DIVISION 400

BITUMINOUS PAVEMENTS

SECTION 401

HOT MIXED ASPHALT PAVEMENT

401.01 Description. This work covers the general requirements that are applicable to all types of hot mixed asphalt for base courses, intermediate courses, and surface courses, irrespective of gradation of mineral aggregates or the kind, type, and amount of asphalt binder and additives.

The base, intermediate or surface course shall consist of one or more courses of asphalt coated mineral aggregates constructed on the prepared surface in accordance with these specifications and the specific requirements of the type under contract. The courses shall conform to the required lines, dimensions, thickness and typical cross-section or specified rate of application.

MATERIALS

401.02 Asphalt Binder and Additives. Asphalt binder (asphalt cement) shall conform to all the requirements of AASHTO MP 1 and shall be PG64-22 unless otherwise specified.

A. Liquid Anti-Stripping Agent. Any liquid anti-stripping agents or other additives that are required shall be approved by the Engineer before their use.

Liquid anti-stripping additive shall be thoroughly blended in line between the asphalt binder storage tank and the point of discharge from the asphalt binder supply line. Blending shall be accomplished by means of a static spiral pipe line mixer or by other approved devices. The

anti-stripping additive delivery system shall be approved by the Engineer.

The liquid anti-stripping additive shall be controlled by a proportioning device that shall be accurate to within ±15% of the amount required. The proportioning device shall have a convenient and accurate means of calibration. The proportioning device shall be interlocked with the asphalt binder feed system so as to maintain the correct proportions for all rates of production and batch sizes and to insure that all mixtures produced are properly treated with anti-stripping additive. Flow indicators or sensing devices for the anti-stripping additive shall be provided and interlocked with the plant controls so that mixture production will be interrupted if introduction of the anti-stripping additive fails. A meter displaying the accumulative number of gallons of anti-stripping additive used in the asphalt mixture shall be located between the anti-stripping additive storage tank and the point the anti-stripping additive is blended in-line with the liquid asphalt. The meter shall be easily accessible to the Engineer.

B. Hydrated Lime. When hydrated lime is used as an asphalt anti-stripping additive, it shall conform to the requirements of AASHTO M 303, Type 1.

401.03 Aggregates.

A. Mineral Aggregate. The mineral aggregate shall be composed of fine aggregate or a combination of coarse and fine aggregate. The gradation requirements for coarse and fine aggregates are specified in the tables entitled **Gradation of Coarse Aggregates** and **Gradation of Fine Aggregates** located in the Appendix of these specifications. The blending shall be done through separate bins at the cold elevator feeders and not in the stockpile. Coarse aggregate shall be that portion of the total aggregate retained on a No. 4 sieve and fine aggregate shall be considered that portion passing a No. 4 sieve. When crusher-run material is used, it will not be necessary

that it be screened before entering the cold feed bin. The fine aggregate, coarse aggregate, and any additives in combination with the specified percentage of asphalt binder shall meet the requirements of tests specified before approval may be given for their individual use. The combined effective specific gravity of aggregates in any mix shall not be greater than 2.90. The use of marine (fossiliferous) limestone shall be restricted for surface courses as outlined in Section **403**. Fine and coarse chrome slag aggregate shall not be used in Surface Types 1C, 1B, and 1.

B. Mineral Filler. Mineral filler shall conform to the requirements of AASHTO M 17.

C. Fine Aggregate. The fine aggregate shall consist of sand, stone, slag, gravel, screenings, or a combination of sand and screenings. Fine aggregate shall be uniformly graded from coarse to fine, shall be free of lumps of clay, loam or other foreign matter, and shall not have a coating of injurious material. The Engineer will sample the stockpiled materials at the plant site in order to insure compliance with the requirements.

1. Sand. Sand shall consist of hard, sharp, angular grains of quartz or other durable rock, free from excessive quantities of clay or other deleterious substances and shall contain not more than 10% total material passing the No. 200 sieve with a maximum of 6% clay, except as provided below. Material passing the No. 200 sieve will be determined by SC-T-5. The percent clay will be determined by SC-T-34. Clay contained in the sand must be uniformly dispersed throughout the sand and the sand must be free of clay balls. Sand shall be so excavated, blended, and stockpiled that a uniform product will be obtained. When sands are blended, one of the sands may contain not greater than 12% minus No. 200 material; however, the composite blend shall not exceed 10% total material passing the No. 200 sieve as stated

above.

2. Screenings. Screening shall consist of hard, sharp, angular grains of durable materials produced from stone, slag or gravel meeting the quality requirements of coarse aggregate as specified in Subsection **401.03D**. When 15% or less screenings are used in a mix, the screenings shall not contain more than 35% passing the No. 200 sieve as determined by SC-T-5. When more than 15% screenings are used in a mix, the screenings shall contain not more than 15% passing the No. 200 sieve as determined by SC-T-5. Screenings containing an excessive amount of flaky, micaceous or other injurious particles shall not be used. Regular screenings shall not have a sand equivalent less than 40 in accordance to AASHTO T 176. Marine limestone screenings and fines contained in a crusher-run material produced from marine limestone material shall have a sand equivalent not less than 28.

D. Coarse Aggregate. Coarse aggregate shall consist of clean, washed, tough, durable particles of crushed stone, gravel or approved crushed slag and shall be free from an excess of soft or laminated pieces, disintegrated particles and vegetable or other deleterious substances and free from aggregate coated with soil or other objectionable matter. Dry slag shall have a weight of not less than 75 pounds per cubic foot.

Crushed stone or gravel shall have an abrasion loss of not more than 60% when subjected to the Los Angeles Abrasion Test (AASHTO T 96). Slag shall have an abrasion loss of not more than 45% when subjected to AASHTO T 96.

Crushed coarse aggregate shall have 2 or more freshly mechanically induced fractured faces on at least 70%, based on count, of the material retained of the No. 4 sieve, and not more that 10% flat and elongated particles

based on a 5:1 ratio.

Crushed aggregate used in Surface Types 1C and 1B on interstate projects will have an abrasion loss of not more that 55% when subjected to the Los Angeles Abrasion Test (AASHTO T 96).

When coarse aggregates used in Surface Types 1C, 1B, 1, and 3 are subjected to 5 alternations of the Sodium Sulfate Soundness Test (AASHTO T 104), the weight loss shall not exceed 15%.

When used in Hot Mix Asphalt (HMA) Courses, steel slag shall be crushed to the desired gradation and kept in a controlled, continuously saturated stockpile for a minimum of six (6) months prior to use. No additional material shall be added to this stockpile during this time.

Before use in an HMA mixture, the stockpiled material shall be tested for expansion following the SC-T-89 procedure titled *Evaluation of Potential Expansion of Steel Slag.* At the completion of the curing period, the material tested shall have an average total volumetric expansion of less than 0.05% when subjected to the SC-T-89 procedure. Stockpiles not meeting the expansion criterion shall be allowed to cure for an additional two (2) months minimum before re-testing.

When the stockpiled material has been aged, and is to be included in an HMA mix design, the Contractor shall present a certification to the Engineer, along with the mix design for verification, stating that the material has been cured according to specification. A stockpile number will be assigned to the stockpile after receiving certification from the Contractor. Steel slag used by the Contractor for mix designs shall be aged in accordance with this specification.

E. Crusher-Run Material. Crusher-run material to be used in asphalt mixtures shall be produced from areas in the quarry that will not allow the possibility of intrusion of

overburden, dirt, sap rock, or any other deleterious material.

The process for manufacturing the crusher-run material and the quality control program for controlling production shall be approved by the Engineer. The manufacturing process shall be such that a consistent gradation is maintained and this consistent gradation must be verified by quality control test performed by the producer on a daily basis. All test results will be made available to the Engineer upon request.

The coarse aggregate in the crusher-run material shall be free of clay coatings or other harmful films. The fines in the crusher-run shall meet the quality requirements specified for screenings including the sand equivalent requirement. Crusher-run material will not be required to be screened before entering the cold feed bin(s) provided a uniform mixture is being produced. If segregation of the finished mixture is evident, the crusher-run material may be required to be screened into a coarse and a fine size before entering the cold feed bin(s).

Hot Mix Asphalt Aggregate Base Types 1 and 2, Binder Types 1 and 2, and Surface Type 3 shall not contain more than 50% crusher-run material. Crusher-run material will not be permitted in Hot Mix Asphalt Surface Course Types 1C, 1B, and 1.

F. Recycled Asphalt Pavement (RAP). When so stated, reclaimed asphalt pavement will be allowed for use in hot mix asphalt pavements.

The RAP will be milled material from Department projects. Stockpiles of RAP material shall be separated by project and a sign satisfactory to the Engineer shall be erected and maintained by the Contractor on each stockpile to identify the source(s).

The Contractor shall maintain at the plant site a record

system for all RAP stockpiles. These records shall contain, but not be limited to, the following:

1. Stockpile identification.

2. Sketch of all stockpile areas at the plant site.

3. RAP source (project, state route, road, or street name.)

4. Dates milled and approximate number of tons in the stockpile.

5. All extraction test results.

The RAP stockpile records shall be available to the Engineer at the plant site. The Department reserves the right to reject, by visual inspection, any stockpiles that are not kept clean and free of foreign materials.

Extraction tests shall be performed at a rate of one per 1000 tons of RAP, with a minimum of 3 per stockpile.

The RAP shall be processed in such a manner that all particles will pass a 2 inch screen before entering the plant and shall be free of foreign matter or other contamination and shall be uniformly graded. RAP particles retained on the 2 inch screen may be re-crushed in such a manner that will not result in further degradation of the aggregates.

The range of RAP in recycled hot mix asphalt mixtures is as follows:

Type Mix	% RAP*
Asphalt Aggregate Base Types 1 & 2	10 - 30
Binder Types 1 & 2 and Surface Types 3 & 4	10 - 25
Surface Type 1	10 - 20

* RAP is limited to 15% maximum when introduced in the hot elevator.

Reclaimed asphalt material will not be allowed in Superpave mixes or Surface Types 1B and 1C.

G. Crushed Glass. Crushed glass is permitted for use as an aggregate in Asphalt Aggregate Base Types 1 and 2 and Binder Types 1 and 2. When used in these mixes, crushed glass shall be limited to a maximum of 15% by weight of total aggregate. The crushed glass shall be processed to meet the following limits:

Sieve	% Passing
3/8 inch	100.0
No. 200	8.0 max.

The recycled glass shall be free of organic and toxic materials, hypodermic needles and any hazardous materials, and must meet South Carolina DHEC regulations as a non-hazardous material. The lead content for the glass aggregate shall not exceed 5 ppm and the silver content shall not exceed 5 ppm. The aggregate shall also meet the limits established by the EPA for the primary and secondary drinking water standards. The glass aggregate shall contain not more that 1% by weight of the non-glassy materials and shall not contain any portion from mirror glass.

When the stockpiled material is to be included in an HMA mix design, the Contractor shall present a certification to the Engineer, along with the mix design for verification, stating that the material meets specification. A stockpile number will be assigned to the stockpile after receiving certification from the Contractor.

401.04 Composition of Mixture.

A. Submission of Materials and Job Mix Formula. All Marshall and Superpave asphalt mix designs shall be designed by the Contractor and approved by the Department's Research and Materials Laboratory in Columbia, South Carolina. The mix designs shall be prepared in a laboratory approved by the Engineer. Technicians designing Marshall mixes shall be certified as a Level 2, Marshall Method of Mix Design technician. A Level 2S, Superpave Mix Design technician shall design Superpave mixes. The Contractor is responsible for providing a mix with the appropriate materials that will comply with all specifications.

The job mix formula shall indicate a single definite percentage of aggregate passing each required sieve and a single definite percentage of asphalt binder to be contained in the mixture. This percentage of asphalt binder shall be the percentage recovered by SC-T-64, *Field Method of Determining Binder Content and Sieve Analysis of Asphalt Hot Mixtures*, or SC-T-75, *Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven,* and will not include any asphalt binder that may be absorbed in the aggregates. If an anti-stripping agent or other additives are required, the percent of each to be incorporated in the mixture shall also be indicated in the job mix formula.

The Engineer may make adjustments in the job mix formula submitted by the Contractor and, if so, will advise the Contractor of the job mix formula to be used.

No work shall be started nor any mixture accepted until the Contractor has submitted in writing and received the Engineer's approval of his intended source of materials and his job mix formulas for the mixture(s) he proposes to furnish.

A job mix formula will not be required for Sand Asphalt Base Courses or for Asphalt Aggregate Base Courses. However, the asphalt content for each mixture will be verified by the Engineer.

B. Gradation Test Methods. The gradation of Asphalt Aggregate Base Courses, Type 1 and 2, and the No. 8 sieve and above for Hot Mix Asphalt Binder Courses, Type 1 and 2, will be determined by SC-T-63, *Basket Method of Determining Gradation of Coarse Asphaltic Mix*. The gradation for sieves below the No. 8 will be determined by SC-T-64, *Field Method of Determining Binder Content and Sieve Analysis of Asphalt Hot Mixtures*. The gradation of Surface Course Types 1C, 1B, 1, and 3 shall be determined using SC-T-64.

If SC-T-75, *Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven*, is used to determine the asphalt binder content, SC-T-76, *Determination of Washed Aggregate Gradation of Hot Mix Asphalt Extracted Aggregates*, will be used to determine the aggregate gradation for all sieves.

C. Tolerances. The tolerances for mixtures are contained in the document entitled *Control and Acceptance of Hot Mix Asphalt Mixtures*. This document may be obtained from the Engineer.

D. Moisture Susceptibility. Hot Mix Asphalt Binder Types 1 and 2 and Surface Types 1C, 1B, 1, and 3 shall be subjected to the indirect tensile strength test during the mix design and during actual production of the mix. The test shall be conducted in accordance with SC-T-70 entitled *Laboratory Determination of Moisture Susceptibility Based on Retained Strength of Asphalt Concrete Mixtures*. A copy of SC-T-70 is available from the Engineer upon request.

Hot Mix Asphalt Binder Types 1 and 2 and Surface

Types 1C, 1B, 1, and 3 shall have a minimum wet conditioned strength of 65 psi and a minimum tensile strength ratio of 85% during mix design.

Contractors shall resubmit asphalt job mix request for mixtures that do not meet minimum wet conditioned strength and/or minimum tensile strength ratio requirements.

Cores may be molded in the field anytime during construction to determine the moisture susceptibility of an asphalt mix. Hot mix asphalt produced through a plant shall have a minimum wet conditioned strength of 60 psi and a minimum tensile strength ratio of 80%.

E. Dust to Asphalt Ratio. The dust to asphalt ratio for Binder Types 1 and 2 and Surface Types 1C, 1B, 1, 3, and 4 shall be in the limits of 0.60 to 1.20. The dust to asphalt ratio is defined as the percentage of material passing the No. 200 sieve divided by the percentage of asphalt binder. The total amount passing the No. 200 sieve on mix designs will be determined by AASHTO T 11 and AASHTO T 27. The amount passing the No. 200 sieve in the field will be determined by SC-T-64 or SC-T-76.

F. Wash Gradations. During mix designs, wash gradations on coarse and fine aggregates will be used to determine the combined blend of aggregates in the total mixture. Aggregate washed gradations will be determined by AASHTO T 11 and AASHTO T 27. Contractors shall submit washed gradations on Lab Form 269 when requesting a job mix formula.

G. Aggregate Selection. The Contractor shall use a combination of aggregates so that mix adjustments can be readily performed to correct mix design and field problems related to air voids, dust to asphalt ratio, and gradation. It is recommended that at least 3 uniformly graded aggregated types be used to compose an asphalt mix design: fine, intermediate, and coarse aggregates.

401.05 Mix and Pavement Samples. Samples of the mixture in use will be taken and tested as many times daily as deemed necessary by the Engineer and the mixture must be maintained uniform throughout the project within the applicable tolerances.

The Contractor shall furnish samples of asphalt paving mixtures for testing from trucks at the asphalt plant site, trucks at the roadway site, or samples may be cut from the completed pavement structure. The areas of pavement so removed shall be replaced with new mixture and refinished. No additional compensation will be allowed for furnishing test samples and replacing the areas with new mixtures.

EQUIPMENT

401.06 General. The method employed in performing the work and all equipment, plants, machinery, tools, etc., used in handling the materials and performing any part of the work shall be subject to the approval of the Engineer before work is started, and, when found unsatisfactory, shall be changed and/or improved as required. All equipment, tools, machinery and plants used must be maintained in a satisfactory working condition.

401.07 Mixing Plants. Plants shall be either the batch mixing type or the drum mixing type and shall be so designed, equipped and operated that the weighing, proportioning and mixing of the materials will result in a uniform and satisfactory asphalt mixture meeting the requirements of these specifications. The plant site shall have sufficient storage space for separate stockpiles, bins, or stalls for each size of aggregate. The different sizes shall be kept separated until they have been delivered, without segregation, by the feeder or feeders to the boot of the cold elevator or elevators in their proper proportions. The storage yard shall be maintained neat and orderly and separate stockpiles shall be readily accessible for sampling. Separate dry storage of adequate capacity shall be provided for mineral filler when used.

Mixing plants shall be of sufficient capacity and coordinated to adequately handle the proposed construction. All mixing plants shall comply with the requirements contained in AASHTO M 156 with the following modifications:

1. Section 4.1 of AASHTO M 156 shall be deleted and the following substituted:

   Plant screens capable of screening all aggregates to the specified sizes and proportions and having normal capacities slightly more than the full capacity of the mixer shall be provided. The screen over the fine bin shall be a No. 6 square or a No. 6 slotted screen. The selection of the other screen sizes shall meet the approval of the Engineer and shall be made so that in screening the remainder of the aggregate, approximate equal proportions will be delivered to each bin insofar as is practicable. A scalping screen will be required to remove oversize aggregates, sticks, roots, or lumps.

2. Batching Plants. Section 6.7, *Automation of Batching*, and Section 6.8, *Recording of Batching*, shall apply.

3. Drum Mixing Plants. The drum mixing plant shall be equipped so that asphalt binder, aggregate, and a total of asphalt binder and aggregate in tons per hour will be printed on a ticket at a time interval prescribed by the Engineer.

401.08 Hydrated Lime Systems. Hydrated lime systems shall be controlled by a proportioning device, which shall be accurate to within plus or minus 10% of the amount required. The lime proportioning system shall consist of a continuous feeder system, which will proportion the flow rate of lime by actual weight. The lime weighing and feeding system shall be controlled by a positive weighing system. The system shall have the ability to continuously monitor the flow rate of dry aggregate in tons per hour. The system shall automati-

cally adjust the flow of lime for any change in dry aggregate flow rate. Volumetrically controlled lime feeder systems will not be allowed.

The moisture content of the damp aggregate shall be entered into the control and the system shall provide a dry aggregate tons per hour signal to control the lime feed.

The control system shall display the following:

1. Percent moisture in the total aggregate.

2. Tons per hour of dry aggregate.

3. Tons per hour or pounds per minute of lime.

The display output shall be from actual continuous scale readings.

The system shall have high and low out of tolerance sensing ability by weight. The system shall sound a horn if the lime is not feeding or if the flow rate of lime is out of tolerance. The horn shall be audible in the plant control room, field lab and at any location at the plant site. There shall be a simple and convenient means of stopping the flow of lime near the silo, so that the monitoring system can be checked when the Engineer deems necessary.

The Contractor shall provide a convenient means to divert the flow of lime from the feeder to an outside sample container to check the lime calibration. Instead of diverting lime from the feeders, the weighing system may be verified in accordance with SC-T-78. All the necessary equipment for checking the lime calibration shall be provided by the Contractor and shall remain at the plant site.

A water spray delivery system shall be available to dampen the aggregates. This system shall consist of a spray bar mounted over the cold feed gathering conveyor before adding the hydrated lime. The water spray delivery system

shall not be mounted over the aggregate belt conveyor equipment with the weigh monitoring system. All virgin aggregates being fed to the plant shall pass under the spray bar. The spray bar shall have a minimum of 3 spray nozzles equally spaced across the width of the conveyor belt.

Blending of the lime with the aggregates shall be accomplished by a continuous single shaft or a twin shaft motorized continuous premixing pugmill before entering the dryer of the plant. The continuous premixing pugmill shall be designed such that the aggregate and lime, upon entering the pugmill, is moved in a near horizontal direction by the mixing paddles, without the aid of a conveyor belt, for a distance of at least 3 1/2 feet. The pugmill shall have adequate capacity to uniformly mix and coat the aggregate with the lime without interfering with the normal production rate of the asphalt plant. There shall not be any traces of unmixed lime after the aggregate and lime exit the pugmill.

The lime feeder system and continuous premixing pugmill shall be adequately enclosed to prevent lime from becoming airborne.

The inverted twin-shaft-belt box mixer or any other type of belt mixing device will not be allowed. Mixing devices, which permit the aggregate to fall through the mixing paddles, are not acceptable.

A lime slurry system may be used instead of the damp aggregate system.

All lime systems, including the continuous premixing pugmill, shall be approved by the Engineer before any mix is produced for use in the project.

401.09 Hauling Equipment. Trucks used for hauling asphalt mixture shall have tight, clean, smooth metal beds which have been thinly coated with a minimum amount of paraffin, lime water solution, soap or detergent solution or other approved material, to prevent the mixture from adhering

to the beds. Under no circumstances will any petroleum-based product be permitted for use to prevent asphalt mixtures from adhering to the beds. In all cases, after spraying with solution, truck bodies must be raised so that excess material is drained before placing mixture in the truck. A hole shall be placed in the truck bed at a suitable location for checking the temperature of the mixture. The Contractor shall provide and have installed on vehicles covers made of canvas or other suitable material that will provide a weather-tight enclosure to completely cover and protect the mixture from inclement weather, or where there is evidence of a crust forming.

401.10 Batch and Truck Scales. The Contractor shall provide satisfactory platform truck scales at the plant site for use in obtaining the net weight of each load of finished mixture. All platform scales shall be of sufficient size to permit the entire vehicle or combination of vehicles to rest on the scale platform while being weighed. Combination vehicles may be weighed as separate units provided they are disconnected while being weighed. The scales shall be tested and sealed by an authorized public official or scale serviceperson without any additional compensation at least each six (6) months and as often as the Engineer may deem necessary to insure their accuracy. When an asphalt plant is relocated, the scales shall be tested and sealed by an authorized public official or scale serviceperson.

A digital recorder shall be installed as a part of the platform truck scales. The recorder shall produce a printed digital record on a ticket of the gross and tare weights of the delivery trucks along with a time and date print for each ticket. Provisions shall be made so that scales may not be manually manipulated during the printing process. In addition, the system shall be so interlocked as to allow printing only when the scale has come to rest. The scales and recorder shall be of sufficient capacity and size to accurately weigh the heaviest loaded trucks or tractor trailers that are used for the delivery of the asphalt concrete from that plant.

For batch plants, the Contractor shall provide an approved automatic printer system as specified by AASHTO M 156, which will print the weights of the material delivered. The system shall be used in conjunction with an approved automatic batching and mixing control system. The system shall record the total net weight of each load and a total net weight of asphalt binder for each load. Such weights shall be evidenced by a weight ticket (in sufficient copies) for each load. Where tickets are printed in such manner, only the applicable portions of Subsection **401.37** shall apply.

401.11 Paver. Unless otherwise permitted or directed by the Engineer, the asphalt mixture shall be spread by means of a mechanical self-powered paver capable of spreading and finishing the asphalt mixture without segregation to the depth and width required, true to line, grade, and crown set by the Engineer. The paver shall be equipped with hoppers and distributing screws or satisfactory devices for placing the mixture uniformly in front of the screed. When extendable screeds are used, the distributing screws or augers shall be extended sufficiently to provide uniform distribution of the mixture for the full width of the screed. The screed or strike-off assembly shall operate by cutting, crowding or other practical action that is effective on the mixture at workable temperatures without tearing, shoving, or gouging and that will produce a finished surface of the smoothness and texture required. The screed shall be adjustable as to level and shall have an indicating level attached.

Pavers shall be capable of operating at variable speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver should be avoided.

On projects of sufficient length, in addition to the above requirements, the paver shall be equipped with a system for automatically controlling the pavement cross-slope and for automatically controlling the longitudinal profile. As the paver moves forward, the system shall be such that the paver will automatically anticipate and make adjustments for undulations encountered on the existing surface. A 40 foot mobile

stringline, a 40 foot long ski, or an approved electronic leveling device shall be attached to the paver with the mobile stringline or ski reference being used to establish the longitudinal profile. The grade-following sensor shall be capable of following the taut string, wire, or other reasonable rigid grade reference produced by the leveling device. The automatic cross-slope device shall be adjustable and be able to obtain the proper super-elevation going into curves and maintain the maximum super-elevation within curves once the maximum super-elevation has been reached. For tying into an existing layer of material, the existing material will be used as the grade reference for the grade following sensor.

Manual operation will be permitted for constructing irregularly shaped and minor areas. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained. If the Contractor fails to obtain and maintain the specified surface tolerance, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

401.12 Rollers. The Contractor shall present to the Engineer at the job site the manufacturer's literature for the rollers being used, in order that the Engineer can determine that the rollers conform to the specifications. Means shall be provided so that the tire pressure in the pneumatic-tired roller can be checked. Upon request and without additional compensation, the Contractor shall check the weight of any rollers in use in the presence of the Engineer.

Roller speeds shall be that which gives maximum compaction and a smooth pavement.

A. Steel-Wheel Rollers. Three-wheel steel rollers shall be 10 to 12 tons in weight and two-axle tandem rollers of 8 to 12 tons in weight. These rollers, under working conditions, shall develop a pressure of 250 to 350 pounds per inch of roller width in the compression wheel. Rollers shall be in good working condition and shall be capable of re-

versing without backlash. Rollers shall be equipped with adjustable scrapers to keep the rollers clean and with efficient means of keeping the wheels wet to prevent mixes from sticking to the rollers.

The surface of the rollers shall be free of flat areas, openings or projections that will mar the surface of the pavement.

B. Pneumatic-Tire Rollers. Pneumatic-tire rollers shall be self-propelled, having an effective rolling width of not less than 60 inches. The rollers shall be equipped with pneumatic tires of equal size and diameter which are capable of exerting average contact pressures varying from 40 psi to 90 psi by adjusting the ballast or tire inflation pressures. The wheels of the rollers shall be placed so that one pass will accomplish one complete coverage equal to the rolling width of the machine. There shall be a minimum of 1/4 inch overlap of the tracking wheels. The wheels shall not wobble. The roller shall be constructed so that the contact pressure shall be uniform for all wheels, and the tire pressure of the several tires shall not vary more than 5 pounds per square inch. Pneumatic-tire rollers shall be constructed with enough ballast space to provide uniform wheel loading as may be required. The total operating weight and tire pressure of the roller shall be varied as directed by the Engineer to obtain contact pressures that will result in adequate compaction.

C. Vibratory Rollers. Vibratory rollers shall weigh at least 8 tons and may have either one or two vibrating wheels. The roller shall be operated at a speed, frequency, and amplitude that will yield maximum compaction and a smooth pavement.

401.13 Field Laboratory. The Contractor shall provide and maintain a fully equipped field laboratory and furnish all supplies necessary for performing the quality control inspection and testing at the asphalt plant. The building shall be used exclusively by the Engineer or his representative while mate-

rial is being produced for the Department. It shall have satisfactory electric lighting and electric outlets. The building shall have a minimum floor space of 250 square feet, minimum height of 7 feet, minimum width of 10 feet, have suitable work benches and sufficient water available for tests, be provided with a suitable table or desk with drawers for office work, be supplied with two chairs, and shall also be equipped with a heating oven of satisfactory size with adequate controls for adjusting and maintaining different temperatures. Locks shall be provided for the windows and doors. The building will be so located that the Contractor's plant is in close proximity and full view from the vicinity. The Contractor shall also provide a substantial platform, constructed to the proper height, for use by the Engineer in obtaining asphalt mix samples and inspecting mixtures in truck beds.

The field laboratory shall be so equipped that, with the windows and doors closed and the ventilation system functioning in the prescribed manner, the ambient air temperature shall be maintained between 65°F and 80°F. Enclosures shall be provided for the rotarex, ash determination, and any other procedures where the vapor of the extracting solvent is emitted. Drying the sample after extracting the asphalt binder shall be done under an enclosure or inside an oven vented outside the laboratory. Each enclosure shall be equipped with a hood and glass or other doors capable of enclosing the above processes from the ambient air in the laboratory. An exhaust fan shall be located in the rear or top of the hood for each work compartment with replacement air provided through an open window or other opening as necessary to achieve the specified exchange of air.

The ventilation system shall be capable of exchanging air at the rate of 100 ft^3/ft^2/minute over the entire open door area of each enclosure. The enclosure for ash determination shall be equipped with a damper that can be regulated or some other suitable means to prevent any loss of ash during the ash determination. The ventilation system and the heating and cooling systems for the laboratory shall be so located that the exhausted extracting solvent vapors will not reenter

the laboratory through either the heating or cooling systems. The extracting solvent shall be supplied for use in the laboratory through a closed system opening only under the enclosures. The storage containers for the extracting solvent shall be mounted outside the laboratory and a feed line run from the container to a cut-off valve located in the enclosures. All parts of enclosures, hoods, and other related equipment shall be completely functional whenever testing is being performed. The Contractor shall furnish all electricity, fuel and gas including the furnishing and maintaining of all necessary piping and valves. A cut-off valve for the gas shall be located inside the enclosures for ash determination and copper tubing shall be used from the cut-off valve to the burners.

The Contractor shall furnish, and maintain in good condition, all required testing equipment and supplies at the field laboratory. A list of the required testing equipment and supplies can be obtained from the Research and Materials Laboratory. All testing equipment and supplies shall be subject to approval by a representative from the Research and Materials Laboratory. It shall be the Contractor's responsibility to properly hold and dispose of all used extracting solvent.

When SC-T-75, *Determination of Asphalt Binder Content for Asphalt Paving Mixtures by the Ignition Oven*, is used to determine the asphalt binder content, the Contractor shall vent, maintain and operate the ignition oven as per the manufacturers literature and SC-T-75. All records shall be immediately available to the Engineer at the asphalt plant upon request.

401.14 Rumble Strips. A rotary type cutting head will be required for Milled-In Rumble Strips. The head shall have a maximum outside diameter of 24 inches and will be a minimum of 16 inches long. The cutting head shall have the cutting tips arranged in such a pattern as to provide a relatively smooth cut. The cutting head(s) shall be on its own independent suspension from that of the power unit to allow the tool to self-align with the slope of the shoulder and/or any irregularities in the shoulder surface. The cutting tool shall be

equipped with guides to provide consistent alignment of each cut in relation to the roadway and provide uniformity and consistency throughout the project.

CONSTRUCTION REQUIREMENTS

401.15 Plant Inspection. The preparation of all asphalt mixtures shall be subject to inspection at the plant. For checking the adequacy of the equipment in use, inspecting the condition and operation of the plant for the verification of weights or proportions and character of materials, and for the determination and checking of temperatures being maintained in the preparation of the mixtures, the Engineer, or his authorized representative, shall have access at any time to all parts of the paving plant.

When it is anticipated that less than 500 tons of asphalt hot plant mix will be produced in a day, the Engineer may elect not to send as asphalt plant inspector to the plant site to sample and test the mix. Instead, a sample (or samples) will be taken at the project site and will be tested later at the asphalt plant laboratory or may be tested at the Department's District or Columbia Laboratory. The percentage of asphalt binder as determined will be used to determine the quantity of asphalt binder in paving mixture provided the asphalt content is within the job mix formula tolerances. If the sample (or samples) has not been tested by the time the monthly estimate is prepared, then the percent asphalt binder set up in the job mix formula will be paid. This percent will be adjusted if necessary when the sample is tested for asphalt binder content.

Should low volumes be produced for more than 5 successive production days, then the Engineer will place a plant inspector at the plant for a day to sample and test the asphalt mixture.

The Contractor shall notify the Engineer at least 5 days before beginning paving operations in order that inspection of the plant and materials can be performed.

401.16 Paving from Multiple Plants. Paving on the same road using mix from more than one plant will not be permitted during a day's production; however, multiple plants may be permitted by the Engineer when paving work is being performed at different locations with work being performed by separate paving operations.

401.17 Weather and Surface Temperature Restrictions. Asphalt mixture shall not be applied when the existing surface is wet or frozen. The placing of Asphalt Concrete Surface Courses (including Sand Asphalt Surface Courses) will not be permitted during the months of December, January and February except with written permission of the Engineer. For all other mixtures, the existing surface temperature for the placement of asphalt mixtures shall be in accordance with the following table:

Lift Thickness (inches)	Minimum Surface Temperature (degrees F)*
1.0 or less	55
1.1 to 2.0	45
2.1 to 3.0	40
3.1 to 4.5	35

* Surface temperature to be measured with handheld infrared non-contact thermometer away from artificial heat.

401.18 Plant Calibration and Operations. The Contractor shall calibrate his asphalt plant before production so that the mix will conform to the job mix formula and Marshall field criteria. Stockpile aggregate gradation test results and calibration charts or graphs will be kept at the plant and will be immediately available to the Engineer upon request.

A. Batch Plant. When batch plants are used, the Contractor shall calibrate the cold feed bins to the correct proportions on the job mix information sheet. Calibration charts or graphs shall be developed for each individual cold feed bin. The Contractor shall sample each hot bin and perform gradation tests on each hot bin sample. The

Contractor shall be responsible for determining the percentage of material weighed from each hot bin. The Contractor shall immediately correct the automatic proportioning system when it does not consistently deliver materials within the full range of batch sizes within the tolerances stated in AASHTO M 156, Subsection 6.7.3 entitled *Accuracy*. The automatic proportioning system shall also be corrected when the liquid asphalt content does not reasonably compare with the extraction test results.

B. Drum Mixer Plants. When drum mixer plants are used, the Contractor shall calibrate the cold feed bins to the correct proportions on the job mix information sheet. Calibration charts or graphs shall be developed for each individual cold feed bin. Liquid asphalt systems shall be recalibrated when there is variance in the asphalt content or when the Engineer deems necessary. The Contractor shall determine the moisture content of the aggregates before entering the drum at least twice a day or when the Engineer deems necessary. Aggregate moisture content test results will be kept in the field lab and will be immediately available to the Engineer upon request.

C. Contractors Monitoring Operations. The Contractor shall be responsible for monitoring the gradation and quality of materials that are delivered to the asphalt plant. When one or more aggregate gradations do not reasonably conform to the gradation on the job mix information sheet, the Contractor shall resubmit another job mix design request. The Contractor's monitoring operation shall not interfere with the Department's routine testing.

D. Failing Samples and Plant Operations. When two consecutive samples fail on gradation, asphalt content, dust to asphalt ratio and/or field criteria, the Contractor shall stop production and make the necessary adjustments. The Contractor shall produce three truck loads of mix and hold plant production until the test results are obtained from the third truck load. This procedure will be followed until the mix produced meets the job mix formula

and/or Marshall field criteria. If after a day's production, the mix fails to meet specifications, the Contractor shall check his plant calibration, perform gradation tests on all stockpiled aggregates, perform a detailed plant inspection, and make necessary adjustments or changes before starting the next day's production. This procedure may be altered when the Engineer deems necessary.

Asphalt plant inspectors will immediately advise the Contractor when air voids are out of specification and the inspector will make another set of Marshall specimens after 3 loads of mix to check air voids.

Marshall specimens will be compacted at a temperature not greater than 300°F, and not less than 290°F or as recommended by the supplier.

401.19 Silos and Surge Bins. Silos shall be approved by the Engineer before being used for overnight storage. Overnight storage approval is based on the recovered viscosity of stored asphalt samples. The recovered viscosity shall not be greater than 13,200 poises.

Silo overnight storage approval is valid for one (1) year and the Contractor must provide to the Engineer a written request for silo approval each year. During the course of the year, if a silo is found not to comply with the specifications then the approval process must be repeated.

The Department is not obligated to purchase any mix stored in a silo or surge bin that does not comply with the job mix formula and/or Marshall field criteria.

401.20 Preparation of Asphalt Binder. The asphalt binder shall be heated to a temperature between 250°F and 325°F, or as recommended by the supplier, in tanks designed to secure uniform heating of the entire content and to provide a continuous supply of the asphalt binder to the mixer at a uniform temperature. At no time before or after shipment to the plant site, shall the asphalt be heated more than 325°F or as recommended by the supplier.

401.21 Preparation of Aggregate. The aggregate for the mixture shall be dried and heated at the plant. The aggregate shall be heated to a temperature between 250°F and 325°F or as recommended by the supplier.

401.22 Preparation of Mixture. The ingredients shall be heated and completed in such manner as to produce a mixture which, when discharged, shall be at a temperature of not less than 250°F nor more than 325°F, or as recommended by the supplier, and, except for sand asphalt mixture for base course construction, shall be within 20°F of the temperature specified by the Engineer. The sand asphalt mixture for base course construction shall be mixed at a temperature (between 250°F and 325°F) to provide complete coating of all particles.

Unless otherwise permitted by the Engineer, the Contractor shall devote the full production of the plant to the project in order that the work will be performed as continuously as possible.

401.23 Mixing: Batch, Drum, and Continuous Mix Plants. The production of HMA at all asphalt plants must follow the asphalt mix design job mix formula, in order to give the correct individual proportions. The aggregates must be dried to a consistent mixing temperature before introducing the asphalt binder into the HMA. The correct proportions of aggregate, mineral filler, lime, and asphalt binder content must be mixed to produce a homogenous asphalt mix in which all particles are thoroughly coated. The asphalt plants must meet AASHTO M 156, and all lime systems are to be checked initially by the Engineer. The plants must be able to produce a consistent asphalt mix, without problems with segregation, mix temperature, and varying asphalt binder content to meet Departmental specifications.

401.24 Blending of Hydrated Lime. Hydrated lime shall be uniformly blended with the damp aggregated at a rate 1% by weight of dry aggregate. The damp aggregate shall contain a

minimum of 3% moisture. The water spray delivery system shall be used if aggregate moisture is less than 3% or when the Engineer deems it necessary to prevent lime from becoming airborne. The production rate shall be adjusted so there will not be any retained moisture in the finished mix.

The Contractor shall perform aggregate moisture tests at least twice a day or when deemed necessary by the Engineer. The aggregate moisture samples shall be obtained at a location between the water spray delivery system and the lime feed system.

The percentage of hydrated lime being introduced into the asphaltic mixture will be determined in accordance with SC-T-71, *Field Determination of Percent of Lime in Asphalt Mixture* or SC-T-78, *Method of Verification of Hydrated Lime Weighing Systems for Hot Mix Asphalt*. If SC-T-71 is used, the Contractor shall check the percentage of hydrated lime at least twice a day or when the Engineer deems necessary. When verifying the lime rate, the Department shall have a representative present to verify all measurements necessary to determine the percentage of hydrated lime being introduced into the asphalt mixture. The Contractor shall verify the weighing system once a week or as the Engineer deems necessary, when SC-T-78 is used. The Department inspector will check the lime rate from the digital display in the control room daily.

The Contractor shall keep a daily record of aggregate moisture tests and lime percentage determinations on Lab Form No. 283. The percent of hydrated lime by dry aggregate weight shall be in the range of 0.90 to 1.10. All records shall be immediately available to the Engineer at the asphalt plant upon request.

401.25 Conditioning of Existing Surface. Base courses shall be prepared as set forth in the various sections covering such base course.

Where the surface of the existing pavement or old base is

irregular (including widened shoulders where settled), it shall be brought to uniform contour by leveling with an asphalt mixture and thoroughly compacted until it conforms to the surrounding surface. Where necessary, the leveling shall be performed with a motor grader or paver.

The base course, old pavement, or existing surface shall be thoroughly swept and scraped clean and free from dust and foreign material and maintained until the asphalt mixture is superimposed.

401.26 Conditioning of Subgrade. Before placing any asphalt base course mixture, the subgrade shall be prepared in accordance with the requirements specified in Section **208**.

401.27 Transportation and Delivery of Mixes. The mixture shall be transported from the plant to the point of use in vehicles meeting the requirements of Subsection **401.09**. No load of mixture shall leave the plant so late in the day that it cannot be spread, finished, and compacted during daylight of that same day unless an approved artificial lighting system is provided.

The mixture shall be delivered to the spreader at a temperature between 250°F and 325°F, or as recommended by the Engineer, and, except for sand asphalt mixture for base course construction, within 20°F of the temperature set at the plant.

401.28 Application of Prime or Tack Coat.

a. Where the plans call for an asphalt mixture to be placed directly on a sand clay base course, coquina shell base, macadam base course or stabilized aggregate base course, the priming of which is not otherwise provided, a prime coat meeting the requirements of Section **303**, **304**, **305**, or **306** as applicable shall be applied. A prime coat will not be required when an asphalt mixture is placed directly on the subgrade.
b. Before laying any bituminous mixture on existing

pavements or on unsealed bituminous surface course, a tack coat shall be uniformly applied by use of the distributor spray bars at the rate of 0.05 to 0.15 gallons per square yard of residual asphalt. Lesser amounts will be placed on new pavements while a larger amount will be placed on dry pavements to ensure a bond between the surface being paved and the overlying course. In areas where it is impractical to use distributor spray bars, such as crossovers, small areas, etc., the material may be applied by the use of the handheld nozzle. In both cases, the actual rate of application shall be applied as directed by the Engineer. The tack coat shall consist of asphalt binder or emulsified asphalt. The acceptable grades of emulsified asphalt are RS-1, MS-1, MS-2, HFMS-1, HFMS-2, SS-1, CRS-1, CRS-2, CMS-2, and CSS-1. The emulsified asphalt, with the exception of grades RS-1 and CRS-1, may be diluted with up to 50% water provided the dilution is performed at the manufacturing plant by the manufacturer using acceptable procedures. In no case may any of the emulsions be diluted at the point of use by the user.

In all cases, regardless of the type tack material used, the existing pavement or unsealed bituminous surface course shall be dry and thoroughly cleaned before applying the tack material.

c. When Hot Mix Sand Asphalt Base Course is constructed in layers, the compacted layer upon which another layer is to be placed shall be cleaned and scarified as directed by the Engineer before placing the next successive layer. When considered necessary, as determined by the Engineer, a tack coat shall be applied between layers as stipulated above.

d. Contact surfaces of headers, curbings, gutters, edges of existing pavement, manholes, catch basins, etc. shall be painted with a thin, uniform coating of asphalt material just before the asphalt mixture is placed against them.

e. The tack coat as outlined above shall be applied a sufficient length of time in advance of the laying of the asphalt mixture to permit drying but shall not be applied so far in advance or over such an area as to cause it to lose its adhesiveness.

f. No additional compensation will be allowed for the furnishing and application of the prime and tack coats specified in Subsection **401.28** (**b**), (**c**), and (**d**).

401.29 Spreading and Finishing. Upon arrival at the point of use, the mixture shall be dumped into the mechanical spreader and immediately spread and struck off true to the line, grade, and cross-section stipulated and to such appropriate loose depth for each successive course that when the work is completed, the specified thickness or weight per square yard will be secured. All mixtures shall be delivered and spread while in a thoroughly workable condition and free from lumps. Material should be handled in such a manner to reduce segregation. The mixture shall be dumped in the center of the hoppers and care taken to avoid overloading and spillage on the base. Pavers shall operate, when laying asphalt mixtures, at such speed as may be approved by the Engineer.

If during construction it is found that the spreading and finishing equipment leaves tracks or indented areas in the new course that are not satisfactorily corrected by the scheduled operations, or which produces other permanent blemishes, the use of such equipment shall be discontinued and other satisfactory spreading and finishing equipment shall be provided by the Contractor.

The Contractor shall provide competent personnel who are capable of performing the work incidental to the correction of all pavement irregularities. Irregularities in all hot mix asphalt courses shall be corrected while the mixture is still hot. The Contractor shall give special attention to the straight

edging of construction joints immediately following the final

rolling. The Contractor shall select a competent employee of his organization to perform the straight edging.

Immediately after any course is screeded and before roller compaction is started, the surface shall be checked by the Contractor, any inequalities adjusted and all fat spots and irregular areas removed and replaced with satisfactory material. Irregularities in alignment and grade along the outside edge shall also be corrected by the addition or removal of mixture before the edge is rolled.

Unless directed otherwise by the Engineer, compacted thickness of any single constructed course shall not exceed a maximum of 6 inches for Hot Mix Asphalt Aggregate Base Course, 4 inches for Hot Mix Sand Asphalt Base Course and Binder courses, and 3 inches for Hot Mix Surface Course. Each layer shall be placed to such thickness as instructed by the Engineer. Joints in the layers shall overlap a minimum of 6 inches where practicable.

In ditch paving, narrow widening, deep or irregular sections, intersections, turnouts, driveways, or at other locations where it is impracticable to spread and finish the mixture by standard methods, the Contractor may use approved spreading equipment, or acceptable hand methods. When it is considered necessary to improve the profile and cross-section of an existing pavement before placing the additional normal layer of a mixture, the Engineer may require that the material be spread with a blade grader or other type of construction equipment that will give the desired results. Loads shall not be dumped faster than the material can be properly handled. The raking shall be carefully and skillfully done to avoid segregation, and so that after the first passage of the roller over the raked mixture, a minimum amount of back-patching may be required.

The Contractor shall provide approved means for keeping all small tools clean and free from accumulations of asphalt material.

The finished surface of surface courses placed adjacent to

curbs, gutter, manholes, etc. shall be approximately 1/4 inch above the edges of these structures.

401.30 Compaction (Standard). The following compaction requirements prevail where there are no specific density stipulations established in the special provisions of the contract.

The Contractor may select the equipment for spreading and compacting the mixture. Roller patterns and target densities will be established by the Contractor in accordance with SC-T-65, *Field Determination of Target Density for Asphaltic Concrete Materials by Use of the Control Strip Technique*. All random sample locations will be determined by SC-T-100, *Random Method of Sampling Highway Construction Materials*. These test procedures can be obtained from the Engineer. The cost of all the work determining compaction shall be included in the contract unit price for Hot Mix Asphalt.

To prevent adhesion of mixtures to the steel-wheel roller, the wheels shall be kept moistened, but excess water will not be permitted. The use of oil will not be permitted.

In areas such as ditches or along forms, curbs, headers, and walls not accessible for the operation of rollers as specified herein, compaction shall be performed with hand or mechanical tampers, hand-drawn steel wheel rollers, or self-propelled tandem steel wheel rollers as directed by the Engineer.

The surface of the mixture after compaction shall be smooth and true to the established crown and grade. Any mixture that becomes loose and broken, mixed with dirt, or in any way defective shall be removed and replaced with fresh mix that shall be immediately compacted to conform to the surrounding area.

A. Hot Mix Asphalt Aggregate Bases and Thin Lift Surface Courses. For Hot Mix Asphalt Aggregate Base and thin lift surface courses placed at a rate less than

140 pounds per square yard, the percent compaction will be determined at least every 500 feet per paving lane width. In-place density will be determined with the nuclear gauge at randomly selected locations, and at least one foot from any unsupported edge. In-place density shall be between 98% and 102% of the target density established in accordance with SC-T-65.

B. Sand Asphalt Base, Binders and Surface Courses Placed at a Rate of 140 Pounds per Square Yard or Greater. For Hot Mix Sand Asphalt Base, Binders and Surface Courses placed at a rate of 140 pounds per square yard or greater, 10 cores shall be taken at the same locations within the control strip that nuclear gauge tests were performed in order to establish target density. The average density of the cores shall be determined and this average core density for Binder and Surface courses shall be at least 96% of the average daily field laboratory density as determined by the Marshall Method of test. The average core density for Hot Mix Asphalt Sand Base shall be at least 92% of the average daily field laboratory density determined by the Marshall method of test.

C. Compaction Monitoring. The Contractor shall be responsible for monitoring the compaction process and will be responsible for making adjustments in equipment and/or roller patterns so that the finished asphalt pavement will meet the specified in-place density requirement. In-place density tests shall be conducted by the Contractor at least every 500 feet per paving lane width by conducting nuclear gauge tests at randomly selected locations approved by the Engineer and at least one foot from any unsupported edge. Randomly selected locations will be determined by SC-T-100 entitled *Random Method of Sampling Highway Construction Materials*.

The average nuclear gauge density for a lot, a day's production of asphalt mixture, should be at least 100% of the target density obtained by SC-T-65. Individual nuclear density tests should not be less than 98% of the target

density.

D. Quality Acceptance. The quality acceptance of the in-place density of each lot of Sand Asphalt Bases, Binder Courses, and Surface Courses placed at a rate of 140 pounds per square yard or greater will be based on the average of five, 6 inch diameter cores randomly obtained from the compacted roadway. A lot is defined as a day's production of asphalt mix. The Contractor shall obtain the required cores from the compacted layer at a time and location randomly selected by the Engineer. Random location will be determined by SC-T-100.

The average daily field laboratory density shall be the average bulk density of up to 4 sets of Marshall specimens molded in the field laboratory. One set of Marshall specimens will be molded in the morning and another set in the afternoon to represent a day's production. Each set will be comprised of 2 Marshall specimens. Marshall specimens used for compaction control will meet required air void criteria.

The Contractor shall not start production in a lot until he has obtained the roadway cores from the previous day's production, unless permission is given by the Engineer. The average roadway core density for a day's production shall be a least 96% of the average daily field laboratory density as determined by the Marshall method of test. Individual roadway core densities shall not be less than 95% of the field lab Marshall density.

All nuclear gauge tests and cores required for compaction control shall be obtained by the Contractor using equipment and procedures approved by the Engineer. Dry ice may be used to cool the mat. Any patching and traffic control required during compaction control shall be furnished by the Contractor. These requirements do not apply to patching and leveling courses.

E. Documentation. The Contractor shall submit all nuclear gauge compaction tests on Laboratory Form 266, which can be obtained from the Engineer upon request. The Contractor shall submit his compaction test results to the Engineer at least once a week. The Engineer will report all cored roadway compaction test results on Laboratory Form 266 at least once a week.

F. Weak Base or Poor Surface Conditions. If in the judgement of the Engineer, a weak base or poor surface condition results in a density lower than the minimum specified, a "maximum practical density" lower than that specified may be established by the Engineer.

G. Basis of Payment. The cost of all work determining compaction shall be included in the contract unit price for asphalt mixes.

401.31 Compaction (End Result). The following compaction requirements prevail when end result compaction specifications are stipulated in the contract.

The Contractor may select the equipment for spreading and compacting the mixture, except that intermediate rolling shall be accomplished with a pneumatic roller. When roadway cores are required, it is recommended that the Contractor establish roller patterns and target densities in accordance with SC-T-65, *Field Determination of Target Density for Asphaltic Concrete Materials by Use of the Control Strip Technique*. The Contractor shall be responsible for monitoring the compaction process and will be responsible for making adjustments in equipment and/or roller patterns so that the finished asphalt pavement will meet the specified in-place density requirement.

All nuclear gauge tests and cores required for compaction monitoring and acceptance procedures shall be obtained by the Contractor using equipment and procedures approved by the Engineer. Any patching and traffic control required during compaction monitoring and acceptance procedures shall be

furnished by the Contractor. These compaction requirements do not apply to patching and leveling courses.

A. Hot Mix Asphalt Aggregate Bases and Thin Lift Surface Courses The in-place density of Hot Mix Asphalt Aggregate Base and thin lift surface courses placed at a rate less than 140 pounds per square yard will be based on densities determined by the use of the nuclear density gauge using the backscatter method of testing. The gauge shall be furnished and operated by the Contractor. The nuclear density gauge shall be of the Troxler Model 3400 series, 4600 series or equivalent.

The Contractor shall construct control strips and determine target densities according to SC-T-65. One control strip shall be constructed at the beginning of work on each roadway, shoulder course and on each lift of each course. An additional control strip shall be constructed when a change is made in the type or source of materials or compaction equipment, or whenever a significant change occurs in the composition of the underlying pavement structure or the composition of the material being placed from the same source. The Engineer or the Contractor may initiate an additional control strip at anytime.

Quality Acceptance of Hot Mix Asphalt Aggregate Bases and Thin Lift Surface Courses

For the purpose of acceptance, each day's production is considered a lot. Acceptance will be based on the average of 10 random nuclear density gauge tests per lot. Randomly selected density locations will be determined by the Engineer using the procedure stated in SC-T-100 entitled *Random Method of Sampling Highway Construction Materials*, except that 10 successions will be used. The Engineer will observe the Contractor performing density testing for acceptance and record all nuclear density tests on Lab Form 266. The Engineer will report nuclear density compaction acceptance results at least once a week.

There will be a reductions in payment for asphalt mix-

ture when the required nuclear density of the compacted course is not at least 98.0% of the established target density and when it is more than 102.0% of the established target density. The payment schedule for lot densities is listed below.

Average Percent of Target Nuclear Control Strip Density	Percent of Unit Price of Mix
Greater than 102.0	97
98.0 - 102.0	100
97.0 - 97.9	95
96.0 - 96.9	90
Less than 96.0	80

Any reduction in payment that is necessary will be determined based on the adjusted unit price per ton of asphalt concrete mixture. The total amount of any reduction in payment will be deducted as a lump sum from monies due the Contractor.

B. Hot Mix Sand Asphalt Base, Binder and Surface Courses Placed at a Rate of 140 Pounds per Square Yard or Greater. For Hot Mix Sand Asphalt Base, Binders and Surface Courses placed at a rate of 140 pounds per square yard or greater, 10 cores shall be taken at the same locations within the control strip that nuclear gauge test were performed in order to establish target density. The in-place density of Sand Asphalt Base, Binder and Surface courses will be determined from the bulk density of cores taken from the roadway. Bulk density of roadway cores will be determined by SC-T-68 entitled *Determination of Percent Air Voids in Compacted Marshall Specimen*.

The average roadway core density for Binder and Surface courses will be at least 96.5% of the average daily field laboratory density as determined by the Marshall Method of test. The average core density for Sand Asphalt Base will be at least 92% of the average daily field laboratory density as determined by the Marshall Method of test.

Quality Acceptance of Hot Mix Sand Asphalt Base, Binder and Surface Courses Placed at a Rate of 140 Pounds per Square Yard or Greater.

The quality acceptance of the in-place density of each lot, a days production, of Sand Asphalt Base, Binder and Surface placed at a rate of 140 pounds per square yard or greater will be based on the average of 5 cores randomly obtained from the compacted roadway. Cores from the roadway shall be 6 inches in diameter. The Contractor shall obtain the required cores from the compacted layer at a time and random location determined by the Engineer. Random locations will be determined by SC-T-100. The Engineer will report cored roadway compaction results at least once a week on Lab Form 266.

The average daily field laboratory density shall be the average bulk density of up to 4 sets of Marshall specimens molded in the field laboratory. One set of Marshall specimens will be molded in the morning and another set in the afternoon to represent a day's production. Each set will be comprised of 2 Marshall specimens. Marshall specimens used for compaction control will meet required air void criteria.

There will be a reduction in payment for asphalt mixture when the required average core density is less than the specified percentage of average daily field laboratory density as determined by the Marshall Method of test. Contractors will receive an incentive payment when the average core density of a lot is in the range of 97.1% to 98.5% of the average daily field laboratory density. The payment schedule for lot densities of Binder and Surface is listed as follows:

Average Percent of Daily Field Lab Marshall Density	Percent of Unit Price of Mix
Greater than 98.5	98
97.1 - 98.5	103
96.5 - 97.0	100
96.0 - 96.4	95
95.0 - 95.9	90
94.0 - 94.9	70
Less than 94.0	Reject and Replace

The pavement shall be rejected and replaced at the Contractor's expense when the average lot density for Binder and Surface is less than 94.0% of the average daily field lab density.

The Contractor will not have the option of accepting a price reduction instead of production specification material. The intent of this specification is for the Contractor to achieve an average in-place mat compacted density of at least 96.5% of the average daily field lab Marshall density. The Contractor will not be permitted to continuously produce mix when this compaction requirement is not being met. Material which does not substantially comply with the compaction requirement, even though it may be restricted to isolated areas may be rejected without regard to sampling locations within a lot.

The payment schedule for lot density of Sand Asphalt Base is listed below:

Average Percent of Daily Field Lab Marshall Density	Percent of Unit Price of Mix
Greater than 92.0	100
91.5 - 91.9	97
90.5 - 91.4	95
89.5 - 90.4	90
Less than 89.5	80

Any reduction or incentive payment will be determined on the adjusted unit price per ton of asphalt concrete mixture. The total amount of any reductions in payment will be deducted as a lump sum from monies due the Contractor.

401.32 Joints. Placing of the mixture shall be as continuous as practicable and the roller shall pass over the unprotected end of the fresh laid mixture only when the laying of the course is to be discontinued, or in the case of hot laid mixtures, discontinued long enough to permit the mixture to become chilled.

Longitudinal joints shall be rolled directly behind the paver. The paver shall be so positioned that in spreading, the material overlaps the edge of the lane previously placed by 1 to 2 inches. The loose material shall be left high enough to allow for compaction to the depth of the previously rolled lane. The overlapped material shall be pushed back by means of lutes or other suitable tools to the edge of the “cold” joint. This work shall be performed in such manner to provide a uniform joint when rolled.

Transverse joints shall be carefully constructed and thoroughly compacted to provide a smooth riding surface. Joints shall be straight edged or stringlined to assure true alignments.

Longitudinal and transverse joints shall be made in a careful manner and shall present the same texture, density, and smoothness as other sections of the course.

Joints between old and new pavements, or between successive strips, shall be made in such manner as to insure proper bond between the old and new surface for the full depth of the course. The joints, transverse and longitudinal, are to be thoroughly coated with an approved asphalt material before placement of adjacent material. If necessary, joints shall be formed by cutting back on the course. The cost of cutting back and painting of joints shall be included in the contract price for the mixture.

On contracts containing multiple courses, the width of the lanes shall be arranged so that the longitudinal joints of each successive course are offset from the joints of the previous course at least 6 inches where practicable. The width of each lane in the top layer shall be the width of the design travel lanes, unless directed otherwise by the Engineer.

401.33 Rumble Strips and Pavement Markers. If rumble strips are called for in the plans, they shall be placed in the mainline paved shoulder only. No rumble strips will be placed on ramp shoulders.

Milled-in rumble strips (MIRS) shall have finished dimensions of 7 inches ± 1/2 inch wide in the direction of travel and shall be a minimum of 16 inches long measured perpendicular to the direction of travel. The depressions shall have a concave circular shape with a minimum 1/2 inch depth at center. The MIRS shall be placed perpendicular to the roadway on 12 inch centers. The edge of the milled area nearest the road centerline shall be 10 inches from the right edge of the travelway of the shoulder.

Milled-in rumble strips will not be constructed on the median paved shoulder unless specified in the plans. If the median shoulder is specified, the milled area shall be 4 inches from the left edge of the travelway on the shoulder. Two 4 inch x 4 inch raised yellow pavement markers shall be placed together at 40 foot intervals along the travelway. The markers are to be placed between the pavement edge line and the

MIRS. The markers shall be placed directly adjacent to each other perpendicular to the travelway.

Removed pavement material suitable for recycling may be used by the Contractor on the project or for use in his other operations at the Contractor's option and expense.

Excess waste material resulting from the operation shall be broomed daily from the road and paved shoulder in a manner approved by the Engineer.

At the end of each working day, all equipment shall be removed to a location where it does not present a hazard to traffic. The pavement shall be cleaned by sweeping or flushing; and the work area shall be reopened to traffic each day.

401.34 Protection of Surface. The newly constructed surface shall be protected from traffic until the mixture has hardened sufficiently to prevent distortion. The surface shall be kept clean and free from foreign material when the shoulders are being constructed.

401.35 Finished Surface Requirements. After compaction, the finished surface of the binder or surface courses shall be smooth, of uniform texture, and true to the specified crown and grade. When checked with a 10 foot straightedge applied parallel to the centerline of the pavement, the finished surface of the binder course shall not vary more than 1/4 inch and the finished surface course shall not vary more than 1/8 inch as measured from the bottom of the straightedge to the top of the finished mixture. Binder or surface courses not meeting these finished surface requirements shall be corrected by repairing, or if necessary, by removing and replacing subject to the approval of the Engineer.

In addition to meeting any specified requirements for surface tolerances, binder and surface courses shall meet the satisfactory riding qualities for the mixture being placed as determined by the Engineer.

401.36 Rideability Requirements. Asphalt concrete surfaces of will be evaluated for a satisfactory ride as determined by the Engineer. If conditions permit and unless otherwise specified in the special provisions, the Department will test the asphalt surface with a Mays Ride Meter in accordance with the *Test Method for Determining Pavement Roughness with the Mays Ride Meter*.

For the Mays Ride Meter to be used, the following conditions must be met:

1. A constant speed of 50 miles per hour must be maintainable throughout each section[1] for which measurements are made.

2. The segment of roadway is a minimum continuous length of 0.5 mile (bridges are considered areas of discontinuity.)

[1]Normally a section will be considered as 1.0 mile in length. However, no measurement will be made on any section less than 0.5 mile in length. Sections that are less than 1.0 mile, but are 0.5 mile or greater, normally occur at the end of a project.

A. New Construction. On new roadway projects, the Mays Ride Meter measurement shall not exceed 40 inches for each mile of each vehicle lane when tested. When initial measurements are 40 inches per mile or less, payment will be based on the original contract unit price per ton of asphalt concrete mixture tested according to the following Schedule for Adjusted Payment:

Schedule For Adjusted Payment	
Roughness (inches/mile)	Price Adjustment
Less than 24	105%
25 – 29	103%
30 – 34	101%
35 – 40	100%
41 – 45	95%
46 – 50	90%
51 – 55	80%
56 and above	See Note 1

Note 1:

For each additional increment of 5 inches per mile of roughness above 55 inches per mile, an additional 10% reduction will be made based on the contract unit price of the asphalt surface mixture.

When the measurement exceeds 40 and the Engineer determines that the pavement does not have an acceptably smooth ride, the Contractor shall correct such deficient sections without additional compensation. The Engineer may withhold payment for the asphalt concrete mixture (or a portion thereof) until the deficiencies have been corrected, and the surface is re-tested and provides an acceptably smooth ride. The method of correcting the surface deficiencies shall be subject to approval by the Engineer. No more than 100% of the contract unit price will be paid for sections where corrective work results in measurements less than 35 inches per mile. If corrections are not made, then the price adjustment based on the original contract unit price per ton of the asphalt concrete mixture according to the Schedule for Adjusted Payment. The total amount of any reduction in payment will be deducted as a lump sum from monies due the Contractor.

Sections of roadway for which the roughness measurement is 56 inches per mile or above will be reviewed on an individual basis. If the Engineer determines that the section is unacceptable, the material shall be removed and replaced or overlaid subject to the approval of the Engineer. Should the Engineer determine that the material may remain in place and does not require an overlay or other corrective action, a price adjustment will be assessed based on the Schedule for Adjusted Payment.

B. Resurfacing Projects. On resurfacing projects, the existing pavement will be tested with the Mays Ride Meter or other method specified in the special provisions before any work is performed by the Contractor and again on the finished surface. To ensure attainment of as smooth a ride as possible, the original roughness value measured on the existing surface for each mile of each vehicle lane shall be improved as shown in the Acceptable Roughness Specification Table (see Appendix.) Where measurements on the finished surface exceed the acceptable limit, the Contractor shall correct such sections without additional compensation. The method of correcting the surface deficiencies shall be approved by the Engineer.

In the event the corrections are not made, then a penalty will be assessed based on the original contract unit price for the asphalt concrete mixture tested as follows:

Roughness over Acceptable Limit(Inches/Mile)	Price Adjustment
1 – 5	95%
6 – 10	90%
11 – 15	85%
16 – 20	80%
21 – 25	75%
26 and above	Replace

The tonnage subject to price adjustment will be based on the original plan quantity for the asphalt concrete mixture as shown on the typical section. When an acceptably smooth ride is not obtained as outlined above, the Engineer may withhold payment for the asphalt concrete mixture (or a portion thereof) until the corrections have been made and the pavement provides an acceptably smooth ride. The total amount of any reduction in payment will be deducted as a lump sum from monies due the Contractor.

401.37 Plant Tickets. The net weight of each load of mixture and the accumulated net weight of the loads for the day shall be recorded in triplicate upon forms furnished by the Contractor and approved by the Engineer. At his discretion, the Engineer may furnish forms for recording the net weight of the loads. The recording of the weights shall be performed by an authorized representative of the Department.

When each load of mixture is delivered to the work, the original copy of the plant ticket for the load shall be presented to the Engineer. The plant inspector shall keep the stub copy until the completion of the work. The tickets delivered to the Engineer on the work shall be included and made a part of and submitted along with the final plans package to the Engineer.

Any changes in the amounts designated on the tickets necessitated by the rejection of any material shall be noted on all copies by the Engineer or Inspector, and the reason stated for such rejection.

At any time during the delivery of material and for the purpose of checking the weighing equipment at the plant, the Engineer may direct the Contractor to weigh or cause to be weighed on tested and approved platform scales, without compensation, any truck load that is to be delivered to the work.

401.38 Method of Measurement. Asphalt plant base, binder, and surface course mixes will be measured by the

ton. The quantity shall be the weight, using approved scales, used in the accepted work and no deduction will be made for the weight of asphalt materials in the mixture.

The quantity of liquid asphalt binder in the paving mixture shall be the number of tons contained in the accepted work. The amount of asphalt binder in the mix shall be determined by either the centrifuge method of extraction, ignition oven, or at the option of the Engineer may be the amounts as printed on the load tickets by use of an approved ticket printer. In order to check scale accuracy when using a ticket printer for payment for asphalt binder, periodic extraction tests will be made (not for pay purposes) on mixes other than those that contain marine limestone or slag.

The quantity of asphalt binder will not include any asphalt that may be absorbed by the aggregate; therefore, if an absorbent type aggregate (such as marine (fossiliferous) limestone or slag) is used in the composition of mixture and a discrepancy is determined between the centrifuge method of extraction or ignition oven and the ticket printer, the centrifuge method of extraction shall be used for payment of the asphalt binder.

Samples from which extraction tests are to be made in order to determine the asphalt content may be taken from mixtures before or after incorporating the mix in the pavement structure. The Engineer may determine the amount of asphalt binder in the mix at such time and frequencies as he may elect.

When the asphalt binder is not being measured by ticket printout, the percentage of asphalt binder as determined by the Engineer at the field laboratory shall be used to determine the quantity of asphalt binder in the paving mixture, unless otherwise directed by the Engineer.

Deductions will be made for all asphalt mixture wasted or lost due to the negligence of the Contractor; asphalt mixture or asphalt binder applied in excess of the rate specified or

directed in writing; and any asphalt mixture applied beyond the limits of the work.

The quantity of Milled-In Rumble Strips will be taken as the sum of the lengths in miles of the individual segments where the MIRS have been satisfactorily installed as indicated on the plans or as directed by the Engineer. Lengths will be measured along the inside edge of the shoulder from the center of the first MIRS in a segment to the center of the last MIRS in that segment. Where MIRS are provided on more than one shoulder, lengths will be measured separately for each segment and added to the sum.

Raised yellow pavement markers will be measured separately for each unit placed.

401.39 Basis of Payment. When the standard method of controlling, accepting, and paying for hot mix asphalt concrete mixtures is used, this work, as measured in Subsection **401.38**, will be paid for at the contract unit price for Hot Mix Asphalt Course of the type specified. Specific requirements and listing of pay items for the Hot Mix Asphalt Binder Courses and Hot Mix Surface Courses, can be are found in Subsections **402** and **403** respectively.

When a method of control and acceptance other than the standard method contained herein is specified, the contract unit price for hot mix asphalt courses will be adjusted in accordance with that method. The details of that method of control and acceptance will be found in the special provisions of the contract.

The above mentioned contract unit prices and payments shall be full compensation for furnishing, mixing, hauling, placing, and compacting all materials, including furnishing and application of tack and prime coats, and for all tools, equipment, labor, and incidentals necessary to complete the work.

The Department reserves the right to base payment on

samples cored from the roadway should the Engineer determine that the asphalt mixture is not adequately represented by the field laboratory results. If payment is based on core samples, the standard method of acceptance will apply regardless of the acceptance method prescribed in the contract.

Unless otherwise specified elsewhere in the contract, hydrated lime will not be paid for separately, and all costs for furnishing and incorporating the lime into the mixture shall be included in the contract unit price for asphalt mixes.

The liquid asphalt binder contained in paving mixtures will be paid for as Liquid Asphalt Binder of the grade specified.

The contract unit price and payment for Milled-In Rumble Strips shall be full compensation for furnishing all tools, equipment, labor, and incidentals to satisfactory complete the work.

Raised yellow pavement markers will be paid for at the contract unit price for Permanent Yellow Pavement Markers Mono-Directional, Retroreflective, 4" X 4", which price and payment shall be full compensation for all materials, tools, equipment, labor, and incidentals required to satisfactorily complete the work.

Payment for each item includes all direct and indirect costs and expenses required to complete the work.

Payment will be made under:

Item No.	**Pay Item**	**Pay Unit**
401100X	Liquid Asphalt Binder (*grade*)	Ton
4019000	Milled-In Rumble Strip	Mile
6050005	Permanent Yellow Pavement Markers Mono-Directional Retroreflective 4" X 4"	Each