Implementation of Superpave

by Dr. Richard W. May, Director of Technical Services, Asphalt Institute

The Superpave system is the culmination of five years and $50 million of research effort in asphalt materials by the Strategic Highway Research Program (SHRP). The fast-track research conducted under SHRP was unprecedented in its scope and depth, and it has brought to the highway industry many products that will improve the performance and durability of United States roads and to make those roads safer for both motorists and highway workers.

However, as with any massive research effort, completing the research means that only half the work is done. Research products must be brought out of the laboratory and used in the field, and Superpave is no different. And as experience is gained during product implementation, new concerns and issues arise that were either not the scope of the original research or have come up as the new product is used. This is no different with Superpave.

The Federal Highway Administration (FHWA) has been tasked by Congress to direct the implementation of all of the SHRP research results. There are many entities involved in this vast implementation effort and this article has been written to highlight the status some of the programs pertaining to Superpave, as well as the various sources of information.

TWG and ETGs

The FHWA has formed two groups to manage and assist in the ongoing evaluation of the various products developed by the SHRP research. A Technical Working Group (TWG) oversees many aspects of a specific subject area of the SHRP research. The Asphalt TWG manages the Superpave evaluation and implementation. A TWG is supported technically by various Expert Task Groups (ETGs); the Binder ETG and Mixtures ETG are two that work with the Asphalt TWG.

There are two primary sources of funding now being used to investigate specific ways to improve Superpave. The National Cooperative Highway Research Program (NCHRP) is funded by the state transportation departments to conduct research of a national scope, and it funds research in all aspects of highway needs, including Superpave. The FHWA has included funding in its second National Asphalt Training Center contract (NATC II) with the Asphalt Institute to use national expertise in investigating Superpave concerns.

PG Asphalt Binder

Superpave represents a good direction for the asphalt industry. The Superpave system includes a new Performance Graded (PG) asphalt binder specification that incorporates a number of new and adopted test procedures to measure the physical properties over the complete range of the binder service life. The condition of the asphalt binder is simulated at various stages of its service life. The test procedures evaluate the ability of the binder to do its part in preventing the three critical distresses of asphalt pavements: rutting, fatigue cracking and low temperature cracking.

The binder specification was the most complete part of Superpave when the SHRP research was completed, and most states will be using the PG grading by January 1, 1997. Arkansas, Utah, and Texas have already implemented the PG grading spec. The FHWA initiated and has completed a pooled-fund purchase providing the first set of the PG test equipment for all the states, and much of the industry is comfortable with the PG system. As with any new test or piece of equipment, there are things that are being refined and reevaluated; everyone has definitely learned as they used them.

Superpave Binder Studies

The Binder ETG is investigating issues related to the PG specification. Topics that the Binder ETG is exploring include various equipment concerns, such as those related to different manufacturers using different design approaches for "new" equipment. They are recommending more research to establish a method of calculating low pavement temperature. Currently it is assumed to be equal to the air temperature, which is very conservative. Through the FHWA Long-Term Pavement Performance (LTPP) program, data is being collected and new calculation methods are being explored.

One study has been initiated to further explore how various types of modified asphalts fit into this system and how to establish mixing and compaction temperatures. The NCHRP has awarded Project 9-10 to the Institute and the National Center for Asphalt Technology (NCAT) to investigate these materials. In addition, under the NATC II contract, the Institute is comparing the behavior of various types of modified PG 76-22 binders. Also, everyone wants to know the repeatability and variability of the PG test results to understand how to interpret differences in measurements. Several round-robin test programs are underway to resolve this issue.

Even with all of the questions, the PG binder specification represents a significant improvement for the asphalt industry over penetration, ductility, and viscosity measurements. The questions

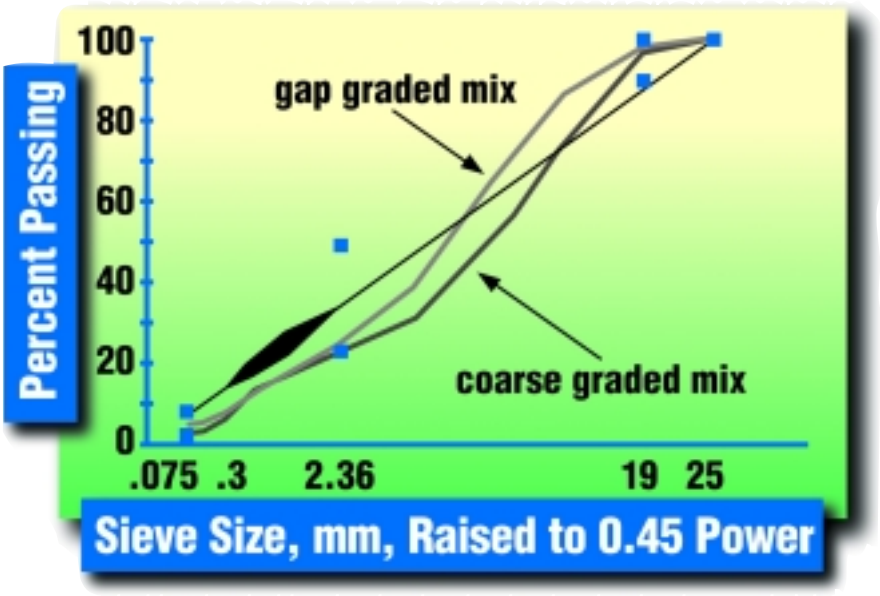

Figure 1. Aggregate Gradation Controls in Superpave

will eventually be resolved.

AI has been working with the American Association of State Highway and Transportation Officials (AASHTO) to develop a Standard Practice for an Approved Supplier Certification System for Suppliers of Performance Graded Asphalt Binders, PP 26, which will facilitate the overall implementation process for both suppliers and agencies. The procedures included in PP 26 will help ensure that the binder used on a project meets the specified PG grade.

Superpave Asphalt Mixture Design

Superpave also includes a completely-revised asphalt mixture design and analysis practice. To obtain specimens that represent the actual pavement, SHRP developed the Superpave Gyratory Compactor (SGC), adopting the most reasonable parameters from the French and Texas gyratory compaction devices. The SGC slowly kneads the mix together into a mass that has similar composition and aggregate orientation as found in the roadway. In mix design, the SGC specimen is used to evaluate the proper volumetric proportioning of the asphalt, aggregate and air that make up the mix.

Existing aggregate criteria and test procedures have been adopted, by consensus, to provide a uniform method for all agencies to select aggregate materials for different traffic levels and the depth of the layer in the pavement structure. In the only new step that is different from current practice, the desired blend of aggregate stockpiles is selected from a number of trial blends based on several factors, such as aggregate gradation control points and a restricted zone. These gradation controls (see Figure 1) are intended to build an aggregate structure or skeleton that achieves a compromise that will produce both a durable and a stable asphalt mixture.

In trying to achieve consistency on a national level, SHRP adopted the 0.45 power chart, the ASTM D 3515 standard set of sieve sizes and control points to evaluate these trial blends. The restricted zone was adopted to avoid mixes that have too much fine sand material. These types of mixes have experienced problems many times in the past, exhibiting plastic flow behavior under traffic.

Superpave Gyratory Compactor

One of the nicest features of the SGC is that it provides additional data to evaluate the compactability of the laboratory mixture. By monitoring how the mix compacts (see Figure 2) initially (N_i), as well as after a maximum number of gyrations (N_m), an indication of mixture behavior is provided. The Institute and other organizations are investigating if the slope of the compaction curve will provide some useful information.

As one might expect, there are varying opinions over parts of this mix design framework. There is considerable debate over the Fine Aggregate Angularity (FAA) test and criteria and its intent to reduce the amount of rounded sands in the mix. Several organizations are investigating this issue.

Many people have questioned the use of the restricted zone; as a guideline, this zone is intended to help engineers

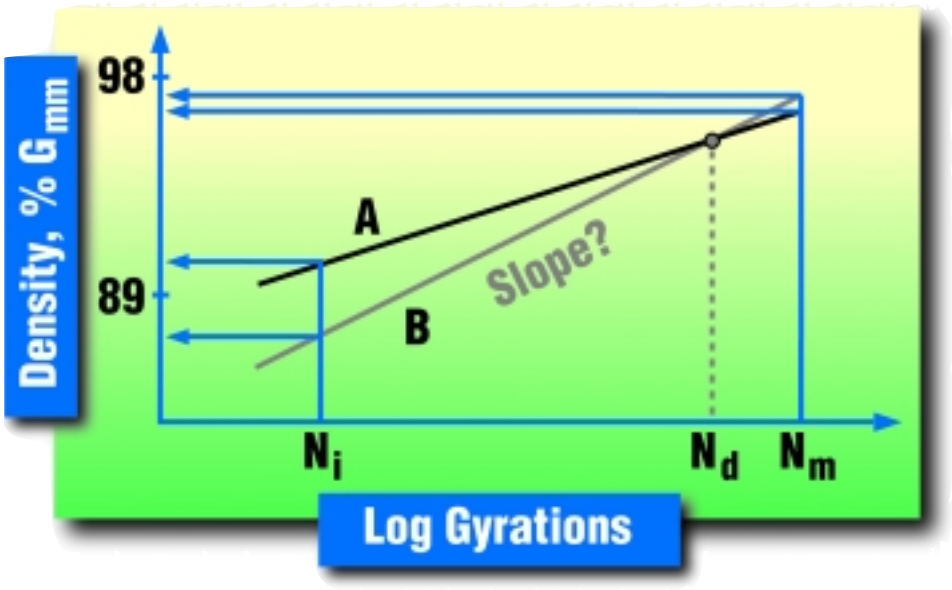

Figure 2. The SGC allows the compactability of the mix to be evaluated

when working with unfamiliar aggregates. Much of the controversy would disappear if everyone would use practical engineering judgment and remember that experience should always dictate. Good performing mixes that violate the restricted zone should not be abandoned. However, if the engineer has had bad experience or no experience with a blend of materials, the zone should be avoided. The Institute strongly recommends not only avoiding the restricted zone but also using gradations that fall below the restricted zone, especially for heavy traffic.

In addition, there are a few questions that need to be answered concerning the procedure used for measuring moisture sensitivity -- AASHTO T-283. The questions include the size of the specimen (100 mm vs. 150 mm diameter) as well as the aging process to be used (T-283 vs. Superpave short-term aging). Regardless of these issues, AASHTO T-283 has been shown in several studies to be the most consistently reasonable method for evaluating moisture susceptibility or detecting mixes in which the binder will strip off the aggregate. Further study will be done under a contract soon to be awarded by NCHRP.

Non-Conventional Mixes

More work needs to be done for mixes other than conventional dense-graded mixtures, such as open-graded mixes, stone matrix asphalt (SMA), and mixes that contain a significant amount of reclaimed asphalt pavement (RAP). NCHRP awarded Project 9-9 to NCAT and the Institute to explore some of the questions with non-conventional mixes. To answer some of the questions pertaining to RAP (e.g. blending binders, extractions, material variability, mix criteria), the FHWA has authorized some testing at the Institute under the NATC II and NCHRP is soon to award a new contract in this area.

In addition, under NATC II, the Institute and the Heritage Research Group are testing specimens cored from in-place pavements to further investigate the design number of gyrations (N_d) needed in the SGC to achieve 96 percent density or 4 percent air voids. Some believe that SHRP established too many design compaction levels (28) and it is known that these levels were based on limited data. Even though the current N_d concept appears to be working well based on hundreds of already-constructed projects, the FHWA Mix ETG has directed that more work be done to reevaluate this issue.

FHWA has completed the initial pooled-fund purchase of the SGC, providing the first device for all of the states. According to FOCUS, the FHWA newsletter that reports on the implementation of SHRP technology, a majority of states constructed Superpave Mix Design projects in 1996 (see Figure 3). Many of these states had previously constructed projects and are close to using Superpave mix design on a routine basis. The original goal established by FHWA for mix design implementation was the year 2000.

Beyond volumetric mix design, Superpave Mix Analysis involves sophisticated testing of SGC-prepared specimens and computer software analysis to process the test results. The Superpave Shear Tester (SST) and Indirect Tensile tester (IDT) are used to subject these specimens to various stress conditions to measure fundamental structural material properties that can then be used in various computer models to predict future

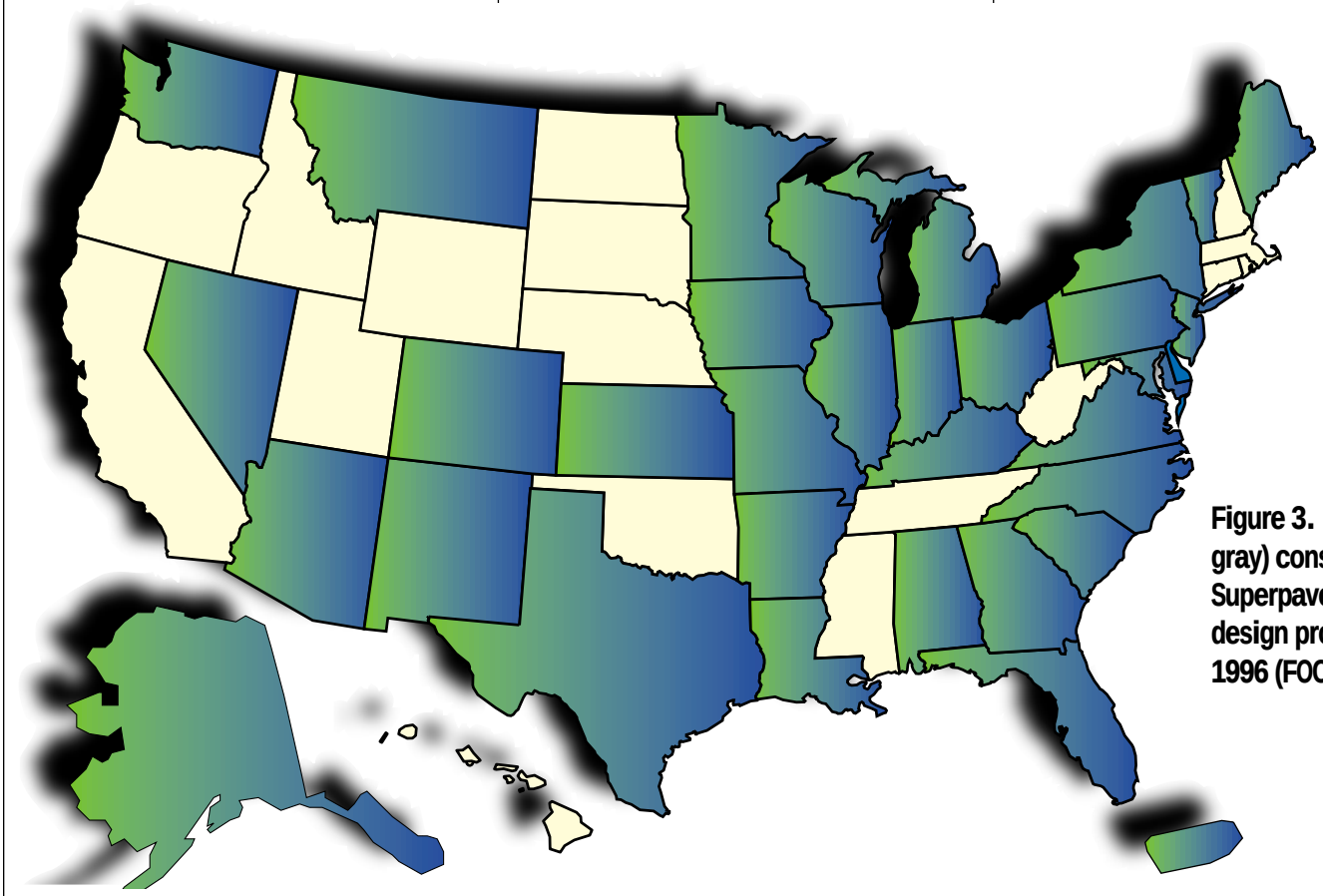

Figure 3. States (in gray) constructing Superpave mix design projects in 1996 (FOCUS).

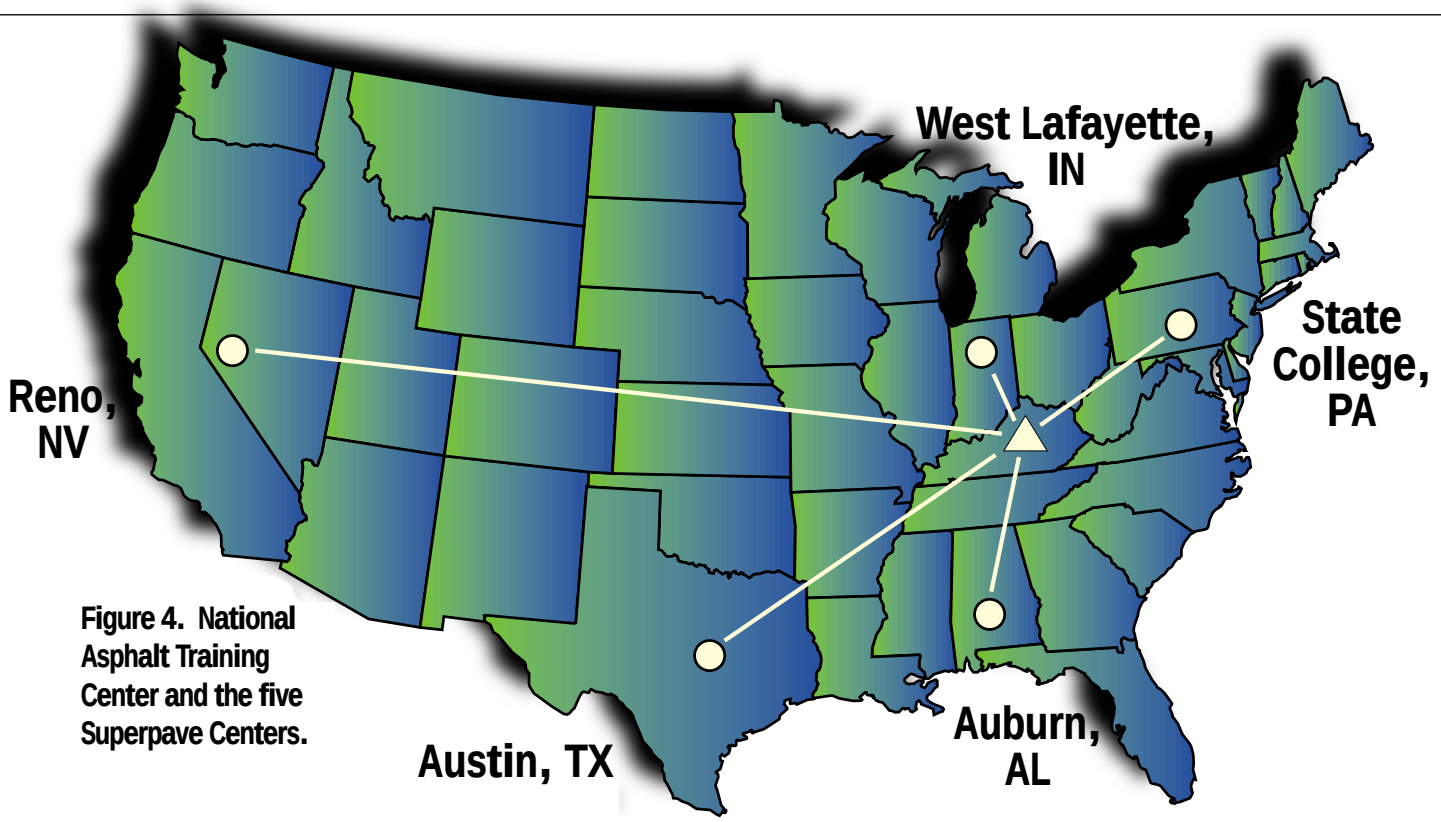

Figure 4. National Asphalt Training Center and the five Superpave Centers.

performance. This is the ultimate goal of Superpave. If the modeling and test procedures were verified and available, we would have a tool to explore various compromises and truly optimize the mix design for the specific traffic, climate, and structure of the specific project.

Because this goal is so important to the asphalt industry, the Asphalt Institute has done a lot of work in this area. We performed the first evaluation of the final SHRP testing, modeling, and software framework, and provided the initial feedback to FHWA. There are many questions that need to be resolved before Superpave Mix Analysis can be used confidently. However, two states (Arizona and Indiana) have partially implemented mix analysis on an experimental basis. The Superpave Mix Analysis system is now being evaluated under an FHWA contract by the University of Maryland. Basic changes in the software have been identified and recommendations for model improvement and change have been submitted.

To implement Superpave in the field, there is a great need for a process of field verification and quality control and assurance. NCHRP Project 9-7 was awarded to Brent Rauhut Engineering, Inc. soon after SHRP concluded to address these issues. The final report for this work is due at the end of the year.

Superpave Centers

Fortunately, unlike in the past, there are many forums available for both raising issues and obtaining information. An interesting and innovative concept of cooperation developed around SHRP. Based on the original Pacific Coast organization, five Asphalt User-Producer Groups, representing various parts of this country and Canada, have been formed to work on and resolve these kinds of problems. Their goal is for agencies, asphalt producers, and asphalt contractors to reach practical solutions for all. FHWA has reestablished the NATC to provide training and on-site field assistance. Between the two NATC contracts at the Institute, one-week hands-on laboratory courses on both Superpave Binder Testing and Superpave Mix Design have been provided to about 700 people.

In addition, FHWA has established five Superpave Regional Centers (see Figure 4), through initial seed funding and loaned laboratory equipment. These Centers are available to assist states in their geographical regions with training, laboratory needs, or other questions pertaining to Superpave.

Publications on Superpave are currently available from many of these sources. FHWA has printed publications on binder testing and mix design. The Institute has developed Superpave manuals, written in practical simplified format, on Binder Testing (SP-1) and Mix Design (SP-2). The Institute is also developing detailed operation manuals on specific testings hints and troubleshooting ideas. In addition, through the NATC II contract, AI and the Superpave Regional Center at Austin are developing National Highway Institute (NHI) course materials for the individuals less interested in hands-on training. These courses will be taught at the Superpave Regional Centers, beginning next year.

The Superpave system does represent a good direction for the asphalt industry. We encourage everyone to stay in touch as the technology and asphalt pavement performance advance further in the future. ▲