

SECTION 10 BITUMINOUS SEAL COATS

10-1 GENERAL

10-1.1 General - This work in general shall consist of mixing asphalt emulsion, aggregate, set –control additives, granulated reclaimed rubber, and water and spreading the mixture on a surfacing or pavement where shown on the plans, as specified in the Special Provisions, as specified herein, and as directed by the Engineer.

The Contractor shall execute all work in a safe, orderly and expeditious manner and shall specifically exercise due care and consideration to minimize inconvenience to residents and businesses of the project areas relative to parking of vehicles, access to properties and the movement of vehicles and persons through the work areas. To that end, general clean-up and debris removal shall be scheduled to precede surface preparation and paving work by the least feasible period of time.

10-1.2 Notifications and Parking Restrictions - Contractor's attention is directed to Section 6-10 of the General Provisions in addition to the requirements below.

Prior to starting each phase of work, Contractor shall furnish and install special notification signs to announce impending work at all entrances to and exits from the work area, with a minimum of two signs per street. Sign layout and message shall conform to the Project Special Provisions. Signs shall be mounted on Type III barricades and in place at least five (5) working days in advance of the initial work on a street, and at least two (2) working days in advance of subsequent phases of work. Contractor shall maintain signs in good condition, with sign messages legible at all times, for the entire duration of Work.

If the phase of work indicated on the special notification signs is not undertaken on the stated date(s) and time(s), Contractor shall revise the signs to reflect the new date(s) and time(s). Revision of signs shall be in place at least 48 hours in advance of performing the work governed by the revision.

10-1.3 Work Phasing Schedule and Traffic Control Plan - A minimum of ten (10) working days prior to the start of any bituminous seal coat, the Contractor shall submit a Work Phasing Schedule and Traffic Control Plan for the approval of the Engineer. Contractor shall not proceed with any work prior to having said plans approved by the Engineer.

10-1.4 Weather Limitations - The bituminous seal coat shall be applied only when the existing surface is clean and free of visible moisture. The slurry seal shall be applied only when the pavement is 50°F, or greater, and the atmospheric temperature is at least 60°F and rising. The slurry seal shall not be applied on any day when rainfall is forecast, or high relative humidity prolongs the curing time beyond a reasonable length.

10-1.5 Adjustments in Applications - Prior to the start of work, the Contractor shall furnish the Engineer with a calibration sheet for each mixing and/or application machine to be used to lay the seal coats. At any time during the application of seal coats, if the Engineer determines that the application may not achieve a result that conforms to Specifications, he may order the Contractor to stop the application and make adjustments in the product mixture, application rate, or machinery as necessary to achieve compliance with Contract. Contractor shall make such adjustments when instructed. Failure to do so shall be considered sufficient ground for rejecting the Work.

10-1.6 Pre-Inspection - The bituminous seal coat shall not be applied until an inspection of the surface has been made by the Engineer, and the Engineer has determined the surface is suitable for bituminous seal coat application.

10-1.7 Protection and Restoration of Pavement Delineators, Markings and Striping - Immediately prior to applying the bituminous slurry seal or Cape Seal, all pavement delineators, markers and striping not designated to be replaced or abandoned by the Contract Plans shall be protected by means approved by the Engineer. Upon completion of the slurry seal application protection shall be removed and the pavement delineators, markers and striping cleaned to the satisfaction of the Engineer.

The Contractor, in lieu of protecting existing pavement delineators and markings, or when required by the Special Provisions and Contract Plans, may remove and replace all pavement delineators, markings and striping in kind, or as shown on the Contract Plans. Unless provided for otherwise in the bid proposal, replacement of existing pavement delineators, markings and striping shall be at no additional expense to the City. All delineators, markings and striping,

not specifically shown on the Contract Plans or Special Provisions to be replaced or abandoned, but damaged by the Contractor's, operations shall be replaced at no expense to the City.

All pavement shall be vacuum swept before placing pavement delineators, markings or striping.

10-1.8 Surface Preparation - Preparatory repair work, including that required by Section 12, "Asphalt Concrete Leveling Course and Crack Fill Repairs," and Section 5, "Street Failed Area Repair," of these Technical Provisions, shall be completed prior to application of the bituminous seal coat. Repairs shall be performed when the weather will not damage the quality of the finished product. Asphalt concrete patches shall be allowed to set a minimum of twenty-four (24) hours before the bituminous seal coat is applied.

The surface shall be cleaned by vacuum sweeping, flushing or other means necessary to remove all vegetation, loose particles of paving, dirt, and other extraneous material. Vegetation shall be removed from cracks and at the interface between pavement and gutter prior to sweeping. Contractor may use high-pressure air (minimum 90 psi) to clean loose materials from cracks. Pavements impregnated with grease, oil, or fuel shall be thoroughly scrubbed with water and an approved detergent and then flushed and swept clean. Wash water shall be vacuumed and disposed of and shall not be allowed to enter the storm drain system. Contractor shall finally sweep the entire width of pavement from curb to curb until it is sufficiently clean to the satisfaction of the Engineer. Areas inaccessible to mechanical sweepers shall be manually swept. All debris shall become the property of Contractor and be disposed in accordance with Section 6-16, "Disposal Outside Project Limits," of the General Provisions. Pavement shall be completely dry immediately prior to the application of slurry seal.

10-1.9 Survey Monuments, Utility and Manhole Frames and Covers - The Contractor shall locate, protect and reference all manholes, valve covers, and survey monuments prior to construction. Immediately prior to applying the bituminous seal coat, all utility covers shall be protected with butcher paper or plastic with an appropriate adhesive, or by means approved by the Engineer. Protected facilities shall be uncovered and thoroughly cleaned of bituminous seal materials by the end of the same work day.

For double cape seals, the Contractor shall adjust all survey monuments boxes and City owned manhole covers to finished grade. Should the monument within the monument box require resetting, the it will be reset by the City at no expense to the Contractor.

Manholes, meters and valve covers not owned by the City shall be adjusted to grade by the utility owner involved and at the utility company's expense. It shall be the responsibility of the Contractor to notify affected utility companies and coordinate the work.

All manholes, survey monuments and water valve covers shall be thoroughly cleaned of any construction debris or markings resulting from the Contractor's operations.

10-1.10 Protection from Traffic - Where necessary to provide vehicular or pedestrian crossings over the fresh seal coat, the Engineer shall direct the spreading of sufficient sand to eliminate tracking or damage to the slurry mixture. Otherwise, Contractor shall provide barricades and flagmen to keep traffic off the fresh seal coat until it can accommodate vehicular traffic without damage.

10-2 SLURRY SEAL - Unless provided otherwise in the Special Provisions, slurry seal shall conform to the specifications herein. A bituminous seal coat shall be applied at all locations designated on the Contract Plans. All incidental work such as surfacing returns shall be done concurrently with surfacing of the street proper, and shall not be postponed for completion at a later date.

The slurry seal shall consist of a mixture of emulsified asphalt or polymer modified asphaltic emulsion, mineral aggregate, set-control additives, and water, properly proportioned, mixed and spread evenly on the surface of the existing pavement, as specified herein and as approved by the Engineer. The cured slurry shall have a homogeneous, asphalt-like appearance, fill all cracks, adhere firmly to the surface, and have skid-resistant texture. A latex modified asphalt emulsion shall be used to achieve this product.

10-2.1 Materials - Emulsion-aggregate slurry shall be a stable mixture of emulsified asphalt, mineral aggregate and water, which is intended for surface sealing pavements. The amount of emulsified asphalt shall be determined by the wet track abrasion test results and by trial laboratory mixes in accordance with ASTM D3910. The aggregate fractions and mineral filler shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets

the grading requirements of the job mix formula (JMF) below. The combined aggregate and filler shall be graded smoothly and shall not vary from the low limit on one sieve to the high limit on the adjacent sieve. The slurry seal mixture shall conform to the additional requirements as set forth herein.

10-2.1.1 Job Mix Formula (JMF) - At least ten (10) working days prior to the placement of the slurry seal the Contractor shall furnish the Engineer with a Job Mix Formula (JMF). The JMF prepared by the Contractor must represent materials that have been used within the previous six (6) months. The JMF shall indicate the:

- 1) Type and quantity of asphalt emulsion,
- 2) Quantity and type of chemical additive, or diluent,
- 3) Residual asphalt content, the water content,
- 4) Aggregate type and gradation,
- 5) Type and quantity of mineral filler,
- 6) Rate of application to fit Project conditions,
- 7) Abrasion loss aggregate from the wet track abrasion test,
- 8) Results of the consistency test.
- 9) Set time and cure time in accordance with ASTM D3910.
- 10) Temperature-viscosity relationship of the asphalt cement

When requested by the Engineer, samples of materials to be used on the job shall be submitted to the City.

The proposed slurry seal mixture shall conform to the requirements specified when tested in accordance with the following tests by the International Slurry Seal Association (ISSA):

Test	ISSA Test No.	Requirement
Slurry Seal Consistency	T106	20-30 mm
Wet Stripping	T114	Pass (90% min.)
Compatibility	T115	Pass ^(a)
Cohesion, kg-mm	T139	20 min. ^(b)
Wet Track Abrasion, g/ft ²	T100	75 (807g/m ²) max.

(a) *Mixing test must pass at the maximum expected air temperature at job site during application.*

(b) *Using project source aggregate, asphalt emulsion, and set-control agents.*

The laboratory that performed the test and mix design shall sign the original laboratory report. The report, as a minimum, shall show the results of the tests on individual materials, comparing the test results to those required by the specifications. The report shall clearly show the minimum and maximum proportions of; aggregate, filler, water, asphalt solids content (based on the dry weight of aggregate) and set-control agent usage. Previous laboratory reports covering the same materials may be accepted provided they were made within the previous six-(6) months.

No substitutions for the materials in the approved mix design shall be made without testing and the Engineers approved of revised JFM.

10-2.1.2 Consistency - The slurry seal mixture shall contain the minimum amount of water necessary to obtain the required consistency. When placing slurry seal on grades of 8 percent or greater, adjustments shall be made to the consistency of the mixture as approved by the Engineer.

10-2.1.3 Water - Water shall be clear, potable, and compatible with the slurry mixture, and shall be of such quality that the asphalt will not separate from the asphalt emulsion. If necessary for workability, a set-control agent that will not adversely affect the slurry seal may be used.

10-2.1.4 Latex Modified Asphalt Emulsion - The emulsified asphalt shall be a quick setting type, Grade - PMCQS1h cationic, conforming to the requirements set forth in the following table. Emulsion shall be homogeneous throughout and show no separation after thorough mixing. Emulsion shall break and set on the aggregate within five (5) minutes and shall be ready for cross-traffic within fifteen (15) to forty-five (45) minutes. Upon standing undisturbed for twenty-four (24) hours, it shall show no white or milky-color substance on its surface.

The emulsion shall conform to requirements for properties in the following table:

Tests	ASTM No.	Requirements
Emulsion		
Furol Viscosity, @ 77°F, sec.	D244	15 to 100
Residue from Distillation, % by Weight	D244	60 minimum
pH	D244	2 +/- 1
Residue		
Penetration 77°F, 100 g, 5 s	D5	45 to 80
Softening Point (Ring & Ball), °F	D36	130+
Ductility, 77°F, 5 cm/min (minimum)	D113	25
Fraass Breaking Point (°C)	DIN 52012	-18 min.

Asphalt emulsion shall constitute 12% to 18% by weight of dry aggregates in the job mix formula.

10-2.1.5 Aggregate - Aggregate shall consist of sound, durable, crushed stone or crushed gravel and approved mineral filler. The material shall be free from vegetation matter and other deleterious substances. Aggregate shall be 100% crushed with no rounded particles, volcanic in origin and black in color, as supplied by George Reed, Table Mountain Plant, Sonora, CA, or approved equal. The use of gray or light colored aggregate shall not be allowed. The Contractor shall submit aggregate samples for approval at least ten (10) working days prior to starting slurry seal operations. Aggregates shall conform to the following quality requirements:

Test	California Test Method	Requirements
Sand Equivalent	217	70 min.
Durability Index	229	75 min.
Percentage of Crushed Particles (Min) ¹	205	100%
Los Angeles Rattler Loss at 500 Rev. (Max) ²	211	35%

Notes:

1. CT205, Section D, is amended to read: "Any particle having 2 or more freshly, mechanically fractured faces shall be considered a crushed particle."
2. Los Angeles Rattler shall be performed on the parent aggregate before crushing.

Mineral fillers such as Portland Cement, limestone dust, and aluminum sulfate fly ash shall be considered as part of the blended aggregate and shall be used in minimum required amounts. Mineral fillers shall only be used if needed to improve the workability of the mix of gradation of the aggregate.

10-2.1.6 Gradation of Aggregate - The combined mineral aggregated shall conform to the following gradation.

Sieve Size	Percent Passing (CA Test 202)
3/8"	100
No.4	94-100
No.8	65-90
No. 16	40-70
No. 30	25-50
No. 50	-
No. 100	-
No. 200	5-15

Note: When the specific gravity between blends of different aggregates exceeds a difference of .02, CA Test 202 shall be modified by CA Test 105.

10-2.1.7 Accelerator or Retardant - The retardant shall be of the type stated in the JMF and approved by the Engineer. The amount of accelerator to be included in the mixture shall be the amount necessary to ensure the applied slurry can support vehicular traffic within four (4) hours after the last application.

10-2.1.8 Proportioning - Aggregate, asphalt emulsion, water and additives, including 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 used to produce the required gradation 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 slurry seal mixture shall be proportioned by the operation of a single stop/start switch or lever that automatically sequences the introduction of aggregates, asphalt emulsion, admixtures, and water to the pug mill. Calibrated flow meters shall be provided to measure both the addition of water and liquid additives. A retardant agent may be used if necessary for workability, provided that it will not adversely affect the seal coat.

The completed mixture, after addition of water and any set-control agent used, shall be such that the slurry seal mixture has proper workability and will:

- 1) Permit traffic, not controlled with pilot cars, on the slurry seal within three (3) hours after placement without the occurrence of bleeding, raveling, separation or other distress, and
- 2) Prevent development of bleeding raveling, separation or other distress with fifteen (15) days after days after placing the slurry seal.

10-2.2 NOT USED

10-2.3 Equipment - Only equipment conforming to these specifications shall be used in performance of the Work. All equipment shall be maintained in safe and satisfactory working condition for the entire duration of Work.

10-2.3.1 Mixer-Spreader Trucks - Contractor shall furnish and maintain a minimum of two operational mixing machines with a capacity of 12 cubic yards or larger. The mixing machine shall have sufficient storage capacity of aggregate, emulsified asphalt, and water to maintain an adequate supply to the proportioning controls. The slurry seal shall be mixed in a self-propelled mixing machine equipped with continuous flow, double-shafted, multi-blade pug mill mixer, capable of delivering and automatically proportioning the various material components. The mixer shall be capable of a minimum speed of 200 revolutions per minute.

The mixed slurry seal material retention time in the pug mill shall be less than three seconds. No retention of mixed slurry seal material shall be allowed within the pug mill by gate shut-off or other mechanical means. Any machine with pug mill retention or shut-off gates shall have them removed prior to being used on this project. The mixing machine shall be equipped with hydraulic controls for proportioning the material by volume to the mix. Each material control device shall be calibrated, properly marked, preset and lockable at the direction of the Engineer. The mixing machine shall be equipped with a water pressure system and nozzle type spray bars to provide a water spray immediately ahead of the spreader box.

The mixing machine shall be equipped with an approved fines feeder that provides a uniform, positive, accurately metered, predetermined amount of the mineral filler at the same time and location that the aggregate is fed.

Each mixing unit to be used in the performance of the work shall be calibrated in the presence of the Engineer prior to the start of the project. Previous calibration documentation covering the exact materials to be used will be acceptable, provided that no more than 60 calendar days have lapsed. The documentation shall include an individual calibration of each material at various settings that can be related to the machine metering devices. Any component replacement affecting material proportioning shall require the machine to be recalibrated. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

All rotation and reciprocating equipment on mixer-spreader trucks shall be covered with metal guards. The mixer-spreader truck shall not be operated unless all low-flow and no-flow warning devices and revolution counters are in good working condition and functioning and all metal guards are in place. The mixer-spreader truck shall be equipped with appropriate indicators that are visible while walking alongside the truck.

10-2.3.2 Spreader Box - The slurry mixture shall be uniformly spread by means of a controlled spreader box conforming to the following requirements:

- 1) The spreader shall be capable of spreading a traffic lane width 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 positively prevent loss of slurry from the box.
- 2) Spreader boxes over 7'-6" in width shall have baffles, reversible motor driven augers, or other suitable means, to ensure uniform application on super-elevated sections and shoulder slopes.
- 3) Spreader box skids shall be maintained in such manner as to prevent chatter (wash boarding) in the finish product.
- 4) Rear flexible strike-off blades shall make close contact with the pavement and shall be capable of being adjusted to the various crown shapes so as to apply a uniform slurry seal.
- 5) Flexible drags shall be attached to the rear of the spreader-box when necessary.

Slurry mixture to be spread in areas inaccessible to the controlled spreader box, may be spread by other methods approved by the Engineer.

All drags and strike-off blades shall be cleaned or changed as necessary to prevent problems with cleanliness and longitudinal scour. The spreader box shall be clean, free of all slurry seal and emulsion, at the start of each day. Slurry seal spreader box shall be wrapped in plastic or other suitable material to prevent slurry materials being dropped on the haul routes while in transit to and from the stockpile area or from one project street to another. Failure to comply with this requirement shall be grounds for suspension of work until corrective measures are implemented.

10-2.3.3 Cleaning Equipment - Power brooms, power blowers, air compressors, water flushing equipment, and hand brooms shall be suitable for cleaning the surface and cracks of the old pavement.

10-2.4 Application - The slurry seal shall be spread at the rate of 14 to 18 pounds of dry aggregate per square yard. For streets having received a chip seal, slurry seal shall be applied a minimum seven (7) days after the completion of chip seal.

The slurry mixture of the required consistency shall be uniformly spread on the existing surfacing, within the specified application rate, without segregation, spotting, streaking, excessive build-up, solidification of the asphalt, balling or lumping of the aggregates, unsightly appearance, unsightly joints, re-handling, or shifting of the mixture. Any material not meeting these requirements, or the presence of uncoated aggregates, shall be cause for rejection of the slurry seal.

The slurry seal mixture shall fill all minor cracks, depressions or low areas and leave a uniform surface free from ruts, humps, depressions, or irregularities. Any ridges, indentations, or other objectionable marks left in the surface shall be eliminated by rolling or other means. The mixture shall be uniform and homogeneous after spreading on the existing surface and shall not show separation of the emulsion and aggregate after setting. Unless approved otherwise by the Engineer longitudinal joints shall correspond with the edges of existing traffic lanes.

Asphalt impregnated building paper shall be placed at transverse joints, over previously placed slurry seal, or, other suitable methods shall be used to avoid double placement of slurry seal. Construction joints shall be neat in appearance and be tapered or feathered to conform to the existing adjacent surfaces.

Hand squeegees may be used to spread slurry in areas inaccessible to the slurry spreader. Care shall be exercised to leave no unsightly appearance from handwork. Burlap drags, or other suitable means, to even the surface and leave a rough texture of slurry applications shall be used as necessary.

Where the completed slurry is not uniform in color, the areas affected shall be treated to eliminate the color variation at the Contractor's expense. The method of treatment shall be as approved by the Engineer. At the direction of the Engineer and at the Contractor's expense, the Contractor shall repair and reseal all areas that have not been properly or completely sealed.

The Contractor shall exercise care to prevent slurry from being deposited on other surfaces. Slurry on surfaces not designated to be sealed shall be removed to the satisfaction of the Engineer at the Contractor's expense. Following application of the slurry seal, the Contractor shall protect the slurry seal from any traffic that may cause damage to the finished surface or result in tracking of the slurry material until such time as the material has sufficiently cured.

A sand blotter shall be spread at selected driveways, intersections and where required by the Engineer to accommodate pedestrian or vehicular traffic until slurry cures. The sand used shall be Lone Star Lupis Luster dried sand grades, #213, 2-

16, 16, 120 or an approved equal. Substitutes must be submitted for approval prior to use. Sand blotters at intersections shall be swept within fourteen (14) hours of placement or sooner if directed by the Engineer. If the City has the sand removed, the Contractor will be charged the cost of the removal and disposal.

Any slurry seal material that is spilled onto concrete gutter surfaces shall be removed on the same day the material was placed. Concrete surfaces that are stained due to spilled slurry materials shall be cleaned to the satisfaction of the Engineer.

Seal coats that show continuous or excessive raveling of aggregate shall be considered defective and rejected by the Engineer.

10-2.5 Rolling - The surface of the street shall be rolled by a self-propelled, 10-ton (maximum) pneumatic tire roller equipped with a water spray system. All tires shall be inflated per manufacturer’s specifications. Rolling shall not start until the seal coat has cured sufficiently to avoid damage by the roller. Areas which require rolling shall receive a minimum of two (2) full coverage passes.

10-2.6 Street Sweeping - Once the slurry seal has cured and is open to traffic, any excessive raveling of the aggregate from the seal coat shall be swept up by the Contractor. Sweeping shall continue until such time when the raveling ceases. Failure to provide adequate sweeping shall result in the City performing said work at the Contractor’s sole expense, which shall be deducted from any monies due to the Contractor under Contract. Sweeping by City shall not relieve the Contractor of any liability arising from his failure to comply with these provisions.

10-3 ASPHALT RUBBER (RUBBERIZED) CHIP SEAL

10-3.1 General - This section covers various processes for incorporation of reclaimed rubber into a bituminous seal coat. The method utilizes whole scrap tire rubber or similar rubber products. These specifications include the equipment, personnel, materials, and skills that are necessary to place an asphalt-rubber bituminous chip seal onto an existing asphalt concrete pavement in conformance with the Contract.

10-3.2 Materials - Only materials conforming to these specifications shall be incorporated in the work. Prior to their use, materials delivered to the site shall be inspected by the Engineer for contamination and damage. Materials shall be unloaded and stored with a minimum of handling. Aggregates shall be stored in such a manner to protect them from contamination and segregation. Storage sites shall be approved by Engineer in advance of Work.

10-3.2.1 General - The chip seal utilizes an asphalt rubber binder consists of a mixture of paving asphalt, asphalt modifier, and crumb rubber modifier (CRM). The exact proportions shall be in accordance with a job mix formula to be approved by Engineer.

10-3.2.2 Asphalt - Paving asphalt shall conform to Section 92, “Asphalts,” of the State Specifications and shall be steam refined paving asphalt, viscosity grade PG64-16.

The temperature of the paving asphalt and extender oil shall be between 350°F and 425°F at the time the rubber is added and reacted for a minimum of 45 minutes at this temperature to produce a product with the following properties:

Property	Applicable Test	Requirement
Viscosity at 400°F	ASTM E-102	1,500 min
Softening Point	R&B	120°F min
Flex Temperature	90 Bend Test	20°F max

The asphalt-rubber binder shall consist of between 78 and 82 percent paving asphalt, (including extender oil) and between 18 and 22 percent rubber (by weight to the total asphalt-rubber mixture).

The asphalt rubber mixture shall be spread as soon as possible after reaching the desired consistency. In the event a delay occurs when the product is ready to be applied, the heat will be turned off until the job resumes. The material shall not be held at temperatures over 400°F for more than 4 hours.

10-3.2.3 Asphalt Modifier - The asphalt modifier shall be a resinous, high flash point aromatic hydrocarbon meeting the following test requirements:

Test Parameter	Test No.	Requirement
Viscosity, SSU @ 100°F	ASTM D-88	1,500 min
Flash Point, COC, 0 °F	ASTM D-92	390 min
<u>Molecular Analysis:</u>		
Asphaltenes, % by weight	ASTM D-2007	0.1 max
Aromatics, % by weight	ASTM D-2007	55.0 min

The asphalt modifier shall be proportionately added to the paving asphalt at the production site where the asphalt rubber binder is blended and reacted. Asphalt modifier shall be added at an amount of 2.5 percent to 6.0 percent by weight of the paving asphalt based on the recommendation of the asphalt rubber binder supplier. The paving asphalt shall be at a temperature of not less than 375°F nor more than 440°F when the asphalt modifier is added. When the asphalt modifier is combined with the paving asphalt before being blended with the CRM, the combined paving asphalt and asphalt modifier shall be mixed by circulation for a period of not less than 20 minutes. This premixing of asphalt modifier and paving asphalt will not be required when all ingredients of the asphalt rubber binder are proportioned and mixed simultaneously.

10-3.2.4 Crumb Rubber Modifier (CRM) - Crumb rubber modifier (CRM) shall consist of a combination of scrap tire CRM and high natural CRM. The scrap tire CRM shall consist of ground or granulated rubber derived from any combination of automobile tires, truck tires, or tire buffings. The high natural CRM shall consist of ground or granulated rubber derived from materials that utilize high natural rubber sources. Contractor shall submit a Certificate of Compliance certifying that the asphalt rubber binder contains a minimum 15% by weight of crumb rubber derived from 100% California waste tires. Steel and fiber separation may employ any method. Cryogenic separation shall be performed separately from and prior to grinding or granulating. The CRM shall be produced by ambient temperature grinding processes only. Cryogenically produced CRM particles that pass through the grinder or granulator without being ground or granulated, respectively, shall not be used.

The gradation of the CRM, when tested in accordance with ASTM C136 and using a 50 gram \pm 1 gram sample, shall meet the following requirements:

Sieve Size	High Natural CRM % Passing	Scrap Tire CRM % Passing
No. 8	100	100
No. 10	100	90-100
No. 16	85-100	32-88
No. 30	20-90	1-30
No. 50	2-40	0-15
No. 100	0-10	0-10
No. 200	0-5	0-5

The use of rubber from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements. In addition to the above gradation requirements, the individual CRM particles, irrespective of diameter, shall not be greater in length than 3/16 inch.

CRM shall not contain more than 0.01 percent wire by weight of CRM and shall be free of other contaminants, except fabric. Fabric shall not exceed 0.05 percent by weight of CRM.

The CRM shall have a specific gravity of 1.1 to 1.2 as determined by California Test 208. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the blended paving asphalt and asphalt modifier mixture. Calcium carbonate or talc may be added at a maximum amount of 3 percent by weight of CRM to prevent CRM particles from sticking together. Scrap tire CRM and high natural CRM shall be delivered to the production site in separate bags and shall be sampled and tested separately. CRM material shall conform to the following requirements as determined by ASTM Designation D297:

Test Parameter	Scrap Tire CRM Percent		High Natural CRM Percent	
	Min	Max	Min	Max
Acetone Extract	6.0	16.0	4.0	16.0
Rubber Hydrocarbon	42.0	65.0	50.0	0.0
Natural Rubber Content	22.0	39.0	40.0	48.0
Carbon Black Content	28.0	38.0	0.0	0.0
Ash Content	0.0	8.0	0.0	0.0

10-3.2.5 Job Mix Formula (JMF) - The Contractor shall furnish the Engineer with a Job Mix Formula (JMF) for the chip seal. The JMF prepared by the Contractor must represent materials that have been used within the previous six-(6) months. The JMF shall be submitted at least ten (10) working days prior to the commencement of work. The JMF shall indicate the:

- 1) Source, grade of paving asphalt.
- 2) Source, quantity (as a percentage by weight of paving asphalt), and type of modifiers used.
- 3) Quantity of combined blend of paving asphalt and asphalt modifier as a percentage by total weight of asphalt-rubber binder mixture.
- 4) Minimum reaction time and temperature for asphalt rubber binder.
- 5) Aggregate source, type, gradation, and results of aggregate stripping characteristic tests.
- 6) Type and quantity of mineral filler.
- 7) Source and type of scrap tire and high natural crumb rubber modifier (CRM).
- 8) Quantity of scrap tire and high natural CRM as a percentage by total weight of the asphalt rubber binder mixture.
- 9) Results of all required laboratory tests specified in these provisions.

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. When requested by the Engineer, samples of materials to be used on the job shall be submitted to the City. If crumb rubber from more than one source is utilized, the above information will be required for each source. No substitutions for the materials in the approved JMF shall be made without testing and approval of the revised JMF by the Engineer.

The proportions of the materials, by total weight of asphalt rubber binder, shall be 79 percent ±1 percent combined paving asphalt and asphalt modifier, and 21 percent ±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 ±2 percent scrap tire CRM and 24 percent ±2 percent high natural CRM, by weight.

The paving asphalt and asphalt modifier shall be combined into a blended mixture that is chemically compatible with the crumb rubber modifier to be used. The blended mixture shall be considered to be chemically compatible when the mixture meets the requirements for asphalt rubber binder (after reacting) found in these provisions. 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 temperatures 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:

Test Parameter	ASTM Test Method	Requirements	
		Min	Max
Cone Penetration at 25°C, 1/10 mm	D217	25	60
Resilience at 25°C, Percent rebound	D5329	18	40
Field Softening Point, °C	D36	55	88
Viscosity @ 190°C, Pa*s(x10 ⁻³)	See Note	1500	2500

Note: The viscosity test shall be conducted using a hand held Haake Viscometer Model VT-02 with rotor 1, 24 mm depth x 53mm height, or equivalent. The reacted asphalt rubber binder shall be maintained at a temperature of not less than 190°C nor more than 219°C.

If a material in a batch of asphalt rubber binder is not used within six hours after the reaction period is complete, heating of the material shall be discontinued. When the asphalt rubber binder temperature cools below 375°F and is then reheated, it shall be considered a reheat cycle. The total number of reheat cycles shall not exceed two (2). The binder material shall be uniformly reheated to a temperature of not less than 375°F. Additional scrap tire CRM may be added to the reheated asphalt rubber binder and reacted for a minimum of 30 minutes and shall not exceed 10 percent of the total binder weight. Reheated asphalt rubber binder shall conform to the requirements in table above.

Certified Test Reports - The Contractor shall submit certified test reports stating that the asphalt, rubber and aggregates are in compliance with these specification.

Certificate of Compliance - The JMFC submittal shall be accompanied by Certificates of Compliance, indicating that materials to be incorporated in the work fulfill the requirements of these specifications. The material supplier or representative shall sign the Certificates of Compliance.

10-3.2.6 (Blank)

10-3.2.7 Screened Aggregate - The cover material shall be crushed stone, crushed gravel, or both, and shall consist of clean, sound, hard, and tough particles, free of soft or disintegrated fragments and foreign matter. At least 90 percent by weight of the screenings shall consist of crushed particles as determined by CA Test Method 205, and at least 90 percent by weight of the particles shall have at least two fractured faces.

Maximum aggregate size for the Chip Seal shall conform to the following gradation. Second lift applies only when a double chip seal is required.

Sieve Size	Percentage Passing	
	3/8" First Lift	1/2" Second Lift
5/8"	----	100
1/2"	100	95-100
3/8"	70-85	0-40
No.4	0-15	0-15
No.8	0-5	0-2
No. 16	----	----
No. 30	----	----
No. 200	0-1	0-1

Note: 3/8-inch gradation is not a Caltrans standard specification for a 9.5mm x 3.35mm (3/8-inch x #6) chip. Second lift applies only when specified in Contract.

Aggregate screenings shall also conform to the following requirements:

Test	Results
Loss in L.A. Rattler, per CA Test Method 211 (after 100 revolutions)	10% max
Loss in L.A. Rattler, per CA Test Method 211 (after 500 revolutions)	40% max
Film Stripping, per CA Test Method 302	25% max
Cleanness Value, per CA Test Method 227	80 min
Durability, per CA Test Method 229	52 min

Screened aggregate shall be of such nature that a thorough coat of the bituminous material used in the work will not strip off upon contact with water. The moisture content of the aggregate shall be such that the aggregate will be readily coated with the bituminous material. Drying may be required, as approved.

All screenings shall be preheated to a temperature between 260°F and 325°F and then pre-coated with paving-grade asphalt applied at a rate of 0.5 to 1.0 percent of paving asphalt by weight of dry aggregate. The pre-coating of aggregate shall be performed in an asphalt concrete plant.

Dusty screenings will be rejected. Stockpiling of screening after preheating and pre-coating will not be permitted.

Canvas or similar covers that completely cover each load of pre-coated aggregate shall be used during to minimize temperature drop of the pre-coated aggregate. Aggregate shall be spread when the temperature of the pre-coated aggregate is not less than 225°F.

Contractor shall arrange with the batch plant to coordinate the pre-coating application such that only coated chips are produced. Experience has shown that if a load of asphalt is produced in the same drum, the next load of chips will contain excessive dust and fine material, and shall be cause for rejection of the load. The drum shall also be cleaned of all fine material prior to commencing the pre-coating operations.

No single aggregate grading of cleanness value test shall represent more than 300 tons or one day’s production, whichever is smaller. Representative samples for grading requirements will be taken prior to pre-coating with paving asphalt. Representative samples for cleanness value test shall be taken immediately prior to preheating the material.

10-3.3 Equipment - Only equipment conforming to these specifications shall be used for the Work. All equipment shall be maintained in safe and satisfactory working condition at all times. The Engineer reserves the right to order the discontinuance of use of any equipment that fails to produce a satisfactory distribution of asphalt rubber in accordance with these Specifications.

A minimum of two (2) truck mounted, self-powered distributor units shall be used. Tractor-trailer spreader units may be allowed based on field conditions as determined by the Engineer. Each unit is to be equipped with a hot oil heating unit to heat the asphalt to the required temperature for blending with the rubber, a mixing unit capable of producing a homogeneous mixture of asphalt and rubber, pumps capable of spraying asphalt rubber within a tolerance ± 0.03 gallons per square yard of the specified rate, and a fully circulating spray bar capable of applying asphalt rubber without a streaked or otherwise irregular pattern. The spray bar shall be equipped with a set of controls so that the asphalt rubber application may be controlled by a “bootman”. The “bootman” shall accompany the distributor and ride in a position so that all spray bar nozzles are in his full view and readily accessible for unplugging. The distributor units shall also be equipped with a tachometer, pressure gauges, volume measuring devices, computerized rate control, and a temperature gauge.

A minimum of three operational self-propelled pneumatic-tired rollers shall be used for the required rolling of the material. The pneumatic-tired rollers shall carry a minimum loading of 3,000 pounds on each wheel and a minimum air pressure of 100 pounds per square inch in each tire.

10-3.4 Application - Where not specified in these Technical Provisions, application shall conform to Section 37-2.03F, “Applying Emulsion,” 37-2.03G, “Spreading Screenings,” and 37-2.03H, “Finishing,” of the State Specifications.

10-3.4.1 (Blank)

10-3.4.2 (Blank)

10-3.4.3 Application of Asphalt Rubber Material - Placement of the asphalt rubber shall be permitted only under the following conditions:

- 1) The pavement surface temperature is 55°F and rising.
- 2) The pavement surface is clean and dry.
- 3) The ambient temperature is 65°F or above, and the wind conditions are not excessive as determined by the Engineer.
- 4) All construction equipment such as asphalt rubber distributor, cover, material spreader, haul trucks with cover material, and rollers are in position and ready to commence asphalt rubber placement operations.

The asphalt rubber mixture shall be applied at a minimum temperature of 360°F at a rate of 0.55 to 0.65 gallons per square yard, or at a rate necessary to completely fill all existing pavement cracks and spalls; whichever is greater. The distribution shall not vary more than 15 percent transversely from the average as determined by tests and not more than 10 percent longitudinally from the specified rate of application, as determined by California Test 399.

Upon commencing spray distribution, the distribution bar height, speed, and shielding materials shall be utilized to reduce the effects of wind as directed by the Engineer.

Transverse joints shall be constructed by placing building paper across and over the end of the previous asphalt-rubber application. Once the spraying has progressed beyond the paper, the paper shall be removed and disposed of immediately. All longitudinal joints shall not exceed a four-inch overlap.

The asphalt rubber shall not be applied until sufficient screenings are on hand for immediate cover. The maximum placement width in any pass shall be no more than one-half the street width on residential streets, and one-half the street width plus adjacent parking strip on commercial streets. The remainder of the street shall be placed only after the first section has completely cured as required.

The asphalt rubber shall not be spread a greater distance than can be covered within fifteen (15) minutes by aggregate screenings.

10-3.4.4 Spreading of Screened Aggregates - Cover aggregates shall be spread immediately and uniformly over the asphalt rubber at a spreading rate of 26 to 30 pounds per square yard. At the time of spreading, the temperature of the pre-coated screenings shall be not less than 225°F, and shall be surface dry so as to gain proper adhesion to the asphalt-rubber material.

The screening spreader shall not be more than fifty (50) feet behind the asphalt rubber binder distribution truck. Operating the aggregate-spreading equipment at speeds which cause the chips to roll over after striking the asphalt rubber surface shall not be permitted.

Trucks for hauling screenings shall be tailgate discharge and 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 of a bed which results in screenings spilling while dumping into the receiving hopper. Trucks hauling screenings shall be kept clear of the freshly placed screenings until ready to dump materials in the spreader equipment.

A minimum one-foot-wide strip shall be swept with a self-propelled kick broom along the edge of the roadway prior to chip sealing the next lane. All loose aggregate shall be pushed back onto the lane just chip sealed. All reasonable efforts shall be made to prevent skips and overlapping, double-thickness joints. Joints shall be neat and uniform in appearance, true to the lines shown on the Plans and established by the Engineer. The joint between adjacent applications of aggregates shall coincide with the line between designated traffic lanes, and shall not overlap by more than four (4) inches. Adjacent applications shall be blended by brooming. The transverse cut off of screenings shall be complete and any excess screenings shall be removed from the surface prior to resuming operations.

10-3.4.5 Compacting and Finishing - After the screenings have been spread upon the asphalt rubber, any piles, ridges, or uneven aggregate distribution shall be carefully removed to prevent permanent ridges, bumps or

depressions in the completed surface before the surface is rolled. Additional screenings shall be spread in whatever quantities necessary to prevent picking up by the rollers or traffic.

At least three (3) operational pneumatic-tired rollers complying with the requirements of Section 10-3.3, "Equipment," of these Technical Provisions shall be provided to accomplish the required embedment of the aggregates.

Sufficient rollers shall be used in tandem for the initial rolling to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the aggregate spreader, with the distance between the rollers and the spreader not exceeding 200 feet at any given time during the spreading operations. If the spreading is stopped for an extended period, the aggregate spreader shall be moved ahead or off the side, so that all aggregates may be rolled immediately. Four complete passes with pneumatic-tired rollers shall be made with all rolling completed within one hour after the application of the cover aggregates. A steel wheel roller rated 12 tons minimum shall be used to make a finish rolling pass following the pneumatic-tired rollers.

The completed surface shall present a uniform appearance and shall be thoroughly compacted. The surface shall be free from ruts, humps, depressions, and irregularities due to an uneven distribution of asphalt rubber or aggregate screenings.

Where a "Double Cape Seal" has been specified, the second lift shall be applied a minimum of twenty-four (24) hours after the aggregates for the first lift are placed. All loose aggregates shall be swept prior to application.

10-3.4.6 Sweeping - A minimum of three (3) self-propelled power brooms shall be used. Brooms shall be capable of cleaning the pavement and removing loose screenings without dislodging screenings set in the asphalt rubber mixture. Gutter brooms or steel-tined brooms shall not be used.

Sweeping of loose aggregates shall begin within one (1) hour after placement of chip seal and shall be completed as soon as possible, prior to allowing uncontrolled traffic on the road surface. Excess screenings shall be removed and disposed of by the Contractor, in accordance with Section 6-16, "Disposal outside the Project Limits," of the General Provisions, at the Contractor's expense. Two brooms shall be used within the street receiving the chip seal, and a third shall directly follow the chip seal operations to clean the surrounding streets and adjacent surfaces to sweep up the tracking of loose materials. Water shall not be used on streets receiving chip seals on the day that the chip seals would be placed.

In areas not accessible by broom sweepers, such as cul-de-sacs, Contractor shall remove loose debris using other means acceptable to the Engineer, such as a vacuum sweeper.

Subsequent to the placement of chip seals, three (3) additional sweepings shall be performed. The first sweeping shall be done one day after placement of the chip seal, the second 2 days after placement of the chip seal, and the final sweeping shall occur 7 days after placement of the chip seal, just prior to placing the slurry seal or micro-surfacing, if any. The Contractor shall spray water on these subsequent sweepings for dust control. Excess screenings shall be removed from the job site and disposed of by the Contractor. At the end of each day's sweeping operations, the Contractor shall remove any and all remaining loose materials from sidewalks, landscaped areas, and adjacent properties manually or by any other means acceptable to the Engineer.

10-3.4.7 Set and Cure Time - Except when it is necessary for hauling equipment to travel on the newly applied chip seal, traffic of all types shall be kept off the surface until it has had time to set properly. The speed of all hauling equipment shall not exceed 15 miles per hour when traveling over a chip seal which is not adequately set. The minimum traffic-free period shall not be less than one (1) hour, unless otherwise allowed by the Engineer.

10-4 MODIFIED ASPHALT RUBBER BINDER CHIP SEAL

10-4.1 General - This section covers a modified blend of rubberized chip seal specified in Section 10-3 of these Technical Provisions. Use of Modified Asphalt Rubber Binder Chip Seal shall be allowed if specified by the Project Special Provisions.

10-4.2 Materials -

10-4.2.1 Modified Asphalt Rubber Binder - At least ten (10) working days prior to beginning Contract Work, Contractor shall submit a binder formulation to the Engineer for review and approval. Modified binder shall be terminally blended PG76-22TR. Field blending of modified binder shall not be allowed. A Certificate of Compliance shall be furnished to the Engineer certifying that the binder conforms to the following requirements:

Property	AASHTO Test Method	Test Requirement
Original Binder		
Flash Point, Minimum °C	T48	230
Solubility, Minimum %	T44 ^c	97.5
Viscosity at 135 °C, Maximum, Pa*s	T316	3.0
Dynamic Shear, Test Temp at 10 rad/s, °C Minimum $G^*/\sin(\delta)$, kPa	T315	76 1.00
RTFO Test, Mass Loss, Maximum, %	T240	1.00
RTFO Test Aged Binder		
Dynamic Shear, Test Temp at 10 rad/s, °C Minimum $G^*/\sin(\delta)$, kPa	T315	76 2.20
Dynamic Shear, Test Temp at 10 rad/s, °C Maximum (δ) , %	T315	Note f 80
Elastic Recovery ^b , Test Temp, °C Minimum recovery, %	T301	25 65
PAV ^h Aging, Temperature, °C	R28	110
RTFO Test and PAV Aged Binder		
Dynamic Shear, Test Temp at 10 rad/s, °C Minimum $G^*/\sin(\delta)$, kPa	T315	31 5000
Creep Stiffness Test Temperature, °C Maximum S-value, MPa Minimum M-value	T313	-12 300 0.300

Notes:

- a. Do not modify binder using acid modification.
- b. Supplier is required to certify the inclusion of 15% minimum California scrap tire rubber modifier in binder.
- c. ASTM D5546 may be used instead of AASHTO T44.
- d. Test temperature is the temperature at which $G^*/\sin(\delta)$ is 2.2 kPa. A graph of $\log G^*\sin(\delta)$ plotted against temperature may be used to determine δ at the temperature when $G^*/\sin(\delta)$ is 2.2 kPa. The Engineer also accepts direct measurement of (δ) at the temperature when $G^*\sin(\delta)$ is 2.2 kPa.
- e. Tests without a force ductility clamp may be performed.
- f. "PAV" means Pressurized Aging Vessel.

The percentage of tire rubber, by weight, of the total modified binder shall be 15%. Rubber shall consist of 100% California scrap tire rubber and shall consist of ground or granulated rubber derived from any combination of automobile tires and truck tires. Use of tire buffing shall not be permitted. The source and identification of scrap tire rubber and percentage of scrap tire rubber by total weight of the modified binder shall be indicated on the Certificate of Compliance.

10-4.2.2 Screened Aggregates - Aggregates shall conform to Section 10-3.2.7 of these Technical Provisions.

10-4.3 Application - Work shall conform to the entire Section 10-3.4, "Application," for Asphalt Rubber Chip Seal, except where specifically modified herein.

The binder shall be applied at a rate from 0.35 gallon to 0.45 gallon per square yard. The exact rate shall be as approved by the Engineer. Binder shall be applied at a temperature between 330°F and 375 °F. Pavement temperature shall be at least 55°F.

Screenings shall be spread at a rate of 28 to 32 pounds per square yard. The exact rate shall be as approved by the Engineer.

10-5 MICRO-SURFACING

10-5.1 General - This section covers the installation of a micro-surfacing seal coat on existing pavement. Micro-surfacing is an application of a mixture of micro-surfacing emulsion, water, additives, mineral fillers, and aggregates. These specifications include equipment, personnel, materials, and skills that are necessary to complete Work conforming to the Contract.

10-5.2 Materials

10-5.2.1 Micro-Surfacing Emulsion (MSE) - Emulsion shall be homogenous and be milled or blended into the asphalt or blended into the emulsifier solution prior to the emulsification process. The MSE shall conform to the following requirements when tested in conformance with the following test methods:

Polymer Modified Cationic MSE

<u>Specification</u>	<u>Method of Test</u>	<u>Requirement</u>
Viscosity, SSF, @ 77° F, sec	AASHTO T 59	15-90 Secs.
Sieve, Max	AASHTO T 59	0.30 Percent
Settlement, 5 days, max.	ASTM D244	5 Percent
Storage Stability, 1 day, max.	AASHTO T 59	1 Percent
Residue by Evaporation, min.	California Test 331	62 Percent
<u>Tests on Emulsified Asphalt Residue</u>		
Penetration, 77°F, 100g, 5s, 0.1mm	AASHTO T 51	40-90
Softening Point (Ring-and Ball Apparatus), Min	AASHTO T53	135°F (57°C)

10-5.2.2 Aggregates and Mineral Fillers - Aggregates and mineral fillers shall be based on a laboratory mix design submitted for approval by the Engineer prior to beginning of work. Both shall conform to Section 10-2.1.5 and 10-2.1.6 of these Technical Provisions. Mineral fillers shall be considered a part of the aggregate gradation.

10-5.2.3 Water - Water shall be of such quality that the asphalt will not separate from the MSE before the micro-surfacing is placed on the pavement. If necessary for workability, a set-control agent that will not adversely affect the micro-surfacing product may be used.

10-5.2.4 Mix Design - At least ten (10) 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 to be used 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, with adjustments made based on field conditions:

Residual Asphalt:	5.5% to 10.5% by dry weight of aggregate
Polymer Solids:	3% Minimum based on bitumen weight content
Mineral Filler:	0% to 3% by dry weight of aggregate

Additive:	As needed
Water:	As needed

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:

<u>TEST</u>	<u>ISSA TEST METHOD</u>	<u>REQUIREMENT</u>
Wet Cohesion @30 Minute (Set)(Min.) @60 Minute (Traffic)(Min.)	Technical Bulletin (TB) 139	12 kg-cm 20 kg-cm
Excess Asphalt (Max)	TB109	540 g/m ²
Wet Stripping (Min.)	TB114	90%
Wet Track Abrasion 6-day Soak Loss (Max)	TB100	810 g/m ²
Displacement Lateral (Max)	T147A	5%
Specified Gravity After 1000 Cycles of 125 lbs (56.8 kg)(Max)		2.10
Classification Compatibility	TB144	11 Grade Points Minimum (AAA,BAA)
Mix Time @77°F(25°C)	TB113	Controllable to 120 Seconds

The laboratory that performs the tests and designs the mixture shall sign the laboratory report. The report shall show the results of the tests on individual materials and shall compare their values to those required by these provisions. The report shall clearly show the proportions of aggregate, filler (minimum and maximum), water (minimum and maximum), set control additive, and MSE solids content (minimum and maximum) based on the dry mass of aggregate. The laboratory shall report the quantitative effects of moisture content on the unit mass 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 mix design shall further show the recommended changes in mineral filler, water, and additive proportions for high temperature weather conditions by reporting proportions of materials required for 60 seconds of mix time with materials heated to 100 °F (38°C). This 100 °F (38°C) mixing report will not be required for projects requiring nighttime application.

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 materials 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 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 Section 6-12, "Traffic Control," of the General Provisions of the Standard Specifications, or as otherwise required by the Special Provisions; the micro-surfacing mixture shall be sufficiently cured to support unrestricted traffic.

10-5.2.5 Proportioning and Related Equipment - Aggregate, mineral filler, MSE, 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 aggregates is used, the correct amount of each kind of aggregates 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 aggregates shall be proportioned using a belt feeder operated with an adjustable cutoff gate. The height of the gate opening shall be determinable. The MSE 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 California Test 109 prior to usage.

The delivery rate of aggregates and MSE 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 California Test 109 and in conformance with the provisions of these special provisions.

The aggregate belt feeder shall deliver aggregates to the pugmill 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 (3) tons (or tonnes) each. The emulsion and water pumps shall deliver MSE and water, respectively, to the pugmill with such volumetric consistency that the deviation for any individual delivery rate of MSE or water check-run shall be within 2.0 percent of the mathematical average of 3 runs of at least 300 gallons (1135 L) each.

The MSE 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 MSE 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 MSE and shall be accurate to within 10°F (5°C).

The belt delivering the aggregate to the pugmill shall be equipped with a device to monitor the depth of aggregates being delivered to the pugmill. The device for monitoring the depth of aggregates shall automatically shut down the power to the aggregate belt feeder whenever the depth of aggregates 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.

10-5.3 Equipment - The micro-surfacing shall be mixed in continuous pugmill 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 provisions and shall be in working order prior to commencing mixing and spreading operations.

10-5.3.1 Mixing and Spreading Equipment - Mixer-spreader trucks shall be equipped to proportion the MSE, 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.

Each mixing unit to be used in the performance of the work shall be calibrated in the presence of the Engineer prior to the start of the project. Previous calibration documentation covering the exact materials to be used will be acceptable, provided that no more than 60 calendar days have lapsed. The documentation shall include an individual calibration of each material at various settings that can be related to the machine metering devices. Any component replacement affecting material proportioning requires that the machine be recalibrated. No machine will be allowed to work on the project until the calibration has been completed and/or accepted.

10-5.3.2 Spreader Box - The micro-surfacing mixture shall be spread by a spreader box conforming to the following provisions. Failure to comply with these specifications shall be grounds for suspension of work in accordance with Section 8-3 of the General Provisions of the Standard Specifications, until corrective measures are implemented.

1. The spreader box shall be capable of placing the micro-surfacing 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.
2. Spreader boxes over eight (8) feet in application width shall have baffles, reversible motor driven augers or other suitable means to insure uniform application on superelevated sections and shoulder slopes.
3. Spreader box skids shall be maintained in such manner as to prevent chatter (wash boarding) in the finished mat.
4. The spreader box in use shall be clean and free of micro-surfacing and MSE at the start of each work shift.
5. 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 suitable for the intended use and shall be designed and operated to ensure that 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.
6. Flexible fabric drags attached to the rear of the spreader box shall not be used.
7. Micro-surfacing spreader box shall be wrapped in plastic or other suitable material to prevent micro-surfacing materials being dropped on the haul routes while in transit to and from the stockpile area or from one Project street to another.

10-5.4 Placing - Micro-surfacing shall be spread at the rate of 14-18 lbs. of dry aggregate per square yard. The micro-surfacing mixture shall be uniformly spread on the existing surfacing within the rate range specified without spotting, rehandling, or otherwise shifting of the mixture. On streets specified for a cape seal, micro-surfacing shall be placed a minimum of seven (7) calendar days after the completion of the chip seal.

The micro-surfacing mixture shall not be placed when the ambient temperature is below 50 °F (10°C) 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.

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 three (3) inches. Building paper shall be placed at the transverse joints, or Contractor may request the Engineer to approve another effective method, to avoid double placement of the micro-surfacing. 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 MSE 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. Any micro-surfacing material that is spilled onto concrete gutter surfaces shall be removed on the same day the material was placed. Concrete surfaces that are stained due to spilled materials shall be cleaned to the satisfaction of the Engineer.

10-5.5 Rolling - Rolling shall conform to Section 10-2.5 of these Technical Provisions.

10-5.6 Sweeping - Sweeping shall conform to Section 10-2.6 of these Technical Provisions.

10-5.7 Repair of Early Distress - If bleeding, raveling, delamination, rutting, or washboarding occurs within sixty (60) days after placing the micro-surfacing, Contractor shall diligently pursue repairs by any method approved by the Engineer. While pursuing repair options, Contractor shall continually maintain the area having received micro-surfacing to ensure public safety and roadway cleanliness. The Contractor shall not be relieved from maintenance of the micro-surfacing surface until repairs have been completed. Inability to provide a satisfactory repair shall be

ground for the Engineer rejecting the micro-surfacing as defective work. The Engineer's decision shall be final regarding satisfactory repairs and determination of defective work.

10-6 TESTING BY THE CITY - At the discretion of the Engineer, he may take samples of individual materials or composite materials to be incorporated in the work at any time, at the point of application or production. Samples may be tested for conformance to the JMF or other material specifications. The Contractor will be notified within five (5) working days of the results of any tests performed.

10-7 TOLERANCES - Tolerances for individual materials, as well as the bituminous seal coat mixtures, are as follows:

- 1) After the designed residual point asphalt content is determined, a one percentage point (1%) variation will be permitted.
- 2) The percent of aggregate passing each sieve shall not vary more than 4.0% from the Job Mix Formula (JMF).
- 3) The percent of aggregate passing shall not go from the high end to the low of the specified range of any two successive sieves.
- 4) The slurry consistency shall not vary more than 0.5 cm from the JMF after field adjustments.
- 5) The average rate of application of the chip seal mixture shall not be less than the specified rate when measured for any contiguous area of 5,000 square feet. When the total theoretical volume of chip seal mixture is less than that calculated at the minimum application rate, the contract price shall be reduced proportionately.

10-8 MEASUREMENT - Measurement for bituminous seal coats shall be measure by the square foot, square yard, or square meter of surface completed as shown and specified to the nearest whole unit. No deduction will be made for manhole or utility covers. No measurement will be made for bituminous seal coat placed outside the limits of work or not furnished and installed according to specifications.

10-9 PAYMENT - The contract unit price shall include full compensation for all furnishing all labor, equipment, materials, tools, testing, furnishing mix design, and incidentals required to construct the bituminous seal coat, (Slurry Seal, Micro Surfacing, and Chip Seal) including but not limited to; mobilization, site preparation, traffic control, cleanup, posting of notices, masking and cleaning of pavement markers, adjusting and protecting utility and manhole covers, applying the seal coats as specified, and all other incidental work required to complete the work as shown on the Project Plans, as specified in the Specifications, and as directed by the Engineer, and no additional compensation shall be made therefor.