

SMA PROVES ITS LONG-TERM DURABILITY

**After more than 10 years,
U.S. pavements of Stone Matrix
Asphalt are still going strong**



You could say that we're all either watching, or are involved in, a long-running play called "SMA in the USA." We're talking about Stone Matrix Asphalt, or SMA, and after more than 10 years, its performances are drawing excellent reviews from all evaluators.

SMA is a rut-resistant, gap-graded Hot Mix Asphalt (HMA) that relies on stone-on-stone contact to provide strength. The mix uses a high content of asphalt cement (AC) – typically 6 to 7 percent or more – to give it durability. Frequently a polymer modifier is used in the AC. Mineral fillers and fibers of either mineral or cellulose are commonly added to form a stiff mortar and prevent draindown of the AC. In-place air voids are kept low – to less than 6 percent – to make the mix impermeable to water. SMA is typically applied to Interstates and high-volume roadways, in both intermediate and surface courses.

THE NEW ASPHALT, ABSOLUTELY!

SMOOTH | DURABLE | SAFE | QUIET

"Most tenacious mix"

Since 1992, Maryland has placed some 1,400 lane miles of SMA. "It is without a doubt the most tenacious mix I have ever seen," says Larry Michael, regional engineer, Western Regional Laboratory, Maryland State Highway Administration. "It is almost impossible to make SMA rut, and it will outlast any other mix." Maryland uses SMA as standard practice on projects that carry more than 20,000 vehicles per day and have a traffic speed of 55 miles per hour or greater.

The Georgia DOT has paved some 3 million tons of SMA since 1991. "With SMA, it's easier to achieve mat density than with conventional mixes, and you get high rut resistance and high durability," says Peter Wu, state bituminous construction engineer with the Georgia DOT. "You don't have to spend a lot of energy to achieve mat density." On all asphalt-surfaced Interstates, Georgia resurfaces with SMA, topped by an open-graded friction course. The state also uses SMA for all state routes that carry more than 50,000 vehicles per day.

SMA got its start in the United States as a result of the European Asphalt Study Tour taken by industry leaders in 1990. At that time, SMA had been used successfully in Europe for more than

20 years. The first SMA was placed in the U.S. in Wisconsin in 1991, and Georgia, Michigan, and Missouri followed suit in the same year. By the summer of 1997, at least 28 states had built more than 100 projects totaling more than 3 million tons of SMA. As of 2002, some 15 million tons of SMA have been placed in more than 250 projects in the U.S., estimates Don Watson, a research engineer with the National Center for Asphalt Technology (NCAT).

High performance, renewed interest

Industry officials agree that SMA is enjoying a current resurgence of interest by transportation agencies. "A lot of states are reevaluating their highway loadings and they want to put down a mixture that will be bullet-proof, even if it costs somewhat more," says John D'Angelo, asphalt materials engineer, Office of Pavement Technology, Federal Highway Administration. "So states are looking at SMA and saying that it's worth the extra cost, now that it has proven itself."

Richard Schreck, executive vice president of the Virginia Asphalt Association, was instrumental in helping import SMA technology into the U.S. from Europe. According to Schreck, SMA use has been growing steadily in the U.S. since the early 1990s. Since implementation of Superpave by most states, there has been a tremendous increase in interest in SMA. The states see that the SMA projects constructed in the early '90s are outperforming all other mixes. On a global scale, SMA use has grown substantially. Schreck notes: "SMA has become



the dominant, longest-lasting high-performance mix throughout the world. There is no other mix that will outperform a well-designed and -constructed SMA."

The Maryland State Highway Administration's Western Regional Laboratory recently completed an evaluation of SMA projects in the state. Nearly 1,000 sets of quality control properties and 300 sets of performance measurements were downloaded from a database and analyzed for the report, which was prepared by Charles Schwartz of the University of Maryland, working with Larry Michael and Gloria Burke of the Western Regional Laboratory.

Values for cumulative rut depth (over time) for Maryland SMA projects, including projects with up to 10 years of performance data, averaged just 0.14 inches for the 12.5-mm mixes and 0.13 inches for the 19-mm mixes. (The 12.5-mm and 19-mm mixes refer to the nominal maximum aggregate sizes used.)

"The performance of SMA pavements in Maryland has been outstanding," the report concludes. "Very little rutting, increase in roughness, or decrease of friction has been observed, even for pavements that have been in service for as long as ten years. Other notable benefits of SMA include reduced tire splash and reduced tire noise. Many of the Maryland SMA pavement sections look better today than when first opened to traffic."

Design characteristics

SMA consists of a coarse aggregate skeleton with a binder-rich mortar. Key to SMA's success is stone-on-stone contact of the coarse aggregate. According to a technical document, *Designing and Constructing SMA Mixtures – State of the Practice*, published by the National Asphalt Pavement Association (NAPA), the five steps required to obtain a satisfactory SMA mixture are:

- Select proper aggregate materials (The Maryland report recommends cubical coarse aggregate with 100 percent crushed faces.);
- Determine an aggregate gradation yielding stone-on-stone contact;
- Ensure that the chosen gradation meets or exceeds minimum requirements of voids in the mineral aggregate (VMA), or allows the minimum binder content to be used;
- Choose an AC content that provides the desired air void level, and
- Evaluate the moisture susceptibility and AC draindown sensitivity.

To assure good stone-on-stone contact, one measures the voids in the coarse aggregate (VCA) for the coarse aggregate fraction of the mixture. Stone-on-stone contact will occur when the VCA of the entire SMA mixture is equal to or less than the VCA of the coarse aggregate fraction as determined by the dry rodded unit weight test (AASHTO T19).

SMA mixes are very sensitive to changes in the amount of material passing the respective "break" sieve. For example, the NAPA document defines 4.75 mm and 2.38 mm as break sieves for SMA mixtures of 12.5 mm and 9.5 mm nominal maximum aggregate sizes, respectively. If excessive material passes the break sieve, the mix will lose stone-on-stone contact.

Life-cycle cost

Proponents of SMA, including state officials, acknowledge that it costs on the order of 20 percent to 40 percent more than conventional mixes. "I would say SMA costs 30 to 40 percent more, because of the polymer modifiers, the added mineral filler, fiber additive and the plant modifications needed," says Wu of the Georgia DOT. "But your expected service life is 40 percent longer – and you gain from the lowered highway user costs, because you're not disrupting traffic as often."

"Based on experience in Germany, it appears that we won't have any problem getting SMA pavements to last at least 25 percent longer than conventional asphalt pavements," says NCAT's Watson. "The big issue is to get highway agencies to look at total life cycle costs rather than the initial outlay."



According to Schreck, "Pavement designers need to give SMA the correct service life when analyzing the life-cycle cost of this mix. Too often agencies assign the same service life to all mixes when performing life-cycle cost analysis. SMA's higher initial cost is more than offset by its longer service life."

If built on a well-designed Superpave base, SMA surfaces will last 20 years or longer, says Pierce Flanigan, president, P. Flanigan & Sons Inc., a Baltimore, Maryland, contractor with extensive SMA experience. SMA has put the asphalt pavement industry in a favorable competitive position with portland cement concrete on high-type pavements, Flanigan says. "Now we have the superior products," he says.

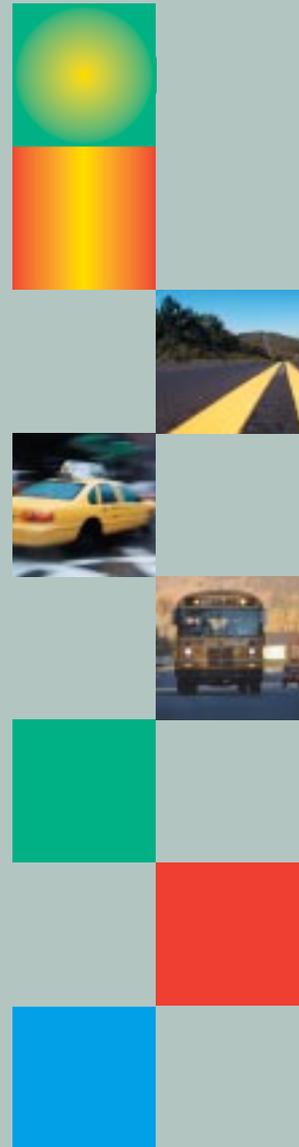
Construction issues are critical

SMA gradations usually require about 10 percent to pass the 0.075 mm sieve. That means at least 5 percent commercial mineral filler must be added to the mixture. "The mineral filler acts as a stabilizer to prevent the liquid asphalt from draining out of the mixture," says Brent Moore, vice president, Mega Contractors Inc. The Richmond, Virginia-based contractor has placed seven SMA projects.

"It's very important to have an accurate metering system for your mineral filler," says Moore. "The quantity of mineral filler will really affect the volumetrics of the mix. If you add too much filler, your voids will be too low, and if you add too little, you'll open up the mix and you can't get density."

Both cellulose and mineral fibers have been used in SMA in the United States. Typical dosage rates by total mixture mass are 0.3 percent for cellulose and 0.3 to 0.4 percent for mineral fiber. Fibers can be purchased as either loose fibers or pellets. "I use pelletized cellulose fibers, because of their unique characteristics of flow," says Marshall Klinefelter, quality control director for David A. Bramble Inc., a Chestertown, Md., contractor with considerable SMA experience. "I recommend the use of microwave flow sensors to detect any interruption in the flow of stabilizers. Any interruption in the flow of any ingredient can spell disaster, so make sure you have all the bells and whistles necessary to make it a non-event."

For successful SMA production and placement, every person in the process – from material suppliers through roller operators – must practice exacting quality control, says Klinefelter. "Never, ever get complacent," he says. "Everybody has to be on their toes during an SMA project."



Asphalt Pavement Alliance

877-APA-0077

877-272-0077

E-mail: publications@asphaltalliance.com

www.AsphaltAlliance.com

