APPENDIX E
Specifications
a) Caltrans

Latest AR specifications (including notes to designers) can be found on the Caltrans website
http://www.dot.ca.gov
10-1. ASPHALT-RUBBER SEAL COAT

Asphalt-rubber seal coat shall consist of an application of asphalt-rubber binder and screenings precoated with paving asphalt. Asphalt-rubber seal coat shall conform to the provisions specified for seal coats in Section 37-1, "Seal Coats," of the Standard Specifications and to these special provisions.

GENERAL

Attention is directed to "Order of Work" and "Damage Claims" of these special provisions regarding placement of asphalt-rubber seal coat. Attention is directed to "Flush Coat" of these special provisions regarding application of a fog seal coat and sand cover over asphalt-rubber seal coat.

The Contractor shall furnish a Certificate of Compliance to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for each material used in the asphalt-rubber binder and the asphalt-rubber binder mixture. When requested by the Engineer, the Contractor shall also submit samples with the Certificates of Compliance. The Contractor shall provide the Engineer a Material Safety Data Sheet (MSDS) for each of the constituent components of the asphalt-rubber binder and for the completed mixture of the asphalt-rubber binder.

The Contractor shall provide a Certificate of Compliance for each truck load of crumb rubber modifier (CRM), paving asphalt, and asphalt modifier delivered to the project. The Quality Control Program used by the manufacturer of each ingredient shall include a sampling and testing frequency as shown below:

A. CRM shall be tested except for the grading requirement, at least once for every 225 tonnes with a minimum of once per project. CRM shall be tested for grading for every truck load delivered to the project.
B. Paving asphalt shall be tested at least once for every 180 tonnes of production with a minimum of once per project.
C. Asphalt modifier shall be tested at least once for every 23 tonnes of production with a minimum of once per project.
D. A copy of the laboratory test results for the test parameters specified in these special provisions for CRM, paving asphalt, and asphalt modifier shall be submitted to the Engineer with the Certificate of Compliance for each truck load of individual material delivered to the project.

Certified volume or mass slips shall be delivered to the Engineer for materials supplied.

On multilane roads, the maximum length of asphalt-rubber seal coat operations at any one location, including pilot-car-assisted traffic control shall be limited to ___ kilometers. The minimum space between successive seal coat operations on adjacent lanes in the same direction of travel shall be ___ kilometers.

PAVING ASPHALT

Paving asphalt to be used in the asphalt-rubber binder shall be AR-4000 and shall conform to the provisions in Section 92, "Asphalts," of the Standard Specifications and these special provisions.
The paving asphalt for use in asphalt-rubber binder shall be modified with an asphalt modifier.

**ASPHALT MODIFIER**

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

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, m²/s (10⁻⁶) at 100°C</td>
<td>D 445</td>
<td>X ± 3*</td>
</tr>
<tr>
<td>Flash Point, CL.O.C. °C</td>
<td>D 92</td>
<td>207 min.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Molecular Analysis</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltenes, percent by mass</td>
<td>D 2007</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>Aromatics, percent by mass</td>
<td>D 2007</td>
<td>55 min.</td>
</tr>
</tbody>
</table>

* The symbol "X" is the viscosity of the asphalt modifier the Contractor proposes to furnish. The value "X" which the Contractor proposes shall be between the limits 19 and 36 and shall be submitted in writing to the Engineer. Any proposed change, requested by the Contractor, in the value "X" shall require a new asphalt-rubber binder design.

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 mass 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 190°C nor more than 226°C when the asphalt modifier is added. If 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. Asphalt modifier and paving asphalt shall be measured for proportioning with meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications.

**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.

Steel and fiber separation shall be accomplished by any method. Cryogenic separation, if utilized, shall be performed separately from and prior to grinding or granulating.

CRM shall be ground or granulated at ambient temperature. Cryogenically produced CRM particles that pass through the grinder or granulator without being ground or granulated, respectively, shall not be used.

CRM shall not contain more than 0.01-percent wire (by mass of CRM) and shall be free of other contaminants, except fabric. Fabric shall not exceed 0.05-percent by mass of CRM. The test and method for determining the percent by mass of wire and fabric is available at the Transportation Laboratory, Office of Pavement Consulting Services, Sacramento, California, Telephone (916) 227-7300, and will be furnished to interested persons upon request. A
certificate of compliance certifying these percentages shall be furnished to the Engineer in
conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard
Specifications.

The length of an individual CRM particle shall not exceed 4.75 mm.

The CRM shall be sufficiently dry so that the CRM will be free flowing and will not produce
foaming when combined with the blended paving asphalt and asphalt modifier mixture. Calcium
carbonate or talc may be added at a maximum amount of 3 percent by mass of CRM to prevent
CRM particles from sticking together. The CRM shall have a specific gravity of between 1.1
and 1.2 as determined by California Test 208. 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: D 297:

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>SCRAP TIRE CRM</th>
<th>HIGH NATURAL CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Acetone Extract</td>
<td>6.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>42.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Natural Rubber content</td>
<td>22.0</td>
<td>39.0</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>28.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Ash Content</td>
<td>—</td>
<td>8.0</td>
</tr>
</tbody>
</table>

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

A. Split or quarter 100 g ± 5 g from the CRM sample and dry to a constant mass at a
temperature of not less than 57°C nor more than 63°C and record the dry sample mass. Place the CRM sample and 5.0 g of talc in a 0.5-L jar. Seal the jar, then shake the jar by
hand for a minimum of one minute to mix the CRM and the talc. Continue shaking or
open the jar and stir until particle agglomerates and clumps are broken and the talc is
uniformly mixed.

B. Place one rubber ball on each sieve. Each ball shall have a mass of 8.5 g ± 0.5 g, have a
diameter of 24.5 mm ± 0.5 mm, and shall have a Shore Durometer "A" hardness of 50 ± 5
in conformance with the requirements in ASTM Designation: D 2240. After sieving the
combined material for 10 minutes ±1 minute, disassemble the sieves. Material adhering
to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the
mass of the material retained on the 2.36-mm sieve and leave this material (do not
discard) on the scale or balance. Observed fabric balls shall remain on the scale or
balance and shall be placed together on the side of the scale or balance to prevent the
fabric balls from being covered or disturbed when placing the material from finer sieves
onto the scale or balance. The material retained on the next finer sieve (2.00-mm sieve)
shall be added to the scale or balance. Weigh and record that mass as the accumulative
mass retained on that sieve (2.00-mm sieve). Continue weighing and recording the
accumulated masses retained on the remaining sieves until the accumulated mass retained
in the pan has been determined. Prior to discarding the CRM sample, separately weigh
and record the total mass of fabric balls in the sample.

C. Determine the mass of material passing the 75-µm sieve (or mass retained in the pan) by
subtracting the accumulated mass retained on the 75-µm sieve from the accumulated
mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass of 5 g or less, cross out the recorded number for the accumulated mass retained in the pan and copy the number recorded for the accumulated mass retained on the 75-µm sieve and record that number (next to the crossed out number) as the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass greater than 5 g, cross out the recorded number for the accumulated mass retained in the pan, subtract 5 g from that number and record the difference next to the crossed out number. The adjustment to the accumulated mass retained in the pan is made to account for the 5 g of talc added to the sample. For calculation purposes, the adjusted total sample mass is the same as the adjusted accumulated mass retained in the pan. Determine the percent passing based on the adjusted total sample mass and record to the nearest 0.1 percent:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>SCRAP TIRE CRM</th>
<th>HIGH NATURAL CRM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent Passing</td>
<td>Percent Passing</td>
</tr>
<tr>
<td>2.36-mm</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2.00-mm</td>
<td>98-100</td>
<td>100</td>
</tr>
<tr>
<td>1.18-mm</td>
<td>45-75</td>
<td>95-100</td>
</tr>
<tr>
<td>600-µm</td>
<td>2-20</td>
<td>35-85</td>
</tr>
<tr>
<td>300-µm</td>
<td>0-6</td>
<td>10-30</td>
</tr>
<tr>
<td>150-µm</td>
<td>0-2</td>
<td>0-4</td>
</tr>
<tr>
<td>75-µm</td>
<td>0</td>
<td>0-1</td>
</tr>
</tbody>
</table>

ASPHALT-RUBBER BINDER

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

At least 2 weeks before its intended use, the Contractor shall furnish the Engineer 4 one liter cans filled with the asphalt-rubber binder proposed for use on the project. The Contractor shall supply the Engineer, for approval, a binder formulation and samples of all materials to be used in the asphalt-rubber binder, at least 2 weeks before construction is scheduled to begin. The binder formulations shall consist of the following information:

A. Paving Asphalt and Modifiers

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

B. Crumb Rubber Modifier (CRM)

1. Source and identification (or type) of scrap tire and high natural CRM.
2. Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend.
3. If CRM from more than one source is used, the above information will be required for each CRM source used.
4. Laboratory test results for test parameters shown in these special provisions.

C. Asphalt-Rubber Binder

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

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

The proportions of the materials, by total mass of asphalt-rubber binder, shall be 80 percent ± 2 percent combined paving asphalt and asphalt modifier and 20 percent ± 2 percent CRM. However, the minimum amount of CRM shall not be less than 18.0 percent. Lower values shall not be rounded up. The CRM shall be combined at the production site and shall contain 75 percent ± 2 percent scrap tire CRM and 25 percent ± 2 percent high natural CRM, by mass.

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 special 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 190°C nor more than 226°C 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 190°C nor more than 218°C. The temperature shall not be higher than 6°C below the actual flash point of the asphalt-rubber binder.

After reacting, the blended asphalt-rubber binder shall conform to the following requirements:
BLENDED ASPHALT-RUBBER BINDER

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone Penetration @ 25°C, 1/10 mm</td>
<td>D 217</td>
<td>Minimum: 25</td>
</tr>
<tr>
<td>Resilience @ 25°C, Percent rebound</td>
<td>D 3407</td>
<td>Minimum: 18</td>
</tr>
<tr>
<td>Field Softening Point, °C</td>
<td>D 36</td>
<td>Minimum: 52</td>
</tr>
<tr>
<td>Viscosity @ 190°C, Pa • s (x10^-3)</td>
<td>See Note</td>
<td>Minimum: 1500</td>
</tr>
</tbody>
</table>

NOTE: The viscosity test shall be conducted using a hand held Haake Viscometer Model VT-02 with Rotor 1, 24 mm depth x 53 mm height, or equivalent, as determined by the Engineer. The accuracy of the viscometer shall be verified by comparing the viscosity results obtained with the hand held viscometer to 3 separate calibration fluids of known viscosities ranging from 1000 Pa to 5000 Pa • s (x10^-3). The viscometer will be considered accurate if the values obtained are within 300 Pa • s (x10^-3) of the known viscosity. The known viscosity value shall be based on the fluid manufacturer's standard test temperature or the test temperature versus viscosity correlation table provided by the fluid manufacturer. All viscometers used on the project shall be verified to be accurate. The test method for determining the viscosity of asphalt-rubber binder using a hand held viscometer is available at the Transportation Laboratory, Office of Pavement Consulting Services, Sacramento, California, Telephone (916) 227-7300. The accuracy verification results shall be provided to the Engineer and shall be certified by a Certificate of Compliance. The Certificate of Compliance shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.

The Contractor shall provide a Haake Viscometer, or equivalent, at the production site during the combining of asphalt-rubber binder materials. The Contractor shall take viscosity readings of asphalt-rubber binder from samples taken from the distributor truck a minimum of 45 minutes after incorporation of the CRM. Readings shall be taken at least every hour with not less than one reading for each batch of asphalt-rubber binder. The Contractor shall log these results, including time and asphalt-rubber temperature. A copy of the log shall be submitted to the Engineer on a daily basis. As determined by the Engineer, the Contractor shall either notify the Engineer at least 15 minutes prior to each test or provide the Engineer a schedule of testing times.

The reacted asphalt-rubber binder shall be maintained at a temperature of not less than 190°C nor more than 218°C.

If any of the material in a batch of asphalt-rubber binder is not used within 4 hours after the 45-minute reaction period, heating of the material shall be discontinued. If the asphalt-rubber binder cools below 190°C and is then reheated, it shall be considered a reheat cycle. The total number of reheat cycles shall not exceed 2. The material shall be uniformly reheated to a temperature of not less than 190°C nor more than 218°C prior to use. Additional scrap tire CRM may be added to the reheated binder and reacted for a minimum of 45 minutes. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder mass. Reheated asphalt-rubber binder shall conform to the requirements for blended asphalt-rubber binder.

c screens shall conform to the provisions in these special provisions and in Section 37-1.02, "Materials," of the Standard Specifications, except that the third, fourth, eighth, and ninth paragraphs of Section 37-1.02 shall not apply.

Stockpiling of screenings after preheating and precoating with paving asphalt will not be permitted.
Canvas or similar covers that completely cover each load of precoated screenings shall be used during hauling to minimize temperature drop of the precoated screenings.

Screenings shall conform to the following grading requirements prior to precoating with paving asphalt:

<table>
<thead>
<tr>
<th>SCREENINGS GRADING REQUIREMENTS 9.5-mm Maximum</th>
<th>Sieve Sizes</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5-mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>9.5-mm</td>
<td>70-85</td>
<td></td>
</tr>
<tr>
<td>4.75-mm</td>
<td>0-15</td>
<td></td>
</tr>
<tr>
<td>2.36-mm</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>75-µm</td>
<td>0-1</td>
<td></td>
</tr>
</tbody>
</table>

Screenings shall conform to the following grading requirements prior to precoating with paving asphalt:

<table>
<thead>
<tr>
<th>SCREENINGS GRADING REQUIREMENTS 12.5-mm Maximum</th>
<th>Sieve Sizes</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-mm</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>12.5-mm</td>
<td>95-100</td>
<td></td>
</tr>
<tr>
<td>9.5-mm</td>
<td>70-85</td>
<td></td>
</tr>
<tr>
<td>4.75-mm</td>
<td>0-15</td>
<td></td>
</tr>
<tr>
<td>2.36-mm</td>
<td>0-5</td>
<td></td>
</tr>
<tr>
<td>75-µm</td>
<td>0-1</td>
<td></td>
</tr>
</tbody>
</table>

Screenings shall conform to the following quality requirements immediately prior to preheating:

<table>
<thead>
<tr>
<th>SCREENINGS QUALITY REQUIREMENTS</th>
<th>Test Parameters</th>
<th>California Test</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Los Angeles Rattler Loss (100 Revolutions)</td>
<td>211</td>
<td>10 Max.</td>
</tr>
<tr>
<td></td>
<td>Los Angeles Rattler Loss (500 Revolutions)</td>
<td>211</td>
<td>40 Max.</td>
</tr>
<tr>
<td></td>
<td>Film Stripping</td>
<td>302</td>
<td>25 Max.</td>
</tr>
<tr>
<td></td>
<td>Cleanness Value</td>
<td>227</td>
<td>80 Min.</td>
</tr>
<tr>
<td></td>
<td>Durability</td>
<td>229</td>
<td>52 Min.</td>
</tr>
</tbody>
</table>

Screenings for asphalt-rubber seal coat shall be preheated to between 127°C and 163°C and uniformly coated at a rate of 0.7 percent to one percent of grade AR-4000 paving asphalt by mass of dry aggregate at a central mixing asphalt concrete plant which has been approved in conformance with the requirements in California Test 109. The exact rate will be determined by the Engineer.

**EQUIPMENT**

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

A. Self-propelled power brooms that clean the existing pavement and remove loose screenings without dislodging screenings set in the asphalt-rubber binder. Gutter brooms or steel-tinned brooms shall not be used;
B. Pneumatic tired rollers conforming to the provisions in Section 39-5.02, "Compacting Equipment," of the Standard Specifications, except that the rollers shall have an air pressure of 690 KPa and maintained so that the air pressure will not vary more than ±35 KPa in each tire. A sufficient number of rollers shall be used so that one complete coverage will be provided in one pass;

C. A self-propelled screenings spreader, equipped with a screenings hopper in the rear, belt conveyors to carry the screenings to the front, and a spreading hopper equipped with full-width distribution auger and spread roll. The screenings spreader shall be capable of providing a uniform screening spread rate over the entire width of the traffic lane in one application;

D. An asphalt heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ±3°C and shall be of the recording type;

E. A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier, and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer through meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications. The blending system shall vary the rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than ±14°C. The paving asphalt feed, the asphalt modifier feed, and CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Meters used for proportioning individual ingredients shall be equipped with rate-of-flow indicators to show the rates of delivery and resettable totalizers so that the total amounts of liquid ingredients introduced into the mixture can be determined. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced. The Contractor shall provide a safe sampling device that delivers a representative sample of the completed asphalt-rubber binder of sufficient size to permit the required tests;

F. An asphalt-rubber binder storage tank equipped with a heating system to maintain the proper temperature of the asphalt-rubber binder and an internal mixing unit that maintains a homogeneous mixture of blended paving asphalt, asphalt modifier, and CRM;

G. A self-propelled truck or trailer mounted distributor, equipped with an internal mixing unit that maintains a homogeneous mixture of blended paving asphalt, asphalt modifier, and CRM. The distributor shall have a pump or pumps that sprays asphalt-rubber binder within ±0.25 L/m² of the specified rate. The distributor shall have a fully circulating spray bar that applies the asphalt-rubber binder without a streaked or otherwise irregular pattern. The distributor shall be equipped with a tachometer, pressure gages, volume measuring devices, and thermometer. The distributor shall have a platform on the rear of the vehicle and an observer shall accompany the distributor. The observer shall ride in
such a position that all spray nozzles are in full view and readily accessible for unplugging plugged nozzles, should plugging occur; and

H. Tailgate discharge trucks for hauling screenings shall be equipped with a device to lock onto the hitch at the rear of the screenings spreader. Haul trucks shall be compatible with the screenings spreader so that the dump bed will not push down on the spreader when fully raised or have too short a bed which results in screenings spilling while dumping into the receiving hopper.

Equipment shall be approved by the Engineer prior to use.

**APPLYING ASPHALT-RUBBER BINDER**

Asphalt-rubber binder shall be applied in conformance with the provisions specified for applying asphaltic emulsion in these special provisions and in Section 37-1.05, "Applying Asphaltic Emulsion," of the Standard Specifications, except that the second, third, fourth, fifth, ninth, and twelfth paragraphs of Section 37-1.05 shall not apply.

Asphalt-rubber binder for asphalt-rubber seal coat shall be applied where shown on the plans at a rate of 2.5 L/m$^2$ to 3.0 L/m$^2$. The exact rate will be determined by the Engineer.

Attention is directed to Section 7-1.11, "Preservation Of Property," of the Standard Specifications and "Existing Highway Facilities" of these special provisions regarding protecting highway facilities from seal coat.

Asphalt-rubber binder shall be placed upon a clean, dry surface. The pavement surface temperature shall be a minimum of 13°C where asphalt-rubber binder is to be applied. The atmospheric temperature shall be a minimum of 16°C.

Distributor bar height, distribution speed, and shielding materials shall be utilized to reduce the effects of wind upon spray distribution as directed by the Engineer. The Engineer will delay or reschedule work when high, gusting or dirty winds prevent or adversely affect binder or screening application operations. Necessary equipment shall be in position and ready to commence placement operations before starting.

The Contractor shall comply with Federal, State, and Local environmental laws, rules, regulations, and ordinances including, but not limited to, air quality requirements.

The asphalt-rubber binder shall be applied to the roadway immediately following mixing and reacting and shall be applied at a temperature not less than 196°C nor more than 213°C. Asphalt-rubber binder application shall not be in excess of that which can be covered with screenings within 2 minutes.

When placing asphalt-rubber seal coat at intersections, left turn lanes, gore points, and other irregular areas, asphalt-rubber application shall not be in excess of that which can be covered with screenings within 15 minutes.

When joining edges against areas with screenings, the joint shall be swept clean of excess screenings prior to the adjacent application of asphalt-rubber binder. Transverse joints of this type shall be constructed by placing roofing paper across and over the end of the previous asphalt-rubber seal coat application. Once the spraying has progressed beyond the paper, the paper shall be removed immediately.

The longitudinal joint between adjacent applications of screenings shall coincide with the line between designated traffic lanes. Longitudinal joints shall be overlapped for complete coverage. The overlap shall not exceed 100 mm.
At longitudinal joints with screenings, the edge shall be broomed back and blended to eliminate differences in elevation. The joints shall be free from ridges and depressions and shall have a uniform appearance consistent with the adjacent sealed surface. Defects shall be corrected at the Contractor's expense.

Joints between areas of asphalt-rubber binder without screenings shall be made by overlapping asphalt-rubber binder distributions. The excess material shall be properly dispersed by spreading with a squeegee or rake over a larger area of freshly applied asphalt-rubber binder.

The application of asphalt-rubber binder to areas not accessible with the distributor bar on the distributor truck shall be accomplished by using pressurized hand wands or other means approved by the Engineer.

**SPREADING SCREENINGS**

Screenings for asphalt-rubber seal coat shall be spread in conformance with the provisions specified for spreading screenings on asphaltic emulsion in these special provisions and in Section 37-1.06, "Spreading Screenings," of the Standard Specifications, except that the first, fifth, sixth, and seventh paragraphs of Section 37-1.06 shall not apply.

Following the application of the asphalt-rubber binder, screenings shall be placed over areas receiving asphalt-rubber binder.

Screenings for asphalt-rubber seal coat shall be applied at a temperature not less than 107°C and not more than 163°C after applying asphalt-rubber binder.

The Contractor shall prevent any vehicle, including construction equipment, from driving on the asphalt-rubber binder prior to application of screenings.

Screenings shall be applied at a rate of 15 kg/m² to 22 kg/m². The exact rate will be determined by the Engineer. The completed spread rate shall be within 10 percent of the rate determined by the Engineer. The completed surface shall be free of gaps, ridges, depressions or other irregularities caused by the application of the asphalt-rubber seal coat.

**FINISHING**

Asphalt-rubber seal coat shall be finished in conformance with the provisions for finishing screenings spread on asphaltic emulsion in these special provisions and in Section 37-1.07, "Finishing," of the Standard Specifications, except that the second, third, seventh, eighth, and ninth paragraphs of Section 37-1.07 shall not apply.

Initial rolling of the asphalt-rubber seal coat shall consist of a minimum of one complete coverage with one or more pneumatic-tired rollers and shall begin within 90 seconds following the placement of the screenings.

The distance between the rollers and the screenings spreader shall not exceed 60 m at any time during the spreading of the screenings operations.

A minimum of 3 complete coverages as defined in Section 39-6.03, "Compacting," of the Standard Specifications with pneumatic-tired rollers, after the initial coverage, shall be made on the asphalt-rubber seal coat. When permitted by the Engineer, the final roller coverage may be made with one steel wheel roller weighing 7.25 tonnes minimum and 9 tonnes maximum. If a steel wheel roller is used, the roller shall be operated in the static mode only.

Sweeping shall be a multi-step operation following final rolling of the screenings. Loose screenings shall be removed from the roadway surface and abutting adjacent areas. Loose screenings shall be disposed of at least 46 m from the nearest waterway.
Initial sweeping shall be completed before controlled traffic is permitted on the asphalt-rubber seal coat. Removal of excess screenings shall be completed before uncontrolled traffic is permitted on the completed asphalt-rubber seal coat. Final sweeping shall be done and loose screenings shall be removed without dislodging the screenings set in the asphalt-rubber binder prior to acceptance.

Sufficient pilot cars shall be available to continuously convoy and control public traffic. Pilot cars used to convoy or otherwise control public traffic shall have radio contact with each other and other personnel in the work area. Pilot cars shall use only traffic lanes open to public traffic.

**MEASUREMENT AND PAYMENT**

Quantities of asphalt-rubber binder for asphalt-rubber seal coat will be measured in the same manner specified for asphalt in Section 92-1.05, "Measurement," of the Standard Specifications.

Quantities of screenings for asphalt-rubber seal coat to be paid for by the tonne will be determined after preheating and precoating with paving asphalt in the same manner specified for asphalt concrete in Section 39-8.01, "Measurement," of the Standard Specifications.

The contract price paid per tonne for asphalt-rubber binder shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals and for doing all the work involved in furnishing and applying asphalt-rubber binder, complete in place, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

The contract price paid per tonne for screenings (hot-applied) shall include full compensation for furnishing all labor, materials (including paving asphalt for precoating screenings), tools, equipment, and incidentals and for doing all the work involved in furnishing and applying screenings, complete in place, including preparation for seal coat and preheating and precoating screenings, as shown on the plans, as specified in the Standard Specifications and these special provisions, and as directed by the Engineer.

Full compensation for furnishing, placing, maintaining, and removing C6 (Loose Gravel) and W6 (35 MPH) signs and temporary supports or barricades for the signs required for the application of asphalt-rubber seal coat shall be considered as included in the contract price paid for the items of work involved and no additional compensation will be allowed therefor.

**10-1. FLUSH COAT**

This work shall consist of an application of a fog seal coat and sand cover to the surface of asphalt-rubber seal coat as shown on the plans and in conformance with the provisions in Section 37-1, "Seal Coats," of the Standard Specifications and these special provisions.

Flush coat shall be applied to the asphalt-rubber seal coat immediately after removal of excess screenings following initial brooming of the asphalt-rubber seal coat and prior to opening the lane to uncontrolled public traffic, as directed by the Engineer.

Attention is directed to asphalt-rubber seal coat of these special provisions regarding finishing of asphalt-rubber seal coat and flush coat.

**FOG SEAL COAT**

Attention is directed to "Order Of Work" of these special provisions regarding application of asphaltic emulsion (fog seal coat).

Asphaltic emulsion shall be grade CSS1 or CSS1h, unless otherwise ordered by the Engineer.
The application rate of the fog seal coat (asphaltic emulsion and added water) shall be such that the original asphaltic emulsion will be spread at a rate of 0.14- to 0.27-L/m$^2$. The exact rate of application will be determined by the Engineer.

Attention is directed to Section 7-1.11, "Preservation Of Property," of the Standard Specifications and "Existing Highway Facilities" of these special provisions regarding protecting the highway facilities from the fog seal coat.

During fog seal coat operations, the surface upon which a seal coat is being applied shall be closed to public traffic. Care shall be taken to avoid tracking fog seal coat material onto existing pavement surfaces beyond the limits of construction.

**SAND COVER**

Sand for sand cover shall conform to the provisions for fine aggregate grading in Section 90-3.03, "Fine Aggregate Grading," of the Standard Specifications and these special provisions. Sand shall be free from clay or organic material.

Sand shall be spread by means of a self-propelled chip spreader equipped with a mechanical device that will spread 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 1 kg/m$^2$ to 2 kg/m$^2$. The exact rate will be determined by the Engineer.

Sand cover shall be applied immediately following application of the fog seal coat.

**MEASUREMENT AND PAYMENT**

Sand cover will be measured and paid for in the same manner specified for screenings in Section 37-1.08, "Measurement," and Section 37-1.09, "Payment," of the Standard Specifications.

Full compensation for furnishing, placing, maintaining, and removing C6 (Loose Gravel) and W6 (35 MPH) signs and temporary supports or barricades for the signs required for the application of flush coat shall be considered as included in the contract price paid for the items of work involved and no additional compensation will be allowed therefor.

No adjustment in compensation will be made for any increase or decrease in the quantity of asphaltic emulsion (fog seal coat) required, regardless of the reason for the increase or decrease. The provisions in Section 4-1.03B, "Increased or Decreased Quantities," of the Standard Specifications shall not apply to the item of asphaltic emulsion (fog seal coat).
10-1. RUBBERIZED ASPHALT CONCRETE (TYPE G)

Rubberized asphalt concrete (Type G) shall consist of furnishing and mixing gap graded aggregate and asphalt-rubber binder and spreading and compacting the mixture. Type G rubberized asphalt concrete shall conform, except as otherwise provided, to the provisions for Type A asphalt concrete in Section 39, "Asphalt Concrete," of the Standard Specifications and these special provisions.

GENERAL

The Contractor shall furnish samples of aggregate to the Engineer in conformance with the provisions in Section 39-3.03, "Proportioning," of the Standard Specifications.

Aggregate for Type G rubberized asphalt concrete shall be of such quality that the optimum amount of asphalt-rubber binder to be mixed with the aggregate, as determined by the Engineer in conformance with the requirements in California Test 367 (as amended below), shall be a minimum of 7.0 percent by mass of dry aggregate and a maximum of 9.0 percent by mass of dry aggregate. Aggregates which result in an optimum asphalt-rubber binder content of less than 7.0 percent or more than 9.0 percent by mass of dry aggregate shall not be used. The Engineer will determine the exact amount of asphalt-rubber binder to be mixed with the aggregate in conformance with the requirements in California Test 367, except as follows:

A. The specific gravity used in California Test 367, Section "B. Voids Content of Specimen," will be determined using California Test 308, Method A.

B. California Test 367, Section "C. Optimum Bitumen Content," is revised as follows:

1. Plot asphalt-rubber binder content versus void content for each specimen on Form TL-306 (Figure 3), and connect adjacent points with straight lines.
2. From Figure 3 select the theoretical asphalt-rubber binder content that has ___ percent voids.
3. Record the asphalt-rubber binder content in Step 2 as the Optimum Bitumen Content (OBC).
4. To establish a recommended range, use the Optimum Bitumen Content (OBC) as the high value and 0.3 percent less as the low value. Notwithstanding, the recommended range shall not extend below 7.0 percent nor shall the high value to establish the recommended range be above 9.0 percent. If the OBC is 7.0 percent, then there shall be no recommended range, and 7.0 percent shall be the recommended value.

C. Laboratory mixing and compaction shall be in conformance with the requirements of California Test 304, except that the mixing temperature of the aggregate shall be between 149°C and 163°C. The compaction temperature of the combined mixture shall be between 143°C and 149°C.

The rubberized asphalt concrete mixture, composed of the aggregate proposed for use and the optimum amount of asphalt-rubber binder as determined in conformance with the requirements in California Test 367 modified above, shall conform to the following quality requirements:
RUBBERIZED ASPHALT CONCRETE MIXTURE

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>California Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stabilometer Value, Minimum</td>
<td>304 and 366</td>
<td>23</td>
</tr>
<tr>
<td>Voids in Mineral Aggregate, Percent, Minimum</td>
<td>See Note</td>
<td>18</td>
</tr>
</tbody>
</table>

Note: Voids in mineral aggregate test shall be determined as described in Asphalt Institute Mix Design Methods for Asphalt Concrete (MS-2).

The asphalt-rubber binder content of the rubberized asphalt concrete (Type G) will be determined by extraction tests in conformance with the requirements in California Test 362, or will be determined in conformance with the requirements in California Test 379.

The Contractor shall furnish a Certificate of Compliance to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for each material used in asphalt-rubber binder and the asphalt-rubber binder mixture. The Certificate of Compliance shall certify that the material conforms to the provisions in these special provisions. When requested by the Engineer, the Contractor shall submit samples with the Certificate of Compliance. The Contractor shall provide the Engineer a Material Safety Data Sheet (MSDS) for each of the constituent components of the asphalt-rubber binder, for the completed mixture of asphalt-rubber binder and for the Type G rubberized asphalt concrete.

The Contractor shall provide a Certificate of Compliance for each truck load of crumb rubber modifier (CRM), paving asphalt, and asphalt modifier delivered to the project. The Quality Control Program used by the manufacturer of each ingredient shall include a sampling and testing frequency as shown below:

A. CRM shall be tested, except for the grading requirement, at least once for every 225 tonnes of production, with a minimum of once for each project. CRM shall be tested for grading for every truck load delivered to the project.
B. Paving asphalt shall be tested at least once for every 180 tonnes of production with a minimum of once for each project.
C. Asphalt modifier shall be tested at least once for every 23 tonnes of production with a minimum of once for each project.
D. A copy of the laboratory test results for the test parameters specified in these special provisions for CRM, paving asphalt, and asphalt modifier shall be submitted to the Engineer with the Certificate of Compliance for each truck load of individual material delivered to the project.

Certified volume or weight slips shall be delivered to the Engineer for the materials supplied.

PAVING ASPHALT

The grade of paving asphalt to be used in the asphalt-rubber binder shall be AR-4000 and shall conform to the provisions in Section 92, "Asphalts," of the Standard Specifications and these special provisions.

The paving asphalt for use in asphalt-rubber binder shall be modified with an asphalt modifier.
ASPHALT MODIFIER

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

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, m²/s (x10⁻⁶) at 100°C</td>
<td>D 445</td>
<td>X ± 3*</td>
</tr>
<tr>
<td>Flash Point, CL.O.C., °C</td>
<td>D 92</td>
<td>207 min.</td>
</tr>
</tbody>
</table>

Molecular Analysis:

<table>
<thead>
<tr>
<th></th>
<th>ASTM Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphaltenes, percent by mass</td>
<td>D 2007</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>Aromatics, percent by mass</td>
<td>D 2007</td>
<td>55 min.</td>
</tr>
</tbody>
</table>

* The symbol "X" is the viscosity of the asphalt modifier the Contractor proposes to furnish. The value "X" which the Contractor proposes shall be between the limits 19 and 36 and shall be submitted in writing to the Engineer. A proposed change, requested by the Contractor, in the value "X" shall require a new asphalt-rubber binder design.

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 in an amount of 2.5 percent to 6.0 percent by mass 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 190°C or more than 226°C when the asphalt modifier is added. If 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. Premixing of asphalt modifier and paving asphalt will not be required when the ingredients of the asphalt-rubber binder are proportioned and mixed simultaneously. Asphalt modifier and paving asphalt shall be measured for proportioning with meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications.

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 a 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.

Steel and fiber separation may be accomplished by any method. Cryogenic separation, if utilized, shall be performed separately from and prior to grinding or granulating.

CRM shall be ground or granulated at ambient temperature. Cryogenically produced CRM particles which can pass through the grinder or granulator without being ground or granulated respectively shall not be used.

CRM shall not contain more than 0.01-percent wire (by mass of CRM) and shall be free of other contaminants, except fabric. Fabric shall not exceed 0.05-percent by mass of CRM. The test and method for determining the percent by mass of wire and fabric is available at the Transportation Laboratory, Pavement Branch, Telephone 916-227-7300, and will be furnished to interested persons upon request. A Certificate of Compliance certifying these percentages shall
be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.

The length of an individual CRM particle shall not exceed 4.75 mm.

The CRM shall be sufficiently dry so that the CRM will be free flowing and not produce foaming when combined with the blended paving asphalt and asphalt modifier mixture. Calcium carbonate or talc may be added at a maximum amount of 3 percent by mass of CRM to prevent CRM particles from sticking together. The CRM shall have a specific gravity between 1.1 and 1.2 as determined by California Test 208. 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 of ASTM Designation: D 297:

**SCRAP TIRE CRUMB RUBBER MODIFIER**

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone Extract</td>
<td>6.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Ash Content</td>
<td>—</td>
<td>8.0</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>28.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>42.0</td>
<td>65.0</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>22.0</td>
<td>39.0</td>
</tr>
</tbody>
</table>

**HIGH NATURAL CRUMB RUBBER MODIFIER**

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone Extract</td>
<td>4.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>50.0</td>
<td>—</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>40.0</td>
<td>48.0</td>
</tr>
</tbody>
</table>

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

A. Split or quarter 100 g ± 5 g from the CRM sample and dry to a constant mass at a temperature of not less than 57°C or more than 63°C and record the dry sample mass. Place the CRM sample and 5.0 g of talc in a 0.5-L jar. Seal the jar, then shake it by hand for a minimum of one minute to mix the CRM and the talc. Continue shaking or open the jar and stir until particle agglomerates and clumps are broken and the talc is uniformly mixed.

B. Place one rubber ball on each sieve. Each ball shall have a mass of 8.5 g ± 0.5 g, have a diameter of 24.5 mm ± 0.5 mm, and shall have a Shore Durometer "A" hardness of 50 ± 5 in conformance with the requirements in ASTM Designation: D 2240. After sieving the combined material for 10 minutes ± 1 minute, disassemble the sieves. Material adhering to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the mass of the material retained on the 2.36-mm sieve and leave this material (do not discard) on the scale or balance. Observed fabric balls shall remain on the scale or balance and shall be placed together on the side of the scale or balance to prevent the fabric balls from being covered or disturbed when placing the material from finer sieves onto the scale or balance. The material retained on the next finer sieve (2.00-mm sieve)
shall be added to the scale or balance. Weigh and record that mass as the accumulative mass retained on that sieve (2.00-mm sieve). Continue weighing and recording the accumulated masses retained on the remaining sieves until the accumulated mass retained in the pan has been determined. Prior to discarding the CRM sample, separately weigh and record the total mass of fabric balls in the sample.

C. Determine the mass of material passing the 75-µm sieve (or mass retained in the pan) by subtracting the accumulated mass retained on the 75-µm sieve from the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass of 5 g or less, cross out the recorded number for the accumulated mass retained in the pan and copy the number recorded for the accumulated mass retained on the 75-µm sieve and record that number (next to the crossed out number) as the accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the pan) has a mass greater than 5 g, cross out the recorded number for the accumulated mass retained in the pan, subtract 5 g from that number and record the difference next to the crossed out number. The adjustment to the accumulated mass retained in the pan is made to account for the 5 g of talc added to the sample. For calculation purposes, the adjusted total sample mass is the same as the adjusted accumulated mass retained in the pan. Determine the percent passing based on the adjusted total sample mass and record to the nearest 0.1 percent.

<table>
<thead>
<tr>
<th>CRM GRADATIONS</th>
<th>Sieve Size</th>
<th>Scrap Tire CRM Percent Passing</th>
<th>High Natural CRM Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.36-mm</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>2.00-mm</td>
<td>98-100</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>1.18-mm</td>
<td>45-75</td>
<td>95-100</td>
</tr>
<tr>
<td></td>
<td>600-µm</td>
<td>2-20</td>
<td>35-85</td>
</tr>
<tr>
<td></td>
<td>300-µm</td>
<td>0-6</td>
<td>10-30</td>
</tr>
<tr>
<td></td>
<td>150-µm</td>
<td>0-2</td>
<td>0-4</td>
</tr>
<tr>
<td></td>
<td>75-µm</td>
<td>0</td>
<td>0-1</td>
</tr>
</tbody>
</table>

**ASPHALT-RUBBER BINDER**

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

At least 2 weeks before the binder's intended use, the Contractor shall furnish the Engineer 4 one-liter cans filled with the asphalt-rubber binder proposed for use on the project. The Contractor shall supply the Engineer, for approval, a binder formulation and samples of the materials to be used in the asphalt-rubber binder at least 2 weeks before construction is scheduled to begin. The binder formulations shall consist of the following information:

A. Paving Asphalt and Modifiers:

1. Source and grade of paving asphalt.
2. Source and identification (or type) of modifiers used.
3. Percentage of asphalt modifier by mass of paving asphalt.
4. Percentage of the combined blend of paving asphalt and asphalt modifier by total mass of asphalt-rubber binder to be used.
5. Laboratory test results for test parameters shown in these special provisions.
B Crumb Rubber Modifier (CRM):

1. Source and identification (or type) of scrap tire and high natural CRM.
2. Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend.
3. If CRM from more than one source is used, the above information will be required for each CRM source used.
4. Laboratory test results for test parameters shown in these special provisions.

C. Asphalt-Rubber Binder:

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

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

The proportions of the materials, by total mass of asphalt-rubber binder, shall be 80 percent ± 2 percent combined paving asphalt and asphalt modifier, and 20 percent ± 2 percent CRM. However, the minimum amount of CRM shall not be less than 18.0 percent. Lower values which are rounded up shall not be allowed. The CRM shall be combined at the production site and shall contain 75 percent ± 2 percent scrap tire CRM and 25 percent ± 2 percent high natural CRM, by mass.

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 is considered to be chemically compatible when it meets the provisions for asphalt-rubber binder (after reacting) found in these special 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 be not less than 190°C nor more than 226°C 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 190°C nor more than 218°C. The temperature shall not be higher than 6°C below the actual flash point of the asphalt-rubber binder.

After reacting, the asphalt-rubber binder shall conform to the following requirements:
### ASPHALT-RUBBER BINDER

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone Penetration @ 25°C, 1/10 mm</td>
<td>D 217</td>
<td>25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>Resilience @ 25°C, Percent rebound</td>
<td>D 3407</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>Field Softening Point, °C</td>
<td>D 36</td>
<td>52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>74</td>
</tr>
<tr>
<td>Viscosity @ 190°C, Pa • s (x10(^{-3}))</td>
<td>See Note</td>
<td>1500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4000</td>
</tr>
</tbody>
</table>

**NOTE:** The viscosity test shall be conducted using a hand held Haake Viscometer Model VT-02 with Rotor 1, 24 mm in depth x 53 mm in height, or equivalent, as determined by the Engineer. The accuracy of the viscometer shall be verified by comparing the viscosity results obtained with the hand held viscometer to 3 separate calibration fluids of known viscosities ranging from 1000 to 5000 Pa • s (x10\(^{-3}\)). The viscometer will be considered accurate if the values obtained are within 300 Pa • s (x10\(^{-3}\)) of the known viscosity. The known viscosity value shall be based on the fluid manufacturers standard test temperature or the test temperature versus viscosity correlation table provided by the fluid manufacturer. Viscometers used on the project shall be verified to be accurate. The test method for determining the viscosity of asphalt-rubber binder using a hand held viscometer is available at the Transportation Laboratory, Pavement Branch, Telephone (916) 227-7300. The accuracy verification results shall be provided to the Engineer and shall be certified by a Certificate of Compliance. The Certificate of Compliance shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.

The Contractor shall provide a Haake Viscometer, or equivalent, at the production site during combining of asphalt-rubber binder materials. The Contractor shall take viscosity readings of asphalt-rubber binder from samples taken from the feed line connecting the storage and reaction tank to the asphalt concrete plant. Readings shall be taken at least every hour with not less than one reading for each batch of asphalt-rubber binder. The Contractor shall log these results, including time and asphalt-rubber binder temperature, and a copy of the log shall be submitted to the Engineer on a daily basis. As determined by the Engineer, the Contractor shall either notify the Engineer at least 15 minutes prior to each test or provide the Engineer a schedule of testing times.

The reacted asphalt-rubber binder shall be maintained at a temperature of not less than 190°C nor more than 218°C.

If any of the material in a batch of asphalt-rubber binder is not used within 4 hours after the 45-minute reaction period, heating of the material shall be discontinued. Any time the asphalt-rubber binder cools below 190°C and is reheated shall be considered a reheat cycle. The total number of reheat cycles shall not exceed 2. The material shall be uniformly reheated to a temperature of not less than 190°C nor more than 218°C prior to use. Additional scrap tire CRM may be added to the reheated binder and reacted for a minimum of 45 minutes. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder mass. Reheated asphalt-rubber binder shall conform to the provisions for asphalt-rubber binder.
EQUIPMENT FOR PRODUCTION OF ASPHALT-RUBBER BINDER

The Contractor shall utilize the following equipment for production of asphalt-rubber binder:

A. An asphalt heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ± 3°C and shall be of the recording type.

B. A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier, and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer through meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications. The blending system shall be capable of varying the rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than ± 14°C. The paving asphalt feed, the asphalt modifier feed, and CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Meters used for proportioning individual ingredients shall be equipped with rate-of-flow indicators to show the rates of delivery and resettable totalizers so that the total amounts of liquid ingredients introduced into the mixture can be determined. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced. The Contractor shall provide a safe sampling device capable of delivering a representative sample of the completed asphalt-rubber binder of sufficient size to permit the required tests.

C. An asphalt-rubber binder storage tank equipped with a heating system furnished with a temperature reading device to maintain the proper temperature of the asphalt-rubber binder and an internal mixing unit capable of maintaining a homogeneous mixture of paving asphalt, asphalt modifier, and CRM.

The equipment shall be approved by the Engineer prior to use.

AGGREGATE

The aggregate for Type G rubberized asphalt concrete shall conform to the following grading and shall meet the quality provisions specified for Type A asphalt concrete in Section 39-2.02, "Aggregate," of the Standard Specifications, except as follows:

A. California Test 211, Los Angeles Rattler loss at 500 revolutions shall be 40 percent maximum.

B. California Test 205, Section D, definition of a crushed particle is revised as follows: "A particle having 2 or more fresh mechanically fractured faces shall be considered a crushed particle."

C. The swell and moisture vapor susceptibility requirements shall not apply.
The symbol "X" in the following table is the gradation which the Contractor proposes to furnish for the specific sieve.

### Aggregate Grading Requirements

#### Percentage Passing

**12.5-mm maximum**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Limits of Proposed Gradation</th>
<th>Operating Range</th>
<th>Contract Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-mm</td>
<td>—</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>12.5-mm</td>
<td>—</td>
<td>90-100</td>
<td>90-100</td>
</tr>
<tr>
<td>9.5-mm</td>
<td>83-87</td>
<td>X±5</td>
<td>X±7</td>
</tr>
<tr>
<td>4.75-mm</td>
<td>33-37</td>
<td>X±5</td>
<td>X±7</td>
</tr>
<tr>
<td>2.36-mm</td>
<td>18-22</td>
<td>X±4</td>
<td>X±5</td>
</tr>
<tr>
<td>600-µm</td>
<td>8-12</td>
<td>X±4</td>
<td>X±5</td>
</tr>
<tr>
<td>75-µm</td>
<td>—</td>
<td>2-7</td>
<td>0-8</td>
</tr>
</tbody>
</table>

The symbol "X" in the following table is the gradation which the Contractor proposes to furnish for the specific sieve.

### Aggregate Grading Requirements

#### Percentage Passing

**19-mm maximum**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Limits of Proposed Gradation</th>
<th>Operating Range</th>
<th>Contract Compliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-mm</td>
<td>—</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>19-mm</td>
<td>—</td>
<td>95-100</td>
<td>90-100</td>
</tr>
<tr>
<td>12.5-mm</td>
<td>83-87</td>
<td>X±5</td>
<td>X±7</td>
</tr>
<tr>
<td>9.5-mm</td>
<td>65-70</td>
<td>X±5</td>
<td>X±7</td>
</tr>
<tr>
<td>4.75-mm</td>
<td>33-37</td>
<td>X±5</td>
<td>X±7</td>
</tr>
<tr>
<td>2.36-mm</td>
<td>18-22</td>
<td>X±4</td>
<td>X±5</td>
</tr>
<tr>
<td>600-µm</td>
<td>8-12</td>
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<td>X±5</td>
</tr>
<tr>
<td>75-µm</td>
<td>—</td>
<td>2-7</td>
<td>0-8</td>
</tr>
</tbody>
</table>

### PROPORTIONING, SPREADING AND COMPACTING

When batch type asphalt concrete plants are used to produce Type G rubberized asphalt concrete, the asphalt-rubber binder and mineral aggregate shall be proportioned by mass.

When continuous mixing type asphalt concrete plants are used to produce Type G rubberized asphalt concrete, the asphalt-rubber binder shall be proportioned by an asphalt meter of the mass flow, Coriolis effect type. The meter shall have been Type-approved by the Division of Measurement Standards prior to the start of production. The meter shall be calibrated in conformance with the requirements in California Test 109. The meter shall be interfaced with the existing continuous mixing plant controller in use on the asphalt concrete plant.

Type G rubberized asphalt concrete shall be placed only when the atmospheric and pavement surface temperatures are 13°C or above.

When the atmospheric and pavement surface temperature is 18°C or higher, the following shall apply:
A. The temperature of the aggregate shall not be greater than 163°C at the time the asphalt-rubber binder is added to the aggregate.

B. Type G rubberized asphalt concrete shall be spread at a temperature of not less than 138°C or more than 163°C, measured in the mat directly behind the paving machine.

C. The first coverage of initial or breakdown compaction shall be performed when the temperature of the Type G rubberized asphalt concrete is not less than 135°C. Breakdown compaction shall be completed before the temperature of the Type G rubberized asphalt concrete drops below 121°C.

When the atmospheric or pavement surface temperature is below 18°C, the following shall apply:

A. The temperature of the aggregate shall not be less than 149°C nor more than 163°C at the time the asphalt-rubber binder is added to the aggregate.

B. The Contractor shall cover the loads of Type G rubberized asphalt concrete with tarpaulins. The tarpaulins shall completely cover the exposed Type G rubberized asphalt concrete until the Type G rubberized asphalt concrete has been completely transferred into the asphalt concrete paver hopper or deposited on the roadbed.

C. Type G rubberized asphalt concrete shall be spread at a temperature of not less than 143°C nor more than 163°C, measured in the mat directly behind the paving machine.

D. The first coverage of initial or breakdown compaction shall be performed when the temperature of the Type G rubberized asphalt concrete is not less than 138°C. Breakdown compaction shall be completed before the temperature of the Type G rubberized asphalt concrete drops below 127°C.

Pneumatic tired rollers shall not be used to compact Type G rubberized asphalt concrete. Alternative compacting equipment conforming to the provisions in Section 39-6.03, "Compacting," of the Standard Specifications shall be used to compact the Type G rubberized asphalt concrete.

Traffic shall not be allowed on the Type G rubberized asphalt concrete until final rolling operations have been completed and sand has been applied to the surface.

Sand shall be spread on the surface of Type G rubberized asphalt concrete at a rate of 0.5 kg/m² to 1.0 kg/m². The exact rate will be determined by the Engineer. When ordered by the Engineer excess sand shall be removed from the pavement surface by sweeping. Sand shall be free from clay or organic material. Sand shall conform to the fine aggregate grading provisions in Section 90-3.03, "Fine Aggregate Grading," of the Standard Specifications.

MEASUREMENT AND PAYMENT

Rubberized asphalt concrete (Type G) will be measured and paid for by the tonne in the same manner specified for asphalt concrete in Section 39-8, "Measurement and Payment," of the Standard Specifications.

Full compensation for furnishing and spreading sand on the rubberized asphalt concrete surface and for sweeping and removing excess sand from the pavement surface shall be considered as included in the contract price paid per tonne for rubberized asphalt concrete (Type G) and no separate payment will be made therefor.
10-1. RUBBERIZED ASPHALT CONCRETE (TYPE O)

Rubberized asphalt concrete (Type O) shall consist of furnishing and mixing Open Graded aggregate and asphalt-rubber binder and spreading and compacting the mixture. Type O rubberized asphalt concrete shall conform, except as otherwise provided, to the provisions for Open Graded asphalt concrete in Section 39, "Asphalt Concrete," of the Standard Specifications and to these special provisions.

GENERAL

The Contractor shall furnish samples of aggregate to the Engineer in conformance with the provisions in Section 39-3.03, "Proportioning," of the Standard Specifications.

The amount of asphalt-rubber binder to be mixed with the aggregate for Type O rubberized asphalt concrete will be determined by the Engineer using the samples of aggregates furnished by the Contractor in conformance with the provisions in Section 39-3.03, "Proportioning," of the Standard Specifications. The Engineer will determine the exact amount of asphalt-rubber binder to be mixed with the aggregate in conformance with the provisions in California Test 368 with the following exceptions. The aggregate shall be mixed with AR-4000 paving asphalt and the optimum bitumen content shall be determined in conformance with the test procedure. The optimum binder content for rubberized asphalt concrete Type O shall then be determined using the following formula:

\[
A. \quad OBC_2 = (OBC_1) \times 1.20 \\
B. \quad OBC_1 = \text{Optimum bitumen content using AR-4000 paving asphalt} \\
C. \quad OBC_2 = \text{Optimum bitumen content using asphalt-rubber binder}
\]

The asphalt-rubber binder content of the Type O rubberized asphalt concrete will be determined by extraction tests in conformance with the provisions in California Test 362 or will be determined in conformance with the provisions in California Test 379.

The Contractor shall furnish to the Engineer a Certificate of Compliance in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for each material used in asphalt-rubber binder and the asphalt-rubber binder mixture. The Certificate of Compliance shall certify that the material conforms to the provisions in these special provisions. When requested by the Engineer, the Contractor shall also submit samples with the Certificate of Compliance. The Contractor shall provide the Engineer a Material Safety Data Sheet (MSDS) for each of the constituent components of the asphalt-rubber binder, for the completed mixture of asphalt-rubber binder and for the Type O rubberized asphalt concrete.

The Contractor shall provide a Certificate of Compliance for each truck load of crumb rubber modifier (CRM), paving asphalt, and asphalt modifier delivered to the project. The Quality Control Program used by the manufacturer of each ingredient shall include a sampling and testing frequency as follows:

A. CRM shall be tested, except for the grading requirement, at least once for every 225 tonnes of production, with a minimum of once for each project. CRM shall be tested for grading for every truck load delivered to the project.
B. Paving asphalt shall be tested at least once for every 180 tonnes of production with a minimum of once for each project.
C. Asphalt modifier shall be tested at least once for every 23 tonnes of production with a minimum of once for each project.
D. A copy of the laboratory test results for the test parameters specified in these special provisions for CRM, paving asphalt, and asphalt modifier shall be submitted to the Engineer with the Certificate of Compliance for each truck load of individual material delivered to the project.

**PAVING ASPHALT**

The grade of paving asphalt to be used in the asphalt-rubber binder shall be AR-4000 and shall conform to the provisions in Section 92, "Asphalts," of the Standard Specifications and these special provisions.

The paving asphalt for use in asphalt-rubber binder shall be modified with an asphalt modifier.

**ASPHALT MODIFIER**

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

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, m²/s (x10⁻⁶) at 100°C</td>
<td>D 445</td>
<td>X ± 3*</td>
</tr>
<tr>
<td>Flash Point, C.L.O.C., °C</td>
<td>D 92</td>
<td>207 min.</td>
</tr>
<tr>
<td>Molecular Analysis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphaltenes, percent by mass</td>
<td>D 2007</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>Aromatics, percent by mass</td>
<td>D 2007</td>
<td>55 min.</td>
</tr>
</tbody>
</table>

* The symbol "X" is the viscosity of the asphalt modifier the Contractor proposes to furnish. The value "X" which the Contractor proposes shall be between the limits 19 and 36 and shall be submitted in writing to the Engineer. A proposed change, requested by the Contractor, in the value "X" shall require a new asphalt-rubber binder design.

The asphalt modifier shall be proportionately added at the production site where the asphalt-rubber binder is blended and reacted. Asphalt modifier shall be added to the paving asphalt at an amount of 2.5 percent to 6.0 percent by mass of the paving asphalt based on the recommendation of the asphalt-rubber binder supplier. The exact amount will be determined by the Engineer. The paving asphalt shall be at a temperature of not less than 190°C or more than 226°C when the asphalt modifier is added. If 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 the paving asphalt will not be required when the ingredients of the asphalt-rubber binder are proportioned and mixed simultaneously. Asphalt modifier and paving asphalt shall be measured for proportioning with meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications.
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 a 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.

Steel and fiber separation may be accomplished by any method. Cryogenic separation, if utilized, shall be performed separately from and prior to grinding or granulating.

CRM shall be ground or granulated at ambient temperature. Cryogenically produced CRM particles that can pass through the grinder or granulator without being ground or granulated respectively shall not be used.

CRM shall not contain more than 0.01-percent wire (by mass of CRM) and shall be free of other contaminants, except fabric. Fabric shall not exceed 0.05-percent by mass of CRM. The test and method for determining the percent by mass of wire and fabric is available at the Transportation Laboratory, Pavement Branch, Telephone 916-227-7300, and will be furnished to interested persons upon request. A Certificate of Compliance certifying these percentages shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.

The length of an individual CRM particle shall not exceed 4.75 mm.

The CRM shall be sufficiently dry so as to be free flowing and not produce foaming when combined 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. The CRM shall have a specific gravity between 1.1 and 1.2 as determined in conformance with the requirements in California Test 208. 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 in conformance with the requirements in ASTM Designation: D 297:

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>Acetone Extract</td>
<td>6.0</td>
</tr>
<tr>
<td>Ash Content</td>
<td>—</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>28.0</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>42.0</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>22.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
</tr>
<tr>
<td>Acetone Extract</td>
<td>4.0</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>50.0</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>40.0</td>
</tr>
</tbody>
</table>

The CRM for asphalt-rubber binder shall conform to the gradations specified below when tested in conformance with the requirements in ASTM Designation: C 136, except as follows:
A. Split or quarter 100 g ± 5 g from the CRM sample and dry to a constant mass at a
temperature of not less than 57°C or more than 63°C and record the dry sample mass.
Place the CRM sample and 5.0 g of talc in a 0.5-L jar. Seal the jar, then shake it by hand
for a minimum of one minute to mix the CRM and the talc. Continue shaking or open the
jar and stir until particle agglomerates and clumps are broken and the talc is uniformly
mixed.

B. Place one rubber ball on each sieve. Each ball shall have a mass of 8.5 g ± 0.5 g,
have a
diameter of 24.5 mm ± 0.5 mm, and shall have a Shore Durometer "A" hardness of 50 ± 5
in conformance with the requirements in ASTM Designation: D 2240. After sieving the
combined material for 10 minutes ± 1 minute, disassemble the sieves. Material adhering
to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the
mass of the material retained on the 2.36-mm sieve and leave this material (do not
discard) on the scale or balance. Observed fabric balls shall remain on the scale or
balance and shall be placed together on the side of the scale or balance to prevent the
fabric balls from being covered or disturbed when placing the material from finer sieves
onto the scale or balance. The material retained on the next finer sieve (2.00-mm sieve)
shall be added to the scale or balance. Weigh and record that mass as the accumulative
mass retained on that sieve (2.00-mm sieve). Continue weighing and recording the
accumulated masses retained on the remaining sieves until the accumulated mass retained
in the pan has been determined. Prior to discarding the CRM sample, separately weigh
and record the total mass of fabric balls in the sample.

C. Determine the mass of material passing the 75-µm sieve (or mass retained in the pan) by
subtracting the accumulated mass retained on the 75-µm sieve from the accumulated
mass retained in the pan. If the material passing the 75-µm sieve (or mass retained in the
pan) has a mass of 5 g or less, cross out the recorded number for the accumulated mass
retained in the pan and copy the number recorded for the accumulated mass retained on
the 75-µm sieve and record that number (next to the crossed out number) as the
accumulated mass retained in the pan. If the material passing the 75-µm sieve (or mass
retained in the pan) has a mass greater than 5 g, cross out the recorded number for the
accumulated mass retained in the pan, subtract 5 g from that number and record the
difference next to the crossed out number. The adjustment to the accumulated mass
retained in the pan is made to account for the 5 g of talc added to the sample. For
calculation purposes, the adjusted total sample mass is the same as the adjusted
accumulated mass retained in the pan. Determine the percent passing based on the
adjusted total sample mass and record to the nearest 0.1 percent.
CRM GRADATIONS

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Scrap Tire CRM Percent Passing</th>
<th>High Natural CRM Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.36-mm</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2.00-mm</td>
<td>98-100</td>
<td>100</td>
</tr>
<tr>
<td>1.18-mm</td>
<td>45-75</td>
<td>95-100</td>
</tr>
<tr>
<td>600-µm</td>
<td>2-20</td>
<td>35-85</td>
</tr>
<tr>
<td>300-µm</td>
<td>0-6</td>
<td>10-30</td>
</tr>
<tr>
<td>150-µm</td>
<td>0-2</td>
<td>0-4</td>
</tr>
<tr>
<td>75-µm</td>
<td>0</td>
<td>0-1</td>
</tr>
</tbody>
</table>

ASPHALT-RUBBER BINDER

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

At least 2 weeks before the binder's intended use, the Contractor shall furnish the Engineer 4 one liter cans filled with the asphalt-rubber binder proposed for use on the project. The Contractor shall supply the Engineer, for approval, a binder formulation and samples of the materials to be used in the asphalt-rubber binder at least 2 weeks before construction is scheduled to begin. The binder formulations shall consist of the following information:

A. Paving Asphalt and Modifiers:

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

B. Crumb Rubber Modifier (CRM):

1. Source and identification (or type) of scrap tire and high natural CRM.
2. Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend.
3. If CRM from more than one source is used, the above information will be required for each CRM source used.
4. Laboratory test results for test parameters shown in these special provisions.

C. Asphalt-Rubber Binder:

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

The method and equipment for combining paving asphalt, asphalt modifier, and CRM shall be so designed and accessible that the Engineer can readily determine the percentages by mass for each material being incorporated into the mixture.
The proportions of the materials, by total mass of asphalt-rubber binder, shall be 80 percent ± 2 percent combined paving asphalt and asphalt modifier, and 20 percent ± 2 percent CRM. However, the minimum amount of CRM shall not be less than 18.0 percent. Lower values which are rounded up shall not be allowed. The CRM shall be combined at the production site and shall contain 75 percent ± 2 percent scrap tire CRM and 25 percent ± 2 percent high natural CRM, by mass.

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 is considered to be chemically compatible when the mixture meets the provisions for asphalt-rubber binder (after reacting) of these special 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 be not less than 190°C or more than 226°C 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 190°C or more than 218°C. The temperature shall not be higher than 6°C below the actual flash point of the asphalt-rubber binder.

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

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Test Method</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone Penetration @ 25°C, 1/10 mm</td>
<td>D 217</td>
<td>25 - 70</td>
</tr>
<tr>
<td>Resilience @ 25°C, Percent rebound</td>
<td>D 3407</td>
<td>18 - —</td>
</tr>
<tr>
<td>Field Softening Point, °C</td>
<td>D 36</td>
<td>52 - 74</td>
</tr>
<tr>
<td>Viscosity @ 190°C, Pa • s (x10^{-3})</td>
<td>See Note</td>
<td>1500 - 4000</td>
</tr>
</tbody>
</table>

Note: The viscosity test shall be conducted using a hand held Haake Viscometer Model VT-02 with Rotor 1, 24 mm in depth x 53 mm in height, or equivalent, as determined by the Engineer. The accuracy of the viscometer shall be verified by comparing the viscosity results obtained with the hand held viscometer to 3 separate calibration fluids of known viscosities ranging from 1000 to 5000 Pa • s (x10^{-3}). The viscometer will be considered accurate if the values obtained are within 300 Pa • s (x10^{-3}) of the known viscosity. The known viscosity value shall be based on the fluid manufacturers standard test temperature or the test temperature versus viscosity correlation table provided by the fluid manufacturer. Viscometers used on the project shall be verified to be accurate. The test method for determining the viscosity of asphalt-rubber binder using a hand held viscometer is available at the Transportation Laboratory, Pavement Branch, Telephone 916-227-7300. The accuracy verification results shall be provided to the Engineer and shall be certified by a Certificate of Compliance. The Certificate of Compliance shall be furnished to the Engineer in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications.

The Contractor shall provide a Haake Viscometer, or equivalent, at the production site during the combining of asphalt-rubber binder materials. The Contractor shall take viscosity readings of
asphalt-rubber binder from samples taken from the feed line connecting the storage and reaction tank and the asphalt concrete plant. Readings shall be taken at least every hour with no less than one reading for each batch of asphalt-rubber binder. The Contractor shall log these results including time and asphalt-rubber binder temperature, and a copy of the log shall be submitted to the Engineer on a daily basis. As determined by the Engineer, the Contractor shall either notify the Engineer at least 15 minutes prior to each test or provide the Engineer a schedule of testing times.

The reacted asphalt-rubber binder shall be maintained at a temperature of not less than 190°C nor more than 218°C.

If material in a batch of asphalt-rubber binder is not used within 4 hours after the 45-minute reaction period, heating of the material shall be discontinued. Any time the asphalt-rubber binder cools below 190°C and is reheated shall be considered a reheat cycle. The total number of reheat cycles shall not exceed 2. The material shall be uniformly reheated to a temperature of not less than 190°C nor more than 218°C prior to use. Additional scrap tire CRM may be added to the reheated binder and reacted for a minimum of 45 minutes. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder mass. Reheated asphalt-rubber binder shall conform to the provisions for blended asphalt-rubber binder.

**EQUIPMENT FOR PRODUCTION OF ASPHALT-RUBBER BINDER**

The Contractor shall utilize the following equipment for production of asphalt-rubber binder:

A. An asphalt heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ±3°C and shall be of the recording type.

B. A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer through meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications. The blending system shall be capable of varying the rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than ±14°C. The paving asphalt feed, the asphalt modifier feed, and CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Meters used for proportioning individual ingredients shall be equipped with rate-of-flow indicators to show the rates of delivery and resettable totalizers so that the total amounts of liquid ingredients introduced into the mixture can be determined. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced. The Contractor shall provide a safe sampling device capable of delivering a representative sample of the completed asphalt-rubber binder of sufficient size to permit the required tests.
C. An asphalt-rubber binder storage tank equipped with a heating system furnished with a 
temperature reading device to maintain the proper temperature of the asphalt-rubber 
binder and an internal mixing unit capable of maintaining a homogeneous mixture of 
blended paving asphalt, asphalt modifier and CRM.

The equipment shall be approved by the Engineer prior to use.

**AGGREGATE**

The aggregate for Type O rubberized asphalt concrete shall conform to the 12.5-mm 
maximum grading conforming to the provisions in Section 39-2.02, "Aggregate," of the Standard 
Specifications. California Test 205, Section D, definition of a crushed particle is revised as 
follows: "A particle having 2 or more fresh mechanically fractured faces shall be considered a 
crushed particle".

**PROPORTIONING, SPREADING AND COMPACTING.—**

When batch type asphalt concrete plants are used to produce Type O rubberized asphalt 
concrete, the asphalt-rubber binder and mineral aggregate shall be proportioned by mass.

When continuous mixing type asphalt concrete plants are used to produce Type O rubberized 
asphalt concrete, the asphalt-rubber binder shall be proportioned by an asphalt meter of the mass 
flow, Coriolis effect type. The meter shall have been Type-approved by the Division of 
Measurement Standards prior to the start of production. The meter shall be calibrated in 
conformance with the provisions in California Test 109. The meter shall be interfaced with the 
existing continuous mixing plant controller in use on the asphalt concrete plant.

Type O rubberized asphalt concrete shall be placed only when the atmospheric and pavement 
surface temperatures are 13°C and above.

When the atmospheric and pavement surface temperature is 18°C or higher, the following 
shall apply:

A. The temperature of the aggregate shall not be greater than 163°C at the time the 
asphalt-rubber binder is added to the aggregate.
B. Type O rubberized asphalt concrete shall be spread at a temperature of not less than 
138°C nor more than 163°C, measured in the mat directly behind the paving machine.
C. The first coverage of initial or breakdown compaction shall be performed when the 
temperature of the Type O rubberized asphalt concrete is not less than 135°C. 
Breakdown compaction shall be completed before the temperature of the Type O 
rubberized asphalt concrete drops below 121°C.

When the atmospheric or pavement surface temperature is below 18°C, the following shall 
apply:

A. The temperature of the aggregate shall be not less than 149°C nor more than 163°C at the 
time the asphalt-rubber binder is added to the aggregate.
B. The Contractor shall cover loads of Type O rubberized asphalt concrete with tarpaulins. 
The tarpaulins shall completely cover exposed Type O rubberized asphalt concrete until 
the Type O rubberized asphalt concrete has been completely transferred into the asphalt 
concrete paver hopper or deposited on the roadbed.
C. Type O rubberized asphalt concrete shall be spread at a temperature of not less than
143°C nor more than 163°C, measured in the mat directly behind the paving machine.
D. The first coverage of initial or breakdown compaction shall be performed when the
temperature of the Type O rubberized asphalt concrete is not less than 138°C.
Breakdown compaction shall be completed before the temperature of the Type O
rubberized asphalt concrete drops below 127°C.

Pneumatic tired rollers shall not be used to compact Type O rubberized asphalt concrete.
Traffic shall not be allowed on Type O rubberized asphalt concrete until final rolling
operations have been completed and sand has been applied to the surface.
Sand shall be spread on the surface of Type O rubberized asphalt concrete at a rate of
0.5 kg/m² to 1.0 kg/m². The exact rate will be determined by the Engineer. When ordered by the
Engineer excess sand shall be removed from the pavement surface by sweeping. Sand shall be
free from clay or organic material. Sand shall conform to the fine aggregate grading
requirements in conformance with the provisions in Section 90-3.03, "Fine Aggregate Grading,"
of the Standard Specifications.

**MEASUREMENT AND PAYMENT**

Rubberized asphalt concrete (Type O) will be measured and paid for by the tonne in the same
manner specified for asphalt concrete in Section 39-8, "Measurement and Payment," of the
Standard Specifications.

Full compensation for furnishing and spreading sand on the rubberized asphalt concrete
surfacing and for sweeping and removing excess sand from the pavement surface shall be
considered as included in the contract price paid per tonne for rubberized asphalt concrete
(Type O) and no separate payment will be made therefor.
b) Greenbook

Contacts for information on Greenbook specification are:
Bill Rider (909-392-5076)
Dan Peterson (626-446-3117)
203-11 ASPHALT RUBBER HOT MIX (ARHM) WET PROCESS.

203-11.1 General. Asphalt Rubber Hot Mix shall consist of a mixture of paving asphalt, asphalt modifier, crumb rubber modifier (CRM), and aggregate mixed in a central mixing plant, all conforming to these specifications.

203-11.2 Materials. The Contractor shall submit test reports and Certificates of Compliance for the paving asphalt, asphalt modifier, and CRM to be used. In addition, when requested by the Engineer, the Contractor shall submit samples of the tested material along with the Certificate of Compliance.

203-11.2.1 Paving Asphalt. The asphalt used for asphalt-rubber shall be AR 4000 conforming to 203-1 and shall be modified with an asphalt modifier.

203-11.2.2 Asphalt Modifier. The asphalt modifier will be a resinous, high flash point, aromatic hydrocarbon compound and shall conform to the requirements in Table 203-11.2.2(A).

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test Method</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flash Point, C.L.O.C., °C (°F)</td>
<td>D 92</td>
<td>207 (405) min</td>
</tr>
<tr>
<td>Viscosity, cSt @ 100°C (212°F)</td>
<td>D 445</td>
<td>X ± 3*</td>
</tr>
<tr>
<td>Molecular Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphaltenes, percent by mass</td>
<td>D 2007</td>
<td>0.1 max</td>
</tr>
<tr>
<td>Aromatics, percent by mass</td>
<td>D 2007</td>
<td>55 min</td>
</tr>
</tbody>
</table>

* The symbol “X” is the viscosity of the asphalt modifier the Contractor proposes to furnish. The value “X” which the Contractor proposes shall be between the limits of 19 and 36 and shall be submitted in writing to the Engineer. Any proposed change requested by the Contractor in the value “X” shall require a new asphalt-rubber binder design.

203-11.2.3 Crumb Rubber Modifier (CRM). The material shall consist of a combination of scrap tire CRM and high natural CRM meeting the requirements of this subsection. 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. The high natural CRM may consist of blended CRM.

CRM shall be ground or granulated at ambient temperature. Cryogenically produced CRM particles which can pass through the grinder or granulator without being ground or granulated shall not be used. Cryogenic separation, if utilized, shall be performed separately from and prior to grinding or granulating. Steel and fiber separation may employ any method.

CRM shall not contain more than 0.01 percent of wire by weight and shall be free of all other contaminants, except fabric. Fabric shall not exceed 0.05 percent by weight of CRM. A Certificate of Compliance certifying these percentages shall be furnished to the Engineer.

CRM shall be dry and free-flowing and not produce foaming when combined with the blended paving asphalt and asphalt modifier mixture. Calcium carbonate or talc may be added up to a maximum of 3 percent by weight of CRM to prevent CRM particles from sticking together. The CRM shall have a specific gravity range from 1.1 minimum to 1.2 maximum as determined by ASTM D 297. Scrap tire CRM and high natural CRM shall be delivered to the production site in separate bags and shall be sampled and tested separately. Scrap tire CRM material shall conform to the following chemical analysis in Table 203-11.2.3(A).
TABLE 203-11.2.3 (A)
CHEMICAL REQUIREMENTS FOR SCRAP TIRE CRM

<table>
<thead>
<tr>
<th>Test</th>
<th>ASTM Test Method</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone Extract</td>
<td>D 297</td>
<td>6.0%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Ash Content</td>
<td>D 297</td>
<td>—</td>
<td>8.0%</td>
</tr>
<tr>
<td>Carbon Black Content</td>
<td>D 297</td>
<td>28.0%</td>
<td>38.0%</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>D 297</td>
<td>42.0%</td>
<td>65.0%</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>D 297</td>
<td>22.0%</td>
<td>39.0%</td>
</tr>
</tbody>
</table>

The scrap tire CRM described above shall be mixed at the job site with high natural CRM so that 75% ± 2% of the product used is derived from scrap tires and 25% ± 2% from materials that utilize high natural rubber sources. The high natural rubber CRM may consist of blended CRM which, after blending, conforms to the following chemical analysis in Table 203-11.2.3(B).

TABLE 203-11.2.3(B)
CHEMICAL REQUIREMENTS FOR HIGH NATURAL CRM

<table>
<thead>
<tr>
<th>Test</th>
<th>ASTM Test Method</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone Extract</td>
<td>D 297</td>
<td>4.0%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Rubber Hydrocarbons</td>
<td>D 297</td>
<td>50.0%</td>
<td>–</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>D 297</td>
<td>40.0%</td>
<td>48.0%</td>
</tr>
</tbody>
</table>

With the approval of the Engineer, the High Natural Rubber per 203-11.2.3 and the Asphalt Modifier per 203-11.2.2 may be eliminated. If High Natural Rubber is not used, then the full amount of required CRM shall be Scrap Tire CRM per Table 203-11.2.3(A). Asphalt Rubber binder without natural rubber shall be designated as Type I and ARHM manufactured with Type I binder shall be designated as ARHM-I.

203-11.2.3.1 CRM Gradations. CRM gradations shall conform to the requirements of Table 203-11.2.4 (A) when tested in accordance with the requirements of ASTM C136, amended as follows:

Split or quarter 100 grams ± 5 grams from the representative CRM sample and dry to a constant weight at a temperature of not less than 57°C (135°F) nor more than 63°C (145°F) and record the dry sample weight. Place the CRM sample and 5.0 grams of talc (or calcium carbonate) in a 1 pint jar. Seal the jar and shake it by hand for a minimum of one minute to mix the CRM and the talc (or calcium carbonate). Continue shaking or open the jar and stir until particle agglomerates and clumps are broken and the talc (or calcium carbonate) is uniformly mixed.

A Rotap (or equivalent) test shaker shall be used for the sieve analysis. Place one rubber ball on each sieve. Each ball shall have a weight of 8.5 ± 0.5 grams, have a diameter of 24.5 ± 0.5mm, and shall have a Shore Durometer “A” hardness of 50 ± 5 in accordance with the requirements in ASTM D2240. After sieving the combined material for 10 minutes ± 1 minute, disassemble the sieves. Any material adhering to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the weight of the material retained on the 2.36mm (No 8) sieve and leave this material (do not discard) on the scale or balance. Any observed fabric balls shall remain on the scale or balance and shall be placed together on the side of the scale or balance to prevent the fabric balls from being covered or disturbed when placing the material from finer sieves onto the scale or balance. The material retained on the next finer sieve (2.00mm (No 10) sieve) shall be added to the scale or balance. Weigh and record that weight as the accumulative weight retained on that sieve (2.00mm (No. 10) sieve). Continue weighing and recording the accumulated weight retained on the remaining sieves until the
accumulated weight retained in the pan has been determined. Prior to discarding the CRM sample, separately weigh and record the total weight of fabric balls in the sample.

Determine the weight of material passing the 75µm (No. 200) sieve (or weight retained in the pan) by subtracting the accumulated weight retained on the 75µm (No. 200) sieve from the accumulated weight retained in the pan. If the material passing the 75µm (No. 200) sieve (or weight retained in the pan) has a weight of 5 grams or less, cross out the recorded number for the accumulated weight retained in the pan and copy the number recorded for the accumulated weight retained on the 75µm (No. 200) sieve and record that number (next to the crossed out number) as the accumulated weight retained in the pan. If the material passing the 75µm (No. 200) sieve (or weight retained in the pan) has a weight greater than 5 grams, cross out the recorded number for the accumulated weight retained in the pan, subtract 5 grams from that number and record the difference next to the crossed out number. The adjustment to the accumulated weight retrained in the pan is made to account for the 5 grams of talc (or calcium carbonate) added to the sample. For calculation purposes, the adjusted total sample weight is the same as the adjusted accumulated weight retained in the pan. Determine the percent passing based on the adjusted total sample weight and record to the nearest 0.1 percent.

**TABLE 203-11.2.3.1 (A) GRADING REQUIREMENTS FOR CRM**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Scrap Tire CRM percent passing</th>
<th>High Natural CRM percent passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.36 mm (No. 8)</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>98 – 100</td>
<td>100</td>
</tr>
<tr>
<td>1.18 mm (No. 16)</td>
<td>45 – 75</td>
<td>95 - 100</td>
</tr>
<tr>
<td>600 µm (No. 30)</td>
<td>2 – 6</td>
<td>35 – 85</td>
</tr>
<tr>
<td>300 µm (No. 50)</td>
<td>0 – 6</td>
<td>10 – 30</td>
</tr>
<tr>
<td>150 µm (No. 100)</td>
<td>0 – 2</td>
<td>0 - 4</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>–</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>

* CRM from more than one source may be used provided the combined CRM gradation meets the specified limits. No particles shall exceed a length of 5mm (3/16 inch) as measured on any axis.

**203-11.2.4 Aggregate.** The aggregate for ARHM shall meet the quality requirements specified in 200-1 for asphalt concrete.

**203-11.3 Composition and Grading.** Asphalt-rubber hot-mix -gap-graded (ARHM-GG) will be designated by class, i.e., ARHM-GG-C, and shall conform to the requirements of this Section and Table 203-11.3 (A).
### TABLE 203-11.3 (A)
**REQUIREMENTS FOR ARHM-GG**

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>ARHM-GG-B</th>
<th>ARHM-GG-C</th>
<th>ARHM-GG-D</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in)</td>
<td>100</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>19.0 mm (3/4 in)</td>
<td>90 – 100</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>12.5 mm (1/2 in)</td>
<td>—</td>
<td>90 – 100</td>
<td>100</td>
</tr>
<tr>
<td>9.5 mm (3/8 in)</td>
<td>60 – 75</td>
<td>78 – 92</td>
<td>78 – 92</td>
</tr>
<tr>
<td>4.5 mm (No. 4)</td>
<td>28 – 42</td>
<td>28 – 42</td>
<td>28 – 42</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>15 – 25</td>
<td>15 – 25</td>
<td>15 – 25</td>
</tr>
<tr>
<td>600 µm (No. 30)</td>
<td>5 – 15</td>
<td>5 – 15</td>
<td>5 – 15</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>0 – 5</td>
<td>2 – 7</td>
<td>2 – 7</td>
</tr>
<tr>
<td>% Asphalt Rubber Binder by Weight of Dry Aggregate*</td>
<td>7.5 – 8.4</td>
<td>7.5 - 8.7</td>
<td>7.5 - 8.7</td>
</tr>
<tr>
<td>Air Voids % Calif. Test 367</td>
<td>3 – 6</td>
<td>3 – 6</td>
<td>3 – 6</td>
</tr>
<tr>
<td>Stabiliometer Value Min. Calif. Test 304 and 366</td>
<td>25</td>
<td>23</td>
<td>23</td>
</tr>
<tr>
<td>Voids in Mineral Agg. Percent Min.</td>
<td>18</td>
<td>18</td>
<td>18</td>
</tr>
</tbody>
</table>

*Once the percent asphalt rubber binder is determined by the mix design, the production tolerance shall be ±0.5 % as determined by California Test Method 362, 379, or 382.

#### 203-11.4 Mixing
Mixing of the asphalt and CRM shall be accomplished as specified herein. 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 is considered to be chemically compatible when it meets the requirements for asphalt rubber binder (after reacting) found in Table 203-11.4(A).

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% to 6.0% 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 190°C (375°F) nor more than 226°C (440°F) when the asphalt modifier is added. If 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 the paving asphalt will not be required when all ingredients of the asphalt rubber binder are proportioned and mixed simultaneously. Asphalt modifier and paving asphalt shall be measured for proportioning with meters conforming to the requirements of asphalt plant proportioning in 203-6-5.

The proportions of the materials, by total weight of asphalt-rubber binder, shall be 80% ± 2% combined paving asphalt and asphalt modifier, and 20% ± 2% CRM. However, the minimum amount of CRM shall not be less than 18%. The temperature of the blended asphalt and modifier shall be between 190°C (375°F) minimum and 226°C (440°F) maximum when the CRM is added. The temperature shall not exceed 6°C (10°F) below the actual flash point of the mixture. The CRM shall be combined and mixed together in an asphalt-rubber mechanical blender meeting the requirements of 203-11.5. The combined asphalt and CRM shall be pumped into a storage/reaction tank or distributor truck meeting the requirements of 203-11.5. The required mixing/reaction time shall be 45 minutes minimum. The temperature of the asphalt-rubber mixture shall be between 190°C (375°F) minimum to 218°C (425°F) maximum during the reaction period. After reacting, the asphalt rubber binder shall conform to the requirements in Table 203-11.4(A).
TABLE 203-11.4 (A)
REQUIREMENTS FOR ASPHALT RUBBER BINDER

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Test Method</th>
<th>Specification Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haake Field Viscosity @ 191°C (375°F), (Centipoise)</td>
<td>See 203-11.4.1</td>
<td>Minimum 1500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum 4000</td>
</tr>
<tr>
<td>Cone Penetration @ 25°C (77°F), 0.1mm</td>
<td>ASTM D 217</td>
<td>Minimum 25</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum 70</td>
</tr>
<tr>
<td>Resilient @ 25°C (77°F), % Rebound</td>
<td>ASTM D 3407</td>
<td>Minimum 18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum —</td>
</tr>
<tr>
<td>Field Softening Point, °C (°F)</td>
<td>ASTM D 36</td>
<td>Minimum 52 (125)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum 74 (165)</td>
</tr>
</tbody>
</table>

The reacted asphalt rubber binder shall be maintained at a temperature of not less than 190°C (375°F) nor more than 218°C (425°F). If any of the material in a batch of asphalt rubber binder is not used within 4 hours after the 45-minute reaction period, heating of the material shall be discontinued. Any time the asphalt rubber binder cools below 190°C (375°F), and is then reheated, shall be considered a reheat cycle. The total number of reheat cycles shall not exceed 2. The material shall be uniformly reheated to a temperature of not less than 190°C (375°F) nor more than 218°C (425°F) prior to use. Additional scrap tire CRM meeting the requirements of 203-11.2.3 may be added to the reheated binder and reacted for a minimum of 45 minutes. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder weight. Reheated asphalt rubber binder shall conform to the requirements in Table 203-11.4(A).

When permitted by the Engineer, asphalt-rubber binder produced on another agency’s project and defined here as “hold over material”, may be used on the project if the initial agency certifies the following:

1. The total tons and type of material being held over.
2. The amount of CRM contained within the holdover load on a percentage basis.
3. The grade of paving asphalt and asphalt modifier used and its source.
4. Date of original mixing.
5. Number of reheat cycles.

In no case, will more than 20 tons of holdover material be allowed to be transferred from one project to another. In all cases, the holdover material when blended with new asphalt-rubber binder, shall conform to the requirements in Table 203-11.4(A).

203-11.4.1 Hand Held Viscometer Test. The Hand Held Viscometer Test shall be conducted as follows:

Precautions

This test method may involve hazardous materials, operations and equipment. This test method does not purport to address all the safety issues associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Apparatus

1) Viscometer: Haake Model VT-02 rotational viscometer or equivalent
2) Spindle: Rotor No.1, diameter 24 mm ± 0.1 mm, height 53 mm ± 0.1 mm or equivalent
3) Thermometer: digital with metal-jacketed probe, 1°C (1°F) precision
4) Sample Container: 1 gallon metal can with wire bale
5) Standard Fluids: per fluid manufacturer recommendations calibrate viscometer in absolute viscosity (centipoise).
Calibration
The viscometer shall be calibrated per manufacturer recommendations. The accuracy of the viscometer shall be verified by comparing the viscosity results obtained with the hand held viscometer to 3 separate calibration fluids of known viscosity ranging from 1000 to 5000 centipose. The viscometer will be considered accurate if the values obtained are within 300 centipose of the known viscosity. The known viscosity value shall be based on the fluid manufacturer standard test temperature or the test temperature versus viscosity correlation table provided by the fluid manufacturer. The viscometer calibration may be performed at an offsite laboratory and Certificate of Compliance verifying the calibration shall be provided to the Engineer.

Test Procedure
1. Obtain a representative sample of asphalt rubber binder from an appropriate sample valve during production. Prior to sampling, run a one-gallon sample of binder through the sampling valve and discard the sample. Place a clean one-gallon sample can under the sampling valve and fill the container to approximately 85% full.

2. Transport the sample immediately to the testing location. The testing location should be reasonably close to the sampling location to avoid undue temperature loss. The temperature of the binder prior to sampling should be a minimum of 190°C (375°F). The sample container shall then be placed on a smooth, level support for testing.

3. The binder shall be continuously stirred using an appropriate metal stirring rod. Use of the temperature probe is permitted. Insert the temperature probe into the binder and check the temperature. Stirring shall continue until the binder reaches a temperature of 190°C ± 3°C (375°F ± 5°F).

4. The viscometer spindle shall be cleaned in a suitable solvent and free of any binder material prior to test. While holding the viscometer over the sample container insert the spindle of the viscometer into the sample container near the side of the container and turn the viscometer on. While the spindle is rotating, move the spindle in and out of the binder three times to bring the spindle up the temperature of the binder. Continue stirring the binder.

5. Determine the viscosity of the binder at 190°C ± 3°C (375°F ± 5°F) as follows. In one continuous operation, remove the spindle from the binder (after heating), discontinue stirring the binder and immediately insert the spindle back into the center of the binder sample. While holding the viscometer level watch the needle on the viscometer dial and record the maximum value obtained on the dial. Record the test temperature and the maximum viscosity. Subtract 100 centipoise from the maximum value recorded and report this as the viscosity of the asphalt rubber binder. (The viscometer shall be maintained and operated in accordance with the instructions from the manufacturer. However, this test method shall apply if there are any differences in the instructions for determination of the viscosity.)

6. Report the following information for the viscosity test; technician performing viscometer test, date and location of plant, asphalt rubber binder supplier, binder test temperature and viscosity, spindle size and rotating speed in revolutions per minute, viscometer model and serial number.

203-11.5 Equipment for production of Asphalt-Rubber. The Contractor shall utilize the following equipment for production of asphalt-rubber binder:
1. **Asphalt Heating Tank.** An asphalt heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ± 3°C (± 5°F) and shall be of the recording type.

2. **Blender Equipment.** A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier, and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer through meters. The blending system shall be capable of varying the rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than ± 14°C (± 25°F). The paving asphalt feed, the asphalt modifier feed and CRM feed, shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. Meters used for proportioning individual ingredients shall be equipped with rate-of-flow indicators to show the rates of delivery and resettable totalizers so that the total amounts of liquid ingredients introduced into the mixture can be determined. The liquid and dry ingredients shall be fed directly into the mixer at a uniform and controlled rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt-rubber binder of unchanging appearance and consistency is produced. The Contractor shall provide a safe sampling device capable of delivering a representative sample of the completed asphalt-rubber binder of sufficient size to permit the required tests.

3. **Storage/Reaction Tank.** An asphalt-rubber binder storage/reaction tank equipped with a heating system that is equipped with a temperature reading device to maintain the proper temperature of the asphalt-rubber binder and an internal mixing unit capable of maintaining a homogeneous mixture of paving asphalt, asphalt modifier and CRM.

4. **Viscometers.** The Contractor shall supply a Haake Viscometer per 203-11.4.1 (or equivalent) for use by the Engineer to verify the viscosity of the asphalt-rubber on all projects where a field laboratory is used. All asphalt concrete plants are required to have a field laboratory for use by the Engineer per 8-3.

   The equipment shall be approved by the Engineer prior to use.

   **203-11.6 Mix Designs and Certifications.** The optimum binder content for ARHM-GG mixes shall be determined by California Test Method 367 except that Step 2 regarding surface flushing shall not be used. Optimum binder content shall be determined by using a void content between 3 percent minimum to 6 percent maximum as approved by the Engineer. Compaction shall be in accordance with California Test Method 304 except for the following:

   **Mixing Temperatures:**
   - Asphalt-rubber = 163°C to 182°C (325°F to 360°F)
   - Aggregate = 143°C to 163°C (290°F to 325°F)
   - Compaction Temperature = 143°C to 149°C (290°F to 300°F)
In addition to the formulations and certifications required in 203-11.3 and 203-11.4 for asphalt-rubber, the Contractor shall furnish to the Engineer a mix design and samples of all materials to be used at least 10 working days before construction is scheduled to begin. The mix design and certifications shall include, but are not limited to, the following:

1) Combined aggregate gradation.
2) Individual bin gradations (hot for batch, cold for drum plant).
3) Percentage of each bin.
4) Asphalt rubber binder content.
5) Density.
6) Air Voids.
7) Voids in Mineral Aggregates (VMA).
8) Stability.
9) Aggregate source
10) Asphalt binder source

**203-11.7 Miscellaneous Requirements.** Miscellaneous requirements shall conform to 203-6.8 except that the temperature of the asphalt-rubber binder shall be $191^\circ C$ ($375^\circ F$) minimum to $218^\circ C$ ($425^\circ F$) maximum for asphalt-rubber when added to the aggregate. The temperature of the aggregate at the time of adding the asphalt-rubber binder shall be $149^\circ C$ ($300^\circ F$) minimum to $166^\circ C$ ($330^\circ F$) maximum.

**203-12 Asphalt Rubber and Aggregate Membrane (ARAM) Surfacing or Interlayer.**

**203-12.1 General.** ARAM surfacing or interlayer shall involve cleaning and preparing the existing surface, spreading asphalt rubber and cover aggregate, rolling, and sweeping.

The construction sequence of an ARAM shall be as follows:

1) The surface shall be cleaned.
2) Asphalt-rubber shall be applied.
3) Screenings shall be placed, rolled, and loose material removed. Only then will the ARAM surface be opened to traffic. A minimum of 48 hours shall elapse after placement of the screenings before a slurry seal conforming to 302-4 may be applied, unless otherwise directed by the Engineer.

Certified volume or weight slips shall be delivered to the Engineer for all materials supplied.

**203-12.2 Materials.** Materials used in the construction of ARAM shall be asphalt rubber and screenings as specified below.

**203-12.2.1 Asphalt Rubber.** Asphalt Rubber shall conform to 203-11

**203-12.2.2 Screenings.** Screenings, when used as a cover aggregate for ARAM shall be crushed rock conforming to the following gradations in Table 203-12.2.2 (A):
### TABLE 203-12.2.2 (A)
#### SCREENINGS

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing Sieve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coarse 12.5mm (1/2 in)</td>
</tr>
<tr>
<td>19.0 mm (3/4 in)</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in)</td>
<td>90 – 100</td>
</tr>
<tr>
<td>9.5 mm (3/8 in)</td>
<td>50 – 80</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>0 - 15</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>0 - 5</td>
</tr>
<tr>
<td>1.18 mm (No. 16)</td>
<td>—</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>

1. Lower percentages are desirable.

Screenings shall be medium 9.5mm (3/8 inch) unless otherwise specified. Screenings shall be preheated between 127°C (260°F) to 163°C (325°F) and adequately coated with 0.70 percent to 1 percent Paving Grade AR 4000 asphalt at a central mixing plant to prevent free dust. The exact amount of asphalt shall be recommended by the Contractor and approved by the Engineer. Screenings shall conform to the requirements of Table 200-1.2 (B).

### 302-9 Asphalt Rubber Hot Mix (ARHM)

**302-9.1 General.** ARHM shall conform to 203-6.5, 203-11.5, and 302-5.

**302-9.2 Mixing Binder With Aggregate.** Mixing of the Asphalt Rubber binder with aggregate shall conform to 203-6.6 except that temperature requirements of ARHM shall supercede the requirements in 203-6.6.

**302-9.4 Storage.** Storage of ARHM shall conform to 203-6.7

**302-9.4 Distribution and Spreading.** Distribution and spreading shall conform to 302-5.5 except that at the time of delivery to the work site, the temperature of the ARHM-GG shall be 149°C (300°F) minimum to 166°C (330°F) maximum. When atmospheric temperatures are above 29°C (85°F), the temperature of the mix delivered to the site may be reduced to 143°C (290°F) if approved by the Engineer. Atmospheric temperature shall be 10°C (50°F) and rising. ARHM-GG shall conform to the specifications for 302-5 except ARHM-GG shall consist of one or more courses of an asphalt-rubber binder and graded aggregate conforming to 203-11.3 placed upon a prepared roadbed or base, or over existing pavement. The courses shall conform to the requirements as shown on the Plans or in the Specifications.

**302-9.5 Rolling.** Rolling shall conform to 302-5.6 except that vibratory rollers using the vibratory mode shall be used for initial breakdown rolling. The initial coverage of breakdown rolling shall commence before the ARHM-GG temperature falls below 143°C (290°F). If the atmospheric temperature is above 29°C (85°F), the initial breakdown rolling temperature may be reduced to 138°C (280°F). Pneumatic rollers shall not be used. If the temperature of the mat during breakdown rolling is reduced, this will not relieve the Contractor of his compaction requirements.

**302-9.6 Rock Dust Blotter.** At the option of the Engineer, when traffic conditions warrant, a rock dust blotter may be required to avoid tracking. Rock dust blotter shall conform to 200-1.2 and be uniformly applied using a mechanical spreader at a rate of 1.1 kg/m² (2 lbs./yd²) minimum to 2.2 kg/m² (4 lbs./yd²) maximum. When the ARHM-GG pavement has cooled to below 66°C (150°F), the rock dust blotter may not be required. Rock dust blotter placement and sweeping shall be included in the price bid for other items of work and no additional compensation will be allowed therefor.
302-10  Asphalt Rubber Aggregate Membrane.

302-10.1  Application.  Asphalt rubber shall be placed upon a clean dry surface. The pavement surface temperature shall be a minimum of 13°C (55°F) including shaded areas; the atmospheric temperature shall be a minimum of 16°C (60°F); the wind shall not adversely affect spray distribution; and all necessary equipment shall be in position and ready to commence placement operations prior to starting the work. The contractor shall take temperature readings with a temperature measuring device approved by the Engineer.

Asphalt rubber shall be applied by distributor equipment meeting the requirements of the following:

1. Distributor trucks shall meet the requirements for distributing equipment of 203-2.5 and be equipped with an internal heating device capable of evenly heating the material to a temperature of 218°C (425°F).
2. The distributor shall have a platform on the rear of the vehicle and an observer shall accompany the distributor.
3. The observer shall ride in a position so that all spray bar tips are in full view and readily accessible for unplugging if a plugged tip should occur.
4. Material shall be applied at a rate between 2.5 to 3.0 Liters per square meter (0.55 to 0.65 gallons per square yard) as directed by the Engineer.
5. Material spreading shall not be in excess of that which can be covered with aggregate within 15 minutes maximum.

Distribution and spreading shall conform to 302-5.5 except that at the time of delivery to the work site, the temperature of the asphalt rubber shall be 149°C (300°F) minimum.

The asphalt rubber mixture may be applied to the roadway immediately following mixing and reacting at a temperature between 191°C (375°F) minimum to 218°C (425°F) maximum. However, if the material is not to be used within 6 hours of mixing, the mixture shall be allowed to cool below 149°C (300°F) for 12 hours maximum, or to ambient temperature for longer periods, and shall be uniformly reheated to a temperature between 149°C (300°F) minimum to 218°C (425°F) maximum at time of placement and conform to the viscosity requirements.

When joining edges against areas with cover aggregate, the joint shall be swept clean of excess aggregate prior to the adjacent application of asphalt rubber material. Transverse joints of this type 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 immediately.

Joints between areas of asphalt rubber without cover aggregate shall be made by overlapping asphalt rubber distributions. The excess material shall be dispersed by spreading with a squeegee or rake over a larger area of freshly applied asphalt rubber. The longitudinal joint between adjacent applications of screenings shall coincide with the line between designated traffic lines. All longitudinal joints shall be overlapped for complete coverage. The overlap shall not exceed 100mm (4 inches). At longitudinal joints, the edge shall be broomed back and blended so there are no gaps and the elevations are the same, free from ridges and depressions.

The application of asphalt rubber to areas not accessible with the distributor bar on the truck shall be accomplished by using pressurized hand wands or other means approved by the Engineer.

Application of asphalt rubber shall be discontinued sufficiently early in the workday to permit completion of initial sweeping prior to the termination of traffic control.
302-10.2 Screenings. Following the application of asphalt rubber, screenings conforming to 203-12.2 shall be placed over all areas receiving asphalt rubber. Screenings shall be applied (within a maximum of 15 minutes) at a temperature between 127°C (260°F) minimum to 163°C (325°F) maximum at a rate of 15 to 22 kilograms per square meter (28 to 40 pounds per square yard) as directed by the Engineer. Stockpiling of screenings after preheating and precoating with paving asphalt will not be permitted.

The contractor shall prevent any vehicle, including construction equipment, from driving on the uncovered asphalt rubber. Screenings shall be placed with a self-propelled aggregate-spraying machine that can be adjusted to accurately spread the specified amounts per square meter (yard). Trucks for hauling screening material shall conform to 302-2.3.

Initial rolling shall commence within 90 seconds following the placement of screenings. Rolling shall be accomplished by three self-propelled, pneumatic-tired rollers meeting the requirements of 302-5.6.1 except that the tires shall be inflated to 690 kPa (100 pounds per square inch). The operating weight of each roller shall be a minimum of 7200 kg (16,000 pounds). If in the opinion of the Engineer, complete coverage may be provided by two rollers in one pass, then two pneumatic-tired rollers are sufficient. The initial rolling equipment shall maintain a distance of not more than 60m (200 feet) behind the cover-aggregate spreader on the first pass. There shall be at least four complete coverages (single pass in one direction) by the pneumatic-tired rollers before final roller coverage. A steel-drum roller weighing 7.2 Tonnes (8 tons) minimum to 9.1 Tonnes (10 tons) maximum shall complete the final roller coverage.

Sweeping shall be a multi-step operation following final rolling of the aggregate. A power broom shall be used to remove loose material without dislodging aggregate set in the asphalt rubber. The initial sweeping shall be a light brooming on the same day as ARAM placement. The ARAM shall be maintained free of loose screenings for a minimum of 5 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 done and all loose aggregate shall be removed prior to acceptance. The sweeping operations shall be accomplished without the use of gutter brooms or steel-tined brooms.

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.

At the option of the Engineer, rock dust blotter material shall be applied immediately after the initial pass of the rollers or after sweeping, but prior to opening to traffic, to prevent bleeding and pickup of the asphalt rubber material. Rock dust blotter conforming to 200-1.2 shall be uniformly applied using a mechanical spreader at a rate of 1.1 kg/m² (2 lbs./yd²) minimum to 2.2 kg/m² (4 lbs./yd²) maximum. The Contractor shall include in the bid price for ARAM the full cost of applying rock dust blotter to all areas of ARAM, as directed by the Engineer. If the ARAM is to be used as a finished surface, a flush coat shall be used.

The Contractor shall protect all existing manhole, valve, survey monument, and other miscellaneous frames and covers. The Contractor shall cooperate with the owners of any frames and covers and shall cover and completely protect them with heavy roofing paper or other suitable material. Petroleum-based release agents shall not be used for this purpose.
**302-10.3 Flush Coat.** If required a flush coat shall be applied. This work shall consist of an application of fog seal coat and rock dust blotter material to the surface of ARAM. The Contractor shall include in the bid price for ARAM the full cost of applying a flush coat (if required) to all areas of ARAM, as directed by the Engineer.

Flush coat shall be applied to the ARAM immediately after removal of excess screenings following initial brooming of the ARAM and prior to opening the lane to uncontrolled public traffic, as directed by the Engineer.

Asphaltic emulsion (fog seal coat) shall be applied to the surface of the ARAM and shall be grade CSS1 or CSS1H, per 203-3, unless otherwise ordered by the Engineer.

The application rate of the fog seal coat (asphaltic emulsion and an equal amount of water) shall be such that the diluted asphaltic emulsion will be spread at a rate of 0.27 L/m² (0.06 gal./yd²) minimum to 0.54 L/m² (0.12 gal./yd²) maximum. The exact rate of application will be determined by the Engineer.

During fog seal coat operations the surface upon which an ARAM is being applied shall be closed to public traffic. Care shall be taken to avoid tracking fog seal coat material onto existing pavement surfaces beyond the limits of construction.

**302-10.4 Public Convenience and Traffic Control.** The Contractor shall prohibit traffic on the street until the initial sweeping is complete. Prior to opening the streets to traffic, “Loose Gravel,” C6 signs, and appropriate speed-reduction signs conforming to local, State, and Federal regulations shall be posted and maintained by the Contractor. These signs shall remain in place until there is no further dislodging of the cover aggregate.

**302-10.5 Measurement and Payment.** ARAM including asphalt rubber and cover aggregate will be paid for at the contract unit price per square meter (square yard). Unless otherwise specified, such price shall include full compensation for pavement preparation, furnishing and placing materials required, including rock dust blotter, and for all labor, equipment, sweeping, tools, and incidentals needed to complete the work in place.
c) Sacramento County

Contact for Sacramento County specifications is:
Theron Roschen (916-874-7225)
24. **PRE-CHIP SEAL PREPARATION**

The County shall be responsible for clearing grass from the edge of pavement before the Contractor performs the rubberized chip seal, and making minor roadway repairs in advance of the chip operation.

The Contractor shall sweep the pavement and remove and dispose of all raised pavement markers no earlier than 2 days prior to the rubberized chip seal operations, and shall cover and protect any raised traffic bars or utility covers from being coated, as directed by the Engineer.

The County will replace the raised pavement markers and striping after the rubberized chip seal operation is complete.

The Contractor shall be responsible for inspecting the street prior to performing the rubberized chip seal operation to assure proper bonding. If the Engineer determines that additional sweeping is necessary, the Contractor shall schedule an additional sweeper as soon as possible at no cost to the County. The County shall be held free of any liability due to any delays experienced by the Contractor during the time a sweeper is scheduled and the sweeper finishes the work.

All thermoplastic stop limit lines and legends painted on the road surface shall be scarified prior to placing rubberized chip seal. Scarification shall be performed by grinding or sandblasting such that approximately 30% of the underlying pavement is exposed. The bid price for the rubberized chip seal shall include this work and all pavement sweeping, and no additional compensation shall be allowed therefor.

25. **RUBBERIZED CHIP SEAL**

Rubberized chip seal shall consist of an application of asphalt-rubber binder and screenings precoated with paving asphalt. Rubberized chip seal shall conform to the requirements specified for seal coats in section 37-1, “Seal Coats”, of the CALTRANS Standard Specifications and to these special provisions.

A certificate of compliance shall be furnished to the engineer in accordance with Section 6-1.07, “Certificates of Compliance”, of the Standard Specifications for each material used in asphalt-rubber binder and the asphalt-rubber binder mixture. It shall certify that the material conforms to the requirements of these special provisions. When requested by the engineer, the contractor shall also submit samples with certificates of compliance. The contractor shall provide the engineer with a Material Safety Data Sheet (MSDS) for each of the constituent components of the asphalt-rubber binder and for the completed mixture of the asphalt-rubber binder.

Crumb Rubber Modifier (CRM) shall be tested, except for the grading requirement, at least once for every 250 tons with a minimum of once per project. CRM shall be tested for grading every truckload delivered to the project.

Paving asphalt shall be tested at least once for every 200 tons of production with a minimum of once per project.
Asphalt modifier shall be tested at least once for every 25 tons of production with a minimum of once per project.

A copy of the laboratory test results for the test parameters specified in these special provisions for CRM, paving asphalt and asphalt modifier shall be submitted to the engineer with the certificate of compliance for each truck load of individual material delivered to the project.

Certified volume or weight slips shall be delivered to the engineer for all materials supplied.

Paving asphalt to be used in the asphalt rubber binder shall be grade AR-4000 and shall conform to Section 92, “Asphalts”, of the Standard Specifications and these special provisions.

The paving asphalt for use in Rubberized asphalt shall be modified with an asphalt modifier.

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

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Designation</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, cSt. At 100 °C</td>
<td>D445</td>
<td>X +/- 3*</td>
</tr>
<tr>
<td>Flash Point, COC, °F</td>
<td>D92</td>
<td>405 min.</td>
</tr>
<tr>
<td>Molecular Analysis:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asphaltenes, percent By weight</td>
<td>D2007</td>
<td>0.1 max.</td>
</tr>
<tr>
<td>Aromatics, percent by Weight</td>
<td>D2007</td>
<td>55 min.</td>
</tr>
</tbody>
</table>

- The symbol “X” is the viscosity of the asphalt modifier the contractor proposes to furnish. The value “X” which the Contractor proposes shall be between the limits 19 and 36 and shall be submitted in writing to the engineer. Any proposed change requested by the Contractor, in the value “X” shall require a new asphalt-rubber design.

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 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. If 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 the paving asphalt will not be required when all ingredients of the asphalt rubber binder are proportioned and mixed simultaneously. Asphalt modifier and paving asphalt shall be measured for proportioning.
CRUMB RUBBER MODIFIER (CRM) – Crumb rubber modifier shall consist of high natural CRM. The high natural CRM shall consist of ground or granulated rubber derived from materials that utilize high natural rubber sources.

Steel fiber separation may be accomplished by any method. Cryogenic separation, if utilized, shall be performed separately from and prior to grinding or granulating.

All CRM shall be ground or granulated at ambient temperature. Cryogenically produced CRM particles that can pass through the grinder or granulator without being ground or granulated respectively, shall not be used.

CRM shall not contain more than 0.01 percent wire (by weight of CRM) and shall be free of all other contaminants, except for fabric. Fabric shall not exceed 0.05 percent by weight of CRM. The test and method for determining the percent by weight of wire and fabric is available at the Transportation Laboratory, Pavement Consulting Services Branch, Sacramento, California, Telephone (916) 227-7300 and will be furnished to interested persons upon request. A certificate of compliance certifying these percentages shall be furnished to the engineer in accordance with Section 6-1.07, “Certificates of Compliance,” of the Standard Specifications.

The length of any individual particle shall not exceed 3/16 inch.

The CRM shall be sufficiently dry so as to be free flowing and not produce foaming when combined with the blended paving asphalt and asphalt modifier mixture. Calcium carbonate or talc may be added at a maximum of 3 percent by weight of CRM to prevent CRM particles from sticking together. The CRM shall have a specific gravity between 1.1 and 1.2 as determined by California Test 208. High natural CRM shall be delivered to the production site in bags and shall be sampled and tested. CRM material shall conform to the following requirements as determined by ASTM Designation D 297:

### HIGH NATURAL CRUMB RUBBER MODIFIER

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone Extract</td>
<td>4.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Rubber Hydrocarbon</td>
<td>50.0</td>
<td>-</td>
</tr>
<tr>
<td>Natural Rubber Content</td>
<td>40.0</td>
<td>48.0</td>
</tr>
</tbody>
</table>

The CRM for asphalt rubber binder shall conform to the gradations specified below when tested in accordance with ASTM Designation C 136 amended as follows:

Split or quarter 100 grams +/- 5 grams from the CRM sample and dry to a constant weight at a temperature of not less than 135 °F. nor more than 145 °F. and record the dry sample weight. Place the CRM sample and 5.0 grams of talc in a one-pint jar, then shake it by hand for a minimum of one minute to mix the CRM and the talc. Continue shaking or open the jar and stir until the particle agglomerates and clumps are broken and the talc is uniformly mixed.
Place one rubber ball on each sieve. Each ball shall have a weight of 8.5+/-0.5 grams, have a diameter of 24.5 +/- mm, and shall have a Shore Durometer “A” hardness of 50 +/-5 per ASTM Designation D 2240. After sieving the combined material for 10 minutes +/-1 minute, disassemble the sieves. Any material adhering to the bottom of a sieve shall be brushed into the next finer sieve. Weigh and record the weight of the material retained on the No. 8 sieve and leave this material (do not discard) on the scale or balance. Any observed fabric balls shall remain on the scale or balance and shall be placed together on the side of the scale or balance to prevent the fabric balls from being covered or disturbed when placing the material from finer sieves onto the scale or balance. The material retained on the next finer sieve (No. 10 sieve) shall be added to the scale or balance. Weigh and record that weight as the accumulative weight retained on that sieve (No. 10 sieve). Continue weighing and recording the accumulated weights retained on the remaining sieves until the accumulated weight retained in the pan has been determined. Prior to discarding the CRM sample, separately weigh and record the total weight of the fabric balls in the sample.

Determine the weight of material passing the No. 200 sieve (or weight retained in the pan) by subtracting the accumulated weight retained on the No. 200 sieve from the accumulated retained weight in the pan. If the material passing the No. 200 sieve (or weight retained in the pan) has a weight of 5 grams or less, cross out the recorded number for the accumulated weight retained in the pan and copy the number recorded for the accumulated weight retained on the No. 200 sieve and record that number (next to the crossed out number) as the accumulated weight retained in the pan. If the material passing the No. 200 sieve (or weight retained in the pan) has a weight greater than 5 grams, cross out the recorded number for the accumulated weight retained in the pan, subtract 5 grams from that number and record the difference next to the crossed out number. The adjustment to the accumulated weight in the pan is made to account for the 5 grams of the talc added to the sample. For calculation purposes, the adjusted accumulated weight is the same as the adjusted accumulated weight retained in the pan. Determine the percent passing based on the adjusted total sample weight and recorded to the nearest 0.1 percent.

**CRM GRADATIONS**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Scrap Tire CRM Percent Passing</th>
<th>High Natural CRM Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>No. 10</td>
<td>98-100</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>45-75</td>
<td>95-100</td>
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<tr>
<td>No. 30</td>
<td>2-20</td>
<td>35-85</td>
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<tr>
<td>No. 50</td>
<td>0-6</td>
<td>10-30</td>
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<tr>
<td>No. 100</td>
<td>0-2</td>
<td>0-4</td>
</tr>
<tr>
<td>No. 200</td>
<td>0</td>
<td>0-1</td>
</tr>
</tbody>
</table>

**ASPHALT RUBBER BINDER** – Asphalt rubber binder shall consist of a mixture of paving asphalt, asphalt modifier and crumb rubber modifier.

At least two weeks before it’s intended use, the contractor shall furnish to the engineer 4 one quart cans filled with the asphalt rubber binder proposed for use on the project. The contractor shall supply to the engineer for approval a binder formulation and samples of all materials to be
used in the asphalt binder, at least two weeks before construction is to begin. The binder formulations shall consist of the following information:

**Paving and Asphalt Modifiers**

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

**Crumb Rubber Modifier (CRM)**

1. Source and identification (or type) of scrap tire and high natural CRM.
2. Percentage of scrap tire and high natural CRM by total weight of the asphalt rubber blend.
3. If CRM from more than one source is to be used, the above information will be required for each CRM source used.
4. Laboratory test results for test parameters shown elsewhere in these special provisions.

**Asphalt Rubber Binder**

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

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

The proportions of the materials, by total weight of the asphalt rubber binder shall be 80 percent +/-2 percent combined paving asphalt and asphalt modifier, and 20 percent +/-2 percent CRM. However, the minimum amount of CRM shall not be less than 18.0 percent. Lower values that are rounded up shall not be allowed. The CRM shall be combined at the production site and shall contain 75 percent +/-2 percent scrap tire CRM and 25 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 is considered to be chemically compatible when it meets the requirements for asphalt rubber binder (after reacting) found elsewhere in these special 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 homogenous 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 all the CRM at a temperature of not less than 375 °F. nor more than 425 °F. The temperature shall not be higher than 10 °F. below the actual flash point of the asphalt rubber binder.

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

### BLENDED ASPHALT RUBBER BINDER

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone Penetration @ 77°F, 1/10 mm</td>
<td>D217</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>Resilience @ 77 °F.</td>
<td>D3407</td>
<td>18</td>
<td>-</td>
</tr>
<tr>
<td>Field Softening Point °F.</td>
<td>D36</td>
<td>125</td>
<td>165</td>
</tr>
<tr>
<td>Viscosity @ 375 °F. Centipoise</td>
<td>See Note</td>
<td>1,500</td>
<td>3,500</td>
</tr>
</tbody>
</table>

The reacted asphalt rubber binder shall be maintained at a temperature of not less than 375 °F. nor more than 425 °F.

If any of the material in a batch of asphalt rubber binder is not used within four hours after the 45-minute reaction period, heating of the material shall be discontinued. Any time the asphalt rubber binder cools below 375 °F. and is then reheated, it shall be considered a reheat cycle. The total number of reheat cycles shall not exceed 2. The material shall be uniformly reheated to a temperature of not less than 375 °F. nor more than 425 °F. prior to use. Additional scrap tire CRM may be added to the reheated binder and reacted for a minimum of 45 minutes. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder weight. Reheated asphalt rubber binder shall conform to the requirements for blended asphalt rubber.

SCREENINGS – Screenings shall conform to the requirements in these special provisions and Section 37-1.02, “Materials”, of the Standard Specifications, except that the third, fourth, eighth and ninth paragraphs of Section 37-1.02 shall not apply.

Stockpiling of screenings after preheating and precoating with paving asphalt will not be permitted.
Canvas or similar covers that completely cover each load of precoated screenings shall be used during hauling to minimize temperature drop of the precoated screenings.

The screenings grading shall conform to the following requirements prior to precoating with paving asphalt:

**SCREENINGS GRADING REQUIREMENT**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>1/2” Maximum Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/4</td>
<td>100</td>
</tr>
<tr>
<td>1/2</td>
<td>95-100</td>
</tr>
<tr>
<td>3/8</td>
<td>70-85</td>
</tr>
<tr>
<td>No. 4</td>
<td>0-15</td>
</tr>
<tr>
<td>No. 8</td>
<td>0-5</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-1</td>
</tr>
</tbody>
</table>

Screenings shall conform to the following quality requirements immediately prior to preheating:

**SCREENINGS QUALITY REQUIREMENT**

<table>
<thead>
<tr>
<th>Test Parameters</th>
<th>California Test</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Angeles Rattler Loss (100 Revolutions)</td>
<td>211</td>
<td>10 max.</td>
</tr>
<tr>
<td>Los Angeles Rattler Loss (500 Revolutions)</td>
<td>211</td>
<td>40 max.</td>
</tr>
<tr>
<td>Film Stripping</td>
<td>302</td>
<td>25 max.</td>
</tr>
<tr>
<td>Cleansness Value</td>
<td>227</td>
<td>80 min.</td>
</tr>
<tr>
<td>Durability</td>
<td>229</td>
<td>52 min.</td>
</tr>
</tbody>
</table>

Screenings for asphalt rubber seal coat shall be preheated between 260 °F. and 325 °F. uniformly coated at a rate of 0.5 to 1 percent of grade AR-4000 paving asphalt by weight of dry aggregate at a central mixing plant. The coating will be determined upon a visual inspection of the first load and thereafter as deemed necessary by the engineer.

EQUIPMENT – The contractor shall utilize the following equipment for asphalt rubber seal coat operations:
1. Self propelled power brooms capable of cleaning the existing pavement and removing loose screenings without dislodging screenings set in the asphalt rubber binder. Gutter brooms or steel tinned brooms shall not be used.

2. Pneumatic tired rollers conforming to the requirements specified in Section 39-5.02, “Compacting Equipment”, of the Standard Specifications except that the rollers shall have an air pressure of 100 pounds per square inch and maintained so that the air pressure will not vary more than +/- 5 psi in each tire. A sufficient number of rollers shall be used so that one complete coverage will be provided in one pass.

3. A self-propelled, computerized screenings spreader, equipped with a screenings hopper in the rear, belt conveyors to carry the screenings to the front of the spreader hopper. The screenings spreader shall be capable of providing a uniform spread rate over the entire width of the traffic lane in one application.

4. An asphalt-heating tank equipped to heat and maintain the blended paving asphalt and asphalt modifier mixture at the necessary temperature before blending with crumb rubber modifier (CRM). This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate within 5 °F. and shall be of the recording type.

5. A mechanical mixer for the complete, homogeneous blending of paving asphalt, asphalt modifier, and CRM. Paving asphalt and asphalt modifier shall be introduced into the mixer. The blending system shall be capable of varying rate of delivery of paving asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of paving asphalt and the asphalt modifier shall not vary more than +/- 25 °F. The paving asphalt feed, the asphalt modifier feed, and CRM feed shall be equipped with devices by which the rate of feed can be determined during the proportioning operation. The liquid and dry ingredients shall be fed directly into the mixer at a uniform rate. The rate of feed to the mixer shall not exceed that which will permit complete mixing of all the materials. Dead areas in the mixer, in which the material does not move or is not sufficiently agitated, shall be corrected by a reduction in the volume of material or by other adjustments. Mixing shall continue until a homogeneous mixture of uniformly distributed and properly blended asphalt rubber binder of unchanging appearance and consistency is produced. The contractor shall provide a safe sampling device capable of delivering a representative sample of completed asphalt rubber binder of sufficient size to permit required tests.

6. An asphalt rubber binder storage tank equipped with a heating system to maintain the proper temperature of the asphalt rubber binder and an internal mixing unit capable of maintaining a homogeneous mixture of blended paving asphalt, asphalt modifier, and CRM.

7. A self propelled truck or trailer mounted distributor, equipped with an internal mixing unit capable of maintaining a homogeneous mixture of blended paving asphalt, asphalt modifier, and CRM. The distributor shall have a pump or pumps capable of spraying asphalt rubber binder within +/- 0.05 gallons per square yard of the specified rate. The distributor shall have a fully circulating spray bar capable of applying the asphalt rubber without a streaked or otherwise irregular pattern. The distributor shall be equipped with a tachometer, pressure gages, volume measuring devices, and a thermometer. The distributor shall have a platform
on the rear of the vehicle and an observer shall accompany the distributor. The observer shall ride in such a position that all spray nozzles are in full view and readily accessible for unplugging any plugged nozzles, should they occur.

8. Tailgate discharge trucks for hauling screenings shall be equipped with a device to lock on to 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 spilling while dumping into the receiving hopper.

All equipment shall be approved by the engineer prior to use.

APPLYING ASPHALT RUBBER BINDER – Asphalt rubber binder shall be applied in accordance with the requirements specified for applying asphaltic emulsion in these special provisions and in Section 37-1.05, “Applying Asphaltic Emulsion”, of the Standard Specifications, except that the second, third, fourth, fifth, ninth, and twelfth paragraphs of Section 37-1.05 shall not apply.

Asphalt rubber binder for asphalt rubber seal coat shall be applied where shown on the plans at the rate of 0.55 to 0.65 gallons per square yard. The exact rate will be determined by the engineer.

Asphalt rubber binder shall be placed upon a clean, dry surface. The pavement surface temperature shall be a minimum of 50 °F. where asphalt rubber binder is to be applied. The atmospheric temperature shall be a minimum of 50 °F. and a maximum of 105 °F.

Distributor bar height, distribution speed, and shielding materials shall be utilized to reduce the effects of wind upon spray distribution as directed by the engineer. The engineer shall delay or reschedule work when high gusting or dirty winds prevent or adversely affect binder or screening application operations. All necessary equipment shall be in position and ready to commence operations before starting.

The contractor shall comply with all Federal, State, and local environmental laws, rules, regulations, and ordinances including but not limited to air quality requirements.

The asphalt rubber binder shall be applied to the roadway immediately following mixing and reacting and shall be applied at a temperature of not less than 385 °F. nor more than 415 °F. Asphalt rubber binder applications shall not be in excess of that which can be covered with screenings within four minutes.

When placing asphalt rubber seal coat at intersections, turn pockets, gore points, and other irregular areas, asphalt rubber application shall not be in excess of that which can be covered with screenings within 15 minutes.

When joining edges against areas with screenings, the joint shall be swept clean of excess screenings prior to the adjacent application of asphalt rubber binder. Transverse joints of this type shall be constructed by placing roofing paper across and over the edge of the previous asphalt rubber seal coat application. Once the spraying has progressed beyond the paper, the paper shall be removed immediately.
The longitudinal joint between adjacent applications of screenings shall coincide with the line between designated traffic lanes. All longitudinal joints shall be overlapped for complete coverage. The overlap shall not exceed four inches.

At longitudinal joints with screenings, the edge shall be broomed back and blended to eliminate any difference in elevation. They shall be free from ridges and depressions and have a uniform appearance consistent with the adjacent sealed surface. All defects shall be corrected at the contractor’s expense.

Joints between areas of asphalt rubber binder without screenings shall be made by overlapping asphalt rubber binder distributions. The excess material shall be properly dispersed by spreading with a squeegee or rake over a larger area of freshly applied asphalt rubber binder.

The application of asphalt rubber binder to areas not accessible with the distributor bar on the distributor truck shall be accomplished by using pressurized hand wands or other means approved by the engineer.

SPREADING SCREENINGS – Screenings for asphalt rubber seal coat shall be spread in accordance with the requirements specified for spreading screenings on asphaltic emulsion in these special provisions and in Section 37-1.06, “Spreading Screenings”, of the Standard Specifications, except the first, fifth, sixth, and seventh paragraphs of Section 37-1.06 shall not apply.

Following the application of the asphalt rubber binder, screenings shall be placed on all areas receiving asphalt rubber binder.

Screenings for asphalt rubber seal coat shall be applied at a temperature of not less than 225 °F. and not more than 325 °F. after applying the asphalt rubber binder.

The contractor shall prevent any vehicle, including construction equipment, from driving on the asphalt rubber binder prior to the application of screenings.

Screenings shall be applied at a rate of 23 to 30 pounds per square yard. The exact rate will be determined by the engineer. The completed spread rate shall be within 10 percent of the rate determined by the engineer. The completed surface shall be free of gaps, ridges, depressions, or other irregularities caused by the application of the asphalt rubber seal coat.

FINISHING – Asphalt rubber seal coat shall be finished in accordance with the requirements for finishing screenings spread on asphaltic emulsion in these special provisions and in Section 37-1.07, “Finishing”, of the Standard Specifications, except that the second, third, seventh, eighth, and ninth paragraphs of Section 37-1.07 shall not apply.

Initial rolling of the asphalt rubber seal coat shall consist of a minimum of one complete coverage with one or more pneumatic tired rollers and shall begin within 90 seconds after the placement of screenings.
The distance between the rollers and the screenings spreader shall not exceed 200 feet at any time during the screenings spreading operation.

A minimum of three complete coverages as defined in Section 39-6.03, “Compacting”, of the Standard Specifications with pneumatic tired rollers, after the initial coverage, shall be made on the asphalt rubber seal coat. At the contractor’s option, if approved by the engineer, the final roller coverage may be made with a steel-wheeled roller weighing between 8 and 10 tons. It shall be operated in static mode only.

Sweeping shall be a multi-step operation following final rolling of the screenings. Loose screenings shall be removed from the roadway surface and abutting adjacent areas. Loose screenings shall be disposed of at least 150 feet from the nearest waterway and areas shall be provided and identified for this purpose.

Removal of excess screenings shall be completed before uncontrolled traffic is permitted on the completed asphalt rubber seal coat. Final sweeping shall be done and all loose screenings shall be removed without dislodging the screenings set in the asphalt rubber binder prior to acceptance.

Pilot cars shall be sufficiently available to continuously convoy and control traffic. Pilot cars used to convoy or otherwise control traffic shall have radio contact with each other and other personnel in the work area. Pilot cars shall use only traffic lanes open to public traffic.

26. AC15-5TR CHIP SEAL

The easterly 7,000 feet of Bilby Road shall be chip sealed using AC15-5TR sealcoat asphalt cement and screenings precoated with paving asphalt. AC15-5TR is a product of TRMAC distributed by Paramount Petroleum, 14700 Downey Avenue, Paramount, CA 90723, telephone (310) 590-9999.

AC15-5TR shall meet the following specifications:

- Minimum Ground Tire Rubber Content: 5.0% min.
- Penetration @ 25 °C, 100g, 5 sec: 50 – 75
- Viscosity @ 60 °C, poise: 1500 min.
- Viscosity @ 135 °C, centistokes: 2000 max.
- Elastic Recovery after 1 hour @ 25 °C, 20 cm elongation, 5 cm/min: 55% min.
- Softening Point, °C: 45 min.
- Phase Separation, 163 °C, 48 hours, % difference between top and bottom: 4.0% max.
- RTFO Residual Tests
  - Retained Penetration Ratio, 25 °C, 100g, 5 secs./Orig.: 60% min.

The screenings applied to AC15-5TR shall meet the grading requirement described in “Rubberized Chip Seal” of these Special Provisions as well as the precoating requirements, spreading requirements, and the finishing requirements.

The application of AC15-5TR asphalt cement shall meet the requirements of the subsection Applying Asphalt Rubber Binder of “Rubberized Chip Seal” of these Special Provisions except
that the AC15-5TR asphalt cement application temperature shall be between 325 °F. and 350° F.,
the road surface temperature shall be 60 °F. and rising, and the application rate shall be between
.28 and .35 gallons per square yard.

The square foot unit price bid shall include all labor, materials, equipment, and incidentals for
the placement of AC15-5TR chip seal surfacing and shall include, but is not limited to, AC15-
5TR asphalt cement, screenings, and finishing, and no additional compensation shall be allowed
therefor.

27. STAGING AREAS

The Contractor is responsible for making their own arrangements to stockpile material and store
equipment as work is performed.

28. WORK LOCATIONS

The list of County streets and roads that are to be chip sealed and slurry sealed is included in
these special provisions. These listed streets and roads total 838,086 square feet. The final pay
quantity for the project shall be the amount bid and accepted by the County
SACRAMENTO COUNTY ASPHALT RUBBER HOT MIX-GAP GRADED (ARHM-GG):

ARHM-GG shall conform to the provisions for Type "A" asphalt concrete in Section 39, "Asphalt Concrete," of the State Standard Specifications and these Special Provisions.

Binder for ARHM-GG shall be, at the Contractor's option, Type 1 or Type 2 asphalt-rubber binder as specified in these Special Provisions.

The asphalt used in asphalt-rubber binder shall be, at the asphalt-rubber suppliers option, either paving grade AR-2000 or AR-4000.

The amount of asphalt used in asphalt-rubber binder to be added to the aggregate shall be between 6.7% and 8.7% by dry weight of the aggregate. The amount used will be determined by the Engineer. The temperature of the aggregate at the time the asphalt-rubber binder is added shall be not more than 350°F.

Rubber for use in asphalt-rubber binder 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 rubber particles from sticking together. The rubber shall be sufficiently dry so as to be free flowing and not produce foaming when blended with the hot asphalt. The Contractor shall furnish a "Certificate of Compliance" as outlined in Section 6-1.07, "Certificates of Compliance," of the State Standard Specifications.

A sample of the asphalt-rubber binder proposed for use on the project, consisting of four one-quarter cans, together with the proposed formulation of the binder shall be furnished to the Engineer at least two weeks before ARHM-GG pavement construction is scheduled to begin. These samples will be held at the County Lab for comparison to material in the field, if necessary.

The method and equipment for combining the rubber and asphalt shall be so designed and accessible that the Engineer can readily determine the percentage by weight for each material being incorporated into the mixture.

Equipment utilized in the production and proportioning of the asphalt-rubber binder shall include the following:

- An asphalt heating tank with hot oil heat transfer to heat the asphalt to the necessary temperature before blending with the granulated rubber. This unit shall be equipped with a thermostatic heat control device.

- A mechanical blender for proper proportioning and thorough mixing of the asphalt and rubber. This unit shall have both an asphalt totalizing meter (gallons or liters) and a flow rate meter (gallons per minute or liters per minute).

- An asphalt-rubber supply system equipped with a pump and metering device capable of adding the binder by volume to the aggregate at the percentage specified.

The swell, moisture vapor susceptibility, and the stabilometer value requirement in Section 39-2.02, "Aggregate," of the State Specifications shall not apply to ARHM-GG.

Before opening a traffic lane to public traffic the Engineer may direct a sand cover be spread uniformly over areas where ARHM-GG has been placed.

Sand shall be free from clay or organic material and shall be of such size that from 90% to 100% will pass a No. 4 sieve and not more than 5% will pass a No. 200 sieve.

Sand shall be spread at the approximate rate of one to two pounds per square yard.

TRAFFIC SHALL NOT BE ALLOWED ON THE ARHM-GG FOR AT LEAST ONE HOUR AFTER FINAL ROLLING OPERATIONS HAVE BEEN COMPLETED. ALLOWING TRAFFIC ON COMPLETED PAVEMENT TOO SOON MAY RESULT IN FLUSHING.
IT IS IMPORTANT THAT THE BREAKDOWN ROLLER COMPACT THE MAT WHILE THE ARHM IS WARM. A COOL MAT WILL BE RESISTANT TO COMPACTION. IT IS RECOMMENDED THAT TWO (2) VIBRATORY ROLLERS BE USED TO INSURE TIMELY COMPACTION.

Pneumatic tired rollers shall not be used to compact ARHM-GG.

The asphalt-rubber mixture shall not be used as a binder after it has been retained for more than 48 hours.

Type 1 Asphalt-Rubber Binder - Type 1 asphalt-rubber binder shall be a uniform reacted mixture of compatible paving grade asphalt and reclaimed vulcanized rubber.

The reclaimed vulcanized rubber shall be produced primarily from the processing of automobile and truck tires. The rubber shall be produced by ambient temperature grinding process only.

The specific gravity of the rubber shall be between 1.10 and 1.20 and shall conform to the following gradation when tested in accordance with ASTI C 136:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 10</td>
<td>100</td>
</tr>
</tbody>
</table>

The length of the individual rubber particles shall not exceed 3/16 inch.

The asphalt-rubber mixture shall contain between 14 percent and 20 percent rubber by weight of the total asphalt-rubber mixture.

The temperature of the asphalt shall be between 350°F and 425°F at the time the rubber is blended with the asphalt. The asphalt and rubber shall be combined and mixed together in a blender unit, pumped into the agitated storage tank, and then reacted for a minimum of 45 minutes from the time the rubber is added to the asphalt. The temperature of the asphalt-rubber mixture shall be maintained between 325°F and 375°F during the reaction period and shall possess the following physical property after the reaction period:

Viscosity, 350°F (ASTI D 2196) 1500 cp minimum (Brookfield)

After the material has reacted for at least 30 minutes, the asphalt-rubber shall be metered into the mixing chamber of the asphalt concrete production plant at the percentage specified or designated by the Engineer.

After reaching the desired consistency the asphalt-rubber mixture shall not be held at temperatures over 325°F for more than 4 hours.

The Contractor shall provide to the Engineer confirmation of viscosity test results from the asphalt-rubber tank. The test shall be, in the opinion of the Engineer, sufficient to verify that the viscosity of the entire tank is homogenous during the asphalt concrete production.

Type 2 Asphalt-Rubber Binder - Type 2 asphalt-rubber binder shall be a uniform reacted mixture of compatible paving grade asphalt, extender oil, and granulated reclaimed vulcanized rubber.

Extender oil shall be resinous, high flash point aromatic hydrocarbon conforming to the following:
Viscosity, SUS @ 100°F (ASTM D 88) 2500. min
Flash Point, COC, °F (ASTM D 92) 390. min
Molecular Analysis (ASTM D 2007)
Asphaltness, % by weight 0.1 max
Aromatics, % by weight 55.0 min

The asphalt and extender oil, when combined shall form a material that is chemically compatible with the rubber.

The rubber used in Type 2 asphalt-rubber binder shall be reclaimed vulcanized rubber and shall contain between 20 percent and 30 percent by weight, natural rubber when tested in accordance with ASTM D 297. The rubber shall conform to the following grading when tested in accordance with ASTM C 136:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percentage Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 8</td>
<td>100</td>
</tr>
</tbody>
</table>

The rubber shall contain no particles longer than 1/4 inch in length.

The extender oil shall be added to the asphalt at a rate between 2 percent and 6 percent by weight of the asphalt, the exact amount shall be determined by the asphalt-rubber supplier. The asphalt shall be at temperature of not less than 350°F nor more than 425°F when the extender oil is added. The asphalt-extender oil blend and rubber shall be combined and mixed together in the blender unit to produce a homogeneous mixture.

The amount of rubber to be added to the asphalt-extender oil blend shall be between 17 percent and 23 percent by weight of the total combined mixture of asphalt, extender oil, and rubber. The exact amount shall be determined by the asphalt-rubber supplier. The asphalt-extender oil blend shall be at a temperature of not less than 350°F nor more than 425°F when the rubber is added. After the material has reacted for at least 30 minutes, the asphalt-rubber shall be metered into the mixing chamber of the asphalt concrete production plant at the percentage specified or ordered.

The asphalt-rubber mixture shall be reacted for a minimum of 30 minutes from the time the rubber is added to the asphalt-extender oil blend. The temperature of the asphalt-rubber mixture shall be maintained between 375°F and 425°F during the reaction period.

The asphalt-rubber mixture shall possess the following physical property after the reaction period:

- Viscosity at 400°F(ASTM D 2196) 600 to 2,000 cp (Brookfield)

The asphalt-rubber mixture after reaching the desired consistency shall not be held at temperatures over 375°F for more than 4 hours.

The Contractor shall provide to the Engineer confirmation of viscosity test results from the asphalt-rubber tank. The tests shall be, in the opinion of the Engineer, sufficient to verify that the viscosity of the entire tank is homogenous during the asphalt concrete production.

**General Requirements** - The aggregate for ARHM-GG shall conform to the following gradation and shall meet the quality requirements for "Type A" as specified in Section 39-2.02, "Aggregate" of the State Specifications.
The stabilometer value requirement in Section 39-2.02, "Aggregate" of the State Standard Specifications shall not apply to ARHM-GG.

The Los Angeles Rattler requirement in Section 39-2.02, "Aggregate" of the State Standard Specifications shall be amended to read "40 percent maximum loss at 500 revolutions."

ARHM-GG is particularly temperature sensitive and shall be spread at a temperature of not less than 285°F and not more than 325°F, measured in the hopper of the paving machine.

**Measurement** - The mixture of ARHM-GG will be measured by the ton in the same manner specified for asphalt concrete in Section 39-8.01, "Measurement," of the State Standard Specifications.

**Payment** - The contract unit price paid per ton for ARHM-GG shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all work involved in placing ARHM-GG complete in place, including furnishing and spreading sand cover if directed by the Engineer, as shown on the plan, as specified in the State Standard Construction Specifications and these Special Provisions, and as directed by the Engineer.

**EQUIPMENT**

**Haulers:** All trucks hauling asphalt concrete shall have tarp available and the loads shall be covered from the plant to the paving machine unless the ambient air temperature exceed 75°F, or the haul distance is less than 10 miles.

**Asphalt Heating Tank:** The asphalt heating tank shall be equipped with a hot oil heat transfer system or retort heating system capable of heating asphalt cement to the necessary temperature for blending with granulated rubber. This unit shall be capable of heating a minimum of 2,500 gallons of asphalt cement.

**Blender:** The asphalt-rubber mechanical blender shall have a two stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and granulated rubber, at the mix design specified rations, as directed by the Engineer. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system, ass 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 oriented horizontally in the blending vessel. The blending unit shall be capable of fully blending the individual rubber particles with the asphalt cement. A separate asphalt cement feed pump and finished product pump are required. This unit shall have both an asphalt cement totaling meter in gallons and a flow rate meter in gallons per minute.

**Storage/Reaction Tank:** The asphalt-rubber storage/reaction tank shall be equipped with a heating system capable of maintaining a temperature of 300°F to 375°F for reacting, pumping, and for adding the binder to the aggregate. The storage/reaction tank shall be separate from the primary blender and
secondary blender of the blending unit. The maximum capacity of the storage/reaction unit shall be 8,000 gallons. This unit shall have an internal mixing device capable of maintaining a uniform mixture of asphalt cement and granulated rubber. The internal mixing device shall be oriented horizontally in the tank.

**Supply System:** The asphalt-rubber supply system shall be equipped with a pump and a direct interlock metering device capable of adding the binder by volume to the aggregate at the percentage required by the mix design.

**Temperature Gage:** An armored thermometer of adequate range in temperature reading shall be fixed in the asphalt-rubber feed line at a suitable location near the mixing unit.

A leveling course may be required. Leveling courses shall be Type - "A" asphalt concrete. A leveling course shall be required for all locations for which the difference in elevation between the existing pavement surface and the finished pavement surface, as indicated on the Contract plans, exceeds the thickness of the overlay designated for the associated areas of roadway by more than 0.02 feet. The total thickness for asphalt concrete leveling course varies. At locations where the leveling course thickness exceeds three (3) inches, the leveling course shall be placed in lifts not exceeding three inches.

The Contractor shall be responsible for furnishing and placing an asphalt emulsion tack coat in advance of the overlay as provided in Section SS-25 of the Standard Construction Specifications, except for payment.

The Contractor shall be responsible for removing all vegetation from the edge of pavement and sweeping and washing the pavement, if required, in advance of the overlay operation. It is recommended that a power water wash be used in the deceleration zones of intersections for the complete removal of dust that may cause overlay slippage. The Contractor shall remove and dispose of all pavement markers, temporary Type "B" Detector Handhole protection, and temporary traffic stripe (tape), if any, prior to the overlay, and remove and dispose of traffic bars as required by the Engineer.

All thermoplastic limit lines, crosswalks, and legends existing on the road surface shall be scarified prior to placing the overlay. Scarification shall be performed by grinding such that approximately 20% of the underlying pavement is exposed. All material resulting from the grinding operation shall be removed immediately from the right-of-way and shall be disposed of per Section SS3-12 of the Standard Construction Specifications.

All manhole and other utility covers encountered in the area to be overlaid with asphalt concrete shall be carefully referenced out by the Contractor and the locations of the cover painted on the surface immediately after paving. All storm drain and sewer manhole and monitoring well box adjustments shall be the responsibility of the contractor. Adjustment to grade of other utility covers shall be by others.

The unit price paid per ton for Asphalt Rubber Hot Mix - Gap Graded shall include all the work referenced in this section, except that Type - "A" A.C. leveling courses shall be paid per ton of Type - "A" A. C., and no additional compensation will be allowed therefore.
SECTION 02000

RUBBERIZED ASPHALT CONCRETE DELIVERY AND PLACEMENT
(BID ITEM NO. 1A, 1B, 1C, 1D, 1E, & 2)

PART 1.00 – GENERAL

1.01 GENERAL

This work shall be performed in agreement with the Standard Specifications and this Special Provision.

This work generally consists of providing delivery and placement of County supplied materials. Scope includes trucking, placement, labor and incidentals required to deliver and place on grade Asphalt Rubberized Hot Mix – Gap Graded, (ARHM-GG), conforming with the County of Sacramento Special Provision #### Section ####.

PART 2.00 – PRODUCT

2.01 RUBBERIZED ASPHALT CONCRETE

Contractor shall arrange to transport Asphalt Rubberized Hot Mix – Gap Graded from a predetermined Supplier/Producer. All materials costs associated with the design, production, and storage of ARHM-GG should not be consisted within these provisions. All ARHM-GG provided the County and their agents shall comply with Section ### of the County of Sacramento Specifications. All ARHM-GG shall be obtained at the point of production or adjacent storage silos from the County of Sacramento or their agents and trucked by the Contractor to specific project locations.

Materials requested by the Contractor yet not transported to the project location shall be the responsibility of the Contractor. Storage of materials shall not exceed XXX hours and conform with Section ### of the County of Sacramento Specifications. The Contractor shall bear all costs for unused tonnage.

2.02 NOTICES

The Contractor shall submit, in writing, a request for materials to the County of Sacramento or their agents a minimum of five (5) working days before producing ARHM-GG. The Contractor’s notice shall include the type of ARHM-GG needed, amount of tons planned, number of trucks to be used, first load-out time, tons per hour and list any production stagers or delays. The County of Sacramento or their agents will provide written confirmation of receiving notice within 24 hours of receipt.
Should the County of Sacramento or their agents determine that the request for materials be delayed or postponed due to conflicting production requirements from other projects, plant breakdown or holidays, the Contractor shall be notified in writing regarding rescheduling material production and listing any deviations from the original request.

2.03 MINIMUM TONNAGE

The minimum daily order of ARHM-GG ordered shall be 800-tons. ARHM-GG shall be supplied at night, weekend and State recognized holidays. Night production is defined as between the hours of 6:00pm to 6:00am.

PART 3.00 – MATERIALS DELIVERY

3.01 GENERAL

The Contractor shall transport ARHM-GG materials to the project site indicated in Section ### of the County of Sacramento Specifications.

A. All trucks hauling ARHM-GG shall have tarps available and the loads shall be covered from the plant to the paving machine unless the ambient temperature exceed 75 degrees F, or the haul distance is less than 10 miles.

B. Temperatures of materials supplied shall comply with Section ### of the County of Sacramento Special Provisions.

C. Materials not placed within 120 minutes of load-time shall be rejected at the site. The Contractor shall responsible to bear the costs for all compliant materials delivered to the site, yet not placed.

3.02 DELIVERY RANGE

The haul distance from the Producer’s plant to the project street(s) varies for each project. Delivery costs shall be determined and paid for based on the average distance from the predetermined Supplier/Producer plant to the project street(s).

Prior to the start of work, the County of Sacramento will determine the average haul distance based on the number of tons per street and anticipated truck routes. The costs for delivery of ARHM-GG per ton varies as follows:

A. Range 0 to 5.0 miles
3.03 DELAYS

Any delays in delivery of compliant materials to the project site that result in loss of temperature to below the minimum requirement is the responsibility of the Contractor. Any costs resulting from delays or cancellations of the ARHM-GG production at the Producer’s plant caused by the Contractor’s forces or equipment will be borne solely by the Contractor. **The Contractor shall be responsible for any costs associated with delays caused by inclement weather that delays paving operations.**

PART 4.00 – ARHM-GG PLACEMENT

4.01 GENERAL

The nominal compacted thickness for each street is specified on the plan drawings. The Contractor shall follow the County of Sacramento’s QA/QC package included herein. ARHM-GG shall comply with the California Standard Specifications, (CSS) and any **Special Provisions within the County of Sacramento Specifications.** The actual overlay thickness shall not vary more than one-quarter inch (1/4”) from the nominal thickness specified. At gutter lips the finished grade shall not be less than flush and no more than _” higher than the top of the PCC conform.

4.02 CLEANING OF STREET SURFACE

Prior to placing the overlay, all areas to be overlaid with ARHM-GG and other unsuitable materials along the edge of pavement shall be completely cleaned by the Contractor and shall be free of loose or extraneous material. If the ARHM-GG is to be placed on an existing base or pavement which was not constructed as part of the contract, the surface shall be cleaned by sweeping, flushing power broom and/or power blowers, or other means, to remove all loose particles of paving, dirt and all other extraneous materials, immediately before applying paving fabric or paint binder (tack coat).

All surfaces to receive rubberized asphalt concrete shall be thoroughly cleaned including caked mud and debris to the satisfaction of the Engineer prior to paving. The Contractor shall scrape (as needed), sweep and then wash with pressurized water the roadway no more than 24 hrs before paving. Full compensation for cleaning the
roadway as required by the Engineer shall be considered as included in the prices paid for rubberized asphalt concrete, and no additional compensation will be allowed. The Contractor shall remove all existing pavement markers (reflective and non-reflective), and thermoplastic (and preformed plastic) traffic stripes and markings that are within the limits of resurfacing, including solid and broken long-line stripes, stop lines, crosswalk lines, crossbars, and word and symbol markings, prior to beginning paving operations. Removal of pavement markers and traffic stripes and markings shall be performed by a method approved by the Engineer, and will not be paid separately but will be considered as included in the price paid per ton of rubberized asphalt concrete.

4.03 PAINT BINDER (TACK COAT)

A paint binder (tack coat) of asphaltic emulsion shall be furnished and applied in accordance with the provisions in CSS, Section 94, “Asphaltic Emulsions”, of the Standard Specifications, and shall be applied to all vertical surfaces of existing pavement, curbs, gutters, and construction joints in the surfacing against which additional material is to be placed, to a pavement to be surfaced, and to other surfaces where paving fabric is not used prior to placement of new rubberized asphalt concrete.

Paint binder (tack coat) shall be applied in one application. If the SS-1 or RS-1 emulsion is applied undiluted, it shall be applied at a rate of from 0.05 to 0.15 gallons per square yard; if the emulsion is applied diluted 1:1 with water, it shall be applied at a rate of 0.10 to 0.30 gallons per square yard, as directed by the Engineer. Rubberized asphalt concrete should not be placed until the tack coat has cured to the point where it is tacky to the touch and as directed by the Engineer. Paint binder (tack coat) shall be applied only so far in advance of placing the surfacing as may be permitted by the Engineer.

Immediately in advance of placing rubberized asphalt concrete, additional paint binder (tack coat) shall be applied as directed by the Engineer to areas where the paint binder (tack coat) has been damaged, and loose or extraneous material shall be removed, and no additional compensation will be allowed therefor. The area to which paint binder has been applied shall be closed to public traffic. Care shall be taken to avoid tracking binder material onto existing pavement surfaces beyond the limits of the construction. If an area is tacked and placement of rubberized asphalt concrete is not done the same day, the surface should be re-tacked lightly at the beginning of the next paving day as directed by the Engineer.
4.04 PLACEMENT

Any time ARHM-GG is placed in contact with existing asphalt concrete, the surface shall be completely dry of water, clean of dirt and debris, and paving fabric or a tack coat of asphaltic emulsion shall be applied to insure proper bond.

The ARHM-GG shall be delivered to the site in a thoroughly blended condition and shall be spread by a self-propelled asphalt paving machine in such a manner as to avoid segregation and pockets of coarse or fine material during the placing operations. Areas inaccessible to spreading and compaction equipment may be paved by such methods as may be approved by the Engineer. Initial rolling shall be performed immediately after placement.

No rubberized asphalt concrete is to be placed when the atmospheric temperature is below 50 degrees F. When the atmospheric and pavement surface temperature is 64°F (18°C) or higher, the following shall apply:

A. The temperature of the aggregate shall not be greater than 325°F (163°C) at the time the asphalt-rubber binder is added to the aggregate.

B. ARHM-GG shall be spread at a temperature of not less than 280°F (138°C) or more than 325°F (163°C), measured in the mat directly behind the paving machine.

C. The first coverage of initial or breakdown compaction shall be performed when the temperature of the ARHM-GG is not less than 275°F (135°C). Breakdown compaction shall be completed before the temperature of the Type G rubberized asphalt concrete drops below 261°F (127°C).

When the atmospheric or pavement surface temperature is below 64°F (18°C), the following shall apply:

A. The temperature of the aggregate shall not be less than 300°F (149°C) nor more than 325°F (163°C) at the time the asphalt-rubber binder is added to the aggregate.

B. The Contractor shall cover the loads of ARHM-GG with tarpaulins. The tarpaulins shall completely cover the exposed Type G rubberized asphalt concrete until the ARHM-GG has been completely transferred into the asphalt concrete paver hopper or deposited on the roadbed.

C. ARHM-GG shall be spread at a temperature of not less than 289°F (143°C) nor more than 325°F (163°C), measured in the mat directly behind the paving machine.

D. The first coverage of initial or breakdown compaction shall be performed when the temperature of the ARHM-GG is not less than 280°F (138°C). Breakdown
compaction shall be completed before the temperature of the ARHM-GG drops below 261°F (127°C).

Asphalt pavers shall be self-propelled mechanical spreading and finishing equipment, provided with a screed or strike-off assembly capable of distributing the material to not less than ten (10) feet. Screed action shall include any cutting, crowding or other practical action which is effective on the mixture without tearing, shoving or gouging, and which produces a surface texture of uniform appearance. The screed shall be adjustable to the required section and thickness. The paver shall be provided with a full width roller or tamper or other suitable compacting devices. Pavers that leave ridges, indentations or other marks in the surface shall not be used unless the ridges, indentations or other marks are eliminated by rolling or prevented by adjustment in operation.

In addition to the requirements in CSS Section 39-7.01, “Spreading Equipment”, elsewhere in these special provisions, asphalt paving equipment shall be equipped with automatic screed controls and a sensing device or devices. When placing the initial mat of rubberized asphalt concrete on existing pavement or prepared aggregate base, the end of the screed nearest the centerline shall be controlled by a sensor activated by a ski device not less than thirty feet (30’) long. The end of the screed farthest from centerline shall be controlled by a sensor that responds to the grade of the existing surface and will reproduce final grade in the new mat within a 0.01 foot tolerance. The end of the screed farthest from the previously placed mat shall be controlled in the same manner as when placing the initial mat.

Should the automatic screed controls fail to operate properly and all remedial attempts to correct the equipment by the Contractor have been applied during any day’s work, the Contractor may use manual control of spreading equipment for the remainder of the day. However, the equipment shall be corrected or replaced with alternative automatically controlled equipment conforming to the requirements in this section before starting another day’s work.

The asphalt paver shall operate independently of the vehicle being unloaded and shall be capable of propelling the vehicles being unloaded in satisfactory manner and, if necessary, the load of the haul vehicle shall be limited to that which will insure satisfactory spreading. While being unloaded, the haul vehicle shall be in contact with the machine at all times, and the brakes on the haul vehicles shall not be depended upon to maintain contact between the vehicle and the machine.

Should the methods and equipment furnished by the Contractor fail to produce a layer of asphalt concrete conforming to the requirements, including straightedge tolerance as noted in Section 4.06, “Tolerances” of these provisions, the paving operations shall be discontinued and the Contractor shall modify the equipment or methods, or furnish substitute equipment.
ARHM-GG surfacing shall be placed in lifts no greater than 3 inches in thickness (compacted). Total thickness of surfacing shall be as indicated on the plans.

Longitudinal pavement joints shall be on, or as close as possible to, the lane lines. A drop-off of more than 0.15-foot will not be allowed at any time between adjacent lanes open to public traffic.

The contractor shall schedule his paving operations such that each layer of asphalt concrete is placed on all contiguous lanes of a traveled way each work shift. At the end of each work shift, the distance between the ends of the layers of asphalt concrete on adjacent lanes shall not be greater than 10 feet nor less than 5 feet. Additional rubberized asphalt concrete shall be placed along the transverse edge at the end of each lane and along the exposed longitudinal edges between adjacent lanes, hand raked, and compacted to form temporary conforms. Kraft paper, or other approved bond breaker, may be placed under the conform tapers to facilitate the removal of the taper when paving operations resume.

Where the existing pavement is to be widened by constructing a new structural section adjacent to the existing pavement, the new structural section, on both sides of the existing pavement, shall be completed to match the elevation of the edge of the existing pavement at each location prior to spreading and compacting rubberized asphalt concrete over the adjacent existing pavement.

Rubberized asphalt concrete surfacing shall be placed on all existing surfacing, including curve widening, turnouts, left turn pockets and public and private road connections shown on the plans, unless otherwise directed by the Engineer. Shoulders or median borders adjacent to a lane being paved shall be surfaced prior to opening the lane to traffic.

Connections to existing surfacing shall match edge grinding or be feathered to conform to the requirements for smoothness. Private driveways are to have a minimum two (2’) foot paveouts and are to be placed during mainline paving with the mainline paver screed extended. Shoulders or median borders adjacent to a lane being paved shall be surfaced prior to opening the lane to traffic. Shoulder conform tapers, as shown on the plans, shall be placed concurrently with the paving of the adjacent lane. Longitudinal joints shall be trimmed to a vertical face and to a neat line if the edges of the previously laid surfacing are, in the opinion of the Engineer, in such condition that the quality of the completed joint will be affected.

Additional rubberized asphalt concrete surfacing material shall be placed along the edge of the surfacing at private drives, hand raked, if necessary, and compacted to form smooth tapered conforms. Full compensation for furnishing all labor and tools and doing all the work necessary to hand rake said conforms shall be considered as included in the contract prices paid per ton for the various contract items of rubberized asphalt concrete surfacing involved and no additional compensation will be allowed therefor.
Paving operations shall be discontinued, at the Engineer's discretion, during periods of precipitation. Rubberized asphalt concrete delivered to the site and not placed due to weather conditions shall become the property of the Contractor, and no payment shall be allowed therefor. The Contractor shall count and tie out utility covers prior to any work in the area. Within five days after completion of the rubberized asphalt concrete overlay scheduled for the area the Contractor shall raise the water valve, manholes, and monument covers to grade.

4.05 COMPACTING

The Contractor shall furnish a sufficient number of rollers to obtain the specified compaction and surface finish required by these specifications. One roller each shall be provided for breakdown, intermediate, and finish rolling. The Contractor shall size the rollers to achieve the required results. Pneumatic tired rollers shall not be used.

All rollers shall be equipped with pads and water systems which prevent sticking of rubberized asphalt concrete mixtures to the steel drum wheels. A parting agent which will not damage the rubberized asphalt concrete mixture, as approved by the Engineer, may be used to aid in preventing the sticking of the rubberized asphalt concrete mixture to the drums.

Vibratory rollers shall be double steel drum, having adjustable frequency and amplitude settings directly available to the operator during operation. The roller shall be equipped with self-reversing eccentrics. The vibratory mode shall automatically shut off when machine comes to a stop or direction is changed. Rolling shall be performed in such a manner that cracking, shoving or displacement will be avoided. Equipment which, does not perform satisfactorily in the opinion of the Engineer, shall be disallowed and removed from the site of the work.

The completed surfacing shall be thoroughly compacted, smooth, and free from ruts, humps, depressions, or irregularities. Any ridges, indentations or other objectionable marks left in the surface of the rubberized asphalt concrete by blading or other equipment shall be eliminated by rolling or other suitable means. The use of any equipment that leaves ridges, indentations, or other objectionable marks in the rubberized asphalt concrete shall be discontinued, and acceptable equipment shall be furnished by the Contractor.

At locations where the rubberized asphalt concrete is to be placed over areas inaccessible to spreading and rolling equipment, the rubberized asphalt concrete shall be spread by any means practicable so as to obtain the specified results and shall be compacted thoroughly to the required lines, grades and cross sections by means of pneumatic tampers, or by other methods that will produce the same degree of compaction as pneumatic tampers.
The County will monitor density during the compaction process with nuclear density gauges calibrated to core density test data. Rubberized asphalt concrete shall be compacted to a maximum theoretical specific gravity (rice density) of not less than 93.0 percent and shall be finished to the lines, grades, and cross sections shown on the plans. In-place density of rubberized asphalt concrete will be determined prior to opening the pavement to public traffic. Test locations will be established for rubberized asphalt concrete areas to be tested as specified in California Test 375 or ASTM D-2950.

While the testing provided by the County can be used to assist the Contractor in achieving contract compliance, it in no way relieves the Contractor of his primary responsibility for quality control.

The Contractor shall demonstrate that the compaction equipment can compact the rubberized asphalt concrete to the required density by compacting a 300 foot demonstration strip. The density of the demonstration strip shall be the average of a minimum of three (3) tests after rolling is complete. No single test result shall be below 91.0 percent of maximum theoretical specific gravity per ASTM D-2041.

If the Contractor is unsuccessful in achieving the compaction of the demonstration strip, a second strip shall be constructed and compacted. If the second demonstration strip is unsuccessfully compacted, placement of rubberized asphalt concrete shall be suspended until adequate compaction equipment, other than that unsuccessfully used, is placed into operation. No equipment shall be allowed which is unable to successfully compact a demonstration strip.

Any area, which has an interim compaction result less than 92.0 percent of maximum theoretical specific gravity, shall be reworked while the mat is above 220 degrees F. until the area is compacted to a density of 93.0 percent.

Traffic shall not be allowed on the ARHM-GG at least one hour after final rolling operations have been completed.

Where applicable and if directed by the Engineer, sand shall been applied to the newly overlayed surface. No water shall be applied. Sand shall be spread on the surface of ARHM-GG at a rate of 1 to 2 pounds per square yard (0.5 kg/m² to 1.0 kg/m²). The exact rate will be determined by the Engineer. When ordered by the Engineer excess sand shall be removed from the pavement surface by sweeping. Sand shall be free from clay or organic material. Sand shall conform to the fine aggregate grading provisions in CSS Section 90-3.03, "Fine Aggregate Grading," of the Standard Specifications.

4.06 TOLERANCES
The overlay surface, when completed, shall be smooth, dense, well-bonded and of uniform texture and appearance. When a straightedge 12 feet long is laid on the finished surface and parallel with the centerline, the surface shall not vary more than 0.01 feet from the lower edge of the straightedge. The transverse slope of the finished surface shall be uniform to a degree such that no depressions greater than 0.02 feet are present when tested with a straightedge 12 feet long laid in a direction transverse to the center line and extending from edge to edge of a 12 foot traffic lane.

Equipment which does not perform satisfactorily in the opinion of the Engineer shall be disallowed and removed from the site of the work.

If the finished surface of the rubberized asphalt concrete does not meet the specified surface tolerances, it shall be brought within tolerance by either; (1) abrasive grinding (with fog or sand seal coat on the areas which have been ground), (2) removal and replacement, or (3) placing an overlay of rubberized asphalt concrete. The method will be selected by the Engineer. The corrective work shall be at the Contractor’s expense.

If abrasive grinding is used to bring the finished surface to specified surface tolerances, additional grinding shall be performed, as necessary, to extend the area ground in each lateral direction so that the lateral limits of grinding are at a constant offset from, and parallel to, the nearest lane line or pavement edge, and in each longitudinal direction so that the grinding begins and ends at lines normal to the pavement centerline, within any ground area.

All ground areas shall be neat rectangular areas of uniform surface appearance. Abrasive grinding shall conform to the requirements in the first paragraph and the last 4 paragraphs in Section 42-2.02, “Construction”, of the Standard Specifications, except that the grinding residue shall be legally disposed of outside the COUNTY’s right of way.

4.07 ACCEPTANCE TESTING

Average in-place density will be determined by a certified nuclear gauge device. Rubberized asphalt concrete shall be compacted to an average density of not less than 93.0 percent of maximum theoretical specific gravity (rice density) as determined by American Society of Testing Materials (ASTM) D-2041. No single test shall be less than 88.8 percent.

If the test results, for any lot of rubberized asphalt concrete indicate that the relative compaction is below 93.0 percent, but above 88.8 percent, the Contractor will be advised by the Engineer or Engineer’s representative that he is not attaining the required compaction and that his material or his procedures, or both, need adjustment. Rubberized asphalt concrete spreading operations shall not continue until the Contractor has notified the Engineer of the adjustment that will be made in order to meet the required compaction.
Nuclear gauge tests for determining average in-place density shall be taken at locations determined by "Sequential Random Numbers" per California Test 375 and which represent each day’s production of lots of 500 tons or less of mix. The extent of each lot shall be determined by the Engineer. In determining the limits of each lot, consideration will be given to such factors as production rate, location (main line, shoulder, etc.), lift thickness and differences in asphalt concrete mix.

For purposes of test site selection, a lot or portions of a lot are defined into two categories as follows:

**MAJOR LOT:** AC production of 500 tons.  
For any given street, continuous AC production of 500 tons shall be considered a major lot. **A minimum of ten (10) randomly selected locations within each major lot shall be tested in conformance with CTM 375 or ASTM D-2950.** Nuclear gauge measurements shall be correlated with asphalt core density for final acceptance. A minimum of two (2) pavement core samples, 4 to 6 inches in diameter, shall be obtained at separate locations where nuclear density gauge readings were taken.

**MINOR LOT:** AC production of less than 500 tons.  
For any given street, continuous AC production of; 1) less than 500 tons, 2) any portion of a lot that is separated by a day’s production, shall be considered a minor lot. **A minimum of five (5) randomly selected locations within each minor lot shall be tested in conformance with CTM 375 or ASTM D-2950.** Nuclear gauge measurements shall be correlated with asphalt core density for final acceptance. A minimum of one (1) pavement core sample shall be obtained at the locations where nuclear density gauge readings were taken.

The difference (plus or minus) between nuclear gauge readings and core density is then calculated and averaged by the Engineer to obtain a calibration value for each lot for correlation of the nuclear density gauge readings. The density of each core shall be determined in accordance with CTM 308A or ASTM D-1188. The interim compaction test results (prior to final core correlation) shall be immediately available to the Contractor.

Dry ice may be used for cooling the pavement prior to coring. Core holes shall be repaired by the Contractor.

If the core thickness varies by plus or minus one-half inch (1/2") of the nominal design thickness and/or any nuclear gauge reading correlated to core density varies by more than 5.0 lbs. per cubic foot or 0.08 gm/cc, the Engineer shall consider it statistically invalid and exclude it from the correlation data.

**A minimum of one (1) randomly selected field sample for every 500 tons or any portion of 500 tons of AC production shall be tested for maximum theoretical specific gravity in conformance with ASTM D-2041.** The maximum theoretical
density (rice density) value and the correlated in-place density is used to obtain the 
average relative compaction for each lot.

If the test results for any lot of finished rubberized asphalt concrete indicates that the 
average relative compaction is less than 88.8 percent, the rubberized asphalt concrete 
represented by that lot shall be removed, except as otherwise provided below. 
Rubberized asphalt concrete spreading operations shall not continue until the 
Contractor makes significant adjustments to his materials or procedures or both in order 
to meet the required compaction. The adjustments shall be as agreed to by the 
Engineer. However, if requested by the Contractor and approved by the Engineer, 
finished asphalt concrete with a relative compaction of 88.8% or greater, may remain in 
place and the Contractor shall receive a reduced compensation for such lots with low 
compaction. The County may deduct the amount of reduced compensation from any 
moneys due, or that may become due, the Contractor under the contract. The amount 
of reduced compensation the County shall pay to the Contractor will be calculated using 
the total tons represented in the lot with low compaction less the following reduced 
compensation factors multiplied by the contract price per ton for the contract item of 
rubberized asphalt concrete:

<table>
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<th>Relative Compaction of ASTM D-2041 (Percent)</th>
<th>Reduced Compensation Factor</th>
<th>Relative Compaction of ASTM D-2041 (Percent)</th>
<th>Reduced Compensation Factor</th>
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All materials testing necessary to determine conformance with the requirements 
specified in these special provisions will be performed by the County without cost to the 
Contractor. If any particular portion of the work does not pass this testing, it shall be 
subject to a retest after the Contractor has remedied the deficiency. All re-testing 
expenses including additional engineering, laboratory costs, etc. shall be paid by the 
Contractor.

PART 5.00 – PAYMENT

5.01 PAYMENT
Full compensation for hauling and placing rubberized asphalt concrete shall be included in the contract price paid for each item and no additional payment will be made therefor.

Full compensation for all hauling of ARHM-GG, “ARHM-GG Delivery”, shall be included in the contract unit price per ton for Bid Items 1A – 1E and no additional payment will be made therefor. Payment shall include full compensation for supplying trucking, equipment, labor and incidentals to deliver the product to the specific location on each site where it is required for placement operations as described herein. A price for each range specified above is required.

Full compensation for placement of “Placement of ARHM-GG”, shall be included in the contract unit price per ton for Bid Item 2 and no additional payment will be made therefor. Payment shall include full compensation for supplying equipment, labor and incidentals to place the product as described herein.

The basis of award of this contract shall be the total base bid of Item 1 and Item 2. The base bid for Item 1 shall be the average of the cost per ton for all five ranges multiplied by the total tonnage. The average is defined as the sum of Items 1A through 1E divided by five (5).

The Contractor is responsible for any additional costs from the Producer resulting from not meeting any of the above mentioned production minimums. Any material produced that is ordered by the Contractor but not utilized shall be at the Contractors expense.
# BID SCHEDULE
## EXAMPLE
### HAULING AND LAYDOWN
#### COUNTY OF SACRAMENTO

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<th>ITEM</th>
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**TOTAL BASE BID** | |