

MULTILAYER BITUMINOUS SYSTEMS

Multilayer bituminous systems include but are not limited to applying micro surfacing as a mass crack filler and leveling course, a seal coat to provide an additional moisture resistant and crack mitigation layer, and a top layer of micro surfacing to act as a wearing course. Below is a list of options for each layer specified by the checked box. Refer to the attached specifications for each application specified.

Leveling Course	
<input type="checkbox"/>	Type III Micro Surfacing
<input type="checkbox"/>	Type III Micro Surfacing with Fiber
<input type="checkbox"/>	Type II Micro Surfacing
<input type="checkbox"/>	Type II Micro Surfacing with Fiber
<input type="checkbox"/>	Other
<input type="checkbox"/>	
<input type="checkbox"/>	

Seal Course	
<input type="checkbox"/>	3/8" Asphalt Rubber Seal Coat
<input type="checkbox"/>	1/2" Asphalt Rubber Seal Coat
<input type="checkbox"/>	3/8" Asphalt Emulsion Seal Coat (PMCQS-1h)
<input type="checkbox"/>	1/2" Asphalt Emulsion Seal Coat (PMRE)
<input type="checkbox"/>	3/8" Asphalt Emulsion Seal Coat (PMRE)
<input type="checkbox"/>	3/8" Asphalt Emulsion Seal Coat with Tire Rubber (PMRE-TR)
<input type="checkbox"/>	Other

Wearing Course	
<input type="checkbox"/>	Type III Micro Surfacing
<input type="checkbox"/>	Type III Micro Surfacing with Fiber
<input type="checkbox"/>	Type II Micro Surfacing
<input type="checkbox"/>	Type II Micro Surfacing with Fiber
<input type="checkbox"/>	Other
<input type="checkbox"/>	
<input type="checkbox"/>	

MICRO SURFACING

Micro surfacing shall consist of mixing a polymer modified cationic quickset emulsion, aggregate, mineral filler, set-control additives, and water and spreading the mixture on a pavement surface where shown on the plans, in conformance with the provisions in these special provisions, and as directed by the Engineer.

MATERIAL

The material for micro surfacing shall conform to the following requirements:

Emulsion

The asphalt emulsion shall be a polymer modified cationic quickset (PMCQS-1h), shall be homogenous and shall conform to the provisions of these special provisions. The polymer shall be milled or blended into the asphalt or blended into the emulsifier solution prior to the emulsification process. Polymer solids must be a minimum of 3.0 % by weight of the emulsion's residual asphalt. Provide a certificate of compliance certifying the amount of polymer.

The PMCQS-1h emulsion shall conform to the following requirements when tested in conformance with the following test methods:

Polymer Modified, Cationic Quickset Emulsion		
Specification Designation	Test Method	Requirement
Viscosity SSF @ 77°F (25°C)	AASHTO T 59	15-90 Seconds
Sieve, max.	AASHTO T 59	0.30 Percent
Settlement, 5 days, max.*	ASTM D 244	5 Percent
Residue by Evaporation, min.	AASHTO T59	62 Percent
*Waived if to be used within 48 hours of manufacture.		

Specification Designation for Residue		
Specification Designation	Test Method	Requirement
Penetration @ 77°F (25°C), 100g, 5s ,0.1mm	AASHTO T 51	40-90
Softening Point °F (°C) min.	AASHTO T 53	135 (57)
Torsional Recovery min.	California Test 332	20

Water and Additives

The water shall be potable and free of harmful soluble salts or reactive chemicals and other contaminants. If necessary for workability, a set-control agent may be used and must be included as part of the mix design and be compatible with the other components of the mix.

Mineral Filler

Mineral filler shall be Portland cement or hydrated lime that is free of lumps. The type of mineral filler shall be determined by the Contractor based on laboratory mix designs and will be considered part of the aggregate gradation.

Aggregate

The mineral aggregate used shall be of the type and grade specified for the particular use of micro surfacing. Aggregate shall consist of sound, durable, crushed stone or crushed gravel and approved mineral filler. The material shall be free from vegetable matter and other deleterious substances. All aggregate shall be free of caked lumps and oversize particles.

The aggregate, prior to the addition of emulsion, shall conform to the requirements of this section. If aggregates are blended each component aggregate shall meet the sand equivalency and abrasion resistance and shall be 100% crushed.

The percentage composition by weight of the aggregate (including mineral filler) shall conform to the following grading requirements when tested in conformance with AASHTO T 27 and AASHTO T 11:

Type II	
Sieve Size	Percentage Passing
3/8"	100
No. 4	94-100
No. 8	65-90
No. 16	40-70
No. 30	25-50
No. 200	5-15

Type III	
Sieve Size	Percentage Passing
3/8"	100
No. 4	70-90
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 200	5-15

The aggregate (excluding mineral filler) shall conform to the following quality requirements:

Test	Test Method	Requirements
Sand Equivalent (Min.)	AASHTO T 176	65
Durability Index (Min.)	AASHTO T 210	60
Percentage of Crushed Particles (Min.)	ASTM D 5821	100%
Loss Angeles Rattler Loss at 500 Rev. (Max.) ¹	AASHTO T 96	35%

Notes: 1. Los Angeles Rattler shall be performed on the parent aggregate before crushing

If the results of the aggregate grading do not meet the specified gradation, the micro surfacing represented by the test shall be removed. However, if requested in writing by the Contractor and approved by the Engineer, the micro surfacing may remain in place and the Contractor shall pay to the State \$2.00 per ton for the aggregate represented by the tests and left in place.

If the results of the Sand Equivalent test for aggregate do not meet the specified requirement, the micro surfacing represented by the test shall be removed. However, if requested in writing by the Contractor and approved by the Engineer, the micro surfacing may remain in place and the Contractor shall pay to the State \$2.00 per ton for the aggregate represented by the tests and left in place.

When the results of both the aggregate grading and the Sand Equivalent tests do not conform to the specified requirements, both payments to the State shall apply. The Department may deduct these amounts

from any moneys due or to become due to the Contractor.

No single aggregate grading or Sand Equivalent test shall represent more than 300 tons or one day's production, whichever is smaller.

MIX DESIGN

At least 7 working days before the micro surfacing placement commences, the Contractor shall submit for approval of the Engineer a laboratory report of tests and a proposed mix design covering the specific materials proposed for use on the project.

The percentages of each individual material proposed in the mix design shall be shown in the laboratory report. Individual materials shall be within the following limits:

Residual Asphalt	5.5% to 10.5% by dry weight of aggregate
Mineral Filler	0.5% to 3% by dry weight of aggregate
Additive and Water	As needed

Adjustments may be required during construction based on field conditions.

The mix design and aggregate tests shall be performed by a laboratory capable of performing the applicable International Slurry Surfacing Association (ISSA) tests. The proposed micro surfacing mixture shall conform to the specified requirements when tested in conformance with the following tests:

The laboratory that performed the tests and designed the mixture shall sign the laboratory report and shall be AMRL certified and/or participate in the AASHTO Proficiency Program. The report shall show the results of the tests on individual materials and shall compare their values to those required by these special provisions. The report shall clearly show the proportions of aggregate, mineral filler (minimum and maximum), water, set control additive, and PMCQS-1h solids content (minimum and maximum) based on the dry weight of aggregate. The laboratory shall report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect) in conformance with the requirements of ASTM Designation C

Test	ISSA Test Method	Requirements
Wet Cohesion @ 30 Minute (Set) (Min.) @ 60 Minute (Traffic) (Min.)	TB*139	12 kg-cm 20 kg-cm
Excess Asphalt	TB*109	540 g/m ²
Wet Stripping (Min.)	TB* 114	90%
Wet Track Abrasion 6-day Soak Loss (Max.)	TB*100	810g/m ²
Displacement Lateral (Max.) Specific Gravity After 1000 Cycles of 125 lbs. (56.8 kg)(Max.)	TB*147A	5% 2.10
Classification Compatibility	TB* 144	(AAA, BAA) 11 Grade Points
Mix Time @ 77°F (25°C)	TB* 113	Controllable to 120 Seconds
TB* = Technical Bulletin		

29M. Previous laboratory reports covering the same materials may be accepted provided the material test reports were completed within the previous 12 months.

The component materials used in the mix design shall be representative of the micro surfacing materials proposed by the Contractor for use on the project.

Once the mix design is approved by the Engineer, no substitution of other material will be permitted unless the materials proposed for substitution are first tested and a laboratory report is submitted for the substituted design in conformance with the provisions of these special provisions. Substituted materials shall not be used until the mix design for those materials has been approved by the Engineer.

The completed mixture, after addition of water and set control agent, if used, shall be such that the micro surfacing mixture has proper workability. At the expiration of the road closure hours, in conformance with the provisions in "Maintaining Traffic" of these special provisions, the micro surfacing mixture shall be sufficiently cured to support unrestricted traffic.

PROPORTIONING

Aggregate, mineral filler, PMCQS-1h, water, and additives, including the set-control agent, if used, shall be proportioned by volume utilizing the mix design approved by the Engineer. If more than one kind of aggregate is used, the correct amount of each kind of aggregate to produce the required grading shall be proportioned separately, prior to adding the other materials of the mixture, in a manner that will result in a uniform and homogeneous blend.

The aggregate shall be proportioned using a belt feeder operated with an adjustable cut off gate. The height of the gate opening shall be determinable. The PMCQS-1h shall be proportioned by a positive displacement pump. Variable rate emulsion pumps, if used, shall be calibrated and sealed in the pump's calibrated condition in conformance with the ISSA Inspector's Manual MA-1 prior to usage.

The delivery rate of aggregate and PMCQS-1h per revolution of the aggregate feeder shall be calibrated at the appropriate gate settings for each mixer-spreader truck used on the project in conformance with ISSA Inspector's Manual MA-1 and in conformance with the provisions of these special provisions.

The aggregate belt feeder shall deliver aggregate to the pug-mill with such volumetric consistency that the deviation for any individual aggregate delivery rate check-run shall not exceed 2.0 percent of the mathematical average of 3 runs of at least three tons each. The emulsion pump shall deliver PMCQS-1h to the pug-mill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of 3 runs of at least 300 gallons each. The water pump shall deliver water to the pug-mill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of 3 runs of at least 300 gallons each.

The PMCQS-1h storage tank shall be located immediately before the emulsion pump and shall be equipped with a device which will automatically shut down the power to the emulsion pump and aggregate belt feeder when the PMCQS-1h level is lowered to a point where the pump suction line is exposed.

A temperature-indicating device shall be installed in the emulsion storage tank at the pump suction level. The device shall indicate the temperature of the PMCQS-1h and shall be accurate to within 10°F.

The belt delivering the aggregate to the pug-mill shall be equipped with a device to monitor the depth of

aggregate being delivered to the pug-mill. The device for monitoring the depth of aggregate shall automatically shut down the power to the aggregate belt feeder whenever the depth of aggregate is less than the target depth of flow. A second device shall be located where the device will monitor the movement of the aggregate belt by detecting revolutions of the belt feeder. The devices for monitoring no flow or belt movement shall automatically shut down the power to the aggregate belt when the aggregate belt movement is interrupted. The device to detect revolutions of the belt feeder will not be required where the aggregate delivery belt is an integral part of the drive chain. To avoid erroneous shutdown by normal fluctuation, a delay of 3 seconds will be permitted between sensing and shutdown of the operation.

MIXING AND SPREADING EQUIPMENT

The micro surfacing shall be mixed in continuous pug-mill mixers of adequate size and power for the type of micro surfacing to be placed. All indicators shall be in conformance with the provisions of these special provisions and shall be in working order prior to commencing mixing and spreading operations.

Mixer-spreader trucks shall be equipped to proportion the PMCQS-1h, water, aggregate, mineral filler, and set-control additives by volume. Rotating and reciprocating equipment on mixer-spreader trucks shall be covered with metal guards.

The mixer-spreader truck shall not be operated unless low-flow and no-flow devices and revolution counters are in good working condition and functioning and metal guards are in place. Indicators required by these special provisions shall be visible while walking alongside the mixer-spreader truck.

Aggregate feeders shall be connected directly to the drive on the emulsion pump. The drive shaft of the aggregate feeder shall be equipped with a revolution counter reading to the nearest one-tenth of a revolution.

In addition to the requirements of the fourth paragraph of Section 5 1.10, "Equipment and Plants," of the Standard Specifications, the identifying number of mixer-spreader trucks shall be at least three inches in height, located on the front and rear of the vehicle.

The micro surfacing mixture shall be spread by means of a spreader box conforming to the requirements in the "Spreader Box" section of these specifications.

Spreader Box

For Type II micro surfacing the spreader box shall be capable of spreading a lane width and equipped with a material such as flexible rubber belting on each side and in contact with the pavement. If the spread width is wider than 7.5 feet, a spreader box shall be equipped with a means, such as baffles or reversible motor-driven augers, to uniformly apply micro surfacing on super-elevated sections and shoulder slopes. The spreader box shall be equipped with rear flexible strike-off blades making close contact with the pavement and adjustable to various crown shapes in order to apply a uniform micro surfacing. The spreader box shall be equipped with flexible drags attached to the rear and cleaned daily and changed if longitudinal scouring occurs. The spreader box shall be clean and free of excess micro surfacing and/or PMCQS-1h at the start of each work shift.

For Type III micro surfacing the spreader box shall be capable of placing a minimum of 12 feet wide and shall have strips of flexible rubber belting or similar material on each side of the spreader box and in contact with the pavement to prevent the loss of micro surfacing from the box. Spreader boxes over eight feet in application width shall have baffles and be double shafted reversible motor driven augers. Spreader box skids shall be maintained in such manner as to prevent chatter (wash boarding) in the finished mat. The

spreader box in use shall be clean and free of micro surfacing and PMCQS-1h at the start of each work shift.

For Type III micro surfacing the spreader box shall have a series of strike-off devices at the rear of the box. The leading strike-off device shall be fabricated of steel, stiff rubber or other suitable material. The number of strike-off devices shall be determined by the Contractor. The first strike-off device shall be designed to maintain close contact with the pavement during the spreading operations, shall obtain the thickness required, and shall be capable of being adjusted to the various pavement cross sections for application of a uniform micro surfacing finished surface. The final strike-off device shall be fabricated of flexible material and shall be designed and operated to ensure a uniform texture is achieved in the finished surface of the micro surfacing. The final strike-off device shall be cleaned or changed daily if problems with longitudinal scouring occur.

Wheel Path Depression (Rut) Box

The wheel path depression (rut) box shall be designed to have adjustable strike-off devices to regulate the depth and shall have a width of between five feet and six feet. Hydraulic augers, or similar devices, shall be installed and shall be capable of moving the mixed material from the rear to the front of the filling chamber. These devices shall also be capable of guiding the larger aggregate into the center, deeper section of the wheel path depression, and forcing the finer material toward the outer edges of the spreader box.

The micro surfacing mixture, to be spread in areas inaccessible to the controlled spreader box, may be spread by other methods upon approval of the Engineer.

PREPARATION FOR MICRO SURFACING

Before placing the micro surfacing, the pavement surface shall be cleaned by sweeping, flushing or by other means necessary to remove loose particles of paving, dirt, and other extraneous material. When required, the roadway surface may be fogged with water ahead of the spreader box. The application of the fog spray may be adjusted to suit temperatures, surface texture, humidity and dryness of pavement.

A tack coat of asphaltic emulsion shall be applied to all Portland cement concrete surfaces when there is a contract item for the work or when the work is required in these special provisions. The asphaltic emulsion for tack coat shall be grade SS-1, SS-1h, CSS-1 or CSS-1h and shall conform to the provisions in Section 94, "Asphaltic Emulsions," of the Standard Specifications. The asphaltic emulsion shall be mixed in the proportion of one part of emulsion (which contains up to 43 percent water) to 3 parts water. The mixture shall be applied at the approximate rate of 0.04 – 0.08 gal/yd². When asphaltic emulsion is used as a tack coat, micro surfacing shall not be placed until the asphaltic emulsion has cured.

PLACING

The micro surfacing mixture shall be uniformly spread on the existing surface within the rate specified without spotting, re-handling or otherwise shifting of the mixture.

The micro surfacing mixture shall not be placed when the ambient temperature is below 50 °F or during unsuitable weather. Micro surfacing shall not be placed if rain is imminent or if there is the possibility that there will be freezing temperatures within 24 hours.

When wheel path depressions have a cross section that is deformed ½ inch or more, the individual wheel paths shall first be filled with micro surfacing utilizing a wheel path depression (rut) box in conformance with the provisions of the special provisions. The depth of the wheel path depression shall be determined after the adjacent ridges have been removed, when applicable. The maximum single application for wheel path depressions shall be one inch. Wheel path depressions of depths greater than one inch shall require multiple

applications in each depression.

Wheel path depression repair shall be constructed with a slight crown to allow for initial compaction by traffic on the micro surfacing.

Freshly filled wheel path depressions shall be compacted by traffic for a minimum of 12 hours before additional lifts of micro surfacing material are placed for rut filling purposes or as surface courses.

Micro surfacing shall be spread at a rate within the following ranges of pound of dry aggregate per square yard:

Micro Surfacing Type	Location	Spread Rate (lbs. agg./sq.yd.)
Type II	Full Traffic Width	12-20
Type III	Full Traffic Width	20-30

Longitudinal joints shall correspond with the edges of the traffic lanes. The Engineer may permit other patterns of longitudinal joints if the patterns will not adversely affect the quality of the finished product.

Through traffic lanes shall be spread in full lane widths only. Longitudinal joints common to 2 traffic lanes shall be (butt joints) with overlaps not to exceed 3 inches. Building paper shall be placed at the transverse joints to avoid double placement of the micro surfacing. Other suitable methods to avoid double placement of the micro surfacing will be allowed. Hand tools shall be available to remove spillage.

The mixture shall be uniform and homogeneous after placing on the surfacing and shall not show separation of the PMCQS-1h and aggregate after setting. The completed surface shall be of uniform texture and free from ruts, humps, depressions, or irregularities.

Adequate means shall be provided to protect the micro surfacing from damage by traffic until such time that the mixture has cured sufficiently so that the micro surfacing will not adhere to or be picked up by the tires of vehicles.

When placing multiple layers of micro surfacing (excluding wheel path depressions) the second layer shall not be placed until the following day or later.

After the initial break of the micro surfacing and within a minimum of 2 hours after placement the micro surfacing shall be rolled with a pneumatic tire roller meeting the following requirements:

1. 9.3 tons minimum weight
2. The roller shall be equipped with 7 total wheels, 4 in the rear and 3 in the front of the roller.

The roller shall make a minimum of three passes on the surface.

Placement of the micro surfacing shall cease a minimum of one hour before the expiration of the road closure hours as specified in "Maintaining Traffic" of these special provisions, unless the Contractor proves to the satisfaction of the Engineer that the surface will be ready for unrestricted traffic at the expiration of the road closure hours.

TEST STRIP

The Contractor shall construct a test strip for evaluation by the Engineer. The test strip shall be 300 feet to 500 feet long and shall consist of the application courses specified. The test strip shall be constructed at the same time of day or night that the full production of micro surfacing will be placed and may be constructed in 2 days or nights when multiple course applications are specified.

The Engineer will evaluate the completed test strip after 12 hours of traffic on the completed test strip to determine if the mix design and placement procedure are acceptable. If the mix design or the placement procedure is determined by the Engineer to be unacceptable, the test strip will be rejected, the Contractor shall make modifications, and a new test strip shall be constructed and evaluated by the Engineer. The cost of materials and placement of the test strips, which have been rejected, shall be borne by the Contractor and will not be considered as part of the contract work. If ordered by the Engineer, rejected test strips shall be removed at the Contractors expense. If approve by the Engineer, the Contractor may continue with production work after placement of the test strip at his own risk. If the test strip is rejected, all production work shall be stopped and evaluated by the Engineer. The production work will be evaluated in the same manner as the placement of the test strip and shall conform to the same requirements for the test strip material.

REPAIR OF EARLY DISTRESS

If bleeding, raveling, delamination, rutting, or wash boarding occurs within 60 days after placing the micro surfacing, the Contractor shall diligently pursue repairs by any method approved by the Engineer. The Contractor shall not be relieved from maintenance until repairs have been completed.

MEASUREMENT

Micro surfacing will be measured by the square yard placed or by the tons of dry aggregate, whichever is specified by the bid item(s).

Quantities of asphaltic emulsion for paint binder (tack coat), to be paid for as contract items of work, will be determined in accordance with the methods provided in Section 94, "Asphaltic Emulsions," of the Standard Specifications.

PAYMENT

The contract price paid per square yard or tons, whichever is specified by the bid item(s), for micro surfacing shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in placing micro surfacing, complete in place, including testing for and furnishing mix design, cleaning the surface, furnishing added water and set-control additives, and protecting the micro surfacing until it has set, as shown on the plans, as specified in these special provisions, and as directed by the Engineer.

When there is a contract item for asphaltic emulsion tack coat, the quantity of asphaltic emulsion used as tack coat will be paid for at the contract price per ton for asphaltic emulsion tack coat. When there is no contract item for asphaltic emulsion (paint binder), full compensation for furnishing and applying tack coat shall be paid for by "Extra Work Force Account".

FIBERIZED MICRO SURFACING

Fiberized micro surfacing shall consist of mixing a polymer modified cationic quickset emulsion, glass fibers, aggregate, mineral filler, set-control additives, and water and spreading the mixture on a pavement surface where shown on the plans, in conformance with the provisions in these special provisions, and as directed by the Engineer.

The fibers shall be added by means of automatic injection into the micro surfacing pug-mill at a consistent length and application rate which is adjustable to meet the approval of the Engineer.

MATERIAL

The material for fiberized micro surfacing shall conform to the following requirements:

Emulsion

The asphalt emulsion for fiberized micro surfacing shall be a polymer modified cationic quickset (PMCQS-1h), shall be homogenous and shall conform to the provisions of these special provisions. The polymer shall be milled or blended into the asphalt or blended into the emulsifier solution prior to the emulsification process. Polymer solids must be a minimum of 3.0 % by weight of the emulsion's residual asphalt. Provide a certificate of compliance certifying the amount of polymer.

The PMCQS-1h emulsion shall conform to the following requirements when tested in conformance with the following test methods:

Polymer Modified, Cationic Quickset Emulsion		
Specification Designation	Test Method	Requirement
Viscosity SSF @ 77°F (25°C)	AASHTO T 59	15-90 Seconds
Sieve, max.	AASHTO T 59	0.30 Percent
Settlement, 5 days, max.*	ASTM D 244	5 Percent
Residue by Evaporation, min.	AASHTO T59	62 Percent
*Waived if to be used within 48 hours of manufacture.		

Specification Designation for Residue		
Specification Designation	Test Method	Requirement
Penetration @ 77°F (25°C), 100g, 5s, 0.1mm	AASHTO T 51	40-90
Softening Point °F (°C) min.	AASHTO T 53	135 (57)
Torsional Recovery min.	California Test 332	20

Fiber

The fiber used in the fiberized micro surfacing shall be RoadChem Fiber 1 or equivalent chemical resistant glass fiber meeting the following specifications. It shall be cut to 3/8 +/- 1/8 inch in length prior to adding to the PMCQS-1h emulsion. The fiber shall be added at a rate of 0.15 % - 0.40 % by dry weight of aggregate for

bottom lifts and 0.05 % - 0.30 % by dry weight of aggregate for surface lifts. The fiber shall meet the following requirements:

Alkali and Acid Resistant Glass Fiber					
Linear Weight of Roving (tex) ISO 1889	Linear Weight of Strand (tex) ISO 1889	Moisture Content (%) ISO 3344	Specific Gravity	Softening Point (°C)	Tensile Strength (MPa)
2500 min.	82 min.	0.35 max.	2.68 g/cm ³	860 min.	1700 min.
4800 min.	100 min.				

Water and Additives

The water shall be potable and free of harmful soluble salts or reactive chemicals and other contaminants. If necessary for workability, a set-control agent may be used and must be included as part of the mix design and be compatible with the other components of the mix.

Mineral Filler

Mineral filler shall be Portland cement or hydrated lime that is free of lumps. The type of mineral filler shall be determined by the Contractor based on laboratory mix designs and will be considered part of the aggregate gradation.

Aggregate

The mineral aggregate used shall be of the type and grade specified for the particular use of the fiberized micro surfacing. Aggregate shall consist of sound, durable, crushed stone or crushed gravel and approved mineral filler. The material shall be free from vegetable matter and other deleterious substances. All aggregate shall be free of caked lumps and oversize particles.

The aggregate, prior to the addition of emulsion, shall conform to the requirements of this section. If aggregates are blended each component aggregate shall meet the sand equivalency and abrasion resistance and shall be 100% crushed.

The percentage composition by weight of the aggregate (including mineral filler) shall conform to the following grading requirements when tested in conformance with AASHTO T 27 and AASHTO T 11:

Type II	
Sieve Size	Percentage Passing
3/8"	100
No. 4	94-100
No. 8	65-90
No. 16	40-70
No. 30	25-50
No. 200	5-15

Type III	
Sieve Size	Percentage Passing
3/8"	100
No. 4	70-90
No. 8	45-70
No. 16	28-50
No. 30	19-34
No. 200	5-15

The aggregate (excluding mineral filler) shall conform to the following quality requirements:

Test	Test Method	Requirements
Sand Equivalent (Min.)	AASHTO T 176	65
Durability Index (Min.)	AASHTO T 210	60
Percentage of Crushed Particles (Min.)	ASTM D 5821	100%
Loss Angeles Rattler Loss at 500 Rev. (Max.) ¹	AASHTO T 96	35%
Notes: 1. Los Angeles Rattler shall be performed on the parent aggregate before crushing		

If the results of the aggregate grading do not meet the specified gradation, the fiberized micro surfacing represented by the test shall be removed. However, if requested in writing by the Contractor and approved by the Engineer, the fiberized micro surfacing may remain in place and the Contractor shall pay to the State \$2.00 per ton for the aggregate represented by the tests and left in place.

If the results of the Sand Equivalent test for aggregate do not meet the specified requirement, the fiberized micro surfacing represented by the test shall be removed. However, if requested in writing by the Contractor and approved by the Engineer, the fiberized micro surfacing may remain in place and the Contractor shall pay to the State \$2.00 per ton for the aggregate represented by the tests and left in place.

When the results of both the aggregate grading and the Sand Equivalent tests do not conform to the specified requirements, both payments to the State shall apply. The Department may deduct these amounts from any moneys due or to become due to the Contractor.

No single aggregate grading or Sand Equivalent test shall represent more than 300 tons or one day's production, whichever is smaller.

MIX DESIGN

At least 7 working days before the fiberized micro surfacing placement commences, the Contractor shall submit for approval of the Engineer a laboratory report of tests and a proposed mix design covering the specific materials proposed for use on the project.

The percentages of each individual material proposed in the mix design shall be shown in the laboratory report. Individual materials shall be within the following limits:

Residual Asphalt	5.5% to 10.5% by dry weight of aggregate
Mineral Filler	0.5% to 3% by dry weight of aggregate
Glass Fiber	Top Lift: 0.05% to 0.30% by dry weight of aggregate Bottom Lift: 0.15% to 0.40% by dry weight of aggregate
Additive and Water	As needed

Adjustments may be required during construction based on field conditions.

The mix design and aggregate tests shall be performed by a laboratory capable of performing the applicable International Slurry Surfacing Association (ISSA) tests. The proposed fiberized micro surfacing

mixture shall conform to the specified requirements when tested in conformance with the following tests:

Test	ISSA Test Method	Requirements
Wet Cohesion @ 30 Minute (Set) (Min.) @ 60 Minute (Traffic) (Min.)	TB*139	12 kg-cm 20 kg-cm
Excess Asphalt	TB*109	540 g/m ²
Wet Stripping (Min.)	TB* 114	90%
Wet Track Abrasion 6-day Soak Loss (Max.)	TB*100	810g/m ²
Displacement Lateral (Max.) Specific Gravity After 1000 Cycles of 125 lbs. (56.8 kg)(Max.)	TB*147A	5% 2.10
Classification Compatibility	TB* 144	(AAA, BAA) 11 Grade Points
Mix Time @ 77°F (25°C)	TB* 113	Controllable to 120 Seconds
TB* = Technical Bulletin		

The laboratory that performed the tests and designed the mixture shall sign the laboratory report and shall be AMRL certified and/or participate in the AASHTO Proficiency Program. The report shall show the results of the tests on individual materials and shall compare their values to those required by these special provisions. The report shall clearly show the proportions of aggregate, fiber, filler (minimum and maximum), water, set control additive, and PMCQS-1h solids content (minimum and maximum) based on the dry weight of aggregate. The laboratory shall report the quantitative effects of moisture content on the unit weight of the aggregate (bulking effect) in conformance with the requirements of ASTM Designation C 29M. Previous laboratory reports covering the same materials may be accepted provided the material test reports were completed within the previous 12 months.

The component materials used in the mix design shall be representative of the fiberized micro surfacing materials proposed by the Contractor for use on the project.

Once the mix design is approved by the Engineer, no substitution of other material will be permitted unless the materials proposed for substitution are first tested and a laboratory report is submitted for the substituted design in conformance with the provisions of these special provisions. Substituted materials shall not be used until the mix design for those materials has been approved by the Engineer.

The completed mixture, after addition of water and set control agent, if used, shall be such that the fiberized micro surfacing mixture has proper workability. At the expiration of the road closure hours, in conformance with the provisions in "Maintaining Traffic" of these special provisions, the fiberized micro surfacing mixture shall be sufficiently cured to support unrestricted traffic.

PROPORTIONING

Aggregate, mineral filler, PMCQS-1h, fiber, water, and additives, including the set-control agent, if used, shall be proportioned by volume utilizing the mix design approved by the Engineer. If more than one kind of aggregate is used, the correct amount of each kind of aggregate to produce the required grading shall be proportioned separately, prior to adding the other materials of the mixture, in a manner that will result in a uniform and homogeneous blend.

The aggregate shall be proportioned using a belt feeder operated with an adjustable cut off gate. The height of the gate opening shall be determinable. The PMCQS-1h shall be proportioned by a positive displacement pump. Variable rate emulsion pumps, if used, shall be calibrated and sealed in the pump's calibrated condition in conformance with the ISSA Inspector's Manual MA-1 prior to usage.

The delivery rate of aggregate and PMCQS-1h per revolution of the aggregate feeder shall be calibrated at the appropriate gate settings for each mixer-spreader truck used on the project in conformance with ISSA Inspector's Manual MA-1 and in conformance with the provisions of these special provisions.

The aggregate belt feeder shall deliver aggregate to the pug-mill with such volumetric consistency that the deviation for any individual aggregate delivery rate check-run shall not exceed 2.0 percent of the mathematical average of 3 runs of at least three tons each. The emulsion pump shall deliver PMCQS-1h to the pug-mill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of 3 runs of at least 300 gallons each. The water pump shall deliver water to the pug-mill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of 3 runs of at least 300 gallons each.

The PMCQS-1h storage tank shall be located immediately before the emulsion pump and shall be equipped with a device which will automatically shut down the power to the emulsion pump and aggregate belt feeder when the PMCQS-1h level is lowered to a point where the pump suction line is exposed.

A temperature-indicating device shall be installed in the emulsion storage tank at the pump suction level. The device shall indicate the temperature of the PMCQS-1h and shall be accurate to within 10°F.

The fiber shall be added at a rate of 0.05 to 0.40% by weight of dry aggregate. The mixer-spreader trucks shall be equipped with a fiber chopper, fiber storage and control systems for injecting fibers into the micro surfacing mix. It shall be capable of providing up to 7 lbs./min. of fiber injection. The chopper shall cut from 3 to 4 bobbins of fiber into 3/8 +/- 1/8 inch long pieces and feed them into the aggregate as it enters the inlet hopper. The system shall turn on and off with the main start of the mixer-spreader truck. The system shall be powered by the main hydraulic system of the mixer-spreader truck. The mixer-spreader truck shall be capable of providing 3-5 cu.ft./min. of air from the truck air compressor for nozzle cooling and chopper flushing. The mixer-spreader truck shall include an enclosure/mounting and feed system for up to 4 bobbins of fiber roving.

The belt delivering the aggregate to the pug-mill shall be equipped with a device to monitor the depth of aggregate being delivered to the pug-mill. The device for monitoring the depth of aggregate shall automatically shut down the power to the aggregate belt feeder whenever the depth of aggregate is less than the target depth of flow. A second device shall be located where the device will monitor the movement of the aggregate belt by detecting revolutions of the belt feeder. The devices for monitoring no flow or belt movement shall automatically shut down the power to the aggregate belt when the aggregate belt movement is interrupted. The device to detect revolutions of the belt feeder will not be required where the aggregate delivery belt is an integral part of the drive chain. To avoid erroneous shutdown by normal fluctuation, a delay of 3 seconds will be permitted between sensing and shutdown of the operation.

MIXING AND SPREADING EQUIPMENT

The fiberized micro surfacing shall be mixed in continuous pug-mill mixers of adequate size and power for the type of fiberized micro surfacing to be placed. All indicators shall be in conformance with the provisions of these special provisions and shall be in working order prior to commencing mixing and spreading operations.

Mixer-spreader trucks shall be equipped to proportion the PMCQS-1h, water, aggregate, mineral filler, and set-control additives by volume. Rotating and reciprocating equipment on mixer-spreader trucks shall be covered with metal guards.

The mixer-spreader truck shall not be operated unless low-flow and no-flow devices and revolution counters are in good working condition and functioning and metal guards are in place. Indicators required by these special provisions shall be visible while walking alongside the mixer-spreader truck.

Aggregate feeders shall be connected directly to the drive on the emulsion pump. The drive shaft of the aggregate feeder shall be equipped with a revolution counter reading to the nearest one-tenth of a revolution.

In addition to the requirements of the fourth paragraph of Section 5 1.10, "Equipment and Plants," of the Standard Specifications, the identifying number of mixer-spreader trucks shall be at least three inches in height, located on the front and rear of the vehicle.

The fiberized micro surfacing mixture shall be spread by means of a spreader box conforming to the requirements in the "Spreader Box" section of these specifications.

Spreader Box

For Type II fiberized micro surfacing the spreader box shall be capable of spreading a lane width and equipped with a material such as flexible rubber belting on each side and in contact with the pavement. If the spread width is wider than 7.5 feet, a spreader box shall be equipped with a means, such as baffles or reversible motor-driven augers, to uniformly apply micro surfacing on superelevated sections and shoulder slopes. The spreader box shall be equipped with rear flexible strike-off blades making close contact with the pavement and adjustable to various crown shapes in order to apply a uniform micro surfacing. The spreader box shall be equipped with flexible drags attached to the rear and cleaned daily and changed if longitudinal scouring occurs. The spreader box shall be clean and free of excess micro surfacing and/or PMCQS-1h at the start of each work shift.

For Type III fiberized micro surfacing the spreader box shall be capable of placing a minimum of 12 feet wide and shall have strips of flexible rubber belting or similar material on each side of the spreader box and in contact with the pavement to prevent the loss of fiberized micro surfacing from the box. Spreader boxes over eight feet in application width shall have baffles and be double shafted reversible motor driven augers. Spreader box skids shall be maintained in such manner as to prevent chatter (wash boarding) in the finished mat. The spreader box in use shall be clean and free of fiberized micro surfacing and PMCQS-1h at the start of each work shift.

For Type III fiberized micro surfacing the spreader box shall have a series of strike-off devices at the rear of the box. The leading strike-off device shall be fabricated of steel, stiff rubber or other suitable material. The number of strike-off devices shall be determined by the Contractor. The first strike-off device shall be designed to maintain close contact with the pavement during the spreading operations, shall obtain the thickness required, and shall be capable of being adjusted to the various pavement cross sections for

application of a uniform fiberized micro surfacing finished surface. The final strike-off device shall be fabricated of flexible material and shall be designed and operated to ensure a uniform texture is achieved in the finished surface of the fiberized micro surfacing. The final strike-off device shall be cleaned or changed daily if problems with longitudinal scouring occur.

Wheel Path Depression (Rut) Box

The wheel path depression (rut) box shall be designed to have adjustable strike-off devices to regulate the depth and shall have a width of between five feet and six feet. Hydraulic augers, or similar devices, shall be installed and shall be capable of moving the mixed material from the rear to the front of the filling chamber. These devices shall also be capable of guiding the larger aggregate into the center, deeper section of the wheel path depression, and forcing the finer material toward the outer edges of the spreader box.

The fiberized micro surfacing mixture, to be spread in areas inaccessible to the controlled spreader box, may be spread by other methods upon approval of the Engineer.

PREPARATION FOR FIBERIZED MICRO SURFACING

Before placing the fiberized micro surfacing, the pavement surface shall be cleaned by sweeping, flushing or by other means necessary to remove loose particles of paving, dirt, and other extraneous material. When required, the roadway surface may be fogged with water ahead of the spreader box. The application of the fog spray may be adjusted to suit temperatures, surface texture, humidity and dryness of pavement.

A tack coat of asphaltic emulsion shall be applied to all Portland cement concrete surfaces when there is a contract item for the work or when the work is required in these special provisions. The asphaltic emulsion for tack coat shall be grade SS-1, SS-1h, CSS-1 or CSS-1h and shall conform to the provisions in Section 94, "Asphaltic Emulsions," of the Standard Specifications. The asphaltic emulsion shall be mixed in the proportion of one part of emulsion (which contains up to 43 percent water) to 3 parts water. The mixture shall be applied at the approximate rate of 0.04 – 0.08 gal/yd². When asphaltic emulsion is used as a tack coat, fiberized micro surfacing shall not be placed until the asphaltic emulsion has cured.

PLACING

The fiberized micro surfacing mixture shall be uniformly spread on the existing surface within the rate specified without spotting, re-handling or otherwise shifting of the mixture.

The fiberized micro surfacing mixture shall not be placed when the ambient temperature is below 50 °F or during unsuitable weather. Fiberized micro surfacing shall not be placed if rain is imminent or if there is the possibility that there will be freezing temperatures within 24 hours.

When wheel path depressions have a cross section that is deformed ½ inch or more, the individual wheel paths shall first be filled with fiberized micro surfacing utilizing a wheel path depression (rut) box in conformance with the provisions of the special provisions. The depth of the wheel path depression shall be determined after the adjacent ridges have been removed, when applicable. The maximum single application for wheel path depressions shall be one inch. Wheel path depressions of depths greater than one inch shall require multiple applications in each depression.

Wheel path depression repair shall be constructed with a slight crown to allow for initial compaction by traffic on the fiberized micro surfacing.

Freshly filled wheel path depressions shall be compacted by traffic for a minimum of 12 hours before additional lifts of fiberized micro surfacing material are placed for rut filling purposes or as surface courses.

Fiberized micro surfacing shall be spread at a rate within the following ranges of pound of dry aggregate per square yard:

Fiberized Micro Surfacing Type	Location	Spread Rate (lbs. agg./sq.yd.)
Type II	Full Traffic Width	15-20
Type III	Full Traffic Width	30-35

Longitudinal joints shall correspond with the edges of the traffic lanes. The Engineer may permit other patterns of longitudinal joints if the patterns will not adversely affect the quality of the finished product.

Through traffic lanes shall be spread in full lane widths only. Longitudinal joints common to 2 traffic lanes shall be (butt joints) with overlaps not to exceed 3 inches. Building paper shall be placed at the transverse joints to avoid double placement of the fiberized micro surfacing. Other suitable methods to avoid double placement of the fiberized micro surfacing will be allowed. Hand tools shall be available to remove spillage.

The mixture shall be uniform and homogeneous after placing on the surfacing and shall not show separation of the PMCQS-1h and aggregate after setting. The completed surface shall be of uniform texture and free from ruts, humps, depressions, or irregularities.

Adequate means shall be provided to protect the fiberized micro surfacing from damage by traffic until such time that the mixture has cured sufficiently so that the fiberized micro surfacing will not adhere to or be picked up by the tires of vehicles.

When placing multiple layers of fiberized micro surfacing (excluding wheel path depressions) the second layer shall not be placed until the following day or later.

After the initial break of the fiberized micro surfacing and within a minimum of 2 hours after placement the fiberized micro surfacing shall be rolled with a pneumatic tire roller meeting the following requirements:

1. 9.3 tons minimum weight
2. The roller shall be equipped with 7 total wheels, 4 in the rear and 3 in the front of the roller.

The roller shall make a minimum of three passes on the surface.

Placement of the fiberized micro surfacing shall cease a minimum of one hour before the expiration of the road closure hours as specified in "Maintaining Traffic" of these special provisions, unless the Contractor proves to the satisfaction of the Engineer that the surface will be ready for unrestricted traffic at the expiration of the road closure hours.

TEST STRIP

The Contractor shall construct a test strip for evaluation by the Engineer. The test strip shall be 300 feet to 500 feet long and shall consist of the application courses specified. The test strip shall be constructed at the same time of day or night that the full production of fiberized micro surfacing will be placed and may be constructed in 2 days or nights when multiple course applications are specified.

The Engineer will evaluate the completed test strip after 12 hours of traffic on the completed test strip to determine if the mix design and placement procedure are acceptable. If the mix design or the placement procedure is determined by the Engineer to be unacceptable, the test strip will be rejected, the Contractor shall make modifications, and a new test strip shall be constructed and evaluated by the Engineer. The cost of materials and placement of the test strips, which have been rejected, shall be borne by the Contractor and will not be considered as part of the contract work. If ordered by the Engineer, rejected test strips shall be removed at the Contractor's expense. If approved by the Engineer, the Contractor may continue with production work after placement of the test strip at his own risk. If the test strip is rejected, all production work shall be stopped and evaluated by the Engineer. The production work will be evaluated in the same manner as the placement of the test strip and shall conform to the same requirements for the test strip material.

REPAIR OF EARLY DISTRESS

If bleeding, raveling, delamination, rutting, or washboarding occurs within 60 days after placing the fiberized micro surfacing, the Contractor shall diligently pursue repairs by any method approved by the Engineer. The Contractor shall not be relieved from maintenance until repairs have been completed.

MEASUREMENT

Fiberized micro surfacing will be measured by the square yard placed or by the tons of dry aggregate, whichever is specified by the bid item(s).

Quantities of asphaltic emulsion for paint binder (tack coat), to be paid for as contract items of work, will be determined in accordance with the methods provided in Section 94, "Asphaltic Emulsions," of the Standard Specifications.

PAYMENT

The contract price paid per square yard or tons, whichever is specified by the bid item(s), for fiberized micro surfacing shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in placing fiberized micro surfacing, complete in place, including testing for and furnishing mix design, cleaning the surface, furnishing added water and set-control additives, and protecting the fiberized micro surfacing until it has set, as shown on the plans, as specified in these special provisions, and as directed by the Engineer.

When there is a contract item for asphaltic emulsion tack coat, the quantity of asphaltic emulsion used as tack coat will be paid for at the contract price per ton for asphaltic emulsion tack coat. When there is no contract item for asphaltic emulsion (paint binder), full compensation for furnishing and applying tack coat shall be paid for by "Extra Work Force Account".

ASPHALT RUBBER SEAL COAT

Asphalt-rubber seal coat shall consist of an application of asphalt-rubber binder and screenings precoated with paving asphalt. Asphalt-rubber seal coat shall conform to the provisions specified for seal coats in Section 37-2, "Seal Coats," of the Caltrans Standard Specifications 2010 and to these special provisions.

PAVING ASPHALT

Paving asphalt to be used in the asphalt-rubber binder shall be Grade 64-16 and shall conform to the provisions in Section 92 of the Caltrans Standard Specifications and ASTM 6373. The paving asphalt for use in asphalt-rubber binder shall not be polymer modified.

ASPHALT MODIFIER

The asphalt modifier shall be a resinous, high flash point, aromatic hydrocarbon compound and shall conform to the following requirements:

Asphalt Modifier		
Test Parameter	ASTM Designation	Requirement
Viscosity, m ² /s (10-6) at 100°C	D 445	X ±3*
Flash Point, CL.O.C. °C	D 92	207 min.
Molecular Analysis		
Asphaltenes, % by mass	D 2007	0.1 max.
Aromatics, % by mass	D 2007	55 min.

* "X" denotes the proposed asphalt modifier viscosity from 19 to 36. A change in "X" requires a new asphalt rubber binder submittal.

Asphalt modifier and asphalt binder must be blended at the production site. Asphalt modifier must be from 2.5 to 6.0 percent by weight of the asphalt binder in the asphalt rubber binder. The asphalt rubber binder supplier determines the exact percentage.

If blended, the asphalt binder must be from 375 to 440 degrees F when asphalt modifier is added and the mixture must circulate for at least 20 minutes. Asphalt binder, asphalt modifier, and crumb rubber modifier may be proportioned and combined simultaneously.

CRUMB RUBBER MODIFIER (CRM)

Crumb rubber modifier (CRM) shall consist of a combination of scrap tire CRM and high natural CRM. CRM shall be ground or granulated at ambient temperature.

Steel and fiber must be separated. If steel and fiber are cryogenically separated, it must occur before grinding and granulating. Cryogenically-produced crumb rubber modifier particles must be large enough to be ground or granulated.

Wire must not be more than 0.01 percent by weight of crumb rubber modifier. Crumb rubber modifier must be free of contaminants except fabric, which must not exceed 0.05 percent by weight of crumb rubber modifier.

The length of an individual crumb rubber modifier particle must not exceed 3/16 inch.

Crumb rubber modifier must be dry, free-flowing particles that do not stick together. A maximum of 3 percent

calcium carbonate or talc by weight of crumb rubber modifier may be added. Crumb rubber modifier must not cause foaming when combined with the asphalt binder and asphalt modifier.

Specific gravity of crumb rubber modifier must be from 1.1 to 1.2 determined under California Test 208.

When tested under ASTM D 297, crumb rubber modifier must comply with the requirements shown in the following table:

Crumb Rubber Modifier Gradations				
Test Parameter	Scrap Tire CRM Percent		High Natural CRM Percent	
	Minimum	Maximum	Minimum	Maximum
Acetone Extract	6.0	16.0	4.0	16.0
Rubber Hydrocarbon	42.0	65.0	50.0	—
Natural Rubber content	22.0	39.0	40.0	48.0
Carbon Black Content	28.0	38.0	—	—
Ash Content	—	8.0	—	—

The CRM for asphalt-rubber binder shall conform to the gradations specified below when tested in conformance with the requirements in ASTM C 136, except as follows:

- A. Split or quarter 100 g±5 g from the CRM sample and dry to a constant mass at a temperature of not less than 57°C nor more than 63°C and record the dry sample mass. Place the CRM sample and 5 g of talc in a 0.5-L jar. Seal the jar, then shake the jar by hand for a minimum of one minute to mix the CRM and the talc. Continue shaking or open the jar and stir until particle agglomerates and clumps are broken and the talc is uniformly mixed.
- B. Place one rubber ball on each sieve. Each ball shall have a mass of 8.5 g ±0.5 g, have a diameter of 24.5 mm ±0.5 mm, and shall have a Shore Durometer "A" hardness of 50 ±5 in conformance with the requirements in ASTM Designation: D 2240. After sieving the combined material for 10 minutes ±1 minute, disassemble the sieves. Material adhering to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the mass of the material retained on the 2.36-mm sieve and leave this material (do not discard) on the scale or balance. Observed fabric balls shall remain on the scale or balance and shall be placed together on the side of the scale or balance to prevent the fabric balls from being covered or disturbed when placing the material from finer sieves onto the scale or balance. The material retained on the next finer sieve (2.00-mm sieve) shall be added to the scale or balance. Weigh and record that mass as the accumulative mass retained on that sieve (2.00-mm sieve). Continue weighing and recording the accumulated masses retained on the remaining sieves until the accumulated mass retained in the pan has been determined. Prior to discarding the CRM sample, separately weigh and record the total mass of fabric balls in the sample.
- C. Determine the mass of material passing the 75-µm sieve (or mass retained in the pan) by subtracting the accumulated mass retained on the 75-µm sieve from the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass of 5 g or less, cross out the recorded number for the accumulated mass retained in the pan and copy the number recorded for the accumulated mass retained on the 75-µm sieve and record that number (next to the crossed out number) as the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass greater than 5 g, cross out the recorded number for the accumulated mass retained in the pan, subtract 5 g from that number and record the difference next to the crossed out number. The adjustment to the accumulated mass retained in the pan is made to account for the 5 g of talc added to the sample. For calculation purposes, the adjusted total sample

mass is the same as the adjusted accumulated mass retained in the pan. Determine the percent passing based on the adjusted total sample mass and record to the nearest 0.1 percent.

Scrap Tire CRM Gradation			
Percentage Passing			
Sieve Size	Gradation Limit	Operating Range	Contract Compliance
No. 8	100	100	100
No. 10	98-100	95-100	90-100
No. 16	45-75	35-85	32-88
No. 30	2-20	2-25	1-30
No. 50	0-6	0-10	0-15
No. 100	0-2	0-5	0-10
No. 200	0	0-2	0-5

High Natural CRM Gradation			
Percentage Passing			
Sieve Size	Gradation Limit	Operating Range	Contract Compliance
No. 10	100	100	100
No. 16	95-100	92-100	85-100
No. 30	35-85	25-95	20-98
No. 50	10-30	6-35	2-40
No. 100	0-4	0-7	0-10
No. 200	0-1	0-3	0-5

ASPHALT-RUBBER BINDER

Asphalt-rubber binder shall consist of a mixture of paving asphalt, asphalt modifier, and crumb rubber modifier.

At least 15 days before its intended use, the Contractor shall furnish the Engineer four 1-quart cans filled with the asphalt-rubber binder proposed for use on the project. The Contractor shall supply the Engineer, for approval, a binder formulation and samples of all materials to be used in the asphalt-rubber binder, at least 15 days before construction is scheduled to begin. The binder formulations shall consist of the following information:

- A. Paving Asphalt and Modifiers:
 1. Source and grade of paving asphalt.
 2. Source and identification (or type) of modifiers used.
 3. Percentage of asphalt modifier by weight of paving asphalt.
 4. Percentage of the combined blend of paving asphalt and asphalt modifier by total weight of asphalt-rubber binder to be used.
 5. Laboratory test results for test parameters shown in these special provisions.

- B. Crumb Rubber Modifier (CRM):
 1. Source and identification (or type) of scrap tire and high natural CRM.
 2. Percentage of scrap tire and high natural CRM by total weight of the asphalt-rubber blend.
 3. If CRM from more than one source is used, the above information will be required for each CRM source used.

4. Laboratory test results for test parameters shown in these special provisions.

C. Asphalt-Rubber Binder:

1. Laboratory test results of the proposed blend for test parameters shown in these special provisions.
2. The minimum reaction time and temperature.

The method and equipment for combining the paving asphalt, asphalt modifier, and CRM shall be so designed and accessible that the Engineer can readily determine the percentages by weight for each material being incorporated into the mixture.

The proportions of the materials, by total weight of asphalt-rubber binder, shall be 79 percent \pm 1 percent combined paving asphalt and asphalt modifier and 21 percent \pm 1 percent CRM. However, the minimum amount of CRM shall not be less than 20.0 percent. Lower values shall not be rounded up. The CRM shall be combined at the production site and shall contain 76 percent \pm 2 percent scrap tire CRM and 24 percent \pm 2 percent high natural CRM, by weight.

The blended paving asphalt and asphalt modifier mixture and the CRM shall be combined and mixed together at the production site in a blender unit to produce a homogeneous mixture.

The temperature of the blended paving asphalt and asphalt modifier mixture shall not be less than 375 °F nor more than 440 °F when the CRM is added. The combined materials shall be reacted for a minimum of 45 minutes after incorporation of the CRM at a temperature of not less than 375 °F nor more than 425 °F. The temperature shall not be higher than 10 °F below the actual flash point of the asphalt-rubber binder.

After reacting, the blended asphalt-rubber binder shall conform to the following requirements:

Blended Asphalt-Rubber Binder			
Test Parameter	ASTM Test Method	Requirement	
		Minimum	Maximum
Cone Penetration @ 25°C, 1/10 mm	D 217	25	60
Resilience @ 25°C, Percent rebound	D 5329	18	50
Field Softening Point, °C	D 36	55	88
Viscosity @190°C, Pa • s (x10-3)	ASTM D 7741	1500	2500
Vialit Test "French Chip"	Caltrans Method	90%	-

- 1) The Vialit test shall be performed according to Caltrans specifications except asphalt rubber shall be applied to the test plates in an amount equivalent to the specified application rate for the project. The 48 hour cure shall be at ambient temperature not 60C. Test pan lips shall be high enough to prevent asphalt cement from over flowing. Aggregate used shall be the aggregate proposed for use on the project and shall be pre-coated as required for asphalt rubber chip seal.

The reacted asphalt-rubber binder shall be maintained at a temperature of not less than 375 °F or more than 415 °F.

Stop heating unused asphalt rubber binder 4 hours after the 45-minute reaction period. Reheating asphalt rubber binder that cools below 375 degrees F is a reheat cycle. Do not exceed 2 reheat cycles. If reheating, asphalt rubber binder must be from 375 to 415 degrees F before use.

During reheating, you may add scrap tire crumb rubber. Scrap tire crumb rubber must not exceed 10 percent by weight of the asphalt rubber binder. Allow added scrap tire crumb rubber to react for at least 45 minutes.

Reheated asphalt rubber binder must comply with the specifications for asphalt rubber

SCREENINGS

Screenings for asphalt rubber seal coat must comply with the _____ grading.

Before precoating with asphalt binder and when tested under California Test 202, screenings for asphalt rubber seal coat must have the gradation shown in the following table:

Asphalt Rubber Seal Coat Screenings Gradation			
Sieve sizes	Percentage passing by weight		
	Coarse 1/2" max	Medium 1/2" max	Fine 3/8" max
3/4"	100	100	100
1/2"	75-90	85-90	95-100
3/8"	0-20	0-30	70-85
No. 4	0-2	0-5	0-15
No. 8	--	--	0-5
No. 200	0-1	0-1	0-1

Screenings must have the values for the properties shown in the following table:

Seal Coat Screenings		
Properties	Test method	Value
Cleanness value, min	California Test 227	80
Durability, min	California Test 229	52

EQUIPMENT

The Contractor shall utilize the following equipment for asphalt-rubber seal coat operations:

- A. Self-propelled power brooms that clean the existing pavement and remove loose screenings without dislodging screenings set in the asphalt-rubber binder. Gutter brooms or steel-tined brooms shall not be used;
- B. Pneumatic tired rollers conforming to the provisions in Section 39-3.03, "Spreading and Compacting Equipment," of the Standard Specifications, except that the rollers shall have an air pressure of 100 pounds per square inch and maintained so that the air pressure will not vary more than ± 5 pounds per square inch in each tire or the tires shall be foam filled. A sufficient number of rollers shall be used so that one complete coverage will be provided in one pass;
- C. A self-propelled screenings spreader, equipped with a screenings hopper in the rear and belt conveyors to carry the screenings to the front of a spreading hopper. The screenings spreader shall be capable of providing a uniform screening spread rate over the entire width of the traffic lane in one application;
- D. An asphalt heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ± 5 °F and shall be of the recording type;
- E. A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier, and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer through meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications. The blending system shall vary the rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than ± 25 °F. The paving asphalt feed, the asphalt modifier feed, and CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Meters used for proportioning individual ingredients shall be equipped with rate-of-flow indicators to show the rates of

delivery and resettable totalizers so that the total amounts of liquid ingredients introduced into the mixture can be determined. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced. The Contractor shall provide a safe sampling device that delivers a representative sample of the completed asphalt-rubber binder of sufficient size to permit the required tests;

- F. An asphalt-rubber binder storage tank equipped with a heating system to maintain the proper temperature of the asphalt-rubber binder and an internal mixing unit that maintains a homogeneous mixture of blended paving asphalt, asphalt modifier, and CRM;
- G. A self-propelled truck or trailer mounted distributor, equipped with an internal mixing unit that maintains a homogeneous mixture of blended paving asphalt, asphalt modifier and CRM. The distributor shall have a pump or pumps that sprays asphalt-rubber binder within ± 0.05 gallon per square yard of the specified rate. The distributor shall have a fully circulating spray bar that applies the asphalt-rubber binder without a streaked or otherwise irregular pattern. The distributor shall be equipped with a tachometer, pressure gages, volume measuring devices, and thermometer. The distributor shall have a platform on the rear of the vehicle and an observer shall accompany the distributor. The observer shall ride in such a position that all spray nozzles are in full view and readily accessible for unplugging plugged nozzles, should plugging occur; and
- H. Tailgate discharge trucks for hauling screenings shall be equipped with a device to lock onto the hitch at the rear of the screenings spreader. Haul trucks shall be compatible with the screenings spreader so that the dump bed will not push down on the spreader when fully raised or have too short a bed which results in screenings spilling while dumping into the receiving hopper.
- I. Under supports for scale bearing points for scale structures where the total load, live plus dead load, is less than 17 tons, shall be as follows:
 - 1. Structure shall be supported on at least 4 legs. The total load on any one leg shall not be greater than 14.5 psi.
 - 2. Undersupport shall be structural grade steel with a minimum cross sectional dimension of 20 inches and a minimum thickness of 1.5 inch.
 - 3. Entire scale structure including supports shall be constructed so no movement or deflection is possible during production operations. Only metal shall be used in the scale support structure.
 - 4. Scale structure shall be level during device calibration and material production.
 - 5. Adequate drainage shall be provided to prevent saturation of the ground under the scale. The ground under the scale shall remain in a condition which will support 14.5 psi at each support.
 - 6. At the option of the Contractor, the scale structure shall be installed using concrete under supports in conformance with the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications may be used.

Equipment shall be approved by the Engineer prior to use.

ASPHALT-RUBBER BINDER APPLICATION

Apply asphalt rubber binder immediately after the reaction period. At the time of application, the temperature of asphalt rubber binder must be from 385 to 415 degrees F.

Apply asphalt rubber binder at a rate from 0.55 to 0.65 gal/sq yd. The Engineer determines the exact rate.
Apply asphalt rubber binder when the atmospheric temperature is from 60 to 105 degrees F and the pavement

surface temperature is at least 55 degrees F.

Do not apply asphalt rubber binder unless there are sufficient screenings available to cover the asphalt rubber binder within 2 minutes. Intersections, turn lanes, gore points, and irregular areas must be covered within 15 minutes.

Do not apply asphalt rubber binder when weather or road conditions are unsuitable, including high wind or when the pavement is damp. In windy conditions you may adjust the distributor bar height and distribution speed, and use shielding equipment, if the Engineer authorizes your request.

SCREENINGS APPLICATION

During transit, cover precoated screenings for asphalt rubber seal coat with tarpaulins if the ambient air temperature is below 65 degrees F or the haul time exceeds 30 minutes.

At the time of application, screenings for asphalt rubber seal coat must be from 225 to 325 degrees F.

Spread screenings at a rate from 28 to 40 lb/sq yd. The exact rate is determined by the Engineer. Spread to within 10 percent of the determined rate.

ROLLING AND SWEEPING

Perform initial rolling within 90 seconds of spreading screenings. Do not spread screenings more than 200 feet ahead of the initial rolling.

For final rolling, you may request use of a steel-wheeled roller weighing from 8 to 10 tons, static mode only.

Perform a final sweeping before Contract acceptance. The final sweeping must not dislodge screenings.

Dispose of swept screenings at least 150 feet from any waterway.

MEASUREMENT AND PAYMENT

Screenings for asphalt rubber seal coat are measured by coated weight after they are preheated and precoated with asphalt binder. The weight of screenings must be the coated weight.

If recorded batch weights are printed automatically, the bid item for screenings for asphalt-rubber seal coat are measured using the printed batch weights, provided:

1. Total aggregate weight for screenings per batch is printed
2. Total asphalt binder weight per batch is printed
3. Each truckload's zero tolerance weight is printed before weighing the first batch and after weighing the last batch
4. Time, date, mix number, load number and truck identification are correlated with a load slip
5. A copy of the recorded batch weights is certified by a licensed weighmaster and submitted to the Engineer

Screenings for asphalt rubber seal coat is paid for as screenings (hot applied).

Asphalt-rubber binder is measured under the specifications for asphalts.

If test results for gradation tests do not comply with the specifications, deductions are taken.

Each gradation test for scrap tire crumb rubber represents 10,000 lbs or the amount used in that day's production, whichever is less.

Each gradation test for high natural rubber represents 3,400 lbs or the amount used in that day's production, whichever is less.

For each gradation test, the following pay deductions will be taken from the asphalt rubber bid item:

Gradation Test		
Material	Test result a	Deduction
Scrap tire crumb rubber	Operating range < TR < Contract compliance	\$250
Scrap tire crumb rubber	TR > Contract compliance	\$1,100
High natural crumb rubber	Operating range < TR < Contract compliance	\$250
High natural crumb rubber	TR > Contract compliance	\$600

^a Test Result = TR

ASPHALT EMULSION SEAL COAT

Asphalt emulsion seal coat consist of applying asphaltic emulsion and screenings on the pavement where shown on the plans, as specified in these specifications and the special provisions, and as directed by the Engineer.

Asphalt emulsion seal coat consists of one of the following:

1. Polymer modified cationic rapid set emulsion (PMCRS-2h)
2. Polymer modified rejuvenating emulsion (PMRE)
3. Polymer modified rejuvenating emulsion with tire rubber (PMRE-TR)

MATERIALS

The asphalt emulsion applied for seal coat shall be _____.

The specified emulsion for chip seal shall conform to the following applicable requirements:

Asphalt Emulsion

PMCQS-1h emulsion shall conform with Caltrans Standard Specification Section 94 and to the following requirements when tested in conformance with the following methods:

Polymer Modified Cationic Rapid-Set Emulsion (PMCRS-2h)		
Tests on Emulsion		
Specification Designation	Test Method	Requirement
Viscosity SSF @ 122°F (50°C)	AASHTO T 59	75 - 300 Seconds
Sieve, max.	AASHTO T 59	0.30 Percent
Settlement, 5 days, max.*	ASTM D 244	5 Percent
Demulsibility, min.	AASHTO T 59	40 percent
pH	ASTM E 70	2.0 - 5.0
Residue by Evaporation, min.	California TM 331	65 Percent
Tests on Residue By Evaporation		
Specification Designation	Test Method	Requirement
Penetration @ 77°F (25°C), 100g, 5s, 0.1mm	AASHTO T 49	40-90
Ductility @ 77°F (25°C), mm, min.	AASHTO T 51	400
Torsional Recovery, %, min.	California Test 332	18

PMRE shall conform to the following requirements when tested in conformance with the following methods:

Polymer Modified Rejuvenating Emulsion (PMRE)		
Tests on Emulsion		
Specification Designation	Test Method	Requirement
Viscosity SFs @ 122°F (50°C), sec.	AASHTO T 59	50 - 350
Sieve, %	AASHTO T 59	0.10 maximum
Settlement, 5 days, %*	ASTM D 244	5.0 maximum
pH	ASTM E 70	2.0 – 5.0
Oil Distillate, wt. %	ASTM T 59	0.5 maximum
Residue by Evaporation, wt. %	California TM 331	65 minimum
Tests on Residue By Evaporation		
Specification Designation	Test Method	Requirement
Penetration @ 39.2°F (4°C), 200g, 60s ,0.1mm	AASHTO T 49	40 minimum
Viscosity @ 140°F (60°C), P	ASTM D 2171	5000 maximum
Elastic Recovery ^(1,2) , 50°F (10°C), %	ASSHTO T 301	60 minimum
OR Torsional Recovery ^(1,3) , %	California TM 332	45 minimum
Tests on Rejuvenating Agent		
Specification Designation	Test Method	Requirement
Viscosity @ 140°F (60°C), cSt	ASTM D 2170	50 – 175
Flash Point, COC, °F	ASTM D 92	380 minimum
Saturates, wt. %	ASTM D 2007	30 maximum
Asphaltenes, wt. %	ASTM D 2007	1.0 maximum
Tests on Rejuvenating Agent RTFO Residue		
Specification Designation	Test Method	Requirement
Weight Change, wt. %	ASTM D 2872	6.5 maximum
Viscosity Ratio (RTFO/Original)	ASTM D 2170	3.0 maximum

⁽¹⁾ Choose either Elastic Recovery or Torsional Recovery as a test.

⁽²⁾ Elastic Recovery @ 10°C (50°F): Hour glass sides, pull to 20cm, hold 5 minutes then cut, let sit 1 hour.

⁽³⁾ Torsional recovery shall include the first 30 second.

PMRE-TR shall conform to the following requirements when tested in conformance with the following methods:

Polymer Modified Rejuvenating Emulsion with Tire Rubber (PMRE-TR)		
Tests on Emulsion		
Specification Designation	Test Method	Requirement
Viscosity SSF @ 77°F (25°C)	AASHTO T 59	75 - 300 Seconds
pH	ASTM E 70	2.0 - 5.0
Residue by Evaporation, min.	California TM 331	65 Percent
Tests on Residue By Evaporation		
Specification Designation	Test Method	Requirement
Penetration @ 77°F (25°C), 100g, 5s, 0.1mm	AASHTO T 49	50-120
Elastic Recovery @ 77°F (25°C), mm, min.	AASHTO T 301	55 minimum
Dynamic Shear Rheometer, 70°C, 2mm gap,	AASHTO T 315	1.00 minimum
Test on Ground Tire Rubber		
Specification Designation	Test Method	Requirement
Ground Tire Rubber Content, wt. %	calculation	8.0 minimum
Tire Rubber Gradation, passing	ASTM C 136	No. 20, 100 percent
		No. 30, 95 – 100 percent

Screenings

Screenings for the asphalt emulsion _____ seal coat must comply with _____.

Screenings shall consist of sound, durable, crushed stone or crushed gravel. The material shall be free from vegetable matter and other deleterious substances. Screenings shall be 100% crushed particles as determined by California Test 205. The percentage composition by weight of the screenings shall conform to the specified gradation for the appropriate asphalt emulsion:

PMCRS-2h Seal Coat Screenings Gradation				
	Percentage passing			
Sieve sizes	Coarse 1/2" max	Medium 3/8" max	Medium fine 5/16" max	Fine 1/4" max
3/4"	100	--	--	--
1/2"	85-100	100	--	--
3/8"	0-30	85-100	100	100
No. 4	0-5	0-15	0-50	60-85
No. 8	--	0-5	0-15	0-25
No. 16	--	--	0-5	0-5
No. 30	--	--	0-3	0-3
No. 200	0-2	0-2	0-2	0-2

The cleanliness value determined California Test 227 must be 86 for PMCRS-2h seal coat screenings.

PMRE and PMRE-TR Seal Coat Screenings Gradation			
	Percentage passing		
Sieve sizes	Medium 3/8" max	Medium fine 5/16" max	Fine 1/4" max
3/4"	--	--	--
1/2"	100	--	--
3/8"	90-100	100	100
No. 4	5-20	35-55	60-80
No. 8	0-7	0-10	0-15
No. 16	0-5	0-5	0-5
No. 30	0-4	0-4	0-4
No. 200	0-3	0-3	0-3

The cleanliness value determined California Test 227 must be 80 for PMRE and PMRE-TR seal coat screenings.

APPLICATION

Polymer modified asphaltic emulsion must be applied within the application rate ranges shown in the following table:

Polymer Modified Asphaltic Emulsion Application Rates	
Screenings	Application rate range(gallons per square yard)
Fine	0.15-0.30
Medium fine	0.25-0.35
Medium	0.25-0.40
Coarse	0.30-0.40

The Engineer determines the exact application rate.

At the time of application, the temperature of asphalt emulsion must be from 130 to 180 °F for PMCRS-2h and 110 to 180°F for PMRE.

Apply asphalt emulsion when the ambient air temperature is from 60 to 105 °F and the pavement surface temperature is at least 55 ° F.

Do not apply asphalt emulsion when weather forecasts predict the ambient air temperature will fall below 39 °F within 24 hours after application.

When tested under California Test 339, the application rate for polymer modified asphaltic emulsion must not vary from the average by more than:

1. 15 percent in the transverse direction
2. 10 percent in the longitudinal direction

The emulsion shall be applied with a distributor truck to the pavement surface capable of rate of 0.15 to 0.40 gallons per square yard.

EQUIPMENT

Immediately following the emulsion, an application of screenings shall be spread evenly by a mechanical spreader.

The rate shall be adjusted up or down so that no bleed through occurs during rolling.

Pneumatic tire rolling shall follow immediately after the screenings is applied. The following equipment to be used for the chip seal shall be as follows:

- A. An asphalt distributor for application of the emulsion shall have a full circulation spray bar that is adjustable to at least sixteen (16) feet wide and capable of heating and circulating the emulsion simultaneously. It must have computerized rate control for adjusting and controlling the application from the cab by .01 gallons per square yard increments. The distributor shall also be equipped with a volume measuring devise and a thermometer for measuring the emulsion temperature in the tank.

- B. A self-propelled screenings spreader with front discharge that can evenly distribute screenings throughout the entire range of application rates specified for the project gradation. The spreader shall be equipped with computerized rate control.
- C. Two (2) pneumatic-tired rollers weighing at least five (5) tons each.
- D. Two (2) mechanically powered kick-brooms or mechanically powered pick up brooms equipped with vacuum type suction, for sweeping on city streets.
- E. A back pack blower for removing excess screenings during the sweeping operation.

The seal coat shall not be placed if either the pavement or the air temperature is below forty (40) degrees F and falling, but may be applied when both the air and pavement temperature is forty (40) degrees F or above and rising. The weather forecast should be for highs near sixty (60) degrees F and no rain forecast for the next twenty-four (24) hours after the seal coat has been applied. The mixture shall not be applied if high relative humidity prolongs the curing beyond a reasonable time.

Seal coat to be placed shall consist of an application of Polymer Modified Rejuvenating Emulsion and a single screening; and shall be applied and finished in conformance with these Special Provisions. The lane to be sealed shall be closed from the time the asphaltic emulsion is applied until the time the seal coat has set sufficiently to open traffic.

The Contractor shall take precautions such that no asphaltic emulsion or screenings are allowed to enter streams and waterways near the project during the course of the work.

Immediately before commencing the seal coat operations, all surface metal utility covers (including survey monuments) shall be protected by thoroughly covering the surface with an appropriate adhesive and paper or plastic. No adhesive material shall be permitted to cover, seal or fill the joint between the frame and cover of the structure. Covers are to be uncovered and cleaned of seal coat material by the end of the same work day.

For the purpose of this project, the construction zone is defined to include all stockpile staging areas and travel routes to/from streets where the seal coat is to be applied.

FINISHING

Rollers shall be pneumatic-tired and a minimum of 2 rollers shall be used. Initial rolling shall begin immediately behind the chip spreader. The pneumatic tired-rollers shall carry a minimum loading of three thousand (3000) pounds. On each wheel an air pressure of one hundred (100) pounds per square inch is required.

All streets shall be power swept after placing the seal coat before the end of day. The sweepers shall be self-propelled vacuum or mechanical broom pickup, with water spray bars to reduce dust. If necessary, more than one type of sweeper may be used. Sidewinder sweepers or brooms that windrow material and do not remove it shall not be used. A minimum of two (2) sweepers shall be used at all times. All areas shall be swept a second time or more if necessary in the same manner as the first sweeping. Completion of sweeping shall be evidenced by the absence of loose screenings in gutters or driveways. Special attention shall be required in sweeping from the driveways clear of loose chips. The contractor shall also be responsible for removal of all screenings from the sidewalks and other affected areas such as adjacent streets and truck route.

The Contractor shall exercise care to prevent oil from being deposited on concrete surfaces. The Contractor shall remove oil from the surfaces not designated to be seal coated.

MEASUREMENT AND PAYMENT

Seal coat will be measured and paid for by the square yard for the actual surface areas covered.

The contract price paid per square yard for seal coat shall include full compensation for furnishing all labor, materials, tools, equipment and incidentals and for doing all the work involved in the furnishing and placing of the seal coat complete in place, including cleaning the surface, all as shown on the plans, as specified in these specifications and as directed by the Engineer.

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