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SECTION 23 - ASPHALT CONCRETE

23-1 GENERAL

Asphalt Concrete (AC) must conform to Section 39 of the State Specifications, except that Sections 39-3, "Method Construction Process" and 39-4, "Quality Control/Quality Assurance Construction Process", do not apply to Agency projects. All Agency projects must comply with Section 39-2, "Standard Construction Process", of the State Specifications and these Specifications. "AC" or "AC" is the same as "Hot Mix Asphalt" or HMA". "Asphalt Rubber Hot Mix" or "ARHM" is the same as "Rubberized Hot Mix Asphalt" or "RHMA".

AC is designated as Type A, Type B, Open Graded, or ARHM. AC is also designated by gradation, according to the percentage of crushed particles and sand equivalent of the aggregate (for dense graded mixtures) or according to intended use (for open graded mixes) and by class, according to texture of the mixture.

The Contractor's operations must be conducted in a manner that will not harm or damage existing facilities or improvements.

At locations where public traffic is routed over the base grade, the Contractor must plan the paving operations to minimize the delay of traffic.

The Contractor, when required to provide for the passage of public traffic through the work, must do so in accordance with the provisions of Section 12, "Construction Area Traffic Control", of these Specifications.

23-2 MIX FORMULA AND DESIGN

Mix designs for Type A, Type B, Open Graded, and ARHM must meet all of the requirements of Section 39-1.03B, "Hot Mix Asphalt Mix Design", of the State Specifications.

The Contractor must submit a job mix formula and mix design to the Agency for approval. Mix designs must be accompanied by current test results that indicate compliance with these Specifications and the Special Provisions. A job mix formula must be submitted by the Contractor for each designation of AC, based on samples of conforming aggregate materials supplied for each source or supplier proposed by the Contractor, with optimum binder content determined per California Test Method 367 with the exception that CKE test is waived and California Test Method 309 must be used to determine the Maximum Theoretical Density of the mixture. The job mix formula must establish a single percentage of aggregate passing each required sieve size and a percentage of asphalt binder to be added to the aggregate. The AC binder content must be based on 4.0 percent air voids.

Where more than one source or supplier is designated to supply AC, those mixes must be kept separate. The mixes must not be intermixed in the same lift or section of pavement. The Contractor must submit paving plans showing, in advance, where the mixes from each source will be used. This plan will be subject to approval by the Agency.

23-3 AGGREGATES AND BINDERS

23-3.01 Aggregates

The aggregate gradation must be 3/4, 1/2, or 3/8 inch for Type A or B AC and 1/2 inch for ARHM-GG and must conform to Section 39-1.02E, "Aggregate", of the State Specifications. Select aggregate size based on AC lift thickness.

AC Lift Thickness	Aggregate Size
Less than 2-1/4"	1/2"
Greater than or equal to 2-1/4" where total AC section is less than or equal to 3"	1/2"
Greater than or equal to 2-1/4" where total AC section is greater than 3"	3/4"

23-3.02 **Binders**

The asphalt binder grade must comply with Section 92, "Asphalts" of the State Specifications and the following:

Type of AC and Use	PG Grade Binder
Conventional dense graded AC used on on-ramps, off-ramps, arterial streets and thoroughfare streets	64-10
Conventional dense graded AC used on residential and collector streets	64-10
ARHM	64-16

23-3.03 **Quality Control Sampling and Testing**

Sampling and testing must be done in accordance with Section 39-2.02B, "Quality Control Testing", of the State Specifications.

23-4 **RECLAIMED ASPHALT PAVEMENT**

At the option of the Contractor, reclaimed asphalt pavement (RAP) may be substituted for virgin aggregate in accordance with Section 39 of the State Specifications. The Agency must be given unrestricted access to stockpiles for inspection and testing as deemed necessary.

The amount of virgin asphalt binder to be mixed with the combined virgin aggregate and RAP will be determined by the Contractor in conformance with California Test Method 367, with the exception that the C.K.E. test is waived and California Test Method 309 must be used to determine the Maximum Theoretical Density. In lieu of historical data, the approximate asphalt demand may be calculated in accordance with the Asphalt Institute Handbook MS-4.

The percentage of RAP and the mixture gradation Target Values must be designated job mix design. Changes in the Target Values of the aggregate grading and design asphalt content will not be permitted without additional testing to verify compliance with the requirements for stability and air voids. Changes will not be allowed without the approval of the Agency.

The proposed mix design must be submitted to the Agency for review and approval. In addition to the requirements of Section 39 of the State Specifications, the Contractor must provide the Agency with the following information:

- Location of RAP stockpile
- The individual and average asphalt content test results representative of the proposed RAP stockpile based on a minimum of 1 test per 5,000 tons of material in the RAP stockpile. The asphalt content must be determined in accordance with ASTM D 2172, Method B.
- The individual and average asphalt-free gradations of the RAP material derived from the samples used to determine the asphalt content.

RAP must be produced per Section 39, "Hot Mix Asphalt", of the State Specifications, except that the requirement for storing and drying does not apply to the RAP material. When the RAP mixture is produced by batch mixing, the time of mixing must not be less than 35 seconds.

The Contractor's mixing equipment must be equipped with a suitable, safe sampling device, or locations, capable of providing representative samples of virgin aggregates and RAP production materials being incorporated into the recycled asphalt pavement mixture. Should a continuous mixing plant be used, the RAP material must be protected from direct contact with the burner flame by means of a shield, separator, secondary drum or other method approved by the Agency.

The binder must be introduced into the mixer after the virgin aggregate and RAP material have been combined. If a batch mixing plant be used, the RAP material must be kept separate from the virgin aggregate until both ingredients enter the weigh hopper and/or pugmill.

23-5 HAULING EQUIPMENT

Vehicles used for hauling AC mixtures must have tight, smooth, metal beds, and must be free from dust, screenings, excessive petroleum oils, volatiles, or other mineral spirits that may affect the mix being hauled. Trucks must be provided with tarpaulins or cargo covers of sufficient size and weight to protect the entire load.

23-6 WARM MIX ASPHALT (WMA)

At the option of the Contractor, WMA technology may be used. Acceptable WMA technologies include water injected foam, chemical additive or organic additive technologies. WMA must be produced in accordance with the manufactures recommendations. AC mixes produced using warm mix technology must be produced between 230 and 300° F. The Job Mix Formula (JMF) submitted to the Engineer for approval must not incorporate the WMA additive. When WMA technology is proposed for use, identify the WMA manufacturer and dosage rate on the JMF submittal. When required, JMF verification testing will be performed on plant-produced material.

23-7 NOT USED

23-8 AC PLACEMENT METHOD

23-8.01 General

Unless otherwise specified in the Special Provisions, AC must be placed as specified in this Section.

AC placed on minor streets may be placed in a single lift up to 3 inches thick. For major streets, the top layer of AC must be placed in a lift between 1-1/2 and 2-1/2 inches in compacted thickness. The next lower layer of AC must be placed in a lift between 1-1/2 and 3 inches in compacted thickness. All other lower layers must be placed in lifts 4 inches or less in compacted thickness.

The total thickness of AC must be as shown on the plans with the following exception for AC paving in the vicinity of sidewalk ramps. For the area of pavement that is no greater than twelve feet wide and adjoins the lip of gutter of a sidewalk ramp, new AC paving must be allowed to be constructed with a pavement thickness that is up to 3/4 inch less than the thickness of the AC pavement section shown on the plans (see Standard Drawing 4-51).

Paving must be a continuous non-stop operation with delivery trucks arriving in a uniform manner. The Agency will meet daily with the Contractor to evaluate the Contractor's operations relative to the work time restrictions.

The AC must be delivered to the site in a thoroughly blended condition and must be spread by a self-propelled asphalt paving machine in such a manner as to avoid segregation during the placing operations. AC must be transported, spread, and compacted in accordance with Section 39-3.04, "Transporting, Spreading, and Compacting", of the State Specifications, except

as specified in the Contract or these Specifications. The first lift of multi-lift pavement can be placed at a lower temperature if approved in writing in advance by the Agency.

Paving is not allowed when the roadway is moist or damp or when it is raining. For the purpose of this provision, "raining" means any weather condition that causes the roadway to become moist or damp. In the case of sudden precipitation, all paving work must stop immediately, all AC on site not yet placed and all AC in transit from the plant will be rejected and no payment will be made for the rejected material.

When new AC is placed in contact with existing AC, the surface must be cleaned and a tack coat of asphaltic emulsion applied per Section 39-1.09C, "Tack Coat", of the State Specifications. Asphaltic emulsion must be applied to vertical edges of existing pavement, curbs, and gutters adjoining the area to be paved. Asphaltic emulsion must be of the high viscosity type subject to the approval of the Agency, and must conform to Sections 39 and 94 of the State Specifications.

Unless otherwise specified in the Special Provisions or these Specifications, the minimum compacted thickness of AC must be as shown on the Plans.

At the end of the work day, the distance between the ends of adjacent improved lanes must be between 5 and 10 feet, unless otherwise approved by the Agency.

23-8.02 Pre-Overlay Preparation

Existing AC roadways to be overlaid with AC must be prepared as follows:

- A leveling course is required where the difference in elevation between the existing pavement surface and the finished pavement surface, as indicated on the Plans, exceeds the thickness of the overlay designated for the associated areas of roadway by more than 0.02 feet. The total thickness for AC leveling course varies. When the leveling course exceeds 3 inches in thickness, the leveling course must be placed in lifts 3" or less. For projects with pavement reinforcing fabric, leveling course material must be placed prior to the placement of the fabric. Leveling courses must be Type "A" AC with 3/8 inch aggregate gradation.
- All vegetation must be removed from the edge of pavement and the pavement swept and washed, if required, in advance of the overlay operation. A power water wash must be used in the deceleration zones of intersections for the complete removal of dust that may cause overlay slippage.
- All pavement markers, temporary Type "B" Detector Handhole protection devices, and temporary traffic stripe (tape), must be removed. In addition, the Contractor must remove and dispose of existing traffic bars as required by the Agency.
- All thermoplastic limit lines, crosswalks, and legends existing on the road surface must be scarified prior to placing the overlay. Scarification must be performed by grinding to expose a minimum of 50 percent of the underlying pavement. All areas where thermoplastic is to be removed must show evidence of scarification. All material resulting from the grinding operation are the property of the Contractor and must be removed immediately from the right-of-way and properly disposed of.
- Striping removal should occur immediately prior to placement of AC overlay, and cannot occur sooner than the day before the scheduled date for the placement of AC overlay. If striping is removed on a day other than the day of the pavement overlay, the Contractor must supply and install temporary pavement markings. Temporary pavement markings must be flush mounted reflectorized tape squares, 4-inch by 4-inch #M "Staymark" with backing liners, detour grade, #6350 yellow and #6351 white, or approved equal. Right turn barrier lines, edge lines, and shoulder lane lines must not be delineated with temporary pavement markings. Temporary pavement markings must be removed prior to placement of the overlay. The spacing of the temporary pavement markings must be:

Line Type	Color	Spacing
Centerline (straight roadway portions)	Yellow	48' O.C.
Centerline (tapered or curving portions)	Yellow	24' O.C.
Stop Lines	White	6' O.C.
Channelizing Line	White	24' O.C.

- Manhole and other utility covers in the area to be overlaid must be carefully referenced out by the Contractor and the locations of the covers painted on the surface immediately after paving. All storm drain and sewer manhole and monitoring well box adjustments are the responsibility of the Contractor. Adjustment to grade of other utility covers will be by others.
- The Contractor is responsible for furnishing and placing an asphalt emulsion tack coat in advance of the overlay per Section 23-8.01 of these Specifications.

23-8.03 Spreading

23-8.03.A Hand Spreading

Areas inaccessible to spreading and compaction equipment may be paved by methods and in areas approved by the Agency. In limited areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the AC mixture may be spread, raked, and luted by hand tools. The mixture must be thoroughly compacted by means of pneumatic tampers or other methods. AC paving placed by hand is exempt from the pay reduction factors in Section 23-9.02, "Pay Factors", in these Specifications. When hand spreading is permitted, the mixture must be dumped either on the grade or on dump sheets outside the area where it is to be spread, and then distributed into place using hot shovels, and spread with hot rakes in a uniformly loose layer to the full width required and at a depth that, when the Work is completed, will have the required thickness and will conform to the grade and surface tolerance specified.

Whenever hand spreading or backwork is required behind the paving spread, the paving machine must be stopped until such hand spreading or backwork is completed.

23-8.03.B Mechanical Spreading Equipment

In addition to the requirements in Section 39-1.10, "Spreading and Compacting Equipment", of the State Specifications, a 12-foot long straightedge is required on all paving machines.

The paver must have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The paver must be equipped with distributing screws to place the mixture uniformly in front of the screed.

The screed must be equipped with a controlled heating device for use when required. The screed must strike off the mix to the depth and cross-section specified.

The material being placed in the abutting lanes must be tightly crowded against the face of the previously placed lane. The paving machine must be positioned to overlap the existing mat only to the extent that the material placed against the joint is tightly crowded against the vertical face at the joint and that the conform raking leaves no ridges or depressions. Before compacting or pinching the joint, the coarse aggregate in the overlapped material that has dislodged through raking must be removed from the pavement surface and discarded.

When placing AC to lines and grades established by the Agency, the automatic controls must control the longitudinal grade. Grade and slope references must be furnished, installed, and maintained by the Contractor. A ski device must be used on roadways with 2 or more lanes

in any one direction, or if required by the Special Provisions. The minimum length of the ski device is 27 feet, and the entire length must be utilized in activating the sensor.

When placing the initial mat of AC on existing pavement, the end of the screed nearest the centerline must be controlled by a sensor activated by a ski device. When paving contiguously with previously placed mats, the end of the screed adjacent to the previously placed mat must be controlled by a sensor that responds to the grade of the previously placed mat and will reproduce the grade in the new mat within a 0.01-foot tolerance. The end of the screed farthest from the previously placed mat must be controlled in the same manner as when placing the initial mat.

Should the automatic screed controls fail to operate properly during any day's work, the Contractor may use manual control of spreading equipment for the remainder of that day. However, the equipment must be corrected or replaced with alternative automatically controlled equipment conforming to the requirements in this Section before starting another day's work.

23-8.04 Joints

Lines for the paver to follow in placing individual lanes must be parallel to the centerline of the roadway or to a baseline established by the Agency. Longitudinal pavement joints must be within 6 inches of the lane lines shown on the Plans or as specified in the Special Provisions.

Transverse construction joints and temporary runoff tapers must be constructed so that no gradual ramping down of the mat occurs back from the joint. Bond breaking paper may be required under the runoff taper for later removal if specified by the Special Provisions.

23-8.05 Compacting

The Contractor must furnish equipment capable of producing the required compaction. For vibratory rollers, the vibratory mode must automatically shut off when machine direction is changed.

All AC paving must be constructed to produce material with a density between 92 and 97 percent per California Test Method 309. The density of the initial lift of multi-lift paving may be between 90 and 97 percent, if approved by the Agency.

23-8.05.A Density requirements - Minor Streets

Density on minor streets must be determined by nuclear gage testing or approved non-destructive testing method. The Contractor must provide quality control testing at locations based on a random sampling plan with at least 1 test per 500 tons. If the density is outside of the density range, the Contractor may test at two additional locations within the same 500 tons and average the results of all of the 3 tests. This averaged result must fall within the above-specified range. The Contractor must notify the County inspector prior to paving and provide contact information for Contractor's testing personnel. The Agency reserves the right to conduct parallel quality assurance testing at its discretion in accordance with California Test Methods 308, 309, and 375.

23-8.05.B Density Requirements - Major Streets

Density of AC paving placed on major streets must be measured as specified in Section 23-9.

23-9 AC PLACEMENT ACCEPTANCE TESTING

Laboratories must be accredited for testing AC in accordance with ASTM D3666. Technicians must be certified by Caltrans to perform specified tests.

Except as detailed above for minor streets, materials testing necessary to determine conformance with the requirements of this Section, excluding bituminous distributor testing, will be performed by the Agency and the cost thereof will be borne by the Agency.

When testing plant-produced WMA to determine mix volumetrics or stability, condition the

mix for 15 to 18 hours at 140 ± 5 degrees F or for 2 to 3 hours at 295 ± 5 degrees F in accordance with California Test Method 304M (August 2008) prior to testing. WMA may be cooled to room temperature prior to conditioning. Mixture conditioning is not required for the Theoretical Maximum Specific Gravity test.

23-9.01 Pavement Density Testing

Pavement density will be determined by comparing the average density of cores taken from the compacted pavement to the Maximum Theoretical Density as determined by California Test 309.

23-9.01.A Lot Sizes

The pavement will be accepted for density on a lot basis. A lot is 500 tons or a portion thereof. If the portion is 200 tons or less it might be incorporated into the last 500-ton lot of the day or the first 500-ton lot of the following day and might not be sampled separately.

23-9.01.B Maximum Theoretical Density (Rice)

Bituminous mixture for Maximum Theoretical Density must be randomly sampled on a lot basis.

23-9.01.C Core Density

Cores for determining the density of the compacted pavement will be taken on a lot basis, a minimum of 3 random cores per lot taken in the presence of the Inspector. The cores must be taken in accordance with the Special Provisions and as directed by the Agency. The density of each core must be determined per California Test Method 308.

Core samples for determination of the density of completed pavements must be obtained by the Contractor at the Contractor's expense, and no additional compensation will be paid. The core samples must be 4 inches in diameter. The Contractor may utilize a nuclear density gauge for preliminary testing. Dry ice may be used for cooling the pavement prior to coring. The number and locations of the samples will be as agreed upon in the field by the Agency and the Contractor. Samples must be neatly cut with a saw, core drill, or other approved equipment. The Contractor must provide the core samples to the Agency within 2 hours after final compaction. Special arrangements must be made with the Agency Material Testing Laboratory if the Contractor wishes test results within less than 12 hours for night paving or normal work performed late in the day.

Actual test location will be randomly selected per ASTM D3665 (Random Method).

23-9.02 Pay Factors

AC paving placed on minor streets and base course paving as defined in Section 23-8.05 are exempt from the pay reduction factors.

For all AC pavement subject to acceptance testing, the finished AC pavements that do not conform to the specified relative compaction requirements will be paid for using the following pay factors:

Reduced Payment Factors for Percent of Maximum Theoretical Density			
AC Type A and B and ARHM-GG Percent of Maximum Theoretical Density	Reduced Payment Factor	AC Type A and B and ARHM-GG Percent of Maximum Theoretical Density	Reduced Payment Factor
92.0	0.0000	97.0	0.0000
91.9	0.0125	97.1	0.0125
91.8	0.0250	97.2	0.0250
91.7	0.0375	97.3	0.0375
91.6	0.0500	97.4	0.0500
91.5	0.0625	97.5	0.0625
91.4	0.0750	97.6	0.0750
91.3	0.0875	97.7	0.0875
91.2	0.1000	97.8	0.1000
91.1	0.1125	97.9	0.1125
91.0	0.1250	98.0	0.1250
90.9	0.1375	98.1	0.1375
90.8	0.1500	98.2	0.1500
90.7	0.1625	98.3	0.1625
90.6	0.1750	98.4	0.1750
90.5	0.1875	98.5	0.1875
90.4	0.2000	98.6	0.2000
90.3	0.2125	98.7	0.2125
90.2	0.2250	98.8	0.2250
90.1	0.2375	98.9	0.2375
90.0	0.2500	99.0	0.2500
< 90.0	Remove and Replace	> 99.0	Remove and Replace

23-10 ASPHALT RUBBER HOT MIX-GAP GRADED (ARHM-GG)

Where specified in the Special Provisions, Asphalt Rubber Hot Mix-Gap Graded (ARHM-GG) must be used. ARHM-GG must conform to the provisions for RHMA-G AC in Section 39,

“Hot Mix Asphalt”, of the State Specifications, and these Specifications. ARHM-GG must conform to the quality characteristics shown for RHMA-G in Section 39-1.03B, “Hot Mix Asphalt Design”, of the State Specifications.

Binder for ARHM-GG may be, at the Contractor’s option, Type 1 or Type 2 asphalt-rubber binder as specified in Sections 23-10.01 and 23-10.02 of these Specifications.

The asphalt used in asphalt-rubber binder must be PG 64-16 per Section 92 of the State Specifications. The amount of asphalt in the mix must be established per Section 23-2 of these Specifications. The temperature of the aggregate at the time the asphalt-rubber binder is added must be not more than 350 degrees F.

Rubber for use in asphalt-rubber binder must 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 must be sufficiently dry to be free flowing and not produce foaming when blended with the hot asphalt. The Contractor must furnish a "Certificate of Compliance" per Section 6-2.05B, "6-2.05B Crumb Rubber (Pub Res Code § 42703(D))", of the State Specifications.

A sample of the asphalt-rubber binder proposed for use on the project, consisting of 4 one-quarter cans, together with the proposed formulation of the binder, must be furnished to the Agency at least two weeks before ARHM-GG pavement construction is scheduled to begin. These samples will be held at the Agency Lab for comparison to material in the field, if necessary.

The method and equipment for combining the rubber and asphalt must be designed and accessible so the Agency 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 must include the following:

- An asphalt heating tank (per Section 23-10.04.B in this Section)
- A mechanical blender (per Section 23-10.04.C in this Section)
- A supply system (per Section 23-10.04.E in this Section)

Traffic must not be allowed on the ARHM-GG for at least 1 hour after final rolling operations have been completed. Before opening a traffic lane to public traffic, the Agency may direct that a sand cover be spread uniformly over areas where ARHM-GG has been placed. The sand must be free from clay or organic material and must be of such size that from 90 to 100 percent will pass a No. 4 sieve and not more than 5 percent will pass a No. 200 sieve. Sand must be spread at the approximate rate of 1 to 2 pounds per square yard.

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

23-10.01 Type 1 Asphalt-Rubber Binder

Type 1 asphalt-rubber binder must be a uniform reacted mixture of compatible paving grade asphalt and reclaimed vulcanized rubber.

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

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

Sieve Size	Percentage Passing
No. 10	100%

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

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

The temperature of the asphalt must be between 350°F and 425°F at the time the rubber is blended with the asphalt. The asphalt and rubber must 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 must be maintained between 325°F and 375°F during the reaction period and must possess the following physical property after the reaction period:

Viscosity, 350°F (ASTM D 2196) (Brookfield)	1500 cp minimum
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After the material has reacted for at least 30 minutes, the asphalt-rubber must be metered into the mixing chamber of the AC production plant at the percentage specified or designated by the Agency.

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

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

23-10.02 Type 2 Asphalt-Rubber Binder

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

Extender oil must be resinous, high flash point aromatic hydrocarbon conforming to the following:

Test Parameter	Requirement
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, must form a material that is chemically compatible with the rubber.

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

Sieve Size	Percentage Passing
No. 8	100

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

The extender oil must be added to the asphalt at a rate between 2 percent and 6 percent by weight of the asphalt. The exact amount must be determined by the asphalt-rubber supplier. The asphalt must be at a temperature between 350°F but not more and 425°F when the extender oil is added.

The asphalt-extender oil blend and rubber must 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 must be between 17 percent and 23 percent by weight of the total combined mixture of asphalt, extender oil, and rubber. The exact amount must be determined by the asphalt-rubber supplier. The asphalt-extender oil blend must be at a temperature between 350°F and 425°F when the rubber is added. After the material has reacted for at least 30 minutes, the asphalt-rubber must be metered into the mixing chamber of the AC production plant at the percentage specified or ordered.

The asphalt-rubber mixture must 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 must be maintained between 375°F and 425°F during the reaction period.

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

Viscosity at 400°F (ASTM D 2196) (Brookfield)	600 to 2,000 cp
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The asphalt-rubber mixture, after reaching the desired consistency, must not be held at temperatures over 375°F for more than 4 hours.

The Contractor must provide the Agency viscosity test results from the asphalt-rubber tank, which must be, in the opinion of the Agency, sufficient to verify that the viscosity of the entire tank is homogenous during the AC production.

23-10.03 Aggregate

The aggregate for ARHM-GG must comply with Section 39-1.02E, "Aggregate", of the State Specifications.

23-10.04 Equipment

23-10.04.A Haulers

All trucks hauling AC must have tarps available and the loads must be covered from the plant to the paving machine, unless the ambient air temperature exceeds 75°F or the haul distance is less than 10 miles.

23-10.04.B Asphalt Heating Tank

The asphalt heating tank must 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 must be equipped with a thermostatic heat control device and capable of heating a minimum of 2500 hundred gallons of asphalt cement.

23-10.04.C Mechanical Blender

The asphalt-rubber mechanical blender must be capable of proper proportioning and thorough mixing of the asphalt and rubber and have a 2 stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and granulated rubber at the mix design ratios. The unit must be equipped with a granulated rubber feed system capable of supplying the asphalt cement feed system so the continuity of the blending process is not interrupted. The maximum capacity of the primary blending vessel must be 500 hundred gallons. Both the primary and secondary blenders must be equipped with an agitation device oriented horizontally in the blending vessel. The blending unit must be capable of fully blending the individual rubber particles with the asphalt cement. Separate asphalt cement feed and finished product pumps are required. This unit must have both an asphalt cement totaling meter (gallons or liters) and a flow rate meter (gallons per minute or liters per minute).

23-10.04.D Storage/Reaction Tank

The asphalt-rubber storage/reaction tank must be equipped with a heating system capable of maintaining the temperature between 300 and 375 degrees F for reacting, pumping, and adding the binder to the aggregate. The storage/reaction tank must be separate from the primary blender and secondary blender of the blending unit. The maximum capacity of the storage/reaction unit must be 800 gallons. The unit must have an internal mixing device capable of maintaining a uniform mixture of asphalt cement and granulated rubber. The internal mixing device must be oriented horizontally in the tank.

23-10.04.E Supply System

The asphalt-rubber supply system must 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.

23-10.04.F Temperature Gage

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

23-10.05 Placement

ARHM-GG must be spread at a temperature between 285 and 325 degrees F, measured in the hopper of the paving machine. See Section 23-8.02, “Pre–Overlay Preparation”, of these Specifications for additional placement requirements.

23-11 MEASUREMENT AND PAYMENT

Measurement and payment for AC will be as specified in Section 9-1.02, “Measurement”, and 39-6, “Payment”, of the State Specifications, and these Specifications.

When acceptance testing is required for AC placement, full compensation for placement of the test section is included in the price paid per ton for AC and no additional compensation will be paid.

ARHM-GG will be measured by the ton as specified for AC in Section 9-1.02, “Measurement”, of the State Specifications.

The unit price paid per ton for ARHM-GG includes 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 Agency, as shown on the Plan, as specified in the State Specifications, these Specifications, and the Special Provisions, and as directed by the Agency, except that Type “A” AC leveling courses will be paid per ton of Type “A” AC, and no additional compensation will be paid.

Type A AC leveling courses will be measured and paid for by the ton as AC.

23-12 COMPENSATION ADJUSTMENTS FOR PRICE INDEX FLUCTUATIONS

23-12.01 General

Each lot must be subject to a Pay Factor as specified in Section 23-9.02, “Pay Factors,” of the Standard Construction Specifications.

The Agency adjusts payment if the California Statewide Crude Oil Price Index for the month the material is placed is more than five percent (5%) higher or lower than the price index at the time of bid.

The California Statewide Crude Oil Price Index is determined each month on or about the 1st business day of the month by the Department using the average of the posted prices in effect for the previous month as posted by Chevron, ExxonMobil, and ConocoPhillips for the Buena Vista, Huntington Beach, and Midway Sunset fields.

If a company discontinues posting its prices for a field, the Department determines the index from the remaining posted prices. The Department may include additional fields to determine the index.

For the California Statewide Crude Oil Price Index, go to <http://www.dot.ca.gov/hq/construc/crudeoilindex/>

The Department includes payment adjustments for price index fluctuations when making adjustments under Section 2.101, Unit Price Bid in these Specifications.

If you do not complete the work within the contract time, payment adjustments during the overrun period are determined using the California Statewide Crude Oil Price Index in effect for the month in which the overrun period began.

If the price index at the time of placement increases twenty-five percent (25%) or more over the price index at bid opening, do not furnish material containing asphalt until the Agency

authorizes you to proceed with that work. The Agency may decrease Bid item quantities, eliminate Bid items, or terminate the contract.

23-12.02 Asphalt Quantities

HMA:

The Engineer calculates the quantity of asphalt in Hot Mix Asphalt (HMA) using the following formula:

$$Q_h = \text{HMATT} \times [X_a / (100 + X_a)]$$

where:

Q_h = quantity in tons of asphalt used in HMA

HMATT = HMA total tons placed

X_a = theoretical asphalt content from the job mix formula expressed as percentage of the weight of dry aggregate

RHMA:

The Engineer calculates the quantity of asphalt in rubberized HMA (RHMA) using the following formula:

$$Q_{rh} = \text{RHMATT} \times 0.80 \times [X_{arb} / (100 + X_{arb})]$$

where:

Q_{rh} = quantity in tons of asphalt in asphalt rubber binder used in RHMA

RHMATT = RHMA total tons placed

X_{arb} = theoretical asphalt rubber binder content from the job mix formula expressed as percentage of the weight of dry aggregate

HMA (with Modified Asphalt Binder):

The Engineer calculates the quantity of asphalt in modified asphalt binder using the following formula:

$$Q_{mh} = \text{MHMATT} \times [(100 - X_{am}) / 100] \times [X_{mab} / (100 + X_{mab})]$$

where:

Q_{mh} = quantity in tons of asphalt in modified asphalt binder used in HMA

MHMATT = modified asphalt binder HMA total tons placed

X_{am} = specified percentage of asphalt modifier

X_{mab} = theoretical modified asphalt binder content from the job mix formula expressed as percentage of the weight of dry aggregate

HMA (with RAP):

The Engineer calculates the quantity of asphalt in HMA containing RAP using the following formulas:

$$Q_{rap} = \text{HMATT} \times [X_{aa} / (100 + X_{aa})]$$

where:

$$X_{aa} = X_{ta} - [(100 - X_{new}) \times (X_{ra} / 100)]$$

and

Q_{rap} = quantity in tons of asphalt used in HMA containing RAP

HMATT = HMA total tons placed

X_{aa} = asphalt content of HMA adjusted to account for the asphalt content in RAP expressed as percentage of the weight of dry aggregate

X_{ta} = total asphalt content of HMA expressed as percentage of the weight of dry aggregate

X_{new} = theoretical percentage of new aggregate in the HMA containing RAP determined from RAP percentage in the job mix formula

Xra = asphalt content of RAP expressed as percentage

Other:

For other materials containing asphalt not covered above are not subject to payment adjustments.

23-12.03 Payment Adjustments

Payment adjustments for price index fluctuations will be included in Contract Change Orders per section 9-14, Contract Change Orders in these Specifications. If material containing asphalt is placed within 2 months during 1 estimate period, the Engineer calculates 2 separate adjustments. Each adjustment is calculated using the price index for the month in which the quantity of material containing asphalt subject to adjustment is placed in the work. The sum of the 2 adjustments is used for increasing or decreasing payment in the progress pay estimate. The Engineer calculates each payment adjustment as follows:

$$PA = Qt \times A$$

where:

PA = Payment adjustment in dollars for asphalt contained in materials placed in the work for a given month.

Qt = Sum of all quantities of asphalt-contained materials in pavement structural sections and pavement surface treatments placed (Qh + Qrh + Qmh + Qrap).

A = Adjustment in dollars per ton of asphalt used to produce materials placed in the work rounded to the nearest \$0.01.

$A = [(Iu / Ib) - 1.05] \times Ib \times [1 + (T / 100)]$ for an increase in the crude oil price index exceeding 5 percent

$A = [(Iu / Ib) - 0.95] \times Ib \times [1 + (T / 100)]$ for a decrease in the crude oil price index exceeding 5 percent

Iu = California Statewide Crude Oil Price Index for the month in which the quantity of asphalt subject to adjustment was placed in the work.

Ib = California Statewide Crude Oil Price Index for the month in which the bid opening for the project occurred

T = Sales and use tax rate, expressed as a percent, currently in effect in the tax jurisdiction where the material is placed. If the tax rate information is not submitted timely, the statewide sales and use tax rate is used in the payment adjustment calculations until the tax rate information is submitted.