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Observations of Field Experience with Superpave Projects Constructed in 1996

Asphalt Institute

Resolution of Problems

Background

According to a recent national survey, performed by the AASHTO Superpave Lead States (Florida, Indiana, Maryland, New York, Texas, and Utah), approximately 93 Superpave projects were constructed in 1996. Many more (316) are planned for construction during 1997. Regrettably, rumors regarding construction concerns of Superpave projects began spreading during and after the 1996 pavement construction season. Eventually, it became almost impossible to distinguish between opinions and fact. Without knowing all of the factors involved in a project, it is very difficult to objectively conclude what is the cause or even the true identity of a problem. Unfortunately, the solutions that were utilized to resolve many of these issues have not been widely circulated..

In reality, from a construction perspective there may or may not be much difference between Superpave mixes and conventional mixes. The difference depends on what kinds of mixes are currently being designed and produced in each state. If a state had previously experienced rutting problems and had instituted changes in their conventional design criteria to address this situation, there may be little difference in behavior with the "new" Superpave mixes. As evidence, the consensus aggregate properties were selected based on much of the past experience that the states had with unstable mixes. In addition, if the state had previously done some work with modified binders in heavy traffic areas, the use of premium PG binders may represent little if any shift from familiar practices. It should be noted that many PG grades are not modified and that the required binder based on climate and traffic may be very similar to the binder specified in the past using the viscosity or penetration system.

However, if a state has been using mixes that were providing some minimal performance level, but were easy to construct, there may be some necessary adjustments to their construction practices. Mixes, which are easy to construct and meet density requirements reliably, are often easily deformed under heavy truck traffic. Superpave is an acronym for Superior Performing Asphalt Pavements. The cost of superior performance may not be just the potential increase in cost of materials (aggregates and binders); it may mean more effort during construction.

Approach

In an attempt to document construction "problems" with Superpave mixes, the Asphalt Institute, with assistance from the Federal Highway Administration, conducted an informal review of the 1996 construction season. The New York DOT was the initial agency contacted and provided valuable guidance. This review represents a conglomeration of various types of input, from telephone conversations with Asphalt Institute Field Engineers to on-site interviews. With these limitations, the database may not be as complete as desired; however, it is felt that this review captured a good representation of the national experience with Superpave construction in 1996.

The efforts given by those individuals that responded to the review, documenting their experience, is gratefully appreciated.

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Results

The summarized responses of all of the inquiries are tabulated in Table 1. Information was gathered from 18 states on 86 of the estimated 93 Superpave projects constructed in 1996.. Some of these projects may have started construction in 1995. These projects represent all sizes of Superpave projects from small experimental sections to major projects with large amounts of asphalt concrete tonnage covering several lanes and layers.

Of these 86 projects, 33 percent (28 projects) reported "problems" during construction. This is not unexpected when implementing a new system and utilizing different materials. However, it should be noted that in many cases, the difficulties were overcome during construction, using well-recognized corrective actions to the normal construction practices of the contractor.

Most of the difficulties during construction fall into the following categories :

- Obtaining specified density
- Meeting VMA
- Segregation of coarse graded mixes
- Shoving under intermediate roller
- Pick-up of modified mix with pneumatic rollers
- Sticking of mix to truckbeds

Summaries of the responses on individual state projects are contained in the Appendix.

Table 1: Compilation of State Responses

1996 Superpave Projects					
		Projects	Projects		
	Total '96	with few	with		
State	Projects	problems	difficulty	Description of Problem	Other Comment
Alabama	4	1	3	19mm binder course - ok	VMA ran 13.8% - said to be low
				12.5mm surf - trouble with	
				VMA (?) & density - tried adding	lowered VMA req. to <u>14</u>
				another vib. breakdown roller	
Arizona	7	5	2	Placing 25mm nom. in 37.5 mm	Once rolling pattern is established
				lift - difficult to compact	compaction is relatively easy
				Density placing overlay over	Ten other city & county jobs
				badly-deformed pavement	
California	0				2 county jobs - no problems
Delaware	5	4	1	Density of SP and Marshall	One contractor has chosen
				mixes less than 1" thick	to produce all SP even though
				solved by going 1.25" thick.	bid under Marshall
				& moving roller closer to paver	
Florida	8	2	6	density was much lower than	changed to core-spec, higher
				measured with nuclear gauge	density req., increased lift thick.
				high permeability, high air voids	increased rolling temp.

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Table 1: Compilation of State Responses (Cont.)

					Problem seems to be resolved
Georgia	3	2	1	Density of 12.5mm surf (1.5")	OK for shoulder rumble strips also
				More temp loss than expected	Use MTV
Indiana	17	14	3		Very Positive
Kansas	1	1	0	Some problems meeting VMA	Used extra roller up close
Kentucky	2	1	1	segregation in 7" base course	Trouble meeting VMA in field
				base density - no problem	
				surf. density met after adding	
				roller & moving closer	
Louisiana	1	1			
Maine	2	0	2	segregation was resolved	
				density difficult, shoving	
Maryland	5	5	0		37.5mm design-too low binder
					solved by lowered Ndes
Michigan	1	0	1	Field compaction slightly more	
				difficult	
Missouri	5	2	3	difficulty with density, exhibiting	Worse with 12.5 mm than 19mm
				long. & trans. movements	coarse-grading (S-shaped)
				plastic under intermediate roller,	on one problem project,
				difficulty with VMA as pay item	19mm binder coarse - OK
Montana	2	2	0		

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Table 1: Compilation of State Responses (Cont.)

New York	7	4	3	Shoving under intermediate	after cooling - more stable
				roller (after 2 passes),	
				25mm mix - minor segregation	
Ohio	3	3	0	Checking of surface course	
				behind screed, did not roll out	
				Met required density after	
				changing compaction proc.	
				HMA sticking to truckbeds	
				solved by rel.agent & incr. temp	
Pennsylvania	5	5	0	Initial problem w/test strip	One contractor preferred SP mix
Texas	3	3	0	Initial shoving - added more	Lowered binder content on one
				intermediate sizes in design	job
Virginia	2	0	2	VMA drop 1% for 1% increase	JMF Production volumetrics low
				in P200, agg breakdown	Field densities low
				mix tender under roller -	
				changed blend alot	
Washington	3	3	0		
Total	86	58	28		

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Resolution of Problems

Density

With a Superpave mixture, probably the most often heard remark concerns the difficulty with obtaining the specified density. To quote Donald P. Steinke, the FHWA Chief of the Highway Operations Division, from an April 18, 1997 memorandum,

"*The fact that compaction was not achieved on some projects using standard rolling operations and equipment used for Marshall designed mixes does not justify questioning the Superpave technology.*"

A mixture that provides good rutting resistance under heavy traffic will also require more compactive effort to build it. Depending on how similar the components (aggregate gradation, sources and shapes; binder content and type) are to the mixes that were designed in the past, some adjustments to the field compaction process may be necessary to get a properly constructed pavement. Adjustments will probably need to be made on a case-by-case basis. This means that paving a test strip to work out the proper rolling pattern and rolling equipment needed for the job is *highly recommended* for all Superpave projects. When the agency and/or contractor has no prior experience with these stiff stone-to-stone contact mixes, a test strip should be a requirement.

Many of the 1996 density problems were resolved by doing one or a combination of the following:

Having the mix placed at an appropriate temperature (for the binder used) [greater than 280° F] for high PG grades

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Using a heavier (12 to 15 ton) breakdown roller

Keeping the breakdown roller (and possibly the intermediate roller also) up close the paver

Most of these recommendations are simply based on logic and good paving practice. Because a Superpave mixture is typically rougher in texture and shape, even if not coarser than some conventional dense-graded mixtures, the amount of observed rolldown will many times be less than normal experience. Therefore, it is not necessary to "stay off" a Superpave mix to allow it to set up. Similar experiences were also noted when Stone Matrix Asphalt (SMA) mixes started being used.

An additional suggestion that has already been promoted by the Florida and Minnesota DOTs is to increase the lift thickness, if possible. A good minimum lift thickness may be 50 mm or up to four times the nominal maximum aggregate size of the blend. The additional volume of mix provides more space for aggregate reorientation beneath the roller. For some resurfacing projects, a thicker lift may be financially prohibitive for local agencies. In this case, the agency may have to weigh the benefits of using a thicker lift to obtain density with a larger size aggregate, against using a thinner lift with a smaller maximum aggregate size of possibly better quality (coarse and fine aggregate angularity) material.

VMA

Asphalt mixtures are designed to meet certain minimum requirements so that the mix will have a reasonable assurance of performance. One of these requirements is a volumetric property identified as the percentage of voids in the mineral aggregate (VMA).. This property was intended to ensure that an asphalt mixture will have sufficient intergranular space for both asphalt binder and air voids. VMA is a durability requirement that is strongly affected by laboratory compaction procedures. It also is one of the most difficult requirements to meet within any mix design system.

Achieving VMA has been reported as a problem on a number of Superpave projects. There are several possible reasons for these VMA problems with Superpave mixtures. One is that some agencies using Superpave are experiencing the VMA criterion for the first time. Previous mix design systems in these states may not have required VMA. It is very likely that, in these cases, the agencies would also experience similar problems with conventional mixes.

A second possible reason for difficulty with achieving VMA is the different compaction procedure used in Superpave. The Superpave gyratory compactor (SGC) uses a shear compaction effort, while the Marshall compaction uses impact energy. The aggregate orientation, and consequently the development of density, is different for specimens compacted using these two compaction processes. Experience with Superpave mixes has been mainly confined to pavements with medium to high traffic. The SGC compactive effort required for high traffic mixes, typically 95 to 135 gyrations, is different than typical Marshall compaction (75 blows). In many cases, this compactive effort will result in higher specimen density and lower VMA.

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Superpave mixes can be designed in the laboratory with acceptable VMA. There are two approaches the designer can follow in attempting to achieve a minimum VMA. The first is to alter the gradation of the mixture. Dense-graded mixtures (those that follow the maximum density line) often have difficulty achieving VMA. Unfortunately there is no consistent method of adjusting gradation to achieve VMA that holds true for all combinations of aggregates.

The second approach that a mix designer can use to achieve VMA is to change the aggregates used in the mix. Increasing the use of clean, angular, cubical aggregates will typically help to increase VMA. Soft aggregates, and aggregates with high water absorption, may hinder efforts to achieve VMA.

Many times an acceptable mix in the lab will experience a decrease in VMA during production. This is a situation that has existed before Superpave. Several potential reasons exist for a decrease in VMA during production. One possibility is that the coarse aggregate loses some angularity as sharp edges are chipped off in the drum. Aggregates may also degrade slightly resulting in an increase in fines. In many cases, the fines (passing the 0.075 mm sieve) are substantially smaller than 0.075 millimeters. These fine particles serve two negative functions: they fill the void spaces between coarse aggregate particles and they become part of the asphalt binder, thereby extending the apparent volume of asphalt. While no specific solution can be offered to minimize the effects of a VMA decrease during production, one possible solution is to add mineral filler or baghouse fines to the mix during lab design. In this instance, the properties from the lab design should more closely match the properties of the plant-produced mixture.

While VMA continues to be a controversial topic, both before and after Superpave, it is a necessary property to provide enough binder in the mix for durability reasons. Future research items, identified by the AASHTO Superpave Lead States (June 2, 1997 Superpave Implementation Guidance), will address such issues as whether the VMA requirement might be different for fine and coarse graded mixes with the same nominal maximum aggregate size and whether the requirement should be increased for projects with low traffic volumes.

Segregation
Whenever the aggregate gradation is designed away from a well-graded very dense blend of all the intermediate sizes between the maximum size and the 75-micron sieve, there is a potential for segregation. Superpave mixes, for reasons of durability and rutting resistance, typically have gradations that do not lie along the path of the maximum density line. A number of papers and publications have already been written which contain various checklists for avoiding the numerous points in the construction process where segregation can occur. The following suggestions are worth noting for all paving projects, not just Superpave:

- Building uniform, low elevation stockpiles
- Loading the cold-feed bins from the stockpiles properly
- Aligning the conveyors to avoid slinging material
- Using a surge bin or batcher to load the silo
- Maintaining sufficient mix in the silo
- Loading the trucks in three "mass" drops from the silo (rear, front, middle)
- Keeping the tailgate latched until the front of the bed is fully lifted
- Keeping the paver hopper full and a constant head of material in front of the screed
- Using paving augers which are capable of uniformly distributing the mix across the width
- Avoid dumping the wings of the hopper
- Maintaining equipment, replacing worn out augers, flowgates, screeds, etc.

As noted by a few states, a Material Transfer Vehicle (MTV) can help minimize or eliminate segregation; however, most mix segregation problems can be addressed by following already-established good construction practice.

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Intermediate Shoving
It has been discussed in the Superpave Mix Expert Task Group, in several newsletters, and in many other circles, that some Superpave mixes appear to be demonstrating an intermediate temperature range (approximately 120 to 90° C (250 to 200° F)) where the mix is shoving under the roller. After cooling below that range, the mix can be further compacted. As with most pavement situations, the reason for this behavior is rarely linked to one or two specific causes. Most people understand that this kind of shoving is not really just a Superpave issue. However, in certain situations, the type of gradations usually associated with Superpave, S-shaped below the restricted zone, appear to act differently than dense-graded mixes under normal field compaction practices.

Although no direct or definite link has been found to be common to all reported cases, there are a combination of factors that seem to be somewhat connected with this behavior:

- Wet aggregate stockpiles, high moisture contents
- High aggregate moisture absorption
- Coarse gradations
- Modified binders
- Higher mixing and compaction temperatures

Obviously, not all mixes, which incorporate these factors, shove under the intermediate roller. But, there does appear to be some group of factors affecting the temperature susceptibility of the mix during compaction. Many theories are being proposed to explain this behavior.

One possibility is that coarser aggregates are more difficult to dry completely since the flow path from internal pores is relatively longer. This is especially true if saturated by rainfall. Water entrapped in the mixture may be released later in storage, during transport to the job site, or under the shearing action of the roller. This additional moisture adds more lubrication to the mix, which could explain the shoving. This scenario would be further aggravated by high aggregate porosity or high percent absorption. The escaping moisture may also help explain the faster cooling rate reported for several Superpave mixes.

It is well known that asphalt expands in volume when it is heated to mixing temperatures. This reduces the amount of air voids and increases the voids filled with asphalt (VFA). If compacted enough at the higher temperatures, the mix could become unstable due to high VFA, before the mixture cools sufficiently for the binder to again contract, reducing the VFA. If the binder is modified, the temperature-volume relationship may also be altered, which may exacerbate the situation.

Regardless of the cause, these mixes can be compacted provided this kind of behavior is recognized when constructing the test strip. Once the rolling pattern and spacing, weight, and type of equipment are established for the Superpave mix, the contractor should be able to achieve density without significant lateral rollout.

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Pick-up with Modified Binders

Prior to Superpave, it was noted that mixes with some modified binders (SBS, SBR, CRM, etc.) have a tendency to exhibit particle pick-up which stick to the tires of pneumatic rollers, even when properly pre-heated and lubricated. Although not all Superpave mixes (and PG binders) use modification, there will be some projects where this behavior will occur. For surface courses, it appears that steel-wheeled rollers may be necessary for breakdown and intermediate rolling until the mix, if modified, has cooled to temperatures more appropriate for finish rolling. However, because the pick-up problem is more of a cosmetic issue rather than a structural deficiency, pneumatic rollers should continue to be considered an option for base or binder courses for their beneficial kneading, sealing, and non-bridging action which can help obtain proper density.

Sticking to Truckbeds

As experienced in Ohio, these same modified mixtures, Superpave or not, may also exhibit a tendency to stick to the flat beds of the dump trucks, even more than conventional asphalts. This problem can be reduced by using proper mixing temperature and maintaining the elevated temperature of the mixture in the truck, by using tarps to help insulate from heat loss. A release agent could be applied in a uniform thin spray coating after the truck has been properly emptied and cleaned. In addition, some release agents do appear to be more effective with modified binders.