

# ASPHALT TECHNOLOGY NEWS

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## NCAT HOSTS AUTOMATED, REAL-TIME QUALITY CONTROL OPEN HOUSE

The National Center for Asphalt Technology (NCAT) hosted an open house on July 20-21, 2004 for demonstrating automated, real-time quality control (QC) for hot mix asphalt. The Alabama Department of Transportation and the Federal Highway Administration contracted with East Alabama Paving Company to buy some automation equipment and install it on their plant in Opelika, Alabama. NCAT and the Alabama DOT are developing a system to automate sampling and testing of materials during HMA production.



*More than 100 asphalt industry professionals attended the open house for automated, real-time QC for hot mix asphalt at the Opelika plant*

The open house was attended by HMA industry and DOT representatives from all over the United States.

### Background

Current quality control methods for hot mix asphalt are manpower and time intensive, which leads to inefficient gathering of information needed to monitor and control the production of quality asphalt mixtures. The majority of attention in QC testing is now spent on sampling and testing after the mixtures are produced. Considering that it typically takes about three hours to complete the suite of tests commonly used for QC of asphalt mixtures, and that the majority of plants commonly produce HMA at rates of 200 to 300 tons per hour, then it is common for 600 to 900 tons of HMA to be produced between tests. This lag of information puts the HMA producer at significant financial risk and the customer (i.e. agency) at risk of accepting a significant amount of poor quality materials.

In addition to the risks associated with the QC information time lag, it is recognized by the collective HMA industry that most of the tests used in QC and acceptance testing suffer from poor precision. Part of the poor precision is attributable to sampling variability and testing variability

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## —NCAT Hosts Open House

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which are related to the skill and ability of technicians. The effect of poor precision is that it confounds decision making. If uncertain about a test result, technicians or managers will often resample and test to validate the first result. This further extends the information lag and increases the risks. However, if the technician or manager incorrectly reacts to bad data, then the mixture may be adjusted when it should not have been. More efficient techniques are needed to assure that quality HMA is being produced.



Figure 1. Automated belt sampler is used to obtain a sample of the material rapidly from the moving conveyor belt



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### Purpose and Scope

This project was established to explore possible new ways of gathering real-time quality control information. If the concept of real-time QC appears feasible, a strategy for the evaluation of new methods and technologies should be developed.

The two primary goals of real-time testing are: first, to dramatically shrink the time lag for quality control information, and second, to improve the reliability of the data (i.e. significantly reduce sampling and testing variability). Ultimately, these improvements should reduce the risks to producers and customers and lead to better pavement performance by providing better materials quality control.

As it is envisioned, real-time automated testing is a quantum leap ahead in quality assurance. Real-time testing will involve automated feedback during the mix production process and construction operations. Automated testing is envisioned to mean that information is obtained without direct human interaction.

### New Devices for Automated QC Testing

This QC Automation Open House highlighted the following methods for sampling and testing of materials during the production of HMA. These devices installed on East Alabama Paving Company's Opelika plant are being evaluated by NCAT.

#### Automated Belt Sampling

Automated belt samplers (Figure 1) are used to obtain a sample of the material on a moving conveyor belt. When a belt sampler is activated, an open box rapidly sweeps transversely across the belt closely following the contour of the belt so that all of the material in the cross-section is removed. The speed of the sweep is very fast to obtain an even cross-section of material and

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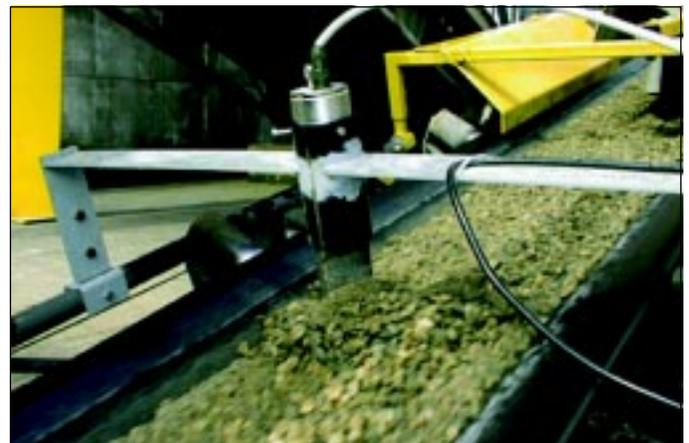


Figure 2. Microwave moisture probe



Figure 3. Automated sample drying device

minimize the potential influence on belt scales. The sample obtained by the belt sampler can be deposited into a bucket or go straight into another automated device such as a drying unit or gradation unit. Belt samplers can be placed on virgin aggregate conveyors and/or RAP conveyors.

#### Automated Moisture Content of Aggregates and RAP

The moisture content of the materials on the belt are needed to correct the mass measurement (e.g. tons/hour) of the conveyor belt scales. There are two techniques that are being evaluated on the project to determine moisture contents. The first technique utilizes probes that can be inserted into the stream of material traveling on the belt (Figure 2). These probes are based on a microwave technology which instantaneously senses the microwave energy absorbed by the material. The energy absorbed is proportional to the moisture content of that material. For this project, moisture probes are installed on the virgin aggregate conveyor belt and the RAP belt. The second method for determining moisture content in this study is with automated sample driers, which receive materials from the automated belt samplers. The driers used on this project are first production units. These driers (Figure 3) use electric heating elements to heat the sample to a temperature around 325°F until the sample reaches a constant mass. The drying units are suspended on load cells so that the sample mass can be monitored by a PLC and the moisture content of the

sample is automatically calculated.

#### Automated Gradation of Virgin Aggregate

After the aggregate sample is dried by the automated drying unit, it is then directed into an automatic gradation device (Figure 4). The gradation device is similar to laboratory sieving equipment. It is equipped with seven standard sieve screens (12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 0.3 mm, and 0.075 mm). Other sieve sizes can be used. The shaking of the screens is accomplished with variable frequency vibrators. After shaking for a programmed interval, the unit is rotated 90 degrees and each screen is emptied one at a time into a catch pan. The catch pan is suspended on three small load cells connected to a PLC which calculates the gradation as percent passing each sieve. The gradation unit used on this project is one of the first built for use at an asphalt plant.

#### Automated Viscosity of Asphalt Binders

An in-line viscometer is installed in the asphalt supply line from the plant's tanks to the point of mixing in the drum (Figure 5). The purpose of the in-line viscometer is to indicate if the correct binder grade (e.g. PG 64-22 or PG 76-22 binder) is being used in the mix. This viscometer uses a magnetically excited vibrating rod in the flow of the fluid (asphalt). The dampening effect of the fluid on the vibrating rod is proportional to the viscosity of the fluid. To compensate for the effect

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Figure 4. Automated gradation device



Figure 5. In-line asphalt viscometer

instrument also records the temperature of the material and a PLC interface corrects the viscosity to a standard temperature.

#### Automated Calibration of Asphalt Meters

Continuous-mix asphalt plants use positive displacement pumps or Coriolis type mass flow meters to determine the flow rate of asphalt binder delivered to the point of mixing. These pumps and mass flow meters must be calibrated periodically to assure that the flow rate is accurate for the different binders used at HMA plants. AC calibration tanks provide a reliable, efficient, and safe means for doing this. On this project, a 1000 gallon calibration tank has been plumbed to the plant's asphalt lines (Figure 6). The tank is insulated and is equipped with a hot oil system to maintain temperature. It is supported on three load cells to determine the mass of the tank and asphalt held during the calibration routine. When the calibration procedure is initiated, electronically activated valves divert the



Figure 6. Asphalt meter calibration tank

asphalt flowing through the flow rate pump into the calibration tank for a specific time interval. The PLC takes the reading of gallons from the pump, converts that volume to mass, and compares that mass to the mass of the asphalt in the tank. If the two mass measurements do not agree, an

adjustment factor is applied to the pump reading and the procedure is repeated until the readings agree within a programmed tolerance.

#### Automated Data Management

A key element of automated testing is programming of the devices and management of the data received from the devices. Programming the devices on the front end deals with triggering of the devices, determining how and what information should be obtained, calibration, and setting of limits. During the test, raw test data from each of the automation devices is sent back to a central data acquisition system located in the plant's control house. The data acquisition system makes associations of data from each source, obtains related plant information, and organizes the information in user-friendly formats such as test reports, tables, and control charts.



Figure 7. Robotic truck sampler

#### Robotic Truck Sampler

Also being evaluated as part of this project is a robotic truck sampler (Figure 7) for obtaining a representative sample of HMA from a loaded truck. This machine does require a technician to operate it and so it is not automated like the above devices. However, the robotic truck sampler does obtain a sample from the interior of the load which should be more representative of the load than a sample shoveled from the upper part of the load. The machine also eliminates the need for the technician to get into the back of the truck, which is potentially unsafe.

The evaluation of automated, real-time QC devices in this project is expected to be completed by NCAT by the end of this year.

- Randy West

## PUTTING RESEARCH INTO PRACTICE

The following paper was presented at the annual meeting of the Association of Asphalt Paving Technologists (AAPPT) held in Baton Rouge, Louisiana in March. We are reporting observations and conclusions from it 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. Title of the paper is given, with names of authors in parentheses, followed by a brief summary.

### EVALUATION OF RUTTING PERFORMANCE ON THE 2000 NCAT TEST TRACK (Brown, Prowell, Cooley, Zhang, and Powell)

The primary objective of the 2000 NCAT Test Track was to provide an accelerated loading facility that could be used to rapidly test a large number of test sections simultaneously. Primarily, the test sections were comprised of materials selected by the different sponsors (highway agencies) to answer local questions about the performance of their HMA under accelerated loadings. (Editor: Details of the 46 test sections constructed on this 1.7-mile oval test track can be seen in the Fall 2000 issue of the *Asphalt Technology News*. Previous issues can be seen by visiting NCAT's web site at <[www.ncat.us](http://www.ncat.us)>.)

The objective of this paper was to use the results from the 2000 NCAT Test Track to compare laboratory rutting tests and field performance for a number of mixes subjected to similar loadings that were representative

of actual traffic. Also, several mini experiments were evaluated: performance of fine graded vs. coarse graded mixes, effect of asphalt binder grade on performance, effect of aggregate type on performance, and performance of several mixture types including Superpave, SMA, and open graded friction courses.

After the planned 46 test sections were constructed in September 2000, a total of 10,000,000 ESALs were applied over a 2-year period. The ESALs were applied with four fully loaded trucks with three trailers per tractor.

A total of eight aggregate types (or combinations) were utilized in the 46 sections of the Track. These aggregate types included: siliceous gravel, granite, limestone/slag, sandstone, limestone/recycled asphalt pavement, limestone, limestone/gravel, and marble schist. All surface mixes utilized 9.5 or 12.5 mm nominal maximum aggregate sizes (NMAS). Five general gradation shapes were placed on the track: gradations passing above the Superpave designed restricted zone (ARZ), gradations passing through the restricted zone (TRZ), Superpave gradations passing below the restricted zone (BRZ), stone matrix asphalt (SMA), and open-graded friction courses (OGFC). The predominant method of compacting samples during mix design was the Superpave gyratory compactor (SGC). A total of 34 mixes were designed using the SGC with a design number of gyrations ( $N_{\text{design}}$ ) of 100. Two mixes were designed using 125  $N_{\text{design}}$  gyrations. All of the SMA mixes were designed using a Marshall hammer with 50 blows per face. Five Superpave designed sections intentionally targeted binder contents that were

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### 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 14-23 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>>.

### JOIN US

We at NCAT hope you enjoy this issue of *Asphalt Technology News*. It is provided free of charge. If you wish to be added to our mailing list, please send your business card or your name, company, mailing address, and email address (ATN is sometimes distributed by email only) to us and also indicate whether you prefer to receive ATN in the mail or by email. Outside the U.S., ATN is sent by email only. Send your information to:

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## SUPERPAVE MIX DESIGN WORKSHOP

Superpave mix design workshop will be held at NCAT on March 28-31, 2005. 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.

Please call (334) 844-NCAT (6228) 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. editions of **Asphalt Technology News** are also available from our homepage.

0.5 percent higher than optimum. Three different asphalt binder grades were used within the mixes on the Track: PG 64-22 (meeting high temperature requirements above 67C), PG 70-28, and PG 76-22. For the modified binders (PG 70-28 and PG 76-22) three different modifiers were used: SB, SBS, and SBR.

Based upon the test results and analyses, the following conclusions were drawn:

- The amount of permanent deformation in all of the test sections was very low. Permanent deformation essentially stopped when the air temperature was less than 28°C. The accumulation of permanent deformation in the second summer was significantly less than the first.
- Under traffic, mixes containing PG 64-22 densified more than the mixes containing PG 76-22 binder. This may indicate that slightly more binder can be added to mixes with two high temperature binder bumps to improve durability without sacrificing rut resistance. As expected, the binder layers containing PG 64-22 densified less than the surface layers

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containing PG 64-22.

- The amount of permanent deformation was over 60 percent less in the sections that contained PG 76-22 as compared to the sections containing PG 64-22.
- The performance of the coarse graded and fine graded mixes was about the same. Hence, this study indicates that similar performance would be expected for coarse graded and fine graded mixes with respect to permanent deformation.
- Adding an additional 0.5 percent binder above optimum to the mixes produced with PG 64-22 increased permanent deformation by approximately 50 percent. However, there was no significant increase when an extra 0.5 percent binder was added to mixes produced with PG 76-22.
- The secondary slope calculated from the repeated load permanent deformation test produced the best correlation with final deformation values. However, the test is highly variable. In excess of three replicates will be needed to produce statistical conclusions.
- The results from the dynamic modulus test indicate no relationship with field deformation. However, testing did deviate from the NCHRP 9-19 protocol.

Due to the small amount of rutting, many sections will remain in place for another two years of traffic to better evaluate rutting potential and gain some early indications of the mixtures durability.

## 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/>>.





## NCAT TEST TRACK UPDATE

Trucking for the 2003 NCAT Pavement Test Track is approximately 34 percent complete (3.4 millions ESALs).

With the development of extensive fatigue cracking in some sections within the structural experiment, it became necessary to implement a system to map surface cracks. Early on Monday mornings (the day the trucking operation is suspended) before the pavement heats up and small cracks become more difficult to see, a visual inspection is performed where the beginning and ending point of each crack is carefully marked with a paint pen.

When full alligator cracking develops, the corner boundaries of cracked areas are marked in a similar manner. A video camera is then mounted on a forklift boom such that a full lane width vertical picture of the surface of the pavement can be obtained.

The cross-sections of eight structural test sections along with the mixtures used therein, were given in the Fall 2003 issue of the Asphalt Technology News. This issue can be seen on the NCAT web site, <[www.ncat.us](http://www.ncat.us)>.

Extensive fatigue cracking is occurring in the thinner N1 and N2 structural test sections, as shown in figures A and B.



Figure A. Fatigue cracking in structural Test Section N1



Figure B. Fatigue cracking in structural Test Section N2

## 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.*

### Florida (Gale Page, Florida DOT)

A number of asphalt suppliers in Florida have indicated concern that their competitors may be using acid or chemically modified binders. We are neither aware nor do we have any evidence that this is occurring. Our questions are: (a) What is the effect on performance of the binder and/or mix of acid or chemical modification of binders that meet all specification requirements? and (b) How would an agency specify and test the binder to make sure no acid or chemical modification has been made if indeed the current specification requirements are inadequate?

### Tennessee (Brian Egan, Tennessee DOT)

The Tennessee Department of Transportation is in the process of revising the cold milling specification. An increased number of mill and overlay projects are underway and smoothness is tough to achieve. Are any other states taking similar action?

### Washington (Dennis Duffy, Washington DOT)

(a) Has any agency implemented a process to qualify/certify HMA paving contractors for DOT work? If so, how has it been working?

(b) This question is for those agencies that require contractor quality control (QC). Since the implementation of contractor QC, has the quality of HMA pavements improved?

## ASPHALT FORUM RESPONSES

*The following responses have been received to questions raised in the Spring 2004 Asphalt Forum.*

*Colorado is interested in any agency experience or any field performance data comparing projects built with polymer modified binders and projects built with acid or chemically modified binders. Are any other agencies taking action to limit the use of chemically modified binders in Superpave mixtures? (Bill Schiebel, Colorado DOT)*

*How are other states dealing with the issue of acid modified binders? Are restrictions being placed on all binder testing to minimize their use, such as an elastic recovery specification, or are the restrictions such that no acid modification is allowed at all? (Milton Fletcher, South Carolina DOT)*

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

The Alabama DOT allows only SB (styrene butadiene), SBS (styrene butadiene styrene), and SBR (styrene butadiene rubber) as modifiers of asphalt cement. No oxidation is allowed whether it is physical (super heating or forced air induction) or chemical (acid). However, some companies use a proprietary co-linking agent in the polymer modified asphalt blends. These agents are chemically bonded to the polymer and asphalt.

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

The Connecticut DOT is currently trying to address concerns regarding acid modified binders with the industry. Long-term effects of acid modified binders are not really known or understood. We are working in conjunction with the Northeast User/Producer Group to address this issue.

### **Florida (Gale Page, Florida DOT)**

Many asphalt suppliers in Florida have indicated concern that their competitors may be using acid or chemically modified binders. We do not have any evidence that this is occurring. We are concerned about the effect on performance of the binder and/or mix of acid or chemical modification of binders that meet all specification requirements. We do not know how to specify and test the binder to make sure that acid or chemical modification is not happening if indeed the current specification requirements are inadequate.

### **Idaho (Michael Santi, Idaho Transportation Department)**

Idaho is using the elastic recovery test to restrict the use of acid modified binders. We are not aware of any projects built in Idaho using acid modified binder. We do not use Superpave at this time.

### **Kansas (Cliff Hobson, Kansas DOT)**

The Kansas DOT does not allow acid modifiers in any binder. At the present time, performance graded asphalt binders must meet all the requirements of AASHTO M320 after the addition of 0.5 percent (by mass) high molecular weight amine antistripping agent. Polymer modified binders must also meet Separation (ASTM D5976) and Elastic Recovery (ASTM D6084) requirements.

### **Louisiana (Christopher Abadie, Louisiana DOT)**

The Louisiana DOT requires elastic recovery and force ductility ratio tests to be conducted for acceptance of polymer modified asphalts. The Louisiana Transportation Research Council is sponsoring research that will examine the characteristics of polymer modified asphalts after increasing levels of aging. Perhaps these tests on binders performed after extended periods of laboratory aging will identify potential problems, if any, caused by acid or chemical modification.

### **Missouri (Mark Shelton, Missouri DOT)**

The Missouri DOT has not looked specifically at chemically modified binders. Beginning with lettings in October this year, a requirement for elastic recovery has been incorporated into our binder specification based on the absolute spread between the high and low temperatures.

### **Montana (Scott Barnes, Montana Dept. of Highways)**

To our knowledge we have not encountered any 'modified' binders coming into Montana with acid or chemical modification. We do have a cold temperature ductility specification for our modified binders, but we do not know whether this would prevent any such material from being used.

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### **Tennessee (Brian Egan, Tennessee DOT)**

Currently, the Tennessee DOT does not allow the use of chemically or acid modified binders. The specifications call for modified asphalts to be modified with either SB, SBS, or SBR. In addition, there is a requirement for the polymer modified asphalt to pass a softening point test and an elastic recovery test.

### **Texas (Dale Rand, Texas DOT)**

We do not allow acid modified binders. We have a requirement for elastic recovery, which eliminates acid modified binders.

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

So far we have good experience with polymer modified binders. No attempt has been made to discriminate "acid modified" binders as we are adhering 100 percent to Superpave binder specifications. We do not have any experience with acid-modified binders.

*Since 1992, the National Center for Asphalt Technology (NCAT) has conducted extensive research on different techniques of constructing longitudinal joints. The objective was to recommend techniques which give durable longitudinal joints. NCAT Research Reports 97-4 and 02-03 pertaining to this research can be downloaded free from our website, <<http://www.ncat.us>>. The main conclusions from this research project are as follows:*

- *The longitudinal joints with high densities right at the joint generally show better performance than those with relatively low densities. Highway agencies should specify minimum compaction levels to be achieved at the longitudinal joint to ensure good performance. It is recommended that the density right on the joint be not more than two percent lower than the density specified in the lanes away from the joint.*

- *Application of rubberized asphalt tack coat on the unconfined edge of the first paved lane resulted in a durable longitudinal joint.*
- *The Michigan notched wedge joint (12.5 mm vertical offset and 12:1 taper) has a good potential of obtaining a satisfactory longitudinal joint.*

*NCAT would like to ask the highway agencies what steps they have taken in recent years for obtaining a durable longitudinal joint. Please report the techniques and related specification criteria implemented. This will facilitate exchange of ideas on this important subject, which will be published in the next issue of the Asphalt Technology News.*  
**(Prithvi "Ken" Kandhal, Associate Director Emeritus, NCAT)**

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

The Connecticut DOT has experimented with heated joints, tapered joints, various joint makers, and hot-side/cold-side compaction methods for several years. Based on the experience from these experiments, the DOT has initiated a joint density specification for HMA. This specification has been used for the last eight years and includes an adjusted pay factor. We have been requiring that the density on the "hot side" of the joint be no less than 90 percent of the theoretical maximum density compared to 92 percent for the "mat" away from the joint. We do not specify the method of joint construction nor require any application of tack or other materials. We require that a rolling pattern be established that provides minimum specified density on the "hot side" of the joint and the "mat" away from the joint.

With the release of our new specifications (Form 816-2004), the specification has been changed to 92 percent minimum for "mat" & joint "hot-side" only with a weighted correction that puts emphasis on the joint density when there is an adjustment, as follows:

Final Density Adjustment = 40% (Mat density) + 60% (Joint density)

### **Idaho (Michael Santi, Idaho Transportation Department)**

Idaho has obtained a copy of the Washington DOT's notched wedge joint specification and is trying it on a couple of projects this year.

### **Kansas (Cliff Hobson, Kansas DOT)**

For three years, the contractors and the Kansas DOT have been gathering data on joint density using the Texas DOT criteria. With the October 2004 letting, the Texas  
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## **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.

joint criteria will be implemented. The criterion is: interior density minus joint density (taken at 8 inches from the joint) should be equal to or less than 3.0 pounds for cubic foot or the joint density should be greater than or equal to 90 percent of the maximum theoretical density. If either condition is met, the joint density passes.

#### **Kentucky (Allen Myers, Kentucky Transportation Cabinet)**

About five years ago, the Kentucky Transportation Center (KTC) at the University of Kentucky conducted a research project involving longitudinal joint construction. This study included an evaluation of various joint construction techniques (e.g., notched wedge, restrained edge, joint adhesive, etc.) and an analysis of pavement density data across the HMA mat for several experimental projects. One of the products from this research effort was a proposed specification for the density of HMA surface courses near the longitudinal joint. The recommended requirement was a minimum density value of 89.0 percent of the theoretical maximum density from roadway cores obtained within  $3.0 \pm 0.5$  inches of the longitudinal joint. This specification is three percent less than the corresponding requirement for density cores obtained from the remainder of the lane.

After evaluating this specification on numerous trial projects, Kentucky implemented the requirement on HMA surface pavements this year. Our joint density specification may be viewed at [http://transportation.ky.gov/construction/spec/2004/2004\\_Division400.pdf](http://transportation.ky.gov/construction/spec/2004/2004_Division400.pdf). The KTC research report on this topic may be viewed at [http://www.ktc.uky.edu/Reports/KTC\\_02\\_10\\_SPR200\\_00\\_1F.pdf](http://www.ktc.uky.edu/Reports/KTC_02_10_SPR200_00_1F.pdf). KTC will continue to monitor the experimental projects from the research study for a number of years to evaluate the performance of the various joint construction techniques and treatments.

#### **Louisiana (Christopher Abadie, Louisiana DOT)**

Louisiana currently has no specification for longitudinal joint density. The LTRC is currently investigating procedures and/or methods to achieve satisfactory joint density.

#### **Missouri (Mark Shelton, Missouri DOT)**

We have a specification for longitudinal joint density that has been in place since the mid 1990s. The unconfined side of the joint continues to be a struggle for obtaining adequate density. There have been some modifications over the last ten years. Currently, the confined side of the joint is measured as part of the

main pavement away from the joint. The unconfined side is allowed a 2 percent tolerance from the density specified for the main pavement.

#### **Montana (Scott Barnes, Montana Dept. of Highways)**

We have not made a change to density requirements on the longitudinal joint yet, but intend to. Presently, free edges may be tested to within one foot, the longitudinal joint may be tested if it comes up in the random location selection, and must meet the same requirements as the main line.

#### **Ohio (David Powers, Ohio DOT)**

The Ohio DOT currently is evaluating longitudinal joint densities on a statewide basis. Following that, Ohio may implement changes in accordance with the NCAT recommendations to obtain good joint performance.

#### **Tennessee (Brian Egan, Tennessee DOT)**

The Tennessee DOT currently does not have a density specification for longitudinal joints. We require density test to be taken one foot away from the edge for acceptance.

#### **Washington (Dennis Duffy, Washington DOT)**

The Washington DOT is currently researching an in-place density specification requirement for longitudinal joints.

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

Ontario has developed a lane-edge compaction specification based on cores taken at the confined and unconfined edges of each lane for contracts of at least 15,000 tonnes of hot mix. Sublots range from 500 to 1000 tonnes depending on the size of the contract. Price adjustments are based on percent within limits (PWL) criteria using lower limits which range from 89 percent to 90 percent of the theoretical maximum density depending upon the mix type.

The price adjustments are as follows:

- More than 95 percent PWL    Bonus up to 1 percent
- 90 to 95 percent PWL        Full pay
- Less than 90 percent PWL    Price reduction

**(Prithvi Kandhal, Editor: A session on longitudinal joint density will be held at the annual meeting of the Transportation Research Board on January 9, 2005 (Sunday) at 1:30 pm. This session will be part of a workshop on "Factors Affecting Compaction on Asphalt Pavements" to be held from 8:30 am to 5:00 pm on that day.)**

## NCAT HOSTS INTERNATIONAL SYMPOSIUM ON LONG LASTING ASPHALT PAVEMENTS

The National Center for Asphalt Technology (NCAT) hosted the International Society for Asphalt Pavements' (ISAP) international symposium on **Design and Construction of Long Lasting Asphalt Pavements** on June 7-9, 2004. The symposium was also sponsored by the U.S. Department of Transportation (Federal Highway Administration), the Alabama Department of Transportation, Asphalt Pavement Alliance, and the National Asphalt Pavement Association.

The venue of the international symposium was The Lodge and Conference Center at Grand National Golf Course in the Auburn/Opelika area, set in the serene countryside of east Alabama.

Over 35 very good technical papers from many countries concerning long lasting asphalt pavements were presented in three days at the symposium.

The symposium was attended by about 220 people with delegates from twelve countries besides the United States: Australia, Belgium, Brazil, Canada, China, Denmark, India, Korea, Netherlands, Sweden, Switzerland, and United Kingdom.

Professor Carl Monismith, an international leader in pavement design and analysis, was the keynote speaker at the symposium. His presentation provided insight into material selection, structural design, and construction methods for long lasting pavements.

The following papers concerning different aspects of long lasting asphalt pavements were presented at the symposium.

### Long Lasting Asphalt Pavements Program

- The Federal Highway Administration's Long Life Pavement Technology Program

### Concepts for Long Lasting Pavements

- A New Canadian Initiative to Develop a Long Term Program of Pavement Research



*Participants from twelve countries besides the U.S. registered at the Symposium*



*Prof. Carl Monismith, University of California at Berkeley, was the keynote speaker at the Symposium*

- The European Approach to Long Lasting Pavements - A State of the Art review by ELLPAG
- Making Best Use of Long Life Pavements in Europe
- The Technical and Economic Feasibility of Long-Life Wearing Courses
- Making Best Use of Long Life Pavements in Europe

### Pavement Design

- Foundation Requirements for Perpetual Pavements
- The Effect of Load Spectra and Variability on Perpetual Pavement Design
- Some Suggestions to Improve the Mechanistic Empirical Bituminous Pavement Design in Indian Context
- Comparison of Design Pavement Methods in France and Quebec
- Long Life AC Pavements: A Discussion of Design and Construction Criteria based on California Experience
- Design Principles of Long Lasting HMA Pavements

### Materials and Mix Testing

- Stone Skeleton Asphalt Mixes for High Performance
  - An Integrated Approach to Avoid Asphalt Moisture Damage
  - Effect of Hydrated Lime on the Rheological Properties of
- (continued on page 12)*

### Compatible and Incompatible Asphalts After Long-Term Oxidative Aging

- Imaging Based Evaluation of Coarse Aggregate Used In the NCAT Test Track Asphalt Mixes
- Open Graded HMAC Considering the Stone on Stone Contact
- Laboratory Study of Fatigue Characteristics of Asphalt Surface Mixtures Containing RAP
- A Rapid Performance Test for Superpave Mixtures
- Prediction of Flow Rutting
- Design of 4.75 mm NMA Mixes for Thin Maintenance Treatments
- Fatigue Considerations in the Design of Long-Lasting Pavements
- Determination of Threshold Strain Level for Fatigue Endurance Limit in Asphalt Mixtures
- MDV9 Method for Aggregate Polish Resistance Determination



*Active participation by the audience at the Symposium*

### Accelerated Loading

- Comparison of Rutting Behavior on Test Sections and a Circular Test Track Using a Model Mobile Load Simulator
- Hot-Mix Asphalt Analysis Using Accelerated Testing

### Warranties

- European Asphalt Pavement Warranties

### Construction

- Evaluation of Segregation of Expressway Asphalt Pavement
- A Construction Planning and Evaluation Tool for Urban Freeway Rehabilitation Projects
- Importance of a Good Quality Control Program in the Performance of HMA Pavements

### Case Studies

- Performance of a Long Life Overlay on a “Perpetual Pavement” Infrastructure Project
- The I-710 Freeway Rehabilitation Project: Mix and



*Ray Brown, NCAT director (center) with Don Brock (left) and Mike Acott*

### Structural Section Design, Construction Specifications, and Lessons Learned

- Long Lasting Low Volume Pavements in Washington State
- Kansas Turnpike - An Example of Long Lasting Asphalt Pavement
- Performance and Rehabilitation of Heavy-Duty Pavements in the UK: Some Case Studies
- Performance of A Long-Life Overlay on a “Perpetual Pavement” Infrastructure Project
- Performance of Flexible Pavements in South Brazil
- A Case Study of Three Full-Depth HMA Interstate Pavements
- Long Lasting Asphalt Pavements - The Danish Experience

A bound volume of the proceedings, titled “International Symposium on Design and Construction of Long Lasting Asphalt Pavements,” June 7-9, 2004, is available from the National Center for Asphalt Technology, Auburn University. Contact Carol Mims at <taplecp@eng.auburn.edu> to obtain the proceedings.

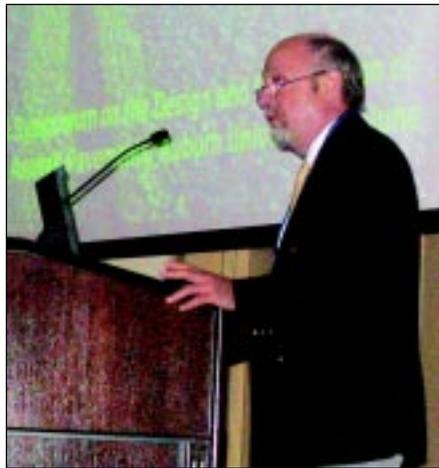


*Symposium participants were given a tour of NCAT laboratories*

## SOME OF THE SPEAKERS AT THE INTERNATIONAL SYMPOSIUM



*Ralph Haas, Canada*



*Michael Nunn, U.K.*



*Hans Ertman Larsen, Denmark*



*Ian Rickards, Australia*



*Safwat Said, Sweden*



*Rita Fortes, Brazil*



*Manfred Partl, Switzerland*



*Stephen Brown, U.K.*



*Mikael Thau, Denmark*

## SPECIFICATION CORNER

**California** - The California Department of Transportation (Caltrans) is in the process of revising old specifications and developing new ones to accommodate the following changes:

- Large stone mix (LSM) permitting the use of 37.5mm aggregate. The LSM mix is intended for areas where rutting is a concern such as climbing lanes, on and off ramps, slow truck lanes, weigh stations, etc. The LSM will have higher stability requirements, may require modified/high viscosity asphalt binders, and 100 percent crushed aggregates. The LSM will be covered by either a slurry seal or an OGFC layer to provide smoother and quieter riding surface.
- High stability mix is being introduced and is meant to reduce rutting problems at urban intersections and in desert areas. The requirements for this mix are 100 percent crushed aggregate, flat and elongated particle limits, angularity, and modified stability and binder requirements with stricter process control requirements.
- Theoretical maximum specific gravity (Rice specific gravity/density) will replace "Laboratory test maximum density" for field density requirements. Density determinations using the Rice gravity should improve the accuracy and consistency of pavement density determinations.
- Introduction of rubberized asphalt concrete warranty projects, where the specification will require the contractor to warranty the construction for a period of five years from the date of acceptance by Caltrans. During the five-year warranty period the contractor will be responsible for all required repairs/maintenance.
- Specifications are being developed for the use of gap-graded rubberized asphalt concrete allowing the use of "dry process" in rubberized asphalt concrete construction.
- Specifications have been changed to allow the use of larger-size open-graded asphalt concrete (allowing the use of 25mm aggregate) with modified PBA-6A or PBA-6B binders in the northern region, colder, and high rainfall areas. The change should result in improved permeability.
- Anti-strip specifications are being considered for HMA allowing the use of lime slurry marination, dry lime on damp aggregate, and liquid anti-strip agent usage.

**Kansas** - Starting with the October 2004 lettings, the Texas longitudinal joint density criteria will be implemented. The criterion is: Interior Density minus Joint Density (taken at 8 inches from the joint) should be equal to or less than 3.0

PCF or the Joint Density should be greater than or equal to 90 percent of the theoretical maximum density (Gmm). The joint density passes when either condition is met.

**Louisiana** - The following revisions have been made to HMA specifications:

- Plant quality assurance: removed the pay factor for VMA, and reduced VMA design and validation limit by 1 percent.
- Plant pay will be determined by air voids alone. Also implemented a new stepped pay plan for PWL for air voids (n=5). An 88 PWL is required for 100 percent pay, 100 PWL provides 103 percent pay, and 70 PWL would result in 98 percent pay.
- IRI specifications utilizing inertial profile measurements provided by contractor-owned lightweight profilers, are being implemented. Interstate level construction requires an average IRI of 65 inches per mile with staged incentives for an average of 55 for each lot and an average of 45 for the entire project.
- The lower limit for VFA was raised to a minimum of 68 percent. The limits for VFA are now 68 -78 percent for all mixes. Also, design voids are now 3.5 percent with a range of 2.5 to 4.5 percent. The minimum percent passing 200 sieve was raised by 1 percent. The lower control point limit for the number 8 sieve was also raised by 4 percent to 6 percent, depending on nominal maximum size of the aggregate.

**Missouri** - Missouri's new Standard Specifications were implemented on July 1, 2004. The entire specification book was reviewed to write out method specifications where possible. This has resulted in numerous items being shifted from agency control to the contractor. The full impact of this will not be realized until the 2005 construction season.

**Montana** - Montana has adopted a new volumetric Superpave specification. Aggregate gradations are not obtained except for the minus 200 fraction for determining the dust-asphalt ratio. The DOT measures and pays only on four volumetric properties: air voids, VMA, VFA, and dust-asphalt ratio. Dust-asphalt ratio is used rather than the dust proportion for field control as it is much more easily computed. Incentives up to 12 percent of the plant mix bid price are available, in addition to the ride and density incentives. Total incentive available is 42 percent of the plant mix bid price (does not include the binder which is paid separately). This major change in the way of doing business for the DOT and for the contractors has been very successful. Both the contractors and the DOT field engineers like it. Contractors have slowed

*(continued on page 15)*

their production down and are paying attention to the details which produce quality and incentives.

**Ohio** - The following specification revisions have been made or are being considered:

- Ohio is currently evaluating longitudinal joints statewide for specification improvement.
- Ohio is moving toward International Roughness Index (IRI) in place of Profile Index (PI) on projects. Included will be allowance for high or low speed profilers. Ohio is using a trial smoothness specification on some low volume roads; this specification has no disincentive.
- Ohio is implementing paver modification requirements to alleviate hidden longitudinal segregation that leads to odd longitudinal cracks. This was inspired by a study done in Colorado.
- The SMA mix design will now require 65 gyrations instead of 75 gyrations used in the past.

**Tennessee** - The Tennessee DOT is in the process of introducing SMA and OGFC into the resurfacing program. The first SMA project was undertaken in September this year.

The DOT is considering allowing more reclaimed asphalt pavement material (RAP) to be added to a mix if the RAP is either processed beforehand or crushed in-line and screened so that the largest RAP particle is no larger than the nominal maximum size of the aggregate in the mix. This would also allow the use of RAP in surface mixes for the first time.

The anti-stripping additive policy will have requirements on how the material is being stored, how long it is stored, how it is being metered into the plant, and how it will be paid for.

The milling requirements for interstates have been revised to include grade control systems as well as a 12.5-foot drum.

**Washington** - The HMA contractors are now required to do their mix designs. The DOT verifies these mix designs for specification compliance. Volumetric specification requirements have been incorporated in all HMA mix designs. The use of material transfer device/vehicle will be encouraged to minimize temperature differential and segregation during HMA laydown.

**Ontario** - The following changes have been made to the end-result specification for hot mix asphalt:

- VMA has been added as a criteria for acceptance of Superpave and Marshall mixes.
- Mix Design Submissions:
  - (a) Volumetric properties and moisture susceptibility: For Superpave mixes, the contractor will now be required to retain an independent, third party laboratory to check mix volumetric properties and moisture susceptibility, and submit a conformance document which is signed and sealed by the laboratory's supervising engineer.

(b) Testing aggregates for specific gravity for mix design and during hot mix production: In addition to conducting aggregate specific gravity testing in the mix design stage, during HMA production, the contractor will now be required to procure samples from alternate lots of hot mix and conduct specific gravity tests for RAP and each of the aggregates identified in the mix design. The QC aggregate specific gravity results will be used to calculate VMA.

- Sampling Superpave and SMA: For large asphalt mix samples, it will now be permitted to place the material in a maximum of two receptacles and it won't be mandatory to mix them once they are received at the testing laboratory.
- Conditions for Referee Testing: Differences in QA and QC testing of the combined aggregate specific gravity used in calculating VMA have been added as a possible condition for referee testing.
- Specification Limit for Asphalt Content: The lower limit has now been revised to 0.4 percent below the Job Mix Formula.

## 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 January 31-February 4, 2005 and February 28-March 4, 2005, 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.

## NCAT's Professor Training Course in Asphalt Technology June 15-24, 2004



**Back, L-R:** Doug Hanson (Instructor), Luis Diaz, Jeffrey Fetzko, Ray Brown (Instructor), Ashraf Rahim, Keith Plemmons, Phillip Ooi, Fabricio Leiva Villacorta, Christos Drakos, Jon Epps (Instructor)

**Middle, L-R:** Randy West (Instructor), Miguel Picornell-Darder, Zhong Wu, Ahmad Abu Abdo, Mike Arasteh, Chen Chen, Sanjaya Senadheera, Zhanping You

**Front, L-R:** Randall Caley, Medhat Shehata, Junan Shen, Kunawee Kanitpong, Mohammad Jamal Khattak, Akhter Hossain, Khalid Al-Hamdouni



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