space between the surface and a 4-foot straightedge placed perpendicular to the joint.

413.10.5.3.2 The edges of the micro-surfacing shall follow the centerline, lane lines, shoulder lines and curb lines. The edges shall be repaired if the edges vary more than 3 inches from a 100-foot straight line or from a 100-foot arc on a curved section. The repaired surface shall be dense with a uniform texture.

413.10.5.3.3 Any successive passes shall be separated such that each layer placed undergoes approximately 12 hours of traffic for compaction and curing.

413.10.5.3.4 Type IIIR applications to raise shoulders or fill ruts shall be applied with the rut spreader box, and the contractor shall place a strip as designated in the contract documents to raise an area to match the surroundings. Rutting or traffic-bearing applications, excluding shoulders, shall be crowned 1/8 to 1/4 inch per inch of depth, to allow for compaction. Shoulder applications shall drain and slope uniformly downward to the shoulder point. A Type II or Type III application may follow as a surface course if specified in the contract documents.

413.10.5.3.5 Micro-surfacing shall not be placed over steel expansion plates.

413.10.5.3.6 When micro-surfacing is placed on concrete, a tack coat shall be applied first in accordance with [Sec 407](#) and shall be given adequate time to break.

413.10.5.3.7 The micro-surfacing shall permit traffic operations on a 1/2 inch thick surface within one hour after placement at 75 F and 50 percent humidity.

413.10.5.4 Weather Limitations. Micro-surfacing shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, when it is raining, or when there is a chance of temperatures below 32 F within 24 hours after placement. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.10.5.5 Repair of Damaged Areas. Any traffic-damaged, marred areas or deficiencies as defined in [Sec 413.10.5.3](#) shall be repaired by the contractor at the contractor's expense.

413.10.5.6 Incidental Construction. Areas that cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. Utilities shall be protected from coverage by a suitable method. Work at intersections shall be done in stages, or blotter material shall be used to allow crossing or turning movements. Regardless of the method, no marred sections will be permitted.

413.10.6 Method of Measurement. Final measurement of completed Type II and Type III surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of Type II, Type III and Type IIIR micro-surfacing, complete in place, will be made to the nearest square yard. Final measurement of Type IIIR surface may be made as necessary to determine the actual areas placed. Field measurement will be based on the estimated width and length dimensions necessary to bring a designated area to a level plane, and not necessarily for the full rutted area. The revision or correction will be computed and added to or deducted from the contract quantity.

413.10.7 Basis of Payment. The accepted quantities of micro-surfacing will be paid for at the contract unit price for each of the pay items included in the contract. No additional payment will be made for removing and replacing test strips.

SECTION 413.20 SCRUB SEAL.

413.20.1 Description. This work shall consist of producing and placing a polymer modified asphalt (scrub seal) emulsion intended for use as a surface rejuvenation treatment and to fill and seal cracks.

413.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Aggregate ^a	1005.3
Emulsion	1015

^aAggregate substitutions may be allowed as approved by the engineer.

413.20.3 Equipment.

413.20.3.1 Aggregate Spreader. The aggregate spreader shall be self-propelled and capable of evenly spreading aggregate.

413.20.3.2 Pneumatic Tire Roller. The pneumatic tire roller shall be in accordance with Sec 401.

413.20.3.3 Brooms. Brooms shall be capable of adequately scrubbing the mixture into the cracks and surface.

413.20.4 Construction Requirements.

413.20.4.1 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material immediately prior to application of the scrub seal emulsion.

413.20.4.2 Application. The scrub seal emulsion shall be uniformly applied with a pressure distributor at the rate specified in the contract or as designated by the engineer. The mixture shall be spread to fill cracks and minor surface irregularities and shall leave a uniform surface.

413.20.4.3 Physical Characteristics for Scrub Seal Emulsion.

Properties	Minimum	Maximum
Application rate of emulsion, gallons/sq. yard ^a	0.18	0.22
Emulsion Temperature, F	110	160
Application rate of aggregate, lb./sy ^b	16	22
Time of set prior to opening, hours		2

^aApplication rate may change, final decision will be made by the engineer.

^bThe final decision for opening will be made by the engineer.

413.20.4.4 Method of Placement. After proper surface preparation, a distributor truck shall place the scrub seal emulsion at the prescribed rate. The distributor truck shall pull the broom assembly to sweep and spread the emulsion uniformly on the surface and into the cracks of the pavement.

413.20.4.4.1 Fine aggregate shall be placed immediately after the application of the emulsion and prior to the emulsion breaking. Immediately following the aggregate spreader, a second broom assembly shall be pulled to combine the aggregate with the emulsion.

413.20.4.4.2 The pneumatic tire roller shall immediately follow the second broom and shall make a minimum of two passes.

413.20.4.4.3 All excess sand shall be removed from the roadway, paved shoulders and paved side roads within 24 hours of application or as directed by the engineer.

413.20.4.5 Weather Limitations. The scrub seal emulsion shall not be placed on any wet surface or when the ambient temperature or the temperature of the pavement on which the mixture is to be placed is below 60 F. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.20.4.6 Damaged or Marred Areas. Any traffic damaged or marred areas shall be repaired by the contractor at the contractor's expense.

413.20.5 Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of scrub seal emulsion and mineral aggregate, complete in place, including multiple passes or courses, will be made to the nearest square yard. Measurement of individual passes or courses will not be made. The revision or correction will be computed and added to or deducted from the contract quantity.

413.20.6 Basis of Payment. The accepted quantity of scrub seal, in place, will be paid for at the contract unit price.

SECTION 413.30 ULTRATHIN BONDED ASPHALT WEARING SURFACE.

413.30.1 Description. This work shall consist of producing and placing an ultrathin bonded asphalt wearing surface.

413.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows, except as modified herein:

Item	Section
Coarse Aggregate	1002.2
Fine Aggregate	1002.3
Mineral Filler	1002.4

413.30.2.1 Coarse Aggregate. Coarse aggregate may consist of crushed gravel, limestone, dolomite, porphyry, steel slag, flint chat, or blends of two or more of these aggregates will be acceptable. When coarse aggregate for these mixes are from more than one source or of more than one type of material, the coarse aggregate shall be proportioned and blended to provide a uniform mixture. Coarse aggregate shall be material predominantly retained above the No. 4 sieve and shall be in accordance with the following requirements:

Coarse Aggregate Modified Requirements			
Test	Method	Min	Max
Los Angeles Abrasion Value, % Loss ^a	AASHTO T 96		35
Soundness, % Loss, Sodium Sulfate ^a	AASHTO T 104		12
Flat & Elongated Ratio, % @ 3:1 ^b	ASTM D 4791		25
% Crushed, single face ^b	ASTM D 5821	95	
% Crushed, two faces ^b	ASTM D 5821	85	
Micro-Deval, % loss ^a	AASHTO T 327		18

^aTests shall be determined on each individual ledge basis.

^bTested on the coarse portion of the blended aggregate

413.30.2.2 Fine Aggregate. Fine aggregate shall be material predominantly passing the No. 4 sieve and shall be in accordance with the following requirements:

Fine Aggregate Modified Requirements			
Tests	Method	Min	Max
Sand Equivalent ^a	AASHTO T 176	45	
Methylene Blue ^a	AASHTO T 330		10
Uncompacted Void Content ^d	AASHTO T 304	40	

^aTested on the fine portion of the blended aggregate

413.30.2.3 Asphalt Binder. The asphalt binder shall be in accordance with [Sec 1015](#), including all subsections pertaining to PG70-22.

413.30.2.4 Polymer Modified Emulsion Membrane. The emulsion shall be polymer modified and shall be in accordance with [Sec. 1015](#).

413.30.3 Job Mix Formula. At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design to Construction and Materials for approval. Representative samples from each ingredient for the mix shall be submitted with the mix design.

413.30.3.1 Proficiency Sample Program. Laboratories that participate in and achieve a score of three or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304 (ASTM C 1252), T 308 and T 312 will have the mixture verification process waived. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production.

413.30.3.2 Required Information. The mix design shall include raw data from the design process and contain the following information:

- (a) Source, grade and specific gravity of asphalt binder.
- (b) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregate.
- (c) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate including all raw data.
- (d) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.
- (e) Percentage of each aggregate component.
- (f) Combined gradation of the job mix.
- (g) Percent asphalt binder, by weight, based on the total mixture.
- (h) Theoretical maximum specific gravity (G_{mm}^*) as determined by AASHTO T 209, in accordance with Sec 403.19.3.1, after the sample has been short term aged in accordance with AASHTO R 30.
- (i) The tensile strength ratio as determined by AASHTO T 283 including all raw data.
- (j) Mixing temperature and gyratory molding temperature.
- (k) Bulk specific gravity (G_{sb}) of the combined aggregate.

- (l) Percent chert contained in each aggregate fraction.
- (m) Percent deleterious contained in each aggregate fraction.
- (n) Blended aggregate properties for clay content, angularity, and thin and elongated particles.
- (o) Draindown for mixture.
- (p) Film thickness for mixture

413.30.4 Composition of Mixture.

413.30.4.1 Asphalt Amount. The amount of asphalt binder in the mixture shall meet the following limits for the type of mixture specified in the contract.

Mix Design Criteria			
	Type A	Type B	Type C
Asphalt Content, %	5.0 – 5.8	4.8 – 5.6	4.6 – 5.6

413.30.4.2 Gradation. Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Mix Design Criteria			
Composition by Weight Percentages			
	Type A	Type B	Type C
Sieves	% Passing	% Passing	% Passing
3/4 in.			100
1/2 in.		100	75 – 100
3/8 in.	100	75 – 100	50 – 80
No. 4	40 – 55	25 – 38	25 – 38
No. 8	22 – 32	19 – 27	19 – 27
No. 16	15 – 25	23 max.	23 max.
No. 30	18 max.	18 max.	18 max.
No. 50	13 max.	13 max.	13 max.
No. 100	10 max.	10 max.	10 max.
No. 200	4.0 – 6.0	4.0 – 6.0	4.0 – 6.0

413.30.4.3 Film Thickness. The film thickness shall be a minimum 9.0 microns when calculated using the effective asphalt content in conjunction with the surface area for the aggregate in the Job Mix Formula. The surface area factors can be found in Table 6.1 of the Asphalt Institute MS-2, *Mix Design Methods for Asphalt Concrete and Other Hot Mix Types*, Sixth Edition.

413.30.4.4 Non-Carbonate Aggregate Requirement. Mixtures containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the plus No. 4 sieve criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Coarse Aggregate (+ No. 4)	Minimum Non-Carbonate by Volume
Limestone	30% Plus No. 4
Dolomite	No Requirement

413.30.4.5 Drain Down. Drain down from the loose mixture shall not exceed 0.10 percent when tested in accordance with AASHTO T 305.

413.30.4.6 Moisture Susceptibility. The mixture shall have a tensile strength ratio (TSR) of 80 percent or greater when compacted to 3.7 inches with 7 +/- 0.5 percent air voids and tested in accordance with AASHTO T 283.

413.30.4.7 Reclaimed Material. The mixture shall not contain reclaimed material.

413.30.5 Construction Requirements.

413.30.5.1 Weather Limitations. A damp pavement surface may be acceptable for placement if free of standing water and favorable weather conditions are expected to follow. Mix shall not be placed if the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, the surface is wet or frozen, or weather conditions prevent the proper handling or finishing of the mixture. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.30.5.2 Paver. The paver shall be capable of spraying the polymer modified asphalt emulsion membrane, applying the hot mix asphalt overlay and leveling the surface of the mat in one pass. Wheels or other parts of the paving machine shall not come in contact with the polymer modified emulsion membrane before the hot mix asphalt concrete wearing course is applied. The screed shall have the ability to crown the pavement at the center and shall have vertically adjusted extensions to accommodate the desired pavement profile.

413.30.5.3 Surface Preparation. Immediately prior to placing the ultrathin bonded asphalt wearing surface, the roadway surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material. All non-working surface cracks with an opening size exceeding 1/4 inch and any size working crack shall be sealed prior to placement of the ultrathin bonded asphalt wearing surface. Immediately prior to spraying the polymer modified emulsion membrane, the surface shall be free of fresh bituminous mix. The ultrathin bonded asphalt wearing surface shall not be placed until the sealant has cured. Curing time of sealant shall be in accordance with the manufacturer's recommendations.

413.30.5.4 Application of Membrane. The polymer modified emulsion membrane application shall be applied in accordance with the manufacturer's recommendations. The sprayer shall accurately and continuously monitor the rate of spray and shall provide a uniform application across the entire width to be overlaid.

413.30.5.4.1 Adjusting Membrane Rate. The engineer may make adjustments to the spray rate based on the existing pavement surface conditions and the recommendations of the polymer modified emulsion membrane manufacturer.

413.30.5.4.2 Application Rate of Membrane. Limits of the target application rate of the asphalt emulsion shall be 0.20 ± 0.07 gallon per square yard.

413.30.5.5 Application of Mixture. The hot mix asphalt concrete shall be applied at a temperature of 290 to 330 F and shall be spread over the polymer modified emulsion membrane immediately after application of the polymer modified emulsion. The hot asphalt concrete wearing course shall be placed over the full width of the polymer modified emulsion membrane with a heated vibratory-tamping bar screed.

413.30.5.5.1 Handwork. For handwork, the hot mix asphalt shall be applied within five minutes after the application of the polymer modified emulsion.

413.30.5.5.2 Application Rate of Mixture. The target application rate of the ultrathin bonded asphalt wearing course shall be as shown on the plans. The application rate shall be adjusted to minimize fracturing of the top size aggregate by the screed. The engineer will determine the acceptable extent of fracturing at the edges for tapering purposes.

413.30.5.6 Rolling. Rolling of the wearing course shall consist of no more than three passes immediately following placement of the ultrathin bonded asphalt wearing course with a steel, double-drum, asphalt roller with a minimum weight of 10 tons. All rolling shall be completed before the material temperature has fallen below 195 F. Rollers shall be equipped with a functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. An acceptable release agent approved by the engineer may be added to the water system to prevent adhesion of the fresh mix to the roller drum and wheels. Rolling shall be done in the static mode. Excessive rolling to the extent of aggregate degradation will not be permitted. The engineer will determine the acceptable extent of fracturing at the edge of the pavement from the rolling operation. New pavement shall not be opened to traffic nor shall any roller sit idle on the pavement until the rolling operation is complete and the material has been cooled below 140 F.

413.30.5.7 Bituminous Mixing Plants. Bituminous mixing plants and preparation of materials and mixtures shall be in accordance with [Sec 404](#).

413.30.5.8 Hauling Equipment. Trucks used for hauling bituminous mixtures shall be in accordance with [Sec 404](#).

413.30.5.9 Wearing Course. The finished wearing course shall have a minimum thickness of 1/2 inch for Type A, 5/8 inch for Type B, and 3/4 inch for Type C.

413.30.5.10 Pavement Marking. Pavement marking shall be replaced in accordance with [Sec 620](#).

413.30.5.11 Acceptance. Acceptance will be based on test results indicating that the ultrathin bonded asphalt wearing surface meets the specification requirements, the contractor following the approved QC Plan, and favorable comparison of the contractor's QC test and the engineer's QA test.

413.30.6 Quality Control.

413.30.6.1 Quality Control Operations. Quality control shall be conducted in accordance with [Sec 403.17](#), except as follows.

413.30.6.1.1 Aggregate Gradation. Sieve analysis shall be performed for every 600 tons of mixture produced. Test shall be performed in accordance with AASHTO T 27 from randomly sampled material taken from the composite cold feed belt or the hot bins.

413.30.6.1.2 Asphalt Content. The asphalt binder content shall be determined for each 600 tons of mixture produced. Test shall be performed in accordance with AASHTO T 287 or AASHTO T 308. Samples for determination of the asphalt binder content shall be retrieved from the hot elevator at the asphalt plant or from the transport truck at the plant by random sampling.

413.30.6.1.3 Deleterious Content. Deleterious content shall be determined for every 600 tons of mixture produced. Test shall be performed in accordance with MoDOT Test Method TM 71 from randomly sampled material taken from the composite cold feed belt.

413.30.6.2 Gradation and Asphalt Binder Tolerances. The total aggregate gradation and asphalt content shall be within the range specified in [Sec 413.30. 4.2](#) and the maximum variations from the approved job mix formula shall be within the following tolerances:

Gradation and Asphalt Binder Tolerances			
Sieves	Percent Passing		
	Type A	Type B	Type C
3/4 in.	-	-	-
1/2 in.	-	-	± 5.0
3/8 in.	-	± 5.0	-
No. 4	± 5.0	± 4.0	± 4.0
No. 8	± 4.0	± 4.0	± 4.0
No. 16	± 4.0	-	-
No. 200	± 1.0	± 1.0	± 1.0
Asphalt Content, %	± 0.3	± 0.3	± 0.3

413.30.6.3 Deleterious Content Tolerance. The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in [Sec 1002.2](#).

413.30.6.4. Verifying Membrane Rate. The application rate of the polymer emulsion membrane shall be verified by dividing the volume of polymer modified emulsion membrane used by the area of paving for that day.

413.30.6.5 Mix Adjustments. The contractor may make field adjustments to the job mix formula as noted herein. The adjusted job mix formula shall be in accordance with the mix design requirements of [Sec 413.30.4](#). The engineer shall be notified prior to making any change in the cold feed settings, the hot bin settings or the binder content. No additional fractions of material or new material will be permitted for field adjustments.

413.30.6.6 Defective Areas. The contractor shall remove and replace defective areas at the contractor's expense with material meeting specification requirements as directed by the engineer.

413.30.7 Quality Assurance. Quality assurance will be conducted in accordance with [Sec 403](#) except as follows.

413.30.7.1 Sampling Frequency. Corrective action shall be taken by the contractor if any QA tests are outside the QC tolerances shown in [Sec 413.30.6.2](#). The engineer will, at a minimum, independently sample and test at the following frequency:

Sample	Frequency
Aggregate Gradation	1 per day
Asphalt Binder Content	1 per day
Deleterious Content	1 per day

413.30.7.2 Testing Retain Samples. The engineer will test, at a minimum, one retained QC gradation sample and one retained QC asphalt binder content sample per calendar week. The engineer's test results, including all raw data, will be made available to the contractor by the next working day.

413.30.7.2.1 Aggregate Comparison. A favorable aggregate comparison will be achieved when test results are within the specified tolerances shown in [Sec 403.18.2](#).

413.30.7.2.2 Asphalt Content Comparison. A favorable asphalt content will be achieved when test results are within 0.3 percent.

413.30.8 Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of ultrathin bonded asphalt wearing surface, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

413.30.9 Basis of Payment. The accepted quantity of ultrathin bonded asphalt wearing surface will be paid for at the contract unit price.

SECTION 413.40 BITUMINOUS FOG SEALING.

413.40.1 Description. This work shall consist of furnishing diluted asphalt emulsion and preparing and sealing surfaces by means of a bituminous distributor.

413.40.2 Material. Asphalt emulsion grades SS-1, SS-1H, CSS-1, or CSS-1H shall be in accordance with [Sec 1015](#) and shall be used unless otherwise directed by the engineer.

413.40.3 Equipment. The distributor shall be designed, equipped, maintained and operated such that liquid asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. The distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and with full circulation spray bars adjustable both laterally and vertically. The calibration of all distributors shall be approved by the engineer prior to use, and the contractor shall furnish all equipment, material and assistance necessary if calibration will be required.

413.40.4 Construction Requirements.

413.40.4.1 Asphalt emulsion shall be applied only during weather conditions under which satisfactory application and curing can be obtained. Asphalt emulsion shall not be placed on a damp or wet surface except as approved by the engineer. The surface shall be free of objectionable material prior to sealing.

413.40.4.2 The asphalt emulsion shall be diluted with water prior to application. The dilution rate shall be as shown on the plans or as directed by the engineer. The contractor shall provide documentation to the engineer that the specified coating system has been properly diluted.

413.40.4.3 The diluted asphalt emulsion shall be uniformly applied at the rate of 0.20 gallon per square yard surface. The application rate may be adjusted as directed by the engineer. Application widths shall be such that the entire surface is covered in one application.

413.40.4.4 Care shall be taken such that asphalt emulsion is applied only to designated areas. Sand dams or other approved means may be necessary to prevent emulsion from being applied outside of designated areas. Pavement marking obliterated by this operation shall be replaced by the contractor at the contractor's expense in accordance with [Sec 620](#), unless otherwise provided for in the contract.

413.40.4.5 After application of the sealant, the surface shall be tack-free and capable of being open to traffic within four hours without tracking.

413.40.5 Method of Measurement. Measurement of the undiluted asphalt emulsion, complete in place and accepted by the engineer, will be made to the nearest gallon in accordance with [Sec 1015](#).

413.40.6 Basis of Payment. The accepted quantity of bituminous fog seal will be paid for at the contract unit price for undiluted asphalt emulsion for seal that is mixed and used on the project. Diluted asphalt emulsion that is delivered to the job site, but not applied to the surface, will not be considered for payment. No direct payment will be made for sand.

SECTION 413.50 BITUMINOUS PAVEMENT CRACK SEALING.

413.50.1 Description. This work shall consist of preparing and sealing all working transverse and longitudinal cracks in bituminous pavement as shown on the plans or as directed by the engineer.

413.50.2 Material. The sealant shall be a single-component material in accordance with AASHTO M 324, except as herein modified.

413.50.2.1 The sealant shall be capable of being reheated to pouring temperatures at least once after the initial heating, while retaining the sealant's physical characteristics.

413.50.2.2 Penetration at 77 F, 50 grams, 5 seconds, shall be no less than 50 or greater than 90.

413.50.2.3 When tested at 77 F, the resilience recovery shall be a minimum of 50 percent.

413.50.2.4 The sealant shall meet all physical requirements after prolonged heating for six hours with constant mixing in a laboratory melter at the recommended field pouring temperature, complete cool down, and reheating to the recommended pouring temperature.

413.50.3 Construction Requirements.

413.50.3.1 The engineer will mark the cracks to be sealed. Sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40 F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer's recommendations.

413.50.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 1/2-inch wide x 1/2-inch deep. The crack shall be clean, free from all loose and foreign material, and dry, prior to application of the sealant. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.50.3.3 The sealant shall be applied to the reservoir from the bottom up. The reservoir shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.50.3.4 The contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed sealant if traffic results in tracking of the crack sealing material.

413.50.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.50.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

SECTION 413.60 PORTLAND CEMENT CONCRETE PAVEMENT JOINT/CRACK SEALING.

413.60.1 Description. This work shall consist of preparing and resealing all existing transverse and longitudinal joints, and working transverse and longitudinal cracks in Portland cement concrete pavement (PCCP) as shown on the plans or as directed by the engineer.

413.60.2 Material. Sealant material shall be in accordance with [Sec 1057](#).

413.60.3 Construction Requirements.

413.60.3.1 The engineer will mark the existing joints and cracks to be sealed. The sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40 F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer's recommendations.

413.60.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 3/8-inch wide x d/4 deep, where d is the thickness of the pavement. The joint/crack shall be clean, free from all loose and foreign material, including existing sealant, and dry prior to application of the sealant.

413.60.3.3 Sealant shall be applied to the joint or reservoir uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.60.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.60.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

SECTION 413.70 BITUMINOUS PAVEMENT CRACK FILLING.

413.70.1 Description. This work shall consist of preparing and filling all cracks in bituminous pavement as shown on the plans or as directed by the engineer.

413.70.2 Material. Filler material shall be in accordance with one of the following:

Item	Section
Asphalt Binder	1015.3
Polymer Modified Emulsion	1015.20.5
Crack Sealing Material	413.50.2

413.70.3 Construction Requirements.

413.70.3.1 The engineer will mark the cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40 F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer's recommendations.

413.70.3.2 The crack shall be clean, free from all loose and foreign material, and dry prior to application of the filler material. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.70.3.3 Filler material shall be applied to the crack from the bottom up. The crack shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.70.3.4 The contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed filler if traffic results in tracking of the crack sealing material.

413.70.4 Method of Measurement. Measurement of crack filling will be made to the nearest linear foot of cracks filled, complete in place, and accepted by the engineer.

413.70.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.

SECTION 413.80 PORTLAND CEMENT CONCRETE PAVEMENT CRACK FILLING.

413.80.1 Description. This work shall consist of preparing and filling all cracks in PCCP, as shown on the plans or as directed by the engineer.

413.80.2 Material. Filler material shall be in accordance with [Sec 413.50.2](#) or [Sec 1057](#).

413.80.3 Construction Requirements.

413.80.3.1 The engineer will mark the existing cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40 F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer's recommendations.

413.80.3.2 The crack shall be clean, free from any loose and foreign material, and dry prior to application of the filler material.

413.80.3.3 Filler material shall be applied to the crack uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.80.4 Method of Measurement. Measurement of crack filling material will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.80.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.