

**GUIDELINES — PROJECTS REQUIRING STONE MATRIX ASPHALT CONCRETE MIXES. WHEN THIS SECTION APPLIES INCLUDE THE FOLLOWING IN THE PROPOSAL: SS21001 Asphalt Materials SS21113 SuperPave - Asphalt Concrete, SS31510 SuperPave -Asphalt Conc Place, and SS31706 SMA -Asphalt Concrete Place.**

SS24807-1214

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VIRGINIA DEPARTMENT OF TRANSPORTATION  
2007 ROAD AND BRIDGE SUPPLEMENTAL SPECIFICATIONS

**SUPPLEMENTAL SECTION 248—STONE MATRIX ASPHALT CONCRETE**

**SECTION 248—STONE MATRIX ASPHALT CONCRETE** of the Specifications is replaced with the following:

**248.01—Description**

These specifications cover the materials used to produce stone matrix asphalt (SMA) concrete pavement. SMA shall be in accordance to this specification and Section 211. SMA consists of a combination of coarse aggregate, fine aggregate, mineral filler, fiber additives, and liquid asphalt binder mechanically mixed in a plant to produce a stable gap-graded asphalt concrete paving mixture.

**248.02—Materials**

- (a) **Coarse Aggregate:** Coarse aggregate shall conform to the following requirements when tested in accordance with the specified tests:

1. Los Angeles Abrasion	AASHTO T96	40% max.
2. Flat and Elongated Particles: Measured on No. 4 VTM-121 retained,		
3 to 1		20% max.
5 to 1		5% max.
3. Magnesium Sulfate Soundness Loss, 5 cycles	AASHTO T104	15% max.
4. Particles retained on No. 4 sieve shall have at least	ASTM D5821	
1 fractured face		100% min.
2 fractured faces		90% min.
5. Absorption	AASHTO T 85	2% max.

Except for the determination of flat and elongated particles in (a)2 herein, the aggregate properties specified are for each stockpile of coarse aggregate material designated on the job mix form (Form No. TL-127). The material contained in each stockpile shall meet the minimum or maximum criteria specified.

For flat and elongated particles, these values are based on the mathematical blend of the coarse aggregate material designated on the job mix form (TL-127). During production, these values are based on the SMA material sampled during the acceptance process (QC testing).

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SMA must contain two or more coarse aggregate sizes. At least two of the aggregate sizes must comprise a minimum of 10 percent of the total mix composition each. At least one cold feed bin shall be used for each aggregate size.

The Engineer will not permit the use of slag in the job mix formula.

At the Engineer's discretion, mixes containing Reclaimed Asphalt Pavement (RAP) may be tested by VDOT for aggregate breakdown during lab compaction in accordance with VTM-99. If the percent of the total mix passing the No. 4 sieve increases by more than 10 percent after being compacted to  $N_{design}$  then the RAP component shall be changed or the Engineer will discontinue its use in the mix.

- (b) **Fine Aggregate:** Virgin fine aggregates shall consist of a blend of 100 percent crushed aggregate. If RAP is being used as a component in SMA then the portion of the final SMA blend passing the No. 8 sieve shall have a minimum Fine Aggregate Angularity value of 45 percent as determined in accordance with AASHTO T 304 (Method A). The magnesium sulfate soundness loss in 5 cycles shall not exceed 20 percent. In addition, the liquid limit shall not exceed 25 as determined in accordance with AASHTO T89.
- (c) **Asphalt Binder:** Asphalt binders shall be performance graded binder PG 64H-22 or polymer modified binder PG 64E-22 conforming to the requirements of the mix designation (E) designated by the Department. The supplier shall certify to the Department that the binder complies with the requirements for all properties of the grade as specified in AASHTO M332 Table 1 for performance-graded asphalt binder. This certification shall be based on testing performed on samples of binder provided to the Contractor for incorporation into the mixture. The Engineer will not allow certification based on testing performed on laboratory-produced binders.

The Contractor shall submit to the Engineer for Department review the source, formulation, and PG grading of the binder at least 15 days prior to the production of the SMA mixture.

The Department will perform testing during mixture production to determine the binder PG grade on samples taken from storage at the hot-mix asphalt plant at the Engineer's direction. The Contractor shall be responsible for obtaining the sample of binder when requested by the Engineer. If the Department determines the binder does not comply with the requirements of the specified PG grade, production shall be stopped until further testing indicates that the problem has been corrected.

- (d) **Mineral Filler:** Mineral filler shall consist of finely divided mineral matter such as rock or limestone dust or other suitable material. The Engineer will not permit the use of hydrated lime and fly ash. The supplier may blend up to two mineral fillers to comply with the mineral filler requirements. Mineral filler shall conform to the requirements of Section 201 with the following modifications. The mineral filler or mineral filler blend used in surface and intermediate SMA shall have a minimum of 55 percent passing the No. 200 sieve. At the time of use, it shall be sufficiently dry to flow freely and be essentially free from agglomerations.
- (e) **Fiber Additive:** The supplier shall use cellulose fiber in either loose or pelletized form. The minimum dosage rate for cellulose is 0.3 percent by weight of the total mixture. The Department may require the percentage of fiber additive to be increased during production if visual inspection or draindown testing on plant-produced material indicates that draindown in excess of 0.3 percent by weight of the mixture is occurring as determined in accordance with VTM-100. Allowable tolerances of fiber dosage shall be  $\pm 10$  percent of the required fiber weight.

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**NOTE:** When using pelletized fiber, the dosage rate shall be adjusted to comply with the specified minimum dosage rates for cellulose fiber. Pelletized fiber consists of cellulose fiber and a binder. The specified minimum dosage rates are based on fiber content only. Therefore, the amount of pelletized fiber added shall typically be higher than for loose fiber.

The Engineer will accept fibers based on the manufacturer's certification.

**TABLE II-23**

<b>Cellulose Fiber Properties</b>		
<b>Sieve Analysis</b>		
<b>Method A: Alpine Sieve<sup>1</sup> Analysis</b>		
Fiber Length:		0.25 inch max.
Passing	No. 100 Sieve	70% (±10%)
<b>Method B: Mesh Screen<sup>2</sup> Analysis</b>		
Fiber Length:		0.25 inch max.
Passing	No. 20 Sieve	85% (±10%)
	No. 40 Sieve	65% (±10%)
	No. 140 Sieve	30% (±10%)
<b>Ash Content<sup>3</sup></b>		18% (±5%) non-volatile
<b>pH<sup>4</sup></b>		7.5 (±1.0)
<b>Oil Absorption<sup>5</sup></b>		5.0 (±1.0) (times fiber weight)
<b>Moisture Content<sup>6</sup></b>		<5%

<sup>1</sup>*Method A: Alpine Sieve Analysis.* Performed using an Alpine Air Jet Sieve (Type 200 LS). A representative 5-gram sample of fiber is sieved for 14 minutes at a controlled vacuum of 22 inches (±3 inches) of water. The portion remaining on the screen is weighed.

<sup>2</sup>*Method B: Mesh Screen Analysis.* This test is performed using standard Nos. 20, 40, 60, 80, 100, and 140 sieves, nylon brushes, and a shaker. A representative 10-gram sample of fiber is sieved, using a shaker and two nylon brushes on each screen. The amount retained on each sieve is weighed and the percentage passing calculated.

<sup>3</sup>*Ash Content:* A representative 2- to 3-gram sample of fiber is placed in a tared crucible and heated between 1100 and 1200 degrees F for not less than 2 hours. The crucible and ash are cooled in a desiccator and reweighed.

<sup>4</sup>*pH Test:* Five grams of fiber is added to 3.5 ounces of distilled water, stirred, and allowed to set for 30 minutes. The pH is determined with a probe calibrated with a pH 7.0 buffer.

<sup>5</sup>*Oil Absorption Test:* Five grams of fiber is accurately weighed and suspended in an excess of mineral spirits for not less than 5 minutes to ensure total saturation. It is then placed in a screen mesh strainer (with a hole size of approximately 0.5 square millimeter), and shaken on a wrist action shaker for 10 minutes (approximately 1¼-inch motion at 20 shakes/minute). The shaken mass is then transferred without touching to a

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tared container and weighed. Results are reported as the amount (number or times its own weight) the fibers are able to absorb.

<sup>6</sup>*Moisture Content:* Ten grams of fiber is weighed and placed in a 250 degree F forced air oven for 2 hours. The sample is then reweighed immediately upon removal from the oven.

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- (f) **Antistripping Additive:** An antistripping additive shall be used in all stone matrix asphalt mixes. It may be hydrated lime or a chemical additive from the VDOT Materials Division Approved Products List No. 7 or a combination of both. The approved chemical additive shall be added at a rate of not less than 0.30 percent by weight of the total asphalt content of the mixture.

The mixture shall produce a tensile strength ratio (TSR) of not less than 0.80 for the design and production tests. The TSR shall be determined in accordance with AASHTO T283, including a freeze-thaw cycle (4-inch specimens compacted with a Marshall Hammer or 3.5 by 6-inch specimens when compacted with a gyratory compactor); except that the 16-hour curing time requirement and the 72 to 96-hour storage period will not be enforced by the Department. Design tests shall use the same materials that are to be used in the production mix and shall be conducted in a laboratory approved by the Department.

When a chemical additive is used, it shall be added to the asphalt cement prior to the introduction of the asphalt cement into the mix. Any chemical additive or particular concentration of chemical additive found to be harmful to the asphalt material or that changes the original asphalt binder performance grade (PG) shall not be used.

- (g) **Hydrated lime** shall conform to the requirements of ASTM C977. Hydrated lime shall be added at a rate of not less than 1 percent by weight of the total dry aggregate.

A separate bin or tank and feeder system shall be provided to store and accurately proportion the dry or slurried lime into the aggregate. The lime and aggregate shall be mixed by pugmill or other Department approved means to achieve a uniform lime coating of the aggregate prior to entering the drier. If lime is added in dry form, the aggregate shall contain at least 3 percent free moisture. The Department will not permit the stockpiling of lime treated aggregate.

The feeder system shall be controlled by a proportioning device, which shall be accurate to within  $\pm 10$  percent of the specified amount. The proportioning device shall have a convenient and accurate means of calibration. A flow indicator or sensor shall be provided with the proportioning device and interlocked with the plant controls, aggregate feed or weigh system, such that production of the mixture shall be consistently maintained and, if there is a stoppage of the lime feed, interrupted.

The method of introducing and mixing the lime and aggregate shall be subject to approval by the Engineer prior to beginning production.

- (h) **RAP:** The Contractor or his supplier may use Reclaimed Asphalt Pavement (RAP) material as a component material of SMA mixtures provided it conforms to the following:
1. SMA surface and intermediate mixtures containing RAP shall use the PG grade of asphalt cement designated by the mix specified on the plans or in the proposal e.g. an SMA-12.5 (64E-22).

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2. The final asphalt mixture shall conform to the requirements for the type specified.
3. During the production process, RAP material shall not be allowed to contact open flame.
4. The Contractor or his supplier shall handle, haul and store the RAP material in a manner that will minimize contamination. Further, the material shall be stockpiled and used in such manner that variable asphalt contents and asphalt penetration values will not adversely affect the consistency of the mixture.

### 248.03—Composition of SMA Mixture

The Contractor or his supplier shall design and test the SMA mixture using a gyratory compactor. The mixture shall conform to the requirements listed in Table II-24 and Table II-25. One percent hydrated lime will be required as an antistripping additive. An alternative antistripping additive can be used only with the Engineer's permission.

**TABLE II-24  
SMA Design Range**

Percentage by Weight Passing Square Mesh Sieves (in)								
Type No. (See Note)	1	¾	1/2	3/8	No. 4	No. 8	No. 30	No. 200
Surface Mixes								
SMA 12.5		100	83-93	80 max	22-28	16-24	15-20	9-11
SMA 9.5		100	90-100	65-75	25-32	15-25		9-11
Intermediate Mixes								
SMA 19.0	100	85-95	50-60	30-45		16-24	12-16	8-10

Note: The required PG binder will be shown in parentheses as part of the mix type on the plans or proposal, e.g., SMA 12.5 (64E-22).

**TABLE II-25  
SMA Mixture Requirements**

Mix Type	VTM <sup>1</sup> (%)	VMA Design (Min. %)	VMA Production (Min. %)	VCA Design and Production <sup>2</sup> (%)	AC (Min. %)	Draindown (%)	Design Gyrations	Specimen Height <sup>3</sup>
SMA 9.5	2.0-4.0	18.0	17.0	<VCA <sub>DRC</sub>	6.3	0.3 max	75	115
SMA 12.5	2.0-4.0	18.0	17.0	<VCA <sub>DRC</sub>	6.3	0.3 max	75	115
SMA 19.0	2.0-4.0	17.0	16.0	<VCA <sub>DRC</sub>	5.5	0.3 max	75	115

- 1) Asphalt content shall be selected at the midpoint of the VTM range but shall not be less than the minimum specified.
- 2) The voids in coarse aggregates (VCA) of the dry rodded condition (DRC) and mix shall be determined in accordance with VTM-99.
- 3) Specimen height after compaction shall be between 4.33 inches (110mm) and 4.75 inches (120mm). The fines-effective asphalt ratio shall be 1.2-2.0

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NOTE: The SUPERPAVE gyratory compactor (SGC) shall be from the Department's approved list maintained by the Department's Materials Division. Gyratory procedures shall be performed in accordance with VTM-99. Calculations for volumetrics shall be performed in accordance with VTM-57 and VTM-58, 6-inch specimens.

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Draindown testing shall be conducted in accordance with VTM-100.

RAP Percentages are allowed as follows:

**TABLE II-26  
Specified Performance Grade of Asphalt and Use of RAP**

Mix Type & PG	Allowable RAP Percentage in Mix
SMA-9.5 (64H-22), SMA-12.5 (64H-22) & SMA-19.0(64H-22)	0.0 to 20.0
SMA-9.5 (64E-22), SMA-12.5 (64E-22) & SMA-19.0 (64E-22)	0.0 to 15.0

#### 248.04—Acceptance

The Engineer will consider a lot to be acceptable for gradation and asphalt content if the mean of the test results obtained is within the tolerance allowed from the job-mix formula. The production tolerances for the control sieves and asphalt content shall be as follows:

#### Process Tolerance

Tolerance on Each Laboratory Sieve and Asphalt Content: Percent Plus and Minus									
No. Tests	Top Size	¾"	½"	3/8"	No. 4	No. 8	No. 30	No. 200	A.C.
1	0.0	8.0	8.0	8.0	6.0	6.0	6.0	4.0	0.60
2	0.0	5.7	5.7	5.7	4.3	4.3	4.3	2.8	0.43
3	0.0	4.4	4.4	4.4	3.3	3.3	3.3	2.2	0.33
4	0.0	4.0	4.0	4.0	3.0	3.0	3.0	2.0	0.30
5	0.0	3.6	3.6	3.6	2.7	2.7	2.7	1.8	0.27
6	0.0	3.3	3.3	3.3	2.4	2.4	2.4	1.6	0.24
7	0.0	3.0	3.0	3.0	2.3	2.3	2.3	1.5	0.23
8	0.0	2.8	2.8	2.8	2.1	2.1	2.1	1.4	0.21
12	0.0	2.3	2.3	2.3	1.7	1.7	1.7	1.2	0.17

The production tolerance for the specimen height after compaction is 4.33 inches (110mm) and 4.75 inches (120mm).

The Contractor shall check and report the VCA of the mix during production for each gyratory sample. If the VCA of the mix exceeds the VCA of the DRC, the Contractor shall stop production and notify the Engineer. Production shall not resume until the Contractor has taken corrective action and the Engineer has accepted the Contractor's means of correction.

The Contractor shall check and report the percentage of flat and elongated particles (F&E) in the coarse aggregates of the mix design during production. When the Contractor samples the SMA material for acceptance (gradation and AC content), two of eight sub-lots must be selected for F&E verification in the first lot. The F&E testing shall be performed on the coarse aggregate material retained on the #4 sieve, in accordance with the requirements of VTM-121, after the gradation is performed. If passing results are obtained on each sample in the first lot, then F&E testing shall be

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performed on a frequency of every second lot of material produced (i.e., Lots 3, 5, 7, etc.) by randomly selecting two sub-lots. If the F&E of the mix exceeds the specified limits, the Contractor shall stop production and notify the Engineer. Production shall not resume until the Contractor has taken corrective action and the Engineer has accepted the Contractor's means of correction.

Once production has resumed, the Contractor shall determine the F&E of the mix for two consecutive lots by randomly selecting two sub-lots per lot. If passing results are obtained for these two lots, then the F&E testing frequency shall return to every second lot of material produced.

If the Department determines that the mixture being produced does not conform to the approved job-mix formula and volumetric properties in Table II-25 based on Department or Contractor's test results, the Contractor shall immediately make corrections to bring the mixture into conformance with the approved job-mix formula or cease paving with that mixture.

The Engineer will limit subsequent paving operations, using either a revised or other job-mix formula which has not been verified as described herein, to a test run of 300 tons maximum if such material is to be placed in Department project work. The Engineer will not allow any further paving for the Department using that specific mixture until the acceptability of the mixture being produced has received the Engineer's approval based on the 300-ton constraint.

For SMA surface mixes, permeability test data shall be submitted in accordance with VTM 120 using either single point verification or the regression method for each surface mix having a different gradation.

Samples will be taken in the first lot, and every other lot thereafter, and results submitted to the District Materials Engineer.

#### **248.05—SMA Mixing Plant**

Plants used for the preparation of the SMA mixture shall conform to the following:

- (a) **Handling of Mineral Filler:** Adequate dry storage shall be provided for the mineral filler that will, at a minimum, consist of a waterproof cover that shall completely cover the stockpile at all times. Provisions shall be made for metering of the filler into the mixture uniformly and in the desired quantities. In a batch plant, mineral filler shall be added directly into the weigh hopper. In a drum plant, mineral filler shall be added directly onto the cold feed belt. Equipment shall be capable of accurately and uniformly metering the large amounts of mineral filler up to 25 percent of the total mix.
- (b) **Fiber Addition:** Adequate dry storage shall be provided for the fiber additive, and provisions shall be made for accurately and uniformly metering fiber into the mixture at plus or minus 10 percent of the desired quantities.

Introduction of loose or pelletized fiber shall require a separate system that can accurately proportion, by weight, the required quantity of fiber in such a manner as to ensure consistent, uniform blending into the mixture at all rates of production and batch sizes. This supply system shall be interlocked with the other feeding devices of the plant system, and sensing devices shall provide for interruption of mixture production if the introduction of fiber fails.

**Batch Plant:** Loose fiber or pelletized fiber shall be added through a separate inlet directly into the weigh hopper above the pugmill. The addition of fiber shall be timed to occur during the hot aggregate charging of the hopper. Adequate dry mixing time is required to ensure proper blending of the aggregate and fiber stabilizer. Therefore, dry

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mixing time shall typically be increased 5 to 15 seconds. Wet mixing time shall typically be increased at least 5 seconds for cellulose fibers to ensure adequate blending with the asphalt cement.

When fiber is used, the fiber supply system shall include low level and no flow indicators and a printout of the date, time, and net batch weight of fiber.

**Drum Mix Plant:** When fiber is used, the fibers shall be added in such a manner as not to be entrained into the exhaust gases of the drum plant. The fiber supply system shall include low level and no flow indicators and a printout of status of feed rate in pounds per minute.

When pelletized fibers are used, they shall be added directly into the drum mixer through the RAP inlet or a specialized fiber inlet. Operation of the drum mixer shall be such as to ensure complete blending of the pelletized fiber into the mix.

- (c) **Hot Mixture Storage:** When the Contractor does not immediately haul and place the hot mixture on the project, it, he shall provide suitable bins for storage of the hot mixture. Such bins shall be either surge bins to balance production capacity with hauling and placing capacity or storage bins that are heated and insulated and that have a controlled atmosphere around the mixture. The Engineer will impose limitations on the holding times based on laboratory tests of the stored mixture. In no case shall the SMA mixture be kept in storage more than 8 hours.
- (d) **Mixing Temperature:** The recommended plant mixing temperatures for PG 64H-22 should be 315 to 340 degrees F and at no time shall the temperature exceed 350 degrees F. For PG 64E-22, the plant mixing temperatures shall be within the limits of the asphalt supplier's recommendations.