CHAPTER 6
SUPERPAVE™ & STONE MATRIX ASPHALT (SMA) CONSTRUCTION

In 2000, Virginia implemented a new system for designing and producing asphalt mixes. The new mix design process called SUPERPAVE™ stands for Superior Performing Asphalt Pavements and was the end result of a $50 million research program conducted in the early 1990’s by the Federal Highway Administration. The research on asphalt was performed under the umbrella of a large transportation initiative entitled the Strategic Highway Research Program (SHRP). An important new mix that has become a part of SUPERPAVE™ is stone mastic asphalt or SMA. This mix has been used successfully and extensively in Europe for a number of years and is an extremely durable and rut resistant material. The open graded, high binder mix features strong stone on stone contact and a tough mortar or glue made up of an increased liquid asphalt percentage with fibers and dust added for improved strength. The mix has properties that make it a valuable option for use on Virginia’s interstate and high-traffic primary roads.

The SUPERPAVE™ system introduced a whole new approach to the design of asphalt mixes. The asphalt binders used in SUPERPAVE™ mixes now require much more sophisticated testing to assure that the asphalt cement meets certain performance related specifications. The new binders sold to asphalt plants by asphalt cement suppliers now have a new terminology that is associated with performance characteristics. Instead of the old viscosity based asphalt cement designations such as AC-20 or AC-30, we now refer to these binders as PG64-22, PG70-22 or PG76-22. The PG stands for “performance graded” and the numbers indicate the temperature range in degrees centigrade at which the asphalt mix will retain the necessary characteristics to prevent rutting or other performance problems. As an example of this, an asphalt cement which grades out at PG64-22 will pass tests that will assure good performance where pavement surface temperature range from 64ºC (143ºF) to -22 ºC (-8 ºF). SMA uses either a PG70-22 or PG76-22 binder to provide added toughness for these high performance mixes.

SUPERPAVE™ mixes also receive much more rigorous testing in the lab to assure performance. Instead of the old marshall hammer a new device called a gyratory compactor is used in the lab to test for the volumetric properties of the mix. The gyratory compactor is the key piece of equipment that lab technicians use to conduct trial runs to determine the proper mix design for the job at hand. Different gradations and asphalt contents are tested to come up with the best mix for pavements ranging from high stress urban intersections and interstates to a residential street. Other technological advances include the use of an “ignition oven” to determine the asphalt content of mixes instead of the old solvent extraction method and under SUPERPAVE™ a whole series of aggregate tests are run to help improve mix consistency and durability. Restrictions on the quality of aggregates used for SMA are even more rigorous to assure that sound, cubical material is incorporated into the mix.

So how will the SUPERPAVE™ mix design system and the use of SMA affect the construction side of asphalt paving? We should see far fewer instances of serious mix problems in the field with materials produced at the asphalt plant. The more rigorous and comprehensive testing in the lab should eliminate most major mix design flaws.
On the other hand, SUPERPAVE™ allows considerable flexibility by the producer in the choice of a coarse graded, dense graded, open graded or fine graded mix design within a given mix designation. For example, a SM12.5A mix that is commonly used by VDOT as a surface layer can be produced on the fine side or the coarse side. The differences can be significant enough to affect compaction efforts, appearance, segregation potential, joint quality, handwork and other issues. So long as the volumetric targets are achieved and testing assures good performance in the field, contractors can produce highly variable mixes for the same type of job which in turn can lead to major differences in how the mix must be handled during lay down and compaction. Field personnel must be knowledgeable of how these different types of mixes will appear and act when constructed on the roadway. It is important to remember that SUPERPAVE™ mixes are still made with graded stone that has been coated with asphalt. All of the basic good practices that we employ to correctly produce, place and compact the mix on the road still apply. There are a few unique differences with some SUPERPAVE™ mixes, including in particular SMA, that are helpful to understand as we begin to see more of these pavements being placed on Virginia roadways.

**Training**

Since the new SUPERPAVE™ mix design technology involves the use of special lab testing equipment and a different design procedure, it is important to have a good training program in place for lab technicians. VDOT has established a mix design certification program to insure that the HMA produced by Virginia asphalt contractors meets all Virginia specifications.

**SUPERPAVE™ Binders**

SUPERPAVE™ binders must undergo rigorous testing by the asphalt suppliers to assure that the binders meet very specific binder specifications. Binders are now supplied which will allow pavement design engineers to match the proper binder to a mix that will handle varying traffic levels and pavement stress scenarios. The testing that is performed by the oil companies assures that the asphalt binder supplied will have the necessary stiffness and flexibility to prevent pavement failures. Pavement temperatures associated with regional climate characteristics and anticipated traffic loadings are built into the SUPERPAVE™ binder performance grading system.
As previously noted, SUPERPAVE™ binders are now specified using performance grades. PG64-22 is the most commonly used binder in VDOT mixes. It is found in “A” mix designations under VDOT specifications. “D” mix designations will use a PG70-22 grade binder. PG76-22 is used for “E” mix designations. This binder is typically specified for very heavy traffic loading such as interstates and high stress intersections. SMA uses either a PG70-22 or PG76-22 as the binder.

VDOT SUPERPAVE™ Mixes

Current VDOT specifications still contain two sets of mix designations; one for SUPERPAVE™ and one for the old classifications (SM-2A, etc.). Although it is somewhat confusing to have two sets of mix specifications, it is necessary until older jobs that were bid with the old mix designations have been completed. Additionally, many localities and consultants continue to request the older, pre-Superpave™ mixes and rely on the VDOT specifications in their design process. Mixes having a numerical designation in millimeters (9.5, 12.5, 19.5, etc.) that identifies the maximum stone size are the SUPERPAVE™ mixes. Examples would be SM-12.5A or IM-19.0A. Both systems still utilize “SM” for surface mixes, “IM” for intermediate mixes and “BM” for base mixes. There is also a letter designation in both mix classification systems which, under SUPERPAVE™, describes what gyration level will be used for design in the lab as well as the PG binder that will be used. “A” mixes will have a PG64-22 binder, “D” mixes a PG70-22 and “E” mixes will have PG76-22 binder. A, D and E mixes will all act differently in the field when being placed so some knowledge of the basic way in which these mixes behave is important for field personnel. “A” mixes are used in most standard pavement applications and the PG64-22 binder may not cause this mix to act much different from conventional VDOT mixes used for similar work. “D” mixes contain PG70-22 and are used for heavier traffic loading. This mix is “stiffer” so it must be produced and placed at higher temperatures (typically 300°F behind the screed). “E” mixes are used for extreme traffic loading conditions (interstates carrying high truck traffic) and high stress intersections. This mix is produced at even higher temperatures (up to 350°F) and is more difficult to place and compact. Each mix has its own minimum placement temperature; 250°F for A mixes, 270°F for D mixes, and 290°F for E mixes. Remember, there can be significant changes in field handling characteristics between different mix designs, even with the same mix type. Since lab technicians have greater flexibility in their choice of gradation and asphalt content, you could for example, have a number of different SM-12.5A mixes produced that will not act the same in the field. A gap-graded SM-12.5A will look and handle differently in the field from a dense or fine graded SM-12.5A mix. Despite the fact that these two forms of the same type of mix look and act differently in the field, they can and will meet all SUPERPAVE™ mix design specifications.
VDOT mix type designations are different under SUPERPAVE™. Maximum stone sizes in the mix are now identified with a metric designation. For example an SM-2A will most likely be an SM-12.5A under SUPERPAVE™. Generally speaking, this means that the mix under either mix designation as a ½ inch maximum stone size.

The number “12.5” in the SUPERPAVE™ mix type refers to the maximum stone size in millimeters (12.5mm = ½ inch). Both sets of mix classification systems will be used for several more years since many existing contracts still carry the old mix designation.

**Stone Matrix Asphalt (SMA)**

SMA is being used with increased frequency by the Department for high traffic situations and as an overlay for concrete. VDOT has placed over 300,000 tons of this mix. It is expected that SMA will be used even more often as we continue the process of renovating and improving the state’s interstate system. SMA will have either PG70-22 or PG76-22 as the binder and can be produced and placed as a 9.5, 12.5, or 19.5 mix. Typically, PG76-22 is specified for overlays over jointed concrete pavements to help prevent reflective cracking at the joints. This is a very tough and difficult mix to work with in the field as it must be delivered very hot (300°F in the truck and 290°F behind the paver when PG70-22 is used and 310°F in the truck and 300°F behind the screed when PG76-22 is used) It’s coarse gradation and very sticky binder also make it hard to compact and work with rakes and lutes.

### Table A - SMA Design Range

<table>
<thead>
<tr>
<th>Type# (see note)</th>
<th>1</th>
<th>3/4</th>
<th>1/2</th>
<th>3/8</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No.30</th>
<th>No. 200</th>
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<tbody>
<tr>
<td><strong>Surface Mixes</strong></td>
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<tr>
<td>SMA 12.5</td>
<td>-</td>
<td>100</td>
<td>85-95</td>
<td>80 max</td>
<td>22-30</td>
<td>16-24</td>
<td>15-20</td>
<td>10-12</td>
</tr>
<tr>
<td>SMA 9.5</td>
<td>---</td>
<td>100</td>
<td>90-100</td>
<td>70-85</td>
<td>25-40</td>
<td>15-25</td>
<td>-</td>
<td>10-12</td>
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<td><strong>Intermediate Mixes</strong></td>
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<tr>
<td>SMA 19.0</td>
<td>100</td>
<td>85-95</td>
<td>50-60</td>
<td>30-45</td>
<td>---</td>
<td>16-24</td>
<td>12-16</td>
<td>8-10</td>
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</tbody>
</table>

**Note** - The required PG binder will be shown in parenthesis as part of the mix type on the plans or proposal e.g. SMA 12.5 (76-22)
HMA Delivery Issues – SUPERPAVETM/SMA

Many of the issues associated with HMA delivery that have already been covered in this training become magnified with SUPERPAVETM mixes. D, E, and SMA mixes generally are produced at a higher temperature and also must be delivered to the job site at a high enough temperature to allow successful placement. These mixes can lose their heat more rapidly than conventional mixes, so extra care must be given to prevent heat loss. Some coarse graded SUPERPAVETM mixes are also prone to segregation so attention must be given to those actions that can contribute to the loss of gradation integrity. These mixes present handwork and joint construction challenges. Extra care must be exercised when working with these mixes.

SUPERPAVETM mixes, especially the “D” and “E” mixes and SMA are produced at very high temperatures and must be hauled and placed while still very hot. Mixes that have cooled too much have been known to stick to the truck bed and not slide into the paver hopper.

Placement Issues - SUPERPAVETM/SMA

As noted previously, some SUPERPAVETM mixes and SMA can be very stiff and due to their gradation be susceptible to low temperature problems. Care must be taken that these mixes do not sit in the truck too long or be hauled long distances, particularly in the spring and fall. Segregation can still be a problem, although some mixes that are fine-graded are not as prone to segregation. The stiffer mixes such as SMA, “D” and “E” can be difficult to place and challenging for handwork. The mixes must be hot enough at the job site to allow for easy workability. These mixes with their added “stickiness” are more prone to clumping up in the paver so extra diligence is required to watch for cold mix build-ups within the paver that might dislodge and end up in the mat.

Keep an eye out for clumps appearing in the mat behind the paver. This is an indication that the mix has gotten too cool.
Compaction Issues – SUPERPAVE™/SMA

Compaction success is of course, highly dependent on mix temperature in the field. Many SUPERPAVE mix designs will require higher production, placement and compaction temperatures. Compaction must take place while the mix is still very hot. In general, SUPERPAVE™ mixes (especially SMA) will require more compactive effort than conventional mixes. Particular care must be given in test sections that the proper number of rollers are used for the job as well as enough roller passes to achieve density. Because density can be hard to achieve, even greater care must be given planning pulls and density testing to make sure that the density specification is achieved. Since obtaining density can be challenging with some SUPERPAVE™ mixes, including SMA, extra attention should be given to the compaction of longitudinal joints and the outside edges of the mat. Sometimes a slow roller speed is enough to obtain the necessary density. Additionally, SMA with its strong stone skeleton is susceptible to fractured stone if vibratory rollers are used in an aggressive mode, therefore no more than 3 vibratory passes made on the mat. If fracturing of stone is observed, adjustments should be made to the frequency and amplitude settings on the vibratory rollers to eliminate the problem.

To achieve density, the rollers must aggressively compact the mat while it is still very hot. Often several rollers operate within 50 feet of the back of the paver when working with SMA. Sometimes several rollers must be operated one right behind the other and almost work in “echlon mode”.

Conclusions – SUPERPAVE™ Mixes and SMA

SUPERPAVE™ mixes including SMA are the new asphalt technology for the 21st century. The SUPERPAVE™ system represents a giant leap forward in advancing the quality of asphalt pavements. These mixes will be more durable and resistant to many pavement problems such as rutting, pushing, shoving and cracking. Field personnel must recognize that many of these mixes will be more sensitive to the various placement factors that are important in producing a smooth, durable mat. The basic principles of field placement of asphalt are still the same, however, and close attention to proper paving techniques will help assure that these new asphalt mixes will significantly improve the quality of our asphalt pavements.
1. A VDOT SM-12.5A mix must be placed at no lower than the following temperature:
   A. 270°F
   B. 250°F
   C. 290°F
   D. 300°F

2. Coarse SUPERPAVE™ mixes typically require a roller pattern that applies high compactive effort very close behind the paver.
   A. True
   B. False

3. An asphalt mix that uses a PG76-22 liquid asphalt would be a good choice for a residential street.
   A. True
   B. False

4. “D” and “E” mixes are “stiff” mixes that can be difficult to place and hand work.
   A. True
   B. False