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SECTION 23 ASPHALT CONCRETE

23-1 GENERAL

Asphalt concrete shall conform to Section 39 of the State Specifications, and these Specifications.

Asphalt concrete is designated as Type A, Type B, Type C, or Open Graded. Type C asphalt concrete shall be as specified in the Special Provisions. Asphalt concrete is also designated by gradation, according to 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 shall 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 shall 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, shall do so in accordance with the provisions of Section 12, "Construction Area Traffic Control", of these Specifications.

23-2 MIX FORMULA AND DESIGN

The Contractor shall submit to the Agency for approval a job mix formula and mix design. Mix designs shall be accompanied by current test results that indicate compliance with these Specifications and the Special Provisions. A job mix formula shall be submitted by the Contractor for each designation of asphalt concrete, 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. The job mix formula shall establish a single percentage of aggregate passing each required sieve size, a percentage of asphalt binder to be added to the aggregate, and a single temperature at which the mixture shall be discharged from the pugmill to the haul vehicle. The Agency will determine the tolerance for binder content based on submitted mix design. Binder content will be determined in accordance with California Test Method 382, "Determination of Asphalt Content of Bituminous Mixtures by the Ignition Oven" or California Test Method 379, "Method of Determining Asphalt Content by the Use of Nuclear Gauge".

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

23-3 AGGREGATE

Unless otherwise shown or specified in the Contract, aggregate for asphalt concrete structural sections of one and one-half inches (1-1/2") or greater in thickness shall be Type A and meet the specifications for three-quarter-inch (3/4") maximum, medium grading as specified in Section 39, "Asphalt Concrete", of the State Specifications; and the paving asphalt shall be viscosity grade AR-8000 as specified in Section 92, "Asphalts", of the State Specifications. All aggregate passing the number 200 sieve shall be mechanically crushed material and no natural sand shall be allowed.

Unless otherwise shown or specified in the Contract, the aggregate for all other structural sections shall be Type B and shall meet the specifications for one-half inch (1/2") maximum,

medium grading as specified in Section 39, “Asphalt Concrete”, of the State Specifications. Asphalt binder and proportioning shall be as specified in this Section (Section 23), in the Contract, or by the Agency.

23-4 RECYCLED ASPHALT PAVEMENT

At the option of the Contractor, reclaimed asphalt pavement (RAP) may be substituted for virgin aggregate at a rate of up to fifteen percent (15%) by total weight of aggregate in the asphalt concrete. RAP shall be permitted for use in all asphalt concrete construction except for the top four inches (4”) of pavement on major streets. For the purpose of this section, major streets shall be defined as all County roadways within the limits of work for the Project with two or more striped vehicular traffic lanes in one direction. A list of any additional streets designated as major may be indicated on the Plans or provided in the Special Provisions.

RAP stockpiles may be from a single source or multiple sources and shall consist solely of RAP material. Stockpiling and processing of RAP shall be performed in a manner that will prevent contamination and segregation, resulting in a uniformly blended and homogenous material. The height of RAP stockpiles shall be limited to fifteen feet (15'). Heavy equipment shall not be permitted on RAP stockpiles. Stockpiles shall be located on surfaces that are smooth and free of debris and organic material. The Agency shall 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 shall be waived and the Test Method ASTM D 2041 shall 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 X values shall be designated at the time of the asphalt mix design. Subsequent changes in the X 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 shall be submitted to the Agency for review and approval. In addition to the requirements of Section 39 of the State Specifications, the Contractor shall provide the Agency with the following information:

1. Location of RAP stockpile
2. The individual and average asphalt content test results representative of the proposed RAP stockpile based on a minimum of 1 test per 1,000 tons of material in the RAP stockpile. The asphalt content shall be determined in accordance with ASTM D 2172, Method B.
3. The individual and average asphalt-free gradations of the RAP material derived from the samples used to determine the asphalt content.
4. The individual and average asphalt viscosities of the recovered asphalt derived from the samples used to determine the asphalt content. Asphalt viscosities shall be determined in accordance with ASTM D 2170.
5. An Asphalt Institute viscosity-blending chart (or equal) indicating that the resultant asphalt grade will be within 2000 cSt of the specified asphalt grading limits.
6. A power 45 grading chart showing the combined gradation and the associated specification grading band of the virgin and asphalt-free RAP aggregate at the proposed percentages.

For the purpose of quality control the following test shall be performed by the Contractor:

TABLE 23-1. QUALITY CONTROL TESTING				
Quality Characteristic	Action Limit	Test Method	Testing Frequency	Point of Sampling
Gradation	Per Specified Tolerance	Cal. Test 202	1/500 tons ⁽¹⁾	Composite cold feed or hot bins ⁽²⁾
Mix Asphalt Content	± .2 %	Cal. Test 379 or 382	1/1000 tons ⁽¹⁾	From truck, windrow, or behind paver
⁽¹⁾ One per day minimum ⁽²⁾ At continuous mix plants from composite cold feed belt. At batch plants from hot bins.				

Quality control testing shall be performed in a timely manner. Quality control test results shall be provided to the Agency upon request.

Asphalt concrete shall be produced in conformance with the requirements of Section 39 of the State Specifications, except that the requirement for storing and drying shall not apply to the RAP material. Ingredient proportioning shall comply with the requirements of Section 39 of the State Specifications. The virgin aggregate may be heated to a temperature of 340°F if, in the opinion of the Agency, the higher temperature does not damage the virgin binder or the binder in the RAP when the materials are combined.

When the recycled asphalt pavement mixture is produced by batch mixing, the time of mixing shall not be less than thirty-five (35) seconds. When combined mathematically, the virgin aggregate and the asphalt-free RAP aggregates shall conform to the design gradation as required by these Specifications.

The Contractor's mixing equipment shall 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 shall 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 shall be introduced into the mixer after the virgin aggregate and RAP material have been combined. Should a batch mixing plant be used, the RAP material shall 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 asphalt concrete mixtures shall have tight, smooth, metal beds, and shall be free from dust, screenings, excessive petroleum oils, volatiles, or other mineral spirits that may affect the mix being hauled. Trucks shall be provided with tarpaulins or cargo covers of sufficient size and weight to protect the entire load. Loads shall be covered whenever the air temperature is 75°F or below, if the temperature of any load leaving the plant falls more than 20°F between the time of leaving the plant and placing on the roadbed, the haul distance is ten (10) miles or greater, and at other times as directed by the Agency. The Contractor shall provide haul trucks of size, speed, and condition to ensure orderly and continuous operation.

23-6 TEST SECTIONS

For a project that requires a total placement of greater than 1500 tons on a major street as defined in Section 7-8, “Peak Hours, Hours of Darkness, Holidays, and Weekends”, of these Specifications, the first fifteen hundred (1,500) tons of each asphalt concrete type to be placed shall constitute a test section for the placement of asphalt concrete for the balance of the project. The location of the test section shall be decided by the Contractor, subject to approval by the Agency. The equipment used in construction of the test section shall be the same type and weight to be used for the balance of the project. Placement of the test section shall conform to the State Specifications, these Specifications, the Special Provisions, and as directed by the Agency, and no additional compensation will be paid.

Asphalt concrete in test sections shall be compacted between a minimum ninety-two percent (92%) and a maximum ninety-seven percent (97%) of Maximum Theoretical Density as determined by ASTM Designation: D 2041. The following matrix shall be used to determine the necessary procedures and secondary test sections needed if any lot in the test section falls out of the acceptable operating range specified.

COMPACTION RESULTS	ACTION
97.1% and greater OR 88% to 91.9%	Work shall not be continued. A mandatory meeting shall be held between the Contractor and the Agency. The Contractor shall propose adjustments to his materials and/or procedures in order to meet required compaction, to the satisfaction of the Agency. Paving may then resume, after the twenty-four- (24-) hour mandatory waiting period, with a seven hundred fifty (750)-ton maximum secondary test section.
87.9% and less	The Agency will stop the work. At the Contractor's expense, an independent engineering consultant acceptable to the Agency shall be hired to analyze mix design, structural adequacy of existing road and overlay, placement and/or compaction methods, and test data. Working days shall cease for a maximum period of ten (10) calendar days while the engineering consultant is selected and the investigation perform. Paving may then resume by incorporating the recommended changes of the engineering consultant with a 750-ton maximum secondary test section.

No more than one (1) secondary test section will be allowed. If compaction results from the secondary test section do not fall within ninety-two percent (92%) to ninety-seven percent (97%), and at the sole discretion of the Agency, all remaining paving work and any associated work (striping, shoulders, etc.) may be terminated per Section 5-21, “Temporary Suspension or Delay of Work”, of these Specifications.

23-7 CONSTRUCTION PLAN

After acceptable results have been obtained from the test sections per Section 23-6 in this Section of these Specifications, the Contractor shall submit to the Agency a written construction plan. No paving will be allowed until the written construction plan is submitted. This plan shall be based on the test sections for each asphalt type and shall include:

- sweeping and cleaning equipment
- paving equipment and speed
- breakdown and finish roller type

- roller speed and number of passes required
- amplitude and period of roller vibration (if used)
- truck haul route
- number of trucks and rate of material delivery

23-8 ASPHALT CONCRETE PLACEMENT METHOD

23-8.01 General

Unless otherwise specified in the Special Provisions, asphalt concrete shall be placed as specified in this Section.

The top layer of asphalt concrete shall be placed in a lift no less than one and one-half inches (1-1/2") and no greater than two and one-half inches (2-1/2") in compacted thickness. The next lower layer of asphalt concrete shall be placed in a lift no less than one and one-half inches (1-1/2") and no greater than three (3") in compacted thickness. All other lower layers shall be placed in lifts no greater than four inches (4") in compacted thickness. The total thickness of asphalt concrete surfacing shall be as shown on the Plans.

Paving work shall be a continuous non-stop operation with delivery trucks arriving in a uniform manner. The Agency has the authority to adjust paver speed if, in the Agency's opinion, the work is not progressing 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 asphalt concrete 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 during the placing operations. Initial rolling shall be performed immediately after placement. No asphalt concrete shall be placed when the atmospheric temperature is below 55°F, except as follows:

- When asphalt concrete is placed as a base course, the asphalt concrete may be placed when the ambient temperature is 40°F and rising, if the material is deposited directly into the hopper of the paving machine.
- No paving work whatsoever shall be allowed when the roadway is moist or damp. No paving work whatsoever shall be allowed when it is raining. For the purpose of this provision, "raining" shall mean 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 asphalt concrete on site not yet placed and all asphalt concrete in transit from the plant shall be rejected and no payment will be allowed.

Any time new asphalt concrete is to be placed in contact with existing asphalt concrete, the surface shall be cleaned and a tack coat of asphaltic emulsion shall be applied to ensure proper bond. Asphaltic emulsion shall be applied to vertical edges of any existing pavement, curbs, and gutters adjoining the area to be paved. Asphaltic emulsion shall be of the high viscosity type subject to the approval of the Agency, and shall 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 asphalt concrete shall be the thickness shown on the Plans. The tolerance for minimum thickness for all operations shall be 0.01 feet. The tolerance for maximum thickness for asphalt concrete structural sections less than 0.35 feet thick shall be 0.02 feet, and for sections more than 0.35 feet thick shall be 0.03 feet.

At the end of the Working Day, the distance between the ends of the adjacent improved lanes shall be between five feet (5') and ten feet (10').

23-8.02 Pre-Overlay Preparation

Existing asphalt concrete roadways to be overlaid with asphalt concrete shall be prepared as follows:

A leveling course may be required. Leveling courses shall be Type "A" asphalt concrete with three-eighths inch (3/8") inch maximum aggregate gradation. 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 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 inches (3"), the leveling course shall be placed in lifts not exceeding three inches (3"). For projects with pavement reinforcing fabric, leveling course material shall be placed prior to the placement of the fabric.

The Contractor is 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 devices, and temporary traffic stripe (tape), if any, prior to the overlay. In addition, the Contractor shall remove and dispose of existing traffic bars as required by the Agency.

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 twenty percent (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 become the property of the Contractor and properly disposed of.

Striping removal shall occur no sooner than one Calendar Day prior to the scheduled date for the placement of asphalt concrete overlay. If the stripe removal is performed on a day other than the day of the pavement overlay, the Contractor shall supply and install temporary pavement markings. Temporary pavement markings shall be flush mounted reflectorized tape squares, 4" x 4" #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 shall not be delineated with temporary pavement markings. The spacing of the temporary pavement markings shall be as follows:

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.

The Contractor shall be responsible for the removal of the temporary pavement markings prior to the placement of the overlay.

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 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 as provided in Sections 37, 39, and 94 of the State Specifications.

23-8.03 Spreading

All mixtures shall be spread at a temperature of not less than 260°F, and not greater than 300°F.

23-8.03.A Hand Spreading

Areas inaccessible to spreading and compaction equipment may be paved by such methods as approved by the Agency. In limited areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impracticable, the asphalt concrete mixture may be spread, raked, and luted by hand tools. The mixture shall be thoroughly compacted by means of pneumatic tampers or other methods that will produce the required compacted thickness.

When hand spreading is permitted, the mixture shall be dumped either on the grade or on dump sheets outside the area upon which 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 shall be stopped until such hand spreading or backwork is completed.

23-8.03.B Mechanical Spreading Equipment

In addition to the requirements in Section 39-5.01, "Spreading Equipment", of the State Specifications, asphalt equipment shall be equipped with automatic screed controls and a sensing device or devices. A twelve-foot (12') long straightedge shall be required on all paving machines.

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 twelve feet (12') in width. Screed actions 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, tamper, or other suitable compacting devices. Pavers shall not leave ridges, indentations, or other marks that cannot be eliminated by rolling or prevented by adjustment of operation.

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

The screed shall be equipped with a controlled heating device for use when required. The screed shall strike off the mix to the depth and cross-section specified without the aid of manual adjustment during operation. Particular attention shall be directed to the setting, clearance and wear condition of the tamper bar on paver screeds so equipped.

The material being placed in the abutting lanes shall be tightly crowded against the face of the previously placed lane. The paving machine shall 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 shall be removed from the pavement surface and discarded.

When placing asphalt concrete to lines and grades established by the Agency, the automatic controls shall control the longitudinal grade and transverse slope of the screed. Grade and slope references shall be furnished, installed, and maintained by the Contractor. Should the Contractor elect to use a ski device, or if it is required by the Special Provisions, the minimum length of the ski device shall be thirty feet (30'). The ski device shall be a rigid one-piece unit and the entire length shall be utilized in activating the sensor.

When placing the initial mat of asphalt concrete on existing pavement, 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 an automatic transverse slope device set to reproduce the cross slope designated by the Agency. When paving contiguously with previously placed mats, the end of the screed adjacent to the previously placed mat shall 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 shall 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 shall 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

Longitudinal joints and edges shall be constructed to true line markings. Lines for the paver to follow in placing individual lanes shall be parallel to the centerline of the roadway or to a baseline established by the Agency. Longitudinal pavement joints shall be on, or as close as possible to, the lane lines shown on the Plans. The Agency shall determine the locations of the longitudinal pavement joints.

Transverse construction joints and temporary runoff tapers shall 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 shall furnish equipment capable of producing the required compaction. 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 direction is changed.

The Contractor's method shall be adjusted as necessary from that required in Section 39 of the State Specifications and Section 23-6, "Test Sections", in this Section of these Specifications to insure an average density equal to or greater than ninety-five percent (95%) of the laboratory density derived from compacting and testing the mixture in accordance with California Test Methods 304 and 308.

The base course of paving, that layer of asphalt concrete that is constructed upon aggregate base (or upon subgrade for deep lift applications), should be constructed conforming to the requirements of Section 39-6.03, "Compacting", of the State Specifications. For the base course of paving, the pay reduction factors included in Section 23-9.02, "Pay Factors", in this Section of these Specifications shall not apply. Unless otherwise indicated in the Special Provisions, all subsequent layers of asphalt concrete, including any paving placed upon existing roadway surfaces, are to be subject to the contract requirements detailed in Section 23-9.02, "Pay Factors", in this Section of these Specifications.

23-9 ASPHALT CONCRETE PLACEMENT ACCEPTANCE TESTING

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.

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 ASTM D 2041.

23-9.01.A Lot Sizes

The pavement will be accepted for density on a lot basis. A lot will consist of five hundred (500) tons or portions thereof. Lot sizes shall be two hundred fifty (250) tons in secondary test sections.

23-9.01.B Laboratory Density

Bituminous mixture for laboratory-compacted specimens will be sampled on a lot basis per Section 39-3.04 of the State Specifications. The lot size will be the same as indicated in Section 23-9.01.A in this Section of these Specifications. One sample shall be taken from each lot on a random basis. One laboratory-compacted specimen shall be prepared from each lot.

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 three (3) cores per lot. The lot size shall be as indicated in Section 23-9.01.A in this Section of these Specifications. A minimum of three (3) cores shall be taken from each lot on a random basis, in the presence of the Inspector. The cores shall be taken in accordance with these Special Provisions and as directed by the Agency. The density of each core shall be determined per ASTM D 2726-89.

Core samples for determination of the density of completed pavements shall be obtained by the Contractor at the Contractor's expense, and no additional compensation will be paid. The core samples shall be four inches (4") 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 shall be neatly cut with a saw, core drill, or other approved equipment. The Contractor shall provide the core samples to the Agency within two (2) hours after final compaction. The Agency has the ability to provide compaction testing results within two (2) hours of the final core sample taken from the field. Special arrangements must be made with the Agency Material Testing Laboratory if the Contractor wishes test results within less than twelve (12) hours for night paving or normal work performed late in the day.

The Agency will meet in the field with the Contractor and mutually agree on several locations for compaction testing for the given lot and provide a reference marker to the sidewalk or side of the road. The actual test location will be randomly selected from the several agreed-upon locations.

23-9.02 Pay Factors

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

In-Place Relative Compaction	Pay Factor
97.1 % or higher (Over-asphalted mix)	90% Pay Factor
92 - 97.0% (Ideal)	100% Pay Factor
89 - 91.9% (Marginal air voids)	85% Pay Factor
88.9% or less (Unacceptable air voids)	60% Pay Factor

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

Where specified in the Special Provisions, Asphalt Rubber Hot Mix-Gap Graded (ARHM-GG) shall be used. Asphalt Rubber Hot Mix-Gap Graded shall conform to the provisions for Type A asphalt concrete in Section 39, "Asphalt Concrete", of the State Specifications, and these Specifications.

Binder for ARHM-GG shall 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 respectively, in this Section of these Specifications.

The asphalt used in asphalt-rubber binder shall be, at the Contractor's option, paving grade or AR-8000, per the State Specifications.

The amount of asphalt used in asphalt-rubber binder to be added to the aggregate shall be between six and seven-tenths percent (6.7%) and eight and seven-tenths percent (8.7%) by dry weight of the aggregate. The amount used will be determined by the Agency. 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 four percent (4%) (by weight of rubber) calcium carbonate or talc may be added to prevent rubber particles from sticking together. The rubber shall be sufficiently dry 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 Specifications.

A sample of the asphalt-rubber binder proposed for use on the project, consisting of four (4) one-quarter (1/4) cans, together with the proposed formulation of the binder, shall 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 shall be so designed and accessible that 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 shall 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)

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.

Traffic shall not be allowed on the ARHM-GG for at least one hour after final rolling operations have been completed. Before opening a traffic lane to public traffic, the Agency 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 ninety to one hundred percent (90 to 100%) will pass a No. 4 sieve and not more than five percent (5%) will pass a No. 200 sieve. Sand shall be spread at the approximate rate of one (1) to two (2) pounds per square yard.

It is important that the breakdown roller compact the mat while the ARHM-GG is within the proper temperature zone. 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 forty-eight (48) hours.

23-10.01 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 ASTM C 136:

<u>Sieve Size</u>	<u>Percentage Passing</u>
No. 10	100%

The length of the individual rubber particles shall not exceed three-sixteenths inch (3/16”).

The asphalt-rubber mixture shall contain between fourteen percent (14%) and twenty percent (20%) 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 forty-five (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 (ASTM D 2196) (Brookfield)	1500 cp minimum
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After the material has reacted for at least thirty (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 Agency.

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

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

23-10.02 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:

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, 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 twenty percent (20%) and thirty percent (30%), 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:

<u>Sieve Size</u>	<u>Percentage Passing</u>
No. 8	100

The rubber shall contain no particles longer than one-quarter inch (1/4”) in length.

The extender oil shall be added to the asphalt at a rate between two percent (2%) and six percent (6%) by weight of the asphalt. The exact amount shall be determined by the asphalt-rubber supplier. The asphalt shall be at a 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 seventeen percent (17%) and twenty-three percent (23%) 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 thirty (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 thirty (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) (Brookfield)	600 to 2,000 cp
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The asphalt-rubber mixture, after reaching the desired consistency, shall not be held at temperatures over 375°F for more than four (4) hours.

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

23-10.03 Aggregate

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.

SIEVE SIZE	LIMITS OF PROPOSED GRADATION	OPERATING RANGE	CONTRACT COMPLIANCE
3/4"		100	100
1/2"		90-100	90-100
3/8"	79-87	X±5	X±7
#4	32-40	X±5	X±7
#8	18-24	X±4	X±5
#30	9-12	X±4	X±5
#200		2-7	0-8

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

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

23-10.04 Equipment

23-10.04.A Haulers

All trucks hauling asphalt concrete shall have tarps available and the loads shall 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 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 equipped with a thermostatic heat control device and capable of heating a minimum of twenty-five hundred (2,500) gallons of asphalt cement.

23-10.04.C Mechanical Blender

The asphalt-rubber mechanical blender shall be capable of proper proportioning and thorough mixing of the asphalt and rubber, and have a two (2) stage continuous mixing process capable of producing a homogenous mixture of asphalt cement and granulated rubber at the mix design specified ratios as directed by the Agency. This unit shall 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 shall be five hundred (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 (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 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 eight-hundred (800) 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.

23-10.04.E 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.

23-10.04.F 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.

23-10.05 Placement

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. See Section 23-8.02, "Pre-Overlay Preparation", in this Section of these Specifications for additional placement requirements.

23-11 MEASUREMENT AND PAYMENT

Measurement and payment for asphalt concrete shall be as specified in Section 39-8, "Measurement and Payment", of the State Specifications, and these Specifications.

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

ARHM-GG will be measured by the ton as specified for asphalt concrete in Section 39-8.01, "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" asphalt concrete leveling courses shall be paid per ton of Type "A" asphalt concrete, and no additional compensation will be paid.

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