10-1. RUBBERIZED ASPHALT CONCRETE (TYPE O or TYPE O-HB)

1. GENERAL

Rubberized asphalt concrete (Type O or Type O-HB) shall consist of furnishing and mixing Open Graded aggregate and asphalt-rubber binder and spreading and compacting the mixture. Type O and Type O-HB rubberized asphalt concrete (RAC) 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.

2. MATERIALS

Prior to use of scrap tire crumb rubber modifier (CRM), high natural CRM and asphalt modifier, 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 and these special provisions. In addition, asphalt shall be provided in conformance with Caltrans Certification Program for Suppliers of Asphalt available at http://www.dot.ca.gov/hq/esc/Translab/fpmcoc.htm. When requested by the Engineer, the Contractor shall submit samples of material(s) 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 Quality Control Programs used by the respective manufacturer of each ingredient shall include a sampling and testing frequency as shown below:

A. CRM shall be tested for grading for every 10,000 pounds of scrap tire CRM and 3,400 pounds of high natural CRM delivered to the project.
B. Asphalt to be used in the asphalt rubber binder shall be tested according to the requirements in Caltrans Certification Program for Suppliers of Asphalt.
C. Asphalt modifier shall be tested at least once for every 23 tonnes of production and 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, and asphalt modifier shall be submitted by the Contractor to the Engineer 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.

6* Insert appropriate PG binder grade. PG binder can be determined from Table 6XX-XXX available at www.XXXXXXXXXXXX.

ASPHALT

The grade of asphalt to be used in the asphalt-rubber binder shall be Performance Graded PG _____ asphalt and shall conform to the provisions in Section 92, "Asphalts," of the Standard Specifications and these special provisions.

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Asphalt furnished by an Approved Supplier can be used prior to sampling and testing. The Department’s “Certification Program for Suppliers of Asphalt” maintains a list of Approved Suppliers at http://www.dot.ca.gov/hq/esc/Translab/fpmcoc.htm. Asphalt furnished by a Supplier not on the list of Approved Suppliers shall not be used unless and until testing has fulfilled the requirements of “Requirements for Suppliers Supplying Asphalt Without a Certificate of Compliance,” as provided in the Department’s “Certification Program for Suppliers of Asphalt.”
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 that include 40 to 48% natural rubber by mass as certified by the Supplier according to ASTM D 297.

Steel and fiber separation may be accomplished by any method. Cryogenic separation of steel and fiber, 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 Laboratory Procedure LP-XX.

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 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 according to Laboratory Procedure LP-XX.

The scrap tire and high natural CRM for asphalt-rubber binder shall meet the following gradation requirements when tested in conformance with the requirements of Laboratory Procedure LP-XX.

Scrap Tire CRM: 100% passing the No. 8 (2.36 mm) sieve size

High Natural CRM: 100% passing the No. 10 (2.00 mm) sieve size

14 ASPHALT MODIFIER

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

Table 1 - ASPHALT MODIFIER
Test Parameter Designation Requirement

<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>
<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 to the asphalt at the production site where the asphalt-rubber binder is blended and reacted. Asphalt modifier shall be added in an amount of 1 to 6 percent by mass of the asphalt that corresponds to the amount used in the approved asphalt-rubber binder design profile provided by the asphalt-rubber binder supplier. The asphalt shall be at a temperature of not less than 375°F or more than 435°F when the asphalt modifier is added. If the asphalt modifier is combined with the asphalt before being blended with the CRM the combined asphalt and asphalt modifier shall be mixed by circulation for a period of not less than 20 minutes. Premixing of asphalt modifier and asphalt will not be required when the ingredients of the asphalt-rubber binder are proportioned and mixed simultaneously. Asphalt modifier and asphalt shall be measured for proportioning with meters conforming to the provisions in Section 9-1.01, "Measurement of Quantities," of the Standard Specifications.

AGGREGATE

The aggregate for Type O and Type O-HB rubberized asphalt concrete shall conform to the corresponding grading and the quality requirements for open-graded asphalt concrete of the provisions in Section 39-2.02, "Aggregate," of the Standard Specifications, except as follows:

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

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

<table>
<thead>
<tr>
<th>Table 2 - Aggregate Grading Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage Passing</td>
</tr>
<tr>
<td>9.5-mm maximum</td>
</tr>
<tr>
<td>½&quot; (12.5 mm)</td>
</tr>
<tr>
<td>3/8&quot; (9.5 mm)</td>
</tr>
<tr>
<td>No. 4 (4.75 mm)</td>
</tr>
<tr>
<td>No. 8 (2.36 mm)</td>
</tr>
<tr>
<td>No. 16 (1.18 mm)</td>
</tr>
<tr>
<td>No. 200 (75µm)</td>
</tr>
</tbody>
</table>

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

| Sieve Size |
|------------------|------------------|------------------|------------------|
| in. (mm)         | Limits of Proposed Gradation | Operating Range | Contract Compliance |
| ¾” (19 mm)      | —                | 100             | 100              |
| ½” (12.5 mm)    | —                | 95-100          | 92-100           |
| 3/8” (9.5 mm)   | 78-89            | X±4             | X±7              |
| No. 4 (4.75 mm) | 28-37            | X±4             | X±7              |
| No. 8 (2.36 mm) | 7-18             | X±4             | X±5              |
| No. 16 (1.18 mm)| —                | 0-10            | 0-13             |
| No. 200 (75µm)  | —                | 0-3             | 0-4              |

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.

### 3. PROPORTIONING AND MIXING

#### 19 ASPHALT-RUBBER BINDER DESIGN

Asphalt-rubber binder shall be an interacted blend of hot asphalt, asphalt modifier, and crumb rubber modifier. The Contractor shall provide the asphalt-rubber binder design and design profile.
The proportions of the materials, by total mass of asphalt-rubber binder, shall be 80 percent ± 2 percent combined 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 in conformance with the approved asphalt-rubber binder design and shall contain 75 percent ± 2 percent scrap tire CRM and 25 percent ± 2 percent high natural CRM, by mass.

The 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 interacting) presented in these special provisions.

Asphalt-rubber binder design shall include testing to develop and present a design profile of each specification property value measured from samples taken at intervals over a 24-hour interaction period including, at a minimum, results after an initial interaction period of 45 minutes, 4 hours later, and simulated overnight cool-down by reducing oven temperature to 275°F for a period of 14 hours starting at 6 hours after CRM addition to 22 hours after CRM addition. After the 14-hour cool-down, reheat the binder to 375°F for sampling and testing at 24 hours after CRM addition. Viscosity shall also be measured and recorded at 2 and 3 hours after addition of the CRM to identify the expected trends for field production. Viscosity tests shall be performed and recorded at the indicated intervals.

Asphalt rubber design profile is based on laboratory testing of the specific suppliers and grades of asphalt, asphalt modifier, and CRM identified for use in asphalt rubber binder production for this project. It shall not apply to any combinations of different component materials. Due to differences between laboratory and field production, the asphalt rubber binder design profile shall serve only as a guide to indicate expected trends in asphalt rubber viscosity during asphalt rubber binder production and shall not be interpreted as a specification. Asphalt rubber binder design profile and test results shall be no more than one year old when production of the RAC mixture starts.

The temperature of the blended asphalt and asphalt modifier mixture shall be not less than 375°F nor more than 435°F when the CRM is added. The combined materials shall be interacted for a minimum of 45 minutes after incorporation of the CRM at a temperature of not less than 375°F nor more than 425°F. The temperature shall not be higher than 10°F below the actual flash point of the asphalt-rubber binder.
After interacting for a minimum of 45 minutes, the asphalt-rubber binder shall conform to the requirements in Table 3 throughout the 24-hour laboratory interaction:

<table>
<thead>
<tr>
<th>Test Parameter</th>
<th>ASTM Test</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cone Penetration @ 77°F, 1/10 mm</td>
<td>D 217</td>
<td>25</td>
<td>70</td>
</tr>
<tr>
<td>Resilience @ 77°F, Percent rebound</td>
<td>D 5329</td>
<td>18</td>
<td>—</td>
</tr>
<tr>
<td>Field Softening Point, °F</td>
<td>D 36</td>
<td>125</td>
<td>165</td>
</tr>
<tr>
<td>Viscosity @ 375°F, Pa • s (x10⁻³)</td>
<td>See Note</td>
<td>1500</td>
<td>4000</td>
</tr>
</tbody>
</table>

NOTE: The viscosity test shall be conducted according to CT XXX using a hand held high range analog or digital rotational viscometer such as Rion Model VT-04E, Haake Model VT-02 or VT-02 plus, with Rotor 1, 24 mm in depth x 53 mm in height, or equivalent. 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 accuracy verification results shall be provided to the Engineer.

RAC MIXTURE DESIGN

The Contractor shall 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.

A. The aggregate shall be mixed with Performance Graded PG _____ asphalt and the optimum bitumen content shall be determined in conformance with the test procedure and item B or C below as applicable.

B. For rubberized asphalt concrete Type O, the optimum binder content shall then be determined using the following formula:
   1. \( OBC_2 = (OBC_1) \times 1.20 \)
   2. \( OBC_1 = \) Optimum bitumen content using PG _____ asphalt as specified in Paragraph 6
   3. \( OBC_2 = \) Optimum bitumen content using asphalt-rubber binder

C. For rubberized asphalt concrete Type O-HB, the optimum binder content shall then be determined using the following formula:
   1. \( OBC_2 = (OBC_1) \times 1.65 \)
   2. \( OBC_1 = \) Optimum bitumen content using PG _____ asphalt as specified in Paragraph 6
   3. \( OBC_2 = \) Optimum bitumen content using asphalt-rubber binder
   4. The \( OBC_2 \) shall be a minimum of 8.5 percent by weight of dry aggregate and a maximum of 10.0 percent by dry weight of the aggregate. Aggregates which result in an \( OBC_2 \) of less than 8.5 percent or more than 10.0 percent by weight of dry aggregate shall not be used.

During production and placement, the RAC Type O or Type O-HB shall conform to the requirements of Table 6. The asphalt-rubber binder content of the Type O or Type O-HB rubberized asphalt concrete will be determined by California Test 362, California Test 379 or California Test 382.
MIX DESIGN SUBMITTALS

The Contractor shall submit for the Engineer's review a proposed rubberized asphalt concrete mix design for the RAC Type O or RAC Type O-HB mixture to be used at least 2 weeks prior to production and placement. A laboratory (or laboratories) whose proficiency has been reviewed and qualified in conformance with the Department’s Independent Assurance Program shall prepare the rubberized asphalt concrete mix design. Aggregate quality and RAC Type O or RAC Type O-HB mix design test results shall be no more than one year old when production of the rubber asphalt concrete mixture starts.

The Contractor shall submit the following information for each rubberized asphalt concrete mixture proposed:

A. Aggregate and supplemental fine aggregate (including lime, if used):
   1. Aggregate gradation (“X” values) for percent passing each sieve size for the aggregate blend, including supplemental fine aggregate;
   2. Results of quality tests for coarse aggregate, fine aggregate, and aggregate blend;
   3. Source of each aggregate to be used, including producer, location and California Mine Identification number;
   4. Percentage of each aggregate cold feed or hot bin and supplemental fine aggregate used in the mix design;
   5. Typical gradation of each aggregate cold feed or hot bin to be used;
   6. Material Safety Data Sheet for lime if used.

B. Crumb Rubber Modifier (CRM):
   1. Supplier and identification (or type) of scrap tire and high natural CRM.
   2. Typical gradation of each type of CRM material used in the asphalt rubber binder design
   3. Percentage of scrap tire and high natural CRM by total mass of the asphalt-rubber blend.
   4. If CRM from more than one supplier is used, the above information will be required for each CRM supplier used.
   5. Laboratory test results for test parameters shown in these special provisions.

C. Asphalt Rubber Binder:
   1. Base asphalt PG binder grade and supplier and Certificate of Compliance
   2. Percentage of the combined blend of asphalt and asphalt modifier by total mass of asphalt-rubber binder to be used.
   3. Asphalt modifier type, supplier and identification and test results demonstrating conformance to these special provisions
   4. Percentage of asphalt modifier by mass of asphalt.
   5. Selected asphalt rubber content as determined by California Test 368 modified by these special provisions;
   6. Design profile.
   7. The minimum interaction time and temperature.
   8. Material Safety Data Sheets.
D. Antistrip additives, when applicable:

1. Name of product, manufacturer, manufacturer's designation and proposed rate, location, and method of addition; and

E. Samples that are representative of the materials to be used.

1. Aggregate - Minimum sample sizes shall be as follows:

<table>
<thead>
<tr>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>70 kg of each coarse aggregate;</td>
</tr>
<tr>
<td>30 kg of each fine aggregate; and</td>
</tr>
<tr>
<td>5 kg of each supplemental fine aggregate.</td>
</tr>
</tbody>
</table>

2. 4 one-liter cans of asphalt rubber binder blended with the asphalt, asphalt modifier and CRM and in the proportions that will be used on the project.
3. 0.25 liter of liquid antistrip or 1 kg of dry lime, if used.

The proposed RAC Type O or RAC Type O-HB mix design submittal will be considered complete only when the items enumerated above, including the test results and samples, have been received by the Engineer. Any changes in the source or supplier of component materials will require review of the binder design and mix design. If not verifiable as tested, a new mix design may be required.

**REVIEW OF RUBBERIZED ASPHALT CONCRETE MIX DESIGN**

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The Engineer will review the Contractor’s mix design proposal. The Engineer will reject a proposed mixture that, during review, fails to meet the quality requirements of these special provisions. If the mix design is rejected, the Contractor shall resubmit a mix design letter providing new test results, and plots.

The Engineer will verify that the Contractor’s mix design meets requirements for aggregate gradation and asphalt rubber binder content.

Should the Engineer fail to complete the evaluation within the time allowance and, if in the opinion of the Engineer, the Contractor’s controlling operation is delayed or interfered with by the delay in evaluating the mix design, the delay will be considered a right of way delay as specified in Section 8-1.09, “Right of Way Delays,” of the Standard Specifications.

**CONTRACTOR QUALITY CONTROL SAMPLING, AND TESTING**

The Contractor shall submit a Quality Control Plan to the Engineer at least 15 days prior to the start of RAC Type O or RAC Type O-HB mix production. The Quality Control Plan shall describe the procedures that will be used to control the quality of RAC mix entering the work and of the work performed. The Contractor shall perform quality control sampling and testing and exercise management control to ensure that asphalt rubber binder and rubberized asphalt concrete production and placement conform to the provisions of these special provisions. The Contractor shall retain all records generated as part of the Contractor RAC Type O or RAC Type O-HB quality control sampling and testing plan for a period of not less than 3 years for inspection by Caltrans.
During RAC Type O or RAC Type O-HB mix production, quality control sampling and testing shall be performed at a rate sufficient to ensure that asphalt concrete conforms to the provisions of these special provisions. The Contractor shall notify the Engineer of the proposed sampling plan. Minimum sampling and testing requirements for RAC Type O or RAC Type O-HB mixture quality control shall be as listed in Tables 4 and 5.

Table 4 - MINIMUM QUALITY CONTROL SAMPLING REQUIREMENTS

<table>
<thead>
<tr>
<th>Quality</th>
<th>Location</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Gradation</td>
<td>Plant</td>
<td>1 per 500 tons¹</td>
</tr>
<tr>
<td>Binder content</td>
<td>Mat Behind Paver, or at the AC Plant</td>
<td>1 per 500 tons¹</td>
</tr>
</tbody>
</table>

Notes:
1. No less than 1 sample per day.

37a. Minimum Quality Control testing requirements are listed in Table 5.

Table 5 - MINIMUM QUALITY CONTROL TESTING REQUIREMENTS

<table>
<thead>
<tr>
<th>Quality</th>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Gradation</td>
<td>CT 202</td>
<td>Per Table 2</td>
</tr>
<tr>
<td>Binder content, %</td>
<td>CT 362, 379 or 382</td>
<td>TV ± 0.45%</td>
</tr>
</tbody>
</table>

Sampling at the AC plant and behind the paver shall be random and shall conform to the requirements of California Test 125. The Contractor shall test in conformance with the Quality Control Plan and Table 5. Quality control test results shall be submitted to the Engineer within 24 hours after sampling.

37c

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 or from an approved sampling point, using a hand held high range analog or digital rotational viscometer (see Table 3 Note). Readings shall be taken according to California Laboratory Procedure LP-XX 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.

37d

If the Contractor’s QC testing of RAC Type O or Type O-HB mix shows deviations from the requirements of these special provisions, appropriate adjustments shall be made to meet the requirements.

Caltrans shall test the RAC Type O or Type O-HB mixture for acceptance. Acceptance of the RAC Type O or Type O-HB mixture shall be based on conformance of samples tested by Caltrans with the requirements for aggregate and mixture properties listed in Table 6, Minimum Acceptance Requirements, of these special provisions.

Table 6 - MINIMUM ACCEPTANCE REQUIREMENTS for RAC TYPE O or Type O-HB

<table>
<thead>
<tr>
<th>Quality</th>
<th>Test</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aggregate Gradation</td>
<td>CT 202</td>
<td>Per Table 2</td>
</tr>
<tr>
<td>Binder content, %</td>
<td>CT 362, 379 or 382</td>
<td>TV ± 0.45%</td>
</tr>
</tbody>
</table>

ASPHALT-RUBBER BINDER PRODUCTION
The blended asphalt and asphalt modifier mixture, and the CRM shall be combined and thoroughly mixed together at the production site in a blender unit to produce a mixture with CRM particles that visually appear to be uniformly distributed. The reacted asphalt-rubber binder shall be maintained at a temperature of not less than 375°F nor more than 425°F.

The Contractor shall provide a Haake Viscometer, or equivalent, at the production site during combining of asphalt-rubber binder materials to monitor viscosity. Asphalt rubber binder that meets requirements for interaction time and viscosity may be used to make RAC Type O or Type O-HB.

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 375°F 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 375°F nor more than 425°F prior to use. Additional scrap tire CRM may be added to the reheated binder and the combined materials shall be interacted for a minimum of 45 minutes after incorporation of the CRM at a temperature of not less than 375°F nor more than 425°F. The cumulative amount of additional scrap tire CRM shall not exceed 10 percent of the total binder mass. Viscosity of the reheated asphalt-rubber binder shall conform to the provisions for asphalt-rubber binder listed in Table 3 before mixing with the aggregate.

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

The method and equipment for combining 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 or the batch.

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 asphalt and asphalt modifier mixture at the necessary temperature before blending with the CRM. This unit shall be equipped with a thermostatic heat control device and a temperature reading device and shall be accurate to within ± 5°F and shall be of the recording type.

B. Scale structures: Where the total load, including live and dead load, of a scale structure is less than 15 tonnes the requirements for undersupports for scale bearing points shall be as follows or as described in Section 9 of the Standard Specifications.

1. The structure shall be supported on at least 4 legs. The total load on any one leg shall be no greater than 100 kPa.
2. The undersupport shall be structural grade steel with a minimum cross sectional dimension of 600 mm and a minimum thickness of 25 mm.
3. The entire scale structure, including undersupports, shall be constructed with such rigidity that no movement or deflection is possible during production operations. Only metal shall be used in the scale support structure.
4. The scale structure shall be level throughout the period of device calibration and material production.
5. Adequate drainage shall be provided to prevent saturation of the ground under the scale. The ground under the scale shall remain in a condition which will support 100 kPa at each undersupport.

C. A mechanical mixer for the complete, homogeneous blending of asphalt, asphalt modifier, and CRM. 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 asphalt and asphalt modifier proportionate with the delivery of CRM. During the proportioning and blending of the liquid ingredients, the temperature of asphalt and the asphalt modifier shall not vary more than ± 25°F. The 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.

D. 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 asphalt, asphalt modifier, and CRM.

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

4. PROPORTIONING, SPREADING AND COMPACTING

When batch type asphalt concrete plants are used to produce Type O or Type O-HB 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 or Type O-HB 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 O or Type O-HB rubberized asphalt concrete shall be placed only when the atmospheric and pavement surface temperatures are 55°F or above.

Type O or Type O-HB rubberized asphalt concrete shall be compacted with steel-tired rollers operated in the static mode only. Rollers shall be equipped with pads and water systems that prevent sticking of RAC mixture to the steel-tired wheels. A parting agent that will not damage the RAC mixture may be used. Pneumatic tired rollers shall not be used.

When the atmospheric or pavement surface temperature is below 65°F and at least 55°F, the following shall apply:

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

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

C. Type O or Type O-HB rubberized asphalt concrete shall be spread at a temperature of not less than 290°F nor more than 325°F, 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 or Type O-HB rubberized asphalt concrete is not less than 280°F. Breakdown compaction shall be completed before the temperature of the Type O or Type O-HB rubberized asphalt concrete drops below 260°F.

When the atmospheric and pavement surface temperature is 65°F or higher, the following shall apply:

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

B. Type O or Type O-HB rubberized asphalt concrete shall be spread at a temperature of not less than 280°F nor more than 325°F, 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 or Type O-HB rubberized asphalt concrete is not less than 275°F. Breakdown compaction shall be completed before the temperature of the Type O or Type O-HB rubberized asphalt concrete drops below 250°F.

Traffic shall not be allowed on Type O or Type O-HB rubberized asphalt concrete until final rolling operations have been completed and sand (if used) has been applied to the surface.

Sand shall be spread on the surface of Type O or Type O-HB rubberized asphalt concrete at a rate of 0.5 kg/m² to 1.0 kg/m². If requested by the Contractor and accepted by the Engineer, use of sand may be eliminated. 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 or Type O-HB) 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 or Type O-HB) and no separate payment will be made therefor.

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Full compensation for the Contractor's Quality Control Plan, including furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in developing, implementing, modifying, and fulfilling the requirements of the Quality Control Plan shall be considered as included in the contract price paid per tonne for RAC Type O or Type O-HB mix and no additional compensation will be allowed therefor. This includes Contractor mix design, sampling, QC testing, inspection, testing facilities, and preparation and submission of results.