

Asphalt Technology News

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Over 250 Attend NCAT Test Track Conference



With over 20 speakers, the conference delivers attendees the tools needed to make positive and innovative changes to improve their asphalt pavements.

NCAT hosted its sixth Test Track Conference March 27-29, 2018, at the Hotel at Auburn University and Dixon Conference Center in Auburn, Alabama. Held every three years, the symposium is an opportunity to present research findings from NCAT's previous cycle of accelerated pavement testing. The primary areas of focus of this cycle were the pavement preservation studies and validating asphalt cracking performance tests, which include experimental test sections at NCAT and the Minnesota Department of Transportation's MnROAD facility.

During the two-and-a-half-day event, participants learned about cost-effective and performance-improving innovations in the design, construction, preservation, and maintenance of asphalt pavements. Representatives from sponsoring agencies also offered testimonials about how implementing Test Track research has

helped their states build safer and longer lasting asphalt pavements.

The conference opened with a welcome by John Mason, vice president for research and economic development at Auburn University. Dr. Mason remarked on the example that NCAT has set for successful collaboration and interdisciplinary work and the continuing need for developing and strengthening partnerships between the university and industry. Kevin Hall, Hicks Endowed Professor of Infrastructure Engineering at the University of Arkansas, followed with a keynote on the importance of achieving and maintaining balance in current and future asphalt pavement research and development needs.

The remainder of Tuesday's presentations focused on studies for the Kentucky Transportation Cabinet, Georgia DOT, Florida DOT, and the cracking group, an experiment funded by nine state

agencies and the Federal Highway Administration. The presentations were followed by transportation to the Test Track, where attendees were able to get an up-close look at numerous test sections, high friction surfaces, track instrumentation, falling weight deflectometer (FWD) testing, and profiling equipment. Events later resumed at the conference center with an evening reception.

Pavement preservation was a central theme of Wednesday's presentations. The most complex range of experiments to date, this research includes test sections on Alabama's Lee Road 159 and US 280, and Minnesota's CSAH 8 and US 169. Jerry Geib, Minnesota

DOT research operations engineer, shared preliminary observations and described how this study will quantify the life-extending benefits of pavement preservation treatments. NCAT researchers also presented on thinlays, open-graded friction courses, and high friction surface treatments. Afterward, participants had the opportunity to tour the local pavement preservation sites before returning to the conference center for a reception and dinner with comedian Rik Roberts.

Thursday morning's session consisted of a presentation of lab results from the cracking group experiment, as well as findings from the Delta S™ rejuvenator study



John Mason welcomes conference attendees and provides an overview of the research happening at Auburn University.



Dave Timm describes how FWD testing is conducted on the Test Track.



Kevin Hall discusses the possibility of preventing rather than predicting pavement distress.



Participants take a walking tour of NCAT's pavement preservation research on Lee Road 159.

and an open-graded friction course study for Alabama DOT. The conference closed with remarks from NCAT Director Randy West and MnROAD Operations Engineer Ben Worel regarding the next research cycle and future sponsorship meetings and opportunities.

NCAT would like to thank the Test Track sponsors as well as conference attendees, exhibitors, and reception sponsors. All presentations can be viewed online at <http://ncat.us/pavetrack/conference>.

There are various public and private sponsorship opportunities remaining for the seventh Test Track research cycle. For more information, contact Buzz Powell at buzz@auburn.edu.



Comedian Rik Roberts entertains the crowd while providing insights into increasing productivity and customer service.



The conference provides a valuable networking opportunity and sets the stage for further cooperation.

High-Modulus Asphalt Concrete Mixtures

Introduction

In the 1980s, the French Public Works Research Institute or Laboratoire Central des Ponts et Chaussées (LCPC) developed high-modulus mixtures (HMAC), referred to as *Enrobé à Module Élevé (EME)*. The objective for this type of new mixture was to improve mechanical properties to include high-modulus, good fatigue behavior, and excellent resistance to rutting. Another goal of the EME developers was to reduce geometric constraints (overhead clearance constraints) during rehabilitation. A specification was set by the early 1990s, and in the late 1990s, the mixture became part of the standard catalog of mixtures used in pavement structural design for high traffic pavements, 20 million equivalent single axle loads (ESALs) or greater.

Most asphalt paving mixtures in the United States are designed using the Superpave system, which relies mainly on volumetric properties. Early Superpave implementation focused primarily on rutting resistance. Most highway agencies now report that rutting problems have been virtually eliminated. However, there have been growing concerns that the primary mode of distress for asphalt pavements is cracking of some form or another. Therefore, evaluation of HMAC mixtures with lab-validated fatigue performance has become part of the U.S. asphalt industry's agenda.

HMAC Mixtures as Part of Perpetual Pavement Design Philosophy

The Asphalt Pavement Alliance defines a perpetual pavement as "an asphalt pavement designed and built to last longer than 50 years without requiring major structural rehabilitation or reconstruction and needing only periodic surface renewal in response to distresses confined to the top of the pavement." Distresses arising from damage to lower pavement layers, such as fatigue cracking or base or subgrade deformations, are eliminated by designing layer thicknesses and selecting asphalt mixtures, base materials, and/or stabilized subgrade layers to avoid critical stresses.

HMAC layers offer means to reduce the thickness and cost of perpetual pavements. In this design approach, a stiff HMAC mixture is used as the base and intermediate layers. These layers are made with a stiff binder combined with a relatively high binder content

and low void content. These designs have resulted in reductions in thickness between 25 to 30 percent in the pavement structure.

Design Criteria

Mix design for HMAC is not controlled by volumetric properties; rather, it is driven by performance-based design criteria. The specification for LCPC High Modulus Mixture is contained in the European specification EN 13108-1. For HMAC asphalt mixes, the binder type is not specified. Actual binder contents are selected based on experience and fine-tuned through asphalt mix performance testing, and based on minimum recommended binder contents. Table 1 provides minimum recommended binder contents based on typical aggregate densities in Europe, mix class, and maximum aggregate size. Binder content is not based on volumetric properties like in the U.S., but by calculating a richness factor, *K*. However, the traditional binder film thickness equation can also be used to estimate an initial binder content since it excludes absorbed asphalt.

Once the binder content is determined, the final phase of mixture design is to conduct a series of performance tests to ensure that the mixture will be durable in the field. The French suite of tests includes five standards to evaluate workability, durability, permanent

deformation, dynamic modulus, and fatigue.

Table 2 shows an example of specifications for HMAC mixtures compared to conventional asphalt concrete (AC) mixtures in Europe. Table 3 shows EME specifications used in Australia. Australian criteria were based on the European criteria with several differences. For instance, stiffness modulus specimens shall be compacted to an air void content of 1.5 to 4.5% in Australia, while in Europe, samples shall be compacted between 3.0 and 6.0% air voids. Another significant difference is Australia's stricter fatigue criterion of 150 $\mu\epsilon$ compared to 130 $\mu\epsilon$ for Europe.

NCAT's Experience with HMAC

NCAT Report 17-04 documents a recent research study on HMAC mixtures in the U.S. A comprehensive literature study was completed to assess the current state-of-the-practice for HMAC mixture design, pavement design, laboratory performance tests, and full-scale pavement performance.

Table 1. Typical Values for Minimum Binder Content and Target Richness Factor

	HMAC Base Course		
	Class 1	Class 2	
Max. aggregate size (mm)	10, 14, 20	10, 14	20
Min. P_b for agg. densities $\geq 2.65 \text{ g/cm}^3$	3.8%	5.1%	5.0%
Min. P_b for agg. densities $\geq 2.75 \text{ g/cm}^3$	3.8%	4.9%	4.9%
Richness factor, <i>K</i>	2.5	3.4	3.4

Table 2. Roadbase High-Modulus Asphalt Concrete versus Traditional Asphalt Concrete

Test	EME 1	EME 2	AC
Immersion compression test at 18°C	>0.7	>0.75	>0.7
Rutting test at 60°C 30,000 cycles	<7.5mm	<7.5mm	<10mm
Stiffness modulus at 15°C and 10Hz	>14,000 MPa	>14,000 MPa	>9,000 MPa
Allowed microstrain from fatigue law at 10°C and 25 Hz and for 10^6 cycles	>100	>130	>90
Void content for laying thickness	<10%	<6%	<10%

Table 3. Australian EME 2 Laboratory Performance Criteria

Property	Test Method	Unit	Limit	Value	
Air voids in specimens compacted by gyratory compactor at 100 gyrations	AS/NZS2891.2.2	%	Maximum	6.0	
Water sensitivity	AGPT/T232	%	Minimum	80	
Wheel tracking	At 60°C and 60,000 passes	AGPT/T231	mm	Maximum	4.0
	At 60°C and 10,000 passes	AGPT/T231	mm	Maximum	2.0
Stiffness modulus at $50 \pm 3 \mu\epsilon$ at 15°C and 10Hz	AGPT/T274	MPa	Minimum	14,000	
Fatigue cycles at 20°C, 10Hz, and 10^6	AGPT/T274	$\mu\epsilon$	Minimum	150	
Resilient modulus at 25°C, 0.04s rise time	AS 2891.13.1	MPa	N/A	Report	

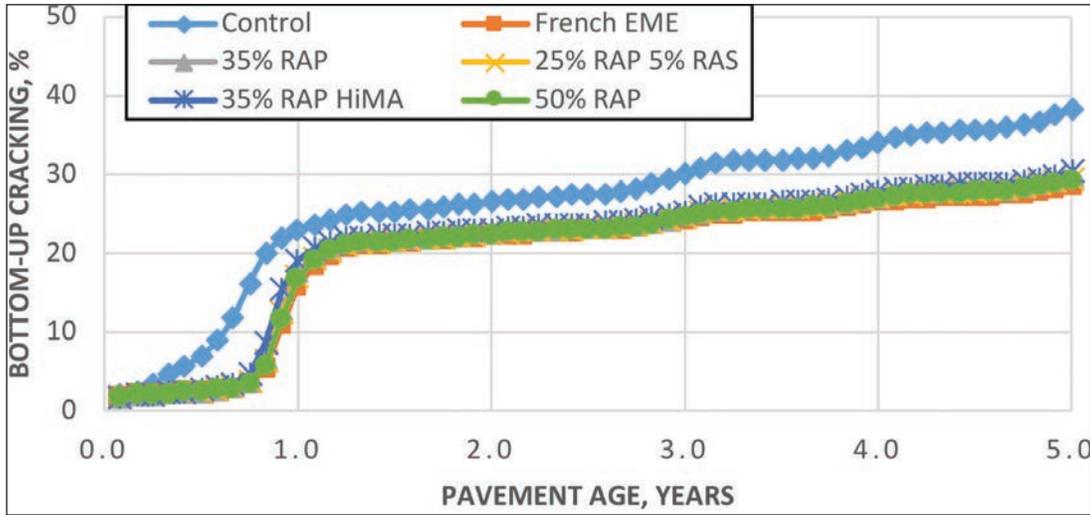


Figure 1. Estimated Bottom-Up Fatigue Cracking

An experimental plan included a variety of mixtures with different materials such that higher moduli were obtained compared to conventional mixtures. The plan included a French mixture with a stiff binder (PG 88-16), two mixtures containing 35% RAP (both with polymer-modified binders, but one high polymer content [HiMA]), a mixture containing 25% RAP and 5% RAS with a polymer-modified binder, and finally, a 50% RAP mixture with a polymer-modified binder. The laboratory testing program evaluated binder performance grade, mixture stiffness over a wide temperature range, fatigue cracking, and permanent deformation. In addition, AASHTOWare Pavement ME software was used to determine how a high-modulus base would affect predicted performance of asphalt pavements.

Laboratory results indicated that mix designs could meet the European standards using domestic virgin and recycled materials. The Pavement ME software predicted better performance for the HMAC mixtures compared to a conventional asphalt base mixture. Cracking of the asphalt layer was expected to decrease by the use of high-modulus base courses. Figure 1 shows estimated results of bottom-up cracking. It was observed that the use of high-modulus base courses could reduce bottom-up cracking compared to a control mixture (unmodified binder and no recycled material), which was reasonable since high-modulus base may reduce the tensile stress and strain at the bottom of the binder layer. This reduction in cracking could range from 20% to 25%. Moreover, it was also observed that the effect on top-down cracking can be more significant with a decrease in cracking ranging from 28% to 35%.

Based on the results of the NCAT study and the current state-of-the-practice, the following steps were recommended for HMAC mixture design.

1. Determine the aggregate trial blend for the HMAC mixture.
2. Determine the minimum asphalt binder content using the French method, or the estimated film thickness equation can be used as an alternate.
3. Set N_{des} with the Superpave gyratory compactor to 80 gyrations and compact design samples to target air voids lower than 6%.
4. Prepare three trial dynamic modulus samples, compacted to 3.0 to 6.0% air voids according to the French methodology, and test at 15°C and 10 Hz.
5. Select optimum binder content to meet $E^*=14,000$ MPa (at 15°C and 10 Hz) to meet the minimum asphalt content from Step 2 and to meet N_{des} specimen target air voids lower than 6%.
 - a. Adjusting the gradation or mixture components (additives, recycled material, binder grade, etc.) may be necessary to meet the E^* and air voids requirements.
 - b. For each gradation adjustment, the minimum AC required will need to be recalculated.
6. Select laboratory performance tests and criteria (rutting, cracking, and moisture damage) for further verification and conduct AASHTO TP 79-15 to determine dynamic modulus to be used in ME simulations.

Cold Recycling of Asphalt Pavements

Over the years, asphalt has become the material of choice for constructing environmentally friendly pavements. Asphalt continues to be reclaimed and reused more than any other product in the United States, and cold asphalt pavement recycling takes sustainability one step further. As its name implies, cold recycling is an asphalt pavement rehabilitation method without the application of heat during the construction process. This economical technique is not only effective in eliminating rutting and cracking distresses of asphalt pavements, but also conserves non-renewable resources and energy.

Cold recycling includes two subcategories, i.e., cold in-place recycling (CIR) and cold central-plant recycling (CCPR). Typically performed using a “train” of equipment, CIR occurs on the roadway in a continuously moving process that recycles 100% of the existing asphalt pavement. CCPR is a process in which the asphalt recycling takes place at a central location using a stationary cold mix plant. Cold recycling usually requires multiple additives, including bituminous material (e.g., foamed or emulsified asphalt binder), chemical additives (e.g., lime, cement, or fly ash), and water. A job mix formula defines the RAP gradation and the percentages of each of the additives for cold recycled asphalt mixtures. Due to the high void content of cold recycled asphalt mixtures, a surface course is required to protect the mixture from the intrusion of surface moisture. Asphalt overlays are typically used for pavements with high traffic volumes, while chip seals, slurry seals, and micro surfacing may be used for pavements with low traffic volumes.

In 2011, the Virginia Department of Transportation (VDOT) reconstructed a 3.7-mile section on Interstate 81 (I-81) involving both CIR and CCPR techniques. Table 1 provides the pavement structures of the cold recycling test section on I-81. As of spring 2018, the left lane has carried approximately 3.3 million equivalent single axle loads (ESALs) and the right lane sections have carried approximately 13 million ESALs. As of June 2017, the left lane has an International Roughness Index (IRI) of 53 inches per mile and 0.1-inch rut depth, and the right lane has an IRI of 44 inches per mile and 0.08-inch rut depth. These results demonstrate that both CIR and CCPR perform superbly in high traffic applications. In addition to the environmental benefits, this cold



CIR involves the same process as CCPR but takes place on the roadway using a train of equipment.



CCPR combines RAP with foamed or emulsified asphalt in a central production plant without the application of heat.

Table 1. Pavement Structures of I-81 VDOT Cold Recycling Test Sections

Left Lane	Right Lane (First 0.40 mile)	Right Lane (Remaining 3.26 miles)
4-inch New AC	4-inch New AC	6-inch New AC
5-inch CIR	8-inch CCPR	6-inch CCPR
Existing Aggregate	12-inch FDR	12-inch FDR
Existing Subgrade	Existing Subgrade	Existing Subgrade

recycling project saved VDOT and taxpayers millions of dollars by reusing existing resources.

In 2012, VDOT sponsored three instrumented test sections at the NCAT Test Track to further study CCPR pavements under high truck traffic conditions. The project was executed in coordination with the Virginia Transportation Research Council (VTRC). Table 2 shows the pavement structures of the cold recycling test sections at the track. After 19 million ESALs of trafficking, these three sections have shown excellent performance with no cracking distress observed, rut depths

Table 2. Pavement Structures of NCAT Test Track Cold Recycling Sections

Section N3	Section N4	Section S12
6-inch New AC	4-inch New AC	4-inch New AC
5-inch CCPR	5-inch CCPR	5-inch CCPR
6-inch Aggregate	6-inch Aggregate	8-inch FDR
Subgrade	Subgrade	Subgrade

less than 0.3-inches, and ride quality remaining nearly unchanged. The structural characterization indicates that the layer coefficients of cold recycled asphalt mixtures range from 0.36 to 0.44. This study, *Structural Study of Cold Central Plant Recycling Sections at the National Center for Asphalt Technology (NCAT) Test Track*, was selected by AASHTO as a “Sweet Sixteen” project for 2017. The Sweet Sixteen program is administered by the Value of Research Task Force in AASHTO to identify and promote sixteen projects per year (four from each AASHTO Region) that are considered to be high-value research. Dr. Brian Diefenderfer (VTRC), Miguel Diaz (NCAT Ph.D. graduate student), Dr. David Timm (AU Civil Engineering), and Dr. Benjamin Bowers (VTRC) authored the report selected for the Sweet Sixteen.

In 2015, NCAT constructed four test sections on US 280 in Lee County, Alabama, to evaluate the field performance of cold recycled asphalt pavements under thinner surface layers. These sections included CCPR with emulsified binder and with foamed binder, and CIR with emulsified binder and with foamed binder. The four-inch cold recycled layers were surfaced with a one-inch Superpave mix. As of 2018, the four test sections have carried over 2.0 million ESALs with rut depth less than 0.25-inches.

In 2017, NCAT prepared two AASHTO provisional standards for cold recycling mix design, which have been approved by the AASHTO Subcommittee on Materials. These standards specify the minimum quality requirements to produce a job mix formula for cold recycled asphalt and document the procedures to determine its optimum asphalt content.

Cold recycling is a leading technology in structural road rehabilitation that reuses existing resources and reduces project time. The field experience from VDOT and NCAT shows that this technology is not only suitable for low and medium traffic volume roadways but is also applicable to high traffic volume pavements. The recent success achieved by VDOT and NCAT is expected to promote the application of cold recycling technology to high traffic volume pavements nationally.

Aging: Avoiding the Inevitable

The chemical composition of asphalt depends primarily on its crude oil source and processing methodology. Differences in the asphalt composition can strongly affect its mechanical properties and chemical reactivity. Asphalt binder is a complex mixture of high molecular weight hydrocarbon molecules and naturally occurring heteroatoms (nitrogen, oxygen, and sulfur) and trace metals (e.g., vanadium and nickel) that contribute to the polarity within the asphalt molecules. Asphalt binder is often described as a colloid that consists of a dispersion of large molecular weight asphaltenes in an oily matrix constituted by saturates, aromatics, and resins. It has been established that asphaltenes are stabilized in crude oils by natural resins that are surfactant-like agents (Figure 1). The polarity among asphalt molecules varies widely and the physical properties of the asphalt binder are governed by the balance of polar and non-polar components. In an asphalt molecule, the polar matrix is responsible for the elastic behavior of the material and the continuous non-polar phase controls the viscous behavior. During the oxidative aging process, the concentration of polar functional groups in an asphalt binder increases, resulting in an immobilization of molecules through intermolecular association. Hence, the molecules or molecular agglomerates lose sufficient mobility to flow past one another under thermal or mechanical stress. This results in embrittlement of the asphalt binder, making it more susceptible to cracking and more resistant to healing.

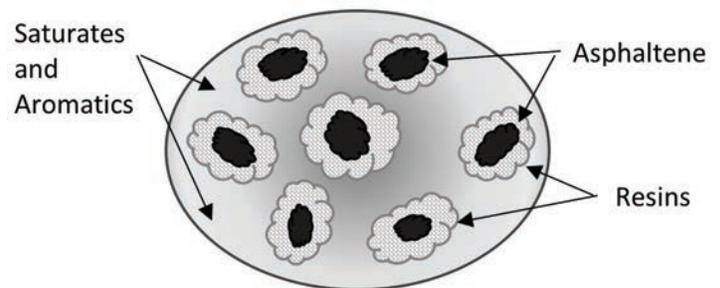


Figure 1. Schematic of Asphalt Components

The properties of asphalt mixtures change as the asphalt binder ages. The aging of asphalt binders is caused by volatilization (i.e., evaporation of the light fractions of asphalt), thermal and ultraviolet oxidation, and other chemical processes. Volatilization and oxidation occur rapidly during production and construction of asphalt mixtures when the asphalt is spread in thin films to coat the aggregate at a high temperature. This is sometimes

referred to as short-term aging. The oxidative aging processes continue throughout the pavement service life (i.e., long-term aging).

Factors affecting the rate of aging include the chemical composition and physicochemical state of the asphalt binder, air permeability of the mix, depth in the pavement structure, asphalt binder content, aggregate mineralogy, mix production-related factors, and in-service temperature and time. Surface layers age at a much faster rate than lower layers in the pavement due to exposure to air, solar radiation, and higher temperatures. Asphalt binder oxidation has a significant impact on age-related pavement damage since it changes the time-temperature dependence of the viscoelastic asphalt binder. The chemical and/or physicochemical changes that occur in asphalt due to oxidative aging increase both the viscous and elastic properties of the binder, leading to a global hardening (i.e., stiffening) of the material. Aged asphalt binder can typically sustain high shear stress due to its increased elastic stiffness, but it has reduced stress relaxation properties through viscous flow. As a result, asphalt pavements become more susceptible to cracking and other durability-related distresses.

Simulating Aging in the Laboratory

Over the last few decades, several laboratory aging protocols have been developed to condition/age asphalt mixtures for mix design and performance testing. The standard short-term aging protocol in AASHTO R30 is to condition loose mix for two hours at the compaction temperature for volumetric mix design or for four hours at 135°C for mechanical property testing. This protocol is designed to simulate the aging of asphalt binders that occurs during plant production and construction. National Cooperative Highway Research Program (NCHRP) Project 9-52 evaluated over 40 asphalt mixtures and concluded that two hours of loose-mix aging at 135°C for hot mix asphalt (HMA) and 116°C for warm mix asphalt (WMA) was appropriate for simulating the effects of plant mixing and storage to the point of loading in haul trucks. Similar findings have also been reported by NCHRP 9-43 and a study by the Colorado Department of Transportation.

For long-term aging, AASHTO R 30 recommends aging compacted specimens for five days at 85°C. However, this protocol has been criticized over the years for lack of correlation with the actual field aging of asphalt pavements. NCHRP 9-52 indicated that five days of compacted specimen aging at 85°C could only simulate approximately two to three years of field aging. Research by the University of New Mexico and Mississippi State

University also reported that this standard aging protocol was representative of no more than one year of field aging.

Recently, alternative methods have been proposed for long-term aging using loose mix prior to compaction. As compared to compacted specimens, aging of loose mixes increases the rate of oxidative aging due to increased exposure of the thin asphalt coating to heat and oxygen. The ongoing NCHRP 9-54 project has recommended loose mix aging at 95°C for a period of time based on climate, depth, and years of service. For surface layers with four years of service, the recommended aging time ranges from three to five days for most of the continental U.S. A longer time is required in order to simulate surface layers with a longer in-service time. Although this protocol is promising to simulate the field aging of asphalt pavements, the lengthy time span makes it difficult to implement into routine mix design and production practices. To address this shortcoming, research studies by the University of Illinois Urbana-Champaign, MTE Services, Inc., and NCAT have recommended loose mix aging at 135°C for much shorter time periods ranging from 8 to 24 hours. Besides loose mix aging, accelerated pavement weathering systems that provide simultaneous cyclic actions of thermal oxidation, ultraviolet radiation, and moisture infiltration and diffusion can also be used to simulate the long-term field aging of asphalt pavements. The limitation of this approach is special equipment that is not widely available.

Extending Service Life with Pavement Preservation Techniques

The FHWA's Pavement Preservation Expert Task Group defines pavement preservation as "a program employing a network level, long-term strategy that enhances pavement performance by using an integrated, cost-effective set of practices that extend pavement life, improve safety and meet motorist expectations." A pavement preservation program consists primarily of three components: minor rehabilitation (non-structural), preventive maintenance, and routine maintenance.

Pavement preservation has gained popularity among highway agencies as a proactive approach to maintain the functional and structural integrity of pavements and delay the need for more costly rehabilitation treatments. It refers to the application of correctly selected surface treatments at the optimum time to extend the service life of a pavement. There are many recognized techniques for preserving asphalt pavements, including crack sealing and crack filling, fog seals and asphalt rejuvenators, seal treatments (scrub, sand, chip, slurry, and cape),

micro surfacing, and thin overlays. The purpose of these treatments is to preserve pavement functional and structural integrity and to retard deterioration in order to avoid more costly rehabilitation treatments in the near future.

In order to improve pavement preservation techniques and to spread their appropriate use among highway agencies, research is needed to advance a fundamental understanding of the effectiveness of pavement preservation treatments. It is known that pavement preservation treatments can temporarily seal or fill the cracks on the pavement surface, preventing water from penetrating into the underlying layers, which weakens the materials and ultimately reduces the structural capacity of the pavement. There is also a hypothesis that these treatments provide a protective “coating” delaying the oxidative aging and physical hardening of the asphalt binder located underneath the surface treatment, which consequently could reduce the susceptibility of the pavement to cracking and other durability-related distresses. However, the validity of this hypothesis remains unknown since field performance data still showed cracking as the primary type of distress on pavements that were treated. Thus, future research is needed to evaluate the optimum timing of treatments and specification criteria for the treatment materials and their application.

Slowing the Aging Process

Another aging-related topic for future research is the exploration of antioxidants as anti-aging additives for asphalt mixtures. Currently, many state highway agencies

allow the use of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) in asphalt mixtures. The inclusion of these recycled materials provides economic and environmental benefits, but in some cases it may result in asphalt mixtures with less resistance to cracking. To address this, some agencies permit the use of recycling agents (a.k.a. rejuvenators) to improve the durability of asphalt mixtures containing RAS or high RAP contents. Studies have shown that recycling agents can help mitigate the stiffening effect of RAP and RAS materials through uniform dispersion within the mix and diffusion into heavily aged recycled binders. However, the effectiveness of recycling agents was found to diminish with aging. This raises the question whether these agents improve the long-term cracking performance of asphalt mixtures with RAP and RAS.

Another potential solution to reduce the detrimental effects of aging is to use antioxidants to decelerate the oxidative aging of asphalt binders. Although antioxidants have been successfully used to enhance the resistance of polymers to oxidation and embrittlement, research studies on their use in asphalt binders are limited. Some of the antioxidants that have been found successful in literature include lignin, hindered phenols, lead and zinc dithiocarbamates, sodium hydroxide, and carbon black. Nevertheless, more research is warranted to establish a comprehensive understanding of the mechanism of antioxidants to slow the aging of asphalt binders and to evaluate their effect on the engineering properties of asphalt mixtures.

NCAT'S laboratories are AASHTO-accredited and can provide independent performance testing for a nominal fee.

- Semi Circular Bend Test (SCB)
- Indirect Tensile Creep Compliance
- S-VECD Fatigue Test
- Bending Beam Fatigue
- Bond Strength
- Tensile Strength Ratio (TSR)
- Disk-Shaped Compact Tension Test (DCT)
- Hamburg Wheel-Track Testing
- Asphalt Pavement Analyzer (APA)
- Flow Number
- Dynamic Modulus (E*)
- Resilient Modulus (Mr)
- Overlay Test
- Illinois Flexibility Index Test (I-FIT)

Contact NCAT Lab Manager Jason Moore at moore02@auburn.edu or 334-844-7336.

Where Are They Now?

When NCAT opened its doors over 30 years ago, its employees could only hope that their research would spread throughout the United States and around the world. This year at the Test Track Conference, NCAT hosted individuals from all over the U.S. and as far away as South Africa. Attendees included researchers and students, as well as representatives from private industries. The success of NCAT did not only happen through its dedication and research but by implementing a set of core values that allows its impact to reach beyond the vision and mission statement. One of these values lies in how NCAT views its employees as an NCAT family. NCAT provides an environment where all employees feel welcomed into that family and those connections extend long beyond the NCAT experience.

Cynthia Lynn

Cynthia Lynn became part of the NCAT family in September 1993 as a research assistant and teaching assistant. She received her master's degree at Auburn University in 1996 but found herself back at NCAT in 2000 working at the Test Track in various capacities from data acquisition and reporting to quality control on the construction of the 2003 research cycle.

While working at NCAT, she opened Thunderhead Testing, a consulting business. In January 2006, her family and company moved to Tulsa, Oklahoma. Thunderhead Testing later opened its first full-service construction materials testing laboratory facility in November 2010.

In her role as president, Cynthia manages six full-time and several part-time employees. They work primarily in two areas: research of asphalt-related products, and general construction material testing for the highway industry.

Cynthia married Dr. Todd Lynn in 1993, who was also working at NCAT, and they have four daughters. The oldest, Tiana, was born in Auburn while they were in graduate school. Tiana is following in her parents' footsteps in the asphalt field and is currently studying to be a civil engineer at Lipscomb University in Nashville, Tennessee. Their daughter Tommi is a freshman biology major at Lipscomb and the youngest two girls, Tessa and Tylah, are both still in high school. In her free time, Cynthia loves to go camping and travel and takes any opportunity to see new things and visit new places.

When asked what she would say to students who have since become part of the NCAT family, Cynthia remarks, "NCAT laid the foundation for what I do every day. I can't imagine having a better experience for training and networking than what I found at NCAT. Exposure to cutting-edge technology, equipment, and personnel who were moving our industry forward was and is unmatched. You will be able to look back in 20 years and identify equipment that you had the privilege of helping to develop or test standards that you helped establish. The networking that happens during your day to day activities is something that will follow you throughout your career. I would never have imagined that I would interact with former classmates, professors, and Test Track sponsors in every other job I have had since NCAT. Treasure your time spent there and make the most of every experience and networking opportunity. My husband and I both still feel very much a part of the NCAT family."



Kristy Harris

Kristy Harris joined the NCAT family in 2001 under Dr. Frazier Parker. She was the first graduate student to drive the automatic road analyzer, more commonly known as the ARAN van. Each week she drove it around the track to capture data and practice for her off-site research.

Kristy received both her bachelor's and master's degrees from Auburn University, and she met her husband Sandy during graduate school. They live in Wetumpka, Alabama and have two children, Ethan (age 11) and Eli (age 5). With her husband and sons being involved in all kinds of activities, she loves the challenge of capturing that perfect picture that tells the story of their day and all of the challenges that amateur photography entails.



Currently, Kristy works at the Alabama Division of the Federal Highway Administration (FHWA) and has been there for 15 years. As the pavements and materials engineer for the division and the program management analyst, she reviews specifications, paving practices, and testing. Kristy is also the emergency relief coordinator, research engineer and Every Day Counts coordinator for the division.

Her advice to current and future NCAT family members is to have fun, but always realize that life after school doesn't have instructors directing every step. She encourages them to practice innovating and self-directing at an early age. Kristy's concluding thoughts sum up her experience at NCAT, "I believe in Auburn [University] and love it! NCAT is a large part of why I moved into the pavements world. I was just finishing my undergraduate degree and starting graduate school when the first track was being built. Having access to that has always been a great asset to my pavement knowledge and career. I got to know the staff, as they were often my fellow graduate students. I still keep in touch with many of them and know that if I have a question, the NCAT family will immediately help answer it."

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Staff Promotions

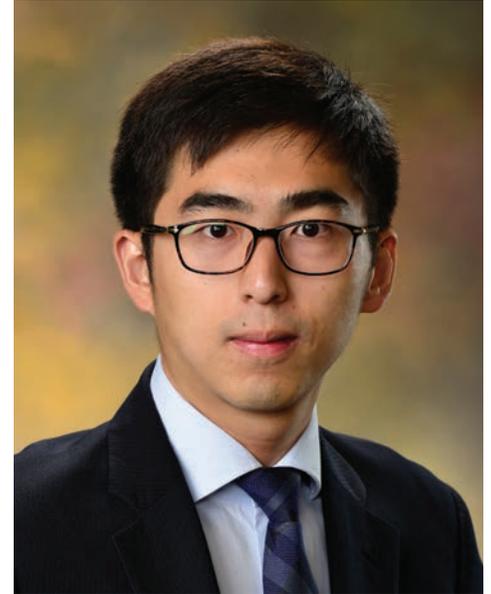
NCAT has strengthened its team through several staff promotions to enhance its research, training and technical services capabilities aimed at advancing asphalt pavement technologies. Key personnel changes include the following:



Jason Nelson has been appointed to test track manager. He will support Assistant Director Buzz Powell and have the primary responsibility for day-to-day operations and safety at the NCAT Test Track. Nelson has been a member of NCAT's team for the past 11 years. He earned his bachelors and master's degrees in civil engineering from Auburn University.



Nam Tran has been promoted to assistant director. He will be primarily responsible for leading research and outreach programs, developing proposals and fostering client relationships while guiding the definition and demonstration of NCAT's vision. Tran joined the NCAT team in 2007. He received his Ph.D. from the University of Arkansas in 2005 and recently completed his master's in business administration from Auburn.



Fan Yin has been appointed to assistant research professor. He will lead NCAT's research efforts in Balanced Mix Design and porous asphalt pavements. Yin received his master's degree and doctorate from Texas A&M University and worked as a graduate research assistant and postdoctoral researcher at the Texas A&M Transportation Institute before joining NCAT as a postdoctoral researcher in 2016.



Earn Continuing Education Hours Online

Auburn University's Office of Continuing Education, in cooperation with NCAT and the Department of Civil Engineering, offers a variety of online professional development courses ranging from one to nine hours in length. For a list of courses and detailed information, visit <http://eng.auburn.edu/online/professional-development>

Employee Spotlight: Raquel Moraes



Raquel Moraes joined the NCAT team as a postdoctoral researcher in October 2017. She is a materials scientist and chemist with nine years of research experience. Moraes obtained master's and doctoral degrees in civil engineering at the University of Wisconsin-Madison and worked at their Modified Asphalt Research Center for six years before joining the NCAT team. She is working on asphalt rejuvenators, modifiers, and aging of asphalt materials.

What inspired you to study engineering and chemistry?

I have always had an interest in science and a desire for intellectual challenge. Since I was very young I have sought to understand the driving forces and processes behind all things around me. I decided to study chemistry in college and follow in my grandfather's footsteps. Very soon, through chemistry, I got involved in asphalt science. When I was finalizing my master's in inorganic chemistry, I had the opportunity to meet Professor Hussain Bahia during an asphalt conference in Brazil. This connection changed my life and led me to join the Modified Asphalt Research Center (MARC) at the University of Wisconsin-Madison. At MARC, the experience of being surrounded by very talented people from all over the world created something that made a real difference in my life, and for that, I am very grateful. Everything that I learned from engineering, combined with my passion for chemistry, allowed

me to delve much deeper into the science than I ever had before. The combination of both chemistry and engineering encouraged me to carve out an area of expertise for myself.

Do you consider yourself a chemist or engineer?

I think that the asphalt field is very unique in a sense that it brings together people from many different backgrounds. At a typical meeting, you can find pavement engineers, chemists, modeling experts, and many other types of specialists. I think of myself as a material scientist and I try to combine the world of engineering and chemistry.

Where are you from originally?

I was born and raised in Fortaleza, a city and port of Brazil and the capital of the state of Ceará. This beautiful city has a combination of sunny beaches, delicious cuisine, the rich Brazilian culture, and very peaceful and friendly people.

You relocated from Texas to the "The Loveliest Village On The Plains." What drew you to make the move to Auburn?

The opportunity of working for a globally recognized research center was a very special distinction for me. While Auburn is far from Houston, it offers excellent research opportunities, which for a person who enjoys doing research, are hard to pass up.

What excites you most about joining the NCAT team?

The immediate impact that the work done here has had on the industry. It is amazing to see how quickly some technologies that have been initiated here are translated to the field. The opportunity of being part of this process excites me the most. I hope that the unique skill set that I bring to the table will give the NCAT research an edge in pursuing the innovative technologies proposed by NCAT researchers and its partners.

Tell us about your personal life and interests.

I am a person very blessed by God, and my faith is involved in every aspect of my life. I have by my side my lovely husband that I love very much, and I have a beautiful family that supports me from afar. I am strong-minded and often driven by a cause, and this helps me to set goals and to overcome obstacles. I believe in integrity, maintaining a positive attitude, and in charity and compassion, because we can grow as individuals by reaching out to others.

Specification Corner

Colorado DOT

We did not have any significant changes to our specifications this past year.

Florida DOT

FDOT is incorporating incentives and disincentives based on pavement smoothness as measured by the laser profiler and evaluated with the International Roughness Index (IRI). This specification will be for use on interstate and limited access roadways.

Warm mix asphalt has been formally defined. A mixture containing an unmodified binder will be considered a warm mix asphalt design if the mixing temperature is 285°F or less. For mixtures containing a PG 76-22 or high polymer binder, a mixture will be considered a warm mix asphalt design if the mixing temperature is 305°F or less.

Minnesota DOT

MnDOT has fully implemented multiple stress creep recovery (MSCR). We are also using thermal profiling on all HMA jobs.

Montana DOT

Montana has no significant changes for 2018.

Nebraska DOT

We are focusing on increased in-place compaction density for improved long term performance.

Ohio DOT

We had significant changes to our micro surfacing specification in January 2018, which includes adding quality control (QC) requirements, QC plans, a more defined calibration procedure, mix design requirement changes, and mix paver equipment requirement changes.

We are continuing trial projects to evaluate void reducing asphalt membranes (VRAM), to evaluate thermal imaging for thermal segregation, and to evaluate a finer 19 mm asphalt mix to increase AC and reduce segregation in our intermediate courses.

Tennessee DOT

TDOT is implementing intelligent compaction on selected projects including all interstates for the 2018 paving season. At this time, this specification only includes tracking temperature/location and is primarily focused on implementing the technology as a quality control tool.

Asphalt Forum

NCAT invites your comments and questions, which may be submitted to Christine Hall at christine@auburn.edu. Questions and responses are published with editing for consistency and space limitations.

Greg Sholar, Florida DOT

Are states limiting the amount of re-refined engine oil bottoms (REOBs) or banning them completely?

Oak Metcalfe, Montana DOT

How do states address sand equivalent testing, and more specifically, batching specimens for testing? Do you batch from stockpiles or cold feed? How do you address baghouse effects on the job mix formula? We don't have a state asphalt paving association in Montana, so we don't have standardized batching procedures yet; however, we will be publishing ours soon.

Oak Metcalfe, Montana DOT

How do states deal with quality assurance (QA) testing of asphalt pavements as opposed to contractor quality control (QC)? In Montana, we have a long standing internal argument about requiring QC testing from the contractor. Our solution is to craft our specifications to force QC. In reality, our contractors are using the state's QA results for their QC because "that's what they get paid on." This causes issues when test results aren't returned ASAP, if there are math errors, etc. I'm wondering if any other DOTs use this process or does everyone else keep QA and QC separate?

Asphalt Forum Responses

The following responses have been received to questions shared in the previous issue.

TDOT is considering to start fogging rumble strips. Do you fog seal rumble strips? If so, do you do anything special (strips painted over with the edgeline)?

-Matthew Chandler, Tennessee DOT

Michael Stanford, Colorado DOT

Typically, CDOT does not fog their rumble strips.

Greg Sholar, Florida DOT

FDOT does not fog seal (or treat in any other way) rumble strips.

Jerry Geib, Minnesota DOT

I would always fog a rumble strip. The MnDOT special provision leaves fogging as an “option” that can be required or deleted. It’s a project by project decision.

Oak Metcalfe, Montana DOT

In Montana, we chip seal all of our new pavements, so our rumble strips get sealed during the chip seal operation; however, we are currently installing centerline rumble strips statewide for safety reasons and we have specified they be fog sealed. So, if rumble strips are ground in, either edge or centerline, and chip seal operations are more than 10 days out, we require a double shot of fog seal. If the project schedule pushes chip seal operations out to the next season, rumble strips are not to be ground until the next season so they don’t go through the winter without a chip seal. For centerline rumble strips, we stripe on either side so no paint is in the hole. Edge stripes are inside the rumble strips.

Robert C. Rea, Nebraska DOT

No, but I agree that this would be beneficial for the rumble strips. The logistics of fog sealing, rumble strips, and permanent long term striping is challenging.

Eric Biehl, Ohio DOT

We have a few districts that fog seal shoulders, including rumble strips, if the rumble strips are in good shape when the mainline is either milled and filled or micro-surfaced. For high/heavy traffic routes, they typically use a mastic seal for more microtexture compared to a conventional fog seal. I do not believe we just fog seal the shoulder/ rumble strip without taking care of the mainline.

What method does your DOT require for determining RAP aggregate specific gravity?

-Randy West, NCAT

Michael Stanford, Colorado DOT

CDOT requires an effective specific gravity of RAP in lieu of the RAP aggregate specific gravity. We use CP 51 (Colorado Procedure), Method B, which is Asphalt Cement Add-In for calculating the effective specific gravity for RAP.

Greg Sholar, Florida DOT

Calculating the Gsb based on other properties, Gmm, assumed absorption based on aggregate type, and asphalt content.

Jerry Geib, Minnesota DOT

The procedure is in the MnDOT lab manual. Link: <http://www.dot.state.mn.us/materials/manuals/laboratory/1815.pdf>

Oak Metcalfe, Montana DOT

Currently, we do not specify a method. That is one of the issues we are working on. It hasn’t been a critical issue up until now due to our relatively low use of RAP.

Robert C. Rea, Nebraska DOT

We use an assigned gravity to calculate volumetrics. We use burn off RAP material to perform combined aggregate specific gravity for fine aggregate angularity.

Eric Biehl, Ohio DOT

We use Gse.

Matthew Chandler, Tennessee DOT

It’s not directly calculated, as the contractor is only required to establish AC and gradation of RAP. Gse is back calculated for combined gradation of completed mix.



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NCAT has recently adopted the roadside of its pavement preservation test sections on US 280 as part of the Alabama PALS Adopt-A-Mile program. NCAT employees and family members spent the morning of Saturday, February 24 cleaning roadside litter. The program helps keep our roads and highways clean and litter free and enhances the beauty of Alabama while having a positive economic impact for our great state.