

Southeastern Superpave Center News

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Inside this issue

Winter is meeting time. When the snow flies or it is just too cold to pave, industry, agencies and academics get together to share information. Budget cuts and hard times have made it harder than ever to travel to meetings, however. So, this issue of the newsletter is filled with summaries of some of the more important recent regional and national meetings. It is hoped that these summaries can help you stay up to date on the latest advances and concerns in asphalt.

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Accelerated Pavement Testing and Test Tracks: Why we can't live without them

by Don Watson

The title of this article was the theme of the 2009 NCAT Pavement Test Track Conference at the Auburn/Opelika Grand National Conference Center February 10-11, 2009. Presentations were given that noted the value of being able to place materials of questionable performance, verify mechanistic-empirical pavement design methods, and conduct experiments that test the limits of current specifications and test procedures.

Keynote speaker Dr. Joe Mahoney, University of Washington, emphasized the valuable information that has been learned from controlled loading provided



Dr. Joe Mahoney

by accelerated pavement testing (APT) facilities. For example, the AASHTO Road Test, even with its limitations, has provided valuable research data that has been used for five decades in building the complex transportation system we have today. Currently there are 15 APT facilities in the U.S. and 28 worldwide. Dr. Mahoney went on to say, "Detailed gains in knowledge about pavements will continue to be advanced by APT facilities over the next several decades."

Dr. Buzz Powell, NCAT Test Track Manager, added that the NCAT Test Track is a "mechanism for innovation." It allows both agencies and private

material suppliers to try new materials, new or revised design methods, and new technologies for performance measurement that would not be possible on a mainline traveled way due to liability issues involved in placing a research test section subjected to live vehicle traffic.

One such example was the Indiana low air voids experiment. Through an evaluation of QC program data, INDOT learned that in-place air voids of their pavements were four times more variable than originally thought. This presented a common scenario in which the agency assumes significant risk if low void sections are allowed to remain in place, while contractors face significant monetary costs if sections are removed and replaced unnecessarily. The INDOT research sections were used to intentionally place mixtures with low air voids in order to determine cut-off levels for remove and replace versus leave in-place with a reduced pay factor. INDOT test sections showed that, from a performance basis, in-place mixtures using PG 64-22 (PG 67-22 in southeastern states) with air voids higher than 2.75% did not appear to require a removal. Rutting results, however, dramatically increased when air void results were below this level, and suggested that removal and replacement may be necessary. A comparison with other test track sections indicates that the rutting relationship of polymer-modified mixtures is different. Polymer-modified mixtures can withstand lower air voids without rutting.

Dr. Randy West, NCAT Director, described the NCAT RAP experiment which tested current specification limitations on the amount of RAP material allowed in asphalt mixtures. Specifications have typically limited RAP because of uncertainty of the selected binder grade to use and the lack of documented performance of high RAP mixtures. The NCAT Test Track incorporated six RAP test sections with three sections each of 20%

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Accelerated Pavement Testing...(continued from page 1)

and 45% RAP. Performance of these sections was compared to a control section without RAP. The binder grade used in these test sections varied from PG 52-28 to PG 76-22. Mixtures were tested for performance related to rutting, raveling, roughness and cracking.

Five of the six RAP mixtures resulted in less rutting than the virgin aggregate control mix. The only exception was a mix with 20% RAP which had about 2% in-place air voids. Rutting in this section was 8.5 mm after 10 million ESALs of trafficking.

Raveling was determined by taking various ARAN van texture depth measurements over the life of the test cycle. The ARAN unit uses a high frequency laser profiler mounted over the right wheelpath. Although the 45% RAP sections had greater changes in texture depth, the difference was within normal observed testing variation; therefore, all sections are expected to give excellent resistance to raveling.

Roughness was measured with inertial profilers and results calculated for International Roughness Index (IRI). IRI values for the 45% RAP mixtures remained constant throughout the testing cycle. Gradual increases in IRI were reported only for the control mix and the 20% RAP mixture with low air voids and virgin PG 67-22 binder.

Two RAP sections, one with 20% percent and one with 45% RAP, experienced minor cracking. However, a crack-mapping study confirmed that the cracking was primarily due to reflective cracking from underlying layers left from the 2003 test cycle. Performance results showed that softer binders are not necessary for high RAP mixes, and that differences in fatigue results were more related to effective binder content than binder stiffness.

Several of the Test Track sections were designed and constructed as part of a structural experiment to study mechanistic pavement response under dynamic loading and to relate the results to mechanistic-empirical design principles as used in the Mechanistic-Empirical Pavement Design Guide (MEPDG). Several studies were conducted under the direction of Dr. Dave Timm as part of the structural experiment by using comparisons to measured values taken from instrumentation strategically placed within the structure during construction. One study considered the effect of load durations on strain measurements at the bottom of the HMA structure. The study, conducted by Mary Robbins, found that haversine stress pulses used in MEPDG calculations resulted in load durations that were over-predicted by about 80%. This difference could mean that pavements may be over-designed when using the MEPDG.

A study by Richard Willis evaluated the concept of a fatigue endurance limit that is used in perpetual pavement design. The principle for that design procedure is that if the strain at the bottom of the HMA structure can be controlled at a certain threshold, the pavement will never crack from the bottom upward as in typical fatigue cracking.

Strain-temperature relationship data was collected weekly and, due to the high range of temperatures from the surface to the bottom of the HMA structure, it was decided to use the mid-depth temperature as the basis for this study. It was found that the *predicted* threshold of 100 micro-strains was reached at a critical mid-depth temperature of about 78°F (25.6°C) for vehicle speeds of 65 mph (105 kph) or less. However, the mid-depth temperature *actually* reached nearly 118°F (48°C) and the resulting tensile strain approached 575 micro-strains. In spite of the higher strains, the pavement has performed very well with no cracking and less than 5 mm of rutting. This indicates that the strain threshold of in-place pavements could exceed the 100 micro-strain value often used as a controlling factor for pavement design and could lead to the design of thinner pavement structures.

A third study, conducted by Mary Robbins, compared measured dynamic modulus (E^*) values to results from prediction models. Testing was conducted on ten mixtures including five binder types and three nominal maximum aggregate sizes. This study found that the Witczak prediction models for E^* that are used in MEPDG (1-37A and 1-40D) were unreliable, and that the 1-40D model consistently over-predicted the dynamic modulus. As a result of the study, the Hirsch model was recommended although that model also has discrepancies at low temperatures and high frequencies.

Another vital aspect of APT facilities is the ability to rapidly accelerate research studies and findings so that results can be quickly implemented. In this regard, the NCAT Test Track has been extremely valuable. Agencies have been able to evaluate a variety of materials and construction methods that would have taken years of performance history to compare with using conventional test sections.

Almost all agencies were encouraged to design coarse-graded mixtures during the early implementation of Superpave. However, several experiments at the NCAT Test Track showed that fine-graded mixtures performed equally well, if not better. The finer mixtures were typically easier to compact, less prone to segregation, and less permeable while being just as rut resistant as coarser-graded mixtures. As a result, several agencies, such as Alabama, Florida, and North Carolina, typically allow fine-graded mixtures even on high traffic volume routes. In fact, Florida DOT estimates that 90% of mixes currently being used are now fine-graded mixes, and North Carolina has found that the finer mixes are also more resistant to top-down fatigue cracking.

Georgia DOT specifications required the same aggregate standards for open-graded mixtures as for the high quality SMA mixtures. However, many quarries had found that it was not economical to install special crushers to produce stone that had limited application. As a result, the cost of stone for SMA and open-graded mixtures has risen considerably.

By evaluating test sections that used conventional aggregate requirements, GDOT found that open-graded mixtures actually performed just as well and drainage was even improved over the more expensive cubical aggregate.

Mississippi also used the Test Track to experiment with aggregate selection and placed an SMA mix with 100% gravel. After this experiment proved very successful, a 100% gravel open-graded mixture was also placed. The gravel open-graded mix has performed very well and provides excellent drainage. It has one of the highest coefficients of permeability of any section on the track with the exception of a special dual layer open-graded mix. Tennessee has also found the use of 100% gravel mixes to be successful. TNDOT has experimented with lower gyrations levels in order to improve durability of Superpave mixtures and has placed a 65 gyration surface mix that has rutted only 1.5 mm after 10 million ESALs.

Missouri conducted aggregate experiments as well because there was only one aggregate source that could meet the stringent SMA aggregate requirements. As a result of the good performance of a 100% limestone SMA, MoDOT now allows limestone in SMA except in commercial zones. MoDOT estimates they have saved over \$500,000 on just five projects with the revised aggregate specifications.

South Carolina used test sections to evaluate the use of high abrasion aggregate in SMA mixtures. One section used aggregate with L.A. abrasion values of 30% loss while a second section used material with a loss of 54%. The higher abrasion aggregate proved to be rut resistant with only 7.7 mm rut depth after 20 million ESALs. However, there was a slight increase in macrotexture that may indicate a potential for raveling and reduced durability.

Texas DOT placed a special rich bottom layer to evaluate for arresting reflective cracking. The section was sawed into slabs before placing the crack arresting mix (CAM). A three-inch (75 mm) dense-graded surface was then placed as the final surface. After 10 million ESALs there are no cracks evident, but 26 mm of rutting has occurred in the upper layer, which was designed with 50 gyrations.

For the 2009 Test Track, a "Group Experiment" is being designed for six sections that will evaluate performance using two warm mix technologies, two high RAP sections, a control section, and one section to determine the load carrying capabilities of open-graded mixes. Other sections are planned for structural studies to validate the MEPDG methodology. Calibration of the conservative MEPDG design method has the potential to save agencies nationwide as much as one billion dollars if only a 10% reduction in design structure can be accomplished.

Private sponsors are also participating in the 2009 Test Track, as there is a need to continue evaluating new materials and technologies in a rugged experiment such as the NCAT Test Track.

Research Update

by Don Watson

Research continues on a national level to address many issues and opportunities facing the asphalt industry. A summary of current National Cooperative Highway Research Projects (NCHRP) that NCAT is conducting is shown below as well as a list of all current NCHRP projects related to the asphalt industry. This information was given by Thomas Harman, Pavement and Materials Team Leader for FHWA, at the recent SEAUPG annual meeting. Much of the information was furnished courtesy of Fred Hejl with the Transportation Research Board.

NCHRP 9-38: Endurance Limit of HMA Mixtures to Prevent Fatigue Cracking in Flexible Pavements is scheduled for completion in March 2009. The premise for this research is that if asphalt pavement structures are designed so that the bottom layer never exceeds its strain threshold, the pavement will not exhibit the typical bottom-up fatigue distress that occurs over time. Prior research has suggested a fatigue endurance limit of about 75 to 100 micro-strain. Results from this study show that the endurance limit varies from as low as 70 to as high as 200 micro-strain. These results indicate that there is a fatigue endurance limit, which is primarily an HMA mixture property.

NCHRP 9-39: Determining the Mixing and Compaction Temperatures of Superpave Asphalt Binders in HMA is completed and the draft final report is being reviewed by the project panel. The objective of this research was to recommend a method of determining the mixing and compaction temperatures of HMA mixtures that

would be applicable for both modified and unmodified asphalt binders. The method needed to be simple to perform and, if possible, use binder test equipment that would already be available in most binder testing facilities. The dynamic shear method which uses the binder phase angle (referred to as the Casola method) appears most promising. Other test procedures such as Steady Shear Flow and High Shear Rate Viscosity were also evaluated. Tests for smoke and emissions potential, mix coating, and mix workability were also used to evaluate possible construction issues at the various temperatures.

NCHRP 9-46: Improved Mix Design for HMA with High RAP Content is underway but is not scheduled for completion until 2010. There is a three-fold objective for this research:

- Adapt AASHTO R35 to include high RAP content mix designs.
- Include performance-related tests, specification criteria, and measures of durability.
- Develop guidelines for RAP material management and processing.

Harman provided the following categorized list of other ongoing NCHRP projects:

- HMA Quality Assurance
 - » 9-22: Beta Testing and Validation of HMA Performance Related Specifications
 - » 9-48: Field Versus Laboratory Volumetrics and Mechanical Properties
- HMA Mixture Design

- » 9-29: Simple Performance Tester for Superpave Mix Design
- » 9-33: A Mix Design Manual for Hot Mix Asphalt
- » 9-46: Improved Mix Design, Evaluation, and Materials Management Practices for Hot Mix Asphalt with High Reclaimed Asphalt Pavement Content
- Warm Mix Asphalt (WMA)
 - » 9-43: Mix Design Practices for Warm Mix Asphalt
 - » 9-47: Engineering Properties, Emissions, and Field Performance of Warm Mix Asphalt Technologies
- Mixture and Structural Design
 - » 9-30A: Calibration of Rutting Models for HMA Structural and Mix Design
 - » 9-38: Endurance Limit of Hot Mix Asphalt Mixtures to Prevent Fatigue Cracking in Flexible Pavements
 - » 9-44A: Validating an Endurance Limit for HMA Pavements: Laboratory Experiment and Algorithm Development (pending)
- Other Tests and Procedures
 - » 9-34: Improved Conditioning Procedure for Predicting the Moisture Susceptibility of HMA Pavements
 - » 9-39: Procedure for Determining Mixing and Compaction Temperatures of Asphalt Binders in Hot Mix Asphalt
 - » 9-45: Test Methods and Specification Criteria for Mineral Filler Used in HMA

Asphalt Binder Training Course Offered

by Don Watson

A 3-1/2 day binder training course will be held at the Southeastern Superpave Center at NCAT in Auburn, Alabama October 5-8, 2009. The course will enable technicians and engineers to become familiar with Superpave binder requirements, terminology, and test procedures. Classroom sessions and laboratory testing will reinforce the experienced technician's skills and develop the knowledge and ability necessary for new technicians as well.

The training will provide:

- A history of binder testing and how test procedures have developed from empirical tests to current Superpave performance grades.
- Classroom lectures to help participants learn why the various tests are needed and how variations in production or binder grade may affect pavement performance.

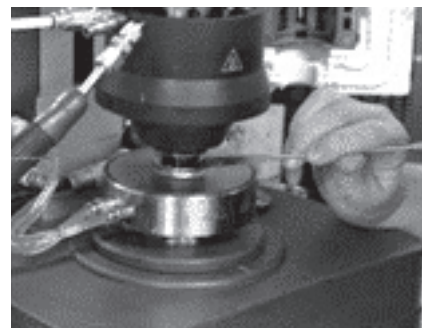
- Intensive "hands-on" time for participants to thoroughly understand the testing procedures.
- A review of LTPPBind software
- A certification exam will be administered at the end of the training.

Registration and Cost

The total cost for this training is \$800. Applicants may register on-line at www.ncat.us or call Linda Kerr at 334-844-7308. Participants will receive a course notebook with presentations and handout materials along with a copy of The Asphalt Institute SP-1 Manual.

Benefit

Technicians and Engineers will gain a better understanding of the important contribution of asphalt



Trimming a DSR Binder Sample

binders and their effect on pavement performance for both short-term and long-term applications. The attendee will learn how to analyze asphalt binder test results to assure and certify specification compliance.



National Center for
Asphalt Technology

NCAT
AUBURN UNIVERSITY

National Center for Asphalt Technology
Southeastern Superpave Center
Auburn University
277 Technology Parkway
Auburn, AL 36830

Non-Profit Organization
U.S. Postage
PAID
Purdue University

**National Center for Asphalt
Technology
(NCAT)
Southeastern Superpave Center
Auburn University
277 Technology Parkway
Auburn, AL 36830**

Don Watson (334) 844-7306
Manager, Superpave Center
watsode@auburn.edu

Randy C. West (334) 844-6244
Director, NCAT
westran@auburn.edu

Buzz Powell (334) 844-7304
Assistant Director
buzz@auburn.edu

Michael Heitzman (334) 844-7309
Assistant Director
Mah0016@auburn.edu

Andrea Kvasnak (334) 844-7303
Research Engineer
ank0004@eng.auburn.edu

Nam Tran (334) 844-7322
Research Engineer
nht0002@auburn.edu

Alessandra Bianchini (334) 844-7301
Research Engineer
bianchini@auburn.edu

Jaeseung Kim (334) 844-4964
Research Engineer
jzk0016@auburn.edu

Fax: (334) 844-6248
Website: <http://www.ncat.us>

Jody Leddy (765) 463-2317
Coordinating Editor ext. 224
jody@purdue.edu

Calendar of Events

2009

- June 8-10 NAPA Warm Mix Asphalt and Recycling Symposium
Sacramento, CA
<http://www.hotmix.org>
- June 16-25 NCAT Professor Training Course
Auburn, AL
Contact: Randy West
Phone: (334) 844-6244
Email: westran@auburn.edu
- June 29-July 2 8th International Conference on the Bearing Capacity of Roads,
Railways and Airfields
Champaign, IL
<http://www.BCR2A.org>
- July 13-15 The Petersen Asphalt Research Conference
Washakie Center, University of Wyoming
Laramie, WY
<http://www.petersenasphaltconference.org>
- July 15-17 The Pavement Performance Prediction Symposium
Washakie Center, University of Wyoming
Laramie, WY
<http://www.petersenasphaltconference.org>
- July 27-28 National Asphalt Pavement Association (NAPA) Midyear Meeting
Hilton Head, SC
<http://www.hotmix.org/index.php>
- August 25-27 2009 M-TRAC Annual Meeting
 Fargo, ND
<http://rebar.ecn.purdue.edu/Superpave/M-TRAC/index.htm>
- Sept. 30-Oct. 2 International Conference on Perpetual Pavements
Columbus, OH
<http://www.ohio.edu/icpp/>
- November 10-12 Southeastern Asphalt User Producer Group Annual Meeting
Hilton Head, SC
Contact: Jill Baumgardner
Phone: (601) 206-5530
Email: jillrbaum@msn.com
<http://www.seaupg.org/>