Asphalt Pavement Research Expands to Address National Needs in Sixth Testing Cycle

After the successful construction of new test sections this summer, NCAT has begun its sixth cycle of accelerated pavement testing, which includes structural experiments, surface mix experiments, and pavement preservation studies. The scope of the pavement preservation research has been expanded in this cycle to include continued evaluation of Lee County Road 159, a low volume route, and new treatment sections on U.S. Route 280, a much higher traffic volume roadway.

Sequence of a research cycle
Initially constructed 15 years ago, NCAT’s Test Track is a 1.7-mile oval comprised of 46 200-ft test sections sponsored on three-year cycles. The first phase of the 2015 research cycle consists of constructing test sections on and off the Test Track. Representatives from research sponsors make on-site visits during this phase in order to ensure that the sections satisfy their research needs. This cycle, NCAT used Pavia’s HeadLight software to document and share construction data in real time among NCAT staff and track sponsors. To facilitate lab to field performance correlations, a large amount of mixture samples from construction are tested and analyzed in the laboratory. Various parameters are also measured during the construction process to capture in-place properties of the sections.

In the second phase, each section on the track is subjected to 10 million equivalent single axle loads (ESALs) of heavy truck traffic applied over a period of two years. The performance of each track section is closely monitored on a weekly basis. A
new automated pavement distress data collection vehicle will be used to quantify roughness, macrotexture, rutting, and cracking in the same manner used by most state highway departments for their pavement management systems. Other tests such as surface friction, falling weight deflectometer, sound, and permeability are also conducted. Similar performance data is conducted on the off-track sections, but due to the open traffic on these roadways, data collection is conducted on a less frequent basis than the closed-loop track.

The final part of the three-year cycles at the test track involves forensic analyses of damaged sections in order to determine the contributing factors to pavement distresses. Many forensic investigations conducted during this stage include destructive testing such as trenching and coring.

**Cutting-edge technology**

For structural sections on the Test Track, NCAT closely monitors how the pavement sections respond to loading and environmental changes. A wireless network covers the entire track to safely and effectively transmit high-speed data from stress, strain, and temperature sensors built into the structural sections. Measurements from the sensors can then be compared between test sections, monitored over time, and linked to performance in order to develop pavement response models and improve mechanistic-empirical design procedures.

**Pavement preservation**

A major focus of the sixth research cycle is to quantify the life-extending benefits of different pavement preservation treatments by determining the field performance of treatments applied at various stages of pavement life and decay. In this highly controlled experiment, quantifying the benefits of various pavement preservation alternatives as a function of pretreatment condition will provide transportation agencies an objective basis for pavement management decisions.

In 2014, pavement preservation treatments were applied to several Test Track sections at predetermined distress levels. Traffic and examination of these sections, as well as those on Lee County Road 159, will continue throughout the sixth research cycle. Sponsors will also select consensus treatments for placement on comparable roadways in Minnesota through a partnership with the Minnesota Department of Transportation.
New pavement preservation treatments have also been installed on a nearby section of U.S. Route 280, expanding the scope of our research to include a higher volume route and cold recycling techniques. These sections serve as a complement to existing sections on the Test Track and Lee County Road 159 and are essential to accurately quantify the condition improving benefit curve of each treatment/treatment combination under different levels of traffic. The core objective of this research is to quantify the benefits of pavement preservation on a more typical highway, somewhere between the accelerated damage environment of the track and the low ADT environment of Lee County Road 159. Sections on U.S. 280 are 0.1 miles in length and include 34 treatments and treatment combinations such as microsurfacing, crack sealing, chip seals, fog seals, scrub seals, cape seals, thin asphalt overlays, and cold recycled sections using foamed and emulsified asphalts in both central plant and in-place production.

Results from the expanded 2015 preservation experiment will provide a rational starting point for the implementation of a life cycle cost based preservation treatment selection process that can be refined over time with location-specific pavement performance feedback. A second objective is to develop guide specifications and recommend guidelines for quality assurance testing and inspection of pavement preservation treatments.

Asphalt cracking performance testing
While many tests have been developed to evaluate cracking potential of asphalt mixtures, it is not clear which ones correlate the best with field performance and what criteria could be used in specifications. This is the second focus area of the 2015 Pavement Test Track cycle. The objective is to validate laboratory cracking tests by establishing correlations between test results and measured cracking in pavement test sections. New track sections have been constructed with asphalt surface layer mixtures that have a range of expected cracking susceptibilities. Other factors that can impact top-down cracking, such as underlying pavement structure and differences in aging, have been controlled to the highest degree possible. A battery of laboratory cracking tests will be performed, which will include semi-circular bend tests using the Illinois and Louisiana methods, the energy ratio method, and the Texas overlay test. The analysis of the laboratory cracking tests will identify which method provides results that best correlate with field cracking while also considering practicality for use in mix design control testing, cost-effectiveness, and the ability to accommodate recycled...
materials, new and future additives, and mix combinations.

**Implementable findings**

Test Track findings have been and will continue to be used to improve materials, tests, specifications, and design policies in many ways. Research experiments based on single test sections or groups of test sections provide sponsors the confidence to move concepts into practice. This cycle is expected to yield information to advance the use of laboratory performance tests, novel materials and additives, and structural design.

**Sponsors funding research**

Sponsors of the sixth cycle include highway agencies and private sector partners. The number of sixth cycle sponsors funding on and off-track research is currently at 18, and additional sponsors are anticipated.

The sixth cycle offers a new chapter in real-world pavement research through a partnership with MnROAD, which brings about expansion of experiments to include a cold-weather climate. Many of the same pavement preservation treatments installed by NCAT in Alabama will also be installed on low and high volume routes in Minnesota. In 2016, MnROAD will also build complimentary cracking group sections to validate low-temperature cracking tests. These parallel studies are aimed at producing findings that can be directly implemented by a larger geographic base of state departments of transportation. With the addition of this new partnership, researchers are confident that this full-scale pavement testing cycle will provide far-reaching impacts in advancing pavement technologies.
Laboratory and Field Evaluation of Florida Mixtures at the 2012 NCAT Test Track

Top-down cracking is a distress that affects pavement durability. As the name implies, top-down cracks form at the top of the pavement structure and are load related, as they tend to originate in the wheelpath. The Florida DOT (FDOT) and the University of Florida were among the first to recognize the widespread nature of this distress. With a vast majority of cracking in Florida categorized as top-down, the Florida Department of Transportation recently conducted a study at the NCAT Pavement Test Track to examine the cracking potential of various asphalt mixtures.

For this study, four 100-foot test sections with different types of binder modification and recycled material contents were constructed in the 2012 Test Track cycle to determine which asphalt mixtures were more prone to surface cracking. The study also characterized the mixtures’ properties in the laboratory to determine which cracking tests would best predict cracking resistance.

Four mixtures were designed for this experiment. The first (E7A) was a virgin asphalt mixture using an asphalt binder modified with SBS. The second (E7B) used the same aggregate gradation as E7A but with binder modified using FDOT’s experimental ground tire rubber (GTR) specification. E8A used 20% RAP in the mixture with an SBS-modified binder, and E8B incorporated 20% RAP and 5% RAS with an SBS-modified binder.

Laboratory characterization of the binders and mixtures showed a significant increase in the stiffness when RAS and/or RAP were added to the mix. The recovered binder from E8A had a critical high temperature grade 13.5°C higher than that from E7A, and including RAS increased the critical binder high temperature another 7.9°C. Similar effects were seen for the critical low and intermediate temperatures. The RAP mixture had its critical low temperature reduced by one performance grade and the RAP/RAS mixture’s critical low temperature grade was reduced by three performance grades.

Dynamic modulus test results showed that the mixture with GTR-modified binder was less stiff than the other three mixtures at all temperatures and frequencies. On the other hand, the two mixtures with recycled materials were stiffer than both of the virgin mixtures.

Hamburg wheel-track test results did not show any signs of stripping and all four mixtures had good resistance to rutting. Asphalt Pavement Analyzer results...
also indicated that the mixtures were rut resistant.

None of the mixtures performed well in the Overlay Test, but the mixtures containing RAP and/or RAS were more prone to cracking than the virgin mixes.

Results from the Energy Ratio test indicated that that the RAP and RAS mixtures were susceptible to top down cracking despite the addition of polymer.

The semi-circular bend (SCB) test for cracking susceptibility was used to determine the critical J-Integral (Jc) value for each mix. A higher Jc value should indicate better resistance to cracking. However, mixtures with recycled material had significantly higher Jc values than the virgin mixtures.

Correlations between lab results and field performance were examined. No rutting was evident in the test sections; therefore, correlations could not be developed for the Hamburg APA results. Table 1 shows the percent lane cracking for each of the four sections at various points in trafficking. As can be seen, the virgin mix with GTR was the first to crack; however, cracking area did not progress further after the first year of trafficking. In contrast, the mix containing RAP and RAS was the last to crack, but once cracking started, it progressed much faster than the other sections. All of the cracks in these sections were low severity cracks at the end of the research cycle.

Pearson correlation coefficients between the laboratory mixture results and percent cracking at the end of the cycle are provided in Table 2. The Energy Ratio results were not included due to the low DSCE values, which rendered the ER results inconclusive for the RAP and RAP/RAS mixtures. R-values close to 1 or -1 indicate high degrees of correlation. R-values near zero are indicate that the factors are not correlated.

As can be seen, the correlations between laboratory results and field performance were completely different at 5 million ESALs and 10 million ESALs of traffic. At 5 million ESALs, resilient modulus showed the best correlation to field percent cracking while the OT results had the poorest correlation. The dissipated stress creep energy at failure (DSCE), creep slope, and SCB Jc showed moderate correlations with observed cracking. However, correlations for DCSE, and creep slope runs counter to the expected trend (i.e. a higher fracture energy correlating to a higher percent cracking).

At 10 million ESALs, the Pearson correlation coefficients changed signs and followed expected trends, with the exception of the SCB Jc. The OT results showed the best correlation to field percent cracking at 10 million ESALs, while the DSCE showed the weakest correlation. At 10 million ESALs, the SCB Jc results were higher for sections having more cracking, counter to the expected trend.

Although none of the mixtures experienced severe cracking after 10 million ESALs of trafficking, the results from this study showed that stiffer polymer-modified binders should not be used in conjunction with RAP/RAS mixtures because this causes mixes to be too stiff. These mixtures can become too stiff and are susceptible to cracking.

<table>
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<tr>
<th>Traffic, million ESALs</th>
<th>SBS</th>
<th>GTR</th>
<th>RAP</th>
<th>RAP/RAS</th>
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<td>93,828</td>
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<td>5,084,518</td>
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<td>20.2</td>
<td>4.7</td>
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<td>6.8</td>
<td>10.8</td>
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<td>13.4</td>
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<td>22.1</td>
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<td>10,045,790</td>
<td>7.7</td>
<td>20.2</td>
<td>22.5</td>
<td>73.4</td>
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Table 2: Pearson Correlations – Laboratory and Field Measurements

<table>
<thead>
<tr>
<th></th>
<th>ESALs at 1st crack</th>
<th>% cracking at 5 million ESALs</th>
<th>% cracking at 10 million ESALs</th>
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<tr>
<td>OT, N</td>
<td>-0.773</td>
<td>0.263</td>
<td>-0.853</td>
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<tr>
<td>DSCE</td>
<td>-0.603</td>
<td>0.572</td>
<td>-0.574</td>
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<tr>
<td>MR</td>
<td>0.720</td>
<td>-0.860</td>
<td>0.592</td>
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<tr>
<td>Creep Slope, M</td>
<td>-0.715</td>
<td>0.419</td>
<td>-0.747</td>
</tr>
<tr>
<td>SCB Jc</td>
<td>0.684</td>
<td>-0.706</td>
<td>0.615</td>
</tr>
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</table>
Comparing Friction Reducers for Use in AMPT Testing

An inter-laboratory study conducted under NCHRP Project 09-29 found that the variability of unconfined flow number testing did not meet the standards developed for rutting resistance criteria in NCHRP Project 9-33. Researchers suggested that test result variability might be reduced by making improvements in the friction reducers used in flow number testing.

Per AASHTO TP 79-13 Annex A, friction reducers are prepared using 0.25 ± 0.05 g of paste silicone grease between two layers of latex membrane. This study, available online as NCAT Report 15-01, evaluated alternate methods for preparing greased latex friction reducers (using paste silicone and two types of spray silicone at varying application rates) as well as Teflon friction reducers, which are more easily fabricated. Reusing paste silicone friction reducers was also investigated. Additionally, dynamic modulus testing was conducted to ensure that the selected friction reducers would not adversely affect dynamic modulus results.

All samples used in this study were prepared from a dense-graded mixture with PG67-22 binder and 20% RAP. The test temperature of 60.5°C was selected based on the LTPPBind v3.1 50% reliability high temperature at a depth of 20 mm for the location from which the mix was sampled (Dothan, Alabama). Test parameters are given in Table 1.

Past experience at NCAT and other laboratories has shown that the recommended application rate may be too high, so lower application rates were evaluated. Tighter tolerances of 0.02 g were used in order to better evaluate the effect of application rate. Both of the silicone sprays were intended to be tested at a rate of 0.10 ± 0.02 g, but it was difficult to achieve a uniform spray at that rate with the Permatex Wet Type, so the target was adjusted for that material. Four replicate specimens were tested for each friction reducer type and application rate. Specimens were grouped using a random, stratified process so that the air void average and variability were similar within each group, thus making the effect of air voids on flow number test results negligible.

Flow number results are shown in Figure 1. The single-layer Teflon friction reducer yielded statistically higher flow number results than the other friction reducers. The flow number results for all of the silicone latex friction reducers as well as the double-layer Teflon friction reducer were statistically similar.

Both of the Teflon friction reducers seemed to negatively impact the deformation of the specimens during the course of the test. When compressing a specimen with frictionless ends, the height should decrease and the diameter should increase uniformly, as shown for specimen C in Figure 2. However, the samples tested using Teflon friction reducers (specimens B and D in Figure 2) show a bulging effect around the middle of each specimen.

Figure 3 shows the coefficient of variation (COV) of the flow number results. There was no trend indicating any particular effect of friction reducer type or application rate on flow number variability.

Dynamic modulus testing was also conducted on one set of three specimens using multiple friction reducer types. Paste silicone and both silicone sprays were tested at application rates of 0.25 g ± 0.02 g and 0.15 g ± 0.02 g. Single-layer Teflon (0.01 in. sheet) was tested but the double-layer Teflon type was not. A new friction reducer was used for each individual test.

<table>
<thead>
<tr>
<th>Test Procedure</th>
<th>Friction Reducer Type</th>
<th>Application Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unconfined Flow Number</td>
<td>Paste Silicone Latex (DOW Corning 112 HP)</td>
<td>0.25 ± 0.02 g (baseline)</td>
</tr>
<tr>
<td>(NCHRP 09-33 method)</td>
<td></td>
<td>0.15 ± 0.02 g</td>
</tr>
<tr>
<td>Confine: None</td>
<td>Silicone Spray A Latex (3M Dry Type)</td>
<td>0.25 ± 0.02 g</td>
</tr>
<tr>
<td>Deviator Stress: 600 kPa (87 psi)</td>
<td></td>
<td>0.10 ± 0.02 g</td>
</tr>
<tr>
<td>Contact Stress: 30 kPa (4.35 psi)</td>
<td>Silicone Spray B Latex (Permatex Wet Type)</td>
<td>0.25 ± 0.02 g</td>
</tr>
<tr>
<td>Temperature: 60.5°C</td>
<td>Teflon</td>
<td>0.15 ± 0.02 g</td>
</tr>
<tr>
<td></td>
<td>Single 0.01-in. thick sheet</td>
<td>Double 0.01-in. thick sheets</td>
</tr>
</tbody>
</table>

Table 1: Testing Plan for Evaluating Effect of Friction Reducers on Flow Number Test Results
Testing was performed in accordance with the recommended parameters given in AASHTO PP 61-13. At test temperatures of 4°C and 20°C, testing frequencies were 10, 1, and 0.1 Hz. At 40°C, test frequencies were 10, 1, 0.1, and 0.01 Hz. Dynamic modulus test results showed that the effect of these seven friction reducers was not statistically significant.

Based on these findings, the following recommendations are given:

- Two-layer latex friction reducers should be used for flow number testing as currently specified in AASHTO TP 79-13, except that the layers may be greased with paste silicone or spray silicone (dry- or wet-type), depending upon technician preference, applied at a rate of 0.20 ± 0.05 g.
- Friction reducers for dynamic modulus testing may be made of latex or Teflon as currently specified in AASHTO TP 79-13, except that latex layers may be greased with paste silicone or spray silicone at an application rate of 0.20 ± 0.05 g.
- To improve cost-effectiveness, another study is needed to evaluate using the same set of silicone latex friction reducers for testing a full set of flow number and/or dynamic modulus specimens.
A Commitment to Conservation and Sustainability: Exploring Japan’s Asphalt Pavement Innovations

Japan’s current average RAP content in asphalt mixtures is approximately 47%, more than double the current average percentage in the United States. Despite the desire of most asphalt technologists in the U.S. to increase RAP usage, the national average RAP content seems to have plateaued at 20%. In December 2014, representatives from NAPA, NCAT, state DOTs, state asphalt pavement associations, and NAPA member producer and associate companies took a 10-day tour to learn about Japan’s use of RAP as well as their construction operations and practices.

As a whole, Japan has a deep rooted culture of sustainability and quality. The primary motivation for asphalt pavement recycling in Japan appears to be for conservation reasons rather than for economic benefits. Japan has a number of environmental laws that require the responsible reuse of waste pavement materials. Japanese contractors have invested heavily in state-of-the-art RAP processing plants and sophisticated asphalt mix plants to effectively utilize RAP at high percentages. The large contractors have also built and staffed advanced central laboratories to explore innovations and the development of proprietary products. Productivity and competition are much less of an emphasis compared to the U.S. road building industry.

Japan reached its current high percentage of RAP utilization over several decades of research and field performance evaluations. Through analysis of pavement performance on hundreds of projects and experimentation in the lab and field, they have developed fairly simple standards and practices that have proven to provide equal performance for high RAP content mixes and virgin mixes. It should be noted that axle loads on Japan’s highways are much lower than in the U.S., which likely has a significant effect on strain levels experienced by Japan’s pavements.

Japanese specifications for mixes containing RAP were designed to encourage high RAP contents. Typically, RAP is processed from multiple sources with no restrictions as to the origin. Although fractionation of RAP is not a requirement, most contractors choose to do so. They also take great care in minimizing moisture in the raw materials by utilizing as little water as possible in crushing operations and keeping the stockpiles and bins covered. RAP quality is judged by three criteria:

1. It must have a minimum asphalt content of 3.8%.
2. The recovered RAP binder must have a penetration greater than 20, or samples of the compacted RAP must have an IDT modulus of less than 1.70 MPa/mm.
3. The processed RAP material may not contain more than 5.0% $P_{200}$ fines. Note that this is the $P_{200}$ of the RAP, not the extracted RAP aggregate gradation.

Mix designs use the Marshall method and volumetric criteria with the addition of a simple indirect tensile test to ensure good cracking resistance. Figure 1 illustrates...
Japan’s indirect tensile coefficient test, which is conducted using the same specimen loading approach used for IDT in TSR testing except that the tests are conducted at 20°C. Blending charts may be used to select soft virgin asphalts or recycling agents to meet a target penetration value for the composite binder or a desired indirect tensile coefficient for the mixture.

Japan currently has 1,150 asphalt plants, and all but 176 plants are capable of producing mixes with RAP. Of the Japanese plants with recycling capability, 15.5% are drum mix plants, 17.7% are batch plants utilizing an indirect heating approach for RAP, and 68.8% are batch plants that heat RAP in second drum, referred to as a parallel heating system. The parallel heating method uses thermal oxidizers to eliminate smoke generated by heating the RAP to the mixing temperature. Typically, the heated RAP is mixed with a rejuvenator in a small pugmill and then held in a small surge bin to allow the material time to “activate and condition” the aged RAP binder. The heated and conditioned RAP is then mixed with virgin aggregate and new binder in a separate pugmill. The finished mix is very well coated and uniform with a temperature of typically about 160°C (320°F). The Japanese batch plants have low production rates, typically 100–180 metric tons per hour.

The U.S. tour group visited one working paving site. Several aspects of the paving operation differed from U.S. practices including a slow paving speed, no signs of segregation (despite some practices that would seem to cause it), vertical-edge longitudinal joint construction, and a slow compaction process. There was a high level of quality and attention to detail in every step of the paving process.

Japan’s porous friction course (PFC) mixtures were another area of interest for the U.S. tour group. The use of PFCs is more widespread in Japan than in the United States with more than 70% of expressways in Japan surfaced with a PFC. Most of Japan’s PFC mixes use all virgin materials; however, some trial PFC mixes have been constructed using 20% to 50% RAP. The Japanese asphalt industry and highway agencies have worked to improve the performance of PFCs and address many of the common issues with these layers. Key innovations for PFCs in Japan are:

- Thick PFC layers (4–5 cm) to better suppress tire–pavement noise and improve drainage. The
economic justification of thicker layers is aided by the fact that PFCs are given the same structural layer coefficient as dense-graded mixes.

- Use of highly modified asphalt binders (4% to 8% SBS polymer) to improve resistance to raveling and eliminate the need for fibers.
- Use of edge drains with PFCs placed in curb and gutter sections (i.e., urban areas).
- Use of spray pavers to apply a thick asphalt emulsion layer just before the PFC mix. The residual asphalt from the emulsion creates an impermeable layer at the bottom of the PFC to protect underlying asphalt layers.
- Routine cleaning of the PFC with specialized equipment that flushes the voids, helping maintain permeability for a much longer period of time.

Another pavement innovation used in Japan is the double-layer porous asphalt, referred to as “Twinlay”. Its advantages are excellent noise reduction capabilities and less clogging (permeability loss) compared to conventional porous friction course layers. Built in a single process with a special paver designed to receive two mixes and simultaneously pave two layers with separate screeds, this technology is believed to have been developed in Germany and has been used in several European countries and China. A successful demonstration of double-layer porous asphalt was also conducted on the NCAT Pavement Test Track from 2006 to 2012.

The tour of asphalt pavement innovations in Japan was enlightening in many ways. The group learned that several technical, political, and cultural factors have enabled Japanese contractors to achieve such high RAP contents and left with an appreciation of the Japanese attention to quality, simplicity, and trust between highway agencies and contractors. The tour readily illustrated the potential for asphalt mixtures with higher RAP content (>25%) to maintain equivalent or better quality and performance. Primary lessons learned that could be applied in the U.S. include covered RAP stockpiles and processing, using a simple lab mix stiffness test and criteria to determine mixture suitability, heating and isolating the RAP (along with using a rejuvenator or softening binder), longer mixing and storage times, and using smoke and odor control equipment. A full report with additional details will soon be released.

### Doctoral Student Receives International Scholarship from the Association of Asphalt Paving Technologists

Michael Vrtis, a doctoral candidate in Auburn University’s Department of Civil Engineering, has received a scholarship from the Association of Asphalt Paving Technologists (AAPT). This annual international scholarship is designed to increase the number of scientists and engineers preparing for careers in the field of asphalt pavement technology.

Vrtis earned both a bachelor’s degree in civil engineering and a master’s degree in civil and environmental engineering from the University of Utah. Under the direction of civil engineering professor David Timm, he is conducting research on pavement responses to vehicular loading and environmental changes using instrumented test sections on the NCAT Pavement Test Track.

“As a graduate student, Michael has taken on many roles at NCAT and within the civil engineering department,” remarked Timm, who is also a former AAPT scholarship recipient. “His hard work, determination, enthusiasm and leadership have made him a successful researcher and excellent teaching assistant. We are fortunate to have him in our program.”

Vrtis is one of two recipients this year whose achievement will be officially recognized at the annual AAPT meeting in March 2016.

Michael Vrtis discusses NCAT’s research during the 2015 Pavement Test Track Conference.
Online Professional Development Courses for Pavement Engineering

If you need continuing education units (CEUs), look no further. You can earn them from the comfort of your home or office via online professional development courses taught by NCAT staff. Eleven courses covering a wide range of pavement engineering topics are currently offered, with plans underway to add more within the next two years. Reasonable pricing options are available for both individuals and organizations, and credits are accepted for engineering licensure renewal in most states. To order a course, visit Auburn Engineering Online at http://eng.auburn.edu/online/professional-development/index.html.

<table>
<thead>
<tr>
<th>Course Title</th>
<th>Instructor</th>
<th>Length</th>
<th>Description</th>
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<tbody>
<tr>
<td>Accelerated Pavement Testing</td>
<td>Dr. R. Buzz Powell</td>
<td>1 hour (0.1 CEU or 1 PDH)</td>
<td>This course provides an overview of historical and current accelerated pavement testing (APT) programs. Participants will gain an understanding of how APT experiments are designed and executed, as well as how investment in APT research can be cost effective.</td>
</tr>
<tr>
<td>Aggregate Properties and Testing</td>
<td>Jason R. Moore</td>
<td>1 hour (0.1 CEU or 1 PDH)</td>
<td>This course covers Superpave test procedures, specifications, and consensus properties for aggregates used in producing asphalt mixtures. Procedures covered include sampling, unit weight and voids, sieve analysis, flat and elongated particles, L.A. abrasion, soundness loss, and testing related to friction and polishing.</td>
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<td>Asphalt Binder Tests and Specifiications</td>
<td>Pamela Turner</td>
<td>2 hours (0.2 CEU or 2 PDH)</td>
<td>This course reviews historical asphalt binder testing and covers the testing procedures and specifications for the Superpave binder performance grading system.</td>
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<td>Asphalt Mix Design</td>
<td>Don Watson</td>
<td>3 hours (0.3 CEU or 3 PDH)</td>
<td>This course covers historical and current asphalt mix design procedures. Topics covered include aggregate blending, batching materials, volumetric mix design and analysis, and specifications.</td>
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<tr>
<td>Asphalt Pavement Preservation and Rehabilitation</td>
<td>Douglas I. Hanson</td>
<td>5 hours (0.5 CEU or 5 PDH)</td>
<td>This course is broken into two units. The first unit covers pavement management concepts such as pavement structural and condition assessment, HMA distress mechanisms, and project evaluation. The second unit covers pavement maintenance techniques, surface rehabilitation procedures, recycling asphalt pavements, and asphalt overlays.</td>
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<tr>
<td>Hot Mix Asphalt Compaction</td>
<td>Don Watson</td>
<td>1 hour (0.1 CEU or 1 PDH)</td>
<td>This course uses both lecture and problem-solving case studies to help participants gain an understanding of the importance of HMA compaction and how to optimize efficiency of the roadway compaction operation.</td>
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<tr>
<td>Hot Mix Asphalt Delivery and Placement</td>
<td>Don Watson</td>
<td>1 hour (0.1 CEU or 1 PDH)</td>
<td>This course covers all aspects of the HMA placement operation, from delivery trucks to components of the paver. Participants will gain an understanding of the challenges involved in constructing quality HMA pavements and the best practices used to overcome those challenges.</td>
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<td>Hot Mix Asphalt Paving Construction Specifications &amp; Quality Control and Quality Assurance</td>
<td>Dr. Michael A Holitsman</td>
<td>3 hours (0.3 CEU or 3 PDH)</td>
<td>This course examines types of specifications used to measure quality during the production, placement, and compaction of hot mix asphalt. Key elements of an effective QA program are also discussed, including the percent within limits concept.</td>
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<td>Pavement Management Systems</td>
<td>J. Richard Willis</td>
<td>1 hour (0.1 CEU or 1 PDH)</td>
<td>This course covers the levels of a pavement management system and its components, including what type of data is collected and what type of equipment is available for pavement condition surveys. Participants will learn how to determine the best alternatives for rehabilitation and preventive maintenance, as well as the best timing for applying them.</td>
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<td>Sustainable Pavements: Part 1</td>
<td>J. Richard Willis</td>
<td>4 hours (0.4 CEU or 4 PDH)</td>
<td>This course discusses how the “triple bottom line” of sustainability relates to pavements. Participants will learn how to assess the environmental impact of pavements throughout their entire life cycle, from raw material acquisition to production, construction, use, and end of life. Participants will also learn which recycled materials are appropriate for use in asphalt and concrete pavements as well as the environmental and economic impacts of material selection.</td>
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<tr>
<td>Sustainable Pavements: Part 2</td>
<td>J. Richard Willis</td>
<td>2 hours (0.2 CEU or 2 PDH)</td>
<td>This course focuses on three methods of improving asphalt pavement sustainability: use of ground tire rubber, warm mix asphalt, and compaction of asphalt mixtures.</td>
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Dedication of Dr. J. Don Brock Classroom

On July 20, NCAT dedicated its main training classroom to the memory of J. Don Brock, Ph.D., P.E., whose knowledge and leadership transformed the asphalt pavement industry and helped turn the vision of NCAT into a reality. He was the chairman of NCAT’s Applications Steering Committee from 1993-1998 and served on NCAT’s Board of Directors.

Dr. Brock was a great leader and advocate for improving asphalt pavement construction. He founded Astec Industries in 1972 and built it into a billion-dollar family of companies including 18 subsidiaries and employing over 4,000 globally (including 350 engineers).

“Astec was a founding major contributor to the endowment to support NCAT, but Don continued to faithfully give so much of his time, energy, and resources to help NCAT accomplish its mission.” said NCAT Director Randy West at the dedication.

During his career, Dr. Brock was the recipient of numerous awards due to his ingenuity, integrity, humility, and constant commitment to his work. An innovator who tirelessly sought to advance asphalt recycling and construction quality, he held over 100 U.S. and foreign patents for construction equipment.

“Don was a strong supporter of NCAT from its beginning,” stated NCAT Director Emeritus Dr. Ray Brown. “He had the ability to identify issues facing the asphalt industry and provided general guidance to help NCAT address these issues. It is fitting that the classroom has been dedicated to Don Brock, as he insisted that the classroom be included as a part of our facility. He was a very good friend of mine and will be missed very much.”

Dr. Brock believed in training his employees and educating his customers, and a number of Astec companies have state of the art facilities dedicated to training and innovation due to his belief in lifelong growth and improvement. Astec has over 23,000 square feet dedicated to training at its Chattanooga, Tennessee facility alone.

Dr. Brock was chairman of the board and CEO of Astec Industries until 2014, when his son Ben became President and CEO of the company. Ben Brock attended the dedication with his wife, Carolyn and their two sons, Garrison and Pierce. Members of NCAT’s staff and board of directors were also in attendance.
Asphalt Forum

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

Jerry Geib, Minnesota DOT
MnDOT is moving toward the implementation of the disk-shaped compact tension (DCT) test. This test measures fracture energy. High fracture energy provides greater resistance to thermal cracking. Are other DOT’s looking at new performance tests? MnDOT is developing a 4.75mm mix spec.

Asphalt Forum Responses

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

1. What specifications are other states using as their “go to” in areas of extremely high traffic or extremely severe circumstances? Are special additives or binder grades being used, or do most states simply specify SMAs in these situations? (Mark Woods, Tennessee DOT)

   **Eric Biehl, Ohio DOT**
   Other than resorting to PCC, we’ve recently started using PG 88-22M with our standard Superpave mixes (intermediate and surface), primarily in intersections. After one year, this seems to be working well. We do have some districts that will use SMA. We use PG 88-22M (ex. HiMA).

   **Howard J. Anderson, Utah DOT**
   We use SMA pavement.

   **Jerry Geib, Minnesota DOT**
   MnDOT would use SMA. The SMA would use a 70-28 binder.

   **James Williams, Mississippi DOT**
   SMA is typically specified on the Interstates and occasionally in high traffic intersections. On Interstates, an OGFC wearing surface is placed on the SMA. A PG 76-22 polymer modified binder is used in SMA.

   **Greg Sholar, FDOT**
   In these situations, we have used a PG 82-22 modified with SBS for the past few years. However, we plan to switch to using a PG 76-22 high polymer binder, which contains approximately 7-8% SBS. The mix will not have RAP.

   **Kevin Kennedy, Michigan DOT**
   We use gap-graded Superpave (SMA) and/or high stress HMA (bump high end of binder grade).

   **Michael Stanford, Colorado DOT**
   Colorado DOT generally uses SMA with a PG 76-28 binder in high severity locations.
Colorado DOT
We revised Section 403 to clarify the agency’s ability to adjust the volumetrics and AC content of the contractor submitted mix designs when establishing the job mix formula targets. Sections 105 and 106 were revised to clarify that dispute testing on less than 5000 ton projects is not allowed unless a check testing program has been established.

Michigan DOT
We now regress the mix design target air void content to 3% to increase asphalt content in mixes. We only allow fine graded mixes (or gap graded Superpave (SMA)) on top course to increase durability of mixes.

Minnesota DOT
2360 Plant Mixed Asphalt Pavement (number and name of the standard specification) will have little or no changes. On the binder side, MnDOT is almost ready to implement M 332 (MSCR). It will be in the 2016 jobs if possible. All 2017 projects should use the MSCR spec.

Ohio DOT
We are in the process of making a 2016 Construction and Materials Specification Book.

Tennessee DOT
We updated language specifying allowable distance between augers and end plates to indicate the maximum distance will be 18 inches (except for temporary screed extensions, such as driveway connections). We replaced Elastic Recovery and Ring and Ball Softening Point “PG plus” specs with AASHTO M332 specs for Jr. %diff, and indication of elastic response (curve).

Utah DOT
We are developing a new CIR specification. It is not ready for distribution yet. We are trying some pavement sections with high polymer and fiber modified asphalt this summer.