

# ASPHALT TECHNOLOGY NEWS

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## NCAT TEST TRACK READY FOR SECOND CYCLE OF LOADING

The first cycle of loading of the National Center for Asphalt Technology (NCAT) Test Track sections was completed in December 2002. The performance of the 46 test sections after two years, 10 million ESALs loading was reported in the Spring 2003 issue of Asphalt Technology News.

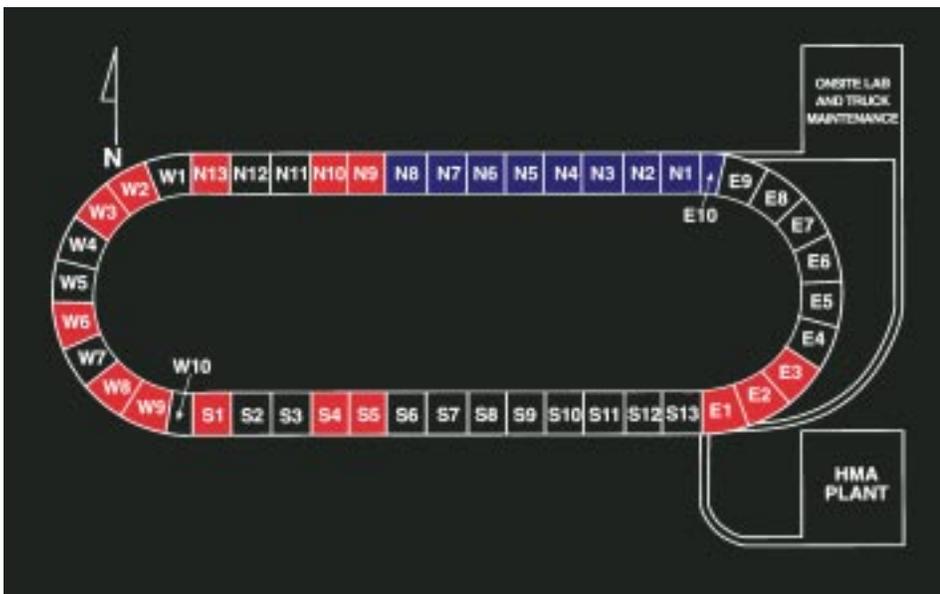
Construction of the new test sections for the second cycle of loading began in May 2003. Hot mix asphalt (HMA) was produced and placed in July and August. All construction activities were completed by mid-September.

As shown in the layout plan, the second-cycle test sections can be categorized as follows:

- Eight new structural sections N1 through N8 (shown in blue)
- Milling and inlaying of 14 test sections with different HMA mixes for rutting evaluation (shown in red)
- Leaving 24 first-cycle test sections in place to apply an additional 10 million ESALs over the next two years (shown in black)

### Structural Test Sections

Eight first-cycle test sections (N1 through N8) were milled very deep and reconstructed to facilitate a small, instrumented AASHO-like structural experiment. As illustrated in the cross-section of the new structural test sections, the two  
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NCAT Test Track layout showing second-cycle test sections

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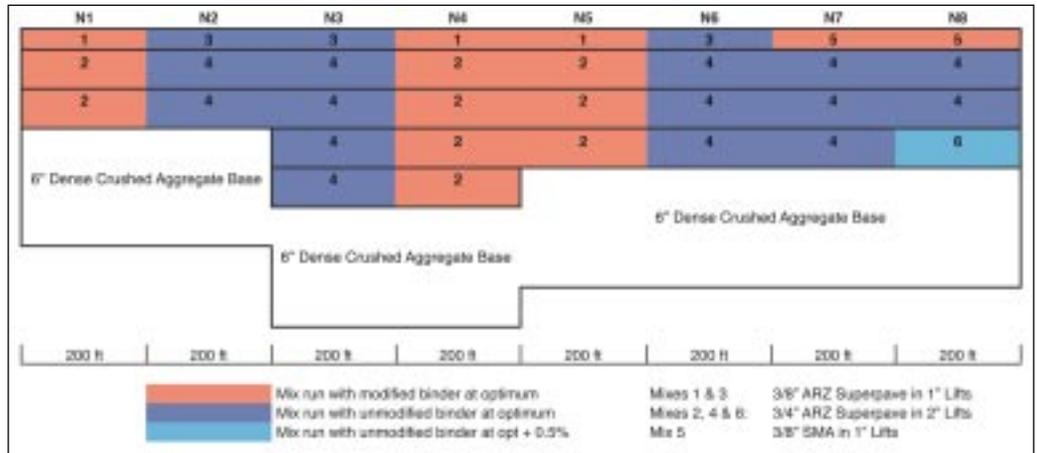
## —NCAT Test Track

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primary variables are as follows:

- Varying HMA thickness. Three total HMA thicknesses of 5, 7, and 9 inches have been placed over 6 inches of dense crushed aggregate base.
- Asphalt binder type (unmodified versus polymer-modified). Most highway agencies assign the same structural coefficient to all dense-grade HMA regardless of asphalt binder type. Many laboratory studies have shown shown polymer-modified HMA is stronger and has longer fatigue life compared to conventional HMA. However, this is probably the first time such comparison will be evaluated in a full-scale field experiment.

The structural test sections also involve two other variables. Stone matrix asphalt is the wearing course in two test sections (N7 and N8), whereas Superpave mix (gradation above the restricted zone or ARZ) has



Cross-section of eight structural test sections

been used as the wearing course in the other six test sections. One test section (N8) has a rich HMA base course with a binder content of optimum plus 0.5 percent. The rich base course has a potential of minimizing the propagation of fatigue cracks from the bottom upwards.

All structural test sections are fully instrumented to measure stress, strain, moisture, and temperature.

## Milled and Inlaid Test Sections

Fourteen first-cycle test sections were milled and inlaid with new binder and/or wearing course mixtures to evaluate their resistance to rutting and/or overall performance. The following mix attributes will be evaluated:

- Superpave and stone matrix asphalt (SMA) mixes containing aggregate with high Los Angeles abrasion loss.
- SMA mixes with varying aggregate quality: does not meet specifications; borderline; and exceeds the specification requirements.

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Placement of binder course in new test sections



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**E. Ray Brown, Director**  
**Prithvi (Ken) Kandhal, Associate Director Emeritus/ Editor**  
**James S. Killian III, Associate Editor, College of Engineering**



*Placement of wearing course in new test sections*

- Fine Superpave mix (4.75 mm nominal maximum aggregate size) for low-volume roads.
- Superpave mix with  $N_{\text{design}} = 75$  gyrations (the same mix with  $N_{\text{design}} = 125$  gyrations had negligible rutting in the first cycle).
- Thin Superpave mix overlay versus Novachip overlay (both are one inch thick and contain the same aggregate).
- Superpave mix containing PG 67 and PG 76 asphalt binders.



*Reconstruction in progress for installing eight structural test sections*

### Test Sections for Additional Trafficking

As mentioned in the spring issue of Asphalt Technology News, most first-cycle test sections had negligible rutting after two years, 10 million ESALs loading. Some state DOTs have decided to keep their test sections in place for additional trafficking of 10 million ESALs. The test sections, which perform well after 20 million ESALs loading, will be deemed suitable for very high traffic, interstate highway pavements. The additional trafficking may also better discern performance differences among different mix types (such as Superpave versus SMA) compared to the first cycle.

Test sections for the second cycle of loading have been sponsored by the Federal Highway Administration and ten states: Alabama, Florida, Georgia, Indiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, and Tennessee.

Trafficking of the second-cycle test sections will begin in October and will continue until 10 million ESALs are applied in about two years (by October 2005). Design and construction details can be seen at the test track web site, <<http://www.pavetrack.com/>>. Performance data will continually be posted on this web site as it is gathered.

## RESEARCH IN PROGRESS

We have discontinued the publication of this column in this newsletter because it can now be accessed on NCAT's homepage (<http://www.ncat.us>). Click on "Information" at the top of the page, then "Research in Progress." It is updated frequently based on the information received from the Departments of Transportation and other sources.

## NCAT WILL HOST INTERNATIONAL SYMPOSIUM ON LONG LASTING ASPHALT PAVEMENTS

The National Center for Asphalt Technology will host an international symposium on **Design and Construction of Long Lasting Asphalt Pavements** on June 7-9, 2004. The International Society for Asphalt Pavements (ISAP) is the primary sponsor for this symposium. Other sponsors are the U.S. Department of Transportation (Federal Highway Administration), the Alabama Department of Transportation, and the National Asphalt Pavement Association.

The venue of the international symposium is **The Lodge and Conference Center** at Grand National Golf Course in the Auburn/Opelika area, set in the serene countryside of east Alabama. Auburn is approximately 100 miles southwest of Atlanta, Georgia.

About 40 very good technical papers from many countries concerning long lasting asphalt pavements will be presented in three days at the symposium. Some of the topics are as follows:

- Experience with long lasting pavements in United States, Canada, and Europe
- State-of-the-art review of approach to long lasting pavements
- Fatigue consideration and foundation requirements for designing long lasting pavements
- Construction and quality control for long lasting pavements
- Stone matrix asphalt (SMA)

- Asphalt pavement warranties in Europe
- Rehabilitation of heavy duty pavements
- Integrated approach to avoid moisture-induced damage
- Evaluation of segregation
- Aggregate resistance to polishing

The tentative schedule of the symposium is as follows:

### **Sunday, June 6, 2004**

**Registration, 1-6 pm**

**Reception, 6-8 pm**

### **Monday, June 7, 2004**

**Technical sessions, 9 am - 5 pm**

### **Tuesday, June 8, 2004**

**Technical sessions, 8 am - 5 pm**

**Dinner, 7-9 pm**

### **Wednesday, June 9, 2004**

**Technical sessions, 8 am - 5 pm**

**Dinner**

### **Thursday, June 10, 2004**

**Optional tour of NCAT research facility and Test Track, 8 am - 12 noon**

Exhibits will be open on Sunday through Wednesday. The following guest program has been planned:

- Tour and luncheon at the Jules Collin Smith Art Museum featuring a 35 ft chandelier crafted by world-famous artist, Dale Chihuly.
  - Day trip to Callaway Gardens, featuring the Sibley Horticultural Center followed by a luncheon, then your choice of shopping in nearby Warm Springs, Georgia or a visit to the Roosevelt Little White House.
- To obtain a registration package or questions about the symposium, please call NCAT at 334-844-6228, or email <taplecp@eng.auburn.edu>. Online registration available at **www.ncat.us**; follow the link to "Upcoming Meetings" on the left.

Mark your calendar for June 7-9, 2004! You don't want to miss the first international symposium on Design and Construction of Long Lasting Asphalt Pavements.



*The Lodge and Conference Center at Grand National Golf Course, the venue of International Symposium on Long Lasting Asphalt Pavements*

## PUTTING RESEARCH INTO PRACTICE

The following papers were presented at the annual meeting of the Association of Asphalt Paving Technologists (AAPT) held in Lexington, Kentucky in March. We are reporting observations and conclusions from them which may be of value to field engineers. These comments are obtained mostly from research projects with a limited scope; before application to practice we recommend that you read the entire paper to determine its limitations. Titles of the papers are given, with names of authors in parentheses, followed by a brief summary.

### 1. PERFORMANCE OF STONE MATRIX ASPHALT PAVEMENTS IN MARYLAND (Michael, Burke, and Schwartz)

Maryland has constructed over 85 stone matrix asphalt (SMA) projects since 1992, totaling over 1300 lane miles of paving. The SMA mixes have been placed exclusively on high volume, high speed highway segments where the traffic counts exceed 20,000 AADT and the posted speed is 55 mph or higher; the vast majority of the SMA placement in Maryland has been on Interstate highways. The SMA mixes have included 9.5, 12.5, and 19 mm nominal maximum aggregate sizes, with the 19 mm mixes being the most widely used.

This paper documents the performance of SMA in Maryland. Project data, construction quality control (QC) test data, and pavement performance data have been combined into a single web-based data storage, reporting, and display system developed at the University of Washington.

High quality coarse aggregates are required for SMA mixtures. Coarse aggregate should be cubical with 100 percent crushed faces. The coarse aggregate must also be sufficiently hard and durable to minimize particle breakage at the stone-to-stone contacts. Fine aggregate should also be 100 percent crushed. Maryland has ready access to high quality aggregate in most parts of the state, with crushed limestone predominating in the western mountainous regions and crushed limestone diabase in the central part of the state.

A 19 mm nominal maximum size has been the most common mixture for early SMA projects in Maryland, largely because it was the most common European mixture. More recent Maryland SMA projects have used 12.5 mm mixes, and Maryland has recently begun placing 9.5 mm SMA mixtures as well.

SMA mixtures typically have high asphalt cement contents. Asphalt binders are classified using the

Superpave Performance Grading (PG) system, with the design high temperature grade often increased by one or two grades for SMA mixtures. Nearly all Maryland SMA projects have used unmodified PG 70-22 or modified PG 76-22 binder, depending upon traffic level. Current specifications require elastomeric polymers for modified binders, although other types have been employed in the past. Mineral filler and stabilizing agents (typically cellulose or mineral fibers and/or polymers) are used to provide a satisfactory mortar consistency and to prevent draindown of the binder during transport and paving.

Except for very early projects, all Maryland SMA mixtures have been designed using a Superpave gyratory compactor with 100 gyrations. The design asphalt content is selected to produce 4 percent air voids in the compacted mixture. A minimum tensile strength ratio (AASHTO T283) of 85 percent is required for all SMA mixtures.

The following average data have been reported for the SMA projects.

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### A SHORT COURSE IN ASPHALT TECHNOLOGY

This training course has been developed by NCAT for practicing engineers who are involved with hot mix asphalt (HMA). The purpose of this one-week intensive course, which will be held on February 2-6, 2004 and March 1-5, 2004, is to provide a general understanding of all phases of HMA technology. Upon completion, the participant will be able to make knowledgeable decisions related to HMA pavements and communicate effectively with asphalt specialists when the need arises. NCAT will accept applications from practicing engineers from both private and public sectors in the United States and abroad. This includes personnel from the FHWA, state DOTs, FAA, Corps of Engineers, Air Force, Navy, county engineers, city engineers, consulting engineers, and contractors. Please call (334) 844-6228 ext. 110 or visit our web site at <<http://www.ncat.us>> (Click on "Education" at the top of the page, then click on "Upcoming Training Courses") for a brochure or information. On-line registration is now available.

## SUPERPAVE MIX DESIGN WORKSHOP

Superpave mix design workshop will be held at NCAT on January 20-23, 2004. This workshop consists of three and a half days of intensive lecture, demonstration, and hands-on training on Superpave volumetric mix design procedures. Upon completion the participants will be able to conduct the Superpave mix designs in their laboratories.

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incorporating RAP. This study was closely coordinated with a national study on the same topic (NCHRP 9-12, *Incorporation of Reclaimed Asphalt Pavement in the Superpave System*). Specifically, this regional project looked at typical materials from the north-central United States to determine if the findings of NCHRP 9-12 were valid for midwestern materials and to expand the NCHRP findings to include higher RAP contents.

Three RAP materials from Indiana, Michigan, and Missouri were evaluated. Mixtures were designed and tested in the laboratory with each RAP, virgin binder and virgin aggregate at RAP contents up to 50 percent. The laboratory mixtures were compared to plant produced mixtures with the same materials at the medium RAP content of 15-25 percent. Binder and mixture tests were performed.

Performance graded (PG) binder tests were conducted on the virgin binders and the binders recovered from RAP and plant recycled mixtures.

The recycled mixtures were analyzed using the Superpave shear tester (SST). The frequency sweep test at constant height, the simple shear test, and the repeated shear at constant height tests were conducted according to AASHTO TP7-94, *Standard Test Method for Determining the Permanent Deformation and Fatigue Cracking Characteristics of Hot Mix Asphalt (HMA) Using the Simple Shear Test (SST) Device*.

The SST data clearly demonstrated the stiffening effect of the RAP binder on mixture properties. This increased high temperature stiffness can help reduce the potential for rutting. Increased stiffness, however, can also increase the potential for thermal and fatigue cracking.

While no mixture fatigue testing was conducted as a part of this pooled fund project, beam fatigue testing was conducted by the Asphalt Institute as part of NCHRP 9-12. That testing did show that increasing the RAP content, without changing the virgin binder grade, reduced a mixture's fatigue life. At RAP contents up to between 10 and 20 percent the effects were not significant. The testing also showed that mixtures produced with softer binder grades exhibited longer fatigue lives.

Low-temperature mixture testing in the Indirect Tensile Tester, conducted under NCHRP 9-12, showed that the addition of RAP had little effect on tensile strength, but did affect tensile stiffness. This can lead to increased low-temperature cracking, if the binder grade is not properly adjusted to counteract the stiffening effect.

The following conclusions have been drawn from this study:

	<u>12.5 mm</u>		<u>19 mm</u>	
	mean	std. dev.	mean	std. dev.
Asphalt Content	6.4	0.22	6.4	0.26
Air Voids,%	3.6	0.72	3.5	1.20
VMA, %	18.3	1.1	18.8	1.34

The values for cumulative rut depth for Maryland SMA projects, including projects with up to 10 years of performance data, averaged 0.14 inches for the 12.5 mm mixes, and 0.13 inches for the 19 mm projects. The cumulative International Roughness Index (RI) values on the latest survey date averaged 75.7 inches/mile for the 12.5 mm mixes, and 97.1 inches/mile for the 19 mm projects. The values for surface friction on the latest survey date averaged 49.1 for the 12.5 mm mixes and 46.5 for the 19 mm projects.

SMA mixtures have typically cost 10 to 30 percent more than the dense-graded asphalt mixtures.

In summary, the performance of SMA pavements in Maryland has been outstanding. 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.

## 2. USE OF RECLAIMED ASPHALT PAVEMENTS (RAP) UNDER SUPERPAVE SPECIFICATIONS (McDaniel and Shah)

This project was conducted to investigate the performance of Superpave asphalt mixtures

- Using the RAP materials in this study, acceptable Superpave mixtures can be designed with up to 40 or 50 percent RAP.
- The binder and mixture test data obtained in this study generally support the interim guidance developed by a task force of the FHWA Superpave Mixtures Expert Task Group in 1997. These guidelines established a tiered approach for RAP usage. Up to 15 percent RAP could be used with no change in binder grade. Between 15 and 25 percent RAP, the virgin binder grade should be decreased one increment (6°) on both the high and low temperature grades. Above 25 percent RAP, blending charts should be used to determine how much RAP can be used.



*Joseph McInnes (center), director, Alabama Department of Transportation (ALDOT) visited the NCAT laboratory in May. He is seen with Donald Vaughn (left), deputy director, ALDOT, and Brian Prowell (right), assistant director, NCAT*

### **3. COMPARISON OF THE SATURATED SURFACE-DRY AND VACUUM SEALING METHODS FOR DETERMINING THE BULK SPECIFIC GRAVITY OF COMPACTED HMA (Cooley, Prowell, and Hainin)**

Typically, the bulk specific gravity of compacted hot mix asphalt (HMA) is determined using the saturated surface dry condition in accordance with AASHTO T166 or ASTM 2726. However, there has been an increasing concern about determining the bulk specific gravity of compacted HMA by this method for mixes having coarse gradations like many Superpave designed mixes and stone matrix asphalt (SMA).

The concern with the saturated surface dry condition method is that these coarse-graded mixes contain a large proportion of interconnected air voids, especially in field compacted HMA. Large interconnected air voids that are connected to the surface of a sample potentially allow water to exit the sample during the patting of the sample to reach the saturated surface dry condition. This loss of the water from the sample causes error with the saturated surface dry method.

Recently, a new method of determining the bulk specific gravity of compacted HMA has been developed. This method uses a vacuum-sealing device to tightly conform a plastic bag around compacted samples. A number of recent studies have shown that this method provides a good estimation of bulk specific gravity, even when samples have low density (i.e., high air voids). However, most of the work has focused on laboratory compacted samples (e.g., Superpave gyratory

compactor samples). Also, guidance on when this new test method should be used instead of the saturated surface dry method has not been provided.

The objective of this study was to first confirm that the vacuum sealing method does provide an accurate estimation of bulk specific gravity of compacted HMA. If the vacuum-sealing method did provide an accurate estimation of bulk specific gravity, the second primary objective of this study was to provide guidance when the vacuum-sealing device should be used instead of the saturated surface dry method.

Two separate experiments were conducted to accomplish the objectives of this study. First, samples prepared in the laboratory with the Superpave gyratory compactor were tested using the saturated surface dry method and the vacuum-sealing method. The second experiment included the testing of 355 cores cut from the roadway prior to traffic from 42 different field projects, again with both methods.

Based upon the results of this study, the vacuum-sealing method did provide an accurate estimation of bulk specific gravity. It was concluded that for laboratory prepared HMA samples having gradations passing above the maximum density line, the saturated surface dry test method provided accurate results for the air void content range encountered. However, it was

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## NCAT HAS NEW DOMAIN NAME

NCAT has a new domain name, to make it easier to find our web page. <<http://www.ncat.us>> is the new address, but you can also reach our web page by going to our old address, <<http://www.eng.auburn.edu/center/ncat/>>.

also concluded that the vacuum-sealing method should be used for laboratory prepared HMA samples having gradations passing below the maximum density line. This includes mix design samples. On average, the use of the vacuum-sealing method during mix design would have resulted in an increase of about 0.2 percent to the optimum asphalt content.

For field compacted samples (cores), it was concluded that the saturated surface dry method was adequate for HMA mixes having gradations more than 10 percent finer than the maximum density line on the 2.36 mm (No. 8) sieve. The vacuum-sealing method should be utilized on field compacted samples (cores) for all other coarser gradations based on the 2.36 mm sieve.

#### 4. EVALUATION OF THE INTERNAL ANGLE OF GYRATION OF SUPERPAVE GYRATORY COMPACTORS IN ALABAMA (Prowell, Brown, and Huner)

The application of a compaction effort that will produce similar densities from one Superpave Gyratory Compactor (SGC) to another is crucial to the proper design, production control, and acceptance of HMA mixes. The angle of gyration is believed to be an important factor affecting the compaction effort. This study evaluated the relationship between the internal angle of gyration measured by the FHWA Dynamic Angle Validation Kit (DAVK) and the resulting sample density for a wide range of SGCs. The DAVK is placed inside the SGC mold with or without HMA sample. A data acquisition system within the DAVK dynamically records the internal angle of gyration during compaction. The DAVK device was used to verify that all of the SGCs used in Alabama; by the contractors, mix designers, and the Alabama Department of Transportation are compacting with an angle of gyration, under load, that is within the specification values (1.23 to 1.27 degrees) provided in AASHTO T312. Following the measurements with the DAVK, three replicate samples of a standard mix were compacted to evaluate the sample density produced by the compactor. This procedure was conducted on 116

SGCs throughout Alabama.

The following conclusions have been drawn from this study:

- Different brands/models of SGCs tend to have different internal angles of gyration, likely resulting from differing degrees of machine compliance, even though all of the external angles of gyration are similar.
- There is a statistically significant trend between internal angle of gyration and sample density for all of the compactor types included in this study. Excluding the Interlaken and Rainhart compactors, the internal angle of gyration explains 32 percent of the variation in sample density. There is a similar, but shifted trend for the Interlaken compactors. The shift is believed to be related to the compliance of the Interlaken SGC's ram and the resulting difference between the internal angle of gyration when the DAVK is on the top and bottom of the mold. There were insufficient Rainhart compactor data evaluated to draw any firm conclusions.
- Based on the averages by brand and model of SGC (excluding the Interlaken and Rainhart SGCs) a change of 0.1 degrees in internal angle will result in a change of 0.015  $G_{mb}$  (bulk specific gravity) units or a difference in air voids of about 0.6 percent. There is a trend between external angle of gyration and sample density for a single compactor. The external angle of gyration does not explain differences in sample density from one compactor to another.

## PROFESSOR TRAINING COURSE IN ASPHALT TECHNOLOGY

NCAT has written and published an up-to-date college textbook on asphalt technology. NCAT has also developed a training program for college and university civil engineering faculty that will allow them to offer state-of-the-art undergraduate and elective courses in asphalt technology. This 8-day intensive course is conducted at NCAT in June every year. It will be held on June 15-24 next year. The course has been updated to include Superpave binder and mix technology, and stone matrix asphalt (SMA). Some financial assistance in attending this course is possible. Please call NCAT at (334) 844-NCAT for brochure or information or visit our web site at <<http://www.ncat.us>>.

## ASPHALT FORUM

NCAT invites your comments and questions. Questions and responses are published in each issue of **Asphalt Technology News**. Some are edited for consistency and space limitations.

### Minnesota (Ed Johnson, Minnesota DOT)

What are the experiences of other states with the fine aggregate angularity (FAA) requirement in Superpave mixture design? We are interested in finding out if ASTM D1252 Method A has been preferred or if alternate methods/technologies have been used for evaluating the fine aggregates. Have some agencies discontinued the FAA evaluation?

### Australia (John Bethune, Australian Asphalt Pavement Association)

The Australian Asphalt Pavement Association has recently issued two implementation Guides that may be of interest to other agencies.

- *Implementation Guide No. 5 Light-Duty Asphalt Pavements – Design, Specification and Construction* - This implementation guide has been prepared for engineers, architects, and contractors in the planning, design, and construction of light-duty flexible pavements incorporating asphalt layers.

- A light-duty pavement is defined as one that is predominately subjected to low traffic volumes, lightly loaded vehicles, bike, and pedestrian traffic, or that provides a purely architectural feature. Such pavements include: (1) local access roads; (2) commercial building driveways and car parking lots other than those subjected to regular trafficking by heavy vehicles; (3) residential driveways; (4) bikeways; (5) footpaths and pedestrian precincts; (6) cafes and outdoor dining areas; and (7) landscape architectural features.
- *Implementation Guide No.6 Selection and Design of Flexible Pavements* - This guide provides assistance in the selection, specification and design of flexible roads pavements for a variety of applications. It brings together information on design, construction, performance, and maintenance on a wide range of flexible road pavements.



NCAT Board of Directors met in Auburn in August

## ASPHALT FORUM RESPONSES

*The following responses have been received to questions raised in the Spring 2003 Asphalt Forum.*

*Which other states require Micro Deval test for aggregate quality and how did they establish their specification criteria for percent loss allowed? How is the Micro Deval test used (for example, pass/fail, price reduction, or for quality control at established frequencies throughout production)?* **(Bill Schiebel, Colorado DOT)**

### **Connecticut (Keith Lane, Connecticut DOT)**

Connecticut is doing some preliminary work, but has not yet established any correlation.

### **South Carolina (Milton Fletcher, South Carolina DOT)**

The South Carolina DOT in conjunction with Clemson University is conducting an aggregate durability study that is investigating the Micro Deval test and possible specification limits.

### **Ontario (Kai Tam, Ontario Ministry of Transportation)**

Ontario uses the Micro Deval test for aggregate quality for all granular materials, concrete and asphalt aggregates. The specification criteria were established through a program where test results were compared to performance for more than 100 different aggregates. Both quality control (QC) and quality assurance (QA) include the Micro Deval test. Ontario uses an accept/reject criteria with a option for referee testing if the QA results fail. Ontario may allow a price reduction in lieu of removal for material that is marginally out of specifications. We recommend the following references on this test:

*Laboratory Tests for Predicting Coarse Aggregate Performance in Ontario*, S. A. Senior and C. A. Rogers, Transportation Research Record No 1301, TRB, 1991.

The actual specification limits were established after additional analysis and were first published in the following papers:

*Recent Developments in Physical testing of Aggregates to Ensure Durable Concrete*, C. A. Rogers and S. A. Senior, Advances in Cement and Concrete, Engineering Foundation Conference Proceeding (ASCE), July 24 - 29, 1994, University of New Hampshire, M. W. Grutzeck and S. L. Sarkar (EDs.), pp 338 - 361.

*Predicting Aggregate Performance Using the Micro-Deval Abrasion Test*, C. A. Rogers and S. A. Senior, Proceedings: 3rd Annual Symposium of the Center for Aggregate Research, University of Texas, Austin, March 2 - 4, 1995.

*Are other states that use nuclear asphalt content gauges or ignition furnaces for determination of asphalt content aware of the impact of amount of lime on the accuracy of results? Colorado has determined +0.37 percent impact on ignition test and approx. -0.3 percent impact on nuclear gauge when one percent required lime included during calibration is not present in the production material? What is the experience of other states and how are they dealing with it?* **(Bill Schiebel, Colorado DOT)**

### **Montana (Scott Barnes, Montana DOT)**

We are aware of the differences in measured asphalt content due to the presence or lack of lime. We use the ignition ovens, having abandoned the nuclear asphalt content gauges years ago. Ovens are calibrated with the lime, and the produced hot mix is required to include the lime. There are good production verifications to assure the lime is present. We pay for asphalt binder separately, payment being based upon the calibrated flow meter of the HMA plant, checked against the delivery tickets and tank stabs. Hydrated lime is also measured and paid separately. There is no monetary incentive for the contractor to reduce the asphalt or lime content in the mix.

### **New York (Russell Thielke, New York State DOT)**

This issue was addressed in Transportation Research Record 1712, 2000, Paper No. 00-1452, "Effect of Lime on Ignition Furnace Calibration," by Brian Prowell and Jack Youtcheff. The New York State DOT (NYSDOT) recommends testing laboratory samples, made with the materials and percentages to be used during production, to determine an appropriate calibration/correction factor for each mix if the ignition oven results are going to be used. NYSDOT does not specify lime as an additive in HMA, however some micro-surfacing mix designs use lime.

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**Ontario, Canada (Kai Tam, Ontario Ministry of Transportation)**

Ontario is starting to use the ignition oven for determination of asphalt binder content. One of our consultant laboratories has found about a 0.5 percent apparent increase in asphalt content when one percent lime is added.

*How many states give bonus payment for consistency of asphalt content? How many states utilize VMA as an acceptance property? Is the laboratory minimum VMA required for full pay, or is some tolerance below the laboratory minimum permitted? (Allen H. Myers, Kentucky Transportation Cabinet)*

**Alabama (Randy Mountcastle, Alabama DOT)**

Laboratory air voids, asphalt content, and roadway density are standard pay factor items with a 1.02 bonus allowed.

VMA is a “shut down and correct the mix” property. If two consecutive VMA tests are too low, no more mix is allowed to be delivered to the project until the VMA requirement is met. Using a minimum VMA for pay is a good idea.

**Connecticut (Keith Lane, Connecticut DOT)**

No bonus payment is given for consistency of asphalt content. VMA is an acceptance property with -0.5 and +2.0 percent tolerance allowed from the specified VMA.

**Missouri (Joe Schroer, Missouri DOT)**

Both asphalt content and VMA are pay factors in our percent within limits (PWL) specification. We give equal weight to the pay factors for asphalt content, VMA, air voids, and density to calculate the total pay factor. We currently allow production to be “1.2 percent from the mix design VMA, however, we are in the process of changing this to -0.5 percent and +2.0 percent from the minimum VMA specified for the mixture type.

**Montana (Scott Barnes, Montana DOT)**

A new specification for volumetric acceptance of Superpave mixes based on voids, VMA, VFA, and dust/asphalt ratio has been adopted. Please see the Specification Corner for details.

**New York (Russell Thielke, New York State DOT)**

The New York State DOT does not consider consistency of asphalt content for payment adjustments. VMA is an acceptance property with an allowable -1.0 percent production tolerance from the submitted mix

design VMA. If all acceptance properties are met, quality payment adjustments (incentive/disincentive) are based on percent air voids for volumetric mix designs.

**South Carolina (Milton Fletcher, South Carolina DOT)**

VMA is an acceptance property and tolerance is given based on the job mix formula.

**Ontario, Canada (Kai Tam, Ontario Ministry of Transportation)**

Ontario has a fully developed specification based on percent within limits (PWL) criteria for asphalt content, four sieve sizes, air voids, and compaction. Price adjustments can include bonuses for any of these attributes. As far as VMA is concerned, Ontario only requires that the minimum VMA be met. However, there have been discussions concerning VMA as an additional attribute in the PWL specification.

*Is anyone using the CoreLok device to determine aggregate specific gravities for mix design or field verification? (Mark Shelton, Missouri DOT)*

**Florida (Gregory A. Sholar, Florida DOT)**

The Florida DOT (FDOT) has evaluated the CoreLok device for determining aggregate specific gravity and did not find results consistent with established AASHTO procedures. The report is available at the FDOT State Materials Office Website.

**Montana (Scott Barnes, Montana DOT)**

We are experimenting with the use of the CoreLok device and the SSDetect device for determining the fine aggregate specific gravities for mix design.

*We plan to implement tensile strength testing of plant produced HMA mixtures using AASHTO T283. This would allow us to eliminate requirements for anti-strip additives, the method of introducing the additives, and the requirement for aggregates to be nonplastic. We would appreciate other states' comments and experience with TSR testing of plant produced mixtures. (Mark Shelton, Missouri DOT)*

**Alabama (Randy Mountcastle, Alabama DOT)**

We use a modified AASHTO T283 (no freeze-thaw cycle) on plant produced HMA. However, if there is any visual stripping, we require the use of anti-stripping  
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agents.

**Kentucky (Allen H. Myers, Kentucky Transportation Cabinet)**

Kentucky has experienced a general increase (five to ten percent) in the tensile strength ratio of plant-produced HMA compared to the same mixture fabricated in the laboratory. We believe the HMA plant “cleans up” the aggregate better during the heating and mixing operation and is more efficient at mixing than the corresponding simulations in the laboratory. Therefore, the mixture is less susceptible to stripping and the tensile strength ratio improves.

**Montana (Scott Barnes, Montana DOT)**

Montana presently requires 1.4 percent hydrated lime in all HMA mixes. In the past, we used AASHTO T283 (Modified Lottman), and Immersion Compression testing to determine the need for lime. However, there were only a few projects that did not require lime. So now we require lime in all mixes. Modified Lottman was run on plant-produced HMA for all projects to verify the effectiveness of lime. The TSR results were almost always better for the plant-produced mix, usually by 10 percent or more compared to laboratory-prepared mix.

We noticed polymer modified HMA was able to produce Modified Lottman results that were acceptable without lime. We had a couple of our first polymer modified HMA projects, which were placed without lime because they had satisfactory Lottman test results, strip within three years of placement. Those projects had to be milled and replaced. After that, the Lottman test to determine the need for lime is conducted on HMA made with the base (unmodified) asphalt binder.

**Nevada (Darin Tedford, Nevada DOT)**

The Nevada DOT has extensive experience with TSR testing, which has led to exclusive use of lime in the state for stripping resistance.

**New York (Russell Thielke, New York State DOT)**

One of the biggest concerns we have heard about AASHTO T283 is test result variability. Our test results have shown improved repeatability when maintaining tighter tolerance ranges than specified in AASHTO T283.

*We recently checked dimensions of the molds for gyratory compactors. A large number of molds have worn to be out of specification on diameter. The estimated cost to replace is about \$850 each. We believe the specification is too restrictive on diameter—the*

*tolerance is much tighter than it was for Marshall molds. Should the tolerance be loosened? Our molds have only worn a couple of thousands of an inch—they were made to the top end of the tolerance. (Scott Barnes, Montana DOT)*

**Alabama (Randy Mountcastle, Alabama DOT)**

The gyratory mold dimension’s tolerance seems too restrictive. What percent compaction differences do you see using old versus new molds?

**Connecticut (Keith Lane, Connecticut DOT)**

We believe the tolerance should be loosened.

**Florida (Gregory A. Sholar, Florida DOT)**

Pine Instrument Co. (Frank Dalton) has done research on the mold wear issue. Their research indicates that mold wear at the end plate locations can cause a reduction in compaction effort and result in higher air voids of the compacted specimens. Pine’s recommendation is not to exceed 0.5 mm total between the end plate and the mold wall.

**Missouri (Joe Schroer, Missouri DOT)**

We have been using the same molds since 1995 and they are still within the inside diameter range, but close to being out. We would support a larger tolerance but not as much as the Marshall molds due to the difference in steel. The AASHTO T312 molds are hardened, whereas the AASHTO T245 molds are not required to be.

*Has any state revised the Superpave VMA criteria to make any modifications to their asphalt mixes? (Charles Dusseault, New Hampshire DOT)*

**Alabama (Randy Mountcastle, Alabama DOT)**

Fine-graded mixes (gradation above the maximum density line) are required to have higher minimum VMA than coarse-graded mixes.

**Connecticut (Keith Lane, Connecticut DOT)**

The Connecticut DOT is looking into calculating VMA using the following formula, to determine if better monitoring of production VMA can be facilitated:  $VMA = Va + Vbt$ , where  $Va$  = air voids at  $N_{design}$  and  $Vbt = (Pb + Gmb \text{ at } N_{design})/Gb$ .

**Montana (Scott Barnes, Montana DOT)**

We have an upper limit on the VMA in the new volumetric specifications. The incentive band for VMA  
*(continued on page 13)*

ranges from 13 to 18 percent. Both lower and upper limits can be 0.3 percent further out without a deduction.

We have reduced the air voids target from 4 to 3.5 percent for the mix design. We have determined that with the change from back calculation to direct measurement of the bulk specific gravity of the

compacted specimens at  $N_{design}$  gyrations, we usually lost about 0.2 percent asphalt content. The reduction in target air voids should offset the loss in asphalt content. Along with this air voids change, the VFA limit has been increased to 80 percent.

## SPECIFICATION CORNER

**Alabama** - All Superpave mixtures for upper binder course and wearing course are now designed on the fine side of the restricted zone to minimize permeability. Superpave mixtures now have a minimum asphalt binder content requirement. If the contractor's mix fails to meet the  $N_{initial}$  requirement, the mix may still be approved if the amount of natural fine aggregate is limited.

The tolerance for air voids and asphalt content during HMA production for the test strip has been narrowed to minimize the potential for a pay reduction when the full production begins.

The use of pneumatic tired rollers is mandatory for all Superpave mixtures. Nuclear density gauge is still used for quality control. However, the roadway density is now based on cores rather than nuclear gauge.

A pay factor table has been added for open-graded asphalt friction course and permeable asphalt treated base. The pay factors will not be implemented until more data is obtained.

The use of any "blanking band" when measuring profile (rideability) has been discontinued.

**Florida** - A three-year materials and workmanship warranty will be implemented on projects bid starting January next year. There will be specific performance criteria (such as rut depth, cracking, delamination, and smoothness) that will be evaluated periodically. Remedial measures will depend on the severity of the distress.

**Missouri** - The Missouri Department of Transportation is in the process of reviewing all specifications to make them more performance-related. Superpave mixture design and quality control/quality assurance (QC/QA) will become part of the standard specification for roadways over 3500 ADT. Some material requirements, such as non-plastic manufactured fines, will be replaced by field testing mixtures for moisture-induced damage using AASHTO T-283. Many of the equipment descriptions (for pavers, rollers, etc.) will be removed.

More emphasis will be placed on the contractor providing a well-compacted, uniform mat. Uniformity of the mat can be checked with MoDOT TM-75, "Determining Segregation Using the Nuclear Density Gauge," which is based on a test method developed by the Kansas Department of Transportation.

**Montana** - A new specification for volumetric acceptance of Superpave mixes has been adopted. Payment is "statistically" based on voids, VMA, VFA, and dust/asphalt (D/A) ratio. There are both incentives and disincentives based on all four of these parameters, and no cold feed gradations are now required. The ignition oven is used to determine the asphalt content and minus 200 for the D/A ratio. Targets must be set on all parameters within the required ranges, and payment is based on average and range for each lot of HMA production. There is also a Hamburg Wheel Track specification requirement to be met for the mix design and during production. Targets and ranges for the 19mm mix are as follows:

<u>Parameter</u>	<u>Target Range</u>	<u>Tolerance</u>
Voids	3.4 - 4	+/- 1.0
VMA	13.3 - 17.7	+/- 0.6
VFA	65 - 80	+/- 5.0
D/A Ratio	N/A	+/- 0.4

Incentives are paid if the range is within half tolerance. Incentives are 2 percent for each parameter above, with an additional 4 percent "bonus" if three or more of the parameters earn the incentive. Possible volumetric incentive is 12 percent. Density (5 percent) and ride (up to 25 percent) incentives are available as well, for a total possible incentive of 42 percent. Disincentives are available as well.

So far the results have been good. The contractors have been working hard and even slowing production in order to attain the incentives. There have been several

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self-imposed shut downs by contractors to improve their production. Bid prices have been lower than previous Superpave bids.

**New Mexico** - Four significant changes have been made to the Superpave hot mix asphalt specifications. These changes relate to HMA mix design requirements; the amount of hydrated lime that is required in all mixes both for design and production; using the asphalt ignition oven (AASHTO T 308) for quality control and acceptance testing results; and new production acceptance testing tolerances and associated pay factors. The HMA mix design requirements such as air voids, VMA and VFA have been specified separately for mixes containing aggregates with less than 3 percent water absorption and for mixes containing aggregates with more than 3 percent water absorption.

If the retained strength measured in accordance with AASHTO T165 is less than 85 percent the percentage of hydrated lime is increased until it meets the minimum strength requirement. Once this design percentage for hydrated lime has been established, it is increased by 0.2 percent for production purposes to account for loss of lime through the HMA plant. All quality control and acceptance testing results for gradation and volumetric properties are based on the results obtained using the ignition oven. Finally, the production acceptance testing tolerances and the associated pay factors have been revised. The payment for the asphalt binder will be made separately from the payment associated with the production of the hot mix asphalt material.

**New York** - HMA construction specifications are being revised to allow the use of non-nuclear gauges for monitoring mat density. The evaluation of these gauges by the New York State Department of Transportation and the conclusions of the Pooled Fund Study, "Evaluation of Non-Nuclear Gauges to Measure Density of Hot-Mix Asphalt Pavements," prompted the revisions.

**South Carolina** - The South Carolina Department of Transportation will let a project in fall this year to evaluate the use of cryogenically ground tire rubber in an open graded friction course mixture. The intent of the provisional specification is to compare an in-line rubber blended binder process versus a PG 76-22 binder to see what benefits would be obtained. The ground tire rubber will be added at a rate of 12 percent by weight of the binder.

A new SMA specification has also been developed which allowed the letting of an SMA project in July.

**Ontario Ministry of Transportation** - The newly completed special provision for SMA will be used on all new contracts with more than 30 million ESALS (20-year design life). Penalties for smoothness will now be phased-in for some single lift contracts which were previously exempt from penalties. An end-result specification for acceptance of surface course thickness using 50 mm diameter cores and a non-destructive method are currently being used on trial contracts. An end-result specification for longitudinal joint construction and a specification for the trial construction of longitudinal joints using various methods are being drafted. A material and construction specification for a 25 mm Superpave rich bottom mix is being developed for use on pavements using perpetual pavement design.

**Australia** - The Australian Asphalt Pavement Association is about to issue the Second Edition of "National Asphalt Specifications." The specification clauses are applicable to component materials; design, manufacture, and placement of dense-graded asphalt, open-graded asphalt, stone mastic asphalt, and fine gap-graded asphalt. It replaces the First Edition (2000) which covered dense-graded asphalt only.



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## ASPHALT NEWS

The National Cooperative Highway Research Program (NCHRP) is undertaking an important research project, "Endurance Limit of Hot Mix Asphalt Mixtures to Prevent Fatigue Cracking in Flexible Pavements." Fatigue cracking originating at the bottom of a hot mix asphalt (HMA) structure has long been acknowledged as the most costly form of distress to correct through rehabilitation.

Performance data from well-constructed flexible pavements with a thick HMA structure, some of which have been in service for more than 40 years, show that bottom-up fatigue cracking does not occur in these pavements. This field experience suggests that an endurance limit, that is, a level of strain below which fatigue damage does not occur for any number of load repetitions, is a valid concept for HMA mixtures; its quantification could aid in the efficient design of long-life flexible pavements with a significantly reduced life cycle cost.

The objectives of this study are to (1) test the hypothesis that there is an endurance limit in the fatigue behavior of HMA mixtures and measure its value for a representative range of HMA mixtures and (2) recommend a procedure to incorporate the effects of the endurance limit into mechanistic pavement design methods.

The \$750,000 research project is expected to begin in March next year and is scheduled for completion in two years.

\* \* \*

The Texas Transportation Institute has developed a Stirred Air-Flow Test (SAFT) to replace the rolling thin-film oven test (RTFOT) and the thin-film oven test (TFOT), which are used to simulate the asphalt binder aging process during HMA production and construction. SAFT uses air blowing to oxidize the asphalt binder. SAFT is faster (testing time of 35 minutes), and its cost is half of the current test equipment. It also eliminates the glass bottles used in RTFOT. SAFT is also suited for testing polymer-modified binders.

\* \* \*

Research conducted at Purdue University for the South Dakota Department of Transportation has concluded that the use of different types of burner fuels in well-maintained and well-tuned HMA plants had no significant effect on HMA mix properties. A small amount of burner fuel residue (less than 35 parts per



*Chuck van Deusen (center), chairman, NCAT Board of Directors discussing the agenda for the July meeting of the NCAT Applications Steering Committee (ASC) with Ray Brown (left), NCAT director, and Jack Weigel (right), chairman of ASC.*

billion by weight of aggregate) was found in aggregate heated with No. 6 fuel when there was insufficient oxygen available for combustion. The report concludes that mixture contamination is not likely to be a problem when fuels are properly preheated and the plant is in good working order. The report is available from South Dakota DOT, Office of Research, 700 East Broadway Avenue, Pierre, SD 57501-2586.

\* \* \*

Thousands of highway construction specifications from all 50 states, the District of Columbia, and Puerto Rico are now instantly available online at the new National Highway Specifications Web site ([www.specs.fhwa.dot.gov](http://www.specs.fhwa.dot.gov)). The site is a collaborative effort of the Federal Highway Administration (FHWA) and the American Association of State Highway and Transportation Officials (AASHTO).

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## NCAT's Professor Training Course in Asphalt Technology, June 17-26, 2003



**Back, L-R:** Ray Brown, Hak-Chul Shin, David Jared, Baoshan Huang, Rachel Thomas, Muge Mukaddes Darwish, Don Watso, Joe Mahoney  
**Front, L-R:** Edgar David de León Izeppi, Jo Daniel, Kenneth Meeks, Natacha Thomas, Tom Gaetz, Randy Rainwater, Kyungwon Park  
(Not Pictured: Moayyad Al Nasra, Matt Corrigan)



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