

Asphalt Technology News

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Can Local Aggregates Provide Enough Friction?



High friction surface treatments (HFST) provide enhanced pavement friction in critical safety locations such as horizontal curves and bridge decks. HFSTs are a thin layer of durable, high friction aggregate bonded to an existing pavement surface using a liquid polymer resin binder. The resulting surface is extremely rough and polish-resistant, providing long-lasting skid resistance in locations where tire-pavement friction is paramount.

Calcined bauxite is the only aggregate that currently meets the friction performance requirements for HFSTs per AASHTO specification PP 79-14 Standard Practice for High Friction Surface Treatment for Asphalt and Concrete Pavements. Since calcined bauxite must be imported from overseas, it is costly. Some states, including Michigan, also have specifications for thin polymer-bonded overlays, which have been used as bridge deck treatments for many years and often allow the use of less-expensive, regionally available friction aggregate. In this article, the term HFST is used broadly to include any thin bonded surface treatment that increases the friction capability of a pavement surface.

Michigan DOT recently sponsored an evaluation of 11 friction aggregates, detailed in NCAT Report 17-01, using NCAT's Three Wheel Polishing Device (TWPD). This laboratory method applies uniformly controlled conditioning (polishing) in the TWPD followed by testing with the dynamic friction tester (DFT) and the circular texture meter (CTM). This procedure allows engineers to make relative comparisons of friction aggregate performance while agencies retain the responsibility to determine an acceptable friction threshold value.

In addition to calcined bauxite, the study included a basalt and copper slag from Wisconsin, flint from Oklahoma, three varieties of calcined kaolin from Georgia, three varieties of quartz (from Ohio, Washington, and Maryland), and feldspar mineral from Wyoming. Two replicates were made for each aggregate. The surface of each 20x20-inch asphalt test slab was covered with an epoxy bonding agent (E-BOND 526) at a rate of 0.04 gal/sq ft, and the aggregate was spread by hand over the epoxy. After curing for 24 hours, the surface was swept, rubbed with a wooden board to remove loosely bound aggregate, and swept again.

The two replicate slabs for each aggregate were conditioned using the TWPD units. The TWPD operates at a speed of 60 rpm, uniformly polishing a circular path 284 mm in diameter on each test surface. All three pneumatic tires on the TWPD that performed the polishing were replaced for each slab. Previous studies have shown that terminal surface friction is reached between 80,000 and 100,000 cycles, but this study extended testing to a total of 140,000 (140K) cycles in order to better distinguish between higher performing aggregates.

Each slab was tested using the CTM (according to ASTM E 2157) and DFT (according to ASTM E 1911). The CTM measures surface macrotexture in terms of mean texture depth (MTD). The DFT measures surface friction as a function of speed (20, 40, and 60 km/h for this study). The result is a dimensionless value known as the friction number (Fn). In this study, 40 km/h produced the most repeatable results, so the friction values are expressed as DFT(40). Higher values indicate better friction properties. The testing sequence involved initial CTM

and DFT measurements on each slab followed by TWPD conditioning for 70K cycles. After drying overnight, each slab was tested again using the CTM and DFT. Additional TWPD conditioning of 70K cycles was performed, and final CTM and DFT measurements were taken after the slabs dried overnight.

The difference between DFT measurements for replicate slabs was evaluated for similarity. The average difference in DFT(40) for replicate slabs was 0.034. Only three differences were greater than two standard deviations from the mean (0.08), and they represent initial DFT measurements not critical to the analysis. More than 60% of the differences in DFT(40) between replicates were less than 0.040, which is similar to the results of an earlier study (NCAT Report 15-04). The CTM data were very repeatable, so no quality control evaluation was needed.

Figure 1 shows the DFT friction values measured at 40 km/h (DFT(40)) for each aggregate tested. The legend ranks the aggregates from highest to lowest DFT(40) values after 140K TWPD polishing cycles. Calcined bauxite maintained

higher friction performance than the other aggregates tested. All three calcined kaolin products (47 – 4x20, 60 – 4x20, and 70 – 4x20), as well as the OK flint, had similar high performance compared to the remainder of the other aggregates. The WA quartz (Armor Stone) continued to polish between 70K and 140K cycles, so its terminal friction placed it in a middle performance category along with the WI copper slag and WY feldspar (Traction Control). The WI basalt had the lowest initial DFT(40) value but showed good polish resistance with minimal friction loss after 140K polishing cycles. The quartz aggregates from Ohio (Best Sand) and Maryland (EP5 MOD) exhibited the lowest friction performance.

Figure 2 shows the CTM macrotexture measurements for each aggregate tested. After 140K TWPD cycles, all MTD measurements were in the range of 1.2 to 1.8 mm, which is typical for HFSTs after conditioning. By comparison, terminal macrotexture values are typically less than 1.2 mm for porous asphalt mixes and less than 0.60 mm for dense-graded asphalt mixes. As noted in previous HFST studies, measured friction and surface macrotexture had no correlation.

A previous FHWA-sponsored study comparing laboratory TWPD conditioning

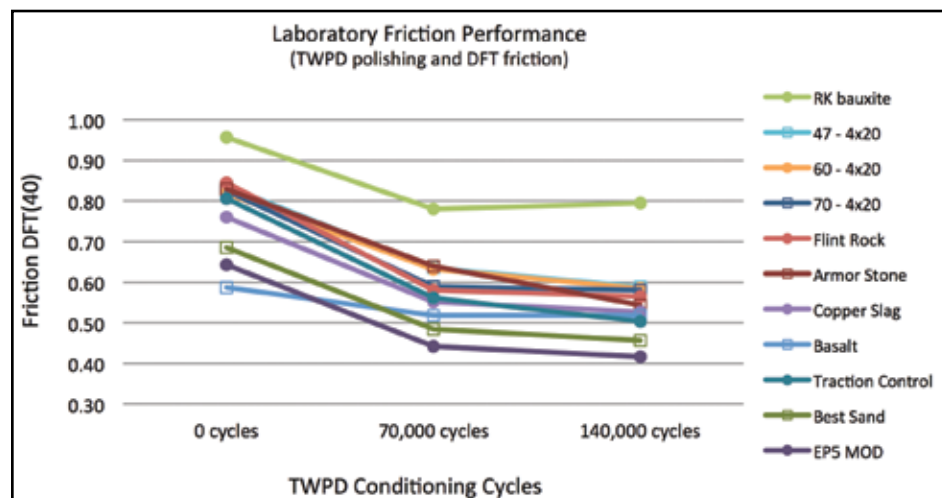


Figure 1: Comparison of Laboratory Friction Performance

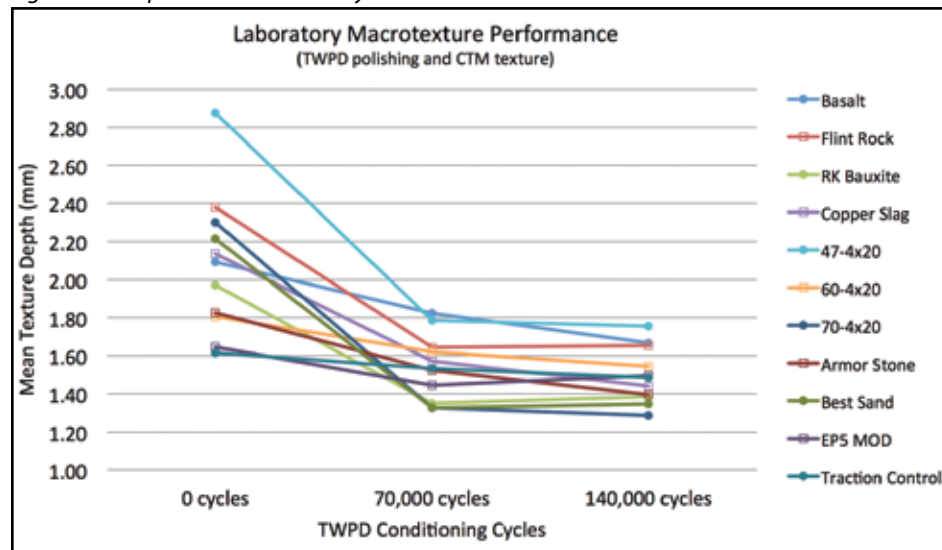


Figure 2: Comparison of Laboratory Surface Texture Performance

and test sections at the Test Track showed that laboratory DFT terminal friction values are higher than field terminal friction values measured using a locked-wheel skid trailer, ASTM E 274. Based on the correlation developed in that study (NCAT Report 15-04), the calcined kaolin products and flint would be expected to have a terminal friction value of approximately 40 (SN40R) using a skid trailer.

For the eleven aggregates selected by Michigan DOT, measured DFT(40) values ranged from 0.40 to 0.80. This wide range indicates substantial differences in friction performance among the various aggregates. It is the governing agency's responsibility to set acceptable thresholds for friction aggregate performance. Depending on site-specific factors, regionally available friction aggregate may be appropriate for some applications. The success of locally placed sections, measured in terms of crash reduction, is one approach to developing acceptable friction thresholds.

HFSTs do not extend pavement life and should not be applied to existing pavements in poor condition. Further, conventional pavement preservation techniques do not provide the same level of friction as HFSTs. Ongoing work at the NCAT Test Track is evaluating higher friction preservation treatments using calcined bauxite as an aggregate. Section W7A, placed in 2015, has a 0.25-inch microsurface treatment with 50% bauxite. Section W3, a 0.75-inch thinlay stone matrix asphalt (SMA) with bauxite and granite, was placed in the spring of 2017.

W7A has a friction value of 55 (SN40R) after eight million equivalent single axle loads (ESALs) of traffic. By comparison, the HFST with bauxite (section W8B) has a friction value of 60 after 20 million ESALs. Although W7A has lower friction than the bauxite HFST, it is still very good. Further trafficking will determine whether the bauxite microsurfing continues to maintain good friction over time. W3 only had three million ESALs applied at the time of these friction measurements. Initially, friction was lower at 44 (SN40R) due to the asphalt surface film. This film has been worn off by traffic, and the friction values are currently comparable to W7A.

CTM macrotexture measurements are very good (near 1.00 mm) for the bauxite HFST (W8B). W7A has good macrotexture (0.75 mm), but W3 is less than 0.40 mm. Although W7A and W3 have similar friction at this time, bauxite micro-surfing (W7A) may be a better safety surface based on its higher macrotexture, which reduces hydroplaning potential. With crash reduction in mind, researchers continue to evaluate surface friction performance to better understand what levels of macrotexture and friction are sufficient to provide safe pavement surfaces.

Putting the Balance Back in Mix Design

Background

The original vision of the Superpave mix design system was to include three levels. Level I was envisioned for low traffic pavements and the mix design requirements would be primarily based on traditional volumetric properties. Level II would be used for projects that carry moderate travel levels and would include volumetric requirements plus a limited set of mixture performance tests. Level III would be for high traffic pavements and would start with volumetric based mix design followed by an expanded set of advanced performance tests. However, the proposed performance tests were never implemented, primarily because they were not practical for use in routine mix designs.

In the early years of Superpave implementation, the focus was on rutting resistance. Several changes in mix designs were proposed and were found successful in improving mixture resistance to rutting. A number of states also added a rutting test requirement for mixes designed for moderate and high traffic projects. Nowadays, most highway agencies report that rutting problems have been virtually eliminated, but many agencies have indicated that the primary form of distress for asphalt pavements is cracking of some form or another.

There are several possible contributing factors to increased cracking, including issues with the mix designs, increased use of recycled materials and byproducts, problems with the quality of construction, and failure to properly address underlying pavement distresses. Since it is now well recognized that the volumetric based mix design system has some shortcomings, many highway agencies and the asphalt paving industry are revisiting the possibility of using mixture performance tests in the mix design process to improve the life of asphalt pavements.

Balanced mix design (BMD) provides highway agencies with an alternative way to design asphalt mixtures by using performance tests to address multiple modes of distress while taking into consideration mix aging, traffic, climate, and location within the pavement structure. For BMD, asphalt mixtures are designed to achieve a balance between rutting resistance and cracking resistance using appropriately selected performance tests rather than relying solely on volumetric guidelines.

The FHWA Task Force on BMD has identified three potential approaches to the use of BMD: (1) volumetric design with performance verification, (2) performance-modified volumetric mix design, and (3) performance design.



Figure 1: U.S. Map of Current Use of BMD Approaches

State-of-the-Practice

A few highway agencies have started to adopt approaches to BMD, and others are in the process of evaluating performance tests for integration into mix design requirements. Figure 1 highlights highway agencies identified by NCAT researchers as being focused on BMD. In addition, several other agencies currently require a performance test in their mix design specifications, but they are not using a “true” BMD approach according to the definition set forth by the FHWA Task Force to include at least one rutting test and one cracking test.

Currently, the most popular BMD approach among highway agencies is volumetric design with performance verification (Approach 1). States using this method include Illinois, Iowa, Louisiana, New Jersey, and Texas. This approach starts with the current Superpave mix design method for determining optimum asphalt binder content. Selected performance tests are then used to assess the mixture’s resistance to rutting, cracking, and moisture damage. If the mix design satisfies the performance requirements, the job mix formula (JMF) is established and production begins; otherwise, the mix design process is repeated using different materials or mix proportions until all performance criteria are met.

California is the only state using the second approach, performance-modified volumetric mix design. This approach begins with the Superpave mix design method to establish a design aggregate structure and preliminary binder content. Performance test results are then used to adjust either the binder content or component properties until the performance requirements are satisfied. The final design from this approach is primarily focused on passing performance test criteria and may not be required to meet all of the Superpave volumetric requirements.

No states have yet been identified for using the performance design approach, which would establish proportions of mixture components based on performance test results. Minimum requirements may be set for asphalt binder and aggregate properties. Air void and voids in mineral aggregates (VMA) might be non-mandatory suggestions. Once a mix satisfies the performance criteria, mixture volumetrics could be set for process control and/or simple and quick performance tests could be used to ensure quality during construction.

Additionally, several states have constructed or are preparing to construct pilot projects with BMD approaches by including performance testing and criteria. For example, Wisconsin constructed demonstration projects for mixtures containing more than 25% recycled materials in 2014. For these projects, the mix design target air void was lowered from 4.0% to 3.5% and the minimum tensile strength ratio (TSR) requirement was increased from 0.70 to 0.75. Performance tests including the Hamburg wheel-tracking test (HWTT), semi-circular bend (SCB-Jc) test, and disk-shaped compact tension (DCT) test were used to assess mixture resistance to rutting, moisture susceptibility, fatigue cracking, and low-temperature cracking. Oklahoma also plans to construct BMD trial projects in early 2018. It is anticipated that mix design and production samples will be tested with the HWTT, Illinois flexibility index (I-FIT) test, Cantabro, and TSR to ensure the designed mixtures have adequate resistance to rutting, cracking, and moisture susceptibility.

Knowledge Gaps for Implementation

Although many highway agencies have recognized the benefits of BMD approaches, there are gaps in the knowledge needed for future development of a detailed, comprehensive standard practice for BMD. In addition, there is an overall lack of understanding of the BMD concept among the asphalt paving industry. The three biggest questions that need to be addressed by future research on BMD are:

1. For each mode of pavement distress, what are the best performance tests for BMD?
2. What mixture conditioning/aging protocols should be used for selected performance tests?
3. What are appropriate criteria for performance test results used in mix design and quality assurance?

Over the past few decades, numerous mixture performance tests have been developed to evaluate the rutting resistance, cracking resistance, and moisture susceptibility of asphalt mixtures. Considering the different mechanisms involved in

crack initiation and propagation, mixture cracking tests can be further categorized into tests for thermal cracking, reflection cracking, bottom-up fatigue cracking, and top-down fatigue cracking. Some of these tests are better suited for routine use in mix design and quality assurance testing, while others are more focused on characterizing the fundamental properties of asphalt mixtures and predicting pavement response. In order to include these in the BMD procedure, criteria should first be established with good correlations to the corresponding pavement performance in the field. Considerations must also be given to practical issues such as testing time, data analysis complexity, test variability, equipment availability and cost, and sensitivity to mix design parameters.

Considering that asphalt aging plays a significant role on mixture performance, it is important to select an appropriate mixture conditioning/aging protocol for selected performance tests in BMD. There is a general consensus that rutting and moisture damage tests should be performed on short-term aged specimens because asphalt mixtures are more vulnerable to these two distresses right after construction. On the other hand, mixtures tend to be more susceptible to cracking after aging due to reduced flexibility; thus, long-term aged specimens should be used for mixture cracking tests. The standard short-term aging protocol specified in AASHTO R 30 is to condition loose mix for two hours at compaction temperature for mix design, but four hours at 135°C for performance testing. For long-term aging, AASHTO R 30 recommends aging compacted specimens for five days at 85°C. However, the long time span of this five-day protocol makes it difficult to implement in routine mix designs. Recently, alternative aging methods have been proposed to conduct long-term aging using loose mix prior to compaction. Loose-mix aging increases the rate of asphalt binder aging due to increased exposure to heat and oxygen to the thin asphalt coating. Some research has recommended loose mix aging at 95°C for five days, while other studies have recommended a higher temperature such as 135°C for much shorter time periods ranging from 12 to 24 hours.

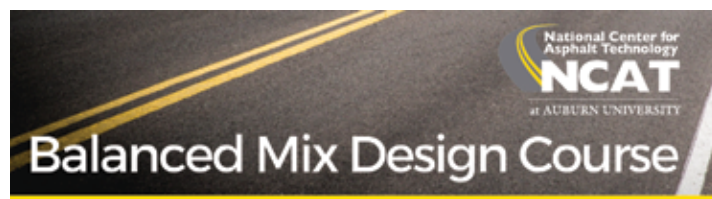
NCAT's Efforts on Balanced Mix Design

As a leading organization in asphalt pavement research, NCAT has identified BMD as a primary area of research. Currently, NCAT researchers are working on NCHRP Project 20-07/ Task 406 Development of a Framework for Balanced Asphalt Mixture Design. The objective of this project is to develop a framework that addresses alternate approaches to devise and implement BMD procedures incorporating performance testing and criteria. Surveys of highway agencies and asphalt contractors were recently conducted to gather their experience, insights, and concerns with mixture performance testing and BMD approaches. Results will be presented in a

webinar in fall 2017 through the Association of Asphalt Paving Technologists (www.asphalttechnology.org). Information collected through the survey and literature review will be used to develop research problem statements that address gaps in the knowledge required for future development and implementation of BMD.

Over the past five Test Track research cycles, NCAT has devoted significant research efforts on mixture design and performance testing of asphalt mixtures. The currently ongoing NCAT/MnROAD Cracking Group Experiment aims at validating mixture cracking tests by establishing correlations between laboratory test results and measured cracking in real pavements using real loading conditions. Upon completion of this experiment, industry-accepted laboratory cracking tests will be identified that can reliably relate to top-down and thermal cracking in asphalt pavements. The research findings will help highway agencies select the most suitable cracking tests for their BMD approach.

In spring 2017, NCAT engineers began offering a Balanced Mix Design Course consisting of lectures, discussions, and hands-on training with performance-based mix design procedures. This course is specifically designed to provide asphalt industry and agency personnel with a better understanding of the BMD concept based on results of laboratory tests that reflect how a mix performs in regard to rutting resistance, resistance to cracking, and long-term durability.



This 2 1/2-day workshop provides a basic understanding of the balanced mix design process and provides hands-on training using the laboratory tests being considered by various agencies to evaluate potential mix performance. Upon completion, attendees will be able to develop a balanced asphalt mix design in their laboratories.

Upcoming course dates:

November 7-9, 2017

January 23-25, 2018

For additional information, call 334-844-6202 or visit ncat.us/education/training.

Alabama Legislature Recognizes NCAT's 30 Years of Research



From left, Chris Roberts, dean of the Samuel Ginn College of Engineering, Auburn University President Steven Leath, Alabama Sen. Tom Whatley, Alabama Rep. Joe Lovvorn, NCAT Director Randy West, and Ron Sines, chairman of the NCAT Board of Directors.

NCAT was recognized on July 24 with resolutions from the Alabama Legislature commending 30 years of service to the state. State Sen. Tom Whatley and Rep. Joe Lovvorn, both of Auburn, sponsored the resolutions and presented the documents during NCAT's Board of Directors meeting. Auburn University President Steven Leath and Christopher Roberts, Dean of Auburn's Samuel Ginn College of Engineering, attended the event.

"It's an honor to be here to celebrate this milestone and recognize 30 years of accomplishment at NCAT," Leath said. "I'm impressed by the partnership between this university and the National Asphalt Pavement Association. It's a great example for what others can do here and around the country."

The identically worded resolutions read in part, "The National Center for Asphalt Technology at Auburn University is hereby recognized, and we offer this resolution in the highest tribute to their staff, researchers, and leaders, along with sincere best wishes for continued success as they chart the pathway forward for transportation infrastructure in the State of Alabama."

NCAT brings in millions of dollars of sponsored research

projects to Auburn University each year and has an annual economic impact of more than \$125 million on Alabama.

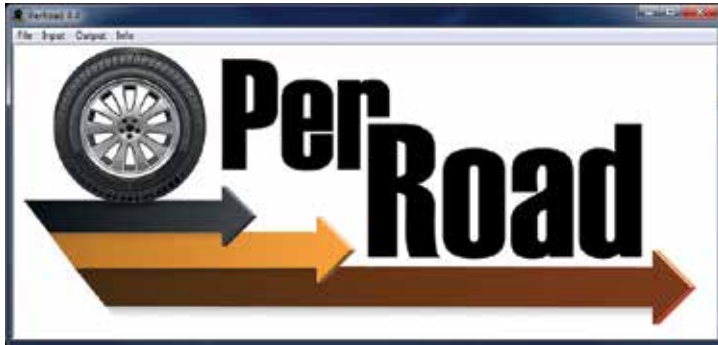
Whatley recognized the event as a day to celebrate the impact NCAT has had on infrastructure development and the economy in Alabama. "When you build a road, you create a job," said Whatley, a Lee County resident and Auburn graduate. "What you are doing promotes the economy for Alabama and the country as a whole."

Lovvorn, also an Auburn alumnus, praised NCAT's developments in technology and its potential for continued innovation. "I look forward to the next 30 years," he said. "I feel that they will definitely be the best 30 years of the program."

Auburn's civil engineering curriculum was also recognized for its nearly 150 years of improving the state's transportation network through education, research and outreach.

"NCAT is a shining example of how to take the fundamentals that we try to provide in the classrooms and laboratories and bring them into application," Roberts said. "This center epitomizes our philosophy to applied research, making our roadways safer and saving taxpayer dollars. NCAT is truly a national asset with national exposure."

Perpetual Pavement Design Gets an Upgrade



Perpetual pavements are long-life asphalt pavements designed to perform longer than 50 years with minimal maintenance. A perpetual pavement requires only periodic mill and inlay of the top layer to maintain an excellent riding surface. Many successful perpetual pavements have been built in the United States, and in 2001, the Asphalt Pavement Alliance instituted the Perpetual Pavement Award program to recognize those long lasting roadways.

Perpetual pavement structural design relies on controlling the bending strain at the bottom of the asphalt concrete (AC) to prevent bottom-up fatigue cracking and vertical compressive strain deeper in the structure to prevent rutting of non-AC layers. The computer program, PerRoad, was initially created to enable designers to consider these critical locations in the pavement cross-section and choose appropriate thicknesses and materials needed to achieve a perpetual pavement. PerRoad was first released in 2003 and a major update was completed in 2010 with the release of Version 3.5. These early versions relied on single threshold values that had the potential to produce overly conservative perpetual designs. If a designer then wanted to compare the results with mechanistic-empirical (M-E) design that predicts pavement failure, separate design calculations had to be used. In some cases, a small increase in AC thickness or other layer inputs result in a perpetual pavement, so it is a good practice to compare the results, especially if a life cycle cost analysis is also being conducted.

New criteria recommended in recent research at NCAT have shown to yield more optimal perpetual pavement cross-sections consistent with those found in the Perpetual Pavement Award winners and those at the NCAT Test Track (NCAT Report 15-05). The new criteria focus on controlling the tensile strain distribution, rather than a single value, at the bottom of the AC to avoid bottom-up fatigue, and a single compressive strain percentile at the top of subgrade to mitigate non-AC rutting.

PerRoad 4.4 was redesigned to implement the new criteria and enable designers to execute conventional M-E designs within PerRoad to compare pavement cross-sections during the design phase. The new release of the software also allows the designer to select default strain distributions based on previous studies or enter a laboratory-determined fatigue endurance limit that the program will use to compute a control strain distribution. Figure 1 shows an example where a particular pavement becomes perpetual at 12.5 inches regardless of the traffic volume (axles/day). The M-E curve shows how the conventional design requires increasing pavement thickness with increasing traffic volume, with no upper limit. After about 400 axle groups/day, the conventional M-E design is over-designed for this set of conditions. At less than 400 axle groups/day, the designer could evaluate the additional thickness (and cost) required to achieve perpetual status and how best to proceed.

The design analysis results within PerRoad 4.4 are presented in a pass/fail format. If the pavement fails to meet the criteria or is overly conservative, then the structure can be adjusted accordingly. In addition to the input and output updates, the software was also enhanced to provide an Excel® output formatted ready-to-print. These reports may be used when developing a pavement design project and document all inputs and outputs developed in the design process. PerRoad Version 4.4 can be downloaded free of charge at <http://www.asphaltroads.org/perpetual-pavement/about-perpetual-pavements/>.

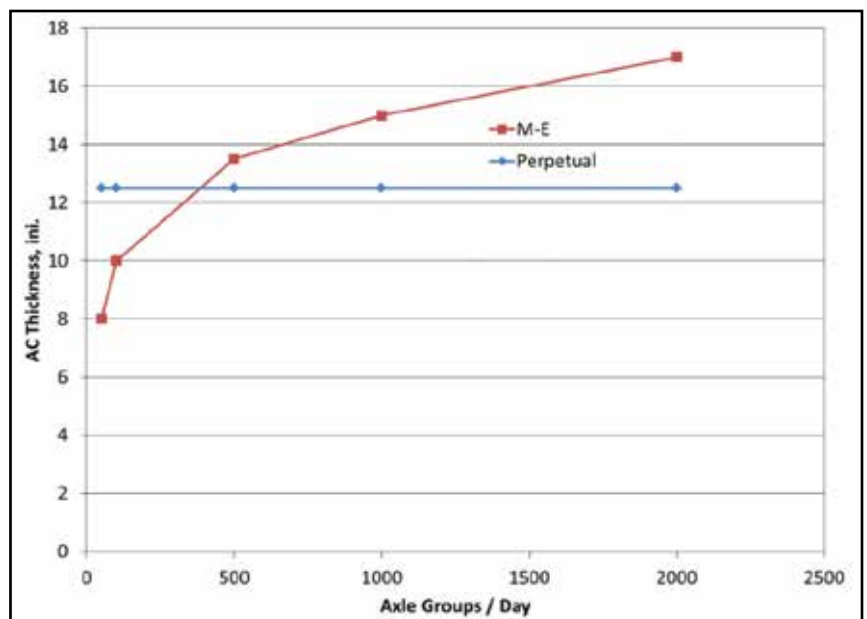


Figure 1: Conventional M-E versus Perpetual Design

Open House Celebrates 30 Years of NCAT

It's a milestone not all partnerships reach, so when over 90 attendees gathered at NCAT's open house in April, their faces echoed a sense of accomplishment and enthusiasm for an optimistic future. NCAT welcomed both newcomers and longstanding colleagues to the two-day event celebrating 30 years of research, development, and outreach to the asphalt paving industry.

The open house began with a golf tournament on Tuesday, April 25, where six teams of golfers spent a beautiful day at the award-winning Robert Trent Jones Golf Trail at Grand National. The festivities then moved to the Auburn Marriott Opelika Hotel & Conference Center at Grand National for a reception sponsored by state asphalt pavement associations. Attendees reflected on NCAT's development and evolution, and it was mentioned repeatedly throughout the evening that NCAT's success is directly related to its strong collaboration with a multitude of partners.

The reception was followed by a dinner and program, which began with a video showing NCAT's mission in action: to provide innovative, relevant and implementable research, technology development, and education that advances safe, durable, and sustainable asphalt pavements.

The presentation portion of the evening included speeches by individuals who have helped shape NCAT's success: Randy West, NCAT Director; Mike Acott, President of the National Asphalt Pavement Association; Ray Brown, NCAT Director Emeritus; Christopher B. Roberts, Dean of the Samuel Ginn College of Engineering at Auburn University; George Conner,

Deputy Director for Operations at the Alabama Department of Transportation; Tom Harman, Director of the Center for Accelerating Innovation at FHWA; and Ron Sines, 2017 NCAT Board of Directors Chairman and Oldcastle Materials Vice President of Asphalt Performance.

Guided tours of NCAT's main facility and Test Track on Wednesday featured demonstrations that gave visitors a sense of the center's approach to providing practical research and development to the asphalt pavement industry. The successful event concluded with a fish fry at the track followed by closing remarks from Randy West.



The winning team, "Where the Rubber Meets the Road," from left to right: Ronald Griess, Mike Jenkins, Buzz Powell, and Tyler Andrews.



Jamie Hill (left) watches Ray Brown (right) hit a drive over Lake Saugahatchee at Grand National.



Auburn University Dean of Engineering Christopher Roberts (left) and David Timm, Brasfield & Gorrie professor in Auburn's Department of Civil Engineering (right), enjoying the evening reception.



The evening program looked back at NCAT's many accomplishments, acknowledged those who have helped NCAT over the past three decades, and looked forward to the opportunities that lie ahead.



Engineer Adam Taylor discusses NCAT's unique testing capabilities with a tour group.



Assistant Research Engineer Jason Nelson answers questions about one of the oldest test sections on the track.



Assistant Research Engineer Nathan Moore demonstrates the Test Track's instrumentation system with open house guests.



A group of guests stop at the Test Track for an up-close look of NCAT's mobile laboratory, falling weight deflectometer (FWD), and PathRunner data collection vehicle.



NCAT Director Randy West provides closing remarks to employees and guests at Wednesday's fish fry luncheon.

Where Are They Now?

The National Center for Asphalt Technology's ongoing efforts to provide safe, durable and sustainable asphalt pavements could not, at its core, be realized without a successful education program. Auburn University and NCAT realize the importance of education through its civil engineering program where students learn through coursework and research how to apply knowledge to real world situations. NCAT's vision is only as strong as our willingness to teach others how to ask questions, solve relevant issues in the industry, and apply those solutions. Many former NCAT researchers and students have benefited from what they learned at Auburn and continue to contribute to the asphalt community. Dr. Steve Cross, Dr. Rajib Mallick, and Dr. Alan Carter are three Auburn/NCAT alumni that have committed to take what they gained from their time at NCAT to continue the vision of education transfer and focus their efforts in academia.



Dr. Steve Cross

Dr. Steve Cross grew up in Denton, Texas, where his father was a professor at what was then North Texas State University. He has been married to his wife, Helena, for almost 30 years. They have two grown daughters, Kelli and Kaitlyn, and a new granddaughter Ava. Dr. Cross was a Senior Research Associate at NCAT from 1988 to 1992, making him one of the first employees at NCAT, established in 1986. He completed his Ph.D. at Auburn while working full time. His main research focus was on the national rutting study; however, he did manage to find time to play a little golf. After leaving NCAT, he became the asphalt professor at the University of Kansas until 2002.

Currently, Dr. Cross is a professor at Oklahoma State University where he continues to conduct research while also serving as the technical director for the Asphalt Recycling & Reclaiming Association. He hopes to retire in the near future to spend more time playing with his granddaughter, fly fishing, and playing golf.

No matter where he went after graduating from Auburn, he felt his association with NCAT gave him immediate credibility. With many thanks to their Auburn/NCAT family for being involved in all aspects of their life, Helena and Steve consider their time at NCAT as one of the best times of their lives.

Dr. Rajib Mallick

Originally from Calcutta, India, Dr. Rajib Mallick is part of a family of civil engineers that includes his father, father-in-law, and his wife. He received his Bachelor of Engineering degree from Jadavpur University in Calcutta and received his masters and Ph.D. degrees from Auburn. He joined NCAT in January 1992 as a research assistant.

While he accomplished many things at Auburn, what stands out to him is how much he learned. He recalled, "NCAT was a pretty exciting place to me. We focused on learning, but we focused on research applications all the time, and that's what made it so exciting." He worked on a wide range of projects from open-graded friction courses to developing the NCAT website, all while authoring multiple papers. He is forever grateful for the wide range of opportunities that was afforded to him and the lifelong friendships that he maintains to this day.

Currently, Dr. Mallick is a Professor of Civil and Environmental Engineering at Worcester Polytechnic Institute in Worcester, Massachusetts where he teaches and continues to conduct research on pavements. His most significant takeaway from NCAT was that he realized the need for a balance between learning and application, and between theoretical research and practical implementation.





Dr. Alan Carter

Dr. Alan Carter is originally from Quebec, Canada. He is married and has three boys; one of which was born when he was in graduate school at Auburn. He earned his bachelor's and master's degree from École de technologie supérieure, ÉTS, in Montreal. As part of a contract for future employment with ÉTS, he needed to complete his education in a bituminous materials related field. Alan chose Auburn and NCAT, where under the supervision of Dr. Mary Stroup-Gardiner he completed his Ph.D. His primary research focus was on the development of a test to characterize asphalt mixes without the use of solvent to extract the bitumen.

Since 2005, Alan has worked as a professor at ÉTS in Montreal, one of the largest engineering schools in Canada with approximately 11,000 engineering students. Dr. Carter teaches pavement materials and pavement design and continues to research pavement recycling technologies. He has authored or coauthored around 100 publications in journals and conferences, as well as actively serving on several technical committees. He is a past president of the Canadian Technical Asphalt Association (CTAA), a current director at large for the International Society for Asphalt Pavements (ISAP), and co-chairs a technical committee on cold bitumen emulsion materials and a task group on cold asphalt recycling for the International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM). His time at NCAT confirmed his love for working with asphalt while giving him the opportunity to meet and learn from incredible people, staff, and students.

Training Opportunities

Our training courses are designed for the asphalt pavement industry, and we can customize workshops designed to meet your specific training needs. CEU's and Professional Development Hours are available.

Training is conducted at NCAT's state-of-the-art research facility in Auburn, Alabama. Course details and registration can be found online at www.ncat.us/education/training.

Asphalt Binder Technician Training & Certification
April 24-27, 2018

Asphalt Engineers Workshop
February 12-16, 2018



Asphalt Mix Design
March 12-16, 2018

Asphalt Technology
February 26-March 2, 2018

Balanced Mix Design
November 7-9, 2017
January 23-25, 2018

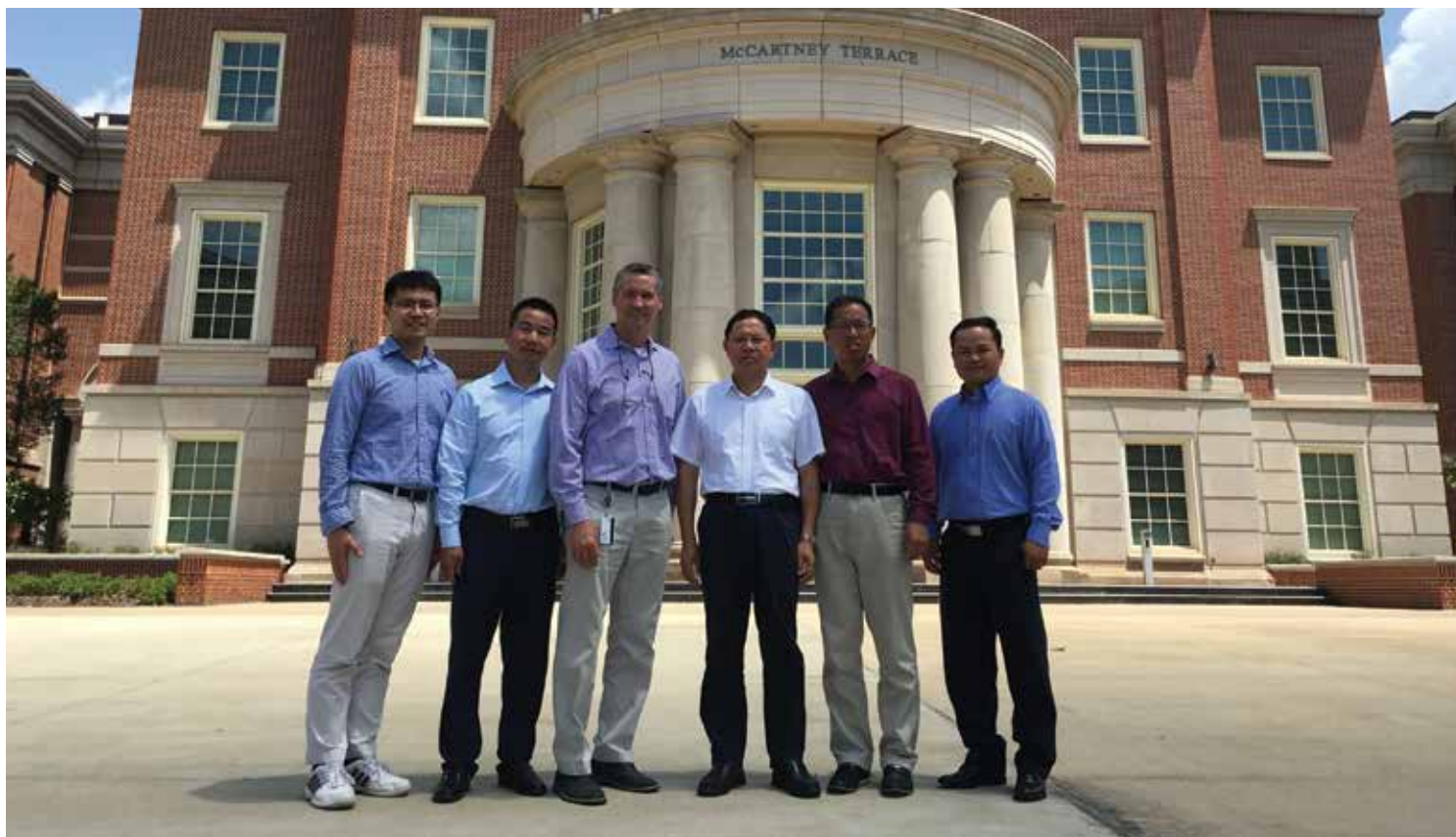
DID YOU KNOW?

Our AASHTO-accredited lab can provide independent performance testing for a nominal fee.

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

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

Joint Research and Development Program to Advance Asphalt Pavement Practices in China



Employees of Sinyue visit Auburn University on a campus tour. From left, NCAT Postdoctoral Researcher Fan Gu, Sinyue Senior Advisor Bin Wang, NCAT Director Randy West, Sinyue President Shuihui Wu, Sinyue Senior Advisor James Luo, and NCAT Associate Research Professor Nam Tran.

NCAT and Jiangsu Sinyue Asphalt Co. of China have established a 10-year research and development agreement focused on advancing cost-effective and sustainable asphalt pavement practices in China and throughout the world.

NCAT researchers will provide technical support in developing innovative asphalt technologies, training programs, and workshops to foster technological advancements involving high percentages of reclaimed asphalt pavement, cold asphalt recycling, highly modified asphalt binders, and asphalt pavement preventive maintenance and rehabilitation.

"This program represents a unique opportunity for NCAT to expand our research and outreach," NCAT Director Randy West said. "The knowledge and experience gained from the program will benefit the asphalt paving industry in the United States and worldwide, as SINYUE's resources will multiply our efforts to build sound technical data to advance the state of practice in China as well as to develop technologies that can be implemented here in the U.S."

SINYUE will finance the program, which will include building

a new facility in Jiangsu Province and purchasing new testing equipment. In turn, NCAT engineers will travel to China for up to three months each year to provide leadership and technical expertise, while SINYUE employees will receive training each year at the NCAT facility in Auburn.

SINYUE is a leading comprehensive asphalt company in China with business operations in asphalt transport and storage, trade, liquid asphalt products manufacturing, mixture production and paving. In the past decade, the company has actively cooperated with a number of companies, research institutions, and universities to complete pavement construction projects and to develop innovative asphalt products and paving technologies.

"SINYUE and NCAT will work together to establish a comprehensive, innovation-oriented research and development program," SINYUE Chairman Shuihui Wu said. "Both parties will make full use of their respective expertise and experience to serve the growth of the asphalt industry in China and aid in the advancement of more cost-effective and sustainable asphalt pavement materials and technologies."

Registration Open for New Asphalt Engineers Workshop



The Federal Highway Administration discontinued their Highway Materials Engineering Course offered for more than 20 years. To fill this gap, NCAT has developed a new one-week asphalt workshop in order to ensure that highway agency personnel have a sound background in asphalt pavement engineering. This program is being offered free of charge to public agency engineers.

The workshop will provide the technical background and current state of practice for all aspects of asphalt pavement engineering. Engineers who participate in this course will return to their agency with a better understanding of the basic principles of asphalt materials, pavement design, and construction best practices needed to achieve high quality asphalt pavements.

The intensive five-day program will cover asphalt binder and aggregate properties, recycled materials, mix design, mixture performance testing, pavement structure design, plant production, paving, pavement performance, preservation, rehabilitation, construction troubleshooting, and forensic investigations. The workshop will include lectures, laboratory demonstrations, and peer discussions to understand all phases of asphalt technology for practicing agency engineers. Those involved with materials, design, construction, preservation, and rehabilitation of asphalt pavements will benefit from the course.

The first workshop will be held February 12-16, 2018 at NCAT's main research and training facility in Auburn, Alabama.

Registration is open to any agency engineer or consultant and closes on December 8, 2017. The workshop is limited to 24 participants and is expected to be offered every two years.

There is no course or materials fee for engineers employed by public agencies in the U.S. Costs for housing, food, and transportation are the responsibility of each participant and their respective agency. The Southeast Superpave Center pooled fund can be used to cover travel expenses for this workshop. The course will provide 3.6 continuing education units or 36 professional development hours. Additional details and registration can be found online at <http://ncat.us/education/training/engineers.html>.

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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.

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

-Randy West, NCAT

Asphalt Forum Responses

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

Are any other agencies having difficulties with trackless tack materials?

-Greg Sholar, Florida DOT

Michael Stanford, Colorado DOT

Not at this time, although we rarely see it used.

Bryan Engstrom, Massachusetts DOT

We are using RS-1h as our standard tack coat hoping that it will track less than RS-1.

Charlie Pan, Nevada DOT

Not in Nevada.

Eric Biehl, Ohio DOT

From a performance standpoint of being non-tracking, we have not had this issue except on high temperature days with or without humidity. We would see some tracking, but not as much as we would with our normal (SS-1h) tack. From an asphalt emulsion standpoint, we have seen the material not be stable and wanting to break in the emulsion bottle or the tank (we have not figured that out yet) prior to testing for acceptance or approval. This typically results in low percent residue and/or low viscosity with or without a failing sieve test. We believe it's the nature of the material as designed to not only be non-tracking but also break fast. We do not currently perform a bond test on tack coats.

Howard Anderson, Utah DOT

I have not seen it used much in Utah.

Joe DeVol, Washington State DOT

We do not currently use or specify trackless tack materials.

Specification Corner

Colorado DOT

No significant specification changes, although we developed a Project Special Provision to allow up to 0.5% PPA. To date, it has not been used on any CDOT projects. Our default is no PPA modification.

Florida DOT

Effective in January 2017, PG 76-22 polymer modified asphalt (PMA) and PG 76-22 asphalt-rubber binders (ARB) are considered equivalent, and it will be the contractor's choice as to which binder to use. Both binders must meet the same PG binder tests including MSCR Jnr and % recovery.

Effective in July 2017, FDOT has removed PG 82-22 (PMA) from its binder program and replaced it with a highly polymer modified binder, conventionally referred to as HiMa binder.

FDOT is considering implementing an FTIR scan of modified binders as part of being included on the Approved Products List. It will not be used in routine acceptance testing, but would be used for forensics testing and perhaps in IA sampling. This will likely happen in 2018.

Montana DOT

We are slowly moving towards implementing MSCR for our binder acceptance. We are waiting for comments from our local refineries. Our hope is to have it in place for construction season 2018.

Ohio DOT

We are currently planning on making significant changes to our 421 microsurfacing specification to include more QC related items as well as including a few more mix design tests.

South Carolina DOT

We have revised our SC-M-402 specification dealing with mix design properties. We are now using a 9.5mm surface PMA mix under our OGFC mixes, and our old 12.5mm surface PMA mix has become an intermediate mix. We are encouraging the HMA contractors to use COAC on RAP/RAS mixtures using a 0.75 availability percentage based on percent aged binder in surface and intermediate mixtures to improve mix durability.

Tennessee DOT

We will begin allowing GTR modification as an option in 2018.

Utah DOT

We added a longitudinal joint specification to our HMA this year and are evaluating it to see how things went.

Washington State DOT

We will be implementing AASHTO Standard Specification M 332 and Standard Method T 350, Multiple Stress Creep Recovery (MSCR), for PG binders in Washington State effective January 1, 2018. After several years of research and testing, WSDOT states that the implementation of this specification and test procedure will require products and processes used to modify asphalt binders in WA that ensure performance. Additional benefits of implementing M 332 and T 350 include eliminating the PG plus specification (elastic recovery) and test procedure (T 301), which WSDOT has been using since 2012. Eliminating T 301 will reduce laboratory test time, volume of RTFO aged material, as well as time spent cleaning molds, bottles, etc.



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