TOPS

Targeted Overlay Pavement Solutions

Stone Matrix Asphalt

How-To Document

July 2022

U.S. Department of Transportation
Federal Highway Administration

Every Day Counts
Innovation for a Nation on the Move

NOTICE

NON-BINDING CONTENTS

QUALITY ASSURANCE STATEMENT

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This document highlights FHWA's Every Day Counts initiative, Targeted Overlay Pavement Solutions. TOPS integrates innovative overlay procedures into practices to improve performance, lessen traffic impacts, and reduce the cost of pavement ownership.
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16. Abstract
Stone matrix asphalt (SMA) was developed as a durable, highly rut-resistant asphalt mix that could withstand the abrasive effect of studded tires used in the winter. The mix concept depended on a coarse aggregate skeleton to provide resistance to rutting and wear, and a rich mortar of mineral filler and binder to provide long-term durability. SMA has been used in Europe for 60 years and was first introduced in the United States in 1990. The Georgia Department of Transportation (GDOT) was one of the first agencies to place test sections to evaluate its performance on some of its heaviest-traveled interstate routes. This document describes DOT experiences with these products and includes project design and planning considerations, mixture and material selection, and construction specifications.

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LIST OF ACRONYMS

AASHTO	American Association of State Highway Transportation Officials
GDOT	Georgia Department of Transportation
LCCA	Life cycle cost analysis
ME	Mechanistic-empirical
NMAS	Nominal maximum aggregate size
SMA	Stone matrix asphalt
VCA	Voids in coarse aggregate
VMA	Voids in mineral aggregate
WMA	Warm mix asphalt

INTRODUCTION

Stone matrix asphalt (SMA) is a gap-graded mixture that maximizes rutting resistance and durability using stone-on-stone contact and higher asphalt binder contents. SMA mixtures have been used in Europe for nearly 60 years due to their excellent rutting resistance and ability to withstand the wearing effect of studded tires used during winter driving. They were first introduced to the United States during the 1990 European Asphalt Study Tour (AASHTO, 1991). SMA has a coarse aggregate skeleton to enhance rutting resistance and a rich mortar of mineral filler and binder to provide durability. Years of research, early project performance assessment, and review of European experiences suggest SMA mixtures are more rut-resistant with extended fatigue and service lives compared to conventional dense-graded mixtures.

This SMA how-to document is designed to assist agencies, contractors, and material suppliers in adopting and using this technology. The use of SMA is not a federal requirement. It provides information in the following areas:

- Project selection and pavement design
- Material selection
- Materials and construction specifications
- Materials handling practices

DESIGN

Project Selection Criteria

SMA mixture can cost more than conventional mixtures due to additional specifications such as higher-quality aggregates, a binder stabilizer, added mineral filler, and modified asphalt binders; however, the added cost can be offset by extended pavement life and improved rutting resistance (Figure 1). A 20 to 30 percent increase in service life is expected over a conventional mix (Yin and West, 2018).

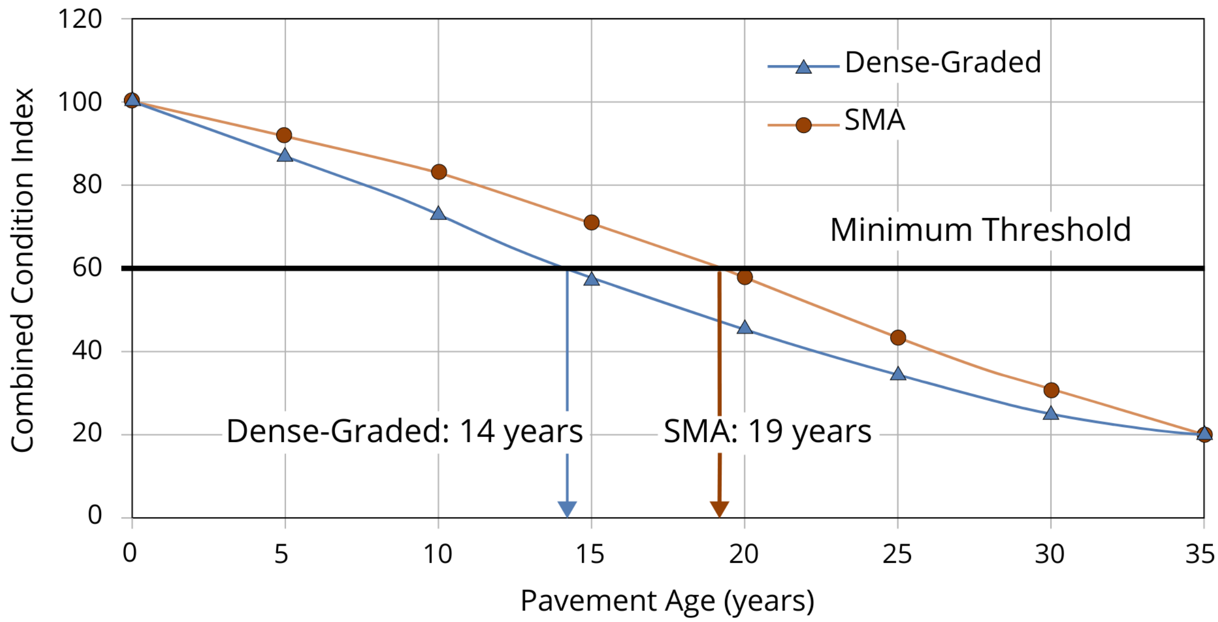

Figure 1: Life expectancy example for flexible pavements in Virginia. (Source: Yin and West, 2018)

Several life cycle cost analyses (LCCA) have compared SMA performance to conventional mix, but overall results are inconclusive. SMA is often used in high-traffic facilities and heavy truck routes, so paving is scheduled during off-peak times (nights and weekends), limiting working hours and increasing the asphalt mix bid price. A 2018 LCCA evaluation of SMA and Superpave mixes for several States showed varying results, but equivalent uniform annual costs indicate SMA is cost-competitive with conventional mixes (Yin and West, 2018).

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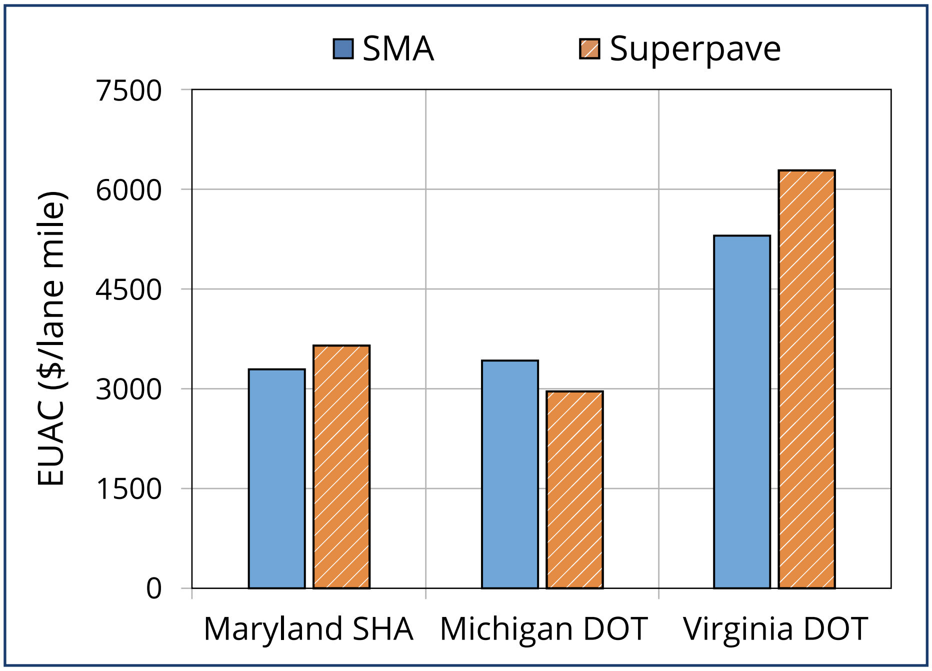

Figure 2: LCCA results summary. (Source: Yin and West, 2018)

Agencies typically use SMA on interstates and State routes with a traffic volume of 50,000 average daily traffic or more. SMA may also be helpful in situations with slow-moving traffic, such as bus stops, truck terminals, intersections, and turning lanes.

SMA has also been used to help retard reflective cracking propagating through overlays placed directly on portland cement concrete pavements. The Georgia Department of Transportation (GDOT) has used 19 mm SMA mixtures as an intermediate layer to overlay concrete pavements on I-75 test sections south of Atlanta (1992), on I-95 along Georgia's coastline (1992-1995), and I-75 north of Atlanta (1995). A 12.5 mm SMA surface mix was placed next and then topped with a 12.5 mm open-graded friction course-wearing layer. One of the early SMA projects in the United States — a jointed, reinforced concrete pavement on I-43 in Wisconsin — was overlaid in 1993 with SMA in the outside lane, where most trucks travel, and conventional mix in the inside lane. A review in 2001 (Watson, 2003) estimated there was 40 percent less reflective cracking in the SMA lanes (Figure 3).


Figure 3: A concrete pavement overlay in Wisconsin after eight years. (Source: National Center for Asphalt Technology (NCAT))

Pavement Design Methods

The empirical method of the 1993 AASHTO Guide for Design of Pavement Structures (not a Federal requirement) uses structural layer coefficients based on material properties and mixture characterization to determine pavement thickness. For years, many agencies used a 0.44 structural value to represent the coefficient for layers of conventional asphalt pavement. Washington and Alabama studies found that coefficients of 0.50-0.54 better represent current practices and materials. An analysis of SMA mixes used on an Alabama test track suggested a value of 0.54 be used in the future (Rodezno et al., 2018).

Mechanistic-empirical (ME) pavement design procedures use pavement modeling and equations to predict performance and determine pavement thickness. Long-term field performance should be used to properly calibrate the internal transfer functions used in ME software. Agencies should conduct their own laboratory and field studies using local materials.

Thickness Criteria

SMA layer thickness is typically based on the aggregate blend's nominal maximum aggregate size (NMAS) (NAPA, 2001). The National Asphalt Paving Association's suggested minimum layer thickness for SMA based on NMAS is provided in Table 1.

Table 1. NAPA Suggested Minimum Lift Thickness Ranges for SMA.

(Source: NAPA)

SMA Mix Type	Minimum Thickness Range
19 mm	2-3 inches
12.5 mm	1.5-2 inches
9.5 mm	1-1.5 inches

Some agencies use thin overlays to address surface needs to maximize funding resources for resurfacing. Washington State conducted a study (Lim et al., 2021) to compare the performance of 9.5 mm SMA, 9.5 mm conventional mix, and 12.5 mm SMA. The study found that the 9.5 mm SMA was successful as a thin lift overlay on heavy traffic routes where studded tires are used for winter driving. The 9.5 mm SMA performed better than the 12.5 mm SMA in resistance to bottom-up fatigue and thermal cracking, as expected, performed better than the 9.5 mm conventional mix in resistance to studded tire wear.

MIXTURES AND MATERIALS

SMA mixes differ from conventional asphalt mixtures and are called "gap-graded" mixtures. The sand-sized particles usually are eliminated from the mix. The mixture consists of a hard, durable coarse aggregate designed for stone-on-stone contact and a binder-rich mortar to provide a thicker asphalt coating on the individual aggregate particles. Eliminating the sand fraction of the gradation facilitates the stone-on-stone contact while reducing the overall demand for binder as there is less aggregate surface area that needs to be coated. These unique differences help improve performance for rutting resistance and durability. Some of these overall differences are:

- Higher quality material
- Coarser "gap-graded" gradation
- Higher proportion of mineral filler that blends with the binder to form a mortar
- Stabilizing additives (fiber or warm mix technology) to prevent draindown
- Higher asphalt content that typically includes a polymer or rubber-modified binder.

Aggregates

Aggregates will generally have higher quality specifications than conventional mix. Limits on Los Angeles (LA) abrasion loss and determining the flat and elongated property based on a 3:1 ratio provide more resistance to rutting and less breakdown of materials during construction. Sample specifications are provided in Table 2.

Table 2. Example Aggregate Quality Specifications (AASHTO M 325, not a Federal requirement).

Coarse Aggregrate Test	Test Variation	Method	Specification
LA Abrasion, % Loss	--	AASHTO T 96	30* max
Flat and Elongated, %	3:1	ASTM D 4791	20 max
	5:1	ASTM D 4791	5 max
Absorption, %	--	AASHTO T 85	2 max
Crushed Content	One face	ASTM D 5821	100 min
	Two faces	ASTM D 5821	90 min
Soundness (5 Cycles), %	Sodium Sulfate	AASHTO T 104	15 max
	Magnesium Sulfate	AASHTO T 104	20 max
Fine Aggregate Test	**Test Variation**	**Method**	**Specification**
Soundness (5 Cycles), %	Sodium Sulfate	AASHTO T 104	15 max
	Magnesium Sulfate	AASHTO T 104	20 max
Angularity, %	--	AASHTO TP 33(A)	45 min
Liquid Limit, %	--	AASHTO T 89	25 max
Plasticity Index	--	AASHTO T 90	Non-plastic

*Although aggregates with higher LA abrasion loss above 30 have been used successfully, excessive aggregate breakdown may occur in the laboratory compaction process or during in-place compaction with these aggregates. AASHTO and ASTM specifications in table are not Federal requirements.

Binders

The asphalt binder used in SMA is generally two performance grades higher than the agency's standard high-temperature paving grade (NAPA, 2002). The binders are often modified with polymer or ground tire rubber.

Additives

Figure 4: Cubical (left) versus flat and elongated particles (right). (Source: NCAT)

SMA has an asphalt film of approximately 25 percent thicker than conventional dense-graded mixes. For that reason, fiber stabilizers are used to prevent the draindown of the thick film. Draindown occurs when the intermediate or "sand" fraction is removed from the mix. This "gap grading," inherent to SMA mixtures, increases the binder coating on the larger aggregate particles. While the binder is at an elevated temperature during manufacture and paving, there are no intermediate particles to prevent the binder from "draining" out of the mixture without a stabilizer. Cellulose or mineral fiber stabilizers are added at a rate of 0.3 to 0.4 percent based on the total mix weight.

Instead of fiber stabilizers, some agencies have approved the use of specific warm mix asphalt (WMA) and other chemical additives engineered to prevent draindown. WMA technologies may also reduce the potential for draindown by allowing the mix to be produced at a lower temperature.

MIX DESIGN SPECIFICATIONS

An SMA mix is designed similarly to conventional mixes and consists of five steps as detailed in AASHTO R 46 (not a Federal requirement).

- Select materials
- Perform trial gradations
- Evaluate trial mixes
- Select optimum asphalt content
- Conduct performance tests

Gradation

AASHTO M 325 (not a Federal requirement) specifies the gradation range for SMA based on NMAS. Agencies may need to adjust the ranges slightly depending on the availability of aggregate materials to achieve a proper blend. An example of AASHTO, Georgia, and Maryland specifications is given in Table 3. Mix designers should develop three trial blends (coarse gradation, intermediate gradation, and fine gradation) based on the specified gradation bands and evaluate mix properties to decide on the final blend. It is recommended that the blend meet or exceed the 17 percent minimum voids in mineral aggregate (VMA) (AASHTO M 325, not a Federal requirement). According to AASHTO R 46 (not a Federal requirement), VCA_{mix} should be less than VCA_{DRC}. A detailed description of VCA testing is in Table 3.

Table 3: Gradation Range for SMA based on NMAS.

Sieve, mm	19.0 mm (AASHTO Specification)	12.5 mm (AASHTO Specification)	9.5 mm (AASHTO Specification)	19.0 mm (Georgia Specification)	12.5 mm (Georgia Specification)	9.5 mm (Georgia Specification)	19.0 mm (Maryland Specification)	12.5 mm (Maryland Specification)	9.5 mm (Maryland Specification)
25	100	--	--	100	--	--	--	--	--
19	90-100	100	--	90-100	100	100	100	100	--
12.5	50-88	90-100	100	44-70	85-100	98-100(1)	82-88	90-99	100
9.5	25-60	50-80	70-95	25-60	50-75	70-100	60 max.	70-85	75-90
4.75	20-28	20-35	30-50	20-28	20-28	28-50	22-30	28-40	30-50
2.36	16-24	16-24	20-30	15-22	16-24	15-30	14-20	18-30	20-30
0.075	8-11	8-11	8-12	8-12	8-12	8-13	9-11	8-11	8-13

Note 1: 100% passing is required on this sieve if spread rate is ≤135 lb/sy.

Volumetric Properties

SMA mix volumetric properties not included in conventional asphalt mixes include the determination of voids in coarse aggregate based on the dry-rodded condition (VCA_{DRC}) and voids in coarse aggregate of the mix (VCA_{mix}). Three trial blends show that as the mix gets finer, the VCA_{mix} increases. This results from the greater proportion of fine aggregate forcing the coarser particles further apart, so there is no longer stone-on-stone contact of the coarse particles. For this reason, it is recommended to use less VCA_{mix} than VCA_{DRC}, so stone-on-stone contact of the coarse aggregate particles can be achieved.

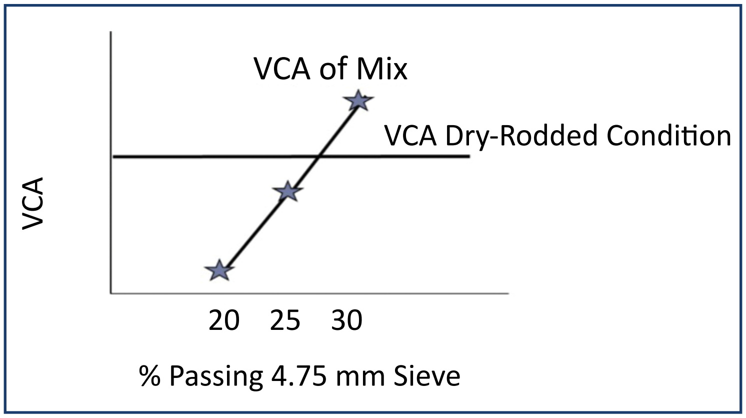

Figure 5: VCA of mix versus VCA of dry-rodded aggregate. (Source: NCAT)

VCA_{DRC} can be determined by the unit weight procedure of AASHTO T 19 (not a Federal requirement), "Unit Weight and Voids in Aggregate." The unit weight is determined by placing aggregate in a cubic foot bucket in three layers and rodding each layer 25 blows to obtain the maximum packing of aggregate particles. The procedure uses only the portion of aggregate blend retained on the breakpoint sieve. The breakpoint sieve is the point at which there is a definite break in the slope of the gradation curve. Figure 6 shows that the 4.75 mm sieve is the breakpoint sieve. This will generally be true for 19- and 12.5-mm SMA mixes. For the 9.5-mm SMA mix, the 2.36-mm sieve is generally the breakpoint sieve.

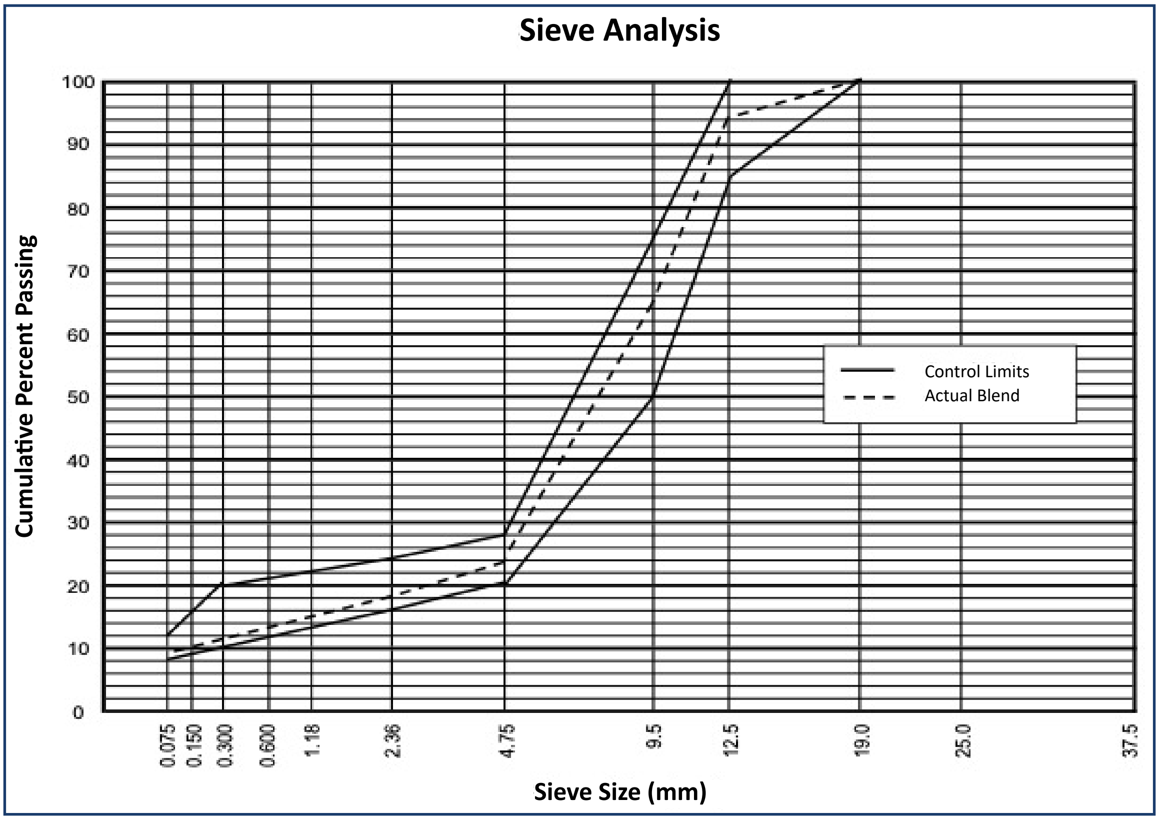

Figure 6: Typical 12.5 mm NMAS SMA gradation. (Source: NCAT)

The VCA_{DRC} can be calculated using Equation 1.

$$VCA_{DRC} = \left[\frac{(G_{ca} \times \gamma_w) - \gamma_s}{G_{ca} \times \gamma_w}\right] \times 100$$ **Equation 1**

Where,

G_{ca} = Bulk specific gravity of the coarse aggregate fraction

γ_w = Unit weight of water

γ_s = Dry-rodded unit weight of the coarse aggregate fraction

Next, determine the percent of coarse aggregate retained on the breakpoint sieve (Pbp) based on the total weight of the mix by using Equation 2. Lastly, determine the VCA_{mix} with Equation 3.

$$P_{bp} = (100 - \%\ passing\ breakpoint\ sieve) \times \left[1.0 - \frac{\%\ asphalt + \%\ fiber}{100}\right]$$ **Equation 2**

$$VCA_{mix} = 100 - \left[\left(\frac{G_{mb}}{G_{ca}}\right) \times P_{bp}\right]$$ **Equation 3**

Where,

G_{mb} =Bulk specific gravity of the compacted mix

G_{ca} = Bulk specific gravity of the coarse aggregate fraction

P_{bp} = Percent aggregate retained on breakpoint sieve by weight of total mix

VCA calculations on an example mix design (based on the equations above) are as follows:

Given:

G_{mb}: 2.348
G_{ca}: 2.716
Unit weight of coarse aggregate: 1635 kg/m^3
Asphalt binder content: 6.3%
Fiber: 0.4%
Unit weight of water: 998 kg/m^3
Percent passing breakpoint sieve: 24%

(1) $$VCA_{DRC} = \frac{(2.716*998-1635)}{(2.716*998)} * 100 = 39.7\%$$

(2) $$P_{bp} = (100 - 24)*(1 - \frac{(6.3+0.4)}{100}) = 70.9\%$$

(3) $$VCA_{mix} = 100 - \frac{2.348*70.9}{2.716} = 38.7\%$$

In this example, VCA_{mix} (38.7 percent) is less than VCA_{DRC} (39.7 percent), so stone-on-stone contact exists.

In Europe, the optimum asphalt content for SMA is selected at 3 percent air voids (AASHTO, 1991). Superpave mix design calls for 4 percent air voids for optimum asphalt content. Georgia and South Carolina select optimum at 3.5 percent air voids, and Virginia uses 3 percent air voids.

A minimum VMA of 17 percent is generally used for SMA mixtures, although VMA varies by the agency from 16 to 18.5 percent. However, the stone-on-stone SMA aggregate structure tends to resist densification, so the VMA curve is often relatively flat. The VMA can be increased by coarsening the gradation or reducing the mineral filler proportion. Some agencies, such as Maryland and Virginia, design with a minimum of 18 percent VMA and a minimum of 17 percent during production.

Performance Testing

Testing the SMA mix for performance parameters during the design phase is common practice. Agencies using SMA often test for draindown, moisture susceptibility, and rutting. Other performance tests that may be used are permeability, raveling, durability, and cracking. Conventional asphalt mixture performance tests are used for all these parameters with slight variations (i.e., air voids, gyration levels, etc.) to align with the SMA mix design for the agency. Test procedures and suggested criteria (not Federally required) for the various mix properties are as follows:

- Draindown (0.3% max.) - AASHTO T 305
- Moisture susceptibility (0.70 min.) – AASHTO T 283
- Rutting
  - Hamburg (12.5 mm max. after 20,000 passes) – AASHTO T 324 (GA, TX)
  - APA (5 mm max. after 8,000 passes) – AASHTO T 340 (SC)

CONSTRUCTION SPECIFICATIONS

Production Criteria

SMA mixture production will likely include modifications and additional equipment installed at the asphalt plant. For example, a mineral filler silo and a fiber dispensing machine are commonly used when producing SMA. SMA is composed of a rich, stiff binder mortar that supplies additional durability. This mortar results from higher proportions of material passing the 0.075 mm sieve blending with a higher binder content.

Figure 7: Silo modified with a larger opening for feeding mineral filler. (Source: NCAT)

Material passing the 0.075 mm sieve is generally in the 8 to 12 percent range, higher than the conventional mix's typical range of 4 to 7 percent. In most cases, the high filler content cannot be satisfied with standard quarry materials alone, and a mineral filler may be needed as another mix component. Material such as crusher fines, fly ash, and marble dust is suitable filler sources.

Figure 8: Fiber dispensing machine. (Source: NCAT)

Proportioning filler through a cold feed bin is not suggested. The filler is essentially dust-sized particles that are free-flowing and must be kept enclosed and dry before metering into the production process. Therefore, using a silo is the preferred method to introduce material into the plant. A typical silo designed for feeding hydrated lime in asphalt mixes may not work. Hydrated lime is generally added at approximately 1 percent of the aggregate weight, so the opening at the bottom of the silo, piping, and metering system may not be sufficiently sized to feed the larger proportions needed for SMA mixes. The silo must be interlocked with plant controls so the plant will shut down if a no-flow situation develops.

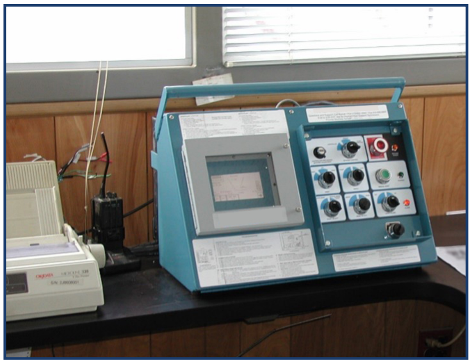

Figure 9: Fiber rate controller. (Source: NCAT)

A stabilizing additive such as cellulose or mineral fiber is generally added at a rate of 0.3 to 0.4 percent by weight of the total mix to prevent binder draindown. Fibers are usually shipped in bales or bulk bags and fed through a dispensing machine (Figure 8) mounted on load cells to continually monitor the feed rate.

The feed rate controller on the fiber dispensing machine (Figure 9) is interlocked with plant controls, so the plant is shut down if a no-flow situation occurs. Some agencies insert a clear tube into the fiber supply line between the fiber machine blower and the plant so the fiber flow can be visually verified if needed.

In some cases, fibers were shipped in low-melt bags and introduced into batch-type plants at the aggregate weigh hopper. The fiber is pre-weighed, so one bag of fiber per batch is used. For batch plants, the dry mixing time (before binder introduction) is increased by 5 to 15 seconds to allow time for fiber dispersion throughout the aggregate. The wet mixing time is also increased by 5 seconds or more to allow time for the asphalt binder to coat fibers sufficiently.

Storage and Transportation

SMA mixture storage should be limited to reduce the chances of draindown in the mixture and the potential for binder aging. While storage for 2 to 3 hours has been beneficial, it is suggested that overnight storage not be allowed.

Consider spraying an agency-approved asphalt release agent over the interior of the truck bed to prevent the mix from sticking to the metal bed. Diesel fuel should not be used as a release agent.

Surface Preparation

Place SMA on a solid foundation. Locate and correct the distress if the existing surface has rutted or exhibits plastic flow or shoving. A simple mill and overlay project can be performed without pre-overlay repairs if the only distress exhibited on the existing pavement is surface rutting. SMA is highly resistant to rutting, but if it is placed on a pavement that is experiencing internal rutting, the SMA is likely to rut as well, and the extra cost of the SMA mix will be money wasted. As shown in Figure 10, a forensic evaluation of a rutted SMA project involved taking a transverse slab from the rutted section of pavement for analysis. The rutted SMA surface layer is of uniform thickness across the transverse section.

Figure 10: Partial slab from a rutted SMA project. (Source: Alabama DOT)

Place the SMA layer on a clean, dry surface tacked with a PG binder or the appropriate type and amount of emulsion allowed to break and cure before opening to construction traffic.

Figure 11: Transverse "bleeding" caused by paver stop. (Source: NCAT)

Placement

Since SMA consists primarily of a gap-graded coarse aggregate blend, there is little potential for aggregate particle segregation where coarse and fine aggregate is separated by mix handling and transferring. End-of-load aggregate segregation seen in conventional mixtures has not been an issue with SMA mixes. However, binder segregation occurs, so the paving operation must keep moving continuously at a constant speed. This is a best practice for placing all asphalt mixes but is especially important with SMA. If the paver stops, any fines and binder mortar built up on the conveyor slats and augers will spill onto the pavement. This may lead to a surface transverse "bleeding" spot (Figure 11).

Figure 12: Random "bleeding" spot caused by plant start-up and shutdown or MTV without mix. (Source: NCAT)

Many agencies use a materials transfer vehicle (MTV) to help maintain the continuous movement of the paving train. If the MTV runs out of mix, or if the plant must frequently start up and shut down, random bleeding spots may occur. The cause could be fines and binder mortar dripping from plant and MTV conveyors while stopped. If the MTV must stop during paving, stop the transfer conveyors.

Reduce or avoid handwork while constructing SMA mixtures, as with any asphalt mixture that uses stiff or polymer-modified binders.

Compaction

Vibratory rollers should be operated in low amplitude and high frequency or static mode. The compaction effort for SMA is like the effort used for conventional dense-graded mixes. Use a nuclear or electrostatic density gauge to establish a roller pattern for each roller in the compaction train. This ensures proper compaction occurs uniformly across the mat.

Pneumatic rollers are not suggested for SMA mixtures because the modified binders typically used in mix production are prone to stick to the rubber tires.

Germany and Sweden require less than 6 percent air voids and generally obtain 3 to 5 percent (Stuart, 1992). This is similar to Georgia, where roadway density is targeted at five percent air voids. Compacting SMA mix is generally equivalent to compacting conventional mixtures with modified binders.

The roll down for SMA mixtures is 10 to 15 percent of the thickness placed by the screed. This equates to 1/8 of an inch per inch thickness rather than the traditional 1/4 inch per inch roll down.

Quality Assurance

Samples for quality assurance are generally taken from a loaded truck at the plant or the roadway behind the paver before compaction. Mixture properties for acceptance vary by the agency but usually include gradation, asphalt content, plant lab air voids, roadway density, and smoothness.

Since the percent aggregate passing the breakpoint sieve is critical to maintaining stone-on-stone contact of the coarse aggregate particles, the gradation on the breakpoint sieve must be closely controlled. Georgia controls SMA mix gradation tolerance at approximately 75 percent of the tolerance allowed for conventional mixes.

Some agencies use plant lab air voids as a volumetric control property. Alabama, for example, requires plant lab air voids to be within 0.75 percent of the design air voids specified in the job mix formula for full payment (based on the average of absolute deviations of four test results). There is a decreasing pay reduction when the average absolute deviation ranges from 0.76 to 1.05. The agency may require removal and replacement for average absolute deviations higher than 1.05.

VMA may also be controlled during the project. Most agencies specify a minimum VMA of 17 percent for all SMA mix types during mix design. Maryland and Virginia specify a minimum of 18 percent VMA for mix design and a minimum of 17 percent for production samples.

While not federally required, some agencies take cores from the roadway and use AASHTO T 331 “Standard Method of Test for Bulk Specific Gravity and Density of Compacted Hot Mix Asphalt Using Automatic Vacuum Sealing Method” to determine SMA field density. Georgia targets field density of asphalt mixes at 95 percent of theoretical maximum density (5 percent pavement mean air voids) and a minimum average density of at least 93 percent (7 percent pavement mean air voids). Colorado specifies a density range of 93 to 97 percent of the theoretical maximum specific gravity.

Nuclear density gauges are often used for quality control during construction and provide reliable measurements when calibrated to the cores. Care is needed with the SMA mix to ensure the bottom of the gauge remains clean. Some gauge manufacturers suggest using a trowel or straight edge to strike off a thin layer of clean, dry sand at the individual measurement sites to address the increased macro texture.

MAINTENANCE AND PRESERVATION

Well-designed and constructed SMA pavements have been documented to last 20 years with little to no maintenance. Consequently, many agencies use SMA mixtures as an integral part of a perpetual pavement strategy.

As with any asphalt pavement, routine monitoring of the surface conditions to properly time the needed treatment becomes a crucial step to extending the overall life of the pavement. If SMA is the surface course of the pavement, the most common maintenance and preservation is crack sealing. In southeastern States, where an open-graded friction course is commonly used as the surface course, the adequately timed replacement becomes the best way to maintain SMA to prevent top-down cracking.

SUMMARY

Possible tips (not Federal requirements) to help ensure the successful performance of SMA include:

- Use a binder grade two paving grades higher than the standard paving grade recommended for the geographical area.
- Use high-quality aggregates that meet Superpave quality specifications.
- Design VCA_{mix} less than VCA_{DRC} to ensure stone-on-stone contact of coarse aggregate particles.
- Select the optimum binder content at 3 to 4 percent design air voids.
- Prevent draindown using fiber stabilizers, modified binder, or warm mix additive technology.
- Conduct performance tests for draindown, rutting resistance, and moisture susceptibility.
- Avoid stopping and starting plant and paving operations.
- Follow paving best practices to include:
  - Use MTVs.
  - Clean the existing surface.
  - Apply a uniform coat of tack and let it set.
- Balance production, trucking, paving, and compaction operations.
- Establish a quality assurance program that accounts for binder, gradation, and density requirements.
- Control gradation more closely than conventional mix, especially on the breakpoint sieve.

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TOPS

Targeted Overlay Pavement Solutions

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