



SECTION 403

ASPHALTIC CONCRETE PAVEMENT

403.1 Description. This work shall consist of a mixture of aggregate, filler if needed, admixture if required and asphalt binder prepared in a stationary bituminous mixing plant. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements, within specified tolerances, of the job-mix formula. The mixture shall be placed in one or more courses on a prepared base or underlying course in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans, or established by the engineer.

403.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

Item	Section
Coarse Aggregate	1002.1
Fine Aggregate	1002.2
Mineral Filler	1002.3
Hydrated Lime	1002.4
Asphalt Binder, Performance Graded (PG)	1015
Fiber Additive	1071

The grade of asphalt binder will be specified in the contract.

403.3 Composition of Mixtures.

403.3.1 Prior to mixing with asphalt binder the total aggregate, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract:

TABLE I			
Percent Passing by Weight (Mass)			
Sieve Size	Type I-B	Type A, I-C, LP & LS	Stone Mastic Asphalt (SMA)
1 inch (25.0 mm)	100	----	----
3/4 inch (19.0 mm)	80-100	100	100
1/2 inch (12.5 mm)	60-85	90-100	85-95
3/8 inch (9.5 mm)	50-75	60-90	75 max.
No. 4 (4.75 mm)	35-55	40-65	20-28
No. 8 (2.36 mm)	25-40	25-45	16-24
No. 16 (1.18 mm)	15-30	18-35	----
No. 30 (600 μm)	10-20	12-25	12-16
No. 50 (300 μm)	6-15	7-19	12-15
No. 100 (150 μm)	4-12	4-11	----
No. 200 (75 μm)	2-7	2-7	8-10

403.3.2 In addition to other requirements, material for stone mastic asphalt (SMA) mixtures shall meet the following.

403.3.2.1 Coarse aggregates shall consist of crushed limestone and either porphyry or steel slag, all meeting the quality requirements of [Sec 1002](#) except as follows. The Los Angeles abrasion, when tested in accordance with AASHTO T 96, shall not exceed 40 percent based on preliminary ledge approval and the final product. The amount of flat and elongated particles, measured on material retained on a No. 4 (4.75 mm) sieve, shall not exceed 20 percent based on a 3:1 ratio nor 5 percent based on a 5:1 ratio. The percent absorption, when tested in accordance with AASHTO T 85 shall not exceed 3.5 percent based on a final product. The limestone may be furnished in one fraction and shall generally pass the 1/2 inch (12.5 mm) sieve and shall have a minimal amount passing the No. 4 (4.75 mm) sieve. Porphyry or steel slag shall be furnished in two or more fractions.

403.3.2.2 Fine aggregate shall consist of 100 percent crushed, manufactured sand meeting [Sec 1002.2](#) except the gradation on the No. 4 (4.75 mm) sieve shall be modified to 70-100 percent passing.

403.3.2.3 Portland cement shall not be used as mineral filler.

403.3.2.4 A fiber additive shall be utilized as a stabilizer. Fibers provided in loose form shall be in plastic bags suitable for dissolving in the mixture or fibers may be mechanically blown into the plant. Pelletized fibers may be approved provided the fibers can be uniformly distributed by the end of the plant mixing process and provided any additive used to form the pellets does not affect the final product. The dosage rate for fibers shall not be less than 0.3 percent by weight (mass) of the total mix for cellulose and not less than 8 percent of the binder weight (mass) for mineral fibers.

403.3.3 The total aggregate for Type A mixtures shall contain approximately 80 percent of an approved crushed porphyry rock. Either natural or manufactured fine aggregate may be used in Type A mixtures. The percentage to be used will be specified by the engineer at the time the job-mix is approved.

403.3.4 The total aggregate for Type I-B and I-C mixtures shall contain not less than 85 percent crushed material. Natural fine aggregate shall be limited to a maximum of 15 percent of the total aggregate in Type I-B and I-C mixtures. The engineer will adjust quantities of the various components of the mixture as necessary to obtain the required characteristics of the mixture.

403.3.5 The total aggregate for limestone-porphyry (LP) mixtures shall contain approximately 60 percent by weight (mass) of plus No. 8 (2.36 mm) material. At least 50 percent by volume of the plus No. 8 (2.36 mm) material shall be from crushed porphyry as specified in [Sec 1002.1](#). Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required will vary. The actual percentage of required material will be designated by the engineer at the time the job mix is approved but at least 40 percent by weight (mass) of crushed porphyry will be required. Either natural or manufactured fine aggregate may be used in Type LP mixtures. The cold aggregate feeders shall be controlled to ensure proper proportioning of the various aggregate fractions in the mix.

403.3.6 Limestone-steel slag (LS) mixtures shall contain approximately 60 percent by weight (mass) of plus No. 8 (2.36 mm) material. At least 50 percent by volume of the plus No. 8 (2.36 mm) material shall be from crushed steel slag as specified in [Sec 1002.1](#). Depending on the actual gradation of steel slag furnished, the amount of crushed steel slag required will vary. The actual percentage of required material will be designated by the engineer at the time the job mix is approved but at least 50 percent by weight (mass) of crushed steel slag will be required. Either natural or manufactured fine aggregate may be used in Type LS mixtures.

The cold aggregate feeders shall be controlled to ensure proper proportioning of the various aggregate fractions in the mix.

403.3.7 No mixture shall contain more than 10 percent by weight (mass) of chat sand produced from flint chat in the Joplin area, unless otherwise permitted by the engineer.

403.4 Job Mix Formulas. The contractor shall obtain, in the presence of the engineer, representative samples of asphalt binder and mineral aggregates for tests. The samples of material shall be of the size specified by the engineer and shall be submitted to the Central Laboratory for testing. The contractor shall also submit for the engineer's approval, a job-mix formula for each mixture to be supplied for the project. At least 45 days prior to the contractor preparing any of the mixture on the project, the engineer shall have received both the representative samples of the job-mix material and the contractor's proposed job-mix formula. No mixture will be accepted for use until the job-mix formula for the project is approved by the engineer. The job-mix formula shall be within the master range specified for the particular type of asphaltic concrete, and shall include the type and sources of all material, the gradations of the aggregates, the relative quantity of each ingredient, and shall state a definite percentage for each sieve fraction of aggregate and for asphalt binder. Except for SMA mixtures, no job-mix formula will be approved which does not permit, within the limits of the master range, the full tolerances specified in [Sec 403.5\(b\)](#) and [\(c\)](#) for asphalt binder and for material passing the No. 200 (75 µm) sieve. The job-mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions occur, or should a source of material be changed, a new job-mix formula may be required.

403.4.1 Moisture susceptibility may be tested in accordance with AASHTO T 283 or AASHTO T 165, at the option of the engineer. A minimum retained strength of 70 percent shall be obtained when tested for moisture susceptibility. If requested by the contractor, hydrated lime may be added to increase retained strength to a passing level.

403.4.2 [Secs 403.4.3](#) and [403.4.4](#) do not apply to SMA mixtures. The following requirements shall apply.

403.4.2.1 SMA mix design will be done in accordance with applicable requirements of [Sec 403](#) except as noted herein. The final proportion of the mineral aggregates, asphalt binder and fibers will be determined by the mix design. A mixture meeting the proportioning requirements for LP or LS mixtures in [Secs 403.3.5](#) or [403.3.6](#) shall be used.

403.4.2.2 Mixtures will be tested in accordance with AASHTO T 245, 50 Blow Test Method, modified as follows. AASHTO T 245 shall be modified by aging the mixture for two hours, at the specified compaction temperature range of the asphalt binder, prior to compaction of the specimens. Mixtures shall have physical characteristics meeting the requirements as listed below when calculated from a voidless mixture composed of the same material in like proportions. The engineer may make adjustments in the job mix formula submitted by the contractor in order that a minimum of 75 percent of the VMA is filled with asphalt binder. The requirement for the ratio of minus No. 200 (75 µm) material to asphalt binder to be between 0.6 to 1.2 is waived.

Percent Asphalt Binder	6 min.
Air Voids	3.0-5.0
Voids in Mineral Aggregate (VMA)	17.0 min.

403.4.2.3 A job mix formula may be approved which permits the combined aggregate gradation to be outside the limits of the master range when the full tolerances specified herein are applied.

403.4.2.4 MoDOT Test Method T61, draindown test, will be performed on the mixtures prior to approving a job mix formula. The mixture shall be stabilized in such a way that the draindown of asphalt binder shall not exceed 0.3 percent by weight (mass) of mix.

403.4.3 The minimum voids in the mineral aggregate (VMA) shall be as listed below. The engineer may make adjustments in the job-mix formula submitted by the contractor in order that 60 to 80 percent of the VMA is filled with asphalt binder and the ratio of minus No. 200 (75 µm) material to asphalt binder is between 0.6 and 1.2. Approved mixtures, when compacted and tested in the laboratory in accordance with AASHTO T 167 or AASHTO T 245, shall have an air void content within the range listed below when calculated from a voidless mixture composed of the same material in like proportions. AASHTO T 167 and AASHTO T 245 shall be modified by aging the mixture for two hours, at the specified compaction temperature range of the asphalt binder, prior to compaction of the specimens.

403.4.3.1 Mixtures shall have a minimum stability as listed below, when tested in accordance with AASHTO T 167.

Type of Mixture	Percent Air Voids	AASHTO T 167 Modified, Stability PSI (kPa)	Voids in Mineral Aggregate (VMA)
A	4.0-7.0	500 (3500)	15.0
I-B	4.0-7.0	500 (3500)	14.0
I-C	4.0-7.0	500 (3500)	15.0
LP	4.0-7.0	500 (3500)	15.0
LS	4.0-7.0	500 (3500)	15.0

403.4.3.2 Mixtures shall have a minimum stability as listed below, when tested in accordance with AASHTO T 245. The number of blows with the compaction hammer shall be 75. AASHTO T 245 shall be modified by aging the mixture for two hours, at the specified compaction temperature range of the asphalt binder, prior to compaction of the specimens.

Type of Mixture	Percent Air Voids	AASHTO T 245 Modified, Stability lb (N)	Voids in Mineral Aggregate (VMA)
A	3.0-5.0	2500 (11200)	15.0
I-B	3.0-5.0	2500 (11200)	14.0
I-C	3.0-5.0	2500 (11200)	15.0
LP	3.0-5.0	2500 (11200)	15.0
LS	3.0-5.0	2500 (11200)	15.0

403.4.4 In mixtures containing rounded or uncrushed aggregate, it may be necessary for a portion of the aggregate to be a highly angular or crushed material in order to comply with the stability and other requirements. If difficulty is experienced with the aggregate combinations submitted, the engineer may designate the proportion of angular or crushed material necessary after laboratory investigations are made of the combinations proposed by the contractor.

403.4.5 If difficulty is experienced in obtaining a satisfactory mixture with the aggregate combinations submitted, the contractor will be advised and new types or sources of material may be required by the engineer.

403.5 Gradation Control. In producing mixtures for the project, the plant shall be operated so that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls:

(a) They shall be within the master range in [Sec 403.3.1](#) for the particular type of mixture specified.

(b) The maximum variation from the approved job-mix formula shall be within the following tolerances:

Sieve Size	Percent Points	
	All except SMA	SMA
3/4 inch (19.0 mm)	±5.0	0.0
1/2 inch (12.5 mm)	±5.0	±4.0
3/8 inch (9.5 mm)	±4.0	±4.0
No. 4 (4.75 mm)	±4.0	±3.0
No. 8 (2.36 mm)	±3.0	±3.0
No. 16 (1.18 mm)	±3.0	-.-
No. 30 (600 µm)	±3.0	±3.0
No. 50 (300 µm)	±2.0	±2.0
No. 100 (150 µm)	±2.0	-.-
No. 200 (75 µm)	±1.0	±2.0

(c) The quantity of asphalt binder introduced into the mixer shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt binder specified in the job-mix formula without written approval of the engineer. The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than ±0.3 percentage point from the approved job-mix formula.

(d) For SMA mixtures, the engineer may make adjustments to the job mix formula to lower the proportion of mineral filler content by one percent to accommodate for minus No. 200 (75 µm) material generated by the plant. The fiber proportioning and delivery system shall have an accuracy of 10 percent by weight (mass) of the material actually being measured in any given period of time.

(e) All mixtures, except SMA, shall contain a minimum of one percent hydrated lime by weight (mass) of the total aggregate. The hydrated lime shall be added during, or ahead of, the addition of the asphalt binder. If minus No. 200 (75 µm) material is needed in addition to the one percent hydrated lime to comply with gradation requirements, mineral filler shall be added. Additional hydrated lime may be used as a mineral filler.

403.5.1 The gradation of the aggregates will be determined from samples taken from the hot bins on batch-type or continuous mixing plants or from the composite cold feed belt on drum mix plants. Batch-type or continuous mixing plants shall have a screening unit which separates the usable heated aggregate into at least three sizes. One of the bins for the aggregate sizes produced by the screening unit shall contain not more than 15 percent by weight (mass) retained on the No. 8 (2.36 mm) sieve.

403.6 The asphaltic concrete mixture, when sampled and tested in accordance with MoDOT Test Method T53, shall not contain more than 0.5 percent moisture by weight (mass) of the mixture.

403.7 The asphaltic concrete mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue, or any other material not inherent to the job mix formula.

403.8 Field Laboratory. The contractor shall provide a Type 3 Field Laboratory meeting the requirements of [Sec 601](#). No direct payment will be made for providing the laboratory.

403.9 Bituminous Mixing Plants. Bituminous mixing plants and preparation of material and mixtures shall conform to the requirements of [Sec 404](#).

403.10 Hauling Equipment. Trucks used for hauling bituminous mixtures shall comply with the requirements of [Sec 404](#).

403.11 Pavers. Bituminous pavers shall be self-contained units, provided with an activated screen or strike-off assembly, heated if necessary, and capable of spreading and finishing asphaltic concrete in lane widths applicable to the specified typical sections and thicknesses shown on the plans. The paver shall be equipped with a receiving hopper having sufficient capacity for a uniform spreading operation. The hopper shall be equipped with a distribution system to place the mixture uniformly in front of the screed or strike-off. For screed extensions greater than one foot (300 mm), the distribution system shall be increased accordingly. The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture. When laying mixtures, the paver shall be capable of operating at forward speeds consistent with satisfactory laying of the mixture. Equipment used for shoulders and similar construction shall be capable of spreading and finishing the courses in widths shown on the plans.

403.12 Rollers. All rollers, vibrators or other equipment used to compact the asphaltic mixture shall be in satisfactory working condition. All rollers shall be capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Pneumatic tire rollers shall be self-propelled, of the oscillating-type and equipped with smooth tires of equal size, diameter and ply rating, all maintained at the same inflation pressure. The contractor shall furnish evidence regarding tire size, pressure and loading. Rollers shall have a system for moistening each wheel or roll. Rollers shall be of a size and used in sufficient numbers to achieve specified compaction. Trench rollers, vibrators and other special equipment used for compacting mixtures placed in areas inaccessible to the rollers specified, shall be of a weight (mass) and design approved by the engineer.

403.13 Construction Requirements.

403.13.1 Weather Limitations. Asphaltic concrete shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F (10 C) for the surface course or below 40 F (5 C) for subsurface courses, (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing of the mixture, or (4) between October 1 and April 1 except when authorized by the engineer. Placement within these dates will be permitted only when it is to the Commission's advantage to do so. In addition, SMA mixture shall not be placed when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 60 F (15 C). The contractor shall conduct operations in such a manner that all binder course asphaltic concrete is covered with surface course asphaltic concrete prior to October 1. Temperatures are to be obtained in accordance with MoDOT Test Method T20.

403.13.2 Test Strip. Asphaltic concrete test strips shall be provided by the contractor for each separate asphaltic concrete mixture of 2,000 tons (2,000 Mg) or greater per contract, to determine the compactive effort necessary to provide the specified density.

403.13.2.1 Test strips shall be constructed after approval of a job mix formula and calibration of the bituminous mixing plant. Prime or tack coat, if specified, shall be applied to the roadbed section followed by the placement of approximately 250 tons (250 Mg) or one hour's production, whichever is less, of an approved mixture in a single lane within the project limits. The paver and rollers to be used on the project shall be equivalent to the paver and rollers used to place the test strip in accordance with [Sec 403.18](#). Separate test strips shall be provided for

each mix design, using the thickness specified on the typical section. If more than one thickness is used for a specified mixture, the thicker lift shall be placed in a test strip as a minimum. Test strips for subsequent lifts which incorporate a new mix design may, at the contractor's option, be placed after completion of the previous lift. Acceptable test strips shall meet density and all other specification requirements for the mixture tested.

403.13.2.2 Density will be determined in accordance with [Sec 403.18](#) and if necessary, additional test strips shall be constructed until a rolling pattern has been established which will provide the specified density. A new test strip shall also be required whenever a change in the job mix formula occurs or unacceptable results occur. If the test strip fails to meet the specified density, it may be left in place and the material paid for at a reduced rate provided the second test strip meets the specifications. If the second test strip also fails, both test strips shall be removed. Any subsequent test strips that fail shall also be removed. Additional placement of the mixture will not be allowed until a test strip meeting specifications has been laid.

403.13.2.3 The material in test strips approved by the engineer will be paid for at the contract unit price. All material in unacceptable test strips shall become the contractor's property and shall be removed at the contractor's expense.

403.14 Application of Prime or Tack. The prime or tack coat, if specified, shall be applied as set forth in [Secs 407](#) or [408](#), whichever is applicable.

403.15 Spreading and Finishing. The base course, primed or tacked surface, or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign material prior to spreading the asphaltic mixture. The mixture, when delivered to the spreading and finishing machine, shall have a temperature of not less than 260 F (130 C) and be within 25 F (15 C) of that specified by the engineer. If lumps are present or a crust of mixture has formed, the entire load shall be rejected. The paver shall be operated at a speed that will give the best results. The rate of delivery of the mixture to the paver shall be coordinated so as to provide, where practicable, a uniform rate of placement without intermittent operation of the paver.

403.15.1 The thickness and width of each course shall conform to the typical section in the contract. The contractor may elect to construct each course in any number of layers; but no individual layer shall have a compacted thickness greater than 3 inches (75 mm) for Type I-B mixture, or 2 inches (50 mm) for Type A, I-C, LP, LS or SMA mixtures. These thicknesses may be increased one inch (25 mm) when used for spot wedge or leveling course.

403.15.2 For pavements having a width of 16 to 24 feet (5 to 7 m), inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement and the full width completed as soon as practicable. Unless otherwise permitted, a single lane of any course shall not be constructed to a length which cannot be completed to full width of the pavement the succeeding operating day. For pavements greater than 24 feet (7.3 m) wide, single lane width construction shall be limited to one day's production and completion to full width shall be accomplished as soon as practicable.

403.15.3 No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. All layers shall be feathered out, by hand raking if necessary, in transitioning the depth of the surface to meet present grades at bridges or ends of projects, to provide a uniform, smooth riding surface free of irregularities. Where only the top layer of the surfacing continues across a bridge, the bottom layers shall be feathered out.

403.15.4 If the asphaltic concrete construction consists of more than a single layer, each layer shall be compacted as specified and allowed to cool to the ambient temperature before the next

layer is placed. The contractor shall keep traffic off the asphaltic concrete until it has cooled sufficiently to prevent flushing of the asphalt binder to the surface, marking or distorting the surface, or breaking down the edges and in any case, until the surface of the asphaltic concrete is 140 F (60 C) or below. The final surface layer shall be laid in the same sequence over the entire project as the previously constructed layers unless otherwise approved by the engineer.

403.15.5 For SMA mixtures, maximum haul distance should be minimized due to the potential for asphalt binder separation from the mixture. Evidence of asphalt binder separation or draindown at delivery will be cause for rejection. SMA mixtures, when delivered to the spreading and finishing machine, shall have a temperature of not less than 290 F (143 C) and be within 25 F (10 C) of that specified by the engineer. The paver speed shall be such that delivery of mixture to the paver is continuous and so that the breakdown rollers can be maintained within approximately 200 feet (60 m) of the paver.

403.15.6 When a [Sec 403](#) mixture is specified for the traffic lanes, the same mixture may be used for the adjacent shoulder, subject to the density requirements herein. However, no additional pay will be made for the use of Types A, LS, LP or SMA when used in lieu of Type I-C for the shoulder.

403.16 Spot Wedging and Leveling Course. The engineer will specify the locations and thickness of spot wedging and the thickness of leveling course to obtain the smoothest possible riding surface. This procedure may result in spot wedging operations over small areas with feather-edging at high points and ends of wedge areas. Rigid control of the placement thickness of the leveling course will be required. Leveling course, consisting of a layer of asphaltic concrete of variable thickness used to super-elevate curves and eliminate irregularities in the existing base, shall be spread uniformly to the specified profile grade and cross section. The use of an approved finishing machine will be required on the spot wedge and the leveling course except that spreading of the spot wedging with a blade grader will be permitted if results indicate the mixture is practically free from segregation and is uniformly spread and compacted. Type I-C, LP or LS mixtures, as applicable, shall be used for the spot wedging and for the leveling course.

403.17 Blank.

403.18 Compaction. After the asphaltic mixture has been spread, struck off and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. When test strips are required, the roller equipment, rolling pattern and effort used in the test strip to establish compactive effort, shall not be lessened in any manner unless a new test strip is requested by the contractor and satisfactory results are established. Rolling shall begin as soon after spreading the mixture as it will bear the weight (mass) of the roller without undue displacement. The type and number of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. A pneumatic tire roller shall be used as the initial or intermediate roller on any course placed as a wedge or leveling course. All rolling shall be completed prior to the surface temperature of the mixture decreasing to 175 F (80 C).

403.18.1 Any displacement occurring as a result of starting, stopping or changing direction of a roller, or from other causes, shall be avoided. Areas of displacement shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the asphaltic concrete. If necessary to prevent adhesion of the mixture to the rollers, the wheels and rolls shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted. Diesel fuel, fuel oil or other detrimental products shall not be used as wetting agents. Along forms, curbs, headers, walls and other places not accessible to the roller, the mixture shall be thoroughly compacted with hot hand

tampers, smoothing irons or with mechanical tampers. A trench roller shall be used on depressed areas inaccessible to regular width equipment.

403.18.2 Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform with the surrounding area. Any area showing an excess or deficiency of asphalt binder shall be removed and replaced.

403.18.3 Except as otherwise specified, rolling shall be continued until all roller marks are eliminated and a minimum density of 98 percent of a laboratory specimen made in the proportions of the job-mix formula in accordance with AASHTO T 167 or 96 percent of a laboratory specimen made in the proportions of the job-mix formula in accordance with AASHTO T 245, is attained. The applicable density will be determined by the engineer to correspond with the mix design test method. Density will be determined by nuclear methods in accordance with MoDOT Test Method T41 or by a specific gravity method. The direct transmission nuclear method of test will be used for Type A, I-C, LP or LS mixtures placed in layers 2 inches (50 mm) thick or thicker, and for Type I-B mixtures only when used in lieu of plant mix bituminous base in layers 2 inches (50 mm) thick or thicker. The backscatter nuclear method of test will only be used for Type A, I-C, LP or LS mixtures constructed in layers less than 2 inches (50 mm) thick.

403.18.4 [Sec 403](#) mixtures used for surfacing medians and similar areas, shoulders adjacent to rigid or flexible pavement and shoulders adjacent to resurfaced pavement shall be compacted to the specified densities for the mixture. Once an established rolling pattern has been demonstrated to provide the required density for shoulders, at the engineer's discretion the pattern may be used in lieu of density tests provided no changes in the material, typical location or temperatures are made. Regardless of the method, density is still required and subject to testing as deemed necessary by the engineer. In lieu of roller and density requirements, temporary by-passes to be maintained at the expense of the contractor may be thoroughly compacted by at least three complete coverages over the entire area, with a tandem-type steel wheel roller weighing (having a mass of) not less than 10 tons (9 Mg). The rolling shall be performed at proper time intervals and shall be continued until there is no visible evidence of further consolidation.

403.18.5 For SMA mixtures, rolling shall be continued until all roller marks are eliminated and density is attained. Pneumatic tire rollers shall not be used. Minimum density shall be 98.0 percent of a laboratory specimen made in the proportions of the job mix formula in accordance with AASHTO T 245, 50 blow. Density will be determined by a specific gravity method. Traffic shall be kept off of the SMA until the surface of the SMA is 140 F (60 C) or below and has cooled sufficiently to prevent flushing of the asphalt binder to the surface, marking or distorting the surface or breaking down the edges. Cores for determining the in-place density of the mixture shall be taken not later than the day following placement. In addition to any adjustments in pay due to profile, the contract unit price for the SMA mixture represented by each set of cores will be adjusted based on the following schedule:

Field Density Percent of Laboratory Compacted Specimens	Pay Factor Percent of Contract Unit Price
98.0 or greater	100.0
97.5 - 97.9	90.0
97.0 - 97.4	75.0
96.5 - 96.9	55.0
96.4 or less	0.0

No cores shall be taken later than the day following placement for any payment purposes. All mixtures with less than 96.5 percent compaction shall be removed and replaced with approved mixture.

403.19 Joints. Transverse joints shall be formed by any method that will produce a dense, vertical section for use when laying is resumed. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the engineer. The joint formed when the fresh mixture is placed shall be dense, well sealed, and the grade, line and surface texture of the succeeding surface shall conform to that of the joined surface. If deemed necessary by the engineer, the transverse joint shall be painted with a light coating of liquid asphalt. Hand manipulation of the mixture is to be minimized to avoid unsightly surface texture. Placing of asphaltic mixture shall be as nearly continuous as possible and the roller shall not pass over the unprotected end unless laying of additional mixture is to be delayed for sufficient time to permit the mixture to become chilled.

403.19.1 Longitudinal joints shall be formed by the use of an edging plate fixed on both sides of the finishing machine. These plates shall be adjustable and the outside plate shall be set at an angle of approximately 45 degrees with the surface of the roadbed and in a position that will lightly compact the mixture. The inside plate, or that placing material for the longitudinal joint, shall be normal to the roadbed. When placing the first lane, if the mixture at the longitudinal joint tends to slump, it shall be set up to a vertical edge by light compaction with the back of a rake. Care shall be taken to obtain a well bonded and sealed longitudinal joint by placing the hot mixture in a manner ensuring maximum compaction at this point. If it is deemed necessary by the engineer in properly sealing the longitudinal joint, a light coating of bituminous material shall be applied to the exposed edge before the joint is made. The minimum density of all traveled way pavement within 6 inches (150 mm) of a longitudinal joint, including the pavement on the traveled way side of the shoulder joint, shall not be less than 2.0 percent below the specified density. Once an established procedure has been demonstrated to provide the required density for longitudinal joints, at the engineer's discretion, the procedure may be used in lieu of density tests provided no changes in the material, typical location or temperatures are made. Pay adjustments due to longitudinal joint density shall apply to the full width of the traveled way pavement and shall be in addition to any other pay adjustments. Irregularities in the outside edge alignment shall be corrected by removing or adding mixture before the surface is compacted.

403.19.2 The longitudinal joint in any layer shall offset that in the layer immediately below by approximately 6 inches (150 mm); however, the joints in the completed surfacing shall be at the lane lines of the traveled way or other required placement width outside the travel lane. The placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint.

403.20 Surface Test. The surface of each layer shall be substantially free from waves or irregularities. As soon as practicable, the pavement surface shall be thoroughly tested by profilographing or straightedging as indicated. Testing applicable to this specification, except straightedging, shall be performed by the contractor in the presence of the engineer.

Profilographing shall be performed on the surface course on all resurfacing work containing leveling course, coldmilling or multiple course construction as an operation to improve the original riding surface prior to placing the new surface and on the surface course of all new construction. On all other work except medians and similar areas, shoulders adjacent to rigid pavement or adjacent to resurfaced rigid pavement, and temporary bypasses, the final surface shall not vary from a 10-foot (3 m) straightedge, applied parallel to the centerline, by more than 1/8 inch (3 mm). At transverse construction joints, the surface of all other layers shall not vary from the 10-foot (3 m) straightedge by more than 1/4 inch (6 mm).

403.20.1 Profilographing. Profilographing is applicable to the surface of all mainline paving, auxiliary lanes, turning lanes and ramps. Specifically excluded are:

- (a) Bridge decks and their approach slabs.
- (b) Pavement on horizontal curves with centerline radius of curve less than 1000 feet (300 m) and pavement within the superelevation transition of such curves.
- (c) Pavement on vertical curves having a "K" value of less than 90 and a length less than 500 feet (150 m).
- (d) Contracts or stages of construction with less than one half mile (0.8 km) of continuous bituminous pavement.
- (e) Width transitions.
- (f) Fifty feet (15 m) in direction of travel on each side of utility appurtenances such as manholes and valve boxes.
- (g) Fifty feet (15 m) in direction of travel on each side of intersecting routes with special grade transitions.
- (h) Bituminous shoulders.

403.20.1.1 Pavement profile shall be taken 3 feet (1 m) from and parallel to either edge of pavement or along the centerline of the lane being placed as directed by the engineer.

403.20.1.2 Additional profiles shall be required only to define limits of areas representing deviations greater than 0.4 inch (10 mm), except as required in [Sec 403.20.6.4](#).

403.20.1.3 A profilogram shall be made for each continuous section of 50 feet (15 m) or more for each day's placement. A section is defined where paving begins and terminates at a days work joint, a bridge or other interruptions designated by the engineer. Sections will be divided into segments of 0.1 mile (100 m) with the exception of the last segment which normally will be less than 0.1 mile (100 m).

403.20.1.4 Individual sections shorter than 50 feet (15 m) and the last 50 feet (15 m) of any section where the contractor is not responsible for the adjoining surface, will be straightedged in accordance with [Sec 403.20.2](#).

403.20.1.5 If there is a segment of 250 feet (75 m) or less in length at the end of a section, the profilogram for that segment shall be included in the evaluation of the adjacent segment in that section.

403.20.1.6 If there is an independently placed section of a length between 50 and 250 feet (15 and 75 mm), a profilogram shall be made for that section and included in the evaluation of the most recently placed adjacent segment.

403.20.1.7 The contractor shall furnish the profilogram and its evaluation to the engineer. The testing shall be done by a trained operator in the presence of the engineer. The testing procedure and the evaluation of the profilogram shall be done in accordance with this specification and MoDOT Test Method T59. The profilogram and evaluation shall be furnished to the engineer not later than the end of the next working day following placement of the pavement and within two working days after corrective action.

403.20.1.8 The engineer may also test the surface or re-evaluate the profilogram for comparison and assurance purposes. If these tests or re-evaluations indicate the contractor-furnished profilograms are not accurate within 3.0 inches per mile (45 mm/km), the engineer may test the entire project length. If the entire project length is tested, the contractor will be charged for this work at the rate of \$500.00 per lane mile (\$310.00 per lane kilometer). Furnishing inaccurate test results may result in disapproval of the operator.

403.20.1.9 The profilogram line drawn by the profilograph will be referred to as the profile trace in this specification.

403.20.1.10 Profile index will be calculated from the profilogram for pavements 50 feet (15 m) or more in length. The profile index is calculated by summing the vertical deviations of the profile trace above and below the dashed reference line on the transparent scale. The units of this measure are inches per mile (mm/km).

403.20.1.11 Bumps will be separately identified. These appear as high points on the profile trace and correspond to high points or bumps on the pavement surface. They are identified by locating vertical deviations greater than 0.40 inch (10 mm) for a 25 foot (7.622 m) span, as indicated on the profile trace.

403.20.2 Straightedging. As soon as practicable, all segments of the pavement surface not profilographed will be thoroughly straightedged by the engineer and all variations exceeding 1/8 inch (3 mm) in 10 feet (3 m) will be plainly marked. Areas more than 1/8 inch (3 mm) high shall be removed by an approved device as listed in [Sec 403.20.6.3](#). At transverse construction joints, the surface shall not vary from the 10 foot (3 m) straightedge by more than 1/8 inch (3 mm).

403.20.3 Equipment. The profilograph shall be a California type as approved by the engineer. The equipment furnished shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump at the same time. The pavement profile is recorded from the vertical movement of a sensing wheel attached to the frame at mid-point and is in reference to the mean elevation of the 12 points of contact with the road surface established by the support wheels. The profilogram is recorded with a scale of one inch (1 mm) equals one inch (1 mm) vertically and one inch (1 mm) equals 25 feet (300 mm) longitudinally.

403.20.4 Calibration. All profilographs used shall be calibrated at least annually on a test section established by MoDOT. The contractor's calibration profile index shall not vary more than 2.0 inches per mile (30 mm/km) from a standard profile index produced by a MoDOT profilograph.

403.20.4.1 Longitudinal calibration consists of pushing the profilograph over a pre-measured test distance and determining the scale factor by dividing the pre-measured test distance by the length of the paper in inches (millimeters). This factor shall be 25, one inch equals 25 feet

(300, 25 mm equals 7.622 mm). If not, the machine shall be adjusted until the scale factor is 25 (300) plus or minus 0.2 percent.

403.20.4.2 Vertical calibration consists of sliding a pre-measured calibration block, measured to the nearest 0.01 inch (0.25 mm), under the sensing wheel while the profilograph is stationary. The measurement of the vertical trace line from the base line to the peak and return shall be the same as the calibration block. The trace line must return to the base line. No tolerance will be allowed.

403.20.4.3 A profilograph equipped with automatic profile trace reduction capabilities shall be checked by comparing the machine's results with the results obtained by the engineer. This shall be done for the profile trace obtained on MoDOT's test section. The results and the profilogram shall be submitted to the engineer. The results of the comparison may not differ by more than 2.0 inches per mile (30 mm/km).

403.20.4.4 The contractor shall furnish certification that the 25 foot (7.622 m) profilograph test and evaluation was conducted by an operator trained in the use of profilograph equipment and with sufficient experience to demonstrate the operator's competence.

403.20.5 Test Procedures. Smoothness will be tested immediately behind the finish roller by measurement with a profilograph. This device produces a profilogram of the surface tested.

403.20.5.1 All objects and foreign material on the pavement surface shall be removed by the contractor prior to testing.

403.20.5.2 The profilograph shall be propelled at walking speed in the paths indicated in [Sec 403.20.1.1](#) for each section of pavement. Propulsion may be provided by personnel pushing manually or by a suitable propulsion unit.

403.20.5.3 A location indicator for lateral placement is mandatory. More than one person may be required to hold the back end of the profilograph exactly in the required path on horizontal curves except as stated in [Sec 403.20.1\(b\)](#).

403.20.5.4 Walking speed shall be decreased if excessive spikes are encountered.

403.20.5.5 The sensing wheel shall be lifted, rotated to take slack out of the linkage, and lowered to the starting point prior to testing.

403.20.5.6 The actual stationing shall be noted on the profilogram at least every 200 feet (50 m). Station referencing is used to accurately locate deviations greater than 0.40 inch (10 mm).

403.20.5.7 Both ends of the profilogram shall be labeled with the stationing, lane designation, position on the pavement, and the direction the pavement was placed. A report form furnished by the engineer shall be completed and placed with the profilogram.

403.20.5.8 When operating the profilograph, all wheels shall be on the new pavement for which the contractor is responsible.

403.20.6 Surface Corrections. Bump correction or smoothness correction or both may be required.

403.20.6.1 If an average profile index of 45.0 inches per mile (711 mm/km) for pavements having a final posted speed greater than 45 mph (70 km/h), or 65.0 inches per mile (1026 mm/km) for pavements having a final posted speed of 45 mph (70 km/h) or less, is

exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action approved by the engineer is taken by the contractor.

403.20.6.2 All bumps greater than 0.40 inch (10 mm) in height over a 25-foot (7.622-meter) span, as indicated on the profile trace, shall be corrected. The corrected bumps will be considered satisfactory when measurements by the profilograph show that the bumps are 0.40 inch (10 mm) or less in height over a 25-foot (7.622-meter) span.

403.20.6.3 Corrective action to improve the average profile index shall be accomplished either transversely or longitudinally by approved diamond grinding or other devices specifically designed to improve the profile of the riding surface. The device used must be approved by the engineer.

403.20.6.4 After removing all individual deviations greater than 0.40 inch (10 mm) in height, additional correction shall be performed if necessary to reduce the average profile index to 30.0 inches (474 mm) or less per mile (kilometer) for pavements having a final posted speed greater than 45 mph (70 km/h), or 45.0 inches (711 mm) or less per mile (kilometer) for pavements having a final posted speed of 45 mph (70 km/h) or less. All corrective work shall be completed prior to acceptance of the segments involved. On pavement segments where corrections are necessary, additional profiles shall be made to verify that the corrections have produced an average profile index within the limits noted above.

403.20.6.5 If the initial average profile index of any segment is less than 30.1 inches per mile (475 mm/km) for pavements having a final posted speed greater than 45 mph (70 km/h), or less than 45.1 inches per mile (712 mm/km) for pavements having a final posted speed of 45 mph (70 km/h) or less, only the areas with deviations greater than 0.40 inch (10 mm) in height shall be retested for correction verification.

403.20.6.6 Any final lift pavement surface, which does not meet the longitudinal smoothness requirements given above, shall be repaired by the contractor to meet the requirements either by methods discussed in [Sec 403.20.6.3](#), by overlaying, or by removing and replacing, as approved by the engineer, in accordance with the following:

(a) Approved Grinding or Milling Devices. Individual high points in excess of 0.40 inch (10 mm), as determined by measurements of the profilograph shall be reduced by milling/grinding as provided in this section until such high points, as indicated by reruns of the profilograph, do not exceed 0.40 inch (10 mm). After milling/grinding has been completed to reduce individual high points, additional milling/grinding shall be performed as necessary to reduce the average profile index to 30.0 inches (474 mm) or less per mile (kilometer) for pavements having a final posted speed greater than 45 mph (70 km/h), or 45.0 inches (711 mm) or less per mile (kilometer) for pavements having a final posted speed of 45 mph (70 km/h) or less. Additional milling/grinding shall be performed as necessary to produce a uniform cross section. All milled areas shall be neat and of uniform surface appearance.

(b) Overlaying. When an additional lift of asphaltic concrete is used to repair a rough pavement, it shall meet all the requirements of the preceding specifications. The overlay lift shall extend for the full width of the underlying pavement surface and have a finished compacted thickness sufficient to correct the roughness and produce a final surface meeting specifications. If the overlay does not meet the longitudinal smoothness requirement, a second overlay will not be allowed. The repairs to an overlay not meeting smoothness requirement shall be made by the contractor in accordance with the specifications.

(c) Removing and Replacing. Where repair of rough pavement is made by removing and replacing the material, replacement shall meet the preceding specifications.

403.20.6.7 The final texture of the corrected asphaltic concrete pavement shall be such that the texture is comparable to adjacent sections that do not require correcting.

403.21 Testing Pavement. The finished courses shall have the nominal thickness shown on the plans. Tests will be made to ensure that each course is being constructed of proper thickness, composition and density. The contractor shall cut samples from any layer of the compacted mixture at locations designated by the engineer. The sample shall be cut and delivered to the engineer no later than the end of the next calendar day following the laydown operation. If the sample is not cut and delivered as stated, the asphaltic laydown operation may be suspended and a deduction of 5 percent per day of the contract unit price of the representative material may be applied, until samples are cut and delivered to the engineer. Samples may be obtained by either sawing with a power saw or by drilling 4-inch (100 mm) diameter cores. Each sawed sample shall consist of a single piece of the pavement of the size designated by the engineer, but not larger than 12 inches (300 mm) square.

403.21.1 Each cored sample for density determination shall consist of four cores. All samples, whether sawed or cored, shall consist of an undisturbed portion of the compacted mixture removed for the full depth of the layer or course to be tested. Cores used to establish a nuclear correction factor shall be taken in a number designated by the engineer and each four cores and fraction thereof shall be considered a sample.

403.21.2 Each sample taken for total course thickness shall consist of one 4-inch (100 mm) diameter core taken for the full depth of the course. Each sample taken for total compacted thickness shall consist of one 4-inch (100 mm) diameter core taken for the full depth of bituminous construction, including the surface course, binder course, leveling course or bituminous base course. Total thickness samples may be obtained after all bituminous construction is completed on the project and shall be taken at locations specified by the engineer.

403.21.3 The surface from which samples have been taken shall be restored by the contractor with the mixture then being produced not later than the next day of plant operation, if construction is still active. If bituminous construction has been completed, the surface from which samples have been taken shall be restored within 48 hours with an approved commercial mixture or with cold patch mixtures acceptable to the engineer.

403.22 General Requirements.

403.22.1 Sequence of Operations. To reduce inconvenience to the traveling public during widening or surfacing, the contractor will not be permitted to place any final surface course until the base widening, the leveling course, and the binder course have been completed throughout the entire combination of sections, unless otherwise authorized by the engineer. The proper condition of the base widening, the leveling course and the binder course, at the time of placing the surface course, shall be the contractor's responsibility.

403.22.2 Traffic Striping. If the contractor's work has obliterated the existing traffic striping on resurfacing projects open to through traffic, the traffic marking shall be replaced in accordance with [Sec 620](#).

403.22.3 Surfaced Approaches. At locations designated in the contract or as specified by the engineer, approaches shall be primed in accordance with [Sec 408](#) and surfaced with Type I-C, LP or LS asphaltic concrete. The asphaltic concrete surface shall be placed in accordance with the details shown on the typical section or as specified by the engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. No direct

payment will be made for any work required to condition and prepare the subgrade on the approaches.

403.22.4 Filling Drain Basins. If shown on the plans, existing drain basins shall be filled to the top of the lip with plant mix bituminous base course or asphaltic concrete from the pavement edge to the edge of the shoulder. No direct payment will be made for any difficulty or delay occasioned by this requirement.

403.22.5 Pavement Repairs (Blow-Ups). A blow-up will be considered that area where excessive expansion has resulted in distress to the existing pavement. Blow-ups occurring prior to the application of the tack coat on the existing surface will generally be repaired by the Commission. Blow-ups occurring after the application of the tack coat shall be repaired by the contractor by removing the distressed concrete and making replacement with asphaltic concrete mixture, thoroughly compacted.

403.23 Method of Measurement.

403.23.1 The weight (mass) of the mixture will be determined from the batch weights (masses) if a batch-type plant is used, and will be determined by weighing (determining the mass of) each truck load on scales conforming to the requirements of [Sec 310.4.3](#) if other types of plants are used.

403.23.2 Measurement of asphalt binder, to the nearest 0.1 ton (0.1 Mg) for the total tonnage (quantity) used in the accepted work, will be determined by the use of job-mix formula applied to the weight (mass) of accepted mixture of mineral aggregate and asphalt binder.

403.23.3 Measurement of the weight (mass) of mineral aggregate, to the nearest ton (megagram), will be determined by subtracting the weight (mass) of the asphalt binder from the weight (mass) of the mixed mineral aggregate and asphalt binder.

403.24 Basis of Payment.

403.24.1 Due to possible variations in the specific gravity of the aggregates, the tonnage (quantity) used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

403.24.2 Payment for obtaining and delivering samples of compacted mixture from the pavement and replacing the surface will be made at \$75.00 per sample.

403.24.3 Payment for Pavement Repairs (Blow-ups). Payment for removing and disposing of the broken concrete and for preparing subgrade will be made as provided in [Sec 104.3](#). Payment for furnishing, placing and compacting the asphaltic concrete replacement material will be at the contract unit price for the mixture used.

403.24.4 The contract unit price for all mixes, except wedge or level course, shall be adjusted based on smoothness as measured on the surface course. Payment for smoothness will be based on either Table I or Table II. Table I will be used for pavements having a final posted speed greater than 45 mph (70 km/h). Table II shall be used for pavements having a final posted speed of 45 mph (70 km/h) or less and for pavements with no posted speed limits. Constant width acceleration and deceleration lanes shall be considered as mainline pavements.

Final Profile Index, Inches Per Mile (mm/km)		Percent of Contract Price
Table I	Table II	
10.0 (158) or less		107
10.1 - 15.0 (159 - 237)	15.0 (237) or less	105
15.1 - 18.0 (238 - 284)	15.1 - 25.0 (238 - 395)	103
18.1 - 30.0 (285 - 474)	25.1 - 45.0 (396 - 711)	100
30.1 - 45.0 (475 - 711)	45.1 - 65.0 (712 - 1026)	95*
45.1 (712) or greater	65.1 (1027) or more	93*

*Correction required.

403.24.4.1 Smoothness incentive will be paid per section based on the profile index before bump correction. Within a section qualifying for incentive pay, any segment having a profile index requiring a reduction in contract price will not be included in incentive payment for that section.

403.24.4.2 Segments with a profile index of 30.1 (475) or greater, Table I, or 45.1 (712) or greater, Table II, after bump correction, shall be corrected as specified in [Sec 403.20.6](#) until the profile index is 30.0 (474) or less, Table I, or 45.0 (711) or less, Table II, or at the contractor's option the segment may be removed and replaced with no additional payment. Under Table I, those segments with a profile index of greater than 30.0 (474) and less than 45.1 (712) after bump correction will receive 100 percent of contract price when reduced to 30.0 (474) or less, and those segments with a profile index of 45.1 (712) or greater before bump correction will receive 93 percent when reduced to 30.0 (474) or less. Under Table II, those segments with a profile index of greater than 45.0 (711) and less than 65.1 (1027) after bump correction will receive 100 percent of contract price when reduced to 45.0 (711) or less, and those segments with a profile index of 65.1 (1027) or greater before bump correction will receive 93 percent when reduced to 45.0 (711) or less.

403.24.4.3 On sections where corrections are made, the pavement will be tested by the contractor to verify that corrections have produced a profile index of 30.0 (474) or less, Table I, or 45.0 (711) or less, Table II.

403.24.4.4 The contractor will not be allowed to make corrections to increase the percent of pay when the final profile index is 30.0 (474) or less, Table I, or 45.0 (711) or less, Table II.

403.24.4.5 If the profile index, after bump correction, is 30.1 (475) or greater, Table I, or 45.1 (712) or greater, Table II, and the contractor elects to remove and replace the segment, the contractor will be paid the percent of contract price that corresponds to the replaced segment's profile index as specified above.

403.24.4.6 The contract unit prices for asphaltic concrete pavement will be considered as full compensation for all material entering into the construction of the pavement and for the cost of the smoothness testing.

403.24.4.7 When paving widths are greater than the travel lane widths, profiling and payment for profiling will apply to the traffic lane design driving width only, normally 12 feet (3.6 m).

403.24.5 Random lane coring for thickness or required lane replacement will include the full paved lane width to the longitudinal joints or edge of shoulder, whichever is first.

403.24.6 Payment for test strips including all equipment, labor and any other work necessary to complete this item will be considered as completely covered by the contract unit price. Accepted test strips meeting density and all other specification requirements will be paid for at

the contract unit price per test strip. No payment will be made for test strips required as a result of a change in the job mix formula, compaction method or equipment when initiated by the contractor or when unacceptable results occur as determined by the engineer. Test strips meeting density requirements, but fail to meet other specification requirements, may be left in place and the material paid for as determined by the engineer.