national superpave news

Volume 1, Number 3 Summer 1999

Asphalt Institute Announces a Superpave Event for the 21st Century

Superpave: Building Roads for the 21st Century, a jointly sponsored Asphalt Institute and Federal Highway Administration conference, will be held April 10-12, 2000, at the Denver Marriott Tech Center, 4900 S. Syracuse Street, Denver, Colorado 80237, (303-740-2531). It will start at 1:00 p.m. on Monday, April 10, and adjourn at noon on Wednesday, April 12. There will be four sessions.

Session I.Selecting Materials includes Aggregates, RAP, and Binders.

Session II. Design and Production includes Right Pavement in the Right Place, Criteria, Volumetrics, Hot Mix Production, and Production QC/QA.

Session III. Construction and QC/QA includes Lay Down, Compaction, QC/QA, Smoothness, Equipment for Quality Paving, Work Force Development

Session IV. Performance and the Future includes Performance Experience, Binders-Spec Changes, Performance Testing, and Performance Related Specifications.

This conference will provide an interactive forum to continue the partnerships and common goals of implementing the Superpave system. Practitioners experienced in Superpave will present their findings in construction, performance and the reality of Superpave for the Hot Mix Asphalt industry.

Participants will have a unique opportunity to exchange practical applications and experiences with individuals experienced in the design specification, production and construction of Hot Mix Asphalt using the Superpave System.

Performance of Superpave Mixes Surveyed

E. R. Brown, Director, NCAT

Superpave was developed in the laboratory and there has been very little actual performance data available. Since some projects (such as WesTrack) had shown some performance problems with the Superpave coarse-graded mixes, it was determined that an early evaluation was needed. The Federal Highway Administration contracted with NCAT to inspect approximately 40 in-place Superpave mixes to evaluate performance to date. Eight states that had used a significant amount of Superpave were selected to participate in this study. The states were also selected so that all geographical areas of the United States were covered. The states selected included Arizona, Colorado, Florida, Indiana, Maryland, New York, Virginia and Wisconsin. A minimum of three projects were randomly selected from each state. In the selection process, emphasis was placed on older Superpave pavements so that a better evaluation of performance could be determined. The survey evaluated the amount of cracking, raveling, and rutting. The overall appearance was also evaluated. No sampling or testing was involved, however, QC\QA data was collected where available.

The inspection of 44 Superpave pavements in eight states has indicated that the short term performance of Superpave is good. The age of most of the Superpave mixes was too low to establish long term performance. The age of the projects ranged from new construction to three years. At the time of inspection, there were 38 projects or subprojects of projects that were rated as good, eight rated as fair, and two rated as poor. There were some early problems with some of the pavements inspected, but most of the problems appeared to be related to the underlying layers or construction deficiencies. Some states have made adjustments in specifications and design procedures to reduce the occurrence of some of these early problems, such as high permeability.

There is some concern about the long term durability of some of these coarse-graded Superpave mixes, especially those that have permeability problems. It is necessary that those projects having high permeability continue to be monitored so that performance data is available on a regular schedule. A data collection form is provided as a part of this study.

The most common problem that was observed, that is specifically related to Superpave mixes, is permeability. The coarse-graded Superpave mixes do have high permeability when not properly compacted. With fine-graded mixes, permeability is not a problem until about 8 percent air voids are exceeded. It appears with these coarse-graded mixes that permeability may become a problem when 6 percent air voids are exceeded.

Some of the Superpave mixes evaluated have varying amounts of cracking. Most of the cracking observed, however, appeared to be related to the underlying material. As these Superpave mixes continue to age, data must be collected to verify the ability of these mixes to resist cracking.

Superpave Specifications for Surface Treatments

Darren Hazlett, TxDOT Asphalt & Chemical Branch Manager

There have been some initiatives to develop Superpave-like specification requirements for surface treatment binders, both asphalt emulsions and hot applied asphalt cements.

The Superpave binder tests certainly can be used to evaluate soft asphalts and emulsion residues which are used for surface treatments, but directly using the Superpave specification criteria is questionable. Superpave was developed to address, rutting, fatigue cracking and thermal cracking in HMAC.

1) Rutting resistance is not meaningful for surface treatments, but we want a stiff enough binder to retain aggregate chips under traffic (not be dislodged, roll or move).

2) Thermal cracking of HMAC is not meaningful for surface treatments, but we don't want the binder becoming brittle in cold weather, fracturing under load and losing the aggregate.

3) Certainly the HMAC plant aging simulated by the RTFOT is not applicable, but surface treatment binders do age in the long term so the PAV might be applicable.

Some of the Superpave tests can apply to surface treatment binders, but the specification limits may not be correct to address surface treatment distresses.

In addition to the above complications in using the Superpave binder specification for surface treatment binders, there are some other considerations. The temperatures seen by surface treatment binders are higher than Superpave grade selection temperatures for HMAC. Also, traditionally the binders used have been less stiff than binders used for HMAC under the Asphalt Cement grading system.

ASTM Subcommittee D04.41, "Emulsified Asphalt Specifications," has begun looking at using some of the Superpave tests for emulsion residues. The issue first arose as an attempt to develop specifications for polymer modified emulsions. Darren Hazlett with the Texas Department of Transportation is the chairman of a task force set up to address this issue. The task was broadened to address testing emulsion residues with some of the Superpave binder tests for all emulsions and to cover both modified and unmodified systems. A proposed specification has been sent to ASTM D04.41 for ballot. The proposed specifications require nomenclature to describe the emulsion and the residue. The residue properties are termed SG for Surface Grade and use associated high and low temperature designations similar to PG binders. Some of the above complications and considerations have been addressed in the proposed ASTM specification by the choice of tests and values. The actual numbers in the proposed specification are a starting point in the specification development process. The ballot should generate a lot of interest and constructive comments.

The two tables numbered as "Table 1" present the requirements for the Cationic Emulsified Asphalt and Emulsified Asphalt. Both of these tables refer to "Table 2" for emulsion residue properties.

TABLE 1 Requirements for Emulsified Asphalt

Type	Rapid-Setting						Slow-Setting	
Grade	RS-1(SG xy)		RS-2(SG xy)		HFRS-2(SG xy)		SS-1(SG xy)	
	min	max	min	max	min	max	min	max
Tests on emulsions:							20	100
Viscosity, Saybolt Furol at 25C, SFs	20	100						
Viscosity, Saybolt Furol at 50C, SFs			75	400	75	400		
Storage stability test, 24-h, %*		1		1		1		1
Demulsibility, 35 ml, 0.02 N CaCl2,%	60		60		60			
Coating ability and water resistance:								
Coating, dry aggregate								
Coating, after spraying								
Coating, wet aggregate								
Coating, after spraying								
Cement mixing test, %								2.0
Sieve test, %*		0.10		0.10		0.10		0.10
Residue by distillation, %	55		63		63		57	
Oil distillate by volume of emulsion, %								
Tests on residue from distillation test:								
Residue Properties	Must Meet One of the Surface Grades in Table 2 as Specified (SG xy)							
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5	
Float test, 60C, s					1200			

Type	Medium-Setting									
Grade	MS-1(SG xy)		MS-2(SG xy)		HFMS-1(SG xy)		HFMS-2(SG xy)		HFMS-2s(SG xy)	
	min	max	min	max	min	max	min	max	min	max
Tests on emulsions:					20	100	100		50	
Viscosity, Saybolt Furol at 25C, SFs	20	100	100							
Viscosity, Saybolt Furol at 50C, SFs										
Storage stability test, 24-h, %*		1		1		1		1		1
Demulsibility, 35 ml, 0.02 N CaCl2,%										
Coating ability and water resistance:										
Coating, dry aggregate	good		good		good		good		good	
Coating, after spraying	fair		fair		fair		fair		fair	
Coating, wet aggregate	fair		fair		fair		fair		fair	
Coating, after spraying	fair		fair		fair		fair		fair	
Cement mixing test, %										
Sieve test, %*		0.10		0.10		0.10		0.10		0.10
Residue by distillation, %	55		65		55		65		65	
Oil distillate by volume of emulsion, %									1	7
Tests on residue from distillation test:										
Residue Properties	Must Meet One of the Surface Grades in Table 2 as Specified (SG xy)									
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5		97.5	
Float test, 60C, s					1200		1200		1200	

* This test requirement on representataive samples is waived if successful application of the material has been achieved in the field.

Table 1 - Requirements for Emulsified Asphalt

TABLE 1 Requirements for Cationic Emulsified Asphalt

Type	Rapid-Setting				Medium-Setting		Slow-Setting	
Grade	CRS-1(SG xy)		CRS-2(SG xy)		CMS-2(SG xy)		CSS-1(SG xy)	
	min	max	min	max	min	max	min	max
Test on emulsions:								
Viscosity, Saybolt Furol at 25C, SFs							20	100
Viscosity, Saybolt Furol at 50C, SFs	20	100	100	400	50	450		
Storage stability test, 24-h, %*		1		1		1		1
Demulsibility, 35 mL, 0.8% dioctyl sodium sulfosuccinate, %	40		40					
Coating ability and water resistance:								
Coating, dry aggregate					good			
Coating, after spraying					fair			
Coating, wet aggregate					fair			
Coating, after spraying					fair			
Particle charge test	positive		positive		positive		positive	
Sieve test, %*		0.10		0.10		0.10		0.10
Cement mixing test, %								2.0
Distillation:								
Oil distillate, by volume of emulsion, %		3		3		12		
Residue, %	60		65		65		57	
Test on residue from distillation test:								
Residue Properties	Must Meet One of the Surface Grades in Table 2 as Specified (SG xy)							
Solubility in trichloroethylene, %	97.5		97.5		97.5		97.5	

*This test requirement on representative samples is waived if successful application of the material has been achieved in the field.

Requirements for Cationic Emulsified Asphalt

Table 2 Surface Grade Emulsion Residue Properties

Surface Grade (SG xy)	SG 58				SG 64			SG 70			SG 76			SG 82		
	-16	-22	-28	-34	-16	-22	-28	-16	-22	-28	-16	-22	-28	-16	-22	-28
x = Average 7-day Maximum **Surface** Design Temp, C (1)	<58				<64			<70			<76			<82		
y = Minimum **Surface** Design Temperature, C (1)	>-16	>-22	>-28	>-34	>-16	>-22	>-28	>-16	>-22	>-28	>-16	>-22	>-28	>-16	>-22	>-28
Original Emulsion Residue																
Dynamic Shear, AASHTO TP5: G*/sin , Minimum, 0.50 kPa, Test Temp @ 10 rad/s, C	58				64			70			76			82		
Phase Angle δ , max. @ Temp x			80	80			80		80	80		80	80		80	80
Pressure Aging Vessel Emulsion Residue (AASHTO PP1)																
PAV Aging Temperature, C	100															
Creep Stiffness, AASHTO TP1: S, Maximum, 300.0 Mpa, m-value, Minimum, 0.300, Test Temp @ 60 s, C	-6	-12	-18	-24	-6	-12	-18	-6	-12	-18	-6	-12	-18	-6	-12	-18
Direct Tension, AASHTO TP3: Failure Strain, Minimum, 1.0%, Test Temp @ 1.0 mm/min, C (2)	-6	-12	-18	-24	-6	-12	-18	-6	-12	-18	-6	-12	-18	-6	-12	-18

(1) Temperatures are at the Surface of the pavement structure. These may be determined from experience or may be estimated using equations developed by SHRP or LTPP, but modified to represent surface temperatures. Surface Grade high temperatures are generally 3°C to 4°C greater than those determined for Superpave PG binders.

(2) If the creep stiffness is below 300.0 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

Table 2 - Surface Grade Emulsion Residue Properties

RESEARCH IN PROGRESS:

Mixing and Compaction Temperatures for Modified Asphalt Binders

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Superpave mixture design requires that gyratory specimens be mixed and compacted at equiviscous binder temperatures corresponding to viscosities of 0.17 and 0.28 Pa·s, respectively. Those values were previously used in the Marshall mix design method to determine the mixing and compaction temperatures. Estimation of the proper mixing and compaction temperatures involves developing a temperature viscosity relationship for the binder (ASTM D2493, *Calculation of Mixing and Compaction Temperatures*).

This approach is simple and provides reasonable temperatures for unmodified binders. However, some modified binders have exhibited unreasonably high mixing and compaction temperatures when using this technique. This is due to the fact that modified binders are very sensitive to shear rate. Currently, low shear rates are used to attain viscosities of 0.17 and 0.28 Pa·s. It is common that modified binders tested at low shear values result in high temperatures, where binder temperatures in excess of 190º C have often been reported. Currently, mix designers address this issue by consulting with the supplier of the modified binder to obtain recommended temperatures. In many cases, however, the supplier has no solid information on which to base a recommendation. Furthermore, binder suppliers may even be dealing with a material with which they have little or no experience. Thus, there is a need to establish a more rigorous and fundamentally sound procedure for selecting reasonable mixing and compaction temperatures for use in Superpave mix design. In this study the objective is to develop a new protocol that can be used to establish sensible values for mixing and compaction temperatures.

It is important to emphasize that ASTM D2493 was established for unmodified asphalt binders, which are Newtonian fluids at high temperatures. For these materials, viscosity does not depend on shear rate. However, modified asphalt binders exhibit a phenomenon known as pseudoplasticity, commonly referred as shear thinning at high temperatures where viscosity values depend on shear rate. Figure 1 shows the viscosity-shear rate relationship for a multigrade modified asphalt binder (MG 40-20 that grades as a PG 70-22). It can be seen that viscosity decreases with an increase in shear rate. Figure 2 shows the viscosity-shear rate relationship for an unmodified asphalt binder (PG 64-22). The viscosity of

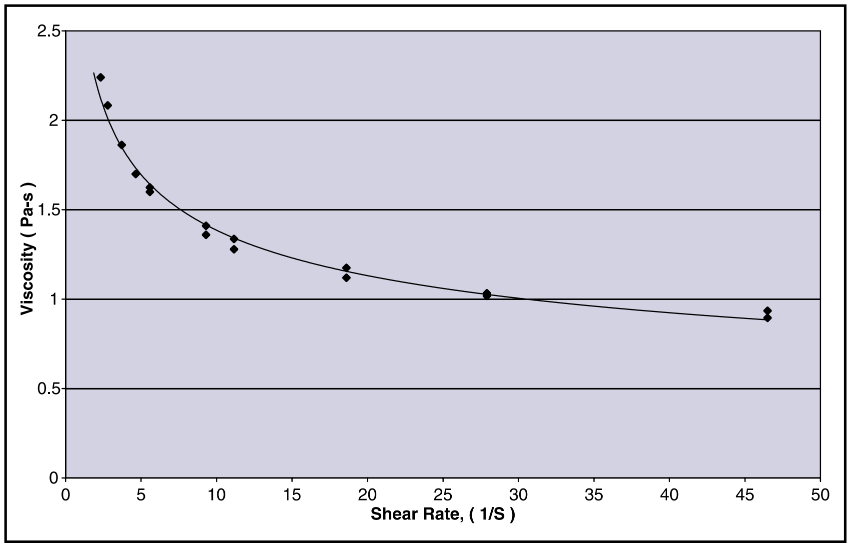

Figure 1. Viscosity vs. Shear rate - modified binder.

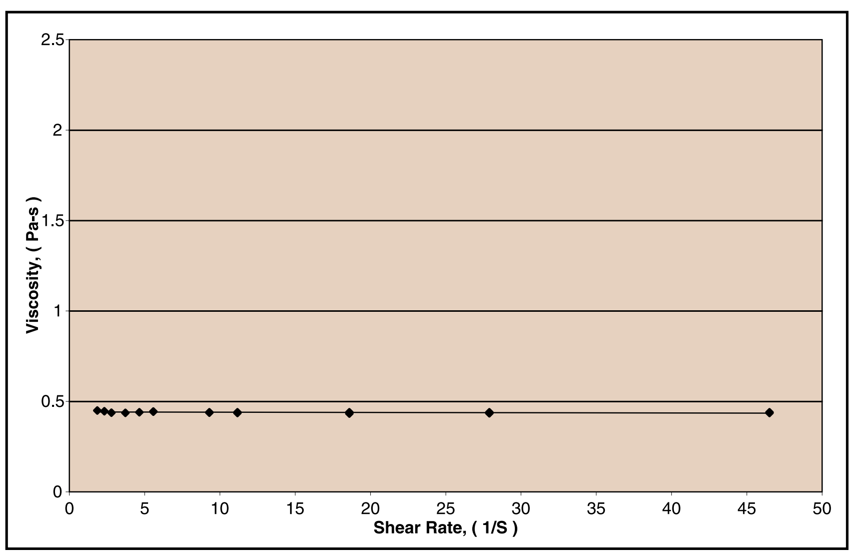

Figure 2. Viscosity vs. Shear rate - unmodified binder.

the unmodified asphalt binder does not change as the shear rate increases. The viscosity of unmodified asphalt binders does not depend on shear rate.

The shear rate during the mixing and compaction process is greater than the shear rate that is used during viscosity measurements. Therefore, viscosity measurements with the current procedure for modified asphalt binders do not reflect the viscosity values of the binder during mixing and compaction. ASTM D2493 does not specify any shear rate value for viscosity measurements.

In the research study in progress, the shear rate during mixing and compaction will be determined such that the effect of it will be included during viscosity measurements. The use of practical shear values will result in sensible mixing and compaction temperatures used for hot mix asphalt design with modified asphalt binders.

There are several factors that affect the bulk specific gravity (G_{mb}) of a bituminous specimen. They include gradation of the aggregate, aggregate type, asphalt content, viscosity of the asphalt binder and the type of compactor. If all factors that have an effect on G_{mb} are kept the same, the G_{mb} for any two specimens will be similar. This idea can be used in the calculation of shear rate inside the SGC.

Specimens will be compacted at different temperatures and their G_{mb} values will be calculated. All variables other than temperature will be kept the same. Generally the G_{mb} values will increase with increasing temperature. The relationship between G_{mb} and temperature will be determined for compacted specimens made with a modified asphalt binder and an unmodified asphalt binder. By using this relationship for the modified and the unmodified asphalt binder, the temperatures that give the same G_{mb} values will be found. Thus it is believed that specimens compacted with modified and unmodified asphalt binders with the same G_{mb} will have the same viscosity during compaction. The shear rate viscosity relationship, similar to that seen in Figures 1 and 2, will have determined for these two binders at the temperatures yielding the same G_{mb}. The Rotational Viscometer and Dynamic Shear Rheometers will be used to find these relationships. The shear rate experienced during compaction for these two binders will be calculated from the measured shear rate-viscosity relationship.

In summary, the significance of this shear rate is that it can be used in determining viscosity for mixing and compaction temperature calculations for modified asphalt binders. It is foreseen that this procedure will produce practical temperatures because it is based on laboratory compacted specimens, as well as advanced testing devices. For this study all research work is expected to be completed by the end of the summer.

AASHTO Approves Superpave Changes

Rebecca S. McDaniel, Technical Director
North Central Superpave Center

The results of the AASHTO ballot on recommended changes in the Superpave specifications are in. As reported in the last issue of this newsletter, changes to four specifications related to Superpave were recommended to AASHTO by a task force under the Subcommittee on Materials. The specifications being modified include PP2, *Standard Practice for Short and Long Term Aging of Hot Mix Asphalt*; TP4, *Standard Method for Preparing and Determining the Density of Hot Mix Asphalt Specimens by Means of SHRP Gyratory Compactor;* MP*2, Standard Specifications for Superpave Volumetric Mix Design*; and PP28, *Standard Practice for Designing Superpave Hot Mix Asphalt*. All of the changes recommended have been approved by the Subcommittee on Materials and are included in the May 1999 Interim Edition of the AASHTO Provisional Standards.

The most significant changes include the following ten items.

- A new, simplified N_{design} table has been adopted. This new table, combined with the aggregate consensus properties, results in five mix design levels for four different traffic levels. The separate design air temperature columns have been deleted.
- Other issues associated with use of the N_{design} table, such as the definition of the design period and depth of layer, have been clarified.
- The short term mixture aging temperature has been changed to correspond to the compaction temperature, reducing the number of ovens required to do a mix design from three to two.
- The application of the short term aging procedure has also been clarified. For volumetric mix design purposes, the short term aging period is two hours. When mechanical property testing is to be performed on samples, a four-hour short term aging period is to be used. The new specification also clarifies that short term aging, now referred to as short term mixture conditioning, is only applicable to laboratory prepared loose mix, not to plant mixed material.
- Gyratory specimens for volumetric properties should be compacted to N_{design} rather than $N_{maximum}$.
- Gyratory samples at the design binder content should be compacted to N_{max} to verify that 2% air voids still remain in the sample (98% G_{mm}).
- The allowable dust proportion has been increased to 0.6 to 1.6. The previous maximum allowable dust proportion was 1.2, therefore this change allows more dust in the mixtures.
- The voids filled with asphalt (VFA) requirements for some nominal maximum aggregate sizes have been changed to be more realistic. The VFA range for 9.5 mm mixes with traffic volumes over 3 million ESALs is now 73-76%. The range for 25.0 mm mixes with less than 0.3 million ESALs is 66-80%. For 37.5 mm mixes, the lower limit for VFA shall be 63% at all

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ESAL levels. This change may allow higher percentages of sand for the lower traffic volumes.

- The maximum density (%G_{mm}) at $N_{initial}$ has been changed for traffic levels up to 3 million ESALs. For under 0.3 million ESALs, the maximum %G_{mm} is 91.5% and for 0.3 to 3 million ESALs, the maximum G_{mm} is 90.5%. For greater than 3 million ESALs, the maximum %G_{mm} remains 89.0%.
- The new specifications also incorporate the new LTPP algorithm for low pavement temperature. This new algorithm acknowledges that the low pavement temperature is warmer than the low air temperature. This may affect the low temperature binder grade specified in some areas by one or two grades.

There are other changes, but these are probably the most significant.

Copies of the Interim Edition of the Provisional Standards are available for purchase from the American Association of State Highway and Transportation Officials, 444 North Capitol Street, NW, Suite 249, Washington, DC, 20001, www.aashto.org.

RESEARCH IN PROGRESS:

RESTRICTED ZONE IN THE SUPERPAVE AGGREGATE GRADATION SPECIFICATION

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The Strategic Highway Research Program's (SHRP) asphalt research was primarily aimed at the properties of asphalt binders and paving mixes and their effect on asphalt pavement performance. The study of aggregate properties (including gradation) was intentionally excluded from the asphalt research program. Yet the SHRP researchers had to recommend a set of aggregate properties and an aggregate gradation specification without the benefit of experimentation so that a comprehensive Superpave mix design system could be formulated.

SHRP formed an Aggregate Expert Task Group (ETG) consisting of 14 acknowledged experts in the area of aggregate. In lieu of a formal aggregate research program, the aggregate ETG used a modified Delphi approach to develop a set of *recommended* aggregate properties and criteria that are now included in the Superpave volumetric mix design method. The Delphi process was conducted with five rounds of questionnaires. The final recommended aggregate gradation criteria included control points which the gradation must fall between and a restricted zone that lies along the maximum density line (MDL) between the intermediate size (either 4.75 or 2.36 mm depending on the nominal maximum size of the aggregate in the mix) and the 0.3 mm size.

Although the restricted zone was included in Superpave as a recommended guideline and not a required specification, some highway agencies are interpreting it as a requirement.

Many asphalt technologists believe that the compliance with the restricted zone criteria may not be desirable or necessary in every case to produce asphalt mixes with good performance. If highly angular aggregates are used in the mix it is likely that the mix will not exhibit any tenderness during construction and will be rut-resistant under traffic although its gradation may pass through the restricted zone. The Georgia Department of Transportation has used such mixes successfully for many years. Some asphalt technologists also question the need for the restricted zone when the mix has to meet volumetric properties such as minimum voids in the mineral aggregate (VMA) and specified air void contents at $N_{initial}$, N_{design} , and $N_{maximum}$ gyrations.

It is obvious that the effect of the restricted zone on mix performance should be evaluated on the basis of a statistically planned and properly controlled experiment. This is the subject of the National Cooperative Highway Research Program (NCHRP) Project 9-14 "Investigation of Restricted Zone in the Superpave Aggregate Gradation Specification" undertaken by the National Center for Asphalt Technology (NCAT) in May 1998. The primary objective for this research is to determine under what conditions, if any, compliance with the restricted zone requirement is necessary when the asphalt paving mix meets all other Superpave requirements such as fine aggregate angularity (FAA) and volumetric mix criteria for the project.

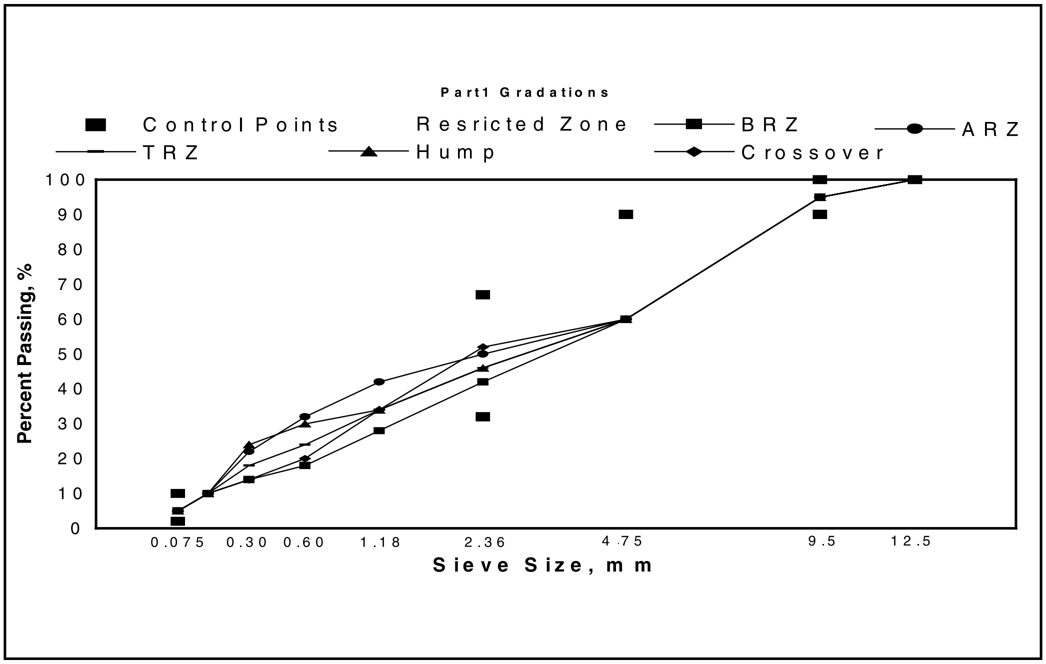
Since the restricted zone is applied within the fine aggregate sieve sizes, the shape and texture of the fine aggregates are the most important factors affecting the performance of HMA mixtures. Therefore, the approach taken in identifying and selecting fine aggregates for use in this study was to select aggregates with varying values of fine aggregate angularity (FAA). Also included within the selection criteria were mineralogical composition of the fine aggregates and type of crusher. Maximization of these three criteria will ensure using fine aggregates with a wide range of properties.

Factor-level combinations to be included in Part 1 of this project consist of two coarse aggregates, nine fine aggregates, five 9.5 mm nominal maximum aggregate size (NMAS) gradations, and one compactive effort. Different NMAS gradations and compactive efforts will be used in Parts 2 and 3 of this project. Of the five gradations proposed to be used in all parts, three will violate the restricted zone (VRZ) while two will reside outside the restricted zone (control). These five gradations are illustrated in Figure 1.

All five gradations follow the same trend from the 12.5 mm sieve down to the 4.75 mm sieve. From the 4.75 mm sieve, the BRZ gradation passes below the restricted zone and above the lower control points. The ARZ gradation passes above the restricted zone and below the upper control points. These two gradations are designated the control gradations since they do not violate the Superpave restricted zone. The remaining three gradations do violate the restricted zone. From the 4.75 mm sieve, the TRZ gradation passes almost directly along the maximum density line through the restricted zone. The Hump (HRZ) gradation follows a similar gradation as the TRZ gradation down to the 1.18 mm sieve where it humps on the 0.6 and 0.3 mm

Restricted Zone continued next page

sieves. The HRZ gradation represents gradations generally containing a large percentage of natural sands, and is likely to cause tender mixes. From the 4.75 mm sieve, the Crossover (CRZ) gradation begins above the restricted zone on the 2.36 mm sieve but then crosses through the restricted zone between the 0.6 and 0.3 mm sieves. The CRZ gradation represents gradations which are not continuously graded between 2.36 mm and 0.60 mm sizes and generally exhibit low mix stability. All five of the gradations then meet at the 0.15 mm sieve and follow the same trend down to the 0.075 mm sieve. A common material passing 0.075 mm sieve or No. 200 sieve (P200) will be used in all HMA mixtures to eliminate P200 as a variable. Different P200 materials stiffen the asphalt binder and HMA mixtures to a different degree and, therefore, will affect the mix performance test results.



Based on Figure 1, for a given factor-level combination mixture designs will first be conducted for the three gradations violating the restricted zone (TRZ, HRZ, and CRZ). If any of these three mix designs meet all Superpave volumetric requirements, then mix designs will be conducted for the two control gradations (ARZ and BRZ). However, if none of the mix designs violating the restricted zone meet all volumetric requirements, then testing will be stopped for that factor-level combination. Mixtures meeting all volumetric requirements will be used for performance testing. This approach was selected because the Superpave volumetric requirements are believed to detect a potential problem mixture.

The performance of mixes with various factor-level combinations meeting volumetric requirements will be evaluated on the basis of performance related mechanical tests. Since the primary purpose of the restricted zone is to avoid rut-prone mixes, the mixes in this study will be evaluated for their rutting potential. This will be accomplished by two different types of tests: empirical and fundamental. For the empirical test, the Asphalt Pavement Analyzer (APA) will be used. The Superpave shear tester (SST) and the dynamic confined creep (DCC) test will be utilized as fundamental tests. These three tests are proposed to ensure a satisfactory conclusion of this study.

The Asphalt Pavement Analyzer (APA) II is an automated, new generation of Georgia Load Wheel Tester. The APA II features controllable wheel load and contact pressure, adjustable temperature inside the test chamber, and the capability to test the samples either while they are dry or submerged in water. The APA test will be conducted dry with 8,000 cycles, and rut depths will be measured continuously. The APA can test three pairs of gyratory compacted specimens of 75 mm height. Testing with the APA will be conducted at 64°C, which corresponds to a PG 64 asphalt binder to be used in this study.

The Superpave shear tester (SST) developed by SHRP is a closed-loop feedback, servo hydraulic system that consists of four major components: a *testing apparatus*; a *test control unit*; an *environmental control chamber*; and a *hydraulic system*. The ability of a pavement structure to resist permanent deformation and fatigue cracking is estimated through the use of the SST. The SST simulates, among other things, the comparatively high shear stresses that exist near the pavement surface at the edge of vehicle tires; stresses that lead to the lateral and vertical deformations associated with permanent deformation in surface layers.

Dynamic confined creep test (or repeated, constant stress permanent deformation test) is considered to be a fundamental experimental method to characterize the rutting potential of HMA, since fundamental creep principles can be applied to deformation of viscoelastic mixes. A Material Testing System (MTS) will be used to conduct this test. A deviator stress along with a confining stress is applied on a HMA sample for 1 hour, with 0.1 second load duration and 0.9 second rest period. After the one hour test the load is removed and the rebound measured for 15 minutes. The strain observed at the end of this period is reported as the permanent strain. The permanent strain indicates the rutting potential of the mix. This test has been used successfully by NCAT in a national study of rutting. The test temperature will be 60°C. Test loadings will consist of an 138 kPa (20 psi) confining pressure and an 827 kPa (120 psi) normal pressure.

Test results from the three mechanical tests will be analyzed to obtain performance data of HMA mixtures containing different gradations and FAA values.

It is not expected that all three permanent deformation tests (one empirical and two fundamental) will provide exactly similar results. If that was the case, only one mix validation test would have been sufficient. However, all three tests may not be equally sensitive to changes in gradation and FAA values. Their relative sensitivity to changes in gradation and FAA values will be evident from the test data. The test which is most sensitive to these two important factors of this research project will be considered relevant and significant.

Statistical analysis of the test data should demonstrate very clearly under what conditions, if any, compliance with the restricted zone requirement is necessary when the HMA mix meets all other Superpave requirements such as FAA and volumetric mix criteria for the project.

This project is scheduled to be completed by April 30, 2000.

Superpave Usage Doubles Nationwide

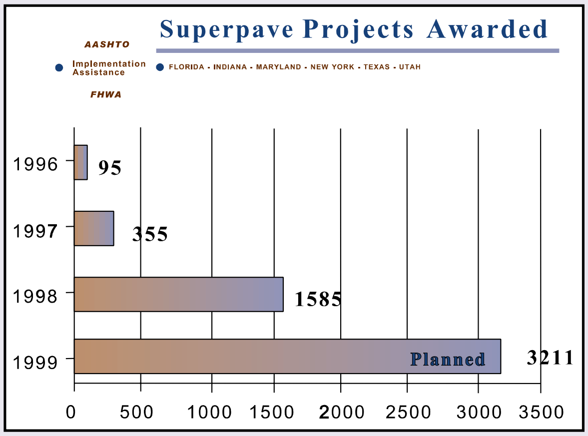


Figure 1

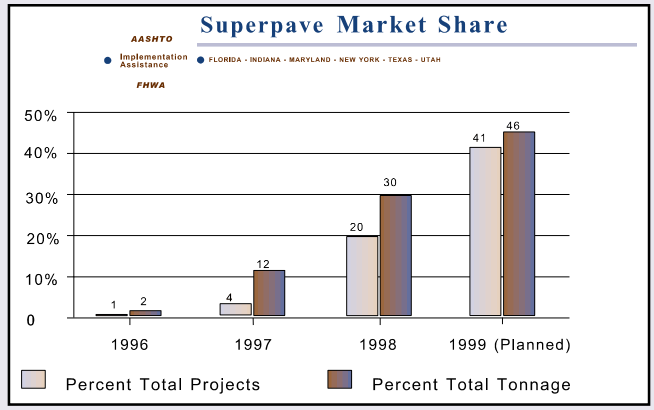


Figure 2

Results of a nationwide survey conducted by the New York DOT on behalf of the Superpave Lead State team show that twice as many Superpave projects were awarded for 1999 as for 1998. Plans for the 1999 construction season called for over 3200 Superpave projects to be awarded, up from 1585 projects awarded in 1998. Figure 1 graphically shows the dramatic increase in numbers of projects since 1996.

The projects planned for 1999 represent about 41% of the planned projects overall and 45% of the total tonnage of hot mix asphalt. Again, this is a large increase over 1998 and a huge growth since 1996. See Figure 2 for details. By the year 2001, projections indicate that Superpave mixtures will account for over 124 million tons of hot mix, representing 82% of the total tonnage (Figure 3). The distribution of projects on a state by state basis is shown in Figure 4.

Nearly every state in the US plans to implement the binder specification by the year 2000, with the exceptions of California and Utah, which have not yet determined when they will implement PG binders, and Nevada and New Jersey, which will implement after 2000.

Implementation of the mixture design process is progressing less rapidly, as expected. However, the majority of the states do plan to implement the Superpave mixture specifications by the year 2000 as shown in Figure 5.

Additional information from the survey is available on the Lead States webpage at http://leadstates.tamu.edu.

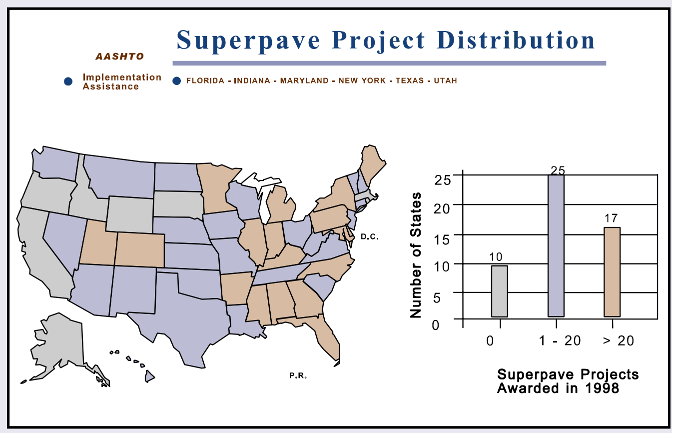


Figure 3

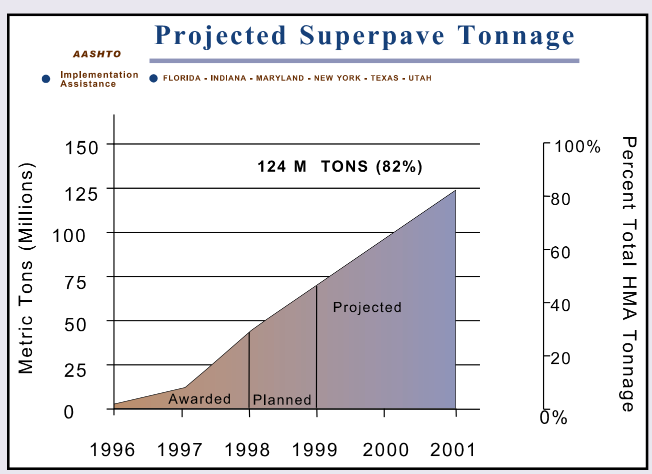


Figure 4

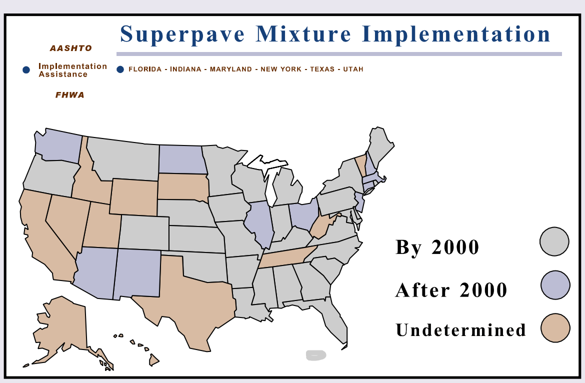


Figure 5