

SECTION 248—STONE MATRIX ASPHALT CONCRETE

248.01—Description

These specifications cover the materials used to produce stone matrix asphalt (SMA) concrete pavement. SMA shall be in accordance to this specifications 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 retained, 3 to 1	VTM-121	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 1 fractured face	ASTM D5821	100% min.
2 fractured faces		90% min.
5. Absorption	AASHTO T 85	2% max.

Except for the determination of flat and elongated particles (Section 248.02(a)2), 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).

The use of slag will not be permitted.

- (b) **Fine Aggregate:** Fine aggregate shall consist of a blend of 100 percent crushed aggregate. 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 70-22 or polymer-modified binder PG 76-22 conforming to the requirements of the mix designation (M) as designated by the Department. The supplier shall certify to the Department that the binder complies with the requirements for all properties of that grade as specified in AASHTO M320 (Provisional Specification MP-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. Certification based on testing performed on laboratory-produced binders will not be acceptable.

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.

During mixture production, testing to determine the binder PG grade will be performed by the Department on samples taken from storage at the hot-mix asphalt plant as directed by the Engineer. The Contractor shall be responsible for obtaining the sample of binder when requested. In the event it is determined that 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. Hydrated lime and fly ash will not be allowed. Up to two mineral fillers may be blended 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:** Cellulose fiber in either loose or pelletized form shall be used. The minimum dosage rate for cellulose is 0.3 percent by weight of the total mixture. During production, the Department may require the percentage of fiber additive to be increased 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 ± 10 percent of the required fiber weight.

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.

Fibers will be accepted based on the manufacturer's certification.

TABLE II-23
Cellulose Fiber Properties

Sieve Analysis		
Method A: Alpine Sieve 1 Analysis		
Fiber Length:		0.25 inch max.
Passing	No. 100 Sieve	70% ($\pm 10\%$)
Method B: Mesh Screen 2 Analysis		
Fiber Length:		0.25 inch max.
Passing	No. 20 Sieve	85% ($\pm 10\%$)
	No. 40 Sieve	65% ($\pm 10\%$)
	No. 140 Sieve	30% ($\pm 10\%$)
Ash Content³		18% ($\pm 5\%$) non-volatile
pH⁴		7.5 (± 1.0)
Oil Absorption⁵		5.0 (± 1.0) (times fiber weight)
Moisture Content⁶		<5%

¹*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.

²*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.

³*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.

⁴*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.

⁵*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 tared container and weighed. Results are reported as the amount (number or times its own weight) the fibers are able to absorb.

⁶*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.

- (f) **RAP:** The use of RAP will not be permitted.

248.03—Composition of SMA Mixture

The SMA mixture shall be designed and tested using a gyratory compactor and 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 if permitted by the Engineer.

TABLE II-24

SMA Design Range

Type No. (See Note)	Percentage by Weight Passing Square Mesh Sieves (in)							
	1	¾	1/2	3/8	No. 4	No. 8	No. 30	No. 200
<i>Surface Mixes</i>								
SMA 12.5	-	100	85-95	80 max.	22-30	16-24	15-20	10-12
SMA 9.5	----	100	90-100	70-85	25-40	15-25	-	10-12
<i>Intermediate Mixes</i>								
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 (76-22).

TABLE II-25

SMA Mixture Requirements

Mix Type	VTM ¹	VMA Design	VMA Production	VCA Design and Production ²	AC	Draindown	Design Gyrations	Specimen Height ³
	(%)	(Min. %)	(Min. %)	(%)	(Min. %)	(%)		
SMA 9.5	2.0-4.0	18.0	17.0	<VCA _{DRC}	6.3	0.3 max	75	115
SMA 12.5	2.0-4.0	18.0	17.0	<VCA _{DRC}	6.3	0.3 max	75	115
SMA 19.0	2.0-4.0	17.0	16.0	<VCA _{DRC}	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 4.25 and 4.75 inches. The fines-effective asphalt ratio shall be 1.2-2.0

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.

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

248.04—Acceptance

A lot will be considered 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 (in) and Asphalt Content (+/-%)									
No. Tests	Top Size	3/4	1/2	3/8	No. 4	No. 8	No. 30	No. 200	AC
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
8	0.0	2.8	2.8	2.8	2.1	2.1	2.1	1.4	0.21

The production tolerance for the specimen height after compaction is 4.25 to 4.75 inches.

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.

The Contractor shall check and report the percentage of Flat and Elongated Particles (F&E) in the Coarse Aggregates of the mix during production. When the SMA material is sampled for acceptance (gradation and AC content); one of the four sub-lots must be selected for F&E verification. The F&E testing will be performed on the coarse aggregate material retained on the #4 sieve (per ASTM VTM-121) after the gradation analysis is performed. At initial start-up of production, the F&E shall be determined for each of the first two lots of material produced. If passing results are obtained on each sample in the first two lots, then F&E testing shall be performed on a frequency of every second lot of material produced (i.e. – Lots 4, 6, 8, etc.). 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 approved the corrective action. Once production has resumed, the Contractor shall determine the F&E of the mix for two consecutive lots. If passing results are obtained for these two lots, then the F&E testing frequency shall return to every second lot of material produced.

In the event the Department determines that the mixture being produced does not conform to the approved job-mix formula and volumetric properties in Table I-B 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.

Subsequent paving operations, using either a revised or other job-mix formula which has not been verified as described herein, shall be limited to a test run of 300 tons maximum if such material is to be placed in Department project work. No further paving for the Department using that specific mixture shall occur until the acceptability of the mixture being produced has been verified using the 300-ton constraint.

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 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 hot mixture is not hauled immediately to the project and placed, suitable bins for storage shall be provided. 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 holding times shall be within limitations imposed by the Engineer, 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 Temperatures:** The recommended plant mixing temperature shall be 315 to 340 degrees F and at no time shall the exceed 350 degrees F.