SECTION 401
PLANT MIX BITUMINOUS BASE AND PAVEMENT

401.1 Description. This work shall consist of a bituminous mixture placed, spread and compacted as shown on the plans or as directed by the engineer.

401.2 Material. The grade of asphalt binder will be specified in the contract. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Bituminous Asphalt Mixes	490
Coarse Aggregate	1004.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Hydrated Lime	1002.5
Asphalt Binder, Asphalt Emulsion	1015

401.2.1 Job Mix Formula (JMF). At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design in accordance with Sec 490 for approval by Construction and Materials. Bituminous Base (BB) and Bituminous Pavement (BP-1, BP-2, or BP-3) mixtures as designated by the plans are used for Section 401 pay items.
401.2.1.1 Mixture Approval. No mixture will be accepted for use until the job mix formula for the project is approved by Construction and Materials. 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.

401.2.1.2 Mixture Adjustments. In producing mixtures for the project, the plant shall be operated such that no intentional deviations from the job-mix formula are made except as follows. Aggregate only bin changes are allowable so long as the original gradation tolerances and non-carbonate requirements are met. Anytime the gradation tolerances are exceeded or there is a change to binder providing components, the contractor shall verify the mix still meets the Sec 490 requirements for recycle contribution, VMA and VFA with the adjusted Gsb, D/B ratio, and non-carbonate aggregates. The contractor shall provide a record of the time and tonnage of all mixture adjustments as well as all verification testing to the engineer.

401.2.2 Substitutions. At the option of the contractor and at no cost to the Commission, the contractor may use a Sec 401 mixture with a smaller nominal maximum size aggregate or an approved Sec 403 mixture, design level C, E, or F with the same or smaller nominal maximum size aggregate in lieu of any Sec 401 mixture. When a Sec 403 mixture is substituted, all Sec 401 requirements including QC/QA requirements shall remain except the layer thickness requirements of Sec 403 shall apply.

401.2.3 Commercial Mixture. A mixture other than those approved following Sec. 490 may be used if specified in the contract as an approved commercial mixture or for temporary construction that is to be maintained at the contractor's expense and removed prior to completion of the contract. The plant requirements of Sec 404 will not be required. A field laboratory will not be required. The mixture shall be produced, transported, and placed accordance with Sec 401.5 to be uniform, thoroughly mixed, and free from segregation. Upon completion of the work, the contractor shall supply a certification for the total quantity detailing the components and proportions used. Acceptance of commercial mixture will be by visual inspection.
401.2.4 Contamination. The bituminous mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue or any other material not inherent in the job mix formula.

401.3 Mixing Plants and Hauling Equipment. Bituminous mixing plants, trucks used for hauling bituminous mixtures, and preparation of material and mixtures shall be in accordance with Sec 404.

401.4 Field Laboratory. The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. A field laboratory shall not be required for small quantity work.

401.5 Construction Requirements.

401.5.1 Weather Limitations. Bituminous mixtures shall not be placed on any wet surface or frozen pavement.

401.5.2 Subgrade or Surface Preparation. The subgrade upon which the bituminous mixture is to be placed shall be prepared in accordance with Sec 209 and primed as specified in the contract in accordance with Sec 408, as applicable. All material requirements of a tacked surface shall be in accordance with Sec 407.

401.5.2.1 Base Widening. For base widening work, the bottom of the trench shall be compacted until further consolidation is not visually evident, by use of a trench roller having a weight of no less than 300 psi of width of rear roller, or by mechanical tampers or other methods approved by the engineer. Suitable excavated material may be used in shouldering operations. On the outside of curves, the design depth of trench at the beginning of the superelevation transition shall be varied gradually to the minimum depth at the end of the superelevation transition. Slight transitioning of the width of the base widening will be necessary to permit the indicated angle of repose or shear angle outside of the ultimate edge of surface. The bottom of the trench shall in no case be less than 3 inches below the surface of the existing pavement. All surplus excavated material shall be disposed of by the contractor in areas to be secured by the contractor beyond the right of way limits. An acceptable written agreement with the property owner on whose property the material is placed shall be submitted to the engineer.

401.5.2.2 Application of Prime or Tack. Application of prime or tack shall be in accordance with Sec 403.11.2.

401.5.3 Spreading. The base course, tacked or primed surface, or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign matter prior to spreading the bituminous mixture. The mixture shall be spread in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. When placing multiple layers with varying thicknesses, the thicker layer shall be placed first. The compacted thickness of a single layer of bituminous pavement mixture shall be no more than 2 inches for the surface course and 4 inches for the leveling course.

401.5.3.1 Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.

401.5.3.2 Leveling Course. If required by the contract, a leveling course consisting of a layer of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface.

401.5.3.3 Base Widening. The specified total thickness of base widening shall be completed to the adjacent traveled way elevation as shown on the plans. Additional thickness of base widening may be placed as required prior to coldmilling, at the contractor's expense, and shall subsequently be coldmilled to the same elevation as the traveled way, if conducive to expedite operations. On base-widening work, a succeeding layer of bituminous mixture may be placed the same day as the previous layer, if it can be shown that the desired results are being obtained. On small areas, and on areas that are inaccessible to mechanical spreading and finishing equipment, the mixture may be spread and finished by hand methods if permitted by the engineer. At least one lane of the existing pavement and the adjacent shoulder shall be kept open to traffic at all times during construction, except for short intervals when the movement of the contractor's equipment will seriously hinder the flow of traffic. Intervals during which the contractor will be allowed to halt traffic shall be as designated by the engineer. The contractor shall not open more trenches ahead of the first layer of the base widening than is necessary for placing that layer in one half a day's operations. The first layer of the base widening shall not be placed for a greater distance ahead of the second layer than is necessary for placing the second layer in one half a day's operations. The second layer shall not be placed for a greater distance ahead of the final layer than is necessary for placing the final layer in one day's operation. Any changes in these lengths shall be made only with written permission from the engineer.

401.5.4 Defective Mixture. Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective, shall be removed and replaced with a satisfactory mixture, which shall be immediately compacted to conform to the surrounding area.

401.5.5 Longitudinal Joints. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches. The joints in the final surface layer shall be at the lane lines of the traveled way, except that the placement width shall be adjusted such that pavement marking shall not fall on a longitudinal joint. Each side of the joint shall be flush and along true lines.

401.5.6 Transverse Joints. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the layer. When a transverse vertical edge is to be left in place and opened to traffic, a temporary depth transition shall be constructed as approved by the engineer.

401.5.7 Surfaced Approaches. At locations designated in the contract or as specified by the engineer, approaches shall be primed or tacked in accordance with Sec 408 and surfaced with a plant mix bituminous mixture. The bituminous surface shall be placed as shown on the plans or as directed by the engineer. Approaches shall not be surfaced before 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.

401.5.8 Other Compaction. In lieu of density requirements, mixtures used for wedging, transitions, shoulders, temporary bypasses to be maintained at the expense of the contractor, and areas where a commercial mixture is used shall be thoroughly compacted by at least three complete coverage's over the entire area with either a pneumatic tire roller weighing no less than 10

tons, a tandem-type steel wheel roller weighing no less than 10 tons or an approved vibratory roller. Rolling shall be performed at proper time intervals on each layer and shall be continued until there is no visible evidence of further consolidation.

401.5.9 Pavement Marking. If the contractor's work has obliterated existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced at the contractor's expense in accordance with Sec 620.

401.5.10 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade. The pavement shall be thoroughly tested for smoothness by profiling or straightedging in accordance with Sec 610.

401.5.11 Pavement Edge Treatment. For roadways constructed under traffic, pavement edge treatments as described in Standard Plan 619.10 shall be required. No pavement edge treatments shall be left in place for more than seven days, unless approved by the engineer.

401.5.12 Coring. The contractor shall restore the surface from which samples have been taken immediately with the mixture under production or with a cold patch mixture acceptable to the engineer.

401.6 Quality Control. The contractor shall control and monitor the quality of the work. At the engineer's discretion, testing may be waived when production does not exceed 200 tons per day. Mixture suppliers shall have either a standard quality control plan on file with the Construction & Materials division for the applicable plant or be included in the contractor's quality control plan.

401.6.1 Retained Samples. One half of the contractor's sample for mixture gradation, aggregate deleterious content, and mixture asphalt content as well as all cores shall be retained for the engineer. The contractor shall retain the samples for 7 days after testing has been completed and the results accepted by the engineer.

401.6.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

401.6.3 Mixture Temperature. The contractor shall periodically record temperature of mix before it leaves the plant.

401.6.4 Mixture Gradation. The gradations of the total aggregate will be determined from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP gradation from the ignition or extraction residual aggregate. Mixtures as produced shall be subject to the maximum variations from the approved JMF in the table below. If a gradation test falls between the Tolerance and Action Limits, mixture adjustments per Sec 401.2.1.2 shall be made and another gradation shall be taken immediately. Plant production for the following day shall not resume until the gradation tolerances are met or the mixture adjustment is successfully verified. If a gradation test falls outside the Action Limit, production shall cease until the mixture is brought back into specification.

Mix Type	Sieve Size	Percent Passing by Weight	
		Tolerance	Action Limit
BP-1, BP-2	No. 8	± 5.0	± 10.0
BP-3	No 16		
All	No. 200	± 2.0	± 4.0

401.6.5 Mixture Asphalt Content. Samples for asphalt content determination may be taken at the plant. The quantity of asphalt binder determined by tests on the final mixture shall not vary by more than – 0.3 to + 0.5 percent from the job-mix formula. If an asphalt content test result falls outside of the specification tolerances, a review or mixture adjustment per Sec 401.2.1.2 shall be made and another sample shall be immediately taken. If the second test falls outside of the specification tolerances, production shall be immediately ceased until the mixture can be brought back into specification.

401.6.6 Mixture Moisture Content. The bituminous mixture, when sampled and tested in accordance with AASHTO T 329, shall contain no more than 0.5 percent moisture by weight of the mixture

401.6.7 Moisture Susceptibility. TSR results shall be 70 percent or above. QC TSR testing shall be waived when independent QA deleterious and plasticity index tests compare favorably.

401.6.8 RAP Gradation. The contractor shall test the residual aggregate from the RAP asphalt content testing to determine its gradation.

401.6.9 RAP Asphalt Content. RAP shall be sampled from the RAP feeding system on the asphalt plant. Solvent extraction or binder ignition methods shall be used to determine RAP asphalt contents. If AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77.

401.6.10 RAP Durability. All RAP material not from a MoDOT roadway shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Samples of RAP for this test shall have the asphalt coating removed either by extraction or binder ignition. The percent loss of RAP shall not exceed the loss of the combined loss of the virgin material by more than five percent.

401.6.11 Aggregate Deleterious. The deleterious content of the total aggregate shall be determined from samples taken per Sec 401.6.3. The deleterious content of the material retained on the No. 4 sieve for the combined virgin aggregates shall not exceed the limits specified in Sec 1004.2. QC deleterious testing shall be waived when independent QA deleterious and plasticity index tests compare favorably.

401.6.12 Aggregate Plasticity Index. All individual aggregate fractions shall be tested for plasticity. Samples for plasticity index shall be taken from the stockpile. The plasticity index shall be within two of the Job Mix Formula. QC plasticity index testing shall be waived when independent QA deleterious and plasticity index tests compare favorably.

401.6.13 Surface Smoothness. See Sec 610 for additional details.

401.6.14 Lift Thickness. The thickness of the layer to be tested shall be measured on all density and joint cores.

401.6.15 Pavement Density. The compacted mixture shall have a minimum density of 92 percent of the theoretical maximum specific gravity shown on the JMF. Density will be determined by the direct transmission nuclear method in accordance with MoDOT TM 41 or by a specific gravity method. Density of the pavement shall be determined by one core obtained by the contractor at each random location selected by the engineer. Minimum 4-inch diameter cores, shall be taken the full depth of the layer to be tested. Cores tested by AASHTO T 166 shall be in accordance with Sec 490.8. When the contractor elects to place a lift of mixture greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined separately.

401.6.16 Longitudinal Joint Density. Core sampling and testing shall be in accordance Sec 401.6.15 unless modified herein. The minimum density of all traveled way pavement within 8 inches of a longitudinal joint, shall be no less than 90%. One longitudinal joint density core shall be taken from the same transverse cross section as each pavement density core. The longitudinal joint density core shall alternate sides of the paved layer. The cores shall be centered 6 inches from the longitudinal joint.

401.6.17 Segregation Limits. Areas in question will be tested in accordance with MoDOT Test Method TM 75. QC shall ensure MoDOT has the opportunity to witness TM 75 being performed.

401.6.18 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample directly in the inspector's absence.

401.7 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor.

401.7.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples **401.9 Method of Measurement.** Measurement will be in accordance with Sec 403.

401.10 Basis of Payment. The accepted quantities of plant mix bituminous pavement and base course will be paid for at the contract unit price for each of the pay items included in the contract. Payment for obtaining and delivering samples of compacted mixture from the base and replacement of the surface will be made per sample at the fixed contract unit price specified in Sec 109. No direct payment will be made for QC testing, excavating the trench for base widening, or for hauling and disposing of excess excavation material.

401.10.1 Density Adjustment. The contract unit price shall be adjusted by whichever is lower of the pavement density pay factor or the longitudinal joint density pay factor. Pay adjustments due to longitudinal joint density pay factor shall apply to the full width of the lane paved. When a core is cut in half due to lift thickness, the lower of the two densities results will be used to determine the pay factor. Pay factors in the table below shall be applied to material represented by each density sample.

Pavement Density	Longitudinal Joint Density Pay Factor	Percent of Contract Unit Price Pay Factor
91.5 or above	89.5 or above	100%
91.0 to 91.4	89.0 to 89.4	97%
90.5 to 90.9	88.5 to 88.9	94%
90.0 to 90.4	88.0 to 88.4	90%
89.5 to 89.9	87.5 to 87.9	80%
Below 89.5	Below 87.5	Remove and Replace

401.10.2 Surface Smoothness Adjustment. Payment for mixture placed shall be adjusted per Sec 610 when applicable.

SECTION 403
ASPHALTIC CONCRETE PAVEMENT

403.1 Description. This work shall consist of providing a bituminous mixture to be placed in one or more courses on a prepared base or underlying course as shown on the plans or as directed by the engineer.

403.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Bituminous Asphalt Mixtures	490
Aggregate	1002
Asphalt Binder	1015
Asphalt Emulsions	1015
Fiber Additive	1071
Anti-Strip Additive	1071

403.2.1 Job Mix Formula (JMF). At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design in accordance with Sec 490 for approval to Construction and Materials. Superpave (SP) and Stone Mastic (SM) mixtures intended for Section 403 pay items as shown on the plans. The plant shall be operated such that no intentional deviations from the job mix formula are made.

403.2.2 Substitutions. At the option of the contractor and at no cost to the Commission, the contractor may substitute a smaller nominal maximum size mixture for a larger sized mixture. Specifications governing the substitute mixture shall apply. For multi-lift or single-lift construction paid for by area, the total plan pavement thickness shall be maintained. The contract unit price for the original mixture shall be used.

403.2.3 Shoulder Substitution. When a Sec 403 mixture is specified for traffic lanes, the same mixture may be used for the adjacent shoulder, subject to the density requirements in Sec 403.

403.2.4 Mixture Approval. No mixture will be accepted for use until the JMF for the project is approved by Construction and Materials. When test results indicate the mixture produced does not meet the specification requirements, the contractor may field adjust the job mix formula as noted herein. Field adjustments may consist of changing the percent binder as listed on the original approved job mix by no more than 0.3 percent. Additional fractions of material or new material will not be permitted as field adjustments. The engineer shall be notified immediately when any change is made in the cold feed settings, the hot bin settings or the binder content. A new Gsb shall be calculated using the new aggregate percentages. The gradation of the adjusted mixture shall meet the requirements of the mixture type specified in the contract. When the binder content is adjusted more than 0.3 percent, the mixture will be considered out of specification, and a new mix design shall be established.

403.2.5 Field Mix Redesign. When a new mix design will be required, the contractor will be permitted to establish the new mix design in the field. The mixture shall be designed in accordance with AASHTO R 35 or AASHTO R 46 and shall meet the mix design requirements, including TSR. A representative sample of the mixture shall be submitted with the new mix design to the Central Laboratory for mixture verification. The amount of mixture submitted for verification shall weigh at least 50 pounds.

403.2.5.1 Redesign Approval. New mix designs established in the field shall be submitted for approval to Construction and Materials. Upon approval, Construction and Materials will assign a new mix number to the mixture.

403.2.5.2 Resume Production. No mixture shall be placed on the project until the new field mix design is approved.

403.2.6 Contamination. 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.

403.3 Mixing Plants and Hauling Equipment. Bituminous mixing plants, trucks used for hauling bituminous mixtures, and preparation of material and mixtures shall be in accordance with Sec 404.

403.4 Field Laboratory. The contractor shall provide a Type 3 field laboratory in accordance with Sec 601. The contractor shall furnish the bituminous mixture equipment to perform all required test methods for QC and QA work. A field laboratory shall not be required for small quantity work.

403.5 Acceptance and Payment for Work Types. Acceptance of bituminous mixtures will be by the QC/QA process as designated within. The applicable pay adjustments shall be based on the type of work performed.

403.5.1 Multiple Lift Mainline Construction. For mainline traveled way work consisting of placing multiple lifts all QC/QA requirements and pay adjustments shall apply. Shoulders placed integrally with the mainline shall be included in the QC/QA lot process and adjustments for mainline.

403.5.1.1 Roadway/Shoulder Lots. For the purpose of pay adjustments mixture placed on the traveled way or placed on the traveled way and shoulders integrally, shall be accounted for in a regular lot/sublot routine with density being included in the pay factor total. Mixture placed on shoulders only shall be accounted for in a shoulder lot/sublot routine.

403.5.2 Non-Integral Shoulders. All QC/QA requirements shall apply for mixtures used on non-integral shoulders, surfacing medians, and similar areas, except that density acceptance is as described in Sec. 403.11.11.2. All pay adjustments shall apply except for when an established roller pattern is utilized, no density related pay adjustment shall be made. No unconfined joint cores or pay factor shall apply to non-integral shoulder work.

403.5.3 Mill and Fill. For resurfacing projects specifying a milling operation prior to mixture placement, the QC/QA requirements and pay adjustments of multiple lift construction shall apply.

403.5.4 Single Lift or Leveling Course. For resurfacing projects without milling specifying a single lift overlay or for leveling course work all QC/QA requirements shall apply. All applicable adjustments shall be used in determining payment for acceptable work except that the density adjustment shall be used in lieu of including the pavement density in the pay factor total.

403.5.5 Base Widening and Entrances. For base widening and entrance work, all QC/QA requirements shall apply. For base widening mixture and entrance work, compaction may be performed and accepted in accordance with Sec 403.11.11.2. No pay adjustments shall be made. Payment for these mixtures will be made at 100 percent of contract unit price for material that otherwise meets the specifications.

403.5.6 Temporary Pavement. All QC/QA requirements shall apply for mixture placed for temporary work items except that moisture susceptibility and surface smoothness testing is not required. The Superpave adjustment without the density payfactor as well as the density adjustment shall apply to temporary work.

403.5.7 Small Quantity. When less than 4000 tons for each separate mixture is called for it shall be considered a small quantity. This designation applies to individual projects, individual projects in combination contracts or projects with short discontinuous sections. For small quantities the contractor may elect to perform either the full QC/QA process or the modified process using the QC Small Quantity frequencies listed in the Sec 403.14 table. QA frequency for small quantities will be determined by the engineer. All applicable adjustments shall be used in determining payment for acceptable work except that when the QC Small Quantity frequencies are used, the Superpave adjustment shall not apply.

403.5.8 Certifiable Quantity. At the engineer's discretion, QC/QA requirements may be waived when production does not exceed 200 tons per day. The contractor shall certify the proper proportions of a previously proven mixture were used. No price adjustments shall be made, payment for these mixtures will be made at 100 percent of contract unit price for material that otherwise meets the specifications.

403.6 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.

403.7 Pavement Marking. If the contractor's work has obliterated the existing pavement marking on resurfacing projects open to through traffic, the pavement marking shall be replaced in accordance with Sec 620.

403.8 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 SP125 asphaltic concrete. The asphaltic concrete surface shall be placed in accordance with the details shown on the plans or as specified by the engineer. Approaches shall not be surfaced until after the surface course adjacent to the entrance is completed. Any work required to condition and prepare the subgrade on the approaches will be at the contractor's expense.

403.9 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. Any difficulty or delay created by this requirement will be at the contractor's expense.

403.10 Blow-Ups. A blow-up will be considered 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 normally 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 pavement and replacing the pavement in accordance with Sec 613.

403.11 Construction Requirements.

403.11.1 Weather Limitations. Bituminous mixtures shall not be placed on any wet or frozen surface.

403.11.2 Application of Prime or Tack. The prime coat, if specified, shall be applied in accordance with Sec 408. A tack coat shall be applied on all existing pavement and shoulder surfaces that will be overlaid with a bituminous mixture. A tack coat shall also be required between all lifts of bituminous pavements placed within the driving and turn lanes, unless otherwise specified in the contract. All construction requirements of a tacked surface shall be in accordance with Sec 407, and specified herein. The tack coat shall be applied uniformly and shall completely cover the surface upon which the bituminous mixture is to be placed. Placement of a bituminous mixture shall not be placed upon a tacked surface that is not uniformly covered or surfaces that have experienced excessive loss of tack due to tracking. Re-application of tack due to excess tracking or non-uniform coverage shall be at the contractor's expense.

403.11.3 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. Truck loads not free of lumps or crusted material shall be rejected. 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 multiple layers. The minimum compacted thickness shall be 0.75 inches for SP048, 1.25 inches for SP095, 1.75 inches for SP125, 2 inches for SP190, and 3 inches for SP250.

403.11.3.1 Transitions. 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.

403.11.4 Paving Widths. The following shall apply for roadways constructed under traffic. For pavements having a width of 16 to 24 feet, inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement, and the full width shall be completed as soon as practical. Unless otherwise permitted, a single lane of any course shall not be constructed to a length that cannot be completed to full width of the pavement the succeeding operating day. For pavements greater than 24 feet wide, single lane width construction shall be limited to one day's production and completion to full width shall be accomplished as soon as practical. Uneven pavement shall be left in place for no more than seven days, unless approved by the engineer. Removal of pavement to be in accordance with this specification shall be at the contractor's expense.

403.11.5 Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.

403.11.6 Release to Traffic. 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 the surface of the asphaltic concrete is 140 F or below and the asphaltic concrete has cooled sufficiently to prevent flushing of the asphalt binder to the surface, marking or distorting the surface or breaking down the edges.

403.11.7 Draindown. Evidence of asphalt binder separation or draindown at delivery will be cause for rejection.

403.11.8 Defective Mixture. 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.

403.11.9 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 shall be required. Leveling course, consisting of a layer of asphaltic concrete of variable thickness used to superelevate curves and eliminate irregularities in the existing base, shall be spread uniformly to the specified profile grade and cross section. The mixture shall be uniformly spread and compacted, with only minor segregation as accepted by the engineer. Type SP125 or finer mixtures, as applicable, shall be used for the spot wedging and for the leveling course.

403.11.10 Base Widening. All base widening shall be constructed in accordance with Sec 401.5.2.1 and subsections.

403.11.11 Compaction. After the asphaltic mixture has been spread, struck off and surface irregularities adjusted, the asphaltic mixture shall be compacted thoroughly and uniformly by rolling to obtain the required compaction while the mixture is in a

workable condition. Excessive rolling, to the extent of aggregate degradation, will not be permitted. A pneumatic tire roller shall be used as the initial or intermediate roller on any course placed as a single lift, as a wedge or leveling course. Rollers shall not be used in the vibratory mode when the mixture temperature is below 225 F. When warm mix technology is used, as approved by the engineer, rollers shall not be used in the vibratory mode when the mixture temperature is below 200 F .

403.11.11.1 Rolling. Any displacement occurring as a result of starting, stopping or changing direction of a roller, or from other causes, shall be avoided. Excess liquid, to prevent adhesion of the mixture to the rollers, 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.

403.11.11.2 Non-Traffic Area Compaction. Mixtures used for non-integral shoulders, surfacing medians, and similar areas 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 will still be required and subject to testing as deemed necessary by the engineer.

403.11.12 Transverse 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 directed by the engineer for properly sealing the transverse joint, a light coating of bituminous material shall be applied to the exposed edge before the joint is made. Hand manipulation of the mixture shall be minimized to avoid unsightly surface texture.

403.11.13 Longitudinal Joints. The longitudinal joint in any layer shall offset that in the layer immediately below by a minimum of 6 inches; except, 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. Longitudinal joints shall be formed by the use of an edging plate fixed on both sides of the finishing machine. 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 directed by the engineer for properly sealing the longitudinal joint, a light coating of bituminous material shall be applied to the exposed edge before the joint is made. Each side of the joint shall be flush and along true lines.

403.11.14 Surface Smoothness. The finish of the pavement surface shall be substantially free from waves or irregularities and shall be true to the established crown and grade.

403.11.15 Coring. The surface from which samples have been taken, including those for density measurements, shall be restored by the contractor with the mixture then being produced no 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.

403.12 Quality Control. The contractor shall control and monitor the quality of the work. Mixture suppliers shall have either a standard quality control plan on file with the Construction & Materials division for the applicable plant or be included in the contractor’s quality control plan. The contractor's test results will be used when applicable to determine the PWL, provided the contractor's QC tests and the engineer's QA tests compare favorably, and provided the engineer's inspection and monitoring activities indicate the contractor is following the approved QC Plan.

403.12.1 Lots/Sublots. Loose mix material will be sampled from the roadway behind the paver in lots or sublots on a random basis through the use of a random number system and evaluated using a Quality Level Analysis (QLA). A QLA will determine payment based on a combination of the total PWL (PWLt) determined for each pay factor item for each lot of material produced. The lot size shall be designated in the contractor’s QC Plan. Each lot shall contain no less than four sublots with a maximum sublot size of 1,000 tons. Sublots from incomplete lots shall be combined with the previous complete lot for determination of pay factors. When no previous lot exists, the mixture shall be treated as a small quantity A new lot shall begin when the asphalt content of a mixture is adjusted in accordance with Sec 403.2.5.

403.12.2 Random Numbers. The engineer will generate random numbers for density cores and loose mix sampling locations. For the purpose of QLA, all mixture placed on the roadway shall be subject to random testing, except mixture placed within 6 inches of an unconfined longitudinal joint shall not be subject to pavement density evaluation. Random loose mix samples taken in the same day may be separated by 200 tons.

403.12.3 Retained Samples. All samples taken by the contractor, including but not limited to tested aggregate, volumetric and density samples, shall be retained for the engineer for a minimum of seven days after the contractor’s tests are complete and

accepted unless otherwise instructed. These samples shall be maintained in clean covered containers, without contamination, readily accessible to the engineer. The retained sample's identification shall consist of, but is not limited to:

(a) Time and date sampled.

(b) Product specification number.

(c) Type of sample, i.e. belt, bin, stockpile.

(d) Lot and sublot designation.

(e) Sampler/Tester.

(f) Project Job Number.

403.12.4 Temperature of Base and Air. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

403.12.5 Mixture Temperature. The contractor shall periodically record the temperature of the mix before it leaves the plant.

403.12.6 Mixture Moisture Content. The asphaltic concrete mixture, when sampled and tested in accordance with AASHTO T 329, shall not contain more than 0.5 percent moisture by weight of the mixture. In addition to the minimum frequency listed in the table, mixture moisture content shall be taken any time the aggregate stockpiles' moisture content is significantly changed.

403.12.7 Mixture Gradation. The gradations of the total aggregate will be determined using AASHTO T 27 from samples taken from the hot bins on batch-type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. The mixture gradation may be determined directly by using residual aggregate from the binder ignition process or by mathematical combination of the cold feed and recycled materials gradations. When the mathematical combination method is used, the RAS gradation shall be from the JMF and RAP gradation from the ignition or extraction residual aggregate. Mixtures as produced shall be subject to the maximum tolerance in the table below.

<table>
<tr><th rowspan="2">Sieve Size</th><th colspan="7">Percent Passing by Weight</th></tr>
<tr><th colspan="7">Tolerance</th></tr>
<tr><td></td><td>SP095SM</td><td>SP125SM</td><td>SP048</td><td>SP095</td><td>SP125</td><td>SP190</td><td>SP250</td></tr>
<tr><td>3/4 inch</td><td rowspan="2">-</td><td>-</td><td rowspan="4">-</td><td rowspan="3">-</td><td rowspan="2">-</td><td>-</td><td>0 - 92</td></tr>
<tr><td>1/2 inch</td><td>JMF ±4</td><td>0 - 92</td><td rowspan="3">-</td></tr>
<tr><td>3/8 inch</td><td>JMF ±4</td><td>JMF ±4</td><td>0 - 92</td><td rowspan="2">-</td></tr>
<tr><td>No. 4</td><td>JMF ±3</td><td>JMF ±3</td><td>0 - 92</td><td>-</td></tr>
<tr><td>No. 8</td><td>JMF ±3</td><td>JMF ±3</td><td>0 - 92</td><td>30 - 69</td><td>26 - 60</td><td>21 - 51</td><td>17 - 47</td></tr>
<tr><td>N0. 16</td><td>-</td><td>-</td><td>28 - 62</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>No. 200</td><td>JMF ±2</td><td>JMF ±2</td><td>7 - 12</td><td>2 - 10</td><td>2 - 10</td><td>2 - 8</td><td>1 - 7</td></tr>
</table>

403.12.8 Aggregate Deleterious The deleterious content of the total aggregate shall be determined using AASHTO T 11 from samples taken from the composite cold feed belt. The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.

403.12.9 Aggregate Consensus Properties. Aggregate properties include fine aggregate angularity (FAA), course aggregate angularity (CAA), sand equivalent, and thin, elongated particles as defined in Sec 490 on the composite cold feed belt aggregate shall be as follows:

<table>
<tr><th>Design</th><th>FAA Minimum %</th><th>CAA w/One Fractured Faces Minimum %</th><th>CAA w/Two Fractured Faces Minimum %</th><th>Sand Equivalent Minimum %</th><th>Thin, Elongated 5:1 Particles Maximum %</th></tr>
<tr><td>F</td><td>-</td><td>50</td><td rowspan="2">-</td><td rowspan="3">35</td><td rowspan="3">12</td></tr>
<tr><td>E</td><td>38</td><td>70</td></tr>
<tr><td>C</td><td>43</td><td>90</td><td>85</td></tr>
<tr><td>B</td><td>43</td><td>95</td><td>95</td></tr>
</table>

403.12.10 Mixture Asphalt Content. All loose mix samples for determination asphalt binder content shall be taken from the roadway at random locations designated by the engineer. The quantity of asphalt binder determined by AASHTO T 308 tests on

the final mixture shall be within ±0.3 percent of the approved job-mix formula. The aggregate correction factor shall be applied to ignition oven results. The ignition oven temperature shall match the temperature used to when determining the correction factor.

403.12.11 Volumetric Properties. All loose mix samples for determination of volumetrics shall be taken from the roadway at random locations designated by the engineer. A volumetric properties including Voids in Coarse Aggregate (VCA), Voids in the Mineral Aggregate (VMA), Air Voids (Va), Voids Filled with Asphalt (VFA), Theoretical Maximum Specific Gravity (Gmm), and Mixture Bulk Specific Gravity (Gmb) shall be determined by the contractor. The combined bulk specific gravity (Gsb) of the aggregate as listed on the approved job mix formula shall be used in calculations. If the bin percentages have been altered, a new Gsb shall be calculated and used in volumetrics calculations. The aggregate content used for calculations shall be that determined from field asphalt content testing.

403.12.11.1 VCA. No acceptance criteria exist.

403.12.11.2 VMA. The VMA shall be within – 0.5 and + 2.0 percent of the minimum required for each type of mixture at N_{des} gyrations in Sec. 490.

403.12.11.3 Va. Air voids shall be within ±1.0 percent of the approved JMF at N_{des} gyrations. Any sublot of material with air voids in the compacted specimens less than 2.5 percent shall be removed and replaced with acceptable material by the contractor.

403.12.11.4 VFA. No acceptance criteria exist.

403.12.11.5 Gmm. No acceptance criteria exist. Gmm shall be determined in accordance with Sec 490.9

403.12.11.6 Gmb. Two gyratory specimens shall be compacted for each sample and the average of the two specimens will be used. Bulk specific gravity shall be determined as specified in Sec 490.

403.12.12 RAP Gradation The contractor shall test the residual aggregate from the RAP %AC testing to determine its gradation..

403.12.13 RAP Asphalt Content. RAP shall be sampled from the RAP feeding system on the asphalt plant. Solvent extraction or binder ignition methods shall be used to determine RAP asphalt contents. If AASHTO T 308 is used to determine the asphalt content, the binder ignition oven shall be calibrated in accordance with MoDOT Test Method TM 77.

403.12.14 RAP Durability. All RAP material not from MoDOT roadway shall be tested in accordance with AASHTO T 327, Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus. Samples of RAP for this test shall have the asphalt coating removed either by extraction or binder ignition.. The RAP percent loss shall not exceed the loss of the combined virgin material by more than five percent.

403.12.15 RAS Maximum Size. The contractor shall test shingle material being incorporated into the mixture to ensure that 100% passes a 3/8" sieve. The sample for this test shall be taken from the feed to the plant. The test may be performed on either raw RAS material or residual material from an extraction or ignition process.

403.12.16 Moisture Susceptibility. Loose mix samples for determination of Tensile Strength Ratio (TSR) may be taken from the roadway or at the plant at random tonnages designated by the engineer. The TSR shall be greater than or equal to 75 percent as determined from loose mixture taken from the roadway and tested in accordance with AASHTO T 283.

403.12.17 Surface Smoothness. See Sec 610 for additional details.

403.12.18 Lift Thickness. The finished courses shall have the nominal thickness shown on the plans. Lift thickness shall be determined by the average thickness of pavement density cores taken for each lot. The thickness of the layer to be tested shall be measured on all pavement and joint density cores.

403.12.19 Full Depth Thickness. When a full depth pavement is being constructed the following shall apply.
Total thickness samples for new full depth asphalt pavements shall be obtained after all bituminous construction is completed on the project. Full depth pavement cores shall be measured in accordance with AASHTO T 148. Sections of any pavement determined to be less than the thickness shown on the plans by 0.5 inches or more shall be corrected by the contractor. No payment will be made for any costs incurred by the contractor in correcting pavement deficient in thickness. Each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement.

403.12.20 Pavement Density. The contractor shall cut four inch core samples at locations designated by the engineer. The final, in-place density shall be 94.5 ± 2.5 percent for all mixtures except SMA. SMA mixtures shall have a minimum density of 94.0 percent. Any sublot of material with a pavement density of less than 90.0 percent or greater than 98.0 percent shall be removed and replaced with acceptable material by the contractor. For SMA mixtures, any sublot of material with a pavement density of less than 92.0 percent shall be removed and replaced with acceptable material by the contractor.

403.12.20.1 Bulk specific gravity shall be determined as specified in Sec 490. The Gmm of production material corresponding with the core being tested shall be used to determine the percent density. All cores shall be a minimum of 4" diameter. Material from underlying layers that remain adhered to the core shall be removed in a manner that does not harm the integrity of the specimen.

403.12.20.2 A pavement density sample may consist of between one and three cores as stated in the QC plan. When multiple cores are used, the second and third cores shall be obtained at the same offset within one foot of the randomly selected location. The average of the cores cut shall represent the density for that sublot.

403.12.20.3 For lift thicknesses greater than six times the nominal maximum aggregate size, cores shall be cut in half and the density of each half determined. The lowest percent density from both halves shall count for acceptance and pay adjustments.

403.12.20.4 Measurements for determining the in-place density of the mixture shall be taken no later than the day following placement.

403.12.21 Unconfined Joint Density The final, in-place density of all traveled way pavement within 6 inches of a longitudinal joint, including the pavement on the traveled way side of the shoulder joint when unconfined during placement, shall not be less than 88 percent for non-SMA mixtures and 90 percent for SMA mixtures. Testing and handling of joint cores shall be the same as pavement density cores.

403.12.22 Segregation Limits. Areas in question will be tested in accordance with MoDOT Test Method TM 75. QC shall ensure MoDOT has the opportunity to witness TM 75 being performed.

403.12.23 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample directly in the inspector's absence.

403.13 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor.

403.13.1 Independent QA Samples. QA independent samples will be of sufficient size to retain half for possible disputes. Further testing of QA retained material will be under the direction of the engineer.. The engineer's test results, including all raw data, will be made available to the contractor when completed and no later than the next working day. For volumetric properties, pavement density, and mixture asphalt content favorable comparison will be obtained when the engineer's QA test results are within two standard deviations, or one-half the specification tolerance, whichever is greater, from the mean of the QC's results for that particular lot. For all other independent QA samples, a favorable comparison will be obtained when QA samples meet the same specification criteria as QC.

403.13.2 Split QA Samples. QA will test samples split from QC samples as follows.

403.13.2.1 Gradation Comparison. A favorable mixture gradation comparison shall be obtained when QA is within the below ranges of QCs result.

Sieve Size	Range
3/4 inch and larger	±5.0%
1/2 inch	±5.0%
3/8 inch	±4.0%
No. 4	±4.0%
No. 8	±3.0%
No. 10	±3.0%
No. 16	±3.0%
No. 20	±3.0%
No. 30	±3.0%
No. 40	±2.0%

No. 50	±2.0%
No. 100	±2.0%
No. 200	±1.0%

403.13.2.2 Mixture Asphalt Content Comparison. A favorable comparison of mixture asphalt content shall be obtained when QA is within ±0.1% of QC.

403.13.2.3 Volumetric Properties Comparison. A favorable comparison of volumetric properties shall be obtained when QA is within ±0.005 of QC's Gmm and within ±0.010 of QC's Gmb

403.13.2.4 Aggregate Consensus Comparison. A favorable comparison for virgin aggregate properties shall be obtained when QA is within the range of QC's results listed in the following chart.

Property	Course Aggregate Angularity	Fine Aggregate Angularity	Sand Equivalent	Thin, Elongated Particles
Range	±5%	±5%	±8%	±1%

403.13.2.5 Deleterious Comparison. A favorable comparison for virgin aggregate deleterious content shall be obtained when the QA is within one half the Sec 1002.2 requirements of the QC results.

403.13.3 Contractor Responsibility for QA Cores. QA density cores that are not in possession of the engineer for the entire time from extraction till testing shall be sealed in tamper proof bags after extraction. QA cores shall be cut and delivered to the engineer no later than the end of the next day following the laydown operation.

403.14 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency		QC Small Quantity Frequency
		Independent Samples	Split Samples	
Temperature of Base and Air	As Needed	As Needed	-	As Needed
Mixture Temperature	1 per Sublot	1 per Day		1 per Day
Mixture Moisture	1 per Week	1 per Project		-
Mixture Gradation	1 per 2 Sublots	1 per 4 Sublots	1 per Week	1 per 750 Tons
Aggregate Deleterious				-
Aggregate Consensus Properties	1 per 10,000 Tons	-	1 per Project	
Mixture Asphalt Content	1 per Sublot	1 per 4 Sublots	1 per Week	1 per 750 Tons
Volumetric Properties				
RAP Gradation	1 per 4 Sublots	1 per Project	-	-
RAP Asphalt Content				
RAP Durability	1 per 1500 Tons			
RAS Maximum Size	1 per 10,000 Tons	1 per Project		
Moisture Susceptibility	1 per 10,000 Tons	1 per 50,000 Tons		1 per Project
Surface Smoothness	Per Section 610			
Lift Thickness	1 per QC Core	1 per QA Core	-	1 per QC Core
Full Depth Thickness	1 per 1000 Feet	1 per 5000 Feet		1 per 1000 Feet
Pavement Density	1 per Sublot	1 per 4 Sublots		1 per Day
Unconfined Joint Density	1 per Sublot	1 per 4 QC Cores		1 per Day
Segregation Limits	As Needed	As Needed		As Needed
Binder Quality	-	1 per Day		-

403.20 Method of Measurement.

403.20.1 Weight Determination. The weight of the mixture will be determined from the batch weights if a batch-type plant is used, and will be determined by weighing each truck load on scales in accordance with Sec 109 if other types of plants are used. Measurement will be made to the nearest 0.1 ton for the total tonnage of material accepted.

403.20.2 Full Depth.

403.20.2.1 The final driving surface area, for the full depth of the pavement, will be used as the area for all underlying bituminous lifts and will not include the additional quantity needed to construct the slope or edge treatment.

403.20.2.2 Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of the pavement complete in place will be made to the nearest 0.1 square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

403.20.3 Alternate Overlay.

403.20.3.1 Field Established Quantity. When bid as an alternate to a Portland cement concrete overlay, the contractor shall establish the existing roadway profile and set the final overlay profile. The engineer may adjust the final profile as needed. The tons of hot mix asphalt required will be determined by the engineer from the set or adjusted profile. This quantity will be the field established plan quantity.

403.20.3.2 Overlay Measurement. Final measurement of the completed pavement will be based on the field established plan quantity except for authorized changes during construction. The revision or correction will be computed and added to or deducted from the contract quantity. Measurement of the pavement complete in place will be made to the nearest 0.1 ton.

403.21 Basis of Payment.

403.21.1 Aggregate Variation. Due to possible variations in the specific gravity of the aggregates, the tonnage of mixture used may vary from the proposal quantities. No adjustment in contract unit price will be made because of such variation.

403.21.2 Pavement Density Samples. Payment for obtaining and delivering QA pavement density samples will be made per sample at the fixed price specified in Sec 109. No direct payment will be made for QC samples. If QA cores are not cut and delivered as required, the asphaltic laydown operation may be suspended and a deduction of 5 percent of the contract unit price of the representative material may be applied, until samples are cut and delivered to the engineer.

403.21.3 Payment for Blow-ups. Payment for repairing blow-ups will be made in accordance with Sec 104.

403.21.4 Surface Smoothness Adjustment. The contract unit price for all mixes, except wedge or level course, will be adjusted in accordance with Sec 610.5. The contract unit prices for asphaltic concrete pavement will be considered full compensation for all materials entering into the construction of the pavement and for the cost of the smoothness testing and correction.

403.21.5 Moisture Susceptibility Adjustment. The contract unit price of each 10,000 tons or fraction thereof for all mixtures shall be adjusted based on moisture susceptibility according to the following:

TSR	Pay Factor
90% or above	103
75-89%	100
70-74%	98
65-69%	97
<65%	Remove and Replace

403.21.6 Superpave Adjustment. Each sublot of material shall have its contract unit price adjusted based off either the pay factor total or the unconfined joint density pay factor. The unconfined joint density pay factor shall only be used for lots where it is less than 100% and it is less than the pay factor total.

403.21.6.1 Pay Factor Total. The engineer will make the QLA no more than 24 hours after receipt of the contractor's test results, by determining the PWLt for each designated pay factor item. All lots of material with a PF_T less than 50.0 shall be removed and replaced with acceptable material by the contractor. The total pay factor (PF_T) will be equal to the weighted sum of the pay factors for each pay factor item, and is determined as follows:

$$PF_T = + (0.25)\ PF_{\text{Mixture \%AC}} + (0.25)\ PF_{\text{VMA}} + (0.25)\ PF_{\text{Va}} + (0.25)\ PF_{\text{Pavement Density}}$$

The PF_T on the shoulder or otherwise when the density PWL pay factor is not directly included, shall be equal to the weighted sum of the PF for each pay factor item, and will be determined as follows:

$$PF_T = + (0.3333)\ PF_{\text{Mixture \%AC}} + (0.3333)\ PF_{\text{VMA}} + (0.3333)\ PF_{\text{Va}}$$

The PF for each pay factor item will be based on the PWL_t of each pay factor item and will be determined as follows:

When PWL_t is greater than or equal to 70: $PF = 0.5\ PWL_t + 55$
When PWL_t is less than 70: $PF = 2\ PWL_t - 50$

403.21.6.2 Unconfined Joint Density Pay Factor. The average of all unconfined joint cores from each lot will be used determine the unconfined joint density pay factor for sublots with an unconfined joint. The unconfined joint payfactor will be in accordance with the following:

For Non- SMA mixtures:		For SMA mixtures:	
Unconfined Joint Density	**Pay Factor**	**Unconfined Joint Density**	**Pay Factor**
98.0 or Above	Remove and Replace	92.0 or Above	100
97.6 to 97.9	80	91.5 to 91.9	90
97.1 to 97.5	90	91.0 to 91.4	85
90.0 to 97.0	100	90.5 to 90.9	80
89.5 to 89.9	90	90.0 to 90.4	75
89.0 to 89.4	85	Below 90.0	Remove and Replace
88.5 to 88.9	80	-	-
88.0 to 88.4	75		
Below 88.0	Remove and Replace		

403.21.7 Density Adjustment. When QC/QA is in effect and pavement density is not included in the Superpave adjustment, the contract unit price shall be adjusted using the following density payfactor table. The density adjustment shall be applied to material represented by each pavement density sample.

For Non- SMA mixtures:		For SMA mixtures:	
Mixture Density	**Pay Factor**	**Mixture Density**	**Pay Factor**
98.0 or Above	Remove and Replace	94.0 or Above	100
97.6 to 98.0	80	93.5 to 93.9	90
97.1 to 97.5	90	93.0 to 93.4	85
92.0 to 97.0	100	92.5 to 92.9	80
91.5 to 91.9	90	92.0 to 92.4	75
91.0 to 91.4	85	Below 92.0	Remove and Replace
90.5 to 90.9	80	-	-
90.0 to 90.4	75		
Below 90.0	Remove and Replace		

403.21.8 Removal and Replacement of Material. No additional payment will be made for removal and replacement of material when required by this specification. Replacement material will be subject to the same testing requirements as the original material. Pay for the replacement material will be determined in accordance with the applicable portions of this specification.

SECTION 404
BITUMINOUS MIXING PLANTS

404.1 Description. This specification covers the requirements for mixing plants and equipment used in the production of bituminous mixtures.

404.2 Requirements for All Plants.

404.2.1 Aggregate. Sufficient storage space shall be provided for each size of aggregate. The different aggregate sizes shall be kept separated until delivery to the combined cold feed belt. The storage yard shall be maintained in a neat and orderly condition and the separate stockpiles shall be readily accessible for sampling.

404.2.2 Asphalt Binder. An asphalt binder storage tank shall be provided at the proportioning and mixing plant. If more than one storage tank is used to deliver asphalt binder to the proportioning unit, piping and valve arrangements shall permit material to be used from any one of the tanks without using from another at the same time.

404.2.2.1 Storage. Each tank used for storage from which asphalt binder is delivered to the proportioning unit shall be equipped for heating the material under effective and positive control at all times to the temperature requirements set forth in Sec 1015. Heating shall not allow contact of flame with the heating tank. The contractor shall furnish a tank capacity chart calculated in increments suitable for verifying quantities used during a normal production period.

404.2.2.2 Circulation. A circulating system of adequate capacity shall provide proper and continuous circulation of the asphalt binder between the storage tank and proportioning units during the entire operating period. The discharge end of the circulating pipe shall be maintained below the surface of the asphalt binder in the storage tank to prevent discharging into the open air. All pipe lines and fittings shall be properly insulated to prevent heat loss.

404.2.2.3 Binder Sampling. The contractor shall provide a sampling outlet in the asphalt binder feed lines connecting the plant storage tanks to the proportioning or injection system. The sampling outlet shall be installed in a readily accessible location such that representative samples may be withdrawn safely and slowly at any time during plant operation. A drainage receptacle shall be provided for flushing the outlet prior to sampling. When all of the chemical admixtures are added to the plant storage tank prior to use, the engineer may allow the contractor to sample the asphalt binder from the storage tanks located at the mixing facilities. Sampling procedures shall be approved by the engineer prior to samples being taken.

404.2.3 Cold Aggregate Feeder. The plant shall be provided with an accurate mechanical means for uniformly feeding the aggregate into the drier to provide uniform production and temperature. A synchronized method of proportioning the aggregate at the cold feeder shall be provided.

404.2.3.1 Cold Feed Calibration. For all plants producing bituminous mixtures composed of more than one fraction of aggregate, the aggregate cold feeds shall be calibrated as required by the engineer. On the basis of the calibration, aggregate cold feeds shall be adjusted to ensure the proper percentage of the various aggregate fractions of the mix, as required by the job mix formula.

404.2.3.2 Aggregate Sampling. Safe, adequate and convenient facilities shall be provided for obtaining representative aggregate samples from the full width and length of the discharge flow of the combined cold feed, or from each hot bin on batch-type plants.

404.2.4 Drier. A drier of any satisfactory design for drying and heating the aggregate shall be provided. The drier shall be capable of drying and heating the aggregate to a temperature within the limits of the range specified in Sec 1015 for the grade of asphalt binder used, without leaving any visible unburned oil or carbon residue on the aggregate. The mixture may be tested for contamination. Absorbed moisture in the aggregate shall be reduced to such a quantity that there is no visible segregation of asphalt binder resulting from escaping water vapor in the prepared mixture.

404.2.5 Dust Collector. An efficient dust collecting system shall be provided to prevent the loss of fine material into the surrounding environment. The material collected may be returned to the mixture at a uniform rate through a metering device or the dust may be wasted.

404.2.6 Filler Storage. If mineral filler or hydrated lime, or both, are required, adequate dry storage shall be provided and provisions shall be made for accurate proportioning.

404.2.7 Asphalt Control Unit. Satisfactory means, either by weighing or metering, shall be provided to obtain the proper quantity of asphalt binder. Metering pumps for asphalt shall deliver accurately to within plus or minus 2.0 percent of the required quantity when tested for accuracy. Asphalt scales shall be in accordance with Sec 404.3.4. If the quantity of asphalt binder is controlled by metering, provisions shall be made whereby the delivery meter may be readily checked by actual weight.

404.2.8 Thermometric Equipment. A thermometer of suitable range shall be fixed in the asphalt feed line at a suitable location near the discharge at the mixer unit. The thermometer included in the asphalt metering unit shall be displayed in a location readily accessible to the engineer. An approved recording thermometer, pyrometer or other recording thermometric instrument shall be installed in plants in such manner that the temperature of the heated mixture or aggregate is automatically registered and recorded. The terminal shall be maintained free of accumulated mixture or aggregate to ensure accuracy. The thermometric instrument shall be installed in the discharge chute of drum mix plants and in at least one hot aggregate bin of batch plants. The terminals shall be located where the hot material will flow around the terminals during the proportioning operation and shall not be located near the corners of the bins or at points where the material will collect or pack around the terminals. This instrument shall be located in clear view of the plant operator. A chart shall continuously record both time and temperature. The smallest interval of time shall be a maximum of 15 minutes and the temperature graduations shall be no more than 10 F. The chart shall be furnished to the engineer at the end of each day's operation.

404.2.9 Plant Calibration. Personnel, scales and equipment necessary for calibrating the plant and for verifying the accuracy of proportions shall be furnished by the contractor and shall be available at all times. All scales used in the final measurement of the mixture shall be in accordance with Sec 109. Records of all calibration shall be provided to the engineer.

404.2.10 Safety Requirements. A conveniently located, easily opened gate or door shall be provided in the mixer cover for observation of pugmill mixing operations. Adequate and safe stairways to the pugmill mixer platform and sampling points shall be provided. Guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the engineer to obtain samples and mixture temperature data. All gears, pulleys, chains, sprockets and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the pugmill mixing platform. A clear and unobstructed passage shall be maintained at all times in and around the truck loading area. This area shall be kept free from drippings from the mixing platform.

404.2.11 Surge Bins. Surge bins used in the production of bituminous mixtures shall maintain the temperature of the mixture within 25 F of the contractor’s designated temperature. Mixture shall not be stored more than 8 hours.

404.2.12 Automatic Ticket Printer. The asphalt plant shall be equipped with an automatic ticket printer connected to the weighing system in such a manner that the printer automatically detects and prints the weight determined by the system. The printer shall store and recall the tare weight when the operator enters the vehicle identification. The weight shall be shown to at least the nearest 20 pounds or nearest one one-hundredth of a ton.

404.2.13 Ticket Information. The printer shall be capable of keeping and printing cumulative totals for each project for each type of bituminous mixture. The printer shall produce a ticket in triplicate to accompany each load delivered to the project and shall be furnished to the engineer. The ticket shall show the following: (as a minimum)

(a) Gross and tare and/or net weights.

(b) Current date and time.

(c) MoDOT mix number assigned to the mix being placed.

(d) Unique ticket number (may be preprinted on the ticket).

(e) Job number, route and county.

(f) License plate number of the delivery vehicle (Must be displayed legibly on the ticket).

404.2.13.1 Net Weight. The gross and tare weights will not be required when the net weight of bituminous mixture is determined by batch weights.

404.2.13.2 Gross Weight. When the net weight of bituminous mixture is determined from the gross weight of the loaded delivery vehicle, the empty delivery vehicle weight shall be determined daily or from time to time during the day as directed by the engineer.

404.2.13.3 Daily Total. At the end of each day's operation, the contractor shall furnish to the engineer a total tonnage of mixture produced by the asphalt plant in sufficient detail to determine the amount of asphalt binder used in that day's operation.

404.2.13.4 Printer Failure. In the event of automatic ticket printer failure, the contractor may be permitted, without approval from the engineer, to furnish manually written tickets to complete that day's operation.

404.3 Requirements for Batch-Type Plants.

404.3.1 Automatic Batching. For all contracts containing no more than 10,000 tons of bituminous mixture, standard manual batching methods approved by the engineer will be permitted. For contracts containing more than 10,000 tons of bituminous mixture, in accordance with Sec 401 or Sec 403, batching plants shall be equipped to operate automatically to the extent that the only manual operation required for the proportioning of all ingredients for one batch shall be a single actuation of a switch or starter. The equipment shall include devices capable of automatically proportioning each ingredient of the mixture in the selected sequence and quantity. Interlocks shall be provided which will hold or delay the automatic batch cycling whenever the batched quantity of any ingredient is not within the specified tolerance. The weight setting and timing controls shall be suitably equipped so the controls may be locked when specified by the engineer. Manual operation will not be permitted beyond 24 hours after breakdown in the automatic equipment, except with written approval from the engineer.

404.3.2 Aggregate Scales. Scales for weighing aggregate and mineral filler or hydrated lime, or both, may be beam, springless dial or electronic digital weigh meter type, and shall be of standard make and design having tolerances on overregistration and underregistration not exceeding 0.4 percent of the indicated weight when tested for accuracy. Each aggregate fraction shall be measured within one percent of the total batch weight of the mixture. Mineral filler or hydrated lime, or both, shall be measured within 0.5 percent of the total batch weight of the mixture. The total weight of the batch shall be within 2.0 percent of the desired batch weight. The change in load required to change the position of the rest of the indicating element or elements of a non-automatic indicating scale an observable amount shall be no greater than 0.1 percent of the nominal scale capacity. If manual batching methods are used, beam-type scales shall be equipped with a device to indicate to the operator that the required load is being approached. This device shall indicate at least the last 5 percent of the load weighed on any beam, except that this increment will not be required to be greater than 200 pounds. Multiple beam-type scales shall be equipped with a tare beam and a separate beam for each size of aggregate. Dial scales shall be equipped with adjustable pointers for marking the weight of each material to be weighed (incorporated) into the batch. Graduation intervals for either beam or dial scales shall be no greater than 0.1 percent of the nominal scale capacity. Quantity indicators necessary for batching shall be in full view of the operator.

404.3.3 Asphalt Bucket. If a bucket is used for weighing the asphalt binder, the filling system and bucket shall be of such design, size and shape that asphalt will not overflow, splash or spill outside the confines of the bucket during filling and weighing.

404.3.4 Asphalt Scales. Scales for weighing asphalt binder shall be in accordance with Sec 404.3.2, except a device to indicate at least the last 20 pounds of the approaching total load shall be provided. Asphalt binder shall be measured within 0.1 percent of the total batch weight of the mixture. Beam-type scales shall be equipped with a tare beam or adequate counter-balance for balancing the bucket and compensating periodically for the accumulation of asphalt on the bucket. Springless dial scales used for weighing asphalt binder shall have a tare beam and a dial graduated in increments not to exceed 0.1 percent of the nominal scale capacity and the maximum dial capacity shall be no more than 15 percent of the nominal capacity of the mixer.

404.3.5 Mixer Unit. The plant shall be capable of producing a uniform mixture. The mixer shall be heated and shall have a minimum capacity of 2000 pounds per batch. The mixer shall be constructed to prevent leakage of the contents and the mixer box shall be equipped with a hood to prevent loss of dust.

404.3.5.1 Time Lock. The mixer shall have an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer until the closing of the mixer gates at the completion of the cycle. The time lock shall lock the asphalt bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods.

404.3.5.2 Mixer Rating Plate. A rating plate designating the manufacturer's rated capacity shall be attached to the mixer. The quantity of mixture produced per batch shall not exceed the manufacturer's rated capacity.

404.3.5.3 Mixing Times. The mineral aggregate for mixtures specified in Sec.401 and Sec 402 shall be mixed dry for at least 10 seconds and for mixtures specified in Sec 403 shall be mixed dry for at least 15 seconds. The dry mixing period shall start when all of the mineral aggregate has been charged into the mixer, and end when the introduction of the asphalt binder begins. After dry mixing, the asphalt binder shall be charged into the mixer in a manner that will uniformly distribute the asphalt over at least 3/4 of the full length of the mixer. The time required to add the asphalt binder shall not exceed 15 seconds. Wet mixing shall begin at the introduction of the asphalt binder and shall continue for at least 30 seconds, or longer if necessary, to produce a complete and uniform coating of the particles and a thorough distribution of the asphalt binder throughout the aggregate. The wet mixing period shall end when the discharge gate is opened.

404.4 Requirements for Drum Mix Plants.

404.4.1 Drum Plant. The plant shall be specifically designed for drum mixing and shall be capable of satisfactorily heating, drying and mixing bituminous mixtures. Heating shall be controlled to prevent damage to the aggregate or the asphalt binder. The temperature of the mixture when discharged from the mixer shall be within the range specified in Sec 1015 for the grade of asphalt binder being used. The rate of flow through the drum shall be controlled such that the bituminous material and aggregate shall be mixed until a homogeneous mixture with all particles uniformly coated is obtained, and in no case shall the quantity of mixture produced exceed the manufacturer's rated capacity.

404.4.2 Feed Indicators. Each feeding orifice shall have an adjustable gate with an indicator provided to reference the opening setting. A device shall be installed on each aggregate feeder to indicate when the flow of material from the bin is below the point where accurate proportioning through the feeder gates can be accomplished. These indicators shall be positive in action and shall actuate a clearly visible or audible signal to the plant operator, or stop the flow of material to the drum when the level of material in the bin is too low for accurate proportioning. A scalping screen mounted independent of other proportioning or weighing equipment shall be provided if directed by the engineer. The total daily asphalt binder quantity numbers for the project shall be provided to the engineer.

404.4.3 Asphalt Meter. Asphalt binder shall be introduced through a continuously registering cumulative indicating meter by a pump specifically designed for drum mix plants. The meter shall be located in the asphalt line so that the meter will continuously register the asphalt discharge to the mixer and such that the discharge through the meter can be readily diverted into a container for measurement. The meter shall be equipped with a nonsetback register and shall have an accuracy within 2 percent by weight of the material actually being measured in any given period of time. The nonsetback register shall register only the asphalt discharged to the mixer and shall not record asphalt circulated back to the storage tank. A device shall be provided in the asphalt storage tank to indicate when the supply of asphalt to the pump and metering device is such that accurate proportioning is not accomplished. The

accuracy of the pump and meter shall be verified at periodic intervals as designated by the engineer. The total daily asphalt binder quantity number for the project shall be provided to the engineer.

404.4.4 Mineral Filler. If mineral filler or hydrated lime, or both, are used, a separate bin and feeder for each material shall be furnished and each material shall be dispensed by weight by continuous batching device. The batching device shall have a continuous weight display in clear view of the plant operator. The delivery system shall be variable speed and interlocked with the aggregate weigh belt so the total dry aggregate weight, including mineral filler or hydrated lime, or both, is indicated to the asphalt proportioning system. A continuously registering, cumulative, nonsetback register shall record the quantity of mineral filler or hydrated lime, or both, discharged into the mixer. Mineral filler and hydrated lime shall be introduced and uniformly dispersed into the drum mixer at the point of introduction of the asphalt binder without loss to the dust collection system. The mineral filler and hydrated lime proportioning and delivery system shall have an accuracy of 10 percent by weight of the material actually being measured in any given period of time. The total daily mineral filler and hydrated lime quantity numbers for the project shall be project shall be provided to the engineer.

404.4.5 Belt Scales. Positive weight measurement of the combined cold feed aggregate shall be by use of belt scales. The combined cold feed aggregate shall be continuously recorded on a nonsetback register. The belt scale shall have an accuracy within 2 percent by weight of the material actually being measured in any given period of time. The accuracy of the belt scales shall be verified at periodic intervals as directed by the engineer. The total daily aggregate quantity numbers for the project shall be provided to the engineer.

404.4.6 Reclaimed Asphalt Pavement Weighing. Positive weight measurement of reclaimed asphaltic pavement shall be by use of belt scales in accordance with Sec 404.4.5.

404.4.7 System Interlocks. The aggregate feed system, reclaimed asphaltic pavement feed system if recycling is permitted, mineral filler or hydrated lime, or both if specified, and the asphalt flow shall be interlocked by a blending system which will automatically regulate the asphalt binder, mineral filler, hydrated lime and reclaimed asphaltic pavement flow, and shall cause synchronized corrections for variations in aggregate flow. The blending system shall include a moisture-compensating device to correct for moisture in the aggregate passing over the belt scales. Moisture determinations shall be made periodically during each day's operation. The blending system shall include a device to correct for changes in the specific gravity of the asphalt binder.

404.4.8 Sampling. Safe, adequate and convenient facilities shall be provided for obtaining representative samples of asphalt binder, cold aggregate and bituminous mixture. The plant shall be equipped with sampling devices capable of providing a sample of sufficient size from the full width of the combined aggregate flow and from the full width of the mixer discharge flow. Sampling devices shall be designed such that samples may be taken while the plant is operating at normal production rates.

404.4.9 Calibration. Safe, adequate and convenient facilities shall be provided for calibrating or verifying the asphalt binder, mineral filler, hydrated lime, reclaimed asphaltic pavement and the aggregate nonsetback registers. The manufacturer's recommendations shall be followed for calibration unless specified otherwise. The quantities of aggregate and asphalt binder measured in any given period of time shall vary no more than 2.0 percent by weight from the required quantity of each.

404.5 Stone Matrix Asphalt Mixtures. A homogeneous mixture shall be produced.

404.5.1 Fibers in Batch Plants. For batch plants, fibers shall be added to the mineral aggregate either in the weigh hopper or in the pugmill. The fibers shall be accurately added by weight, either manually by bag or other measure, or by an approved weight metering device. If fibers are added in the weigh hopper, no fiber shall be added until mineral aggregate from at least one hot bin has been placed in the weigh hopper. If fibers are added in the pugmill, the fiber shall be added immediately after the mineral aggregate and before the asphalt binder is added.

404.5.1.1 Dry Mixing. The mineral aggregate and the fibers shall be dry mixed for at least 20 seconds.

404.5.1.2 Wet Mixing. The wet mixing time shall be no less than 35 seconds to allow the cellulose fibers to expand and to ensure adequate distribution of the fibers and asphalt binder.

404.5.1.3 Uniformity. Dry and wet mixing times and batch mixing temperatures shall be adjusted as necessary to achieve a uniform mixture.

404.5.2 Fibers in Drum Plants. For drum plants, fibers shall be introduced into the plant in either loose or pelletized form.

404.5.2.1 Metering. Equipment for metering fibers into the plant shall ensure a consistent, uniform blending of the fibers into the mixture. The metering system shall be variable speed, shall proportion the fibers by weight, shall be accomplished as specified by the equipment manufacturer and be to the satisfaction of the engineer.

404.5.2.2 Pelletized Fibers. If used in a drum mix plant, pelletized fiber shall be added directly into the drum mixer through the recycle asphalt inlet.

404.5.3 Fiber Metering. The fiber proportioning and delivery system for SMA mixtures shall have an accuracy of 10 percent by weight of the material actually being measured in any given period of time.

404.6 Liquid Anti-Strip Additive Systems. Type I liquid anti-strip additives shall be blended into the asphalt binder. Type II additives shall be sprayed on the combined cold feed aggregate. Both shall be incorporated in a consistent and uniform manner.

404.6.1 Calibration. The method of adding an additive into the mix shall be accurate to within ± 10 percent of the amount to be added. Calibration of the blending system shall be provided to the engineer.

404.6.2 Flow Interruption. The feed system shall be equipped with a flow meter that signals if the additive is or is not being added. It shall be interlocked so that the operation will cease if the additive flow is interrupted or not within the allowable limits.

404.6.3 Interlock. The rate of application shall be interlocked with the plant to coincide with plant production rates when the additive is incorporated during mixture production.

404.6.4 Type I Addition. For Type I liquid anti-strip additive used in drum mix plants, the blending system shall add the material into a static in-line mixer between the asphalt binder storage tank and the asphalt binder flow meter. For batch plants, the blending system shall add the material into a static in-liner mixer between the asphalt binder storage tank and the mixing plant injection point. Controls shall be in place so that blended material is not permitted to recirculate back to the asphalt binder storage tank.

404.6.5 Type II Addition. For Type II liquid anti-strip blending systems, the blending system shall uniformly apply the material to the cold feed prior to the drum for continuous, batch and drum plants.

404.7 Hauling Equipment. Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds that have been thinly coated with a minimum quantity of lime solution or an approved bituminous mixture release agent in accordance with Sec 1071 to prevent the mixture from adhering to the beds. The release agent shall not be diluted less than the minimum rate specified by the manufacturer and shall be applied with equipment recommended by the manufacturer. Use of diesel fuel, fuel oil or other detrimental products as a bed coating or dilution agent will not be permitted. Each truck shall have a cover of canvas or other suitable material of such size to protect the mixture from the weather. The cover shall be securely fastened over all sides of the truck bed. Truck beds shall be insulated, when necessary, such that the mixture will be delivered on the road at the specified temperature.

SECTION 409
SEAL COAT

409.1 Description. This work shall consist of placing bituminous material followed by placing cover aggregate material.

409.2 Material. The grade of aggregate will be specified in the contract All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Aggregate for Seal Coats	1003
Asphalt Emulsion	1015

409.2.1 All limestone and dolomite shall be either pre-coated as specified herein or fog sealed in accordance with Sec 413. Pre-coating binder shall be in accordance with Sec 1015 for PG binder or emulsions.

409.2.2 Emulsified asphalt or polymer modified emulsions shall be in accordance with Sec 1015, with the following exceptions:

Asphalt Emulsion Requirements			
Tests on Asphalt Binder[a]	**Test Method**	**Minimum**	**Maximum**
Penetration @ 77°F	ASTM D 5	60	150
Elastic Recovery @ 50°F, %	AASHTO T 301	65	-

[a]These tests shall be done on the asphalt residue for emulsions and cutbacks.

409.3 Job Mix Formula. The contractor shall submit the mix design to the laboratory for approval no less than two weeks prior to placing the seal coat.

409.3.1 The mix design shall contain the following information:

(a) All possible sources intended for use, grade and certified test results for the asphalt binder.

(b) Source, type (formation, etc.), ledge number if applicable, and gradation of the aggregate.

(c) The grade and certified test results for the aggregate.

(d) The application rate used to pre-coat the aggregate as allowed in Sec 1003.

(e) The percent binder application rate, gallons per square yard. The adjustment factor shall be included if specified in the contract plans.

(f) The aggregate application rate, pounds per square yard.

409.3.1.1 The generic binder application rates for each aggregate grade, as found in Sec 1003, shall be:

Grade	A1	A2	B1	B2	C
Generic Binder Application Rate, gal/sy	0.38	0.28	0.38	0.28	0.38

409.3.2 A surface condition, aggregate properties and traffic volume correction may be provided in the plans. When provided, this assessment shall be used to adjust the generic binder application rate to create a target rate for each individual route. The aggregate application rates shall not vary from the mix design by more than ± 5 pounds per square yard.

409.4 Equipment. Equipment shall be capable to perform the following:

(a) Heating and applying bituminous material, measuring temperature of tank contents and continuously verify application rates. The calibration of the system shall be accomplished by the contractor and approved by the engineer prior to use. The contractor shall furnish all equipment, material, labor and supervision necessary to perform this calibration. Equipment shall be calibrated subsequent to any repair that may affect calibration.

(b) Removal of loose aggregate from applied surface.

(c) Seating of aggregate without causing aggregate fracture.

(d) Accurately measuring and uniformly spreading of the aggregate over the full width of the bituminous material and have ability to vary the application width depending upon road width. It shall also be able to have verifiable application rates. The calibration of the system shall be accomplished by the contractor and approved by the engineer prior to use. The contractor shall furnish all equipment, material, labor and supervision necessary to perform this calibration. Equipment shall be calibrated subsequent to any repair that may affect calibration.

409.5 Construction Requirements.

409.5.1 Weather Limitations. Bituminous material shall not be placed on any wet surface. Seal coat shall only be placed when the ambient temperature and the temperature of the pavement on which it is to be placed is above 60 F. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

409.5.1.1 Forecasted Weather. No seal coat shall be placed when the forecast from the National Weather Service predicts ambient temperatures falling below 40 F within 24 hours of construction.

409.5.2 Surface Preparation. The surface shall be thoroughly cleaned or swept to remove all dirt, packed soil, or any other foreign material prior to spraying the bituminous material.

409.5.3 Application of Bituminous Material.

409.5.3.1 Bituminous material shall be uniformly applied within the temperature range recommended by the manufacturer. Any bituminous material applied on adjacent Portland cement or asphaltic concrete pavements, curbs, bridges or any areas not specified to be sealed shall be removed by the contractor, at the contractor's expense.

409.5.3.2 When pre-coating is required, the cover aggregate shall be pre-coated at a minimum rate of 0.5 percent residual asphalt by weight of aggregate.

409.5.4 Compaction. All aggregate shall be uniformly seated over the entire area being sealed in a manner which minimizes aggregate loss and prevents crushing of aggregate.

409.5.5 Dust Control. The contractor may be required to control dust should airborne dust become a concern, or as directed by the engineer.

409.5.6 Loose Aggregate. Loose aggregate shall be removed from curbs, gutters, sidewalks, driveways, and other areas designated by the engineer.

409.5.7 Traffic Control.

409.5.7.1 During application of the seal coat, the contractor shall control traffic through the work zone by means of pilot vehicles traveling at a maximum speed of 35 miles per hour. The contractor shall designate a responsible person for receiving and resolving damage claims made by the public. This person shall be available by telephone during the contractor's normal business hours Monday through Friday.

409.5.7.2 The contractor shall provide contact information signs with their company name and phone number on a variable width by 24 inch tall sign with black lettering on an orange background. The first line shall state "CONTRACTOR" in uppercase 4 inch C highway font, the second line shall contain the contractor name in upper/lower case 4 inch B highway font and the third line shall contain the contractor's phone number in 4 inch C highway font. Signs shall be posted near the beginning and end of the project limits as approved by the engineer.

409.6 Quality Control. The contractor shall control and monitor the quality of the work. A QC Plan will not be required.

409.6.1 Sample Location. All samples will be taken from the last stockpile location prior to incorporation.

409.6.2 Retained Samples. One half of the contractor's sample for aggregate gradation and deleterious content shall be retained for the engineer. The contractor shall retain the samples for 7 days after testing has been completed and the results accepted by the engineer.

409.6.3 Mixture Gradation. The aggregate gradation shall be determined and meet the Sec 1003 requirements.

409.6.4 Aggregate Deleterious. The deleterious content of the material shall not exceed the limits specified in Sec 1003 for deleterious rock, shale, and other foreign material requirements

409.6.5 Pre-Coating. When pre-coated aggregate is utilized, the percent residual binder shall be tested and meet the specification requirements. If an ignition oven is used, an aggregate correction factor shall be utilized.

409.7 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Results of QA testing will be furnished to the contractor within 24 hours of obtaining the sample.

409.7.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

409.7.2 Split QA Samples. No QA split samples are required.

409.8 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Aggregate Gradation	1 per 5000 Tons	1 per Project	-
Aggregate Deleterious			
Pre-Coating	1 per Project	-	

409.9 Basis of Acceptance. Acceptance shall be made no less than 14 days from completion of the route. Seal coat will be evaluated for acceptance by the engineer based on the following criteria:

(a) No location having bleeding of binder in excess of two square feet or a combined area of bleeding greater than 10 square feet on any 50 foot length of two lane roadway.

(b) No continued or ongoing tracking from seal coat onto other roadways or adjacent driveways.

(c) No transverse and longitudinal construction joints from the seal coat application that are not straight, create a bump, or produce a poor riding surface.

(d) Longitudinal construction joints that are straight and contain no gaps.

(e) No asymmetric appearance stemming from longitudinal grooves or ridges in the surface.

(f) A pavement treatment having complete aggregate coverage with full adherence to the roadway.

The contractor is responsible for any damage claims that are associated with the seal coat until the route is accepted by the engineer.

409.10 Method of Measurement.

409.10.1 Final measurement for aggregate in the completed seal coat will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity.

409.10.2 Where required, measurement of seal coat, complete in place, will be made to the nearest square yard for aggregate.

409.10.3 Final measurement for binder will be in accordance with Sec 1015 and will be made to the nearest 10 gallons for actual quantity used. Any revision or correction will be computed and added to or deducted from the contract quantity.

409.11 Basis of Payment. The accepted quantities of seal coat aggregate and binder, in place, will be paid for at the contract unit price. No separate payment will be made for pre-coating aggregate, fog sealing, dust control, or for providing and installing contract information signs. If the binder application rate includes a correction factor, it is included in the plan quantities.

SECTION 413

SURFACE TREATMENTS

SECTION 413.10 MICRO-SURFACING.

413.10.1 Description. This work shall consist of producing and placing a mixture of cationic polymer-modified asphalt emulsions, mineral aggregate, mineral filler, water, and other additives as needed at locations shown on the plans or as directed by the engineer.

413.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Emulsified Asphalt	1015
Aggregate	1002

413.10.2.1 Aggregate.

413.10.2.1.1 The mineral aggregate shall be flint chat from the Joplin area, an approved crushed porphyry or an approved crushed steel slag. Blast furnace slag may be used from sources with a documented history of satisfactory use and that have been previously approved by MoDOT for use in micro-surfacing. For non-traffic areas such as shoulders, the mineral aggregate may be crushed limestone or crushed gravel in accordance with Sec 1002.2. The aggregate shall be free of cemented or conglomerated material and shall not have any coating or detrimental material. All aggregate shall be sampled, tested and approved by the engineer prior to use.

413.10.2.1.2 Blends of approved aggregate may be supplied provided:

(a) The individual aggregates are reasonably uniform in gradation and other qualities.

(b) The aggregates are uniformly blended with designated proportions into a separate stockpile prior to use. Aggregate may be blended directly into the supply truck provided the blending device has been calibrated, gate settings are unchanged, and belt samples indicate material gradation compliance.

(c) The proportion is not changed from the job mix formula during the course of placement.

413.10.2.1.3 The final aggregate, or blend of aggregates, shall be in accordance with one of the following gradations.

Aggregate Gradation Requirements		
Sieve	**Type II**	**Type III Type IIIR**
3/8 inch	≤ 100	≤ 100
No. 4	90 - 100	70 - 90
No. 8	65 - 90	45 - 70
No. 16	45 - 70	28 - 50
No. 30	30 - 50	19 - 34
No. 50	18 - 30	12 - 25
No. 100	10 - 21	7 - 18
No. 200	5 - 15	5 - 15

413.10.2.1.4 The final aggregate mixture shall have no oversize material when deposited at the stockpile site. If the stockpile area contains any particles exceeding the specified maximum sieve, all aggregate shall be screened again as the aggregate is loaded into the final placement machine.

413.10.2.2 Mineral Filler. Mineral filler shall be Type 1 Portland cement or hydrated lime, and shall be free of lumps or any other deleterious material. Portland cement and hydrated lime acceptance is by visual examination.

413.10.2.3 Water. Water shall be potable and free of harmful soluble salts.

413.10.2.4 Additives. Any other material added to the mixture or to any of the component materials to provide the required properties shall be supplied by the emulsion manufacturer.

413.10.3 Job Mix Formula. The manufacturer of the emulsion shall develop the job mix formula and shall present certified test results for the engineer's approval. The job mix formula shall be designed in accordance with the International Slurry Surfacing Association (ISSA) recommended standards by an ISSA recognized laboratory. Mix acceptance will be subject to satisfactory field performance. The job mix formula, all possible emulsion sources intended for use, all material, the methods and the proportions shall be submitted for approval prior to use. Proportions to be used shall be within the limits provided in the table below. If more than one aggregate is used, the aggregates shall be blended in designated proportions as indicated in the job mix formula, and those proportions shall be maintained throughout the placement process. If aggregate proportions are changed, a new job mix formula shall be submitted for approval.

Material	Requirement
Type II Mineral agg, lbs/yd^2 dry mass, min.	10 - 20
Type III Mineral agg, lbs/ yd^2 dry mass, min.	15 - 30
Type IIIR	As necessary
Polymer Modified Emulsion (residual), percent	5.5 to 10.5 by dry weight of aggregate
Mineral Filler, percent by mass of dry aggregate	0.0 to 3.0 by dry weight of aggregate
Additive	As required

413.10.3.1 All Types. The minimum dry mass per unit area will be based on a bulk specific gravity (BSG) of 2.65. In the event that crushed steel slag aggregate is used as a part of the blended aggregate or as the entire aggregate, the BSG of the final aggregate blend shall be determined and shown as part of the job mix formula criteria. If the BSG is different from 2.65 by more than 0.05, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiplying by the new BSG. (For example, for a slag BSG = 3.15, the new minimum would be 3.15/2.65 * 10.8 = 23.8 lbs./sy). These adjusted values shall be designated on the job mix formula and will apply in the field.

413.10.3.2 Type II. For Type II, if a specified thickness will be required, the amount of mineral aggregate per square yard shall be increased as necessary to obtain the thickness.

413.10.3.3 Type III. When specified, Type III shall be applied in two passes of approximately equal quantities, the first of which shall be to fill depressions and level the surface for the final pass.

413.10.3.4 Type IIIR. For Type IIIR mixes, there will be no minimum or maximum unit quantities. The contractor shall make the determination as to the amount necessary, except all depressed areas shall be filled level as specified. Type IIIR may be applied in more than one pass at the contractor's expense. Type IIIR shall not be added to Type II or Type III applications in the field, but shall be a separate application.

413.10.4 Equipment.

413.10.4.1 Mixing Equipment. The micro-surfacing mixture shall be mixed and laid by a self-propelled mixing machine. The mixing machine shall be able to accurately deliver and proportion the aggregate, mineral filler, water, additive and emulsion to a revolving multi-blade dual mixer and to discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for all components to maintain an adequate supply to the proportioning controls.

413.10.4.1.1 Individual volume or weight controls for proportioning each item to be added to the mix shall be provided. Each material control device shall be calibrated and properly marked. The calibration shall be approved by the engineer prior to proportion. Each device shall be accessible for ready calibration and placed such that the engineer may determine the amount of each material used at the time.

413.10.4.1.2 The mixing machine shall be equipped with a water pressure system and nozzle-type spray bar to provide a water spray to dampen the surface when required immediately ahead of and outside the spreader box as required. No free flowing water shall be present.

413.10.4.2 Spreading Equipment. The micro-surfacing mixture shall be spread uniformly by means of a mechanical-type spreader box attached to the mixer. The spreader box shall be equipped with paddles or augers to agitate and spread the material uniformly throughout the box. The paddles or augers shall be designed and operated so all the fresh mix will be agitated to prevent the mixture from setting up in the box, causing side buildup and lumps.

413.10.4.2.1 The spreader box used for surface course construction shall be equipped with flexible seals in contact with the road to prevent loss of mixture from the box. The box shall be equipped with devices to adjust the thickness or grade of the surface and shall have a squeegee strike-off rear plate.

413.10.4.2.2 A secondary strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same adjustments as the spreader box.

413.10.4.2.3 The spreader box used for rut-filling shall have two metal strike-offs, angled from each side toward the center at approximately 45 degrees. Interrupted flight augers shall be used ahead of the first strike-off plate to spread the mix and maintain laminar flow. The second strike-off plate shall be adjusted to produce the desired grade and depth. The first strike-off and augers shall be adjustable up and down in order to maintain a fairly uniform flow or roll of material in front of the second strike-off. A rubber squeegee shall be attached to the adjustable metal plate at the rear of the spreader box, behind the second strike-off, to texture the surface. The adjustable metal plate shall have sufficient clearance not to affect the grade established by the second strike-off.

413.10.5 Construction Requirements.

413.10.5.1 Weather Limitations. Micro-surfacing 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 50 F, when it is raining, or when there is a chance of temperatures below 32 F within 24 hours after placement.

413.10.5.2 Test Strip. A test strip 500 feet long and the width of one lane shall be provided. The test strip will be evaluated for 24 hours after placement and will be subject to approval from the engineer before any further production. If unsatisfactory, the test strip shall be removed and another strip placed for evaluation at the contractor's expense.

413.10.5.3 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud, and other objectionable material and shall be pre-wetted as required immediately prior to application of the micro-surfacing. All pavement marking shall be removed, maintained, and compensated for in accordance to Sec 620.

413.10.5.4 Application. The micro-surfacing mixture shall be spread to fill cracks and minor surface irregularities, and shall leave a uniform surface. No lumping, balling or unmixed aggregate will be permitted. Longitudinal joints shall be placed on lane lines. Excessive overlap will not be permitted. The finished micro-surfacing shall have a uniform texture free of scratches, tears and other surface irregularities. The contractor shall repair the surface if any of the following conditions exist:

(a) More than one surface irregularity that is 1/4 inch or wider and 10 feet or longer in any 100-foot section of the micro-surfacing.

(b) More than three surface irregularities that are 1/2 inch or wider and more than 6 inches long in any 100-foot section of the micro-surfacing.

(c) Any surface irregularity that is one inch or wider and more than 4 inches long. The finished longitudinal and transverse joints in the micro-surfacing shall be complete and uniform.

413.10.5.4.1 The contractor shall repair joints if any of these conditions exist:

(a) Build-up of micro-surfacing material at the joints.

(b) Uncovered areas at the joints.

(c) Longitudinal joints with more than 1/2 inch vertical space between the surface and a 4-foot straightedge placed perpendicular to the joint.

(d) Transverse joints with more than 1/4 inch vertical space between the surface and a 4-foot straightedge placed perpendicular to the joint.

413.10.5.4.2 The edges of the micro-surfacing shall follow the centerline, lane lines, shoulder lines and curb lines. The edges shall be repaired if the edges vary more than 3 inches from a 100-foot straight line or from a 100-foot arc on a curved section. The repaired surface shall be dense with a uniform texture.

413.10.5.4.3 Any successive passes shall be separated such that each layer placed undergoes approximately 12 hours of traffic for compaction and curing.

413.10.5.4.4 Type IIIR applications to raise shoulders or fill ruts shall be applied with the rut spreader box, and the contractor shall place a strip as designated in the contract documents to raise an area to match the surroundings. Rutting or traffic-bearing applications, excluding shoulders, shall be crowned 1/8 to 1/4 inch per inch of depth, to allow for compaction. Shoulder

applications shall drain and slope uniformly downward to the shoulder point. A Type II or Type III application may follow as a surface course if specified in the contract documents.

413.10.5.4.5 Micro-surfacing shall not be placed over steel expansion plates.

413.10.5.4.6 When micro-surfacing is placed on concrete, a tack coat shall be applied first in accordance with Sec 407 and shall be given adequate time to break.

413.10.5.4.7 The micro-surfacing shall permit traffic operations on a 1/2 inch thick surface within one hour after placement at 75 F and 50 percent humidity.

413.10.5.5 Repair of Damaged Areas. Any traffic-damaged, marred areas or deficiencies as defined in Sec 413.10.5.4 shall be repaired by the contractor at the contractor's expense.

413.10.5.6 Incidental Construction. Areas that cannot be reached with the mixing machine shall be surfaced using hand squeegees to provide complete and uniform coverage. Utilities shall be protected from coverage by a suitable method. Work at intersections shall be done in stages, or blotter material shall be used to allow crossing or turning movements. Regardless of the method, no marred sections will be permitted.

413.10.6 Quality Control. The contractor shall control and monitor the quality of work.

413.10.6.1 Sample Location. Samples will be taken from the last stockpile location prior to incorporation.

413.10.6.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect microsurfacing production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.10.6.3 Aggregate Gradation. The aggregate gradation shall be within ± 5 percent of the designated job mix gradation for all plus No. 200 material and within ± 2 percent for the minus No. 200 material.

413.10.6.4 Emulsified Asphalt. A certification shall be supplied to the engineer once per shipment for emulsified asphalt.

413.10.7 Quality Assurance. The engineer or designated representative will be responsible for monitoring work and quality control efforts fo the contractor.

413.10.7.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when idependent QA samples meet the same specification criteria as QC.

413.10.7.2 Split QA Samples. No split samples required for microsurfacing.

413.10.8 QC/QA Frequency Table

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Temperature of Base and Air	As Needed	As Needed	-
Aggregate Gradation	1 per 1000 Tons	1 per 5000 Tons	
Emulsified Asphalt	1 per Shipment	1 per Project	

413.10.9 Method of Measurement. Final measurement of completed Type II and Type III surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of Type II, Type III and Type IIIR micro-surfacing, complete in place, will be made to the nearest square yard. Final measurement of Type IIIR surface may be made as necessary to determine the actual areas placed. Field measurement will be based on the estimated width and length dimensions necessary to bring a designated area to a level plane, and not necessarily for the full rutted area. The revision or correction will be computed and added to or deducted from the contract quantity.

413.10.10 Basis of Payment. The accepted quantities of micro-surfacing will be paid for at the contract unit price for each of the pay items included in the contract. No additional payment will be made for removing and replacing test strips.

SECTION 413.20 SCRUB SEAL.

413.20.1 Description. This work shall consist of producing and placing a polymer modified asphalt (scrub seal) emulsion intended for use as a surface rejuvenation treatment and to fill and seal cracks.

413.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Aggregate	1005.3
Emulsion	1015

413.20.2 Aggregate Substitution. Aggregates not meeting Sec 1005.3 may be allowed as approved by the engineer.

413.20.3 Equipment.

413.20.3.1 Aggregate Spreader. The aggregate spreader shall be self-propelled and capable of evenly spreading aggregate.

413.20.3.2 Pneumatic Tire Roller. The pneumatic tire roller shall have a wetting system and be at least 10 tons..

413.20.3.3 Brooms. Brooms shall be capable of adequately scrubbing the mixture into the cracks and surface.

413.20.4 Construction Requirements.

413.20.4.1 Weather Limitations. The scrub seal emulsion shall not be placed on any wet surface or when the ambient temperature or the temperature of the pavement on which the mixture is to be placed is below 60° F.

413.20.4.2 Surface Preparation. The surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material immediately prior to application of the scrub seal emulsion.

413.20.4.3 Application. The scrub seal emulsion shall be uniformly applied with a pressure distributor at the rate specified in the contract or as designated by the engineer. The mixture shall be spread to fill cracks and minor surface irregularities and shall leave a uniform surface.

413.20.4.4 Physical Characteristics for Scrub Seal Emulsion.

Properties	Minimum	Maximum
Application rate of emulsion, gallons/sq. yard[a]	0.18	0.22
Emulsion Temperature, F	110	160
Application rate of aggregate, lb./sy[a]	16	22
Time of set prior to opening, hours[b]	-	2

[a]Application rate may change, final decision will be made by the engineer.
[b]The final decision for opening will be made by the engineer.

413.20.4.5 Method of Placement. After proper surface preparation, a distributor truck shall place the scrub seal emulsion at the prescribed rate. The distributor truck shall pull the broom assembly to sweep and spread the emulsion uniformly on the surface and into the cracks of the pavement.

413.20.4.5.1 Fine aggregate shall be placed immediately after the application of the emulsion and prior to the emulsion breaking. Immediately following the aggregate spreader, a second broom assembly shall be pulled to combine the aggregate with the emulsion.

413.20.4.5.2 The pneumatic tire roller shall immediately follow the second broom and shall make a minimum of two passes.

413.20.4.5.3 All excess sand shall be removed from the roadway, paved shoulders and paved side roads within 24 hours of application or as directed by the engineer.

413.20.4.6 Damaged or Marred Areas. Any traffic damaged or marred areas shall be repaired by the contractor at the contractor's expense.

413.20.5 Quality Control. The contractor shall control and monitor the quality of work.

413.20.5.1 Sample Location. Samples will be taken from the last stockpile location prior to incorporation.

413.20.5.2 Temperature of Air and Base. The contractor shall monitor the environmental conditions that affect scrub seal production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.20.5.3 Aggregate Gradation. The aggregate gradation shall comply with Sec 1005.3.

413.10.5.4 Emulsified Asphalt. A certification shall be supplied to the engineer once per shipment for emulsified asphalt.

413.20.6 Quality Assurance. The engineer or designated representative will be responsible for monitoring work and quality control efforts fo the contractor.

413.20.6.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when idependent QA samples meet the same specification criteria as QC.

413.20.6.2 Split QA Samples. No split samples required for scrub seals.

413.20.7 QC/QA Frequency Table

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Temperature of Base and Air	As Needed	As Needed	-
Aggregate Gradation	1 per 1000 Tons	1 per 5000 Tons	
Emulsified Asphalt	1 per Shipment	1 per Project	

413.20.5 Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of scrub seal emulsion and mineral aggregate, complete in place, including multiple passes or courses, will be made to the nearest square yard. Measurement of individual passes or courses will not be made. The revision or correction will be computed and added to or deducted from the contract quantity.

413.20.6 Basis of Payment. The accepted quantity of scrub seal, in place, will be paid for at the contract unit price.

SECTION 413.30 ULTRATHIN BONDED ASPHALT WEARING SURFACE.

413.30.1 Description. This work shall consist of producing and placing an ultrathin bonded asphalt wearing surface.

413.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows, except as modified herein:

Item	Section
Bituminous Asphalt Mixtures	490
Coarse Aggregate	1002.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Asphalt Binder, Asphalt Emulsions	1015

413.30.2.1 Polymer Modified Emulsion Membrane. The emulsion shall be polymer modified and shall be in accordance with Sec. 1015.

413.30.3 Job Mix Formula. At least 30 days prior to placing any mixture on the project, the contractor shall submit a mix design to Construction and Materials for approval. Representative samples from each ingredient for the mix shall be submitted with the mix design. UBAWS Type 1, Type 2, and Type 3 mixtures as defined in Sec 490 are used for Sec 413 Ultrathin Bonded Wearing Surface work items.

413.30.3.1 Mix Adjustments. The contractor may make field adjustments to the job mix formula as noted herein. The adjusted job mix formula shall be in accordance with the mix design requirements of Sec 490. The engineer shall be notified prior to making any change in the cold feed settings, the hot bin settings or the binder content. No additional fractions of material or new material will be permitted for field adjustments.

413.30.4 Construction Requirements.

413.30.4.1 Weather Limitations. A damp pavement surface may be acceptable for placement if free of standing water and favorable weather conditions are expected to follow. Mix shall not be placed if the air temperature or the temperature of the surface on which the mixture is to be placed is below 50 F, the surface is wet or frozen, or weather conditions prevent the proper handling or finishing of the mixture. +

413.30.4.2 Bituminous Mixing Plants. Bituminous mixing plants and preparation of materials and mixtures shall be in accordance with Sec 404.

413.30.4.3 Hauling Equipment. Trucks used for hauling bituminous mixtures shall be in accordance with Sec 404.

413.30.4.4 Paver. The paver shall be capable of spraying the polymer modified asphalt emulsion membrane, applying the hot mix asphalt overlay and leveling the surface of the mat in one pass. Wheels or other parts of the paving machine shall not come in contact with the polymer modified emulsion membrane before the hot mix asphalt concrete wearing course is applied. The screed shall have the ability to crown the pavement at the center and shall have vertically adjusted extensions to accommodate the desired pavement profile.

413.30.4.5 Surface Preparation. Immediately prior to placing the ultrathin bonded asphalt wearing surface, the roadway surface shall be thoroughly cleaned of all vegetation, loose material, dirt, mud and other objectionable material. All non-working surface cracks with an opening size exceeding 1/4 inch and any size working crack shall be sealed prior to placement of the ultrathin bonded asphalt wearing surface. Immediately prior to spraying the polymer modified emulsion membrane, the surface shall be free of fresh bituminous mix. The ultrathin bonded asphalt wearing surface shall not be placed until the sealant has cured. Curing time of sealant shall be in accordance with the manufacturer's recommendations.

413.30.4.6 Application of Membrane. The polymer modified emulsion membrane application shall be applied in accordance with the manufacturer's recommendations. The sprayer shall accurately and continuously monitor the rate of spray and shall provide a uniform application across the entire width to be overlaid.

413.30.4.6.1 Adjusting Membrane Rate. The engineer may make adjustments to the spray rate based on the existing pavement surface conditions and the recommendations of the polymer modified emulsion membrane manufacturer.

413.30.4.6.2 Application Rate of Membrane. Unless otherwise shown on the plans, the target field application rate of the asphalt emulsion shall be as follows for the type of mixture specified in the contract.

Membrane Application Rate	
Mixture Type	Field Application Rate (gal/sy)
Type A	0.15
Type B and C	0.19

413.30.4.6.3 Tolerance for Membrane Application Rate. At any given time during placement, the application rate of the asphalt emulsion shall be within 0.02 gal/sy of the target field application rate in the table or as indicated in the plans. The yield of the application rate over the entire project area shall be within 0.01 gal/sy of the target field application rate given in the table or as indicated in the plans.

413.30.4.7 Application of Mixture. The hot mix asphalt concrete shall be applied at a temperature of 290 to 330 F and shall be spread over the polymer modified emulsion membrane immediately after application of the polymer modified emulsion. The hot asphalt concrete wearing course shall be placed over the full width of the polymer modified emulsion membrane with a heated vibratory-tamping bar screed.

413.30.4.7.1 Application Rate of Mixture. The target application rate of the ultrathin bonded asphalt wearing course shall be as shown on the plans. The application rate shall be adjusted to minimize fracturing of the top size aggregate by the screed. The engineer will determine the acceptable extent of fracturing at the edges for tapering purposes.

413.30.4.8 Handwork. For handwork, the hot mix asphalt shall be applied within five minutes after the application of the polymer modified emulsion.

413.30.4.9 Rolling. Rolling of the wearing course shall consist of no more than three passes immediately following placement of the ultrathin bonded asphalt wearing course with a steel, double-drum, asphalt roller with a minimum weight of 10 tons. All rolling shall be completed before the material temperature has fallen below 195° F. Rollers shall be equipped with a functioning water system and scrapers to prevent adhesion of the fresh mix onto the roller drums. An acceptable release agent approved by the engineer may be added to the water system to prevent adhesion of the fresh mix to the roller drum and wheels. Rolling shall be done in the static mode. Excessive rolling to the extent of aggregate degradation will not be permitted. The engineer will determine the acceptable extent of fracturing at the edge of the pavement from the rolling operation. New pavement shall not be opened to traffic nor shall any roller sit idle on the pavement until the rolling operation is complete and the material has been cooled below 140 F.

413.30.4.10 Minimum Lift Thicknesses. The finished wearing course shall have a minimum thickness of 1/2 inch for Type A, 3/4 inch for Type B, and 3/4 inch for Type C.

413.30.4.11 Defective Areas. The contractor shall remove and replace defective areas at the contractor's expense with material meeting specification requirements as directed by the engineer.

413.30.4.12 Segregation. No segregation will be permitted in handling the mixture at the plant, from the truck or during spreading operations on the roadbed. Mixture production shall immediately cease if either criteria of MoDOT Test Method TM 75 fail. Segregated mixture shall be removed and replaced to the limits determined by the engineer.

413.30.4.13 Pavement Marking. Pavement marking shall be replaced in accordance with Sec 620.

413.30.5 Quality Control. The contractor shall control and monitor the quality of work.

413.30.5.1 Sample Location. The gradations of the total aggregate will be determined from samples taken randomly from the composite cold feed belt or the hot bins. The deleterious content of the total aggregate will be determined from the samples taken from the combined cold feed belt. Asphalt content samples shall not be retrieved after placement on the roadway.

413.30.5.2 Aggregate Gradation. Sieve analysis shall be performed in accordance with AASHTO T 27 from randomly sampled material taken from the composite cold feed belt or the hot bins. The total aggregate gradation shall be within the range specified in Sec 490.10.6 and within the maximum variations from the approved job mix formula shown here:

Gradation Tolerances from JMF			
Sieves	**Type A**	**Type B**	**Type C**
3/4 in.	-	-	-
1/2 in.			± 5.0
3/8 in.		± 5.0	-
No. 4	± 5.0	± 4.0	± 4.0
No. 8	± 4.0	± 4.0	± 4.0
No. 16	± 4.0	-	-
No. 200	± 1.0	± 1.0	± 1.0

413.30.5.3 Mixture Asphalt Content. The asphalt binder content shall be performed in accordance with AASHTO T 287 or AASHTO T 308. The asphalt content of the mix shall be within +/-0.3% of the approved job mix formula.

413.30.5.4 Deleterious Content. Deleterious content shall be performed in accordance with MoDOT Test Method TM 71. The deleterious content of the material retained on the No. 4 sieve shall not exceed the limits specified in Sec 1002.2.

413.30.5.5 Membrane Application Rate. The application rate of the polymer emulsion membrane shall be verified by dividing the volume of polymer modified emulsion membrane used by the area of paving for that day.

413.30.5.6 Temperature of Base and Air. The contractor shall monitor the environmental conditions that affect asphalt production and laydown operations. Temperatures shall be obtained in accordance with MoDOT Test Method TM 20.

413.30.5.7 Segregation Limits. In situations where there is a dispute in the existence of segregation, the area in question will be tested in accordance with MoDOT Test Method TM 75. QC shall ensure MoDOT has the opportunity to witness TM 75 being performed.

413.30.5.8 Binder Quality. The contractor shall ensure the binder is handled and stored in a manner that does not affect its quality. When the contractor is modifying the binder after delivery, additional quality control requirements apply. QC shall either assist QA in taking samples or obtain the QA sample directly in the inspector's absence.

413.30.6 Quality Assurance. The engineer or designated representative will be responsible for monitoring the work and quality control efforts of the contractor. Corrective action shall be taken by the contractor if any QA tests are outside the QC tolerances shown in Sec 413.30.5.

413.30.6.1 Independent QA Samples. Unless otherwise stated, a favorable comparison shall be obtained when independent QA samples meet the same specification criteria as QC.

413.30.6.2 QA Split Samples. Split samples shall be clearly labeled and stored by the contractor in a manner that prevents contamination. Uncollected split samples shall be retained by the contractor until the engineer authorizes disposal or until the Final Inspection, whichever occurs earlier. A favorable mixture gradation comparison will be achieved when test results are within the specified tolerances shown in Sec 403.17.2.1. A favorable mixture %AC comparison shall be obtained when QA is within 0.3% of QC. A favorable comparison for deleterious content shall be obtained when QA is within one half the Sec 1004.2

requirements of the QC results. .The engineer's test results, including all raw data, will be made available to the contractor by the next working day.

413.30.7 QC/QA Frequency Table.

Tested Property	QC Frequency	QA Frequency	
		Independent Samples	Split Samples
Aggregate Gradation	1 per 600 Tons	1 per Day	-
Mixture Asphalt Content			1 per Week
Membrane Application Rate	1 per Day	1 per Week	-
Temperature of Base and Air	As Needed	As Needed	
Segregation Limits			
Binder Quality	-	1 per Day	

413.30.8 Method of Measurement. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Where required, measurement of ultrathin bonded asphalt wearing surface, complete in place, will be made to the nearest square yard. The revision or correction will be computed and added to or deducted from the contract quantity.

413.30.9 Basis of Payment. Acceptance will be based on test results indicating that the ultrathin bonded asphalt wearing surface meets the specification requirements, the contractor following the approved QC Plan, and favorable comparison of the contractor's QC test and the engineer's QA test.The accepted quantity of ultrathin bonded asphalt wearing surface will be paid for at the contract unit price.

SECTION 413.31 BONDED HOT MIX ASPHALT USING POLYMER MODIFIED EMULSION MEMBRANE.

413.31.1 Description. This work shall consist of the placement of a Polymer Modified Emulsion Membrane prior to a bituminous overlay of hot asphaltic concrete pavement. The Polymer Modified Emulsion Membrane shall be spray applied immediately prior to the application of the hot asphaltic concrete pavement so as to produce a homogeneous surface in accordance with Secs 401, 402, or 403.

413.31.2 Materials. The Polymer Modified Emulsion Membrane shall be in accordance with Sec 1015.20.6.2.

413.31.3 Construction Requirements. The asphaltic concrete pavement shall be placed in accordance with Secs 401, 402, or 403, except as modified herein.

413.31.4 Equipment. No wheel, track or other part of the paving machine or any hauling equipment shall come in contact with the Polymer Modified Emulsion Membrane before the asphaltic concrete pavement mixture is applied.

413.31.5 Application of Polymer Modified Emulsion Membrane.

413.31.5.1 The Polymer Modified Emulsion Membrane shall be sprayed at a temperature of 120° - 180°. The sprayer shall accurately and continuously monitor the application rate and provide a uniform coverage across the entire width to be overlaid. The target application rate of the asphalt emulsion membrane shall be 0.20 gallons per square yard. The Engineer may make adjustments to the application rate based upon the existing pavement surface conditions and the recommendations of the Polymer Modified Emulsion Membrane supplier; however, the application rate shall be within +/- 0.05 gallon per square yard of the target application rate.

413.31.5.2 The application rate of the Polymer Modified Emulsion Membrane shall be verified by dividing the volume (of Polymer Modified Emulsion Membrane used) by the area of paving for that day.

413.31.5.3 No water shall be added to the Polymer Modified Emulsion Membrane.

413.31.6 Method of Measurement. Measurement of the Polymer Modified Emulsion Membrane shall be based on the volume in gallons in accordance with Sec 1015.

413.31.7 Basis of Payment. The accepted quantity of the Polymer Modified Emulsion Membrane will be paid for at the contract unit price.

SECTION 413.40 BITUMINOUS FOG SEALING.

413.40.1 Description. This work shall consist of furnishing diluted asphalt emulsion and preparing and sealing surfaces by means of a bituminous distributor.

413.40.2 Material. Asphalt emulsion grades SS-1, SS-1H, CSS-1, or CSS-1H shall be in accordance with Sec 1015 and shall be used unless otherwise directed by the engineer.

413.40.3 Equipment. The distributor shall be designed, equipped, maintained and operated such that liquid asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallon per square yard. The distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and with full circulation spray bars adjustable both laterally and vertically. The calibration of all distributors shall be approved by the engineer prior to use, and the contractor shall furnish all equipment, material and assistance necessary if calibration will be required.

413.40.4 Construction Requirements.

413.40.4.1 Asphalt emulsion shall be applied only during weather conditions under which satisfactory application and curing can be obtained. Asphalt emulsion shall not be placed on a damp or wet surface except as approved by the engineer. The surface shall be free of objectionable material prior to sealing.

413.40.4.2 The asphalt emulsion shall be diluted with water prior to application. The dilution rate shall be as shown on the plans or as directed by the engineer. The contractor shall provide documentation to the engineer that the specified coating system has been properly diluted.

413.40.4.3 The diluted asphalt emulsion shall be uniformly applied at the rate of 0.20 gallon per square yard surface. The application rate may be adjusted as directed by the engineer. Application widths shall be such that the entire surface is covered in one application.

413.40.4.4 Care shall be taken such that asphalt emulsion is applied only to designated areas. Sand dams or other approved means may be necessary to prevent emulsion from being applied outside of designated areas. Pavement marking obliterated by this operation shall be replaced by the contractor at the contractor's expense in accordance with Sec 620, unless otherwise provided for in the contract.

413.40.4.5 After application of the sealant, the surface shall be tack-free and capable of being open to traffic within four hours without tracking.

413.40.5 Method of Measurement. Measurement of the undiluted asphalt emulsion, complete in place and accepted by the engineer, will be made to the nearest gallon in accordance with Sec 1015.

413.40.6 Basis of Payment. The accepted quantity of bituminous fog seal will be paid for at the contract unit price for undiluted asphalt emulsion for seal that is mixed and used on the project. Diluted asphalt emulsion that is delivered to the job site, but not applied to the surface, will not be considered for payment. No direct payment will be made for sand.

SECTION 413.50 BITUMINOUS PAVEMENT CRACK SEALING.

413.50.1 Description. This work shall consist of preparing and sealing all working transverse and longitudinal cracks in bituminous pavement as shown on the plans or as directed by the engineer.

413.50.2 Material. The sealant shall be a single-component material in accordance with AASHTO M 324, except as herein modified.

413.50.2.1 The sealant shall be capable of being reheated to pouring temperatures at least once after the initial heating, while retaining the sealant's physical characteristics.

413.50.2.2 Penetration at 77° F, 50 grams, 5 seconds, shall be no less than 50 or greater than 90.

413.50.2.3 When tested at 77° F, the resilience recovery shall be a minimum of 50 percent.

413.50.2.4 The sealant shall meet all physical requirements after prolonged heating for six hours with constant mixing in a laboratory melter at the recommended field pouring temperature, complete cool down, and reheating to the recommended pouring temperature.

413.50.3 Construction Requirements.

413.50.3.1 The engineer will mark the cracks to be sealed. Sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer's recommendations.

413.50.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 1/2-inch wide x 1/2-inch deep. The crack shall be clean, free from all loose and foreign material, and dry, prior to application of the sealant. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.50.3.3 The sealant shall be applied to the reservoir from the bottom up. The reservoir shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.50.3.4 The contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed sealant if traffic results in tracking of the crack sealing material.

413.50.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.50.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

SECTION 413.60 PORTLAND CEMENT CONCRETE PAVEMENT JOINT/CRACK SEALING.

413.60.1 Description. This work shall consist of preparing and resealing all existing transverse and longitudinal joints, and working transverse and longitudinal cracks in Portland cement concrete pavement (PCCP) as shown on the plans or as directed by the engineer.

413.60.2 Material. Sealant material shall be in accordance with Sec 1057.

413.60.3 Construction Requirements.

413.60.3.1 The engineer will mark the existing joints and cracks to be sealed. The sealant shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack sealant in accordance with the manufacturer's recommendations.

413.60.3.2 Cracks shall be routed or sawed to provide a reservoir centered over the existing crack. The reservoir shall be slightly larger than the existing crack, with a minimum size of 3/8-inch wide x d/4 deep, where d is the thickness of the pavement. The joint/crack shall be clean, free from all loose and foreign material, including existing sealant, and dry prior to application of the sealant.

413.60.3.3 Sealant shall be applied to the joint or reservoir uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.60.4 Method of Measurement. Measurement of crack sealing will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.60.5 Basis of Payment. The accepted quantity of pavement crack sealing will be paid for at the contract unit price.

SECTION 413.70 BITUMINOUS PAVEMENT CRACK FILLING.

413.70.1 Description. This work shall consist of preparing and filling all cracks in bituminous pavement as shown on the plans or as directed by the engineer.

413.70.2 Material. Filler material shall be in accordance with one of the following:

Item	Section
Asphalt Binder	1015.3
Polymer Modified Emulsion	1015.20.5

Crack Sealing Material	413.50.2

413.70.3 Construction Requirements.

413.70.3.1 The engineer will mark the cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer's recommendations.

413.70.3.2 The crack shall be clean, free from all loose and foreign material, and dry prior to application of the filler material. Loose material on the surface within 2 inches of the crack shall be removed to permit proper adhesion.

413.70.3.3 Filler material shall be applied to the crack from the bottom up. The crack shall be slightly overfilled and excess material squeegeed with a V or U-shaped squeegee, level to the adjoining surface pavement forming a wipe zone 3 to 4 inches wide.

413.70.3.4 The contractor shall apply a light coating of sand or other blotting material to the surface of the newly placed filler if traffic results in tracking of the crack sealing material.

413.70.4 Method of Measurement. Measurement of crack filling will be made to the nearest linear foot of cracks filled, complete in place, and accepted by the engineer.

413.70.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.

SECTION 413.80 PORTLAND CEMENT CONCRETE PAVEMENT CRACK FILLING.

413.80.1 Description. This work shall consist of preparing and filling all cracks in PCCP, as shown on the plans or as directed by the engineer.

413.80.2 Material. Sealant material shall be in accordance with Sec 413.50.2 or Sec 1057.

413.80.3 Construction Requirements.

413.80.3.1 The engineer will mark the existing cracks to be filled. Filler material shall not be placed when the pavement is wet, or when the ambient or pavement temperature falls below 40° F. The contractor shall furnish to the engineer the manufacturer's recommendations for mixing and application, including temperature restrictions, and shall prepare and apply the crack filler material in accordance with the manufacturer's recommendations.

413.80.3.2 The crack shall be clean, free from any loose and foreign material, and dry prior to application of the filler material.

413.80.3.3 Filler material shall be applied to the crack uniformly from the bottom to 1/2 inch from the top. Any excess material shall be removed from the pavement surface.

413.80.4 Method of Measurement. Measurement of crack filling material will be made to the nearest linear foot of cracks sealed, complete in place, and accepted by the engineer.

413.80.5 Basis of Payment. The accepted quantity of pavement crack filler will be paid for at the contract unit price.

SECTION 490
BITUMINUMOUS ASPHALT MIXES

490.1 Description. This work covers the requirements for obtaining an approved job mix formula (JMF) for bituminous asphalt mixtures.

490.2 Naming Convention. The nomenclature of bituminous mixture will be as follows. When only the mixture type or aggregate size is shown, such as SP125, the specifications shall apply to all variations of that type or size, such as SP125B, SP125C, SP125CLP, etc. When "x" is indicated, such as SP125xLP, specifications shall apply to all variations of mixture designs. Stone Matrix Asphalt will be generally referred to as SMA and designated by SM or SMR.

Sec 401 Nomenclature	
BP	**Bituminous Pavement**
-x	Design Type -1,-2, or -3
NC	With Non-Carbonate Requirements
BB	**Bituminous Base**
Sec 402 Nomenclature	
SL	**Surface Leveling**
Sec 403 Nomenclature	
SP	**Superpave**
048	4.75mm (No. 4) nominal aggregate size
095	9.5 mm (3/8 inch) nominal aggregate size
125	12.5 mm (1/2 inch) nominal aggregate size
190	19.0 mm (3/4 inch) nominal aggregate size
250	25.0 mm (1 inch) nominal aggregate size
x	Design Level: B, C, E or F
LP	Limestone Porphyry
NC	With Non-Carbonate Requirements
SM	Stone Matrix Asphalt
SMR	Stone Matrix Asphalt Limestone/Non-Carbonate
Sec 413 Nomenclature	
UBAWS	Ultrathin Bonded Wearing Surface
Type x	Type A, B, or C

490.3 Superpave Design Levels. The following cumulative equivalent single axle loads (ESALs) shall be used for the specified Superpave mix design. The same size aggregate mix design at a higher design traffic may be substituted at the contractor's expense for the contract specified mixture design with the approval from the engineer. Substitutions shall be done uniformly and project mixing of various designs for the same work will not be permitted. For example, an SP125B mixture may be substituted for an SP125C mixture, or SP190C for SP190E, etc. Mixture design substitution will be limited to one design level higher than that specified in the contract.

Design Traffic (ESALs)	**Design**
< 300,000	F
300,000 to < 3,000,000	E
3,000,000 to < 30,000,000	C
≥ 30,000,000	B

490.4 Time Limit. Approved mix designs may be transferred to other projects with similar specifications for a period of three years from the original approval date provided satisfactory results are obtained during production and placement.

490.5 Design Methodology. Asphalt mixtures shall be designed by the contractor using a method appropriate for the type as follows and as designated below.

Mixture Type	**BB, BP, SL**	**SP**	**SMA**	**UBAWS**

Design Method	AASHTO R 35 or Marshall	AASHTO R 35	AASHTO R 46	MoDOT Requirements

490.5.1 Marshall Designs. Designs using the Marshall method shall follow Asphalt Institute Publication MS-2, Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types. The mixture shall be compacted and tested at a minimum of three asphalt contents separated by a maximum of 0.5 percent in accordance with AASHTO T 245, except as herein noted. The test method shall be modified by short-term aging the specimens in accordance with AASHTO R 30.

490.6 Material. The grade of asphalt binder will be specified in the contract. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
SP, UBAWS Course Aggregate	1002.2
BB, BP, SL Coarse Aggregate	1004.2
Fine Aggregate	1002.3
Mineral Filler	1002.4
Hydrated Lime	1002.5
Asphalt Binder	1015

490.6.1 Wet Bottom Boiler Slag. The contractor may furnish wet bottom boiler slag of approved quality in lieu of coarse aggregate. If wet bottom boiler slag is used, the slag shall meet the requirements for applicable coarse aggregate. The Los Angles Abrasion requirements will not apply.

490.6.2 Reclaimed Asphalt. Reclaimed Asphalt may be obtained from Reclaimed Asphalt Pavement (RAP) and Reclaimed Asphalt Shingles (RAS). The asphalt binder content of recycled asphalt materials shall be determined in accordance with AASHTO T 164, ASTM D 2172 or other approved method of solvent extraction. RAP and/or RAS correction factor(s) for binder ignition use during production shall be determined by burning a sample in accordance with AASHTO T 308 and subtracting from the binder content determined by extraction.

490.6.2.1 RAP. Reclaimed Asphalt Pavement (RAP) may be used in any mixture, except SMA mixtures. All RAP material shall be in accordance with Sec 1004 for deleterious and other foreign material. The aggregate specific gravity shall be determined by performing AASHTO T 209 in accordance with Sec 490.9 and calculating the G_{se} as follows:

$$\text{RAP } G_{se} = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}}$$

Mixture Type	BB, BP, and SL	SP, UBAWS
RAP Gsb Calculation	G_{sb} = RAP G_{se} x 0.98	G_{sb} = RAP G_{se}

490.6.2.1.1 RAP Durability All RAP material not originating from a MoDOT roadway shall be tested in accordance with AASHTO T 327, *Method of Resistance of Coarse Aggregate Degradation by Abrasion in the Micro-Deval Apparatus*. The Micro-Deval percent loss for the RAP aggregate shall not exceed loss of the combined virgin material by more than five percent.

490.6.2.1.2 UBAWS RAP. The RAP used in UBAWS shall have 100 percent passing the 3/8 inch and no less than 70 percent passing the No. 4 sieve.

490.6.2.2 RAS. Reclaimed Asphalt Shingles (RAS) may be used in any mixture specified to use PG 64-22. RAS shall be ground to 3/8-inch minus. Waste, manufacturer or new, shingles shall be essential free of deleterious materials. Post-consumer RAS shall not contain more than 1.5 percent wood by weight or more than 3.0 percent total deleterious by weight. Post-consumer RAS shall be certified to contain less than the maximum allowable amount of asbestos as defined by national or local standards. The bulk specific gravity of RAS shall be determined as follows:

Mixture Type	BB, BP, and SL	SP
RAS Gsb Calculation	G_{sb} = 2.600	$G_{sb} = \frac{100 - Pb}{\frac{100}{G_{mm}} - \frac{Pb}{G_b}}$

490.6.2.2.1 RAS Gradation. The gradation of the RAS aggregate may be determined by solvent extraction of the binder or by using the following as a standard gradation:

Standard Shingle Gradation	
Sieve Size	**Percent Passing by Weight**
3/8 in.	100%
No. 4	95%
No. 8	85%
No. 16	70%
No. 30	50%
No. 50	45%
No. 100	35%
No. 200	25%

490.6.3 Rejuvenators. Rejuvenators may be used in any asphalt mixture containing reclaimed asphalt. When a rejuvenator is used for the purpose of softening the virgin binder grade, the requirements for the Extraction Grading of the final mixture option in Sec 490.10 must be satisfied.

490.6.4 Anti-Strip Agent. An anti-strip may be used to improve resistance to stripping. Anti-strip agents shall be from the approved list in accordance with Sec 1071.

490.7 Aggregate Correction Factor. When AASHTO T 308 will be used to determine mixture asphalt content during production, an aggregate correction factor in accordance with AASHTO T 308 ANNEX 2 shall be determined. The test method shall be modified by adding the following: If the calibration factor exceeds 1.0 percent, lower the test temperature to 800 ± 8 F and repeat test.

490.8 Compacted Specimens. The surface of puck and cores prepared for testing may have the surface texture removed by sawing a minimal amount. Specimens shall be securely held in a jig or other clamping device to eliminate distortion and retain a face parallel to the original surface. Measurements for lift thickness shall be made prior to sawing.

490.8.1 Bulk Specific Gravity. During both the design and production phases for both gyro pucks and pavement cores; the following shall apply. Either AASHTO T 166 or T 331 shall be used to determine bulk specific gravity of compacted specimens. When AASHTO T 166 is used and absorption is above the 2% limit, ASTM D 1188 shall be used. The use of AASHTO T 275 is prohibited.

490.9 Maximum Theoretical Specific Gravity. AASHTO T 209 shall be used including the supplemental procedure for mixtures containing porous aggregate when the water absorption of any aggregate fraction is greater than 2.0 percent. Design samples shall be short-term aged in accordance with AASHTO R 30.

490.10 Composition of Mixtures.

490.10.1 Gradation. The combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Percent Passing by Weight												
Sieve Size	**SP250**	**SP190**	**SP125**	**SP095**	**SP048**	**SP125xSM SP125xSMR**	**SP095xSM SP095xSMR**	**BB**	**BP-1**	**BP2**	**BP-3**	**SL**
1 1/2 in.	≤100	-	-	-	-	-	-	-	-	-	-	-
1 in.	≥ 90	≤100						≤100				
3/4 in.	≤ 90	≥ 90	≤100			≤100		≥ 85	≤100	≤100		≤100
1/2 in.	-	≤ 90	≥ 90	≤100		≥ 90	≤100	60-90	≥ 85	≥ 95		≥ 99
3/8 in.		-	≤ 90	≥ 90	≤100	50-80	70-95	-	-	-	≤100	≥ 90
No. 4			-	≤ 90.	≥ 90	20-35	30-50	35-65	50-70	60-90	≥ 90	60-90
No. 8	19-45	23-49	28-58	32-67	-	16-24	20-30	25-50	30-55	40-70	-	40-70
No. 16	-	-	-	-	30-60	-	≤ 21	-	-	-	30-60	-
No. 30					-		≤ 18	10-35	10-30	15-35	-	15-35
No. 50							≤ 15	-	-	-	-	-
No. 100							-					
No. 200	1-7	2-8	2-10	2-10	7-12	8.0-11.0	8.0-12.0	4-12	5-12	5-12	7-12	5-12

490.10.2 Reclaimed Asphalt Allowances. The use of reclaimed asphalt shall be limited as follows. The percent binder replacements shown below are the percent recycle binder contribution to the total asphalt binder.

Mixture Type	Binder	Percent Effective Virgin Binder Replacement		
		RAP	RAS	RAP and RAS combination
BP	Contract Grade Virgin Binder	0 - 20	0 -10	RAP + (2*RAS) ≤ 20
	Virgin Binder Softened One Grade	21 - 40	11 - 20	20 < RAP + (2*RAS) ≤ 40
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	0 - 100		
BB	Contract Grade Virgin Binder	0 - 30	0 -15	RAP + (2*RAS) ≤ 30
	Virgin Binder Softened One Grade	31 - 50	16 - 25	30 < RAP + (2*RAS) ≤ 50
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	0 - 100		
SL	Contract Grade Virgin Binder	0 - 30	0 - 15	0 – 30 total and 0-15 from RAS
	Virgin Binder Softened One Grade	31 - 40	16 - 20	31 – 40 total and 0-20 from RAS
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	N/A		
SP	Contract Grade Virgin Binder	0 - 30	0 - 30	0-30
	Virgin Binder Softened One Grade	N/A	31 - 40	31-40
	Blend Chart	0 - 100	N/A	
	Extraction Grading of Final Mixture	N/A		
UBAWS	Contract Grade Virgin Binder	0 - 20	N/A	
	Virgin Binder Softened One Grade	N/A		
	Blend Chart	0 - 20	N/A	
	Extraction Grading of Final Mixture	0 - 20	N/A	

490.10.2.1 Virgin Binder Softened One Grade. When the contractor elects to provide a softer grade of virgin binder than specified in the contract the following shall apply. The virgin binder shall have a low temperature grade 6 degrees lower than the binder grade specified in the contract. Lowering the high temperature of the virgin binder is not required; however, if lowered, the virgin binder shall have a high temperature grade no lower than 6 degrees below the binder grade specified in the contract (Ex. Contract grade PG 64-22; virgin binder could be either PG 58-28 or PG 64-28). The Pressure Aging Vessel (PAV) test temperature (AASHTO M 320) shall be tested at 19° C, regardless of the high temperature grade of the selected virgin binder.

490.10.2.2 Blend Chart. When the contractor elects to utilize a blend chart to prove the as designed binder grade meets the contract specifications the following shall apply. Testing in accordance with AASHTO M 323 shall be performed on all binder supplying components and the raw data included with the mix design. The calculation which demonstrates that the grade of the combine mixture meets the contract requirements shall be included with the mix design. RAS is not allowable when blend charts are used. No significant alterations to binder providing components during production shall be allowed without a new blend chart evaluation.

490.10.2.3 Extraction Grading. When the contractor elects to utilize an extraction process to prove the as designed binder grade meets the contract specifications the following shall apply. Testing in accordance with either AASHTO T 319, or AASHTO T 164 and AASHTO R 59 along with grading in accordance with AASHTO M 320 including raw data shall be included with the mix design which demonstrates that the grade of the combine mixture and rejuvenator, if applicable, meets the contract requirements. No significant alterations to binder providing components during production shall be allowed without a new extraction grading evaluation.

490.10.3 Moisture Susceptibility. Moisture susceptibility shall be tested in accordance with AASHTO T 283 with the exception that SMA mixtures test specimens shall have 6±0.5 percent air voids. An approved anti-strip additive may be added to increase retained strength to a passing level. TSR testing shall only be required for BB and BP mixtures when any plasticity index on a individual aggregate fractions with 10 percent or more passing the No. 30 sieve exceeds 3. The TSR shall meet the following requirements.

Mix Type	BB, BP	SL	SP, UBAWS
Min. TSR	70%	NA	80%

490.10.4 BB, BP, SL Mixture Characteristics.

490.10.4.1 Base, BP-1, BP-2, BP-3, and SL mixtures shall have the following properties, when tested in accordance with AASHTO T 245 or AASHTO T 312. The number of blows with the compaction hammer shall be 35 or the number of gyrations shall be 35 with the gyratory compactor.

Mix Type	Percent Air Voids	AASHTO T 245 Stability (lbs)	Voids in Mineral Aggregate (VMA)[b]		VMA filled with Asphalt (VFA)	Dust to Effective Binder Ratio
			Virgin Binder Replacement			
			≤ 40%	> 40%		
BB	3.5	750	13.0 (12.0)[a]	13.5 (12.5)[a]	-	-
BP-1			13.5	14.0	60 - 80	0.8 - 1.6
BP-2			14.0	14.5		0.8 - 1.6
BP-3			15.0	15.5	≥ 75	0.9 - 2.0
SL			14.5	15.0		0.8 - 1.6

[a]Bituminous base mixtures with a gradation that would require 12.0 percent VMA following Asphalt Institute MS-2 may use the lower VMA shown.

490.10.4.2 Non-Carbonate. When specified in the contract as BP-3NC, BP-3 mixtures containing limestone aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the criteria of crushed non-carbonate material. The A.I.R. shall be determined on the minus No. 4 sieve. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Aggregate	Minimum Non-Carbonate by Volume
Limestone	20% Minus No. 4
Dolomite	No Requirement

490.10.5 SP Mixture Characteristics

490.10.5.1 Fine Aggregate Angularity. Fine aggregate angularity (FAA) shall be measured on the fine portion of the blended aggregate. When tested in accordance with AASHTO T 304 Method A, aggregate particles passing the No. 8 sieve shall meet the following criteria for the minimum percent air voids in loosely compacted fine aggregate:

Design	FAA
F	-
E	40
C, B	45

490.10.5.2 Coarse Aggregate Angularity. Coarse aggregate angularity (CAA) shall be measured on the coarse portion of the blended aggregate. When tested in accordance with ASTM D 5821, the coarse aggregate shall meet the following percent criteria for the number of fracture faces listed. Crushed limestone, dolomite, steel slag and porphyry will be considered as having 100 percent two fractured faces unless visual observations indicate an undesirable particle shape is being produced.

Design	Fractured Faces	
	One	Two
F	55	-
E	75	
C	95	90
B	100	100

490.10.5.3 Clay Content. When tested in accordance with AASHTO T 176, blended aggregate particles passing the No. 4 sieve shall meet the following minimum sand equivalent criteria:

Design	Sand Equivalent
F, E	40
C	45
B	50

490.10.5.4 Surface Mixtures. Design level B surface mixtures, except non-integral shoulders and other non-traffic areas, containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate. The LA abrasion values,

AASHTO T 96, of the limestone will determine the type and amount of non-carbonate aggregate required as shown in the table below. The LA abrasion value will be determined from the most recent source approval sample. In lieu of the above requirements, the aggregate blend shall have an acid insoluble residue (AIR), MoDOT Test Method TM 76, meeting the plus No. 4 criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an AIR of at least 85 percent insoluble residue.

Mixture	Coarse Aggregate (Plus No. 4)	Minimum Non-Carbonate by Volume
SP095	Dolomite	No Requirement
SP125	Limestone, LA ≤ 30	30% of Plus No. 4
	Limestone, LA > 30	20% of Minus No. 4
SP095	All Limestone	

490.10.5.5 Design Gyrations. The number (N) of gyrations required for gyratory compaction shall be as follows:

Design	$N_{initial}$	N_{design}	$N_{maximum}$
F	-	50	-
E	7	75	115
C	8	100	160
	-	80	-
B	9	125	205
SMA	-	100	-

490.10.5.5 Design Density. The density, as a percent of theoretical maximum specific gravity, shall be as follows:

Design	$N_{initial}$	N_{design}	$N_{maximum}$
F	≤ 91.5	96.0	≤ 98,0
E	≤ 90.5		
C	≤ 89.0		
B			
SMA			

490.10.5.6 Volumetric Characteristics. When compacted in accordance with AASHTO T 312, the mixture shall meet the following criteria.

490.10.5.6.1 Air Voids (V_a). Design air voids for all mixtures at all traffic levels shall be 4.0%.

490.10.5.6.2 Voids in the Mineral Aggregate (VMA).

Mixture	VMA Minimum
SP250	12.0%
SP190	13.0%
SP125 (except for SMA)	14.0%
SP095 (except for SMA)	15.0%
SP048	16.0%
SMA	17.0%

490.10.5.6.3 Voids Filled With Asphalt (VFA).

Design	VFA
F	70 – 80%
E	65 – 78%
B, C	65 – 75%
SP095B	≤ 76%
SMA, SP048F	≥ 75%

490.10.5.6.4 Dust to Binder Ratio. For all mixtures the ratio of minus No. 200 material to effective asphalt binder (Pbe) shall as follows.

Design	D/B
SP095, SP125, SP190, SP250	0.8 – 1.6
SP048	0.9 – 2.0
SMA	-

490.10.5.7 Porphyry Mixtures. In addition to the SP mixture requirements, mixtures designated as porphyry (LP) mixtures shall meet the following. At least 50 percent by volume of the aggregate shall be crushed porphyry retained on the following sieves: No. 30 for SP048, No. 16 for SP095 and No. 8 for SP125. Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required may vary, however at least 40 percent by weight of crushed porphyry will be required. Steel slag may be substituted for porphyry in LP mixtures, except at least 45 percent by weight of crushed porphyry and/or slag will be required. The engineer may approve the use of other hard, durable aggregate in addition to porphyry and steel slag.

490.10.5.8 Stone Matrix Asphalt Mixtures. In addition to the SP mixture requirements, SMA mixtures shall meet the following. Coarse aggregate shall consist of crushed limestone and either porphyry or steel slag in accordance with the quality requirements of Sec 1002, except as follows. The Los Angeles (LA) abrasion, when tested in accordance with AASHTO T 96, shall not exceed 40 percent based on initial ledge approval and source approval. The percent absorption, when tested in accordance with AASHTO T 85, shall not exceed 3.5 percent based on the individual fractions. The amount of flat and elongated particles, measured on material retained on a No. 4 sieve, of the blended aggregate shall not exceed 20 percent based on a 3:1 ratio or 5 percent based on a 5:1 ratio.

490.10.5.8.1 Voids in Coarse Aggregate. The percent VCA_{MIX} of SMA mixtures shall be less than or equal to the VCA_{DRC} as determined using AASHTO T 19 using the following equations:

$$VCA_{DRC} = 100 \times (G_{CA}\gamma_W - \gamma s) / G_{CA}\gamma_W$$

$$VCA_{MIX} = 100 - (P_{bp} \times G_{MB} / G_{CA})$$

$$P_{bp} = P_s \times PA_{bp}$$

Where: G_{CA} = bulk specific gravity of the combined coarse aggregate (AASHTO T 85)
γ_S = unit weight of coarse aggregate in the dry-rodded condition (DRC) (lb/ft3) (AASHTO T 19)
γ_W = unit weight of water (62.34 lb/ft3)
P_{bp} = percent aggregate by total mixture weight retained on No. 4 sieve*
PA_{bp} = percent aggregate by total aggregate weight retained on No. 4 sieve*

*Use No. 8 sieve for SP095xSM

490.10.5.8.2 Filler Restriction. Rigden void content determined in accordance with MoDOT Test Method TM-73 shall be no greater than 50 percent.

490.10.5.8.3 Draindown. AASHTO T 305, Draindown Test, shall be performed on all SMA mixtures prior to job mix approval. The mixture shall be stabilized in such a way that the draindown of the asphalt binder shall not exceed 0.3 percent by weight of mixture.

490.10.5.8.4 Fibers. A fiber additive shall be used as a stabilizer in SMA mixtures. Fibers shall be uniformly distributed by the end of the plant mixing process. The dosage rate for fibers shall be no less than 0.3 percent by weight of the total mixture for cellulose and no less than 0.4 percent by weight for mineral fibers.

490.10.5.8.5 Minimum Stone Matrix Asphalt Binder. The percent asphalt binder for SMA mixtures shall not be less than 6.0 percent unless otherwise allowed by the engineer.

490.10.5.8.6 Durability. SMA mixtures shall meet the requirements of a Sec 490.10.5.12 for Porphyry mixtures. When an SMR mixture is designated, in lieu of the porphyry requirement, the mixture shall contain aggregate blends with at least 30 percent non-carbonate material as defined in Sec 490.10.5.4.

490.10.6 UBAWS Mixture Characteristics.

490.10.6.1 Coarse Aggregate. Coarse aggregate may consist of crushed gravel, limestone, dolomite, porphyry, steel slag, flint chat, or blends of two or more of these aggregates will be acceptable. When coarse aggregate for these mixes are from more than

one source or of more than one type of material, the coarse aggregate shall be proportioned and blended to provide a uniform mixture. Coarse aggregate shall be material predominantly retained above the No. 4 sieve and shall be in accordance with the following requirements:

Coarse Aggregate			
Requirements on Individual Ledge Basis	**Method**	**Min.**	**Max.**
Micro-Deval, % loss	AASHTO T 327	-	18
Los Angeles Abrasion Value, % Loss	AASHTO T 96		35
Soundness, % Loss, Sodium Sulfate	AASHTO T 104		12
Requirements on the Course Portion of the Blended Aggregate	**Method**	**Min.**	**Max.**
Flat & Elongated Ratio, % @ 3:1	ASTM D 4791	-	25
% Crushed, single faces	ASTM D 5821	95	-
% Crushed, two faces	ASTM D 5821	85	

490.10.6.2 Fine Aggregate. Fine aggregate portion of the blended aggregate shall be material predominantly passing the No. 4 sieve and shall be in accordance with the following requirements:

Tests	Method	Min	Max
Sand Equivalent	AASHTO T 176	45	-
Methylene Blue	AASHTO T 330	-	10
Uncompacted Void Content	AASHTO T 304	40	-

490.10.6.3 Gradation. Prior to mixing with asphalt binder, the combined aggregate gradation, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

Composition by Weight Percentages			
	Type A	**Type B**	**Type C**
Sieves	**% Passing**	**% Passing**	**% Passing**
3/4 in.	-	100	100
1/2 in.		97 - 100	85 – 100
3/8 in.	100	75 – 100	50 – 80
No. 4	40 – 55	25 – 41	25 – 41
No. 8	22 – 32	17 – 27	17 – 27
No. 16	15 – 25	≤ 23	≤ 23
No. 30	≤ 18	≤ 18	≤ 18
No. 50	≤ 13	≤ 13	≤ 13
No. 100	≤ 10	≤ 10	≤ 10
No. 200	4.0 – 6.0	4.0 – 6.0	4.0 – 6.0

490.10.6.4 Non-Carbonate Aggregate Requirement. Mixtures containing limestone coarse aggregate shall contain a minimum amount of non-carbonate aggregate as shown in the table below, or the aggregate blend shall have an acid-insoluble residue (A.I.R.), MoDOT Test Method TM 76, meeting the plus No. 4 sieve criteria of crushed non-carbonate material. Non-carbonate aggregate shall have an A.I.R. of at least 85 percent insoluble residue.

Coarse Aggregate (+ No. 4)	Minimum Non-Carbonate by Volume
Limestone	30% Plus No. 4
Dolomite	No Requirement

490.10.6.5 Asphalt Binder. The asphalt binder shall be PG76-22 in accordance with Sec 1015, including all subsections pertaining to UBAWS.

490.10.6.6 Binder Content. The amount of asphalt binder in the mixture shall meet the following limits for the type of mixture specified in the contract.

UBAWS	Type A	Type B	Type C
Asphalt Content	5.3 – 5.8 %	5.1 – 5.6 %	4.9 – 5.6 %

490.10.6.7 Film Thickness. The film thickness shall be a minimum 10.0 microns when calculated using the effective asphalt content in conjunction with the surface area for the aggregate in the Job Mix Formula. The surface area factors can be found in Table 6.1 of the Asphalt Institute MS-2, *Mix Design Methods for Asphalt Concrete and Other Hot Mix Types,* Sixth Edition.

490.10.6.8 Drain Down. Drain down from the loose mixture shall not exceed 0.10 percent when tested in accordance with AASHTO T 305.

490.20 Approval Process.

490.20.1 Mix designs may be approved by the engineer either through a full verification process or a 7-day review process. The engineer has the right to perform a full verification on any mixture submitted.

490.20.2 Job Mix Formula Modification. The JMF approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results occur or should a source of material be changed, a new JMF may be required.

490.20.3 7-Day Review. Laboratories that participate and achieve a score of 3 or greater in the AASHTO proficiency sample program for T 11, T 27, T 84, T 85, T 166, T 176, T 209, T 304, T 308 and T 245 or T 312 will have the option of submitting mix designs for 7-day review. The mix design shall be submitted to Construction and Materials for approval at least seven days prior to mixture production. Samples of components will not be required unless for nuclear density or ignition oven correction factor purposes.

490.20.4 Full Verification. When a full verification is required representative samples of each ingredient for the mixture shall be submitted with the mix design. The mix design and ingredients shall be submitted to Construction and Materials for approval at least thirty days prior to production. Aggregate fractions submitted shall be in the same proportions as the proposed job mix formula with a minimum of 150 pounds required for any individual fraction. The amount of each ingredient submitted shall be as follows for each mix design to be verified:

Ingredient	Marshall Design	Superpave or SMA Design
Aggregate, RAP, and/or RAS	300 Pounds	750 Pounds
Hydrated Lime, Mineral Filler and/or Baghouse Fines	20 Pounds	20 Pounds
Asphalt Binder	10 Gallon	10 Gallons
Antistrip, Warm Mix Additives, and/or Rejuvenating Agents.	1 Gallon	1 Gallon

490.20.5 Required Information. The mix design shall include a detailed description of the mix design process and raw data from the design process including the following information when applicable:

(a) All possible sources intended for use, and grade and specific gravity of asphalt binder.

(b) Source, type (formation, etc.), ledge number(s) if applicable, gradation, and percent chert of each aggregate fraction.

(c) For BB, BP, and SL mixtures, plasticity index of each aggregate fraction which has 10 percent or more passing the No. 30 sieve.

(d) Bulk and apparent specific gravities and absorption of each aggregate fraction in accordance with AASHTO T 85 for coarse aggregate and AASHTO T 84 for fine aggregate, including all raw data, or in accordance with MoDOT TM 81.

(e) Specific gravity of hydrated lime, mineral filler or baghouse fines, if used, in accordance with AASHTO T 100.

(f) Percentage of each aggregate component.

(g) Combined gradation of the job mix.

(h) Percent of asphalt binder, by weight, based on the total mixture.

(i) Bulk specific gravity (G_{mb}) by AASHTO T 166, Method A of a laboratory compacted mixture.

(j) Percent air voids (V_a) of the laboratory compacted specimen.

(k) Voids in the mineral aggregate (VMA) and voids in the mineral aggregate filled with asphalt binder (VFA).

(l) Theoretical maximum specific gravity (G_{mm}) in accordance with Sec 490.9.

(m) Mixing temperature and molding temperature as well as the gyratory sample weight to produce a 115 mm minimum height specimen.

(n) Bulk specific gravity (G_{sb}) of the combined aggregate.

(o) Percent deleterious content of the combine aggregate.

(p) Reclaimed asphalt binder contribution worksheet as well as any extraction or blend calculations needed to prove contract compliance.

(q) The tensile strength ratio as determined by AASHTO T 283 including all raw data.

(r) The film thickness for UBAWS mixtures.

(s) Number of gyrations at $N_{initial}$, N_{design}, and $N_{maximum}$.

(t) Dust proportion ratio ($-200/P_{be}$).

(u) Percent of G_{mm} at $N_{initial}$ and $N_{maximum}$.

(v) Blended aggregate properties for clay content, angularity, and thin and elongated particles.

(w) Voids in coarse aggregate (VCA) for both the mixture and dry-rodded condition for SMA mixtures.

(x) Draindown for SMA and UBAWS mixtures.

(y) Baghouse fines added for design. Provide the combine gradation with and without the baghouse percentage.

(y-i) Batch and continuous mix plants – Indicate which aggregate fraction to add baghouse percentage during production.

(y-ii) Drum mix plants – Provide cold feed settings with and without baghouse percentage.

(z) Ignition oven correction factor(s) and test temperatures used when testing of the combined aggregate, RAP, or RAS gradations.