

SPECIFICATION FOR

ASPHALT RUBBER CHIP SEAL (SAM) WITH EMULSIFIED ASPHALT FLUSH COAT

1. DESCRIPTION

GENERAL

This project shall consist of a bituminous surface Stress Absorbing Membrane (SAM) composed of a single application of Asphalt-Rubber material and hot pre-coated 3/8" aggregate. Pre-maintenance (crack sealing and patching) of the existing pavement surface will be recommended by Contractor and approved by the Engineer.

This specification requires the application of a specified blend of asphalt-rubber binder material (i.e. a field blend product). This specification expressly determines that the asphalt-rubber binder material specified herein (i.e. a field blend product) and modified binder, rubber modified asphalt or PG 76-22TR (i.e. terminal blend products) are sufficiently different such that they are not functionally equivalent. Therefore, any substitutions for the asphalt-rubber binder material specified herein, such as but not limited to any rubber modified asphalt binder (i.e. a terminal blend product) will not be accepted.

2. MATERIAL COMPONENTS

2.1 ASPHALT CEMENT

The type and grade of PG asphalt cement utilized to manufacture the Asphalt Rubber binder shall be PG 58-22, PG 64-16, or PG 70-10 which shall comply with requirements in Table #1.

Table #1 – PG Asphalt Cement Grading Requirements

Climate	PG Grading
Cold	PG 58-22
Moderate	PG 64-16
Hot	PG 70-10

- *The exact grade of PG asphalt cement, if different than PG 64-16, shall be determined by the Asphalt Rubber supplier dependant on the specific project requirements.*

2.2 GRANULATED RECLAIMED TIRE RUBBER

The CRM shall be produced primarily from the processing of whole automobile and truck tires. The rubber shall be produced by ambient temperature grinding processes only. The gradation of the CRM when tested in accordance with ASTM C-136 (dry sieve only) and using a 100 gram sample, shall meet the requirements in Table #2.

Table #2 - CRM Grading Requirements

Sieve Size	Reclaimed Tire CRM Percent Passing
#8 (2.36 mm)	100
#10 (2 mm)	95 - 100
#16 (1.18 mm)	45 - 75
#20 (. mm)	---
#30 (600 μm)	2 - 20
#50 (300 μm)	0 - 10
#200 (75 μm)	---

The use of CRM from multiple sources is acceptable provided that the overall blend of rubber meets the gradation requirements.

The individual CRM particles, irrespective of diameter, shall not be greater in length than 3/16 of an inch (5mm).

The CRM shall have a specific gravity of 1.15 ± 0.05 as determined by, and shall be free of loose fabric, wire and other contaminants except that up to 4 percent (by weight of rubber) calcium carbonate or talc may be added to prevent the rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce a foaming problem when blended with the hot asphalt cement. The CRM shall be accepted by certification from the approved supplier. The Reclaimed Tire CRM material shall conform to the chemical analysis in Table # 3.

Table #3 - Reclaimed Tire CRM Chemical Requirements

Test	ASTM Test Method	Minimum	Maximum
Acetone Extract	D 297	6.0 %	16.0 %
Ash Content	D 297	----	8.0 %
Carbon Black Content	D 297	28.0 %	38.0 %
Rubber Hydrocarbon	D 297	42.0 %	65.0 %
Natural Rubber Content	D 297	22.0 %	39.0 %

Note: All reclaimed tire rubber CRM shall be certified to have originated in California, and the CRM material will also be certified to have been processed in California, through invoice and bill of lading.

2.3 ASPHALT RUBBER BINDER

The temperature of the blended PG asphalt cement shall not be less than 375° F nor more than 450° F when the CRM is homogeneously blended, in the field. The combined materials shall be reacted for a minimum of 45 minutes after the incorporation of all the CRM. The Asphalt Rubber binder shall meet the requirements in Table #4, when the reaction/interaction is complete.

Table #4 - Specification Limits for (Asphalt Rubber Binder)

		Hot Climate	Moderate Climate	Cold Climate
Apparent viscosity, 347° F Spindle 3 @ 12 RPM: cps (ASTM D2669)	Min	1500	1500	1500
	Max	3500	3500	3500
Cone Penetration, 77° F (25° C), 150g, 5 sec; 1/10 dm (ASTM D217)	Min	15	20	25
	Max	40	70	100
Softening Point, °F (° C) (ASTM D36)	Min	170° F (77° C)	160° F (71° C)	150° F (66° C)
Resilience, 77° F (25° C), % (ASTM D3407)	Min	45	35	25

The viscosity shall be conducted by using a hand-held HAAKE VISCOMETER, with rotor 1, 24mm in depth x 53mm in height, or equivalent. When applying Asphalt Rubber, the reacted Asphalt Rubber binder shall be maintained at a temperature of not less than 375° F and no more than 425° F. If 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 applying Asphalt Rubber, if the Asphalt Rubber binder temperature cools below 300° 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 materials shall be uniformly reheated to a temperature of not less than 320° F for application. Additional scrap tire CRM may be added to the reheated Asphalt Rubber binder and reacted for a minimum of 45 minutes and shall not exceed 10 percent of the total binder weight. Reheated Asphalt Rubber binder shall conform to the requirements for blended Asphalt Rubber binder.

2.4 ASPHALT RUBBER BINDER FORMULATION

The Asphalt Rubber binder supplier, shall furnish to the Engineer within 15 days of the notice to proceed, the Asphalt Rubber binder formulations which shall contain the following information:

PG Asphalt Cement

Source of PG Asphalt

Grade of PG Asphalt

Percentage of PG Asphalt by total weight of the Asphalt Rubber mixture

Reclaimed Tire Rubber (CRM)

Source of CRM

Grade of CRM

Percentage of CRM by total weight of the Asphalt Rubber mixture

2.5 AGGREGATE COVER MATERIAL

Aggregate shall be composed of clean and durable crushed rock or crushed gravel conforming to the following requirements:

If the aggregate is to be crushed stone, it shall be manufactured from sound, hard, durable material of accepted quality and crushed to specification size. All strata, streaks and pockets of clay, dirt, sandstone, soft rock or other unsuitable material accompanying the sound rock shall be discarded and not allowed to enter the crusher.

If the aggregate material is to be crushed gravel, it shall consist of hard, durable fragments of stone or gravel of accepted quality and crushed to specification size. All strata, streaks, pockets of sand, excessively fine gravel, clay or other unsuitable material including all stones, rocks and boulders of inferior quality shall be discarded and not allowed to enter the crusher. The crushing of the gravel shall separate the #4, 3/8 and 1/2 inch sieves and shall have a minimum 95% of the particles with a minimum of one mechanically fractured face and 90% of the particles shall have a minimum of two mechanically fractured faces.

The crushed aggregate or crushed gravel shall not contain more than 8% by weight of flat or elongated pieces and shall be free from wood, roots and vegetable or other organic extraneous matter. The 3/8 inch crushed aggregate or crushed gravel shall have a minimum Cleanness Value (CV) of 80 and shall have a percentage of wear not more than 7 percent at 100 revolutions and not more than 30 percent at 500 revolutions, as determined by ASTM C131 or California Test Method 211.

The crushed aggregate for Asphalt Rubber binder applications shall meet the requirements for gradation given in Table 5.

If the aggregate material is to be from Recycled Asphalt Pavement (RAP) it shall be produced by crushing asphalt concrete pavement, free of detrimental quantities of deleterious materials, and have a minimum sand equivalent of 80 when tested in accordance with California Test 217. Grading shall conform to the requirements shown in Table 5.

Table 5 - Aggregate Gradation Requirements –Asphalt Rubber

3/8 inch Asphalt Rubber Aggregate Gradation	
Sieve Size	Percent Passing
1/2 inch (12 mm)	95-100
3/8 inch (9 mm)	70 – 85
1/4 inch (4.75 mm)	0 – 15
#8 (2.36 mm)	0 – 5
#200 (75 µm)	0 – 1
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The aggregate to be utilized shall be hot pre-coated with 0.5 to 1.0 percent PG asphalt cement. The Engineer shall determine the appropriate amount of pre-coat. At no time shall the bag house fines be allowed to be reintroduced back into the hot coated aggregate. The pre-coated aggregate shall have a “salt and pepper” appearance and shall be supplied to the project site at 225° F to 325° F. When Recycled Asphalt Pavement (RAP) is used as aggregate, it shall not be preheated or precoated with asphalt.

2.6 FLUSH COAT

Applying a flush coat includes applying a fog seal coat followed by sand. Emulsion for Flush Coat shall be CSS1-h.

CSS1h Slow-Setting Cationic Asphaltic Emulsion Requirements

Quality Characteristic	Test Method	Requirement
Saybolt Furol viscosity, @ 25 °C (Saybolt Furol Seconds)	AASHTO T 59	20–100
Settlement, 5 days (max, %)		5
Storage stability test, 1 day (max, %) ^a		1
Particle charge test		Positive ^b
Sieve test (max, %)		0.10
Cement mixing test (max, %)		2.0
Residue by distillation (min, %)		57
Tests on residue from distillation test:		
Penetration, 25 °C		40–90
Ductility, 25 °C, 50 mm/minute (min, mm)		400
Solubility in trichloroethylene (min, %)		97.5

^aThe 24-hour storage stability test may be used instead of the 5-day settlement test.

^b Must comply with a pH requirement of 6.7 maximum under ASTM E70 if the particle charge test result is inconclusive.

At least 15 days before use, submit:

1. Proposed target X values for sand gradation.
2. Gradation test results for sand

Submit quality control test results for sand gradation within 3 business days of sampling.

Flush coat acceptance is based on fog seal acceptance and the following:

1. Visual inspection for uniform application of sand.
2. Sand acceptance is based on the Department's sampling and testing for compliance with the requirements shown in the following table:

Sand Gradation Acceptance Criteria

Quality characteristic	Test method	Requirement
Gradation (% passing by weight)	California Test 202	
Sieve size:		
3/8"		100
No. 4		93–100
No. 8		61–99
No. 16		X ± 13
No. 30		X ± 12
No. 50		X ± 9
No.100		1–15
No. 200		0–10

NOTE: "X" is the gradation that you propose to furnish for the specific sieve size. Sand must be free from deleterious coatings, clay balls, roots, bark, sticks, rags, and other extraneous material. Sand for a flush coat must comply with the gradations shown in the table above.

3. EQUIPMENT

3.1 GENERAL

The equipment used by the contractor for pavement cleaning and excess aggregate removal shall include operational top dumping pick-up brooms.

3.2 ASPHALT RUBBER EQUIPMENT

All equipment utilized in the production and application of AR binder material shall be described as follows:

- a) A PG asphalt cement heating tank with a hot oil heat transfer system or a retort heating system capable of heating the PG asphalt cement to the proper temperature for blending with the CRM.
- b) An Asphalt Rubber mechanical blender shall have a two-stage continuous mixing process capable of producing a homogenous blend of PG asphalt cement and CRM, at the mix design specified ratios, as directed by the engineer. The mechanical blender shall be equipped with a granulated rubber feed system capable of supplying the PG asphalt cement feed system, as not to interrupt the continuity of the blending process. The maximum capacity of the primary blending vessel shall be 500 gallons. Both the primary and secondary blenders shall be equipped with an agitation device orientated vertically in the blending vessel. The mechanical blender shall be capable of fully blending the individual modifier particles (CRM) with the PG asphalt cement. A separate PG asphalt cement feed pump and finished product pump are required. This unit shall have a PG asphalt cement totalizing meter in gallons and a flow rate meter in gallons per minute.
- c) A distributor truck equipped with a heating unit, and an internal mixing device capable of maintaining a uniform mixture of PG asphalt cement and CRM. It shall be equipped with a full circulating spreader bar and pumping system capable of applying the Asphalt Rubber binder material within a 5% tolerance of the specified application rate, and must achieve a uniform covering of the surface to be treated. The distributor shall have a boot board on the rear of the vehicle and a bootman shall accompany the distributor. The bootman shall ride in a position so that all the spray bar tips are in full view and readily assessable for unplugging, if a plugged tip should occur. The distributor truck shall also require a thermometer and a computer rate control (CRC)

3.3 AGGREGATE COVER MATERIAL SPREADER

The cover material (chip) spreader shall be a self-propelled machine with an aggregate receiving hopper in the rear, belt conveyors to carry the pre-coated aggregate to the front, and a full width spreading hopper. The spreader shall be in good mechanical condition and shall be capable of applying the cover aggregate uniformly across the spread width and at the specified application rate, and heat-treated belts should be installed on the chip spreader.

3.4 ROLLING EQUIPMENT

Sufficient rollers shall be used to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the aggregate spreader as the aggregate is being placed. Three (3) complete passes with the pneumatic tire rollers shall be made. The pneumatic-tired rollers shall carry a minimum loading of 3,000 pounds on each wheel and a minimum pressure of 90 pounds per square inch in each tire. Foam filled tires can be utilized.

3.5 HAULING EQUIPMENT

Trucks for hauling the pre-coated cover aggregate shall be tailgate discharge and shall be equipped with a device to lock onto the hitch of the cover material spreader. Haul trucks shall also be compatible with the cover aggregate 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 aggregate spillage while dumping into the receiving hopper.

4. **CONSTRUCTION METHODS**

4.1 GENERAL

Immediately prior to the application of the Asphalt Rubber binder chip seal application, the surface shall be clean in order to insure adequate adhesion of the Asphalt Rubber to the existing pavement surface.

4.2 WEATHER CONDITIONS

Asphalt Rubber binder material shall be applied only when the existing surface is dry and the atmospheric temperature is at least 65° F and rising. No material shall be applied when predicted chance of rain is higher than 75 % or when the wind is in excess of 20 mph, as directed by the Engineer.

4.3 ASPHALT RUBBER BINDER - MIXING AND REACTION

Concerning the Asphalt Rubber binder, the percentage of Reclaimed Tire Rubber CRM shall be a minimum of 18 percent by weight of the total Asphalt Rubber mixture; the exact CRM content shall be determined by the binder design submitted by the Asphalt Rubber supplier. During Asphalt Rubber binder manufacture the CRM percentage shall not fluctuate by more than 1 (one) percent by weight of total Asphalt Rubber mixture, as determined by the original laboratory binder design.

The temperature of the PG asphalt cement shall be between 375° F and 450° F at the addition of the CRM. The PG asphalt cement, CRM shall be combined and mixed together in the Asphalt Rubber binder, and reacted in the distributor truck or a reaction vessel for a minimum period of 45 minutes from the time the CRM is blended with the PG asphalt cement. The temperature of the Asphalt Rubber binder shall be above 375° F during the reaction period, but shall not exceed 425° F at any time.

When a job delay occurs after full reaction, the Asphalt Rubber binder may be allowed to cool. For application, the Asphalt Rubber binder shall be re-heated slowly just prior to application to a temperature between 375° F and 425° F. An additional quantity of PG asphalt cement and/or CRM may be added to only to Asphalt Rubber binder as required to produce a material with the appropriate viscosity.

4.4 APPLICATION OF ASPHALT RUBBER BINDER

Placement of the Asphalt Rubber shall proceed only under the following conditions:

- a) The atmospheric temperature shall be at least 65° F and rising.
- b) The pavement surface temperature shall be at least 65° F and rising.
- c) The pavement surface is clean and dry.
- d) The wind conditions do not exceed 20 mph.
- e) All of the construction equipment such as the Asphalt-Rubber distributor, aggregate spreader, haul trucks loaded with cover material, rollers and brooms are in position and ready to commence placement operations.
- f) Chance of rain does not exceed 75%.

Asphalt Rubber binder shall be applied to the roadway following the mixing, reacting and blending of Asphalt Rubber binder at a rate of 0.55 to 0.65 gallons per square yard.

Distributor bar height, tip size, distribution, speed and shielding materials shall be utilized to reduce the effects of excess wind upon the spray distribution (fan), of each binder. The Engineer shall delay or reschedule work when high gusting or dusty winds in excess of 20 mph prevent or adversely affect binder or aggregate application.

The application of Asphalt Rubber binder to areas not accessible with the distributor bar on the distributor truck shall be accomplished by using a squeegee or other means approved by the Engineer.

The contractor shall comply with all Federal, State and Local environmental laws, regulations and ordinances.

4.5 APPLICATION OF AGGREGATE COVER MATERIAL

The 3/8 inch cover material shall be applied immediately onto the Asphalt Rubber membrane at a rate of 28 to 32 pounds per square yard. The actual rate selected within this range will be determined in the field based on the appearance of the Asphalt Rubber chip seal after initial rolling.

At the time of application, the temperature of the aggregate shall range from 225° F to 325° F. If Recycled Asphalt Pavement (RAP) is used as aggregate, this does not apply.

4.6 ROLLING

Sufficient rollers shall be used for the initial rolling to cover the width of the aggregate spread with one pass. The first pass shall be made immediately behind the cover material spreader (chip-box) as the aggregate is being placed. If the spreading is stopped for an extended period, the cover material spreader (chip-box) shall be moved ahead or off the chip seal surface so that all cover material may be immediately rolled. Three complete passes shall be made with the pneumatic rollers. If a steel wheel roller is used, the pneumatic tire rollers shall be operated in front of the steel wheel roller.

4.7 SWEEPING

Sweeping shall be a multi-step operation following final rolling of the aggregate. Mechanical pickup brooms shall be used to remove loose material without dislodging the aggregate set in the Asphalt-Rubber. The initial sweeping shall be performed within one-hour from the start of the Asphalt-Rubber Chip Seal placement.

The Asphalt-Rubber Chip Seal placement shall be maintained free of loose screenings for a minimum of two working days following placement. During this period, the surface shall be swept as necessary to remove any loose cover material as directed by the Engineer. Final sweeping shall be completed, and all loose aggregate shall be removed prior to acceptance. The sweeping operations shall be accomplished with the use of nylon gutter brooms. The number of sweepers shall be determined by the amount of production for the day. One operational sweeper shall be working for every 10,000 square yards of chip seal placed for the day. Therefore, if a contractor is intending to perform 30,000 square yards per day, a minimum of 3 operated sweepers shall be used throughout the construction process.

Immediately upon opening the street to traffic, the Contractor shall start removing loose aggregate from parkways, sidewalks, and intersecting streets. Both operations shall continue until all excess or loose aggregate is removed from the roadway surface and abutting adjacent areas.

4.8 FLUSH COAT

For Asphalt Rubber SAM Chip Seal applications, a fog seal or flush coat shall be applied during the same day of the placement of the Asphalt Rubber SAM. The surface shall be dry and free of loose material at the time of application. This timeframe may be extended by the Engineer when weather and / or traffic conditions are not favorable. The flush coat shall not be applied when the surface is wet or when there is threat of rain. The ambient temperature shall be a minimum of 70° F (21° C) and rising, with constant sunshine.

Asphaltic emulsion shall be grade CSS1, CSS1H or CQS1H diluted 50/50 with water shall be used for the flush coat. Immediately before applying the emulsion, the area to be flushed shall be cleaned of all loose aggregate and foreign material. This will be accomplished by power brooms or pick-up brooms, supplemented by hand brooms.

The diluted asphalt emulsion shall be well mixed before application and shall be applied by a distributor truck, in sound mechanical condition, at a rate of 0.10 to 0.20 gallons per square yard, allowing for a residual after the emulsion “breaks” of 0.03 to 0.06 gallons per square yard.

4.9 SAND COVER

Sand cover material, if required, shall conform to the fine aggregate grading requirements of the specifying agency.

Sand shall be spread by means of a self-propelled chip spreader equipped with a computerized device that will allow for application of the sand at a uniform rate over the full width of a traffic lane in a single application. Sand shall be spread at a rate of 2 to 4 pounds per square yard. The exact rate will be determined by the Engineer. If approved by the Engineer other equipment may be used to spread the sand.

4.10 TRAFFIC CONTROL

The speed of the hauling equipment shall not exceed 15 miles per hour when traveling over a membrane that has not had sufficient time to properly set. All barricades, signage and traffic control procedures for the traveling public shall follow current MUTCD (Manual on Uniform Traffic Control devices) standards.

5.0 METHOD OF MEASUREMENT

Asphalt Rubber Binder

The Asphalt Rubber binder shall be measured by the square yard at the specified application rate for Asphalt Rubber binder and approved by the Engineer.

Cover Aggregate Material

The quantity of the cover aggregate material shall be measured by the square yard and approved by the Engineer.

Flush Coat

The emulsified asphalt material, diluted 50/50, shall be measured by the square yard at the specified application rate for Emulsified binder and approved by the Engineer.

Sand Cover

The quantity of the sand cover material (**if required**) shall be measured by the square yard and approved by the Engineer.

6.0 BASIS OF PAYMENT

Payment shall be made at the contract unit price per square yard for Asphalt Rubber binder application and the cover aggregate material per square yard. The emulsified asphalt flush coat shall also be paid for by the square yard at the specified application rate. The sand cover for the flush coat / fog seal (if needed) shall be at the contract unit price per square yard.

These prices shall be full compensation for furnishing all materials and for all preparation, hauling and application of the materials, including labor, equipment, tools and incidentals necessary to complete the item.