SECTION 419 – ASPHALT RUBBER GAP-GRADED HOT MIX

419.01 Description.

The work shall consist of placing a 2 inch compacted asphalt rubber concrete overlay on an existing bituminous surface. The asphalt rubber concrete mix consists of a gap-graded surface course, composed of mineral aggregate and a reacted asphalt-rubber binder, mixed in a central mixing plant, and placed on a prepared course, in accordance with these specifications. Asphalt-rubber concrete shall conform to Section 402 of the FP-03, except as modified in this specification, and to the lines, grades, thickness, and typical cross-sections shown on the plans.

The asphalt rubber concrete shall conform to the mix design requirements as shown in Table 419-2. Mix design will be performed in accordance with AASHTO T 245, test specimens compacted at 295°F ± 5°F (75 blows), and with the Asphalt Institute MS-2, May 1984 Edition procedure (Marshall Method). The percentage of asphalt rubber material by weight, to be added to the aggregate shall be between 7.5 to 8.5% of the total weight of the mixture.

The exact percentage of asphalt rubber binder to be used in the mix shall be determined by the CO on the basis of the Marshall Mix Design and job-mix formula submitted by the contractor. All mix designs and testing shall be performed by the Independent Testing Laboratory.

The asphalt rubber concrete shall contain 1.5 percent Hydrated lime, based on the dry weight of the mineral aggregate, and in accordance with Subsection 702.08, type 3 (conforming to ASTM C 207 type N).

Asphalt rubber concrete pavement aggregate gradation shall conform to Subsection 703.07 and to the gradation limits shown below:

**TABLE 419-1**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
<th>Allowable Deviation Percent (\pm/-) From Target Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1”</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>¾”</td>
<td>97 – 100</td>
<td></td>
</tr>
<tr>
<td>½”</td>
<td>75 – 90</td>
<td>(7)</td>
</tr>
<tr>
<td>⅜”</td>
<td>55 – 70</td>
<td>(7)</td>
</tr>
<tr>
<td>No. 4</td>
<td>30 – 40</td>
<td>(7)</td>
</tr>
<tr>
<td>No. 8</td>
<td>15 – 20</td>
<td>(5)</td>
</tr>
<tr>
<td>No. 30</td>
<td>5 – 10</td>
<td>(5)</td>
</tr>
<tr>
<td>No. 200</td>
<td>2 – 6</td>
<td>(2)</td>
</tr>
</tbody>
</table>

Statistical acceptance procedures do not apply to 100% passing.
The sand equivalent when tested in accordance with AASHTO T 176 on the untreated mineral aggregate composite sample shall have a minimum value of 65.

Hydrated lime shall be mixed with damp aggregate in a pugmill prior to entering the drum drier of the hot plant. The combine cold feed mineral aggregate shall contain a minimum of two (2) percent moisture above SSD at the time the lime is mixed with the aggregates. The pugmill shall be a twin shaft, have a minimum length of 8 feet and the shaft paddles shall have a minimum diameter of 24 inches. The bottom of the pugmill shall conform to the configuration of the shafts.

**Blotter Requirements:** Blotter material shall be composed of fine aggregate, dry-washed sand or lime water.

If aggregate or sand is used, the contractor shall be responsible for sweeping the blotter sand within 24 hours of opening to traffic. The blotter material shall meet the following gradation requirements, when tested in accordance with AASHTO T-11 and T-27.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>⅜”</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>80 - 100</td>
</tr>
<tr>
<td>No. 16</td>
<td>40 - 80</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 – 10</td>
</tr>
</tbody>
</table>

If lime water is used, the contractor shall submit the method of application and equipment for approval. A lime water solution shall be applied at the rate of 0.5 gallons to 1.0 gallons per square yard. A minimum of three (3) complete coverages shall be applied to the new pavement surface. The lime shall be mixed, using a minimum of one (1) bag of hydrated lime (94 lbs.) per 3,000 gallons of water.

**TABLE 419-2**

**ASPHALT RUBBER CONCRETE MIX REQUIREMENTS**

<table>
<thead>
<tr>
<th>Design Parameters</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Marshal Stability, 75 blows, lbs., min.</td>
<td>1,200</td>
</tr>
<tr>
<td>(2) Flow, 0.01 inch, min.</td>
<td>16</td>
</tr>
<tr>
<td>(3) Percent air voids</td>
<td>3 - 5</td>
</tr>
<tr>
<td>(4) Voids in mineral aggregate min. %</td>
<td>19</td>
</tr>
<tr>
<td>(5) Compaction number of blows each end of test specimen</td>
<td>75</td>
</tr>
<tr>
<td>(6) Asphalt Rubber Binder Content Percent, range.</td>
<td>7.5 - 8.5</td>
</tr>
</tbody>
</table>
419.02 Materials.

The materials used shall conform to the following requirements:

Aggregate 703.07
Asphalt cement 702.01
Antistrip Additive 702.08

(1) Aggregate: Under Subsection 703.07

(a) Coarse aggregate (retained on a No. 4 sieve)

(1) Los Angeles abrasion, AASHTO T-96; Delete 40% max and substitute 30% max.

(3) Fracture faces, FLH T507; Delete 75% min. and insert the following: “not less than 90% by weight of the particles retained on the No. 4 sieve shall have at least one manufactured face.

(2) Asphalt Cement: Asphalt Cement Shall be PG 64-16 in conformance with the requirements of AASHTO Provisional Standard MP-1.

(3) Crumb Rubber Modifier (CRM): The CRM shall be primarily from the processing of automobile and/or truck tires by ambient grinding methods.

The gradation of the CRM when tested in accordance with ASTM C-136 (dry sieve only) and using a 50 gram sample, shall meet the following requirements:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 10</td>
<td>100</td>
</tr>
<tr>
<td>No. 16</td>
<td>75 – 100</td>
</tr>
<tr>
<td>No. 30</td>
<td>25 – 60</td>
</tr>
<tr>
<td>No. 50</td>
<td>0 – 20</td>
</tr>
<tr>
<td>No. 200</td>
<td>0 – 5</td>
</tr>
</tbody>
</table>

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

The individual CRM particles, irrespective of diameter, shall not be greater than 0.2 inches in length.

CRM (shall have a specific gravity 1.15 ±/- 0.05 (ASTM D-297). The rubber shall be substantially free from contaminants, including fabric, metal, mineral, and other non-rubber substances. The rubber shall be sufficiently dry to be free flowing and not produce a foaming problem when added to hot asphalt cement.
Not more than 4 percent (by weight of rubber) calcium carbonate may be added to prevent rubber from sticking together.

Fiber content in the rubber shall be less than 0.1% by weight. The moisture content in the rubber shall be less than 0.75% by weight. Mineral contaminant in the rubber shall not be greater than 0.25% by weight, as determined after separating a 50 gram rubber sample in a one liter glass beaker of water. The rubber shall contain no visible metal particles, as indicated by a thorough stirring of a 50 gram sample with a magnet.

The rubber manufacturer shall ship, along with the rubber, Certificates of Compliance, which certify that all requirements of this specification are complied with for each production lot number or shipment.

(4) Asphalt Rubber Binder: Asphalt Rubber Binder shall consist of a properly proportioned mixture of paving grade asphalt cement, crumb rubber modifier (CRM), and other additives, if required. The asphalt rubber binder shall meet the physical parameters listed in Table 419-3, when reacted at 350 degrees F for 60 minutes.

<table>
<thead>
<tr>
<th>Specification for Asphalt Rubber Binder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational Viscosity; 350°F (177°C); Pascal seconds, Rion type viscometer (1)</td>
</tr>
<tr>
<td>Penetration, 39.2°F, 200 g, 60 sec. (ASTM D-5); 1/10 mm</td>
</tr>
<tr>
<td>Penetration, 77°F, 100 g, 5 sec. (ASTM D-5); 1/10 mm</td>
</tr>
<tr>
<td>Resilience, 77°F (ASTM D-3407)</td>
</tr>
<tr>
<td>Softening Point (ASTM D-36)</td>
</tr>
<tr>
<td>Ductility, 39.2°F (ASTM D-113), 1 CPM</td>
</tr>
</tbody>
</table>

(1) The viscometer used must be correlated to Rion (formerly Haake) Viscometer, Model VT-04, Rotor No. 1.

The Independent Testing Laboratory shall maintain at the plant site, a Haake type viscometer to measure the viscosity during production of the asphalt rubber binder. The viscosity shall be checked and recorded for each 30 tons of asphalt rubber binder.
MIX DESIGN REQUIREMENTS

419.03 Composition of Asphalt Rubber Concrete Mix.

The asphalt rubber concrete mix shall conform to the requirements of Subsection 402.03 except as modified by Table 419-2. No recycled aggregate will be permitted in the asphalt rubber concrete mix.

(a) Asphalt Rubber Mix Design.

The contractor shall submit five (5) copies of an asphalt rubber concrete mix design prepared by the Independent Testing Laboratory 15 days prior to production of the asphalt rubber hot mix. The mix design shall conform to the mix design requirements as shown in Table 419-2. Asphalt rubber concrete mix design will be performed in accordance with AASHTO T-245 (modified), test specimens compacted at 295+/- 5°F., (75 blows) and the Asphalt Institute MS-2, May 1984 Edition procedure, Marshall Method. The mix design must include all tests and product certification specified in this section.

(b) Job-Mix Formula.

The mix design shall recommend the job-mix formula and shall list the following information:

1. Aggregate: Source and identification for each material used; gradation for each material; blend percentage, mixture gradation, and test results required as per Subsection 703.07 of FP-03, and Subsection 419.02.

2. Asphalt Rubber Binder: Source and grade of asphalt cement; source and identification of CRM. CRM percentage for the asphalt rubber binder, recommended percentage of asphalt rubber binder by weight of total mix. If CRM from more than one source is to be utilized, the above information will be required for each CRM used. The asphalt rubber binder design shall include the properties listed in Table 419-3 for the reaction periods of 60, 90, 135, 360, and 1440 minutes.

(c) Qualification of Asphalt Rubber Binder Supplier.

The contractor will be required to pre-qualify with the COR the asphalt rubber binder supplier. The data required to be submitted for qualification approval will include experience records and equipment list indicating ability to comply with the specification.

The asphalt rubber supplier must have supplied asphalt rubber binder to a minimum of three asphalt rubber surface treatments over existing pavements that have been in place at least three years under traffic.
419.04  Asphalt Rubber Mixing and Reaction.

The percentage of CRM shall be 20 percent plus or minus 3 percent by weight of total asphalt rubber mixture, the exact CRM content shall be determined by the binder mix design prepared by the Independent Testing Laboratory and submitted by the contractor. During construction, the CRM shall not fluctuate more than one (1) percent by weight of total asphalt rubber mixture. Exceeding the one percent limit will be grounds for immediate suspension of production and rejection of the affected asphalt rubber material.

The temperature of the asphalt cement shall be between 375°F and 450°F at the addition of the CRM. The asphalt and rubber shall be combined and mixed together in the asphalt blending unit and reacted in the reaction/storage tank for a minimum period of 30 minutes from the time the CRM is added to asphalt cement. The temperature of the asphalt rubber mixture shall be above 350°F during the reaction period, but shall not exceed 450°F at any time. Exceeding the 450°F limit will be grounds for rejection of the affected material.

When a job delay occurs after full reaction, the asphalt rubber may be allowed to cool. The asphalt rubber material shall be reheated slowly just prior to be fed into the hot plant to a temperature between 350°F and 400°F. An additional quantity of asphalt cement and/or CRM may be added as required to produce a material with the appropriate viscosity.

419.05  Equipment.

Asphalt Rubber Mixing and Production Equipment: All equipment used in production and proportioning of the asphalt-rubber binder shall be as follows:

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

(b) Blender: The asphalt rubber mechanical blender shall be capable of producing a homogenous mixture of asphalt cement and granulated rubber, at the mix design specified ratios. This unit shall be equipped with a granulated rubber feed system capable of supplying the asphalt cement so, as not to interrupt the continuity of the blending process. A system for metering both amount specified of granulate rubber and asphalt cement feeding into the blender shall be provided and maintained at all times. The maximum capacity of the blending vessel shall be 500 gallons. The blending unit shall be capable of fully blending the individual rubber particles with asphalt cement. A separate asphalt cement feed pump and finish product are required. This unit shall have both an asphalt cement totalizer meter in gallons and a flow rate meter in gallons per minute.
(c) **Storage Reaction Tank:** An asphalt rubber storage/reaction tank equipped with a heating system to maintain a temperature of 350°F to 375°F for reacting, pumping, and for adding the binder to the aggregate. The storage/reaction tank shall be separate from the blending unit. This unit shall have an internal mixing device capable of maintaining a uniform mixture of asphalt cement and granulated rubber.

(d) **Supply System:** An asphalt rubber supply system equipped with a pump and a metering device capable of adding the asphalt rubber binder to the aggregate in the mixing chamber of the asphalt concrete production plant at the percentage required by the job-mix formula. The temperature and viscosity of the asphalt rubber binder shall be within the range specified by the job-mix formula.

5. **Temperature Gauge.**

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

**Hot Plant Requirements**

419.06 **Mixing Plant.**

The mixing plant shall conform to the requirements of Subsection 402.04:

**Asphalt-Rubber/Aggregate Mixing Equipment:**

The combining and mixing of the asphalt rubber with the aggregate shall be accomplished with one (1) of the following types of hot-mix asphalt plants:

- **Batch Mixing** – Batch mix plant, consisting of cold aggregate storage and feed, dryer, gradation control unit, hot aggregate storage bins, aggregate weigh-hopper, and a twin-shaft pugmill mixing unit. Also, the plant may be equipped with hot-mix surge or storage bins for short-term holding of the mixture until spreading.

- **Dryer-Drum Mixing** – Dryer-drum mix plant, consisting of cold aggregate storage and feed, automatic weighing system, dryer-drum mixer and hot-mix surge or storage bins for short-term holding of the mixture until spreading.

The asphalt rubber/aggregate mixing equipment shall be capable of producing a paving mixture meeting all of the requirements contained in this specification. Specifically, the plant shall provide proper aggregate gradation, asphalt rubber binder content, and mixing temperature.

419.07 **Quality Control.**

Quality Control shall be the responsibility of the Contractor. The COR reserves the right to obtain samples of any portion of any material, at anytime during the operations, for his own use.
419.08 **Stockpiling.**

The Contractor will not be allowed to feed the hot plant from stockpiles containing less than two full days of production, unless only two day’s production remains to be done. Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

419.09 **Proportioning.**

A positive signal system and a limit switch device shall be installed in the plant, at the point of introduction of the mineral admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production, whereby the mixing shall automatically be stopped if the admixture is not being introduced into the asphalt rubber concrete mixture.

If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding the asphalt rubber binder.

The Contractor shall furnish daily documentation to the COR that the required amount of mineral admixture has been incorporated into the asphalt rubber concrete.

No fine material, which has been collected in the dust collection system, shall be returned to the mixture, unless the COR, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If the COR so determines, he will authorize, in writing, the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are uniformly metered into the mixture.

When mineral aggregate, mineral admixture, and asphalt rubber binder are proportioned by weight, all boxes, hoppers, buckets, or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the plant. The entire plant operating, shall not exceed two percent for any setting, nor one and one-half percent for any batch. Bituminous material shall be weighed in an insulated bucket suspended from a spring-less dial scale system. All scales must be certified.

When mineral aggregate, mineral admixture, and asphalt rubber binder are proportioned by volume, the correct portion of each mineral aggregate size introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder. The continuous feeder will supply the correct amount of mineral aggregate in proportion to the bituminous material, and so arranged that the proportion of each mineral aggregate size can be separately adjusted. The continuous feeder for the mineral aggregate shall be mechanically or electrically actuated.

The introduction of asphalt rubber binder shall be controlled by an automated system, fully integrated with the controls for mineral aggregate and mineral admixture.
419.10  Drying and Heating.

A recording pyrometer or other approved recording thermometric instrument, sensitive to a rate of temperature change not less than 10 degrees F. per minute, shall be placed at the discharge chute of the dryer, in order to automatically record the temperature of the asphalt rubber concrete or mineral aggregate. A copy of the recording shall be given to the COR at the end of each shift.

The moisture content of the asphalt rubber concrete immediately behind paver shall not exceed one percent by total weight of the mix. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

419.11  Mixing.

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials. Mixing shall continue until the uniformity of coating, when tested in accordance with the requirements of AASHTO T-195, is at least 100 percent.

A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The temperature of the asphalt rubber concrete upon discharge from the mixer shall not exceed 335ºF. If the asphalt rubber concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that the segregation of the mix will be minimized.

Add: Control of asphalt rubber concrete mix

If the Contractor fails to meet the requirements of Table 419-2 and/or fails to submit to the COR the results on the first acceptance sample within three (3) hours after the paving operation begins, the Contractor will suspend work on this portion of the contract until corrective action is submitted for approval to the COR and/or the results are submitted to the COR.

The Contractor’s independent testing laboratory shall determine the specific gravity (AASHTO T-209, Rice Test), air voids, voids in mineral aggregate, flow, stability, and unit weight daily on the first acceptance sample taken in the morning and the first acceptance sample taken in the afternoon. Test results shall be submitted to the COR within three (3) hours after the samples are taken. The sand equivalent test shall be performed daily on composite samples before the addition of the hydrated lime.

On the basis of the test results above, the COR may request the Independent Testing Laboratory to adjust or submit a new mix design for the asphalt mixture.
Maximum theoretical specific gravity, herein after referred to the Rice Gravity, shall be performed in accordance with AASHTO T 209 and in addition shall have a manometer or vacuum gage suitable for measuring a specified vacuum. The manometer or vacuum gage shall be fitted to the top of the flask and shall not be in line with the vacuum pump. The manometer details shall be in accordance with ASTM D-2041.

The COR shall be provided materials, certifications, samples, all test reports, and unrestricted access to current plant production records.

Any corrective work, due to deviations from the requirements for mineral aggregate, shall be done at no additional cost to the government.

419.12 Asphalt Rubber Binder Content.

During production of asphalt concrete, the Independent Testing Laboratory shall maintain, at the plant site, a nuclear asphalt content gauge, calibrated in accordance with the gauge manufacturer’s recommendations, on the material being tested. The asphalt rubber binder content shall be measured by the Independent Testing Laboratory by means of the nuclear asphalt content gauge, a minimum of one every 300 tons. Production of asphalt concrete shall cease immediately and the plant re-calibrated if the COR determines the percentage of asphalt rubber has varied by either an amount greater than ± 0.5 percent for any single reading, or an amount greater than ± 0.4 percent for the average day’s production, from the amount required by the job-mix formula.

419.13 Pavers.

Asphalt Concrete Paver shall conform to the requirements of Subsection 401.05 and the following:

Paving shall be accomplished with self-propelled, mechanical spreading and finishing equipment, pneumatic tire or tracked type, having a tamping bar or vibratory screed or strike-off assembly, capable of distributing the material to not less than the full width of a traffic lane and to the depth needed to achieve the minimum compacted thickness or finished grade, as required. The screed or strike-off assembly shall be equipped with a heating unit that maintains the temperature needed to prevent tearing of the paving mixture during spreading. Pavers that leave ridges, indentations or other marks in the surface that cannot be eliminated by rolling or prevented by adjustment in operation of the equipment, shall not be used.

419.14 Hauling Equipment.

Trucks for hauling the paving mixture shall be tailgate discharge, dump (belly or bottom gate) or moving bottom (horizontal discharge) type, and compatible with the spreading equipment. The trucks shall be equipped with a canvas or similar covering, so as to prevent rapid mixture heat loss during cooler weather, or as a result of long hauling distances.
419.15 Compaction Equipment.

Rollers shall be self-propelled, 2-axle (tandem) steel-wheel vibratory type and shall have a minimum weight of 8 tons. All rollers shall be equipped with pads and a watering system to prevent sticking of the paving mixture to the steel-wheels (drums). Vibratory rollers should be used for breakdown passes only. The Contractor shall furnish a minimum of three rollers, as described above. **Pneumatic-tired rollers shall not be used.**

419.16 Blotter Spreading Equipment.

If fine aggregate or sand is used, blotter shall be spread using hopper or whirl-type tailgate spreaders. If lime water is used, the method of application and equipment must be submitted to the COR for approval.

CONSTRUCTION PROCEDURES

419.17 Cleaning Existing Surface.

Immediately prior to applying a tack coat, the surface shall be thoroughly swept clean.

419.18 Weather Limitations.

The asphalt rubber concrete pavement shall be placed on a dry and swept clean pavement surface as approved by the COR and when the atmosphere temperature in the shade is above 50°F, and rising. The temperature of the existing pavement surface shall be 50°F or greater before placement.

419.19 Tack Coat.

The tack coat shall meet the requirements of Section 412, emulsified asphalt, diluted in the proration of 50% water and 50% emulsion, and applied at the rate of 0.05 to 0.10 gallons per sq. yard.

419.20 Asphalt Rubber Production Records.

The asphalt rubber supplier shall maintain records, indicating for each batch of asphalt rubber binder produced, the quantity of asphalt cement in gallons and tons. The temperature of the asphalt cement, the amount of anti-stripping or other additives, if used, in gallons and/or tons, and the quantity of CRM in pounds shall be provided to the COR on a daily basis.
419.21 Asphalt Rubber/Aggregate Mixture Preparation.

The asphalt rubber binder shall be at a temperature of 300°F to 375°F when pumped and metered into the mixing plant.

The aggregate shall be dried and heated to provide a paving mixture immediately after mixing with a temperature not exceeding 335°F (168°C) and a moisture content not exceeding 1.0 percent by weight of mixture.

The mixing operation shall be sufficient to achieve a satisfactory mixture with 100% coated particles, as determined by AASHTO T-195.

If the mixture is discharged from the mixer into a hot-mix surge or storage bin, the bin shall be operated so that segregation of the mixture will be minimized.

419.22 Hauling of Asphalt Rubber/Aggregate Mixture.

Truck beds shall be clean of materials such as dirt, mud and aggregates. Just prior to loading of the mixture, the truck bed shall be sprayed with a light application of a soapy solution or a silicone emulsion, to reduce sticking of the mixture to the truck bed. Oiling of truck beds with kerosene or diesel fuel will not be permitted.

419.23 Spreading of Asphalt Rubber/Aggregate Mixture.

The mixture shall be placed and finished by means of paving equipment, as required by Subsection 419.13. The temperature of the mixture immediately behind the paver shall be between 275°F and 325°F.

The paving equipment shall place the mixture without segregation or tearing within the specified tolerances and true to the line, grade and crown indicated on the plans. In order to achieve a continuous spreading operation, the speed of the paver shall be coordinated with the production of the mixing plant.

The width of each pass of the paver shall be limited to the maximum width of the heated screed or strike-off assembly and side augers.

End dumping into the paver receiving hopper will not be permitted except when paving subdivision streets and road approaches.

419.24 Joints.

Joints shall conform to the requirements of Subsection 401.15 and the following:

Longitudinal joins of each course shall be staggered a minimum of 12” with relation to the longitudinal joint of the immediate underlying course.
The Contractor shall schedule his paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the COR, the Contractor shall limit the placement of asphalt rubber concrete courses, in advance of adjacent courses, to one shift of asphalt rubber concrete production. The Contractor shall schedule his paving operations in such a manner as to eliminate exposed longitudinal edges over weekends or holidays.

Longitudinal joints shall be located within 12” of the center of a lane, or within 12” of the centerline between two adjacent lanes.

Before a surface course is placed in contact with a cold traverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense, and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

419.25 Compaction of Asphalt Rubber/Aggregate Mixture.

The mixture shall be rolled by means of the compaction equipment herein specified. A minimum of three rollers shall be used for mixture compaction, unless otherwise directed by the COR. The steel-wheel (drums) shall be wetted with plain water or, if necessary, with soapy water, to prevent mixture pick-up during rolling.

The density of the compacted mixture, at construction, shall not be less than 95% of the Marshall unit weight, composed of the same mixture, compacted at 290°F in the laboratory, by the 75 blow Marshall method (AASHTO T-245). Rolling shall commence immediately after mixture spreading. Rolling shall continue until 95% of 75 blow Marshall bulk density is achieved.

419.26 Production Start-Up Procedure.

Production Start-Up Procedure shall be in accordance with Subsection 401.12 as amended in this Subsection.

On the first day of construction, the first 500 tons of asphalt rubber concrete mix shall be placed as a test strip. This test strip will be used to establish a rolling pattern for compaction, calibration of nuclear density gauges for core densities, and to verify the mix design. Construction will not proceed until the rolling pattern for compaction has been accepted by the COR.

(b) Compaction:

Delete the first sentence of the second paragraph and replace with the following: At a minimum of five (5) locations within the control test strip, take nuclear gauge readings and cut cores from the same locations in the pavement for calibration of nuclear gauges.
(c) Mixture Properties:

One control strip asphalt rubber concrete mixture sample shall be tested for mixture properties in as per Table 419-2 and the gradation requirements in accordance with Table 419-1.

419.27 Pavement Smoothness:

After final rolling, measure the smoothness of the asphalt rubber surface course with a California type profilograph.

a) Profilograph measurements:

Measure the traveled way parallel to the centerline in the outside wheel path using a California type profilograph in accordance with California Test 526 (1978). The measurements and all original test data (profilograms) with the analysis must be performed by the Independent Testing Laboratory and submitted to the COR within 14 days after the mainline paving is completed.

Profiles taken parallel to centerline shall be in each outside wheel path with one profile obtained for each lane placed. The highest value profilogram lane inches per mile in excess of the 0.2 inch blanking band will be the Profile Index. Stationing will be identified and recorded at 0.1 mile intervals on each of the profilograms.

The contractor shall produce a Type II pavement smoothness. The profile index shall be defined in California Test 526 (1978).

A profile index will be calculated for each 0.1 mile of traveled way using a 0.2 inch wide blanking band. Bumps will be located using a 0.3 inch bump template. Defective areas are those with bumps in excess of 0.3 inch in 25 feet or less, and/or those with 0.1 mile profile indexes greater than 1.0 inches and surfaces with a pay factor less than 0.75 as determined by Table 419-4, Type II pavement smoothness, shall be corrected by the Contractor at no cost to the Government or if the CO allows the material to remain in place it will be paid for at a pay factor of 0.50.

The roadway profilogram will terminate 16 feet from a structure, approach pavement, transition area or joint with an old/existing pavement. Bridge decks, cattle-guards, bridge approach pavement, transition areas and roadway pavements having horizontal curvature of less than 350 feet radius will not be checked by a profilograph. This test shall not include miscellaneous paved areas such as short turning lanes, side roads, parking areas, and driveways.
TABLE 419-4
Profile Index and Pay Factor

<table>
<thead>
<tr>
<th>Pay Factor</th>
<th>Pavement Smoothness Type I-Range in Inches/Mile</th>
<th>Pavement Smoothness Type II % of Original Smoothness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.05</td>
<td>0.0 - 4.0</td>
<td>0% - 38%</td>
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<tr>
<td>1.04</td>
<td>4.1 - 4.8</td>
<td>39% - 45%</td>
</tr>
<tr>
<td>1.03</td>
<td>4.9 - 5.4</td>
<td>46% - 51%</td>
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<tr>
<td>1.02</td>
<td>5.5 - 6.2</td>
<td>52% - 57%</td>
</tr>
<tr>
<td>1.01</td>
<td>6.3 - 6.6</td>
<td>58% - 63%</td>
</tr>
<tr>
<td>1.00</td>
<td>6.7 - 7.4</td>
<td>64% - 69%</td>
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<tr>
<td>0.95</td>
<td>7.5 - 7.9</td>
<td>70% - 75%</td>
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<td>0.90</td>
<td>8.0 - 8.5</td>
<td>76% - 80%</td>
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<td>0.85</td>
<td>8.6 - 9.1</td>
<td>81% - 86%</td>
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<td>0.80</td>
<td>9.2 - 9.7</td>
<td>87% - 92%</td>
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<tr>
<td>0.75</td>
<td>9.8 - 10.0</td>
<td>93% - 95%</td>
</tr>
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</table>

Defect Limit 12.0 >95%

b) Straightedge Measurement.

Longitudinal testing for the areas noted in the above paragraph and transverse slopes shall be performed using a 10 foot metal straightedge provided and operated by the Independent Testing Laboratory. The deviation of the surface from the testing edge of the straightedge shall not exceed 0.2 inches in 10 feet. When using a straight edge, the maximum pay factor that can be obtained is a 1.0.

c) Defective area Correction.

All areas represented by points having deviations in excess of 0.3 inches in 25 feet, if a profilograph is used and 0.2 inches in 10 feet if a straight edge is used to determine surface smoothness shall be corrected by the Contractor.

Corrective action shall consist of one or more of the following, as approved by the COR which shall be at no cost to the government:

1. Remove and replace the surface course.

2. Place an overlay course at least 2 times as thick as the maximum sized aggregate in the asphalt rubber mixture.
3. Grind the pavement surface with equipment that is equipped with diamond-tipped saw blades on a horizontal grinding head which cuts or grinds asphalt concrete leaving a corduroy surface behind. The type of equipment to be used shall be submitted in writing to the CO for approval. The thickness of the remaining pavement shall not be less than \( \frac{3}{8} \) inches less than the design thickness. Cores may be required by the CO to verify the thickness at no cost to the government. The final pavement surface shall be uniform in appearance to the surrounding pavement. A fog coat seal shall be required to protect the ground pavement surface as approved by the CO.

Upon completion of corrective work, the Independent Testing Laboratory will re-measure the final pavement surface and re-compute the average profile index and pay factor values.

419.28 Acceptance.

Asphalt-rubber content, aggregate gradation and density shall be evaluated under subsection 106.05.

If the acceptance test results are such that a reduced pay factor is determined for more than one characteristic, only the price adjustments for the greatest reduction will apply.

The sand equivalent will be accepted under Subsection 106.04.

Asphalt Rubber Binder:

The acceptance procedures for asphalt rubber binder shall conform with the requirements as shown in Table 419-3. Final acceptance of bituminous materials shall be determined on the basis of the acceptance sample test results with the applicable specification requirements contained in Table 419-3. Asphalt rubber concrete material which deviates from the specification requirements to the extent that an unsatisfactory product results, shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

Asphalt Rubber Concrete Mixture:

The hot asphalt rubber concrete pavement will not be accepted under any acceptance provisions if one or more of the following conditions exist:

The asphalt rubber concrete is determined by the CO to be an unsatisfactory product if any one of the following is true: (a) The asphalt rubber binder does not meet the requirements of these special contract requirements, (b) gradation and density does not meet the requirements of these special contract requirements and/or (c) pavement smoothness has less than a 0.75 pay factor. The material shall be removed if it is not accepted by the CO. If the CO allows the material to remain in place, it will be paid for at a pay factor of 0.50.
a) Asphalt Rubber Content:

The Contractor shall determine the asphalt rubber binder content in accordance with the Ignition Method as described in Arizona Department of Transportation Test Procedure Interim Ariz. 427, February 6, 1998 as described in Subsection 702.01 of these Special Contract Requirements.

The upper and lower limits are the approved job-mix formula target value +/- 0.5 percent. See Table 419-5 for acceptance quality characteristic category.

b) Aggregate gradation:

Aggregate gradation shall be as shown in Table 419-1.

The upper and lower specification limits are the approved job-mix formula target value plus or minus the allowable deviations shown in Table 419-1.

See Table 419-5 for the acceptance quality characteristic category.

c) Density:

The lower specification limit is 95% of the 75 blow Marshall laboratory density determined according to AASHTO T-245.

Cut 6 inch diameter core samples from the compacted pavement according to AASHTO T-230. Fill and compact the sample holes with an approved hot asphalt rubber concrete mixture.

Cores must be 6 inches in diameter, measured for thickness, and labeled. Density of the cores shall be determined in accordance with AASHTO T-166 and thickness tests shall be performed on the 6 inch cores in accordance with ASTM D-3549. Sample cores shall be delivered to the Agency Roads office after testing.

d) Pavement Smoothness:

The maximum profile index upper specification limit for overlays shall be determined by the product of 0.67 times the smoothness of the existing surface. The defect limit will be greater than 95% of the original pavement smoothness as outlined in Table 419-4.

419.29 Measurement.

No direct payment will be made for the 1.5% hydrated lime required in the asphalt rubber concrete. This item will be considered a subsidiary obligation of the contract.

The asphalt rubber binder used in the work shall be measured by the ton as determined by averaging the daily asphalt rubber binder contents from the Ignition Test Method for each days production.
The Contractor shall provide the COR daily invoices and weight tickets on each load of asphalt rubber concrete, asphalt rubber binder, asphalt cement and rubber delivered to the project.

The Contractor shall provide equipment that is capable of measuring the hydrated lime that is added as the mix is produced. The amount of hydrated lime shall be weighed and recorded on a daily basis.

Asphalt rubber binder, tack coat, and asphalt rubber concrete pavement will be measured by the Ton.

419.30 Payment.

Pavement smoothness adjustment formula shall be as follows:

\[ A = Q \times UP \times (PF - 1.00) \]

Where:

- \( A \) = The adjustments to contract payment, in dollars, for longitudinal surface tolerance.
- \( Q \) = The product of a fixed factor of the number of Tons that represents Tons per lane mile and the number of lane miles traveled way profiled.

**NOTE:** This value shall be determined by Regional Roads Construction Engineer once the mix design has been accepted and the unit weight of the material is known

- \( UP \) = The contract unit price for Item 41901 (asphalt rubber concrete pavement) prior to application of pay factor adjustments for materials quality.
- \( PF \) = Pay factor for surface tolerance determined by Table 419-4 after completion of corrective work, if any. Pay factor shall not exceed a value of 1.05.

When the surface tolerance pay factor as determined by Table 419-4 is less than 1.0 but not less than 0.9, the Contractor will not be allowed to reduce the average profile index except as required by 419.27 c and shall accept a contract unit price adjustment in accordance with the above formula.
Add the following to this subsection:

Payment for Item 41901 Hot asphalt-rubber concrete pavement and Item 41902 Asphalt-rubber binder is limited to 80% of the plan quantity until all tests and pavement smoothness results are received by the CO.

No direct payment will be made for the application of lime solution, blotter sand or for any sweeping to the hot asphalt-rubber concrete pavement surface, but will be considered a subsidiary obligation of this Section.

Add: Payment will be made under:

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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</thead>
<tbody>
<tr>
<td>41901 Hot asphalt-rubber concrete pavement, gap graded</td>
<td>Ton</td>
</tr>
<tr>
<td>41902 Asphalt-rubber binder, asphalt cement portion shall be grade PG 64-16</td>
<td>Ton</td>
</tr>
<tr>
<td>Material</td>
<td>Quality Characteristics</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Hot asphalt rubber concrete pavement</td>
<td>Asphalt Rubber Content</td>
</tr>
<tr>
<td></td>
<td>Gradation <em>(¹)</em></td>
</tr>
<tr>
<td></td>
<td>Sieve Size</td>
</tr>
<tr>
<td>½”</td>
<td>I</td>
</tr>
<tr>
<td>¾”</td>
<td>I</td>
</tr>
<tr>
<td>No. 4</td>
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<tr>
<td>No. 8</td>
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<tr>
<td>Other Specified Sieves</td>
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</tr>
<tr>
<td>Core Density <em>(²)</em></td>
<td>I</td>
</tr>
<tr>
<td>Smoothness <em>(³)</em></td>
<td>I</td>
</tr>
</tbody>
</table>

(1) Use only sieves indicated for the specified gradation. Do not use maximum or nominal maximum size sieve.

(2) Cut core samples from the compacted pavement according to AASHTO T-230 method B. Fill and compact the sample holes with asphalt concrete mixture.

(3) Applies only to an item used as a final surface course constructed under the contract.